# TEST REPORT

## FCC HAC T-COIL Test for SM-A276U
Certification

APPLICANT
SAMSUNG Electronics Co., Ltd.

REPORT NO.
HCT-SR-2604-FC004

DATE OF ISSUE
April 23, 2026

Tested by
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# TEST REPORT

HAC T-COIL Test for certification

REPORT NO.
HCT-SR-2604-FC004

DATE OF ISSUE
April.23, 2026

FCC ID
A3LSMA276U

| | |
|---|---|
| Applicant | SAMSUNG Electronics Co., Ltd<br>129, Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do, 16677, Korea |
| Product Name | Mobile Phone |
| Model Name | SM-A276U |
| Additional Model Name | SM-A276U1, SM-S276V |
| Date of Test | Mar. 16, 2026~ Apr. 14,2026 |
| Location of Test | ■ Permanent Testing Lab ☐ On Site Testing Lab<br>(Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea) |
| FCC Rule Part(s) | FCC 47 CFR § 20.19, ANSI C63.19-2019 |
| C63.19-2019HACResult: | PASS |

## REVISION HISTORY

The revision history for this test report is shown in table.

| Revision No. | Date of Issue | Description |
|---|---|---|
| 0 | April. 23, 2026 | Initial Release |

## Notice

| Content |
|---|
| The results shown in this test report only apply to the sample(s), as received, provided by the applicant, unless otherwise stated.<br>The test results have only been applied with the test methods required by the standard(s).<br>The laboratory is not accredited for the test results marked *.<br>Information provided by the applicant is marked **.<br>Test results provided by external providers are marked ***.<br><br>When confirmation of authenticity of this test report is required, please contact www.hct.co.kr<br><br>The test results in this test report are not associated with the ((KS Q) ISO/IEC 17025) accreditation by KOLAS (Korea Laboratory Accreditation Scheme) / A2LA (American Association for Laboratory Accreditation) that are under the ILAC (International Laboratory Accreditation Cooperation) Mutual Recognition Agreement (MRA). |

CONTENTS

# 1. Test Regulations

The tests were performed according to the following regulations:

| | |
|---|---|
| Test Standard | FCC 47 CFR § 20.19, ANSI C63.19-2019 |
| Test Method | ・FCC CFR47 Part 20.19<br>・ ANSI C63.19 2019-version<br>・ FCC KDB 285076 D01 HAC Guidance v06r04<br>・ FCC KDB 285076 D02 T Coil testing v04<br>・ FCC KDB 285076 D03 HAC FAQ v01r07<br>・ TCB workshop updates |

# 2. Test Location

## 2.1 Test Laboratory

| | |
|---|---|
| Company Name | HCT Co., Ltd. |
| Address | 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea |
| Telephone | 031-645-6300 |
| Fax. | 031-645-6401 |

## 2.2 Test Facilities

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

| | |
|---|---|
| Korea | National Radio Research Agency (Designation No. KR0032) |
| | KOLAS (Testing No. KT197) |

# 3. DEVICE UNDER TEST DESCRIPTION

## 3.1 General Information of the EUT

| | |
|---|---|
| Model Name | SM-A276U |
| Additional Model Name | SM-A276U1, SM-S276V |
| Equipment Type | Mobile Phone |
| FCC ID | A3LSMA276U |
| Application Type | Certification |
| Applicant | SAMSUNG Electronics Co., Ltd. |

## 3.2 DUT specification

| Device Wireless specification overview | | |
|---|---|---|
| Band & Mode | Operating Mode | Tx Frequency |
| GSM850 | Voice / Data | 824.2 MHz ~ 848.8 MHz |
| GSM1900 | Voice / Data | 1 850.2 MHz ~ 1 909.8 MHz |
| UMTS Band 2 | Voice / Data | 1 852.4 MHz ~ 1 907.6 MHz |
| UMTS Band 4 | Voice / Data | 1 712.4 MHz ~ 1 752.6 MHz |
| UMTS Band 5 | Voice / Data | 826.4 MHz ~ 846.6 MHz |
| LTE FDD Band 2 (PCS) | Voice / Data | 1 850.7 MHz ~ 1 909.3 MHz |
| LTE FDD Band 4 (AWS) | Voice / Data | 1 710.7 MHz ~ 1 754.3 MHz |
| LTE FDD Band 5 (Cell) | Voice / Data | 824.7 MHz ~ 848.3 MHz |
| LTE FDD Band 7 | Voice / Data | 2 502.5 MHz ~ 2 567.5 MHz |
| LTE FDD Band 12 | Voice / Data | 699.7 MHz ~ 715.3 MHz |
| LTE FDD Band 13 | Voice / Data | 779.5 MHz ~ 784.5 MHz |
| LTE FDD Band 14 | Voice / Data | 790.5 MHz ~ 795.5 MHz |
| LTE FDD Band 25 | Voice / Data | 1 850.7 MHz ~ 1 914.3 MHz |
| LTE FDD Band 26 | Voice / Data | 814.7 MHz ~ 848.3 MHz |
| LTE FDD Band 30 | Voice / Data | 2 307.5 MHz ~ 2 312.5 MHz |
| LTE TDD Band 38 | Voice / Data | 2 572.5 MHz ~ 2 617.5 MHz |
| LTE TDD Band 41 | Voice / Data | 2 498.5 MHz ~ 2 687.5 MHz |
| LTE TDD Band 48 | Voice / Data | 3 552.5 MHz ~ 3 697.5 MHz |
| LTE FDD Band 66 (AWS) | Voice / Data | 1 710.7 MHz ~ 1 779.3 MHz |
| LTE FDD Band 71 | Voice / Data | 665.5 MHz ~ 695.5 MHz |
| NR FDD Band n2 (PCS) | Voice / Data | 1 852.5 MHz ~ 1 907.5 MHz |
| NR FDD Band n5 | Voice / Data | 826.5 MHz ~ 846.5 MHz |
| NR FDD Band n25 (PCS) | Voice / Data | 1 852.5 MHz ~ 1 912.5 MHz |
| NR FDD Band n30 | Voice / Data | 2 307.5 MHz ~ 2 312.5 MHz |
| NR TDD Band n41 | Voice / Data | 2 501.01 MHz ~ 2 685 MHz |
| NR TDD Band n48 | Voice / Data | 3 555 MHz ~ 3 695.01 MHz |
| NR FDD Band n66 | Voice / Data | 1 712.5 MHz ~ 1 777.5 MHz |
| NR FDD Band n70 | Voice / Data | 1 697.5 MHz ~ 1 707.5 MHz |
| NR FDD Band n71 | Voice / Data | 665.5 MHz ~ 695.5 MHz |
| NR TDD Band n77 | Voice / Data | 3 705 MHz ~ 3 975 MHz |
| NR TDD Band n77 DoD | Voice / Data | 3 445.01 MHz ~ 3 544.98 MHz |
| NR TDD Band n78 | Voice / Data | 3 705 MHz ~ 3 795 MHz |
| NR TDD Band n78 DoD | Voice / Data | 3 455.01 MHz ~ 3 544.98 MHz |
| U-NII-1 | Voice / Data | 5 180 MHz ~ 5 240 MHz |
| U-NII-2A | Voice / Data | 5 260 MHz ~ 5 320 MHz |
| U-NII-2C | Voice / Data | 5 500 MHz ~ 5 720 MHz |
| U-NII-3 | Voice / Data | 5 745 MHz ~ 5 825 MHz |
| 2.4 GHz WLAN | Voice / Data | 2 412 MHz ~ 2 462 MHz |
| Bluetooth / LE | Data | 2 402 MHz ~ 2 480 MHz |
| NFC | Data | 13.56 MHz |

## 4. Measuring Instrument Calibration

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.

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| ABM Probe | SPEAG | AM1DV3 | 3050 | 05/22/2026 |
| AMCC | SPEAG | SD HAC P02 AB | - | N/A |
| AMMI | SPEAG | SE UMS 010 CA | 2019 | N/A |
| Data Acquisition Electronics | SPEAG | DAE4 | 652 | 06/19/2026 |
| DAC | Sound Devices | USBPre 2 | HB1318341009 | N/A |
| Radio Communication Tester | R & S | CMW 500 | 167916 | 09/13/2026 |
| USB Audio Module | KEYSIGHT | U8903B-UAM | 101006 | N/A |
| UXM 5G Wireless Test Set | KEYSIGHT | E7515B | MY60102101 | 04/28/2026 |

## 5. Measurement Uncertainty

Measurement Uncertainty for Audio Band Magnetic Measurement

| Error Description | Uncertainty ± % | Probability distribution | Div. | $c_i$ | $c_i$ | Std. Unc. | Std. Unc. |
|---|---|---|---|---|---|---|---|
| | | | | $ABM_d$ | $ABM_u$ | $ABM_d$ | $ABM_u$ |
| Probe Sensitivity | | | | | | | |
| Reference Level | 3.0 | N | 1 | 1 | 1 | 3.0 | 3.0 |
| AMCC Geometry | 0.4 | R | 1.73 | 1 | 1 | 0.2 | 0.2 |
| AMCC Current | 1.0 | R | 1.73 | 1 | 1 | 0.6 | 0.6 |
| Probe Positioning during Calibr. | 0.1 | R | 1.73 | 1 | 1 | 0.1 | 0.1 |
| Noise Contribution | 0.7 | R | 1.73 | 0.0143 | 1 | 0.0 | 0.4 |
| Frequency Slope | 5.9 | R | 1.73 | 0.1 | 1.0 | 0.3 | 3.5 |
| Probe System | | | | | | | |
| Repeatability / Drift | 1.0 | R | 1.73 | 1 | 1 | 0.6 | 0.6 |
| Linearity / Dynamic Range | 0.6 | R | 1.73 | 1 | 1 | 0.4 | 0.4 |
| Acoustic Noise | 1.0 | R | 1.73 | 0.1 | 1 | 0.1 | 0.6 |
| Probe Angle | 1.0 | R | 1.73 | 1 | 1 | 0.6 | 0.6 |
| Spectral Processing | 0.9 | R | 1.73 | 1 | 1 | 0.5 | 0.5 |
| Integration Time | 0.6 | N | 1.00 | 1 | 5 | 0.6 | 3.0 |
| Field Distribution | 0.2 | R | 1.73 | 1 | 1 | 0.1 | 0.1 |
| Test Signal | | | | | | | |
| Ref. Signal Spectral Response | 0.6 | R | 1.73 | 0 | 1 | 0.0 | 0.4 |
| Positioning | | | | | | | |
| Probe Positioning | 1.9 | R | 1.73 | 1 | 1 | 1.1 | 1.1 |
| Phantom Thickness | 0.9 | R | 1.73 | 1 | 1 | 0.5 | 0.5 |
| DUT Positioning | 1.9 | R | 1.73 | 1 | 1 | 1.1 | 1.1 |
| External Contributions | | | | | | | |
| RF Interference | 0.0 | R | 1.73 | 1 | 0.3 | 0.0 | 0.0 |
| Test Signal Variation | 2.0 | R | 1.73 | 1 | 1 | 1.2 | 1.2 |
| Combined Uncertainty | | | | | | | |
| Combined Std. Uncertainty | *(k=1)* | | | | | 3.9 | 6.0 |
| Expanded uncertainty | *(Coverage factor for 95%, k=2)* | | | | | 7.8 | 12.0 |
| Notes for table : N –Normal, R –Rectangular, Div. - Divisor used to obtain standard uncertainty | | | | | | | |

# 6. Test Procedures for all Technologies

## 6.1 General Procedures C63.19-2019, Section 6

ANSI C63.19-2019, Section 6

This document describes the measurement of the baseband (audio frequency) magnetic T-Coil signal from a WD. The goal is to evaluate the size of the area where a user could position their WD relative to their hearing aid's telecoil and receive an acceptable magnetically coupled signal. Three quantities are measured and evaluated. The first is the field strength of the desired signal at the center of the audio band (desired ABM signal).31 The second is the frequency response of the desired signal measured across the audio band.

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 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. 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 D.4 through D.6. Measurements shall not include undesired properties from the WD's RF field; therefore, use of a coaxial connection to a base station simulator or non-radiating load may be necessary. However, even then with a coaxial connection to a base station simulator or non-radiating load there may still be RF leakage from the WD, which may interfere with the desired measurement.

Measurements shall be performed with the probe coil oriented in the transverse direction, as illustrated in 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.

### Test flow for T-Coil signal test

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 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㎑ 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.35 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㎑ 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 fi) 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 (fi) shall be centered in each 1/3 octave band maintaining the same drive level as determined in Step c), and the reading taken for that band. Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform(FFT) analysis using noise excitation or input–output comparison using simulated speech. The full-band integrated or half-band integrated probe output, as described in D.9, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB(A/m).) 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.

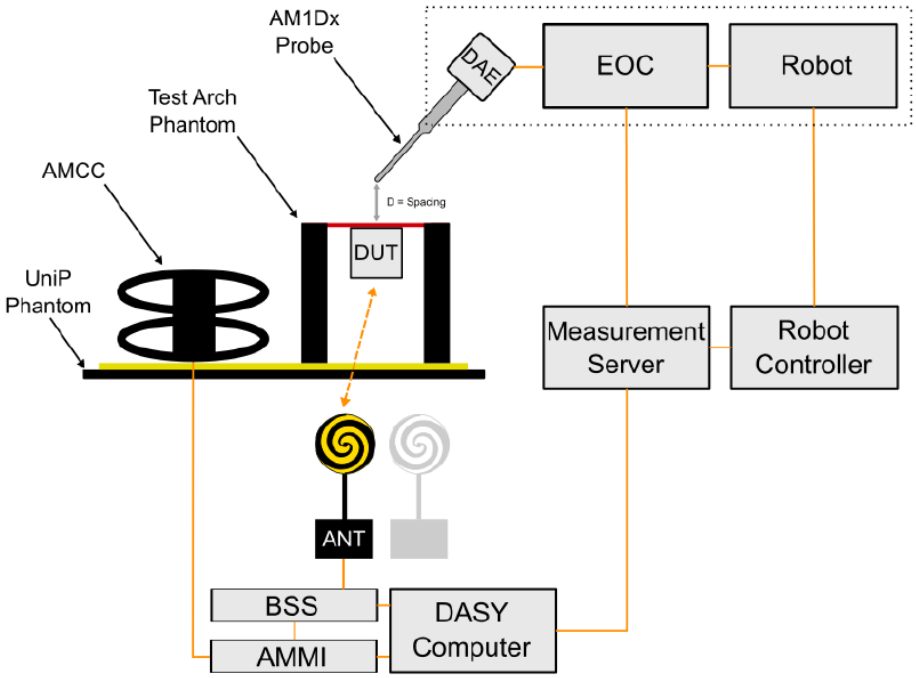
h) Calculate and record the location and number of the measurement points that satisfy both the minimum desired ABM signal level and the maximum undesired ABM field level specified in 6.6.2. Compare this to the requirements in 6.6.4 and record the result.

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.

All measurements of the desired signal shall be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal ON and OFF with the probe measuring the scanned locations.

At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in 6.4.2 g) with no audio signal applied (or digital zero applied, if appropriate) using A-weighting and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).
Obtain the data from the postprocessor, SEMCAD, and determine the primary group, secondary group that properly the signal quality based on Table8.

Test Setup Diagram




## 6.2 VoWiFi

This device supports Wi-Fi calling (aka Voice over Wi-Fi or VoWiFi) which is an extended feature of the carriers CMRS service to offload VoLTE calls onto local area networks over Wi-Fi via the internet and subject to HAC assessment for phones with a HAC rating.

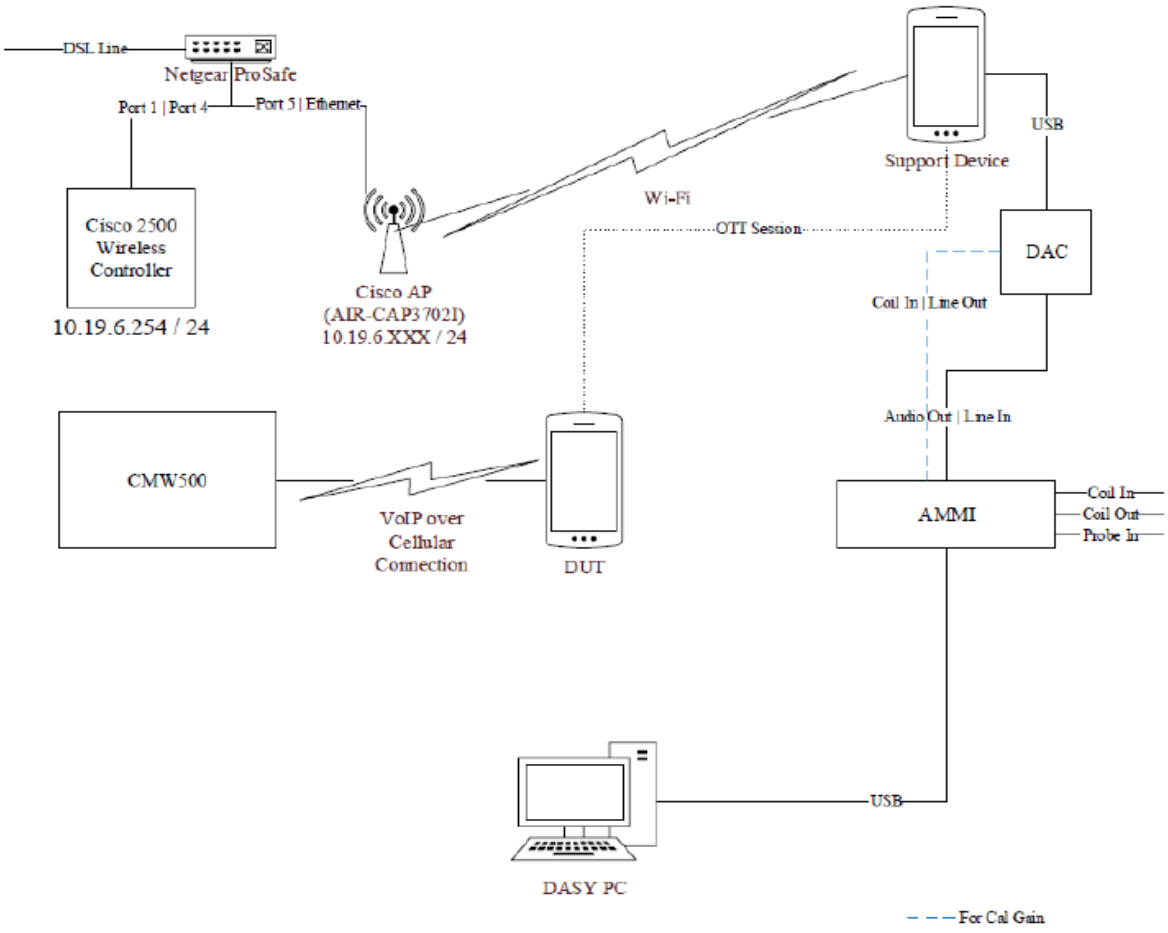
The set up for VoWiFi uses the Base station as described in section 7.1 with the exception that the reference audio level is set at -16dBm0. The reference level is calibrated using the standard call box calibration procedures with the exception of the -16dBm0 reference level being used.

