

## 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: 6/10/2019 - 6/12/2019 Test Site/Location: PCTEST Lab, Columbia, MD, USA Test Report Serial No.: 1M1905200075-11-R1.ZNF

**Date of Issue:** 6/24/2019

FCC ID: ZNFQ720VS

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:** LM-Q720VSP

Additional Model(s): LM-Q720VS, LM-Q720VSPP, LMQ720VS, LMQ720VSP,

LMQ720VSPP, Q720VS, Q720VSP, Q720VSPP, LM-Q720VSPB, LMQ720VSPB, Q720VSPB

**Test Device Serial No.:** Pre-Production Sample [S/N: 02831]

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

Note: This revised Test Report (S/N: 1M1905200075-11-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

<sup>&</sup>lt;sup>1</sup> FCC Rule & Order, WT Docket 01-309 RM-8658

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#### **DUT DESCRIPTION** 2.



FCC ID: ZNFQ720VS

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

1000 Sylvan Avenue

Englewood Cliffs, NJ 07632

**United States** 

Model: LM-Q720VSP

LM-Q720VS, LM-Q720VSPP, LMQ720VS, LMQ720VSP,

LMQ720VSPP, Q720VS, Q720VSP, Q720VSPP, Additional Model(s):

LM-Q720VSPB, LMQ720VSPB, Q720VSPB

Serial Number: 02831 HW Version: Rev.1.0 SW Version: Q720VS0Ca Antenna: Internal Antenna DUT Type: Portable Handset

### Table 2-1 ZNFQ720VS HAC Air Interfaces

Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service	Audio Codec Evaluated
	835	VO	Yes	Yes: WIFI or BT	CMRS Voice <sup>1</sup>	EVRC
CDMA	1900		163		Cirillo Tolice	21110
	EvDO	VD	Yes	Yes: WIFI or BT	Google Duo <sup>2</sup>	OPUS
	850	vo	Yes	Yes: WIFI or BT	CMRS Voice <sup>1</sup>	EFR
GSM	1900	VO	163	res. Will of Bi	CIVINS VOICE	EIN
	GPRS/EDGE	VD	Yes	Yes: WIFI or BT	Google Duo <sup>2</sup>	OPUS
	850	VD	Yes	Yes: WIFI or BT	CMRS Voice <sup>1</sup>	NB AMR
UMTS	1900	VD	res	res. WIFI OF BT	CIVINS VOICE	ND AIVIN
	HSPA	VD	Yes	Yes: WIFI or BT	Google Duo²	OPUS
	780 (B13)					
	850 (B5)					VoLTE: NB AMR, WB AMR Google Duo: OPUS
LTE (FDD)	1700 (B4)	VD	Yes	Yes: WIFI or BT	VoLTE <sup>1</sup> , Google Duo <sup>2</sup>	
	1700 (B66)					doogle buo. or os
	1900 (B2)					
	2450					
	5200 (U-NII 1)					
WIFI	5300 (U-NII 2A)	VD	Yes	Yes: CDMA, GSM, UMTS, or LTE	VoWIFI², Google Duo²	VoWIFI: NB AMR, WB AMR Google Duo: OPUS
	5500 (U-NII 2C)	)0 (U-NII 2C)		Google Duo. OPO3		
	5800 (U-NII 3)					
ВТ	2450	DT	No	Yes: CDMA, GSM, UMTS, or LTE	N/A	N/A
Type Transport			Notes:			

Type Transport

VO = Voice Only

DT = Digital Data - Not intended for Voice Services VD = CMRS and/or IP Voice over Data Transport

1. Reference level in accordance with 7.4.2.1 of ANSI C63.19-2011 and July 2012 C63 VoLTE Interpretation.

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

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#### I. LTE Band Selection

This device supports the following pair of LTE bands with similar frequencies: LTE B4 & B66. This pair of LTE bands has the same target power and shares the same transmission path. Since the supported frequency span for the smaller LTE band is completely covered by the larger LTE band, only the larger LTE band (LTE B66) was evaluated for hearing-aid compliance.

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#### 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.

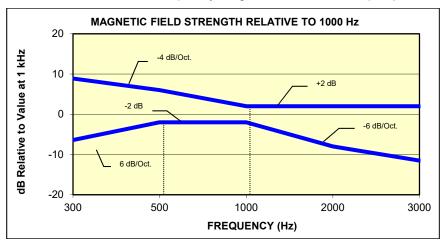


Figure 3-1 Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB(A/m) at 1 kHz

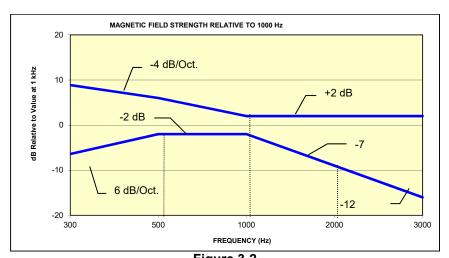


Figure 3-2 Magnetic Field frequency response for wireless devices with an axial field that exceeds -15 dB(A/m) at 1 kHz

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### **Signal Quality**

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

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

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

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

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## 4. METHOD OF MEASUREMENT

# I. Test Setup

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

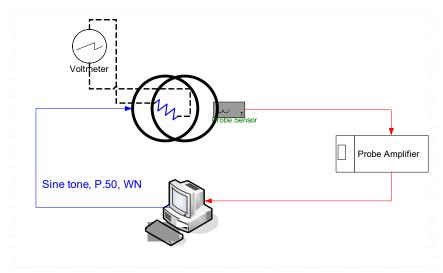


Figure 4-1 Validation Setup with Helmholtz Coil

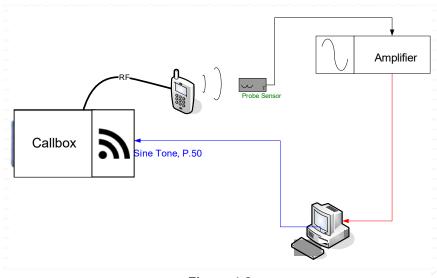


Figure 4-2 T-Coil Test Setup

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## II. Scanning Mechanism

Manufacturer: TEM

Accuracy: ± 0.83 cm/meter

Minimum Step Size: 0.1 mm

Maximum speed 6.1 cm/sec

Line Voltage: 115 VAC

Line Frequency: 60 Hz

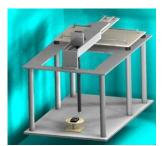
Material Composite: Delrin (Acetal)

Data Control: Parallel Port

Dynamic Range (X-Y-Z): 45 x 31.75 x 47 cm

Dimensions: 36" x 25" x 38" Operating Area: 36" x 49" x 55"

Reflections: < -20 dB (in anechoic chamber)



**Figure 4-3** RF Near-Field Scanner

#### III. ITU-T P.50 Artificial Voice

Manufacturer: ITU-T

Active Frequency Range: 100 Hz – 8 kHz

Stimulus Type: Male and Female, no spaces

Single Sample 20.96 seconds

Duration: 20.96 seco

Activity Level: 100%

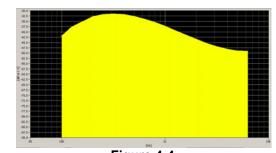


Figure 4-4
Spectral Characteristic of full P.50

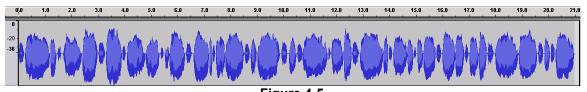
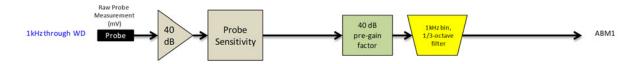


Figure 4-5
Temporal Characteristic of full P.50

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ABM2 Measurement Block Diagram:



Figure 4-6 Magnetic Measurement Processing Steps

#### IV. **Test Procedure**

- 1. Ambient Noise Check per C63.19 §7.3.1
  - Ambient interference was monitored using a Real-Time Analyzer between 100-10,000 Hz with 1/3 octave filtering.
  - "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.
  - b. ABM1 Validation

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

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

Where H<sub>c</sub> = 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 37).

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c. Frequency Response Validation

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

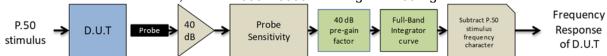


Figure 4-7 Frequency Response Validation

#### d. ABM2 Measurement Validation

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

Table 4-1
ABM2 Frequency Response Validation

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

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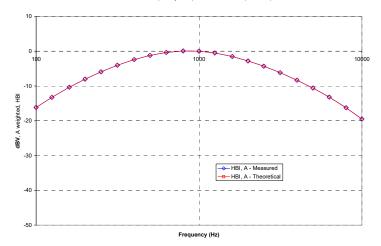
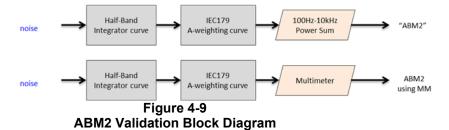


Figure 4-8
ABM2 Frequency Response Validation

The ABM2 result is a power sum from 100Hz to 10kHz with half-band integration and A-weighting. To verify the power sum measurement, a power sum over the full band was measured and verified to track with the source level (See Figure 4-9). Therefore the setup in this step was used to verify the power sum post-processing for ABM2 measurements. See below block diagram:



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

Table 4-2
ABM2 Power Sum Validation

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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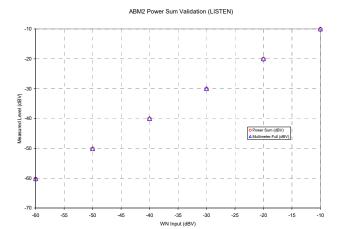
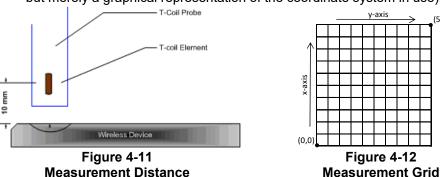


Figure 4-10
ABM2 Power Sum Validation

- 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 <sup>TM</sup>	TDMA (22 and 11 Hz)	-18

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(5.2,5.2)

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

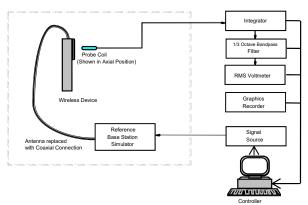


Figure 4-13
Audio Magnetic Field Test Setup

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

Test frequencies & associated channels				
Channel	Frequency (MHz)			
Cellular 850				
384 (CDMA)	836.52			
190 (GSM)	836.60			
4183 (UMTS)	836.60			
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. The middle channel and supported bandwidths from the worst-case band according to Table 7-6 was additionally evaluated with OTT VoIP for each probe orientation. See Tables 9-5 to 9-8, as well as Table 9-16 for LTE bandwidths and channels.

