

PCTEST ENGINEERING LABORATORY, INC.

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HEARING AID COMPATIBILITY

Applicant Name:

LG Electronics MobileComm U.S.A. Inc. 1000 Sylvan Avenue Englewood Cliffs, NJ 07632 **United States**

Date of Testing: 04/12/2018 - 04/15/2018 Test Site/Location: PCTEST Lab, Columbia, MD, USA **Test Report Serial No.:** 1M1803140041-10-R2.ZNF

ZNFX410AS FCC ID:

APPLICANT: LG ELECTRONICS MOBILECOMM U.S.A. INC.

Scope of Test: Audio Band Magnetic Testing (T-Coil)

Application Type: Certification CFR §20.19(b) FCC Rule Part(s): **HAC Standard:** ANSI C63.19-2011

285076 D01 HAC Guidance v05

285076 D02 T-Coil testing for CMRS IP v03

DUT Type: Portable Handset Model: LM-X410AS

Additional Model(s): LMX410AS, X410AS, LM-X410ASR, LMX410ASR, X410ASR

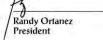
Test Device Serial No.: Pre-Production Sample [S/N: 01264]

C63.19-2011 HAC Category: T3 (SIGNAL TO NOISE CATEGORY)

Note: This revised Test Report (S/N: 1M1803140041-10-R2.ZNF) 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 wireless portable device has been shown to be hearing-aid compatible 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.







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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. An estimated more than 10% of the population in the United States show signs of hearing impairment and of that fraction, almost 80% use hearing aids. 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
- 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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DUT DESCRIPTION 2.



FCC ID: ZNFX410AS

Applicant: LG Electronics MobileComm U.S.A. Inc.

1000 Sylvan Avenue

Englewood Cliffs, NJ 07632

United States

Model: LM-X410AS

Additional Model(s): LMX410AS, X410AS, LM-X410ASR, LMX410ASR, X410ASR

Serial Number: 01264 HW Version: Rev.B X410AS09c SW Version: Antenna: Internal Antenna DUT Type: Portable Handset

Table 2-1 **ZNFX410AS HAC Air Interfaces**

Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service
	850	VO	Yes	Yes: WIFI or BT	CMRS Voice*
GSM	1900	VO	163	res. Will of B1	CIVING VOICE
	GPRS/EDGE	VD	Yes	Yes: WIFI or BT	Google Duo**
	850				
UMTS	1700	VD	Yes	Yes: WIFI or BT	CMRS Voice*
OIVITS	1900				
	HSPA	VD	Yes	Yes: WIFI or BT	Google Duo**
	700 (B12)				
	790 (B14)	VD	Yes	Yes: WIFI or BT	VoLTE*, Google Duo**
LTE (FDD)	850 (B5)				
	1700 (B4)				
	1900 (B2)				
	2450				
	5200 (U-NII 1)				
WIFI	5300 (U-NII 2A)	VD	Yes	Yes: GSM, UMTS, or LTE	VoWIFI**, Google Duo**
	5500 (U-NII 2C)				
	5800 (U-NII 3)				
BT	2450	DT	No	Yes: GSM, UMTS, or LTE	N/A
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3. ANSI C63.19-2011 PERFORMANCE CATEGORIES

I. MAGNETIC COUPLING

Axial and Radial Field Intensity

All orientations of the magnetic field, in the axial and radial position along the measurement plane shall be \geq -18 dB(A/m) at 1 kHz in a 1/3 octave band filter per §8.3.1.

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 §8.3.2.

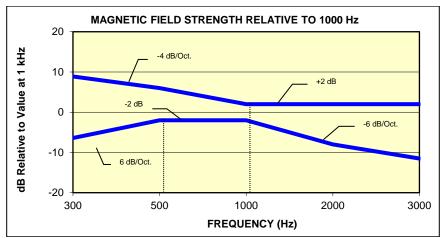


Figure 3-1
Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB(A/m) at 1 kHz

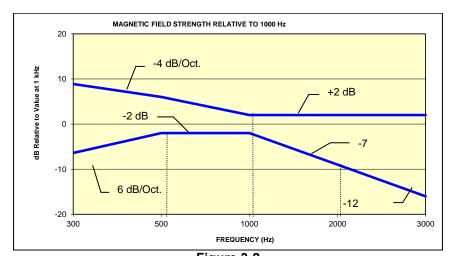


Figure 3-2
Magnetic Field frequency response for wireless devices with an axial field that exceeds
-15 dB(A/m) at 1 kHz

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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.

Catamani	Telephone RF Parameters		
Category	Wireless Device Signal Quality [(Signal + Noise)-to-noise ratio in dB]		
T1	0 to 10 dB		
T2	10 to 20 dB		
Т3	20 to 30 dB		
T4	> 30 dB		
Table 3-1 Magnetic Coupling Parameters			

Note: The FCC limit for SNNR is 20dB and the test data margins will indicate a margin from the FCC limit for compliance.

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4. METHOD OF MEASUREMENT

I. Test Setup

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

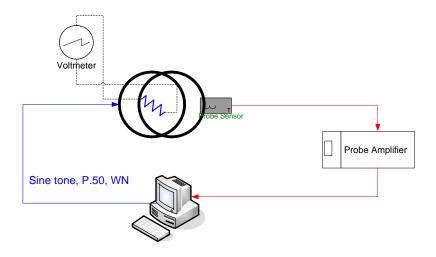
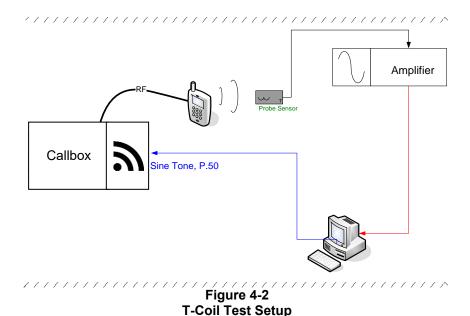


Figure 4-1
Validation Setup with Helmholtz Coil



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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)

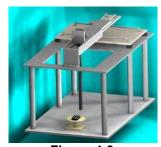


Figure 4-3 RF Near-Field Scanner

III. ITU-T P.50 Artificial Voice

Manufacturer: ITU-T

Active Frequency Range: 100 Hz – 8 kHz

Stimulus Type: Male and Female, no spaces

Single Sample 20.96 seconds Duration:

Activity Level: 100%

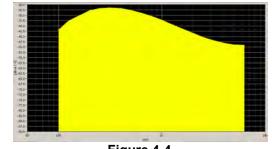
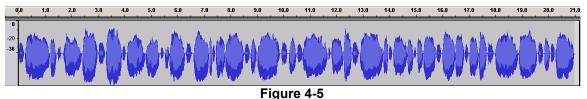


Figure 4-4 Spectral Characteristic of full P.50



Temporal Characteristic of full P.50

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ABM2 Measurement Block Diagram:



Figure 4-6 Magnetic Measurement Processing Steps

IV. Test Procedure

- 1. Ambient Noise Check per C63.19 §7.3.1
 - 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 more 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:

- 2. Measurement System Validation(See Figure 4-1)
 - 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.10.1):

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

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=10.2Ω and using V=18mV:

$$H_c = \frac{20 \cdot (\frac{0.018}{10.2})}{0.08 \cdot \sqrt{1.25^3}} = 0.316A/m \approx -10dB(A/m)$$

Therefore a pure tone of 1kHz was applied into the coils such that 18mV was observed across the 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 -10 dB(A/m) in the center of the Helmholtz coil which was used to validate the probe measurement at -10dB(A/m). This was verified to be within \pm 0.5 dB of the -10dB(A/m) value (see Page 33).

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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 1kHz, between 300 – 3000 Hz using the P.50 signal as shown below:



Figure 4-7 Frequency Response Validation

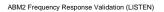
d. ABM2 Measurement Validation

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 4-1 **ABM2 Frequency Response Validation**

	HBI, A -	HBI, A -	
f (Hz)	Measured	Theoretical	dB Var.
	(dB re 1kHz)	(dB re 1kHz)	
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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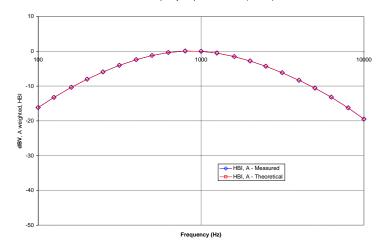
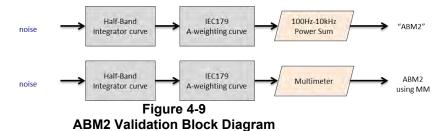


Figure 4-8 **ABM2 Frequency Response Validation**

The ABM2 result is a power sum from 100Hz to 10kHz with half-band integration and Aweighting. 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 4-9). Therefore the setup in this step was used to verify the power sum post-processing for ABM2 measurements. See below 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 4-2 **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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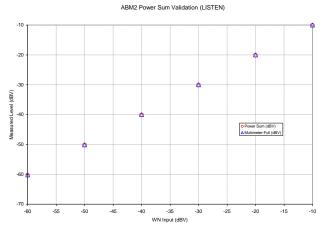


Figure 4-10
ABM2 Power Sum Validation

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 (note that in Figure 4-12, the grid is not to scale but merely a graphical representation of the coordinate system in use):

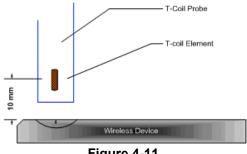
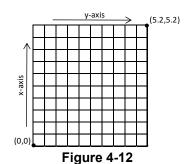


Figure 4-11 Measurement Distance



Measurement Grid

- 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 SoundCheck system.
- iii. These steps were repeated for all T-coil orientations (axial and radial) per Figure 4-15 after a T-coil orientation was fully measured with the SoundCheck system.

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- b. Speech Signal Setup to Base Station Simulator
 - i. C63.19 Table 7-1 states audio reference input levels for various technologies:

Standard	Technology	Input Level (dBm0)
TIA/EIA/IS-2000	CDMA	-18
J-STD-007	GSM (217)	-16
T1/T1P1/3GPP	UMTS (WCDMA)	-16
iDEN™	TDMA (22 and 11 Hz)	-18

- ii. See Section 5 and 6 for more information regarding CMW500 audio level settings for Voice Over LTE (VoLTE), and Voice Over WIFI (VoWIFI) testing.
- iii. See Section 7 for more information regarding audio level settings for Over-The-Top (OTT) Voice Over IP (VoIP) Testing.
- c. Real-Time Analyzer (RTA)
 - i. The Real-Time Analyzer was configured to analyze measurements using 1/3 Octave band weighted filtering.
- WD Radio Configuration Selection
 - i. The device was chosen to be tested in the worst-case ABM2 condition (see below for GSM, see Section 8 for more information regarding worst-case configurations for UMTS. LTE configuration information can be found in Section 5. WIFI configuration information can be found in Section 6 and 7):

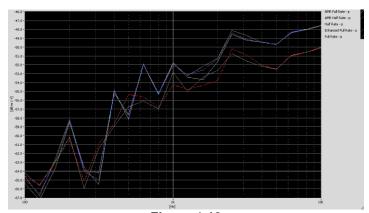


Figure 4-13 Vocoder Analysis for ABM Noise for GSM

- 4. Signal Quality Data Analysis
 - a. Narrow-band Magnetic Intensity
 - i. The standard specifies a 1kHz 1/3 octave band minimum field intensity for a sine tone. The ABM1 measurements were evaluated at 1kHz with 1/3 octave band filtering over an averaged period of 10 seconds.
 - b. Frequency Response
 - The appropriate frequency response curve was measured to curves in Figure 3-1 or Figure 3-2 between 300 - 3000 Hz using digital linear averaging (limit lines chosen according to measurement found in step 4a). A linear average over 3x the length of the artificial voice 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.

