



HAC T-Coil Test Report

FCC ID:	A3LSMS942U	Samsung Electronics Co., Ltd. 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea Certification
Model(s):	SM-S942U SM-S942U1	
Device Type:	Portable Handset	
Report Issue Date:	12/1/2025	

Provisions Tested	T-Coil
47 CFR 2.1033(d) & §20.19(b) FCC KDB 285076 D01 FCC KDB 285076 D02 FCC KDB 285076 D03 ANSI C63.19-2019 Clause 6	PASS

The measurement evaluation presented in this report are based on the tested device(s), which have been shown to be capable of compliance for hearing aid RF interference federal limits per 47CFR §20.19, in accordance with the measurement procedures specified in this report.

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1. Introduction

The FCC has a longstanding commitment to ensuring that all Americans, including individuals with disabilities, can access communications services on an equal basis. This commitment explicitly includes accessibility for individuals with hearing loss. More than 37.5 million Americans rely on equal access to communications services, as required under Section 710 of the Communications Act.

According to the FCC, the Hearing Aid Compatibility Act and other federal statutes require the Commission to ensure that wireless handsets are compatible with hearing aids and cochlear implants.

When people with hearing aids use telephones or wireless handsets that are not hearing-aid compatible, they may experience significant unwanted noise. Wireline telephones and wireless handsets certified as hearing-aid compatible under FCC requirements are designed to minimize such noise and to operate effectively with the magnetic coils (telecoils or T-coils) in hearing aids. These devices also provide volume control within prescribed amplification limits.



Figure 1.1 Smartphone
Held-to-Ear

Hearing aids operating in acoustic coupling mode receive sound through a microphone and amplify all surrounding audio including both desired signals (e.g., handset audio) and unwanted ambient noise. To use a mobile handset with a hearing aid or cochlear implant in acoustic coupling mode, radiofrequency and other electromagnetic interference must be controlled.

The FCC employs a technical standard to determine whether a handset is hearing-aid compatible. The most recent standard is the 2019 ANSI Standard, and handsets meeting this standard are labeled as “hearing aid compatible.” Wireless communications devices are tested for compatibility during standard call conditions, in accordance with FCC HAC requirements.

The device was tested for compatibility with hearing aids operating in T-Coil mode, as per the FCC HAC requirements. The tests evaluate the magnetic field strength, frequency response, and signal-to-noise ratio of the device in T-Coil mode.

The testing was conducted to evaluate the performance of the device in T-coil mode concerning:

- T-coil mode, magnetic-signal strength in the audio band
- T-coil mode, magnetic-signal frequency response through the audio band
- T-coil mode, magnetic-signal and noise articulation index

2. T-Coil Testing (from ANSI C63.19)

The purpose of the measurements in ANSI C63.19 Section 6 is to characterize the audio-frequency magnetic field from a WD that couples into a hearing aid telecoil, expressed as the “audio-band magnetic (ABM) signal.” Conceptually, this definition is intended to correlate to the user perception of desired signal and interference received through an idealized telecoil-equipped hearing aid and is characterized by the following attributes:

- The WD is operated in a representative in-use calling mode while a defined audio signal is applied through the communications path. The resulting audio-band magnetic field produced by the WD is sampled over the specified measurement area using a calibrated probe coil and measurement chain whose bandwidth encompasses the full ABM band. The probe output is converted to an equivalent magnetic field, providing a baseband representation of the signal that would be coupled into a hearing aid telecoil. The test configuration is arranged so that contributions from the WD’s RF carrier field are excluded from the measurement.
- The time-domain representation of the ABM signal, including both desired components and any undesired audio-band magnetic field (noise and distortion), is processed using the spectral and temporal weighting functions defined in ANSI C63.19 Annex D.4 through D.6 (and, where applicable, the half-band integration defined in Annex D.9). This weighting models the frequency shaping and temporal integration characteristics of typical hearing aid telecoil paths.

A WD’s interference potential in T-coil mode is a function of both the magnitude and spatial distribution of the desired ABM signal and the level and temporal characteristics of the undesired ABM field after Annex D weighting. The effective ratio of weighted signal-plus-noise to weighted noise, together with the absolute ABM field strength and frequency response over the audio band, is used to evaluate compliance with the ANSI C63.19 telecoil performance criteria and to assess a WD’s inductive compatibility with hearing aids during product development.

3. Executive Summary

3.1. Scope

All relevant provisions and test cases from ANSI C63.19-2019 are included in the testing process, covering operating modes, frequency bands, and handset configurations relevant to T-coil magnetic coupling performance.

3.2. Device Description

The equipment unit tested per ANSI C63.19-2019 Section 9.4 is as follows:

FCC ID:	A3LSMS942U
Model Number(s):	SM-S942U, SM-S942U1
Serial Number:	YK60400M
Product Type:	Portable Handset
Modifications:	None
Accessories or Cables:	N/A

3.3. Air Interfaces

Table 3.1 –Air interfaces and Voice Services Capability

Air-Interface	Band (MHz)	Type Transport	T-Coil Evaluation	Simultaneous Transmissions	Name of Voice Service	Audio Codec Evaluated
GSM ¹	850	VO	Yes	Yes: BT, WLAN	CMRS Voice	EFR
	1900					
	GPRS/EDGE	VD	Yes	Yes: BT, WLAN	Google Meet	OPUS
UMTS ¹	850	VO	Yes	Yes: BT, WLAN	CMRS Voice	NB AMR, WB AMR
	1700					
	1900					
	HSPA	VD	Yes	Yes: BT, WLAN	Google Meet	OPUS
LTE (FDD) ¹	680 (B71)	VD	Yes	Yes: NR, BT, WLAN	VoLTE, Google Meet	VoLTE: NB AMR, WB AMR, EVS Google Meet: OPUS
	700 (B12/13/14)					
	850 (B5,26)					
	1700 (B4/66)					
	1900 (B2,25)					
	2300 (B30)					
	2500 (B7)					
LTE (TDD) ¹	2600 (B38/41)	VD	Yes	Yes: NR, WIFI or BT	VoLTE, Google Meet	VoLTE: NB AMR, WB AMR, EVS Google Meet: OPUS
	3600 (B48)					
NB NTN	1640 (B255)	DT	No	N/A	N/A	N/A
NR (FDD) ¹	680 (n71)	VD	Yes	Yes: LTE, WIFI or BT	VoNR, Google Meet	VoNR: NB AMR, WB AMR, EVS Google Meet: OPUS
	700 (n12/14)					
	850 (n5/26)					
	1700 (n66)					
	1900 (n2/25)					
	2300 (n30)					
	2500 (n7)					
NR (TDD) ¹	2600 (n38/41)	VD	Yes	Yes: LTE, WLAN or BT	VoNR, Google Meet	VoNR: NB AMR, WB AMR, EVS Google Meet: OPUS
	3600 (n48)					
	3800 (n77/78)					
WLAN ^{1,2,3}	2450	VD	Yes	Yes: WWAN, BT and WLAN 5GHz,	VoWIFI, Google Meet	VoWIFI: NB AMR, WB AMR, EVS Google Meet: OPUS
	5200 (U-NII 1)			Yes: WWAN and WLAN 2.4GHz, BT		
	5300 (U-NII 2A)					
	5500 (U-NII 2C)					
	5800 (U-NII 3)					
	5900 (U-NII 4)					
	6200 (UNII 5)					
	6500 (UNII 6)		No			
	6700 (UNII 7)					
	7000 (UNII 8)					
BT	2450	DT		No	Yes: WWAN and WLAN	N/A
Type Transport VO = Voice Only DT = Digital Data - Not intended for Voice Services VD = CMRS and/or IP Voice over Data Transport			Notes: 1. Reference input level in accordance with 6.4.3.2, Table 6-1 Normal speech input levels of ANSI C63.19-2019 2. WIFI U-NII band 5 was evaluated for operations which are entirely below 6 GHz. Operations partially or entirely above 6 GHz were not evaluated due to equipment limitations and being outside the scope of ANSI C63.19 and FCC HAC regulations. 3. WIFI U-NII bands 6 through 8 were not evaluated due to equipment limitations and being outside the scope of ANSI C63.19 and FCC HAC regulations.			

3.4. Location of Test Site

RF Safety Laboratory, LLC
5520 Research Park Drive, Suite 140
Catonsville, Maryland 21228 USA

3.5. Ambient Conditions / Test Environment

Per ANSI C63.19-2019, tests are performed at the manufacturer recommended normal operating temperature and humidity, and if important barometric pressure.

The basic ambient conditions specified in ANSI C63.19-2019 Section 8.2 are as follows:

Table 3.2 - Normal Operating Test Environment per ANSI C63.19

Ambient Temperature:	23 °C ± 5°C
Relative Humidity (RH):	0% < RH < 80%
Baseband magnetic ambient noise:	> 10 dB below the measurement level, where applicable

3.6. LTE Band Selection

This device supports LTE functionality across overlapping frequency ranges. When an LTE band's frequency range is fully contained within that of another LTE band with a broader range, and both bands have the same or higher target power (with the broader band having the greater power), and share identical transmission paths and signal characteristics, hearing-aid compatibility is evaluated only for the LTE band with the larger frequency range. In cases where overlapping LTE bands serve as anchor bands for dual connectivity (EN-DC) scenarios with NR, each LTE band is assessed independently.

3.7. NR Band Selection

This device also supports NR functionality with overlapping frequency ranges. If an NR band's frequency range is completely within another NR band with a larger range, and both bands have the same target power or the larger band has a higher power, sharing the same transmission path and signal characteristics, hearing-aid compatibility is evaluated solely for the NR band with the larger frequency range.

4. T-Coil Measurement System Information

4.1. AM1D Audio Magnetic Field Probe for General Near-Field Measurements



Figure 4.1
AM1DV3 Audio Magnetic Field Probe

Manufacturer	Schmid & Partner Engineering AG
Probe Model	AM1DV3 – Audio Magnetic 1D Field Probe
Construction	Active single-sensor audio band magnetic probe Single pickup coil (1-D sensor) for axial / radial scans, depending on probe orientation
Frequency Range	0.1 – 20 kHz
Dynamic Range	At 1 kHz (AM1DV3): - 60 dB A/m to + 40 dB A/m
Dimensions	Overall length: 296 mm Tip Length: 290 mm (Probe's body up to the round tip) Tip diameter: 6.0 mm (rounded tip) Distance from probe tip to dipole centers: 1.5 mm Sensor displacement to probe's calibration point: <0.7 mm

4.2. Measurement System

The Dosimetric Assessment System (DASY) is a robot-based high precision electromagnetic (EM) near-field scanning platform. DASY8, the 8th generation of DASY, is the most precise and advanced flexible scanning platform for testing compliance with any national (e.g., FCC, CENELEC) and international guidelines, standards, and regulations (e.g., IEC, IEEE, ICNIRP) and for a wide range of R&D measurement tasks related to EM exposure from 3 kHz to 110 GHz.

The DASY8 Modules offer optimal solutions for any near-field tasks and are continuously updated to meet the latest regulatory and research requirements.

DASY8 Module HAC (Hearing Aid Compatibility) is composed of hardware and software components optimized to demonstrate the compliance of wireless devices according to ANSI-C63.19-2019. The solution comprises the Radiofrequency (RF) Extension for RF emission tests and the Tele-Coil (T-COIL) Extension for audio-band magnetic tests.

These components are required to fully characterize wireless devices according to the ANSI-C63.19-2019 standard.



Figure 4.2 DASY8 with Module HAC

The T-Coil hardware adds the capability of audio band magnetic (ABM) measurements according to ANSI C63.19-2019. It is composed of an audio magnetic field probe (i.e., AM1DVx) mounted to the precision TX2 robot, a Helmholtz calibration coil (i.e., AMCC), and an audio magnetic measurement instrument (i.e., AMMI). This extension is used to determine the quality of the audio band magnetic field originating from wireless devices. Jupyter Notebook based graphical user interfaces (GUIs) guide the user through the compliance workflow.

5. System Validation

To ensure that the T-coil system is working properly, system calibration and TMFS verification takes place before any T-coil test is conducted. The system calibration includes the cables and connections available in the setup. Probe sensitivity is determined during the system calibration in the AMCC. Once the probe has been calibrated and evaluated by the provided means matching the uncertainty in this budget, the Audio Magnetic Calibration Coil (AMCC) is calibrated.

5.1. System Calibration

During the Angle Alignment procedure, a full 1D rotation is performed with 10-degree steps. The H-field readings are recorded at each step. Once the measurement is complete, the measured sensor response is compared to the theoretical one and the angle is determined with an optimization procedure. Please note that the resulting angle is a combination of several factors: DAE connector angle, probe connector angle, robot holder rotation. It can't be directly compared with the probe connector angle given in the calibration certificate.

During the System Response Calibration procedure, a multi-sine signal with single components covering each third-octave band from 50 Hz to 10 kHz is generated and applied to both audio outputs. The Coil In channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the Probe In channel samples the amplified signal picked up by the probe coil. The probe sensitivity is defined as the ratio of the two voltages at 1 kHz. The response spectrum is defined as the ratio of the voltages in each 1/3 octave band, normalized to the probe sensitivity. The system calibration values are available in section 3.1.

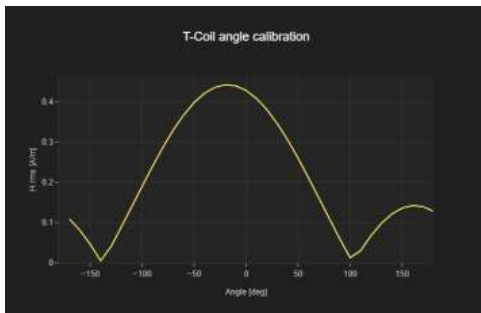


Figure 5.1
SPEAG Angle Alignment

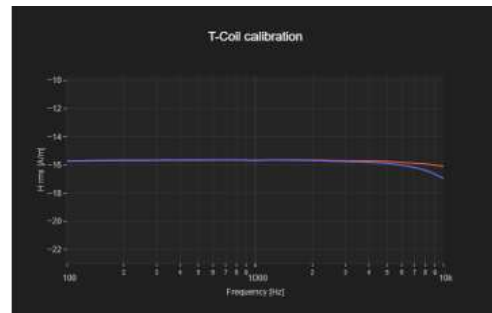


Figure 5.2
SPEAG System Frequency Response Calibration

Table 5.1
SPEAG T-Coil System Calibration Results

Date	AMD Probe	Coil Channel [V]	Probe Channel [V]	Probe Sensitivity [mV/(A/m)]	Calibrated Angle [deg]
9/10/2025	3166	2.38	1.34	7.31	-43.41
9/22/2025	3166	2.38	1.34	7.31	-43.41

5.2. TMFS Verification

The TMFS is designed according to ANSI S3.22-2003. It is optimized for use with the HAC Test Arch and generates a well-defined magnetic field for the reference check of the T-coil Signal Test setup according to ANSI C63.19-2019. The TMFS can be operated in the [100 Hz – 20 kHz] frequency range. The input impedance of 600 Ohm and the separate connectors for supplying and monitoring the audio signal minimize the uncertainty involved by connecting the instrumentation. It is delivered with adapters for operation and calibrated for 1 kHz for the radial (transverse) field maxima at a 10 mm scanning distance. The verification results are available in section 3.2.



Figure 5.3
SPEAG TMFS Verification

Table 5.2
SPEAG TMFS Verification Results

System	SW Version	Date	TE	TMFS SN	Measured Radial Peak 1 [dB A/m]	Measured Radial Peak 2 [dB A/m]	Measured Avg Radial Max [dB A/m]	Radial Max Dev [dB]	Measured Freq. Response at 1 kHz [dB]	Freq. Response Dev [dB]
Alpha	1.2.6.5211	9/10/2025	YL	1066	-26.37	-26.11	-26.24	-0.35	0.00736	0.00
Alpha	1.2.6.5211	9/22/2025	YL	1066	-26.49	-26.09	-26.29	-0.40	0.00736	0.00

6. Magnetic Coupling Requirements Per ANSI C63.19-2019

6.1. Qualifying Field Strengths for T-coil

According to this standard, there are two sets of qualifying measurement criteria:

Primary Group: For a measurement point to qualify, the T-Coil signal at that point must have a desired ABM signal of at least -18 dB(A/m) at 1 kHz when measured with a 1/3 octave band filter. These measurements must be taken with the device operating at the reference input level specified in Table 6.1. Additionally, the weighted magnetic noise (undesired ABM field) at the same point must be no greater than -38 dB(A/m).

