HAC T-COIL SIGNAL TEST REPORT

FCC 47 CFR § 20.19
ANSI C63.19-2019

For
SMARTPHONE

FCC ID: BCG-E8954A
Model Name: A3516

Report Number: 15496283-S2V1
Issue Date: 7/29/2025

Prepared for
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CERT #0751.05

Revision History

Rev.	Date	Revisions	Revised By
V1	7/29/2025	Initial Issue	--

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1. Attestation of Test Results

Applicant Name	APPLE, INC.
FCC ID	BCG-E8954A
Model Name	A3516
Applicable Standards	FCC 47 CFR § 20.19 ANSI C63.19-2019
Date Tested	5/19/2025 to 7/23/2025
Test Results	Pass

UL Verification Services Inc. assessed the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment assessed can demonstrate compliance with the requirements as documented in this report.

This report contains data provided by the customer which can impact the validity of results. UL Verification Services Inc. is only responsible for the validity of results after the integration of the data provided by the customer.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples assessed were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not considered unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are noted in the revisions section. Any alteration of this document not conducted by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the U.S. Government, or any agency of the U.S. government.

Approved & Released By:	Prepared By:
	
Devin Chang Senior Laboratory Engineer UL Verification Services Inc.	Miguel Llamas Laboratory Supervisor UL Verification Services Inc.

2. Test Methodology

The tests documented in this report were performed in accordance with ANSI C63.19-2019 Methods of Measurement of Compatibility Between Wireless Communications Devices and Hearing Aids and FCC published procedure:

KDB 285076 D01 HAC Guidance v06r04
KDB 285076 D02 T-Coil testing for CMRS IP v04
KDB 285076 D03 HAC FAQ v01r06

In addition to the above, the following guidance was used:
TCB workshop updates:

- TCB Workshop October 2022; Publication Update & Administrative Notes (Publication Update: 285076 D01 & D04)
- TCB Workshop October 2022; Federal Communications Commission Hearing Aid Compatibility Updates
- TCB Workshop April 2023; Publication Update& Administrative Notes (Publications Since Oct Workshop: 285076 HAC Update)
- TCB Workshop October 2023; Publication Update & Administrative Notes (Publication Update: 285076 09/29/2023: HAC Guidance blanket)
- TCB Workshop April 2024; HAC Updates (Handset Configuration)

3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

47266 Benicia Street
SAR Lab 16

UL Verification Services Inc. is accredited by A2LA, Certificate Number 0751.05

The Test Lab Conformity Assessment Body Identifier (CABID)

Location	CABID	Company Number
47173 Benicia Street, Fremont, CA, 94538 UNITED STATES	US0104	2324A
47266 Benicia Street, Fremont, CA, 94538 UNITED STATES		

4. Test Equipment and Uncertainty

4.1. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations and is traceable to recognized national standards.

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Magnetic Field Probe	SPEAG	AM1DV3	3092	4/10/2026
Data Acquisition Electronics	SPEAG	DAE4	1621	4/10/2026
AMMI	SPEAG	SE UMS 010 BB	2015	N/A
DAC	Sound Devices	USBPre2	HB1420133009	N/A
DAC	Yellow tech	YT4211	248643	N/A
Switch	TP-Link	TL-SG1016D	2165473001109	N/A
Support Device	APPLE	Macbook 2	KQLYW3VG95	N/A
Radio Communication Tester	R&S	CMW 500	125236-eS	2/14/2026
Radio Communication Tester	R&S	CMX 500	101639-EE	2/14/2026

4.1.1. Base Station Simulator Software and Firmware

The following software/firmware was used to simulate the VoLTE, VoNR (5G NR) and VoWiFi server for CMRS testing using R&S CMW500 and CMX500 base station simulators.

Technology	Firmware	License Key	Software Name
VoLTE	V3.8.10 for LTE	KS500	LTE FDD R8 SIG BASIC
		KS550	LTE TDD R8 SIG BASIC
	V3.8.10 for Audio	KA100	IP APPL ENABLING IPv4
		KA150	IP APPL ENABLING IPv6
		KAA20	IP APPL IMS BASIC
		KM050	DATA APPL MEAS
		KS104	EVS SPEECH CODEC
VoNR - 5G NR (FR1)	V7.70.0.116 for 5G NR	CMX-KS600B	NR SIG BASIC FSET1
		CMX-KS600M	NR SIG MEDIUM FSET1
		CMX-KS600X	NR SIG XPERT FSET1
		CMX-KS601B	NR SIG BASIC FSET2
		CMX-KS601M	NR SIG MEDIUM FSET2
		CMX-KS601X	NR SIG XPERT FSET2
		CMX-KS610B	NR SIG BASIC FSET3
		CMX-KS610M	NR SIG MEDIUM FSET3
		CMX-KS610X	NR SIG XPERT FSET3
		CMX-KS611B	NR SIG BASIC FSET4
		CMX-KS611M	NR SIG MEDIUM FSET4
		CMX-KS611X	NR SIG XPERT FSET4
		CMX-KS612B-CMX-KS612B	NR SIG EXT. BASIC FSET5
		CMX-KS612M-CMX-KS612M	NR SIG EXT. MEDIUM FSET5
		CMX-KS612X-CMX-KS612X	NR SIG EXT. EXPERT FSET5
		CMX-KS617B-CMX-KS617B	NR SIG EXT. BASIC FSET6
		CMX-KS617M-CMX-KS617M	NR SIG EXT. MEDIUM FSET6
		CMX-KS617X-CMX-KS617X	NR SIG EXT. EXPERT FSET6
VoWiFi	V3.8.20 for WLAN	KS650	WLAN A/B/G SIG BASIC
		KS651	WLAN N SIG BASIC
		KS656	WLAN IEEE 802.11ac
		KS657	WLAN IEEE 802.11ax
	V3.8.10 for Audio	KA100	IP APPL ENABLING IPv4
		KA150	IP APPL ENABLING IPv6
		KAA20	IP APPL IMS BASIC
		KM050	DATA APPL MEAS
		KS104	EVS SPEECH CODEC

4.2. Measurement Uncertainty

Uncertainty of Audio Band Magnetic Measurements							
Error Description	**Uncertainty Values (±%)**	**Probe Dist.**	**Div.**	**(c_i) ABMd**	**c_i ABMu**	**Std. Uncertainty**	
						ABMd (±%)	**ABMu (±%)**
Probe Sensitivity							
Reference Level	3.0	N	1	1	1	3.0	3.0
AMCC Geometry	0.4	R	√3	1	1	0.2	0.2
AMCC Current	1.0	R	√3	1	1	0.6	0.6
Probe Positioning during Calibration	0.1	R	√3	1	1	0.1	0.1
Noise Contribution	0.7	R	√3	0.0143	1	0.0	0.4
Frequency Slope	5.9	R	√3	0.1	1.0	0.3	3.5
Probe System							
Repeatability / Drift	1.0	R	√3	1	1	0.6	0.6
Linearity / Dynamic Range	0.6	R	√3	1	1	0.4	0.4
Acoustic Noise	1.0	R	√3	0.1	1	0.1	0.6
Probe Angle	1.0	R	√3	1	1	0.6	0.6
Spectral Processing	0.9	R	√3	1	1	0.5	0.5
Integration Time	0.6	N	1	1	5	0.6	3.0
Field Disturbation	0.2	R	√3	1	1	0.1	0.1
Test Signal							
Reference Signal Spectral Response	0.6	R	√3	0	1	0.0	0.4
Positioning							
Probe Positioning	1.9	R	√3	1	1	1.1	1.1
Phantom Thickness	0.9	R	√3	1	1	0.5	0.5
DUT Positioning	1.9	R	√3	1	1	1.1	1.1
External Contributions							
RF Interference	0.0	R	√3	1	0.3	0.0	0.0
Test Signal Variation	2.0	R	√3	1	1	1.2	1.2
Combined Uncertainty							
Combined Std. Uncertainty (ABM field)						3.9	6.0
Expanded Std. Uncertainty (%)						**7.8**	**11.9**

Notes:
1. N - Nomal
2. R - Rectangular
3. Div. - Divisor used to obtain standard uncertainty
4. ABMd - Desired ABM Signal
5. ABMu - Undesired ABM Field

5. Test Procedures for all Technologies

5.1. Test Procedure for T-Coil signal per ANSI C63.19-2019, §6

This subclause describes the procedures used to measure the ABM (T-Coil) performance of the WD. Measurements shall be performed over a measurement area 50 mm square, in the measurement plane, as specified in Annex A.3. The measurement area shall be scanned with a uniform measurement point spacing of 2.0 mm ± 0.5 mm in each X-Y axis of the plane, yielding 676 measurement points with approximately even spacing throughout the area.

Optionally, measurement point spacing may be increased to 4 mm, with interpolation employed to yield the required 676 equivalent measurement points distributed uniformly over the 50 mm square measurement area. Interpolated points shall be derived from the average of the linear representations of the field strengths of the nearest two or four equidistant measured points. The area of measurement is increased to a 52 mm square so that edge rows and columns of the required 50 mm square can be either measured or interpolated, with none extrapolated.

In addition to measuring the desired ABM signal levels, the weighted magnitude of the unintended signal shall also be determined. Weighting of the unintended and undesired ABM field shall be by the spectral and temporal weighting described in Annex D.4 through D.6.

