Hearing Aid Compatibility (HAC) TEST REPORT

<For T-Coil Measurement>

Applicant Name	SHARP CORPORATION
Address of Applicant	22-22, Nagaike-cho, Abeno-ku, CS & Env. Promotion Div. Quality Compliance Dept. Osaka 545-8522, Japan
EUT Name	Smart Phone
Brand Name	SHARP
Model No.	HR00204
FCC ID	APYHRO00204
Date of Receive	May. 25, 2014
Date of Test(s)	Jun. 24, 2014
Date of Issue	Jul. 03, 2014

Standards:

ANSI C63.19-2011

FCC RULE PART(S): 47 CFR PART 20.19(B)

HAC RATE CATEGORY: T4 (T Category)

In the configuration tested, the EUT complied with the standards specified above.

Remarks:

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS Taiwan Electronics & Communication Laboratory or testing done by SGS Taiwan Electronics & Communication Laboratory in connection with distribution or use of the product described in this report must be approved by SGS Taiwan Electronics & Communication Laboratory in writing.

Signed on behalf of SGS

Engineer	**Sr. Engineer**
Sam Kuo	John Yeh
Sam Kuo	**John Yeh**
Date: Jul. 03, 2014	**Date: Jul. 03, 2014**

Version

Report Number	Revision	Description	Issue Date
ES/2014/50014	00	Initial Version	Jul. 03, 2014

This test report contains a reference to the previous version test report that it replaces.

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Table of Contents

1. Introduction

The purpose of this standard is to establish categories for hearing aids and for WD (wireless communications devices) that can indicate to health care practitioners and hearing aid users which hearing aids are compatible with which WD, and to provide tests that can be used to assess the electromagnetic characteristics of hearing aids and WD and assign them to these categories. The various parameters required, in order to demonstrate compatibility and accessibility are measured. The design of the standard is such that when a hearing aid and WD achieve one of the categories specified, as measured by the methodology of this standard, the indicated performance is realized.

In order to provide for the usability of a hearing aid with a WD, several factors must be coordinated:

a) Radio frequency (RF) measurements of the near-field electric and magnetic fields emitted by a WD to categorize these emissions for correlation with the RF immunity of a hearing aid.
b) Magnetic field measurements of a WD emitted via the audio transducer associated with the T-coil mode of the hearing aid, for assessment of hearing aid performance.
c) Measurements with the hearing aid and a simulation of the categorized WD T-coil emissions to assess the hearing aid RF immunity in the T-coil mode.

The WD radio frequency (RF) and audio band emissions are measured.

Hence, the following are measurements made for the WD:

a) RF E-Field emissions
b) T-coil mode, magnetic signal strength in the audio band
c) T-coil mode, magnetic signal and noise articulation index
d) T-coil mode, magnetic signal frequency response through the audio band

Corresponding to the WD measurements, the hearing aid is measured for:

a) RF immunity in microphone mode
b) RF immunity in T-coil mode

2. Testing Laboratory

Company Name	SGS Taiwan Ltd. Electronics & Communication Laboratory
Company Address	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan
Tel	+886-2-2299-3279
Fax	+886-2-2298-0488
Website	http://www.tw.sgs.com

3. Details of Applicant

Applicant Name	SHARP CORPORATION
Applicant Address	22-22, Nagaike-cho, Abeno-ku, CS & Env. Promotion Div. Quality Compliance Dept. Osaka 545-8522, Japan

4. Description of EUT

EUT Name	Smart Phone
Brand Name	SHARP
Model No.	HR00204
FCC ID	APYHRO00204
MEID	99000527001210
Mode of Operation	☒CDMA ☒CDMA EVDO Rev.0/ Rev. A ☒LTE ☒WLAN802.11 b/g/n (20M) ☒Bluetooth

Duty Cycle	CDMA	1		
	CDMA EVDO Rev.0/Rev.A	1		
	LTE	1		
	WLAN 802.11 b/g/n(20M)	1		
	Bluetooth	1		
TX Frequency Range (MHz)	CDMA (BC0)	824.7	—	848.31
	CDMA (BC1)	1851.25	—	1908.75
	CDMA (BC10)	817.9	—	823.1
	LTE FDD Band 25	1850	—	1915
	LTE FDD Band 26	814	—	849
	LTE FDD Band 41	2496	—	2690
	WLAN 802.11 b/g/n(20M)	2412	—	2462
	Bluetooth	2402	—	2480
Channel Number (ARFCN)	CDMA (BC0)	1013	—	777
	CDMA (BC1)	25	—	1175
	CDMA (BC10)	476	—	684
	LTE FDD Band 25	26140	—	26590
	LTE FDD Band 26	26740	—	26990
	LTE FDD Band 41	39750	—	41490
	WLAN 802.11 b/g/n(20M)	1	—	11
	Bluetooth	0	—	78

