

HEARING AID COMPATIBILITY

Applicant Name:
Samsung Electronics, Co. Ltd.
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Yeongtong-gu, Suwon-si
Gyeonggi-do 443-742, Korea

Date of Testing:
12/22/2014
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Test Report Serial No.:
0Y1412232325-R1.A3L

FCC ID: A3LSMG360V

APPLICANT: SAMSUNG ELECTRONICS, CO. LTD.


Scope of Test: Audio Band Magnetic Testing (T-Coil)
Application Type: Class II Permissive Change
FCC Rule Part(s): CFR § 20.19(b)
HAC Standard: ANSI C63.19-2011
CTIA Test Plan for Hearing Aid Compatibility Rev 3.0, November 2013
EUT Type: Portable Handset
Model(s): SM-G360V
Test Device Serial No.: Pre-Production Sample [S/N: 2311-5]
Class II Permissive Change(s): VoLTE Testing
Original Grant Date: 12/30/2014

C63.19-2011 HAC Category: T4 (SIGNAL TO NOISE CATEGORY, LTE ONLY)

This revised Test Report (S/N: 0Y1412232325-R1.A3L) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

This report and category rating pertains only to the LTE bands supported by this wireless portable device. The overall category rating of the device is determined by the lowest rating obtained over all air interfaces supported by the device. This device has been shown to be hearing-aid compatible for the LTE air interface, under the above rated category, specified in ANSI/IEEE Std. C63.19-2011 and has been tested in accordance with the specified measurement procedures. Test results reported herein relate only to the item(s) tested. Hearing-Aid Compatibility is based on the assumption that all production units will be designed electrically identical to the device tested in this report. North American Bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.


Randy Ortanez
President







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1. INTRODUCTION

On July 10, 2003, the Federal Communications Commission (FCC) adopted new rules requiring wireless manufacturers and service providers to provide digital wireless phones that are compatible with hearing aids. The FCC has modified the exemption for wireless phones under the Hearing Aid Compatibility Act of 1998 (HAC Act) in WT Docket 01-309 RM-8658¹ to extend the benefits of wireless telecommunications to individuals with hearing disabilities. These benefits encompass business, social and emergency communications, which increase the value of the wireless network for everyone. Approximately 500 million people worldwide and 30 million people in the United States suffer from hearing loss.

Compatibility Tests Involved:

The standard calls for wireless communications devices to be measured for:

- RF Electric-field emissions
- RF Magnetic-field emissions
- T-coil mode, magnetic-signal strength in the audio band
- T-coil mode, magnetic-signal frequency response through the audio band
- T-coil mode, magnetic-signal and noise articulation index

The hearing aid must be measured for:

- RF immunity in microphone mode
- RF immunity in T-coil mode

In the following tests and results, this report includes the evaluation for a wireless communications device.

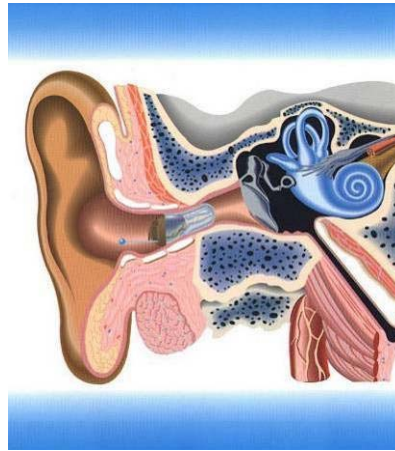




Figure 1-1 Hearing Aid *in-vitu*

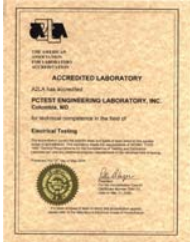
¹ FCC Rule & Order, WT Docket 01-309 RM-8658

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2. TEST SITE LOCATION

I. Test Facility / Accreditations:

Measurements were performed at an independent accredited PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.



- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing-Aid Compatibility (HAC), CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST facility is an FCC registered (PCTEST Reg. No. 90864) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (IC-2451).
- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and all Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (IC-2451) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS and CDMA, and EvDO mobile phones.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO Data, CDMA 1xRTT Data.

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3. EUT DESCRIPTION



FCC ID: A3LSMG360V
 Applicant: Samsung Electronics, Co. Ltd.
 129, Samsung-ro, Maetan dong,
 Yeongtong-gu, Suwon-si
 Gyeonggi-do 443-742, Korea

Model(s): SM-G360V
 Serial Number: 2311-5
 HW Version: G360V.03
 SW Version: G360VVRE0ANK4
 Antenna: Internal Antenna
 HAC Test Configurations: LTE FDD B13; BW's: 10MHz, 5MHz; BT Off, WLAN Off
 LTE FDD B4; BW's: 20MHz, 15MHz, 10MHz, 5MHz; BT Off, WLAN Off
 LTE FDD B2; BW's: 20MHz, 15MHz, 10MHz, 5MHz; BT Off, WLAN Off
 * Note: LTE test channels for different bands and bandwidths can be found in Sect. 7.II

EUT Type: Portable Handset

| Air-Interface | Band (MHz) | Type Transport | HAC Tested | Simultaneous But Not Tested | Voice over Digital Transport OTT Capability | WIFI Low Power | Additional GSM Power Reduction |
|--|------------|-----------------|--|-----------------------------|---|----------------|--------------------------------|
| CDMA | 835 | VO | Yes ² | Yes: WIFI or BT | N/A | N/A | N/A |
| | 1900 | | | | | | |
| | EVDO | DT | No | Yes: WIFI or BT | Yes | N/A | N/A |
| LTE | 700 | VD ¹ | Yes | Yes: WIFI or BT | Yes | N/A | N/A |
| | 1700 | | | | | | |
| | 1900 | | | | | | |
| WIFI | 2450 | DT | No | Yes: CDMA or LTE | Yes | N/A | N/A |
| | 5200 | | | | | | |
| | 5300 | | | | | | |
| | 5500 | | | | | | |
| 5800 | | | | | | | |
| BT | 2450 | DT | No | Yes: CDMA or LTE | N/A | N/A | N/A |
| Type Transport VO = Voice Only DT = Digital Data - Not intended for CMRS Service VD = CMRS and Data Transport | | | Notes: 1. The 3GPP VoLTE CMRS service is defined by GSMA in PRD IR.92 for IP Voice Service and Digital Transport. 2. CDMA air interfaces are not within the scope of this test report. Please refer to appropriate test reports. | | | | |

Table 3: SM-G360V HAC Air Interfaces

| | | | | |
|----------------------------------|---------------------------|-------------------------------|--------------|---------------------------------|
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4. ANSI C63.19-2011 PERFORMANCE CATEGORIES

I. MAGNETIC COUPLING

Axial and Radial Field Intensity

All orientations of the magnetic field, in the axial, horizontal and vertical position along the measurement plane shall be ≥ -18 dB(A/m) at 1 kHz in a 1/3 octave band filter per 7.3.1.

Frequency Response

The frequency response of the axial component of the magnetic field shall follow the response curve specified in EIA RS-504-1983, over the frequency range 300 Hz – 3000 Hz per 7.3.2.

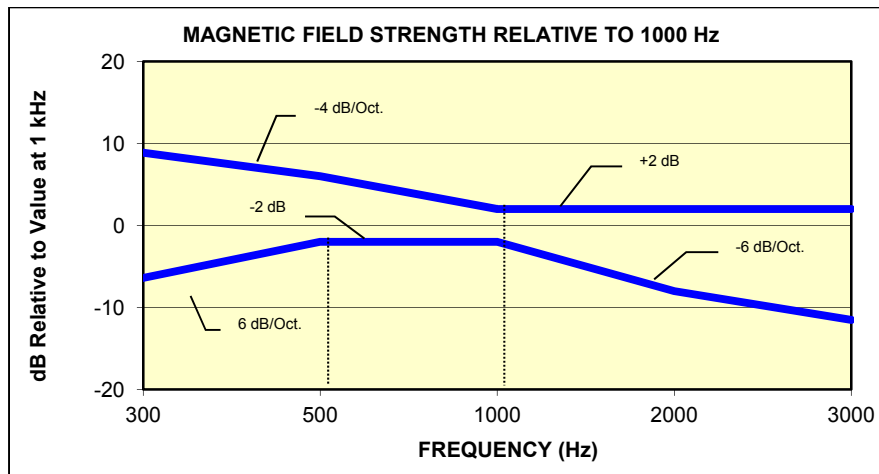


Figure 4-1
Magnetic field frequency response for Wireless Devices with an axial field ≤ -15 dB(A/m) at 1 kHz

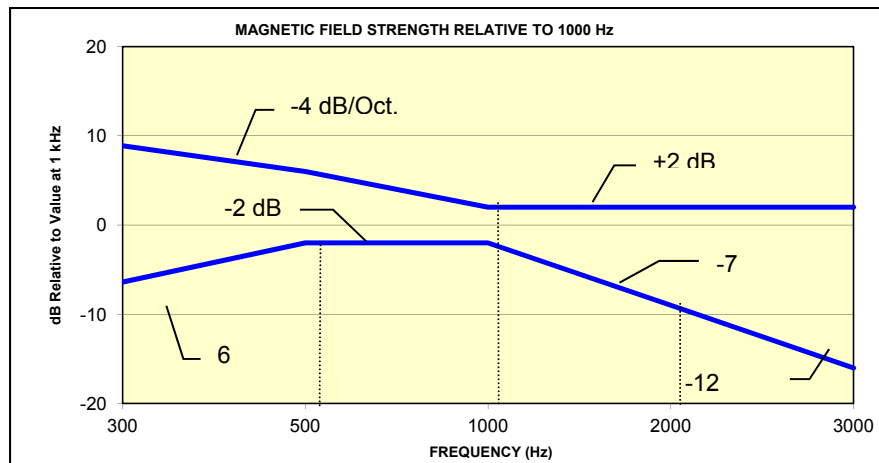




Figure 4-2
Magnetic Field frequency response for wireless devices with an axial field that exceeds -15 dB(A/m) at 1 kHz

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Signal Quality

The table below provides the signal quality requirement for the intended audio magnetic signal from a wireless device. Only the RF immunity of the hearing aid is measured in T-coil mode. It is assumed that a hearing aid can have no immunity to an interference signal in the audio band, which is the intended reception band for this mode. The only criterion that can be measured is the RF immunity in T-coil mode. This is measured using the same procedure as the audio coupling mode at the same levels.

