FCC HAC (T-Coil) Test Report

Report No.	:	**PSU-NQN2403180115SA03**
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	:	**Smart phone**
FCC ID	:	**2AJOTTA-1600**
Brand	:	**HMD**
Model No.	:	**TA-1600/TA-1688**
Standards	:	**CC 47 CFR PART 20.19 / ANSI C63.19-2019** **KDB 285076 D01 v06r04 / KDB 285076 D02 v04 / KDB 285076 D03 v01r06**
Date of Testing	:	**Apr. 22, 2024 ~ May. 23, 2024**
FCC Designation No.	:	**CN1325** **FCC Site Registration No. : 434559**
Issued By	:	**Huarui 7layers High Technology (Suzhou) Co., Ltd.**
Address	:	**Tower N, Innovation Center, 88 Zuyi Road, High-tech District, Suzhou City, Anhui Province China**

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.

Prepared By : Chang Gao

Chang Gao / Engineer

Approved By : Simpeibo

Peibo Sun / Manager

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Release Control Record

Report No.	Reason for Change	Date Issued
PSU-NQN2403180115SA03	Initial release	Jun. 03, 2024

1. Summary of Maximum RF Value

Mode	Band	Frequency Response	Result
GSM CMRS Voice	GSM850	PASS	PASS
	GSM1900	PASS	PASS
UMTS CMRS Voice	Band II	PASS	PASS
	Band IV	PASS	PASS
	Band V	PASS	PASS
VoLTE	Band 7	PASS	PASS
	Band 12/17	PASS	PASS
	Band 13	PASS	PASS
	Band 25/2	PASS	PASS
	Band 26/5	PASS	PASS
	Band 38	PASS	PASS
	Band 41	PASS	PASS
	Band 66/4	PASS	PASS
	Band 71	PASS	PASS
VoNR	NR n7	PASS	PASS
	NR n25/2	PASS	PASS
	NR n5	PASS	PASS
	NR n38	PASS	PASS
	NR n41	PASS	PASS
	NR n48	PASS	PASS
	NR n66	PASS	PASS
	NR n71	PASS	PASS
	NR n77	PASS	PASS
	NR n78	PASS	PASS
VoWiFi	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
	WLAN 6E	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	Smart phone
FCC ID	2AJOTTA-1600
Brand Name	HMD
Model Name	TA-1600/TA-1688
IMEI Code	Sample 1: 355876370026597 / 355876370026605 Sample 2: 355876370062113 / 355876370062121
HW Version	V2
SW Version	00WW_0_340
Tx Frequency Bands (Unit: MHz)	GSM850 : 824 ~ 849 GSM1900 : 1850 ~ 1910 WCDMA Band II : 1850 ~ 1910 WCDMA Band IV : 1710 ~ 1755 WCDMA Band V : 824 ~ 849 LTE Band 2 : 1850 ~ 19010 LTE Band 4 : 1710 ~ 1755 LTE Band 5 : 824 ~ 849 LTE Band 7 : 2500 ~ 2570 LTE Band 12 : 699 ~ 716 LTE Band 13 : 777 ~ 787 LTE Band 17 : 704 ~ 716 LTE Band 25 : 1850 ~ 1915 LTE Band 26 : 814 ~ 849 LTE Band 38 : 2570 ~ 2620 LTE Band 41 : 2496 ~ 2690 LTE Band 66 : 1710 ~ 1780 LTE Band 71 : 663 ~ 698 NR Band n2 : 1850 ~ 1910 NR Band n5 : 824 ~ 849 NR Band n7 : 2500 ~ 2570 NR Band n25 : 1850 ~ 1915 NR Band n38 : 2570 ~ 2620 NR Band n41 : 2496 ~ 2690 NR Band n48 : 3550 ~ 3700 NR Band n66 : 1710 ~ 1780 NR Band n71 : 663 ~ 698 NR Band n77 : 3450 ~ 3550, 3700 ~ 3980 NR Band n78 : 3450 ~ 3550 WLAN : 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5700, 5745 ~ 5825 WLAN 6E: 5945 ~ 6425, 6425 ~ 6525, 6525 ~ 6875, 6875 ~ 7125 Bluetooth : 2402 ~ 2480
Uplink Modulations	GSM & GPRS & EDGE : GMSK, 8PSK WCDMA : QPSK LTE : QPSK, 16QAM, 64QAM 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 802.11ax : OFDMA 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	IFA 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

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 4					No
	Band 5					No
	HSPA	VD	Yes	WLAN, BT	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 7					No
	Band 12					No
	Band 13					No
	Band 17					No
	Band 25					No
	Band 26					No
	Band 66					No
	Band 71					No
LTE (TDD)	Band 38					No
	Band 41					No
NR (FDD)	NR n2	VD	Yes	LTE, WLAN, BT	VoNR / Google Meet(1)	No
	NR n5					No
	NR n7					No
	NR n25					No
	NR n66					No
	NR n71					No
NR (TDD)	NR n38					No
	NR n41					No
	NR n48					No
	NR n77					No
	NR n78					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
WLAN	6E	VD	No	GSM, WCDMA, LTE, NR	VoWiFi / Google Meet(1)	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 UNII-5 was evaluated for operations which are entirely below 6GHz, above 6GHz were not evaluated due outside of the

current scope of ANSI C63.19 and FCC HAC regulations.

4. The device have similar frequency in some LTE/5G NR FR1 bands: LTE B2/25, 5/26, 4/66, 12/17, 5G NR n2/25 since the supported frequency spans for the smaller LTE/5G NR FR1 bands are completely cover by the larger LTE/5G NR FR1 bands, therefore, only larger LTE/5G NR FR1 bands were required to be tested for hearing-aid compliance.
5. 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.

2 HAC T-Coil Measurement System

2.1 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.

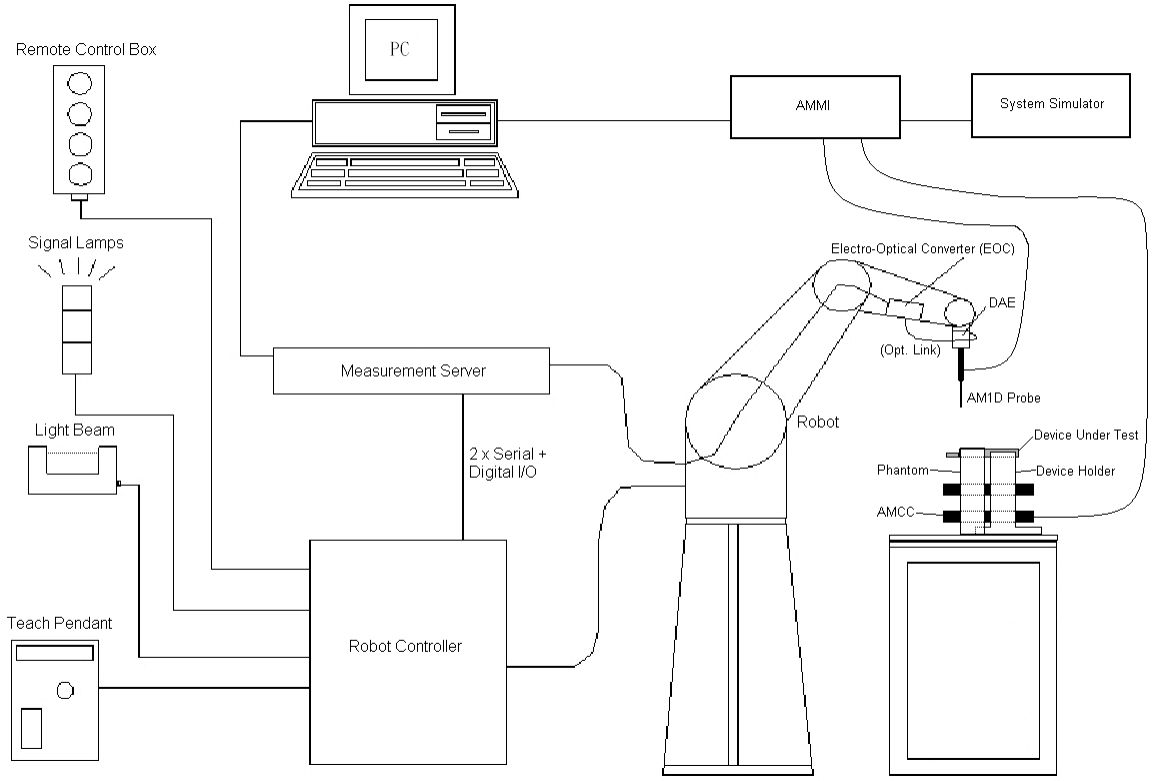


Fig-3.1 DASY System Setup

2.1.1 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)

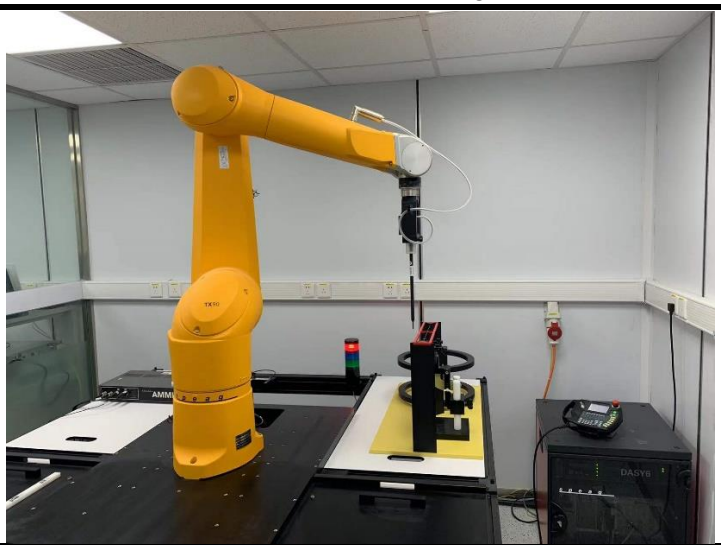
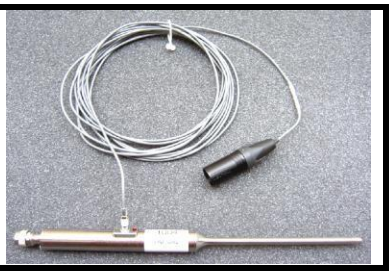


Fig-3.2 DASY6 Measurement System

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	-60 to 40 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)

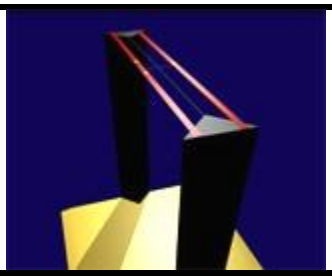
The AMMI is a desktop 19-inch unit containing a sampling unit, a waveform generator for test and calibration signals, and a USB interface.

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, 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.

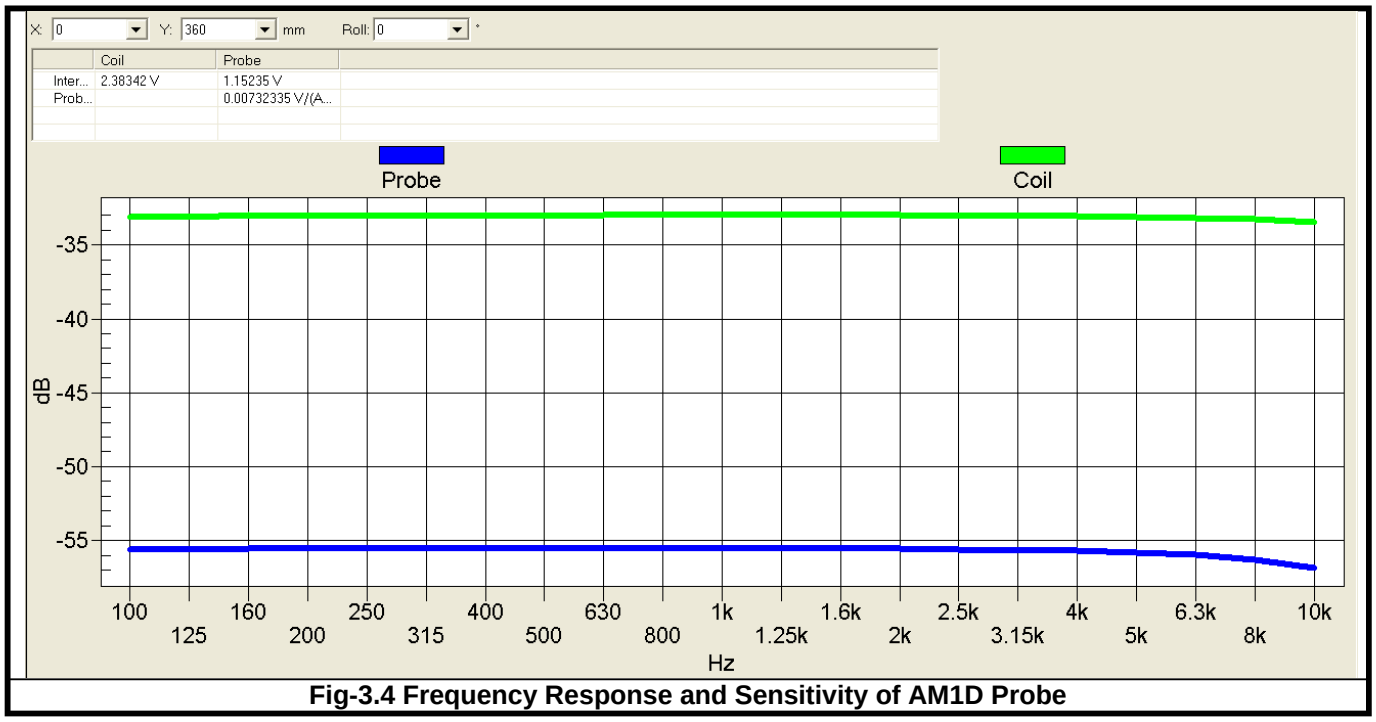


Fig-3.4 Frequency Response and Sensitivity of AM1D Probe

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 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.

