

# ***HAC (T-Coil) Test Report***

<b>Application No.:</b>	SUCR2401000022WM
<b>Applicant:</b>	Cloud Mobile Holdings, LLC
<b>Manufacturer:</b>	Cloud Mobile Holdings, LLC
<b>Product Name:</b>	Smart Phone
<b>Model No.(EUT):</b>	Stratus C8
<b>FCC ID:</b>	2AY6A-C8
<b>Standards:</b>	ANSI C63.19-2019 CFR 47 FCC Part 20
<b>Date of Receipt:</b>	2024-03-16
<b>Date of Test:</b>	2024-03-20 to 2024-04-03
<b>Date of Issue:</b>	2024-04-07
<b>Test conclusion:</b>	<b>PASS *</b>

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

Authorized Signature:

well we'

Well Wei

Wireless Laboratory Manager



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Rev.: 01

Page: 2 of 33

## REVISION HISTORY

Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2024-04-07		Original



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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 3 of 33

## TEST SUMMARY

Frequency Band	Test Results
GSM850	PASS
GSM1900	PASS
WCDMA Band II	PASS
WCDMA Band IV	PASS
WCDMA Band V	PASS
LTE Band 2	PASS
LTE Band 4	PASS
LTE Band 5	PASS
LTE Band 7	PASS
LTE Band 12	PASS
LTE Band 13	PASS
LTE Band 17	PASS
LTE Band 66	PASS
LTE Band 71	PASS
LTE Band 41	PASS
<b>HAC Test result: PASS</b>	

Reviewed by



Nick Hu

Prepared by



Alger Du

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## CONTENTS

<b>1 GENERAL INFORMATION .....</b>	<b>5</b>
1.1 Introduction .....	5
1.2 Details of Client .....	5
1.3 Test Location .....	5
1.4 Test Facility .....	6
1.5 General Description of EUT .....	7
1.5.1 DUT Antenna Locations(Back view) .....	7
1.5.2 List of air interfaces/frequency bands .....	10
1.6 Test Specification .....	11
1.7 ANSI C63.19-2019 limits .....	11
<b>2 CALIBRATION CERTIFICATE .....</b>	<b>12</b>
<b>3 HAC (T-COIL) MEASUREMENT SYSTEM.....</b>	<b>13</b>
3.1 Measurement System Diagram for SPEAG Robotic .....	13
3.2 T-Coil Measurement .....	14
3.3 System Calibration .....	19
3.4 Audio Magnetic Probe AM1DV3.....	20
3.5 Test Arch .....	20
3.6 Phone Holder .....	20
3.7 AMCC- Audio Magnetic Calibration Coil .....	21
3.8 AMMI - Audio Magnetic Measurement Instrument .....	21
<b>4 MEASUREMENT UNCERTAINTY EVALUATION .....</b>	<b>22</b>
<b>5 HAC (T-COIL) MEASUREMENT.....</b>	<b>23</b>
5.1 T-Coil Performance Requirements .....	23
5.2 T-Coil measurement points and reference plane .....	25
5.3 T-Coil Measurement Procedure .....	26
<b>6 T-COIL TESTING FOR CMRS VOICE.....</b>	<b>27</b>
6.1 General Description .....	27
6.2 GSM Tests Results .....	27
6.3 UMTS Tests Results .....	28
<b>7 T-COIL TESTING FOR CMRS IP VOICE .....</b>	<b>29</b>
7.1 VoLTE/VONR Tests Results .....	29
7.2 T-Coil testing for OTT VoIP Application .....	33
<b>8 EQUIPMENT LIST .....</b>	<b>35</b>
<b>9 CALIBRATION CERTIFICATE .....</b>	<b>35</b>
<b>10 PHOTOGRAPHS .....</b>	<b>35</b>
<b>APPENDIX A: DETAILED TEST RESULTS .....</b>	<b>35</b>
<b>APPENDIX B: CALIBRATION CERTIFICATE .....</b>	<b>35</b>
<b>APPENDIX C: PHOTOGRAPHS .....</b>	<b>35</b>



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 5 of 33

## 1 General Information

### 1.1 Introduction

The purpose of this standard is to provide tests and establish requirements for hearing aids and for WDs that allow a hearing aid user to effectively use a WD when both the hearing aid and WD meet the requirements of this standard. The various parameters required in order to demonstrate compatibility are measured. The design of the standard is such that when a hearing aid and a WD achieve the specified requirements, as measured by the methodology of this standard, the user of a hearing aid can effectively use a WD. In order to provide for the usability of a hearing aid with a WD, several factors are coordinated, as follows:

- a) The field strength emitted by a WD must not exceed the RF immunity of the hearing aid.
- b) The T-Coil baseband H-field transmission of the WD must be compatible with the T-Coil mode of the hearing aid.
- c) The magnetic noise from the WD in the T-Coil band must not degrade the reception quality to unacceptable levels.

Both the WD's RF and audio-band emissions are measured. Hence, the following measurements are made for the WDs:

- a) RF amplitude modulation characteristics and power level or, optionally, near-field E-field emissions
- b) T-Coil mode, magnetic signal strength in the audio band.
- c) T-Coil mode, magnetic noise in the audio band
- d) T-Coil mode, magnetic signal frequency response in the audio band

Corresponding to these quantities, the hearing aid is measured for the following:

- 1) RF immunity in microphone mode
- 2) RF immunity in T-Coil mode

### 1.2 Details of Client

Applicant:	Cloud Mobile Holdings, LLC
Address:	1149 S Hill St, H-400 Los Angeles, CA 90015
Manufacturer:	Cloud Mobile Holdings, LLC
Address:	1149 S Hill St, H-400 Los Angeles, CA 90015

### 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:	Alger Du



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 6 of 33

## 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**

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- **FCC –Designation Number: CN1312**