The signal quality of the axial and radial components of the magnetic field was used to determine the T-coil mode category.

| Category | Telephone RF Parameters |
|----------|---|
| | Wireless Device Signal Quality (Signal + Noise-to-noise ratio in dB) |
| T1 | 0 to 10 dB |
| T2 | 10 to 20 dB |
| T3 | 20 to 30 dB |
| T4 | > 30 dB |

Table 4-1
Magnetic Coupling Parameters

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  PCTEST This office is in Devonport, NH | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
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5. METHOD OF MEASUREMENT

I. Test Setup

The equipment was connected as shown in an acoustic/RF hemi-anechoic chamber:

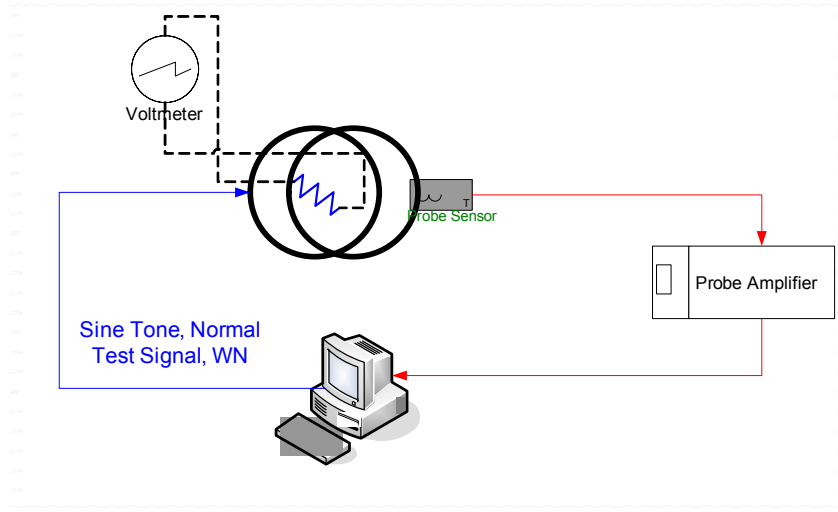


Figure 5-1
Validation Setup with Helmholtz Coil

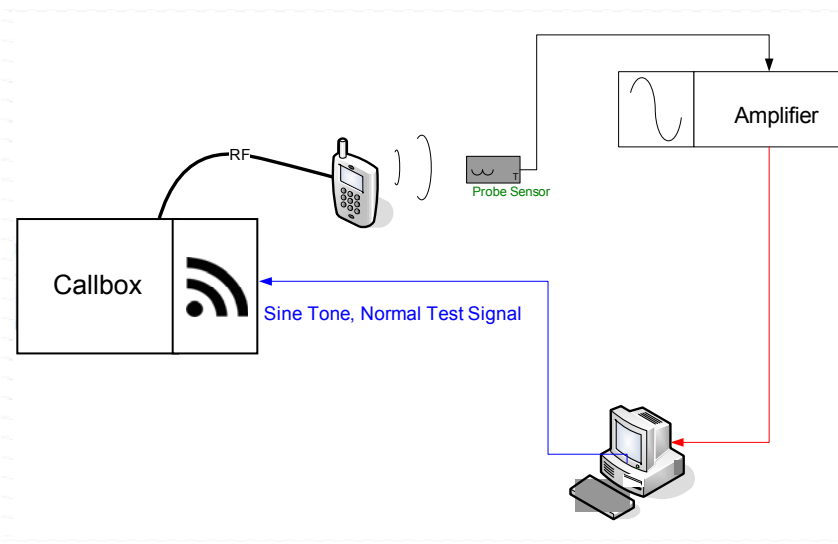




Figure 5-2
T-Coil Test Setup

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II. Scanning Mechanism

Manufacturer: TEM
 Accuracy: ± 0.83 cm/meter
 Minimum Step Size: 0.1 mm
 Maximum speed: 6.1 cm/sec
 Line Voltage: 115 VAC
 Line Frequency: 60 Hz
 Material Composite: Delrin (Acetal)
 Data Control: Parallel Port
 Dynamic Range (X-Y-Z): 45 x 31.75 x 47 cm
 Dimensions: 36" x 25" x 38"
 Operating Area: 36" x 49" x 55"
 Reflections: < -20 dB (in anechoic chamber)

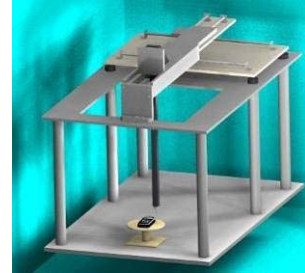


Figure 5-3
RF Near-Field Scanner

III. 3GPP2 Normal Test Signal (speech)

Manufacturer: 3GPP2 (TIA 1042 §3.3.1)
 Stimulus Type: Modified-IRS weighted, multi-talker speech signal, 4 Male and 4 Female speakers (alternating)
 Single Sample Duration: 51.62 seconds
 Activity Level: 77.4%

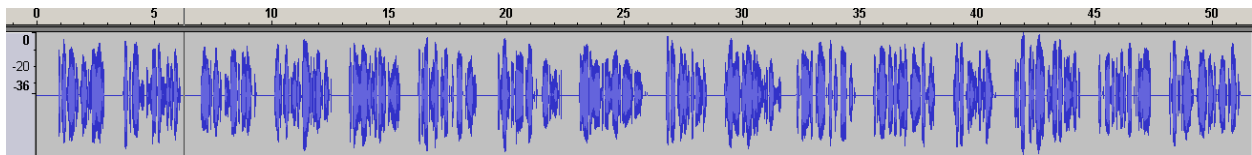


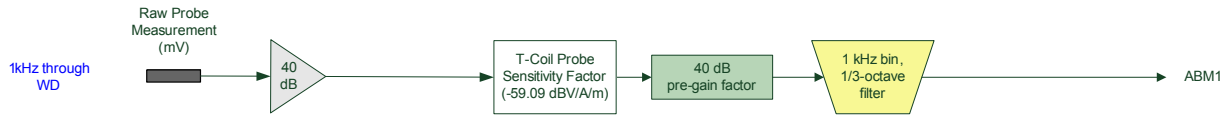


Figure 5-4
Temporal Characteristic of Normal Test Signal

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ABM1 Measurement Block Diagram :



ABM2 Measurement Block Diagram :

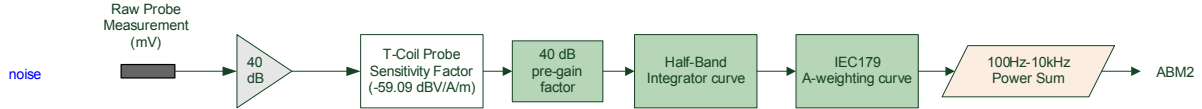


Figure 5-5 Magnetic Measurement Processing Steps

IV. Test Procedure

1. Ambient Noise Check per C63.19 §6.2.1
 - a. Ambient interference was monitored using a Real-Time Analyzer between 100-10,000 Hz with 1/3 octave filtering.
 - b. “A-weighting” and Half-Band Integration was applied to the measurements.
 - c. Since this measurement was measured in the same method as ABM2 measurements, this level was verified to be less than 10 dB below the lowest measurement signal (which is the highest ABM2 measurement for a T4 WD). Therefore the maximum noise level for a T4 WD with an ABM1 = -18 dBA/m is:

$$-18 - 30 - 10 = -58 \text{ dBA/m}$$
2. Measurement System Validation (See Figure 5-1)
 - a. The measurement system including the probe, pre-amplifier and acquisition system were validated as an entire system to ensure the reliability of test measurements.
 - b. ABM1 Validation
 The magnetic field at the center of the Helmholtz coil is given by the equation (per C63.19 Annex D.9.1):



$$H_c = \frac{NI}{r\sqrt{1.25^3}} = \frac{N\left(\frac{V}{R}\right)}{r\sqrt{1.25^3}}$$

Where H_c = magnetic field strength in amperes per meter
 N = number of turns per coil

For the Helmholtz Coil, N=20; r=0.08m; R=10.193Ω and using V=57mV:

$$H_c = \frac{20 \cdot \left(\frac{0.057}{10.193}\right)}{0.08 \cdot \sqrt{1.25^3}} = 1.0003 \text{ A/m}$$

Therefore a pure tone of 1kHz was applied into the coils such that 57 mV was observed across the 10 Ω resistor. The voltmeter used for measurement was verified to be capable of measurements in the audio band range. This theoretically generates an expected field of 1 A/m in the center of the Helmholtz coil which was used to validate the probe measurement at 1 A/m. This was verified to be within ± 0.5 dB of the 1 A/m value (see Page 21).

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c. Frequency Response Validation

The frequency response through the Helmholtz Coil was verified to be within 0.5 dB relative to 1 kHz, between 300 – 3000 Hz using the Normal speech signal as shown below:

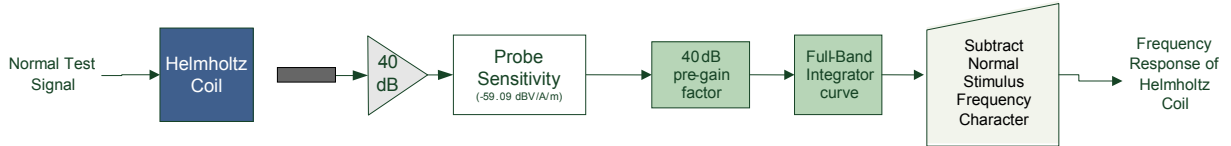




Figure 5-6 Frequency Response Validation

d. ABM2 Measurement Validation

WD noise measurements are filtered with A-weighting and Half-Band Integration over a frequency range of 100Hz – 10kHz to process ABM2 measurements. Below is the verification of the system processing A-weighting and Half-Band integration between system input to output within 0.5 dB of the theoretical result:

**Table 5-1
ABM2 Frequency Response Validation**

| f (Hz) | HBI, A - Measured (dB re 1kHz) | HBI, A - Theoretical (dB re 1kHz) | dB Var. |
|--------|--------------------------------|-----------------------------------|---------|
| 100 | -16.180 | -16.170 | -0.010 |
| 125 | -13.257 | -13.250 | -0.007 |
| 160 | -10.347 | -10.340 | -0.007 |
| 200 | -8.017 | -8.010 | -0.007 |
| 250 | -5.925 | -5.920 | -0.005 |
| 315 | -4.045 | -4.040 | -0.005 |
| 400 | -2.405 | -2.400 | -0.005 |
| 500 | -1.212 | -1.210 | -0.002 |
| 630 | -0.349 | -0.350 | 0.001 |
| 800 | 0.071 | 0.070 | 0.001 |
| 1000 | 0.000 | 0.000 | 0.000 |
| 1250 | -0.503 | -0.500 | -0.003 |
| 1600 | -1.513 | -1.510 | -0.003 |
| 2000 | -2.778 | -2.780 | 0.002 |
| 2500 | -4.316 | -4.320 | 0.004 |
| 3150 | -6.166 | -6.170 | 0.004 |
| 4000 | -8.322 | -8.330 | 0.008 |
| 5000 | -10.573 | -10.590 | 0.017 |
| 6300 | -13.178 | -13.200 | 0.022 |
| 8000 | -16.241 | -16.270 | 0.029 |
| 10000 | -19.495 | -19.520 | 0.025 |

