HAC T-COIL SIGNAL TEST REPORT

FCC 47 CFR § 20.19
ANSI C63.19-2019

For
Smartphone

FCC ID: BCG-E8948A
Model Name: A3260

Report Number: 15496282-S2V2
Issue Date: 7/21/2025

Prepared for
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Revision History

Rev.	Date	Revisions	Revised By
V1	7/17/2025	Initial Issue	--
V2	7/21/2025	Updated section 1: ending test date, Section 10: 5GNR results to include n41 PC3/2, section 10.1: worst case test plot	

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1. Attestation of Test Results

Applicant Name	APPLE, INC.
FCC ID	BCG-E8948A
Model Name	A3260
Applicable Standards	FCC 47 CFR § 20.19 ANSI C63.19-2019
Date Tested	5/12/2025 to 7/18/2025
Test Results	Pass

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested 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 tested 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 carried out 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.	Kiara Davis Laboratory Engineer 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 v01r07

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 19
SAR Lab 16

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

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 (SAR 19	SPEAG	AM1DV3	3165	3/4/2026
Data Acquisition Electronics (SAR 19)	SPEAG	DAE4ip	1881	2/17/2026
AMMI (SAR 19)	SPEAG	SE UMS 010 BB	2010	N/A
Magnetic Field Probe (SAR 16)	SPEAG	AM1DV3	3092	4/10/2026
Data Acquisition Electronics (SAR 16)	SPEAG	DAE4	1621	4/10/2026
AMMI (SAR 16)	SPEAG	SE UMS 010 BB	2015	N/A
DAC	Sound Devices	USBPre 2	HB1118191000	N/A
DAC	Sound Devices	USBPre 2	HB1420133009	N/A
DAC	Yellowtech	YT4211	248643	N/A
Switch	TP-Link	TL-SG1016D	2165473001109	N/A
Support Device	Apple	Macbook	HRP119301	N/A
Base Station Simulator (SAR 19)	R&S	CMW 500	170269-HX	2/10/2026
Base Station Simulator (SAR 16)	R&S	CMW 500	125236-eS	2/14/2026
Base Station Simulator	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 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)	V8.20.0.112 for 5G NR	CMX-KS600B	NR SIG BASIC FSET1
		CMX-KS600M	NR SIG MEDIUM FSET1
		CMX-KS601B	NR SIG BASIC FSET2
		CMX-KS601M	NR SIG MEDIUM FSET2
		CMX-KS610B	NR SIG ETX. BASIC FSET3
		CMX-KS610M	NR SIG ETX. MEDIUM FSET3
		CMX-KS611B	NR SIG ETX. BASIC FSET4
	V8.20.0.112 for Audio	CMX-KA100	IP APPL FSET1
		CMX-KA110	IP APPL FSET2
		CMX-KA180	APPL AUDIO
		CMX-KA181	APPL AUDIO POLQA
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.

To ensure 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

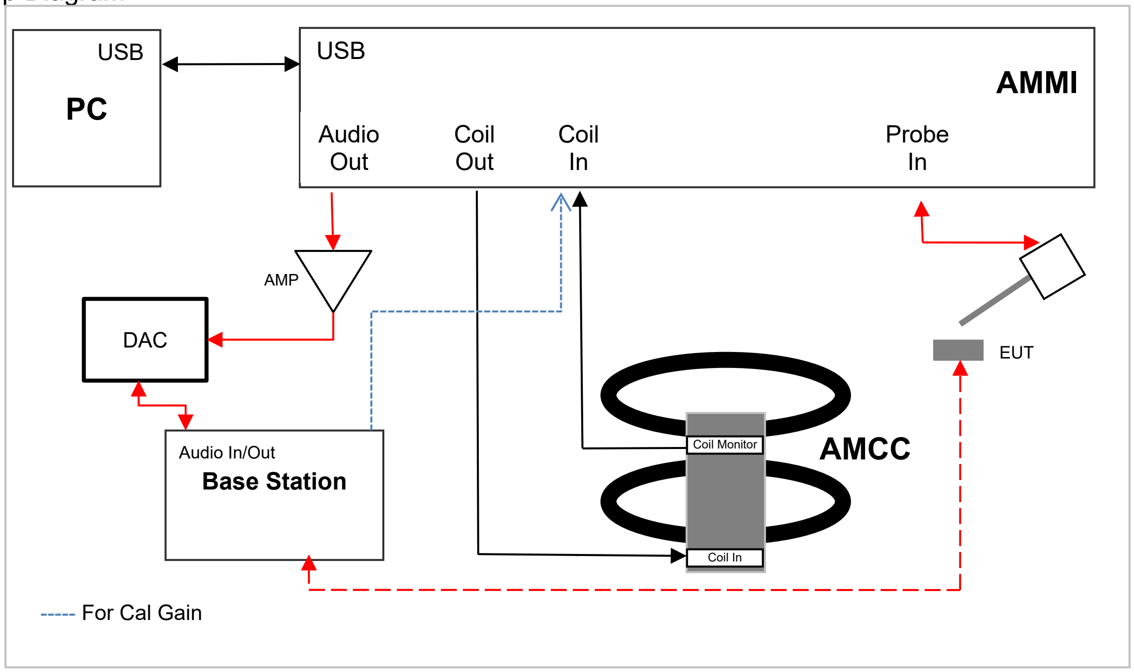
[1] The allowance to not test all modes does not remove the requirement that all modes meet the requirements of this standard if a claim of compliance is to be made. What is allowed is a reduction of testing, where there is a good basis for believing that testing that is performed demonstrates the compliance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

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]

