HAC T-Coil Test Report

Report No.	:	**HFBCUN-WTW-P25020520-1**
Applicant	:	**Askey Computer Corporation**
Address	:	**10F, NO.119, JIANKANG RD., ZHONGHE DIST., NEW TAIPEI CITY, TAIWAN**
Product	:	**Mobile Computer**
FCC ID	:	**H8NPCTE020**
Brand	:	**Askey**
Model No.	:	**RC40**
FCC Rule Part	:	**CFR §20.19**
Standards	:	**ANSI C63.19-2019, KDB 285076 D01 v06r02, KDB 285076 D02 v04, KDB 285076 D03 v01r06, RSS-HAC-2022 ISSUE2 AMEDMENT**
Sample Received Date	:	**Mar. 11, 2025**
Date of Testing	:	**May 21, 2025 ~ Jun. 26, 2025**
Lab Address	:	**No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan**
Test Location	:	**No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City, Taiwan**
FCC Accredited No.	:	**TW0003**

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch – Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's HAC characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

Prepared By : Gina Liu

Gina Liu / Specialist

Approved By : Gordon Lin

Gordon Lin / Manager

Testing Laboratory
2021

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Release Control Record

Report No.	Reason for Change	Date Issued
HFBCUN-WTW-P25020520-1	Initial release	Jul. 04, 2025

1. Description of Equipment Under Test

EUT Type	Mobile Computer
FCC ID	H8NPCTE020
Brand Name	Askey
Model Name	RC40
Tx Frequency Bands (Unit: MHz)	WCDMA Band II : 1852.4 ~ 1907.6 WCDMA Band IV : 1712.4 ~ 1752.6 WCDMA Band V : 826.4 ~ 846.6 LTE Band 2 : 1850 ~ 1900 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M) LTE Band 4 : 1710 ~ 1755 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M) LTE Band 5 : 824 ~ 849 (BW: 1.4M, 3M, 5M, 10M) LTE Band 12 : 699 ~ 716 (BW: 1.4M, 3M, 5M, 10M) LTE Band 13 : 777 ~ 787 (BW: 5M, 10M) LTE Band 14 : 788 ~ 798 (BW: 5M, 10M) LTE Band 17 : 704 ~ 716 (BW: 5M, 10M) LTE Band 25 : 1850 ~ 1915 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M) LTE Band 26 : 814 ~ 849 (BW: 1.4M, 3M, 5M, 10M, 15M) LTE Band 30 : 2305 ~ 2315 (BW: 5M, 10M) LTE Band 38 : 2570~ 2620 (BW: 5M, 10M, 15M, 20M) LTE Band 41 : 2496 ~ 2690 (BW: 5M, 10M, 15M, 20M) LTE Band 42 : 3450 ~ 3600 (BW: 5M, 10M, 15M, 20M) LTE Band 43 : 3600 ~ 3700 (BW: 5M, 10M, 15M, 20M) LTE Band 48 : 3550 ~ 3700 (BW: 5M, 10M, 15M, 20M) LTE Band 53 : 2483.5 ~ 2495 (BW: 1.4M, 3M, 5M, 10M) LTE Band 66 : 1710 ~ 1780 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M) LTE Band 70 : 1695 ~ 1710 (BW: 5M, 10M, 15M) LTE Band 71 : 663 ~ 698 (BW: 5M, 10M, 15M, 20M) 5GNR-n2 : 1850 ~ 1910 (BW: 5M, 10M, 15M, 20M) 5GNR-n5 : 824 ~ 849 (BW: 5M, 10M, 15M, 20M) 5GNR-n7 : 2500 ~ 2570 (BW: 5M, 10M, 15M, 20M) 5GNR-n12 : 699 ~ 716 (BW: 5M, 10M, 15M) 5GNR-n13 : 777 ~ 787 (BW: 5M, 10M) 5GNR-n14 : 788 ~ 798 (BW: 5M, 10M) 5GNR-n25 : 1850 ~ 1915 (BW: 5M, 10M, 15M, 20M) 5GNR-n26 : 814 ~ 849 (BW: 5M, 10M, 15M, 20M) 5GNR-n30 : 2305 ~ 2315 (BW: 10M) 5GNR-n38 : 2570 ~ 2620 (BW: 15M, 20M, 30M, 40M) 5GNR-n41 : 2496 ~ 2690 (BW: 20M, 30M, 40M, 50M, 60M, 70M, 80M, 90M, 100M) 5GNR-n48 : 3550 ~ 3700 (BW: 20M, 40M) 5GNR-n53 : 2483.5 ~ 2495 (BW: 10M) 5GNR-n66 : 1710 ~ 1780 (BW: 5M, 10M, 15M, 20M) 5GNR-n70 : 1695 ~ 1710 (BW: 15M) 5GNR-n71 : 663 ~ 698 (BW: 5M, 10M, 15M, 20M) 5GNR-n77 : 3450 ~ 3550, 3700 ~ 3980 (BW: 20M, 30M, 40M, 60M, 80M, 100M) 5GNR-n78 : 3450 ~ 3550, 3700 ~ 3800(BW: 20M, 30M, 40M, 60M, 80M, 100M) WLAN : 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5720, 5745 ~ 5825, 5955 ~ 6415, 6435 ~ 6515, 6535 ~ 6855, 6875 ~ 7115 Bluetooth : 2402 ~ 2480 NFC : 13.56

Modulations Supported in Uplink	WCDMA : QPSK LTE : QPSK, 16QAM, 64QAM, 256QAM 5G NR: Pi/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM 802.11b : DSSS 802.11a/g/n/ac : OFDM 802.11ax : OFDMA Bluetooth : GFSK, π/4-DQPSK, 8-DPSK
Antenna Type	PIFA Antenna
EUT Stage	Engineering Sample

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

List of Accessory:

Battery	**Brand Name**	Askey
	Model Name	RC40-BR-SBL500
	Nominal Voltage	3.85V
	Nominal Capacity	5000mAh 19.25Wh
	Rated Capacity	4900mAh 18.865Wh
	Limited Charging Voltage	4.4V

<table>
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Interface</th><th>Bands</th><th>Transport
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Tested</th><th>Simultaneous
But Not Tested</th><th>Name of
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(UNII 5 ~ 8)</td><td>DT</td><td>No</td><td>WWAN, BT</td><td>N/A</td><td>No</td></tr>
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Transport Type
VO = Legacy Cellular Voice Service
DT = Digital Transport Only (No Voice)
VD = IP Voice Service over Digital Transport

Note
1. Reference level in accordance with 7.4.2.1 of ANSI C63.19-2019.
2. Reference level is −20 dBm0 in accordance with FCC KDB 285076 D02.
3. The device supported a pre-installed application, Google Meet, whose features allow the option of voice-only communications.
4. Because features of Google Meet and hangouts allow the option of voice-only communications, Meet has been tested for HAC/T-Coil compatibility to ensure the best user experience.
5. Wi-Fi 6E (U-NII 5 ~ 8) was not evaluated due to equipment limitations and being outside the scope of ANSI C63.19 and FCC HAC regulations in part 20.19.

