

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: 12/10/2018 - 12/26/2018 Test Site/Location: PCTEST Lab, Columbia, MD, USA

Test Report Serial No.: 1M1811280213-10-R2.ZNF

FCC ID: ZNFL423DL

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

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

Application Type: Certification
FCC Rule Part(s): CFR §20.19(b)
HAC Standard: ANSI C63.19-2011

285076 D01 HAC Guidance v05

285076 D02 T-Coil testing for CMRS IP v03

DUT Type: Portable Handset

Model: LG L423DL

Additional Model(s): LGL423DL, L423DL

Test Device Serial No.: Pre-Production Sample [S/N: 11258]

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

Note: This revised Test Report (S/N: 1M1811280213-10-R2.ZNF) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

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

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

Randy Ortanez
President





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1. INTRODUCTION

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

Compatibility Tests Involved:

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

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

The hearing aid must be measured for:

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

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



Figure 1-1 Hearing Aid in-vitu

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

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2. DUT DESCRIPTION



FCC ID: ZNFL423DL

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

1000 Sylvan Avenue

Englewood Cliffs, NJ 07632

United States

Model: LG L423DL

Additional Model(s): LGL423DL, L423DL

Serial Number: 11258
HW Version: Rev.1.0
SW Version: L423DL07x
Antenna: Internal Antenna
DUT Type: Portable Handset

Table 2-1
ZNFL423DL HAC Air Interfaces

Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service	Audio Codec Evaluated
	835	VO	Vac	Yes: WIFI or BT	CMRS Voice ¹	EVRC
CDMA	1900	\ \v0	Yes	Yes: WIFI OF BT	CIMIKS VOICE.	EVKC
	EvDO	VD	Yes	Yes: WIFI or BT	Google Duo ²	OPUS
	850	vo	Yes	Yes: WIFI or BT	CMRS Voice ¹	EFR
GSM	1900	VO	Yes	res: WIFI OF BT	CINIK2 ADICE.	EFK
	GPRS/EDGE	VD	Yes	Yes: WIFI or BT	Google Duo ²	OPUS
	850					
UMTS	1700	VD	Yes	Yes: WIFI or BT	CMRS Voice ¹	NB AMR
UIVITS	1900					
	HSPA	VD	Yes	Yes: WIFI or BT	Google Duo ²	OPUS
	680 (B71)		Yes³			VoLTE: NB AMR, WB AMR Google Duo: OPUS
	700 (B12)					
	780 (B13)					
LTE (FDD)	850 (B5)	VD	Yes	Yes: WIFI or BT	VoLTE ¹ , Google Duo ²	
	1700 (B4)		res		Google Du	
	1700 (B66)					
	1900 (B2)					
	2450					
	5200 (U-NII 1)					
WIFI	5300 (U-NII 2A)	VD	Yes	Yes: CDMA, GSM, UMTS, or LTE	VoWIFI ² , Google Duo ²	VoWIFI: NB AMR, WB AMR Google Duo: OPUS
	5500 (U-NII 2C)					Google Buo. Ol OS
	5800 (U-NII 3)					
BT	2450	DT	No	Yes: CDMA, GSM, UMTS, or LTE	N/A	N/A
-			² Reference lev	rel in accordance with 7.4.2.1 of ANSI C63.19-201 vel is -20dBm0 in accordance with FCC KDB 28507 e outside the scope of ANSI C63.19 and FCC HAC	76 D02	

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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3. ANSI C63.19-2011 PERFORMANCE CATEGORIES

I. MAGNETIC COUPLING

Axial and Radial Field Intensity

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

Frequency Response

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

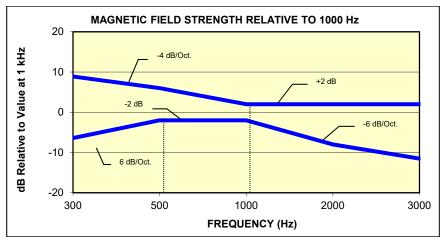


Figure 3-1
Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB(A/m) at 1 kHz

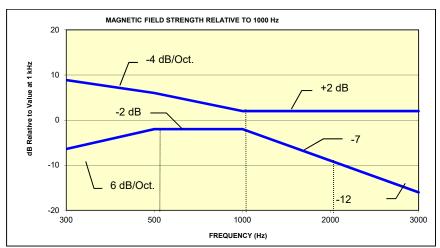


Figure 3-2
Magnetic Field frequency response for wireless devices with an axial field that exceeds
-15 dB(A/m) at 1 kHz

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Signal Quality

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

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

Category	Telephone RF Parameters		
outogory	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:

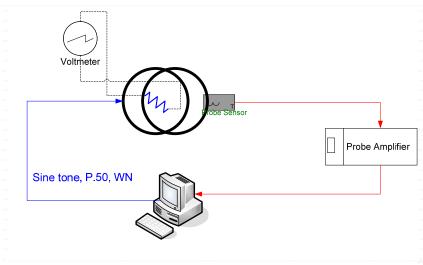


Figure 4-1
Validation Setup with Helmholtz Coil

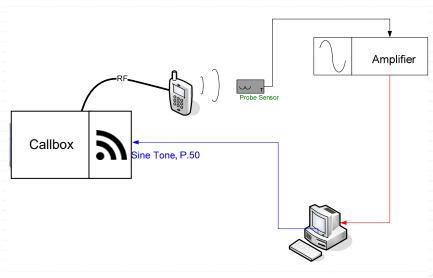


Figure 4-2 T-Coil Test Setup

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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)

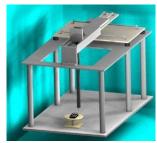


Figure 4-3 RF Near-Field Scanner

III. ITU-T P.50 Artificial Voice

Manufacturer: ITU-T

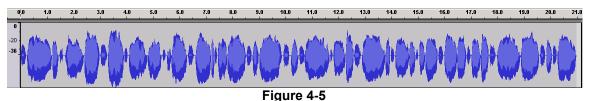
Active Frequency Range: 100 Hz – 8 kHz

Stimulus Type: Male and Female, no spaces

Single Sample Duration: 20.96 seconds

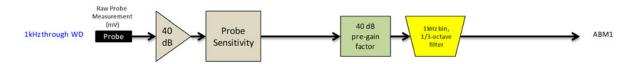
Activity Level: 100%

Figure 4-4
Spectral Characteristic of full P.50



Temporal Characteristic of full P.50

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ABM2 Measurement Block Diagram:



Figure 4-6 Magnetic Measurement Processing Steps

IV. Test Procedure

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

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

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

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

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

For the Helmholtz Coil, N=20; r=0.13m; 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 \pm 0.5 dB of the -10dB(A/m) value (see Page 36).

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



Figure 4-7 Frequency Response Validation

d. ABM2 Measurement Validation

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

Table 4-1
ABM2 Frequency Response Validation

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

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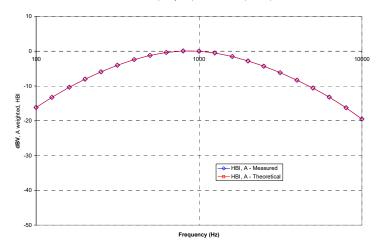
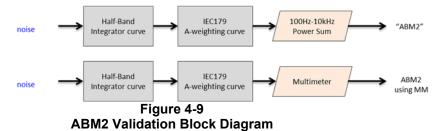


Figure 4-8 **ABM2 Frequency Response Validation**

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



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

Table 4-2 **ABM2 Power Sum Validation**

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

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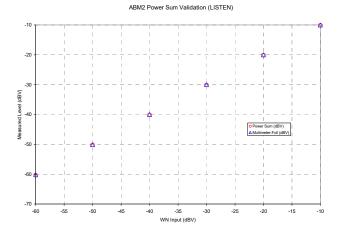


Figure 4-10
ABM2 Power Sum Validation

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

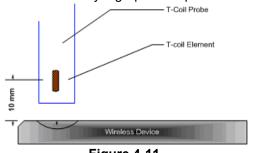


Figure 4-11 Measurement Distance

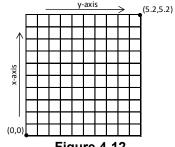


Figure 4-12 Measurement Grid

- ii. After scanning, the planar field maximum point was determined. The position of the probe was moved to this location to setup the test using the SoundCheck system.
- iii. These steps were repeated for all T-coil orientations (axial and radial) per Figure 4-15 after a T-coil orientation was fully measured with the SoundCheck system.
- b. Speech Signal Setup to Base Station Simulator
 - i. C63.19 Table 7-1 states audio reference input levels for various technologies:

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

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- ii. See Section 5 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.

Real-Time Analyzer (RTA)

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

d. WD Radio Configuration Selection

i. The device was chosen to be tested in the worst-case ABM2 condition (see below for GSM, see Section 8 for more information regarding worst-case configurations for CDMA and UMTS. LTE configuration information can be found in Section 5. WIFI configuration information can be found in Section 6 and 7):

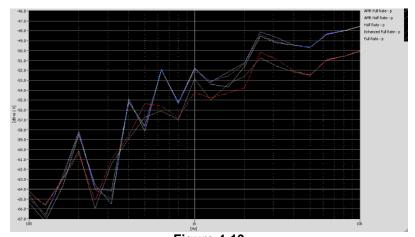


Figure 4-13 Vocoder Analysis for ABM Noise for GSM

4. Signal Quality Data Analysis

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

b. Frequency Response

- i. The appropriate frequency response curve was measured to curves in Figure 3-1 or Figure 3-2 between 300 - 3000 Hz using digital linear averaging (limit lines chosen according to measurement found in step 4a). A linear average over 3x the length of the artificial voice signal (3x sampling) was performed. A 10 second delay was configured in the measurement process of the stimulus to ensure handset vocoder latency effects and echo cancellation devices (if any) were appropriately stabilized during measurements.
- ii. The appropriate post-processing was applied according to the system processing chain illustrated in Figure 4-7. All R10 frequencies were plotted with respect to 0dB at 1kHz value and aligned with respect to the EIA-504 mask.
- iii. The margin is represented by the closest measured data point on the curve to the EIA-504 limit lines, in dB.