In order to assure that the required signal quality is measured, the measurement of the intended signal and the measurement of the unintended signal shall be made at the same locations. Measurements shall not include undesired influence from the WD's RF field; therefore, use of a coaxial connection to a base station simulator or non-radiating load might be necessary. However, even then with a coaxial connection to a base station simulator or non-radiating load there could still be RF leakage from the WD, which could interfere with the desired measurement. Pre-measurement checks should be made to avoid this possibility. All measurements shall be done with the WD operating on battery power with an appropriate normal speech audio signal input level given in Table 6.1. If the device display can be turned off during a phone call, then that may be done during the measurement as well. If tested with the display in the off state this shall be documented in the test report.

Measurements shall be performed with the probe coil oriented in the transverse direction, as illustrated in Annex A.3, that is, aligned in the plane of the measurement area and perpendicular to the long dimension of the WD. A multi-stage sequence consists of first measuring the field strength of the desired T-Coil signal (desired ABM signal) that is useful to a hearing aid T-Coil at each specified measurement point. The undesired magnetic component (undesired ABM field) is then measured in the same transverse orientation at each of the same measurement points. At a single location only, taken at or near the highest desired ABM signal reading, the desired ABM signal frequency response shall be determined in a third measurement stage. The flowchart in Figure 6.3 illustrates this three-stage process.

To minimize the need to test every WD operating mode to the telecoil requirements of Clause 6, it is permissible to exclude some subset of supported configurations. For a given WD, every mode that supports voice communication shall be considered for telecoil testing. However, if it can be demonstrated that a certain configuration will not be the worst-case telecoil configuration, such configurations may be excluded from the full telecoil scans of 6.4.[1] For example, operating modes may be pre-screened by scanning for both desired ABM signal and undesired ABM field at a lower measurement point density than the final scans, thus saving considerable testing time by eliminating configurations that are excellent performers from more detailed testing for worst-case. In any case, the specific methods and criteria used to determine which configurations are excluded for a WD shall be explicitly stated and justified in the test report. To be considered for exclusion from telecoil testing, operating modes shall also be shown to pass the frequency response requirements of 6.6.3.

Many factors could affect telecoil test results. RF power level and amplitude modulation characteristics as well as the specific current paths within the WD associated with the RF output stage(s), the display, and processing circuitry could affect the undesired ABM field. Audio codec implementation and acoustic receiver characteristics could also affect the desired ABM signal). Therefore, any justifications for exclusions should be thorough documented. If an operating mode is under user control and instructions on how to place the WD in a less interfering condition is in the user instructions, those instructions may be followed in configuring the device for testing.

The following steps summarize the basic test flow for determining desired ABM signal and undesired ABM field. These steps assume that a sine wave or narrowband 1/3 octave signal can be used for the measurement of desired

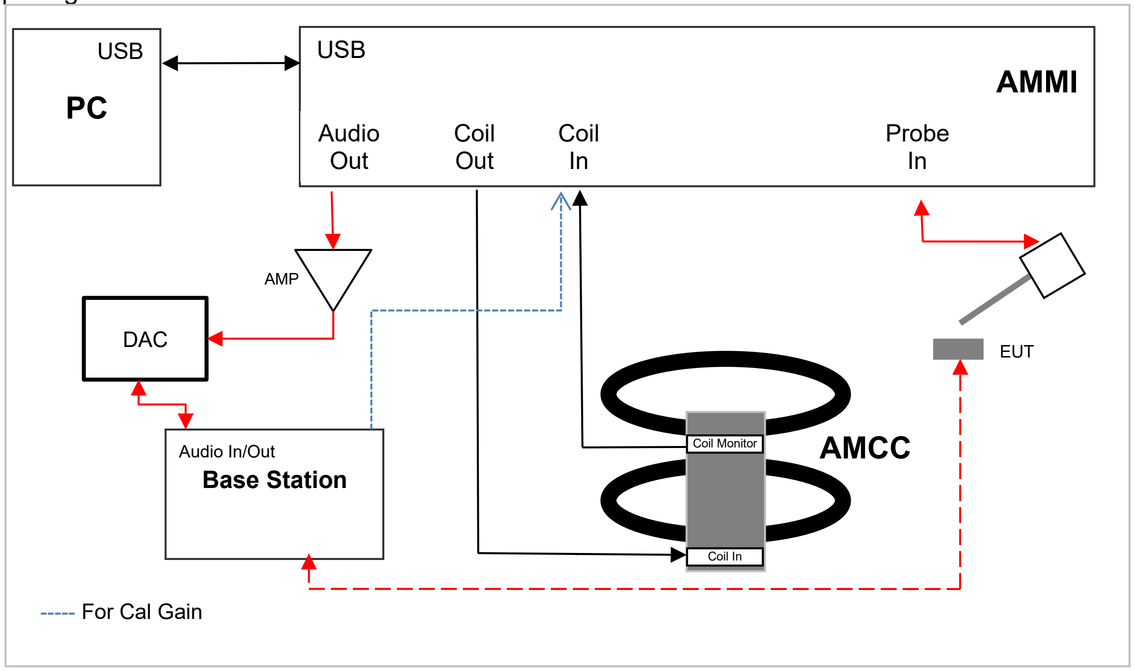
[1] The allowance to not test all modes does not remove the requirement that all modes meet the requirements of this standard if a claim of compliance is to be made. What is allowed is a reduction of testing, where there is a good basis for believing that testing that is performed demonstrates the compliance of all possible operating modes.

ABM signal level. An alternative procedure, yielding equivalent results, using a broadband excitation is described in 6.5.

a) A validation of the test setup and instrumentation shall be performed. This may be done using a TMFS or Helmholtz Coil. Measure the emissions and confirm that they are within tolerance of the expected values.
b) Confirm that equipment that requires calibration has been calibrated, and that the noise level meets the requirements given in 6.3.2.
c) Position the WD in the test setup and connect the WD RF connector to a base station simulator or a non-radiating load (if necessary to control RF interference in the measurement equipment) as shown in Figure 6.1 or Figure 6.2.
d) The drive level to the WD is set such that the reference input level specified in Table 6.1 is input to the base station simulator (or manufacturer's test mode equivalent) in the 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (desired ABM signal) at f = 1 kHz. Either a sine wave at 1025 Hz, or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as specified in 6.4.3, shall be used for the reference audio signal. If interference is found at 1025 Hz an alternative nearby reference audio signal frequency may be used.[2] The same drive level will be used for the desired ABM signal frequency response measurements at each 1/3 octave band center frequency. The WD volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.
e) At each measurement location over the measurement area and in the transverse orientation, measure and record the desired 1 kHz T-Coil magnetic signal (desired ABM signal) as described in Step c).
f) At or near a location representing a maximum in the just-measured desired ABM signal, measure and record the desired T-Coil magnetic signals (desired ABM signal at f_i) as described in 6.4.5.2 in each individual ISO 266:1975 R10 standard 1/3 octave band. The desired audio band input frequency (f_i) shall be centered in each 1/3 octave band maintaining the same drive level as determined in Step c), and the reading taken for that band.[3] 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).) Compare the frequency response found to the requirements of 6.6.3.
g) At the same locations measured in Step d), measure and record the undesired broadband audio magnetic signal (undesired ABM field) with no audio signal applied (or digital zero applied, if appropriate) using the specified spectral weighting, the half-band integrator followed by the temporal weighting.
h) Calculate and record the location and number of the measurement points that satisfy both the minimum desired ABM signal level and the maximum undesired ABM field level specified in 6.6.2. Compare this to the requirements in 6.6.4 and record the result.
i) Calculate and record the location and number of the measurement points that satisfy the maximum undesired ABM field level and distribution requirements specified in 6.6.4.

[2] The 1025 Hz frequency was selected rather than 1 kHz because a 1 kHz reference frequency could interfere with emission harmonics or test equipment fundamental frequencies.
[3] See 6.4.5.2 and 6.4.5.4 for details.

Test Setup Diagram



Note(s):
For Audio OUT, an amplifier was added to amplify signal to meet DAC specifications.

5.2. Reference Input Levels per ANSI C63.19-2019, §6

The following reference input levels (Figure 6.1) that correlate to a normal speech input level shall be used for the standard transmission protocols.[4]

Table 6.1 - Normal speech input levels

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

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

For protocols not listed in Table 6.1, use the normal speech input level per the relevant specifications for that air interface.