2. HAC T-Coil Measurement System

2.1 SPEAG DASY8 System

The SPEAG DASY8 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY8 software defined. The DASY8 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

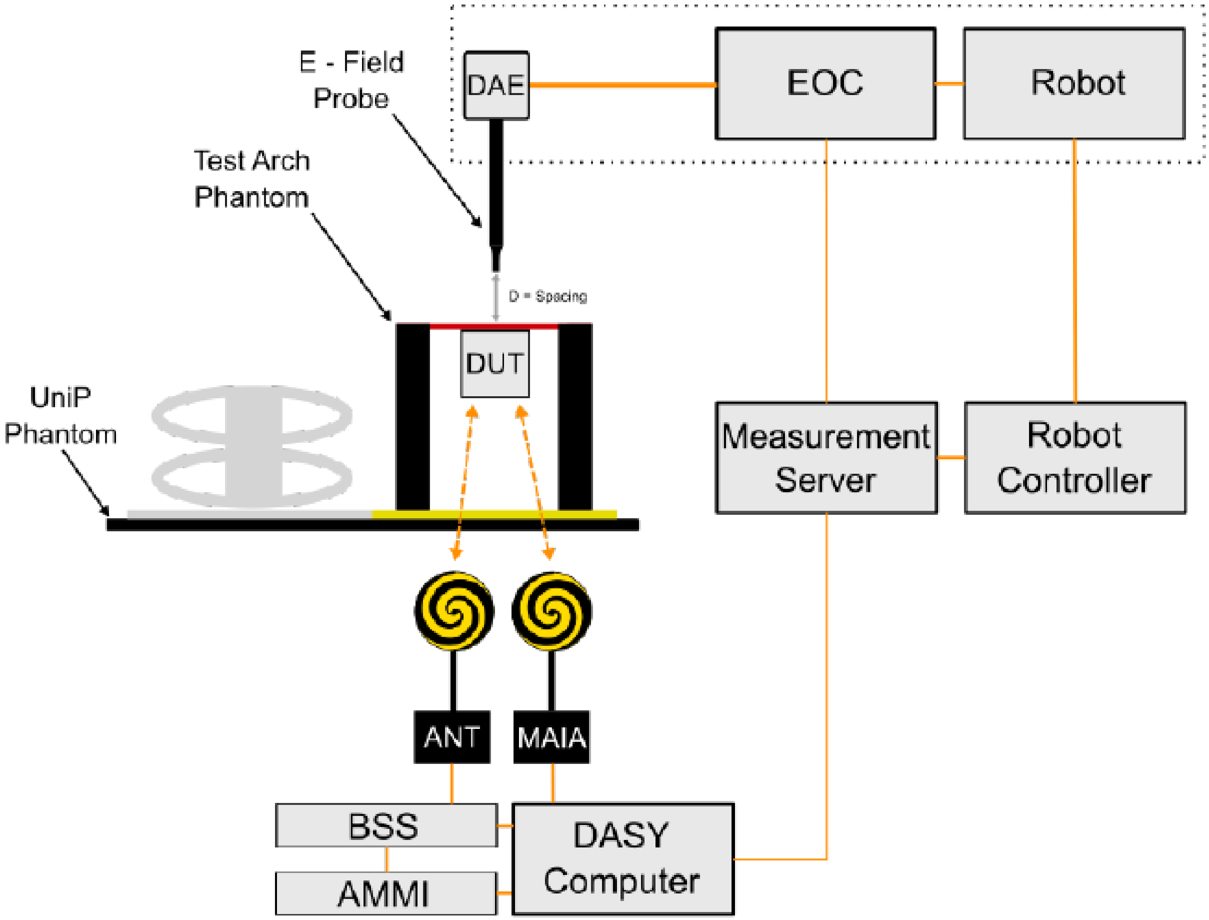


Fig-3.1 DASY8 System Setup

2.1.1 Robot

The DASY8 system uses the high-precision industrial robots TX2-60L and TX2-90XL from Stäubli SA (France). The TX2 family of robots provides the ideal combination of speed, rigidity, size, and precision:

- High precision (repeatability ±0.03 mm)
- High reliability and low maintenance costs (industrial design)
- ELF interference (motor control fields are shielded by the closed metallic construction)
- Hygienic encapsulated 6-axis arm enabled by a hollow shaft gearbox, no external cables.

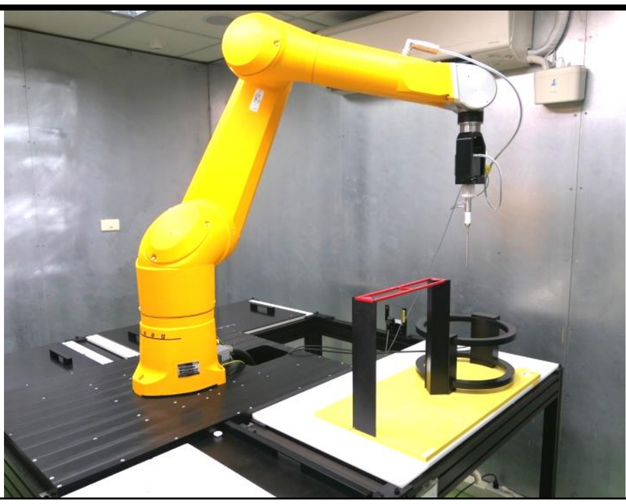
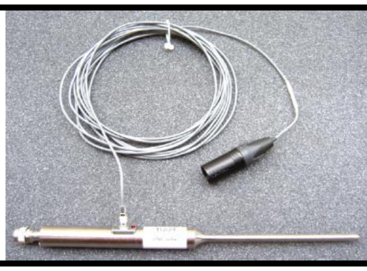


Fig-3.3 DASY8 Measurement System

2.1.2 AM1D Probe

The AM1D probe is an active probe with a single sensor. It is fully RF-shielded and has a rounded tip 6 mm in diameter incorporating a pickup coil with its center offset 3 mm from the tip and the sides. The symmetric signal preamplifier in the probe is fed via the shielded symmetric output cable from the AMMI with a 48V "phantom" voltage supply. The 7-pin connector on the back in the axis of the probe does not carry any signals. It is mounted to the DAE for the correct orientation of the sensor. If the probe axis is tilted 54.7 degrees from the vertical, the sensor is approximately vertical when the signal connector is at the underside of the probe (cable hanging downwards).

Model	AM1DV3
Sampling Rate	0.1 kHz to 20 kHz RF sensitivity < -100 dB
Preamplifier	Symmetric, 40 dB
Dynamic Range	-50 to 35 dB A/m
Calibration	at 1kHz
Dimensions	Tip diameter : 6 mm Length : 290 mm



2.1.3 Audio Magnetic Calibration Coil (AMCC)

The AMCC is a Helmholtz Coil designed for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction. The DC input resistance is adjusted by a series resistor to approximately 50 Ohm, and a shunt resistor of 10 Ohm permits monitoring the current with a scale of 1:10.

Signal	Connector	Resistance
Coil In	BNC	Typically 50 Ohm
Coil Monitor	BNO	10 Ohm ±1% (100mV corresponding to 1 A/m)
Dimensions	370 x 370 x 196 mm	

2.1.4 Audio Magnetic Measuring Instrument (AMMI)

The AMMI is a desktop 19-inch unit containing a sampling unit, a waveform generator for test and calibration signals, and a USB interface.

