HAC(T-Coil)Test Report

Report No.: AGC04845170301FH05

FCC ID	:	2ADLJ-VOLT8
APPLICATION PURPOSE	:	Original Equipment
PRODUCT DESIGNATION	:	Mobile Phone
BRAND NAME	:	VORTEX
MODEL NAME	:	VOLT 8, UW5009K
CLIENT	:	Xwireless LLC
DATE OF ISSUE	:	May 10,2017
STANDARD(S)	:	FCC 47 CFR §20.19 ANSI C63.19-2011
REPORT VERSION	:	V1.0

Attestation of Global Compliance(Shenzhen) Co., Ltd.

Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	May 10,2017	Valid	Original Report

Test Report Certification

Applicant Name	:	Xwireless LLC
Applicant Address	:	11426 Rockville pike, Rockville, MD 20852United States
Manufacturer Name	:	Xwireless LLC
Manufacturer Address	:	11426 Rockville pike, Rockville, MD 20852United States
Product Designation	:	Mobile Phone
Brand Name	:	VORTEX
Model Name	:	VOLT 8, UW5009K
Different Description		All the same, except for the model name. The test model is VOLT 8.
EUT Voltage	:	DC3.7V by battery
Applicable Standard	:	FCC 47 CFR §20.19 ANSI C63.19-2011
Test Date	:	May 7,2017
Performed Location		Attestation of Global Compliance(Shenzhen) Co., Ltd. 2 F, Building 2, No.1-No.4, Chaxi Sanwei Technical Industrial Park, Gushu, Xixiang Street, Bao'an District, Shenzhen, China
Report Template		AGCRT-US-2G2/HAC (2015-01-01)

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1. STATEMENT OF COMPLIANCE

The maximum results of T-Coil of Hearing Aid Compliance (HAC) found during testing for **VOLT 8** are follows:

Band	Channel	T Rating
GSM850	190	T3
PCS1900	661	T4
UMTS Band II	9400	T4
UMTS Band V	4182	T4

The test plans were performed in accordance with FCC 47 CFR §20.19, ANSI C63.19:2011 and the following specific FCC Test Procedures:

- KDB285076 D02 T-Coil Testing for CMRS IP v02;

2. GENERAL INFORMATION

2.1. EUT Description

General Information	
Product Designation	Mobile Phone
Test Model	VOLT 8
Hardware Version	T55_MB_V11
Software Version	full_t55_hengcs_x51_user_201704051821
Device Category	Portable
RF Exposure Environment	Uncontrolled
Antenna Type	Internal
GSM and GPRS	
Support Band	☒GSM 850 ☒PCS 1900 ☒GSM 900 ☒DCS 1800
GPRS Type	Class B
GPRS Class	Class 12(1Tx+4Rx, 2Tx+3Rx, 3Tx+2Rx, 4Tx+1Rx)
TX Frequency Range	GSM 850 : 820-850MHz; PCS 1900: 1850-1910MHz;
RX Frequency Range	GSM 850 : 869~894MHz; PCS 1900: 1930~1990MHz
Release Version	R99
Type of modulation	GMSK for GSM/GPRS
Antenna Gain	1.0dBi
Max. Average Power	GSM850: 31.69dBm; PCS1900: 28.11dBm
WCDMA	
Support Band	☒UMTS FDD Band II ☒UMTS FDD Band V ☐UMTS FDD Band I ☐UMTS FDD Band VIII
HS Type	HSPA(HSUPA/HSDPA)
TX Frequency Range	WCDMA FDD Band II: 1850-1910MHz;WCDMA FDD Band V: 820-850MHz
RX Frequency Range	WCDMA FDD Band II: 1930-1990MHz;WCDMA FDD Band V: 869-894MHz
Release Version	Rel-6
Type of modulation	HSDPA:QPSK/16QAM; HSUPA:BPSK; WCDMA:QPSK
Antenna Gain	1.0dBi
Max. Average Power	Band II: 20.48dBm; Band V: 19.99dBm

EUT Description(Continue)

Bluetooth	
Bluetooth Version	☐V2.0 ☐V2.1 ☐V2.1+EDR ☒V3.0 ☐V3.0+HS ☒V4.0 ☐V4.1
Operation Frequency	2402~2480MHz
Type of modulation	☒GFSK ☒Π/4-DQPSK ☒8-DPSK
Avg. Burst Power	6.345dBm
Antenna Gain	1.19dBi
WIFI	
WIFI Specification	☐802.11a ☒802.11b ☒802.11g ☒802.11n(20) ☒802.11n(40)
Operation Frequency	2412~2462MHz
Avg. Burst Power	11b: 14.69dBm,11g: 12.84dBm,11n(20): 11.72dBm,11n(40): 10.82dBm
Antenna Gain	1.19dBi
Accessories	
Battery	Brand name: N/A Model No. : GS03 Voltage and Capacitance: 3.7 V & 2000mAh
Adapter	Brand name: N/A Model No. : GS03 Input: AC 100-240V, 50/60Hz, 0.2A Output: DC 5V, 700mA
Earphone	Brand name: N/A Model No. : N/A

Note:1.CMU200 can measure the average power and Peak power at the same time
2.The sample used for testing is end product.

Product	Type	
	☒ Production unit	☐ Identical Prototype

3. TEST CONFIGURATION AND SETTING

3.1 Test Configuration

The device was controlled by using a base station emulator R&S CMU200. Communication between the device and the emulator was established by air link. Measurements were performed on the middle channel of both bands. The DUT was set from the emulator to radiate maximum output power during all tests.

List of air interfaces / frequency bands as below:

Air Interface	Band (MHz)	Type	C63.19:2011 Tested	Simultaneous but not tested	OTT	Concurrent HAC Tested	Additional GSM power reduction
GSM	850	VO	Yes	Yes: WiFi/BT	N/A	Not tested①	N/A
	1900	VO	Yes	Yes: WiFi/BT	N/A	Not tested①	N/A
	GPRS/EDGE	DT	No	Yes: WiFi/BT	Yes	N/A	N/A
UMTS	Band II(1900)	VO	Yes	Yes: WiFi/BT	N/A	Not tested①	N/A
	Band V(850)	VO	Yes	Yes: WiFi/BT	N/A	Not tested①	N/A
	HSPA/DC-HSDPA	DT	No	Yes: WiFi/BT	Yes	N/A	N/A
WIFI	2450	DT	No	Yes: GSM/UMTS	Yes	N/A	N/A
BT	2450	DT	No	Yes: GSM/UMTS	N/A	N/A	N/A
Type Transport: VO = CMRS Voice Service DT = Digital Transport VD = CMRS IP Voice Service and Digital Transport							

Note:

1. ①No Concurent mode was found to be the worst case mode;

2. The device does not support VoIP over Wi-Fi for CMRS Service;

3. No associated T-Coil measurement has been made in accordance with the guidance issued by OET in KDB Publication 285076 D02 T-Coil Testing for CMRS IP;

3.2 Applied Standards

ANSI C63.19-2011	American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices
KDB 285076 D01	HAC Guidance v04r01
KDB 285076 D02	T-Coil testing for CMRS IP v02

3.3 Test Conditions

3.3.1 Ambient Condition

Ambient Temperature	20-24℃
Humidity	<60%
Acoustic Ambient Noise	>10dB below the measurement level

3.3.2 Test Configuration

The device was controlled by using a base station emulator R&S CMU200. Communication between the device and the emulator was established by coaxial connection. The DUT was set from the emulator to radiate maximum output power during all testing.

4. HAC T-Coil MEASUREMENT SETUP

4.1 System Configuration

T-Coil setup with HAC Test Arch and AMCC

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

§A standard high precision 6-axis robot with controller, a teach pendant and software

§ A data acquisition electronic (DAE) attached to the robot arm extension

§ A dosimetric probe equipped with an optical surface detector system

§ The electro-optical converter (EOC) performs the conversion between optical and electrical signals

§ A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.

§ A probe alignment unit which improves the accuracy of the probe positioning

§ A computer operating Windows 7

§ DASY software

§ Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.

§ The SAM twin phantom

§ A device holder

§ Tissue simulating liquid

§ Dipole for evaluating the proper functioning of the system

Some of the components are described in details in the following sub-sections.

4.2 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:

<table>
<tr><td>Frequency Range</td><td>0.1 ~ 20 kHz (RF sensitivity <-100dB, fully RF shielded)</td><td rowspan="4"></td></tr>
<tr><td>Sensitivity</td><td><-50dB A/m @ 1 kHz</td></tr>
<tr><td>Pre-amplifier</td><td>40 dB, symmetric</td></tr>
<tr><td>Dimensions</td><td>Tip diameter/ length: 6/290mm, sensor according to ANSI-C63.19</td></tr>
</table>

4.3 AMCC

The Audio Magnetic Calibration coil is 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 50Ohm permits monitoring the current with a scale of 1:10.

