

R&S®TS-EMF

EMF Measurement System

Easy, frequency-selective
measurement of EMF
emissions



R&S®TS-EMF EMF Measurement System At a glance

In combination with Rohde & Schwarz spectrum analyzers, the R&S®TS-EMF measurement system detects high-frequency electromagnetic fields in the environment (EMF). The isotropic antenna, together with the software, which has been specifically designed for EMF measurements, allows simple and precise evaluation of total and individual emissions on site.

Measuring EMF emissions in line with national and international standards provides a basis for ensuring that transmitter systems comply with the applicable limits and for communicating this to the general public. The key criterion is a precise, easy-to-make on-site measurement.

The R&S®TS-EMF measurement system supports users by providing automated test sequences, including preconfigured measurement packets. The isotropic antenna detects fields independent of their direction and polarization. A wide range of Rohde & Schwarz spectrum analyzers and test receivers is available for performing such measurements. In particular, the compact one-box solution with the R&S®FPL spectrum analyzer or configurations with the handheld analyzers R&S FSH and R&S FPH allow measurements to be performed even in locations that are difficult to access.

Key facts

- Automated EMF measurements
- Precise measurements of complex scenarios and RF signals
- Wide frequency range from 9 kHz to 6 GHz, covered by isotropic antennas
- Isotropic antenna detecting fields independent of direction and polarization
- Combined use possible with various Rohde & Schwarz spectrum analyzers, test receivers and network scanners



R&S®TS-EMF EMF Measurement System

Benefits and key features



Safety based on exact measurements for reproducible and reliable results

- Evaluation of total emissions, individual radio services or individual frequencies
- Measurements in line with all common EMF standards and measurement methods
- Correct evaluation of complex scenarios or RF signals
- Excellent reproducibility using automated measurements

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Efficient on-site measurements

- Fast, efficient measurements thanks to predefined test routines
- On-site interpretation of results using integrated report generation
- Easy adaptation to local conditions
- Versatile use due to the compact one-box solution with the R&S®FPL spectrum analyzer
- Standalone measurements of R&S®FPH and R&S®FSH spectrum analyzers with isotropic antennas

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Suitable for a wide range of applications

- Investigation of specific problems or radio signals by directly setting individual measurement parameters
- Additional manual measurements using a full-fledged spectrum analyzer
- Optional storage of raw measurement data for further in-depth result evaluation
- Precise extrapolation for WCDMA and LTE signals using demodulation

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Future-ready

- Coverage of the complete frequency range from 9 kHz to 6 GHz using isotropic antennas
- Measurements of advanced radio services with wide bandwidths and high crest factors

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Compact EMF measurement solution: R&S®TS-EMF and R&S®FPL.

Safety based on exact measurements for reproducible and reliable results

Evaluation of total emissions, individual radio services or individual frequencies

Discussion about radiation exposure frequently focuses on individual transmitter sites or radio services. However, it is important in all cases to measure and assess the total emissions.

The R&S®TS-EMF measurement system provides an overview of the total emissions along with the individual results, e.g. for specific radio services. Moreover, for each subrange, the individual frequencies can be accessed to identify the emitters. Emissions that are not allocated to any measurement packet are handled as "Intermediate" and output.

Measurements in line with all common EMF standards and measurement methods

International and national EMF regulations protect the general public as well as workers against electromagnetic radiation.