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c. Signal Quality Index

- i. Ensuring the WD was at maximum RF power, maximum volume, backlight off, display on, maximum contrast setting, keypad lights on (when possible) with no audio signal through the vocoder, the WD was measured over at least 100 Hz 10,000 Hz, maximized over 5 seconds with a 50ms sample time for the ABM2 measurement (5 second time period is used in noise measurements under standards such as IEEE 269, etc.).
- ii. After applying half-band integration and A-weighting to the result, a power sum was applied over each 1/3 octave bandwidth frequency for an ABM2 value.
- This result was subtracted from the ABM1 result in step a, to obtain the Signal Quality.

V. Test Setup

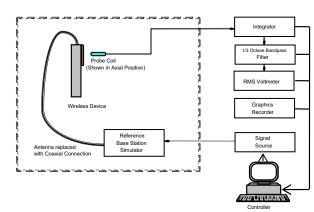


Figure 4-14
Audio Magnetic Field Test Setup

VI. Deviation from C63.19 Test Procedure

Non-conducted RF connection due to 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				
AWS 1750					
1412 (UMTS)	1730.40				
PCS 1900	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 were additionally evaluated with OTT VoIP for each probe orientation. See Tables 9-5 to 9-10 as well as 9-18 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 9-11 to 9-14 as well as 9-19 to 9-22 for WIFI standards and channels.

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IX. Test Flow

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

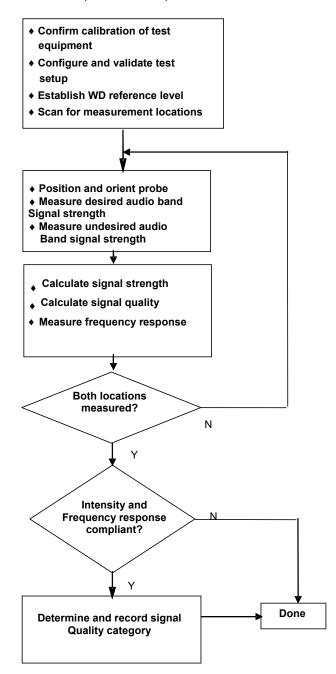


Figure 4-15 C63.19 T-Coil Signal Test Process

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5. VOLTE TEST SYSTEM SETUP AND DUT CONFIGURATION

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

1. Equipment Setup

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

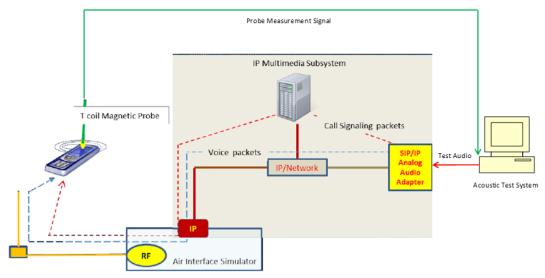


Figure 5-1
Test Setup for VoLTE over IMS T-Coil Measurements

2. Audio Level Settings

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

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

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

1. Radio Configuration

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

Table 5-1
VoLTE over IMS SNNR by Radio Configuration

	VOLTE OVER INIO CIVILITY BY REGIO CONTINUE CONTI									
Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]		
836.5	20525	10	QPSK	1	0	25.57	-29.00	54.57		
836.5	20525	10	QPSK	1	25	25.18	-30.04	55.22		
836.5	20525	10	QPSK	1	49	25.44	-29.19	54.63		
836.5	20525	10	QPSK	25	0	25.43	-33.43	58.86		
836.5	20525	10	QPSK	25	12	25.22	-31.28	56.50		
836.5	20525	10	QPSK	25	25	25.30	-30.45	55.75		
836.5	20525	10	QPSK	50	0	25.34	-28.61	53.95		
836.5	20525	10	16QAM	1	0	25.41	-24.99	50.40		
836.5	20525	10	16QAM	1	25	25.23	-26.20	51.43		
836.5	20525	10	16QAM	1	49	25.41	-25.39	50.80		
836.5	20525	10	16QAM	25	0	25.07	-30.74	55.81		
836.5	20525	10	16QAM	25	12	25.46	-31.16	56.62		
836.5	20525	10	16QAM	25	25	25.46	-30.71	56.17		
836.5	20525	10	16QAM	50	0	25.47	-30.47	55.94		
836.5	20525	10	64QAM	1	0	25.32	-27.39	52.71		
836.5	20525	10	64QAM	1	25	25.48	-27.13	52.61		
836.5	20525	10	64QAM	1	49	25.21	-26.05	51.26		
836.5	20525	10	64QAM	25	0	25.50	-30.86	56.36		
836.5	20525	10	64QAM	25	12	25.48	-30.28	55.76		
836.5	20525	10	64QAM	25	25	25.43	-29.68	55.11		
836.5	20525	10	64QAM	50	0	25.43	-30.88	56.31		

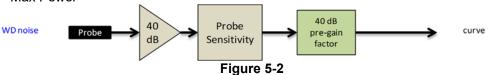
2. Codec Configuration

An investigation was performed to determine the audio codec configuration to be used for testing. The NB AMR 4.75kbps 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)	24.69	25.25	25.45	25.11		Band 5 10MHz	20525
ABM2 (dBA/m)	-25.77	-25.63	-25.74	-24.71	Axial		
Frequency Response	Pass	Pass	Pass	Pass	Axiai		
S+N/N (dB)	50.46	50.88	51.19	49.82			

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



Audio Band Magnetic Curve Measurement Block Diagram

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VOWIFI TEST SYSTEM SETUP AND DUT CONFIGURATION 6.

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

1. Equipment Setup

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

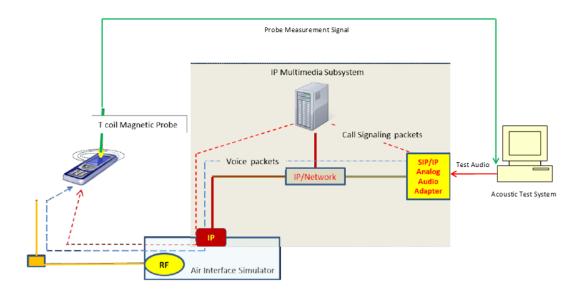


Figure 6-1 Test Setup for VoWIFI over IMS T-Coil Measurements

2. Audio Level Settings

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

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

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

1. Radio Configuration

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

Table 6-1 802.11b SNNR by Radio Configuration

	transfer to the state of the st									
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]				
802.11b	6	DSSS	1	23.03	-37.53	60.56				
802.11b	6	DSSS	2	23.04	-38.54	61.58				
802.11b	6	CCK	5.5	23.01	-37.58	60.59				
802.11b	6	CCK	11	23.05	-38.28	61.33				

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

602: 11g/a Civiti by Radio Configuration									
Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]			
802.11g	6	BPSK	6	23.03	-36.56	59.59			
802.11g	6	BPSK	9	23.08	-37.85	60.93			
802.11g	6	QPSK	12	23.02	-37.59	60.61			
802.11g	6	QPSK	18	23.40	-37.55	60.95			
802.11g	6	16-QAM	24	23.13	-39.60	62.73			
802.11g	6	16-QAM	36	23.34	-36.53	59.87			
802.11g	6	64-QAM	48	23.58	-37.99	61.57			
802.11g	6	64-QAM	54	23.14	-37.47	60.61			

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

	602.1 m/ac 20Mil 2 BW ONNIX by Radio Configuration									
Mode	Bandwidth [MHz]	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]			
802.11n	20	40	BPSK	6.5	22.91	-37.68	60.59			
802.11n	20	40	QPSK	13	22.96	-37.94	60.90			
802.11n	20	40	QPSK	19.5	22.94	-37.52	60.46			
802.11n	20	40	16-QAM	26	22.96	-37.04	60.00			
802.11n	20	40	16-QAM	39	23.35	-36.36	59.71			
802.11n	20	40	64-QAM	52	22.95	-36.28	59.23			
802.11n	20	40	64-QAM	58.5	22.93	-37.99	60.92			
802.11n	20	40	64-QAM	65	23.02	-37.91	60.93			
802.11ac	20	40	256-QAM	78	24.55	-39.58	64.13			

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

	ouzi i iii do foimiz bit oititit by itadio comigaration								
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	23.11	-37.03	60.14		
802.11n	40	38	QPSK	27	22.90	-37.44	60.34		
802.11n	40	38	QPSK	40.5	22.91	-38.16	61.07		
802.11n	40	38	16-QAM	54	23.46	-37.54	61.00		
802.11n	40	38	16-QAM	81	23.29	-37.53	60.82		
802.11n	40	38	64-QAM	108	23.52	-38.49	62.01		
802.11n	40	38	64-QAM	121.5	23.20	-37.84	61.04		
802.11n	40	38	64-QAM	135	23.06	-38.50	61.56		
802.11ac	40	38	256-QAM	162	23.09	-39.56	62.65		
802.11ac	40	38	256-QAM	180	23.27	-37.62	60.89		

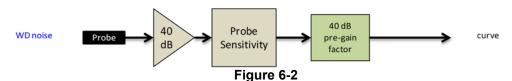
2. Codec Configuration

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

Table 6-5
AMR Codec Investigation – VoWIFI over IMS

	7 mint obtato introdugación Tottin i otto inic							
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)	24.24	23.05	24.89	25.03	Axial		IEEE 802.11b	6
ABM2 (dBA/m)	-38.33	-37.08	-38.28	-38.12		2.4GHz		
Frequency Response	Pass	Pass	Pass	Pass				
S+N/N (dB)	62.57	60.13	63.17	63.15				

Mute on; Backlight off; Max Volume; Max Contrast



Audio Band Magnetic Curve Measurement Block Diagram

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OTT VOIP TEST SYSTEM AND DUT CONFIGURATION 7.