Port description:

Signal	Connector	Resistance
Coil In	BNC	Typically 50Ohm
Coil Monitor	BNO	10Ohm±1%(100Mv corresponding to 1A/m)

Specification:

Dimensions	370 x 370 x 196 mm, according to ANSI-C63.19

4.4 AMMI

AMMI front panel

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

Specification:

Sampling rate	48 kHz/24 bit
Dynamic	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

4.5 DATA Acquisition on Electronics (DAE)

The data acquisition electronics (DAE4) consist 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 with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock. The input impedance the DAE4 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB	

4.6. Robot

The DASY system uses the high precision robots (DASY5:TX60) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from is used. The XL robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

4.7. Device Holder

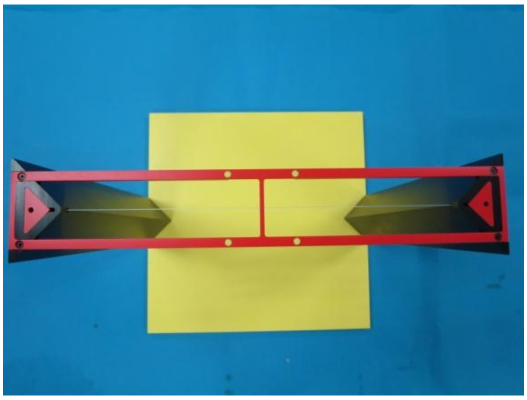
The Device Holder is used to adjust DUT to the suitable position.

4.8. Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chip-disk (DASY5: 128MB), RAM (DASY5: 128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DAYS I/O board, which is directly connected to the PC/104 bus of the CPU board.

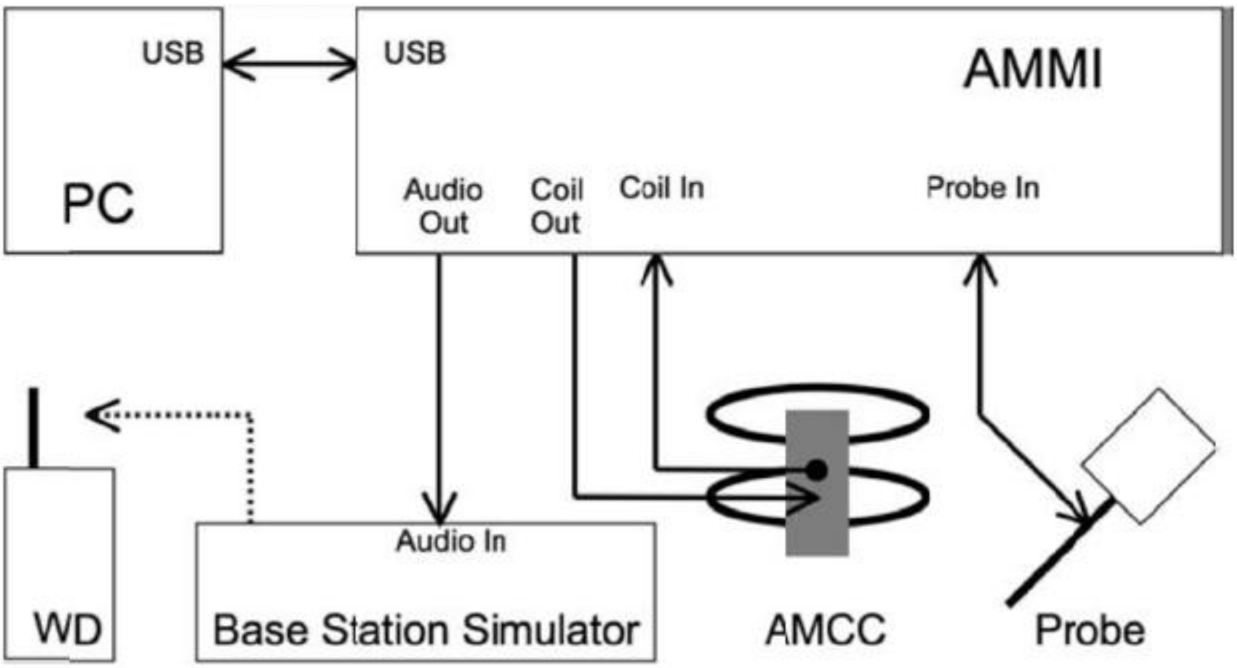
The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

4.9. Test Arch Phantom

Construction	Enable easy and well defined positioning the phone and validation dipoles as well as simple teaching of the robot	
Dimensions	370 x 370 x 370 mm	

4.10 Cabling of System

The principal cabling of the T-Coil setup is shown as follow. All cables provided with the setup have a length of approximately 5m.



T-Coil setup with HAC Test Arch and AMCC

4.11 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial/ Number	Calibration	
				Last Cal.	Due Date
SPEAG	Data Acquisition Electronics	DAE4	1398	01/19/2017	01/18/2018
SPEAG	Active Audio Magnetic Field Probe	AM1DV3	3120	09/22/2016	09/21/2017
SPEAG	Test Arch Phantom	Par phantom	1140	N/A	N/A
SPEAG	Phone Positioner	N/A	SD 000 H01	N/A	N/A
R&S	Universal Radio Communication Tester	CMU200	121209	03/02/2017	03/01/2018
SPEAG	Audio Magnetic Measuring Instrument	AMMI	1147	N/A	N/A
SPEAG	Helmholtz calibration coil	AMCC	N/A	N/A	N/A

5 T-Coil Measurement

5.1 T-Coil measurement points and reference plane

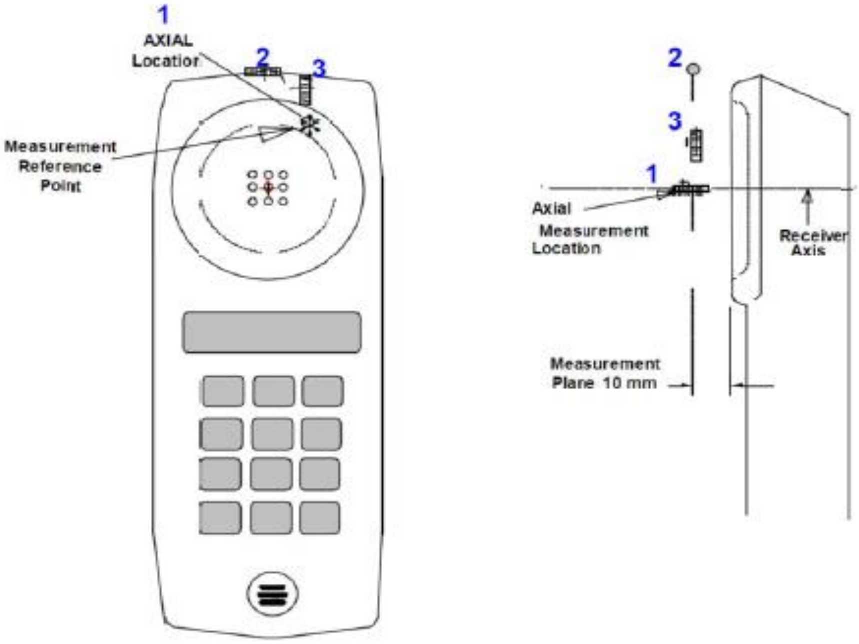
The follow figure illustrate the references and reference plane that shall be used in a typical DUT emissions measurement. The principle of this applied to DUT with similar geometry. Please refer to Appendix D for the setup photographs.

1. The area is 5cm x 5cm.

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

3. The area is in a reference plane, which is defined as the planar area that contains the highest point in the area of the receiver area of the phone and is defined by the points of the receiver-end of the DUT handset, which, in normal handset use, rest against the ear.

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



A typical DUT reference and plane for T-Coil measurement

5.2 T-Coil test procedure

According to ANSI C63.19-2011,section7.4：

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 nonradiating load might be necessary. However, even with a coaxial connection to a base station simulator or nonradiating load, there might still be RF leakage from the WD, which can interfere with the desired measurement. Premeasurement 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.

Measurements 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 (ABM1) that is useful to a hearing aid T-Coil. The undesired magnetic components (ABM2) shall be examined for each probe orientation to determine the possible effects from the WD display and battery current paths that might disrupt the desired T-Coil signal. The undesired magnetic signal (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 nonradiating load as shown in ANSI C63.19-2011 Figure 7.1 or Figure 7.2. Confirm that the equipment that requires calibration has been calibrated and that the noise level meets the requirements of ANSI C63.19-2011 clause 7.3.1.

c) The drive level to the WD is 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 the 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 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.47 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 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 specified in C63.19-2011 clause 7.4.4.2 in each 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 or half-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 C63.19-2011 clause7.3.1.

f) At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in C63.19-2011 clause 7.4.4.4 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting49 and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).

g) Determine the category that properly classifies the signal quality, based on C63.19-2011 Table 8.5.