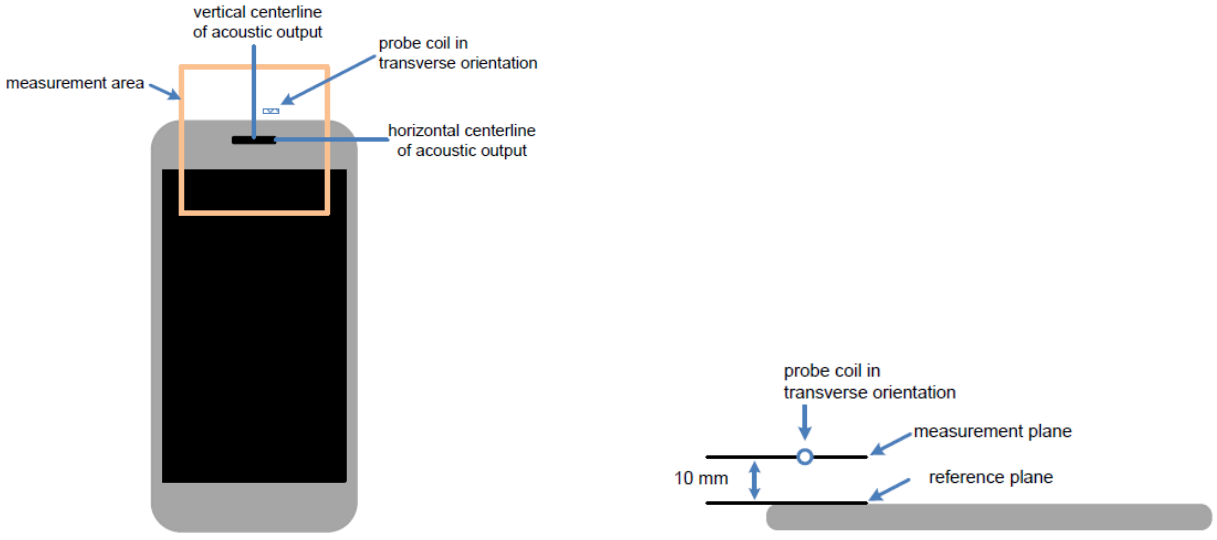


Fig-3.5 Measurement and reference planes probe orientation for WD audio frequency magnetic field measurements

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. 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.

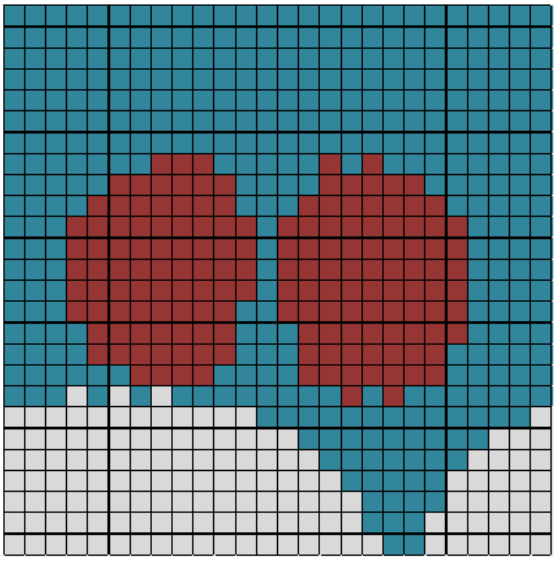
Figure 6.6 is an example of a qualifying scan. The total number of primary group qualifying measurement points is 161 , which is ≥75. The total number of secondary group qualifying points is 536, which is ≥300.

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:

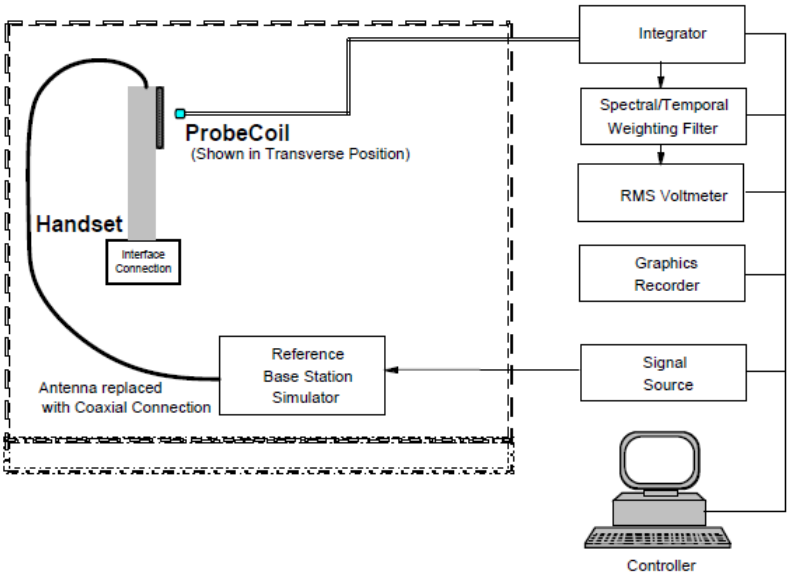


Fig-3.6 T-Coil Measurement Test Setup

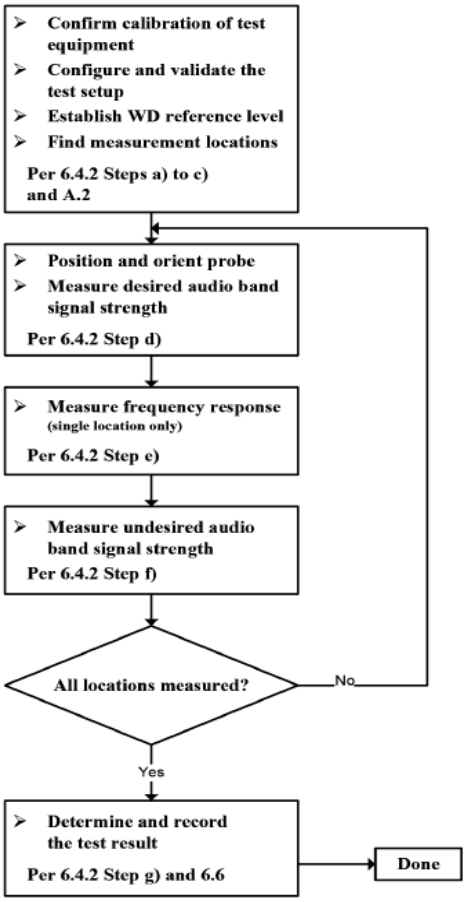


Fig-3.7 T-Coil Signal Test Flowchart

2.5 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.

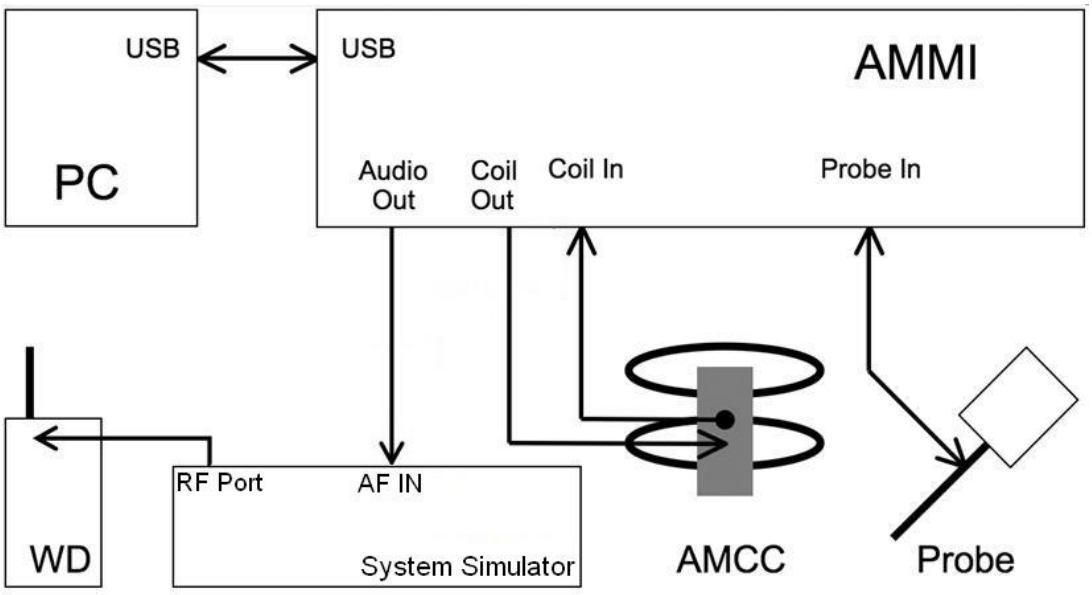


Fig-3.8 System Setup for T-Coil Testing

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.

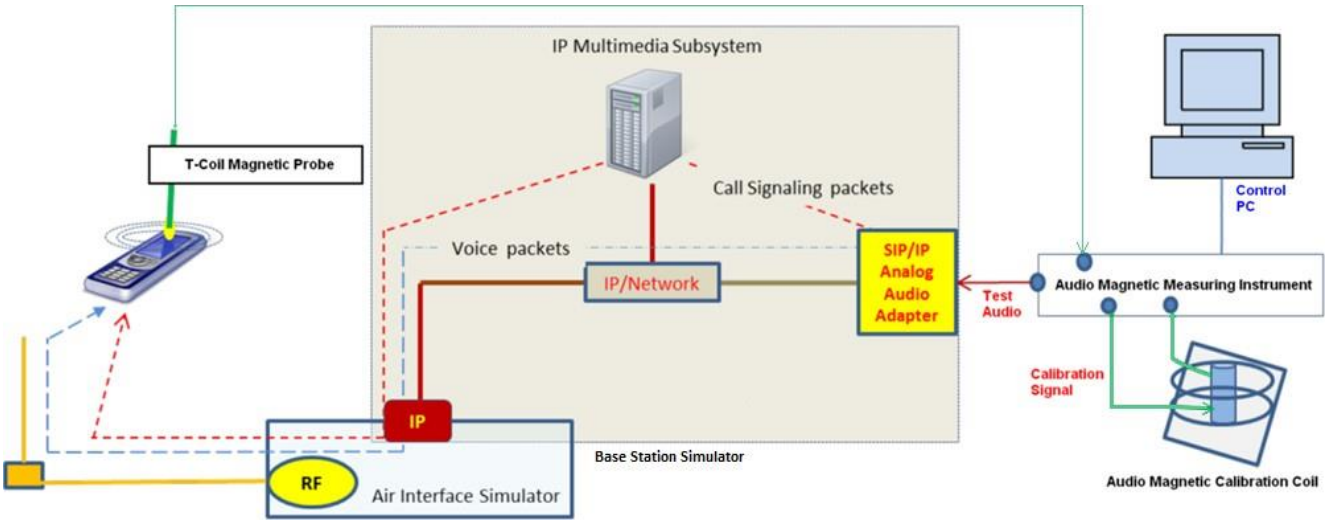


Fig-3.9 Testing Setup for OTT VoIP

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 = ***X*** dBV = -3.01 dBV
-16 dBm0 = $L_{-16dBm0}$ dBV = -22.00 dBV
Gain 100 = ***G*** dBV = 3.13 dBV
Difference for -16 dBm0 = $D_{-16dBm0} = L_{-16dBm0} - G$ = -22 – 3.13 = -25.13 dBV
Resulting Gain for -16 dBm0 = 10 ^ ($D_{-16dBm0}$ / 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

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

3.1.2 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.

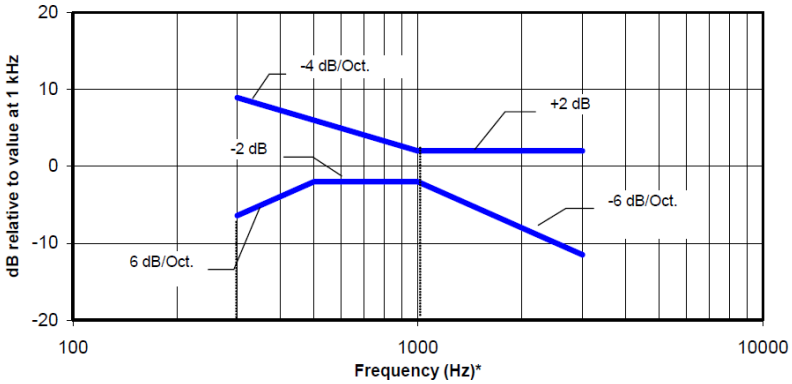


Fig-4.1 Boundaries for EUT with a field ≤ -15 dB (A/m) at 1 kHz

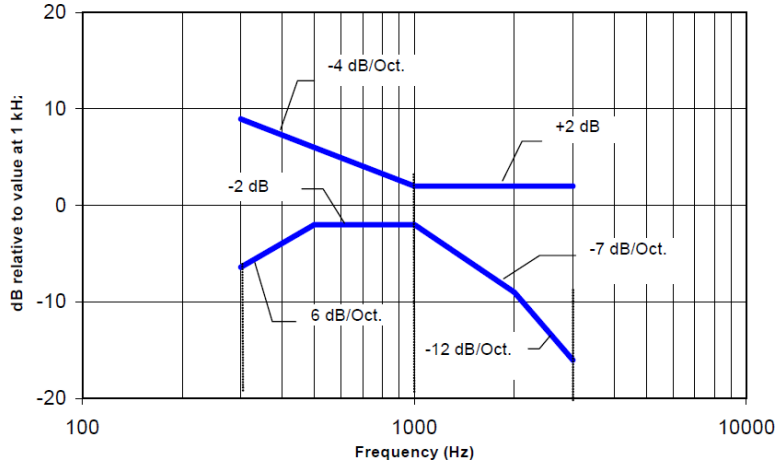


Fig-4.2 Boundaries for EUT with a field > -15 dB (A/m) at 1 kHz

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 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	96	97	**58**	61	99	Transversal (Y)	GSM850 / 189
Secondary Group Contiguous Point Count	320	317	312	318	319		
Secondary Group Max Longitudinal	18	18	18	18	18		
Secondary Group Max Transverse	26	26	26	26	26		
Frequency Response	PASS	PASS	PASS	PASS	PASS		

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

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)	58	312	18	26	PASS	-58.04
P02	GSM1900	Voice	661	1	Transversal (Y)	81	351	19	26	PASS	-57.75
	GSM850	Voice	189	2	Transversal (Y)	75	355	20	26	PASS	-57.86