#### 3. WIFI

The middle channel for each 802.11 standard was tested for each probe orientation. The 2.4GHz 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels. The 5GHz 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested on higher U-NII bands as well as applicable low and high channels. See Tables 9-9 to 9-12 as well as Tables 9-17 to 9-20 for WIFI standards and channels.

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## IX. Test Flow

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

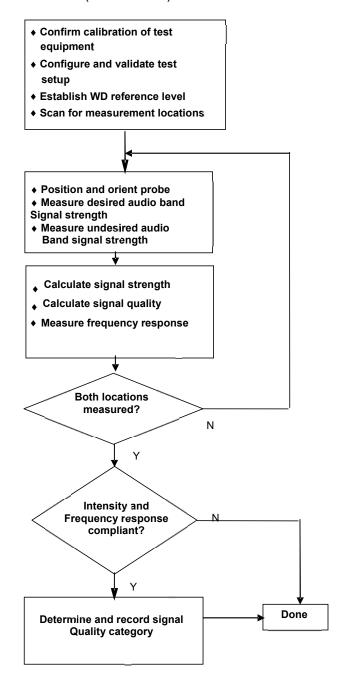


Figure 4-14 C63.19 T-Coil Signal Test Process

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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.

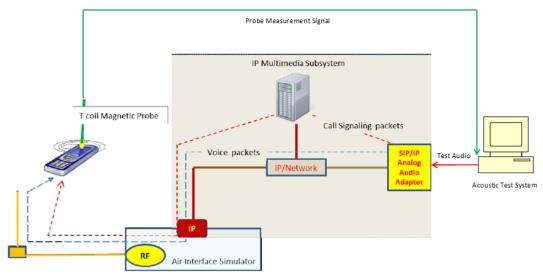


Figure 5-1
Test Setup for VoLTE over IMS T-Coil Measurements

## 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.

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<sup>\*</sup> http://c63.org/documents/misc/posting/new\_interpretations.htm

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

## 1. Radio Configuration

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

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

Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
13	782.0	23230	10	QPSK	1	0	1.97	-50.11	52.08
13	782.0	23230	10	QPSK	1	25	2.12	-49.15	51.27
13	782.0	23230	10	QPSK	1	49	2.11	-48.65	50.76
13	782.0	23230	10	QPSK	25	0	2.13	-52.13	54.26
13	782.0	23230	10	QPSK	25	12	2.41	-52.61	55.02
13	782.0	23230	10	QPSK	25	25	2.05	-51.72	53.77
13	782.0	23230	10	QPSK	50	0	2.03	-51.89	53.92
13	782.0	23230	10	16QAM	1	0	2.26	-45.96	48.22
13	782.0	23230	10	16QAM	1	25	2.02	-48.76	50.78
13	782.0	23230	10	16QAM	1	49	2.49	-48.07	50.56
13	782.0	23230	10	16QAM	25	0	2.00	-52.07	54.07
13	782.0	23230	10	16QAM	25	12	2.31	-52.56	54.87
13	782.0	23230	10	16QAM	25	25	1.90	-53.15	55.05
13	782.0	23230	10	16QAM	50	0	2.00	-52.78	54.78
13	782.0	23230	10	64QAM	1	0	2.01	-47.50	49.51
13	782.0	23230	10	64QAM	1	25	2.36	-49.73	52.09
13	782.0	23230	10	64QAM	1	49	2.50	-47.34	49.84
13	782.0	23230	10	64QAM	25	0	2.02	-51.12	53.14
13	782.0	23230	10	64QAM	25	12	2.07	-52.52	54.59
13	782.0	23230	10	64QAM	25	25	2.18	-52.44	54.62
13	782.0	23230	10	64QAM	50	0	2.04	-52.65	54.69

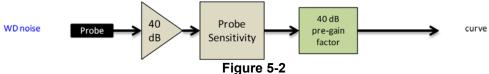
### 2. Codec Configuration

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

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

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)	3.28	2.05	3.21	3.27			23230
ABM2 (dBA/m)	-45.75	-45.77	-45.07	-45.41	Axial	Band 13 10MHz	
Frequency Response	Pass	Pass	Pass	Pass	Axiai		
S+N/N (dB)	49.03	47.82	48.28	48.68			

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



**Audio Band Magnetic Curve Measurement Block Diagram** 

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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.

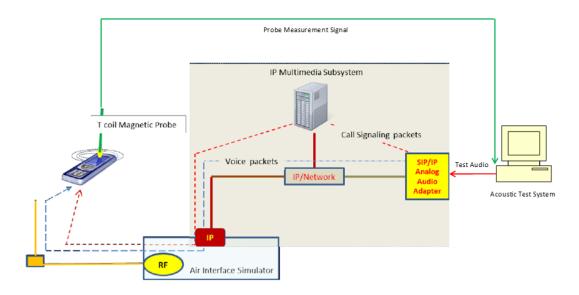


Figure 6-1 Test Setup for VoWIFI over IMS T-Coil Measurements

#### 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 level<sup>2</sup>. 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.

Note: The green highlighted 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.

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

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

## 1. Radio Configuration

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

> Table 6-1 802.11b SNNR by Radio Configuration

· · · · · · · · · · · · · · · · · · ·								
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]		
802.11b	6	DSSS	1	-0.79	-46.45	45.66		
802.11b	6	DSSS	2	-0.75	-45.81	45.06		
802.11b	6	CCK	5.5	-0.71	-47.31	46.60		
802.11b	6	CCK	11	-0.47	-47.03	46.56		

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

Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
802.11g	6	BPSK	6	-0.68	-49.54	48.86
802.11g	6	BPSK	9	-0.83	-50.73	49.90
802.11g	6	QPSK	12	-1.09	-52.00	50.91
802.11g	6	QPSK	18	-1.05	-51.76	50.71
802.11g	6	16-QAM	24	-1.03	-51.29	50.26
802.11g	6	16-QAM	36	-1.08	-52.68	51.60
802.11g	6	64-QAM	48	-1.15	-51.69	50.54
802.11g	6	64-QAM	54	-1.01	-52.41	51.40

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

	Our initial pri cities by italic configuration									
Mode	Bandwidth [MHz]	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]			
802.11n	20	40	BPSK	6.5	-1.00	-47.37	46.37			
802.11n	20	40	QPSK	13	-1.09	-48.91	47.82			
802.11n	20	40	QPSK	19.5	-1.06	-51.58	50.52			
802.11n	20	40	16-QAM	26	-1.16	-49.32	48.16			
802.11n	20	40	16-QAM	39	-1.18	-51.70	50.52			
802.11n	20	40	64-QAM	52	-1.17	-50.60	49.43			
802.11n	20	40	64-QAM	58.5	-1.13	-51.88	50.75			
802.11n	20	40	64-QAM	65	-1.04	-52.57	51.53			
802.11ac	20	40	256-QAM	78	-1.01	-52.18	51.17			

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

	002.1 Till/ac 40Mill2 BW Chilik by Radio Collingaration										
Mode	Bandwidth [MHz]	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]				
802.11n	40	38	BPSK	13.5	-0.95	-50.54	49.59				
802.11n	40	38	QPSK	27	-1.03	-51.99	50.96				
802.11n	40	38	QPSK	40.5	-1.04	-51.81	50.77				
802.11n	40	38	16-QAM	54	-1.05	-50.03	48.98				
802.11n	40	38	16-QAM	81	-1.12	-50.06	48.94				
802.11n	40	38	64-QAM	108	-1.09	-53.47	52.38				
802.11n	40	38	64-QAM	121.5	-1.29	-52.41	51.12				
802.11n	40	38	64-QAM	135	-1.31	-53.26	51.95				
802.11ac	40	38	256-QAM	162	-1.47	-50.68	49.21				
802.11ac	40	38	256-QAM	180	-1.23	-53.79	52.56				

#### 2. Codec Configuration

An investigation was performed to determine the audio codec configuration to be used for testing. The WB AMR 6.6kbps 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

7 mm t o duo a mi o dugado a l'o tim t o tot amo									
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)	0.18	-0.73	0.17	0.22		Add 0 4015			
ABM2 (dBA/m)	-46.91	-46.51	-46.59	-46.22	ا مناحا				
Frequency Response	Pass	Pass	Pass	Pass	Axial	2.4GHz	IEEE 802.11b	6	
S+N/N (dB)	47.09	45.78	46.76	46.44					

Mute on; Backlight off; Max Volume; Max Contrast

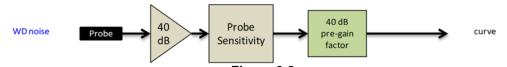


Figure 6-2
Audio Band Magnetic Curve Measurement Block Diagram

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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 interpretation<sup>3</sup>. 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 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 64kbps codec setting was used for the audio codec on the auxiliary VoIP unit for OTT VoIP T-Coil testing. See below tables for comparisons between codec data rates on all applicable data modes:

