Hearing Aid Compatibility

RF Emissions Measurement
TCB Review Guidance

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Outline

- Background

- FCC Rules and Policy

- Review Guidance for ANSI C63.19 Testing

- Questions and answers

Hearing Aid Compatibility TCB Guidance

Background

- HAC ACT put in place hearing aid compatibility requirements for telephones connected to the public network.

- Mobile phones were exempt due to lack of applicable rating and measurement standards.

- ANSI C63.19 approved in 2001 was a relevant rating and measurement standard.

Background

- R&O FCC 03-168 removed exemption of certain digital wireless devices (WD) (Part 22, 24, and 90 mobile phones). ANSI C63.19-2001 was referenced in the associated rules given in 47 CFR section 20.19.

- Public Notice DA-05-1134A1 accepts an updated standard draft version 2005.

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FCC Rules and Policy

The following section of this presentation will provide guidance for FCC rules and policies that are relevant to HAC RF emissions testing. This information is not intended to replace the FCC rules but only to clarify them and to provide policies where necessary.
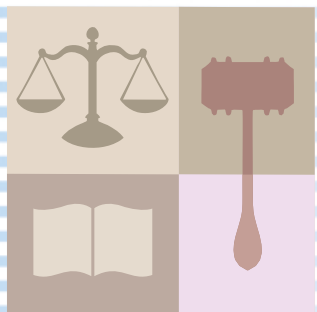
FCC Rules and Policy

47 CFR section 20.19– General

- All digital transmission modes in all frequency bands contained in a HAC phone must meet M3 or M4 levels.
  - Assumes held to ear usage.
  - Subsets for HAC require a new FCC ID
- AMPs and other analog standards do not need to comply or be evaluated.
  - Assumes no TDMA/burst structure.

FCC Rules and Policy

- 20.19 b1-- The original U rating is equal to an M rating in C63.19-2005.

- 20.19 b2-- The original UT rating is equal to a T rating in C63.19-2005. (FYI only)

FCC Rules and Policy

20.19 f) Labeling Requirements--Relevant user information should be provided that:

- is complete, clear and easily understood by a lay person.

- explains the HAC rating system for both WD and hearing aids and their use as a pair.

- explains how to use the device including specific instructions about antenna positioning if applicable i.e. "the antenna should be extended for best compatibility…".

- provides details of any special user selectable HAC modes. Acceptable modes might be back light off, BT off, Tcoil on, and similar. (RF power cannot be reduced and basic phone functionality must be preserved.)

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FCC Rules and Policy

20.19 f) Labeling Requirements

- A package label is <u>not</u> required for certification but if provided should be for checked for correct, readable, and understandable rating values. The label should contain the worst case M rating value.

FCC Rules and Policy

20.19 c3 Phase in requirements

(FYI only—not a certification issue please contact WTB with questions)

- FCC requirements for manufacturers are phased in over several years
  - September 16 2005 --2 phones per air interface (PAI) must meet clause 4 RF emission rating of level 3
  - September 16 2006 --2 phones PAI must meet C63.19 clause 6 Tcoil signal quality rating of level 3
  - February 18 2008 --50% of phones PAI must meet clause 4 rating of M3
- Service providers also have phased in requirements.

De minimis exception applies for small manufacturers and providers.

FCC Rules and Policy

- 2.1033 d) Test report should contain a statement of compliance with HAC requirements per

- Scenario/FCC Policy table—see the separate document.

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FCC Rules and Policy

Administrative procedures

- Be fully versed in C63.19 Clause 4 testing before granting
- Review filings in a manner that assures both C63.19 and FCC policies are fully adhered to.
- Use grant note code HC.
- HAC mode can be added via Class II Permissive Change.
  - *SAR and EMC results should be addressed under permissive change rules.*

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FCC Rules and Policy

Administrative procedures

- Perform market surveillance testing.

- Seek FCC guidance prior to authorizing grant with HAC compliance tested according to ANSI C63.19-2001.

- Seek FCC guidance prior to authorizing grant for measurements using a single sensor probe or manual scanning system, see C63.19 section 4.3.1.2.1.

