Hearing Aid Compatibility (HAC) T-Coil Test Report

APPLICANT	:	Nubia Technology Co., Ltd.
PRODUCT NAME	:	5G Mobile Phone
MODEL NAME	:	NX679J
BRAND NAME	:	REDMAGIC
FCC ID	:	2AHJO-NX679J
STANDARD(S)	:	FCC 47CFR Part 20(20.19) ANSI C63.19-2011
RECEIPT DATE	:	2021-10-22
TEST DATE	:	2021-12-23 to 2022-02-09
ISSUE DATE	:	2022-03-31

Edited by: Gan Yueming (Rapporteur)

Approved by: Shen Junsheng (Supervisor)

NOTE: This document is issued by Shenzhen Morlab Communications Technology Co., Ltd., the test report shall not be reproduced except in full without prior written permission of the company. The test results apply only to the particular sample(s) tested and to the specific tests carried out which is available on request for validation and information confirmed at our website.

MORLAB
Shenzhen Morlab Communications Technology Co., Ltd.
FL1-3, Building A, FeiYang Science Park, No.8 LongChang Road,
Block67, BaoAn District, ShenZhen , GuangDong Province, P. R. China
Tel: 86-755-36698555 Fax: 86-755-36698525
Http://www.morlab.cn E-mail: service@morlab.cn

DIRECTORY

1. Attestation of Testing Summary 4
2. Technical Information 5
2.1. Applicant and Manufacturer Information 5
2.2. Equipment under Test (EUT) Description 5
2.3. Photographs of the EUT 7
2.4. Applied Reference Documents 7
3. Air Interface and Operating Mode 8
4. Measurement standards for T-Coil 10
4.1. T-Coil Signal Quality Categories 10
4.2. Frequency Response 10
5. HAC (T-Coil) Measurement System 12
5.1. T-Coil Measurement Setup 12
5.2. System Validation 13
5.3. Base Station Gain Factor 14
6. T-Coil Measurement Procedure 16
6.1. General Guidance 16
6.2. T-Coil Test Flow 18
6.3. Information of EUT Test Position 19
7. Test Equipment List 20
8. T-Coil Testing for CMRS Voice 21
8.1. Test Guidance 21
8.2. Test Results 21
9. T-Coil Testing for CMRS IP Voice 23
9.1. T-Coil Testing for VoLTE 23
9.2. T-Coil Testing for VoWi-Fi 25
10. Uncertainty Assessment 27

Annex A General Information·····28

Change History		
Version	**Date**	**Reason for Change**
1.0	2022-03-31	First edition

1. Attestation of Testing Summary

Air Interface	Frequency Band	T-Rating	Frequency Response	Magnetic Intensity
GSM CMRS Voice	GSM850	T4	PASS	PASS
	GSM1900	T4	PASS	PASS
UMTS CMRS Voice	Band II	T4	PASS	PASS
	Band IV	T4	PASS	PASS
	Band V	T4	PASS	PASS
VoLTE	Band 2	T4	PASS	PASS
	Band 4	T4	PASS	PASS
	Band 5	T4	PASS	PASS
	Band 7	T3	PASS	PASS
	Band 12	T4	PASS	PASS
	Band 17	T4	PASS	PASS
	Band 18	T4	PASS	PASS
	Band 19	T4	PASS	PASS
	Band 26	T4	PASS	PASS
	Band 38	T3	PASS	PASS
	Band 40A	T3	PASS	PASS
	Band 40B	T3	PASS	PASS
	Band 41	T3	PASS	PASS
	Band 66	T3	PASS	PASS
VoWi-Fi	2.4GHz	T4	PASS	PASS
	5GHz	T4	PASS	PASS

Note:

1. It is compliance with HAC limits for this device that specified in FCC 47 CFR Part 20(20.19) and ANSI C63.19.
2. When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.

2. Technical Information

Note: Provide by applicant.

2.1. Applicant and Manufacturer Information

Applicant:	Nubia Technology Co., Ltd.
Applicant Address:	Room 1801, Building 2, Chongwen Park, Nanshan Zhiyuan, No.3370, Liuxian Rd, Nanshan District, Shenzhen City, Guangdong Province, P. R. China
Manufacturer:	Nubia Technology Co., Ltd.
Manufacturer Address:	Room 1801, Building 2, Chongwen Park, Nanshan Zhiyuan, No.3370, Liuxian Rd, Nanshan District, Shenzhen City, Guangdong Province, P. R. China

2.2. Equipment under Test (EUT) Description

Product Name:	5G Mobile Phone
EUT IMEI:	869351050017257 / 00
Hardware Version:	NX679J_V1AMB
Software Version:	NX679J_UNCommon_V4.01
Frequency Bands:	GSM 850: 824 MHz ~ 849 MHz GSM 1900: 1850 MHz ~ 1910 MHz WCDMA Band II: 1850 MHz ~ 1910 MHz WCDMA Band IV: 1710 MHz ~ 1755 MHz WCDMA Band V: 824 MHz ~ 849 MHz CDMA2000 BC0: 824 MHz ~ 849 MHz CDMA2000 BC1: 1850 MHz ~ 1910 MHz LTE Band 2: 1850 MHz ~ 1910 MHz LTE Band 4: 1710 MHz ~ 1755 MHz LTE Band 5: 824 MHz ~ 849 MHz LTE Band 7: 2500 MHz ~ 2570 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 17: 704 MHz ~ 716 MHz LTE Band 18: 815 MHz ~ 830 MHz LTE Band 19: 830 MHz ~ 845 MHz LTE Band 26: 814 MHz ~ 849 MHz LTE Band 38: 2570 MHz ~ 2620 MHz

