

Measuring radiated RF characteristics of mobile phones right on the lab bench

First-time pass in certification measurements – this is a goal that every developer would like to achieve. The new R&S®DST200 RF diagnostic chamber can make this difficult path much smoother. It allows developers to perform a wide variety of radiated tests and receiver sensitivity measurements on wireless devices (e.g. mobile phones) – and it is available directly on the lab bench.

Vital to high product quality: verification of the air interface

Smart phones integrate a large number of functional units in the tightest of spaces. This high density makes the devices vulnerable to desense effects (self-interference). Desense effects can lower receiver sensitivity on specific channels, so that calls near the edge of a radio cell may become unstable. Developers must therefore take countermeasures early on. The R&S®DST200 RF diagnostic chamber enables developers of high-end mobile phones to measure and optimize devices in the lab during the development phase in order to reduce self-interference to acceptable levels (FIG 1).

Further crucial quality characteristics of wireless devices include the radiation characteristics of the built-in antenna as well as a consistently high receiver sensitivity across the entire band. Various radiated RF measurements ensure that a high quality of service (QoS) is later achieved in the radio cell. The R&S®DST200 supports the following measurements, for example (see also box on pages 8/9):

- Desense (self-interference) testing
- Detection of EMI sources
- Coexistence testing of wireless devices for multiple RF standards
- Verification of over-the-air (OTA) performance
- Measurement of radiated spurious emissions (RSE)



FIG 1 The R&S®DST200 RF diagnostic chamber with 3D positioner (R&S®DST-B150 option). It allows the user to position the EUT in any orientation relative to the test antenna with a turn of the wrist.

Reduced development time – shorter time to market

Wireless devices, e.g. smart phones with numerous air interfaces, require comprehensive testing during the development phase in order to ensure defined product characteristics later during operation. This fast-paced market calls for an efficient development process aimed at achieving first-time pass in certification measurements. Radiated measurements play an important role here and require well-coordinated tools and test environments.

Thanks to its compact size ($W \times H \times D$: 770 mm \times 760 mm \times 695 mm), the R&S®DST200 fits on any lab bench. For product optimization, this means that no continuous access to large EMC test chambers is necessary – which are often not available at short notice. Wait times are eliminated and development time is reduced, resulting in lower cost of ownership.

Free-space conditions ensure outstanding reproducibility of measurements

With a frequency range of 700 MHz to 6 GHz, the R&S®DST200 covers all important wireless standards. The broadband test antenna with circular polarization delivers reliable results throughout the R&S®DST200's frequency range.

Free-space conditions exist within the actual test chamber. This is achieved through the use of high-grade RF absorbers, the geometrical arrangement of the test antenna and the location of the equipment under test (EUT) within the EUT test volume. The RF absorbers minimize parasitic coupling of the EUT as well as detuning of the EUT's built-in antenna caused by conductive parts of the chamber frame.

Sensitivity tests on GPS receivers with input levels < -160 dBm call for perfect RF shielding of the test setup. With its outstanding shielding effectiveness of > 110 dB, the R&S®DST200 blocks all interferers present – whether from adjacent test setups or from sources such as base stations or TV transmitters.

The excellent electric field uniformity throughout the EUT volume ensures reproducible test results (FIGS 2 and 3). By contrast, RF test chambers that use near-field couplers demand an intricate, precise fixing of the EUT in the millimeter range because the near-field field strength changes considerably over short distances. The R&S®DST200 ensures stable results even if the position of the EUT is slightly changed.

Manual 3D positioner

The product design process often requires measurements with the EUT placed in a specific orientation, for example in order to test and optimize the radiation characteristics of

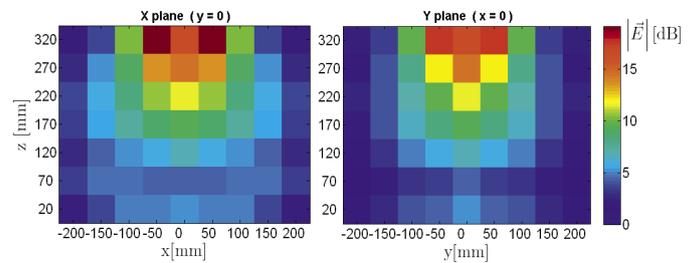


FIG 2 Spatial distribution of the radiated electric field in two vertical planes; R&S®DST200 test antenna at 950 MHz. The origin of the coordinate system is located in the center of the EUT table.

