

PCTEST ENGINEERING LABORATORY, INC.

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HEARING AID COMPATIBILITY

Applicant Name:

LG Electronics U.S.A, Inc. 1000 Sylvan Avenue Englewood Cliffs, NJ 07632 United States **Date of Testing:** 8/5/2018 - 8/16/2018 **Test Site/Location:**

PCTEST Lab, Columbia, MD, USA

Test Report Serial No.: 1M1808070153-11-R2.ZNF

FCC ID: ZNFV405UA

APPLICANT: LG ELECTRONICS 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-V405UA

Additional Model(s): LMV405UA, LM-V405TA, LMV405TA, LM-V405MA, LMV405MA,

LM-V405QA, LMV405QA, LM-V405QA5, LMV405QA5, LM-V405QA6, LMV405QA6, LM-V405UAB, LMV405UAB,

LM-V405UAL, LMV405UAL

Test Device Serial No.: Pre-Production Sample [S/N: 06572]

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

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

Note: This revised Test Report (S/N: 1M1808070153-11-R2.ZNF) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

This wireless portable device has been shown to be hearing-aid compatible under the above rated category, specified in ANSI/IEEE Std. C63.19-2011 and has been tested in accordance with the specified measurement procedures. Test results reported herein relate only to the item(s) tested. Hearing-Aid Compatibility is based on the assumption that all production units will be designed electrically identical to the device tested in this report. North American Bands only.

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







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1. INTRODUCTION

On July 10, 2003, the Federal Communications Commission (FCC) adopted new rules requiring wireless manufacturers and service providers to provide digital wireless phones that are compatible with hearing aids. The FCC has modified the exemption for wireless phones under the Hearing Aid Compatibility Act of 1998 (HAC Act) in WT Docket 01-309 RM-8658¹ to extend the benefits of wireless telecommunications to individuals with hearing disabilities. These benefits encompass business, social and emergency communications, which increase the value of the wireless network for everyone. An estimated more than 10% of the population in the United States show signs of hearing impairment and of that fraction, almost 80% use hearing aids. Approximately 500 million people worldwide and 30 million people in the United States suffer from hearing loss.

Compatibility Tests Involved:

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

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

The hearing aid must be measured for:

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

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



Figure 1-1 Hearing Aid in-vitu

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

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2. DUT DESCRIPTION



FCC ID: ZNFV405UA

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

1000 Sylvan Avenue

Englewood Cliffs, NJ 07632

United States

Model: LM-V405UA

LMV405UA, LM-V405TA, LMV405TA, LM-V405MA,

Additional Model(s): LMV405MA, LM-V405QA, LMV405QA, LM-V405QA5, LMV405QA6, LMV405QA6, LMV405QA6, LM-V405UAB,

LMV405UAB, LM-V405UAL, LMV405UAL

Serial Number: 06572

HW Version: Rev.1.0

SW Version: V405UA07g

Antenna: Internal Antenna

DUT Type: Portable Handset

I. LTE Band Selection

This device supports the following pairs of LTE bands with similar frequencies: LTE B12 & B17, LTE B66 & B4, and LTE B25 & B2. These pair of LTE bands have the same target power and shares the same transmission path. Since the supported frequency span for the smaller LTE bands are completely covered by the larger LTE bands, only the larger LTE band (LTE B12, B66, and B25) were evaluated for hearing-aid compliance.

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Table 2-1 ZNFV405UA 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 ¹		
CDMA	1900						
	EvDO	VD	Yes	Yes: WIFI or BT	Google Duo ²		
	850	vo	Yes	Yes: WIFI or BT	CMRS Voice ¹		
GSM	1900						
	GPRS/EDGE	VD	Yes	Yes: WIFI or BT	Google Duo ²		
	850						
UMTS	1700	VD	VD Yes Yes: WIFI or BT CMRS Voice	CMRS Voice ¹			
	1900						
	HSPA	VD	Yes	Yes: WIFI or BT	Google Duo ²		
	680 (B71)		Yes ³				
	700 (B12)			Yes: WIFI or BT			
	700 (B17)						
	780 (B13)						
	790 (B14)						
	850 (B5)				VoLTE ¹ , Google Duo ²		
LTE (FDD)	850 (B26)	VD	Yes				
	1700 (B4)						
	1700 (B66)						
	1900 (B2)						
	1900 (B25)						
	2300 (B30)						
	2500 (B7)						
LTE (TDD)	2600 (B41)	VD	Yes	Yes: WIFI or BT	VoLTE ¹ , Google Duo ²		
	2450						
	5200 (U-NII 1)						
WIFI	5300 (U-NII 2A)	VD	Yes	Yes: CDMA, GSM, UMTS, or LTE	VoWIFI ² , Google Duo ²		
	5500 (U-NII 2C)						
	5800 (U-NII 3)						
BT	2450	DT	No	Yes: CDMA, GSM, UMTS, or LTE	N/A		
•	y ta - Not intended for IP Voice over Data T		Interpretation. ² Reference lev ³ LTE B71, while	el in accordance with 7.4.2.1 of ANSI C63.19-20 el is -20dBm0 in accordance with FCC KDB 285 e outside the scope of ANSI C63.19 and FCC HA HAC procedures.	5076 D02		

. /pc	1101001
VO = Voice Only	¹ Reference level in accordance with 7.4.2.1 of ANSI C63.19-2011 and July 2012 C63 VoLTE
DT = Digital Data - Not intended for CMRS Service	Interpretation.
VD = CMRS and IP Voice over Data Transport	² Reference level is -20dBm0 in accordance with FCC KDB 285076 D02
	³ LTE B71, while outside the scope of ANSI C63.19 and FCC HAC regulations, was tested according
	to the existing HAC procedures.

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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.

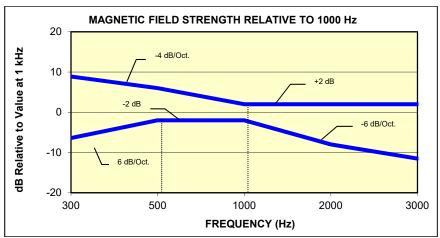


Figure 3-1
Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB(A/m) at 1 kHz

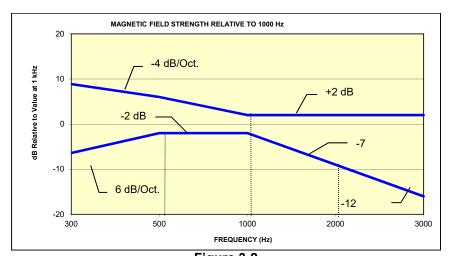


Figure 3-2
Magnetic Field frequency response for wireless devices with an axial field that exceeds
-15 dB(A/m) at 1 kHz

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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		
	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:

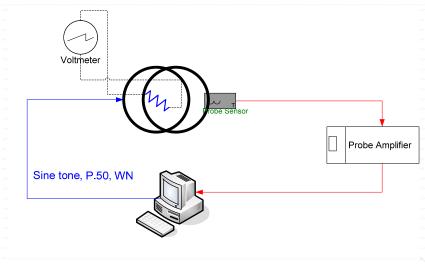


Figure 4-1
Validation Setup with Helmholtz Coil

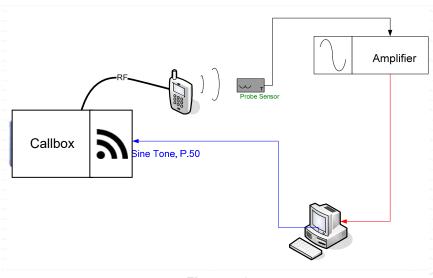


Figure 4-2 T-Coil Test Setup

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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)

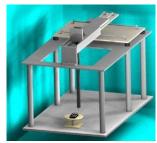


Figure 4-3 RF Near-Field Scanner

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: 20.90 set

Activity Level: 100%

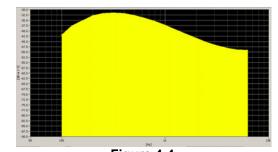


Figure 4-4
Spectral Characteristic of full P.50

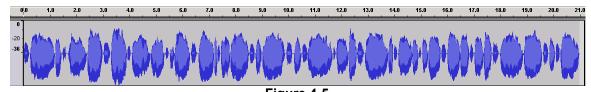
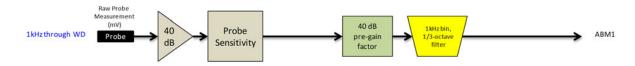


Figure 4-5
Temporal Characteristic of full P.50

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

- 2. Measurement System Validation(See Figure 4-1)
 - a. The measurement system including the probe, pre-amplifier and acquisition system were validated as an entire system to ensure the reliability of test measurements.
 - b. ABM1 Validation

The magnetic field at the center of the Helmholtz coil is given by the equation (per C63.19 Annex D.10.1):

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

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

For the Helmholtz Coil, N=20; r=0.08m; R=10.2Ω and using V=18mV:

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

Therefore a pure tone of 1kHz was applied into the coils such that 18mV was observed across the resistor. The voltmeter used for measurement was verified to be capable of measurements in the audio band range. This theoretically generates an expected field of $-10 \, \mathrm{dB(A/m)}$ in the center of the Helmholtz coil which was used to validate the probe measurement at $-10 \, \mathrm{dB(A/m)}$. This was verified to be within $\pm 0.5 \, \mathrm{dB}$ of the $-10 \, \mathrm{dB(A/m)}$ value (see Page 43).

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c. Frequency Response Validation

The frequency response through the Helmholtz Coil was verified to be within 0.5 dB relative to 1kHz, between 300 – 3000 Hz using the P.50 signal as shown below:

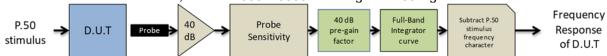


Figure 4-7 Frequency Response Validation

d. ABM2 Measurement Validation

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

Table 4-1
ABM2 Frequency Response Validation

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

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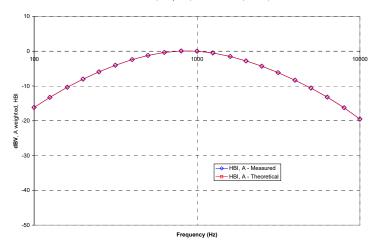
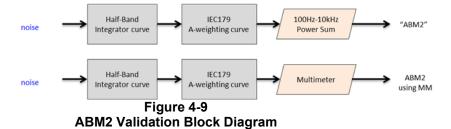


Figure 4-8
ABM2 Frequency Response Validation

The ABM2 result is a power sum from 100Hz to 10kHz with half-band integration and A-weighting. To verify the power sum measurement, a power sum over the full band was measured and verified to track with the source level (See Figure 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

7121121 01101 04111 1411441011					
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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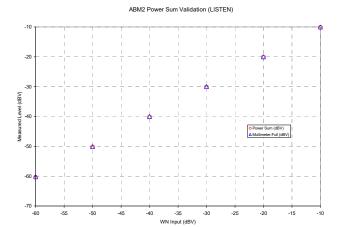


Figure 4-10
ABM2 Power Sum Validation

- 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):

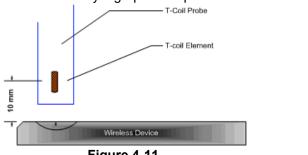


Figure 4-11 Measurement Distance

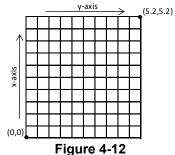


Figure 4-12
Measurement Grid

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

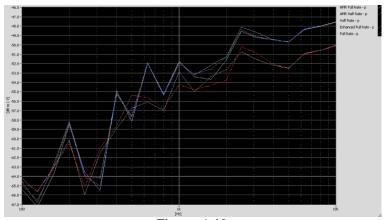


Figure 4-13 Vocoder Analysis for ABM Noise for GSM

- 4. Signal Quality Data Analysis
 - a. Narrow-band Magnetic Intensity
 - i. The standard specifies a 1kHz 1/3 octave band minimum field intensity for a sine tone. The ABM1 measurements were evaluated at 1kHz with 1/3 octave band filtering over an averaged period of 10 seconds.
 - b. Frequency Response
 - 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.
 - 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

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- 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**

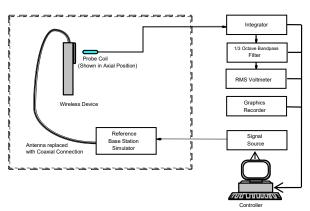


Figure 4-14 **Audio Magnetic Field Test Setup**

Deviation from C63.19 Test Procedure

Non-conducted RF connection due to inaccessible RF ports.

