Hearing Aid Compatibility (HAC) T-Coil Test Report

APPLICANT	: ZTE CORPORATION
EQUIPMENT	: LTE/CDMA Multi-Mode Digital Mobile Phone
BRAND NAME	: ZTE
MODEL NAME	: Z2321U
FCC ID	: SRQ-Z2321U
STANDARD	: FCC 47 CFR §20.19 ANSI C63.19-2011

We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the procedures and had been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

Mark Qu

Approved by: Mark Qu / Manager

NVLAP®
TESTING
NVLAP LAB CODE 600155-0

Sporton International (Kunshan) Inc.
No.3-2 Ping-Xiang Rd, Kunshan Development Zone Kunshan City Jiangsu Province 215335 China

Table of Contents

Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
HA7N2813B	Rev. 01	Initial issue of report	Jan. 23, 2018

1. Attestation of Test Results

Applicant Name	ZTE CORPORATION
Equipment Name	LTE/CDMA Multi-Mode Digital Mobile Phone
Brand Name	ZTE
Model Name	Z2321U
FCC ID	SRQ-Z2321U
MEID Code	99000899000488
HW Version	Z2321UHW1.0
SW Version	Z2321UV1.0.0B01
EUT Stage	Identical Prototype
HAC Rating	T4
Date Tested	2018/1/16
Test Result	Pass

The device is compliance with HAC limits specified in guidelines FCC 47CFR §20.19 and ANSI Standard ANSI C63.19.

2. Administration Data

Testing Site	
Test Site	Sporton International (Kunshan) Inc.
Test Site Location	No.3-2 Ping-Xiang Rd, Kunshan Development Zone Kunshan City Jiangsu Province 215335 China TEL : +86-512-57900158 FAX : +86-512-57900958
Test Site No.	Sporton Site No. : **SAR01-KS**
Applicant	
Company Name	ZTE CORPORATION
Address	ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P.R.China
Manufacturer	
Company Name	ZTE CORPORATION
Address	ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P.R.China

3. General Information

3.1 Description of Equipment Under Test (EUT)

Product Feature & Specification	
Wireless Technology and Frequency Range	CDMA2000 BC0: 824.7 MHz ~ 848.31 MHz CDMA 2000 BC1: 1851.25 MHz ~ 1908.75 MHz LTE Band 2: 1850.7 MHz ~ 1909.3 MHz LTE Band 4: 1710.7 MHz ~ 1754.3 MHz LTE Band 5: 824.7 MHz ~ 848.3 MHz LTE Band 12: 699.7 MHz ~ 715.3 MHz LTE Band 25: 1850.7 MHz ~ 1914.3 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	CDMA2000 : 1xRTT/1xEv-Do(Rev.0)/1xEv-Do(Rev.A) LTE: QPSK, 16QAM WLAN 2.4GHz : 802.11b/g/n HT20/HT40 Bluetooth v2.1 + EDR, Bluetooth v4.0 LE, Bluetooth v4.2 LE
Remark: 1. This device doesn't support VoIP function. 2. This device supports VoLTE operation.	

3.2 Air Interface and Operating Mode

Air Interface	Band MHz	Type	C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Reduction
CDMA	BC0	VO	Yes	WLAN, BT	NA	Yes
	BC1			WLAN, BT		Yes
	EVDO	DT	No	WLAN, BT		Yes
LTE	Band 2	VD	Yes	WLAN, BT	VoLTE*	Yes
	Band 4			WLAN, BT		Yes
	Band 5			WLAN, BT		Yes
	Band 12			WLAN, BT		No
	Band 25			WLAN, BT		Yes
WLAN	2450	DT	No	CDMA,LTE	NA	No
BT	2450	DT	No	CDMA,LTE	NA	No

VO= legacy Cellular Voice Service from Table 7.1 in 7.4.2.1 of ANSI C63.19-2011
DT= Digital Transport only (no voice)
VD= IP Voice Service over Digital Transport
BT= Bluetooth

Remark:
* Ref Lev in accordance with 7.4.2.1 of ANSI C63.19-2011 and the July 2012 VoLTE interpretation

3.3 Applied Standards

- FCC CFR47 Part 20.19
- ANSI C63.19 2011-version
- FCC KDB 285076 D01 HAC Guidance v05
- FCC KDB 285076 D02 T Coil testing for CMRS IP v03

4. HAC T-Coil

FCC wireless hearing aid compatibility rules ensure that consumers with hearing loss are able to access wireless communications services through a wide selection of handsets without experiencing disabling radio frequency (RF) interference or other technical obstacles.
To define and measure the hearing aid compatibility of handsets, in CFR47 part 20.19 ANSI C63.19 is referenced. A handset is considered hearing aid-compatible for acoustic coupling if it meets a rating of at least M3 under ANSI C63.19, and A handset is considered hearing aid compatible for inductive coupling if it meets a rating of at least T3.

For inductive coupling, the wireless communication devices should be measured as below.
1) Magnetic signal strength in the audio band
2) Magnetic signal frequency response through the audio band
3) Magnetic signal to noise

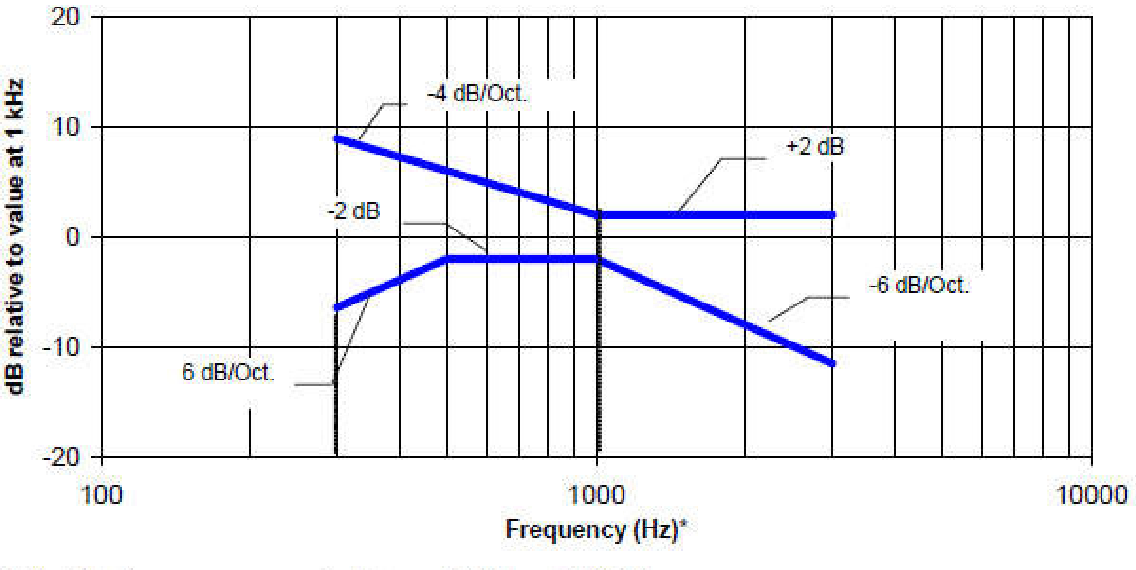
4.1 T-Coil Coupling Field Intensity

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

4.2 T-Coil Frequency Response

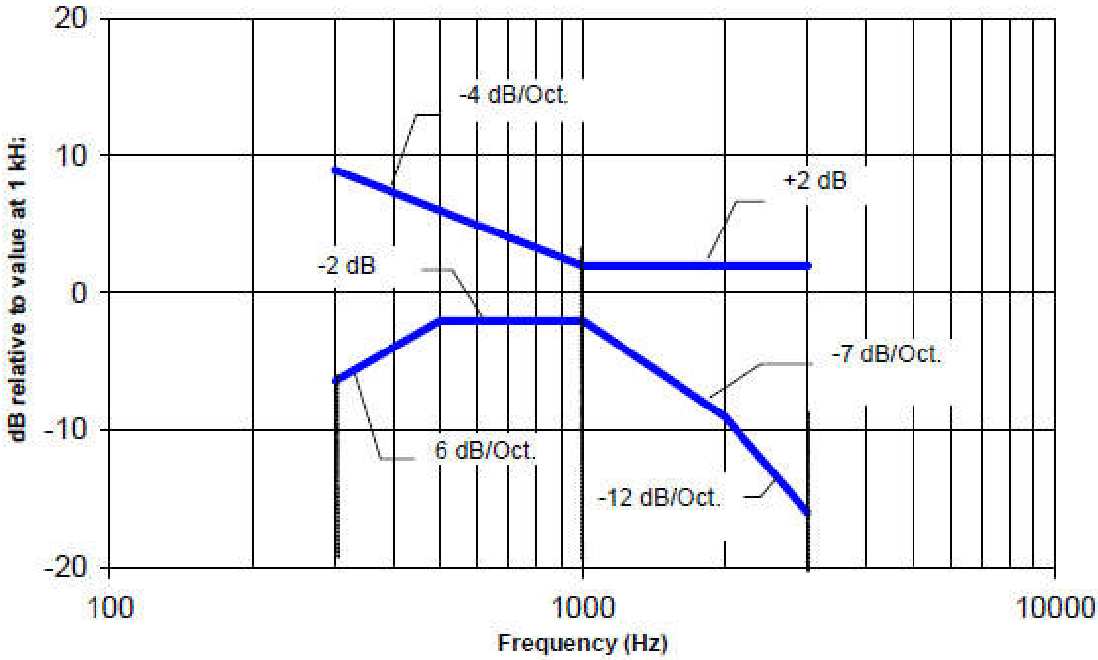
The frequency response of the perpendicular component of the magnetic field, measured in 1/3 octave bands, shall follow the response curve specified in this sub-clause, over the frequency range 300 Hz to 3000 Hz.

Figure 4.1 and Figure 4.2 provide the boundaries as a function of 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.



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

Fig. 4.1 Magnetic field frequency response for WDs with field strength≤-15dB 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

4.3 T-Coil Signal Quality Categories

This section provides the signal quality requirement for the intended T-Coil signal from a WD. Only the RF immunity of the hearing aid is measured in T-Coil mode. It is assumed that a hearing aid can have no immunity to an interference signal in the audio band, which is the intended reception band for this mode. A device is assessed beginning by determining the category of the RF environment in the area of the T-Coil source.

The RF measurements made for the T-Coil evaluation are used to assign the category T1 through T4. The limitation is given in Table 4.3. 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 dB)
Category T1	0 to 10 dB
Category T2	10 to 20 dB
Category T3	20 to 30 dB
Category T4	> 30 dB

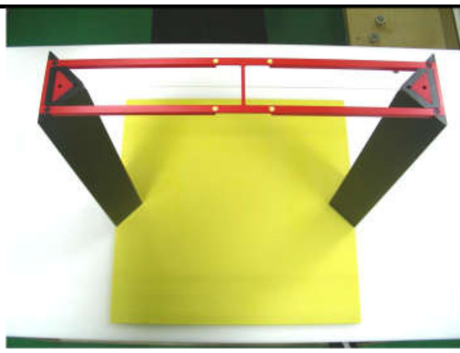
Table 4.1 T-Coil Signal Quality Categories

5. Measurement System Specification

5.1 System Configuration

Fig. 5.1 T-Coil setup with HAC Test Arch and AMCC

5.2 Test Arch Phantom

Construction :	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.	 **Fig. 5.2 Photo of Arch Phantom**
Dimensions :	370 x 370 x 370 mm	

5.3 AMCC

The Audio Magnetic Calibration coil is a Helmholtz Coil designed for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction. The DC input resistance is adjusted by a series resistor to approximately 50Ohm, and a shunt resistor of 10 Ohm permits monitoring the current with a scale of 1:10.		
Port description		
Signal	**Connector**	**Resistance**
Coil In	BNC	typically 50 Ohm
Coil Monitor	BNO	10Ohm ±1%(100mV corresponding to 1 A/m)
Specification		
Dimensions	370 x 370 x 196 mm, according to ANSI C63.19	

5.4 AM1D Probe

The AM1D probe is an active probe with a single sensor. It is fully RF-shielded and has a rounded tip 6mm in diameter incorporating a pickup coil with its center offset 3mm from the tip and the sides. The symmetric signal preamplifier in the probe is fed via the shielded symmetric output cable from the AMMI with a 48V “phantom” voltage supply. The 7-pin connector on the back in the axis of the probe does not carry any signals. It is mounted to the DAE for the correct orientation of the sensor. If the probe axis is tilted 54.7 degree from the vertical, the sensor is approximately vertical when the signal connector is at the underside of the probe (cable hanging downwards).	
Specification	
Frequency Range	0.1 ~ 20 kHz (RF sensitivity <-100dB, fully RF shielded)
Sensitivity	<-50dB A/m @ 1 kHz
Pre-amplifier	40 dB, symmetric
Dimensions	Tip diameter/ length: 6/ 290 mm, sensor according to ANSI-C63.19

5.5 AMMI

Fig. 5.3 AMMI front panel

The Audio Magnetic Measuring Instrument (AMMI) is a desktop 19-inch unit containing a sampling unit, a waveform generator for test and calibration signals, and a USB interface.

Specification	
Sampling rate	48 kHz/24 bit
Dynamic range	85 dB
Test signal generation	User selectable and predefined (vis PC)
Calibration	Auto-calibration/full system calibration using AMCC with monitor output
Dimensions	482 x 65 x 270 mm

5.6 System Hardware

DAE
The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit.
Robot
The SPEAG DASY system uses the high precision robots (DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used.

5.7 Cabling of System for UMTS

The principal cabling of the T-Coil setup is shown in Fig. 5.4 All cables provided with the basic setup have a length of approximately 5 m.