Secondary Group: For a measurement point to qualify under this group, the weighted magnetic noise (undesired ABM field) must be ≤ -38 dB(A/m). This group inherently includes all points that meet the criteria of the primary group.

6.2. Desired ABM Signal, Undesired ABM Field Qualification Requirements

According to the standard:

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

For 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

For 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 point



6.3. Frequency Response

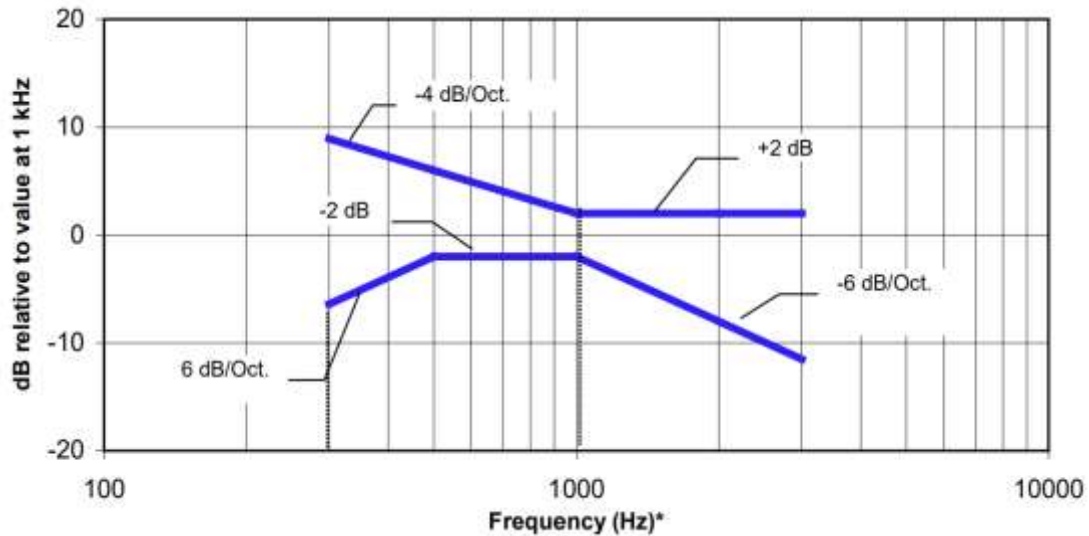


Figure 6.1
Frequency Response Curves for ≤ -15 dBA/m max field strength

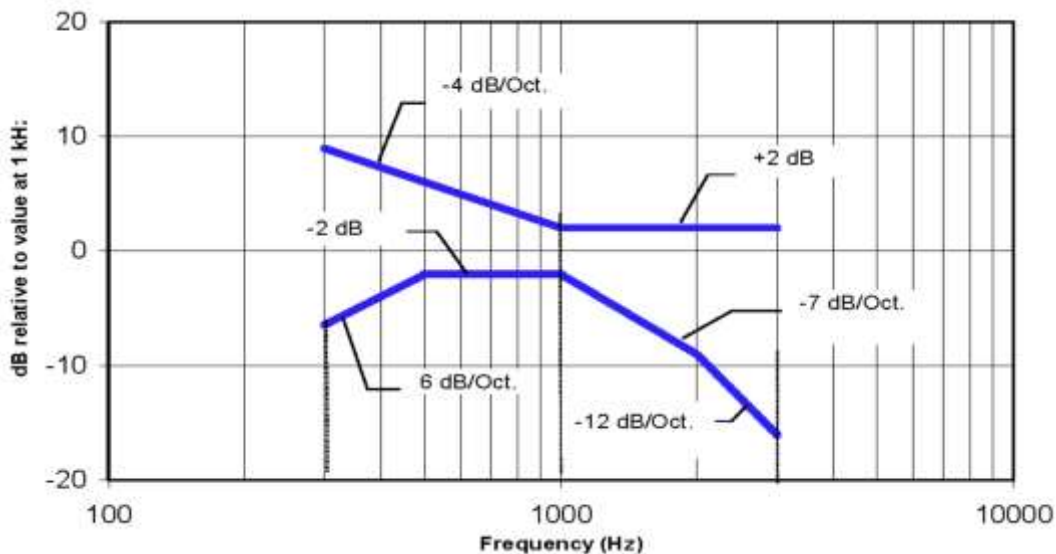


Figure 6.2
Frequency response Curves for devices > -15 dBA/m

7. Test Procedure

The purpose of this test is to evaluate the size of the area where a user could position a WD relative to the hearing aid's T-coil and receive an acceptable magnetically coupled signal.

Three quantities are measured and evaluated:

- The field strength of the desired audio signal at the center of the audio band (desired ABM signal)
- The frequency response of the desired signal across the audio band at the field strength maximum location
- The weighted field strength of the undesired audio signal across the audio band (undesired ABM field)

The ANSI C63.19-2019 standard requires measurements with the probe sensor coil positioned in the transverse orientation (perpendicular to the long side of the WD) only.

The test setup consisted of the DUT placed on a non-conductive table with the T-Coil probe positioned at a distance of 10 mm in the transverse axis. A base station simulator was used to provide a voice connection through the air interface (e.g., Voice over LTE, Voice over NR, etc.) for signal input.

For OTT VoIP testing, the data application unit (DAU) of the call simulator is utilized to connect to the internet and enables the IP data connection on the DUT. An auxiliary VoIP device was used to initiate an OTT VoIP call to the DUT. The auxiliary VoIP device is equipped with the test application in which the capability of monitoring the input signal level and setting the codec bitrate during a call.

The T-Coil probe measured the magnetic field strength in the audio band (300 Hz to 3 kHz) across a 50 mm measurement plane in accordance with ANSI C63.19 §6.4.1. The setup also included a Helmholtz coil for calibration verification.

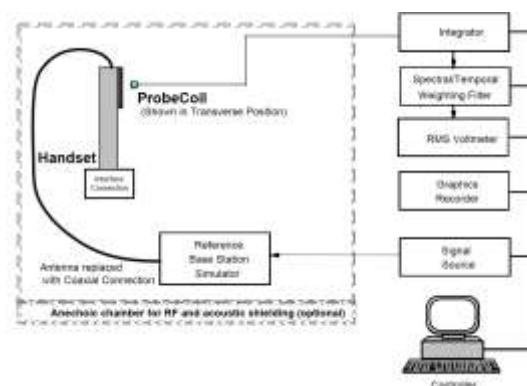


Figure 7.1 Test Setup In Call Method

7.1. Ambient Noise Check per C63.19-2019 §6.3.2

Measured field strengths due to noise in the test system or from the environment should be at least 10 dB below the limit being measured, which is specified in ANSI C63.19-2019 Section 6.6.2. For the measurement of both desired ABM signal and undesired ABM field, the environmental noise level should be ≤ -48 dB(A/m), weighted according to the spectral/temporal weighting of D.4 to D.6. For the measurement of desired ABM signal (audio band magnetic signal—desired), this criterion applies in each 1/3 octave band over the specified voiceband. The noise ambient shall be measured and recorded in the test report to document its level. Satisfaction of the criterion may be confirmed by moving the probe throughout the positions to be used for WD field strength measurements. Remove the WD and measure the remaining noise field strength in the same way and over the same frequency range used for WD measurements.

7.2. T-coil Testing Flow Chart per ANSI C63.19-2019

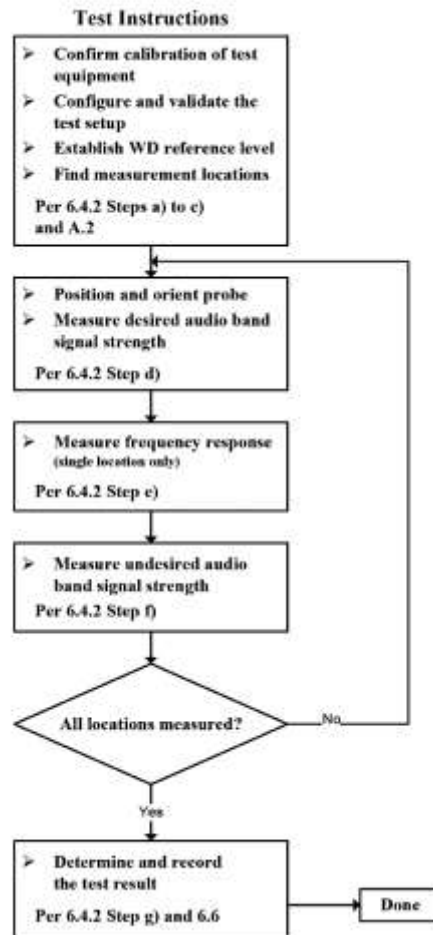


Figure 7.2 Test Flow Chart

7.3. Test Signal

The Speech signal is a 48 kHz Voice 300-3000 Hz signal provided by SPEAG

7.4. Measurement Steps

The test setup consisted of the DUT placed on a non-conductive table with the T-Coil probe positioned at a distance of 10 mm in the transverse axis. A base station simulator was used to provide a voice connection through the air interface (e.g., VoLTE over LTE) for signal input.

The T-Coil probe measured the magnetic field strength in the audio band (300 Hz to 3 kHz) across a 50 mm measurement plane in accordance with ANSI C63.19 §6.4.1. The setup also included a Helmholtz coil for calibration verification.

The testing followed the detailed steps outlined in ANSI C63.19 §6.4.2:

Step 1: Calibration of the T-Coil Probe

- The T-Coil probe is calibrated using a Helmholtz coil to verify the accuracy of magnetic field strength measurements.

Step 2: Magnetic Field Measurement

- The DUT is placed on the measurement plane, and the T-Coil probe was used to measure the magnetic signal strength at a desired signal. The single point measurements (Desired ABM + Undesired ABM = SNNR) are taken at the maximum desired ABM location to determine the worst-case test configuration for all the applicable air interfaces.
- The DUT is configured to the worst-case configuration per single point measurement data, and a near field scan is performed. The probe was moved to 676 evenly spaced points in a 52 mm square area to record the field strength and signal-to-noise ratio.

Step 3: Frequency Response

- The frequency response of the T-Coil signal was measured between 300 Hz and 3 kHz, with key points at 300 Hz, 500 Hz, 1 kHz, 2 kHz, and 3 kHz.

Step 4: Ambient Noise Measurement

- Ambient noise was measured in the test environment, and the undesired ABM (audio band magnetic) field was recorded.

7.5. Measurement Settings:

- Speech input level: -16 dBm0 as per ANSI C63.19 Table 6-1
- Frequency range: 300 Hz to 3 kHz
- a. Ambient interference was monitored using a Real-Time Analyzer across a frequency range of 100 Hz to 10,000 Hz, with 1/3 octave band filtering applied.
- b. Spectral and temporal weighting, as specified in C63.19-2019 Annex D.4 to D.6, was used during the measurement.
- c. This measurement method, which is consistent with those used for assessing undesired ABM field measurements, confirmed that the ambient noise level was more than 10 dB below the lowest measurement signal (i.e., the highest undesired ABM field measurement for a compliant WD). Consequently, the maximum permissible noise level for a compliant WD is calculated as: -38 dB - 10 dB = -48 dB (A/m).

8. Audio Level and Gain Measurements

-16 dBm0 is the normal speech input level for testing and to ensure that the RMS equals to -16 dBm0 while keeping peaks safely below the full scale, audio files' RMS level have to be assessed. During the Compute Gain Settings procedure, the test system analyzes each file's peaks and crest factor (peak-to-RMS) and applies Scaling (Gain) in dB.

For CMRS Voice, the gain levels were configured according to the -16dBm0 input level. Please see values below.

Table 8.1
CMRS Voice Audio Level and Gain Measurements

Audio Settings for CMRS Voice Services						
Mode	Signal Type	Audio Level [dBm0]	Peak to Full Scale [dB]	Peak to RMS Ratio [dB]	BWC [dB]	Scaling (Gain) [dB]
GSM Voice	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
UMTS Voice	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
Voice over LTE	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
Voice over NR	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
Voice over WIFI	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74

For OTT VoIP, the gain levels were configured according to the -16dBm0 input level. Please see values below.

Table 8.2
OTT VoIP Audio Level and Gain Measurements

Audio Settings for OTT VoIP [Google Meet]						
Mode	Signal Type	Audio Level [dBm0]	Peak to Full Scale [dB]	Peak to RMS Ratio [dB]	BWC [dB]	Scaling (Gain) [dB]
Google Meet over EDGE	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
Google Meet over HSPA	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
Google Meet over LTE	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
Google Meet over NR	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74
Google Meet over WIFI	48KHz Voice 1KHz	-16.00	-0.37	15.74	0.07	-12.56 to -12.57
	Voice 300-3000Hz	-16.00	0.00	21.57	10.81	-6.73 to -6.74

9. C63.19 T-Coil Codec Investigation

Per ANSI C63.19-2019 Table 6.1, a nominal -16 dBm0 speech input level is used for GSM (J-STD-007), UMTS (per 3GPP TS 26.131/26.132), and the entire family of IP-based telephony which includes VoLTE, VoNR, VoWiFi and any app-based VoIP.

9.1. CMRS Codec Investigation

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

Table 9.1
CMRS Voice Codec Investigation

Test Condition									
Mode:	CMRS	Hearing Aid Mode:	On	Volume Level:	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s
Band	Test Configuration	Codec Type	Codec Bandwidth	Codec Bitrate (kbps)	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
GSM 850	ANT E CH.190	FR V1	NB	13.00	7.30	-28.40	35.70	1.99	12.0, -7.0
		FR V2	NB	12.20	8.31	-28.88	37.19	2.00	
		HR V1	NB	5.60	8.27	-28.63	36.90	1.64	
		AMR	NB	4.75	7.43	-44.57	52.00	2.00	
UMTS Band 2	ANT A CH.9400	AMR	NB	12.20	7.62	-44.84	52.46	1.99	
		AMR	WB	6.60	7.37	-44.73	52.10	2.00	
		AMR	WB	23.85	7.44	-44.92	52.36	2.00	
		AMR	NB	4.75	7.50	-36.64	44.14	1.40	
LTE Band 25	Antenna A 20MHz CH.26365 16QAM 1/0RB	AMR	NB	12.20	7.57	-36.47	44.04	2.00	
		AMR	WB	6.60	7.21	-35.21	42.42	2.00	
		AMR	WB	23.85	7.38	-35.28	42.66	2.00	
		EVS	NB	5.90	7.95	-36.93	44.88	1.74	
		EVS	NB	24.40	8.23	-36.79	45.02	2.00	
		EVS	WB	5.90	7.77	-36.02	43.79	1.74	
		EVS	WB	128.00	7.87	-34.33	42.20	2.00	
		EVS	SWB	9.60	7.82	-35.71	43.53	1.48	
		EVS	SWB	128.00	7.90	-36.23	44.13	1.12	
		AMR	NB	4.75	7.58	-36.89	44.47	1.32	
		AMR	NB	12.20	7.68	-36.01	43.69	1.82	
		AMR	WB	6.60	7.28	-36.28	43.56	2.00	
NR n25	Antenna A CP-OFDM 40MHz CH.376500 QPSK 108/64RB	AMR	WB	23.85	7.46	-37.07	44.53	2.00	
		EVS	NB	5.90	7.95	-37.08	45.03	1.72	
		EVS	NB	24.40	8.37	-37.25	45.62	2.00	
		EVS	WB	5.90	7.82	-37.32	45.14	2.00	
		EVS	WB	128.00	7.96	-37.95	45.91	2.00	
		EVS	SWB	9.60	7.52	-35.45	42.97	1.80	
		EVS	SWB	128.00	7.66	-36.86	44.52	1.22	
		AMR	NB	4.75	7.59	-34.59	42.18	1.53	
		AMR	NB	12.20	7.51	-34.12	41.63	1.60	
		AMR	WB	6.60	7.21	-34.02	41.23	2.00	
		AMR	WB	23.85	7.30	-33.99	41.29	2.00	
		EVS	NB	5.90	7.82	-34.27	42.09	1.54	
2.4GHz WIFI	WIFI Antenna 1 IEEE 802.11b CH.6 CCK 11MBPS	EVS	NB	24.40	8.29	-34.02	42.31	2.00	
		EVS	WB	5.90	7.42	-34.50	41.92	2.00	
		EVS	WB	128.00	7.56	-34.21	41.77	2.00	
		EVS	SWB	9.60	7.48	-34.10	41.58	1.63	
		EVS	SWB	128.00	7.45	-33.18	40.63	1.13	
		AMR	NB	4.75	7.51	-34.12	41.63	1.60	
		AMR	WB	6.60	7.21	-34.02	41.23	2.00	
		AMR	WB	23.85	7.30	-33.99	41.29	2.00	

Per Codec check investigation, FR V1 was used for the testing as the worst-case configuration for the wireless device on the GSM Mode. For UMTS Voice, VoLTE, VoNR and VoWiFi, AMR WB 6.60KBPS was used for testing as the worst-case configuration for the wireless device.

