HAC T-Coil Test Report

For

Applicant Name:	**Xwireless LLC**
Address:	11565 Old Georgetown Road, Rockville, MD, USA
EUT Name:	Mobile Phone
Brand Name:	Vortex
Model Number:	C24

Issued By

Company Name:	**BTF Testing Lab (Shenzhen) Co., Ltd.**
Address:	F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
Report Number:	BTF240419R00402
Test Standards:	ANSI C63.19-2019 FCC 47 CFR §20.19 KDB 285076 D01 KDB 285076 D02 KDB 285076 D03
FCC ID:	2ADLJ-C24
Test Conclusion:	Pass
Test Date:	2024-05-31 to 2024-06-04
Date of Issue:	2024-06-05

Prepared By:	Zoey Zhang
	Zoey Zhang / Project Engineer
Date:	2024-06-05
Approved By:	Ryan.CJ
	Ryan.CJ / EMC Manager
Date:	2024-06-05

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Revision History		
Version	Issue Date	Revisions Content
R_V0	2024-06-05	Original
Note:	*Once the revision has been made, then previous versions reports are invalid.*	

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1. Introduction

1.1 Identification of Testing Laboratory

Company Name:	BTF Testing Lab (Shenzhen) Co., Ltd.
Address:	F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
Phone Number:	+86-0755-23146130
Fax Number:	+86-0755-23146130

1.2 Identification of the Responsible Testing Location

Test Location:	BTF Testing Lab (Shenzhen) Co., Ltd.
Address:	F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
Description:	All measurement facilities used to collect the measurement data are located at F101,201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China
FCC Registration Number	518915
Designation Number	CN1330

1.3 Laboratory Condition

Ambient Temperature:	21℃ to 25℃
Ambient Relative Humidity:	48% to 59%
Ambient Pressure:	100 kPa to 102 kPa

1.4 Announcement

(1) The test report reference to the report template version v0.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing, reviewing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) This document may not be altered or revised in any way unless done so by BTF and all revisions are duly noted in the revisions section.

(5) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

(6) The laboratory is only responsible for the data released by the laboratory, except for the part provided by the applicant.

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2. Product Information

2.1 Application Information

Company Name:	Xwireless LLC
Address:	11565 Old Georgetown Road, Rockville, MD, USA

2.2 Manufacturer Information

Company Name:	Xwireless LLC
Address:	11565 Old Georgetown Road, Rockville, MD, USA

2.3 Factory Information

Company Name:	ZTECH COMMNICATION(SZ) CO LTD
Address:	FL 7 BLOCK D BAO' AN ZHIGU INNOVATION PARK YIN' TIAN ROAD NO.4 XI' XIANG STR' BAO' AN DISTRICT SZ CHINA

2.4 General Description of Equipment under Test (EUT)

EUT Name	Mobile Phone
Under Test Model Name	C24
Sample No.	BTFSN240419013/4 E1-E4

2.5 Equipment under Test Ancillary Equipment

Ancillary Equipment 1	Rechargeable Battery	
	Capacity	2300mAh
	Rated Voltage	3.8V

2.6 Technical Information

Network and Wireless connectivity	2G Network GSM/GPRS/EGPRS 850/1900 3G Network WCDMA/HSDPA/HSUPA Band 2/4/5 4G Network FDD LTE Band 2/4/5/12/13/25/26/66/71 TDD LTE Band 41 2.4G WIFI 802.11b, 802.11g, 802.11n(HT20) BT (EDR+BLE)

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2.7 Air Interfaces / Bands Indicating Operating Modes

Air Interface	Band	C63.19 Tested	Type	Simultaneous Transmitter	Name of Service	Power Reduction
GSM	850	Yes	VO	WLAN & BT	CMRS Voice	No
	1900	Yes	VO	WLAN & BT	CMRS Voice	No
	GPRS/EGPRS	Yes	DT	N/A	N/A	No
WCDMA	Band II	Yes	VO	WLAN & BT	CMRS Voice	No
	Band IV	Yes	VO	WLAN & BT	CMRS Voice	No
	Band V	Yes	VO	WLAN & BT	CMRS Voice	No
	HSPA	Yes	DT	N/A	N/A	No
LTE	Band 2	Yes	VD	WLAN & BT	VoLTE	No
	Band 4	Yes	VD	WLAN & BT	VoLTE	No
	Band 5	Yes	VD	WLAN & BT	VoLTE	No
	Band 12	Yes	VD	WLAN & BT	VoLTE	No
	Band 13	Yes	VD	WLAN & BT	VoLTE	No
	Band 25	Yes	VD	WLAN & BT	VoLTE	No
	Band 26	Yes	VD	WLAN & BT	VoLTE	No
	Band 41	Yes	VD	WLAN & BT	VoLTE	No
	Band 66	Yes	VD	WLAN & BT	VoLTE	No
	Band 71	Yes	VD	WLAN & BT	VoLTE	No
WLAN	2.4g	No	DT	WWAN	N/A	No
BT	2450	No	DT	WWAN	N/A	No

NA: Not Applicable
VO: Voice Only
VD: CMRS and IP Voice Service over Digital Transport
DT: Digital Transport Only

Notes:
1. For protocols not listed in Table 6.1 of ANSI C63.19:2019,the average speech level of -20 dBm0 should be used.
2. The hearing aid compatibility mode of the prototype was turned on during testing, and all tests were performed in HAC mode.

3. Summary of Test Results

3.1 Test Standards

No.	Identity	Document Title
1	ANSI C63.19-2019	American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids
2	FCC 47 CFR §20.19	Hearing Aid Compatible Mobile Headsets
3	KDB 285076 D01	HAC Guidance v06r04
4	KDB 285076 D02	T-coil testing for CMRS IP v04
5	KDB 285076 D03	HAC FAQ v01r06

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3.2 Attestation of Testing Summary

Frequency Band	Frequency Response	result
GSM 850	Pass	Pass
GSM 1900	Pass	Pass
WCDMA II	Pass	Pass
WCDMA IV	Pass	Pass
WCDMA V	Pass	Pass
LTE Band 2	Pass	Pass
LTE Band 4	Pass	Pass
LTE Band 5	Pass	Pass
LTE Band 12	Pass	Pass
LTE Band 13	Pass	Pass
LTE Band 25	Pass	Pass
LTE Band 26	Pass	Pass
LTE Band 41	Pass	Pass
LTE Band 66	Pass	Pass
LTE Band 71	Pass	Pass

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4. Test Uncertainty

UNCERTAINTY EVALUATION FOR AUDIO HAC MEASUREMENT					
Uncertainty Component	Tol (+- %)	Prob. Dist.	Div.	Uncertainty (dB)	Uncertainty (%)
Measurement System					
RF reflections	0.1	R	√3	0.06	
Acoustic noise	0.1	R	√3	0.06	
Probe coil sensitivity	0.49	R	√3	0.28	
Reference signal level	0.25	R	√3	0.14	
Positioning accuracy	0.4	R	√3	0.23	
Cable loss	0.1	N	2	0.05	
Frequency analyzer	0.15	R	√3	0.09	
System repeatability	0.2	N	1	0.20	
Repeatability of the WD	0.4	N	1	0.40	
Combined Standard Uncertainty		N	1	0.61	
Expanded uncertainty (confidence level of 95%,k = 2)		N	K=2	1.22	15.05
REPORTED Expanded uncertainty (confidence level of 95%, k = 2)		N	K=2	1.20	15.00