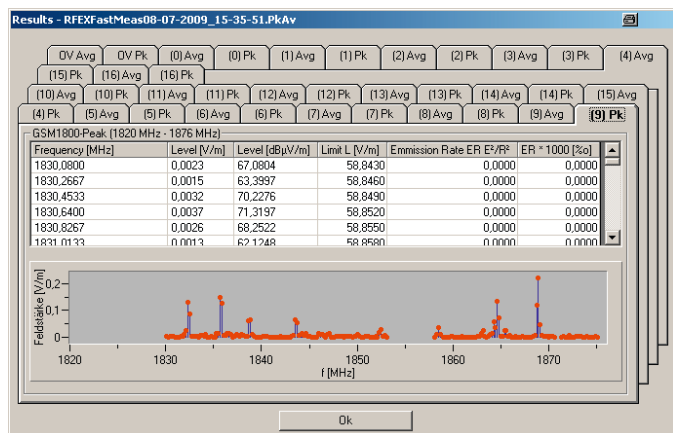
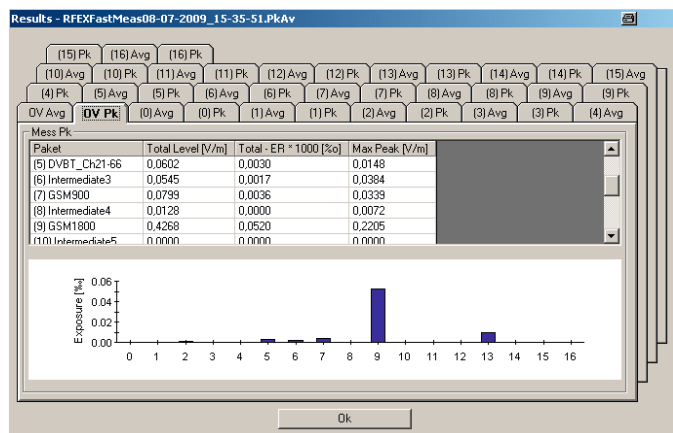
The R&S®TS-EMF covers the requirements of ICNIRP, EN50400 and EN50499 as well as many national standards that are derived from these standards.

All EMF measurement methods used in actual practice are covered by a single measurement system:

- Fast overview measurement
 - Provides a summary of the emissions scenario in the measurement range within seconds
- Average/peak value versus time
 - Measures the maximum and average value of signals, e.g. measurement of a six-minute interval in line with ICNIRP
- Grid method
 - Using different measurement points, a spatial area is covered, e.g. the human torso
- Stirring method
 - The peak value for a measurement range is exactly determined by manually moving the antenna in a defined spatial range
- Long-term measurement
 - Changes in the field strength of individual radio services and the total value are determined over a user-definable period of time

The R&S®TS-EMF enables users to immediately decide on site which measurement method (or combination of measurement methods) is to be used for a particular test location. Software supports them by providing identical operation and evaluation for all measurement methods.

Fast overview of the total exposure and individual emissions immediately after the measurement.



Correct evaluation of complex scenarios or RF signals

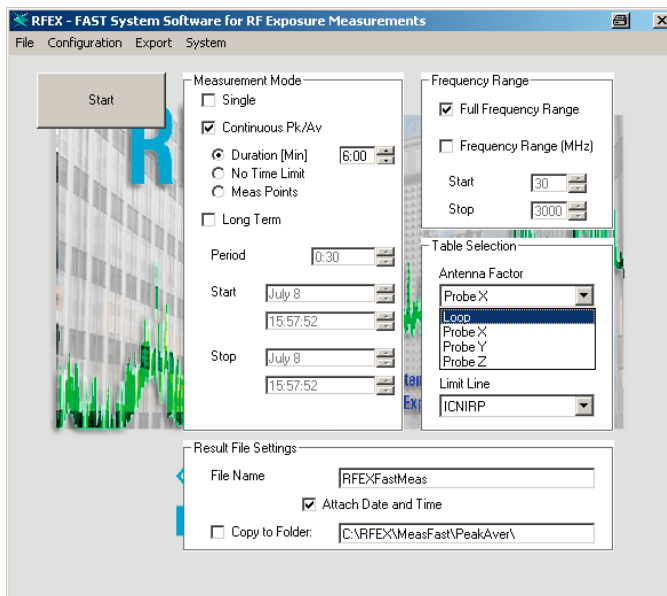
In an EMF measurement, it is important to ensure that signals with different bandwidths, modulation schemes and timing structures are correctly detected. The R&S®TS-EMF measurement system meets this requirement by covering frequency subranges with individually configured measurement packets. This makes it possible to correctly measure a mixture of different signals. The R&S®TS-EMF offers two different measurement modes:

■ R&S®RFEX-Fast

The R&S®RFEX-Fast measurement software allows the user to select the required measurement packets for any particular measurement. Each measurement packet is defined on the basis of the frequency range and signal type. The signal type (e.g. FM, DVB-T/T2, DAB, GSM, WCDMA, LTE, WIFI, DECT) automatically defines all other measurement parameters. Standard measurements are covered in a straightforward manner with this approach. Simply selecting the radio services ensures a correct measurement

■ R&S®RFEX

The R&S®RFEX measurement software handles special signal types and can also be used for detailed investigations. The different measurement parameters can be set individually. A library of sample measurement packets and a detailed description support users during the configuration process

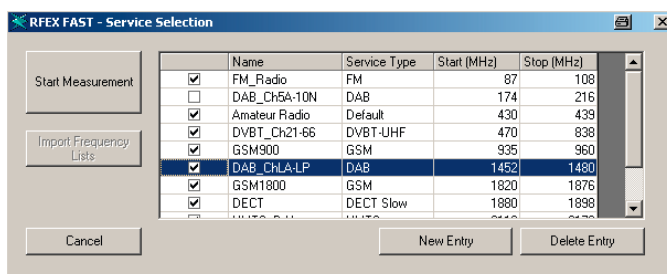


R&S®RFEX allows users to investigate special problems by directly configuring the measurement parameters.

Both measurement software packages (R&S®RFEX-Fast for fast standard measurements and R&S®RFEX for greater flexibility) are an integral part of the R&S®TS-EMF.

Excellent reproducibility using automated measurements

Using automated test sequences makes on-site work easier and also reduces the risk of errors. The measurement settings and (when using a GPS receiver) the location are automatically documented. This simplifies quality assurance and allows comparative measurement campaigns with identical settings for detecting changes that have occurred at a site.



R&S®RFEX-Fast software: easy measurement configuration for all measurement methods.

Efficient on-site measurements

Fast, efficient measurements thanks to predefined test routines

Predefined test routines and an automated test sequence allow measurements without a high expenditure on personnel along with a fast response to special requests and discussions or questions at the test site.

On-site interpretation of results using integrated report generation

The automatically generated test report is useful for immediate evaluation of the measurement. The graphical presentation offers a fast overview, while the table shows precise results. Results are displayed as absolute values or as a % of the limit value. Fast evaluation allows immediate discussion and interpretation of the results and can be used to decide whether additional measurements are needed. Measurement results are also accessible in MS Excel format and are available for creating a custom test report.

Easy adaptation to local conditions

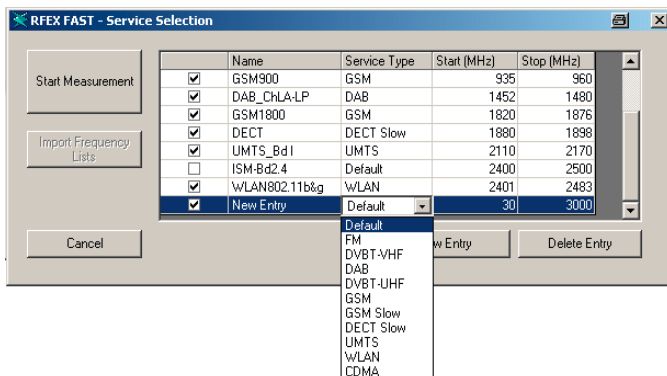
When making a measurement with measurement packets, other radio services can be added or removed to adapt the predefined measurement packets to local conditions. Even new services that have not yet been defined can be added to the R&S®RFEX-Fast measurement software simply by indicating the frequency range and signal type. They can then be measured separately.

Versatile use due to the compact one-box solution with the R&S®FPL spectrum analyzer

EMF measurement sites are often difficult to reach. The mobility provided by the R&S®TS-EMF is increased further through the one-box solution using the R&S®FPL spectrum analyzer. The R&S®RFEX-Fast measurement software runs directly on the compact analyzer and is operated solely via the instrument's keypad. The isotropic antenna, the software and the analyzer form the measurement system.