5.3 T-Coil Performance Requirements

In order to be rated for T-Coil use, a WD shall meet the requirements for signal level and signal quality contained in this part.

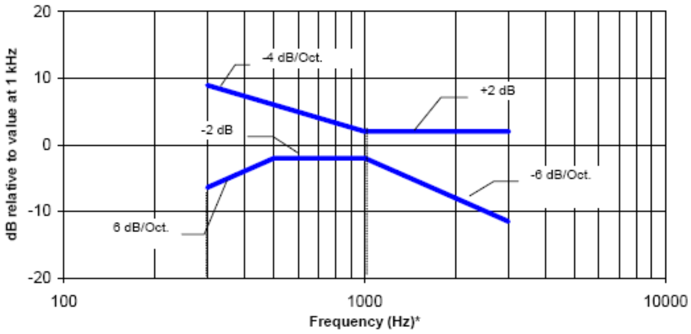
1) T-Coil coupling field intensity

When measured as specified in ANSI C63.19, the T-Coil signal shall be ≥ –18 dB (A/m) at 1 kHz, in a 1/3 octave band filter for all orientations.

2) Frequency response

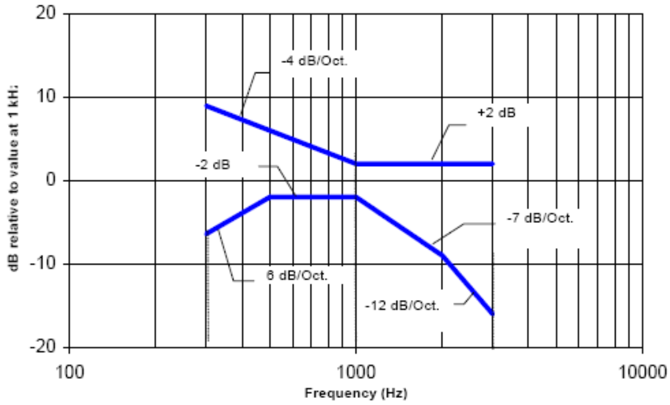
The frequency response of the axial component of the magnetic field, measured in 1/3 octave bands, shall follow the response curve specified in this sub-clause, over the frequency range 300 Hz to 3000 Hz. The follow 2 figures provide the boundaries for the specified frequency.

These response curves are for true field strength measurements of the T-Coil signal. Thus the 6 dB/octave probe response has been corrected from the raw readings.



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

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



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

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

3) Signal quality

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 follow Table. 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

T-Coil Signal Quality Categories

6. T-COIL TEST CONFIGURATION

6.1 General Description

The phone was tested in all normal configurations for the ear use. The EUT is mounted in the device holder equivalent as for classic dosimeter measurements. The acoustic output of the EUT shall coincide with the center point of the area formed by the dielectric wire and the middle bar of the arch's top frame. The EUT shall be moved vertically upwards until it touches the frame. The fine adjustment is possible by sliding the complete. The EUT holder is on the yellow base plate of the Test Arch phantom. These test configurations are tested at the middle frequency channels of each applicable operating mode; for example, GSM, WCDMA(UMTS),CDMA and TDMA.

6.2 GSM Test Configuration

A communication link is set up with a System Simulator (SS) by RF cable, and a call is established. The Absolute Radio Frequency Channel Number(ARFCN) are allocated to 190CH respectively in the case of GSM850, allocated to 661CH respectively in the case of GSM1900. T-Coil configurations is measured in Speech cod/Handset Low using System Simulator (SS) of CMU200, at the same time the EUT shall be operated at its maximum RF output power setting.

6.3 UMTS Test Configuration

A communication link is set up with a System Simulator (SS) by RF cable, and a call is established. The Absolute Radio Frequency Channel Number(ARFCN) are allocated to 9400CH respectively in the case of UMTS Band II, allocated to 4182CH respectively in the case of UMTS Band V. T-Coil configurations is measured in voice mode (Voice Coder: Speechcodec Low) using System Simulator (SS) of CMU200, at the same time the EUT shall be operated at its maximum RF output power setting.

7. HAC T-Coil TEST RESULTS

7.1 Conducted Power (Unit: dBm)

Mode	Test Mode	Frequency(MHz)	Avg. Burst Power(dBm)	Tune-up limit(dBm)
GSM 850	GSM(CS)	824.2	31.03	32.0
		836.6	31.28	
		848.8	**31.69**	
PCS1900	GSM(CS)	1850.2	27.86	28.5
		1880	28.00	
		1909.8	**28.11**	
UMTS BAND II	RMC	1852.4	**20.48**	20.5
		1880	20.42	
		1907.6	20.28	
	AMR	1852.4	20.19	
		1880	20.21	
		1907.6	20.06	
UMTS BAND V	RMC	826.4	19.85	20.5
		836.6	**19.99**	
		846.6	19.98	
	AMR	826.4	19.62	
		836.6	19.59	
		846.6	19.51	

7.2 Magnitude Result

The follow table shows testing result in position coordinates which are defined as deviation from earpiece center in millimeters. Axial measurement location was defined by the manufacture of the device. Signal strength measurement scans are presented in appendix A.

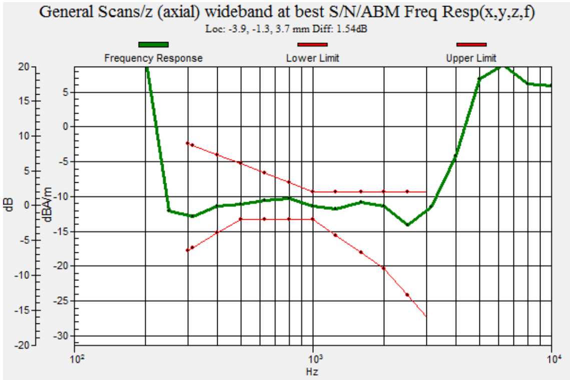
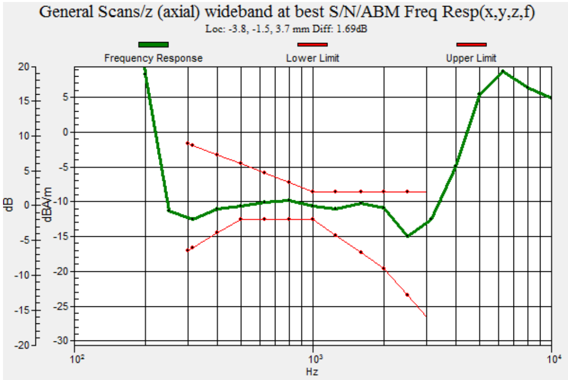
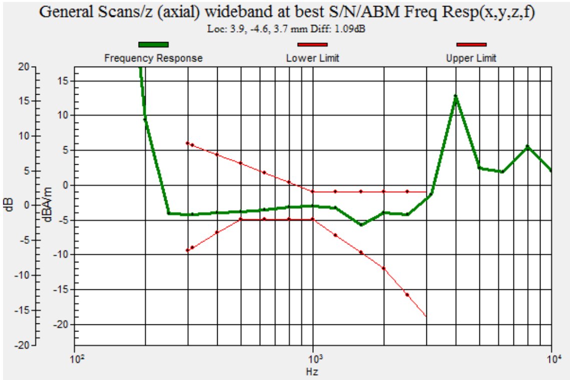
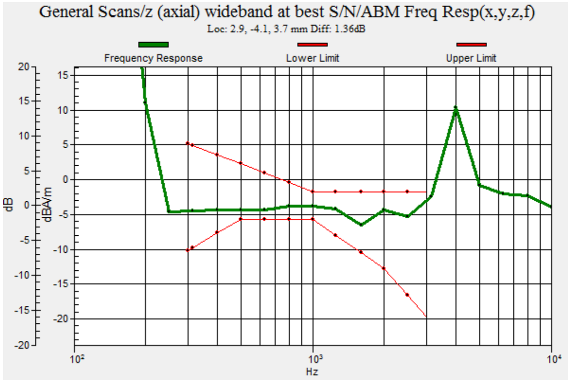
Plots	Band	Mode	Channel	Probe Position	ABM1 (dB A/m)	ABM2 (dB A/m)	SNR (dB)	T-Rating
1	GSM850	Voice	190/836.4	Axial (Z)	-8.35	-36.77	28.42	T3
				Radial (Y)	-9.05	-38.23	29.18	T3
2	PCS1900	Voice	661/1880	Axial (Z)	-8.22	-38.79	30.57	T4
				Radial (Y)	-9.10	-40.01	30.91	T4
3	UMTS Band II	Voice	9400/1880	Axial (Z)	-1.67	-44.63	42.96	T4
				Radial (Y)	-9.99	-47.51	37.52	T4
4	UMTS Band V	Voice	4182/836.4	Axial (Z)	-2.07	-42.62	40.55	T4
				Radial (Y)	-10.56	-49.37	38.81	T4

Remark:

1) There is no special HAC mode software on this DUT.

