

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:** 11/04/19 - 11/14/19 **Test Site/Location:**

PCTEST Lab, Columbia, MD, USA

Test Report Serial No.: 1M1910280174-11-R1.ZNF

Date of Issue: 11/26/2019

FCC ID: ZNFL455DL

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

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

Application Type: Certification
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: LG L455DL

Additional Model(s): LG-L455DL, LM-K400UM, LM-K400MM, LM-K400QM, LM-

K400VPP, LM-K400QM5, LM-K400QM6, LGL455DL, LMK400UM, LMK400MM, LMK400QM, LMK400QM5, LMK400QM6, LMK400VPP, L455DL, K400UM, K400MM,

K400QM, K400QM5, K400QM6, K400VPP

Test Device Serial No.: Pre-Production Sample [S/N: 00319]

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

Note: This revised Test Report (S/N: 1M1910280174-11-R1.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: ZNFL455DL

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

1000 Sylvan Avenue

Englewood Cliffs, NJ 07632

United States

Model: LG L455DL

LG-L455DL, LM-K400UM, LM-K400MM, LM-K400QM, LM-

K400VPP, LM-K400QM5, LM-K400QM6, LGL455DL,

Additional Model(s): LMK400UM, LMK400MM, LMK400QM, LMK400QM5,

LMK400QM6, LMK400VPP, L455DL, K400UM, K400MM,

K400QM, K400QM5, K400QM6, K400VPP

Serial Number: 00319 HW Version: Rev.B

SW Version: L455DL04y

Antenna: Internal Antenna
DUT Type: Portable Handset

I. LTE Band Selection

This device supports the following pairs of LTE bands with similar frequencies: LTE B25 & B2, B26 & B5, and B66 & B4. These pairs of LTE bands have the same target powers and share the same transmission paths. Since the supported frequency span for the smaller LTE bands are completely covered by the larger LTE bands, only the larger LTE bands (LTE B25, B26, and B66) were evaluated for hearing-aid compliance.

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Table 2-1 ZNFL455DL HAC Air Interfaces

				T LTOODE 11/10 / III IIIIOIIGO			
Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service	Audio Codec Evaluated	
	835		.,	V 14151 25	0110011 : 1	51/00	
CDMA	1900	VO	Yes	Yes: WIFI or BT	CMRS Voice ¹	EVRC	
	EvDO	VD	Yes	Yes: WIFI or BT	Google Duo²	OPUS	
	850	VO	Yes	Yes: WIFI or BT	CMRS Voice ¹	EFR	
GSM	1900	VO	162	res. Wiri Oi Bi	CIVINS VOICE	LFK	
	GPRS/EDGE	VD	Yes	Yes: WIFI or BT	Google Duo²	OPUS	
	850						
UMTS	1700	VD	Yes	Yes: WIFI or BT	CMRS Voice ¹	NB AMR	
OWITS	1900						
	HSPA	VD	Yes	Yes: WIFI or BT	Google Duo²	OPUS	
	680 (B71)		Yes³				
	700 (B12)					VOLTE: NB AMR, WB AMR, EVS Google Duo: OPUS	
	780 (B13)						
	850 (B5)						
LTE (FDD)	850 (B26)	VD	Yes	Yes: WIFI or BT	VoLTE¹, Google Duo²		
	1700 (B4)		res				
	1700 (B66)						
	1900 (B2)						
	1900 (B25)						
LTE (TDD)	2600 (B41)	VD	Yes	Yes: WIFI or BT	VoLTE ¹ , Google Duo ²	VoLTE: NB AMR, WB AMR, EVS Google Duo: OPUS	
	2450						
	5200 (U-NII 1)						
WIFI		VD	Yes	Yes: CDMA, GSM, UMTS, or LTE	VoWIFI², Google Duo²	VoWIFI: NB AMR, WB AMR, EVS Google Duo: OPUS	
	5500 (U-NII 2C)				Go	Google Duo. OPO3	
	5800 (U-NII 3)						
ВТ	2450	DT	No	Yes: CDMA, GSM, UMTS, or LTE	N/A	N/A	
Type Transport VO = Voice Only DT = Digital Dat					ation.		

- 3. LTE B71, while outside the scope of ANSI C63.19 and FCC HAC regulations, was additionally tested according to the existing HAC procedures with currently available test equipment.

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VD = CMRS and/or IP Voice over Data Transport

ANSI C63.19-2011 PERFORMANCE CATEGORIES 3.

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.

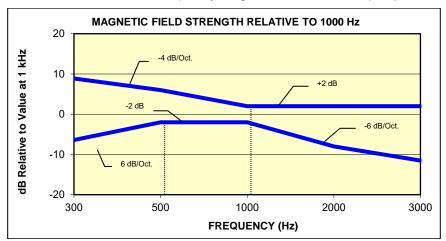
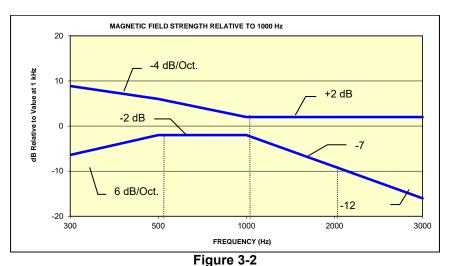


Figure 3-1 Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB(A/m) at 1 kHz



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

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Signal Quality

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

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

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

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

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4. METHOD OF MEASUREMENT

I. Test Setup

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

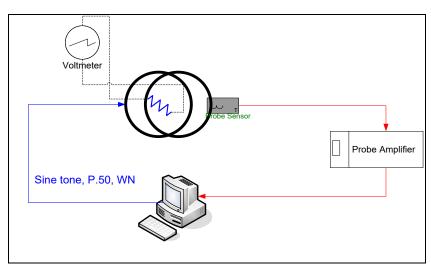


Figure 4-1
Validation Setup with Helmholtz Coil

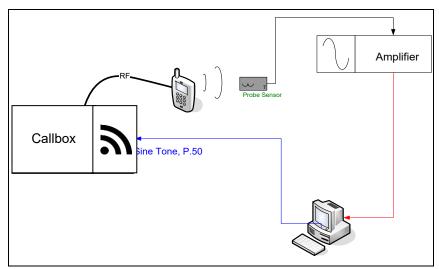


Figure 4-2 T-Coil Test Setup

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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 Range: 100 Hz – 8 kHz

Stimulus Type: Male and Female, no spaces

Single Sample 20.96 seconds

Duration: 20.96 Activity Level: 100%

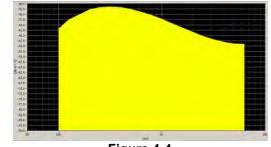


Figure 4-4
Spectral Characteristic of full P.50

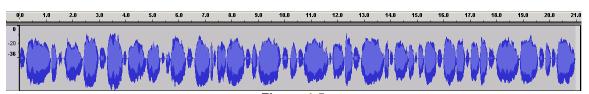
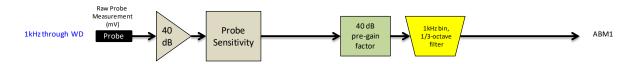


Figure 4-5
Temporal Characteristic of full P.50

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ABM1 Measurement Block Diagram:



ABM2 Measurement Block Diagram:

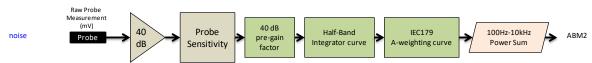


Figure 4-6 Magnetic Measurement Processing Steps

IV. **Test Procedure**

- 1. Ambient Noise Check per C63.19 §7.3.1
 - a. Ambient interference was monitored using a Real-Time Analyzer between 100-10,000 Hz with 1/3 octave filtering.
 - "A-weighting" and Half-Band Integration was applied to the measurements.
 - Since this measurement was measured in the same method as ABM2 measurements, this level was verified to be more than 10 dB below the lowest measurement signal (which is the highest ABM2 measurement for a T4 WD). Therefore the maximum noise level for a T4 WD with an ABM1 = -18 dBA/m is:

- 2. Measurement System Validation (See Figure 4-1)
 - a. The measurement system including the probe, pre-amplifier and acquisition system were validated as an entire system to ensure the reliability of test measurements.
 - ABM1 Validation The magnetic field at the center of the 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=0.13m; R=10.193Ω and using V=29mV:

$$H_c = \frac{20 \cdot (\frac{0.029}{10.193})}{0.13 \cdot \sqrt{1.25^3}} = 0.316A/m \approx -10dB(A/m)$$

Therefore a pure tone of 1kHz was applied into the coils such that 29mV was observed across the resistor. The voltmeter used for measurement was verified to be capable of measurements in the audio band range. This theoretically generates an expected field of -10 dB(A/m) in the center of the Helmholtz coil which was used to validate the probe measurement at -10dB(A/m). This was verified to be within ± 0.5 dB of the -10dB(A/m) value (see Page 42).

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



Figure 4-7 Frequency Response Validation

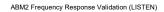
d. ABM2 Measurement Validation

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

Table 4-1
ABM2 Frequency Response Validation

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

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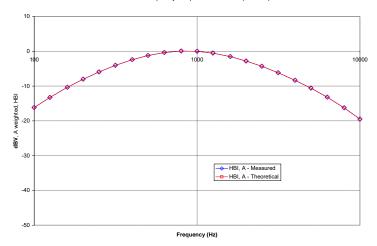
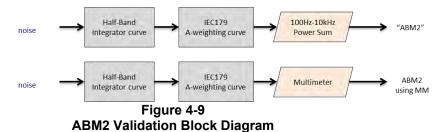


Figure 4-8
ABM2 Frequency Response Validation

The ABM2 result is a power sum from 100Hz to 10kHz with half-band integration and 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

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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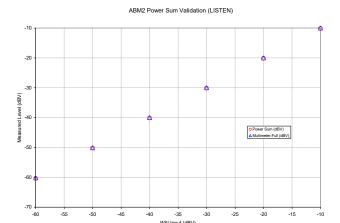
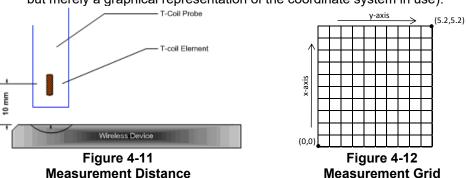


Figure 4-10
ABM2 Power Sum Validation

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):



- 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 4-14 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)

 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 Section 8 for more information regarding worst-case configurations for CDMA and UMTS. LTE configuration information can be found in Section 5 and 7. WIFI configuration information can be found in Section 6 and 7.)
- ii. Supported GSM vocoders were investigated for the worst-case ABM2 condition. GSM-EFR was deemed the worst-case condition for the GSM air interface.

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 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.

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V. Test Setup

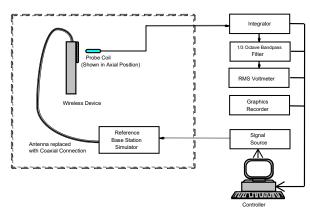


Figure 4-13
Audio Magnetic Field Test Setup

Environmental conditions such as temperature and relative humidity are monitored to ensure there are no impacts on system specifications. Proper voltage and power line frequency conditions are maintained with three phase power sources. Environmental noise and reflections are monitored through system checks.

VI. Deviation from C63.19 Test Procedure

Non-conducted RF connection due to inaccessible RF ports.

VII. Air Interface Technologies Tested

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

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VIII. Wireless Device Channels and Frequencies

1. 2G/3G Modes

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

Table 4-3
Center Channels and Frequencies

Center Chainleis 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 9-12 and 9-20 to 9-21 for LTE bandwidths and channels.

3. WIFI

The middle channel for each IEEE 802.11 standard was tested for each probe orientation. The 2.4GHz IEEE 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels. The 5GHz IEEE 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 9-13 to 9-16 and 9-22 to 9-25 for WIFI standards and channels.

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IX. Test Flow

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

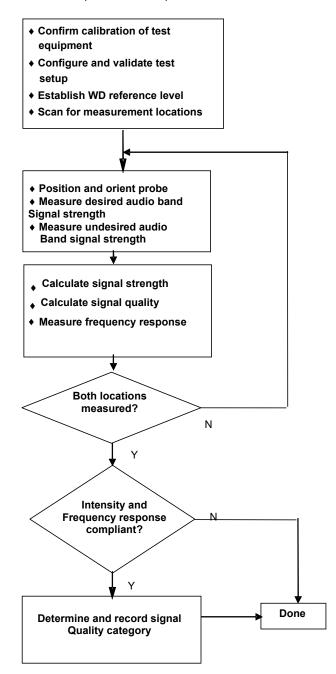


Figure 4-14 C63.19 T-Coil Signal Test Process

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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.