VII. Air Interface Technologies Tested

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

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VIII. Wireless Device Channels and Frequencies

1. 2G/3G Modes

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

Table 4-3
Center Channels and Frequencies

Center Chamiles and Frequencies				
Test frequencies & associated channels				
Channel	Frequency (MHz)			
Secondary Cellular 8	20			
564 (CDMA)	820.10			
Cellular 850				
384 (CDMA)	836.52			
190 (GSM)	836.60			
4183 (UMTS)	836.60			
AWS 1750				
1412 (UMTS)	1730.40			
PCS 1900				
600 (CDMA)	1880			
661 (GSM)	1880			
9400 (UMTS)	1880			

2. 4G (LTE) Modes

The middle channel for every band and bandwidth combination was tested for each probe orientation. The band and bandwidth combination from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels for that band and bandwidth combination. Low-mid and mid-high channels are additionally tested for LTE TDD. The middle channel and supported bandwidths from the worst-case bands according to Table 7-6 and 7-7 were additionally evaluated with OTT VoIP for each probe orientation. See Tables 9-5 to 9-16 and Tables 9-24 and 9-25 for LTE bandwidths and channels.

3. WIFI

The middle channel for each 802.11 standard was tested for each probe orientation. The 2.4GHz 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels. The 5GHz 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested on higher U-NII bands as well as applicable low and high channels. See Tables 9-17 to 9-20 and Tables 9-26 to 9-29 for WIFI standards and channels.

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IX. Test Flow

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

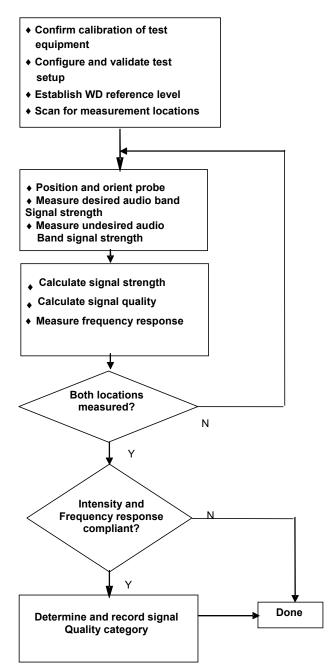


Figure 4-15 C63.19 T-Coil Signal Test Process

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5. VOLTE TEST SYSTEM SETUP AND DUT CONFIGURATION

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

1. Equipment Setup

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

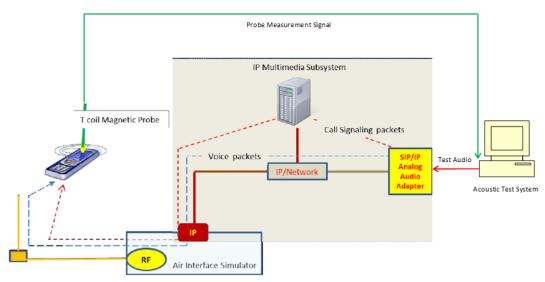


Figure 5-1
Test Setup for VoLTE over IMS T-Coil Measurements

2. Audio Level Settings

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

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

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

1. Radio Configuration

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

> Table 5-1 Vol TE over IMS SNNR by Radio Configuration

	VOLTE OVER INIO SINING BY RAULO CONTIGURATION										
Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]			
1745.0	132322	20	QPSK	1	0	7.08	-42.50	49.58			
1745.0	132322	20	QPSK	1	50	7.33	-44.52	51.85			
1745.0	132322	20	QPSK	1	99	7.10	-46.12	53.22			
1745.0	132322	20	QPSK	50	0	7.22	-41.93	49.15			
1745.0	132322	20	QPSK	50	25	7.10	-41.50	48.60			
1745.0	132322	20	QPSK	50	50	6.94	-45.04	51.98			
1745.0	132322	20	QPSK	100	0	6.89	-41.86	48.75			
1745.0	132322	20	16QAM	1	0	7.33	-38.01	45.34			
1745.0	132322	20	16QAM	1	50	7.03	-38.61	45.64			
1745.0	132322	20	16QAM	1	99	7.07	-40.66	47.73			
1745.0	132322	20	16QAM	50	0	7.09	-41.83	48.92			
1745.0	132322	20	16QAM	50	25	6.55	-42.87	49.42			
1745.0	132322	20	16QAM	50	50	7.18	-40.60	47.78			
1745.0	132322	20	16QAM	100	0	7.02	-41.53	48.55			
1745.0	132322	20	64QAM	1	0	7.27	-39.96	47.23			
1745.0	132322	20	64QAM	1	50	6.96	-38.53	45.49			
1745.0	132322	20	64QAM	1	99	6.96	-41.63	48.59			
1745.0	132322	20	64QAM	50	0	7.01	-42.67	49.68			
1745.0	132322	20	64QAM	50	25	6.94	-43.89	50.83			
1745.0	132322	20	64QAM	50	50	7.13	-41.88	49.01			
1745.0	132322	20	64QAM	100	0	6.94	-42.52	49.46			

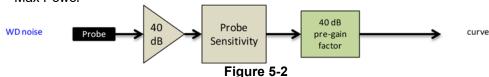
2. Codec Configuration

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

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

i i i i i i i i i i i i i i i i i i i											
Codec Setting:	WB AMR 23.85kbps	WB AMR 6.60kbps	NB AMR 12.2kbps	NB AMR 4.75kbps	Orientation	Band / BW	Channel				
ABM1 (dBA/m)	8.15	7.34	7.78	7.82							
ABM2 (dBA/m)	-38.90	-38.22	-38.89	-38.44	Axial	LTE Band 66 20MHz	132322				
Frequency Response	Pass	Pass	Pass	Pass	Axiai						
S+N/N (dB)	47.05	45.56	46.67	46.26							

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



Audio Band Magnetic Curve Measurement Block Diagram

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3. LTE TDD Uplink-Downlink Configuration Investigation for VoLTE over IMS

An investigation was performed to determine the worst-case Uplink-Downlink configuration for VoLTE over IMS 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 5-3 **Uplink-Downlink Configurations for Type 2 Frame Structures**

	Dennik Bottimink Gotti				- 7 17							
Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									Calculated Transmission	
configuration	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	J	J	U	61.4%
1	5 ms	D	S	U	U	D	D	S	J	J	D	41.4%
2	5 ms	D	S	U	D	D	D	S	J	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%

Power Class 3 Uplink-Downlink Configuration Investigation

Power class 3 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 VoLTE over IMS T-Coil testing. See table below for the SNNR comparison between each Uplink-Downlink configuration:

Table 5-4 Power Class 3 VoLTE over IMS SNNR by UL-DL 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	6.66	-33.06	39.72		
2593.0	40620	20	16QAM	1	0	1	7.27	-32.43	39.70		
2593.0	40620	20	16QAM	1	0	2	6.96	-32.97	39.93		
2593.0	40620	20	16QAM	1	0	3	6.89	-35.38	42.27		
2593.0	40620	20	16QAM	1	0	4	6.91	-35.14	42.05		
2593.0	40620	20	16QAM	1	0	5	6.89	-35.64	42.53		
2593.0	40620	20	16QAM	1	0	6	6.93	-32.09	39.02		

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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 2 was used as the worst-case configuration for Power Class 2 VoLTE over IMS T-Coil testing. See table below for the SNNR comparison between each Uplink-Downlink configuration:

Table 5-5
Power Class 2 VoLTE over IMS SNNR by UL-DL 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	1	6.86	-30.82	37.68
2593.0	40620	20	16QAM	1	0	2	6.80	-30.20	37.00
2593.0	40620	20	16QAM	1	0	3	7.44	-33.85	41.29
2593.0	40620	20	16QAM	1	0	4	7.20	-31.03	38.23
2593.0	40620	20	16QAM	1	0	5	7.45	-33.90	41.35

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 VoLTE over IMS and UL-DL Configuration 2 was used to evaluate Power Class 2 VoLTE over IMS.

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6. 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.

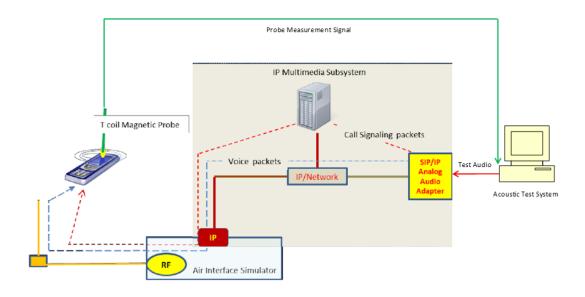


Figure 6-1
Test Setup for VoWIFI over IMS T-Coil Measurements

2. Audio Level Settings

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

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

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

1. Radio Configuration

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

> Table 6-1 802.11b SNNR by Radio Configuration

	COZ: 115 SWINK BY Madio Collingulation											
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]						
802.11b	6	DSSS	1	3.99	-23.53	27.52						
802.11b	6	DSSS	2	3.45	-25.43	28.88						
802.11b	6	CCK	5.5	3.42	-25.50	28.92						
802.11b	6	CCK	11	3.45	-24.36	27.81						

Table 6-2 802.11g/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	3.37	-30.20	33.57
802.11g	6	BPSK	9	3.53	-29.20	32.73
802.11g	6	QPSK	12	3.32	-32.97	36.29
802.11g	6	QPSK	18	3.39	-31.83	35.22
802.11g	6	16-QAM	24	3.42	-35.40	38.82
802.11g	6	16-QAM	36	3.90	-31.80	35.70
802.11g	6	64-QAM	48	3.79	-34.33	38.12
802.11g	6	64-QAM	54	3.39	-35.90	39.29

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

	602.1111/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	3.79	-28.36	32.15				
802.11n	20	40	QPSK	13	3.24	-31.14	34.38				
802.11n	20	40	QPSK	19.5	3.35	-29.88	33.23				
802.11n	20	40	16-QAM	26	3.34	-26.83	30.17				
802.11n	20	40	16-QAM	39	3.05	-35.84	38.89				
802.11n	20	40	64-QAM	52	3.91	-33.70	37.61				
802.11n	20	40	64-QAM	58.5	3.94	-33.39	37.33				
802.11n	20	40	64-QAM	65	3.29	-29.08	32.37				
802.11ac	20	40	256-QAM	78	3.43	-31.91	35.34				

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

	002.1 m/ac 40MHz BW ONNE 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	3.76	-29.79	33.55		
802.11n	40	38	QPSK	27	3.74	-31.72	35.46		
802.11n	40	38	QPSK	40.5	3.78	-31.82	35.60		
802.11n	40	38	16-QAM	54	3.32	-34.80	38.12		
802.11n	40	38	16-QAM	81	3.20	-34.19	37.39		
802.11n	40	38	64-QAM	108	3.26	-34.87	38.13		
802.11n	40	38	64-QAM	121.5	3.67	-33.71	37.38		
802.11n	40	38	64-QAM	135	3.82	-33.58	37.40		
802.11ac	40	38	256-QAM	162	3.28	-34.38	37.66		
802.11ac	40	38	256-QAM	180	3.22	-32.23	35.45		

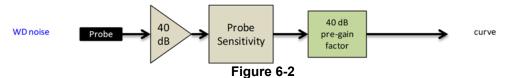
2. Codec Configuration

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

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

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)	4.86	3.40	4.33	4.18							
ABM2 (dBA/m)	-25.22	-23.86	-24.78	-23.76	Axial	2.4GHz	IEEE 802.11b	6			
Frequency Response	Pass	Pass	Pass	Pass	Axiai	2.4912 ILLE 002.110					
S+N/N (dB)	30.08	27.26	29.11	27.94							

Mute on; Backlight off; Max Volume; Max Contrast



Audio Band Magnetic Curve Measurement Block Diagram

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OTT VOIP TEST SYSTEM AND DUT CONFIGURATION 7.