9.2. OTT VoIP Codec investigation

A set of measurements were performed for each applicable data mode per single point measurement to determine the audio codec configuration to be used for testing. The effects of codec configuration were found to be independent of radio configuration; therefore, only one radio configuration for each applicable data mode was used for these investigations. The DUT's nested OTT VoIP application (Google Meet) supports range of codec bitrate 6KBPS to 510KBPS. The Codec investigation was performed to check 6KBPS, 75KBPS, and 510KBPS to determine the worst-case bit rates for testing. See below tables for comparisons between codec data rates on all applicable data modes:

Table 9.2
OTT VoIP Voice Codec Investigation

Test Condition								
Google Meet	Hearing Aid Mode:	On	Volume Level:	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s
Band	Configuration	Codec Type	Codec Bitrate (kbps)	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
EDGE 850	190	OPUS	6.00	5.28	-33.14	38.42	2.00	12.0, -7.0
			75.00	5.58	-33.22	38.80	2.00	
			510.00	5.62	-33.37	38.99	2.00	
HSPA Band 2	9400	OPUS	6.00	5.81	-37.05	42.86	2.00	
			75.00	5.83	-37.19	43.02	2.00	
			510.00	5.83	-37.28	43.11	2.00	
LTE Band 25	20MHz 26365	OPUS	6.00	5.81	-35.78	41.59	2.00	
			75.00	5.88	-35.77	41.65	2.00	
			510.00	5.83	-35.80	41.63	2.00	
NR n25	45MHz 349000	OPUS	6.00	5.62	-36.20	41.82	2.00	
			75.00	5.67	-36.41	42.08	2.00	
			510.00	5.72	-36.49	42.21	2.00	
2.4GHz WIFI	IEEE802.11b CH.6	OPUS	6.00	5.46	-35.63	41.09	2.00	
			75.00	5.75	-35.68	41.43	2.00	
			510.00	5.45	-35.80	41.25	2.00	

Per Codec check investigation, OPUS 6KBPS was used for the testing as the worst-case configuration for the wireless device on the Google Meet VoIP application.

10. C63.19 GSM T-Coil Measurements

10.1. GSM Voice

A set of measurements were performed to investigate the worst-case configuration for GSM Voice. A single point measurement was taken on the middle channel for every band at the maximum desired ABM location. Low, middle and high channels were tested in the worst-case band for FCC compliance to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 10.1
GSM Voice Single Point Measurement Results

Test Condition								
CMRS	Hearing Aid Mode:	On	Volume Level:	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s
Band	Channel	Antenna	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
GSM850	128	E	FR V1	7.41	-27.64	35.05	2.00	12.0, -7.0
	190	A	FR V1	7.48	-28.48	35.96	2.00	
	190	E	FR V1	7.49	-27.30	34.79	1.82	
	251	E	FR V1	7.54	-26.68	34.22	2.00	
GSM1900	512	A	FR V1	7.13	-38.53	45.66	2.00	
	661	A	FR V1	7.27	-35.55	42.82	2.00	
	810	A	FR V1	7.20	-37.54	44.74	2.00	

Table 10.2
GSM Voice Worst-case Scan Result

Mode	Connection Configuration	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
GSM850	ANT E CH.251	FR V1	76	247	18	26	2.00	Compliant

10.2. OTT VoIP over EDGE

A set of measurements were performed to investigate the worst-case configuration for OTT VoIP over EDGE. A single point measurement was taken on the middle channel for every band at the maximum desired ABM location. Low, middle and high channels were tested in the worst-case band for FCC compliance to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 10.3
EDGE (OTT VoIP) Single Point Measurement Results

Test Condition										
VoIP Application:	Google Meet	Hearing Aid Mode:		On	Volume Level:		Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio
Band	Channel	Antenna	Codec Type	Codec Bandwidth	Codec Bitrate (kbps)	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	48K Voice 300-3000 2s
EDGE850	128	E	OPUS	NB	6.00	5.46	-33.84	39.30	2.00	12.0, -7.0
	190	A	OPUS	NB	6.00	5.13	-34.71	39.84	2.00	
	190	E	OPUS	NB	6.00	5.21	-33.17	38.38	2.00	
	251	E	OPUS	NB	6.00	5.32	-32.96	38.28	2.00	
EDGE1900	512	A	OPUS	NB	6.00	5.93	-36.96	42.89	2.00	
	661	A	OPUS	NB	6.00	6.15	-36.85	43.00	2.00	
	810	A	OPUS	NB	6.00	6.27	-36.47	42.74	2.00	

Table 10.4
EDGE (OTT VoIP) Worst-case Scan Result

Mode	Channel	Codec Type	Codec Bandwidth	Codec Bitrate (kbps)	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
EDGE850	251	OPUS	NB	6.00	137	337	20	26	2.00	Compliant

11. C63.19 UMTS T-Coil Measurements

11.1. UMTS Voice

A set of measurements were performed to investigate the worst-case configuration for UMTS Voice. A single point measurement was taken on the middle channel for every band at the maximum desired ABM location. Low, middle and high channels were tested in the worst-case band for FCC compliance to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 11.1
UMTS Voice Single Point Measurement Results

Test Condition								
CMRS	Hearing Aid Mode:	On	Volume Level:	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s
Band	Channel	Antenna	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
UMTS Band 5	4132	A	AMR WB 6.60kbps	7.02	-45.64	52.66	2.00	12.0, -7.0
	4183	A	AMR WB 6.60kbps	7.03	-45.66	52.69	2.00	
	4183	E	AMR WB 6.60kbps	7.10	-45.81	52.91	2.00	
	4233	A	AMR WB 6.60kbps	7.37	-45.29	52.66	1.71	
UMTS Band 4	1312	A	AMR WB 6.60kbps	6.82	-45.64	52.46	2.00	
	1412	A	AMR WB 6.60kbps	7.48	-45.70	53.18	2.00	
	1513	A	AMR WB 6.60kbps	7.20	-46.70	53.90	2.00	
UMTS Band 2	9262	A	AMR WB 6.60kbps	7.19	-45.34	52.53	2.00	
	9400	A	AMR WB 6.60kbps	7.36	-45.51	52.87	2.00	
	9538	A	AMR WB 6.60kbps	7.08	-45.62	52.70	2.00	

Table 11.2
UMTS Voice Worst-case Scan Result

Mode	Connection Configuration	Codec	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
UMTS Band 4	ANT A CH.1312	AMR WB 6.60kbps	458	646	26	26	1.95	Compliant

11.2. OTT VoIP over HSPA

A set of measurements were performed to investigate the worst-case configuration for OTT VoIP over HSPA. A single point measurement was taken on the middle channel for every band at the maximum desired ABM location. Low, middle and high channels were tested in the worst-case band for FCC compliance to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 11.3
HSPA (OTT VoIP) Single Point Measurement Results

Test Condition										
VoIP Application:	Google Meet	Hearing Aid Mode:		On	Volume Level:	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s
Band	Channel	Antenna	Codec Type	Codec Bandwidth	Codec Bitrate (kbps)	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
HSPA Band 5	4132	A	OPUS	NB	6.00	5.86	-35.59	41.45	2.00	12.0, -7.0
	4183	A	OPUS	NB	6.00	5.81	-36.34	42.15	2.00	
	4183	E	OPUS	NB	6.00	5.52	-37.73	43.25	2.00	
	4233	A	OPUS	NB	6.00	5.94	-35.77	41.71	2.00	
HSPA Band 4	1312	A	OPUS	NB	6.00	5.76	-36.60	42.36	2.00	
	1412	A	OPUS	NB	6.00	5.67	-37.32	42.99	2.00	
	1513	A	OPUS	NB	6.00	5.77	-37.17	42.94	2.00	
HSPA Band 2	9262	A	OPUS	NB	6.00	5.83	-36.61	42.44	2.00	
	9400	A	OPUS	NB	6.00	5.87	-37.29	43.16	2.00	
	9538	A	OPUS	NB	6.00	5.81	-37.00	42.81	2.00	

Table 11.4
HSPA (OTT VoIP) Worst-case Scan Result

Mode	Channel	Antenna	Codec Type	Codec Bandwidth	Codec Bitrate (kbps)	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
HSPA Band 5	4132	A	OPUS	NB	6.00	353	577	26	26	2.00	Compliant

12. C63.19 4G LTE T-Coil Measurements

12.1. Radio Configuration Investigation

A set of measurements were performed to determine the modulation and RB configuration to be used for testing. The effects of modulation and RB configuration were found to be independent of band and bandwidth; therefore, only one band and bandwidth were used for this investigation. 16QAM, 1RB, 0RB offset was used for the testing as the worst-case configuration for the handset. See below table for Undesired ABM comparison between different radio configurations:

Table 12.1
LTE Radio Configuration Investigation Results

Test Condition					
Hearing Aid Mode:		On	Codec Type	AMR WB 6.60kbps	
LTE FDD	RF Bandwidth (MHz)	Channel	Radio Configuration (Modulation/RB/RB offset)	Undesired ABM [dB/A/m]	Peak Measurement Location [x,y]
LTE Band 25 ANTE	20	26365	QPSK/1RB/0RB offset	-44.5	12.0, -7.0
			16QAM/1RB/0RB offset	-43.73	
			64QAM/1RB/0RB offset	-44.46	
			256QAM/1RB/0RB offset	-44.44	
			16QAM/1RB/50RB offset	-44.35	
			16QAM/1RB/99RB offset	-44.36	
			16QAM/50RB/0RB offset	-44.95	
			16QAM/50RB/25RB offset	-44.55	
			16QAM/50RB/50RB offset	-44.03	
			16QAM/100RB/0RB offset	-44.25	

12.2. Power Class 3 Uplink-Downlink Configuration Investigation

A set of measurements were performed to determine the worst-case Uplink-Downlink configuration for VoLTE over IMS T-Coil testing. Power Class 3 was evaluated with the following radio configuration: channel 40620, 20MHz BW, 16QAM, 1RB, 0RB offset. For Power Class 3, all configurations (0-6) are supported. The configuration which resulted in the worst undesired ABM was used for full testing. Uplink-Downlink configuration 2 was used as the worst-case configuration for Power Class 3 VoLTE over IMS T-Coil testing. See table below for the SNNR comparison between each Uplink-Downlink configuration:

Table 12.2
LTE TDD UL-DL Investigation Results

Test Condition						
Hearing Aid Mode:		On	Codec Type		AMR WB 6.60kbps	
LTE TDD	RF Bandwidth (MHz)	Radio Configuration (Modulation/RB/RB offset)	Channel	3GPP 36.211 UL-DL Configuration #	Undesired ABM [dB/A/m]	Peak Measurement Location [x,y]
LTE Band 41 ANT F	20	16QAM/1RB/0RB offset	40620	0	-33.25	12.0, -7.0
				1	-33.69	
				2	-33.07	
				3	-35.60	
				4	-35.31	
				5	-34.94	
				6	-33.69	

12.3. LTE TDD ULCA for OTT VoIP

LTE TDD ULCA was evaluated to ensure standard compliance. This test case satisfies the configuration requirements as defined in 3GPP 36.101.

Table 12.3
LTE TDD ULCA Investigation Result

Test Condition							
Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s
LTE TDD	RF Bandwidth (MHz)	Radio Configuration (Modulation/RB/RB offset)	Channel	Desire ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNMR [dB]	Peak Measurement Location [x,y]
LTE Band 48C	20MHz	16QAM/1RB/0RB offset	55990	5.82	-35.46	41.28	12.0, -7.0

12.4. LTE Band Investigation

12.4.1. Voice Over LTE

A set of measurements were performed to investigate the worst-case band configuration for VoLTE over IMS. A single point measurement was taken on the middle channel for every band and maximum bandwidth combination at the maximum desired ABM location. The middle channels and supported bandwidths from the worst-case band are additionally evaluated. Low, middle and high channels were tested in the worst-case band & bandwidth combination for FCC compliance evaluation to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 12.4
VoLTE Single Point Measurement Results

Band Investigation														
Mode:	VoLTE	Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 40.51dB				
Band	Antenna Configuration	RF Bandwidth (MHz)	Channel	Radio Configuration (Modulation/ RB/RB offset)	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]				
LTE Band 71	A	20	133297	16QAM/1RB/ORB offset	AMR WB 6.60kbps	7.80	-36.86	44.66	2.00	12.0, -7.0				
	E					7.55	-37.94	45.49	2.00					
LTE Band 12	A	10	23095			7.66	-44.90	52.56	2.00					
	E					7.70	-38.38	46.08	1.87					
LTE Band 13	A	10	23230			7.90	-44.95	52.85	2.00					
	E					7.62	-44.59	52.21	2.00					
LTE Band 14	A	10	23330			7.64	-44.69	52.33	2.00					
	E					7.62	-37.53	45.15	2.00					
LTE Band 26	A	15	26865			7.62	-38.27	45.89	2.00					
	E					7.75	-38.96	46.71	2.00					
LTE Band 66	A	20	132322			7.79	-44.45	52.24	2.00					
	F					7.78	-44.17	51.95	1.99					
LTE Band 25	A	20	26365			7.61	-35.88	43.49	2.00					
	F					7.65	-43.58	51.23	2.00					
LTE Band 30	A	10	27710			7.90	-44.03	51.93	2.00					
	F					7.52	-36.13	43.65	2.00					
LTE Band 7	B	20	21100			7.76	-45.34	53.10	1.70					
	F					7.66	-44.39	52.05	2.00					
LTE Band 41 (PC3)	B	20	40620			7.21	-41.06	48.27	2.00					
	F					7.66	-32.85	40.51	2.00					
LTE Band 48	F	20	55990					7.62	-39.94		47.56	2.00		
Worst-case Band Evaluation														
Mode:	VoLTE	Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 40.46dB				
Band	Antenna Configuration	RF Bandwidth (MHz)	Channel	Radio Configuration (Modulation/ RB/RB offset)	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]				
LTE Band 41 (PC3)	F	20	39750	16QAM/1RB/ORB offset	AMR WB 6.60kbps	7.68	-32.99	40.67	1.74	12.0, -7.0				
			40185			7.91	-33.93	41.84	2.00					
			40620			7.61	-32.85	40.46	2.00					
			41055			7.59	-35.72	43.31	2.00					
			41490			7.77	-33.61	41.38	2.00					
		15	40620			7.82	-33.86	41.68	2.00					
		10	40620			7.65	-33.87	41.52	2.00					
		5	40620			7.68	-34.10	41.78	2.00					

Table 12.5
VoLTE Worst-case Scan Result

Band / BW	Connection Configuration	Radio Configuration (Modulation/ RB/RB offset)	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
LTE Band 41 (PC3)	Antenna F 20MHz CH.40620	16QAM/1RB/ORB offset	AMR WB 6.60kbps	306	498	26	26	1.61	Compliant

