Early verification of the air interface of wireless terminals

The R&S®R-Line compact test chamber allows wireless equipment manufacturers to reliably verify the radiated RF performance of wireless terminals at an early stage of development, thus avoiding unpleasant surprises during the certification measurements.

Compact test chamber for use in the lab

In the development of wireless terminals, the RF characteristics have to be optimized by striking the best possible balance between reducing radiated spurious emissions (RSE), minimizing the specific absorption rate (SAR), and achieving high-quality antenna characteristics (over-the-air-performance = OTA). Any adjustment of one of these parameters also affects the others. The precise and repeatable measurement of RSE and OTA has so far taken up valuable time in an anechoic chamber.

The new R&S®R-Line test chamber (FIG 1) makes it possible to perform effective RSE and OTA measurements already at the development stage without the need for a large anechoic chamber. The test chamber fits into any lab and requires no special infrastructure or constructional measures. As it is equipped with castors, it can quickly and easily be moved to wherever it is needed. The size of the test chamber has been optimized to make it as compact as possible (W × D × H: 1690 mm × 1560 mm × 2130 mm) without making unreasonable compromises in terms of performance.

Measurements in a compact test chamber will provide the desired benefit, i.e. reduce the subsequent measurement time in an anechoic chamber, only if the results it delivers are directly comparable to those obtained in the anechoic chamber. This requirement must be met in order to ensure that the measurements performed during development are not just estimates that provide no reliable information about the results to be expected in an anechoic chamber. One of the big advantages of the R&S®R-Line is the high level of comparability it offers. This is a prerequisite for the subsequent, successful certification of equipment under test (EUT) that has passed the measurements in the test chamber.

In addition to carefully selected absorber materials and features, the R&S®R-Line has a dual-polarized test antenna for the frequency range from 0.8 GHz to 18 GHz, a circularly polarized communications antenna for the range up to 6 GHz, and a two-axis turntable for positioning the EUT in any orientation. Due to the special design of the turntable using RF-transparent material, effects on field uniformity are minimal. A particularly critical area here is the zone directly surrounding the EUT, since even plastic materials with a dielectric constant of >1.5 result in major field distortions and consequently measurement inaccuracies. For this reason, the R&S®R-Line has been specially optimized in this zone to cause low interference while providing sufficient stability. This applies to the support and fixture taking up the EUT, as well as to the mounting and the drive gear for the inner positioner (FIG 3). The motors are remotely controlled, which enables not only accurate positioning but also automatic measurements and thus reduced measurement costs.

FIG 1 Featuring compact dimensions and lockable castors, the R&S®R-Line test chamber can quickly and easily be moved to any desired location.

