

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: 07/10/2018 - 07/19/2018 Test Site/Location: PCTEST Lab, Columbia, MD, USA Test Report Serial No.:

1M1806270133-11.ZNF

FCC ID: ZNFX410PM

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

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

285076 D01 HAC Guidance v05

285076 D02 T-Coil testing for CMRS IP v03

DUT Type: Portable Handset **Model:** LM-X410PM

Additional Model(s): LMX410PM, X410PM

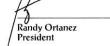
Test Device Serial No.: Pre-Production Sample [S/N: 05154]

Class II Permissive Change(s): See FCC Change Document

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

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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2. DUT DESCRIPTION



FCC ID: ZNFX410PM

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

1000 Sylvan Avenue

Englewood Cliffs, NJ 07632

United States

Model: LM-X410PM

Additional Model(s): LMX410PM, X410PM

Serial Number: 05154

HW Version: Rev.1.0

SW Version: X410PM07e

Antenna: Internal Antenna

DUT Type: Portable Handset

I. LTE Band Selection

This device supports the following pair of LTE bands with similar frequencies: LTE B2 & B25 and B5 & B26. These pairs of LTE bands have the same target power and share the same transmission path. Since the supported frequency spans for the smaller LTE bands are completely covered by the larger LTE bands, only the larger LTE bands (LTE B25 and B26) were evaluated for hearing-aid compliance.

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Table 2-1 **ZNFX410PM HAC Air Interfaces**

Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service
	835	vo	Yes	Yes: WIFI or BT	CMRS Voice*
CDMA 1900					
	EvDO	VD	Yes	Yes: WIFI or BT	Google Duo**
	850	vo	Yes	Yes: WIFI or BT	CMRS Voice*
GSM	1900	,,	163	163. WIIT OF BT	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)				
	780 (B13)				
	850 (B5)	VD	Yes	Yes: WIFI or BT	Google Duo**
LTE (FDD)	850 (B26)				
	1700 (B4)				
	1900 (B2)				
	1900 (B25)				
LTE (TDD)	2600 (B41)	VD	Yes	Yes: WIFI or BT	Google Duo**
	2450				
	5200 (U-NII 1)				
WIFI	5300 (U-NII 2A)	VD	Yes	Yes: CDMA, GSM, UMTS, or LTE	VoWIFI**, Google Duo**
	5500 (U-NII 2C)				
	5800 (U-NII 3)				
ВТ	2450	DT	No	Yes: CDMA, GSM, UMTS, or LTE	N/A
ype Transport O = Voice Onl	у		Notes: * Reference le	evel in accordance with 7.4.2.1 of ANSI C63.19-20	11 and July 2012 C63 VoLTE

DT = Digital Data - Not intended for CMRS Service VD = CMRS and IP Voice over Data Transport

Interpretation.

** Reference level is -20dBm0 in accordance with FCC KDB 285076 D02

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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.

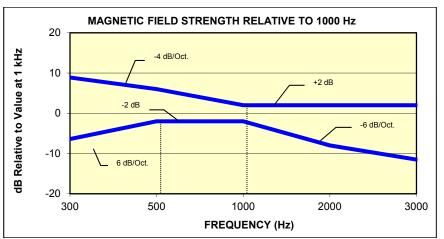


Figure 3-1
Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB(A/m) at 1 kHz

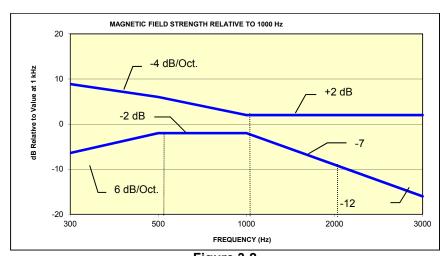


Figure 3-2
Magnetic Field frequency response for wireless devices with an axial field that exceeds
-15 dB(A/m) at 1 kHz

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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.

Category	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:

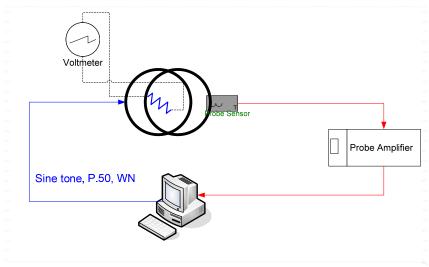


Figure 4-1
Validation Setup with Helmholtz Coil

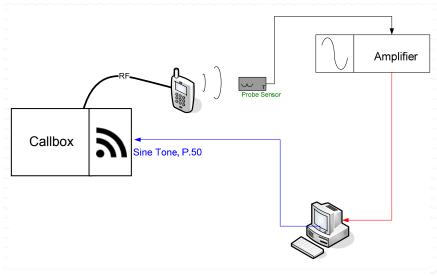


Figure 4-2 T-Coil Test Setup

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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)

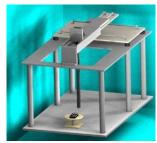


Figure 4-3 RF Near-Field Scanner

III. ITU-T P.50 Artificial Voice

Manufacturer: ITU-T

Active Frequency 100 Hz – 8 kHz

Range:

Stimulus Type: Male and Female, no spaces

Single Sample 20.96 seconds

Duration:

Activity Level: 100%

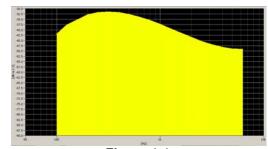


Figure 4-4
Spectral Characteristic of full P.50

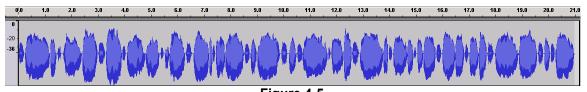


Figure 4-5
Temporal Characteristic of full P.50

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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
 - 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 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.
 - ABM1 Validation
 The magnetic field at the center of the Helmh

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 $-10 \, dB(A/m)$. This was verified to be within $\pm 0.5 \, dB$ of the $-10 \, dB(A/m)$ value (see Page 36).

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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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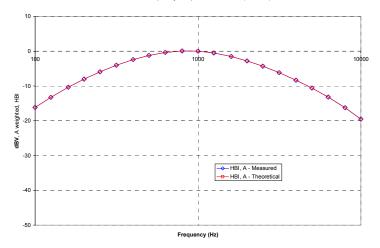
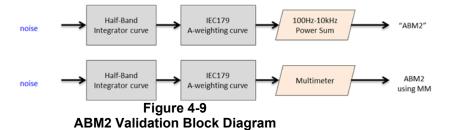


Figure 4-8 **ABM2 Frequency Response Validation**

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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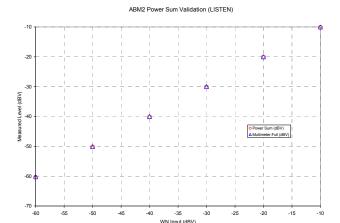


Figure 4-10
ABM2 Power Sum Validation

- 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):

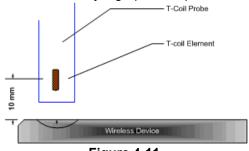


Figure 4-11 Measurement Distance

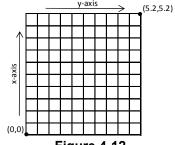


Figure 4-12 Measurement Grid

- 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.
- 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 TM	TDMA (22 and 11 Hz)	-18

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- ii. See Section 5 for more information regarding CMW500 audio level settings for Voice Over WIFI (VoWIFI) testing.
- iii. See Section 6 for more information regarding audio level settings for Over-The-Top (OTT) Voice Over IP (VoIP) Testing.

c. Real-Time Analyzer (RTA)

 The Real-Time Analyzer was configured to analyze measurements using 1/3 Octave band weighted filtering.

d. WD Radio Configuration Selection

i. The device was chosen to be tested in the worst-case ABM2 condition (see below for GSM, see Section 7 for more information regarding worst-case configurations for CDMA and UMTS. LTE configuration information can be found in Section 6. WIFI configuration information can be found in Section 5 and 6.):

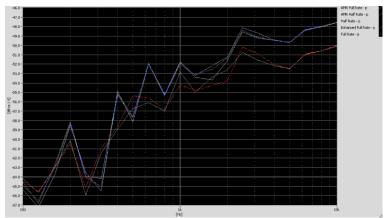


Figure 4-13 Vocoder Analysis for ABM Noise for GSM

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

- i. 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.
- 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.

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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

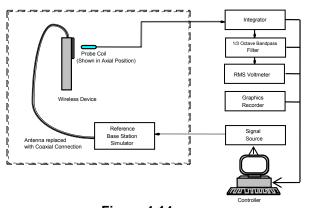


Figure 4-14
Audio Magnetic Field Test Setup

VI. Deviation from C63.19 Test Procedure

Non-conducted RF connection due to inaccessibility of RF ports with battery installed.

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. 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.

> Table 4-3 Center Channels and Frequencies

Center Gridiniers und Frequencies				
Test frequencies & associated channels				
Frequency (MHz)				
20				
820.10				
Cellular 850				
836.52				
836.60				
836.60				
1730.40				
PCS 1900				
1880				
1880				
1880				

2. 4G (LTE) Modes

The middle channel and supported bandwidths from the worst-case bands according to Tables 6-7 and 6-8 were evaluated with OTT VoIP for each probe orientation. The bandwidth from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels for that bandwidth. Low-mid and mid-high channels are additionally tested for LTE TDD. See Tables 8-12 and 8-13 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 8-5 to 8-8 and 8-14 to 8-17 for WIFI standards and channels.

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IX. Test Flow

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

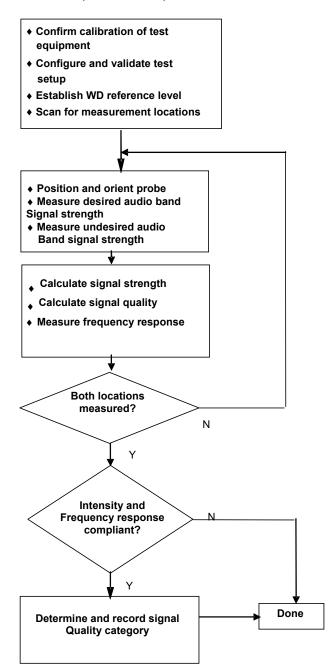


Figure 4-15 C63.19 T-Coil Signal Test Process

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5. VOWIFI TEST SYSTEM SETUP AND DUT CONFIGURATION

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.