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 Rev.: 01  
 Page: 7 of 33

## 1.5 General Description of EUT

Device Type :	Smart Phone		
Exposure Category:	uncontrolled environment / general population		
Product Name:	Smart Phone		
Model No.(EUT):	Stratus C8		
FCC ID:	2AY6A-C8		
Trade Mark:	Cloud Mobile		
Product Phase:	Identical Prototype		
IMEI:	1# 354904220001387		
	2# 354904220001148		
Hardware Version:	AL_W20_MB_V12_C		
Software Version:	Stratus_C8_V202_20240129		
Device Operating Configurations :			
Modulation Mode:	<b>GSM:</b> GMSK, 8PSK; <b>WCDMA:</b> QPSK,16QAM; <b>LTE:</b> QPSK,16QAM,64QAM;		
Device Class:	B		
GRPS Multi-slots Class:	12	EGPRS Multi-slots Class:	12
HSDPA UE Category:	24	HSUPA UE Category	7
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 7	2500-2570	2620-2690
	LTE Band 12	699-716	729-746
	LTE Band 13	777-787	746-756
	LTE Band 17	704-716	734-746
	LTE Band 41	2496-2690	2496-2690
	LTE Band 66	1710-1780	2110-2200
	LTE Band 71	663-698	617-652



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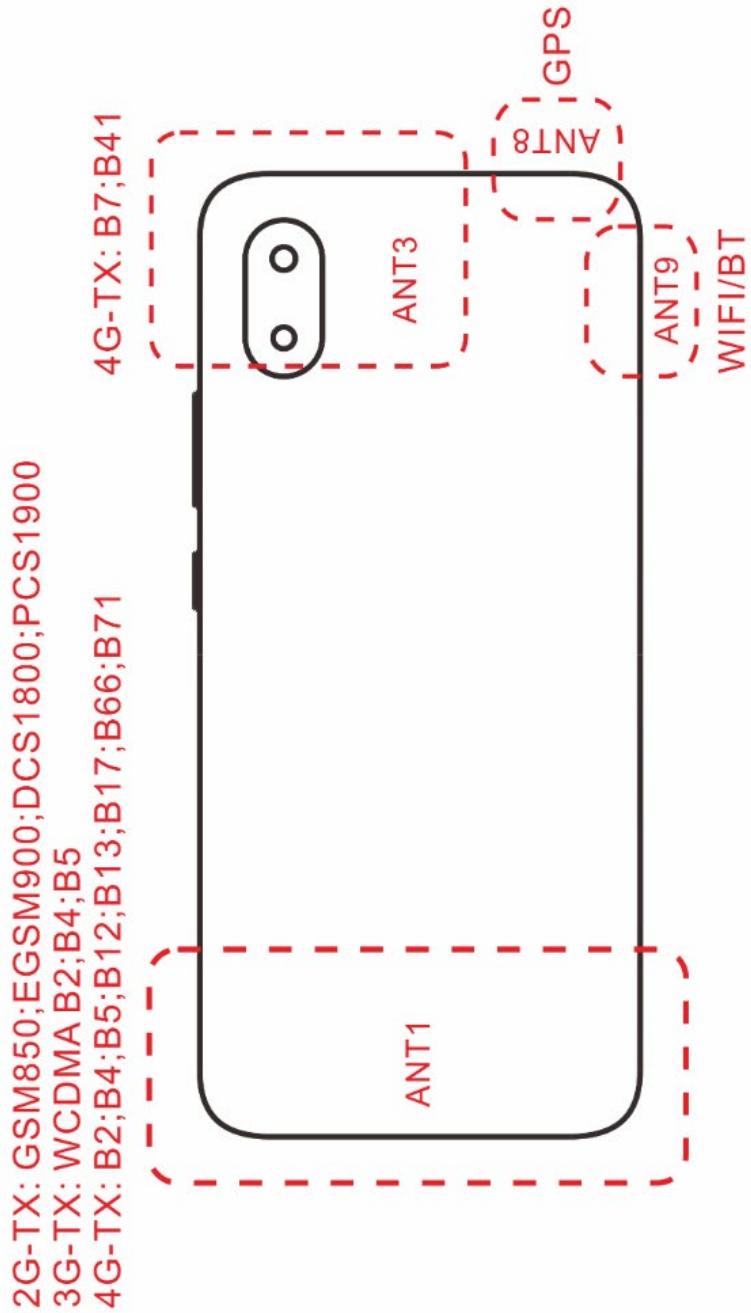
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### 1.5.1 DUT Antenna Locations(Back view)



**Note:**

- 1) The diversity Antenna does not support transmitter function.



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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 10 of 33

### 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	Yes	BT, Wi-Fi	CMRS Voice	No
	1900					
WCDMA	Band II	VO	Yes	BT, Wi-Fi	CMRS Voice	No
	Band IV					
	Band V				Google Meet*	
	HSPA	VD	Yes			
LTE (FDD)	LTE Band 2	VD	Yes	BT, Wi-Fi	VoLTE Google Meet*	No
	LTE Band 4					
	LTE Band 5					
	LTE Band 7					
	LTE Band 12					
	LTE Band 13					
	LTE Band 17					
	LTE Band 66					
	LTE Band 71					
LTE (TDD)	Band 41	VD	Yes	BT, Wi-Fi	VoLTE Google Meet*	No
VO: Legacy Cellular Voice Service						
DT: Digital Transport (no voice)						
VD: IP Voice Service over Digital Transport						
* For protocols not listed in Table 6.1 of ANSI C63.19-2019, the average speech level of -20 dBm0 should be used.						



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 11 of 33

## 1.6 Test Specification

Identity	Document Title
CFR 47 FCC Part 20	§20.19 Hearing aid-compatible mobile handsets.
ANSI C63.19-2019	American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices
KDB 285076 D01	HAC Guidance v06
KDB 285076 D02	T-Coil testing v04

## 1.7 ANSI C63.19-2019 limits

### GSM operating modes:

- The primary group shall include at least 25 measurement points.
- The secondary group shall include at least 125 contiguous measurement points.

### Non-2G GSM operating modes:

- The primary group shall include at least 75 measurement points.
- The secondary group shall include at least 300 contiguous measurement points

Additionally, to avoid an oddly shaped area of low noise, the secondary group shall

include at least one longitudinal column of at least 10 contiguous qualifying points and at least one transverse row containing at least 15 contiguous qualifying points.