	LTE Band 40A: 2305 MHz ~ 2315 MHz LTE Band 40B: 2350 MHz ~ 2360 MHz LTE Band 41: 2496 MHz ~ 2690 MHz LTE Band 66: 1710 MHz ~ 1780 MHz 5G NR n41: 2496 MHz ~ 2690 MHz 5G NR n77: 3700 MHz ~ 3980 MHz 5G NR n78: 3700 MHz ~ 3800 MHz WLAN 2.4GHz: 2412 MHz ~ 2462 MHz WLAN 5.2GHz: 5180 MHz ~ 5240 MHz WLAN 5.3GHz: 5260 MHz ~ 5320 MHz WLAN 5.6GHz: 5500 MHz ~ 5720 MHz WLAN 5.8GHz: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz NFC: 13.56 MHz
Modulation Mode:	GSM/GPRS: GMSK EDGE: 8PSK WCDMA: QPSK, 16QAM CDMA2000 1xRTT: BPSK,QPSK LTE: QPSK, 16QAM, 64QAM 5G NR: DFT-s-OFDM/CP-OFDM, PI/2 BPSK QPSK, 16QAM, 64QAM, 256QAM 802.11b: DSSS 802.11a/g/n-HT20/HT40/ac-VHT20/40/80: OFDM 802.11ax-HEW20/40/80: OFDMA BR+EDR: GFSK(1Mbps), π/4-DQPSK(2Mbps), 8-DPSK(3Mbps) Bluetooth LE: GFSK(1Mbps) NFC: ASK
VoLTE Mode:	Support
VoWi-Fi Mode:	Support
SIM Cards Description:	GSM+WCDMA+CDMA2000+LTE+5G NR

Note:

For more detailed description, please refer to specification or user manual supplied by the applicant and/or manufacturer.

2.3. Photographs of the EUT

Please refer to the External Photos for the Photos of the EUT

2.4. Applied Reference Documents

Leading reference documents for testing:

No.	Identity	Document Title	Method determination Remark
1	FCC 47 CFR Part 20(20.19)	Hearing aid-compatible mobile handsets.	No deviation
2	ANSI C63.19-2011	American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids	No deviation
3	KDB 285076 D01v05	HAC Guidance	No deviation
4	KDB 285076 D02v01r01	T-Coil testing for CMRS IP	No deviation

Note 1: The test item is not applicable.
Note 2: Additions to, deviation, or exclusions from the method shall be judged in the "method determination" column of add, deviate or exclude from the specific method shall be explained in the "Remark" of the above table.

3. Air Interface and Operating Mode

Air Interface	Band	Transport Type	Simultaneous Transmitter	Name of Voice Service	Power Reduction
GSM	GSM850	VO	Wi-Fi & BT	CMRS Voice	No
	GSM1900				No
WCDMA (UMTS)	Band II	VO	Wi-Fi & BT	CMRS Voice	No
	Band IV				No
	Band V				No
CDMA2000	BC0	VO	Wi-Fi & BT	CMRS Voice	No
	BC1				No
LTE	Band 2	VD	Wi-Fi & BT	VoLTE	No
	Band 4				No
	Band 5				No
	Band 7				No
	Band 12				No
	Band 17				No
	Band 18				No
	Band 19				No
	Band 26				No
	Band 38				No
	Band 40A				No
	Band 40B				No
	Band 41				No
	Band 66				No
5G NR	n41	DT	Wi-Fi & BT	N/A	No
	n77				No
	n78				No
Wi-Fi	2450	DT	GSM,UMTS, CDMA2000 LTE	Wi-Fi Calling	No
	5200 (U-NII-1)				No
	5300 (U-NII-2A)				No
	5500 (U-NII-2C)				No
	5800 (U-NII-3)				No
BT	2450	DT	GSM,UMTS, CDMA2000 LTE	N/A	No

Where:
VO=Voice Only
DT=Digital Transport only
VD=CMRS and IP Voice Service over Digital Transport
BT=Bluetooth
* Ref Lev in accordance with 7.4.2.1 of ANSI C63.19-2011 and the July 2012 VoLTE interpretation
** Ref Lev −20 dBm0
*** Ref Lev XYNet established by KDB Inquiry NNNNNN @ −16 dBm0

Note:

1) **Air Interface/Band MHz:** List of all air interfaces and bands supported by the handset.
2) **Type: For each air interface, indicate the type of voice transport mode:**
   i. VO = legacy Cellular Voice Service, from Table 7.1 in 7.4.2.1 of ANSI C63.19-2011;
   ii. DT = Digital Transport only (no voice); and
   iii. VD = IP Voice Service over Digital Transport.
3) **Simultaneous Transmitter:** Indicate any air interface/bands that operate in simultaneous or concurrent service transmission mode**.**
4) **Name of Voice Service:** See Q4 in 285076 D03 HAC FAQ for further clarification.

a) Ref Lev in accordance with 7.4.2.1 of ANSI C63.19-2011 and the July 2012 VoLTE interpretation
b) ** Ref Lev −20 dBm0
c) *** Ref Lev XY Net established by KDB Inquiry NNNNNN @ −16 dBm0

4. Measurement standards for T-Coil

4.1. T-Coil Signal Quality Categories

This sub clause specifies the signal-to-noise quality requirement for the intended T-Coil signal from a WD. The worst signal to noise of the two T-Coil signal measurements, as determined in Clause 7, shall be used to determine the T-Coil mode category per Table 2.1.

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 criterion that can be measured is the RF immunity in T-Coil mode. The RF measurements made for the T-Coil evaluation are used to assign the category T1 through T4. The limitation is given in Table 1. This establishes the RF environment presented by the WD to a hearing aid.

