# HEARING AID COMPATIBILITY T-COIL TEST REPORT

| | |
|---|---|
| **FCC ID** | **: IHDT56AL6** |
| **Equipment** | **: Mobile Cellular Phone** |
| **Brand Name** | **: Motorola** |
| **Model Name** | **: XT2303-1, XT2303-2** |
| **T-Rating** | **: T3** |
| **Applicant** | **: Motorola Mobility LLC<br>222 W,Merchandise Mart Plaza, Chicago IL 60654 USA** |
| **Manufacturer** | **: Motorola Mobility LLC<br>222 W,Merchandise Mart Plaza, Chicago IL 60654 USA** |
| **Standard** | **: FCC 47 CFR §20.19<br>ANSI C63.19-2011** |

**We, Sporton International Inc. (Kunshan), would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.**

**The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.**

Si Zhang

**Approved by: Si Zhang**

ACCREDITED Cert #5145.02

***Sporton International Inc. (Kunshan)***
***No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China***

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# History of this test report

| Report No. | Version | Description | Issued Date |
|---|---|---|---|
| HA320205B | Rev. 01 | Initial issue of report | Mar. 27, 2023 |
| | | | |
| | | | |

# 1. Attestation of Test Results

| Air Interface | Band MHz | T-Rating | Frequency Response | Magnetic Intensity |
|---|---|---|---|---|
| GSM CMRS Voice | GSM850 | T3 | Pass | Pass |
| | GSM1900 | T4 | Pass | Pass |
| UMTS CMRS Voice | Band II | T4 | Pass | Pass |
| | Band IV | T4 | Pass | Pass |
| | Band V | T4 | Pass | Pass |
| VoLTE | Band 2 | T4 | Pass | Pass |
| | Band 12/17 | T4 | Pass | Pass |
| | Band 13 | T4 | Pass | Pass |
| | Band 26/5 | T4 | Pass | Pass |
| | Band 66/4 | T4 | Pass | Pass |
| | Band 7 | T4 | Pass | Pass |
| | Band 41/38 | T3 | Pass | Pass |
| | Band 42 | T4 | Pass | Pass |
| VoNR | n2 | T4 | Pass | Pass |
| | n5 | T4 | Pass | Pass |
| | n66 | T3 | Pass | Pass |
| | n7 | T3 | Pass | Pass |
| | n41/n38 | T4 | Pass | Pass |
| | n77/n78 | T3 | Pass | Pass |
| VoWiFI | 2450 | T4 | Pass | Pass |
| | 5200 | T4 | Pass | Pass |
| | 5300 | T4 | Pass | Pass |
| | 5500 | T4 | Pass | Pass |
| | 5800 | T4 | Pass | Pass |
| Date Tested | 2023/2/27 ~ 2023/3/21 | | | |

1. The device is compliance with HAC limits specified in guidelines FCC 47CFR §20.19 and ANSI Standard ANSI C63.19.
2. This is partial report for CMRS voice T-Coil testing . VOIP test report will be separately submitted.

## 2. General Information

| Product Feature & Specification | |
|---|---|
| **Applicant Name** | Motorola Mobility LLC |
| **Equipment Name** | Mobile Cellular Phone |
| **Brand Name** | Motorola |
| **Model Name** | XT2303-1, XT2303-2 |
| **IMEI Code** | IMEI 1: 358543770016852<br>IMEI 2: 358543770016860 |
| **FCC ID** | IHDT56AL6 |
| **HW** | DVT2 |
| **SW** | TTL33.38 |
| **EUT Stage** | Identical Prototype |
| **Frequency Band** | GSM850: 824 MHz ~ 849 MHz<br>GSM1900: 1850 MHz ~ 1910 MHz<br>WCDMA Band II: 1850 MHz ~ 1910 MHz<br>WCDMA Band IV: 1710 MHz ~ 1755 MHz<br>WCDMA Band V: 824 MHz ~ 849 MHz<br>LTE Band 2: 1850 MHz ~ 1910 MHz<br>LTE Band 4: 1710 MHz ~ 1755 MHz<br>LTE Band 5: 824 MHz ~ 849 MHz<br>LTE Band 7: 2500 MHz ~ 2570 MHz<br>LTE Band 12: 699 MHz ~ 716 MHz<br>LTE Band 13: 777 MHz ~ 787 MHz<br>LTE Band 17: 704 MHz ~ 716 MHz<br>LTE Band 26: 814 MHz ~ 849 MHz<br>LTE Band 38: 2570 MHz ~ 2620 MHz<br>LTE Band 41: 2496 MHz ~ 2690 MHz<br>LTE Band 42: 3450 MHz ~ 3550MHz<br>LTE Band 66: 1710 MHz ~ 1780 MHz<br>5G NR n2 : 1850 MHz ~ 1910 MHz<br>5G NR n5: 824 MHz ~ 849 MHz<br>5G NR n7: 2500 MHz ~ 2570 MHz<br>5G NR n66: 1710 MHz ~ 1780 MHz<br>5G NR n38 : 2570 MHz ~ 2620 MHz<br>5G NR n41 : 2496 MHz ~ 2690 MHz<br>5G NR n77: 3700 MHz ~ 3980 MHz<br>5G NR n78: 3700 MHz ~ 3800 MHz<br>WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz<br>WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz<br>WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz<br>WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz<br>WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz<br>Bluetooth: 2402 MHz ~ 2480 MHz<br>NFC: 13.56 MHz |
| **Mode** | GSM/GPRS/EGPRS<br>RMC/AMR 12.2Kbps<br>HSDPA<br>HSUPA<br>DC-HSDPA<br>HSPA+(16QAM uplink is not supported)<br>LTE: QPSK, 16QAM, 64QAM<br>5G NR : CP-OFDM / DFT-s-OFDM, PI/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM<br>WLAN 2.4GHz 802.11b/g/n HT20/HT40<br>WLAN 2.4GHz 802.11ax HE20/HE40<br>WLAN 5GHz 802.11a/n HT20/HT40<br>WLAN 5GHz 802.11ac/ax VHT20/VHT40/VHT80/HE20/HE40/HE80<br>Bluetooth BR/EDR/LE<br>NFC: ASK |
| **Remark:**<br>1. The two model names: XT2303-1 is USIM(DS/SS) sample and XT2303-2 is eSIM + USIM(SS) sample, they are only SIM Slot difference, since the difference does not affect hearing-aid compliance, so only choose XT2303-1 sample to full test, XT2303-2 sample is not tested. | |

## 3. Testing Location

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

| Testing Laboratory | | | |
|---|---|---|---|
| **Test Firm** | Sporton International Inc. (Kunshan) | | |
| **Test Site Location** | No. 1098, Pengxi North Road, Kunshan Economic Development Zone<br>Jiangsu Province 215300 People's Republic of China<br>TEL : +86-512-57900158<br>FAX : +86-512-57900958 | | |
| **Test Site No.** | **Sporton Site No.** | **FCC Designation No.** | **FCC Test Firm Registration No.** |
| | SAR01-KS | CN1257 | 314309 |

## 4. Applied Standards

- FCC CFR47 Part 20.19
- ANSI C63.19-2011
- FCC KDB 285076 D01 HAC Guidance v06r02
- FCC KDB 285076 D02 T-Coil testing v04
- FCC KDB 285076 D03 HAC FAQ v01r06

