HEARING AID COMPATIBILITY T-COIL TEST REPORT

FCC ID	:	**SRQ-Z5151V**
Equipment	:	**LTE/WCDMA/GSM(GPRS) Multi-Mode Digital Mobile Phone**
Brand Name	:	**ZTE**
T-Rating	:	**T4**
Applicant	:	**ZTE CORPORATION** **ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District,Shenzhen, Guangdong, 518057, P.R.China**
Manufacturer	:	**ZTE CORPORATION** **ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District,Shenzhen, Guangdong, 518057, P.R.China**
Standard	:	**FCC 47 CFR §20.19** **ANSI C63.19-2011**

We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this variant report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Jones Tsai

Approved by: Jones Tsai / Manager

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History of this test report

Report No.	Version	Description	Issued Date
HA831902B	Rev. 01	Initial issue of report	Oct. 29, 2018

1. General Information

Product Feature & Specification	
Applicant Name	ZTE CORPORATION
Equipment Name	LTE/WCDMA/GSM(GPRS) Multi-Mode Digital Mobile Phone
Brand Name	ZTE
FCC ID	SRQ-Z5151V
IMEI Code	990010380001975
HW Version	Z5151VHW1.0
SW Version	Z5151VV1.0.0B01
EUT Stage	Identical prototype
Exposure category	General Population/Uncontrolled Exposure
Date Tested	2018/09/15 ~ 2018/10/24
Frequency Band	GSM850: 824.2 MHz ~ 848.8 MHz GSM1900: 1850.2 MHz ~ 1909.8 MHz WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz WCDMA Band V: 826.4 MHz ~ 846.6 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 13: 779.5 MHz ~ 784.5 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	GSM/GPRS/EGPRS RMC/AMR 12.2Kbps HSDPA HSUPA HSPA+ (16QAM uplink is not supported) LTE: QPSK, 16QAM, 64QAM(downlink only) WLAN 2.4GHz : 802.11b/g/n HT20 Bluetooth BR/EDR/LE

Reviewed by: Eric Huang
Report Producer: Wan Liu

2. Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test.

Testing Laboratory	
Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No.: **SAR04-HY**

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 v03
- FCC KDB 285076 D03 HAC FAQ v01

4. Air Interface and Operating Mode

Air Interface	Band MHz	Type	C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Reduction
GSM	GSM850	VO	Yes	WLAN, BT	CMRS Voice	No
	GSM1900			WLAN, BT		No
	EDGE850	VD	Yes	WLAN, BT	Google Duo[1]	No
	EDGE1900					
UMTS	850	VO	Yes	WLAN, BT	CMRS Voice	No
	1900			WLAN, BT		No
	HSPA	VD	Yes	WLAN, BT	Google Duo[1]	No
LTE (FDD)	Band 2	VD	Yes	WLAN, BT	VoLTE / Google Duo[1]	No
	Band 4			WLAN, BT		No
	Band 5			WLAN, BT		No
	Band 13			WLAN, BT		No
Wi-Fi	2450	VD	Yes	GSM,WCDMA,LTE	VoWiFi / Google Duo[1]	No
						No
BT	2450	DT	No	GSM,WCDMA,LTE	NA	No

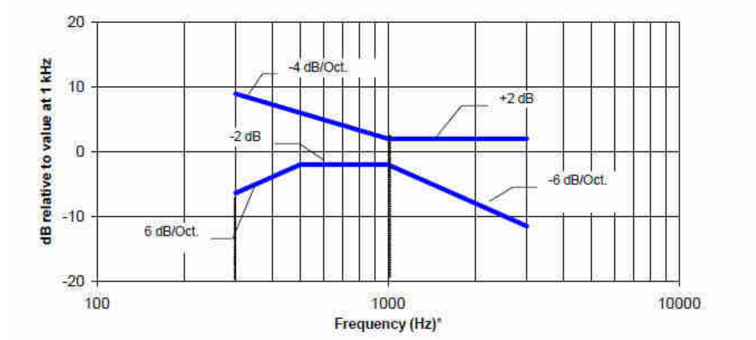
Type Transport:
VO= Voice only
DT= Digital Transport only (no voice)
VD= CMRS and IP Voice Service over Digital Transport

Remark:
1. For protocols not listed in Table 7.1 of ANSI C63.19-2011 or the ANSI C63.19-2011 VoLTE interpretation, the average speech level of −20 dBm0 should be used.

5. Measurement standards for T-Coil

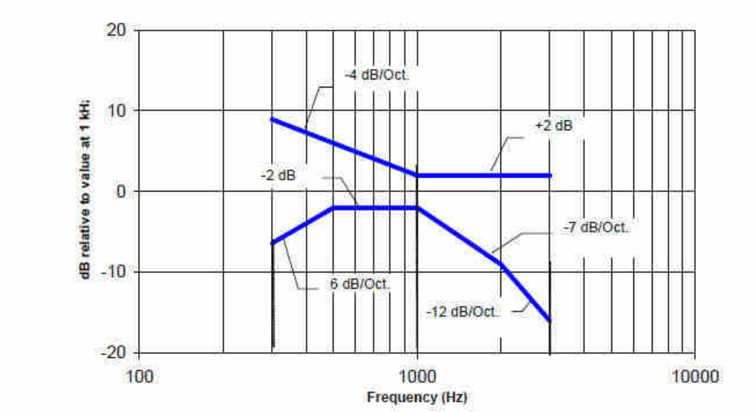
5.1 Frequency Response

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 1.1 and Figure 1.2 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. 1.1 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. 1.2 Magnetic field frequency response for WDs with a field that exceeds –15 dB(A/m) at 1 kHz

5.2 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 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 dB)
Category T1	0 to 10 dB
Category T2	10 to 20 dB
Category T3	20 to 30 dB
Category T4	> 30 dB

Table 1 T-Coil Signal Quality Categories

6. T-Coil Test Procedure

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.
f. Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input-output comparison using simulated speech. The full-band integrated probe output, as specified in D.9, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB A/m.)
g. All Measurements of the desired signal shall be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal ON and OFF with the probe measuring the same location. If the scanning method is used the scans shall show that all measurement points selected for the ABM1 measurement meet the ambient and test system noise criteria in ANSI C63.19-2011 clause 7.3.1.
h. At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in 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).
i. 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.

6.1 Test Flow Chart

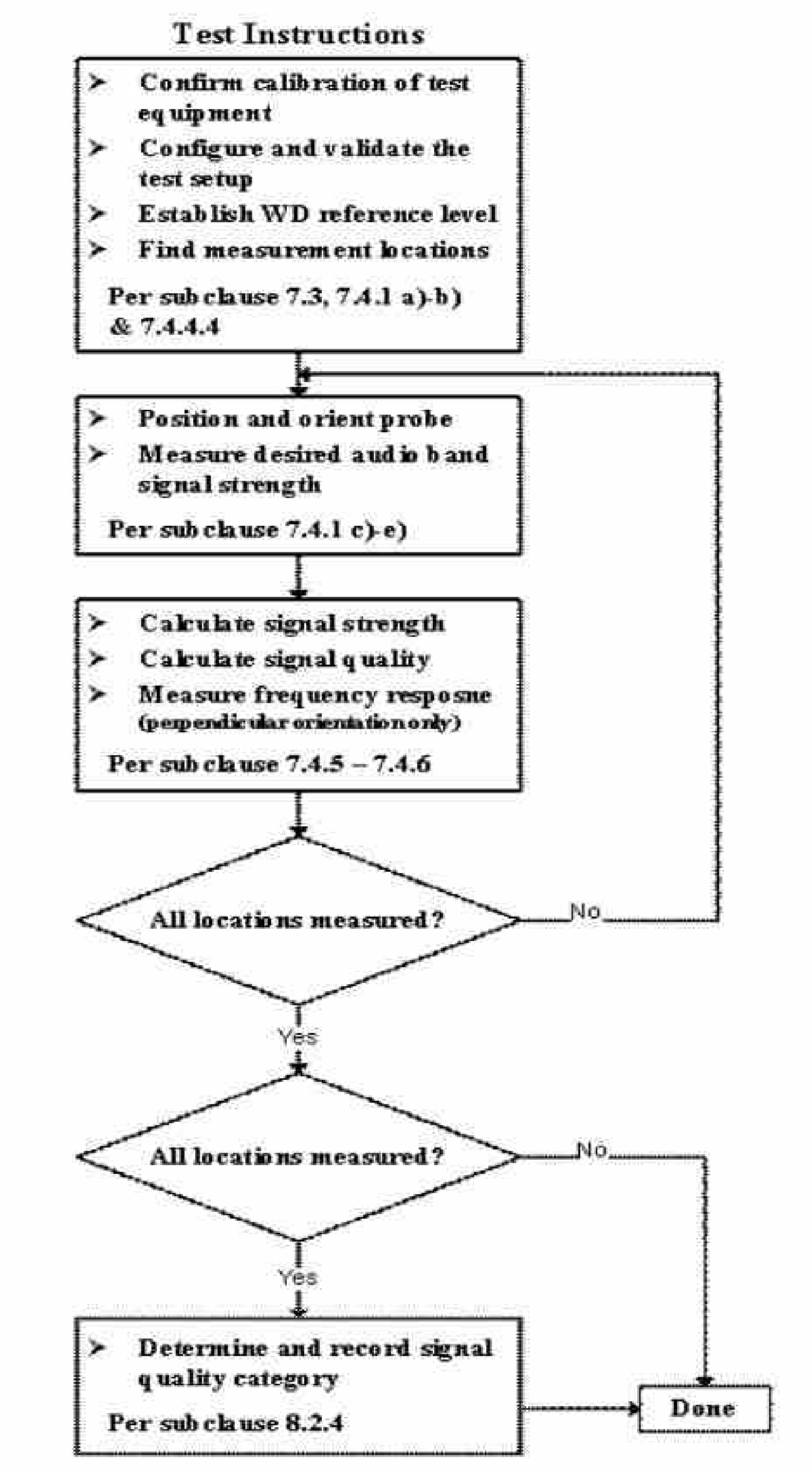
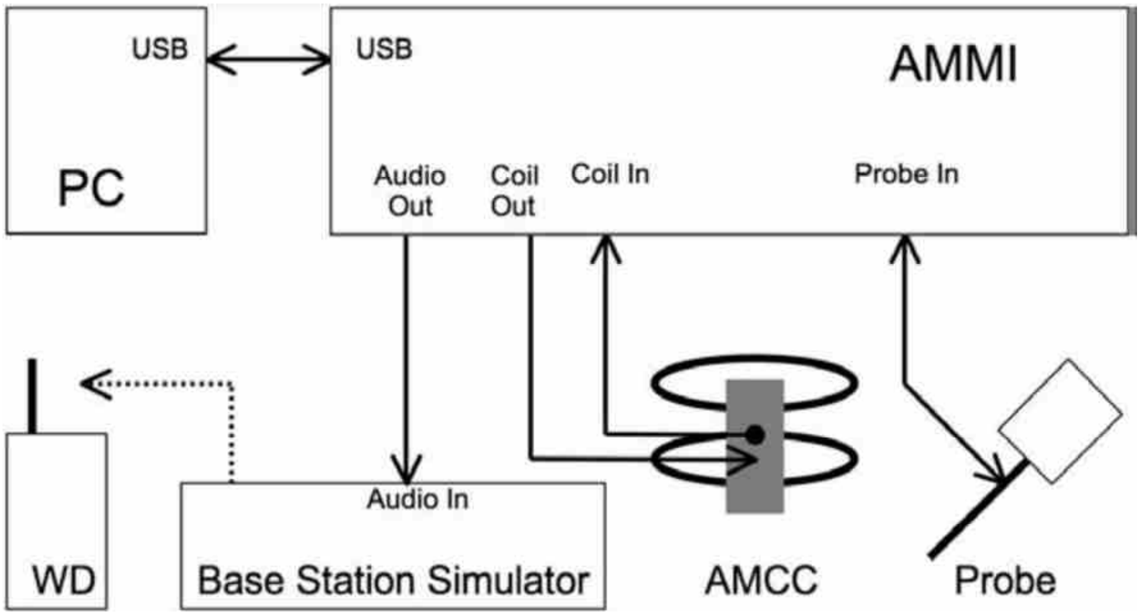


Fig. 2 T-Coil Signal Test flowchart

6.2 Test Setup Diagram



General Note:

1. Define the all applicable input audio level as below according to C63.19 and KDB 285076 D02v03:
   - GSM input level: -16dBm0
   - UMTS input level: -16dBm0
   - VoLTE input level: -16dBm0
   - VoWiFi input level: -20dBm0
   - OTT VoIP input Level: -20dBm0
2. For GSM / UMTS test setup and input level, the correct input level definition is via a communication tester CMU200's "Decoder Cal" and "Codec Cal" with audio option B52 and B85 to set the correct audio input levels.
3. CMU200 is able to output 1kHz audio signal equivalent to 3.14dBm0 at "Decoder Cal." confuguration, the signal reference is used to adjust the AMMI gain setting to reach -16dBm0 for GSM/UMTS. CMW500 input is calibrated and the relation between the analog input voltage and the internal level in dBm0 can be determined.
4. The test setup used for VoLTE over IMS is via the callbox of CMW500 for T-coil measurement, The data application unit of the CMW500 was used to simulate the IP multimedia subsystem server. The CMW500 can be manually configured to ensure and control the speech input level result is -16dBm0 for VoLTE , -20dBm0 for VoWiFi when the device during the IMS connection.
5. The test setup used for Google DUO VoIP call is via the data application unit on CMW500 connection to the Internet, also connection to the other auxiliary VoIP unit which is used to configure the audio codec and bit rate and also monitor the audio input level of -20dBm0.

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

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

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

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

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

Calculation formula:
- Audio Level at -16dBm0 = ((-16dBm0) – (3.14dBm0)) + X dBv
- Calculated Gain at -16dBm0 = 10((audio level at -16dBm0 – Y dBm0) / 20) * 10
- Gatting setting at -16dBm0 = required gain factor * calculated gain

Gain Value	20* log(gain)	AMCC Coil In	Level
(linear)	dB	(dBv RMS)	dBm0
		-2.47	3.14
10	20	-19.85	-14.24
8.17	18.24	-21.61	-16

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Required Gain Factor	Calculated Gain Setting
1kHz sine	-	3	0	1	8.17
48k_voice_1kHz	1	16.2	-12.7	4.33	35.36
48k_voice_300Hz ~ 3kHz	2	21.6	-18.6	8.48	69.25

6.3 Description of EUT Test Position

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

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

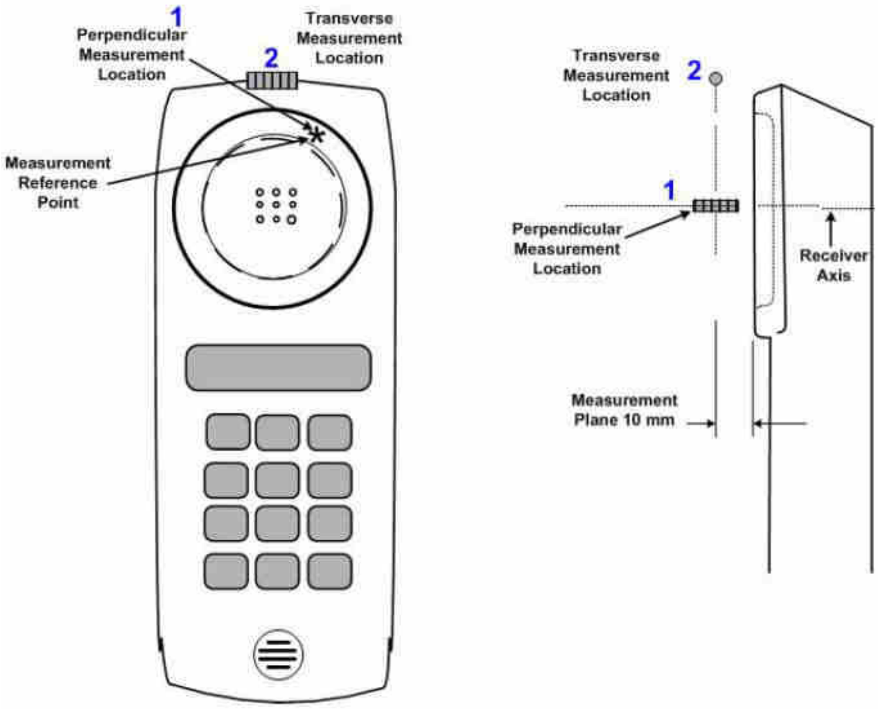


Fig.3 A typical EUT reference and plane for T-Coil measurements

7. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Data Acquisition Electronics	DAE4	1305	2018/5/11	2019/5/10
SPEAG	Data Acquisition Electronics	DAE4	854	2018/6/14	2019/6/13
SPEAG	Audio Magnetic 1D Field Probe	AM1DV3	3093	2018/5/25	2019/5/24
SPEAG	Audio Magnetic 1D Field Probe	AM1DV3	3130	2017/11/21	2018/11/20
SPEAG	Audio Magnetic Calibration Coil	AMCC	NA	NCR	NCR
SPEAG	Audio Magnetic Calibration Coil	AMCC	1049	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1128	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1041	NCR	NCR
TESTO	Hygro meter	608-H1	34913631	2018/8/27	2019/8/26
RCPTWN	Thermometer	HTC-1	TM685-1	2018/3/16	2019/3/15
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
R&S	Power Meter	NRVD	102081	2018/8/16	2019/8/15
Anritsu	Power Meter	ML2495A	1419002	2018/5/18	2019/5/17
R&S	Power Sensor	NRV-Z5	100538	2018/8/16	2019/8/15
Anritsu	Power Sensor	MA2411B	1339124	2018/5/18	2019/5/17
Anritsu	Radio Communication Analyzer	MT8820C	6201074414	2018/4/2	2019/4/1
R&S	Universal Radio Communication Tester	CMU200	116456	2018/8/3	2019/8/2
R&S	Base Station(Measure)	CMU200	116457	2018/5/30	2019/5/29

Note: NCR: “No-Calibration Required”

