R&S®DST200 RF diagnostic chamber for automated OTA and RSE measurements

An automated 3D positioner is now available for the R&S®DST200 RF diagnostic chamber. This opens the door to automated OTA and RSE measurements in R&D and quality assurance. The test chamber is the most compact on the market and allows users to perform measurements directly on the lab bench. Users will especially like the excellent correlation of results achieved with the R&S®DST200 with those obtained with larger OTA test chambers.

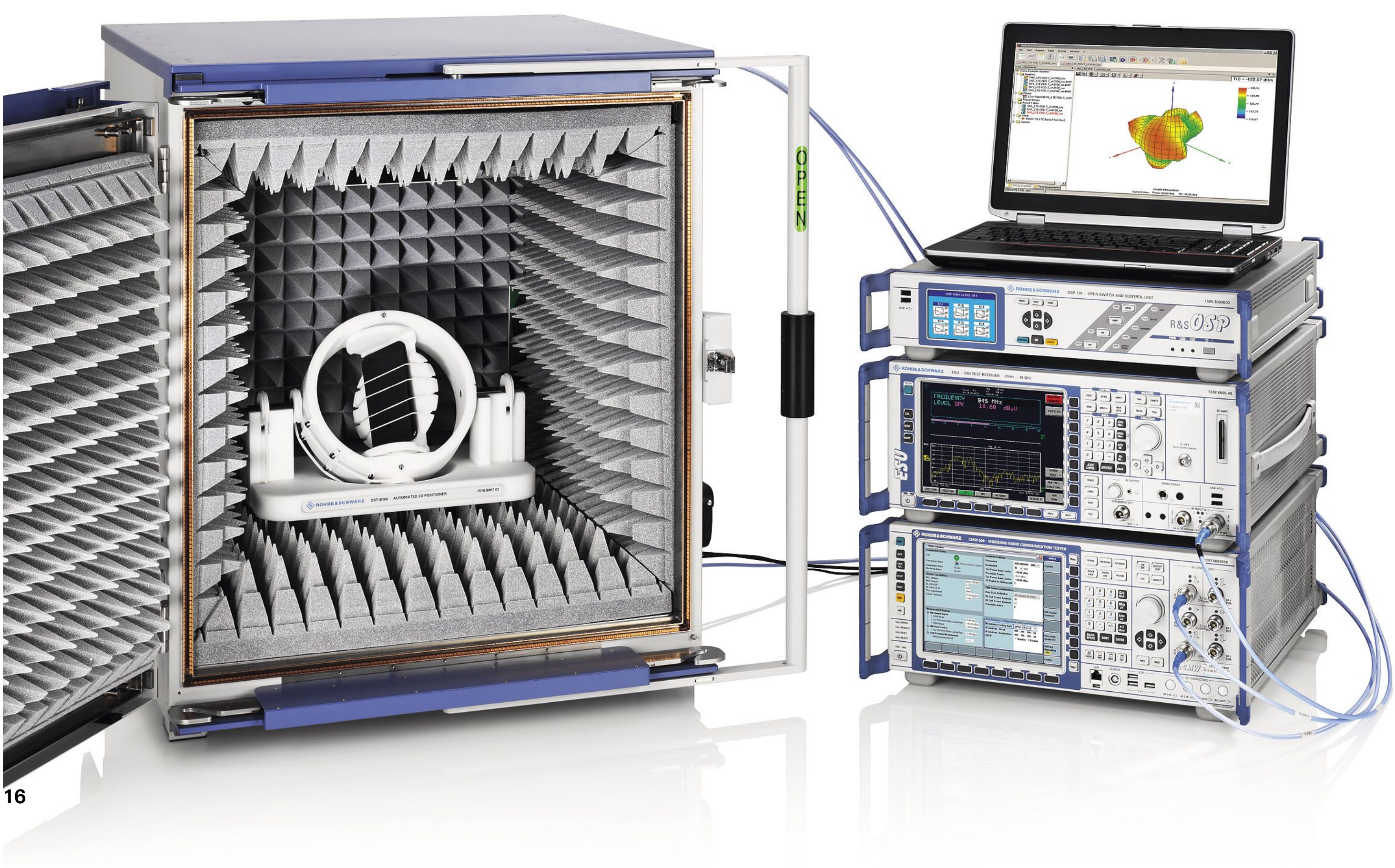
Over-the-air (OTA) measurements

Every wireless device has to undergo OTA testing before it is put on the market. Tests have been specified by CTIA, and similarly by 3GPP, for the three-dimensional, angle-dependent measurement of key parameters such as total radiated power (TRP) and total isotropic sensitivity (TIS). These tests are usually carried out in an RF shielded environment. They deliver conclusive information about how a wireless device will behave in a network and are therefore required by network operators.

