Hearing Aid Compatibility for Wireless Devices

HAC Testing Adds Another Layer of Compliance Complexity

by David Seabury

The use of wireless devices for both personal and business use continues to rise exponentially in developed and now in many immerging countries. The U.S. government has taken a strong position that the hearing impaired should have access to the networks through digital wireless phones. The testing and enforcement of these devices comes under the auspices of the Federal Communications Commission (FCC).

The U.S. Hearing Aid Compatibility Act of 1988 requires that audio frequency magnetic output of a wireline telephone be compatible with the operation of a hearing aid. The so-called "HAC Act" placed FCC requirements for phones intended for use on the public switch telephone network (PSTN). With the introduction of wireless devices and services in the 1990s, it was determined that excessive RF

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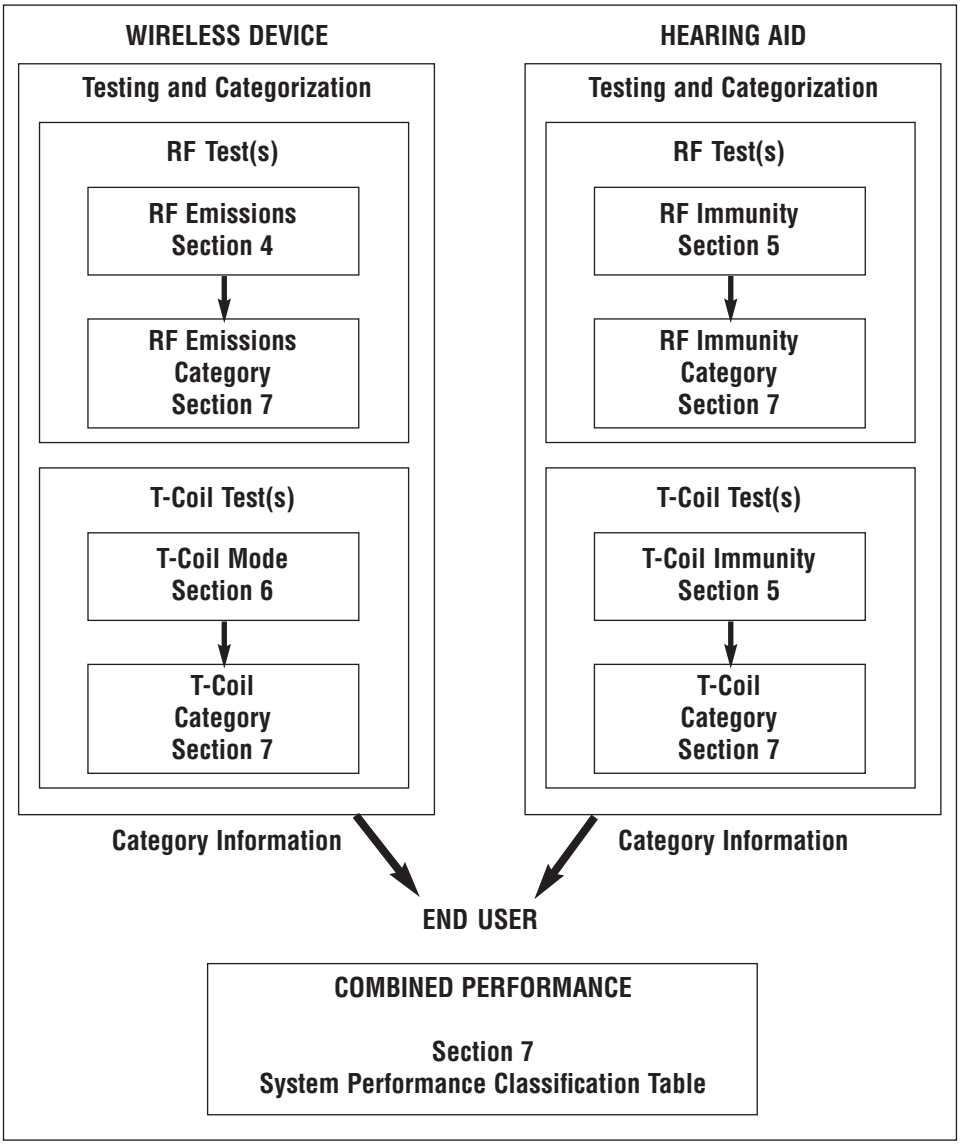

Figure 1: Organization and use of the HAC standard

interference could substantially interfere with the audio signal, but mobile phones were initially exempt from the requirements, due to a lack of existing measurement standards.