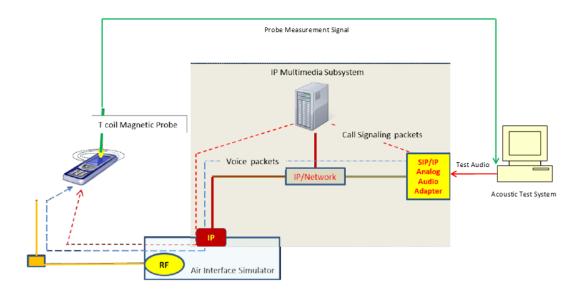


Figure 5-1
Test Setup for VoWIFI over IMS T-Coil Measurements

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 5-1 802.11b 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	1.55	-27.50	29.05
802.11b	6	DSSS	2	1.82	-27.55	29.37
802.11b	6	CCK	5.5	1.92	-27.31	29.23
802.11b	6	CCK	11	1.86	-28.35	30.21

Table 5-2 802.11g/a SNNR by Radio Configuration

Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
802.11g	6	BPSK	6	1.79	-32.55	34.34
802.11g	6	BPSK	9	1.99	-33.71	35.70
802.11g	6	QPSK	12	1.84	-33.03	34.87
802.11g	6	QPSK	18	1.86	-34.43	36.29
802.11g	6	16-QAM	24	2.01	-33.89	35.90
802.11g	6	16-QAM	36	1.85	-34.24	36.09
802.11g	6	64-QAM	48	1.92	-36.59	38.51
802.11g	6	64-QAM	54	1.65	-35.08	36.73

Table 5-3 802.11n/ac 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	1.63	-30.26	31.89
802.11n	20	40	QPSK	13	1.65	-30.53	32.18
802.11n	20	40	QPSK	19.5	1.57	-32.71	34.28
802.11n	20	40	16-QAM	26	1.60	-32.96	34.56
802.11n	20	40	16-QAM	39	1.60	-32.51	34.11
802.11n	20	40	64-QAM	52	1.38	-31.94	33.32
802.11n	20	40	64-QAM	58.5	1.63	-32.73	34.36
802.11n	20	40	64-QAM	65	1.66	-33.15	34.81
802.11ac	20	40	256-QAM	78	1.67	-32.31	33.98

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Table 5-4 802.11n/ac 40MHz BW SNNR by Radio Configuration

	002:1 111/40 40MH 2 BW ONNIX BY Radio 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	1.67	-33.33	35.00			
802.11n	40	38	QPSK	27	1.48	-32.79	34.27			
802.11n	40	38	QPSK	40.5	1.46	-34.51	35.97			
802.11n	40	38	16-QAM	54	1.48	-34.12	35.60			
802.11n	40	38	16-QAM	81	1.63	-34.29	35.92			
802.11n	40	38	64-QAM	108	1.63	-33.06	34.69			
802.11n	40	38	64-QAM	121.5	1.26	-34.06	35.32			
802.11n	40	38	64-QAM	135	1.63	-34.13	35.76			
802.11ac	40	38	256-QAM	162	1.59	-34.09	35.68			
802.11ac	40	38	256-QAM	180	1.61	-32.72	34.33			

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 5-5
AMR Codec Investigation – VoWIFI over IMS

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)	2.93	1.53	11.16	11.15				
ABM2 (dBA/m)	-27.19	-26.62	-27.60	-27.24	Avial	2.40	4GHz IEEE 802.11b	6
Frequency Response	Pass	Pass	Pass	Pass	Axial	AXIAI 2.4GFI2		
S+N/N (dB)	30.12	28.15	38.76	38.39				

Mute on; Backlight off; Max Volume; Max Contrast

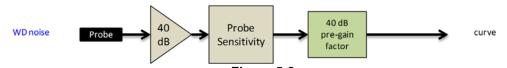


Figure 5-2
Audio Band Magnetic Curve Measurement Block Diagram

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6. OTT VOIP TEST SYSTEM AND DUT CONFIGURATION

I. Test System Setup for OTT VolP 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.

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 VolP 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 6-1 Codec Investigation - OTT VolP (EvDO)

Oddec investigation – OTT voil (Evbo)						
Codec Setting:	64kbps	6kbps	Orientation	Channel		
ABM1 (dBA/m)	14.04	13.00				
ABM2 (dBA/m)	-33.21	-32.67	Axial	600		
Frequency Response	Pass	Pass	Axiai			
S+N/N (dB)	47.25	45.67				

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 6-2
Codec Investigation – OTT VoIP (EDGE)

Codec Setting:	64kbps	6kbps	Orientation	Channel		
ABM1 (dBA/m)	13.92	12.79				
ABM2 (dBA/m)	-28.56	-28.56	Axial	661		
Frequency Response	Pass	Pass	Axiai			
S+N/N (dB)	42.48	41.35				

Table 6-3
Codec Investigation – OTT VoIP (HSPA)

	'			
Codec Setting:	64kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	13.77	13.24		
ABM2 (dBA/m)	-33.71	-33.93	Avial	9400
Frequency Response	Pass	Pass	- Axial	
S+N/N (dB)	47.48	47.17		

Table 6-4
Codec Investigation – OTT VoIP (LTE)

	0400 111100	<u> </u>	<u> </u>		
Codec Setting:	64kbps	6kbps	Orientation	Band / BW	Channel
ABM1 (dBA/m)	12.26	12.55			
ABM2 (dBA/m)	-29.73	-26.58	Axial	Band 12	23095
Frequency Response	Pass	Pass	10MHz		25055
S+N/N (dB)	41.99	39.13			

Table 6-5
Codec Investigation – OTT VoIP (WIFI)

Codec investigation - OTT voir (WIFI)											
Codec Setting:	64kbps	6kbps	Orientation	Band	Standard	Channel					
ABM1 (dBA/m)	13.41	13.19			4GHz IEEE 802.11b						
ABM2 (dBA/m)	-23.16	-23.12	Axial	2 4GHz		6					
Frequency Response	Pass	Pass	AAIai	2.4GHz		Ü					
S+N/N (dB)	36.57	36.31									

- Mute on; Backlight off; Max Volume; Max Contrast
- Radio Configurations can be found in Section 8.II.F

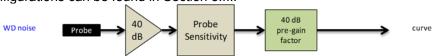


Figure 6-1
Audio Band Magnetic Curve Measurement Block Diagram

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2. Radio Configuration for OTT VoIP (LTE)

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 6-6
OTT VoIP (LTE) SNNR by Radio Configuration

Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
707.5	23095	10	QPSK	1	0	12.76	-33.86	46.62
707.5	23095	10	QPSK	1	25	12.41	-32.34	44.75
707.5	23095	10	QPSK	1	49	12.66	-33.48	46.14
707.5	23095	10	QPSK	25	0	12.54	-33.28	45.82
707.5	23095	10	QPSK	25	12	12.50	-32.65	45.15
707.5	23095	10	QPSK	25	25	12.65	-32.31	44.96
707.5	23095	10	QPSK	50	0	12.37	-34.59	46.96
707.5	23095	10	16QAM	1	0	12.54	-29.69	42.23
707.5	23095	10	16QAM	1	25	12.39	-31.43	43.82
707.5	23095	10	16QAM	1	49	12.32	-31.22	43.54
707.5	23095	10	16QAM	25	0	12.39	-33.07	45.46
707.5	23095	10	16QAM	25	12	12.21	-33.60	45.81
707.5	23095	10	16QAM	25	25	12.59	-32.64	45.23
707.5	23095	10	16QAM	50	0	12.23	-32.52	44.75

An investigation was performed to determine the worst-case LTE FDD and LTE TDD band and mode to be used for OTT VoIP testing. LTE FDD Band 12 and LTE TDD Band 41 (Power Class 2) were used for the testing as the worst-case configurations for the handset. See below tables for SNNR comparison between different LTE bands:

Table 6-7
OTT VoIP (LTE) SNNR by LTE FDD Band

	orr von (212) orrittoj 2121 bb bana											
Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]			
4	1732.5	20175	20	16QAM	1	0	12.66	-29.77	42.43			
12	707.5	23095	10	16QAM	1	0	12.41	-29.71	42.12			
13	782.0	23230	10	16QAM	1	0	12.55	-31.13	43.68			
25	1882.5	26365	20	16QAM	1	0	12.36	-30.95	43.31			
26	831.5	26865	15	16QAM	1	0	12.04	-30.47	42.51			

Table 6-8
OTT VoIP (LTE) SNNR by LTE TDD Band

Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
41 PC2	2593.0	40620	20	16QAM	1	0	12.59	-21.29	33.88
41 PC3	2593.0	40620	20	16QAM	1	0	12.63	-22.47	35.10

Note: UL-DL Configuration 6 was used for Power Class 3 and UL-DL Configuration 1 was used for Power Class 2 testing. See Tables 6-10 and 6-11 for more information about the chosen UL-DL configurations.

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3. LTE TDD Uplink-Downlink Configuration Investigation for OTT VoIP

An investigation was performed to determine the worst-case Uplink-Downlink configuration for OTT VoIP T-Coil testing.

Per 3GPP TS 36.211, the total frame length for each TDD radio frame of length $T_f = 307200 \cdot T_s$ = 10 ms, where T_s is a number of time units equal to 1/(15000 x 2048) seconds. Additionally, each radio frame consists of 10 subframes, each of length $30720 \cdot T_s = 1$ ms, and subframes can be designated as uplink (U), downlink (D), or special subframe (S), depending on the Uplink-Downlink configuration as indicated in Table 4.2-2 of 3GPP TS 36.211. In the transmission duty factor calculation, the special subframe configuration with the shortest UpPTS duration within the special subframe is used and will be applied for measurement. From 3GPP TS 36.211 Table 4.2-1, the shortest UpPTS is 2192 · Ts which occurs in the normal cyclic prefix and special subframe configuration 4.

