R&S® ESME
WIDEBAND MONITORING RECEIVER

High-performance ITU-compliant spectrum monitoring and direction finding
The R&S®ESME wideband monitoring receiver is ideal for high-performance ITU-compliant spectrum monitoring, signal analysis and multichannel digital data streaming from 8 kHz to 40 GHz. In combination with Rohde & Schwarz single-channel direction finding (DF) antennas, it optionally supports angle of arrival (AOA) direction finding from 300 kHz to 8.2 GHz. Thanks to its exceptional RF performance, the R&S®ESME provides cutting-edge signal detection and measurement capabilities even in high-density spectrum environments.

AT A GLANCE

The R&S®ESME wideband monitoring receiver with up to 80 MHz real-time bandwidth is designed for detection, analysis and digital data streaming of signals over a wide frequency range from 8 kHz to 40 GHz. Thanks to its high dynamic range and its spectrum scan speed of up to 110 GHz/s, even weak and low probability of intercept (LPI) signals close to strong transmitters can be reliably detected and measured.

In addition to its wide selection of signal measurement functions, the R&S®ESME provides a powerful feature set for detection and analysis of unwanted emissions as well as for multichannel processing, classification, demodulation and continuous I/Q streaming of unknown signals of interest. All measurements can be recorded for later documentation and further offline analysis. Recorded information ranges from simple spectral data and demodulated audio content to wideband I/Q snapshots with full 80 MHz real-time bandwidth.

In combination with Rohde & Schwarz single-channel direction finding (DF) antennas, the R&S®ESME can be upgraded to an angle of arrival (AOA) based direction finder that provides highly accurate bearing results from 300 kHz to 8.2 GHz.
In a network of multiple R&S®ESME receivers, the high timestamp accuracy provided by the optional internal GNSS module additionally supports precise time difference of arrival (TDOA) radiolocation over the entire frequency range.

What sets the R&S®ESME apart from other devices is its excellent RF performance across all relevant frequency bands, the real-time event capture trigger functionality to automatically detect sporadic, pulsed and burst signals, and simultaneous signal representation in the frequency and time domains.

The R&S®ESME can be operated via front panel or LAN remote control and supports a wide range of other Rohde & Schwarz products ranging from I/Q recorders and signal generators to dedicated analysis and system software. Its versatile and well-documented data and control interfaces make third-party system integration an easy task.
In an R&S®RAMON radio monitoring system, the R&S®ESME can be used for fast scanning as well as audio content analysis, and with the R&S®MobileLocator software extension, transmitters of interest can be automatically detected and located from a single mobile monitoring station.

Besides standard measurement features and inherent analog demodulation, the R&S®ESME supports both wideband and multichannel narrowband I/Q data streaming and recording. Optional external R&S®CA100 and R&S®CA120 signal analysis software and hardware allow online analysis of digital signals, including automatic detection and classification, digital demodulation and dehopping of agile signals. This feature set can be further extended to advanced offline I/Q recording analysis with the R&S®CA210 signal analysis software for tactical communications signals or R&S®TPA pulse analysis software for pulsed, burst and continuous wave (CW) radar signals, including interpulse and intrapulse analysis.

TYPICAL APPLICATIONS

ITU-compliant spectrum monitoring and radiolocation

Spectrum monitoring helps verify compliance with licenses, regulations and communications standards and facilitates network management and planning. The R&S®ESME forms the basis for fixed and mobile spectrum monitoring stations, and in combination with Rohde & Schwarz DF antennas provides precise direction finding. Thanks to its wideband operation with gapless 80 MHz real-time processing, high scan speed and powerful measurement toolset, the R&S®ESME integrated into an R&S®ARGUS spectrum monitoring system is the key component for all ITU-compliant monitoring tasks, including automated detection, identification and localization of interfering signals and unlicensed emissions.