12.4.2. OTT VoIP over LTE

A set of measurements were performed to investigate the worst-case band configuration for OTT VoIP over LTE. A single point measurement was taken on the middle channel for every band and maximum bandwidth combination at the maximum desired ABM location. The middle channels and supported bandwidths from the worst-case band are additionally evaluated. Low, middle and high channels were tested in the worst-case band & bandwidth combination for FCC compliance evaluation to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 12.6
OTT VoIP over LTE Single Point Measurement Results

Test Condition										
Mode:	Google Meet	Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 37.86dB
Band	Antenna Configuration	RF Bandwidth (MHz)	Channel	Radio Configuration (Modulation/ RB/RB offset)	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
LTE Band 71	A	20	133297	16QAM/1RB/0RB offset	OPUS 6KBPS	6.03	-35.01	41.04	2.00	12.0, -7.0
	E					6.01	-35.54	41.55	2.00	
LTE Band 12	A	10	23095			6.06	-34.66	40.72	2.00	
	E					6.01	-35.67	41.68	2.00	
LTE Band 13	A	10	23230			6.04	-34.97	41.01	2.00	
	E					6.02	-36.07	42.09	2.00	
LTE Band 14	A	10	23330			6.15	-34.90	41.05	2.00	
	E					6.03	-35.57	41.60	2.00	
LTE Band 26	A	15	26865			5.99	-35.28	41.27	2.00	
	E					6.01	-36.21	42.22	2.00	
LTE Band 66	A	20	132322			6.00	-35.95	41.95	2.00	
	F					5.97	-35.97	41.94	2.00	
LTE Band 25	A	20	26365			5.94	-35.99	41.93	2.00	
	F					6.02	-36.31	42.33	2.00	
LTE Band 30	A	10	27710			5.88	-34.45	40.33	2.00	
	F					5.96	-35.39	41.35	2.00	
LTE Band 7	B	20	21100			5.86	-35.26	41.12	2.00	
	F					5.87	-35.36	41.23	2.00	
LTE Band 41 (PC3)	B	20	40620			5.87	-35.36	41.23	2.00	
	F					5.86	-32.00	37.86	1.67	
LTE Band 48	F	20	55990			5.83	-34.71	40.54	2.00	
Worst-case Band Evaluation										
Mode:	Google Meet	Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 36.17dB
Band	Antenna Configuration	RF Bandwidth (MHz)	Channel	Radio Configuration (Modulation/ RB/RB offset)	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
LTE Band 41 (PC3)	F	20	40620	16QAM/1RB/0RB offset	OPUS 6KBPS	5.86	-32.00	37.86	1.67	12.0, -7.0
		15	40620			6.00	-31.56	37.56	2.00	
		10	39750			5.97	-32.65	38.62	2.00	
			40185			6.20	-32.97	39.17	2.00	
			40620			5.94	-30.23	36.17	2.00	
			41055			5.99	-33.04	39.03	2.00	
			41490			6.01	-32.06	38.07	2.00	
			40620			5.92	-31.61	37.53	2.00	
		5	40620							

Table 12.7
OTT VoIP over LTE Worst-case Scan Result

Band / Bw	Antenna	Connection Configuration (Bw / Channel)	Radio Configuration (Modulation/ RB/RB offset)	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
LTE Band 41 (PC3)	F	10MHz CH.40620	16QAM/1RB/0RB offset	OPUS 6KBPS	227	468	22	26	1.88	Compliant

13. C63.19 5G NR T-Coil Measurements

13.1. Radio Configuration Investigation

A set of measurements were performed to determine the radio configuration for testing. The effects of modulation and RB configuration were found to be independent of band and bandwidth; therefore, only one band and bandwidth was used for this investigation. DFT-s-OFDM, 16QAM, 1RB, 1RB offset was used for the testing as the worst-case configuration for the handset. See below table for Undesired ABM comparison between different radio configurations:

Table 13.1
NR Radio Configuration Investigation Results

Test Condition						
Hearing Aid Mode:	On	Codec Type	AMR WB 6.60KBPS	Volume Level:	Max	
LTE FDD	Waveform	RF Bandwidth (MHz)	Radio Configuration (Modulation/RB/RB offset)	Channel	Undesired ABM [dB/A/m]	Peak Measurement Location [x,y]
NR n25	CP-OFDM	40	QPSK/1RB/1RB offset	376500	-42.17	12.0, -7.0
			16QAM/1RB/1RB offset		-41.87	
			64QAM/1RB/1RB offset		-36.89	
			256QAM/1RB/1RB offset		-41.73	
	DFT-s-OFDM		BPSK1RB/1RB offset		-36.37	12.0, -7.0
			QPSK/1RB/1RB offset		-34.85	
			16QAM/1RB/1RB offset		-34.12	
			64QAM/1RB/1RB offset		-40.12	
			256QAM/1RB/1RB offset		-40.15	
			16QAM/1RB/108RB offset		-41.46	
			16QAM/1RB/214RB offset		-41.89	
			16QAM/108RB/0RB offset		-41.62	
			16QAM/108RB/54RB offset		-41.57	
			16QAM/108RB/108RB offset		-41.89	
			16QAM/216RB/0RB offset		-42.14	



13.2. Voice Over NR

A set of measurements were performed to investigate the worst-case band configuration for VoNR over IMS. A single point measurement was taken on the middle channel for every band and maximum bandwidth combination at the maximum desired ABM location. The middle channels and supported bandwidths from the worst-case band are additionally evaluated. Low, middle and high channels were tested in the worst-case band & bandwidth combination for FCC compliance evaluation to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 13.2
VoNR Single Point Measurement Results

Test Condition												
Mode:	VoNR	Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 34.49dB		
Band	Standard	RF Bandwidth (MHz)	Radio Configuration (Waveform/Modulation/ RB/RB offset)	Channel	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]		
NR n71	A	30	DFT-s-OFDM 16QAM/1RB/1RB offset	136100	AMR WB 6.60KBPS	7.71	-35.09	42.80	2.00	12.0, -7.0		
	E					7.95	-30.64	38.59	1.99			
NR n12	A	15		141500		7.49	-35.23	42.72	1.87			
	E					7.71	-30.49	38.20	1.75			
NR n14	A	10		158600		7.41	-35.29	42.70	2.00			
	E					7.84	-30.15	37.99	2.00			
NR n26	A	20		166300		7.24	-35.64	42.88	2.00			
	E					7.23	-30.00	37.23	2.00			
NR n70	A	15		340500		7.53	-29.92	37.45	2.00			
	F					7.42	-35.26	42.68	1.86			
NR n66	A	45		349000		7.12	-32.10	39.22	2.00			
	F					7.32	-35.39	42.71	1.90			
NR n25	A	40		376500		7.40	-31.90	39.30	2.00			
	F					7.28	-35.34	42.62	2.00			
NR n30	A	10		462000		7.23	-35.56	42.79	2.00			
	F					7.47	-31.89	39.36	2.00			
NR n7	B	50		507000		7.41	-32.65	40.06	2.00			
	F					7.53	-32.49	40.02	2.00			
NR n41 (PC2)	B	100		518598		7.22	-27.27	34.49	2.00			
	F					7.15	-28.20	35.35	2.00			
NR n48	F	40		641666		7.38	-31.24	38.62	2.00			
NR n77 DoD (PC2)	F	100		633334		7.07	-30.59	37.66	2.00			
NR n77 C (PC2)	F	100		656000		7.58	-29.73	37.31	2.00			
Worst-Case Band Evaluation												
Mode:	VoNR	Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 33.50dB		
Band	Connection Configuration	RF Bandwidth (MHz)	Radio Configuration (Waveform/Modulation/ RB/RB offset)	Channel	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]		
n41	B	100	DFT-s-OFDM 16QAM/1RB/1RB offset	518598	AMR WB 6.60kbps	7.22	-27.27	34.49	2.00	12.0, -7.0		
		90		518598		7.30	-27.11	34.41	2.00			
		80		518598		7.33	-27.23	34.56	2.00			
		70		518598		7.24	-27.03	34.27	2.00			
		60		518598		7.23	-26.90	34.13	2.00			
		50		518598		7.76	-26.82	34.58	2.00			
		45		518598		7.36	-26.58	33.94	2.00			
		40		518598		7.35	-26.91	34.26	2.00			
		35		518598		7.46	-26.66	34.12	2.00			
		30		518598		7.36	-26.35	33.71	2.00			
		25		501698		7.40	-26.78	34.18	2.00			
				510148		7.20	-26.83	34.03	2.00			
				518598		7.22	-26.28	33.50	2.00			
				527050		7.37	-26.67	34.04	2.00			
		20		535500		7.33	-26.82	34.15	2.00			
				518598		7.39	-26.39	33.78	2.00			
				518598		7.23	-26.68	33.91	2.00			
				518598		7.14	-26.78	33.92	2.00			
		15		518598								
		10		518598								

Table 13.3
VoNR Worst-case Scan Result

Band / BW	Connection Configuration	RF Bandwidth (MHz)	Channel	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
NR n41 (PC2)	B	25	518598	AMR WB 6.60kbps	151	330	15	26	2.00	Compliant



13.3. OTT VoIP over NR

A set of measurements were performed to investigate the worst-case band configuration for OTT VoIP over NR. A single point measurement was taken on the middle channel for every band and maximum bandwidth combination at the maximum desired ABM location. The middle channels and supported bandwidths from the worst-case band are additionally evaluated. Low, middle and high channels were tested in the worst-case band & bandwidth combination for FCC compliance evaluation to ensure the maximum emission is captured across the entire mode. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration to show compliance.

Table 13.4
OTT VoIP over NR Single Point Measurement Results

Test Condition													
Mode:	Google Meet	Hearing Aid Mode:	On	Volume Level	Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 34.66dB			
Band	Standard	RF Bandwidth (MHz)	Radio Configuration (Waveform/Modulation/ RB/RB offset)	Channel	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]			
NR n71	A	30	DFT-s-OFDM 16QAM/1RB/1RB offset	136100	OPUS 6KBPS	5.31	-36.36	41.67	2.00	12.0, -7.0			
	E					5.76	-34.84	40.60	2.00				
NR n12	A	15		141500		5.27	-35.97	41.24	1.48				
	E					5.46	-34.84	40.30	2.00				
NR n14	A	10		158600		5.21	-34.39	39.60	2.00				
	E					5.24	-37.44	42.68	1.98				
NR n26	A	20		166300		5.06	-35.65	40.71	2.00				
	E					5.40	-34.77	40.17	1.98				
NR n70	A	15		340500		5.14	-35.29	40.43	1.64				
	F					5.20	-35.68	40.88	2.00				
NR n66	A	45		349000		5.12	-35.47	40.59	1.91				
	F					5.88	-34.89	40.77	2.00				
NR n25	A	40		376500		5.17	-35.77	40.94	1.63				
	F					5.96	-34.79	40.75	2.00				
NR n30	A	10		462000		5.54	-35.58	41.12	2.00				
	F					5.04	-35.15	40.19	1.97				
NR n7	B	50		507000		5.46	-34.97	40.43	2.00				
	F					5.89	-34.95	40.84	2.00				
NR n41 (PC2)	B	100		518598		5.41	-29.25	34.66	2.00				
	F					5.43	-30.13	35.56	2.00				
NR n48	F	40				641666		5.92	-30.40		36.32	2.00	
NR n77 DoD (PC2)	F	100				633334		5.33	-33.34		38.67	2.00	
NR n77 C (PC2)	F	100				656000		5.23	-32.55		37.78	2.00	
Worst-Case Band Evaluation													
Mode:	Google Meet	Hearing Aid Mode:		On		Volume Level	Max	Desired ABM	48K Voice 1KHz 1s		Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 33.03dB
Band	Connection Configuration	RF Bandwidth (MHz)	Radio Configuration (Waveform/Modulation/ RB/RB offset)	Channel	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]			
n41	B	100	DFT-s-OFDM 16QAM/1RB/1RB offset	518598	OPUS 6KBPS	5.41	-29.25	35.66	2.00	12.0, -7.0			
				508200		5.07	-29.15	34.22	2.00				
		90		513399		5.37	-28.17	33.54	2.00				
				518598		5.21	-27.82	33.03	2.00				
		80		523797		5.11	-28.25	33.36	2.00				
				528996		5.40	-29.12	34.52	2.00				
		70		518598		5.46	-30.00	35.46	2.00				
				518598		5.86	-29.71	35.57	2.00				
		60		518598		5.48	-29.49	34.97	2.00				
				518598		5.46	-29.07	34.53	2.00				
		45		518598		5.45	-28.72	34.17	2.00				
				518598		5.40	-28.95	34.35	2.00				
		35		518598		5.47	-28.89	34.36	2.00				
				518598		5.43	-28.46	33.89	2.00				
		30		518598		5.46	-28.59	34.05	2.00				
				518598		5.50	-28.73	34.23	2.00				
		25		518598		5.38	-28.52	33.90	2.00				
				518598		5.32	-29.00	34.32	2.00				
		20		518598		5.32	-29.00	34.32	2.00				
				518598		5.32	-29.00	34.32	2.00				

Table 13.5
OTT VoIP over NR Worst-case Scan Result

Band / BW	Connection Configuration	RF Bandwidth (MHz)	Channel	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
NR n41 (PC2)	B	90	518598	OPUS 6KBPS	138	355	15	26	2.00	Compliant

14. C63.19 WLAN T-Coil Measurements

14.1. Radio Configuration Investigation

A set of measurements were performed on all applicable data rates and modulations to determine the radio configuration to be used for testing. This evaluation was performed on MIMO mode. See tables below for undesired ABM comparison between radio configurations in each IEEE 802.11 standard:

Table 14.1
2.4 GHz data rate investigation

Test Condition								
Hearing Aid Mode:	On	Codec Type		AMR WB 6.60KBPS		Volume Level:	Max	
Band	Standard	RF Bandwidth (MHz)	Channel	Modulation	Data Rate	RU Index	Undesired ABM [dB(A/m)]	Peak Measurement Location [x,y]
2.4GHz	IEEE 802.11b	20	6	DSSS	1	N/A	-30.59	12.0, -7.0
	IEEE 802.11b	20	6	CCK	11	N/A	-30.57	
	IEEE 802.11g	20	6	BPSK	6	N/A	-31.34	
	IEEE 802.11g	20	6	64QAM	54	N/A	-29.41	
	IEEE 802.11n	20	6	BPSK	MCS 0	N/A	-31.48	
	IEEE 802.11n	20	6	64QAM	MCS 7	N/A	-32.10	
	IEEE 802.11ac	20	6	BPSK	MCS 0	N/A	-32.35	
	IEEE 802.11ac	20	6	256QAM	MCS 8	N/A	-32.64	
	IEEE 802.11ax (SU)	20	6	BPSK	MCS 0	N/A	-30.98	
	IEEE 802.11ax (SU)	20	6	1024QAM	MCS 11	N/A	-30.88	
	IEEE 802.11ax (RU)	20	6	1024QAM	MCS 11	1	-31.09	
	IEEE 802.11ax (RU)	20	6	1024QAM	MCS 11	9	-31.00	
	IEEE 802.11be (SU)	20	6	BPSK	MCS 0	N/A	-31.94	
	IEEE 802.11be (SU)	20	6	4096QAM	MCS 13	N/A	-31.85	
	IEEE 802.11be (RU)	20	6	4096QAM	MCS 13	1	-31.76	
	IEEE 802.11be (RU)	20	6	4096QAM	MCS 13	9	-31.75	