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FCC Rules and Policy

Administrative procedures

- The following applications should be submitted to the FCC.

  - Filings with Clause 6 data.

  - Filings that require special external HAC accessories.

  - Filings with evaluation of composite devices transmitting simultaneously.

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Review Guidance for ANSI C63.19 Testing

The following section of this presentation will provide guidance for certain sections of C63.19-2005 that are relevant to Clause 4 testing. This information is not intended to replace C63.19 but only to emphasize or clarify key issues, and provide interpretations thought necessary. The corresponding C63.19 section reference number is provided.

Review Guidance for ANSI C63.19 Testing

Standard Overview

- Hearing aids are rated for interference rejection.

- Phones/WDs are rated for RF emission generated

  - RF Emission ratings are based on peak field strength as measured over a 5x5 cm grid in the region of the ear piece.

Review Guidance for ANSI C63.19 Testing

A brief overview

- Phones/WDs are also rated for quality of desired signal in T coil mode.

  - Tcoil mode ratings are base on measurement of audio band magnetic signal strength, signal to noise, and frequency response.

- Sum of hearing aid and phone ratings gives a measure of performance for the hearing aid and WD pair.

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Review Guidance for ANSI C63.19 Testing

A brief overview

- The 2001 version has been revised in 2005.

- Version 2005 was accepted by C63 and is currently in draft 3.5 going through final ANSI/IEEE processing.

- The primary changes for phone RF emission testing are

    - a relocation of the measurement grid,

    - added details for system verification,

    - revision of the probe conversion factor procedure,

    - adjustments to the exclusion block allowance,

    - Wording and procedure clean up.

Review Guidance for ANSI C63.19 Testing

4.1.2 Near-Field Measurement System

- Review probe requirements carefully. See comments for Annex C and D.

- Design of system with a single element probe must allow rotation and measurement in all three axes. There is a need for special focus on spherical isotropicity in measurement uncertainty and perturbation of EM fields. See FCC for guidance.

- Description of the HAC scanning measurement system is detailed enough to establish that C63.19 recommendations are followed.

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Review Guidance for ANSI C63.19 Testing

4.1.2 Near-Field Measurement System

- Means to adjust for center of sensor (commonly used for SAR systems) to nearest element point offset.

- Assure that HAC system manufacturer recommendations are followed.

- Special attention is needed for manual scan systems. See FCC for guidance.

Review Guidance for ANSI C63.19 Testing

- 4.1.2.1 Probe Modulation Factor
  - See comments for Annex C.3

- 4.2.2.1 Validation Procedures using Dipoles
  - Dipole (not other source types) should be used for TCB review.

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Review Guidance for ANSI C63.19 Testing

4.2.2.1.2 Test Cases

- Full validation with all three signal types mentioned should be performed at least weekly during periods of testing.

- Validation at system reconfiguration should be preformed with at least the WD type of modulation.

- Forward power to the dipole should be carefully measured using directional coupler techniques to compensate for mismatch.

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Review Guidance for ANSI C63.19 Testing

4.2.2.1.2 Test Cases

- Target values should be fully justified and not simply taken from table 4-1 in C63.19.

  - HAC system manufacturer developed target values are generally sufficient.

- Target values for AM and WD modulation should be fully justified.

  - In some cases it may be difficult to emulate the signal from the WD. For example CDMA signals may or may not have real time power loop control activated and as a result the signal and conversion factor will change. Also, signals from a base station simulator may differ from the handset signal. The difference should be accounted for.

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4.2.2.1.2 Test Cases

- Verification frequencies must be within each operating band; preferably at band center.

- Details of how the measurement plane was established and maintained. A special jig may be necessary to maintain reasonable uncertainty.

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4.2.2.1.2 Test Cases

- Measured values more than 10% from target for CW case should be investigated.

- Field contour plots included. Check for expected pattern.

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4.2.2.1.3 and 4.2.2.1.4 Procedure using … Dipoles

- Orientation of the probe relative to the dipole is critical. In general the probe tube should be parallel to the dipole fee coax with the dipole off the end of the probe.