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5. Measurement System

5.1 Definition of Hearing Aid Compatibility (HAC)

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

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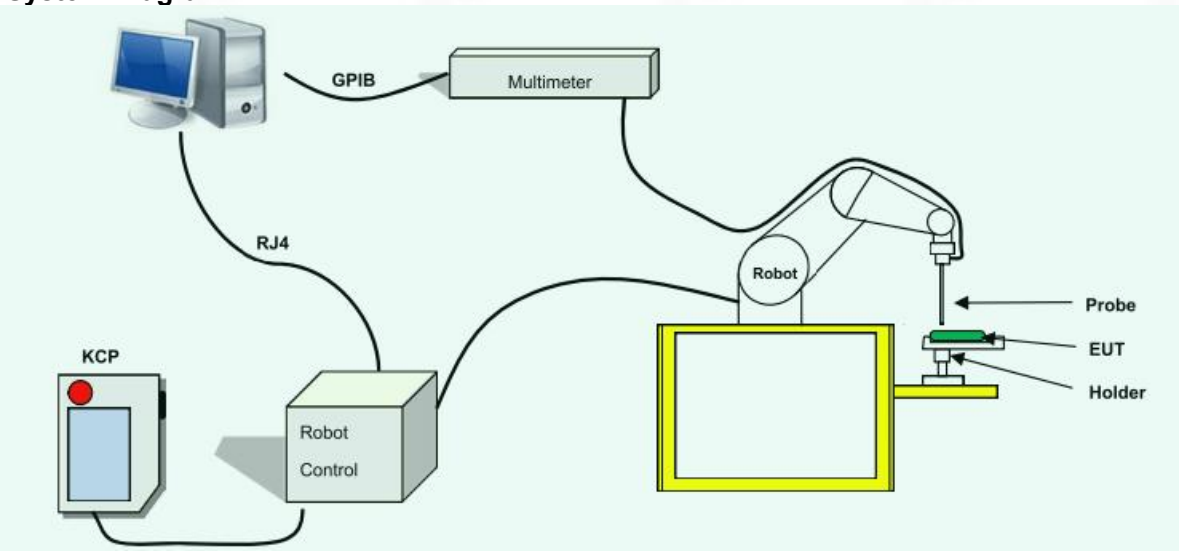
5.2 MVG HAC System

MVG HAC System Diagram



5.2.1 Robot

A standard high precision 6-axis robot (Denso) with teaches pendant with Scanning System
· It must be able to scan all the volume of the phantom to evaluate the tridimensional distribution of SAR.
· Must be able to set the probe orthogonal of the surface of the phantom (±30°).
· Detects stresses on the probe and stop itself if necessary to keep the integrity of the probe.

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5.2.2 T-coil Probe

Figure 1 – *MVG COMOHAC T-coil Probe*

Coil Dimension	6.55 mm length * 2.29 mm diameter
DC resistance	860.6 Ω
Wire size	51AWG
Inductance at 1 kHz	132.1 mH at 1 kHz

Device Under Test	
Device Type	COMOHAC T-COIL PROBE
Manufacturer	MVG
Model	STCOIL
Serial Number	SN 07/17 TCP38
Product Condition (new / used)	New
Frequency Range of Probe	200-5000 Hz

This probe is designed to fulfill ANSI recommendations for the measurement of audio frequency magnetic fields radiated by mobile phones. The T-Coil probe has two connectors:

the 6 male wires connector enables to fix the probe on the robot
the BNC connector enables to link the probe to the audio DAQ

This probe was designed for a 6-axis robot. The coil is oriented with a 45 degree angle so that used with a 6-axis robot, both radial and axial measurements can be performed with one probe.

5.2.3 TMFS

MVG COMOHAC Magnetic Simulator

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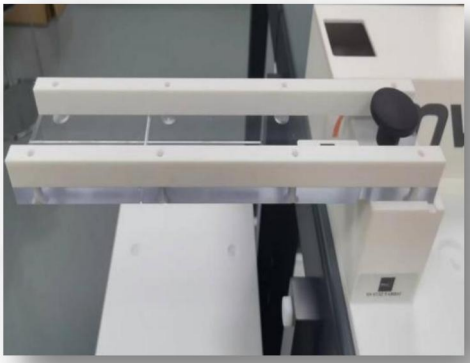
Device Under Test	
Device Type	COMOHAC Magnetic Field Simulator
Manufacturer	MVG
Model	STMFS
Serial Number	SN 13/22 TMFS30
Product Condition (new / used)	New
Frequency Range	200-5000 Hz

All methods used to perform the measurements and calibrations comply with the ANSI C63.19. All measurements were performed with the TMFS in the standard device test configuration, with the TMFS in free space, 10 mm below the coil center.

5.2.4 Device Holder/DUT positioner

	
DUT Holder	DUT Positioner

During test, use DUT positioner to check if the Speaker is aligned with the positioner center.

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5.3 T-Coil Measurement Set-up

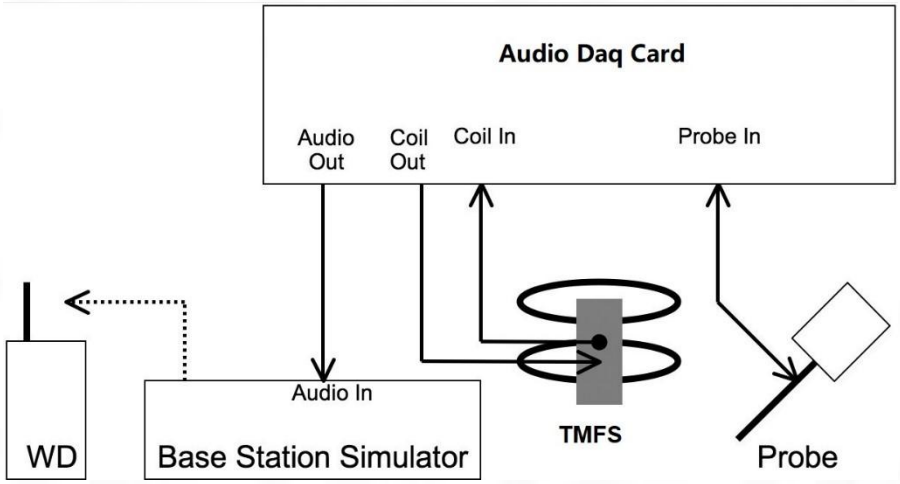
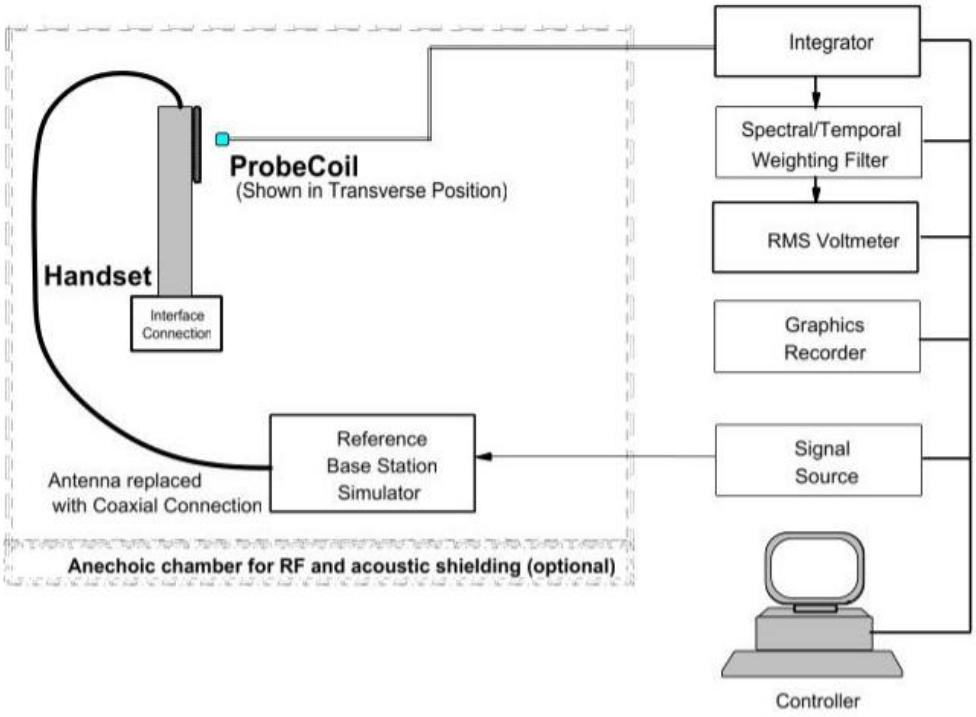


Fig. 2. T-coil signal measurement test setup



Note：

1. The setup assumes that the proper reference input level to the base station simulator or phone interface as specified in ANSI C63.19-2019 section 6.4.3.2 has already been determined.
2. The receive audio signal for the WD may be injected into the base station simulator, which transmits it to the WD while the WD is on a call. An alternative method is to use the WD manufacturer's test mode, if available. If a manufacturer's test mode is used, it is up to the tester to show that the signal is equivalent to the reference input level into a base station simulator as specified in ANSI C63.19-2019 Table 6.1.

