Portable System for EMF Measurements R&S®TS-EMF

Even more universal: EMF measurements from 100 kHz to 40 GHz and for UMTS

The expanded frequency range of 100 kHz to 40 GHz and the newly implemented measurement method for UMTS make the R&S®TS-EMF test system (FIG 1) even more universal in application.

FIG 1 Portable System for EMF Measurements R&S®TS-EMF.

From LW to SHF using just one test system

With EMF measurements, all emitters in the vicinity must be taken into account, even if the measurements focus on only one special radio service or transmitter location. This is a highly complicated task when manually performing frequency-selective measurements. The R&S®TS-EMF, however, quickly and easily provides users with an overview of the different radio services on site. The previous frequency range of 80 MHz to 2.5 GHz covered all wireless radio applications as well as TV and FM broadcast frequencies. With its expanded frequency range of 30 MHz to 3 GHz, the base system with an isotropic antenna now also covers VHF radio services (e.g. civil authorities radio).

Measurement and evaluation at low frequencies

Many EMF test specifications begin at 100 kHz [1] or below. Studies show that medium- and shortwave transmitters even several kilometers away significantly contribute to emissions and must therefore be taken into account [2].

The inclusion of low frequencies places additional requirements on the R&S®RFEX measurement software. There is usually no fixed channel spacing in this frequency range, which is why the software alternatively evaluates the highest field strength peaks within a measurement packet. In addition, the software adds up the individual emissions not only with reference to power, but below 10 MHz also with regard to field strength according to the body current model. The data and associated units to be indicated in the report can be selected.

These measurements must always take the near field conditions into account. At frequencies above 30 MHz, you are virtually always in the radiated field, which means there is a fixed relationship between the electric and magnetic fields as well as the power flux density. At frequencies below 30 MHz, it must be determined whether you are in the reactive near field, depending on the distance from the transmitter (FIG 2). The electric and magnetic fields must be measured in the reactive near field. This can be done very easily using the Loop Antenna R&S®HFH2-Z2, which is widely used in field strength test and measurement. The R&S®TS-EMF can also be combined with other desired antennas (FIGs 3 and 4). The software automatically evaluates the measurements in different polarizations.

Measurements up to 40 GHz

Most EMF measurements are performed up to 3 GHz, because this covers the radio services most widely used. But if, for example, radar or directional radio is also to be taken into account, measurements above 3 GHz are required. A frequency range up to 40 GHz is possible by combining the R&S®TS-EMF with the Spectrum Analyzer R&S®FSP or R&S®FSU. Directional antennas such as the outstanding R&S®HL050, which covers the entire frequency range from 850 MHz to 26.5 GHz (FIG 3), are usually used in this case, especially for the stirring method.

	Reactive near field	Radiated near field	Far field
Limit distance*	0 to λ	λ to $2D^2/\lambda$	$>2D^2/\lambda$
E perpendicular to H?	No	Almost	Yes
E, H ~ 1/r	No	No	Yes
$Z_F = E/H$	$\neq 377\ \Omega$	$\approx 377\ \Omega$	$= 377\ \Omega$
To measure	E and H	E or H	E or H

FIG 2
Differences between near and far field;
*** heavily dependent on the type of transmit antenna (D = largest antenna dimension, e.g. diameter of a parabolic reflector).**

FIG 3 Configuration of the R&S®TS-EMF with the R&S®FSP / FSU / ESPI.

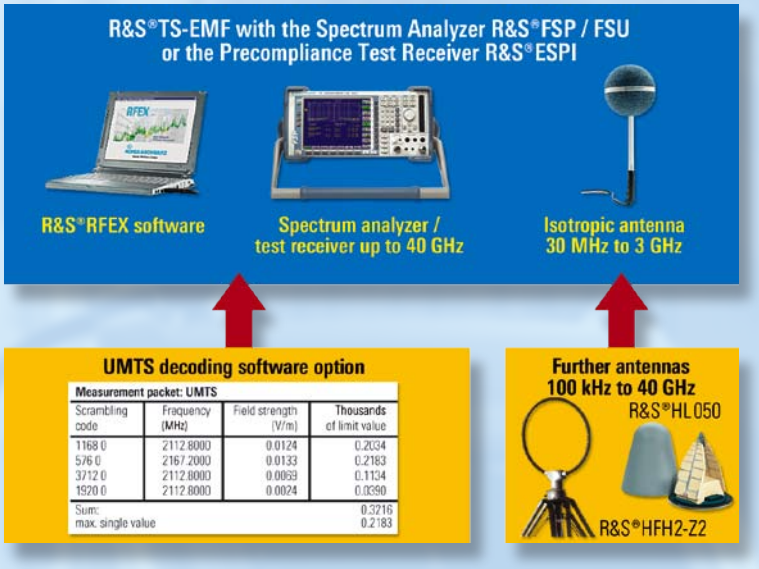

FIG 4 Configuration of the R&S®TS-EMF with the R&S®FSH3.