Table 14.2
5GHz data rate investigation

Test Condition									
Hearing Aid Mode:	On	Codec Type		AMR WB 6.60KBPS		Volume Level:		Max	
Band	Standard	RF Bandwidth (MHz)	U-NII Band	Channel	Modulation	Data Rate	RU Index	Undesired ABM [dB(A/m)]	Peak Measurement Location [x,y]
5GHz	IEEE 802.11a	20	1	40	BPSK	6	N/A	-33.69	12.0, -7.0
	IEEE 802.11a	20	1	40	64QAM	54	N/A	-34.55	
	IEEE 802.11n	20	1	40	BPSK	MCS 0	N/A	-29.10	
	IEEE 802.11n	20	1	40	64QAM	MCS 7	N/A	-30.62	
	IEEE 802.11n	40	1	38	BPSK	MCS 0	N/A	-30.08	
	IEEE 802.11n	40	1	38	64QAM	MCS 7	N/A	-29.78	
	IEEE 802.11ac	20	1	40	BPSK	MCS 0	N/A	-30.82	
	IEEE 802.11ac	20	1	40	256QAM	MCS 8	N/A	-30.87	
	IEEE 802.11ac	40	1	38	BPSK	MCS 0	N/A	-30.48	
	IEEE 802.11ac	40	1	38	256QAM	MCS 9	N/A	-30.90	
	IEEE 802.11ac	80	1	38	BPSK	MCS 0	N/A	-30.73	
	IEEE 802.11ac	80	1	38	256QAM	MCS 9	N/A	-31.75	
	IEEE 802.11ac	160	1	38	BPSK	MCS 0	N/A	-31.09	
	IEEE 802.11ac	160	1	38	256QAM	MCS 9	N/A	-31.09	
	IEEE 802.11ax (SU)	20	1	40	BPSK	MCS 0	N/A	-30.09	
	IEEE 802.11ax (SU)	20	1	40	1024QAM	MCS 11	N/A	-30.96	
	IEEE 802.11ax (RU)	20	1	40	BPSK	MCS 0	1	-31.11	
	IEEE 802.11ax (RU)	20	1	40	BPSK	MCS 0	9	-30.98	
	IEEE 802.11ax (SU)	40	1	38	BPSK	MCS 0	N/A	-31.35	
	IEEE 802.11ax (SU)	40	1	38	1024QAM	MCS 11	N/A	-31.19	
	IEEE 802.11ax (RU)	40	1	38	1024QAM	MCS 11	1	-36.89	
	IEEE 802.11ax (RU)	40	1	38	1024QAM	MCS 11	18	-32.65	
	IEEE 802.11ax (SU)	80	1	42	BPSK	MCS 0	N/A	-29.19	
	IEEE 802.11ax (SU)	80	1	42	1024QAM	MCS 11	N/A	-29.29	
	IEEE 802.11ax (RU)	80	1	42	BPSK	MCS 0	1	-30.08	
	IEEE 802.11ax (RU)	80	1	42	BPSK	MCS 0	37	-31.24	
	IEEE 802.11ax (SU)	160	1	50	BPSK	MCS 0	N/A	-29.52	
	IEEE 802.11ax (SU)	160	1	50	1024QAM	MCS 11	N/A	-29.53	
	IEEE 802.11ax (RU)	160	1	50	BPSK	MCS 0	1	-29.44	
	IEEE 802.11ax (RU)	160	1	50	BPSK	MCS 0	37	-30.96	
	IEEE 802.11be (SU)	20	1	40	BPSK	MCS 0	N/A	-30.73	
	IEEE 802.11be (SU)	20	1	40	4096QAM	MCS 13	N/A	-31.36	
	IEEE 802.11be (RU)	20	1	40	BPSK	MCS 0	1	-31.27	
	IEEE 802.11be (RU)	20	1	40	BPSK	MCS 0	9	-31.30	
	IEEE 802.11be (SU)	40	1	38	BPSK	MCS 0	N/A	-30.29	
	IEEE 802.11be (SU)	40	1	38	4096QAM	MCS 13	N/A	-30.24	
	IEEE 802.11be (RU)	40	1	38	4096QAM	MCS 13	1	-30.53	
	IEEE 802.11be (RU)	40	1	38	4096QAM	MCS 13	18	-29.93	
	IEEE 802.11be (SU)	80	1	42	BPSK	MCS 0	N/A	-31.66	
	IEEE 802.11be (SU)	80	1	42	4096QAM	MCS 13	N/A	-31.73	
	IEEE 802.11be (RU)	80	1	42	BPSK	MCS 0	1	-29.30	
	IEEE 802.11be (RU)	80	1	42	BPSK	MCS 0	37	-31.92	
	IEEE 802.11be (SU)	160	1	50	BPSK	MCS 0	N/A	-31.50	
	IEEE 802.11be (SU)	160	1	50	4096QAM	MCS 13	N/A	-31.44	
	IEEE 802.11be (RU)	160	1	50	4096QAM	MCS 13	1	-31.20	
	IEEE 802.11be (RU)	160	1	50	4096QAM	MCS 13	37	-30.98	

14.2. Antenna Configuration Investigation

Based on the results from table 12-1 and table 12-2, Scan measurement was performed on the highest undesired ABM connection configuration to determine the WLAN antenna operation to be evaluated. As a result, worst-case SISO (Antenna 2) and MIMO WLAN configurations were determined to be tested for compliance. See table below for comparison:

Table 14.3
WLAN configuration Scan evaluation

Band	Standard	Connection Configuration	Data Rate	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
2.4GHz	IEEE 802.11g	ANT 1 / CH. 6	54MBPS	AMR WB 6.60kbps	330	471	26	26	2.00	Compliant
2.4GHz	IEEE 802.11g	ANT 2 / CH. 6	54MBPS		305	445	23	26	2.00	Compliant
2.4GHz	IEEE 802.11g	ANT 1 & 2 / CH. 6	54MBPS		298	433	21	26	2.00	Compliant
5GHz	IEEE 802.11n	ANT 1 / 20MHz CH. 40	MCS 0		394	531	26	26	2.00	Compliant
5GHz	IEEE 802.11n	ANT 2 / 20MHz CH. 40	MCS 0		361	507	26	25	2.00	Compliant
5GHz	IEEE 802.11n	ANT 1 & 2 / 20MHz CH. 40	MCS 0		282	510	26	26	2.00	Compliant

14.3. Voice Over WIFI

A set of measurements were performed to investigate the worst-case operating condition for VoWIFI over IMS. A single point measurement was taken on each IEEE 802.11 standard, fixed channels (CH. 6 for 2.4 GHz operation, CH.40 for 5GHz operation) at the maximum desired ABM coordinate. 2.4GHz IEEE 802.11 standard resulting in the worst-case SNNR was additionally tested using low and high channels. The 5GHz IEEE 802.11 standard resulting in the worst-case SNNR was additionally tested on higher bandwidth and U-NII bands as well as applicable low and high channels. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration.

Table 14.4
VoWIFI (SISO) Single Point Measurement Results

Worst case band - VoWIFI SISO											
VoNR	Hearing Aid Mode:		On	Volume Level		Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 36.58dB
Band	Standard	RF Bandwidth (MHz)	U-NII Band	Channel	Data Rate	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
2.4GHz	IEEE 802.11b	20	N/A	6	11Mbps	AMR WB 6.60kbps	7.64	-32.03	39.67	2.00	12.0, -7.0
				1	54Mbps		7.38	-33.52	40.90	2.00	
	IEEE 802.11g	20		6	54Mbps		7.52	-29.30	36.82	2.00	
				11	54Mbps		7.64	-28.94	36.58	2.00	
	IEEE 802.11n	20		6	MCS 0		7.47	-31.89	39.36	2.00	
	IEEE 802.11ac	20		6	MCS 0		7.53	-30.14	37.67	2.00	
	IEEE 802.11ax (SU)	20		6	MCS 11		7.57	-31.44	39.01	2.00	
	IEEE 802.11ax (RU)	20		6	MCS 11 RU INDEX 9		7.60	-30.65	38.25	2.00	
	IEEE 802.11be (SU)	20		6	MCS 13		7.63	-31.47	39.10	2.00	
	IEEE 802.11be (RU)	20		6	MCS 13 RU INDEX 9		7.45	-31.66	39.11	2.00	
5GHz	IEEE 802.11a	20	1	40	6Mbps	AMR WB 6.60kbps	7.67	-29.31	36.98	2.00	12.0, -7.0
	IEEE 802.11n	20	1	40	MCS 0		7.60	-32.76	40.36	2.00	
	IEEE 802.11ac	20	1	40	MCS 0		7.43	-30.68	38.11	2.00	
	IEEE 802.11ax (SU)	20	1	40	MCS 0		7.62	-32.98	40.60	2.00	
	IEEE 802.11ax (RU)	20	1	40	MCS 0 RU INDEX 9		7.52	-32.38	39.90	2.00	
	IEEE 802.11be (SU)	20	1	40	MCS 0		7.70	-30.89	38.59	2.00	
	IEEE 802.11be (RU)	20	1	40	MCS 0 RU INDEX 1		7.40	-30.80	38.20	2.00	

Table 14.5
VoWIFI (SISO) Worst-case Scan Result

Band	Standard	RF Bandwidth (MHz)	Channel	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
2.4GHz	IEEE 802.11g	20MHz	11	AMR WB 6.60kbps	244	429	23	26	2.00	Compliant

Table 14.6
VoWiFi (MIMO) Single Point Measurement Results

Worst case band - VoWiFi MIMO												
VoNR	Hearing Aid Mode:		On	Volume Level		Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 34.65dB	
Band	Standard	RF Bandwidth (MHz)	U-NII Band	Channel	Data Rate	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]	
2.4GHz	IEEE 802.11g	20	N/A	6	54MBPS	AMR WB 6.60kbps	7.38	-31.56	38.94	2.00	12.0, -7.0	
	IEEE 802.11n	20		6	MCS 0		7.37	-31.57	38.94	2.00		
	IEEE 802.11ac	20		6	MCS 0		7.34	-32.80	40.14	2.00		
	IEEE 802.11ax (SU)	20		6	MCS 11		7.52	-31.92	39.44	2.00		
	IEEE 802.11ax (RU)	20		6	MCS 11 RU INDEX 9		7.62	-32.38	40.00	2.00		
	IEEE 802.11be (SU)	20		6	MCS 13		7.61	-32.55	40.16	2.00		
	IEEE 802.11be (RU)	20		6	MCS 13 RU INDEX 9		7.64	-32.24	39.88	2.00		
	IEEE 802.11a	20		1	40		6MBPS	7.01	-30.85	37.86		2.00
	IEEE 802.11n	20		1	40		MCS 0	7.06	-31.71	38.77		2.00
	IEEE 802.11ac	20		1	40		MCS 0	7.05	-32.76	39.81		2.00
5GHz	IEEE 802.11ax (SU)	20	1	40	MCS 0	7.19	-30.83	38.02	2.00			
	IEEE 802.11ax (RU)	20	1	40	MCS 0 RU INDEX 9	7.22	-29.86	37.08	2.00			
	IEEE 802.11be (SU)	20	1	40	MCS 0	7.28	-29.34	36.62	2.00			
	IEEE 802.11be (RU)	20	1	40	MCS 0 RU INDEX 1	7.32	-29.15	36.47	2.00			
			2A	56		7.25	-32.40	39.65	2.00			
			2C	120		7.35	-29.76	37.11	2.00			
			3	157		7.24	-30.98	38.22	2.00			
			4	169		7.29	-30.03	37.32	2.00			
			5	5		7.32	-27.33	34.65	2.00			
	IEEE 802.11be (RU)	40	1	38		7.17	-31.59	38.76	2.00			
	IEEE 802.11be (RU)	80	1	42		7.24	-31.95	39.19	2.00			
	IEEE 802.11be (RU)	160	1	50		7.32	-31.04	38.36	2.00			

Table 14.7
VoWiFi (MIMO) Worst-case Scan Result

Band	Standard	RF Bandwidth (MHz)	Channel	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
2.4GHz	IEEE 802.11ax (RU)	20	5	AMR WB 6.60kbps	251	430	26	26	2.00	Compliant

14.4. OTT VoIP over WIFI

A set of measurements were performed to investigate the worst-case band configuration for OTT VoIP over WIFI. For each IEEE 802.11 standard, fixed channels (CH. 6 for 2.4 GHz operation, CH.40 for 5GHz operation) at the maximum desired ABM coordinate were evaluated. 2.4GHz IEEE 802.11 standard resulting in the worst-case SNNR was additionally tested using low and high channels. The 5GHz IEEE 802.11 standard resulting in the worst-case SNNR was additionally tested on higher bandwidth and U-NII bands as well as applicable low and high channels. T-Coil scan specified in C63.19-2019 was performed on the worst-case configuration.

Table 14.8
OTT VoIP over WIFI (SISO) Single Point Measurement Results

Worst case band - OTT VoIP over WiFi (SISO)											
Google Meet	Hearing Aid Mode:		On	Volume Level		Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 39.71dB
Band	Standard	RF Bandwidth (MHz)	U-NII Band	Channel	Data Rate	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin [dB]	Peak Measurement Location [x,y]
2.4GHz	IEEE 802.11b	20	N/A	6	11MBPS	OPUS 6KBPS	5.86	-36.07	41.93	2.00	12.0, -7.0
	IEEE 802.11g	20		6	54MBPS		5.79	-35.16	40.95	2.00	
	IEEE 802.11n	20		6	MCS 0		6.11	-36.55	42.66	2.00	
	IEEE 802.11ac	20		6	MCS 0		6.28	-37.09	43.37	2.00	
	IEEE 802.11ax (SU)	20		6	MCS 11		5.89	-37.22	43.11	2.00	
	IEEE 802.11ax (RU)	20		6	MCS 11 RU INDEX 9		6.28	-35.97	42.25	2.00	
	IEEE 802.11be (SU)	20		6	MCS 13		6.46	-36.71	43.17	2.00	
	IEEE 802.11be (RU)	20		6	MCS 13 RU INDEX 9		5.98	-36.76	42.74	2.00	
	IEEE 802.11a	20		1	40		6MBPS	5.68	-36.18	41.86	
5GHz	IEEE 802.11n	20	1	40	MCS 0	5.43	-34.28	39.71	2.00		
			2A	56		5.37	-35.06	40.43	2.00		
			2C	120		5.66	-35.24	40.90	2.00		
			3	157		5.55	-35.76	41.31	2.00		
			4	169		5.22	-35.92	41.14	2.00		
			IEEE 802.11n	40		1	38	MCS 7	5.95	-35.86	
	IEEE 802.11ac	20	1	40	MCS 0	5.21	-35.74	40.95	2.00		
	IEEE 802.11ax (SU)	20	1	40	MCS 0	5.27	-34.79	40.06	2.00		
	IEEE 802.11ax (RU)	20	1	40	MCS 0 RU INDEX 9	5.48	-35.67	41.15	2.00		
	IEEE 802.11be (SU)	20	1	40	MCS 0	5.55	-35.53	41.08	2.00		
	IEEE 802.11be (RU)	20	1	40	MCS 0 RU INDEX 1	5.66	-36.03	41.69	2.00		

Table 14.9
OTT VoIP over WIFI (SISO) Worst-case Scan Result

Band	Standard	RF Bandwidth (MHz)	Channel	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
5GHz	IEEE 802.11n	20MHz	40	OPUS 6KBPBS	278	573	26	26	2.00	Compliant

Table 14.10
OTT VoIP over WIFI (MIMO) Single Point Measurement Results

Worst case band - OTT VoIP over WiFi (MIMO)											
Google Meet	Hearing Aid Mode:		On	Volume Level		Max	Desired ABM	48K Voice 1KHz 1s	Frequency Response Audio	48K Voice 300-3000 2s	Worstcase SNNR: 37.15dB
Band	Standard	RF Bandwidth (MHz)	U-NII Band	Channel	Data Rate	Codec Type	Desired ABM [dB/A/m]	Undesired ABM [dB/A/m]	SNNR [dB]	Frequency Response Mask Margin (dB)	Peak Measurement Location [x,y]
2.4GHz	IEEE 802.11g	20	N/A	6	54MBPS	OPUS 6KBPS	6.23	-35.87	42.10	2.00	12.0, -7.0
	IEEE 802.11n	20		1	MCS 0		5.63	-34.04	39.67	2.00	
		6		6.03			-31.12	37.15	2.00		
		11		5.57			-34.02	39.59	2.00		
		IEEE 802.11ac		20	6		MCS 0	6.35	-35.70	42.05	
	IEEE 802.11ax (SU)	20		6	MCS 11		6.03	-36.58	42.61	2.00	
	IEEE 802.11ax (RU)	20		6	MCS 11 RU INDEX 9		5.50	-36.99	42.49	2.00	
	IEEE 802.11be (SU)	20		6	MCS 13		6.00	-36.22	42.22	2.00	
	IEEE 802.11be (RU)	20		6	MCS 13 RU INDEX 9		5.51	-36.21	41.72	2.00	
	5GHz	IEEE 802.11a		20	1		40	6MBPS	OPUS 6KBPS	5.91	
IEEE 802.11n		20	1	40	MCS 0	5.88	-35.09	40.97		2.00	
IEEE 802.11ac		20	1	40	MCS 0	5.87	-33.63	39.50		2.00	
IEEE 802.11ax (SU)		20	1	40	MCS 0	5.71	-34.96	40.67		2.00	
IEEE 802.11ax (RU)		20	1	40	MCS 0 RU INDEX 9	5.77	-34.67	40.44		2.00	
IEEE 802.11be (SU)		20	1	40	MCS 0	6.09	-34.91	41.00		2.00	
IEEE 802.11be (RU)		20	1	40	MCS 0 RU INDEX 1	6.07	-34.83	40.90		2.00	

Table 14.11
OTT VoIP over WIFI (MIMO) Worst-case Scan Result

Band	Standard	RF Bandwidth (MHz)	Channel	Codec Type	Primary	Secondary	longitudinal	Transverse	Frequency Response Mask Margin (dB)	Result
2.4GHz	IEEE 802.11n	20	6	OPUS 6KBPS	239	523	25	26	2.00	Compliant

15. Summary of Test Results

The wireless device has been tested for compatibility with hearing aids equipped with telecoils according to ANSI C63.19-2019.

