



Hearing Aid Compatibility

TCB Review Guidance

October 2006

(Updates of 12 May, 2006 and 18 July 2006)

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Outline

- Background
- FCC Rules and Policy
- Review Guidance for ANSI C63.19 Testing
- Questions and answers





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



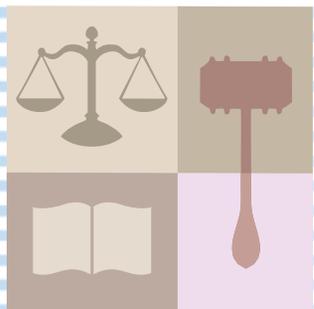
- R&O FCC 03-168 removed exemption of certain digital wireless devices (WD) (Part 22, 24, and 90 mobile phones). ANSI C63.19-2001 was referenced in the associated rules given in 47 CFR section 20.19.
- Public Notice DA-05-1134A1 accepts an updated standard version 2005.
- Public Notice DA-06 1215 accepts an updated standard version 2006 (3.12)



FCC Rules and Policy

This document was updated to include new *additions and edits for TCB review of HAC compliance testing using ANSI C63.19-2006 and includes both RF and T-coil rating. Updates since the July TCB conference call version are marked.*

New





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.



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.)



FCC Rules and Policy

20.19 f) Labeling Requirements

- ◆ A package label is not 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 and T rating value as applicable.

New



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
- See document titled “FAQs for Hearing Aid Compatibility Scenarios”



FCC Rules and Policy

Administrative procedures

- Be fully versed in C63.19 Clause 4 and 6 testing before granting
- Review filings in a manner that assures both C63.19 and FCC policies are fully adhered to.



FCC Rules and Policy

- Use grant note code HC.
- Grant comment “HAC Rating: M# T#”
- If there are multiple models but if M or T rating is added to only some of the models this should be clearly documented in the filing and the following grant comment should be added.

“HAC rating only evaluated for the specific configurations described in this filing”

New



FCC Rules and Policy

Administrative procedures

- HAC modes can be added via Class II Permissive Change.
 - *SAR and EMC results should be addressed under permissive change rules.*
 - All final device ratings should be determined using the same version of C63.19.
 - Adding T-coil to devices approved under the GSM waiver requires full retest using C63.19-2006.
- Perform TCB market surveillance testing.



FCC Rules and Policy

Administrative procedures

- Seek FCC guidance prior to authorizing grant with
 - HAC compliance tested according to ANSI C63.19-2001 or 2005.
 - For measurements using a single sensor RF probe or manual scanning system,
 - Review of 6.4.1 measurements that do not directly measure the input spectrum.
 - Use of external HAC attachments.
 - Use of 20 KHz VBW validation for PMF other than “averaging” see later slide.



FCC Rules and Policy

Administrative procedures

- The following applications should be submitted to the FCC.
 - Filings with Clause 6 data and
 - S/N is under 15 dB
 - Special user modes for frequency response compliance
 - Filings with composite devices that can transmit simultaneously while at the ear.
 - Filings that use Mu shielding as mentioned in 6.3.4.2



Review Guidance for ANSI C63.19 Testing

The following section of this presentation will provide guidance for certain sections of C63.19-2006 that are relevant to Clause 4 and 6 testing. This information is not intended to replace C63.19 but only to emphasize or explain key issues. 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 and T-Coil output.





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A brief overview

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





Review Guidance for ANSI C63.19 Testing

A brief overview

- The 2001 version was revised in 2005.
- 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

New

A brief overview

- The 2005 version was further revised in 2006.
- The primary changes for phone RF emission testing are
 - Relaxed RF field limit for the 800 MHz band by 10 dB
 - added details for system verification,
 - Details for a fast response probe.
 - revision of the probe conversion factor procedure (added 20 KHz VBW for peak power)
 - Wording and procedure clean up.



Review Guidance for ANSI C63.19 Testing

4.2.2 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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4.2.2 Near-Field Measurement System

- Assure that HAC system manufacturer recommendations are followed.
- Special attention is needed for manual scan systems. See FCC for guidance.