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5.4 System Calibration

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

for cable loss calibration:

a) Use Audio Generator to determine the loss between Audio Generator and TMFS

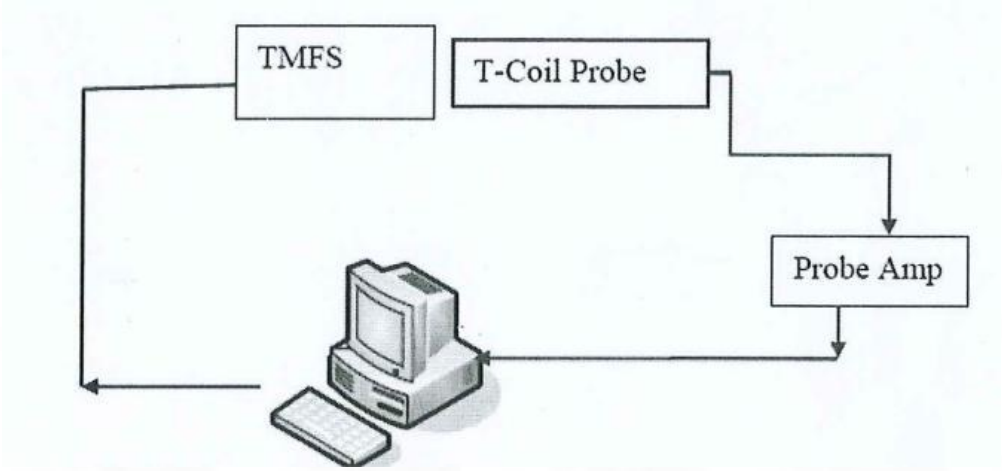
b) Audio output power to TMFS: 1025Hz, 500mV.

c) adjust the audio signal output power to check the cable loss, and use front panel of Multimeter to show target level: 1025Hz, 500mW. (for example, set the audio output power to TMFS: 1025Hz, 0.5924V)

for system verification:

a) Place TMFS properly—the distance between the center of TMFS and T-coil probe is 10mm.

b) send the signal to TMFS, and use probe to measure the ABM1 over the TMFS.



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6. HAC (T-Coil) Measurement

6.1 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.

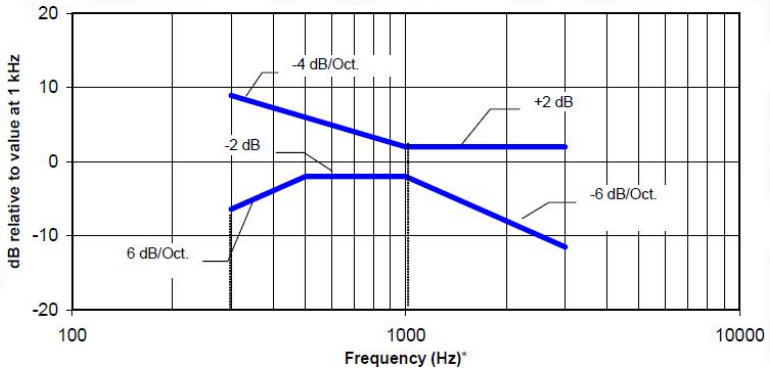
1) T-Coil coupling field intensity
When measured as specified in this standard, there arc two groups of qualifying measurement points:

Primary group: A qualifying measurement point shall have its T-Coil signal, desired ABM signal, >-18 dB(A/m) at I kHz, in a 1/3 octave band filter. These measurements shall be made with the WD operating at a reference input level as specified in Table 6.1. Simultaneously, the qualifying measurement point shall have its weighted magnetic noise, undesired ABM field <-38 dB(A/m).

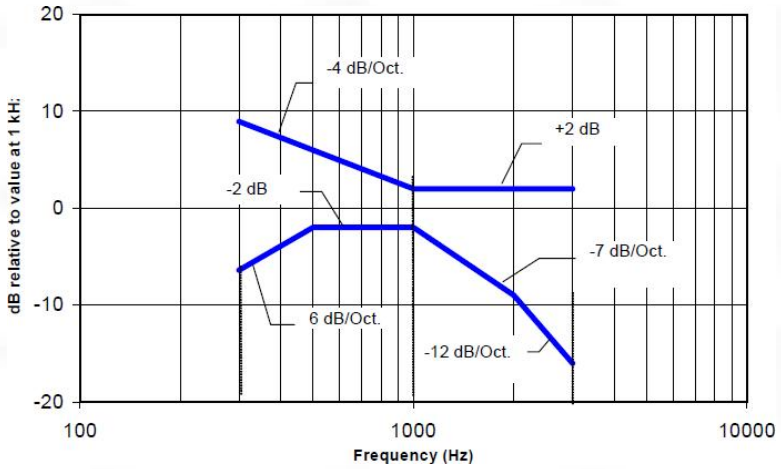
Secondary group: A qualifying measurement point shall have its weighted magnetic noise, undesired ABM field <-38 dB(A/m). This group inherently includes all the members of the primary group.

These levels arc designed to be compatible with hearing aids that produce the same acoustic output level for either an acoustic input level of 65 dB SPL or a magnetic input level of-25 dB(A/m) (56.2 mA/m)39 at either 1.0 kHz or 1.6 kHz. The hearing aid operational measurements are performed per ANSI S3.22-2014.

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.



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



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

3) Desired ABM signal, undesired ABM field qualification requirements

<Non-2G GSM operating modes>

The goal of this requirement is to ensure an adequate area where desired ABM signal is sufficiently strong to be heard clearly and a larger area where undesired ABM field is sufficiently low as to avoid undue annoyance. Qualifying measurement points shall fulfill the requirements of ANSI 63.19-2019 section 6.6.2; both the primary and secondary group requirements shall be met:

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

Additionally, to avoid an oddly shaped area of low noise,the secondary group shall include at least one longitudinal column of at least 10 contiguous qualifying points and at least one transverse row containing at least 15 contiguous qualifying points.

Figure 6.6 is an example of a qualifying scan. The total number of primary group qualifying measurement points is 161, which is ≥75.The total number of secondary group qualifying points is 536,which is ≥300.

The secondary group has a longitudinal column of 26,which is ≥10,and a transverse row also of 26 contiguous points, which is≥15.

