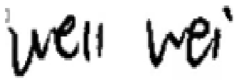
HAC (T-Coil) Test Report

Application No.:	SEWM2308000314RG
Applicant:	Shenzhen Tinno Mobile Technology Corp.
Manufacturer:	Shenzhen Tinno Mobile Technology Corp.
Product Name:	Smart Phone
Model No.(EUT):	Celero3 5G
FCC ID:	XD6U653DS
Standards:	ANSI C63.19-2011 CFR 47 FCC Part 20
Date of Receipt:	2023-08-23
Date of Test:	2023-09-18 to 2023-09-29
Date of Issue:	2023-10-19
Test conclusion:	**PASS ***

* In the configuration tested, the EUT detailed in this report complied with the standards specified above.

Authorized Signature:



Well Wei

Wireless Laboratory Manager

SGS-CSTC Standards Technical Services (Suzhou) Co., Ltd.
Wireless Laboratory

REVISION HISTORY

Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2023-10-19		Original

TEST SUMMARY

Frequency Band	T-rating
GSM850	T3
GSM1900	T4
WCDMA Band II	T4
WCDMA Band IV	T4
WCDMA Band V	T4
LTE Band 2	T4
LTE Band 4	T4
LTE Band 5	T4
LTE Band 12	T4
LTE Band 14	T4
LTE Band 17	T4
LTE Band 26	T4
LTE Band 30	T4
LTE Band 66	T4
LTE Band 71	T4
LTE Band 48	T3
FR1 n2	T3
FR1 n5	T3
FR1 n25	T3
FR1 n26	T3
FR1 n30	T3
FR1 n41	T3
FR1 n48	T3
FR1 n66	T3
FR1 n70	T3
FR1 n71	T3
FR1 n77	T3
WI-FI(2.4GHz)	T3
WI-FI(5GHz)	T3
HAC Rate Category: T3	

Reviewed by

Nick Hu

Prepared by

Leon Xu

CONTENTS

1 General Information

1.1 Introduction

The purpose of this standard is to establish categories for hearing aids and for WD (wireless communications devices) that can indicate to health care practitioners and hearing aid users which hearing aids are compatible with which WD, and to provide tests that can be used to assess the electromagnetic characteristics of hearing aids and WD and assign them to these categories. The various parameters required, in order to demonstrate compatibility and accessibility are measured. The design of the standard is such that when a hearing aid and WD achieve one of the categories specified, as measured by the methodology of this standard, the indicated performance is realized.

In order to provide for the usability of a hearing aid with a WD, several factors must be coordinated:

a) Radio frequency (RF) measurements of the near-field electric and magnetic fields emitted by a WD to categorize these emissions for correlation with the RF immunity of a hearing aid.

b) Magnetic field measurements of a WD emitted via the audio transducer associated with the T-coil mode of the hearing aid, for assessment of hearing aid performance.

c) Measurements with the hearing aid and a simulation of the categorized WD T-coil emissions to assess the hearing aid RF immunity in the T-coil mode.

The WD radio frequency (RF) and audio band emissions are measured.

Hence, the following are measurements made for the WD:

a) RF E-Field emissions
b) T-coil mode, magnetic signal strength in the audio band
c) T-coil mode, magnetic signal and noise articulation index
d) T-coil mode, magnetic signal frequency response through the audio band

Corresponding to the WD measurements, the hearing aid is measured for:

a) RF immunity in microphone mode
b) RF immunity in T-coil mode

1.2 Details of Client

Applicant:	Shenzhen Tinno Mobile Technology Corp.
Address:	27-001, South Side of Tianlong Mobile Headquarters Building, Tongfa South Road, Xili Community, Xili Street, Nanshan District, Shenzhen ,PRC
Manufacturer:	Shenzhen Tinno Mobile Technology Corp.
Address:	27-001, South Side of Tianlong Mobile Headquarters Building, Tongfa South Road, Xili Community, Xili Street, Nanshan District, Shenzhen ,PRC

1.3 Test Location

Company:	SGS-CSTC Standards Technical Services (Suzhou) Co., Ltd.
Address:	South of No. 6 Plant, No. 1, Runsheng Road, Suzhou Industrial Park, Suzhou Area, China (Jiangsu) Pilot Free Trade Zone
Post code:	215000
Test Engineer:	Leon Liu

1.4 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

• **A2LA (Certificate No. 6336.01)**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 6336.01.

• **Innovation, Science and Economic Development Canada**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0120.

IC#: 27594.

• **FCC –Designation Number: CN1312**

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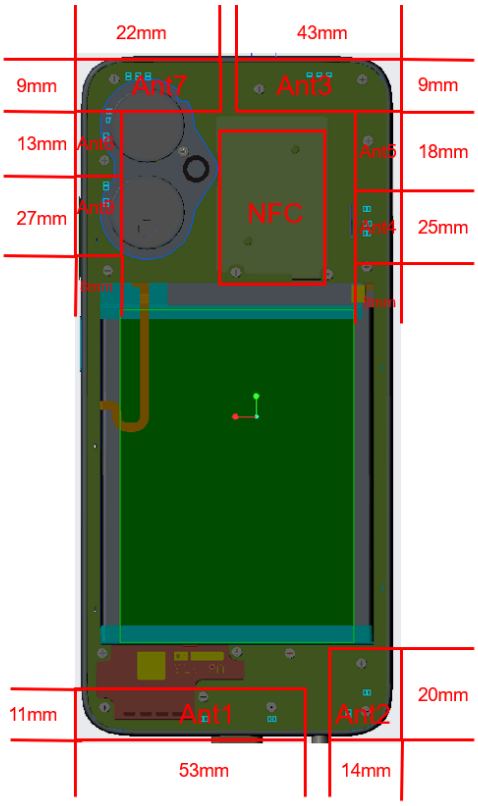
1.5 General Description of EUT

Device Type :	portable device		
Exposure Category:	uncontrolled environment / general population		
Product Name:	Mobile Phone		
Model No.(EUT):	Celero3 5G		
FCC ID:	XD6U653DS		
Product Phase:	Identical Prototype		
IMEI:	860284060018164, 860284060014858, 860284060017737, 860284060017414		
Hardware Version:	V1.0		
Software Version:	/		
Antenna Type:	Fixed Internal Antenna, PIFA Antenna		
Device Operating Configurations :			
Modulation Mode:	**GSM:** GMSK, 8PSK; **WCDMA:** QPSK, 16QAM(HSPA+); **LTE:** QPSK,16QAM,64QAM, 256QAM; **5G NR:** DFT-s-OFDM (PI/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM), CP-OFDM (QPSK, 16QAM, 64QAM, 256QAM) **WIFI:** DSSS, OFDM, OFDMA; **BT:** GFSK, π/4DQPSK,8DPSK **NFC:** ASK		
Device Class:	B		
GPRS Multi-slots Class:	12	EGPRS Multi-slots Class:	12
HSDPA UE Category:	10	HSUPA UE Category	6
DC-HSDPA UE Category:	24		
Power Class:	4,tested with power level 5(GSM850)		
	1,tested with power level 0(GSM1900)		
	3, tested with power control "all 1"(WCDMA Band)		
	3, tested with power control Max Power(LTE Band)		
Frequency Bands:	Band	Tx (MHz)	Rx (MHz)
	GSM850	824~849	869~894
	GSM1900	1850~1910	1930~1990
	WCDMA Band II	1850~1910	1930~1990
	WCDMA Band IV	1710~1755	2110~2155
	WCDMA Band V	824~849	869~894
	LTE Band 2	1850~1910	1930~1990
	LTE Band 4	1710~1755	2110~2155
	LTE Band 5	824~849	869~894
	LTE Band 12	699~716	729~746
	LTE Band 14	788~798	758~768
	LTE Band 17	704~716	734~746
	LTE Band 26	814~849	859~894
	LTE Band 30	2305~2315	2350~2360
	LTE Band 48	3550~3700	3550~3700
	LTE Band 66	1710~1780	2110~2200
	LTE Band 71	663~698	617~652
	NR Band n2	1850~1910	1930 ~1990
	NR Band n5	824~849	869-894

	NR Band n25	1850~1915	1930~1995
	NR Band n26	814~849	859~894
	NR Band n30	2305~2315	2350~2360
	NR Band n41	2496~2690	2496~2690
	NR Band n48	3550~3700	3550~3700
	NR Band n66	1710~1780	2110~2200
	NR Band n70	1695 - 1710	1995 - 2020
	NR Band n71	663 - 698	617 - 652
	NR Band n77	3450~3550	3450~3550
		3700~3980	3700~3980
	Bluetooth	2402~2480	2402~2480
	Wi-Fi 2.4G	2412~2462	2412~2462
	Wi-Fi 5G	5150~5250	5150~5250
		5250~5350	5250~5350
		5470~5725	5470~5725
		5725~5850	5725~5850
	NFC	13.56	13.56
RF Cable:	☒ Provided by the applicant ☐ Provided by the laboratory		
Battery Information:	Model:	486786	
	Normal Voltage:	+3.85V	
	Rated capacity:	4900mAh	
	Manufacturer:	Guangdong Fenghua New Energy Co.,Ltd.	

Note: *Since the above data and/or information is provided by the client relevant results or conclusions of this report are only made for these data and/or information, SGS is not responsible for the authenticity, integrity and results of the data and information and/or the validity of the conclusion.
Remark:
As above information is provided and confirmed by the applicant. SGS is not liable to the accuracy, suitability, reliability or/and integrity of the information.

1.5.1 DUT Antenna Locations(Back view)



Antenna	TX Bands
Ant 1	GSM:850, WCDMA:B5 LTE:B5/B12/B14/B17/B26/B29/B71 SA:N5/26/29/41/71
Ant 2	GSM:1900, WCDMA:B2/4 LTE:B2/4/66 SA:N2/25/66/70/77
Ant 3	LTE:B2/4/30/66/70 SA:N2/25/30/41/66/70
Ant 4	SA:N41/77
Ant 5	LTE:B48 SA:N48/77
Ant 6	SA:N41/77
Ant 7	WiFi2.4G/5G/6E BT
Ant 8	NFC
Ant 9	WiFi2.4G/5G/6E

Note:
1) The diversity Antenna does not support transmitter function.