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- 4.2.2.1 Probe Modulation Factor
 - See comments for Annex C.3
- 4.3.2.1 Validation Procedures using Dipoles
 - Dipole (not other source types) should be used for TCB review.



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4.3.2.1.2 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 performed 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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4.3.2.1.2 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 have real time power loop control or supplemental channels activated; 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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4.3.2.1.2 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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4.3.2.1.2 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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4.3.2.1.3 and 4.3.2.1.4

Procedure using ... Dipoles

- Orientation of the probe relative to the dipole is critical to obtain accurate comparison to the target value. The configuration should be the same as was used for the target value development. The probe should be perpendicular to the dipole and parallel to the feed as pictured. Use with the planer dipole laying down would be incorrect.





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4.3.3 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, then only the extended position needs to be tested.
 - User instructions are not considered sufficient to test a subset of operational configurations.



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4.3.3 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? Vocoder effects. 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.



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4.3.3 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%).
- See FCC 3G policy for RF and vocoder modes from May 05 TCB conference call. See next slide.



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- Excerpt from FCC/OET document “Preliminary Guidance for FCC Third Generation Technologies Certification Policy Reviewing Applications for Certification of 3G Devices.” dated May 2006

See also “Over riding policy” section

Hearing Aid Compatibility related policies

Filings for 3 G devices with section 20.19 HAC compliance information should be handled in a similar fashion as EMC is handled above.

Voice modes for at the ear usage modes should be addressed

Simultaneous transmissions with data modes transmitters (e.g. WLAN) should be submitted to the FCC for certification. User turn off of simultaneous transmissions is acceptable for review by TCB. Appropriate user instructions should be provided.

Subset testing should be justified as mentioned for EMC. The key parameters to focus on for RF emission testing are peak field, and peak power (defined in C63.19 section 4). Conditions where modulation rates fall into the audio spectrum are of special interest. Sample testing of the various modes can be performed at the worst case probe location for each band and field type (E or H) as part of subset testing justification. Sample testing of conducted RF peak power can also be used to help in the justification.

For T-coil compliance, modes that produce higher levels of base band magnetic noise are of interest for the ABM2 measurements, such as RF modes with high peak-to-average power ratio, noisy display settings, or operational modes requiring high digital computations/processing.

Additionally, ABM1 measurements might be influenced by audio processing such as vocoder or audio auto leveling options and should be investigated.



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4.3.3 WD Setup and Use

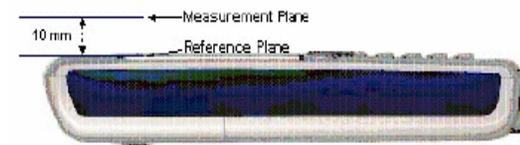
- Device options that could affect the HAC results are tested e.g. form factors, batteries and metallic face plates.
 - Justification is needed if limited or “worst-case” combinations only are tested. Generally, external HAC accessories should not be used for compliance.
- Account for special user selectable software HAC modes.
- How are composite transmitters such as Bluetooth and WLAN handled? C63.19 contains no procedures for simultaneous transmission. User turn off is allowed.



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4.4.1.2.2 Automated Scanning Method

- The measurement grid should be centered on the outputs (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.

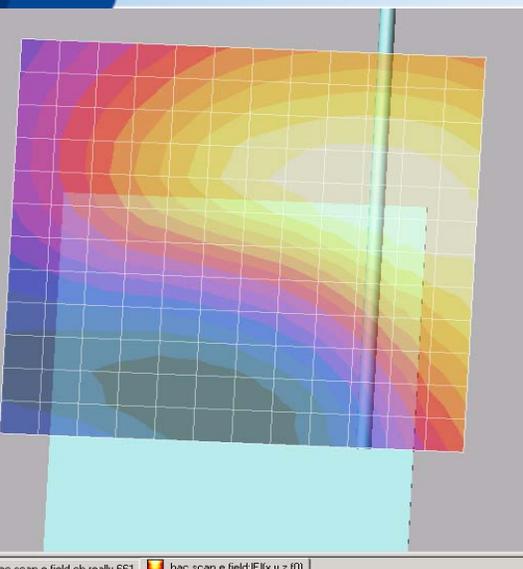




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4.4.1.2.2 Automated Scanning Method