Review Guidance for ANSI C63.19 Testing

4.2.3 WD Setup and Use

- All normal configurations for at the ear use should be described and tested.
  - Example: a slider phone may be designed to be used in both open and closed configurations.
  - Exception, if the WD has an extendable antenna, than only the extended position needs to be tested.
  - User instructions are not considered sufficient to test a subset of operational configurations.

Review Guidance for ANSI C63.19 Testing

4.2.3 WD Setup and Use

- The device setup and resulting signal should be fully represented in the probe modulation conversion factor steps. See comments on probe calibration and Annex C3 and D.

- All operating modes handled appropriately– CDMA, TDMA, GPRS, GSM, etc? How is power loop controlled for CDMA, consider "vox" or "punch out". Zero span spectrum analyzer plot provided to confirm mode.

- Procedures given to establish the test signals described e.g., base-station simulator vs. internal test codes.

Review Guidance for ANSI C63.19 Testing

4.2.3 WD Setup and Use

- Maximum power is used and agrees with EMC/SAR reports and tune-up procedure. Conducted power in HAC report should be greater than or equal to what's in EMC report, but not exceeding tune-up/tolerance.

- Demonstration that device power is steady through test. Before/after power or field drift (<5%).

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Review Guidance for ANSI C63.19 Testing

4.2.3 WD Setup and Use

- Device options that could affect the HAC results are tested e.g. form factors, batteries and metallic face plates.

  - Justification is needed if limited or "worst-case" combinations only are tested. Generally, external HAC accessories should not be used for compliance.

- Account for special user selectable software HAC modes.

- How are composite transmitters such as Bluetooth and WLAN handled? C63.19 contains no procedures for simultaneous transmission.

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Review Guidance for ANSI C63.19 Testing

4.3.1.2.2 Automated Scanning Method

Vertical centerline of the acoustic output (coincident in this case with the vertical centerline of the phone)

Horizontal centerline of acoustic output

- The measurement grid should be centered on the output (acoustic or Tcoil).

  - 2001 version had the top of the grid and the top of WD aligned.

- The measurement plane is defined to the nearest point on the probe sensor element. Most measurement systems reference the center of the sensor. The offset should be appropriately handled.

  - Two options include demonstrating that:
    - testing at sensor center is worst case
    - the measurement system can accurately measure at the mentioned offset.

10 mm — Measurement Plane — Reference Plane

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Review Guidance for ANSI C63.19 Testing

4.3.1.2.2 Automated Scanning Method

- Description of scan procedures, including step size, locations relative to the measurement grid, and peak location determination.

- Step size should be justified and not exceed 5 mm. Uncertainty evaluation concerns should be reviewed to see if smaller step sizes are necessary.

- Consider spanning grid line to avoid question with shared values on grid lines e.g. 3.334 mm.

- Contour plots should be reviewed and demonstrate that finer step size would not be required.

  - Peaks should be clearly defined and of a dimension (e.g. 3 dB width) much greater than the step size.

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4.3.1.2.2 Automated Scanning Method

- Probe is rotated for maximum reading at the final measurement location.

- Conversion to peak field strength is correct.

- Processing of the raw measurement values both in the measurement electronics as well as post measurement in the computer are described.

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4.3.1.2.2 Automated Scanning Method

- Details of how exclusion blocks are identified and handled.

  - 3 exclusion blocks are allowed for each measurement

  - only 5 total exclusion blocks for both E and H field measurements.

- Measurements are made at low, middle and high frequency channels.

Review Guidance for ANSI C63.19 Testing

7.2 Audio Coupling Mode

- Assure that AWF is accounted for correctly.

  - GSM has a -5 dB factor

  - Other standard modulations use 0 dB.

- Treat GPRS as a subcategory of GSM.

- The final rating is the worst case of all measurement configurations for all frequency bands.

Review Guidance for ANSI C63.19 Testing

8. Calibration and Measurement Uncertainty

- System uncertainty should be fully justified, site specific and accurate.