8. T-Coil testing for CMRS Voice

General Note:

1. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following worst investigation codec would be remarked to be used for the testing for the handset.
2. Air Interface Investigation:
   a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface.
   b. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

8.1 GSM Tests Results

<Codec Investigation>

Codec	FR_V1	HR_V1	Orientation	Band / Channel
ABM 1 (dBA/m)	8.46	8.72	Axial	GSM850 / 189
ABM 2 (dBA/m)	-33.69	-37.19		
Signal Quality (dB)	42.15	45.91		
Freq. Response	Pass	Pass		

<Air Interface Investigation>

Plot No.	Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality dB	T Rating	Ambient Noise dB (A/m)	Freq. Response Variation dB	Frequency Response
1	GSM850	Voice(speech codec handset low)	189	Axial (Z)	8.46	-33.69	42.15	T4	-49.63	1.84	Pass
				Transversal (Y)	-8.51	-48.36	39.85	T4	-49.65		
2	GSM1900	Voice(speech codec handset low)	661	Axial (Z)	8.45	-33.81	42.26	T4	-49.68	2	Pass
				Transversal (Y)	-8.61	-48.58	39.97	T4	-49.62		

8.2 UMTS Tests Results

<Codec Investigation>

Codec	AMR 4.75Kbps	AMR 7.95Kbps	AMR 12.2Kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	3.2	4.07	2.91	Axial	Band 5 / 4182
ABM 2 (dBA/m)	-48.93	-47.56	-49.5		
Signal Quality (dB)	52.13	51.63	52.41		
Freq. Response	Pass	Pass	Pass		

<Air Interface Investigation>

Plot No.	Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality dB	T Rating	Ambient Noise dB (A/m)	Freq. Response Variation dB	Frequency Response
3	WCDMA V	Voice (speech codec low)	4182	Axial (Z)	4.07	-47.56	51.63	T4	-49.68	1.33	Pass
				Transversal (Y)	-4.25	-47.33	43.08	T4	-49.64		
4	WCDMA II	Voice (speech codec low)	9400	Axial (Z)	2.91	-48.81	51.72	T4	-49.61	1	Pass
				Transversal (Y)	-5.06	-47.61	42.55	T4	-49.56		

9. T-Coil testing for CMRS IP Voice

9.1 VoLTE Tests Results

General Note:

1. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel / band, the following worst investigation codec would be remarked to be used for the testing for the handset.
2. Air Interface Investigation:
   a. Use the worst-case codec test and document a limited set of bands / channel / bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface and the following worst configure would be remarked to be used for the testing for the handset.
   b. Select LTE FDD one frequency band to do measurement at the worst SNR position was additionally performed with varying the BWs/Modulations/RB size to verify the variation to find out worst configuration , the observed variation is very little to be within 1.5 dB which is much less than the margin from the rating threshold.
   c. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

<AMR Codec Investigation>

Codec	NB AMR 4.75Kbps	WB AMR 6.60Kbps	NB AMR 12.2Kbps	WB AMR 23.85Kbps	Orientation	Band / BW / Channel
ABM 1 (dBA/m)	5.83	3.56	4.05	5.43	Axial	B2 / 20M / 18900
ABM 2 (dBA/m)	-45.99	-46.69	-46.89	-47.31		
Signal Quality (dB)	51.82	50.25	50.94	52.74		
Freq. Response	Pass	Pass	Pass	Pass		

<EVS Codec Investigation>

Codec	EVS SWB 9.6Kbps	EVS SWB 128Kbps	EVS WB 5.9Kbps	EVS WB 128Kbps	EVS NB 5.9Kbps	EVS NB 24.4Kbps	Orientation	Band / BW / Channel
ABM 1 (dBA/m)	7.17	5.22	4.02	4.14	5.19	4.59	Axial	B2 / 20M / 18900
ABM 2 (dBA/m)	-39.81	-40.9	-42.83	-42.62	-41.66	-42.27		
Signal Quality (dB)	46.98	46.12	46.85	46.76	46.85	46.86		
Freq. Response	Pass	Pass	Pass	Pass	Pass	Pass		

<Air Interface Investigation>

Air Interface	Bandwidth (MHz)	Modulation	RB size	RB offset	channel	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)
LTE Band 2	20	QPSK	1	0	18900	6.59	-44.18	50.77
LTE Band 2	20	QPSK	50	0	18900	6.44	-45.79	52.23
LTE Band 2	20	QPSK	100	0	18900	6.49	-46.64	53.13
LTE Band 2	20	16QAM	1	0	18900	6.62	-45.11	51.73
LTE Band 2	15	QPSK	1	0	18900	6.53	-45.78	52.31
LTE Band 2	10	QPSK	1	0	18900	6.53	-45.49	52.02
LTE Band 2	5	QPSK	1	0	18900	6.64	-46.90	53.54
LTE Band 2	3	QPSK	1	0	18900	6.59	-45.69	52.28
LTE Band 2	1.4	QPSK	1	0	18900	6.62	-46.01	52.63

Plot No.	Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality dB	T Rating	Ambient Noise dB (A/m)	Freq. Response Variation dB	Frequency Response
5	LTE Band 2	20	QPSK	1	0	18900	Axial (Z)	3.56	-46.69	50.25	T4	-50.12	1.96	Pass
							Transversal (Y)	-3.81	-47.86	44.05	T4	-49.98		
6	LTE Band 4	20	QPSK	1	0	20175	Axial (Z)	2.49	-47.79	50.28	T4	-50.12	1.53	Pass
							Transversal (Y)	-4.89	-47.99	43.10	T4	-50.22		
7	LTE Band 5	10	QPSK	1	0	20525	Axial (Z)	3.41	-46.15	49.56	T4	-49.99	2	Pass
							Transversal (Y)	-4.05	-47.57	43.52	T4	-50.09		
8	LTE Band 13	10	QPSK	1	0	23230	Axial (Z)	2.67	-47.86	50.53	T4	-50.25	1.69	Pass
							Transversal (Y)	-4.64	-49.27	44.63	T4	-49.99		

9.2 VoWiFi Tests Results

General Note:

1. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following worst investigation codec would be remarked to be used for the testing for the handset.
2. Air Interface Investigation:
    a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface and the following worst configure would be remarked to be used for the testing for the handset.
    b. Select WLAN 2.4GHz one frequency band to do measurement at the worst SNR position was additionally performed with varying the BWs/Modulations/data rate to verify the variation to find out worst configuration , the observed variation is very little to be within 1 dB which is much less than the margin from the rating threshold.
    c. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.

<AMR Codec Investigation>

Codec	NB AMR 4.75Kbps	WB AMR 6.60Kbps	NB AMR 12.2Kbps	WB AMR 23.85Kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	-0.2	-0.21	0.27	-0.28	Axial	2.4GHz WLAN / 6
ABM 2 (dBA/m)	-43.17	-42.5	-43.15	-42.85		
Signal Quality (dB)	42.97	42.29	43.42	42.57		
Freq. Response	Pass	Pass	Pass	Pass		

<EVS Codec Investigation>

Codec	EVS SWB 9.6Kbps	EVS SWB 128Kbps	EVS WB 5.9Kbps	EVS WB 128Kbps	EVS NB 5.9Kbps	EVS NB 24.4Kbps	Orientation	Band / BW / Channel
ABM 1 (dBA/m)	2.65	2.07	2.46	2.59	2.62	2.66	Axial	2.4GHz WLAN / 6
ABM 2 (dBA/m)	-41.66	-40.72	-41.62	-41.23	-41.28	-41.48		
Signal Quality (dB)	44.31	42.79	44.08	43.82	43.9	44.14		
Freq. Response	Pass	Pass	Pass	Pass	Pass	Pass		

<Air Interface Investigation>

Air Interface	Bandwidth (MHz)	Data Rate	channel	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality (dB)
WLAN2.4GHz	802.11b	1Mbps	6	0.86	-42.78	43.64
WLAN2.4GHz	802.11b	11Mbps	6	1.07	-43.10	44.17
WLAN2.4GHz	802.11g	6Mbps	6	1.04	-43.17	44.21
WLAN2.4GHz	802.11g	54Mbps	6	0.95	-43.11	44.06
WLAN2.4GHz	802.11n-HT20	MCS0	6	1.02	-42.99	44.01
WLAN2.4GHz	802.11n-HT20	MCS7	6	1.08	-42.76	43.84

<Summary Tests Results>

Plot No.	Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality dB	T Rating	Ambient Noise dB (A/m)	Freq. Response Variation dB	Frequency Response
9	WLAN2.4GHz	802.11b 1Mbps	6	Axial (Z)	-0.21	-42.50	42.29	T4	-50.33	1.89	Pass
				Transversal (Y)	-6.32	-39.29	32.97	T4	-50.21		

10. T-Coil testing for OTT VoIP Calling

General Notes:

1. According to the ANSI C63.19 2011 section 7.3.2, test middle channel of each frequency band for HAC testing for each orientation to determine worst HAC T-Coil rating.
2. The google Duo VoIP application are pre-installed on this device. According to KDB 285076 D02, all air interfaces via a data connection with VoIP application need to be considered HAC testing.
3. The Google Duo only support OPUS audio codec and support 6Kbps to 75Kbps bitrate.
4. The test setup used for OTT VoIP call is the DUT connect to the CMW500 and via the data application unit on CMW500 connection to the Internet, the Auxiliary EUT is connected to the WiFi access point, the channel/Modulation/Frequency bands/data rate is configured on the CMW500 for the DUT unit. For the Auxiliary VoIP unit which is used to configure the audio codec rate and determine the audio input level of -20dBm0 based on the KDB 285076 D02v03 requirement.
5. Codec Investigation: For a voice service/air interface, investigate the variations of codec configurations (WB, NB bit rate) and document the parameters (ABM1, ABM2, S+N/N, frequency response) for that voice service. It is only necessary to document this for one channel/band, the following tests results which the worst case codec would be remarked to be used for the testing for the handset.
6. Air Interface Investigation:
   a. Use the worst-case codec test and document a limited set of bands/channel/bandwidths. Observe the effect of changing the band and bandwidth to ensure that there are no unexpected variations. Using the knowledge of the observed variations, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface.
   b. Due to OTT service and CMRS IP service are all be established over the internet protocol for the voice service, and on both services use the identical RF air interface for the WIFI and LTE, therefore according to VoLTE and VoWiFi test results of air interface investigation, the worst configuration and frequency band of air interface was used for OTT T-Coil testing.
   -LTE FDD worst configuration and band: LTE Band 2/20MHz/QPSK/1RB Size
   -WLAN2.4GHz worst configuration: 802.11b /1Mbps

<Google Duo Codec Investigation>

EDGE

Codec	Opus 6kbps	Opus 40kbps	Opus 75kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	4.93	5.16	4.11	Axial	GSM850 / 189
ABM 2 (dBA/m)	-32.31	-32.07	-31.11		
Signal Quality (dB)	37.24	37.23	35.22		
Freq. Response	Pass	Pass	Pass		

Remark: According to codec investigation, the worst codec bitrate is 75Kbps

HSPA

Codec	Opus 6kbps	Opus 40kbps	Opus 75kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	0.49	2.75	2.93	Axial	UMTS B2 / 9400
ABM 2 (dBA/m)	-42.87	-38.93	-38.13		
Signal Quality (dB)	43.36	41.68	41.06		
Freq. Response	Pass	Pass	Pass		

Remark: According to codec investigation, the worst codec bitrate is 75Kbps

LTE FDD

Codec	Opus 6kbps	Opus 40kbps	Opus 75kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	0.82	1.57	0.41	Axial	B2 / 20M / 18900
ABM 2 (dBA/m)	-42.14	-39.52	-38.77		
Signal Quality (dB)	42.96	41.09	39.18		
Freq. Response	Pass	Pass	Pass		

Remark: According to codec investigation, the worst codec bitrate is 75Kbps

WLAN

Codec	Opus 6kbps	Opus 40kbps	Opus 75kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	0.46	1	2.44	Axial	WLAN2.4G / 6
ABM 2 (dBA/m)	-39.38	-38.17	-34.75		
Signal Quality (dB)	39.84	39.17	37.19		
Freq. Response	Pass	Pass	Pass		

Remark: According to codec investigation, the worst codec bitrate is 75Kbps

<Air Interface Investigation>

Plot No.	Air Interface	Mode	Channel	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality dB	T Rating	Ambient Noise dB (A/m)	Freq. Response Variation dB	Frequency Response
10	GSM850	EDGE 2 Tx slots	189	Axial (Z)	4.11	-31.11	35.22	T4	-50.36	1.72	Pass
				Transversal (Y)	-9.59	-43.36	33.77	T4	-50.24		
11	GSM1900	EDGE 2 Tx slots	661	Axial (Z)	4.03	-31.77	35.80	T4	-50.37	1.82	Pass
				Transversal (Y)	-5.76	-41.06	35.30	T4	-50.23		
12	WCDMA II	HSPA	9400	Axial (Z)	2.93	-38.13	41.06	T4	-50.33	1.6	Pass
				Transversal (Y)	-6.66	-44.74	38.08	T4	-50.22		
13	WCDMA V	HSPA	4182	Axial (Z)	1.08	-39.63	40.71	T4	-50.34	1.71	Pass
				Transversal (Y)	-6.42	-44.67	38.25	T4	-50.21		
14	LTE Band 4	20M_QPSK_1_0	20175	Axial (Z)	0.41	-38.77	39.18	T4	-50.32	1.69	Pass
				Transversal (Y)	-8.72	-44.73	36.01	T4	-50.21		
15	WLAN2.4GHz	802.11b 1Mbps	6	Axial (Z)	2.44	-34.75	37.19	T4	-50.36	1.65	Pass
				Transversal (Y)	-10.05	-40.42	30.37	T4	-50.25		

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.
3. Test Engineer: Tom Jiang Galen Chang Iran Wang and Steven Chang

11. 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 8.2.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (ABM1)	Ci (ABM2)	Standard Uncertainty (ABM1)	Standard Uncertainty (ABM2)
Probe Sensitivity							
Reference Level	3.0	Normal	1	1	1	± 3.0 %	± 3.0 %
AMCC Geometry	0.4	Rectangular	√3	1	1	± 0.2 %	± 0.2 %
AMCC Current	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Probe Positioning During Calibrate	0.1	Rectangular	√3	1	1	± 0.1 %	± 0.1 %
Noise Contribution	0.7	Rectangular	√3	0.0143	1	± 0.0 %	± 0.4 %
Frequency Slope	5.9	Rectangular	√3	0.1	1	± 0.3 %	± 3.5 %
Probe System							
Repeatability / Drift	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Linearity / Dynamic Range	0.6	Rectangular	√3	1	1	± 0.4 %	± 0.4 %
Acoustic Noise	1.0	Rectangular	√3	0.1	1	± 0.1 %	± 0.6 %
Probe Angle	2.3	Rectangular	√3	1	1	± 1.4 %	± 1.4 %
Spectral Processing	0.9	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	0.6	Normal	1	1	5	± 0.6 %	± 3.0 %
Field Disturbation	0.2	Rectangular	√3	1	1	± 0.1 %	± 0.1 %
Test Signal							
Reference Signal Spectral Response	0.6	Rectangular	√3	0	1	± 0.0 %	± 0.4 %
Positioning							
Probe Positioning	1.9	Rectangular	√3	1	1	± 1.1 %	± 1.1 %
Phantom Thickness	0.9	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
EUT Positioning	1.9	Rectangular	√3	1	1	± 1.1 %	± 1.1 %
External Contributions							
RF Interference	0.0	Rectangular	√3	1	0.3	± 0.0 %	± 0.0 %
Test Signal Variation	2.0	Rectangular	√3	1	1	± 1.2 %	± 1.2 %
Combined Standard Uncertainty						± 4.1 %	± 6.1 %
Coverage Factor for 95 %						K = 2	
Expanded Uncertainty						± 8.1 %	± 12.3 %

Table 8.2 Uncertainty Budget of audio band magnetic measurement

12. 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 (e.g., LTE and WiFi) to support CMRS based telephone services”, Sep 2017
[4] FCC KDB 285076 D03v01, “Hearing aid compatibility frequently asked questions”, Sep 2017
[5] SPEAG DASY System Handbook

Appendix A. Plots of T-Coil Measurement

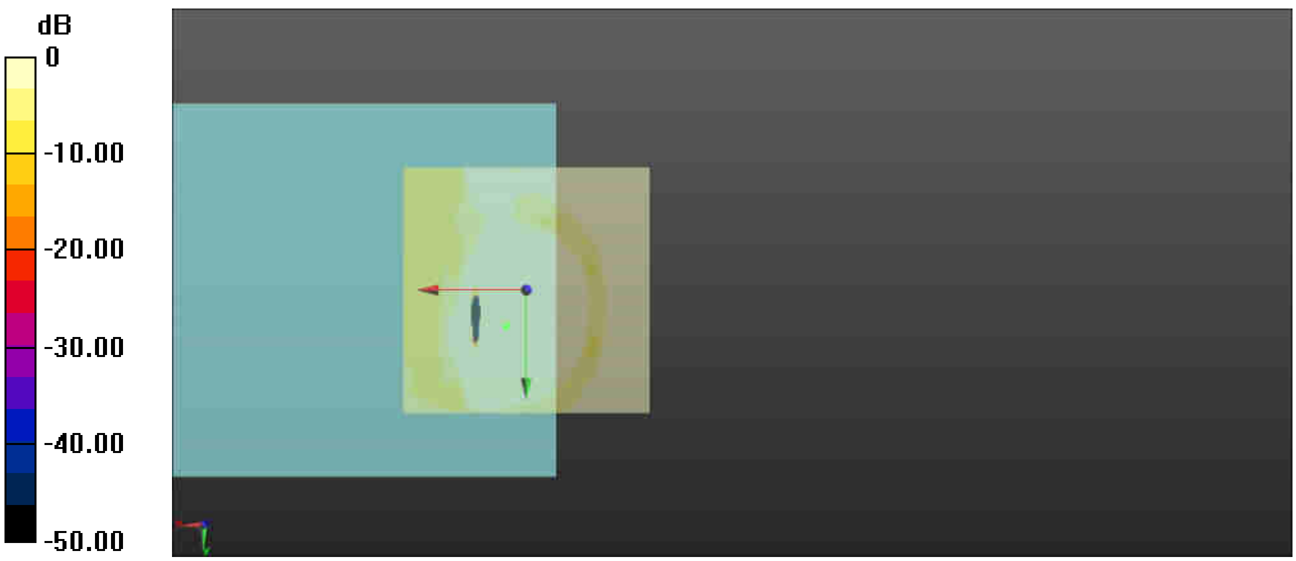
The plots are shown as follows.