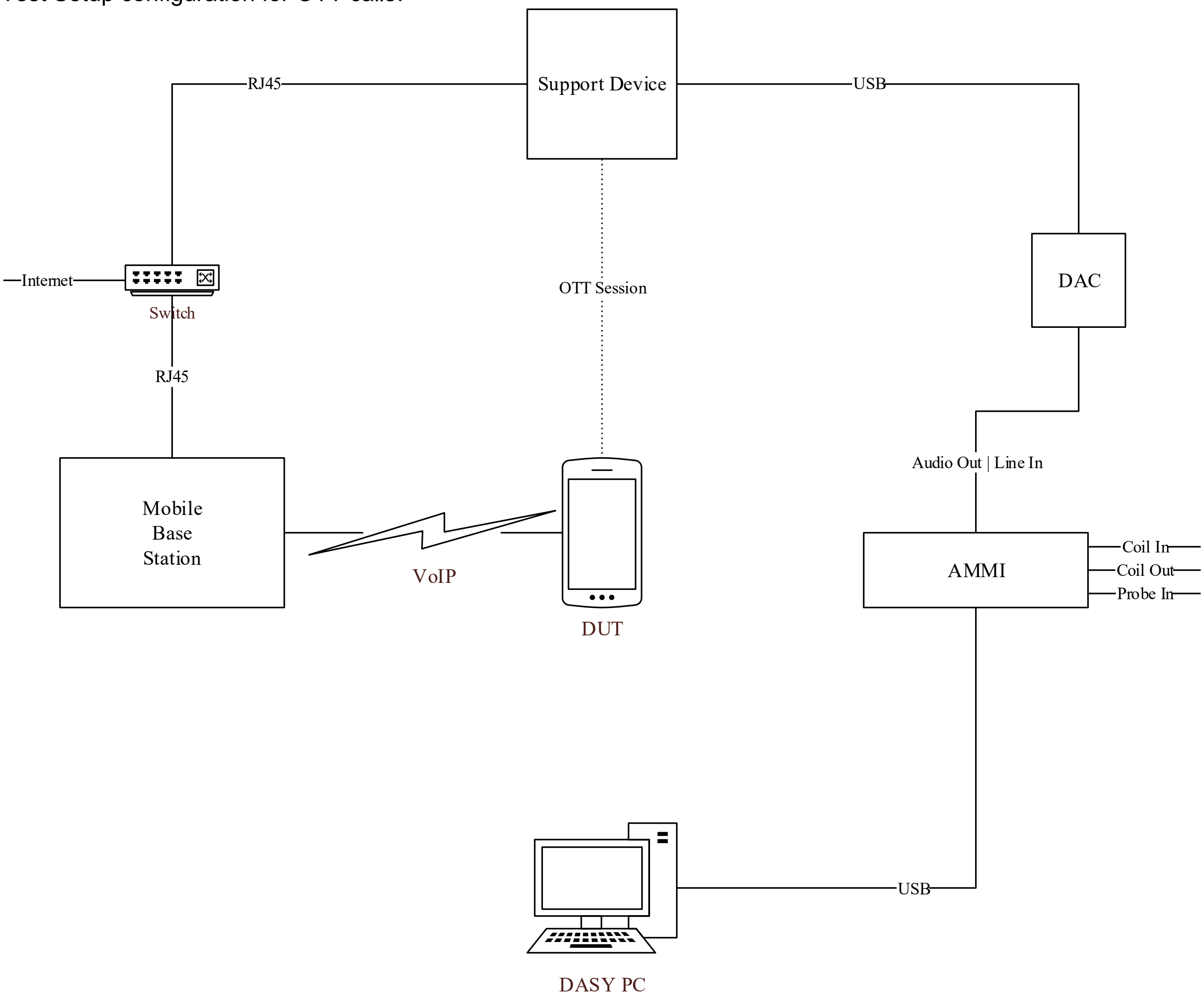
[4] The intent of this subclause is to provide a nominal level speech input independent of air interface and measure the magnetic response in a normal use condition without requiring an acoustic reference. The nominal level speech signals in 6.4.3.2 will result in acoustic speech levels that are mutually consistent and also span a range including 94 dB SPL, as shown in the examples below. This is intended to allow the operator to set WD adjustable volume controls as needed to produce a sufficient desired magnetic level (desired ABM signal) based on intended usage. When measuring with the specified nominal speech input level of –16 dBm0 for GSM, a GSM phone shall not exceed a receive loudness rating (RLR) of –13 dB at maximum volume setting. However, at a nominal volume control setting with the same –16 dBm0 input, a GSM phone shall have an RLR of at least 2 dB ± 3 dB. An RLR of 2 dB ± 3 dB corresponds to a sound pressure level of 84 dB ± 3 dB SPL, assuming an earpiece frequency response that is flat over the frequency bands specified as per ITU-T Recommendation P.79. An RLR of –13 dB corresponds to a sound pressure level of 99 dB SPL, assuming an earpiece frequency response that is flat over the frequency bands specified as per ITU-T Recommendation P.79. When measuring with the specified nominal speech input level of –18 dBm0 for CDMA, a CDMA phone with volume control set to the midpoint should provide an RLR of 2 dB ± 5 dB. The CTIA (Rev. 3.21, 2003) CDMA test plan (V1.2) does not specifically place an upper limit on RLR. References: ITU-T Recommendation P.79. Calculation of loudness ratings for telephone handsets. Cellular Telecommunications Industry Association Performance Evaluation Standard for 800 MHz AMPS and Cellular/PCS CDMA Dual Mode Wireless Subscriber Stations.

5.3. Over the Top (OTT)

This device supports VoIP via a preinstalled application that uses the FaceTime service, using ACC-ELD as its only codec (refer to §8.1 for air interface details and §9.2.2 for codec bit rates). VoIP capabilities require HAC assessment when voice calls are supported over the cellular data connection via pre-installed VoIP applications.

The equipment is set up as shown below with a support device used to originate the call using the IP transport. The support device[5] connects to the cloud-based FaceTime service via a Wi-Fi access point and router, or an RJ45 Ethernet connection. The DUT connects to the VoIP service via a cellular/unlicensed air interface to the call box and an Ethernet connection from call box to Internet. The various codec bit rate and air interface configurations are evaluated to determine the worst-case configuration (refer to §9.2).

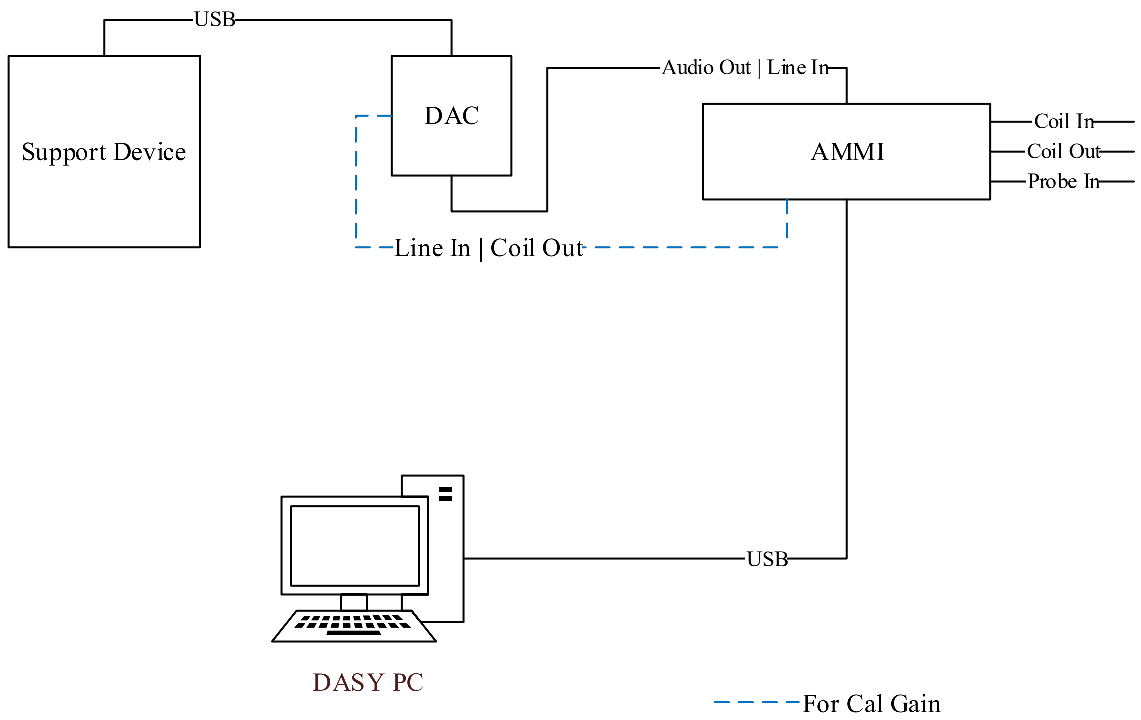
Test Setup configuration for OTT calls:



For the OTT call, the calibrated audio card within the CMW500 cannot be used so the AMMI is connected to an external Digital-Analog Converter (DAC) and the DAC is connected to the Support Device via USB. The test signal is sent from the DASY PC to the AMMI, from the AMMI to the DAC, from the DAC to the Support Device, and, via the VoIP call, to the DUT.

[5] The support device is a Apple Macbook.

As this test set up uses an external DAC between the AMMI's audio output and support device, the appropriate gain factor for the OTT call needs to be determined. This is done by connecting the DAC between the AMMI Audio output and Coil input as shown below.



Once the proper cable connections are established, the procedures outlined in §6 are followed to calculate the appropriate Gain and codec / system delays for OTT measurements. Please refer to §6.5 for computed OTT gain settings and the test data tables in §9 & 10 for all Codec / system delay measurements performed during OTT testing.

6. Calibrations & Gain Measurements

Calibrations and Gain measurements are performed using guidance from SPEAG's *DASY6/8 Module HAC System Handbook §7.3.*

6.1. Calibration of AM1DVx Probe

For correct measurement of the audio-band magnetic field, the AM1DVx probe must first calibrated. The calibration is performed in the Helmholtz Audio Magnetic Calibration Coil (AMCC).

6.1.1. Calibration Setup

During the calibration procedure, the system is set as described below:

- the AMMI is powered on and connected to the DASY6/8 PC via USB.
- the AMMI COIL OUT port is connected to the AMCC COIL IN.
- the AMMI COIL IN port is connected to the AMCC COIL MONITOR.
- the AM1DVx probe is mounted on the robot.