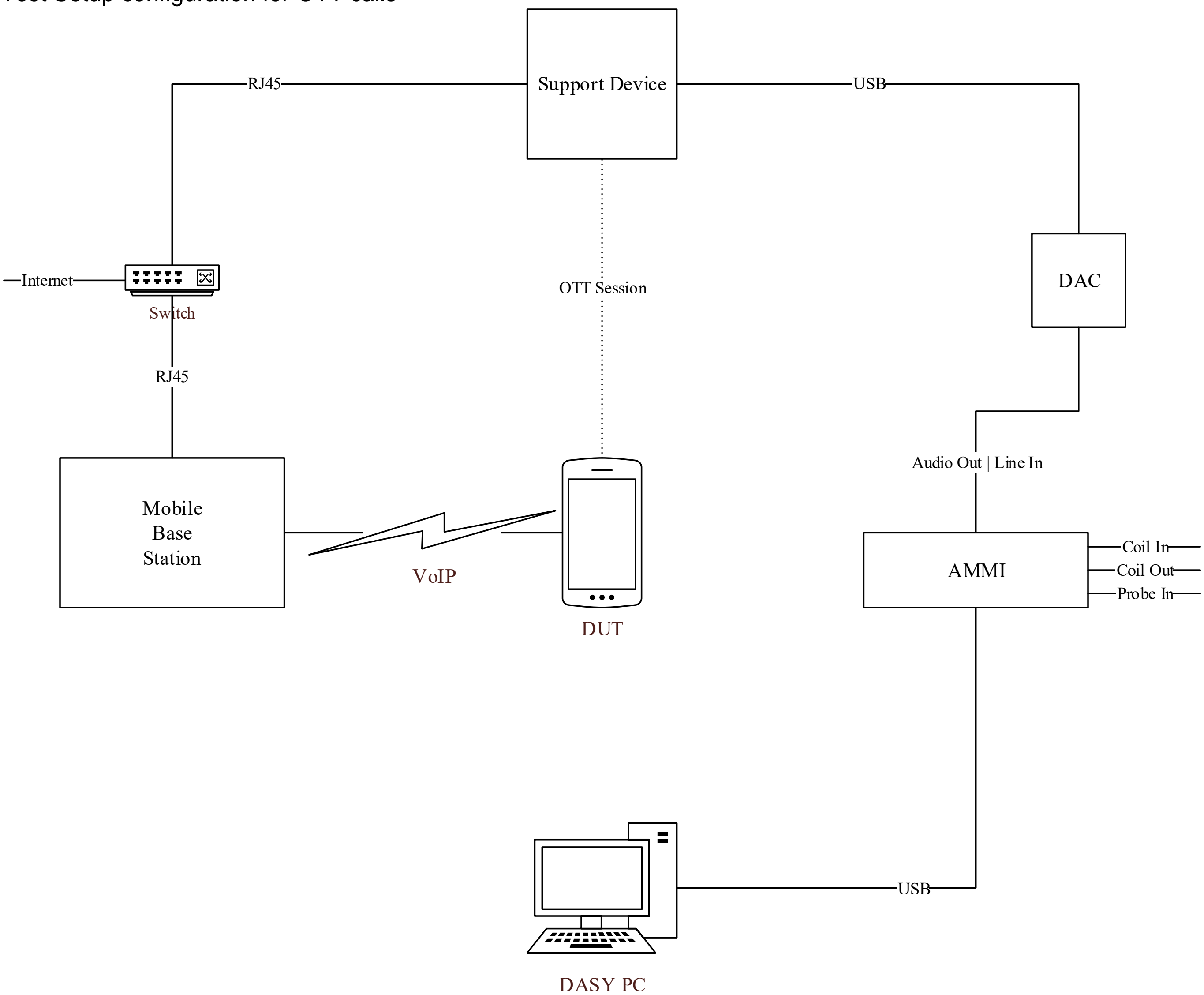
[4] The intent of this subclause is to provide a nominal level speech input independent of air interface and measure the magnetic response in a normal use condition without requiring an acoustic reference. The nominal level speech signals in 6.4.3.2 will result in acoustic speech levels that are mutually 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).

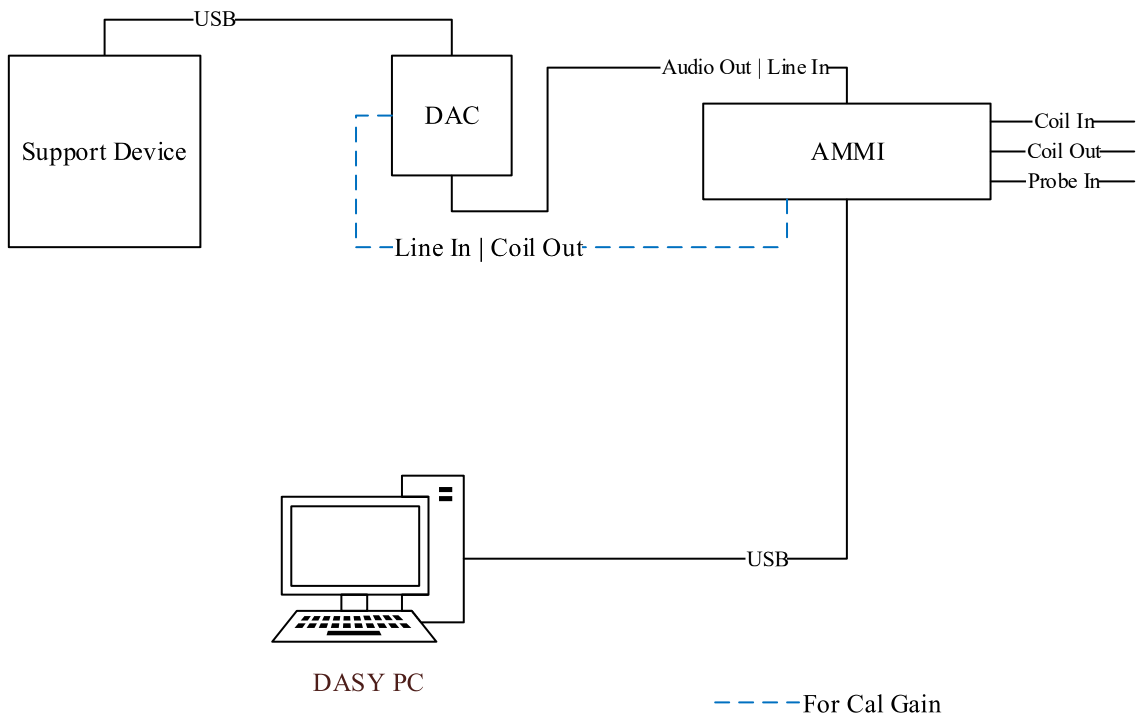
Test Setup configuration for OTT calls



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 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 take into account 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.

Please refer to test data tables in §9 & 10 for all Codec / system delay measurements performed during testing.

