

CTIA test requirements cover over-the-air performance

Phones destined for the US market must undergo stringent over-the-air performance tests.

Martin Wiles explains the procedure, which could soon be adopted by Europe and Asia.

New test methods and performance criteria for over-the-air (OTA) testing of handheld wireless devices are now becoming mandatory. These tests scrutinize the connectivity of the mobile handset and ensure the detection and rejection of manufacturing defects. OTA tests determine how a specific network will influence the connectivity performance of a mobile handset. They yield data that can be used by handset makers to demonstrate that their products meet performance criteria. The tests reduce the need to perform field tests for connectivity and also allow operators to rapidly evaluate new products. Ultimately, OTA tests result in better products for the customer.

The US-based Cellular Telecommunications and Internet Association (CTIA) is currently the only organisation that produces OTA performance tests. Other organisations involved in this field are the PCS Type Certification Review Board (PTCRB), 3GPP and COST 273. The US based PTCRB provides a framework for GSM mobile equipment type certification. This includes the definition of the test specifications and methods to implement the type certification process for GSM mobile equipment. These requirements became mandatory for all GSM equipment in July 2004. While Europe's ETSI and 3GPP produce a range of standards, they have yet to publish OTA specifications. While it is likely that work now being done by Europe's COST 273 could result in OTA standards, there is unfortunately no known schedule for publication.

The CTIA aims to provide the wireless industry with an unbiased, independent and centralized product certification programme. The organization addresses the key cellular technologies used in the US: cdmaOne, cdma2000, GSM, TDMA as well as analogue.

CTIA certified products must pass a three-part technical evaluation process. Part one focuses on compliance with the wireless industry's technology platform standards. These tests are con-

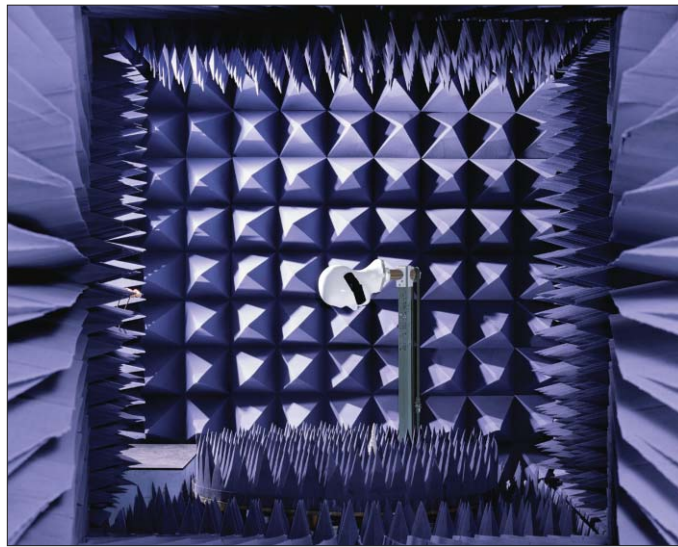


Fig. 1. Over-the-air testing of mobile phones is done using a SAM phantom, which determines the effect of the user's head on the antenna pattern.

ducted by a CTIA authorized testing laboratory and defined by the relevant test plans, which include (in part one) the CTIA CDMA Test Plan for CDMA handsets and the 3GPP TS 51.010 Test Plan for GSM products per the requirements defined by the GSM North America (GSMNA) PTCRB.

Also performed in an authorized testing laboratory, part two of the process tests OTA performance and is defined in CTIA Test Plan for Mobile Station Over the Air Performance. Part three is Federal Communications Commission (FCC) Type Acceptance Testing, which is

performed by an FCC authorized testing laboratory

There are currently five CTIA Authorised Test Labs (CATLs) — four in the US and one in Finland. All five facilities have accreditation to perform OTA performance testing and also possess other specialized accreditations. Other test laboratories in the USA and worldwide are working towards CATL status because part-two tests must be performed at a CATL to be CTIA certified. Many manufacturers are equipping their compliance laboratories for CTIA certification and type approval and some third-party test laboratories claim to have the capability to do CTIA tests but stop short of the full accreditation.

Although the CTIA requirements are intended primarily for handsets used in the US, both Europe and Asia appear to be following suit. Earlier this year a CTIA test facility was accredited in Europe and more will surely follow. Most major manufacturers produce products for a global market with several different protocols including those specific to the US. Manufacturers must test US protocols according to CTIA criteria and it would be logical to test European and Asian protocols at the same time.

Although none of the European or Asian network operators can enforce CTIA requirements at the moment, there is a widespread belief that identical or very similar requirements will be adopted shortly. W-CDMA in Europe could benefit from this

approach, but methods and criteria are not yet available for these new protocols.

Over-the-air performance tests measure the magnitude and direction of radiating energy to determine the performance of a wireless device. A typical polar pattern configuration is obtained with the measurement antenna fixed the antenna under test is rotated through 360°. There are two methods for acquiring the data — the great circle and the conical cut. Both produce the same 3D pattern.