2) The volume was adjusted to maximum level and the backlight turned off during T-Coil testing.

7.3 Frequency Response Plots

GSM850 Ch190	PCS1900 Ch661
	
UMTS Band II Ch9400	**UMTS Band V Ch4182**
	

8. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. 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.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table below.

Uncertainty Distributions	Normal	Rectangular	Triangular	U-shape
Multiplying factor(a)	1/k (b)	1/√3	1/√6	1/√2

Multiplying Factions for Various Distributions

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity.

(b) κ is the coverage factor.

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. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. 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 the next Table.

HAC Uncertainty							
Error Description	**Uncert. value**	**Prob Dist.**	**Div.**	**(Ci) (ABM1)**	**(Ci) (ABM2)**	**Std. Unc. (ABM1)**	**Std. Unc. (ABM2)**
Probe Sensitivity							
Reference Level	3.0	N	1	1	1	3.00	3.00
AMMC Geometry	0.4	R	$\sqrt{3}$	1	1	0.23	0.23
AMCC Current	1.0	R	$\sqrt{3}$	1	1	0.58	0.58
Probe Position During Calibrate	0.05	R	$\sqrt{3}$	1	1	0.03	0.03
Noise Contribution	0.7	R	$\sqrt{3}$	0.0143	1	0.01	0.40
Frequency Slope	5.9	R	$\sqrt{3}$	0.1	1	0.34	3.41
Probe System							
Repeatability/Drift	1.0	R	$\sqrt{3}$	1	1	0.58	0.58
Linearity/Dynamic Range	0.6	R	$\sqrt{3}$	1	1	0.60	0.60
Acoustic Noise	1.0	R	$\sqrt{3}$	0.1	1	0.06	0.58
Probe Angle	2.3	R	$\sqrt{3}$	1	1	1.33	1.33
Spectral Processing	0.9	R	$\sqrt{3}$	1	1	0.52	0.52
Integration Time	0.6	N	1	1	1	0.60	0.60
Field Distribution	0.2	R	$\sqrt{3}$	1	1	0.12	0.12
Test Signal							
Reference Signal Spectral Response	0.6	R	$\sqrt{3}$	0	1	0.00	0.35
Positioning							
Probe Positioning	0.05	R	$\sqrt{3}$	1	1	0.03	0.03
Phantom Thickness	0.05	R	$\sqrt{3}$	1	1	0.03	0.03
DUT Positioning	0.05	R	$\sqrt{3}$	1	1	0.03	0.03
External Contributions							
RF Interference	0.0	R	$\sqrt{3}$	1	0.3	0	0
Test Signal Variation	2.0	R	$\sqrt{3}$	1	1	1.15	1.15
Combined Std. Uncertainty						3.72	5.10
Coverage Factor for 95%						K=2	
Expanded Std. Uncertainty						**7.44**	**10.20**

Uncertainty Budget of DASY

APPENDIX A. T-Coil EMISSION MEASUREMENT PLOTS

Frequency Band：GSM850

CHANNEL：Mid

DUT: Mobile Phone; Type: VOLT 8;

Communication System: UID 0, Generic GSM (0); Communication System Band: GSM 850 (820.0 - 850.0 MHz); Frequency: 836.4 MHz; Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3

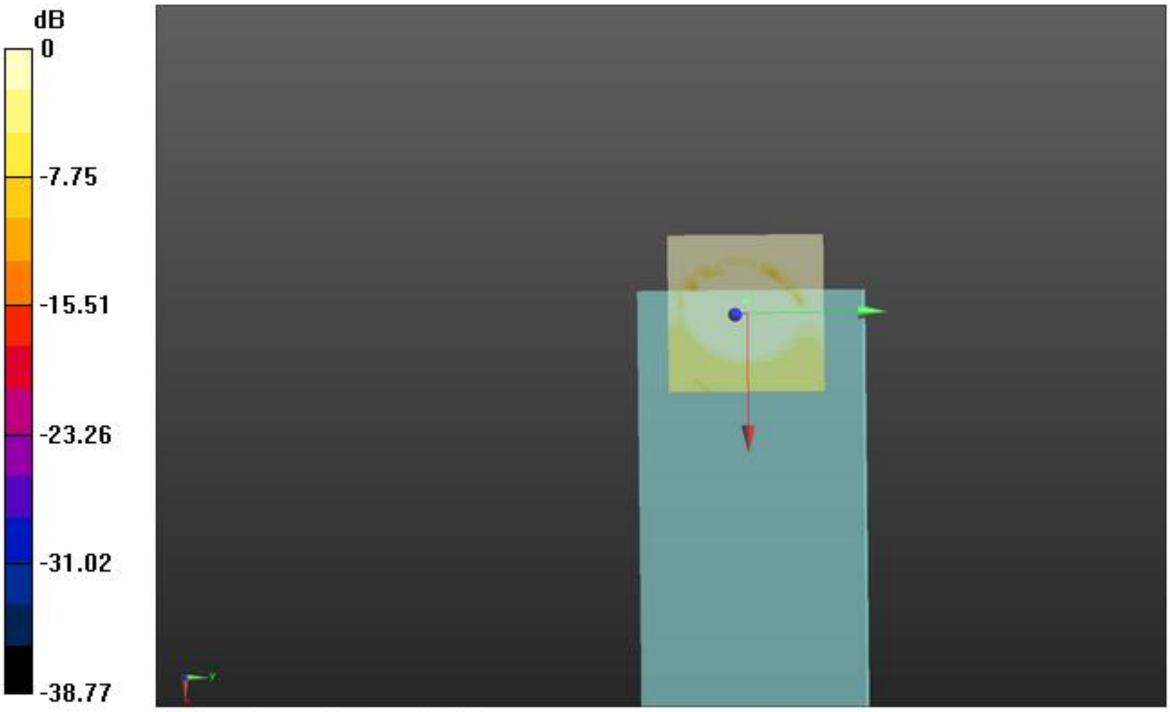
DASY Configuration:

- Probe: AM1DV3 - 3120; ; Calibrated: 9/22/2016
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE4 Sn1398; Calibrated: 01/19/2017
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

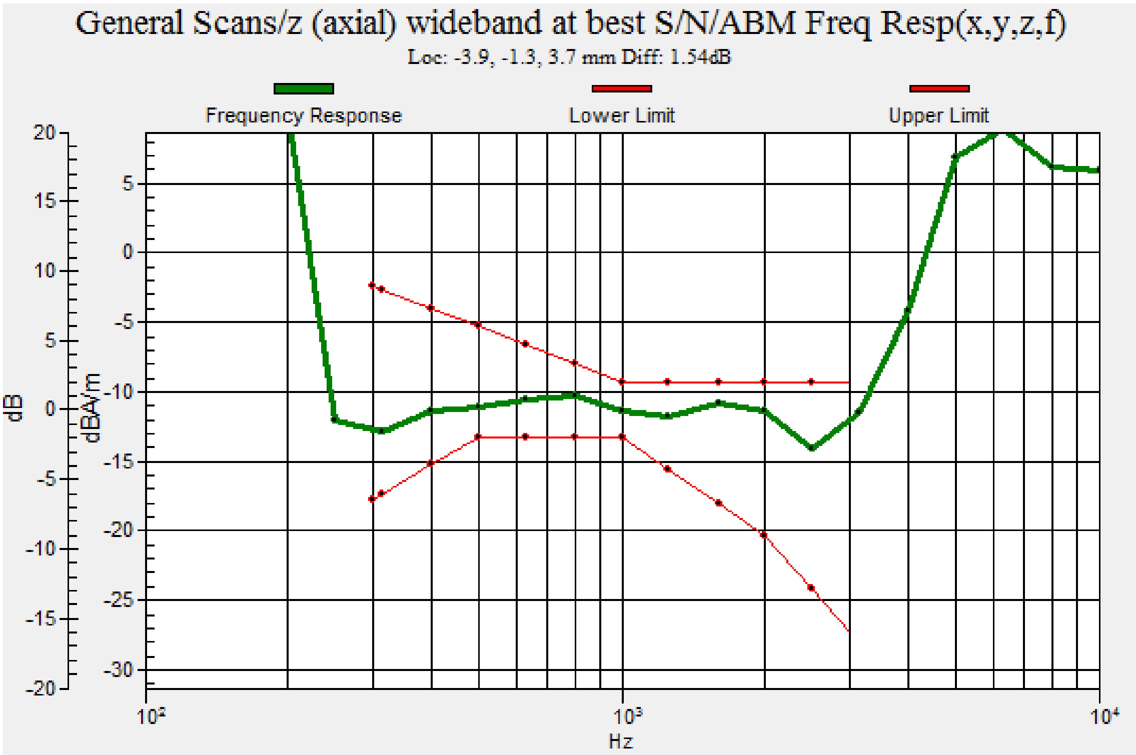
Ch190/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.14 dB
Device Reference Point: 0, 0, -6.3 mm