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- ii. The appropriate post-processing was applied according to the system processing chain illustrated in Figure 4-7. All R10 frequencies were plotted with respect to 0dB at 1kHz value and aligned with respect to the EIA-504 mask.
- 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 off, 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 for an ABM2 value.
- iii. This result was subtracted from the ABM1 result in step a, to obtain the Signal Quality.

V. Test Setup

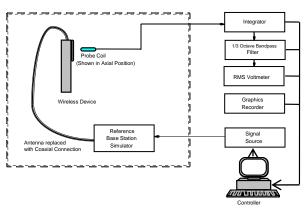


Figure 4-14
Audio Magnetic Field Test Setup

VI. Deviation from C63.19 Test Procedure

Non-conducted RF connection due to inaccessible RF ports.

VII. Air Interface Technologies Tested

All air interfaces which support voice capabilities over a managed CMRS or pre-installed OTT VoIP applications were tested for T-coil unless otherwise noted. See Table 2-1 for more details regarding which modes were tested.

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VIII. Wireless Device Channels and Frequencies

1. 2G/3G Modes

The frequencies listed in the table below are those that lie in the center of the bands used for cellular telephony. Low, middle and high channels were tested in each band for FCC compliance evaluation to ensure the maximum emission is captured across the entire band. Only middle channels were evaluated for data modes since circuit-switched voice modes were worst-case.

> Table 4-3 Center Channels and Frequencies

ochici onamicio una i requencies				
Test frequencies & associated channels				
Channel	Frequency (MHz)			
Cellular 850				
190 (GSM)	836.60			
4183 (UMTS)	836.60			
AWS 1750				
1412 (UMTS)	1730.40			
PCS 1900				
661 (GSM)	1880			
9400 (UMTS)	1880			

2. 4G (LTE) Modes

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. The middle channel and supported bandwidths from the worst-case band according to Table 7-5 were additionally evaluated with OTT VoIP for each probe orientation. See Tables 9-4 to 9-8, and Table 9-15 for LTE bandwidths and channels.

3. WIFI

The middle channel for each 802.11 standard was tested for each probe orientation. The 2.4GHz 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels. The 5GHz 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested on higher U-NII bands as well as applicable low and high channels. See Tables 9-9 to 9-12 and Tables 9-16 to 9-19 for WIFI standards and channels.

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IX. Test Flow

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

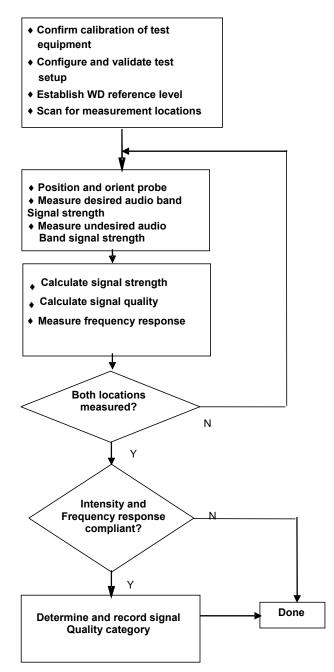


Figure 4-15 C63.19 T-Coil Signal Test Process

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VOLTE TEST SYSTEM SETUP AND DUT CONFIGURATION 5.

I. Test System Setup for VoLTE over IMS T-coil Testing

1. Equipment Setup

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

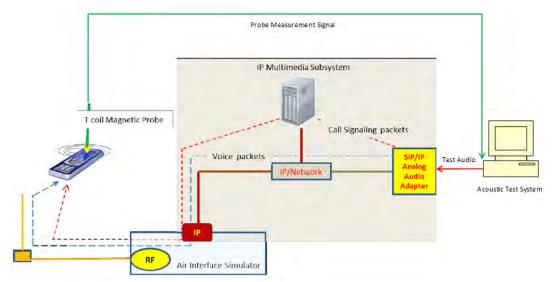


Figure 5-1 Test Setup for VoLTE over IMS T-Coil Measurements

2. Audio Level Settings

According to the July 2012 interpretations by the C63 Committee regarding the appropriate audio levels to be used for VoLTE over IMS 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 over IMS connection.

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

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II. **DUT Configuration for VoLTE over IMS T-coil Testing**

1. Radio Configuration

An investigation was performed 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:

> Table 5-1 **VoLTE over IMS SNNR by Radio Configuration**

	VOLTE OVER INIS SIGNIC BY Radio Configuration										
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	12.40	-29.54	41.94			
1880.0	18900	20	QPSK	1	50	12.17	-29.49	41.66			
1880.0	18900	20	QPSK	1	99	12.16	-29.47	41.63			
1880.0	18900	20	QPSK	50	0	12.36	-33.70	46.06			
1880.0	18900	20	QPSK	50	25	12.27	-33.87	46.14			
1880.0	18900	20	QPSK	50	50	12.15	-33.52	45.67			
1880.0	18900	20	QPSK	100	0	12.04	-34.01	46.05			
1880.0	18900	20	16QAM	1	0	12.22	-24.92	37.14			
1880.0	18900	20	16QAM	1	50	12.29	-24.98	37.27			
1880.0	18900	20	16QAM	1	99	12.12	-25.38	37.50			
1880.0	18900	20	16QAM	50	0	12.18	-33.13	45.31			
1880.0	18900	20	16QAM	50	25	12.23	-33.08	45.31			
1880.0	18900	20	16QAM	50	50	12.29	-33.50	45.79			
1880.0	18900	20	16QAM	100	0	12.37	-33.44	45.81			

2. Codec Configuration

An investigation was performed to determine the audio codec configuration to be used for testing. The WB AMR 6.60kbps setting was used for the audio codec on the CMW500 for VoLTE over IMS T-coil testing. See below table for comparisons between different codecs and codec data rates:

> Table 5-2 AMR Codec Investigation - VolTE over IMS

	/ 111	n v Oodoo iii	roonganon	102120	701 11110		
Codec Setting:	WB AMR 23.85kbps	WB AMR 6.60kbps	NB AMR 12.2kbps	NB AMR 4.75kbps	Orientation	Band / BW	Channel
ABM1 (dBA/m)	13.03	11.98	13.72	13.44			
ABM2 (dBA/m)	-24.87	-24.83	-24.53	-24.73	Audal	Band 2 20MHz BW	18900
Frequency Response	Pass	Pass	Pass	Pass	Axial		
S+N/N (dB)	37.90	36.81	38.25	38.17			

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

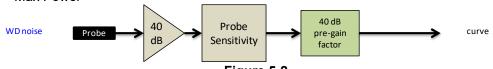


Figure 5-2 **Audio Band Magnetic Curve Measurement Block Diagram**

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VOWIFI TEST SYSTEM SETUP AND DUT CONFIGURATION 6.

I. Test System Setup for VoWIFI over IMS T-coil Testing

Equipment Setup

The general test setup used for VoWIFI over IMS, or CMRS WIFI Calling, is shown below. The callbox used when performing VoWIFI over IMS T-coil measurements is a CMW500. The Data Application Unit (DAU) of the CMW500 was used to simulate the IP Multimedia Subsystem (IMS) server.

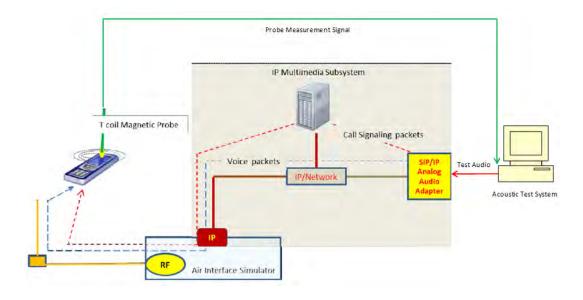


Figure 6-1 Test Setup for VoWIFI over IMS T-Coil Measurements

2. Audio Level Settings

According to KDB 285076 D02 released by the FCC OET regarding the appropriate audio levels to be used for VoWIFI over IMS T-Coil testing, -20dBm0 shall be used for the normal speech input level2. The CMW500 base station simulator was manually configured to ensure that the settings for speech input and full scale levels resulted in the -20dBm0 speech input level to the DUT for the VoWIFI over IMS connection.

² FCC Office of Engineering and Technology KDB, "285076 D02 T-Coil Testing for CMRS IP v03," September 13, 2017

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DUT Configuration for VoWIFI over IMS T-coil Testing II.

1. Radio Configuration

An investigation was performed on all applicable data rates and modulations to determine the radio configuration to be used for testing. See tables below for SNNR comparison between radio configurations in each 802.11 standard:

> Table 6-1 802.11b SNNR by Radio Configuration

Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
802.11b	6	DSSS	1	7.08	-28.71	35.79
802.11b	6	DSSS	2	6.86	-28.28	35.14
802.11b	6	CCK	5.5	7.60	-28.57	36.17
802.11b	6	CCK	11	7.51	-27.54	35.05

Table 6-2 802.11g/a SNNR by Radio Configuration

	COLITISA CHARLES TRANSCOLO									
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]				
802.11g	6	BPSK	6	7.19	-26.60	33.79				
802.11g	6	BPSK	9	7.65	-27.75	35.40				
802.11g	6	QPSK	12	7.15	-27.13	34.28				
802.11g	6	QPSK	18	7.35	-26.20	33.55				
802.11g	6	16-QAM	24	7.08	-27.90	34.98				
802.11g	6	16-QAM	36	7.13	-27.18	34.31				
802.11g	6	64-QAM	48	7.01	-28.31	35.32				
802.11g	6	64-QAM	54	7.55	-27.29	34.84				

Table 6-3 802 11n/ac 20MHz RW SNNR by Radio Configuration

	602.1 Thrac 20MHZ BW SNNR by Radio Configuration									
Mode	Bandwidth [MHz]	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]			
802.11n	20	40	BPSK	6.5	7.51	-31.73	39.24			
802.11n	20	40	QPSK	13	7.01	-31.19	38.20			
802.11n	20	40	QPSK	19.5	7.48	-32.41	39.89			
802.11n	20	40	16-QAM	26	7.07	-32.46	39.53			
802.11n	20	40	16-QAM	39	7.62	-33.30	40.92			
802.11n	20	40	64-QAM	52	7.23	-32.94	40.17			
802.11n	20	40	64-QAM	58.5	7.03	-32.76	39.79			
802.11n	20	40	64-QAM	65	7.02	-33.76	40.78			
802.11ac	20	40	256-QAM	78	7.19	-33.94	41.13			