1.5.2 List of air interfaces/frequency bands

Air Interface	Band (MHz)	Type	ANSI C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Reduction
GSM	850	VO	NA	BT, Wi-Fi	CMRS Voice	NA
	1900					
	EDGE	VD	NA		Google Duo*	
WCDMA	Band II	VO	Yes	BT, Wi-Fi	CMRS Voice	NA
	Band IV					
	Band V					
	HSPA	VD	Yes		Google Duo*	
LTE (FDD)	LTE Band 2	VD	Yes	BT, Wi-Fi	VoLTE Google Duo*	NA
	LTE Band 4					
	LTE Band 5					
	LTE Band 12					
	LTE Band 14					
	LTE Band 17					
	LTE Band 26					
	LTE Band 30					
	LTE Band 66					
	LTE Band 71					
LTE (TDD)	Band 48	VD	Yes	BT, Wi-Fi	VoLTE Google Duo*	NA
5G NR (FDD)	NR Band n2	VD	Yes	BT, Wi-Fi	VoNR Google Duo*	NA
	NR Band n5					
	NR Band n25					
	NR Band n26					
	NR Band n30					
	NR Band n66					
	NR Band n70					
	NR Band n71					
5G NR (FDD	NR Band n41	VD	Yes	BT, Wi-Fi	VoNR Google Duo*	NA
	NR Band n48					
	NR Band n77					
Wi-Fi	2450	VD	Yes	WWAN	Google Duo*	NA
BT	2450	DT	NA	WWAN	NA	NA

VO: Legacy Cellular Voice Service from Table 7.1 in 7.4.2.1 of ANSI C63.19-2011
DT: Digital Transport (no voice)
VD: IP Voice Service over Digital Transport
* For protocols not listed in Table 7.1 of ANSI C63.19-2011 or the ANSI C63.19-2011 VoLTE interpretation, the average speech level of −20 dBm0 should be used.

1.6 Test Specification

Identity	Document Title
CFR 47 FCC Part 20	§20.19 Hearing aid-compatible mobile handsets.
ANSI C63.19-2011	American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices
KDB 285076 D01	HAC Guidance v05r01
KDB 285076 D02	T-Coil testing v03

2 Calibration certificate

Temperature	Min. = 18°C, Max. = 25 °C
Relative humidity	Min. = 30%, Max. = 70%

Table 1: The Ambient Conditions

3 HAC (T-Coil) Measurement System

3.1 Measurement System Diagram for SPEAG Robotic

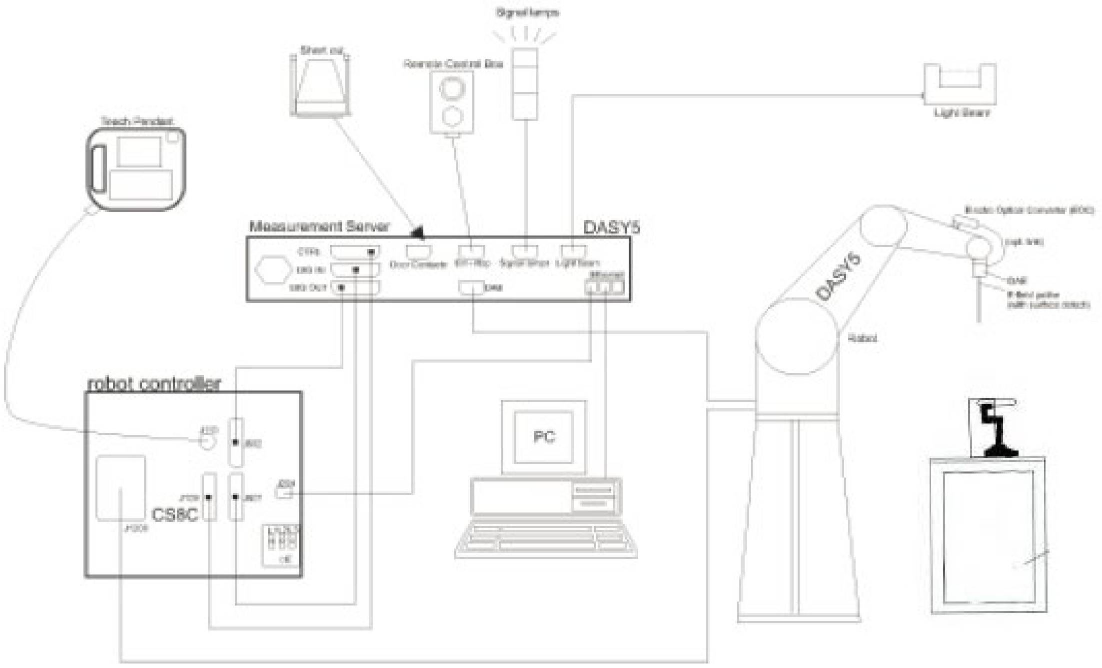


Fig. 1. The SPEAG Robotic Diagram

The DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stabile RX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- An Audio Magnetic probe.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The Test Arch SAM phantom
- The device holder for handheld mobile phones.
- Validation dipole kits allowing to validate the proper functioning of the system.

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3.2 T-Coil Measurement Set-up for GSM/UMTS/LTE/VoWiFi

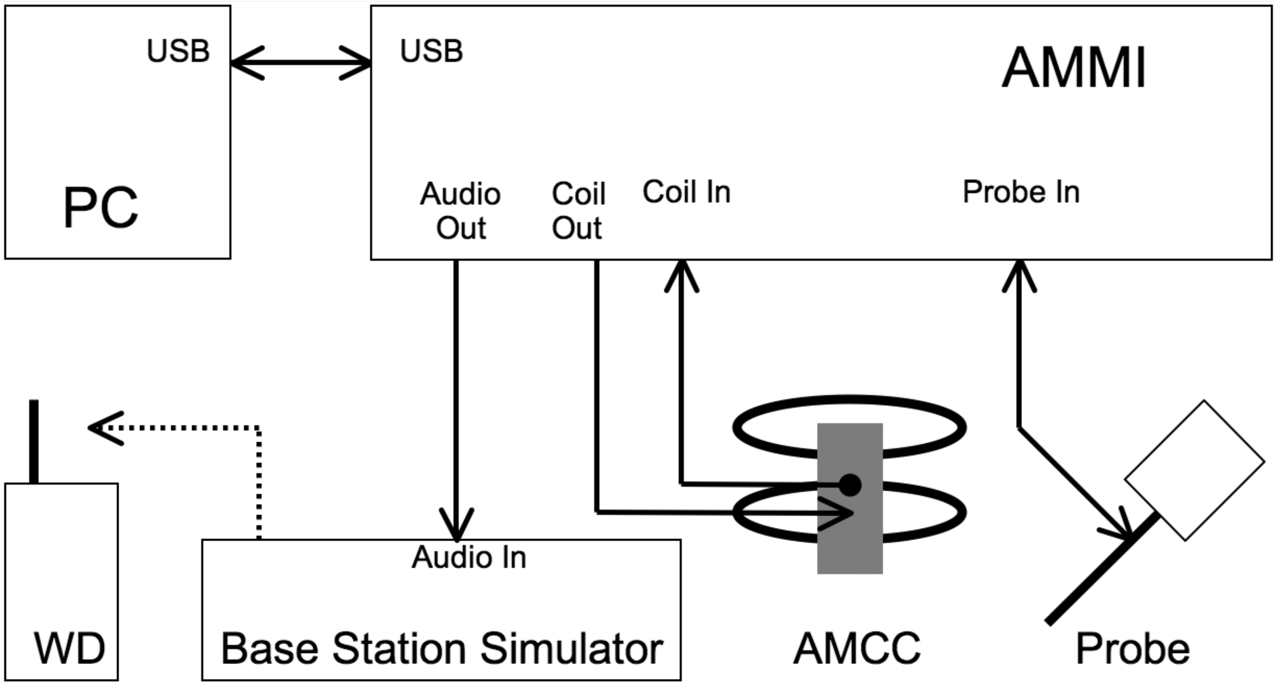

Fig. 2. T-coil signal measurement test setup

The sequence of the measurement is T-Coil testing procedure over a wireless communication device:

1. Confirm Geometry & signal check. Probe phantom alignment and check of accuracy.
2. Background noise measurement in the area of the WD.
3. Perform 50x50mm area scan with narrow band signal to determine ABM1, ABM2 and SNR for axial and radial orientation positions.
4. For Axial position, perform optimal SNR point measurement with a broadband signal – determine Frequency Response
5. Define the all applicable input audio level according to ANSI C63.19-2011 and KDB 285076 D02v03.

Note.

#. The EUT do not use the special HAC SW.
#. Setting the maximum volume for EUT during the measurement.
#. For the measurement, it don't use the "post-test measurement processing of results".
#. Per KDB 285076 D01v05, handsets that that have the ability to support concurrent connections using simultaneous transmissions shall be independently tested for each air interface/band given in ANSI C63.19-2011. At the present time ANSI C63.19 does not provide simultaneous transmission test procedures.

Define the all applicable inpot audio level as below according to c63 and KDB 285076 D02v03：
GSM input Level: -16dB
UMTS input Level: -16dB
VoLTE input Level: -16dB
VoWIFI input Level: -20dB
For UMTS test setup and input level, the correct input level definition is via a communication tester CMW500 "Decoder Cal" and "Codec Cal" with audio option B52 and B85 to set the correct audiao input levels.

CMW500 is able to output 1 kHz audio signal equivalent to 3.14dBm0 at "Decoder Cal”. configuration, the signal reference is used to adjust the AMMI gain setting to reach-16Bm0 for UMTS/VoLTE. CMW500 input is calibrated and the relation between the analog input voltage and the internal level in dBm0 can be determined

Voice over Long-Term Evolution (VoLTE) is a standard for high-speed wireless communication for mobile phones and data terminals-including IoT devices and wearables. It is based on the IP Multimedia Subsystem (IMS)network, with specific profiles for control and media planes of voice service on LTE defined by GSMA in PRD IR.92This approach results in the voice service (control and media planes) being delivered as data flows within the LTE data bearer. This means that there is no dependency on the legacy circuit-switched voice network to be maintained

The test setup used for VoLTE over IMS is via the callbox of CMW500 for T-coil measurement, the data application unit of the CMW500 was used to simulate the IP multimedia subsystem server. The CMW500 can be manually configured to ensure and control the speech input level result is -16dBm0 for VoLTE when the device during the IMS connection.

For Voice over Wi-Fi (VowiFi) is a term typically employed to describe the delivery of commercial telephony services using Voice over IP (VoIP) technologies from mobile devices connected across WI-Fi. This is typically counter to alternatives, predominantly Voice over LTE (VoLTE), in which a mobile network operator's (MNO's) licensed spectrum (iLe. 4G LTE) is used to carry packetized voice. Broadly speaking, VoWifi terminology is assigned to all core MS services accessed from unlicensed spectrum and across untrusted access infrastructures, such as public Wi-Fi access points

The test setup used for VoWiFi over IMs is via the callbox of CMW500 for T-coil measurement, the data application unit of the CMW500 was used to simulate the IP multimedia subsystem server. The CMW500 can be manually configured to ensure and control the speech input level result is -20dBmd for VoWiFi when the device during the IMS connection.