<2G GSM operating modes>

If the 2G GSM operating mode(s) are selected for qualification, the qualifying measurement points shall fulfil the requirements of 6.6.2; both the primary and secondary group requirements shall be met:

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

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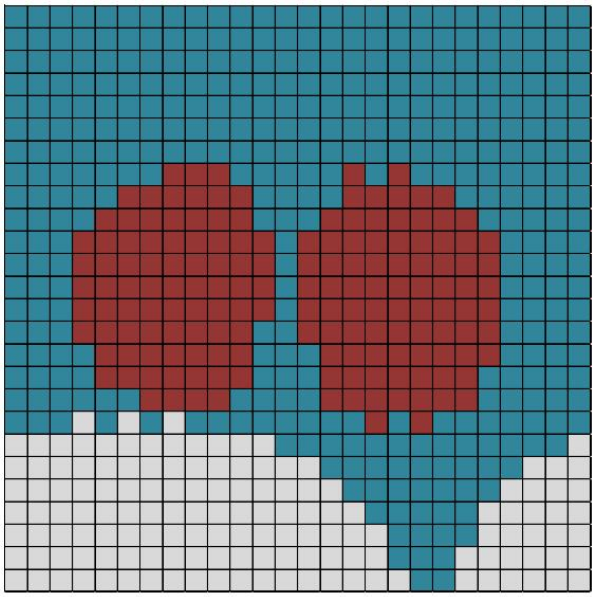

Red (primary group): AB desired ABM signal M1 ≥−18 dB(A/m) and undesired ABM field ≤−38 dB(A/m)
Blue and red (secondary group): undesired ABM field ≤−38 dB(A/m)

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6.2 T-Coil measurement points and reference plane

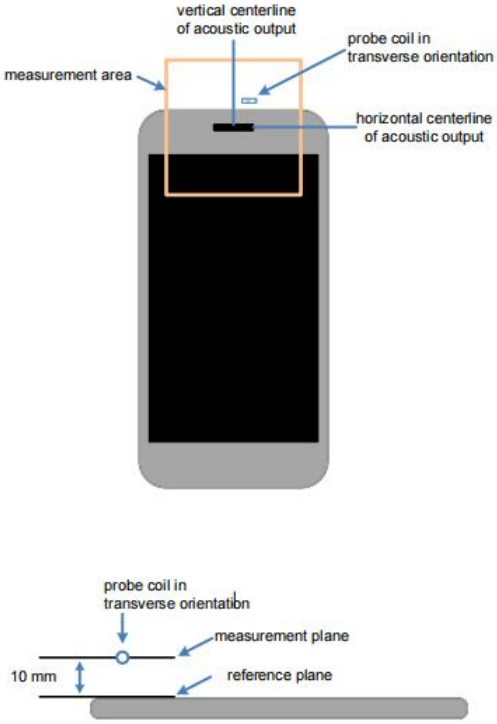
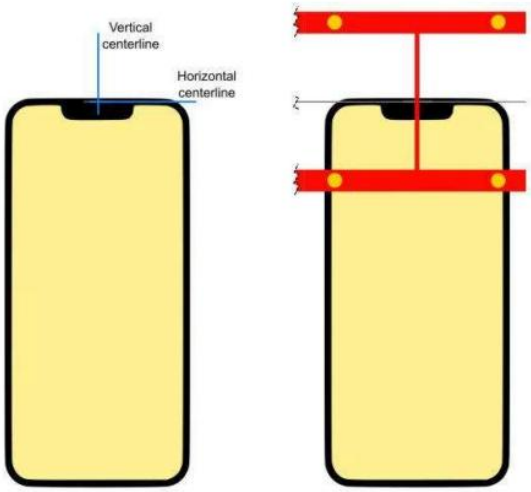


Figure A.4—Measurement and reference planes probe orientation for WD audio frequency magnetic field measurements



Device Under Test Positioning under the Test Arch

The T-Coil measurement plane, reference plane and other measurement parameters shall be:

a) The reference plane is 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 WD handset, which, in normal handset use, rest against the ear.

b) The measurement plane is parallel to, and 10 mm in front of, the reference plane.

c) 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.

d) 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.

e) 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, per 6.4.

f) Desired ABM signal frequency response is measured at a single location at or near the maximum desired ABM signal strength location.

g) The actual locations of the measurement points shall be noted in the test report.

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6.3 Test procedure for T-Coil signal—preferred

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

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

In addition to measuring the desired ABM signal levels, the weighted magnitude of the unintended signal shall also be determined. Weighting of the unintended and undesired ABM field shall be by the spectral and temporal weighting described in D.4 through D.6.

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, as illustrated in A.3, that is, aligned in the plane of the measurement area and perpendicular to the long dimension of the WD. A multi-stage sequence consists of first measuring the field strength of the desired T-Coil signal (desired ABM signal) that is useful to a hearing aid T-Coil at each specified measurement point. The undesired magnetic component (undesired ABM field) is then measured in the same transverse orientation at each of the same measurement points. At a single location only, taken at or near the highest desired ABM signal reading, the desired ABM signal frequency response shall be determined in a third measurement stage. The flowchart in Figure 6.3 illustrates this three-stage process.

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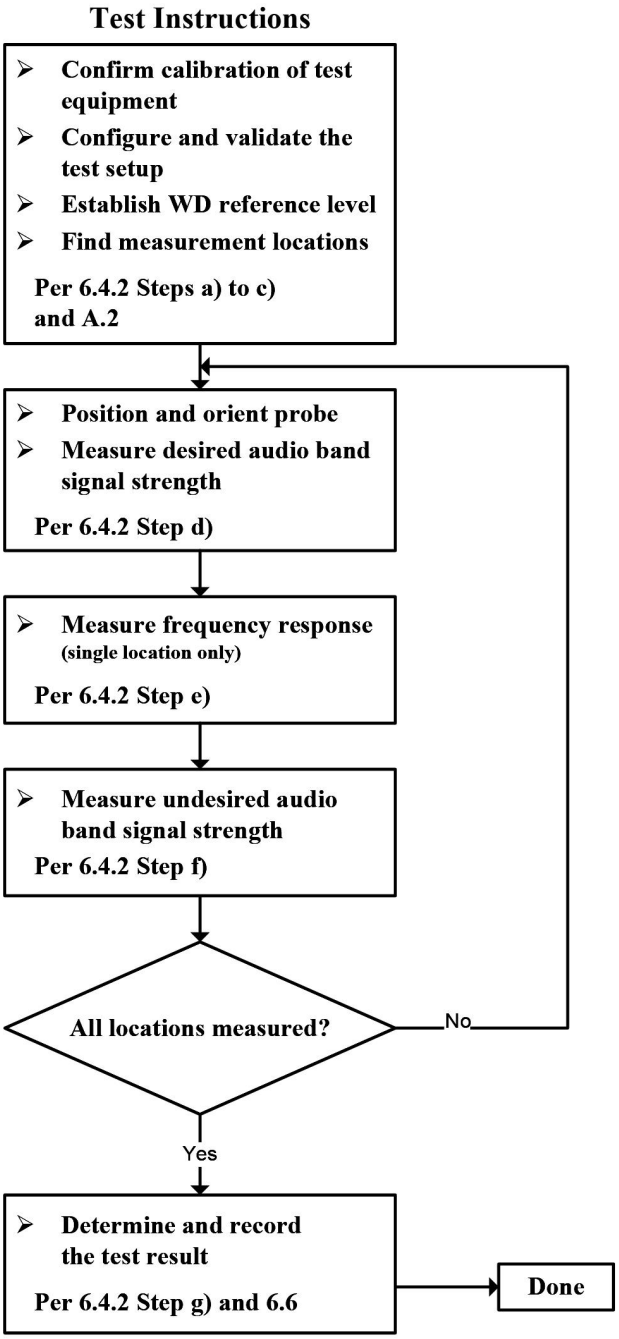
Test flow for T-Coil signal test



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The following steps summarize the basic test flow for determining desired ABM signal and undesired ABM field. These steps assume that a sine wave or narrowband 1/3 octave signal can be used for the measurement of desired ABM signal level. An alternative procedure, yielding equivalent results, using a broadband excitation is described in 6.5.

a) A validation of the test setup and instrumentation shall be performed. This may be done using a TMFS or Helmholtz Coil. Measure the emissions and confirm that they are within tolerance of the expected values.

b) Confirm that equipment that requires calibration has been calibrated, and that the noise level meets the requirements given in 6.3.2.

c) Position the WD in the test setup and connect the WD RF connector to a base station simulator or a non-radiating load (if necessary to control RF interference in the measurement equipment) as shown in Figure 6.1 or Figure 6.2.

d) The drive level to the WD is set such that the reference input level specified in Table 6.1 is input to the base station simulator (or manufacturer's test mode equivalent) in the 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (desired ABM signal) at f = 1 kHz. Either a sine wave at 1025 Hz, or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as specified in 6.4.3, shall be used for the reference audio signal. If interference is found at 1025 Hz an alternative nearby reference audio signal frequency may be used.35 The same drive level will be used for the desired ABM signal frequency response measurements at each 1/3 octave band center frequency. The WD volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.

e) At each measurement location over the measurement area and in the transverse orientation, measure and record the desired 1 kHz T-Coil magnetic signal (desired ABM signal) as described in Step c).

f) At or near a location representing a maximum in the just-measured desired ABM signal, measure and record the desired T-Coil magnetic signals (desired ABM signal at f_i) as described in 6.4.5.2 in each individual ISO 266:1975 R10 standard 1/3 octave band. The desired audio band input frequency (f_i) shall be centered in each 1/3 octave band maintaining the same drive level as determined in Step c), and the reading taken for that band.

Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input–output comparison using simulated speech. The full-band integrated or half-band integrated probe output, as described in D.9, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB(A/m).) Compare the frequency response found to the requirements of 6.6.3.

g) At the same locations measured in Step d), measure and record the undesired broadband audio magnetic signal (undesired ABM field) with no audio signal applied (or digital zero applied, if appropriate) using the specified spectral weighting, the half-band integrator followed by the temporal weighting.

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

i) Calculate and record the location and number of the measurement points that satisfy the maximum undesired ABM field level and distribution requirements specified in 6.6.4.

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7. Max. Conducted RF Output Power

2G

Mode: GSM850	Maximum Tune-up(dBm)	Burst Average Power (dBm)		
		CH128	CH190	CH251
		824.2MHz	836.6MHz	848.8MHz
GSM	**33.00**	**32.57**	32.41	32.30
Mode: GSM1900	**Maximum Tune-up(dBm)**	**Burst Average Power (dBm)**		
		CH512	CH661	CH810
		1850.2MHz	1880.0MHz	1909.8MHz
GSM	**30.00**	**29.91**	29.74	29.67

3G

Mode	Maximum Tune-up(dBm)	WCDMA Band II		
		Conducted Power (dBm)		
		CH9262	CH9400	CH9538
		1852.4	1880.0	1907.6
RMC 12.2K	**22.00**	**21.78**	21.56	21.61
Mode	Maximum Tune-up(dBm)	WCDMA Band IV		
		Conducted Power (dBm)		
		CH1312	CH1413	CH1513
		1712.4	1732.6	1752.6
RMC 12.2K	**23.00**	**22.76**	22.71	22.52
Mode	Maximum Tune-up(dBm)	WCDMA Band V		
		Conducted Power (dBm)		
		CH4132	CH4183	CH4233
		826.4	836.6	846.6
RMC 12.2K	**23.00**	22.66	22.72	**22.77**

4G

Band 2

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	18700	18900	19100
					1860.0MHz	1880.0MHz	1900.0MHz
20MHz	QPSK	1	0	**23.50**	**23.34**	22.95	23.18
			50	23.50	23.16	22.92	23.17
			99	23.50	23.15	23.05	23.19
		50	0	22.50	22.02	22.05	22.03
			25	22.50	22.07	21.95	21.93
			50	22.50	**22.08**	21.90	22.11
		100	0	22.50	22.17	21.99	22.12
	16QAM	1	0	23.50	22.82	23.23	22.79
			50	23.50	22.58	23.20	22.80
			99	23.50	22.53	23.18	22.89
		50	0	21.50	21.35	21.00	21.14
			25	21.50	21.23	21.00	21.16
			50	21.50	21.21	21.09	21.26
		100	0	21.50	21.22	21.13	21.14

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Band 4

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	20050	20175	20300
					1720.0MHz	1732.5MHz	1745.0MHz
20MHz	QPSK	1	0	24.50	24.20	24.04	24.16
			50	24.50	24.18	24.05	24.09
			99	**24.50**	**24.21**	23.99	24.12
		50	0	23.50	**23.14**	23.11	23.02
			25	23.50	22.98	23.12	22.91
			50	23.50	23.08	23.12	22.90
		100	0	23.50	23.10	23.16	22.84
	16QAM	1	0	24.50	23.60	24.15	23.31
			50	24.00	23.62	23.94	23.21
			99	24.00	23.64	23.97	23.22
		50	0	22.50	22.25	22.14	22.02
			25	22.50	22.20	22.20	21.97
			50	22.50	22.23	22.21	22.03
		100	0	22.50	22.08	22.23	21.94

Band 5

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	20450	20525	20600
					829.0MHz	836.5MHz	844.0MHz
10MHz	QPSK	1	0	**24.50**	23.85	**24.08**	24.02
			25	24.50	24.02	23.97	23.97
			49	24.50	24.04	24.06	23.97
		25	0	23.50	23.07	**23.24**	23.12
			13	23.50	23.01	22.97	23.01
			25	23.50	23.05	23.15	23.13
		50	0	23.50	23.07	23.01	23.00
	16QAM	1	0	24.50	23.67	23.50	24.26
			25	24.50	23.69	23.37	24.13
			49	24.50	23.90	23.44	24.15
		25	0	22.50	22.35	22.29	22.11
			13	22.50	22.10	22.25	22.07
			25	22.50	22.05	22.36	22.23
		50	0	22.50	22.20	22.02	22.05

Band 12

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	23060	23095	23130
					704.0MHz	707.5MHz	711.0MHz
10MHz	QPSK	1	0	23.50	23.18	23.17	23.18
			25	23.50	23.24	23.18	23.31
			49	**23.50**	23.30	23.36	**23.46**
		25	0	22.50	22.12	22.36	22.33
			13	22.50	22.12	22.26	22.37
			25	22.50	22.26	22.45	**22.48**
		50	0	22.50	22.21	22.25	22.33
	16QAM	1	0	23.50	22.76	23.01	22.46
			25	23.50	22.68	23.20	22.60
			49	23.50	22.88	23.25	22.61
		25	0	21.50	21.23	21.31	21.32
			13	22.00	21.37	21.26	21.60
			25	22.00	21.28	21.54	21.74
		50	0	21.50	21.36	21.23	21.45

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Band 13

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	23230
					782.0MHz
10MHz	QPSK	1	0	**24.00**	**23.70**
			25	24.00	23.61
			49	24.00	23.63
		25	0	23.00	22.77
			13	23.00	**22.80**
			25	23.00	22.69
		50	0	23.00	22.59
	16QAM	1	0	23.50	23.46
			25	23.50	23.41
			49	23.50	23.34
		25	0	22.00	21.74
			13	22.00	21.76
			25	22.00	21.74
		50	0	22.00	21.80

Band 25

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	26140	26365	26590
					1860.0MHz	1882.5MHz	1905.0MHz
20MHz	QPSK	1	0	**23.50**	**23.31**	23.06	23.24
			50	23.50	23.20	23.07	23.19
			99	23.50	23.25	23.08	23.12
		50	0	22.50	22.12	22.08	22.01
			25	22.50	**22.17**	22.04	21.96
			50	22.50	21.99	22.20	22.22
		100	0	22.50	22.13	22.13	22.15
	16QAM	1	0	23.50	22.76	23.28	22.85
			50	23.50	22.71	23.35	22.90
			99	23.50	22.73	23.26	22.84
		50	0	21.50	21.30	21.15	21.25
			25	21.50	21.27	21.11	21.19
			50	21.50	21.19	21.25	21.28
		100	0	21.50	21.18	21.13	21.22