See table below outlining the calculated transmission duty cycles for each Uplink-Downlink configuration:

> Table 6-9 **Uplink-Downlink Configurations for Type 2 Frame Structures**

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity		Subframe number									Calculated Transmission
comiguration	Switch-point periodicity	0	1	2	3	4	5	6	7	8	9	Duty Cycle (%)
0	5 ms	D	S	U	U	U	D	S	U	U	U	61.4%
1	5 ms	D	S	U	U	D	D	S	٦	٦	D	41.4%
2	5 ms	D	S	U	D	D	D	S	٦	D	D	21.4%
3	10 ms	D	S	U	U	U	D	D	D	D	D	30.7%
4	10 ms	D	S	U	U	D	D	D	D	D	D	20.7%
5	10 ms	D	S	U	D	D	D	D	D	D	D	10.7%
6	5 ms	D	S	U	U	U	D	S	U	U	D	51.4%

a. Power Class 3 Uplink-Downlink Configuration Investigation

LTE TDD was evaluated with the following radio configuration: channel 40620, 20MHz BW, 16QAM, 1RB, 0RB Offset. For Power Class 3, all configurations (0-6) are supported. The configuration which resulted in the worst SNNR was used for full testing. Uplink-Downlink configuration 6 was used as the worst-case configuration for Power Class 3 OTT VoIP T-Coil testing. See table below for the SNNR comparison between each Uplink-Downlink configuration:

> **Table 6-10** Power Class 3 OTT VolP SNNR by UL-DL Configuration

	1 on or elace of the ton elant by of be configuration										
Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	UL-DL Configuration	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]		
2593.0	40620	20	16QAM	1	0	0	12.47	-23.87	36.34		
2593.0	40620	20	16QAM	1	0	1	12.36	-23.67	36.03		
2593.0	40620	20	16QAM	1	0	2	12.27	-23.71	35.98		
2593.0	40620	20	16QAM	1	0	3	12.81	-25.90	38.71		
2593.0	40620	20	16QAM	1	0	4	12.85	-26.04	38.89		
2593.0	40620	20	16QAM	1	0	5	12.77	-26.33	39.10		
2593.0	40620	20	16QAM	1	0	6	12.47	-22.64	35.11		

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b. Power Class 2 Uplink-Downlink Configuration Investigation

Power Class 2 was evaluated with the following radio configuration: channel 40620, 20MHz BW, 16QAM, 1RB, 0RB Offset. For Power Class 2, configurations 1-5 are supported. The configuration which resulted in the worst SNNR was used for full testing. Uplink-Downlink configuration 1 was used as the worst-case configuration for Power Class OTT VoIP T-Coil testing. See table below for the SNNR comparison between each Uplink-Downlink configuration:

Table 6-11
Power Class 2 OTT VoIP SNNR by UL-DL Configuration

	1 on or oraco z o re von oracit by o z b z o o migaration										
Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	UL-DL Configuration	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]		
2593.0	40620	20	16QAM	1	0	1	12.67	-20.98	33.65		
2593.0	40620	20	16QAM	1	0	2	12.72	-21.08	33.80		
2593.0	40620	20	16QAM	1	0	3	12.56	-23.79	36.35		
2593.0	40620	20	16QAM	1	0	4	12.53	-24.10	36.63		
2593.0	40620	20	16QAM	1	0	5	12.70	-23.87	36.57		

Note: LTE TDD B41 Power Class 2 only supports UL-DL configurations 1-5, not 0 or 6.

c. Conclusion

Per the investigations above, UL-DL Configuration 6 was used to evaluate Power Class 3 OTT VoIP and UL-DL Configuration 1 was used to evaluate Power Class 2 OTT VoIP.

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7. FCC 3G MEASUREMENTS

I. CDMA Test Configurations

Radio Configuration 1, Service Option 3 (thick, green data curve) was used for the testing as the worst-case configuration for the handset due to vocoder gating from the EVRC logic. See below plot for ABM noise comparison between operational field service options and radio configurations for a CDMA2000 handset:

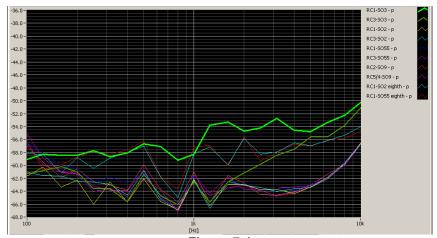
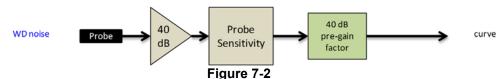


Figure 7-1
CDMA Audio Band Magnetic Noise

Table 7-1 FCC 3G ABM Measurements for ZNFX410PM (CDMA)

Configuration:	RC1/SO3	RC3/SO3	RC4/SO3	Orientation	Channel	
ABM1 (dBA/m)	10.61	10.36	10.36 11.00			
ABM2 (dBA/m)	-28.98	-35.88	-35.32	Axial	600	
Frequency Response	Pass	Pass			600	
S+N/N (dB)	39.59	46.24	46.32			

- Mute on; Backlight off; Max Volume; Max Contrast
- Power Control Bits = "All Up"



Audio Band Magnetic Curve Measurement Block Diagram

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II. 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:

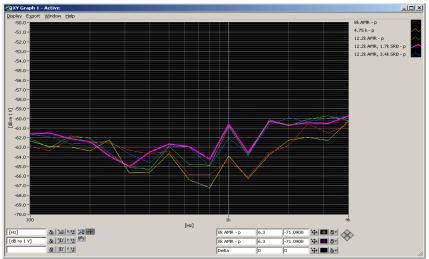
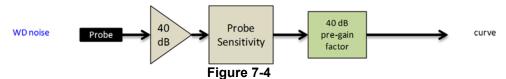


Figure 7-3
UMTS Audio Band Magnetic Noise

Table 7-2 Codec Investigation - UMTS

Codec Setting:	AMR 12.2kbps	AMR 7.95kbps	AMR 4.75kbps	Orientation	Channel	
ABM1 (dBA/m)	11.83	11.75	11.29			
ABM2 (dBA/m)	-39.85	-41.44	-41.04	Axial	9400	
Frequency Response	Pass	Pass	Pass	Axiai	3400	
S+N/N (dB)	51.68	53.19	52.33			

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



Audio Band Magnetic Curve Measurement Block Diagram

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8. T-COIL TEST SUMMARY

Table 8-1 Consolidated Tabled Results

_			COHSON	uateu 1	abled Re	Suits			
		-	esponse rgin	•	netic / Verdict		SNNR dict	Margin from FCC Limit	C63.19-2011
C63 10	9 Section	8.3	3.2	8.3	3.1	8.3	3.4	(dB)	Rating
C03. 18	3 Section	Axial	Radial	Axial	Radial	Axial	Radial		
	Secondary Cellular	PASS	NA	PASS	PASS	PASS	PASS		
CDMA	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-16.51	T4
	PCS	PASS	NA	PASS	PASS	PASS	PASS		
	Secondary Cellular	PASS	NA	PASS	PASS	PASS	PASS		
EvDO (OTT VoIP)	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-23.20	T4
(222.2011)	PCS	PASS	NA	PASS	PASS	PASS	PASS		
GSM	Cellular	PASS	NA	PASS	PASS	PASS	PASS	7 70	To
GSIVI	PCS	PASS	NA	PASS	PASS	PASS	PASS	-7.70	Т3
EDGE	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-10.43	T4
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-10.43	14
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
UMTS	AWS	PASS	NA	PASS	PASS	PASS	PASS	-26.43	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	-24.99	T4
	PCS	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD (OTT VoIP)	B12	PASS	NA	PASS	PASS	PASS	PASS	-16.55	T4
LTE TDD (OTT VoIP)	B41	PASS	NA	PASS	PASS	PASS	PASS	-11.55	T4
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN	802.11g	PASS	NA	PASS	PASS	PASS	PASS	-8.58	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	-15.39	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	-10.25	T4
	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		
11 500	802.11a	PASS	NA	PASS	PASS	PASS	PASS		
U-NII (OTT VoIP)	802.11n	PASS	NA	PASS	PASS	PASS	PASS	-21.20	T4
, ,	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		

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I. **Raw Handset Data**

Table 8-2 **Raw Data Results for CDMA**

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		
		476	11.05	-28.14		1.81	39.19	20.00	-19.19	T4			
	Axial	564	10.58	-28.20	-64.14	1.86	38.78	20.00	-18.78	T4	2.6, 3.4		
Secondary		684	10.39	-29.84		1.86	40.23	20.00	-20.23	T4			
Cellular		476	3.75	-34.18			37.93	20.00	-17.93	T4			
	Radial	564	3.91	-34.17	-64.69	N/A	38.08	20.00	-18.08	T4	2.6, 4.4		
		684	3.59	-34.88			38.47	20.00	-18.47	T4			
		1013	10.61	-29.71		1.78	40.32	20.00	-20.32	T4			
Cellular —	Axial	384	10.97	-28.88	-64.14	1.78	39.85	20.00	-19.85	T4	2.6, 3.4		
		777	10.96	-27.63		1.86	38.59	20.00	-18.59	T4			
Celiulai		1013	3.69	-35.71			39.40	20.00	-19.40	T4			
	Radial	384	3.67	-34.86	-64.69	-64.69	-64.69	N/A	38.53	20.00	-18.53	T4	2.6, 4.4
		777	3.93	-33.76			37.69	20.00	-17.69	T4			
		25	10.64	-27.50		1.83	38.14	20.00	-18.14	T4			
	Axial	600	10.74	-28.76	-64.14	1.83	39.50	20.00	-19.50	T4	2.6, 3.4		
PCS		1175	11.19	-28.98		1.85	40.17	20.00	-20.17	T4			
FCS		25	3.34	-33.17			36.51	20.00	-16.51	T4			
	Radial	600	3.84	-33.98	-64.69	3.98 -64.69 N/A 37	37.82	20.00	-17.82	T4	2.6, 4.4		
		1175	3.21	-34.35			37.56	20.00	-17.56	T4			