Category	Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 28.42 dB
ABM1 comp = -8.35 dBA/m
BWC Factor = 0.14 dB
Location: -4.2, 0, 3.7 mm



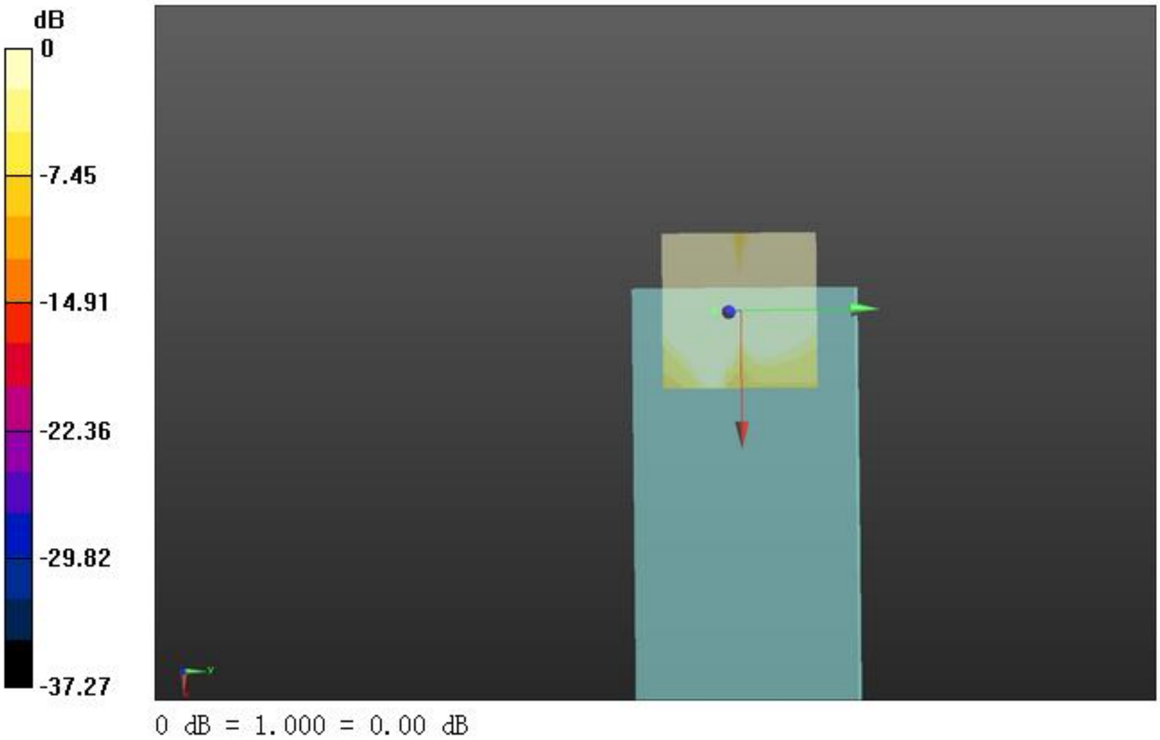
0 dB = 1.000 = 0.00 dB



Ch190/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.14 dB
Device Reference Point: 0, 0, -6.3 mm

Category	Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 29.18 dB
ABM1 comp = -9.05 dBA/m
BWC Factor = 0.14 dB
Location: 0, -8.3, 3.7 mm



Frequency Band：PCS 1900

CHANNEL：Mid

DUT: Mobile Phone; Type: VOLT 8;

Communication System: UID 0, Generic GSM (0); Communication System Band: PCS 1900 (1850.0 - 1910.0 MHz); Frequency: 1880 MHz; Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 0 kg/m^3

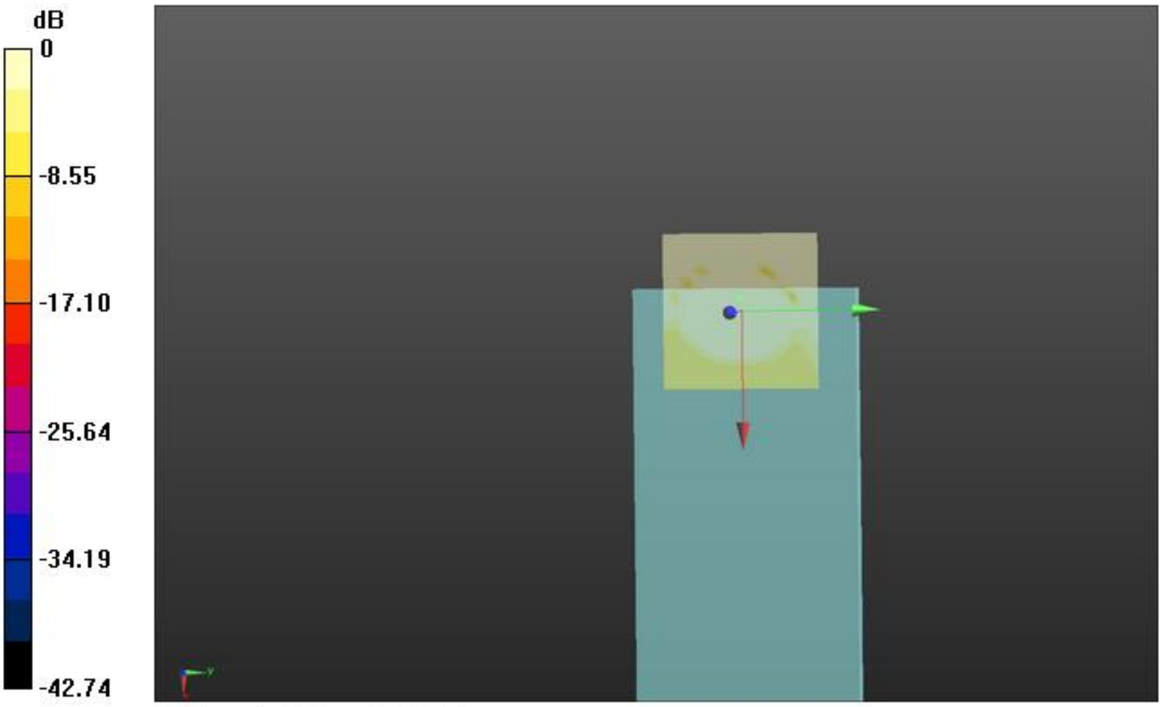
DASY Configuration:

- Probe: AM1DV3 - 3120; ; Calibrated: 9/22/2016
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE4 Sn1398; Calibrated: 01/19/2017
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

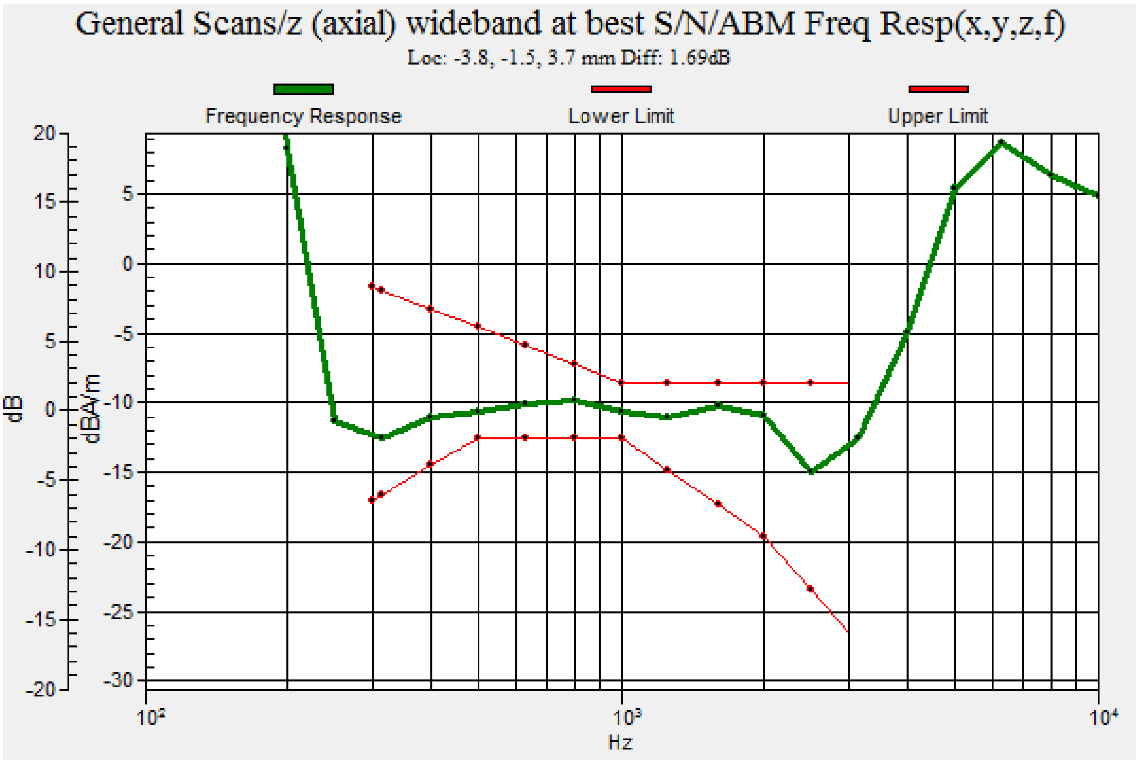
CH661/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.14 dB
Device Reference Point: 0, 0, -6.3 mm