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 1.23V 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 is illustrated in the table below:

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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	-12.48
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.65
W-CDMA	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-12.48
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.65
VoLTE	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-12.48
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.65
VoNR	Voice 1 kHz	-16.0				
	Voice 300-3kHz	-16.0				
VoWiFi	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-12.49
	Voice 300-3kHz	-16.0	0	21.57	10.81	-6.66

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 measurement using Input level of 1.228292V is used for USBPre 2

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

SAR 19

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	-10.69
	Voice 300-3kHz	-16.0	0	21.57	10.81	-4.86
W-CDMA	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.69
	Voice 300-3kHz	-16.0	0	21.57	10.81	-4.86
LTE	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.67
	Voice 300-3kHz	-16.0	0	21.57	10.81	-4.84
5G NR	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.7
	Voice 300-3kHz	-16.0	0	21.57	10.81	-4.87
WLAN	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.71
	Voice 300-3kHz	-16.0	0	21.57	10.81	-4.87

SAR 16

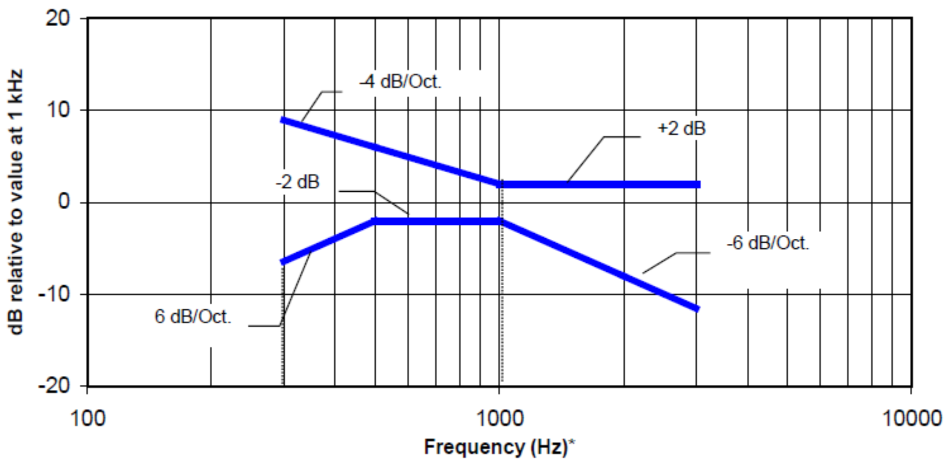
Computed Gain Settings						
Technology	**Signal Type**	**Speech Level (dBm0)**	**Peak to Full Scale (dB)**	**Peak to RMS Scale (dB)**	**BWC (dB)**	**Scaling (Gain) (dB)**
WLAN	Voice 1 kHz	-16.0	-0.37	15.74	0.07	-10.86
	Voice 300-3kHz	-16.0	0	21.57	10.81	-5.03

7. T-coil Measurement Criteria

7.1. Frequency Response

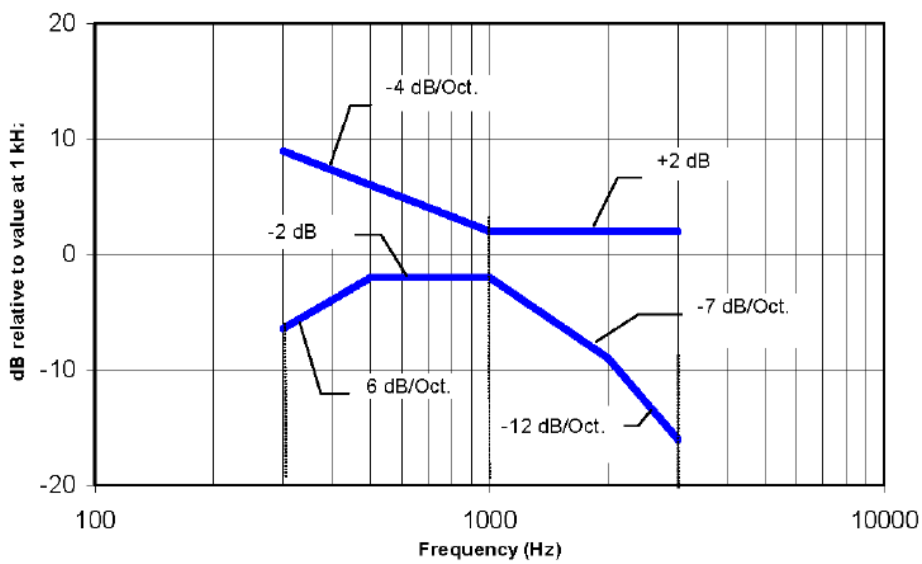
The frequency response of the magnetic field, measured in 1/3 octave bands, shall follow the response curve specified in this subclause, over the frequency range 300 Hz to 3 kHz.

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.

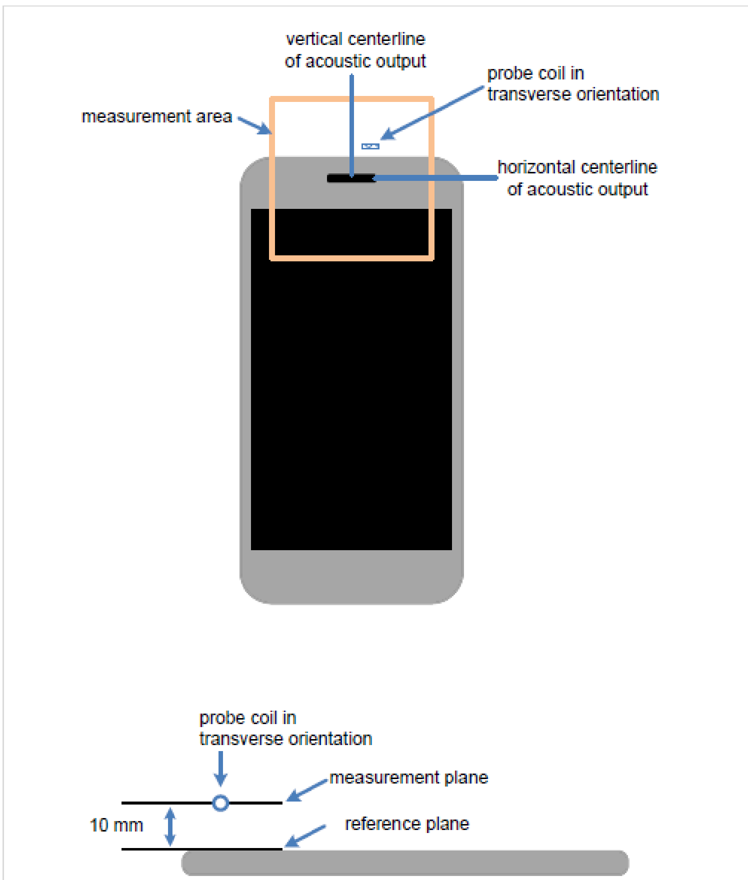
When measured as specified in this standard, there are two groups of qualifying measurement points:

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**
	FN6L479Y22	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 tested.