#An investigation was perfromed to determine worst case codec, bit rate and air interface configuration refer to section 7.2

3.2.1 Define the input level for GSM/UMTS/LTE

1. The Required gain factor for the specific signal shall typically be multiplied by this factor to achieve approx.the same level as for the 1kHz sine signal
2. The below calculation formula is an example and showing how to determine the input level for the device

The predefined signal types have the following differences / factors compared to the 1kHz sine signal:

Signal [file name]	Duration [s]	Peak-to-RMS [dB]	RMS [dB]	Required gain factor *)	Gain setting
1kHz sine	---	3.0	0.0	1.00	
48k_1.025kHz_10s.wav	10	3.0	0.0	1.00	
48k_1kHz_3.15kHz_10s.wav	10	6.0	-3.0	1.42	
48k_315Hz_1kHz_10s.wav	10	6.0	-2.9	1.40	
48k_csek_8k_441_white_10s.wav	10	13.8	-10.5	3.34	
48k_multisine_50-5000_10s.wav	10	11.1	-7.9	2.49	
48k_voice_1kHz_1s.wav	1	16.2	-12.7	4.33	
48k_voice_300-3000_2s.wav	2	21.6	-18.6	8.48	

(*) The gain for the specific signal shall typically be multiplied by this factor to acheive approx. the same level as for the 1kHz sine signal.

Insert the gain applicable for your setup in the last column of the table.

Input Level for GSM/UMTS/VoLTE

Gain Value	dBm0	Full scal Voltage	dB	AMMI audio out dBv (RMS)	AMCC Coil Out (dBv (RMS)
	3.14	1.5		0.51	
100	5.87		40	3.24	3.39
8.06	-16		18.13		-18.48
Signal Type	**Duration (s)**	**Peak to RMS (dB)**	**RMS (dB)**	**Gain Factor**	**Gain Setting**
1kHz sine	-	3	0	1	8.06
48k_voice_1kHz	1	16.2	-12.7	4.33	34.92
48k_voice_300-3000	2	21.6	-18.6	8.48	68.39

Input Level for VoWiFi

Gain Value	dBm0	Full scal Voltage	dB	AMMI audio out dBv (RMS)	AMCC Coil Out (dBv (RMS)
	3.14	1.5		0.51	
100	5.67		40	3.04	3.19
5.21	-20		14.33		-22.48
Signal Type	**Duration (s)**	**Peak to RMS (dB)**	**RMS (dB)**	**Gain Factor**	**Gain Setting**
1kHz sine	-	3	0	1	5.21
48k_voice_1kHz	1	16.2	-12.7	4.33	22.55
48k_voice_300-3000	2	21.6	-18.6	8.48	44.15

3.3 T-Coil Measurement Set-up For OTT VoIP

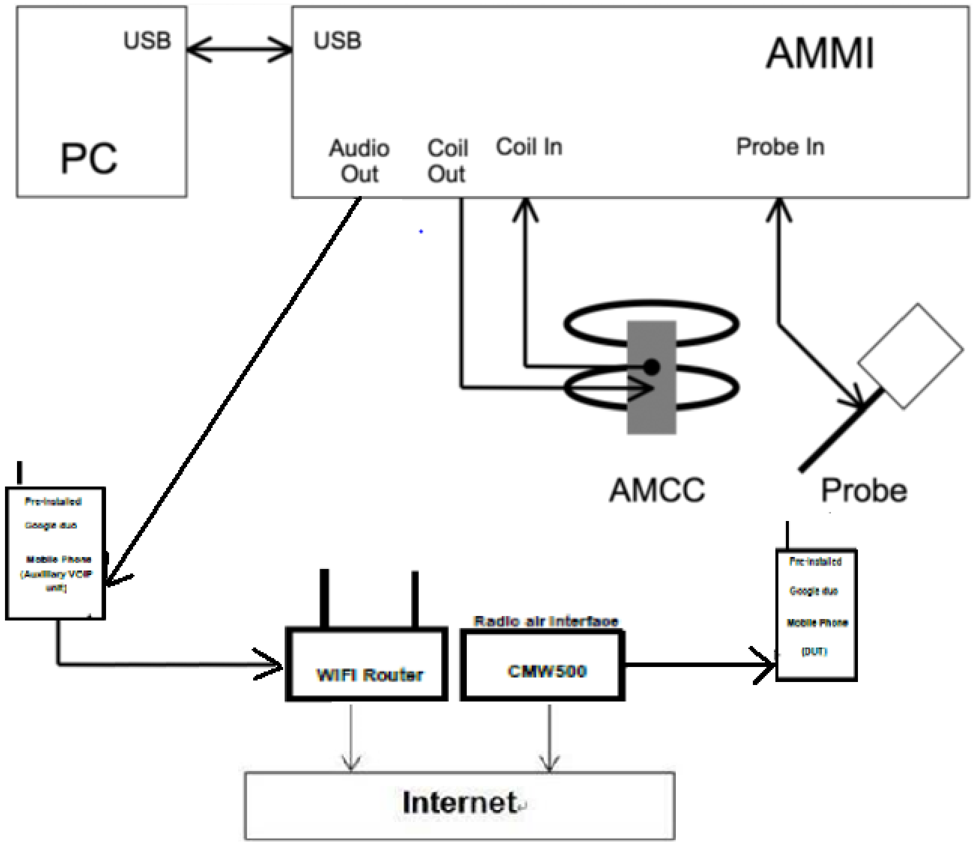

Fig. 2. T-coil signal measurement test setup

The sequence of the measurement is T-Coil testing procedure over a wireless communication device:

1. Confirm Geometry & signal check. Probe phantom alignment and check of accuracy.
2. Background noise measurement in the area of the WD.
3. Perform 50x50mm area scan with narrow band signal to determine ABM1, ABM2 and SNR for axial and radial orientation positions.
4. For Axial position, perform optimal SNR point measurement with a broadband signal – determine Frequency Response
5. Define the all applicable input audio level according to ANSI C63.19-2011 and KDB 285076 D02v03.

Note.

#. The EUT do not use the special HAC SW.
#. Setting the maximum volume for EUT during the measurement.
#. For the measurement, it don't use the "post-test measurement processing of results".
#. Per KDB 285076 D01v05, handsets that that have the ability to support concurrent connections using simultaneous transmissions shall be independently tested for each air interface/band given in ANSI C63.19-2011. At the present time ANSI C63.19 does not provide simultaneous transmission test procedures.
#. Define the all applicable input audio level as below according to C63 and KDB 285076 D02v03:
OTT VoIP input Level: -20dBm0

#. Voice over Internet Protocol (VoIP) such as google duo application, also called IP telephony, is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet. The terms Internet telephony, broadband telephony, and broadband phone service specifically refer to the provisioning of communications services (voice, fax, SMS, voice-messaging) over the public Internet, rather than via the public switched telephone network (PSTN)

#. The Google DUO service support code and bitrate are list in section9, the customized Google DUO software is installed on a mobile phone which is used as the Auxiliary for the test. The software enables audio coding rate to be changed, and reports the input digital audio level before audio processing which can be used to calibrate the input audio level

.#. This device comes with the preinstalled VoIP application that supports the Google DUO service and related codec. The test configuration establishes a call between the device under test and an auxiliary handset via the google DUO server

#. The test setup used for Google DUO VoIP call is via the data application unit on the 3G/4G/5G/WiFi simulate base station, connected to the internet via the google DUO serverr to the auxiliary device. The auxiliary device runs special software that allows the codecs and bit rate to be fixed to a specific value. Please refer to section9, an assessment was made of each of the different codec bit rates to determine the worst case for each of the different OTT transport (WiFi, LTE, WCDMA)

#. The auxiliary device includes software that displays the audio level in dBFS which allows calibration of the system to establish the -20dBm0 reference level. After establishing the voice call between auxiliary device and device under test the audio output from the AMMI is injected into the auxiliary device. The gain factor to establish a reference level of -20dBm0 for use during the test is determined as detailed in the next page based on the 0dBFull Scale (0dBFS) value being equivalent to 3.14dBm0.

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Input level for OTT VoIP

1. The Required gain factor for the specific signal shall typically be multiplied by this factor to achieve approx. the same level as for the 1kHz sine signal
2. The below calculation formula is an example and showing how to determine the input level for the device.
3. Input a gain value to readout the -23dBFS level as reference. (0dBFS=3.14 dBm0)
4. Adjust gain level until to readout the dBFS level until it changes to -24dBFS
5. Based on the step 1 and 2, and then calculate the gain value(dB) by interpolation to get the -20dBm0 corresponding gain value.

The predefined signal types have the following differences / factors compared to the 1kHz sine signal:

Signal [file name]	Duration [s]	Peak-to-RMS [dB]	RMS [dB]	Required gain factor *)	Gain setting
1kHz sine	---	3.0	0.0	1.00	
48k_1.025kHz_10s.wav	10	3.0	0.0	1.00	
48k_1kHz_3.15kHz_10s.wav	10	6.0	-3.0	1.42	
48k_315Hz_1kHz_10s.wav	10	6.0	-2.9	1.40	
48k_csek_8k_441_white_10s.wav	10	13.8	-10.5	3.34	
48k_multisine_50-5000_10s.wav	10	11.1	-7.9	2.49	
48k_voice_1kHz_1s.wav	1	16.2	-12.7	4.33	
48k_voice_300-3000_2s.wav	2	21.6	-18.6	8.48	

(*) The gain for the specific signal shall typically be multiplied by this factor to acheive approx. the same level as for the 1kHz sine signal.

Insert the gain applicable for your setup in the last column of the table.