Table 7-1 Codec Investigation – OTT VolP (EvDO)

couco invocagation of the (2120)						
Codec Setting:	64kbps	6kbps	Orientation	Channel		
ABM1 (dBA/m)	-0.81	-0.83		600		
ABM2 (dBA/m)	-50.27	-51.04	Axial			
Frequency Response	Pass	Pass	Axiai			
S+N/N (dB)	49.46	50.21				

<sup>3</sup> 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)

O G G G III		,			
Codec Setting:	64kbps	6kbps	Orientation	Channel	
ABM1 (dBA/m)	-0.36	-0.42			
ABM2 (dBA/m)	-25.02	-25.40	Axial	190	
Frequency Response	Pass	Pass	Axiai		
S+N/N (dB)	24.66	24.98			

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

Oddec investigation – Ott von (nor A)							
Codec Setting:	64kbps	6kbps	Orientation	Channel			
ABM1 (dBA/m)	-0.88	-0.74		9400			
ABM2 (dBA/m)	-50.25	-50.89	Axial				
Frequency Response	Pass	Pass	Axiai				
S+N/N (dB)	49.37	50.15					

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

Oddec investigation – OTT voil (LTL)								
Codec Setting:	64kbps	6kbps	Orientation	Band / BW	Channel			
ABM1 (dBA/m)	-0.29	-0.38		Band 2 20MHz	40000			
ABM2 (dBA/m)	-49.05	-49.44	A					
Frequency Response	Pass	Pass	Axial		18900			
S+N/N (dB)	48.76	49.06						

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

Codec investigation – OTT voir (WIFI)									
Codec Setting:	64kbps	6kbps	Orientation	Band	Standard	Channel			
ABM1 (dBA/m)	0.09	0.08							
ABM2 (dBA/m)	-41.35	-42.93	Avial	2.4GHz	IEEE 802.11b	6			
Frequency Response	Pass	Pass	Axial						
S+N/N (dB)	41.44	43.01							

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

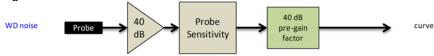


Figure 7-1 **Audio Band Magnetic Curve Measurement Block Diagram** 

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## 2. Radio Configuration for OTT VoIP (LTE)

An investigation was performed to determine the worst-case LTE 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 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]
13	782.0	23230	10	16QAM	1	0	-0.37	-50.02	49.65
5	836.5	20525	10	16QAM	1	0	-0.37	-52.62	52.25
66	1745.0	132322	20	16QAM	1	0	-0.37	-47.75	47.38
2	1880.0	18900	20	16QAM	1	0	-0.40	-48.65	48.25

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## 8. FCC 3G MEASUREMENTS

## I. CDMA Test Configurations

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

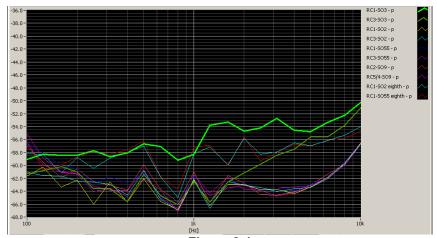
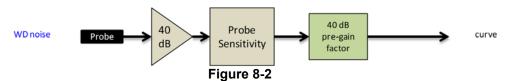


Figure 8-1
CDMA Audio Band Magnetic Noise

Table 8-1 FCC 3G ABM Measurements for ZNFQ720VS (CDMA)

Configuration:	RC1/SO3	RC3/SO3	RC4/SO3	Orientation	Channel		
ABM1 (dBA/m)	0.57	0.60	0.70	– Axial	600		
ABM2 (dBA/m)	-40.60	-57.50	-57.35				
Frequency Response	Pass	Pass	Pass				
S+N/N (dB)	41.17	58.10	58.05				

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



Audio Band Magnetic Curve Measurement Block Diagram

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#### II. **UMTS Test Configurations**

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

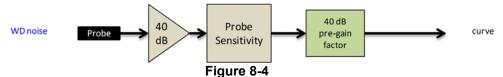


Figure 8-3 **UMTS Audio Band Magnetic Noise** 

Table 8-2 Codec Investigation - UMTS

Oddec mivestigation - Omito							
Codec Setting:	AMR 12.2kbps	AMR 7.95kbps	AMR 4.75kbps	Orientation	Channel		
ABM1 (dBA/m)	2.16	2.13	2.04	- Axial	9400		
ABM2 (dBA/m)	-55.82	-55.95	-56.05				
Frequency Response	Pass	Pass	Pass				
S+N/N (dB)	57.98	58.08	58.09				

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



**Audio Band Magnetic Curve Measurement Block Diagram** 

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# 9. T-COIL TEST SUMMARY

Table 9-1 Consolidated Tabled Results

_									
		-	esponse rgin	_	netic / Verdict		SNNR dict	Margin from FCC Limit	C63.19-2011
000.44	0.0	8.3	3.2	8.3	3.1	8.3	3.4	(dB)	Rating
C63.18	9 Section	Axial	Radial	Axial	Radial	Axial	Radial		
	Secondary Cellular	PASS	NA	PASS	PASS	PASS	PASS		
CDMA	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-14.50	T4
	PCS	PASS	NA	PASS	PASS	PASS	PASS		
EvDO	Cellular	PASS	NA	PASS	PASS	PASS	PASS	00.44	Τ.4
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-26.41	T4
0011	Cellular	PASS	NA	PASS	PASS	PASS	PASS	0.00	To
GSM	PCS	PASS	NA	PASS	PASS	PASS	PASS	-2.00	Т3
EDGE	Cellular	PASS	NA	PASS	PASS	PASS	PASS	2.50	To
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-2.50	Т3
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
UMTS	AWS	PASS	NA	PASS	PASS	PASS	PASS	-30.09	T4
	PCS	PASS	NA	PASS	PASS	PASS	PASS		
HSPA	Cellular	PASS	NA	PASS	PASS	PASS	PASS	26.24	T4
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-26.31	14
	B13	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD	B5	PASS	NA	PASS	PASS	PASS	PASS	-22.81	T4
LIE FDD	B66	PASS	NA	PASS	PASS	PASS	PASS	-22.01	14
	B2	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD (OTT VoIP)	B66	PASS	NA	PASS	PASS	PASS	PASS	-21.09	T4
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN	802.11g	PASS	NA	PASS	PASS	PASS	PASS	-20.52	T4
	802.11n	PASS	NA	PASS	PASS	PASS	PASS		
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN (OTT VoIP)	802.11g	PASS	NA	PASS	PASS	PASS	PASS	-19.78	T4
(0)	802.11n	PASS	NA	PASS	PASS	PASS	PASS		
	802.11a	PASS	NA	PASS	PASS	PASS	PASS		
U-NII	802.11n	PASS	NA	PASS	PASS	PASS	PASS	-22.02	T4
	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		
	802.11a	PASS	NA	PASS	PASS	PASS	PASS		
U-NII (OTT VoIP)	802.11n	PASS	NA	PASS	PASS	PASS	PASS	-22.60	T4
(3.1.33)	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		

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#### I. **Raw Handset Data**

Table 9-2 **Raw Data Results for CDMA** 

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
		1013	0.66	-41.28		1.90	41.94	20.00	-21.94	T4		
	Axial	384	0.63	-41.41	-59.31	1.94	42.04	20.00	-22.04	T4	2.4, 2.6	
Cellular		777	0.73	-40.40		1.91	41.13	20.00	-21.13	T4		
Celiulai		1013	-7.48	-44.24			36.76	20.00	-16.76	T4		
Radial	384	-7.60	-44.26	-63.68	-63.68	-63.68	N/A	36.66	20.00	-16.66	T4	2.4, 3.4
		777	-7.44	-43.71			36.27	20.00	-16.27	T4		
		25	0.61	-39.64		1.90	40.25	20.00	-20.25	T4		
	Axial	600	0.45	-40.38	-59.31	1.91	40.83	20.00	-20.83	T4	2.4, 2.6	
PCS		1175	0.64	-39.56		1.65	40.20	20.00	-20.20	T4		
PCS		25	-7.72	-42.71			34.99	20.00	-14.99	T4		
	Radial	600	-7.90	-43.02	-63.68	N/A	35.12	20.00	-15.12	T4	2.4, 3.4	
		1175	-7.85	-42.35			34.50	20.00	-14.50	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	3.97	-21.95		1.79	25.92	20.00	-5.92	Т3	
	Axial	190	3.20	-23.77	-59.31	1.78	26.97	20.00	-6.97	Т3	2.4, 2.6
GSM850		251	3.32	-24.03		1.75	27.35	20.00	-7.35	Т3	
GSIVIOSU		128	-3.76	-25.76			22.00	20.00	-2.00	Т3	
Radial	190	-4.09	-27.18	-63.68	-63.68	N/A	23.09	20.00	-3.09	Т3	2.4, 3.4
		251	-3.72	-28.53			24.81	20.00	-4.81	Т3	
		512	3.41	-25.98		1.78	29.39	20.00	-9.39	Т3	
	Axial	661	3.43	-25.97	-59.31	1.77	29.40	20.00	-9.40	Т3	2.4, 2.6
GSM1900		810	3.44	-26.28		1.80	29.72	20.00	-9.72	Т3	
G3W1900		512	-4.05	-30.28			26.23	20.00	-6.23	Т3	
	Radial	661	-4.13	-30.46	-63.68	N/A	26.33	20.00	-6.33	Т3	2.4, 3.4
		810	-4.02	-31.20			27.18	20.00	-7.18	Т3	

