



## HAC T-COIL SIGNAL TEST REPORT

**FCC 47 CFR § 20.19  
ANSI C63.19-2011**

*For*  
**SMARTPHONE**

**FCC ID: BCG-E3500A  
Model Name: A2275, A2297, and A2298**

**Report Number: 13018973-S2V2  
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NVLAP LAB CODE 200065-0

**Revision History**

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| V1   | 1/29/2020 | Initial Issue              | --          |
| V2   | 3/25/2020 | Section 8.1: updated typo. | Devin Chang |
|      |           |                            |             |
|      |           |                            |             |
|      |           |                            |             |

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# 1. Attestation of Test Results

|                          |                                                                                                                                                                                       |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applicant Name           | APPLE, INC.                                                                                                                                                                           |
| FCC ID                   | BCG-E3500A                                                                                                                                                                            |
| Model Name               | A2275, A2297, and A2298                                                                                                                                                               |
| Difference in Model Name | Model A2297, A2298 are electrically identical to Model A2275. Three model numbers are allocated for marketing and logistic purposes only. A2275 was used to perform all tests herein. |
| Applicable Standards     | FCC 47 CFR § 20.19<br>ANSI C63.19-2011                                                                                                                                                |
| HAC Rating               | T4                                                                                                                                                                                    |
| Date Tested              | 11/18/2019 to 12/31/2019                                                                                                                                                              |
| Test Results             | Pass                                                                                                                                                                                  |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

|                                                                                                                |                                                                                                      |
|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Approved & Released By:<br> | Prepared By:<br> |
| Devin Chang<br>Senior Test Engineer<br>UL Verification Services Inc.                                           | Lance Fleischer<br>Laboratory Engineer<br>UL Verification Services Inc.                              |

## 2. Test Methodology

The tests documented in this report were performed in accordance with ANSI C63.19-2011 Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids and FCC published procedure

KDB 285076 D01 HAC Guidance v05

KDB 285076 D02 T-Coil testing for CMRS IP v03

KDB 285076 D03 HAC FAQ v01

TCB workshop updates

## 3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

|                      |
|----------------------|
| 47266 Benicia Street |
| SAR Lab 7            |

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

## 4. Calibration and Uncertainty

### 4.1. Measuring Instrument Calibration

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations and is traceable to recognized national standards.

| Name of Equipment            | Manufacturer  | Type/Model | Serial No.    | Cal. Due Date |
|------------------------------|---------------|------------|---------------|---------------|
| ABM Probe                    | SPEAG         | AM1DV3     | 3083          | 1/15/2020     |
| Data Acquisition Electronics | SPEAG         | DAE4       | 1540          | 2/18/2020     |
| Radio Communication Tester   | R & S         | CMW 500    | 125236        | 4/10/2020     |
| DAC                          | Sound Devices | USBPre 2   | HB11173410003 | N/A           |
| Support Device               | Apple         | iMac 14,4  | C02NP00JGD92  | N/A           |

## 4.2. Measurement Uncertainty

### Measurement Uncertainty for Audio Band Magnetic Measurement

| Error Description                                     | Uncertainty values (±%) | Probe Dist. | Div. | C <sub>i</sub> ABM1 | C <sub>i</sub> ABM2 | Std. Unc. |           |
|-------------------------------------------------------|-------------------------|-------------|------|---------------------|---------------------|-----------|-----------|
|                                                       |                         |             |      |                     |                     | ABM1 (±%) | ABM2 (±%) |
| Probe Sensitivity                                     |                         |             |      |                     |                     |           |           |
| Reference level                                       | 3.0                     | N           | 1    | 1                   | 1                   | 3.0       | 3.0       |
| AMCC geometry                                         | 0.4                     | R           | √3   | 1                   | 1                   | 0.2       | 0.2       |
| AMCC current                                          | 1.0                     | R           | √3   | 1                   | 1                   | 0.6       | 0.6       |
| Probe positioning during calibration                  | 0.1                     | R           | √3   | 1                   | 1                   | 0.1       | 0.1       |
| Noise contribution                                    | 0.7                     | R           | √3   | 0.0143              | 1                   | 0.0       | 0.4       |
| Frequency slope                                       | 5.9                     | R           | √3   | 0.1                 | 1.00                | 0.3       | 3.5       |
| Probe System                                          |                         |             |      |                     |                     |           |           |
| Repeatability / drift                                 | 1.0                     | R           | √3   | 1                   | 1                   | 0.6       | 0.6       |
| Linearity / Dynamic range                             | 0.6                     | R           | √3   | 1                   | 1                   | 0.4       | 0.4       |
| Acoustic noise                                        | 1.0                     | R           | √3   | 0.1                 | 1                   | 0.1       | 0.6       |
| Probe angle                                           | 2.3                     | R           | √3   | 1                   | 1                   | 1.4       | 1.4       |
| Spectral processing                                   | 0.9                     | R           | √3   | 1                   | 1                   | 0.5       | 0.5       |
| Integration time                                      | 0.6                     | N           | 1    | 1                   | 5                   | 0.6       | 3.0       |
| Field disturbance                                     | 0.2                     | R           | √3   | 1                   | 1                   | 0.1       | 0.1       |
| Test Signal                                           |                         |             |      |                     |                     |           |           |
| Reference signal spectral response                    | 0.6                     | R           | √3   | 0                   | 1                   | 0.0       | 0.4       |
| Positioning                                           |                         |             |      |                     |                     |           |           |
| Probe positioning                                     | 1.9                     | R           | √3   | 1                   | 1                   | 1.1       | 1.1       |
| Phantom positioning                                   | 0.9                     | R           | √3   | 1                   | 1                   | 0.5       | 0.5       |
| EUT positioning                                       | 1.9                     | R           | √3   | 1                   | 1                   | 1.1       | 1.1       |
| External Contributions                                |                         |             |      |                     |                     |           |           |
| RF interference                                       | 0.0                     | R           | √3   | 1                   | 0.3                 | 0.0       | 0.0       |
| Test signal variation                                 | 2.0                     | R           | √3   | 1                   | 1                   | 1.2       | 1.2       |
| Combined Std. Uncertainty (ABM field)                 |                         |             |      |                     |                     | 4.1       | 6.1       |
| Expanded Std. Uncertainty (%)                         |                         |             |      |                     |                     | 8.1       | 12.3      |
| Notes for table                                       |                         |             |      |                     |                     |           |           |
| 1. N - Nomal                                          |                         |             |      |                     |                     |           |           |
| 2. R - Rectangular                                    |                         |             |      |                     |                     |           |           |
| 3. Div. - Divisor used to obtain standard uncertainty |                         |             |      |                     |                     |           |           |

## 5. Test Procedures for all Technologies

### 5.1. General Procedures C63.19-2011, §7

ANSI C63.19-2011, §7

This document describes the procedures used to measure the ABM (T-Coil) performance of the WD. In addition to measuring the absolute signal levels, the A-weighted magnitude of the unintended signal shall also be determined. In order to assure that the required signal quality is measured, the measurement of the intended signal and the measurement of the unintended signal must be made at the same location for all measurement positions. In addition, the RF field strength at each measurement location must be at or below that required for the assigned category.

Measurements shall not include undesired properties from the WD's RF field; therefore, use of a coaxial connection to a base station simulator or non-radiating load may be necessary. However, even then with a coaxial connection to a base station simulator or non-radiating load there may still be RF leakage from the WD, which may interfere with the desired measurement. Pre-measurement checks should be made to avoid this possibility. All measurements shall be done with the WD operating on battery power with an appropriate normal speech audio signal input level given in Table 7.1. If the device display can be turned off during a phone call then that may be done during the measurement as well.

Measurements shall be performed at two locations specified in A.3, with the correct probe orientation for a particular location, in a multistage sequence by first measuring the field intensity of the desired T-Coil signal (ABM1) that is useful to a hearing aid T-Coil. The undesired magnetic components (ABM2) must be measured at the same location as the desired ABM or T-Coil signal (ABM1), and the ratio of desired to undesired ABM signals must be calculated. For the perpendicular field location, only the ABM1 frequency response shall be determined in a third measurement stage. The flow chart in Figure 7.3 illustrates this three-stage, two orientation process.

The following steps summarize the basic test flow for determining ABM1<sup>1</sup> and ABM2<sup>2</sup>. These steps assume that a sine wave or narrowband 1/3 octave signal can be used for the measurement of ABM1.

- a. A validation of the test setup and instrumentation may be performed using a TMFS or Helmholtz coil. Measure the emissions and confirm that they are within the specified tolerance.
- b. Position the WD in the test setup and connect the WD RF connector to a base station simulator or a non-radiating load as shown in Figure 7.1 or Figure 7.2. Confirm that equipment that requires calibration has been calibrated, and that the noise level meets the requirements given in 7.3.1.
- c. The drive level to the WD is set such that the reference input level specified in Table 7.1 is input to the base station simulator (or manufacturer's test mode equivalent) in the 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (ABM1) at  $f = 1$  kHz. Either a sine wave at 1025 Hz or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as defined in 7.4.2, shall be used for the reference audio signal. If interference is found at 1025 Hz an alternative nearby reference audio signal frequency may be used.<sup>46</sup> The same drive level will be used for the ABM1 frequency response measurements at each 1/3 octave band center frequency. The WD volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.
- d. Determine the magnetic measurement locations for the WD device (A.3), if not already specified by the manufacturer, as described in 7.4.4.1.1 and 7.4.4.2.

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<sup>1</sup> **Audio Band Magnetic signal - desired (ABM1):** Measured quantity of the desired magnetic signal

<sup>2</sup> **Audio Band Magnetic signal - undesired (ABM2):** Measured quantity of the undesired magnetic signal, such as interference from battery current and similar non-signal elements.



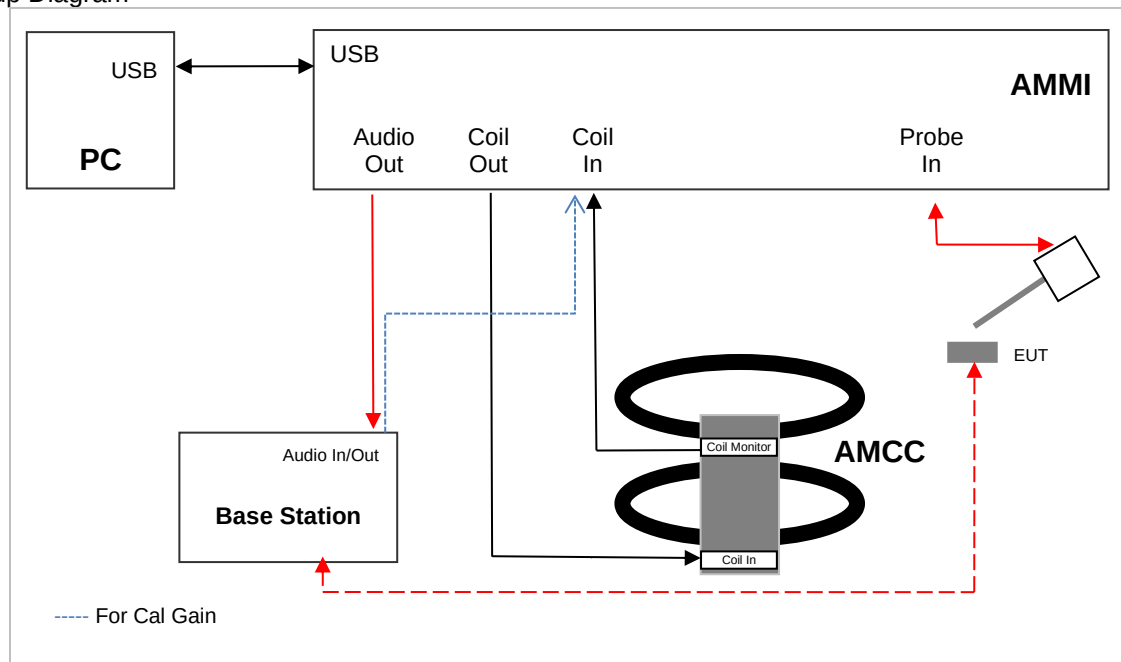
- e. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at  $f_i$ ) as described in 7.4.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency ( $f_i$ ) shall be centered in each 1/3 octave band maintaining the same drive level as determined in item c) and the reading taken for that band.

Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input–output comparison using simulated speech. The full-band integrated or half-band integrated probe output, as specified in D.9, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB A/m.)

All measurements of the desired signal shall be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal ON and OFF with the probe measuring the same location. If the scanning method is used the scans shall show that all measurement points selected for the ABM1 measurement meet the ambient and test system noise criteria in 7.3.1.

- f. At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in 7.4.4.4 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).
- g. Obtain the data from the postprocessor, SEMCAD, and determine the category that properly classifies the signal quality based on Table 8.5.

Test Setup Diagram



## 5.2. VoWiFi – For PAG REUSE

This device supports Wi-Fi calling (aka Voice over Wi-Fi or VoWi-Fi) which is an extended feature of the carriers CMRS service to offload VoLTE calls onto local area networks over Wi-Fi via the Internet and subject to HAC assessment for phones with a HAC rating. HAC assessment for this feature is subject to Pre Approval Guidance.

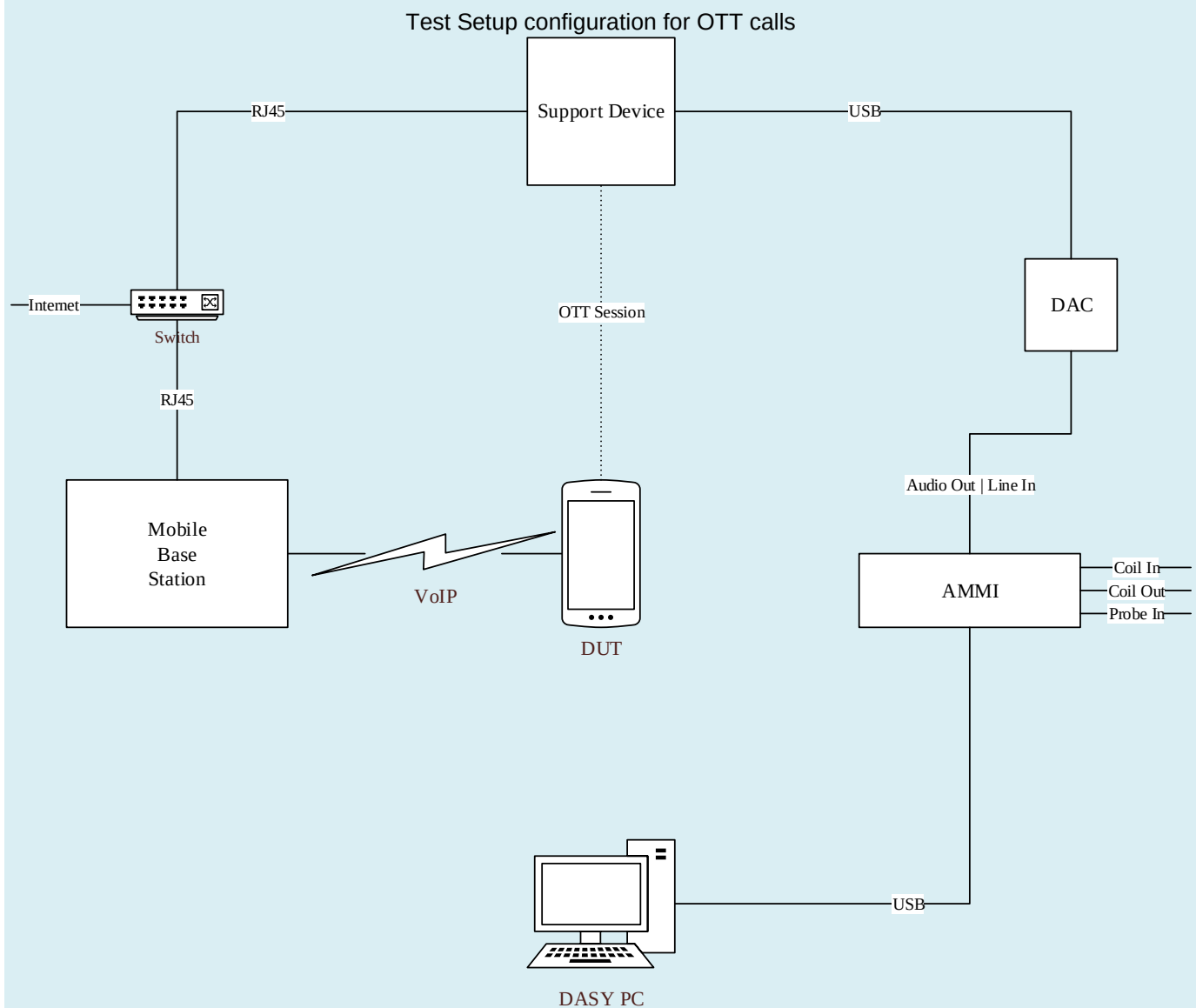
The set up for VoWi-Fi uses the base station as described in §5.1 with the exception that the reference audio level is set to -20dBm0. The reference level is calibrated using the standard call box calibration procedures with the exception of the -20dBm0 reference level being used (refer to §6).

An investigation was performed to determine worst case codec, bit rate, and air interface configuration (refer to §9).

### 5.3. Over the Top (OTT) – For PAG REUSE

This device supports VoIP via a preinstalled application that uses the FaceTime service, using ACC-ELD as its only codec (refer to §8.1 for air interface details and §9.2.2 for codec bit rates). VoIP capabilities require HAC assessment when voice calls are supported over the cellular data connection via pre-installed VoIP applications and the assessment is subject to Pre-Approval Guidance procedures.

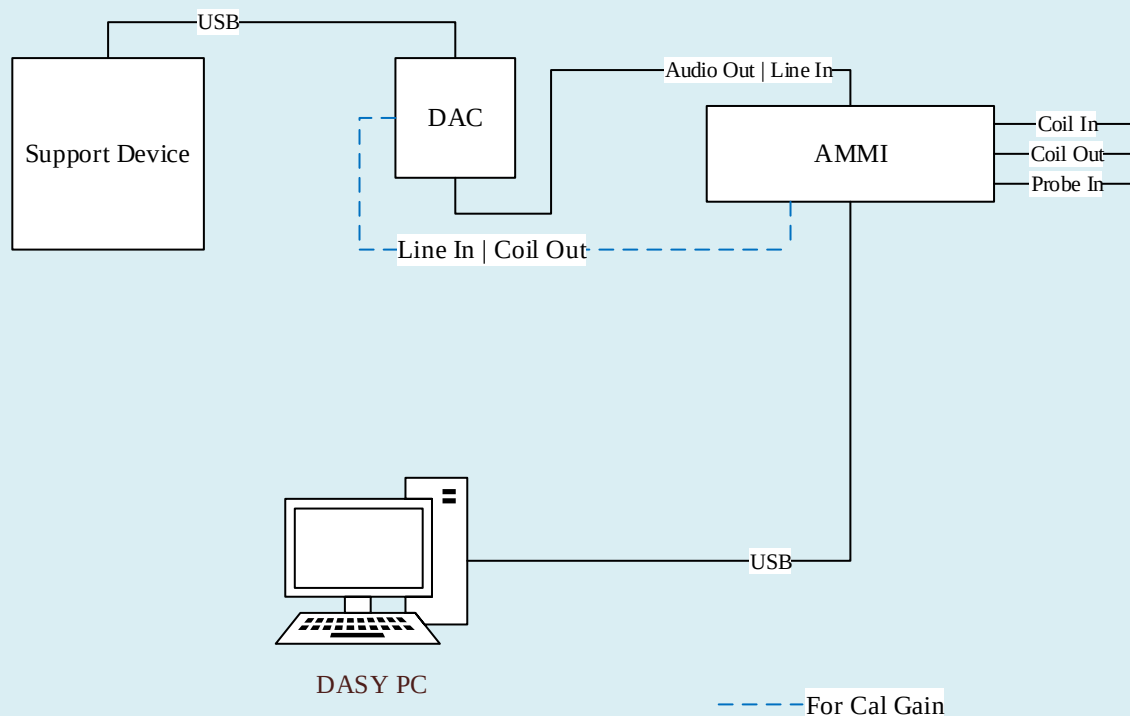
The equipment is set up as shown below with a support device used to originate the call using the IP transport. The support device<sup>3</sup> connects to the cloud-based FaceTime service via a Wi-Fi access point and router, or a RJ45 Ethernet connection. The DUT connects to the VoIP service via a cellular/unlicensed air interface to the call box and an Ethernet connection from call box to Internet. The various codec bit rate and air interface configurations are evaluated to determine the worst-case configuration (refer to §9.2.2).