5. Air Interfaces and Bands

Air- Interface	Band (MHZ)	Type Transport	C63.19 tested	Simultaneous Transmitter but not tested	Voice Over Digital Transport OTT capability
CDMA 1xRTT	CDMA(BC0)	VO	Yes	Yes, WiFi or Bluetooth	No
	CDMA (BC1)				No
	CDMA (BC10)				No
CDMA EVDO Rev.0/ Rev. A	CDMA(BC0)	DT	NA	Yes, WiFi or Bluetooth	Yes
	CDMA (BC1)				Yes
	CDMA (BC10)				Yes
LTE	Band 25	DT	NA	Yes, WiFi or Bluetooth	Yes
	Band 26				Yes
	Band 41				Yes
WiFi	2450	DT	NA	Yes, CDMA/LTE	Yes
Bluetooth	2450	DT	NA	Yes, CDMA/LTE	No

VO= CMRS Voice Service

DT= Digital Transport

6. Test Environment

Ambient Temperature	21.7° C
Relative Humidity	<80 %

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7. Description of test system

7.1 Measurement System Diagram for SPEAG Robotic

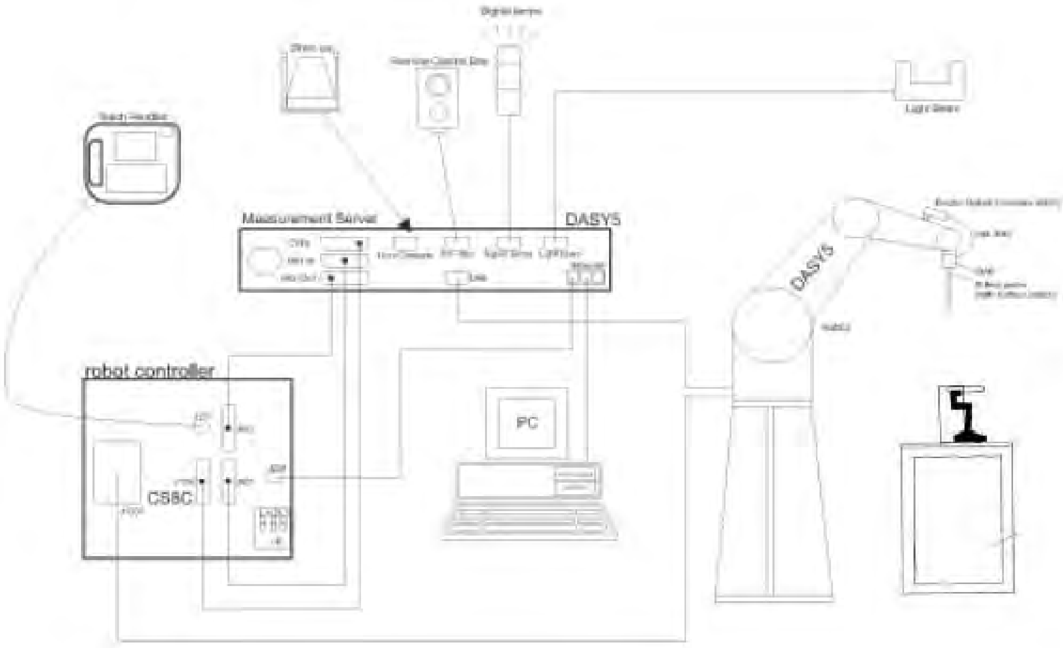

Fig. 1. The SPEAG Robotic Diagram

The DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stabile RX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- An Audio Magnetic probe.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal

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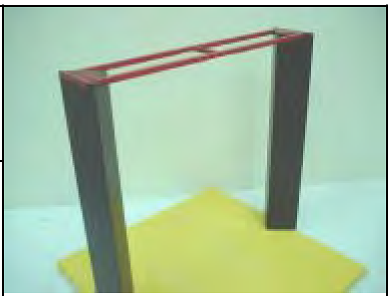
filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The Test Arch SAM phantom
- The device holder for handheld mobile phones.
- Validation dipole kits allowing to validate the proper functioning of the system.

7.2 Audio Magnetic Probe AM1DV3

Description	- Active single sensor probe for both axial and radial measurement scans - Fully RF shielded, compatible with DAE, with adapted probe cup	 AM1DV3 Audio Probe
Dynamic Range	0.1 KHz to 20 KHz	
Sensitivity	<-50dB A/m @ 1KHz	
Internal Amp	20dB	
Dimensions	300X18mm	

7.3 Test Arch

Description	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.	 Test Arch
Dimensions	length: 370 mm width: 370 mm height: 370 mm	

7.4 AMCC- Audio Magnetic Calibration Coil

Description	Allows calibration of the complete measurement setup, The two horizontal coils create a homogeneous magnetic field in the z direction. Refer to Appendix 5 for more detail on AMCC coil	 AMCC

7.5 Phone Holder

Description	Supports accurate and reliable positioning of any phone Effect on near field <+/- 0.5 dB	 Phone Holder