Gain	dBFS	**20*log(Gain)**
7.90	-23	17.95
6.80	-24	16.65
7.74	-23.14	17.77

Signal Type	**Duration (s)**	**Peak to RMS (dB)**	**RMS (dB)**	**Gain Factor**	**Gain Setting**
1kHz sine	-	3	0	1	7.74
48k_voice_1kHz	1	16.2	-12.7	4.33	33.50
48k_voice_300-3000	2	21.6	-18.6	8.48	65.60

5G FR1 OTT evaluation

General Notes:

1. According to KDB 285076 D03, for 5G Sub 6 calls that use the same protocol, Codec(s) and reference level as OTT voice calling applications (such as Duo or AppleTalk), the tests are as follows.
2. For LTE, establish the ABM1S65G value by using the ABM1LTE magnetic intensity for an LTE call in the same band as the 5G sub6 band under test.
3. For OTT, establish the ABM1S65G value by using an IP connection for magnetic intensity for a call in the same band as the 5G sub6 band under test.
4. Also note the actual ABM2LTE/OTT value and establish an ABM2S65G value, using a 5G manufacture test mode over 5G Sub 6 channels for the same band under test.
5. Document in the test report matrix:
   a. Include columns for both ABM2LTE & ABM2S65G for comparison
   b. Establish the S+N1/N2 for the rating
      i. S+N1 = ABM1LTE (step 1) and
      ii. N2 = ABM2S65G (step 2).
      iii. Subtract 3 dB from S+N1/N2
   c. Rating based on (ABM1LTE/ ABM2S65G) -3dB.
6. OTT service and CMRS IP service are established over the internet protocol for the voice service, and on both services the identical RF air interface is used for NR. Therefore according to HA340401B VoNR test results from the air interface investigation, the worst configuration and frequency band of the air interface is used for OTT T-Coil testing.
   -NR FDD worst configuration and band: NR n66/40MHz/BPSK/1RB Size
   -NR TDD worst configuration and band: NR n77/100MHz/BPSK/1RB Size

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

3.4 System Calibration

For correct and calibrated measurement of the voltages and ABM field, DASY will perform a calibration job as below.

In phase 1, the audio output is switched off, and a 200 mVpp symmetric rectangular signal of 1 kHz is generated and internally connected directly to both channels of the sampling unit (Coil in, Probe in).

In phase 2, the audio output is off, and a 20 mVpp symmetric 100 Hz signal is internally connected. The signals during phases 1 and 2 are available at the output on the rear panel of the AMMI. However, the output must not be loaded, in order to avoid influencing the calibration. An RMS voltmeter would indicate 100 mVRMS during the first phase and 10 mVRMS during the second phase. After the first two phases, the two input channels are both calibrated for absolute measurements of voltages. The resulting factors are displayed above the multi-meter window.

After phases 1 and 2, the input channels are calibrated to measure exact voltages. This is required to use the inputs for measuring voltages with their peak and RMS value.

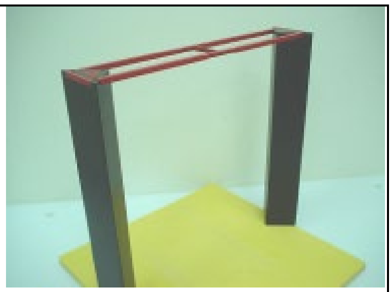
In phase 3, a multi-sine signal covering each third-octave band from 50 Hz to 10 kHz is generated and applied to both audio outputs. The probe should be positioned in the center of the AMCC and aligned in the z-direction, the field orientation of the AMCC. The “Coil In” channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the “Probe In" channel samples the amplified

signal picked up by the probe coil and provides it to a numerical integrator. The ratio of the two voltages in each third-octave filter leads to the spectral representation over the frequency band of interest. The Coil signal is scaled in dBV, and the Probe signal is first integrated and normalized to show dB A/m. The ratio probe-to-coil at the frequency of 1 kHz is the sensitivity which will be used in the consecutive T-Coil jobs.

3.5 Audio Magnetic Probe AM1DV3

Description	Active single sensor probe for both axial and radial measurement scans- Fully RF shielded, compatible with DAE, with adapted probe cup	
Dynamic Range	0.1 KHz to 20 KHz	
Sensitivity	<-50dB A/m @ 1KHz	
Internal Amp	20dB	
Dimensions	300X18mm	AM1DV3 Audio Probe

3.6 Test Arch

Description	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.	
Dimensions	length: 370 mm width: 370 mm height: 370 mm	Test Arch

3.7 Phone Holder

Description	Supports accurate and reliable positioning of any phone Effect on near field <+/- 0.5 dB	 Phone Holder

3.8 AMCC- Audio Magnetic Calibration Coil

Description	Allows calibration of the complete measurement setup, the two horizontal coils create a homogeneous magnetic field in the z direction. Refer to Appendix 5 for more detail on AMCC coil	 AMCC

3.9 AMMI - Audio Magnetic Measurement Instrument

Description	-USB interface to PC - Probe signal digitization and power supply- Test signal generation for wireless device (via base station simulator)- Auto-calibration and interfaces to AMCC for complete setup-calibration	 AMMI
Data Rate	48 KHz / 24bit	
Dynamic Range	85 dB	
Dimensions:	19” X 65 X 270mm	

4 Measurement uncertainty evaluation

Error Description	Uncertainty Value (%)	Probability Dist.	Divisor	ci ABM1	ci ABM2	Standard Uncertainty ABM1 (%)	Standard Uncertainty ABM2 (%)
Related to probe sensitivity							
Reference level	±3.0	R	$\sqrt{3}$	1	1	±3.0	±3.0
AMCC geometry	±0.4	R	$\sqrt{3}$	1	1	±0.2	±0.2
AMCC current	±0.6	R	$\sqrt{3}$	1	1	±0.4	±0.4
Probe positioning during calibration	±0.2	R	$\sqrt{3}$	1	1	±0.1	±0.1
Noise distribution	±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
Related to probe system							
Repeatability / drift	±1.0	R	$\sqrt{3}$	1	1	±0.6	±0.6
Linearity / dynamic range	±0.6	N	1	1	1	±0.4	±0.4
Audio noise	±1.0	R	$\sqrt{3}$	0.1	1	±0.1	±0.6
Probe angle	±2.3	R	$\sqrt{3}$	1	1	±1.4	±1.4
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 distribution	±0.2	R	$\sqrt{3}$	1	1	±0.1	±0.1
Test signal							
Reference signal spectrum 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 Std. Uncertainty (ABM Field)	$u_c' = \sqrt{\sum_{i=1}^{20} c_i^2 u_i^2}$					±4.1	±6.2
Expanded Std. Uncertainty (K=2)						±8.2	±12.4

Table 2： Measurement uncertainties for T-Coil

5 HAC (T-Coil) Measurement

5.1 T-Coil Performance Requirements

In order to be rated for T-Coil use, a WD shall meet the requirements for signal level and signal quality contained in this part.

1) T-Coil coupling field intensity

When measured as specified in ANSI C63.19, the T-Coil signal shall be ≥ –18 dB (A/m) at 1 kHz, in a 1/3 octave band filter for all orientations.

2) Frequency response

The frequency response of the axial component of the magnetic field, measured in 1/3 octave bands, shall follow the response curve specified in this sub-clause, over the frequency range 300 Hz to 3000 Hz. Figure 1 and Figure 2 provide the boundaries for the specified frequency.
These response curves are for true field strength measurements of the T-Coil signal. Thus the 6 dB/octave probe response has been corrected from the raw readings.

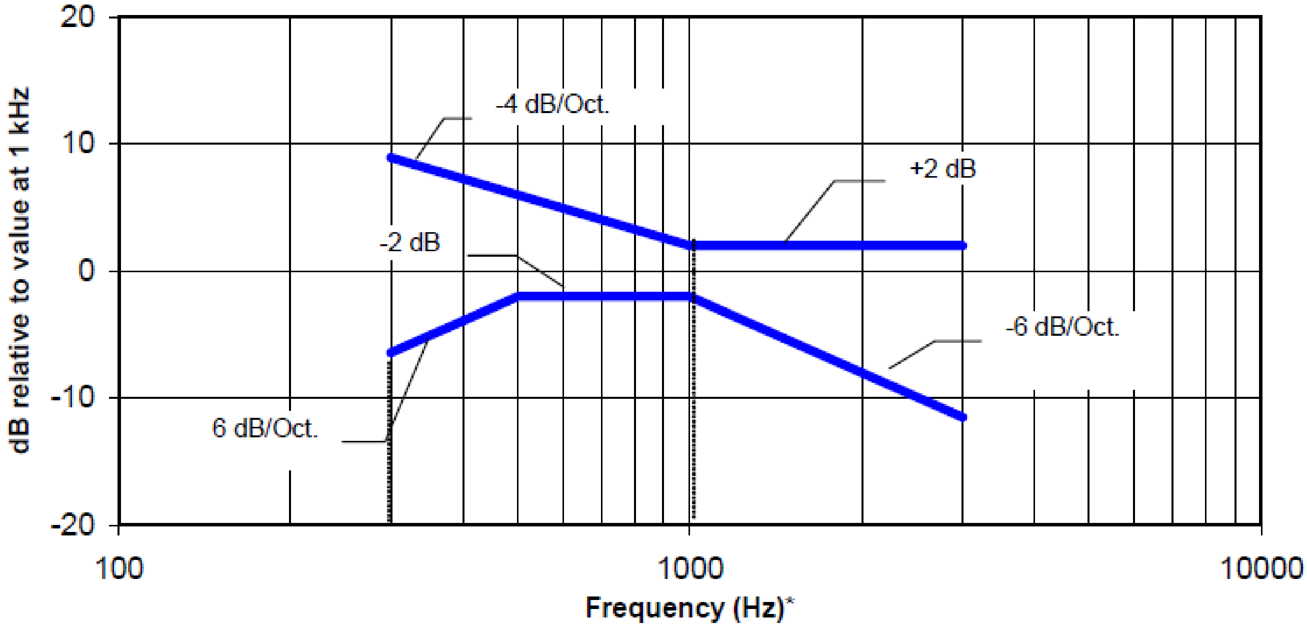


Figure 1—Magnetic field frequency response for WDs with a field ≤ –15 dB (A/m) at 1 kHz