For the OTT call, the calibrated audio card within the CMW500 cannot be used so the AMMI is connected to an external Digital-Analog Converter (DAC) and the DAC is connected to the Support Device via USB. The test signal is sent from the DASY PC to the AMMI, from the AMMI to the DAC, from the DAC to the Support Device, and, via the VoIP call, to the DUT.

<sup>3</sup> The support device is an Apple iMac

As this test set up uses an external DAC between the AMMI's audio output and support device, the appropriate gain factor for the OTT call needs to be determined. This is done by connecting the DAC between the AMMI Audio output and Coil input as shown below.



The DAC's gain is adjusted until the volume reaches 0 dBFS (3.14 dBm0 based on TIA/EIA 810-A) at the output. SPEAG's "TN-LK-05042018-C-T-Coil\_Levels" document (Appendix E) steps E through H are then followed to determine the adjusted gain values as detailed in §6 so that the reference level is set to 23.14dB below full scale, i.e. at -20dBm0. A verification of the DAC's output is performed prior to testing.

## 6. Audio Level and Gain Measurements

The adjusted gain was calculated using Speag's *TN-LK-05042018-D-T-Coil\_Levels* document (please refer to Appendix E). First, the output of AMMI is determined in a closed loop, then, using the CMW500's input sensitivity, the adjusted gain required for testing can then be calculated. The adjusted linear gain used within this report is as follows:

### 6.1. GSM/W-CDMA and VoLTE

| Signal type    | Audio level<br>[dBm0] | Gain<br>[dB] | Gain<br>(linear) |
|----------------|-----------------------|--------------|------------------|
| 1 kHz sine     | -16.00                | 14.90        | 5.56             |
| Voice 1 kHz    | -16.00                | 27.63        | 24.07            |
| Voice 300-3kHz | -16.00                | 33.48        | 47.20            |

The following software/firmware was used to simulate the VoLTE server for testing:

| Firmware          | License Keys | Software Name         |
|-------------------|--------------|-----------------------|
| V3.7.60 for LTE   | KS500        | LTE FDD R8 SIG BASIC  |
|                   | KS550        | LTE TDD R8 SIG BASIC  |
| V3.7.20 for Audio | KA100        | IP APPL ENABLING IPv4 |
|                   | KA150        | IP APPL ENABLING IPv6 |
|                   | KAA20        | IP APPL IMS BASIC     |
|                   | KM050        | DATA APPL MEAS        |
|                   | KS104        | EVS SPEECH CODEC      |

### 6.2. CDMA (1xRTT)

| Signal type    | Audio level<br>[dBm0] | Gain<br>[dB] | Gain<br>(linear) |
|----------------|-----------------------|--------------|------------------|
| 1 kHz sine     | -18.00                | 12.90        | 4.42             |
| Voice 1 kHz    | -18.00                | 25.63        | 19.12            |
| Voice 300-3kHz | -18.00                | 31.48        | 37.50            |

### 6.3. VoWi-Fi – For PAG REUSE

| Signal type    | Audio level<br>[dBm0] | Gain<br>[dB] | Gain<br>(linear) |
|----------------|-----------------------|--------------|------------------|
| 1 kHz sine     | -20.00                | 10.90        | 3.51             |
| Voice 1 kHz    | -20.00                | 23.63        | 15.19            |
| Voice 300-3kHz | -20.00                | 29.48        | 29.78            |

| Firmware          | License Keys | Software Name         |
|-------------------|--------------|-----------------------|
| V3.7.40 for WLAN  | KS650        | WLAN A/B/G SIG BASIC  |
|                   | KS651        | WLAN N SIG BASIC      |
|                   | KS656        | WLAN IEEE 802.11ac    |
|                   | KS657        | WLAN IEEE 802.11ax    |
| V3.7.20 for Audio | KA100        | IP APPL ENABLING IPv4 |
|                   | KA150        | IP APPL ENABLING IPv6 |
|                   | KAA20        | IP APPL IMS BASIC     |
|                   | KM050        | DATA APPL MEAS        |
|                   | KS104        | EVS SPEECH CODEC      |

#### 6.4. Over the Top (OTT) – For PAG REUSE

For EDGE, HSPA, Ev-Do, LTE, and Wi-Fi, the linear gain levels are listed below were used. The results below are based on a reference input level of -20 dBm0. Granted, the C63.19-2011 interpretation for T-coil audio levels for LTE states that an input reference level of -16 dBm0 should be used, we, the test lab, opted for -20 dBm0 for LTE due to it being a more conservative input reference level.

To calibrate the DAC (refer §5.3), three .wav audio files (sine wave, 1 kHz voice, and 300 to 3 kHz voice) are sent from the DASY5 PC to the AMMI, then to the DAC. The Helmholtz resonator measures the field strength, which represents the AMMI to DAC input sensitivity. After determining the input sensitivity, the adjusted linear gain values can then be calculated.

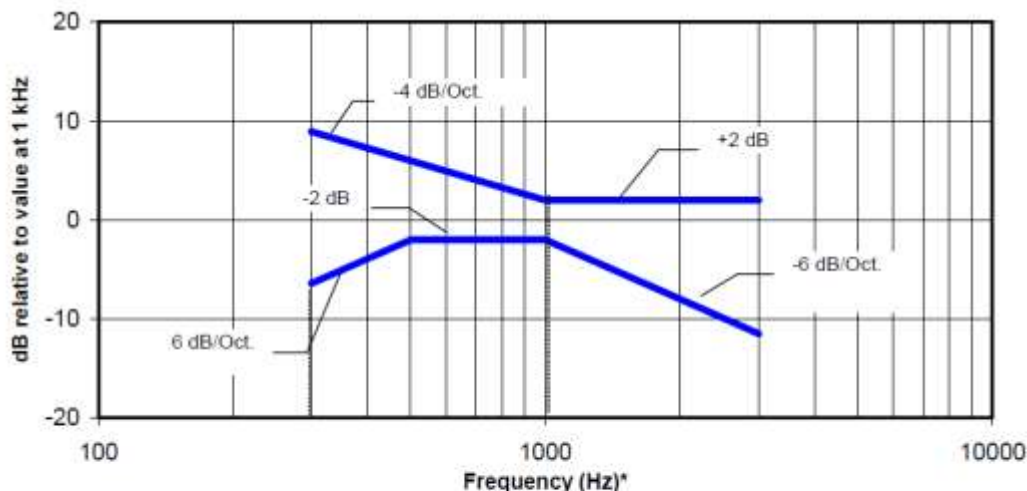
| Signal type    | Audio level<br>[dBm0] | Gain<br>[dB] | Gain<br>(linear) |
|----------------|-----------------------|--------------|------------------|
| 1 kHz sine     | -20.00                | 18.69        | 8.60             |
| Voice 1 kHz    | -20.00                | 31.42        | 37.22            |
| Voice 300-3kHz | -20.00                | 37.27        | 72.99            |

## 7. T-coil Measurement Criteria

### 7.1. Frequency Response

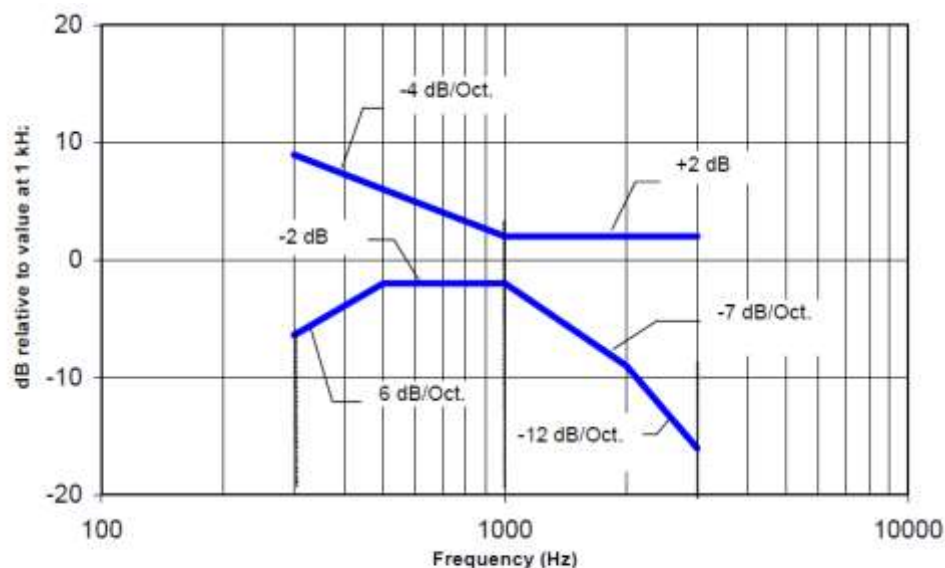
The frequency response of the axial component of the magnetic field, measured in 1/3 octave bands, shall follow the response curve, over the frequency range 300 Hz to 3000 Hz.

Figure 8.1 and Figure 8.2 provide the boundaries for the specified frequency. These response curves are for true field strength measurements of the T-Coil signal. Thus the 6 dB/octave probe response has been corrected from the raw readings.



NOTE—The frequency response is between 300 Hz and 3000 Hz.

**Figure 8.1—Magnetic field frequency response for WDs with field strength  $\leq -15$  dB (A/m) at 1 kHz**



NOTE—The frequency response is between 300 Hz and 3000 Hz.

**Figure 8.2—Magnetic field frequency response for WDs with a field that exceeds  $-15$  dB(A/m) at 1 kHz**

## 7.2. Signal to Noise

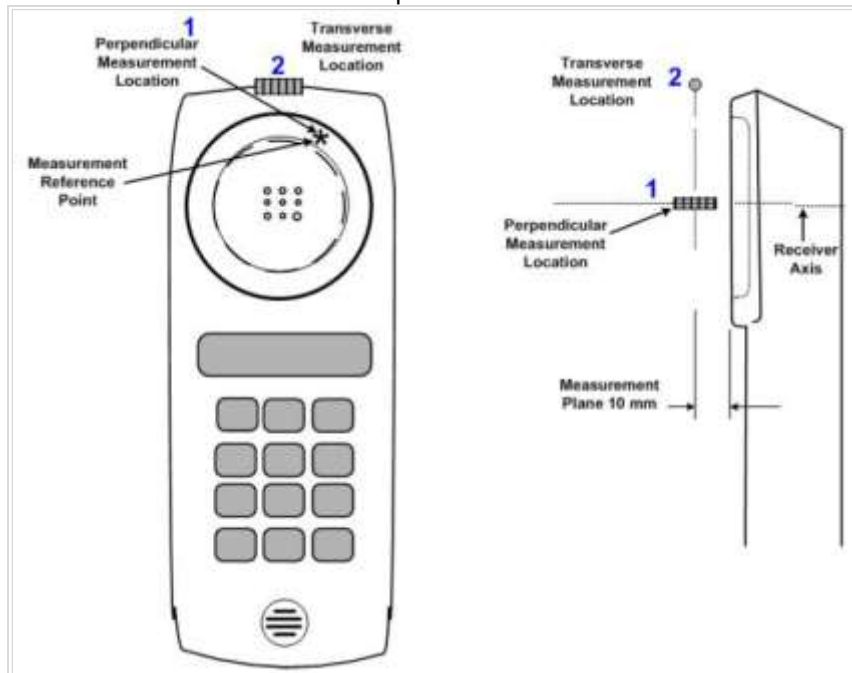
This specifies the signal-to-noise quality requirement for the intended T-Coil signal from a WD. The worst signal to noise of the two T-Coil signal measurements, as determined in Clause 7, shall be used to determine the T-Coil mode category per Table 8.5.

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. So, the only criterion that can be measured is the RF immunity in T-Coil Mode. This is measured using the same procedure as for the audio coupling mode and at the same levels as specified in 6.4.

**Table 8.5—T-Coil signal-to-noise categories**

| Category    | Telephone parameters<br>WD signal quality<br>[(signal + noise)-to-noise ratio in decibels] |
|-------------|--------------------------------------------------------------------------------------------|
| Category T1 | 0 dB to 10 dB                                                                              |
| Category T2 | 10 dB to 20 dB                                                                             |
| Category T3 | 20 dB to 30 dB                                                                             |
| Category T4 | >30 dB                                                                                     |

Measurement locations and reference plane to be used for the T-coil measurements



## 8. Device Under Test

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, GPS and NFC. All models support at least one UICC based SIM. The second SIM, if present, is either UICC based pSIM (physical SIM) or e-SIM (electronic SIM). The device has a built-in inductive charging receiver. The rechargeable battery is also not user accessible.

LAT 1 (Primary Cellular Antenna) - located all along the bottom of the device.

UAT 1 (Secondary Cellular Antenna (699 – 2700 MHz only), Wi-Fi 2.4 GHz, and Bluetooth) - located all along the top of the device.

UAT 2 (Secondary Cellular 3.4 GHz Antenna (only) and Wi-Fi 5GHz Bands) – located at the upper left corner of the device.

LAT 3 (Wi-Fi 2.4/5 GHz Bands and Bluetooth) – located at the lower right corner of the device.

|                  |                                 |
|------------------|---------------------------------|
| Normal operation | Held to head                    |
| Back Cover       | The Back Cover is not removable |

### 8.1. Air Interfaces and Operating Mode

| Air Interface                                                                                                                                                              | Bands (MHz)             | Type | C63.19 Tested                                                                                                                                                                                                                       | Simultaneous Transmitter   | OTT Testing Required? Name of Voice Service <sup>1,2</sup> | Power Reduction | Audio Codecs Evaluated         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------------------------------------------------------------|-----------------|--------------------------------|
| GSM                                                                                                                                                                        | 850                     | VO   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | CMRS                                                       | N/A             | EFR                            |
|                                                                                                                                                                            | 1900                    |      |                                                                                                                                                                                                                                     |                            |                                                            | No              |                                |
|                                                                                                                                                                            | GPRS/EDGE               | VD   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | Yes FaceTime                                               | N/A             | ACC-ELD                        |
| W-CDMA (UMTS)                                                                                                                                                              | 850                     | VO   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | CMRS                                                       | N/A             | AMR-NB & AMR-WB                |
|                                                                                                                                                                            | 1700                    |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 1900                    |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | HSPA                    | VD   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | Yes FaceTime                                               | N/A             | ACC-ELD                        |
| CDMA                                                                                                                                                                       | 800                     | VO   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | CMRS                                                       | N/A             | EVRC & EVRC-B                  |
|                                                                                                                                                                            | 1900                    |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | EVDO                    | VD   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | Yes FaceTime                                               | N/A             | ACC-ELD                        |
| LTE - FDD                                                                                                                                                                  | 600 (B71)               | VD   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | Yes FaceTime & VoLTE                                       | N/A             | AMR-NB, AMR-WB, EVS, & ACC-ELD |
|                                                                                                                                                                            | 700 (B12/13/14/17)      |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 850 (B5/26)             |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 1700 (B4/66)            |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 1900 (B2/25)            |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 2300 (B30)              |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 2600 (B7)               |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
| LTE - TDD                                                                                                                                                                  | 2500 (41 <sup>3</sup> ) | VD   | Yes                                                                                                                                                                                                                                 | Wi-Fi & BT                 | Yes FaceTime & VoLTE                                       | N/A             | AMR-NB, AMR-WB, EVS, & ACC-ELD |
|                                                                                                                                                                            | 3600 (B48)              |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
| Wi-Fi                                                                                                                                                                      | 2450                    | VD   | Yes                                                                                                                                                                                                                                 | WWAN                       | Yes FaceTime & Wi-Fi Calling                               | N/A             | AMR-NB, AMR-WB, EVS, & ACC-ELD |
|                                                                                                                                                                            | 5200 (U-NII-1)          |      |                                                                                                                                                                                                                                     | WWAN & BT                  |                                                            |                 |                                |
|                                                                                                                                                                            | 5300 (U-NII-2A)         |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 5500 (U-NII-2C)         |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
|                                                                                                                                                                            | 5800 (U-NII-3)          |      |                                                                                                                                                                                                                                     |                            |                                                            |                 |                                |
| BT                                                                                                                                                                         | 2450                    | DT   | NA                                                                                                                                                                                                                                  | WWAN & Wi-Fi (5 GHz bands) | NA                                                         | N/A             | N/A                            |
| Type<br>VO: Legacy Cellular Voice Service<br>DT: Digital Transport only (no voice)<br>VD: IP Voice Service over Digital Transport<br>CMRS: Commercial Mobile Radio Service |                         |      | Note:<br>1. For protocols not listed in Table 7.1 of ANSI C63.19-2011 or the ANSI C63.19-2011 VoLTE interpretation, the average speech level of -20 dBm0 was used<br>2. For PAG REUSE<br>3. LTE-TDD was tested using Power Class II |                            |                                                            |                 |                                |



## 9. Investigations (Antenna, Codec, & Air Interface)

### 9.1. CMRS

An investigation was performed to determine the worst-case antenna per technology. All subsequent measurements were determined by this investigation.