1 HAC T-Coil GSM850_Voice_Ch189_FR（Z）

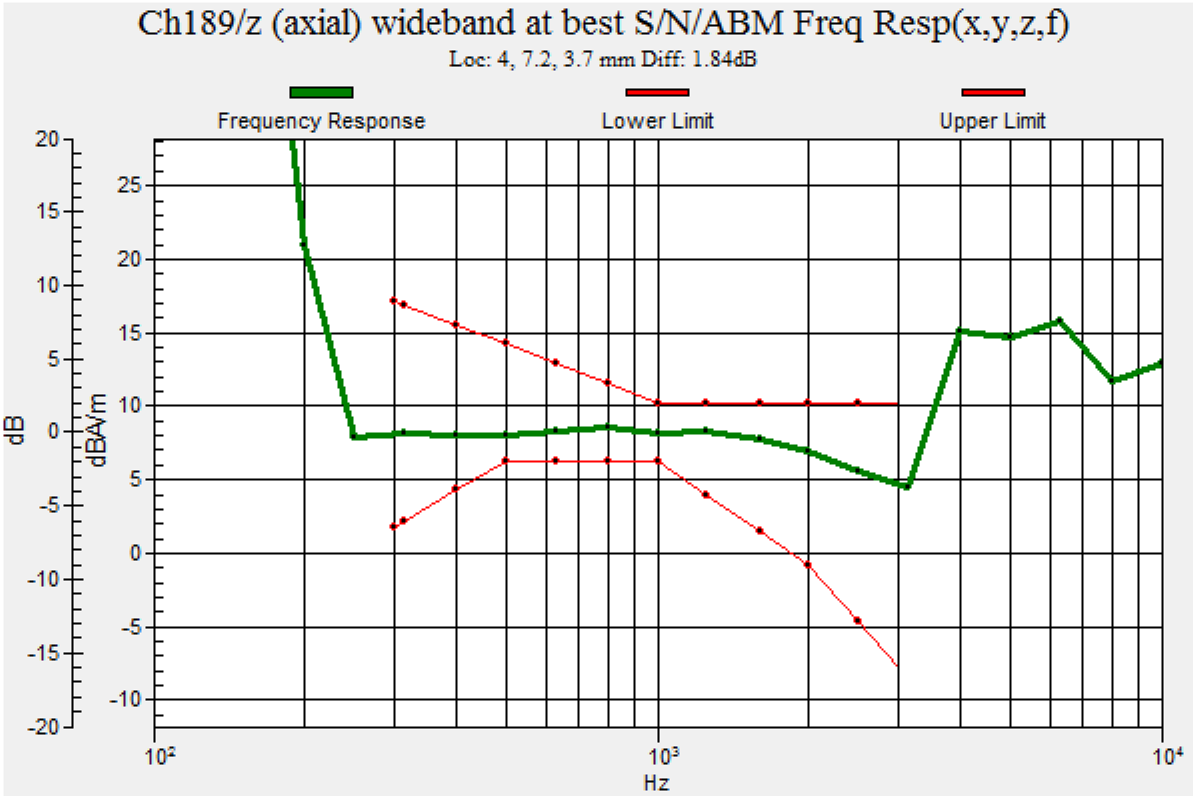
Communication System: UID 0, GSM850 (0); Frequency: 836.4 MHz;Duty Cycle: 1:8.30042
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch189/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.15 dB
ABM1 comp = 8.46 dBA/m
Location: 4.2, 7.5, 3.7 mm



0 dB = 1.000 = 0.00 dB



Ch189/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4, 7.2, 3.7 mm Diff: 1.84dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2018.9.15

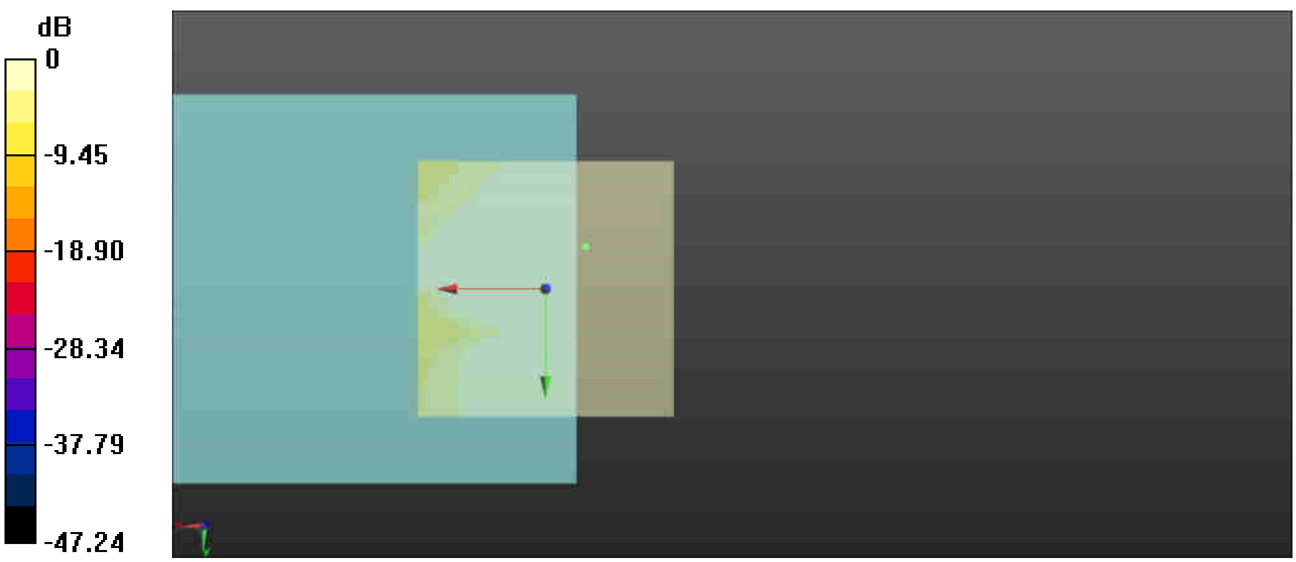
1 HAC T-Coil GSM850_Voice_Ch189_FR（Y）

Communication System: UID 0, GSM850 (0); Frequency: 836.4 MHz;Duty Cycle: 1:8.30042
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: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch189/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 39.85 dB
ABM1 comp = -8.51 dBA/m
Location: -7.9, -8.3, 3.7 mm



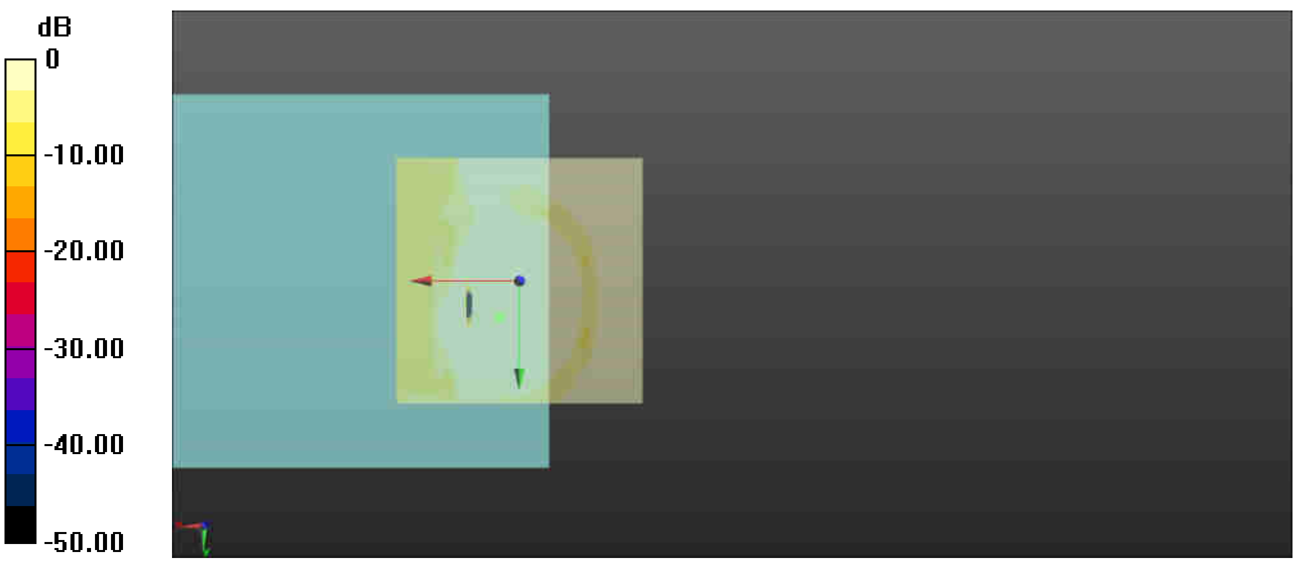
0 dB = 1.000 = 0.00 dB

2 HAC T-Coil GSM 1900_Voice_Ch661_FR（Z）

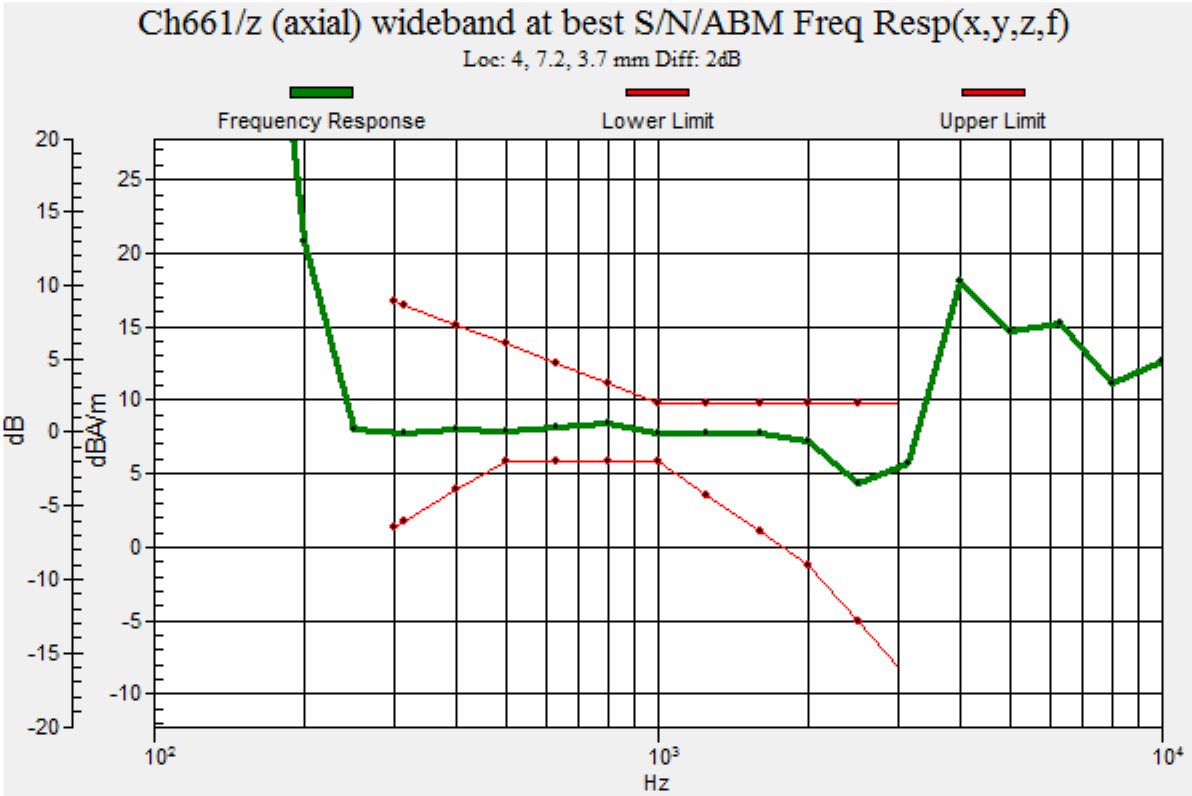
Communication System: UID 0, PCS (0); Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch661/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.26 dB
ABM1 comp = 8.45 dBA/m
Location: 4.2, 7.5, 3.7 mm



0 dB = 1.000 = 0.00 dB



Ch661/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4, 7.2, 3.7 mm Diff: 2dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

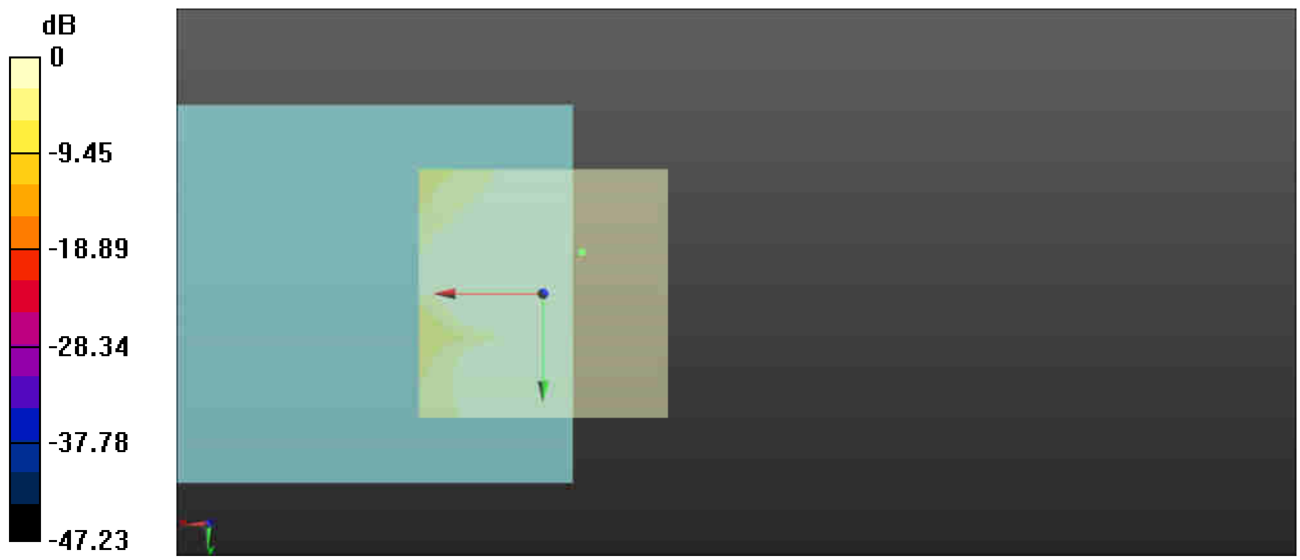
2 HAC T-Coil GSM 1900_Voice_Ch661_FR (Y)

Communication System: UID 0, PCS (0); Frequency: 1880 MHz;Duty Cycle: 1:8.3
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: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch661/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 39.97 dB
ABM1 comp = -8.61 dBA/m
Location: -7.9, -8.3, 3.7 mm