In 2001, ANSI C63.19 was initially approved as the measurement standard with relevant ratings, which would provide the hearing impaired with access to the growing market for wireless services. The standard addresses both hearing aids and wireless communications devices (WDs). As such, it applies emissions levels for operational compatibility for WDs, including cordless phones, PCS phones and VoIP devices that operate in the range of 800 MHz to 3 GHz. For the hearing aid, susceptibility tests are required for all types that provide an acoustic output. These tests include both RF and the T-coil mode emission measurements for the WD.

Correspondingly, the hearing aid is tested for immunity in the microphone and T-coil mode. All test levels are then categorized to provide a combined performance rating of both devices.

ANSI C63.19 states that "the purpose of this standard is to establish categories for hearing aids and for WDs that can indicate to healthcare practitioners and hearing aid users which hearing aids are compatible with which WDs, and to provide tests that can be used to assess the electromagnetic characteristics of hearing aids and WDs and assign them to these categories."

Figure 1 is from ANSI C63.19, and provides for an overview of the standard as defined in the main sections of the document.

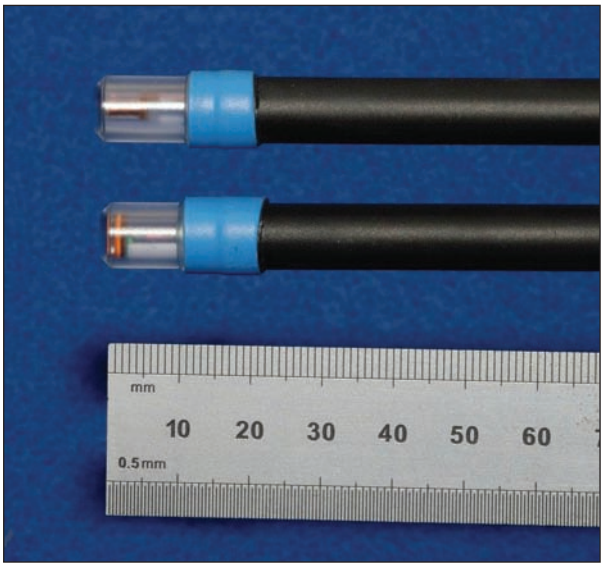

Figure 2: The Axial and Transverse T-coil probes (from top)