Example of field Distribution in the R&S®R-Line test chamber

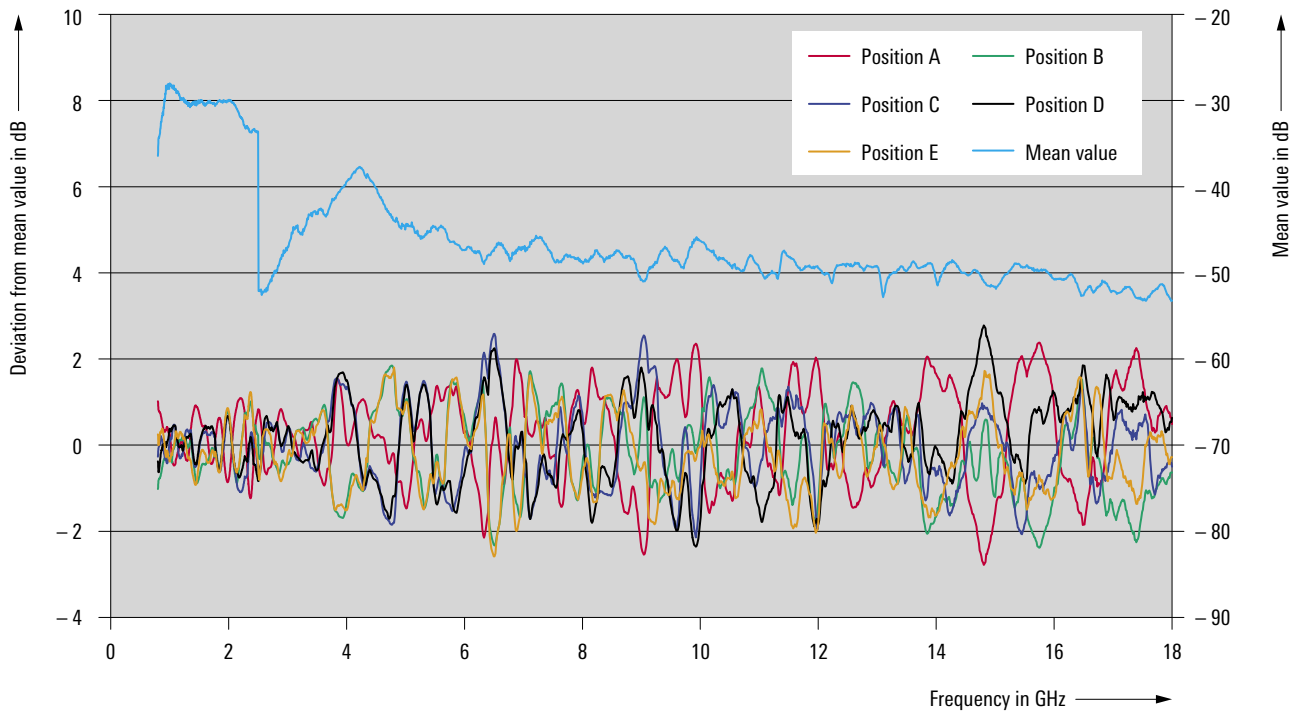

FIG 2 Field distribution in the R&S®R-Line. The above example demonstrates the high degree of uniformity of the electromagnetic field, measured at five positions of a plane.

Demonstrably good RF characteristics

To demonstrate the good RF characteristics of the R&S®R-Line test chamber, field distribution measurements were first performed. A reference dipole was installed on the turntable in place of the EUT and fed with signals from the tracking generator of a spectrum analyzer. The test antenna picked up the field thus generated with the appropriate polarization. These measurements were repeated at various positions in the chamber to check uniformity of the field distribution.

FIG 2 shows an example of such a measurement. The reference antenna was placed in five different positions: in the center of the zone surrounding the EUT and at the four corner points of a horizontal square with 20 cm edge length around the center point. The transmission loss measured with the test antenna was determined. The diagram shows the deviation from the mean value versus frequency for each position of the reference antenna (colored lines in lower half of diagram with left-hand scale). The mean value (blue line in upper half of diagram with right-hand scale) is the mean of the maximum and the minimum transmission loss and also indicates the frequency response of the reference antenna (two antennas for the ranges 0.8 GHz to 2.5 GHz and 2.5 GHz to 18 GHz), since no corrections were made to the antenna factors.

Measurement of radiated spurious emissions (RSE)

Measuring the radiated spurious emissions of an EUT requires tests at a high degree of sensitivity. Since the EUT also communicates with the radiocommunications tester (i.e. the base station emulator = BSE), the uplink signal, i.e. the signal in the direction of the BSE, must be sufficiently suppressed to enable reception of the weak spurious signals. This is achieved through the use of filters that suppress exactly the uplink frequencies. Since the EUTs normally support different wireless frequency bands, a separate filter is required for each of these bands. The filter is switched into the path between the antenna and the preamplifier via a switching matrix. The R&S®TS8996 RSE test system from Rohde&Schwarz includes all components required for these measurements and offers a user-friendly solution together with the R&S®R-Line test chamber.

RSE measurements are performed to verify whether and in what direction an EUT radiates spurious emissions above the specified limit values. The EUT must therefore be rotated into a wide range of positions so that it can be tested from all directions. Automatic positioning can significantly facilitate these measurements. The R&S®R-Line is equipped with a two-

axis turntable for this purpose (FIG 3). It includes a supporting plate with an inner positioner at its center. The positioner, which takes up the EUT, is rotated by means of a belt drive. The supporting plate is rotated vertically about the main axis.