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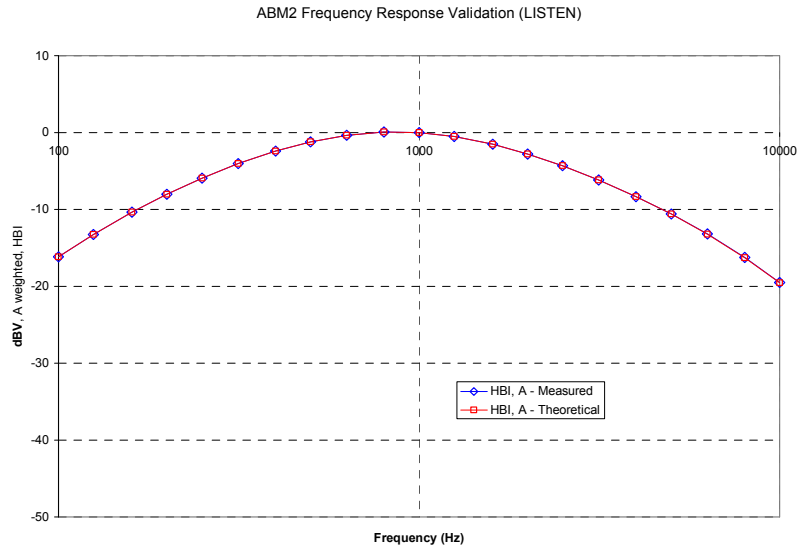


Figure 5-7
ABM2 Frequency Response Validation

The ABM2 result is a power sum from 100 Hz to 10 kHz with half-band integration and A-weighting. To verify the power sum measurement, a power sum over the full band was measured and verified to track with the source level (See Figure 5-8). Therefore the setup in this step was used to verify the power sum post-processing for ABM2 measurements. See below block diagram:

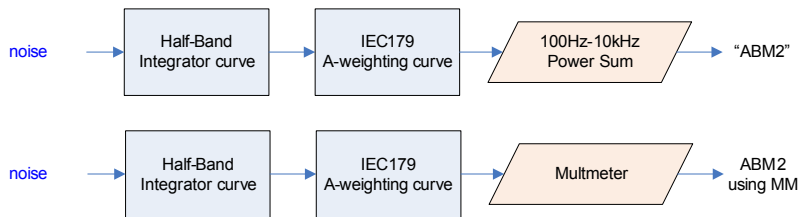


Figure 5-8
ABM2 Validation Block Diagram

The power summed output results for a known input were compared to the multi-meter results to verify any deviation in the post-processing implemented with the power-sum.

Table 5-2
ABM2 Power Sum Validation

| WN Input (dBV) | Power Sum (dBV) | Multimeter-Full (dBV) | Dev (dB) |
|----------------|-----------------|-----------------------|----------|
| -60 | -60.36 | -60.2 | 0.16 |
| -50 | -50.19 | -50.13 | 0.06 |
| -40 | -40.14 | -40.03 | 0.11 |
| -30 | -30.13 | -30.01 | 0.12 |
| -20 | -20.12 | -20 | 0.12 |
| -10 | -10.14 | -10 | 0.14 |

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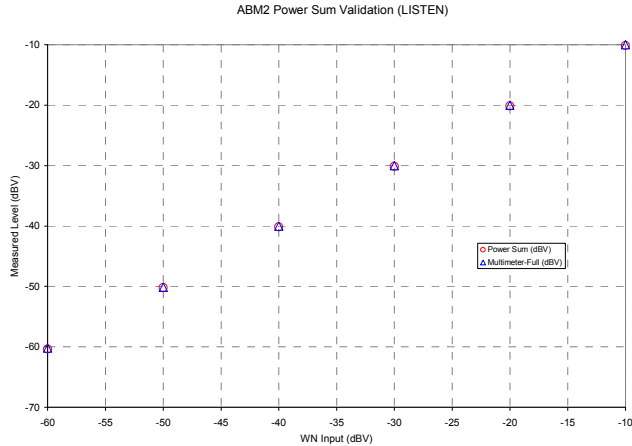


Figure 5-9
ABM2 Power Sum Validation

3. Measurement Test Setup

a. Fine scan above the WD (TEM)

- i. A multitone signal was applied to the handset such that the phone acoustic output was stable within 1dB over the probe settling time and with the acoustic output level at the C63.19 specified levels (below). The measurement step size was in 2 mm increments at a distance of 10 mm between the surface of the wireless device as shown below:

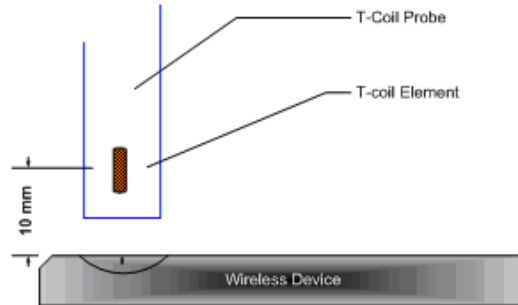




Figure 5-10
Measurement Distance

- ii. After scanning, the planar field maximum point was determined. The position of the probe was moved to this location to setup the test using the Sound Check system.
 - iii. These steps were repeated for the other T-coil orientations (of axial or radial transverse) per Figure 5-13 after a T-coil orientation was fully measured with the Sound Check system.
- b. Speech Signal Setup to Base Station Simulator
- i. According to the C63 Committee, a speech input level of -16dBm0 shall be used for LTE T-Coil testing.
 - ii. See Section 6 for more information regarding CMW500 audio level settings for Voice Over LTE (VoLTE) testing.
- c. Real-Time Analyzer (RTA)
- i. The Real-Time Analyzer was configured to analyze measurements using 1/3 Octave band weighted filtering.

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- d. WD Radio Configuration Selection
 - i. LTE configuration information can be found in Section 6
- 4. Signal Quality Data Analysis
 - a. Narrow-band Magnetic Intensity
 - i. The standard specifies a 1 kHz 1/3 octave band minimum field intensity for a sine tone. The ABM1 measurements were evaluated at 1 kHz with 1/3 octave band filtering over an averaged period of 10 seconds.
 - b. Frequency Response
 - i. The appropriate frequency response curve was measured to curves in Figure 4-1 or Figure 4-2 between 300 – 3000 Hz using digital linear averaging (limit lines chosen according to measurement found in step 3.d.ia.) A linear average over 3x the length of the speech signal (3x sampling) was performed. A 10 second delay was configured in the measurement process of the stimulus to ensure handset vocoder latency effects and echo cancellation devices (if any) were appropriately stabilized during measurements.
 - ii. The appropriate post-processing was applied according to the system processing chain illustrated in Figure 5-11. All R10 frequencies were plotted with respect to 0dB at 1 kHz value and aligned with respect to the EIA-504 mask.

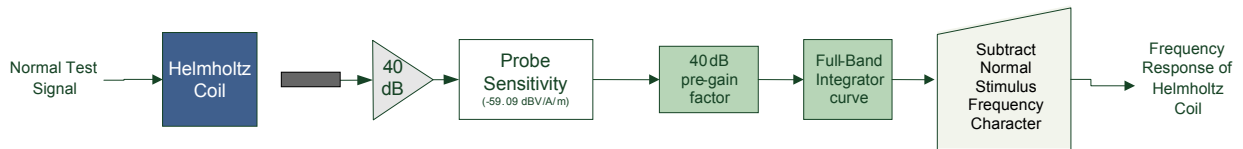


Figure 5-11 Frequency Response Block Diagram



- iii. The margin is represented by the closest measured data point on the curve to the EIA-504 limit lines, in dB.
- c. Signal Quality Index
 - i. Ensuring the WD was at maximum RF power, maximum volume, backlight on, display on, maximum contrast setting, keypad lights on (when possible) with no audio signal through the vocoder, the WD was measured over at least 100 Hz – 10,000 Hz, maximized over 5 seconds with a 50ms sample time for the ABM2 measurement (5 second time period is used in noise measurements under standards such as IEEE 269, etc.)
 - ii. After applying half-band integration and A-weighting to the result, a power sum was applied over each 1/3 octave bandwidth frequency to obtain an ABM2 value.
 - iii. This result was subtracted from the ABM1 result in step a, to obtain the Signal Quality.

V. Deviation from C63.19 Test Procedure

Non-conducted RF connection to account for effects of metallic shielding in the battery cover.

VI. Air Interface Technologies Tested

This report covers only T-Coil testing for LTE. Other air interfaces supported by the device are not included in the test scope for this report.

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
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VII. Wireless Device Channels and Frequencies

For LTE testing, the middle channel for every band and bandwidth combination was tested for each probe orientation. The band and bandwidth combination from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels for that band and bandwidth combination. See Tables 7-5 through 7-13 for LTE bandwidths and channels.

