

#### **PCTEST**

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# **HEARING AID COMPATIBILITY**

Applicant Name:

LG Electronics U.S.A, Inc. 111 Sylvan Avenue, North Building Englewood Cliffs, NJ 07632 United States Date of Testing: 12/7/2020 - 2/2/2021 Test Site/Location: PCTEST, Columbia, MD, USA Test Report Serial No.: 1M2011240185-09.ZNF Date of Issue:

FCC ID: ZNFK200AM

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

2/5/2021

**DUT Type:** Portable Handset **Model:** LM-K200AM

Additional Model(s): LMK200AM, K200AM, LM-K200CMR, LMK200CMR, K200CMR

**Test Device Serial No.:** Pre-Production Sample [S/N: 11852, 11993]

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

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

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







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# 1. INTRODUCTION

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

#### **Compatibility Tests Involved:**

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

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

The hearing aid must be measured for:

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

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



Figure 1-1 Hearing Aid in-vitu

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

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



FCC ID: ZNFK200AM

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

111 Sylvan Avenue, North Building

Englewood Cliffs, NJ 07632

**United States** 

Model: LM-K200AM

LMK200AM, K200AM, LM-K200CMR, LMK200CMR, Additional Model(s):

K200CMR Serial Number: 11852, 11993

HW Version: Rev.1.0 SW Version: K200AM07i

Antenna: Internal Antenna DUT Type: Portable Handset

#### **Device Serial Numbers**

Several samples with identical hardware were used to support HAC testing. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical, and thermal characteristics are within operational tolerances expected for production units. The serial numbers used for each test are indicated alongside the results in Section 9.

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# **Table 2-1** ZNFK200AM HAC Air Interfaces

2141 142007 WITH 10 7 WI WINDHOOD							
Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service	Audio Codec Evaluated	
	850	VO	Yes	Yes: WIFI or BT	CMRS Voice <sup>1</sup>	EFR	
GSM	1900	] VO	Yes	Yes: WIFI OF BT	CIVIKS VOICE.	EFK	
	GPRS/EDGE	VD	Yes	Yes: WIFI or BT	Google Duo²	OPUS	
	850						
UMTS	1700	VD	Yes	Yes: WIFI or BT	Yes: WIFI or BT CMRS Voice <sup>1</sup> NB AI	NB AMR	
UMIS	1900						
	HSPA	VD	Yes	Yes: WIFI or BT	Google Duo²	OPUS	
	700 (B12)						
	850 (B5)					Volte: NB AMR, WB AMR, EVS	
LTE (FDD)	1700 (B4)	VD	Yes	Yes: WIFI or BT	VoLTE <sup>1</sup> , Google Duo <sup>2</sup>	Google Duo: OPUS	
	1900 (B2)						
WIFI	2450	VD	Yes	Yes: GSM, UMTS, or LTE	VoWIFI², Google Duo²	VoWIFI: NB AMR, WB AMR, EVS Google Duo: OPUS	
ВТ	2450	DT	No	Yes: GSM, UMTS, or LTE	N/A	N/A	
VO = Voice Only			evel in accordance with 7.4.2.1 of ANSI C63.19-20 evel is -20dBm0 in accordance with FCC KDB 285	·	tation.		

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# 3. ANSI C63.19-2011 PERFORMANCE CATEGORIES

#### I. MAGNETIC COUPLING

## **Axial and Radial Field Intensity**

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

#### **Frequency Response**

The frequency response of the axial component of the magnetic field shall follow the response curve specified in EIA RS-504-1983, over the frequency range 300 Hz – 3000 Hz per §8.3.2.

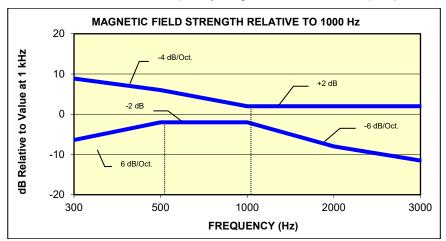
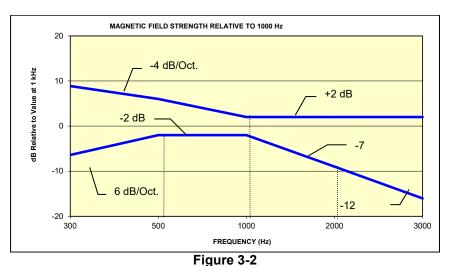


Figure 3-1
Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB(A/m) at 1 kHz



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:

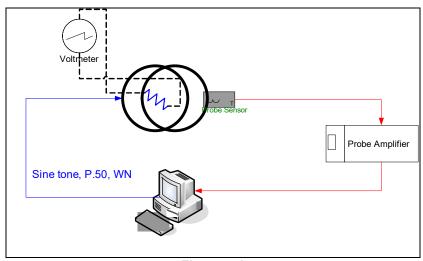


Figure 4-1
Validation Setup with Helmholtz Coil

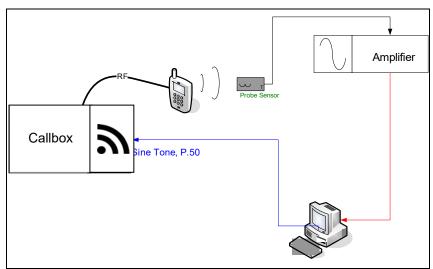


Figure 4-2 T-Coil Test Setup

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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

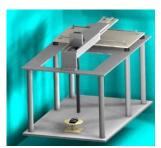
Material Composite: Delrin (Acetal)

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 Se

Activity Level: 100%

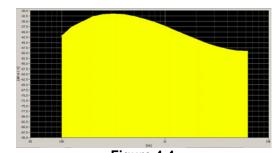


Figure 4-4
Spectral Characteristic of full P.50

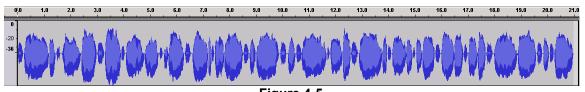
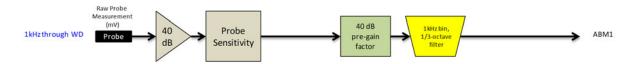


Figure 4-5
Temporal Characteristic of full P.50

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ABM2 Measurement Block Diagram:



Figure 4-6 Magnetic Measurement Processing Steps

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

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

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

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

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

Where H<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 35).

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



Figure 4-7 Frequency Response Validation

#### d. ABM2 Measurement Validation

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

Table 4-1
ABM2 Frequency Response Validation

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

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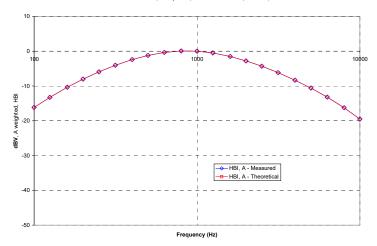
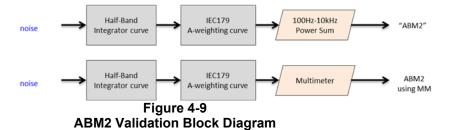


Figure 4-8
ABM2 Frequency Response Validation

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



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

Table 4-2
ABM2 Power Sum Validation

WN Input (dBV)	Power Sum (dBV)	Multimeter-Full (dBV)	Dev (dB)
-60	-60.36	-60.2	0.16
-50	-50.19	-50.13	0.06
-40	-40.14	-40.03	0.11
-30	-30.13	-30.01	0.12
-20	-20.12	-20	0.12
-10	-10.14	-10	0.14

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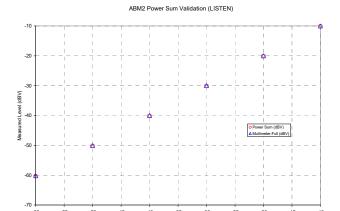
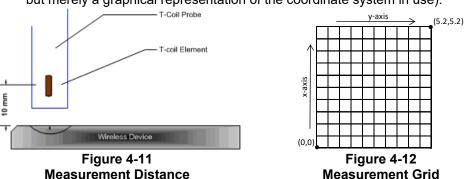


Figure 4-10 **ABM2 Power Sum Validation** 

- 3. Measurement Test Setup
  - a. Fine scan above the WD (TEM)
    - i. A multitone signal was applied to the handset such that the phone acoustic output was stable within 1dB over the probe settling time and with the acoustic output level at the C63.19 specified levels (below). The measurement step size was in 2 mm increments at a distance of 10 mm between the surface of the wireless device as shown below (note that in Figure 4-12, the grid is not to scale but merely a graphical representation of the coordinate system in use):



- ii. After scanning, the planar field maximum point was determined. The position of the probe was moved to this location to setup the test using the SoundCheck system.
- iii. These steps were repeated for all T-coil orientations (axial and radial) per Figure 4-14 after a T-coil orientation was fully measured with the SoundCheck system.
- b. Speech Signal Setup to Base Station Simulator
  - i. C63.19 Table 7-1 states audio reference input levels for various technologies:

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

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

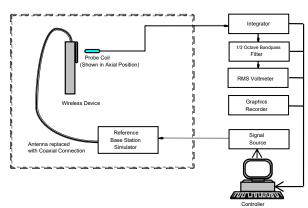


Figure 4-13 **Audio Magnetic Field Test Setup** 

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. 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				
190 (GSM)	836.60			
4183 (UMTS)	836.60			
AWS 1750				
1412 (UMTS)	1730.40			
PCS 1900				
661 (GSM)	1880			
9400 (UMTS)	1880			

#### 2. 4G (LTE) Modes

The middle channel for every band and bandwidth combination was tested for each probe orientation. The band and bandwidth combination from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels for that band and bandwidth combination. The middle channel and supported bandwidths from the worst-case band according to Table 7-5 was additionally evaluated with OTT VoIP for each probe orientation. See Tables 9-4 to 9-7 and 9-11 for LTE bandwidths and channels.