Category	Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 30.57 dB
ABM1 comp = -8.22 dBA/m
BWC Factor = 0.14 dB
Location: -4.2, 0, 3.7 mm



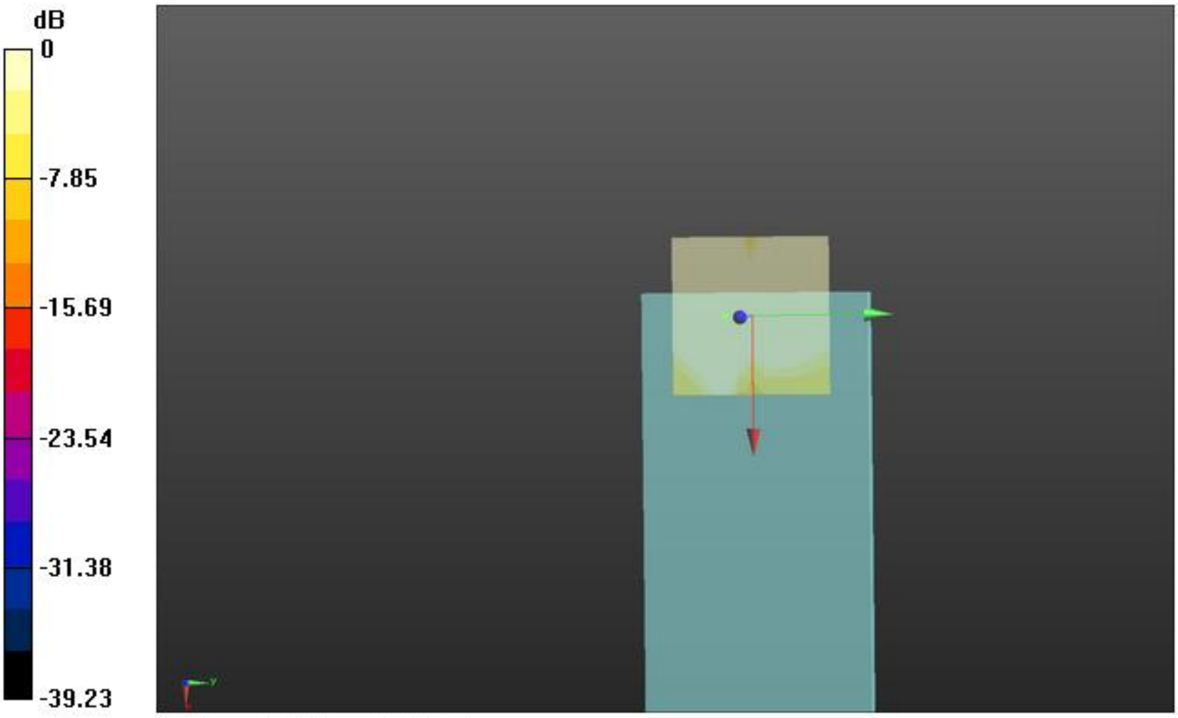
0 dB = 1.000 = 0.00 dB



Ch661/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.14 dB
Device Reference Point: 0, 0, -6.3 mm

Category	Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 30.91 dB
ABM1 comp = -9.10 dBA/m
BWC Factor = 0.14 dB
Location: 0, -8.3, 3.7 mm



0 dB = 1.000 = 0.00 dB

Frequency Band：UMTS Band II

CHANNEL：Mid

DUT: Mobile Phone; Type: VOLT 8;

Communication System: UID 0, UMTS Band II (0); Communication System Band: WCDMA 1900 (1850.0 - 1910.0 MHz); Frequency: 1880 MHz; Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3

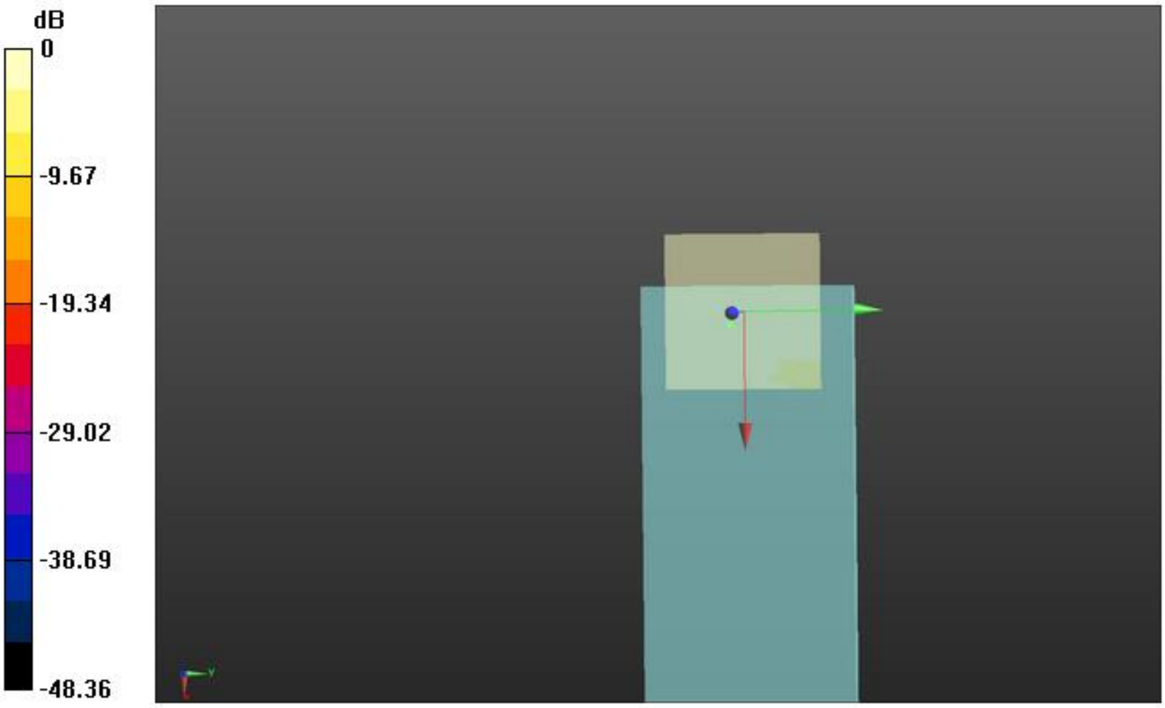
DASY Configuration:

- Probe: AM1DV3 - 3120; ; Calibrated: 9/22/2016
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE4 Sn1398; Calibrated: 01/19/2017
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