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

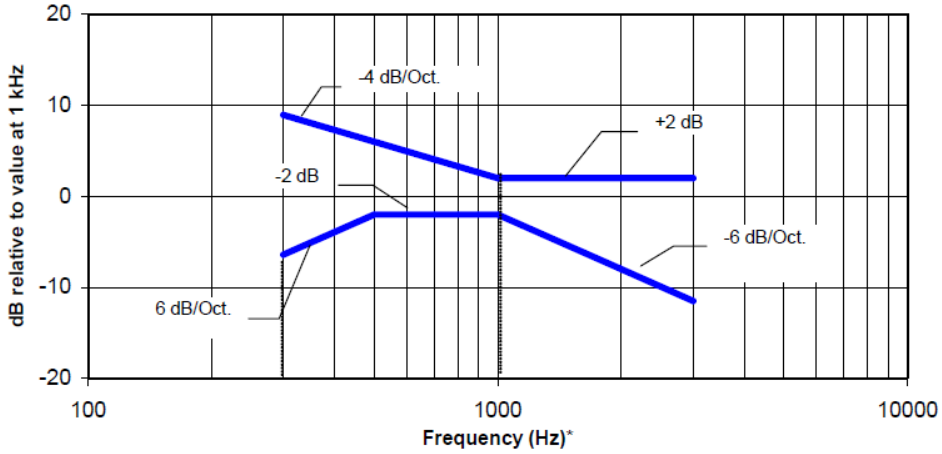
Table 4.1 T-Coil signal-to-noise categories

4.2. Frequency Response

This sub clause describes the relationship between the M rating, which is based on the RF emission tests performed in Clause 5, and the T rating, which is based on the T-Coil tests performed in Clause 7.

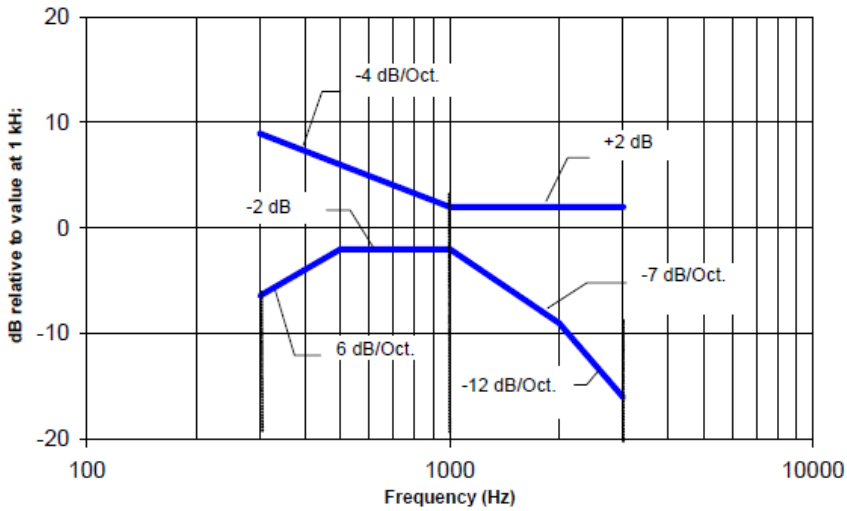
If the WD achieves an acceptable category rating per ANSI C63.19-2011 section 8.2, as determined by the appropriate regulating authority, it becomes a candidate for the T designation (see ANSI C63.19-2011 section 8.3.4).

The frequency response of the perpendicular 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.



NOTE—The frequency response is between 300 Hz and 3000 Hz.

Fig 4.1 Magnetic field frequency response for WDs with field strength ≤ –15 dB (A/m) at 1 kHz



NOTE—The frequency response is between 300 Hz and 3000 Hz.

Fig 4.2 Magnetic field frequency response for WDs with a field that exceeds –15 dB(A/m) at 1 kHz

5. HAC (T-Coil) Measurement System

5.1. T-Coil Measurement Setup

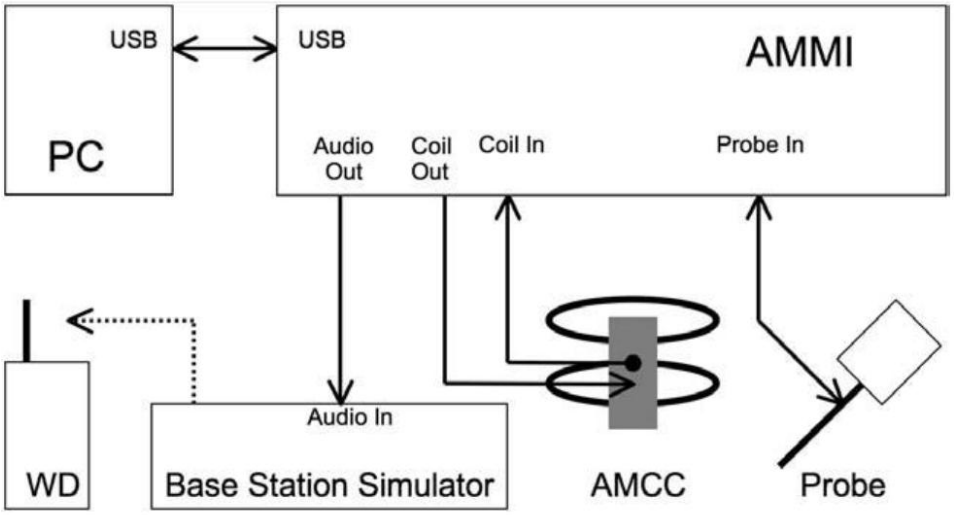


Fig 5.1 SPEAG T-Coil System Configurations

Note:

1、Per C63 & KDB 285076 D02v03, define the all applicable input audio level:

1) GSM input level: -16dBm0
2) UMTS input level: -16dBm0
3) VoLTE input level: -16dBm0
4) VoWiFi input level: -20dBm0
5) OTT Voip input level: -20dBm0

2、A communication base station CMU200 is used for testing GSM / UMTS / CDMA, and it's "Decode Cal" and "Codec Cal" with audio option B52 and B85 to set the correct audio input level.