- 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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4.4.1.2.2 Automated Scanning Method

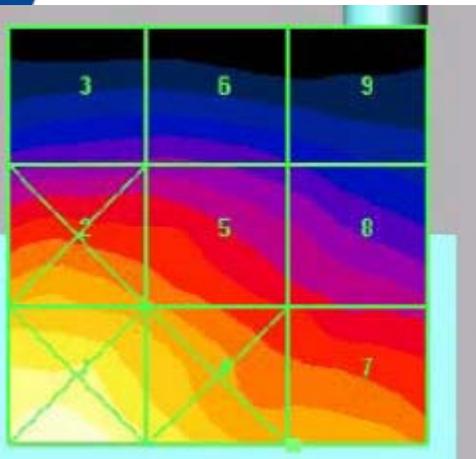
- Probe is rotated for maximum reading at the final measurement location.
- Conversion to peak field strength is correct.
- Processing of the raw measurement values both in the measurement electronics as well as post measurement in the computer are described.



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4.4.1.2.2 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.





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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.
- Class A GPRS devices should be evaluated with GSM only and GSM/GPRS modes.
- The final rating is the worst case of all measurement configurations for all frequency bands.

New



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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.





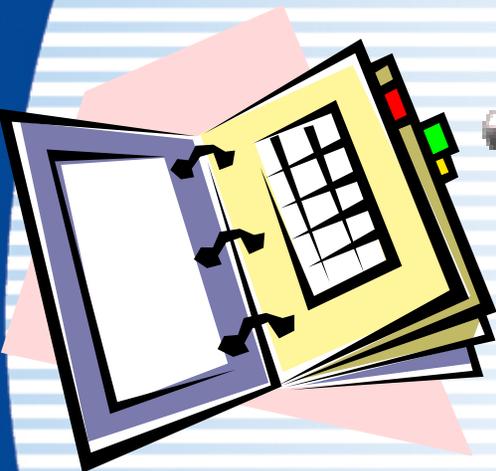
Review Guidance for ANSI C63.19 Testing

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.

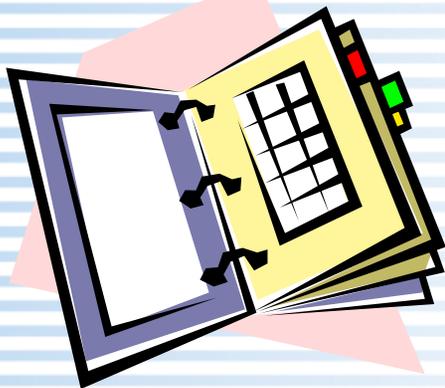




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9.9 Reporting Measurement Data

- 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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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.



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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.