An investigation was performed to determine worst case codec, bit rate and air interface configuration (refer to sections 11.3, 11.4 and 11.5).

## 6.3 Over the Top(OTT) Voice over IP(VoIP)

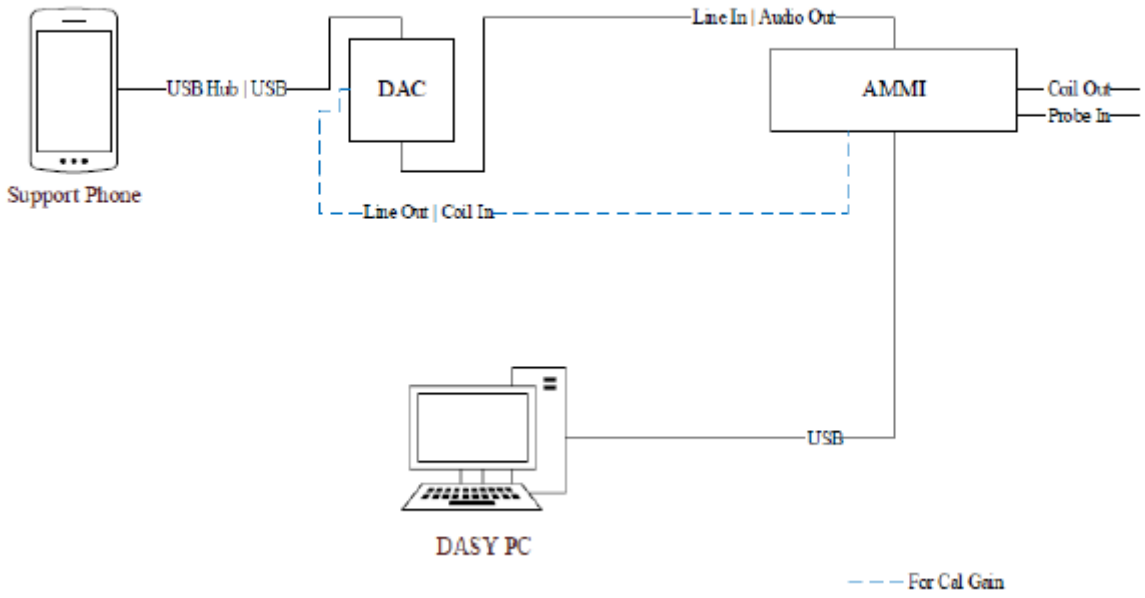
This device supports VoIP via a preinstalled application that uses the Google Meet service, using OPUS as its only codec (refer to § 10 for air interface details and § 11.6 for codec bit rates). VoIP capabilities require HAC assessment when voice calls are supported over the cellular data connection 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 connects to the cloud-based Google Meet service via Wi-Fi access point and router, or RJ45. 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 § 11.6).
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.

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.




Using the metering function on the DAC, the DAC gain is adjusted until the volume reaches 0dBFS (3.14 dBm0 based on TIA/EIA 810-A).

## 7. Audio Level and Gain Measurements

The following reference input levels (table 6.1—Normal speech input level of ANSI C63.19-2019) that correlate to a normal speech input level shall be used for the standard transmission protocols.
Normal speech input level -16 dBm0 is used for all testing: GSM, WCDMA, VOLTE, VONR, VoWiFi.
According to FCC KDB 285076 D02 T Coil testing v04 Sec.3, Other services not defined by note 2 shall use -20dBm0 or the level defined in an attestation by the manufacture.
Input level -20dBm0 is Over The top (OTT) Voice over IP(VOIP) Testing (Codec: OPUS).

**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).<br>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.

## 7.1 GSM, UMTS, VoLTE, VoNR, VoWiFi

Refer to the below table for the gains used to measure.

GSM, UMTS, VoLTE, VoWiFi 2.4 GHz,5 GHz

| Signal Type | Audio Level [dBm] | Peak to Full Scale [dB] | Peak to RMS Scale [dB] | BWC [dB] | Scaling [Gain] |
|---|---|---|---|---|---|
| Voice 1 kHz | -16 | -0.37 | 15.74 | 0.07 | -12.40 to –12.39 |
| Normal Voice | -16 | 0 | 21.57 | 10.81 | -6.57 to -6.56 |

VoNR

| Signal Type | Audio Level [dBm] | Peak to Full Scale [dB] | Peak to RMS Scale [dB] | BWC [dB] | Scaling [Gain] |
|---|---|---|---|---|---|
| Voice 1 kHz | -16 | -0.37 | 15.74 | 0.07 | -7.30 to -7.27 |
| Normal Voice | -16 | 0 | 21.57 | 10.81 | -1.47 to -1.44 |

Refer to the below table for the gains used to measure VoLTE.(CMW500)

The following software/firmware was used to simulate the VoLTE server for testing:

| Firmware | License Keys | Software Name |
|---|---|---|
| V4.0.24 for LTE | KS500 | LTE FDD R8 SIG BASIC |
| | KS550 | LTE TDD R8 SIG BASIC |
| V4.0.56 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 |

Refer to the below table for the gains used to measure VoWIFI.(CMW500)

| Firmware | License Keys | Software Name |
|---|---|---|
| V4.0.23 for Wi-Fi | KS650 | Wi-Fi a/b/g SIG BASIC |
| | KS651 | Wi-Fi n SIG BASIC |
| | KS656 | Wi-Fi IEEE 802.11ac |
| | KS657 | Wi-Fi IEEE 802.11ax |
| V4.0.56for Audio | KA100 | IP APPL ENABLING IPv4 |
| | KA150 | IP APPL ENABLING IPv4 |
| | KAA20 | IP APPL IMS BASIC |
| | KM050 | DATA APPL MEAS |
| | KS104 | EVS SPEECH CODEC |

Refer to the below table for the gains used to measure VoNR (UXM)

The following software/firmware was used to simulate the VoNR server for testing:

| Firmware | License Model | Software Name |
|---|---|---|
| 5G NR | C8700200A | Test Application Framework |
| Audio | C8700201A | IMS-SIP Emulation |
| | C87300P1A | LTE IP data |
| | C87350P1A | 5G NR IP data |

## 7.2 Over the Top(OTT) Voice over IP(VoIP)

For EDGE, HSPA, LTE, NR and Wi-Fi the linear gain levels listed below were used. The results below were based on a reference input level of -20 dBm.

To calibrate the DAC (refer § 6.3 ), three. Way audio files (sine wave, 1 ㎑ voice, and 300 to 3 ㎑ voice) are sent from the DASY PC to the AMMI, then to the DAC. The Helmholtz resonator measures the field strength, which represents the AMMI to DAC input sensitivity. After determining the input sensitivity, the adjusted linear gain values can then be calculated.

### OTT GSM, UMTS, WIFI, LTE, NR

| Signal Type | Audio Level [dBm] | Peak to Full Scale [dB] | Peak to RMS Scale [dB] | BWC [dB] | Scaling [Gain] |
|---|---|---|---|---|---|
| Voice 1 ㎑ | -20 | -0.37 | 15.74 | 0.07 | -12.96 |
| Normal Voice | -20 | 0 | 21.57 | 10.81 | -7.13 |

# 8. System Validation

To ensure proper operation of the T-Coil system, system calibration and TMFS verification are performed prior to any T-Coil testing. The system calibration includes verification of the cables and connections used in the setup. Probe sensitivity is determined during system calibration using the AMCC. After the probe has been calibrated and validated (consistent with the uncertainty budget), the Audio Magnetic Calibration Coil (AMCC) is calibrated.

## 8.1 System Calibration

During the Angle Alignment procedure, the system performs a full 1-D rotation in 10-degree increments, and the H-field reading is recorded at each step. After the rotation is completed, the measured sensor response is compared with the theoretical response, and an optimization routine is used to determine the alignment angle. Please note that the final angle includes the combined effects of several factors (e.g., the DAE connector angle, the probe connector angle, and rotation of the robot holder). Therefore, it cannot be directly compared with the probe connector angle listed on the calibration certificate.

During the System Response Calibration procedure, a multi-sine signal is generated with individual components spanning each one-third-octave band from 50 Hz to 10 kHz, and this signal is applied to both audio outputs. The Coil In channel measures the voltage across the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the Probe In channel measures the amplified signal picked up by the probe coil. Probe sensitivity is defined as the ratio of these two voltages at 1 kHz. The response spectrum is then calculated as the voltage ratio in each 1/3-octave band, normalized to the probe sensitivity. The resulting system calibration values are provided below the table

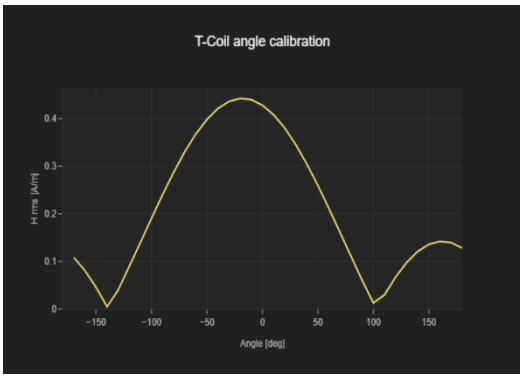



Figure 8.1

SPEAG Angle Alignment

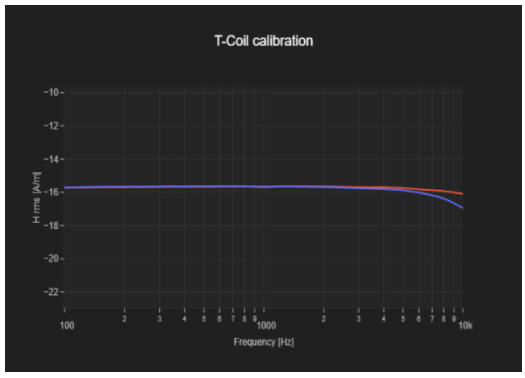



Figure 8.2

SPEAG System Frequency Response Calibration

| Test | AMD Probe | Coil Channel [V] | Probe Channel [V] | Probe Sensitivity [mV/(A/m)] | Calibrated Angle [deg] |
|---|---|---|---|---|---|
| T-coil Codec | 3050 | 2.39 | 1.36 | 7.54 | -48.1 |
| T-coil GSM/UMTS | 3050 | 2.39 | 1.36 | 7.54 | -47.1 |
| T-coil LTE | 3050 | 2.39 | 1.36 | 7.54 | -47.03 |
| T-coil WIFI | 3050 | 2.39 | 1.36 | 7.54 | -46.32 |
| T-coil NR | 3050 | 2.39 | 1.36 | 7.54 | -45.67 |
| OTT Codec | 3050 | 2.39 | 1.37 | 7.54 | -45.84 |
| OTT GSM/UMTS | 3050 | 2.39 | 1.37 | 7.54 | -45.84 |
| OTT LTE | 3050 | 2.39 | 1.36 | 7.54 | -45.67 |
| OTT NR | 3050 | 2.39 | 1.36 | 7.54 | -45.67 |
| OTT WIFI | 3050 | 2.39 | 1.37 | 7.54 | -45.84 |

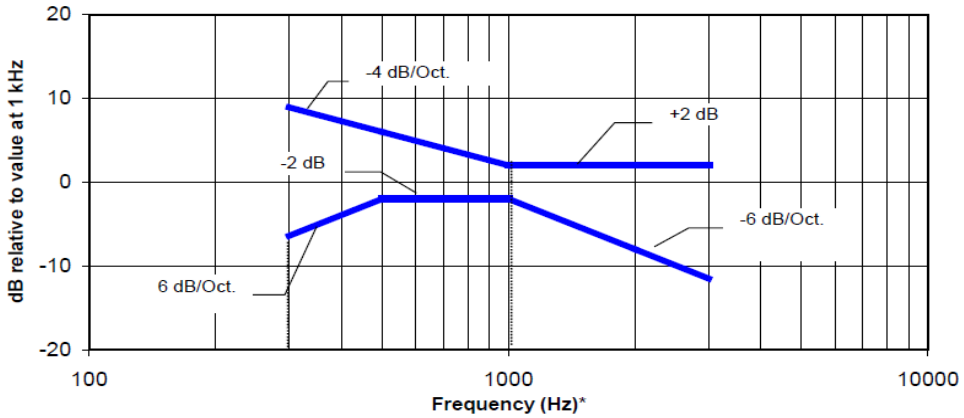
SPEAG T-Coil System Calibration Results

# 9. T-coil Measurement Criteria

## 9.1 Frequency Response

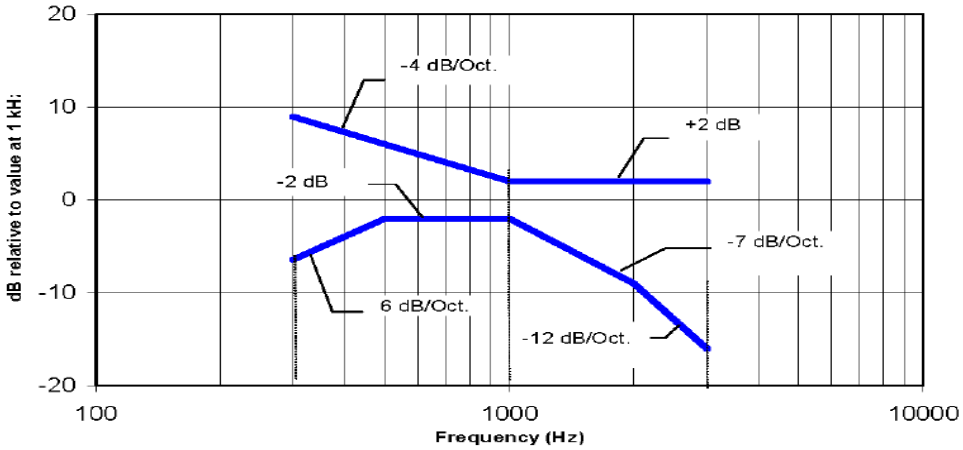
The frequency response of the axial component of the magnetic field, measured in 1/3 octave bands, shall follow the response curve, over the frequency range 300 Hz to 3 kHz.

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**

## 9.2 Desired ABM Signal, Undesired ABM Field qualification requirements

### ANSI C63.19-2019, Section 6.6.4.1

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:

a) The WD 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.
b) If the WD 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.

### ANSI C63.19-2019,6.6.4.2 Non-2G GSM operating modes

The goal of this requirement is to ensure an adequate area where desired ABM signal is sufficiently strong to be heard clearly and a larger area where undesired ABM field is sufficiently low as to avoid undue annoyance. Qualifying measurement points shall fulfill the requirements of 6.6.2; both the primary and secondary group requirements shall be met:
- The primary group shall include at least 75 measurement points.
- The secondary group shall include at least 300 contiguous measurement points.
Additionally, to avoid an oddly shaped area of low noise, the secondary group shall include at least one longitudinal column of at least 10 contiguous qualifying points and at least one transverse row containing at least 15 contiguous qualifying points.

### ANSI C63.19-2019, 6.6.4.3 2G GSM operating modes

If the 2G GSM operating mode(s) are selected for qualification, the qualifying measurement points shall fulfil the requirements of 6.6.2; both the primary and secondary group requirements shall be met:
- The primary group shall include at least 25 measurement points.
- The secondary group shall include at least 125 contiguous measurement points.

## 10. Device Under Test

| | | |
|---|---|---|
| Normal operation | Held to head | |
| Back Cover | The Back Cover is not removable | |
| Test sample information | S/N | Notes |
| | ZCD0291M | T-coil Test |
| | ZC60344M | |
| | ZD30741M | |

Note: T-Coil Measurements in this report were performed by Maximum Power (Pmax) in static power condition.

## 11. Air Interfaces and Operating Mode

| Air Interface | Bands (MHz) | Type | C63.19 Tested | Simultaneous Transmitter | Name of voice service | Audio Codecs Evaluated |
|---|---|---|---|---|---|---|
| GSM | 850 | VO | Yes | Wi-Fi, BT | CMRS Voice[1] | FR V1,FR V2,HR V1 |
| | 1 900 | | | | | |
| | GPRS/EDGE | VD | Yes | Wi-Fi, BT | Google Meet[1] | OPUS |
| UMTS | 850 | VO | Yes | Wi-Fi, BT | CMRS Voice[1] | AMR-NB &AMR-WB |
| | 1 700 | | | | | |
| | 1 900 | | | | | |
| | HSPA | VD | Yes | Wi-Fi, BT | Google Meet[1] | OPUS |
| LTE - FDD | 680 (B71) | VD | Yes | NR, Wi-Fi, BT | VoLTE[1]<br>Google Meet[1] | VoLTE: AMR-NB, AMR-WB, EVS-NB, EVS-WB, EVS-SWB<br>Google Meet :OPUS |
| | 700 (B12/13/14) | | | | | |
| | 850 (B5/26) | | | | | |
| | 1 700 (B4/66) | | | | | |
| | 1 900 (B2/25) | | | | | |
| | 2 300 (B30) | | | | | |
| | 2 500 (B7) | | | | | |
| LTE – TDD | 2 600 (B38/41) | VD | Yes | NR, Wi-Fi, BT | VoLTE[1]<br>Google Meet[1] | VoLTE: AMR-NB, AMR-WB, EVS-NB, EVS-WB, EVS-SWB<br>Google Meet :OPUS |
| | 3 600 (B48) | | | | | |
| NR -FDD | 680(n71) | VD | Yes | LTE, Wi-Fi, BT | VoNR[1]<br>Google Meet[1] | VoNR: AMR-NB, AMR-WB, EVS-NB, EVS-WB, EVS-SWB<br>Google Meet :OPUS |
| | 850(n5) | | | | | |
| | 1 700(n66,n70) | | | | | |
| | 1 900(n2/n25) | | | | | |
| | 2 300(n30) | | | | | |
| NR -TDD | 2 600(n41) | VD | Yes | LTE, Wi-Fi, BT | VoNR[1]<br>Google Meet[1] | VoNR: AMR-NB, AMR-WB, EVS-NB, EVS-WB, EVS-SWB<br>Google Meet :OPUS |
| | 3 600 (n48) | | Yes | | | |
| | 3 800(n77, n78) | | Yes | | | |
| Wi-Fi | 2 450 | VD | Yes | WWAN | VoWiFi[1]<br>Google Meet[1] | VoWiFi: AMR-NB, AMR-WB, EVS-NB, EVS-WB, EVS-SWB<br>Google Meet :OPUS |
| | 5 200 (U-NII-1) | | Yes | WWAN and BT | | |
| | 5 300 (U-NII-2A) | | | | | |
| | 5 500 (U-NII-2C) | | | | | |
| | 5 800 (U-NII-3) | | | | | |
| BT | 2 450 | DT | N/A | WWAN and Wi-Fi 5 | N/A | N/A |

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

Note:
1. Ref Lev in accordance with the ANSI 63.19-2019 Table 6.1

# 12. HAC (T-coil) Test Results

## 12.1.1 Codec Investigation

A complete set of measurements was performed for each applicable Voice mode to determine the audio codec configuration to be used for testing. The effects of codec configuration were found to be independent of the radio configuration; therefore, only one representative radio configuration was used for each applicable Voice mode for these investigations.