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Table 6-4 802.11n/ac 40MHz BW SNNR by Radio Configuration

	002:111//ac 40///112 BW ONNIX by Nadio Configuration									
Mode	Bandwidth [MHz]	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]			
802.11n	40	38	BPSK	13.5	7.43	-31.76	39.19			
802.11n	40	38	QPSK	27	7.57	-32.22	39.79			
802.11n	40	38	QPSK	40.5	7.22	-32.76	39.98			
802.11n	40	38	16-QAM	54	6.95	-33.05	40.00			
802.11n	40	38	16-QAM	81	7.40	-32.72	40.12			
802.11n	40	38	64-QAM	108	7.04	-33.09	40.13			
802.11n	40	38	64-QAM	121.5	7.51	-33.78	41.29			
802.11n	40	38	64-QAM	135	7.43	-33.08	40.51			
802.11ac	40	38	256-QAM	162	7.63	-33.08	40.71			
802.11ac	40	38	256-QAM	180	7.16	-32.80	39.96			

2. Codec Configuration

An investigation was performed to determine the audio codec configuration to be used for testing. The WB AMR 6.60kbps setting was used for the audio codec on the CMW500 for VoWIFI over IMS T-coil testing. See below table for comparisons between different codecs and codec data rates:

> Table 6-5 AMR Codec Investigation - VoWIFI over IMS

Awik Codec investigation – vovil i over iwis								
Codec Setting:	WB AMR 23.85kbps	WB AMR 6.60kbps	NB AMR 12.2kbps	NB AMR 4.75kbps	Orientation	Band	Standard	Channel
ABM1 (dBA/m)	8.71	7.38	9.31	9.40			802.11b	6
ABM2 (dBA/m)	-26.99	-27.17	-26.75	-27.42	Axial	2.4GHz		
Frequency Response	Pass	Pass	Pass	Pass	Axiai	2.46П2		
S+N/N (dB)	35.70	34.55	36.06	36.82				

Mute on; Backlight off; Max Volume; Max Contrast

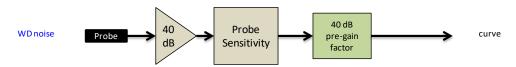


Figure 6-2 **Audio Band Magnetic Curve Measurement Block Diagram**

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7. OTT VOIP TEST SYSTEM AND DUT CONFIGURATION

I. Test System Setup for OTT VoIP T-Coil Testing

1. OTT VoIP Application

Google Duo is a pre-installed application on the DUT which allows for VoIP calls in a held-to-ear scenario. Duo uses the OPUS audio codec and supports a bitrate range of 6kb/s to 64kb/s. All air interfaces capable of a data connection were evaluated with Google Duo.

2. Equipment Setup

A CMW500 callbox was used to perform OTT VoIP T-coil measurements. The Data Application Unit (DAU) of the CMW500 was connected to the internet and allowed for an IP data connection on the DUT. An auxiliary VoIP unit was used to initiate an OTT VoIP call to the DUT. The auxiliary VoIP unit allowed for the configuration and monitoring of the OTT VoIP codec bitrate during a call. Both high and low bitrate settings were evaluated in to determine the worst-case configuration.

3. Audio Level Settings

According to KDB 285076 D02, the average speech level of -20dBm0 shall be used for protocols not specifically listed in Table 7.1 of ANSI C63.19-2011 or the ANSI C63.19-2011 VoLTE interpretation³. The auxiliary VoIP unit allowed for monitoring the signal input level to ensure that the settings for speech input and full scale levels resulted in the -20dBm0 speech input level to the DUT for the OTT VoIP call.

II. DUT Configuration for OTT VoIP T-Coil Testing

1. Codec Configuration

An investigation was performed for each applicable data mode to determine the audio codec configuration to be used for testing. The 6kbps codec setting was used for the audio codec on the auxiliary VoIP unit for OTT VoIP T-Coil testing. See below tables for comparisons between codec data rates on all applicable data modes:

Table 7-1
Codec Investigation – OTT VoIP (EDGE)

Codec Setting:	64kbps	6kbps	Orientation	Channel	
ABM1 (dBA/m)	19.13	19.47			
ABM2 (dBA/m)	-15.57	-15.07	Axial	661	
Frequency Response	Pass	Pass	Axiai		
S+N/N (dB)	34.70	34.54			

³ FCC Office of Engineering and Technology KDB, "285076 D02 T-Coil Testing for CMRS IP v03," September 13, 2017

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Table 7-2 Codec Investigation - OTT VoIP (HSPA)

	011 (1101 7	·/			
Codec Setting:	64kbps	6kbps	6kbps Orientation		
ABM1 (dBA/m)	19.01	18.61			
ABM2 (dBA/m)	-33.89	-33.08	Axial	0.400	
Frequency Response	Pass	Pass	Axiai	9400	
S+N/N (dB)	52.90	51.69			

Table 7-3 Codec Investigation - OTT VoIP (LTE)

				<u> </u>			
Codec Setting:	64kbps	6kbps	Orientation	Band / BW	Channel		
ABM1 (dBA/m)	18.90	18.78					
ABM2 (dBA/m)	-25.23	-24.93	Axial	Band 2	18900		
Frequency Response	Pass	Pass	20MHz		18900		
S+N/N (dB)	44.13	43.71					

Table 7-4 Codec Investigation - OTT VoIP (WIFI)

Codec investigation – OTT voil (vvii i)										
Codec Setting:	64kbps	6kbps	Orientation	Band	Standard	Channel				
ABM1 (dBA/m)	19.33	18.75			999 444	6				
ABM2 (dBA/m)	-24.19	-24.35	Avial							
Frequency Response	Pass	Pass	Axial	2.4GHz	802.11b					
S+N/N (dB)	43.52	43.10								

- Mute on; Backlight off; Max Volume; Max Contrast
- Radio Configurations can be found in Section 9.II.F

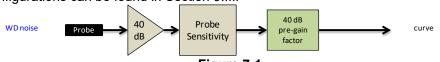


Figure 7-1 **Audio Band Magnetic Curve Measurement Block Diagram**

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2. LTE FDD Band Investigation

An investigation was performed to determine the worst-case LTE FDD band for OTT VoIP T-Coil testing. LTE Band 14 was evaluated for OTT VoIP over LTE T-Coil testing. See table below for the SNNR comparison between each LTE FDD band.:

Table 7-5
OTT VoIP (LTE) SNNR by LTE FDD Band

	<u> </u>									
Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]	
2	1880.0	18900	20	16QAM	1	0	18.74	-24.76	43.50	
4	1732.5	20175	20	16QAM	1	0	18.97	-25.05	44.02	
5	836.5	20525	10	16QAM	1	0	19.10	-28.89	47.99	
12	707.5	20395	10	16QAM	1	0	19.01	-26.05	45.06	
14	793.0	23330	10	16QAM	1	0	18.89	-23.68	42.57	

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8. FCC 3G MEASUREMENTS

I. UMTS Test Configurations

AMR at 12.2kbps, 13.6kbps SRB was used for the testing as the worst-case configuration for the handset. See below plot for ABM noise comparison between vocoder rates:

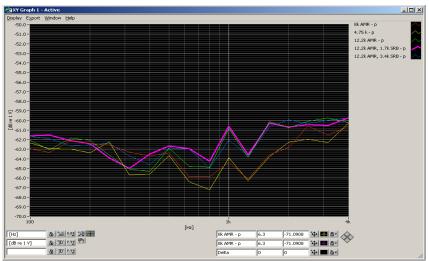


Figure 8-1
UMTS Audio Band Magnetic Noise

Table 8-1
Codec Investigation - UMTS

		oo miroongano	00			
Codec Setting:	AMR 12.2kbps	pps AMR 7.95kbps AMR 4.75kbps		Orientation	Channel	
ABM1 (dBA/m)	13.65	13.65	13.42			
ABM2 (dBA/m)	-36.37	-37.21	-37.25	axial	9400	
Frequency Response	Pass	Pass	Pass	axiai		
S+N/N (dB)	50.02	50.86	50.67			

- Mute on; Backlight off; Max Volume; Max Contrast
- · TPC="All 1s"

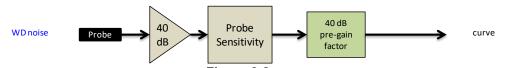


Figure 8-2
Audio Band Magnetic Curve Measurement Block Diagram

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T-COIL TEST SUMMARY 9.

Table 9-1 **Consolidated Tabled Results**

		-	esponse	0	Magnetic Intensity Verdict		SNNR dict	Margin from	C63.19-2011
		8.3.2		_	8.3.1			FCC Limit	Rating
C63.19	9 Section	Axial	3.2 Radial	Axial	3.1 Radial	Axial	3.4 Radial	(dB)	
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
GSM	PCS	PASS	NA	PASS	PASS	PASS	PASS	-6.84	Т3
EDGE	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-6.93	Т3
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
UMTS	AWS	PASS	NA	PASS	PASS	PASS	PASS	-26.61	T4
	PCS	PASS	NA	PASS	PASS	PASS	PASS		
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
HSPA (OTT VoIP)	AWS	PASS	NA	PASS	PASS	PASS	PASS	-20.30	T4
(61116)	PCS	PASS	NA	PASS	PASS	PASS	PASS		
	B12	PASS	NA	PASS	PASS	PASS	PASS		
	B14	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD	B5	PASS	NA	PASS	PASS	PASS	PASS	-12.21	T4
	B4	PASS	NA	PASS	PASS	PASS	PASS		
	B2	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD (OTT VoIP)	B14	PASS	NA	PASS	PASS	PASS	PASS	-18.99	Т4
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN	802.11g	PASS	NA	PASS	PASS	PASS	PASS	-8.99	Т3
	802.11n	PASS	NA	PASS	PASS	PASS	PASS		
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN (OTT VoIP)	802.11g	PASS	NA	PASS	PASS	PASS	PASS	-18.17	T4
	802.11n	PASS	NA	PASS	PASS	PASS	PASS		
	802.11a	PASS	NA	PASS	PASS	PASS	PASS		
U-NII	802.11n	PASS	NA	PASS	PASS	PASS	PASS	-8.64	Т3
	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		
U-NII	802.11a	PASS	NA	PASS	PASS	PASS	PASS		
(OTT VoIP)	802.11n	PASS	NA	PASS	PASS	PASS	PASS	-19.39	T4
	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		