Table 15.1
Summary of Test Results

Category Modes	Primary Points	Secondary Points	Contiguous Longitudinal	Contiguous 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
WLAN	Pass	Pass	Pass	Pass	Pass	Pass
OTT VoIP	Pass	Pass	Pass	Pass	Pass	Pass

16. Conclusion

This wireless device was tested for hearing aid compatibility in T-Coil mode in accordance with ANSI C63.19-2019. The device met the required limits for desired magnetic signal strength, undesired noise, and frequency response.

The measurements indicate that the wireless communications device is compliant with the HAC limits specified in ANSI C63.19-2019 Standard and FCC WT Docket No. 01-309 RM-8658. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters specific to the test. The test results and statements relate only to the item(s) tested.

17. Equipment List

Table 17.1
Equipment List

Manufacturer	Model	Serial #	Description	Cal Interval	Cal Due
SPEAG	DAE	1838	Data Acquisition Electronics	Annual	12/4/2025
SPEAG	AM1DV3	3166	Magnetic field probes	Annual	8/15/2026
SPEAG	SD HAC P02 AD	2013	Audio Magnetic Calibration Coil	CBT*	N/A
SPEAG	SE UMS 010 CA	2018	Audio Magnetic Measuring Instrument	CBT*	N/A
SPEAG	SD HAC P01 BB	1115	HAC Phantom	N/A	N/A
SPEAG	MAIA	1814	Modulation and Audio Interference Analyser	CBT*	N/A
Yellow Tec	YT4211	24001232	USB Audio Interface	CBT*	N/A
Rohde & Schwarz	CMW 500	168212	Wideband Radio Communication Tester	Annual	9/30/2026
Rohde & Schwarz	CMX OBT	100198	Radio Communication Tester	Annual	8/28/2026
Mini-Circuits	BW-E6-1W653+	N/A	6dB Power Attenuator	CBT*	N/A
HUBER & SUHNER	74Z-0-0-21	27655	Torque Wrench (100 cN·m)	Biennial	10/7/2026

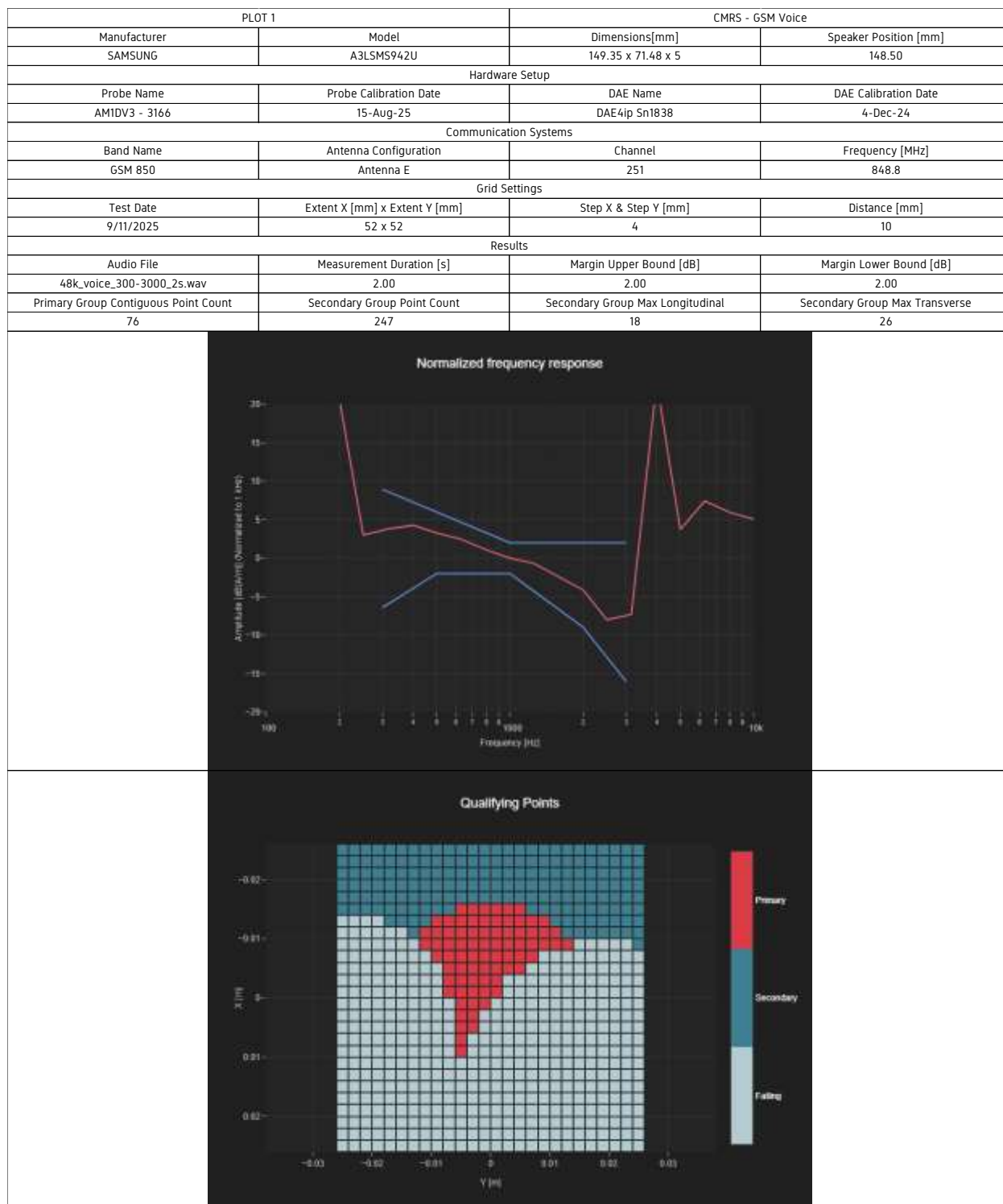
*Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements

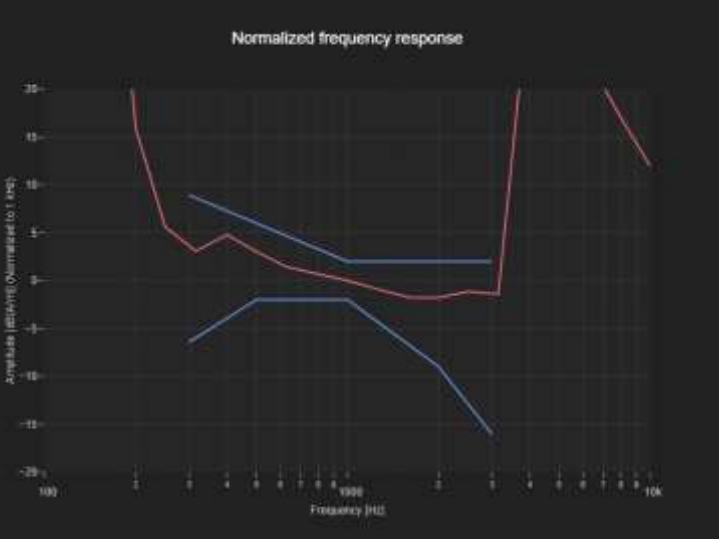
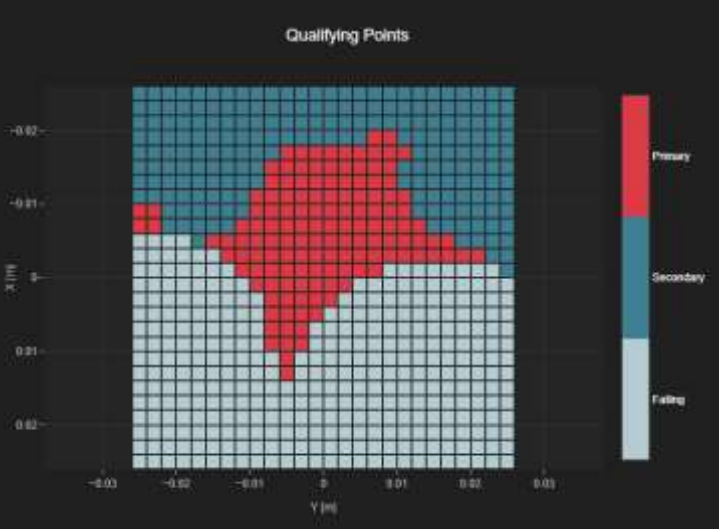
18. Measurement Uncertainty

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

Note: Worst-Case uncertainty budget for HAC free field assessment according to ANSI C63.19- 2019. The budget is valid for the frequency range 600 MHz - 6 GHz (with AM1DV3 probe) and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerably smaller. Some of the parameters are dependent on the user situation and need adjustment according to the actual laboratory conditions.

Appendix A: T-Coil Test Plots



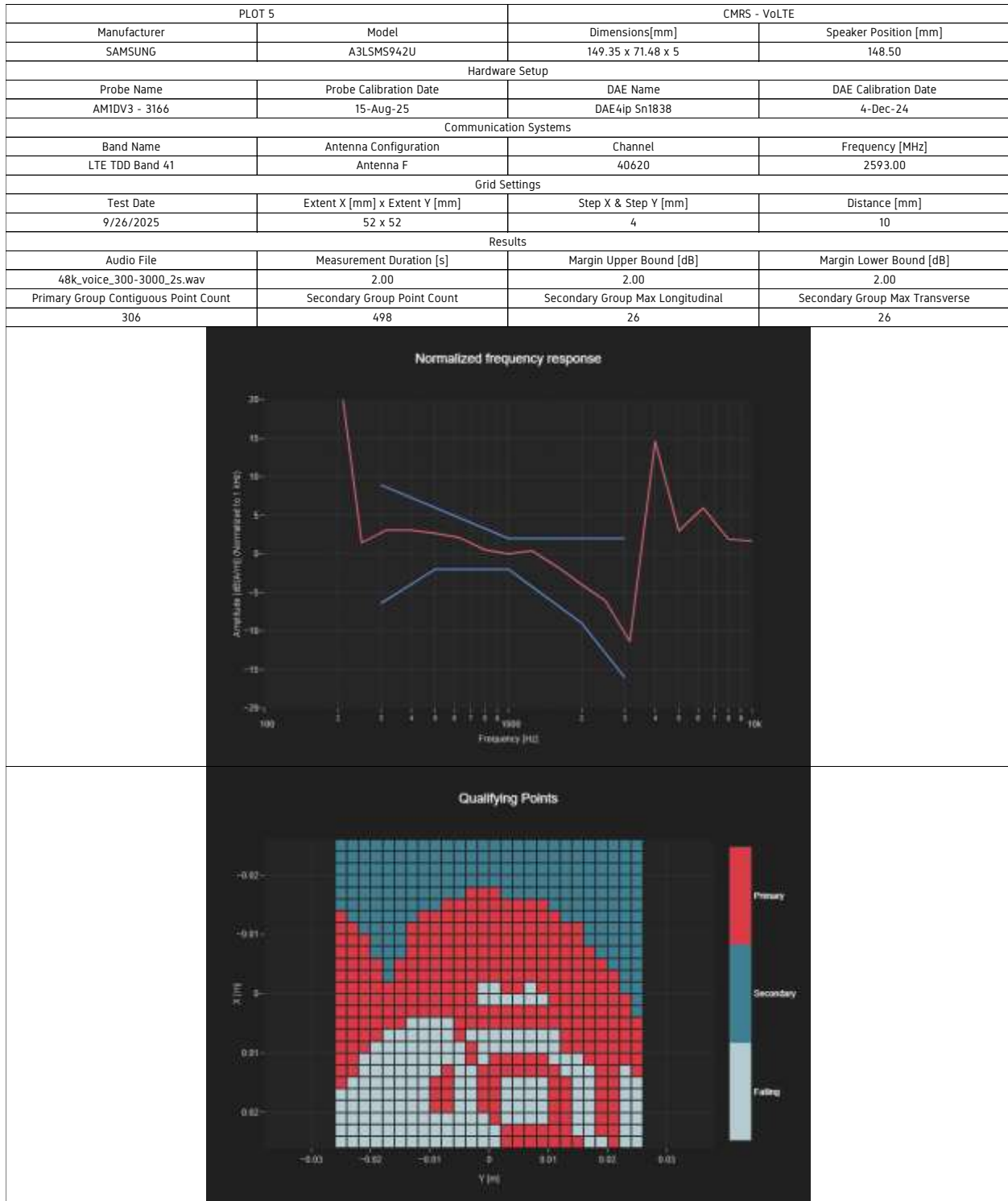
PLOT 2		Google Meet - EDGE	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
EDGE 850	Antenna E	251	848.8
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/25/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2.00	2.00	2.00
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
137	337	20	26
Normalized frequency response 			
Qualifying Points 			



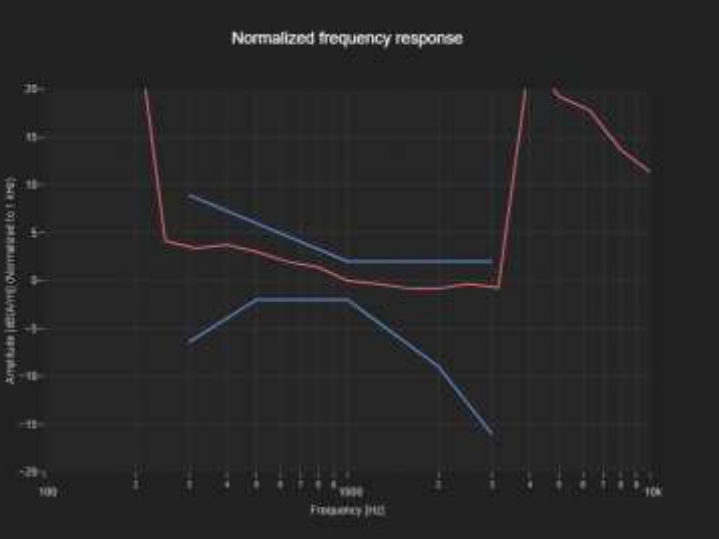
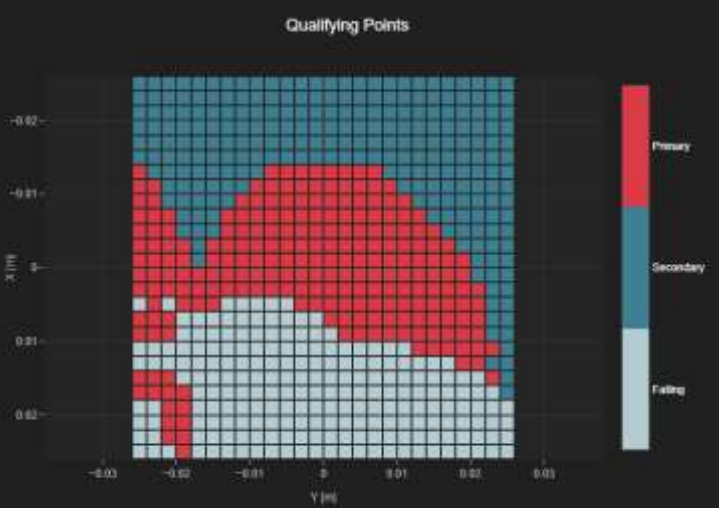
PLOT 3		CMRS - UMTS Voice	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
UMTS Band 4	Antenna A	1312	1712.4
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/11/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_300-3000_2s.wav	2.00	1.95	2.00
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
458	646	26	26