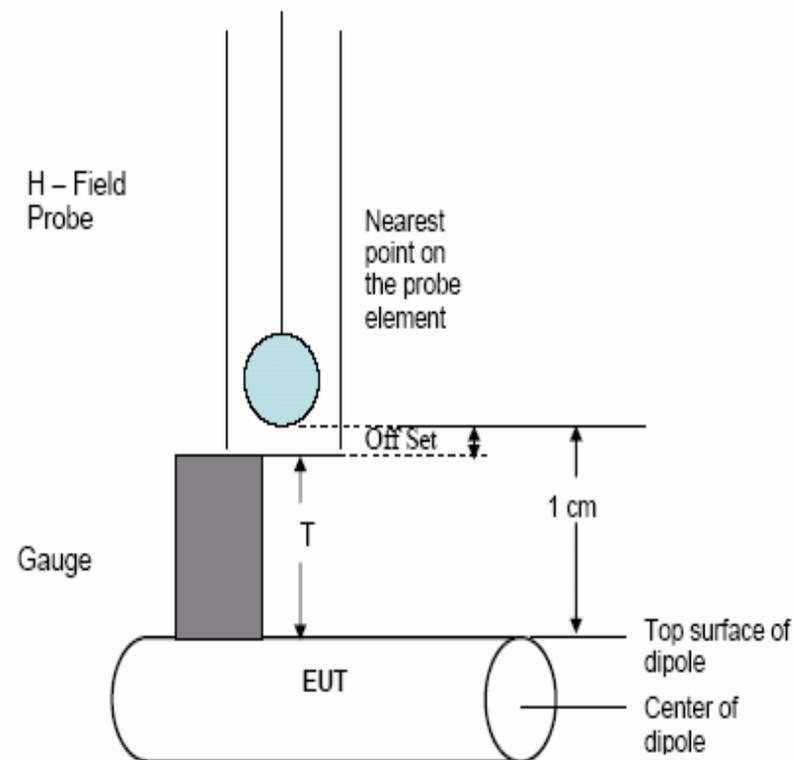


Figure A-4 – Gauge Block with H-Field Probe



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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/field over a long time period and is associated with average power of the WD.
- RMS field strength is calculated based on probe/system calibration.
- C63.19 ratings are based on peak field strength which is the highest RMS field strength found over any short time period. Commonly associated with Peak Envelop Power (PEP).
- The implementation of this procedure to measure a correction factor to convert from long term RMS to peak field strength should be carefully reviewed.



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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.
- 20 KHz VBW is now allowed
 - 20 KHz VBW
 - Validate by measuring correct average power using very low VBW i.e. 30 Hz VBW. Seek FCC advise for use of other methods.
 - Otherwise use $VBW > 3 RBW$.



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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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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.



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D.5.1.3 Wireless Device lab verification Dipoles

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



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D.10 and D.11 Probe E-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.
- 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.
- Separate uncertainty may be needed



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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.



Inductive Coupling or T-coil Measurements. ANSI C63.19-2006 Section 6.0



Review Guidance for ANSI C63.19 Testing

A brief overview

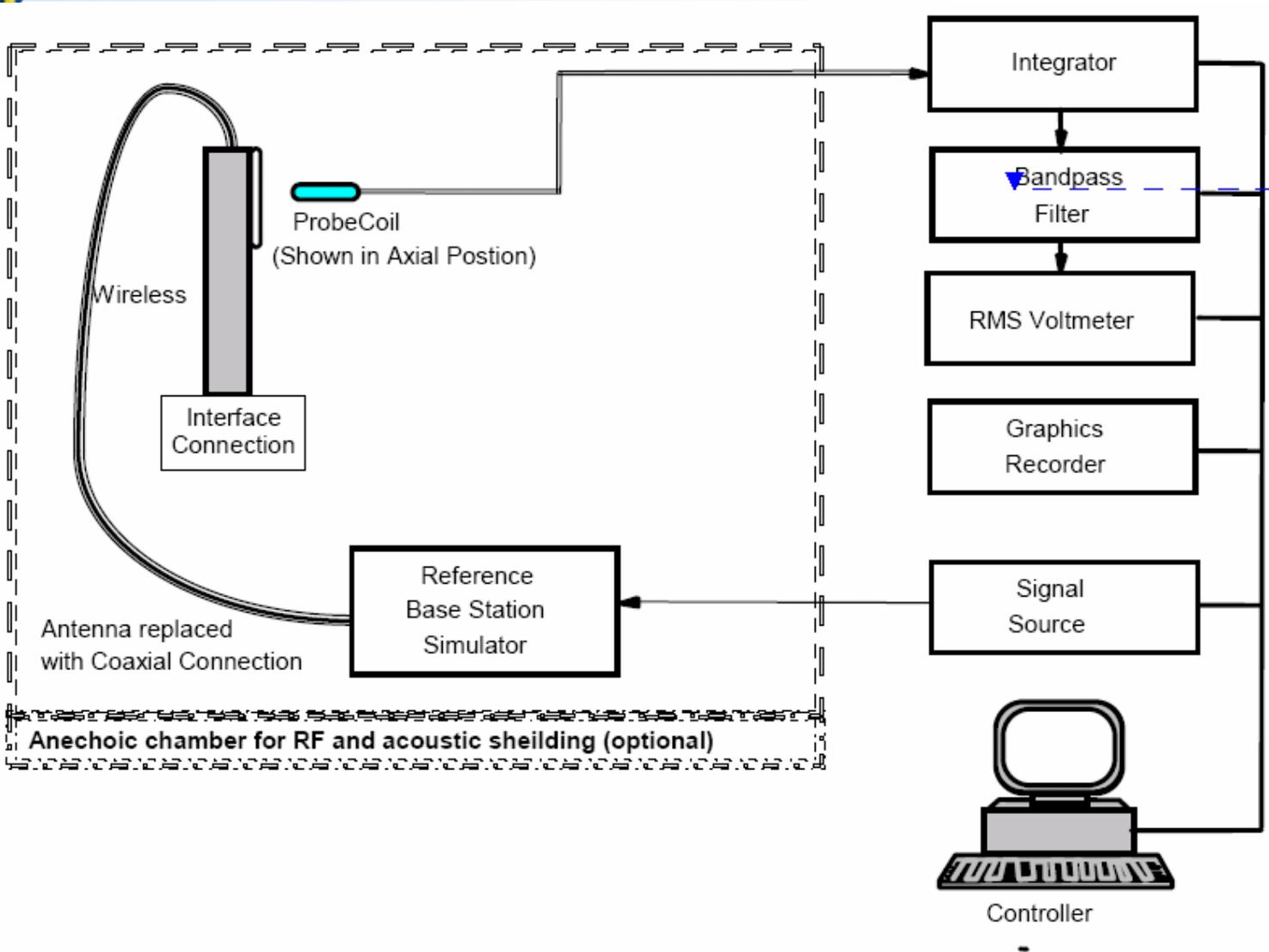
- The 2001 version was revised in 2005.
- The primary changes for phone T-coil testing are:
 - Change from 5 point to 3 point grid
 - S/N at all three points
 - Change from acoustic output reference to electrical input level
 - Added A weighting for noise
 - Added a broad band signal alternative