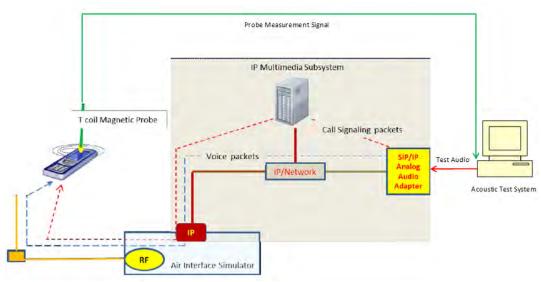


Figure 5-1
Test Setup for VoLTE over IMS T-Coil Measurements

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. The effects of modulation and RB configuration were found to be independent of band and bandwidth; therefore, only one band and bandwidth were used for this investigation. 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

		VOL	_ i = over iiv	12 SIMIMIC D	y ixauio	Connigu	iation		
Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
12	707.5	23095	10	QPSK	1	0	11.46	-29.29	40.75
12	707.5	23095	10	QPSK	1	25	11.63	-31.16	42.79
12	707.5	23095	10	QPSK	1	49	11.16	-30.10	41.26
12	707.5	23095	10	QPSK	25	0	11.61	-33.16	44.77
12	707.5	23095	10	QPSK	25	12	11.12	-32.66	43.78
12	707.5	23095	10	QPSK	25	25	11.70	-33.13	44.83
12	707.5	23095	10	QPSK	50	0	11.24	-33.05	44.29
12	707.5	23095	10	16QAM	1	0	11.39	-22.99	34.38
12	707.5	23095	10	16QAM	1	25	11.36	-25.53	36.89
12	707.5	23095	10	16QAM	1	49	11.03	-24.23	35.26
12	707.5	23095	10	16QAM	25	0	11.21	-29.75	40.96
12	707.5	23095	10	16QAM	25	12	11.50	-29.70	41.20
12	707.5	23095	10	16QAM	25	25	11.59	-30.37	41.96
12	707.5	23095	10	16QAM	50	0	11.76	-31.11	42.87
12	707.5	23095	10	64QAM	1	0	11.52	-23.60	35.12
12	707.5	23095	10	64QAM	1	25	11.37	-25.94	37.31
12	707.5	23095	10	64QAM	1	49	11.61	-25.13	36.74
12	707.5	23095	10	64QAM	25	0	11.59	-30.92	42.51
12	707.5	23095	10	64QAM	25	12	11.60	-31.94	43.54
12	707.5	23095	10	64QAM	25	25	11.66	-32.27	43.93
12	707.5	23095	10	64QAM	50	0	11.71	-32.17	43.88

2. Codec Configuration

An investigation was performed to determine the audio codec configuration to be used for testing. The effects of codec configuration were found to be independent of radio configuration; therefore, only one radio configuration was used for this investigation. The WB AMR 23.85kbps 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 - Vol TF over IMS

	, , , , ,	ii v Oodoo iii	011 10212 0101 11110					
Codec Setting:	WB AMR 23.85kbps	WB AMR 6.60kbps	NB AMR 12.2kbps	NB AMR 4.75kbps	Orientation	Band / BW	Channel	
ABM1 (dBA/m)	11.46	13.51	12.58	12.78				
ABM2 (dBA/m)	-22.76	-22.82	-22.76	-22.56	Axial	Band 12 10MHz	22225	
Frequency Response	Pass	Pass	Pass	Pass	Axiai		23095	
S+N/N (dB)	34.22	36.33	35.34	35.34				

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

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Table 5-3
EVS Codec Investigation - VoLTE over IMS

Codec Setting:	EVS Primary WB 13.2kbps	EVS Primary WB 5.9kbps	EVS Primary NB 13.2kbps	EVS Primary NB 5.9kbps	Orientation	Band / BW	Channel		
ABM1 (dBA/m)	13.89	12.84	13.96	11.97					
ABM2 (dBA/m)	-22.03	-22.60	-22.36	-22.42	Axial	Band 12 10MHz	23095		
Frequency Response	Pass	Pass	Pass	Pass	Axiai				
S+N/N (dB)	35.92	35.44	36.32	34.39					

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

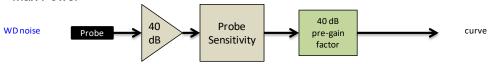


Figure 5-2
Audio Band Magnetic Curve Measurement Block Diagram

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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 · 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 5-4 **Uplink-Downlink Configurations for Type 2 Frame Structures**

	Opinik Bollinink Gon	<u>g a.</u> .	atioi	Opinik Bownink Configurations for Typo 2 Trains of actual												
Uplink-downlink	Downlink-to-Uplink Switch-point periodicity		Subframe number								Calculated Transmission					
configuration	Switch-point periodicity		1	2	3	4	5	6	7	8	9	Duty Cycle (%)				
0	5 ms	D	S	U	U	U	D	S	U	U	U	61.4%				
1	5 ms	D	S	U	U	D	D	S	U	U	D	41.4%				
2	5 ms	D	S	U	D	D	D	S	U	D	D	21.4%				
3	10 ms	D	S	U	U	U	D	D	D	D	D	30.7%				
4	10 ms	D	S	U	U	D	D	D	D	D	D	20.7%				
5	10 ms	D	S	U	D	D	D	D	D	D	D	10.7%				
6	5 ms	D	S	U	U	U	D	S	U	U	D	51.4%				

a. Power Class 3 Uplink-Downlink Configuration Investigation

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 0 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 5-5 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	11.17	-14.52	25.69
2593.0	40620	20	16QAM	1	0	1	11.54	-14.61	26.15
2593.0	40620	20	16QAM	1	0	2	11.59	-14.54	26.13
2593.0	40620	20	16QAM	1	0	3	11.01	-17.77	28.78
2593.0	40620	20	16QAM	1	0	4	11.17	-17.46	28.63
2593.0	40620	20	16QAM	1	0	5	11.55	-17.11	28.66
2593.0	40620	20	16QAM	1	0	6	11.80	-14.46	26.26

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b. Power Class 2 Uplink-Downlink Configuration Investigation

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

Table 5-6
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	11.85	-10.70	22.55
2593.0	40620	20	16QAM	1	0	2	11.94	-10.67	22.61
2593.0	40620	20	16QAM	1	0	3	11.85	-13.27	25.12
2593.0	40620	20	16QAM	1	0	4	11.07	-13.44	24.51
2593.0	40620	20	16QAM	1	0	5	11.40	-13.58	24.98

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 0 was used to evaluate Power Class 3 VoLTE over IMS and UL-DL Configuration 1 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

1. 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.

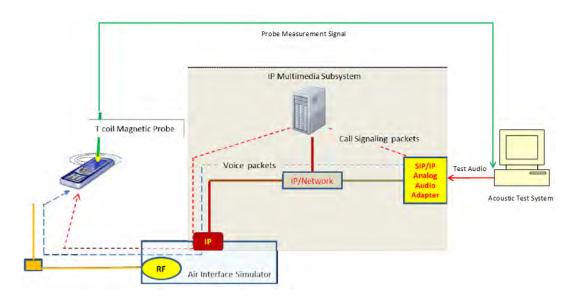


Figure 6-1
Test Setup for VoWIFI over IMS T-Coil Measurements

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

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 IEEE 802.11 standard:

Table 6-1
IEEE 802.11b SNNR by Radio Configuration

in the second se						
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
IEEE 802.11b	6	DSSS	1	8.75	-27.10	35.85
IEEE 802.11b	6	DSSS	2	8.86	-26.76	35.62
IEEE 802.11b	6	CCK	5.5	8.95	-27.87	36.82
IEEE 802.11b	6	CCK	11	8.92	-28.20	37.12

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

i=== oozii i gia oittiit by itaalo ooiiii galadoii							
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]	
IEEE 802.11g	6	BPSK	6	8.58	-30.86	39.44	
IEEE 802.11g	6	BPSK	9	8.81	-33.04	41.85	
IEEE 802.11g	6	QPSK	12	8.77	-30.43	39.20	
IEEE 802.11g	6	QPSK	18	8.79	-34.17	42.96	
IEEE 802.11g	6	16-QAM	24	8.78	-35.82	44.60	
IEEE 802.11g	6	16-QAM	36	8.30	-33.77	42.07	
IEEE 802.11g	6	64-QAM	48	8.77	-36.72	45.49	
IEEE 802.11g	6	64-QAM	54	8.79	-34.12	42.91	

Table 6-3
IEEE 802.11n/ac 20MHz BW SNNR by Radio Configuration

					The same of the sa		
Mode	Bandwidth [MHz]	Channel	Modulation	MCS Index	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
IEEE 802.11n	20	40	BPSK	0	8.72	-30.26	38.98
IEEE 802.11n	20	40	QPSK	1	8.67	-29.88	38.55
IEEE 802.11n	20	40	QPSK	2	8.65	-30.66	39.31
IEEE 802.11n	20	40	16-QAM	3	8.82	-30.89	39.71
IEEE 802.11n	20	40	16-QAM	4	8.47	-31.25	39.72
IEEE 802.11n	20	40	64-QAM	5	8.40	-31.36	39.76
IEEE 802.11n	20	40	64-QAM	6	8.47	-31.48	39.95
IEEE 802.11n	20	40	64-QAM	7	8.49	-31.19	39.68
IEEE 802.11ac	20	40	256-QAM	8	8.71	-31.15	39.86

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

-							
Mode	Bandwidth [MHz]	Channel	Modulation	MCS Index	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
IEEE 802.11n	40	38	BPSK	0	8.57	-30.82	39.39
IEEE 802.11n	40	38	QPSK	1	8.45	-30.92	39.37
IEEE 802.11n	40	38	QPSK	2	8.51	-31.16	39.67
IEEE 802.11n	40	38	16-QAM	3	8.54	-31.72	40.26
IEEE 802.11n	40	38	16-QAM	4	8.75	-31.70	40.45
IEEE 802.11n	40	38	64-QAM	5	8.49	-31.09	39.58
IEEE 802.11n	40	38	64-QAM	6	8.59	-30.79	39.38
IEEE 802.11n	40	38	64-QAM	7	8.64	-32.07	40.71
IEEE 802.11ac	40	38	256-QAM	8	8.49	-31.95	40.44
IEEE 802.11ac	40	38	256-QAM	9	8.71	-31.46	40.17

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2. Codec Configuration

An investigation was performed to determine the audio codec configuration to be used for testing. The effects of codec configuration were found to be independent of radio configuration; therefore, only one radio configuration was used for this investigation. The NB AMR 4.75kbps 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

		Ami Oou	o investig	ution vo				
Codec Setting:	WB AMR 23.85kbps	WB AMR 6.60kbps	NB AMR 12.2kbps	NB AMR 4.75kbps	Orientation	Band	Standard	Channel
ABM1 (dBA/m)	8.83	8.62	8.79	8.69				
ABM2 (dBA/m)	-26.91	-27.11	-26.84	-26.77	Axial	2.4GHz	IEEE 802.11b	6
Frequency Response	Pass	Pass	Pass	Pass	Axiai	2.4002	IEEE 802.11b	6
S+N/N (dB)	35.74	35.73	35.63	35.46				

Table 6-6
EVS Codec Investigation – VoWIFI over IMS

Codec Setting:	EVS Primary WB 13.2kbps	EVS Primary WB 5.9kbps	EVS Primary NB 13.2kbps	EVS Primary NB 5.9kbps	Orientation	Band	Standard	Channel
ABM1 (dBA/m)	9.86	8.80	9.96	9.17		2.4GHz	IEEE 802.11b	6
ABM2 (dBA/m)	-27.70	-26.80	-26.98	-27.87	Axial			
Frequency Response	Pass	Pass	Pass	Pass	Axiai	2.4002		
S+N/N (dB)	37.56	35.60	36.94	37.04				

Mute on; Backlight off; Max Volume; Max Contrast



Figure 6-2
Audio Band Magnetic Curve Measurement Block Diagram

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7. OTT VOIP TEST SYSTEM AND DUT CONFIGURATION

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

1. OTT VoIP Application

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

2. Equipment Setup

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

3. Audio Level Settings

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

Note: The green highlighted text is approved by FCC under the TCB PAG Re-Use Policy 388624 D01 IV. D. for T-Coil Testing for WI-FI calling and Google Duo.