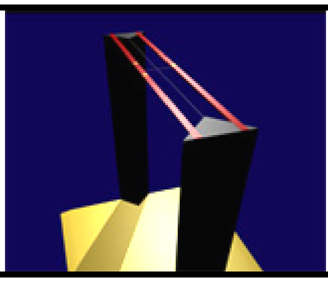
Sampling Rate	48 kHz / 24 bit
Dynamic Range	100 dB (with AM1DV3 probe)
Test Signal Generation	User selectable and predefined (via PC)
Calibration	Auto-calibration / full system calibration using AMCC with monitor output
Dimensions	482 x 65 x 270 mm

2.1.5 Data Acquisition Electronics (DAE)

Model	DAE3, DAE4
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage	< 5μV (with auto zero)
Input Bias Current	< 50 fA
Dimensions	60 x 60 x 68 mm

2.1.6 Phantoms

Model	Test Arch
Construction	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.
Dimensions	Length : 370 mm Width : 370 mm Height : 370 mm



2.1.7 Device Holder

Model	Mounting Device
Construction	The Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to ANSI C63.19.
Material	POM

2.2 System Calibration

For correct and calibrated measurement of the voltages and ABM field, DASY8 will perform a calibration job as below. In phase 1, the audio output is switched off, and a 200 mV_{pp} symmetric rectangular signal of 1 kHz is generated and internally connected directly to both channels of the sampling unit (Coil in, Probe in).

In phase 2, the audio output is off, and a 20 mV_{pp} symmetric 100 Hz signal is internally connected. The signals during phases 1 and 2 are available at the output on the rear panel of the AMMI. However, the output must not be loaded, in order to avoid influencing the calibration. An RMS voltmeter would indicate 100 mV_{RMS} during the first phase and 10 mV_{RMS} during the second phase. After the first two phases, the two input channels are both calibrated for absolute measurements of voltages. The resulting factors are displayed above the multi-meter window.

After phases 1 and 2, the input channels are calibrated to measure exact voltages. This is required to use the inputs for measuring voltages with their peak and RMS value.

In phase 3, a multi-sine signal covering each third-octave band from 50 Hz to 10 kHz is generated and applied to both audio outputs. The probe should be positioned in the center of the AMCC and aligned in the z-direction, the field orientation of the AMCC. The “Coil In” channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the “Probe In" channel samples the amplified signal picked up by the probe coil and provides it to a numerical integrator. The ratio of the two voltages in each third-octave filter leads to the spectral representation over the frequency band of interest. The Coil signal is scaled in dBV, and the Probe signal is first integrated and normalized to show dB A/m. The ratio probe-to-coil at the frequency of 1 kHz is the sensitivity which will be used in the consecutive T-Coil jobs.

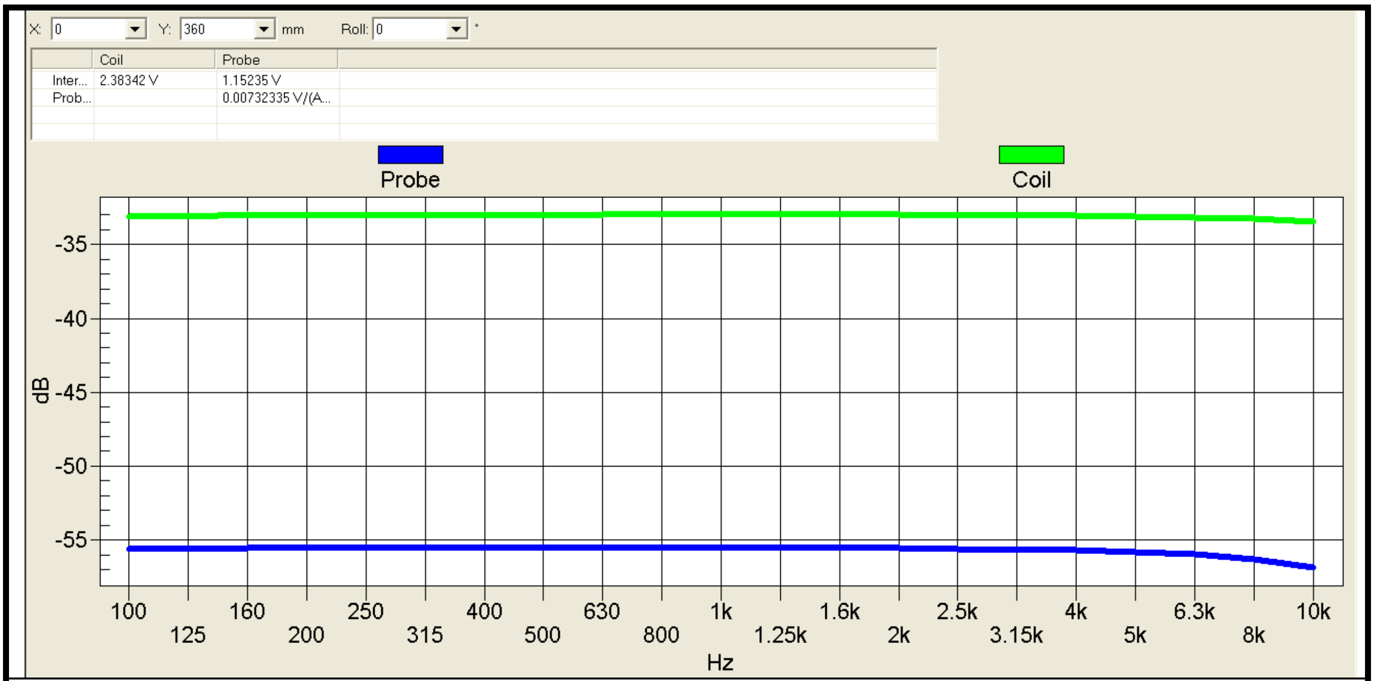


Fig-2.1 Frequency Response and Sensitivity of AM1D Probe

2.3 EUT Measurements Reference and Plane

The EUT is mounted in the device holder. The acoustic output of the EUT will coincide with the center point of the area formed by the dielectric wire and the middle bar of the arch’s top frame. Then EUT will be moved vertically upwards until it touches the frame.

Figure 3.5 illustrates the three standard probe orientations. Position 1 is the perpendicular (axial) orientation of the probe coil. Orientation 2 is the transverse (radial) orientation. The space between the measurement positions is not fixed. It is recommended that a scan of the EUT be done for each probe coil orientation and that the maximum level recorded be used as the reading for that orientation of the probe coil.

(1) The reference plane is 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 WD handset, which, in normal handset use, rest against the ear.

(2) The measurement plane is parallel to, and 10 mm in front of, the reference plane.

(3) The reference axis is normal to the reference plane and passes through the center of the receiver speaker section or it may be centered on a secondary inductive source.

(4) The measurement area shall be 50 mm by 50 mm. The measurement area for both desired ABM signal and undesired ABM field may be located where the transverse magnetic measurements are optimum with regard to the requirements. However, the measurement area should be in the vicinity of the acoustic output of the WD and shall be located in the same half of the phone as the WD receiver. In a WD handset with a centered receiver and a circularly symmetrical magnetic field, the measurement axis and the reference axis would coincide.