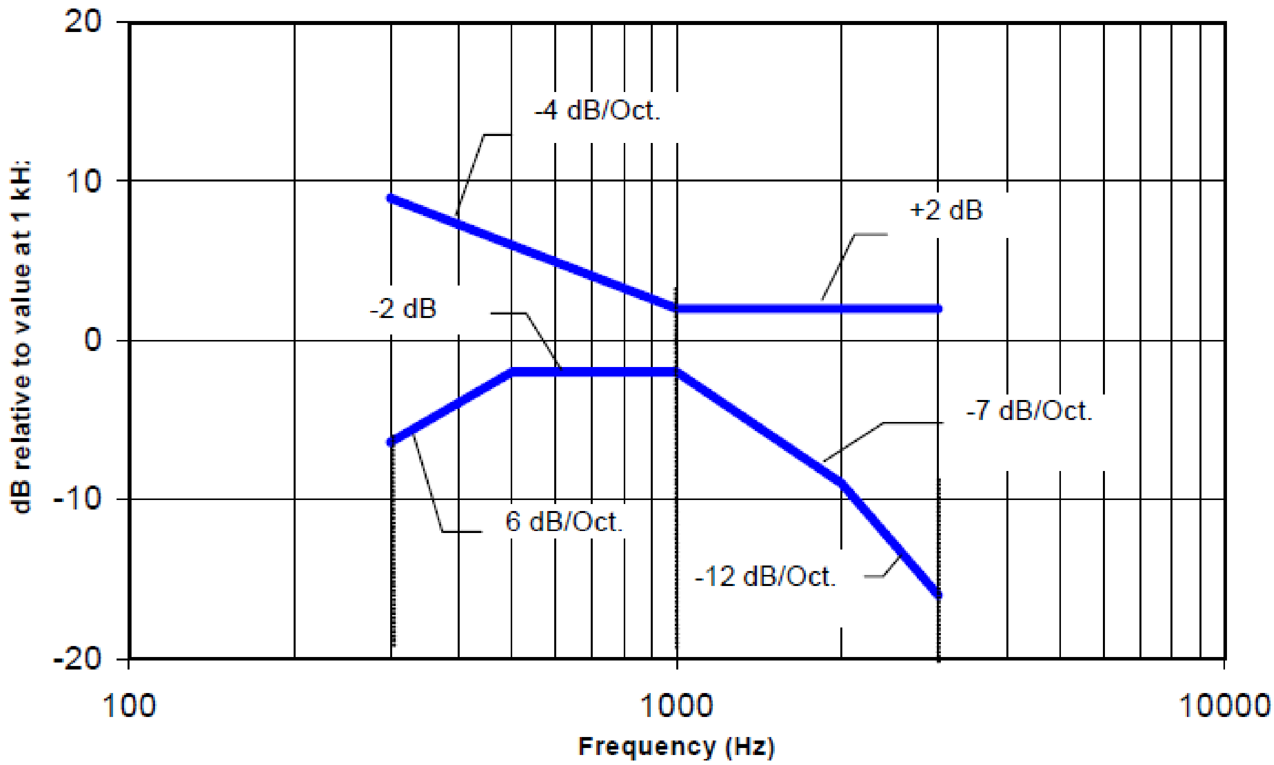


Figure 2 —Magnetic field frequency response for WDs with a field that exceeds –15dB(A/m) at 1 kHz

3) Signal quality

This part provides the signal quality requirement for the intended T-Coil signal from a WD. Only the RF immunity of the hearing aid is measured in T-Coil mode. It is assumed that a hearing aid can have no immunity to an interference signal in the audio band, which is the intended reception band for this mode. So, the only criteria that can be measured is the RF immunity in T-Coil mode. This is measured using the same procedure as for the audio coupling mode and at the same levels.

The worst signal quality of the three T-Coil signal measurements shall be used to determine the T-Coil mode category per Table 3

Category	Telephone parameters WD signal quality [(signal + noise) – to – noise ratio in decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Table 3: T-Coil signal quality categories

5.2 T-Coil measurement points and reference plane

Figure 3 illustrate the references and reference plane that shall be used in a typical EUT emissions measurement. The principle of this section is applied to EUT with similar geometry. Please refer to Appendix C for the setup photographs.

- The area is 5 cm by 5 cm.
- The area is centered on the audio frequency output transducer of the EUT.
- The area is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the EUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 10 mm in front of, the reference plane.

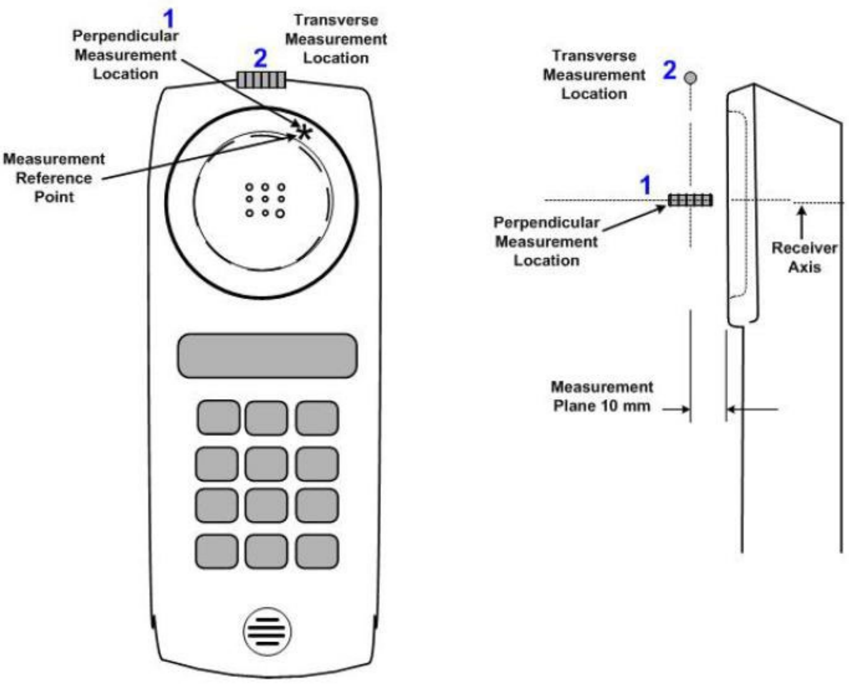


Figure 3 Axis and planes for WD audio frequency magnetic field measurements

5.3 T-Coil Measurement Procedure

According to ANSI C63.19-2011, section 7.4:
This section describes the procedures used to measure the ABM (T-Coil) performance of the WD. In addition to measuring the absolute signal levels, the A-weighted magnitude of the unintended signal shall also be determined. To assure that the required signal quality is measured, the measurement of the intended signal and the measurement of the unintended signal must be made at the same location for each measurement position. In addition, the RF field strength at each measurement location must be at or below that required for the assigned category.
Measurements shall not include undesired properties from the WD's RF field; therefore, use of a coaxial connection to a base station simulator or nonradiating load might be necessary. However, even with a coaxial connection to a base station simulator or nonradiating load, there might still be RF leakage from the WD, which can interfere with the desired measurement. Premeasurement checks should be made to avoid this possibility. All measurements shall be performed with the WD operating on battery power with an appropriate normal speech audio signal input level given in ANSI C63.19-2011 Table 7.1. If the device display can be turned off during a phone call, then that may be done during the measurement as well.
Measurements shall be performed at two locations specified in ANSI C63.19-2011 A.3, with the correct probe orientation for aparticular location, in a multistage sequence by first measuring the field intensity of the desired T-Coil signal (ABM1) that is useful to a hearing aid T-Coil. The undesired magnetic components (ABM2) shall be examined for each probe orientation to determine the possible effects from the WD display and battery current paths that might disrupt the desired T-Coil signal. The undesired magnetic signal (ABM2) must be measured at the same location as the desired ABM or T-Coil signal (ABM1), and the ratio of desired to undesired ABM signals must be calculated. For the perpendicular field location, only the ABM1 frequency response shall be determined in a third measurement stage.
The following steps summarize the basic test flow for determining ABM1 and ABM2. These steps assume that a sine-wave or narrowband 1/3 octave signal can be used for the measurement of ABM1.
a) A validation of the test setup and instrumentation may be performed using a TMFS or Helmholtz coil. Measure the emissions and confirm that they are within the specified tolerance.
b) Position the WD in the test setup and connect the WD RF connector to a base station simulator or a nonradiating load as shown in ANSI C63.19-2011 Figure 7.1 or Figure 7.2. Confirm that the equipment that requires calibration has been calibrated and that the noise level meets the requirements of ANSI C63.19-2011 clause 7.3.1.
c) The drive level to the WD is set such that the reference input level specified in ANSI C63.19-2011Table 7.1 is input to the base station simulator (or manufacturer's test mode equivalent) in the 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (ABM1) at f = 1 kHz. Either a sine wave at 1025 Hz or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as defined in C63.19-2011 clause 7.4.2, shall be used for the reference audio signal. If interference is found at 1025 Hz, an alternative nearby reference audio signal frequency may be used.47 The same drive level shall be used for the ABM1 frequency response measurements at each 1/3 octave band center frequency.The WD volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.
d) Determine the magnetic measurement locations for the WD device (A.3), if not already specified by the manufacturer, as described in C63.19-2011 clause 7.4.4.1.1 and 7.4.4.2.
e) At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at fi) as specified in C63.19-2011 clause 7.4.4.2 in each ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency (fi) shall be centered in each 1/3 octave band maintaining the same drive level as determined in item c) and the reading taken for that band.
f) Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input–output comparison using simulated speech. The full-band integrated or half-band integrated probe output, as specified in D.9, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB A/m.)

g) All measurements of the desired signal shall be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal ON and OFF with the probe measuring the same location. If the scanning method is used, the scans shall show that all measurement points selected for the ABM1 measurement meet the ambient and test system noise criteria in C63.19-2011 clause 7.3.1.
h) At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in C63.19-2011 clause 7.4.4.4 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting49 and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).
g) Determine the category that properly classifies the signal quality, based on C63.19-2011 Table 8.5.

6 T-Coil testing for CMRS Voice

6.1 General Description

1. Codec Investigation:

For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following worst investigation codec would be remarked to be used for the testing for the handset.

2. Air Interface Investigation:

a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface.

b. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

6.2 GSM Tests Results

Codec Investigation:

Band	Test Mode	Codec Setting	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response
GSM850	GSM Voice	FR V1	190/836.6	Axial (Z)	-0.68	-30.56	29.88	T3	0.54	PASS
	GSM Voice	HR V1	190/836.6	Axial (Z)	-0.56	-33.48	32.92	T4	0.69	PASS

Remark: According to codec investigation, the worst codec is **FR_V1**

Air Interface Investigation:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response
GSM850	GSM Voice	190/836.6	Axial (Z)	-0.68	-30.56	29.88	T3	0.54	PASS
			Transversal (Y)	-10.45	-49.11	38.66	T4	/	/
GSM1900	GSM Voice	661/1880	Axial (Z)	-1.04	-31.86	30.82	T4	0.32	PASS
			Transversal (Y)	-10.88	-48.94	38.06	T4	/	/

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

6.3 UMTS Tests Results

Codec Investigation:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
WCDMA Band V	AMR Voice	4182/836.4	Axial (Z)	-0.73	-48.37	47.64	T4	2.00	PASS	4.75kbps
	AMR Voice	4182/836.4	Axial (Z)	-0.96	-48.70	47.74	T4	1.73	PASS	7.95kbps
	AMR Voice	4182/836.4	Axial (Z)	-0.87	-48.64	47.77	T4	1.65	PASS	12.2kbps

Remark: According to codec investigation, the worst codec is **4.75kbps**

Air Interface Investigation:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
WCDMA Band II	AMR Voice	9400/1900	Axial (Z)	-0.82	-48.06	47.24	T4	1.22	PASS	4.75kbps
			Transversal (Y)	-10.35	-50.82	40.47	T4	/	/	
WCDMA Band IV	AMR Voice	1412/1732.4	Axial (Z)	-0.73	-47.41	46.68	T4	1.15	PASS	4.75kbps
			Transversal (Y)	-9.46	-48.87	39.41	T4	/	/	
WCDMA Band V	AMR Voice	4182/836.4	Axial (Z)	-0.73	-48.37	47.64	T4	2.00	PASS	4.75kbps
			Transversal (Y)	-10.33	-50.95	40.62	T4	/	/	

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

7 T-Coil testing for CMRS IP Voice

7.1 VoLTE Tests Results

1. Codec Investigation:

For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel / band, the following worst investigation codec would be remarked to be used for the testing for the handset.

