FCC HAC (T-Coil) Test Report

Report No.	:	**PSU-NQN2412090210SA03**
Applicant	:	**HMD Global Oy**
Address	:	**Bertel Jungin aukio 9,02600 Espoo, Finland**
Manufacturer	:	**HMD Global Oy**
Address	:	**Bertel Jungin aukio 9,02600 Espoo, Finland**
Product	:	**Mobile phone**
FCC ID	:	**2AJOTTA-1715**
Brand	:	**HMD**
Model No.	:	**H1715V**
Standards	:	**FCC 47 CFR PART 20.19 / ANSI C63.19-2019** **KDB 285076 D01 v06r04 / KDB 285076 D02 v04 / KDB 285076 D03 v01r06**
Date of Testing	:	**Jan. 20, 2025 ~ Mar. 10, 2025**
FCC Designation No.	:	**CN1325** **FCC Site Registration No. : 434559**
Issued By	:	**Huarui 7layers High Technology (Suzhou) Co., Ltd.**
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CERTIFICATION: The above equipment have been tested by **Huarui 7layers High Technology (Suzhou) Co., Ltd.**, 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 SAR 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 A2LA or any government agencies.

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Release Control Record

Report No.	Reason for Change	Date Issued
PSU-NQN2412090210SA03	Initial release	Mar. 21, 2025

1. Summary of Maximum RF Value

Operating Mode	Band	Frequency Response	Result
GSM CMRS Voice	GSM850	PASS	PASS
	GSM1900	PASS	PASS
UMTS CMRS Voice	Band II	PASS	PASS
	Band V	PASS	PASS
VoLTE	Band 2	PASS	PASS
	Band 4	PASS	PASS
	Band 5	PASS	PASS
	Band 12	PASS	PASS
	Band 13	PASS	PASS
	Band 66	PASS	PASS
VoNR	NR n2	PASS	PASS
	NR n5	PASS	PASS
	NR n66	PASS	PASS
	NR n77	PASS	PASS
VoWi-Fi	WLAN 2.4G	PASS	PASS
	WLAN 5.2G	PASS	PASS
	WLAN 5.3G	PASS	PASS
	WLAN 5.5G	PASS	PASS
	WLAN 5.8G	PASS	PASS

Note:

1. The HAC T-Coil emission limit is specified in FCC 47 CFR part 20.19 and ANSI C63.19.

2. Description of Equipment Under Test

EUT Type	Mobile phone
FCC ID	2AJOTTA-1715
Brand Name	HMD
Model Name	H1715V
IMEI Code	Sample 1: 356426480018867 / 356426480018875 Sample 2: 356426480034104 / 356426480034112
HW Version	V1.0
SW Version	000T_0_310
Tx Frequency Bands (Unit: MHz)	GSM850 : 824 ~ 849 GSM1900 : 1850 ~ 1910 WCDMA Band II : 1850 ~ 1910 WCDMA Band V : 824 ~ 849 LTE Band 2 : 1850 ~ 19010 LTE Band 4 : 1710 ~ 1755 LTE Band 5 : 824 ~ 849 LTE Band 12 : 699 ~ 716 LTE Band 13 : 777 ~ 787 LTE Band 66 : 1710 ~ 1780 NR Band n2 : 1850 ~ 1910 NR Band n5 : 824 ~ 849 NR Band n66 : 1710 ~ 1780 NR Band n77 : 3450 ~ 3550, 3700 ~ 3980 WLAN : 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5700, 5745 ~ 5825 Bluetooth : 2402 ~ 2480
Uplink Modulations	GSM & GPRS & EDGE : GMSK, 8PSK WCDMA : QPSK LTE : QPSK, 16QAM, 64QAM, 256QAM NR : Pi/2 BPSK (DFT-s-OFDM), QPSK (DFT-s-OFDM, CP-OFDM), 16QAM (DFT-s-OFDM, CP-OFDM), 64QAM (DFT-s-OFDM, CP-OFDM), 256QAM DFT-s-OFDM, CP-OFDM) 802.11b : DSSS 802.11a/g/n/ac : OFDM Bluetooth : GFSK, π/4-DQPSK, 8-DPSK, LE
Subcarrier Spacing	15 kHz（FDD）/ 30 kHz（TDD）
Uplink Transmission Duty Cycle	For 5G NR bands test, using FTM (Factory Test Mode) with default 100% duty cycle transmission to perform evaluation.
Antenna Type	PIFA Antenna
EUT Stage	Identical Prototype

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.
2. According to the document <Difference of change> provided by the manufacturer, these changes do not affect the RF parameters, so sample 1 is fully tested, and sample 2 verifies the worst case

2.1 Air Interface and Operational Mode

Air Interface	Bands	Transport Type	ANSI C63.19	Simultaneous But Not Tested	Name of Voice Service	Power Reduction
GSM	850	VO	Yes	WLAN, BT	CMRS Voice	No
	1900					No
	EGPRS	VD	Yes	WLAN, BT	Google Meet(1)	No
UMTS	Band 2	VO	Yes	WLAN, BT	CMRS Voice	No
	Band 5					No
	HSPA				Google Meet(1)	No
LTE (FDD)	Band 2	VD	Yes	NR, WLAN, BT	VoLTE / Google Meet(1)	No
	Band 4					No
	Band 5					No
	Band 12					No
	Band 13					No
	Band 66					No
NR (FDD)	NR n2	VD	Yes	LTE, WLAN, BT	VoNR / Google Meet(1)	No
	NR n5					No
	NR n66					No
NR (TDD)	NR n77					No
WLAN	2.4G	VD	Yes	GSM, WCDMA, LTE, NR	VoWiFi / Google Meet(1)	No
	5.2G					No
	5.3G					No
	5.5G					No
	5.8G					No
Bluetooth	2.4G	DT	No	GSM, WCDMA, LTE, NR	N/A	No

Transport Type:
VO = Legacy Cellular Voice Service
DT = Digital Transport Only (No Voice)
VD = IP Voice Service over Digital Transport

Note:
1. For protocols not listed in Table 6.1 of ANSI C63.19:2019, the average speech level of −20 dBm0 should be used.
2. Because features of Google Meet allow the option of voice-only communications, Meet has been tested for HAC/T-Coil compatibility to ensure the best user experience.
3. The device have similar frequency in some LTE bands: LTE B4/66, since the supported frequency spans for the smaller LTE bands are completely cover by the larger LTE bands, therefore, only larger LTE bands were required to be tested for hearing-aid compliance.
4. Because features of Google Meet allow the option of voice-only communications, Meet has been tested for HAC/T-Coil compatibility to ensure the best user experience.

3. HAC T-Coil Measurement System

3.1 Speag Dasy System

DASY 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 DASY5 software defined. The DASY 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.