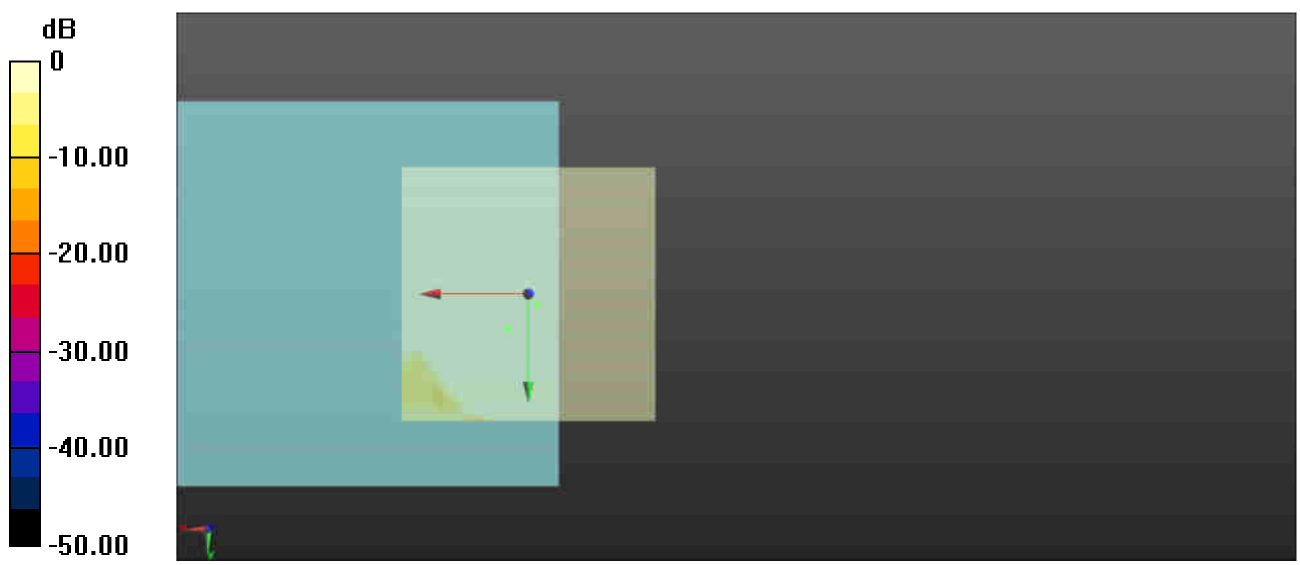
0 dB = 1.000 = 0.00 dB

3 HAC T-Coil WCDMA V_Voice AMR 7.95Kbps_Ch4182（Z）

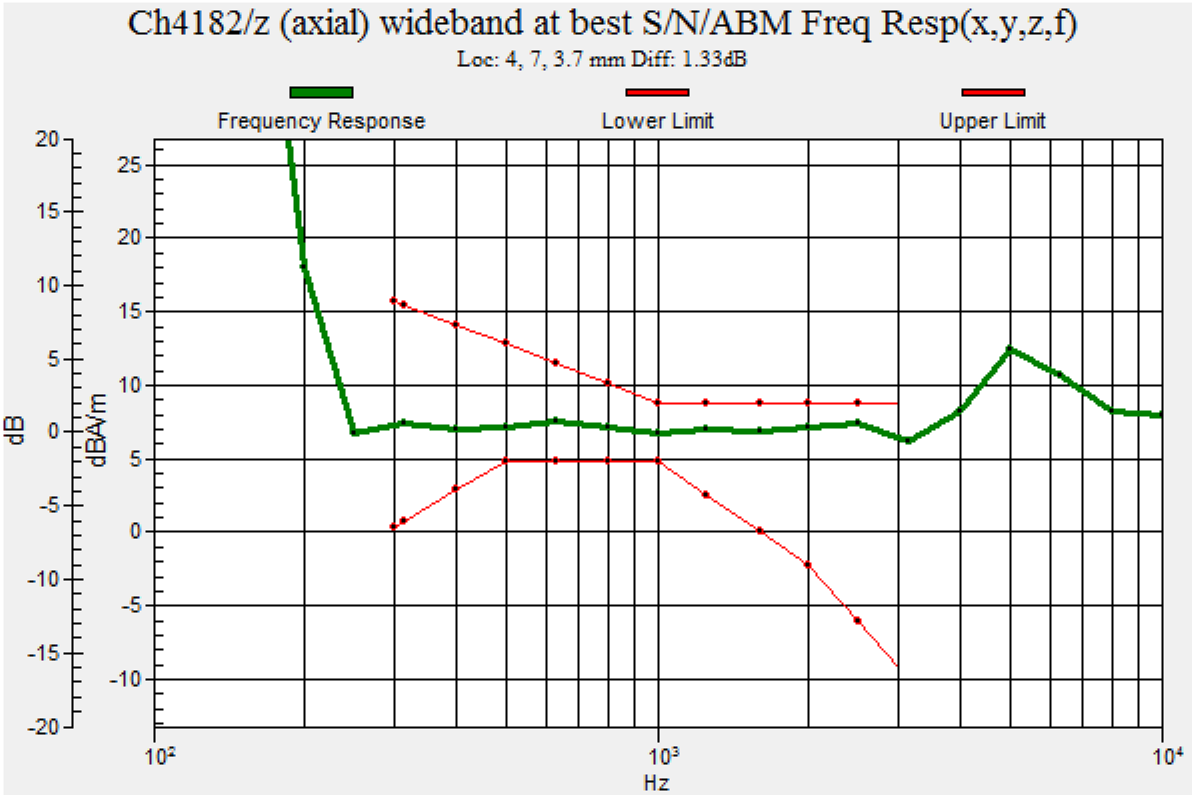
Communication System: UID 0, WCDMA (0); Frequency: 836.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch4182/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 51.63 dB
ABM1 comp = 4.07 dBA/m
Location: -1.7, 2.1, 3.7 mm



0 dB = 1.000 = 0.00 dB



Ch4182/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4, 7, 3.7 mm Diff: 1.33dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

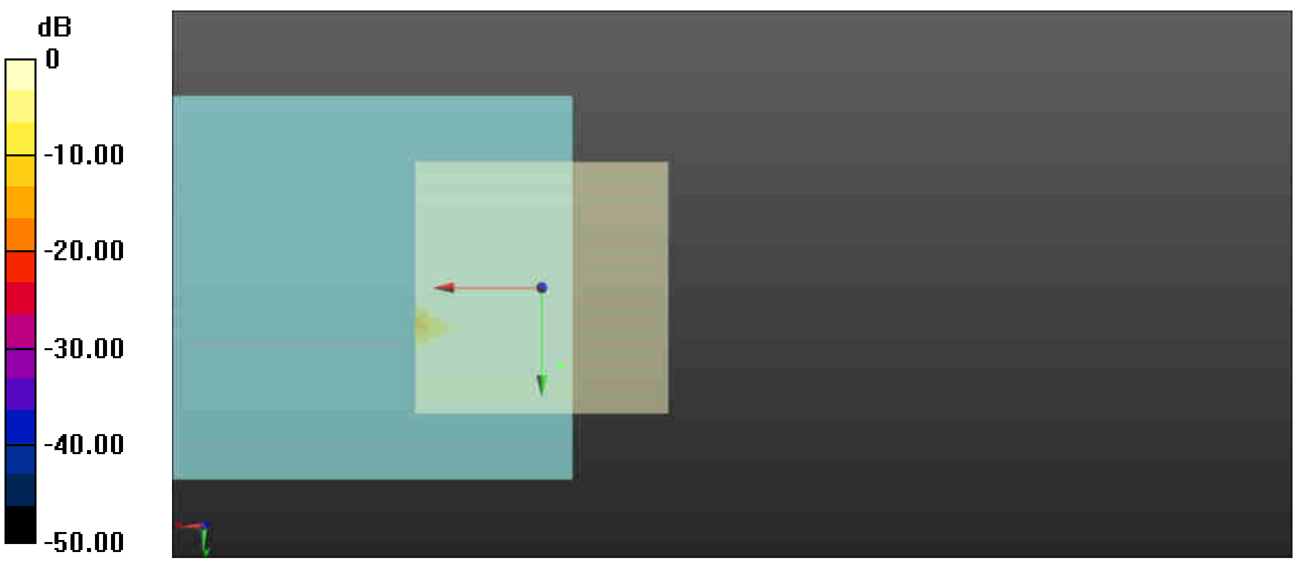
3 HAC T-Coil WCDMA V_Voice _AMR 7.95Kbps_Ch4182（Y）

Communication System: UID 0, WCDMA (0); Frequency: 836.4 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: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch4182/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 43.08 dB
ABM1 comp = -4.25 dBA/m
Location: -3.7, 15.4, 3.7 mm



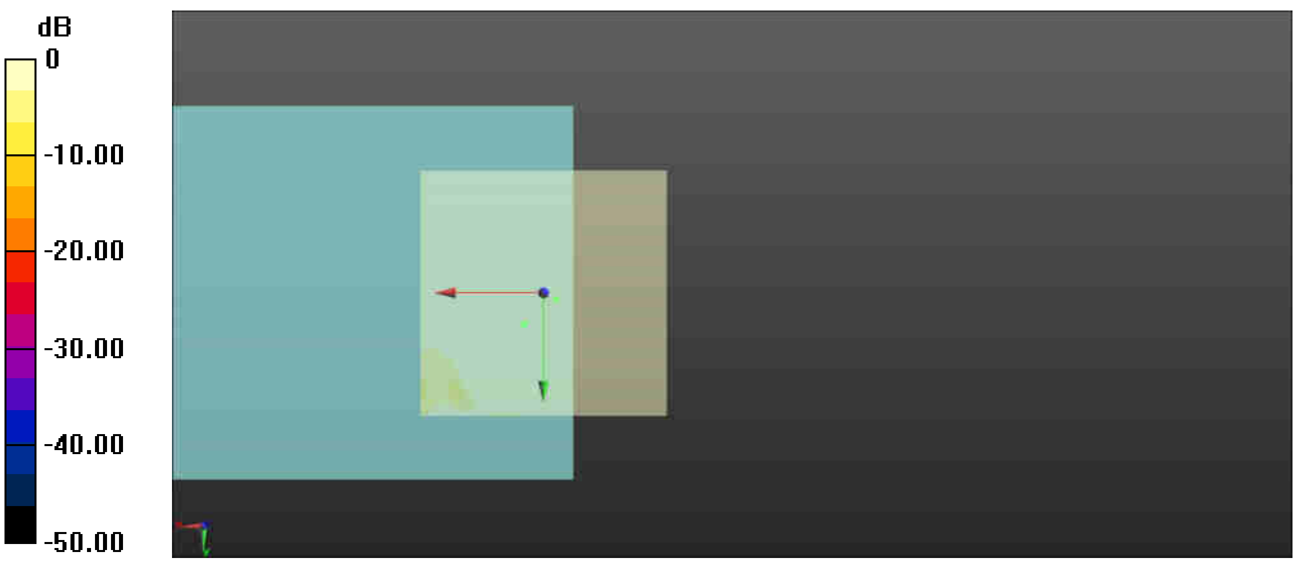
0 dB = 1.000 = 0.00 dB

4 HAC T-Coil WCDMA V_Voice AMR 7.95Kbps_Ch9400（Z）

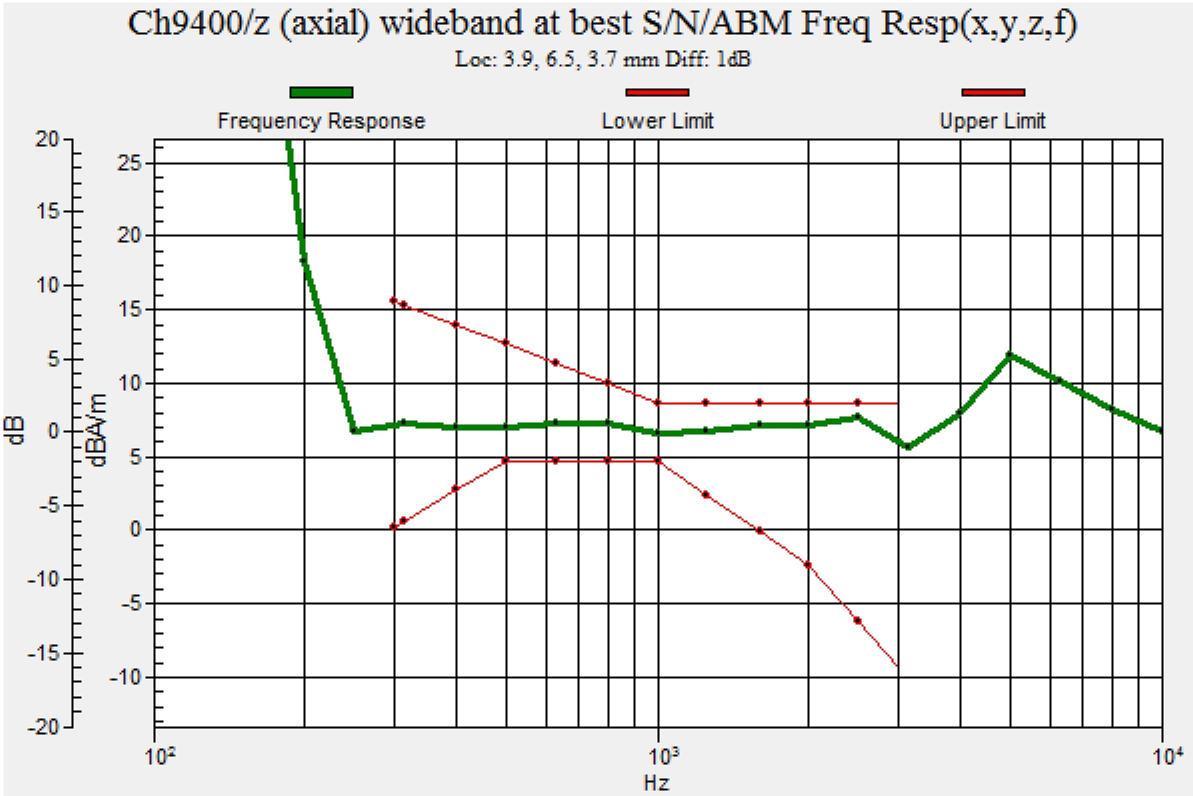
Communication System: UID 0, WCDMA (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 0 kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch9400/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 51.72 dB
ABM1 comp = 2.91 dBA/m
Location: -2.5, 1.2, 3.7 mm



0 dB = 1.000 = 0.00 dB


Ch9400/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 3.9, 6.5, 3.7 mm Diff: 1dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
20
15
10
5
0
-5
-10
-15
-20
25
20
15
10
5
0
-5
-10
10²
10³
10⁴

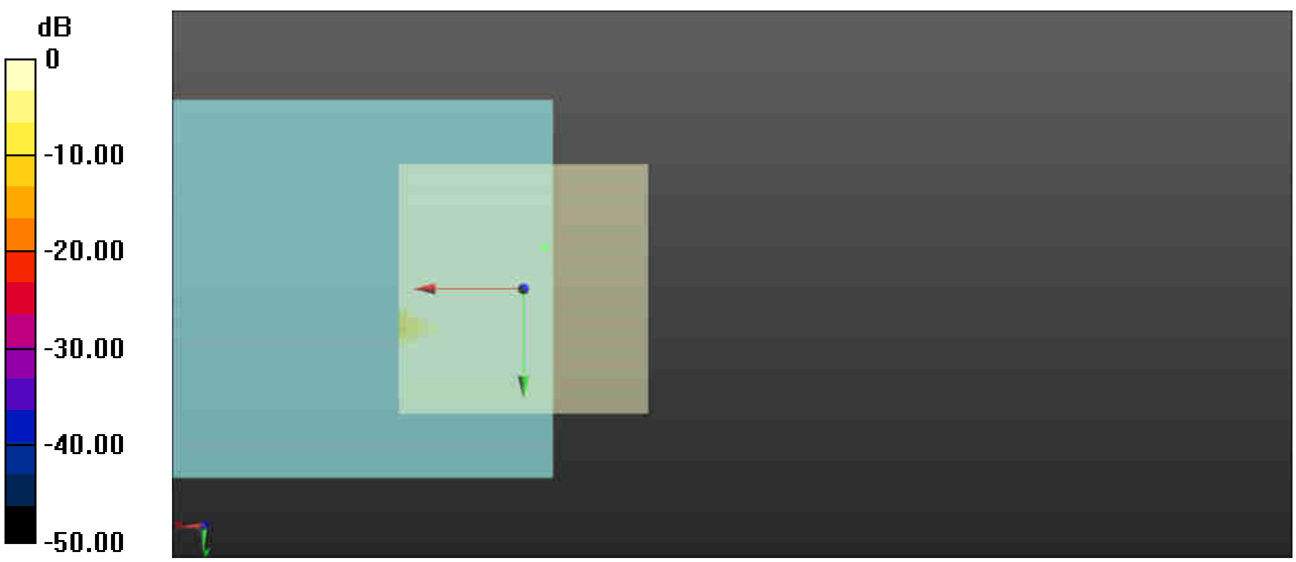
4 HAC T-Coil WCDMA V_Voice AMR 7.95Kbps_Ch9400（Y）

Communication System: UID 0, WCDMA (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: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

Ch9400/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.55 dB
ABM1 comp = -5.06 dBA/m
Location: -4.2, -8.3, 3.7 mm



0 dB = 1.000 = 0.00 dB

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2018.9.15

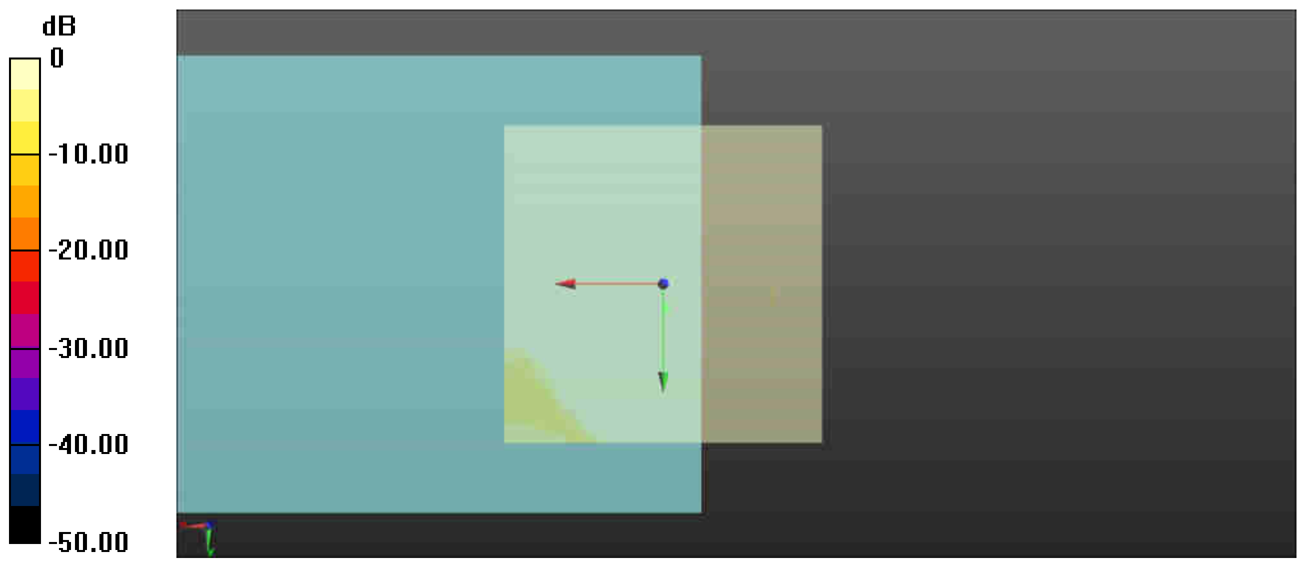
5_HAC_T-Coil_LTE Band 2_20M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_Ch18900(Z)