#### 3. WIFI

The middle channel for each IEEE 802.11 standard was tested for each probe orientation. The 2.4GHz IEEE 802.11 standard from each probe orientation resulting in the worst-case SNNR was additionally tested using low and high channels. See Tables 9-8 and 9-12 for WIFI standards and channels.

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### IX. Test Flow

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

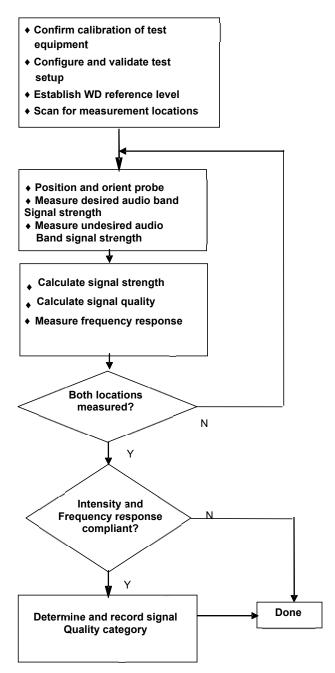


Figure 4-14 C63.19 T-Coil Signal Test Process

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# 5. VOLTE TEST SYSTEM SETUP AND DUT CONFIGURATION

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

### 1. Equipment Setup

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

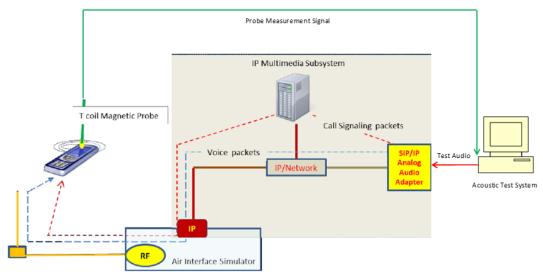


Figure 5-1
Test Setup for VoLTE over IMS T-Coil Measurements

## 2. Audio Level Settings

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

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

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

# 1. Radio Configuration

An investigation was performed to determine the modulation and RB configuration to be used for testing. The effects of modulation and RB configuration were found to be independent of band and bandwidth; therefore, only one band and bandwidth were used for this investigation. 16QAM, 1RB, 0RB offset was used for the testing as the worst-case configuration for the handset. See below table for SNNR comparison between different radio configurations:

Table 5-1
VoLTE over IMS SNNR by Radio Configuration

	_				<b>,</b>				
Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
4	1732.5	20175	20	QPSK	1	0	13.67	-46.62	60.29
4	1732.5	20175	20	QPSK	1	50	13.60	-46.11	59.71
4	1732.5	20175	20	QPSK	1	99	13.67	-46.70	60.37
4	1732.5	20175	20	QPSK	50	0	13.62	-47.63	61.25
4	1732.5	20175	20	QPSK	50	25	13.68	-45.33	59.01
4	1732.5	20175	20	QPSK	50	50	13.68	-47.56	61.24
4	1732.5	20175	20	QPSK	100	0	13.65	-47.61	61.26
4	1732.5	20175	20	16QAM	1	0	13.70	-41.47	55.17
4	1732.5	20175	20	16QAM	1	50	13.67	-42.22	55.89
4	1732.5	20175	20	16QAM	1	99	13.72	-41.83	55.55
4	1732.5	20175	20	16QAM	50	0	13.65	-46.84	60.49
4	1732.5	20175	20	16QAM	50	25	13.65	-47.63	61.28
4	1732.5	20175	20	16QAM	50	50	13.70	-45.61	59.31
4	1732.5	20175	20	16QAM	100	0	13.74	-47.23	60.97
4	1732.5	20175	20	64QAM	1	0	13.66	-42.91	56.57
4	1732.5	20175	20	64QAM	1	50	13.70	-43.16	56.86
4	1732.5	20175	20	64QAM	1	99	13.68	-43.12	56.80
4	1732.5	20175	20	64QAM	50	0	13.70	-47.21	60.91
4	1732.5	20175	20	64QAM	50	25	13.72	-48.47	62.19
4	1732.5	20175	20	64QAM	50	50	13.71	-47.17	60.88
4	1732.5	20175	20	64QAM	100	0	13.68	-45.62	59.30

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#### 2. Codec Configuration

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

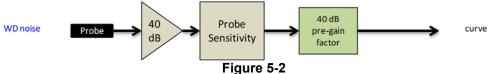
Codec Setting:	WB AMR 23.85kbps	WB AMR 6.60kbps	NB AMR 12.2kbps	NB AMR 4.75kbps	Orientation	Band / BW	Channel
ABM1 (dBA/m)	13.69	13.69	13.71	13.90			
ABM2 (dBA/m)	-42.61	-42.59	-43.11	-42.39	Axial	LTE Band 12 10MHz	23095
Frequency Response	Pass	Pass	Pass	Pass			
S+N/N (dB)	56.30	56.28	56.82	56.29			

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

Table 5-3
EVS Codec Investigation - VoLTE over IMS

Codec Setting:	EVS Primary WB 13.2kbps	EVS Primary WB 5.9kbps	EVS Primary NB 13.2kbps	EVS Primary NB 5.9kbps	Orientation	Band / BW	Channel
ABM1 (dBA/m)	13.61	13.63	13.71	13.82			
ABM2 (dBA/m)	-42.99	-42.77	-42.94	-43.87	Axial	LTE Band 12 10MHz	23095
Frequency Response	Pass	Pass	Pass	Pass	Axiai		
S+N/N (dB)	56.60	56.40	56.65	57.69			

- 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.

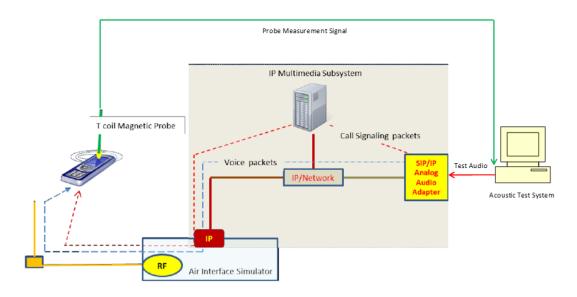


Figure 6-1 Test Setup for VoWIFI over IMS T-Coil Measurements

#### 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.

<sup>&</sup>lt;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 IEEE 802.11 standard:

> Table 6-1 IEEE 802.11b SNNR by Radio Configuration

in the state of th								
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]		
IEEE 802.11b	6	DSSS	1	6.04	-42.37	48.41		
IEEE 802.11b	6	DSSS	2	5.69	-42.42	48.11		
IEEE 802.11b	6	CCK	5.5	6.14	-42.47	48.61		
IEEE 802.11b	6	CCK	11	6.21	-42.71	48.92		

Table 6-2 IEEE 802.11g SNNR by Radio Configuration

in the state of th								
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]		
IEEE 802.11g	6	BPSK	6	6.42	-44.06	50.48		
IEEE 802.11g	6	BPSK	9	5.86	-44.04	49.90		
IEEE 802.11g	6	QPSK	12	6.04	-44.47	50.51		
IEEE 802.11g	6	QPSK	18	5.79	-44.37	50.16		
IEEE 802.11g	6	16QAM	24	5.80	-44.35	50.15		
IEEE 802.11g	6	16QAM	36	6.35	-44.65	51.00		
IEEE 802.11g	6	64QAM	48	6.77	-44.58	51.35		
IEEE 802.11g	6	64QAM	54	5.96	-44.35	50.31		

Table 6-3 IEEE 802.11n SNNR by Radio Configuration

Mode	Channel	Modulation	MCS Index	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
IEEE 802.11n	6	BPSK	0	5.59	-45.00	50.59
IEEE 802.11n	6	QPSK	1	6.66	-43.87	50.53
IEEE 802.11n	6	QPSK	2	5.85	-43.24	49.09
IEEE 802.11n	6	16QAM	3	6.47	-43.92	50.39
IEEE 802.11n	6	16QAM	4	6.39	-44.05	50.44
IEEE 802.11n	6	64QAM	5	6.75	-44.00	50.75
IEEE 802.11n	6	64QAM	6	6.69	-44.18	50.87
IEEE 802.11n	6	64QAM	7	6.36	-43.54	49.90

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#### 2. Codec Configuration

An investigation was performed to determine the audio codec configuration to be used for testing. The effects of codec configuration were found to be independent of radio configuration; therefore, only one radio configuration was used for this investigation. The NB AMR 4.75kbps setting was used for the audio codec on the CMW500 for VoWIFI over IMS T-coil testing. See below table for comparisons between different codecs and codec data rates:

Table 6-4
AMR Codec Investigation – VoWIFI over IMS

	Aim Codeo in Conganon Vovin Tover into										
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)	6.30	6.42	7.01	5.59			2.4GHz   IEEE 802.11b	6			
ABM2 (dBA/m)	-42.92	-43.06	-43.03	-42.78	Avial	Axial 2.4GHz					
Frequency Response	Pass	Pass	Pass	Pass	Axiai						
S+N/N (dB)	49.22	49.48	50.04	48.37							

Table 6-5
EVS Codec Investigation – VoWIFI over IMS

	210 codo intodigation total inc								
Codec Setting:	EVS Primary WB 13.2kbps	EVS Primary WB 5.9kbps	EVS Primary NB 13.2kbps	EVS Primary NB 5.9kbps	Orientation	Band	Standard	Channel	
ABM1 (dBA/m)	6.88	5.96	7.03	6.99					
ABM2 (dBA/m)	-43.76	-42.94	-43.75	-43.70	Axial	2.4GHz	IEEE 802.11b	6	
Frequency Response	Pass	Pass	Pass	Pass	Axiai	2.40112	ILLE 002.11D	O	
S+N/N (dB)	50.64	48.90	50.78	50.69					

Mute on; Backlight off; Max Volume; Max Contrast

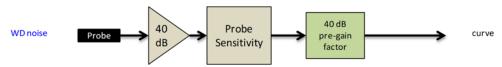


Figure 6-2
Audio Band Magnetic Curve Measurement Block Diagram

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# 7. OTT VOIP TEST SYSTEM AND DUT CONFIGURATION

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

# 1. OTT VoIP Application

Google Duo is a pre-installed application on the DUT which allows for VoIP calls in a held-to-ear scenario. Duo uses the OPUS audio codec and supports a bitrate range of 6kb/s to 75kb/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 text is approved by FCC under the TCB PAG Re-Use Policy 388624 D01 IV. D. for T-Coil Testing for WI-FI calling and Google Duo.