6.1.2. Sensor Angle Alignment

The sensor angle relative to the robot arm depends on several factors: probe connector angle, Data Acquisition Electronics (DAE) connector angle, use of a Quick Adaptor Change System (QACS). In DASY6/8, the sensor angle is assessed automatically during the alignment phase.

The alignment procedure consists of rotating the probe in the AMCC for angle within the [0° −360°] in 10° steps. The sensor angle is defined as the angle giving the maximum H-field response for the sensor. The angle corresponds to the sensor in the axial direction (same orientation as the AMCC field).

Note: The calibration must be repeated after any change in the measurement instrumentation, especially when the probe / DAE has been remounted on the robot.

6.1.3. System Response Calibration

The sensitivity and frequency response of the AM1DVx probe is calibrated over the [50Hz − 10 kHz] frequency range using a multi-sine signal. The sines are at the center frequency of each 1/3 octave band.

The measurement is performed in the AMCC with the probe sensor in axial orientation. The Coil In channel of the Audio Magnetic Measurement Instrument (AMMI) measures the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMMI. In parallel, the Probe In channel measured the amplified signal picked up by the probe coil. The sensitivity of the probe in V/(A/m) is defined at the voltage ratio at 1 kHz. The frequency response in dB is defined as the ratio between the voltages in each 1/3 octave band normalized to the 1 kHz ratio.

The obtained sensitivity is compared to the one from the probe configuration file for verification purposes. A warning is issued if the deviation exceeds 2 %.

6.2. AMMI Audio Output Calibration

The audio output calibration of the AMMI is performed as described below:

- Connect Audio Out to Coil In on the AMMI and click on Calibrate.
- Click on the Calibrate button.
- Once calibration is complete, re-establish the cabling illustrated in Test Setup Diagram §5.1.

6.3. Codec / System Delay Measurements

Codec / system delay measurements are calculated using the guidance from SPEAG's *DASY6/8 Module HAC System Handbook §7.3.2.4:*

- A time delay might occur in the audio signal path (latency of the codec, Windows settings ...). For accurate measurements, the system must consider this delay, and shift in time the probe readings accordingly.
- Module HAC features automated measurement of the delay. The assessed delay will then be used for the subsequent desired ABM signal level and undesired ABM field level measurements.
- The delay is measured by pressing the Assess Delay button under the Scan Control section of the Measurement tab. The system must be ready to measure, and the DUT must be transmitting in the desired test mode.
- A scan with reduced resolution will be performed and the delay will be assessed at the measured maximum.
- This measurement must be repeated after every change in the hardware setup, or when a different DUT / Codec is used.

6.4. Compute Gain Settings

Gain settings are computed using the following procedure:

- Define the Scan Type as Signal in the Scan Type section.
- Specify the Input Level and Codec Delay in the Base Station Simulator Settings.
    - Input level refers to full scale input level equivalent to 3.14 dBm0.
        - Input level of 1V is used for R&S CMW500 Base Station Simulator.
        - Input level of 1V is used for R&S CMX500
    - The codec delay can be measured automatically using the procedure described above in §6.3 above.
- Enter the desired speech level in dBm0. Refer to §5.2 for applicable Reference Input Levels.
- Specify the audio file and the measurement duration to be used for the area and frequency response scans.
    - Use Audio file 48k_voice_1kHz_1s.wav for ABMd and ABMu measurements.
    - Use Audio file 48k_voice_300-3000_2s.wav for Frequency Response measurements.
- Click on Compute Gain Settings. The properties of the audio file, such as the bandwidth compensation factor (BWC), peak value, etc. will be automatically computed. In addition, the audio file scaling (also called gain) will calculated. A popup is displayed in case the resulting gain exceeds the AMMI dynamic range.

Computed Gain settings for each supported technology for CMRS evaluations is illustrated in the table below:

SAR 16

Computed Gain Settings						
Technology	**Signal Type**	**Speech Level (dBm0)**	**Peak to Full Scale (dB)**	**Peak to RMS Scale (dB)**	**BWC (dB)**	**Scaling (Gain) (dB)**
GSM	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-12.62
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.79
W-CDMA	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-12.63
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.8
VoLTE	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-12.63
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.8
VoNR	Voice 1 kHz	-16.0				
	Voice 300-3kHz	-16.0				
VoWiFi	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-12.64
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.81

6.5. Over the Top (OTT)

For GSM, W-CDMA, LTE, 5G NR and Wi-Fi, the procedures outlined in §6.4 above were followed to compute the appropriate Gain settings for OTT measurements.

Computed Gain settings for each supported technology for OTT evaluations is illustrated in the table below:

SAR 16

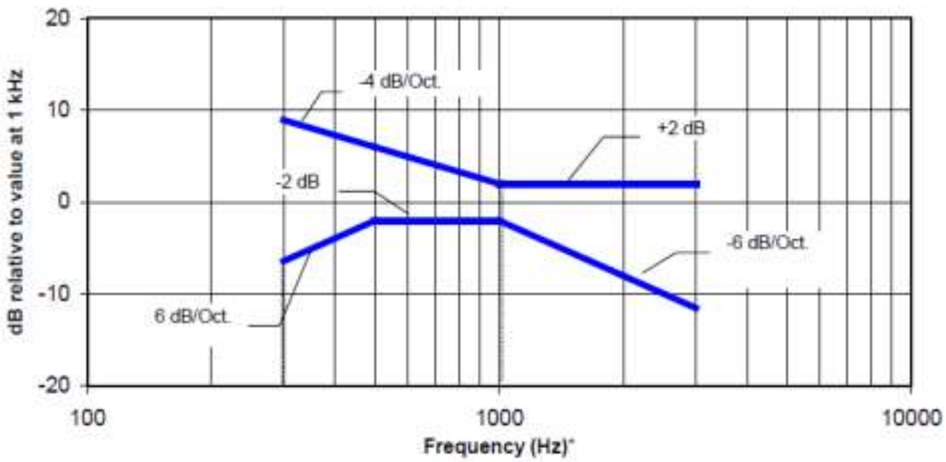
Computed Gain Settings						
Technology	**Signal Type**	**Speech Level (dBm0)**	**Peak to Full Scale (dB)**	**Peak to RMS Scale (dB)**	**BWC (dB)**	**Scaling (Gain) (dB)**
GSM	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.86
	Voice 300-3kHz	-16.0	0	21.57	10.81	-5.03
W-CDMA	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.85
	Voice 300-3kHz	-16.0	0	21.57	10.81	-5.02
LTE	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.85
	Voice 300-3kHz	-16.0	0	21.57	10.81	-5.02
5G NR	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.86
	Voice 300-3kHz	-16.0	0	21.57	10.81	-5.03
WLAN	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.86
	Voice 300-3kHz	-16.0	0	21.57	10.81	-5.03

7. T-coil Measurement Criteria

7.1. Frequency Response

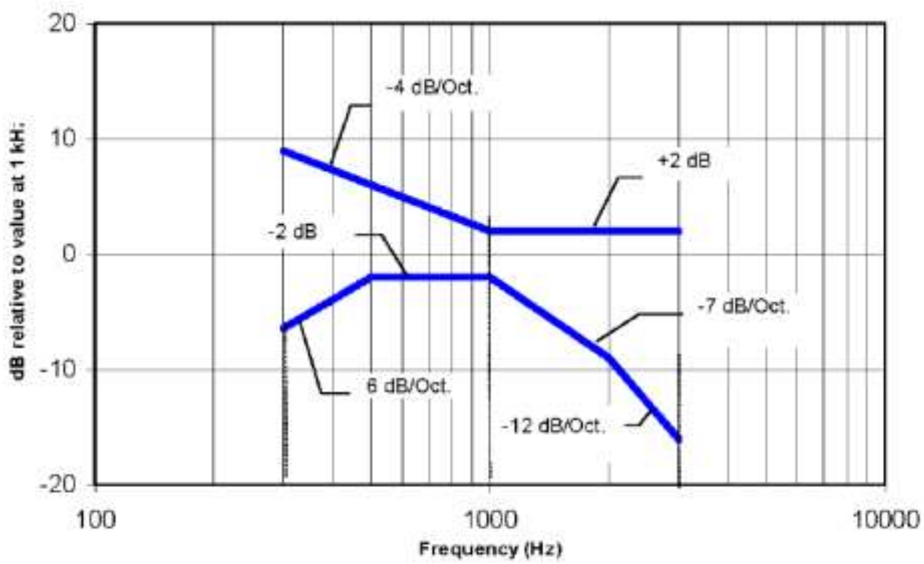
The frequency response of the magnetic field, measured in 1/3 octave bands, shall follow the response curve specified in this subclause, over the frequency range 300 Hz to 3 kHz.

Figure 6.4 and Figure 6.5 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.



NOTE—Frequency response is between 300 Hz and 3 kHz.

Figure 6.4—Magnetic field frequency response for WDs with a maximum field ≤−15 dB(A/m) at 1 kHz



NOTE—Frequency response is between 300 Hz and 3000 Hz.

Figure 6.5—Magnetic field frequency response for WDs with a maximum field that exceeds −15 dB(A/m) at 1 kHz

7.2. Coupling Mode Requirements

To comply with the requirements for T-Coil use, a WD's tested operating modes shall simultaneously meet the requirements for minimum desired ABM signal level and maximum undesired ABM field contained in this subclause at the minimum specified number of scanned locations.