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

1. OTT VoIP Application

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

2. Equipment Setup

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

3. Audio Level Settings

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

II. **DUT Configuration for OTT VolP T-Coil Testing**

1. Codec Configuration

An investigation was performed for each applicable data mode to determine the audio codec configuration to be used for testing. The 6kbps codec setting was used for the audio codec on the auxiliary VoIP unit for OTT VoIP T-Coil testing. See below tables for comparisons between codec data rates on all applicable data modes:

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

Codec Setting:	64kbps	6kbps	Orientation	Channel				
ABM1 (dBA/m)	7.79	7.37						
ABM2 (dBA/m)	-52.61	-51.13	Axial	600				
Frequency Response	Pass	Pass	Axiai					
S+N/N (dB)	60.40	58.50						

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

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

Codec Setting:	64kbps	6kbps	Orientation	Channel			
ABM1 (dBA/m)	7.66	7.40					
ABM2 (dBA/m)	-36.34	-35.57	Axial	661			
Frequency Response	Pass	Pass	Axiai				
S+N/N (dB)	44.00	42.97					

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

Couco investigation CTT von (1101 A)							
Codec Setting:	64kbps	6kbps	Orientation	Channel			
ABM1 (dBA/m)	7.63	7.11					
ABM2 (dBA/m)	-52.36	-52.25	Axial	9400			
Frequency Response	Pass	Pass	Axiai				
S+N/N (dB)	59.99	59.36					

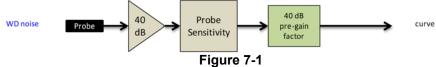
Table 7-4 Codec Investigation - OTT VolP (LTE)

Odec investigation – OTT voil (LTL)									
Codec Setting:	64kbps	6kbps	Orientation	Band / BW	Channel				
ABM1 (dBA/m)	7.27	7.11		Band 71	133297				
ABM2 (dBA/m)	-48.41	-48.50	Axial						
Frequency Response	Pass	Pass	Axiai	20MHz					
S+N/N (dB)	55.68	55.61							

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

Codo invocagation CTT von (vvn)									
Codec Setting:	64kbps	6kbps	Orientation	Band	Standard	Channel			
ABM1 (dBA/m)	7.28	7.42							
ABM2 (dBA/m)	-42.55	-41.51	Avial	Axial 5GHz	IEEE 802.11ac	40			
Frequency Response	Pass	Pass	Axiai			40			
S+N/N (dB)	49.83	48.93							

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



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 Band 2 was used for the testing as the worst-case configuration for the handset. See below table for SNNR comparison between different LTE bands:

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

Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	SNNR [dB]
71	680.5	133297	20	16QAM	1	0	7.21	-48.57	55.78
12	707.5	23095	10	16QAM	1	0	7.09	-47.14	54.23
13	782.0	23230	10	16QAM	1	0	6.99	-47.19	54.18
5	836.5	20525	10	16QAM	1	0	7.04	-48.37	55.41
66	1745.0	132322	20	16QAM	1	0	7.28	-47.54	54.82
2	1880.0	18900	20	16QAM	1	0	7.49	-46.33	53.82

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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:

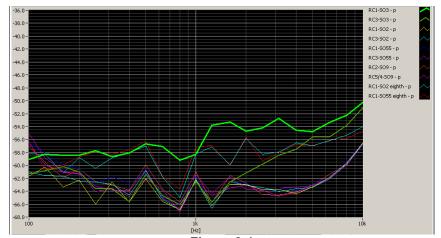
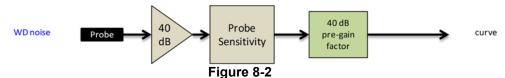


Figure 8-1
CDMA Audio Band Magnetic Noise

Table 8-1 FCC 3G ABM Measurements for ZNFL423DL (CDMA)

1.00.00712								
Configuration:	RC1/SO3	RC3/SO3	RC4/SO3	Orientation	Channel			
ABM1 (dBA/m)	26.32	24.98	25.27	A.d.al	600			
ABM2 (dBA/m)	-25.04	-38.61	-37.48					
Frequency Response	Pass	Pass	Pass	Axial				
S+N/N (dB)	51.36	63.59	62.75					

- 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:

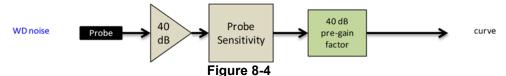


Figure 8-3
UMTS Audio Band Magnetic Noise

Table 8-2 Codec Investigation - UMTS

Ocace investigation Cline							
Codec Setting:	AMR 12.2kbps	AMR 7.95kbps	AMR 4.75kbps	Orientation	Channel		
ABM1 (dBA/m)	24.87	24.84	24.83	– Axial	4132		
ABM2 (dBA/m)	-37.29	-37.42	-37.50				
Frequency Response	Pass	Pass	Pass				
S+N/N (dB)	62.16	62.26	62.33				

- · 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

_			20113011	dated 1	abled R	counto			
			esponse rgin	_	netic / Verdict		SNNR dict	Margin from FCC Limit	C63.19-2011
000.40	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	1	
CDMA	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-27.49	T4
ODMA	PCS	PASS	NA	PASS	PASS	PASS	PASS	-27.43	7
EvDO	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-30.15	T4
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-30.13	1
GSM	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-6.41	Т3
GSIVI	PCS	PASS	NA	PASS	PASS	PASS	PASS	-0.41	13
EDGE	Cellular	PASS	NA	PASS	PASS	PASS	PASS	-21.24	T4
(OTT VoIP)	PCS	PASS	NA	PASS	PASS	PASS	PASS	-21.24	14
	Cellular	PASS	NA	PASS	PASS	PASS	PASS		
UMTS	AWS	PASS	NA	PASS	PASS	PASS	PASS	-41.18	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	-17.11	T4
(011 70)	PCS	PASS	NA	PASS	PASS	PASS	PASS		
	B71	PASS	NA	PASS	PASS	PASS	PASS		
	B12	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD	B13	PASS	NA	PASS	PASS	PASS	PASS	-28.41	T4
LIE FUU	B5	PASS	NA	PASS	PASS	PASS	PASS	-20.41	14
	B66	PASS	NA	PASS	PASS	PASS	PASS		
	B2	PASS	NA	PASS	PASS	PASS	PASS		
LTE FDD (OTT VoIP)	B2	PASS	NA	PASS	PASS	PASS	PASS	-14.69	Т4
	802.11b	PASS	NA	PASS	PASS	PASS	PASS		
WLAN	802.11g	PASS	NA	PASS	PASS	PASS	PASS	-30.39	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	-6.62	Т3
(5 7011)	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	-33.92	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	-10.45	T4
(0.1. 4011)	802.11ac	PASS	NA	PASS	PASS	PASS	PASS		

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REV 3.2.M

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	26.90	-25.27		0.82	52.17	20.00	-32.17	T4	
	Axial	384	26.95	-25.04	-63.90	0.81	51.99	20.00	-31.99	T4	1.8, 3.4
Cellular		777	26.96	-23.58		0.79	50.54	20.00	-30.54	T4	
Celiulai		1013	18.96	-30.61			49.57	20.00	-29.57	T4	
	Radial	384	19.02	-30.52	-63.77	N/A	49.54	20.00	-29.54	T4	1.8, 2.6
		777	18.97	-28.91			47.88	20.00	-27.88	T4	
		25	27.16	-24.63		0.78	51.79	20.00	-31.79	T4	
	Axial	600	27.18	-25.92	-63.90	0.78	53.10	20.00	-33.10	T4	1.8, 3.4
PCS		1175	27.29	-22.65		0.87	49.94	20.00	-29.94	T4	
FGS		25	19.11	-29.33			48.44	20.00	-28.44	T4	
	Radial	600	19.26	-31.50	-63.77	N/A	50.76	20.00	-30.76	T4	1.8, 2.6
		1175	19.12	-28.37			47.49	20.00	-27.49	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	25.79	-6.92		0.47	32.71	20.00	-12.71	T4			
	Axial	190	25.84	-6.62	-63.72	0.48	32.46	20.00	-12.46	T4	1.8, 3.4		
GSM850		251	25.82	-7.17		0.49	32.99	20.00	-12.99	T4			
GSIVIOSU		128	16.18	-10.24			26.42	20.00	-6.42	T3			
	Radial	190	16.19	-10.22	-61.87	-61.87 N/A		20.00	-6.41	Т3	1.8, 2.6		
		251	16.17	-10.76			26.93	20.00	-6.93	Т3			
		512	25.81	-11.27		0.46	37.08	20.00	-17.08	T4			
	Axial	661	25.82	-10.48	-63.72	0.46	36.30	20.00	-16.30	T4	1.8, 3.4		
GSM1900		810	25.72	-9.67		0.47	35.39	20.00	-15.39	T4			
G3W1900		512	16.19	-14.84			31.03	20.00	-11.03	T4			
	Radial	661	16.19	-13.94	-61.87	-61.87	-61.87	N/A	30.13	20.00	-10.13	T4	1.8, 2.6
		810	16.18	-13.19			29.37	20.00	-9.37	T3			

Table 9-4
Raw Data Results for UMTS

				I KO II D	ala Nesu	<u> </u>	<u> </u>				
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	24.94	-38.04		0.93	62.98	20.00	-42.98	T4	
	Axial	4183	24.95	-37.87	-63.28	0.92	62.82	20.00	-42.82	T4	1.8,3.4
UMTS V		4233	24.94	-36.68		0.93	61.62	20.00	-41.62	T4	
UNITSV		4132	15.39	-48.28			63.67	20.00	-43.67	T4	
	Radial	4183	15.25	-48.34	-63.77	N/A	63.59	20.00	-43.59	T4	1.8, 2.6
		4233	15.39	-48.57			63.96	20.00	-43.96	T4	
		1312	24.91	-36.61		0.93	61.52	20.00	-41.52	T4	
	Axial	1412	24.88	-36.68	-63.28	0.91	61.56	20.00	-41.56	T4	1.8,3.4
UMTS IV		1513	24.88	-36.91		0.92	61.79	20.00	-41.79	T4	
OWITSTV		1312	14.97	-47.85			62.82	20.00	-42.82	T4	
	Radial	1412	15.42	-47.99	-63.77	N/A	63.41	20.00	-43.41	T4	1.8, 2.6
		1513	15.39	-48.74			64.13	20.00	-44.13	T4	
		9262	24.85	-36.33		0.94	61.18	20.00	-41.18	T4	
	Axial	9400	24.81	-37.24	-63.28	0.95	62.05	20.00	-42.05	T4	1.8,3.4
UMTS II		9538	24.78	-36.69		0.92	61.47	20.00	-41.47	T4	
OM 13 II		9262	15.41	-48.43			63.84	20.00	-43.84	T4	
	Radial	9400	15.39	-49.17	-63.77	N/A	64.56	20.00	-44.56	T4	1.8, 2.6
		9538	15.41	-48.05			63.46	20.00	-43.46	T4	