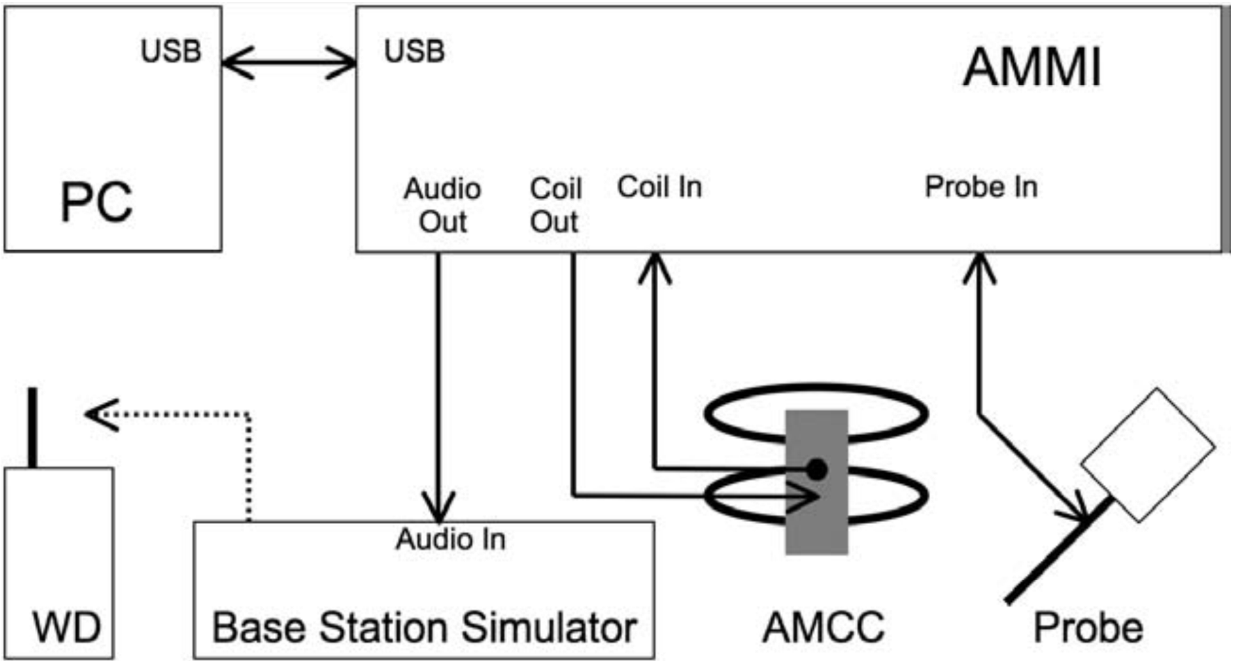


Fig. 5.4 T-Coil setup cabling

5.8 Cabling of System for VoLTE

The principal cabling of the T-Coil setup is shown in Fig. 5.5 All cables provided with the basic setup have a length of approximately 5 m.

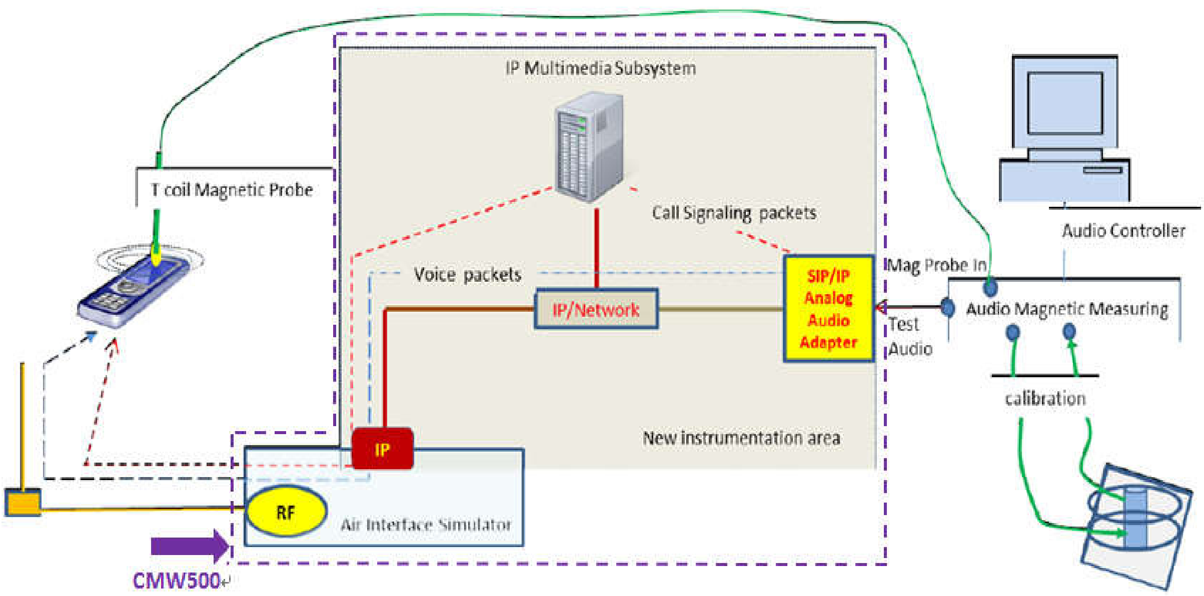


Fig. 5.5 T-Coil setup cabling

5.9 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Data Acquisition Electronics	DAE4	1326	2017/9/15	2018/9/14
SPEAG	Active Audio Magnetic Field Probe	AM1DV3	3093	2017/5/19	2018/5/18
SPEAG	Test Arch Phantom	Par phantom	1105	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
R&S	Universal Radio Communication Tester	CMU200	112568	2017/6/29	2018/6/28
R&S	Universal Radio Communication Tester	CMW500	143030	2017/8/17	2018/8/16
SPEAG	Audio Magnetic Measuring Instrument	AMMI	1128	NA	NA
SPEAG	Helmholtz calibration coil	AMCC	NA	NA	NA

Table 5.1 Test Equipment List

Note: NCR: “No-Calibration Required”

5.10 Probe Calibration in AMCC

The probe sensitivity at 1 kHz is 0.06556 V/(A/m) (-23.66 dBV/(A/m)) was calibrated by AMCC coil for verification of setup performance.

The evaluated probe sensitivity was able to be compared to the calibration of the AM1D probe. The frequency response and sensitivity was shown in Fig. 5.5. The probe signal is represented after application of an ideal integrator. The green curve represents the current though the AMCC, the blue curve the integrated probe signal. The DIFFERENCE between the two curves is equivalent to the frequency response of the probe system and shows the characteristics. The probe/system complies with the frequency response and linearity requirements in C63.19 according to the SPEAG's calibrated report as shown in Annex B (AM1D probe: SPAM100AF) (1)The frequency response has been tested within +/- 0.5 dB of ideal differentiator from 100 Hz to 10 kHz. (2)The linearity has also been tested within 0.1dB from 5 dB below limitation to 16 dB above noise level. The AMCC coil is qualified according to certificate report, SDHACPO02A as shown in Annex B.

	Coil	Probe
Internal calibration...	2.3029 V	1.1453 V
Probe sensitivity a...		0.06556 V/(A/m)

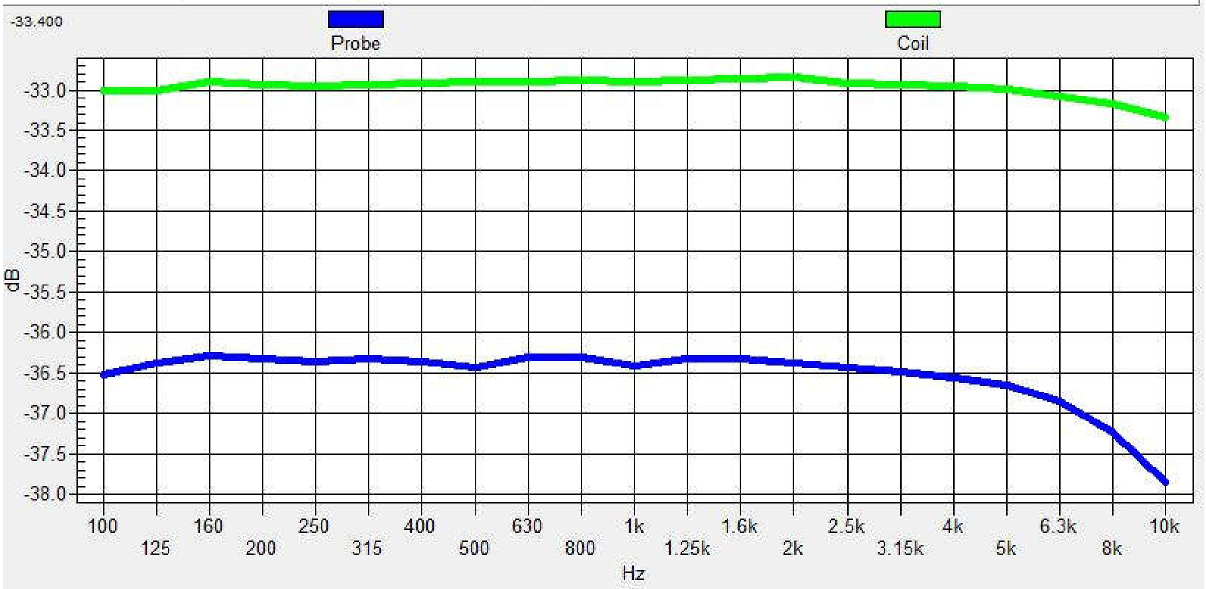


Fig. 5.6 The frequency response and sensitivity of AM1D probe

5.11 Reference Input of Audio Signal Spectrum

With the reference job "use as reference" in the beginning of a procedure, measure the spectrum of the current when applied to the AMCC, i.e. the input magnetic field spectrum, as shown below Fig. 5.6 and Fig. 5.7. For this, the delay of the window shall be set to a multiple of the signal period and at least 2s. From the measurement on the device, using the same signal, the postprocessor deducts the input spectrum, so the result represents the net EUT response.

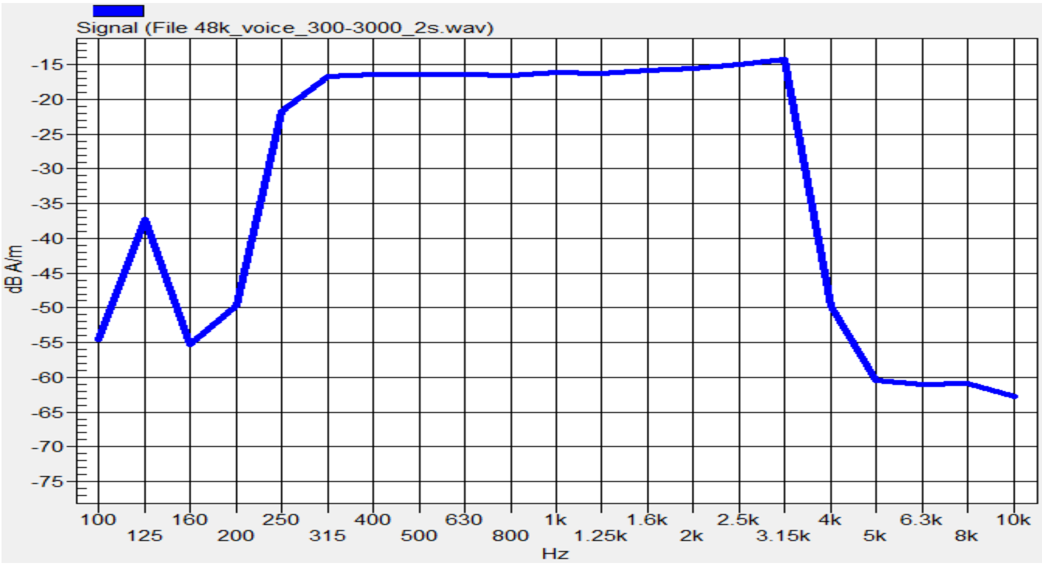


Fig. 5.7 Audio signal spectrum of the broadband signal (48kHz_voice_300Hz~3 kHz)

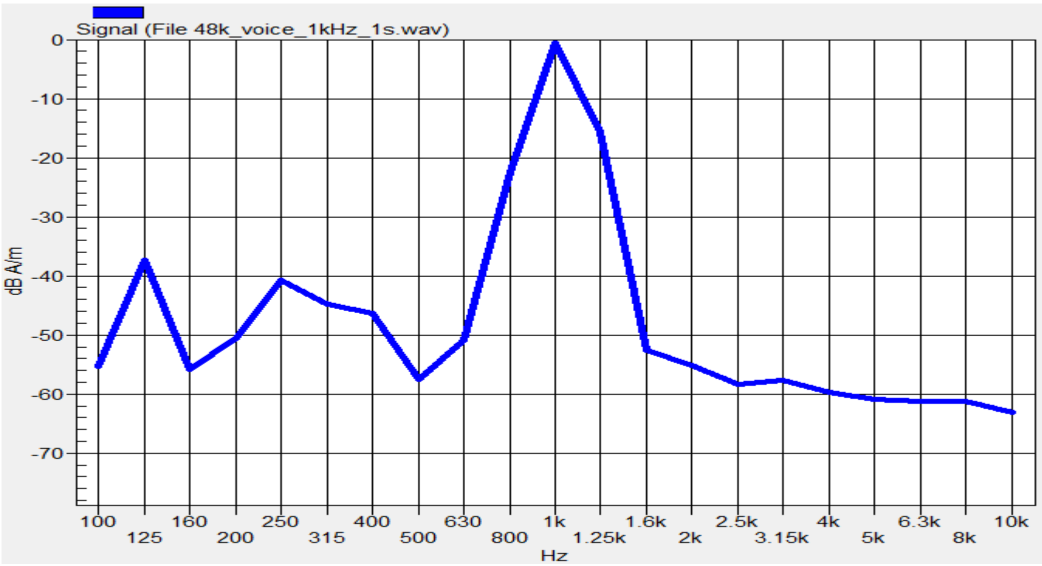


Fig. 5.8 Audio signal spectrum of the narrowband signal (48kHz_voice_1kHz)

5.12 Establish Reference Level for GSM / UMTS / CDMA

According to ANSI C63.19:2011 section 7.4.2.1, the normal speech input level for HAC T-coil tests shall be set to -16 dBm0 for GSM and UMTS (WCDMA), to -18 dBm0 for CDMA and to -16 dBm0 for LTE. This technical note shows a possibility to evaluate and set the correct level with the HAC T-Coil setup with a Rohde&Schwarz communication tester CMU200 with audio option B52 and B85.