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 effects of codec configuration were found to be independent of radio configuration; therefore, only one radio configuration for each applicable data mode was used for these investigations. The 6kbps codec setting was used for the audio codec on the auxiliary VoIP unit for OTT VoIP T-Coil testing. See below tables for comparisons between codec data rates on all applicable data modes:

> Table 7-1 Codec Investigation - OTT VolP (FVDO)

Oddec i	nvestigativ	JII — OII V		')
Codec Setting:	75kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	13.22	13.17		
ABM2 (dBA/m)	-31.78	-31.23	Avial	384
Frequency Response	Pass	Pass	- Axial	
S+N/N (dB)	45.00	44.40		

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)

Couco invocagation CTT von (EDGE)						
Codec Setting:	75kbps	6kbps	Orientation	Channel		
ABM1 (dBA/m)	13.71	13.52				
ABM2 (dBA/m)	-8.75	-8.49	Avial	190		
Frequency Response	Pass	Pass	- Axial			
S+N/N (dB)	22.46	22.01				

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

Touch introdugation of the transfer						
Codec Setting:	75kbps	6kbps	Orientation	Channel		
ABM1 (dBA/m)	13.68	13.50				
ABM2 (dBA/m)	-33.51	-32.14	Avial	4183		
Frequency Response	Pass	Pass	- Axial			
S+N/N (dB)	47.19	45.64				

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

	• • • • • • • • • • • • • • • • • • • •					
Codec Setting:	75kbps	6kbps	Orientation	Band / BW	Channel	
ABM1 (dBA/m)	13.05	12.96				
ABM2 (dBA/m)	-24.83	-24.38	Axial	Band 12	23095	
Frequency Response	Pass	Pass	Axiai	10MHz	23095	
S+N/N (dB)	37.88	37.34				

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

		mvoongan	011 	· • · · · · · ·		
Codec Setting:	75kbps	6kbps	Orientation	Band	Standard	Channel
ABM1 (dBA/m)	13.30	13.14				6
ABM2 (dBA/m)	-24.29	-23.87	Axial	2.4GHz	IEEE 802.11b	
Frequency Response	Pass	Pass	Axiai	2.4 G HZ		
S+N/N (dB)	37.59	37.01				

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

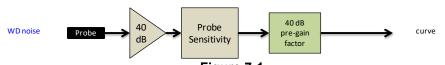


Figure 7-1 **Audio Band Magnetic Curve Measurement Block Diagram**

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2. Radio Configuration for OTT VoIP (LTE)

An investigation was performed to determine the worst-case LTE FDD band to be used for OTT VoIP testing. LTE FDD Band 66 was used for the testing as the worst-case configuration for the handset. See below table for SNNR comparison between different LTE FDD bands:

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

			• • . ,	,	•	,			
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	13.37	-26.27	39.64
12	707.5	23095	10	16QAM	1	0	13.33	-24.59	37.92
13	782.0	23230	10	16QAM	1	0	13.02	-24.58	37.60
26	831.5	26865	15	16QAM	1	0	13.19	-24.43	37.62
66	1745.0	132322	20	16QAM	1	0	13.28	-23.99	37.27
25	1882.5	26365	20	16QAM	1	0	13.27	-24.08	37.35

An investigation was performed to determine the worst-case LTE TDD band to be used for OTT VoIP testing. LTE TDD Band 41 PC2 was used for the testing as the worst-case configuration for the handset. See below table for SNNR comparison between different LTE TDD bands:

> Table 7-7 OTT VoIP (LTE TDD) SNNR by LTE Band

Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
41 (PC3)	2593.0	40620	20	16QAM	1	0	13.06	-15.20	28.26
41 (PC2)	2593.0	40620	20	16QAM	1	0	13.17	-10.61	23.78

3. LTE TDD Uplink Carrier Aggregation for OTT VolP

LTE TDD ULCA was evaluated to ensure LTE TDD standalone was the worst-case scenario. The configurations in Table 7-8 were determined from Table 7-7 and satisfy the configuration requirements as defined in 3GPP 36.101.

> Table 7-8 LTE EDD SNNR for OTT VolP Unlink Carrier Aggregation

	ETET DD CHINK TOT C							1011	Opini	in ou		<u> 1991 C</u>	gatioi				
				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]	Modulation	SCC UL# RB	SCC UL RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
CA_41C (PC3)	LTE B41	20	40620	2593.0	16QAM	1	0	LTE B41	20	40422	2573.2	16QAM	1	99	13.25	-17.35	30.60
CA_41C (PC2)	LTE B41	20	40620	2593.0	16QAM	1	0	LTE B41	20	40422	2573.2	16QAM	1	99	13.39	-13.11	26.50

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8. FCC 3G MEASUREMENTS

CDMA Test Configurations I.

Radio Configuration 1, Service Option 3 (thick, green data curve) was used for the testing as the worstcase 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:

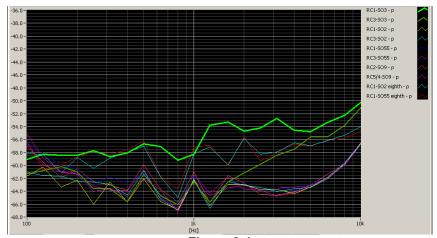
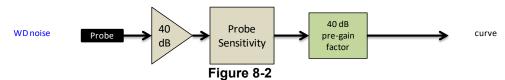


Figure 8-1 **CDMA Audio Band Magnetic Noise**

Table 8-1 FCC 3G ABM Measurements for ZNFL455DL (CDMA)

1 00 00 715 in included of including the 101 EAT E-1005E (OS in 7)										
Configuration:	RC1/SO3 RC3/SO3 RC4/SO3			Orientation	Channel					
ABM1 (dBA/m)	11.49	11.29	10.83		384					
ABM2 (dBA/m)	-20.71	-35.20	-35.51	Axial						
Frequency Response	Pass	Pass	Pass	Axiai						
S+N/N (dB)	32.20	46.49	46.34							

- 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 (thick, purple data curve) was used for the testing as the worst-case configuration for the handset. See below plot for ABM noise comparison between vocoder rates:

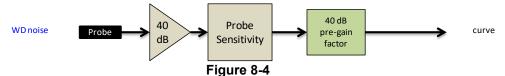


Figure 8-3 **UMTS Audio Band Magnetic Noise**

Table 8-2 **Codec Investigation - UMTS**

		co mvestigatio			
Codec Setting:	AMR 12.2kbps AMR 7.95kbps AMR 4.75kbps		Orientation	Channel	
ABM1 (dBA/m)	12.54	12.30	12.49		9400
ABM2 (dBA/m)	-33.98	-36.29	-36.48	Axial	
Frequency Response	Pass	Pass	Pass	Axidi	
S+N/N (dB)	46.52	48.59	48.97		

- 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

Consolidated Tabled Results											
		-	esponse rgin	Mag Intensity	netic / Verdict		SNNR dict	Margin from FCC Limit	C63.19-2011		
222.4	"	8.3	3.2	8.3	3.1	8.3	3.4	(dB)	Rating		
C63.19	9 Section	Axial	Radial	Axial	Radial	Axial	Radial				
	Secondary Cellular	PASS	NA	PASS	PASS	PASS	PASS				
CDMA	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-8.66	Т3		
	PCS	PASS	NA	PASS	PASS	PASS	PASS				
	Secondary Cellular	PASS	NA	PASS	PASS	PASS	PASS				
EvDO (OTT VoIP)	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-23.18	T4		
(01110)	PCS	PASS	NA	PASS	PASS	PASS	PASS				
GSM	Cellular	PASS	NA	PASS	PASS	PASS	PASS	4.00	To		
GSIVI	PCS	PASS	NA	PASS	PASS	PASS	PASS	-1.98	Т3		
EDGE	Cellular	PASS	NA	PASS	PASS	PASS	PASS	4.00	To		
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-1.96	Т3		
	Cellular	PASS	NA	PASS	PASS	PASS	PASS				
UMTS	AWS	PASS	NA	PASS	PASS	PASS	PASS	-25.13	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	-26.45	T4		
(5333500)	PCS	PASS	NA	PASS	PASS	PASS	PASS				
	B71	PASS	NA	PASS	PASS	PASS	PASS				
	B12	PASS	NA	PASS	PASS	PASS	PASS	-13.41			
LTE FDD	B13	PASS	NA	PASS	PASS	PASS	PASS		T4		
LIEFDD	B26	PASS	NA	PASS	PASS	PASS	PASS		14		
	B66	PASS	NA	PASS	PASS	PASS	PASS				
	B25	PASS	NA	PASS	PASS	PASS	PASS				
LTE FDD (OTT VoIP)	B66	PASS	NA	PASS	PASS	PASS	PASS	-15.68	Т4		
LTE TDD	B41 (PC3)	PASS	NA	PASS	PASS	PASS	PASS	-2.17	Т3		
LIL IDD	B41 (PC2)	PASS	NA	PASS	PASS	PASS	PASS	-2.17	13		
LTE TDD (OTT VoIP)	B41 (PC2)	PASS	NA	PASS	PASS	PASS	PASS	-2.19	Т3		
	IEEE 802.11b	PASS	NA	PASS	PASS	PASS	PASS				
WLAN	IEEE 802.11g	PASS	NA	PASS	PASS	PASS	PASS	-15.07	T4		
WEAK	IEEE 802.11n	PASS	NA	PASS	PASS	PASS	PASS	-13.07	14		
	IEEE 802.11ac	PASS	NA	PASS	PASS	PASS	PASS				
	IEEE 802.11b	PASS	NA	PASS	PASS	PASS	PASS				
WLAN	IEEE 802.11g	PASS	NA	PASS	PASS	PASS	PASS	-17.09	T4		
(OTT VoIP)	IEEE 802.11n	PASS	NA	PASS	PASS	PASS	PASS	-17.03	1.7		
	IEEE 802.11ac	PASS	NA	PASS	PASS	PASS	PASS				
	IEEE 802.11a	PASS	NA	PASS	PASS	PASS	PASS				
U-NII	IEEE 802.11n	PASS	NA	PASS	PASS	PASS	PASS	-16.60	T4		
	IEEE 802.11ac	PASS	NA	PASS	PASS	PASS	PASS				
11 8111	IEEE 802.11a	PASS	NA	PASS	PASS	PASS	PASS				
U-NII (OTT VoIP)	IEEE 802.11n	PASS	NA	PASS	PASS	PASS	PASS	-18.12	T4		
	IEEE 802.11ac	PASS	NA	PASS	PASS	PASS	PASS				

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I. Raw Handset Data

Table 9-2
Raw Data Results for CDMA

					ata Nosa				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
		476	10.90	-20.17		0.70	31.07	20.00	-11.07	T4	
	Axial	564	10.88	-20.42	-58.17	0.77	31.30	20.00	-11.30	T4	1.6, 3.2
Secondary		684	10.75	-21.43		0.76	32.18	20.00	-12.18	T4	
Cellular		476	3.63	-35.69			39.32	20.00	-19.32	T4	
	Radial	564	3.86	-36.02	-58.70	N/A	39.88	20.00	-19.88	T4	1.6, 2.4
		684	3.57	-36.49			40.06	20.00	-20.06	T4	
		1013	11.13	-21.19		0.94	32.32		-12.32	T4	
	Axial	384	11.19	-20.74	-58.17	0.97	31.93	20.00	-11.93	T4	1.6, 3.2
Cellular		777	11.22	-20.08		0.98	31.30	20.00	-11.30	T4	
• • • • • • • • • • • • • • • • • • •		1013	3.53	-36.96			40.49	20.00	-20.49	T4	
	Radial	384	3.87	-36.24	-58.70	N/A	40.11	20.00	-20.11	T4	1.6, 2.4
		777	3.93	-35.48			39.41	20.00	-19.41	T4	
		25	10.85	-19.84		0.74	30.69	20.00	-10.69	T4	
	Axial	600	10.82	-19.85	-58.17	0.75	30.67	20.00	-10.67	T4	1.6, 3.2
PCS		1175	10.81	-17.85		0.73	28.66	20.00	-8.66	T3	
. 30		25	3.56	-34.98			38.54	20.00	-18.54	T4	
	Radial	600	3.91	-35.44	-58.70	N/A	39.35	20.00	-19.35	T4	1.6, 2.4
		1175	3.79	-33.08			36.87	20.00	-16.87	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	18.69	-5.74		0.62	24.43	20.00	-4.43	Т3	
	Axial	190	18.54	-4.58	-58.17	0.61	23.12	20.00	-3.12	Т3	1.6, 3.2
GSM850		251	19.04	-2.94		0.73	21.98	20.00	-1.98	Т3	
GSIVIOSU		128	11.66	-22.21			33.87	20.00	-13.87	T4	
Rad	Radial	190	11.34	-21.33	-58.70	N/A	32.67	20.00	-12.67	T4	1.6, 2.4
		251	11.51	-19.62			31.13	20.00	-11.13	T4	
		512	19.03	-6.27		0.63	25.30	20.00	-5.30	Т3	
	Axial	661	18.67	-6.26	-58.17	0.67	24.93	20.00	-4.93	Т3	1.6, 3.2
CCM4000		810	18.68	-7.47		0.61	26.15	20.00	-6.15	Т3	
GSM1900		512	11.67	-22.71			34.38	20.00	-14.38	T4	
	Radial	661	11.69	-22.67	-58.70	-58.70 N/A	34.36	20.00	-14.36	T4	1.6, 2.4
		810	11.59	-23.65			35.24	20.00	-15.24	T4	

Table 9-4
Raw Data Results for UMTS

				11011 5	ata Nesu						
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		4132	12.37	-34.27		1.07	46.64	20.00	-26.64	T4	
	Axial	4183	12.27	-34.39	-58.17	1.10	46.66	20.00	-26.66	T4	1.6, 3.2
UMTS V		4233	12.33	-33.46		1.06	45.79	20.00	-25.79	T4	
OWISV		4132	5.49	-54.15			59.64	20.00	-39.64	T4	
	Radial	4183	5.49	-53.86	-58.70	N/A	59.35	20.00	-39.35	T4	1.6, 2.4
		4233	5.49	-52.94			58.43	20.00	-38.43	T4	
		1312	12.55	-34.15		1.07	46.70	20.00	-26.70	T4	
	Axial	1412	12.43	-34.46	-58.17	1.11	46.89	20.00	-26.89	T4	1.6, 3.2
UMTS IV		1513	12.39	-32.74		1.54	45.13	20.00	-25.13	T4	
OWITSTV		1312	5.50	-53.70			59.20	20.00	-39.20	T4	
	Radial	1412	5.49	-54.16	-58.70	N/A	59.65 20. 0		-39.65	T4	1.6, 2.4
		1513	5.49	-53.79			59.28	20.00	-39.28	T4	
		9262	12.19	-34.23		1.09	46.42	20.00	-26.42	T4	
	Axial	9400	12.34	-34.63	-58.17	1.08	46.97	20.00	-26.97	T4	1.6, 3.2
UMTS II		9538	12.09	-33.80		1.08	45.89	20.00	-25.89	T4	
OWISI		9262	5.43	-53.95			59.38	20.00	-39.38	T4	
	Radial	9400	5.47	-54.24	-58.70	N/A	59.71	20.00	-39.71	T4	1.6, 2.4
		9538	5.49	-53.01			58.50	20.00	-38.50	T4	