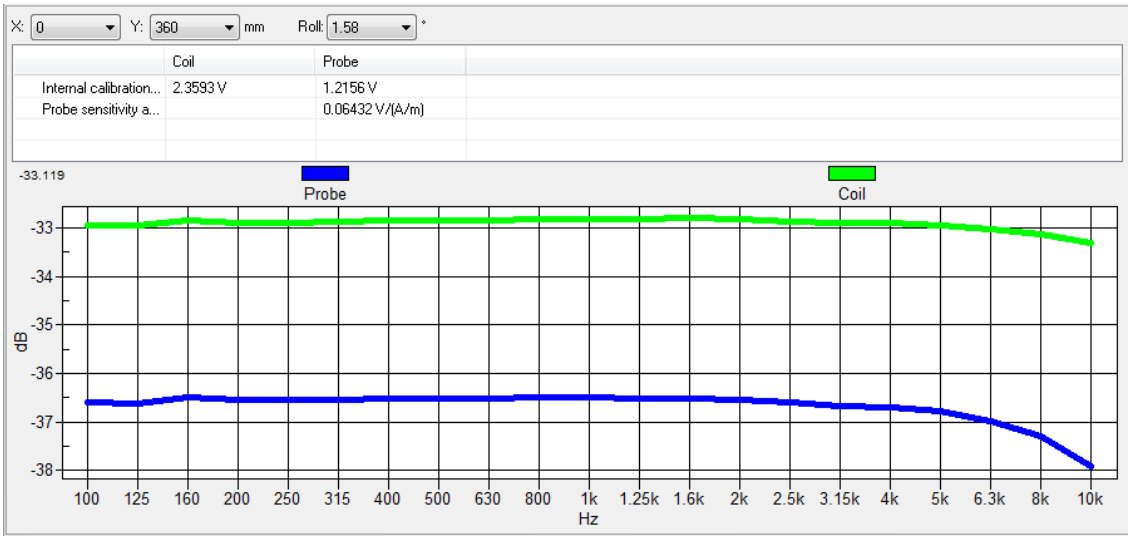
3、CMU200 is able to output 1KHz audio signal equivalent to 3.14dBm0 at "Decode Cal", the signal reference is used to adjust the AMMI gain setting to reach -16dBm0 for GSM/UMTS and -18dBm0 for CDMA.

4、The callbox of CMW500 is used for VoLTE over IMS and VoWiFi over IMS T-Coil measurement, the data application unit of the CMW500 was used to simulate the IP multimedia subsystem server. And the CMW500 can be manually configured to ensure and control the speech input level result is -16dBm0 for VoLTE and -20dBm0 for VoWiFi when the device during the IMS connection.

5.2. System Validation

For correct and calibrated measurement of the voltages and ABM filed, DASY will perform a calibration job follows below:

1. In phase 1, the audio output is switched off, and a 200 mW symmetric rectangular signal of 1 kHz is connected directly to both channels of the sampling unit(Coil in, Probe in).
2. In phase 2, the audio output is off, and a 20 mW 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 100mWRMS, during the second phase after the first two phases, the two input channels are both calibrated for absolute ants of voltages. The resulting factors are displayed above the multi-meter window.
3. 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.
4. In phase 3, a mulit-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 filed orientation of the AMCC. The "Coil In" channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic filed in the AMCC. At the same time, the "Probe In" channel samples the amplified signal picked up by the probe coil and provides a numerical integrator. The radio of 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 radio probe-to-coil at the frequency of 1KHz is the sensitivity which will be used in the consecutive T-coil jobs,.
5. The ABM validation during testing as below.



5.3. Base Station Gain Factor

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 calculation formula as below showing how to determine the input level for air interface for this 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.

CMU200 for GSM WCDMA

<Input level determination >

Gain Value	20* log(gain)	AMCC Coil in	Level
(linear)	dB	(dBv RMS)	dBm0
-	-	-2.44	3.14
10	20	-20.96	-15.38
9.31	19.38	-21.58	-16

<Base station gain factor calculation>

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz sine	-	3	0	1	8.17
48k_voice_1kHz	1	16.2	-12.7	4.33	40.32
48k_voice_300-3000	2	21.6	-18.6	8.48	78.96

CMU200 for CDMA

<Input level determination >

Gain Value	20* log(gain)	AMCC Coil in	Level
(linear)	dB	(dBv RMS)	dBm0
		-2.44	3.14
10	20	-20.96	-15.38
7.40	17.38	-23.58	-18

<Base station gain factor calculation>

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz sine	-	3	0	1	8.17
48k_voice_1kHz	1	16.2	-12.7	4.33	32.02
48k_voice_300-3000	2	21.6	-18.6	8.48	62.72

CMW500 for VoLTE

<Input level determination>

Gain Value	dBm	Full scal Voltage	dB	AMMI audio out (dBv) (RMS)	AMCC Coil Out (dBv) (RMS)
N/A	3.14	1.5	N/A	0.51	N/A
100	5.61	N/A	40	2.98	3.13
8.31	-16	N/A	18.39	N/A	-18.48

<Base station gain factor calculation>

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
48k_voice_1kHz	1	16.2	-12.7	4.33	35.98
48k_voice_300-3000	2	21.6	-18.6	8.48	70.46

6. T-Coil Measurement Procedure

6.1. General Guidance

T-Coil measurement follows 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 non-radiating load, there might still be RF leakage from the WD, which can interfere with the desired measurement. Pre-measurement 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.