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 64kbps codec setting was used for the audio codec on the auxiliary VoIP unit for OTT VoIP T-Coil testing. See below tables for comparisons between codec data rates on all applicable data modes:

> Table 7-1 Codec Investigation - OTT VoIP (EvDO)

Codec Setting:	64kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	3.01	3.01 3.02		
ABM2 (dBA/m)	-48.44	-48.66	Axial	600
Frequency Response	Pass	Pass	Axiai	000
S+N/N (dB)	51.45	51.68		

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

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Table 7-2 Codec Investigation – OTT VoIP (EDGE)

	irroongan		••• \==•	
Codec Setting:	64kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	3.59	2.82		
ABM2 (dBA/m)	-27.05	-28.08	Axial	661
Frequency Response	Pass	Pass	Axiai	501
S+N/N (dB)	30.64	30.90		

Table 7-3 Codec Investigation - OTT VolP (HSPA)

	011 (1101 /	·/		
Codec Setting:	64kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	2.97	3.05		
ABM2 (dBA/m)	-41.07	-42.13	Axial	9400
Frequency Response	Pass	Pass	Avidi	3400
S+N/N (dB)	44.04	45.18		

Table 7-4 Codec Investigation - OTT VolP (LTF)

Codec investigation – OTT voir (LTE)										
Codec Setting:	64kbps	6kbps	Orientation	Band / BW	Channel					
ABM1 (dBA/m)	3.02	3.18								
ABM2 (dBA/m)	-37.77	-37.81	Axial	LTE Band 12	23095					
Frequency Response	Pass	Pass	Axiai	10MHz	23093					
S+N/N (dB)	40.79	40.99								

Table 7-5 Codec Investigation - OTT VoIP (WIFI)

	Odde investigation – OTT voir (vvii)										
Codec Setting:	64kbps	6kbps	Orientation	Band	Standard	Channel					
ABM1 (dBA/m)	2.95	2.56									
ABM2 (dBA/m)	-20.84	-21.70	Axial	2.4047	2.4GHz IEEE 802.11b	6					
Frequency Response	Pass	Pass	Axiai	2.4GHZ							
S+N/N (dB)	23.79	24.26									

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



Figure 7-1 Audio Band Magnetic Curve Measurement Block Diagram

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2. Radio Configuration for OTT VoIP (LTE FDD)

An investigation was performed to determine the worst-case LTE FDD band to be used for OTT VoIP testing. LTE Band 12 was used for the testing as the worst-case configuration for the handset. See below table for SNNR comparison between different LTE bands:

> Table 7-6 OTT VoIP (LTE FDD) SNNR by Radio Configuration

Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
71	680.5	133297	20	16QAM	1	0	3.46	-37.48	40.94
12	707.5	23095	10	16QAM	1	0	3.34	-37.21	40.55
13	782.0	23230	10	16QAM	1	0	3.46	-37.63	41.09
14	793.0	23330	10	16QAM	1	0	3.43	-38.12	41.55
26	831.5	26865	15	16QAM	1	0	3.58	-42.15	45.73
5	836.5	20525	10	16QAM	1	0	3.44	-41.73	45.17
66	1745.0	132322	20	16QAM	1	0	3.74	-39.29	43.03
25	1882.5	26365	20	16QAM	1	0	3.10	-38.86	41.96
7	2535.0	21100	20	16QAM	1	0	3.39	-41.79	45.18
30	2310.0	27710	10	16QAM	1	0	3.17	-40.26	43.43

3. Radio Configuration for OTT VoIP (LTE TDD)

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

> Table 7-7 OTT VolP (LTE FDD) SNNR by Radio Configuration

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	3.56	-33.47	37.03
41 (PC3)	2593.0	40620	20	16QAM	1	0	3.56	-36.04	39.60

4. LTE FDD Uplink Carrier Aggregation for OTT VoIP

LTE FDD ULCA was evaluated with the worst-case bandwidth and channel combination from Table 7-6. The PCC radio configuration was channel 20525, 10MHz BW, 16QAM, 1RB, 0RB Offset. The SCC radio configuration was channel 20453, 5MHz BW, 16QAM, 1RB, 24RB Offset. This radio configuration satisfied the configuration requirements of the applicable LTE CA combination. See results below:

> Table 7-8 LTE FDD SNNR for OTT VoIP Uplink Carrier Aggregation

		PCC									SCC						
Combination	PCC Band	PCC Bandwidth [MHz]		PCC (UL/DL) Frequency [MHz]		PCC UL# RB	PCC UL RB Offset	SCC Band	SCC Bandwidth [MHz]		SCC (UL/DL) Frequency [MHz]	Modulation	SCC UL# RB	SCC UL RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
CA_5B	LTE B5	10	20525	836.5	16QAM	1	0	B5	5	20453	829.3	16QAM	1	24	3.75	-43.38	47.13

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5. LTE TDD Uplink Carrier Aggregation for OTT VoIP

LTE TDD ULCA was evaluated with the worst-case bandwidth and channel combination from Table 7-7. The PCC radio configuration was channel 40620, 20MHz BW, 16QAM, 1RB, 0RB Offset. The SCC radio configuration was channel 40422, 20MHz BW, 16QAM, 1RB, 99RB Offset. ULCA operates in LTE TDD Power Class 3 so UL-DL configuration 6 was used for evaluation. This radio configuration satisfied the configuration requirements of the applicable LTE CA combination. See results below:

Table 7-9
LTE TDD SNNR for OTT VoIP Uplink Carrier Aggregation

		PCC					scc											
	Combination	PCC Band	PCC Bandwidth [MHz]	PCC (UL/DL) Channel	PCC (UL/DL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	SCC Band	SCC Bandwidth [MHz]	SCC (UL/DL) Channel	SCC (UL/DL) Frequency [MHz]		SCC UL# RB	SCC UL RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
Е	CA_41C	LTE B41	20	40620	2593.0	16QAM	1	0	B41	20	40422	2573.2	16QAM	1	99	2.99	-34.37	37.36

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8. 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:

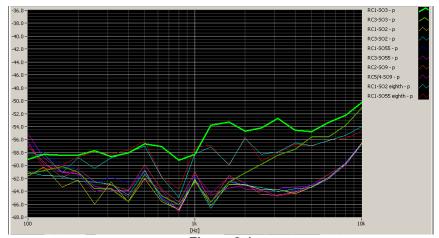
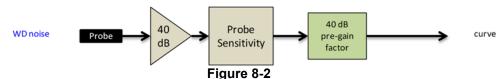


Figure 8-1
CDMA Audio Band Magnetic Noise

Table 8-1 FCC 3G ABM Measurements for ZNFV405UA (CDMA)

Configuration:	RC1/SO3	RC3/SO3	RC4/SO3	Orientation	Channel	
ABM1 (dBA/m)	6.77	6.82	6.60			
ABM2 (dBA/m)	-39.65	-39.97 -43.34		Axial	600	
Frequency Response	Pass	Pass	Pass	Axiai	000	
S+N/N (dB)	46.42	46.79	49.94			

- 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:

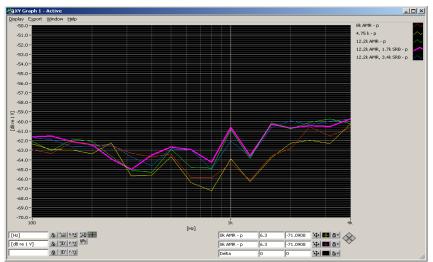
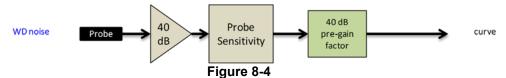


Figure 8-3
UMTS Audio Band Magnetic Noise

Table 8-2 Codec Investigation - UMTS

Codec Setting:	AMR 12.2kbps	AMR 7.95kbps	AMR 4.75kbps	Orientation	Channel	
ABM1 (dBA/m)	7.43	7.47	7.32			
ABM2 (dBA/m)	-39.22	-41.48	-41.75	Axial	9400	
Frequency Response	Pass	Pass	Pass	Axiai	9400	
S+N/N (dB)	46.65	48.95	49.07			

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



Audio Band Magnetic Curve Measurement Block Diagram

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Table 9-1
Consolidated Tabled Results

_			100114	100.	abioa	Result			
			esponse rgin	- 3	netic / Verdict		SNNR dict	Margin from FCC Limit	C63.19-2011
000.46		8.3	3.2	8.3	3.1	8.3	3.4	(dB)	Rating
C63.18	9 Section	Axial	Radial	Axial	Radial	Axial	Radial		
	Secondary Cellular	PASS	NA	PASS	PASS	PASS	PASS		
CDMA	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-22.38	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	-29.61	T4
(011 1011)	PCS	PASS	NA	PASS	PASS	PASS	PASS		
GSM	Cellular	PASS	NA	PASS	PASS	PASS	PASS	0.24	Т3
GSM	PCS	PASS	NA	PASS	PASS	PASS	PASS	-8.21	13
EDGE	Cellular	PASS	NA	PASS	PASS	PASS	PASS	7.40	Т3
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-7.10	13
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
UMTS	AWS	PASS	NA	PASS	PASS	PASS	PASS	-27.93	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	-22.14	T4
,	PCS	PASS	NA	PASS	PASS	PASS	PASS		
	B71	PASS	NA	PASS	PASS	PASS	PASS		
	B12	PASS	NA	PASS	PASS	PASS	PASS		
	B13	PASS	NA	PASS	PASS	PASS	PASS		
	B14	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD	B26	PASS	NA	PASS	PASS	PASS	PASS	-24.39	Т4
LIEFDD	B5	PASS	NA	PASS	PASS	PASS	PASS	-24.39	14
	B66	PASS	NA	PASS	PASS	PASS	PASS		
	B25	PASS	NA	PASS	PASS	PASS	PASS		
	B30	PASS	NA	PASS	PASS	PASS	PASS		
	B7	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD (OTT VoIP)	B12	PASS	NA	PASS	PASS	PASS	PASS	-21.32	Т4
LTE TDD	B41	PASS	NA	PASS	PASS	PASS	PASS	-14.75	T4
LTE TDD (OTT VoIP)	B41	PASS	NA	PASS	PASS	PASS	PASS	-11.89	T4
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
	802.11g	PASS	NA	PASS	PASS	PASS	PASS	F	т.
WLAN	802.11n	PASS	NA	PASS	PASS	PASS	PASS	-5.56	Т3
	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN	802.11g	PASS	NA	PASS	PASS	PASS	PASS	0.00	
(OTT VoIP)	802.11n	PASS	NA	PASS	PASS	PASS	PASS	-2.38	Т3
	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		
	802.11a	PASS	NA	PASS	PASS	PASS	PASS	3	
U-NII	802.11n	PASS	NA	PASS	PASS	PASS	PASS		T4
	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		
	802.11a	PASS	NA	PASS	PASS	PASS	PASS	S	
U-NII (OTT VoIP)	802.11n	PASS	NA	PASS	PASS	PASS	PASS		Т3
(OTT VOIP)	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		
	802.11ac								

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I. **Raw Handset Data**

Table 9-2 **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	6.83	-40.81		2.00	47.64	20.00	-27.64	T4						
	Axial	564	6.72	-42.60	-62.83	2.00	49.32	20.00	-29.32	T4	2.0, 3.2					
Secondary		684	6.55	-42.51		2.00	49.06	20.00	-29.06	T4						
Cellular		476	0.23	-45.43			45.66	20.00	-25.66	T4						
	Radial	564	-0.29	-46.10	-62.89	N/A	45.81	20.00	-25.81	T4	2.2, 2.4					
		684	0.18	-46.64			46.82	20.00	-26.82	T4						
		1013	6.72	-42.48		2.00	49.20	20.00	-29.20	T4						
	Axial	384	7.05	-41.80	-62.83	2.00	48.85	20.00	-28.85	T4	2.0, 3.2					
Cellular		777	6.76	-39.52		2.00	46.28	20.00	-26.28	T4						
Gendiai		1013	-0.32	-46.62			46.30	20.00	-26.30	T4						
	Radial	384	0.03	-46.28	-62.89	-62.89	-62.89	-62.89	-62.89	-62.89	N/A	46.31	20.00	-26.31	T4	2.2, 2.4
		777	-0.36	-43.46			43.10	20.00	-23.10	T4						
		25	6.77	-37.76		2.00	44.53	20.00	-24.53	T4						
	Axial	600	6.95	-39.86	-62.83	-62.83	-62.83	2.00	46.81	20.00	-26.81	T4	2.0, 3.2			
PCS		1175	6.82	-39.22		2.00	46.04	20.00	-26.04	T4						
F 0.3		25	-0.10	-42.48	-62.89		42.38	20.00	-22.38	T4						
	Radial	600	-0.34	-44.04		-62.89 N/A	43.70	20.00	-23.70	T4	2.2, 2.4					
		1175	0.16	-43.79			43.95	20.00	-23.95	T4						

Table 9-3 **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	8.56	-19.65		1.92	28.21	20.00	-8.21	T3	
	Axial	190	8.62	-20.13	-62.83	1.91	28.75	20.00	-8.75	Т3	2.0, 3.2
GSM850		251	8.62	-20.81		1.90	29.43	20.00	-9.43	T3	
GSIVIOSU		128	3.29	-24.92			28.21	20.00	-8.21	T3	
	Radial	190	3.27	-25.32	-62.89	N/A	28.59	20.00	-8.59	T3	2.2, 2.4
		251	3.33	-25.96			29.29	20.00	-9.29	T3	
		512	8.70	-24.46		1.92	33.16	20.00	-13.16	T4	
	Axial	661	8.50	-24.56	-62.83	1.93	33.06	20.00	-13.06	T4	2.0, 3.2
GSM1900		810	8.53	-25.12		1.92	33.65	20.00	-13.65	T4	
G3W1900		512	3.41	-29.68			33.09	20.00	-13.09	T4	
	Radial	661	3.30	-29.91	-62.89	N/A	33.21	20.00	-13.21	T4	2.2, 2.4
		810	3.31	-30.52			33.83	20.00	-13.83	T4	