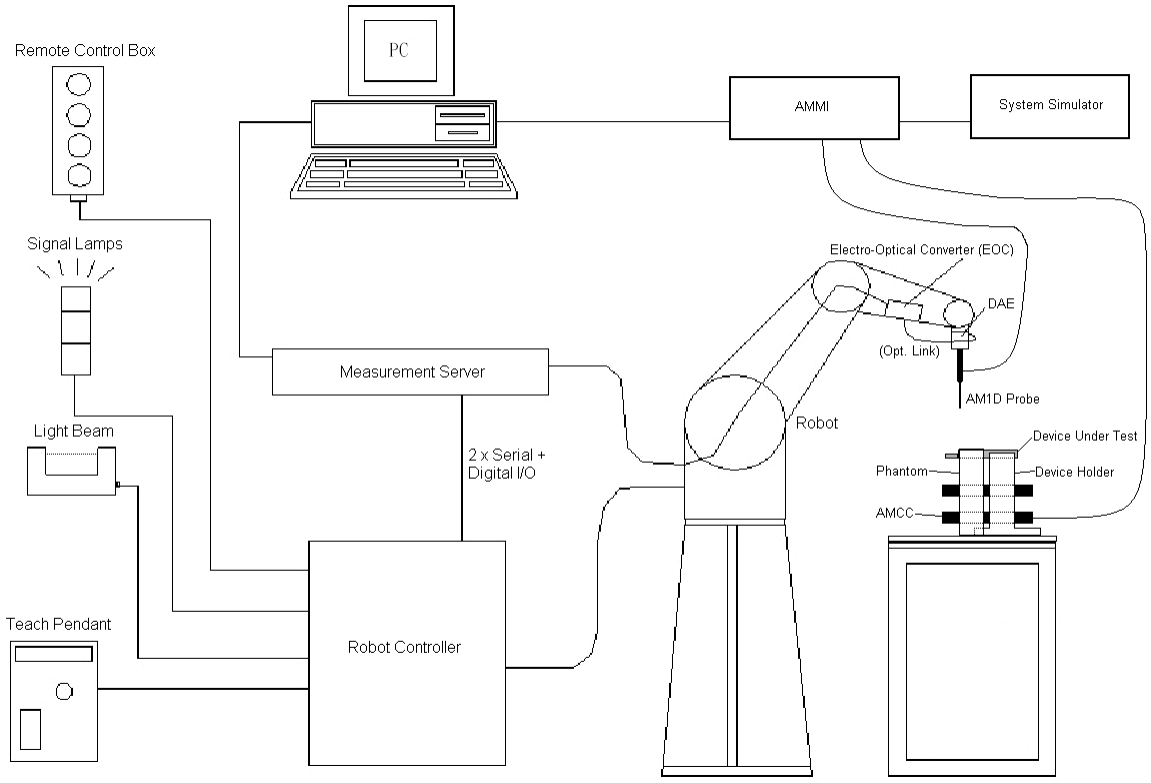


Fig-3.1 DASY System Setup

3.1.1 Robot

The DASY6 system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY6: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

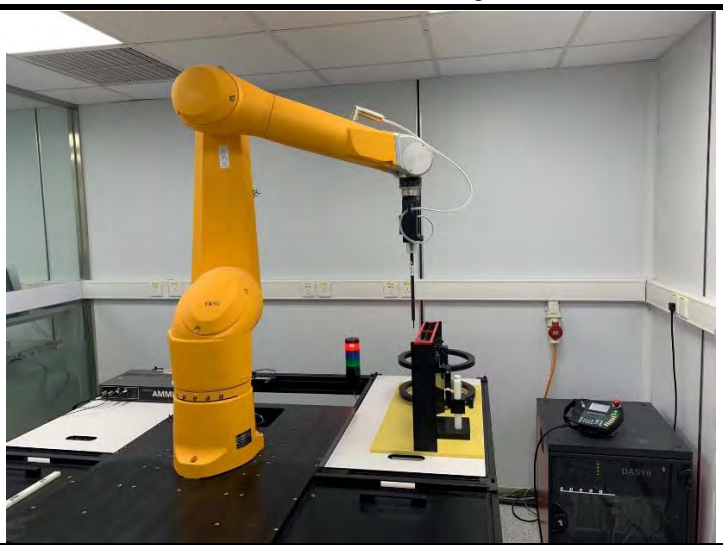


Fig-3.2 DASY6 Measurement System

3.1.2 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	-60 to 40 dB A/m
Calibration	at 1kHz
Dimensions	Tip diameter : 6 mm Length : 290 mm

3.1.3 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	

3.1.4 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

3.1.5 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

3.1.6 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	

3.1.7 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	

3.2 System Calibration

For correct and calibrated measurement of the voltages and ABM field, DASY 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.

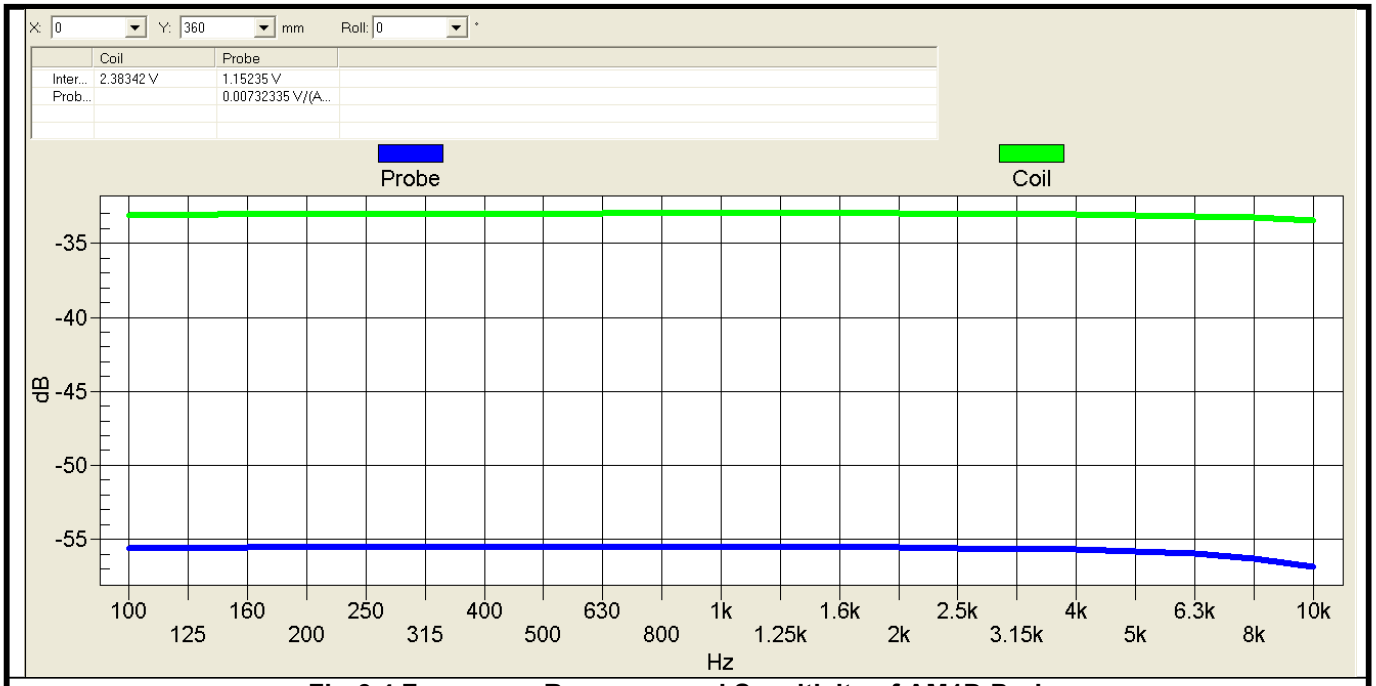


Fig-3.4 Frequency Response and Sensitivity of AM1D Probe

3.3 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 The T-Coil measurement plane, reference plane and other measurement parameters shall be:

(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.