Measurement shall be performed at two locations specified in ANSI C63.19-2011 A.3, with the correct probe orientation for a particular location, in a multistage sequence by first measuring the field intensity of the desired T-Coil signal the same location as the desired ABM or T-Coil signal (ABM1), and the ratio of desired to undesired magnetic components (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.

1) 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.
2) Position the WD in the test setup and connect the WD RF connector to a base station simulator or a non-radiating load. Confirm that equipment that requires calibration has been calibrated, and that the noise level meets the requirements given in ANSI C63.19-2011 clause 7.3.1.
3) The drive level to the WD ise set such that the reference input level specified in ANSI C63.19-2011 Table 7.1 is input to the base station simulator (or manufacturer's test mode equivalent) in 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 ANSI 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. 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.

4) Determine the magnetic measurement locations for the WD device (A.3), if not already specified by the manufacturer, as described in ANSI C63.19-2011 clause 7.4.4.1.1 and 7.4.4.2.
5) At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at fi) as described in ANSI C63.19-2011 clause 7.4.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency (fi) shall be centered in each 1/3 octave band maintaining the same drive level as determined in item 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 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.)
6) 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 ANSI C63.19-2011 clause 7.3.1.
7) At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in ANSI C63.19-2011 clause 7.4.4.4 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i,e., signal quality). Obtain the data from the postprocessor, SEMCAD, and determine the category that properly classifies the signal quality based on ANSI C63.19-2011 Table 8.5.

6.2. T-Coil Test Flow

This section follows ANSI C63.19-2011 section 7.4.1:

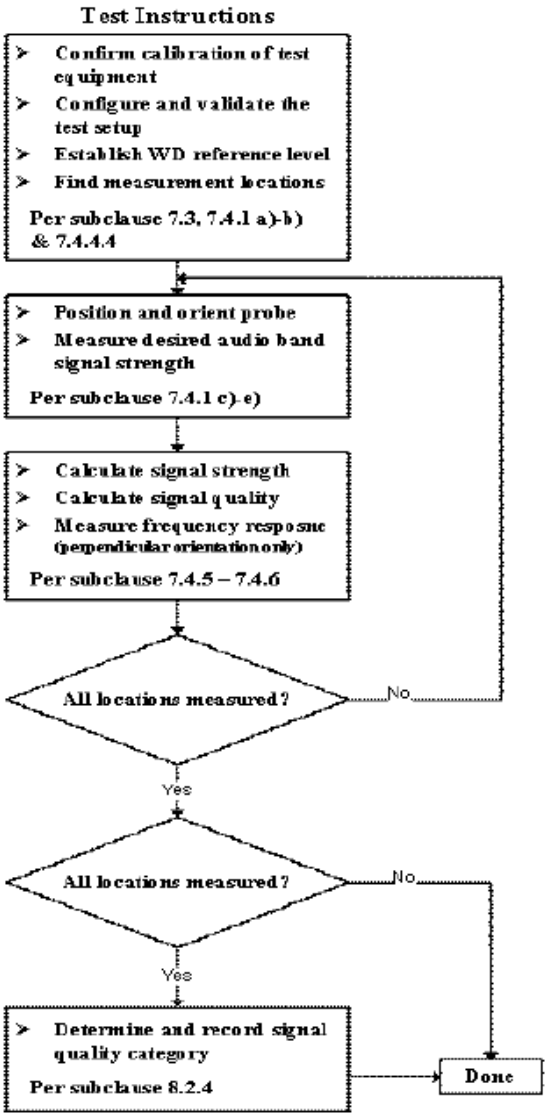


Fig 6.1 WD T-Coil signal test flowchart

6.3. Information of EUT Test Position

Fig2.2 illustrates the measurement locations and reference plane to be used for the T-Coil measurements. And measurement setup follows:

1、 The scan area is 5cm*5cm.

2、 The area is centered on the audio frequency output transducer of the EUT.

3、 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's 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, rests against the ear.