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Table 9-4
Raw Data Results for UMTS

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		4132	7.45	-43.34		2.00	50.79	20.00	-30.79	T4	
	Axial	4183	7.46	-43.47	-62.83	2.00	50.93	20.00	-30.93	T4	2.0, 3.2
UMTS V		4233	7.45	-41.99		2.00	49.44	20.00	-29.44	T4	
OWI S V		4132	2.20	-56.31			58.51	20.00	-38.51	T4	
	Radial	4183	2.24	-56.07	-62.89	N/A	58.31	20.00	-38.31	T4	2.2, 2.4
		4233	2.21	-55.49			57.70	20.00	-37.70	T4	
		1312	7.43	-44.81		2.00	52.24	20.00	-32.24	T4	
	Axial	1412	7.43	-41.34	-62.83	2.00	48.77	20.00	-28.77	T4	2.0, 3.2
UMTS IV		1513	7.35	-43.94		2.00	51.29	20.00	-31.29	T4	
OWITSTV		1312	2.20	-56.61			58.81	20.00	-38.81	T4	
	Radial	1412	2.20	-55.01	-62.89	N/A	57.21	20.00	-37.21	T4	2.2, 2.4
		1513	2.18	-56.48			58.66	20.00	-38.66	T4	
		9262	7.50	-41.40		2.00	48.90	20.00	-28.90	T4	
	Axial	9400	7.51	-40.42	-62.83	2.00	47.93	20.00	-27.93	T4	2.0, 3.2
UMTS II		9538	7.49	-41.61		2.00	49.10	20.00	-29.10	T4	
OWITSII		9262	2.17	-53.07			55.24	20.00	-35.24	T4	
	Radial	9400	2.17	-52.20	-62.89	9 N/A	54.37	20.00	-34.37	T4	2.2, 2.4
		9538	2.19	-52.45			54.64	20.00	-34.64	T4	

Table 9-5 Raw Data Results for LTE B71

						ooaito io		-					
Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
		20MHz	133372	7.42	-38.84		2.00	46.26	20.00	-26.26	T4		
		20MHz	133297	7.21	-37.18		2.00	44.39	20.00	-24.39	T4		
	Axial	20MHz	133222	7.44	-38.36	-62.83	1.99	45.80	20.00	-25.80	T4	2.0, 3.2	
	Axiai	15MHz	133297	7.38	-37.71	-02.63	2.00	45.09	20.00	-25.09	T4	2.0, 3.2	
		10MHz	133297	7.41	-38.95		2.00	46.36	20.00	-26.36	T4		
LTE Band	LTE Band	5MHz	133297	7.36	-39.57		2.00	46.93	20.00	-26.93	T4		
71		20MHz	133372	1.25	-50.51			51.76	20.00	-31.76	T4		
		20MHz	133297	1.33	-45.83			47.16	20.00	-27.16	T4		
	Radial	20MHz	133222	1.32	-47.74	-62.78	-62.78	NI/A	49.06	20.00	-29.06	T4	0004
		15MHz	133297	1.28	-48.19			N/A	49.47	20.00	-29.47	T4	2.2, 2.4
		10MHz	133297	1.68	-48.62				50.30	20.00	-30.30	T4	
		5MHz	133297	1.48	-50.04			51.52	20.00	-31.52	T4		

Table 9-6 Raw Data Results for LTE B12

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		10MHz	23095	7.39	-38.22		2.00	45.61	20.00	-25.61	T4	
	Axial	5MHz	23095	7.22	-40.72	-62.83	2.00	47.94	20.00	-27.94	T4	2.0, 3.2
	Axiai	3MHz	23095	7.50	-41.24	-02.03	2.00	48.74	20.00	-28.74	T4	2.0, 3.2
LTE Band		1.4MHz	23095	7.17	-40.29		2.00	47.46	20.00	-27.46	T4	
12		10MHz	23095	1.31	-47.00			48.31	20.00	-28.31	T4	
	Radial	5MHz	23095	1.40	-50.46	-62.78	N/A	51.86	20.00	-31.86	T4	2.2. 2.4
	radiai	3MHz	23095	1.51	-50.85	-02.76	IN/A	52.36	20.00	-32.36	T4	2.2, 2.4
		1.4MHz	23095	1.30	-49.38			50.68	20.00	-30.68	T4	

Table 9-7 Raw Data Results for LTE B13

								. •				
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
	Axial	10MHz	23230	7.35	-39.18	-62.83	2.00	46.53	20.00	-26.53	T4	2.0, 3.2
LTE Band	Axiai	5MHz	23230	7.24	-39.42	-02.03	2.00	46.66	20.00	-26.66	T4	2.0, 3.2
13	Radial	10MHz	23230	1.27	-47.46	-62.78	N/A	48.73	20.00	-28.73	T4	2.2, 2.4
	Raulai	5MHz	23230	1.64	-48.29	-02.70	IN/A	49.93	20.00	-29.93	T4	2.2, 2.4

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REV 3.2.M

Table 9-8 Raw Data Results for LTE B14

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)		Test Coordinates
	Axial	10MHz	23330	7.10	-38.17	-62.83	2.00	45.27	20.00	-25.27	T4	2.0, 3.2
LTE Band	Axiai	5MHz	23330	7.29	-38.24	-02.03	2.00	45.53	20.00	-25.53	T4	2.0, 3.2
14	Radial	10MHz	23330	1.67	-48.33	-62.78	N/A	50.00	20.00	-30.00	T4	2.2. 2.4
	Radiai	5MHz	23330	1.59	-48.07	-02.76	IN/A	49.66	20.00	-29.66	T4	2.2, 2.4

Table 9-9 Raw Data Results for LTE B26

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
		15MHz	26865	7.22	-42.31		2.00	49.53	20.00	-29.53	T4	
		10MHz	26865	7.43	-40.87		2.00	48.30	20.00	-28.30	T4	
	Axial	5MHz	26865	7.45	-42.13	-62.83	2.00	49.58	20.00	-29.58	T4	2.0, 3.2
		3MHz	26865	7.39	-41.56		2.00	48.95	20.00	-28.95	T4	
LTE Band		1.4MHz	26865	7.15	-42.78		2.00	49.93	20.00	-29.93	T4	
26		15MHz	26865	1.26	-48.61			49.87	20.00	-29.87	T4	
		10MHz	26865	1.24	-50.18			51.42	20.00	-31.42	T4	
Radial	5MHz	26865	1.34	-48.65	-62.78 N/	N/A	49.99	20.00	-29.99	T4	2.2, 2.4	
		3MHz	26865	1.29	-50.21			51.50	20.00	-31.50	T4	
		1.4MHz	26865	1.49	-48.93			50.42	20.00	-30.42	T4	

Table 9-10 Raw Data Results for LTE B5

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Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011	Test Coordinates
		10MHz	20525	7.30	-43.19		2.00	50.49	20.00	-30.49	T4	
	Avial	5MHz	20525	7.47	-42.65	-62.83	2.00	50.12	20.00	-30.12	T4	2.0, 3.2
Axial	3MHz	20525	7.35	-43.84	-02.03	2.00	51.19	20.00	-31.19	T4	2.0, 3.2	
LTE Band 5	LTEDande	1.4MHz	20525	7.24	-41.39		2.00	48.63	20.00	-28.63	T4	
LIE Ballu 5		10MHz	20525	1.32	-51.43			52.75	20.00	-32.75	T4	
	Padial	5MHz	20525	1.56	-51.85	-62.78	N/A	53.41	20.00	-33.41	T4	2.2, 2.4
	Radial	3MHz	20525	1.37	-52.09	-02.76	IN/A	53.46	20.00	-33.46	T4	2.2, 2.4
		1.4MHz	20525	1.62	-48.49			50.11	20.00	-30.11	T4	

Table 9-11 Raw Data Results for LTE B66

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	132322	7.46	-39.56		2.00	47.02	20.00	-27.02	T4	
		15MHz	132322	7.64	-39.87		2.00	47.51	20.00	-27.51	T4	
	Axial	10MHz	132322	7.67	-40.58	-62.83	2.00	48.25	20.00	-28.25	T4	2.0, 3.2
	Axiai	5MHz	132322	7.49	-41.86	-02.03	2.00	49.35	20.00	-29.35	T4	2.0, 3.2
		3MHz	132322	7.26	-41.45		2.00	48.71	20.00	-28.71	T4	
LTE Band		1.4MHz	132322	7.30	-41.57		2.00	48.87	20.00	-28.87	T4	
66		20MHz	132322	1.50	-48.37			49.87	20.00	-29.87	T4	
		15MHz	132322	1.45	-48.14			49.59	20.00	-29.59	T4	
	Radial	10MHz	132322	1.55	-49.05	-62.78	N/A	50.60	20.00	-30.60	T4	2.2, 2.4
	Radiai	5MHz	132322	1.35	-49.32	-02.76	IN/A	50.67	20.00	-30.67	T4	2.2, 2.4
		3MHz	132322	1.25	-48.93			50.18	20.00	-30.18	T4	
		1.4MHz	132322	1.28	-48.42			49.70	20.00	-29.70	T4	

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Table 9-12 Raw Data Results for LTE B25

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	26365	7.38	-40.06		2.00	47.44	20.00	-27.44	T4	
		15MHz	26365	7.40	-39.68		2.00	47.08	20.00	-27.08	T4	
	Axial	10MHz	26365	7.51	-41.45	-62.83	2.00	48.96	20.00	-28.96	T4	2.0, 3.2
	Axiai	5MHz	26365	7.31	-41.45	-02.03	2.00	48.76	20.00	-28.76	T4	2.0, 3.2
		3MHz	26365	7.57	-40.64		2.00	48.21	20.00	-28.21	T4	
LTE Band		1.4MHz	26365	7.64	-42.57		2.00	50.21	20.00	-30.21	T4	
25		20MHz	26365	1.25	-47.78			49.03	20.00	-29.03	T4	
		15MHz	26365	1.31	-49.30			50.61	20.00	-30.61	T4	
	Radial	10MHz	26365	1.29	-48.93	-62.78	N/A	50.22	20.00	-30.22	T4	2.2. 2.4
	Radiai	5MHz	26365	1.37	-49.37	-02.76	IN/A	50.74	20.00	-30.74	T4	2.2, 2.4
		3MHz	26365	1.57	-49.86			51.43	20.00	-31.43	T4	
		1.4MHz	26365	1.34	-48.53			49.87	20.00	-29.87	T4	

Table 9-13 Raw Data Results for LTE B30

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)		Test Coordinates
	Axial	10MHz	27710	7.27	-41.80	-62.83	2.00	49.07	20.00	-29.07	T4	2.0, 3.2
LTE Band	Axiai	5MHz	27710	7.38	-41.14	-02.03	2.00	48.52	20.00	-28.52	T4	2.0, 3.2
30	Radial	10MHz	27710	1.69	-48.93	-62.78	N/A	50.62	20.00	-30.62	T4	2.2. 2.4
	Nadiai	5MHz	27710	1.31	-48.62	-02.76	IV/A	49.93	20.00	-29.93	T4	2.2, 2.4

Table 9-14 Raw Data Results for LTE B7

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	21100	7.53	-40.97		2.00	48.50	20.00	-28.50	T4	
	Axial	15MHz	21100	7.32	-41.99	-62.83	2.00	49.31	20.00	-29.31	T4	2.0, 3.2
	Axiai	10MHz	21100	7.27	-43.37	-02.03	2.00	50.64	20.00	-30.64	T4	2.0, 3.2
LTE Band 7		5MHz	21100	7.49	-41.71		2.00	49.20	20.00	-29.20	T4	
LIE Ballu /		20MHz	21100	1.36	-52.63			53.99	20.00	-33.99	T4	
	Radial	15MHz	21100	1.42	-53.37	-62.78	N/A	54.79	20.00	-34.79	T4	2.2, 2.4
	Naulai	10MHz	21100	1.30	-53.81	-02.76	IN/A	55.11	20.00	-35.11	T4	2.2, 2.4
		5MHz	21100	1.25	-52.24			53.49	20.00	-33.49	T4	