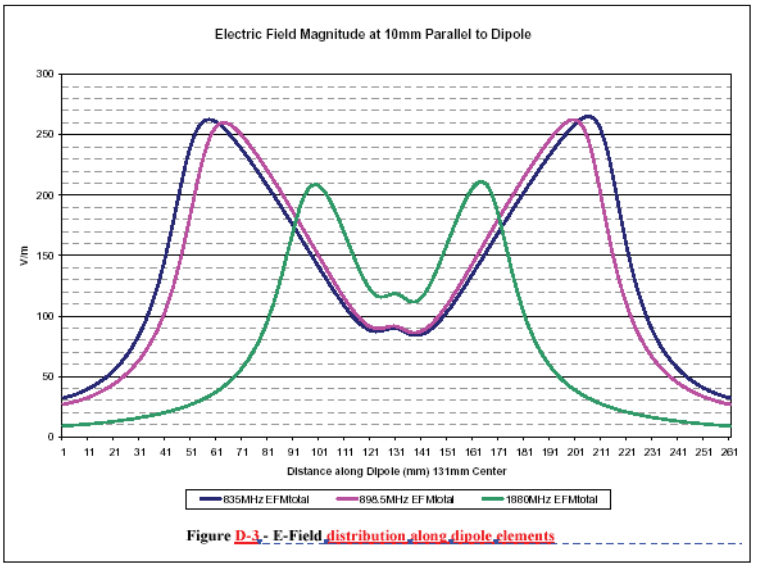

Figure 3: Predicted E-field variation along a dipole

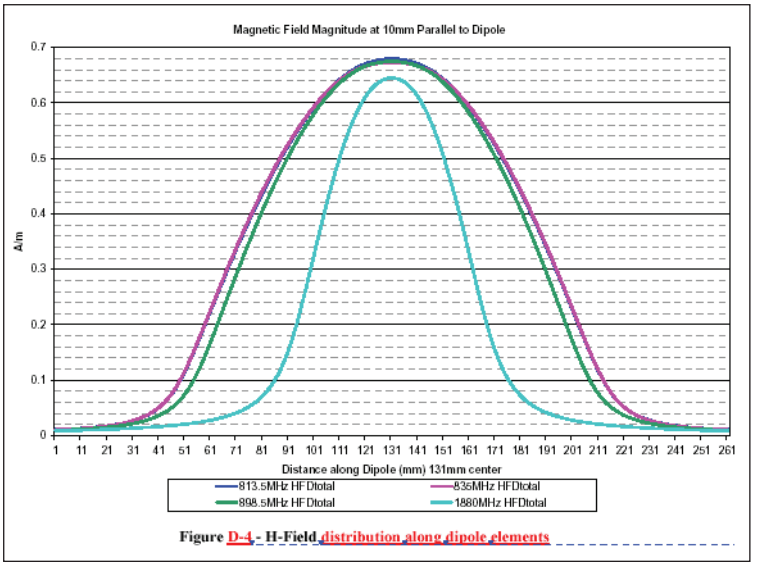

Figure 4: Predicted H-field variation along a dipole

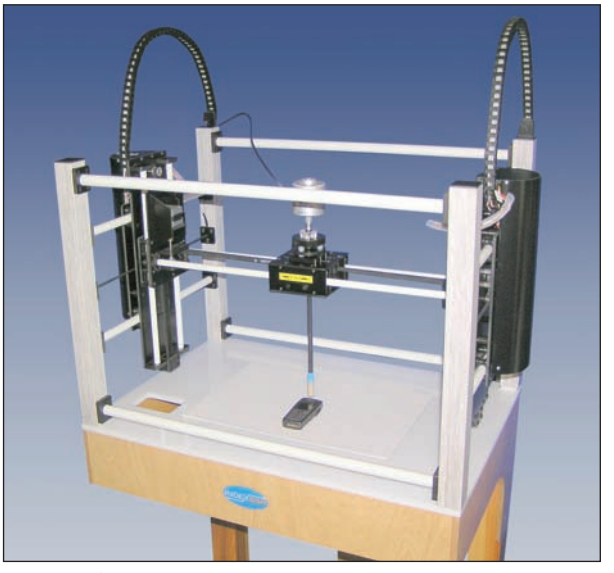

Figure 5: 2D scan with an E-field probe

In July 2003, the FCC issued document R7O 03-168, which removed the exemption for WDs from the original HAC Act, referencing the 2001 ANSI standard. Unlike the FCC specific absorption rate (SAR) requirements, HAC requirements apply not only to the wireless phone manufacturers but also the wireless phone service providers or carriers. An implementation timetable was put into place, requiring that service providers offer consumers by September 2005 access to defined percentages of handsets that met the RF or E and H field emissions requirements. The following year a lesser number of models would need to meet the T-coil categories. By February 2008, service providers must ensure that at least fifty percent of all handset models available meet the RF emissions levels.

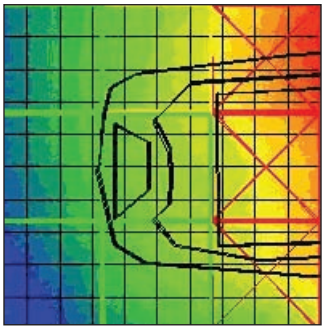

Figure 6: Schematic of the 2D scan, showing the 3 rejected sub-grids in red

Obviously, these requirements have a major impact on the already complex compliance requirements directed at telecom manufacturers already dealing with EMC, SAR and OTA testing. Coupled with ever-shorter design and product life cycles, consumer demands for increased functionality and extreme price competition, all providers are looking for speed and simplicity in meeting the myriad of compliance test requirements.

Complicating the HAC compliance issue are problems with the 2001 ANSI standard, which became apparent during early WD testing. The standard was republished in 2006 after many revisions, and a significant amendment was immediately added. At the October 2006 TCB workshop, the FCC took the position that new devices being submitted for approval would need to be tested to either the 2005 or 2006 versions of the standard, and that the Commission would consider the new amendment probably after six months.