#### 9.1.1. Antenna Investigation

| Note(s) | Mode:                                                         | Channel and Frequency | Bandwidth (Data Rate) | Antenna | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating |
|---------|---------------------------------------------------------------|-----------------------|-----------------------|---------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|
| 1       | GSM 850<br>Voice Codec<br>Speechcodec Low                     | 190<br>836.6 MHz      | N/A                   | LAT 1   | z (Axial)       | 0.57         | -17.56       | -50.58                | 2.00                | 38.86        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -6.99        | -19.39       | -50.55                |                     | 34.05        | T4       |
|         |                                                               |                       |                       | UAT 1   | z (Axial)       | 0.52         | -40.21       | -50.58                | 2.00                | 40.73        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -6.62        | -41.54       | -50.55                |                     | 34.93        | T4       |
| 2       | W-CDMA BII<br>AMR-NB<br>Bit rate: 4.75 kbps                   | 9400<br>1880 MHz      | N/A                   | LAT 1   | z (Axial)       | 5.49         | -24.15       | -50.55                | 2.00                | 50.76        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -2.97        | -24.90       | -50.49                |                     | 40.42        | T4       |
|         |                                                               |                       |                       | UAT 1   | z (Axial)       | 5.81         | -44.80       | -50.55                | 1.69                | 50.61        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | 2.69         | -43.15       | -50.49                |                     | 40.46        | T4       |
| 3       | CDMA2000 BC0<br>RC1 / SO3 Full Fr<br>Voice Codec: 8K EVRC Low | 384<br>836.52 MHz     | N/A                   | LAT 1   | z (Axial)       | 0.88         | -26.01       | -50.49                | 2.00                | 47.63        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -7.89        | -28.74       | -50.49                |                     | 37.11        | T4       |
|         |                                                               |                       |                       | UAT 1   | z (Axial)       | 0.85         | -47.64       | -50.49                | 2.00                | 48.49        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -7.27        | -44.74       | -50.49                |                     | 37.47        | T4       |
| 4       | LTE Band 25 QPSK<br>1/49 RB, AMR-NB<br>Bit rate: 4.75 kbps    | 26365<br>1882.5 MHz   | 20 MHz                | LAT 1   | z (Axial)       | 3.75         | -21.11       | -50.55                | 2.00                | 49.15        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -4.36        | -27.33       | -50.49                |                     | 38.56        | T4       |
|         |                                                               |                       |                       | UAT 1   | z (Axial)       | 3.92         | -45.99       | -50.55                | 1.71                | 49.90        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -4.36        | -42.73       | -50.49                |                     | 38.37        | T4       |
| 5       | LTE Band 41 QPSK<br>1/49 RB, AMR-NB<br>Bit rate: 4.75 kbps    | 40620<br>2593 MHz     | 20 MHz                | LAT 1   | z (Axial)       | 4.98         | -22.96       | -50.55                | 1.85                | 47.04        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -5.59        | -25.33       | -50.49                |                     | 37.59        | T4       |
|         |                                                               |                       |                       | UAT 1   | z (Axial)       | 4.68         | -39.76       | -50.55                | 2.00                | 44.44        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -4.84        | -42.32       | -50.49                |                     | 37.48        | T4       |
| 5a      | LTE Band 48 QPSK<br>1/49 RB, AMR-NB<br>Bit rate: 4.75 kbps    | 55990<br>3625 MHz     | 20 MHz                | LAT 1   | z (Axial)       | 6.27         | -23.10       | -50.50                | 2.00                | 48.33        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -3.45        | -24.38       | -50.46                |                     | 38.48        | T4       |
|         |                                                               |                       |                       | UAT 2   | z (Axial)       | 7.37         | -39.01       | -50.50                | 1.99                | 46.38        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -3.41        | -41.32       | -50.46                |                     | 37.91        | T4       |
| 6       | 802.11b<br>AMR-NB<br>Bit rate: 4.75 kbps                      | 6<br>2437 MHz         | 20 MHz                | LAT 3   | z (Axial)       | 5.14         | -27.26       | -50.55                | 1.75                | 48.95        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -5.26        | -27.05       | -50.48                |                     | 37.95        | T4       |
|         |                                                               |                       |                       | UAT 1   | z (Axial)       | 5.10         | -43.61       | -50.55                | 1.82                | 48.71        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -5.05        | -42.89       | -50.48                |                     | 37.84        | T4       |
| 7       | 802.11a<br>AMR-NB<br>Bit rate: 4.75 kbps                      | 36<br>5180 MHz        | 20 MHz                | LAT 3   | z (Axial)       | 2.78         | -30.13       | -50.53                | 2.00                | 48.73        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -4.60        | -30.27       | -50.45                |                     | 40.97        | T4       |
|         |                                                               |                       |                       | UAT 2   | z (Axial)       | 3.13         | -32.80       | -50.53                | 2.00                | 35.94        | T4       |
|         |                                                               |                       |                       |         | y (Transversal) | -4.54        | -36.85       | -50.45                |                     | 32.31        | T4       |

#### Note(s):

- LAT 1 has been determined to be the worst-case antenna for GSM.
- LAT 1 has been determined to be the worst-case antenna for W-CDMA.
- LAT 1 has been determined to be the worst-case antenna for CDMA.
- UAT 1 has been determined to be the worst-case antenna for LTE-FDD.
- UAT 1 has been determined to be the worst-case antenna for LTE-TDD.
  - UAT 2 has been determined to be the worst-case antenna for LTE-TDD (Band 48 only).
- UAT 1 has been determined to be the worst-case antenna for Wi-Fi 2.4 GHz.
- UAT 2 has been determined to be the worst-case antenna for Wi-Fi 5 GHz.

### 9.1.2. Codec Investigation

An investigation between the various codec configurations (Low/Mid/High bit rates for Narrowband, Wideband and EVS) and specific parameters are documented (ABM1, ABM2, S+N/N, frequency response) to determine the worst-case bit rates for each voice service type. The table below compares the varying codec configurations. A codec investigation was performed on one band of each W-CDMA, LTE FDD and LTE TDD.

The highlighted results below were determined to be the worst-case codec configuration(s) for LTE and W-CDMA.

#### W-CDMA Codec Investigation:

| W-CDMA Codec Investigation |               |        |        |               |        |        |                 |                                 |
|----------------------------|---------------|--------|--------|---------------|--------|--------|-----------------|---------------------------------|
| Codec State                | AMR-NB (kbps) |        |        | AMR-WB (kbps) |        |        | Orientation     | Band/Channel/<br>Bandwidth      |
|                            | 4.75          | 7.4    | 12.2   | 6.6           | 15.85  | 23.85  |                 |                                 |
| ABM1 (dB/m)                | 5.49          | 5.99   | 6.14   | 4.92          | 6.60   | 6.60   | z (Axial)       | W-CDMA BII<br>Ch. 9400<br>LAT 1 |
| ABM2 (dBA/m)               | -24.15        | -45.26 | -44.53 | -25.02        | -43.21 | -44.24 |                 |                                 |
| SNR (dB)                   | 50.76         | 51.25  | 50.67  | 49.92         | 49.82  | 50.84  |                 |                                 |
| Freq. Resposne (dB)        | 2.00          | 2.00   | 2.00   | 0.84          | 2.00   | 2.00   |                 |                                 |
| ABM1 (dB/m)                | -2.97         | -2.55  | -2.36  | -4.60         | -2.93  | -2.91  | y (Transversal) | W-CDMA BII<br>Ch. 9400<br>LAT 1 |
| ABM2 (dBA/m)               | -24.90        | -42.96 | -42.51 | -27.09        | -44.01 | -43.91 |                 |                                 |
| SNR (dB)                   | 40.42         | 40.40  | 40.15  | <b>39.94</b>  | 41.08  | 41.00  |                 |                                 |

#### VoLTE Codec Investigation:

| VoLTE Codec Investigation |               |        |        |               |        |        |              |        |        |                 |                                                                   |
|---------------------------|---------------|--------|--------|---------------|--------|--------|--------------|--------|--------|-----------------|-------------------------------------------------------------------|
| Codec State               | AMR-NB (kbps) |        |        | AMR-WB (kbps) |        |        | EVS (kbps)   |        |        | Orientation     | Band/Channel/<br>Bandwidth                                        |
|                           | 4.75          | 7.4    | 12.2   | 6.6           | 15.85  | 23.85  | 5.9          | 9.6    | 24.4   |                 |                                                                   |
| ABM1 (dB/m)               | 9.09          | 9.32   | 9.50   | 8.18          | 9.44   | 9.47   | 6.35         | 8.26   | 7.86   | z (Axial)       | LTE Band 25<br>CH. 26365<br>1/49 RB<br>QPSK<br>20 MHz BW<br>UAT 1 |
| ABM2 (dBA/m)              | -23.90        | -41.12 | -40.39 | -22.36        | -40.49 | -40.38 | -24.22       | -38.02 | -38.39 |                 |                                                                   |
| SNR (dB)                  | 50.27         | 50.43  | 49.90  | 48.84         | 49.93  | 49.84  | 44.74        | 46.28  | 46.25  |                 |                                                                   |
| Freq. Resposne (dB)       | 2.00          | 2.00   | 2.00   | 0.31          | 2.00   | 2.00   | 2.00         | 2.00   | 2.00   |                 |                                                                   |
| ABM1 (dB/m)               | -4.04         | -3.38  | -3.20  | -4.46         | -2.83  | -2.77  | -5.13        | -3.39  | -3.26  | y (Transversal) | LTE Band 25<br>CH. 26365<br>1/49 RB<br>QPSK<br>20 MHz BW<br>UAT 1 |
| ABM2 (dBA/m)              | -24.97        | -41.73 | -41.90 | -24.91        | -41.27 | -41.43 | -25.26       | -41.80 | 41.98  |                 |                                                                   |
| SNR (dB)                  | 38.17         | 38.36  | 38.71  | 37.22         | 38.45  | 38.66  | <b>36.87</b> | 38.41  | 38.72  |                 |                                                                   |
| ABM1 (dB/m)               | 9.31          | 9.27   | 9.48   | 8.22          | 9.39   | 9.50   | 8.44         | 9.73   | 9.67   | z (Axial)       | LTE Band 41<br>CH. 40620<br>1/49 RB<br>QPSK<br>20 MHz BW<br>UAT 1 |
| ABM2 (dBA/m)              | -19.89        | -38.93 | -38.54 | -21.13        | -38.66 | -38.88 | -18.59       | -38.27 | -38.59 |                 |                                                                   |
| SNR (dB)                  | 48.45         | 48.19  | 48.02  | 47.07         | 48.00  | 48.39  | 45.75        | 47.99  | 48.25  |                 |                                                                   |
| Freq. Resposne (dB)       | 2.00          | 2.00   | 2.00   | 0.48          | 2.00   | 2.00   | 2.00         | 2.00   | 2.00   |                 |                                                                   |
| ABM1 (dB/m)               | -3.60         | -3.27  | -3.02  | -4.14         | -2.89  | -2.78  | -4.33        | -2.96  | -3.09  | y (Transversal) | LTE Band 41<br>CH. 40620<br>1/49 RB<br>QPSK<br>20 MHz BW<br>UAT 1 |
| ABM2 (dBA/m)              | -22.68        | -40.86 | -41.19 | -22.77        | -40.73 | -40.62 | -22.92       | -41.53 | -41.36 |                 |                                                                   |
| SNR (dB)                  | 37.46         | 37.59  | 38.17  | 36.76         | 37.84  | 37.85  | <b>36.49</b> | 38.56  | 38.27  |                 |                                                                   |

#### Note(s):

A bit rate investigation was performed on the pre-installed phone application to determine the worst-case bit rate:

1. For W-CDMA, it is observed that 6.60 kbps is the worst-case.
2. For LTE-FDD, it is observed that 5.90 kbps is the worst-case.
3. For LTE-TDD, it is observed that 5.90 kbps is the worst-case.

### 9.1.3. Air Interface Investigation

A limited set of bands/channels/bandwidths were then tested to confirm that there is no effect to the T-rating when changing the band/channel/bandwidth.

#### W-CDMA Air Interface Investigation:

| W-CDMA Air Interface Investigation         |                       |         |                           |                 |              |              |                       |                     |              |          |                  |
|--------------------------------------------|-----------------------|---------|---------------------------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode:                                      | Channel and Frequency | Antenna | Bandwidth (if applicable) | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| W-CDMA BII<br>AMR-WB<br>Bit rate: 6.6 kbps | 9262<br>1852.4 MHz    | LAT 1   | N/A                       | z (Axial)       | 5.66         | -43.79       | -50.55                | 1.11                | 49.45        | T4       | -2.5, 0.9, 3.7   |
|                                            |                       |         |                           | y (Transversal) | -3.85        | -43.83       | -50.49                |                     | 39.98        | T4       | -3.9, -11, 3.7   |
|                                            | 9400<br>1880.0 MHz    | LAT 1   | N/A                       | z (Axial)       | 4.92         | -25.02       | -50.55                | 0.84                | 49.92        | T4       | -2.5, 0.8, 3.7   |
|                                            |                       |         |                           | y (Transversal) | -4.60        | -27.09       | -50.49                |                     | 39.94        | T4       | -3.7, -11.3, 3.7 |
|                                            | 9538<br>1907.6 MHz    | LAT 1   | N/A                       | z (Axial)       | 5.53         | -43.96       | -50.55                | 0.76                | 49.50        | T4       | -2.5, 0.9, 3.7   |
|                                            |                       |         |                           | y (Transversal) | -3.78        | -43.62       | -50.49                |                     | 39.38        | T4       | -3.9, -11, 3.7   |
| W-CDMA BV<br>AMR-WB<br>Bit rate: 6.6 kbps  | 4132<br>826.4 MHz     | LAT 1   | N/A                       | z (Axial)       | 6.52         | -42.29       | -50.55                | 0.72                | 48.81        | T4       | -2.1, 0, 3.7     |
|                                            |                       |         |                           | y (Transversal) | -4.20        | -42.27       | -50.48                |                     | 38.07        | T4       | -4.2, -9.2, 3.7  |
|                                            | 4183<br>836.6 MHz     | LAT 1   | N/A                       | z (Axial)       | 6.43         | -42.53       | -50.55                | 0.52                | 48.96        | T4       | -2.1, 0, 3.7     |
|                                            |                       |         |                           | y (Transversal) | -4.10        | -42.83       | -50.48                |                     | 38.72        | T4       | -4.2, -9.2, 3.7  |
|                                            | 4233<br>846.6 MHz     | LAT 1   | N/A                       | z (Axial)       | 6.51         | -22.80       | -50.55                | 0.67                | 49.67        | T4       | -2.1, 0, 3.7     |
|                                            |                       |         |                           | y (Transversal) | -4.36        | -24.46       | -50.48                |                     | 38.44        | T4       | -4.2, -9.2, 3.7  |
| W-CDMA BV<br>AMR-WB<br>Bit rate: 6.6 kbps  | 1312<br>1712.4 MHz    | LAT 1   | N/A                       | z (Axial)       | 6.74         | -22.30       | -50.55                | 0.36                | 50.05        | T4       | -0.4, 0, 3.7     |
|                                            |                       |         |                           | y (Transversal) | -4.96        | -25.00       | -50.48                |                     | 39.30        | T4       | -1.7, -12.1, 3.7 |
|                                            | 1413<br>1732.6 MHz    | LAT 1   | N/A                       | z (Axial)       | 7.08         | -42.47       | -50.55                | 0.24                | 49.55        | T4       | -0.4, 0, 3.7     |
|                                            |                       |         |                           | y (Transversal) | -4.90        | -44.09       | -50.48                |                     | 39.19        | T4       | -1.7, -12.1, 3.7 |
|                                            | 1513<br>1752.6 MHz    | LAT 1   | N/A                       | z (Axial)       | 7.03         | -42.41       | -50.55                | 32.00               | 49.44        | T4       | -0.4, 0, 3.7     |
|                                            |                       |         |                           | y (Transversal) | -4.85        | -43.94       | -50.48                |                     | 39.09        | T4       | -1.7, -12.1, 3.7 |

**VoLTE Air Interface Investigation:**

| VoLTE Air Interface Investigation              |                              |         |                          |               |    |                 |                 |                 |                             |                           |                 |          |                 |
|------------------------------------------------|------------------------------|---------|--------------------------|---------------|----|-----------------|-----------------|-----------------|-----------------------------|---------------------------|-----------------|----------|-----------------|
| Mode:                                          | Bandwidth<br>(if applicable) | Antenna | Channel and<br>Frequency | RB Allocation |    | Orientation     | ABM1<br>dB(A/m) | ABM2<br>dB(A/m) | Ambient<br>Noise<br>dB(A/m) | Freq.<br>Response<br>(dB) | ABM SNR<br>(dB) | T-Rating | Location        |
| LTE Band 25 QPSK<br>EVS<br>Bit rate: 5.9 kbps  | 20 MHz                       | UAT 1   | 26140<br>1860 MHz        | 100           | 0  | z (Axial)       | 3.30            | -38.38          | -50.50                      | 2.00                      | 41.68           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.18           | -41.77          | -50.46                      |                           | 36.59           | T4       | -4.6, -9.7, 3.7 |
|                                                |                              |         | 26365<br>1882.5 MHz      | 1             | 0  | z (Axial)       | 7.03            | -38.31          | -50.50                      | 1.69                      | 45.34           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -8.43           | -42.07          | -50.46                      |                           | 33.64           | T4       | -4.6, -9.7, 3.7 |
|                                                |                              |         |                          | 1             | 49 | z (Axial)       | 6.35            | -24.22          | -50.50                      | 2.00                      | 44.74           | T4       | -1.2, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.13           | -25.26          | -50.46                      |                           | 36.87           | T4       | -4.6, -9.6, 3.7 |
|                                                |                              |         |                          | 1             | 99 | z (Axial)       | 2.53            | -38.44          | -50.50                      | 0.67                      | 40.97           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.18           | -41.71          | -50.46                      |                           | 36.54           | T4       | -4.6, -9.7, 3.7 |
|                                                |                              |         |                          | 50            | 0  | z (Axial)       | 6.63            | -38.46          | -50.50                      | 1.41                      | 45.10           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -7.87           | -41.86          | -50.46                      |                           | 33.99           | T4       | -4.6, -9.7, 3.7 |
|                                                |                              |         |                          | 50            | 24 | z (Axial)       | 6.35            | -38.10          | -50.50                      | 1.23                      | 44.45           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -8.45           | -41.62          | -50.46                      |                           | 33.16           | T4       | -4.6, -9.7, 3.7 |
|                                                |                              |         |                          | 50            | 49 | z (Axial)       | 6.85            | -38.25          | -50.50                      | 1.06                      | 45.10           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.72           | -41.72          | -50.46                      |                           | 36.00           | T4       | -4.6, -9.7, 3.7 |
|                                                |                              |         |                          | 100           | 0  | z (Axial)       | 6.81            | -38.60          | -50.50                      | 0.55                      | 45.42           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -8.79           | -41.76          | -50.46                      |                           | 32.97           | T4       | -4.6, -9.7, 3.7 |
|                                                |                              |         | 26590<br>1905 MHz        | 100           | 0  | z (Axial)       | 7.30            | -38.54          | -50.50                      | 0.83                      | 45.84           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.37           | -41.93          | -50.46                      |                           | 36.56           | T4       | -4.6, -9.7, 3.7 |
| LTE Band 25 16QAM<br>EVS<br>Bit rate: 5.9 kbps | 20 MHz                       | UAT 1   | 26365<br>1882.5 MHz      | 100           | 0  | z (Axial)       | 4.14            | -38.15          | -50.50                      | 0.50                      | 42.28           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -6.96           | -41.50          | -50.46                      |                           | 34.54           | T4       | -4.6, -9.7, 3.7 |
| LTE Band 25 64QAM<br>EVS<br>Bit rate: 5.9 kbps | 20 MHz                       | UAT 1   | 26365<br>1882.5 MHz      | 100           | 0  | z (Axial)       | 6.35            | -38.64          | -50.50                      | 0.98                      | 44.98           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -7.69           | -41.47          | -50.46                      |                           | 33.78           | T4       | -4.6, -9.7, 3.7 |
| LTE Band 26 QPSK<br>EVS<br>Bit rate: 5.9 kbps  | 15 MHz                       | UAT 1   | 26865<br>831.5 MHz       | 75            | 0  | z (Axial)       | 2.11            | -38.44          | -50.50                      | 1.77                      | 40.55           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.92           | -42.01          | -50.46                      |                           | 36.09           | T4       | -4.6, -9.7, 3.7 |
| LTE Band 12 QPSK<br>EVS<br>Bit rate: 5.9 kbps  | 10 MHz                       | UAT 1   | 23095<br>707.5 MHz       | 50            | 0  | z (Axial)       | 6.40            | -38.62          | -50.50                      | 1.25                      | 45.02           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -7.17           | -41.89          | -50.46                      |                           | 34.72           | T4       | -4.6, -9.7, 3.7 |
| LTE Band 25 QPSK<br>EVS<br>Bit rate: 5.9 kbps  | 5 MHz                        | UAT 1   | 26365<br>1882.5 MHz      | 25            | 0  | z (Axial)       | 6.21            | -38.21          | -50.50                      | 1.09                      | 44.42           | T4       | -1.3, 2.9, 3.7  |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.03           | -42.00          | -50.46                      |                           | 36.97           | T4       | -4.6, -9.7, 3.7 |

**Note(s):**

For all subsequent tests for LTE-FDD, middle channel, QPSK modulation, and 100% RB size and low RB allocation was used in conjunction with the worst-case bit rate found in §9.1.2.