# II. DUT Configuration for OTT VoIP T-Coil Testing

### 1. Codec Configuration

An investigation was performed for each applicable data mode to determine the audio codec configuration to be used for testing. The effects of codec configuration were found to be independent of radio configuration; therefore, only one radio configuration for each applicable data mode was used for these investigations. The 75kbps codec setting was used for the audio codec on the auxiliary VoIP unit for OTT VoIP T-Coil testing. See below tables for comparisons between codec data rates on all applicable data modes:

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

Codec Setting:	75kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	7.87	7.94		
ABM2 (dBA/m)	-33.88	-33.86	Axial	661
Frequency Response	Pass	Pass	Axiai	
S+N/N (dB)	41.75	41.80		

<sup>&</sup>lt;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 (HSPA)

Oddec investigation – OTT voil (1101 A)								
Codec Setting:	75kbps	6kbps	Orientation	Channel				
ABM1 (dBA/m)	7.75	7.78						
ABM2 (dBA/m)	-47.19	-47.24	Axial	9400				
Frequency Response	Pass	Pass	Avidi					
S+N/N (dB)	54.94	55.02						

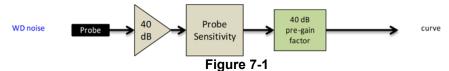
Table 7-3
Codec Investigation – OTT VoIP (LTE)

Oddec investigation – OTT voir (ETE)									
Codec Setting:	75kbps	6kbps	Orientation	Band / BW	Channel				
ABM1 (dBA/m)	7.77	7.44							
ABM2 (dBA/m)	-43.13	-43.52	Axial	LTE Band 12	23095				
Frequency Response	Pass	Pass	Axiai	10MHz					
S+N/N (dB)	50.90	50.96							

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

Codec Setting:	75kbps	6kbps	Orientation	Band	Standard	Channel
ABM1 (dBA/m)	7.40	7.58				6
ABM2 (dBA/m)	-41.70	-41.80	Axial	2.4GHz	IEEE 802.11b	
Frequency Response	Pass	Pass	Axiai	2.4GHZ		
S+N/N (dB)	49.10	49.38				

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



Audio Band Magnetic Curve Measurement Block Diagram

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# 2. Radio Configuration for OTT VoIP (LTE)

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

> Table 7-5 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]
12	707.5	23095	10	16QAM	1	0	7.73	-43.17	50.90
5	836.5	20525	10	16QAM	1	0	7.85	-41.07	48.92
4	1732.5	20175	20	16QAM	1	0	7.74	-40.87	48.61
2	1880.0	18900	20	16QAM	1	0	7.75	-40.59	48.34

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# 8. FCC 3G MEASUREMENTS

# I. UMTS Test Configurations

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

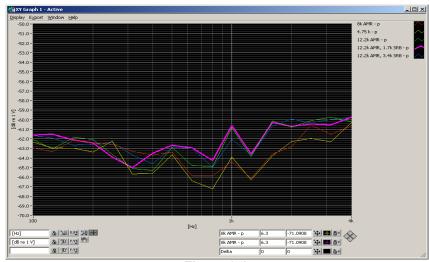
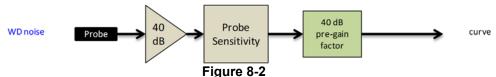


Figure 8-1
UMTS Audio Band Magnetic Noise

Table 8-1 Codec Investigation - UMTS

		<del>ooooaagaaa</del>			
Codec Setting:	AMR 12.2kbps	AMR 7.95kbps	AMR 4.75kbps	Orientation	Channel
ABM1 (dBA/m)	1.81	1.72	1.47		
ABM2 (dBA/m)	-54.77	-55.15	-55.26	Axial	9400
Frequency Response	Pass	Pass	Pass	Axiai	
S+N/N (dB)	56.58	56.87	56.73		

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



Audio Band Magnetic Curve Measurement Block Diagram

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# T-COIL TEST SUMMARY

Table 9-1 **Consolidated Tabled Results** 

			00110011	uutou I	abieu Ne	ounto			
		-	esponse rgin	_	netic / Verdict		SNNR	Margin from FCC Limit	C63.19-2011
C62 10	Section	8.3	3.2	8.3	3.1	8.3	3.4	(dB)	Rating
C03. 18	Section	Axial	Radial	Axial	Radial	Axial	Radial		
GSM	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-1.94	Т3
GSIWI	PCS	PASS	NA	PASS	PASS	PASS	PASS	-1.54	13
EDGE	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-7.07	Т3
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-7.07	13
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		_
UMTS	AWS	PASS	NA	PASS	PASS	PASS	PASS	-21.65	T4
	PCS	PASS	NA	PASS	PASS	PASS	PASS		
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
HSPA (OTT VoIP)	AWS	PASS	NA	PASS	PASS	PASS	PASS	-21.40	T4
(511 1511 )	PCS	PASS	NA	PASS	PASS	PASS	PASS		
	B12	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD	B5	PASS	NA	PASS	PASS	PASS	PASS	-18.81	Т4
LIEFUU	B4	PASS	NA	PASS	PASS	PASS	PASS	-10.01	14
	B2	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD (OTT VoIP)	B2	PASS	NA	PASS	PASS	PASS	PASS	-14.02	T4
	IEEE 802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN	IEEE 802.11g	PASS	NA	PASS	PASS	PASS	PASS	-21.78	T4
	IEEE 802.11n	PASS	NA	PASS	PASS	PASS	PASS		
	IEEE 802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN (OTT VoIP)	IEEE 802.11g	PASS	NA	PASS	PASS	PASS	PASS	-20.65	T4
, , ,	IEEE 802.11n	PASS	NA	PASS	PASS	PASS	PASS		

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# I. Raw Handset Data

Table 9-2 Raw Data Results for GSM

Mode	Orientation	Channel	Sample S/N	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	11852	1.99	-24.48		2.00	26.47	20.00	-6.47	T3	
	Axial	190	11852	1.74	-24.89	-59.72	2.00	26.63	20.00	-6.63	Т3	2.0, 1.8
GSM850		251	11852	1.77	-26.94		2.00	28.71	20.00	-8.71	T3	
GSIVIOSU		128	11852	-6.17	-28.11			21.94	20.00	-1.94	T3	
	Radial	190	11852	-6.31	-29.46	-60.19	N/A	23.15	20.00	-3.15	T3	2.0, 2.6
		251	11852	-6.45	-31.59			25.14	20.00	-5.14	T3	
		512	11852	2.09	-30.20		2.00	32.29	20.00	-12.29	T4	
	Axial	661	11852	2.21	-29.72	-59.72	2.00	31.93	20.00	-11.93	T4	2.0, 1.8
GSM1900		810	11852	2.16	-29.11		2.00	31.27	20.00	-11.27	T4	
G3W1900		512	11852	-6.46	-34.48			28.02	20.00	-8.02	T3	
	Radial	661	11852	-6.41	-34.11	-60.19	N/A	27.70	20.00	-7.70	T3	2.0, 2.6
		810	11852	-6.27	-33.59			27.32	20.00	-7.32	Т3	

Table 9-3
Raw Data Results for UMTS

				-	Data N							
Mode	Orientation	Channel	Sample S/N	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	11852	1.30	-54.85		2.00	56.15	20.00	-36.15	T4	
	Axial	4183	11852	1.35	-55.39	-59.72	2.00	56.74	20.00	-36.74	T4	2.0, 1.8
UMTS V		4233	11852	1.33	-54.80		2.00	56.13	20.00	-36.13	T4	
UNITSV		4132	11852	-6.50	-48.63			42.13	20.00	-22.13	T4	
	Radial	4183	11852	-6.42	-49.42	-60.19	N/A	43.00	20.00	-23.00	T4	2.0 1.0
		4233	11852	-6.45	-48.10	1		41.65	20.00	-21.65	T4	
		1312	11852	1.34	-55.40		2.00	56.74	20.00	-36.74	T4	
	Axial	1412	11852	1.35	-55.33	-59.72	2.00	56.68	20.00	-36.68	T4	2.0, 1.8
UMTS IV		1513	11852	1.32	-55.81		2.00	57.13	20.00	-37.13	T4	
UNITSIV		1312	11852	-6.45	-48.93			42.48	20.00	-22.48	T4	
	Radial	1412	11852	-6.46	-49.66	-60.19	N/A	43.20	20.00	-23.20	T4	2.0 1.0
		1513	11852	-6.45	-49.34			42.89	20.00	-22.89	T4	
		9262	11852	1.50	-55.67		2.00	57.17	20.00	-37.17	T4	
	Axial	9400	11852	1.43	-55.14	-59.72	2.00	56.57	20.00	-36.57	T4	2.0, 1.8
LIMTO		9538	11852	1.34	-55.70		2.00	57.04	20.00	-37.04	T4	
UMTS II		9262	11852	-6.43	-50.23			43.80	20.00	-23.80	T4	
	Radial	9400	11852	-6.47	-49.24	-60.19	N/A	42.77	20.00	-22.77	T4	2.0 1.0
		9538	11852	-6.45	-48.82			42.37	20.00	-22.37	T4	