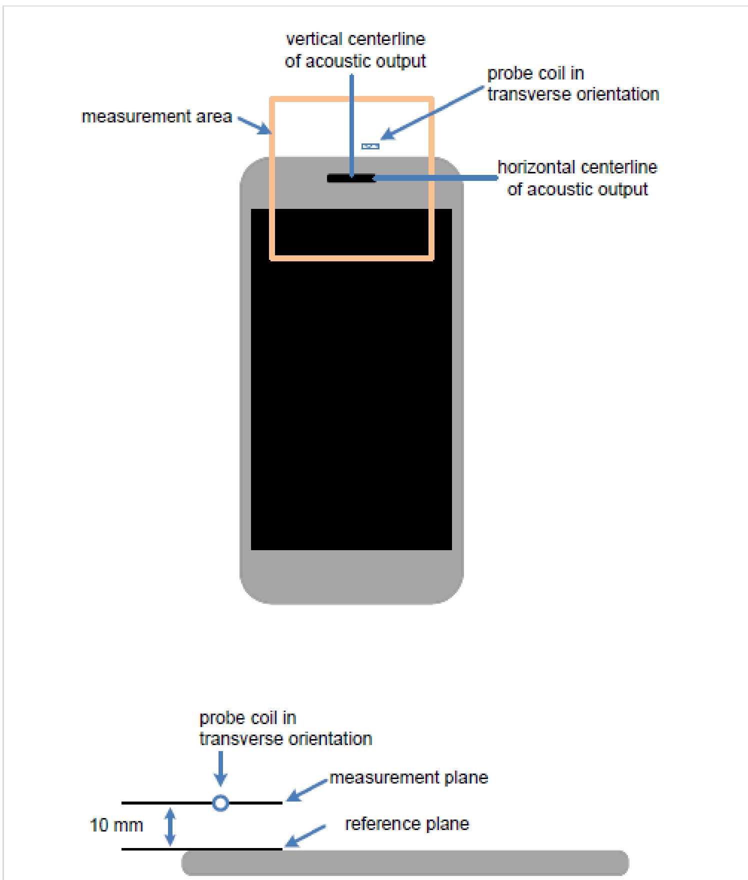
When measured as specified in this standard, there are two groups of qualifying measurement points:

Primary group: A qualifying measurement point shall have its T-Coil signal, desired ABM signal, ≥−18 dB(A/m) at 1 kHz, in a 1/3 octave band filter. These measurements shall be made with the WD operating at a reference input level as specified in Table 6.1. Simultaneously, the qualifying measurement point shall have its weighted magnetic noise, undesired ABM field ≤−38 dB(A/m).

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

These levels are designed to be compatible with hearing aids that produce the same acoustic output level for either an acoustic input level of 65 dB SPL or a magnetic input level of −25 dB(A/m) (56.2 mA/m)[6] at either 1.0 kHz or 1.6 kHz. The hearing aid operational measurements are performed per ANSI S3.22-2014.

Measurement locations and reference plane to be used for the T-coil measurements.



[6] IEC 60118-1 refers to hearing aid output being the same for an acoustic input of 70 dB SPL and a magnetic input of 100 mA/m. Thus 31.6 mA/m is equivalent to an acoustic input of 60 dB SPL, and an acoustic input of 65 dB SPL is equivalent to 56.2 mA/m.

7.3. Desired ABM Signal and Undesired ABM Field Requirements

For a WD that is expected to operate primarily in radio access technologies that include 2G GSM for legacy support, the WD shall be qualified for telecoil compatibility one of two ways:

- The DUT shall be rated for telecoil use for all other voice operating modes, exclusive of 2G GSM, according to the criteria of §6.6.4.2 of ANSI C63.19 2019.
- If the DUT is to be rated for telecoil use in its 2G GSM operating modes, these modes shall be qualified according to the criteria of §6.6.4.3 of ANSI C63.19 2019.

7.3.1. 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 coupling mode requirements; 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.

7.3.2. 2G GSM Operating modes

For 2G GSM operating mode(s), the qualifying measurement points shall fulfil the coupling mode requirements; 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.

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.

8. Device Under Test

Normal operation	Held to head		
Back Cover	The Back Cover is not removable		
Test sample information	**S/N**	**IMEI**	**Notes**
	QFPH3QL20V	N/A	HAC Sample

8.1. Air Interfaces and Operating Mode

All air interfaces which support voice capabilities over a managed CMRS, or pre-installed OTT VoIP applications were evaluated.

Air Interface	Bands (MHz)	Type	C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Mode[3]	Power Reduction	Audio Codecs Evaluated[1]
GSM	850	VO	Yes	Wi-Fi, BT, NB U-NII, 802.15.4 & 802.15.4ab NB	CMRS	Mode A & Power State 1 Head	N/A	EFR, AMR-NB & AMR-WB
	1900						N/A	
	GPRS/EDGE	DT/VD			FaceTime		N/A	ACC-ELD
W-CDMA (UMTS)	850	VO	Yes	Wi-Fi, BT, NB U-NII, 802.15.4 & 802.15.4ab NB	CMRS	Mode A & Power State 1 Head	N/A	AMR-NB & AMR-WB
	1700							
	1900							
	HSPA	VD			FaceTime		N/A	ACC-ELD
LTE - FDD	700 (B12/13/17)	VD	Yes	5G NR, Wi-Fi, BT, NB U-NII, 802.15.4 & 802.15.4ab NB	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	850 (B5/26)							
	1700 (B4/66)							
	1900 (B2/25)							
	2300 (B30)							
	2500 (B7)							
LTE - TDD	2500 (B53)	VD	Yes	5G NR, Wi-Fi, BT, NB U-NII, 802.15.4 & 802.15.4ab NB	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	2600 (B41)							
	3600 (B48)							
5G NR(FR1) FDD	600 (n71)	VD	Yes[2]	LTE, Wi-Fi, BT, NB U-NII, 802.15.4 & 802.15.4ab NB	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	700 (n12/n14)							
	850 (n5/n26)							
	1700 (n66/n70)							
	1900 (n2/n25)							
	2300 (n30)							
	2500 (n7)							
5G NR(FR1) TDD	2500 (n53)	VD	Yes[2]	LTE, Wi-Fi, BT, NB U-NII, 802.15.4 & 802.15.4ab NB	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	2600 (n41)							
	3500 (n77 Block A)							
	3700 (n48)							
	3900 (n77 Block C)							

Type
VO: Legacy Cellular Voice Service
DT: Digital Transport only (no voice)
VD: IP Voice Service over Digital Transport
CMRS: Commercial Mobile Radio Service

Note(s):
1. For protocols not listed in Table 6.1 of ANSI C63.19-2019, the average speech level of -20 dBm0 was used. Refer to §5.2 for reference input levels.
2. 5G NR (VoNR) is supported: manufacturer states that 5G NR (VoNR) uses the same protocol, Codec(s) and bitrates as LTE (VoLTE).
3. For all air interfaces, the maximum held-to-head output power was used for T-Coil evaluations. The maximum held-to-head output power is Power State 1 Mode A for WWAN operating modes and Power State 1 Mode A for WLAN operating modes. Refer to §9 & §10 for T-Coil evaluations.
4. LTE TDD B41 supports Power Class 2 and 3, 5G NR TDD n41 and n77 support Power Class 2 and 3.

Air Interfaces and Operating Modes

Air Interface	Bands (MHz)	Type	C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Mode[3]	Power Reduction	Audio Codecs Evaluated[1]
Wi-Fi	2450	VD	Yes	WWAN, NB U-NII & 802.15.4ab	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	U-NII-1			WWAN, BT, 802.15.4, & 802.15.4ab NB				
	U-NII-2A							
	U-NII-2C							
	U-NII-3							
	U-NII-5	VD	Yes	WWAN, BT, 802.15.4, & 802.15.4ab NB	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	U-NII-6	VD	No[2]	WWAN, BT, 802.15.4, & 802.15.4ab NB	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	U-NII-7							
	U-NII-8							
NB U-NII	U-NII-1	DT	N/A	WWAN, Wi-Fi 2.4 GHz	N/A	N/A	N/A	N/A
	U-NII-3							
	U-NII-5							
802.15ab NB	U-NII-3	DT	N/A	WWAN, BT, 802.15.4 & Wi-Fi[2]	N/A	N/A	N/A	N/A
802.15.4	2450	DT	N/A	WWAN, 802.15.4ab NB & Wi-Fi 5/6G	N/A	N/A	N/A	N/A
BT	2450	DT	N/A	WWAN, 802.15.4ab NB & Wi-Fi 5/6G	N/A	N/A	N/A	N/A
MSS	1600	DT	N/A	N/A	N/A	N/A	N/A	N/A
NFC	13	DT	N/A	WWAN, BT, Wi-Fi 2.4G, Wi-Fi 5/6G, 802.15.4	N/A	N/A	N/A	N/A
UWB (Ultra-Wideband)	6500	DT	N/A	N/A	N/A	N/A	N/A	N/A
	8000							

Type
VO: Legacy Cellular Voice Service
DT: Digital Transport only (no voice)
VD: IP Voice Service over Digital Transport
CMRS: Commercial Mobile Radio Service

Note(s):
1. For protocols not listed in Table 6.1 of ANSI C63.19-2019, the average speech level of -20 dBm0 was used. Refer to §5.2 for reference input levels.
2. Supported Frequency > 6GHz. ANSI C63,19 2019 only requires HAC evaluations for Technologies/Frequencies < 6GHz.
3. For all air interfaces, the maximum held-to-head output power was used for T-Coil evaluations. The maximum held-to-head output power is Power State 1 Mode A for WWAN operating modes and Power State 1 Mode A for WLAN operating modes. Refer to §9 & §10 for T-Coil evaluations.