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Table 9-5 Raw Data Results for LTE B71

				- 10111								
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	133297	11.68	-26.95		1.45	38.63	20.00	-18.63	T4	
	Axial	15MHz	133297	11.56	-28.13	-58.17	1.43	39.69	20.00	-19.69	T4	1622
	Axiai	10MHz	133297	11.61	-25.97	-30.17	1.48	37.58	20.00	-17.58	T4	1.6, 3.2
LTE Band 71		5MHz	133297	11.42	-25.16		1.81	36.58	20.00	-16.58	T4	
LIE Band / I		20MHz	133297	4.90	-42.85			47.75	20.00	-27.75	T4	
	Radial	15MHz	133297	4.79	-45.10	-58.70	N/A	49.89	20.00	-29.89	T4	1604
	Radiai	10MHz	133297	5.05	-44.46	-56.70	IN/A	49.51	20.00	-29.51	T4	1.6, 2.4
		5MHz	133297	4.69	-43.17			47.86	20.00	-27.86	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	11.38	-23.24		1.48	34.62	20.00	-14.62	T4		
	Axial	5MHz	23095	11.40	-22.73	-58.17	1.53	34.13	20.00	-14.13	T4	1.6, 3.2	
	Axiai	3MHz	23095	11.50	-24.01	-50.17	1.56	35.51	20.00	-15.51	T4	1.0, 3.2	
LTE Band 12		1.4MHz	23095	11.56	-25.23		1.36	36.79	20.00	-16.79	T4		
LIE Ballu 12		10MHz	23095	4.65	-38.56			43.21	20.00	-23.21	T4		
	Radial	5MHz	23095	4.93	-40.75	50.70	N/A	45.68	20.00	-25.68	T4	1.6, 2.4	
	Naulai	3MHz	23095	4.63	-41.16	-58.70	IWA	45.79	20.00	-25.79	T4	1.0, 2.4	
		1.4MHz	23095	4.93	-41.33				46.26	20.00	-26.26	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
Ī		Axial	10MHz	23230	11.31	-23.95	-58.17	1.74	35.26	20.00	-15.26	T4	1.6, 3.2
	TE Band 13		5MHz	23230	11.35	-22.84	-56.17	1.61	34.19	20.00	-14.19	T4	1.0, 3.2
ľ	TE Band 13		10MHz	23230	4.84	-41.45	-58.70	N/A	46.29	20.00	-26.29	T4	1.6. 2.4
	Radial	5MHz	23230	5.12	-42.09	-56.70	NA	47.21	20.00	-27.21	T4	1.0, 2.4	

Table 9-8 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 Rating	Test Coordinates
		15MHz	26865	11.40	-26.14		1.58	37.54	20.00	-17.54	T4	
		10MHz	26865	11.79	-25.22		1.34	37.01	20.00	-17.01	T4	
	Axial	5MHz	26865	11.34	-24.27	-58.17	1.81	35.61	20.00	-15.61	T4	1.6, 3.2
		3MHz	26865	11.35	-24.58		1.56	35.93	20.00	-15.93	T4	
LTE Band 26		1.4MHz	26865	11.54	-25.00		1.48	36.54	20.00	-16.54	T4	
LIE Ballu 20		15MHz	26865	4.84	-42.95			47.79	20.00	-27.79	T4	
		10MHz	26865	4.68	-42.43			47.11	20.00	-27.11	T4	
	Radial	5MHz	26865	4.79	-39.39	-58.70	N/A	44.18	20.00	-24.18	T4	1.6, 2.4
		3MHz	26865	4.69	-40.77			45.46	20.00	-25.46	T4	
		1.4MHz	26865	4.89	-41.33			46.22	20.00	-26.22	T4	

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Table 9-9
Raw Data Results for LTE B66

				110.11		Journa 10																	
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	11.82	-23.69		1.60	35.51	20.00	-15.51	T4												
		15MHz	132322	11.66	-22.91		1.67	34.57	20.00	-14.57	T4												
		10MHz	132322	11.45	-22.39		1.81	33.84	20.00	-13.84	T4												
	Axial	5MHz	132647	11.45	-22.21	-58.17	1.39	33.66	20.00	-13.66	T4	1.6, 3.2											
	Axiai	5MHz	132322	11.59	-21.82	-50.17	1.52	33.41	20.00	-13.41	T4	1.0, 3.2											
	LTE Band 66	5MHz	131997	11.50	-24.47		1.84	35.97	20.00	-15.97	T4												
		3MHz	132322	11.60	-21.97		1.65	33.57	20.00	-13.57	T4												
LTE Band 66		1.4MHz	132322	11.81	-22.73		1.42	34.54	20.00	-14.54	T4												
LIE Band 00		20MHz	132322	4.82	-40.28			45.10	20.00	-25.10	T4												
		15MHz	132322	4.87	-40.77			45.64	20.00	-25.64	T4												
		10MHz	132322	4.68	-39.25	-		43.93	20.00	-23.93	T4												
	Radial -	5MHz	132647	4.72	-38.47	50.70	N/A	43.19	20.00	-23.19	T4	1604											
		5MHz	132322	4.78	-38.23	-58.70	-58.70	-58.70				-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	N/A	43.01	20.00	-23.01	T4	1.6, 2.4
		5MHz	131997	5.11	-41.23									46.34	20.00	-26.34	T4						
		3MHz	132322	5.07	-38.73																		
		1.4MHz	132322	5.33	-40.29			45.62	20.00	-25.62	T4												

Table 9-10
Raw Data Results for LTE B25

				- 10111		couito 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	26365	11.74	-24.61		1.82	36.35	20.00	-16.35	T4													
		15MHz	26365	11.75	-24.16		1.62	35.91	20.00	-15.91	T4													
	Axial	10MHz	26365	11.55	-23.51	-58.17	1.83	35.06	20.00	-15.06	T4	1.6, 3.2												
	Axiai	5MHz	26365	11.56	-22.22	-30.17	1.66	33.78	20.00	-13.78	T4	1.6, 3.2												
		3MHz	26365	11.37	-22.31		1.60	33.68	20.00	-13.68	T4													
LTE Band 25		1.4MHz	26365	11.39	-22.20		1.37	33.59	20.00	-13.59	T4													
LTE Ballu 25		20MHz	26365	4.97	-40.18			45.15	20.00	-25.15	T4													
		15MHz	26365	5.17	-40.26			45.43	20.00	-25.43	T4													
	Radial	10MHz	26365	4.96	-40.26	E9 70	N/A	45.22	20.00	-25.22	T4	1.6, 2.4												
		5MHz	26365	4.93	-39.58	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	-58.70	N/A	44.51	20.00	-24.51	T4	1.0, 2.4
		3MHz	26365	4.72	-38.58				43.30	20.00	-23.30	T4												
		1.4MHz	26365	4.96	-38.76			43.72	20.00	-23.72	T4													

Table 9-11
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 Rating	Test Coordinates
		20MHz	40620	11.61	-14.40		1.94	26.01	20.00	-6.01	T3	
	Axial	15MHz	40620	11.44	-13.95	-58.17	1.59	25.39	20.00	-5.39	T3	1.6, 3.2
	Axiai	10MHz	40620	11.50	-14.17	-50.17	1.57	25.67	20.00	-5.67	T3	1.0, 3.2
LTE Band 41		5MHz	40620	11.57	-14.34		1.58	25.91	20.00	-5.91	Т3	
LIE Band 41		20MHz	40620	4.92	-29.69			34.61	20.00	-14.61	T4	
	Radial	15MHz	40620	5.26	-29.94	-58.70	N/A	35.20	20.00	-15.20	T4	1604
	Radiai	10MHz	40620	4.71	-29.63	-56.70	IVA	34.34	20.00	-14.34	T4	1.6, 2.4
		5MHz	40620	5.09	-30.07			35.16	20.00	-15.16	T4	

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Table 9-12
Raw Data Results for LTE B41 Power Class 2

			itaw	Data N	soullo it	OLLIED	41 FOWE	olass				
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	40620	11.80	-10.48		1.53	22.28	20.00	-2.28	Т3	
		15MHz	41490	11.61	-10.56		1.09	22.17	20.00	-2.17	Т3	
		15MHz	41055	11.43	-11.39		1.54	22.82	20.00	-2.82	Т3	
	Axial	15MHz	40620	11.36	-10.89	-58.17	1.63	22.25	20.00	-2.25	Т3	1.6, 3.2
	Axiai	15MHz	40185	11.89	-10.81	-50.17	1.80	22.70	20.00	-2.70	Т3	1.6, 3.2
		15MHz	39750	11.43	-11.33		1.80	22.76	20.00	-2.76	Т3	
		10MHz	40620	11.76	-10.55		1.64	22.31	20.00	-2.31	Т3	
LTE Band 41		5MHz	40620	11.91	-10.62		1.60	22.53	20.00	-2.53	Т3	
LIE Band 41		20MHz	41490	4.63	-25.30			29.93	20.00	-9.93	Т3	
		20MHz	41055	5.07	-25.27			30.34	20.00	-10.34	T4	
		20MHz	40620	4.73	-25.38			30.11	20.00	-10.11	T4	
	D-di-l	20MHz	40185	5.22	-25.34	50.70	N//A	30.56	20.00	-10.56	T4	4004
	Radial	20MHz	39750	5.10	-28.43	-58.70	N/A	33.53	20.00	-13.53	T4	1.6, 2.4
		15MHz	40620	4.76	-25.90			30.66	20.00	-10.66	T4	
		10MHz	40620	5.09	-25.85			30.94	20.00	-10.94	T4	
		5MHz	40620	4.85	-26.01			30.86	20.00	-10.86	T4	

Table 9-13
Raw Data Results for 2.4GHz WIFI

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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	8.66	-27.54		0.77	36.20	20.00	-16.20	T4	
	Axial	6	8.64	-26.43	-58.20	0.71	35.07	20.00	-15.07	T4	1.6, 3.2
IEEE		11	8.58	-27.51		0.74	36.09	20.00	-16.09	T4	
802.11b		1	2.11	-52.05			54.16	20.00	-34.16	T4	
	Radial	6	2.20	-51.00	-58.70	N/A	53.20	20.00	-33.20	T4	1.6, 2.4
		11	2.09	-52.35			54.44	20.00	-34.44	T4	
IEEE	Axial	6	8.46	-30.04	-58.20	0.74	38.50	20.00	-18.50	T4	1.6, 3.2
802.11g	Radial	6	2.24	-51.48	-58.70	N/A	53.72	20.00	-33.72	T4	1.6, 2.4
IEEE	Axial	6	8.59	-29.93	-58.20	0.67	38.52	20.00	-18.52	T4	1.6, 3.2
802.11n	Radial	6	2.04	-53.20	-58.70	N/A	55.24	20.00	-35.24	T4	1.6, 2.4

Table 9-14
Raw Data Results for 5GHz WIFI IEEE 802.11a

Mo	de	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	8.65	-32.34	-58.20	0.78	40.99	20.00	-20.99	T4	1.6, 3.2
IEEE 8	02.11a													
		Radial	20MHz	1	40	2.13	-37.83	-58.70	N/A	39.96	20.00	-19.96	T4	1.6, 2.4

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Table 9-15 Raw Data Results for 5GHz WIFI IEEE 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	8.63	-30.78		0.79	39.41	20.00	-19.41	T4	
		20MHz	1	36	8.51	-29.87		0.69	38.38	20.00	-18.38	T4	
		20MHz	1	40	8.57	-29.74		0.72	38.31	20.00	-18.31	T4	
		20MHz	1	48	8.74	-30.48		0.68	39.22	20.00	-19.22	T4	
	Axial	40MHz	2A	54	8.62	-31.04	-58.20	0.78	39.66	20.00	-19.66	T4	1.6, 3.2
	Axidi	20MHz	2A	56	8.67	-30.29	-30.20	0.70	38.96	20.00	-18.96	T4	1.0, 3.2
		40MHz	2C	110	8.64	-31.47		0.78	40.11	20.00	-20.11	T4	
		20MHz	2C	116	8.65	-30.71		0.79	39.36	20.00	-19.36	T4	
		40MHz	3	151	8.56	-30.29		0.82	38.85	20.00	-18.85	T4	
IEEE		20MHz	3	157	8.81	-30.52		0.90	39.33	20.00	-19.33	T4	
802.11n													
		40MHz	1	38	2.07	-36.72			38.79	20.00	-18.79	T4	
		20MHz	1	40	2.10	-36.23			38.33	20.00	-18.33	T4	
		40MHz	2A	54	2.02	-36.68			38.70	20.00	-18.70	T4	
		20MHz	2A	56	1.99	-35.67			37.66	20.00	-17.66	T4	
	Radial	40MHz	2C	110	1.98	-35.60	-58.70	N/A	37.58	20.00	-17.58	T4	1.6, 2.4
	radiai	20MHz	2C	100	1.96	-35.06	-55.70	19/75	37.02	20.00	-17.02	T4	1.0, 2.4
		20MHz	2C	116	1.97	-34.63			36.60	20.00	-16.60	T4	
		20MHz	2C	140	1.98	-35.01			36.99	20.00	-16.99	T4	
		40MHz	3	151	2.00	-36.88			38.88	20.00	-18.88	T4	
		20MHz	3	157	2.01	-34.64			36.65	20.00	-16.65	T4	