Establish a call from the CMU200 to a wireless device. Select CMU200 Network Bitstream "Decoder Cal" to have a 1 kHz signal with a level of 3.14 dBm0 at the speech output. Run the measurement job and read the voltage level at the multi-meter display "Coil signal". Read the RMS voltage corresponding to 3.14 dBm0 and note it.

GSM or WCDMA
Determine the 1 kHz input level to generate the desired signal level of -16 dBm 0. Select CMU200 Network Bitstream "Codec Cal" to loop the input via the codec to the output. Run the measurement job (AMMI 1 kHz signal with gain 10 inserted) and read the voltage level at the multimeter display "Coil signal". With Gain 10 setting, the measurement signal difference to the desired signal level of -16 dBm 0.

CDMA2000
Determine the 1 kHz input level to generate the desired signal level of -18 dBm0. Select CMU200 Network Bitstream "Codec Cal" to loop the input via the codec to the output. Run the measurement job (AMMI 1 kHz signal with gain 10 inserted) and read the voltage level at the multimeter display "Coil signal". With Gain 10 setting, the measurement signal difference to the desired signal level of -18 dBm0.

CDMA Calculations:

3.14 dBm0 = -2.44 dBV → -18 dBm0 = -23.58 dBV
Gain 10 = -20 dBV
-23.58 - (-20) = -3.58 dB
10 [10 ^ ((-3.58) / 20)] = 10 x 0.662 = 6.62*
Required Gain Factor = 10^(-RMS(dB)/20)
*Gain Setting = Required Gain Factor * 6.62*

Note: Calculated Gain Setting = Resulting Gain * Required Gain Factor

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

Signal Type		Duration (s)	Peak to RMS (dB)	RMS (dB)	Required Gain Factor(1)	Calculated Gain Setting	Adjusted Gain Setting(2)
CDMA	48k_voice_1kHz	1	16.2	-12.7	4.33	28.66	28.66
	48k_voice_300Hz ~ 3kHz	2	21.6	-18.6	8.48	56.14	56.14

Remark:

(1) 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

(2) If the measurement for each signal type with calculated gain setting does not meet the desired level, the gain setting will be manually adjusted until the desired level is obtained.

5.13 Establish Reference Level for VoLTE

The normal speech input level -16dBm0 is used for VoLTE T-coil performance evaluation. The CMW500 base station simulator was manually configured to ensure that the settings for speech input full scale levels resulted in the -16dBm0 speech input level to the DUT for the VoLTE connection.

According to the gain setting for 1kHz sine wave, determine the gain setting for signals below

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.

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Required Gain Factor(1)	Calculated Gain Setting	Adjusted Gain Setting(2)
48k_voice_1kHz	1	16.2	-12.7	4.33	35.51	35.51
48k_voice_300Hz ~ 3kHz	2	21.6	-18.6	8.48	69.54	69.54

Remark:

(1) 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

(2) If the measurement for each signal type with calculated gain setting does not meet the desired level, the gain setting will be manually adjusted until the desired level is obtained.

6. T-Coil Test Procedure

6.1 Test Process and Flow Chart

Referenced to ANSI C63.19-2011, Section 7.4

This section describes the procedures used to measure the ABM (T-Coil) performance of the WD. In addition to measuring the absolute signal levels, the A-weighted magnitude of the unintended signal shall also be determined. To assure that the required signal quality is measured, the measurement of the intended signal and the measurement of the unintended signal must be made at the same location for each measurement position. In addition, the RF field strength at each measurement location must be at or below that required for the assigned category.

Measurements shall not include undesired properties from the WD's RF field; therefore, use of a coaxial connection to a base station simulator or 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.

a) A validation of the test setup and instrumentation may be performed using a TMFS or Helmholtz coil Measure the emissions and confirm that they are within the specified tolerance.

b) Position the WD in the test setup and connect the WD RF connector to a base station simulator or a 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.

c) 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.

d) 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.

e) 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.)

   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.

f) 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).

g) 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.

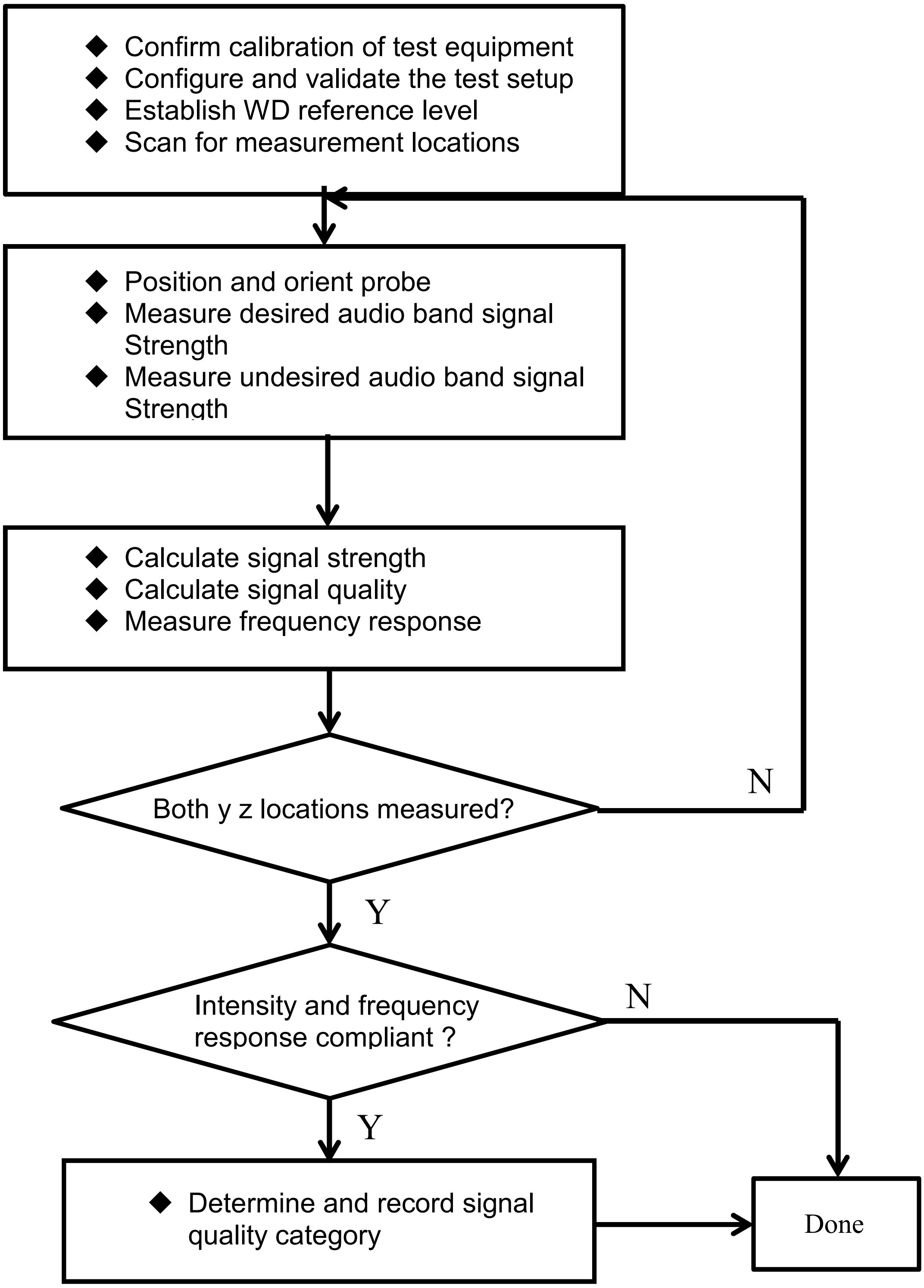


Fig. 6.1 Test Flow Chart

6.2 Description of EUT Test Position

Fig.6.2 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.

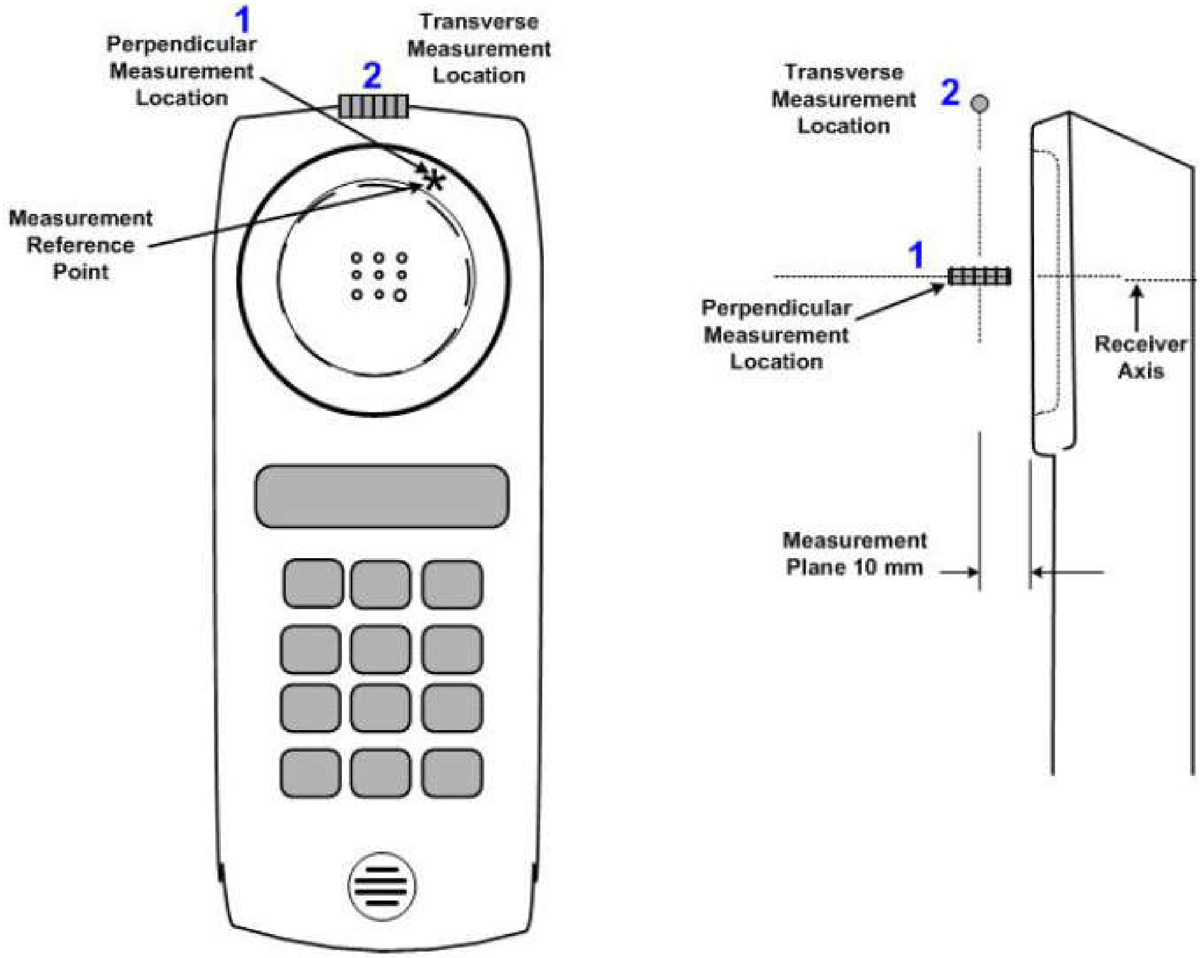


Fig 6.2 A typical EUT reference and plane for T-Coil measurements

7. HAC T-Coil Test Results

7.1 Magnitude Result

System & Position				Probe Position	Signal to Noise					
Plot No.	Air Interface	Mode	Channel		ABM1 dB (A/m)	ABM2 dB (A/m)	Ambient Noise dB (A/m)	Freq. Response Variation dB	Signal Quality dB	T-Rating ANSI C63.19-2011
01	CDMA2000 BC0	RC1 SO3	384	Axial (Z)	-10.06	-53.13	-48.52	0.20	43.07	T4
				Transversal (Y)	-16.28	-53.79	-48.56	-	37.51	T4
02	CDMA2000 BC1	RC1 SO3	600	Axial (Z)	-9.84	-53.19	-49.23	1.64	43.35	T4
				Transversal (Y)	-17.39	-54.19	-49.25	-	36.80	T4

7.2 Preliminary Scan for VoLTE T-coil performance

Step1: Frequency band, configure **LTE Band 2** in the highest power configuration (normally, it will be 1RB configuration and QPSK modulation, MPR=0 dB), and test different codecs. The codec related to the worst SNR will be used for following tests.
Step2: For all LTE bands, configure the uplink transmission in 1 RB and QPSK modulation. Test this code identified in (1), for ABM1 level, SNR, frequency response for all frequency bands

<Step 1>

LTE Codec Investigation-air interface				
Codec State	WB AMR 4.75Kbps	WB AMR 6.6Kbps	WB AMR 12.2kbps	WB AMR 23.85kbps
ABM1 (dBA/m)	-3.19	-3.42	-2.91	-2.75
ABM2 (dBA/m)	-48.94	-50.95	-52.16	-51.10
S+N/N (dB)	**45.75**	47.53	49.25	48.35
Frequency response	1.54	2.00	2.00	2.00

7.3 Magnitude Result for VoLTE

<Step 2>

Plot No.	Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Ambient Noise dB (A/m)	Freq. Response Variation dB	Signal Quality dB	T-Rating ANSI C63.19-2011
03	LTE Band2	20M_QPSK_1RB_49Offset_AMR4.75Kbps	18900	Axial (Z)	-3.19	-48.94	-48.56	1.54	45.75	T4
				Transversal (Y)	-11.47	-53.99	-48.53	-	42.52	T4
04	LTE Band4	20M_QPSK_1RB_49Offset_AMR4.75Kbps	20175	Axial (Z)	-3.33	-52.71	-48.26	1.82	49.38	T4
				Transversal (Y)	-11.22	-53.95	-48.36	-	42.73	T4
05	LTE Band5	20M_QPSK_1RB_25Offset_AMR4.75Kbps	20525	Axial (Z)	-3.55	-52.07	-48.57	2.00	48.52	T4
				Transversal (Y)	-10.72	-54.87	-48.56	-	44.15	T4
06	LTE Band12	20M_QPSK_1RB_25Offset_AMR4.75Kbps	23095	Axial (Z)	-3.44	-52.28	-49.25	1.63	48.84	T4
				Transversal (Y)	-11.48	-53.71	-49.56	-	42.23	T4
07	LTE Band25	20M_QPSK_1RB_49Offset_AMR4.75Kbps	26340	Axial (Z)	-3.50	-51.81	-48.56	1.87	48.31	T4
				Transversal (Y)	-11.49	-54.45	-48.75	-	42.96	T4

Remark:

1. There is a no special HAC mode software on this EUT.
2. The detail frequency response results please refer to appendix A.
3. Test Engineer: Nick Hu

8. Uncertainty Assessment

The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance. The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual “root-sum-squares” (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances. Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is showed in Table 8.1.

