FCC HAC (T-Coil) Test Report

Report No.	: **PSU-NQN2204190209HA01**
Applicant	: **HMD Global Oy**
Address	: **Bertel Jungin aukio 9,02600 Espoo,Finland**
Product	: **GSM/WCDMA/LTE Mobile Phone**
FCC ID	: **2AJOTTA-1469**
Brand	: **NOKIA**
Model No.	: **TA-1469**
Standards	: **FCC 47 CFR Part 20.19, ANSI C63.19-2011** **KDB 285076 D01 v05, KDB 285076 D02 v03, KDB 285076 D03 v01**
Sample Received Date	: **Apr.14, 2022**
Date of Testing	: **Apr.14, 2022 ~ Apr.16, 2022**
Summary T-Rating	: **T4**

CERTIFICATION: The above equipment have been tested by **Huarui Saiwei (Suzhou) Technology 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 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 A2LA or any government agencies.

Prepared By : Shunxin Hou

Shun Xin Hou / Engineer

ACCREDITED

Certificate #6613.01

Approved By : Chao Wu

Chao Wu/ Manager

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Release Control Record

Report No.	Reason for Change	Date Issued
PSU-NQN2204190209HA01	Initial release	Apr.27, 2022

1. Summary of Maximum T-Rating

Mode	Band	ABM1 (dB A/m)	Frequency Response Margin (dB)	SNR (dB)	T-Rating
GSM	GSM850	-1.76	1.92	45.73	T4
WCDMA	Band V	-6.5	0.65	45.04	T4
FDD-LTE	Band 5	-4.96	2	47.4	T4
	Band 7	-7.76	2	46.76	T4
Summary		T4			

Note:

1. The HAC T-Coil limit **(T-Rating Category T3)** is specified in FCC 47 CFR part 20.19 and ANSI C63.19.
2. The device T-Coil rating is determined by the minimum rating.

2. Description of Equipment Under Test

EUT Type	**GSM/WCDMA/LTE Mobile Phone**
FCC ID	**2AJOTTA-1469**
Brand Name	**NOKIA**
Model Name	**TA-1469**
HW Version	**FF618-MB-V0.2**
SW Version	**0.2216.11.08**
Tx Frequency Bands (Unit: MHz)	**GSM** GSM850 : 824.2 ~ 848.8 **WCDMA** Band V : 826.4 ~ 846.6 **FDD-LTE** Band 5 : 824.7 ~ 848.3 (BW: 1.4M, 3M, 5M, 10M) Band 7 :2502.5~2567.5 (BW: 5M, 10M, 15M, 20M)
Modulations Supported in Uplink	GSM & GPRS : GMSK WCDMA : QPSK LTE : QPSK, 16QAM
Antenna Type	Fixed Internal Antenna
EUT Stage	Production Unit

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**	**NOKIA**
	Model Name	**BL-L4E**
	Power Rating	-
	Type	**Rechargeable Li-ion battery**

Air Interface and Operational Mode:

<table>
<tr><th>Air Interface</th><th>Bands</th><th>Transport Type</th><th>ANSI C63.19 Tested</th><th>Simultaneous But Not Tested</th><th>Name of Voice Service</th><th>Power Reduction</th></tr>
<tr><td rowspan="2">GSM</td><td>850</td><td>VO</td><td>YES</td><td>WLAN or BT</td><td>CMRS Voice(1)</td><td>No</td></tr>
<tr><td>EGPRS</td><td>DT</td><td>No</td><td>WLAN or BT</td><td>N/A</td><td>No</td></tr>
<tr><td rowspan="2">WCDMA</td><td>V</td><td>VO</td><td>YES</td><td>WLAN or BT</td><td>CMRS Voice(1)</td><td>No</td></tr>
<tr><td>HSPA</td><td>DT</td><td>No</td><td>WLAN or BT</td><td>N/A</td><td>No</td></tr>
<tr><td rowspan="2">FDD-LTE</td><td>5</td><td rowspan="2">VD</td><td rowspan="2">YES</td><td rowspan="2">WLAN or BT</td><td rowspan="2">VoLTE(1)</td><td>No</td></tr>
<tr><td>7</td><td>No</td></tr>
<tr><td colspan="3">Transport Type
VO = Legacy Cellular Voice Service
DT = Digital Transport Only (No Voice)
VD = IP Voice Service over Digital Transport</td><td colspan="4">Note
1. Reference level in accordance with 7.4.2.1 of ANSI C63.19-2011 and the July 2012 VoLTE interpretation.
2. Reference level is −20 dBm0 in accordance with FCC KDB 285076</td></tr>
</table>

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.