Radiated measurements with the R&S®DST200 – in a minimum of space

The R&S®DST200 RF diagnostic chamber allows for extremely compact test setups. It fits on any lab bench – together with the test equipment and a PC – and is easy to transport and install (Fig. 1). The RF frontend of the R&S®CMW500 wideband radio communication tester contains several RF connectors for transmit and receive signals. In the simplest scenario, no RF switching matrix is required; all that needs to be done is connect the RF cables between the tester and the R&S®DST200. Users can then perform a wide range of measurements (Fig. 2).

Fig. 1 OTA measurements requiring a minimum of lab space: the R&S®DST200 RF diagnostic chamber with automated 3D positioner, R&S®OSP130 open switch and control platform, R&S®ESU EMI test receiver and R&S®CMW500 wideband radio communication tester.



Key component: the automatic 3D positioner

The new, optional R&S®DST-B160 automated 3D positioner (Fig. 3), for which Rohde&Schwarz has a patent pending, is the automatic version of the existing R&S®DST-B150 manual 3D positioner. The equipment under test (EUT) is attached to a removable support at the center of the positioner and is rotated by two servomotors about the azimuth and the elevation axes. An optical sensor ensures high positioning accuracy, allowing both axes of rotation to be automatically reset to a defined start position. The automated 3D positioner is remotely controlled via its RS-232-C interface. The R&S®AMS32 OTA performance measurement software and the R&S®EMC32 EMC measurement software include drivers for this interface.

The servomotors and the motor control unit are accommodated in the RF shielded bottom compartment of the R&S®DST200, preventing EMI leakage to the outside which could affect receiver sensitivity measurements. The positioner is made of a very low relative permittivity material to minimize field perturbation in the EUT quiet zone.

New, cross-polarized test antenna

In OTA and RSE measurements, a series of tests are performed during which the EUT transmits or receives ϕ and θ orthogonally polarized fields. Rohde&Schwarz now offers an antenna suitable for performing these measurements: the new R&S®DST-B210 cross-polarized test antenna. It has two sections arranged at right angles and connected to two RF ports. The compact antenna achieves broadband radiation characteristics in the frequency range from 70 MHz to 12 GHz and features a high cross-polarization ratio. The measurement distance between the center of the 3D positioner and the test antenna is approx. 280 mm. Path loss calibration tables for all test antennas compatible with the R&S®DST200 can be found on the Rohde&Schwarz website. These tables can be used to carry out high-precision absolute-level measurements. Test antennas are easily interchanged after opening the top cover of the R&S®DST200.

Typical measurements

A-GPS testing

Compared to standalone GPS, assisted GPS (A-GPS) reduces the time needed to calculate the position of a wireless device. In addition to satellite information, A-GPS uses information from the base station, such as accurate coordinates of the cell base stations and precise time information. A-GPS capability is a key requirement in order to meet the US Federal Communications Commission (FCC) wireless 911 rules requiring service providers to deliver fast and reliable location information even under poor signal conditions.

The new R&S®DST-B160 automated 3D positioner and the R&S®DST-B210 cross-polarized test antenna are mandatory options for performing A-GPS measurements with the R&S®DST200. The R&S®SMU200 vector signal generator simulates eight satellites, whose downlink signals are applied to the test antenna in the R&S®DST200 in the ϕ and θ polarization planes (Fig. 4, example 3). The EUT extracts information such as position data and received signal level from the satellite data and sends it to the R&S®CMU200 universal radio communication tester via a cellular link.