**VoLTE Air Interface Investigation (continued):**

| VoLTE Air Interface Investigation              |                              |         |                          |               |    |                 |                 |                 |                             |                           |                 |          |                 |
|------------------------------------------------|------------------------------|---------|--------------------------|---------------|----|-----------------|-----------------|-----------------|-----------------------------|---------------------------|-----------------|----------|-----------------|
| Mode:                                          | Bandwidth<br>(if applicable) | Antenna | Channel and<br>Frequency | RB Allocation |    | Orientation     | ABM1<br>dB(A/m) | ABM2<br>dB(A/m) | Ambient<br>Noise<br>dB(A/m) | Freq.<br>Response<br>(dB) | ABM SNR<br>(dB) | T-Rating | Location        |
| LTE Band 41 QPSK<br>EVS<br>Bit rate: 5.9 kbps  | 20 MHz                       | UAT 1   | 39750<br>2506 MHz        | 50            | 0  | z (Axial)       | 7.02            | -39.10          | -50.50                      | 1.35                      | 46.12           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -6.20           | -41.53          | -50.46                      |                           | 35.33           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         | 40185<br>2549.5 MHz      | 50            | 0  | z (Axial)       | 7.30            | -39.18          | -50.50                      | 1.37                      | 46.48           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -7.66           | -41.21          | -50.46                      |                           | 33.55           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         | 40620<br>2593 MHz        | 1             | 0  | z (Axial)       | 3.27            | -38.47          | -50.50                      | 0.76                      | 41.74           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.44           | -41.27          | -50.46                      |                           | 36.83           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         |                          | 1             | 49 | z (Axial)       | 8.44            | -18.59          | -50.50                      | 2.00                      | 45.75           | T4       | 0, 0, 3.7       |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.33           | -22.92          | -50.46                      |                           | 36.49           | T4       | -3.7, -8.8, 3.7 |
|                                                |                              |         |                          | 1             | 99 | z (Axial)       | 8.13            | -34.97          | -50.50                      | 0.80                      | 43.10           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.48           | -40.86          | -50.46                      |                           | 36.38           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         |                          | 50            | 0  | z (Axial)       | 7.57            | -38.45          | -50.50                      | 0.43                      | 46.02           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -9.04           | -41.00          | -50.46                      |                           | 31.96           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         |                          | 50            | 24 | z (Axial)       | 4.26            | -38.90          | -50.50                      | 1.58                      | 43.16           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -3.75           | -41.07          | -50.46                      |                           | 37.32           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         |                          | 50            | 49 | z (Axial)       | 6.30            | -36.10          | -50.50                      | 1.72                      | 42.40           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.58           | -41.27          | -50.46                      |                           | 36.69           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         |                          | 100           | 0  | z (Axial)       | 5.79            | -34.17          | -50.50                      | 1.47                      | 39.96           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.67           | -40.97          | -50.46                      |                           | 36.30           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         | 41055<br>2636.5 MHz      | 50            | 0  | z (Axial)       | 5.17            | -38.69          | -50.50                      | 1.96                      | 43.86           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.22           | -41.22          | -50.46                      |                           | 37.01           | T4       | -3.8, -9, 3.7   |
|                                                |                              |         | 41490<br>2680 MHz        | 50            | 0  | z (Axial)       | 8.91            | -39.02          | -50.50                      | 2.00                      | 47.93           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.97           | -39.86          | -50.46                      |                           | 34.89           | T4       | -3.8, -9, 3.7   |
| LTE Band 41 QPSK<br>EVS<br>Bit rate: 5.9 kbps  | 15 MHz                       | UAT 1   | 40620<br>2593 MHz        | 36            | 0  | z (Axial)       | 5.22            | -38.47          | -50.50                      | 1.50                      | 43.68           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -4.24           | -41.51          | -50.46                      |                           | 37.27           | T4       | -3.8, -9, 3.7   |
|                                                | 10 MHz                       | UAT 1   | 40620<br>2593 MHz        | 25            | 0  | z (Axial)       | 8.10            | -34.28          | -50.50                      | 0.96                      | 42.38           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -5.33           | -40.11          | -50.46                      |                           | 34.78           | T4       | -3.8, -9, 3.7   |
| LTE Band 41 16QAM<br>EVS<br>Bit rate: 5.9 kbps | 20 MHz                       | UAT 1   | 40620<br>2593 MHz        | 50            | 0  | z (Axial)       | 7.48            | -38.97          | -50.50                      | 1.10                      | 46.45           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -7.09           | -39.71          | -50.46                      |                           | 32.62           | T4       | -3.8, -9, 3.7   |
| LTE Band 41 64QAM<br>EVS<br>Bit rate: 5.9 kbps | 20 MHz                       | UAT 1   | 40620<br>2593 MHz        | 50            | 0  | z (Axial)       | 7.85            | -34.13          | -50.50                      | 1.46                      | 41.97           | T4       | 0, -0.1, 3.7    |
|                                                |                              |         |                          |               |    | y (Transversal) | -9.28           | -41.12          | -50.46                      |                           | 31.83           | T4       | -3.8, -9, 3.7   |

**Note(s):**

For all subsequent tests for LTE-TDD, middle channel, 64QAM modulation, and 50% RB size and low RB allocation was used in conjunction with the worst-case bit rate found in §9.1.2.

### 9.1.4. VoWi-Fi Codec Investigation

An investigation between the various codec configurations (Low/Mid/High bit rates for Narrowband, Wideband and EVS) and specific parameters are documented (ABM1, ABM2, S+N/N, frequency response) to determine the worst-case bit rates for each voice service type. The table below compares the varying codec configurations. A codec investigation was performed for each Wi-Fi 2.4GHz and 5GHz.

The highlighted results below were determined to be the worst-case codec configuration(s) for Wi-Fi 2.4GHz and 5GHz

| VoWi-Fi Codec Investigation |                 |        |        |                 |        |        |              |              |              |                 |                                           |
|-----------------------------|-----------------|--------|--------|-----------------|--------|--------|--------------|--------------|--------------|-----------------|-------------------------------------------|
| Codec State                 | AMR-NB (kbit/s) |        |        | AMR-WB (kbit/s) |        |        | EVS (kbit/s) |              |              | Orientation     | Band/Channel/<br>Bandwidth                |
|                             | 4.75            | 7.4    | 12.2   | 6.6             | 15.85  | 23.85  | 5.9          | 9.6          | 24.4         |                 |                                           |
| ABM1 (dB/m)                 | 5.10            | 4.76   | 4.82   | 4.11            | 4.66   | 4.78   | 2.69         | 3.34         | 3.41         | z (Axial)       | 802.11b<br>Ch. 6<br>DSSS 1 Mbps<br>UAT 1  |
| ABM2 (dBA/m)                | -43.61          | -25.54 | -42.30 | -26.60          | -42.41 | -41.96 | -29.19       | -42.63       | -42.60       |                 |                                           |
| SNR (dB)                    | 48.71           | 48.02  | 47.12  | 47.01           | 47.07  | 46.74  | 44.19        | 45.97        | 46.00        |                 |                                           |
| Freq. Resposne (dB)         | 1.82            | 2.00   | 2.00   | 1.30            | 2.00   | 2.00   | 2.00         | 2.00         | 2.00         |                 |                                           |
| ABM1 (dB/m)                 | -5.05           | -5.57  | -4.72  | -11.03          | -10.07 | -10.12 | -4.44        | -4.63        | -3.71        | y (Transversal) | 802.11a<br>Ch. 36<br>BPSK 6 Mbps<br>UAT 2 |
| ABM2 (dBA/m)                | -42.89          | -24.76 | -42.70 | -23.59          | -47.94 | -47.81 | -28.04       | -39.59       | -40.13       |                 |                                           |
| SNR (dB)                    | 37.84           | 37.25  | 37.98  | 36.68           | 37.87  | 37.69  | 38.56        | <b>34.96</b> | 36.43        |                 |                                           |
| ABM1 (dB/m)                 | 3.29            | 3.58   | 3.85   | 3.55            | 4.85   | 4.73   | 3.85         | 4.40         | 4.35         | z (Axial)       | 802.11a<br>Ch. 36<br>BPSK 6 Mbps<br>UAT 2 |
| ABM2 (dBA/m)                | -26.68          | -27.46 | -43.44 | -43.23          | -42.75 | -26.65 | -29.58       | -42.93       | -44.40       |                 |                                           |
| SNR (dB)                    | 48.38           | 48.27  | 47.30  | 46.78           | 47.60  | 47.59  | 47.15        | 47.33        | 48.75        |                 |                                           |
| Freq. Resposne (dB)         | 2.00            | 2.00   | 2.00   | 0.35            | 2.00   | 2.00   | 2.00         | 2.00         | 2.00         |                 |                                           |
| ABM1 (dB/m)                 | -5.04           | -4.94  | -4.36  | -5.62           | -4.69  | -5.08  | -6.62        | 5.70         | -6.56        | y (Transversal) | 802.11a<br>Ch. 36<br>BPSK 6 Mbps<br>UAT 2 |
| ABM2 (dBA/m)                | -28.01          | -27.63 | -45.32 | -45.44          | -45.67 | -27.08 | -30.30       | -46.05       | -45.91       |                 |                                           |
| SNR (dB)                    | 40.84           | 40.48  | 40.96  | 39.82           | 40.98  | 39.78  | 40.01        | 40.35        | <b>39.38</b> |                 |                                           |

#### Note(s):

1. For Wi-Fi 2.4 GHz, it is observed that 9.60 kbps is the worst-case.
2. For Wi-Fi 5 GHz, it is observed that 24.40 kbps is the worst-case.

### 9.1.5. VoWi-Fi Air Interface Investigation

| VoWi-Fi Air Interface Investigation           |                       |         |                  |           |                 |              |              |                       |                     |              |          |                  |
|-----------------------------------------------|-----------------------|---------|------------------|-----------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode                                          | Channel and Frequency | Antenna | Modulation/Index | Data Rate | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| 802.11b<br>EVS<br>Bit rate: 9.6 kbps          | 6<br>2437 MHz         | UAT 1   | CCK              | 5.5 Mbps  | z (Axial)       | 4.42         | -29.18       | -50.50                | 2.00                | 46.99        | T4       | -1.4, 3, 3.7     |
|                                               |                       |         |                  |           | y (Transversal) | -3.81        | -28.00       | -50.53                |                     | 40.35        | T4       | -3.3, -8.8, 3.7  |
|                                               |                       |         |                  | 11 Mbps   | z (Axial)       | 4.53         | -42.04       | -50.50                | 1.85                | 46.57        | T4       | -1.4, 3, 3.7     |
|                                               |                       |         |                  |           | y (Transversal) | -3.46        | -41.93       | -50.53                |                     | 38.48        | T4       | -3.3, -8.8, 3.7  |
| 802.11g<br>EVS<br>Bit rate: 9.6 kbps          | 6<br>2437 MHz         | UAT 1   | DSSS             | 1 Mbps    | z (Axial)       | 5.30         | -29.02       | -50.50                | 2.00                | 46.89        | T4       | -1.3, 1.8, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -3.92        | -26.22       | -50.53                |                     | 40.41        | T4       | -2.5, -10, 3.7   |
|                                               |                       |         | QPSK             | 12 Mbps   | z (Axial)       | 5.32         | -42.43       | -50.50                | 2.00                | 47.75        | T4       | -1.3, 1.8, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -3.87        | -44.80       | -50.53                |                     | 40.93        | T4       | -2.4, -10.1, 3.7 |
|                                               |                       |         | 64QAM            | 54 Mbps   | z (Axial)       | 4.42         | -42.55       | -50.50                | 1.98                | 46.97        | T4       | -1.3, 1.8, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -3.72        | -44.74       | -50.53                |                     | 41.03        | T4       | -2.4, -10.1, 3.7 |
| 802.11n<br>EVS<br>Bit rate: 9.6 kbps          | 6<br>2437 MHz         | UAT 1   | MCS0             | 6.5 Mbps  | z (Axial)       | 6.05         | -22.69       | -50.50                | 2.00                | 46.86        | T4       | -0.3, -0.8, 3.7  |
|                                               |                       |         |                  |           | y (Transversal) | -6.40        | -19.25       | -50.53                |                     | 39.81        | T4       | -5, -12.5, 3.7   |
|                                               |                       |         | MCS3             | 26 Mbps   | z (Axial)       | 5.85         | -40.10       | -50.50                | 1.94                | 45.96        | T4       | -0.3, -0.8, 3.7  |
|                                               |                       |         |                  |           | y (Transversal) | -6.09        | -40.11       | -50.53                |                     | 34.02        | T4       | -5, -12.5, 3.7   |
|                                               |                       |         | MCS7             | 65 Mbps   | z (Axial)       | 6.02         | -40.28       | -50.50                | 2.00                | 46.30        | T4       | -0.3, -0.8, 3.7  |
|                                               |                       |         |                  |           | y (Transversal) | -6.08        | -42.38       | -50.53                |                     | 36.31        | T4       | -5, -12.5, 3.7   |
| 802.11ac<br>EVS<br>Bit rate: 9.6 kbps         | 6<br>2437 MHz         | UAT 1   | MCS0             | 6.5 Mbps  | z (Axial)       | 5.89         | -28.70       | -50.50                | 2.00                | 46.48        | T4       | -0.1, -1.6, 3.7  |
|                                               |                       |         |                  |           | y (Transversal) | -4.24        | -28.30       | -50.53                |                     | 40.76        | T4       | -1.2, -11.3, 3.7 |
|                                               |                       |         | MCS4             | 39 Mbps   | z (Axial)       | 5.52         | -41.50       | -50.50                | 2.00                | 47.02        | T4       | -0.1, -1.6, 3.7  |
|                                               |                       |         |                  |           | y (Transversal) | -4.40        | -45.41       | -50.53                |                     | 41.00        | T4       | -1, -11.3, 3.7   |
|                                               |                       |         | MCS8             | 78 Mbps   | z (Axial)       | 5.70         | -41.74       | -50.50                | 1.87                | 47.44        | T4       | -0.1, -1.6, 3.7  |
|                                               |                       |         |                  |           | y (Transversal) | -4.28        | -45.30       | -50.53                |                     | 41.02        | T4       | -1, -11.3, 3.7   |
| 802.11ax<br>EVS<br>Bit rate: 9.6 kbps         | 6<br>2437 MHz         | UAT 1   | MCS0             | 7.3 Mbps  | z (Axial)       | 4.66         | -30.20       | -50.52                | 2.00                | 47.69        | T4       | -2.9, 1.2, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -3.34        | -29.26       | -50.49                |                     | 41.05        | T4       | -3.7, -9.2, 3.7  |
|                                               |                       |         | MCS5             | 58.5 Mbps | z (Axial)       | 3.85         | -42.43       | -50.52                | 1.79                | 46.28        | T4       | -2.9, 1.4, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -3.66        | -44.86       | -50.49                |                     | 41.20        | T4       | -3.8, -9, 3.7    |
|                                               |                       |         | MCS9             | 97.5 Mbps | z (Axial)       | 3.89         | -42.52       | -50.52                | 2.00                | 46.41        | T4       | -2.9, 1.4, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -3.61        | -45.07       | -50.49                |                     | 41.46        | T4       | -3.8, -9, 3.7    |
| 802.11a<br>EVS<br>Bit rate: 24.4 kbps         | 36<br>5180 MHz        | UAT 2   | QPSK             | 18 Mbps   | z (Axial)       | 5.76         | -31.33       | -50.50                | 2.00                | 47.78        | T4       | -0.3, 1.5, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -4.35        | -32.90       | -50.53                |                     | 42.59        | T4       | -4.2, -7.9, 3.7  |
|                                               |                       |         | 64QAM            | 54 Mbps   | z (Axial)       | 5.63         | -43.28       | -50.50                | 2.00                | 48.91        | T4       | -0.3, 1.5, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -4.11        | -46.07       | -50.53                |                     | 41.96        | T4       | -4.2, -7.8, 3.7  |
| 802.11n 20 MHz<br>EVS<br>Bit rate: 24.4 kbps  | 36<br>5180 MHz        | UAT 2   | MCS0             | 6.5 Mbps  | z (Axial)       | 6.00         | -30.17       | -50.50                | 2.00                | 47.21        | T4       | 0, 0, 3.7        |
|                                               |                       |         |                  |           | y (Transversal) | -4.79        | -29.83       | -50.53                |                     | 41.50        | T4       | -5, -8.8, 3.7    |
|                                               |                       |         | MCS3             | 26 Mbps   | z (Axial)       | 5.69         | -43.03       | -50.50                | 2.00                | 48.72        | T4       | 0, 0.1, 3.7      |
|                                               |                       |         |                  |           | y (Transversal) | -4.51        | -46.17       | -50.53                |                     | 41.66        | T4       | -4.8, -8.7, 3.7  |
|                                               |                       |         | MCS7             | 65 Mbps   | z (Axial)       | 4.97         | -42.52       | -50.50                | 2.00                | 47.49        | T4       | 0, 0.1, 3.7      |
|                                               |                       |         |                  |           | y (Transversal) | -4.34        | -46.48       | -50.53                |                     | 42.14        | T4       | -4.8, -8.7, 3.7  |
| 802.11n 40 MHz<br>EVS<br>Bit rate: 24.4 kbps  | 38<br>5190 MHz        | UAT 2   | MCS0             | 13.5 Mbps | z (Axial)       | 4.51         | -29.41       | -50.52                | 2.00                | 47.37        | T4       | -2.1, 2.1, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -4.91        | -27.16       | -50.50                |                     | 41.16        | T4       | -2.1, -11.7, 3.7 |
|                                               |                       |         | MCS3             | 54 Mbps   | z (Axial)       | 4.95         | -43.90       | -50.52                | 2.00                | 48.85        | T4       | -2.1, 2.1, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -4.73        | -45.62       | -50.50                |                     | 40.89        | T4       | -2.1, -11.7, 3.7 |
|                                               |                       |         | MCS7             | 135 Mbps  | z (Axial)       | 4.88         | -43.58       | -50.52                | 2.00                | 48.46        | T4       | -2.1, 2.1, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -4.53        | -45.66       | -50.50                |                     | 41.13        | T4       | -2.1, -11.7, 3.7 |
| 802.11ac 20 MHz<br>EVS<br>Bit rate: 24.4 kbps | 36<br>5180 MHz        | UAT 2   | MCS0             | 6.5 Mbps  | z (Axial)       | 5.05         | -29.21       | -50.52                | 2.00                | 47.13        | T4       | -1.7, 1.7, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -5.06        | -28.34       | -50.50                |                     | 40.98        | T4       | -2.1, -11.7, 3.7 |
|                                               |                       |         | MCS4             | 39 Mbps   | z (Axial)       | 4.35         | -43.09       | -50.52                | 2.00                | 47.43        | T4       | -1.8, 1.7, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -4.65        | -45.58       | -50.50                |                     | 40.93        | T4       | -2.2, -11.7, 3.7 |
|                                               |                       |         | MCS8             | 78 Mbps   | z (Axial)       | 5.17         | -43.37       | -50.52                | 2.00                | 48.54        | T4       | -1.8, 1.7, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -4.44        | -45.51       | -50.50                |                     | 41.07        | T4       | -2.2, -11.7, 3.7 |
| 802.11ac 40 MHz<br>EVS<br>Bit rate: 24.4 kbps | 38<br>5190 MHz        | ANT 4   | MCS0             | 13.5 Mbps | z (Axial)       | 4.69         | -30.50       | -50.52                | 2.00                | 47.69        | T4       | -0.8, 2.9, 3.7   |
|                                               |                       |         |                  |           | y (Transversal) | -6.00        | -30.34       | -50.50                |                     | 40.93        | T4       | -4.6, -11.7, 3.7 |
|                                               |                       |         | MCS5             | 108 Mbps  | z (Axial)       | 4.58         | -44.24       | -50.52                | 2.00                | 48.82        | T4       | -0.8, 3, 3.7     |
|                                               |                       |         |                  |           | y (Transversal) | -5.18        | -46.38       | -50.50                |                     | 41.20        | T4       | -4.3, -11.6, 3.7 |
|                                               |                       |         | MCS9             | 180 Mbps  | z (Axial)       | 4.09         | -44.38       | -50.52                | 2.00                | 48.47        | T4       | -0.8, 3, 3.7     |
|                                               |                       |         |                  |           | y (Transversal) | -5.92        | -46.60       | -50.50                |                     | 40.68        | T4       | -4.3, -11.6, 3.7 |