Band 26

LTE-TDD Band 26				Maximum Tune-up(dBm)	Conducted Power(dBm)		
Bandwidth	Modulation	RB allocation	RB offset		26865	26915	26965
					831.5MHz	836.5MHz	841.5MHz
15MHz	QPSK	1	0	24.50	23.87	23.92	24.08
			38	24.50	23.98	23.98	24.15
			74	**24.50**	**24.22**	24.05	24.11
		36	0	23.50	**23.10**	23.12	23.14
			18	23.50	23.09	23.02	23.09
			39	23.50	23.03	23.09	23.21
		75	0	23.50	23.07	23.13	23.16
	16QAM	1	0	24.50	23.71	23.78	24.03
			38	24.50	24.27	24.00	24.09
			74	24.50	23.72	24.32	24.07
		36	0	22.50	21.95	22.06	22.17
			18	22.50	22.09	22.19	22.33
			39	22.50	22.08	22.30	22.30
		75	0	22.50	22.14	22.10	22.28

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Band 41

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	40290	40690	41090
					2560.0MHz	2600.0MHz	2640.0MHz
20MHz	QPSK	1	0	22.50	21.32	21.94	22.20
			50	22.50	21.38	22.12	22.16
			99	**22.50**	21.56	22.07	**22.32**
		50	0	21.50	20.47	20.81	21.27
			25	21.50	20.53	20.90	**21.35**
			50	21.50	20.60	20.82	21.29
		100	0	21.50	20.52	20.97	21.42
	16QAM	1	0	21.00	20.56	20.62	20.54
			50	21.50	20.82	21.15	20.47
			99	21.50	20.90	21.28	20.57
		50	0	20.50	19.45	20.09	20.40
			25	21.00	19.70	20.06	20.62
			50	20.50	19.73	20.11	20.44
		100	0	20.50	19.62	19.91	20.47

Band 66

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	132072	132322	132572
					1720.0MHz	1745.0MHz	1770.0MHz
20MHz	QPSK	1	0	**23.00**	**22.70**	22.48	22.41
			50	23.00	22.65	22.45	22.21
			99	23.00	22.67	22.60	22.20
		50	0	22.00	21.58	21.50	21.23
			25	22.00	**21.65**	21.50	21.05
			50	22.00	21.60	21.37	21.06
		100	0	22.00	21.64	21.51	21.10
	16QAM	1	0	22.50	22.04	21.96	21.74
			50	22.50	22.09	21.87	21.55
			99	22.00	21.93	21.93	21.57
		50	0	21.00	20.85	20.58	20.34
			25	21.00	20.79	20.62	20.18
			50	21.00	20.79	20.49	20.28
		100	0	21.00	20.75	20.60	20.18

Band 71

Bandwidth	Modulation	RB allocation	RB offset	Maximum Tune-up(dBm)	133222	133322	133372
					673.0MHz	683.0MHz	688.0MHz
20MHz	QPSK	1	0	22.00	21.45	21.59	21.48
			50	22.00	21.49	21.65	21.65
			99	**22.00**	21.59	21.77	**21.82**
		50	0	21.00	20.72	20.50	20.72
			25	21.00	20.57	20.67	20.73
			50	21.00	20.61	20.68	**20.93**
		100	0	21.00	20.75	20.78	20.64
	16QAM	1	0	21.50	20.57	20.96	21.01
			50	21.50	20.63	21.02	21.30
			99	21.50	20.64	21.31	21.17
		50	0	20.00	19.58	19.60	19.48
			25	20.50	20.35	19.75	20.24
			50	20.50	19.79	20.39	19.85
		100	0	20.50	20.24	19.76	20.24

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2.4G

Band (GHz)	Mode	Channel	Freq. (MHz)	Average Power (dBm)	Maximum Tune-up(dBm)
2.4g Wifi (2.4~2.4835)	802.11b	1	2412	11.89	12.00
		6	2437	**12.17**	**12.50**
		11	2462	12.08	12.50
	802.11g	1	2412	11.51	12.00
		6	2437	11.40	11.50
		11	2462	11.41	11.50
	802.11n(HT20)	1	2412	11.54	12.00
		6	2437	11.91	12.00
		11	2462	11.74	12.00

Bluetooth

	Mode	Maximum Tune-up(dBm)	Average Conducted Output Power (dBm)		
EDR			0	39	78
			2402MHz	2441MHz	2480MHz
	GFSK	**6.50**	**6.02**	5.00	4.09
	π/4QPSK	6.00	5.55	5.14	4.47
	8DPSK	6.00	5.84	5.60	4.72
BLE	Mode	Maximum Tune-up(dBm)	Average Conducted Output Power (dBm)		
			0	20	39
			2402MHz	2440MHz	2480MHz
	1Mbps	-0.50	-3.05	-0.73	-1.23

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8. T-Coil Test Result

General Note:

1.Phone Condition:Mute on; Backlight off; Max Volume

2. 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.

3. Air Interface Investigation:

a. Through Internal radio configuration investigation (e.g.bandwidth, modulation data rate, subcarrier spacings, and resource blocks) that the worst radio configuration was document as below table.

b. Use the worst-case codec test and document a limited set of bands/channel/bandwidths.

c. According to the ANSI C63.19-2019 section 6.3.3, using a frequency near the center of the frequency band perform T-coil evaluation.

<GSM Evaluation Results>

Codec Investigation							
Codec	**AMR NB Full Rate**	**AMR NB Full Rate**	**AMR WB Full Rate**	**AMR WB Full Rate**	**EFR NB (FR V2)**	**Orientation**	**Band/Channel**
Bit rate	**4.75 Kbps**	**12.2 Kbps**	**6.6 Kbps**	**12.65 Kbps**	**12.2Kbps**		
Primary Group Contiguous Point Count	122	**111**	130	118	145	Transversal(Y)	GSM 850/190
Secondary Group Contiguous Point Count	495	**436**	487	466	501		
Secondary Group Max Longitudinal	20	18	25	25	26		
Secondary Group Max Transverse	26	26	26	26	26		
Frequency response	Pass	Pass	Pass	Pass	Pass		
Note: The bold data represents the worst case.							

<WCDMA Evaluation Results>

Codec Investigation						
Codec	**NB AMR**	**WB AMR**	**NB AMR**	**WB AMR**	**Orientation**	**Band/Channel**
Bit rate	**4.75 Kbps**	**6.60 Kbps**	**12.2 Kbps**	**23.85Kbps**		
Primary Group Contiguous Point Count	**229**	272	254	260	Transversal(Y)	WCDMA Band V/4183
Secondary Group Contiguous Point Count	**553**	579	588	596		
Secondary Group Max Longitudinal	25	26	26	26		
Secondary Group Max Transverse	26	26	26	26		
Frequency response	Pass	Pass	Pass	Pass		
Note: The bold data represents the worst case.						

<VoLTE Evaluation Results>

Codec Investigation						
Codec	**NB AMR**	**WB AMR**	**NB AMR**	**WB AMR**	**Orientation**	**Band/Channel**
Bit rate	**4.75 Kbps**	**6.60 Kbps**	**12.2 Kbps**	**23.85Kbps**		
Primary Group Contiguous Point Count	**255**	264	281	273	Transversal(Y)	LTE Band 41/40690
Secondary Group Contiguous Point Count	**576**	605	676	676		
Secondary Group Max Longitudinal	26	25	26	26		
Secondary Group Max Transverse	26	26	26	26		
Frequency response	Pass	Pass	Pass	Pass		
Note: The bold data represents the worst case.						