Table 9-16 Raw Data Results for 5GHz WIFI IEEE 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	Test Coordinates
	Axial	40MHz	1	38	8.53	-31.43	-58.20	0.58	39.96	20.00	-19.96	T4	1.6, 3.2
IEEE	Axiai	20MHz	1	40	8.49	-30.73	-56.20	0.76	39.22	20.00	-19.22	T4	1.0, 3.2
802.11ac													
002.11ac	Radial	40MHz	1	38	2.05	-36.49	-58.70	N/A	38.54	20.00	-18.54	T4	1.6, 2.4
	Natial	20MHz	1	40	2.03	-36.36	-56.70	IN/A	38.39	20.00	-18.39	T4	1.0, 2.4

Table 9-17
Raw Data Results for EvDO (OTT VoIP)

			raw	/ Dala R	esuits ioi		JII 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	13.24	-31.10	-58.20	0.33	44.34	20.00	-24.34	T4	1.6, 3.2
EvDO	Radial	564	5.72	-50.74	-58.70	N/A	56.46	20.00	-36.46	T4	1.6, 2.4
Cellular	Axial	384	13.03	-31.54	-58.20	0.43	44.57	20.00	-24.57	T4	1.6, 3.2
EvDO	Radial	384	5.90	-51.98	-58.70	N/A	57.88	20.00	-37.88	T4	1.6, 2.4
PCS	Axial	600	13.05	-30.13	-58.20	0.30	43.18	20.00	-23.18	T4	1.6, 3.2
EvDO	Radial	600	5.93	-51.56	-58.70	N/A	57.49	20.00	-37.49	T4	1.6, 2.4

Table 9-18
Raw Data Results for EDGE (OTT VoIP)

				Data it	counto ioi		J .	,			
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
EDGE850	Axial	190	13.54	-8.42	-58.20	0.53	21.96	20.00	-1.96	Т3	1.6, 3.2
EDGE030	Radial	190	6.35	-23.48	-58.70	N/A	29.83	20.00	-9.83	Т3	1.6, 2.4
EDGE1900	Axial	661	13.62	-9.50	-58.20	0.44	23.12	20.00	-3.12	Т3	1.6, 3.2
EDGE1900	Radial	661	6.37	-24.08	-58.70	N/A	30.45	20.00	-10.45	T4	1.6, 2.4

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Table 9-19 Raw Data Results for HSPA (OTT VoIP)

Naw Data Results for Hot A (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	Test Coordinates
HSPA V	Axial	4183	13.51	-33.01	-58.20	0.31	46.52	20.00	-26.52	T4	1.6, 3.2
пога у	Radial	4183	6.26	-53.15	-58.70	N/A	59.41	20.00	-39.41	T4	1.6, 2.4
HSPA IV	Axial	1412	13.57	-32.88	-58.20	0.57	46.45	20.00	-26.45	T4	1.6, 3.2
погату	Radial	1412	6.21	-52.81	-58.70	N/A	59.02	20.00	-39.02	T4	1.6, 2.4
HSPA II	Axial	9400	13.57	-33.22	-58.20	0.33	46.79	20.00	-26.79	T4	1.6, 3.2
HOPAII	Radial	9400	6.38	-52.97	-58.70	N/A	59.35	20.00	-39.35	T4	1.6, 2.4

Table 9-20 Raw Data Results for LTE B66 (OTT VoIP)

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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 Rating	Test Coordinates
		20MHz	132322	13.34	-24.05		0.32	37.39	20.00	-17.39	T4	
		15MHz	132322	13.30	-24.27		0.37	37.57	20.00	-17.57	T4	
		10MHz	132322	13.29	-23.75		0.03	37.04	20.00	-17.04	T4	
	Axial	5MHz	132647	13.17	-22.51	-58.20	0.23	35.68	20.00	-15.68	T4	1.6, 3.2
	Axiai	5MHz	132322	13.34	-22.60	-56.20	0.26	35.94	20.00	-15.94	T4	1.6, 3.2
		5MHz	131997	13.17	-24.90		0.26	38.07	20.00	-18.07	T4	
		3MHz	132322	13.30	-22.89		0.27	36.19	20.00	-16.19	T4	
LTE Band 66		1.4MHz	132322	13.24	-23.38		0.04	36.62	20.00	-16.62	T4	
LTE Band 66		20MHz	132322	6.36	-39.11			45.47	20.00	-25.47	T4	
		15MHz	132322	6.46	-38.99			45.45	20.00	-25.45	T4	
		10MHz	132322	6.42	-39.42			45.84	20.00	-25.84	T4	
	Dadial	5MHz	132322	6.43	-39.30	E0 70	NI/A	45.73	20.00	-25.73	T4	1604
	Radial	3MHz	132657	6.34	-38.98	-58.70	N/A	45.32	20.00	-25.32	T4	1.6, 2.4
		3MHz	132322	6.24	-38.34			44.58	20.00	-24.58	T4	
		3MHz	131987	6.27	-39.85				46.12	20.00	-26.12	T4
		1.4MHz	132322	6.58	-39.05			45.63	20.00	-25.63	T4	

Table 9-21 Raw Data Results for LTE B41 PC2 (OTT VoIP)

	Raw Data Results for LTE B41 PC2 (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
		20MHz	41490	13.05	-9.14		0.43	22.19	20.00	-2.19	Т3	
		20MHz	41055	13.08	-10.23		0.79	23.31	20.00	-3.31	Т3	
		20MHz	40620	13.02	-10.46		0.98	23.48	20.00	-3.48	Т3	
	Axial	20MHz	40185	13.10	-9.82	50.00	1.03	22.92	20.00	-2.92	Т3	1.6, 3.2
	Axiai	20MHz	39750	13.13	-10.11	-58.20	0.92	23.24	20.00	-3.24	Т3	1.6, 3.2
		15MHz	40620	13.07	-10.72		0.75	23.79	20.00	-3.79	Т3	
		10MHz	40620	13.12	-10.53		0.91	23.65	20.00	-3.65	Т3	
LTE Band 41		5MHz	40620	13.08	-10.87		0.74	23.95	20.00	-3.95	Т3	
LIE Danu 41		20MHz	40620	6.22	-26.45			32.67	20.00	-12.67	T4	
		15MHz	41490	6.24	-22.17			28.41	20.00	-8.41	Т3	
		15MHz	41055	6.28	-25.27			31.55	20.00	-11.55	T4	
	Desiret	15MHz	40620	6.16	-24.87	50.70	N/A	31.03	20.00	-11.03	T4	4004
	Radial	15MHz	40185	6.12	-24.84	-58.70	N/A	30.96	20.00	-10.96	T4	1.6, 2.4
		15MHz	39750	6.17	-24.93			31.10	20.00	-11.10	T4	
		10MHz	40620	6.21	-25.02			31.23	20.00	-11.23	T4	
		5MHz	40620	6.14	-25.05			31.19	20.00	-11.19	T4	

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Table 9-22 Raw Data Results for 2.4GHz WIFI (OTT VoIP)

	Naw Data Nesults for 2:40112 Will 1 (011 Voir)											
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
		1	13.21	-24.45		0.33	37.66	20.00	-17.66	T4		
	Axial	6	13.23	-23.86	-58.20	0.45	37.09	20.00	-17.09	T4	1.6, 3.2	
IEEE		11	13.18	-24.95		0.30	38.13	20.00	-18.13	T4		
802.11b		1	6.16	-49.11			55.27	20.00	-35.27	T4		
	Radial	6	6.22	-47.80	-58.70	N/A	54.02	20.00	-34.02	T4	1.6, 2.4	
		11	6.27	-48.17			54.44	20.00	-34.44	T4		
IEEE	Axial	6	13.37	-28.52	-58.20	0.23	41.89	20.00	-21.89	T4	1.6, 3.2	
802.11g	Radial	6	6.25	-50.57	-58.70	N/A	56.82	20.00	-36.82	T4	1.6, 2.4	
IEEE	Axial	6	13.19	-27.00	-58.20	0.38	40.19	20.00	-20.19	T4	1.6, 3.2	
802.11n	Radial	6	6.18	-49.77	-58.70	N/A	55.95	20.00	-35.95	T4	1.6, 2.4	

Table 9-23 Raw Data Results for 5GHz WIFI IEEE 802.11a (OTT VoIP)

Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
IEEE	Axial	20MHz	1	40	13.23	-26.52	-58.20	0.06	39.75	20.00	-19.75	T4	1.6, 3.2
802.11a													
002.11a	Radial	20MHz	1	40	5.62	-35.14	-58.70	N/A	40.76	20.00	-20.76	T4	1.6, 2.4

Table 9-24
Raw Data Results for 5GHz WIFI IEEE 802.11n (OTT VoIP)

			w	<u> </u>	4.10 .0.	<u> </u>	· · · · · · · · · · · · · · · · · · ·		<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	
		40MHz	1	38	13.20	-26.52		0.19	39.72	20.00	-19.72	T4		
		20MHz	1	36	13.27	-24.85		0.38	38.12	20.00	-18.12	T4		
		20MHz	1	40	13.20	-25.77		0.32	38.97	20.00	-18.97	T4		
		20MHz	1	48	13.28	-25.50		0.32	38.78	20.00	-18.78	T4		
	Axial	40MHz	2A	54	13.03	-27.52	-58.20	0.21	40.55	20.00	-20.55	T4	1.6, 3.2	
	Axidi	20MHz	2A	56	13.17	-25.93	-36.20	0.25	39.10	20.00	-19.10	T4	1.0, 3.2	
		40MHz	2C	110	13.16	-26.40		0.38	39.56	20.00	-19.56	T4		
		20MHz	2C	116	13.16	-26.06		0.23	39.22	20.00	-19.22	T4		
		40MHz	3	151	13.19	-26.94		0.27	40.13	20.00	-20.13	T4		
IEEE		20MHz	3	157	13.36	-25.98		0.03	39.34	20.00	-19.34	T4		
802.11n														
002		40MHz	1	38	6.14	-35.24			41.38	20.00	-21.38	T4		
		20MHz	1	40	5.89	-34.59			40.48	20.00	-20.48	T4		
		40MHz	2A	54	6.28	-35.27			41.55	20.00	-21.55	T4		
		20MHz	2A	56	6.33	-33.69			40.02	20.00	-20.02	T4		
	Radial	40MHz	2C	110	6.20	-35.05	-58.70	N/A	41.25	20.00	-21.25	T4	1.6, 2.4	
	Itaulai	20MHz	2C	100	6.15	-33.09	-30.70	IVA	39.24	20.00	-19.24	T4	1.0, 2.4	
		20MHz	2C	116	6.33	-32.02			38.35	20.00	-18.35	T4		
		20MHz	2C	140	6.17	-32.38			38.55	20.00	-18.55	T4		
		40MHz	3	151	6.33	-35.35	-35.35	5		41.68	20.00	-21.68	T4	
		20MHz	3	157	6.39	-33.39			39.78	20.00	-19.78	T4		

Table 9-25 Raw Data Results for 5GHz WIFI IEEE 802.11ac (OTT VoIP)

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
Assiml	40MHz	1	38	13.22	-26.49	E0 20	0.44	39.71	20.00	-19.71	T4	1.6, 3.2
Axiai	20MHz	1	40	13.13	-26.02	-56.20	0.25	39.15	20.00	-19.15	T4	1.6, 3.2
	40MHz	1	38	6.39	-34.65	E0.70	NVA	41.04	20.00	-21.04	T4	1.6, 2.4
Radial	20MHz	1	40	6.20	-34.98	-58.70	70 N/A	41.18	20.00	-21.18	T4	1.0, 2.4
c	Orientation Axial Radial	Axial 40MHz 20MHz Radial 40MHz	Axial 40MHz 1 20MHz 1 Radial 40MHz 1	Axial 40MHz 1 38 20MHz 1 40 C Radial 40MHz 1 38	Axial 40MHz 1 38 13.22 20MHz 1 40 13.13	Axial Axia	Orientation Bandwidth O-Nil Channel [dB(A/m)] [dB(A/m)] [dB(A/m)] [dB(A/m)]	Orientation Bandwidth U-NII Channel ABM1 [dB(A/m)] (dB(A/m)] (dB(A/m)] Ambient Noise (dB(A/m)] (dB(A/m)] Axial 40MHz 1 38 13.22 -26.49 -58.20 0.25 -58.20 0.25 C C C C C C C C C	Orientation Bandwidth U-NII Channel ABM1 ABM2 (dB(A/m)) (dB(A/m)) (dB(A/m)) (dB) (dB)	Orientation Bandwidth U-NII Channel ABM1 ABM2 (dB(A/m)) (dB(A/m)) (dB(A/m)) (dB) (Contentation Bandwidth U-NII Channel ABM1 (dB(A/m)) ABM2 (dB(A/m)) (dB) (Orientation Bandwidth U-NII Channel ABM1 (dB(A/m)) (dB(A/m)) (dB(A/m)) (dB) (

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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.
- 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 while testing 2G/3G/4G modes.
- 6. Licensed data modes and Bluetooth were disabled while testing WIFI modes.
- 7. The Margin from FCC limit column indicates a margin from the FCC limit for compliance (T3).

B. 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 23.85kbps
- 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 66 at 5MHz is the worst-case for the Axial and Radial probe orientation.