Table 9-4
Raw Data Results for LTE B12

					. Data	toounte	,						
Mode	Orientation	Bandwidth	Channel	Sample S/N	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		10MHz	23095	11852	13.55	-44.14		2.00	57.69	20.00	-37.69	T4	
	Axial	5MHz	23095	11852	13.58	-41.86	-59.72	1.98	55.44	20.00	-35.44	T4	2.0, 1.8
	Axidi	3MHz	23095	11852	13.64	-42.23	-59.72	2.00	55.87	20.00	-35.87	T4	2.0, 1.6
LTE Band		1.4MHz	23095	11852	13.24	-41.94		2.00	55.18	20.00	-35.18	T4	
12		10MHz	23095	11852	5.52	-38.07			43.59	20.00	-23.59	T4	
	Radial	5MHz	23095	11852	5.63	-35.46	-60.19	N/A	41.09	20.00	-21.09	T4	2.0, 1.0
	Naulai	3MHz	23095	11852	5.46	-36.85	-00.19	IN/A	42.31	20.00	-22.31	T4	2.0, 1.0
		1.4MHz	23095	11852	5.48	-36.50			41.98	20.00	-21.98	T4	

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### Table 9-5 Raw Data Results for LTE B5

						. 1004.6	3 101 E11						
Mode	Orientation	Bandwidth	Channel	Sample S/N	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	11852	13.57	-41.79		2.00	55.36	20.00	-35.36	T4	
		5MHz	20525	11852	13.57	-40.17		2.00	53.74	20.00	-33.74	T4	
	Axial	3MHz	20635	11852	13.49	-40.29	-59.72	2.00	53.78	20.00	-33.78	T4	2.0, 1.8
	Axidi	3MHz	20525	11852	13.57	-39.66	-59.72	2.00	53.23	20.00	-33.23	T4	2.0, 1.0
		3MHz	20415	11852	13.49	-42.02		1.96	55.51	20.00	-35.51	T4	
LTE Band 5		1.4MHz	20525	11852	13.59	-40.03		2.00	53.62	20.00	-33.62	T4	
LIE Ballu 5		10MHz	20525	11852	5.51	-35.51			41.02	20.00	-21.02	T4	
		5MHz	20525	11852	5.57	-34.75			40.32	20.00	-20.32	T4	
	Radial	3MHz	20635	11852	5.49	-33.94	-60.19	N/A	39.43	20.00	-19.43	T4	2.0, 1.0
	Nadiai	3MHz	20525	11852	5.55	-33.26	-00.19	IN/A	38.81	20.00	-18.81	T4	2.0, 1.0
		3MHz	20415	11852	5.48	-36.02			41.50	20.00	-21.50	T4	
		1.4MHz	20525	11852	5.50	-35.41			40.91	20.00	-20.91	T4	

#### Table 9-6 Raw Data Results for LTE B4

				itu	W Data	itosait	3 101 L11						
Mode	Orientation	Bandwidth	Channel	Sample S/N	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	20175	11852	13.61	-41.20		2.00	54.81	20.00	-34.81	T4	
		15MHz	20175	11852	13.59	-42.30		2.00	55.89	20.00	-35.89	T4	
	Axial	10MHz	20175	11852	13.37	-41.03	-59.72	2.00	54.40	20.00	-34.40	T4	2.0, 1.8
	Axidi	5MHz	20175	11852	13.61	-43.23	-59.72	2.00	56.84	20.00	-36.84	T4	2.0, 1.6
		3MHz	20175	11852	13.70	-41.74		2.00	55.44	20.00	-35.44	T4	
LTE Band 4		1.4MHz	20175	11852	13.56	-42.71		2.00	56.27	20.00	-36.27	T4	
LIE Band 4		20MHz	20175	11852	5.46	-34.42			39.88	20.00	-19.88	T4	
		15MHz	20175	11852	5.48	-35.51			40.99	20.00	-20.99	T4	
	Radial	10MHz	20175	11852	5.55	-35.64	-60.19	N/A	41.19	20.00	-21.19	T4	2.0, 1.0
	Naulai	5MHz	20175	11852	5.52	-36.22	-00.19	IN/A	41.74	20.00	-21.74	T4	2.0, 1.0
		3MHz	20175	11852	5.56	-36.85			42.41	20.00	-22.41	T4	
		1.4MHz	20175	11852	5.53	-35.60			41.13	20.00	-21.13	T4	

## Table 9-7 **Raw Data Results for LTE B2**

Mode	Orientation	Bandwidth	Channel	Sample S/N	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	11852	13.56	-41.22		2.00	54.78	20.00	-34.78	T4	
		15MHz	18900	11852	13.62	-40.06		2.00	53.68	20.00	-33.68	T4	ĺ
	Axial	10MHz	18900	11852	13.60	-41.17	-59.72	2.00	54.77	20.00	-34.77	T4	2.0, 1.8
	Axidi	5MHz	18900	11852	13.61	-40.66	-39.72	2.00	54.27	20.00	-34.27	T4	2.0, 1.6
		3MHz	18900	11852	13.60	-41.81		2.00	55.41	20.00	-35.41	T4	
LTE Band 2		1.4MHz	18900	11852	13.62	-41.78		1.91	55.40	20.00	-35.40	T4	
LIE Band 2		20MHz	18900	11852	5.55	-34.86			40.41	20.00	-20.41	T4	
		15MHz	18900	11852	5.56	-34.94			40.50	20.00	-20.50	T4	
	Radial	10MHz	18900	11852	5.50	-35.73	-60.19	N/A	41.23	20.00	-21.23	T4	2.0, 1.0
	Nadiai	5MHz	18900	11852	5.59	-34.35	-00.19	IWA	39.94	20.00	-19.94	T4	2.0, 1.0
		3MHz	18900	11852	5.56	-35.25			40.81	20.00	-20.81	T4	
		1.4MHz	18900	11852	5.48	-35.85			41.33	20.00	-21.33	T4	ĺ

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### Table 9-8 Raw Data Results for 2.4GHz WIFI

				<u> </u>	<del></del>	ito ioi E	<u> </u>	• •				
Mode	Orientation	Channel	Sample S/N	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	11993	6.11	-43.33		1.90	49.44	20.00	-29.44	T4	
IEEE	Axial	6	11993	5.60	-42.49	-60.58	1.94	48.09	20.00	-28.09	T4	2.0, 1.8
802.11b		11	11993	6.93	-42.48		1.88	49.41	20.00	-29.41	T4	
	Radial	6	11993	-2.01	-44.10	-60.91	N/A	42.09	20.00	-22.09	T4	2.0, 1.0
	Axial	6	11993	5.82	-43.57	-60.58	1.84	49.39	20.00	-29.39	T4	2.0, 1.8
IEEE		1	11993	-2.90	-44.68			41.78	20.00	-21.78	T4	
802.11g	Radial	6	11993	-2.56	-44.58	-60.91	N/A	42.02	20.00	-22.02	T4	2.0, 1.0
		11	11993	-2.81	-44.94			42.13	20.00	-22.13	T4	
IEEE	Axial	6	11993	5.85	-43.49	-60.58	1.84	49.34	20.00	-29.34	T4	2.0, 1.8
802.11n	Radial	6	11993	-2.42	-44.79	-60.91	N/A	42.37	20.00	-22.37	T4	2.0, 1.0

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

Mode	Orientation	Channel	Sample S/N	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)		Test Coordinates
EDGE850	Axial	190	11852	7.49	-31.43	-59.72	1.39	38.92	20.00	-18.92	T4	2.0, 1.8
EDGE050	Radial	190	11852	0.39	-26.68	-60.19	N/A	27.07	20.00	-7.07	Т3	2.0, 1.0
EDGE1900	Axial	661	11852	7.80	-33.98	-59.72	1.35	41.78	20.00	-21.78	T4	2.0, 1.8
EDGE1900	Radial	661	11852	0.43	-30.71	-60.19	N/A	31.14	20.00	-11.14	T4	2.0, 1.0

## **Table 9-10** Raw Data Results for HSPA (OTT VoIP)

Mode	Orientation	Channel	Sample S/N	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011	Test Coordinates
HSPA V	Axial	4183	11852	7.64	-46.97	-59.72	1.45	54.61	20.00	-34.61	T4	2.0, 1.8
NOFA V	Radial	4183	11852	0.30	-41.41	-60.19	N/A	41.71	20.00	-21.71	T4	2.0, 1.0
HSPA IV	Axial	1412	11852	7.69	-47.18	-59.72	1.50	54.87	20.00	-34.87	T4	2.0, 1.8
порату	Radial	1412	11852	0.34	-41.06	-60.19	N/A	41.40	20.00	-21.40	T4	2.0, 1.0
HSPA II	Axial	9400	11852	7.92	-47.08	-59.72	1.37	55.00	20.00	-35.00	T4	2.0, 1.8
поган	Radial	9400	11852	0.38	-41.59	-60.19	N/A	41.97	20.00	-21.97	T4	2.0, 1.0

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### **Table 9-11** Raw Data Results for LTE B2 (OTT VoIP)