## 5. Air Interface and Operating Mode

| Air Interface | Band MHz | Type | C63.19 Tested | Simultaneous Transmitter | Name of Voice Service | Power Reduction |
|---|---|---|---|---|---|---|
| GSM | GSM850 | VO | Yes | WLAN, BT | CMRS Voice | No |
| | GSM1900 | | | WLAN, BT | | No |
| | EDGE850 | VD | Yes | WLAN, BT | Google Duo(1) google Fi | No |
| | EDGE1900 | | | | | |
| UMTS | Band II | VO | Yes | WLAN, BT | CMRS Voice | No |
| | Band IV | | | WLAN, BT | | No |
| | Band V | | | WLAN, BT | | No |
| | HSPA | VD | Yes | WLAN, BT | Google Duo(1) google Fi | No |
| LTE (FDD) | Band 2 | VD | Yes | 5G NR, WLAN, BT | VoLTE / Google Duo(1) google Fi | No |
| | Band 4 | | | 5G NR, WLAN, BT | | No |
| | Band 5 | | | 5G NR, WLAN, BT | | No |
| | Band 7 | | | 5G NR, WLAN, BT | | No |
| | Band 12 | | | 5G NR, WLAN, BT | | No |
| | Band 13 | | | 5G NR, WLAN, BT | | No |
| | Band 17 | | | 5G NR, WLAN, BT | | No |
| | Band 26 | | | 5G NR, WLAN, BT | | No |
| | Band 66 | | | 5G NR, WLAN, BT | | No |
| LTE (TDD) | Band 38 | VD | Yes | 5G NR, WLAN, BT | VoLTE / Google Duo(1) google Fi | No |
| | Band 41 | | | 5G NR, WLAN, BT | | No |
| | Band 42 | | | 5G NR, WLAN, BT | | No |
| 5G NR (FDD) | n2 | VD | Yes | LTE, WLAN, BT | VoNR / Google Duo(1) | No |
| | n5 | | | LTE, WLAN, BT | | No |
| | n7 | | | LTE, WLAN, BT | | No |
| | n66 | | | LTE, WLAN, BT | | No |
| 5G NR (TDD) | n38 | VD | Yes | LTE, WLAN, BT | VoNR / Google Duo(1) google Fi | No |
| | n41 | | | LTE, WLAN, BT | | No |
| | n77 | | | LTE, WLAN, BT | | No |
| | n78 | | | LTE, WLAN, BT | | No |
| Wi-Fi | 2450 | VD | Yes | GSM,WCDMA,LTE,5G NR, WLAN 5GHz,BT | VoWiFi(1) / Google Duo(1) google Fi | No |
| | 5200 | VD | Yes | GSM,WCDMA,LTE,5G NR, BT, WLAN 2.4GHz | | No |
| | 5300 | | | | | No |
| | 5500 | | | | | No |
| | 5800 | | | | | No |
| BT | 2450 | DT | No | GSM,WCDMA,LTE,5G NR, WLAN 5GHz, WLAN 2.4GHz | NA | No |

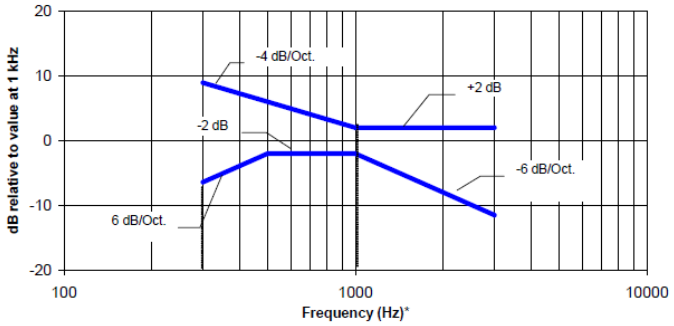
**Type Transport:**
VO= Voice only
DT= Digital Transport only (no voice)
VD= CMRS and IP Voice Service over Digital Transport

**Remark:**
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 should be used.
2. The device have similar frequency in some LTE/5GNR FR1 Bands: LTE B12/17, 5/26, 4/66, 38/41, 66/4, 5G NR n38/41, 5G NR n77/78 since the supported frequency spans for the smaller LTE /5G NR FR1 bands are completely cover by the larger LTE/5G NR FR1 bands, therefore, only larger LTE/5GNR FR1 bands were required to be tested for hearing-aid compliance.
3. The google duo and google Fi the audio path, parameter and audio codec are all the same, therefore, the google duo is evaluation for this device to show compliance.
4. This is partial report for CMRS voice T-Coil testing . VOIP test report will be separately submitted.

# 6. Measurement standards for T-Coil

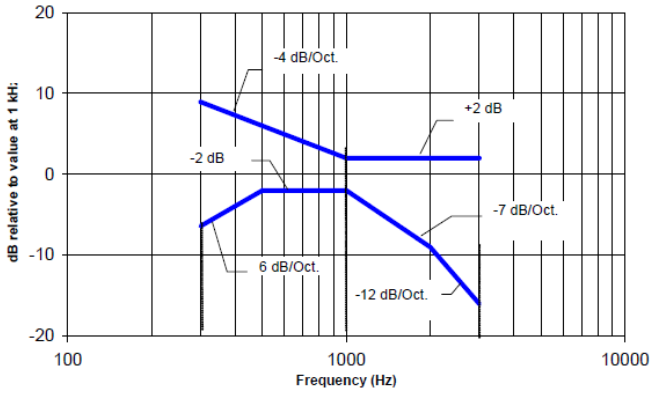
## 6.1 Frequency Response

The frequency response of the perpendicular component of the magnetic field, measured in 1/3 octave bands, shall follow the response curve specified in this sub-clause, over the frequency range 300 Hz to 3000 Hz.
Figure 1.1 and Figure 1.2 provide the boundaries as a function of 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.

**Fig. 1.1 Magnetic field frequency response for WDs with field strength≤-15dB at 1 KHz**




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

**Fig. 1.2 Magnetic field frequency response for WDs with a field that exceeds –15 dB(A/m) at 1 kHz**

## 6.2 T-Coil Signal Quality Categories

This section provides the signal quality requirement for the intended T-Coil signal from a WD. 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. A device is assessed beginning by determining the category of the RF environment in the area of the T-Coil source.
The RF measurements made for the T-Coil evaluation are used to assign the category T1 through T4. The limitation is given in Table 1. This establishes the RF environment presented by the WD to a hearing aid.

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

**Table 1 T-Coil Signal Quality Categories**

## 6.3 Description of EUT Test Position

Fig.3 illustrate the references and reference plane that shall be used in a typical EUT emissions measurement. The principle of this section is applied to EUT with similar geometry. Please refer to Appendix C for the setup photographs.

- The area is 5 cm by 5 cm.
- The area is centered on the audio frequency output transducer of the EUT.
- The area is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the EUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 10 mm in front of, the reference plane.

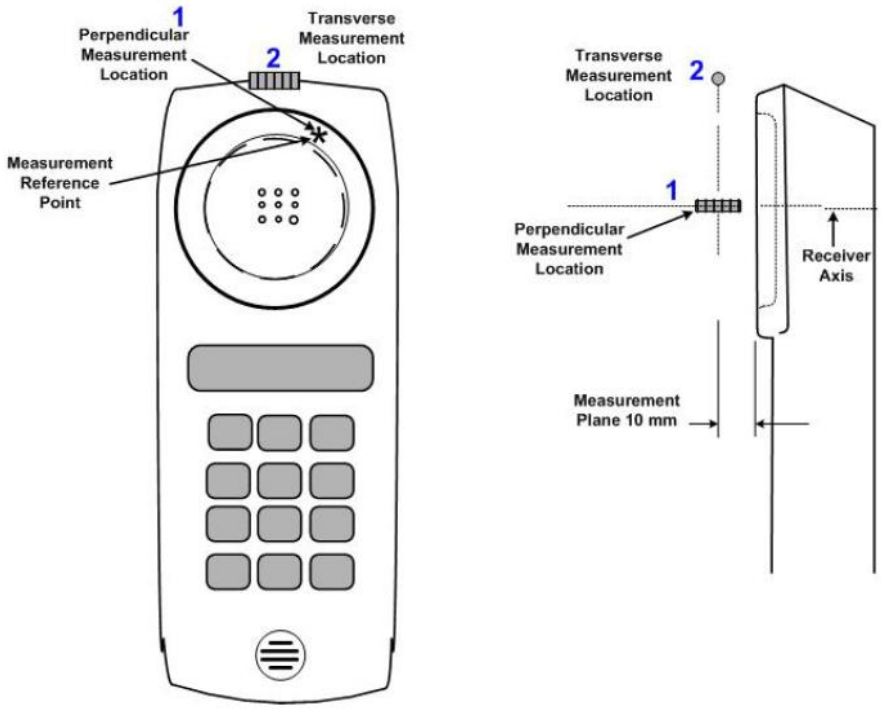



**Fig.3 A typical EUT reference and plane for T-Coil measurements**

# 7. T-Coil Test Procedure

Referenced to ANSI C63.19-2011, Section 7.4

This section 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. 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 each measurement position. 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, there might still be RF leakage from the WD, which can interfere with the desired measurement. Pre-measurement checks should be made to avoid this possibility. All measurements shall be performed with the WD operating on battery power with an appropriate normal speech audio signal input level given in ANSI C63.19-2011 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,