Table 8-3 **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	13.60	-23.15		0.90	36.75	20.00	-16.75	T4	
	Axial	190	13.65	-22.43	-64.14	1.51	36.08	20.00	-16.08	T4	2.6, 3.4
GSM850		251	14.02	-23.13		1.15	37.15	20.00	-17.15	T4	
GSIVIOSU		128	5.89	-22.47			28.36	20.00	-8.36	Т3	
Radial	Radial	190	5.93	-21.77	-64.49	N/A	27.70	20.00	-7.70	Т3	2.6, 4.4
		251	5.53	-22.19			27.72	20.00	-7.72	Т3	
		512	13.65	-26.09		1.16	39.74	20.00	-19.74	T4	
	Axial	661	13.89	-25.93	-64.14	1.09	39.82	20.00	-19.82	T4	2.6, 3.4
CSM1000		810	13.79	-27.53		1.59	41.32	20.00	-21.32	T4	
GSM1900	512	5.89	-25.70			31.59	20.00	-11.59	T4		
	Radial	661	5.94	-25.87	-64.49	N/A	31.81	20.00	-11.81	T4	2.6, 4.4
		810	5.74	-27.17			32.91	20.00	-12.91	T4	

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Table 8-4
Raw Data Results for UMTS

Naw Data Nesults for OWITS												
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	11.36	-41.58		1.25	52.94	20.00	-32.94	T4		
	Axial	4183	11.48	-41.55	-64.14	1.28	53.03	20.00	-33.03	T4 2.6, 3.	2.6, 3.4	
UMTS V		4233	11.41	-41.43		0.94	52.84	20.00	-32.84	T4		
UNITSV		4132	3.72	-44.04			47.76	20.00	-27.76	T4		
	Radial	4183	3.67	-44.02	-64.49	N/A	47.69	20.00	-27.69	T4	2.6, 4.4	
		4233	3.68	-43.96			47.64	20.00	-27.64	T4		
		1312	11.48	-41.43		1.32	52.91	20.00	-32.91	T4		
	Axial	1412	11.51	-41.29	-64.14	1.29	52.80	20.00	-32.80	T4	2.6, 3.4	
UMTS IV		1513	11.46	-41.27		0.93	52.73	20.00	-32.73	T4		
OWITSTV		1312	3.65	-44.09			47.74	20.00	-27.74	T4		
	Radial	1412	3.68	-43.88	-64.49	N/A	47.56	20.00	-27.56	T4	2.6, 4.4	
		1513	3.68	-42.75			46.43	20.00	-26.43	T4		
		9262	11.53	-41.18		0.88	52.71	20.00	-32.71	T4		
	Axial	9400	11.50	-40.66	-64.14	1.12	52.16	20.00	-32.16	T4	2.6, 3.4	
UMTS II		9538	11.46	-41.21		1.11	52.67	20.00	-32.67	T4		
OWISI		9262	3.61	-43.64			47.25	20.00	-27.25	T4		
		9400	3.67	-43.62	-64.49	N/A	47.29	20.00	-27.29	T4	2.6, 4.4	
		9538	3.69	-43.37			47.06	20.00	-27.06	T4		

Table 8-5
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	1.29	-28.73		2.00	30.02	20.00	-10.02	T4	
	Axial	6	1.52	-27.94	-64.36	2.00	29.46	20.00	-9.46	Т3	2.6, 3.4
WLAN		11	1.27	-27.31		2.00	28.58	20.00	-8.58	Т3	
802.11b		1	-7.30	-38.83			31.53	20.00	-11.53	T4	
	Radial	6	-7.37	-36.65	-64.69	N/A	N/A 29.28	20.00	-9.28	Т3	2.6, 4.4
		11	-6.93	-39.05			32.12	20.00	-12.12	T4	1
WLAN	Axial	6	1.35	-32.33	-64.36	2.00	33.68	20.00	-13.68	T4	2.6, 3.4
802.11g	Radial	6	-7.18	-40.50	-64.69	N/A	33.32	20.00	-13.32	T4	2.6, 4.4
WLAN	Axial	6	1.59	-31.16	-64.36	2.00	32.75	20.00	-12.75	T4	2.6, 3.4
802.11n	Radial	6	-7.22	-40.28	-64.69	N/A	33.06	20.00	-13.06	T4	2.6, 4.4

Table 8-6 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	40	1.61	-29.72		2.00	31.33	20.00	-11.33	T4	
		20MHz	2A	56	1.53	-29.76		2.00	31.29	20.00	-11.29	T4	
	Axial	20MHz	2C	120	1.34	-32.49	-64.36	2.00	33.83	20.00	-13.83	T4	T4 2.6, 3.4 T4 T4
	Axiai	20MHz	3	149	1.50	-29.52	-29.52 -28.88 -29.67	2.00	31.02	20.00	-11.02	T4	
		20MHz	3	157	1.37	-28.88		2.00	30.25	20.00	-10.25	T4	
		20MHz	3	165	1.60	-29.67		2.00	31.27	20.00	-11.27	T4	
802.11a													
		20MHz	1	40	-7.10	-41.44			34.34	20.00	-14.34	T4	
		20MHz	2A	52	-7.07	-39.84			32.77	20.00	-12.77	T4	
	Radial	20MHz	2A	56	-7.42	-39.80	-64.69	N/A	32.38	20.00	-12.38	T4	2.6, 4.4
	Raulai	20MHz	2A	64	-7.40	-40.71	-04.09	IN/A	33.31	20.00	-13.31	T4	2.0, 4.4
		20MHz	2C	120	-7.32	-41.25	7		33.93	20.00	-13.93	T4	
		20MHz	3	157	-7.30	-40.97			33.67	20.00	-13.67	T4	

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Table 8-7 Raw Data Results for 5GHz WIFI 802.11n

	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	Test Coordinates
I		Axial	40MHz	1	38	1.47	-32.44	-64.36	2.00	33.91	20.00	-13.91	T4	2.6, 3.4
		Axidi	20MHz	1	40	1.57	-31.01	-04.50	2.00	32.58	20.00	-12.58	T4	2.0, 5.4
	802.11n	n												
		Padial	40MHz	1	38	-7.10	-43.09	-64.69	N/A	35.99	20.00	-15.99	T4	2.6, 4.4
	Radial	20MHz	1	40	-7.05	-42.27	-04.09	INA	35.22	20.00	-15.22	T4	2.0, 4.4	

Table 8-8 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)	C63.19-2011 Rating	Test Coordinates
	Axial	40MHz	1	38	1.33	-31.43	-64.36	2.00	32.76	20.00	-12.76	T4	2.6, 3.4
	Axidi	20MHz	1	40	1.37	-31.99	-04.50	2.00	33.36	20.00	-13.36	T4	2.0, 5.4
802.11ac													
	Radial	40MHz	1	38	-6.84	-42.66	-64.69	N/A	35.82	20.00	-15.82	T4	2.6, 4.4
	Naulai	20MHz	1	40	-7.25	-43.57	-04.09	IWA	36.32	20.00	-16.32	T4	2.0, 4.4

Table 8-9 Raw Data Results for EvDO (OTT VoIP)

			itar	Data IX	esuits ioi		O 1 1 VOII	,			
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
Secondary Cellular	Axial	564	12.95	-33.21	-64.36	1.78	46.16	20.00	-26.16	T4	2.6, 3.4
EvDO	Radial	564	5.49	-39.86	-64.69	N/A	45.35	20.00	-25.35	T4	2.6, 4.4
Cellular	Axial	384	13.29	-32.11	-64.36	1.70	45.40	20.00	-25.40	T4	2.6, 3.4
EvDO	Radial	384	5.32	-39.46	-64.69	N/A	44.78	20.00	-24.78	T4	2.6, 4.4
PCS	Axial	600	13.59	-32.26	-64.36	1.65	45.85	20.00	-25.85	T4	2.6, 3.4
EvDO	Radial	600	5.17	-38.03	-64.69	N/A	43.20	20.00	-23.20	T4	2.6, 4.4

Table 8-10 Raw Data Results for EDGE (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
EDGE850	Axial	190	13.11	-24.29	-64.36	1.72	37.40	20.00	-17.40	T4	2.6, 3.4
EDGE050	Radial	190	5.45	-24.98	-64.69	N/A	30.43	20.00	-10.43	T4	2.6, 4.4
EDGE1900	Axial	661	12.89	-28.39	-64.36	1.73	41.28	20.00	-21.28	T4	2.6, 3.4
EDGE 1900	Radial	661	5.17	-26.95	-64.69	N/A	32.12	20.00	-12.12	T4	2.6, 4.4

Table 8-11 Raw Data Results for HSPA (OTT VoIP)

			Itan	Data IN	souits ioi	1101 - 10	J 1 1 V O 11	,			
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	13.72	-34.15	-64.36	1.73	47.87	20.00	-27.87	T4	2.6, 3.4
пога у	Radial	4183	5.33	-39.66	-64.69	N/A	44.99	20.00	-24.99	T4	2.6, 4.4
HSPA IV	Axial	1412	13.72	-34.03	-64.36	1.71	47.75	20.00	-27.75	T4	2.6, 3.4
погату	Radial	1412	5.69	-39.31	-64.69	N/A	45.00	20.00	-25.00	T4	2.6, 4.4
HSPA II	Axial	9400	13.43	-34.56	-64.36	1.59	47.99	20.00	-27.99	T4	2.6, 3.4
HOPAII	Radial	9400	5.11	-39.90	-64.69	N/A	45.01	20.00	-25.01	T4	2.6, 4.4

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Table 8-12 Raw Data Results for LTE B12 (OTT VoIP)

				<u>– ata</u>	. 100 a.to	IOI LIL	<u> </u>	 ,							
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	23130	12.48	-31.27		1.56	43.75	20.00	-23.75	T4				
		10MHz	23095	12.69	-30.92		1.78	43.61	20.00	-23.61	T4				
	Axial	10MHz	23060	12.37	-30.38	-64.14	1.79	42.75	20.00	-22.75	T4	2.6, 3.4			
	Axiai	5MHz	23095	12.40	-31.86	-04.14	1.34	44.26	20.00	-24.26	T4	2.0, 3.4			
		3MHz	23095	12.41	-31.63		1.79	44.04	20.00	-24.04	T4				
LTE Band		1.4MHz	23095	12.51	-31.40		1.61	43.91	20.00	-23.91	T4				
12		10MHz	23130	5.17	-32.39			37.56	20.00	-17.56	T4				
		10MHz	23095	5.13	-31.42			36.55	20.00	-16.55	T4				
	Radial	10MHz	23060	5.21	-32.06	-64.69	-64.69	-64.69	-64.69	N/A	37.27	20.00	-17.27	T4	2.6, 4.4
	Naulai	5MHz	23095	5.55	-31.68					IN/A	37.23	20.00	-17.23	T4	2.0, 4.4
		3MHz	23095	5.01	-32.28			37.29	20.00	-17.29	T4				
		1.4MHz	23095	5.25	-32.08			37.33	20.00	-17.33	T4				