(5) Measurements of desired ABM signal strength and undesired ABM field are made at 2.0 mm ± 0.5 mm or 4 mm intervals in an X-Y measurement area pattern over the entire measurement area (676 measurement points total); either all measured, or measured plus interpolated, per 6.4.

(6) Desired ABM signal frequency response is measured at a single location at or near the maximum desired ABM signal strength location.

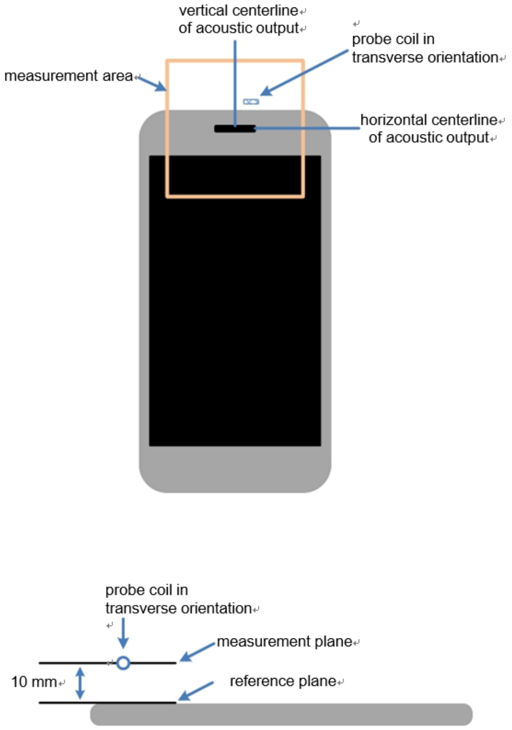


Fig-2.2 Measurement and reference planes probe orientation for WD audio frequency magnetic field measurements

2.4 HAC T-Coil Measurement Procedure

According to ANSI C63.19-2019, the T-Coil test procedure for wireless communications device is as below.

1. A validation of the test setup and instrumentation shall be performed. This may be done using a TMFS or Helmholtz Coil. Measure the emissions and confirm that they are within tolerance of the expected values.
2. Confirm that equipment that requires calibration has been calibrated, and that the noise level meets the requirements given in C63.19_6.3.2.
3. Position the EUT in the test setup and connect the EUT RF connector to a base station simulator or a non-radiating load (if necessary to control RF interference in the measurement equipment) as shown in Figure 2.3 or Figure 2.4.
4. The drive level to the EUT is set such that the reference input level specified in Table 2.1 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 (desired ABM signal) 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 specified in C63.19_6.4.3, 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.[35] The same drive level will be used for the desired ABM signal frequency response measurements at each 1/3 octave band center frequency. The EUT 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.
5. At each measurement location over the measurement area and in the transverse orientation, measure and record the desired 1 kHz T-Coil magnetic signal (desired ABM signal) as described in Step 3).
6. At or near a location representing a maximum in the just-measured desired ABM signal, measure and record the desired T-Coil magnetic signals (desired ABM signal at f_i) as described in C63.19_6.4.5.2 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 Step 3), 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 described in C63.19_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).) Compare the frequency response found to the requirements of C63.19_6.6.3.
7. At the same locations measured in Step 4), measure and record the undesired broadband audio magnetic signal (undesired ABM field) with no audio signal applied (or digital zero applied, if appropriate) using the specified spectral weighting, the half-band integrator followed by the temporal weighting.
8. Calculate and record the location and number of the measurement points that satisfy both the minimum desired ABM signal level and the maximum undesired ABM field level specified in C63-19_6.6.2. Compare this to the requirements in C63.19_6.6.4 and record the result.
9. Calculate and record the location and number of the measurement points that satisfy the maximum undesired ABM field level and distribution requirements specified in C63.19_6.6.4.