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 12 of 33

## 2 Calibration certificate

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

Table 1: The Ambient Conditions

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### 3 HAC (T-Coil) Measurement System

### 3.1 Measurement System Diagram for SPEAG Robotic

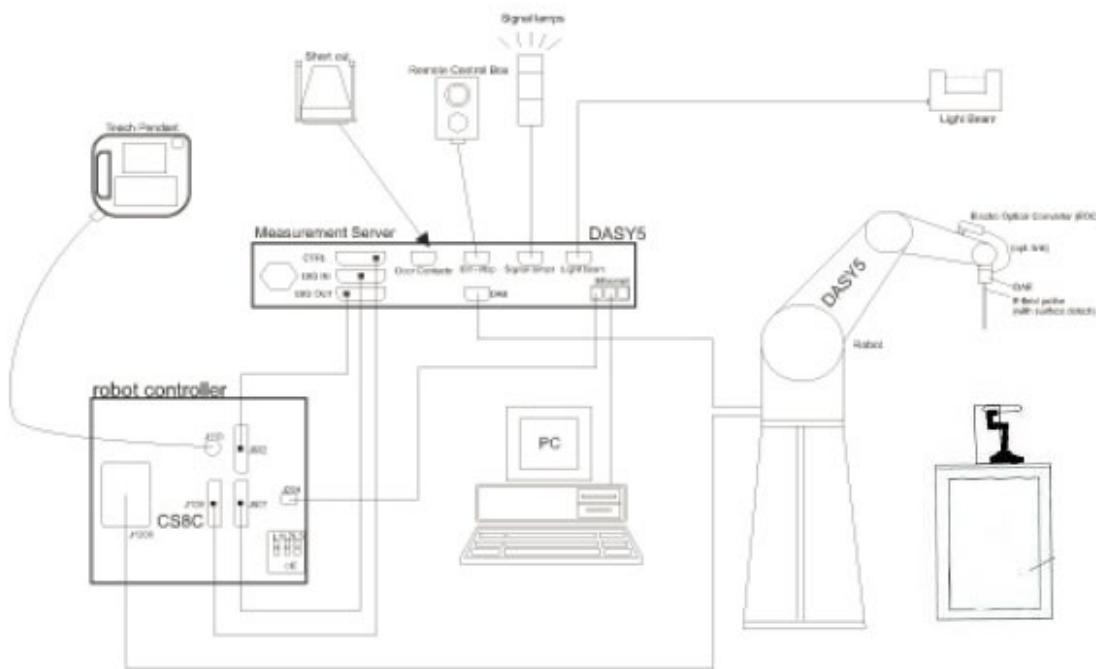


Fig. 1. The SPEAG Robotic Diagram

The DASY8 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

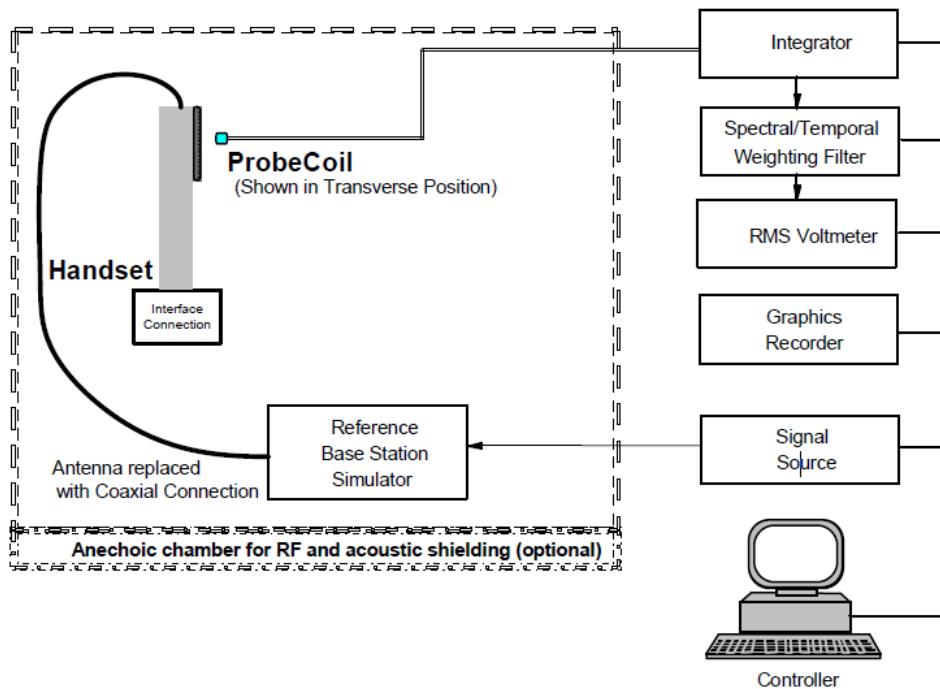


Fig. 2. T-coil signal measurement test setup-in call method

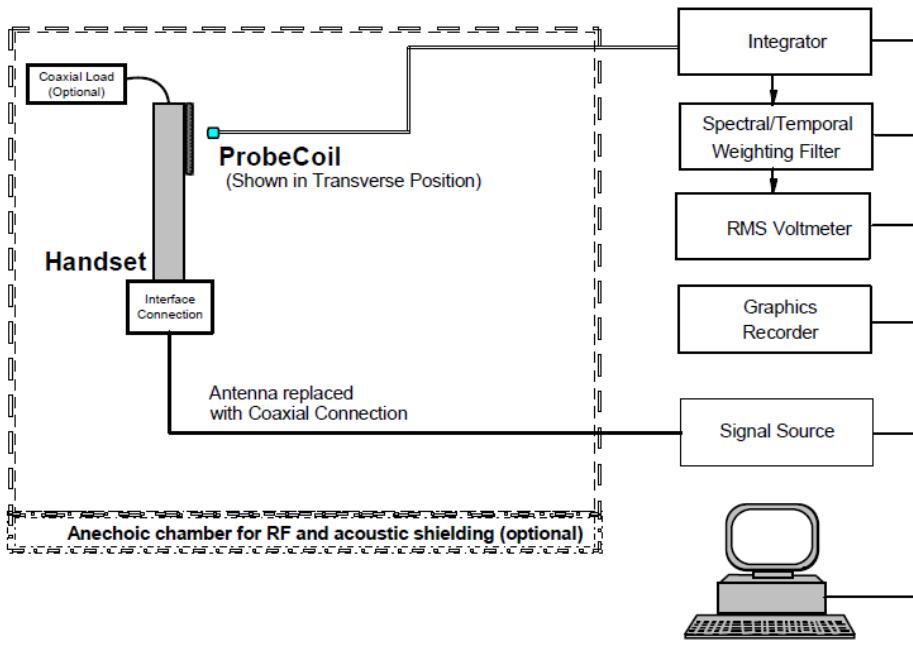


Fig. 3. T-coil signal measurement test setup-test mode method.