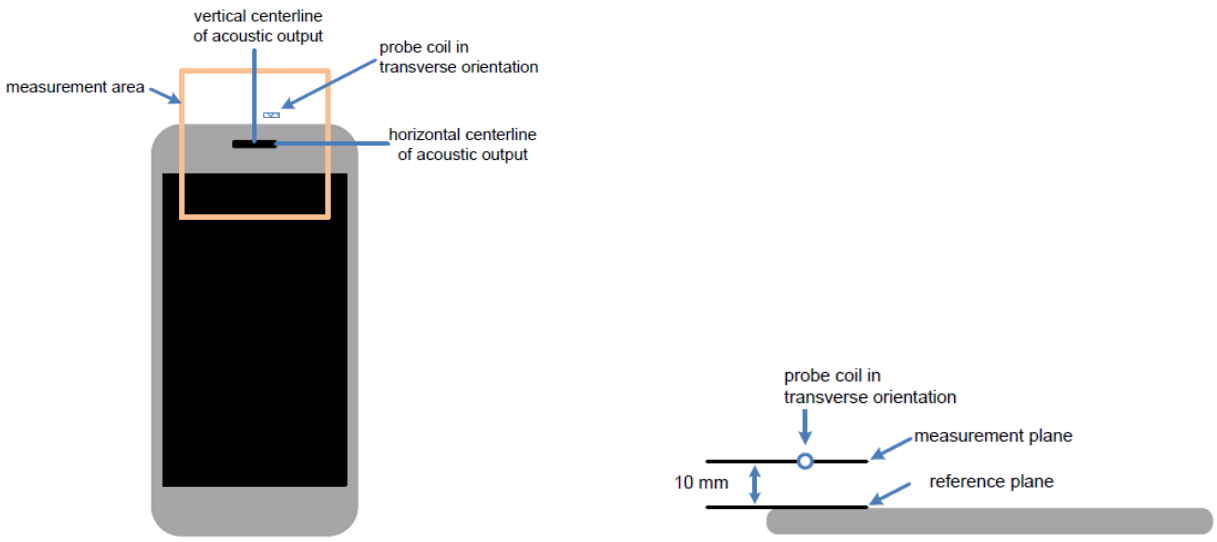


Fig-3.5 Measurement and reference planes probe orientation for WD audio frequency magnetic field measurements

3.4 HAC T-Coil Measurement Procedure

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

1. Position the EUT in the test setup and connect the EUT RF connector to a base station simulator.
2. The drive level to the EUT is set such that the reference input level specified in Table 6.1 is input to the base station simulator 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 alternate nearby reference audio signal frequency may be used. The same drive level will be used for the ABM1 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.
3. Determine the magnetic measurement locations for the EUT, if not already specified by the manufacturer, as described in 6.4.5.2 and 6.4.5.3.
4. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at f_i) as described in 6.4.2 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 Step 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 described 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 ABM signal measurement meet the ambient and test system noise criterion in 6.3.2.

<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.

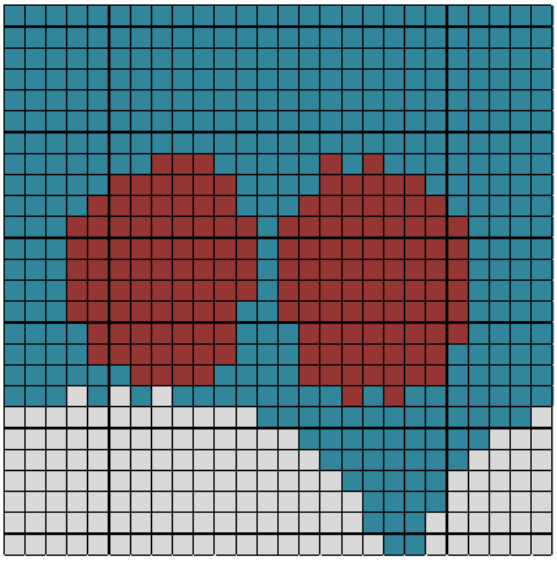
Figure 6.6 is an example of a qualifying scan. The total number of primary group qualifying measurement points is 161 , which is ≥75. The total number of secondary group qualifying points is 536, which is ≥300.

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 ANSI C63.19-2019 section 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



Red (primary group): AB desired ABM signal M1 ≥−18 dB(A/m) and undesired ABM field ≤−38 dB(A/m)
Blue and red (secondary group): undesired ABM field ≤−38 dB(A/m)

Figure 6.6—An example of a qualifying desired ABM signal, undesired ABM field scan:

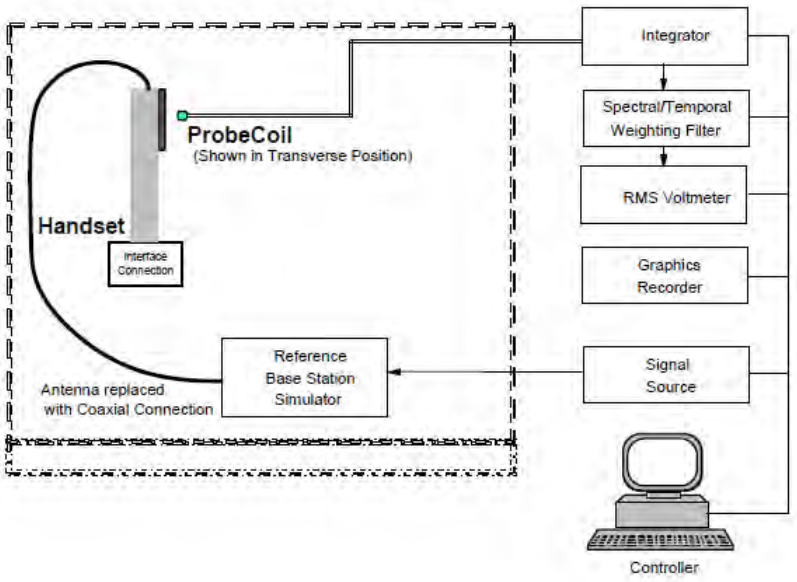


Fig-3.6 T-Coil Measurement Test Setup

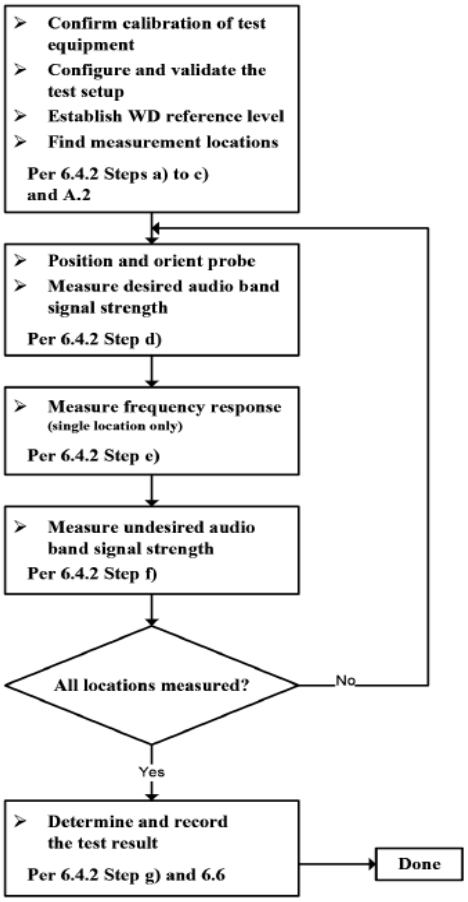


Fig-3.7 T-Coil Signal Test Flowchart

3.5 Test System Setup and Audio Input Level

The test setup shown in below is to extend DASY system with the capability of Audio Band Magnetic (ABM) measurements according to standard ANSI C63.19-2019. Together with the HAC RF extension, it permits complete characterization of the emissions of a wireless device (WD). The signals measured during these tests represent the field picked up by the T-Coil of a hearing aid. Using DASY software, these orthogonal axes can be scanned with a probe incorporating a single sensor coil. The WD is mounted on the Test Arch Phantom. The acoustic center of the WD is mounted in such a way that it is centered, and this represents the reference for the combination of ABM and RF field evaluation. The ABM fields of the WD (frequency range <20 kHz) are scanned with a fully RF-shielded active 1-D probe. The probe axis is oriented in the space diagonal to the three orthogonal axes, and its single sensor can be oriented to the axes by 120 degree rotation. The probe signal is evaluated by an Audio Magnetic Measurement Instrument (AMMI) which is interfaced to the DASY computer via USB. The AMMI also provides test and calibration signals and interfaces to the Helmholtz Audio Magnetic Calibration Coil (AMCC). Through the connector at the AMMI, predefined or user-definable audio signals are available for injection into the WD during the test.

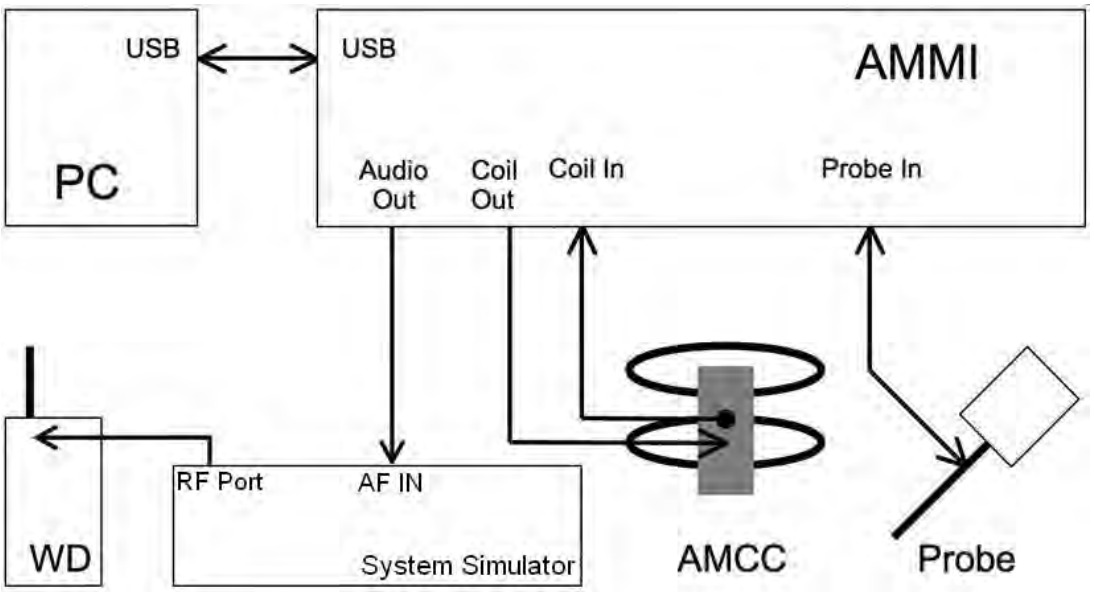


Fig-3.8 System Setup for T-Coil Testing

General Note:

Define the all applicable input audio level as below according to ANSI63.19-2019 table 6.1：

-16 dBm0 is used for GSM input level

-16 dBm0 is used for UMTS input level

-16 dBm0 is used for VoLTE input level

-16 dBm0 is used for VoNR input level

-16 dBm0 is used for VoWiFi input level

The test setup used for GSM/UMTS is via the callbox of CMW500 for T-Coil measurement. The CMW500 input is calibrated and the relation between the analog input voltage and the internal level in dBm0 can be determined. The CWM500 can be manually configured to speech input level and ensure that the result is -16dBm0 for GSM/UMTS CMRD Voice connection.

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.

The test setup used for VoLTE and VoWiFi over IMS is via the callbox if CMW500 for T-Coil measurement. The data application unit of the CMW500 is used to simulate the IP multimedia subsystem server. The CMW500 can be manually configured to control the speech input level and ensure that the result is -16dBm0 for VoLTE, and VoWiFi during the IMS connection.

The test setup used for VoNR over IMS is via the callbox of CMX500 for T-Coil measurement, The data application unit of the CMX500 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 VoNR when the device during the IMS connection.

According to KDB 285076 D02, T-Coil testing for VoLTE, VoNR 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 above Figure. The R&S CMW500 and CMX500 was used as system simulator for VoLTE, VoNR and VoWiFi T-Coil testing. The DAU (Data Application Unit) in CMW500, CMX500 integrates IMS and SIP/IP server that can establish VoLTE, VoNR and Wi-Fi calling, and transport the test tones from AMMI (Audio Magnetic Measuring Instrument) to EUT.

<Example define the input level for GSM/UMTS/VoLTE/VoNR/VoWiFi>

Gain Value	dBm0	Full scal Voltage	dB	AMMI audio out dBv (RMS)	AMCC Coil Out (dBv (RMS)
	3.14	1		-3.01	
100	9.26		40	3.11	3.26
5.46	-16		14.74		
Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz sine	-	3	0	1	5.46
48k_voice_1kHz	1	16.2	-12.7	4.33	23.63
48k_voice_300-3000	2	21.6	-18.6	8.48	46.28

The test setup for OTT VoIP is using the R&S CMW500, CMX500 as base station simulator. The CMW500, CMX500's data application unit was connected to the internet and allowed for an IP data connection on the EUT. An auxiliary VoIP unit installed the same OTT VoIP application was used to initiate an OTT VoIP call to the EUT. The auxiliary VoIP unit can allow for configure and monitor the codec bit rate during the OTT VoIP call.