	Raw Data Results for LTE B2 (OTT VOIP)														
Mode	Orientation	Bandwidth	Channel	Sample S/N	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	11852	7.75	-40.47	0 0 5 4 5	1.48	48.22	20.00	-28.22	T4			
		15MHz	18900	11852	7.71	-40.00			1.35	47.71	20.00	-27.71	T4		
		10MHz	18900	11852	7.64	-40.20		1.46	47.84	20.00	-27.84	T4			
	Axial	5MHz	18900	11852	7.73	-40.35		1.42	48.08	20.00	-28.08	T4	2.0, 1.8		
	Axiai	3MHz	19185	11852	7.77	-39.44		-59.72	-59.72	1.46	47.21	20.00	-27.21	T4	2.0, 1.6
		3MHz	18900	11852	7.70	-39.95		1.40	47.65	20.00	-27.65	T4			
		3MHz	18615	11852	7.71	-41.31		1.47	49.02	20.00	-29.02	T4			
LTE Band 2		1.4MHz	18900	11852	7.70	-40.53		1.41	48.23	20.00	-28.23	T4			
LIE Ballu 2		20MHz	18900	11852	0.41	-34.53	-		34.94	20.00	-14.94	T4			
		15MHz	18900	11852	0.50	-34.43			34.93	20.00	-14.93	T4			
		10MHz	19150	11852	0.48	-35.73			36.21	20.00	-16.21	T4			
	Dadial	10MHz	18900	11852	0.50	-33.52	-60.19	N/A	34.02	20.00	-14.02	T4	2.0, 1.0		
	Radial	10MHz	18650	11852	0.50	-35.06	-00.19	IWA	35.56	20.00	-15.56	T4	2.0, 1.0		
		5MHz	18900	11852	0.52	-34.44	-34.44 -34.58		34.96	20.00	-14.96	T4			
		3MHz	18900	11852	0.49	-34.58				35.07	20.00	-15.07	T4		
		1.4MHz	18900	11852	0.56	-35.07			35.63	20.00	-15.63	T4			

#### **Table 9-12** Raw Data Results for 2 4GHz WIFL (OTT VolP)

			itaw	Data Ne	sound it	) Z.4GH	2 VVII I (C	71 1 VOID	7			-
Mode	Orientation	Channel	Sample S/N	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	11993	7.61	-42.24		1.39	49.85	20.00	-29.85	T4	
IEEE	Axial	6	11993	8.07	-41.91	-60.58	1.43	49.98	20.00	-29.98	T4	2.0, 1.8
802.11b		11	11993	8.00	-41.63		1.34	49.63	20.00	-29.63	T4	
	Radial	6	11993	-1.21	-42.35	-60.91	N/A	41.14	20.00	-21.14	T4	2.0, 1.0
	Axial	6	11993	7.93	-43.88	-60.58	1.48	51.81	20.00	-31.81	T4	2.0, 1.8
IEEE		1	11993	-1.14	-42.09			40.95	20.00	-20.95	T4	
802.11g	Radial	6	11993	-1.33	-41.98	-60.91	N/A	40.65	20.00	-20.65	T4	2.0, 1.0
		11	11993	-1.24	-41.94			40.70	20.00	-20.70	T4	
IEEE	Axial	6	11993	7.89	-43.76	-60.58	1.40	51.65	20.00	-31.65	T4	2.0, 1.8
802.11n	Radial	6	11993	-1.31	-42.07	-60.91	N/A	40.76	20.00	-20.76	T4	2.0, 1.0

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

#### B. GSM

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

#### C. UMTS

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

### D. LTE FDD

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

#### E. WIFI

- 1. Radio Configuration
  - a. IEEE 802.11b; DSSS, 2Mbps
  - b. IEEE 802.11g: BPSK, 9Mbps
  - c. IEEE 802.11n: QPSK, MCS 2
- Vocoder Configuration: NB AMR 4.75kbps
- 3. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. IEEE 802.11b is the worst-case for the Axial probe orientation. IEEE 802.11g is the worst-case for the Radial probe orientation.

#### F. OTT VolP

- 1. Vocoder Configuration: 75kbps
- 2. EDGE Configuration
  - a. MCS Index: 7
  - b. Number of TX slots: 2
- HSPA Configuration:
  - a. Release: 6
  - b. 3GPP 34.121 Subtest 1

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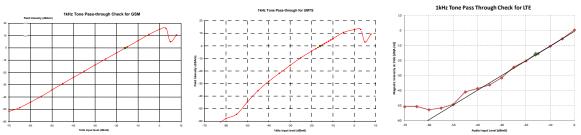
#### 4. LTE FDD Configuration:

- a. Power Configuration: TPC = "Max Power"
- b. Radio Configuration: 16QAM, 1RB, 0RB offset
- c. LTE Band 2 was the worst-case band from Table 7-5 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 2 at 3MHz is the worst-case for the Axial probe orientation. LTE Band 2 at 10MHz bandwidth is the worst-case for the Radial probe orientation.

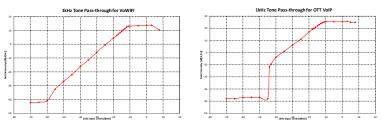
#### 5. WIFI Configuration:

- a. Radio Configuration
  - i. IEEE 802.11b: DSSS, 2Mbps
  - ii. IEEE 802.11g: BPSK, 9Mbps
  - iii. IEEE 802.11n: QPSK, MCS 2
- b. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. IEEE 802.11b is the worst-case for the Axial probe orientation. IEEE 802.11g is the worst-case for the Radial probe orientation.

# III. 1 kHz Vocoder Application Check



This model was verified to be within the linear region for ABM1 measurements at -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.

FCC ID: ZNFK200AM	PCTEST* Proud to be port of a commend	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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# IV. T-Coil Validation Test Results

Table 9-13
Helmholtz Coil Validation Table of Results – 12/7/2020

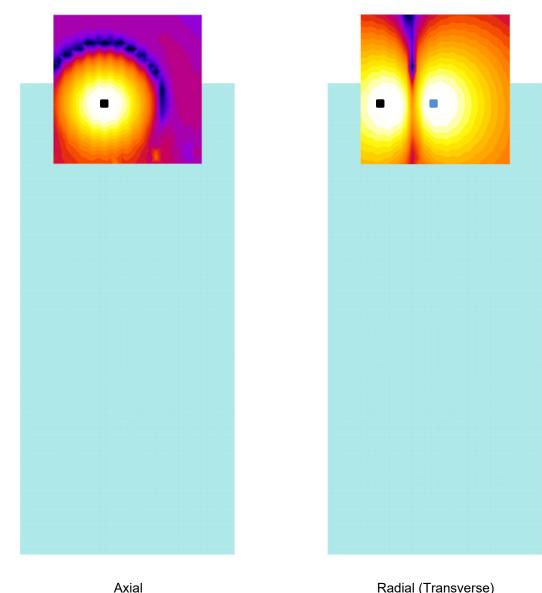
Item	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.004	PASS
Environmental Noise	< -58 dBA/m	-59.72	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.110	PASS
Environmental Noise	< -58 dBA/m	-60.19	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS

Table 9-14
Helmholtz Coil Validation Table of Results – 2/2/2021

Item	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.887	PASS
Environmental Noise	< -58 dBA/m	-60.58	PASS
Frequency Response, from limits	> 0 dB	0.70	PASS
Radial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.140	PASS
Environmental Noise	< -58 dBA/m	-60.91	PASS
Frequency Response, from limits	> 0 dB	0.80	PASS

FCC ID: ZNFK200AM	PCTEST* Proud to be pert of a servered	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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#### **ABM1 Magnetic Field Distribution Scan Overlays** ٧.



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. The blue cursor indicates the radial GSM Voice test location.
- 2. See Test Setup Photographs for actual WD overlay.

FCC ID: ZNFK200AM	PCTEST* Proud to be part of a circums	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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# 10. MEASUREMENT UNCERTAINTY

# Table 10-1 Uncertainty Estimation Table

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

#### Notes:

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

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

FCC ID: ZNFK200AM	PCTEST* Proud to be part of a circums	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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#### **EQUIPMENT LIST** 11.

# **Table 11-1 Equipment List**

	Equipment Liet						
Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number	
Dell	Latitude E6540	SoundCheck Acoustic Analyzer Laptop	9/29/2020	Biennial	9/29/2022	2655082910	
Listen	SoundConnect	Microphone Power Supply	9/24/2020	Biennial	9/24/2022	0899-PS150	
RME	Fireface UC	Soundcheck Acoustic Analyzer External Audio Interface	9/29/2020	Biennial	9/29/2022	23792992	
Rohde & Schwarz	CMW500	Radio Communication Tester	5/21/2020	Annual	5/21/2021	128635	
Rohde & Schwarz	CMW500	Radio Communication tester	9/4/2020	Annual	9/4/2021	140144	
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	2/4/2020	Annual	2/4/2021	162125	
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	6/23/2020	Annual	6/23/2021	161662	
Seekonk	NC-100	Torque Wrench (8" lb)	8/4/2020	Biennial	8/4/2022	21053	
TEM	Axial T-Coil Probe	Axial T-Coil Probe	9/23/2020	Biennial	9/23/2022	TEM-1123	
TEM		HAC Positioner	N/A		N/A	N/A	
TEM		HAC System Controller with Software	N/A		N/A	N/A	
TEM	Helmholtz Coil	Helmholtz Coil	9/23/2020	Biennial	9/23/2022	SBI 1052	
TEM	Radial T-Coil Probe	Radial T-Coil Probe	9/23/2020	Biennial	9/23/2022	TEM-1129	

FCC ID: ZNFK200AM	PCTEST* Proud to be port of serioused	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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# 12. TEST DATA

FCC ID: ZNFK200AM	PCTEST* Proud to be part of a circums	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 20 of 72
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DUT: HH Coil - SN: SBI 1052

Type: HH Coil Serial: SBI 1052

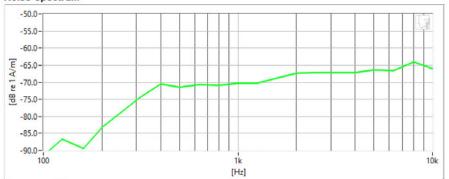
Measurement Standard: ANSI C63.19-2011

#### Equipment:

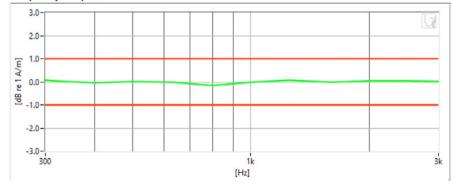
Probe: Axial T-Coil Probe - SN: TEM-1123; Calibrated: 9/23/2020