Standalone measurements of R&S®FPH and R&S®FSH spectrum analyzers with isotropic antennas

The spectrum analyzers R&S®FPH and R&S®FSH support also direct measurement with the isotropic antennas R&S®TSEMF-B1 to R&S®TSEMF-B3. This allows an extremely compact and portable setup where automation of the test software is not required.



R&S®FPL with isotropic antenna.



Suitable for a wide range of applications

Investigation of specific problems or radio signals by directly setting individual measurement parameters

Besides handling standard measurements, the R&S®RFEX measurement software also allows detailed configuration of the measurement parameters. This makes the R&S®TS-EMF an ideal tool for further in-depth analysis, as required for many studies, for example.

Additional manual measurements using a full-fledged spectrum analyzer

In many cases, the EMF measurement is only one out of a whole series of measurements, e.g. when commissioning base stations or for providers of measurement services. For efficient operation, it is important that the spectrum analyzer or EMI test receiver can be used without restrictions for other measurements, too.

Optional storage of raw measurement data for further in-depth result evaluation

For the automatically generated report at the end of a measurement, the measurement results are compressed, especially in case of long measurement cycles. Optional storage of the raw data¹⁾ allows subsequent precision analysis with exact timing and frequency information. This enables users to trace and characterize measurement results in detail even after the measurement has been completed.

¹⁾ ASCII files with all measured isotropic field strength values exceeding an adjustable threshold.



Precise extrapolation for WCDMA and LTE signals using demodulation

In the case of wireless services, frequency-selective measurements have often to be combined with specialized measurement methods for various radio services. These methods allow exact extrapolation to maximum system utilization and allocation of emissions to the appropriate base station.

For WCDMA base stations, this involves demodulation of the CPICH control channel on which data is sent at constant power and a fixed ratio to the maximum power of the base station.

A similar procedure is used for LTE, i. e. the decoding and power measurement of the reference symbols on antennas 1 and 2 and of the S-SCH and P-SCH synchronization channels. Especially the decoding of the reference symbols is very popular because it allows the different MIMO channels to be measured independently.

The R&S®TSEMF-K23 option can decode all required values accurately when combined with the R&S®FSH spectrum analyzer equipped with the WCDMA and LTE decoding options. This allows automatic decoding of the field strength of the surrounding base stations as well as automatic report generation.

The features are:

- Automatic decoding of all received codes
- Identification of base station and sector using the decoded cell ID
- Separate measurement of up to 4 MIMO channels per cell ID

For high performance decoding the R&S®TSME and R&S®TSMW radio network analyzers can be used with R&S®TS-EMF.

This combination provides the following additional features:

- High measurement rate (approx. five measurements/s) to enable all EMF measurement methods, including the stirring method, even for decoding
- Very high sensitivity and wide dynamic range
- Large number of parallel rake receivers for correct evaluation even of signals with many reflections

Combination of R&S®TS-EMF and R&S®TSME for decoding LTE and WCDMA signals.

Future-ready

Coverage of the complete frequency range from 9 kHz to 6 GHz using isotropic antennas

Three isotropic antennas are used to cover the entire frequency range from 9 kHz to 6 GHz:

- Isotropic loop antenna, 9 kHz to 200 MHz
- Isotropic antenna, 30 MHz to 3 GHz
- Isotropic antenna, 700 MHz to 6 GHz

Providing a frequency range from 9 kHz to 6 GHz, the antennas cover all common radio services as well as important standards. All services in the frequency range from 700 MHz to 6 GHz important to mobile radio and broadband services are covered with a single measurement without changing antennas. For frequencies below 10 MHz, the additional linear summation of the field strengths required by ICNIRP and other standards is performed automatically. In addition, the R&S®TS-EMF supports any other nonisotropic antennas, allowing the entire frequency range of the spectrum analyzer to be used.

Measurements of advanced radio services with wide bandwidths and high crest factors

The transmission methods used in today's radio services are undergoing continuous enhancement. Current services such as DVB-T/T2, WCDMA, LTE, and WLAN use wide bandwidths and high crest factors. The R&S®TS-EMF measurement system meets the requirements of current and future services with its true RMS detector and large selection of standard measurement bandwidths. In addition, special channel filters as well as the channel power measurement functions are supported depending on the spectrum analyzer used. The R&S®TS-EMF and a suitable spectrum analyzer are therefore an ideal combination for handling a wide variety of measurements.