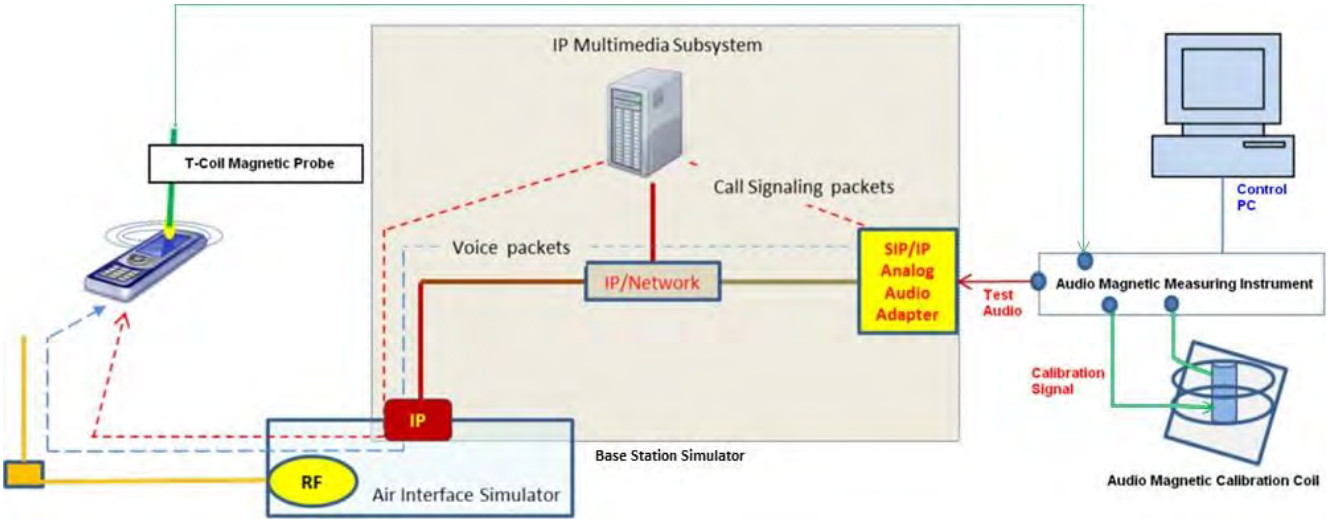


Fig-3.9 Testing Setup for OTT VoIP

1. Define the all applicable input audio level as below according to KDB 285076 D02:
   - OTT Voice calling input Level: -20dBm0

2. OTT voice, such as that enabled when a user opts to communicate in a voice-only mode using the Google Meet application, is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over the internet. The terms Internet telephony, broadband telephony, and broadband phone service specifically refer to the provisioning of communications services (voice, fax, SMS, voice-messaging) over the public Internet, rather than via the public switched telephone network (PSTN).

3. Google Meet application support code and bitrate are listed in section 3.3.6, and the customized Google Meet software is installed on a mobile phone that is used as the Auxiliary for the test. The software enables the audio coding rate to be changed, and reports the input digital audio level before audio processing, which can be used to calibrate the input audio level.

4. This device comes with the preinstalled OTT application that supports the voice-only communication option on the Google Meet application and related codec. The test configuration establishes a call between the device under test and an auxiliary handset via Google Meet server.

5. The test setup used for Google Meet OTT voice-only communication is via the data application unit on the simulate base station, connected to the internet via the Google Meet server to the auxiliary device. The auxiliary device runs special software that allows the codecs and bit rate to be fixed to a specific value. Please refer to

section 3.3.6. An assessment was made of each of the different codec bit rates to determine the worst case for each different OTT transport (GSM, WCDMA, LTE, NR, WiFi).

6. The auxiliary device includes software that displays the audio level in dBFS, which allows calibration of the system to establish the -20dBm0 reference level. After establishing the voice-only communication between auxiliary device and device under test, the audio put from the AMMI is injected into the auxiliary device. The gain factor to establish a reference level of -20dBm0 for use during the test is determined as detailed in the next page based on the 0dBmFull Scale (0dBFS) value being equivalent to 3.14dBm0.

The speech levels with the settings at the AF connector of R&S CMW500, CMX500 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

4. HAC Measurement Evaluation

4.1 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.

4.2 Field Intensity

When measured as specified in this standard, the T-Coil signal shall be ≥ –18 dB (A/m) at 1 kHz, in a 1/3 octave band filter for all orientations.

4.3 Frequency Response

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

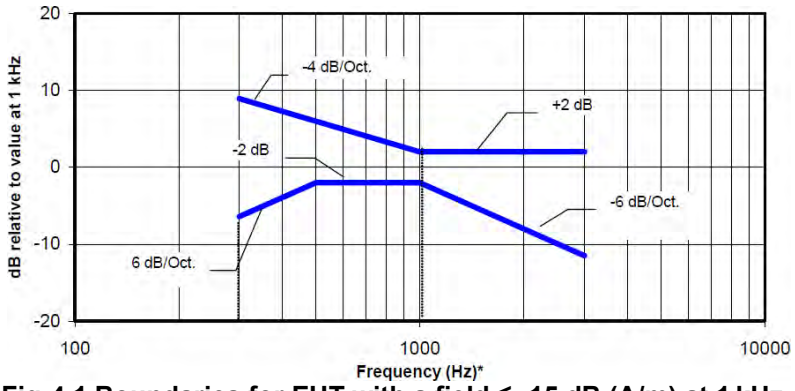


Fig-4.1 Boundaries for EUT with a field ≤ -15 dB (A/m) at 1 kHz

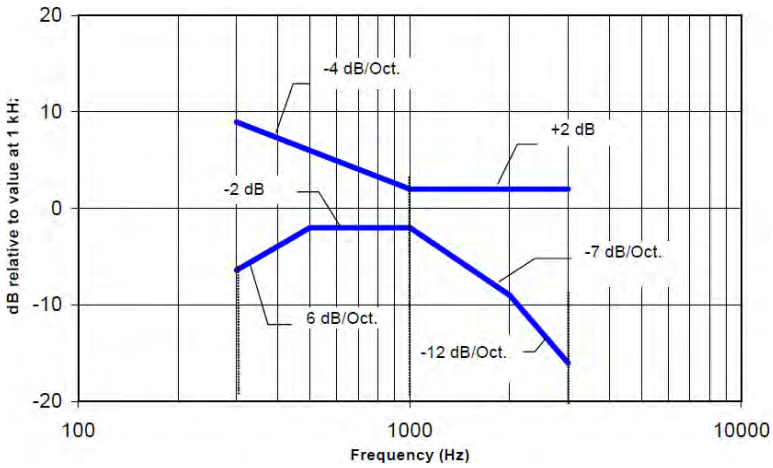


Fig-4.2 Boundaries for EUT with a field > -15 dB (A/m) at 1 kHz

4.4 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.