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	CMRS	Mode A & Power State 1 Head	N/A	EFR, AMR-NB & AMR-WB
	1900						N/A	
	GPRS/EDGE	DT/VD	Yes	Wi-Fi, BT, NB U-NII, & 802.15.4	FaceTime	Mode A & Power State 1 Head	N/A	ACC-ELD
W-CDMA (UMTS)	850	VO	Yes	Wi-Fi, BT, NB U-NII, & 802.15.4	CMRS	Mode A & Power State 1 Head	N/A	AMR-NB & AMR-WB
	1700							
	1900							
	HSPA	VD	Yes	Wi-Fi, BT, NB U-NII, & 802.15.4	FaceTime	Mode A & Power State 1 Head	N/A	ACC-ELD
LTE - FDD	600 (B71)	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
	700 (B12/13/14/17)							
	850 (B5/26)							
	1700 (B4/66)							
	1900 (B2/25)							
	2300 (B30)							
	2600 (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 (B38/41)							
	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 (n38/n41)[4]							
	3500 (n77/n78 Block A)							
	3700(n48/n77/n78 Block B)[4]							
	3900 (n77/n78 Block C)							

Type
VO: Legacy Cellular Voice Service
DT: Digital Transport only (no voice)

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.

VD: IP Voice Service over Digital Transport
CMRS: Commercial Mobile Radio Service

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, n77 and n78 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[2]	Power Reduction	Audio Codecs Evaluated[1]
Wi-Fi	2450	VD	Yes	WWAN, Wi-Fi, BT, NB U-NII, & 802.15.4	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	U-NII-1			WWAN, Wi-Fi, BT, NB U-NII, & 802.15.4				
	U-NII-2A							
	U-NII-2C							
	U-NII-3							
	U-NII-5	VD	Yes	WWAN, Wi-Fi, BT, NB U-NII, & 802.15.4	CMRS FaceTime	Mode A & Power State 1 Head	N/A	AMR-NB, AMR-WB, EVS, & ACC-ELD
	U-NII-6	VD	No[3]	WWAN, Wi-Fi, BT, NB U-NII, & 802.15.4	CMRS FaceTime	Mode A & Power State 1 Head	N/A	N/A
	U-NII-7							
	U-NII-8							
NB-U-NII	U-NII-1	DT	N/A	WWAN, Wi-Fi, BT, & 802.15.4	N/A	N/A	N/A	N/A
	U-NII-3							
	U-NII-5							
802.15ab NB	U-NII-3	DT	N/A	WWAN, Wi-Fi, BT, & 802.15.4	N/A	N/A	N/A	N/A
802.15.4	2450	DT	N/A	WWAN, Wi-Fi, BT, & NB U-NII	N/A	N/A	N/A	N/A
BT	2450	DT	NA	WWAN, Wi-Fi, NB U-NII, & 802.15.4	NA	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	N/A	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. 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
3. Supported Frequency > 6GHz. ANSI C63,19 2019 only requires HAC evaluations for Technologies/Frequencies < 6GHz..

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 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.

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	LB	2
	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 (4) WLAN Tx antennas:

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

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	47
W-CDMA	HSPA	ACC-ELD	47
LTE	FDD	ACC-ELD	43
	TDD	ACC-ELD	42
5G NR	FDD	ACC-ELD	43
	TDD	ACC-ELD	42
WLAN 2.4 GHz	802.11b	ACC-ELD	85
	802.11g	ACC-ELD	85
	802.11n HT20	ACC-ELD	85
	802.11n HT20	ACC-ELD	85
	802.11ax HE20	ACC-ELD	85
WLAN 5 GHz	802.11a	ACC-ELD	85
	802.11n HT20	ACC-ELD	85
	802.11n HT40	ACC-ELD	85
	802.11ac VHT20	ACC-ELD	85
	802.11ac VHT40	ACC-ELD	85
	802.11ac VHT80	ACC-ELD	85
	802.11ac VHT160	ACC-ELD	85
	802.11ax HE20	ACC-ELD	85
	802.11ax HE40	ACC-ELD	85
	802.11ax HE80	ACC-ELD	85
	802.11ax HE160	ACC-ELD	85
WLAN 6 GHz	802.11be EHT320	ACC-ELD	85

GSM Codec Investigation

GSM Codec Investigation																	
I / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.238	Pass	15.3	-11.07	-51.61	153	332	17	26	128	207
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-NB	4.75	Transverse	0.241	Pass	15.49	-11.1	-51.61	154	335	17	26	129	210
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-NB	7.4	Transverse	0.132	Pass	15.39	-10.95	-51.61	155	334	17	26	130	209
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-NB	12.2	Transverse	0.254	Pass	15.59	-10.83	-51.61	158	335	17	26	133	210
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-WB	6.6	Transverse	0.261	Pass	14.96	-10.8	-51.61	151	335	17	26	126	210
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-WB	8.85	Transverse	0.261	Pass	12.73	-10.72	-51.61	118	333	17	26	93	208
GSM 1900 Voice Coder Speechcodec Low	661 1880 MHz	Mode A	B (ANT 2)	AMR-WB	12.65	Transverse	0.261	Pass	12.74	-10.65	-51.61	119	333	17	26	94	208
GSM 1900 EDGE/EGPRS 2 Slot(s)	661 1880 MHz	Mode A	B (ANT 2)	ACC-ELD	47	Transverse	0.449	Pass	8.63	-13.92	-51.57	89	374	18	26	**64**	249

Note(s):