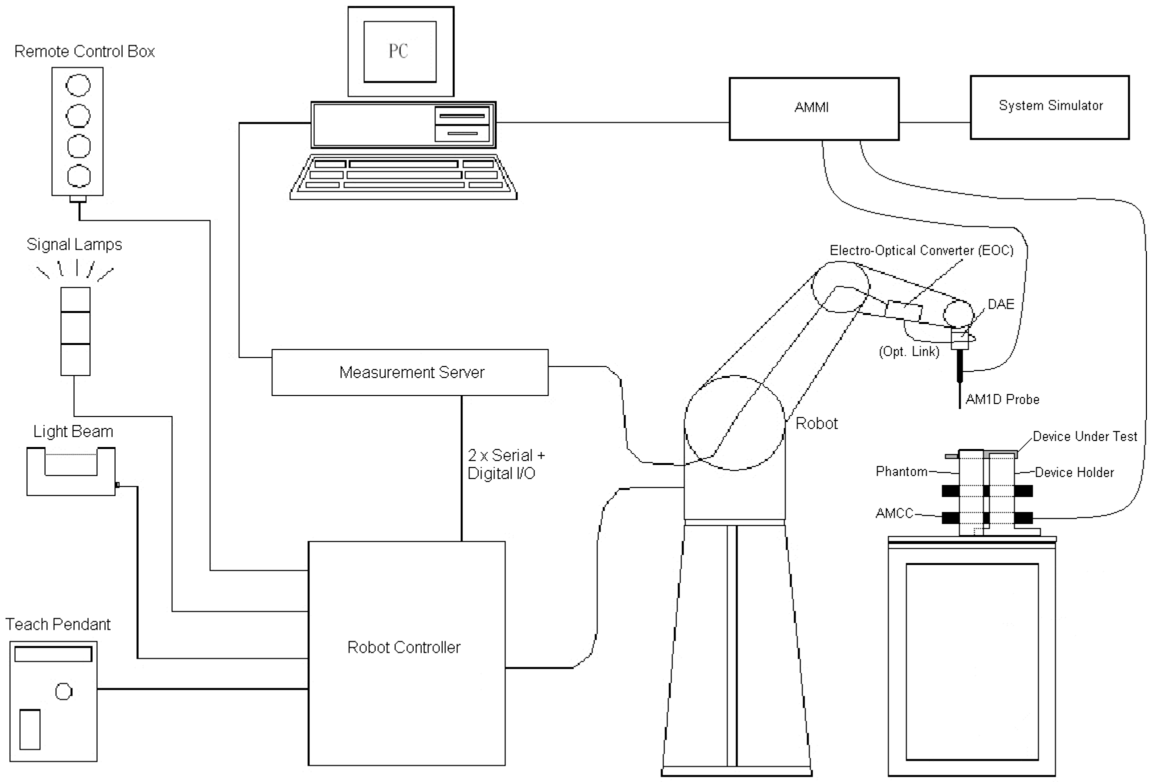


Fig-3.1 DASY System Setup

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:

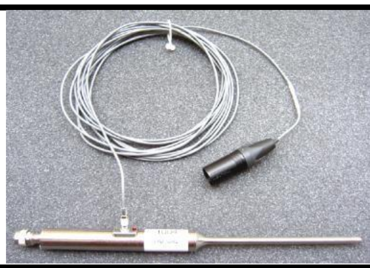
- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

Fig-3.3 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.