5. HAC T-Coil Testing Results

5.1 GSM CMRS Voice Testing 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. Through Internal radio configuration investigation (e.g. bandwidth, modulation data rate, subcarrier spacings, and resource blocks) that the worst radio configuration was document as below table.

   b. Use the worst-case codec test and document a limited set of bands/channel/bandwidths.

   c. According to the ANSI C63.19-2019 section 6.3.3, using a frequency near the center of the frequency band perform T-coil evaluation.

<Codec Investigation>

GSM Codec							
Codec	AMR NB Full Rate	AMR NB Full Rate	AMR WB Full Rate	AMR WB Full Rate	EFR NB (FR V2)	Orientation	Band / Channel
Bit rate	4.75 Kbps	12.2 Kbps	6.6 Kbps	12.65 Kbps	12.2Kbps		
Primary Group Contiguous Point Count	162	165	174	175	**157**	Transversal (Y)	GSM850 / 189
Secondary Group Contiguous Point Count	411	406	402	397	400		
Secondary Group Max Longitudinal	20	19	19	19	18		
Secondary Group Max Transverse	26	26	26	26	26		
Frequency Response	1.05	1.84	2	1.48	0.62		

Note: According to codec investigation, the worst codec is EFR NB 12.2Kbps.

Test Summary

Plot No.	Air Interface	Modulation Mode	Channel	Sample	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Ambient Noise dB (A/m)
P01	GSM850	Voice	189	1	Transversal (Y)	157	400	18	26	0.62	-55.39
P02	GSM1900	Voice	661	1	Transversal (Y)	197	452	20	26	2	-55.41

5.2 WCDMA CMRS Voice Testing Results

<Codec Investigation>

UMTS AMR Codec						
Codec	**NB AMR**	**NB AMR**	**WB AMR**	**WB AMR**	**Orientation**	**Band / Channel**
Bit rate	**4.75 Kbps**	**12.2 Kbps**	**6.6 Kbps**	**23.85Kbps**		
Primary Group Contiguous Point Count	227	**223**	240	240	Transversal (Y)	WCDMA V / 4182
Secondary Group Contiguous Point Count	490	482	484	477		
Secondary Group Max Longitudinal	24	23	23	22		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	1.95	2	2	1.14		

Note: According to codec investigation, the worst codec is NB AMR 12.2Kbps.

Test Summary

Plot No.	Air Interface	Modulation Mode	Channel	Sample	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Ambient Noise dB (A/m)
P03	WCDMA II	Voice	9400	1	Transversal (Y)	234	499	24	26	1.73	-55.28
P04	WCDMA V	Voice	4182	1	Transversal (Y)	223	482	23	26	2	-55.11

5.3 VoLTE Testing Results

LTE FDD

<Codec Investigation>

VoLTE AMR Codec						
Codec	**NB AMR**	**WB AMR**	**NB AMR**	**WB AMR**	**Orientation**	**Band / Channel**
Bit rate	**4.75 Kbps**	**6.60Kbps**	**12.2Kbps**	**23.85Kbps**		
Primary Group Contiguous Point Count	**240**	259	269	259	Transversal (Y)	LTE 2 / 18900
Secondary Group Contiguous Point Count	459	473	471	457		
Secondary Group Max Longitudinal	19	19	19	19		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	1.73	0.39	1.89	-0.29		

VoLTE EVS Codec								
Codec	**EVS WB**	**EVS WB**	**EVS SWB**	**EVS SWB**	**EVS NB**	**EVS NB**	**Orientation**	**Band / Channel**
Bit rate	**9.6Kbps**	**24.4Kbps**	**9.6Kbps**	**24.4Kbps**	**5.9Kbps**	**24.4Kbps**		
Primary Group Contiguous Point Count	253	243	243	259	261	255	Transversal (Y)	LTE 2 / 18900
Secondary Group Contiguous Point Count	462	456	454	472	474	468		
Secondary Group Max Longitudinal	19	19	19	19	19	19		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	0.48	0.56	0.63	0.73	0.56	0.69		

Note: According to codec investigation, the worst codec is NB AMR 4.75kbps

<Air Interface Investigation>

Air Interface	Modulation / Mode	Channel	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response
LTE 2	QPSK_20M_1_0	18900	Transversal (Y)	**240**	459	19	26	1.73
LTE 2	QPSK_20M_50_0	18900	Transversal (Y)	242	468	19	26	1.28
LTE 2	QPSK_20M_100_0	18900	Transversal (Y)	248	474	19	26	0.86
LTE 2	16QAM_20M_1_0	18900	Transversal (Y)	244	468	19	26	1.12
LTE 2	64QAM_20M_1_0	18900	Transversal (Y)	255	483	20	26	0.93
LTE 2	QPSK_15M_1_0	18900	Transversal (Y)	255	478	20	26	1.2
LTE 2	QPSK_10M_1_0	18900	Transversal (Y)	257	481	21	26	1.61
LTE 2	QPSK_5M_1_0	18900	Transversal (Y)	267	496	22	26	1.26
LTE 2	QPSK_3M_1_0	18900	Transversal (Y)	273	500	22	26	0.93
LTE 2	QPSK_1.4M_1_0	18900	Transversal (Y)	276	502	22	26	0.85

Test Summary

Plot No.	Air Interface	Modulation / Mode	Channel	Sample	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Ambient Noise dB (A/m
P05	LTE 2	QPSK20M_1_0	18900	1	Transversal (Y)	240	459	19	26	1.73	-55.34
P06	LTE 5	QPSK10M_1_0	20525	1	Transversal (Y)	267	483	22	26	1.83	-55.09
P07	LTE 12	QPSK10M_1_0	23095	1	Transversal (Y)	272	486	22	26	1.71	-55.21
P08	LTE 13	QPSK10M_1_0	23230	1	Transversal (Y)	270	483	22	26	1.3	-54.56
P09	LTE 66	QPSK20M_1_0	132322	1	Transversal (Y)	255	470	19	26	0.96	-54.97

5.4 VoNR Testing Results

NR FDD

<Codec Investigation>

VoNR AMR Codec						
Codec	**NB AMR**	**WB AMR**	**NB AMR**	**WB AMR**	**Orientation**	**Band / Channel**
Bit rate	**4.75 Kbps**	**6.60Kbps**	**12.2Kbps**	**23.85Kbps**		
Primary Group Contiguous Point Count	268	**237**	270	273	Transversal (Y)	FR1 n2 / 20M / 376000
Secondary Group Contiguous Point Count	506	476	479	478		
Secondary Group Max Longitudinal	22	21	19	19		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	1.13	0.41	2	-0.16		

VoNR EVS Codec								
Codec	**EVS WB**	**EVS WB**	**EVS SWB**	**EVS SWB**	**EVS NB**	**EVS NB**	**Orientation**	**Band / Channel**
Bit rate	**9.6Kbps**	**24.4Kbps**	**9.6Kbps**	**24.4Kbps**	**5.9Kbps**	**24.4Kbps**		
Primary Group Contiguous Point Count	280	264	262	270	260	264	Transversal (Y)	FR1 n2 / 20M / 3760000
Secondary Group Contiguous Point Count	485	480	470	479	479	484		
Secondary Group Max Longitudinal	20	20	19	20	20	20		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	-0.35	-0.16	-0.02	0.03	0.72	0.51		