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	1	1	0.6	0.6
Probe Positioning during Calibr.	0.1	R	1.732	1	1	0.1	0.1
Noise Contribution	0.7	R	1.732	0.014	1	0.0	0.4
Frequency Slope	5.9	R	1.732	0.1	1	0.3	3.4
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	0.3	0.3
Acoustic Noise	1.0	R	1.732	0.1	1	0.1	0.6
Probe Angle	2.3	R	1.732	1	1	1.3	1.3
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 Distribution	0.2	R	1.732	1	1	0.1	0.1
Test Signal							
Ref. Signal Spectral Response	0.6	R	1.732	0	1	0.0	0.3
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
DUT Positioning	1.9	R	1.732	1	1	1.1	1.1
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						4.0%	6.1%
Coverage Factor for 95 %						K=2	K=2
Expanded STD Uncertainty						8.1%	12.2%

Table 8.1 Uncertainty Budget of audio band magnetic measurement

9. References

[1] ANSI C63.19-2011, “American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”, 27 May 2011.

[2] FCC KDB 285076 D01v05, “Equipment Authorization Guidance for Hearing Aid Compatibility”, Sep 2017

[3] FCC KDB 285076 D02v03, “Guidance for Performing T-Coil tests for Air Interfaces Supporting Voice over IP to support CMRS based telephone services”, Sep 2017

[4] SPEAG DASY System Handbook

Appendix A. Plots of T-Coil Measurement

The plots are shown as follows.

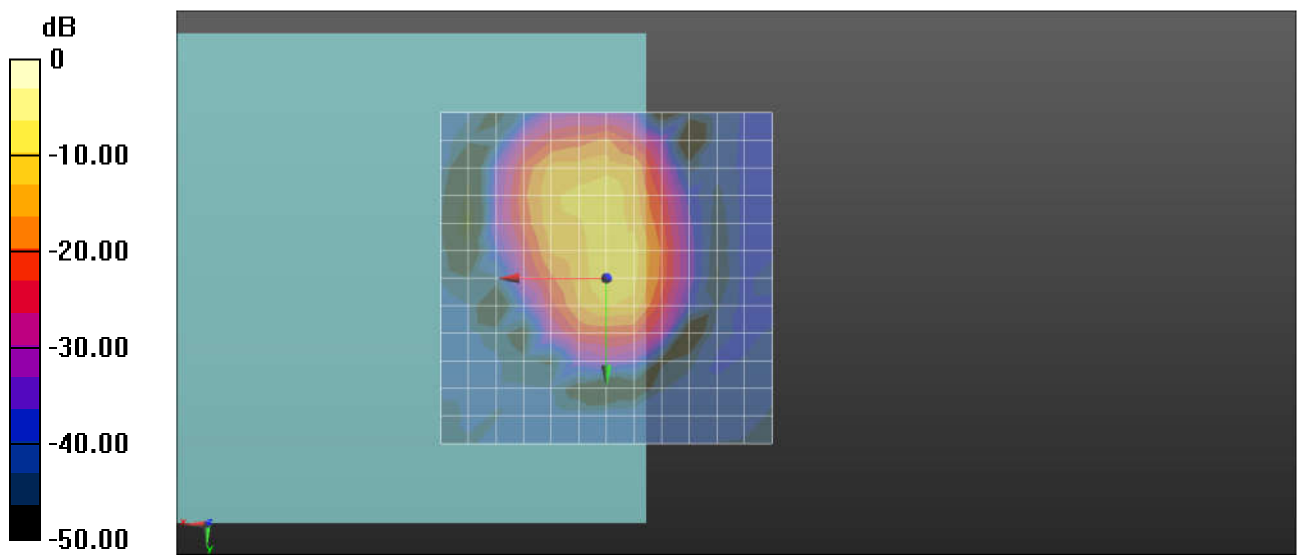
Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2018.1.16

01_CDMA2000 BC0_RC1 SO3_Ch384(Z)

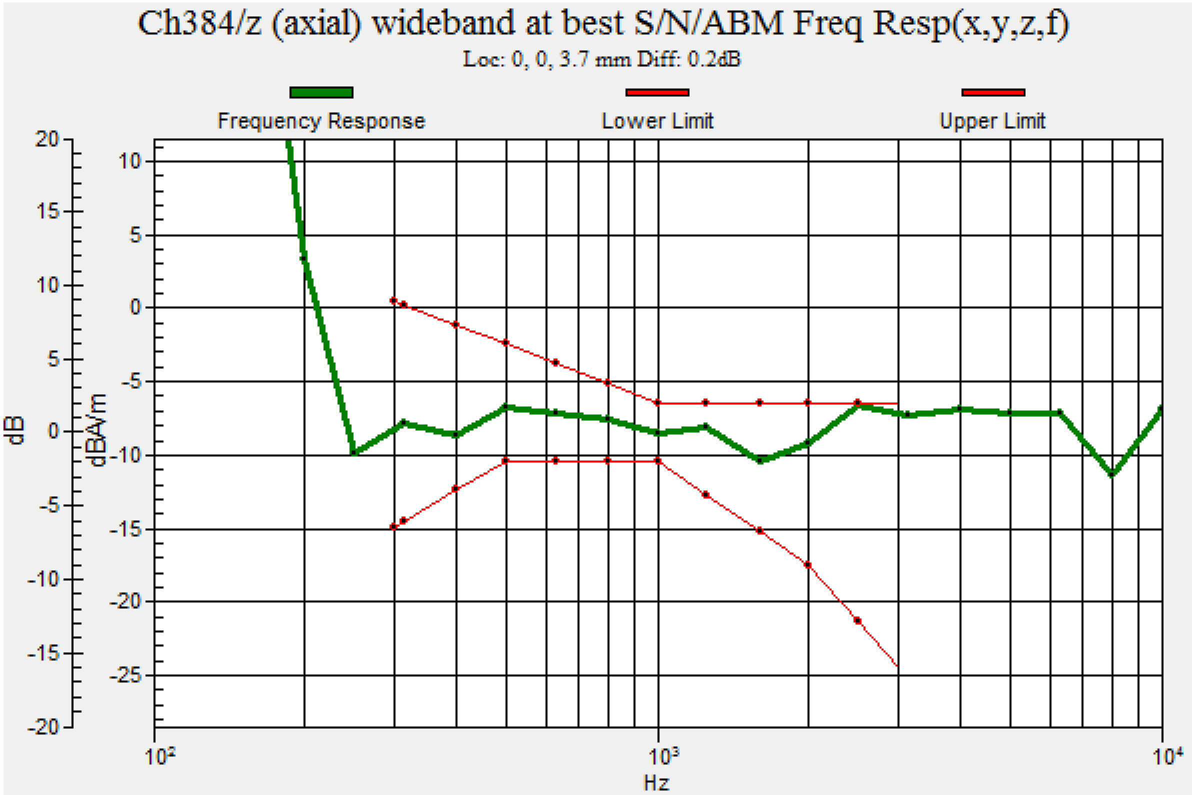
Communication System: UID 0, CDMA2000 (0); Frequency: 836.52 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 0 kg/m^3
Ambient Temperature：23.5 ℃;

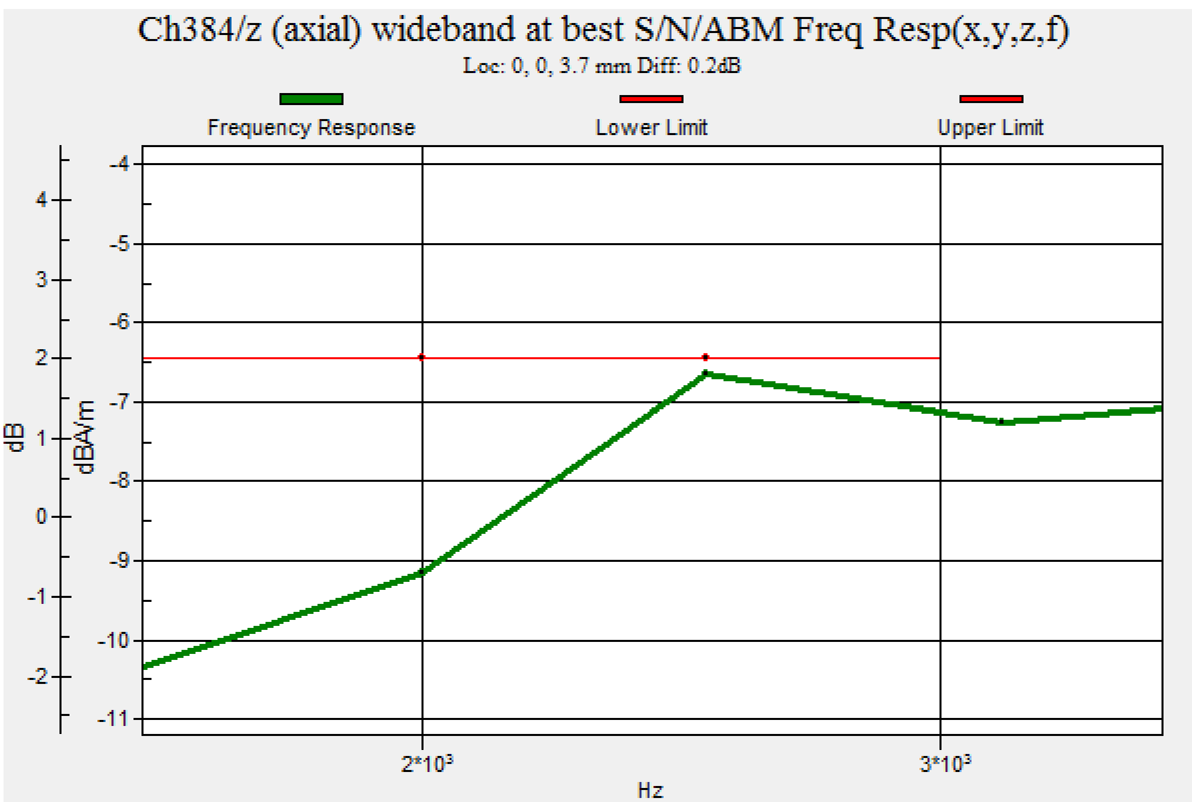
DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch384/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 43.07 dB
ABM1 comp = -10.06 dBA/m
Location: 0, 0, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m


Ch384/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 0, 3.7 mm Diff: 0.2dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10²
10³
10⁴


Ch384/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 0, 3.7 mm Diff: 0.2dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
2*10³
3*10³

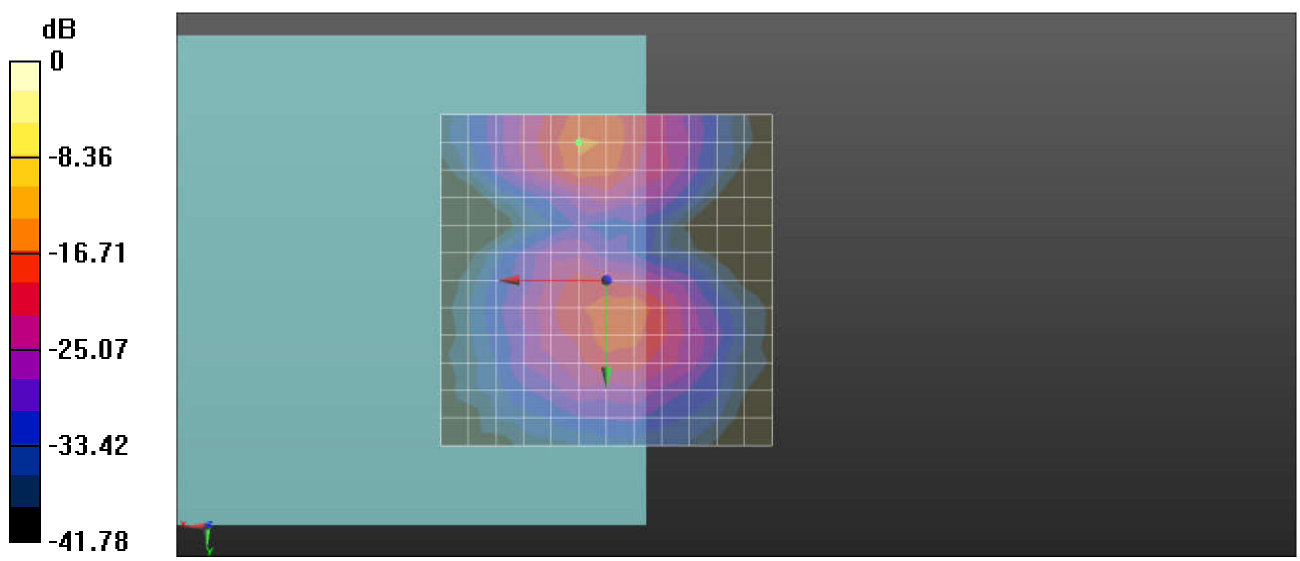
Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab   Date: 2018.1.16