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7.6 AMMI - Audio Magnetic Measurement Instrument

Description	-USB interface to PC - Probe signal digitization and power supply - Test signal generation for wireless device (via base station simulator) - Auto-calibration and interfaces to AMCC for complete setup-calibration	 AMMI
Data Rate	48 KHz / 24bit	
Dynamic Range	85 dB	
Dimensions:	19” X 65 X 270mm	

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8. Measurement Procedure

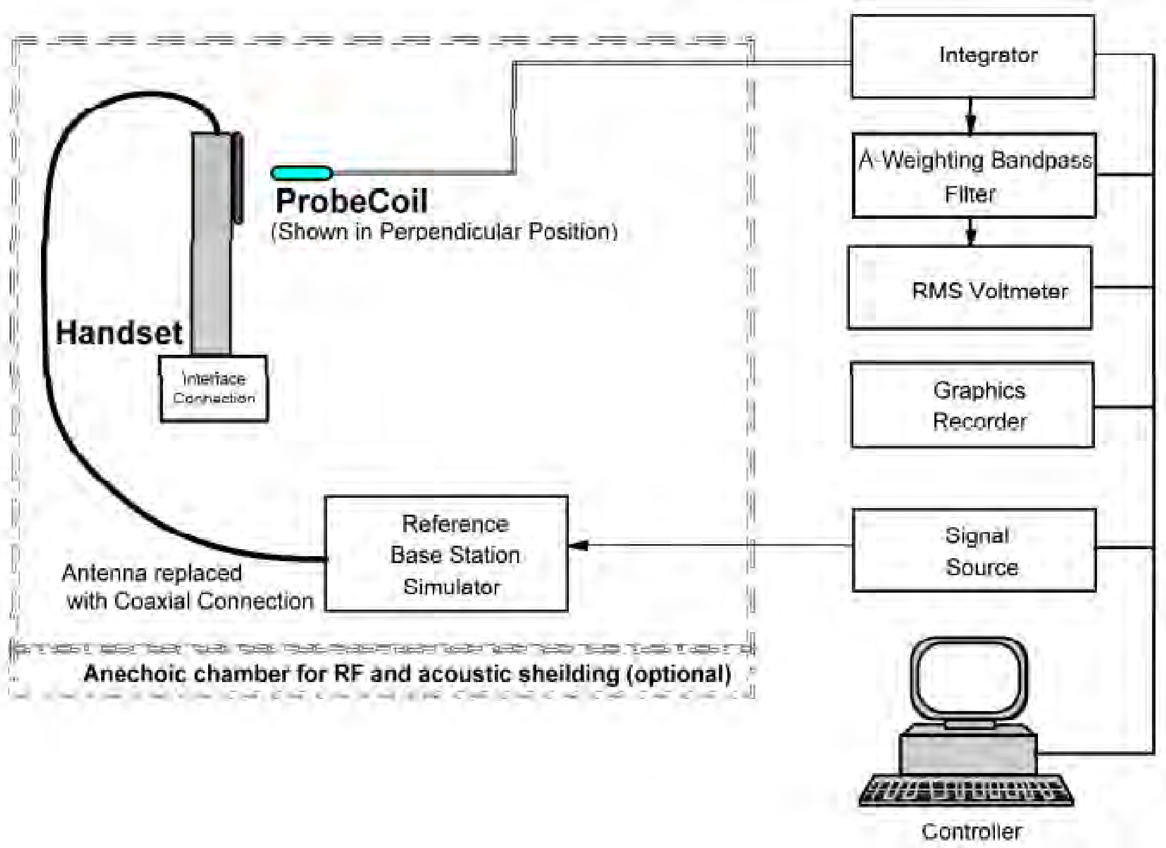

Fig. 2. T-coil signal measurement test setup

The sequence of the measurement is T-Coil testing procedure over a wireless communication device:

1) Confirm Geometry & signal check. Probe phantom alignment and check of accuracy.
2) Background noise measurement in the area of the WD.
3) Perform 50x50mm area scan with narrow band signal to determine ABM1, ABM2 and SNR for axial and radial orientation positions.
4) For Axial position, perform optimal SNR point measurement with a broadband signal – determine Frequency Response.
5) Speech input level is -16dbm.

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Note.

#. The EUT do not use the special HAC SW.

#. Setting the maximum volume for EUT during measurement.

#. For the measurement, it do not use the “post-test measurement processing of results”.

#. Per KDB 285076 D01 v04 item 10)a, handsets that that have the ability to support “concurrent connections” using simultaneous transmissions shall be independently tested for each air interface/band given in ANSI C63.19-2011 separately.

At the present time the ANSI C63.19 standard does not provide simultaneous transmission test procedures.