Note: According to codec investigation, the worst codec is WB AMR 6.6Kbps

NR TDD

<Codec Investigation>

VoNR AMR Codec						
Codec	NB AMR	WB AMR	NB AMR	WB AMR	Orientation	Band / Channel
Bit rate	4.75 Kbps	6.60Kbps	12.2Kbps	23.85Kbps		
Primary Group Contiguous Point Count	**125**	127	137	140	Transversal (Y)	FR1 n77 / 100M / 633334
Secondary Group Contiguous Point Count	343	343	343	344		
Secondary Group Max Longitudinal	19	19	19	19		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	1.73	0.39	2	-0.18		

VoNR EVS Codec								
Codec	EVS WB	EVS WB	EVS SWB	EVS SWB	EVS NB	EVS NB	Orientation	Band / Channel
Bit rate	9.6Kbps	24.4Kbps	9.6Kbps	24.4Kbps	5.9Kbps	24.4Kbps		
Primary Group Contiguous Point Count	148	147	150	140	133	139	Transversal (Y)	FR1 n77 / 100M / 633334
Secondary Group Contiguous Point Count	344	344	346	333	343	344		
Secondary Group Max Longitudinal	19	19	19	19	19	19		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	-0.38	-0.39	-0.28	-0.23	0.79	0.61		

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

<Air Interface Investigation>

Air Interface	Modulation / Mode	Channel	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response
FR1 n2	DFT-QPSK20M_1_1	376000	Transversal (Y)	**237**	476	21	26	0.41
FR1 n2	DFT-QPSK20M_50_0	376000	Transversal (Y)	238	478	20	26	0.5
FR1 n2	DFT-QPSK20M_100_0	376000	Transversal (Y)	253	493	21	26	0.49
FR1 n2	DFT-BPSK20M_1_1	376000	Transversal (Y)	246	483	20	26	0.36
FR1 n2	DFT-16QAM20M_1_1	376000	Transversal (Y)	247	487	22	26	0.28
FR1 n2	DFT-64QAM20M_1_1	376000	Transversal (Y)	247	481	22	26	0.44
FR1 n2	DFT-256QAM20M_1_1	376000	Transversal (Y)	248	489	21	26	0.37
FR1 n2	DFT-QPSK15M_1_1	376000	Transversal (Y)	255	499	20	26	0.44
FR1 n2	DFT-QPSK10M_1_1	376000	Transversal (Y)	250	490	20	26	0.44
FR1 n2	DFT-QPSK5M_1_1	376000	Transversal (Y)	259	500	21	26	0.41
FR1 n77 PC3	DFT-QPSK100M_1_1	633334	Transversal (Y)	135	353	18	26	1.7
FR1 n77 PC2	DFT-QPSK100M_1_1	633334	Transversal (Y)	**125**	343	19	26	1.73

Test Summary

Plot No.	Air Interface	Modulation / Mode	Channel	Sample	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Ambient Noise dB (A/m
P10	FR1 n2	DFT-QPSK20M_1_1	376000	1	Transversal (Y)	237	476	21	26	0.41	-55.13
P11	FR1 n5	DFT-QPSK20M_1_1	167300	1	Transversal (Y)	278	517	24	26	0.35	-55.26
P12	FR1 n66	DFT-QPSK30M_1_1	349000	1	Transversal (Y)	227	461	19	26	0.37	-54.79
P13	FR1 n77	DFT-QPSK100M_1_1	633334	1	Transversal (Y)	125	343	19	26	1.73	-55.12
	FR1 n77	DFT-QPSK100M_1_1	633334	2	Transversal (Y)	146	368	22	26	1.04	-54.31
P14	FR1 n77	DFT-QPSK100M_1_1	656000	1	Transversal (Y)	132	346	20	26	1.45	-55.23

5.5 VoWiFi Testing Results

<Codec Investigation>

VoWiFi AMR Codec						
Codec	**NB AMR**	**WB AMR**	**NB AMR**	**WB AMR**	**Orientation**	**Band / Channel**
Bit rate	**4.75 Kbps**	**6.60Kbps**	**12.2Kbps**	**23.85Kbps**		
Primary Group Contiguous Point Count	180	**160**	187	186	Transversal (Y)	WLAN2.4GHz / 6
Secondary Group Contiguous Point Count	402	381	396	393		
Secondary Group Max Longitudinal	18	18	18	18		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	1.73	0.24	2	-0.15		

VoWiFi EVS Codec								
Codec	**EVS WB**	**EVS WB**	**EVS SWB**	**EVS SWB**	**EVS NB**	**EVS NB**	**Orientation**	**Band / Channel**
Bit rate	**9.6Kbps**	**24.4Kbps**	**9.6Kbps**	**24.4Kbps**	**5.9Kbps**	**24.4Kbps**		
Primary Group Contiguous Point Count	227	208	223	179	204	198	Transversal (Y)	WLAN2.4GHz / 6
Secondary Group Contiguous Point Count	447	429	443	398	425	416		
Secondary Group Max Longitudinal	19	18	19	18	18	18		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	0.43	0.5	0.68	0.49	0.51	0.36		

Note: According to codec investigation, the worst codec is WB AMR 6.6Kbps

<Air Interface Investigation>

Air Interface	Modulation / Mode	Channel	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response
WLAN2.4GHz	802.11b 1Mbps	6	Transversal (Y)	**160**	381	18	26	0.24
	802.11g 6Mbps	6	Transversal (Y)	217	443	19	26	0.2
	802.11n-HT20 MCS0	6	Transversal (Y)	261	491	21	26	0.28
	802.11n-HT40 MCS0	6	Transversal (Y)	187	410	18	26	0.19
	802.11b 11Mbps	6	Transversal (Y)	169	386	18	26	0.3
WLAN5GHz	802.11a 6Mbps	40	Transversal (Y)	**163**	381	19	26	0.41
	802.11n-HT20 MCS0	40	Transversal (Y)	238	461	19	26	0.22
	802.11n-HT40 MCS0	38	Transversal (Y)	230	450	19	26	0.33
	802.11ac-VHT20 MCS0	40	Transversal (Y)	235	453	19	26	0.18
	802.11ac-VHT40 MCS0	38	Transversal (Y)	235	453	19	26	0.31
	802.11ac-VHT80 MCS0	42	Transversal (Y)	180	395	18	26	0.15
	802.11a 54Mbps	40	Transversal (Y)	182	402	19	26	0.17

Test Summary

Plot No.	Air Interface	Modulation / Mode	Channel	Sample	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Ambient Noise dB (A/m
P15	WLAN2.4GHz	802.11b 11Mbps	6	1	Transversal (Y)	160	381	18	26	0.24	-55.34
P16	WLAN5GHz	802.11a 6Mbps	40	1	Transversal (Y)	163	381	19	26	0.41	-55.13
P17	WLAN5GHz	802.11a 6Mbps	60	1	Transversal (Y)	214	432	18	26	0.16	-55.32
P18	WLAN5GHz	802.11a 6Mbps	132	1	Transversal (Y)	258	483	21	26	0.33	-55.19
P19	WLAN5GHz	802.11a 6Mbps	157	1	Transversal (Y)	250	474	20	26	0.14	-55.03