Table 9-15 Raw Data Results for LTE B41 Power Class 3

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	7.27	-31.85		2.00	39.12	20.00	-19.12	T4	
	Axial	15MHz	40620	6.81	-31.76	-62.83	2.00	38.57	20.00	-18.57	T4	2.0, 3.2
	Axiai	10MHz	40620	6.87	-31.50	-02.03	2.00	38.37	20.00	-18.37	T4	2.0, 3.2
LTE Band		5MHz	40620	7.03	-32.00		2.00	39.03	20.00	-19.03	T4	
41		20MHz	40620	1.30	-40.78			42.08	20.00	-22.08	T4	
	Radial	15MHz	40620	1.34	-40.26	-62.78	N/A	41.60	20.00	-21.60	T4	2.2. 2.4
	Naulai	10MHz	40620	1.23	-40.13	-02.76	IN/A	41.36	20.00	-21.36	T4	2.2, 2.4
		5MHz	40620	1.39	-40.17			41.56	20.00	-21.56	T4	

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Table 9-16 Raw Data Results for LTE B41 Power Class 2

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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	7.15	-30.46		2.00	37.61	20.00	-17.61	T4	
		15MHz	40620	6.87	-29.76		2.00	36.63	20.00	-16.63	T4	
		10MHz	40620	7.10	-29.89		2.00	36.99	20.00	-16.99	T4	
	Axial	5MHz	41490	6.96	-27.79	-62.83	2.00	34.75	20.00	-14.75	T4	2.0, 3.2
	Axiai	5MHz	41055	6.93	-28.15	-02.03	2.00	35.08	20.00	-15.08	T4	2.0, 3.2
		5MHz	40620	6.84	-28.06		2.00	34.90	20.00	-14.90	T4	
		5MHz	40185	6.95	-27.92		2.00	34.87	20.00	-14.87	T4	
LTE Band		5MHz	39750	7.00	-27.80		2.00	34.80	20.00	-14.80	T4	
41		20MHz	40620	1.55	-38.25			39.80	20.00	-19.80	T4	
		15MHz	40620	1.24	-38.24			39.48	20.00	-19.48	T4	
		10MHz	40620	1.64	-38.53			40.17	20.00	-20.17	T4	
	Radial	5MHz	41490	1.34	-35.32	-62.78	N/A	36.66	20.00	-16.66	T4	2.2, 2.4
	Radiai	5MHz	41055	1.39	-35.70	-02.70	IN/A	37.09	20.00	-17.09	T4	2.2, 2.4
		5MHz	40620	1.30	-37.98			39.28	20.00	-19.28	T4	
		5MHz	40185	1.45	-34.78			36.23	20.00	-16.23	T4	
		5MHz	39750	1.38	-35.12			36.50	20.00	-16.50	T4	

Table 9-17 Raw Data Results for 2.4GHz WIFI

	Naw Data Results for 2.40112 Will I											
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	3.35	-23.79		2.00	27.14	20.00	-7.14	Т3		
	Axial	6	3.25	-23.16	-62.83	2.00	26.41	20.00	-6.41	Т3	2.0, 3.2	
WLAN		11	3.36	-26.98		2.00	30.34	20.00	-10.34	T4		
802.11b		1	-2.96	-28.82			25.86	20.00	-5.86	T3		
	Radial	6	-2.96	-28.76	-62.78	N/A	25.80	20.00	-5.80	T3	2.2, 2.4	
		11	-3.00	-28.56			25.56	20.00	-5.56	Т3		
WLAN	Axial	6	3.73	-28.82	-62.83	2.00	32.55	20.00	-12.55	T4	2.0, 3.2	
802.11g	Radial	6	-2.97	-37.06	-62.78	N/A	34.09	20.00	-14.09	T4	2.2, 2.4	
WLAN	Axial	6	3.63	-27.84	-62.83	2.00	31.47	20.00	-11.47	T4	2.0, 3.2	
802.11n	Radial	6	-2.75	-35.89	-62.78	N/A	33.14	20.00	-13.14	T4	2.2, 2.4	
WLAN	Axial	6	3.40	-29.99	-62.83	2.00	33.39	20.00	-13.39	T4	2.0, 3.2	
802.11ac	Radial	6	-2.93	-36.55	-62.78	N/A	33.62	20.00	-13.62	T4	2.2, 2.4	

Table 9-18 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	Test Coordinates
	Axial	20MHz	1	40	3.89	-30.42	-62.83	2.00	34.31	20.00	-14.31	T4	2.0, 3.2
		20MHz	1	36	-3.03	-48.41			45.38	20.00	-25.38	T4	
802.11a		20MHz	1	40	-2.89	-46.79			43.90	20.00	-23.90	T4	
002.11a	Radial	20MHz	1	48	-2.95	-47.42	-62.78	N/A	44.47	20.00	-24.47	T4	2.2, 2.4
	Naulai	20MHz	2A	56	-3.07	-48.45	-02.76	IN/A	45.38	20.00	-25.38	T4	2.2, 2.4
		20MHz	2C	120	-3.12	-47.25			44.13	20.00	-24.13	T4	
		20MHz	3	157	-3.05	-47.33			44.28	20.00	-24.28	T4	

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Table 9-19 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 Rating	Test Coordinates
		40MHz	1	38	3.71	-29.77		2.00	33.48	20.00	-13.48	T4	
		20MHz	1	40	3.88	-30.07		2.00	33.95	20.00	-13.95	T4	
		40MHz	2A	54	3.89	-29.30		2.00	33.19	20.00	-13.19	T4	
		20MHz	2A	56	3.84	-29.97		2.00	33.81	20.00	-13.81	T4	
	Axial	40MHz	2C	102	3.73	-28.85	-62.83	2.00	32.58	20.00	-12.58	T4 2.0, 3.2	20.32
		40MHz	2C	118	3.34	-28.31		2.00	31.65	20.00	-11.65	T4	2.0, 5.2
802.11n		40MHz	2C	142	3.73	-28.72		2.00	32.45	20.00	-12.45	T4	
		20MHz	2C	120	3.77	-29.72		2.00	33.49	20.00	-13.49	T4	
		40MHz	3	151	3.25	-29.45		2.00	32.70	20.00	-12.70	T4	
		20MHz	3	157	3.62	-29.79		2.00	33.41	20.00	-13.41	T4	
	Padial	40MHz	1	38	-3.00	-47.92	-62.78	-62.78 N/A	44.92	20.00	-24.92	T4	2.2, 2.4
	Radial —	20MHz	1	40	-2.99	-48.04	-02.76	IN/A	45.05	20.00	-25.05	T4	2.2, 2.4

Table 9-20 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
	Avial	40MHz	1	38	3.26	-31.53	-62.83	2.00	34.79	20.00	-14.79	T4	2.0. 3.2
	Axial	20MHz	1	40	3.83	-30.24	-02.63	2.00	34.07	20.00	-14.07	T4	2.0, 3.2
802.11ac	ac												
	Radial	40MHz	1	38	-2.98	-47.73	62.70	N/A	44.75	20.00	-24.75	T4	2.2. 2.4
Radial	20MHz	1	40	-2.75	-47.68	-47.68 -62.78	-62.78 N/A	44.93	20.00	-24.93	T4	2.2, 2.4	

Table 9-21 Raw Data Results for EvDO (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
Secondary Cellular	Axial	564	3.19	-51.33	-62.83	2.00	54.52	20.00	-34.52	T4	2.0, 3.2
EvDO	Radial	564	-2.12	-53.43	-62.89	N/A	51.31	20.00	-31.31	T4	2.2, 2.4
Cellular	Axial	384	3.26	-46.35	-62.83	2.00	49.61	20.00	-29.61	T4	2.0, 3.2
EvDO	Radial	384	-2.04	-53.68	-62.89	N/A	51.64	20.00	-31.64	T4	2.2, 2.4
PCS	Axial	600	2.98	-48.37	-62.83	2.00	51.35	20.00	-31.35	T4	2.0, 3.2
EvDO	Radial	600	-2.07	-54.89	-62.89	N/A	52.82	20.00	-32.82	T4	2.2, 2.4

Table 9-22 Raw Data Results for EDGE (OTT VoIP)

	Naw Data Nesults for EDGE (OTT VOIL)													
	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		
	EDGESEA	Axial	190	3.51	-24.24	-62.34	1.91	27.75	20.00	-7.75	Т3	2.0, 3.2		
	EDGE850	Radial	190	-3.66	-30.76	-62.78	N/A	27.10	20.00	-7.10	Т3	2.2, 2.4		
I														
Ī	EDGE1000	Axial	661	3.11	-28.14	-62.34	1.84	31.25	20.00	-11.25	T4	2.0, 3.2		
	EDGE1900	Radial	661	-3.61	-34.54	-62.78	N/A	30.93	20.00	-10.93	T4	2.2, 2.4		

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Table 9-23 Raw Data Results for HSPA (OTT VoIP)

	Fraguency Margin from											
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	3.91	-44.56	-62.34	1.98	48.47	20.00	-28.47	T4	2.0, 3.2	
пора у	Radial	4183	-2.84	-46.75	-62.78	N/A	43.91	20.00	-23.91	T4	2.2, 2.4	
HSPA IV	Axial	1412	3.46	-43.59	-62.34	1.95	47.05	20.00	-27.05	T4	2.0, 3.2	
HOFAIV	Radial	1412	-2.80	-47.77	-62.78	N/A	44.97	20.00	-24.97	T4	2.2, 2.4	
HSPA II	Axial	9400	3.74	-39.99	-62.34	2.00	43.73	20.00	-23.73	T4	2.0, 3.2	
IIGPAII	Radial	9400	-3.01	-45.15	-62.78	N/A	42.14	20.00	-22.14	T4	2.2, 2.4	

Table 9-24 Raw Data Results for LTE FDD B12 (OTT VoIP)

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	3.74	-41.26		1.90	45.00	20.00	-25.00	T4	
		10MHz	23095	3.69	-37.63		1.90	41.32	20.00	-21.32	T4	
	Axial	10MHz	23060	3.50	-38.88	-62.34	1.93	42.38	20.00	-22.38	T4	2.0, 3.2
	Axiai	5MHz	23095	3.70	-40.89	-02.34	1.94	44.59	20.00	-24.59	T4	2.0, 3.2
		3MHz	23095	3.34	-41.92		1.94	45.26	20.00	-25.26	T4	
LTE Band		1.4MHz	23095	3.46	-41.89		2.00	45.35	20.00	-25.35	T4	
12		10MHz	23130	-3.40	-45.94			42.54	20.00	-22.54	T4	
		10MHz	23095	-2.70	-44.13	1		41.43	20.00	-21.43	T4	
	Radial	10MHz	23060	-2.91	-44.97	-62.78	N/A	42.06	20.00	-22.06	T4	2.2, 2.4
	Nadiai	5MHz	23095	-3.27	-46.68		IWA	43.41	20.00	-23.41	T4	2.2, 2.4
		3MHz	23095	-3.04	-45.68			42.64	20.00	-22.64	T4	
		1.4MHz	23095	-3.16	-47.33			44.17	20.00	-24.17	T4	

Table 9-25 Raw Data Results for LTE TDD B41 Power Class 2 (OTT VoIP)

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	3.65	-33.73		1.99	37.38	20.00	-17.38	T4	
		15MHz	41490	3.46	-28.86		1.99	32.32	20.00	-12.32	T4	
		15MHz	41055	3.52	-29.31		1.94	32.83	20.00	-12.83	T4	
	Axial	15MHz	40620	3.52	-33.59	-62.34	1.99	37.11	20.00	-17.11	T4	2.0, 3.2
	Axiai	15MHz	40185	3.49	-28.87	-02.34	1.94	32.36	20.00	-12.36	T4	2.0, 3.2
		15MHz	39750	3.46	-28.43		1.95	31.89	20.00	-11.89	T4	
		10MHz	40620	3.47	-33.82		1.98	37.29	20.00	-17.29	T4	
LTE Band		5MHz	40620	3.55	-34.03		1.99	37.58	20.00	-17.58	T4	
41		20MHz	40620	-2.93	-39.39			36.46	20.00	-16.46	T4	
		15MHz	40620	-2.98	-40.08			37.10	20.00	-17.10	T4	
		10MHz	41490	-3.39	-36.56			33.17	20.00	-13.17	T4	
	Radial	10MHz	41055	-3.43	-39.14	-62.78	N/A	35.71	20.00	-15.71	T4	2.2, 2.4
	Naulai	10MHz	40620	-3.47	-39.40	-02.76	IWA	35.93	20.00	-15.93	T4	2.2, 2.4
		10MHz	40185	-3.39	-38.93	3		35.54	20.00	-15.54	T4	
		10MHz	39750	-3.45	-38.95			35.50	20.00	-15.50	T4	
		5MHz	40620	-3.70	-40.39			36.69	20.00	-16.69	T4	