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

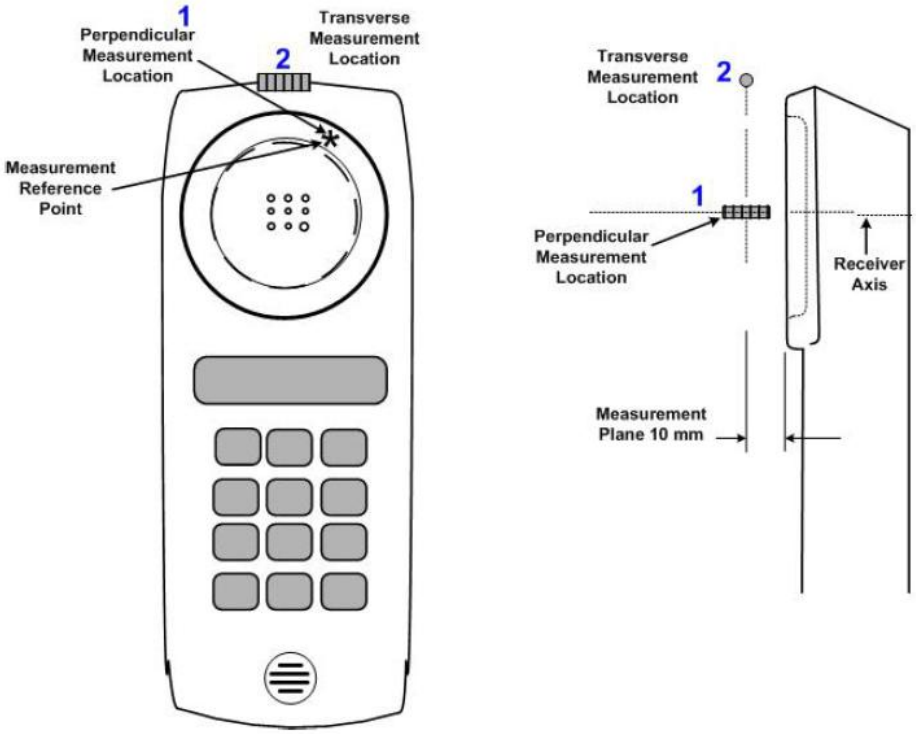


Fig 6.2 A typical EUT reference and plane for T-Coil measurement

7. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial No./ SW Version	Calibration	
				Last Cal.	Due Date
SPEAG	Audio Magnetic 1D Field Probe	AM1DV2	1048	2021.02.22	2022.02.21
SPEAG	DOSIMETRIC ASSESSMENT SYSTEM	DASY52	52.10.4.1527	NCR	NCR
SPEAG	Audio Magnetic Calibration Coil	AMCC	1044	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1032	NCR	NCR
SPEAG	Audio Holder	N/A	1094	NCR	NCR
SPEAG	Data Acquisition Electronics	DAE4	480	2021.06.22	2022.06.21
R&S	Base Station	CMU200	107082	2021.07.26	2022.07.27
R&S	Network Emulator	CMW500	165755	2021.02.25	2022.02.24

8. T-Coil Testing for CMRS Voice

8.1. Test Guidance

1. The middle channel of each frequency band is used for T-Coil testing according ANSI C63.19 2011.
2. For VoLTE radio configuration investigation is choose either one codec and an investigation was performed on all frequency band, data rates and modulations and RB configuration to determine the radio configuration to be used for testing, the following tests results which the worst case configuration would be remarked to be used for the testing for the handset.
3. According to KDB 285076, reporting results involves a two-step process: (1) Codec Investigation to determine the worst-case codec for each voice service, and (2) Air Interface Investigation. Using the worst-case codec for a voice service, a range of channels and bands shall be tested.

8.2. Test Results

➢ **GSM Test Results**

Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)	T Rating	Frequency Response
GSM850	GSM Voice	189	Axial (Z)	-14.43	-47.02	32.59	T4	PASS
			Transversal (Y)	-10.71	-42.26	31.55	T4	
GSM1900	GSM Voice	661	Axial (Z)	-4.18	-37.74	33.56	T4	PASS
			Transversal (Y)	-10.57	-43.36	32.79	T4	

➢ **UMTS Test Results**

<Codec Investigation>

Air Interface	Modulation	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)
WCDMA Band II	AMR 4.75Kbps	9400	Axial (Z)	-13.76	-49.28	35.52
	AMR 7.95Kbps	9400	Axial (Z)	-13.09	-48.74	35.65
	AMR 12.2Kbps	9400	Axial (Z)	-14.89	-49.08	34.19

Note:

The highlight part of the worst codec would be used to testing the other air interface.

Air Interface	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)	T Rating	Frequency Response
WCDMA Band II	9400	Axial (Z)	-14.89	-49.08	34.19	T4	PASS
		Transversal (Y)	-9.04	-42.62	33.58	T4	
WCDMA Band IV	1413	Axial (Z)	-12.78	-46.47	33.69	T4	PASS
		Transversal (Y)	-9.69	-42.98	33.29	T4	
WCDMA Band V	4182	Axial (Z)	1.14	-34.29	35.43	T4	PASS
		Transversal (Y)	-0.44	-35.67	35.23	T4	

- **CDMA2000 Test Results**

<Codec Investigation>

Air Interface	Modulation	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)
CDMA2000 BC1	RC1 SO1	600	Axial (Z)	3.76	-31.76	35.52
	RC1 SO3	600	Axial (Z)	2.42	-32.76	35.18
	RC1 SO68	600	Axial (Z)	4.89	-30.3	35.19

Note:

The highlight part of the worst codec would be used to testing the other air interface.

Air Interface	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)	T Rating	Frequency Response
CDMA2000 BC0	384	Axial (Z)	5.33	-29.80	35.13	T4	PASS
		Transversal (Y)	-0.89	-35.86	34.97	T4	
CDMA2000 BC1	600	Axial (Z)	2.42	-32.76	35.18	T4	PASS
		Transversal (Y)	0.30	-34.66	34.96	T4	

9. T-Coil Testing for CMRS IP Voice

9.1. T-Coil Testing for VoLTE

➢ **General Test Guidance**

1. The middle channel of each frequency band is used for T-Coil testing to determine the worst HAC T-Coil rating according ANSI C63.19 2011.
2. For VoLTE radio configuration investigation is choose either one codec and an investigation was performed on all frequency band, data rates and modulations and RB configuration to determine the radio configuration to be used for testing, the following tests results which the worst case configuration would be remarked to be used for the testing for the handset.
3. According to KDB 285076, reporting results involves a two-step process:
   a. Codec Investigation to determine the worst-case codec for each voice service.
   b. Air Interface Investigation: Using the worst-case codec for a voice service, a range of channels and bands shall be tested.

➢ **T-Coil Testing for VoLTE**

<Radio Configuration Investigation>

Air Interface	Modulation	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)
LTE Band 2	**QPSK** 1RB0 20MHz	18900	Axial (Z)	-9.23	-43.21	33.98
	16QAM 1RB0 20MHz		Axial (Z)	-8.12	-44.18	34.46
	64QAM 1RB0 20MHz		Axial (Z)	-8.57	-49.18	35.61

Note:

The highlight part of the worst modulation would be applied to air interface testing.