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Air Interface Investigation												
Plot No.	Mode	Channel/Freq.	BW	Probe Position	Modulation /Mode	Primary Group Contiguous Point Count	Secondary Grour Contiguous Point Count	Secondary Group Max Longitudinal	Secondary Group Max Transverse	Freq. Response Variation (dB)	Ambient Noise (dB A/m)	Frequency Response
1	GSM850	190/836.6MHz	/	Transversal (Y)	Voice	**111**	**436**	18	26	1.64	-50.03	Pass
2	PCS1900	661/1880.0MHz	/	Transversal (Y)	Voice	127	477	20	26	1.70	-50.12	Pass
3	WCDMA Band II	9400/1880.0MHz	/	Transversal (Y)	Voice	274	590	26	26	1.56	-50.11	Pass
4	WCDMA Band IV	1413/1732.6MHz	/	Transversal (Y)	Voice	236	584	25	26	1.52	-50.03	Pass
5	WCDMA Band V	4183/836.6MHz	/	Transversal (Y)	Voice	**229**	**553**	25	26	1.51	-50.07	Pass
6	LTE FDD Band 2	18900/1880MHz	20MHz_QPSK_1_99	Transversal (Y)	Voice	267	605	26	26	1.60	-50.44	Pass
7	LTE FDD Band 4	20175/1732.5MHz	20MHz_QPSK_1_50	Transversal (Y)	Voice	259	599	25	26	1.57	-50.61	Pass
8	LTE FDD Band 5	20525/836.5MHz	10MHz_QPSK_1_0	Transversal (Y)	Voice	278	612	26	26	1.48	-50.33	Pass
9	LTE FDD Band 12	23095/707.5MHz	10MHz_QPSK_1_49	Transversal (Y)	Voice	263	603	26	26	1.49	-50.07	Pass
10	LTE FDD Band 13	23230/782.0MHz	10MHz_QPSK_1_0	Transversal (Y)	Voice	270	637	26	26	1.50	-50.68	Pass
11	LTE FDD Band 25	26365/1882.5MHz	20MHz_QPSK_1_99	Transversal (Y)	Voice	269	622	26	26	1.52	-50.27	Pass
12	LTE FDD Band 26	26865/831.5MHz	10MHz_QPSK_1_49	Transversal (Y)	Voice	276	676	26	26	1.56	-50.14	Pass
13	LTE TDD Band 41	40690/2600MHz	20MHz_QPSK_1_50	Transversal (Y)	Voice	**255**	**576**	25	26	1.52	-49.87	Pass
14	LTE FDD Band 66	132322/1745MHz	20MHz_QPSK_1_99	Transversal (Y)	Voice	274	676	26	26	1.60	-50.42	Pass
15	LTE FDD Band 71	133322/683.0MHz	20MHz_QPSK_1_99	Transversal (Y)	Voice	277	676	26	26	1.63	-50.01	Pass

Remark:
1. There is special HAC mode software on this EUT.
2. The volume was adjusted to maximum level and the backlight turned off during T-Coil testing

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9. Test Equipment List

Description	Manufacturer	Model	Serial No./Version	Cal. Date	Cal. Due
PC	Dell	N/A	N/A	N/A	N/A
Test Software	MVG	N/A	OpenHAC V5.1.3	N/A	N/A
6 1/2 Multimeter	Keithley	DMM6500	4527164	2023/11/16	2024/11/15
Audio Card	National Instruments	NI PCI-4461	01C4B4EB	N/A	N/A
WIDEBAND RADIO COMMUNICATION T ESTER	ROHDE&SCHWARZ	CMW500	161997	2023/11/16	2024/11/15
COMOHAC T-Coil Probe	MVG	STCOIL	07/17 TCP38	2024/02/06	2025/02/05
TMFS	MVG	STMFS	SN 13/22 TMFS30	N/A	N/A
Antenna network emulator	MVG	ANTA 74	07/22 ANTA 74	/	/

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ANNEX A Test Data

Measurement at GSM850

Date of measurement: 31/5/2024

Experimental Conditions

Probe	SN_0717_TCP38
Signal	GSM
Band	GSM850
Channels	Middle
Channels Number	190
Frequency (MHz)	836.6

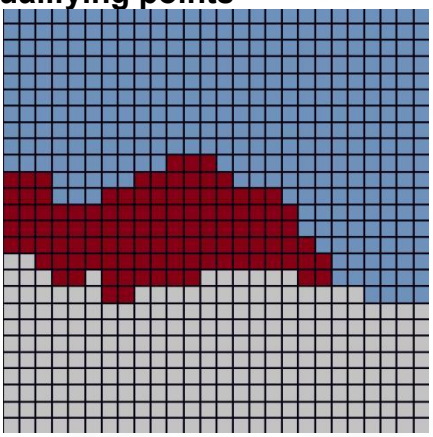
Results

Device compliant	Yes
Measurement status	Complete

Requirement verification

C63.19	Mode	Band	Test Description	Minimum limit	Measured	Verdict
7.3.1.1	GSM	GSM850	Primary group size	25	111	PASS
7.3.1.2			Secondary group size	125	436	PASS
7.3.1.3			Secondary Group Max Longitudinal	-	18	PASS
7.3.1.4			Secondary Group Max Transverse	-	26	PASS
7.3.2			Frequency response inside boundaries	-	1.70	PASS

Qualifying points



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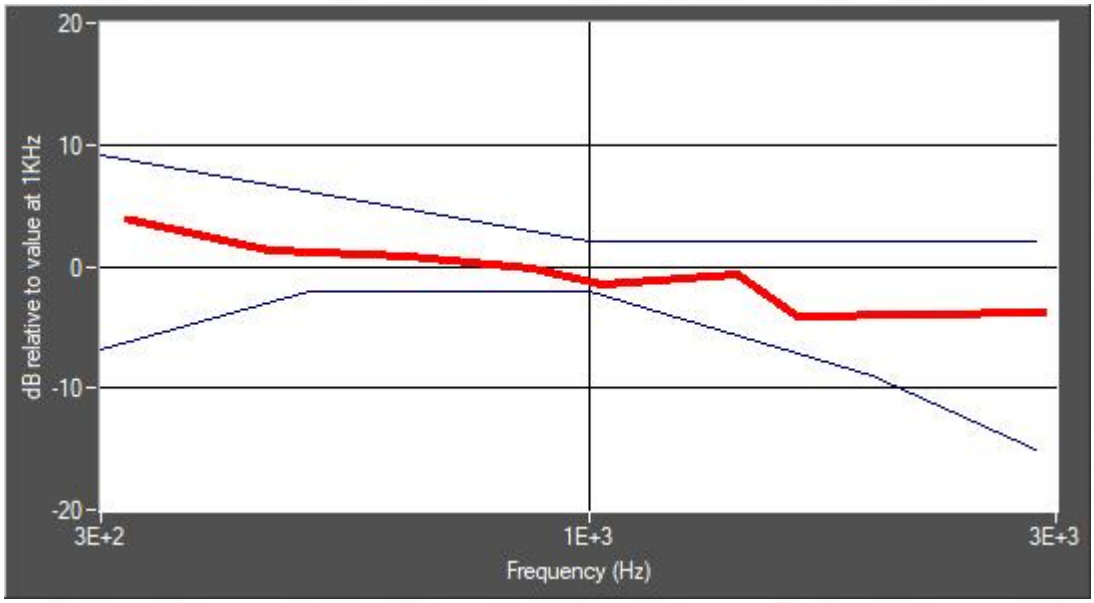
Frequency response（field that exceeds -15 dB）



Measurement at WCDMA Band 5 (850)

Date of measurement: 3/6/2024

Experimental Conditions

Probe	SN_0717_TCP38
Signal	W-CDMA
Band	Band 5 (850)
Channels	Middle
Channels Number	4183
Frequency (MHz)	836.6

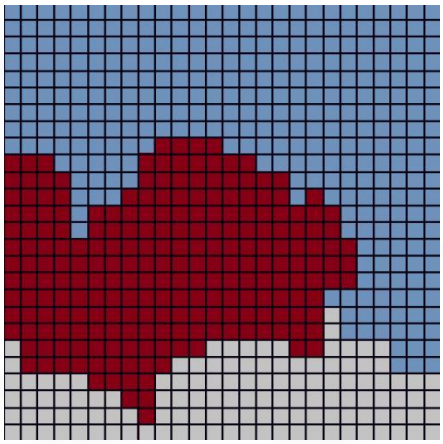
Results

Device compliant	Yes
Measurement status	Complete

Requirement verification

C63.19	Mode	Band	Test Description	Minimum limit	Measured	Verdict
7.3.1.1	WCDMA	Band5_WCDMA850	Primary group size	75	229	PASS
7.3.1.2			Secondary group size	300	553	PASS
7.3.1.3			Secondary Group Max Longitudinal	10	25	PASS
7.3.1.4			Secondary Group Max Transverse	15	26	PASS
7.3.2			Frequency response inside boundaries	-	1.51	PASS