Table 8-13 Raw Data Results for LTE B41 Power Class 2 (OTT VoIP)

		1/0	IW Data	iveanira		: D41 P0	Wei Clas	33 Z (O I	1 VOII)			
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
		20MHz	40620	12.48	-21.57		1.64	34.05	20.00	-14.05	T4	
		15MHz	40620	12.38	-21.78		1.77	34.16	20.00	-14.16	T4	
		10MHz	41490	12.30	-20.60		1.69	32.90	20.00	-12.90	T4	
	Axial	10MHz	41055	12.38	-21.81	-64.14	1.69	34.19	20.00	-14.19	T4	2.6, 3.4
	Axiai	10MHz	40620	12.32	-21.69	-04.14	1.67	34.01	20.00	-14.01	T4	2.0, 3.4
		10MHz	40185	12.34	-20.93		1.74	33.27	20.00	-13.27	T4	
		10MHz	39750	12.23	-19.71		1.75	31.94	20.00	-11.94	T4	
LTE Band		5MHz	40620	12.34	-22.20		1.76	34.54	20.00	-14.54	T4	
41		20MHz	41490	4.89	-27.18			32.07	20.00	-12.07	T4	
		20MHz	41055	4.82	-28.68			33.50	20.00	-13.50	T4	
		20MHz	40620	5.48	-27.87			33.35	20.00	-13.35	T4	
	Radial	20MHz	40185	5.14	-27.88	-64.69	N/A	33.02	20.00	-13.02	T4	2.6, 4.4
	Raulai	20MHz	39750	5.37	-26.18	-04.09	IN/A	31.55	20.00	-11.55	T4	2.0, 4.4
		15MHz	40620	5.54	-28.07			33.61	20.00	-13.61	T4	
		10MHz	40620	5.40	-28.46			33.86	20.00	-13.86	T4	
		5MHz	40620	5.08	-28.66			33.74	20.00	-13.74	T4	

Table 8-14 Raw Data Results for 2.4GHz WIFI (OTT VoIP)

	ADM4 ADM2 Ambient Noice Frequency SANIAN ECC Limit Margin from C62 49 2014 Test												
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	13.50	-25.15		1.58	38.65	20.00	-18.65	T4			
	Axial	6	13.21	-22.18	-64.36	1.80	35.39	20.00	-15.39	T4	2.6, 3.4		
WLAN		11	13.26	-24.50		1.10	37.76	20.00	-17.76	T4			
802.11b		1	4.84	-32.73			37.57	20.00	-17.57	T4			
	Radial	6	5.16	-32.49	-64.69	N/A	37.65	20.00	-17.65	T4	2.6, 4.4		
		11	4.93	-33.49			38.42	20.00	-18.42	T4			
WLAN	Axial	6	13.17	-28.66	-64.36	1.75	41.83	20.00	-21.83	T4	2.6, 3.4		
802.11g	Radial	6	4.83	-38.66	-64.69	N/A	43.49	20.00	-23.49	T4	2.6, 4.4		
WLAN	Axial	6	13.27	-28.50	-64.36	1.62	41.77	20.00	-21.77	T4	2.6, 3.4		
802.11n	Radial	6	4.90	-39.00	-64.69	N/A	43.90	20.00	-23.90	T4	2.6, 4.4		

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Table 8-15 Raw Data Results for 5GHz WIFI 802.11a (OTT VoIP)

				- Data I	Counts		12 **** 1 0	i u	, •	··· ,			
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	Test Coordinates
		20MHz	1	40	13.79	-27.96		1.71	41.75	20.00	-21.75	T4	
		20MHz	2A	56	13.12	-28.72		1.74	41.84	20.00	-21.84	T4	
	Axial	20MHz	2C	100	13.40	-28.50	-64.36	1.58	41.90	20.00	-21.90	T4	2.6, 3.4
	Axiai	20MHz	2C	120	12.93	-28.27	-04.30	1.63	41.20	20.00	-21.20	T4	2.0, 5.4
		20MHz	2C	144	13.44	-27.93		1.64	41.37	20.00	-21.37	T4	
		20MHz	3	157	13.36	-27.87		1.55	41.23	20.00	-21.23	T4	
802.11a													
		20MHz	1	36	4.53	-40.24			44.77	20.00	-24.77	T4	
	Radial	20MHz	1	40	4.84	-39.04			43.88	20.00	-23.88	T4	
		20MHz	1	48	5.28	-39.52	2 -64.69 N/A	N/Δ	44.80	20.00	-24.80	T4	2.6, 4.4
		20MHz	2A	56	4.71	-39.67		IWA	44.38	20.00	-24.38	T4	2.0, 4.4
		20MHz	2C	120	5.39	-38.80			44.19	20.00	-24.19	T4	
	-	20MHz	3	157	5.18	-39.45			44.63	20.00	-24.63	T4	

Table 8-16 Raw Data Results for 5GHz WIFI 802.11n (OTT VoIP)

				IVAV	Data N	Courto	01 001	12 **** 1 0	, o <u>c</u>	(O:: V	,, ,				
	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	Test Coordinates	
		Axial	40MHz	1	38	13.40	-29.03	-64.36	1.65	42.43	20.00	-22.43	T4	2.6. 3.4	
		Axiai	20MHz	1	40	13.65	-29.11		1.50	42.76	20.00	-22.76	T4	2.0, 3.4	
8	02.11n														
		Radial	40MHz	1	38	4.62	-40.04	-40.04 -64.69	64.60	N/A	44.66	20.00	-24.66	T4	2.6, 4.4
		Naulai	20MHz	1	40	5.12	-39.74	-04.09	INVA	44.86	20.00	-24.86	T4	2.0, 4.4	

Table 8-17 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	Test Coordinates	
	Axial	40MHz	1	38	13.32	-29.44	-64.36	1.77	42.76	20.00	-22.76	T4	2.6, 3.4	
	Axidi	20MHz	1	40	13.34	-30.28		1.85	43.62	20.00	-23.62	T4	2.0, 5.4	
802.11ac														
	Radial	40MHz	1	38	5.21	-40.40	-64.69	64.60	N/A	45.61	20.00	-25.61	T4	2.6, 4.4
		20MHz	1	40	5.08	-39.12	-04.09	N/A	44.20	20.00	-24.20	T4	2.0, 4.4	

II. Test Notes

A. General

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

B. CDMA

- 1. Power Configuration: Power Control Bits = "All Up"
- 2. Vocoder Configuration: RC1/SO3 (CDMA EVRC)

C. GSM

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

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D. UMTS

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

E. WIFI

- 1. Radio Configuration
 - a. 802.11b: DSSS, 1Mbps
 - b. 802.11g/a: BPSK, 6Mbps
 - c. 802.11n/ac 20MHz: BPSK, 6.5Mbps
 - d. 802.11n/ac 40MHz: QPSK, 27Mbps
- 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 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 (U-NII 3) is the worst-case for the Axial probe orientation. 802.11a (U-NII 2A) is the worst-case for the Radial probe orientation.

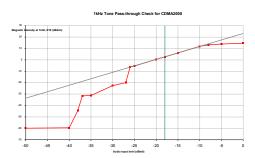
F. OTT VolP

- 1. Vocoder Configuration: 6kbps
- 2. EvDO Configuration
 - a. Revision: A
- 3. EDGE Configuration
 - a. MCS Index: 7
 - b. Number of TX slots: 2
- 4. HSPA Configuration:
 - a. Release: 6
 - b. 3GPP 34.121 Subtest 1
- 5. LTE FDD Configuration:
 - a. Power Configuration: TPC = "Max Power"
 - b. Radio Configuration: 16QAM, 1RB, 0RB offset
 - c. LTE Band 12 was the worst-case band from Table 6-7 and was used to test both Axial and Radial probe orientations.
 - d. 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 12 at 10MHz is the worst-case for both Axial and Radial probe orientations.
- 6. LTE TDD Configuration:
 - a. Power Configuration: TPC = "Max Power"
 - b. Radio Configuration: 16QAM, 1RB, 0RB offset
 - c. Power Class 2 Uplink-Downlink configuration: 1
 - d. LTE Band 41 (PC2) was the worst-case band from Table 6-8 and was used to test both Axial and Radial probe orientations.
 - e. The worst-case band and bandwidth combination for each probe orientation is additionally tested on the low, low-mid, high-mid, and high channels for those combinations. LTE Band 41 (Power Class 2) at 10MHz is the worst-case for the Axial probe orientation and LTE Band 41 (Power Class 2) at 20MHz is the Radial probe orientation.
- 7. WIFI Configuration:
 - a. Radio Configuration
 - i. 802.11b: DSSS, 1Mbps
 - ii. 802.11g/a: BPSK, 6Mbps
 - iii. 802.11n/ac 20MHz: BPSK, 6.5Mbps iv. 802.11n/ac 40MHz: QPSK, 27Mbps

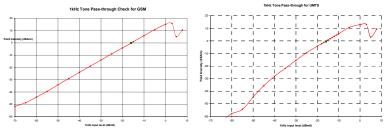
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- b. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. 802.11b is the worst-case for both Axial and Radial probe orientations.
- c. The worst-case standard for 5GHz WIFI in each probe orientation is additionally tested on higher U-NII bands as well as applicable low and high channels, 802,11a (U-NII 2C) is the worst-case for the Axial probe orientation. 802.11a (U-NII 1) is the worst-case for the Radial probe orientation.

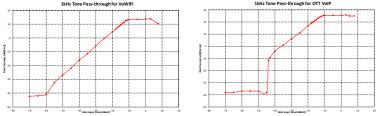
III. 1 kHz Vocoder Application Check



This model was verified to be within the linear region for ABM1 measurements at -18 dBm0 for CDMA. 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 -16 dBm0 for GSM and UMTS. 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.