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 ℃

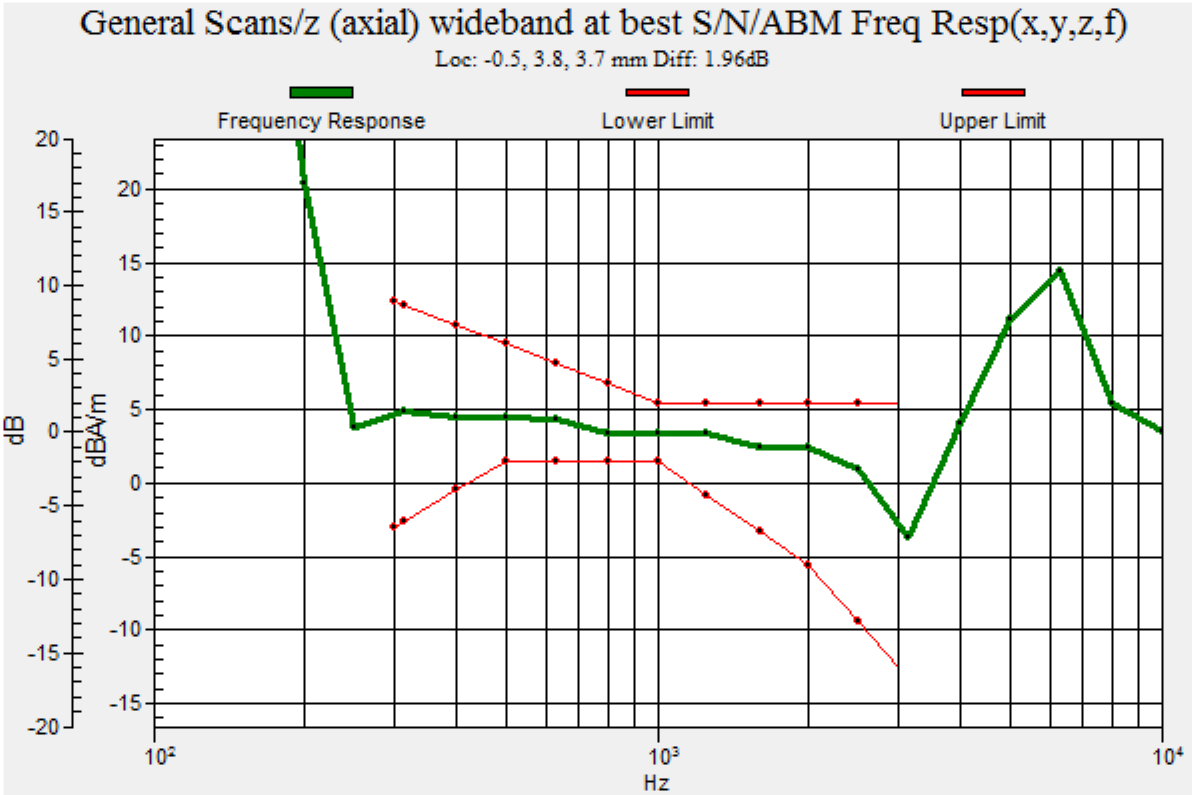
DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 50.25 dB
ABM1 comp = 3.56 dBA/m
Location: -0.4, 3.7, 3.7 mm



0 dB = 1.000 = 0.00 dB

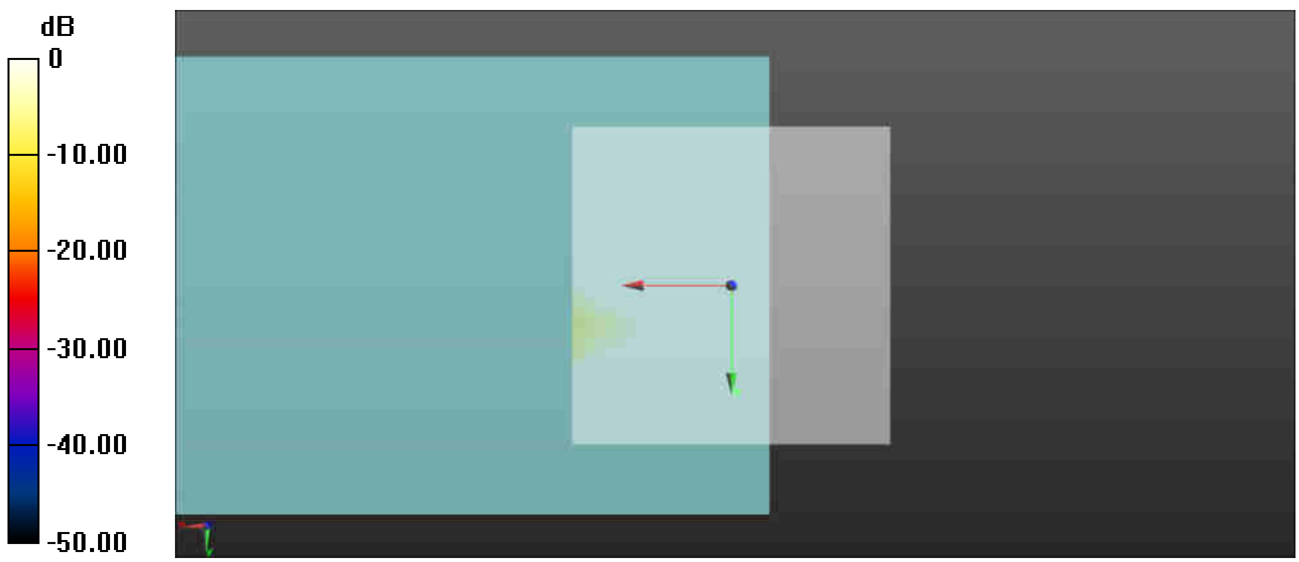

General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -0.5, 3.8, 3.7 mm Diff: 1.96dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
20
15
10
5
0
-5
-10
-15
-20
10^2
10^3
10^4

5_HAC_T-Coil_LTE Band 2_20M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_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：23.0 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 44.05 dB
ABM1 comp = -3.81 dBA/m
Location: -0.8, 16.7, 3.7 mm



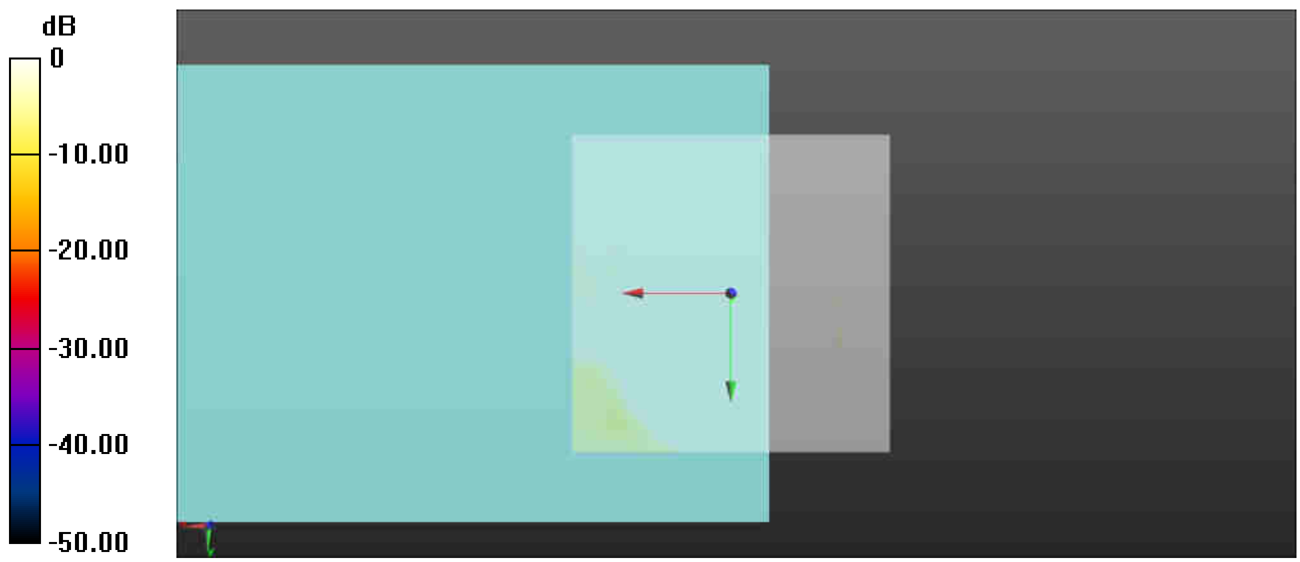
0 dB = 1.000 = 0.00 dB

6_HAC_T-Coil_LTE Band 4_20M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_Ch20175(Z)

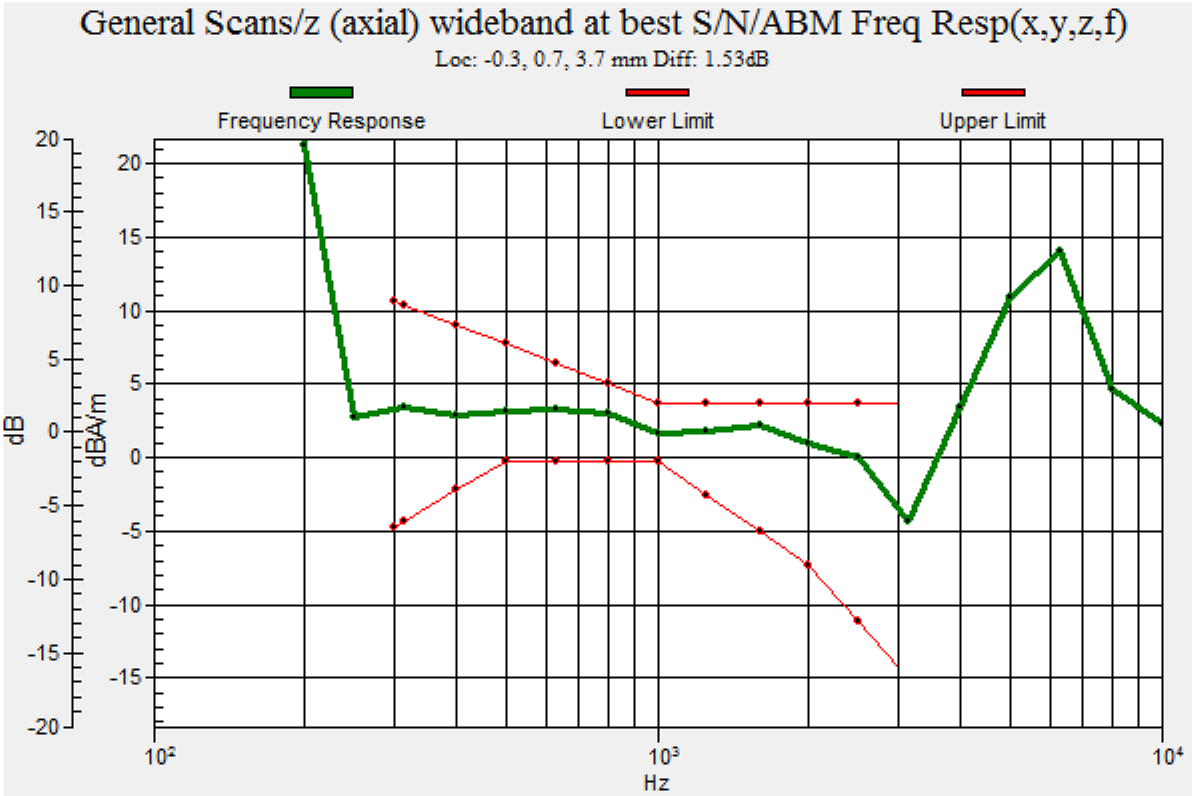
Communication System: UID 0, LTE (0); Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 50.28 dB
ABM1 comp = 2.49 dBA/m
Location: -0.4, 0.8, 3.7 mm



0 dB = 1.000 = 0.00 dB

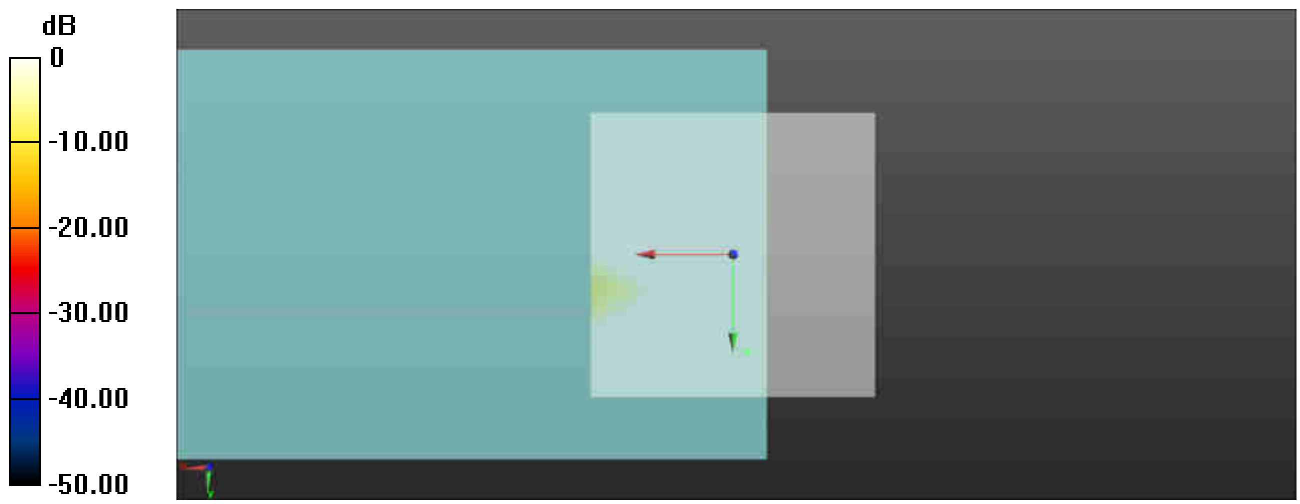

General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -0.3, 0.7, 3.7 mm Diff: 1.53dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10²
10³
10⁴
20
15
10
5
0
-5
-10
-15
-20

6_HAC_T-Coil_LTE Band 4_20M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_Ch20175(Y)

Communication System: UID 0, 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: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 43.10 dB
ABM1 comp = -4.89 dBA/m
Location: -2.5, 17.1, 3.7 mm



0 dB = 1.000 = 0.00 dB

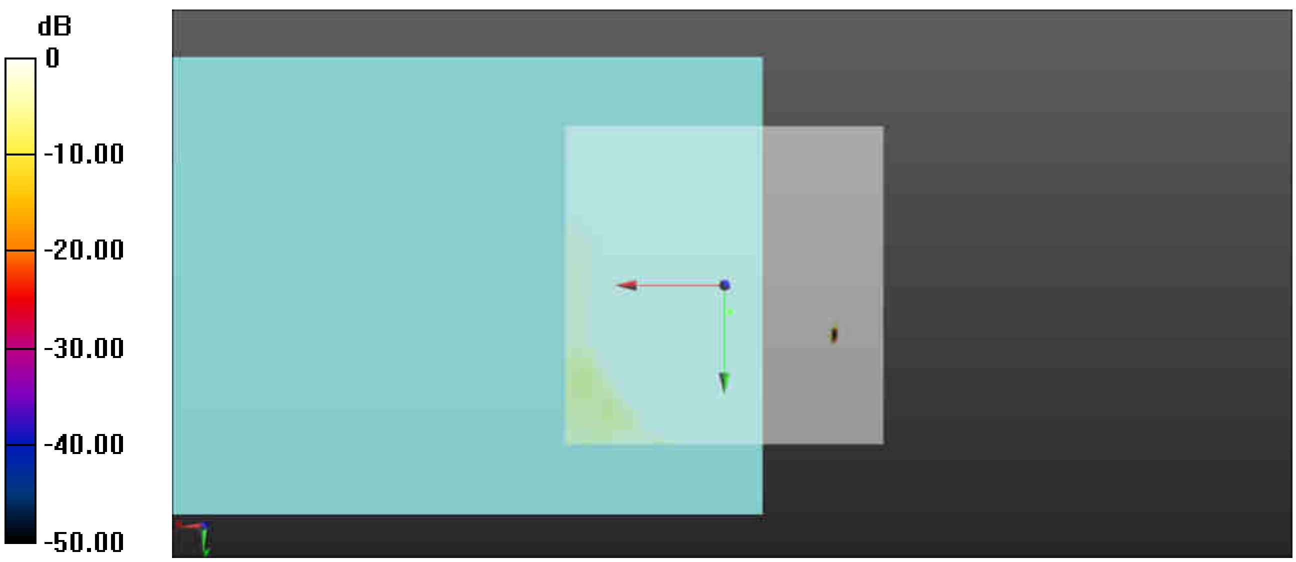
7_HAC_T-Coil_LTE Band 5_10M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_Ch20525(Z)

Communication System: UID 0, 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 ℃

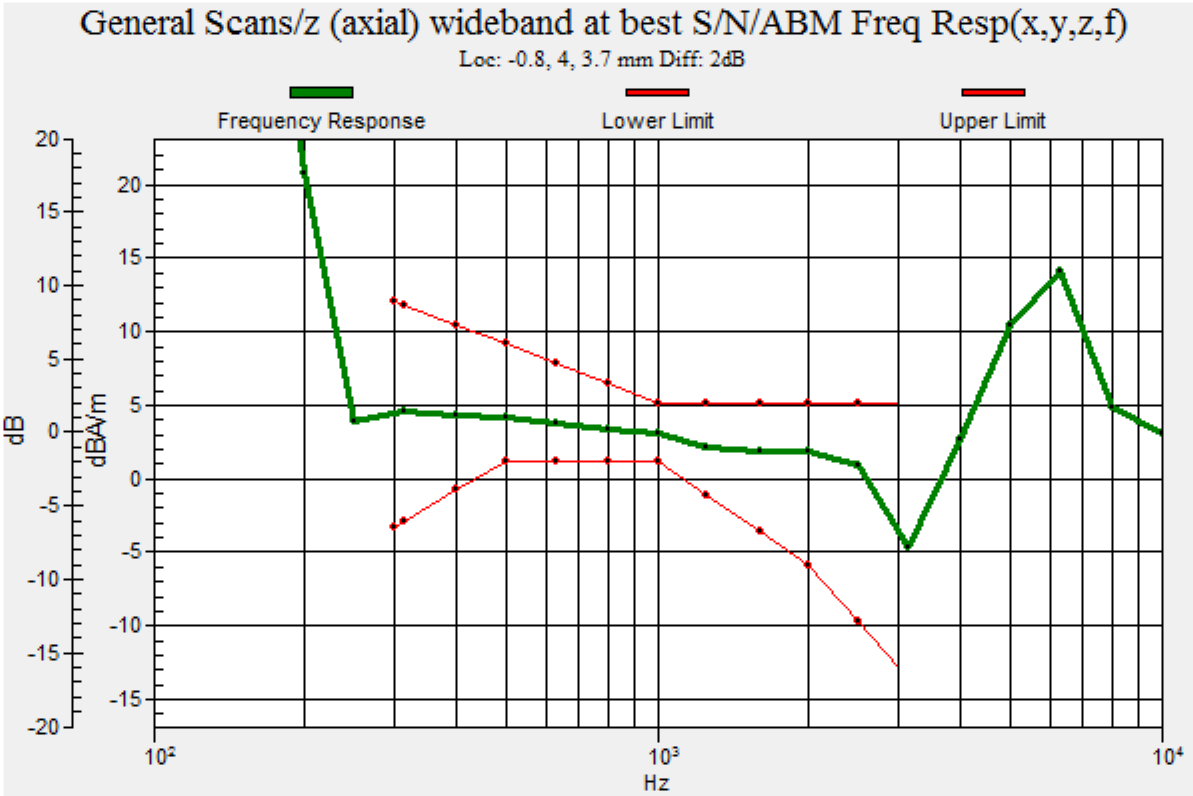
DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 49.56 dB
ABM1 comp = 3.41 dBA/m
Location: -0.8, 4.2, 3.7 mm