2. Air Interface Investigation:

a. Use the worst-case codec test and document a limited set of bands / channel / bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface and the following worst configure would be remarked to be used for the testing for the handset.

b. Select LTE FDD one frequency band to do measurement at the worst SNR single point position was additionally performed with varying the BWs/Modulations/RB size to verify the variation to find out worst configuration, the observed variation is very little to be within 1.5 dB which is much less than the margin from the rating threshold.

c. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

LTE FDD Codec Investigation:

LTE FDD Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
LTE Band 2	20M QPSK 1RB_0	18900/1880	Axial (Z)	-0.49	-44.32	43.83	T4	1.42	PASS	NB AMR 4.75kbps
	20M QPSK 1RB_0	18900/1880	Axial (Z)	-0.02	-44.70	44.68	T4	2.00	PASS	NB AMR 12.2kbps
	20M QPSK 1RB_0	18900/1880	Axial (Z)	-1.28	-42.82	41.54	T4	1.56	PASS	WB AMR 6.60kbps
	20M QPSK 1RB_0	18900/1880	Axial (Z)	0.56	-44.43	44.99	T4	1.42	PASS	WB AMR 23.85kbps
	20M QPSK 1RB_0	18900/1880	Axial (Z)	0.72	-41.98	42.70	T4	1.28	PASS	NB EVS 5.90kbps
	20M QPSK 1RB_0	18900/1880	Axial (Z)	0.11	-44.11	44.22	T4	2.00	PASS	NB EVS 24.4kbps
	20M QPSK 1RB_0	18900/1880	Axial (Z)	0.22	-44.37	44.59	T4	1.49	PASS	WB EVS 5.90kbps
	20M QPSK 1RB_0	18900/1880	Axial (Z)	0.24	-43.90	44.14	T4	2.00	PASS	WB EVS 128kbps

Remark: According to codec investigation, the worst codec is **WB AMR 6.60kbps**

Air Interface Investigation:

LTE FDD

LTE FDD Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating
LTE Band 2	20M QPSK 1RB_0	18900/1880	Axial (Z)	-2.99	-44.82	41.83	T4
	20M QPSK 1RB_50	18900/1880	Axial (Z)	-2.56	-44.62	42.06	T4
	20M QPSK 1RB_99	18900/1880	Axial (Z)	-2.36	-44.54	42.18	T4
	20M QPSK 50RB_0	18900/1880	Axial (Z)	-2.41	-44.77	42.36	T4
	20M QPSK 50RB_25	18900/1880	Axial (Z)	-2.58	-45.09	42.51	T4
	20M QPSK 50RB_50	18900/1880	Axial (Z)	-2.61	-44.86	42.25	T4
	20M QPSK 100RB_0	18900/1880	Axial (Z)	-2.71	-44.98	42.27	T4
	20M 16QAM 100RB_0	18900/1880	Axial (Z)	-2.30	-44.64	42.34	T4
	20M 64QAM 100RB_0	18900/1880	Axial (Z)	-2.84	-45.00	42.16	T4
	15M QPSK 1RB_74	18900/1880	Axial (Z)	-2.47	-45.28	42.81	T4
	10M QPSK 1RB_49	18900/1880	Axial (Z)	-2.61	-45.24	42.63	T4
	5M QPSK 1RB_24	18900/1880	Axial (Z)	-2.68	-45.40	42.72	T4
	3M QPSK 1RB_14	18900/1880	Axial (Z)	-2.43	-45.26	42.83	T4
	1.4M QPSK 1RB_5	18900/1880	Axial (Z)	-2.76	-45.35	42.59	T4

Remark:
1. Select Worst worst codec Bandwidth/Modulation/RB Size from LTE FDD Test results to do LTE FDD
2. Select Worst Bandwidth/Modulation/RB Size from LTE FDD Test results to do LTE FDD

Air interface:

LTE FDD Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
LTE Band 2	20M QPSK 100RB_0	18900/1880	Axial (Z)	-1.28	-42.82	41.54	T4	1.29	PASS	NB EVS 5.90kbps
			Transversal (Y)	-11.80	-46.18	34.38	T4	/	/	
LTE Band 4	20M QPSK 100RB_0	20175/1732.5	Axial (Z)	-1.78	-41.28	39.50	T4	0.71	PASS	NB EVS 5.90kbps
			Transversal (Y)	-12.18	-45.63	33.45	T4	/	/	
LTE Band 5	10M QPSK 50RB_0	20525/836.5	Axial (Z)	-1.13	-44.32	43.19	T4	2.00	PASS	NB EVS 5.90kbps
			Transversal (Y)	-12.42	-48.72	36.30	T4		/	
LTE Band 12	10M QPSK 50RB_0	23095/707.5	Axial (Z)	-1.23	-44.40	43.17	T4	2.00	PASS	NB EVS 5.90kbps
			Transversal (Y)	-11.66	-48.57	36.91	T4		/	
LTE Band 14	10M QPSK 50RB_0	23330/793	Axial (Z)	-1.35	-43.90	42.55	T4	1.94	PASS	NB EVS 5.90kbps
			Transversal (Y)	-11.75	-47.83	36.08	T4	/	/	
LTE Band 17	10M QPSK 50RB_0	23790/710	Axial (Z)	-1.48	-44.59	43.11	T4	2.00	PASS	NB EVS 5.90kbps
			Transversal (Y)	-12.32	-48.12	35.80	T4	/	/	
LTE Band 26	15M QPSK 75RB_0	26865/831.5	Axial (Z)	-1.12	-43.75	42.63	T4	1.66	PASS	NB EVS 5.90kbps
			Transversal (Y)	-11.99	-47.80	35.81	T4	/	/	
LTE Band 30	10M QPSK 50RB_0	27710/2310	Axial (Z)	-1.38	-44.11	42.73	T4	2.00	PASS	NB EVS 5.90kbps
			Transversal (Y)	-11.64	-46.66	35.02	T4	/	/	
LTE Band 66	20M QPSK 100RB_0	132322/1745	Axial (Z)	-2.28	-43.33	41.05	T4	1.82	PASS	NB EVS 5.90kbps
			Transversal (Y)	-12.20	-46.94	34.74	T4	/	/	
LTE Band 71	20M QPSK 100RB_0	133297/680.5	Axial (Z)	-1.15	-43.96	42.81	T4	1.85	PASS	NB EVS 5.90kbps
			Transversal (Y)	-12.77	-48.43	35.66	T4	/	/	

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

LTE TDD Codec Investigation:

LTE FDD Band	Test Mode	Test Ch./Freq.		Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
LTE Band 48 PC3	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	-1.24	-35.64	34.40	T4	0.03	-1.24	NB AMR 4.75kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	-0.44	-35.48	35.04	T4	0.05	-0.44	NB AMR 12.2kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	-1.63	-35.26	33.63	T4	1.56	-1.63	WB AMR 6.60kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	-0.08	-35.50	35.42	T4	0.92	-0.08	WB AMR 23.85kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	0.27	-35.56	35.83	T4	1.06	0.27	WB EVS 5.90kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	0.35	-35.60	35.95	T4	1.10	0.35	WB EVS 128kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	-0.21	-35.68	35.47	T4	0.46	-0.21	NB EVS 5.90kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	0.07	-35.42	35.49	T4	0.45	0.07	NB EVS 24.4kbps

Remark: According to codec investigation, the worst codec is **WB AMR 6.60kbps**

Air Interface Investigation:
LTE TDD

LTE FDD Band	Test Mode	Test Ch./Freq.		Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating
LTE Band 48 PC3	20M QPSK 1RB_0	40807/2611.7	0	Axial (Z)	-3.03	-35.59	32.56	T4
	20M QPSK 1RB_50	40807/2611.7	0	Axial (Z)	-3.15	-36.56	33.41	T4
	20M QPSK 1RB_99	40807/2611.7	0	Axial (Z)	-3.11	-36.37	33.26	T4
	20M QPSK 50RB_0	40807/2611.7	0	Axial (Z)	-3.02	-36.37	33.35	T4
	20M QPSK 50RB_25	40807/2611.7	0	Axial (Z)	-3.41	-36.82	33.41	T4
	20M QPSK 50RB_50	40807/2611.7	0	Axial (Z)	-3.36	-36.64	33.28	T4
	20M QPSK 100RB_0	40807/2611.7	0	Axial (Z)	-3.25	-36.40	33.15	T4
	20M 16QAM 1RB_99	40807/2611.7	0	Axial (Z)	-3.18	-36.57	33.39	T4
	20M 64QAM 1RB_0	40807/2611.7	0	Axial (Z)	-3.31	-36.88	33.57	T4
	15M QPSK 75RB_0	40807/2611.7	0	Axial (Z)	-3.52	-37.01	33.49	T4
	10M QPSK 50RB_0	40807/2611.7	0	Axial (Z)	-2.89	-36.13	33.24	T4
	5M QPSK 25RB_0	40807/2611.7	0	Axial (Z)	-2.94	-36.62	33.68	T4
	20M QPSK 100RB_0	40807/2611.7	1	Axial (Z)	-2.67	-35.36	32.69	T4
	20M QPSK 100RB_0	40807/2611.7	2	Axial (Z)	-2.58	-35.33	32.75	T4
	20M QPSK 100RB_0	40807/2611.7	3	Axial (Z)	-2.67	-35.56	32.89	T4
	20M QPSK 100RB_0	40807/2611.7	4	Axial (Z)	-3.16	-35.90	32.74	T4
	20M QPSK 100RB_0	40807/2611.7	5	Axial (Z)	-3.24	-36.39	33.15	T4
	20M QPSK 100RB_0	40807/2611.7	6	Axial (Z)	-3.85	-37.04	33.19	T4

Remark:

1. Select Worst worst codec Bandwidth/Modulation/RB Size from LTE TDD Test results to do LTE TDD
2. Select Worst Bandwidth/Modulation/RB Size from LTE TDD Test results to do LTE TDD

LTE TDD Air interface:

LTE FDD Band	Test Mode	Test Ch./Freq.	UL-DL configuration	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
LTE Band 48 PC3	20M QPSK 100RB_0	40807/2611.7	0	Axial (Z)	-1.63	-35.26	33.63	T4	1.56	PASS	WB AMR 6.60kbps
				Transversal (Y)	-12.68	-35.75	23.07	T3	/	/	

Remark:
1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

7.2 VoWiFi Tests Results

1. Codec Investigation:

For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following worst investigation codec would be remarked to be used for the testing for the handset.