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IV. T-Coil Validation Test Results

Table 8-18
Helmholtz Coil Validation Table of Results - 7/10/2018

Item	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.177	PASS
Environmental Noise	< -58 dBA/m	-64.14	PASS
Frequency Response, from limits	> 0 dB	0.60	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.319	PASS
Environmental Noise	< -58 dBA/m	-64.49	PASS
Frequency Response, from limits	> 0 dB	0.70	PASS

Table 8-19
Helmholtz Coil Validation Table of Results – 7/17/2018

Item	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.166	PASS
Environmental Noise	< -58 dBA/m	-64.36	PASS
Frequency Response, from limits	> 0 dB	0.60	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.273	PASS
Environmental Noise	< -58 dBA/m	-64.69	PASS
Frequency Response, from limits	> 0 dB	0.70	PASS

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V. ABM1 Magnetic Field Distribution Scan Overlays

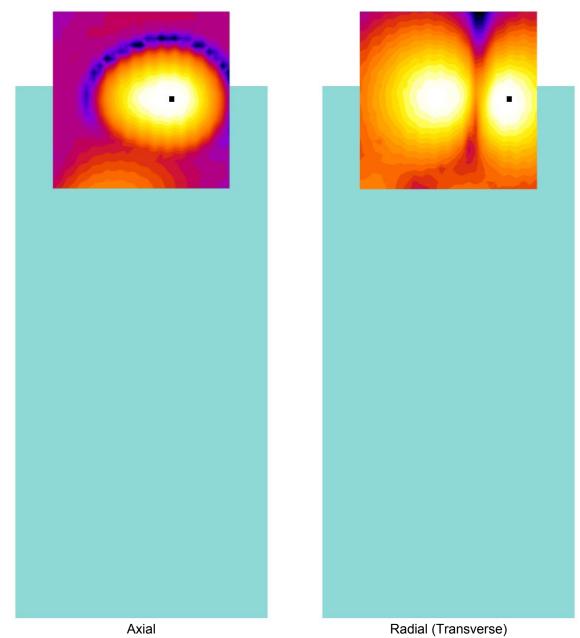


Figure 8-1
T-Coil Scan Overlay Magnetic Field Distributions

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 9.

Table 9-1 **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)							0.71
Expanded uncertainty (k=2), 95% confidence level							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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10. EQUIPMENT LIST

Table 10-1 Equipment List

Equipment List							
Manufacturer	Model	Description	Cal Date	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	7/24/2017	Annual	7/24/2018	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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11. TEST DATA

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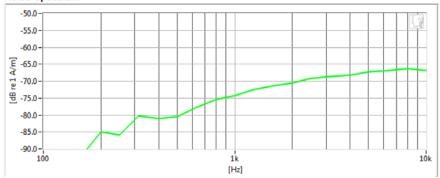
Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

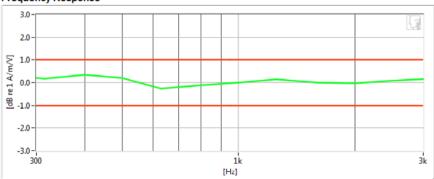
Equipment:

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

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-10.177 dB	\checkmark	Max/Min	-9.5/-10.5	
Verification ABM2	-64.14 dB	•	Maximum	-58.0	
Frequency Response Margin	600m dB	\checkmark	Tolerance curves	Aligned Data	

FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
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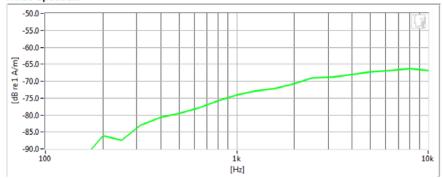
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Measurement Standard: ANSI C63.19-2011

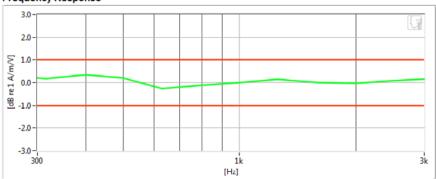
Equipment:

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

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-10.166 dB	\checkmark	Max/Min	-9.5/-10.5	
Verification ABM2	-64.36 dB	•	Maximum	-58.0	
Frequency Response Margin	600m dB	\checkmark	Tolerance curves	Aligned Data	

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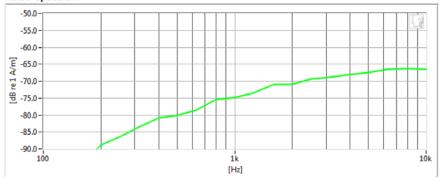
Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

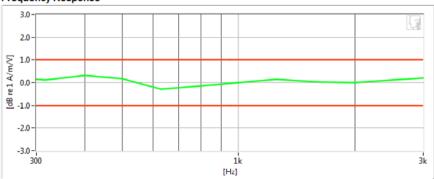
Equipment:

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

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-10.319 dB	\checkmark	Max/Min	-9.5/-10.5
Verification ABM2	-64.49 dB	\checkmark	Maximum	-58.0
Frequency Response Margin	700m dB	•	Tolerance curves	Aligned Data

FCC ID: ZNFX410PM	PCTEST	HAC (I-COIL) IEST REPORT		Approved by: Quality Manager
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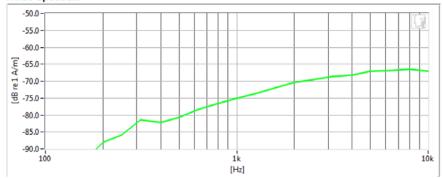
Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

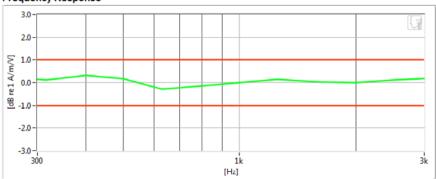
Equipment:

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

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-10.273 dB	\checkmark	Max/Min	-9.5/-10.5	
Verification ABM2	-64.69 dB	\checkmark	Maximum	-58.0	
Frequency Response Margin	700m dB	\checkmark	Tolerance curves	Aligned Data	

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Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

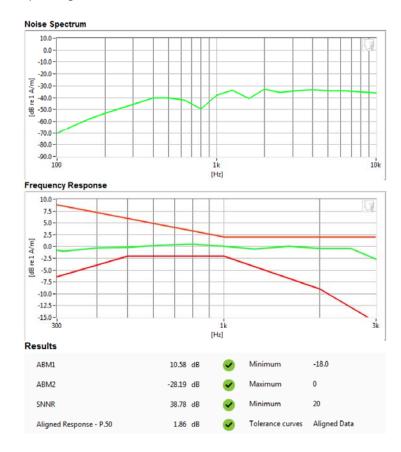
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: CDMA Sec. Cellular

Channel: 564

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



FCC ID: ZNFX410PM	PCTEST	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 45 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 43 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

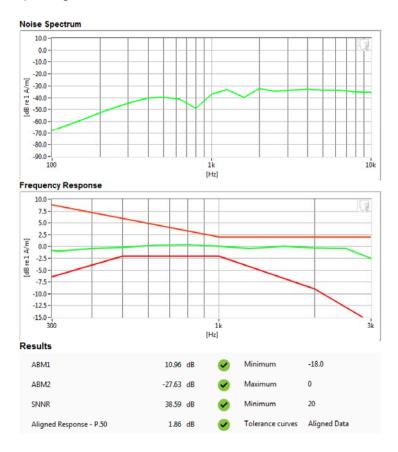
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: CDMA Cellular

Channel: 777

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



FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 46 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 40 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

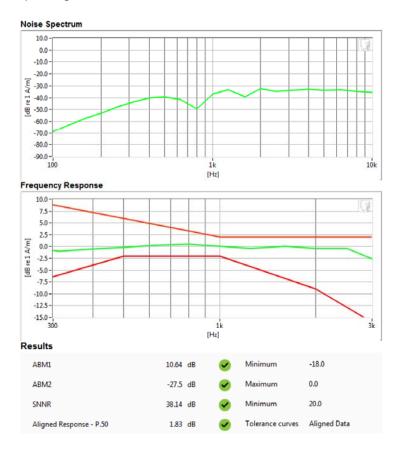
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: CDMA PCS

Channel: 25

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



FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 47 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 47 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

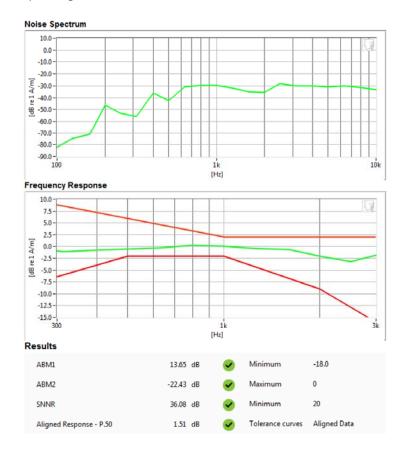
Equipment:

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

Test Configuration:

Mode: GSM850Channel: 190

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 48 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 46 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

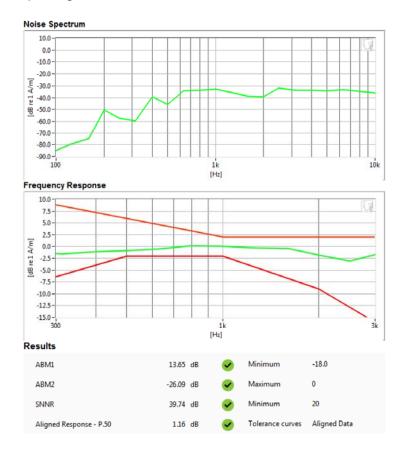
Equipment:

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

Test Configuration:

Mode: GSM1900Channel: 512

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



FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 49 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 49 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

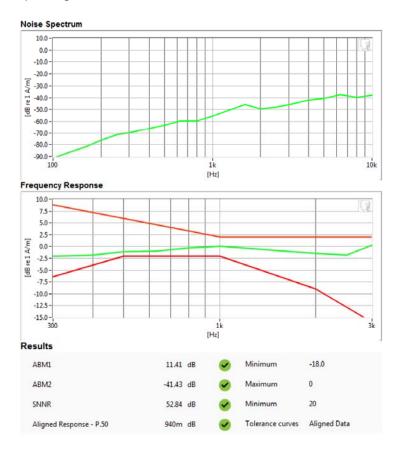
Equipment:

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

Test Configuration:

Mode: UMTS VChannel: 4233

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410PM	PCTEST	HAC (T-COIL) TEST REPORT	(t) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 50 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 50 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

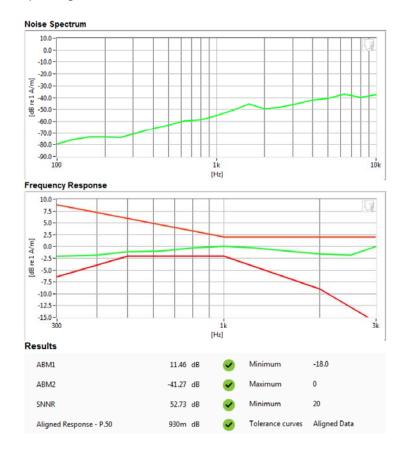
Equipment:

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

Test Configuration:

Mode: UMTS IVChannel: 1513

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 51 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 51 0179



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

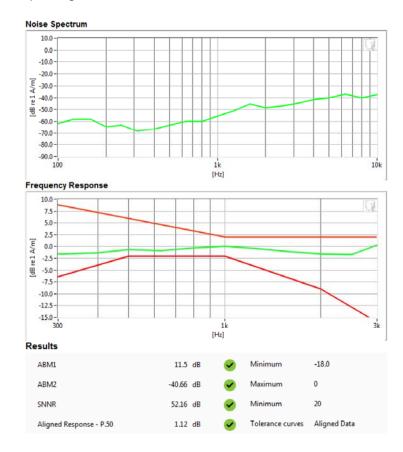
Equipment:

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

Test Configuration:

Mode: UMTS IIChannel: 9400

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



FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 52 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Faye 32 01 79



Type: Portable Handset Serial: 05154

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

Noise Spectrum 10.0 0.0 -10.0 -20.0 -20.0 --30.0 --40.0 --50.0 --60.0 -70.0 -80.0 -90.0 -[Hz] Frequency Response 10.0 7.5 5.0 2.5 [dB re 1 A/m] 0.0 -2.5 -7.5 -10.0 -12.5 -15.0 11 [Hz] Results ABM1 1.27 dB Minimum -18.0 ABM2 -27.31 dB SNNR 28.58 dB 20 Aligned Response - P.50 Tolerance curves Aligned Data 2 dB

FCC ID: ZNFX410PM	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 53 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 55 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

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

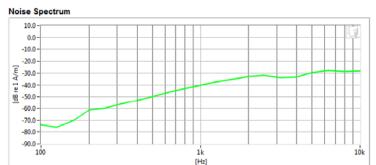
Test Configuration:

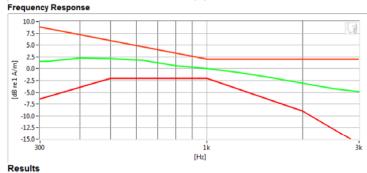
Mode: 5GHz WIFI

Standard: IEEE 802.11a (U-NII 3)

Bandwidth: 20MHzChannel: 157

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





ABM1	1.37	dB	•	Minimum	-18.0
ABM2	-28.88	dB	\checkmark	Maximum	0
SNNR	30.25	dB	\checkmark	Minimum	20
Aligned Response - P.50	2	dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 54 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 34 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

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

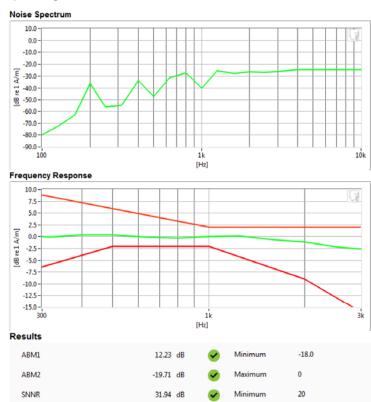
Test Configuration:

VolP Application: Google Duo
Mode: LTE TDD Band 41 (PC2)

Aligned Response - P.50

Bandwidth: 10MHzChannel: 39750

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



PCTEST 2018

FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 55 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Faye 33 01 79

1.75 dB

Aligned Data

Tolerance curves



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

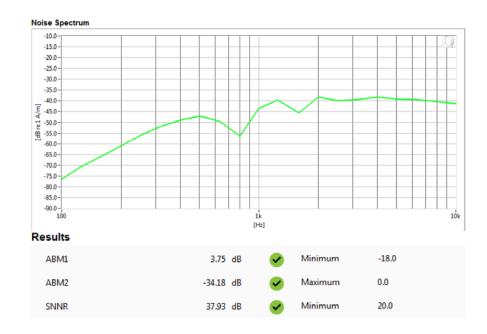
Equipment:

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

Test Configuration:

Mode: CDMA Sec. Cellular

· Channel: 476



FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 56 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 50 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

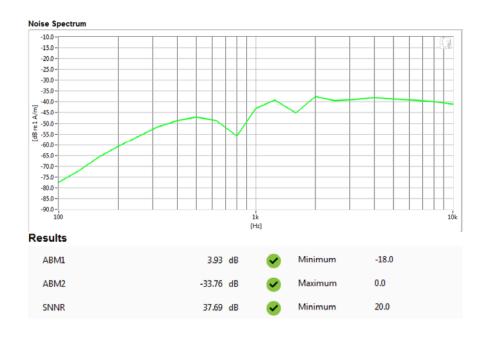
Equipment:

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

Test Configuration:

Mode: CDMA Cellular

Channel: 777



FCC ID: ZNFX410PM	PETEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 57 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 37 01 79



Type: Portable Handset Serial: 05154

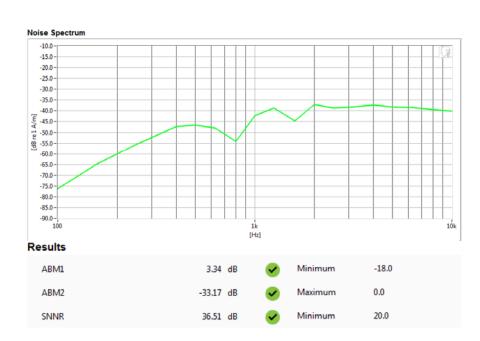
Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: CDMA PCSChannel: 25



FCC ID: ZNFX410PM	PCTEST	HAC (T-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 58 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 56 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: GSM850Channel: 190



FCC ID: ZNFX410PM	PCTEST	HAC (I-COIL) IEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 59 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 39 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: GSM1900Channel: 512



FCC ID: ZNFX410PM	PCTEST*	HAC (T-COIL) TEST REPORT	(t) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 60 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 00 01 79



Type: Portable Handset Serial: 05154

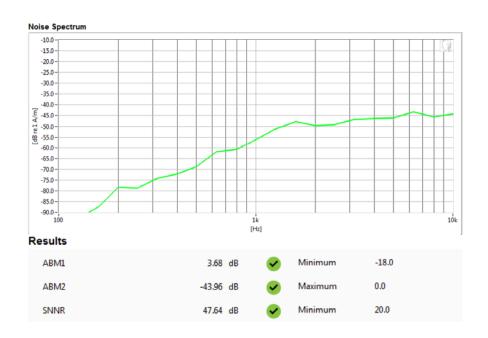
Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: UMTS VChannel: 4233



FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) 1EST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 61 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 010179



Type: Portable Handset Serial: 05154

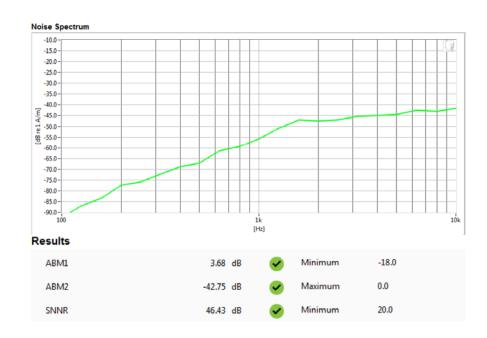
Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: UMTS IVChannel: 1513



FCC ID: ZNFX410PM	PETEST	HAC (I-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 62 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 02 01 79



Type: Portable Handset Serial: 05154

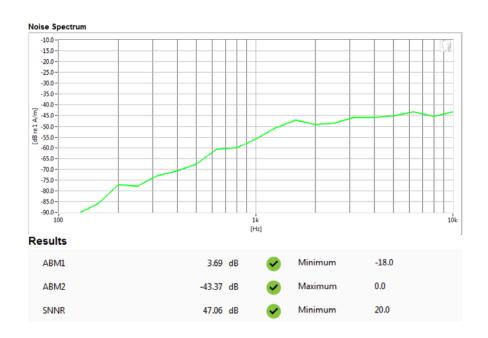
Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: UMTS IIChannel: 9538



FCC ID: ZNFX410PM	PETEST	HAC (I-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 63 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 03 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

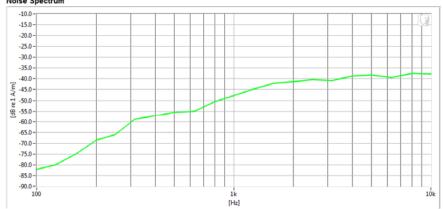
Probe: Radial T-Coil Probe – SN: TEM-1130; Calibrated: 12/07/2016

Test Configuration:

 Mode: 2.4GHz WIFI Standard: IEEE 802.11b

Channel: 6

Noise Spectrum



Results

ABM1	-7.37 dB	✓	Minimum	-18.0
ABM2	-36.65 dB	\checkmark	Maximum	0.0
SNNR	29.28 dB	✓	Minimum	20.0

FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 64 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 64 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

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

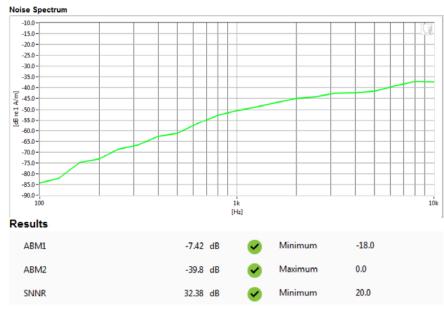
Test Configuration:

Mode: 5GHz WIFI

Standard: IEEE 802.11a (U-NII 2A)