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 15 of 33

The reference axis is normal to the reference plane and passes through the center of the acoustic output (or the center of the hole array); or may be centered on or near a secondary inductive source. The actual location of the reference axis and resultant measurement area shall be noted in the test report.

The measurement area shall be 50 mm by 50 mm. The measurement area for both desired ABM signal and undesired ABM field may be located where the transverse magnetic measurements are optimum with regard to the requirements. However, the measurement area should be in the vicinity of the acoustic output of the WD and shall be located in the same half of the phone as the WD receiver. In a WD handset with a centered receiver and a circularly symmetrical magnetic field, the measurement axis and the reference axis would coincide.

Measurements of desired ABM signal strength and undesired ABM field are made at 2.0 mm +0.5 mm or 4 mm intervals in an X-Y measurement area pattern over the entire measurement area (676 measurement points total); either all measured, or measured plus interpolated.

#### 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 D01v06, handsets that have the ability to support concurrent connections using simultaneous transmissions shall be independently tested for each air interface/band given in ANSI C63.19-2019. 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 D02v04:

GSM input Level: -16dB

UMTS input Level: -16dB

VOLTE input Level: -16dB

OTT input Level: -16dB

# For GSM/UMTS/VoLTE test setup and input level, the correct input level definition is via a communication tester CMW500 "Decoder Cal" and "Codec Cal" to set the correct audio input levels.

# For VONR test setup and input level, the correct input level definition is via a communication tester CMX500 and External DAU USB sound card "Decoder Cal" and "Codec Cal" to set the correct audio input levels.

# CMW500 and External DAU USB sound card 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 GSM/UMTS/VoLTE/VONR. CMW500/CMX500 input is calibrated and the relation between the analog input voltage and the internal level in dBm0 can be determined.



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### 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.

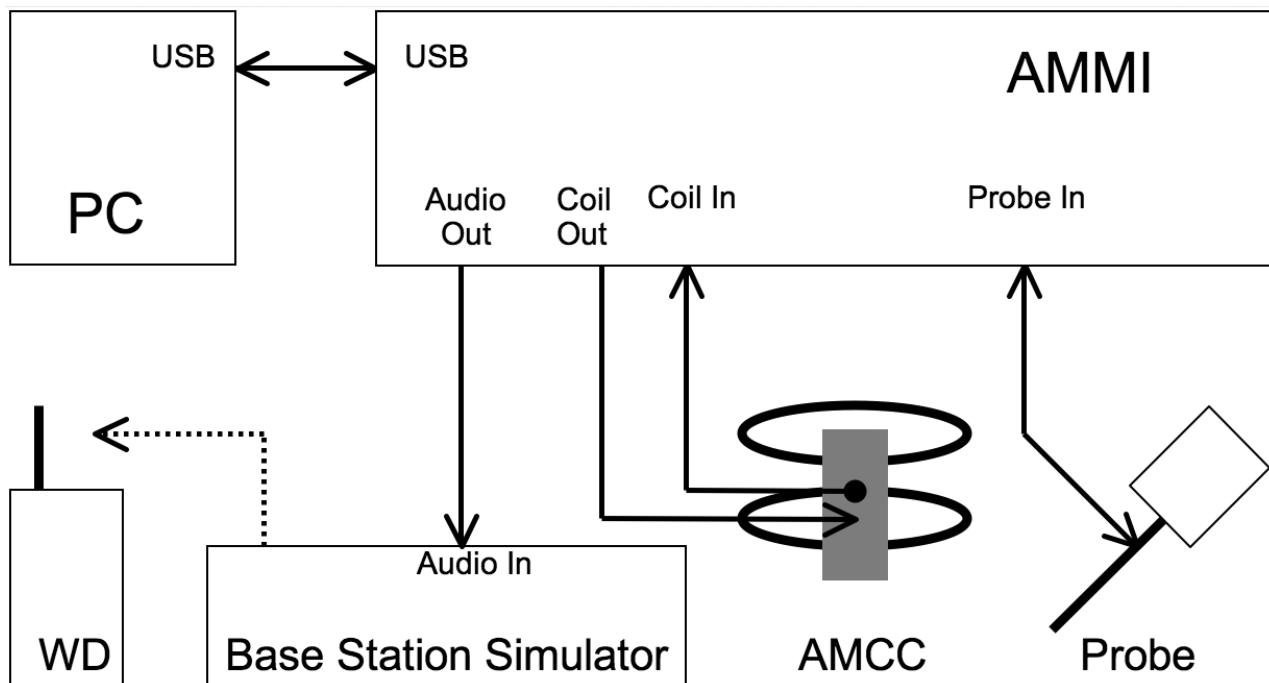


Fig. 2. T-coil signal measurement test setup

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 achieve approx. the same level as for the 1kHz sine signal.

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

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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 17 of 33

### Input Level for GSM/UMTS/VoLTE

Gain Value	dBm0	Full scale Voltage	dB	AMMI audio out dBv (RMS)	AMCC Coil Out (dBv (RMS))
	3.14	1.5		0.55	
100	5.53		40	2.94	3.09
8.39	-16		18.47		-18.44
Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz sine	-	3	0	1	8.39
48k_voice_1kHz	1	15.74	-12.7	4.33	36.32
48k_voice_300-3000	2	21.57	-18.6	8.48	71.13

### Define the input level for OTT

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.