A-GPS measurements in line with CTIA 3.1 can be very time-consuming. Testing multistandard smartphones takes several

Measurement	Description
OTA SISO	Over-the-air performance test in line with CTIA 3.1 TRP and TIS, GSM, WCDMA, CDMA2000®, LTE
OTA MIMO	Over-the-air performance test: transmit diversity, spatial multiplexing modes
A-GPS	Assisted GPS performance test in line with CTIA 3.1
Coexistence	Simultaneous operation of two cellular or wireless services (e.g. GSM and WLAN)
Desense	Verification of OTA sensitivity degradation caused by internal EUT EMI sources (self-interference)
EMI scan	Quick detection of EMI sources within the RF operating band (in-band emissions)
RSE	Radiated spurious emissions measurement, e.g. to verify compliance with specified limits in line with ETSI EN 301 908 (WCDMA) or similar standards

Fig. 2 The R&S®DST200 RF diagnostic chamber enables a wide range of measurements in R&D, quality assurance and product qualification.

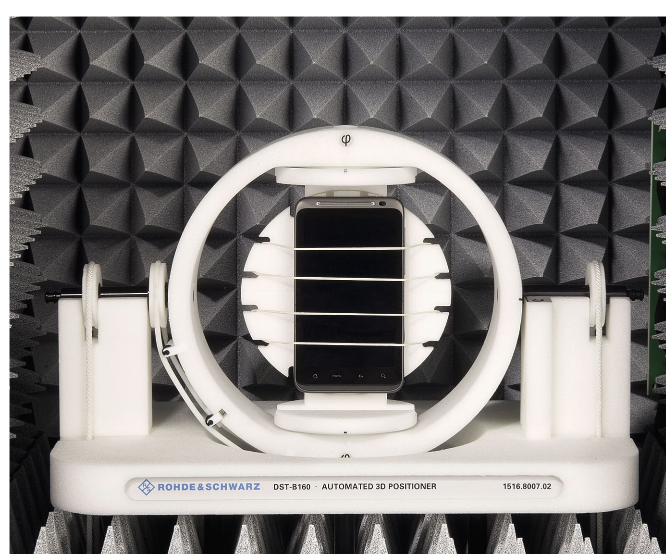


Fig. 3 The R&S®DST-B160 automated 3D positioner.

hours, for example. The compact R&S®DST200 makes it possible to perform such measurements right on the lab bench. Product optimization takes place in the lab, and developers no longer require constant access to large OTA test chambers, which are often not available at short notice.

RSE measurements – mandatory for all wireless devices

All wireless devices need to be tested for radiated harmonics of the carrier frequency or other spurious emissions (radiated spurious emissions, RSE). Measured values must comply with specified limits in line with 3GPP, ETSI or FCC standards, for example. RSE measurements can be made using a simple test setup with the R&S®DST200, an R&S®CMW500 and an R&S®ESU EMI test receiver (Fig. 4, example 4). The R&S®OSP130 open switch and control platform connects the ϕ or θ polarization plane of the test antenna to the test receiver input.

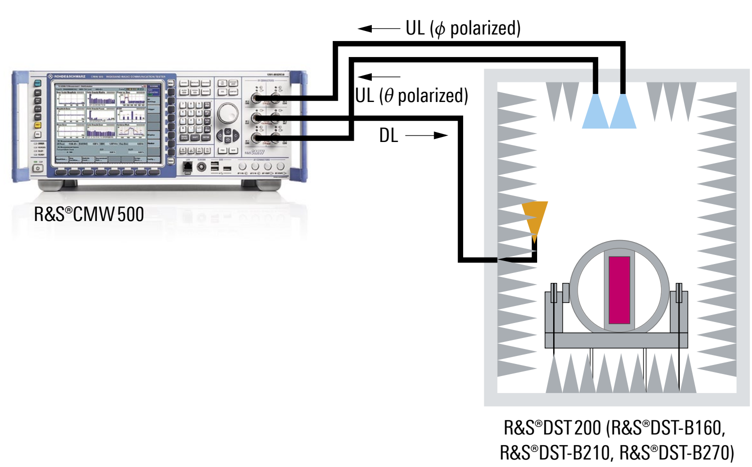
MIMO performance testing made easy

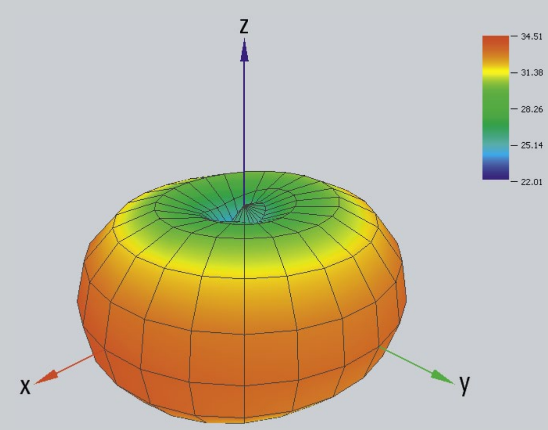
The performance gain achieved with 2×2 MIMO in the downlink – data throughput twice as high as with SISO – has to be verified at various stages in a product's life cycle:

- In R&D, e.g. during antenna design
- In production, for quality assurance
- In servicing, for quality assurance
- In qualification measurements

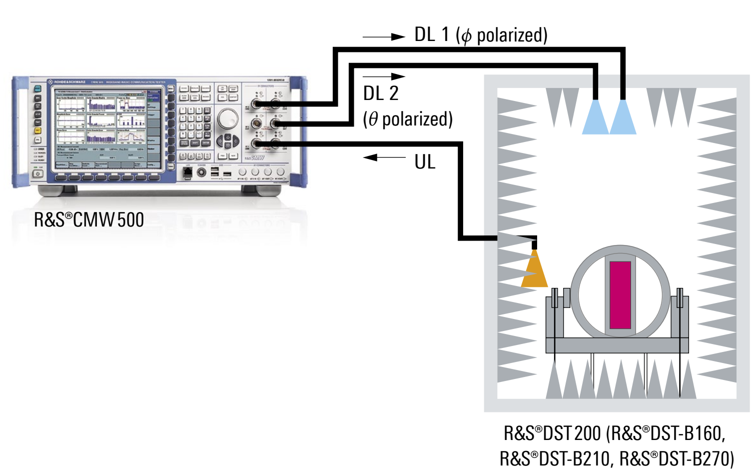
Fig. 4 Four example test setups and results for various radiated measurements with the R&S®DST200 RF diagnostic chamber.

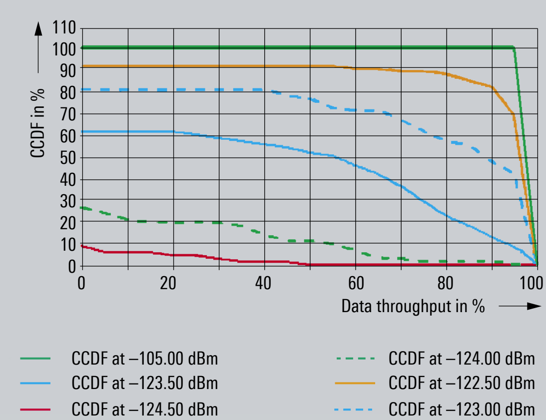
Example 1: OTA performance test; TRP, GSM900