Review Guidance for ANSI C63.19 Testing

A brief overview

- The 2005 version has been further revised in 2006.
- The primary changes for phone T-coil testing are
 - ◆ Wording and procedure clean up.





Review Guidance for ANSI C63.19 Testing

- 6.1.1.1 Voltmeter-- accurate over full audio band. Integration time is important.
- 6.2 Device configuration.
 - Please refer to FCC 3G policy for test configurations
- 6.2 Probe usually requires high impedance amp. (1 M Ohm).
- 6.2.1
 - Ambient noise (phone removed) for ABM1, ABM2 and frequency response should be measured all three orientations. Probe should be located in the vicinity of the measurement reference point (within 3 cm). One set of measurements prior to and following device measurement is generally sufficient unless the noise varies with time.
 - Noise transients should be investigated and avoided.

New



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- 6.2.4 Probe and system should generally be calibrated together.
 - ◆ Frequency and amplitude results for the combination should be provided and demonstrated compliance with Annex C.5 and D.8
 - ◆ Calibration may be required with the specific probe cable used due to stray capacitance.



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- 6.3 Demonstration that set up is not susceptible to RF interference is required. Use a source with no base band noise such as a dipole antenna. Certification by manufacturer is acceptable.
- 6.3.1 Applies only to narrowband sources which are within one 1/3 octave bin.



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● 6.3.1 step 2

- Volume setting should be documented.
- Refer to the FCC issued policy for testing of 3 G technology for configuration of the device. See slide 33. The configuration must be fully justified and documented. The configuration for T-coil HAC testing may not be the same as for other types of testing e.g. SAR, EMC or RF HAC.
- Choice of RF channel should also be justified. Use of an ABM2 like investigation is expected.
- Devices requiring user controllable frequency response should include a description of how the user will access the control. The same mode must be used for all testing.



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6.3.2.1

- Special care should be taken to assure this step is correct. Generally base station simulators require special vocoder calibration. Calibration details and related calculations should be clear and correct.
- Sources like P.50 signals generally vary in amplitude with time and require integration over time to measure input levels. Assure appropriate techniques and time lengths are used to get consistent answer e.g. synchronize with file.