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

W-CDMA Codec Investigation

W-CDMA Codec Investigation																	
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.134	Pass	15.71	-16.51	-51.52	252	451	21	26	177	151
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-NB	7.40	Transverse	0.273	Pass	15.74	-30.74	-51.52	451	650	26	26	376	350
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-NB	12.20	Transverse	0.273	Pass	15.9	-16.19	-51.52	259	451	21	26	184	151
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-WB	6.60	Transverse	0.274	Pass	12.27	-19.34	-51.52	215	483	21	26	140	183
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-WB	15.85	Transverse	0.274	Pass	13.06	-19.44	-51.52	234	486	22	26	159	186
W-CDMA BII Rel. 99	9400 1880 MHz	Mode A	B (ANT 2)	AMR-WB	23.85	Transverse	0.274	Pass	13.22	-19.17	-51.52	241	489	22	26	166	189
W-CDMA BII HSPA	9400 1880 MHz	Mode A	B (ANT 2)	ACC-ELD	47	Transverse	0.394	Pass	5.64	-16.69	-51.57	106	466	21	26	**31**	166

Note(s):

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

LTE (VoLTE) FDD Codec Investigation

LTE FDD Codec Investigation																	
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.163	Pass	14.63	-16.92	-51.55	260	459	20	26	185	159
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-NB	7.4	Transverse	0.151	Pass	14.87	-16.57	-51.55	259	457	21	26	184	157
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-NB	12.2	Transverse	0.15	Pass	14.93	-16.89	-51.55	249	444	20	26	174	144
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-WB	6.6	Transverse	0.19	Pass	11.56	-16.73	-51.55	194	459	21	26	119	159
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-WB	15.85	Transverse	0.16	Pass	12.11	-16.63	-51.55	206	461	21	26	131	161
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	AMR-WB	23.85	Transverse	0.053	Pass	12.08	-16.79	-51.55	208	460	20	26	133	160
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	EVS	5.9	Transverse	0.18	Pass	7.87	-16.95	-51.55	151	461	21	26	76	161
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	EVS	9.6	Transverse	0.153	Pass	15.19	-16.38	-51.55	265	460	20	26	190	160
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	EVS	24.4	Transverse	0.144	Pass	15.04	-16.44	-51.55	265	461	21	26	190	161
LTE Band 25 QPSK RB 1/0 20 MHz BW	26365 1882.5 MHz	Mode A	B (ANT 2)	ACC-ELD	43	Transverse	0.327	Pass	7.94	-14.83	-51.67	112	445	21	26	**37**	145

Note(s):

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

LTE (VoLTE) TDD Codec Investigation

LTE TDD Codec Investigation

Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.15	Pass	15.02	-16.86	-51.55	223	415	20	26	148	115
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-NB	7.4	Transverse	0.154	Pass	15.19	-16.81	-51.55	218	409	20	26	143	109
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-NB	12.2	Transverse	0.163	Pass	15.29	-16.72	-51.55	224	412	20	26	149	112
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-WB	6.6	Transverse	0.206	Pass	11.95	-16.71	-51.55	161	409	19	26	86	109
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-WB	15.85	Transverse	0.209	Pass	12.32	-16.84	-51.56	172	413	20	26	97	113
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	AMR-WB	23.85	Transverse	0.192	Pass	12.39	-16.88	-51.56	168	415	20	26	93	115
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	EVS	5.9	Transverse	0.153	Pass	13.04	-16.46	-51.56	155	410	18	26	80	110
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	EVS	9.6	Transverse	0.151	Pass	15.51	-16.46	-51.56	214	406	18	26	139	106
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	EVS	24.4	Transverse	0.171	Pass	15.5	-16.61	-51.56	209	402	18	26	134	102
LTE Band 41 QPSK RB 1/0 20 MHz BW	40620 2593 MHz	Mode A	B (ANT 2)	ACC-ELD	42	Transverse	0.287	Pass	8.53	-15.76	-51.57	108	418	20	26	33	118

Note(s):

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

WLAN (VoWiFi) 2.4 GHz Codec Interface Investigation

Wi-Fi 2.4GHz Codec Investigation

Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.22	Pass	16.33	-16.78	-51.73	272	476	22	26	197	176
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-NB	7.4	Transverse	0.218	Pass	16.41	-16.73	-51.73	274	474	21	26	199	174
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-NB	12.2	Transverse	0.226	Pass	16.51	-16.65	-51.73	280	478	22	26	205	178
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-WB	6.6	Transverse	0.223	Pass	13.09	-16.7	-51.73	204	473	21	26	129	173
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-WB	15.85	Transverse	0.228	Pass	13.61	-17.24	-51.73	225	488	22	26	150	188
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	AMR-WB	23.85	Transverse	0.227	Pass	13.83	-17.52	-51.73	232	489	23	26	157	189
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	EVS	5.9	Transverse	0.225	Pass	12.87	-17.36	-51.73	210	487	23	26	135	187
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	EVS	9.6	Transverse	0.223	Pass	16.96	-17.35	-51.73	294	488	23	26	219	188
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	EVS	24.4	Transverse	0.23	Pass	16.89	-17.42	-51.73	294	492	23	26	219	192
802.11b DSSS 1 Mbps 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD	85	Transverse	0.222	Pass	9.18	-13.5	-51.73	112	430	19	26	37	130

Note(s):

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

WLAN (VoWiFi) 5 GHz Codec Interface Investigation

Wi-Fi 5GHz Codec Investigation

Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec	Bitrate (kbps)	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.126	Pass	14.88	-16.27	-51.73	174	413	20	26	99	113
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-NB	7.4	Transverse	0.25	Pass	15.18	-16.23	-51.73	180	412	20	26	105	112
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-NB	12.2	Transverse	0.24	Pass	15.24	-16.52	-51.73	176	407	20	26	101	107
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB	6.6	Transverse	0.25	Pass	11.09	-16.2	-51.73	115	411	20	26	40	111
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB	15.85	Transverse	0.256	Pass	11.97	-16.17	-51.73	121	409	20	26	46	109
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB	23.85	Transverse	0.234	Pass	11.95	-16.28	-51.73	121	409	20	26	46	109
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	EVS	5.9	Transverse	0.249	Pass	14.21	-15.99	-51.73	157	403	20	26	82	103
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	EVS	9.6	Transverse	0.234	Pass	15.12	-16.43	-51.73	182	414	20	26	107	114
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	EVS	24.4	Transverse	0.229	Pass	15.11	-15.71	-51.73	179	408	20	26	104	108
802.11a BPSK 6 Mbps 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	ACC-ELD	85	Transverse	0.21	Pass	10.81	-15.85	-50.67	123	450	21	26	48	150

Note(s):

- For Wi-Fi 5 GHz, it is observed that 6.60 kbps is the worst-case bit rate.