Measurement shall be performed at two locations specified in ANSI C63.19-2011 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 the same location as the desired ABM or T-Coil signal (ABM1), and the ratio of desired to 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 following steps summarize the basic test flow for determining ABM1 and ABM2. 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. Confirm that equipment that requires calibration has been calibrated, and that the noise level meets the requirements given in ANSI C63.19-2011 clause 7.3.1.
c. The drive level to the WD ise set such that the reference input level specified in ANSI C63.19-2011 Table 7.1 is input to the base station simulator (or manufacturer's test mode equivalent) in 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 ANSI C63.19-2011 clause 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. The same drive level shall 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 ANSI C63.19-2011 clause 7.4.4.1.1 and 7.4.4.2.
e. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at fi) as described in ANSI C63.19-2011 clause 7.4.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency (fi) 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.
f. 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 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.)
g. 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 ANSI C63.19-2011 clause 7.3.1.
h. At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in ANSI C63.19-2011 clause 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).
i. Obtain the data from the postprocessor, SEMCAD, and determine the category that properly classifies the signal quality based on ANSI C63.19-2011 Table 8.5.

## 7.1 Test Flow Chart

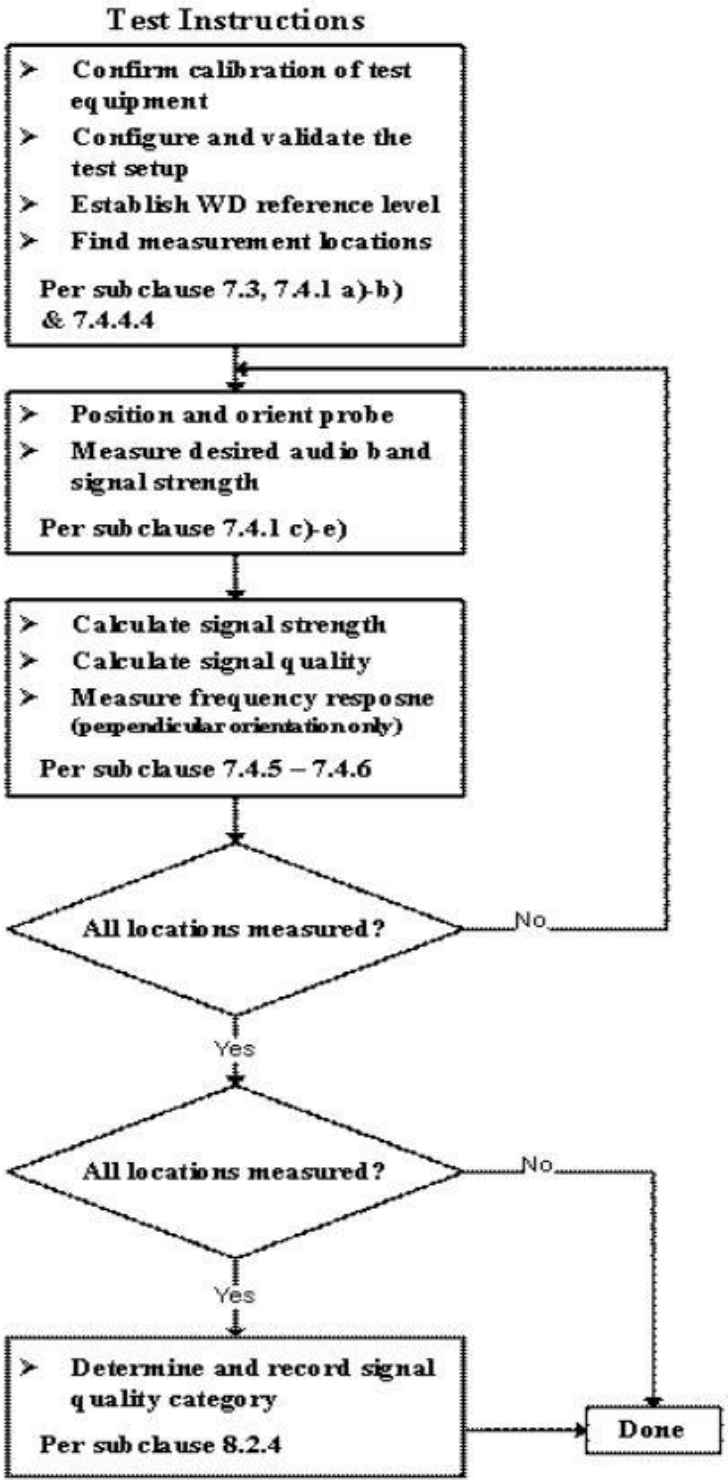
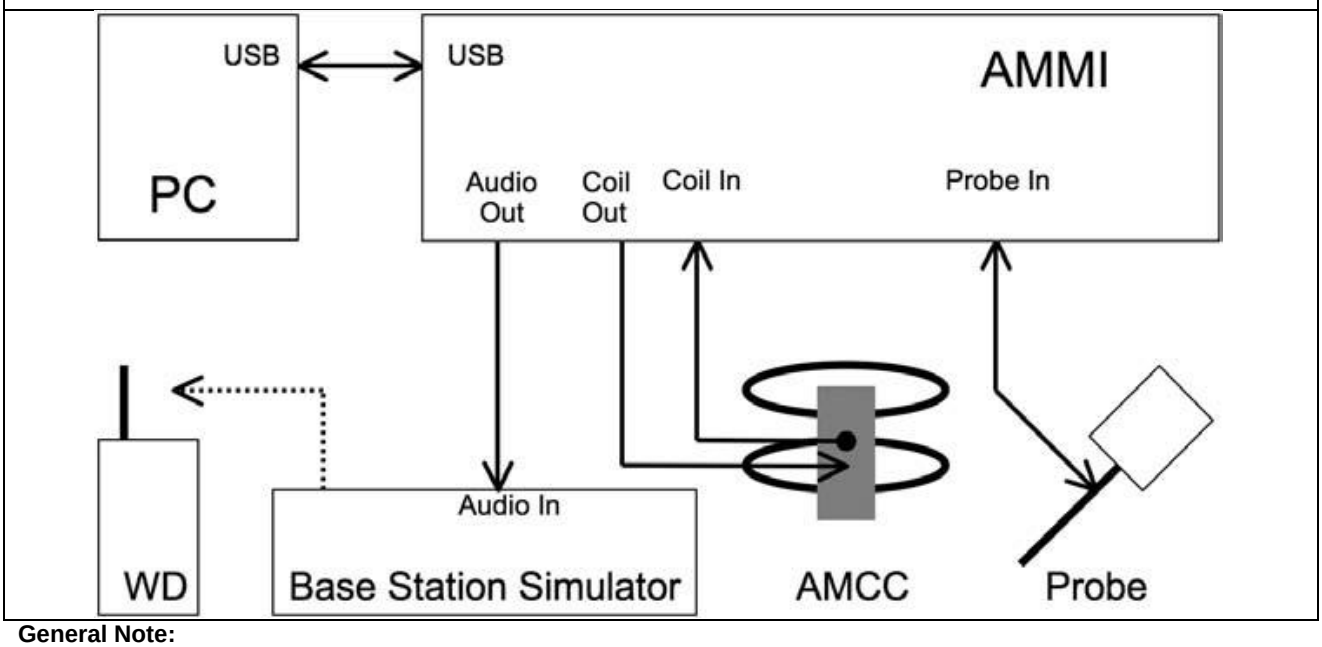