| Band | Ant | Codec (kbit/s) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Desired ABM [dB/A/M] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|
| GSM 850 190ch | A | FR V1 | 82 | 299 | 19 | 26 | 3.21 | 1.56 | (7.0, -5.0) |
| | | FR V2 | 82 | 297 | 19 | 26 | 3.30 | 1.83 | (7.0, -5.0) |
| | | HR V1 | 94 | 314 | 20 | 26 | 3.22 | 1.29 | (7.0, -5.0) |
| UMTS 2 9400ch | A | AMR-NB 4.75 | 344 | 609 | 26 | 26 | 3.00 | 1.69 | (7.0, -5.0) |
| | | AMR-NB 7.4 | 333 | 594 | 26 | 26 | 3.01 | 1.92 | (7.0, -5.0) |
| | | AMR-NB 12.2 | 345 | 607 | 26 | 26 | 3.13 | 1.84 | (7.0, -5.0) |
| | | AMR-WB 6.6 | 308 | 591 | 26 | 26 | 1.92 | 2.00 | (6.0, -5.0) |
| | | AMR-WB 15.85 | 298 | 574 | 26 | 26 | 1.82 | 1.85 | (7.0, -5.0) |
| | | AMR-WB 23.85 | 292 | 565 | 26 | 26 | 1.84 | 1.94 | (7.0, -5.0) |
| LTE 41 QPSK 20MHz 1RB 0offset 40620ch | A | AMR-NB 4.75 | 145 | 379 | 19 | 26 | 2.49 | 1.79 | (6.0, -5.0) |
| | | AMR-NB 7.4 | 145 | 379 | 19 | 26 | 2.43 | 1.67 | (6.0, -5.0) |
| | | AMR-NB 12.2 | 146 | 379 | 19 | 26 | 2.55 | 1.81 | (6.0, -5.0) |
| | | AMR-WB 6.6 | 133 | 384 | 19 | 26 | 1.89 | 2.00 | (6.0, -5.0) |
| | | AMR-WB 15.85 | 130 | 379 | 19 | 26 | 1.88 | 1.99 | (6.0, -20.0) |
| | | AMR-WB 23.85 | 129 | 379 | 19 | 26 | 2.04 | 1.98 | (6.0, -5.0) |
| | | EVS-NB 5.9 | 150 | 376 | 20 | 26 | 3.63 | 2.00 | (6.0, -19.0) |
| | | EVS-NB 13.2 | 149 | 380 | 19 | 26 | 3.16 | 2.00 | (6.0, -20.0) |
| | | EVS-NB 24.4 | 156 | 388 | 19 | 26 | 3.16 | 2.00 | (6.0, -5.0) |
| | | EVS-WB 5.9 | 130 | 372 | 19 | 26 | 2.05 | 1.82 | (6.0, -5.0) |
| | | EVS-WB 13.2 | 129 | 377 | 19 | 26 | 2.09 | 1.74 | (6.0, -5.0) |
| | | EVS-WB 24.4 | 129 | 372 | 19 | 26 | 2.12 | 2.00 | (6.0, -5.0) |
| | | EVS-SWB 9.6 | 134 | 362 | 17 | 26 | 3.13 | 2.00 | (6.0, -5.0) |
| | | EVS-SWB 16.4 | 140 | 363 | 18 | 26 | 3.18 | 2.00 | (6.0, -5.0) |
| | | EVS-SWB 24.4 | 147 | 376 | 19 | 26 | 3.07 | 2.00 | (6.0, -5.0) |

| Band | Ant | Codec (kbit/s) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Desired ABM [dB/A/M] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|
| NR Band n41 DFT-s OFDM QPSK 100 ㎒ 1RB 1offset 518598ch[PC2] | A | AMR-NB 4.75 | 123 | 343 | 16 | 26 | 3.44 | 1.60 | (6.0, -4.0) |
| | | AMR-NB 7.4 | 119 | 339 | 16 | 26 | 3.60 | 1.82 | (7.0, -5.0) |
| | | AMR-NB 12.2 | 120 | 339 | 16 | 26 | 3.61 | 2.00 | (7.0, -5.0) |
| | | AMR-WB 6.6 | 123 | 351 | 17 | 26 | 2.79 | 1.68 | (6.0, -4.0) |
| | | AMR-WB 15.85 | 125 | 349 | 17 | 26 | 3.08 | 1.18 | (6.0, -4.0) |
| | | AMR-WB 23.85 | 119 | 344 | 16 | 26 | 3.02 | 1.19 | (6.0, -5.0) |
| | | EVS-NB 5.9 | 104 | 347 | 16 | 26 | 1.44 | 2.00 | (7.0, -5.0) |
| | | EVS-NB 13.2 | 130 | 346 | 16 | 26 | 3.73 | 2.00 | (7.0, -5.0) |
| | | EVS-NB 24.4 | 130 | 347 | 16 | 26 | 3.67 | 2.00 | (7.0, -5.0) |
| | | EVS-WB 5.9 | 106 | 348 | 17 | 26 | 1.71 | 2.00 | (7.0, -5.0) |
| | | EVS-WB 13.2 | 123 | 335 | 16 | 26 | 3.90 | 2.00 | (6.0, -5.0) |
| | | EVS-WB 24.4 | 122 | 336 | 16 | 26 | 3.76 | 2.00 | (7.0, -5.0) |
| | | EVS-SWB 9.6 | 122 | 337 | 16 | 26 | 3.79 | 2.00 | (7.0, -5.0) |
| | | EVS-SWB 16.4 | 122 | 338 | 16 | 26 | 3.78 | 2.00 | (7.0, -5.0) |
| | | EVS-SWB 24.4 | 122 | 334 | 16 | 26 | 3.77 | 2.00 | (6.0, -5.0) |
| 2.4 ㎓ 802.11b DSSS 1Mbps 6ch | J | AMR-NB 4.75 | 245 | 462 | 21 | 26 | 4.40 | 2.00 | (6.0, -5.0) |
| | | AMR-NB 7.4 | 258 | 473 | 22 | 26 | 4.48 | 2.00 | (6.0, -5.0) |
| | | AMR-NB 12.2 | 265 | 480 | 22 | 26 | 4.66 | 2.00 | (6.0, -5.0) |
| | | AMR-WB 6.6 | 242 | 482 | 22 | 26 | 3.62 | 1.48 | (6.0, -19.0) |
| | | AMR-WB 15.85 | 245 | 475 | 22 | 26 | 4.16 | 1.77 | (6.0, -19.0) |
| | | AMR-WB 23.85 | 244 | 475 | 22 | 26 | 4.14 | 1.75 | (6.0, -5.0) |
| | | EVS-NB 5.9 | 244 | 491 | 22 | 26 | 3.44 | 2.00 | (6.0, -4.0) |
| | | EVS-NB 13.2 | 261 | 476 | 22 | 26 | 4.58 | 2.00 | (6.0, -5.0) |
| | | EVS-NB 24.4 | 303 | 521 | 23 | 26 | 5.04 | 2.00 | (7.0, -5.0) |
| | | EVS-WB 5.9 | 235 | 494 | 23 | 26 | 3.30 | 1.57 | (8.0, -5.0) |
| | | EVS-WB 13.2 | 288 | 515 | 23 | 26 | 4.34 | 1.40 | (6.0, -5.0) |
| | | EVS-WB 24.4 | 244 | 475 | 22 | 26 | 4.29 | 1.48 | (6.0, -5.0) |
| | | EVS-SWB 9.6 | 230 | 479 | 22 | 26 | 2.45 | 2.00 | (6.0, -19.0) |
| | | EVS-SWB 16.4 | 260 | 523 | 24 | 26 | 2.42 | 1.80 | (6.0, -5.0) |
| | | EVS-SWB 24.4 | 256 | 517 | 23 | 26 | 2.47 | 1.88 | (6.0, -5.0) |

As part of the codec check investigation, the worst-case codec configuration was determined under the Primary Worst condition. The Peak Measurement Location evaluation was conducted at Desired ABM Max, representing the maximum operating state of the wireless device.

### 12.1.2 OTT Codec Investigation

A complete set of measurements was performed for each applicable data mode to determine the audio codec configuration to be used for testing. The effects of codec configuration were found to be independent of the radio configuration; therefore, only one representative radio configuration was evaluated for each applicable data mode. The DUT's tested OTT VoIP application (Google Meet) supports codec bit rates ranging from 6 kbps to 510 kbps. Accordingly, codec evaluations were conducted at 6 kbps, 258 kbps, and 510 kbps to identify the worst-case bit rate for testing. The tables below provide a comparison of codec data rates across all applicable data modes.

| Band | Ant | Codec (kbit/s) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Desired ABM [dB/A/M] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|
| GSM 850 EDGE 2 slot 190ch | A | 6 | 53 | 330 | 18 | 26 | -0.93 | 2.00 | (6.0, -20.0) |
| | | 258 | 64 | 327 | 18 | 26 | -0.55 | 2.00 | (6.0, -5.0) |
| | | 510 | 71 | 333 | 18 | 26 | -0.20 | 2.00 | (7.0, -5.0) |
| UMTS Band 2 HSUPA subtest 1 9400ch | A | 6 | 201 | 488 | 21 | 26 | 0.06 | 1.80 | (6.0, -19.0) |
| | | 258 | 202 | 486 | 21 | 26 | 0.39 | 2.00 | (7.0, -5.0) |
| | | 510 | 201 | 485 | 21 | 26 | 0.68 | 2.00 | (6.0, -5.0) |
| LTE 41 QPSK 20MHz 1RB 0offset 40620ch | A | 6 | 118 | 382 | 19 | 26 | 0.08 | 2.00 | (7.0, -19.0) |
| | | 258 | 119 | 385 | 19 | 26 | 0.33 | 2.00 | (6.0, -19.0) |
| | | 510 | 116 | 383 | 19 | 26 | 0.16 | 2.00 | (7.0, -5.0) |
| NR Band n41 DFT-s QPSK 100MHz 1RB 1offset 518598ch[PC2] | A | 6 | 93 | 321 | 15 | 26 | 2.05 | 1.72 | (6.0, -5.0) |
| | | 258 | 103 | 333 | 16 | 26 | 2.08 | 1.77 | (6.0, -19.0) |
| | | 510 | 92 | 322 | 15 | 26 | 2.08 | 1.87 | (6.0, -5.0) |
| 2.4 GHz 802.11b DSSS 1Mbps 6ch | J | 6 | 197 | 478 | 21 | 26 | 0.26 | 1.59 | (6.0, -5.0) |
| | | 258 | 207 | 485 | 21 | 26 | 0.48 | 2.00 | (7.0, -5.0) |
| | | 510 | 189 | 468 | 21 | 26 | 0.55 | 2.00 | (6.0, -20.0) |

As part of the codec check investigation, the worst-case codec configuration was determined under the Primary Worst condition. The Peak Measurement Location evaluation was conducted at Desired ABM Max, representing the maximum operating state of the wireless device.

## 12.2 GSM T-coil Measurements

Measurements were conducted to determine the worst-case configuration for GSM Voice. For each band, the middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. An ANSI C63.19-2019 T-Coil scan was also performed under the worst-case configuration.

### 12.2.1 GSM Voice Single Point Measurement Results

| Band | Ant | Codec (kbit/s) | Ch. | Freq. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|
| GSM 850 | A | FR V2 | 190 | 836.6 | -52.19 | 3.26 | -23.73 | 26.99 | 2.00 | (7.0, -5.0) |
| GSM 1900 | A | | 661 | 1 880 | | 3.24 | -27.67 | 30.91 | 1.91 | |
| GSM 850 | A | | 128 | 824.2 | | 3.30 | -22.49 | 25.79 | 1.84 | |
| | | | 251 | 848.8 | | 3.15 | -23.07 | 26.22 | 1.95 | |

### 12.2.2 GSM Voice Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq(MHz) | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GSM 850 | A | FR V2 | 251 | 848.8 | -52.19 | 67 | 282 | 19 | 26 | 2.00 | 1 |

## 12.3 GSM OTT VoIP EDGE Measurements

Measurements were conducted to determine the worst-case configuration for OTT VoIP over EDGE. The middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. An ANSI C63.19-2019 T-Coil scan was also performed under the worst-case configuration.

### 12.3.1 EDGE(OTT VoIP) Single Point Measurement Results

| Band | Ant | Codec (kbit/s) | Ch. | Freq. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|
| GSM 850 | A | 6 | 190 | 836.6 | -52.08 | -0.98 | -32.36 | 31.38 | 1.88 | (6.0, -20.0) |
| GSM 1905 | A | | 661 | 1 880 | | -1.10 | -35.32 | 34.22 | 1.35 | |
| GSM 850 | A | | 128 | 824.2 | | -1.82 | -32.22 | 30.40 | 2.00 | |
| | | | 251 | 848.8 | | -0.18 | -33.27 | 33.09 | 2.00 | |

### 12.3.2 EDGE(OTT VoIP) Worst Case Scan Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq(MHz) | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GSM 850 | A | 6 | 128 | 824.2 | -52.08 | 62 | 337 | 18 | 26 | 1.41 | 2 |

## 12.4 UMTS T-coil Measurements

Measurements were conducted to identify the worst-case configuration for UMTS Voice. For each band, the middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. An ANSI C63.19-2019 T-Coil scan was also performed under the worst-case configuration to demonstrate compliance.

### 12.4.1 UMTS Voice Single Point Measurement Results

| Band | Ant | Codec (kbit/s) | Ch. | Freq. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|
| UMTS 2 | A | AMR-WB 23.85 | 9400 | 1 880 | -52.19 | 2.04 | -44.07 | 46.11 | 1.88 | (7.0, -5.0) |
| UMTS 4 | A | | 1412 | 1 732.4 | | 2.32 | -42.17 | 44.49 | 2.00 | |
| UMTS 5 | A | | 4183 | 836.6 | | 2.28 | -42.19 | 44.47 | 1.88 | |
| UMTS 5 | A | | 4132 | 826.4 | | 2.23 | -42.60 | 44.83 | 1.76 | |
| | | | 4233 | 846.6 | | 2.15 | -43.20 | 45.35 | 2.00 | |

### 12.4.2 UMTS Voice Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq(㎒) | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UMTS 5 | A | AMR-WB 23.85 | 4183 | 836.6 | -52.19 | 299 | 568 | 26 | 26 | 1.76 | 3 |

## 12.5 OTT VoIP over HSPA Measurements

Measurements were conducted to identify the worst-case configuration for OTT VoIP over HSPA. For each band, the middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. An ANSI C63.19-2019 T-Coil scan was also performed under the worst-case configuration to demonstrate compliance.

### 12.5.1 UMTS HSPA(OTT VoIP) Single Point Measurement Results

| Band | Ant | Codec (kbit/s) | Ch. | Freq. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|
| UMTS 2 | A | 510 | 9400 | 1 880 | -52.13 | -0.50 | -44.19 | 43.69 | 2.00 | (6.0, -19.0) |
| UMTS 4 | A | | 1412 | 1 732.4 | | 0.94 | -44.78 | 45.72 | 2.00 | |
| UMTS 5 | A | | 4183 | 836.6 | | -0.65 | -44.45 | 43.80 | 2.00 | |
| UMTS 2 | A | | 9262 | 1 852.4 | | -0.81 | -44.14 | 43.33 | 2.00 | |
| | | | 9538 | 1 907.6 | | -0.87 | -43.40 | 42.53 | 2.00 | |

### 12.5.2 UMTS HSPA(OTT VoIP) Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq(㎒) | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UMTS 2 | A | 510 | 9538 | 1 907.6 | -52.13 | 208 | 481 | 21 | 26 | 2.00 | 4 |

## 12.6 LTE T-coil Measurements

### 12.6.1 Power Class 3 Uplink-Downlink Configuration Investigation

Measurements were performed to evaluate the Uplink–Downlink configurations for VoLTE over IMS T-Coil testing (Power Class 3) under channel 40620, 20 MHz BW, QPSK, 1 RB, and 0 RB offset conditions. All configurations (0–6) were supported, and the configuration was selected based on the worst-case SNNR evaluation results. The table below summarizes the SNNR comparison across the evaluated configurations.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Mod. | RB Config. | 3GPP 36.211 UL-DL Configuration # | Sub Frame | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 41 | A | EVS-WB 24.4 | 40620 | 2 593 | 20 | QPSK | 1/0 | 0 | 0 | 3.58 | -36.94 | 40.52 | (6.0, -20.0) |
| | | | | | | | | | 1 | 3.68 | -36.94 | 40.62 | |
| | | | | | | | | | 2 | 4.22 | -36.13 | 40.35 | |
| | | | | | | | | | 3 | 4.20 | -36.79 | 40.99 | |
| | | | | | | | | | 4 | 4.08 | -36.71 | 40.79 | |
| | | | | | | | | | 5 | 4.21 | -36.83 | 41.04 | |
| | | | | | | | | | 6 | 4.22 | -36.65 | 40.87 | |
| | | | | | | | | | 7 | 4.19 | -37.04 | 41.23 | |
| | | | | | | | | | 8 | 4.15 | -36.65 | 40.80 | |
| | | | | | | | | | 9 | 4.10 | -36.47 | 40.57 | |

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Mod. | RB Config. | 3GPP 36.211 UL-DL Configuration # | Sub Frame | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 41 | A | EVS-WB 24.4 | 40620 | 2 593 | 20 | QPSK | 1/0 | 0 | 2 | 4.22 | -36.13 | 40.35 | (6.0, -20.0) |
| | | | | | | | | 1 | | 3.84 | -38.15 | 41.99 | |
| | | | | | | | | 2 | | 4.25 | -38.50 | 42.75 | |
| | | | | | | | | 3 | | 4.31 | -40.59 | 44.90 | |
| | | | | | | | | 4 | | 4.29 | -40.74 | 45.03 | |
| | | | | | | | | 5 | | 4.32 | -40.55 | 44.87 | |
| | | | | | | | | 6 | | 4.26 | -38.06 | 42.32 | |

### 12.6.2 LTE Radio Configuration Investigation Results

Measurements were conducted to select the modulation and RB settings for testing. As their impact was independent of band and bandwidth, one representative band/bandwidth was evaluated. The modulation scheme and RB offset were evaluated under the worst-case SNNR condition, and the results are summarized in the table below.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Mod. | RB Config. | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 41 | A | EVS-WB 24.4 | 40620 | 2 593 | 20 | QPSK | 1/0 | 4.20 | -36.65 | 40.85 | (6.0, -20.0) |
| | | | | | | | 1/49 | 4.30 | -36.92 | 41.22 | |
| | | | | | | | 1/99 | 4.26 | -38.59 | 42.85 | |
| | | | | | | | 50/0 | 4.23 | -38.64 | 42.87 | |
| | | | | | | | 50/25 | 4.29 | -38.77 | 43.06 | |
| | | | | | | | 50/49 | 4.28 | -39.00 | 43.28 | |
| | | | | | | | 100/0 | 4.34 | -38.92 | 43.26 | |
| | | | | | | 16QAM | 1/0 | 4.25 | -37.30 | 41.55 | |
| | | | | | | 64QAM | 1/0 | 4.21 | -36.98 | 41.19 | |
| | | | | | | 256QAM | 1/0 | 4.32 | -38.14 | 42.46 | |