Helmholtz Coil - SN: SBI 1052; Calibrated: 9/23/2020

#### **Noise Spectrum**



### Frequency Response



### Results

Verification 1kHz Intensity	-10.004	dB	$\checkmark$	Max/Min	-9.5/-10.5
Verification ABM2	-59.72	dB	•	Maximum	-58.0
Frequency Response Margin	800m	dB	•	Tolerance curves	Aligned Data

FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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# **PCTEST Hearing-Aid Compatibility Facility**

DUT: HH Coil - SN: SBI 1052

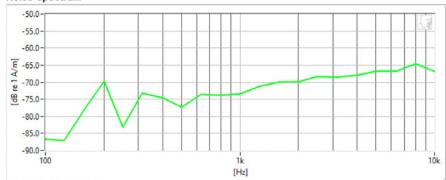
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

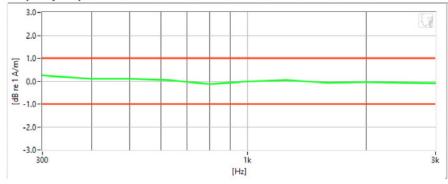
#### Equipment:

- Probe: Axial T-Coil Probe SN: TEM-1123; Calibrated: 9/23/2020
- Helmholtz Coil SN: SBI 1052; Calibrated: 9/23/2020

#### **Noise Spectrum**



#### Frequency Response



#### Results

Verification 1kHz Intensity	-9.887 dB	$\checkmark$	Max/Min	-9.5/-10.5
Verification ABM2	-60.58 dB	•	Maximum	-58.0
Frequency Response Margin	700m dB	~	Tolerance curves	Aligned Data

FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 41 of 72
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DUT: HH Coil - SN: SBI 1052

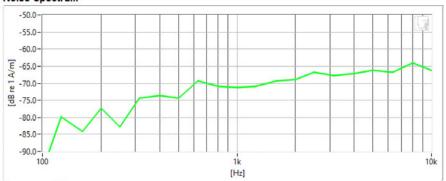
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

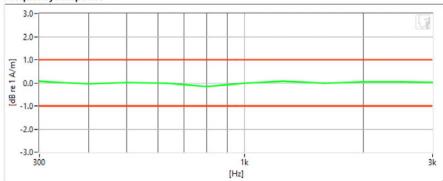
#### Equipment:

- Probe: Radial T-Coil Probe SN: TEM-1129; Calibrated: 9/23/2020
- Helmholtz Coil SN: SBI 1052; Calibrated: 9/23/2020

#### **Noise Spectrum**



### Frequency Response



### Results

Verification 1kHz Intensity	-10.11 dB	$\checkmark$	Max/Min	-9.5/-10.5
Verification ABM2	-60.19 dB	•	Maximum	-58.0
Frequency Response Margin	800m dB	•	Tolerance curves	Aligned Data

FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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DUT: HH Coil - SN: SBI 1052

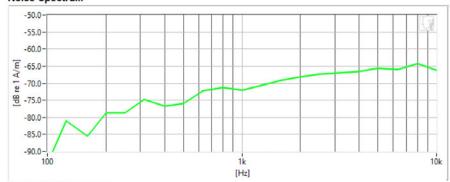
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

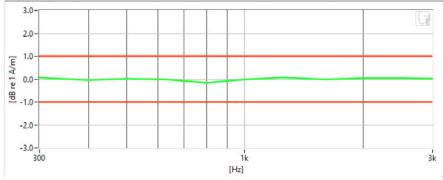
#### Equipment:

- Probe: Radial T-Coil Probe SN: TEM-1129; Calibrated: 9/23/2020
- Helmholtz Coil SN: SBI 1052; Calibrated: 9/23/2020

#### **Noise Spectrum**



### Frequency Response



#### Results

Verification 1kHz Intensity	-10.14 dB	$\checkmark$	Max/Min	-9.5/-10.5
Verification ABM2	-60.91 dB	•	Maximum	-58.0
Frequency Response Margin	800m dB	~	Tolerance curves	Aligned Data

FCC ID: ZNFK200AM	PCTEST* Proud to be past of (6) steroors	HAC (T-COIL) TEST REPORT	HAC (T-COIL) TEST REPORT	
Filename:	Test Dates:	DUT Type:		Page 43 of 72
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

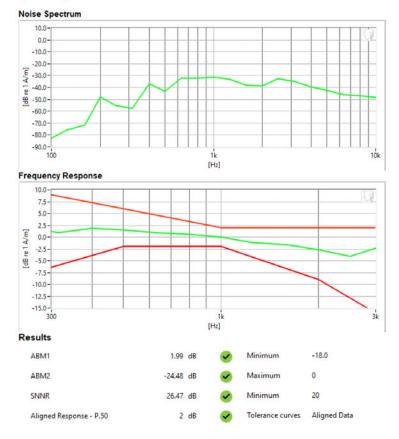
#### Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: GSM850 Channel: 128

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST* Proud to be part of the internet	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 44 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Fage 44 01 72



Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

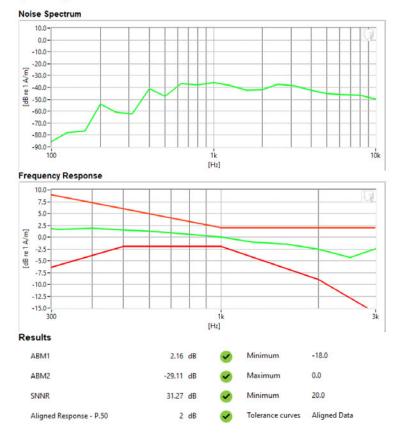
#### Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: GSM1900 Channel: 810

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST* Proud to be part of @ interest	HAC (T-COIL) TEST REPORT	LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 45 of 72
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

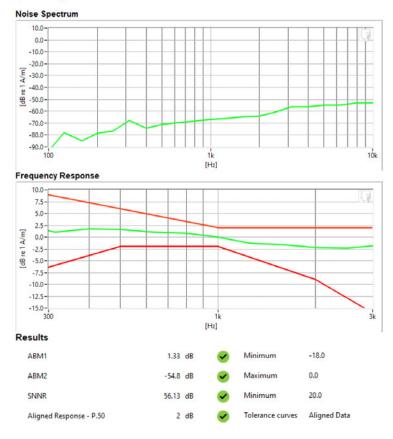
#### Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: UMTS V Channel: 4233

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST* Road to be pert of ® comment	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 46 of 72
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

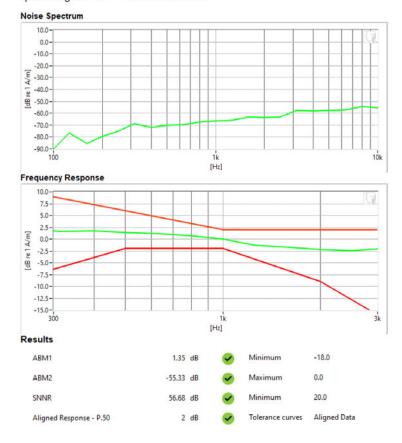
#### Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: UMTS IV Channel: 1412

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST* Proud to be part of @ interest	HAC (T-COIL) TEST REPORT	LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

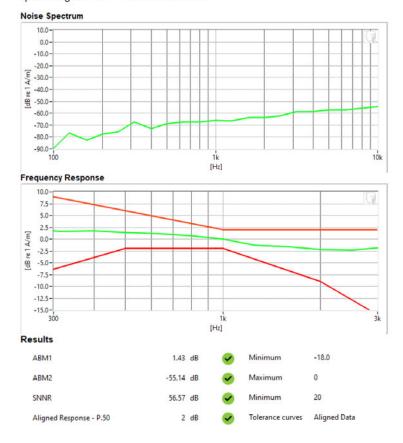
#### Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: UMTS II Channel: 9400

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

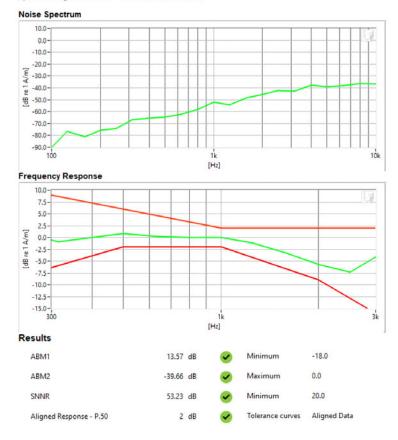
#### Equipment:

Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

### **Test Configuration:**

Mode: LTE FDD Band 5 Bandwidth: 3MHz Channel: 20525

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	TEST REPORT LG	
Filename:	Test Dates:	DUT Type:		Page 49 of 72
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## **DUT: ZNFK200AM** Type: Portable Handset

Serial: 11993

Measurement Standard: ANSI C63.19-2011

#### Equipment:

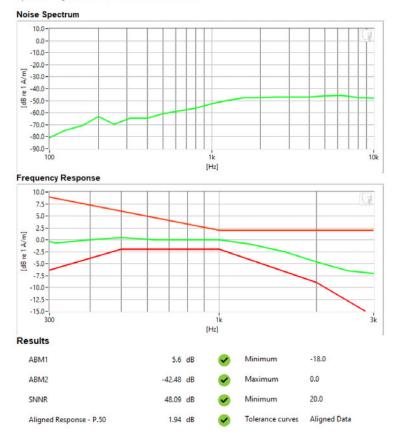
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

### **Test Configuration:**

Mode: 2.4GHz WIFI Standard: IEEE 802.11b

Channel: 6

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 50 of 72
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