**Fig. 2 T-Coil Signal Test flowchart**

## 7.2 Test Setup Diagram for GSM/UMTS/VoLTE/VoWiFi

**Test Setup for GSM / UMTS/ VoLTE/VoWiFi**




**General Note:**

1. Define the all applicable input audio level as below according to C63 and KDB 285076 D02v04:
   - GSM input level: -16dBm0
   - UMTS input level: -16dBm0
   - VoLTE input level: -16dBm0
   - VoWiFi input level: -20dBm0
2. For GSM / UMTS test setup and input level, the correct input level definition is via a communication tester CMU200's "Decoder Cal" and "Codec Cal" with audio option B52 and B85 to set the correct audio input levels.
3. CMU200 is able to output 1kHz audio signal equivalent to 3.14dBm0 at "Decoder Cal." confuguration, the signal reference is used to adjust the AMMI gain setting to reach -16dBm0 for GSM/UMTS. CMW500 input is calibrated and the relation between the analog input voltage and the internal level in dBm0 can be determined
4. Voice over Long-Term Evolution (VoLTE) is a standard for high-speed wireless communication for mobile phones and data terminals — including IoT devices and wearables. It is based on the IP Multimedia Subsystem (IMS) network, with specific profiles for control and media planes of voice service on LTE defined by GSMA in PRD IR.92. This approach results in the voice service (control and media planes) being delivered as data flows within the LTE data bearer. This means that there is no dependency on the legacy circuit-switched voice network to be maintained
5. The test setup used for VoLTE and VoWiFI over IMS is via the callbox of CMW500 for T-coil measurement, The data application unit of the CMW500 was used to simulate the IP multimedia subsystem server. The CMW500 can be manually configured to ensure and control the speech input level result is -16dBm0 for VoLTE, -20dBm0 for VoWiFi when the device during the IMS connection.
6. According to KDB 285076 D02, T-Coil testing for VoLTE and VoWiFi requires test instrumentation that can (1) for the system to be able to establish an IP call from/to the handset under test, (2) through an IMS (IP Multimedia Subsystem) and SIP/IP server, (3) to an analog audio adapter containing the permissible set of codecs used by the device under test, and (4) inject the necessary C63.19 test tones at the average speech level for the measurement The test setup is illustrated in Figure 3.9. The R&S CMW500 was used as system simulator for VoLTE and VoWiFi T-Coil testing. The DAU (Data Application Unit) in CMW500 integrates IMS and SIP/IP server that can establish VoLTE and Wi-Fi calling, and transport the test tones from AMMI (Audio Magnetic Measuring Instrument) to EUT.
7. T-coil performance assessment for 5G FR1 was performed according to KDB 285076 D03 v01r06, Q&A 9, details are illustrated in section 7.4.

**<Define the input level for GSM/UMTS>**

1. The Required gain factor for the specific signal shall typically be multiplied by this factor to achieve approx. the same level as for the 1kHz sine signal
2. The below calculation formula is an example and showing how to determine the input level for the device.

The predefined signal types have the following differences / factors compared to the 1kHz sine signal:

| Signal [file name] | Duration [s] | Peak-to-RMS [dB] | RMS [dB] | Required gain factor *) | Gain setting |
|---|---|---|---|---|---|
| 1kHz sine | --- | 3.0 | 0.0 | 1.00 | |
| 48k_1.025kHz_10s.wav | 10 | 3.0 | 0.0 | 1.00 | |
| 48k_1kHz_3.15kHz_10s.wav | 10 | 6.0 | -3.0 | 1.42 | |
| 48k_315Hz_1kHz_10s.wav | 10 | 6.0 | -2.9 | 1.40 | |
| 48k_csek_8k_441_white_10s.wav | 10 | 13.8 | -10.5 | 3.34 | |
| 48k_multisine_50-5000_10s.wav | 10 | 11.1 | -7.9 | 2.49 | |
| 48k_voice_1kHz_1s.wav | 1 | 16.2 | -12.7 | 4.33 | |
| 48k_voice_300-3000_2s.wav | 2 | 21.6 | -18.6 | 8.48 | |

(*) The gain for the specific signal shall typically be multiplied by this factor to acheive approx. the same level as for the 1kHz sine signal.

Insert the gain applicable for your setup in the last column of the table.

**<Example define the input level for GSM/UMTS>**

| Gain Value | 20* log(gain) | AMCC Coil In | Level |
|---|---|---|---|
| (linear) | dB | (dBv RMS) | dBm0 |
| | | -2.47 | 3.14 |
| 10 | 20 | -19.85 | -14.24 |
| 8.17 | 18.24 | -21.61 | -16 |

| Signal Type | Duration (s) | Peak to RMS (dB) | RMS (dB) | Required Gain Factor | Calculated Gain Setting |
|---|---|---|---|---|---|
| 1kHz sine | - | 3 | 0 | 1 | 8.17 |
| 48k_voice_1kHz | 1 | 16.2 | -12.7 | 4.33 | 35.36 |
| 48k_voice_300Hz ~ 3kHz | 2 | 21.6 | -18.6 | 8.48 | 69.25 |

**<Example define the input level for VoLTE>**

| Gain Value | dBm0 | Full scal Voltage | dB | AMMI audio out dBv (RMS) | AMCC Coil Out (dBv (RMS) |
|---|---|---|---|---|---|
| | 3.14 | 1.5 | | 0.51 | |
| 100 | 5.57 | | 40 | 2.94 | 3.09 |
| 8.35 | -16 | | 18.43 | | -18.48 |
| **Signal Type** | **Duration (s)** | **Peak to RMS (dB)** | **RMS (dB)** | **Gain Factor** | **Gain Setting** |
| 1kHz sine | - | 3 | 0 | 1 | 8.35 |
| 48k_voice_1kHz | 1 | 16.2 | -12.7 | 4.33 | 36.15 |
| 48k_voice_300-3000 | 2 | 21.6 | -18.6 | 8.48 | 70.79 |

**<Example define the input level for VoWiFi>**

| Gain Value | dBm0 | Full scal Voltage | dB | AMMI audio out dBv (RMS) | AMCC Coil Out (dBv (RMS) |
|---|---|---|---|---|---|
| | 3.14 | 1.5 | | 0.51 | |
| 100 | 5.57 | | 40 | 2.94 | 3.09 |
| 5.27 | -20 | | 14.43 | | -22.48 |
| **Signal Type** | **Duration (s)** | **Peak to RMS (dB)** | **RMS (dB)** | **Gain Factor** | **Gain Setting** |
| 1kHz sine | - | 3 | 0 | 1 | 5.27 |
| 48k_voice_1kHz | 1 | 16.2 | -12.7 | 4.33 | 22.81 |
| 48k_voice_300-3000 | 2 | 21.6 | -18.6 | 8.48 | 44.67 |

## 7.3 PAG Reuse section: HAC T-coil measurement procedures for 5G NR

**5G VoNR test procedure:**

1. According to KDB 285076 D03 Q&A 9 , for 5G Sub 6 calls that use the same protocol, Codec(s) and reference level as VoLTE over LTE (i.e. -16 dBm0).
2. For LTE, establish the ABM1S65G value by using the ABM1LTE magnetic intensity for an LTE call in the same band as the 5G sub6 band under test.
3. For VoNR, establish the ABM1S65G value by using an IP connection for magnetic intensity for a call in the same band as the 5G sub6 band under test
4. Also note the actual ABM2LTE value and establish an ABM2S65G value, using a 5G manufacture test mode over 5G Sub 6 channels for the same band under test.
5. Document in the test report matrix:
   a. Include columns for both ABM2LTE & ABM2S65G for comparison
   b. Establish the S+N1/N2 for the rating
      i. S+N1 = ABM1LTE (step 1) and
      ii. N2 = ABM2S65G (step 2).
      iii. Subtract 3 dB from S+N1/N2
   c. Rating based on (ABM1LTE/ ABM2S65G) -3dB.