### 12.6.3 LTE TDD ULCA Investigation Result

LTE TDD ULCA was evaluated to verify compliance with the applicable standards. This test case meets the configuration requirements defined in 3GPP TS 36.101.

| Band | Ant | Codec (kbit/s) | Ch. | Freq(MHz) | BW (MHz) | Mod. | RB Config. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 48 | G | EVS-WB 24.4 | 55773 | 3 603.3 | 20 | QPSK | 1/0 | -52.18 | 3.21 | -40.78 | 43.99 | 1.43 |
| | | | 55575 | 3 583.5 | 20 | QPSK | 1/99 | | | | | |

## 12.6.4 VoLTE Single Point Measurement Results

Measurements were conducted to identify the worst-case band/bandwidth configuration for VoLTE over IMS. For each band and maximum bandwidth combination, the middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. A C63.19-2019 T-Coil scan was also performed under the worst-case configuration to demonstrate compliance.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Mod. | RB Config. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response (dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 25 | A | EVS-WB 24.4 | 26365 | 1 882.5 | 20 | QPSK | 1/0 | -52.18 | 4.01 | -47.21 | 51.22 | 2.00 | (6.0, -20.0) |
| LTE 25 | F | | 26365 | 1 882.5 | 20 | QPSK | | | 2.92 | -43.54 | 46.46 | 1.55 | |
| LTE 7 | A | | 21100 | 2 535 | 20 | QPSK | | | 4.12 | -47.53 | 51.65 | 2.00 | |
| LTE 12 | A | | 23095 | 707.5 | 10 | QPSK | | | 4.21 | -43.62 | 47.83 | 2.00 | |
| LTE 13 | A | | 23230 | 782 | 10 | QPSK | | | 4.14 | -42.93 | 47.07 | 2.00 | |
| LTE 14 | A | | 23330 | 793 | 10 | QPSK | | | 4.21 | -43.08 | 47.29 | 2.00 | |
| LTE 26 | A | | 26865 | 831.5 | 15 | QPSK | | | 4.13 | -46.49 | 50.62 | 2.00 | |
| LTE 30 | A | | 27710 | 2 310 | 10 | QPSK | | | 4.12 | -45.22 | 49.34 | 2.00 | |
| LTE 66 | A | | 132322 | 1 745 | 20 | QPSK | | | 3.45 | -43.59 | 47.04 | 1.14 | |
| LTE 66 | F | | 132322 | 1 745 | 20 | QPSK | | | 3.03 | -43.31 | 46.34 | 1.24 | |
| LTE 71 | A | | 133297 | 680.5 | 20 | QPSK | | | 3.51 | -43.53 | 47.04 | 2.00 | |
| LTE 41 | A | | 40620 | 2 593 | 20 | QPSK | | | 4.22 | -36.13 | 40.35 | 2.00 | |
| LTE 48 | G | | 55773 | 3 603.3 | 20 | QPSK | | | 3.75 | -38.45 | 42.20 | 1.25 | |
| LTE 41 | A | | 40620 | 2 593 | 15 | QPSK | | | 4.23 | -36.61 | 40.84 | 2.00 | |
| | | | 40620 | 2 593 | 10 | QPSK | | | 4.21 | -36.56 | 40.77 | 2.00 | |
| | | | 40620 | 2 593 | 5 | QPSK | | | 4.22 | -36.5 | 40.72 | 2.00 | |
| | | | 39750 | 2 506 | 20 | QPSK | | | 4.20 | -36.92 | 41.12 | 1.90 | |
| | | | 40185 | 2 549.5 | 20 | QPSK | | | 4.22 | -36.42 | 40.64 | 2.00 | |
| | | | 41055 | 2 636.5 | 20 | QPSK | | | 4.19 | -38.08 | 42.27 | 2.00 | |
| | | | 41490 | 2 680 | 20 | QPSK | | | 4.24 | -37.38 | 41.62 | 2.00 | |

## 12.6.5 VoLTE Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq(MHz) | BW (MHz) | Mod. | RB Config. | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 41 | A | EVS-WB 24.4 | 40620 | 2 593 | 20 | QPSK | 1/0 | -52.18 | 154 | 363 | 19 | 26 | 2.00 | 5 |

## 12.7 OTT VoIP over LTE Measurements

Measurements were conducted to identify the worst-case band configuration for OTT VoIP over LTE. For each band and maximum bandwidth combination, the middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. A C63.19-2019 T-Coil scan was also performed under the worst-case configuration to demonstrate compliance.

### 12.7.1 VoIP over LTE Single Point Measurement Results

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Mod. | RB Config. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response (dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 25 | A | 510 | 26365 | 1 882.5 | 20 | QPSK | 1/0 | -52.18 | 0.72 | -42.64 | 43.36 | 2.00 | (7.0, -19.0) |
| LTE 25 | F | | 26365 | 1 882.5 | 20 | QPSK | 1/0 | | 0.55 | -41.87 | 42.42 | 2.00 | |
| LTE 7 | A | | 21100 | 2 535 | 20 | QPSK | 1/0 | | 0.41 | -43.17 | 43.58 | 1.97 | |
| LTE 12 | A | | 23095 | 707.5 | 10 | QPSK | 1/0 | | 0.57 | -43.12 | 43.69 | 2.00 | |
| LTE 13 | A | | 23230 | 782 | 10 | QPSK | 1/0 | | 0.64 | -43.77 | 44.41 | 2.00 | |
| LTE 14 | A | | 23330 | 793 | 10 | QPSK | 1/0 | | 0.63 | -43.00 | 43.63 | 2.00 | |
| LTE 26 | A | | 26865 | 831.5 | 15 | QPSK | 1/0 | | 0.75 | -43.91 | 44.66 | 2.00 | |
| LTE 30 | A | | 27710 | 2 310 | 10 | QPSK | 1/0 | | 0.47 | -42.62 | 43.09 | 2.00 | |
| LTE 66 | A | | 132322 | 1 745 | 20 | QPSK | 1/0 | | 0.71 | -42.96 | 43.67 | 2.00 | |
| LTE 66 | F | | 132322 | 1 745 | 20 | QPSK | 1/0 | | 0.72 | -41.65 | 42.37 | 2.00 | |
| LTE 71 | A | | 133297 | 680.5 | 20 | QPSK | 1/0 | | 0.32 | -43.88 | 44.20 | 2.00 | |
| LTE 41 | A | | 40620 | 2 593 | 20 | QPSK | 1/0 | | 0.75 | -34.02 | 34.77 | 1.92 | |
| LTE 48 | G | | 55773 | 3 603.3 | 20 | QPSK | 1/0 | | 0.89 | -35.58 | 36.47 | 2.00 | |
| LTE 41 | A | | 39750 | 2 506 | 20 | QPSK | 1/0 | | 0.89 | -34.15 | 35.04 | 2.00 | |
| | | | 40185 | 2 549.5 | 20 | QPSK | 1/0 | | 0.78 | -33.19 | 33.97 | 2.00 | |
| | | | 41055 | 2 636.5 | 20 | QPSK | 1/0 | | 0.50 | -33.78 | 34.28 | 2.00 | |
| | | | 41490 | 2 680 | 20 | QPSK | 1/0 | | 0.74 | -33.41 | 34.15 | 1.98 | |

### 12.7.2 OTT VoIP over LTE Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq(MHz) | BW (MHz) | Mod. | RB Config. | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE 41 | A | 510 | 40185 | 2 549.5 | 20 | QPSK | 1/0 | -52.18 | 116 | 357 | 18 | 26 | 1.80 | 6 |

## 12.8 NR T-coil Measurements

### 12.8.1 NR Configuration Investigation Results

Measurements were conducted to select the test radio configuration. Since the effects of modulation and RB were independent of band and bandwidth, one representative condition was evaluated. The radio configuration was determined based on the worst-case SNNR results. The table below presents an SNNR comparison across the evaluated configurations.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | RB Config. | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NR n41[PC2] | A | EVS-NB 5.9 | 518598 | 2 592.99 | 100 | DFT-S QPSK | 1/1 | 2.09 | -25.89 | 27.98 | (7.0, -5.0) |
| | | | | | | | 1/137 | 2.32 | -26.01 | 28.33 | |
| | | | | | | | 1/271 | 1.40 | -24.89 | 26.29 | |
| | | | | | | | 135/0 | 1.96 | -26.35 | 28.31 | |
| | | | | | | | 135/69 | 2.32 | -26.08 | 28.40 | |
| | | | | | | | 135/138 | 1.61 | -26.78 | 28.39 | |
| | | | | | | | 270/0 | 2.62 | -26.52 | 29.14 | |
| | | | | | | DFT-S BPSK | 1/271 | 2.53 | -24.85 | 27.38 | |
| | | | | | | DFT-S 16QAM | 1/271 | 2.38 | -25.55 | 27.93 | |
| | | | | | | DFT-S 64QAM | 1/271 | 2.29 | -26.25 | 28.54 | |
| | | | | | | DFT-S 256QAM | 1/271 | 2.44 | -25.69 | 28.13 | |
| | | | | | | CP QPSK | 1/271 | 3.23 | -25.16 | 28.39 | |
| | | | | | | CP 16QAM | 1/271 | 2.14 | -25.63 | 27.77 | |
| | | | | | | CP 64QAM | 1/271 | 1.25 | -25.82 | 27.07 | |
| | | | | | | CP 256QAM | 1/271 | 1.73 | -26.30 | 28.03 | |

### 12.8.2 VoNR Single Point Measurement Results

Measurements were conducted to identify the worst-case band configuration for VoNR over IMS. For each band and maximum bandwidth combination, the middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. A C63.19-2019 T-Coil scan was also performed under the worst-case configuration to demonstrate compliance.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | RB Config. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response (dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NR n25 | A | EVS-NB 5.9 | 376000 | 1 880 | 40 | DFT-S QPSK | 1/214 | -52.19 | 1.83 | -38.45 | 40.28 | 1.80 | (7.0, -5.0) |
| NR n25 | F | | 376000 | 1 880 | 40 | | 1/214 | | 3.23 | -38.75 | 41.98 | 2.00 | |
| NR n5 | A | | 167300 | 836.5 | 20 | | 1/104 | | 1.52 | -39.67 | 41.19 | 2.00 | |
| NR n30 | A | | 462000 | 2 310 | 10 | | 1/50 | | 2.32 | -41.41 | 43.73 | 2.00 | |
| NR n66 | A | | 349000 | 1 745 | 40 | | 1/214 | | 2.12 | -40.36 | 42.48 | 2.00 | |
| NR n66 | F | | 349000 | 1 745 | 40 | | 1/214 | | 2.71 | -40.49 | 43.2 | 2.00 | |
| NR n70 | A | | 340500 | 1 702.5 | 15 | | 1/77 | | 0.26 | -40.95 | 41.21 | 1.95 | |
| NR n70 | F | | 340500 | 1 702.5 | 15 | | 1/77 | | 2.21 | -41.18 | 43.39 | 2.00 | |
| NR n71 | A | | 136100 | 680.5 | 20 | | 1/104 | | 2.01 | -42.78 | 44.79 | 2.00 | |
| NR n41 [PC2] | A | | 518598 | 2 592.99 | 100 | | 1/271 | | 1.40 | -24.89 | 26.29 | 2.00 | |
| NR n41 [PC3] | A | | 518598 | 2 592.99 | 100 | | 1/271 | | 2.75 | -24.56 | 27.31 | 2.00 | |

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | RB Config. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response (dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NR n48 | G | EVS-NB 5.9 | 641666 | 3 624.99 | 90 | DFT-s QPSK | 1/104 | -52.19 | 1.30 | -27.89 | 29.19 | 2.00 | (7.0, -5.0) |
| NR n77 [PC2] | G | | 650000 | 3 750 | 80 | DFT-s QPSK | 1/271 | | 1.61 | -26.34 | 27.95 | 1.49 | |
| NR n77 [PC3] | G | | 650000 | 3 750 | 70 | DFT-s QPSK | 1/271 | | 1.99 | -26.94 | 28.93 | 1.22 | |
| NR n77 [PC2] DoD | G | | 633334 | 3 500.01 | 60 | DFT-s QPSK | 1/271 | | 1.99 | -25.06 | 27.05 | 2.00 | |
| NR n77 [PC3] DoD | G | | 633334 | 3 500.01 | 50 | DFT-s QPSK | 1/271 | | 2.01 | -25.83 | 27.84 | 2.00 | |
| NR n41 [PC2] | A | | 518598 | 2 592.99 | 90 | DFT-s QPSK | 1/243 | | 1.94 | -24.8 | 26.74 | 2.00 | |
| | | | | | 80 | | 1/215 | | 2.04 | -24.98 | 27.02 | 2.00 | |
| | | | | | 70 | | 1/187 | | 3.29 | -25.12 | 28.41 | 1.63 | |
| | | | | | 60 | | 1/160 | | 1.97 | -26.04 | 28.01 | 2.00 | |
| | | | | | 50 | | 1/131 | | 2.31 | -26.28 | 28.59 | 2.00 | |
| | | | | | 40 | | 1/104 | | 1.97 | -26.67 | 28.64 | 2.00 | |
| | | | | | 30 | | 1/76 | | 2.13 | -26.76 | 28.89 | 2.00 | |
| | | | | | 20 | | 1/49 | | 1.72 | -27.44 | 29.16 | 2.00 | |
| | | | | | 15 | | 1/36 | | 2.55 | -26.58 | 29.13 | 2.00 | |
| | | | | | 10 | | 1/22 | | 1.96 | -27.18 | 29.14 | 2.00 | |

### 12.8.3 VoNR Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | RB Config. | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NR n41 [PC2] | A | EVS-NB 5.9 | 518598 | 2 592.99 | 100 | DFT-s QPSK | 1/271 | -52.19 | 97 | 335 | 17 | 26 | 2.00 | 7 |

## 12.9 OTT VoIP over NR Measurements

Measurements were conducted to identify the worst-case band configuration for OTT VoIP over NR. For each band and maximum bandwidth combination, the middle channel was measured at the maximum desired ABM location, and low/mid/high channels were evaluated under the worst-case SNNR condition for FCC compliance. A C63.19-2019 T-Coil scan was also performed under the worst-case configuration to demonstrate compliance.

### 12.9.1 OTT VoIP over NR Single Point Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | RB Config. | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response (dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NR n25 | A | 510 | 376000 | 1 880 | 40 | DFT-s QPSK | 1/214 | -52.08 | 2.44 | -32.39 | 34.83 | 1.62 | (6.0, -5.0) |
| NR n25 | F | | 376000 | 1 880 | 40 | DFT-s QPSK | 1/214 | | 2.42 | -32.34 | 34.76 | 1.87 | |
| NR n5 | A | | 167300 | 836.5 | 20 | DFT-s QPSK | 1/104 | | 2.47 | -37.43 | 39.90 | 1.76 | |
| NR n30 | A | | 462000 | 2 310 | 10 | DFT-s QPSK | 1/50 | | 1.98 | -37.15 | 39.13 | 2.00 | |
| NR n66 | A | | 349000 | 1 745 | 40 | DFT-s QPSK | 1/214 | | 1.83 | -32.08 | 33.91 | 2.00 | |
| NR n66 | F | | 349000 | 1 745 | 40 | DFT-s QPSK | 1/214 | | 1.81 | -31.63 | 33.44 | 1.79 | |
| NR n70 | A | | 340500 | 1 702.5 | 15 | DFT-s QPSK | 1/77 | | 1.95 | -34.39 | 36.34 | 1.90 | |
| NR n70 | F | | 340500 | 1 702.5 | 15 | DFT-s QPSK | 1/77 | | 1.57 | -38.02 | 39.59 | 1.45 | |
| NR n71 | A | | 136100 | 680.5 | 20 | DFT-s QPSK | 1/104 | | 1.73 | -36.17 | 37.90 | 2.00 | |
| NR n41 [PC2] | A | | 518598 | 2 592.99 | 100 | DFT-s QPSK | 1/271 | | 2.51 | -24.58 | 27.09 | 1.65 | |
| NR n41 [PC3] | A | | 518598 | 2 592.99 | 100 | DFT-s QPSK | 1/271 | | 2.12 | -25.89 | 28.01 | 1.82 | |
| NR n48 | G | | 641666 | 3 624.99 | 40 | DFT-s QPSK | 1/104 | | 2.36 | -28.16 | 30.52 | 1.73 | |
| NR n77 [PC2] | G | | 650000 | 3 750 | 100 | DFT-s QPSK | 1/271 | | 2.48 | -27.27 | 29.75 | 1.70 | |
| NR n77[PC 3] | G | | 650000 | 3 750 | 100 | DFT-s QPSK | 1/271 | | 1.98 | -26.25 | 28.23 | 2.00 | |
| NR n77 [PC2] DoD | G | | 633334 | 3 500.01 | 100 | DFT-s QPSK | 1/271 | | 2.43 | -25.38 | 27.81 | 1.59 | |
| NR n77 [PC3 ] DoD | G | | 633334 | 3 500.01 | 100 | DFT-s QPSK | 1/271 | | 2.09 | -25.13 | 27.22 | 2.00 | |

### 12.9.2 OTT VoIP over NR Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | RB Config. | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NR n41 [PC3] | A | 510 | 518598 | 2 592.99 | 100 | DFT-s QPSK | 1/271 | -52.08 | 88 | 321 | 15 | 26 | 1.77 | 8 |

## 13.1 WIFI 2.4 GHz T-coil Measurements

### 13.1.1 WIFI 2.4 GHz Data rate investigation

Measurements were performed across all applicable data rates and modulations to determine the radio configuration for testing. All evaluations were conducted in SISO mode. The tables below provide an SNNR-based comparison of the evaluated radio configurations for each IEEE 802.11 standard.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|
| 802.11b | J | EVS-SWB 9.6 | CH.6 | 2 437 | 20 | 1 Mbps | 2.42 | -42.84 | 45.26 | (6.0, -5.0) |
| | | | | | | 11 Mbps | 2.41 | -39.32 | 41.73 | |
| 802.11g | | | | | | 6 Mbps | 2.47 | -42.22 | 44.69 | |
| | | | | | | 54 Mbps | 2.45 | -42.58 | 45.03 | |
| 802.11n20 | | | | | | MCS 0 | 2.49 | -42.52 | 45.01 | |
| | | | | | | MCS 7 | 2.34 | -42.71 | 45.05 | |
| 802.11ac20 | | | | | | MCS 0 | 2.40 | -42.22 | 44.62 | |
| | | | | | | MCS 8 | 2.37 | -42.33 | 44.70 | |

### 13.1.2 VoWIFI 2.4 GHz Single Point Measurement Results

Measurements were conducted to identify the worst-case operating condition for VoWIFI over IMS. For each IEEE 802.11 standard, single-point measurements were performed on the mid channel under the worst-case SNNR condition. The configuration determined from the worst-case SNNR analysis was further evaluated on low and high channels. A C63.19-2019 T-Coil scan was also performed under the selected worst-case configuration.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11b | J | EVS-SWB 9.6 | 6 | 2 437 | 20 | 11 Mbps | -52.26 | 2.41 | -39.32 | 41.73 | 1.93 | (6.0, -5.0) |
| 802.11g | | | 6 | 2 437 | | 6 Mbps | | 2.47 | -42.22 | 44.69 | 1.95 | |
| 802.11n20 | | | 6 | 2 437 | | MCS 0 | | 2.49 | -42.52 | 45.01 | 1.58 | |
| 802.11ac20 | | | 6 | 2 437 | | MCS 0 | | 2.40 | -42.22 | 44.62 | 1.74 | |
| 802.11b | | | 1 | 2 412 | | 11 Mbps | | 2.23 | -41.70 | 43.93 | 1.65 | |
| | | | 11 | 2 462 | | 11 Mbps | | 2.34 | -42.23 | 44.57 | 1.91 | |

### 13.1.3 VoWiFi 2.4 GHz Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11b | J | EVS-SWB 9.6 | 6 | 2 437 | 20 | 11 Mbps | -52.26 | 257 | 517 | 23 | 26 | 1.54 | 9 |

## 13.2 OTT VoIP over WIFI 2.4 GHz

Measurements were conducted to identify the worst-case operating condition for VoWIFI over IMS. For each IEEE 802.11 standard, single-point measurements were performed on the mid channel under the worst-case SNNR condition. The configuration determined from the worst-case SNNR analysis was further evaluated on low and high channels. A C63.19-2019 T-Coil scan was also performed under the selected worst-case configuration.