2. Air Interface Investigation:

a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface and the following worst configure would be remarked to be used for the testing for the handset.

b. Select WLAN 2.4GHz and WLAN5GHz one frequency band to do measurement at the worst SNR position was additionally performed with varying the BWs/Modulations/data rate to verify the variation to find out worst configuration, the observed variation is very little to be within 1 dB which is much less than the margin from the rating threshold.

c. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
WiFi 2.4G	802.11b	6/2437	Axial (Z)	-1.43	-37.49	36.06	T4	0.28	PASS	NB AMR 4.75kbps
	802.11b	6/2437	Axial (Z)	-1.24	-37.28	36.04	T4	0.26	PASS	NB AMR 12.2kbps
	802.11b	6/2437	Axial (Z)	-2.56	-33.71	31.15	T4	2.00	PASS	WB AMR 6.60kbps
	802.11b	6/2437	Axial (Z)	-2.26	-33.59	31.33	T4	0.07	PASS	WB AMR 23.85kbps
	802.11b	6/2437	Axial (Z)	-0.32	-33.84	33.52	T4	1.19	PASS	WB EVS 5.90kbps
	802.11b	6/2437	Axial (Z)	-0.74	-39.26	38.52	T4	1.08	PASS	WB EVS 128kbps
	802.11b	6/2437	Axial (Z)	-1.51	-39.58	38.07	T4	0.92	PASS	NB EVS 5.90kbps
	802.11b	6/2437	Axial (Z)	-0.94	-40.07	39.13	T4	0.17	PASS	NB EVS 24.4kbps

Remark: According to codec investigation, the worst codec is **WB AMR 6.60kbps.**

Air Interface Investigation:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Codec Setting
WiFi 2.4G	802.11b	6/2437	Axial (Z)	-2.37	-33.26	30.89	T4	1Mbps
	802.11b	6/2437	Axial (Z)	-2.51	-33.57	31.06	T4	11Mbps
	802.11g	6/2437	Axial (Z)	-2.47	-33.49	31.02	T4	6Mbps
	802.11g	6/2437	Axial (Z)	-2.39	-33.63	31.24	T4	54Mbps
	802.11n-HT20	6/2437	Axial (Z)	-2.43	-33.57	31.14	T4	MCS0
	802.11n-HT20	6/2437	Axial (Z)	-2.41	-33.42	31.01	T4	MCS7
WiFi 5G	802.11a	40/5200	Axial (Z)	-3.12	-40.40	37.28	T4	6Mbps
	802.11a	40/5200	Axial (Z)	-2.86	-40.42	37.56	T4	54Mbps
	802.11n-HT20	40/5200	Axial (Z)	-3.02	-40.65	37.63	T4	MCS0
	802.11n-HT20	40/5200	Axial (Z)	-2.96	-40.78	37.82	T4	MCS7
	802.11n-HT40	38/5190	Axial (Z)	-2.89	-40.65	37.76	T4	MCS0
	802.11n-HT40	38/5190	Axial (Z)	-3.11	-41.17	38.06	T4	MCS7
	802.11ac-VHT20	40/5200	Axial (Z)	-3.26	-41.38	38.12	T4	MCS0
	802.11ac-VHT20	40/5200	Axial (Z)	-3.17	-41.19	38.02	T4	MCS8
	802.11ac-VHT40	38/5190	Axial (Z)	-3.39	-41.50	38.11	T4	MCS0
	802.11ac-VHT40	38/5190	Axial (Z)	-3.24	-41.18	37.94	T4	MCS8
	802.11ac-VHT80	50/5250	Axial (Z)	-2.86	-40.75	37.89	T4	MCS0
	802.11ac-VHT80	50/5250	Axial (Z)	-2.97	-40.94	37.97	T4	MCS8

Remark: According to codec investigation, WiFi 2.4G the worst codec is **802.11b 1Mbps**， WiFi 5G the worst codec is **802.11a 6Mbps.**

Air interface:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
WiFi 2.4G	802.11b	6/2437	Axial (Z)	-2.56	-33.71	31.15	T4	2.00	PASS	1Mbps WB AMR 6.60kbps
			Transversal (Y)	-12.20	-45.42	33.22	T4	/	/	
WiFi 5G	802.11a	40/5200	Axial (Z)	-3.31	-41.09	37.78	T4	1.65	-3.31	6Mbps WB AMR 6.60kbps
			Transversal (Y)	-12.30	-49.73	37.43	T4	/	-12.30	
WiFi 5G	802.11a	60/5300	Axial (Z)	-2.84	-42.89	40.05	T4	2.00	-2.84	6Mbps WB AMR 6.60kbps
			Transversal (Y)	-9.78	-48.50	38.72	T4	/	-9.78	
WiFi 5G	802.11a	124/5620	Axial (Z)	-2.82	-39.72	36.90	T4	1.36	-2.82	6Mbps WB AMR 6.60kbps
			Transversal (Y)	-11.80	-46.21	34.41	T4	/	-11.80	
WiFi 5G	802.11a	157/5785	Axial (Z)	-2.68	-40.40	37.72	T4	2.00	-2.68	6Mbps WB AMR 6.60kbps
			Transversal (Y)	-12.59	-47.40	34.81	T4	/	-12.59	

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

South of No. 6 Plant, No. 1, Runsheng Road, Suzhou Industrial Park, Suzhou Area, China (Jiangsu) Pilot Free Trade Zone 215000 t (86–512) 62992980 www.sgsgroup.com.cn
中国・苏州・中国（江苏）自由贸易试验区苏州片区苏州工业园区润胜路1号的6号厂房南部 邮编：215000 t (86–512) 62992980 sgs.china@sgs.com

7.3 PAG Reuse section: HAC T-coil measurement procedures for 5G NR

5G VoNR test procedure:

1. According to KDB 285076 D03 Q&A 9, use the interim procedure for 5G Sub 6 calls that use the same protocol, Codec(s) and reference level as VoLTE over LTE (i.e. -16 dBm0).
2. For LTE, establish the ABM1S65G value by using the ABM1LTE magnetic intensity for an LTE call in the same band as the 5G sub6 band under test.
3. For VoNR, establish the ABM1S65G value by using an IP connection for magnetic intensity for a call in the same band as the 5G sub6 band under test
4. Also note the actual ABM2LTE value and establish an ABM2S65G value, using a 5G manufacture test mode over 5G Sub 6 channels for the same band under test.
5. Document in the test report matrix:
   a. Include columns for both ABM2LTE & ABM2S65G for comparison
   b. Establish the S+N1/N2 for the rating
      i. S+N1 = ABM1LTE (step 1) and
      ii. N2 = ABM2S65G (step 2).
      iii. Subtract 3 dB from S+N1/N2
   c. Rating based on (ABM1LTE/ ABM2S65G) -3dB.

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1LTE (dBA/m)	ABM2NR (dBA/m)	Signal Quality (dB)	Signal Quality-3dB (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response
LTE Band 2	20M QPSK 1RB_0	18900/1880	Axial (Z)	-1.28	-42.82	-	41.54	T4	1.29	PASS
			Transversal (Y)	-11.80	-46.18	-	34.38	T4	/	/
N 2	20M QPSK 1RB_1	376000/1880	Axial (Z)	-1.28	-40.11	38.83	35.83	T4	1.29	PASS
			Transversal (Y)	-11.80	-40.03	28.23	25.23	T3	/	/
N 25	40M QPSK 1RB_1	376500/1882.5	Axial (Z)	-1.28	-39.00	37.72	34.72	T4	1.29	PASS
			Transversal (Y)	-11.80	-39.47	27.67	24.67	T3	/	/
LTE Band 5	10M QPSK 1RB_0	20525/836.5	Axial (Z)	-1.13	-44.32	-	43.19	T4	2.00	PASS
			Transversal (Y)	-12.42	-48.72	-	36.30	T4		
N 5	20M QPSK 1RB_1	167300/836.5	Axial (Z)	-1.13	-39.94	38.81	35.81	T4	2.00	PASS
			Transversal (Y)	-12.42	-39.66	27.24	24.24	T3	/	/
LTE Band 26	15M QPSK 1RB_0	26865/831.5	Axial (Z)	-1.12	-43.75	-	42.63	T4	1.66	PASS
			Transversal (Y)	-11.99	-47.80	-	35.81	T4	/	/
N 26	20M QPSK 1RB_1	166300/831.5	Axial (Z)	-1.12	-39.24	38.12	35.12	T4	1.66	PASS
			Transversal (Y)	-11.99	-39.02	27.03	24.03	T3	/	/
LTE Band 30	10M QPSK 1RB_0	27710/2310	Axial (Z)	-1.38	-44.11	-	42.73	T4	2.00	PASS
			Transversal (Y)	-11.64	-46.66	-	35.02	T4	/	/
N 30	10M QPSK 1RB_1	462000/2310	Axial (Z)	-1.38	-40.59	39.21	36.21	T4	2.00	PASS
			Transversal (Y)	-11.64	-40.26	28.62	25.62	T3	/	/
N 41	100M QPSK 1RB_1	518598/2592.99	Axial (Z)	-1.38	-40.04	38.66	35.66	T4	2.00	PASS
			Transversal (Y)	-11.64	-39.77	28.13	25.13	T3	/	/
LTE Band 66	20M QPSK 1RB_0	132322/1745	Axial (Z)	-2.28	-43.33	-	41.05	T4	1.82	PASS
			Transversal (Y)	-12.20	-46.94	-	34.74	T4	/	/
N 66	40M QPSK 1RB_1	349000/1745	Axial (Z)	-2.28	-39.01	36.73	33.73	T4	1.82	PASS
			Transversal (Y)	-12.20	-38.57	26.37	23.37	T3	/	/
LTE Band 71	20M QPSK 1RB_0	133297/680.5	Axial (Z)	-1.15	-43.96	-	42.81	T4	1.85	PASS