# 8. Test Equipment List

| Manufacturer | Name of Equipment | Type/Model | Serial Number | Calibration | |
|---|---|---|---|---|---|
| | | | | Last Cal. | Due Date |
| SPEAG | Audio Magnetic 1D Field Probe | AM1DV3 | 3106 | 2022/12/13 | 2023/12/12 |
| SPEAG | Data Acquisition Electronics | DAE4 | 1650 | 2022/8/5 | 2023/8/4 |
| SPEAG | Audio Magnetic Calibration Coil | AMCC | 1049 | NCR | NCR |
| SPEAG | Audio Measuring Instrument | AMMI | 1041 | NCR | NCR |
| Testo | Thermo-Hygrometer | 608-H1 | 1241332126 | 2023/1/5 | 2024/1/4 |
| R&S | Base Station | CMW500 | 143030 | 2022/7/14 | 2023/7/13 |
| SPEAG | Test Arch Phantom | N/A | N/A | NCR | NCR |
| SPEAG | Phone Positioner | N/A | N/A | NCR | NCR |

**Note:**
1. NCR: “No-Calibration Required”

# 9. T-Coil testing for CMRS Voice

**General Note:**

1. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following worst investigation codec would be remarked to be used for the testing for the handset.
2. Air Interface Investigation:
   a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface.
   b. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

## 9.1 GSM Tests Results

**<Codec Investigation>**

| | GSM Codec | | | | |
|---|---|---|---|---|---|
| Codec | AMR NB FR | AMR WB FR | GSM EFR (FR V2) | Orientation | Band / Channel |
| ABM 1 (dBA/m) | 5.35 | 5.04 | 5.66 | Axial | GSM850 / 189 |
| ABM 2 (dBA/m) | -15.59 | -16.21 | -15.77 | | |
| Signal Quality (dB) | 20.94 | 21.25 | 21.43 | | |
| Freq. Response | PASS | PASS | PASS | | |

Remark: According to codec investigation, the worst codec is AMR NB FR.

**<Air Interface Investigation>**

| Plot No. | Air Interface | Mode | Channel | Probe Position | ABM1 dB (A/m) | ABM2 dB (A/m) | Signal Quality dB | T Rating | Ambient Noise dB (A/m) | Freq. Response Variation dB | Frequency Response |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GSM850 | Voice | 189 | Axial (Z) | 5.35 | -15.59 | 20.94 | T3 | -55.62 | 0.78 | Pass |
| | | | | Transversal (Y) | -0.51 | -25.51 | 25.00 | T3 | -55.59 | | |
| 2 | GSM1900 | Voice | 661 | Axial (Z) | 4.03 | -29.82 | 33.85 | T4 | -55.63 | 1.42 | Pass |
| | | | | Transversal (Y) | -6.37 | -41.82 | 35.45 | T4 | -56.13 | | |

## 9.2 UMTS Tests Results

**<Codec Investigation>**

| UMTS AMR Codec | | | | | | |
|---|---|---|---|---|---|---|
| Codec | NB AMR 4.75Kbps | WB AMR 6.60Kbps | NB AMR 12.2Kbps | WB AMR 23.85Kbps | Orientation | Band / BW / Channel |
| ABM 1 (dBA/m) | 3.79 | 2.99 | 6.29 | 4.47 | Axial | B5 / 4182 |
| ABM 2 (dBA/m) | -43.83 | -44.35 | -41.6 | -43.4 | | |
| Signal Quality (dB) | 47.62 | 47.34 | 47.89 | 47.87 | | |
| Freq. Response | PASS | PASS | PASS | PASS | | |

Remark: According to codec investigation, the worst codec is WB AMR 6.60Kbps

**<Air Interface Investigation>**

| Plot No. | Air Interface | Mode | Channel | Probe Position | ABM1 dB (A/m) | ABM2 dB (A/m) | Signal Quality dB | T Rating | Ambient Noise dB (A/m) | Freq. Response Variation dB | Frequency Response |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | WCDMA II | Voice | 9400 | Axial (Z) | 3.87 | -42.90 | 46.77 | T4 | -55.63 | 2 | Pass |
| | | | | Transversal (Y) | -4.84 | -49.05 | 44.21 | T4 | -55.17 | | |
| 4 | WCDMA IV | Voice | 1413 | Axial (Z) | 3.86 | -44.37 | 48.23 | T4 | -55.22 | 1.66 | Pass |
| | | | | Transversal (Y) | -4.67 | -49.40 | 44.73 | T4 | -55.42 | | |
| 5 | WCDMA V | Voice | 4182 | Axial (Z) | 2.99 | -44.35 | 47.34 | T4 | -55.19 | 1.64 | Pass |
| | | | | Transversal (Y) | -7.91 | -51.19 | 43.28 | T4 | -55.10 | | |

# 10. T-Coil testing for CMRS IP Voice

## 10.1 VoLTE Tests Results

**General Note:**

1. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel / band, the following worst investigation codec would be remarked to be used for the testing for the handset.
2. Air Interface Investigation:
   a. Use the worst-case codec test and document a limited set of bands / channel / bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface and the following worst configure would be remarked to be used for the testing for the handset.
   b. Select LTE FDD/TDD one frequency band to do measurement at the worst SNR position was additionally performed with varying the BWs/Modulations/RB size to verify the variation to find out worst configuration , the observed variation is very little to be within 1.5 dB which is much less than the margin from the rating threshold.
   c. The TDD LTE power class 3 supports uplink-downlink configuration 0 and 6 and power class 2 supports uplink-downlink configuration1 to 5 for this device, an investigation was performed to determine the worst-case uplink-downlink configuration to be used for the testing for the handset.
   d. For TDD LTE B41 UL CA is operated in power class3, an investigation is selected worst case UL-DL configuration with worst case radio configuration result is used.
   e. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

**<Codec Investigation>**

**LTE FDD**

| VoLTE AMR Codec | | | | | | |
|---|---|---|---|---|---|---|
| Codec | NB AMR 4.75Kbps | WB AMR 6.60Kbps | NB AMR 12.2Kbps | WB AMR 23.85Kbps | Orientation | Band / BW / Channel |
| ABM 1 (dBA/m) | 3.46 | 1.37 | 3.66 | 3.57 | Axial | B2/ 20M / 18900 |
| ABM 2 (dBA/m) | -37.57 | -37.16 | -37.75 | -36.74 | | |
| Signal Quality (dB) | 41.03 | 38.53 | 41.41 | 40.31 | | |
| Freq. Response | PASS | PASS | PASS | PASS | | |

| VoLTE EVS Codec | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Codec | EVS SWB 9.6Kbps | EVS SWB 128Kbps | EVS WB 5.9Kbps | EVS WB 128Kbps | EVS NB 5.9Kbps | EVS NB 24.4Kbps | Orientation | Band / BW / Channel |
| ABM 1 (dBA/m) | 3.69 | 5.43 | -0.24 | 4.36 | 0.37 | 6.07 | Axial | B2 / 20M / 18900 |
| ABM 2 (dBA/m) | -37.92 | -37.41 | -38.21 | -35.17 | -36.66 | -36.66 | | |
| Signal Quality (dB) | 41.61 | 42.84 | 37.97 | 39.53 | 37.03 | 42.73 | | |
| Freq. Response | PASS | PASS | PASS | PASS | PASS | PASS | | |