9.2. Air Interface Investigation

A limited set of bands/channels/bandwidths were tested to confirm that there is no effect on the ABM levels when changing the band/channel/bandwidth.

GSM Air Interface Investigation

GSM Air Interface Investigation															
Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec and Bit rate (kbps)	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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: 47 kbps	Transverse	0.432	Pass	8.83	-9.62	-51.57	80	364	19	26	**55**	239
GSM 1900 EDGE/EGPRS 2 Slot(s)	661 1880.0 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.449	Pass	8.63	-13.92	-51.57	89	374	18	26	64	249
GSM 1900 EDGE/EGPRS 2 Slot(s)	810 1909.8 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.37	Pass	8.54	-14.23	-51.57	90	381	18	26	65	256

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	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.36	Pass	5.61	-16.41	-51.57	104	461	21	26	**29**	161
W-CDMA BII HSPA	9400 1880.0 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.394	Pass	5.64	-16.69	-51.57	106	466	21	26	31	166
W-CDMA BII HSPA	9538 1907.6 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.364	Pass	5.65	-16.84	-51.57	106	464	21	26	31	164

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	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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	0.327	Pass	7.94	-14.83	-51.67	112	445	21	26	37	145
LTE Band 25 QPSK	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	100	0	ACC-ELD: 43 kbps	Transverse	0.295	Pass	7.86	-15.23	-51.67	114	448	21	26	39	148
LTE Band 25 16QAM	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.26	Pass	7.81	-15.64	-51.67	110	440	20	26	**35**	140
LTE Band 25 64QAM	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.297	Pass	7.71	-15.19	-51.67	111	440	20	26	36	140
LTE Band 25 256QAM	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.288	Pass	7.47	-16.28	-51.67	115	435	20	26	40	135
LTE Band 25 16QAM	26365 1882.5 MHz	1.4 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.338	Pass	7.56	-18.21	-51.67	134	465	20	26	59	165
LTE Band 41 QPSK	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 42 kbps	Transverse	0.287	Pass	8.53	-15.76	-51.57	108	418	20	26	33	118
LTE Band 41 QPSK	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	100	0	ACC-ELD: 42 kbps	Transverse	0.368	Pass	8.42	-15.79	-51.57	107	418	20	26	32	118
LTE Band 41 16QAM	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	100	0	ACC-ELD: 42 kbps	Transverse	0.358	Pass	8.39	-16.13	-51.57	110	422	20	26	35	122
LTE Band 41 64QAM	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	100	0	ACC-ELD: 42 kbps	Transverse	0.318	Pass	8.51	-15.9	-51.57	111	426	20	26	36	126
LTE Band 41 256QAM	40620 2593 MHz	20 MHz	Mode A	B (ANT 2)	100	0	ACC-ELD: 42 kbps	Transverse	0.38	Pass	8.5	-15.16	-51.57	110	432	20	26	35	132
LTE Band 41 QPSK	40620 2593 MHz	5 MHz	Mode A	B (ANT 2)	25	0	ACC-ELD: 42 kbps	Transverse	0.295	Pass	8.47	-15.56	-51.57	106	415	20	26	**31**	115

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, 5 MHz BW, and 100% 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	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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: 85 kbps	DSSS	1 Mbps	Transverse	0.222	Pass	9.18	-13.5	-51.73	112	430	19	26	37	130
802.11b 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 85 kbps	CCK	5.5 Mbps	Transverse	0.213	Pass	9.22	-14.95	-51.73	117	439	20	26	42	139
802.11b 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 85 kbps	CCK	11 Mbps	Transverse	0.214	Pass	9.28	-15.04	-51.73	112	435	20	26	37	135
802.11g 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 85 kbps	DSSS	6 Mbps	Transverse	0.231	Pass	8.25	-11.93	-51.67	114	452	22	26	39	152
802.11n HT20 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 85 kbps	MCS0	6.5 Mbps	Transverse	0.218	Pass	9.29	-14.91	-51.73	111	439	21	26	**36**	139
802.11n HT40 40 MHz BW	9 2452 MHz	Power State 1 Head	ANT 2	ACC-ELD: 85 kbps	MCS0	13.5 Mbps	Transverse	0.203	Pass	8.75	-10.42	-51.67	117	451	23	26	42	151
802.11ax HE20 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 85 kbps	MCS0	8.6 Mbps	Transverse	0.247	Pass	9.23	-16.06	-51.59	118	447	20	26	43	147
802.11a 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	BPSK	6 Mbps	Transverse	0.126	Pass	12.75	-16.42	-51.58	157	388	19	26	82	88
802.11a 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	QPSK	18 Mbps	Transverse	0.244	Pass	12.65	-16.59	-51.58	160	408	20	26	85	108
802.11a 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	64QAM	54 Mbps	Transverse	0.218	Pass	12.78	-16.48	-51.58	164	414	21	26	89	114
802.11n HT20 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	6.5 Mbps	Transverse	0.257	Pass	12.46	-16.42	-51.58	175	435	21	26	100	135
802.11n HT40 40 MHz BW	38 5190 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	13.5 Mbps	Transverse	0.245	Pass	13.58	-16.15	-51.59	202	455	21	26	127	155
802.11ac VHT20 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	6.5 Mbps	Transverse	0.249	Pass	12.43	-16.48	-51.58	160	418	21	26	85	118
802.11ac VHT40 40 MHz BW	38 5190 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	13.5 Mbps	Transverse	0.238	Pass	13.29	-16.26	-51.59	200	453	21	26	125	153
802.11ac VHT80 80 MHz BW	42 5210 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	29.3 Mbps	Transverse	0.334	Pass	11.07	-16.52	-51.59	166	464	21	26	91	164
802.11ac VHT160 160 MHz BW	50 5250 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	58.5 Mbps	Transverse	0.261	Pass	13.17	-16.49	-51.59	198	470	22	26	123	170
802.11ax HE20 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	8.6 Mbps	Transverse	0.353	Pass	13.09	-14.79	-51.59	153	410	19	26	**78**	110
802.11ax HE40 40 MHz BW	38 5190 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	17.2 Mbps	Transverse	0.254	Pass	13.48	-15.95	-51.59	198	452	21	26	123	152
802.11ax HE80 80 MHz BW	42 5210 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	36 Mbps	Transverse	0.253	Pass	13.57	-16.28	-51.59	203	456	21	26	128	156
802.11ax HE160 160 MHz BW	50 5250 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0	72 Mbps	Transverse	0.261	Pass	13.36	-16.76	-51.59	197	468	22	26	122	168

Note(s):

For all subsequent tests for 2.4 GHz, 802.11n MCS0 6.5 Mbps was used in conjunction with the worst-case bit rate found in §9.1.