### Table 9-4 **Raw Data Results for UMTS**

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		4132	2.33	-54.77		1.84	57.10	20.00	-37.10	T4	
	Axial	4183	2.34	-55.57	-59.31	1.87	57.91	20.00	-37.91	T4	2.4, 2.6
UMTS V		4233	2.35	-54.70		1.86	57.05	20.00	-37.05	T4	
UW 13 V		4132	-5.59	-55.80			50.21	20.00	-30.21	T4	
	Radial	4183	-5.58	-55.67	-63.68	N/A	50.09	20.00	-30.09	T4	2.4, 3.4
		4233	-5.57	-56.02			50.45	20.00	-30.45	T4	
		9262	2.02	-55.90		1.86	57.92	20.00	-37.92	T4	
	Axial	9400	2.10	-55.14	-59.31	1.88	57.24	20.00	-37.24	T4	2.4, 2.6
UMTS II		9538	2.13	-55.03		1.86	57.16	20.00	-37.16	T4	
OWISH		9262	-5.57	-55.80			50.23	20.00	-30.23	T4	
	Radial	9400	-5.55	-55.65	-63.68	N/A	50.10	20.00	-30.10	T4	2.4, 3.4
		9538	-5.57	-55.76			50.19	20.00	-30.19	T4	

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#### Table 9-5 **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 Rating	Test Coordinates
		10MHz	23230	1.85	-46.03		1.02	47.88	20.00	-27.88	T4	
	Axial	5MHz	23255	2.11	-48.83	-59.31	1.09	50.94	20.00	-30.94	T4	2.4, 2.6
	Axiai	5MHz	23230	1.95	-45.67	-59.51	1.05	47.62	20.00	-27.62	T4	2.4, 2.0
LTE Band 13		5MHz	23205	1.90	-46.68		1.07	48.58	20.00	-28.58	T4	
LIE Band 13		10MHz	23230	-5.66	-48.57			42.91	20.00	-22.91	T4	
	Radial	5MHz	23255	-5.64	-50.33	-63.68	N/A	44.69	20.00	-24.69	T4	2.4, 3.4
	Naulai	5MHz	23230	-5.51	-48.32	-03.06	INA	42.81	20.00	-22.81	T4	2.4, 3.4
		5MHz	23205	-5.26	-48.92			43.66	20.00	-23.66	T4	

## Table 9-6 **Raw Data Results for LTE B5**

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		10MHz	20525	2.10	-46.22		1.14	48.32	20.00	-28.32	T4	
	Axial	5MHz	20525	1.93	-46.06	-59.31	1.04	47.99	20.00	-27.99	T4	2.4. 2.6
	Axiai	3MHz	20525	2.17	-45.55	-39.31	1.07	47.72	20.00	-27.72	T4	2.4, 2.0
LTE Band 5		1.4MHz	20525	2.07	-46.14		1.12	48.21	20.00	-28.21	T4	
LIE Ballu 5		10MHz	20525	-5.66	-49.35			43.69	20.00	-23.69	T4	
	Radial	5MHz	20525	-5.43	-49.88	-63.68	N/A	44.45	20.00	-24.45	T4	2.4, 3.4
	Radiai	3MHz	20525	-5.63	-49.61	-03.00	IVA	43.98	20.00	-23.98	T4	2.4, 3.4
		1.4MHz	20525	-5.77	-50.04			44.27	20.00	-24.27	T4	

#### Table 9-7 Raw Data Results for LTE B66

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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	2.32	-45.84		0.98	48.16	20.00	-28.16	T4	
		15MHz	132322	2.14	-46.47		1.00	48.61	20.00	-28.61	T4	
	Axial	10MHz	132322	2.01	-47.03	-59.31	0.98	49.04	20.00	-29.04	T4	2.4, 2.6
	Axidi	5MHz	132322	2.46	-46.71	-39.31	1.06	49.17	20.00	-29.17	T4	2.4, 2.0
		3MHz	132322	1.88	-47.40		1.07	49.28	20.00	-29.28	T4	
LTE Band 66		1.4MHz	132322	2.03	-47.41		1.09	49.44	20.00	-29.44	T4	
LIE Danu 66		20MHz	132322	-5.39	-50.12			44.73	20.00	-24.73	T4	
		15MHz	132322	-5.36	-49.37			44.01	20.00	-24.01	T4	
	Radial	10MHz	132322	-5.32	-50.10	-63.68	N/A	44.78	20.00	-24.78	T4	2.4, 3.4
	Naulai	5MHz	132322	-5.29	-50.51	-03.00	IVA	45.22	20.00	-25.22	T4	2.4, 3.4
		3MHz	132322	-5.02	-50.42			45.40	20.00	-25.40	T4	
		1.4MHz	132322	-5.24	-50.77			45.53	20.00	-25.53	T4	

#### Table 9-8 Raw Data Results for LTF B2

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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	18900	2.11	-47.68		0.89	49.79	20.00	-29.79	T4	
		15MHz	18900	2.35	-47.07		1.12	49.42	20.00	-29.42	T4	
	Axial	10MHz	18900	2.12	-47.36	-59.31	1.15	49.48	20.00	-29.48	T4	2.4, 2.6
	Axiai	5MHz	18900	2.08	-47.66	-59.51	0.99	49.74	20.00	-29.74	T4	2.4, 2.0
		3MHz	18900	2.17	-46.16		1.10	48.33	20.00	-28.33	T4	
LTE Band 2		1.4MHz	18900	2.03	-46.82		1.08	48.85	20.00	-28.85	T4	
LIE Ballu 2		20MHz	18900	-5.52	-50.67			45.15	20.00	-25.15	T4	
		15MHz	18900	-5.23	-50.27			45.04	20.00	-25.04	T4	
	Radial	10MHz	18900	-5.51	-50.22	-63.68	N/A	44.71	20.00	-24.71	T4	2.4, 3.4
	radiai	5MHz	18900	-5.34	-50.36	-03.08	IV/A	45.02	20.00	-25.02	T4	2.4, 3.4
		3MHz	18900	-5.20	-49.54			44.34	20.00	-24.34	T4	
		1.4MHz	18900	-5.34	-49.97			44.63	20.00	-24.63	T4	

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# Table 9-9 Raw Data Results for 2.4GHz WIFI

	Frequency Margin from												
Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates		
		1	-0.70	-45.70		1.18	45.00	20.00	-25.00	T4			
	Axial	6	-0.77	-46.05	-59.31	1.00	45.28	20.00	-25.28	T4	2.4, 2.6		
IEEE		11	-0.66	-45.94		1.08	45.28	20.00	-25.28	T4			
802.11b		1	-9.17	-49.69			40.52	20.00	-20.52	T4			
	Radial	6	-8.97	-49.70	-63.68	N/A	40.73	20.00	-20.73	T4	2.4, 3.4		
	Naulai	11	-9.08	-50.03			40.95	20.00	-20.95	T4			
IEEE	Axial	6	-1.20	-49.67	-59.31	1.32	48.47	20.00	-28.47	T4	2.4, 2.6		
802.11g	Radial	6	-9.66	-54.35	-63.68	N/A	44.69	20.00	-24.69	T4	2.4, 3.4		
IEEE	Axial	6	-1.04	-48.74	-59.31	1.23	47.70	20.00	-27.70	T4	2.4, 2.6		
802.11n	Radial	6	-9.60	-52.04	-63.68	N/A	42.44	20.00	-22.44	T4	2.4, 3.4		

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

Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
	Axial	20MHz	1	40	-0.64	-49.10	-59.31	1.25	48.46	20.00	-28.46	T4	2.4, 2.6
		20MHz	1	40	-9.09	-51.26			42.17	20.00	-22.17	T4	
IEEE 802.11a		20MHz	2A	56	-9.06	-51.30			42.24	20.00	-22.24	T4	
IEEE 802.11a	Radial	20MHz	2C	100	-9.64	-53.77	-63.68	N/A	44.13	20.00	-24.13	T4	2.4. 3.4
	Radiai	20MHz	2C	120	-9.14	-51.16	-03.00	IN/A	42.02	20.00	-22.02	T4	2.4, 3.4
		20MHz	2C	140	-9.06	-51.54	-	-	42.48	20.00	-22.48	T4	
		20MHz	3	157	-9.54	-53.58			44.04	20.00	-24.04	T4	

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

	RAW Data Results for Sunz Wiff OUZ. I III													
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	-1.35	-51.97		0.73	50.62	20.00	-30.62	T4		
		20MHz	1	36	-0.70	-51.39		1.05	50.69	20.00	-30.69	T4		
		20MHz	1	40	-1.21	-47.96		1.20	46.75	20.00	-26.75	T4		
		20MHz	1	48	-0.72	-50.16		1.22	49.44	20.00	-29.44	T4		
	Axial	40MHz	2A	54	-0.69	-53.46	59.31	1.19	52.77	20.00	-32.77	T4	2.4, 2.6	
IEEE	Axiai	20MHz	2A	56	-1.24	-48.80		1.21	47.56	20.00	-27.56	T4	2.4, 2.0	
802.11n		40MHz	2C	118	-0.69	-51.47		1.16	50.78	20.00	-30.78	T4		
002.1111		20MHz	2C	120	-0.70	-51.57		1.27	50.87	20.00	-30.87	T4		
		40MHz	3	151	-1.25	-50.74		1.22	49.49	20.00	-29.49	T4		
		20MHz	3	157	-0.91	-50.87		1.10	49.96	20.00	-29.96	T4		
	Padial	40MHz	1	38	-9.28	-54.36	-63 68 N/A	NI/A	45.08	20.00	-25.08	T4	2.4, 3.4	
	Radial	20MHz	1	40	-9.41	-51.61		IN/A	42.20	20.00	-22.20	T4	2.4, 3.4	