3.3.2 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	328	332	**249**	257	Transversal (Y)	B5 / 4182
Secondary Group Contiguous Point Count	665	664	666	665		
Secondary Group Max Longitudinal	26	26	26	26		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	Pass	Pass	Pass	Pass		

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

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)	254	671	26	26	PASS	-57.96
P04	WCDMA IV	Voice	1413	1	Transversal (Y)	247	666	26	26	PASS	-57.24
P05	WCDMA V	Voice	4182	1	Transversal (Y)	249	666	26	26	PASS	-57.38
	WCDMA IV	Voice	1413	2	Transversal (Y)	255	681	26	26	PASS	-57.74

3.3.3 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	253	**203**	276	219	Transversal (Y)	B25 / 20M / 26340
Secondary Group Contiguous Point Count	579	590	597	602		
Secondary Group Max Longitudinal	26	26	26	26		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	Pass	Pass	Pass	Pass		

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	287	283	288	290	224	287	Transversal (Y)	B25 / 20M / 26340
Secondary Group Contiguous Point Count	605	601	599	599	607	603		
Secondary Group Max Longitudinal	26	26	26	26	26	26		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	PASS	PASS	PASS	PASS	PASS	PASS		

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

LTE TDD

<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	190	**135**	195	145	Transversal (Y)	B41 / 20M / 40620
Secondary Group Contiguous Point Count	447	439	448	449		
Secondary Group Max Longitudinal	20	20	20	20		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	Pass	Pass	Pass	Pass		

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	193	194	191	189	145	197	Transversal (Y)	B41 / 20M / 40620
Secondary Group Contiguous Point Count	440	441	439	436	442	445		
Secondary Group Max Longitudinal	20	20	20	19	20	20		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	PASS	PASS	PASS	PASS	PASS	PASS		

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

<Air Interface Investigation>

Air Interface	BW (MHz)	Modulation / Mode	RB Size	RB offset	Channel	Probe Position	Primary Group Contiguous Point Count	Frequency Response
LTE B25	20	QPSK	1	0	26340	Transversal (Y)	203	PASS
LTE B25	20	QPSK	100	0	26340	Transversal (Y)	218	PASS
LTE B25	20	16QAM	1	0	26340	Transversal (Y)	210	PASS
LTE B25	20	64QAM	1	0	26340	Transversal (Y)	214	PASS
LTE B25	15	QPSK	1	0	26340	Transversal (Y)	210	PASS
LTE B25	10	QPSK	1	0	26340	Transversal (Y)	212	PASS
LTE B25	5	QPSK	1	0	26340	Transversal (Y)	211	PASS
LTE B25	3	QPSK	1	0	26340	Transversal (Y)	206	PASS
LTE B25	1.4	QPSK	1	0	26340	Transversal (Y)	213	PASS

Test Summary

Plot No.	Air Interface	BW (MHz)	Modulation / Mode	RB Size	RB offset	Sample	Channel	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
P06	LTE B7	20	QPSK	1	0	1	21100	Transversal (Y)	184	550	26	26	PASS	-56.46
P07	LTE B12	10	QPSK	1	0	1	23095	Transversal (Y)	212	616	26	26	PASS	-55.78
P08	LTE B13	10	QPSK	1	0	1	23230	Transversal (Y)	207	607	26	26	PASS	-55.59
P09	LTE B25	20	QPSK	1	0	1	26340	Transversal (Y)	200	588	26	26	PASS	-56.44
P10	LTE B26	15	QPSK	1	0	1	26865	Transversal (Y)	213	610	26	26	PASS	-56.72
P11	LTE B38	20	QPSK	1	0	1	38000	Transversal (Y)	143	456	20	26	PASS	-56.18
P12	LTE B41_PC2	20	QPSK	1	0	1	40620	Transversal (Y)	135	439	20	26	PASS	-55.93
P13	LTE B66	20	QPSK	1	0	1	132322	Transversal (Y)	187	549	26	26	PASS	-56.09
P14	LTE B71	20	QPSK	1	0	1	133322	Transversal (Y)	212	601	26	26	PASS	-55.87
	LTE B41_PC2	20	QPSK	1	0	2	40620	Transversal (Y)	159	481	20	26	PASS	-56.42

3.3.4 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	196	147	194	143	Transversal (Y)	NR Band n25 / 20M / 376500
Secondary Group Contiguous Point Count	568	559	557	527		
Secondary Group Max Longitudinal	26	26	26	26		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	Pass	Pass	Pass	Pass		

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	169	170	172	170	**120**	202	Transversal (Y)	NR Band n25 / 20M / 376500
Secondary Group Contiguous Point Count	566	562	558	560	563	560		
Secondary Group Max Longitudinal	26	26	26	26	26	26		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	PASS	PASS	PASS	PASS	PASS	PASS		

Note: According to codec investigation, the worst codec is EVS NB 5.9kbps

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	175	**119**	177	124	Transversal (Y)	NR Band n41 / 100M / 518598
Secondary Group Contiguous Point Count	361	365	360	363		
Secondary Group Max Longitudinal	17	17	17	17		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	Pass	Pass	Pass	Pass		

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	129	129	134	134	122	185	Transversal (Y)	NR Band n41 / 100M / 518598
Secondary Group Contiguous Point Count	366	369	370	366	369	378		
Secondary Group Max Longitudinal	18	18	18	18	18	18		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	PASS	PASS	PASS	PASS	PASS	PASS		

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

<Air Interface Investigation>

Air Interface	BW (MHz)	Modulation / Mode	RB Size	RB offset	Channel	Probe Position	Primary Group Contiguous Point Count	Frequency Response
NR n25	20	DFT-s-OFDM QPSK	1	1	376500	Transversal (Y)	120	PASS
NR n25	20	DFT-s-OFDM QPSK	50	0	376500	Transversal (Y)	129	PASS
NR n25	20	DFT-s-OFDM QPSK	100	0	376500	Transversal (Y)	132	PASS
NR n25	20	DFT-s-OFDM BPSK	1	1	376500	Transversal (Y)	199	PASS
NR n25	20	DFT-s-OFDM 16QAM	1	1	376500	Transversal (Y)	202	PASS
NR n25	20	DFT-s-OFDM 64QAM	1	1	376500	Transversal (Y)	204	PASS
NR n25	20	DFT-s-OFDM 256QAM	1	1	376500	Transversal (Y)	199	PASS
NR n25	15	DFT-s-OFDM QPSK	1	1	376500	Transversal (Y)	147	PASS
NR n25	10	DFT-s-OFDM QPSK	1	1	376500	Transversal (Y)	134	PASS
NR n25	5	DFT-s-OFDM QPSK	1	1	376500	Transversal (Y)	131	PASS
NR n41_PC3	100	DFT-s-OFDM QPSK	1	1	518598	Transversal (Y)	119	PASS
NR n41_PC2	100	DFT-s-OFDM QPSK	1	1	518598	Transversal (Y)	107	PASS

Test Summary

Plot No.	Air Interface	BW (MHz)	Modulation / Mode	RB Size	RB offset	Sample	Channel	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	N5	20	QPSK	1	1	1	167300	Transversal (Y)	194	569	26	26	PASS	-57.21
P16	N7	20	QPSK	1	1	1	507000	Transversal (Y)	173	529	26	26	PASS	-56.77
P17	N25	20	QPSK	1	1	1	376500	Transversal (Y)	120	563	26	26	PASS	-56.13
P18	N38	40	QPSK	1	1	1	519000	Transversal (Y)	163	410	19	26	PASS	-56.59
P19	NR n41_PC2	100	QPSK	1	1	1	518598	Transversal (Y)	107	348	17	26	PASS	-57.12
P20	N48	40	QPSK	1	1	1	641666	Transversal (Y)	87	334	19	26	PASS	-56.98
P21	N66	40	QPSK	1	1	1	349000	Transversal (Y)	172	516	23	26	PASS	-56.12
P22	N71	20	QPSK	1	1	1	136100	Transversal (Y)	195	567	26	26	PASS	-56.11
P23	N77	100	QPSK	1	1	1	633334	Transversal (Y)	107	322	15	26	PASS	-56.57
P24	N77	100	QPSK	1	1	1	656000	Transversal (Y)	101	318	15	26	PASS	-56.42
P25	N78	100	QPSK	1	1	1	633334	Transversal (Y)	106	306	15	26	PASS	-56.78
	N48	40	QPSK	1	1	1	641666	Transversal (Y)	119	347	18	26	PASS	-56.95

3.3.5 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	143	95	145	98	Transversal (Y)	WLAN2.4GHz / 6
Secondary Group Contiguous Point Count	442	440	437	472		
Secondary Group Max Longitudinal	23	23	23	23		
Secondary Group Max Transverse	26	26	26	26		
Frequency Response	Pass	Pass	Pass	Pass		

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	159	131	119	153	**93**	149	Transversal (Y)	WLAN2.4GHz / 6
Secondary Group Contiguous Point Count	455	419	404	443	440	438		
Secondary Group Max Longitudinal	23	23	22	22	23	23		
Secondary Group Max Transverse	26	26	26	26	26	26		
Frequency Response	PASS	PASS	PASS	PASS	PASS	PASS		

Note: According to codec investigation, the worst codec is EVS NB 5.9kbps

<Air Interface Investigation>

Frequency Bands	Air Interface	BW (MHz)	Rate	Channel	Probe Position	Primary Group Contiguous Point Count	Frequency Response
WLAN2.4GHz	802.11b	20	1M	6	Transversal (Y)	93	PASS
	802.11g	20	6M	6	Transversal (Y)	117	PASS
	802.11n-HT20	20	MCS0	6	Transversal (Y)	191	PASS
	802.11n-HT40	40	MCS0	6	Transversal (Y)	136	PASS
	802.11ax-HE20	20	MCS0	6	Transversal (Y)	128	PASS
	802.11ax-HE40	40	MCS0	6	Transversal (Y)	134	PASS
	802.11b	20	11M	6	Transversal (Y)	97	PASS
WLAN5GHz	802.11a	20	6M	40	Transversal (Y)	134	PASS
	802.11an-HT20	20	MCS0	40	Transversal (Y)	141	PASS
	802.11an-HT40	40	MCS0	38	Transversal (Y)	194	PASS
	802.11ac-VHT20	20	MCS0	40	Transversal (Y)	177	PASS
	802.11ac-VHT40	40	MCS0	38	Transversal (Y)	166	PASS
	802.11ac-VHT80	80	MCS0	42	Transversal (Y)	159	PASS
	802.11ax-HE20	20	MCS0	40	Transversal (Y)	183	PASS
	802.11ax-HE40	40	MCS0	38	Transversal (Y)	172	PASS
	802.11ax-HE80	80	MCS0	42	Transversal (Y)	169	PASS
	802.11a	20	54M	40	Transversal (Y)	181	PASS

Test Summary

Plot No.	Air Interface	BW (MHz)	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
P26	WLAN2.4GHz	20	802.11b	6	1	Transversal (Y)	93	440	23	26	PASS	-56.78
P27	WLAN5GHz	20	802.11a	40	1	Transversal (Y)	134	485	24	26	PASS	-55.64
P28	WLAN5GHz	20	802.11a	60	1	Transversal (Y)	130	451	24	26	PASS	-56.07
P29	WLAN5GHz	20	802.11a	132	1	Transversal (Y)	154	560	26	26	PASS	-55.88
P30	WLAN5GHz	20	802.11a	157	1	Transversal (Y)	139	502	24	26	PASS	-55.39
P31	WLAN6E	20	802.11ax	5	1	Transversal (Y)	297	508	23	26	PASS	-56.12
	WLAN2.4GHz	20	802.11b	6	2	Transversal (Y)	115	468	24	26	PASS	-56.14

3.3.6 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	**51**	53	58	Transversal (Y)	GSM850 / 189
Secondary Group Contiguous Point Count	285	284	292		
Secondary Group Max Longitudinal	16	16	17		
Secondary Group Max Transverse	26	26	26		
Frequency Response	Pass	Pass	Pass		

HSPA

HSPA					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**384**	385	389	Transversal (Y)	B5 / 4182
Secondary Group Contiguous Point Count	650	632	639		
Secondary Group Max Longitudinal	26	26	26		
Secondary Group Max Transverse	26	26	26		
Frequency Response	Pass	Pass	Pass		

LTE FDD

LTE FDD					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**306**	313	307	Transversal (Y)	B25 / 20M / 26340
Secondary Group Contiguous Point Count	522	531	511		
Secondary Group Max Longitudinal	22	24	23		
Secondary Group Max Transverse	26	26	26		
Frequency Response	Pass	Pass	Pass		

LTE TDD

LTE TDD					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**180**	183	183	Transversal (Y)	B41 / 20M / 40620
Secondary Group Contiguous Point Count	407	399	387		
Secondary Group Max Longitudinal	17	17	18		
Secondary Group Max Transverse	26	26	26		
Frequency Response	Pass	Pass	Pass		

NR FDD

NR FDD					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**274**	283	305	Transversal (Y)	NR Band n25 / 20M / 376500
Secondary Group Contiguous Point Count	520	505	527		
Secondary Group Max Longitudinal	23	22	22		
Secondary Group Max Transverse	26	26	26		
Frequency Response	Pass	Pass	Pass		

NR TDD

NR TDD					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	**140**	156	110	Transversal (Y)	NR Band n41 / 100M / 518598
Secondary Group Contiguous Point Count	362	376	332		
Secondary Group Max Longitudinal	17	18	15		
Secondary Group Max Transverse	26	26	26		
Frequency Response	Pass	Pass	Pass		

WLAN

WLAN					
Codec	**Opus**	**Opus**	**Opus**	**Orientation**	**Band / Channel**
Bit rate	**6kbps**	**40kbps**	**75kbps**		
Primary Group Contiguous Point Count	208	**204**	221	Transversal (Y)	WLAN2.4GHz / 6
Secondary Group Contiguous Point Count	428	401	430		
Secondary Group Max Longitudinal	22	22	23		
Secondary Group Max Transverse	26	26	26		
Frequency Response	Pass	Pass	Pass		

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
P32	GSM850	Voice	189	1	Transversal (Y)	51	285	16	26	PASS	-55.77
P33	GSM1900	Voice	661	1	Transversal (Y)	151	423	20	26	PASS	-55.45
P34	WCDMA II	Voice	9400	1	Transversal (Y)	406	621	26	26	PASS	-56.28
P35	WCDMA IV	Voice	1413	1	Transversal (Y)	284	632	26	26	PASS	-56.42
P36	WCDMA V	Voice	4182	1	Transversal (Y)	384	650	26	26	PASS	-55.79
P37	LTE B7	20M_QPSK_1RB_OS0	21100	1	Transversal (Y)	269	483	20	26	PASS	-56.13
P38	LTE B41_PC2	20M_QPSK_1RB_OS0	40620	1	Transversal (Y)	181	407	19	26	PASS	-55.59
P39	N25	20M_QPSK_1RB_OS1	376500	1	Transversal (Y)	274	520	23	26	PASS	-56.19
P40	N48	40M_QPSK_1RB_OS1	641666	1	Transversal (Y)	117	328	19	26	PASS	-55.47
P41	WLAN2.4GHz	802.11b 1Mbps	6	1	Transversal (Y)	204	401	22	26	PASS	-55.21
P42	WLAN5GHz	802.11a 6Mbps	60	1	Transversal (Y)	336	585	26	26	PASS	-55.93
	GSM850	Voice	189	2	Transversal (Y)	78	317	16	26	PASS	-55.36

Test Engineer： Renjie Liu and Zixiao Xia

4 Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
Audio Band Magnetic Probe	SPEAG	AM1DV3	3144	Feb. 14, 2024	1 Year
Data Acquisition Electronics	SPEAG	DAE	720	Oct. 20, 2023	1 Year
Universal Radio Communication Tester	R&S	CMW500	169210	Jun. 27, 2022	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

5 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

6 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:

Add: Tower N, Innovation Center, 88 Zuyi Road, High-tech District, Suzhou City, Anhui Province
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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Appendix A. Plots of HAC T-Coil Measurement

The plots for HAC measurement are shown as follows.