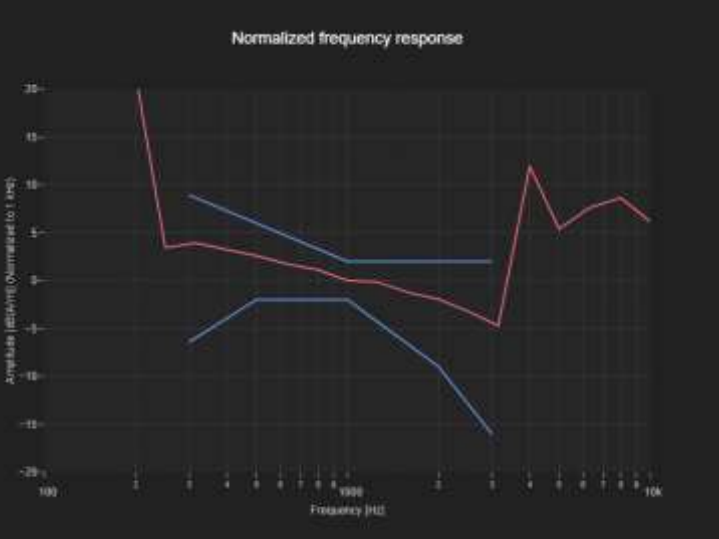
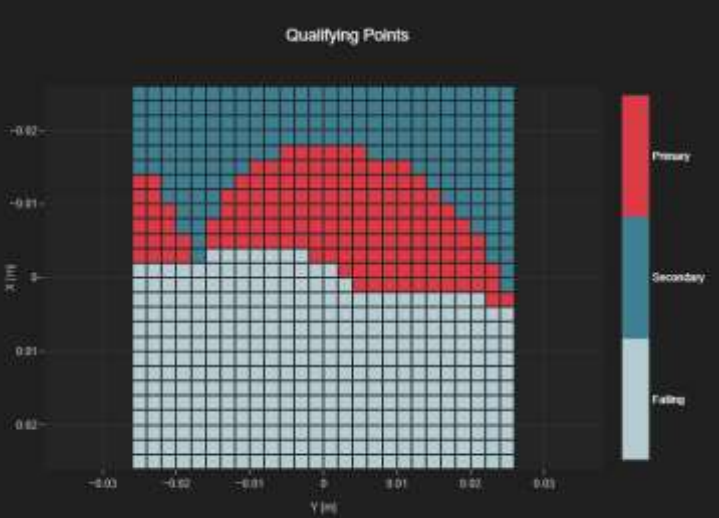


PLOT 4		Google Meet - HSPA	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
HSPA Band 5	Antenna A	4132	826.40
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/11/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2.00	2.00	2.00
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
353	577	26	26
Normalized frequency response			
Qualifying Points			

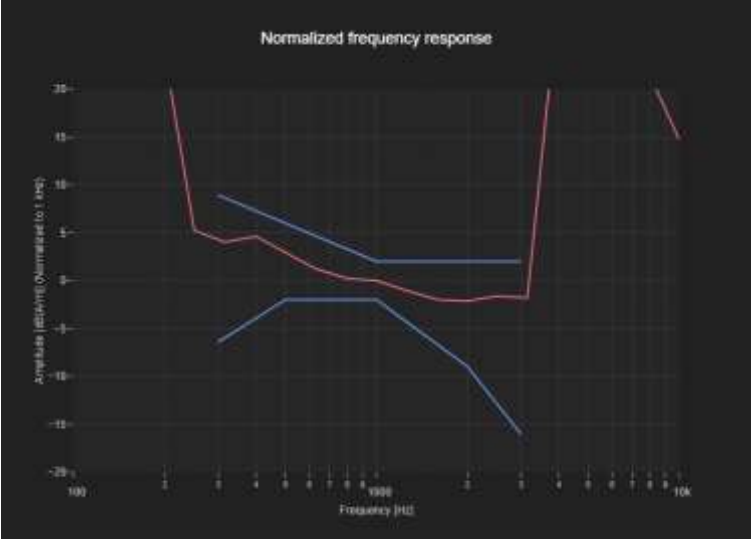
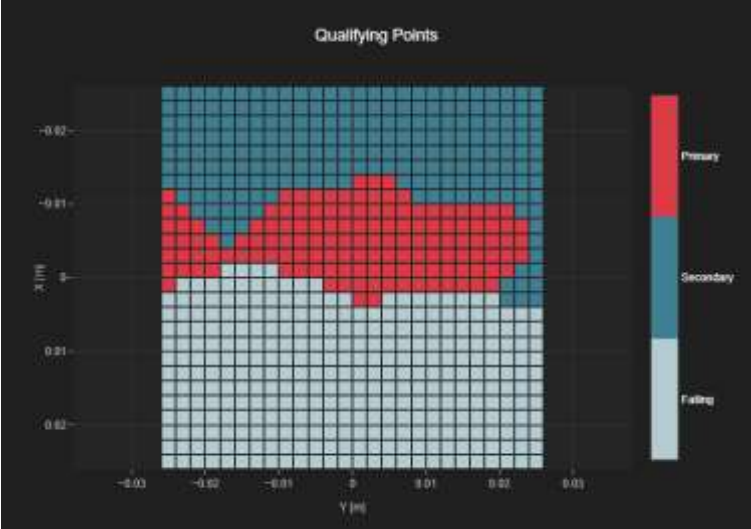




PLOT 6		Google Meet - LTE	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
LTE TDD Band 41	Antenna F	40620	2593.00
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/22/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2.00	1.88	2.00
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
227	468	22	26
Normalized frequency response 			
Qualifying Points 			

PLOT 7		CMRS - VoNR	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
NR TDD n41	Antenna B	518598	2592.99
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/26/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2.00	2.00	2.00
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
151	330	15	26
Normalized frequency response 			
Qualifying Points 			



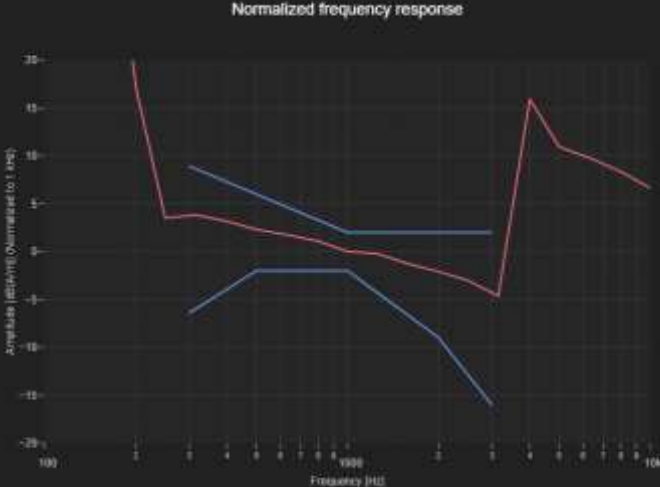
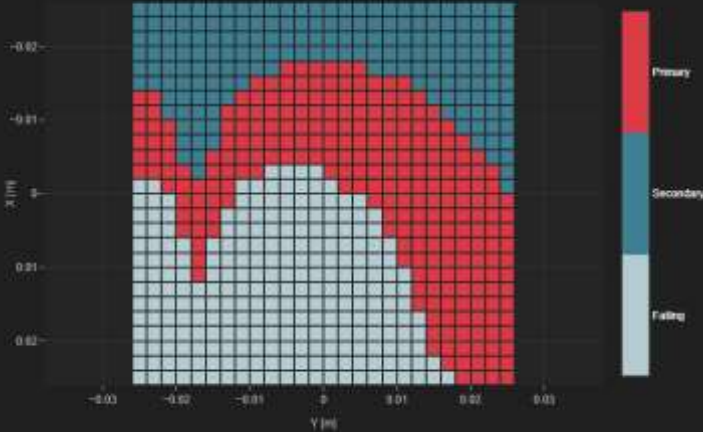
PLOT 8		Google Meet - NR	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
NR TDD n41	Antenna B	518598	2592.99
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/22/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2	2	2
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
138	355	15	26
			
			



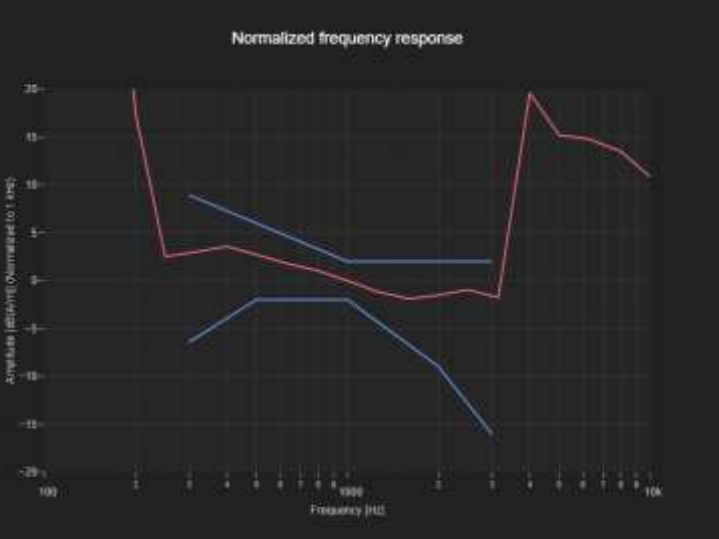
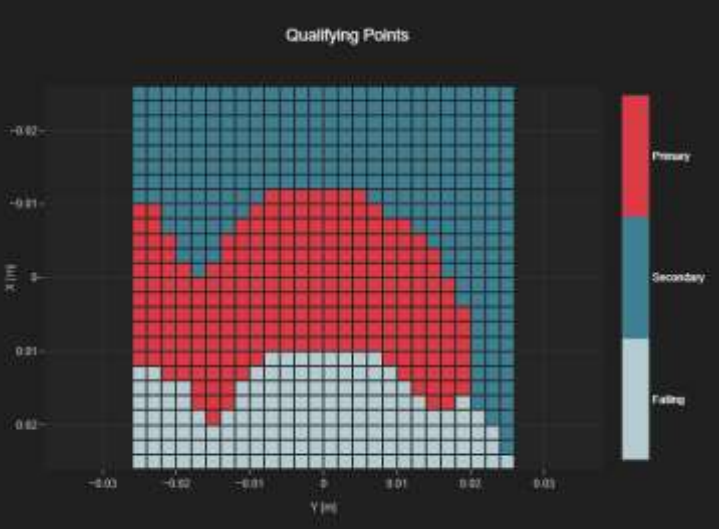
PLOT 9		CMRS - VoWiFi SISO	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Radio Configuration	Antenna Configuration	Channel	Frequency [MHz]
2.4GHz IEEE 802.11g	Antenna 2	11	2462.00
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/26/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2.0	2.0	2.0
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
244	429	23	26
Normalized frequency response			
Qualifying Points			



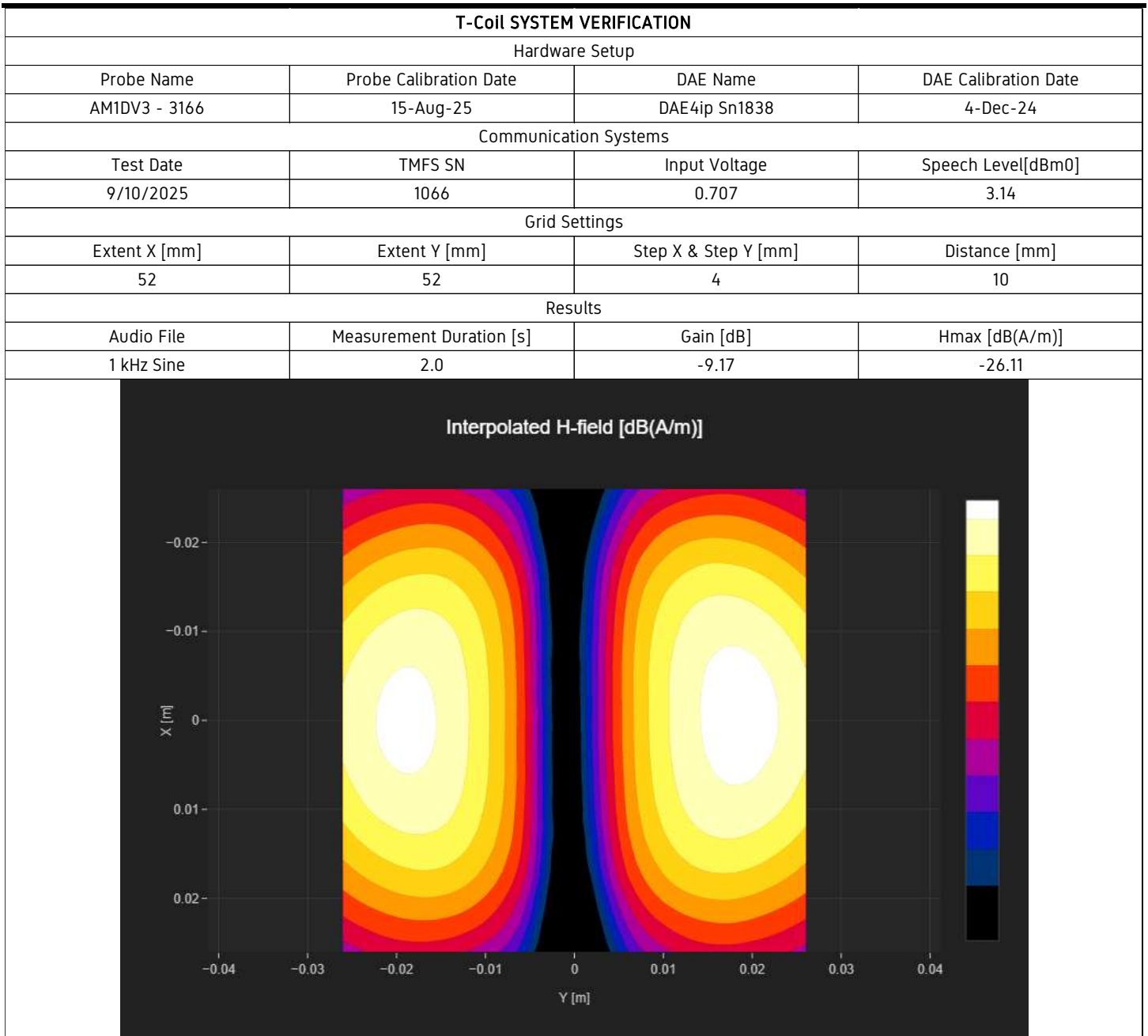
PLOT 10		Google Meet - WIFI SISO	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Radio Configuration	Antenna Configuration	Channel	Frequency [MHz]
IEEE 802.11n 20MHz	Antenna 2	40	5200.00
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/28/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2	2.00	2.00
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
278	573	26	26
Normalized frequency response			
Qualifying Points			