For all subsequent tests for 5 GHz, 802.11ax HE20 MHz MCS0 8.6 Mbps was used in conjunction with the worst-case bit rate found in §9.1.

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	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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: 47 kbps	Transverse	0.428	Pass	8.32	-9.39	-51.57	69	331	16	26	44	206	1 - 2
GSM 1900 EDGE/EGPRS 2 Slot(s)	512 1850.2 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.432	Pass	8.83	-9.62	-51.57	80	364	19	26	55	239	3 - 4
W-CDMA BII HSPA	9262 1852.4 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.414	Pass	5.77	-16.29	-51.57	99	463	21	26	24	163	5 - 6
W-CDMA BIV HSPA	1312 1712.4 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.434	Pass	5.7	-16.46	-51.57	98	462	21	26	23	162	7 - 8
W-CDMA Band V HSPA	4132 826.4 MHz	Mode A	B (ANT 2)	ACC-ELD: 47 kbps	Transverse	0.344	Pass	5.85	-16.61	-51.57	102	462	22	26	27	162	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	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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 16QAM	21100 2535 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.353	Pass	7.35	-18.08	-51.67	152	476	20	26	77	176	11 12
LTE Band 12 16QAM	23095 707.5 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.365	Pass	7.37	-16.25	-51.67	126	439	20	26	51	139	13 - 14
LTE Band 13 16QAM	23230 782 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.338	Pass	7.31	-16.09	-51.67	127	445	20	26	52	145	15 - 16
LTE Band 14 16QAM	23330 793 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.308	Pass	7.39	-16.46	-51.67	129	449	20	26	54	149	17 - 18
LTE Band 25 16QAM	26365 1882.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.26	Pass	7.81	-15.64	-51.67	110	440	20	26	35	140	19 - 20
LTE Band 26 16QAM	26865 831.5 MHz	15 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.317	Pass	7.3	-12.78	-51.67	138	457	21	26	63	157	21 - 22
LTE Band 30 16QAM	27710 2310 MHz	10 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.321	Pass	7.27	-14.98	-51.67	121	438	20	26	46	138	23 - 24
LTE Band 66 16QAM	132322 1745 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.345	Pass	7.39	-17.66	-51.67	153	469	20	26	78	169	25 - 26
LTE Band 71 16QAM	133297 680.5 MHz	20 MHz	Mode A	B (ANT 2)	1	0	ACC-ELD: 43 kbps	Transverse	0.32	Pass	7.36	-18.46	-51.67	154	471	20	26	79	171	27 - 28
LTE Band 41 PC3 QPSK	40620 2593 MHz	5 MHz	Mode A	B (ANT 2)	25	0	ACC-ELD: 42 kbps	Transverse	0.295	Pass	8.47	-15.56	-51.57	106	415	20	26	31	115	29 - 30
LTE Band 41 PC2 QPSK	40620 2593 MHz	5 MHz	Mode A	B (ANT 2)	25	0	ACC-ELD: 42 kbps	Transverse	0.315	Pass	8.97	-15.34	-51.57	101	411	18	26	26	111	31 - 32
LTE Band 48 PC3 QPSK	55990 3625 MHz	5 MHz	Mode A	B (ANT 8)	25	0	ACC-ELD: 42 kbps	Transverse	0.258	Pass	8.96	-15.66	-51.57	104	429	18	26	29	129	33 - 34
LTE Band 53 PC3 QPSK	60197 2489.2 MHz	1.4 MHz	Mode A	B (ANT 2)	6	0	ACC-ELD: 42 kbps	Transverse	0.409	Pass	8.83	-14.6	-51.57	102	411	17	26	27	111	35 - 36

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	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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 n12 DFT-s QPSK	141500 707.5 MHz	15 MHz	15	Mode A	B (ANT 2)	1	1	ACC-ELD: 43 kbps	Transverse	0.289	Pass	8.99	-16.22	-51.57	130	469	22	26	55	169	37 - 38
5G NR Band n25 DFT-s QPSK	376500 1882.5 MHz	40 MHz	15	Mode A	B (ANT 2)	1	1	ACC-ELD: 43 kbps	Transverse	0.321	Pass	8.81	-14.95	-51.41	108	439	21	26	33	139	39 - 40
5G NR Band n30 DFT-s QPSK	462000 2310 MHz	10 MHz	15	Mode A	B (ANT 2)	1	1	ACC-ELD: 43 kbps	Transverse	0.34	Pass	8.87	-15.73	-51.57	126	466	21	26	51	166	41 - 42
5G NR Band n41 PC3 DFT-s π/2 BPSK	518598 2592.99 MHz	10 MHz	30	Mode A	B (ANT 2)	12	6	ACC-ELD: 42 kbps	Transverse	0.279	Pass	8.34	-14.61	-51.57	88	377	19	26	**13**	77	43 - 44
5G NR Band n41 PC2 DFT-s π/2 BPSK	518598 2592.99 MHz	10 MHz	30	Mode A	B (ANT 2)	12	6	ACC-ELD: 42 kbps	Transverse	0.247	Pass	8.18	-14.62	-51.57	95	384	18	26	20	84	45 - 46
5G NR Band n77 PC3 DFT-s π/2 BPSK	656000 3840 MHz	10 MHz	30	Mode A	B (ANT 8)	12	6	ACC-ELD: 42 kbps	Transverse	0.322	Pass	9.49	-16.22	-51.57	107	424	18	26	32	124	47 - 48
5G NR Band n77 PC2 DFT-s π/2 BPSK	656000 3840 MHz	10 MHz	30	Mode A	B (ANT 8)	12	6	ACC-ELD: 42 kbps	Transverse	0.352	Pass	9.49	-15.29	-51.57	96	405	17	26	21	105	49 - 50

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.