01_CDMA2000 BC0_RC1 SO3_Ch384(Y)

Communication System: UID 0, CDMA2000 (0); Frequency: 836.52 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 0 kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch384/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 37.51 dB
ABM1 comp = -16.28 dBA/m
Location: 4.2, -20.8, 3.7 mm



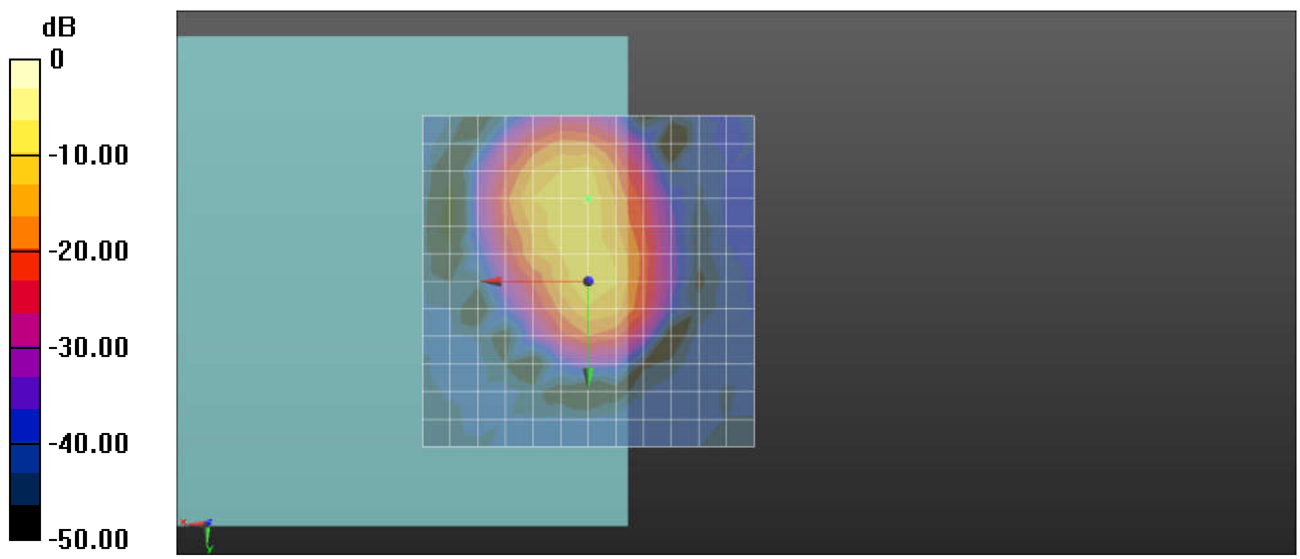
0 dB = 1.000 A/m = 0.00 dBA/m

02_CDMA2000 BC1_RC1 SO3_Ch600(Z)

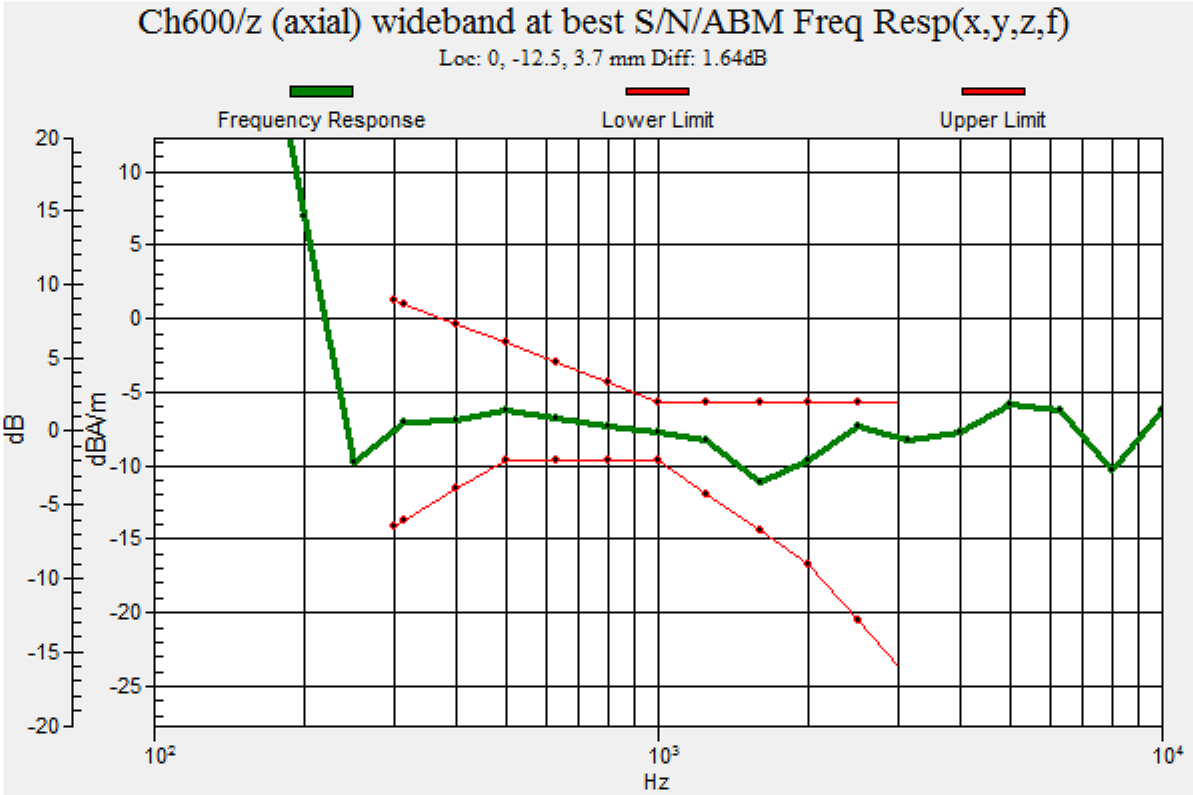
Communication System: UID 0, CDMA2000 (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch600/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 43.35 dB
ABM1 comp = -9.84 dBA/m
Location: 0, -12.5, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m


Ch600/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, -12.5, 3.7 mm Diff: 1.64dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10²
10³
10⁴

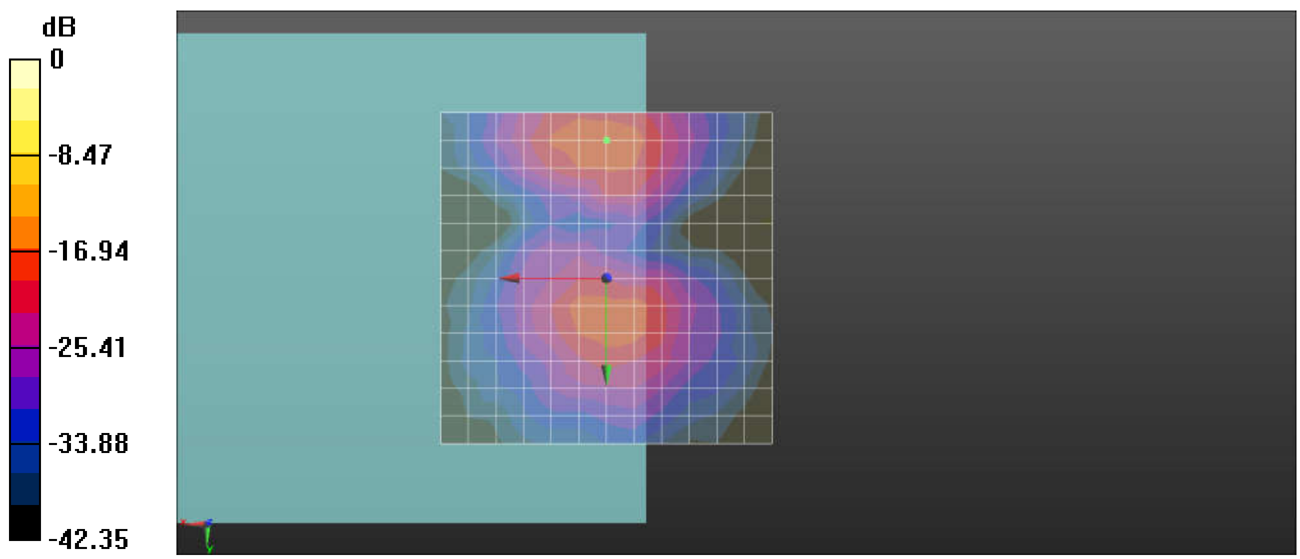
Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2018.1.16

02_CDMA2000 BC1_RC1 SO3_Ch600(Y)

Communication System: UID 0, CDMA2000 (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch600/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 36.80 dB
ABM1 comp = -17.39 dBA/m
Location: 0, -20.8, 3.7 mm



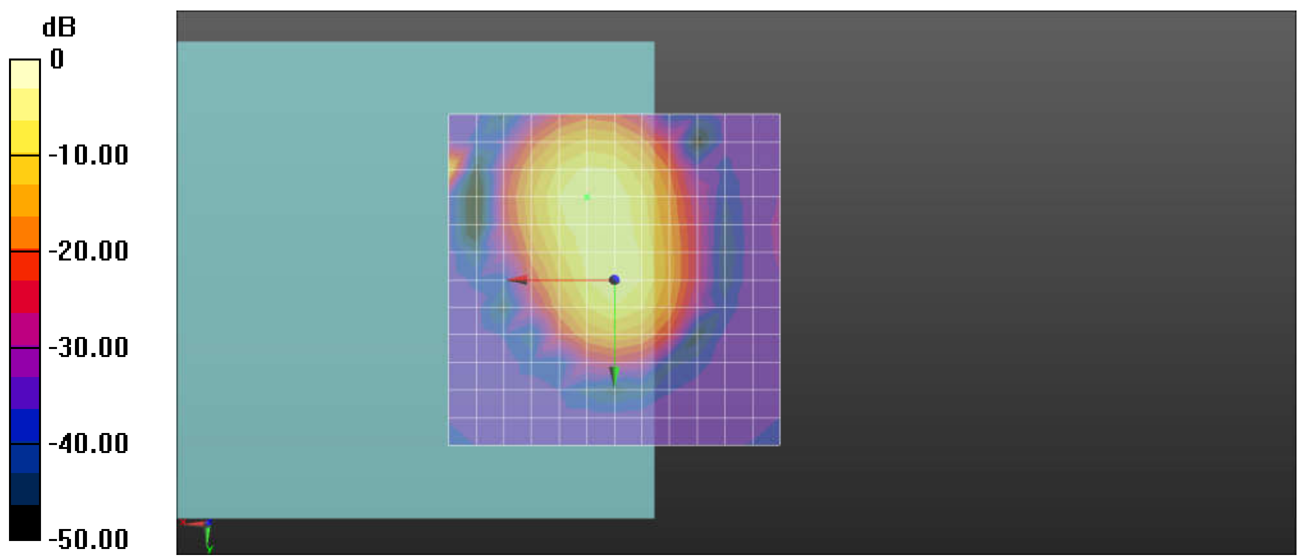
0 dB = 1.000 A/m = 0.00 dBA/m

03_HAC_T-Coil_LTE Band 2_20M_QPSK_1RB_49Offset_4.75Kbps_Ch18900_Z

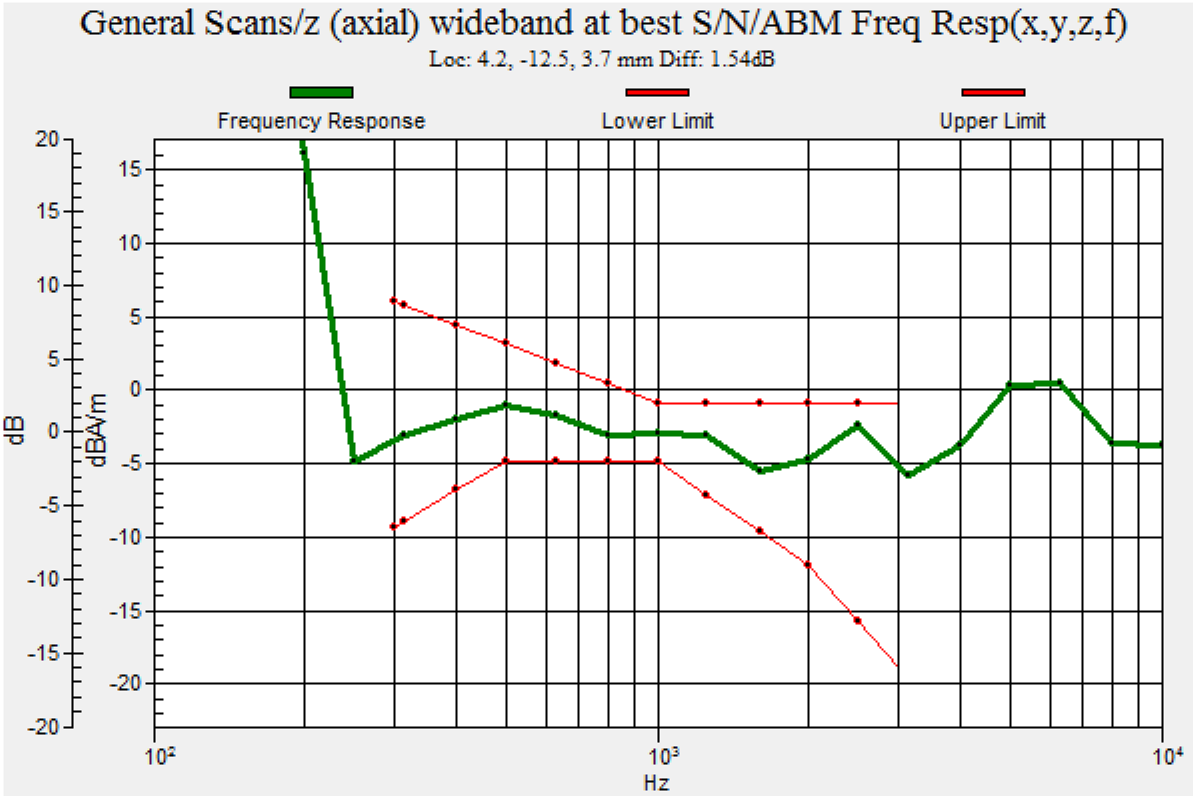
Communication System: UID 0, FDD_LTE (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 45.75 dB
ABM1 comp = -3.19 dBA/m
Location: 4.2, -12.5, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m