VIII. RF Emission Effect on T-coil Measurements

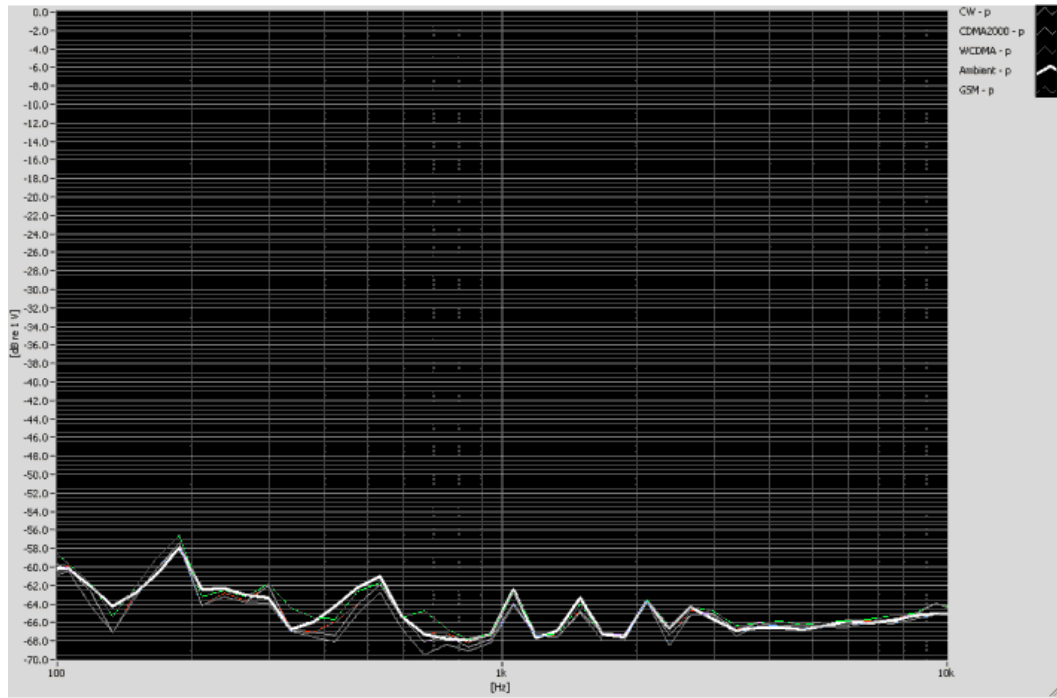


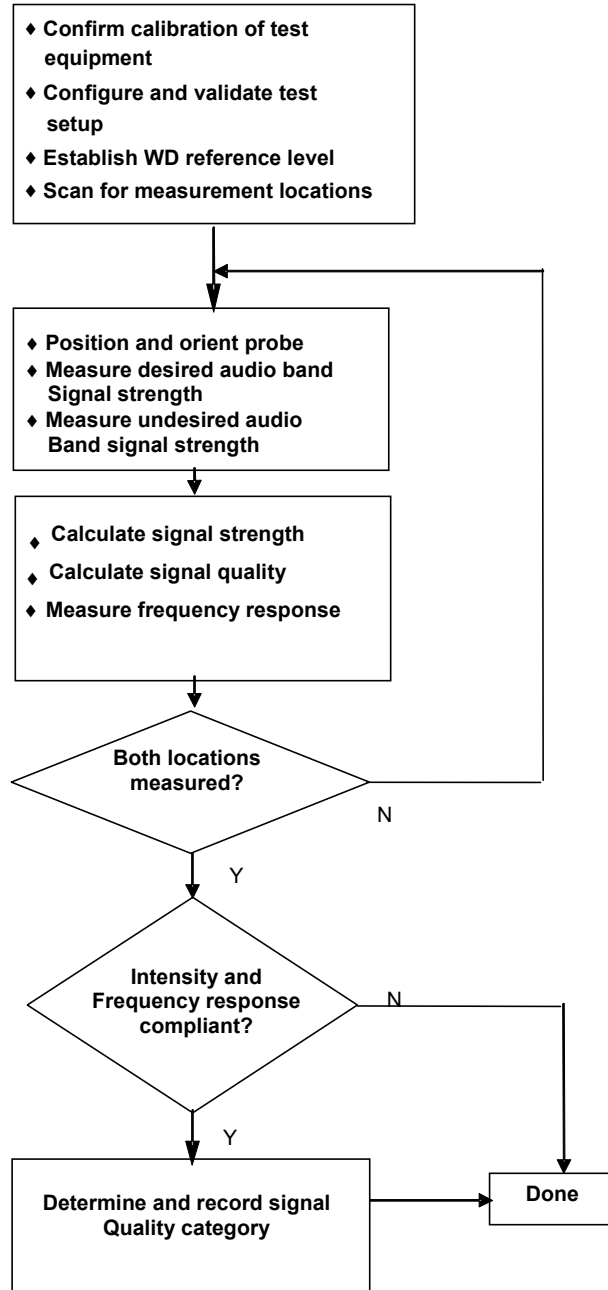


Figure 5-12
High power RF Emissions Effect with HAC Dipole on the T-coil Probe System 10mm between dipole maximum and magnetic probe



| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
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IX. Test Flow

The flow diagram below was followed (From C63.19):



**Figure 5-13
C63.19 T-Coil Signal Test Process**

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
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6. VOLTE TEST SYSTEM SETUP AND DUT CONFIGURATION

I. Test System Setup for VoLTE T-coil Testing

1. Equipment Setup

The general test setup used for VoLTE is shown below (adopted from FCC KDB 285076 D02). The callbox used when performing VoLTE T-coil measurements is a CMW500. The Data Application Unit (DAU) of the CMW500 was used to simulate the IP Multimedia Subsystem (IMS) server.

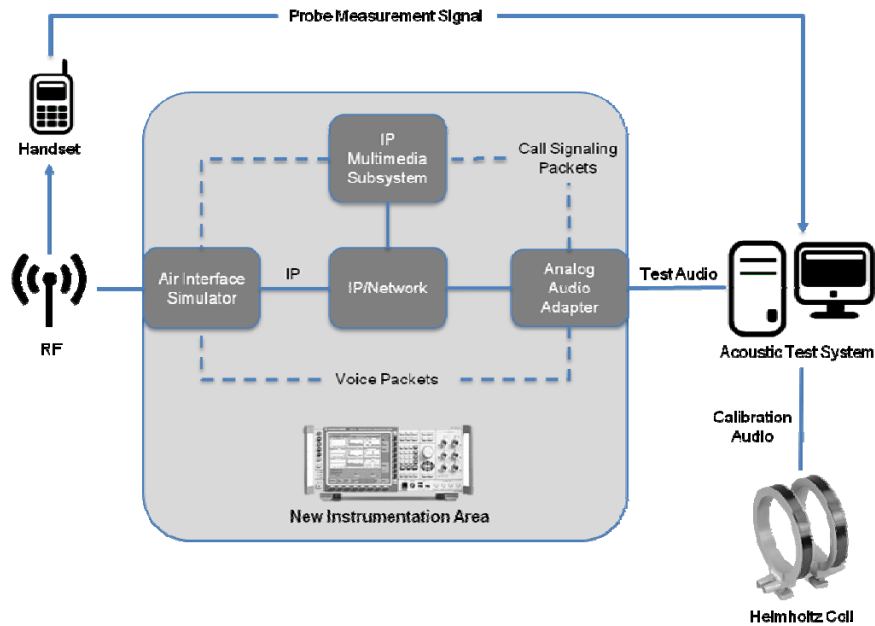




Figure 6-1
Test Setup for VoLTE T-Coil Measurements

2. Audio Level Settings

According to the July 2012 interpretations by the C63 Committee regarding the appropriate audio levels to be used for LTE T-coil testing, -16dBm0 shall be used for the normal speech input level*. The CMW500 base station simulator was manually configured to ensure that the settings for speech input and full scale levels resulted in the -16dBm0 speech input level to the DUT for the VoLTE connection.

* http://c63.org/documents/misc/posting/new_interpretations.htm

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
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II. DUT Configuration for VoLTE T-coil Testing

1. Radio Configuration

An investigation was performed on the worst-case LTE Band and Bandwidth to determine the modulation and RB configuration to be used for testing. 16QAM, 1RB, 0RB offset was used for the testing as the worst-case configuration for the handset. See below table for SNNR comparison between different radio configurations:

| Frequency [MHz] | Channel | Bandwidth [MHz] | Modulation | RB Size | RB Offset | ABM1 [dB(A/m)] | ABM2 [dB(A/m)] | SNNR [dB] |
|-----------------|---------|-----------------|------------|---------|-----------|----------------|----------------|-----------|
| 1880.0 | 18900 | 20 | QPSK | 1 | 0 | 4.83 | -38.16 | 42.99 |
| 1880.0 | 18900 | 20 | QPSK | 1 | 50 | 4.76 | -38.40 | 43.16 |
| 1880.0 | 18900 | 20 | QPSK | 1 | 99 | 4.78 | -38.45 | 43.23 |
| 1880.0 | 18900 | 20 | QPSK | 50 | 0 | 4.72 | -38.05 | 42.77 |
| 1880.0 | 18900 | 20 | QPSK | 50 | 25 | 4.80 | -38.25 | 43.05 |
| 1880.0 | 18900 | 20 | QPSK | 50 | 50 | 4.77 | -38.42 | 43.19 |
| 1880.0 | 18900 | 20 | QPSK | 100 | 0 | 4.72 | -38.40 | 43.12 |
| 1880.0 | 18900 | 20 | 16-QAM | 1 | 0 | 4.78 | -36.99 | 41.77 |
| 1880.0 | 18900 | 20 | 16-QAM | 1 | 50 | 4.71 | -37.40 | 42.11 |
| 1880.0 | 18900 | 20 | 16-QAM | 1 | 99 | 4.73 | -37.53 | 42.26 |
| 1880.0 | 18900 | 20 | 16-QAM | 50 | 0 | 4.76 | -37.97 | 42.73 |
| 1880.0 | 18900 | 20 | 16-QAM | 50 | 25 | 4.72 | -38.27 | 42.99 |
| 1880.0 | 18900 | 20 | 16-QAM | 50 | 50 | 4.70 | -37.97 | 42.67 |
| 1880.0 | 18900 | 20 | 16-QAM | 100 | 0 | 4.72 | -37.97 | 42.69 |

Table 6-1
LTE SNNR by Radio Configuration

2. Codec Configuration

An investigation was performed on the worst-case LTE Band and Bandwidth to determine the audio codec configuration to be used for testing. The WB AMR 23.85kbps setting was used for the audio codec on the CMW500 for VoLTE T-coil testing. See below table for ABM1 and ABM2 comparisons between different codecs and codec data rates:



| Codec Setting: | WB AMR 23.85kbps | WB AMR 6.60kbps | NB AMR 12.2kbps | NB AMR 4.75kbps | Orientation | Channel |
|---|------------------|-----------------|-----------------|-----------------|-------------|---------------------|
| ABM1 Pre-Test (dBA/m) | 4.850 | 4.660 | 7.060 | 5.490 | Axial | 18900 (20MHz BW) |
| ABM2 Pre-Test (dBA/m) (A-weight, Half-Band Int.) | -37.44 | -37.75 | -37.55 | -37.44 | | |
| S+N/N (dB) | 42.29 | 42.41 | 44.61 | 42.93 | | |

Table 6-2
VoLTE Codec Comparison for A3LSMG360V

- Mute on; Backlight on; Max Volume, Max Contrast
- TPC = "Max Power"



Figure 6-2
Audio Band Magnetic Curve Measurement Block Diagram

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
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7. TEST SUMMARY

I. T-Coil Test Summary

**Table 7-1
Table of Results for LTE Band 13**

| C63.19 Sec. | Mode | Band/ BW | Test Description | Minimum Limit* | Measured | Verdict |
|-------------|------|----------------------|-------------------------------|-------------------|-------------|------------------|
| | | | | <i>dB/m</i> | <i>dB/m</i> | <i>PASS/FAIL</i> |
| 8.3.1 | LTE | Band 13/ 5MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.3 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 45.9 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 45.2 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 13/ 10MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 46.6 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 44.7 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |

Note: The above summary table represents the worst-case numerical values according to configurations in Table 7-4.





| | | | | |
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Table 7-2
Table of Results for LTE Band 4

| C63.19 Sec. | Mode | Band/ BW | Test Description | Minimum Limit* | Measured | Verdict |
|-------------|------|----------------------|-------------------------------|-------------------|--------------|------------------|
| | | | | <i>dBA/m</i> | <i>dBA/m</i> | <i>PASS/FAIL</i> |
| 8.3.1 | LTE | Band 4/ 1.4MHz BW | Intensity, Axial | -18 | 4.8 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 45.3 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 43.7 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 4/ 3MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 45.7 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 44.4 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 4/ 5MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 45.9 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 44.8 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 4/ 10MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.3 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 45.5 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 44.8 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 4/ 15MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.3 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 41.8 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 44.4 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 4/ 20MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 42.0 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 44.4 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |



Note: The above summary table represents the worst-case numerical values according to configurations in Tables 7-5 through 7-7.

| | | | | |
|----------------------------------|--|---------------------------------|---|---------------------------------|
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**Table 7-3
Table of Results for LTE Band 2**

| C63.19 Sec. | Mode | Band/ BW | Test Description | Minimum Limit* | Measured | Verdict |
|-------------|------|----------------------|-------------------------------|-------------------|--------------|------------------|
| | | | | <i>dBA/m</i> | <i>dBA/m</i> | <i>PASS/FAIL</i> |
| 8.3.1 | LTE | Band 2/ 1.4MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 45.2 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 45.9 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 2/ 3MHz BW | Intensity, Axial | -18 | 4.8 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 46.5 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 46.6 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 2/ 5MHz BW | Intensity, Axial | -18 | 4.8 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 46.2 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 46.9 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.8 | PASS |
| 8.3.1 | LTE | Band 2/ 10MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 47.6 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 46.1 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.8 | PASS |
| 8.3.1 | LTE | Band 2/ 15MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 43.1 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 46.0 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |
| 8.3.1 | LTE | Band 2/ 20MHz BW | Intensity, Axial | -18 | 4.7 | PASS |
| 8.3.1 | | | Intensity, Radial | -18 | -2.4 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Axial | 20 | 41.8 | PASS |
| 8.3.4 | | | Signal-to-Noise/Noise, Radial | 20 | 45.5 | PASS |
| 8.3.2 | | | Frequency Response, Axial | 0 | 0.9 | PASS |

Note: The above summary table represents the worst-case numerical values according to configurations in Tables 7-8 through 7-10.

| | | | | |
|----------------------------------|---|---------------------------------|---|---------------------------------|
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II. Raw Handset Data

**Table 7-4
Raw Data Results for LTE Band 13**

| | | Volume | 5MHz BW | | |
|------------------------------------|--|---------|------------------------|-----------|---------|
| | | | Axial | Radial | |
| | | | 23230 | 23230 | |
| ABM1, dBA/m | | | 4.70 | -2.34 | |
| ABM2, dBA/m | | | -41.21 | -47.57 | |
| Ambient Noise, dBA/m | | | -58.28 | -58.18 | |
| Freq. Response Margin (dB) | | Maximum | 0.85 | N/A | |
| S+N/N (dB) | | | 45.91 | 45.23 | |
| S+N/N per orientation (dB) | | | 45.91 | 45.23 | |
| C63.19-2011 Rating per orientation | | | T4 | T4 | |
| | | | Volume | 10MHz BW | |
| | | | | Axial | Radial |
| | | | | 23230 | 23230 |
| ABM1, dBA/m | | | 4.73 | -2.36 | |
| ABM2, dBA/m | | | -41.89 | -47.03 | |
| Ambient Noise, dBA/m | | | -58.28 | -58.18 | |
| Freq. Response Margin (dB) | | Maximum | 0.91 | N/A | |
| S+N/N (dB) | | | 46.62 | 44.67 | |
| S+N/N per orientation (dB) | | | 46.62 | 44.67 | |
| C63.19-2011 Rating per orientation | | | T4 | T4 | |
| T-coil Coordinates (cm) | | | [x,y] from bottom left | 2.6,2.6 | 2.6,1.8 |

Notes:

1. Power Configuration: TPC = "Max Power"
2. Radio Configuration: 16QAM, 1RB, 0RB Offset
3. Phone Condition: Mute on; Backlight on; Max Volume, Max Contrast
4. Vocoder Configuration: WB AMR 23.85kbps (LTE)
5. 'Radial' orientation refers to radial transverse.
6. Speech Signal: 3GPP2 Normal Test Signal



| | | | | |
|----------------------------------|--|-------------------------------|---|---------------------------------|
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**Table 7-5
Raw Data Results for LTE Band 4 (1.4MHz and 3MHz BW's)**

| | | Volume | 1.4MHz BW | | | |
|------------------------------------|---------|------------------------|-----------|---------|-----------|--------|
| | | | Axial | | Radial | |
| | | | 20175 | 19957 | 20175 | 20393 |
| ABM1, dBA/m | Maximum | | 4.79 | -2.27 | -2.36 | -2.27 |
| ABM2, dBA/m | | | -40.54 | -45.96 | -46.52 | -47.40 |
| Ambient Noise, dBA/m | | | -58.28 | -58.18 | -58.18 | -58.18 |
| Freq. Response Margin (dB) | | | 0.86 | N/A | N/A | N/A |
| S+N/N (dB) | | | 45.33 | 43.69 | 44.16 | 45.13 |
| S+N/N per orientation (dB) | | | 45.33 | 43.69 | | |
| C63.19-2011 Rating per orientation | | | T4 | | T4 | |
| | | | 3MHz BW | | | |
| | | Volume | Axial | | Radial | |
| | | | 20175 | 20175 | | |
| ABM1, dBA/m | Maximum | | 4.71 | -2.35 | | |
| ABM2, dBA/m | | | -40.97 | -46.76 | | |
| Ambient Noise, dBA/m | | | -58.28 | -58.18 | | |
| Freq. Response Margin (dB) | | | 0.87 | N/A | | |
| S+N/N (dB) | | | 45.68 | 44.41 | | |
| S+N/N per orientation (dB) | | | 45.68 | 44.41 | | |
| C63.19-2011 Rating per orientation | | | T4 | | T4 | |
| T-coil Coordinates (cm) | | [x,y] from bottom left | | 2.6,2.6 | 2.6,1.8 | |

Notes:

1. Power Configuration: TPC = "Max Power"
2. Radio Configuration: 16QAM, 1RB, 0RB Offset
3. Phone Condition: Mute on; Backlight on; Max Volume, Max Contrast
4. Vocoder Configuration: WB AMR 23.85kbps (LTE)
5. 'Radial' orientation refers to radial transverse.
6. Speech Signal: 3GPP2 Normal Test Signal
7. Since LTE Band 4 at 1.4MHz bandwidth was the worst-case configuration for the Radial probe orientation, low and high channels were additionally tested with this configuration.



| | | | | |
|----------------------------------|--|-------------------------------|---|---------------------------------|
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**Table 7-6
Raw Data Results for LTE Band 4 (5MHz and 10MHz BW's)**

| | Volume | 5MHz BW | |
|------------------------------------|------------------------|-----------|-----------|
| | | Axial | Radial |
| | | 20175 | 20175 |
| ABM1, dBA/m | Maximum | 4.68 | -2.36 |
| ABM2, dBA/m | | -41.18 | -47.11 |
| Ambient Noise, dBA/m | | -58.28 | -58.18 |
| Freq. Response Margin (dB) | | 0.87 | N/A |
| S+N/N (dB) | | 45.86 | 44.75 |
| S+N/N per orientation (dB) | | 45.86 | 44.75 |
| C63.19-2011 Rating per orientation | | T4 | T4 |
| | | | |
| | Volume | 10MHz BW | |
| | | Axial | Radial |
| | | 20175 | 20175 |
| ABM1, dBA/m | Maximum | 4.73 | -2.32 |
| ABM2, dBA/m | | -40.78 | -47.07 |
| Ambient Noise, dBA/m | | -58.28 | -58.18 |
| Freq. Response Margin (dB) | | 0.85 | N/A |
| S+N/N (dB) | | 45.51 | 44.75 |
| S+N/N per orientation (dB) | | 45.51 | 44.75 |
| C63.19-2011 Rating per orientation | | T4 | T4 |
| | | | |
| T-coil Coordinates (cm) | [x,y] from bottom left | 2.6,2.6 | 2.6,1.8 |

Notes:

1. Power Configuration: TPC = "Max Power"
2. Radio Configuration: 16QAM, 1RB, 0RB Offset
3. Phone Condition: Mute on; Backlight on; Max Volume, Max Contrast
4. Vocoder Configuration: WB AMR 23.85kbps (LTE)
5. 'Radial' orientation refers to radial transverse.
6. Speech Signal: 3GPP2 Normal Test Signal



| | | | | |
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**Table 7-7
Raw Data Results for LTE Band 4 (15MHz and 20MHz BW's)**

| | Volume | 15MHz BW | |
|------------------------------------|------------------------|-----------|-----------|
| | | Axial | Radial |
| | | 20175 | 20175 |
| ABM1, dBA/m | Maximum | 4.71 | -2.33 |
| ABM2, dBA/m | | -37.12 | -46.76 |
| Ambient Noise, dBA/m | | -58.28 | -58.18 |
| Freq. Response Margin (dB) | | 0.87 | N/A |
| S+N/N (dB) | | 41.83 | 44.43 |
| S+N/N per orientation (dB) | | 41.83 | 44.43 |
| C63.19-2011 Rating per orientation | | T4 | T4 |
| | | | |
| | Volume | 20MHz BW | |
| | | Axial | Radial |
| | | 20175 | 20175 |
| ABM1, dBA/m | Maximum | 4.67 | -2.35 |
| ABM2, dBA/m | | -37.35 | -46.76 |
| Ambient Noise, dBA/m | | -58.28 | -58.18 |
| Freq. Response Margin (dB) | | 0.91 | N/A |
| S+N/N (dB) | | 42.02 | 44.41 |
| S+N/N per orientation (dB) | | 42.02 | 44.41 |
| C63.19-2011 Rating per orientation | | T4 | T4 |
| | | | |
| T-coil Coordinates (cm) | [x,y] from bottom left | 2.6,2.6 | 2.6,1.8 |

Notes:

1. Power Configuration: TPC = "Max Power"
2. Radio Configuration: 16QAM, 1RB, 0RB Offset
3. Phone Condition: Mute on; Backlight on; Max Volume, Max Contrast
4. Vocoder Configuration: WB AMR 23.85kbps (LTE)
5. 'Radial' orientation refers to radial transverse.
6. Speech Signal: 3GPP2 Normal Test Signal



| | | | | |
|----------------------------------|--|-------------------------------|---|---------------------------------|
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**Table 7-8
Raw Data Results for LTE Band 2 (1.4MHz and 3MHz BW's)**

| | Volume | 1.4MHz BW | |
|------------------------------------|---------|------------------------|-----------|
| | | Axial | Radial |
| | | 18900 | 18900 |
| ABM1, dBA/m | Maximum | 4.72 | -2.36 |
| ABM2, dBA/m | | -40.52 | -48.29 |
| Ambient Noise, dBA/m | | -58.28 | -58.18 |
| Freq. Response Margin (dB) | | 0.91 | N/A |
| S+N/N (dB) | | 45.24 | 45.93 |
| S+N/N per orientation (dB) | | 45.24 | 45.93 |
| C63.19-2011 Rating per orientation | | T4 | T4 |
| | | | |
| | Volume | 3MHz BW | |
| | | Axial | Radial |
| | | 18900 | 18900 |
| ABM1, dBA/m | Maximum | 4.75 | -2.36 |
| ABM2, dBA/m | | -41.71 | -48.96 |
| Ambient Noise, dBA/m | | -58.28 | -58.18 |
| Freq. Response Margin (dB) | | 0.87 | N/A |
| S+N/N (dB) | | 46.46 | 46.60 |
| S+N/N per orientation (dB) | | 46.46 | 46.60 |
| C63.19-2011 Rating per orientation | | T4 | T4 |
| T-coil Coordinates (cm) | | [x,y] from bottom left | 2.6,2.6 |

Notes:

1. Power Configuration: TPC = "Max Power"
2. Radio Configuration: 16QAM, 1RB, 0RB Offset
3. Phone Condition: Mute on; Backlight on; Max Volume, Max Contrast
4. Vocoder Configuration: WB AMR 23.85kbps (LTE)
5. 'Radial' orientation refers to radial transverse.
6. Speech Signal: 3GPP2 Normal Test Signal



| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  PCTEST This office is in development, etc. | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | Page 26 of 45 | |

**Table 7-9
Raw Data Results for LTE Band 2 (5MHz and 10MHz BW's)**

| | | 5MHz BW | |
|-------------------------|------------------------------------|-----------|-----------|
| | | Axial | Radial |
| | Volume | 18900 | 18900 |
| | ABM1, dBA/m | 4.75 | -2.36 |
| | ABM2, dBA/m | -41.43 | -49.21 |
| | Ambient Noise, dBA/m | -58.28 | -58.18 |
| | Freq. Response Margin (dB) | 0.83 | N/A |
| | S+N/N (dB) | 46.18 | 46.85 |
| | S+N/N per orientation (dB) | 46.18 | 46.85 |
| | C63.19-2011 Rating per orientation | T4 | T4 |
| | | 10MHz BW | |
| | | Axial | Radial |
| | Volume | 18900 | 18900 |
| | ABM1, dBA/m | 4.70 | -2.41 |
| | ABM2, dBA/m | -42.86 | -48.52 |
| | Ambient Noise, dBA/m | -58.28 | -58.18 |
| | Freq. Response Margin (dB) | 0.82 | N/A |
| | S+N/N (dB) | 47.56 | 46.11 |
| | S+N/N per orientation (dB) | 47.56 | 46.11 |
| | C63.19-2011 Rating per orientation | T4 | T4 |
| T-coil Coordinates (cm) | [x,y] from bottom left | 2.6,2.6 | 2.6,1.8 |

Notes:

1. Power Configuration: TPC = "Max Power"
2. Radio Configuration: 16QAM, 1RB, 0RB Offset
3. Phone Condition: Mute on; Backlight on; Max Volume, Max Contrast
4. Vocoder Configuration: WB AMR 23.85kbps (LTE)
5. 'Radial' orientation refers to radial transverse.
6. Speech Signal: 3GPP2 Normal Test Signal



| | | | | |
|----------------------------------|--|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  PCTEST Engineering Laboratory, Inc. | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | Page 27 of 45 | |

**Table 7-10
Raw Data Results for LTE Band 2 (15MHz and 20MHz BW's)**

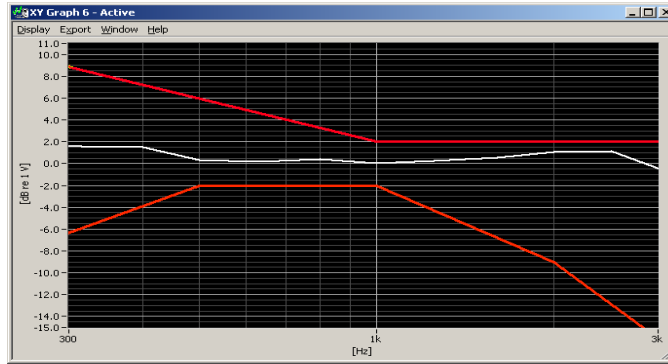
| | | 15MHz BW | | | |
|------------------------------------|---------|------------------------|---------|-----------|-----------|
| | | Axial | | Radial | |
| | Volume | 18900 | | 18900 | |
| | | 4.68 | | -2.39 | |
| ABM1, dBA/m | Maximum | -38.39 | | -48.36 | |
| ABM2, dBA/m | | -58.28 | | -58.18 | |
| Ambient Noise, dBA/m | | 0.87 | | N/A | |
| Freq. Response Margin (dB) | | 43.07 | | 45.97 | |
| S+N/N (dB) | | 43.07 | | 45.97 | |
| S+N/N per orientation (dB) | | T4 | | T4 | |
| C63.19-2011 Rating per orientation | | | | | |
| | | | | | |
| | | 20MHz BW | | | |
| | | Axial | | | Radial |
| | Volume | 18700 | 18900 | 19100 | 18900 |
| | | 4.70 4.70 4.72 | | | -2.40 |
| ABM1, dBA/m | Maximum | -37.51 | -37.11 | -38.01 | -47.85 |
| ABM2, dBA/m | | -58.28 | -58.28 | -58.28 | -58.18 |
| Ambient Noise, dBA/m | | 0.88 | 0.89 | 0.91 | N/A |
| Freq. Response Margin (dB) | | 42.21 | 41.81 | 42.73 | 45.45 |
| S+N/N (dB) | | 41.81 | | | 45.45 |
| S+N/N per orientation (dB) | | T4 | | | T4 |
| C63.19-2011 Rating per orientation | | | | | |
| T-coil Coordinates (cm) | | [x,y] from bottom left | 2.6,2.6 | | |

Notes:

1. Power Configuration: TPC = "Max Power"
2. Radio Configuration: 16QAM, 1RB, 0RB Offset
3. Phone Condition: Mute on; Backlight on; Max Volume, Max Contrast
4. Vocoder Configuration: WB AMR 23.85kbps (LTE)
5. 'Radial' orientation refers to radial transverse.
6. Speech Signal: 3GPP2 Normal Test Signal
7. Since LTE Band 2 at 20MHz bandwidth was the worst-case configuration for the Axial probe orientation, low and high channels were additionally tested with this configuration.

| | | | | |
|----------------------------------|--|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  PCTEST Engineering Laboratory, Inc. | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | Page 28 of 45 | |

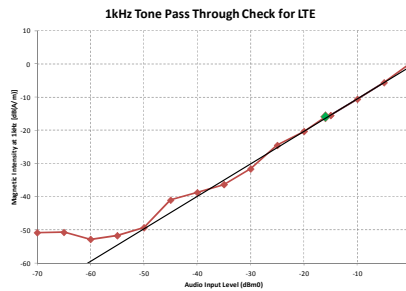
III. Frequency Response Graph



**Figure 7-1
Axial Frequency Response**

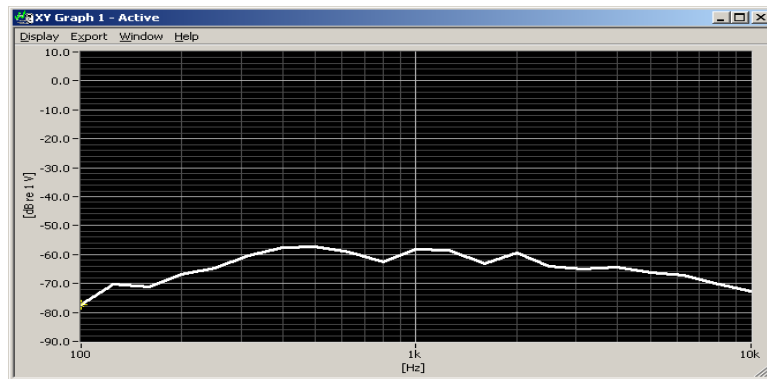
Note: User T-coil Mode (**Settings**→**Call**→**Additional Settings**→**Hearing aids**) was set to ON for Frequency Response compliance. This frequency response represents the worst-case ABM2 test configuration according to Tables 7-4 through 7-10.

IV. 1 kHz Vocoder Application Check





This model was verified to be within the linear region for ABM1 measurements at -16 dBm0 for VoLTE. This measurement was taken in the axial configuration above the maximum location.

V. Undesirable Audio Magnetic Band Plots (ABM2)



**Figure 7-2
Worst-case ABM2 Plot for WD, LTE**

Note: This plot represents the data from the location/configuration resulting in the highest ABM2 result shown in Tables 7-4 through 7-10 (Axial configuration, LTE Band 2, 20MHz BW).

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | Page 29 of 45 | |

VI. T-Coil Validation Test Results

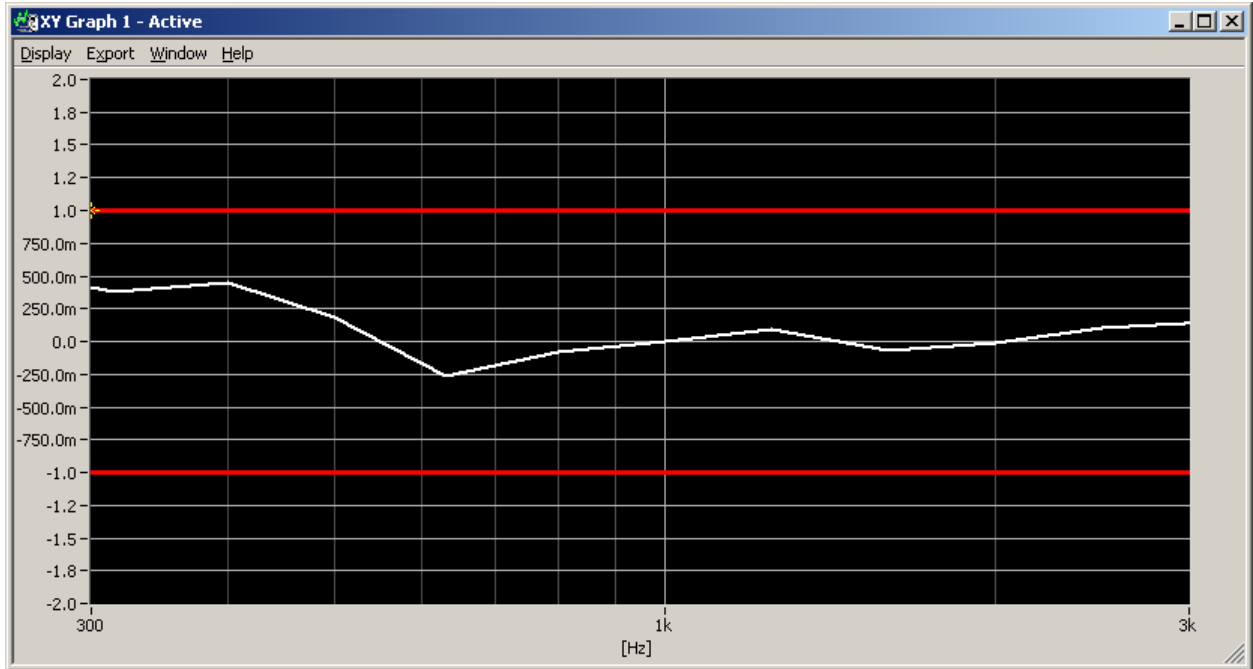




Figure 7-3
Helmholtz Coil Validation for Frequency Response

Table 7-11
Helmholtz Coil Validation Table of Results

| Item | Target | Result | Verdict |
|---------------------------------|--------------------------|--------|---------|
| Signal Validation | | | |
| Frequency Response, from limits | $> 0 \text{ dB}$ | 0.55 | PASS |
| Magnetic Intensity, -10 dBA/m | $-10 \pm 0.5 \text{ dB}$ | -9.711 | PASS |
| Noise Validation | | | |
| Axial Environmental Noise | $< -58 \text{ dBA/m}$ | -58.28 | PASS |
| Radial Environmental Noise | $< -58 \text{ dBA/m}$ | -58.18 | PASS |