Communications intelligence and communications electronic support measures

Intercepting radiocommunications signals to gather relevant information about their characteristics, origin and content is extremely important for many security-providing authorities. The R&S®ESME provides the sensitivity, accuracy and time resolution for any in-depth analysis necessary to identify and locate spectral activities of interest.


2) See “R&S®RAMON Radiomonitoring Software” product brochure (PD 5214.3152.12).

3) See “R&S®MobileLocator” product brochure (PD 3607.1271.12).
Two digital receive paths for individual tasks
The R&S®ESME features two digital receive paths, a wideband spectrum path with 80 MHz real-time bandwidth for maximum scan speed and fast detection, and a narrowband 20 MHz wide demodulation and measurement path with superior sensitivity, linearity and spectral purity for accurate and intuitive measurement of signal parameters.

Superior RF performance in dense signal scenarios
The R&S®ESME provides an optimal trade-off between linearity and sensitivity for any given signal scenario. This is achieved by extensive preselection filtering including filter-banks and tunable bandpass filters over the entire frequency range to protect against intermodulation from strong out-of-band signals. Consequently, the R&S®ESME can reliably detect weak signals among strong unwanted signals in a crowded spectrum.

Covers the frequency range from HF to SHF in a single 19" device
The R&S®ESME base unit covers the monitoring frequency range from 20 MHz to 6 GHz, which can be extended down to 8 kHz with the R&S®ESME-HF option and up to 18 GHz with the R&S®ESME-MW18 option. The external R&S®MC40 microwave downconverter provides a further extension up to 40 GHz. Equipped with the R&S®ESME-DF option, the R&S®ESME provides AOA direction finding from 20 MHz to 6 GHz. The DF range can be extended down to 300 kHz with the R&S®ESME-HF option and up to 8.2 GHz with the R&S®ESME-MW18 option.
**FAST AND RELIABLE DETECTION OF SPECTRAL ACTIVITIES**

**Fast scans with dedicated scan modes**
Whether the operational focus is on detecting unknown signals in a given frequency range or monitoring known communications channels, the R&S®ESME offers different dedicated scan modes for every task. The R&S®ESME-PS panorama scan option provides a fast spectral overview up to 110 GHz/s and selectable frequency resolution. Scanning through various known communications channels (e.g. ATC and PTT transmissions) can be performed in frequency scan (FSCAN) or memory scan (MSCAN) mode with speeds of up to 1700 channels/s. Configurable squelch levels and dwell times allow demodulation and listening in on active channels while scanning.

**Wideband spectrum display in parallel with demodulation and measurements**
During measurement, demodulation or content extraction of detected signals, spectral situational awareness is typically reduced. The two parallel digital receive paths of the R&S®ESME allow users to select a sensitive narrowband demodulation channel within the real-time bandwidth while maintaining the wideband overview of the real-time spectrum. This tremendously reduces reaction times on emerging spectral events with higher priority. The R&S®ESME-DDC digital downconverter option provides four additional internal and independent narrowband channels that all feature measurement, demodulation and streaming.

**Automatically capture pulsed or short-time emissions**
Sporadic, short-time signals are difficult to record and identify, especially when their appearance is not predictable. To avoid resource intensive analysis of mass data, the R&S®ESME-RR option includes a configurable real-time event capture (REC) that can be used to automatically activate I/Q data recording whenever user definable trigger conditions are met (mask based triggering). As a result, the R&S®ESME reliably detects spectral events with durations down to the nanosecond range, for instance radar pulses and electrical spark discharges. The integrated ring buffer ensures that no data is lost, not even prior to the trigger event.