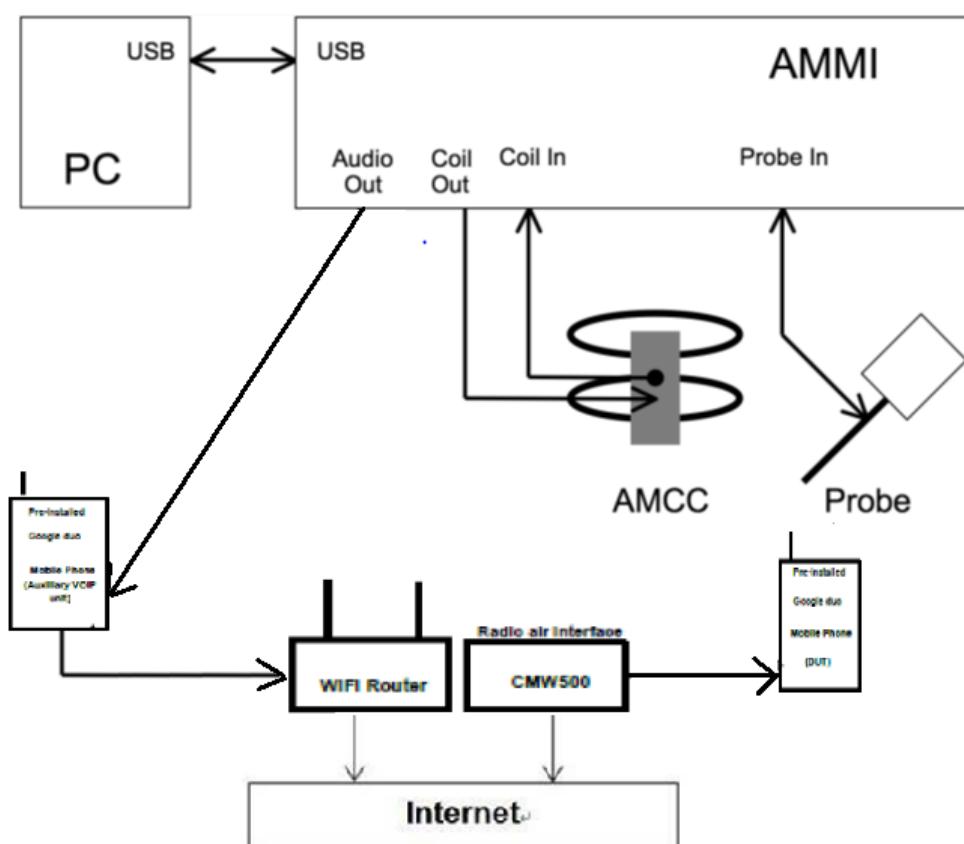


Fig. 2. T-coil signal measurement test setup



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Report No.: SUCR240100002202

Rev.: 01

Page: 18 of 33

- #. 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 simulate base station, connected to the internet via the google DUO server 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 (LTE, WCDMA)
- #. The auxiliary device includes software that displays the audio level in dBFS which allows calibration of the system to establish the -16dBm0 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 -16dBm0 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.

#### Input Level for OTT

Gain Value		20* log(gain)	AMCC Coil Out		Level
(linear)		dB	(dBv RMS)		dBm0
			0.533		3.14
10		20	-18.39		-15.78
9.75		19.78	-22.61		-16
Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz sine	-	3	0	1	9.75
48k_voice_1kHz	1	15.74	-12.7	4.33	42.23
48k_voice_300-3000	2	21.57	-18.6	8.48	82.71

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Report No.: SUCR240100002202  
Rev.: 01  
Page: 19 of 33

### 3.3 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.



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 20 of 33

### 3.4 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

### 3.5 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

### 3.6 Phone Holder

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

Phone Holder



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 21 of 33

### 3.7 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
-------------	---	---

### 3.8 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	



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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 22 of 33

## 4 Measurement uncertainty evaluation

Error Description	Uncertainty Value (%)	Probability Dist.	Divisor	ci ABM1	ci ABM2	Standard Uncertainty ABM1 (%)	Standard Uncertainty ABM2 (%)
<b>Related to probe sensitivity</b>							
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
<b>Related to probe system</b>							
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
<b>Test signal</b>							
Reference signal spectrum response	±0.6	R	$\sqrt{3}$	0	1	±0.0	±0.4
<b>Positioning</b>							
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
<b>External Contributions</b>							
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



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## 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  $\geq -18$  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.