General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4.2, -12.5, 3.7 mm Diff: 1.54dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

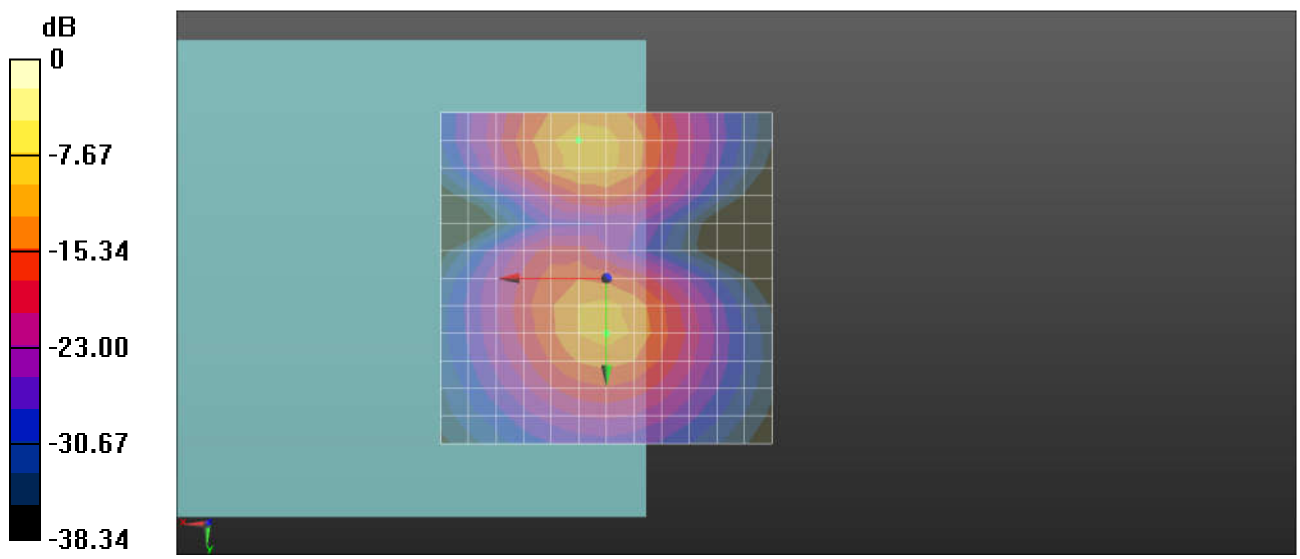
Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2018.1.16

03_HAC_T-Coil_LTE Band 2_20M_QPSK_1RB_49Offset_4.75Kbps_Ch18900_Y

Communication System: UID 0, FDD_LTE (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 42.52 dB
ABM1 comp = -11.47 dBA/m
Location: 0, 8.3, 3.7 mm



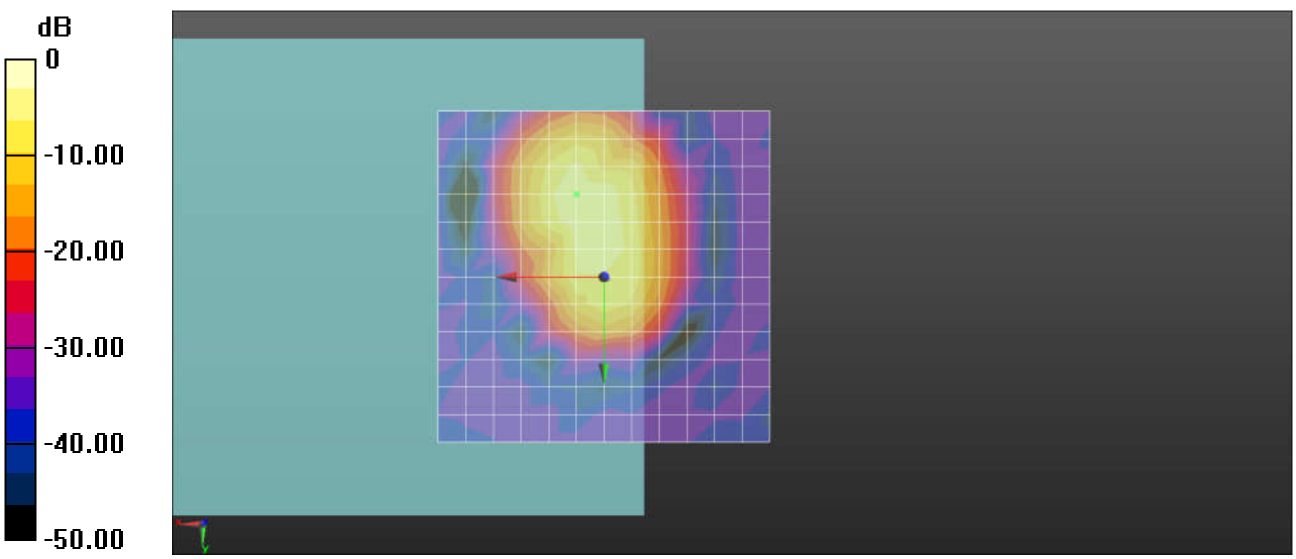
0 dB = 1.000 A/m = 0.00 dBA/m

04_HAC_T-Coil_LTE Band 4_20M_QPSK_1RB_49Offset_4.75Kbps_Ch20175(Z)

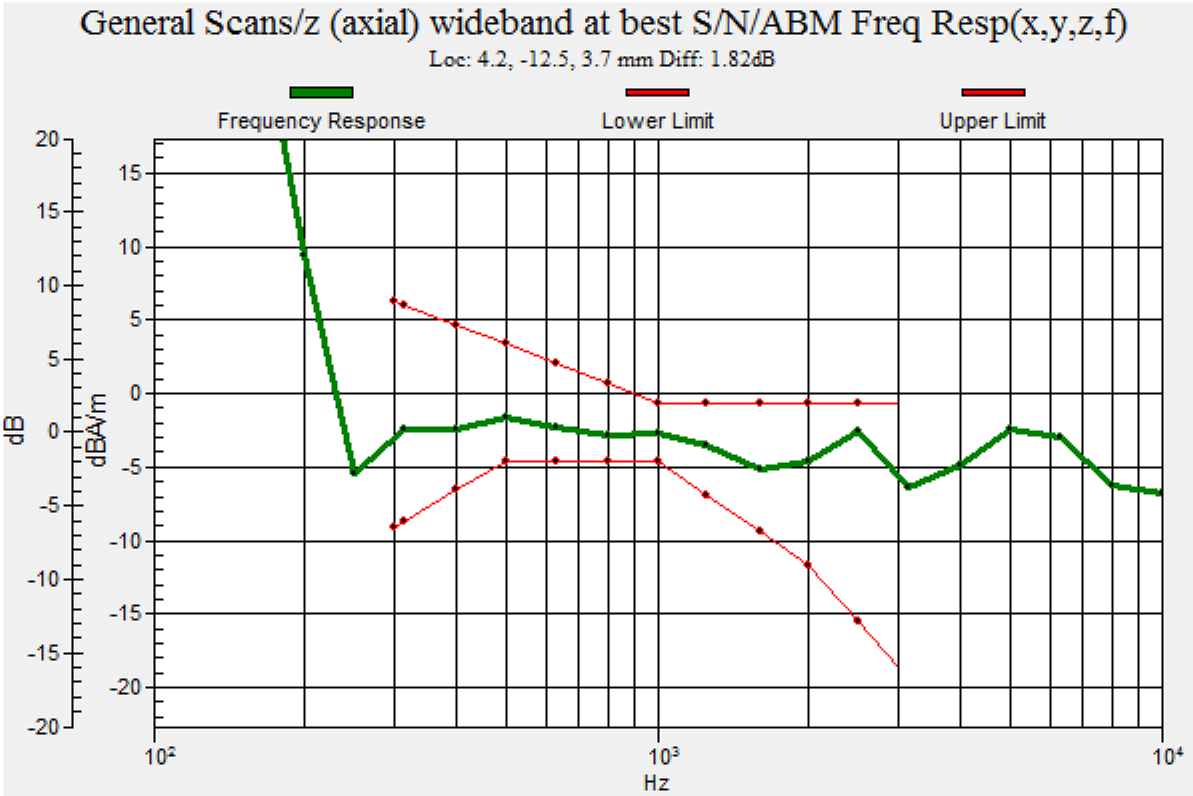
Communication System: UID 0, FDD_LTE (0); Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 49.38 dB
ABM1 comp = -3.33 dBA/m
Location: 4.2, -12.5, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4.2, -12.5, 3.7 mm Diff: 1.82dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10²
10³
10⁴

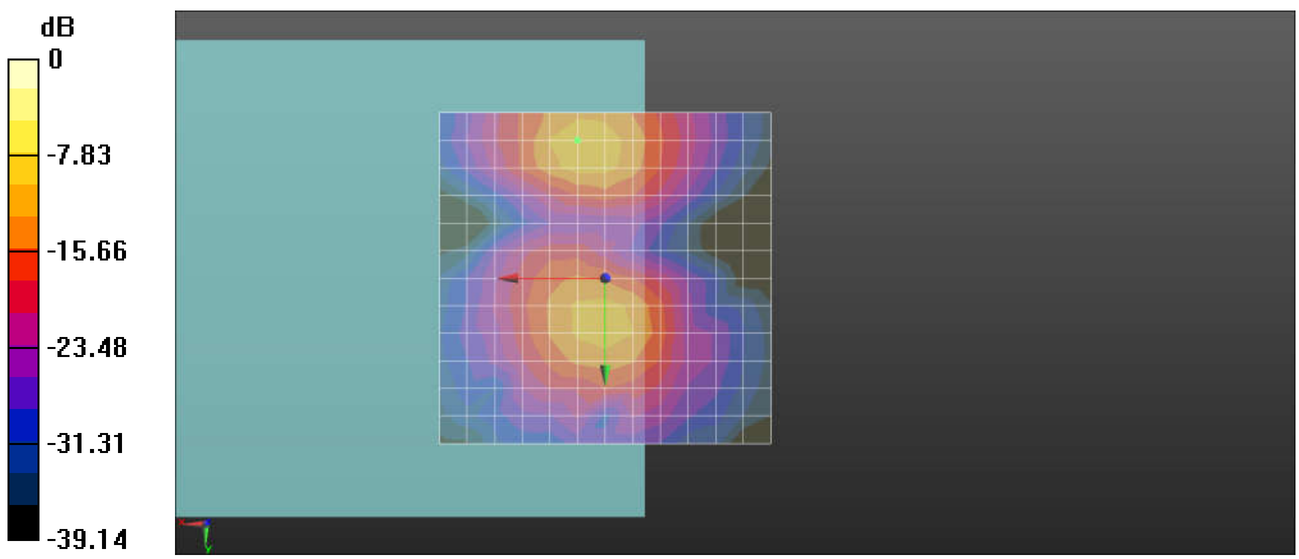
Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2018.1.16

04_HAC_T-Coil_LTE Band 4_20M_QPSK_1RB_49Offset_4.75Kbps_Ch20175(Y)

Communication System: UID 0, FDD_LTE (0); Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 0 kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 42.73 dB
ABM1 comp = -11.22 dBA/m
Location: 4.2, -20.8, 3.7 mm



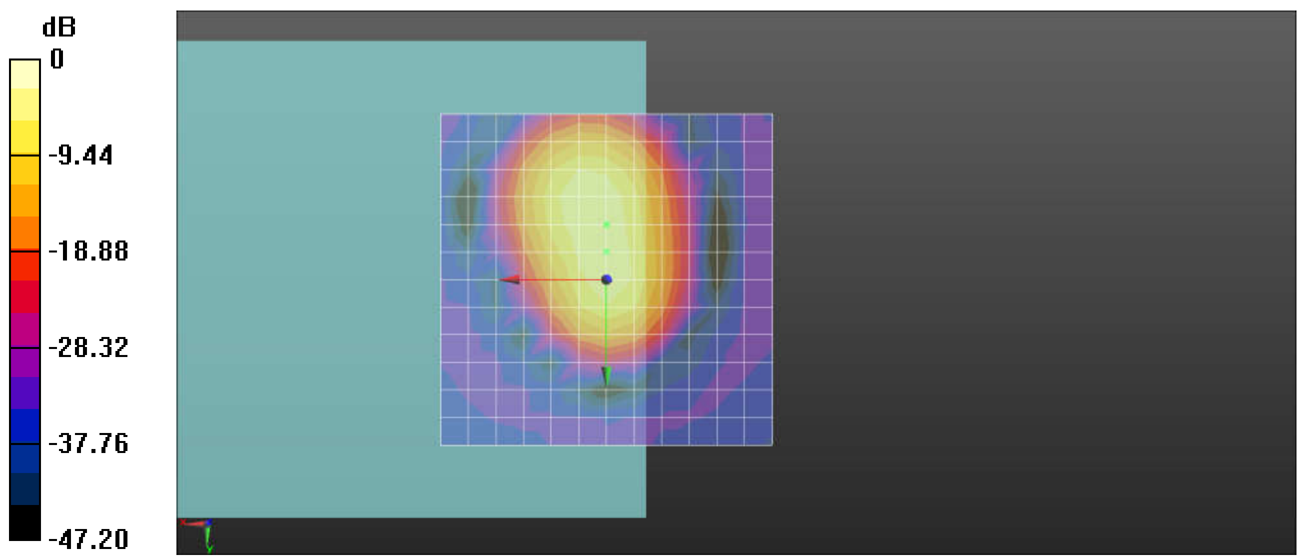
0 dB = 1.000 A/m = 0.00 dBA/m

05_HAC_T-Coil_LTE Band 5_20M_QPSK_1RB_25Offset_4.75Kbps_Ch20525(Z)