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I. Raw Handset Data

Table 9-2
Raw Data Results for GSM

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		128	23.62	-8.08		0.88	31.70	20.00	-11.70	T4	
	Axial	190	23.28	-8.72	-58.23	0.85	32.00	20.00	-12.00	T4	2.6, 3.4
GSM850		251	23.75	-8.11		0.87	31.86	20.00	-11.86	T4	
GSIVIOSU		128	14.18	-12.66	-58.21		26.84	20.00	-6.84	T3	
	Radial	190	14.29	-13.46		N/A	27.75	20.00	-7.75	Т3	2.4, 4.2
		251	14.26	-12.79			27.05	20.00	-7.05	Т3	
		512	23.87	-12.32		0.90	36.19	20.00	-16.19	T4	
	Axial	661	23.74	-12.29	-58.23	0.89	36.03	20.00	-16.03	T4	2.6, 3.4
GSM1900		810	23.68	-11.84		0.90	35.52	20.00	-15.52	T4	
GSW1900		512	14.20	-17.06			31.26	20.00	-11.26	T4	
	Radial	661	14.16	-16.74	-58.21	N/A	30.90	20.00	-10.90	T4	2.4, 4.2
		810	14.49	-16.56			31.05	20.00	-11.05	T4	

Table 9-3
Raw Data Results for UMTS

				ILAW L	ata Kesu	ito ioi oi	WI I O				
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		4132	13.94	-39.92		2.00	53.86	20.00	-33.86	T4	
	Axial	4183	13.97	-40.43	-58.23	2.00	54.40	20.00	-34.40	T4	2.6, 3.4
UMTS V		4233	13.94	-40.58		2.00	54.52	20.00	-34.52	T4	
OWI S V		4132	4.55	-42.84			47.39	20.00	-27.39	T4	
	Radial	4183	4.59	-42.59	-58.21	N/A	47.18	20.00	-27.18	T4	2.4, 4.2
		4233	4.60	-42.71			47.31	20.00	-27.31	T4	
		1312	13.94	-38.93		2.00	52.87	20.00	-32.87	T4	
	Axial	1412	13.94	-39.42	-58.23	2.00	53.36	20.00	-33.36	T4	2.6, 3.4
UMTS IV		1513	13.92	-39.91		2.00	53.83	20.00	-33.83	T4	
OWITSTV		1312	4.52	-42.76			47.28	20.00	-27.28	T4	
	Radial	1412	4.52	-42.09	-58.21	N/A	46.61	20.00	-26.61	T4	2.4, 4.2
		1513	4.55	-42.37			46.92	20.00	-26.92	T4	
		9262	13.94	-38.08		2.00	52.02	20.00	-32.02	T4	
	Axial	9400	13.95	-38.82	-58.23	2.00	52.77	20.00	-32.77	T4	2.6, 3.4
UMTS II		9538	13.95	-39.30		2.00	53.25	20.00	-33.25	T4	
OWISH		9262	4.48	-42.50			46.98	20.00	-26.98	T4	
	Radial	9400	4.47	-42.38		1 N/A	46.85	20.00	-26.85	T4	2.4, 4.2
		9538	4.63	-42.24			46.87	20.00	-26.87	T4	

Table 9-4 Raw Data Results for LTE B12

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011	Test Coordinates
		10MHz	23095	12.24	-24.26		2.00	36.50	20.00	-16.50	T4	
	Axial	5MHz	23095	11.90	-25.91	58.23 -	2.00	37.81	20.00	-17.81	T4	2.6, 3.4
	Axiai	3MHz	23095	12.35	-25.53		2.00	37.88	20.00	-17.88	T4	2.0, 3.4
LTE Band		1.4MHz	23095	12.21	-25.70		2.00	37.91	20.00	-17.91	T4	
12		10MHz	23095	2.79	-33.29	-58.21		36.08	20.00	-16.08	T4	
	Radial	5MHz	23095	3.11	-33.12		N/A	36.23	20.00	-16.23	T4	2.4, 4.2
	Naulai	3MHz	23095	2.83	-32.76	-50.21	IVA	35.59	20.00	-15.59	T4	2.4, 4.2
		1.4MHz	23095	3.16	-31.58	-		34.74	20.00	-14.74	T4	

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Table 9-5 Raw Data Results for LTE B14

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)		Test Coordinates
	Axial	10MHz	23330	12.21	-23.54	-58,23	1.99	35.75	20.00	-15.75	T4	2.6, 3.4
	Axiai	5MHz	23330	12.20	-24.97	-58.23	2.00	37.17	20.00	-17.17	T4	2.0, 3.4
LTE Band		10MHz	23330	3.14	-30.51	-58.21	N/A	33.65	20.00	-13.65	T4	
14	Radial	5MHz	23355	3.00	-31.63			34.63	20.00	-14.63	T4	2,4, 4,2
		5MHz	23330	2.92	-30.09			33.01	20.00	-13.01	T4	2.4, 4.2
		5MHz	23305	3.05	-29.16			32.21	20.00	-12.21	T4	

Table 9-6 Raw Data Results for LTE B5

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		10MHz	20525	12.21	-28.55		2.00	40.76	20.00	-20.76	T4	
	Axial	5MHz	20525	11.96	-27.65	-58.23	2.00	39.61	20.00	-19.61	T4	2.6, 3.4
	Axiai	3MHz	20525	12.27	-26.48		2.00	38.75	20.00	-18.75	T4	2.0, 3.4
LTE Band 5		1.4MHz	20525	12.34	-27.24		2.00	39.58	20.00	-19.58	T4	
LIL Band 5		10MHz	20525	2.85	-35.20	-58.21		38.05	20.00	-18.05	T4	
	Radial	5MHz	20525	2.87	-34.47		N/A	37.34	20.00	-17.34	T4	2.4, 4.2
		3MHz	20525	2.82	-33.60		IVA	36.42	20.00	-16.42	T4	2.4, 4.2
		1.4MHz	20525	3.12	-33.09			36.21	20.00	-16.21	T4	

Table 9-7 Raw Data Results for LTE B4

						Counto IC		•				
Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	20175	12.24	-24.95		2.00	37.19	20.00	-17.19	T4	
		15MHz	20175	12.26	-24.69		2.00	36.95	20.00	-16.95	T4	
		10MHz	20175	12.51	-23.75		2.00	36.26	20.00	-16.26	T4	
	Axial	5MHz	20175	12.41	-23.40	-58.23	2.00	35.81	20.00	-15.81	T4	2.6, 3.4
	Axiai	3MHz	20175	12.35	-23.21	-50.23	2.00	35.56	20.00	-15.56	T4	2.6, 3.4
		1.4MHz	20393	12.05	-23.36		2.00	35.41	20.00	-15.41	T4	
LTE Band 4		1.4MHz	20175	11.94	-23.36		2.00	35.30	20.00	-15.30	T4	
LTE Ballu 4		1.4MHz	19957	12.27	-22.71		2.00	34.98	20.00	-14.98	T4	
		20MHz	20175	2.92	-31.36			34.28	20.00	-14.28	T4	
		15MHz	20175	2.86	-31.24			34.10	20.00	-14.10	T4	
	Radial	10MHz	20175	3.09	-31.22	50.04	N/A	34.31	20.00	-14.31	T4	2.4, 4.2
	Radiai	5MHz	20175	2.83	-31.23	-58.21	IVA	34.06	20.00	-14.06	T4	2.4, 4.2
		3MHz	20175	2.70	-30.58			33.28	20.00	-13.28	T4	
		1.4MHz	20175	2.83	-30.37			33.20	20.00	-13.20	T4	

Table 9-8 Raw Data Results for LTE B2

					Duta I							
Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	18900	11.99	-25.08		2.00	37.07	20.00	-17.07	T4	
		15MHz	18900	12.23	-24.30		2.00	36.53	20.00	-16.53	T4	
	Axial	10MHz	18900	12.18	-24.78	-58.23	2.00	36.96	20.00	-16.96	T4	2.6, 3.4
	Axiai	5MHz	18900	12.36	-25.02	-56.25	2.00	37.38	20.00	-17.38	T4	2.0, 3.4
		3MHz	18900	12.36	-25.15		2.00	37.51	20.00	-17.51	T4	
LTE Band 2		1.4MHz	18900	12.18	-24.90		2.00	37.08	20.00	-17.08	T4	
LIE Ballu 2		20MHz	18900	3.25	-31.27			34.52	20.00	-14.52	T4	
		15MHz	18900	3.22	-31.04			34.26	20.00	-14.26	T4	
	Radial	10MHz	18900	2.87	-31.38	50.04	N/A	34.25	20.00	-14.25	T4	2.4, 4.2
	Radiai	5MHz	18900	2.89	-31.57	-58.21 7	IN/A	34.46	20.00	-14.46	T4	2.4, 4.2
		3MHz	18900	3.01	-30.97			33.98	20.00	-13.98	T4	
		1.4MHz	18900	2.78	-31.62			34.40	20.00	-14.40	T4	

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Table 9-9 Raw Data Results for 2.4GHz WIFI

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		1	7.00	-27.85		2.00	34.85	20.00	-14.85	T4	
	Axial	6	6.96	-26.95	-58.23	2.00	33.91	20.00	-13.91	T4	2.6, 3.4
WLAN		11	7.56	-26.14		2.00	33.70	20.00	-13.70	T4	1
802.11b		1	-0.79	-30.18			29.39	20.00	-9.39	T3	
	Radial	6	-0.91	-30.89	-58.21	N/A	29.98	20.00	-9.98	Т3	2.4, 4.2
		11	-0.90	-29.89			28.99	20.00	-8.99	Т3	
WLAN	Axial	6	7.45	-27.06	-58.23	2.00	34.51	20.00	-14.51	T4	2.6, 3.4
802.11g	Radial	6	-0.43	-32.84	-58.21	N/A	32.41	20.00	-12.41	T4	2.4, 4.2
WLAN	Axial	6	7.50	-28.41	-58.23	2.00	35.91	20.00	-15.91	T4	2.6, 3.4
802.11n	Radial	6	-0.92	-32.43	-58.21	N/A	31.51	20.00	-11.51	T4	2.4, 4.2

Table 9-10 Raw Data Results for 5GHz WIFI 802.11a

Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
		20MHz	1	36	6.98	-28.44		2.00	35.42	20.00	-15.42	T4		
		20MHz	1	40	7.39	-28.82		2.00	36.21	20.00	-16.21	T4		
	Axial	20MHz	1	48	7.46	-30.89	-58.23	2.00	38.35	20.00	-18.35	T4	2.6, 3.4	
	Axiai	20MHz	2A	56	7.02	-30.81	-56.25	2.00	37.83	20.00	-17.83	T4	2.0, 5.4	
		20MHz	2C	120	6.99	-30.28		2.00	37.27	20.00	-17.27	T4		
	D2.11a	20MHz	3	157	7.04	-29.26		2.00	36.30	20.00	-16.30	T4		
802.11a														
		20MHz	1	36	-0.49	-29.78			29.29	20.00	-9.29	T3		
		20MHz	1	40	-0.48	-29.12			28.64	20.00	-8.64	T3		
		20MHz	1	48	-0.94	-31.84	E0 04	NI/A	30.90	20.00	-10.90	T4	2.4, 4.2	
	Naulai	20MHz	2A	56	-1.07	-31.55	-58.21	-58.21 N/A	IWA	30.48	20.00	-10.48	T4	2.4, 4.2
		20MHz	2C	120	-0.46	-30.14			29.68	20.00	-9.68	T3		
		20MHz	3	157	-0.58	-30.35			29.77	20.00	-9.77	T3		