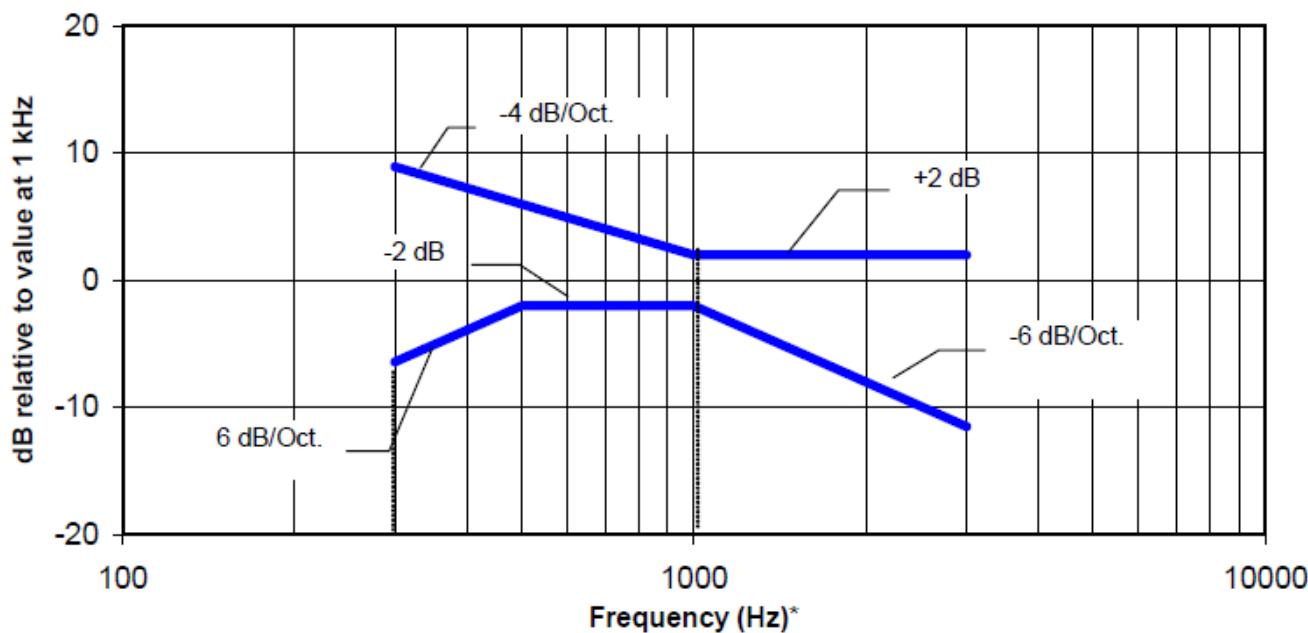


Figure 1—Magnetic field frequency response for WDs with a field  $\leq -15$  dB (A/m) at 1 kHz

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Rev.: 01  
Page: 24 of 33

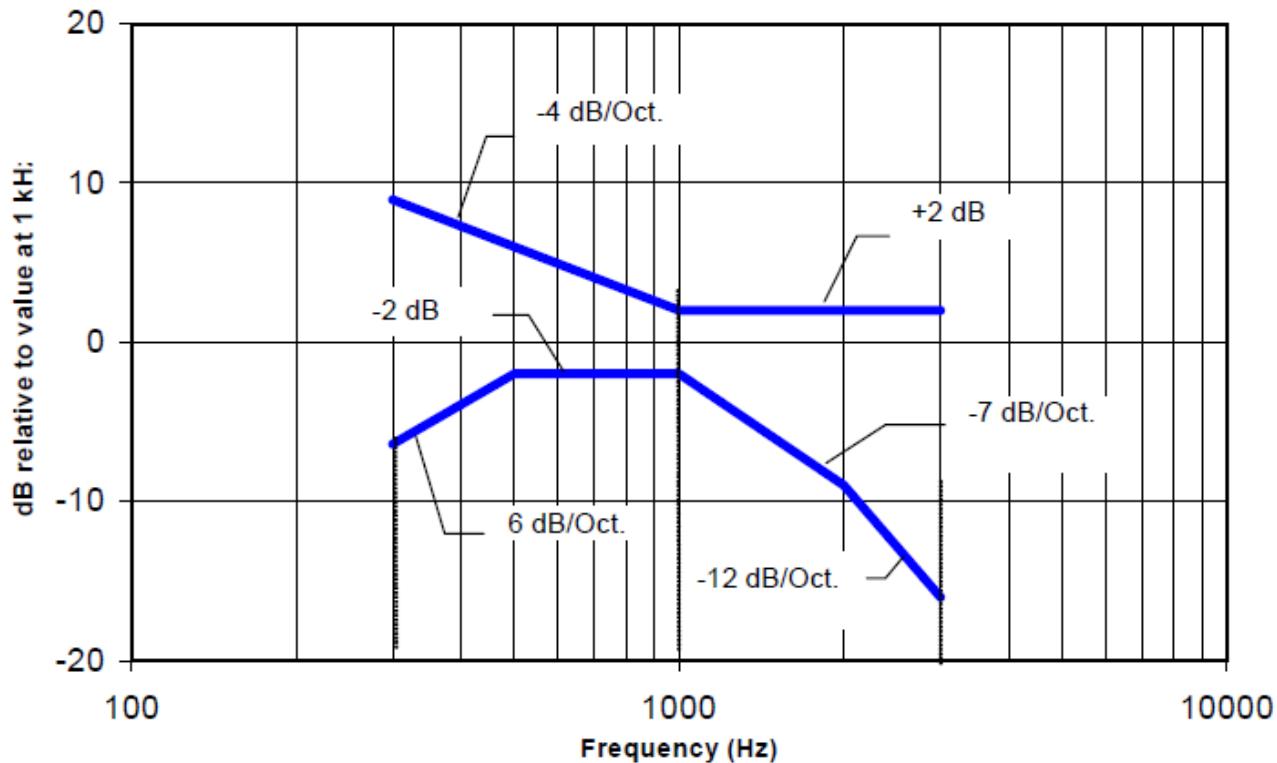


Figure 2 —Magnetic field frequency response for WDs with a field that exceeds  $-15\text{dB(A/m)}$  at 1 kHz

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## 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.

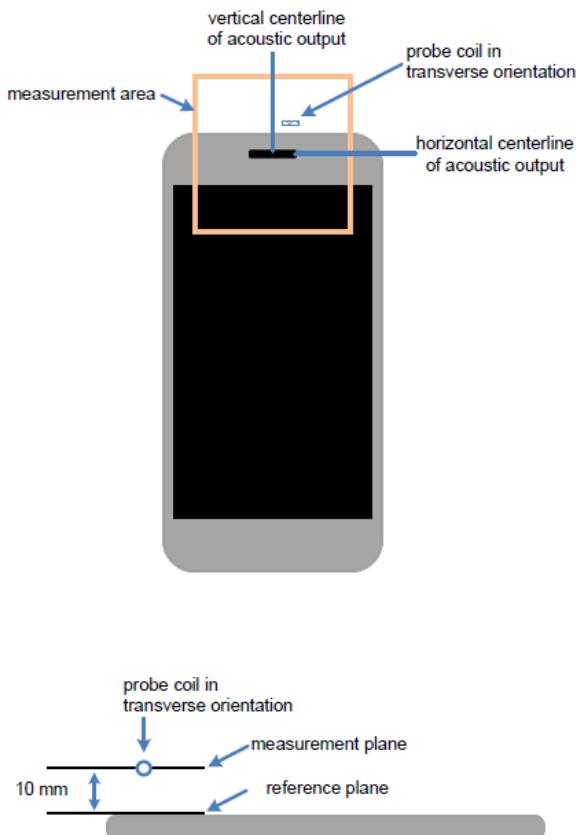


Figure A.4—Measurement and reference planes probe orientation for WD audio frequency magnetic field measurements

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



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### 5.3 T-Coil Measurement Procedure

According to ANSI C63.19-2019, section4:

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

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

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

Measurements shall be performed with the probe coil oriented in the transverse direction, aligned in the plane of the measurement area and perpendicular to the long dimension of the WD. A multi-stage sequence consists of first measuring the field strength of the desired T-Coil signal(desired ABM signal) that is useful to a hearing aid.