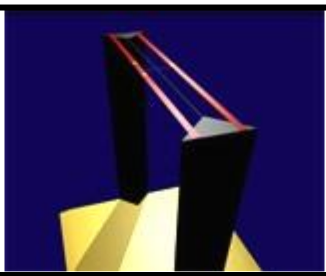
Sampling Rate	48 kHz / 24 bit
Dynamic Range	100 dB (with AM1DV3 probe)
Test Signal Generation	User selectable and predefined (via PC)
Calibration	Auto-calibration / full system calibration using AMCC with monitor output
Dimensions	482 x 65 x 270 mm

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.

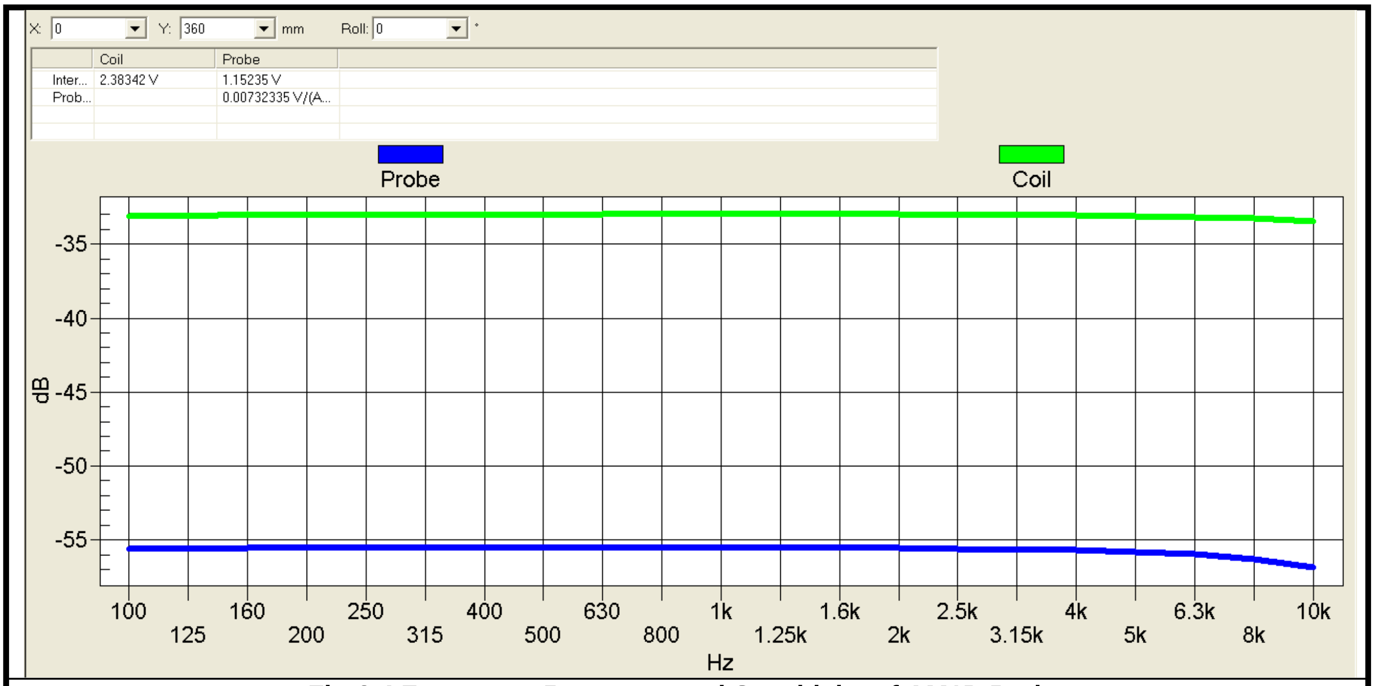


Fig-3.4 Frequency Response and Sensitivity of AM1D Probe

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 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 EUT handset that, 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 points may be located where the perpendicular (axial) and transverse (radial) field intensity measurements are optimum with regard to the requirements. However, the measurement points should be near the acoustic output of the EUT and shall be located in the same half of the phone as the EUT receiver. In a EUT handset with a centered receiver and a circularly symmetrical magnetic field, the measurement axis and the reference axis would coincide.

(5) The relative spacing of each measurement orientations is not fixed. The perpendicular (axial) and transverse (radial) orientations should be chosen to select the optimal position.