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Table 9-5 Raw Data Results for LTE B71

						ocaito io						
Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	133297	25.44	-26.20		0.41	51.64	20.00	-31.64	T4	
	Axial	15MHz	133297	25.44	-26.03	-63.72	0.49	51.47	20.00	-31.47	T4	1.8, 3.4
	Axiai	10MHz	133297	25.35	-26.71	-03.72	0.62	52.06	20.00	-32.06	T4	1.0, 3.4
LTE Band 71		5MHz	133297	25.23	-27.86		0.51	53.09	20.00	-33.09	T4	
LIE Ballu / I		20MHz	133297	17.85	-33.33			51.18	20.00	-31.18	T4	
	Radial	15MHz	133297	18.34	-33.02	-63.77	N/A	51.36	20.00	-31.36	T4	1.8. 2.6
	Naulai	10MHz	133297	17.53	-33.91	-03.77	INA	51.44	20.00	-31.44	T4	1.0, 2.0
		5MHz	133297	18.23	-35.52			53.75	20.00	-33.75	T4	

Table 9-6 Raw Data Results for LTE B12

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		10MHz	23095	24.97	-23.86		0.52	48.83	20.00	-28.83	T4	
	Axial	5MHz	23095	24.94	-26.19	-63.72	0.54	51.13	20.00	-31.13	T4	1.8, 3.4
	Axiai	3MHz	23095	24.76	-27.07	-03.72	0.45	51.83	20.00	-31.83	T4	1.0, 3.4
LTE Band 12		1.4MHz	23095	24.48	-27.34		0.57	51.82	20.00	-31.82	T4	
LIE Ballu 12		10MHz	23095	18.66	-33.48			52.14	20.00	-32.14	T4	
	Radial	5MHz	23095	18.28	-34.65	-63.77 N/A	NVΔ	52.93	20.00	-32.93	T4	1.8, 2.6
	Naulai	3MHz	23095	18.52	-36.34		IVA	54.86	20.00	-34.86	T4	1.0, 2.0
		1.4MHz	23095	18.00	-36.94			54.94	20.00	-34.94	T4	

Table 9-7 Raw Data Results for LTE B13

	Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		Axial	10MHz	23230	25.56	-24.13	-63.72	0.53	49.69	20.00	-29.69	T4	1.8, 3.4
١.	TE Band 13		5MHz	23230	25.62	-29.27	-03.72	0.52	54.89	20.00	-34.89	T4	1.0, 3.4
ľ	TE Band 13	Radial	10MHz	23230	18.43	-33.41	62.77	NI/A	51.84	20.00	-31.84	T4	1.8, 2.6
		Radiai	5MHz	23230	18.37	-36.04	-63.77 N/A		54.41	20.00	-34.41	T4	1.0, 2.0

Table 9-8 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	25.60	-27.42		0.37	53.02	20.00	-33.02	T4	
	Axial	5MHz	20525	25.46	-27.74	-63.72	0.48	53.20	20.00	-33.20	T4	1.8, 3.4
	Axiai	3MHz	20525	25.45	-27.93	-03.72	0.46	53.38	20.00	-33.38	T4	1.0, 3.4
LTE Band 5		1.4MHz	20525	25.63	-27.03		0.62	52.66	20.00	-32.66	T4	
LIE Ballu 5		10MHz	20525	18.32	-35.47			53.79	20.00	-33.79	T4	
	Radial	5MHz	20525	18.33	-35.79	62.77	N/A	54.12	20.00	-34.12	T4	1.8, 2.6
	Radial	3MHz	20525	17.97	-36.03	-63.77	IVA	54.00	20.00	-34.00	T4	1.0, 2.0
		1.4MHz	20525	17.82	-35.28			53.10	20.00	-33.10	T4	

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Table 9-9 Raw Data Results for LTE B66

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	132322	25.36	-24.79		0.57	50.15	20.00	-30.15	T4	
		15MHz	132597	25.24	-26.11] [0.48	51.35	20.00	-31.35	T4	
		15MHz	132322	24.77	-23.64	1	0.55	48.41	20.00	-28.41	T4	
	Axial	15MHz	132047	25.10	-25.27	-63.72	0.55	50.37	20.00	-30.37	T4	1.8, 3.4
	Axidi	10MHz	132322	24.82	-24.57	-03.72	0.59	49.39	20.00	-29.39	T4	1.0, 3.4
		5MHz	132322	24.82	-24.39	1 [0.72	49.21	20.00	-29.21	T4	
	3MHz	132322	24.85	-24.54		0.50	49.39	20.00	-29.39	T4		
LTE Band 66		1.4MHz	132322	24.88	-24.59		0.58	49.47	20.00	-29.47	T4	
LIE Danu 66		20MHz	132322	18.27	-32.06			50.33	20.00	-30.33	T4	
		15MHz	132597	18.35	-32.54	1		50.89	20.00	-30.89	T4	
		15MHz	132322	18.40	-31.45			49.85	20.00	-29.85	T4	
	Radial	15MHz	132047	18.20	-32.34	-63.77	N/A	50.54	20.00	-30.54	T4	10.06
	Radiai	10MHz	132322	18.55	-32.90	-03.77	IWA	51.45	20.00	-31.45	T4	1.8, 2.6
		5MHz	132322	18.57	-32.20			50.77	20.00	-30.77	T4	
		3MHz	132322	18.56	-31.88			50.44	20.00	-30.44	T4	
		1.4MHz	132322	18.59	-33.22			51.81	20.00	-31.81	T4	

Table 9-10 Raw Data Results for LTE B2

					Datan							
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	25.57	-27.28		0.54	52.85	20.00	-32.85	T4	
		15MHz	18900	25.59	-27.63		0.64	53.22	20.00	-33.22	T4	
	Axial	10MHz	18900	25.61	-28.66	-63.72	0.46	54.27	20.00	-34.27	T4	1.8, 3.4
	Axiai	5MHz	18900	25.66	-28.76	-03.72	0.48	54.42	20.00	-34.42	T4	1.0, 3.4
	-	3MHz	18900	25.65	-28.79		0.48	54.44	20.00	-34.44	T4	
LTE Band 2		1.4MHz	18900	25.66	-29.58		0.57	55.24	20.00	-35.24	T4	
LIE Ballu 2		20MHz	18900	18.16	-35.38	8 0 1 1 -63.77 1 1		53.54	20.00	-33.54	T4	
		15MHz	18900	18.15	-35.20			53.35	20.00	-33.35	T4	
	Radial	10MHz	18900	18.16	-36.91		N/A	55.07	20.00	-35.07	T4	1.8, 2.6
	Naulai	5MHz	18900	18.17	-36.97		IVA	55.14	20.00	-35.14	T4	1.0, 2.0
		3MHz	18900	18.17	-36.99			55.16	20.00	-35.16	T4	
		1.4MHz	18900	18.15	-37.67			55.82	20.00	-35.82	T4	

Table 9-11 Raw Data Results for 2.4GHz WIFI

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
	Axial	6	23.80	-38.64	-63.28	0.53	62.44	20.00	-42.44	T4	1.8,3.4
IEEE		1	15.60	-34.79			50.39	20.00	-30.39	T4	
802.11b	Radial	6	15.64	-34.84	-63.77	N/A	50.48	20.00	-30.48	T4	1.8, 2.6
		11	15.97	-35.01			50.98	20.00	-30.98	T4	
		1	23.84	-35.40		0.50	59.24	20.00	-39.24	T4	
IEEE	Axial	6	24.11	-35.48	-63.28	0.34	59.59	20.00	-39.59	T4	1.8,3.4
802.11g		11	22.94	-37.21		0.26	60.15	20.00	-40.15	T4	
	Radial	6	15.60	-39.02	-63.77	N/A	54.62	20.00	-34.62	T4	1.8, 2.6
IEEE	Axial	6	24.07	-35.57	-63.28	0.52	59.64	20.00	-39.64	T4	1.8,3.4
802.11n	Radial	6	15.73	-40.57	-63.77	N/A	56.30	20.00	-36.30	T4	1.8, 2.6

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

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Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	1	36	23.00	-37.76		0.32	60.76	20.00	-40.76	T4	
		20MHz	1	40	22.77	-36.35		0.39	59.12	20.00	-39.12	T4	
	Axial	20MHz	1	48	23.12	-37.90	-63.28	0.38	61.02	20.00	-41.02	T4	1.8,3.4
	Axidi	20MHz	2A	56	23.12	-36.95	-03.26	0.47	60.07	20.00	-40.07	T4	1.0,3.4
		20MHz	2C	120	23.03	-36.36		0.41	59.39	20.00	-39.39	T4	
		20MHz	3	157	23.59	-37.24		0.39	60.83	20.00	-40.83	T4	
IEEE 802.11a													
		20MHz	1	36	15.75	-38.97			54.72	20.00	-34.72	T4	
		20MHz	1	40	15.64	-38.28			53.92	20.00	-33.92	T4	
	Radial	20MHz	1	48	16.09	-38.21	62.77	N/A	54.30	20.00	-34.30	T4	1.8, 2.6
		20MHz	2A	56	15.63	-39.16		IN/A	54.79	20.00	-34.79	T4	1.0, 2.0
		20MHz	2C	120	16.14	-38.64			54.78	20.00	-34.78	T4	
		20MHz	3	157	15.66	-39.04			54.70	20.00	-34.70	T4	

Table 9-13 Raw Data Results for 5GHz WIFI 802.11n

Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
	Assimi	40MHz	1	38	22.82	-39.09	-63.28	0.29	61.91	20.00	-41.91	T4	1.8,3.4	
	Axial	20MHz	1	40	22.77	-38.20	-03.26	0.46	60.97	20.00	-40.97	T4	1.0,3.4	
802.11n														
002.1111	Radial	40MHz	1	38	15.68	-39.13	-63 77	00.77	NUA	54.81	20.00	-34.81	T4	1.8, 2.6
	Radiai	20MHz	1	40	15.62	-40.46		77 N/A	56.08	20.00	-36.08	T4	1.0, 2.0	