0 dB = 1.000 = 0.00 dB



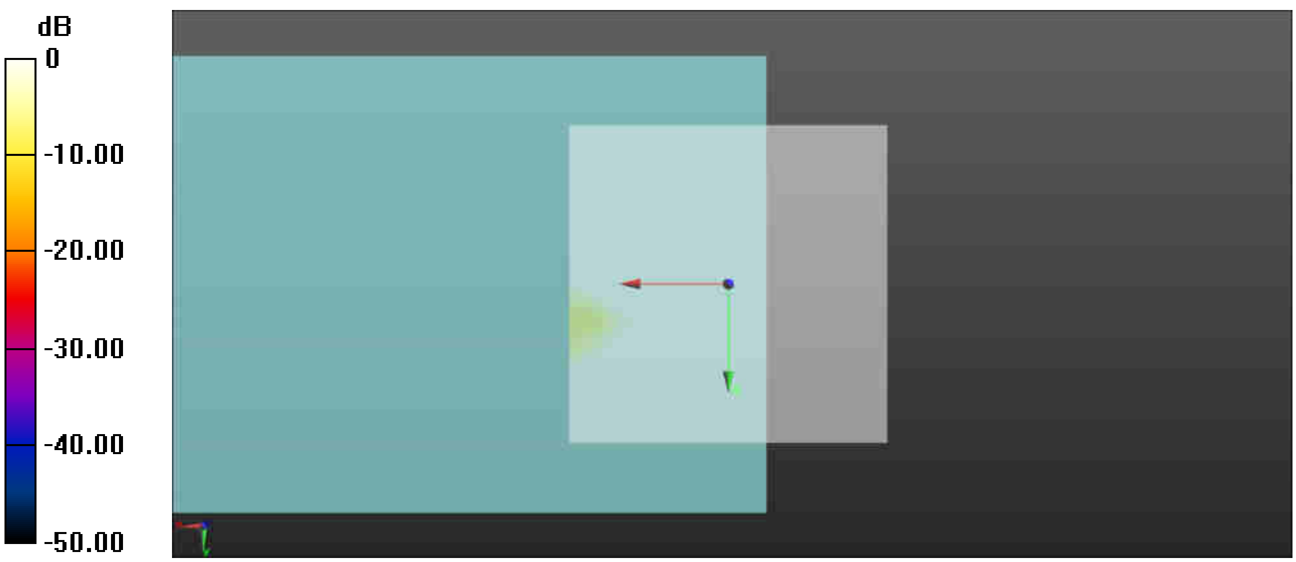
General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -0.8, 4, 3.7 mm Diff: 2dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

7_HAC_T-Coil_LTE Band 5_10M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_Ch20525(Y)

Communication System: UID 0, LTE (0); Frequency: 836.5 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: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 43.52 dB
ABM1 comp = -4.05 dBA/m
Location: -1.2, 16.7, 3.7 mm



0 dB = 1.000 = 0.00 dB

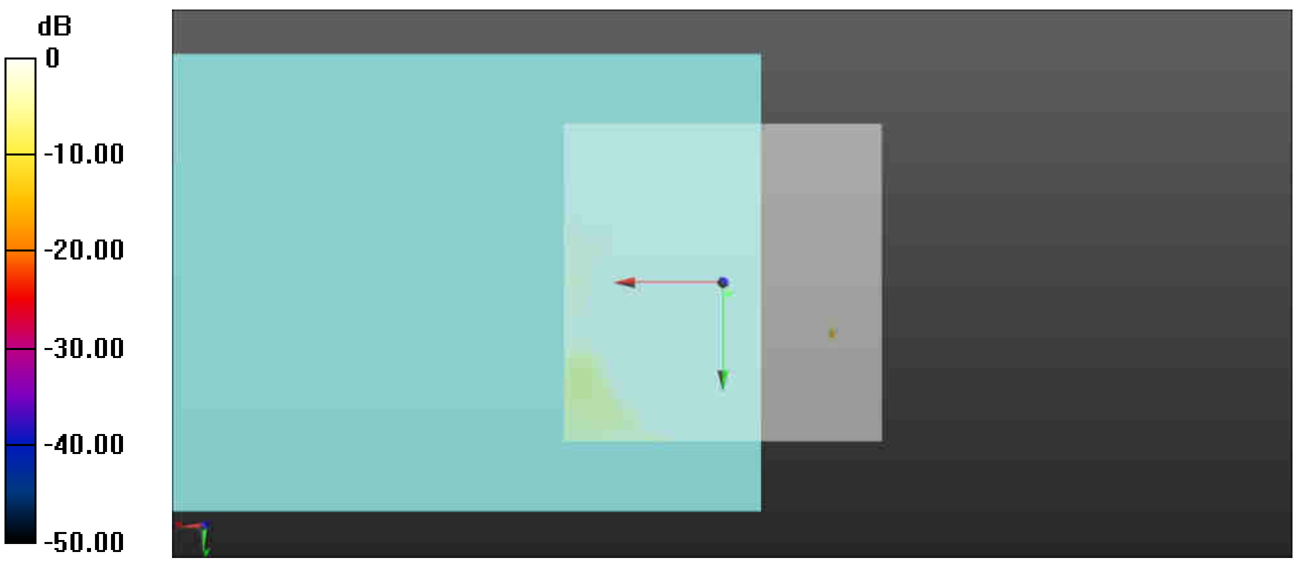
8_HAC_T-Coil_LTE Band 13_10M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_Ch23230(Z)

Communication System: UID 0, LTE (0); Frequency: 782 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 ℃

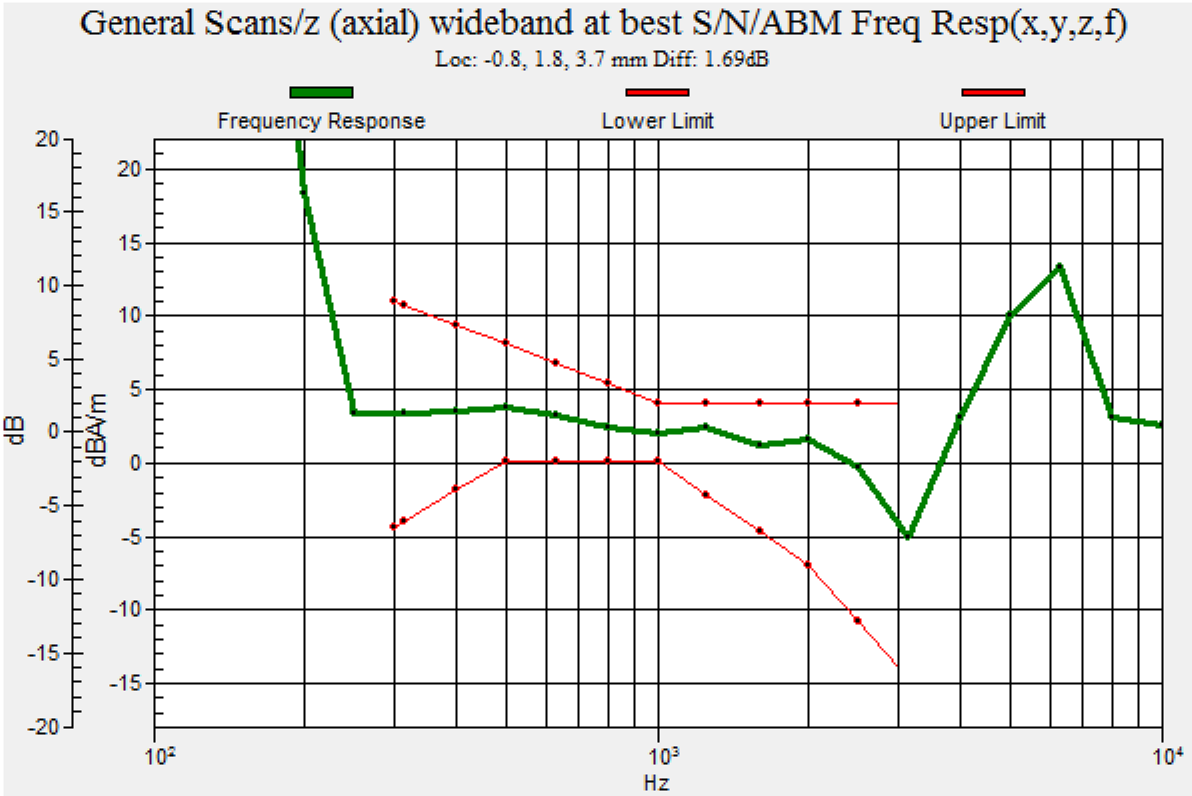
DASY5 Configuration:
- Probe: AM1DV3 - 3093; ; Calibrated: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 50.53 dB
ABM1 comp = 2.67 dBA/m
Location: -0.8, 1.7, 3.7 mm



0 dB = 1.000 = 0.00 dB

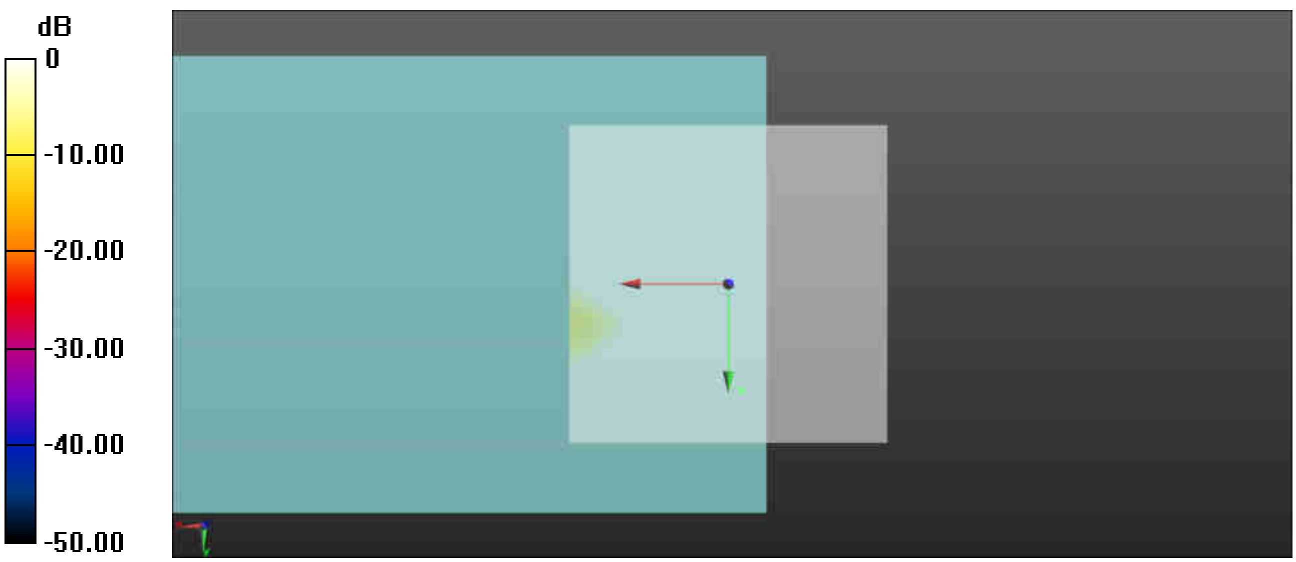

General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -0.8, 1.8, 3.7 mm Diff: 1.69dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10²
10³
10⁴

8_HAC_T-Coil_LTE Band 13_10M_QPSK_1RB_0Offset_WB AMR 6.6Kbps_Ch23230(Y)

Communication System: UID 0, LTE (0); Frequency: 782 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: 2018.5.25
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1305; Calibrated: 2018.5.11
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 44.63 dB
ABM1 comp = -4.64 dBA/m
Location: -2.1, 16.7, 3.7 mm



0 dB = 1.000 = 0.00 dB

9_HAC_T-Coil_WLAN2.4GHz_802.11b 1Mbps_Ch6_Axial (Z)

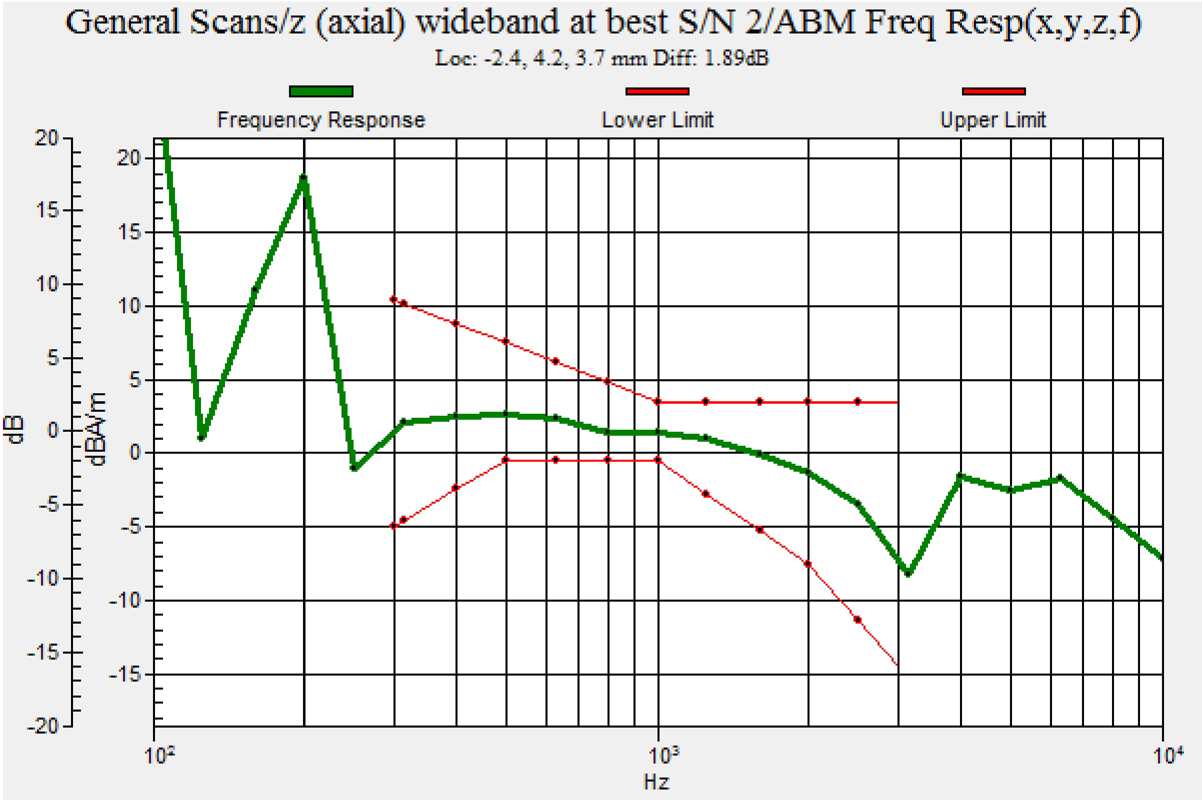
Communication System: 802.11b ; Frequency: 2437 MHz
Medium: Air Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 0 kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.29 dB
ABM1 comp = -0.21 dBA/m
Location: -2.3, 4.4, 3.7 mm

0 dB = 130.2 = 42.29 dB



General Scans/z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f)
Loc: -2.4, 4.2, 3.7 mm Diff: 1.89dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

9_HAC_T-Coil_WLAN2.4GHz_802.11b 1Mbps_Ch6_Transversal (Y)

Communication System: 802.11b ; Frequency: 2437 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 32.97 dB
ABM1 comp = -6.32 dBA/m
Location: -3.7, 17, 3.7 mm