Table 9-11 Raw Data Results for 5GHz WIFI 802.11n

		The state of the s													
	Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
ı		Avial	40MHz	1	38	7.54	-30.01	-58,23	2.00	37.55	20.00	-17.55	T4	2.6, 3.4	
١	Axial	Axiai	20MHz	1	40	7.00	-30.74	-36.23	2.00	37.74	20.00	-17.74	T4	2.0, 3.4	
ı	802.11n	802.11n													
١	Radial	Padial	40MHz	1	38	-1.01	-31.36	E0 21	NI/A	30.35	20.00	-10.35	T4	2.4. 4.2	
ı		Radial	20MHz	1	40	-1.00	-31.23	-58.21	N/A	30.23	20.00	-10.23	T4	2.4, 4.2	

Table 9-12 Raw Data Results for 5GHz WIFI 802.11ac

	Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)		Test Coordinates
ı		Axial	40MHz	1	38	7.74	-29.30	-58,23	2.00	37.04	20.00	-17.04	T4	2.6, 3.4
	200 44	Axidi	20MHz	1	40	7.57	-30.00	-50.25	2.00	37.57	20.00	-17.57	T4	2.0, 3.4
ı	802.11ac													
		Radial	40MHz	1	38	-1.08	-30.86	E0 24	NI/A	29.78	20.00	-9.78	Т3	2.4. 4.2
L		Radial	20MHz	1	40	-1.02	-31.23	-58.21	N/A	30.21	20.00	-10.21	T4	2.4, 4.2

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Table 9-13 Raw Data Results for EDGE (OTT VoIP)

	11411 2414 11554115 151 22 52 (511 1511)										
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011	Test Coordinates
EDGE850	Axial	190	18.42	-13.55	-58.23	1.89	31.97	20.00	-11.97	T4	2.6, 3.4
EDGE650	Radial	190	11.20	-15.73	-58.21	N/A	26.93	20.00	-6.93	Т3	2.4, 4.2
EDGE1900	Axial	661	18.98	-15.39	-58.23	2.00	34.37	20.00	-14.37	T4	2.6, 3.4
LDGL1900	Radial	661	10.97	-18.59	-58.21	N/A	29.56	20.00	-9.56	Т3	2.4, 4.2

Table 9-14 Raw Data Results for HSPA (OTT VoIP)

	Naw Data Nesalts for Hot A (OTT V										
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
HSPA V	Axial	4183	18.41	-33.45	-58.23	1.80	51.86	20.00	-31.86	T4	2.6, 3.4
HOPA V	Radial	4183	11.07	-29.23	-58.21	N/A	40.30	20.00	-20.30	T4	2.4, 4.2
HSPA IV	Axial	1412	18.93	-33.51	-58.23	1.89	52.44	20.00	-32.44	T4	2.6, 3.4
HOPAIV	Radial	1412	11.19	-29.83	-58.21	N/A	41.02	20.00	-21.02	T4	2.4, 4.2
HSPA II	Axial	9400	18.84	-34.06	-58.23	1.83	52.90	20.00	-32.90	T4	2.6, 3.4
HOPAII	Radial	9400	11.74	-29.33	-58.21	N/A	41.07	20.00	-21.07	T4	2.4, 4.2

Table 9-15 Raw Data Results for LTE B14 (OTT VoIP)

		11411 Data 11004110 101 111 211 1011											
	Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
I		Axial	10MHz	23330	19.00	-23.55	-58.23	1.95	42.55	20.00	-22.55	T4	2.6, 3.4
١	LTE Band	Axiai	5MHz	23330	18.85	-25.94	-56.25	1.99	44.79	20.00	-24.79	T4	2.0, 3.4
١	14	Radial	10MHz	23330	11.52	-27.47	-58.21	N/A	38.99	20.00	-18.99	T4	2.4. 4.2
ı		Radiai	5MHz	23330	11.01	-28.23	-50.21	IVA	39.24	20.00	-19.24	T4	2.4, 4.2

Table 9-16 Raw Data Results for 2.4GHz WIFI (OTT VoIP)

Raw Data Results for 2.4GHZ WIFT (OTT VOIP)											
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		1	19.29	-23.60		1.91	42.89	20.00	-22.89	T4	
	Axial	6	19.14	-22.85	-58.23	1.82	41.99	20.00	-21.99	T4	2.6, 3.4
WLAN		11	18.83	-23.60		1.71	42.43	20.00	-22.43	T4	
802.11b		1	10.90	-27.27			38.17	20.00	-18.17	T4	
	Radial	6	11.34	-27.82	-58.21	N/A	39.16	20.00	-19.16	T4	2.4, 4.2
		11	11.51	-26.76			38.27	20.00	-18.27	T4	
WLAN	Axial	6	19.53	-27.16	-58.23	1.91	46.69	20.00	-26.69	T4	2.6, 3.4
802.11g	Radial	6	11.20	-30.50	-58.21	N/A	41.70	20.00	-21.70	T4	2.4, 4.2
WLAN	Axial	6	19.09	-25.50	-58.23	1.81	44.59	20.00	-24.59	T4	2.6, 3.4
802.11n	Radial	6	11.29	-30.05	-58.21	N/A	41.34	20.00	-21.34	T4	2.4, 4.2

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Table 9-17 Raw Data Results for 5GHz WIFI 802.11a (OTT VoIP)

	Naw Data Nesalts for Cont. Will 1 Coz. 1 tu												
Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	1	36	19.27	-28.32		1.88	47.59	20.00	-27.59	T4	
		20MHz	1	40	18.90	-27.90		1.90	46.80	20.00	-26.80	T4	
	Axial	20MHz	1	48	19.13	-27.65	-58.23	1.79	46.78	20.00	-26.78	T4	2.6, 3.4
	Axiai	20MHz	2A	56	18.83	-27.98	-36.23	1.97	46.81	20.00	-26.81	T4	2.0, 3.4
		20MHz	2C	120	19.11	-27.89		1.86	47.00	20.00	-27.00	T4	
		20MHz	3	157	19.22	-28.32		2.00	47.54	20.00	-27.54	T4	
802.11a													
		20MHz	1	40	11.37	-28.60			39.97	20.00	-19.97	T4	
		20MHz	2A	56	11.07	-29.13			40.20	20.00	-20.20	T4	
	Radial	20MHz	2C	120	11.29	-29.01	-58,21	N/A	40.30	20.00	-20.30	T4	2.4, 4.2
	Natiai	20MHz	3	149	11.32	-29.13	-56.21	IN/A	40.45	20.00	-20.45	T4	2.4, 4.2
		20MHz	3	157	11.12	-28.27			39.39	20.00	-19.39	T4	
		20MHz	3	165	11.67	-28.78			40.45	20.00	-20.45	T4	

Table 9-18 Raw Data Results for 5GHz WIFI 802.11n (OTT VoIP)

			itui	Dutait	Courto	0.00		, o z	(
Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)		Test Coordinates
	Axial	40MHz	1	38	19.13	-29.46	-58.23	1.76	48.59	20.00	-28.59	T4	2.6, 3.4
	Axiai	20MHz	1	40	18.98	-29.22	-36.23	2.00	48.20	20.00	-28.20	T4	2.0, 3.4
802.11n													
	Radial	40MHz	1	38	11.58	-30.33	-58.21	N/A	41.91	20.00	-21.91	T4	2.4. 4.2
	Naulai	20MHz	1	40	11.42	-29.94	-36.21	INA	41.36	20.00	-21.36	T4	2.4, 4.2

Table 9-19 Raw Data Results for 5GHz WIFI 802.11ac (OTT VoIP)

	Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		Axial	40MHz	1	38	19.34	-29.48	-58,23	2.00	48.82	20.00	-28.82	T4	2.6, 3.4
		Axiai	20MHz	1	40	19.32	-30.49	-36.23	1.84	49.81	20.00	-29.81	T4	2.0, 3.4
80)2.11ac													
		Radial	40MHz	1	38	10.99	-29.98	-58,21	N/A	40.97	20.00	-20.97	T4	2,4, 4,2
		Naulai	20MHz	1	40	11.28	-29.49	-36.21	IN/A	40.77	20.00	-20.77	T4	2.4, 4.2

II. Test Notes

A. General

- 1. Phone Condition: Mute on; Backlight off; Max Volume; Max Contrast
- 2. 'Radial' orientation refers to radial transverse.
- 3. Hearing Aid Mode (Phone→Settings→More Settings→Hearing aids) as well as Noise suppression Mode (Phone→Settings→More Settings→Noise Suppression) was set to ON for Frequency Response compliance.
- 4. Speech Signal: ITU-T P.50 Artificial Voice
- 5. Bluetooth and WIFI were disabled while testing 2G/3G/4G modes.
- 6. Licensed data modes and Bluetooth were disabled while testing WIFI modes.
- 7. The Margin from FCC Limit column indicates a margin from the FCC limit for compliance (T3).

B. GSM

- 1. Power Configuration: GSM850: PCL=5, GSM1900: PCL=0;
- 2. Vocoder Configuration: EFR (GSM);

C. UMTS

- 1. Power Configuration: TPC= "All 1s";
- 2. Vocoder Configuration: AMR 12.2 kbps (UMTS);

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D. LTE FDD

- 1. Power Configuration: TPC = "Max Power"
- 2. Radio Configuration: 16QAM, 1RB, 0RB offset
- 3. Vocoder Configuration: WB AMR 6.60kbps
- 4. The worst-case band and bandwidth combination for each probe orientation is additionally tested on the low and high channels for those combinations. LTE Band 4 at 1.4MHz is the worst-case for the Axial probe orientation. LTE Band 14 at 5MHz bandwidth is the worst-case for the Radial probe orientation.

E. WIFI

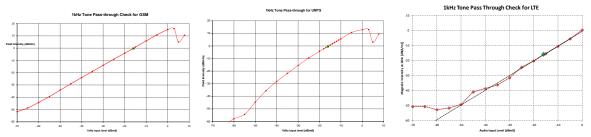
- 1. Radio Configuration
 - a. 802.11b: CCK, 11Mbps
 - b. 802.11g/a: QPSK, 18Mbps
 - c. 802.11n/ac 20MHz: QPSK, 13Mbps
 - d. 802.11n/ac 40MHz: BPSK, 13.5Mbps
- 2. Vocoder Configuration: WB AMR 6.60kbps
- 3. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. 802.11b is the worst-case for both the Axial and Radial probe orientations.
- 4. The worst-case standard for 5GHz WIFI in each probe orientation is additionally tested on higher U-NII bands as well as applicable low and high channels. 802.11a is the worst-case for both the Axial and Radial probe orientations.