Plot 01_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 10:35

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

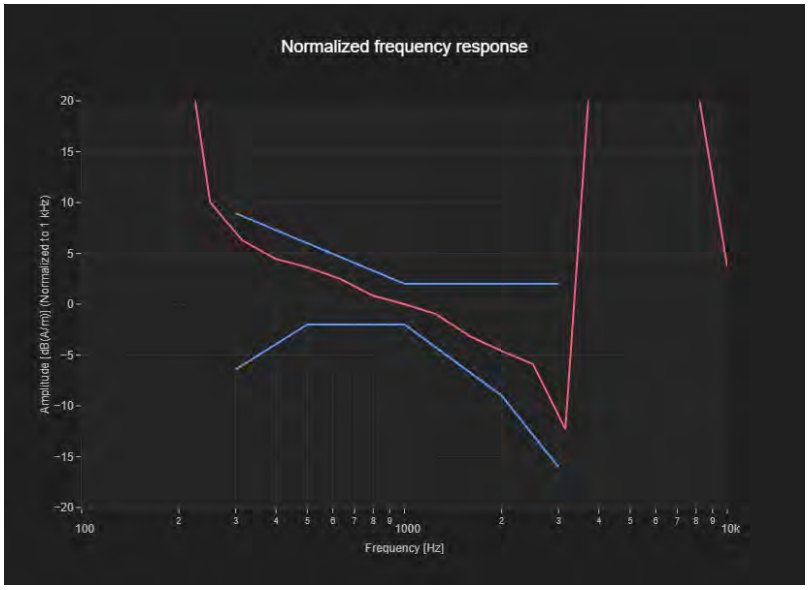
Band Name	Communication Systems Name	Channel	Frequency [MHz]
GSM 850	GSM-FDD (TDMA, GMSK)	189	836.4

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	1.82	2.0



Plot 01_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 10:44

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

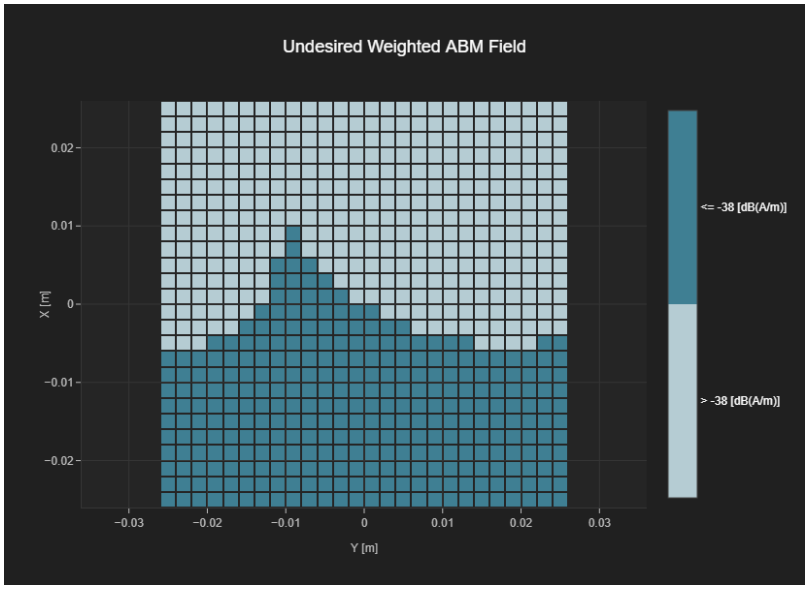
Band Name	Communication Systems Name	Channel	Frequency [MHz]
GSM 850	GSM-FDD (TDMA, GMSK)	189	836.4

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
312	18	26	-8.84



Plot 01_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 10:35

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

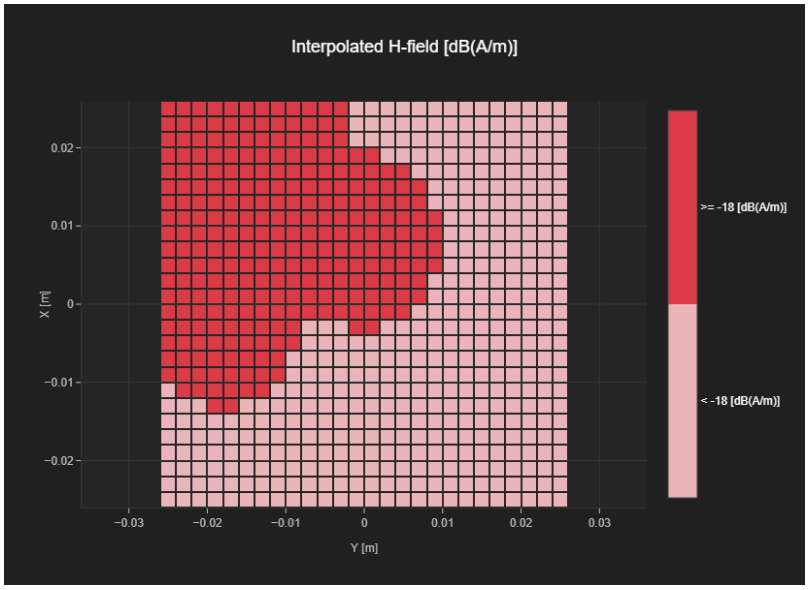
Band Name	Communication Systems Name	Channel	Frequency [MHz]
GSM 850	GSM-FDD (TDMA, GMSK)	189	836.4

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

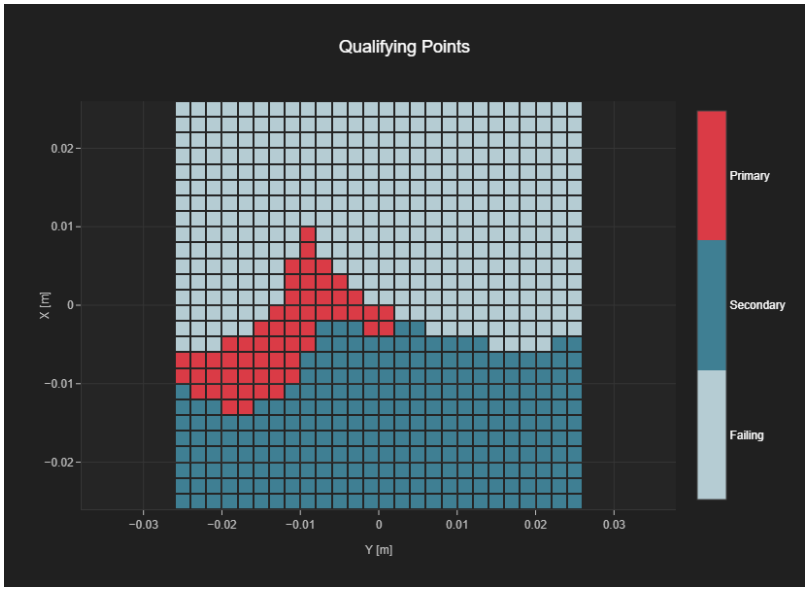
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.65



Plot 01_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
58	312	18	26



Plot 02_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 10:19

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

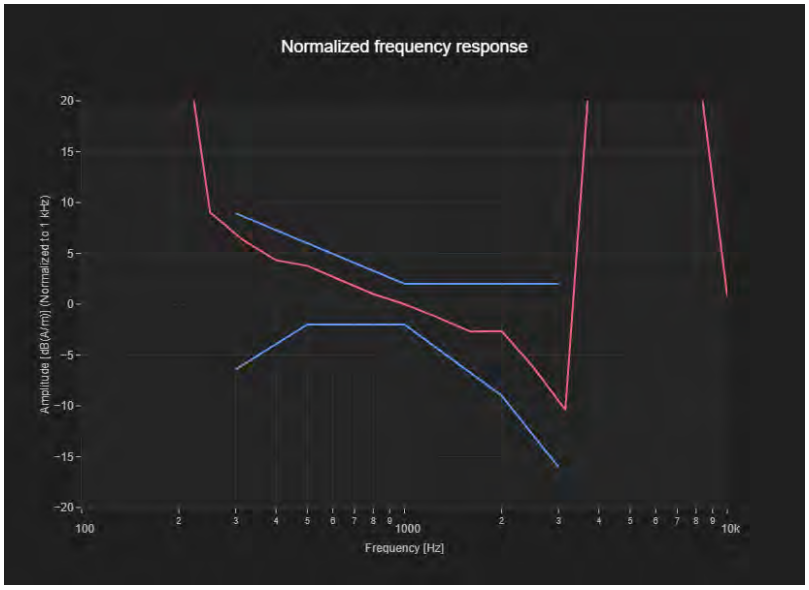
Band Name	Communication Systems Name	Channel	Frequency [MHz]
PCS 1900	GSM-FDD (TDMA, GMSK)	661	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	1.99	2.0



Plot 02_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 10:09

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

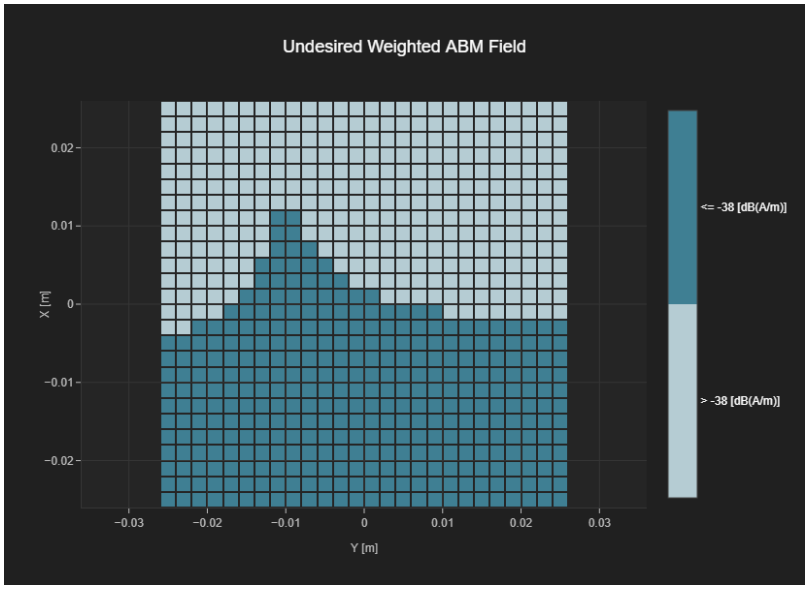
Band Name	Communication Systems Name	Channel	Frequency [MHz]
PCS 1900	GSM-FDD (TDMA, GMSK)	661	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
351	19	26	-11.93



Plot 02_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 10:19

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

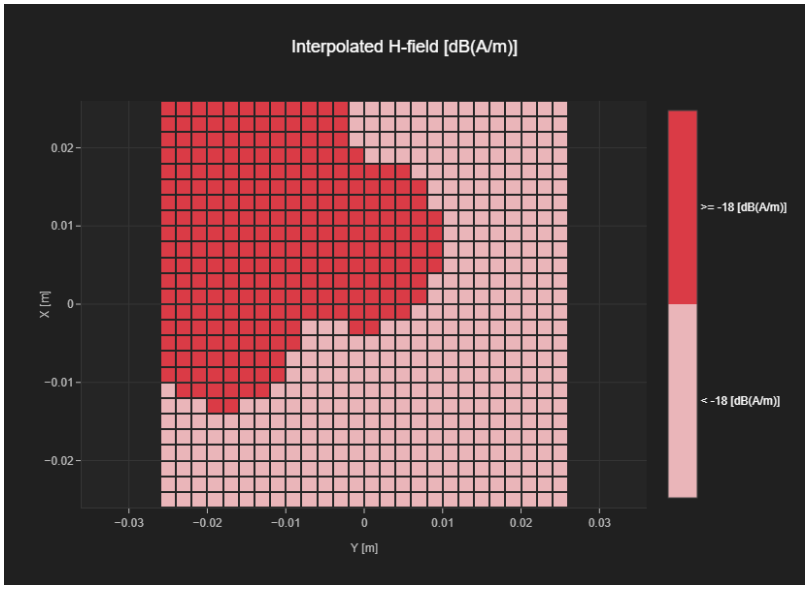
Band Name	Communication Systems Name	Channel	Frequency [MHz]
PCS 1900	GSM-FDD (TDMA, GMSK)	661	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