0 dB = 44.51 = 32.97 dB

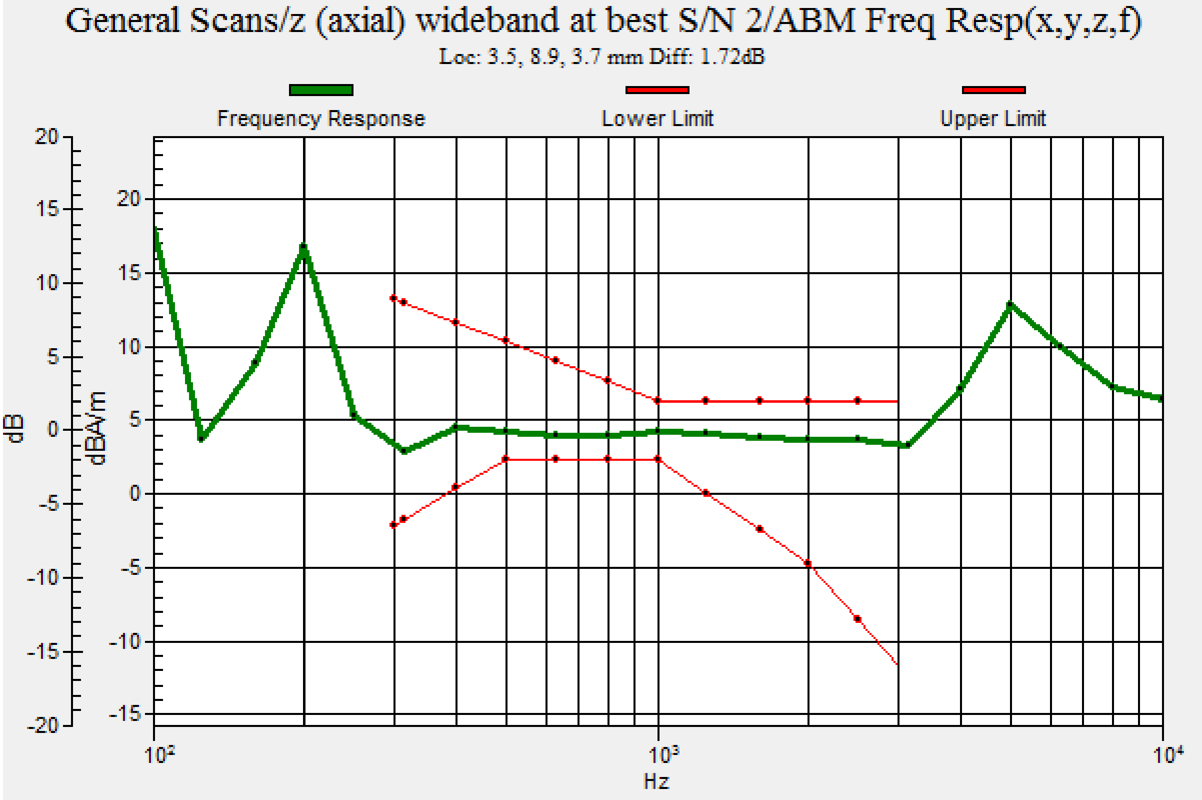
10_HAC_T-Coil_GSM850_EDGE 2 Tx Slots_Ch189_Axial (Z)

Communication System: GSM850 ; Frequency: 836.4 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 35.22 dB
ABM1 comp = 4.11 dBA/m
Location: 3.3, 8.6, 3.7 mm

0 dB = 57.66 = 35.22 dB


General Scans/z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f)
Loc: 3.5, 8.9, 3.7 mm Diff: 1.72dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10²
10³
10⁴

10_HAC_T-Coil_GSM850_EDGE 2 Tx Slots_Ch189_Transversal (Y)

Communication System: GSM850 ; Frequency: 836.4 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 33.77 dB
ABM1 comp = -9.59 dBA/m
Location: -6.5, -4, 3.7 mm

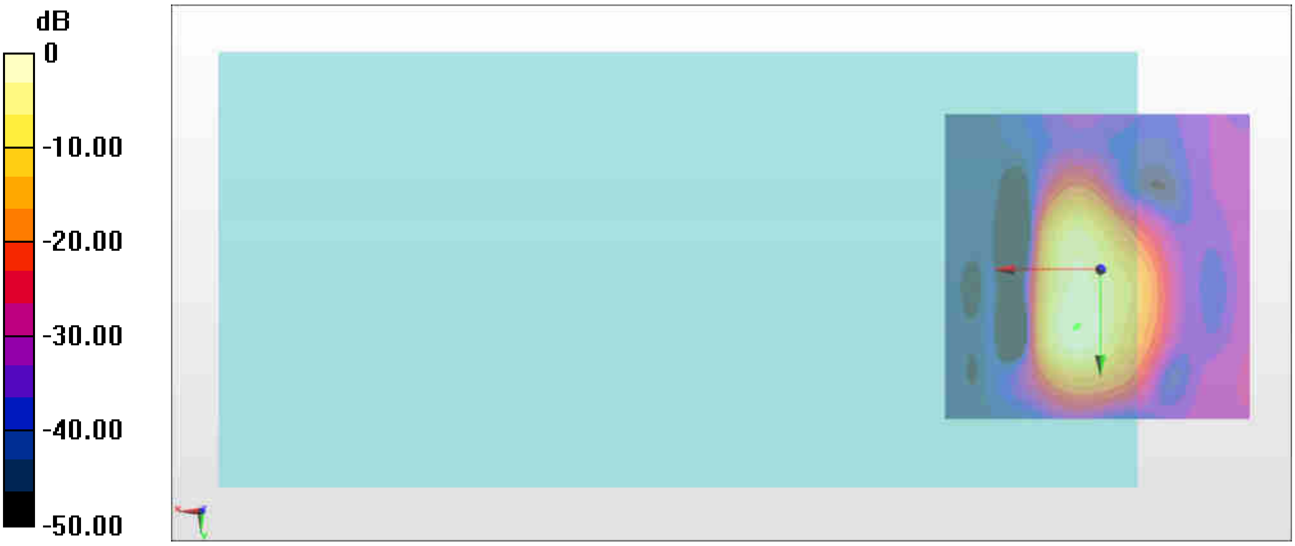
0 dB = 48.84 = 33.78 dB

11_HAC_T-Coil_GSM1900_EDGE 2 Tx Slots_Ch661_Axial (Z)

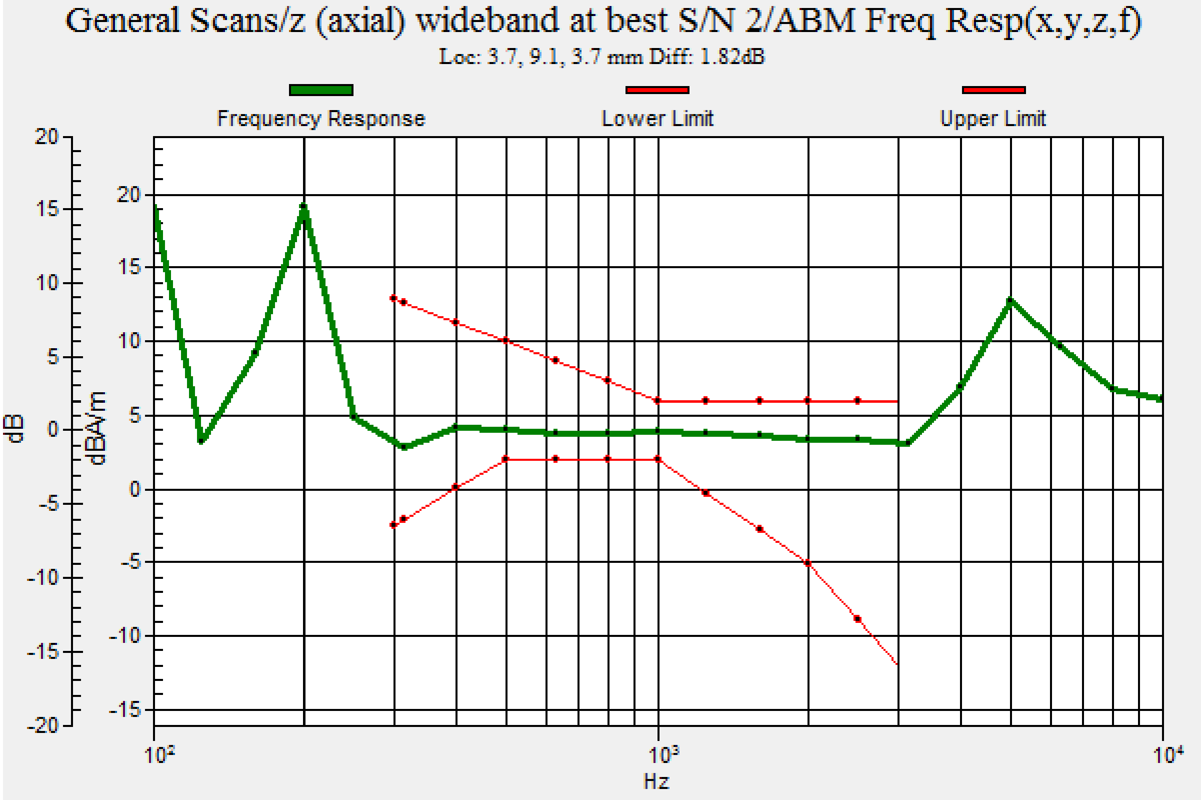
Communication System: PCS ; Frequency: 1880 MHz
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 35.80 dB
ABM1 comp = 4.03 dBA/m
Location: 4, 9.3, 3.7 mm



0 dB = 61.67 = 35.80 dB


General Scans/z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f)
Loc: 3.7, 9.1, 3.7 mm Diff: 1.82dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10^2
10^3
10^4

11_HAC_T-Coil_GSM1900_EDGE 2 Tx Slots_Ch661_Transversal (Y)

Communication System: PCS ; Frequency: 1880 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 35.30 dB
ABM1 comp = -5.76 dBA/m
Location: -3, -4, 3.7 mm

0 dB = 58.23 = 35.30 dB

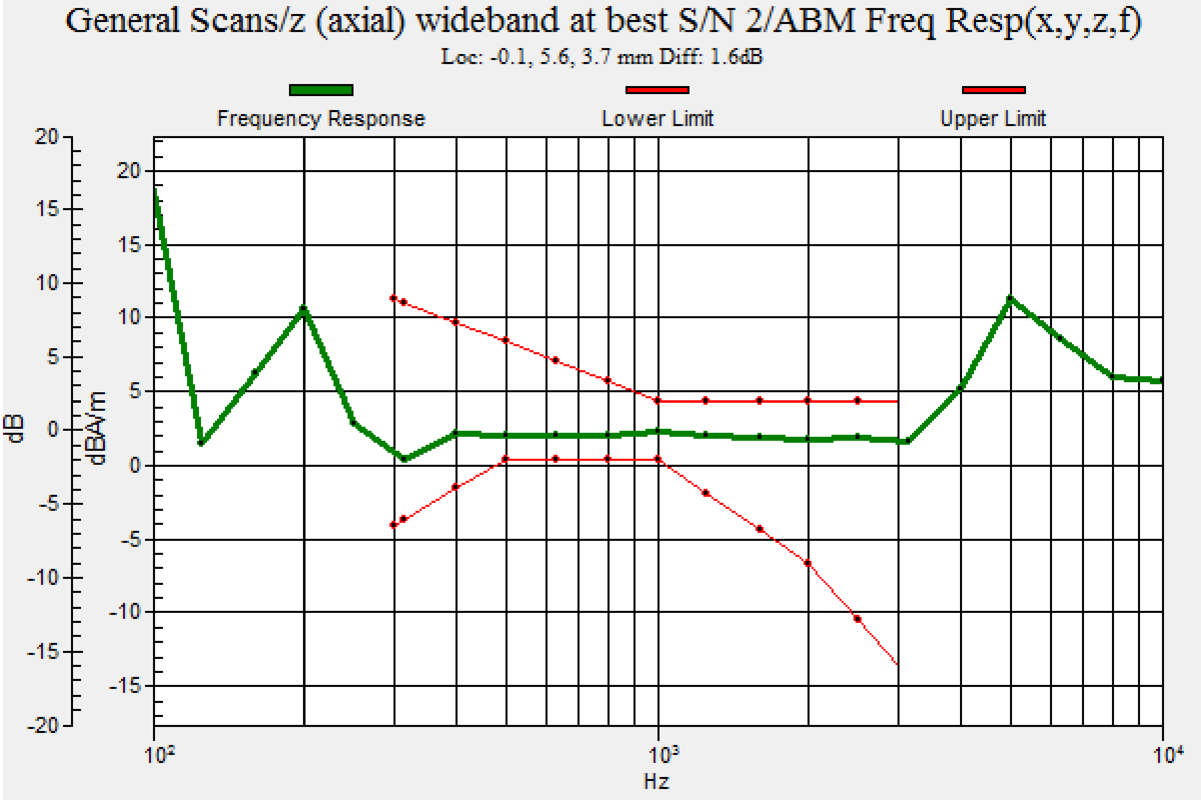
12_HAC_T-Coil_WCDMA II_HSPA_Ch9400_Axial (Z)

Communication System: WCDMA ; Frequency: 1880 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 41.06 dB
ABM1 comp = 2.93 dBA/m
Location: -0.2, 5.8, 3.7 mm

0 dB = 112.9 = 41.05 dB



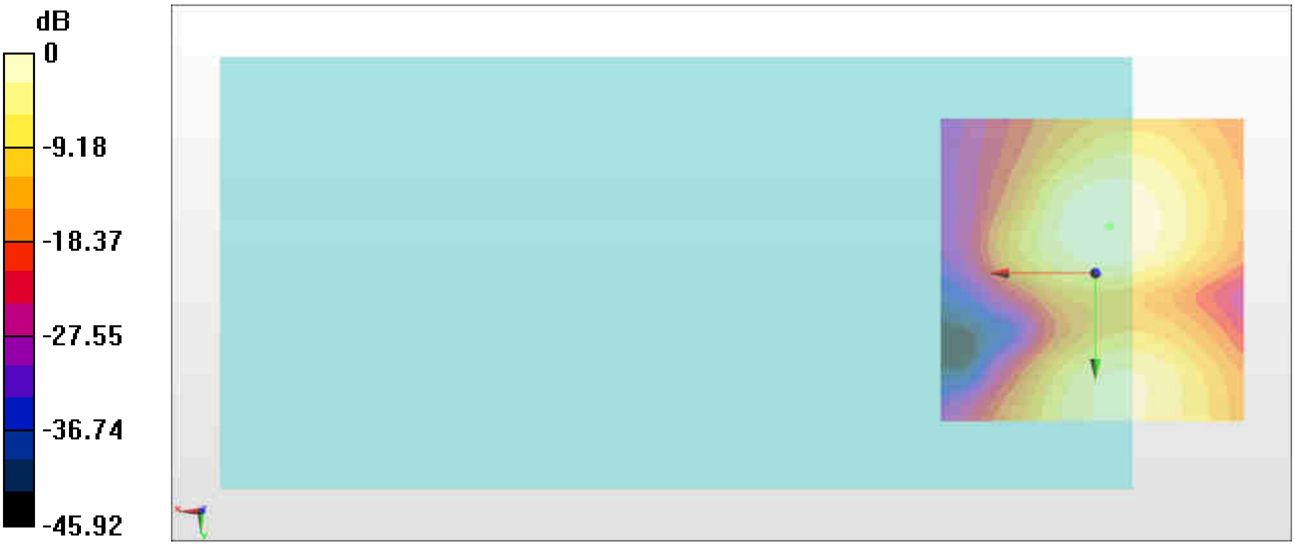
General Scans/z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f)
Loc: -0.1, 5.6, 3.7 mm Diff: 1.6dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
20
15
10
5
0
-5
-10
-15
-20
10^2
10^3
10^4

12_HAC_T-Coil_WCDMA II_HSPA_Ch9400_Transversal (Y)

Communication System: WCDMA ; Frequency: 1880 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 38.08 dB
ABM1 comp = -6.66 dBA/m
Location: -2.3, -7.5, 3.7 mm



0 dB = 80.21 = 38.08 dB

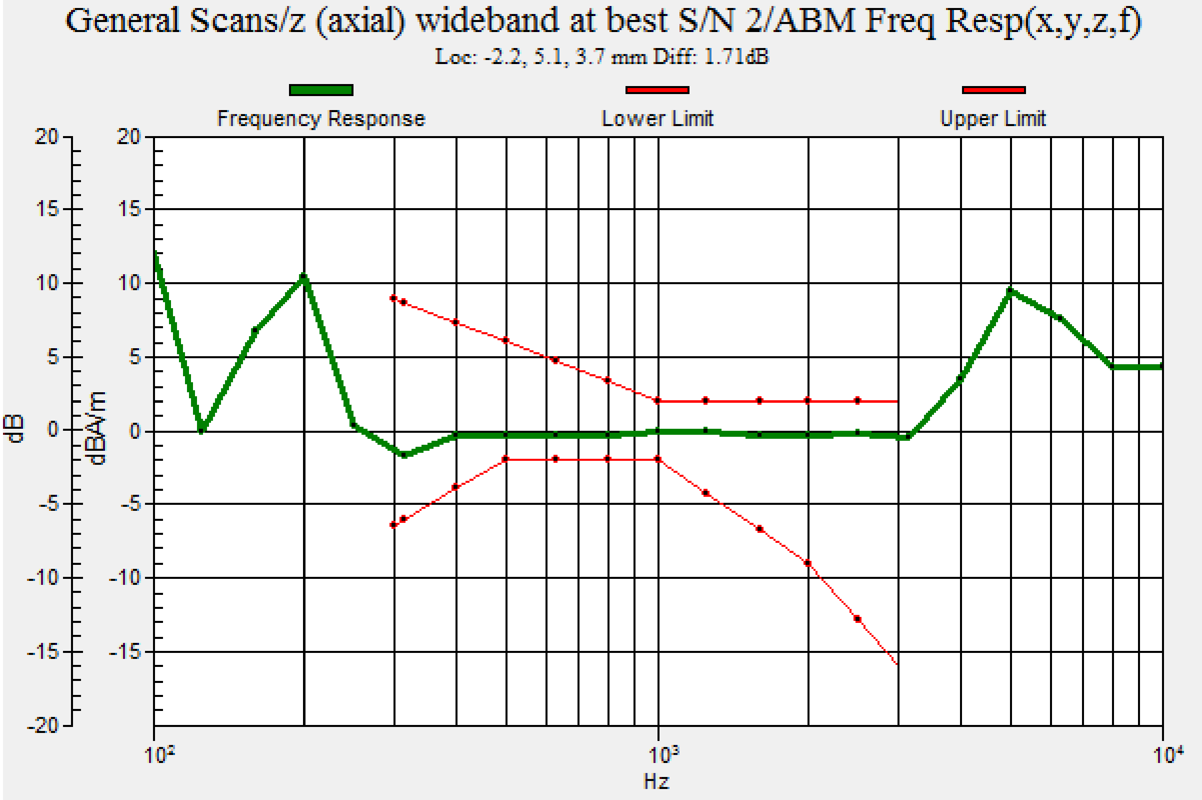
13_HAC_T-Coil_WCDMA V_HSPA_Ch4182_Axial (Z)