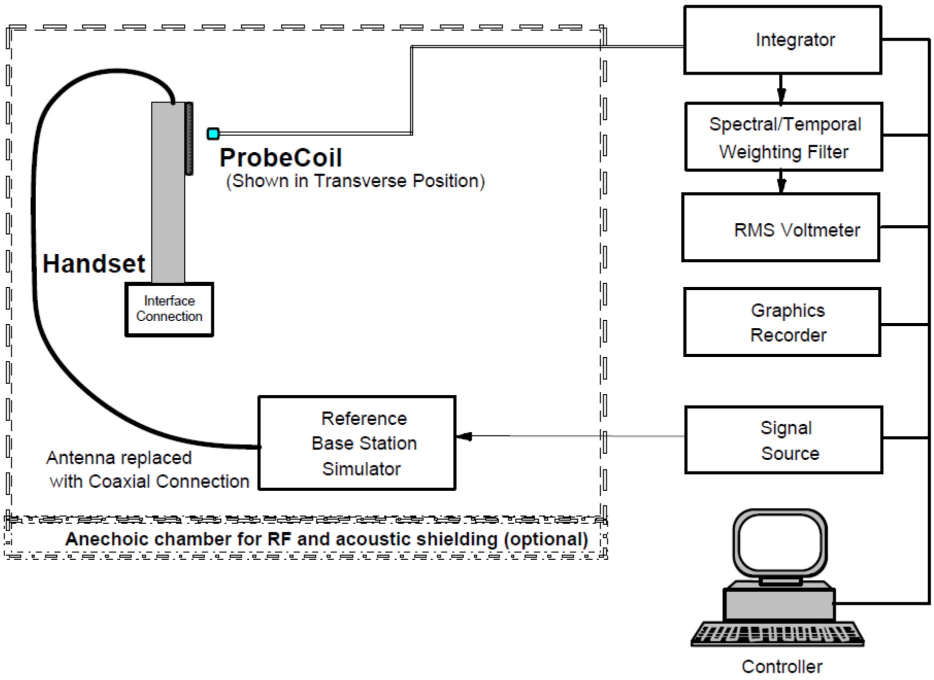


Fig-2.3 T-Coil signal measurement test setup—in call method

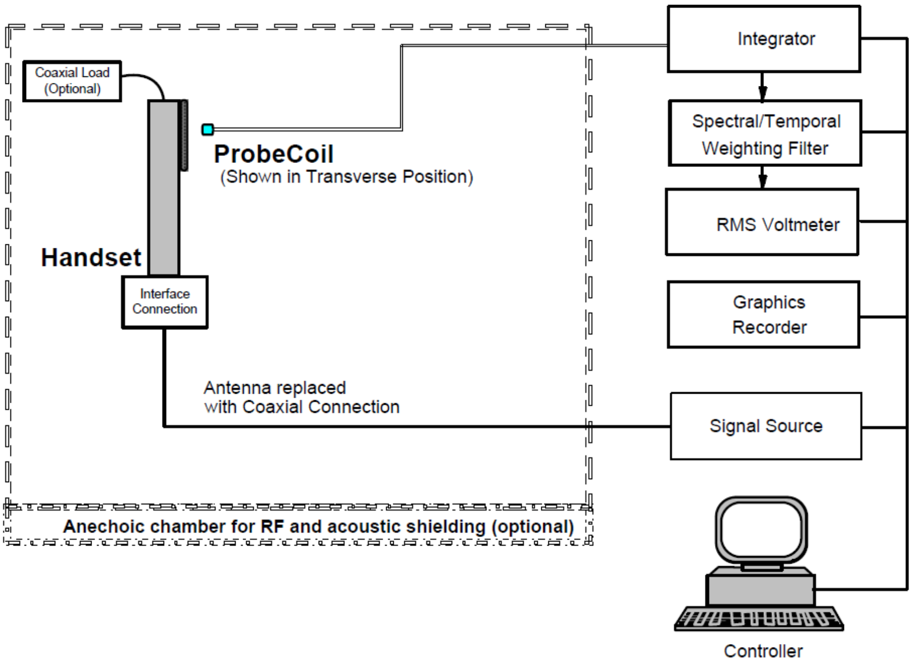


Fig-2.4 T-Coil signal measurement test setup—test mode method

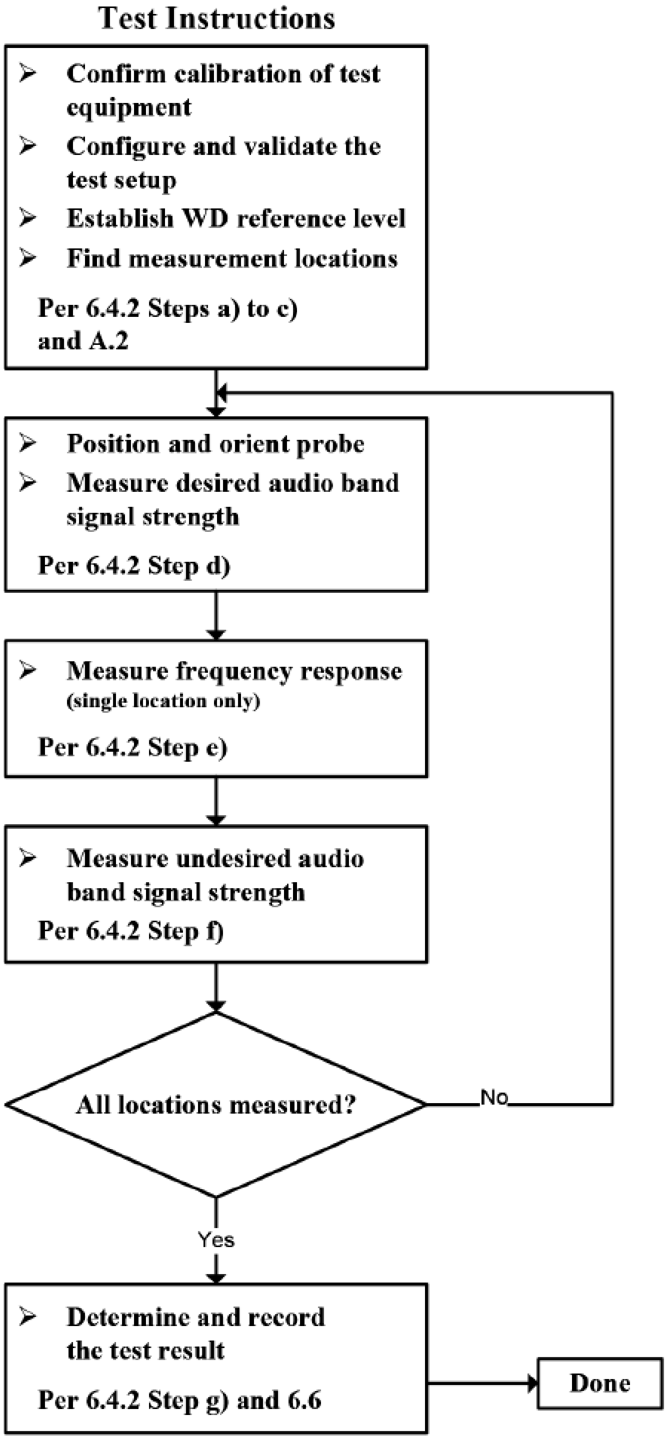


Fig-3.8 WD T-Coil signal test flowchart

2.4.1 Ambient and test system noise

It is necessary that the magnetic and RF ambient levels be low enough as to not significantly affect the intended measurement. In order to achieve these levels, audio band magnetic and RF ambient shielding might be required. In some cases, a full RF shielded chamber may be required to accurately perform the intended measurements.

Care shall be taken to ensure that measured field strengths due to noise in the test system or from the environment should be at least 10 dB below the limit being measured, which is specified in C63.19_6.6.2. For the measurement of both desired ABM signal and undesired ABM field, the environmental noise level should be ≤−48 dB(A/m), weighted according to the spectral/temporal weighting of D.4 to D.6. For the measurement of desired ABM signal (audio band magnetic signal—desired), this criterion applies in each 1/3 octave band over the specified voiceband. The noise ambient shall be measured and recorded in the test report to document its level. Satisfaction of the criterion may be confirmed by moving the probe throughout the positions to be used for WD field strength measurements. Remove the WD and measure the remaining noise field strength in the same way and over the same frequency range used for WD measurements.

2.5 Test System Setup and Signal Test Sequence

Figure 3.9 shows a typical setup for HAC T-CoilF measurement with DASY8.
The WD is mounted under the HAC Test Arch. The acoustic center of the WD, which is the reference point for the RF field evaluations, is aligned to the Arch center.
The AMMI) is used to:

- Drive the AMCC during the calibration phase
- Inject user-defined audio signals into the WD through the BSS during testing
- Sample the probe readings during testing and forward the results to the DASY8 PC.

The AMCC is used to calibrate the probe sensitivity, frequency response, and sensor orientation.
Measurements are performed with a fully RF-shielded active 1D probe (e.g., AM1D) to record audio frequency signals up to 20 kHz.