Remark: According to codec investigation, the worst codec is EVS NB 5.9Kbps

## LTE TDD

| VoLTE AMR Codec | | | | | | |
|---|---|---|---|---|---|---|
| Codec | NB AMR 4.75Kbps | WB AMR 6.60Kbps | NB AMR 12.2Kbps | WB AMR 23.85Kbps | Orientation | Band / BW / Channel |
| ABM 1 (dBA/m) | 5.36 | 1.17 | 4.87 | 3.99 | Axial | B41 / 20M / 40620 |
| ABM 2 (dBA/m) | -26.77 | -27.27 | -26.12 | -27.21 | | |
| Signal Quality (dB) | 32.13 | 28.44 | 30.99 | 31.2 | | |
| Freq. Response | PASS | PASS | PASS | PASS | | |

| VoLTE EVS Codec | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Codec | EVS SWB 9.6Kbps | EVS SWB 128Kbps | EVS WB 5.9Kbps | EVS WB 128Kbps | EVS NB 5.9Kbps | EVS NB 24.4Kbps | Orientation | Band / BW / Channel |
| ABM 1 (dBA/m) | 5.28 | 4.86 | 4.39 | 5 | 1.48 | 5.27 | Axial | B41 / 20M / 40620 |
| ABM 2 (dBA/m) | -27.88 | -27.4 | -26.63 | -27.1 | -24.93 | -27.03 | | |
| Signal Quality (dB) | 33.16 | 32.26 | 31.02 | 32.1 | 26.41 | 32.3 | | |
| Freq. Response | PASS | PASS | PASS | PASS | PASS | PASS | | |

Remark: According to codec investigation, the worst codec is EVS NB 5.9Kbps

## <Air Interface Investigation>

| Air Interface | | BW (MHz) | Modulation | RB Size | RB offset | Channel | UL-DL Configuration | ABM1 dB (A/m) | ABM2 dB (A/m) | Signal Quality dB |
|---|---|---|---|---|---|---|---|---|---|---|
| FDD | LTE B2 | 20 | QPSK | 1 | 0 | 18900 | | 2.59 | -37.04 | 39.63 |
| | LTE B2 | 20 | QPSK | 50 | 0 | 18900 | | 3.14 | -37.89 | 41.03 |
| | LTE B2 | 20 | QPSK | 100 | 0 | 18900 | | 3.97 | -38.44 | 42.41 |
| | LTE B2 | 20 | 16QAM | 1 | 0 | 18900 | | 1.82 | -36.39 | 38.21 |
| | LTE B2 | 20 | 64QAM | 1 | 0 | 18900 | | 2.61 | -36.43 | 39.04 |
| | LTE B2 | 15 | 16QAM | 1 | 0 | 18900 | | 3.40 | -36.72 | 40.12 |
| | LTE B2 | 10 | 16QAM | 1 | 0 | 18900 | | 2.68 | -37.15 | 39.83 |
| | LTE B2 | 5 | 16QAM | 1 | 0 | 18900 | | 4.24 | -35.02 | 39.26 |
| | LTE B2 | 3 | 16QAM | 1 | 0 | 18900 | | 3.15 | -35.14 | 38.29 |
| | LTE B2 | 1.4 | 16QAM | 1 | 0 | 18900 | | 3.11 | -35.94 | 39.05 |
| TDD | LTE B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 0 | 2.14 | -25.89 | 28.03 |
| | LTE B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 1 | 2.21 | -26.30 | 28.51 |
| | LTE B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 2 | 2.28 | -26.84 | 29.12 |
| | LTE B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 3 | 2.19 | -26.25 | 28.44 |
| | LTE B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 4 | 2.37 | -26.35 | 28.72 |
| | LTE B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 5 | 2.22 | -26.85 | 29.07 |
| | LTE B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 6 | 2.25 | -26.18 | 28.43 |
| | ULCA B41_PC3 | 20 | 16QAM | 1 | 0 | 40620 | 0 | 3.25 | -26.11 | 29.36 |

| Plot No. | Air Interface | BW (MHz) | Modulation / Mode | RB Size | RB offset | Channel | Probe Position | ABM1 dB (A/m) | ABM2 dB (A/m) | Signal Quality dB | T Rating | Ambient Noise dB (A/m) | Freq. Response Variation dB | Frequency Response |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | LTE Band 2 | 20M | 16QAM | 1RB | 0 | 18900 | Axial (Z) | 0.37 | -36.66 | 37.03 | T4 | -56.51 | 0.78 | Pass |
| | | | | | | | Transversal (Y) | -9.86 | -43.27 | 33.41 | T4 | -55.59 | | |
| 7 | LTE Band 12 | 10M | 16QAM | 1RB | 0 | 23095 | Axial (Z) | -1.43 | -36.92 | 35.49 | T4 | -55.51 | 0.81 | Pass |
| | | | | | | | Transversal (Y) | -8.02 | -42.57 | 34.55 | T4 | -55.61 | | |
| 8 | LTE Band 13 | 10M | 16QAM | 1RB | 0 | 23230 | Axial (Z) | 2.98 | -32.40 | 35.38 | T4 | -55.65 | 0.18 | Pass |
| | | | | | | | Transversal (Y) | -5.09 | -38.46 | 33.37 | T4 | -55.61 | | |
| 9 | LTE Band 26 | 15M | 16QAM | 1RB | 0 | 26865 | Axial (Z) | 2.52 | -41.61 | 44.13 | T4 | -55.59 | 0.37 | Pass |
| | | | | | | | Transversal (Y) | -11.34 | -49.90 | 38.56 | T4 | -55.63 | | |
| 10 | LTE Band 66 | 20M | 16QAM | 1RB | 0 | 132322 | Axial (Z) | 1.20 | -35.49 | 36.69 | T4 | -55.59 | 0.6 | Pass |
| | | | | | | | Transversal (Y) | -6.60 | -41.09 | 34.49 | T4 | -55.59 | | |
| 11 | LTE Band 7 | 20M | 16QAM | 1RB | 0 | 21100 | Axial (Z) | 3.87 | -35.96 | 39.83 | T4 | -55.57 | 0.65 | Pass |
| | | | | | | | Transversal (Y) | -7.88 | -42.84 | 34.96 | T4 | -55.59 | | |
| 12 | LTE Band 41 | 20M | 16QAM | 1RB | 0 | 40620 | Axial (Z) | 1.48 | -24.93 | 26.41 | T3 | -55.64 | 0.74 | Pass |
| | | | | | | | Transversal (Y) | -9.39 | -38.80 | 29.41 | T3 | -56.11 | | |
| 13 | LTE Band 42 | 20M | 16QAM | 1RB | 0 | 42590 | Axial (Z) | 6.38 | -27.38 | 33.76 | T4 | -55.63 | 0.19 | Pass |
| | | | | | | | Transversal (Y) | -6.61 | -43.99 | 37.38 | T4 | -55.65 | | |

## 10.1 VoNR evaluation

**General Notes:**

1. According to KDB 285076 D03, for 5G Sub 6 calls that use the same protocol, Codec(s) and reference level as VoLTE over LTE (i.e. -16 dBm0).
2. For LTE, establish the ABM1S65G value by using the ABM1LTE magnetic intensity for an LTE call in the same band as the 5G sub6 band under test.
3. For VoNR, establish the ABM1S65G value by using an IP connection for magnetic intensity for a call in the same band as the 5G sub6 band under test
4. Also note the actual ABM2LTE value and establish an ABM2S65G value, using a 5G manufacture test mode over 5G Sub 6 channels for the same band under test.
5. Document in the test report matrix:
   a. Include columns for both ABM2LTE & ABM2S65G for comparison
   b. Establish the S+N1/N2 for the rating
      i. S+N1 = ABM1LTE (step 1) and
      ii. N2 = ABM2S65G (step 2).
      iii. Subtract 3 dB from S+N1/N2
   c. Rating based on (ABM1LTE/ ABM2S65G) -3dB.