R&S®FSH with isotropic antennas.

Models

The R&S®TS-EMF supports the following spectrum analyzers:

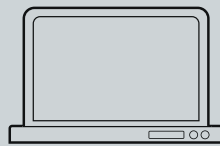
Analyzer	R&S®RFEX-Fast	R&S®RFEX	Decoding WCDMA	LTE	Comment
R&S®FSH	•	•	R&S®FSH-K44, R&S®TSEMF-K23	R&S®FSH-K50/-K50E and R&S®TSEMF-K23	R&S®FSH-K40 required
R&S®FPH	•	•	–	–	–
R&S®TSMW	–	•	R&S®TSEMF-U1 or -U2	R&S®TSEMF-K21	corresponding R&S®TSMW options required
R&S®TSME	–	•	R&S®TSEMF-U1 or -U2	R&S®TSEMF-K21	corresponding R&S®TSME options required
R&S®FSL	•	•	R&S®TSEMF-U1	–	R&S®RFEX-Fast option on ana- lyzer with R&S®TSEMF-K12 and R&S®FSL-K400 or -U400
R&S®FSV/FSU/FSW	–	•	R&S®TSEMF-U1	–	
R&S®ESR/ESRP/ESU	–	•	R&S®TSEMF-U1	–	
R&S®ETL	–	•	R&S®TSEMF-U1	–	

For support of other analyzers, see the R&S®TS-EMF user manual or contact Rohde & Schwarz.

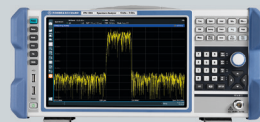
In addition the spectrum analyzers R&S®FPH and R&S®FSH support standalone measurement with the isotropic antennas R&S®TSEMF-B1 to R&S®TSEMF-B3.

R&S®TS-EMF with spectrum analyzer or EMI test receiver

R&S®TS-EMF with Rohde & Schwarz spectrum analyzer



R&S®RFEX software



Spectrum analyzer
up to 40 GHz



Three isotropic antennas
9 kHz to 6 GHz

or



Handheld analyzer

Optional WCDMA and LTE decoding software

Measurement packet: UMTS			
Scrambling code	Frequency (MHz)	Field strength (V/m)	Thousands of limit value
1168 0	2112.8000	0.0124	0.2034
576 0	2167.2000	0.0133	0.2183
3712 0	2112.8000	0.0069	0.1134
1920 0	2112.8000	0.0024	0.0390
Sum:			0.3216
max. single value			0.2183