F. LTE TDD

- 1. Power Configuration: TPC = "Max Power"
- 2. Radio Configuration: 16QAM, 1RB, 0RB offset
- 3. Power Class 3 Uplink-Downlink configuration: 0
- 4. Power Class 2 Uplink-Downlink configuration: 1
- 5. Vocoder Configuration: WB AMR 23.85kbps
- 6. The worst-case band and bandwidth combination for each probe orientation is additionally tested on the low, low-mid, high-mid, and high channels for those combinations. LTE Band 41 (Power Class 2) at 15MHz is the worst-case for the Axial probe orientation. LTE Band 41 (Power Class 2) at 20MHz is the worst-case for the Radial probe orientation.

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G. WIFI

- 1. Radio Configuration
 - a. IEEE 802.11b: DSSS, 2Mbps
 - b. IEEE 802.11g/a: QPSK, 12Mbps
 - c. IEEE 802.11n/ac 20MHz: QPSK, MCS 1
 - d. IEEE 802.11n/ac 40MHz: QPSK, MCS 1
- 2. Vocoder Configuration: NB AMR 4.75kbps
- 3. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. IEEE 802.11b is the worst-case for the Axial and Radial probe orientation.
- 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. IEEE 802.11n at 20MHz (U-NII 1) is the worst-case for the Axial probe orientation. IEEE 802.11n at 20MHz (U-NII 2C) is the worst-case for the Radial probe orientation.

H. OTT VolP

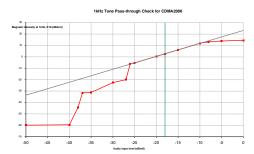
- 1. Vocoder Configuration: 6kbps
- 2. EvDO Configuration
 - a. Revision: A
- 3. EDGE Configuration
 - a. MCS Index: 7
 - b. Number of TX slots: 2
- 4. HSPA Configuration:
 - a. Release: 6
 - b. 3GPP 34.121 Subtest 1
- 5. LTE FDD Configuration:
 - a. Power Configuration: TPC = "Max Power"
 - b. Radio Configuration: 16QAM, 1RB, 0RB offset
 - c. LTE Band 66 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 66 at 5MHz is the worst-case for the Axial probe orientation. LTE Band 66 at 3MHz bandwidth is the worst-case for the Radial probe orientation.
- 6. LTE TDD Configuration:
 - a. Power Configuration: TPC = "Max Power"
 - b. Radio Configuration: 16QAM, 1RB, 0RB offset
 - c. Power Class 2 Uplink-Downlink configuration: 1
 - d. LTE Band 41 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 (Power Class 2) at 20MHz is the worst-case for the Axial probe orientation. LTE Band 41 (Power Class 2) at 15MHz is the worst-case for the Radial probe orientation.

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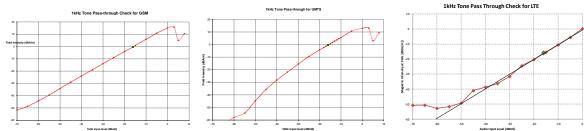
7. WIFI Configuration:

- a. Radio Configuration
 - i. IEEE 802.11b: DSSS, 2Mbps
 - ii. IEEE 802.11g/a: QPSK, 12Mbps
 - iii. IEEE 802.11n/ac 20MHz; QPSK, MCS 1
 - iv. IEEE 802.11n/ac 40MHz: QPSK, MCS 1
- b. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. IEEE 802.11b is the worst-case for the Axial and Radial probe orientation.
- 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. IEEE 802.11n at 20MHz (U-NII 1) is the worst-case for the Axial probe orientation. IEEE 802.11n at 20MHz (U-NII 2C) is the worst-case for the Radial probe orientation.

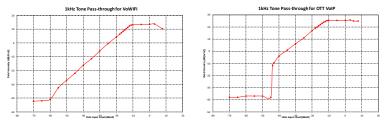
III. 1 kHz Vocoder Application Check



This model was verified to be within the linear region for ABM1 measurements at -18 dBm0 for CDMA. This measurement was taken in the axial configuration above the maximum location.



This model was verified to be within the linear region for ABM1 measurements at -16 dBm0 for GSM, 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 9-26
Helmholtz Coil Validation Table of Results – 11/04/2019

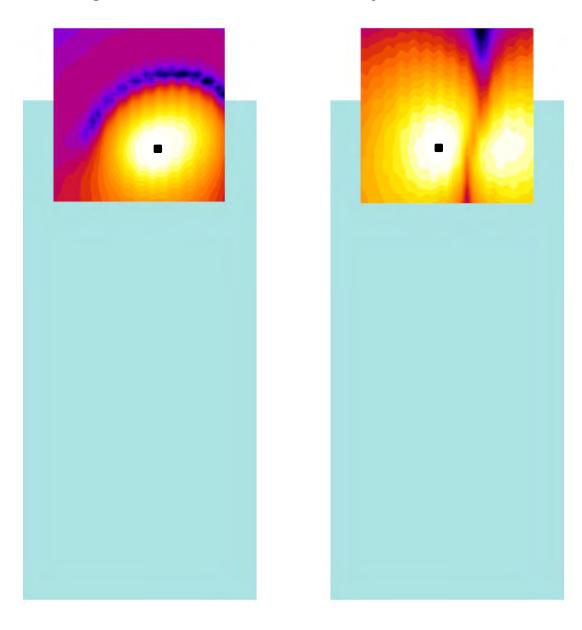
ltem	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.843	PASS
Environmental Noise	< -58 dBA/m	-58.17	PASS
Frequency Response, from limits	> 0 dB	0.70	PASS

Table 9-27
Helmholtz Coil Validation Table of Results – 11/11/2019

ltem	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.844	PASS
Environmental Noise	< -58 dBA/m	-58.20	PASS
Frequency Response, from limits	> 0 dB	0.70	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.078	PASS
Environmental Noise	< -58 dBA/m	-58.70	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS

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ABM1 Magnetic Field Distribution Scan Overlays ٧.



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)							0.71
Expanded uncertainty (k=2),	Expanded uncertainty (k=2), 95% confidence level						1.31

Notes:

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

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

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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		
Control Company	4040	Temperature / Humidity Monitor	2/28/2018	Biennial	2/28/2020	150761911		
Dell	Latitude E6540	SoundCheck Acoustic Analyzer Laptop	9/6/2018	Biennial	9/6/2020	2655082910		
Listen	SoundConnect	Microphone Power Supply	9/6/2018	Biennial	9/6/2020	0899-PS150		
RME	Fireface UC	Soundcheck Acoustic Analyzer External Audio Interface	9/6/2018	Biennial	9/6/2020	23792992		
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	1/30/2019	Annual	1/30/2020	162125		
Rohde & Schwarz	CMW500	Radio Communication tester	5/17/2019	Annual	5/17/2020	128635		
Seekonk	NC-100	Torque Wrench (8" lb)	5/10/2018	Biennial	5/10/2020	21053		
TEM	Axial T-Coil Probe	Axial T-Coil Probe	9/19/2018	Biennial	9/19/2020	TEM-1123		
TEM	Radial T-Coil Probe	Radial T-Coil Probe	9/19/2018	Biennial	9/19/2020	TEM-1129		
TEM	Helmholtz Coil	Helmholtz Coil	10/10/2018	Biennial	10/10/2020	SBI 1052		
TEM		HAC System Controller with Software	N/A		N/A	N/A		
TEM		HAC Positioner	N/A		N/A	N/A		

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12. TEST DATA

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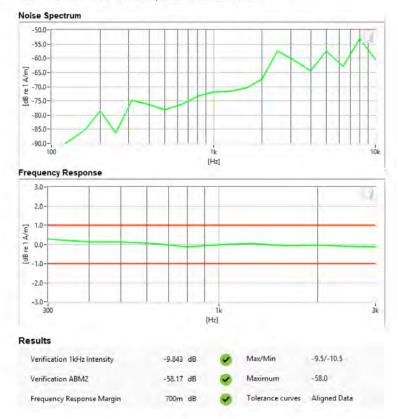
DUT: HH Coil - SN: SBI 1052

Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

Equipment:

- Probe: Axial T-Coil Probe SN: TEM-1123; Calibrated: 09/19/2018
- Helmholtz Coil SN: SBI 1052; Calibrated: 10/10/2018



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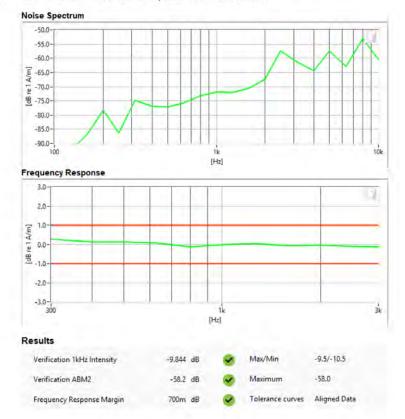
DUT: HH Coil - SN: SBI 1052

Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

Equipment:

- Probe: Axial T-Coil Probe SN: TEM-1123; Calibrated: 09/19/2018
- Helmholtz Coil SN: SBI 1052; Calibrated: 10/10/2018



FCC ID: ZNFL455DL	INGINETALNE LANGERTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 48 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Page 46 01 66



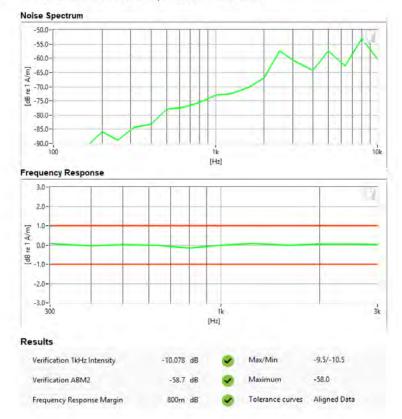
DUT: HH Coil - SN: SBI 1052

Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

Equipment:

- Probe: Radial T-Coil Probe SN: TEM-1129; Calibrated: 09/19/2018
- Helmholtz Coil SN: SBI 1052; Calibrated: 10/10/2018



FCC ID: ZNFL455DL	INCIRCIONE LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 49 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 49 01 00



Type: Portable Handset Serial: 00319

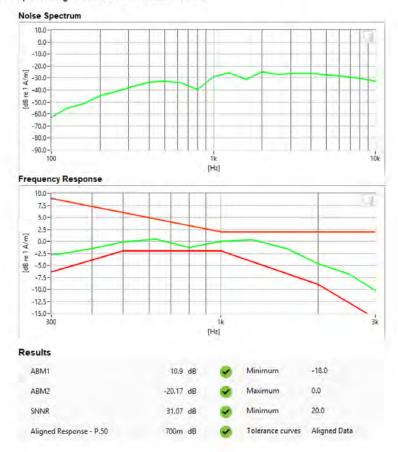
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- . Mode: Secondary Cellular CDMA
- Channel: 476
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	PETEST INCIDENCE LADDETON, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 50 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 50 01 00



Type: Portable Handset Serial: 00319

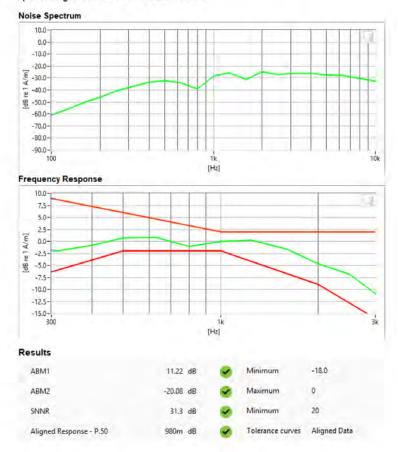
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- Mode: Cellular CDMA
- Channel: 777
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	INCHASTANC LANGESTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 51 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 51 01 00



Type: Portable Handset Serial: 00319

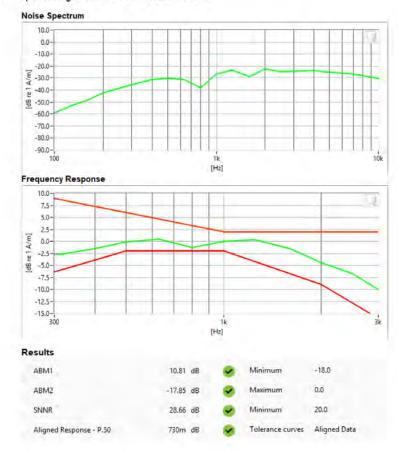
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- Mode: PCS CDMA
- Channel: 1175
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	INCIRCIANG LABORATORS, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 52 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Page 52 01 66



Type: Portable Handset Serial: 00319

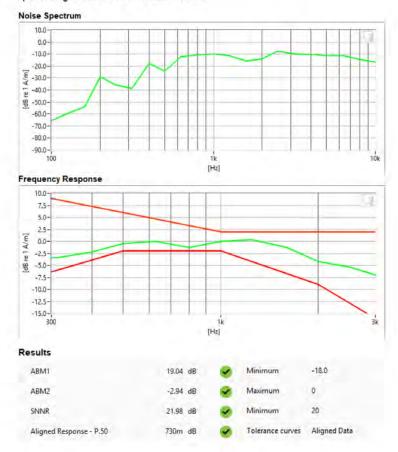
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- Mode: GSM 850
- Channel: 251
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	PCTEST* *** VECTEST* ** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* ** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* ** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* ** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* ** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* ** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* *** VECTEST* **	HAC (T-COIL) TEST REPORT	LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 53 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Fage 33 01 00