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | | Page 30 of 45 |

8. MEASUREMENT UNCERTAINTY



**Table 8-1
Uncertainty Estimation Table**

| Contribution | Data +/- % | Data +/- dB | Data Type | Probability distribution | Divisor | Standard uncertainty | Standard Uncertainty (dB) |
|--|------------|-------------|---------------|--------------------------|---------|----------------------|---------------------------|
| ABM Noise | 7.0% | 0.29 | Std. Dev. | Normal k=1 | 1.00 | 7.0% | |
| RF Reflections | 4.7% | 0.20 | Specification | Rectangular | 1.73 | 2.7% | |
| Reference Signal Level | 12.2% | 0.50 | Specification | Rectangular | 1.73 | 7.0% | |
| Positioning Accuracy | 10.0% | 0.41 | Uncertainty | Rectangular | 1.73 | 5.8% | |
| Probe Coil Sensitivity | 12.2% | 0.50 | Specification | Rectangular | 1.73 | 7.0% | |
| Probe Linearity | 2.4% | 0.10 | Std. Dev. | Normal k=1 | 1.00 | 2.4% | |
| Cable Loss | 2.8% | 0.12 | Specification | Rectangular | 1.73 | 1.6% | |
| Frequency Analyzer | 5.0% | 0.21 | Specification | Rectangular | 1.73 | 2.9% | |
| System Repeatability | 5.0% | 0.21 | Std. Dev. | Normal k=1 | 1.00 | 5.0% | |
| WD Repeatability | 9.0% | 0.37 | Std. Dev. | Normal k=1 | 1.00 | 9.0% | |
| Positioner Accuracy | 1.0% | 0.04 | Specification | Rectangular | 1.73 | 0.6% | |
| Combined standard uncertainty, u_c (k=1) | | | | | | 17.7% | 0.71 |
| Expanded uncertainty (k=2), 95% confidence level | | | | | | 35.3% | 1.31 |

Notes:

1. Test equipments are calibrated according to techniques outlined in NIS81, NIS3003 and NIST Tech Note 1297.
2. All equipments have traceability according to NIST. Measurement Uncertainties are defined in further detail in NIS 81 and NIST Tech Note 1297 and UKAS M3003.



Measurement uncertainty reflects the quality and accuracy of a measured result as compared to the true value. Such statements are generally required when stating results of measurements so that it is clear to the intended audience that the results may differ when reproduced by different facilities. Measurement results vary due to the measurement uncertainty of the instrumentation, measurement technique, and test engineer. Most uncertainties are calculated using the tolerances of the instrumentation used in the measurement, the measurement setup variability, and the technique used in performing the test. While not generally included, the variability of the equipment under test also figures into the overall measurement uncertainty. Another component of the overall uncertainty is based on the variability of repeated measurements (so-called Type A uncertainty). This may mean that the Hearing Aid compatibility tests may have to be repeated by taking down the test setup and resetting it up so that there are a statistically significant number of repeat measurements to identify the measurement uncertainty. By combining the repeat measurement results with that of the instrumentation chain using the technique contained in NIS 81 and NIS 3003, the overall measurement uncertainty was estimated.

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  PCTEST THE OFFICE OF DEVELOPMENT, INC. | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | Page 31 of 45 | |



9. EQUIPMENT LIST

**Table 9-1
Equipment List**

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|-----------------|---------------------|-------------------------------------|------------|--------------|------------|---------------|
| Control Company | 36934-158 | Wall-Mounted Thermometer | 4/29/2014 | Biennial | 4/29/2016 | 122014488 |
| Listen | SoundCheck | Acoustic Analyzer System | 10/17/2014 | Annual | 10/17/2015 | 01-20-03368 |
| Listen | SoundConnect | Microphone Power Supply | 3/14/2014 | Annual | 3/14/2015 | PS2612 |
| NI | 4474 | Data Acquisition Card | N/A | | N/A | N/A |
| Rohde & Schwarz | CMU200 | Base Station Simulator | 4/24/2014 | Annual | 4/24/2015 | 836371/0079 |
| TEM | Axial T-Coil Probe | Axial T-Coil Probe | 2/17/2014 | Annual | 2/17/2015 | TEM-1123 |
| TEM | Radial T-Coil Probe | Radial T-Coil Probe | 2/17/2014 | Annual | 2/17/2015 | TEM-1129 |
| TEM | C63.19 | Helmholtz Coil | 3/8/2014 | Annual | 3/8/2015 | 925 |
| TEM | | HAC System Controller with Software | N/A | | N/A | N/A |
| TEM | | HAC Positioner | N/A | | N/A | N/A |

| | | | | |
|---|---|--------------------------------------|---|--|
| FCC ID: A3LSMG360V |  PCTEST <small>THE BEST IN DEVELOPMENT, INC.</small> | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | Page 32 of 45 | |

10. CALIBRATION CERTIFICATES

| | | | | |
|---|--|--------------------------------------|---|--|
| FCC ID: A3LSMG360V |  PCTEST <small>Engineering Laboratory, Inc.</small> | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | | Page 33 of 45 |

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

Axial T Coil Probe

Manufactured by: TEM CONSULTING
Model No: Axial T Coil Probe
Serial No: TEM-1123
Calibration Recall No: 23889

Submitted By:

Customer: JUSTIN CHAO
Company: PCTEST ENGINEERING LAB
Address: 6660-B DOBBIN ROAD COLUMBIA MD 21045

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. Axial T Coil TEM

Upon receipt for Calibration, the instrument was found to be:

Within (X) see attached Report of Calibration.

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by:

Calibration Date: 17-Feb-14

Certificate No: 23889 - 1

QA Doc. #1051 Rev. 2.0 10/1/01



Certificate Page 1 of 1

JSC
4/4/14
FC
Felix Christopher (QA Mgr.)
ISO/IEC 17025:2005

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.



Calibration Lab. Cert. # 1533.01

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  PCTEST THE BEST IN DEVELOPMENT, NY | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | | Page 34 of 45 |



ISO/IEC 17025: 2005



Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

TEM Consulting LP Axial T Coil Probe

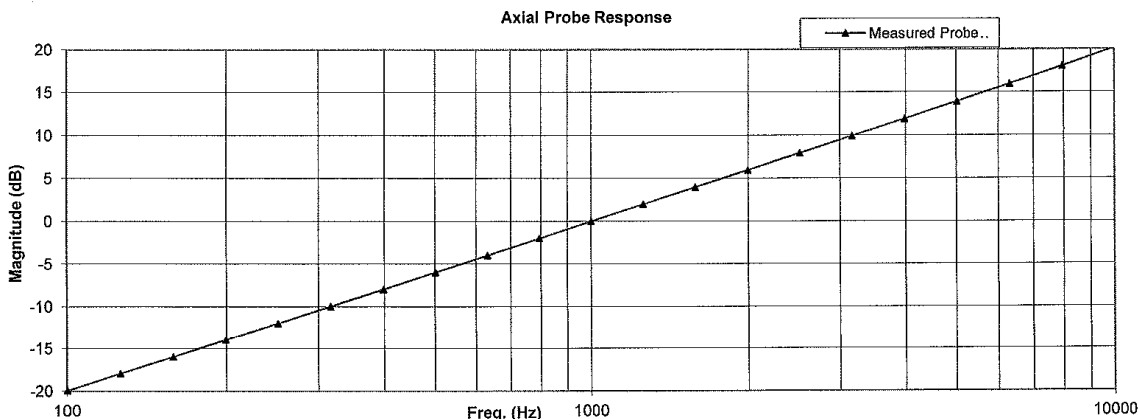
for
Model No.: Axial T Coil Probe

Serial No.: TEM-1123

Company : PCTEST Engineering Lab.

I. D. No: 80582

| | | | |
|---|--------|--|-------------------|
| Calibration results: | | Before data: | After data: |
| Probe Sensitivity measured with Helmholtz Coil | | Before & after data same: ...X..... | |
| <i>Helmholtz Coil;</i> | | | |
| the number of turns on each coil; | 10 | No. | |
| the radius of each coil, in meters; | 0.204 | m | |
| the current in the coils, in amperes.; | 0.09 | A | |
| <i>Helmholtz Coil Constant;</i> | | | |
| | 7.09 | A/m/V | |
| <i>Helmholtz Coil magnetic field;</i> | | | |
| | 5.98 | A/m | |
| Probe Sensitivity at | | | |
| | 1000 | Hz. | |
| was | -60.20 | dBV/A/m | |
| | 0.977 | mV/A/m | |
| Probe resistance | | | |
| | 894 | Ohms | |
| Laboratory Environment: | | Ambient Temperature: 21.2 °C | |
| | | Ambient Humidity: 29.1 % RH | |
| | | Ambient Pressure: 100.7 kPa | |
| | | Calibration Date: 17-Feb-14 | |
| | | Re-calibration Due: 17-Feb-15 | |
| | | Report Number: 23889 -1 | |
| | | Control Number: 23889 | |
| <p>The above listed instrument meets or exceeds the tested manufacturer's specifications.</p> <p>This Calibration is traceable through NIST test numbers: ,287708</p> <p>The expanded uncertainty of calibration: 0.30dB at 95% confidence level with a coverage factor of k=2.</p> <p>Graph represents Probes Frequency Response.</p> | | | |



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 HCATEMC**
 Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Cal. Date: 17-Feb-2014
 Calibrated on WCCL system type 9700

Measurements performed by:
Felix Christopher

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Rev. 7.0 Jan. 24, 2014 Doc. # 1038 HCATEMC

| | | | | |
|----------------------------------|---------------------------|-------------------------------|--|---------------------------------|
| FCC ID: A3LSMG360V | | HAC (T-COIL) TEST REPORT | | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | | Page 35 of 45 |

HCATEMC_TEM-1123_Feb-17-2014

West Caldwell Calibration Laboratories Inc.