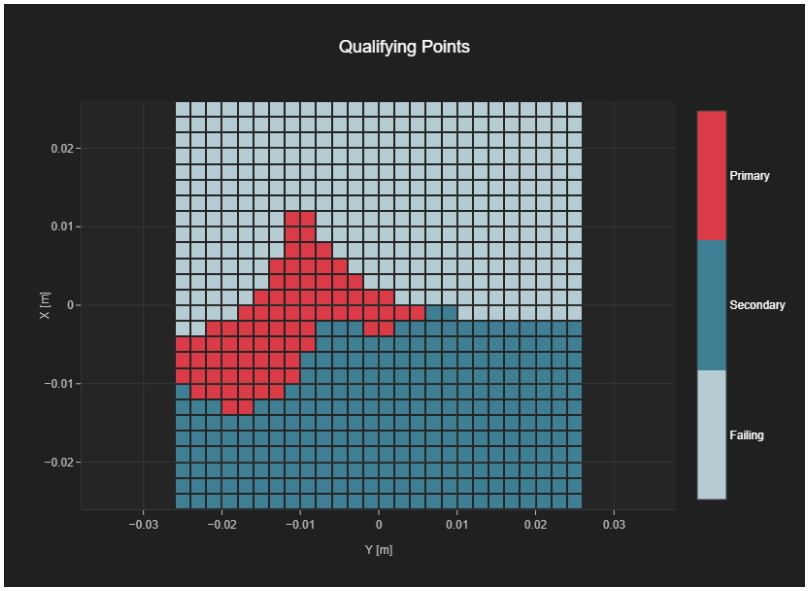
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.73



Plot 02_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
81	351	19	26



Plot 03_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 14:08

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

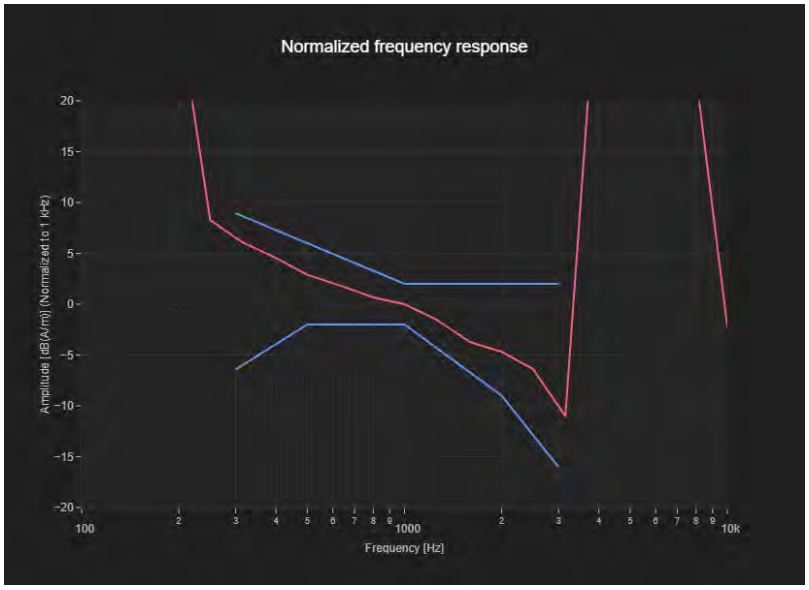
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 2, UTRA/FDD	UMTS-FDD (WCDMA)	9400	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	2.0	2.0



Plot 03_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 14:18

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

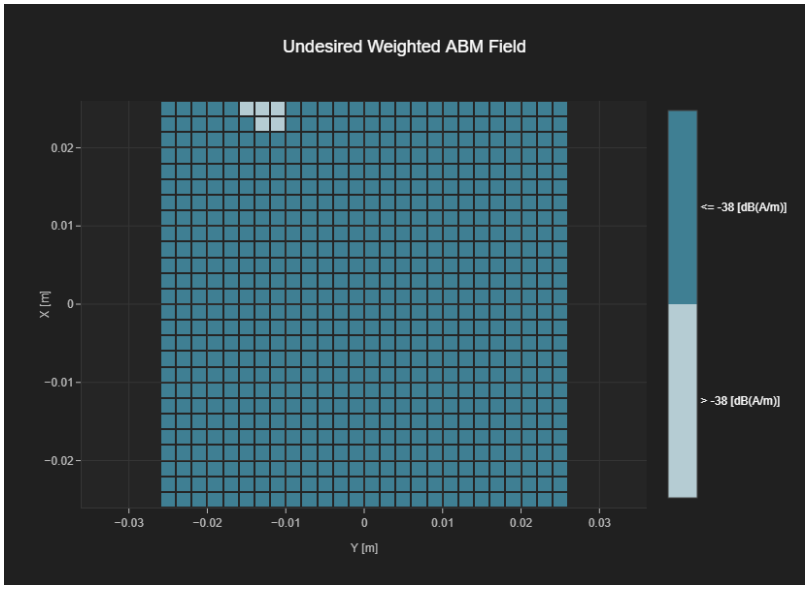
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 2, UTRA/FDD	UMTS-FDD (WCDMA)	9400	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
671	26	26	-36.43



Plot 03_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 14:08

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

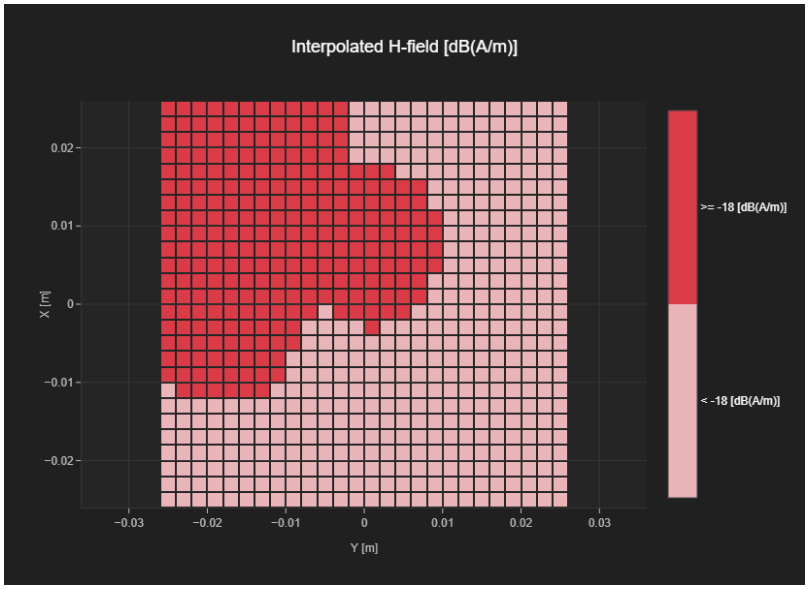
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 2, UTRA/FDD	UMTS-FDD (WCDMA)	9400	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

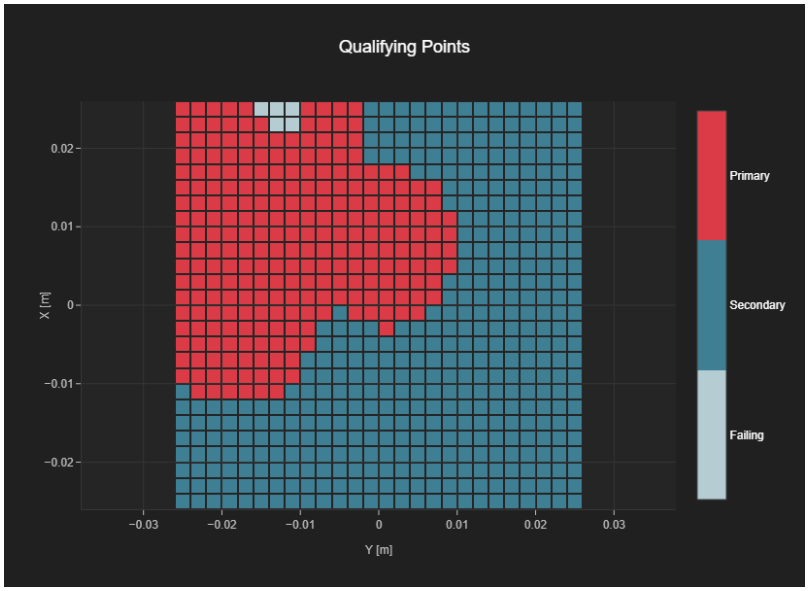
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.63



Plot 03_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
254	671	26	26



Plot 04_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 14:40

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

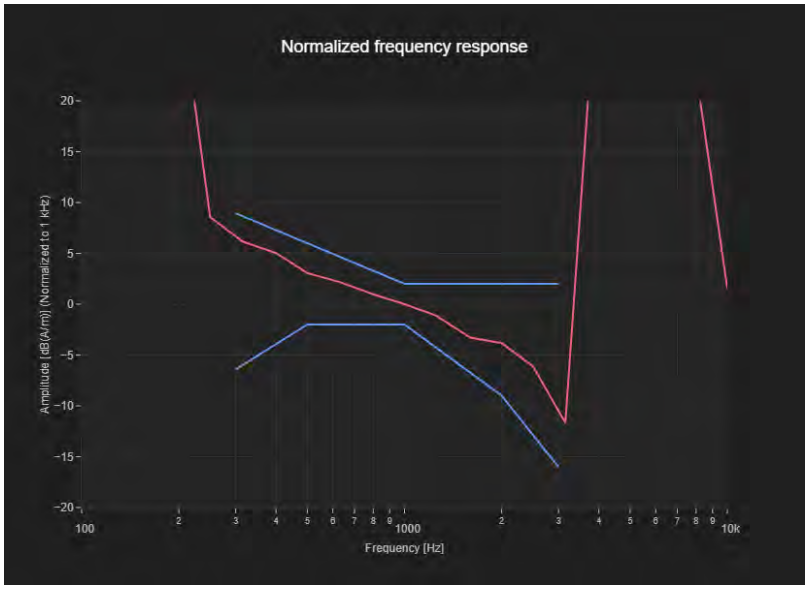
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 4, UTRA/FDD	UMTS-FDD (WCDMA)	1413	1732.6

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	2.0	2.0



Plot 04_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 14:30

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

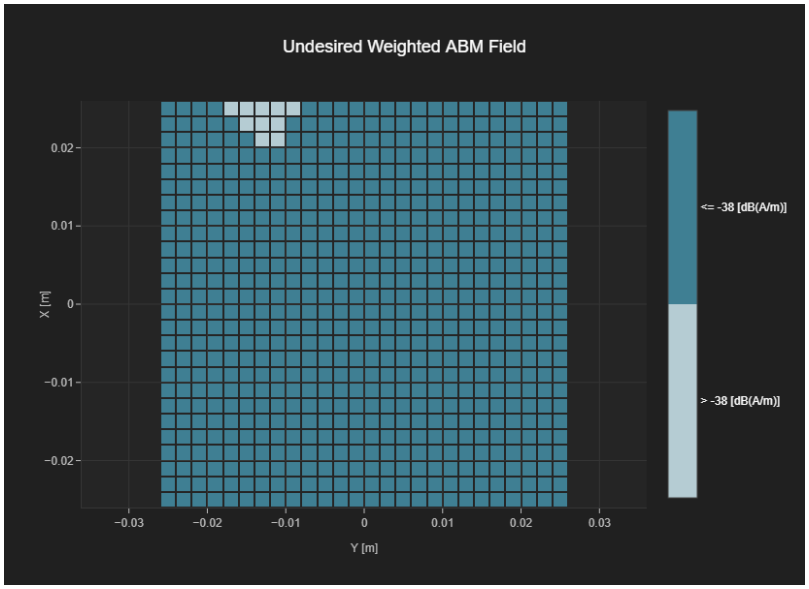
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 4, UTRA/FDD	UMTS-FDD (WCDMA)	1413	1732.6

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
666	26	26	-35.9



Plot 04_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 14:40

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

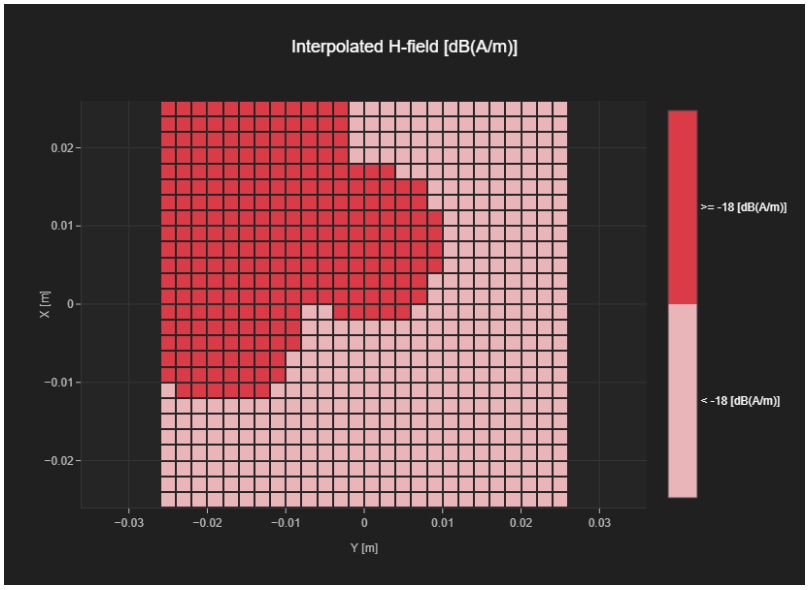
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 4, UTRA/FDD	UMTS-FDD (WCDMA)	1413	1732.6

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

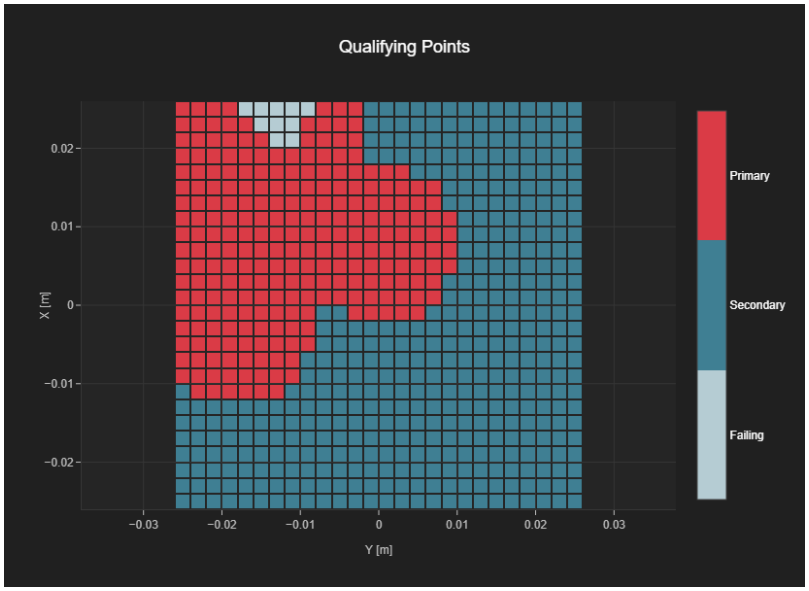
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.52