### 13.2.1 OTT VoIP over WIFI 2.4 GHz Single Point Measurement Results

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11b | J | 510 | 6 | 2 437 | 20 | 11 Mbps | -52.13 | -0.50 | -39.07 | 38.57 | 2.00 | (6.0, -5.0) |
| 802.11g | | | 6 | 2 437 | | 6 Mbps | | 1.48 | -39.73 | 41.21 | 2.00 | |
| 802.11n20 | | | 6 | 2 437 | | MCS 0 | | -0.47 | -39.70 | 39.23 | 2.00 | |
| 802.11ac20 | | | 6 | 2 437 | | MCS 0 | | -0.51 | -39.64 | 39.13 | 2.00 | |
| 802.11b | | | 1 | 2 412 | | 11 Mbps | | 1.19 | -37.25 | 38.44 | 2.00 | |
| | | | 11 | 2 462 | | 11 Mbps | | 0.39 | -38.04 | 38.43 | 2.00 | |

### 13.2.2 OTT VoIP over WIFI 2.4 GHz Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11b | J | 510 | 11 | 2 462 | 20 | 11 Mbps | -52.13 | 183 | 457 | 21 | 26 | 2.00 | 10 |

## 13.3 WiFi 5 GHz T-coil Measurements

### 13.3.1 WiFi 5 GHz Data rate investigation

Measurements were performed across all applicable data rates and modulations to determine the radio configuration for testing. All evaluations were conducted in SISO mode. The tables below provide an SNNR-based comparison of the evaluated radio configurations for each IEEE 802.11 standard.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|
| 802.11a | J | EVS-SWB 9.6 | 40 | 5 200 | 20 | 6 Mbps | 2.32 | -41.28 | 43.60 | (6.0, -5.0) |
| | | | | | | 54 Mbps | 2.54 | -42.21 | 44.75 | |
| 802.11n20 | | | 40 | 5 200 | 20 | MCS 0 | 2.42 | -42.04 | 44.46 | |
| | | | | | | MCS 7 | 2.70 | -41.21 | 43.91 | |
| 802.11n40 | | | 38 | 5 190 | 40 | MCS 0 | 2.57 | -41.06 | 43.63 | |
| | | | | | | MCS 7 | 2.46 | -41.30 | 43.76 | |
| 802.11ac20 | | | 40 | 5 200 | 20 | MCS 0 | 2.23 | -42.58 | 44.81 | |
| | | | | | | MCS 8 | 2.28 | -42.99 | 45.27 | |
| 802.11ac40 | | | 38 | 5 190 | 40 | MCS 0 | 2.28 | -43.30 | 45.58 | |
| | | | | | | MCS 9 | 2.28 | -43.44 | 45.72 | |
| 802.11ac80 | | | 42 | 5 210 | 80 | MCS 0 | 2.33 | -43.21 | 45.54 | |
| | | | | | | MCS 9 | 2.26 | -43.12 | 45.38 | |

### 13.3.2 VoWiFi 5 GHz Single Point Measurement Results

Measurements were conducted to determine the worst-case operating condition for VoWIFI over IMS. For each IEEE 802.11 standard, single-point measurements were performed on the mid channel under the worst-case SNNR condition. The configuration identified through the worst-case SNNR analysis was subsequently evaluated across higher bandwidths, U-NII bands, and applicable low and high channels. A C63.19-2019 T-Coil scan was performed under the selected worst-case configuration.

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11a | J | EVS-SWB 9.6 | 40 | 5 200 | 20 | 6 Mbps | -52.14 | 2.32 | -41.28 | 43.60 | 1.80 | (6.0, -5.0) |
| 802.11n20 | | | 40 | 5 200 | 20 | MCS 7 | | 2.70 | -41.21 | 43.91 | 1.72 | |
| 802.11n40 | | | 38 | 5 190 | 40 | MCS 0 | | 2.57 | -41.06 | 43.63 | 1.89 | |
| 802.11ac20 | | | 40 | 5 200 | 20 | MCS 0 | | 2.23 | -42.58 | 44.81 | 1.88 | |
| 802.11ac40 | | | 38 | 5 190 | 40 | MCS 0 | | 2.28 | -43.30 | 45.58 | 1.83 | |
| 802.11ac80 | | | 42 | 5 210 | 80 | MCS 9 | | 2.26 | -43.12 | 45.38 | 2.00 | |
| 802.11a | | | 56 | 5 280 | 20 | 6 Mbps | | 2.22 | -42.62 | 44.84 | 1.85 | |
| | | | 120 | 5 600 | | | | 2.17 | -42.95 | 45.12 | 1.87 | |
| | | | 165 | 5 825 | | | | 2.13 | -43.15 | 45.28 | 1.83 | |

### 13.3.3 VoWIFI 5 GHz Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11a | J | EVS-SWB 9.6 | 40 | 5 200 | 20 | 6 Mbps | -52.14 | 246 | 505 | 23 | 26 | 1.90 | 11 |

## 13.4 OTT VoIP over WiFi 5 GHz

Measurements were conducted to determine the worst-case band configuration for OTT VoIP over WIFI. For each IEEE 802.11 standard, single-point measurements were performed on the mid channel under the worst-case SNNR condition. The configuration identified through the worst-case SNNR analysis was subsequently evaluated across higher bandwidths, U-NII bands, and applicable low and high channels. A C63.19-2019 T-Coil scan was performed under the selected worst-case configuration.

### 13.4.1 OTT VoIP over WiFi 5 GHz Single Point Measurement Results

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Desired ABM [dB/A/M] | UnDesired ABM [dB/A/M] | SNNR [dB] | Freq. Response(dB) | Peak Measurement Location[x,y] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11a | J | 510 | 40 | 5 200 | 20 | 6 Mbps | -52.13 | 1.30 | -39.98 | 41.28 | 2.00 | (6.0, -5.0) |
| 802.11n20 | | | 40 | 5 200 | 20 | MCS 7 | | 1.26 | -39.79 | 41.05 | 2.00 | |
| 802.11n40 | | | 38 | 5 190 | 40 | MCS 0 | | 0.99 | -39.80 | 40.79 | 2.00 | |
| 802.11ac20 | | | 40 | 5 200 | 20 | MCS 0 | | 1.16 | -39.96 | 41.12 | 2.00 | |
| 802.11ac40 | | | 38 | 5 190 | 40 | MCS 0 | | 1.26 | -39.76 | 41.02 | 2.00 | |
| 802.11ac80 | | | 42 | 5 210 | 80 | MCS 9 | | 1.38 | -39.95 | 41.33 | 2.00 | |
| 802.11n40 | | | 54 | 5 270 | 40 | MCS 0 | | 1.26 | -40.08 | 41.34 | 2.00 | |
| | | | 110 | 5 550 | | | | 1.35 | -40.01 | 41.36 | 2.00 | |
| | | | 159 | 5 795 | | | | 1.43 | -40.08 | 41.51 | 2.00 | |

### 13.4.2 OTT VoIP over WiFi 5 GHz Worst Case Measurement Result

| Band | Ant | Codec (kbit/s) | Ch. | Freq (MHz) | BW (MHz) | Modulation | Ambient Noise dB (A/m) | Primary | Secondary | Contiguous longitudinal | Contiguous Transverse | Freq. Response(dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 802.11n40 | J | 510 | 38 | 5 190 | 40 | MCS 0 | -52.13 | 211 | 480 | 20 | 26 | 2.00 | 12 |

## 14.Summary of Test Results

| | Primary Points | Secondary Points | Continguous Longitudinal | Continguous Transverse | Frequency Response | C63.19 Result |
|---|---|---|---|---|---|---|
| GSM | Pass | Pass | Pass | Pass | Pass | Pass |
| UMTS | Pass | Pass | Pass | Pass | Pass | Pass |
| LTE | Pass | Pass | Pass | Pass | Pass | Pass |
| NR | Pass | Pass | Pass | Pass | Pass | Pass |
| WIFI | Pass | Pass | Pass | Pass | Pass | Pass |
| OTT VoIP | Pass | Pass | Pass | Pass | Pass | Pass |

## 15.Conclusion

The wireless device was evaluated for Hearing Aid Compatibility (HAC) in T-Coil mode in accordance with ANSI C63.19-2019. The device was found to meet the applicable requirements for desired magnetic signal strength, undesired noise, and frequency response.
Based on the test results, the wireless communications device complies with the HAC limits specified in ANSI C63.19-2019 and FCC UT Docket No. 01-309 (RM-8658). All measurements were performed under controlled laboratory conditions in order to ensure repeatability. The test results and statements contained in this report are applicable only to the item(s) tested and to the conditions under which the tests were performed.

End.

# Appendix A. TEST SETUP PHOTO

Please refer to test Setup Photo file no. as follows;

| Rev. No. | File No. |
|---|---|
| 0 | HCT-SR-2604-FC004-P |

# Appendix B. HAC T-COIL Test Plots

Plot 1 GSM 850 CH.251 Voice Codec Speech Codec: FR V2 ANT A

T-Coil Signal Test Report

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

## Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| GSM 850 | GSM-FDD (TDMA, GMSK) | 251 | 848.8 |

## Grid Settings

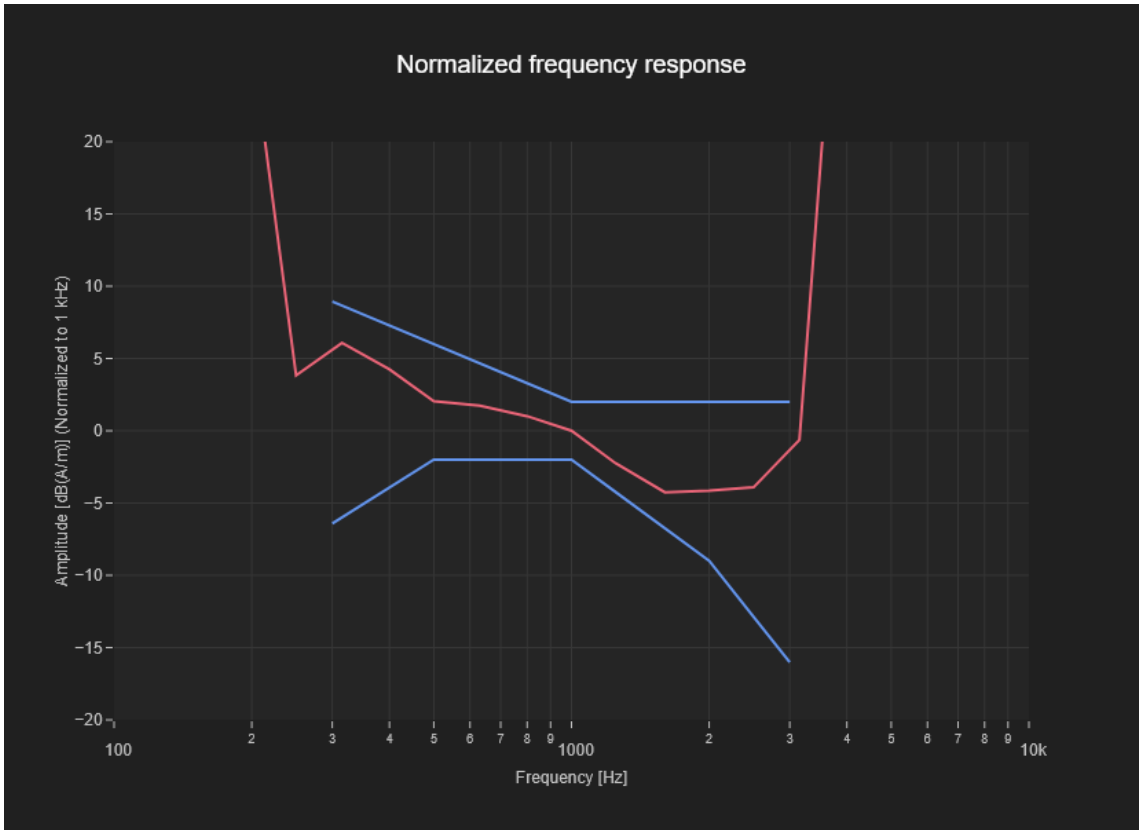
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

## Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 3.1 | (7.0, -5.0) |

## Results

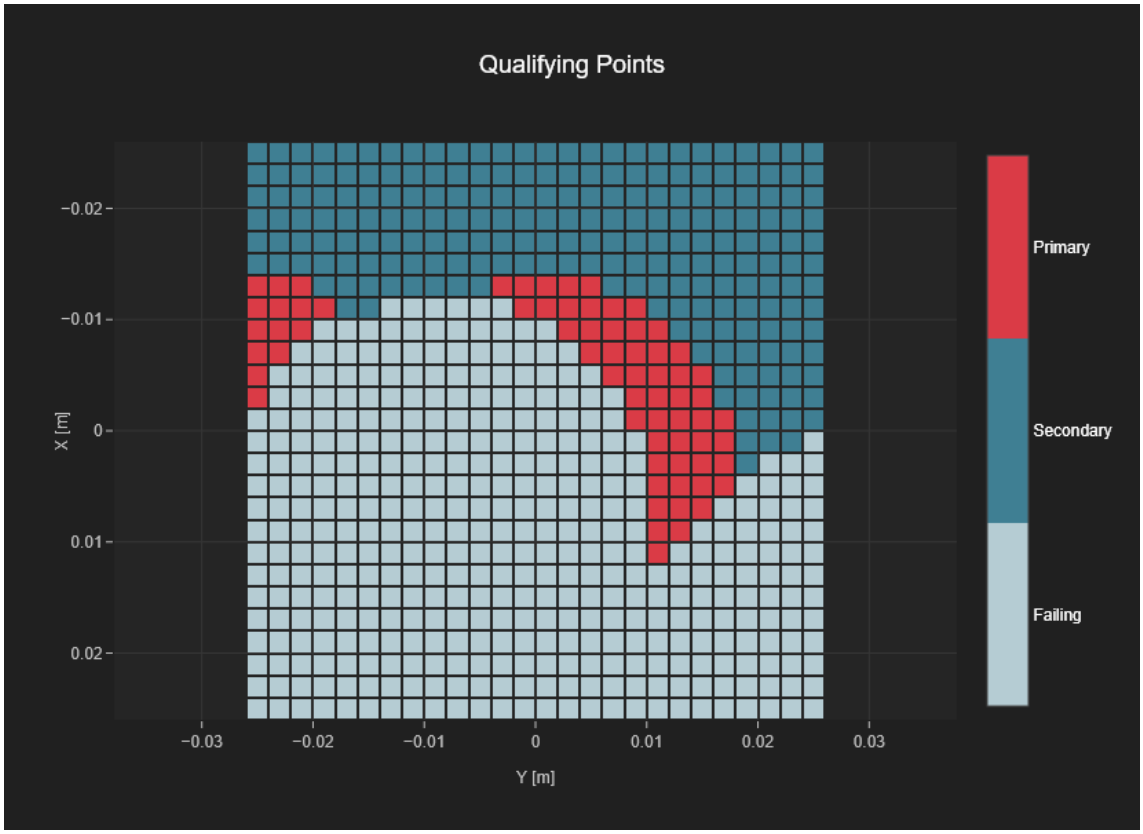
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 2.0 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 67 | 282 | 19 | 26 |



## Plot 2 GSM 850 CH.128EDGE OTT VoIP Google Meet Codec: 6kbps ANT A
## T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| GSM 850 | EDGE-FDD (TDMA, 8PSK, TN 0-1) | 128 | 824.2 |

### Grid Settings

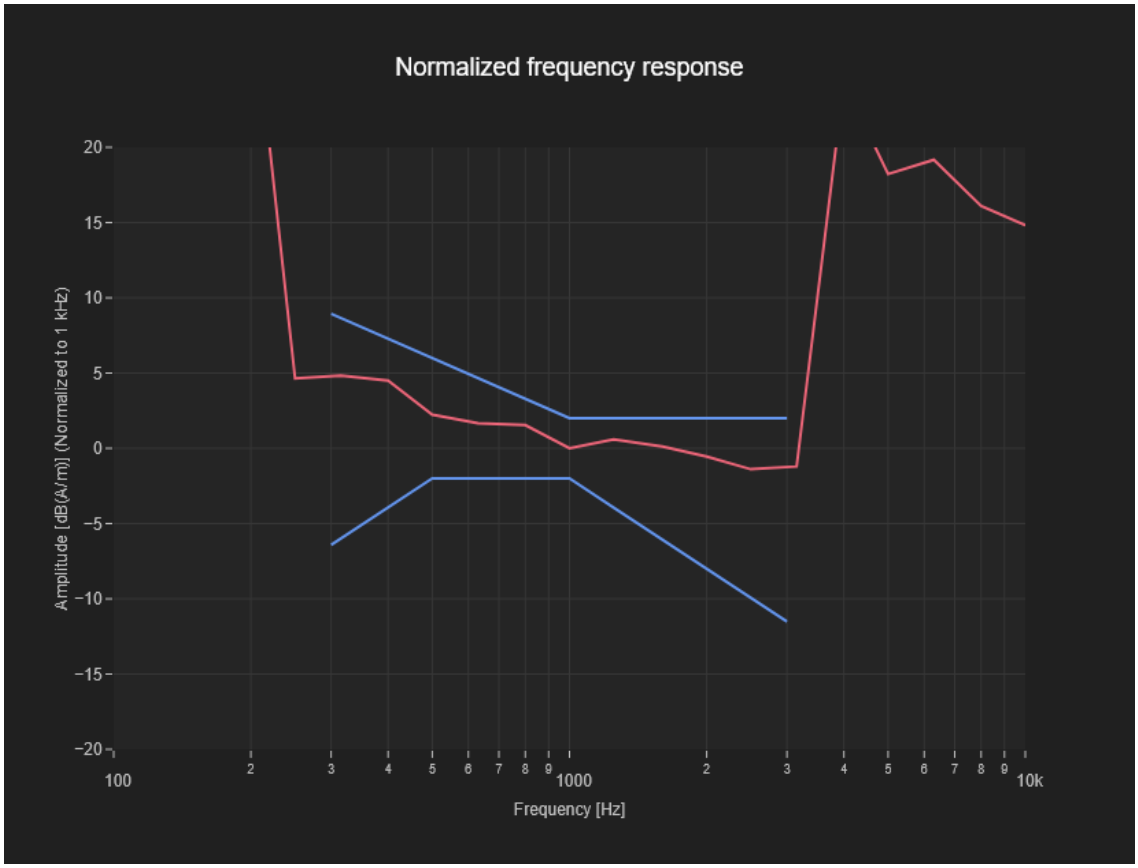
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | -1.53 | (7.0, -5.0) |