F. OTT VoIP

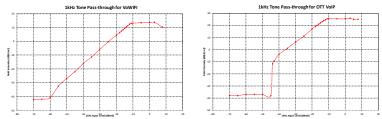
- 1. Vocoder Configuration: 6kbps
- 2. EDGE Configuration
 - a. MCS Index: 7
 - b. Number of TX slots: 2
- 3. HSPA Configuration:
 - a. Release: 6
 - b. 3GPP 34.121 Subtest 1
- 4. LTE FDD Configuration:
 - a. Power Configuration: TPC = "Max Power"
 - b. Radio Configuration: 16QAM, 1RB, 0RB offset
 - c. LTE Band 14 was the worst-case band from Table 7-5 and was used for testing for both Axial and Radial probe orientations.
 - d. The worst-case bandwidth for each probe orientation is additionally tested on the low and high channels for those bandwidths. LTE Band 14 at 10MHz is the worst-case for both the Axial and Radial probe orientations. Since this band and bandwidth combination supports only one channel, no additional testing was performed.
- 5. WIFI Configuration:
 - a. Radio Configuration
 - i. 802.11b: CCK, 11Mbps
 - ii. 802.11g/a: QPSK, 18Mbps
 - iii. 802.11n/ac 20MHz: QPSK, 13Mbps
 - iv. 802.11n/ac 40MHz: BPSK, 13.5Mbps
 - b. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. 802.11b is the worst-case for both the Axial and Radial probe orientations.
 - c. The worst-case standard for 5GHz WIFI in each probe orientation is additionally tested on higher U-NII bands as well as applicable low and high channels. 802.11a is the worst-case for both the Axial and Radial probe orientations.

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1 kHz Vocoder Application Check III.



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



This model was verified to be within the linear region for ABM1 measurements at -20 dBm0 for VoWIFI over IMS and OTT VoIP. This measurement was taken in the axial configuration above the maximum location.

T-Coil Validation Test Results IV.

Table 9-20 Helmholtz Coil Validation Table of Results

Item	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.177	PASS
Environmental Noise	< -58 dBA/m	-58.23	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.275	PASS
Environmental Noise	< -58 dBA/m	-58.21	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS

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ABM1 Magnetic Field Distribution Scan Overlays ٧.

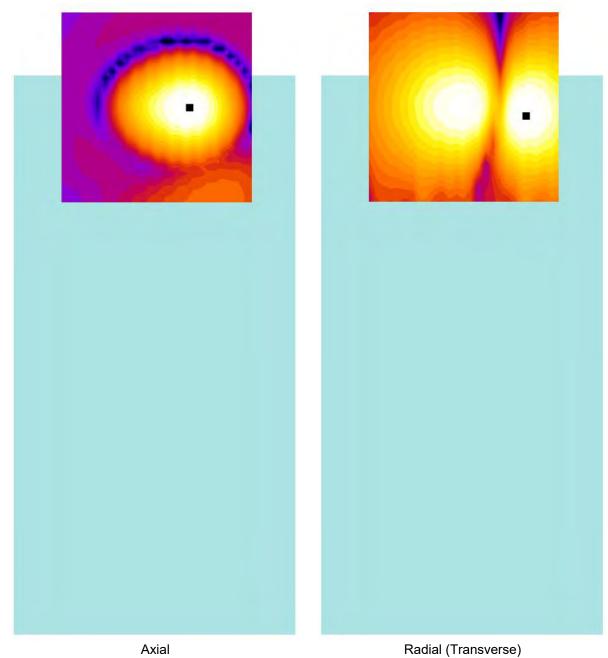


Figure 9-1 T-Coil Scan Overlay Magnetic Field Distributions

Notes:

- 1. Final measurement locations are indicated by a cursor on the contour plots.
- 2. See Test Setup Photographs for actual WD overlay.

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MEASUREMENT UNCERTAINTY 10.

Table 10-1 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, uc (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.
- 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.

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11. EQUIPMENT LIST

Table 11-1 Equipment List

Equipment List						
Manufacturer	Model	Description		Cal Interval	Cal Due	Serial Number
Dell	Latitude E6540	SoundCheck Acoustic Analyzer Laptop	4/11/2017	Biennial	4/11/2019	7BFNM32
Listen	SoundConnect	Microphone Power Supply	N/A		N/A	0899-PS150
Listen	SoundConnect	Microphone Power Supply	12/2/2016	Biennial	12/2/2018	PS2612
RME	Fireface UC	Soundcheck Acoustic Analyzer External Audio Interface	4/11/2017	Biennial	4/11/2019	23528889
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	1/19/2018	Annual	1/19/2019	162125
Rohde & Schwarz	CMW500	Radio Communication tester	7/14/2017	Annual	7/14/2018	140144
Seekonk	NC-100	Torque Wrench (8" lb)	9/1/2016	Biennial	9/1/2018	21053
TEM	C63.19	Helmholtz Coil	12/7/2016	Biennial	12/7/2018	925
TEM	Radial T-Coil Probe	Radial T-Coil Probe	12/7/2016	Biennial	12/7/2018	TEM-1130
TEM	Axial T-Coil Probe	Axial T-Coil Probe	12/7/2016	Biennial	12/7/2018	TEM-1124
TEM		HAC System Controller with Software	N/A		N/A	N/A
TEM		HAC Positioner	N/A		N/A	N/A

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12. TEST DATA

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DUT: HH Coil - SN: 925

Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

Equipment:

- Probe: Axial T-Coil Probe SN: TEM-1124; Calibrated: 12/07/2016
- Helmholtz Coil SN: 925; Calibrated: 12/07/2016

Noise Spectrum -50.0 -55.0 -60.0 -70.0 豊 -75.0 -80.0 -85.0 10k 100 1k [Hz] Frequency Response 3.0 0.0 e1 A/m] B -1.0 -2.0--3.0 -1k [Hz] Results Verification 1kHz Intensity -10.177 dB Max/Min -9.5/-10.5 -58.0 Verification ABM2 -58.23 dB Maximum Aligned Data Tolerance curves Frequency Response Margin 800m dB

FCC ID: ZNFX410AS	EXPLANTAGE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
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DUT: HH Coil - SN: 925

Type: HH Coil Serial: 925

Measurement Standard: ANSI C63, 19-2011

Equipment:

- Probe: Radial T-Coil Probe SN: TEM-1130; Calibrated: 12/07/2016
- Helmholtz Coil SN: 925; Calibrated: 12/07/2016

Noise Spectrum -50,0--55.0 -60.0 -75.0 -75.0 -75.0 --80.0 -85,0 -90.0 10k 100 1k [Hz] Frequency Response 3.0 -2.0 re 1 A/m] 1.0 0.0 8 -1.0 -2.0 -3.0-3k [Hz] Results Verification 1kHz Intensity -10.275 dB Max/Min -9.5/-10.5 Verification ABM2 -58.0 -58.21 dB Maximum Tolerance curves Aligned Data Frequency Response Margin 800m dB

FCC ID: ZNFX410AS	INCHEST OF LANDSTON, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

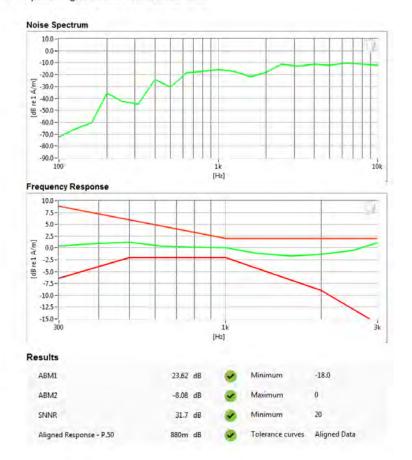
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

- Mode: GSM850
- Channel: 128
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	EXPLANTAGE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

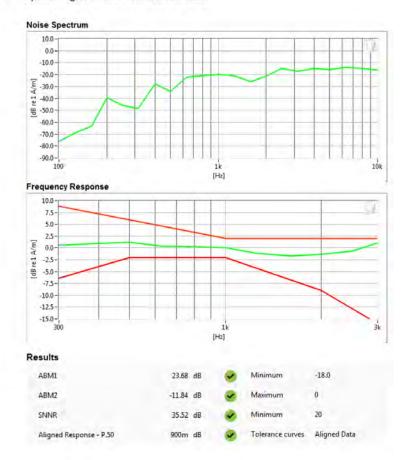
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

- Mode: GSM1900
- Channel: 810
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	INCIDENCE LABORATORS, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

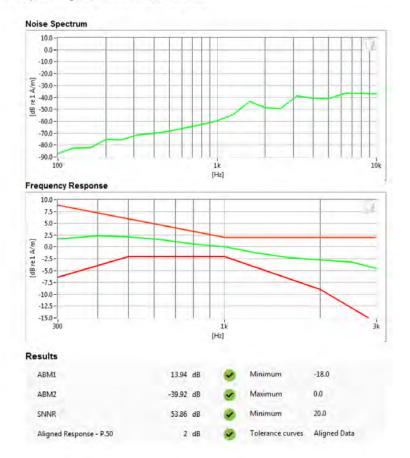
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

- Mode: UMTS VChannel: 4132
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	PETEST VINCHESCO LABORATORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

Measurement Standard: ANSI C63.19-2011

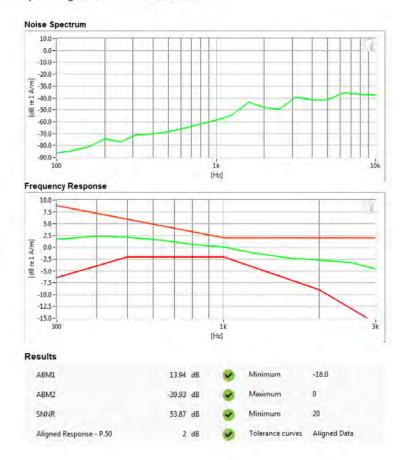
Equipment:

Probe: Axial T-Coil Probe - SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: UMTS IVChannel: 1312

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	POTEST INCHES AND LASDESTON, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

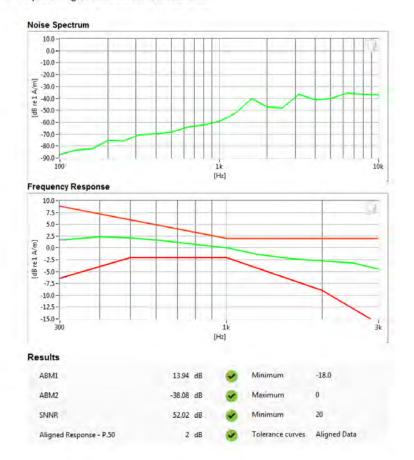
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

- Mode: UMTS IIChannel: 9262
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	PETEST VINGEREGGE LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