  - Duplication of the information in C63.19 is not acceptable. Confirm valid values (according to actual system and test configurations) are used.

- The expanded uncertainty (for k=2) of under 2 dB.

Review Guidance for ANSI C63.19 Testing

9. Test Report

- The test report should be complete and comprehensive.

- Should contain a statement of compliance with HAC requirements per 47 CFR §2.1033 d).

9.3 Equipment Unit Tested

- Differences between prototypes used for testing and final production units should be fully addressed. 47 CFR §2.908.

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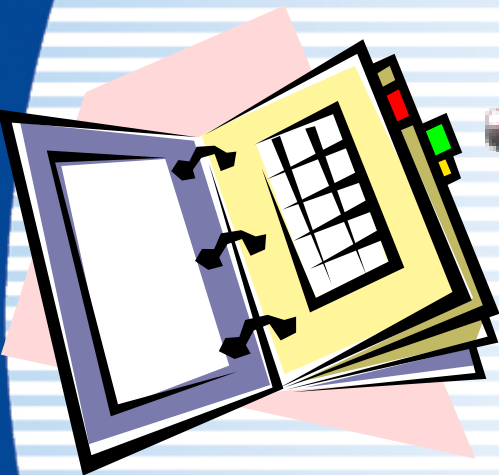
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9.9 Reporting Measurement Data

- All contour plots are included.

- Plots have device and grid overlays.

- A summary of all measured HAC values should be given in a tabular format for all test configurations.

- Measurement system factors used in the tests are given and appropriate for the EUT modulations and modes tested (examples integration time, conversion factors, and crest factors).

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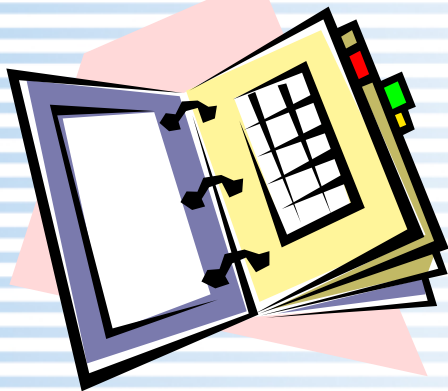
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Annex A.2 WD RF Emission Measurements Reference and Plane

- Reference plane must be parallel to the device in the region around the output.

  - The reference plane is not necessarily parallel to the "face" of the WD. Some phones may have ear conforming angles in the region of the output.

- To support a reasonable uncertainty, generally, some mechanism will be required to position the device/reference plane relative to the measurement plane.

Review Guidance for ANSI C63.19 Testing

A.2.1 Gauge Blocks for Setting Measurement Distance to Probe

- The measurement plane is defined to the nearest point on the probe sensor element. Most measurement systems reference the center of the sensor. The offset should be appropriately handled.
  - Two options may include demonstrating that:
    - testing at sensor center is worst case
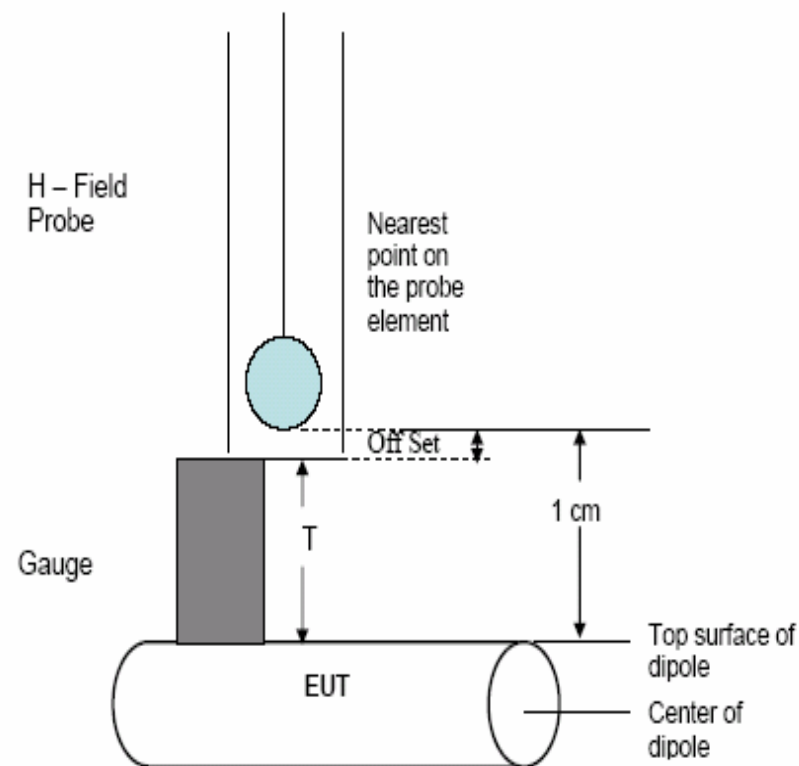   - the measurement system can accurately measure at the mentioned offset.