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9. System calibration

For correct and calibrated measurement of the voltages and ABM field, DASY will perform a calibration job as below.
In phase 1, the audio output is switched off, and a 200 mVpp symmetric rectangular signal of 1 kHz is generated and internally connected directly to both channels of the sampling unit (Coil in, Probe in).
In phase 2, the audio output is off, and a 20 mVpp symmetric 100 Hz signal is internally connected. The signals during phases 1 and 2 are available at the output on the rear panel of the AMMI. However, the output must not be loaded, in order to avoid influencing the calibration. An RMS voltmeter would indicate 100 mVRMS during the first phase and 10 mVRMS during the second phase. After the first two phases, the two input channels are both calibrated for absolute measurements of voltages. The resulting factors are displayed above the multi-meter window.
After phases 1 and 2, the input channels are calibrated to measure exact voltages. This is required to use the inputs for measuring voltages with their peak and RMS value.
In phase 3, a multi-sine signal covering each third-octave band from 50 Hz to 10 kHz is generated and applied to both audio outputs. The probe should be positioned in the center of the AMCC and aligned in the z-direction, the field orientation of the AMCC. The “Coil In” channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the “Probe In" channel samples the amplified signal picked up by the probe coil and provides it to a numerical integrator. The ratio of the two voltages in each third-octave filter leads to the spectral representation over the frequency band of interest. The Coil signal is scaled in dBV, and the Probe signal is first integrated and normalized to show dB A/m. The ratio probe-to-coil at the frequency of 1 kHz is the sensitivity which will be used in the consecutive T-Coil jobs.

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10. Justification of held to ear modes tested

LTE, WIFI and other OTT data services are outside the current definition of a managed CMRS service and are currently not required to be evaluated.

11. Test Standards and Limits

The measurements were performed to ensure compliance to the ANSI C63.19-2011 standard.

The limit values please follow in Table 2

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

Table 2. Signal Quality Range

Signal strength

Axial field intensity

The axial component of the magnetic field, directed along the measurement axis and located at the measurement plane, shall be ≥ -18 dB (A/m) at 1 kHz, in 1/3 octave band filter.

Radial(Y) field intensity

The radial component of the magnetic field, as measured at the radial, measurement points shall be ≥ -18 dB (A/m) at 1 kHz, in 1/3 octave band filter.

12. Instruments List

Manufacturer	Device	Type	Serial Number	Date of Last Calibration	Date of Next Calibration
Schmid & Partner Engineering AG	Data acquisition Electronics	DAE4	547	Mar.26,2014	Mar.25,2015
Schmid & Partner Engineering AG	Software	DASY52 52.8.8	N/A	Calibration not required	Calibration not required
Schmid & Partner Engineering AG	Audio Magnetic 1D Field Probe	AM1DV3	3115	Mar.18.2014	Mar.17.2015
Schmid & Partner Engineering AG	AMMI SE UMS	010 AB	1028	Calibration not required	Calibration not required
Schmid & Partner Engineering AG	AMCC SD HAC	P01 BA	1026	N/A	N/A
Schmid & Partner Engineering AG	Test Arch SD HAC	P01	1047	N/A	N/A
R&S	Radio Communication Test	CMU200	113505	May.08,2014	May.07,2015

13. Summary of Results

CDMA BC0

Probe Position	Frequency Band (MHz)	Channel	ABM2 (Ambient Noise) (dB A/m)	ABM1 (dB A/m)	SNR (dB)	T-coil SNR Rating
Axial	836.52	384	-41.21	3.61	44.82	T4
Radial(Y)	836.52	384	-48.21	-7.01	41.20	T4
Freq Resp		**PASS**				

CDMA BC10

Probe Position	Frequency Band (MHz)	Channel	ABM2 (Ambient Noise) (dB A/m)	ABM1 (dB A/m)	SNR (dB)	T-coil SNR Rating
Axial	820	560	-40.86	2.29	43.15	T4
Radial(Y)	820	560	-47.99	-6.97	41.02	T4
Freq Resp		**PASS**				

CDMA BC1

Probe Position	Frequency Band (MHz)	Channel	ABM2 (Ambient Noise) (dB A/m)	ABM1 (dB A/m)	SNR (dB)	T-coil SNR Rating
Axial	1880	600	-41.86	3.03	44.89	T4
Radial(Y)	1880	600	-47.49	-5.72	41.77	T4
Freq Resp		**PASS**				

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14. Measurement Data

Date: 2014/6/24

HAC-T-Coil-CDMA (BC0) CH384

Communication System: UID 0, CDMA (0); Frequency: 836.52 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: TCoil Section

DASY5 Configuration:

- Probe: AM1DV3 - 3115; ; Calibrated: 2014/3/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch with AMCC; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

T-Coil scan /General Scans/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: 27.3834
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

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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 = 44.82 dB
ABM1 comp = 3.61 dBA/m
BWC Factor = 0.15 dB
Location: 4.2, 16.7, 3.7 mm