(6) The measurement point for the axial position is located 10 mm from the reference plane on the measurement axis.

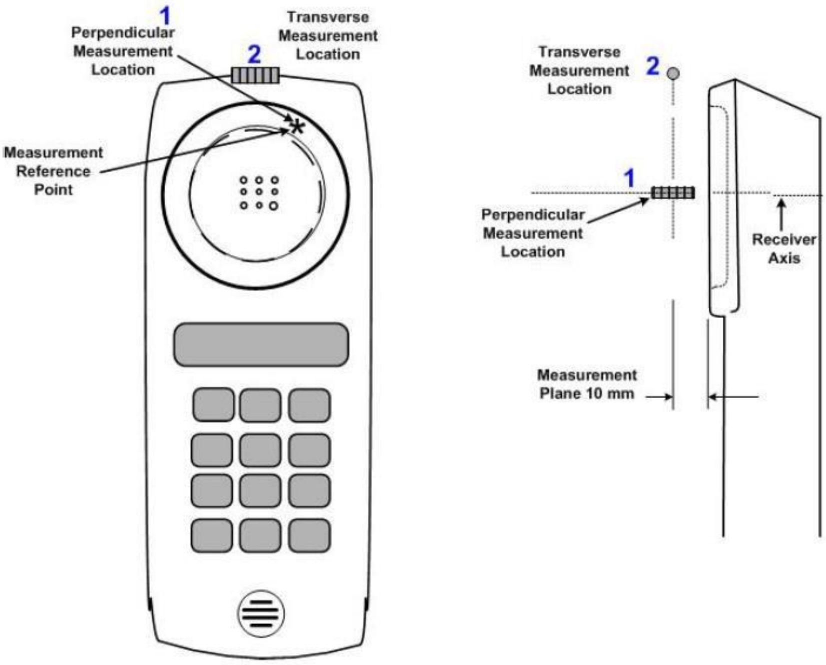


Fig-3.5 Axis and Planes

3.4 HAC T-Coil Measurement Procedure

According to ANSI C63.19-2011, 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 7.1 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 7.4.4.1.1 and 7.4.4.2.
4. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at f_i) as described in 7.4.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency (f_i) shall be centered in each 1/3 octave band maintaining the same drive level as determined in Step 2 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 ABM1 measurement meet the ambient and test system noise criterion in 7.3.1.
5. At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as described in 7.4.4.4 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting, and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).
6. Determine the category that properly classifies the signal quality based on Table 8.5.