9. Investigations (Codec & Air Interface)

To comply with the requirements for T-Coil use, a WD's tested operating modes shall simultaneously meet the requirements for minimum desired ABM signal level and maximum undesired ABM field contained in this subclause at the minimum specified number of scanned locations.

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

Primary group: A qualifying measurement point shall have its T-Coil signal, desired ABM signal, ≥−18 dB(A/m) at 1 kHz, in a 1/3 octave band filter. These measurements shall be made with the WD operating at a reference input level as specified in Table 6.1. Simultaneously, the qualifying measurement point shall have its weighted magnetic noise, undesired ABM field ≤−38 dB(A/m).

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

2G GSM Operating modes
For 2G GSM operating mode(s), the qualifying measurement points shall fulfil the coupling mode requirements; 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.

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.

Non-2G GSM Operating modes
Qualifying measurement points shall fulfill the coupling mode requirements; 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.

5G NR Operating modes
The DUT supports 5G NR, Voice over New Radio (VoNR). Per the manufacturer, 5G NR (VoNR) uses the same protocol, Codec(s) and bitrates as LTE (VoLTE). Investigations were performed on LTE (VoLTE) and the worst-case Codec & Air Interface configurations from LTE (VoLTE) was used for 5G NR (VoNR) evaluations. Refer to §10 for 5G NR (VoNR) evaluations.

All Operating modes

For all air interfaces, the maximum held-to-head output power was used for T-Coil evaluations. The maximum held-to-head output power is Mode A for WWAN operating modes and Power State 1 Mode A for WLAN operating modes. Refer to §9 & §10 for T-Coil evaluations.

The worst-case configuration is determined by the lowest margin of Primary Group Contiguous Points. The margin Primary Group Contiguous Points is calculated by subtracting the Primary Group points coupling mode requirement (25 for GSM modes and 75 for non-GSM modes) from the measured Primary Group Contiguous Points. The lowest margin of Primary Group Contiguous Points will be highlighted in each table.

For WWAN technologies, the DUT utilizes an Antenna - Port mapping feature. A Port is a collection (cluster) of antennas. Once the Port and Frequency Band has been selected, the transmitting Antenna is auto selected. Below is a description of the Port - Antenna mapping for the DUT.

Port	Frequency Band	Antenna
A	LB	3
	LMB	3
	MBHB	3
	UHB	9
B	LB	2
	LMB	2
	MBHB	2
	UHB	8
C	LB	1
	MBHB	1
	UHB	7
D	MBHB	4
	UHB	4

LB = Lower Band (617 MHz - 960 MHz)

LMB = Lower - Mid Band (1427 MHz - 1700 MHz)

MBHB = Mid Band - High Band (1710 MHz - 2960 MHz)

UHB = Ultra High Band (3300 MHz - 4200 MHz)

An investigation was performed to determine the worst-case Port for each Licensed technology. All subsequent measurements were determined by this investigation.

The device supports four (4) WLAN Tx antennas:

Antenna	Technology
1 (Lower)	Wi-Fi 2.4GHz
	Bluetooth
2 (Upper)	Wi-Fi 2.4GHz
	Bluetooth
5 (Lower)	Wi-Fi 5GHz
	Bluetooth
6 (Upper)	Wi-Fi 5GHz
	Bluetooth

An investigation was performed to determine the worst-case WLAN Antenna. All subsequent measurements were determined by this investigation.

9.1. Codec Investigations

CMRS and OTT voice services support the same technologies, antennas and air interfaces. CMRS and OTT voice services require the same Reference input level of -16 dBm0 per ANSI C63.19 2019 §6. An investigation between the various supported codec configurations (Low/Mid/High bit rates for EFR, AMR-NB, AMR-WB, EVS and OTT application) was performed to determine the worst-case codec and bit rate. The table below compares the varying codec configurations. A codec investigation was performed on one band of each technology: GSM, W-CDMA, LTE FDD, LTE TDD, WLAN 2.4GHz and WLAN 5GHz. The worst-case codec/bit rate determined for each technology will be used for all subsequent testing for the respective technology.

The supported OTT Application does not support a means for the test lab to change the codec's (ACC-ELD) bit rates. When a VoIP call was established, the test lab recorded the bit rate used during that session, listed below, for the supported technologies: GSM, W-CDMA, LTE, 5G NR, WLAN 2.4 GHz, and WLAN 5 GHz.

ACC-ELD Codec Bit Rates

Codec Bit Rate			
Technology	**Mode**	**Codec**	**Bit Rate (kbps)**
GSM	EDGE	ACC-ELD	48
W-CDMA	HSPA	ACC-ELD	47
LTE	FDD	ACC-ELD	43
	TDD	ACC-ELD	47
5G NR	FDD	ACC-ELD	43
	TDD	ACC-ELD	47
WLAN 2.4 GHz	802.11b	ACC-ELD	62
	802.11g	ACC-ELD	62
	802.11n HT20	ACC-ELD	62
	802.11n HT20	ACC-ELD	62
	802.11ax HE20	ACC-ELD	62
WLAN 5 GHz	802.11a	ACC-ELD	68
	802.11n HT20	ACC-ELD	68
	802.11n HT40	ACC-ELD	68
	802.11ac VHT20	ACC-ELD	68
	802.11ac VHT40	ACC-ELD	68
	802.11ac VHT80	ACC-ELD	68
	802.11ac VHT160	ACC-ELD	68
	802.11ax HE20	ACC-ELD	68
	802.11ax HE40	ACC-ELD	68
	802.11ax HE80	ACC-ELD	68
	802.11ax HE160	ACC-ELD	68
WLAN 6 GHz	802.11be EHT320	ACC-ELD	68

GSM Codec Investigation

GSM Codec Investigation													
Band / Mode	Channel and Frequency	Pow er Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	EFR	12.2	Transverse	Pass	-50.78	134	317	16	26	109	192
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-NB	4.75	Transverse	Pass	-50.78	130	312	15	26	105	187
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-NB	7.4	Transverse	Pass	-50.78	130	309	15	26	105	184
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-NB	12.2	Transverse	Pass	-50.78	132	308	16	26	107	183
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-WB	6.6	Transverse	Pass	-50.78	119	313	16	26	94	188
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-WB	8.85	Transverse	Pass	-50.77	133	357	16	26	108	232
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-WB	12.65	Transverse	Pass	-50.77	107	338	16	26	82	213
GSM 1900 EDGE/EGPRS 2 Slot(s)	661 1880 MHz	Mode A	B (ANT 2)	ACC-ELD	48	Transverse	Pass	-50.75	96	406	17	26	**71**	281

Note(s):

- For GSM, it is observed that ACC-ELD: 48 kbps is the worst-case bit rate.

W-CDMA Codec Investigation

W-CDMA Codec Investigation													
Band / Mode	Channel and Frequency	Pow er Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-NB	4.75	Transverse	Pass	-50.78	276	481	21	26	201	181
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-NB	7.4	Transverse	Pass	-50.78	279	483	21	26	204	183
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-NB	12.20	Transverse	Pass	-50.78	281	483	21	26	206	183
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-WB	6.60	Transverse	Pass	-50.78	208	479	21	26	133	179
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-WB	15.85	Transverse	Pass	-50.78	222	482	21	26	147	182
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-WB	23.85	Transverse	Pass	-50.78	229	488	21	26	154	188
W-CDMA BII HSPA	9400 1880 MHz	Mode A	B (ANT 2)	ACC-ELD	47	Transverse	Pass	-50.75	132	466	21	26	**57**	166

Note(s):

- For W-CDMA, it is observed that ACC-ELD: 47 kbps is the worst-case bit rate.

LTE (VoLTE) Codec Investigation

LTE FDD Codec Investigation													
and / Mode	Channel and Frequency	Pow er Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-NB	4.75	Transverse	Pass	-50.78	240	457	20	26	165	157
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-NB	7.4	Transverse	Pass	-50.78	224	446	20	26	149	146
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-NB	12.2	Transverse	Pass	-50.78	242	448	19	26	167	148
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-WB	6.6	Transverse	Pass	-50.78	180	456	20	26	105	156
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-WB	15.85	Transverse	Pass	-50.78	187	451	20	26	112	151
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-WB	23.85	Transverse	Pass	-50.78	180	444	20	26	105	144
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	EVS	5.9	Transverse	Pass	-50.78	241	444	20	26	166	144
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	EVS	9.6	Transverse	Pass	-50.78	245	446	20	26	170	146
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	EVS	24.4	Transverse	Pass	-50.78	247	450	20	26	172	150
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	ACC-ELD	43	Transverse	Pass	-50.75	108	449	19	26	**33**	149

Note(s):

- For LTE-FDD, it is observed that ACC-ELD: 43 kbps is the worst-case bit rate.

LTE (VoLTE) Codec Investigation (cont.)