### Results

| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.41 | 2.0 |



T-Coil Coupling Mode Test Report
Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 62 | 337 | 18 | 26 |

## Plot 3 UMTS Band 5 CH.4183 Voice AMR-WB Codec: AMR-WB 23.85 ANT A
## T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band 5 | UMTS-FDD (WCDMA, AMR) | 4183 | 836.6 |

### Grid Settings

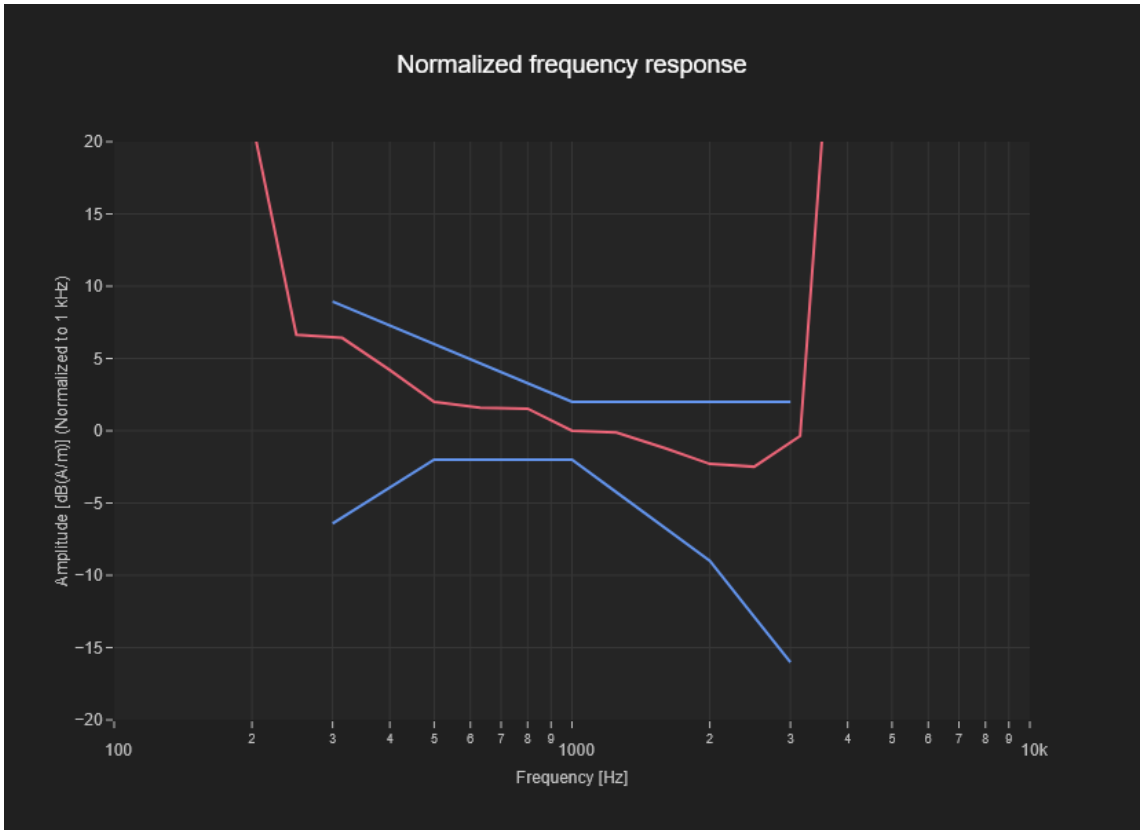
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.82 | (7.0, -5.0) |

### Results

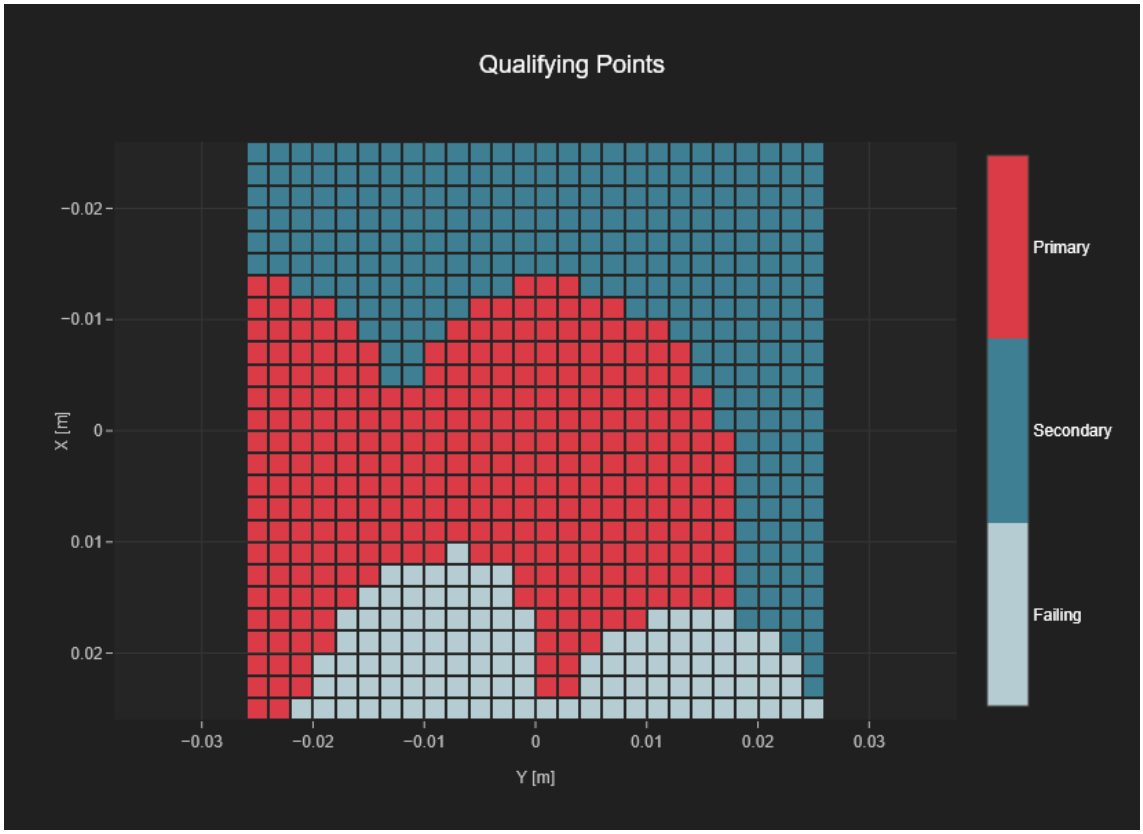
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.76 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 299 | 568 | 26 | 26 |



## Plot 4 UMTS Band 2 CH.9538 HSPA OTT VoIP Google Meet Codec: 510kbps ANT A T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band 2 | UMTS-FDD (HSUPA, Subtest 2) | 9538 | 1907.6 |

### Grid Settings

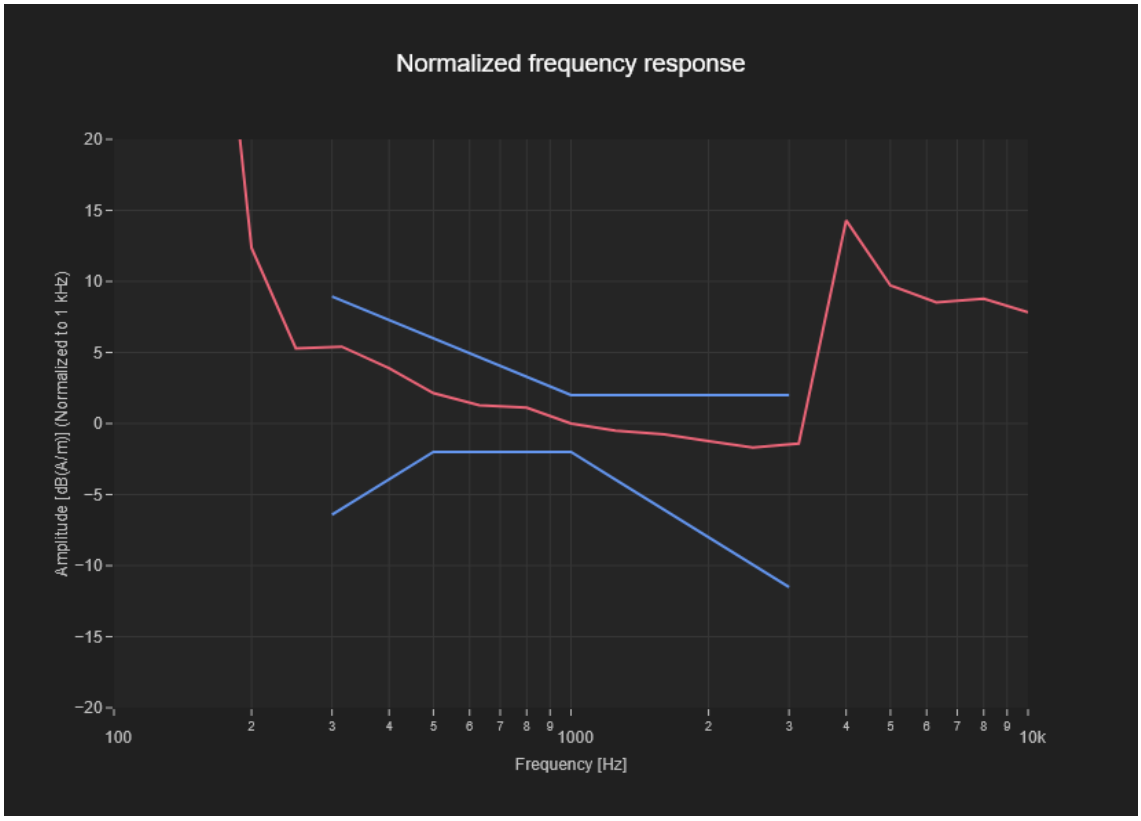
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 0.44 | (6.0, -19.0) |

### 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 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 208 | 481 | 21 | 26 |

## Plot 5 LTE Band 41 20MHz QPSK 1RB 0offset CH.40620 Codec: EVS-WB 24.4 ANT A T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band 41 | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | 40620 | 2593.0 |

### Grid Settings

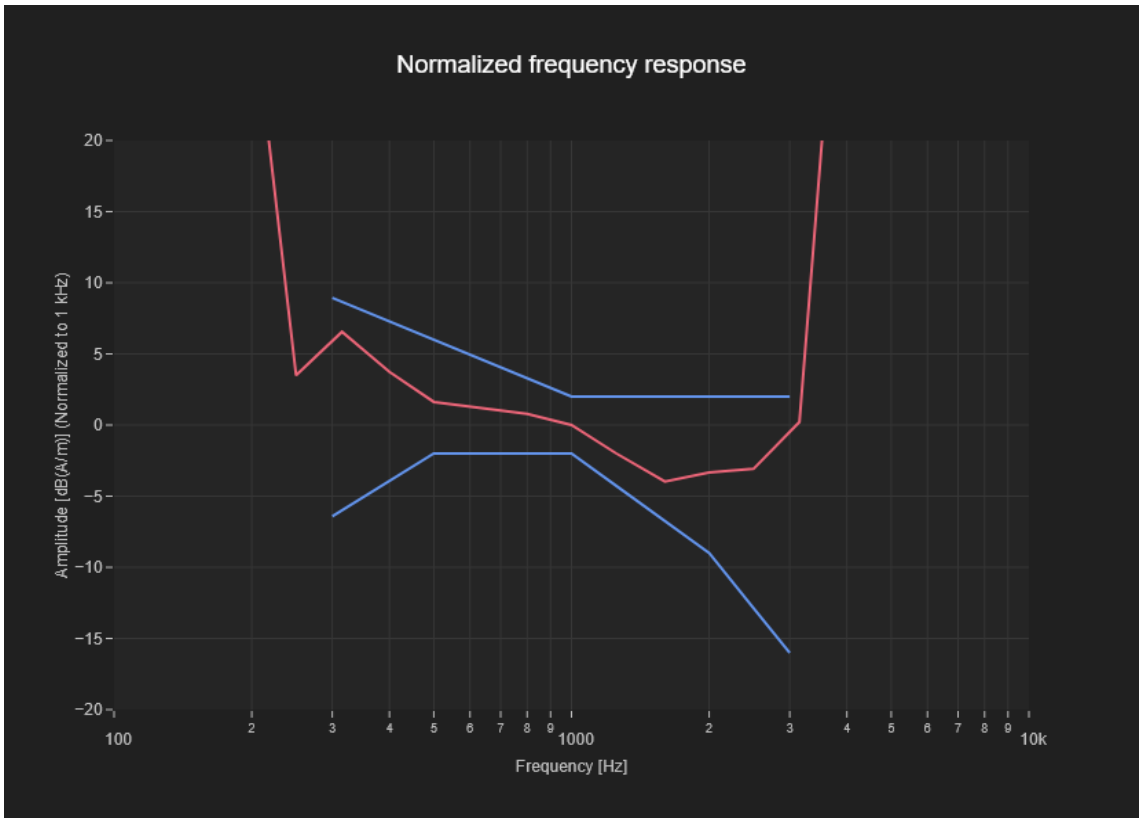
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 4.44 | (6.0, -5.0) |

### Results

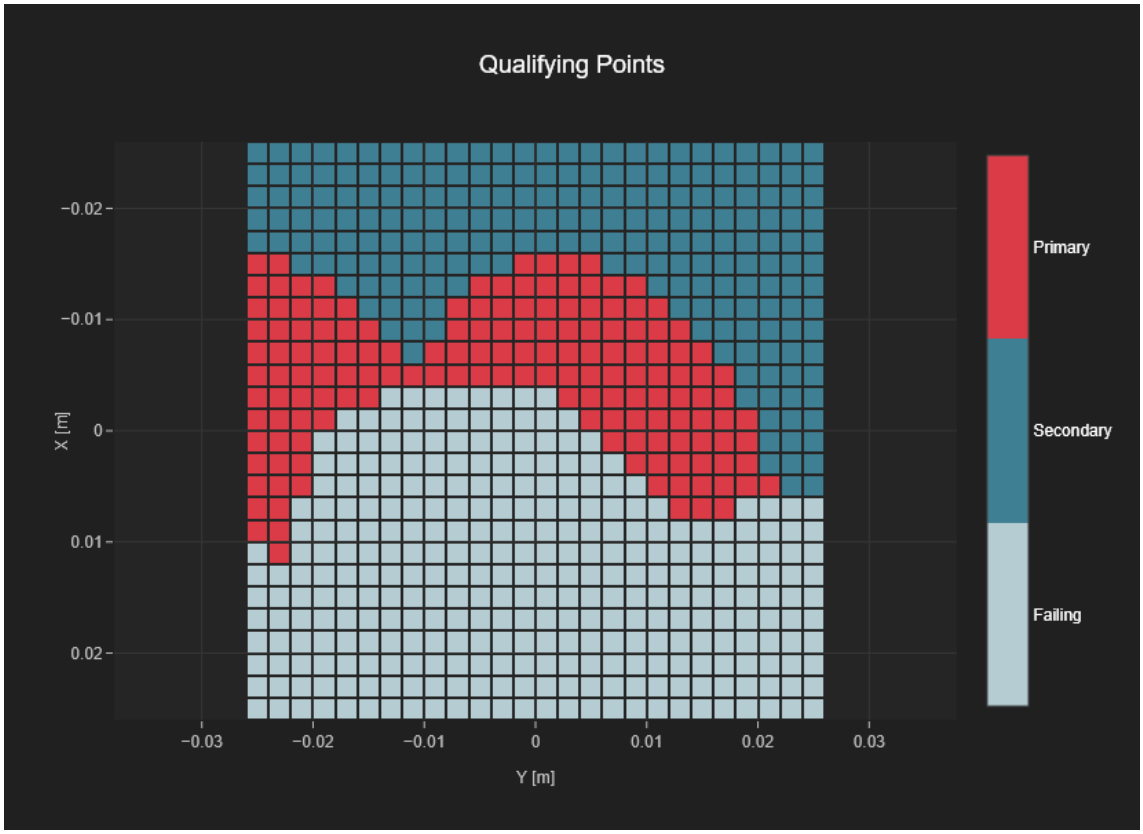
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 2.0 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 154 | 363 | 19 | 26 |



Plot 6 LTE Band 41 20MHz QPSK 1RB 0offset CH.40185
Google Meet Codec: 510kbps ANT A

T-Coil Signal Test Report

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

## Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band 41 | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | 40185 | 2549.5 |

## Grid Settings

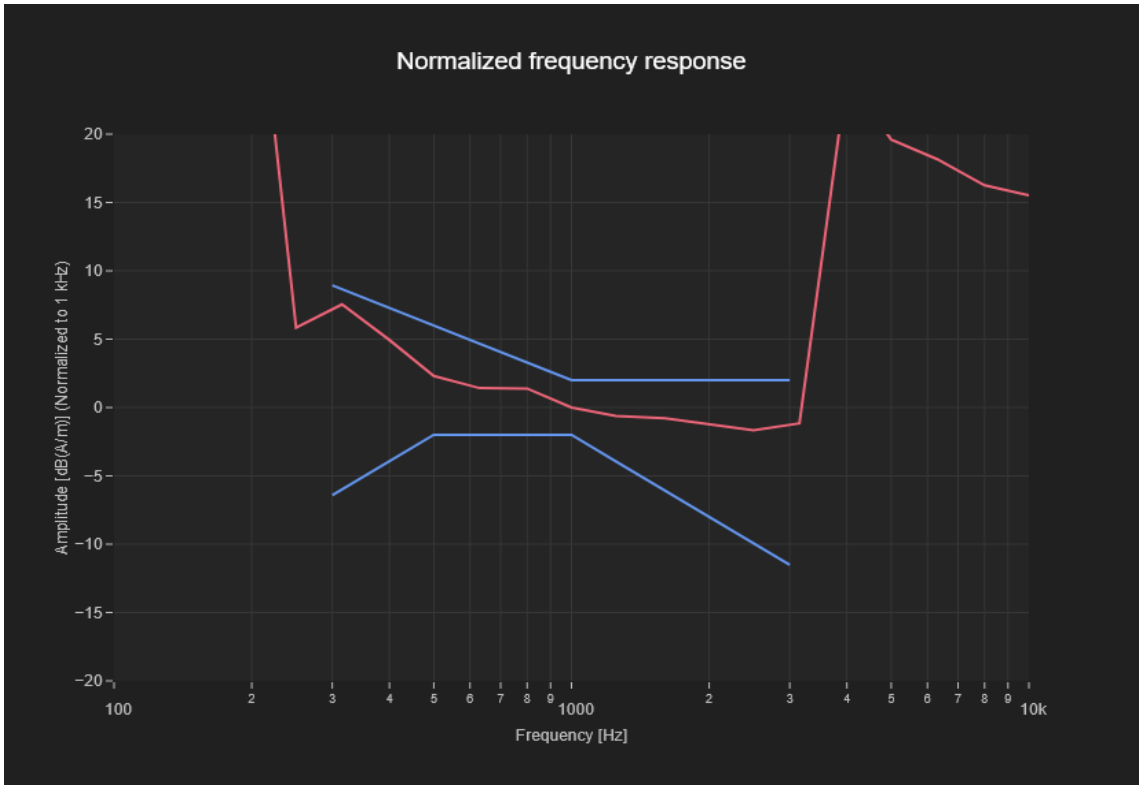
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

## Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.5 | (6.0, -4.0) |

## Results

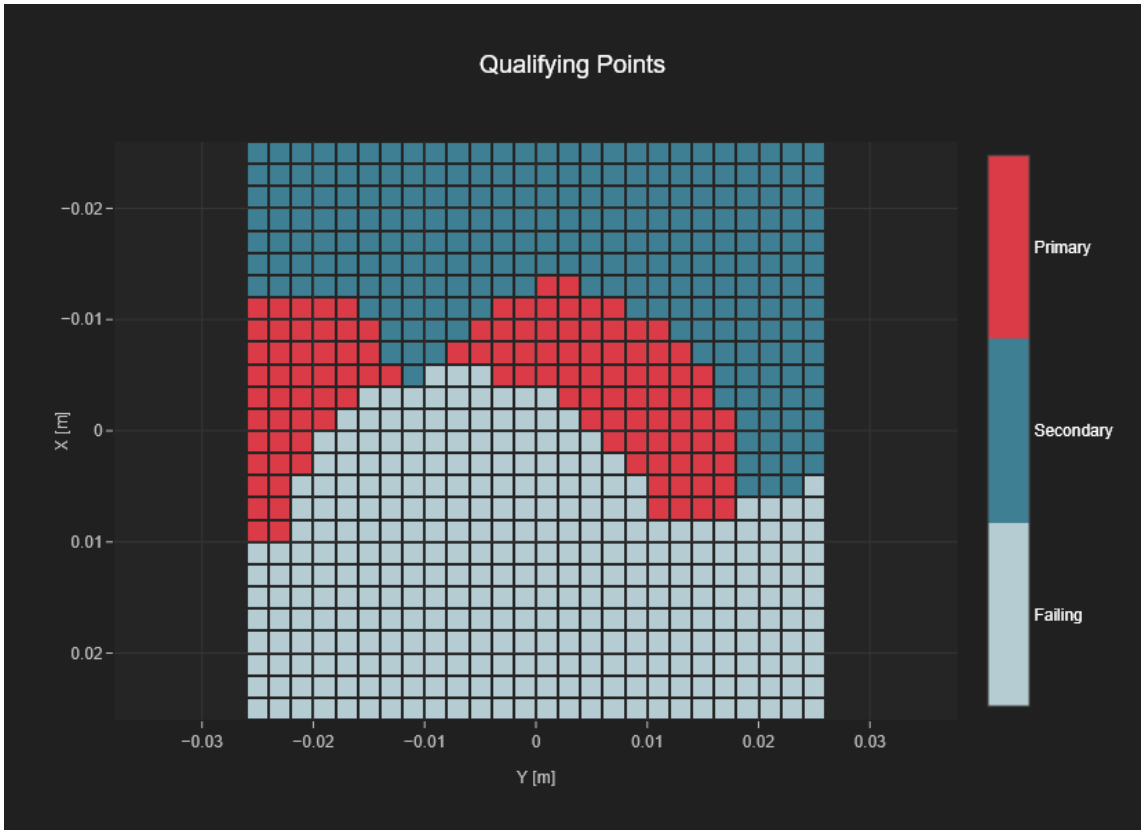
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.8 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 116 | 357 | 18 | 26 |



Plot 7 NR Band n41[PC2] 100MHz DFT-s QPSK 1RB 271offset CH.518598
Codec: EVS-NB 5.9 ANT A

T-Coil Signal Test Report

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

## Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band n41 | 5G NR (DFT-s-OFDM, 1 RB, 100 MHz, QPSK, 30 kHz) | 518598 | 2592.99 |

## Grid Settings

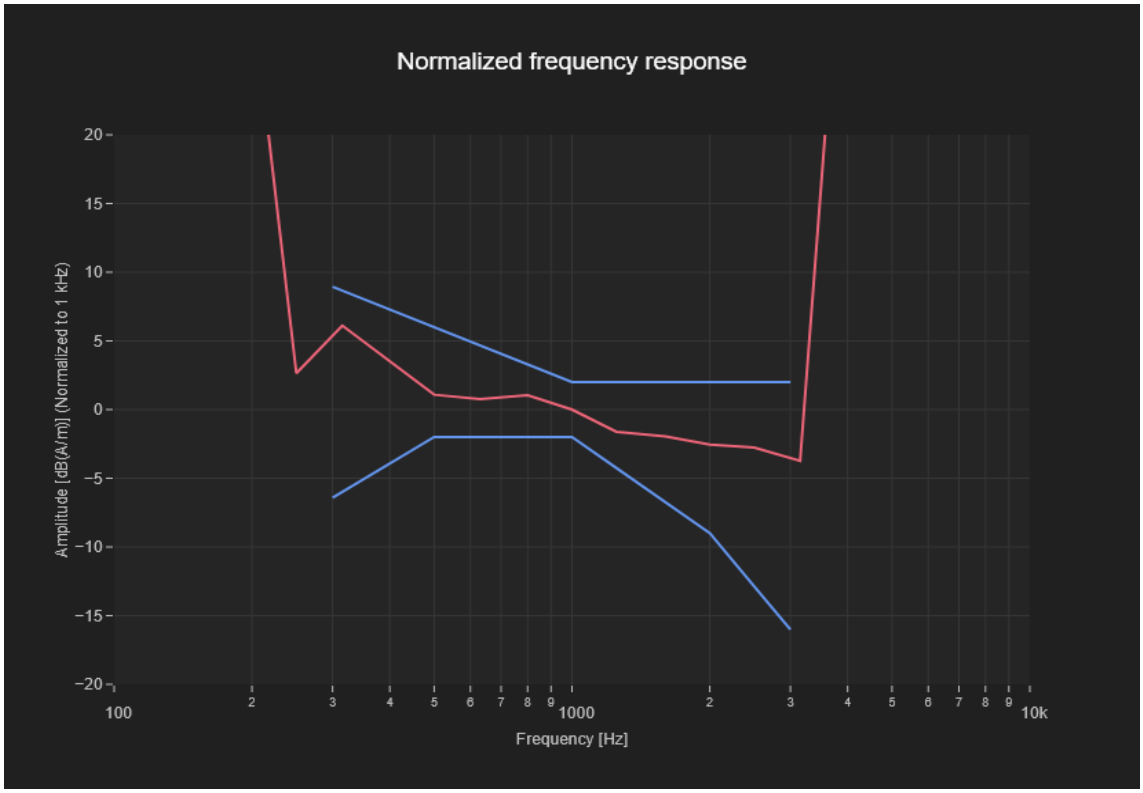
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 54.0 | 54.0 | 4.0 | 4.0 | 10.0 |

## Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.78 | (7.0, -18.0) |

## 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 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 97 | 335 | 17 | 26 |

Plot 8 NR Band n41[PC2] 100MHz DFT-s QPSK 1RB 2711offset CH.518598
Google Meet Codec: 510kbps ANT A

T-Coil Signal Test Report

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

## Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band n41 | 5G NR (DFT-s-OFDM, 1 RB, 100 MHz, QPSK, 30 kHz) | 518598 | 2592.99 |

## Grid Settings

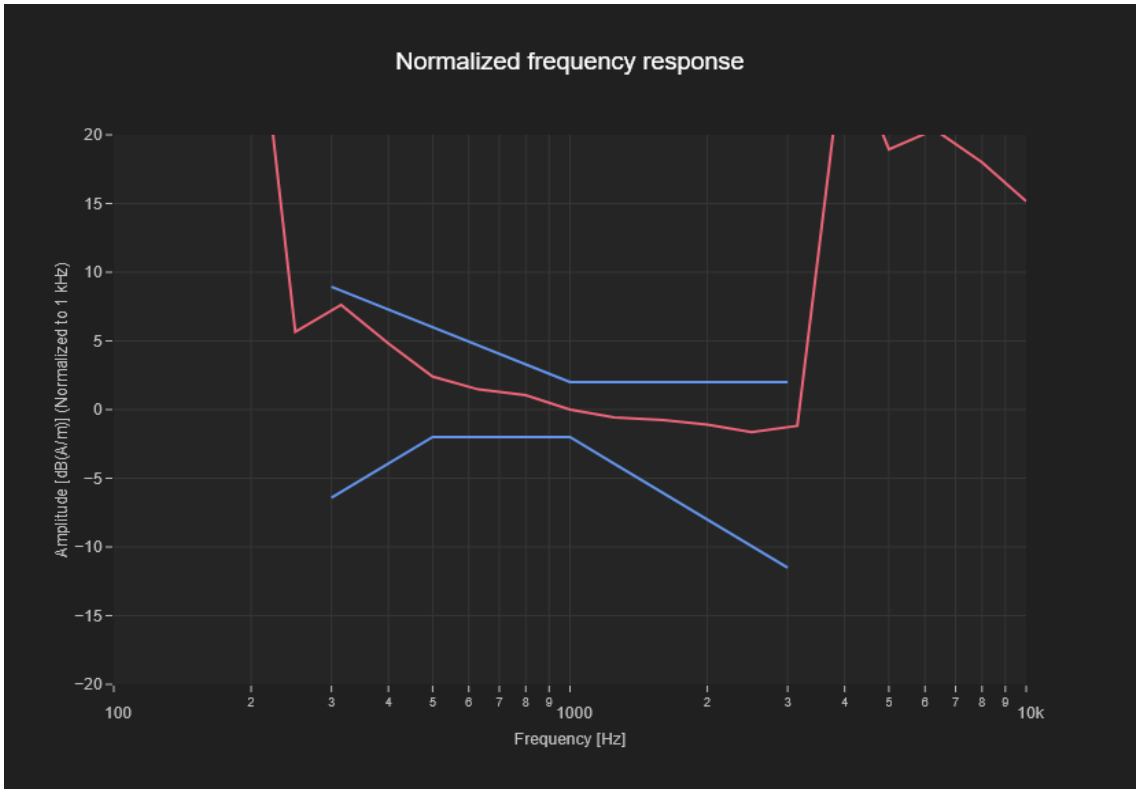
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

## Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 2.1 | (6.0, -5.0) |

## Results

| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.77 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 88 | 321 | 15 | 26 |

## Plot 9 WIFI 2.4 GHz 802.11b CH.6 11Mbps Codec: EVS-SWB 9.6 ANT J

## T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| WLAN 2.4GHz | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps, 99pc duty cycle) | 6 | 2437.0 |

### Grid Settings

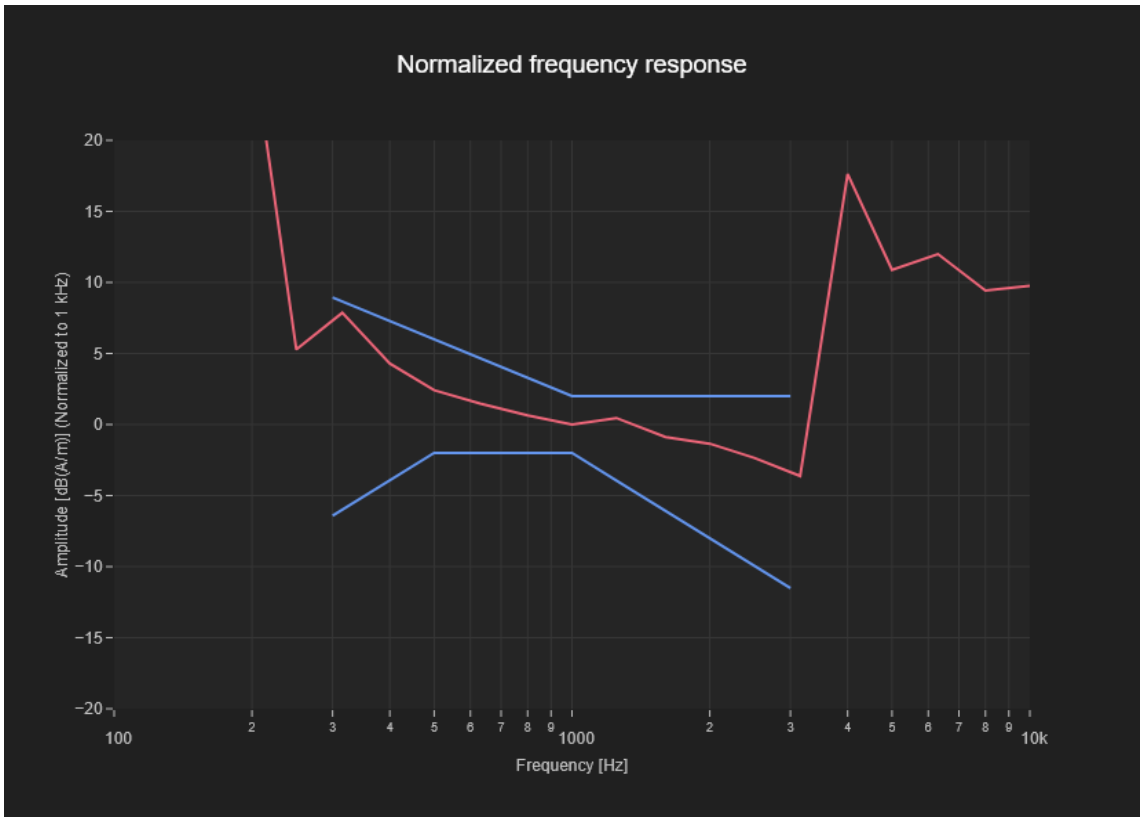
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 2.27 | (6.0, -5.0) |

### Results

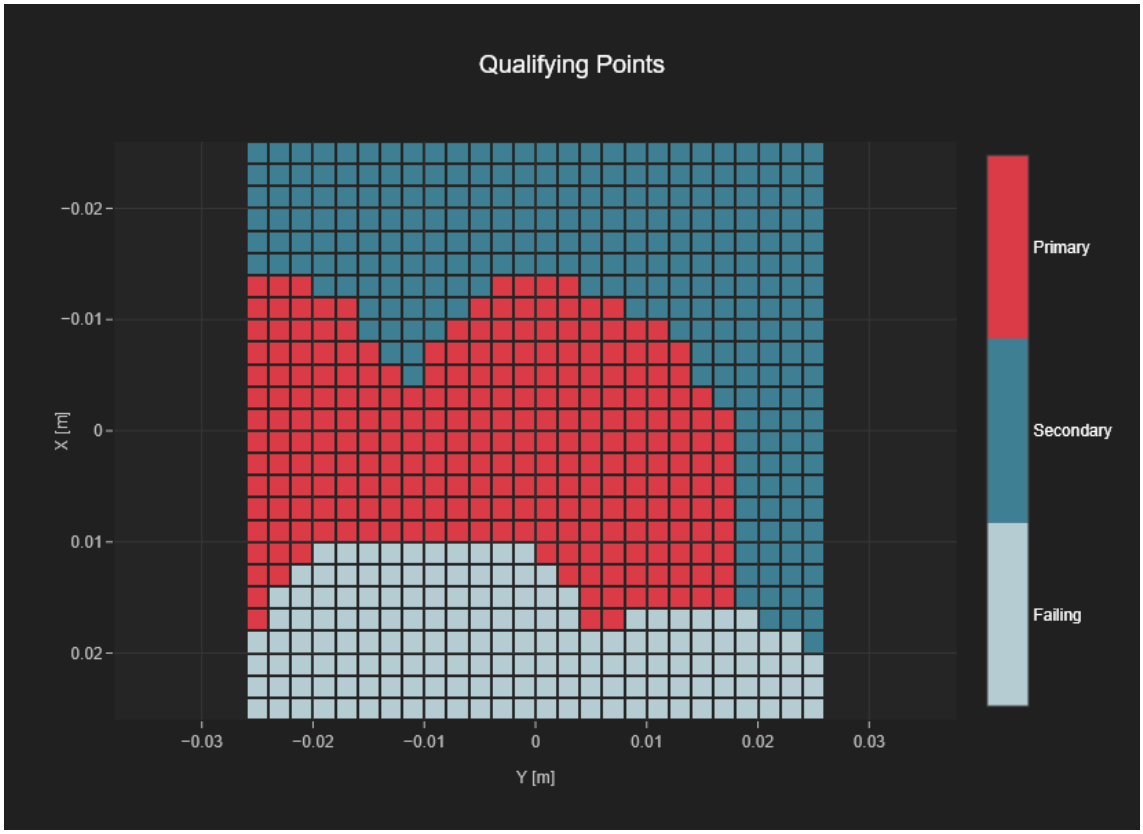
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.54 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 257 | 517 | 23 | 26 |



## Plot 10 WIFI 2.4 GHz 802.11b CH.11 11Mbps Google Meet Codec: 510kbps ANT J

## T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| WLAN 2.4GHz | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps, 90pc duty cycle) | 11 | 2462.0 |