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6.3.4.1

- Demonstrate that vocoders can pass CW signals correctly if used.
- Use of multiple signal types for the different measurements should be clearly documented and justified. Example 1 KHz CW for ABM1 per 6.3 procedure, and P50 for frequency response per 6.4.



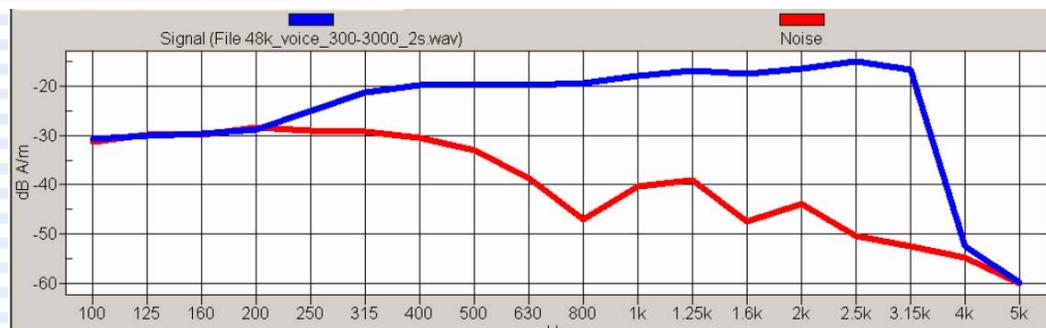
Review Guidance for ANSI C63.19 Testing

- 6.3.4.3 Integration time for ABM2 measurement should be justified. Inclusion of all audio band is required. Specifications for equipment over the 100-10,000 Hz range in Annex D17. Significant noise components higher than 10 KHz must be accounted for.
- Validation of the ABM2 measurement should be reviewed. Generally this will involve at least a frequency response curve and a demonstration of the ability to power sum.
- 6.3.4.4 Method for locating the maximum response position for measurement should be documented.



Review Guidance for ANSI C63.19 Testing

- 6.4.1 step 4 Measurement of the input spectrum is expected. TCB review of other procedures mentioned should be done only after seeking FCC advise.
 - Measurement required during calibration or when equipment is changed in the set-up.



- 6.4.1 step 7 When time integration is required it generally should be performed over the same length of time as used to measure the input signal and synchronized with the file.



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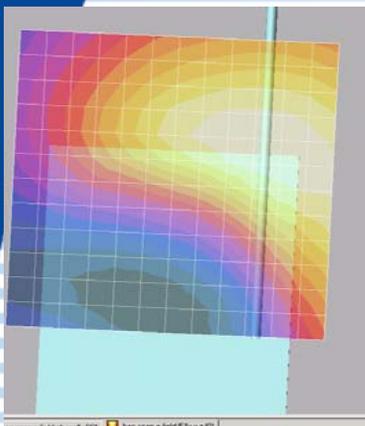
- 6.4.1 step 10 and 6.4.4 These steps corrects the output for the spectral shape of the input signal. The wording can be understood to mean “calculate the ratio of the 1 KHz 1/3 octave ABM1 value and the broad band noise (ABM2)”. For this procedure to be equivalent to the narrowband method of 6.3 section 6.4.4 the 1 KHz 1/3 octave ABM1 value should be adjusted up to the equivalent input reference level for a narrowband signal. The adjustment factor is the ratio of the input signal’s total power and the 1 KHz 1/3 octave power.



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- 7.3.3
- The RF emission measurement plots centered on the T-coil axial location should be provided along with the RF emission T (RT) category.
- Separate RF scan is required when the T-coil is offset from the speaker.
- Final device T-coil mode rating is the lower of the RT category or the signal quality category given in Table 7-7.
- Assure that signal quality is determined for all three orientations.

New





Review Guidance for ANSI C63.19 Testing

- 8.0 Detailed uncertainty analysis must be reviewed and justified.
- Annex D.9 Use of Helmholtz coil is required for calibration. Use of other source e.g. TMFS coil can be used for validation.