Measurement Standard: ANSI C63.19-2011

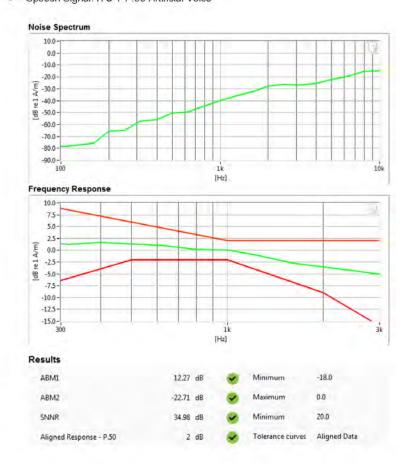
Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: LTE FDD Band 4Bandwidth: 1.4MHzChannel: 19957

• Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	PETEST INCIDENCE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

Measurement Standard: ANSI C63.19-2011

Equipment:

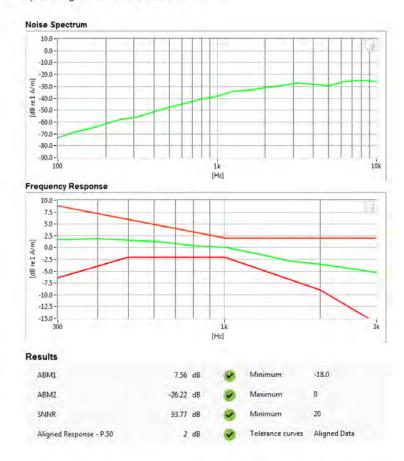
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: 2.4GHz WIFIStandard: IEEE 802.11b

Channel: 11

. Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	PETEST INCIDENCE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

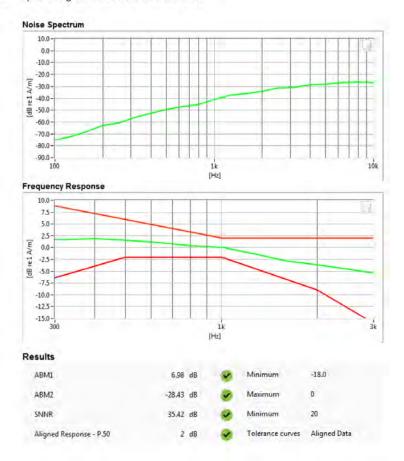
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

- Mode: 5GHz WIFI (U-NII 1)
- Standard: IEEE 802.11a
- · Channel: 36
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	PETEST (IXCHEEGE LADDETON) INC	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

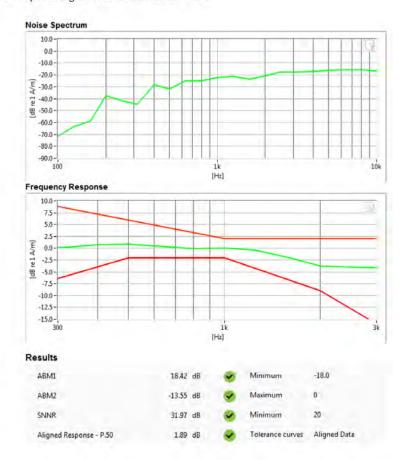
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

- VolP Application: Google Duo
- Mode: EDGE850
- · Channel: 190
- Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410AS	PETEST VENCIALES ON CARDENTON, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

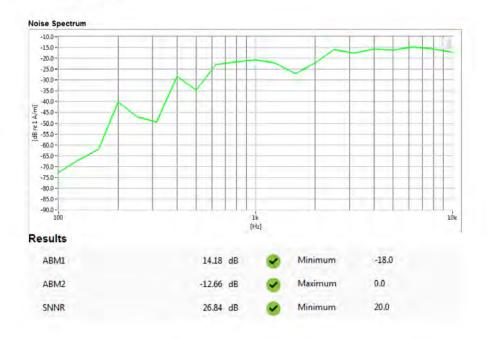
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

Mode: GSM850Channel: 128



FCC ID: ZNFX410AS	POTEST INCHES AND LASDESTON, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 01264

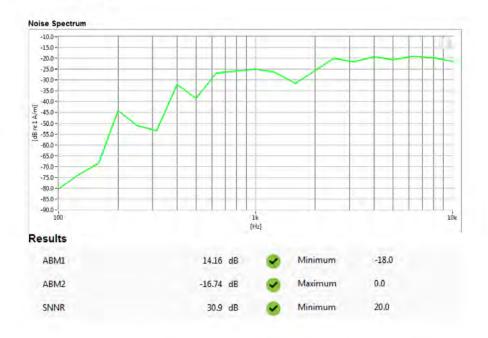
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

Mode: GSM1900Channel: 661



FCC ID: ZNFX410AS	EXPLESE SECURIOR SEC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 50 01 70



Type: Portable Handset Serial: 01264

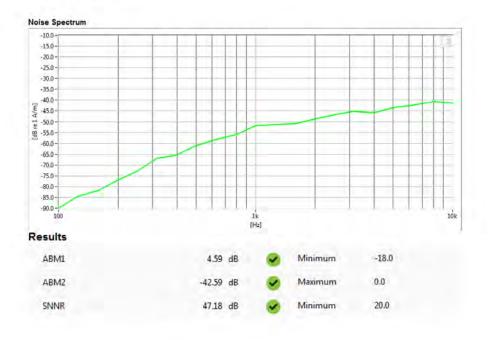
Measurement Standard: ANSI C63,19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

Mode: UMTS VChannel: 4183



FCC ID: ZNFX410AS	PETEST VINCIALES ONE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 51 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 51 of 70



Type: Portable Handset Serial: 01264

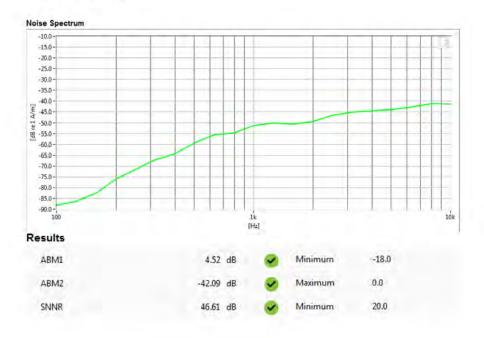
Measurement Standard: ANSI C63,19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

Mode: UMTS IVChannel: 1412



FCC ID: ZNFX410AS	PETEST INCIDENCE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dog 50 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 52 of 70



Type: Portable Handset Serial: 01264

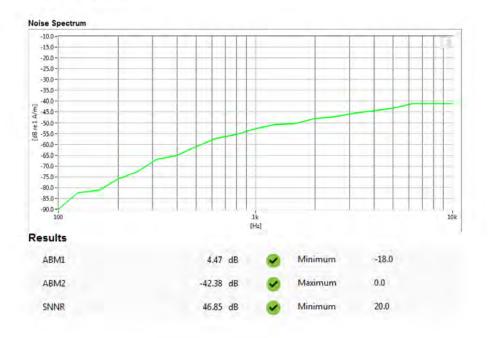
Measurement Standard: ANSI C63,19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

Mode: UMTS IIChannel: 9400



FCC ID: ZNFX410AS	PETEST VIXORESCO LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Daga 52 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 53 of 70



Type: Portable Handset Serial: 01264

Measurement Standard: ANSI C63, 19-2011

Equipment:

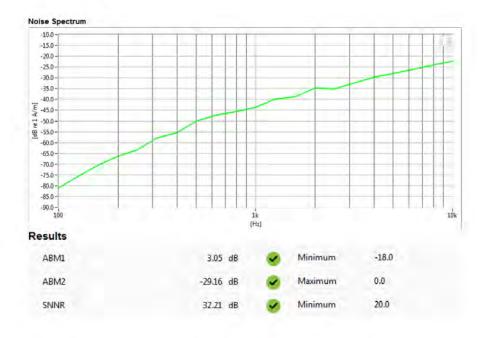
Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

Mode: LTE FDD Band 14

Bandwidth: 5MHz

Channel: 23305



FCC ID: ZNFX410AS	PETEST VIXORESCO LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 54 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 54 of 70



Type: Portable Handset Serial: 01264

Measurement Standard: ANSI C63.19-2011

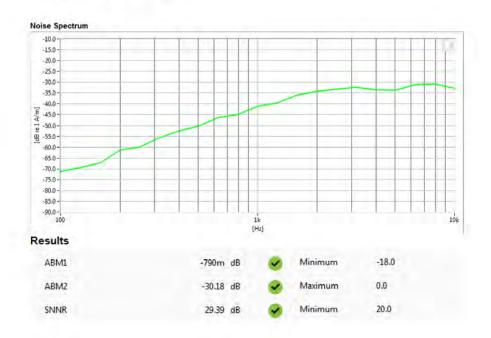
Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

Mode: 2.4GHz WIFIStandard: IEEE 802.11b

Channel: 1



FCC ID: ZNFX410AS	SECULIAR CASSISTAN, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo FF of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 55 of 70



Type: Portable Handset Serial: 01264

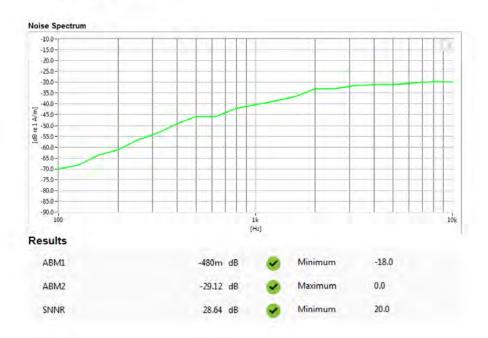
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

- Mode: 5GHz WIFI (U-NII 1)
- Standard: IEEE 802.11a
- Channel: 40



FCC ID: ZNFX410AS	PETEST VINCHESCO LABORATORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 56 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 56 of 70



Type: Portable Handset Serial: 01264

Measurement Standard: ANSI C63.19-2011

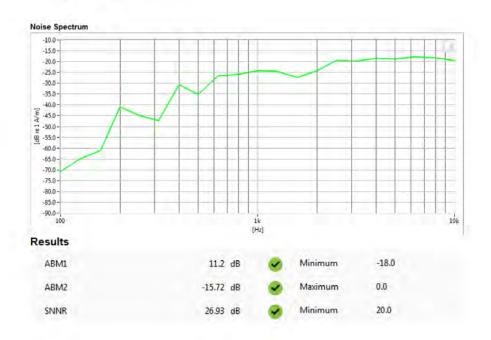
Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