Plot 04_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
247	666	26	26



Plot 05_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 12:35

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

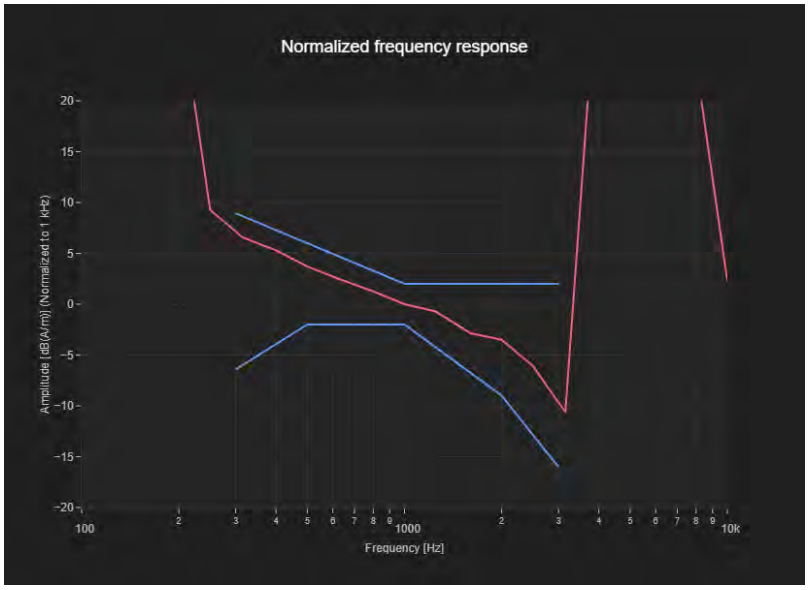
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 5, UTRA/FDD	UMTS-FDD (WCDMA)	4182	836.4

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	1.75	2.0



Plot 05_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 12:25

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

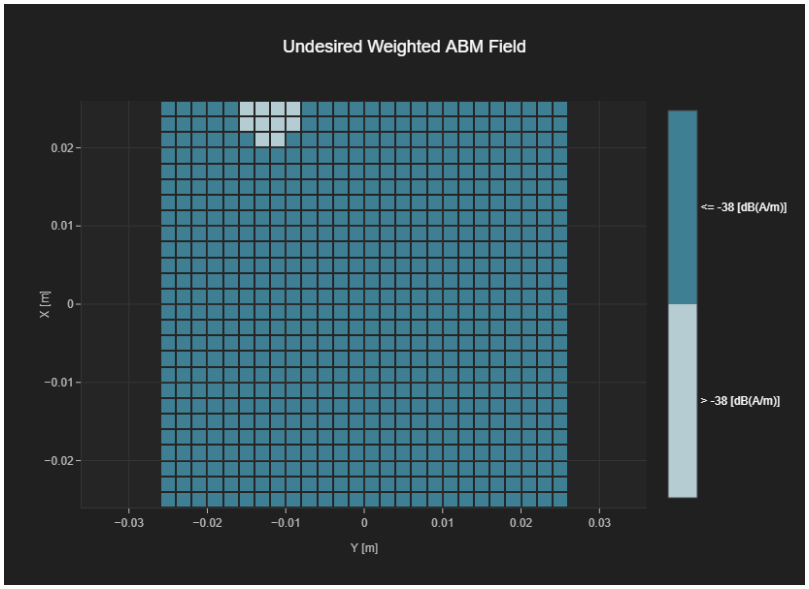
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 5, UTRA/FDD	UMTS-FDD (WCDMA)	4182	836.4

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
666	26	26	-36.1



Plot 05_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 12:35

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

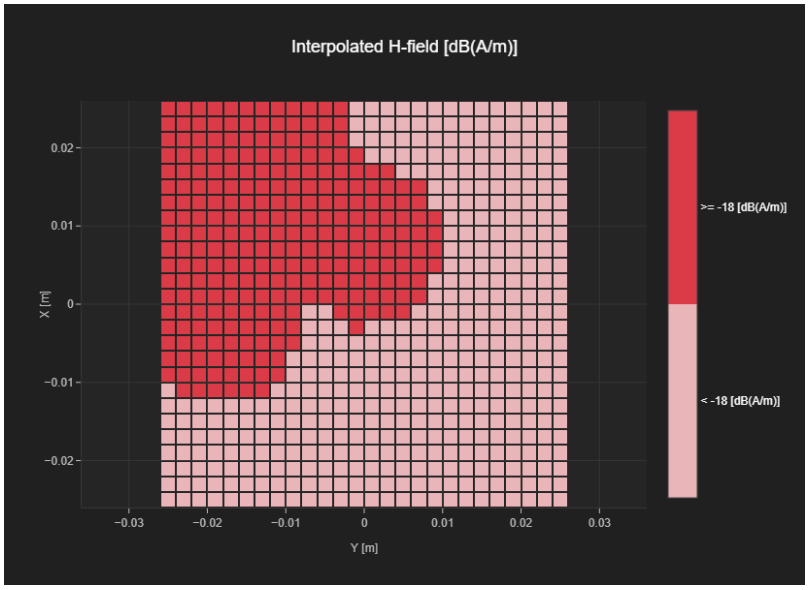
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 5, UTRA/FDD	UMTS-FDD (WCDMA)	4182	836.4

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

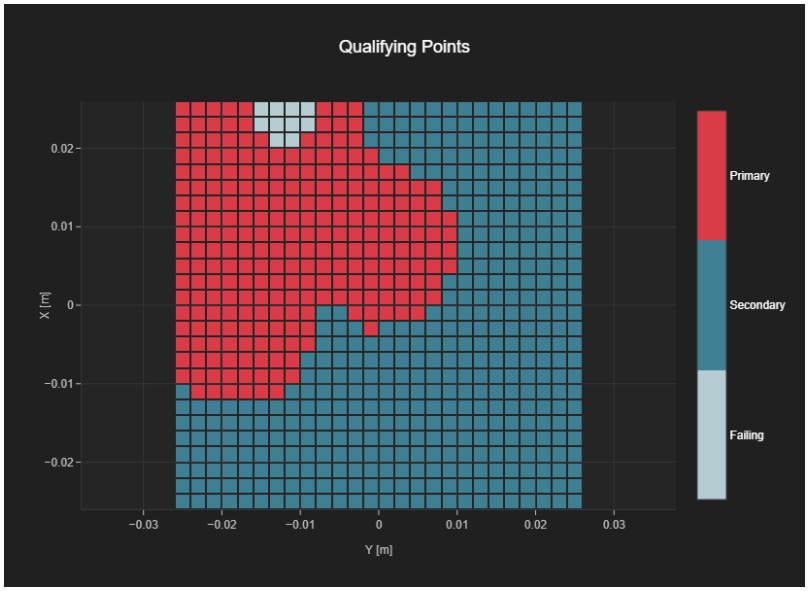
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.56



Plot 05_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
249	666	26	26



Plot 06_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 19:25

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

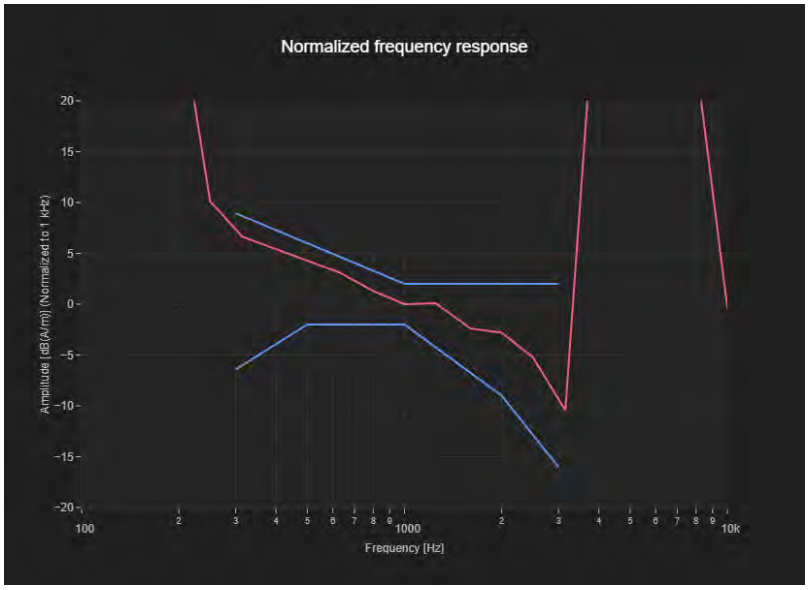
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 7, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	21100	2535.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	1.51	2.0



Plot 06_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 19:39

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

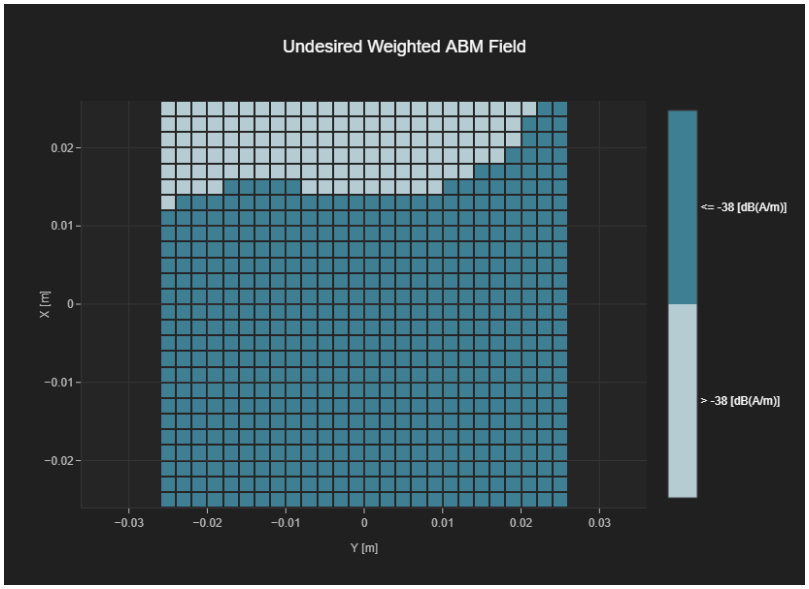
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 7, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	21100	2535.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
550	26	26	-25.32



Plot 06_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 19:25

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

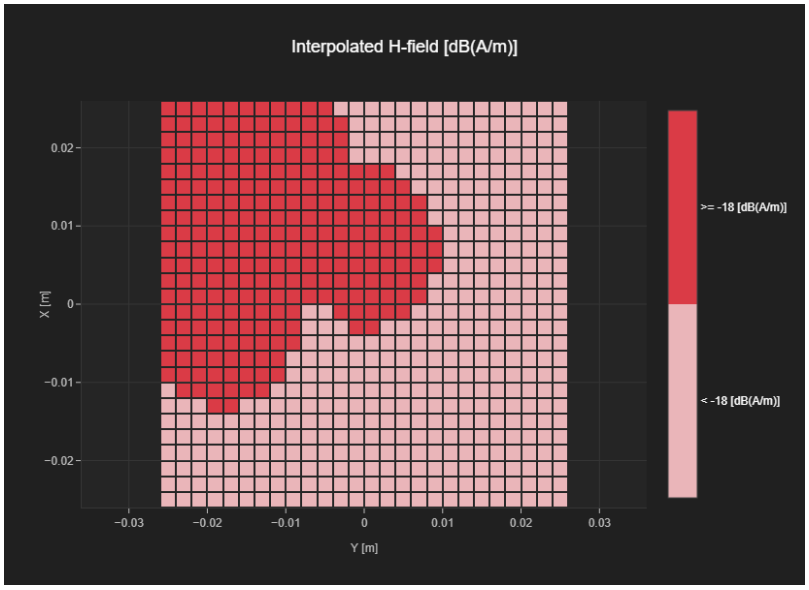
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 7, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	21100	2535.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

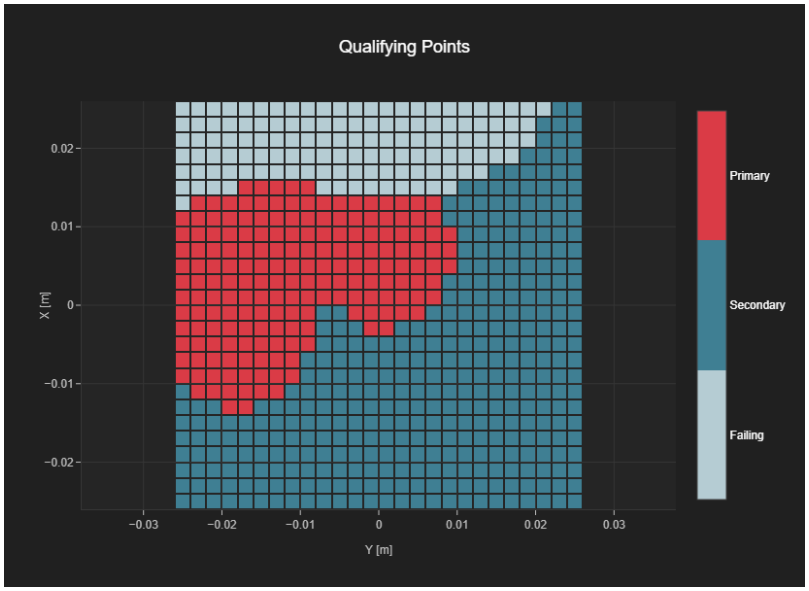
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.44