Example 2: MIMO OTA performance test; transmit diversity, LTE



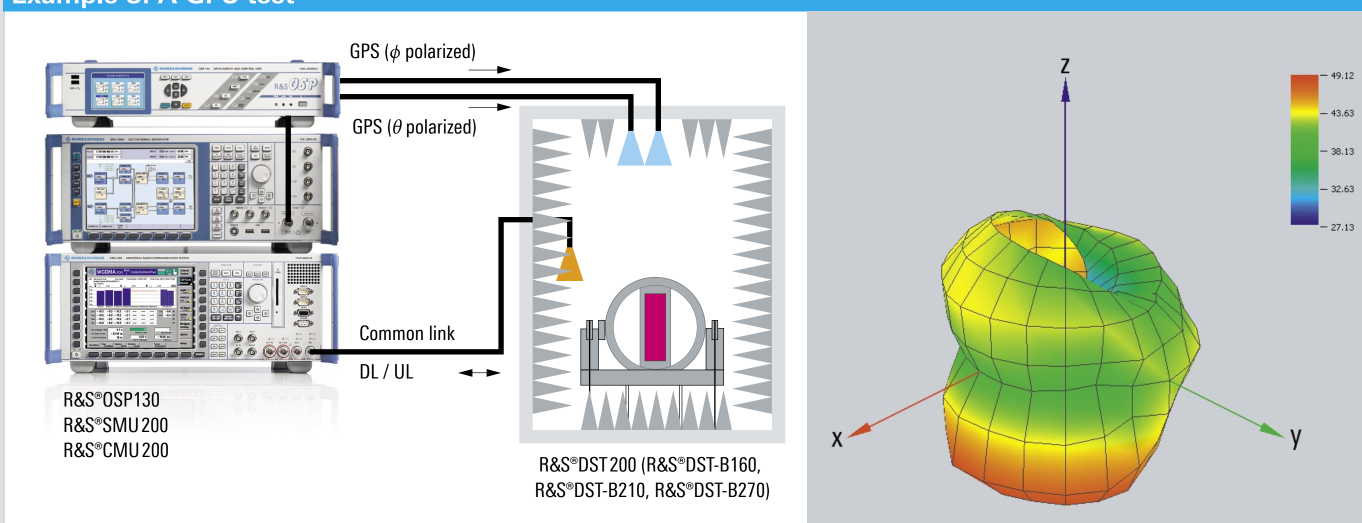


Pass/fail measurements and qualification measurements on MIMO-enabled wireless devices can be performed using a compact and simple test setup with the R&S®DST200 RF diagnostic chamber (Fig. 4, example 2). All LTE parameters can be configured with the R&S®AMS32 measurement software and the R&S®AMS32-K31 option (Fig. 5). The two downlink signals from the R&S®CMW500, which simulates the base station, are connected to the R&S®DST-B210 cross-polarized test antenna. The automated 3D positioner aligns the EUT in any desired orientation in the polar coordinate system to provide a complete picture of the spatial MIMO characteristics. Receiver sensitivity is plotted in a 3D diagram that reveals any sensitivity degradation in partial areas. The average data throughput is plotted versus the received signal level.

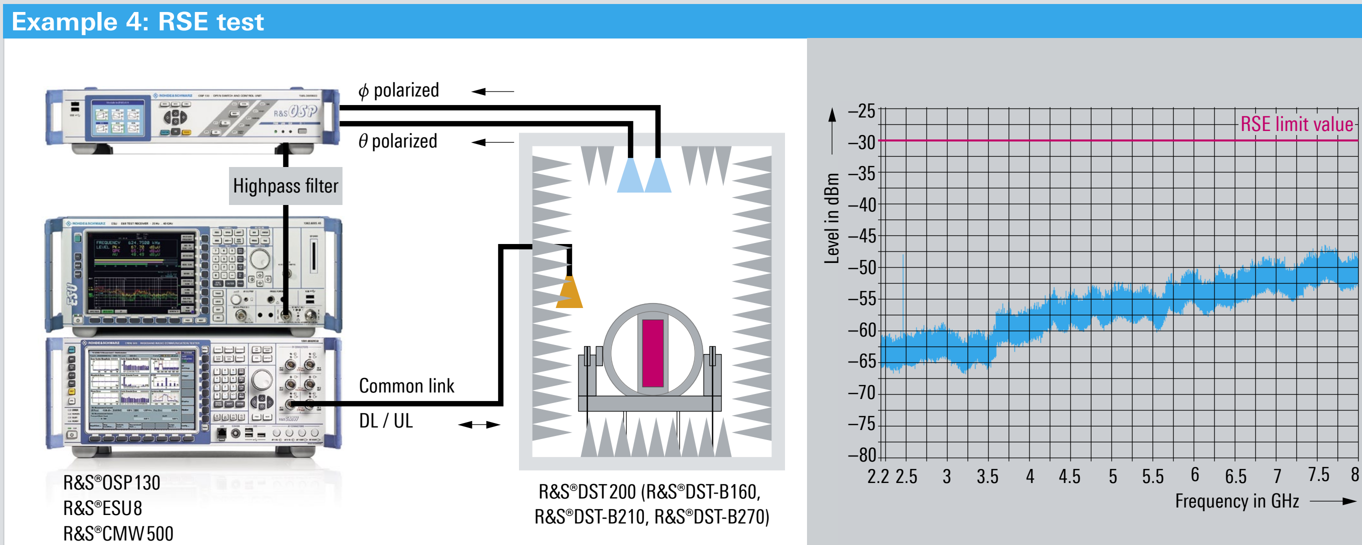
LTE parameter	Settings for LTE link
LTE band	1 to 41, FDD, TDD, depending on EUT capabilities
Radio channels	e.g. 5180 to 5279 for LTE FDD 13
Modulation	QSPK, 16QAM, 64QAM
Resource blocks	1 to 100
Start of resource block	0 to 99
Transport block size index	0 to 26
Bandwidth	1.4 / 3 / 5 / 10 / 15 / 20 MHz
MIMO mode	transmit diversity, open and closed loop spatial multiplexing

Fig. 5 Configuration of MIMO measurements using the R&S®AMS32 OTA performance measurement software and the R&S®AMS32-K31 option.