· VolP Application: Google Duo

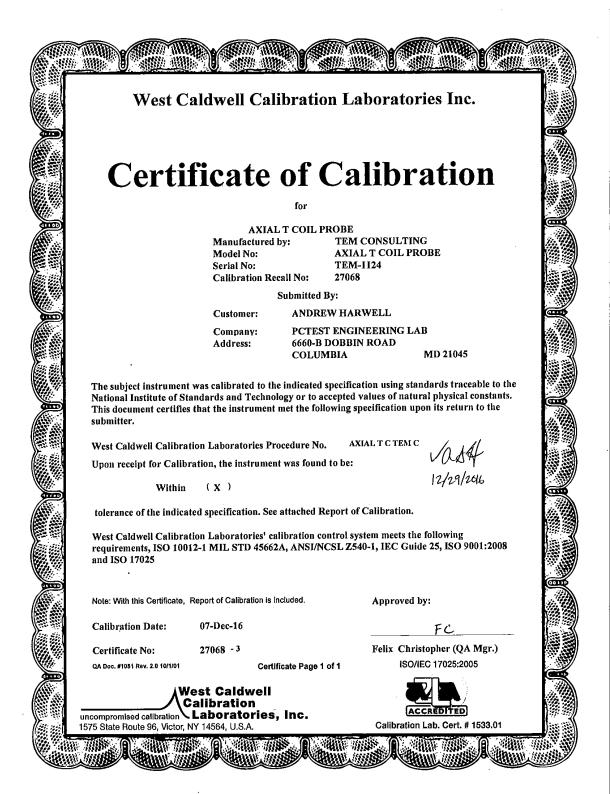
Mode: EDGE850Channel: 190



FCC ID: ZNFX410AS	SCHEER LASSET INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Daga 57 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 57 of 70

13. CALIBRATION CERTIFICATES

FCC ID: ZNFX410AS	INCIRCLASCIANT INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Daga 50 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 58 of 70



FCC ID: ZNFX410AS	INCHEST OF THE PROPERTY OF THE	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 59 of 70
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REV 3.2.M

HCATEMC_TEM 1124_Dec-07-2016



ISO/IEC 17025: 2005

ACCREDITED

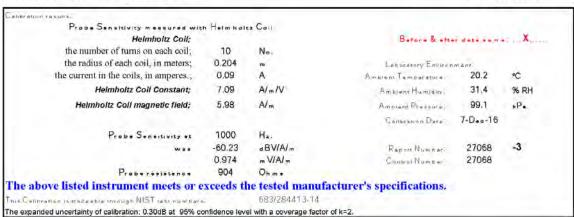
Calibration Leb. Cors. # 1533.01

1575 State Route 96, Victor NY 14564

REPORT OF CALIBRATION

TEM Consulting LP Axial T Coil Probe Model No.: Axial T Coil Probe Serial No.: TEM 1124

Company: PCTEST Engineering Lab. I. D. No: 80578



Graph represents Probes Frequency Response.

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 Wast Caldwell Calibration Laboratories Inc., under Operating Procedures
Interced to implementation requirements or ISO10012-1, IEC Gures 25, ANSI/NCSL Z540-1, (MIL-STD-4566ZA) and ISO 9001 2008, ISO 17025

Freq. (Hz)

Cail. Date: 7-Dac-2016 Massuraments performed by: FC
Calibrated on WCCL system type 9700 Felix Christopher
This assument shall not a recognize a case in bull symbols the writing as a recol from War. Calegori Car Labelle. Rev. 7.01ac 24.2014 Doc. # 1038 HCATEMO

Page 1 of 2

FCC ID: ZNFX410AS	PETEST INCIRCLASCE LASCETORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 60 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 60 of 70

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10000

HCATEMC_TEM 1124_Dec-07-2016

West Caldwell Calibration Laboratories Inc.

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

Calibration Data Record

TEM Consulting LP Axial T Coil Probe

Model No.: Axial T Coil Probe

Serial No.: TEM 1124

Company: PCTEST Engineering Lab.

Test	Function	Tolera	Measured values			
						Remarks
T.0	Prope Sensizivity et	1000 Hz.	a BV/A/m	-60.23		
	- 0.0000 0.00		∌B			*
2.0	Probe Level Linearity		6	6.03		
		Ros. (0 a B)	0 -6	0.00		
				-6.03		
			-12	-12.05		
			H.	14000		
3.0	Proba Frequency Response		100	-19.8		
			126	-18.0		
			158	-16.0		
			200	-13.9		
			251	-12.0		
			316	-9,9		
			398	-8.0		
			501	-6.0		
			631	-4.0		
		24.0.0	794	-2.0		
		Rer. (0 a B)	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 10000	18.0 20.2		
			10000	20,2		

matrumante used for calibratio	7			Date or Cal	Tracaculty No.	Due Date
HP	34401A	S/N	36064102	1-Oas-2016	,287708	1-Oor-2017
HP	34401A	S/N	36102471	1-Oct-2016	.287708	1-Oct-2017
HP	33120A	5/N	36043716	1 Oct 2015	.287708	1 Oct 2017
B&K	2133	S/N	1583254	1-Oat-2016	683/284413-14	1-Oot-2017

Cat. Data: 7-Dac-2016 Collegered on WCGL system type 9700

Tasted by! Felle Christopher

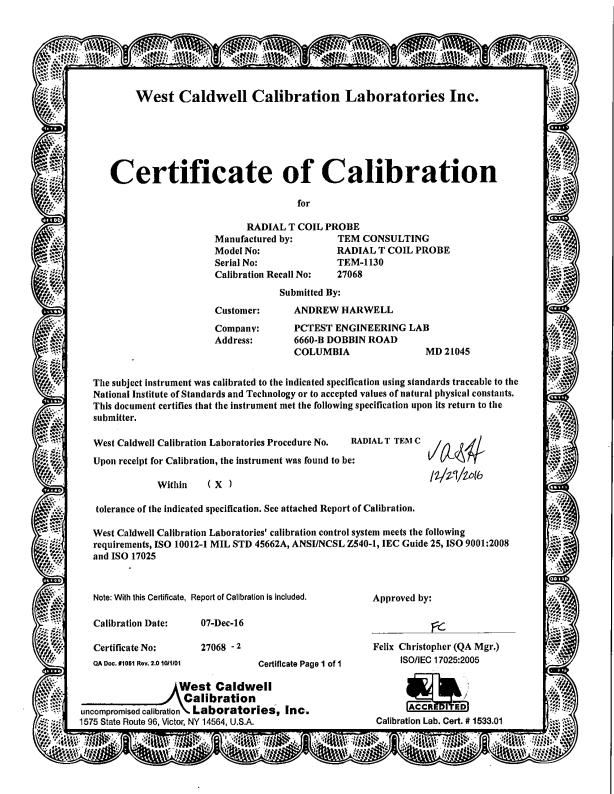
Rev. 7.0 Jan. 24, 2014 Day # 1038 HCATEMO

Page 2 of 2

FCC ID: ZNFX410AS	PETEST INCIRCLASCE LASCETORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 61 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Page 61 01 70

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REV 3.2.M



FCC ID: ZNFX410AS	INGINITION LABORATORS, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 62 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		Fage 02 01 70

HCRTEMC_TEM-1130_Dec-07-2016



ISO/IEC 17025; 2005

ACCREDITED

Calibration Lab. Cert. # 1533.01

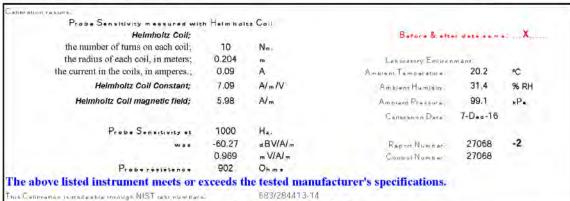
1575 State Route 96, Victor NY 14564

REPORT OF CALIBRATION

TEM Consulting LP Radial T Coil Probe Model No.: Radial T Coil Probe Serial No.: TEM-1130

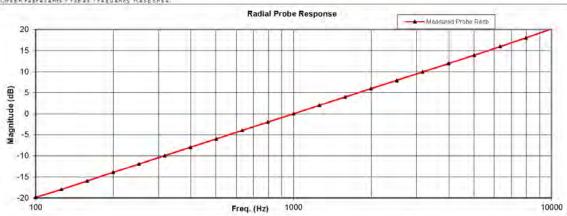
Company: PCTEST Engineering Lab.

I. D. No: 80579



Graph represents Propes Frequency Responses

The expanded uncertainty of calibration: 0.30dB at 95% confidence level with a coverage factor of k=2.



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 Wast Calibration Laboratories Inc., under Operating Procedures interned to implementation requirements of ISO10012-1, IEC Guies 25, ANSI/NCSL Z540-1, (MIL-STD-4566ZA) and ISO 9001 2008, ISO 17025

Cail Date: 7-Dac-2016 Massuraments performed by: FC
Calibrated on WCCL system type 9700 Felix Christopher
This seamon shall not be season by the West Calaborate Car Labella Rev. 70Jac. 24, 2014 Doc. \$1038 HCRTEMC

Page 1 of 2

FCC ID: ZNFX410AS	PETEST INCIRCLASCE LASCETORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogg 62 of 70
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HCRTEMC_TEM-1130_Dec-07-2016

West Caldwell Calibration Laboratories Inc.

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

Calibration Data Record

TEM Consulting LP Radial T Coil Probe

Model No.: Radial T Coil Probe

Serial No.: TEM-1130

Company: PCTEST Engineering Lab.

Test	Function	Tolera	Measured values			
	20000			Betore	Out	Remarks
T 0	Probe Sensitivity et	1000 Hz.	a BV/A/m	-60.27		
	- 6		зB			1
2.0	Probe Level Linearity		6	6.03		
		Rer. (0 aB)	0 -6	0.00		
				-6.03		
			-12	-12.06		
			H.	1		
3.0	Proba Frequency Response		100	-19.9		
			126	-18.0		
			158	-16.0		
			200	-13.9		
			251	-12.0		
			316	-10.0		
			398	-8.0		
			501	-6.0		
			631	-4.0		
		33.0	794	-2.0		
		Rer. (0 aB)	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		

hatrumants used for caller	stian			Date or Cal	Tracadallity No.	Due Date
HP	34401A	S/N	36064102	1-Oss-2016	,287708	1-Oer-2017
HP	34401A	S/N	36102471	1-Oct-2015	.287708	1-Oct-2017
HP	33120A	5/N	36043716	1 Oct 2015	.287708	1 Oct 2017
B&K	2133	S/N	1583254	1-Oat-2016	683/284413-14	1-Oot-2017

Cat. Data: 7-Dac-2016

Collegered on WCGL system type 9700

Tasted by! Felle Christopher

R. 7.0 Jan 24, 2014 Day # 1038 HORTEMO

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FCC ID: ZNFX410AS	INCHEST OF LANDSTON, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Daga 64 of 70
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14. CONCLUSION

The measurements indicate that the wireless communications device complies with the HAC limits specified in accordance with 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.

FCC ID: ZNFX410AS	PETEST INCIDENCE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 65 of 70
1M1803140041-10-R2.ZNF	04/12/2018 - 04/15/2018	Portable Handset		rage 65 of 70

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FCC ID: ZNFX410AS	POTEST INCIDENCE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogg 66 of 70
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FCC ID: ZNFX410AS	INCIRCLASCIANT INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Daga 67 of 70
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