| Plot No. | Air Interface | BW (MHz) | Modulation | RB Size | RB offset | Channel | Probe Position | ABM1 dB (A/m) | ABM2 dB (A/m) | Signal Quality dB | T Rating | Ambient Noise dB (A/m) | Freq. Response Variation dB | Frequency Response |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | LTE Band 2 | 20M | 16QAM | 1 | 0 | 18900 | Axial (Z) | 0.37 | -36.66 | 37.03 | T4 | -56.51 | 0.78 | Pass |
| | | | | | | | Transversal (Y) | -9.86 | -43.27 | 33.41 | T4 | -55.59 | | |
| | FR1 n2 | 20M | QPSK | 1 | 1 | 376000 | Axial (Z) | 0.37 | -48.00 | 45.37 | T4 | -55.17 | | |
| | | | | | | | Transversal (Y) | -9.86 | -54.23 | 41.37 | T4 | -55.33 | | |
| 9 | LTE Band 26 | 15M | 16QAM | 1 | 0 | 26865 | Axial (Z) | 2.52 | -41.61 | 44.13 | T4 | -55.59 | 0.37 | Pass |
| | | | | | | | Transversal (Y) | -11.34 | -49.90 | 38.56 | T4 | -55.63 | | |
| | FR1 n5 | 20M | QPSK | 1 | 1 | 167300 | Axial (Z) | 2.52 | -47.73 | 47.25 | T4 | -55.61 | | |
| | | | | | | | Transversal (Y) | -11.34 | -45.51 | 31.17 | T4 | -55.48 | | |
| 10 | LTE Band 66 | 20M | 16QAM | 1 | 0 | 132322 | Axial (Z) | 1.20 | -35.49 | 36.69 | T4 | -55.59 | 0.6 | Pass |
| | | | | | | | Transversal (Y) | -6.60 | -41.09 | 34.49 | T4 | -55.59 | | |
| | FR1 n66 | 40M | QPSK | 1 | 1 | 349000 | Axial (Z) | 1.20 | -33.21 | 31.41 | T4 | -54.93 | | |
| | | | | | | | Transversal (Y) | -6.60 | -35.20 | 25.60 | T3 | -55.04 | | |
| 11 | LTE Band 7 | 20M | 16QAM | 1 | 0 | 21100 | Axial (Z) | 3.87 | -35.96 | 39.83 | T4 | -55.57 | 0.65 | Pass |
| | | | | | | | Transversal (Y) | -7.88 | -42.84 | 34.96 | T4 | -55.59 | | |
| | FR1 n7 | 50M | QPSK | 1 | 1 | 507000 | Axial (Z) | 3.87 | -31.24 | 32.11 | T4 | -55.11 | | |
| | | | | | | | Transversal (Y) | -7.88 | -37.40 | 26.52 | T3 | -55.16 | | |
| 12 | LTE Band 41 | 20M | 16QAM | 1 | 0 | 40620 | Axial (Z) | 1.48 | -24.93 | 26.41 | T3 | -55.64 | 0.74 | Pass |
| | | | | | | | Transversal (Y) | -9.39 | -38.80 | 29.41 | T3 | -56.11 | | |
| | FR1 n41 | 100M | QPSK | 1 | 1 | 518598 | Axial (Z) | 1.48 | -34.14 | 32.62 | T4 | -55.32 | | |
| | | | | | | | Transversal (Y) | -9.39 | -50.30 | 37.91 | T4 | -55.47 | | |
| 13 | LTE Band 42 | 20M | 16QAM | 1 | 0 | 42590 | Axial (Z) | 6.38 | -27.38 | 33.76 | T4 | -55.63 | 0.19 | Pass |
| | | | | | | | Transversal (Y) | -6.61 | -43.99 | 37.38 | T4 | -55.65 | | |
| | FR1 n77 | 100M | QPSK | 1 | 1 | 656000 | Axial (Z) | 6.38 | -35.33 | 38.71 | T4 | -55.37 | | |
| | | | | | | | Transversal (Y) | -6.61 | -45.80 | 36.19 | T4 | -55.33 | | |

## 10.2 VoWiFi Tests Results

**General Note:**

1. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following worst investigation codec would be remarked to be used for the testing for the handset.
2. Air Interface Investigation:
   a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface and the following worst configure would be remarked to be used for the testing for the handset.
   b. Select WLAN 2.4GHz and WLAN 5GHz one frequency band to do measurement at the worst SNR position was additionally performed with varying the BWs/Modulations/data rate to verify the variation to find out worst configuration , the observed variation is very little to be within 1 dB which is much less than the margin from the rating threshold.
   c. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

**<Codec Investigation>**

| VoWIFI AMR Codec | | | | | | |
|---|---|---|---|---|---|---|
| **Codec** | **NB AMR 4.75Kbps** | **WB AMR 6.60Kbps** | **NB AMR 12.2Kbps** | **WB AMR 23.85Kbps** | **Orientation** | **Band / Channel** |
| ABM 1 (dBA/m) | -4.7 | -4.84 | -4.89 | -4.66 | Axial | 2.4GHz WLAN / 6 |
| ABM 2 (dBA/m) | -37.52 | -38.23 | -39.21 | -38.17 | | |
| Signal Quality (dB) | 32.82 | 33.39 | 34.32 | 33.51 | | |
| Freq. Response | Pass | Pass | Pass | Pass | | |

| VoWIFI EVS Codec | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Codec** | **EVS SWB 9.6Kbps** | **EVS SWB 128Kbps** | **EVS WB 5.9Kbps** | **EVS WB 128Kbps** | **EVS NB 5.9Kbps** | **EVS NB 24.4Kbps** | **Orientation** | **Band / BW / Channel** |
| ABM 1 (dBA/m) | -3.96 | -4.51 | -4.86 | -4.17 | -4.22 | -4.19 | Axial | 2.4GHz WLAN / 6 |
| ABM 2 (dBA/m) | -36.85 | -37.62 | -38.05 | -37.79 | -37.94 | -37.16 | | |
| Signal Quality (dB) | 32.89 | 33.11 | 33.19 | 33.62 | 33.72 | 32.97 | | |
| Freq. Response | Pass | Pass | Pass | Pass | Pass | Pass | | |