**Detection of superimposed pulsed signals**
The R&S®ESME offers a polychrome display to separate superimposed, pulsed signals that cannot be differentiated in conventional spectrum displays. To detect such pulsed interferers in a complex signal scenario, the frequency of occurrence is displayed in a color-coded spectrum. Malfunctioning GSM repeaters and DECT phones with a non-standard center frequency are good examples of disturbances that can easily be spotted with the polychrome display.
ITU-COMPLIANT SPECTRUM MONITORING

Hardware performance verification
The hardware performance of the R&S®ESME fulfills the requirements of Table 3.3-1 of the ITU Handbook on Spectrum Monitoring, Edition 2011. All R&S®ESME specifications are verified in line with the following ITU recommendations:

► ITU-R SM.1836 (IF filter edge steepness measurements)
► ITU-R SM.1837 (IP3 measurements)
► ITU-R SM.2125 (IP2 measurements)
► ITU-R SM.1838 (noise figure measurements)
► ITU-R SM.1839 (scan speed measurements)
► ITU-R SM.1840 (sensitivity measurements)

Equipped with the R&S®ESME-DF direction finder upgrade, the DF performance of the R&S®ESME is compliant with Table 3.4-1 and Table 3.4-2 of the ITU Handbook on Spectrum Monitoring, Edition 2011 and the following ITU recommendations are fulfilled:

► ITU-R SM.2060 (system DF accuracy measurements)
► ITU-R SM.2125 (DF sensitivity and DF scan speed measurements)

Measurement verification
Upgraded with the R&S®ESME-IM option, the R&S®ESME performs all relevant parameter measurements for AM, FM and PM modulated signals. The following ITU recommendations are covered:

► 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 PC based R&S®ARGUS software package)
► ITU-R SM.1600 (parameters of digitally modulated signals, with PC based R&S®CA100 signal analysis software 1)

1) See “R&S®CA100 PC-Based Signal Analysis and Signal Processing Software” product brochure (PD 3606.9340.12).

Real-time comparison of the live result (blue trace) with a reference spectrum mask (red trace) reveals the presence of two unexpected signals at 707.7 MHz and 729.1 MHz. Automatic subsequent in-depth analysis of these frequencies reveals technical parameters, the identity and location of the interferers.
ACCURATE DIRECTION FINDING AND RADIOLOCATION

ITU-compliant direction finding with superior accuracy
Equipped with the R&S®ESME-DF direction finding option, the R&S®ESME turns into a high-performance AOA direction finder. Thanks to the precise correlative interferometer DF method in combination with innovative R&S®ADDx single-channel DF antennas (covered frequency range: 300 kHz to 8.2 GHz), the R&S®ESME produces highly accurate bearing results.

Below 1.3 GHz, the active antenna elements can be switched to passive operation with a mouse click for quick adaption to the signal environment. In the most relevant frequency range from 80 MHz to 1.3 GHz, Rohde & Schwarz DF antennas feature a market-leading system DF accuracy of typ. 0.5° RMS. This performance is not compromised by side-arm lightning protection thanks to the integrated lightning rod. The R&S®ESME-MAP option displays information about the current location, DF measurements and triangulation results directly on a map based on the OpenStreetMap (OSM) format.

Basis for a precise radiolocation system
Multiple R&S®ESME receivers in a network can form the basis for a high-performance radiolocation system. Upgraded with the R&S®ESME-DF option, the R&S®ESME network can perform highly accurate AOA based radiolocation up to 8.2 GHz. Alternatively, if the R&S®ESME features the R&S®ESME-IGT2 internal GNSS option that provides exceptionally accurate timestamps, the network can turn into a precise TDOA system with emitter radiolocation over the entire frequency range. If the R&S®ESME features both the R&S®ESME-DF and the R&S®ESME-IGT2 options, even hybrid AOA and TDOA emitter radiolocation up to 8.2 GHz can be performed.

Whether the R&S®ESME is operated as a single DF system, in a network of multiple DF systems or in a mobile monitoring system, Rohde & Schwarz system software such as R&S®RAMON, R&S®ARGUS and R&S®MobileLocator provides easy control and operation.

AOA DF error correction
The metal structure of a vehicle platform as well as additional monitoring antennas installed near the DF antenna typically affect the operational DF accuracy of mobile monitoring stations. This can be improved significantly by measuring the vehicle on a turntable in combination with DF error correction. The R&S®ESME-COR option together with the R&S®SV-V-8 vehicle measurement service enables DF error correction to significantly improve the DF accuracy.