Plot 06_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
184	550	26	26



Plot 07_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 20:03

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

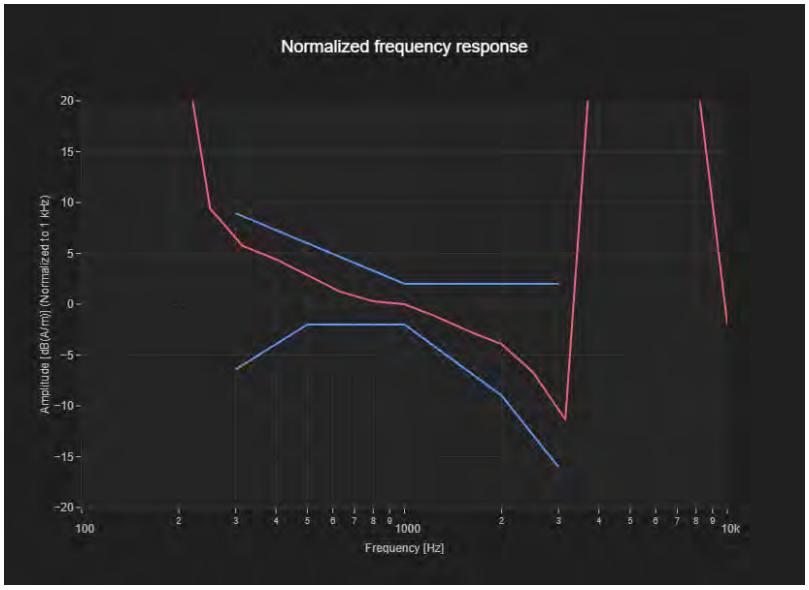
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 12, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	23095	707.5

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	2.0	2.0



Plot 07_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 19:53

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

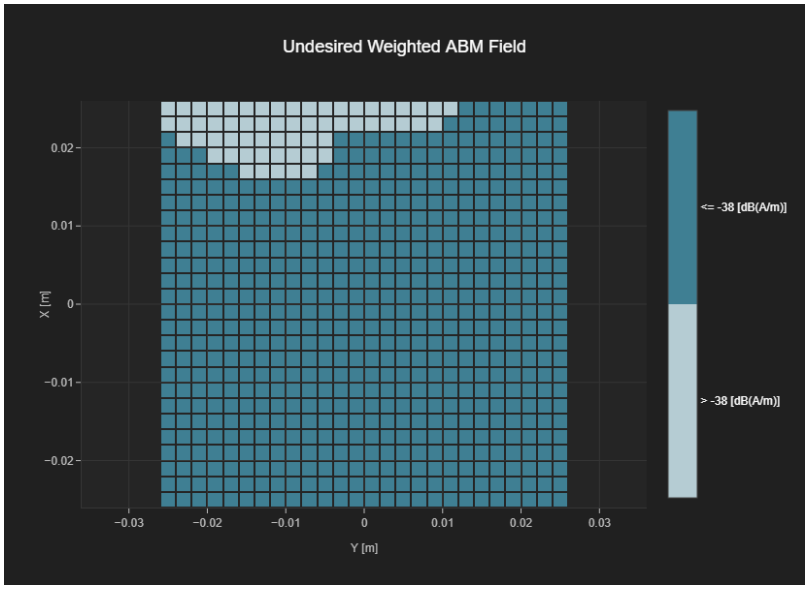
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 12, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	23095	707.5

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
616	26	26	-31.86



Plot 07_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 20:03

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

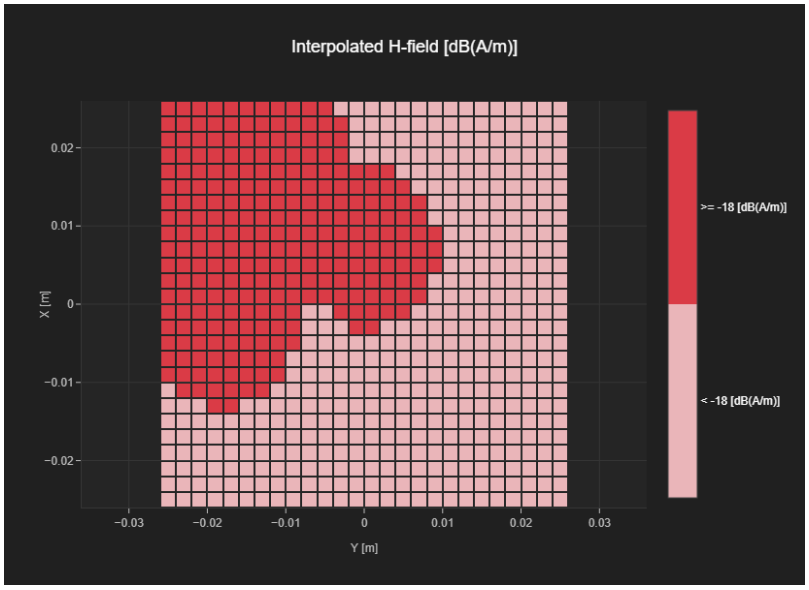
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 12, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	23095	707.5

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

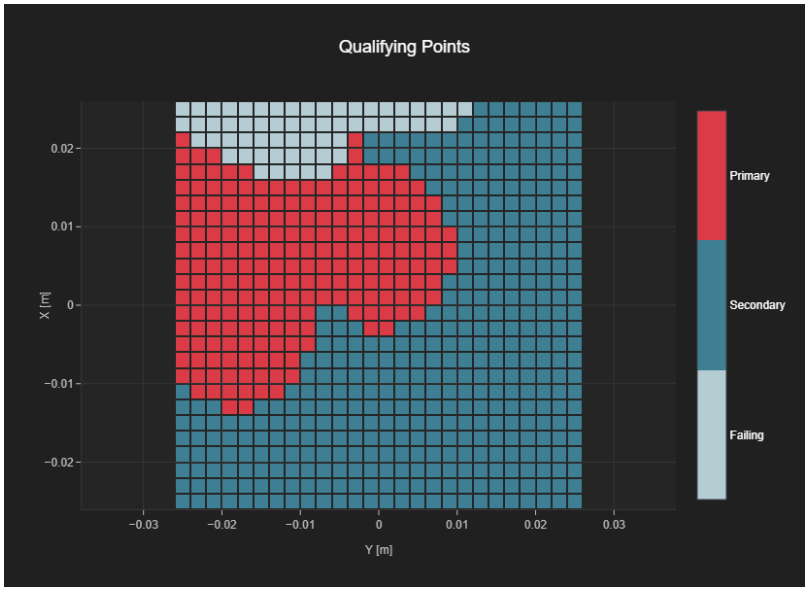
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.41



Plot 07_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
212	616	26	26



Plot 08_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 20:37

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

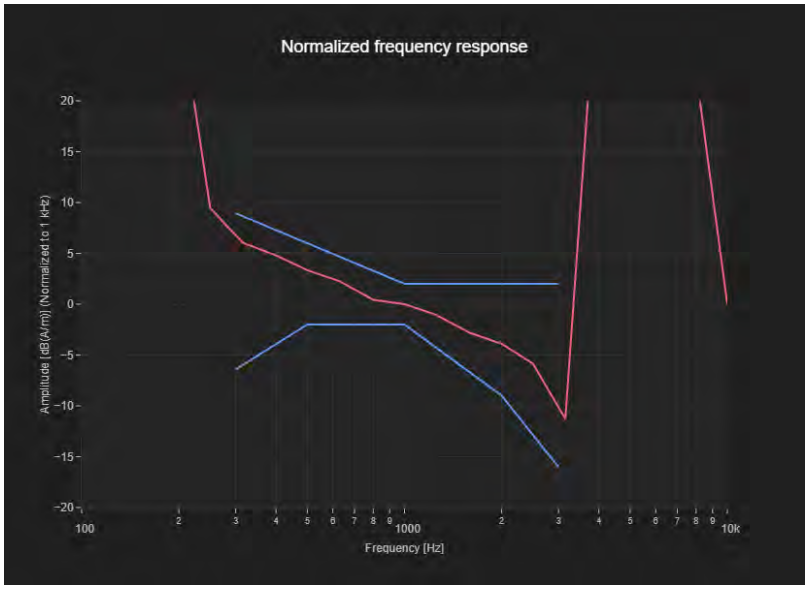
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 13, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	23230	782.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	2.0	2.0



Plot 08_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 20:47

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

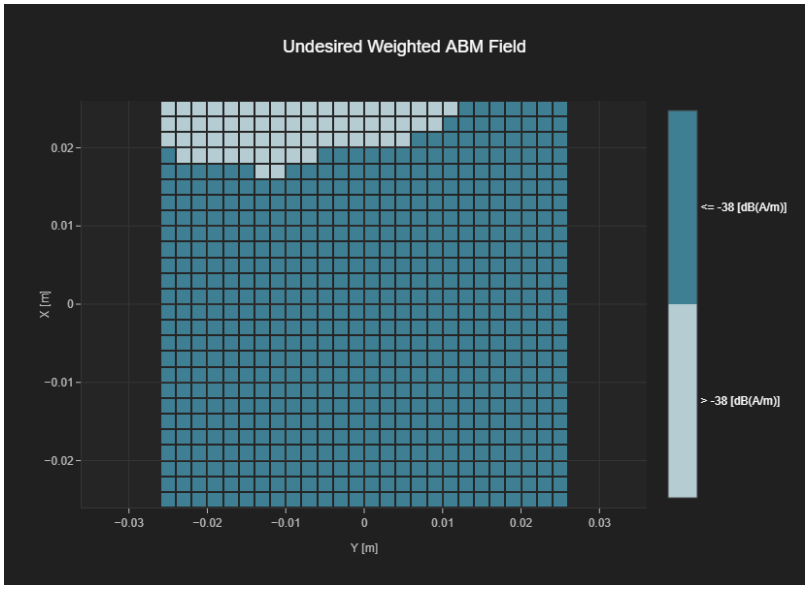
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 13, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	23230	782.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
612	26	26	-32.14



Plot 08_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 20:37

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

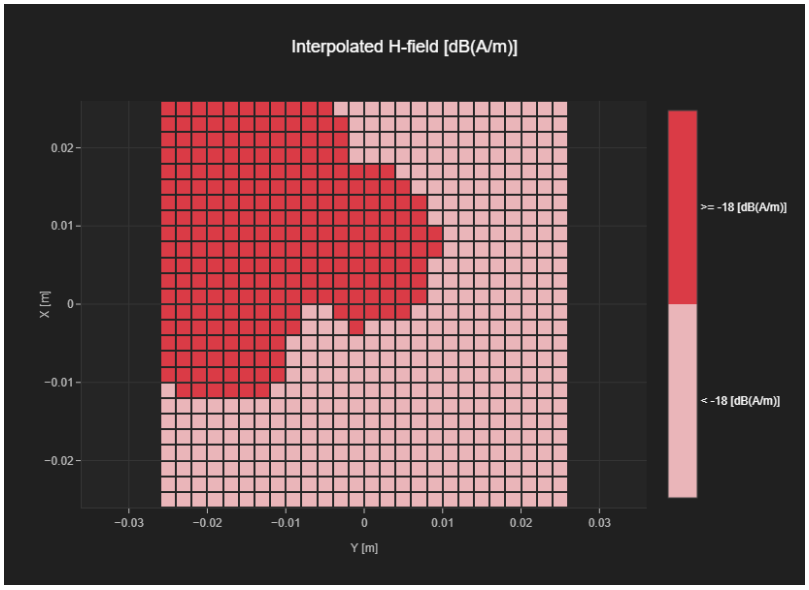
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 13, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	23230	782.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

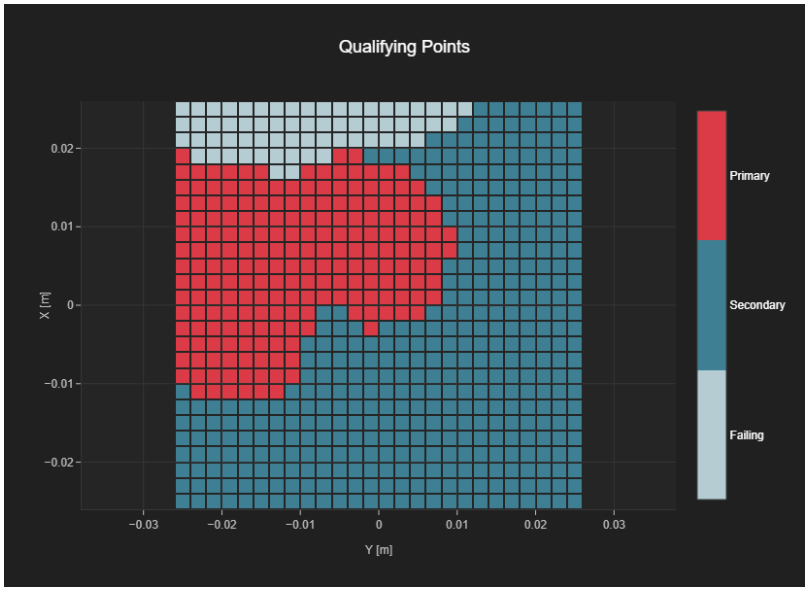
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.44



Plot 08_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
207	607	26	26



Plot 09_T-Coil Signal Test Report

Measurement performed on April 25, 2024 at 22:11

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

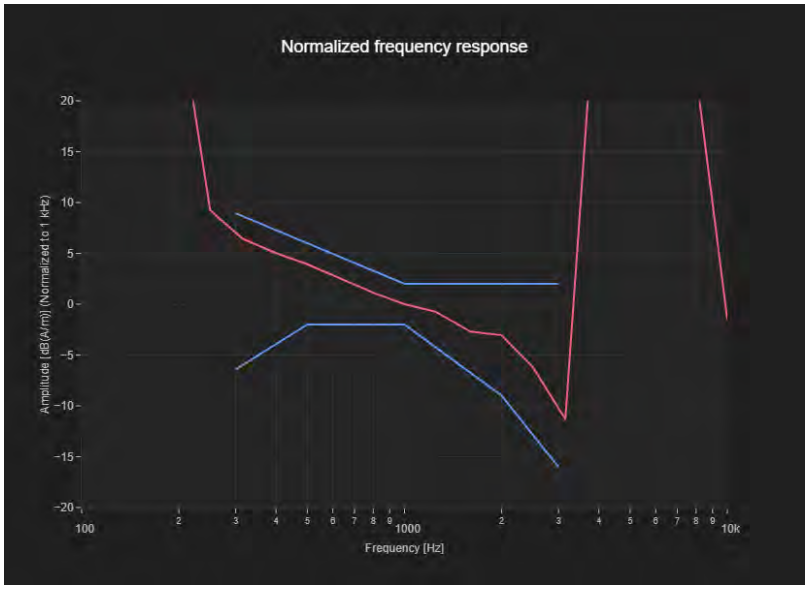
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 25, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	26340	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	1.86	2.0