**VoWi-Fi Air Interface Investigation (continued):**

| VoWi-Fi Air Interface Investigation           |                       |         |                  |            |                 |              |              |                       |                     |              |          |                  |
|-----------------------------------------------|-----------------------|---------|------------------|------------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode:                                         | Channel and Frequency | Antenna | Modulation/Index | Data Rate  | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| 802.11ac 80 MHz<br>EVS<br>Bit rate: 24.4 kbps | 42<br>5210 MHz        | UAT 2   | MCS0             | 13.5 Mbps  | z (Axial)       | 6.11         | -30.44       | -50.52                | 2.00                | 47.54        | T4       | 0, -0.8, 3.7     |
|                                               |                       |         |                  |            | y (Transversal) | -3.41        | -32.92       | -50.50                |                     | 42.71        | T4       | -1.2, -8.8, 3.7  |
|                                               |                       |         | MCS5             | 108 Mbps   | z (Axial)       | 5.83         | -42.47       | -50.52                | 2.00                | 48.30        | T4       | -0.1, -0.6, 3.7  |
|                                               |                       |         |                  |            | y (Transversal) | -3.35        | -45.01       | -50.50                |                     | 41.66        | T4       | -1.5, -8.7, 3.7  |
|                                               |                       |         | MCS9             | 180 Mbps   | z (Axial)       | 5.75         | -41.95       | -50.52                | 2.00                | 47.69        | T4       | -0.1, -0.6, 3.7  |
|                                               |                       |         |                  |            | y (Transversal) | -3.42        | -45.35       | -50.50                |                     | 41.94        | T4       | -1.5, -8.7, 3.7  |
| 802.11ac 20 MHz<br>EVS<br>Bit rate: 24.4 kbps | 36<br>5180 MHz        | UAT 2   | MCS0             | 8.6 Mbps   | z (Axial)       | 3.54         | -29.59       | -50.52                | 2.00                | 46.67        | T4       | -2.1, 2.9, 3.7   |
|                                               |                       |         |                  |            | y (Transversal) | -3.70        | -28.48       | -50.50                |                     | 41.13        | T4       | -0.8, -10.8, 3.7 |
|                                               |                       |         | MCS5             | 58.5 Mbps  | z (Axial)       | 4.19         | -44.77       | -50.52                | 2.00                | 48.96        | T4       | -2, 3.1, 3.7     |
|                                               |                       |         |                  |            | y (Transversal) | -3.85        | -44.44       | -50.50                |                     | 40.59        | T4       | -0.8, -10.7, 3.7 |
|                                               |                       |         | MCS9             | 97.5 Mbps  | z (Axial)       | 4.00         | -44.57       | -50.52                | 2.00                | 48.57        | T4       | -2, 3.1, 3.7     |
|                                               |                       |         |                  |            | y (Transversal) | -4.51        | -43.99       | -50.50                |                     | 39.48        | T4       | -0.8, -10.7, 3.7 |
| 802.11ax 40 MHz<br>EVS<br>Bit rate: 24.4 kbps | 38<br>5190 MHz        | UAT 2   | MCS0             | 17.2 Mbps  | z (Axial)       | 4.94         | -30.06       | -50.52                | 2.00                | 47.85        | T4       | -0.4, 2.5, 3.7   |
|                                               |                       |         |                  |            | y (Transversal) | -3.98        | -21.96       | -50.50                |                     | 41.78        | T4       | -3.3, -9.2, 3.7  |
|                                               |                       |         | MCS5             | 117 Mbps   | z (Axial)       | 4.80         | -44.07       | -50.52                | 2.00                | 48.88        | T4       | -0.3, 2.3, 3.7   |
|                                               |                       |         |                  |            | y (Transversal) | -3.79        | -45.12       | -50.50                |                     | 41.33        | T4       | -3.4, -9.2, 3.7  |
|                                               |                       |         | MCS9             | 195 Mbps   | z (Axial)       | 4.78         | -43.89       | -50.52                | 2.00                | 48.67        | T4       | -0.3, 2.3, 3.7   |
|                                               |                       |         |                  |            | y (Transversal) | -3.94        | -45.25       | -50.50                |                     | 41.31        | T4       | -3.4, -9.2, 3.7  |
| 802.11ax 80 MHz<br>EVS<br>Bit rate: 24.4 kbps | 42<br>5210 MHz        | UAT 2   | MCS0             | 36 Mbps    | z (Axial)       | 4.76         | -30.25       | -50.52                | 2.00                | 47.77        | T4       | -0.8, 2.5, 3.7   |
|                                               |                       |         |                  |            | y (Transversal) | -3.62        | -30.73       | -50.50                |                     | 41.46        | T4       | -0.4, -10, 3.7   |
|                                               |                       |         | MCS5             | 245 Mbps   | z (Axial)       | 4.64         | -44.42       | -50.52                | 2.00                | 49.06        | T4       | -1, 2.6, 3.7     |
|                                               |                       |         |                  |            | y (Transversal) | -3.73        | -43.31       | -50.50                |                     | 39.58        | T4       | -0.4, -10.2, 3.7 |
|                                               |                       |         | MCS9             | 408.3 Mbps | z (Axial)       | 4.60         | -44.74       | -50.52                | 2.00                | 49.34        | T4       | -1, 2.6, 3.7     |
|                                               |                       |         |                  |            | y (Transversal) | -3.95        | -44.90       | -50.50                |                     | 40.95        | T4       | -0.4, -10.2, 3.7 |

**Note(s):**

- For all subsequent tests for 2.4 GHz, 802.11n MCS3 26 Mbps was used in conjunction with the worst-case bit rate found in §9.1.4.
- For all subsequent tests for 5 GHz, 802.11a BPSK 6 Mbps was used in conjunction with the worst-case bit rate found in §9.1.4.



## 9.2. OTT Application

An investigation was performed to determine the worst-case antenna per technology. All subsequent measurements were determined by this investigation.

### 9.2.1. Antenna Investigation

| Note(s) | Mode:                                | Channel and Frequency | Bandwidth (Data Rate) | Antenna | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating |
|---------|--------------------------------------|-----------------------|-----------------------|---------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|
| 1       | GSM 850<br>EGPRS 2 Slots<br>20 kbps  | 190<br>836.6 MHz      | N/A                   | LAT 1   | z (Axial)       | 1.77         | -21.81       | -50.24                | 2.00                | 44.36        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -6.91        | -18.82       | -50.25                |                     | 35.85        | T4       |
|         |                                      |                       |                       | UAT 1   | z (Axial)       | 2.10         | -42.09       | -50.24                | 2.00                | 44.19        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -6.38        | -41.36       | -50.25                |                     | 34.98        | T4       |
| 2       | W-CDMA BII<br>HSPA<br>kbps           | 9400<br>1880 MHz      | N/A                   | LAT 1   | z (Axial)       | 1.47         | -22.24       | -50.57                | 2.00                | 47.16        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -6.81        | -22.54       | -50.53                |                     | 34.82        | T4       |
|         |                                      |                       |                       | UAT 1   | z (Axial)       | 1.86         | -45.55       | -50.57                | 2.00                | 47.41        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -6.47        | -40.38       | -50.53                |                     | 33.91        | T4       |
| 3       | CDMA2000 BC0<br>Ev-Do Rev. 0<br>kbps | 384<br>836.52 MHz     | N/A                   | LAT 1   | z (Axial)       | 1.48         | -25.90       | -50.52                | 2.00                | 49.17        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -6.59        | -27.13       | -50.51                |                     | 38.04        | T4       |
|         |                                      |                       |                       | UAT 1   | z (Axial)       | 1.78         | -47.52       | -50.52                | 2.00                | 49.30        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -6.19        | -43.77       | -50.51                |                     | 37.58        | T4       |
| 3a      | CDMA2000 BC0<br>Ev-Do Rev. A<br>kbps | 384<br>836.52 MHz     | N/A                   | LAT 1   | z (Axial)       | 2.78         | -26.58       | -50.52                | 2.00                | 47.82        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -7.01        | -25.96       | -50.51                |                     | 37.33        | T4       |
|         |                                      |                       |                       | UAT 1   | z (Axial)       | 2.77         | -46.08       | -50.52                | 2.00                | 48.85        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -6.91        | -44.29       | -50.51                |                     | 37.38        | T4       |
| 4       | LTE Band 25 QPSK<br>1/49 RB<br>kbps  | 26365<br>1882.5 MHz   | 20 MHz                | LAT 1   | z (Axial)       | 5.41         | -23.83       | -50.88                | 2.00                | 48.61        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -7.53        | -26.27       | -50.83                |                     | 35.82        | T4       |
|         |                                      |                       |                       | UAT 1   | z (Axial)       | 5.41         | -42.44       | -50.88                | 2.00                | 47.86        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -7.22        | -43.00       | -50.83                |                     | 35.78        | T4       |
| 5       | LTE Band 41 QPSK<br>1/49 RB<br>kbps  | 40620<br>2593 MHz     | 20 MHz                | LAT 1   | z (Axial)       | 5.44         | -23.25       | -50.88                | 2.00                | 47.35        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -7.35        | -24.67       | -50.83                |                     | 35.24        | T4       |
|         |                                      |                       |                       | UAT 1   | z (Axial)       | 5.37         | -37.94       | -50.88                | 2.00                | 43.30        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -7.03        | -41.66       | -50.83                |                     | 34.63        | T4       |
| 5a      | LTE Band 48 QPSK<br>1/49 RB<br>kbps  | 55990<br>3625 MHz     | 20 MHz                | LAT 1   | z (Axial)       | 4.50         | -20.58       | -50.88                | 2.00                | 43.75        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -7.79        | -23.64       | -50.83                |                     | 35.20        | T4       |
|         |                                      |                       |                       | UAT 2   | z (Axial)       | 4.32         | -39.03       | -50.88                | 2.00                | 43.35        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -7.56        | -42.42       | -50.83                |                     | 34.85        | T4       |
| 6       | 802.11b<br>kbps                      | 6<br>2437 MHz         | 20 MHz<br>(1 Mbps)    | LAT 3   | z (Axial)       | 0.04         | -25.12       | -50.52                | 2.00                | 45.11        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -11.42       | -23.46       | -50.53                |                     | 32.60        | T4       |
|         |                                      |                       |                       | UAT 1   | z (Axial)       | -0.10        | -44.87       | -50.52                | 2.00                | 44.78        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -10.78       | -43.27       | -50.53                |                     | 32.49        | T4       |
| 7       | 802.11a<br>kbps                      | 36<br>5180 MHz        | 20 MHz<br>(6 Mbps)    | LAT 3   | z (Axial)       | -0.19        | -28.69       | -50.52                | 2.00                | 46.25        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -9.53        | -28.01       | -50.53                |                     | 36.17        | T4       |
|         |                                      |                       |                       | UAT 2   | z (Axial)       | -0.40        | -24.72       | -50.52                | 2.00                | 45.72        | T4       |
|         |                                      |                       |                       |         | y (Transversal) | -10.68       | -25.77       | -50.53                |                     | 33.64        | T4       |

#### Note(s):

1. UAT 1 has been determined to be the worst-case antenna for EDGE (GSM).
2. UAT 1 has been determined to be the worst-case antenna for HSPA (W-CDMA).
3. UAT 1 has been determined to be the worst-case antenna for Ev-Do Rel. 0 (CDMA).
  - a. LAT 1 has been determined to be the worst-case antenna for Ev-Do Rev. A (CDMA).
4. UAT 1 has been determined to be the worst-case antenna for LTE-FDD.
5. UAT 1 has been determined to be the worst-case antenna for LTE-TDD.
  - a. UAT 2 has been determined to be the worst-case antenna for LTE-TDD (Band 48 only).
6. UAT 1 has been determined to be the worst-case antenna for Wi-Fi 2.4 GHz.
7. UAT 2 has been determined to be the worst-case antenna for Wi-Fi 5 GHz.

### 9.2.2. Codec Investigation

The OTT Application did not support a means for the test lab to change the codec's bit rates. When a VoIP call was established, the test lab recorded the bit rate used during that session, listed below, for the supported technologies: EDGE, HSPA, Ev-Do Rel. 0 and Rev. A, Wi-Fi 2.4 GHz, and Wi-Fi 5 GHz

| Codec Bit Rate<br>(kbps) |                |    |
|--------------------------|----------------|----|
| GSM                      | EDGE           | 20 |
| W-CDMA                   | HSPA           | 32 |
| CDMA                     | Rel. 0         | 28 |
|                          | Rev. A         | 28 |
| LTE                      | FDD            | 28 |
|                          | TDD            | 28 |
| Wi-Fi<br>2.4 GHz         | 802.11b        | 48 |
|                          | 802.11g        | 48 |
|                          | 802.11n        | 48 |
|                          | 802.11ax       | 48 |
| Wi-Fi<br>5 GHz           | 802.11a        | 48 |
|                          | 802.11n HT20   | 48 |
|                          | 802.11n HT40   | 48 |
|                          | 802.11ac VHT20 | 48 |
|                          | 802.11ac VHT40 | 48 |
|                          | 802.11ac VHT80 | 48 |
|                          | 802.11ax HE20  | 48 |
|                          | 802.11ax HE40  | 48 |
|                          | 802.11ax HE80  | 48 |

### 9.2.3. Air Interface Investigation

A limited set of bands/channels/bandwidths were then tested to confirm that there is no effect to the T-rating when changing the band/channel/bandwidth.

#### GSM Air Interface Investigation:

| GSM Air Interface Investigation     |                       |                           |                 |              |              |                       |                     |              |          |                  |
|-------------------------------------|-----------------------|---------------------------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode:                               | Channel and Frequency | Bandwidth (if applicable) | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| GSM 850<br>EGPRS 2 Slots<br>20 kbps | 128<br>824.2 MHz      | N/A                       | z (Axial)       | 2.05         | -42.02       | -50.24                | 2.00                | 44.08        | T4       | -3, 2.9, 3.7     |
|                                     |                       |                           | y (Transversal) | -6.28        | -42.81       | -50.25                |                     | 36.53        | T4       | -4.2, -11.3, 3.7 |
|                                     | 190<br>836.6 MHz      | N/A                       | z (Axial)       | 2.10         | -42.09       | -50.24                | 2.00                | 44.19        | T4       | -3, 2.9, 3.7     |
|                                     |                       |                           | y (Transversal) | -6.38        | -41.36       | -50.25                |                     | 34.98        | T4       | -4.2, -11.3, 3.7 |
|                                     | 251<br>848.8 MHz      | N/A                       | z (Axial)       | 2.03         | -41.27       | -50.24                | 2.00                | 43.30        | T4       | -3, 2.9, 3.7     |
|                                     |                       |                           | y (Transversal) | -6.27        | -40.73       | -50.25                |                     | <b>34.46</b> | T4       | -4.2, -11.3, 3.7 |

#### W-CDMA Air Interface Investigation:

| W-CDMA Air Interface Investigation |                       |         |                           |                 |              |              |                       |                     |              |          |                  |
|------------------------------------|-----------------------|---------|---------------------------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode:                              | Channel and Frequency | Antenna | Bandwidth (if applicable) | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| W-CDMA BII<br>HSPA<br>32 kbps      | 9262<br>1852.4 MHz    | UAT 1   | N/A                       | z (Axial)       | 1.56         | -46.29       | -50.57                | 2.00                | 47.85        | T4       | -4, 1, 3.7       |
|                                    |                       |         |                           | y (Transversal) | -6.48        | -41.47       | -50.53                |                     | 34.99        | T4       | -4.6, -9.5, 3.7  |
|                                    | 9400<br>1880.0 MHz    | UAT 1   | N/A                       | z (Axial)       | 1.86         | -45.55       | -50.57                | 2.00                | 47.41        | T4       | -4, 1, 3.7       |
|                                    |                       |         |                           | y (Transversal) | -6.47        | -40.38       | -50.53                |                     | 33.91        | T4       | -4.6, -9.5, 3.7  |
|                                    | 9538<br>1907.6 MHz    | UAT 1   | N/A                       | z (Axial)       | 1.84         | -46.12       | -50.57                | 2.00                | 47.96        | T4       | -4, 1, 3.7       |
|                                    |                       |         |                           | y (Transversal) | -6.44        | -41.83       | -50.53                |                     | 35.39        | T4       | -4.6, -9.5, 3.7  |
| W-CDMA BII<br>HSPA<br>32 kbps      | 4132<br>826.4 MHz     | UAT 1   | N/A                       | z (Axial)       | 2.55         | -45.77       | -50.90                | 2.00                | 48.32        | T4       | -0.3, 0.3, 3.7   |
|                                    |                       |         |                           | y (Transversal) | -7.44        | -43.38       | -50.92                |                     | 35.94        | T4       | -4.2, -12.5, 3.7 |
|                                    | 4183<br>836.6 MHz     | UAT 1   | N/A                       | z (Axial)       | 2.71         | -21.04       | -50.90                | 2.00                | 47.68        | T4       | -0.4, 0.4, 3.7   |
|                                    |                       |         |                           | y (Transversal) | -7.09        | -23.47       | -50.92                |                     | 35.73        | T4       | -4.2, -10.8, 3.7 |
|                                    | 4233<br>846.6 MHz     | UAT 1   | N/A                       | z (Axial)       | 2.25         | -45.92       | -50.90                | 2.00                | 48.17        | T4       | -0.3, 0.3, 3.7   |
|                                    |                       |         |                           | y (Transversal) | -7.46        | -42.72       | -50.92                |                     | 35.26        | T4       | -4.2, -12.5, 3.7 |
| W-CDMA BII<br>HSPA<br>32 kbps      | 1312<br>1712.4 MHz    | UAT 1   | N/A                       | z (Axial)       | 2.61         | -45.34       | -50.90                | 2.00                | 47.95        | T4       | -1.2, -0.5, 3.7  |
|                                    |                       |         |                           | y (Transversal) | -7.45        | -42.92       | -50.92                |                     | 35.48        | T4       | -4.2, -12.5, 3.7 |
|                                    | 1413<br>1732.6 MHz    | UAT 1   | N/A                       | z (Axial)       | 2.55         | -23.09       | -50.90                | 2.00                | 48.43        | T4       | -1.2, -0.4, 3.7  |
|                                    |                       |         |                           | y (Transversal) | -7.31        | -23.40       | -50.92                |                     | 35.70        | T4       | -4.2, -11.3, 3.7 |
|                                    | 1513<br>1752.6 MHz    | UAT 1   | N/A                       | z (Axial)       | 2.57         | -45.61       | -50.90                | 2.00                | 48.17        | T4       | -1.2, -0.5, 3.7  |
|                                    |                       |         |                           | y (Transversal) | -7.50        | -42.89       | -50.92                |                     | 35.39        | T4       | -4.2, -12.5, 3.7 |