Bandwidth: 20MHzChannel: 56

• Channel:



FCC ID: ZNFX410PM	PCTEST	MAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 65 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 65 01 79



Type: Portable Handset Serial: 05154

Measurement Standard: ANSI C63.19-2011

Equipment:

SNNR

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

Test Configuration:

VoIP Application: Google Duo

Mode: EDGE850Channel: 190



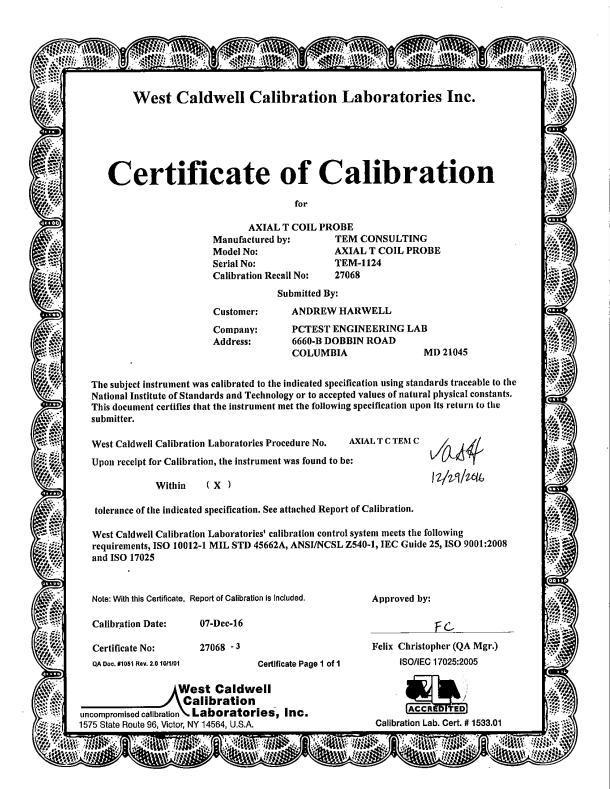
30.43 dB

Minimum

FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 66 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 00 01 79

12. CALIBRATION CERTIFICATES

FCC ID: ZNFX410PM	PCTEST	MAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 67 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Page 07 01 79



FCC ID: ZNFX410PM	PCTEST*	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 68 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		rage 66 01 79

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REV 3.2.M

HCATEMC TEM 1124 Dec-07-2016



ISO/IEC 17025: 2005

1575 State Route 96, Victor NY 14564

Calibration Lab. Cert. # 1533.01

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

Probe Sensitivity measured wit	h Helmhalt	z Call			
Helmholtz Coil;			Botoro & atte	r data same	: X
the number of turns on each coil;	10	No.			
the radius of each coil, in meters;	0.204	m	Laboratory Environ	ment:	
the current in the coils, in amperes.;	0.09	Α	Ambient Temperature:	20.2	°C
Helmholtz Coil Constant;	7.09	A/m/V	Ambient Humidity:	31.4	% RH
Helmholtz Coil magnetic field;	5.98	A/m	Ambient Pressure:	99.1	кP«
			Calibration Date:	7-D••-16	
Probe Sensitivity at	1000	Hz.			
Was	-60.23	a BV/A/m	Report Number:	27068	-3
	0.974	m V/A/m	Control Number:	27068	
Probe resistance	904	On m .			

Graph represents Probes Frequency Response

Axial Probe Response Measured Probe Resp. 20 15 10 Magnitude (dB) 5 0 -5 -10 -15 -20 10000 Freq. (Hz)

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: 7-Dec-2016 Felix Christopher Callbrated on WCCL system type 9700 Rev. 7.0 Jan. 24, 2014 Dec. # 1038 HCATEMC

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

Page 1 of 2

FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 69 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 09 01 79

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HCATEMC_TEM 1124_Dec-07-2016

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

Company: PCTEST Engineering Lab.

Test	Function	Tolera	Tolerance		Measured values		
				Before	Out	Remarks	
1.0	Probe Sensitivity at	1000 Hz.	d BV/A/m	-60.23			
2.0	Probe Level Linearity	Rof. (0 a B)	a B 6 0 -6 -12	6.03 0.00 -6.03 -12.05			
3.0	Probe Frequency Response	Ref. (0 a B)	H ₂ 100 126 158 200 251 316 398 501 631 794 1000 1259 1585 1995 2512 3162 3981 5012 6310 7943 10000	-19.8 -18.0 -16.0 -13.9 -12.0 -9.9 -8.0 -6.0 -4.0 -2.0 0.0 2.0 4.0 6.0 7.9 9.9 11.9 13.9 15.9 18.0 20.2			

Instruments used for calibrat	tion:		Date or Cal.	Traceability No.	Dua Data
HP	34401A	S/N 36064102	1-Oct-2016	,287708	1-Oct-2017
HP	34401A	S/N 36102471	1-Oet-2016	,287708	1-Oct-2017
HP	33120A	S/N 36043716	1-Oct-2016	.287708	1-Oct-2017
B&K	2133	S/N 1583254	1-Oet-2016	683/284413-14	1-Oat-2017

Cal. Date: 7-Dec-2016 Tested by: Fellx Christopher

Calibrated on WCCL system type 9700

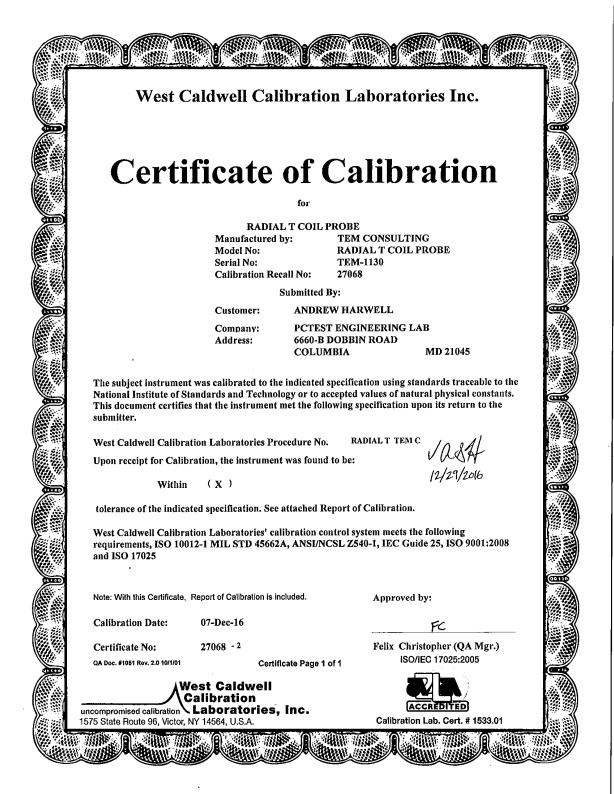
Rev. 7.0 Jan. 24, 2014 Dee. # 1038 HCATEMC

Page 2 of 2

FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 70 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Fage 10 01 19

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REV 3.2.M



FCC ID: ZNFX410PM	POTEST:	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 71 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		rage / 1 01 / 9

HCRTEMC TEM-1130 Dec-07-2016



ISO/IEC 17025: 2005

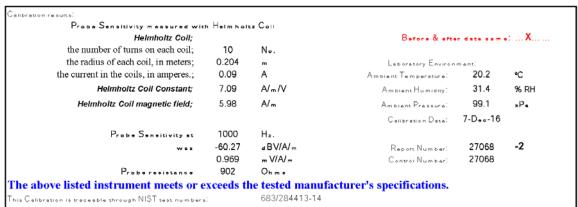
1575 State Route 96, Victor NY 14564

Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

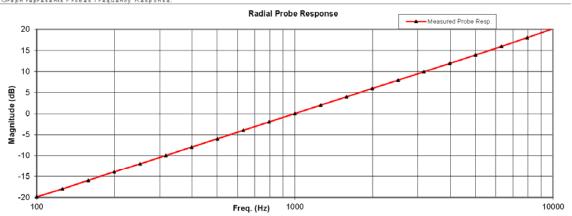
TEM Consulting LP Radial T Coil Probe Model No.: Radial T Coil Probe Serial No.: TEM-1130

Company: PCTEST Engineering Lab. I. D. No: 80579



Graph represents Probes Frequency Response.

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 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: 7-Dec-2016 Felix Christopher Callbrated on WCCL system type 9700

Rev. 7.0 Jan. 24, 2014 Dec. # 1038 HCRTEMC

Page 1 of 2

FCC ID: ZNFX410PM	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 72 of 79
1M1806270133-11.ZNF	07/10/2018 - 07/19/2018	Portable Handset		Faye 12 01 19

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HCRTEMC_TEM-1130_Dec-07-2016

West Caldwell Calibration Laboratories Inc.

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

Calibration Data Record

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

Company: PCTEST Engineering Lab.

Test	Function	Tolera	nce	Measured values		
				Before	Out	Remarks
1.0	Probe Sensitivity at	1000 Hz.	d BV/A/m	-60.27		
2.0	Probe Level Linearity	Ref. (0 dB)	а В 6 О -6	6.03 0.00 -6.03		
			-12	-12.06		
3.0	Probe Frequency Response	Rør. (0 d B)	H ₂ 100 126 158 200 251 316 398 501 631 794 1000 1259 1585 1995 2512 3162 3981 5012 6310 7943 10000	-19.9 -18.0 -16.0 -13.9 -12.0 -10.0 -8.0 -6.0 -4.0 -2.0 0.0 2.0 4.0 6.0 7.9 9.9 11.9 13.9 15.9 18.0 20.2		

Instruments used for calibration:			Date or Cal.	Tracesbility No.	Dua Data
HP	34401A	S/N 36064102	1-Oct-2016	,287708	1-Oct-2017
HP	34401A	S/N 36102471	1-Oet-2016	,287708	1-Oct-2017
HP	33120A	S/N 36043716	1-Oct-2016	.287708	1-Oct-2017
B&K	2133	S/N 1583254	1-Oct-2016	683/284413-14	1-Oct-2017

Cal. Date: 7-Dec-2016 Calibrated on WCCL system type 9700

Tested by: Felix Christopher

Rev. 7.0 Jan. 24, 2014 Dec. # 1038 HCRTEMC

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13. 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.

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