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

	Frequency Margin from													
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	
	Avial	40MHz	1	38	23.15	-38.54	-63,28	0.32	61.69	20.00	-41.69	T4	1.8,3.4	
IEEE	Axial -	20MHz	1	40	23.25	-37.96	-03.20	0.34	61.21	20.00	-41.21	T4	1.0,3.4	
802.11ac														
002.1140	Radial	40MHz	1	38	16.16	-40.99	62.77	NI/A	57.15	20.00	-37.15	T4	1.8, 2.6	
R	Naulai	20MHz	1	40	15.71	-39.78	-63.77	-63.77 N/A	IN/A	55.49	20.00	-35.49	T4	1.0, 2.0

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

Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
Cellular	Axial	384	7.90	-51.51	-63.90	1.58	59.41	20.00	-39.41	T4	2.6, 2.6
EvDO	Radial	384	-1.02	-51.17	-63.77	N/A	50.15	20.00	-30.15	T4	2.4, 3.4
PCS	Axial	600	7.31	-51.91	-63.90	1.45	59.22	20.00	-39.22	T4	2.6, 2.6
EvDO	Radial	600	-0.59	-51.48	-63.77	N/A	50.89	20.00	-30.89	T4	2.4, 3.4

Table 9-16 Raw Data Results for EDGE (OTT VoIP)

	Naw Data Results for EDGE (CTT Voil)													
	Mode	Orientation	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates		
	EDC ESEO	Axial	190	7.84	-33.48	-63.90	1.45	41.32	20.00	-21.32	T4	2.6, 2.6		
	EDGE850	Radial	190	-0.39	-41.63	-63.77	N/A	41.24	20.00	-21.24	T4	2.4, 3.4		
_	:DCE4000	Axial	661	7.16	-36.17	-63.90	1.47	43.33	20.00	-23.33	T4	2.6, 2.6		
	EDGE1900	Radial	661	-0.63	-45.43	-63.77	N/A	44.80	20.00	-24.80	T4	2.4, 3.4		

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

			itar	Data IX	counto ioi	11017	011 4011	,				
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	7.53	-50.37	-63.90	1.43	57.90	20.00	-37.90	T4	2.6, 2.6	
пога у	Radial	4183	-2.90	-41.70	-63.77	N/A	38.80	20.00	-18.80	T4	2.4, 3.4	
HSPA IV	Axial	1412	8.18	-51.08	-63.90	1.75	59.26	20.00	-39.26	T4	2.6, 2.6	
HOFAIV	Radial	1412	-2.99	-41.21	-63.77	N/A	38.22	20.00	-18.22	T4	2.4, 3.4	
HSPA II	Axial	9400	7.39	-50.83	-63.90	1.39	58.22	20.00	-38.22	T4	2.6, 2.6	
HOPAII	Radial	9400	-3.02	-40.13	-63.77	N/A	37.11	20.00	-17.11	T4	2.4, 3.4	

Table 9-18 Raw Data Results for LTE B2 (OTT VoIP)

Mode	Orientation	Bandwidth	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
		20MHz	18900	6.84	-47.23		1.51	54.07	20.00	-34.07	T4		
		15MHz	19125	7.13	-45.14		1.31	52.27	20.00	-32.27	T4		
		15MHz	18900	7.04	-47.01		1.66	54.05	20.00	-34.05	T4		
	Axial	15MHz	18675	6.86	-48.69	63.00	1.56	55.55	20.00	-35.55	T4	2.6, 2.6	
	Axiai	10MHz	18900	6.96	-47.77	-63.90	1.54	54.73	20.00	-34.73	T4	2.0, 2.0	
		5MHz	18900	7.04	-48.98		1.56	56.02	20.00	-36.02	T4		
		3MHz	18900	7.13	-48.72		1.60	55.85	20.00	-35.85	T4		
LTE Band 2		1.4MHz	18900	6.98	-48.43		1.41	55.41	20.00	-35.41	T4		
LIE Ballu Z		20MHz	19100	-2.93	-38.99			36.06	20.00	-16.06	T4		
		20MHz	18900	-3.25	-37.94			34.69	20.00	-14.69	T4		
		20MHz	18700	-3.01	-38.74			35.73	20.00	-15.73	T4		
	5 " 1	15MHz	18900	-2.80	-38.48	00.77		35.68	20.00	-15.68	T4		
	Radial	10MHz	18900	-3.16	-39.08	-63.77	-63 77	-63.77 N/A	35.92	20.00	-15.92	T4	2.4, 3.4
		5MHz	18900	-2.82	-39.36			36.54	20.00	-16.54	T4		
		3MHz	18900	-3.19	-39.58			36.39	20.00	-16.39	T4		
		1.4MHz	18900	-2.80	-39.86			37.06	20.00	-17.06	T4		

Table 9-19 Raw Data Results for 2.4GHz WIFI (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
		1	6.92	-40.76		1.52	47.68	20.00	-27.68	T4	
	Axial	6	7.22	-42.36	-63.90	1.42	49.58	20.00	-29.58	T4	2.6, 2.6
IEEE		11	7.20	-42.30		1.51	49.50	20.00	-29.50	T4	
802.11b		1	-3.27	-29.89			26.62	20.00	-6.62	Т3	
	Radial	6	-3.28	-30.38	-63.77	N/A	27.10	20.00	-7.10	Т3	2.4, 3.4
	radiai	11	-3.34	-32.72			29.38	20.00	-9.38	Т3	
IEEE	Axial	6	6.85	-43.96	-63.90	1.49	50.81	20.00	-30.81	T4	2.6, 2.6
802.11g	Radial	6	-2.86	-31.93	-63.77	N/A	29.07	20.00	-9.07	Т3	2.4, 3.4
IEEE	Axial	6	7.40	-44.66	-63.90	1.41	52.06	20.00	-32.06	T4	2.6, 2.6
802.11n	Radial	6	-3.35	-33.01	-63.77	N/A	29.66	20.00	-9.66	Т3	2.4, 3.4

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

							<u> , </u>		(
Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates
		20MHz	1	36	6.88	-44.47		1.43	51.35	20.00	-31.35	T4	2.6, 2.6
		20MHz	1	40	7.12	-44.11		1.35	51.23	20.00	-31.23	T4	
	Axial	20MHz	1	48	7.02	-44.68	-63.90	1.47	51.70	20.00	-31.70	T4	
	Axidi	20MHz	2A	56	7.03	-44.34		1.38	51.37	20.00	-31.37	T4	
		20MHz	2C	120	6.88	-44.55		1.44	51.43	20.00	-31.43	T4	
IEEE		20MHz	3	157	7.11	-44.37		1.39	51.48	20.00	-31.48	T4	
802.11a													
002.114		20MHz	1	40	-3.13	-34.43			31.30	20.00	-11.30	T4	
		20MHz	2A	52	-2.74	-33.19			30.45	20.00	-10.45	T4	
	Radial	20MHz	2A	56	-3.04	-33.84	-63.77	N/A	30.80	20.00	-10.80	T4	2.4, 3.4
	Natial	20MHz	2A	64	-3.05	-34.26	-03.77	IN/A	31.21	20.00	-11.21	T4	2.4, 3.4
		20MHz	2C	120	-2.83	-34.07			31.24	20.00	-11.24	T4	
		20MHz	3	157	-2.75	-34.14			31.39	20.00	-11.39	T4	

Table 9-21 Raw Data Results for 5GHz WIFI 802.11n (OTT VoIP)

Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011 Rating	Test Coordinates	
	Axial	40MHz	1	38	7.25	-48.58	-63.90	62.00	1.52	55.83	20.00	-35.83	T4	2.6, 2.6
	Axiai	20MHz	1	40	6.84	-47.99		1.45	54.83	20.00	-34.83	T4	2.0, 2.0	
802.11n														
002.1111	Radial	40MHz	1	38	-3.32	-36.96	62.77	N/A	33.64	20.00	-13.64	T4	2.4, 3.4	
	radiai	20MHz	1	40	-2.99	-36.42	-63.77	-03.77	-03.77 INA	33.43	20.00	-13.43	T4	2.4, 3.4

Table 9-22 Raw Data Results for 5GHz WIFI 802.11ac (OTT VoIP)

										\-							
	Mode	Orientation	Bandwidth	U-NII	Channel	ABM1 [dB(A/m)]	ABM2 [dB(A/m)]	Ambient Noise [dB(A/m)]	Frequency Response Margin (dB)	S+N/N (dB)	FCC Limit (dB)	Margin from FCC Limit (dB)	C63.19-2011	Test Coordinates			
ſ		Axial	40MHz	1	38	7.25	-47.69	-63.90	62.00	1.46	54.94	20.00	-34.94	T4	2.6. 2.6		
		Axidi	20MHz	1	40	7.20	-47.16		1.50	54.36	20.00	-34.36	T4	2.0, 2.0			
	IEEE 802.11ac																
	002.11ac	Radial	40MHz	1	38	-3.06	-37.58	-63.77	N/A	34.52	20.00	-14.52	T4	2.4, 3.4			
		Radiai	20MHz	1	40	-3.25	-36.97	-63.77	-03.77	-03.77	-03.77 IVA	IN/A	33.72	20.00	-13.72	T4	2.4, 3.4

II. Test Notes

A. General

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

B. CDMA

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

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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: NB AMR 4.75kbps
- 4. The worst-case band and bandwidth combination for each probe orientation is additionally tested on the low and high channels for those combinations. LTE Band 66 at 15MHz is the worst-case for both the Axial and Radial probe orientations.

F. WIFI

- 1. Radio Configuration
 - a. 802.11b: DSSS, 1Mbps
 - b. 802.11g/a: BPSK, 6Mbps
 - c. 802.11n/ac 20MHz: 64-QAM, 52Mbps
 - d. 802.11n/ac 40MHz: BPSK, 13.5Mbps
- 2. Vocoder Configuration: WB AMR 6.60kbps
- 3. The worst-case standard for 2.4GHz WIFI in each probe orientation is additionally tested on the low and high channels. 802.11g is the worst-case for the Axial probe orientation. 802.11b is the worst-case for the Radial probe orientation.
- 4. The worst-case standard for 5GHz WIFI in each probe orientation is additionally tested on higher U-NII bands as well as applicable low and high channels. 802.11a (U-NII 1) is the worst-case for both the Axial and Radial probe orientations.