#### Equipment:

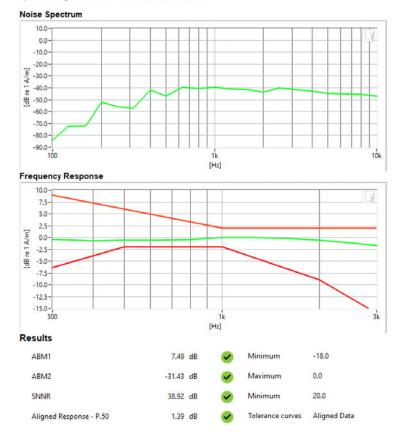
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 9/23/2020

# Test Configuration:

· VoIP Application: Google Duo

Mode: EDGE850 Channel: 190

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	EPORT LG	
Filename:	Test Dates:	DUT Type:		Page 51 of 72
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

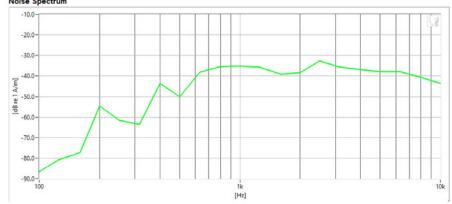
#### Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: GSM850 Channel: 128

#### Noise Spectrum



#### Results

ABM1	-6.17	dB	$\checkmark$	Minimum	-18.0
ABM2	-28.12	dB	$\checkmark$	Maximum	0.0
SNNR	21.94	dB	<b>₹</b>	Minimum	20.0

FCC ID: ZNFK200AM	PCTEST* Proud to be past of a sterner	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 52 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Fage 52 01 72



Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

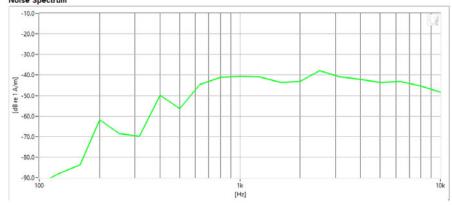
#### Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

# Test Configuration:

 Mode: GSM1900 Channel: 810

#### Noise Spectrum



#### Results

ABM1	-6.27	dB	$\checkmark$	Minimum	-18.0
ABM2	-33.59	dB	<b>✓</b>	Maximum	0.0
SNNR	27.32	dB	$\checkmark$	Minimum	20.0

FCC ID: ZNFK200AM	PCTEST* Proud to be pert of seizement	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 53 of 72
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

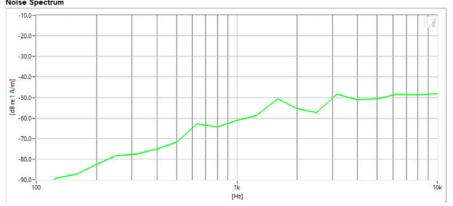
#### Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

# Test Configuration:

 Mode: UMTS V Channel: 4233

#### Noise Spectrum



#### Results

ABM1	-6.45	dB	$\checkmark$	Minimum	-18.0
ABM2	-48.1	dB	•	Maximum	0.0
SNNR	41.65	dB	$\checkmark$	Minimum	20.0

FCC ID: ZNFK200AM	PCTEST* Proud to be part of @ mineral	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 54 of 72
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Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

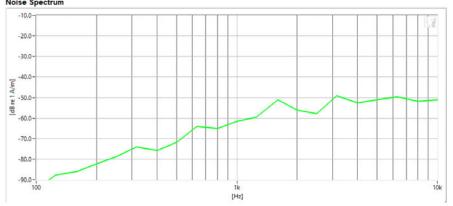
#### Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

# Test Configuration:

 Mode: UMTS IV Channel: 1312

#### Noise Spectrum



#### Results

ABM1	-6.45	dB	$\checkmark$	Minimum	-18.0
ABM2	-48.93	dB	$\checkmark$	Maximum	0.0
SNNR	42.48	dB	$\checkmark$	Minimum	20.0

FCC ID: ZNFK200AM	PCTEST* Proud to be past of a sterner	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 55 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Page 55 01 72



Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

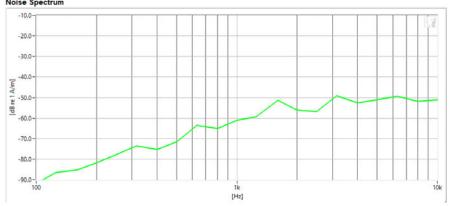
#### Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

# Test Configuration:

 Mode: UMTS II Channel: 9538

#### Noise Spectrum



#### Results

ABM1	-6.45	dB	$\checkmark$	Minimum	-18.0
ABM2	-48.83	dB	$\checkmark$	Maximum	0.0
SNNR	42.37	dB	•	Minimum	20.0

FCC ID: ZNFK200AM	PCTEST: Proud to be part of a sterned	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 56 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		rage 50 of 72



Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

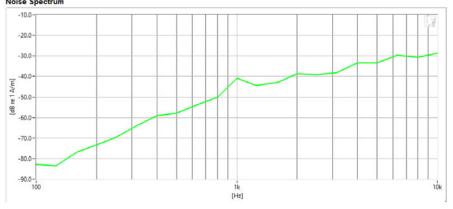
#### Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: LTE FDD Band 5 Bandwidth: 3MHz Channel: 20525

#### Noise Spectrum



#### Results

ABM1	5.55	dB	$\checkmark$	Minimum	-18.0
ABM2	-33.26	dB	•	Maximum	0.0
SNNR	38.81	dB	$\checkmark$	Minimum	20.0

FCC ID: ZNFK200AM	PCTEST: Proud to be part of a sterned	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 57 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Page 37 01 72



# **DUT: ZNFK200AM** Type: Portable Handset

Serial: 11993

Measurement Standard: ANSI C63.19-2011

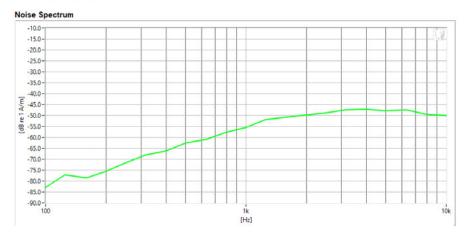
#### Equipment:

Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

### **Test Configuration:**

 Mode: 2.4GHz WIFI Standard: IEEE 802.11g

Channel: 1



#### Results

ABM1	-2.9	dB	$\checkmark$	Minimum		18.0
ABM2	-44.68	dB	•	Maximum	0	0.0
SNNR	41.78	dB	$\checkmark$	Minimum	2	20.0

FCC ID: ZNFK200AM	PCTEST* Proud to be part of a circums	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Dogo 59 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Page 58 of 72



Type: Portable Handset Serial: 11852

Measurement Standard: ANSI C63.19-2011

#### Equipment:

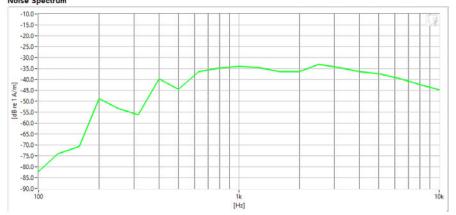
Probe: Radial T-Coil Probe – SN: TEM-1129; Calibrated: 9/23/2020

# Test Configuration:

· VoIP Application: Google Duo

Mode: EDGE850 Channel: 190

#### Noise Spectrum



#### Results

ABM1	390m	dB	$\checkmark$	Minimum	-18.0
ABM2	-26.68	dB	$\checkmark$	Maximum	0.0
SNNR	27.07	dB	•	Minimum	20.0

FCC ID: ZNFK200AM	PCTEST: Proof to be part of a sterner	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
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#### **CALIBRATION CERTIFICATES** 13.

FCC ID: ZNFK200AM	PCTEST* Proud to be port of serioused	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 60 of 72
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# **Certificate of Conformance**

AXIAL T COIL PROBE

Manufactured by: TEM CONSULTING Model No: AXIAL T COIL PROBE

Serial No: TEM-1123 Calibration Recall No: 31288

Submitted By:

ANDREW HARWELL Customer:

PCTEST ENGINEERING LAB Company: Address:

6660-B DOBBIN ROAD

COLUMBIA MD 21045

The subject instrument was calibrated to the indicated specification using standards traceable to the SI through 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:

tolerance of the indicated specification. See attached Report of Calibration. The information supplied relates to the calibrated item listed above and statment of conformance for ALL given specifications and standards fall under the decision rule: A=(L-(U95)), where A is acceptance limit, L is manufacturer specifications and U95 is confidence level of 95% at k=2. This includes but not limited to:1. Measured value does not meet manufacturer's tolerance, 2. Manufacturer's tolerance is too small compared to calibration and measurment capability uncertainties, 3. Test uncertainty ratio does not meet the 4:1 ratio due to test instrumentation limitations. The decision rule has been communicated and approved by customer during contract

West Caldwell Calibration Laboratories' calibration control system meets the following requirements, ISO 10012-1 MIL STD 45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2015, and ISO 17025

Certificate Page 1 of 1

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

Approved by:

Calibration Date: 23-Sep-20 James Zhu

31288 - 2 Certificate No:

Quality Manager ISO/IEC 17025:2017

QA Doc. #1051 Rev. 3.0 5/29/20

West Caldwell Calibration

ACCREDITED Calibration Lab. Cert. # 1533.01

uncompromised calibration Laboratories, Inc.