Type: Portable Handset Serial: 00319

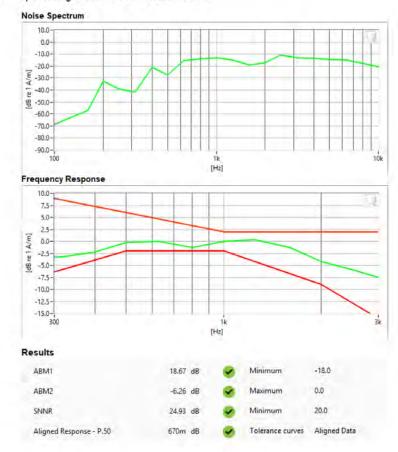
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- Mode: GSM 1900
- Channel: 661
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	INCHESTIC LADDESTON; INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 54 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 34 01 00



Type: Portable Handset Serial: 00319

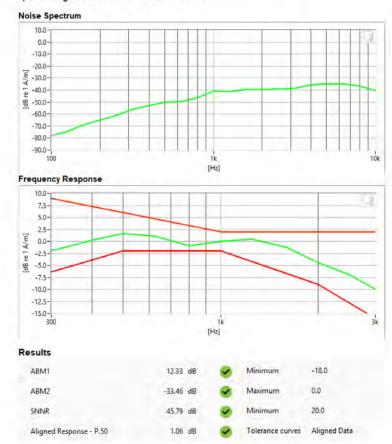
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- . Mode: UMTS Band V
- Channel: 4233
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 55 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Page 55 01 66



Type: Portable Handset Serial: 00319

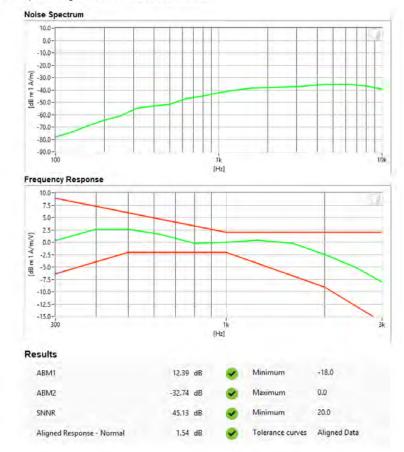
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- Mode: UMTS Band IV
- Channel: 1513
- Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	INCHASIANC LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 56 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 50 01 00



Type: Portable Handset Serial: 00319

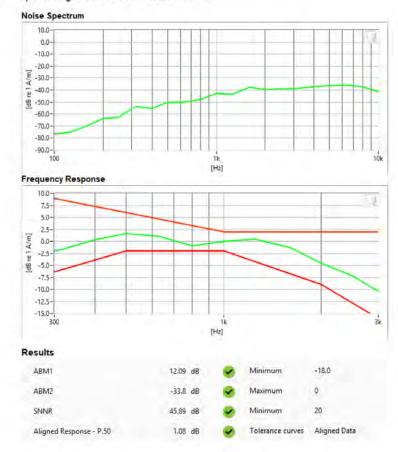
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- Mode: UMTS Band II
- Channel: 9538
- · Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	PETEST INCIDENCE LABORATORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 57 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Fage 37 01 00



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

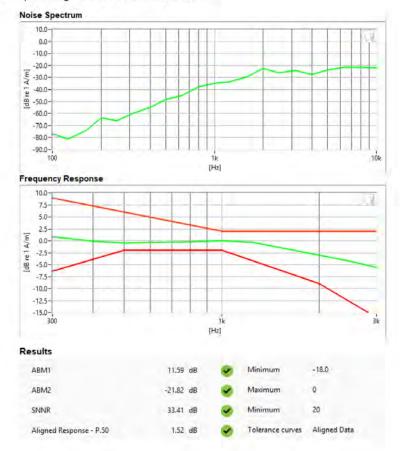
Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

Mode: LTE FDD Band 66Bandwidth: 5MHzChannel: 132322

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	PCTEST INCIDENCE LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 58 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 36 01 66



Type: Portable Handset Serial: 00319

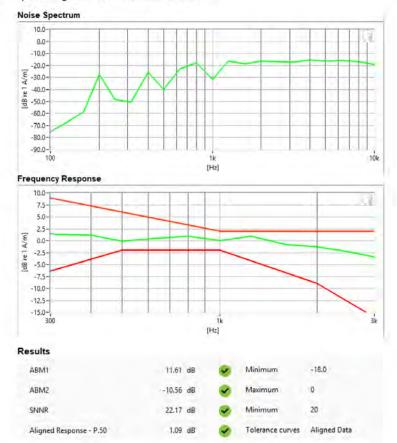
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- . Mode: LTE TDD Band 41 (PC2)
- Bandwidth: 15MHz
- Channel: 41490
- Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 59 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 39 01 66



Type: Portable Handset Serial: 00319

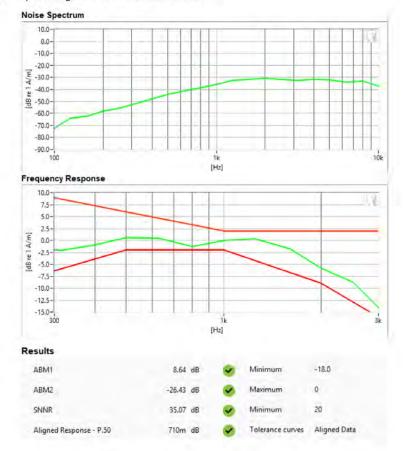
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

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



FCC ID: ZNFL455DL	INCHASTANC LANGESTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 60 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 60 01 66



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

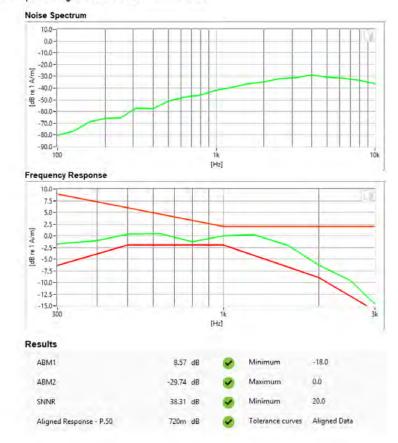
Mode: 5GHz WIFI

Standard: IEEE 802.11n (U-NII 1)

Bandwidth: 20MHz

Channel: 40

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	INCIRCIONE LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 61 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 01 01 00



Type: Portable Handset Serial: 00319

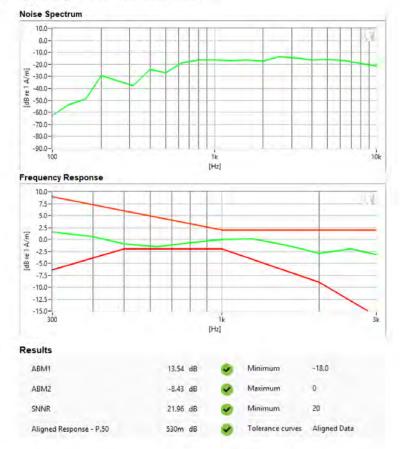
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

- VolP Application: Google Duo
- Mode: EDGE 850
- · Channel: 190
- Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL455DL	PCTEST INCIDENCE LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 62 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 02 01 00



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

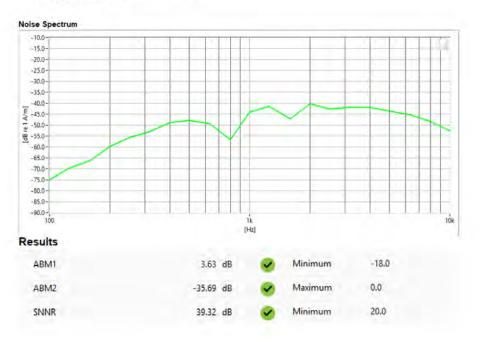
Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: Secondary Cellular CDMA

· Channel: 476



FCC ID: ZNFL455DL	INCHASTANC LANGESTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 63 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 03 01 00



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

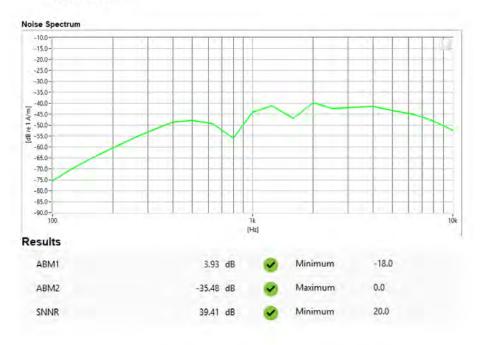
Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: Cellular CDMA

· Channel: 777



FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 64 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Fage 04 01 00



Type: Portable Handset Serial: 00319

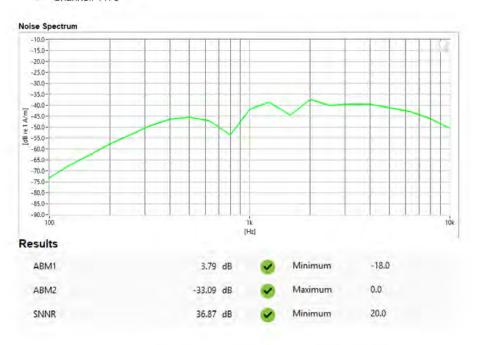
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: PCS CDMA
Channel: 1175



FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 65 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 65 01 66



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: GSM 850
 Channel: 251



FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 66 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 00 01 00



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: GSM 1900
 Channel: 661



FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 67 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 07 01 00



Type: Portable Handset Serial: 00319

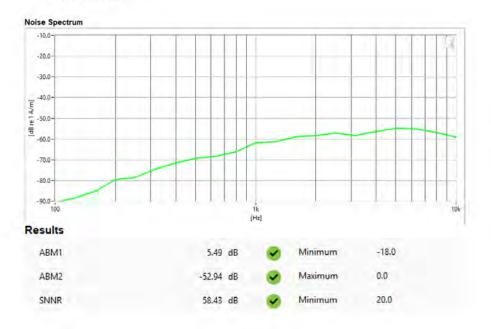
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: UMTS Band V
 Channel: 4233



FCC ID: ZNFL455DL	INCHASTANC LANGESTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 68 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 00 01 00



Type: Portable Handset Serial: 00319

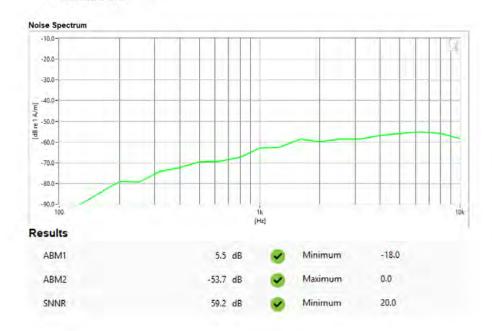
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: UMTS Band IV
 Channel: 1312



FCC ID: ZNFL455DL	INCHESTANC LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 69 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 09 01 00



Type: Portable Handset Serial: 00319

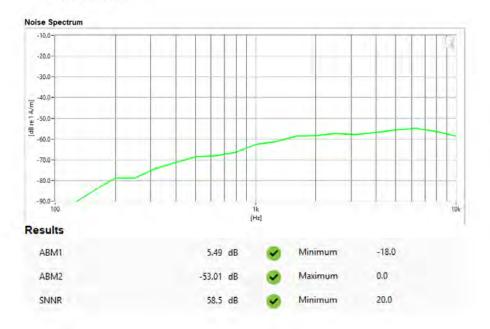
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: UMTS Band II
Channel: 9538



FCC ID: ZNFL455DL	INCHASTANC LANGESTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 70 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 70 01 00



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: LTE FDD Band 66Bandwidth: 5MHz



FCC ID: ZNFL455DL	INCHESTANCE LABORATION, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 71 of 99
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Page 71 of 88



Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: LTE TDD Band 41 (PC2)

Bandwidth: 20MHzChannel: 41490



FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 72 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Fage 72 01 00



DUT: ZNFL455DL

Type: Portable Handset Serial: 00319

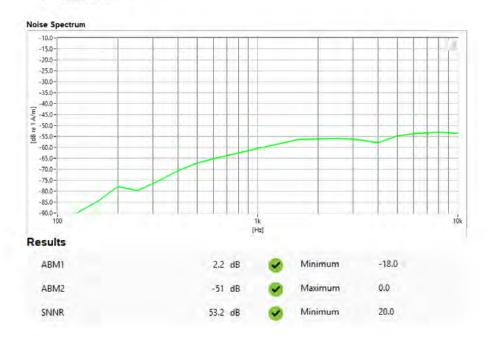
Measurement Standard: ANSI C63.19-2011

Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

- Mode: 2.4GHz WIFI
- Standard: IEEE 802.11b
- Channel: 6



PCTEST 2019

FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 73 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 73 01 00



DUT: ZNFL455DL

Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

Equipment:

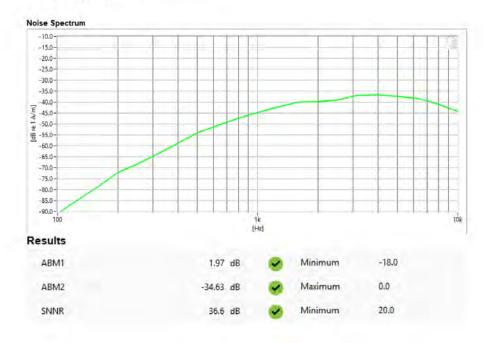
Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

Mode: 5GHz WIFI

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

Bandwidth: 20MHzChannel: 116



PCTEST 2019

FCC ID: ZNFL455DL	INCHASTANC LANGESTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 74 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Page 74 01 00



DUT: ZNFL455DL

Type: Portable Handset Serial: 00319

Measurement Standard: ANSI C63.19-2011

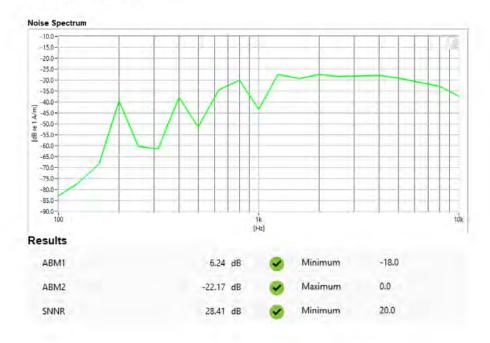
Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 09/19/2018

Test Configuration:

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

Bandwidth: 15MHzChannel: 41490



PCTEST 2019

FCC ID: ZNFL455DL	INGINETALNE LANGERTORY, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 75 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 75 01 00

13. CALIBRATION CERTIFICATES

FCC ID: ZNFL455DL	INCIDENCE LABORATORS, INC.	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 76 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 70 01 00



Certificate of Calibration

for

AXIAL T COIL PROBE

Manufactured by:

TEM CONSULTING LP

Model No: Serial No: AXIAL T COIL PROBE

Calibration Recall No:

TEM-1123 29156

Submitted By:

Customer:

Andrew Harwell

Company: Address:

PCTest Engineering Lab 6660-B Dobbin Road

Columbia

MD 21045

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

West Caldwell Calibration Laboratories Procedure No.