Qualifying points



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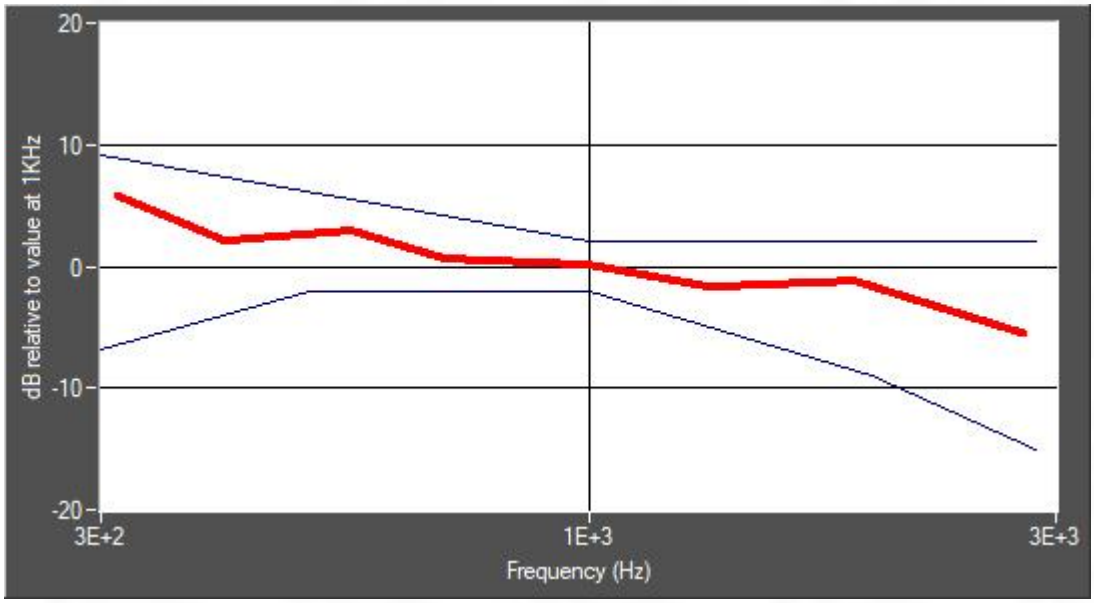
Frequency response（field that exceeds -15 dB）



Measurement at LTE Band 41

Date of measurement: 4/6/2024

Experimental Conditions

Probe	SN_0717_TCP38
Signal	LTE TDD
Band	LTE band 41
Channels	Middle
Channels Number	40690
Frequency (MHz)	2600.0

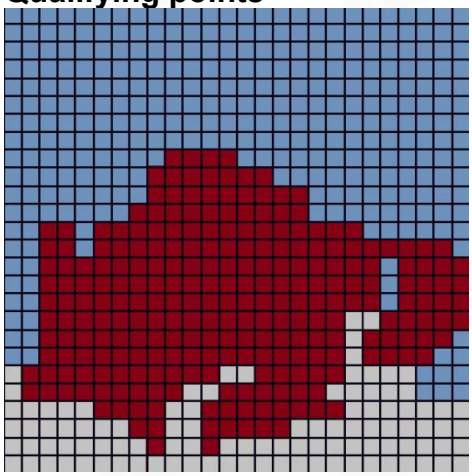
Results

Device compliant	Yes
Measurement status	Complete

Requirement verification

C63.19	Mode	Band	Test Description	Minimum limit	Measured	Verdict
7.3.1.1	LTE	LTE TDD band 41	Primary group size	75	255	PASS
7.3.1.2			Secondary group size	300	576	PASS
7.3.1.3			Secondary Group Max Longitudinal	10	25	PASS
7.3.1.4			Secondary Group Max Transverse	15	26	PASS
7.3.2			Frequency response inside boundaries	-	1.52	PASS

Qualifying points



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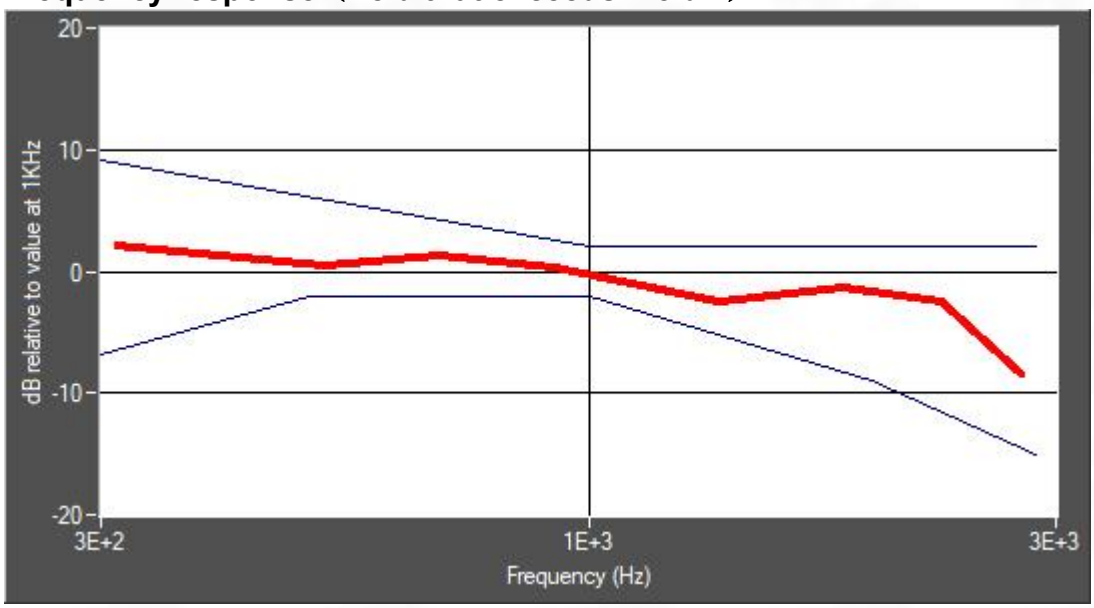
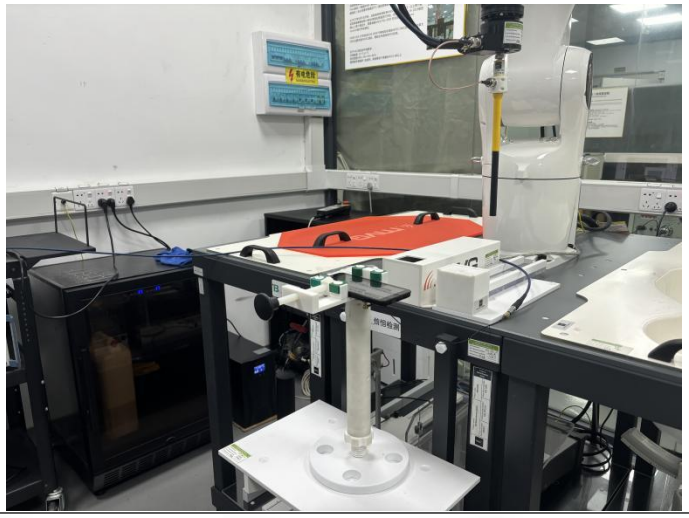
Frequency response（field that exceeds -15 dB）



ANNEX B Test Setup Photo

Reference Photo


ANNEX C EUT External & Internal Photos

Please refer to RF Report.

ANNEX D Calibration Information

Please refer to the document “Calibration.pdf”.

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