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

Approved by: PCTEST FCC ID: ZNFK200AM HAC (T-COIL) TEST REPORT 15 LG Quality Manager Filename: Test Dates: **DUT Type:** Page 61 of 72

1M2011240185-09.ZNF 12/7/2020 - 2/2/2021 Portable Handset © 2021 PCTEST



1575 State Route 96, Victor NY 14564



# REPORT OF CALIBRATION

or

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

Model No.: Axial T Coil Probe

Serial No.: TEM-1123

I. D. No.: XXXX

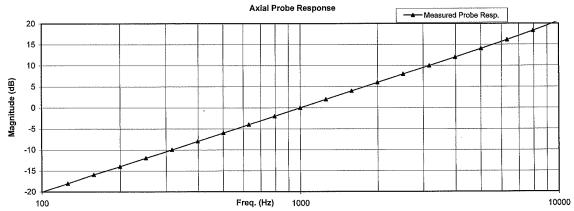
Probe Sensitivity measured wit	h Helmholf	z Coil			
Helmholtz Coil;			Before & after data same:	<b>X</b>	
the number of turns on each coil;	10	No.			
the radius of each coil, in meters;	0.204	m	Laboratory Environment:		
the current in the coils, in amperes.;	0.08	Α	Ambient Temperature:	20.7	°C
Helmholtz Coil Constant;	7.04	A/m/V	Ambient Humidity:	42.1	% RH
Helmholtz Coil magnetic field;	5.71	A/m	Ambient Pressure:	99.094	kPa
			Calibration Date:	23-Sep-2020	
Probe Sensitivity at	1000	Hz.	Calibration Due:		
was	-60.24	dBV/A/m	Report Number:	31288	-2
	0.972	mV/A/m	Control Number:	31288	
Probe resistance	898	Ohms			

This Calibration is traceable through NIST test numbers: 684

684.07/O-0000001126-20

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 9001:2015, ISO 17025

Cal. Date: 23-Sep-2020 Calibrated on WCCL system type 9700

Measurements performed by: .....

James Zhu

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

# Page 1 of 2

FCC ID: ZNFK200AM	PCTEST* Proud to be past of a sterner	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 62 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Page 62 01 72

# HCATEMC\_TEM-1123\_Sep-23-2020

# West Caldwell Calibration Laboratories Inc.

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

# Calibration Data Record

for Model No.: Axial T Coil Probe

Serial No.: TEM-1123

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

Test	Function	Tolera	nce	Measured values			
				Before	Out	Remarks	
1.0	Probe Sensitivity at	1000 Hz.	dBV/A/m	-60.24			
			dB				
2.0	Probe Level Linearity		6	6.03			
		Ref. (0 dB)	0	0.00			
			-6	-6.03			
			-12	-12.05			
			Hz			†	
3.0	Probe Frequency Response		100	-20.0			
			126	-18.0			
			158	-15.9			
	,		200	-14.0			
			251	-12.0			
			316	-10.0			
			398	-8.0			
			501	-6.0			
			631	-4.0			
			794	-2.0			
		Ref. (0 dB)	1000	0.0			
			1259	2.0			
			1585	4.0			
			1995	6.0			
			2512	8.0			
			3162	10.0			
			3981	12.0			
			5012	14.0			
			6310	16.1			
			7943	18.3			
			10000	20.7			
				1 3			

Instruments u	ised for calibration:		Date of Cal.	Traceablity No.	Due Date
HP	34401A	S/N US360641	2-Jul-2020	,610119	2-Jul-2021
HP	34401A	S/N US361024	2-Jul-2020	,610119	2-Jul-2021
HP	33120A	S/N US360437	2-Jul-2020	.610119	2-Jul-2021
B&K	2133	S/N 1583254	1-Jul-2020	684.07/O-0000001126-20	1-Jul-2021

Cal. Date: 23-Sep-2020

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: ZNFK200AM	PCTEST* Proud to be part of @ statement	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 63 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Page 63 01 72



# **Certificate of Conformance**

for

#### RADIAL T COIL PROBE

Submitted By:

Manufactured by:

TEM CONSULTING

Model No:

RADIAL T COIL PROBE

Serial No:

TEM-1129

Calibration Recall No:

31288

Customer:

Address:

ANDREW HARWELL

Company:

PCTEST ENGINEERING LAB

6660-B DOBBIN ROAD

COLUMBIA

MD 21045

The subject instrument was calibrated to the indicated specification using standards traceable to the SI through 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.

RADIAL T TEM C

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

19/13/2021

Within (X

tolerance of the indicated specification. See attached Report of Calibration.

The information supplied relates to the calibrated item listed above and statment of conformance for ALL given specifications and standards fall under the decision rule: A=(L-(U95)), where A is acceptance limit, L is manufacturer specifications and U95 is confidence level of 95% at k=2. This includes but not limited to:1. Measured value does not meet manufacturer's tolerance, 2.Manufacturer's tolerance is too small compared to calibration and measurement capability uncertainties, 3. Test uncertainty ratio does not meet the 4:1 ratio due to test instrumentation limitations. The decision rule has been communicated and approved by customer during contract

West Caldwell Calibration Laboratories' calibration control system meets the following requirements, ISO 10012-1 MIL STD 45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2015, and ISO 17025

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

Approved by:

Calibration Date:

23-Sep-20

James Zhu

Certificate No:

31288 - 1

Quality Manager

QA Doc. #1051 Rev. 3.0 5/29/20

Certificate Page 1 of 1

West Caldwell Calibration

uncompromised calibration Laboratories, Inc.

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

Calibration Lab. Cert. # 1533.01

FCC ID: ZNFK200AM

FILENDER

Test Dates:

1M2011240185-09.ZNF

12/7/2020 - 2/2/2021

HAC (T-COIL) TEST REPORT

DUT Type:
Portable Handset

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REV 3.5.M 8/18/2020



Calibration Lab. Cert. # 1533.01

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

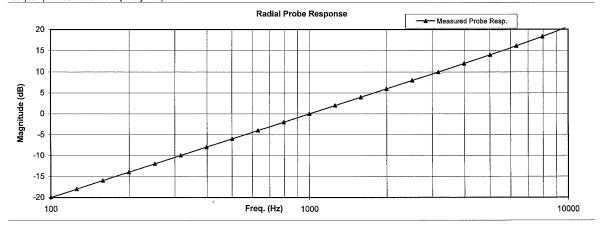
Serial No.: TEM-1129

I. D. No.: XXXX

ISO/IEC 17025: 2017

Probe Sensitivity measured with	Helmholt	z Coil			
Helmholtz Coil;			Before & after data same:X		
the number of turns on each coil;	10	No.			
the radius of each coil, in meters;	0.204	m	Laboratory Environment:		
the current in the coils, in amperes.;	0.08	Α	Ambient Temperature:	20.7	۰C
Helmholtz Coil Constant;	7.04	A/m/V	Ambient Humidity:	42.1	% RH
Helmholtz Coil magnetic field;	5.70	A/m	Ambient Pressure:	99.094	kPa
			Calibration Date:	23-Sep-2020	)
Probe Sensitivity at	1000	Hz.	Re-calibration Due:		
was	-60.37	dBV/A/m	Report Number:	3128	8 -1
•	0.959	mV/A/m	Control Number:	3128	8
Probe resistance	897	Ohms			

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 9001:2015, ISO 17/9/25

Cal. Date: 23-Sep-2020

Measurements performed by: ......

Calibrated on WCCL system type 9700

James Zhu

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

# Page 1 of 2

FCC ID: ZNFK200AM	PCTEST* Proud to be past of @ interest	HAC (T-COIL) TEST REPORT	LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 65 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Page 65 01 72

# HCRTEMC\_TEM-1129\_Sep-23-2020

# 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

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			
		dB				
Probe Level Linearity		6	6.04			
•	Ref. (0 dB)	0	0.00			
		-6	-6.03			
		-12	-12.05			
		Hz	***************************************			
Probe Frequency Response			1			
•						
					1	
					1	
	Ref. (0 dB)					
					1	
					1	
					İ	
		7943	18.3			
		10000	20.7			
		Probe Sensitivity at 1000 Hz.  Probe Level Linearity  Ref. (0 dB)	Probe Sensitivity at 1000 Hz. dBV/A/m  Probe Level Linearity  Ref. (0 dB) 0 -6 -12  Probe Frequency Response 100 126 158 200 251 316 398 501 631 794 Ref. (0 dB) 1000 1259 1585 1995 2512 3162 3981 5012 6310 7943	Probe Sensitivity at 1000 Hz. dBV/A/m -60.37  Probe Level Linearity 6 6 6.04 Ref. (0 dB) 0 0.00 -6 -6.03 -12 -12.05  Hz Probe Frequency Response 100 -20.0 158 -16.0 200 -14.0 251 -12.0 316 -10.0 398 -8.0 501 -6.0 631 -4.0 794 -2.0 Ref. (0 dB) 1000 0.0 1259 2.0 Ref. (0 dB) 1000 0.0 1259 2.0 1585 4.0 1995 6.0 2512 8.0 3162 10.0 3981 12.0 5012 14.0 6310 16.1 7943 18.3	Probe Sensitivity at 1000 Hz. dBV/A/m -60.37    Probe Level Linearity   6	

Instrumen	ts used for calibration:		Date of Cal.	Traceability No.	Due Date
HP	34401A	S/N US360641	2-Jul-2020	,610119	2-Jul-2021
HP	34401A	S/N US361024	2-Jul-2020	,610119	2-Jul-2021
HP	33120A	S/N US360437	2-Jul-2020	.610119	2-Jul-2021
B&K	2133	S/N 1583254	1-Jul-2020	684.07/O-0000001126-20	1-Jul-2021

Cal. Date: 23-Sep-2020

Calibrated on WCCL system type 9700

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Tested by: James Zhu

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

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FCC ID: ZNFK200AM	PCTEST* Proud to be part of @ minered	HAC (T-COIL) TEST REPORT	LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 66 of 72
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#### 14. CONCLUSION

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

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

FCC ID: ZNFK200AM	PCTEST*	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 67 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		

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FCC ID: ZNFK200AM	PCTEST* Proud to be port of serioused	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 68 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		rage to ti 12

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FCC ID: ZNFK200AM	PCTEST: Proud to be part of a sterned	HAC (T-COIL) TEST REPORT	① LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 69 of 72
1M2011240185-09.ZNF	12/7/2020 - 2/2/2021	Portable Handset		Fage 09 01 72