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

		TAN BULL TOOLICE TO GOTTE THE COLUMN													
	Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
		Axial	40MHz	1	38	-0.79	-53.11	-59.31	1.18	52.32	20.00	-32.32	T4	2.4. 2.6	
	IEEE	Axidi	20MHz	1	40	-1.41	-50.61	-59.51	0.76	49.20	20.00	-29.20	T4	2.4, 2.0	
	802.11ac														
	Radial	40MHz	1	38	-9.28	-55.15	62.60	NI/A	45.87	20.00	-25.87	T4	2.4. 3.4		
		Naulai	20MHz	1	40	-9.31	-53.29	-63.68	-63.68 N/A	43.98	20.00	-23.98	T4	2.4, 3.4	

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

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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
Cellular	Axial	384	0.82	-49.56	-59.31	1.61	50.38	20.00	-30.38	T4	2.4, 2.6
EvDO	Radial	384	-8.03	-55.06	-63.68	N/A	47.03	20.00	-27.03	T4	2.4, 3.4
PCS	Axial	600	-0.82	-50.76	-59.31	1.61	49.94	20.00	-29.94	T4	2.4, 2.6
EvDO	Radial	600	-8.10	-54.51	-63.68	N/A	46.41	20.00	-26.41	T4	2.4, 3.4

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

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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	Test Coordinates
EDGE950	Axial	190	-0.35	-24.76	-59.31	1.58	24.41	20.00	-4.41	Т3	2.4, 2.6
EDGE850	Radial	190	-7.96	-30.46	-63.68	N/A	22.50	20.00	-2.50	Т3	2.4, 3.4
EDGE1900	Axial	661	-0.47	-28.39	-59.31	1.54	27.92	20.00	-7.92	Т3	2.4, 2.6
LDGL 1900	Radial	661	-8.00	-33.12	-63.68	N/A	25.12	20.00	-5.12	Т3	2.4, 3.4

# Table 9-15 Raw Data Results for HSPA (OTT VoIP)

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
HSPA V	Axial	4183	-0.79	-50.12	-59.31	1.61	49.33	20.00	-29.33	T4	2.4, 2.6
NOPA V	Radial	4183	-7.99	-54.30	-63.68	N/A	46.31	20.00	-26.31	T4	2.4, 3.4
HSPA II	Axial	9400	-0.76	-50.46	-59.31	1.65	49.70	20.00	-29.70	T4	2.4, 2.6
HOFAII	Radial	9400	-7.98	-54.90	-63.68	N/A	46.92	20.00	-26.92	T4	2.4, 3.4

# Table 9-16 Raw Data Results for LTE B66 (OTT VoIP)

			ita	w Data	itcouito	101 -1-	<u> </u>	1 1011 /				
Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	132322	-0.39	-47.76		1.57	47.37	20.00	-27.37	T4	
		15MHz	132322	-0.29	-47.99		1.57	47.70	20.00	-27.70	T4	
		10MHz	132622	-0.32	-48.12		1.56	47.80	20.00	-27.80	T4	
	Axial	10MHz	132322	-0.32	-47.11	-59.31	1.59	46.79	20.00	-26.79	T4	2.4, 2.6
	Axidi	10MHz	132022	-0.28	-47.73	-59.51	1.60	47.45	20.00	-27.45	T4	2.4, 2.0
		5MHz	132322	-0.32	-47.64		1.60	47.32	20.00	-27.32	T4	
		3MHz	132322	-0.30	-47.96		1.57	47.66	20.00	-27.66	T4	
LTE Band 66		1.4MHz	132322	-0.34	-47.32		1.58	46.98	20.00	-26.98	T4	
LIE Ballu 00		20MHz	132322	-7.99	-49.90			41.91	20.00	-21.91	T4	
		15MHz	132597	-8.04	-49.32			41.28	20.00	-21.28	T4	
		15MHz	132322	-7.98	-49.07			41.09	20.00	-21.09	T4	
	Radial	15MHz	132047	-8.04	-49.60	62.60	N/A	41.56	20.00	-21.56	T4	2.4, 3.4
	Radiai	10MHz	132322	-8.01	-49.47	-63.68	IV/A	41.46	20.00	-21.46	T4	2.4, 3.4
		5MHz	132322	-8.00	-49.94			41.94	20.00	-21.94	T4	
		3MHz	132322	-8.01	-49.98	3		41.97	20.00	-21.97	T4	
		1.4MHz	132322	-8.05	-50.43			42.38	20.00	-22.38	T4	

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# Table 9-17 Raw Data Results for 2.4GHz WIFI (OTT VoIP)

	Raw Data Results for 2.4GHz WiFi (OTT VOIF)													
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	0.08	-42.29		1.57	42.37	20.00	-22.37	T4				
	Axial	6	0.00	-42.42	-59.31	1.58	42.42	20.00	-22.42	T4	2.4, 2.6			
IEEE		11	0.08	-43.07		1.57	43.15	20.00	-23.15	T4				
802.11b		1	-8.03	-47.81			39.78	20.00	-19.78	T4				
	Radial	6	-8.00	-48.26	-63.68	N/A	40.26	20.00	-20.26	T4	2.4, 3.4			
		11	-8.07	-48.69			40.62	20.00	-20.62	T4				
IEEE	Axial	6	-0.05	-43.06	-59.31	1.52	43.01	20.00	-23.01	T4	2.4, 2.6			
802.11g	Radial	6	-8.03	-48.77	-63.68	N/A	40.74	20.00	-20.74	T4	2.4, 3.4			
IEEE	Axial	6	0.04	-45.59	-59.31	1.55	45.63	20.00	-25.63	T4	2.4, 2.6			
802.11n	Radial	6	-8.00	-51.95	-63.68	N/A	43.95	20.00	-23.95	T4	2.4, 3.4			

# Table 9-18 Raw Data Results for 5GHz WIFI 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	Test Coordinates
	Axial	20MHz	1	40	0.01	-45.54	-59.31	1.48	45.55	20.00	-25.55	T4	2.4, 2.6
		20MHz	1	40	-7.97	-50.57			42.60	20.00	-22.60	T4	
IEEE		20MHz	2A	56	-8.10	-50.86			42.76	20.00	-22.76	T4	
802.11a	Radial	20MHz	2C	120	-7.95	-51.34	-63.68	N/A	43.39	20.00	-23.39	T4	2.4. 3.4
	Radiai	20MHz	3	149	-7.96	-51.23	-03.00	IN/A	43.27	20.00	-23.27	T4	2.4, 3.4
		20MHz	3	157	-7.99	-50.70			42.71	20.00	-22.71	T4	i I
		20MHz	3	165	-7.96	-51.35			43.39	20.00	-23.39	T4	

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

			ixaw	Dala N	courto		IZ VVIFI O	04.1111	(011 0	ЛГ <i>)</i>			
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	-0.09	-46.92	-59.31	1.58	46.83	20.00	-26.83	T4	2.4, 2.6
		20MHz	1	36	0.07	-45.96		1.58	46.03	20.00	-26.03	T4	
	Axial	20MHz	1	40	0.05	-45.37		1.52	45.42	20.00	-25.42	T4	
		20MHz	1	48	0.06	-45.15		1.56	45.21	20.00	-25.21	T4	
		40MHz	2A	54	0.08	-48.02		1.62	48.10	20.00	-28.10	T4	
IEEE		20MHz	2A	56	0.06	-45.50		1.55	45.56	20.00	-25.56	T4	
802.11n		40MHz	2C	118	0.09	-47.54		1.55	47.63	20.00	-27.63	T4	
002.1111		20MHz	2C	120	-0.06	-45.68		1.55	45.62	20.00	-25.62	T4	
		40MHz	3	151	0.07	-48.21		1.50	48.28	20.00	-28.28	T4	
		20MHz	3	157	0.05	-45.58		1.53	45.63	20.00	-25.63	T4	
	Padial	40MHz	1	38	-8.03	-52.26	62.60	NI/A	44.23	20.00	-24.23	T4	04.04
	Radial	20MHz	1	40	-7.97	-51.81	-63.68	68 N/A	43.84	20.00	-23.84	T4	2.4, 3.4

# Table 9-20 Raw Data Results for 5GHz WIFI 802.11ac (OTT VoIP)

				IXUV	Duta IX	Juliu I	0. 00	2 **** 1 0	0 <b>2</b> . i iuc	(	o ,			
	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	0.04	-49.17	-59.31	1.53	49.21	20.00	-29.21	T4	2.4. 2.6
	IEEE		20MHz	1	40	0.06	-50.77		1.54	50.83	20.00	-30.83	T4 2.4, 2.1	2.4, 2.0
	802.11ac													
	Radial	40MHz	1	38	-8.01	-54.13	-63.68	N/A	46.12	20.00	-26.12	T4	2.4, 3.4	
		Radiai	20MHz	1	40	-8.04	-53.98	-03.06	IVA	45.94	20.00	-25.94	T4	2.4, 3.4

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#### II. **Test Notes**

#### A. General

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

#### B. CDMA

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

#### C. GSM

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

#### D. UMTS

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

#### E. LTE FDD

- 1. Power Configuration: TPC = "Max Power"
- 2. Radio Configuration: 16QAM, 1RB, 0RB offset
- 3. Vocoder Configuration: WB AMR 6.60kbps
- 4. The worst-case band and bandwidth combination for each probe orientation is additionally tested on the low and high channels for those combinations. LTE Band 13 at 5MHz is the worst-case for both the Axial and Radial probe orientations.

#### F. WIFI

- 1. Radio Configuration
  - a. 802.11b: DSSS, 2Mbps
  - b. 802.11g/a: BPSK, 6Mbps
  - c. 802.11n/ac 20MHz: BPSK, 6.5Mbps
  - d. 802.11n/ac 40MHz: 16-QAM, 81Mbps
- 2. Vocoder Configuration: WB AMR 6.6kbps
- 3. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels, 802.11b is the worst-case for both the Axial and Radial probe orientations.
- 4. The worst-case standard for 5GHz WIFI in each probe orientation is additionally tested on higher U-NII bands as well as applicable low and high channels. 802.11n 20MHz (U-NII 1) is the worstcase for the Axial probe orientation. 802.11a 20MHz (U-NII 2C) is the worst-case for the Radial probe orientation.