G. OTT VolP

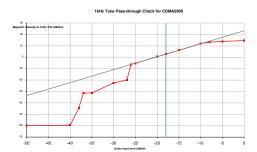
- 1. Vocoder Configuration: 6kbps
- 2. EvDO Configuration
 - a. Revision: A
- 3. EDGE Configuration
 - a. MCS Index: 7
 - b. Number of TX slots: 2
- 4. HSPA Configuration:
 - a. Release: 6
 - b. 3GPP 34.121 Subtest 1
- 5. LTE FDD Configuration:
 - a. Power Configuration: TPC = "Max Power"
 - b. Radio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

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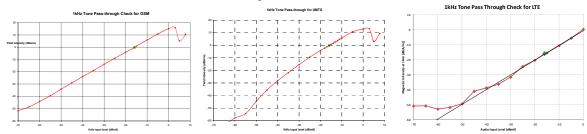
6. WIFI Configuration:

- a. Radio Configuration
 - i. 802.11b: DSSS, 1Mbps
 - ii. 802.11g/a: BPSK, 6Mbps
 - iii. 802.11n/ac 20MHz: 64-QAM, 52Mbps
 - iv. 802.11n/ac 40MHz: BPSK, 13.5Mbps
- 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. 802.11a (U-NII 1) is the worst-case for the Axial probe orientation. 802.11a (U-NII 2A) is the worst-case for the Radial probe orientation.

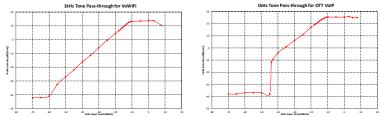
III. 1 kHz Vocoder Application Check



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



This model was verified to be within the linear region for ABM1 measurements at -16 dBm0 for GSM, UMTS, and VoLTE over IMS. This measurement was taken in the axial configuration above the maximum location.



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

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IV. T-Coil Validation Test Results

Table 9-23 Helmholtz Coil Validation Table of Results - 12/10/2018

Tienmore our validation rable of Results 12/10/2010								
ltem	Target	Result	Verdict					
Axial								
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.930	PASS					
Environmental Noise	< -58 dBA/m	-63.72	PASS					
Frequency Response, from limits	> 0 dB 0.60		PASS					
Radial								
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.991	PASS					
Environmental Noise	< -58 dBA/m	-61.87	PASS					
Frequency Response, from limits	> 0 dB	0.70	PASS					

Table 9-24 Helmholtz Coil Validation Table of Results - 12/17/2018

ltem	Target	Result	Verdict
Axial			
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.759	PASS
Environmental Noise	< -58 dBA/m	-63.28	PASS
Frequency Response, from limits	> 0 dB	0.50	PASS

Table 9-25 Helmholtz Coil Validation Table of Results - 12/24/2018

ltem	Target	Result	Verdict	
Axial				
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-9.815	PASS	
Environmental Noise	< -58 dBA/m	-63.90	PASS	
Frequency Response, from limits	> 0 dB 0.50		PASS	
Radial				
Magnetic Intensity, -10 dBA/m	-10 ± 0.5 dB	-10.155	PASS	
Environmental Noise	< -58 dBA/m	-63.77	PASS	
Frequency Response, from limits	> 0 dB	0.70	PASS	

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V. ABM1 Magnetic Field Distribution Scan Overlays

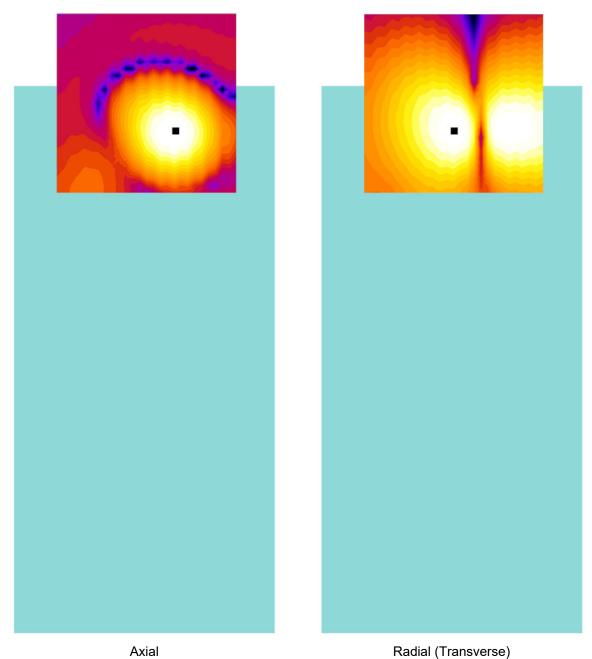


Figure 9-1
T-Coil Scan Overlay Magnetic Field Distributions (CMRS Testing)

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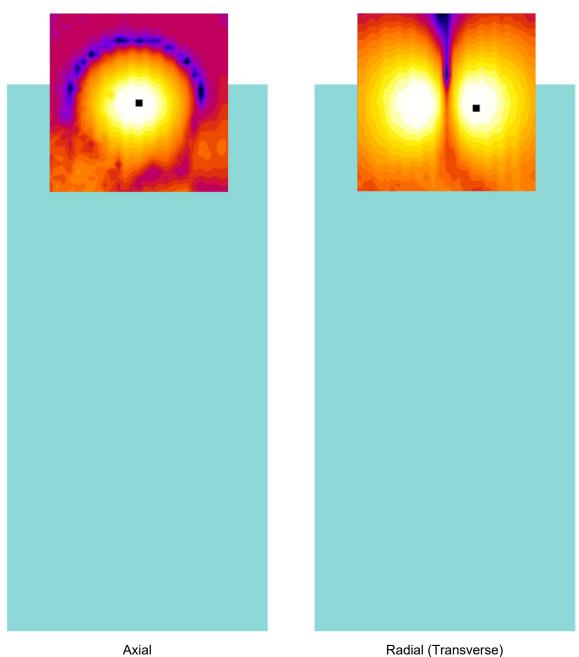


Figure 9-2
T-Coil Scan Overlay Magnetic Field Distributions (OTT VolP Testing)

Notes:

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

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10. MEASUREMENT UNCERTAINTY

Table 10-1
Uncertainty Estimation Table

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

Notes:

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

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

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11. EQUIPMENT LIST

Table 11-1 Equipment List

		Equipment Elst				
Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Listen	SoundConnect	Microphone Power Supply	9/6/2018	Annual	9/6/2020	0899-PS150
Listen	SoundCheck	Acoustic Analyzer System - Audio Interface	9/6/2018	Biennial	9/6/2020	23792992
Listen	SoundCheck	Acoustic Analyzer System - Laptop	9/6/2018	Biennial	9/6/2020	2655082910
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	1/19/2018	Annual	1/19/2019	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	Annual	9/19/2020	TEM-1123
TEM	Radial T-Coil Probe	Radial T-Coil Probe	9/19/2018	Annual	9/19/2020	TEM-1129
TEM	Helmholtz Coil	Helmholtz Coil	10/10/2018	Annual	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

FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 40 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 40 01 62

12. TEST DATA

FCC ID: ZNFL423DL	PETEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 41 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 41 01 62



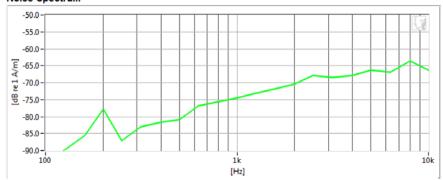
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

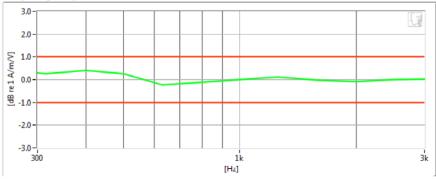
Equipment:

- 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	-9.93 dB	\checkmark	Max/Min	-9.5/-10.5
Verification ABM2	-63.72 dB	\checkmark	Maximum	-58.0
Frequency Response Margin	600m dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 42 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 42 01 02



Type: HH Coil Serial: SBI 1052

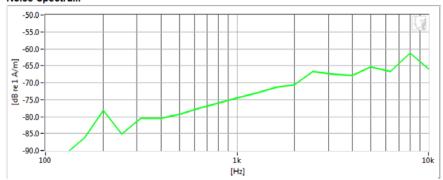
Measurement Standard: ANSI C63.19-2011

Equipment:

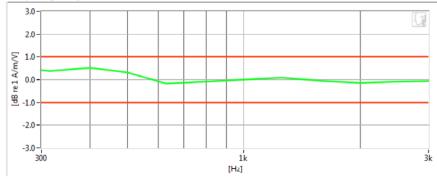
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Helmholtz Coil – SN: SBI 1052; Calibrated: 10/10/2018

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-9.759 dB	\checkmark	Max/Min	-9.5/-10.5
Verification ABM2	-63.28 dB	•	Maximum	-58.0
Frequency Response Margin	500m dB	•	Tolerance curves	Aligned Data

FCC ID: ZNFL423DL	PETEST VANISHEEMS LANGESTON, INC.	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 43 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 43 01 62



Type: HH Coil Serial: SBI 1052

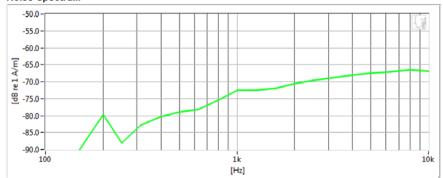
Measurement Standard: ANSI C63.19-2011

Equipment:

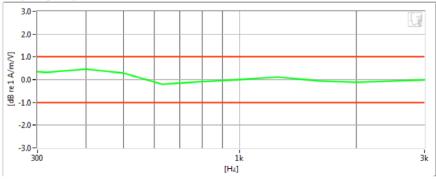
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Helmholtz Coil – SN: SBI 1052; Calibrated: 10/10/2018

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-9.815 dB	\checkmark	Max/Min	-9.5/-10.5
Verification ABM2	-63.9 dB	\checkmark	Maximum	-58.0
Frequency Response Margin	500m dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 44 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 44 01 02



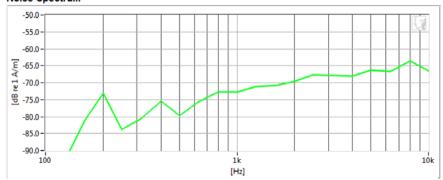
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

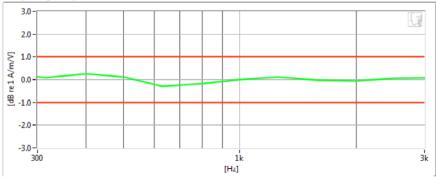
Equipment:

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

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-9.991 dB	\checkmark	Max/Min	-9.5/-10.5
Verification ABM2	-61.87 dB	\checkmark	Maximum	-58.0
Frequency Response Margin	700m dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 45 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 43 01 62



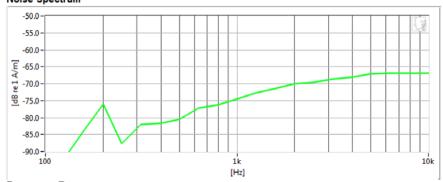
Type: HH Coil Serial: SBI 1052

Measurement Standard: ANSI C63.19-2011

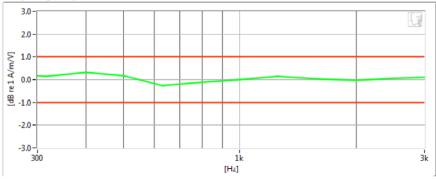
Equipment:

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

Noise Spectrum



Frequency Response



Results

Verification 1kHz Intensity	-10.155 dB	\checkmark	Max/Min	-9.5/-10.5
Verification ABM2	-63.77 dB	\checkmark	Maximum	-58.0
Frequency Response Margin	700m dB	\checkmark	Tolerance curves	Aligned Data

FCC ID: ZNFL423DL	PETEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 46 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 40 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

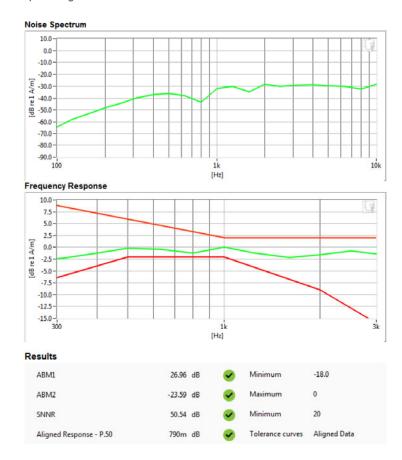
Probe: Axial T-Coil Probe – SN: TEM-123; Calibrated: 09/19/2018

Test Configuration:

Mode: Cellular CDMA

Channel: 777

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



FCC ID: ZNFL423DL	PETEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 47 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 41 01 02



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

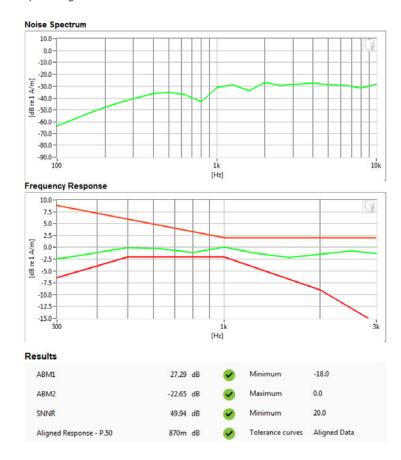
Equipment:

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

Test Configuration:

Mode: PCS CDMAChannel: 1175

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



FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	(l) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 48 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		F aye 40 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

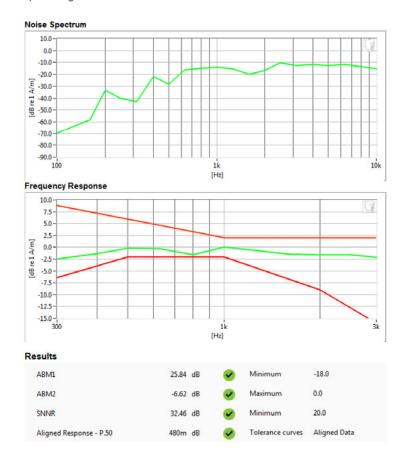
Equipment:

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

Test Configuration:

Mode: GSM850Channel: 190

Speech Signal: ITU-T P.50 Artificial Voice



FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	(t) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 49 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 49 01 02



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

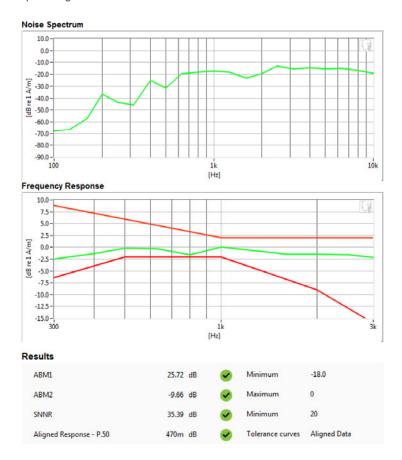
Equipment:

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

Test Configuration:

Mode: GSM1900Channel: 810

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



FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	(t) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 50 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 50 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

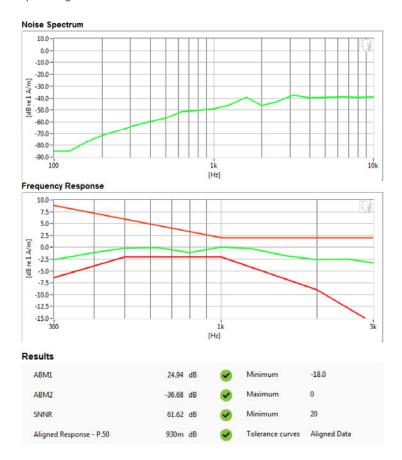
Equipment:

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

Test Configuration:

Mode: UMTS VChannel: 4233

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



FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 51 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 31 01 02



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

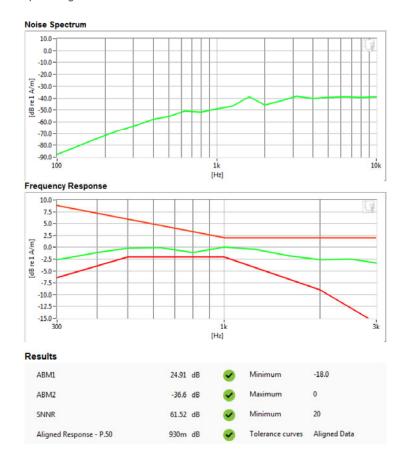
Equipment:

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

Test Configuration:

Mode: UMTS IVChannel: 1312

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



FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	(l) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 52 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 32 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

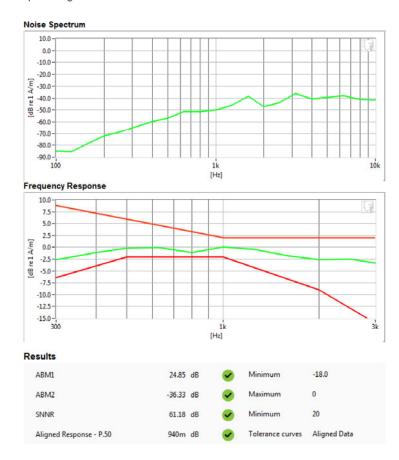
Equipment:

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

Test Configuration:

Mode: UMTS IIChannel: 9262

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



FCC ID: ZNFL423DL	PETEST VINITURE LABORATOR, INC.	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 53 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 33 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

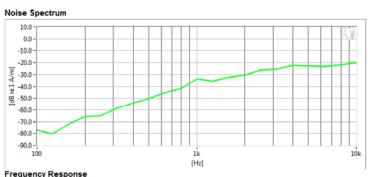
Equipment:

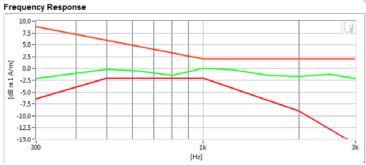
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

Test Configuration:

Mode: LTE FDD Band 66Bandwidth: 15MHzChannel: 132322

Speech Signal: ITU-T P.50 Artificial Voice





Results ABM1 24.77 dB ✓ Minimum -18.0 ABM2 -23.65 dB ✓ Maximum 0 SNNR 48.41 dB ✓ Minimum 20 Aligned Response - P.50 550m dB ✓ Tolerance curves Aligned Data

FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	(l) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 54 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 54 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

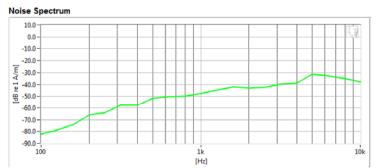
Probe: Axial T-Coil Probe – SN: TEM-1123; Calibrated: 09/19/2018

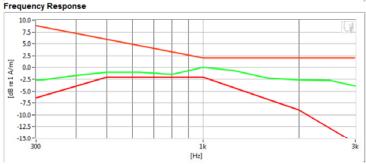
Test Configuration:

Mode: 2.4GHz WIFIStandard: IEEE 802.11g

• Channel: 1

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





Results

ABM1	23.84 dB	•	Minimum	-18.0
ABM2	-35.4 dB	•	Maximum	0
SNNR	59.24 dB	•	Minimum	20
Aligned Response - P.50	500m dB	•	Tolerance curves	Aligned Data

FCC ID: ZNFL423DL	PETEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 55 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 33 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

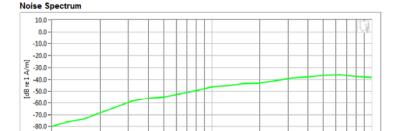
Test Configuration:

Mode: 5GHz WIFI

• Standard: IEEE 802.11a (U-NII 1)

Channel: 40

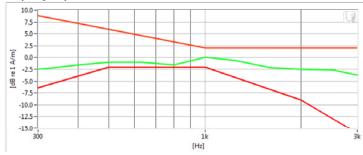
Speech Signal: ITU-T P.50 Artificial Voice



[Hz]



-90.0



Results

ABM1	22.77 dB	•	Minimum	-18.0	
ABM2	-36.35 dB	•	Maximum	0	
SNNR	59.12 dB	•	Minimum	20	
Aligned Response - P.50	390m dB	•	Tolerance curves	Aligned Data	

FCC ID: ZNFL423DL	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 56 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 30 01 62



Type: Portable Handset Serial: 11258

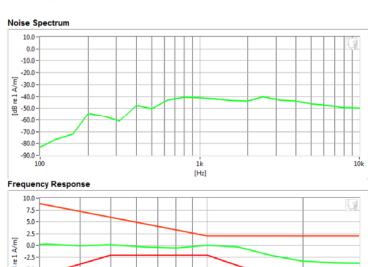
Measurement Standard: ANSI C63.19-2011

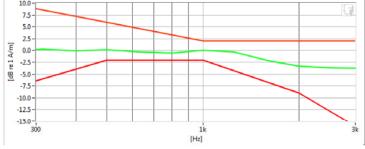
Equipment:

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

Test Configuration:

- VolP Application: Google Duo
- Mode: EDGE850
- Channel: 190
- Speech Signal: ITU-T P.50 Artificial Voice





Results

ABM1	7.84 dB	•	Minimum	-18.0	
ABM2	-33.48 dB	•	Maximum	0	
SNNR	41.32 dB	•	Minimum	20	
Aligned Response - P.50	1.45 dB	•	Tolerance curves	Aligned Data	

FCC ID: ZNFL423DL	PETEST	HAC (T-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 57 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 37 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: Cellular CDMA

Channel: 777



FCC ID: ZNFL423DL	PCTEST*	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 58 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 30 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

ABM2

SNNR

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

Test Configuration:

Mode: PCS CDMAChannel: 1175



-28.36 dB

47.49 dB

Maximum

Minimum

0.0

20.0

FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 59 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 39 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: GSM850Channel: 190



FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 60 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 00 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

 Mode: GSM1900 Channel: 810



29.37 dB

FCC ID: ZNFL423DL	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 61 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Faye 01 01 02



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: UMTS VChannel: 4183



FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 62 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		F aye 02 01 02



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: UMTS IVChannel: 1312



FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager	
Filename:	Test Dates:	DUT Type:		Page 63 of 82	
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 03 01 62	



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: UMTS IIChannel: 9538



FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager	
Filename:	Test Dates:	DUT Type:		Page 64 of 82	
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 04 01 62	



Type: Portable Handset Serial: 11258

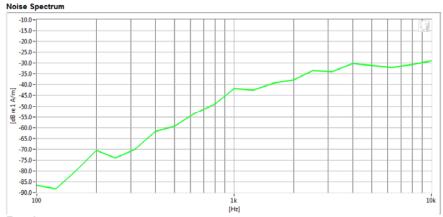
Measurement Standard: ANSI C63.19-2011

Equipment:

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

Test Configuration:

Mode: LTE FDD Band 66Bandwidth: 15MHzChannel: 132322



Results

ABM1	18.4	dB	\checkmark	Minimum	-18.0
ABM2	-31.45	dB	\checkmark	Maximum	0.0
SNNR	49.85	dB	\checkmark	Minimum	20.0

FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	(1) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 65 of 82
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 03 01 62



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

Noise Spectrum

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

Test Configuration:

Mode: 2.4GHz WIFIStandard: IEEE 802.11b

Channel: 1

-90.0-

-75.0 --80.0 --85.0 -

ABM1	15.6	dB	•	Minimum	-18.0
ABM2	-34.79	dB	•	Maximum	0.0
SNNR	50.39	dB	\checkmark	Minimum	20.0

[Hz]

FCC ID: ZNFL423DL	PCTEST	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager	
Filename:	Test Dates:	DUT Type:		Page 66 of 82	
1M1811280213-10-R2.ZNF	12/10/2018 - 12/26/2018	Portable Handset		Fage 00 01 02	



Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

ABM2

SNNR

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

Test Configuration:

Mode: 5GHz WIFI

• Standard: IEEE 802.11a (U-NII 1)

Channel: 40

Noise Spectrum -10.0 -15.0 -20.0 -25.0 -30.0--35.0 -40.0 --45.0-E -50.0-E -50.0-E -50.0--60.0--65.0 --70.0 --75.0 --80.0 -85.0 -90.0 100 Results Minimum -18.0 ABM1 15.64 dB

-38.28 dB

53.92 dB

0.0

20.0

Maximum

Minimum

FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	⊕ LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 67 of 82
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Type: Portable Handset Serial: 11258

Measurement Standard: ANSI C63.19-2011

Equipment:

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

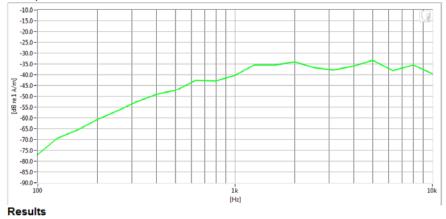
Test Configuration:

 VolP Application: Google Duo Mode: 2.4GHz WLAN Standard: IEEE 802.11b

Channel: 1

Noise Spectrum

ABM1



-3.27 dB

-29.89 dB

ABM2 SNNR 26.62 dB

\checkmark	Maximum	0.0
\checkmark	Minimum	20.0

Minimum

FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	(f) LG	Approved by: Quality Manager
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13. CALIBRATION CERTIFICATES

FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	(l) LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 69 of 82
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Certificate of Calibration

fo

AXIAL T COIL PROBE

Manufactured by:

TEM CONSULTING LP AXIAL T COIL PROBE

Model No:

TEM-1123

Serial No: Calibration Recall No:

29156

Submitted By:

Customer:

Andrew Harwell

Company: Address:

PCTest Engineering Lab 6660-B Dobbin Road

Columbia

MD 21045

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

West Caldwell Calibration Laboratories Procedure No.

AXIAL T C TEM C

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

V OA+ 12/4/2018

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

Calibration Laboratories, Inc.

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

Calibration Lab. Cert. # 1533.01

 FCC ID: ZNFL423DL
 HAC (T-COIL) TEST REPORT
 Approved by: Quality Manager

 Filename:
 Test Dates:
 DUT Type:

 1M1811280213-10-R2.ZNF
 12/10/2018 - 12/26/2018
 Portable Handset

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HCATEMC_TEM-1123_Sep-19-2018



1575 State Route 96, Victor NY 14564



REPORT OF CALIBRATION

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

Model No.: Axial T Coil Probe

Serial No.: TEM-1123

I. D. No.: XXXX

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

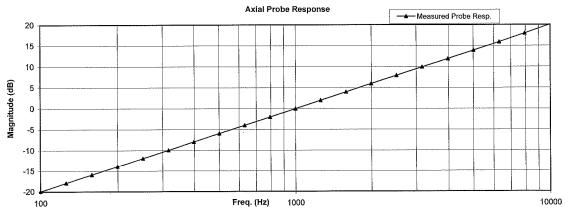
The above listed instrument meets or exceeds the tested manufacturer's specifications.

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

Rev. 7.0 Jan. 24, 2014 Doc. # 1038 HCATEMC Calibration Laboratories Inc. procedure :

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, IŞØy17025

Cal. Date: 19-Sep-2018 Calibrated on WCCL system type 9700

Measurements performed by:

James Zhu

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

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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

Test	Function	Tolera	Tolerance		Measured values		
				Before	Out	Remarks	
1.0	Probe Sensitivity at	1000 Hz.	dBV/A/m	-59.89			
		-114	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	-19.9			
			126	-17.9			
			158	-15.9			
			200	-13.9		ļ	
			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			
			10000	20.1			

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: ZNFL423DL	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 72 of 82
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Certificate of Calibration

for

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 submitter.

West Caldwell Calibration Laboratories Procedure No.

RADIAL T TEM C

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

10th

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.

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



Calibration Lab. Cert. # 1533.01

 Filename:
 Test Dates:
 DUT Type:
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 Portable Handset
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1575 State Route 96, Victor NY 14564



REPORT OF CALIBRATION

for

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

Model No.: Radial T Coil Probe

Serial No.: TEM-1129

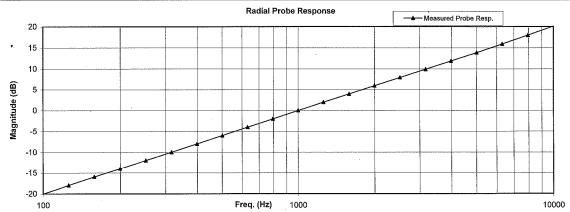
I. D. No.: XXXX

Probe Sensitivity measured wit	h Haimhali	tz Coil			
Helmholtz Coil;	ar riciliiron	L 0011	Before & after data same:	X	
the number of turns on each coil;	10	No.			
the radius of each coil, in meters;	0.204	m	Laboratory Environment:		
the current in the coils, in amperes.;	0.08	Α	Ambient Temperature:	22.7	°C
Helmholtz Coil Constant;	7.09	A/m/V	Ambient Humidity:	52.1	% RH
Helmholtz Coil magnetic field;	5.95	A/m	Ambient Pressure:	99.326	kPa
			Calibration Date:	19-Sep-2018	3
Probe Sensitivity at	1000	Hz.	Re-calibration Due:		
was	-60.37	dBV/A/m	Report Number:	2915	6 -1
	0.958	mV/A/m	Control Number:	2915	6
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, ISO 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

Test	Function	Tolera	Tolerance		Measured values		
	· · · · · · · · · · · · · · · · · · ·			Before	Out	Remarks	
1.0	Probe Sensitivity at	1000 Hz.	dBV/A/m	-60.37			
			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	-17.9			
			158	-15.9			
•			200	-14.0			
		251	-12.0				
			316	-10.0			
			398	-8.0		ļ	
			501	-6.0			
			631	-4.0			
			794	-2.0			
		Ref. (0 dB)	1000	0.0		1	
			1259	2.0			
			1585	4.0			
			1995	6.0			
			2512	7.9			
			3162	9.9			
			3981	11.9			
			5012	13.9			
			6310	15.9			
			7943	18.0			
			10000	20.1			

207700 25 1.4 2040			
,287708 25-Jul-2019	S/N US360641 25-J	34401A	' HP
,287708 25-Jul-2019	S/N US361024 25-J	34401A	HP
,287708 25-Jul-2019	S/N US360437 25-J	33120A	HP
683/284413-14 25-Jul-2019	S/N 1583254 25-J	2133	B&K
			1 '''

Cal. Date: 19-Sep-2018

Calibrated on WCCL system type 9700

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Tested by: James Zhu

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

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FCC ID: ZNFL423DL	PCTEST	HAC (1-COIL) TEST REPORT		Approved by: Quality Manager
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14. CONCLUSION

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

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

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Filename:	Test Dates:	DUT Type:		Page 77 of 82
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FCC ID: ZNFL423DL	PCTEST*	HAC (T-COIL) TEST REPORT	(LG	Approved by: Quality Manager
Filename:	Test Dates:	DUT Type:		Page 78 of 82
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