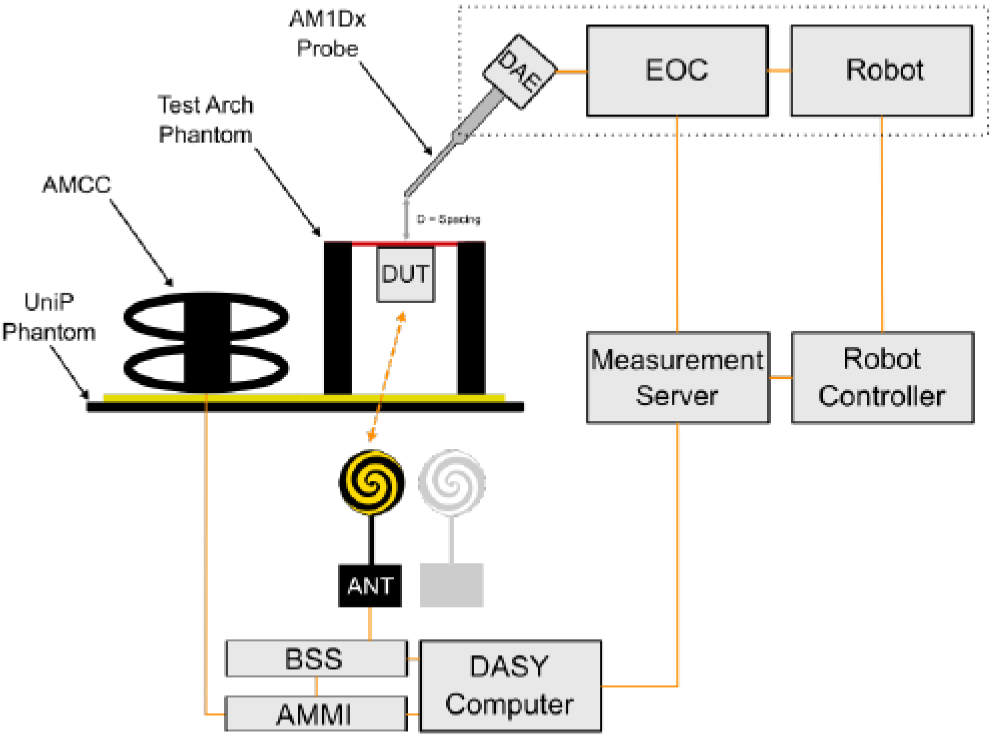


Fig-3.9 System Setup for T-Coil signal Testing

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.

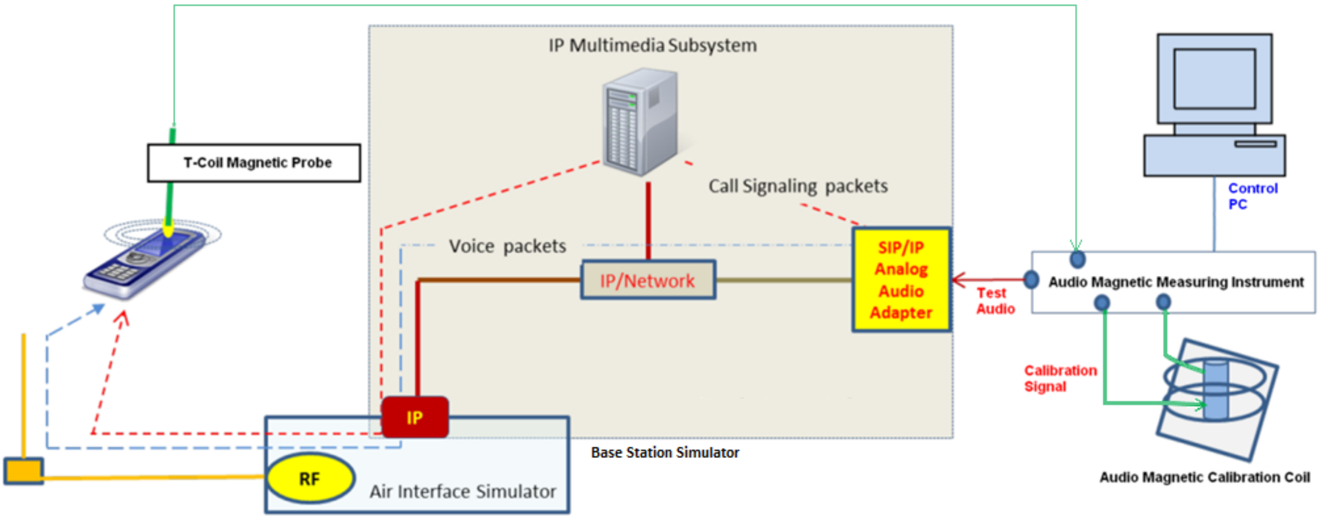


Fig-3.9 Testing Setup for VoLTE, and VoWiFi Calling

Standard	Protocol	Input (dBm0)
TIA-2000	CDMA	−18
TIA/EIA-136	TDMA (50 Hz)	−18
J-STD-007	GSM (217 Hz)	−16
T1/T1P1/3GPP (See Note 1)	UMTS (WCDMA)	−16
iDEN®	TDMA (22 Hz and 11 Hz)	−18
VoIP [a] (See Note 2)	Voice over Internet Protocol	−16
NOTE 1—For UMTS (Universal Mobile Telecommunications System), refer to 3GPP TS26.131 and TS26.132 (http://www.3gpp.org). NOTE 2—VoIP is used in this table as a general term specifying a group of voice services that use −16 dBm0 as their normal acoustic level. The group includes a variety of voice services, including Voice-over-LTE (VoLTE), Voice-over-IP-multimedia-subsystem (VoIMS), Voice-over-Wi-Fi (VoWiFi) and similar services. For 3G, LTE, and WLAN terminals used for Commercial Mobile Radio Service (CMRS) based telephony, refer to 3GPP TS26.131 and TS26.132.		

Table-2.1 Normal speech input levels

[a] The manufacturer shall establish that -16 dBm0 is the normal acoustic level in order to place it in this category.

The speech levels with the settings at the AF connector of R&S CMW500 have been calibrated, and it can be set manually to ensure the specific full-scale speech level during T-Coil testing. For an example, the gain setting for -16 dBm0 has been calculated through below formula.

3.14 dBm0 = $\boldsymbol{X}$ dBV = -3.01 dBV
-16 dBm0 = $\boldsymbol{L_{-16dBm0}}$ dBV = -22.00 dBV
Gain 100 = $\boldsymbol{G}$ dBV = 3.13 dBV
Difference for -16 dBm0 = $\boldsymbol{D_{-16dBm0}}$ = $\boldsymbol{L_{-16dBm0}}$ – $\boldsymbol{G}$ = -22 – 3.13 = -25.13 dBV
Resulting Gain for -16 dBm0 = 10 ^ ($\boldsymbol{D_{-16dBm0}}$ / 20) x 100 = 5.54
Gain Setting = Resulting Gain x Required Gain Factor
Gain setting for voice 1kHz = 5.54 x 4.33 = 23.99
Gain setting for voice 300-3kHz = 5.54 x 8.48 = 46.98

The gain setting for other signal types need to be adjusted to achieve the same average level. Those signal types have the following differences/factors compared to the 1 kHz sine signal:

Signal Type	Duration (s)	BWC (dB)	Required Gain Factor
1 kHz sine	-	0.0	1.00
48k_voice_1kHz	1	0.16	4.33
48k_voice_300-3000	2	10.8	8.48

2.6 Test System Setup for OTT VoIP

OTT Calling: This device supports Over-the-Top VoIP calling via the pre-installed application, Google Meet and associated OPUS codec**.** VoIP capabilities require HAC assessment when voice calls are supported over the cellular or Wi-Fi data connection via pre-installed applications.

The test setup for OTT calling uses the R&S CMW500 as a base station simulator to establish a wireless data call through cellular or Wi-Fi air interface to the device under test. The CMW500's data application unit is connected via internet (Ethernet connection to router) to the OTT service such as Google Meet. An auxiliary device is also connected to the OTT service via a wireless router. A VoIP call is then established between the DUT and the auxiliary device via the VoIP service. The auxiliary device includes special version software that allows it to configure and monitor the OPUS codec bit rate during the OTT call. An investigation is made across all supported codec bit rates and across the various air interfaces (e.g. EGPRS, HSPA, EV-DO, FDD-LTE, TDD-LTE, Wi-Fi etc.) between DUT and CMW500 to determine the worst case T-Coil rating.