Example 3: A-GPS test



Example 4: RSE test



Excellent correlation of results between the R&S®DST 200 and larger OTA test chambers

Fig. 6 reveals statistical performance, showing the cumulative distribution functions (CDF) for the results obtained with three different test chambers. The EUT was operated in LTE MIMO transmit diversity mode, and receiver sensitivity was measured with the EUT set to six spatial orientations. The measurements made with the R&S®DST 200 RF diagnostic chamber were repeated in order to verify reproducibility of results obtained with the test chamber.

The best statistical sensitivity was obtained with the OTA reference test chamber (5 m × 5 m × 5 m), with 50 % of all antenna constellations yielding at least 90 % of the maximum data throughput at a downlink power density of $P_{iso} \approx -127$ dBm/15 kHz referenced to an ideal isotropic radiator. The R&S®R-Line compact test chamber (1.7 m × 1.6 m × 2.2 m) and the R&S®DST 200 delivered sensitivity 1 dB and 2 dB lower, respectively, for the same test parameters. The measurements also exhibited a high level of reproducibility for the tests performed with the R&S®DST 200, with resulting CDF graphs differing by no more than 0.5 dB.

Summary

The R&S®DST 200 RF diagnostic chamber together with its new options enables a wide range of automated OTA and RSE test capabilities, while offering the most compact size on the market. The R&S®DST-B160 automated 3D positioner and the test equipment are controlled using the R&S®AMS 32 and R&S®EMC 32 measurement software. Results are generated in the same way as with large OTA or EMC test chambers. These features combine to open up new applications in R&D and quality assurance in production and subsequent servicing by network operators. Rohde & Schwarz will continue to create new options and add-ons to make the R&S®DST 200 even more flexible.

Erwin Böhler; Adam Tankielun

The article starting on page 12 discusses typical RSE measurements on LTE wireless devices during development using the R&S®DST 200 RF diagnostic chamber.

Result correlation for three test chambers

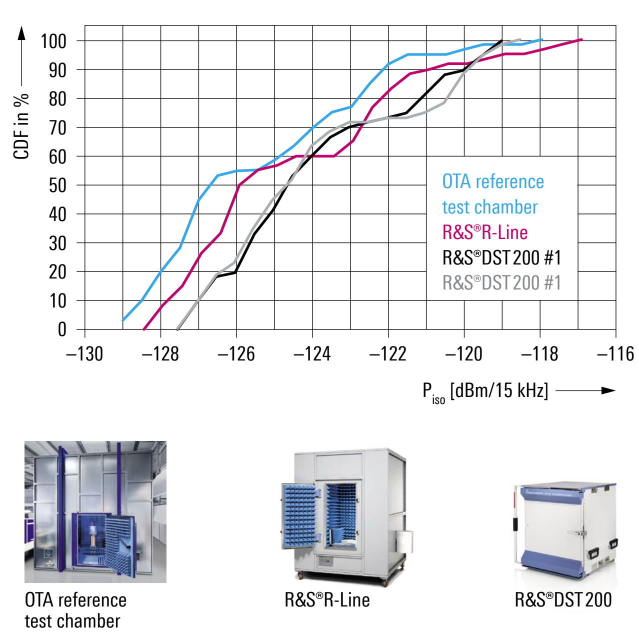


Fig. 6 CDF results obtained with three different RF test chambers for receiver performance tests in LTE transmit diversity mode.

Abbreviations

3GPP	3rd Generation Partnership Project
A-GPS	Assisted global positioning system
CDF	Cumulative distribution function
CTIA	Cellular Telecommunications Industry Association
DL	Downlink
EMI	Electromagnetic interference
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDD	Frequency division duplex
MIMO	Multiple input multiple output
OTA	Over-the-air
RSE	Radiated spurious emissions
SISO	Single input single output
TD	Transmit diversity
TDD	Time division duplex
TIS	Total isotropic sensitivity
TRP	Total radiated power
UL	Uplink
WCDMA	Wideband code divison multiple access