The simplest case involves measuring the co-polarized component of a simple antenna. For complex or unknown antennas a dual-polarized measurement antenna is used to capture both polarization components and to determine a vector sum. In OTA tests it is important to determine the influence of the user's body on the transceiver properties and radiated performance and the differences between free-space and the standard anthropomorphic model (SAM) phantom (figure 1). SAM phantom tests determine the blocking effect of the human head on the antenna pattern, but do not address radiation absorption, hazard or health and safety issues.

There are five key parameters measured in OTA tests. The total radiated power (TRP) is determined by integrating the power measured over the surface or circle (or portion thereof) covered by the test. The peak effective isotropic radiated power (EIRP) measurement is based on the value of the maximum signal received, once the range calibration has been applied. Directivity is the difference between the peak EIRP and the TRP. The antenna efficiency is the difference between the TRP and the antenna port input power (APIP). The antenna gain combines efficiency and directivity and is given by the sum of those two values. The final key parameter is the set of three near-horizon partial radiated power (NHPRP) values.

A CATL test site for OTA measurements is subject to the CTIA site validation procedure, which involves a test of the chamber called the ripple test followed by range calibration test. The ripple test measures the chamber and the positioning system in its normal configuration. There are currently only two required test frequencies 836.5 and 1880 MHz. These may be extended in the future as the method includes additional protocols. Tests are performed onsite by an accredited calibration laboratory. Currently only dedicated positioning equipment used together with a specially designed anechoic layout can be used. Standard antenna chambers and EMC chambers are not suitable for this application.

Range calibration involves determining the total system loss with a reference antenna in the place of the equipment under test (EUT). This single two-step measurement reduces mea-

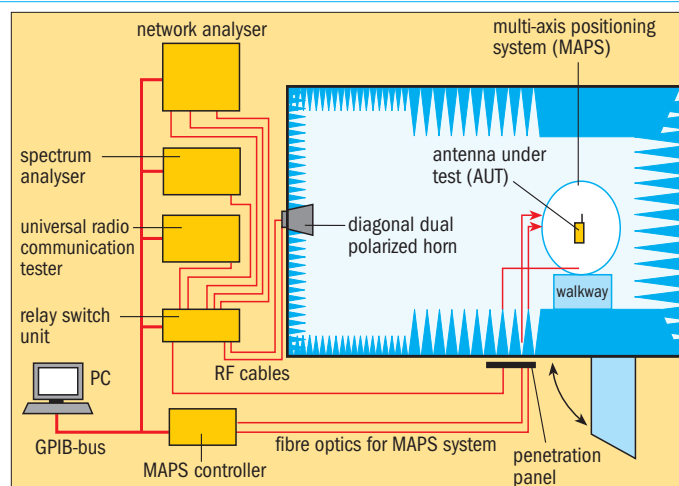


Fig. 2. A typical OTA test system: a range of test and measurement equipment is used to simulate and analyse the links between the antenna under test (AUT) and a base-station.

surement uncertainty related to path loss, receiver antenna gain and cable loss. Transmit cable loss is calibrated out of the measurement and the gain of the reference antenna is applied to relate the receiver power to isotropic radiated power.

Testing can begin once CATL status has been gained. Handheld devices must be evaluated with the device in the head-adjacent position fixed to a SAM phantom head. Non handheld devices can be tested in free space. A communications tester — which is essentially a base station simulator — plays a key role in the

testing (see figure 2). This instrument controls the EUT via one (or more) communications antenna(s) located in the chamber. This is necessary because the EUT is a cordless device and therefore cannot be controlled via cable.

Cellular handsets receive and make calls and both operating modes are addressed by separate sets of 3D antenna pattern tests. The ERP test looks at the mobile transmit power when making a call. The phone is set up in call mode and the measurement antenna determines the total radiated power when the phone is rotated through a full sphere. Data points are taken every 15 degrees in both the theta and phi axes and 264 power measurements are integrated to provide the TRP. The 3D antenna pattern data obtained during the test is used to calculate a number of other parameters including the EIRP, NHPRP, directivity, gain and efficiency. These data must be presented in tabular as well as graphical format.

The receiver loopback test measures receiver sensitivity by determining the minimum received power required to achieve the specified bit error rate (BER) or frame erasure rate (FER). The test involves making 60 measurements at different positions on the sphere, which are integrated to yield a single figure of merit known as the total isotropic sensitivity (TIS). The 3D antenna pattern data is also used to calculate parameters such as effective isotropic sensitivity (EIS), near-horizon partial isotropic sensitivity (NHPIIS). The CTIA specifications do not include pass/fail criteria, which are currently defined by operators and handset manufacturers. This scenario is not expected to change in the future.

OTA measurements are a new addition to the test and measurement requirements of the wireless handset market. The test system requirement validation process is unique, requiring special attention and a dedicated facility. Experience with the procedures is limited but growing and with the increasing number of wireless protocols much expansion is expected in forthcoming versions of the CTIA document. ■

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