According to KDB 285076 D02v03, the average speech level of -20 dBm0 should be used when the protocol is not listed in ANSI C63.19-2019 or ANSI C63.19-2019 VoLTE interpretation. Hence, the testing audio signal from AMMI Audio Out has been calibrated for all test signal types (1 kHz sine, 1 kHz voice and 300 to 3 kHz voice) to determine the gain settings required to inject the audio signal at a level of **-20 dBm0** into the auxiliary device during HAC T-Coil tests for OTT calling.

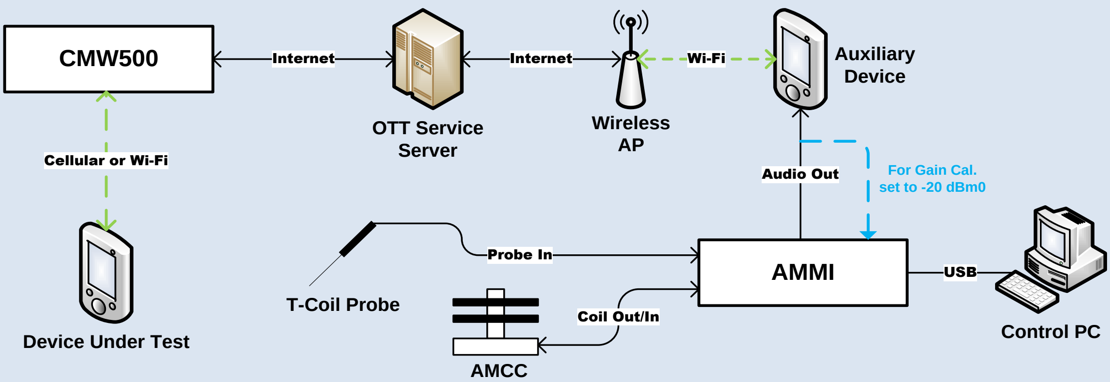


Fig-3.10 Testing Setup for OTT Calling

The calibration to set the AMMI gain level at the input to the auxiliary device is performed as follows:

1. A real time audio analyzer application on the auxiliary device[1] is used to measure the audio level into the device. The AMMI gain values are adjusted to obtain a signal level of 0 dBFS at the auxiliary audio input for the 1 kHz sine wave signal.
2. The gain value recorded in step (1) above is then reduced by 23.14 dB to obtain a signal level of -23.14 dBFS, (equivalent to -20 dBm0), at the auxiliary device's audio input. The gain values are confirmed using the real time audio analyzer to verify the signal level.
3. The gain values calculated in step 2 are adjusted for the 1 kHz voice and 300 to 3 kHz voice signals using the correction values noted in section 3.5.

Note 1: The gain and algorithmic processing in the acoustic path of the auxiliary device are disabled to ensure that the measured signal level is the signal level at the input to the codec.

3. HAC Measurement Evaluation

3.1 Measurement Criteria

The HAC Standard ANSI C63.19-2019 represents performance requirements for acceptable interoperability of hearing aids with wireless communications devices. When these parameters are met, a hearing aid operates acceptably in close proximity to a wireless communications device.

3.1.1 Field Intensity

When measured as specified in this standard, there are two groups of qualifying measurement points:

Primary group: A qualifying measurement point shall have its T-Coil signal, desired ABM signal, ≥−18 dB(A/m) at 1 kHz, in a 1/3 octave band filter. These measurements shall be made with the WD operating at a reference input level as specified in Table 2.1. Simultaneously, the qualifying measurement point shall have its weighted magnetic noise, undesired ABM field ≤−38 dB(A/m).

Secondary group: A qualifying measurement point shall have its weighted magnetic noise, undesired ABM field ≤−38 dB(A/m). This group inherently includes all the members of the primary group.

These levels are designed to be compatible with hearing aids that produce the same acoustic output level for either an acoustic input level of 65 dB SPL or a magnetic input level of −25 dB(A/m) (56.2 mA/m)39 at either 1.0 kHz or 1.6 kHz. The hearing aid operational measurements are performed per ANSI S3.22-201

3.1.2 Frequency Response

The frequency response of the magnetic field, measured in 1/3 octave bands, shall follow the below response curve specified in this subclause, over the frequency range 300 Hz to 3 KHz.

Figure 4.1 and Figure 4.2 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.

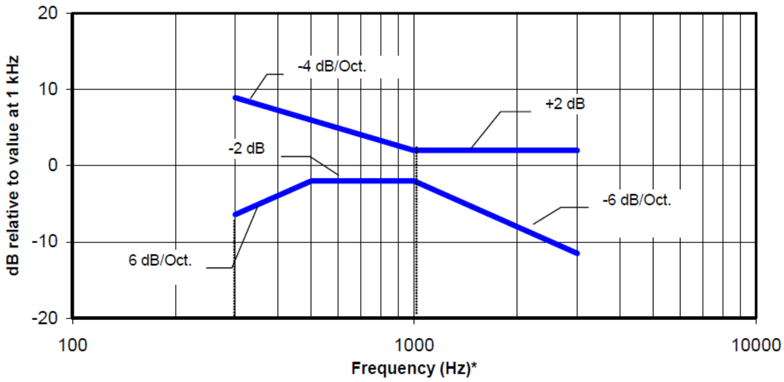


Fig-4.1 Boundaries for EUT with a field ≤ -15 dB (A/m) at 1 kHz

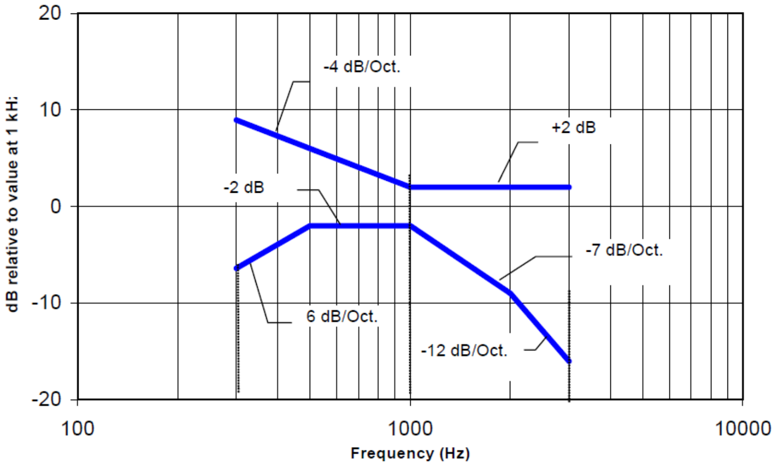


Fig-4.2 Boundaries for EUT with a field > -15 dB (A/m) at 1 kHz

3.1.3 Desired ABM signal, undesired ABM field qualification requirements

Non-2G GSM operating modes

The goal of this requirement is to ensure an adequate area where desired ABM signal is sufficiently strong to be heard clearly and a larger area where undesired ABM field is sufficiently low as to avoid undue annoyance. Qualifying measurement points shall fulfill the requirements of 6.6.2; both the primary and secondary group requirements shall be met:

- The primary group shall include at least 75 measurement points.
- The secondary group shall include at least 300 contiguous measurement points.