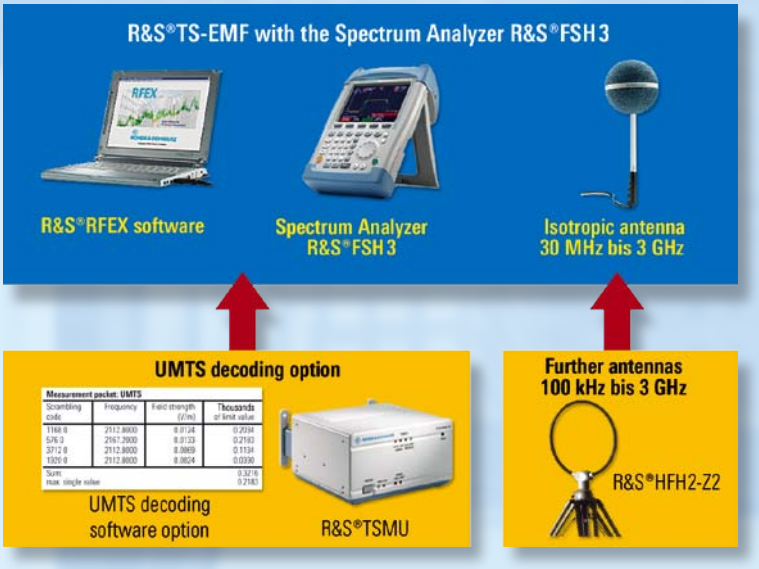

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FIG 5 The R&S®TS-EMF with the Radio Network Analyzer R&S®TSMU.

More information and data sheet at www.rohde-schwarz.com (search term: TS-EMF)

REFERENCES
[1] prEN54000, February 2002
[2] Bochtler/Eidher/Wuschek: Großräumige Ermittlung von Funkwellen in Baden-Württemberg, July 2003 ("www.lfu.baden-wuerttemberg.de/lfu/abt3/funkwellen")
[3] SAEFL: Mobilfunk-Basisstationen (UMTS-FDD), Messempfehlung (draft of 17 Sept. 2003)
[4] Radio Network Analyzer R&S®TSMU: Performance giant in compact format sets new standards. News from Rohde & Schwarz (2003) No. 180, pp 4–7

Measurement of UMTS emissions

While the construction of UMTS networks is progressing at a fast pace, no rules or regulations regarding UMTS and EMF measurements were established yet. The Swiss Agency for the Environment, Forests and Landscape (SAEFL) is now the first civil authority to publish a measurement recommendation [3]. Other countries are expected to adopt a similar form of the measurement methods described therein.

A (simplified) comparison with GSM shows the conditions of EMF measurements in UMTS emissions. With GSM, fixed frequencies are assigned to each base station. A continuous signal is transmitted at constant power at one of these frequencies, which makes it possible to simply extrapolate to the maximum field strength generated by a base station. The measured field strength can be assigned to the base station by means of the frequency.

In the case of UMTS, however, all base stations of a network operator transmit at the same frequency. The base stations are differentiated by means of scrambling codes with which each base station encodes its own signal. With this type of coding, the signal is simultaneously spread, creating a noiselike signal with a bandwidth of 5 MHz. The transmission power depends on the amount of transmitted data and is between approx. 10% for the organization channels and the maximum output power at full capacity utilization.

Frequency-selective measurement with UMTS

Frequency-selective measurements, which are standard practice for measuring electromagnetic fields in the environment, can also be performed for UMTS – but with the following restrictions:

- Assignment to a base station not possible
- Statement only regarding the momentary value
- Restricted sensitivity caused by a broadband, noiselike signal

The measurements obtain only the current summed value of all UMTS base stations in the vicinity. The worst-case scenario for extrapolation to the maximum possible field strength presupposes that only the organization channels were active at the time of the measurement. However, the result of this extrapolation can be as much as 10 dB too high if data was also transmitted at the time of the measurement. This measurement uncertainty can be minimized by performing long-term measurements with the R&S®TS-EMF.

The measurement is made using the RMS detector and at a signal-matched bandwidth. Channel power measurement must be set if the Spectrum Analyzer R&S®FSH3 is used. The measurement parameters for UMTS are stored in a predefined measurement packet that comes with the test system. Rohde & Schwarz verified the measurement-packet settings on real and synthetic UMTS signals.

Code-selective measurement with UMTS

UMTS emissions must be decoded so as to avoid the restrictions of frequency-selective measurements and to be able to use a measurement method that is comparable to GSM. Decoding must be precise and reproducible, even under complex reception conditions involving strong reflections, no line of sight to the transmitting antenna and simultaneously several base stations. Important factors for this measurement are high sensitivity and wide dynamic range, high measurement speed for mobile measurements (stirring method) and the possibility to process many codes in parallel (due to the time offset, each reflection is processed as a separate code).

Rohde & Schwarz has acquired wide-ranging experience with UMTS radiated emission measurements with its coverage test systems for measuring network quality. Owing to this experience, an option for decoding the UMTS organization channel (CPICH) has been added to the R&S®TS-EMF, allowing the test system to comply with the preferred measurement method described in the Swiss recommendation. The system allows the field strength to be accurately measured and extrapolated to the maximum emission and assigned to the base station. The sensitivity is greater than with a spectral GSM measurement. Decoding by means of the R&S®RFEX software can be implemented in connection with a Spectrum Analyzer R&S®FSP or R&S®FSU or the Precompliance Test Receiver R&S®ESPI. Alternatively, the Radio Network Analyzer R&S®TSMU (FIGs 4 and 5) can be used for performing pure UMTS measurements or as a compact addition to the R&S®FSH3 [4]. Existing test systems can be retrofitted with this option. A version without an isotropic antenna is available for users who apply only the stirring method.

Summary

The expanded frequency range of 30 MHz to 3 GHz and the option for precise UMTS measurements provide the Portable System for EMF Measurements R&S®TS-EMF with the greatest possible flexibility in EMF measurements. Additional antennas and spectrum analyzers for the range from 100 kHz to 40 GHz are available for more exacting measurement requirements. Frequency-selective measurements involving UMTS systems are subject to restrictions. CPICH channel decoding, available as an option to the R&S®TS-EMF, yields an accurate measurement method comparable to the technique used with GSM.

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