T-Coil scan /General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f) (1x1x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 53.6285
Measure Window Start: 300ms
Measure Window Length: 2000ms
BWC applied: 10.80 dB
Device Reference Point: 0, 0, -6.3 mm
Cursor:
Diff = 1.28 dB
BWC Factor = 10.80 dB
Location: 4, 16.9, 3.7 mm

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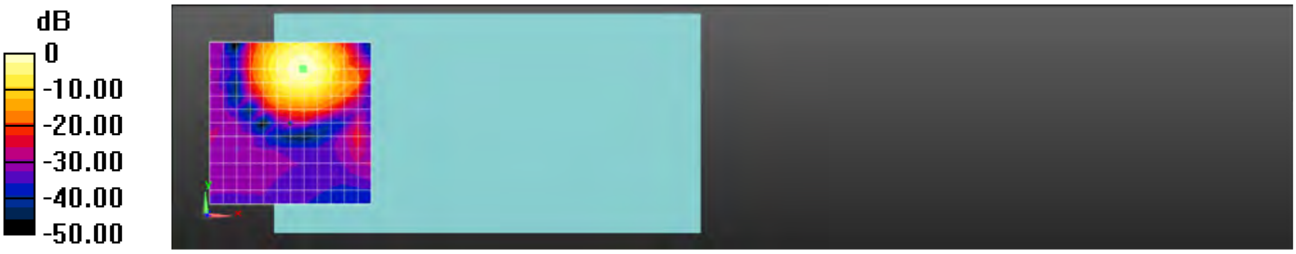
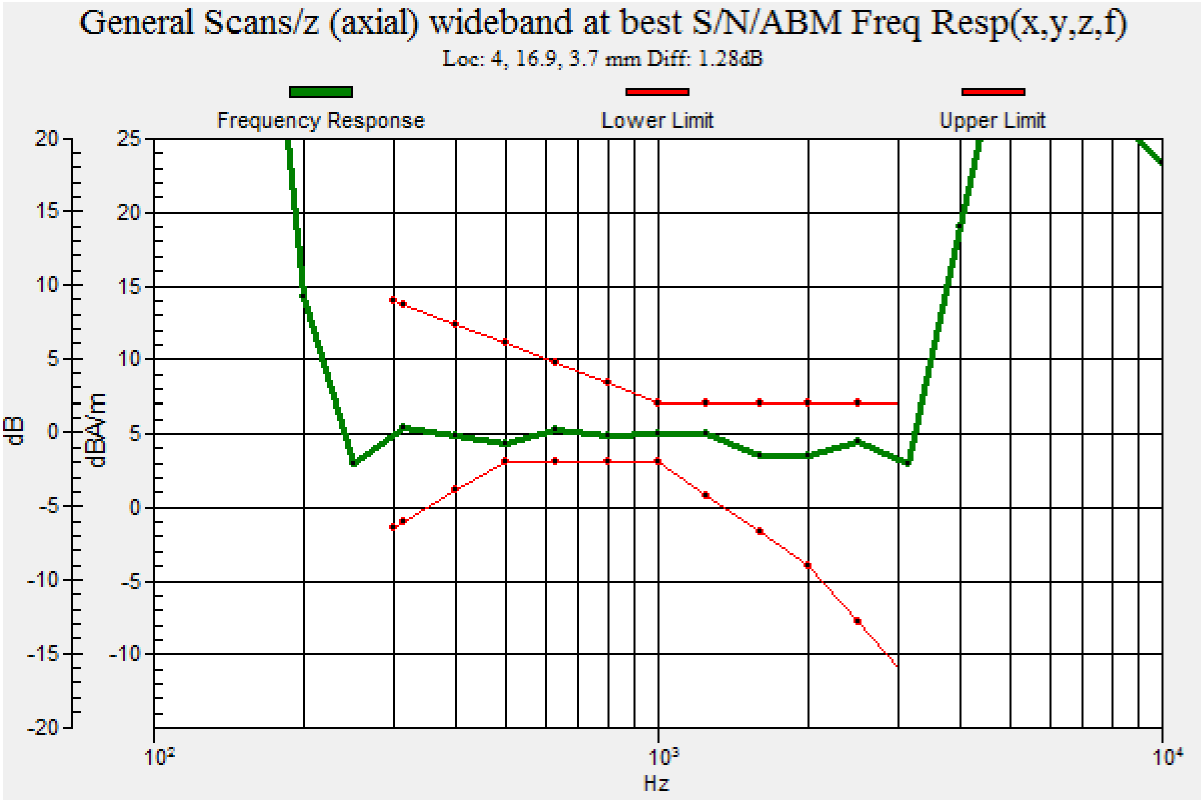


0 dB = 174.2 = 44.82 dB



Date: 2014/6/24

HAC-T-Coil-CDMA (BC0) CH384

Communication System: UID 0, CDMA (0); Frequency: 836.52 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3
Phantom section: TCoil Section

DASY5 Configuration:

- Probe: AM1DV3 - 3115; ; Calibrated: 2014/3/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch with AMCC; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

T-Coil scan /General Scans/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: 27.3834
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

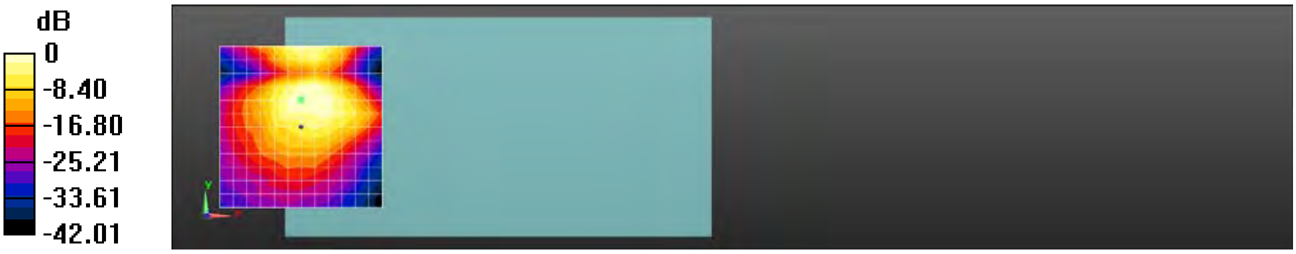
Cursor:

ABM1/ABM2 = 41.20 dB

ABM1 comp = -7.01 dBA/m

BWC Factor = 0.15 dB

Location: 0, 8.3, 3.7 mm



0 dB = 114.9 = 41.20 dB

HAC-T-Coil-CDMA (BC10) CH560

Communication System: UID 0, CDMA (0); Frequency: 820 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3
Phantom section: TCoil Section

DASY5 Configuration:

- Probe: AM1DV3 - 3115; ; Calibrated: 2014/3/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch with AMCC; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

T-Coil scan /General Scans/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: 27.3834
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

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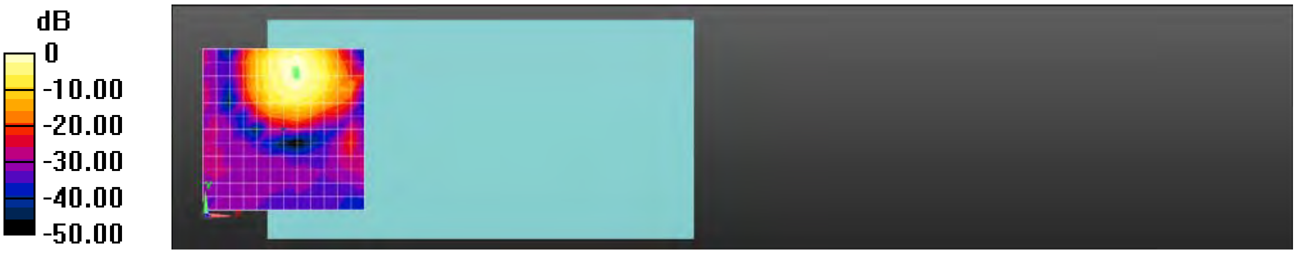
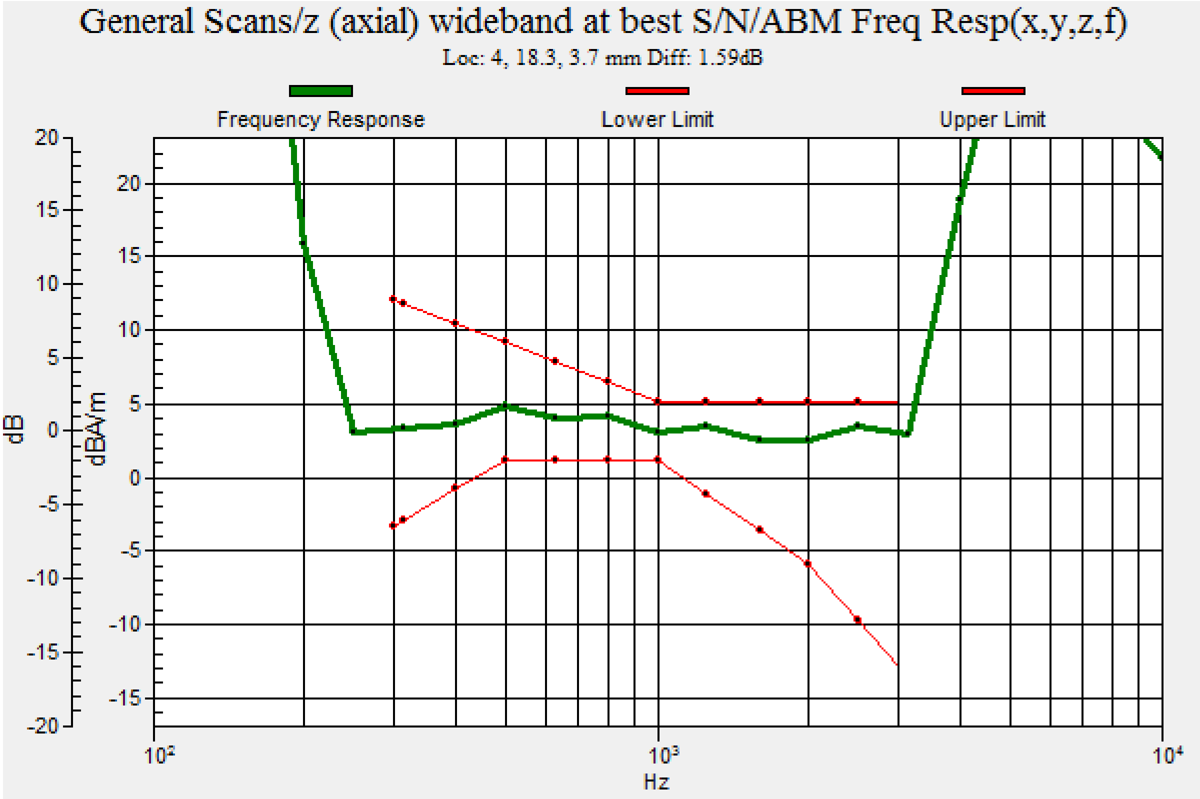
Cursor:
ABM1/ABM2 = 43.15 dB
ABM1 comp = 2.29 dBA/m
BWC Factor = 0.14 dB
Location: 4.2, 16.7, 3.7 mm