#### CDMA Air Interface Investigation:

| CDMA Air Interface Investigation    |                       |         |                           |                 |              |              |                       |                     |              |          |                  |
|-------------------------------------|-----------------------|---------|---------------------------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode:                               | Channel and Frequency | Antenna | Bandwidth (if applicable) | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| CDMA BC0<br>Ev-Do Rel. 0<br>28 kbps | 1013<br>824.7 MHz     | LAT 1   | N/A                       | z (Axial)       | 3.02         | -26.04       | -50.52                | 2.00                | 49.22        | T4       | -0.4, 0, 3.7     |
|                                     |                       |         |                           | y (Transversal) | -6.69        | -25.75       | -50.51                |                     | 37.70        | T4       | -3.9, -9.8, 3.7  |
|                                     | 384<br>836.52 MHz     | LAT 1   | N/A                       | z (Axial)       | 1.48         | -25.90       | -50.52                | 2.00                | 49.17        | T4       | -4.2, 0.4, 3.7   |
|                                     |                       |         |                           | y (Transversal) | -6.59        | -27.13       | -50.51                |                     | 38.04        | T4       | -4.2, -9.2, 3.7  |
|                                     | 777<br>848.31 MHz     | LAT 1   | N/A                       | z (Axial)       | 2.84         | -44.00       | -50.52                | 2.00                | 46.84        | T4       | -0.4, 0.1, 3.7   |
|                                     |                       |         |                           | y (Transversal) | -7.94        | -43.87       | -50.51                |                     | 35.93        | T4       | -3.9, -9.8, 3.7  |
| CDMA BC0<br>Ev-Do Rev. A<br>28 kbps | 777<br>848.31 MHz     | LAT 1   | N/A                       | z (Axial)       | 3.10         | -27.39       | -50.52                | 2.00                | 49.29        | T4       | -0.4, 0, 3.7     |
|                                     |                       |         |                           | y (Transversal) | -7.17        | -27.43       | -50.51                |                     | 38.41        | T4       | -3.7, -10.8, 3.7 |

**LTE Air Interface Investigation:**

| LTE Air Interface Investigation |                              |         |                          |               |        |                 |                 |                 |                             |                           |                 |          |                 |
|---------------------------------|------------------------------|---------|--------------------------|---------------|--------|-----------------|-----------------|-----------------|-----------------------------|---------------------------|-----------------|----------|-----------------|
| Mode:                           | Bandwidth<br>(if applicable) | Antenna | Channel and<br>Frequency | RB Allocation |        | Orientation     | ABM1<br>dB(A/m) | ABM2<br>dB(A/m) | Ambient<br>Noise<br>dB(A/m) | Freq.<br>Response<br>(dB) | ABM SNR<br>(dB) | T-Rating | Location        |
| LTE Band 25 QPSK<br>28 kbps     | 20 MHz                       | UAT 1   | 26140<br>1860 MHz        | 50            | 24     | z (Axial)       | 5.12            | -39.55          | -50.88                      | 2.00                      | 44.67           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.29           | -42.68          | -50.83                      |                           | 35.39           | T4       | -3.6, -9.3, 3.7 |
|                                 |                              |         | 26365<br>1882.5 MHz      | 1             | 0      | z (Axial)       | 5.26            | -39.13          | -50.88                      | 2.00                      | 44.38           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.27           | -42.47          | -50.83                      |                           | 35.20           | T4       | -3.6, -9.3, 3.7 |
|                                 |                              |         |                          | 1             | 49     | z (Axial)       | 5.41            | -42.44          | -50.88                      | 2.00                      | 47.86           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.22           | -43.00          | -50.83                      |                           | 35.78           | T4       | -3.6, -9.3, 3.7 |
|                                 |                              |         |                          | 1             | 99     | z (Axial)       | 5.21            | -39.44          | -50.88                      | 2.00                      | 44.65           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.27           | -42.61          | -50.83                      |                           | 35.33           | T4       | -3.6, -9.3, 3.7 |
|                                 |                              |         |                          | 50            | 0      | z (Axial)       | 5.18            | -39.22          | -50.88                      | 2.00                      | 44.41           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.26           | -42.95          | -50.83                      |                           | 35.68           | T4       | -3.6, -9.3, 3.7 |
|                                 |                              |         |                          | 50            | 24     | z (Axial)       | 5.22            | -39.25          | -50.88                      | 2.00                      | 44.47           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.35           | -42.45          | -50.83                      |                           | 35.10           | T4       | -3.6, -9.3, 3.7 |
|                                 |                              |         |                          | 50            | 49     | z (Axial)       | 5.08            | -38.95          | -50.88                      | 2.00                      | 44.04           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.31           | -42.68          | -50.83                      |                           | 35.37           | T4       | -3.6, -9.3, 3.7 |
|                                 |                              |         |                          | 100           | 0      | z (Axial)       | 5.19            | -39.28          | -50.88                      | 2.00                      | 44.48           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.25           | -42.39          | -50.83                      |                           | 35.14           | T4       | -3.6, -9.3, 3.7 |
| 26590<br>1905 MHz               | 50                           | 24      | z (Axial)                | 5.16          | -38.46 | -50.88          | 2.00            | 43.62           | T4                          | 0.1, 0, 3.7               |                 |          |                 |
|                                 |                              |         | y (Transversal)          | -7.28         | -41.09 | -50.83          |                 | 33.81           | T4                          | -3.6, -9.3, 3.7           |                 |          |                 |
| LTE Band 25 16QAM<br>28 kbps    | 20 MHz                       | UAT 1   | 26590<br>1905 MHz        | 50            | 24     | z (Axial)       | 5.23            | -39.44          | -50.88                      | 2.00                      | 44.66           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.32           | -42.28          | -50.83                      |                           | 34.96           | T4       | -3.6, -9.3, 3.7 |
| LTE Band 25 64QAM<br>28 kbps    | 20 MHz                       | UAT 1   | 26590<br>1905 MHz        | 50            | 24     | z (Axial)       | 5.19            | -39.61          | -50.88                      | 2.00                      | 44.80           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.30           | -42.65          | -50.83                      |                           | 35.35           | T4       | -3.6, -9.3, 3.7 |
| LTE Band 26 QPSK<br>28 kbps     | 15 MHz                       | UAT 1   | 26965<br>841.5 MHz       | 36            | 20     | z (Axial)       | 5.22            | -39.24          | -50.88                      | 2.00                      | 44.46           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.28           | -43.42          | -50.83                      |                           | 36.14           | T4       | -3.6, -9.3, 3.7 |
| LTE Band 12 QPSK<br>28 kbps     | 10 MHz                       | UAT 1   | 23130<br>711 MHz         | 25            | 12     | z (Axial)       | 5.22            | -38.92          | -50.88                      | 2.00                      | 44.14           | T4       | 0.1, 0, 3.7     |
|                                 |                              |         |                          |               |        | y (Transversal) | -7.25           | -43.25          | -50.83                      |                           | 36.01           | T4       | -3.6, -9.3, 3.7 |

**Note(s):**

For all subsequent tests for LTE-FDD, high channel, QPSK modulation, and 50% RB size and middle RB allocation was used in conjunction with the worst-case bit rate found in §9.2.2.

**LTE Air Interface Investigation (continued):**

| LTE Air Interface Investigation |                              |         |                          |               |    |                 |                 |                 |                             |                           |                 |          |                 |
|---------------------------------|------------------------------|---------|--------------------------|---------------|----|-----------------|-----------------|-----------------|-----------------------------|---------------------------|-----------------|----------|-----------------|
| Mode:                           | Bandwidth<br>(if applicable) | Antenna | Channel and<br>Frequency | RB Allocation |    | Orientation     | ABM1<br>dB(A/m) | ABM2<br>dB(A/m) | Ambient<br>Noise<br>dB(A/m) | Freq.<br>Response<br>(dB) | ABM SNR<br>(dB) | T-Rating | Location        |
| LTE Band 41 QPSK<br>28 kbps     | 20 MHz                       | UAT 1   | 39750<br>2506 MHz        | 1             | 49 | z (Axial)       | 5.33            | -38.37          | -50.88                      | 2.00                      | 43.70           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.06           | -41.71          | -50.83                      |                           | 34.65           | T4       | -3.8, -8.7, 3.7 |
|                                 |                              |         | 40185<br>2549.5 MHz      | 1             | 49 | z (Axial)       | 5.28            | -38.24          | -50.88                      | 2.00                      | 43.52           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.08           | -41.94          | -50.83                      |                           | 34.87           | T4       | -3.8, -8.7, 3.7 |
|                                 |                              |         | 40620<br>2593 MHz        | 1             | 0  | z (Axial)       | 5.33            | -38.00          | -50.88                      | 2.00                      | 43.32           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.08           | -41.73          | -50.83                      |                           | 34.65           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         |                          | 1             | 49 | z (Axial)       | 5.37            | -37.94          | -50.88                      | 2.00                      | 43.30           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.03           | -41.66          | -50.83                      |                           | 34.63           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         |                          | 1             | 99 | z (Axial)       | 5.36            | -37.88          | -50.88                      | 2.00                      | 43.24           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.11           | -41.85          | -50.83                      |                           | 34.74           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         |                          | 50            | 0  | z (Axial)       | 5.33            | -38.01          | -50.88                      | 2.00                      | 43.34           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.05           | -41.85          | -50.83                      |                           | 34.80           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         |                          | 50            | 24 | z (Axial)       | 5.37            | -38.13          | -50.88                      | 2.00                      | 43.50           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.00           | -41.97          | -50.83                      |                           | 34.97           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         |                          | 50            | 49 | z (Axial)       | 5.34            | -38.04          | -50.88                      | 2.00                      | 43.38           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.03           | -42.22          | -50.83                      |                           | 35.19           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         |                          | 100           | 0  | z (Axial)       | 5.25            | -38.10          | -50.88                      | 2.00                      | 43.36           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.07           | -41.75          | -50.83                      |                           | 34.68           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         | 41055<br>2636.5 MHz      | 1             | 49 | z (Axial)       | 5.27            | -38.12          | -50.88                      | 2.00                      | 43.39           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.08           | -41.67          | -50.83                      |                           | 34.59           | T4       | -3.7, -8.7, 3.7 |
|                                 |                              |         | 41490<br>2680 MHz        | 1             | 49 | z (Axial)       | 5.23            | -37.96          | -50.88                      | 2.00                      | 43.19           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.13           | -41.85          | -50.83                      |                           | 34.72           | T4       | -3.8, -8.7, 3.7 |
| LTE Band 41 QPSK<br>28 kbps     | 15 MHz                       | UAT 1   | 41055<br>2636.5 MHz      | 1             | 37 | z (Axial)       | 5.27            | -38.15          | -50.88                      | 2.00                      | 43.42           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.10           | -42.08          | -50.83                      |                           | 34.98           | T4       | -3.7, -8.7, 3.7 |
|                                 | 10 MHz                       | UAT 1   | 41055<br>2636.5 MHz      | 1             | 25 | z (Axial)       | 5.20            | -38.22          | -50.88                      | 2.00                      | 43.43           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.11           | -42.32          | -50.83                      |                           | 35.21           | T4       | -3.7, -8.7, 3.7 |
| LTE Band 41 16QAM<br>28 kbps    | 20 MHz                       | UAT 1   | 41055<br>2636.5 MHz      | 1             | 49 | z (Axial)       | 5.25            | -38.07          | -50.88                      | 2.00                      | 43.32           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.10           | -41.78          | -50.83                      |                           | 34.68           | T4       | -3.7, -8.7, 3.7 |
| LTE Band 41 64QAM<br>28 kbps    | 20 MHz                       | UAT 1   | 41055<br>2636.5 MHz      | 1             | 49 | z (Axial)       | 5.29            | -38.22          | -50.88                      | 2.00                      | 43.51           | T4       | 0, 0, 3.7       |
|                                 |                              |         |                          |               |    | y (Transversal) | -7.10           | -41.73          | -50.83                      |                           | 34.63           | T4       | -3.8, -8.7, 3.7 |

**Note(s):**

For all subsequent tests for LTE-TDD, middle high channel, QPSK modulation, and 1% RB size and middle RB allocation was used in conjunction with the worst-case bit rate found in §9.2.2.

## Wi-Fi Air Interface Investigation:

| Wi-Fi Air Interface Investigation |                       |         |                  |           |                 |              |              |                       |                     |              |          |                  |
|-----------------------------------|-----------------------|---------|------------------|-----------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode:                             | Channel and Frequency | Antenna | Modulation/Index | Data Rate | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| 802.11b<br>48 kbps                | 6<br>2437 MHz         | LAT 3   | CKK              | 5.5 Mbps  | z (Axial)       | 4.82         | -23.99       | -50.93                | 2.00                | 48.30        | T4       | 0, -0.4, 3.7     |
|                                   |                       |         |                  |           | y (Transversal) | -12.04       | -22.21       | -50.86                |                     | 35.28        | T4       | -0.4, -17.5, 3.7 |
|                                   |                       |         |                  | 11 Mbps   | z (Axial)       | 3.39         | -44.62       | -50.93                | 2.00                | 48.00        | T4       | 0, -0.6, 3.7     |
|                                   |                       |         |                  |           | y (Transversal) | -11.23       | -46.58       | -50.86                |                     | 35.35        | T4       | -0.4, -17.5, 3.7 |
| 802.11g<br>48 kbps                | 6<br>2437 MHz         | LAT 3   | DSSS             | 1 Mbps    | z (Axial)       | 3.51         | -23.98       | -50.93                | 2.00                | 47.29        | T4       | 0, -0.8, 3.7     |
|                                   |                       |         |                  |           | y (Transversal) | -12.47       | -23.34       | -50.86                |                     | 35.06        | T4       | -0.8, -18.8, 3.7 |
|                                   |                       |         | QPSK             | 12 Mbps   | z (Axial)       | 4.75         | -44.03       | -50.93                | 2.00                | 48.78        | T4       | -0.2, -0.7, 3.7  |
|                                   |                       |         |                  |           | y (Transversal) | -13.35       | -48.52       | -50.86                |                     | 35.17        | T4       | -0.9, -18.8, 3.7 |
|                                   |                       |         | 64QAM            | 54 Mbps   | z (Axial)       | 4.91         | -44.08       | -50.93                | 2.00                | 49.00        | T4       | -0.2, -0.7, 3.7  |
|                                   |                       |         |                  |           | y (Transversal) | -13.48       | -48.66       | -50.86                |                     | 35.18        | T4       | -0.9, -18.8, 3.7 |
| 802.11n<br>48 kbps                | 6<br>2437 MHz         | LAT 3   | MCS0             | 6.5 Mbps  | z (Axial)       | 3.97         | -19.72       | -50.93                | 2.00                | 44.84        | T4       | 3.3, 0, 3.7      |
|                                   |                       |         |                  |           | y (Transversal) | -15.24       | -17.82       | -50.86                |                     | 33.56        | T4       | -1.2, -20.4, 3.7 |
|                                   |                       |         | MCS3             | 26 Mbps   | z (Axial)       | 3.52         | -42.88       | -50.93                | 2.00                | 46.40        | T4       | 3.2, -0.2, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -15.07       | -48.96       | -50.86                |                     | 33.88        | T4       | -1.2, -20.4, 3.7 |
|                                   |                       |         | MCS7             | 65 Mbps   | z (Axial)       | 3.52         | -42.88       | -50.93                | 2.00                | 46.40        | T4       | 3.2, -0.2, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -15.07       | -48.96       | -50.86                |                     | 33.88        | T4       | -1.2, -20.4, 3.7 |
| 802.11ac<br>48 kbps               | 6<br>2437 MHz         | LAT 3   | MCS0             | 6.5 Mbps  | z (Axial)       | 5.40         | -22.12       | -50.93                | 2.00                | 47.69        | T4       | 0.4, -0.4, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -10.68       | -25.46       | -50.86                |                     | 35.39        | T4       | -0.4, -15, 3.7   |
|                                   |                       |         | MCS4             | 39 Mbps   | z (Axial)       | 5.14         | -42.51       | -50.93                | 2.00                | 47.65        | T4       | 0.2, -0.5, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -10.75       | -46.26       | -50.86                |                     | 35.51        | T4       | -0.6, -15, 3.7   |
|                                   |                       |         | MCS8             | 78 Mbps   | z (Axial)       | 5.15         | -42.76       | -50.93                | 2.00                | 47.91        | T4       | 0.2, -0.5, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -10.65       | -45.89       | -50.86                |                     | 35.24        | T4       | -0.6, -15, 3.7   |
| 802.11ax<br>48 kbps               | 6<br>2437 MHz         | LAT 3   | MCS0             | 7.3 Mbps  | z (Axial)       | 5.47         | -26.41       | -50.83                | 2.00                | 49.67        | T4       | 0, 0, 3.7        |
|                                   |                       |         |                  |           | y (Transversal) | -6.74        | -27.19       | -50.81                |                     | 35.62        | T4       | -2.5, -8.8, 3.7  |
|                                   |                       |         | MCS5             | 58.5 Mbps | z (Axial)       | 5.52         | -42.82       | -50.83                | 2.00                | 48.34        | T4       | -0.1, 0, 3.7     |
|                                   |                       |         |                  |           | y (Transversal) | -6.40        | -39.94       | -50.81                |                     | 33.54        | T4       | -2.4, -8.9, 3.7  |
|                                   |                       |         | MCS9             | 97.5 Mbps | z (Axial)       | 5.52         | -42.47       | -50.83                | 2.00                | 47.99        | T4       | -0.1, 0, 3.7     |
|                                   |                       |         |                  |           | y (Transversal) | -6.39        | -42.33       | -50.81                |                     | 35.93        | T4       | -2.4, -8.9, 3.7  |
| 802.11a<br>48 kbps                | 36<br>5180 MHz        | UAT 2   | QPSK             | 18 Mbps   | z (Axial)       | 5.33         | -22.42       | -50.93                | 2.00                | 52.88        | T4       | 1.3, 0, 3.7      |
|                                   |                       |         |                  |           | y (Transversal) | -7.82        | -24.82       | -50.86                |                     | 38.60        | T4       | -4.2, -8.8, 3.7  |
|                                   |                       |         | 64QAM            | 54 Mbps   | z (Axial)       | 5.21         | -46.67       | -50.93                | 2.00                | 51.88        | T4       | 1.1, 0, 3.7      |
|                                   |                       |         |                  |           | y (Transversal) | -7.49        | -45.54       | -50.86                |                     | 38.05        | T4       | -4.1, -8.8, 3.7  |
| 802.11n 20 MHz<br>48 kbps         | 36<br>5180 MHz        | UAT 2   | MCS0             | 6.5 Mbps  | z (Axial)       | 5.11         | -21.58       | -50.93                | 2.00                | 50.59        | T4       | 1.7, 0, 3.7      |
|                                   |                       |         |                  |           | y (Transversal) | -9.92        | -24.40       | -50.86                |                     | 36.45        | T4       | -4.2, -12.5, 3.7 |
|                                   |                       |         | MCS3             | 26 Mbps   | z (Axial)       | 4.99         | -44.80       | -50.93                | 2.00                | 49.79        | T4       | 1.7, 0, 3.7      |
|                                   |                       |         |                  |           | y (Transversal) | -9.20        | -46.71       | -50.86                |                     | 37.51        | T4       | -4.3, -12.3, 3.7 |
|                                   |                       |         | MCS7             | 65 Mbps   | z (Axial)       | 5.00         | -44.42       | -50.93                | 2.00                | 49.42        | T4       | 1.7, 0, 3.7      |
|                                   |                       |         |                  |           | y (Transversal) | -9.20        | -46.13       | -50.86                |                     | 36.93        | T4       | -4.3, -12.3, 3.7 |
| 802.11n 40 MHz<br>48 kbps         | 38<br>5190 MHz        | UAT 2   | MCS0             | 13.5 Mbps | z (Axial)       | 5.35         | -21.29       | -50.93                | 2.00                | 48.49        | T4       | 0.4, 0.4, 3.7    |
|                                   |                       |         |                  |           | y (Transversal) | -11.21       | -22.71       | -50.86                |                     | 35.88        | T4       | 0, -15.8, 3.7    |
|                                   |                       |         | MCS3             | 54 Mbps   | z (Axial)       | 5.32         | -43.73       | -50.93                | 2.00                | 49.05        | T4       | 0.3, 0.3, 3.7    |
|                                   |                       |         |                  |           | y (Transversal) | -10.96       | -46.95       | -50.86                |                     | 35.99        | T4       | -0.2, -15.7, 3.7 |
|                                   |                       |         | MCS7             | 135 Mbps  | z (Axial)       | 5.30         | -43.57       | -50.93                | 2.00                | 48.87        | T4       | 0.3, 0.3, 3.7    |
|                                   |                       |         |                  |           | y (Transversal) | -11.03       | -46.92       | -50.86                |                     | 35.89        | T4       | -0.2, -15.7, 3.7 |
| 802.11ac 20 MHz<br>48 kbps        | 36<br>5180 MHz        | UAT 2   | MCS0             | 6.5 Mbps  | z (Axial)       | 5.23         | -22.25       | -50.93                | 2.00                | 48.60        | T4       | 0.4, 0.4, 3.7    |
|                                   |                       |         |                  |           | y (Transversal) | -11.16       | -23.14       | -50.86                |                     | 36.00        | T4       | 0, -15.8, 3.7    |
|                                   |                       |         | MCS4             | 39 Mbps   | z (Axial)       | 5.26         | -44.27       | -50.93                | 2.00                | 49.53        | T4       | 0.6, 0.2, 3.7    |
|                                   |                       |         |                  |           | y (Transversal) | -11.16       | -47.27       | -50.86                |                     | 36.11        | T4       | -0.2, -15.8, 3.7 |
|                                   |                       |         | MCS8             | 78 Mbps   | z (Axial)       | 5.26         | -44.32       | -50.93                | 2.00                | 49.57        | T4       | 0.6, 0.2, 3.7    |
|                                   |                       |         |                  |           | y (Transversal) | -11.08       | -47.35       | -50.86                |                     | 36.26        | T4       | -0.2, -15.8, 3.7 |
| 802.11ac 40 MHz<br>48 kbps        | 38<br>5190 MHz        | UAT 2   | MCS0             | 13.5 Mbps | z (Axial)       | 3.25         | -24.40       | -50.83                | 2.00                | 46.74        | T4       | -0.8, 3.3, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -9.95        | -24.38       | -50.81                |                     | 36.15        | T4       | -3.7, -12.5, 3.7 |
|                                   |                       |         | MCS5             | 108 Mbps  | z (Axial)       | 3.32         | -45.02       | -50.83                | 2.00                | 48.34        | T4       | -0.8, 3.4, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -9.26        | -45.76       | -50.81                |                     | 36.50        | T4       | -3.7, -12.4, 3.7 |
|                                   |                       |         | MCS9             | 180 Mbps  | z (Axial)       | 3.35         | -44.89       | -50.83                | 2.00                | 48.24        | T4       | -0.8, 3.4, 3.7   |
|                                   |                       |         |                  |           | y (Transversal) | -9.25        | -45.88       | -50.81                |                     | 36.62        | T4       | -3.7, -12.4, 3.7 |