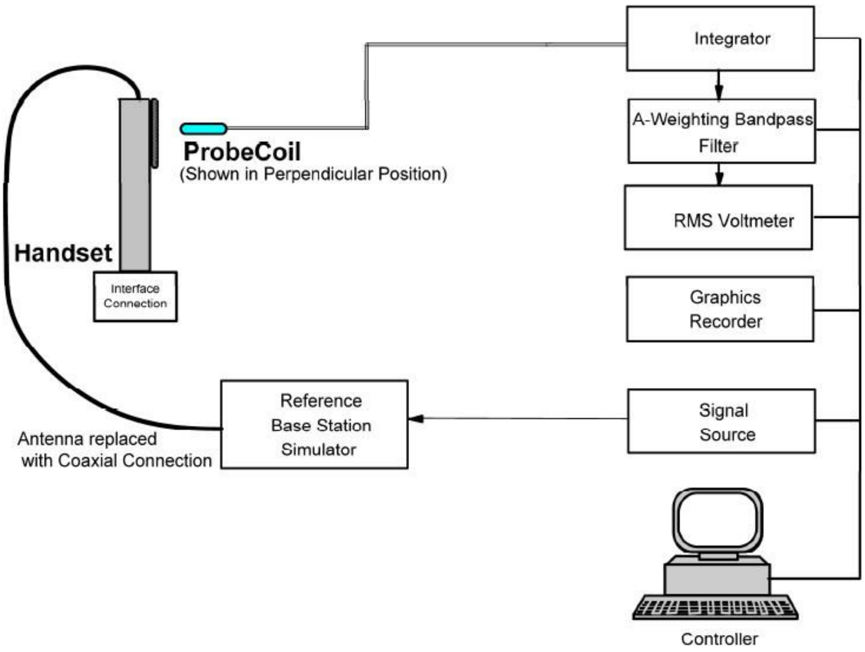


Fig-3.6 T-Coil Measurement Test Setup

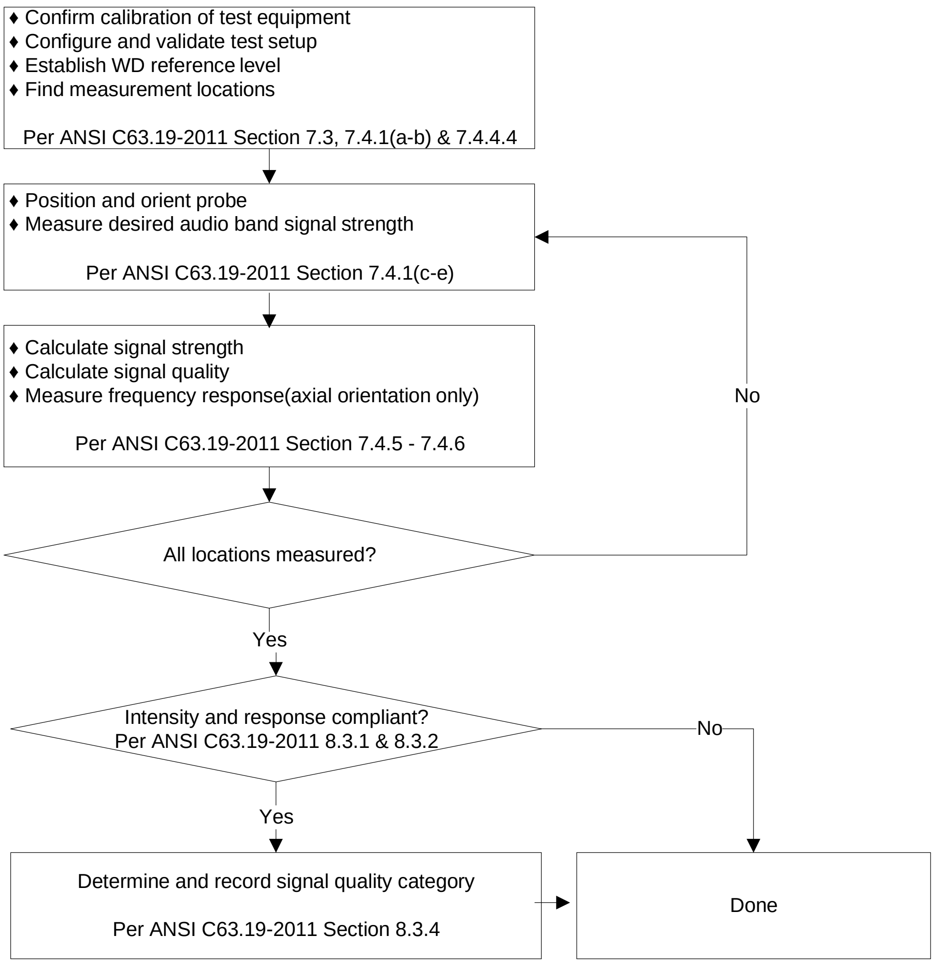


Fig-3.7 T-Coil Signal Test Flowchart

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 C63.19-2011. 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.