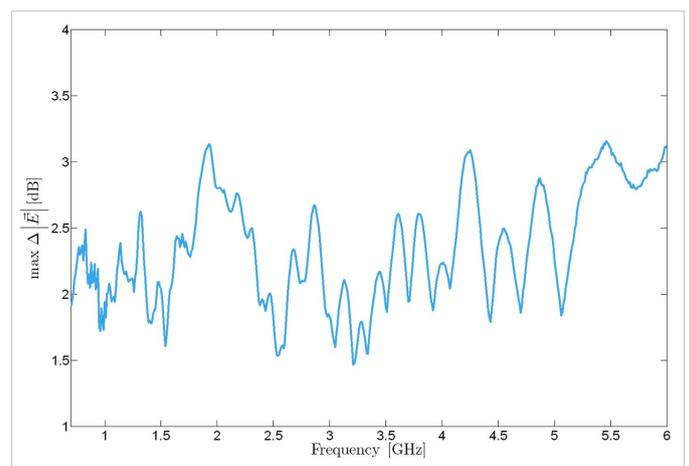


FIG 3 Maximum relative variation of the electric field in a cylindrical EUT volume ($D \times H = 200$ mm \times 30 mm) above the EUT table.

the integrated antenna. An easy-to-operate 3D positioner with two axes of rotation allows the EUT to be secured in any orientation relative to the test antenna (FIG 1). The positioner's open structure provides access to the EUT's keys, switches or touch screen, making it easy to set the required operating modes. Two angular scales permit accurate positioning for reproducible measurements.

Innovative door mechanism

The clever front door locking mechanism provides excellent shielding effectiveness at low locking force and supports long-term operation. The door, which is hinged in a separate frame, is locked into the groove of the RF chamber main frame with a simple turn of the door handle. In contrast to conventional designs, the locking force is uniformly applied to all RF gaskets of the main frame, which protects the gaskets

in continuous use. Pneumatic components are not required. This concept increases availability of the R&S®DST200 and minimizes service costs.

Practical design for customized expansions

Shielded compartments above and below the actual test chamber allow the installation of additional hardware. For example, preamplifiers may be used to extend the dynamic range for radiated spurious emission measurements, or RF switching can be implemented to distribute the test signal to various measuring instruments. This innovative concept does not impair the field characteristics within the EUT volume.

For many measurements, access to external interfaces of the EUT is required. Typical test functions include battery charging, control of the test mode interface, and measurement of

the data throughput. For these measurements, up to three RF filters or RF feedthroughs can be installed in the compartment below the actual test chamber. Various options are available:

- 9-pin D-Sub lowpass filter and two fiber-optic feedthrough connectors (R&S®DST-B101 option)
- Two N RF feedthrough connectors (R&S®DST-B102 option)
- USB 2.0 lowpass filter (R&S®DST-B103 option)

Automated measurements with configurable test templates

The powerful R&S®AMS32 system software supports various test applications in the R&S®DST200, for example desense tests, coexistence tests and verification of over-the-air performance. Measurements of radiated spurious emissions are performed with the R&S®EMC32 EMC test software

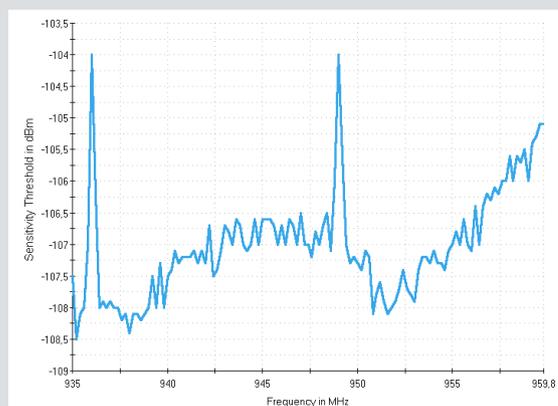


FIG 4 Desense (self-interference) measurement: desense effect in two channels (nos. 5 and 70) in the GSM900 band.



FIG 5 Coexistence measurement: bit error ratios (BER) in the GSM850 band without (green) and with (blue) active Bluetooth™ connection.

Radiated characteristics and receiver sensitivity – the R&S®DST200 supports a wide range of measurements

Desense or desensitization (self-interference)

High-end mobile phones include a large number of components such as RF modules, camera, display, etc. integrated in the smallest possible space. These components can interfere with one another and reduce receiver sensitivity on specific channels. Interference originates from oscillator harmonics or crosstalk on printed board signal paths. It reduces the quality of service (QoS), with the consequence that calls at the edge of a radio cell can become unstable.

Desense measurements (FIG 4) require an active link with a radiocommunications tester (such as the R&S®CMW500). After the link is established, the bit error ratio (BER) or packet error ratio (PER) is measured while a potential interferer is active.

Detection of EMI sources

Oscillator harmonics in the operating band can cause desense effects. For an overview measurement, only a test receiver is required that carries out a frequency sweep. The EUT's RF transceiver remains switched off. To increase sensitivity, the EUT can be moved closer to the test antenna.