Communication System: WCDMA ; Frequency: 836.4 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 40.71 dB
ABM1 comp = 1.08 dBA/m
Location: -2.3, 5.1, 3.7 mm

0 dB = 108.6 = 40.72 dB



General Scans/z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f)
Loc: -2.2, 5.1, 3.7 mm Diff: 1.71dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
20
15
10
5
0
-5
-10
-15
-20
10²
10³
10⁴
Hz

13_HAC_T-Coil_WCDMA V_HSPA_Ch4182_Transversal (Y)

Communication System: WCDMA ; Frequency: 836.4 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 38.25 dB
ABM1 comp = -6.42 dBA/m
BWC Factor = 0.16 dB
Location: -2.3, -7.5, 3.7 mm

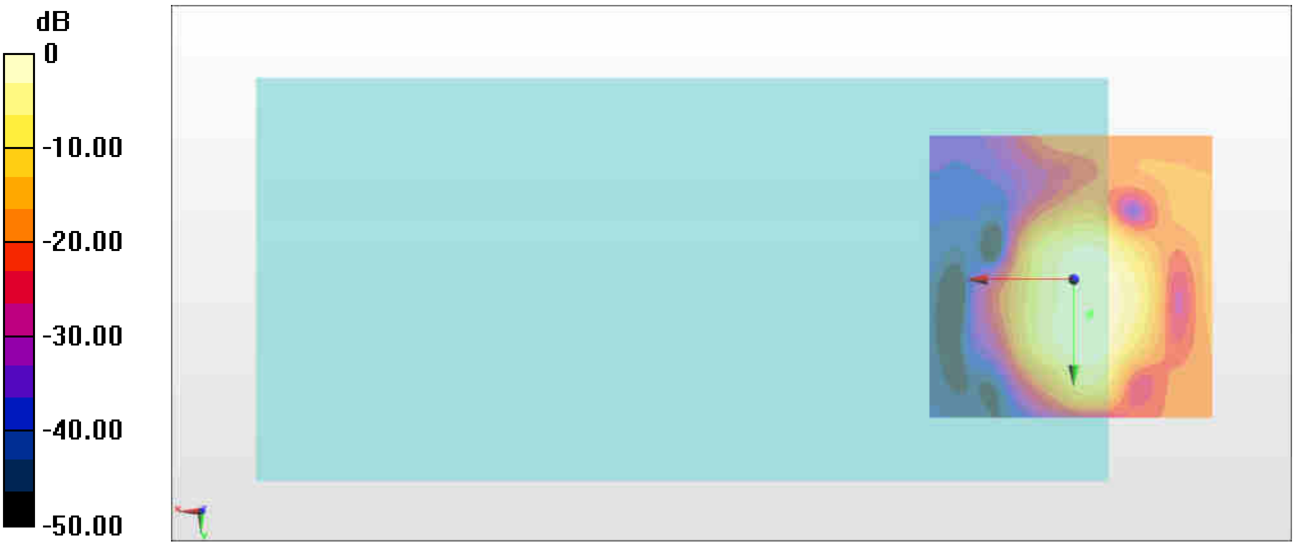
0 dB = 81.72 = 38.25 dB

14_HAC_T-Coil_LTE Band 4_20M_QPSK_1_0_Ch20175_Axial (Z)

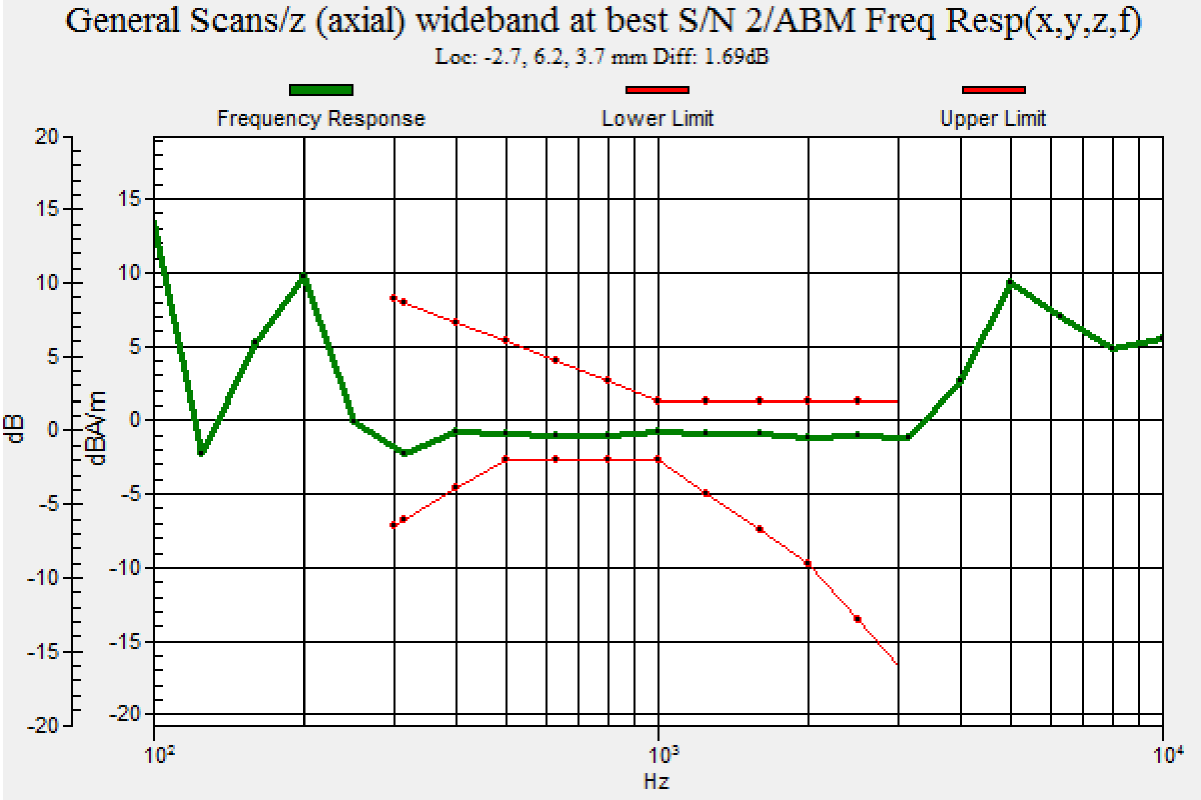
Communication System: LTE ; Frequency: 1732.5 MHz
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Ambient Temperature：23.5 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 39.18 dB
ABM1 comp = 0.41 dBA/m
Location: -3, 5.8, 3.7 mm



0 dB = 91.02 = 39.18 dB

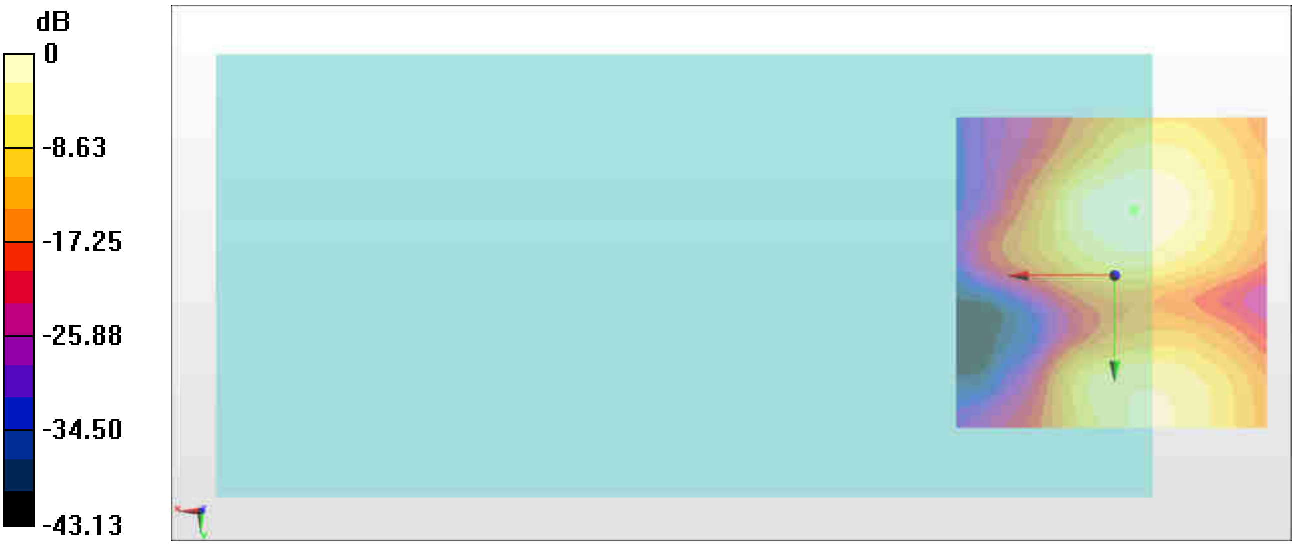

General Scans/z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f)
Loc: -2.7, 6.2, 3.7 mm Diff: 1.69dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
20
15
10
5
0
-5
-10
-15
-20
10^2
10^3
10^4

14_HAC_T-Coil_LTE Band 4_20M_QPSK_1_0_Ch20175_Transversal (Y)

Communication System: LTE ; Frequency: 1732.5 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 36.01 dB
ABM1 comp = -8.72 dBA/m
Location: -3, -10.3, 3.7 mm



0 dB = 63.16 = 36.01 dB

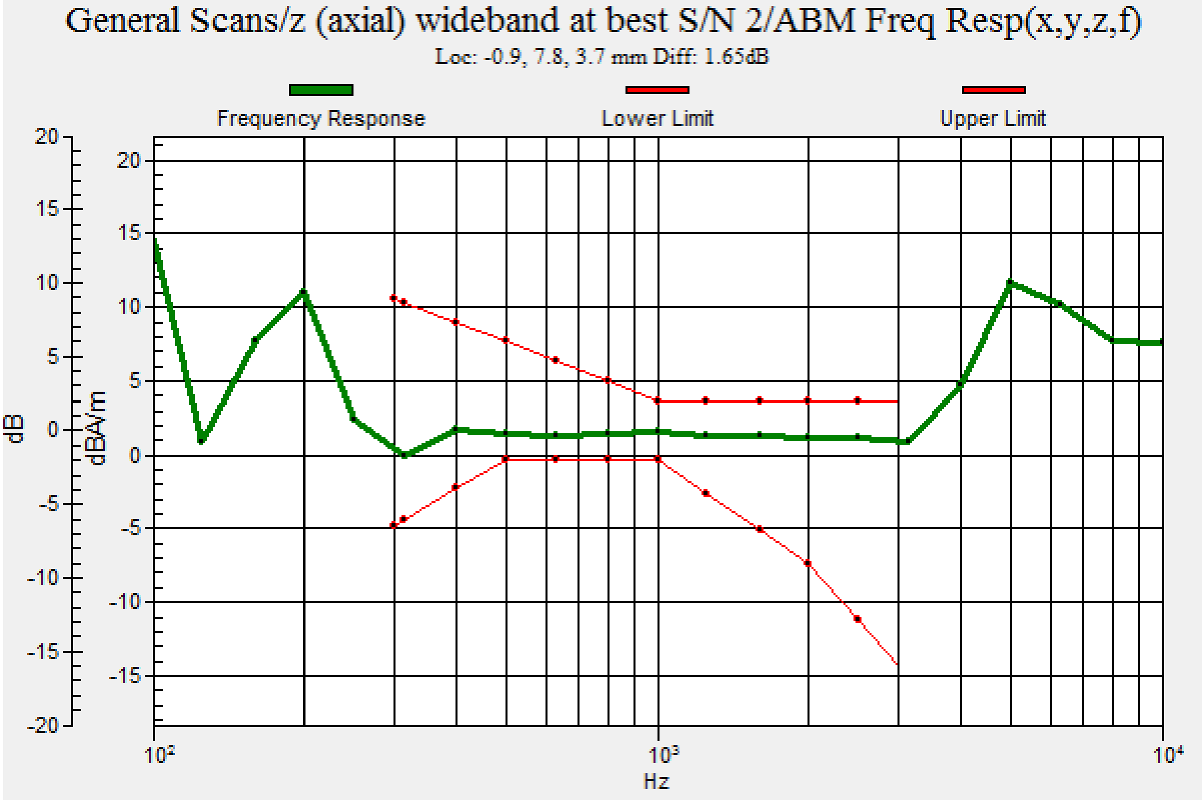
15_HAC_T-Coil_WLAN2.4GHz_802.11b 1Mbps_Ch6_Axial (Z)

Communication System: 802.11b ; Frequency: 2437 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 37.19 dB
ABM1 comp = 2.44 dBA/m
Location: -0.9, 7.9, 3.7 mm

0 dB = 72.34 = 37.19 dB



General Scans/z (axial) wideband at best S/N 2/ABM Freq Resp(x,y,z,f)
Loc: -0.9, 7.8, 3.7 mm Diff: 1.65dB
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

15_HAC_T-Coil_WLAN2.4GHz_802.11b 1Mbps_Ch6_Transversal (Y)

Communication System: 802.11b ; Frequency: 2437 MHz
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 - 3130; ; Calibrated: 2017/11/21
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn854; Calibrated: 2018/6/14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (0);SEMCAD X Version 14.6.10 (7417)

General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 30.37 dB
ABM1 comp = -10.05 dBA/m
Location: -7.2, 16.3, 3.7 mm

0 dB = 32.99 = 30.37 dB

Appendix B. Calibration Data

The DASY calibration certificates are shown as follows.

TTL In Collaboration with s p e a g CALIBRATION LABORATORY
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

中国认可 国际互认 校准 CALIBRATION CNAS L0570

Client : **Auden** **Certificate No: Z18-60107**

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 1305
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	May 11, 2018

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: May 12, 2018

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
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.

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
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	403.659 ± 0.15% (k=2)	403.993 ± 0.15% (k=2)	404.315 ± 0.15% (k=2)
Low Range	3.98260 ± 0.7% (k=2)	3.99157 ± 0.7% (k=2)	3.99746 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	97° ± 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**

Certificate No: DAE4-854_Jun18

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 854
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	June 14, 2018

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	31-Aug-17 (No:21092)	Aug-18
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	04-Jan-18 (in house check)	In house check: Jan-19
Calibrator Box V2.1	SE UMS 006 AA 1002	04-Jan-18 (in house check)	In house check: Jan-19

	Name	Function	Signature
Calibrated by:	Eric Hainfeld	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: June 14, 2018

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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

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	404.937 ± 0.02% (k=2)	404.730 ± 0.02% (k=2)	405.829 ± 0.02% (k=2)
Low Range	3.97284 ± 1.50% (k=2)	3.94535 ± 1.50% (k=2)	3.99553 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	325.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	200033.40	-4.54	-0.00
Channel X	+ Input	20004.28	-1.77	-0.01
Channel X	- Input	-20002.65	2.58	-0.01
Channel Y	+ Input	200036.32	-2.03	-0.00
Channel Y	+ Input	20002.05	-3.86	-0.02
Channel Y	- Input	-20005.10	0.28	-0.00
Channel Z	+ Input	200036.91	-1.46	-0.00
Channel Z	+ Input	20003.85	-2.05	-0.01
Channel Z	- Input	-20005.17	0.36	-0.00

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2002.16	0.22	0.01
Channel X	+ Input	202.15	0.38	0.19
Channel X	- Input	-198.29	-0.31	0.16
Channel Y	+ Input	2001.95	0.27	0.01
Channel Y	+ Input	201.01	-0.63	-0.31
Channel Y	- Input	-198.91	-0.79	0.40
Channel Z	+ Input	2001.73	-0.08	-0.00
Channel Z	+ Input	200.57	-1.12	-0.56
Channel Z	- Input	-199.68	-1.47	0.74

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	-11.94	-13.63
	- 200	15.47	13.71
Channel Y	200	-8.45	-8.32
	- 200	7.64	7.27
Channel Z	200	16.23	16.03
	- 200	-18.86	-19.07

3. Channel separation

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

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	1.45	-3.45
Channel Y	200	7.54	-	3.39
Channel Z	200	9.04	5.14	-

4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	16138	16479
Channel Y	16030	14603
Channel Z	15846	16180

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.51	-0.22	1.41	0.30
Channel Y	1.02	-0.44	1.87	0.35
Channel Z	0.62	-0.69	1.46	0.38

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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

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

Certificate No: AM1DV3-3093_May18

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 25, 2018

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	31-Aug-17 (No. 21092)	Aug-18
Reference Probe AM1DV2	SN: 1008	03-Jan-18 (No. AM1DV2-1008_Jan18)	Jan-19
DAE4	SN: 781	17-Jan-18 (No. DAE4-781_Jan18)	Jan-19

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	SN: 1050	01-Oct-13 (in house check Oct-17)	Oct-19
AMMI Audio Measuring Instrument	SN: 1062	26-Sep-12 (in house check Oct-17)	Oct-19

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

Issued: May 28, 2018

[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, Zurich, Switzerland
Manufacturing date	March 3, 2011

Calibration data

Connector rotation angle	(in DASY system)	**169.5 °**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**1.12 °**	+/- 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%.

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
S 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: AM1DV3-3130_Nov17

CALIBRATION CERTIFICATE

Object	AM1DV3 - SN: 3130
Calibration procedure(s)	QA CAL-24.v4 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range
Calibration date:	November 21, 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	31-Aug-17 (No. 21092)	Aug-18
Reference Probe AM1DV2	SN: 1008	30-Dec-16 (No. AM1D-1008_Dec16)	Dec-17
DAE4	SN: 781	13-Jul-17 (No. DAE4-781_Jul17)	Jul-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	SN: 1050	01-Oct-13 (in house check Oct-17)	Oct-19
AMMI Audio Measuring Instrument	SN: 1062	26-Sep-12 (in house check Oct-17)	Oct-19

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

Issued: November 21, 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	**3130**

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	July 09, 2012
Last calibration date	November 16, 2016

Calibration data

Connector rotation angle	(in DASY system)	**81.2 °**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**1.03 °**	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.00743 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%.