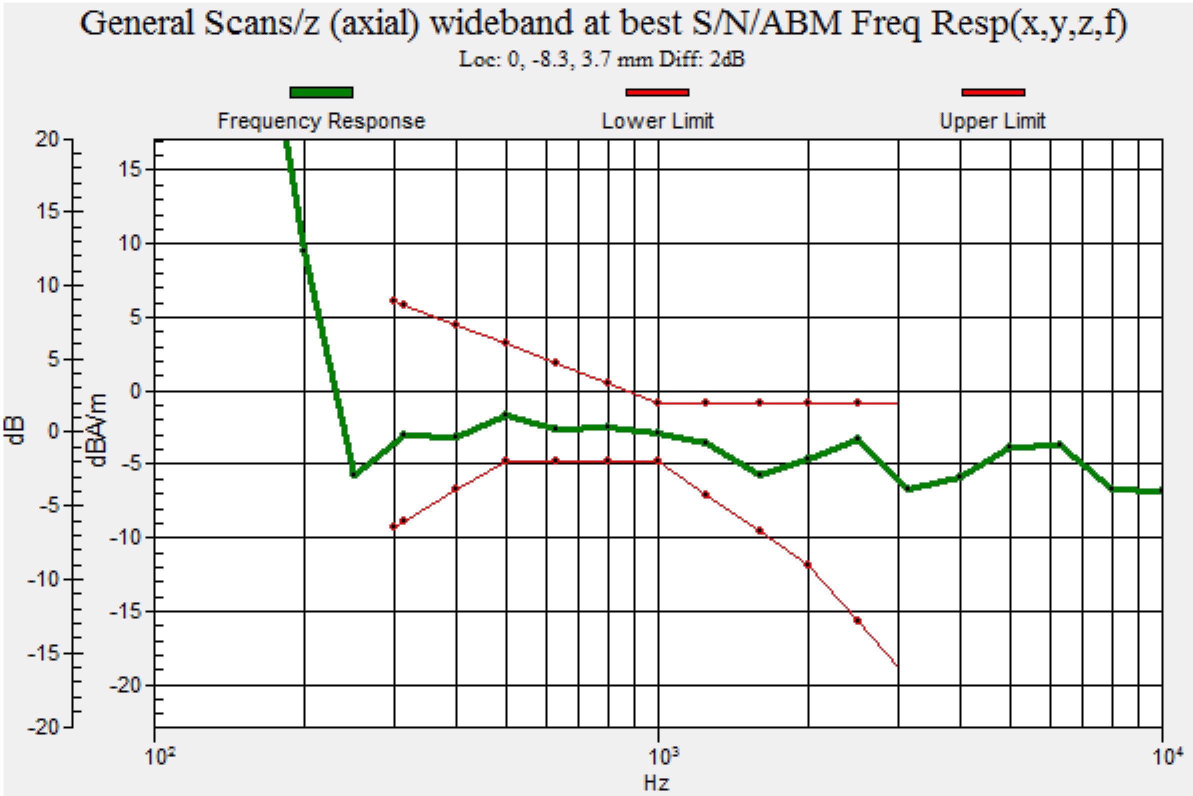
Communication System: UID 0, FDD_LTE (0); Frequency: 836.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 48.52 dB
ABM1 comp = -3.55 dBA/m
Location: 0, -8.3, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m



General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, -8.3, 3.7 mm Diff: 2dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10^2
10^3
10^4

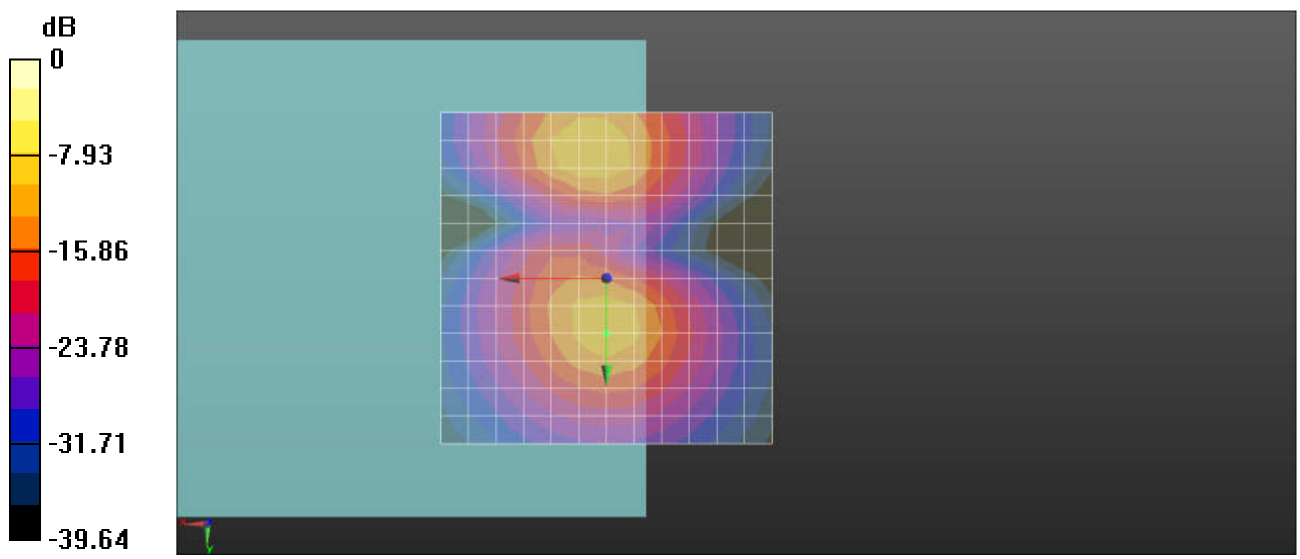
Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2018.1.16

05_HAC_T-Coil_LTE Band 5_20M_QPSK_1RB_25Offset_4.75Kbps_Ch20525(Y)

Communication System: UID 0, FDD_LTE (0); Frequency: 836.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: σ = 0 S/m, $\varepsilon_r = 1$; ρ = 0 kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 44.15 dB
ABM1 comp = -10.72 dBA/m
Location: 0, 8.3, 3.7 mm



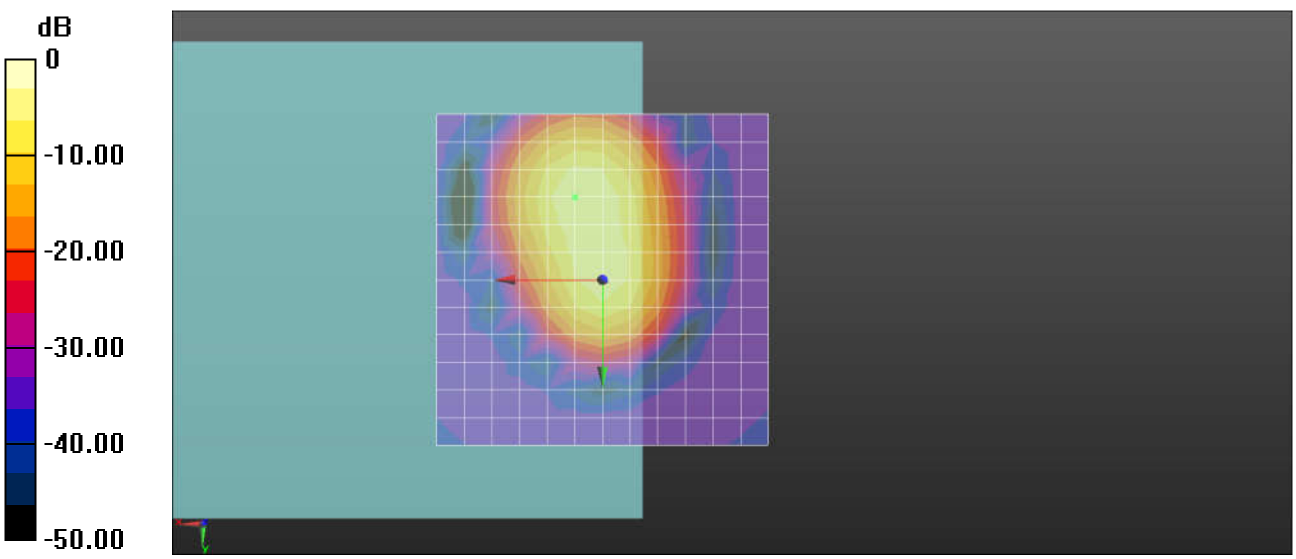
0 dB = 1.000 A/m = 0.00 dBA/m

06_HAC_T-Coil_LTE Band 12_20M_QPSK_1RB_25Offset_4.75Kbps_Ch23095(Z)

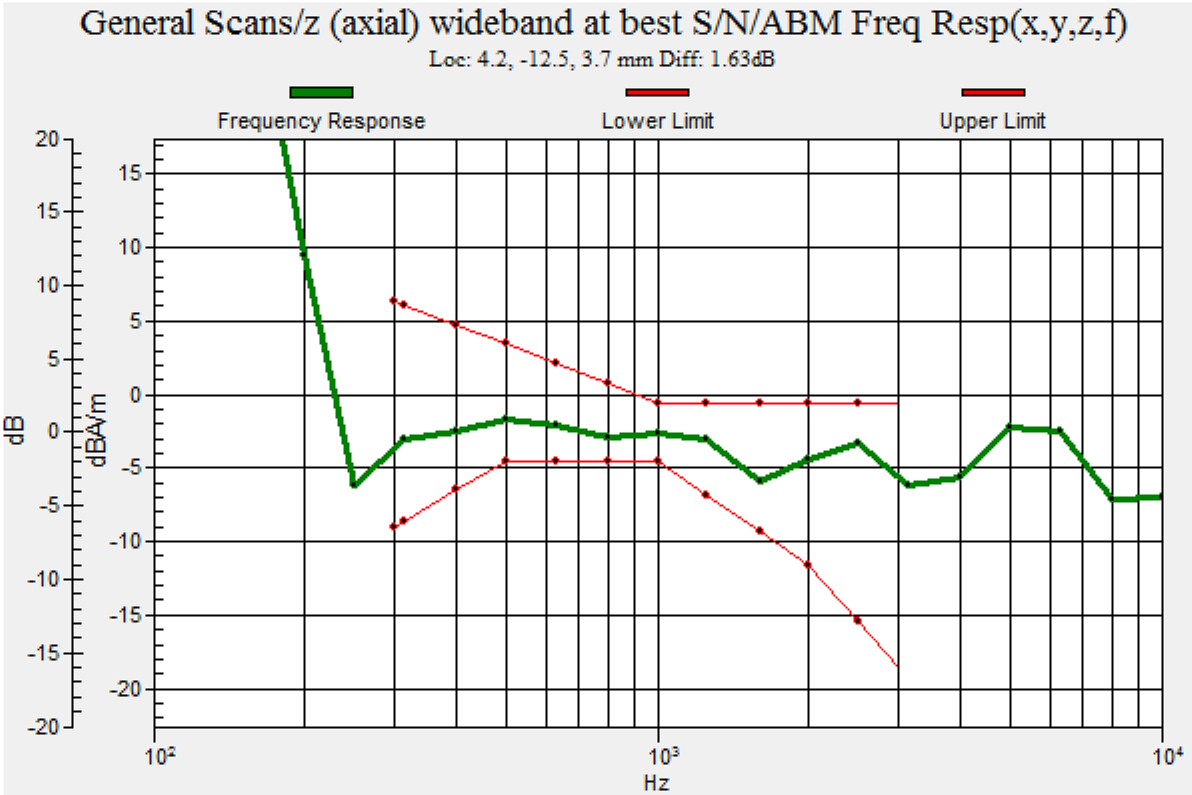
Communication System: UID 0, FDD_LTE (0); Frequency: 707.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 48.84 dB
ABM1 comp = -3.44 dBA/m
Location: 4.2, -12.5, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m



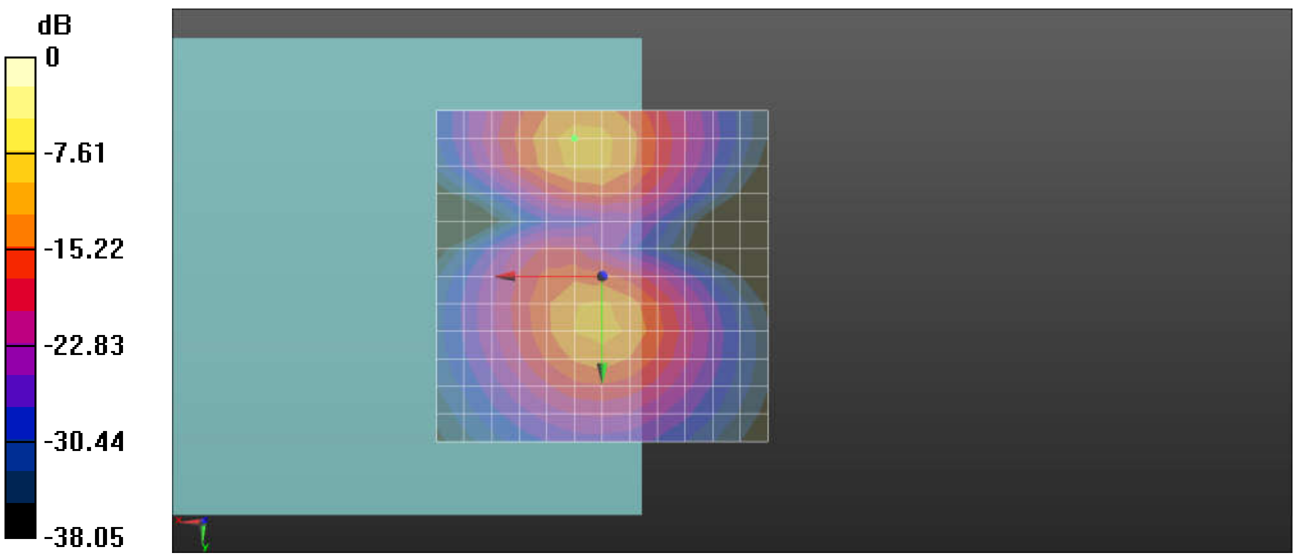
General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4.2, -12.5, 3.7 mm Diff: 1.63dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