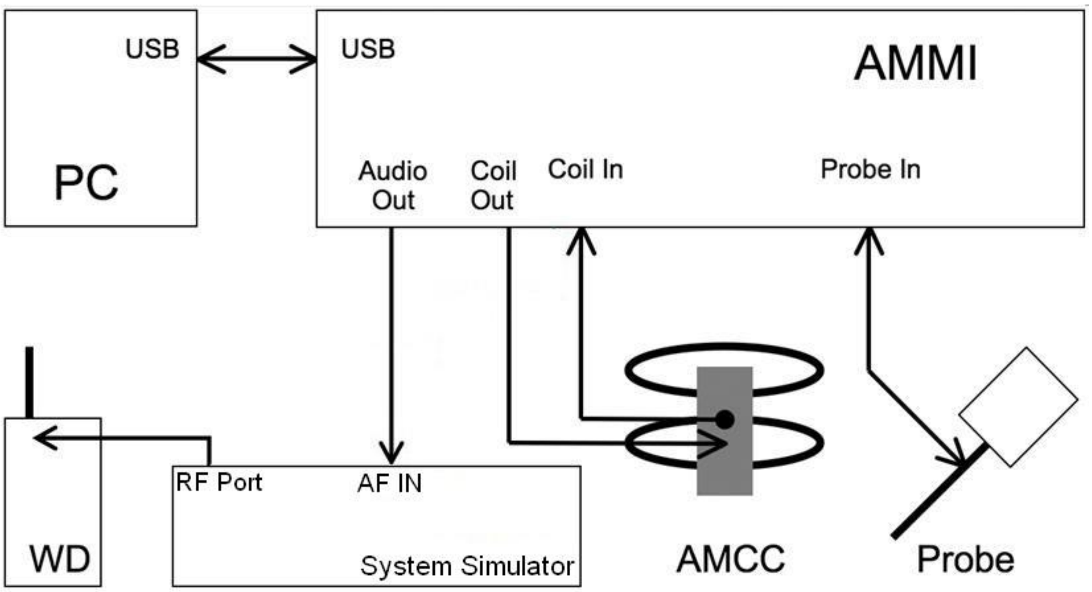


Fig-3.8 System Setup for T-Coil Testing

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.

Reference Audio Input Level:
-16 dBm0 is used for GSM, WCDMA, and VoLTE
-18 dBm0 is used for CDMA

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

4. HAC Measurement Evaluation

4.1 Measurement Criteria

The HAC Standard ANSI C63.19-2011 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.

4.1.1 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.

4.1.2 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.

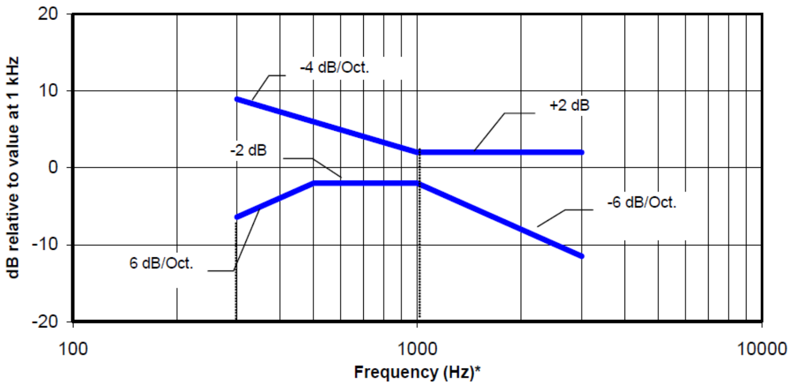


Fig-4.1 Boundaries for EUT with a field ≤ -15 dB (A/m) at 1 kHz

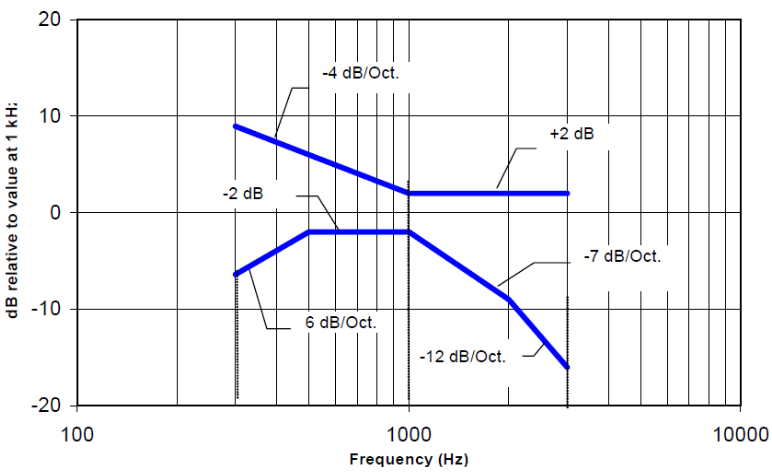


Fig-4.2 Boundaries for EUT with a field > -15 dB (A/m) at 1 kHz

4.1.3 Signal Quality

The worst signal quality of the three T-Coil signal measurements shall be used to determine the T-Coil mode category per below table.