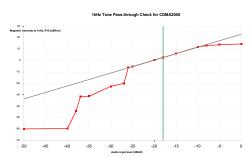
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#### G. OTT VoIP

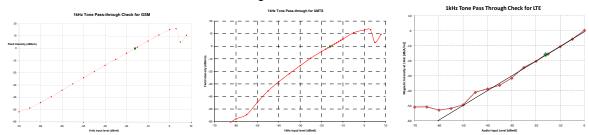
- 1. Vocoder Configuration: 64kbps
- 2. EvDO Configuration
  - a. Revision: A
- 3. EDGE Configuration
  - a. MCS Index: 7
  - b. Number of TX slots: 2
- 4. HSPA Configuration:
  - a. Release: 6
  - b. 3GPP 34.121 Subtest 1
- 5. LTE FDD Configuration:
  - a. Power Configuration: TPC = "Max Power"
  - b. Radio Configuration: 16QAM, 1RB, 0RB offset
  - c. LTE Band 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 10MHz is the worst-case for the Axial probe orientation. LTE Band 66 at 15MHz bandwidth is the worst-case for the Radial probe orientation.
- 6. WIFI Configuration:
  - a. Radio Configuration
    - i. 802.11b: DSSS, 2Mbps
    - ii. 802.11g/a: BPSK, 6Mbps
    - iii. 802.11n/ac 20MHz: BPSK, 6.5Mbps
    - iv. 802.11n/ac 40MHz: 16QAM, 81Mbps
  - b. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. 802.11b is the worst-case for both the Axial and Radial probe orientations.
  - c. The worst-case standard for 5GHz WIFI in each probe orientation is additionally tested on higher U-NII bands as well as applicable low and high channels. 802.11n 20MHz (U-NII 1) is the worst-case for the Axial probe orientation. 802.11a 20MHz (U-NII 3) is the worstcase for the Radial probe orientation.

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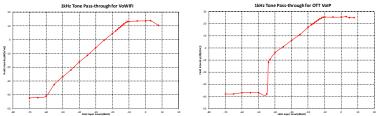
## III. 1 kHz Vocoder Application Check



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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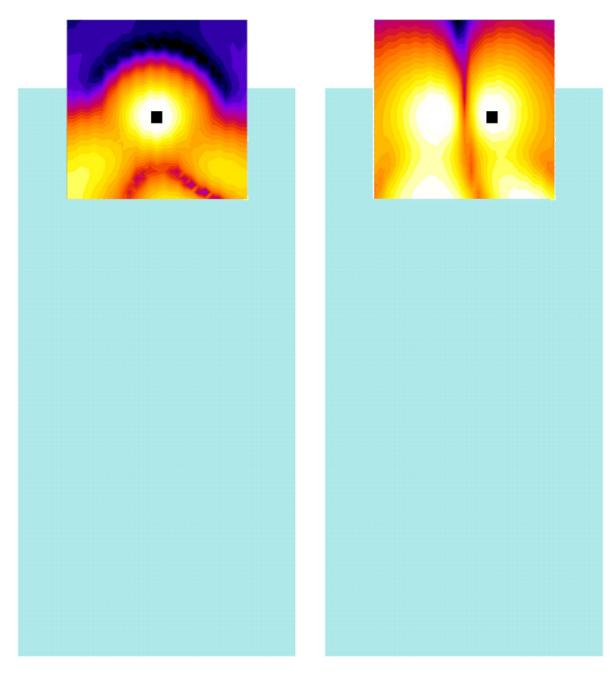
# IV. T-Coil Validation Test Results

Table 9-21
Helmholtz Coil Validation Table of Results

Tienmonz Gon Vandation Table of Results						
ltem	Target	Result	Verdict			
Axial						
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.950	PASS			
Environmental Noise	< -58 dBA/m	-59.31	PASS			
Frequency Response, from limits	> 0 dB 0.60		PASS			
Radial						
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.159	PASS			
Environmental Noise	< -58 dBA/m	-63.68	PASS			
Frequency Response, from limits	> 0 dB	0.70	PASS			

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# V. ABM1 Magnetic Field Distribution Scan Overlays



Axial Radial (Transverse)

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

### Notes:

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

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REV 3.3.M

# 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), 95% confidence level							1.31

#### Notes:

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

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

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# 11. EQUIPMENT LIST

# Table 11-1 Equipment List

	Equipment List						
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	8/3/2018	Annual	8/3/2019	140144	
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 1111 0 11 011 011 4050

DUT: HH Coil - SN: SBI 1052

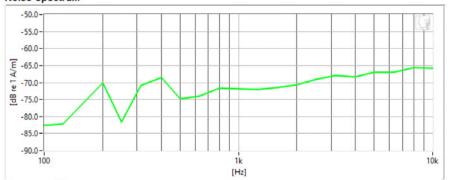
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

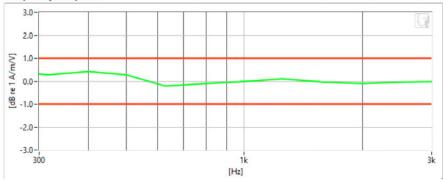
#### Equipment:

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

#### **Noise Spectrum**



### Frequency Response



#### Results

Verification 1kHz Intensity	-9.95	dB	$\checkmark$	Max/Min	-9.5/-10.5
Verification ABM2	-59.31	dB	$\checkmark$	Maximum	-58.0
Frequency Response Margin	600m	dB	•	Tolerance curves	Aligned Data

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DUT: HH Coil - SN: SBI 1052

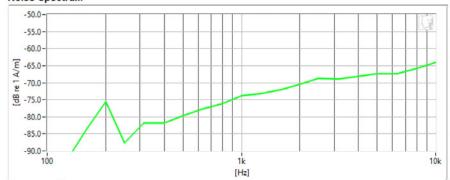
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

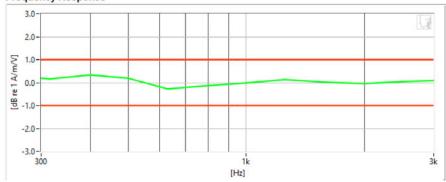
#### Equipment:

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

#### Noise Spectrum



#### Frequency Response



#### Results

Verification 1kHz Intensity	-10.159	dB	$\bigcirc$	Max/Min	-9.5/-10.5
Verification ABM2	-63.68	dB		Maximum	-58.0
Frequency Response Margin	700m	dB	•	Tolerance curves	Aligned Data

FCC ID: ZNFQ720VS	PETEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 43 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		raye 43 01 76



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

#### Equipment:

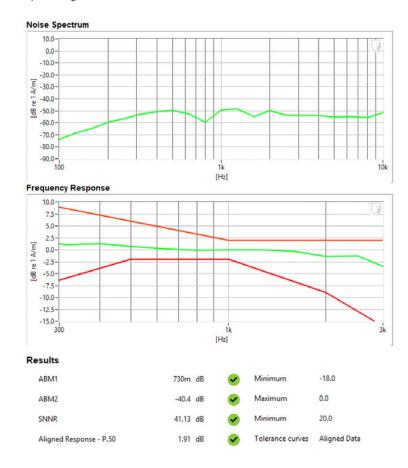
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

#### **Test Configuration:**

Mode: CDMA Cellular

Channel: 777

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



FCC ID: ZNFQ720VS	PETEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 44 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		raye 44 01 76



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

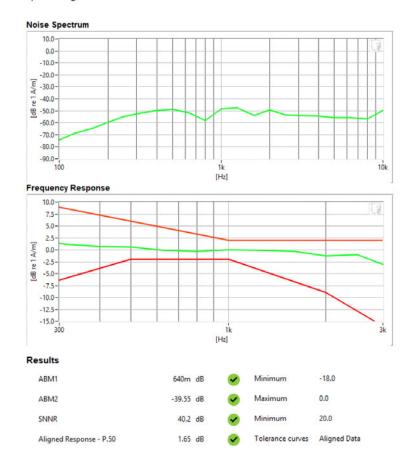
#### Equipment:

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

#### **Test Configuration:**

Mode: CDMA PCSChannel: 1175

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



FCC ID: ZNFQ720VS	PETEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 45 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 45 01 76



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

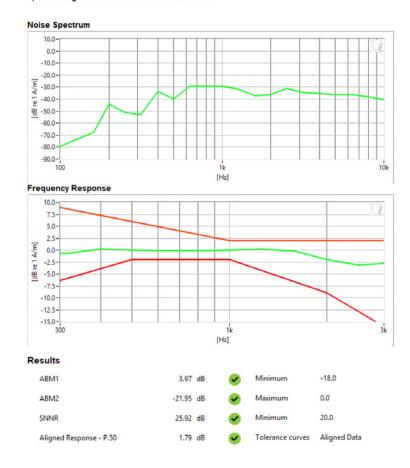
#### Equipment:

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

#### **Test Configuration:**

Mode: GSM 850Channel: 128

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



FCC ID: ZNFQ720VS	PETEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 46 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		raye 40 01 76



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

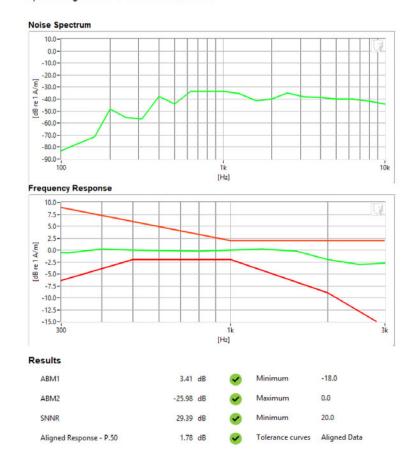
#### Equipment:

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

#### **Test Configuration:**

Mode: GSM 1900Channel: 512

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



FCC ID: ZNFQ720VS	PCTEST*	HAC (T-COIL) TEST REPORT	<b>L</b> G	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 47 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Page 47 of 76



#### ,

DUT: ZNFQ720VS
Type: Portable Handset
Serial: 02831

Measurement Standard: ANSI C63.19-2011

#### Equipment:

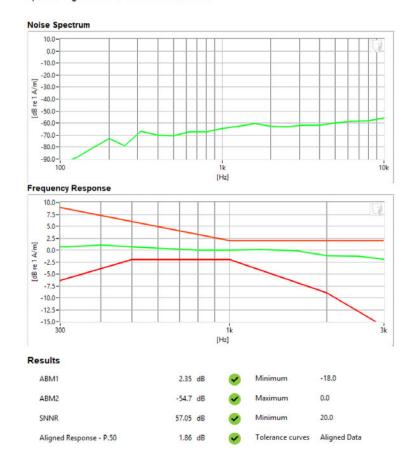
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

#### **Test Configuration:**

. Mode: UMTS Band V

Channel: 4233

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



FCC ID: ZNFQ720VS	PETEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 48 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 40 01 70



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

#### Equipment:

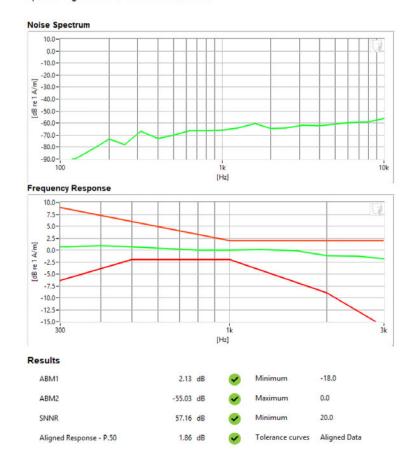
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

#### **Test Configuration:**

Mode: UMTS Band II

Channel: 9538

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



FCC ID: ZNFQ720VS	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 49 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 49 01 76



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

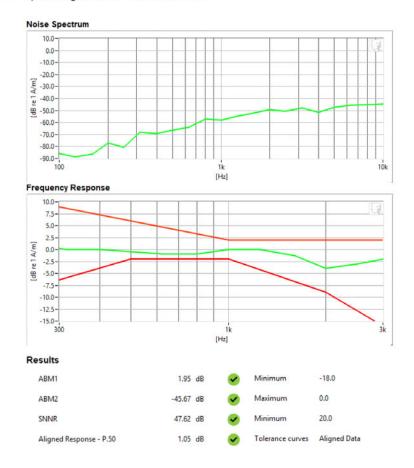
#### Equipment:

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

#### **Test Configuration:**

Mode: LTE FDD Band 13
Bandwidth: 5MHz
Channel: 23230

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFQ720VS	PETEST*	HAC (T-COIL) TEST REPORT	<b>LG</b>	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 50 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage 50 01 70



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

#### Equipment:

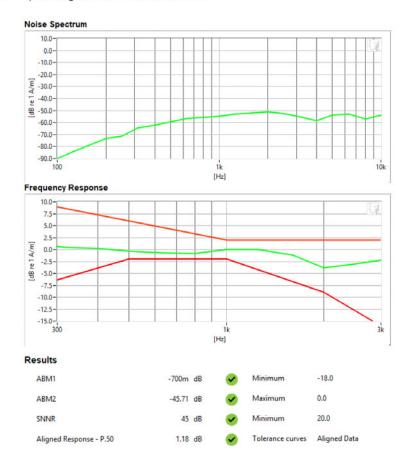
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

#### **Test Configuration:**

Mode: 2.4GHz WIFIStandard: IEEE 802.11b

Channel: 1

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



FCC ID: ZNFQ720VS	PCTEST*	HAC (T-COIL) TEST REPORT	<b>L</b> G	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 51 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Page 51 of 76



# **PCTEST Hearing-Aid Compatibility Facility**

# **DUT: ZNFQ720VS**

Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

#### **Test Configuration:**

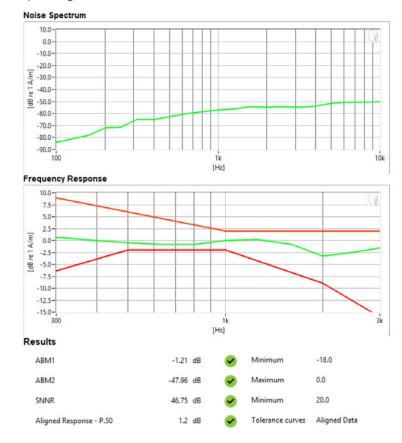
Mode: 5GHz WIFI

Standard: IEEE 802.11n (U-NII 1)

Bandwidth: 20MHz

Channel: 40

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



FCC ID: ZNFQ720VS	PETEST*	HAC (T-COIL) TEST REPORT	<b>LG</b>	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 52 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 52 01 76



# **PCTEST Hearing-Aid Compatibility Facility**

# **DUT: ZNFQ720VS**

Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

#### Equipment:

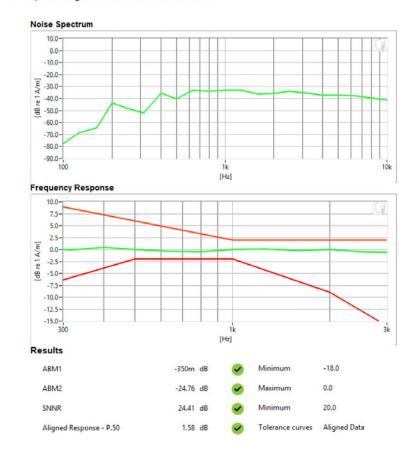
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

#### **Test Configuration:**

· VoIP Application: Google Duo

Mode: EDGE 850 Channel: 190

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFQ720VS	PETEST*	HAC (T-COIL) TEST REPORT	<b>LG</b>	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 53 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 55 01 70



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

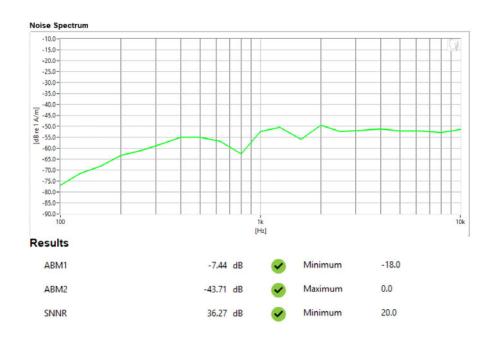
#### Equipment:

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

#### **Test Configuration:**

Mode: CDMA Cellular

· Channel: 777



FCC ID: ZNFQ720VS	PETEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 54 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage 34 01 76



Type: Portable Handset Serial: 02831

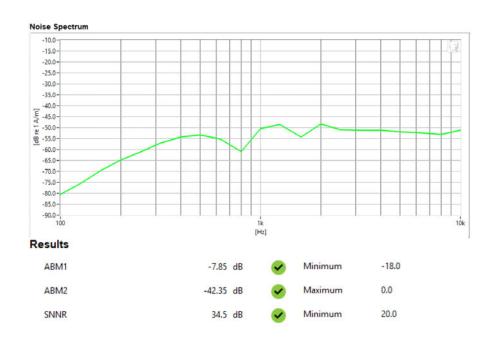
Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

#### **Test Configuration:**

Mode: CDMA PCSChannel: 1175



FCC ID: ZNFQ720VS	PCTEST'	HAC (T-COIL) TEST REPORT	<b>L</b> G	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 55 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Page 55 of 76



Type: Portable Handset Serial: 02831

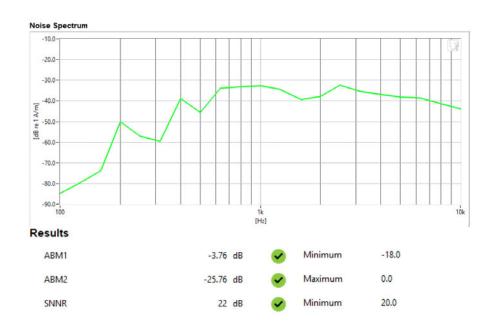
Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

#### **Test Configuration:**

Mode: GSM 850Channel: 128



FCC ID: ZNFQ720VS	CID: ZNFQ720VS HAC (T-COIL) TEST REPORT		<b>L</b> G	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 56 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 50 01 70



Type: Portable Handset Serial: 02831

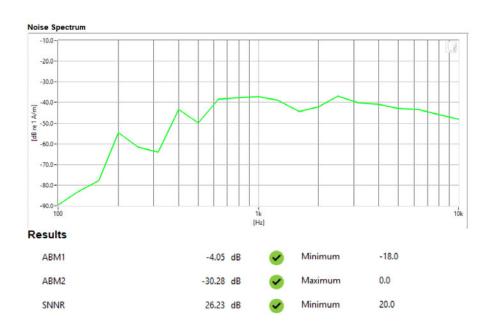
Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

#### **Test Configuration:**

Mode: GSM 1900Channel: 512



FCC ID: ZNFQ720VS	PCTEST	HAC (T-COIL) TEST REPORT	<b>LG</b>	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 57 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage 37 01 70



Type: Portable Handset Serial: 02831

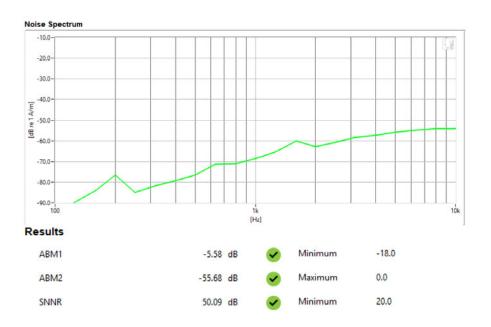
Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