5.6 T-Coil testing for OTT Voice Calling

General Notes:

1. According to the ANSI C63.19-2019 section 6.3.3, using a frequency near the center of the frequency band perform T-coil evaluation.
2. Phone Condition: Mute on; Backlight off; Max Volume
3. 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.
4. Google Meet only support OPUS audio codec and support 6Kbps to 75Kbps bitrate.
5. The test setup used for OTT Voice call is the DUT connect to the CMW500/CMX500 and via the data application unit on CMW500/CMX500 connection to the Internet, the Auxiliary EUT is connected to the WiFi access point, the channel/Modulation/Frequency bands/data rate is configured on the CMW500/CMX500 for the DUT unit. For the Auxiliary OTT unit which is used to configure the audio codec rate and determine the audio input level of -20dBm0 based on the KDB 285076 D02 requirement.
6. 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 tests results which the worst case codec would be remarked to be used for the testing for the handset.
7. Air Interface Investigation:
   a. Through Internal radio configuration investigation (e.g. bandwidth, modulation data rate, subcarrier spacing, and resource blocks) that the worst radio configuration was document as below table.
   b. Use the worst-case codec test and document a limited set of bands/channel/bandwidths.
   c. OTT service and CMRS IP service are established over the internet protocol for the voice service, and on both services the identical RF air interface is used for LTE and WIFI. Therefore, according to HA3O1004B VoLTE and VoWiFi test results from the air interface investigation, the worst configuration and frequency band of the air interface is used for OTT T-Coil testing.

-LTE FDD worst configuration and band: LTE Band 7/20MHz/QPSK/1RB Size
-LTE TDD worst configuration and band: LTE Band 41/20MHz/QPSK/1RB Size
-NR FDD worst configuration and band: NR Band 25/20MHz/QPSK/1RB Size
-NR TDD worst configuration and band: NR Band 48/40MHz/QPSK/1RB Size
-WLAN DTS worst configuration: 802.11b/1Mbps
-WLAN NII worst configuration and Band: WLAN 5.3GHz/11a/6Mbps

<Codec Investigation>

EDGE

EDGE					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**167**	184	189	Transversal (Y)	GSM850 / 189
Secondary Group Contiguous Point Count	356	376	381		
Secondary Group Max Longitudinal	17	16	17		
Secondary Group Max Transverse	26	26	26		
Frequency Response	1.05	-1.53	-1.63		

HSPA

HSPA					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	286	277	**260**	Transversal (Y)	WCDMA V / 4182
Secondary Group Contiguous Point Count	481	473	462		
Secondary Group Max Longitudinal	23	22	22		
Secondary Group Max Transverse	26	26	26		
Frequency Response	-1.76	-1.68	1.14		

LTE FDD

LTE FDD					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	284	**280**	283	Transversal (Y)	LTE 2 / 18900
Secondary Group Contiguous Point Count	484	480	483		
Secondary Group Max Longitudinal	20	20	19		
Secondary Group Max Transverse	26	26	26		
Frequency Response	-1.09	1.36	-1.25		

NR FDD

NR FDD					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**254**	256	261	Transversal (Y)	FR1 n66 / 30M / 349000
Secondary Group Contiguous Point Count	454	456	459		
Secondary Group Max Longitudinal	18	18	18		
Secondary Group Max Transverse	26	26	26		
Frequency Response	0.77	-1.06	-1.31		

NR TDD

NR TDD					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**139**	140	141	Transversal (Y)	FR1 n77 / 100M / 633334
Secondary Group Contiguous Point Count	337	336	336		
Secondary Group Max Longitudinal	18	19	19		
Secondary Group Max Transverse	26	26	26		
Frequency Response	1.38	-1.23	-1.2		

WLAN

WLAN					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	223	**214**	220	Transversal (Y)	WLAN2.4GHz / 6
Secondary Group Contiguous Point Count	417	407	414		
Secondary Group Max Longitudinal	19	18	18		
Secondary Group Max Transverse	26	26	26		
Frequency Response	-1.92	1.84	-1.07		

Test Summary

Plot No.	Air Interface	Modulation / Mode	Channel	Sample	Probe Position	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Ambient Noise dB (A/m
P20	GSM850	Voice	189	1	Transversal (Y)	167	356	17	26	1.05	-55.16
P21	GSM1900	Voice	661	1	Transversal (Y)	260	455	19	26	1.08	-54.97
P22	WCDMA II	Voice	9400	1	Transversal (Y)	274	473	21	26	2	-54.82
P23	WCDMA V	Voice	4182	1	Transversal (Y)	260	462	22	26	1.14	-55.16
P24	LTE 2	QPSK20M_1_0	18900	1	Transversal (Y)	280	480	20	26	1.36	-55.27
P25	FR1 n66	DFT-QPSK30M_1_1	349000	1	Transversal (Y)	254	454	18	26	0.77	-55.34
P26	FR1 n77	DFT-QPSK100M_1_1	633334	1	Transversal (Y)	139	337	18	26	1.38	-55.03
P27	WLAN2.4GHz	802.11b 11Mbps	6	1	Transversal (Y)	214	407	18	26	1.84	-54.96
P28	WLAN5GHz	802.11a 6Mbps	40	1	Transversal (Y)	287	479	20	26	0.95	-55.15

Test Engineer: Renjie Liu and Zixiao Xia

6. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
Audio Band Magnetic Probe	SPEAG	AM1DV3	3144	Feb. 14, 2024	1 Year
Audio Band Magnetic Probe	SPEAG	AM1DV3	1021	Oct. 08, 2024	1 Year
Data Acquisition Electronics	SPEAG	DAE	1288	Sep. 24, 2024	1 Year
Universal Radio Communication Tester	R&S	CMW500	169210	Jun. 19, 2024	2 Years
Universal Radio Communication Tester	R&S	CMX500	101873	Oct. 08, 2023	2 Years
Audio Measuring Instrument	SPEAG	AMMI	1180	N/A	N/A
Audio Magnetic Calibration Coil	SPEAG	AMCC	1158	N/A	N/A
Test Arch Phantom	SPEAG	Arch	N/A	N/A	N/A

7. Measurement Uncertainty

HAC Uncertainty Budget for T-Coil 2019 version According to ANSI C63.19							
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	
Expanded STD Uncertainty						8.1%	12.2%

Uncertainty Budget for HAC T-Coil

8. Information of the Testing Laboratories

We, Huarui 7layers High Technology (Suzhou) Co., Ltd., were founded in 2020 to provide our best service in EMC, Radio, Telecom and Safety consultation.

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

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Tel: +86 (0557) 368 1008

The road map of all our labs can be found in our web site also
Web: http://www.7Layers.com

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