RSE test standards specify measurements in a fully anechoic chamber. Such chambers are installed in many quality assurance test labs. For use in development, however, chambers of this kind would not only involve high investments but also take up too much space. Simple solutions, on the other hand, e.g. GTEM cells for tests in the microwave range, offer only low measurement accuracy and reproducibility and therefore allow no reliable correlation to standard-compliant measurements performed in an anechoic chamber. Here, the R&S®R-Line is impressive for its high quality. Due to its elaborate design and the careful selection of absorber materials and features, it exhibits RF characteristics as good as those of an anechoic chamber. Using the compact test chamber, RSE measurements can also be carried out in the lab, allowing improvements to be made at an early stage in the development of wireless terminals.

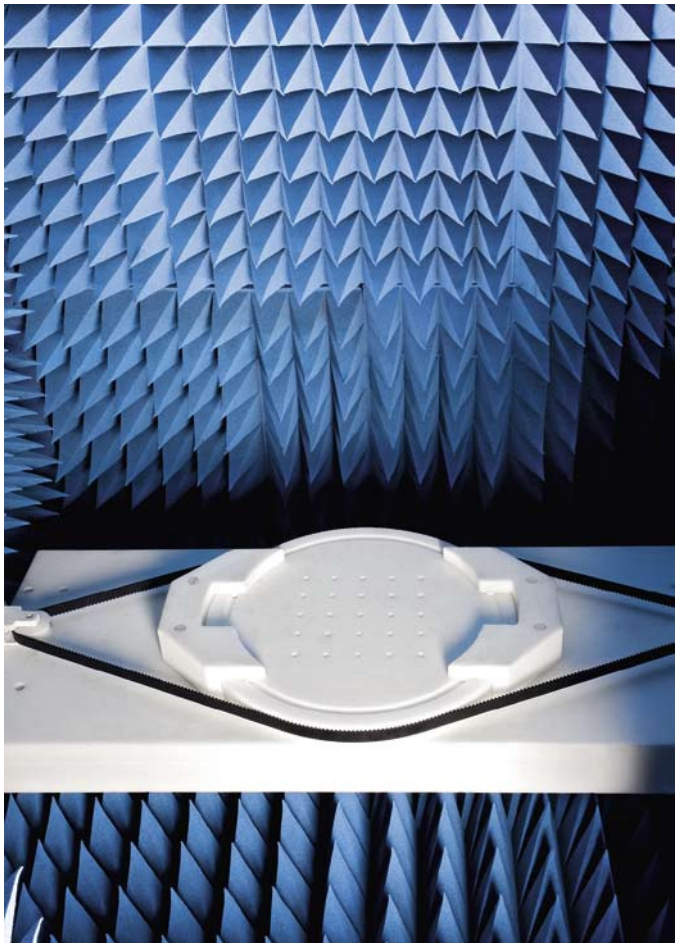

FIG 3 Two-axis turntable in the R&S®R-Line test chamber.

Performance measurements

OTA measurements are normally also carried out in fully anechoic chambers. The suitability of a chamber for these tests is established by measuring the region around the EUT position, which is referred to as the quiet zone. As the good characteristics of the R&S®R-Line shown in FIG 2 indicate, the test chamber can also be used for OTA measurements in conjunction with the R&S®TS8991 test system. In these measurements, both the transmitted power and the sensitivity of reception are recorded three-dimensionally. From the results obtained, the characteristic total radiated power (TRP) and total isotropic sensitivity (TIS) of the EUT are derived [*].

Summary

The R&S®R-Line is a compact test chamber for use at an early stage of development. The results it delivers can be fed back directly into the design of wireless terminals, thus saving valuable time in the development process. The test chamber fits into any lab and, featuring lockable castors, can quickly and easily be set up wherever it is needed.

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REFERENCE

* R&S®TS8991 OTA Performance Test System: First certified test system for OTA measurements on WLAN user equipment. News from Rohde&Schwarz (2007) No. 192, pp 12–15.