T-Coil at each specified measurement point. The undesired magnetic component (undesired ABM field) is then measured in the same transverse orientation at each of the same measurement point.

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

To minimize the need to test every WD operating mode to the telecoil requirements of Clause 6, it is permissible to exclude some subset of supported configurations. For a given WD, every mode that supports voice communication shall be considered for telecoil testing. However, if it can be demonstrated that a certain configuration will not be the worst-case telecoil configuration, such configurations may be excluded from the full telecoil scans of 6.4.4. For example, operating modes may be pre-screened by scanning for both desired ABM signal and undesired ABM field at a lower measurement point density than the final scans, thus saving considerable testing time by eliminating configurations that are excellent performers from more detailed testing for worst-case.

Many factors could affect telecoil test results. RF power level and amplitude modulation characteristics as well as the specific current paths within the WD associated with the RF output stage(s), the display, and processing circuitry could affect the undesired ABM field. Audio codec implementation and acoustic receiver characteristics could also affect the desired ABM signal).



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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 27 of 33

## 6 T-Coil testing for CMRS Voice

### 6.1 General Description

#### 1. Codec Investigation:

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

#### 2. Air Interface Investigation:

- 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.
- According to the ANSI C63.19 2019 section 6.3.4, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil.
- Opening the Hearing-aid can improve the HAC T-Coil performance of the earpiece.

### 6.2 GSM Tests Results

#### Codec Investigation:

Air Interface	Modulation	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Frequency Response	Date
GSM850	Voice	190	AMR NB FR	71	141	PASS	2024/3/26
GSM850	Voice	190	EFR (FR V2)	69	142	PASS	2024/3/26
GSM850	Voice	190	AMR WB FR	27	155	PASS	2024/3/26

Remark: According to codec investigation, the worst codec is AMR WB FR

#### Air Interface Investigation:

Air Interface	Modulation	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Frequency Response	Date
GSM850	Voice	190	AMR WB FR	27	155	PASS	2024/3/26
GSM1900	Voice	661	AMR WB FR	30	161	PASS	2024/3/26

#### Remark:

- Phone Condition: Air Link; Hearing-aid on; Mute on; Backlight off; Max Volume
- The detail frequency response results please refer to appendix A.



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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 28 of 33

## 6.3 UMTS Tests Results

### Codec Investigation:

Air Interface	Modulation	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
WCDMA II	Voice	9400	AMR NB 4.75Kbps	347	633	26	26	PASS	2024/3/20
WCDMA II	Voice	9400	AMR WB 6.60Kbps	325	616	26	26	PASS	2024/3/20
WCDMA II	Voice	9400	AMR NB12.2Kbps	342	614	26	26	PASS	2024/3/20
WCDMA II	Voice	9400	AMR WB 23.85Kbps	359	622	26	26	PASS	2024/3/20

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

### Air Interface Investigation:

Air Interface	Modulation	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
WCDMA II	Voice	9400	AMR WB 6.60Kbps	325	616	26	26	PASS	2024/3/20
WCDMA IV	Voice	1412	AMR WB 6.60Kbps	319	612	26	26	PASS	2024/3/20
WCDMA V	Voice	4183	AMR WB 6.60Kbps	326	617	26	26	PASS	2024/3/20

**Remark:**

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



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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 29 of 33

## 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 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:

- 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.
- Select LTE FDD one frequency band to do measurement at the worst Primary Group Contiguous Point Count 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.

#### LTE FDD Codec Investigation:

Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
LTE Band2	20	QPSK	1	0	18900	AMR NB 4.75Kbps	438	549	23	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	AMR NB 12.2Kbps	436	546	26	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	AMR WB 6.60Kbps	421	554	26	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	AMR WB 23.85Kbps	416	549	26	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	EVS NB 5.9Kbps	398	512	25	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	EVS NB 24.4Kbps	413	521	23	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	EVS WB 5.9Kbps	292	518	24	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	EVS WB 128Kbps	384	513	23	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	EVS SWB 9.6Kbps	260	524	24	26	PASS	2024/3/28
LTE Band2	20	QPSK	1	0	18900	EVS SWB 128Kbps	253	510	23	26	PASS	2024/3/28
LTE Band2	20	QPSK	50	0	18900	EVS SWB 128Kbps	254	515	23	26	PASS	2024/3/28
LTE Band2	20	QPSK	100	0	18900	EVS SWB 128Kbps	266	528	26	26	PASS	2024/3/28
LTE Band2	20	16QAM	1	0	18900	EVS SWB 128Kbps	255	518	24	26	PASS	2024/3/28
LTE Band2	20	64QAM	1	0	18900	EVS SWB 128Kbps	259	524	24	26	PASS	2024/3/28
LTE Band2	15	QPSK	1	0	18900	EVS SWB 128Kbps	268	539	26	26	PASS	2024/3/28
LTE Band2	10	QPSK	1	0	18900	EVS SWB 128Kbps	270	542	24	26	PASS	2024/3/28
LTE Band2	5	QPSK	1	0	18900	EVS SWB 128Kbps	256	512	25	26	PASS	2024/3/28
LTE Band2	3	QPSK	1	0	18900	EVS SWB 128Kbps	257	515	23	26	PASS	2024/3/28
LTE Band2	1.4	QPSK	1	0	18900	EVS SWB 128Kbps	276	538	24	26	PASS	2024/3/28

Remark:

- Select Worst worst codec Bandwidth/Modulation/RB Size from LTE FDD Test results to do LTE FDD
- Select Worst Bandwidth/Modulation/RB Size from LTE FDD Test results to do LTE FDD
- According to codec investigation, the worst codec is **EVS SWB 128Kbps**



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Report No.: SUCR240100002202