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Table 9-26
Raw Data Results for 2.4GHz WIFI (OTT VoIP)

	ADMA ADMA ADMA Ambient Noise Frequency SANAN ECC. Limit Margin from CC2 40 2044 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	3.27	-20.22		1.99	23.49	20.00	-3.49	Т3				
	Axial	6	3.21	-20.16	-62.34	1.91	23.37	20.00	-3.37	Т3	2.0, 3.2			
WLAN		11	2.96	-21.73		2.00	24.69	20.00	-4.69	Т3				
802.11b		1	-2.71	-25.73			23.02	20.00	-3.02	Т3				
	Radial	6	-3.23	-25.61	-62.78	N/A	22.38	20.00	-2.38	Т3	2.2, 2.4			
		11	-2.82	-26.07			23.25	20.00	-3.25	Т3				
WLAN	Axial	6	2.80	-25.20	-62.34	1.95	28.00	20.00	-8.00	Т3	2.0, 3.2			
802.11g	Radial	6	-2.73	-28.32	-62.78	N/A	25.59	20.00	-5.59	Т3	2.2, 2.4			
WLAN	Axial	6	2.83	-28.25	-62.34	1.97	31.08	20.00	-11.08	T4	2.0, 3.2			
802.11n	Radial	6	-3.46	-30.52	-62.78	N/A	27.06	20.00	-7.06	Т3	2.2, 2.4			
WLAN	Axial	6	3.00	-29.90	-62.34	1.95	32.90	20.00	-12.90	T4	2.0, 3.2			
802.11ac	Radial	6	-3.23	-33.01	-62.78	N/A	29.78	20.00	-9.78	Т3	2.2, 2.4			

Table 9-27 Raw Data Results for 5GHz WIFI 802.11a (OTT VoIP)

				Dutan				, o <u> </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 Rating	Test Coordinates
		20MHz	1	40	3.69	-23.95		1.91	27.64	20.00	-7.64	T3	
		20MHz	2A	52	3.21	-24.17		2.00	27.38	20.00	-7.38	Т3	
	Axial	20MHz	2A	56	2.86	-23.96	-62.34	2.00	26.82	20.00	-6.82	T3	2.0, 3.2
	Axiai	20MHz	2A	64	3.04	-24.13	-02.34	2.00	27.17	20.00	-7.17	T3	2.0, 3.2
		20MHz	2C	120	2.81	-24.40	-	1.97	27.21	20.00	-7.21	T3	
		20MHz	3	157	3.30	-24.08		1.91	27.38	20.00	-7.38	T3	
802.11a													
		20MHz	1	40	-3.31	-44.45			41.14	20.00	-21.14	T4	
		20MHz	2A	56	-3.20	-42.97			39.77	20.00	-19.77	T4	
	Radial	20MHz	2C	100	-3.18	-42.90	62.78	N/A	39.72	20.00	-19.72	T4	2.2, 2.4
	Naulai	20MHz	2C	120	-3.19	-42.84 -42.59	-02.76	IN/PA	39.65	20.00	-19.65	T4	2.2, 2.4
		20MHz	2C	144	-3.36			39.23	20.00	-19.23	T4		
		20MHz	3	157	-3.17	-43.05			39.88	20.00	-19.88	T4	

Table 9-28 Raw Data Results for 5GHz WIFI 802.11n (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
I		Avial	40MHz	1	38	3.05	-26.89	-62.34	2.00	29.94	20.00	-9.94	T3	2.0. 3.2
		Axial	20MHz	1	40	3.29	-28.45	-02.34	1.92	31.74	20.00	-11.74	T4	2.0, 3.2
	802.11n													
		Radial	40MHz	1	38	-3.16	-44.80	62.70	NI/A	41.64	20.00	-21.64	T4	2.2. 2.4
		Radial	20MHz	1	40	-2.62	-45.95	78 N/A	43.33	20.00	-23.33	T4	2.2, 2.4	

Table 9-29 Raw Data Results for 5GHz WIFI 802.11ac (OTT VoIP)

								•=:::::	<u> </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
	Axial	40MHz	1	38	3.01	-27.37	-62.34	2.00	30.38	20.00	-10.38	T4	2.0, 3.2
	Axiai	20MHz	1	40	3.64	-25.86		1.99	29.50	20.00	-9.50	T3	T3 2.0, 3.2
802.11ac													
	D- di-l	40MHz	1	38	-3.23	-45.99	62.70	N/A	42.76	20.00	-22.76	T4	2.2. 2.4
Radial	Natiai	20MHz	1	40	-2.63	-46.93 -62.78	-62.76 N/A	44.30	20.00	-24.30	T4	2.2, 2.4	

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II. Test Notes

A. General

- 1. Phone Condition: Mute on; Backlight off; Max Volume; Max Contrast
- 2. 'Radial' orientation refers to radial transverse.
- 3. Hearing Aid Mode (Phone→ 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);

D. UMTS

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

E. LTE FDD

- 1. Power Configuration: TPC = "Max Power"
- 2. Radio Configuration: 16QAM, 1RB, 0RB offset
- 3. Vocoder Configuration: WB AMR 6.60kbps
- 4. The worst-case band and bandwidth combination for each probe orientation is additionally tested on the low and high channels for those combinations. LTE Band 71 at 20MHz is the worst-case for both Axial and Radial probe orientations.

F. LTE TDD

- 1. Power Configuration: TPC = "Max Power"
- 2. Radio Configuration: 16QAM, 1RB, 0RB offset
- 3. Power Class 3 Uplink-Downlink configuration: 6
- 4. Power Class 2 Uplink-Downlink configuration: 2
- 5. Vocoder Configuration: WB AMR 6.60kbps
- 6. The worst-case band and bandwidth combination for each probe orientation is additionally tested on the low, low-mid, mid-high and high channels for those combinations. LTE Band 41 (Power Class 2) at 5MHz is the worst-case for both Axial and Radial probe orientations.

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G. WIFI

- 1. Radio Configuration
 - a. 802.11b: DSSS, 1Mbps
 - b. 802.11g/a: BPSK, 9Mbps
 - c. 802.11n/ac 20MHz: 16QAM, 26Mbps
 - d. 802.11n/ac 40MHz: BPSK, 13.5Mbps
- 2. Vocoder Configuration: WB AMR 6.60kbps
- 3. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. 802.11b is the worst-case for both 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. 802.11n (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.

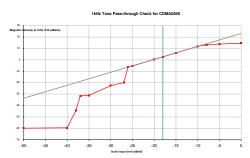
H. OTT VolP

- 1. Vocoder Configuration: 64kbps
- 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 7-6 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: 2
 - d. LTE Band 41 (Power Class 2) was the worst-case band from Table 7-7 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 (Powers Class 2) at 15MHz is the worst-case for the Axial probe orientation and LTE Band 41 (Power Class 2) at 10MHz is the Radial probe orientation.
- 7. WIFI Configuration:
 - a. Radio Configuration
 - i. 802.11b: DSSS, 1Mbps
 - ii. 802.11g/a: BPSK, 9Mbps
 - iii. 802.11n/ac 20MHz: 16QAM, 26Mbps
 - iv. 802.11n/ac 40MHz: BPSK, 13.5Mbps

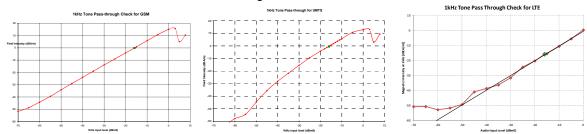
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- b. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. 802.11b is the worst-case for both Axial and Radial probe orientations.
- c. The worst-case standard for 5GHz WIFI in each probe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

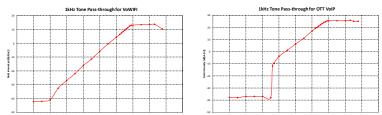
III. 1 kHz Vocoder Application Check



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, UMTS, and VoLTE over IMS. This measurement was taken in the axial configuration above the maximum location.



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

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IV. T-Coil Validation Test Results

Table 9-30 Helmholtz Coil Validation Table of Results - 8/5/2018

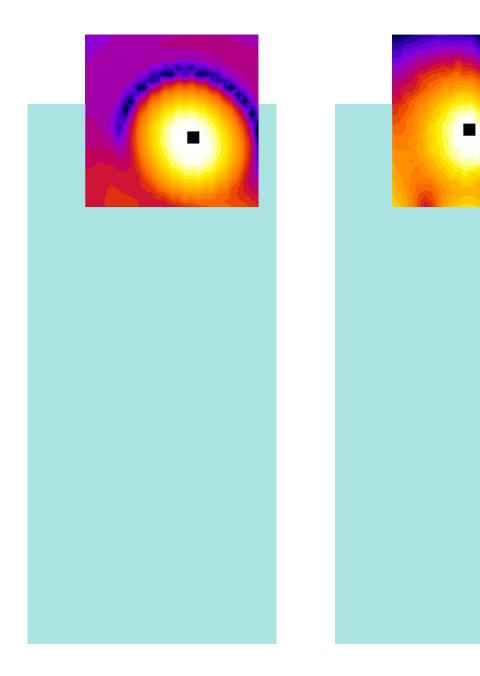
Item	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.163	PASS
Environmental Noise	< -58 dBA/m	-62.83	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.264	PASS
Environmental Noise	< -58 dBA/m	-62.89	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS

Table 9-31
Helmholtz Coil Validation Table of Results – 8/13/2018

Item	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.180	PASS
Environmental Noise	< -58 dBA/m	-62.34	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.271	PASS
Environmental Noise	< -58 dBA/m	-62.78	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS

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V. ABM1 Magnetic Field Distribution Scan Overlays



Axial Radial (Transverse)

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

Notes:

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

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10. MEASUREMENT UNCERTAINTY

Table 10-1
Uncertainty Estimation Table

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

Notes:

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

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

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11. EQUIPMENT LIST

Table 11-1 Equipment List

		Equipment Liet				
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	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	4/20/2018	Annual	4/20/2019	128635
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

FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 46 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 40 01 90

12. TEST DATA

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 47 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 47 OI 90



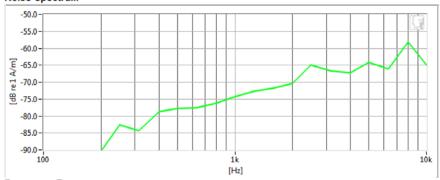
Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

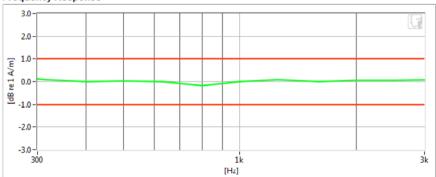
Equipment:

- 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	-10.163 dB	•	Max/Min	-9.5/-10.5
Verification ABM2	-62.83 dB	•	Maximum	-58.0
Frequency Response Margin	800m dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 48 of 90
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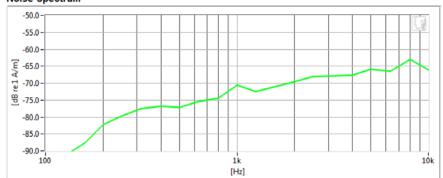
Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

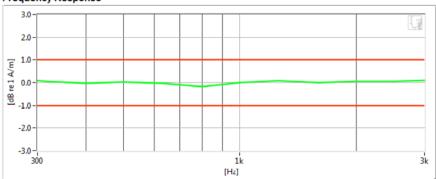
Equipment:

- 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	-10.18 dB	•	Max/Min	-9.5/-10.5
Verification ABM2	-62.34 dB	•	Maximum	-58.0
Frequency Response Margin	800m dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 49 of 90
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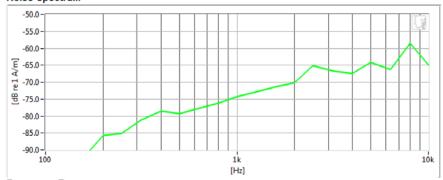
Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

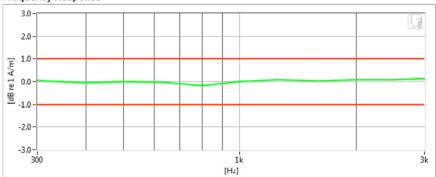
Equipment:

- 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	-10.264 dB	•	Max/Min	-9.5/-10.5
Verification ABM2	-62.89 dB	•	Maximum	-58.0
Frequency Response Margin	800m dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 50 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 50 01 90