2) See “Increasing timestamp accuracy in TDOA applications” application card (PD 3606.7530.92).

Hybrid TDOA/AOA location result in R&S®ARGUS. Combined with data from spectrum management, it shows that the measured location of the interferer does not coincide with a licensed transmitter.
CUTTING-EDGE SIGNAL MEASUREMENT CAPABILITIES

Measurements in frequency and time domains
Besides standard marker functions, the R&S®ESME offers a versatile toolset for signal measurements in the frequency domain, including waterfall (spectrogram), video spectrum and polychrome spectrum. Additionally, the R&S®ESME-ZS zero span option provides simultaneous signal representation in the frequency and time domains with up to 20 MHz real-time bandwidth and enables a wide array of time domain measurements. This functionality is particularly useful when analyzing time division duplex (TDD) signals such as TDD-5G and TDD-LTE or time division multiple access (TDMA) signals such as TETRA, GSM or DECT.

Selective call analysis
Using the R&S®ESME-SL option, selective call information can be demodulated and decoded for signal identification. The following selective call methods are supported: CCIR1, CCIR7, CCITT, EEA, EIA, EURO, DCS, DTMF, CTCSS, NATEL, VDEW, ZVEI1 and ZVEI2.

Multichannel signal detection and analysis
The R&S®ESME-SP signal processing board option in conjunction with the R&S®CA120 multichannel signal analysis software supports parallel multichannel signal detection and analysis.

The R&S®ESME-DDCE DDC signal extraction option provides up to 128 parallel channels for continuous narrowband I/Q data streaming to the R&S®CA120 signal analysis software, which automatically performs classification, demodulation, decoding and voice recording. The R&S®ESME-HRP high-resolution panorama option offers a spectrum at higher frequency resolution for detecting, finding and classifying fixed frequency signals. The R&S®ESME-ST short-time signal detection option allows automatic detection of frequency hopping signals within the receiver’s real-time bandwidth. The detected short-time signals that match user-defined selection criteria are output to R&S®CA120 as a continuous I/Q data stream for further processing.

Example of GSM signal shown using different displays

Measurement of zero span hopper timing interval
EASY SYSTEM INTEGRATION

The R&S®ESME is more than a powerful standalone instrument. If a more advanced system solution is required, the R&S®ESME can be connected to many Rohde & Schwarz products or be used to upgrade an existing Rohde & Schwarz system with minimum installation and setup times. The wide array of well-documented data formats as well as hardware and software interfaces enable easy integration into a multitude of third-party system solutions.

Built-in antenna switch and control interfaces
With several antenna connectors (three to five depending on the configuration) and an integrated fast antenna switch, the R&S®ESME can easily be connected to an antenna network. All necessary control interfaces for DF antennas and external devices such as preamplifiers are included.

Mobile monitoring solution
The R&S®ESME is ideal for integration into vehicles for monitoring and searching for interference sources. The R&S®ESME-DC DC power supply option 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 R&S®ESME can be powered from both car and truck batteries.

Easy connection with a wide array of supported Rohde & Schwarz products
Rohde & Schwarz provides all the components necessary to field a full monitoring system with a streamlined workflow and minimal setup times. High-performance Rohde & Schwarz spectrum monitoring antennas and R&S®ADDx DF antennas featuring an integrated omnidirectional antenna path for spectrum measurements are automatically recognized. With the R&S®ESME at its core, components such as additional handoff receivers, the R&S®DWR100 and R&S®DWR150 digital wideband recorders, the R&S®CA100 and R&S®CA120 signal analysis software and hardware as well as the R&S®RAMON and R&S®ARGUS monitoring software complement the basic receiver functions in a modular and upgradable fashion.
Dedicated and versatile recording, replay and streaming concept for analysis and documentation

Basic recording and streaming functions are a standard R&S®ESME feature. The R&S®ESME-IR internal recording option allows recording of all receiver measurements for documentation purposes. These recordings can be replayed on the internal GUI; all functions of the R&S®ESME-MAP option are available. It is possible to see at a glance where, when and which measurement or audio recording was made. The internal storage capacity can be extended with the R&S®ESME-SSD internal hard disk.