**Wi-Fi Air Interface Investigation (continued):**

| Wi-Fi Air Interface Investigation |                       |         |                  |            |                 |              |              |                       |                     |              |          |                  |
|-----------------------------------|-----------------------|---------|------------------|------------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|
| Mode:                             | Channel and Frequency | Antenna | Modulation/Index | Data Rate  | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         |
| 802.11ac 80 MHz<br>48 kbps        | 42<br>5210 MHz        | UAT 2   | MCS0             | 13.5 Mbps  | z (Axial)       | 4.02         | -23.54       | -50.83                | 2.00                | 47.13        | T4       | -0.4, 2.5, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -11.20       | -24.39       | -50.81                |                     | 35.93        | T4       | -0.4, -15.4, 3.7 |
|                                   |                       |         | MCS5             | 108 Mbps   | z (Axial)       | 4.15         | -44.72       | -50.83                | 2.00                | 48.87        | T4       | -0.5, 2.4, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -11.14       | -47.35       | -50.81                |                     | 36.22        | T4       | -0.5, -15.4, 3.7 |
|                                   |                       |         | MCS9             | 180 Mbps   | z (Axial)       | 4.12         | -44.92       | -50.83                | 2.00                | 49.04        | T4       | -0.5, 2.4, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -11.19       | -47.38       | -50.81                |                     | 36.20        | T4       | -0.5, -15.4, 3.7 |
| 802.11ac 20 MHz<br>48 kbps        | 36<br>5180 MHz        | UAT 2   | MCS0             | 8.6 Mbps   | z (Axial)       | 5.31         | -24.07       | -50.83                | 2.00                | 47.46        | T4       | 0, 0, 3.7        |
|                                   |                       |         |                  |            | y (Transversal) | -9.83        | -24.82       | -50.81                |                     | 35.89        | T4       | -4.2, -12.1, 3.7 |
|                                   |                       |         | MCS5             | 58.5 Mbps  | z (Axial)       | 5.10         | -43.20       | -50.83                | 2.00                | 48.30        | T4       | -0.1, 0.1, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -9.33        | -46.60       | -50.81                |                     | 37.27        | T4       | -4.3, -12.2, 3.7 |
|                                   |                       |         | MCS9             | 97.5 Mbps  | z (Axial)       | 5.11         | -42.23       | -50.83                | 2.00                | 47.34        | T4       | -0.1, 0.1, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -9.28        | -46.06       | -50.81                |                     | 36.78        | T4       | -4.3, -12.2, 3.7 |
| 802.11ac 40 MHz<br>48 kbps        | 38<br>5190 MHz        | UAT 2   | MCS0             | 17.2 Mbps  | z (Axial)       | 4.98         | -23.97       | -50.83                | 2.00                | 47.02        | T4       | -0.4, 0.8, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -8.84        | -25.26       | -50.81                |                     | 36.44        | T4       | -4.2, -10.4, 3.7 |
|                                   |                       |         | MCS5             | 117 Mbps   | z (Axial)       | 4.87         | -42.80       | -50.83                | 2.00                | 47.67        | T4       | -0.3, 0.9, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -8.28        | -44.84       | -50.81                |                     | 36.56        | T4       | -4, -10.4, 3.7   |
|                                   |                       |         | MCS9             | 195 Mbps   | z (Axial)       | 4.92         | -43.35       | -50.83                | 2.00                | 48.27        | T4       | -0.3, 0.9, 3.7   |
|                                   |                       |         |                  |            | y (Transversal) | -8.28        | -44.84       | -50.81                |                     | 36.56        | T4       | -4, -10.4, 3.7   |
| 802.11ac 80 MHz<br>48 kbps        | 42<br>5210 MHz        | UAT 2   | MCS0             | 36 Mbps    | z (Axial)       | 5.44         | -20.98       | -50.83                | 2.00                | 48.65        | T4       | 0, 0, 3.7        |
|                                   |                       |         |                  |            | y (Transversal) | -7.30        | -23.12       | -50.81                |                     | 35.46        | T4       | -3.7, -9.2, 3.7  |
|                                   |                       |         | MCS5             | 245 Mbps   | z (Axial)       | 5.46         | -42.55       | -50.83                | 2.00                | 48.01        | T4       | 0, 0.1, 3.7      |
|                                   |                       |         |                  |            | y (Transversal) | -6.93        | -41.59       | -50.81                |                     | 34.66        | T4       | -3.8, -9.3, 3.7  |
|                                   |                       |         | MCS9             | 408.3 Mbps | z (Axial)       | 5.42         | -42.12       | -50.83                | 2.00                | 47.53        | T4       | 0, 0.1, 3.7      |
|                                   |                       |         |                  |            | y (Transversal) | -6.97        | -41.84       | -50.81                |                     | 34.87        | T4       | -3.8, -9.3, 3.7  |

**Note(s):**

1. For all subsequent tests for 2.4 GHz, 802.11n MCS3 26 Mbps was used in conjunction with the worst-case bit rate found in §9.2.2.
2. For all subsequent tests for 5 GHz, 802.11a BPSK 6 Mbps was used in conjunction with the worst-case bit rate found in §9.2.2.

## 10. HAC (T-coil) Test Results

As the margin for the worst-case T-rating is greater than T3/T4, no further investigation is required into the technology's supported channels to affirm the T-rating.

### 10.1. CMRS

#### GSM/W-CDMA/CDMA:

| Mode:                                                                 | Channel and Frequency | Bandwidth (Data Rate) | Antenna | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         | Plot Page # |
|-----------------------------------------------------------------------|-----------------------|-----------------------|---------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|-------------|
| GSM 850 Voice Coder Speechcodec Low                                   | 190 836.6 MHz         | N/A                   | LAT 1   | z (Axial)       | 0.57         | -17.56       | -50.58                | 2.00                | 38.86        | T4       | -4.6, 0.8, 3.7   | 1 - 3       |
|                                                                       |                       |                       |         | y (Transversal) | -6.99        | -19.39       | -50.55                |                     | 34.05        | T4       | -3.7, -9.2, 3.7  |             |
| GSM 1900 Voice Coder Speechcodec Low                                  | 661 1880 MHz          | N/A                   | LAT 1   | z (Axial)       | 0.60         | -39.26       | -50.58                | 2.00                | 39.85        | T4       | -4.8, 0.7, 3.7   | 4 - 6       |
|                                                                       |                       |                       |         | y (Transversal) | -6.73        | -41.42       | -50.55                |                     | 34.69        | T4       | -3.8, -9.1, 3.7  |             |
| W-CDMA BII AMR-WB Bit rate: 6.6 kbps                                  | 9538 1907.6 MHz       | N/A                   | LAT 1   | z (Axial)       | 5.53         | -43.96       | -50.58                | 0.76                | 49.50        | T4       | -2.5, 0.9, 3.7   | 7 - 9       |
|                                                                       |                       |                       |         | y (Transversal) | -3.78        | -43.62       | -50.55                |                     | 39.83        | T4       | -3.9, -11, 3.7   |             |
| W-CDMA BIV AMR-WB Bit rate: 6.6 kbps                                  | 1513 1752.6 MHz       | N/A                   | LAT 1   | z (Axial)       | 7.03         | -42.41       | -50.55                | 0.32                | 49.44        | T4       | -0.4, 0, 3.7     | 10 - 12     |
|                                                                       |                       |                       |         | y (Transversal) | -4.85        | -43.94       | -50.48                |                     | 39.09        | T4       | -1.7, -12.1, 3.7 |             |
| W-CDMA BV AMR-WB Bit rate: 6.6 kbps                                   | 4233 846.6 MHz        | N/A                   | LAT 1   | z (Axial)       | 6.52         | -42.29       | -50.55                | 0.72                | 48.81        | T4       | -2.1, 0, 3.7     | 13 - 15     |
|                                                                       |                       |                       |         | y (Transversal) | -4.20        | -42.27       | -50.48                |                     | 38.07        | T4       | -4.2, -9.2, 3.7  |             |
| CDMA2000 BC0 RC1 / SO3 Full Fr Voice Coder: 8K EVRC Low               | 384 836.52 MHz        | N/A                   | LAT 1   | z (Axial)       | 0.88         | -26.01       | -50.49                | 2.00                | 47.63        | T4       | -2.1, 2.8, 3.7   | 16 - 18     |
|                                                                       |                       |                       |         | y (Transversal) | -7.89        | -28.74       | -50.49                |                     | 37.11        | T4       | -4.2, -9.2, 3.7  |             |
| CDMA2000 BC1 <sup>2</sup> RC1 / SO3 Full Fr Voice Coder: 8K EVRC Low  | 600 1880 MHz          | N/A                   | LAT 1   | z (Axial)       | 0.15         | -48.46       | -50.49                | 2.00                | 48.61        | T4       | -2.1, 2.8, 3.7   | 19 - 21     |
|                                                                       |                       |                       |         | y (Transversal) | -7.31        | -46.08       | -50.49                |                     | 38.77        | T4       | -4.2, -9.1, 3.7  |             |
| CDMA2000 BC10 <sup>2</sup> RC1 / SO3 Full Fr Voice Coder: 8K EVRC Low | 580 820.5 MHz         | N/A                   | LAT 1   | z (Axial)       | 0.82         | -47.93       | -50.49                | 2.00                | 48.75        | T4       | -2.1, 2.8, 3.7   | 22 - 24     |
|                                                                       |                       |                       |         | y (Transversal) | -7.60        | -45.95       | -50.49                |                     | 38.35        | T4       | -4.2, -9.1, 3.7  |             |

#### Note(s):

1. The radial longitudinal (x axis) measurements are no longer required per ANSI C63.19
2. Denotes single point measurements, as per §7.4.4.2 of ANSI C63.19-2011.



**VoLTE:**

| Mode:                                                       | Channel and Frequency | Bandwidth (Data Rate) | Antenna | RB Allocation |   | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         | Plot Page # |
|-------------------------------------------------------------|-----------------------|-----------------------|---------|---------------|---|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|-------------|
| LTE Band 7 QPSK<br>EVS<br>Bit rate: 5.9 kbps                | 21100<br>2535 MHz     | 20 MHz                | UAT 1   | 100           | 0 | z (Axial)       | 8.26         | -21.85       | -50.78                | 1.94                | 46.91        | T4       | 0, 0, 3.7        | 25 - 27     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -5.67        | -25.32       | -50.75                |                     | 36.55        | T4       | -1.2, -12.1, 3.7 |             |
| LTE Band 12 QPSK <sup>2</sup><br>EVS<br>Bit rate: 5.9 kbps  | 23095<br>707.5 MHz    | 10 MHz                | UAT 1   | 50            | 0 | z (Axial)       | 6.40         | -38.62       | -50.50                | 1.25                | 45.02        | T4       | -1.3, 2.9, 3.7   | 28 - 30     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -7.17        | -41.89       | -50.46                |                     | 34.72        | T4       | -4.6, -9.7, 3.7  |             |
| LTE Band 14 QPSK<br>EVS<br>Bit rate: 5.9 kbps               | 23330<br>793 MHz      | 10 MHz                | UAT 1   | 50            | 0 | z (Axial)       | 8.04         | -23.13       | -50.78                | 1.64                | 46.87        | T4       | -0.4, -0.4, 3.7  | 31 - 33     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -5.11        | -25.60       | -50.75                |                     | 38.14        | T4       | 0, -12.1, 3.7    |             |
| LTE Band 25 QPSK <sup>2</sup><br>EVS<br>Bit rate: 5.9 kbps  | 26365<br>1882.5 MHz   | 20 MHz                | UAT 1   | 100           | 0 | z (Axial)       | 6.81         | -38.60       | -50.50                | 0.55                | 45.42        | T4       | -1.3, 2.9, 3.7   | 34 - 36     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -8.79        | -41.76       | -50.46                |                     | 32.97        | T4       | -4.6, -9.7, 3.7  |             |
| LTE Band 26 QPSK <sup>2</sup><br>EVS<br>Bit rate: 5.9 kbps  | 26865<br>831.5 MHz    | 15 MHz                | UAT 1   | 75            | 0 | z (Axial)       | 2.11         | -38.44       | -50.50                | 1.77                | 40.55        | T4       | -1.3, 2.9, 3.7   | 37 - 39     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -5.92        | -42.01       | -50.46                |                     | 36.09        | T4       | -4.6, -9.7, 3.7  |             |
| LTE Band 30 QPSK<br>EVS<br>Bit rate: 5.9 kbps               | 27710<br>2310 MHz     | 10 MHz                | UAT 1   | 50            | 0 | z (Axial)       | 8.45         | -21.60       | -50.78                | 1.94                | 47.36        | T4       | 0, -0.4, 3.7     | 40 - 42     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -6.39        | -24.60       | -50.75                |                     | 36.85        | T4       | -4.2, -12.9, 3.7 |             |
| LTE Band 41 64QAM <sup>2</sup><br>EVS<br>Bit rate: 5.9 kbps | 40620<br>2593 MHz     | 20 MHz                | UAT 1   | 50            | 0 | z (Axial)       | 7.85         | -34.13       | -50.50                | 1.46                | 41.97        | T4       | 0, -0.1, 3.7     | 43 - 45     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -9.28        | -41.12       | -50.46                |                     | 31.83        | T4       | -3.8, -9, 3.7    |             |
| LTE Band 48 64QAM<br>EVS<br>Bit rate: 5.9 kbps              | 55990<br>3625 MHz     | 20 MHz                | LAT 1   | 50            | 0 | z (Axial)       | 6.30         | -22.01       | -50.78                | 2.00                | 43.90        | T4       | -0.8, -3.8, 3.7  | 46 - 48     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -5.06        | -23.47       | -50.75                |                     | 37.48        | T4       | -0.8, -12.1, 3.7 |             |
| LTE Band 66 QPSK<br>EVS<br>Bit rate: 5.9 kbps               | 132322<br>1745 MHz    | 20 MHz                | UAT 1   | 100           | 0 | z (Axial)       | 8.36         | -24.15       | -50.78                | 2.00                | 46.43        | T4       | -0.4, 0, 3.7     | 49 - 51     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -3.61        | -25.42       | -50.75                |                     | 36.52        | T4       | 0.4, -9.6, 3.7   |             |
| LTE Band 71 QPSK<br>EVS<br>Bit rate: 5.9 kbps               | 133297<br>680.5 MHz   | 20 MHz                | UAT 1   | 100           | 0 | z (Axial)       | 7.94         | -24.04       | -50.78                | 2.00                | 45.47        | T4       | 0.8, -2.9, 3.7   | 52 - 54     |
|                                                             |                       |                       |         |               |   | y (Transversal) | -8.86        | -25.91       | -50.75                |                     | 37.83        | T4       | 0.8, -16.7, 3.7  |             |

**Note(s):**

1. The radial longitudinal (x axis) measurements are no longer required per ANSI C63.19
2. Denotes single point measurements, as per §7.4.4.2 of ANSI C63.19-2011.