1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327



Calibration Data Record

TEM Consulting LP Axial T Coil Probe for Model No.: Axial T Coil Probe Serial No.: TEM-1123
Company : PCTEST Engineering Lab.

| Test | Function | Tolerance | Measured values | | | |
|------|--------------------------|-----------------------|-----------------|-------|---------|--|
| | | | Before | Out | Remarks | |
| 1.0 | Probe Sensitivity at | 1000 Hz. dBV/A/m | -60.20 | | | |
| 2.0 | Probe Level Linearity | | | | | |
| | | | 6 | 6.03 | | |
| | | Ref. (0 dB) | 0 | 0.00 | | |
| | | | -6 | -6.02 | | |
| | | -12 | -12.05 | | | |
| 3.0 | Probe Frequency Response | | | | | |
| | | | 100 | -19.9 | | |
| | | | 126 | -17.9 | | |
| | | | 158 | -16.0 | | |
| | | | 200 | -13.9 | | |
| | | | 251 | -12.0 | | |
| | | | 316 | -10.0 | | |
| | | | 398 | -8.0 | | |
| | | | 501 | -6.0 | | |
| | | | 631 | -4.0 | | |
| | | | 794 | -2.0 | | |
| | | | Ref. (0 dB) | 1000 | 0.0 | |
| | | | | 1259 | 2.0 | |
| | | | | 1585 | 4.0 | |
| | | | | 1995 | 6.0 | |
| | | | | 2512 | 7.9 | |
| | | 3162 | 9.9 | | | |
| | | 3981 | 11.9 | | | |
| | | 5012 | 13.9 | | | |
| | | 6310 | 15.9 | | | |
| | | 7943 | 18.0 | | | |
| | | 10000 | 20.2 | | | |

| Instruments used for calibration: | | | Date of Cal. | Traceability No. | Due Date |
|-----------------------------------|--------|--------------|--------------|------------------|------------|
| HP | 34401A | S/N 36064102 | 8-Oct-2013 | ,287708 | 8-Oct-2014 |
| HP | 34401A | S/N 36102471 | 8-Oct-2013 | ,287708 | 8-Oct-2014 |
| HP | 33120A | S/N 36043716 | 8-Oct-2013 | ,287708 | 8-Oct-2014 |
| Brüel & Kjær | 2133 | S/N 1583254 | 6-Jan-2014 | 683/284413-14 | 7-Jan-2015 |

Cal. Date: 17-Feb-2014 Tested by: Felix Christopher
Calibrated on WCCL system type 9700
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| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | | Page 36 of 45 |

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

Radial T Coil Probe

Manufactured by: TEM CONSULTING
Model No: Radial T Coil Probe
Serial No: TEM-1129
Calibration Recall No: 23889

Submitted By:

Customer: JUSTIN CHAO
Company: PCTEST ENGINEERING LAB
Address: 6660-B DOBBIN ROAD COLUMBIA MD 21045

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. Radial T C TEM

Upon receipt for Calibration, the instrument was found to be:

Within (X) see attached Report of Calibration.

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by:

Calibration Date: 17-Feb-14

Certificate No: 23889 - 2

QA Doc. #1051 Rev. 2.0 10/1/01

Certificate Page 1 of 1



JSC
4/4/14

FC
Felix Christopher (QA Mgr.)
ISO/IEC 17025:2005

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.



Calibration Lab. Cert. # 1533.01

| | | | | |
|----------------------------------|---|-------------------------------|---|---------------------------------|
| FCC ID: A3LSMG360V |  PCTEST THE BEST IN DEVELOPMENT, NY | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
| Filename: 0Y1412232325-R1.A3L | Test Dates: 12/22/2014 | EUT Type: Portable Handset | | Page 37 of 45 |



ISO/IEC 17025: 2005



Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

TEM Consulting LP Radial T Coil Probe

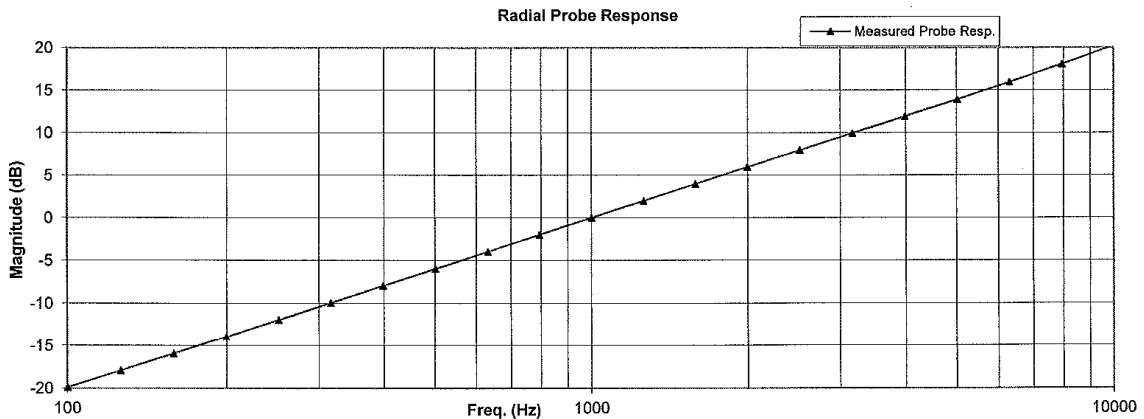
Model No.: Radial T Coil Probe

Serial No.: TEM-1129

Company : PCTEST Engineering Lab.

I. D. No: 80583

| | | |
|---|--------------------|-------------------------------------|
| Calibration results: | Before data: | After data: |
| Probe Sensitivity measured with Helmholtz Coil | | |
| <i>Helmholtz Coil;</i> | | |
| the number of turns on each coil; | 10 | No. |
| the radius of each coil, in meters; | 0.204 | m |
| the current in the coils, in amperes.; | 0.09 | A |
| <i>Helmholtz Coil Constant;</i> | 7.09 | A/m/V |
| <i>Helmholtz Coil magnetic field;</i> | 5.98 | A/m |
| | | |
| Probe Sensitivity at | 1000 | Hz. |
| was | -60.38 | dBV/A/m |
| | 0.957 | mV/A/m |
| Probe resistance | 900 | Ohms |
| | | |
| | | Before & after data same: ...X..... |
| | | Laboratory Environment: |
| | | Ambient Temperature: 21.2 °C |
| | | Ambient Humidity: 29.1 % RH |
| | | Ambient Pressure: 100.7 kPa |
| | | Calibration Date: 17-Feb-14 |
| | | Re-calibration Due: 17-Feb-15 |
| | | Report Number: 23889 -2 |
| | | Control Number: 23889 |
| <p>The above listed instrument meets or exceeds the tested manufacturer's specifications.</p> <p>This Calibration is traceable through NIST test numbers: ,287708</p> <p>The expanded uncertainty of calibration: 0.30dB at 95% confidence level with a coverage factor of k=2.</p> <p>Graph represents Probes Frequency Response.</p> | | |



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 HCRTEMC**
 Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Cal. Date: 17-Feb-2014
 Calibrated on WCCL system type 9700

Measurements performed by: *[Signature]*
Felix Christopher

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HCRTEMC_TEM-1129_Feb-17-2014

West Caldwell Calibration Laboratories Inc.

1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327



Calibration Data Record

TEM Consulting LP Radial T Coil Probe for Model No.: Radial T Coil Probe Serial No.: TEM-1129
Company : PCTEST Engineering Lab.

| Test | Function | Tolerance | Measured values | | |
|------|--------------------------|-----------------------|-----------------|--------|---------|
| | | | Before | Out | Remarks |
| 1.0 | Probe Sensitivity at | 1000 Hz. dBV/A/m | -60.38 | | |
| 2.0 | Probe Level Linearity | | | | |
| | | | 6 | 6.04 | |
| | | Ref. (0 dB) | 0 | 0.00 | |
| | | | -6 | -6.03 | |
| | | | -12 | -12.05 | |
| 3.0 | Probe Frequency Response | | | | |
| | | | 100 | -19.9 | |
| | | | 126 | -17.9 | |
| | | | 158 | -15.9 | |
| | | | 200 | -13.9 | |
| | | | 251 | -12.0 | |
| | | | 316 | -10.0 | |
| | | | 398 | -8.0 | |
| | | | 501 | -6.0 | |
| | | | 631 | -4.0 | |
| | | | 794 | -2.0 | |
| | | Ref. (0 dB) | 1000 | 0.0 | |
| | | | 1259 | 2.0 | |
| | | | 1585 | 4.0 | |
| | | | 1995 | 6.0 | |
| | | | 2512 | 7.9 | |
| | | | 3162 | 9.9 | |
| | 3981 | 11.9 | | | |
| | 5012 | 13.9 | | | |
| | 6310 | 16.0 | | | |
| | 7943 | 18.0 | | | |
| | 10000 | 20.2 | | | |

| Instruments used for calibration: | | | Date of Cal. | Traceability No. | Due Date |
|-----------------------------------|--------|--------------|--------------|------------------|------------|
| HP | 34401A | S/N 36064102 | 8-Oct-2013 | ,287708 | 8-Oct-2014 |
| HP | 34401A | S/N 36102471 | 8-Oct-2013 | ,287708 | 8-Oct-2014 |
| HP | 33120A | S/N 36043716 | 8-Oct-2013 | ,287708 | 8-Oct-2014 |
| Brüel & Kjær | 2133 | S/N 1583254 | 6-Jan-2014 | 683/284413-14 | 7-Jan-2015 |



Cal. Date: 17-Feb-2014 Tested by: Felix Christopher
Calibrated on WCCL system type 9700
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11. CONCLUSION



The measurements taken in accordance with the procedures provided in the CTIA Test Plan for Hearing Aid Compatibility Rev 2.0, April 2010, indicate that the wireless communications device complies with the HAC limits specified in the ANSI C63.19 Standard and FCC WT Docket No. 01-309 RM-8658. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters specific to the test. The test results and statements relate only to the item(s) tested.

The measurement system and techniques presented in this evaluation are proposed in the ANSI standard as a means of best approximating wireless device compatibility with a hearing-aid. The literature is under continual re-construction.



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| FCC ID: A3LSMG360V |  PCTEST This office is a development, LLC | HAC (T-COIL) TEST REPORT |  | Reviewed by: Quality Manager |
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