Category	Telephone Parameters WD Signal Quality (Signal to Noise Ratio, in dB)
Category T1	0 – 10
Category T2	10 – 20
Category T3	20 – 30
Category T4	> 30

4.2 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.

4.3 HAC T-Coil Testing Results

4.3.1 GSM CMRS Voice Testing Results

Codec Investigation

Band	Channel	Codec Setting	Probe Orientation	ABM1 (dB A/m)	ABM2 (dB A/m)	Frequency Response	SNR (dB)
GSM850	189	FR V1	Axial (Z)	-1.76	-47.49	Pass	45.73
GSM850	189	HR V1	Axial (Z)	-4.01	-49.90	Pass	45.89

Test Summary

Plot No.	Band	Channel	Codec Setting	Probe Orientation	ABM1 (dB A/m)	ABM2 (dB A/m)	Ambient Noise (dB A/m)	Frequency Response Margin (dB)	Frequency Response	SNR (dB)	FCC Limit (dB)	FCC Margin (dB)	T-Rating
01	GSM850	189	FR V1	Axial (Z)	-1.76	-47.49	-55.18	1.92	Pass	45.73	20	-25.73	T4
	GSM850	189	FR V1	Radial (Y)	-10.72	-52.13	-55.44			41.41	20	-21.41	T4

4.3.2 WCDMA CMRS Voice Testing Results

Codec Investigation

Band	Channel	Codec Setting	Probe Orientation	ABM1 (dB A/m)	ABM2 (dB A/m)	Frequency Response	SNR (dB)
WCDMA V	4182	AMR 4.75kbps	Axial (Z)	-6.35	-51.87	Pass	45.52
WCDMA V	4182	AMR 7.95kbps	Axial (Z)	-6.5	-51.54	Pass	45.04
WCDMA V	4182	AMR 12.2kbps	Axial (Z)	-6.41	-52.09	Pass	45.68

Test Summary

Plot No.	Band	Channel	Codec Setting	Probe Orientation	ABM1 (dB A/m)	ABM2 (dB A/m)	Ambient Noise (dB A/m)	Frequency Response Margin (dB)	Frequency Response	SNR (dB)	FCC Limit (dB)	FCC Margin (dB)	T-Rating
	WCDMA V	4182	AMR 7.95kbps	Axial (Z)	-6.5	-51.54	-54.42	0.65	Pass	45.04	20	-25.04	T4
02	WCDMA V	4182	AMR 7.95kbps	Radial (Y)	-13.11	-53.75	-55.27		Pass	40.64	20	-20.64	T4

4.3.3 VoLTE Testing Results

Configuration Investigation

Air Interface	Band	Bandwidth (MHz)	Modulation	RB Size	RB Offset	Channel	Codec	Probe Orientation	ABM1 (dB A/m)	ABM2 (dB A/m)	SNR (dB)
FDD-LTE	LTE B7	20	QPSK	1	0	26365	NB AMR 4.75Kbps	Axial (Z)	-3.73	-52.62	48.89
FDD-LTE	LTE B7	20	QPSK	1	0	26365	NB AMR 12.2Kbps	Axial (Z)	-4.56	-52.28	47.72
FDD-LTE	LTE B7	20	QPSK	1	0	26365	WB AMR 6.60Kbps	Axial (Z)	-4.75	-52.71	47.96
FDD-LTE	LTE B7	20	QPSK	1	0	26365	WB AMR 23.85Kbps	Axial (Z)	-4.54	-53.27	48.73
FDD-LTE	LTE B7	20	QPSK	1	0	26365	EVS SWB 9.6Kbps	Axial (Z)	-3.90	-51.65	47.75
FDD-LTE	LTE B7	20	QPSK	1	0	26365	EVS SWB 128Kbps	Axial (Z)	-3.88	-52.67	48.79
FDD-LTE	LTE B7	20	QPSK	1	0	26365	EVS WB 5.9Kbps	Axial (Z)	-3.91	-51.88	47.97
FDD-LTE	LTE B7	20	16QAM	1	0	26365	EVS WB 128Kbps	Axial (Z)	-3.97	-52.29	48.32
FDD-LTE	LTE B7	20	64QAM	1	0	26365	EVS NB 5.9Kbps	Axial (Z)	-3.76	-51.28	47.52
FDD-LTE	LTE B7	20	QPSK	1	0	26365	EVS NB 24.4Kbps	Axial (Z)	-3.71	-52.16	48.45