With the R&S®ESME-RR record and replay option, digital wideband I/Q data can be recorded using internal memory or streamed to dedicated wideband recording devices such as the R&S®DWR100 or R&S®DWR150 via the optional R&S®RX-1G interface. These recordings support the full 80 MHz real-time bandwidth and can either be replayed in real time on the R&S®ESME or used for further offline signal analysis with the R&S®CA210 signal analysis software ¹ for communications signals or R&S®TPA technical pulse analysis software ² for radar signals.

1) See “R&S®CA210 Signal Analysis Software” product brochure (PD 3607.3600.12).

Open remote control interfaces and data formats

Thanks to the open or standard output data formats and interfaces, third-party system integration of the R&S®ESME is a simple process:

► Standard commands for programmable instruments (SCPI standard) for device control
► Baseband I/Q stream from the wideband spectrum path, the main demodulation path and the DDCs, including additional meta information (delivered to the client in documented formats)
► Several I/Q data formats available (e.g. AMMOS, VITA49.0)
► Easily structured trace data format for spectral and measurement data

Extensive examples for software integration are included in the documentation.

Recording and interfaces

R&S®CA120
multichannel signal analysis system

R&S®DWR150
digital wideband recorder

Display and control

Realtime recording
and display

R&S®CA120
signal analysis software

Display and control

Online analysis

Offline analysis

1 Gbit Ethernet

1 Gbit Ethernet

1 Gbit Ethernet

R&S®TPA
technical pulse analysis software
### SPECIFICATIONS IN BRIEF

#### Specifications in brief

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Frequency range</td>
<td><strong>base unit</strong>: 20 MHz to 6 GHz with R&amp;S®ESME-HF option</td>
</tr>
<tr>
<td></td>
<td><strong>8 kHz to 6 GHz</strong> with R&amp;S®ESME-HF and R&amp;S®ESME-MW18 options</td>
</tr>
<tr>
<td></td>
<td><strong>8 kHz to 18 GHz</strong> with external R&amp;S®MC40 microwave downconverter [1]</td>
</tr>
<tr>
<td></td>
<td><strong>up to 40 GHz</strong></td>
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<tr>
<td>Real-time bandwidth</td>
<td><strong>up to 20 MHz</strong></td>
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<tr>
<td></td>
<td><strong>in HF</strong> with R&amp;S®ESME-ADC2 and R&amp;S®ESME-WB options</td>
</tr>
<tr>
<td></td>
<td><strong>up to 80 MHz</strong></td>
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<tr>
<td></td>
<td><strong>demodulation and measurement path</strong></td>
</tr>
<tr>
<td></td>
<td><strong>up to 20 MHz</strong></td>
</tr>
<tr>
<td>Scan speed</td>
<td><strong>up to 110 GHz/s at 2000 kHz resolution bandwidth</strong></td>
</tr>
<tr>
<td>40 Gbit I/Q Interface</td>
<td><strong>with R&amp;S®ESME-PS and R&amp;S®ESME-WB options</strong></td>
</tr>
<tr>
<td></td>
<td><strong>I/Q streaming up to 80 MHz bandwidth</strong></td>
</tr>
<tr>
<td>Optional AOA direction finding</td>
<td><strong>with R&amp;S®ESME-DF option</strong></td>
</tr>
<tr>
<td>Frequency range DF</td>
<td><strong>base unit</strong>: 20 MHz to 6 GHz with R&amp;S®ESME-HF option</td>
</tr>
<tr>
<td></td>
<td><strong>300 kHz to 6 GHz</strong></td>
</tr>
<tr>
<td></td>
<td><strong>20 MHz to 8.2 GHz</strong></td>
</tr>
<tr>
<td></td>
<td><strong>with R&amp;S®ESME-HF and R&amp;S®ESME-MW18 options</strong></td>
</tr>
<tr>
<td></td>
<td><strong>300 kHz to 8.2 GHz</strong></td>
</tr>
<tr>
<td>Real-time bandwidth DF</td>
<td><strong>for wideband DF</strong></td>
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<tr>
<td>Instrument DF accuracy</td>
<td><strong>up to 20 MHz</strong></td>
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<tr>
<td>System DF accuracy (with lightning protection installed)</td>
<td><strong>0.2° RMS (typ.)</strong></td>
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<tr>
<td></td>
<td><strong>80 MHz to 1.3 GHz</strong></td>
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<tr>
<td></td>
<td><strong>0.5° RMS (typ.)</strong></td>
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<tr>
<td></td>
<td><strong>20 MHz to 80 MHz and 1.3 GHz to 6 GHz</strong></td>
</tr>
<tr>
<td></td>
<td><strong>1° RMS (typ.)</strong></td>
</tr>
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</table>