#### **Test Configuration:**

Mode: UMTS Band VChannel: 4183



FCC ID: ZNFQ720VS	PCTEST	HAC (T-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 58 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage 36 01 76



Type: Portable Handset Serial: 02831

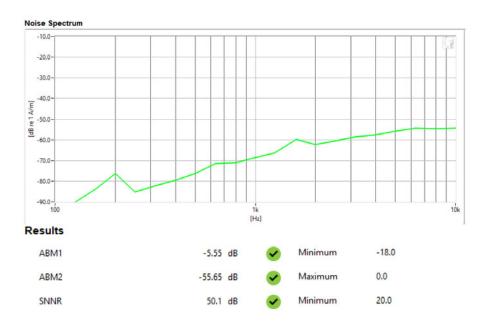
Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

#### **Test Configuration:**

Mode: UMTS Band II
Channel: 9400



FCC ID: ZNFQ720VS	ID: ZNFQ720VS HAC (T-COIL) TEST REPORT		① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 59 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 59 01 76



Type: Portable Handset Serial: 02831

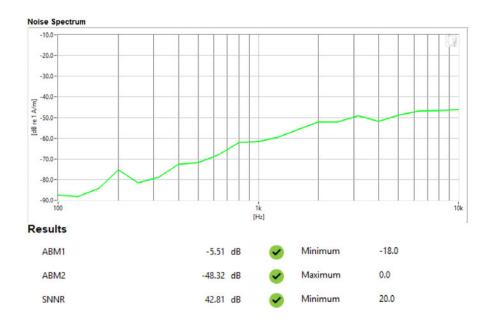
Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

#### **Test Configuration:**

Mode: LTE FDD Band 13Bandwidth: 5MHzChannel: 23230



FCC ID: ZNFQ720VS	ID: ZNFQ720VS HAC (T-COIL) TEST REPORT		<b>L</b> G	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 60 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage ou oi 70



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

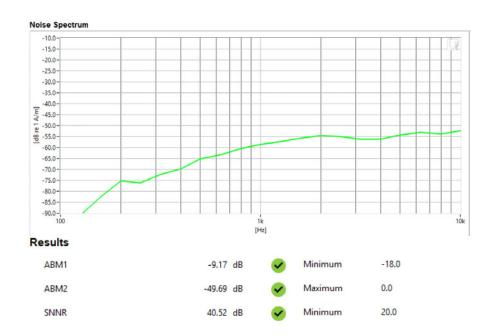
#### Equipment:

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

#### **Test Configuration:**

Mode: 2.4GHz WIFIStandard: IEEE 802.11b

Channel: 1



FCC ID: ZNFQ720VS	CID: ZNFQ720VS HAC (T-COIL) TEST REPORT		<b>L</b> G	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 61 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Page 01 01 70



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

#### Equipment:

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

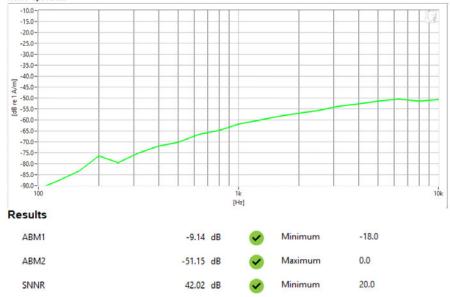
#### **Test Configuration:**

Mode: 5GHz WIFI

• Standard: IEEE 802.11a (U-NII 2C)

Bandwidth: 20MHzChannel: 120

#### Noise Spectrum



FCC ID: ZNFQ720VS	HAC (T-COIL) TEST REPORT		① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 62 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Fage 02 01 76



Type: Portable Handset Serial: 02831

Measurement Standard: ANSI C63.19-2011

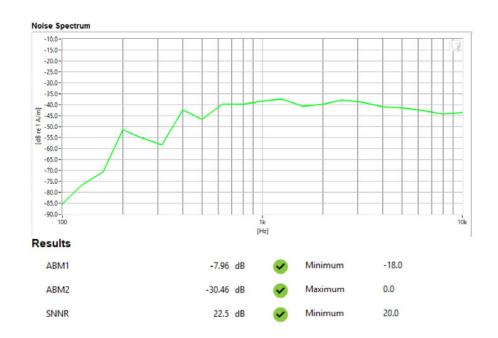
#### Equipment:

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

#### **Test Configuration:**

VolP Application: Google Duo

Mode: EDGE 850Channel: 190



FCC ID: ZNFQ720VS	PCTEST	HAC (T-COIL) TEST REPORT	<b>LG</b>	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 63 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage 03 01 70

# 13. CALIBRATION CERTIFICATES

FCC ID: ZNFQ720VS	C ID: ZNFQ720VS HAC (T-COIL) TEST REPOR		1 LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dags 64 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		Page 64 of 76



# **Certificate of Calibration**

for

#### AXIAL T COIL PROBE

Manufactured by:

TEM CONSULTING LP

Model No:

AXIAL T COIL PROBE

Serial No: 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:

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: Fc

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

uncompromised calibration Laboratories, Inc.

Calibration Lab. Cert. # 1533.01

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

 FCC ID: ZNFQ720VS
 HAC (T-COIL) TEST REPORT
 Approved by: Quality Manager

 Filename:
 Test Dates:
 DUT Type:

 1M1905200075-11-R1.ZNF
 6/10/2019 - 6/12/2019
 Portable Handset



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

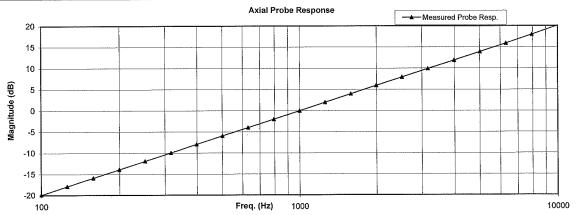
Calibration results: Probe Sensitivity measured with Helmholtz Coil Helmholtz Coll; Before & after data same: ... X ... the number of turns on each coil; 10 No. 0.204 Laboratory Environment: the radius of each coil, in meters; Ambient Temperature: °C 0.08 22.7 Α the current in the coils, in amperes.; Helmholtz Coil Constant; 7.09 A/m/V Ambient Humidity: % RH Helmholtz Coil magnetic field; 5.95 A/m Ambient Pressure: 99.326 Calibration Date: 19-Sep-2018 Calibration Due: Probe Sensitivity at 1000 Hт -59.89 dBV/A/m. Report Number: 29156 -2 was 1.013 mV/A/m Control Number: 29156 903 Ohms Probe resistance The above listed instrument meets or exceeds the tested manufacturer's specifications.

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, ISO217025

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

### Page 1 of 2

FCC ID: ZNFQ720VS	PCTEST	HAC (T-COIL) TEST REPORT	<b>LG</b>	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 66 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage 00 01 70

# 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	Me	asured val	ues
			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		
	***************************************	Hz			
Probe Frequency Response					
	Ref. (0 dB)		1		
			I I		
			I I		
			I I		
		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 6 Ref. (0 dB) 0 -6 -12  Probe Frequency Response 100 126 158 200 251 316 398 501 631 794	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 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 -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 1585 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: ZNFQ720VS	PETEST	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 67 of 76
1M1905200075-11-R1.ZNF	6/10/2019 - 6/12/2019	Portable Handset		rage 07 01 76



# **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:

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

19-Sep-18

Felix Christopher (QA Mgr.)

Certificate No:

29156 -1

Certificate Page 1 of 1

ISO/IEC 17025:2005

West Caldwell Calibration

uncompromised calibration Laboratories, Inc.

ACCREDITED

Calibration Lab. Cert. # 1533.01

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

FCC ID: ZNFQ720VS

HAC (T-COIL) TEST REPORT

1 LG

Approved by: **Quality Manager** 

Filename: 1M1905200075-11-R1.ZNF

Test Dates: 6/10/2019 - 6/12/2019 **DUT Type:** Portable Handset

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### 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

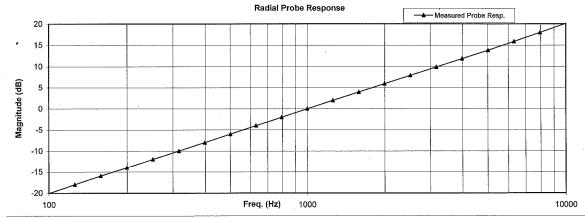
Probe Sensitivity measured wit	h Helmhol	tz Coil			
Helmholtz Coil;			Before & after data same:	<b>X</b>	
the number of turns on each coil;	10	No.			
the radius of each coil, in meters;	0.204	m	Laboratory Environment:		
the current in the coils, in amperes.;	0.08	Α	Ambient Temperature:	22.7	°C
Helmholtz 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	
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: ......

James Zhu

Calibrated on WCCL system type 9700

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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

Function	Tolera	nce	Measured values		
****			Before	Out	Remarks
Probe Sensitivity at	1000 Hz.	dBV/A/m	-60.37		
	-1411	dB			
Probe Level Linearity		6	6.03		
	Ref. (0 dB)	0	0.00		
		-6	-6.03		
		-12	-12.05		
		Hz			
Probe Frequency Response					
					1
•					
			1		
			i i		
	Ref. (0 dB)				
		3981	11.9		
		5012	13.9		
		6310	15.9		
		7943	18.0		
		10000	20.1		
	Probe Sensitivity at	Probe Sensitivity at 1000 Hz.  Probe Level Linearity  Ref. (0 dB)	Probe Sensitivity at 1000 Hz. dBV/A/m    Probe Level Linearity   6	Probe Sensitivity at 1000 Hz. dBV/A/m -60.37    Probe Level Linearity	Probe Sensitivity at 1000 Hz. dBV/A/m -60.37    Probe Level Linearity   6

nstruments used for o	alibration:		Date of Cal.	Traceability 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

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# 14. CONCLUSION

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

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

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