Figure A-4 – Gauge Block with H-Field Probe

Review Guidance for ANSI C63.19 Testing

C.3 Calibration of RF Electric and Magnetic Field Probes

- All aspects of IEEE STD 1309-2005 should be implemented.
  - The various calibration grades are specified in this section.
  - H field probes have a special Annex in 1309. See annex E.
- Comprehensive probe calibration certificate containing calibration date, all relevant probe factors, all modulation related factors, and probe measurement errors e.g. linearity, isotropy, and modulation etc is provided.
- Full dynamic range of the probe is addressed.

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C.3.1 RF Field Probe Modulation Response

- Measurement systems typically measure RMS voltage based over a selectable averaging time and is associated with average power the of WD.

- RMS field strength is calculated based on probe/system calibration.

- C63.19 ratings are based on peak field strength which is commonly associated with Peak Envelop Power (PEP).

- The implementation of this procedure to measure a correction factor to convert from RMS to peak field strength should be carefully reviewed.

Review Guidance for ANSI C63.19 Testing

C.3.1 RF Field Probe Modulation Response

- Determination of PEP is dependent on many factors including modulation type, mode of operation, type of transmitter and other factors.

  - The conversion factor should fully represent the actual signal transmitted by the WD.

  - One generic determination of calibration factor may not represent all WDs with similar modulation.

- PEP should be used as commonly measured with a video bandwidth (VBW) greater than the signal 20 dB BW.

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C.3.1 RF Field Probe Modulation Response

- Forward power should be measured with direct coupler techniques to accurately account for mismatch under load.

- Full dynamic range of the probe should be addressed.

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Review Guidance for ANSI C63.19 Testing

D.5.1.1 and D.5.1.2 Dipoles for … MHz

- The dipoles specified here are those used for Clause 5 testing of hearing aid immunity and may not be identical to the dipoles discussed for Clause 4 system verification.

Review Guidance for ANSI C63.19 Testing

D.5.1.3 Wireless Device lab verification Dipoles

- These dipoles are those used for Clause 4 system verification.

Review Guidance for ANSI C63.19 Testing

D.10 Probe, Near-Field, E-Field

- Note carefully probe requirements. If a single element probe is used the tester should demonstrate that the field is not perturbed for all orientations.

- Assure that HAC measurement system manufacturer's recommendations are followed.

  - Some manufacturers recommend to only use probes designed for free space measurements and not SAR probes.

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Review Guidance for ANSI C63.19 Testing

D.11 Probe, Near-Field, H-Field

- Note carefully probe requirements. If a single element probe is used the tester should demonstrate that the field is not perturbed for all orientations.

- Separate uncertainty may be needed.

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Annex E. Sample Measurement Uncertainty Estimates

- System uncertainty should be fully justified, site specific and accurate. A simple duplication of the information in C63.19 is not acceptable.

Review Guidance for ANSI C63.19 Testing

Annex J Sample HAC Application Forms

- The format given should be used to the extent possible but is not considered comprehensive.

- Additional information should be provided to completely justify the filing and testing procedures used as discussed in this presentation.

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