Coexistence test

Another important test is to verify the correct functioning of multiple radio services operating simultaneously in a wireless device, such as mobile radio, GPS receiver, Bluetooth™ or WLAN. These can reduce receiver sensitivity. For example, harmonics of specific GSM900 channels are located at 5 GHz in the WLAN range. Errors in data transmission necessitate the repeated transmission of packets and lower data throughput (FIG 5).

For a coexistence test, a link with the possibly affected radio service is set up, and the receiver sensitivity is measured across the entire band. Next, an additional connection with the potential interferer is set up, and the receiver sensitivity for the first radio service is tested again. Alternatively, the data throughput with and without an interferer can be measured.

(a comprehensive article starting on page 32 presents new expansions for this software). R&S®AMS32 and R&S®EMC32 include ready-to-use test templates that require no programming knowledge on the part of the user. The individual test plans and the test report format are easily configured via menus.

Summary

The R&S®DST200 RF diagnostic chamber provides developers of wireless devices with an economical means of performing radiated RF measurements under free-space conditions. The compact test chamber fits on every R&D lab bench. Already at the design stage, developers can measure desense as well as radiated spurious emissions, perform coexistence tests, verify OTA performance and detect harmonics in the operating band. The R&S®DST200 also is a highly valuable tool in

production, servicing and qualification measurements in order to monitor and verify product quality.

As a result of the clever design of the R&S®DST200 with shielded compartments above and below the actual test chamber, the R&S®DST200 can be tailored to meet customer's requirements, providing sufficient flexibility for future applications.

Erwin Böhler; Adam Tankielun

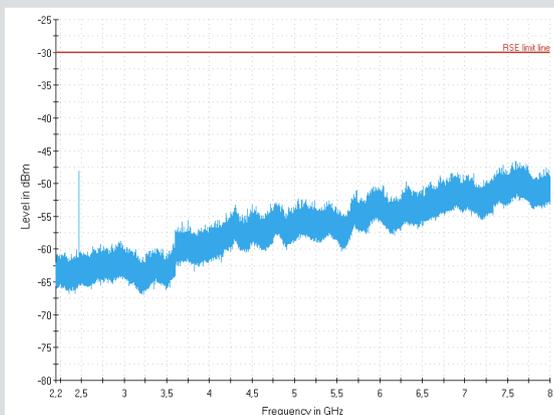


FIG 6 Radiated spurious emission (RSE) measurement: harmonic of the carrier frequency in the GSM850 band.

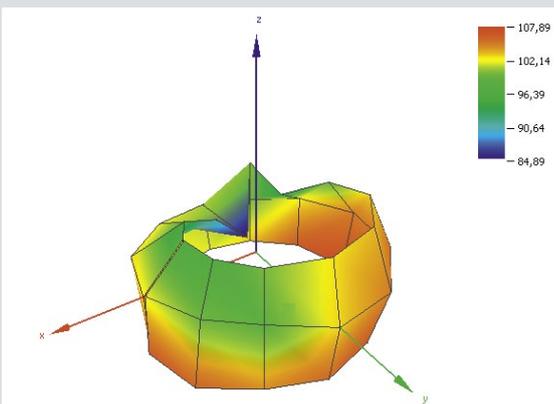


FIG 7 Receiver sensitivity of a mobile phone in the GSM1900 band, measured in three spatial sections.

Radiated spurious emissions (RSE)

The usable frequency spectrum is a valuable resource for network operators. To provide maximum capacity on all channels, radiated spurious emissions of wireless devices must not exceed specified limit values. Radiated harmonics of the carrier frequency and other radiated spurious emissions have to be measured in line with the 3GPP and ETSI test specifications. Further mandatory tests are defined by telecommunications (e.g. R&TTE directive) and government authorities (e.g. FCC). The specified measurements can be performed in the R&S®DST200 with a simple test setup consisting of an R&S®CMW500 universal radio communication tester and a test receiver (FIG 6).

Over-the-air (OTA) performance

CTIA and 3GPP have specified measurements to verify the transmission characteristics of antennas used in wireless devices. Measurements cover the total radiated power (TRP) and the total isotropic sensitivity/total radiated sensitivity (TIS / TRS). These integrated measurement quantities must comply with predefined limit values.

Using the R&S®DST-B150 3D positioner, the RF power and the receiver sensitivity can be measured in the R&S®DST200 in adjustable polar positions (FIG 7). The R&S®AMS32 system software enables semi-automatic measurements with manual positioning and automatic test analysis. Test results are shown both as an azimuth chart with several sections and as a 3D representation.