Remark: According to codec investigation, the worst codec is NB AMR 4.75Kbps

**<Air Interface Investigation>**

| Frequency Bands | Modulation | Bandwidth | Data Rate | Channel | ABM1 dB (A/m) | ABM2 dB (A/m) | Signal Quality dB |
|---|---|---|---|---|---|---|---|
| WLAN 2.4GHz | 802.11b | 20 | 1M | 6 | -3.67 | -36.71 | 33.04 |
| | 802.11b | 20 | 11M | 6 | -2.87 | -37.71 | 34.84 |
| | 802.11g | 20 | 6M | 6 | -2.46 | -36.28 | 33.82 |
| | 802.11g | 20 | 54M | 6 | -2.55 | -36.86 | 34.31 |
| | 802.11n-HT20 | 20 | MCS0 | 6 | -2.87 | -38.60 | 35.73 |
| | 802.11n-HT20 | 20 | MCS7 | 6 | -2.68 | -37.49 | 34.81 |
| | 802.11n-HT40 | 40 | MCS0 | 6 | -2.55 | -41.23 | 38.68 |
| | 802.11n-HT40 | 40 | MCS7 | 6 | -2.65 | -41.36 | 38.71 |
| | 802.11ax-HE20 | 20 | MCS0 | 6 | -2.54 | -41.22 | 38.68 |
| | 802.11ax-HE20 | 20 | MCS11 | 6 | -2.35 | -40.87 | 38.52 |
| | 802.11ax-HE40 | 40 | MCS0 | 6 | -2.39 | -40.96 | 38.57 |
| | 802.11ax-HE40 | 40 | MCS11 | 6 | -2.91 | -41.80 | 38.89 |
| WLAN 5GHz | 802.11a | 20 | 6M | 40 | -2.35 | -35.93 | 33.58 |
| | 802.11a | 20 | 54M | 40 | -2.69 | -38.47 | 35.78 |
| | 802.11an-HT20 | 20 | MCS0 | 40 | -2.31 | -36.33 | 34.02 |
| | 802.11an-HT20 | 20 | MCS7 | 40 | -2.31 | -37.42 | 35.11 |
| | 802.11an-HT40 | 40 | MCS0 | 38 | -2.65 | -38.26 | 35.61 |
| | 802.11an-HT40 | 40 | MCS7 | 38 | -2.51 | -38.06 | 35.55 |
| | 802.11ac-VHT20 | 20 | MCS0 | 40 | -2.67 | -40.11 | 37.44 |
| | 802.11ac-VHT20 | 20 | MCS8 | 40 | -2.51 | -38.86 | 36.35 |
| | 802.11ac-VHT40 | 40 | MCS0 | 38 | -2.36 | -36.83 | 34.47 |
| | 802.11ac-VHT40 | 40 | MCS8 | 38 | -2.22 | -37.73 | 35.51 |
| | 802.11ac-VHT80 | 80 | MCS0 | 58 | -2.19 | -37.97 | 35.78 |
| | 802.11ac-VHT80 | 80 | MCS8 | 58 | -2.23 | -37.84 | 35.61 |
| | 802.11ax-HE20 | 20 | MCS0 | 40 | -2.53 | -36.38 | 33.85 |
| | 802.11ax-HE20 | 20 | MCS11 | 40 | -2.65 | -36.56 | 33.91 |
| | 802.11ax-HE40 | 40 | MCS0 | 38 | -2.71 | -36.82 | 34.11 |
| | 802.11ax-HE40 | 40 | MCS11 | 38 | -3.73 | -37.88 | 34.15 |
| | 802.11ax-HE80 | 80 | MCS0 | 58 | -3.65 | -37.70 | 34.05 |
| | 802.11ax-HE80 | 80 | MCS11 | 58 | -3.52 | -37.58 | 34.06 |

| Plot No. | Air Interface | BW (MHz) | Modulation / Mode | Channel | Probe Position | ABM1 dB (A/m) | ABM2 dB (A/m) | Signal Quality dB | T Rating | Ambient Noise dB (A/m) | Freq. Response Variation dB | Frequency Response |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | WLAN2.4GHz | 20 | 802.11b 1Mbps | 6 | Axial (Z) | -4.70 | -37.52 | 32.82 | T4 | -55.81 | 0.61 | Pass |
| | | | | | Transversal (Y) | -14.22 | -44.23 | 30.01 | T4 | -55.86 | | |
| 16 | WLAN 5.2GHz | 20 | 802.11a 6Mbps | 40 | Axial (Z) | -1.48 | -36.55 | 35.07 | T4 | -55.55 | 0.62 | Pass |
| | | | | | Transversal (Y) | -10.41 | -41.76 | 31.35 | T4 | -55.53 | | |
| 17 | WLAN 5.3GHz | 20 | 802.11a 6Mbps | 60 | Axial (Z) | -4.07 | -40.81 | 36.74 | T4 | -55.61 | 0.36 | Pass |
| | | | | | Transversal (Y) | -10.11 | -42.44 | 32.33 | T4 | -55.60 | | |
| 18 | WLAN 5.5GHz | 20 | 802.11a 6Mbps | 116 | Axial (Z) | -4.30 | -41.32 | 37.02 | T4 | -55.56 | 0.22 | Pass |
| | | | | | Transversal (Y) | -9.99 | -45.20 | 35.21 | T4 | -55.59 | | |
| 19 | WLAN 5.8GHz | 20 | 802.11a 6Mbps | 157 | Axial (Z) | -3.94 | -38.90 | 34.96 | T4 | -55.55 | 1.57 | Pass |
| | | | | | Transversal (Y) | -10.98 | -47.26 | 36.28 | T4 | -55.54 | | |

**Remark:**

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

**Test Engineer :** Martin Li, Varus Wang, Light Wang, Ricky Gu

# 11. Uncertainty Assessment

The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance. The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual “root-sum-squares” (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances. Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is showed in Table 8.2.
The judgment of conformity in the report is based on the measurement results excluding the measurement uncertainty.

| Error Description | Uncertainty Value (±%) | Probability | Divisor | (Ci) ABM1 | (Ci) ABM2 | Standard Uncertainty (ABM1) (±%) | Standard Uncertainty (ABM2) (±%) |
|---|---|---|---|---|---|---|---|
| **Probe Sensitivity** | | | | | | | |
| Reference Level | 3.0 | N | 1 | 1 | 1 | 3.0 | 3.0 |
| AMCC Geometry | 0.4 | R | 1.732 | 1 | 1 | 0.2 | 0.2 |
| AMCC Current | 1.0 | R | 1.732 | 1 | 1 | 0.6 | 0.6 |
| Probe Positioning during Calibr. | 0.1 | R | 1.732 | 1 | 1 | 0.1 | 0.1 |
| Noise Contribution | 0.7 | R | 1.732 | 0.014 | 1 | 0.0 | 0.4 |
| Frequency Slope | 5.9 | R | 1.732 | 0.1 | 1 | 0.3 | 3.4 |
| **Probe System** | | | | | | | |
| Repeatability / Drift | 1.0 | R | 1.732 | 1 | 1 | 0.6 | 0.6 |
| Linearity / Dynamic Range | 0.6 | R | 1.732 | 1 | 1 | 0.3 | 0.3 |
| Acoustic Noise | 1.0 | R | 1.732 | 0.1 | 1 | 0.1 | 0.6 |
| Probe Angle | 2.3 | R | 1.732 | 1 | 1 | 1.3 | 1.3 |
| Spectral Processing | 0.9 | R | 1.732 | 1 | 1 | 0.5 | 0.5 |
| Integration Time | 0.6 | N | 1 | 1 | 5 | 0.6 | 3.0 |
| Field Distribution | 0.2 | R | 1.732 | 1 | 1 | 0.1 | 0.1 |
| **Test Signal** | | | | | | | |
| Ref. Signal Spectral Response | 0.6 | R | 1.732 | 0 | 1 | 0.0 | 0.3 |
| **Positioning** | | | | | | | |
| Probe Positioning | 1.9 | R | 1.732 | 1 | 1 | 1.1 | 1.1 |
| Phantom Thickness | 0.9 | R | 1.732 | 1 | 1 | 0.5 | 0.5 |
| DUT Positioning | 1.9 | R | 1.732 | 1 | 1 | 1.1 | 1.1 |
| **External Contributions** | | | | | | | |
| RF Interference | 0.0 | R | 1.732 | 1 | 0.3 | 0.0 | 0.0 |
| Test Signal Variation | 2.0 | R | 1.732 | 1 | 1 | 1.2 | 1.2 |
| **Combined Std. Uncertainty** | | | | | | 4.0% | 6.1% |
| **Coverage Factor for 95 %** | | | | | | K=2 | K=2 |
| **Expanded STD Uncertainty** | | | | | | 8.1% | 12.2% |

**Table 8.2 Uncertainty Budget of audio band magnetic measurement**

## 12. References

[1] ANSI C63.19-2011, “American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”, 27 May 2011.

[2] FCC KDB 285076 D01v06r02, “Equipment Authorization Guidance for Hearing Aid Compatibility”, September 19, 2022

[3] FCC KDB 285076 D02 v04, “Guidance for performing T-Coil tests for air interfaces supporting voice over IP (e.g., LTE and WiFi) to support CMRS based telephone services”, Feb. 23, 2022

[4] FCC KDB 285076 D03v01r06, “Hearing aid compatibility frequently asked questions”, July 20, 2022

[5] SPEAG DASY System Handbook

------THE END------