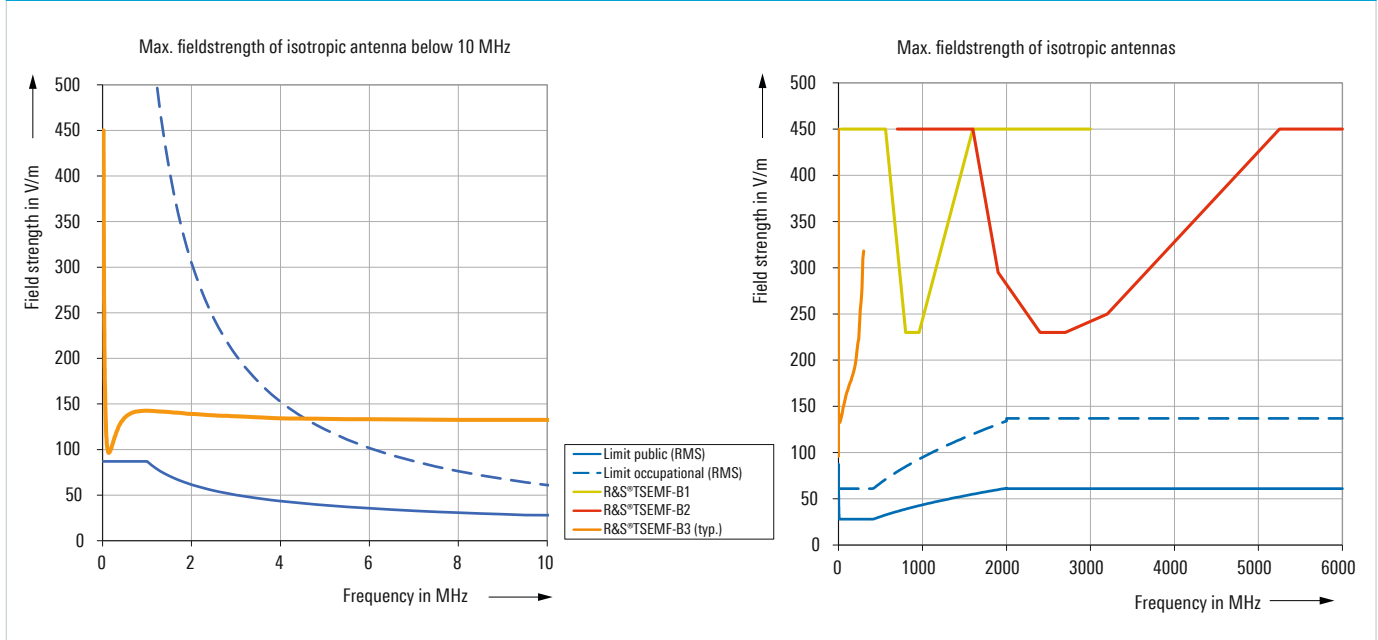
Additional antennas 9 kHz to 40 GHz

R&S®HL050
R&S®HFH2-Z2

Specifications

Isotropic antennas	R&S®TSEMF-B3	R&S®TSEMF-B1	R&S®TSEMF-B2
Measurement principle	isotropic reception due to orthogonally arranged antenna elements that are electronically switched		
Frequency range	9 kHz to 200 MHz	30 MHz to 3 GHz	700 MHz to 6 GHz
Minimum detectable field strength	approx. 1 mV/m		
Maximum field strength	see diagram		
Isotropy	$\leq \pm 1.37$ dB	$\leq \pm 2.1$ dB, ± 1.0 dB (f = 900 MHz), ± 1.7 dB (f = 1800 MHz)	$\leq \pm 2.5$ dB (0.6 GHz to 2 GHz), $\leq \pm 2.2$ dB (2 GHz to 3.6 GHz), $\leq \pm 3.0$ dB (3.6 GHz to 6 GHz)
Mechanical design	radome protection against mechanical damage and environmental hazards		
Antenna factor	individual calibration data, saved on USB dongle and/or CD		
Axis switching	RF solid state switch		
Connecting cables	direct connection to spectrum analyzer (extension cable (length: 8 m) see accessories)	integrated cable (length: 2 m) ferrite-beaded (extension cable (length: 8 m) see accessories)	integrated cable (length: 2 m, extension cable (length: 8 m) see accessories))
RF connector	N male		
Connector, control line	7-pin connector (binder) for direct connection to R&S®FSH power sensor port, adapter cable for connection to notebook or spectrum analyzer with USB output		
Tripod adapter	¼-" thread, quick connector for antenna		
Requirements for notebook (not supplied)	MS Windows7 or Windows8 operating system, free hard disk space: min. 5 Gbyte display resolution: min. 800 × 600 pixel, two USB interfaces interface to test instrument (depending on analyzer: GPIB, LAN, USB or FireWire) recommended application: Excel 2007, 2010, 2013		
Equipment supplied	isotropic sensor with connecting cable, operator's guide for R&S®RFEX and R&S®RFEX-Fast measurement software (on CD), tripod adapter, USB adapter cable, transit case (R&S®TS-EMF with at least one isotropic antenna)		
Expanded measurement uncertainty R&S®TS-EMF with R&S®FSH (95 % confidence level (k = 2))	$\leq \pm 2.5$ dB	$\leq \pm 3.3$ dB, ± 2.3 dB at 0.9 GHz, ± 2.9 dB at 1.8 GHz	$\leq \pm 3.1$ dB (0.7 GHz to 1 GHz), $\leq \pm 3.3$ dB at (1 GHz to 3.6 GHz), $\leq \pm 3.7$ dB at (3.6 GHz to 6 GHz)
Expanded measurement uncertainty R&S®TS-EMF with R&S®FSL (95 % confidence level (k = 2))	$\leq \pm 2.4$ dB	$\leq \pm 3.2$ dB, ± 2.2 dB at 0.9 GHz, ± 2.9 dB at 1.8 GHz	$\leq \pm 2.9$ dB (0.7 GHz to 1 GHz), $\leq \pm 3.2$ dB at (1 GHz to 3.6 GHz), $\leq \pm 3.6$ dB at (3.6 GHz to 6 GHz)
Power supply	via spectrum analyzer or laptop		
Ambient conditions	-10°C to +50°C, safety class IP54 (see user manual for details)		
Weight (incl. cable)	0.85 kg 1.87 lb	1.3 kg 2.87 lb	0.95 kg 2.09 lb
Dimensions (L × Ø)	550 mm × 146 mm 21.7 in. × 5.75 in.	475 mm × 170 mm 18.7 in. × 6.69 in.	415 mm × 87 mm 16.3 in. × 3.43 in.