<EVS Codec Investigation>

Code		**Channel**	**ABM 1 (dBA/m)**	**ABM 2 (dBA/m)**	**SNR (dB)**	**Fre. Response**
NB AMR(Kbps)	**4.75**	18900	-8.67	-46.88	35.21	PASS
	6.60		-8.36	-47.29	34.93	PASS
WB AMR(Kbps)	**12.2**		-9.23	-43.21	33.98	PASS
	23.85		-9.16	-46.71	34.55	PASS
EVS SWB(Kbps)	**9.6**		-9.1	-34.5	34.5	PASS
	128		-9.15	-34.22	34.22	PASS
EVS NB(Kbps)	**5.9**		-9.09	-47.56	34.47	PASS
	24.4		-9.21	-48.61	35.4	PASS
EVS WB(Kbps)	**5.9**		-9.16	-48.19	35.03	PASS

	128		-9.21	-47.74	34.53	PASS

Note: The worst codec for WB AMR 12.2Kbps will be applied to air interface investigation.

Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)	T Rating	Frequency Response
LTE Band 2	1RB0 20MHz	18900	Axial (Z)	-9.23	-43.21	33.98	T4	Pass
			Transversal (Y)	-11.25	-47.09	35.84	T4	
LTE Band 4	1RB0 20MHz	20175	Axial (Z)	-10.92	-49.94	39.02	T4	Pass
			Transversal (Y)	-11.23	-47.86	36.63	T4	
LTE Band 5	1RB0 10MHz	20525	Axial (Z)	-9.88	-47.14	37.26	T4	PASS
			Transversal (Y)	-10.52	-47.46	36.94	T4	
LTE Band 7	1RB0 20MHz	21100	Axial (Z)	-8.04	-35.06	27.02	T3	PASS
			Transversal (Y)	-10.43	-37.14	26.71	T3	
LTE Band 12	1RB0 10MHz	23095	Axial (Z)	-12.32	-49.49	37.17	T4	PASS
			Transversal (Y)	-11.91	-48.26	36.35	T4	
LTE Band 17	1RB0 10MHz	23790	Axial (Z)	-8.59	-45.54	36.95	T4	PASS
			Transversal (Y)	-12.86	-48.94	36.08	T4	
LTE Band 18	1RB0 15MHz	23925	Axial (Z)	-10.22	-47.32	37.10	T4	PASS
			Transversal (Y)	-10.43	-47.37	36.94	T4	
LTE Band 19	1RB0 15MHz	24075	Axial (Z)	-9.95	-47.06	37.11	T4	PASS
			Transversal (Y)	-10.46	-47.35	36.89	T4	
LTE Band 26	1RB0 15MHz	26865	Axial (Z)	-10.34	-47.71	37.37	T4	PASS
			Transversal (Y)	-14.42	-50.23	35.81	T4	
LTE Band 38	1RB0 20MHz	38000	Axial (Z)	-11.25	-37.00	25.75	T3	PASS
			Transversal (Y)	-5.16	-30.35	25.19	T3	
LTE Band 40A	1RB0 10MHz	38750	Axial (Z)	-12.89	-38.60	25.71	T3	PASS
			Transversal (Y)	-4.43	-30.02	25.59	T3	
LTE Band 40B	1RB0 10MHz	39200	Axial (Z)	-8.45	-34.05	25.60	T3	PASS
			Transversal (Y)	-5.14	-30.55	25.41	T3	
LTE Band 41	1RB0 20MHz	40620	Axial (Z)	-13.48	-38.76	25.28	T3	PASS
			Transversal (Y)	-7.69	-32.22	24.53	T3	
LTE Band 66	1RB0 20MHz	132322	Axial (Z)	-7.60	-36.62	29.02	T3	PASS
			Transversal (Y)	-9.29	-38.19	28.90	T3	

9.2. T-Coil Testing for VoWi-Fi

➢ **General Test Guidance**

1. The middle channel of each frequency band is used for T-Coil testing according ANSI C63.19 2011.
2. According to KDB 285076, recording the results involves follow process:
   I. Codec Investigation to determine the worst-case codec for each voice service.
   II. Air Interface Investigation: Using the worst-case codec for a voice service, a range of channels and bands shall be tested.
3. For VoWi-Fi, the lowest data rate of each wireless system for 2.4G WLAN will be used to testing according to the conducted power list.
4. The T-Coil measurement procedure given of VoWi-Fi should be applied:

   Step 1: Comparing the output power of the WLAN systems, the maximum output power including tune-up tolerance for 2.4GHz WLAN was selected to perform codec investigation of Z axial, recording the results of ABM1, ABM2, SNR and frequency response at the same time.

   Step 2: Per step 1, selecting the worst codec perform air interface investigation of all of theWLAN modes including to 2.4GHz and 5GHz WLAN.

   Step 3: Per step 2, selecting the worst SNR of 2.4G WLAN and 5GHz WLAN to perform the T-Coil testing of Z axial and Y transversal and the test results would be recorded in the report.