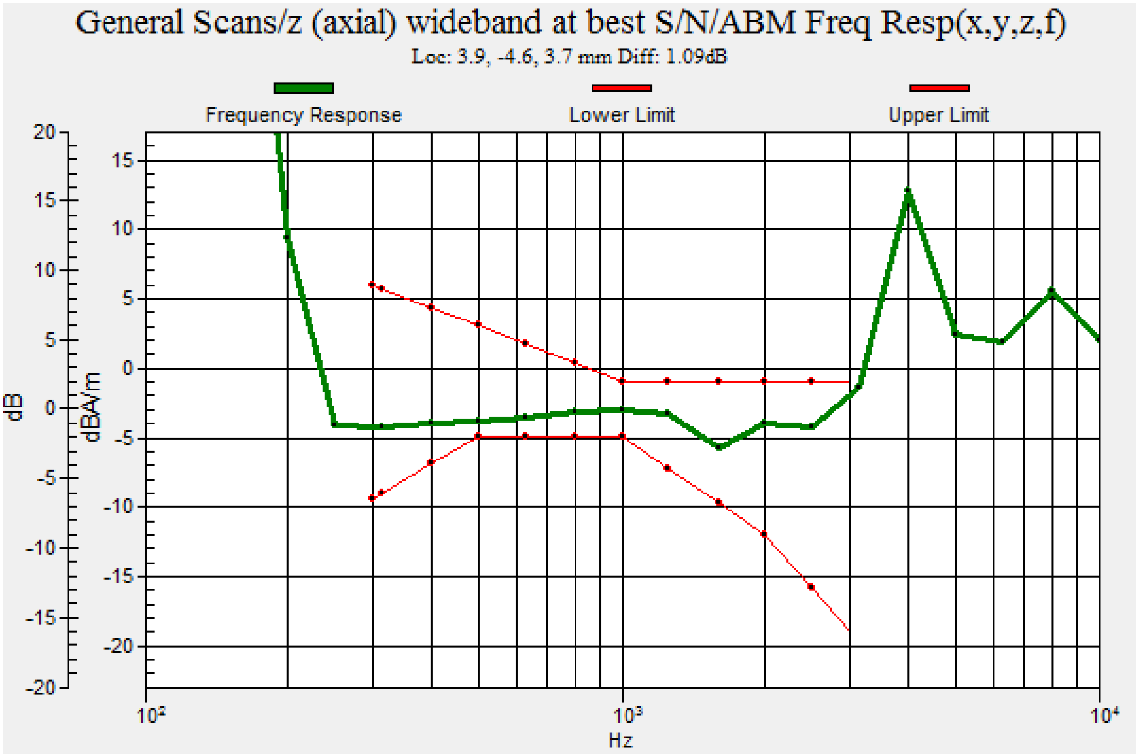
CH9400/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

Category	Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 42.96 dB
ABM1 comp = -1.67 dBA/m
BWC Factor = 0.15 dB
Location: 4.2, -4.2, 3.7 mm



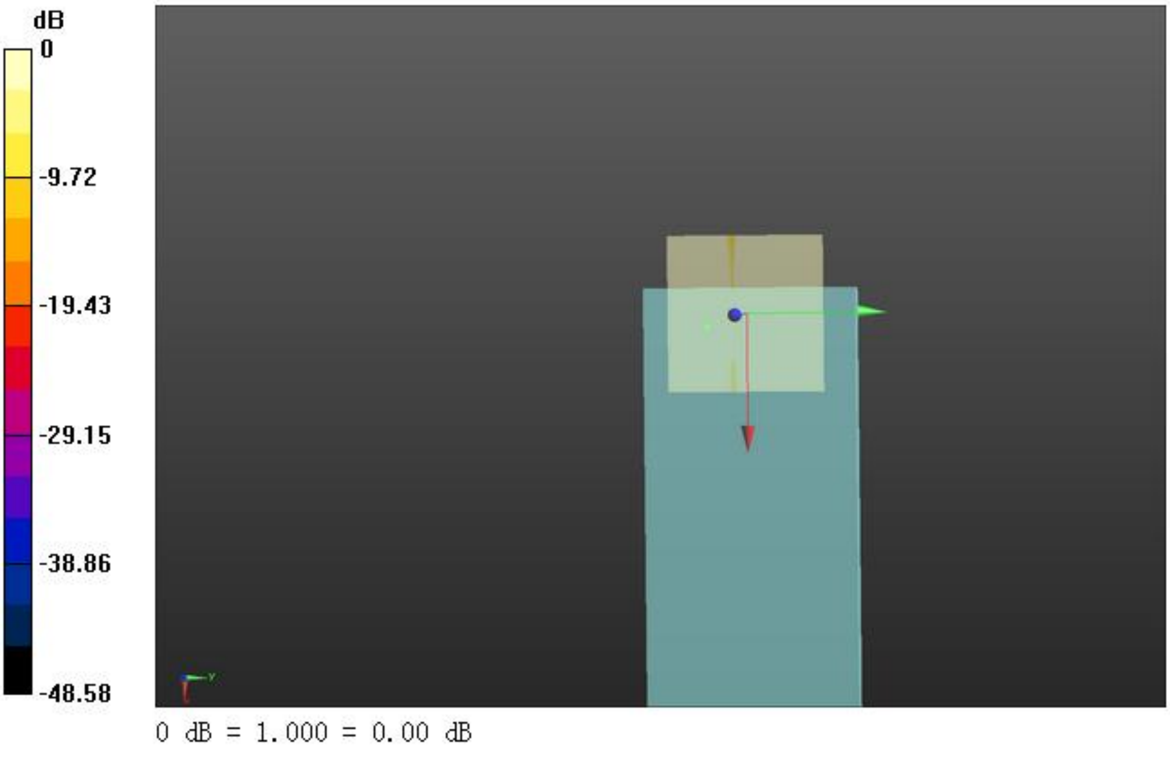
0 dB = 1.000 = 0.00 dB



Ch9400/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

Category	**Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]**
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 37.52 dB
ABM1 comp = -9.99 dBA/m
BWC Factor = 0.15 dB
Location: 4.2, -12.5, 3.7 mm



Frequency Band：UMTS BAND V

CHANNEL：Mid

DUT: Mobile Phone; Type: VOLT 8;

Communication System: UID 0, UID 0, UMTS Band V (0); Communication System Band: WCDMA 850 (824.0 - 849.0 MHz); Frequency: 836.4 MHz; Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3

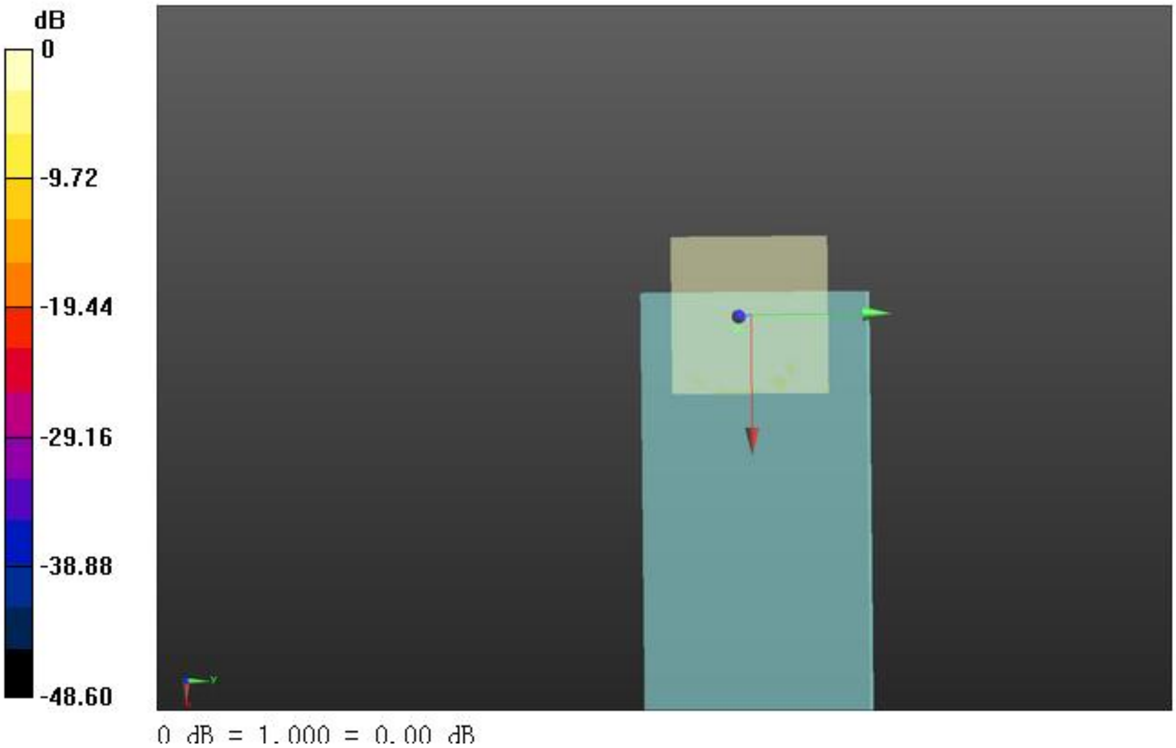
DASY Configuration:

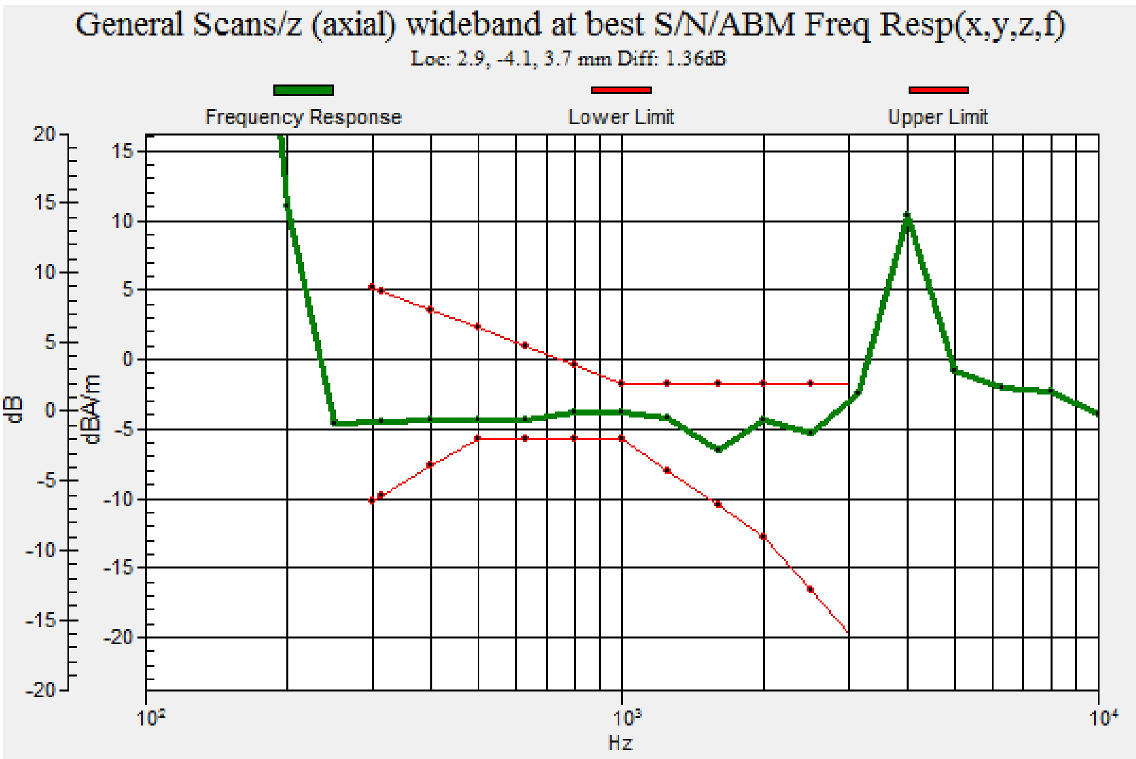
- Probe: AM1DV3 - 3120; ; Calibrated: 9/22/2016
- Sensor-Surface: 0mm (Fix Surface), z = 3.0
- Electronics: DAE4 Sn1398; Calibrated: 01/19/2017
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Ch4182/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

Category	**Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]**
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 40.55 dB
ABM1 comp = -2.07 dBA/m
BWC Factor = 0.15 dB
Location: 4.2, -4.2, 3.7 mm

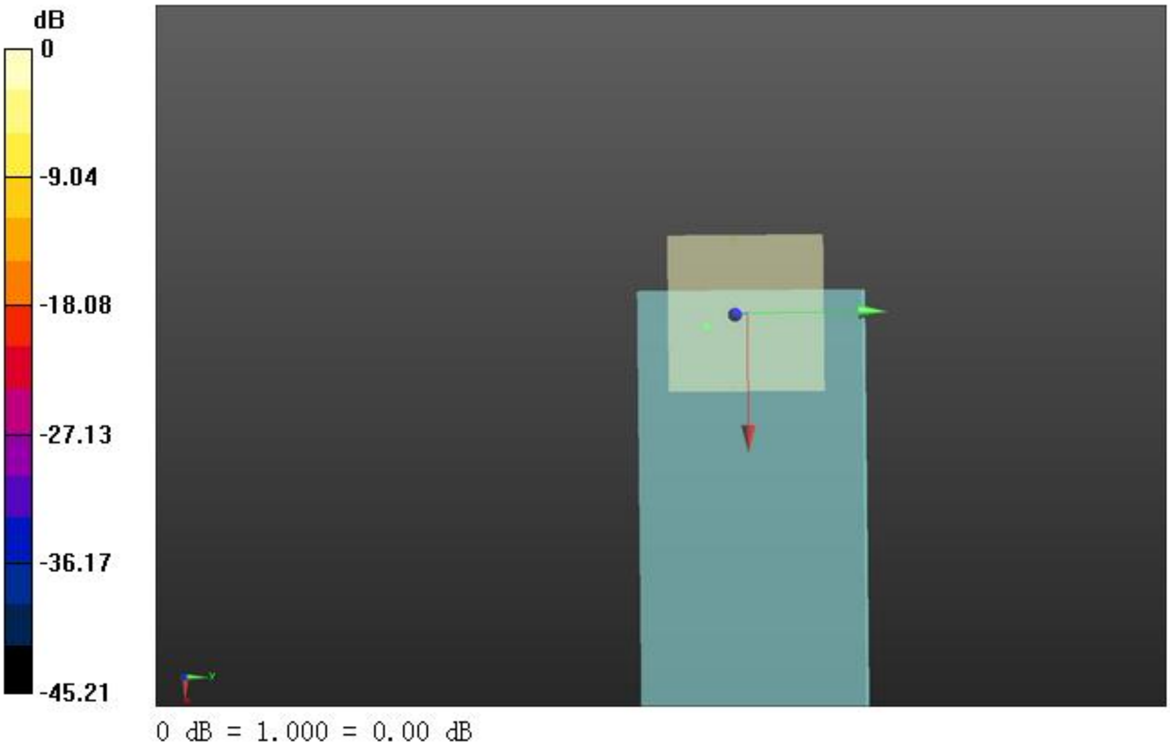

dB
0
-9.72
-19.44
-29.16
-38.88
-48.60
0 dB = 1.000 = 0.00 dB


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 2.9, -4.1, 3.7 mm Diff: 1.36dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

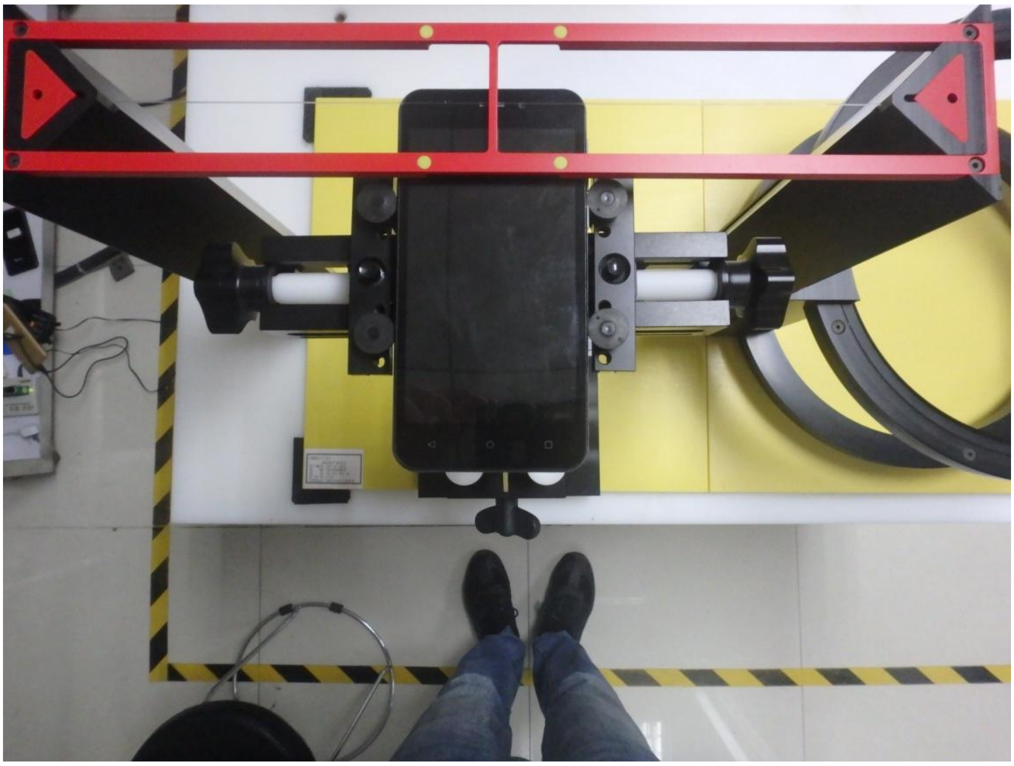
Ch4182/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 39.3
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

Category	**Telephone parameters WD signal quality [(signal+noise)-to-noise ratio in decibels]**
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Cursor:
ABM1/ABM2 = 38.81 dB
ABM1 comp = -10.56 dBA/m
BWC Factor = 0.15 dB
Location: 4.2, -12.5, 3.7 mm



APPENDIX B. TEST SETUP PHOTOGRAPHS



APPENDIX C. CALIBRATION DATA

Refer to Attached files.