			Transversal (Y)	-12.77	-48.43	-	35.66	T4	/	/
N 70	15M QPSK 1RB_1	340500/1702.5	Axial (Z)	-1.15	-39.10	37.95	34.95	T4	0.71	PASS
			Transversal (Y)	-12.77	-39.11	26.34	23.34	T3	/	/
N 71	20M QPSK 1RB_1	136100/680.5	Axial (Z)	-1.15	-37.60	36.45	33.45	T4	1.85	PASS
			Transversal (Y)	-12.77	-40.25	27.48	24.48	T3	/	/
LTE Band 48	20M QPSK 1RB_0	55830/3609	Axial (Z)	-1.63	-35.26	-	33.63	T4	1.85	PASS
			Transversal (Y)	-12.68	-35.75	-	23.07	T3	/	/
N 48	40M QPSK 1RB_1	641666/3624.99	Axial (Z)	-1.63	-39.90	38.27	35.27	T4	1.56	PASS
			Transversal (Y)	-12.68	-39.57	26.89	23.89	T3	/	/
N 77	100M QPSK 1RB_1	650000/3750	Axial (Z)	-1.63	-39.62	37.99	34.99	T4	1.56	PASS
			Transversal (Y)	-12.68	-40.02	27.34	24.34	T3	/	/

7.4 T-Coil testing for OTT VoIP Application

1. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.
2. The google Duo VoIP application are pre-installed on this device. According to KDB 285076 D02, all air interfaces via a data connection with VoIP application need to be considered HAC testing.
3. The Google Duo only support OPUS audio codec and support 6kbps to 75kbps bitrate.
4. The test setup used for OTT VoIP call is the DUT connect to the CMW500 and via the data application unit on CMW500 connection to the Internet, the Auxiliary EUT is connected to the WiFi access point, the channel/Modulation/Frequency bands/data rate is configured on the CMW500 for the DUT unit. For the Auxiliary VoIP unit which is used to configure the audio codec rate and determine the audio input level of -20dBm0 based on the KDB 285076 D02v03 requirement.
5. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following tests results which the worst case codec would be remarked to be used for the testing for the handset.
6. Air Interface Investigation:
a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface.

Codec Investigation:
GSM

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
GSM850	EGPRS 4TS	190/836.6	Axial (Z)	6.82	-42.71	49.53	T4	0.76	PASS	OPUS 6kbps
	EGPRS 4TS	190/836.6	Axial (Z)	6.93	-42.51	49.44	T4	0.74	PASS	OPUS 40kbps
	EGPRS 4TS	190/836.6	Axial (Z)	7.24	-42.11	49.35	T4	0.96	PASS	OPUS 75kbps

Remark: According to codec investigation, the worst codec bitrate is **OPUS 75kbps**.

UMTS:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
WCDMA Band IV	HSPA	9400/1900	Axial (Z)	3.29	-40.97	44.26	T4	0.78	PASS	OPUS 6kbps
	HSPA	9400/1900	Axial (Z)	3.41	-40.98	44.39	T4	0.72	PASS	OPUS 40kbps
	HSPA	9400/1900	Axial (Z)	3.61	-40.39	44.00	T4	0.81	PASS	OPUS 75kbps

Remark: According to codec investigation, the worst codec bitrate is **OPUS 75kbps**.

LTE FDD:

LTE FDD Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
LTE Band 4	20M QPSK 100RB_0	20175/1732.5	Axial (Z)	5.06	-41.52	46.58	T4	0.11	PASS	OPUS 6kbps
	20M QPSK 100RB_0	20175/1732.5	Axial (Z)	4.98	-41.46	46.44	T4	0.05	PASS	OPUS 40kbps
	20M QPSK 100RB_0	20175/1732.5	Axial (Z)	5.14	-41.06	46.20	T4	0.12	PASS	OPUS 75kbps

Remark: According to codec investigation, the worst codec bitrate is **OPUS 75kbps**.

LTE TDD:

LTE TDD Band	Test Mode	Test Ch./Freq.	UL-DL configuration	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
LTE Band 48	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	7.16	-33.70	40.86	T4	0.05	PASS	OPUS 6kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	7.18	-33.61	40.79	T4	0.16	PASS	OPUS 40kbps
	20M QPSK 1RB_0	55830/3609	0	Axial (Z)	7.36	-33.33	40.69	T4	0.32	PASS	OPUS 75kbps

Remark: According to codec investigation, the worst codec bitrate is **OPUS 75kbps**.

WIFI2.4GHz:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
WiFi 2.4G	802.11b	6/2437	Axial (Z)	3.14	-34.92	38.06	T4	0.62	PASS	OPUS 6kbps
	802.11b	6/2437	Axial (Z)	3.19	-34.35	37.54	T4	0.67	PASS	OPUS 40kbps
	802.11b	6/2437	Axial (Z)	3.53	-33.81	37.34	T4	0.73	PASS	OPUS 75kbps

Remark: According to codec investigation, WiFi 2.4G the worst codec is **OPUS 75kbps**.

WIFI5GHz:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
WiFi 5G	802.11a	40/5200	Axial (Z)	4.32	-36.89	41.21	T4	0.87	PASS	OPUS 6kbps
	802.11a	40/5200	Axial (Z)	4.26	-36.80	41.06	T4	1.06	PASS	OPUS 40kbps
	802.11a	40/5200	Axial (Z)	4.45	-36.45	40.90	T4	1.23	PASS	OPUS 75kbps

Remark: According to codec investigation, WiFi 5G the worst codec is **OPUS 75kbps**.

Air interface:

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	T Rating	Freq. Response Variation (dB)	Frequency Response	Codec Setting
GSM850	EGPRS 4TS	190/836.6	Axial (Z)	7.24	-42.11	49.35	T4	0.96	PASS	OPUS 75kbps
			Transversal (Y)	-1.55	-46.70	45.15	T4	/	/	
WCDMA II	HSPA	9400/1900	Axial (Z)	3.61	-40.39	44.00	T4	0.81	PASS	OPUS 75kbps
			Transversal (Y)	-3.73	-45.69	41.96	T4	/	/	
LTE Band 4	20M QPSK 100RB_0	20175/1732.5	Axial (Z)	5.14	-41.06	46.20	T4	0.12	PASS	OPUS 75kbps
			Transversal (Y)	-4.36	-45.62	41.26	T4	/	/	
LTE Band 48	20M QPSK 100RB_0	55830/3609	Axial (Z)	7.36	-33.33	40.69	T4	0.32	PASS	OPUS 75kbps
			Transversal (Y)	-2.28	-35.28	33.00	T4	/	/	
WLAN2.4GHz	802.11b	6/2437	Axial (Z)	3.53	-33.81	37.34	T4	0.73	PASS	OPUS 75kbps
			Transversal (Y)	-5.99	-41.75	35.76	T4	/	/	
WLAN5GHz	802.11a	40/5200	Axial (Z)	4.45	-36.45	40.90	T4	1.23	PASS	OPUS 75kbps
			Transversal (Y)	-5.87	-45.52	39.65	T4	/	/	

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.

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Wireless Laboratory

5G NR OTT test procedure:

6. According to KDB 285076 D03 Q&A 9, use the interim procedure for 5G Sub 6 calls that use the same protocol, Codec(s) and reference level as OTT voice calling applications (such as the option for voice-only communications in the Google Duo app)
7. For OTT, establish the ABM1S65G value by using an IP connection for magnetic intensity for a call in the same LTE band as the 5G sub6 band under test
8. Also note the actual ABM2LTE/OTT value and establish an ABM2S65G value, using a 5G manufacture test mode over 5G Sub 6 channels for the same band under test.
9. Document in the test report matrix:
    a. Include columns for both ABM2LTE & ABM2S65G for comparison
    b. Establish the S+N1/N2 for the rating
        i. S+N1 = ABM1LTE (step 1) and
        ii. N2 = ABM2S65G (step 2).
        iii. Subtract 3 dB from S+N1/N2
    c. Rating based on (ABM1LTE/ ABM2S65G) -3dB.

Band	Test Mode	Test Ch./Freq.	Probe Position	ABM1 (dBA/m)	ABM2 (dBA/m)	Signal Quality (dB)	Signal Quality-3dB (dB)	T Rating	Freq. Response Variation (dB)
LTE Band 48	20M QPSK 100RB_0	55830/3609	Axial (Z)	7.36	-33.33	-	40.69	T4	0.32
			Transversal (Y)	-2.28	-35.28	-	33.00	T4	/
FR1 n48	40M QPSK 100RB_0	641666/3624.99	Axial (Z)	7.36	-39.90	47.26	44.26	T4	1.05
			Transversal (Y)	-2.28	-39.57	37.29	34.29	T4	/

8 Equipment list

	Equipment	Manufacturer	Model	Serial Number	Calibration Date	Due date of calibration
☒	Software	SPEAG	DASY52 52.10.4	NA	NCR	NCR
☒	DAE	SPEAG	DAE4	1324	2022-10-17	2023-10-16
☒	Audio Magnetic 1D Field Probe	SPEAG	AM1DV3	3115	2023-06-13	2024-06-12
☒	Test Arch SD HAC	SPEAG	NA	NA	NCR	NCR
☒	Audio Magnetic Measuring Instrument	SPEAG	AMMI	1028	NCR	NCR
☒	Audio Magnetic	SPEAG	AMCC	1143	N/A	N/A
☒	Universal Radio Communication Tester	R&S	CMW500	111637	2023-02-08	2024-02-27
☒	Humidity and Temperature Indicator	MingGao	MingGao	NA	2023-06-19	2024-06-18

Note:
1. All the equipments are within the valid period when the tests are performed.
2. NCR: “No-Calibration Required”.

9 Calibration certificate

Please see the Appendix B

10 Photographs

Please see the Appendix C

Appendix A: Detailed Test Results

Appendix B: Calibration certificate

Appendix C: Photographs

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South of No. 6 Plant, No. 1, Runsheng Road, Suzhou Industrial Park, Suzhou Area, China (Jiangsu) Pilot Free Trade Zone 215000 t (86–512) 62992980 www.sgsgroup.com.cn
中国・苏州・中国（江苏）自由贸易试验区苏州片区苏州工业园区润胜路1号的6号厂房南部 邮编： 215000 t (86–512) 62992980 sgs.china@sgs.com