➢ **Air Interface Investigation**

Bands	Wireless System	Data Rate (Mbps)	Channel	ABM 1 (dBA/m)	ABM 2 (dBA/m)	SNR(dB)
WLAN 2.4GHz	802.11b	1	6	-7.00	-38.73	31.73
	802.11g	6	6	-7.54	-46.84	39.30
	802.11n-HT20	MCS 0	6	-7.27	-47.83	40.56
	802.11ax-HEW20	RU242	6	-7.21	-45.97	38.76
	802.11ax-HEW40	RU242	6	-6.68	-46.37	39.69
WLAN 5.2GHz	802.11a	6	44	-5.65	-55.00	49.35
WLAN 5.3GHz	802.11a	6	60	-3.21	-45.55	42.34
WLAN 5.5GHz	802.11a	6	120	-1.76	-49.57	47.81
WLAN 5.8GHz	802.11a	6	157	-2.61	-45.16	42.55

➢ **Test Results**

Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	SNR (dB)	T Rating	Frequency Response
WLAN 2.4GHz	802.11b	6	Axial (Z)	-7.00	-38.73	31.73	T4	PASS
			Transversal (Y)	-12.84	-49.60	36.76	T4	

	802.11g	6	Axial (Z)	-7.54	-46.84	39.30	T4	PASS
			Transversal (Y)	-11.61	-51.27	39.66	T4	
	802.11n-HT20	6	Axial (Z)	-7.27	-47.83	40.56	T4	PASS
			Transversal (Y)	-11.39	-48.10	36.71	T4	
	802.11ax20 RU242	6	Axial (Z)	-7.21	-45.97	38.76	T4	PASS
			Transversal (Y)	-12.02	-50.05	38.03	T4	
	802.11ax40 RU242	6	Axial (Z)	-6.68	-46.37	39.69	T4	PASS
			Transversal (Y)	-11.24	-50.43	39.19	T4	
WLAN 5.2GHz	802.11a 6Mbps	44	Axial (Z)	-5.65	-55.00	49.35	T4	PASS
			Transversal (Y)	-6.75	-49.55	42.80	T4	
	802.11n20 MCS0	44	Axial (Z)	5.18	-45.72	50.90	T4	PASS
			Transversal (Y)	-2.30	-46.96	44.66	T4	
	802.11n40 MCS0	46	Axial (Z)	0.50	-55.34	55.84	T4	PASS
			Transversal (Y)	-0.95	-46.92	45.97	T4	
	802.11ac20 MCS0	44	Axial (Z)	-2.81	-55.83	53.02	T4	PASS
			Transversal (Y)	-0.92	-45.97	45.05	T4	
	802.11ac40 MCS0	46	Axial (Z)	7.46	-44.37	51.83	T4	PASS
			Transversal (Y)	-0.24	-46.42	46.18	T4	
	802.11ac80 MCS0	42	Axial (Z)	2.06	-53.66	55.72	T4	PASS
			Transversal (Y)	-3.32	-49.55	46.23	T4	
	802.11ax20 RU242	44	Axial (Z)	-0.17	-50.17	50.00	T4	PASS
			Transversal (Y)	-0.58	-45.58	45.00	T4	
	802.11ax40 RU242	46	Axial (Z)	5.18	-45.72	50.90	T4	PASS
			Transversal (Y)	-2.30	-46.96	44.66	T4	
	802.11ax80 RU242	42	Axial (Z)	0.50	-55.34	55.84	T4	PASS
			Transversal (Y)	-0.95	-46.92	45.97	T4	
WLAN 5.3GHz	802.11a 6Mbps	60	Axial (Z)	-3.21	-45.55	42.34	T4	PASS
			Transversal (Y)	-4.54	-46.01	41.47	T4	
WLAN 5.5GHz	802.11a 6Mbps	120	Axial (Z)	-1.76	-49.57	47.81	T4	PASS
			Transversal (Y)	-7.11	-48.16	41.05	T4	
WLAN 5.8GHz	802.11a 6Mbps	157	Axial (Z)	-2.61	-45.16	42.55	T4	PASS
			Transversal (Y)	-7.42	-49.87	42.45	T4	

Remark:

Phone condition: HAC Air on, Backlight off, maximum volume.

10. Uncertainty Assessment

Error Description	Uncertainty Value (±%)	Probability	Divisor	(Ci) ABM1	(Ci) ABM2	Standard Uncertainty (ABM1) (±%)	Standard Uncertainty (ABM2) (±%)
Probe Sensitivity							
Reference level	3.0	N	1	1	1	3.0	3.0
AMCC geometry	0.4	R	1.732	1	1	0.2	0.2
AMCC current	1.0	R	1.732	0.7	0.7	0.6	0.6
Probe positioning during calibrate	0.1	R	1.732	1	1	0.1	0.1
Noise contribution	0.7	R	1.732	0.0143	1	0.0	0.4
Frequency slope	5.9	R	1.732	0.1	1	0.3	3.5
Probe System							
Repeatability/drift	1.0	R	1.732	1	1	0.6	0.6
Linearity/dynamic range	0.6	R	1.732	1	1	0.4	0.4
Acoustic noise	1.0	R	1.732	0.1	1	0.1	0.6
Probe angle	2.3	R	1.732	1	1	1.4	1.4
Spectral processing	0.9	R	1.732	1	1	0.5	0.5
Integration time	0.6	N	1	1	5	0.6	3.0
Field disturbation	0.2	R	1.732	1	1	0.1	0.1
Test Signal							
Reference signal spectral response	0.6	R	1.732	0	1	0.0	0.4
Positioning							
Probe positioning	1.9	R	1.732	1	1	1.1	1.1
Phantom thickness	0.9	R	1.732	1	1	0.5	0.5
EUT positioning	1.9	N	1	0.78	0.71	0.1	0.1
External contributions							
RF interference	0.0	R	1.732	1	0.3	0.0	0.0
Test signal variation	2.0	R	1.732	1	1	1.2	1.2
Combined Std. Uncertainty						4.1	6.1
Coverage Factor for 95 %						K=2	K=2
Expanded STD Uncertainty						8.1	12.3

Annex A General Information

1. Identification of the Responsible Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Laboratory Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

2. Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China

Note:

The main report is end here and the other annex (B,C,D) will be submitted separately.

****** END OF MAIN REPORT ******