**VoWi-Fi:**

| Mode:                                 | Channel and Frequency | Bandwidth (Data Rate)    | Antenna | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         | Plot Page # |
|---------------------------------------|-----------------------|--------------------------|---------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|-------------|
| 802.11n<br>EVS<br>Bit rate: 9.6 kbps  | 6<br>2437 MHz         | 20 MHz<br>(MCS3 26 Mbps) | UAT 1   | z (Axial)       | 5.85         | -40.10       | -50.50                | 1.94                | 45.96        | T4       | -0.3, -0.8, 3.7  | 55 - 57     |
|                                       |                       |                          |         | y (Transversal) | -6.09        | -40.11       | -50.53                |                     | 34.02        | T4       | -5, -12.5, 3.7   |             |
| 802.11a<br>EVS<br>Bit rate: 24.4 kbps | 36<br>5180 MHz        | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | 4.35         | -44.40       | -50.44                | 2.00                | 48.75        | T4       | -2.6, 2.2, 3.7   | 58 - 60     |
|                                       |                       |                          |         | y (Transversal) | -6.56        | -45.91       | -50.48                |                     | 39.35        | T4       | 0.5, -13.3, 3.7  |             |
|                                       | 52<br>5260 MHz        | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | 5.50         | -29.48       | -50.52                | 2.00                | 47.53        | T4       | -0.8, 1.7, 3.7   | 61 - 63     |
|                                       |                       |                          |         | y (Transversal) | -5.77        | -28.37       | -50.49                |                     | 40.72        | T4       | -4.2, -11.7, 3.7 |             |
|                                       | 100<br>5500 MHz       | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | 5.47         | -43.18       | -50.52                | 2.00                | 48.65        | T4       | -0.7, 1.6, 3.7   | 64 - 66     |
|                                       |                       |                          |         | y (Transversal) | -5.13        | -46.03       | -50.49                |                     | 40.89        | T4       | -4.1, -11.8, 3.7 |             |
|                                       | 149<br>5745 MHz       | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | 5.41         | -43.25       | -50.52                | 2.00                | 48.67        | T4       | -0.7, 1.6, 3.7   | 67 - 69     |
|                                       |                       |                          |         | y (Transversal) | -5.11        | -45.98       | -50.49                |                     | 40.87        | T4       | -4.1, -11.8, 3.7 |             |

**Note(s):**

1. The radial longitudinal (x axis) measurements are no longer required per ANSI C63.19
2. Denotes single point measurements, as per §7.4.4.2 of ANSI C63.19-2011.

## 10.2. OTT Application

### GSM/W-CDMA/CDMA:

| Mode:                                            | Channel and Frequency | Bandwidth (Data Rate) | Antenna | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         | Plot Page # |
|--------------------------------------------------|-----------------------|-----------------------|---------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|-------------|
| GSM 850 <sup>2</sup><br>EGPRS 2 Slots<br>20 kbps | 251<br>848.8 MHz      | N/A                   | UAT 1   | z (Axial)       | 2.03         | -41.27       | -50.24                | 2.00                | 43.30        | T4       | -3, 2.9, 3.7     | 1 - 3       |
|                                                  |                       |                       |         | y (Transversal) | -6.27        | -40.73       | -50.25                |                     | 34.46        | T4       | -4.2, -11.3, 3.7 |             |
| GSM 1900<br>EGPRS 2 Slots<br>20 kbps             | 810<br>1909.8 MHz     | N/A                   | UAT 1   | z (Axial)       | 3.35         | -23.05       | -50.24                | 2.00                | 43.42        | T4       | -0.8, 0.4, 3.7   | 4 - 6       |
|                                                  |                       |                       |         | y (Transversal) | -5.80        | -24.36       | -50.25                |                     | 36.19        | T4       | -4.2, -8.8, 3.7  |             |
| W-CDMA BII <sup>2</sup><br>HSPA<br>32 kbps       | 9400<br>1880 MHz      | N/A                   | UAT 1   | z (Axial)       | 1.86         | -45.55       | -50.57                | 2.00                | 47.41        | T4       | -4, 1, 3.7       | 7 - 9       |
|                                                  |                       |                       |         | y (Transversal) | -6.47        | -40.38       | -50.53                |                     | 33.91        | T4       | -4.6, -9.5, 3.7  |             |
| W-CDMA BIV <sup>2</sup><br>HSPA<br>32 kbps       | 1513<br>1752.6 MHz    | N/A                   | UAT 1   | z (Axial)       | 2.57         | -45.61       | -50.90                | 2.00                | 48.17        | T4       | -1.2, -0.5, 3.7  | 10 - 12     |
|                                                  |                       |                       |         | y (Transversal) | -7.50        | -42.89       | -50.92                |                     | 35.39        | T4       | -4.2, -12.5, 3.7 |             |
| W-CDMA BV<br>HSPA<br>32 kbps                     | 4132<br>826.4 MHz     | N/A                   | UAT 1   | z (Axial)       | 2.55         | -45.77       | -50.90                | 2.00                | 48.32        | T4       | -0.3, 0.3, 3.7   | 13 - 15     |
|                                                  |                       |                       |         | y (Transversal) | -7.44        | -43.38       | -50.92                |                     | 35.94        | T4       | -4.2, -12.5, 3.7 |             |
| CDMA BC0 <sup>2</sup><br>Ev-Do<br>28 kbps        | 777<br>848.31 MHz     | N/A                   | LAT 1   | z (Axial)       | 2.84         | -44.00       | -50.52                | 2.00                | 46.84        | T4       | -0.4, 0.1, 3.7   | 16 - 18     |
|                                                  |                       |                       |         | y (Transversal) | -7.94        | -43.87       | -50.51                |                     | 35.93        | T4       | -3.9, -9.8, 3.7  |             |
| CDMA BC1<br>Ev-Do<br>28 kbps                     | 1175<br>1908.75 MHz   | N/A                   | LAT 1   | z (Axial)       | -5.00        | -26.54       | -50.52                | 2.00                | 46.24        | T4       | -0.8, 0.4, 3.7   | 19 - 21     |
|                                                  |                       |                       |         | y (Transversal) | -10.08       | -27.32       | -50.53                |                     | 34.32        | T4       | -4.2, -9.6, 3.7  |             |
| CDMA BC10 <sup>2</sup><br>Ev-Do<br>28 kbps       | 670<br>822.75 MHz     | N/A                   | LAT 1   | z (Axial)       | -0.51        | -46.91       | -50.52                | 2.00                | 46.41        | T4       | -0.7, 0.2, 3.7   | 22 - 24     |
|                                                  |                       |                       |         | y (Transversal) | -9.74        | -43.93       | -50.53                |                     | 34.19        | T4       | -4.2, -9.6, 3.7  |             |

#### Note(s):

1. The radial longitudinal (x axis) measurements are no longer required per ANSI C63.19
2. Denotes single point measurements, as per §7.4.4.2 of ANSI C63.19-2011.

### LTE:

| Mode:                                 | Channel and Frequency | Bandwidth (Data Rate) | RB Allocation |    | Antenna | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         | Plot Page # |
|---------------------------------------|-----------------------|-----------------------|---------------|----|---------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|-------------|
| LTE Band 7 QPSK 28 kbps               | 21350 2560 MHz        | 20 MHz                | 50            | 24 | UAT 1   | z (Axial)       | 2.98         | -23.27       | -48.94                | 2.00                | 44.17        | T4       | -2.5, 0, 3.7     | 25 - 27     |
|                                       |                       |                       |               |    |         | y (Transversal) | -7.41        | -25.05       | -49.41                |                     | 36.19        | T4       | 8.3, -13.3, 3.7  |             |
| LTE Band 12 <sup>2</sup> QPSK 28 kbps | 23130 711 MHz         | 10 MHz                | 25            | 12 | UAT 1   | z (Axial)       | 5.22         | -38.92       | -50.88                | 2.00                | 44.14        | T4       | 0.1, 0, 3.7      | 28 - 30     |
|                                       |                       |                       |               |    |         | y (Transversal) | -7.25        | -43.25       | -50.83                |                     | 36.01        | T4       | -3.6, -9.3, 3.7  |             |
| LTE Band 14 QPSK 28 kbps              | 23330 793 MHz         | 10 MHz                | 25            | 12 | UAT 1   | z (Axial)       | 2.28         | -24.84       | -48.94                | 2.00                | 44.72        | T4       | -3.7, 0.4, 3.7   | 31 - 33     |
|                                       |                       |                       |               |    |         | y (Transversal) | -5.89        | -26.50       | -49.41                |                     | 37.29        | T4       | -3.3, -9.6, 3.7  |             |
| LTE Band 25 <sup>2</sup> QPSK 28 kbps | 26590 1905 MHz        | 20 MHz                | 50            | 24 | UAT 1   | z (Axial)       | 5.16         | -38.46       | -50.88                | 2.00                | 43.62        | T4       | 0.1, 0, 3.7      | 34 - 36     |
|                                       |                       |                       |               |    |         | y (Transversal) | -7.28        | -41.09       | -50.83                |                     | 33.81        | T4       | -3.6, -9.3, 3.7  |             |
| LTE Band 26 <sup>2</sup> QPSK 28 kbps | 26965 841.5 MHz       | 15 MHz                | 36            | 20 | UAT 1   | z (Axial)       | 5.22         | -39.24       | -50.88                | 2.00                | 44.46        | T4       | 0.1, 0, 3.7      | 37 - 39     |
|                                       |                       |                       |               |    |         | y (Transversal) | -7.28        | -43.42       | -50.83                |                     | 36.14        | T4       | -3.6, -9.3, 3.7  |             |
| LTE Band 30 QPSK 28 kbps              | 27710 2310 MHz        | 10 MHz                | 25            | 12 | UAT 1   | z (Axial)       | 3.68         | -23.35       | -48.94                | 2.00                | 44.30        | T4       | -1.2, 0, 3.7     | 40 - 42     |
|                                       |                       |                       |               |    |         | y (Transversal) | -5.99        | -24.76       | -49.41                |                     | 36.02        | T4       | -1.7, -11.3, 3.7 |             |
| LTE Band 41 <sup>2</sup> QPSK 28 kbps | 41055 2636.5 MHz      | 20 MHz                | 1             | 49 | UAT 1   | z (Axial)       | 5.27         | -38.12       | -50.88                | 2.00                | 43.39        | T4       | 0, 0, 3.7        | 43 - 45     |
|                                       |                       |                       |               |    |         | y (Transversal) | -7.08        | -41.67       | -50.83                |                     | 34.59        | T4       | -3.7, -8.7, 3.7  |             |
| LTE Band 48 QPSK 28 kbps              | 56207 3646.7 MHz      | 20 MHz                | 1             | 49 | LAT 1   | z (Axial)       | 5.28         | -22.40       | -50.88                | 2.00                | 43.57        | T4       | 0, 0, 3.7        | 46 - 48     |
|                                       |                       |                       |               |    |         | y (Transversal) | -7.57        | -23.07       | -50.83                |                     | 34.95        | T4       | -3.3, -9.2, 3.7  |             |
| LTE Band 66 QPSK 28 kbps              | 132572 1770 MHz       | 20 MHz                | 50            | 24 | UAT 1   | z (Axial)       | 3.80         | -23.30       | -48.94                | 2.00                | 44.40        | T4       | -0.4, -0.4, 3.7  | 49 - 51     |
|                                       |                       |                       |               |    |         | y (Transversal) | -5.94        | -25.28       | -49.41                |                     | 36.51        | T4       | -1.2, -11.3, 3.7 |             |
| LTE Band 71 QPSK 28 kbps              | 133372 688 MHz        | 20 MHz                | 50            | 24 | UAT 1   | z (Axial)       | 2.83         | -24.74       | -48.94                | 2.00                | 44.14        | T4       | -2.9, 0, 3.7     | 52 - 54     |
|                                       |                       |                       |               |    |         | y (Transversal) | -5.69        | -26.54       | -49.41                |                     | 37.54        | T4       | -1.2, -10.8, 3.7 |             |

#### Note(s):

1. The radial longitudinal (x axis) measurements are no longer required per ANSI C63.19
2. Denotes single point measurements, as per §7.4.4.2 of ANSI C63.19-2011.

**Wi-Fi:**

| Mode:              | Channel and Frequency        | Bandwidth (Data Rate)    | Antenna | Orientation     | ABM1 dB(A/m) | ABM2 dB(A/m) | Ambient Noise dB(A/m) | Freq. Response (dB) | ABM SNR (dB) | T-Rating | Location         | Plot Page # |
|--------------------|------------------------------|--------------------------|---------|-----------------|--------------|--------------|-----------------------|---------------------|--------------|----------|------------------|-------------|
| 802.11n<br>48 kbps | 6<br>2437 MHz                | 20 MHz<br>(MCS3 26 Mbps) | UAT 1   | z (Axial)       | 0.03         | -27.14       | -50.52                | 2.00                | 45.96        | T4       | -0.4, 0, 3.7     | 55 - 57     |
|                    |                              |                          |         | y (Transversal) | -9.51        | -26.10       | -50.53                |                     | 34.13        | T4       | -3.7, -9.6, 3.7  |             |
| 802.11a<br>48 kbps | 36<br>5180 MHz               | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | -0.40        | -24.72       | -50.52                | 2.00                | 45.72        | T4       | -0.4, 1.2, 3.7   | 58 - 60     |
|                    |                              |                          |         | y (Transversal) | -10.68       | -25.77       | -50.53                |                     | 33.64        | T4       | -5, -9.6, 3.7    |             |
|                    | 52<br>5260 MHz               | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | -0.03        | -23.92       | -50.52                | 2.00                | 45.52        | T4       | -0.4, 0.4, 3.7   | 61 - 63     |
|                    |                              |                          |         | y (Transversal) | -10.63       | -24.80       | -50.53                |                     | 35.05        | T4       | -4.2, -11.7, 3.7 |             |
|                    | 100 <sup>2</sup><br>5500 MHz | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | -0.24        | -45.90       | -50.52                | 2.00                | 45.66        | T4       | -0.2, 0.5, 3.7   | 64 - 66     |
|                    |                              |                          |         | y (Transversal) | -10.04       | -44.80       | -50.53                |                     | 34.76        | T4       | -4.3, -11.7, 3.7 |             |
|                    | 149 <sup>2</sup><br>5745 MHz | 20 MHz<br>(BPSK 6 Mbps)  | UAT 2   | z (Axial)       | -0.20        | -45.09       | -50.52                | 2.00                | 44.89        | T4       | -0.2, 0.5, 3.7   | 67 - 69     |
|                    |                              |                          |         | y (Transversal) | -9.97        | -44.36       | -50.53                |                     | 34.39        | T4       | -4.3, -11.7, 3.7 |             |

**Note(s):**

1. The radial longitudinal (x axis) measurements are no longer required per ANSI C63.19
2. Denotes single point measurements, as per §7.4.4.2 of ANSI C63.19-2011.

### 10.3. Worst Case T-Coil Test Plot

Test Laboratory: UL Verification Services Inc. SAR Lab 7

Date: 12/23/2019

#### LTE TDD

Communication System: UID 0, @LTE (TDD) (0); Frequency: 2593 MHz; Duty Cycle: 1:1.59956

Phantom section: TCoil Section

DASY5 Configuration:

- Probe: AM1DV3 - 3083; ; Calibrated: 1/15/2018

- Sensor-Surface: 0mm (Fix Surface)

- Electronics: DAE4 Sn1540; Calibrated: 2/18/2019

- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BB

- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7470)

#### T-Coil scan (scan for ANSI C63.19 2011 compliance)/LTE Band 41 64QAM 50/0 RB\_Ch 40620\_EVS 5.90 kbps\_UAT 1/y (transversal) Single Point/ABM SNR(x,y,z) (1x1x1):

Measurement grid: dx=10mm, dy=10mm

Signal Type: Audio File (.wav) 48k\_voice\_1kHz\_1s.wav

Output Gain: 24.07

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

#### Cursor:

ABM1/ABM2 = 31.83 dB

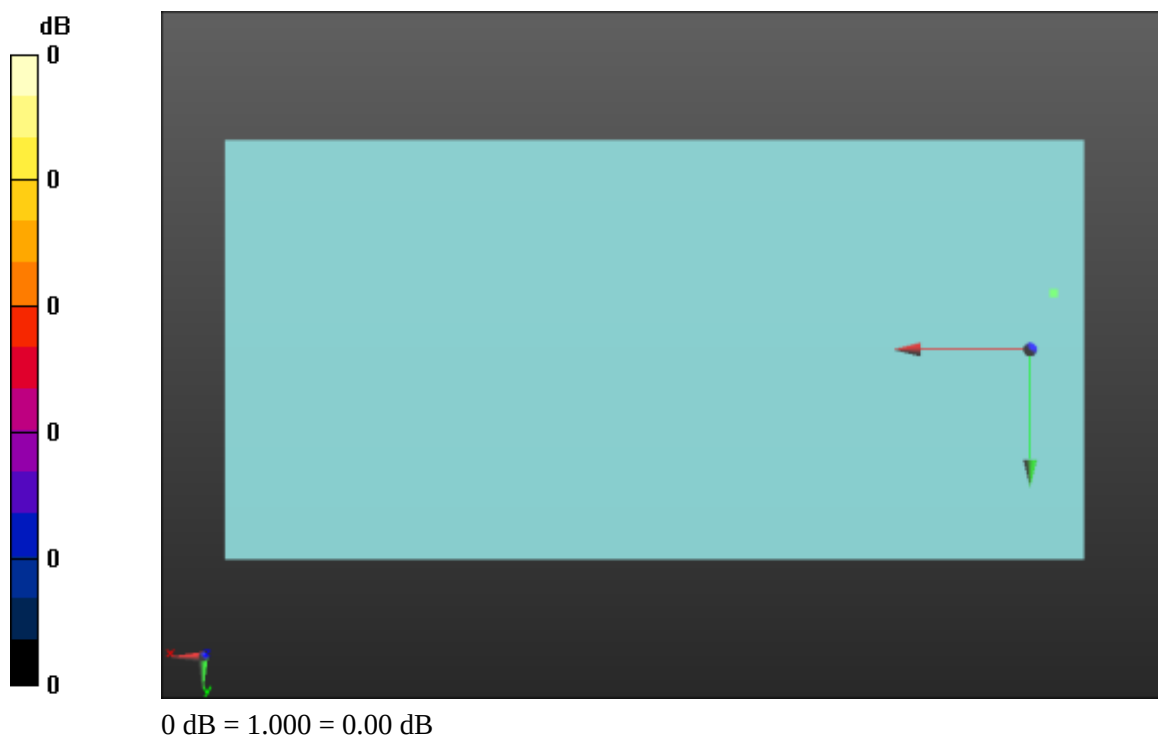
ABM1 comp = -9.28 dBA/m

BWC Factor = 0.16 dB

Location: -3.8, -9, 3.7 mm

ABM2 = -41.12 dBA/m

Location: -3.8, -9, 3.7 mm



## **Appendix**

**Refer to separated files for the following appendixes**

**Appendix A: T-Coil Setup Photo**

**Appendix B: T-Coil Test Plots (CMRS)**

**Appendix C: T-Coil Test Plots (OTT)**

**Appendix D: T-Coil Probe Certificates**

**Appendix E: Adjusted Gain Procedure**

**END OF REPORT**