Air Interface Investigation

Band	Bandwidth (MHz)	Modulation	RB Size	RB Offset	Channel	Codec Setting	Probe Orientation	UL-DL Configuration	ABM1 (dB A/m)	ABM2 (dB A/m)	SNR (dB)
LTE B7	20	QPSK	1	0	21100	EVS NB 5.9Kbps	Axial (Z)	N/A	-3.76	-51.28	47.52
LTE B7	20	QPSK	50	0	21100	EVS NB 5.9Kbps	Axial (Z)	N/A	-3.76	-50.85	47.09
LTE B7	20	QPSK	100	0	21100	EVS NB 5.9Kbps	Axial (Z)	N/A	-7.52	-53.99	46.47
LTE B7	20	16QAM	1	0	21100	EVS NB 5.9Kbps	Axial (Z)	N/A	-3.67	-51.7	48.03
LTE B7	15	QPSK	1	0	21100	EVS NB 5.9Kbps	Axial (Z)	N/A	-3.33	-50.73	47.40
LTE B7	10	QPSK	1	0	21100	EVS NB 5.9Kbps	Axial (Z)	N/A	-3.30	-51.55	48.25
LTE B7	5	QPSK	1	0	21100	EVS NB 5.9Kbps	Axial (Z)	N/A	-3.37	-51.60	48.23

Test Summary

Plot No.	Band	Bandwidth (MHz)	Modulation	RB Size	RB Offset	Channel	UL-DL Configuration	Codec Setting	Probe Orientation	ABM1 (dB A/m)	ABM2 (dB A/m)	Ambient Noise (dB A/m)	Frequency Response Margin (dB)	Frequency Response	SNR (dB)	FCC Limit (dB)	FCC Margin (dB)	T-Rating
	LTE B5	10	QPSK	50	0	20525	N/A	EVS NB 5.9Kbps	Axial (Z)	-4.96	-52.36	-54.56	2	Pass	47.4	20	-27.4	T4
03	LTE B5	10	QPSK	50	0	20525	N/A	EVS NB 5.9Kbps	Radial (Y)	-12.43	-54.23	-55.13		Pass	41.80	20	-21.8	T4
	LTE B7	20	QPSK	100	0	21100	N/A	EVS NB 5.9Kbps	Axial (Z)	-7.76	-54.52	-54.6	2	Pass	46.76	20	-26.76	T4
04	LTE B7	20	QPSK	100	0	21100	N/A	EVS NB 5.9Kbps	Radial (Y)	-13.16	-54.73	-54.866		Pass	41.57	20	-21.57	T4

5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
Audio Band Magnetic Probe	SPEAG	AM1DV3	3144	Feb.23,2022	1 Year
Universal Radio Communication Tester	SPEAG	DAE	1633	Oct.26,2021	1 Year
Universal Radio Communication Tester	R&S	CMW500	169210	Oct.18,2021	1 Year
Data Acquisition Electronics	SPEAG	Arch	N/A	N/A	N/A

6. Measurement Uncertainty

HAC Uncertainty Budget for T-Coil 2011 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	K=2
Expanded STD Uncertainty						8.1%	12.2%

Uncertainty Budget for HAC T-Coil

7. Information of the Testing Laboratories

We, Huarui Saiwei (Suzhou) Technology 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:

Add: Tower N, Innovation Center, 88 Zuyi Road, High-tech District, Suzhou City, Anhui Province

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

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Appendix A. Plots of HAC T-Coil Measurement

The plots for HAC measurement are shown as follows.

Appendix B. Calibration Certificate for Probe

The SPEAG calibration certificates are shown as follows.

Appendix C. Photographs of EUT and Setup