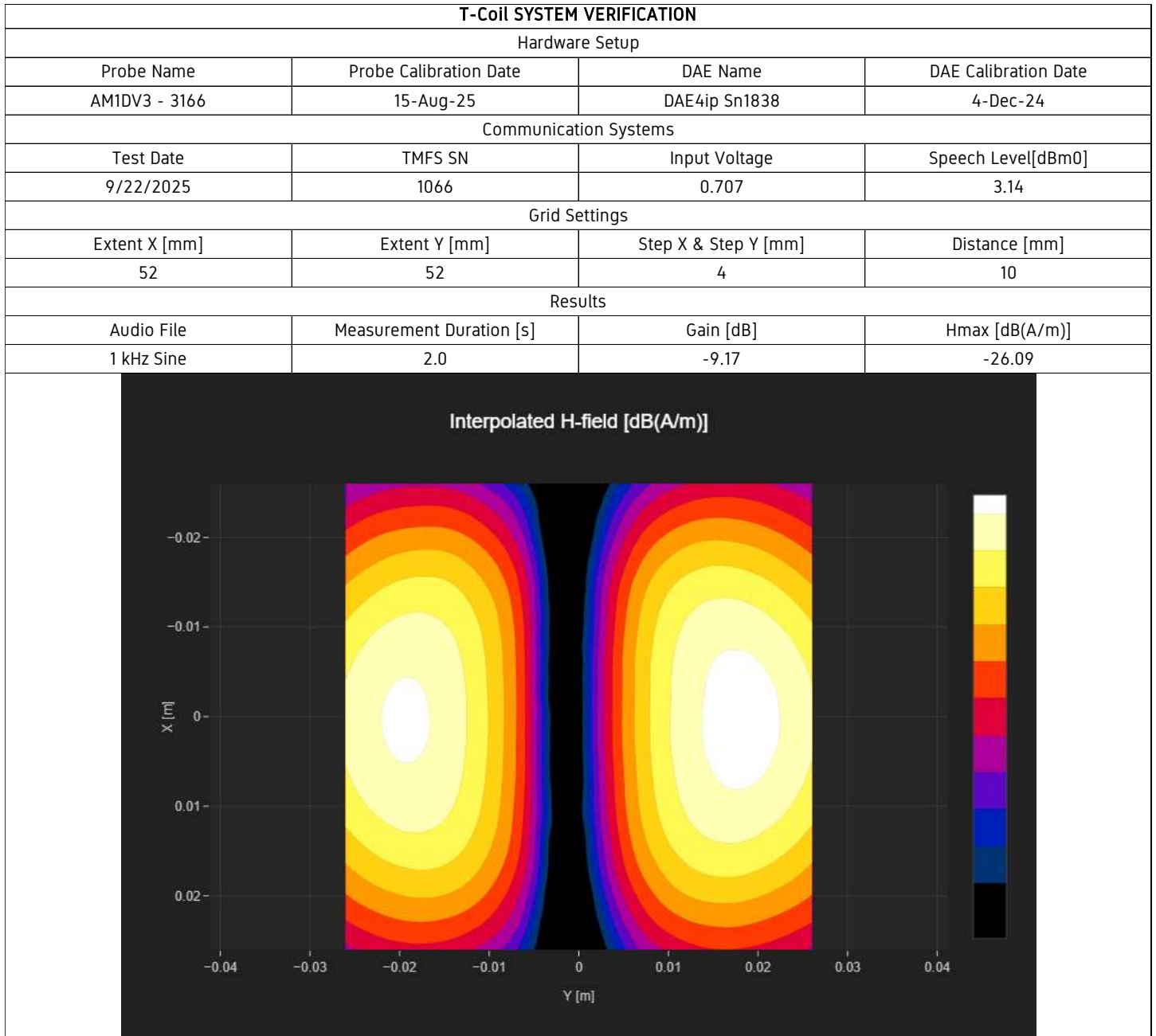
PLOT 11		CMRS - VoWiFi MIMO	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
IEEE 802.11be (RU) 20MHz	MIMO	5	5975.00
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/26/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2	2.00	2.00
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
251	430	26	26
Normalized frequency response 			
Qualifying Points 			



PLOT 12		Google Meet - WIFI MIMO	
Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
SAMSUNG	A3LSMS942U	149.35 x 71.48 x 5	148.50
Hardware Setup			
Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
AM1DV3 - 3166	15-Aug-25	DAE4ip Sn1838	4-Dec-24
Communication Systems			
Band Name	Antenna Configuration	Channel	Frequency [MHz]
IEEE 802.11n	MIMO	6	2437.00
Grid Settings			
Test Date	Extent X [mm] x Extent Y [mm]	Step X & Step Y [mm]	Distance [mm]
9/28/2025	52 x 52	4	10
Results			
Audio File	Measurement Duration [s]	Margin Upper Bound [dB]	Margin Lower Bound [dB]
48k_voice_3000-3000_2s.wav	2.0	2.0	2.0
Primary Group Contiguous Point Count	Secondary Group Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse
239	523	25	26
Normalized frequency response 			
Qualifying Points 			

Appendix B: System Verification Plots





Appendix C: Calibration Certificates



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ANAB 17025 Certificate Number: AT-3274

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



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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: **RF Safety Lab**
Catonsville, USA

Certificate No. **AM1DV3-3166_Aug25**

CALIBRATION CERTIFICATE

Object **AM1DV3 - SN: 3166**

Calibration procedure(s) **QA CAL-24.v4**
Calibration procedure for AM1D magnetic field probes and TMFS in the
audio range

Calibration date: **August 15, 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: 1082	26-Sep-12 (in house check Sep-24)	Sep-25

Calibrated by: **Leif Klysner** **Function**
Laboratory Technician

Approved by: **Sven Kühn** **Technical Manager**

Signature

Issued: August 15, 2025

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: AM1DV3-3166_Aug25

Page 1 of 3



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	3166

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)	212.8°	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	0.80°	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	0.00731 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%.



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**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
S 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 **RF Safety Lab**
Catonsville, USA

Certificate No. **TMFS_1066_Aug25**

CALIBRATION CERTIFICATE

Object / Identification **TMFS – SN: 1066**

Calibration procedure(s) **QA CAL-24.v4**
Calibration procedure for AM1D magnetic field probes and TMFS in the
audio range

Calibration date **August 19, 2025**

MAB 9/1/25

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The calibrations have been conducted in the R&D laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	27-Aug-24 (No. 40547)	Aug-25
Reference Probe AM1DV2	SN: 1006	11-Dec-24 (No. AM1DV2-1006_Dec24)	Dec-25
DAE4	SN: 781	07-Feb-25 (No. DAE4-781_Feb25)	Feb-26
Secondary Standards	ID #	Cal / Check Date	Scheduled Calibration 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
Agilent WF Generator 33120A	MY40005266	03-Oct-13 (in house check Sep-24)	Sep-25

Calibrated by: **Name**
Claudio Leubler **Function**
Laboratory Technician

Approved by: **Sven Kühn** **Technical Manager**

Signature

Issued: August 20, 2025

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: **TMFS_1066_Aug25**

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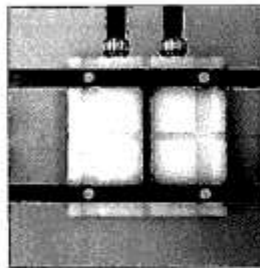


References

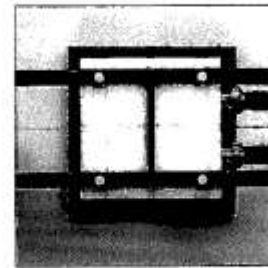
- [1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [2] ANSI-C63.19-2019 (ANSI-C63.19-2011)
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [3] DASY5 manual, Chapter: Hearing Aid Compatibility (HAC) T-Coil Extension

Methods Applied and Interpretation of Parameters

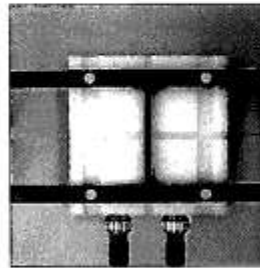
- **Coordinate System:** The TMFS is mounted underneath the HAC Test Arch touching equivalently to a wireless device according to [2] 29.2.2.: In "North" orientation, the TMFS signal connector is directed to the north, with x and y axes of TMFS and Test arch coinciding (see fig. 1). The rotational symmetry axis of the TMFS is aligned to the center of the HAC test Arch. For East, South and West configuration, the TMFS has been rotated clockwise in steps of 90°, so the connector looks into the specified direction. The evaluation of the radial direction is referenced to the device orientation (x equivalent to South direction).
- **Measurement Plane:** In coincidence with standard [1], the measurement plane (probe sensor center) is selected to be at a distance of 10 mm above the the surface of the TMFS touching the frame. The 50 x 50 mm scan area is aligned to the center of the unit. The scanning plane is verified to be parallel to the phantom frame before the measurements using the predefined "Geometry and signal check" procedure according to the predefined procedures described in [2].
- **Measurement Conditions:** Calibration of AM1D probe and AMMI are according to [2]. The 1 kHz sine signal for the level measurement is supplied from an external, independent generator via a BNC cable to TMFS IN and monitored at TMFS OUT with an independent RMS voltmeter or Audio Analyzer. The level is set to 0.5 Vrms and monitored during the scans.
- **For the frequency response,** a higher suppression of the background ambient magnetic field over the full frequency range was achieved by placing the TMFS in a magnetically shielded box. The AM1D probe was fixed without robot positioner near the axial maximum for this measurement. The background noise suppression was typ. 30 dB at 100 Hz (minimum) and 42 dB at 1 kHz. The predefined multisine signal (48k_multisine_50-10000_10s.wav) was used and evaluated in the third-octave bands from 100 Hz to 10000 Hz.



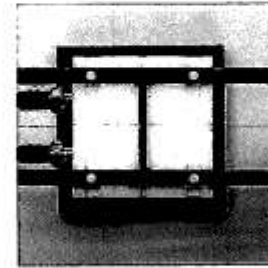
North



East



South



West



1 Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
DASY PP Version	SEMCAD	V14.6.14
Phantom	HAC Test Arch	SD HAC P01 BA, #1002
Distance TMFS Top - Probe Centre	10 mm	
Scan resolution	dx, dy = 5 mm	area = 50 x 50 mm
Frequency	for field scans	1 kHz
Signal level to TMFS	for field scans	500 mV RMS
Signal	for frequency response	multisine signal 50-10000 Hz, each third-octave band

Table 1: System configuration

2 Axial Maximum Field

Configuration	East	South	West	North	Subset Average	Average
Axial Max	-20.28	-20.27	-20.28	-20.27		-20.28
TMFS X Axis 1st Max	-26.00	-25.98	-26.05	-26.01		
TMFS X Axis 2nd Max	-25.79	-25.77	-25.79	-25.76		
Longitudinal Max Avg	-25.90	-25.88	-25.92	-25.89	-25.89	
TMFS Y Axis 1st Max	-25.93	-25.94	-25.94	-25.92		
TMFS Y Axis 2nd Max	-25.82	-25.83	-25.82	-25.81		
Transversal Max Avg	-25.88	-25.89	-25.88	-25.87	-25.88	
Radial Max						-25.89

Table 2: Axial and radial field maxima measured with probe center at 10mm distance in dB A/m

The maximum was calculated as the average from the values measured in the 4 orientations listed in table 2.

Axial Maximum -20.28 dB A/m (+/- 0.33dB, k=2)

3 Radial Maximum Field

In addition, the average from the 16 maxima of the radial field listed in table 2 (measured at 10mm) was calculated:

Radial Maximum -25.89 dB A/m (+/- 0.40dB, 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%.



4 Appendix

4.1 Frequency response

Max. deviation measured, relative to 1 kHz: min. -0.03 dB, max. 0.01 dB

Frequency [Hz]	Response [dB]
100	0.01
125	0.01
160	0.00
200	0.00
250	0.00
315	0.00
400	0.00
500	0.00
630	0.00
800	0.00
1000	0.00
1250	-0.01
1600	-0.01
2000	-0.01
2500	-0.01
3150	-0.01
4000	-0.02
5000	-0.02
6300	-0.02
8000	-0.03
10000	-0.03

Table 3: Frequency response

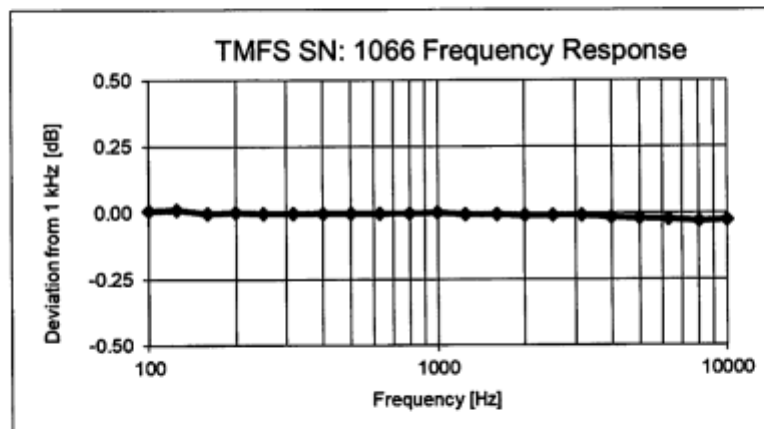


Fig. 2: Frequency response 100 to 10'000 Hz



4.2 Field plots

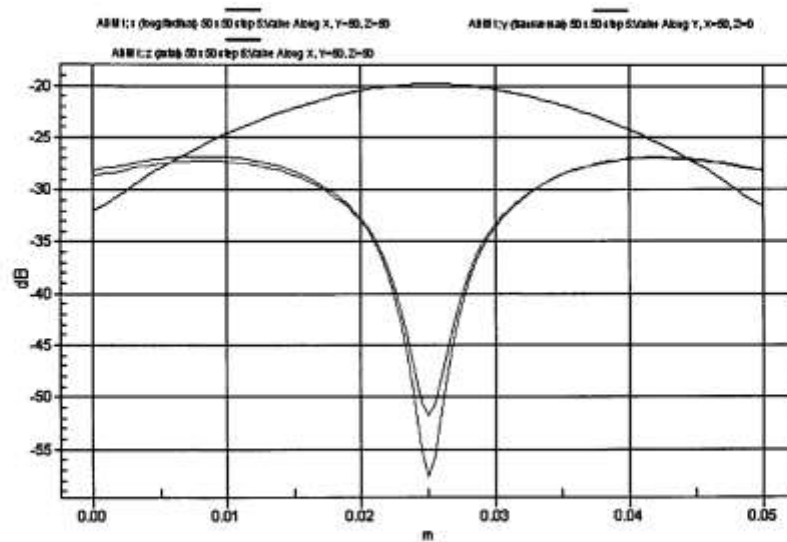


Fig. 3: Typical 2D field plots for x (red), y (green) and z (blue) components

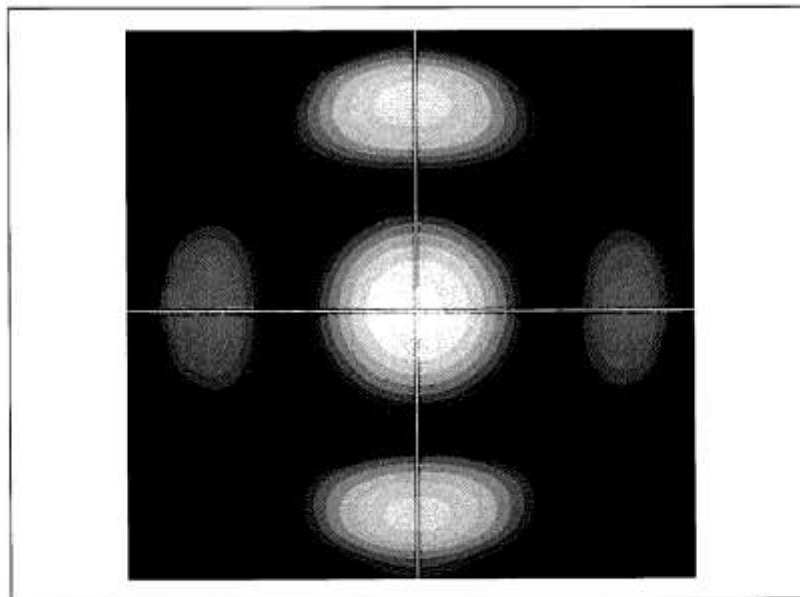


Fig. 4: Superposed field plots of z (axial), x and y radial magnetic field, 50 x 50 mm, individual scaling: white = max. field level, black = -4dB below max. The lines show the position of the 2D field plot of figure 3.