T-Coil scan (scan for ANSI C63.19-2007 & 2011 compliance)/General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f) (1x1x1):

Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 53.6285
Measure Window Start: 300ms
Measure Window Length: 2000ms
BWC applied: 10.79 dB
Device Reference Point: 0, 0, -6.3 mm
Cursor:
Diff = 1.59 dB
BWC Factor = 10.79 dB
Location: 4, 18.3, 3.7 mm



0 dB = 143.7 = 43.15 dB


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4, 18.3, 3.7 mm Diff: 1.59dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz

HAC-T-Coil-CDMA (BC10) CH560

Communication System: UID 0, CDMA (0); Frequency: 820 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: TCoil Section

DASY5 Configuration:

- Probe: AM1DV3 - 3115; ; Calibrated: 2014/3/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch with AMCC; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

T-Coil scan /General Scans/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: 27.3834
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

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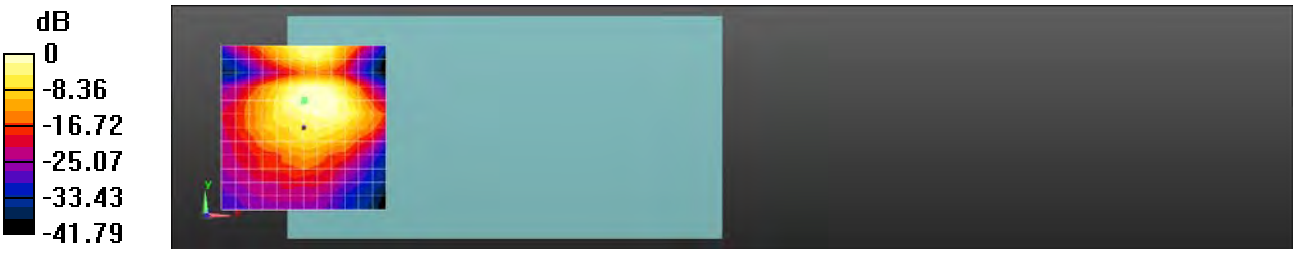
Cursor:

ABM1/ABM2 = 41.02 dB

ABM1 comp = -6.97 dBA/m

BWC Factor = 0.14 dB

Location: 0, 8.3, 3.7 mm



0 dB = 112.5 = 41.02 dB

HAC-T-Coil-CDMA (BC1) CH600

Communication System: UID 0, CDMA (0); Frequency: 1880 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3
Phantom section: TCoil Section

DASY5 Configuration:

- Probe: AM1DV3 - 3115; ; Calibrated: 2014/3/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch with AMCC; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

T-Coil scan /General Scans/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: 27.3834
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