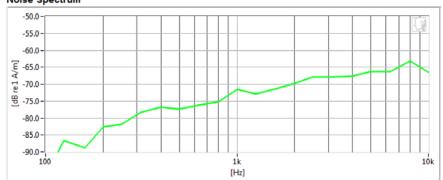
Type: HH Coil Serial: 925

Measurement Standard: ANSI C63.19-2011

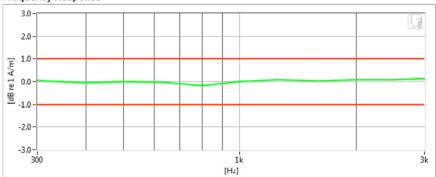
Equipment:

- 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	-10.271 dB	✓	Max/Min	-9.5/-10.5	
Verification ABM2	-62.78 dB	•	Maximum	-58.0	
Frequency Response Margin	800m dB	✓	Tolerance curves	Aligned Data	

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 51 of 90
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LST Hearing-Aid Compatibility Fa

DUT: ZNFV405UA

Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

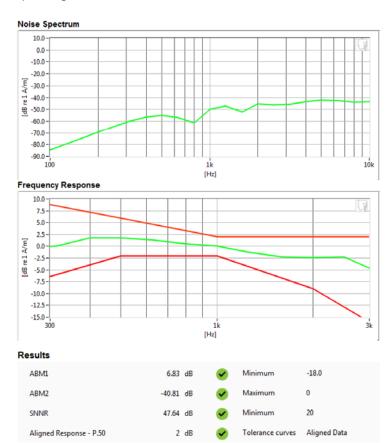
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: Secondary Cellular CDMA

Channel: 476

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



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 52 of 90
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Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

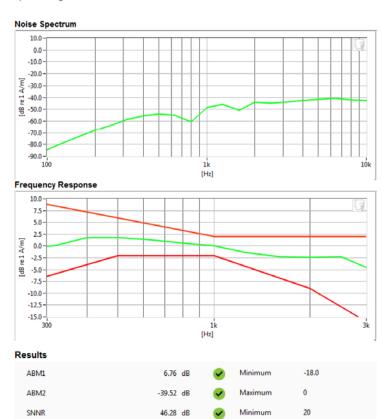
Test Configuration:

Mode: Cellular CDMA

Aligned Response - P.50

Channel: 777

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



PCTEST 2018

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 53 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 33 01 90

2 dB

Tolerance curves Aligned Data



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

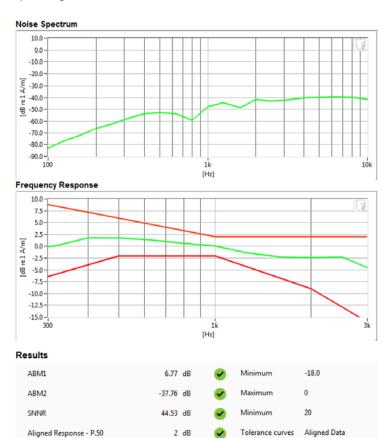
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: PCS CDMA

Channel: 25

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



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 54 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 54 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

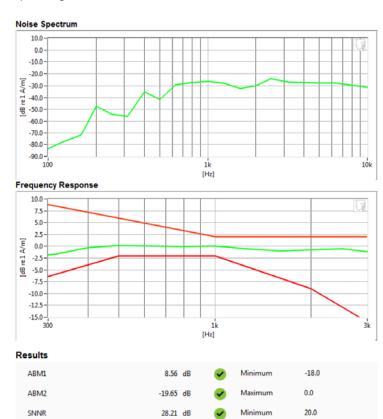
Equipment:

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

Test Configuration:

Mode: GSM 850Channel: 128

Speech Signal: ITU-T P.50 Artificial Voice



PCTEST 2018

FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 55 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 33 01 90

1.92 dB

Aligned Response - P.50

Tolerance curves Aligned Data



Type: Portable Handset Serial: 06572

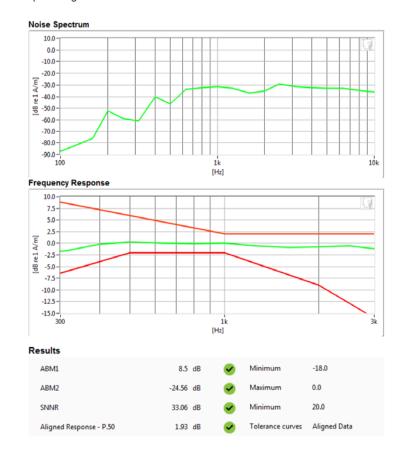
Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

- Mode: GSM 1900
- Channel: 512
- Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 56 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 56 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

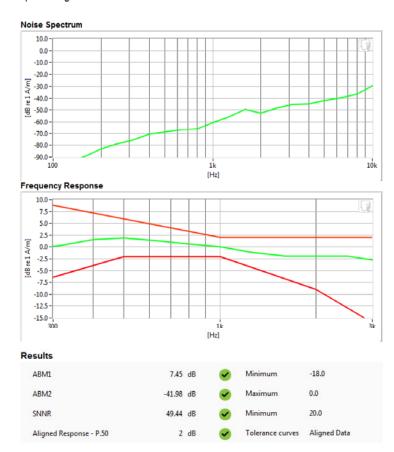
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: UMTS Band V

Channel: 4233

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



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 57 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 57 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

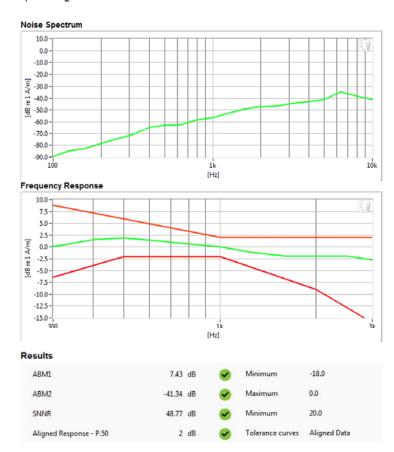
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: UMTS Band IV

Channel: 1412

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



FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager	
Filename:	Test Dates:	DUT Type:		Page 58 of 90	
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 36 01 90	



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

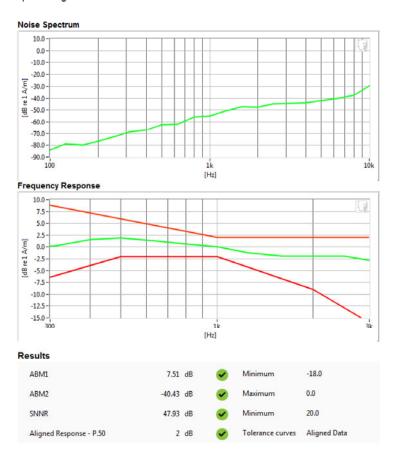
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: UMTS Band II

Channel: 9400

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



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 59 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 59 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

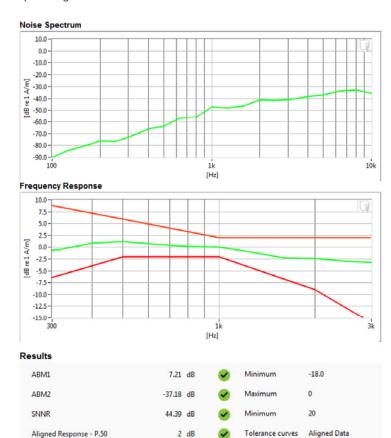
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

Test Configuration:

Mode: LTE FDD Band 71Bandwidth: 20MHz

Channel: 133297

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 60 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		rage 00 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

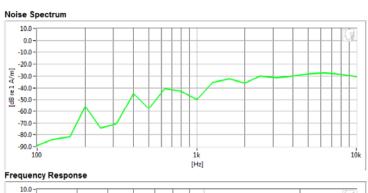
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

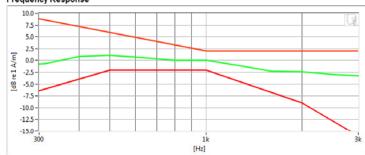
Test Configuration:

Mode: LTE TDD Band 41 (PC2)

Bandwidth: 5MHzChannel: 41490

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





Results

ABM1	6.96	dB	•	Minimum	-18.0	
ABM2	-27.78	dB	\bigcirc	Maximum	0	
SNNR	34.75	dB	•	Minimum	20	
Aligned Response - P.50	2	dB	•	Tolerance curves	Aligned Data	

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 61 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 61 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

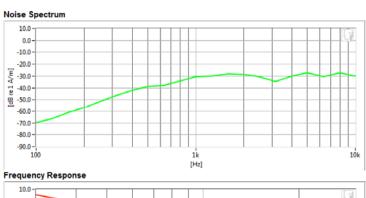
Probe: Axial T-Coil Probe – SN: TEM-1124; Calibrated: 12/07/2016

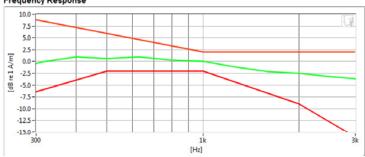
Test Configuration:

Mode: 2.4GHz WIFIStandard: IEEE 802.11b

Channel: 6

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





Results

ABM1	3.25	dB	•	Minimum	-18.0	
ABM2	-23.16	dB	•	Maximum	0	
SNNR	26.41	dB	•	Minimum	20	
Aligned Response - P.50	2	dB	•	Tolerance curves	Aligned Data	

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 62 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 02 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

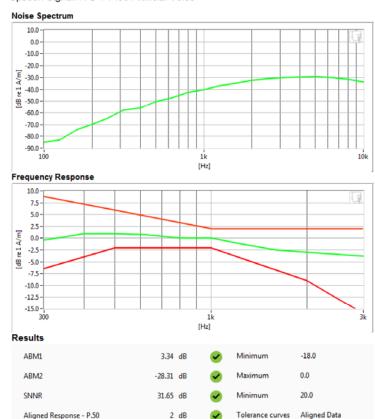
Test Configuration:

Mode: 5GHz WIFI

Standard: IEEE 802.11n (U-NII 2C)

Bandwidth: 40MHzChannel: 118

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



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 63 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		rage 03 01 90



Type: Portable Handset Serial: 06572

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: 2.4GHz WIFI
- Standard: IEEE 802.11b
- Channel: 6
- Speech Signal: ITU-T P.50 Artificial Voice

Noise Spectrum 10.0 0.0 -10.0 -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 -5.0 -7.5 -10.0 -12.5 -15.0 Results ABM1 3.21 dB Minimum -18.0 ABM2 -20.17 dB 0 SNNR 23.37 dB Minimum 20 Aligned Response - P.50 1.91 dB Aligned Data Tolerance curves

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 64 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 04 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: Secondary Cellular CDMA

Channel: 476



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 65 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 03 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

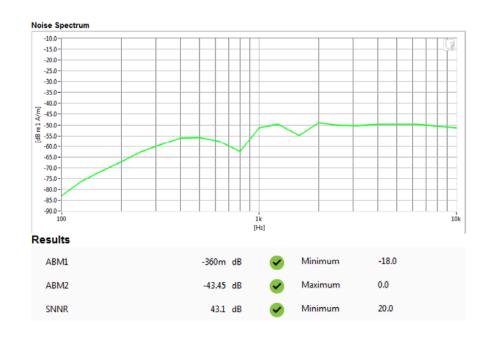
Equipment:

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

Test Configuration:

Mode: Cellular CDMA

Channel: 777



FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	(t) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 66 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		rage 60 of 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: PCS CDMAChannel: 25



ABM1	-100m dB	•	Minimum	-18.0
ABM2	-42.48 dB	•	Maximum	0
SNNR	42.38 dB	•	Minimum	20

FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 67 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 07 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: GSM 850Channel: 128



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 68 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 00 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

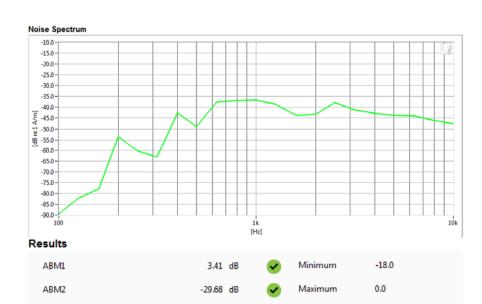
Equipment:

SNNR

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

Test Configuration:

Mode: GSM 1900Channel: 512



33.09 dB

Minimum

20.0

FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 69 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		rage 69 of 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

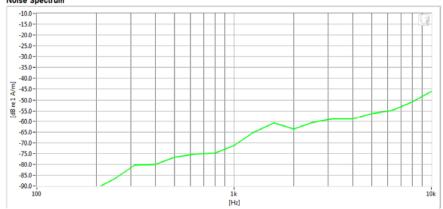
Equipment:

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

Test Configuration:

 Mode: UMTS Band V Channel: 4233

Noise Spectrum



Results

ABM1	2.21 dB	✓ Mi	inimum	-18.0
ABM2	-55.5 dB	✓ Ma	aximum	0.0
SNNR	57.7 dB	✓ Mi	inimum	20.0

FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 70 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 70 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

SNNR

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

Test Configuration:

Mode: UMTS Band IVChannel: 1412

Noise Spectrum -10.0 --15.0 -20.0 -25.0--30.0 --35.0 -40.0 --40.0--45.0--50.0--60.0--65.0 --70.0 -75.0 --80.0 -85.0 --90.0 -100 1k [Hz] Results ABM1 2.2 dB Minimum -18.0 0.0 ABM2 -55.01 dB Maximum

57.21 dB

Minimum

20.0

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 71 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Page 71 01 90



Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: UMTS Band IIChannel: 9400

Noise Spectrum -10.0 --15.0 -20.0 -25.0--30.0 --35.0 -40.0 --40.0-E -45.0-E -50.0-E -50.0--65.0 --70.0 -75.0--80.0--85.0 --90.0 -100 1k [Hz]

Results

ABM1	2.17 dB	✓	Minimum	-18.0
ABM2	-52.2 dB	\checkmark	Maximum	0.0
SNNR	54.37 dB	\checkmark	Minimum	20.0

FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 72 of 90
1M1808070153-11-R2.ZNF	8/5/2018 - 8/16/2018	Portable Handset		Fage 12 01 90



Type: Portable Handset Serial: 06572

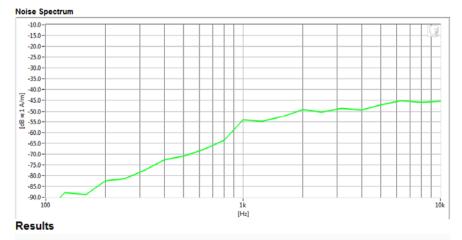
Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

 Mode: LTE FDD Band 71 Bandwidth: 20MHz Channel: 133297



ABM1	1.33	dB	\checkmark	Minimum	-18.0
ABM2	-45.83	dB	✓	Maximum	0.0
SNNR	47.16	dB	•	Minimum	20.0

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Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

ABM2 SNNR

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

Test Configuration:

Mode: LTE TDD Band 41 (PC2)

Bandwidth: 5MHzChannel: 40185



-34.78 dB

36.23 dB

Maximum

Minimum

0.0

20.0

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Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: 2.4GHz WIFIStandard: IEEE 802.11b

Channel: 11

Noise Spectrum -15.0 -20.0 -25.0 -30.0 --35.0 -40.0 -45.0-E -50.0-E -55.0--60.0--65.0 -70.0 --75.0 --80.0 -85.0 -90.0 -100 [Hz] Results ABM1 Minimum -18.0 -3 dB -28.57 dB Maximum ABM2 SNNR 25.56 dB Minimum 20.0

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Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

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

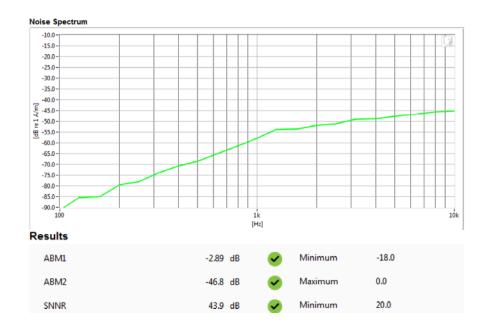
Test Configuration:

Mode: 5GHz WIFI

• Standard: IEEE 802.11a (U-NII 1)

Bandwidth: 20MHz

Channel: 40



FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(l) LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 06572

Measurement Standard: ANSI C63.19-2011

Equipment:

ABM2

SNNR

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

Test Configuration:

VoIP Application: Google Duo

Mode: 2.4GHz WIFI

• Standard: IEEE 802.11b

Channel: 6

Noise Spectrum -10.0 -15.0 --20.0 -25.0 --30.0 -35.0 --40.0 -40.0--45.0--50.0-1 -50.0--60.0 -65.0 -70.0 -75.0 -80.0 --85.0--90.0 -100 1k [Hz] Results ABM1 -3.23 dB Minimum -18.0

-25.61 dB

22.38 dB

0.0

20.0

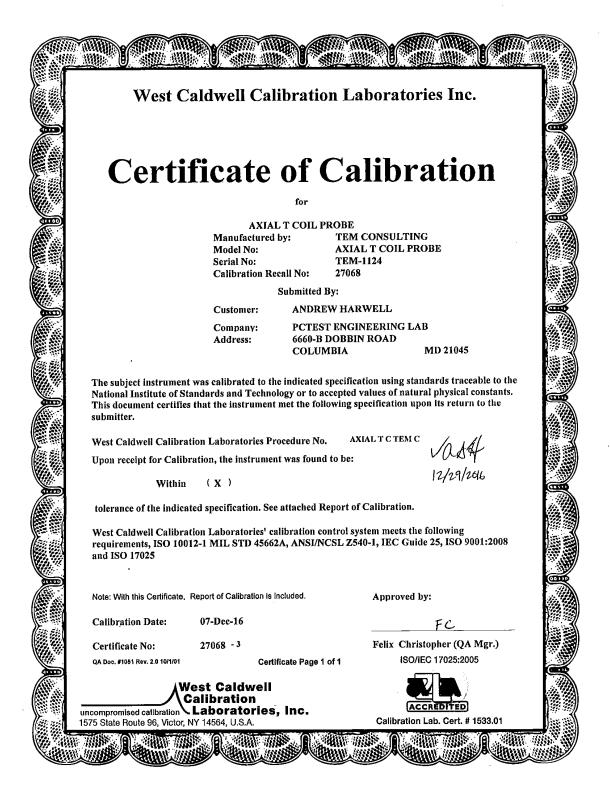
Maximum

Minimum

FCC ID: ZNFV405UA	INCIDENCE LABORTORY, INC.	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
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13. CALIBRATION CERTIFICATES

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REV 3.2.M 04/17/2018

HCATEMC TEM 1124 Dec-07-2016



ISO/IEC 17025: 2005

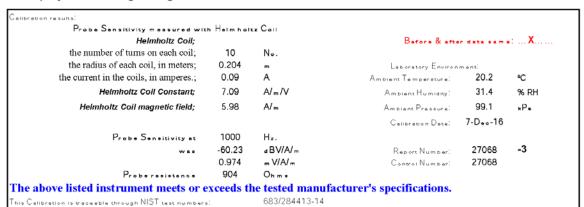
1575 State Route 96, Victor NY 14564

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



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.

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FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
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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

Model No.: Axial T Coil Probe TEM Consulting LP 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				
			σВ					
2.0	Probe Level Linearity		6	6.03				
		R•f. (0 dB)	0	0.00				
			-6	-6.03				
			-12	-12.05				
			Hz					
3.0	Probe Frequency Response		100	-19.8				
			126	-18.0				
			158	-16.0				
			200	-13.9				
			251	-12.0				
			316	-9.9				
			398	-8.0				
			501	-6.0				
			631	-4.0				
			794	-2.0				
		R.f. (0 dB)	1000	0.0				
			1259	2.0				
			1585	4.0				
			1995	6.0				
			2512	7.9				
			3162	9.9				
			3981	11.9				
			5012	13.9				
			6310	15.9				
			7943	18.0				
			10000	20.2				

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

Tested by: Felix Christopher Cal. Date: 7-Dec-2016 Calibrated on WCCL system type 9700

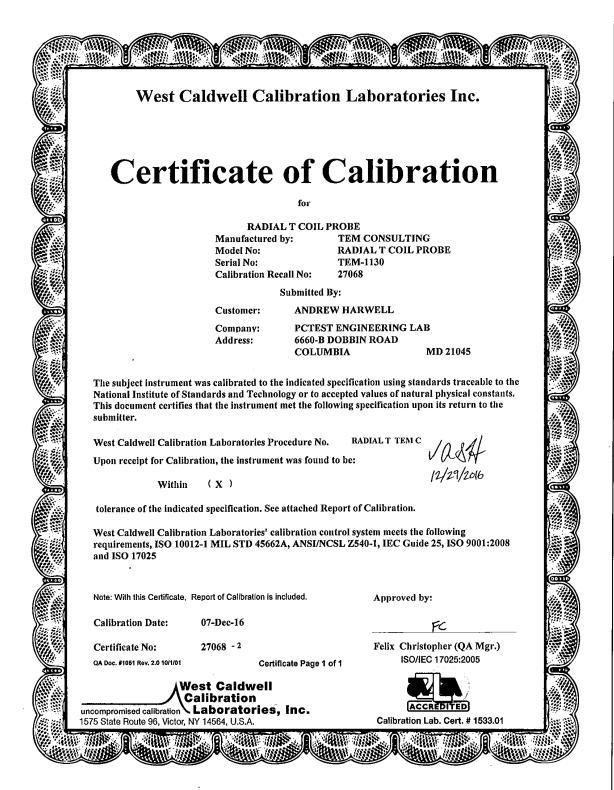
Ray. 7.0 Jan. 24, 2014 Day. # 1038 HCATEMC

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FCC ID: ZNFV405UA	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
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REV 3.2.M



FCC ID: ZNFV405UA	PETEST'	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
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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

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

Probe Sensitivity measured with	Helmhalt	z Co11			
Helmholtz Coil;			Bafora & afte	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•o-16	
Probe Sensitivity at	1000	Hz.			
was	-60.27	a BV/A/m	Report Number:	27068	-2
	0.969	m V/A/m	Control Number:	27068	
Probe resistance	902	On m •			

Graph represents Probes Frequency Response.

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

Radial 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 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 HORTEMO

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FCC ID: ZNFV405UA	PCTEST	HAC (T-COIL) TEST REPORT	(†) LG	Approved by: Quality Manager
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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		nce	Me	asured valu	ıes
			Before	Out	Remarks
Probe Sensitivity at	1000 Hz.	d BV/A/m	-60.27		
		aВ	2.22		
Probe Level Linearity	D (0 D)				
	R•r. (0 aB)				
		-12	-12.06		
		Hz			
Probe Frequency Response					
	- (o - D)				
	Ref. (0 aB)				
		10000	20.2		
	Function Probe Sensitivity at Probe Level Linearity Probe Frequency Response	Probe Sensitivity at 1000 Hz. Probe Level Linearity Ref. (0 a B)	Probe Sensitivity at 1000 Hz. dBV/A/m Probe Level Linearity 6 Ref. (0 dB) 0 -6 -12 Hz Probe Frequency Response 100 126 158 200 251 316 398 501 631 794	Probe Sensitivity at 1000 Hz. dBV/A/m -60.27 Probe Level Linearity 6 6 6.03 Ref. (0 dB) 0 0.00 -6 -6.03 -12 -12.06 Hz Probe Frequency Response 100 -19.9 126 -18.0 158 -16.0 200 -13.9 251 -12.0 316 -10.0 398 -8.0 501 -6.0 631 -4.0 794 -2.0 Ref. (0 dB) 1000 0.0 1259 2.0 1585 4.0 1995 6.0 2512 7.9 3162 9.9 3981 11.9 5012 13.9 6310 15.9 7943 18.0	Probe Sensitivity at 1000 Hz. dBV/A/m -60.27 Probe Level Linearity 6 6.03 Ref. (0 dB) 0 0.000 -6 -6.03 -12 -12.06 Hz Probe Frequency Response 100 -19.9 126 -18.0 158 -16.0 200 -13.9 251 -12.0 316 -10.0 398 -8.0 501 -6.0 631 -4.0 794 -2.0 Ref. (0 dB) 1000 0.0 1259 2.0 1585 4.0 1995 6.0 2512 7.9 3162 9.9 3981 11.9 5012 13.9 6310 15.9 7943 18.0

Instruments used for calibrati	ian:		Date or Cal.	Traceability No.	Due Dete
HP	34401A	S/N 36064102	1-Oct-2016	,287708	1-Oat-2017
HP	34401A	S/N 36102471	1-Oet-2016	,287708	1-Oet-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-Oat-2017

Cal. Date: 7-Dec-2016

Tested by: Felix Christopher

Calibrated on WCCL system type 9700

Ray. 7.0 Jan. 24, 2014 Day. # 1038 HCRTEMC

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14. CONCLUSION

The measurements indicate that the wireless communications device complies with the HAC limits specified in accordance with the ANSI C63.19 Standard and FCC WT Docket No. 01-309 RM-8658. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters specific to the test. The test results and statements relate only to the item(s) tested.

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

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