AXIAL T C TEM C

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

V (XH 12/4/2019

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.
The information supplied relates to the calibrated item listed above.
West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

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

Approved by: Fo

Calibration Date:

19-Sep-18

Felix Christopher (QA Mgr.)

Certificate No:

29156 -2

West Caldwell

ISO/IEC 17025:2005

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

Certificate Page 1 of 1

ACCREDITED

Calibration uncompromised calibration Laboratories, Inc.

1575 State Route 96, Victor, NY 14564, U.S.A.

Calibration Lab. Cert. # 1533.01

FCC ID: ZNFL455DL

HAC (T-COIL) TEST REPORT

Filename:

1M1910280174-11-R1.ZNF

Test Dates:

11/04/19 - 11/14/19

Portable Handset

Approved by:
Quality Manager
Page 77 of 88

HCATEMC_TEM-1123_Sep-19-2018



ISO/IEC 17025: 2005

ACCREDITED

Calibration Lab. Cert. # 1533.01

1575 State Route 96, Victor NY 14564

REPORT OF CALIBRATION

for

TEM Consulting LP Axial T Coil Probe Company: PCTest Enginering Lab

Model No.: Axial T Coil Probe

Serial No.: TEM-1123

I. D. No.; XXXX

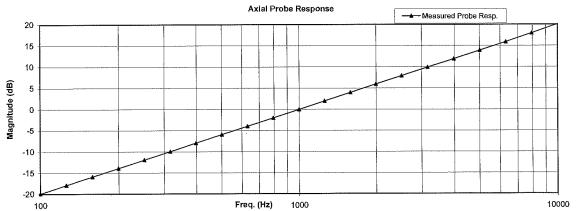
Probe Sensitivity measured wit	h Helmholf	z Coil			
Helmholtz Coil;			Before & after data same:	X .:.	
the number of turns on each coil;	10	No.			
the radius of each coil, in meters;	0.204	m	Laboratory Environment:		
the current in the coils, in amperes.;	0.08	Α	Ambient Temperature:	22.7	°C
Helmholtz Coil Constant;	7.09	A/m/V	Ambient Humidity:	52.1	% RH
Helmholtz Coil magnetic field;	5.95	A/m	Ambient Pressure:	99.326	kPa
			Calibration Date:	19-Sep-2018	
Probe Sensitivity at	1000	Hz.	Calibration Due:		
was	-59.89	dBV/A/m	Report Number:	29156	-2
	1.013	mV/A/m	Control Number:	29156	ì
Probe resistance	903	Ohms			

This Calibration is traceable through NIST test numbers:

683/284413-14

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

Graph represents Probes Frequency Response.



The above listed instrument was checked using calibration procedure documented in West Caldwell

Calibration Laboratories Inc. procedure :

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

Calibration was performed by 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: 19-Sep-2018

Measurements performed by:

James Zhu

Calibrated on WCCL system type 9700

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

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FCC ID: ZNFL455DL	INCHASTANC LANGESTON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 78 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		Page 76 01 00

HCATEMC_TEM-1123_Sep-19-2018

West Caldwell Calibration Laboratories Inc.

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

Calibration Data Record

for

TEM Consulting LP Axial T Coil Probe Company: PCTest Enginering Lab

Model No.: Axial T Coil Probe

Serial No.: TEM-1123

Function	Tolera	nce	Measured values			
			Before	Out	Remarks	
Probe Sensitivity at	1000 Hz.	dBV/A/m	-59.89			
		dB				
Probe Level Linearity		6	6.03			
	Ref. (0 dB)	0	0.00			
		-6	-6.03			
		-12	-12.05			
W		Hz				
Probe Frequency Response						
					į	
		398				
		501	-6.0			
		631	-4.0			
		794	-2.0			
	Ref. (0 dB)	1000	0.0			
		1259	2.0			
		1585	4.0			
		1995	5.9			
		2512	7.9			
		3162	9.9			
		3981	11.9			
		5012	13.9			
		6310	15.9			
		7943	18.0			
		10000	20.1			
		Probe Sensitivity at 1000 Hz. Probe Level Linearity Ref. (0 dB)	Probe Sensitivity at 1000 Hz. dBV/A/m Probe Level Linearity Ref. (0 dB) Ref. (0 dB) O -6 -12 Probe Frequency Response Hz Probe Frequency Response 100 126 158 200 251 316 398 501 631 794 Ref. (0 dB) 1000 1259 1585 1995 2512 3162 3981 5012 6310 7943	Probe Sensitivity at 1000 Hz. dBV/A/m -59.89 Probe Level Linearity 6 6 6.03 Ref. (0 dB) 0 0.00 -6 -6.03 -12 -12.05 Probe Frequency Response 100 -19.9 158 -15.9 200 -13.9 251 -11.9 316 -9.9 398 -7.9 501 -6.0 631 -4.0 794 -2.0 Ref. (0 dB) 1000 0.0 1259 2.0 Ref. (0 dB) 1000 0.0 1259 2.0 1585 4.0 1995 5.9 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 -59.89 Probe Level Linearity Ref. (0 dB) 0 0.00 Ref. (0 dB) 0 0.00 -6 -6.03 -12 -12.05 Probe Frequency Response 100 -19.9 126 -17.9 158 -15.9 200 -13.9 251 -11.9 316 -9.9 398 -7.9 501 -6.0 631 -4.0 794 -2.0 Ref. (0 dB) 1000 0.0 1259 2.0 1865 4.0 1995 5.9 2512 7.9 3162 9.9 3981 11.9 5012 13.9 6310 15.9 7943 18.0	

Instruments used for o	alibration:		Date of Cal.	Traceablity No.	Due Date
HP	34401A	S/N US360641	25-Jul-2018	,287708	25-Jul-2019
HP	34401A	S/N US361024	25-Jul-2018	,287708	25-Jul-2019
HP	33120A	S/N US360437	25-Jul-2018	,287708	25-Jul-2019
B&K	2133	S/N 1583254	25-Jul-2018	683/284413-14	25-Jul-2019

Cal. Date: 19-Sep-2018

Calibrated on WCCL system type 9700

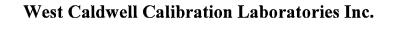
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Tested by: James Zhu

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

Page 2 of 2

FCC ID: ZNFL455DL	PETEST INCINCTING LADDETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 79 of 88
1M1910280174-11-R1.ZNF	11/04/19 - 11/14/19	Portable Handset		rage 79 01 00



Certificate of Calibration

RADIAL T COIL PROBE

Manufactured by:

TEM CONSULTING LP

Model No:

RADIAL T COIL PROBE

Serial No: Calibration Recall No: TEM-1129 29156

Submitted By:

Customer:

Andrew Harwell

Company: Address:

PCTest Engineering Lab 6660-B Dobbin Road

Columbia

MD 21045

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

West Caldwell Calibration Laboratories Procedure No.

RADIAL T TEM C

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

Within (X)

tolerance of the indicated specification. See attached Report of Calibration. The information supplied relates to the calibrated item listed above.

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

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

Approved by: FC

Calibration Date:

19-Sep-18

Felix Christopher (QA Mgr.)

Certificate No:

29156 -1

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

Certificate Page 1 of 1

ISO/IEC 17025:2005

West Caldwell Calibration

uncompromised calibration Laboratories. Inc.

1575 State Route 96, Victor, NY 14564, U.S.A.

Calibration Lab. Cert. # 1533.01

Approved by: FCC ID: ZNFL455DL HAC (T-COIL) TEST REPORT LG Quality Manager Filename: Test Dates: **DUT Type:** Page 80 of 88 Portable Handset 1M1910280174-11-R1.ZNF 11/04/19 - 11/14/19

HCRTEMC_TEM-1129_Sep-19-2018



1575 State Route 96, Victor NY 14564



REPORT OF CALIBRATION

TEM Consulting LP Radial T Coil Probe ,Company: PCTest Engineering Lab

Model No.: Radial T Coil Probe

Serial No.: TEM-1129

I. D. No.: XXXX

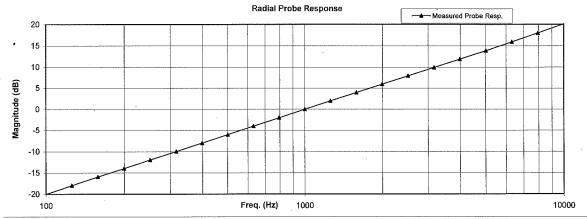
Probe Sensitivity measured wit	h Helmholf	z Coil			
Helmholtz Coil;			Before & after data same:	X	
the number of turns on each coil;	10	No.			
the radius of each coil, in meters;	0.204	m	Laboratory Environment:		
the current in the coils, in amperes.;	0.08	Α	Ambient Temperature:	22.7	°C
Helmholtz Coil Constant;	7.09	A/m/V	Ambient Humidity:	52.1	% RH
Helmholtz Coil magnetic field;	5.95	A/m	Ambient Pressure:	99.326	kPa
			Calibration Date:	19-Sep-2018	
Probe Sensitivity at	1000	Hz.	Re-calibration Due:		
was	-60.37	dBV/A/m	Report Number:	29156	-1
	0.958	mV/A/m	Control Number:	29156	i
Probe resistance	886	Ohms			

This Calibration is traceable through NIST test numbers:

683/284413-14

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

Graph represents Probes Frequency Response.



The above listed instrument was checked using calibration procedure documented in West Caldwell

Calibration Laboratories Inc. procedure :

Rev. 7.0 Jan. 24, 2014 Doc. # 1038 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, ISQ 17025

Cal. Date: 19-Sep-2018

Measurements performed by:

Calibrated on WCCL system type 9700

James Zhu

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

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Filename:	Test Dates:	DUT Type:		Page 81 of 88
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HCRTEMC_TEM-1129_Sep-19-2018

West Caldwell Calibration Laboratories Inc.

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

Calibration Data Record

TEM Consulting LP Radial T Coil Probe Company: PCTest Engineering Lab

for Model No.: Radial T Coil Probe

Serial No.: TEM-1129

i Olera	Tolerance			Measured values			
		Before	Out	Remarks			
1000 Hz.	dBV/A/m	-60.37					
	dB						
	6	6.03					
Ref. (0 dB)	0	0.00					
	-6	-6.03					
	-12	-12.05					
	Hz						
e	100	-20.0					
	126	-17.9					
	158	-15.9					
	200	-14.0					
	251	-12.0					
	316	-10.0					
	398	-8.0		į			
	501	-6.0					
	631	-4.0					
		-2.0					
Ref. (0 dB)	1000	0.0					
	1259	2.0					
	1585	4.0					
	1995	6.0					
		7.9					
		9.9					
	3981	11.9					
	5012	13.9					
	6310	15.9					
	7943	18.0					
	10000	20.1					
	Ref. (0 dB)	794 Ref. (0 dB) 1000 1259 1585 1995 2512 3162 3981 5012 6310 7943	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	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 calibration:			Date of Cal.		Due Date
' HP	34401A	S/N US360641	25-Jul-2018	,287708	25-Jul-2019
HP	34401A	S/N US361024	25-Jul-2018	,287708	25-Jul-2019
HP	33120A	S/N US360437	25-Jul-2018	,287708	25-Jul-2019
B&K	2133	S/N 1583254	25-Jul-2018	683/284413-14	25-Jul-2019

Cal. Date: 19-Sep-2018

Calibrated on WCCL system type 9700

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Tested by: James Zhu

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

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FCC ID: ZNFL455DL	INCHESTIC LADDESTON; INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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14. CONCLUSION

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

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

FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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15. REFERENCES

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FCC ID: ZNFL455DL	INCINESTING LADDRETON, INC	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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