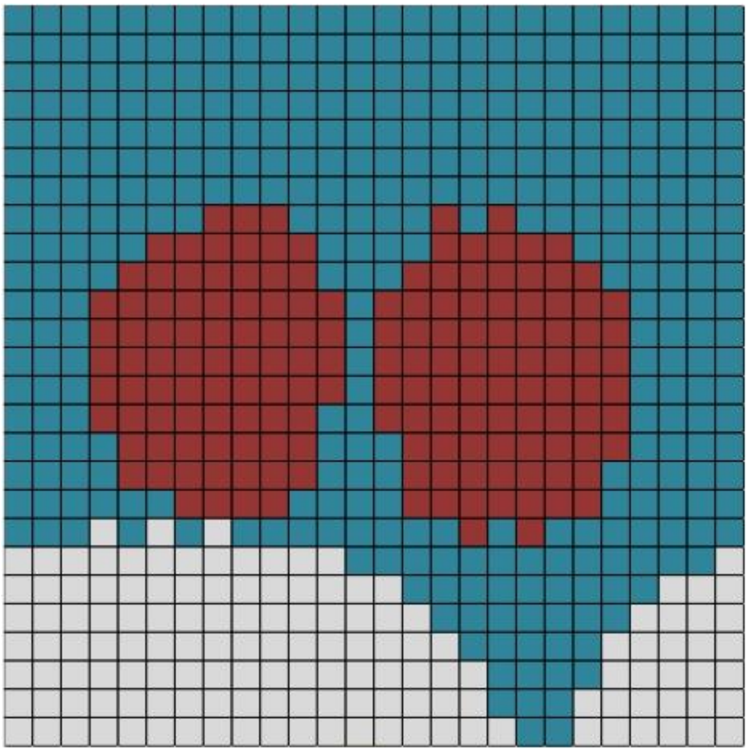
Additionally, to avoid an oddly shaped area of low noise, the secondary group shall include at least one longitudinal column of at least 10 contiguous qualifying points and at least one transverse row containing at least 15 contiguous qualifying points.

Figure 6.6 is an example of a qualifying scan. The total number of primary group qualifying measurement points is 161, which is ≥75. The total number of secondary group qualifying points is 536, which is ≥300.
The secondary group has a longitudinal column of 26, which is ≥10, and a transverse row also of 26 contiguous points, which is ≥15

2G GSM operating modes

If the 2G GSM operating mode(s) are selected for qualification, the qualifying measurement points shall fulfil the requirements of 6.6.2; both the primary and secondary group requirements shall be met:

- The primary group shall include at least 25 measurement points.
- The secondary group shall include at least 125 contiguous measurement points.



3.2 EUT Configuration and Setting

For HAC T-Coil testing, the EUT was linked and controlled by base station emulator. Communication between the EUT and the emulator was established by coaxial connection. The EUT was set from the emulator to radiate maximum output power during HAC testing. Also EUT was set to mute on, maximum volume, and backlight off during T-Coil testing.

3.3 HAC T-Coil Testing Results

3.3.1 WCDMA CMRS Voice Testing Results

Refer to Appendix B

3.3.2 VoLTE Testing Results

Refer to Appendix B

3.3.3 OTT Voice Calling Testing Results

The device supported a pre-installed application, Google Meet, whose features allow the option of voice-only communications. According to KDB 285076 D02, all air interfaces via a data connection with an application providing voice functionality need to be considered for HAC testing. The Google Meet uses the audio codec as Opus and supports codec bit rate from 6 kbps to 75 kbps. All air interfaces capable of a data connection were evaluated.

The device supported a pre-installed application, Google Meet and Hangouts, whose features allow the option of voice-only communications. According to KDB 285076 D02, all air interfaces via a data connection with an application providing voice functionality need to be considered for HAC testing. The Google Meet and Hangouts use the audio codec as Opus and supports codec bit rate from 6 kbps to 75 kbps. All air interfaces capable of a data connection were evaluated.

The Android system in this device supports SIP (Session Initiation Protocol) calling stack that could be used to configure the native Android SIP client in the dialer for an internet call. The Android SIP calling stack supports audio codec as PCMU, PCMA, GSM-FR, GSM-EFR, and AMR-NB. All air interfaces capable of a data connection were evaluated.

Refer to Appendix B

Test Engineer： Ainsley Yang, and Vic Ko

4. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
Audio Band Magnetic Probe	SPEAG	AM1DV3	3060	Jan. 20, 2025	1 Year
Data Acquisition Electronics	SPEAG	DAE4	1698	Nov. 20, 2024	1 Year
Universal Radio Communication Tester	R&S	CMW500	164864	Jul. 19, 2024	1 Year
Test Arch Phantom	SPEAG	Arch	N/A	N/A	N/A

5. Measurement Uncertainty

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (ABM1)	Ci (ABM2)	Standard Uncertainty (ABM1)	Standard Uncertainty (ABM2)
Probe Sensitivity							
Reference Level	3.0	Normal	1	1	1	± 3.0 %	± 3.0 %
AMCC Geometry	0.4	Rectangular	√3	1	1	± 0.2 %	± 0.2 %
AMCC Current	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Probe Positioning During Calibration	0.07	Rectangular	√3	1	1	± 0.04 %	± 0.04 %
Noise Contribution	0.02	Rectangular	√3	0.0143	1	± 0.0 %	± 0.01 %
Frequency Slope	5.9	Rectangular	√3	0.1	1	± 0.3 %	± 3.4 %
Probe System							
Repeatability / Drift	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Linearity / Dynamic Range	0.6	Rectangular	√3	1	1	± 0.3 %	± 0.3 %
Acoustic Noise	1.0	Rectangular	√3	0.1	1	± 0.1 %	± 0.6 %
Probe Angle	2.3	Rectangular	√3	1	1	± 1.3 %	± 1.3 %
Spectral Processing	0.9	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	0.6	Normal	1	1	5	± 0.6 %	± 3.0 %
Field Distribution	0.2	Rectangular	√3	1	1	± 0.1 %	± 0.1 %
Test Signal							
Ref. Signal Spectral Response	0.6	Rectangular	√3	0	1	± 0.0 %	± 0.3 %
Positioning							
Probe Positioning	1.9	Rectangular	√3	1	1	± 1.1 %	± 1.1 %
Phantom Thickness	0.9	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
EUT Positioning	1.9	Rectangular	√3	1	1	± 1.1 %	± 1.1 %
External Contributions							
RF Interference	0.0	Rectangular	√3	1	0.3	± 0.0 %	± 0.0 %
Test Signal Variation	2.0	Rectangular	√3	1	1	± 1.2 %	± 1.2 %
Combined Standard Uncertainty						± 4.0 %	± 6.1 %
Coverage Factor for 95 %						K = 2	
Expanded Uncertainty						**± 8.0 %**	**± 12.2 %**

Uncertainty Budget for HAC T-Coil

6. Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Lin Kou EMC/RF Lab
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab
Tel: 886-3-6668565
Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety/SAR Lab
Tel: 886-3-3183232
Fax: 886-3-3270892

Email: service.adt@bureauveritas.com
Web Site: http://ee.bureauveritas.com.tw

The address and road map of all our labs can be found in our web site also.

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