WLAN (VoWiFi) Test Results

Band / Mode	Channel and Frequency	Power Mode	Port/ANT	Codec and Bit rate (kbps)	Modulation/ Data Rate	Orientation	Codec Delay (s)	Frequency Response	ABM1 dB(A/m)	ABM2 dB(A/m)	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 #
802.11n HT20 20 MHz BW	6 2437 MHz	Power State 1 Head	ANT 2	ACC-ELD: 85 kbps	MCS0 6.5 Mbps	Transverse	0.218	Pass	9.29	-14.91	-51.73	111	439	21	26	36	139	51 - 52
802.11ax HE20 20 MHz BW	36 5180 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.353	Pass	13.09	-14.79	-51.59	153	410	19	26	78	110	53 - 54
	52 5260 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.238	Pass	12.96	-15.44	-51.59	186	442	20	26	111	142	55 - 56
	100 5500 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.266	Pass	13.01	-16.06	-51.59	171	432	21	26	96	132	57 - 58
	149 5745 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.254	Pass	13.01	-15.31	-51.59	175	429	21	26	100	129	59 - 60
	5 5975 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.416	Pass	10.89	-16.31	-51.55	132	432	21	26	57	132	61 - 62
	101 6455 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.388	Pass	10.16	-14.24	-51.55	125	429	21	26	50	129	63 - 64
	133 6615 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.539	Pass	10.98	-16.15	-51.55	132	445	21	26	57	145	65 - 66
	213 7015 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.398	Pass	11.07	-16.08	-51.55	121	426	20	26	46	126	67 - 68
802.11be EHT20 20 MHz BW	5 5975 MHz	Power State 1 Head	ANT 6	AMR-WB: 6.6 kbps	MCS0 8.6 Mbps	Transverse	0.39	Pass	11.32	-15.79	-51.55	124	418	20	26	49	118	69 - 70

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

UL Verification Services Inc. SAR Lab 19 **Date/Time:** July 17, 2025 at 23:46

T-Coil Signal Test Report: 5G NR (DFT-s-OFDM, 50% RB, 10 MHz, π/2 BPSK, 30 kHz)

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 - 3165	March 04, 2025	DAE4ip Sn1881	February 17, 2025

Communication Systems

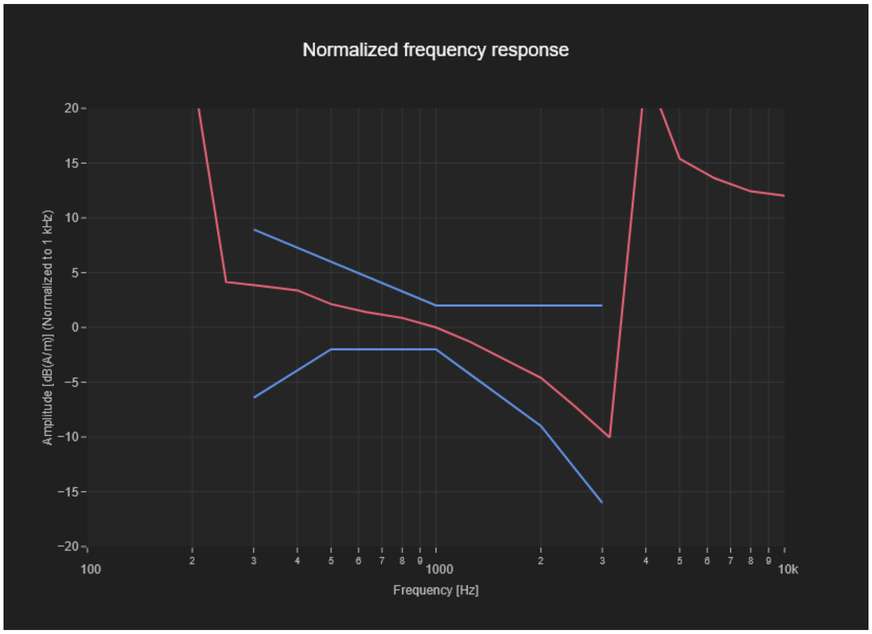
Band Name	Communication Systems Name	Channel	Frequency [MHz]
Band n41 PC3	5G NR (DFT-s-OFDM, 50% RB, 10 MHz, π/2 BPSK, 30 kHz)	518598	2592.99

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

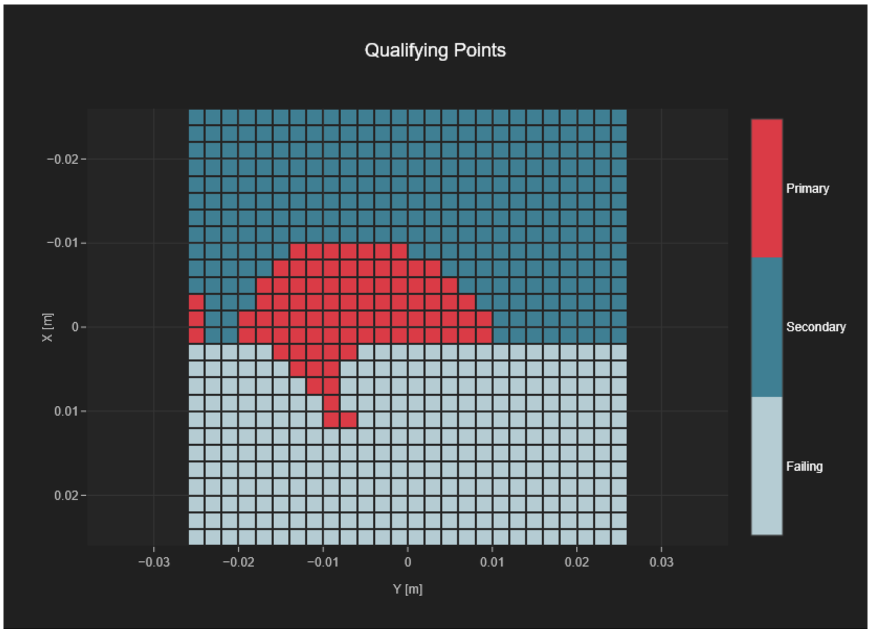


UL Verification Services Inc. SAR Lab 19 **Date/Time:**

T-Coil Coupling Mode Test Report:

Results

Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
88	377	19	26



Appendix

Refer to separate files for the following appendixes:

Appendix A: T-Coil Setup Photo

Appendix B: T-Coil Test Plots

Appendix D: T-Coil Probe Certificates

END OF REPORT