06_HAC_T-Coil_LTE Band 12_20M_QPSK_1RB_25Offset_4.75Kbps_Ch23095(Y)

Communication System: UID 0, FDD_LTE (0); Frequency: 707.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 43.23 dB
ABM1 comp = -11.48 dBA/m
Location: 4.2, -20.8, 3.7 mm



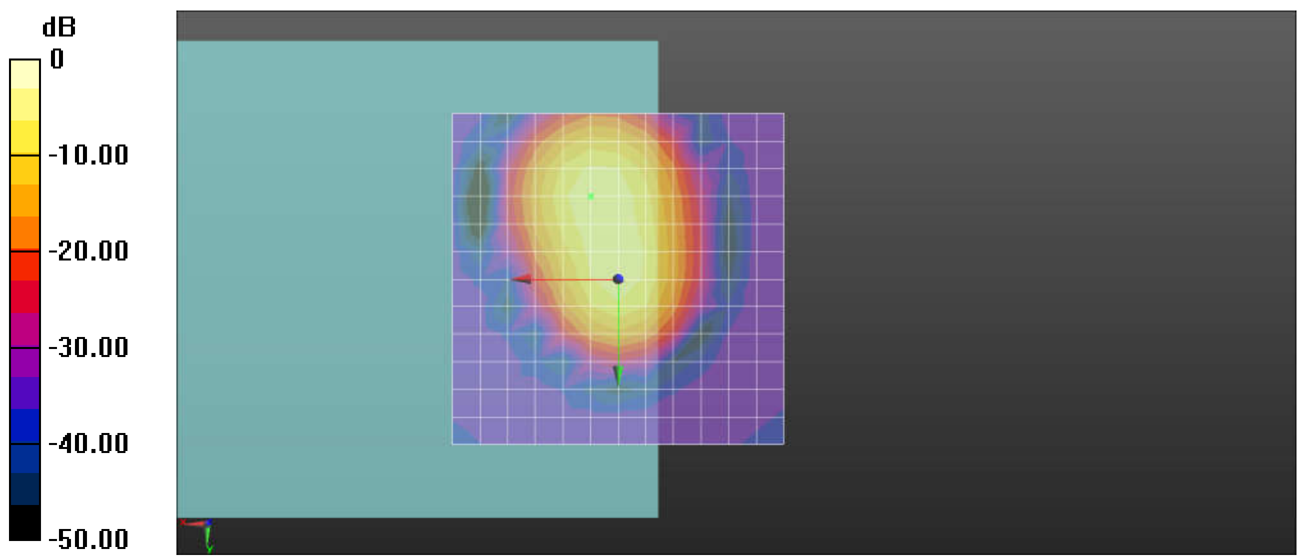
0 dB = 1.000 A/m = 0.00 dBA/m

07_HAC_T-Coil_LTE Band 25_20M_QPSK_1RB_49Offset_4.75Kbps_Ch26340(Z)

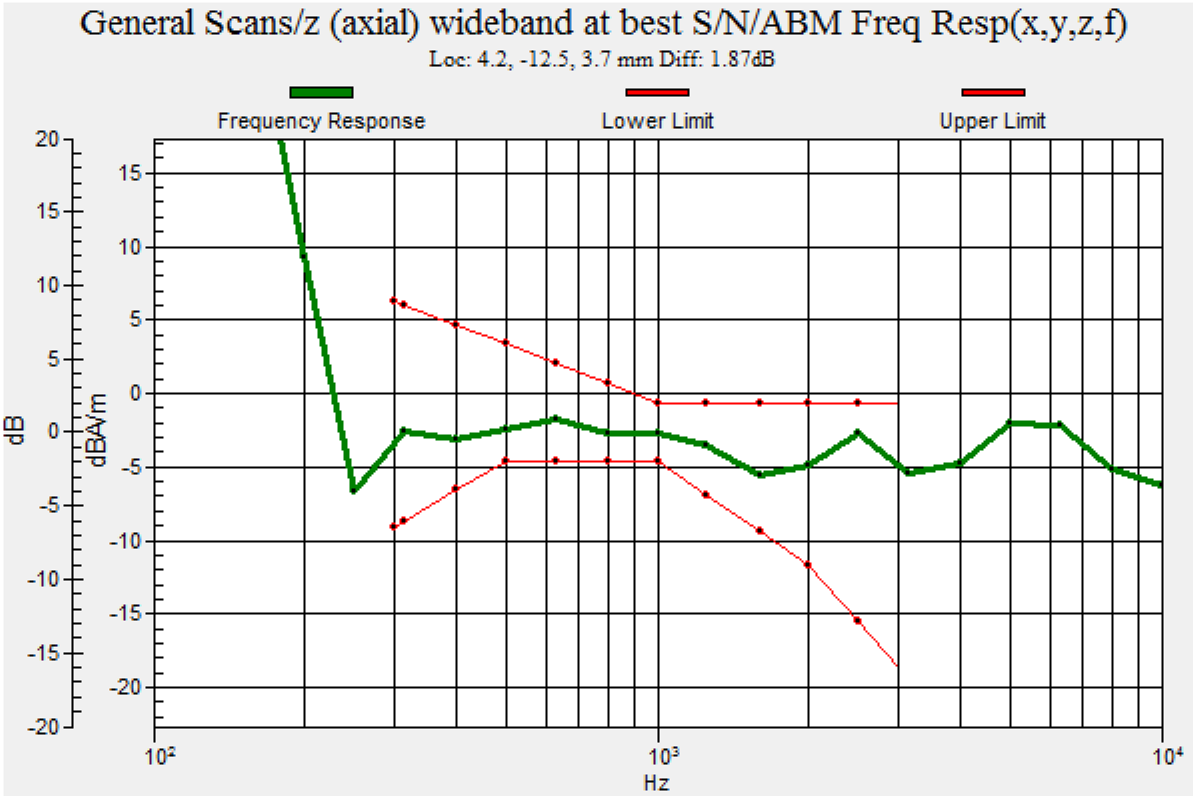
Communication System: UID 0, FDD_LTE (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 0 kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 48.31 dB
ABM1 comp = -3.50 dBA/m
Location: 4.2, -12.5, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m

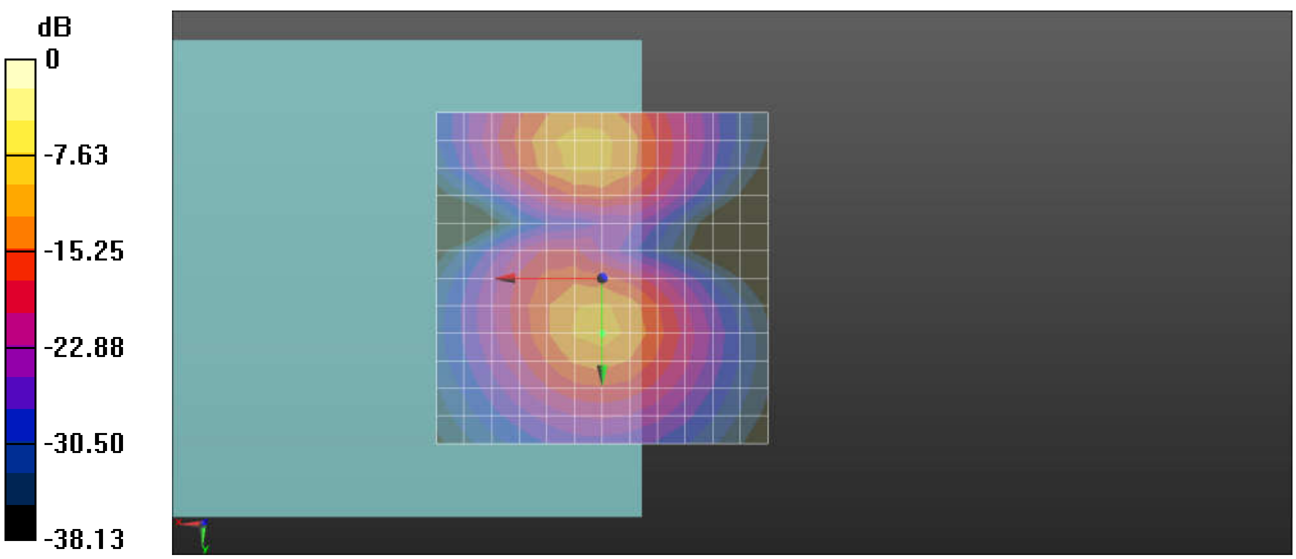

General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4.2, -12.5, 3.7 mm Diff: 1.87dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
20
15
10
5
0
-5
-10
-15
-20
10^2
10^3
10^4

07_HAC_T-Coil_LTE Band 25_20M_QPSK_1RB_49Offset_4.75Kbps_Ch26340(Y)

Communication System: UID 0, FDD_LTE (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃;

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2017.5.19
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1326; Calibrated: 2017.9.15
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 42.96 dB
ABM1 comp = -11.49 dBA/m
Location: 0, 8.3, 3.7 mm



0 dB = 1.000 A/m = 0.00 dBA/m

Appendix B. Calibration Data

The DASY calibration certificates are shown as follows.

In Collaboration with
speag
CALIBRATION LABORATORY
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Client : **Sporton International INC** **Certificate No: Z17-97153**

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 1326
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	September 15, 2017

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	27-Jun-17 (CTTL, No.J17X05859)	June-18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: September 18, 2017

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Glossary:

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters:

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.

- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.

- The report provide only calibration results for DAE, it does not contain other performance test results.

In Collaboration with
s p e a g
CALIBRATION LABORATORY
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.898 ± 0.15% (k=2)	405.241 ± 0.15% (k=2)	404.618 ± 0.15% (k=2)
Low Range	3.98840 ± 0.7% (k=2)	3.99650 ± 0.7% (k=2)	3.99854 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	41.5° ± 1 °

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

S **Schweizerischer Kalibrierdienst**
C **Service suisse d'étalonnage**
S **Servizio svizzero di taratura**
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **Sporton (Auden)**

Certificate No: AM1DV3-3093_May17

CALIBRATION CERTIFICATE

Object	AM1DV3 - SN: 3093
Calibration procedure(s)	QA CAL-24.v4 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range
Calibration date:	May 19, 2017

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	09-Sep-16 (No. 19065)	Sep-17
Reference Probe AM1DV2	SN: 1008	30-Dec-16 (No. AM1D-1008_Dec16)	Dec-17
DAE4	SN: 781	02-Sep-16 (No. DAE4-781_Sep16)	Sep-17

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	SN: 1050	01-Oct-13 (in house check Sep-15)	Oct-17
AMMI Audio Measuring Instrument	SN: 1062	26-Sep-12 (in house check Sep-15)	Oct-17

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 19, 2017

[References

[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

[2] ANSI-C63.19-2011
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

[3] DASY5 manual, Chapter: Hearing Aid Compatibility (HAC) T-Coil Extension

Description of the AM1D probe

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1+2]. The probe includes a symmetric low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface.
The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted nominally 35.3° above the measurement plane, using the connector rotation and sensor angle stated below.
The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1+2] without additional shielding.

Handling of the item

The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in a DASY system, the probe must be operated with the special probe cup provided (larger diameter).

Methods Applied and Interpretation of Parameters

- *Coordinate System:* The AM1D probe is mounted in the DASY system for operation with a HAC Test Arch phantom with AMCC Helmholtz calibration coil according to [3], with the tip pointing to "southwest" orientation.
- *Functional Test:* The functional test preceding calibration includes test of
  Noise level
  RF immunity (1kHz AM modulated signal). The shield of the probe cable must be well connected.
  Frequency response verification from 100 Hz to 10 kHz.
- *Connector Rotation:* The connector at the end of the probe does not carry any signals and is used for fixation to the DAE only. The probe is operated in the center of the AMCC Helmholtz coil using a 1 kHz magnetic field signal. Its angle is determined from the two minima at nominally +120° and –120° rotation, so the sensor in the tip of the probe is aligned to the vertical plane in z-direction, corresponding to the field maximum in the AMCC Helmholtz calibration coil.
- *Sensor Angle:* The sensor tilting in the vertical plane from the ideal vertical direction is determined from the two minima at nominally +120° and –120°. DASY system uses this angle to align the sensor for radial measurements to the x and y axis in the horizontal plane.

Sensitivity: With the probe sensor aligned to the z-field in the AMCC, the output of the probe is compared to the magnetic field in the AMCC at 1 kHz. The field in the AMCC Helmholtz coil is given by the geometry and the current through the coil, which is monitored on the precision shunt resistor of the coil.

AM1D probe identification and configuration data

Item	**AM1DV3** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 BA
Serial No	**3093**

Overall length	296 mm
Tip diameter	6.0 mm (at the tip)
Sensor offset	3.0 mm (centre of sensor from tip)
Internal Amplifier	20 dB

Manufacturer / Origin	Schmid & Partner Engineering AG, Zürich, Switzerland
Manufacturing date	March 3, 2011
Last calibration date	May 19, 2016

Calibration data

Connector rotation angle	(in DASY system)	**167.6 °**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**1.08 °**	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.00728 V / (A/m)**	+/- 2.2 % (k=2)

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.