### Grid Settings

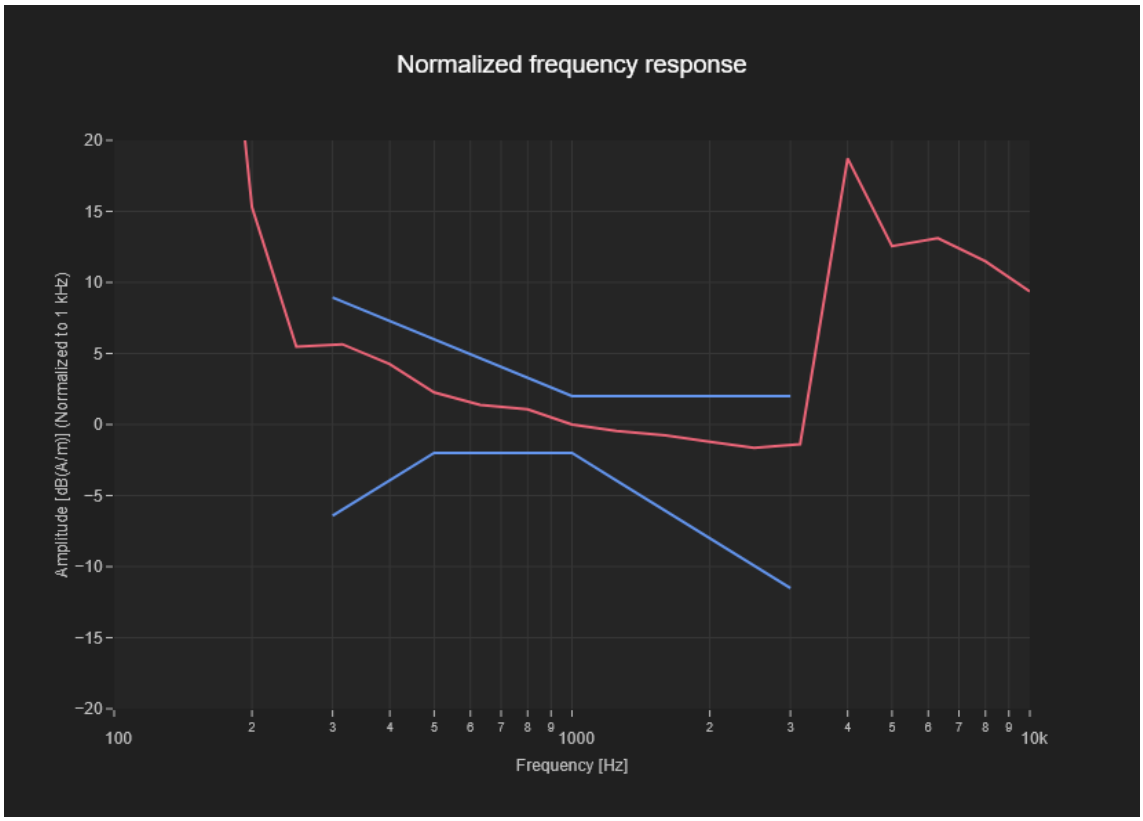
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 0.66 | (6.0, -5.0) |

### 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 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 183 | 457 | 21 | 26 |

## Plot 11 WIFI 5 GHz 802.11a CH.40 6Mbps Codec: EVS-WB 9.6 ANT J

## T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| WLAN 5GHz | IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle) | 40 | 5200.0 |

### Grid Settings

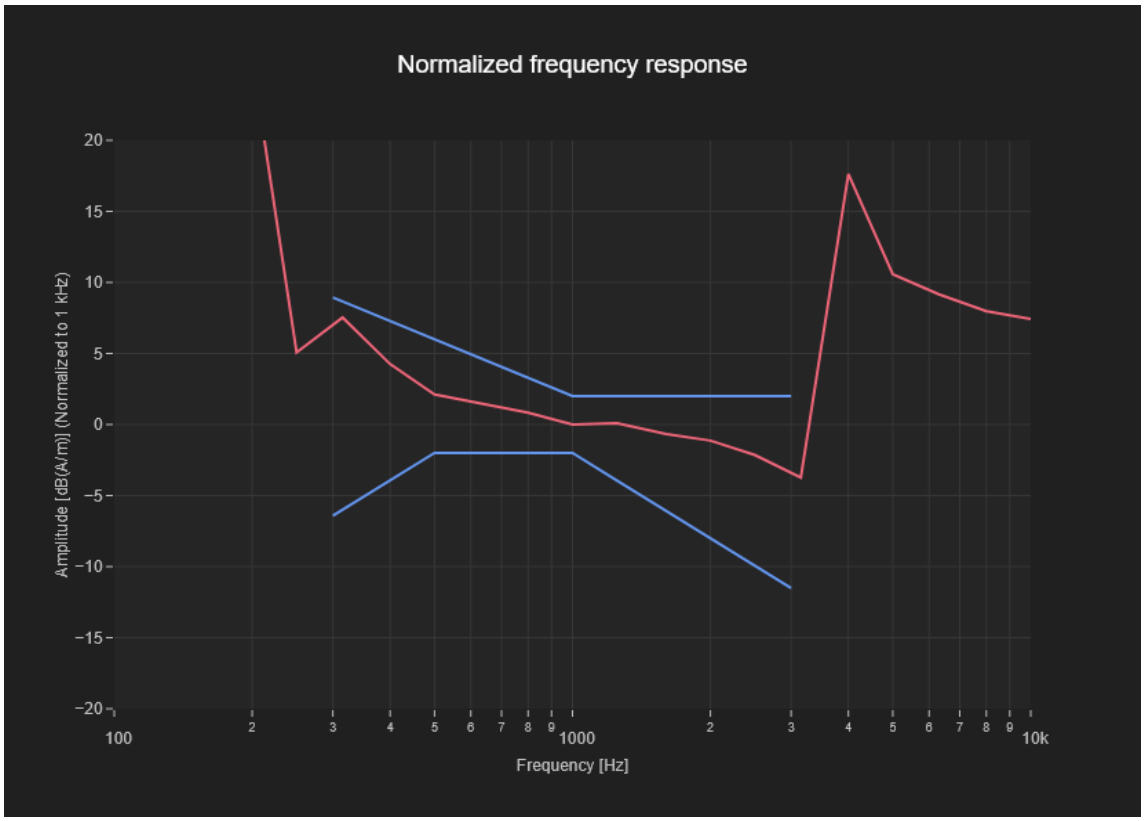
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 2.24 | (6.0, -5.0) |

### Results

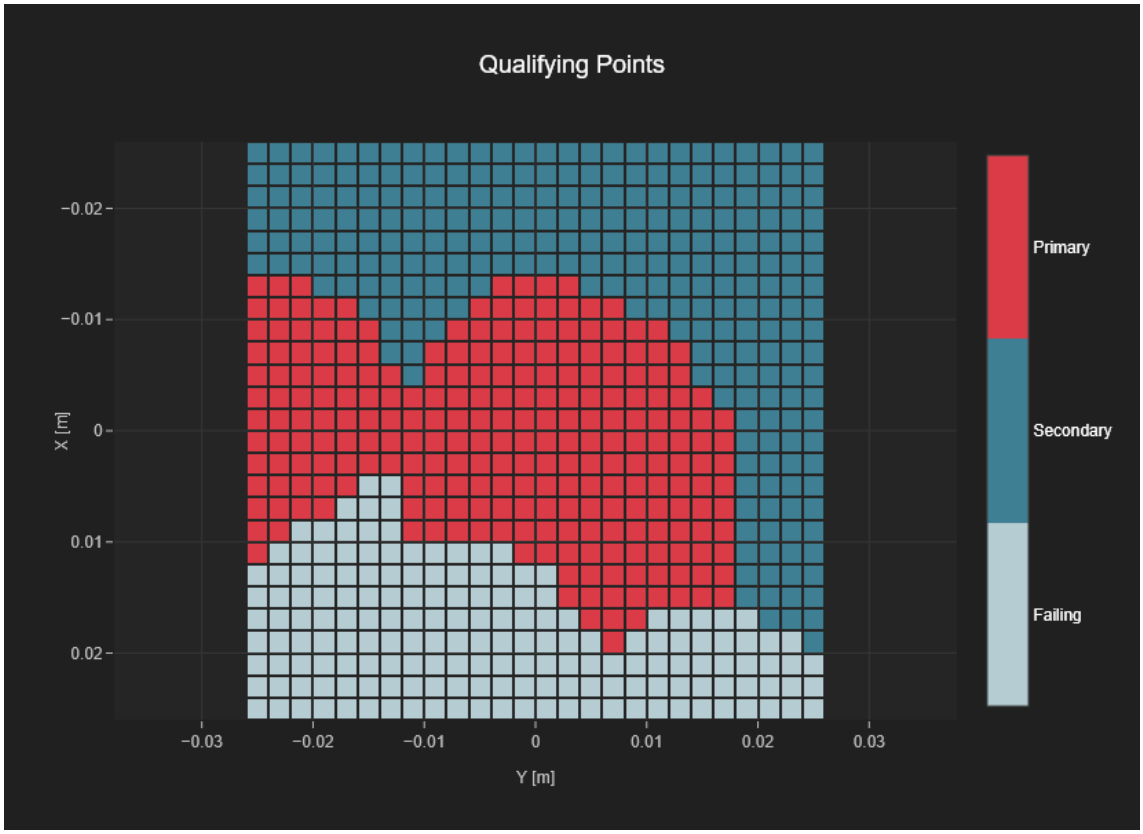
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.9 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 246 | 505 | 23 | 26 |



## Plot 12 WIFI 5 GHz 802.11n40 CH.38 MCS0 Google Meet Codec: 510kbps ANT J

## T-Coil Signal Test Report

### Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3050 | May 22, 2025 | DAE4 Sn652 | June 19, 2025 |

### Communication Systems

| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| WLAN 5GHz | IEEE 802.11n (HT Mixed, 40MHz, MCS0, 90pc duty cycle) | 38 | 5190.0 |

### Grid Settings

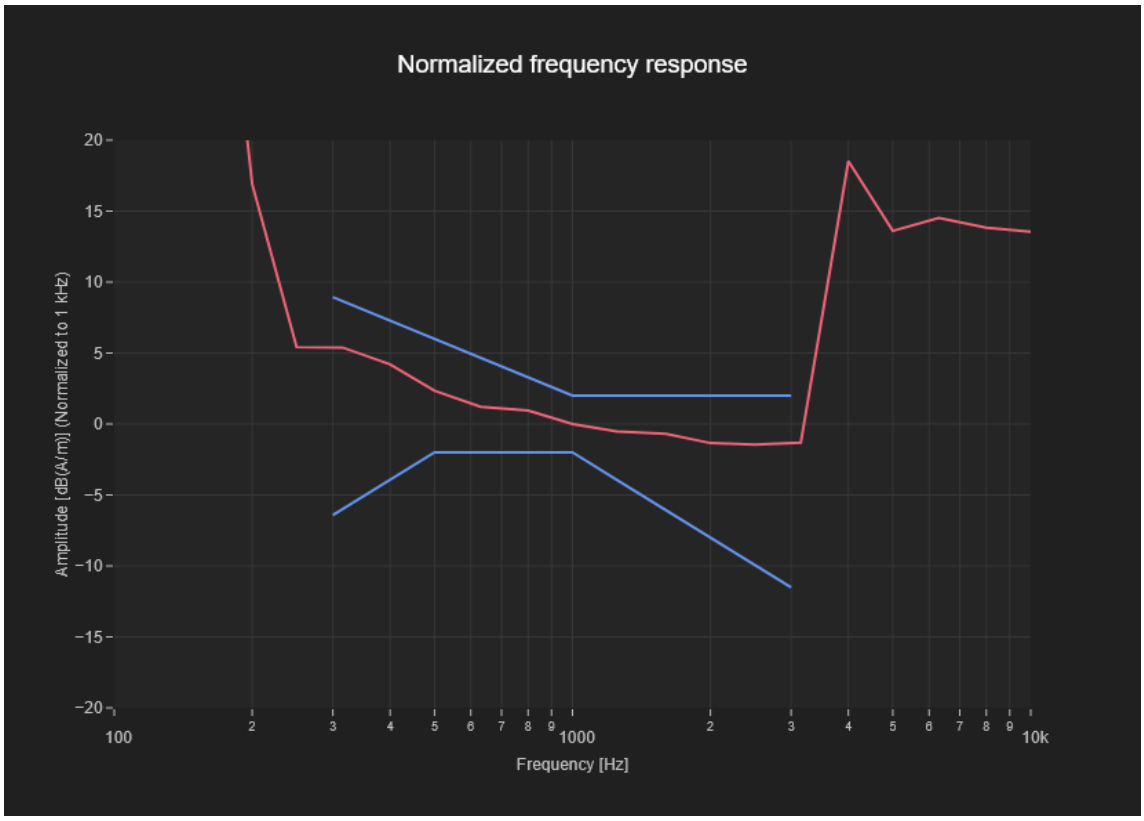
| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

### Audio Results

| Audio File | Measurement Duration [s] | Hmax [dB(A/m)] | Hmax Location |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 0.58 | (6.0, -19.0) |

### Results

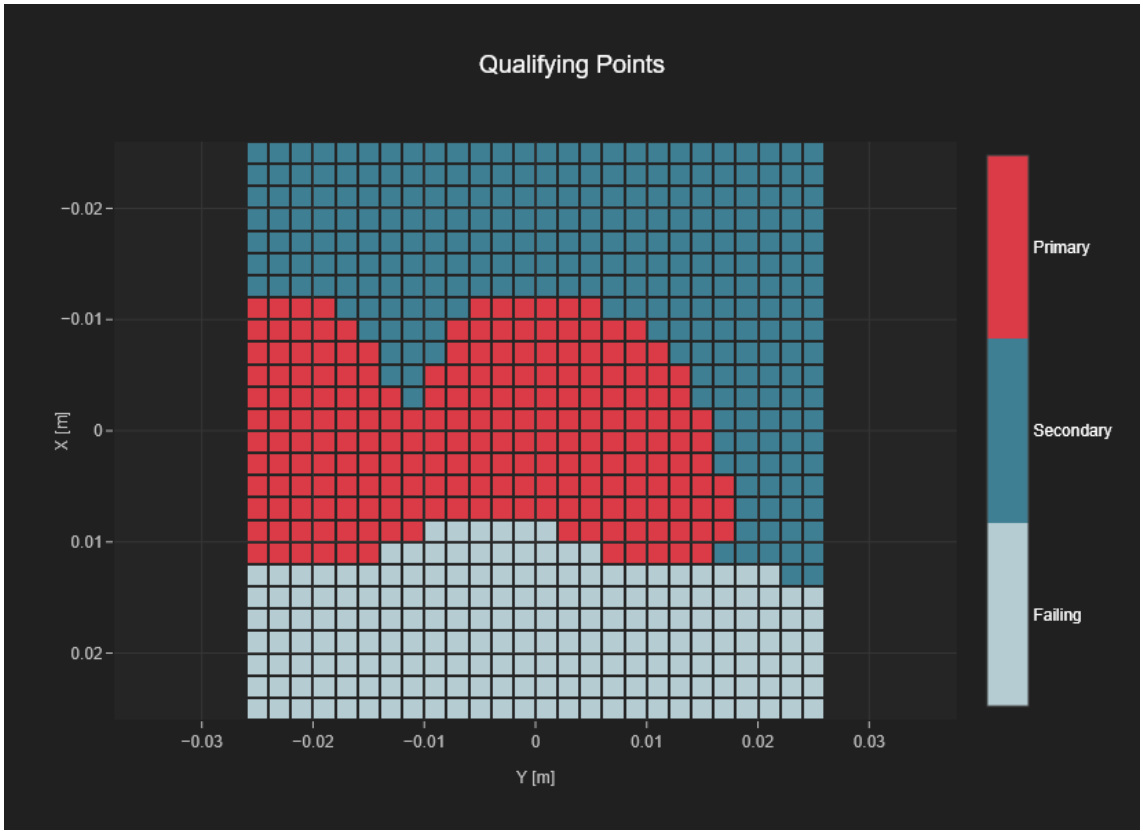
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 2.0 | 2.0 |



## T-Coil Coupling Mode Test Report

### Results

| Primary Group Point Count | Secondary Group Contiguous Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 211 | 480 | 20 | 26 |



# Appendix C. HAC T-Coil Probe Certificates

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT**
Gyeonggi-do, Republic of Korea

Certificate No. **AM1DV3-3050_May25**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | AM1DV3 - SN: 3050 |
| Calibration procedure(s) | QA CAL-24.v4<br>Calibration procedure for AM1D magnetic field probes and TMFS in the audio range |
| Calibration date: | May 22, 2025 |

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Keithley Multimeter Type 2001 | SN: 0810278 | 27-Aug-24 (No. 40547) | Aug-25 |
| Reference Probe AM1DV3 | SN: 3000 | 25-Sep-24 (No. AM1DV3-3000_Sep24) | Sep-25 |
| DAE4 | SN: 781 | 07-Feb-25 (No. DAE4-781_Feb25) | Feb-26 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| AMCC | SN: 1050 | 01-Oct-13 (in house check Sep-24) | Sep-25 |
| AMMI Audio Measuring Instrument | SN: 1062 | 26-Sep-12 (in house check Sep-24) | Sep-25 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Sven Kühn | Technical Manager | |

Issued: May 23, 2025



| 결재 | 담당자 | 확인자 |
|---|---|---|
| | | |
| 직위/성명 | 선임 기사 | BJ / 대리 |
| 일자 | 2025 06 10 | 2025 06 10 |

[References

[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
[2] ANSI-C63.19-2019 (ANSI-C63.19-2011)
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
[3] DASY System Handbook

**Description of the AM1D probe**

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1+2]. The probe includes a symmetric low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface.
The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted nominally 35.3° above the measurement plane, using the connector rotation and sensor angle stated below.
The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1+2] without additional shielding.

**Handling of the item**

The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in a DASY system, the probe must be operated with the special probe cup provided (larger diameter).

**Methods Applied and Interpretation of Parameters**

- *Coordinate System:* The AM1D probe is mounted in the DASY system for operation with a HAC Test Arch phantom with AMCC Helmholtz calibration coil according to [3], with the tip pointing to "southwest" orientation.
- *Functional Test:* The functional test preceding calibration includes test of
  Noise level
  RF immunity (1kHz AM modulated signal). The shield of the probe cable must be well connected.
  Frequency response verification from 100 Hz to 10 kHz.
- *Connector Rotation:* The connector at the end of the probe does not carry any signals and is used for fixation to the DAE only. The probe is operated in the center of the AMCC Helmholtz coil using a 1 kHz magnetic field signal. Its angle is determined from the two minima at nominally +120° and –120° rotation, so the sensor in the tip of the probe is aligned to the vertical plane in z-direction, corresponding to the field maximum in the AMCC Helmholtz calibration coil.
- *Sensor Angle:* The sensor tilting in the vertical plane from the ideal vertical direction is determined from the two minima at nominally +120° and –120°. DASY system uses this angle to align the sensor for radial measurements to the x and y axis in the horizontal plane.

*Sensitivity:* With the probe sensor aligned to the z-field in the AMCC, the output of the probe is compared to the magnetic field in the AMCC at 1 kHz. The field in the AMCC Helmholtz coil is given by the geometry and the current through the coil, which is monitored on the precision shunt resistor of the coil.

**AM1D probe identification and configuration data**

| | |
|---|---|
| Item | **AM1DV3** Audio Magnetic 1D Field Probe |
| Type No | SP AM1 001 BA |
| Serial No | **3050** |

| | |
|---|---|
| Overall length | 296 mm |
| Tip diameter | 6.0 mm (at the tip) |
| Sensor offset | 3.0 mm (centre of sensor from tip) |
| Internal Amplifier | 20 dB |

| | |
|---|---|
| Manufacturer / Origin | Schmid & Partner Engineering AG, Zurich, Switzerland |

**Calibration data**

| | | | |
|---|---|---|---|
| Connector rotation angle | (in DASY system) | **214.3°** | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | **0.12°** | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz | (in DASY system) | **0.00752 V/(A/m)** | +/- 2.2 % (k=2) |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.