\[1\] Requires R&S®ESME-MW18.

### ORDERING INFORMATION

#### Designation

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<tr>
<th>Designation</th>
<th>Type</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base unit</strong> (including accessories such as power cable, manual)</td>
<td>R&amp;S®ESME</td>
<td>4113.0000.02</td>
</tr>
<tr>
<td>Wideband monitoring receiver, without front panel control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wideband monitoring receiver, with front panel control</td>
<td>R&amp;S®ESME</td>
<td>4113.0000.03</td>
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<tr>
<td><strong>Hardware options</strong></td>
<td>R&amp;S®ESME-HF</td>
<td>4113.2232.02</td>
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<tr>
<td>HF frequency range extension, 8 kHz to 32 MHz</td>
<td>R&amp;S®ESME-MW18</td>
<td>4113.2478.02</td>
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<tr>
<td>Microwave extension, 18 GHz</td>
<td>R&amp;S®ESME-ADC2</td>
<td>4113.2355.02</td>
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<tr>
<td>Multifunction board</td>
<td>R&amp;S®ESME-DC</td>
<td>4113.2203.02</td>
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<tr>
<td>DC power supply</td>
<td>R&amp;S®ESME-DIQ</td>
<td>4113.2449.02</td>
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<tr>
<td>Wideband I/O data streaming board [1]</td>
<td>R&amp;S®RX-10G</td>
<td>4074.7604.04</td>
</tr>
<tr>
<td>10 Gbit Ethernet interface (without transceiver module) [2]</td>
<td>R&amp;S®RX-40G</td>
<td>4093.2404.02</td>
</tr>
<tr>
<td>40 Gbit I/O interface [2]</td>
<td>R&amp;S®ESME-IGT2</td>
<td>4113.2384.02</td>
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<tr>
<td>Internal GNSS module (GPS, GLONASS, BeiDou)</td>
<td>R&amp;S®ESME-SSD</td>
<td>4113.2410.02</td>
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<tr>
<td>Internal SSD [3]</td>
<td>R&amp;S®ESME-SP</td>
<td>4113.2261.02</td>
</tr>
<tr>
<td>Internal SSD [3]</td>
<td>R&amp;S®ESME-SP</td>
<td>4113.2261.02</td>
</tr>
</tbody>
</table>

\[1\] Requires R&S®ESME-ADC2.
\[2\] Requires R&S®ESME-DIQ.
\[3\] Requires R&S®ESME model .03 with front panel control.
OpenStreetMap (OSM)

OpenStreetMap (OSM) is a user-editable world map that is available at the following internet address: http://www.openstreetmap.org/

OSM is a wiki project in which users can participate by uploading and editing geographical information such as GPS tracking data or the course of a road or river. This world map is growing daily.

OpenStreetMap data can be used freely under the terms of the Creative Commons Attribution-ShareAlike 2.0 license.
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.

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

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ISO 9001

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