Rev.: 01

Page: 30 of 33

**Air interface:**

Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
LTE Band2	20	QPSK	1	0	18900	EVS SWB 128Kbps	253	510	23	26	PASS	2024/3/28
LTE Band4	20	QPSK	1	0	20175	EVS SWB 128Kbps	302	566	26	26	PASS	2024/3/29
LTE Band5	10	QPSK	1	0	20525	EVS SWB 128Kbps	293	556	26	26	PASS	2024/3/29
LTE Band7	20	QPSK	1	0	21100	EVS SWB 128Kbps	290	551	26	26	PASS	2024/3/29
LTE Band12	10	QPSK	1	0	23095	EVS SWB 128Kbps	301	567	26	26	PASS	2024/3/29
LTE Band13	10	QPSK	1	0	23230	EVS SWB 128Kbps	307	573	26	26	PASS	2024/3/29
LTE Band17	10	QPSK	1	0	23790	EVS SWB 128Kbps	292	559	26	26	PASS	2024/3/29
LTE Band66	20	QPSK	1	0	132322	EVS SWB 128Kbps	278	539	24	26	PASS	2024/3/29
LTE Band71	20	QPSK	1	0	133297	EVS SWB 128Kbps	304	568	26	26	PASS	2024/3/29

**Remark:**

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

**LTE TDD Codec Investigation:**

Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
LTE Band41	20	QPSK	1	0	40620	AMR NB 4.75Kbps	200	317	19	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	AMR NB 12.2Kbps	207	321	21	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	AMR WB 6.60Kbps	131	324	22	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	AMR WB 14.25Kbps	137	318	20	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	EVS NB 5.9Kbps	195	307	17	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	EVS NB 24.4Kbps	209	309	18	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	EVS WB 5.9Kbps	112	320	18	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	EVS WB 128Kbps	213	334	19	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	EVS SWB 9.6Kbps	91	331	18	26	PASS	2024/3/27
LTE Band41	20	QPSK	1	0	40620	EVS SWB 128Kbps	97	331	18	26	PASS	2024/3/27
LTE Band41	20	QPSK	50	0	40620	EVS SWB 9.6Kbps	87	328	18	26	PASS	2024/3/27
LTE Band41	20	QPSK	100	0	40620	EVS SWB 9.6Kbps	89	333	19	26	PASS	2024/3/27
LTE Band41	20	16QAM	50	0	40620	EVS SWB 9.6Kbps	91	331	18	26	PASS	2024/3/27
LTE Band41	20	64QAM	50	0	40620	EVS SWB 9.6Kbps	88	332	18	26	PASS	2024/3/27
LTE Band41	15	QPSK	50	0	40620	EVS SWB 9.6Kbps	89	334	18	26	PASS	2024/3/27
LTE Band41	10	QPSK	50	0	40620	EVS SWB 9.6Kbps	88	330	18	26	PASS	2024/3/27
LTE Band41	5	QPSK	50	0	40620	EVS SWB 9.6Kbps	91	334	18	26	PASS	2024/3/27

**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
3. According to codec investigation, the worst codec is **NB EVS 5.90Kbps**



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Rev.: 01

Page: 31 of 33

**LTE TDD Air interface:**

Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
LTE Band41	20	QPSK	50	0	40620	EVS SWB 9.6Kbps	87	328	18	26	PASS	2024/3/27

## Remark:

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

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Report No.: SUCR240100002202  
 Rev.: 01  
 Page: 32 of 33

## 7.2 T-Coil testing for OTT VoIP Application

1. The Google Duo only support OPUS audio codec and support 6kbps to 75kbps bitrate.
2. 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.
3. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters 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.
4. 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.

### Air interface:

#### WCDMA:

Air Interface	Modulation	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
WCDMA II	HSPA	9400	OPUS 6kbps	371	469	22	26	PASS	2024/4/3
WCDMA II	HSPA	9400	OPUS 40kbps	389	476	23	26	PASS	2024/4/3
WCDMA II	HSPA	9400	OPUS 75kbps	392	480	23	26	PASS	2024/4/3

#### FDD LTE:

Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
LTE Band2	20	QPSK	1	0	18900	OPUS 6kbps	368	478	22	26	PASS	2024/4/3
LTE Band2	20	QPSK	1	0	18900	OPUS 40kbps	377	473	22	26	PASS	2024/4/3
LTE Band2	20	QPSK	1	0	18900	OPUS 75kbps	375	471	22	26	PASS	2024/4/3

#### TDD LTE:

Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	Codec	Primary Group Contiguous Point Count	Secondary Group Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Frequency Response	Date
LTE Band41	20	QPSK	50	0	40620	OPUS 6kbps	207	353	18	26	PASS	2024/4/3
LTE Band41	20	QPSK	50	0	40620	OPUS 40kbps	254	349	18	26	PASS	2024/4/3
LTE Band41	20	QPSK	50	0	40620	OPUS 75kbps	222	348	17	26	PASS	2024/4/3

#### Remark:

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



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Report No.: SUCR240100002202  
Rev.: 01  
Page: 33 of 33

## 8 Equipment list

Equipment		Manufacturer	Model	Serial Number	Calibration Date	Due date of calibration
<input checked="" type="checkbox"/>	Software	SPEAG	DASY8	NA	NCR	NCR
<input checked="" type="checkbox"/>	DAE	SPEAG	DAE4	1484	2023-06-05	2024-06-04
<input checked="" type="checkbox"/>	Audio Magnetic 1D Field Probe	SPEAG	AM1DV3	3115	2023-06-13	2024-06-12
<input checked="" type="checkbox"/>	Test Arch SD HAC	SPEAG	NA	NA	NCR	NCR
<input checked="" type="checkbox"/>	Audio Magnetic Measuring Instrument	SPEAG	AMMI	1028	NCR	NCR
<input checked="" type="checkbox"/>	Audio Magnetic	SPEAG	AMCC	1143	N/A	N/A
<input checked="" type="checkbox"/>	Universal Radio Communication Tester	R&S	CMW500	111637	2023-09-13	2024-09-12
<input checked="" type="checkbox"/>	Humidity and Temperature Indicator	MingGao	MingGao	NA	2023-06-15	2024-06-14

**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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