LTE TDD Codec Investigation														
/ Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-NB	4.75	Transverse	Pass	-50.78	220	423	18	26	145	123
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-NB	7.4	Transverse	Pass	-50.78	216	416	18	26	141	116
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-NB	12.2	Transverse	Pass	-50.78	223	421	18	26	148	121
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-WB	6.6	Transverse	Pass	-50.78	160	415	18	26	85	115
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-WB	15.85	Transverse	Pass	-50.78	172	417	18	26	97	117
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-WB	23.85	Transverse	Pass	-50.78	173	418	18	26	98	118
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	EVS	5.9	Transverse	Pass	-50.78	206	408	18	26	131	108
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	EVS	9.6	Transverse	Pass	-50.78	217	416	18	26	142	116
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	EVS	24.4	Transverse	Pass	-50.78	221	421	18	26	146	121
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	ACC-ELD	47	Transverse	Pass	-50.78	92	393	17	26	**17**	93

Note(s):

- For LTE-TDD, it is observed that ACC-ELD: 47 kbps is the worst-case bit rate.

WLAN (VoWiFi) Codec Investigation

Wi-Fi 2.4GHz Codec Investigation														
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-NB	4.75	Transverse	Pass	-50.75	217	462	21	26	142	162
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-NB	7.4	Transverse	Pass	-50.75	234	477	22	26	159	177
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-NB	12.2	Transverse	Pass	-50.75	230	472	21	26	155	172
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-WB	6.6	Transverse	Pass	-50.75	184	502	23	26	109	202
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-WB	15.85	Transverse	Pass	-50.75	192	497	23	26	117	197
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-WB	23.85	Transverse	Pass	-50.75	196	503	22	26	121	203
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	EVS	5.9	Transverse	Pass	-50.75	142	474	21	26	67	174
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	EVS	9.6	Transverse	Pass	-50.75	235	470	21	26	160	170
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	EVS	24.4	Transverse	Pass	-50.75	237	476	22	26	162	176
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD	62	Transverse	Pass	-50.75	121	451	20	26	**46**	151

Note(s):

- For Wi-Fi 2.4 GHz, it is observed that ACC-ELD: 62 kbps is the worst-case bit rate.

WLAN (VoWiFi) Codec Investigation (cont.)

Wi-Fi 5GHz Codec Investigation														
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-NB	4.75	Transverse	Pass	-50.74	206	458	21	26	131	158
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-NB	7.4	Transverse	Pass	-50.74	189	438	21	26	114	138
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-NB	12.2	Transverse	Pass	-50.74	191	436	21	26	116	136
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB	6.6	Transverse	Pass	-50.74	123	441	21	26	48	141
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB	15.85	Transverse	Pass	-50.74	134	433	21	26	59	133
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB	23.85	Transverse	Pass	-50.74	137	439	21	26	62	139
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	EVS	5.9	Transverse	Pass	-50.74	112	435	21	26	37	135
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	EVS	9.6	Transverse	Pass	-50.74	202	442	21	26	127	142
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	EVS	24.4	Transverse	Pass	-50.74	199	438	21	26	124	138
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD	68	Transverse	Pass	-50.67	94	410	20	26	**19**	110

Note(s):

- For Wi-Fi 5 GHz, it is observed that ACC-ELD: 68 kbps is the worst-case bit rate.

9.2. Air Interface Investigation

A limited set of Air Interface configurations were evaluated to confirm that there is no effect to the ABM levels when changing the Air Interface configuration.

GSM Air Interface Investigation

GSM Air Interface Investigation													
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec and Bit rate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
GSM 1900 EDGE/EGPRS 2 Slot(s)	512 1850.2 MHz	Mode A	B (ANT 2)	ACC-ELD: 48 kbps	Transverse	Pass	-50.41	93	399	17	26	**68**	274
GSM 1900 EDGE/EGPRS 2 Slot(s)	661 1880.0 MHz	Mode A	B (ANT 2)	ACC-ELD: 48 kbps	Transverse	Pass	-50.75	96	406	17	26	71	281
GSM 1900 EDGE/EGPRS 2 Slot(s)	810 1909.8 MHz	Mode A	B (ANT 2)	ACC-ELD: 48 kbps	Transverse	Pass	-50.41	94	397	17	26	69	272

Note(s):

- For all subsequent tests for GSM, low channel was used in conjunction with the worst-case bit rate found in §9.1.

W-CDMA Air Interface Investigation

W-CDMA Air Interface Investigation													
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec and Bit rate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
W-CDMA BII HSPA	9262 1852.4 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	129	462	20	26	**54**	162
W-CDMA BII HSPA	9400 1880.0 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	132	466	21	26	57	166
W-CDMA BII HSPA	9538 1907.6 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	136	470	21	26	61	170

Note(s):

- For all subsequent tests for W-CDMA, low channel was used in conjunction with the worst-case bit rate found in §9.1.

LTE (VoLTE) Air Interface Investigation

LTE Air Interface Investigation																
Band / Mode	Channel and Frequency	Channel Bandwidth	Power Mode	Port/ANT	RB Allocation		Codec and Bit rate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
LTE Band 25 QPSK	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	108	449	19	26	33	149
LTE Band 25 QPSK	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	100	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	110	451	20	26	35	151
LTE Band 25 16QAM	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	108	448	19	26	**33**	148
LTE Band 25 64QAM	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	110	441	20	26	35	141
LTE Band 25 256QAM	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	115	452	20	26	40	152
LTE Band 25 QPSK	26365 1882.5 MHz	1.4 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	116	452	20	26	41	152
LTE Band 41 QPSK	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.78	92	393	17	26	**17**	93
LTE Band 41 QPSK	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	100	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	103	411	19	26	28	111
LTE Band 41 16QAM	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	95	394	18	26	20	94
LTE Band 41 64QAM	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	103	418	19	26	28	118
LTE Band 41 256QAM	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	111	430	19	26	36	130
LTE Band 41 QPSK	40620 2593 MHz	5 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	99	406	17	26	24	106

Note(s):

- For all subsequent tests for LTE-FDD, middle channel, 16QAM modulation, and 1% RB size and low RB allocation was used in conjunction with the worst-case bit rate found in §9.1.
- For all subsequent tests for LTE-TDD, middle channel, QPSK modulation, and 1% RB size and low RB allocation was used in conjunction with the worst-case bit rate found in §9.1.

WLAN (VoWiFi) Air Interface Investigation

Wi-Fi Air Interface Investigation															
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec and Bit rate (kbps)	Modulation/ Index	Data Rate	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin
802.11b 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	DSSS	1 Mbps	Transverse	Pass	-50.75	121	451	20	26	46	151
802.11b 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	CCK	5.5 Mbps	Transverse	Pass	-50.71	125	460	20	26	50	160
802.11b 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	CCK	11 Mbps	Transverse	Pass	-50.71	124	458	20	26	49	158
802.11g 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	DSSS	6 Mbps	Transverse	Pass	-50.71	133	470	21	26	58	170
802.11n HT20 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	MCS0	6.5 Mbps	Transverse	Pass	-50.71	128	468	21	26	53	168
802.11n HT40 40 MHz BW	9 2452 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	MCS0	13.5 Mbps	Transverse	Pass	-50.71	131	468	21	26	56	168
802.11ax HE20 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	MCS0	8.6 Mbps	Transverse	Pass	-50.41	113	449	21	26	**38**	149
802.11a 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	BPSK	6 Mbps	Transverse	Pass	-50.67	94	410	20	26	19	110
802.11a 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	QPSK	18 Mbps	Transverse	Pass	-50.67	80	385	19	26	**5**	85
802.11a 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	64QAM	54 Mbps	Transverse	Pass	-50.67	94	410	20	26	19	110
802.11n HT20 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS3	26 Mbps	Transverse	Pass	-50.67	108	434	20	26	33	134
802.11n HT40 40 MHz BW	38 5190 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS3	54 Mbps	Transverse	Pass	-50.67	118	444	20	26	43	144
802.11ac VHT20 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS4	39 Mbps	Transverse	Pass	-50.67	118	444	20	26	43	144
802.11ac VHT40 40 MHz BW	38 5190 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS5	108 Mbps	Transverse	Pass	-50.67	106	431	20	26	31	131
802.11ac VHT80 80 MHz BW	42 5210 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS5	234 Mbps	Transverse	Pass	-50.67	117	446	20	26	42	146
802.11ac VHT160 160 MHz BW	50 5250 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS5	468 Mbps	Transverse	Pass	-50.61	102	419	19	26	27	119
802.11ax HE20 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS6	77 Mbps	Transverse	Pass	-50.61	83	380	19	26	8	80
802.11ax HE40 40 MHz BW	38 5190 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS6	155 Mbps	Transverse	Pass	-50.61	84	387	19	26	9	87
802.11ax HE80 80 MHz BW	42 5210 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS6	324 Mbps	Transverse	Pass	-50.61	112	435	20	26	37	135
802.11ax HE160 160 MHz BW	50 5250 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	MCS6	649 Mbps	Transverse	Pass	-50.61	86	387	19	26	11	87

Note(s):

- For all subsequent tests for WLAN 2.4 GHz, 802.11ax MHz MCS0 8.6 Mbps was used in conjunction with the worst-case bit rate found in §9.1.
  - 802.11be has the same max output power, supports the same channel BWs (20MHz) and multiplexing as 802.11ax. Therefore, 802.11ax test results are representative of 802.11be.
- For all subsequent tests for WLAN 5 GHz, 802.11a QPSK 18 Mbps was used in conjunction with the worst-case bit rate found in §9.1.
  - 802.11be has the same max output power, supports the same channel BWs (20/40/80/160MHz) and multiplexing as 802.11ax. Therefore, 802.11ax test results are representative of 802.11be.