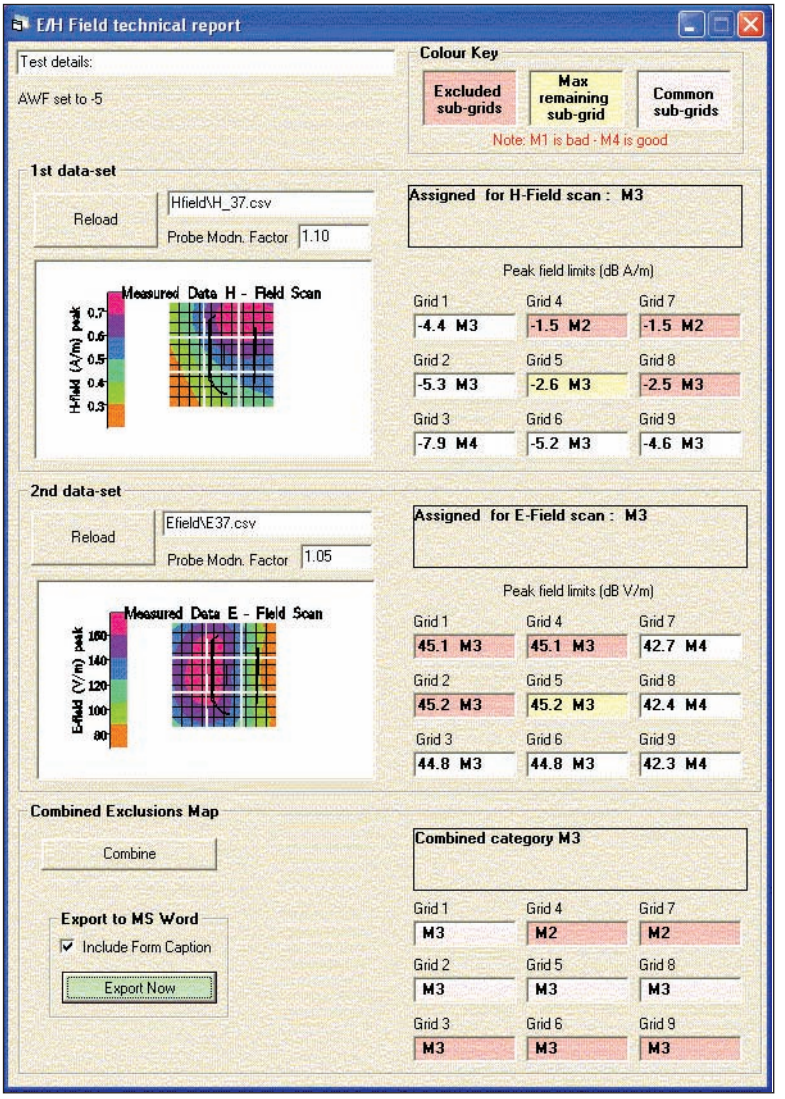

Figure 7: RF scan data

Test Requirements

As no regulatory authority is reviewing or enforcing the hearing aid requirements of ANSI C63.19, we will only discuss the WD testing as provided under FCC guidance.

The RF measurement requirements for HAC compliance are somewhat similar to SAR test procedures. Both HAC and SAR involve closely coupled near field measurements over the face of a WD, with movement of the probe controlled by a robotic device. In testing for HAC compliance, the measurements are on peak field strength and are made in air and not through a tissue-simulant fluid as with SAR. HAC compliance testing also requires separate scans in E and H fields, whereas SAR measurements are of E-field only. The E and H field HAC probes have an isotropic response and are calibrated in accordance with IEEE 1309.

Measurements on a WD's T-coil performance are also called for in the HAC specification. For this, care must be exercised to separate the desired audio band magnetic signal emanating from the WD from the undesired magnetic interference generated by incidental circulating currents in the WD's battery or LCD. For these T-coil measurements, two special probes have been designed to respond separately to the axial and to the transverse components of the magnetic signal. The probes, no more than 10mm in diameter, contain tiny coils made up from more than 20m of ultra-fine AWG51

copper wire. The raw signals they detect must be amplified and filtered by specialized audio equipment to ensure the levels are completely unaffected by outside influences.

One further similarity to SAR procedures is the inclusion in ANSI C63.19 of a system validation measurement. In this measurement, E and H field scans must be taken along a dipole fed with a known input power, and compared against a theoretical value as shown in Figure 3 and Figure 4.

During actual measurements on a WD, separate robotic scans are made over a 5x5 cm grid using an E-field probe, an H-field probe and the T-coil probes (see Figure 5.)