Plot 09_T-Coil Noise Test Report

Measurement performed on April 25, 2024 at 22:22

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

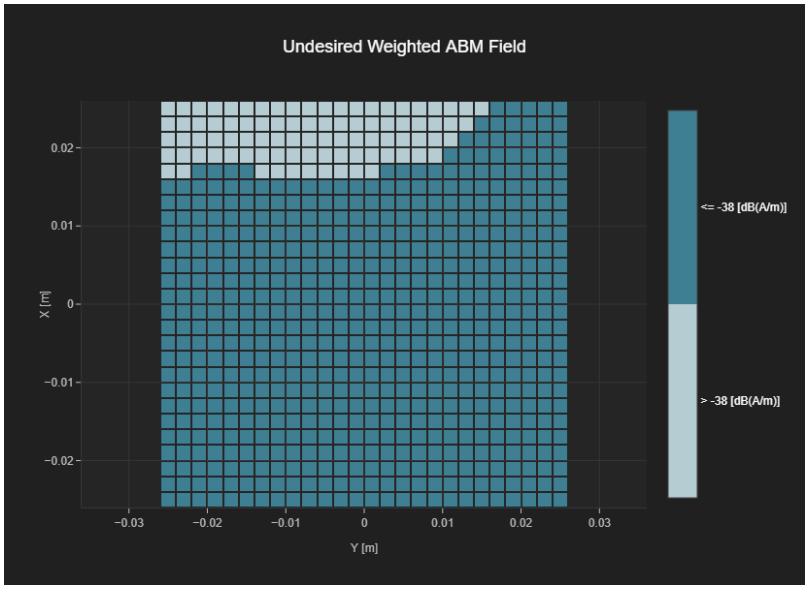
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 25, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	26340	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
588	26	26	-29.51



Plot 09_T-Coil Signal Test Report

Measurement performed on April 25, 2024 at 22:11

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

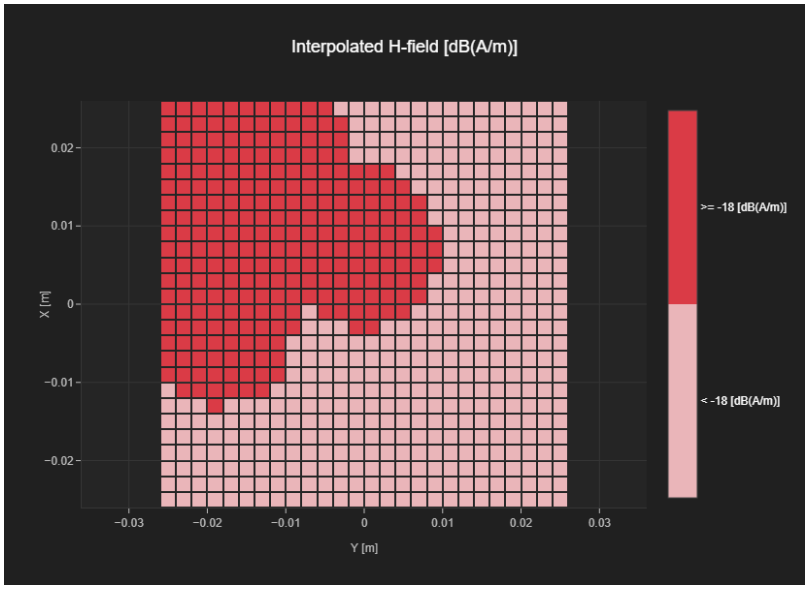
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 25, E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	26340	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

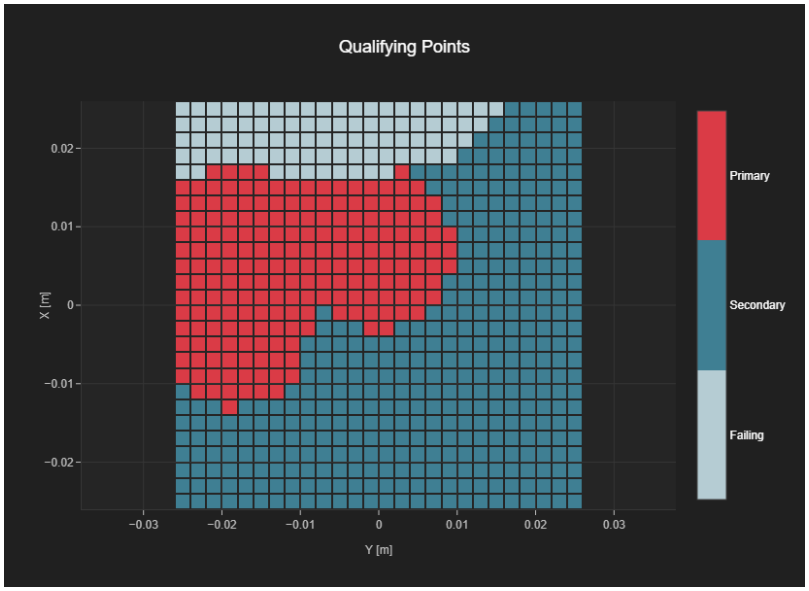
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.57	6.32



T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
200	588	26	26



Plot 10_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 22:20

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

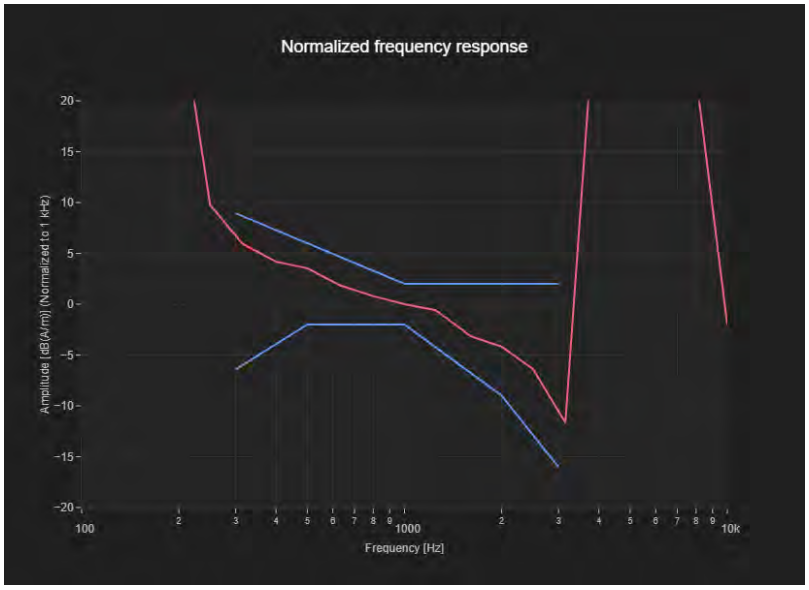
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 26 E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	26865	831.5

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	2.0	2.0



Plot 10_T-Coil Noise Test Report

Measurement performed on April 26, 2024 at 22:09

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

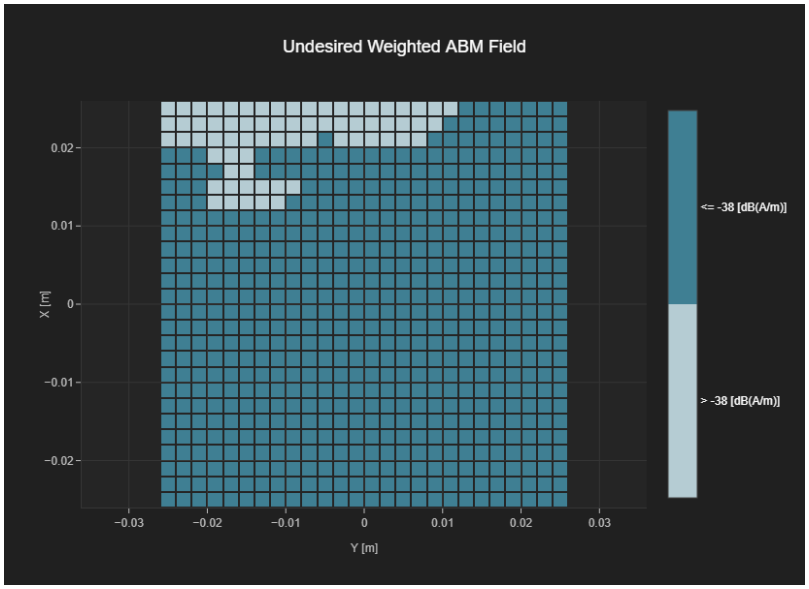
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 26 E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	26865	831.5

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
607	26	26	-33.21



Plot 10_T-Coil Signal Test Report

Measurement performed on April 26, 2024 at 22:20

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

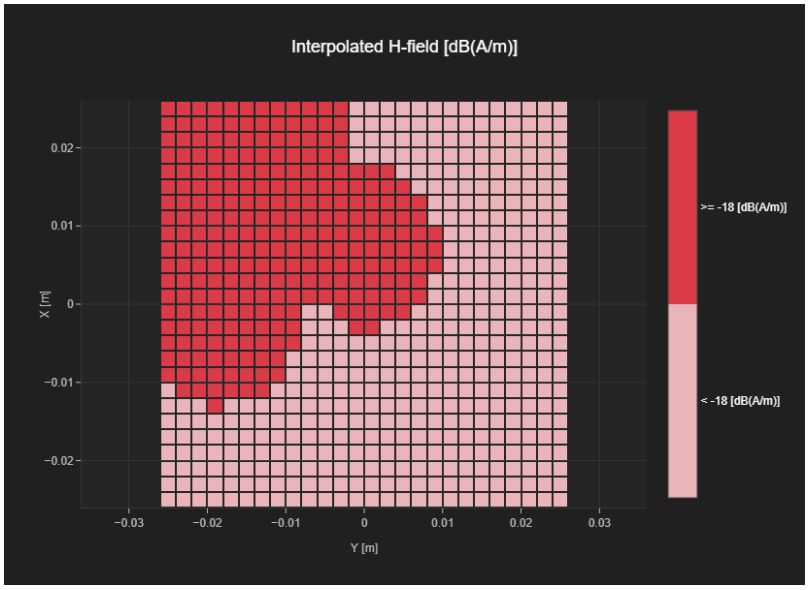
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 26 E-UTRA/FDD	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	26865	831.5

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

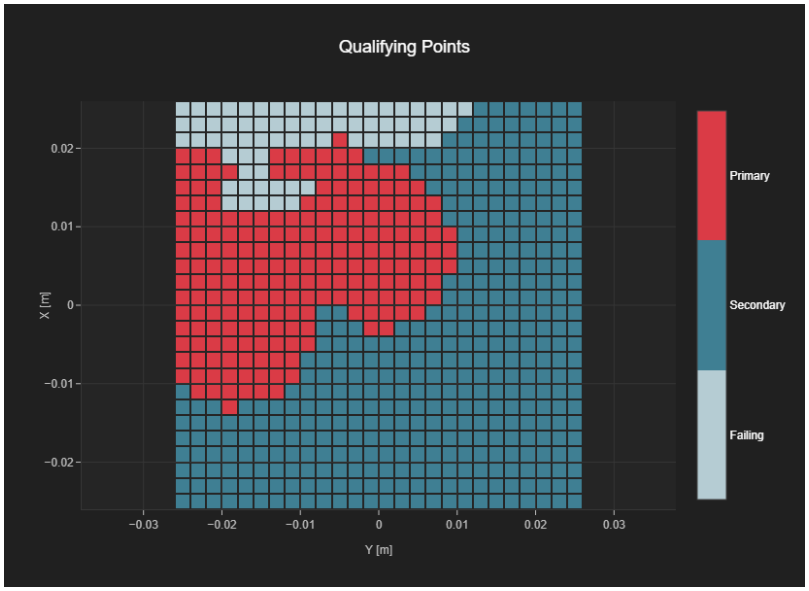
Audio File	Measurement Duration [s]	Gain [dB]	Hmax [dB(A/m)]
48k_voice_1kHz_1s.wav	2.0	-12.56	6.6



Plot 10_T-Coil Coupling Mode Test Report

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
213	610	26	26



Plot 11_T-Coil Signal Test Report

Measurement performed on April 25, 2024 at 00:29

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

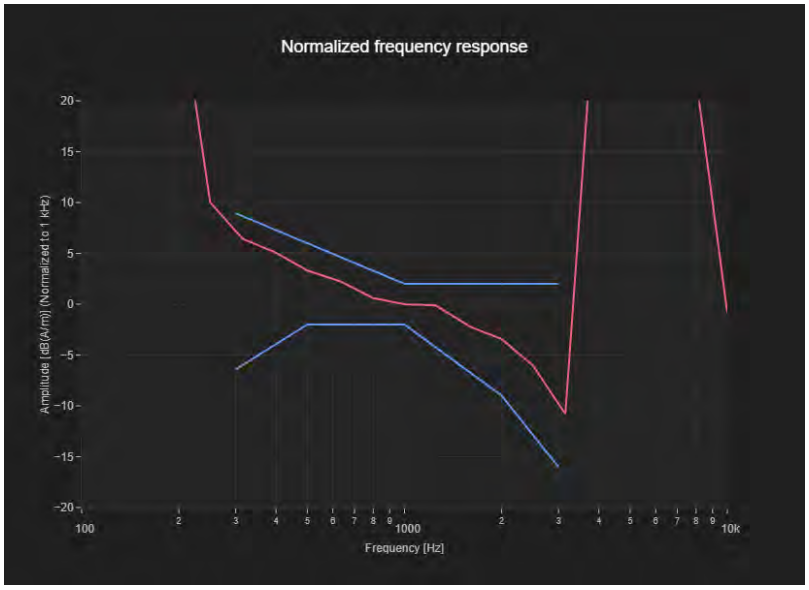
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 38, E-UTRA/TDD	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	38000	2595.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.0	1.69	2.0



Plot 11_T-Coil Noise Test Report

Measurement performed on April 25, 2024 at 00:40

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3144	February 14, 2024	DAE4 Sn720	October 20, 2023

Communication Systems

Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band 38, E-UTRA/TDD	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	38000	2595.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
52.0	52.0	4.0	4.0	10.0

Results

Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Hmax [dB(A/m)]
456	20	26	-21.32