Maximum field strength for R&S®TS-EMF isotropic antennas



Ordering information

Designation	Type	Order number
Portable EMF Measurement System, requires R&S®TSEMF-Bx antenna, (without spectrum analyzer and notebook)	R&S®TS-EMF	1158.9295.06
Options		
Isotropic Antenna, 30 MHz to 3 GHz ¹⁾	R&S®TSEMF-B1	1074.5719.02
Isotropic Antenna, 700 MHz to 6 GHz ¹⁾	R&S®TSEMF-B2	1074.5702.02
Isotropic Antenna, 9 kHz to 200 MHz ²⁾	R&S®TSEMF-B3	1074.5690.02
R&S®TS-EMF Accredited Calibration for R&S®TSEMF-B1 or R&S®TSEMF-B2 (for R&S®TSEMF-B1 ISO calibration below 200 MHz, DAkkS above 200 MHz) ³⁾	R&S®EMF-DKD	1502.5675.14
Keycode for R&S®RFEX Measurement Software on R&S®FSL spectrum analyzer (requires R&S®FSL-K400 or R&S®FSL-U400)	R&S®TSEMF-K12	1510.9201.12
WCDMA Decoding for R&S®TS-EMF (can be used with R&S®FSL/FSU/FSW spectrum analyzers and R&S®ESR/ESRP/ESU test receivers); includes R&S®TSEMF-U2 option	R&S®TSEMF-U1	1063.3390.02
WCDMA Decoding for R&S®TS-EMF (can be used with R&S®TSMW/TSME radio network analyzers)	R&S®TSEMF-U2	1063.3449.02
LTE Decoding for R&S®TS-EMF (requires R&S®TSMW/TSME radio network analyzer with R&S®TSMx-K29 option)	R&S®TSEMF-K21	1516.4199.02
Automated LTE and WCDMA Decoding Measurement for R&S®TS-EMF in combination with R&S®FSH (requires R&S®FSH-K44, -K50 and -K50E)	R&S®TSEMF-K23	1515.3430.02
External accessories		
Cable Set for R&S®TS-EMF (length: 8 m), up to 6 GHz	R&S®TS-EMFZ2	1166.5708.04
Cable Set for R&S®TS-EMF (length: 8 m), up to 6 GHz, with DAkkS calibration	R&S®TS-EMFZ2	1166.5708.05
EMC Tripod for R&S®TS-EMF	R&S®TSEMF-O3	1101.8477.03
Desktop Tripod for R&S®TS-EMF	R&S®TSEMF-O5	1166.5850.02
Alternatives		
R&S®RFEX and R&S®RFEX-Fast EMF Measurement Software	R&S®TSEMF-K1	1166.5937.04

¹⁾ Delivered with individual calibration data (factory calibration) as standard.

²⁾ Delivered with typical calibration data as standard.

³⁾ Other accredited calibrations on request.