Each 5 cm x 5 cm grid must be divided into 9 smaller sub-grids with the overall center of the grid lying immediately above the acoustic (or 'T'-coil) output, and at a known distance.

In determining an overall category for the WD, the standard allows for 3 contiguous sub-grids around the peak signal to be discarded in the E and the H scans separately. In Figure 6, where the results of the 2D scan are depicted, these sub-grids are outlined in red. In practice, these would correspond to a localized hotspot from the WD, which the hearing aid user could easily avoid by repositioning the WD slightly against the ear. The combined performance category for the WD in the RF band requires that a minimum of five common sub-grids in the E and H scans be included with the center sub-grid.

The categories are rated from M1 to M4, with M1 being the worst performance (highest emissions) and M4 the best. A similar categorization is measured for the WD's T-coil performance (T1 to T4, by analogy). From published data, a user can then assess any likely incompatibility issues with a WD simply by adding together the hearing aid's immunity category with the emissions category of the WD. A total of 4 or more indicates the combination would be useable, with higher numbers representing even better choices. Equally, a sum of 3 or lower would highlight a problem combination, either because the WD was emitting relatively large signals, or that the hearing aid was particularly susceptible to interference.

Actual testing and report generation of a WD for both RF and T-coil modes is relatively straight forward and not excessively time consuming as test platforms are by and large automated. As with SAR, there is significant set up and systems validation required. But the actual testing can be done in a few hours. Figure 5 shows a typical system capable of the four axes of required movement.

Most systems also provide automatic reports which capture the required data for reporting to the FCC. Figures 7 and 8 show the outputs for both the RF scans under Section 4 of C63.19 and the T-coil data as specified under Section 6.

Summary

Without a doubt, with the multiple revisions that ANSI C63.19 underwent in the past five years, the handset manufacturers have had a difficult time in meeting the timetables and emissions requirements allowed by the FCC. These same changes have also impacted those few companies whose test platforms address this niche market. One would hope that with all the efforts and costs extended by all involved parties, there will be some future qualitative analysis to assess the end results for the hearing impaired.

In a world that is almost totally dependent on connections to a wireless world, hearing aid compatibility for wireless devices is becoming more and more essential (especially for those of us who are fast approaching the need to acquire a hearing aid!). Unfortunately, as with most of our standards activities, we never seem to evaluate beyond just meeting the limits of the test. ■

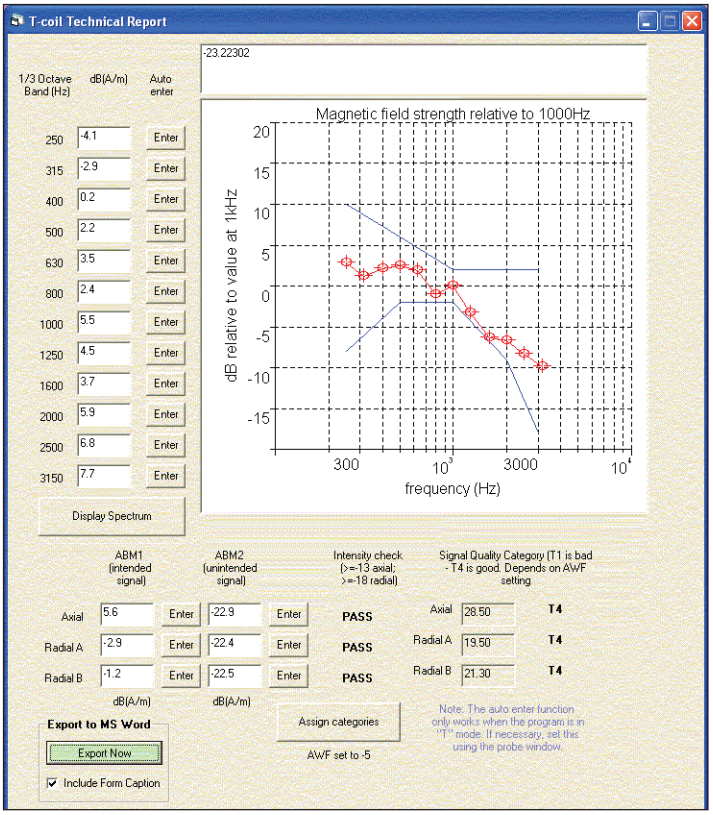

Figure 8: T-Coil data