10. HAC (T-Coil) Test Results

The worst-case codec/bit rate and Air interface determined in §9.1 and §9.2 for each technology was used for HAC T-Coil evaluations. Refer to tables below for HAC T-Coil Test Results.

GSM & W-CDMA Test Results

Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec and Bit rate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin	Plot Page #
GSM 850 EDGE/EGPRS 2 Slot(s)	128 824.2 MHz	Mode A	B (ANT 2)	ACC-ELD: 48 kbps	Transverse	Pass	-50.41	74	362	16	26	49	237	1 - 2
GSM 1900 EDGE/EGPRS 2 Slot(s)	512 1850.2 MHz	Mode A	B (ANT 2)	ACC-ELD: 48 kbps	Transverse	Pass	-50.41	93	399	17	26	68	274	3 - 4
W-CDMA BII HSPA	9262 1852.4 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	129	462	20	26	54	162	5 - 6
W-CDMA BIV HSPA	1312 1712.4 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	117	454	21	26	42	154	7 - 8
W-CDMA Band V HSPA	4132 826.4 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	118	452	21	26	43	152	9 - 10

LTE (VoLTE) Test Results

Band / Mode	Channel and Frequency	Channel Bandwidth	Power Mode	Port/ANT	RB Allocation		Codec and Bit rate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin	Plot Page #
LTE Band 7 QPSK	21100 2535 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	108	429	20	26	33	129	11 12
LTE Band 12 QPSK	23095 707.5 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	108	435	20	26	33	135	13 - 14
LTE Band 13 QPSK	23230 782 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	100	434	20	26	25	134	15 - 16
LTE Band 25 QPSK	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	108	449	19	26	33	149	17 - 18
LTE Band 26 QPSK	26865 831.5 MHz	15 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	101	431	20	26	26	131	19 - 20
LTE Band 30 QPSK	27710 2310 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	91	426	19	26	16	126	21 - 22
LTE Band 66 QPSK	132322 1745 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	Pass	-50.75	111	449	20	26	36	149	23 - 24
LTE Band 41 PC3 QPSK	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.78	92	393	17	26	17	93	25 - 26
LTE Band 41 PC2 QPSK	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	97	403	17	26	22	103	27 - 28
LTE Band 48 PC3 QPSK	55990 3625 MHz	20 MHz	Mode A	B (ANT 4)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	104	428	18	26	29	128	29 - 30
LTE Band 53 PC3 QPSK	60197 2489.5 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 47 kbps	Transverse	Pass	-50.75	99	409	17	26	24	109	31 - 32

5G NR (VoNR) Test Results

Band / Mode	Channel and Frequency	Channel Bandwidth	SCS (kHz)	Power Mode	Port/ANT	RB Allocation		Codec and Bit rate (kbps)	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin	Plot Page #
5G NR Band n7 DFT-s π/2 BPSK	507000 2535 MHz	40 MHz	15	Mode A	B (ANT 2)	1	1	ACC-ELD: 43 kbps	Transverse	Pass	-50.77	105	452	20	26	30	152	33 - 34
5G NR Band n12 DFT-s π/2 BPSK	141500 707.5 MHz	15 MHz	15	Mode A	B (ANT 2)	1	1	ACC-ELD: 43 kbps	Transverse	Pass	-50.77	113	456	21	26	38	156	35 - 36
5G NR Band n25 DFT-s π/2 BPSK	376500 1882.5 MHz	40 MHz	15	Mode A	B (ANT 2)	1	1	ACC-ELD: 43 kbps	Transverse	Pass	-50.77	109	442	19	26	34	142	37 - 38
5G NR Band n41 PC3 DFT-s π/2 BPSK	518598 2592.99 MHz	100 MHz	30	Mode A	B (ANT 2)	1	1	ACC-ELD: 47 kbps	Transverse	Pass	-50.66	167	431	20	26	92	131	39 - 40
5G NR Band n41 PC2 DFT-s π/2 BPSK	518598 2592.99 MHz	100 MHz	30	Mode A	B (ANT 2)	1	1	ACC-ELD: 47 kbps	Transverse	Pass	-50.66	157	428	20	26	82	128	41 - 42
5G NR Band n77 PC3 DFT-s π/2 BPSK	656000 3840 MHz	100 MHz	30	Mode A	B (ANT 4)	1	1	ACC-ELD: 47 kbps	Transverse	Pass	-50.77	82	405	17	26	7	105	43 - 44
5G NR Band n77 PC2 DFT-s π/2 BPSK	656000 3840 MHz	100 MHz	30	Mode A	B (ANT 4)	1	1	ACC-ELD: 47 kbps	Transverse	Pass	-50.77	88	403	17	26	13	103	45 - 46

Note(s):

A limited set of 5GNR (VoNR) bands were evaluated to confirm 5G NR (VoNR) compliance.

- At least one 5G NR (VoNR)-FDD LB, MB and HB were evaluated.
- At least one 5G NR (VoNR)-TDD HB and UHB were evaluated.

Wi-Fi (VoWiFi) Test Results

Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec and Bit rate (kbps)	Modulation/ Data Rate	Orientation	Frequency Response	Ambient Noise dB(A/m)	Primary Group Contiguous Pts	Secondary Group Contiguous Pts	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Primary Group Contiguous Pts Margin	Secondary Group Contiguous Pts Margin	Plot Page #
802.11ax HE20 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 62 kbps	MCS0 8.6 Mbps	Transverse	Pass	-50.41	113	449	21	26	38	149	47 - 48
802.11a 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	QPSK 18 Mbps	Transverse	Pass	-50.67	80	385	19	26	5	85	49 - 50
	52 5260 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	QPSK 18 Mbps	Transverse	Pass	-50.75	83	398	20	26	8	98	51 - 52
	100 5500 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	QPSK 18 Mbps	Transverse	Pass	-50.75	82	400	20	26	7	100	53 - 54
	149 5745 MHz	Power State 1 Head	ANT 6	ACC-ELD: 68 kbps	QPSK 18 Mbps	Transverse	Pass	-50.56	75	383	19	26	**0**	83	55 - 56
802.11ax HE20 20MHz BW	5 5975 MHz	Power State 1 Head	ANT 6	EVS: 5.9 kbps	MCS6 77.4 Mbps	Transverse	Pass	-50.51	236	457	22	26	161	157	57 - 58
802.11be EHT20 20 MHz BW	5 5975 MHz	Power State 1 Head	ANT 6	EVS: 5.9 kbps	MCS6 77.4 Mbps	Transverse	Pass	-50.51	168	442	21	26	93	142	59 - 60

10.1. Worst Case T-Coil Test Plot(s)

UL Verification Services Inc. SAR Lab 16 **Date/Time:** June 23, 2025 at 07:14

T-Coil Signal Test Report: IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps, 99pc duty cycle)

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 - 3092	April 10, 2025	DAE4ip Sn1621	April 10, 2025

Communication Systems

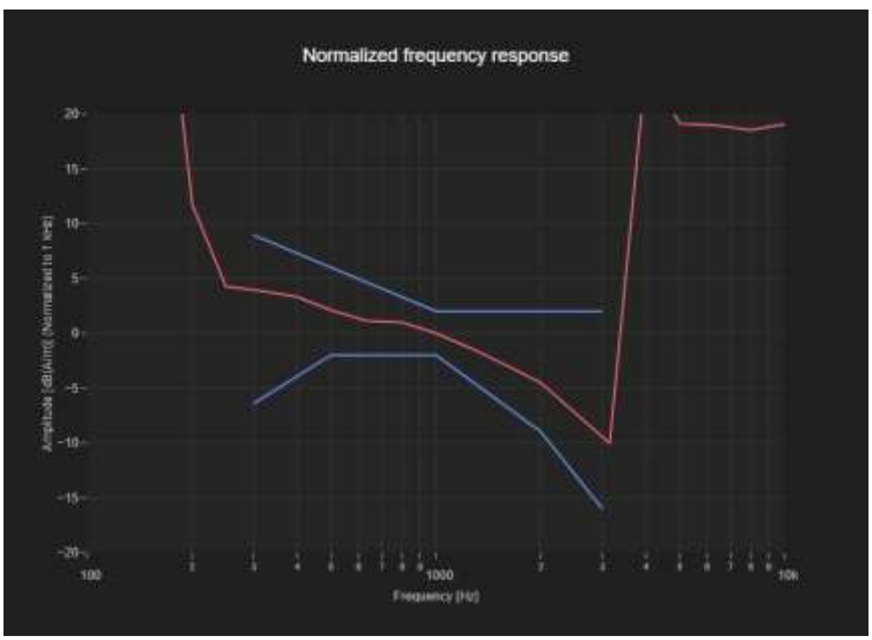
Band Name	Communication Systems Name	Channel	Frequency [MHz]
WLAN 5GHz	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps, 99pc duty cycle)	149	5745.0

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



UL Verification Services Inc. SAR Lab 16 **Date/Time:**

T-Coil Coupling Mode Test Report:

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
75	383	19	26

Appendix

Refer to separated files for the following appendixes.

Appendix A: T-Coil Setup Photo

Appendix B: T-Coil Test Plots

Appendix C: T-Coil Probe Certificates

END OF REPORT