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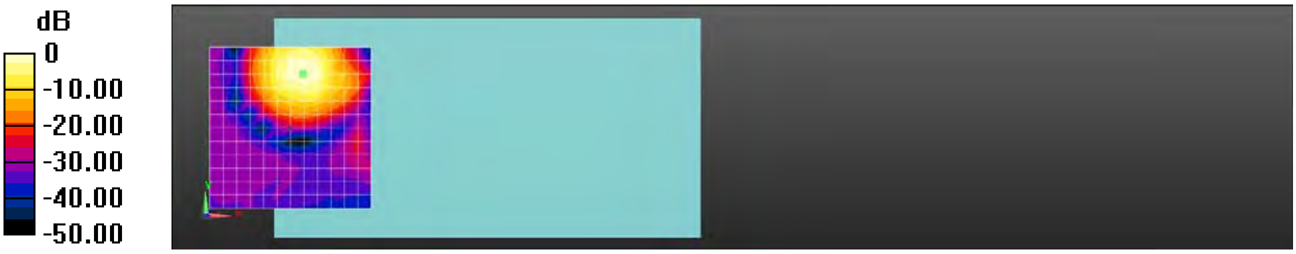
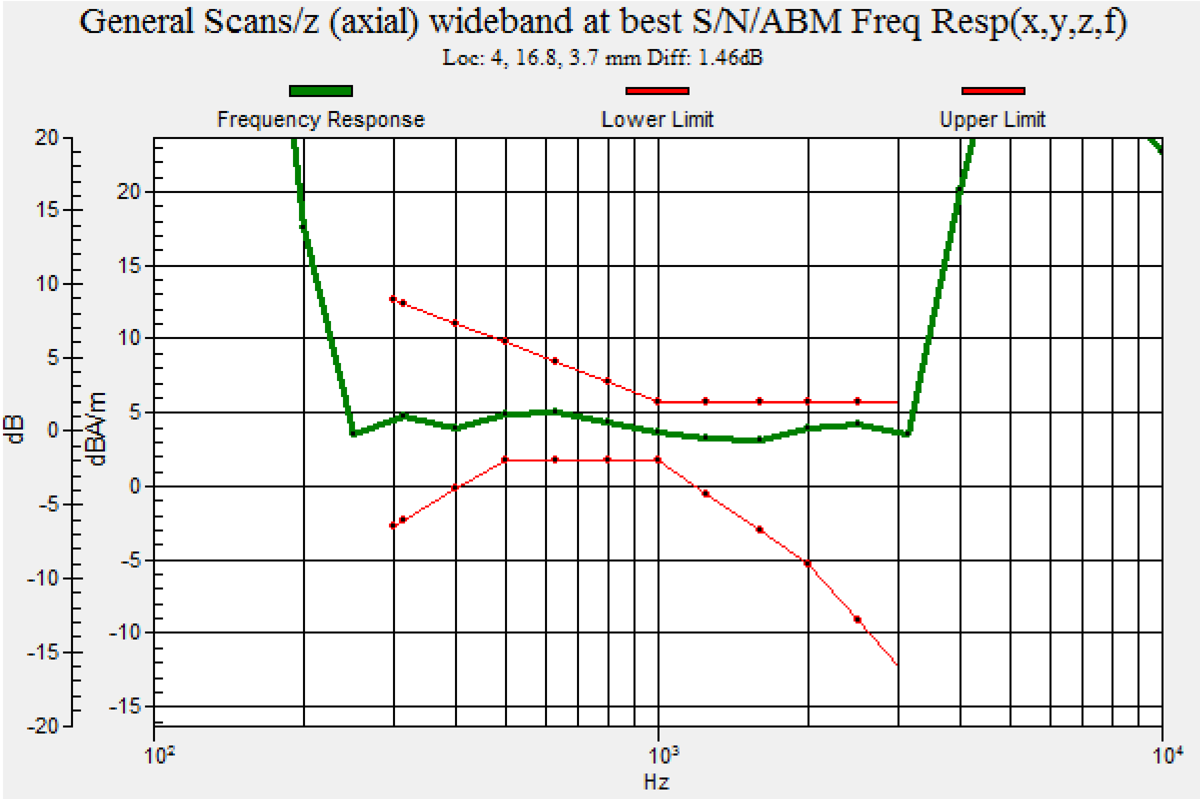
Cursor:
ABM1/ABM2 = 44.89 dB
ABM1 comp = 3.03 dBA/m
BWC Factor = 0.14 dB
Location: 4.2, 16.7, 3.7 mm

T-Coil scan /General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f) (1x1x1): Measurement grid: dx=10mm, dy=10mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 53.6285
Measure Window Start: 300ms
Measure Window Length: 2000ms
BWC applied: 10.79 dB
Device Reference Point: 0, 0, -6.3 mm
Cursor:
Diff = 1.46 dB
BWC Factor = 10.79 dB
Location: 4, 16.8, 3.7 mm



0 dB = 175.7 = 44.89 dB


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 4, 16.8, 3.7 mm Diff: 1.46dB
Frequency Response
Lower Limit
Upper Limit
dB
dBA/m
Hz
10^2
10^3
10^4

Date: 2014/6/24

HAC-T-Coil-CDMA (BC1) CH600

Communication System: UID 0, CDMA (0); Frequency: 1880 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: TCoil Section

DASY5 Configuration:

- Probe: AM1DV3 - 3115; ; Calibrated: 2014/3/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch with AMCC; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

T-Coil scan /General Scans/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: 27.3834
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

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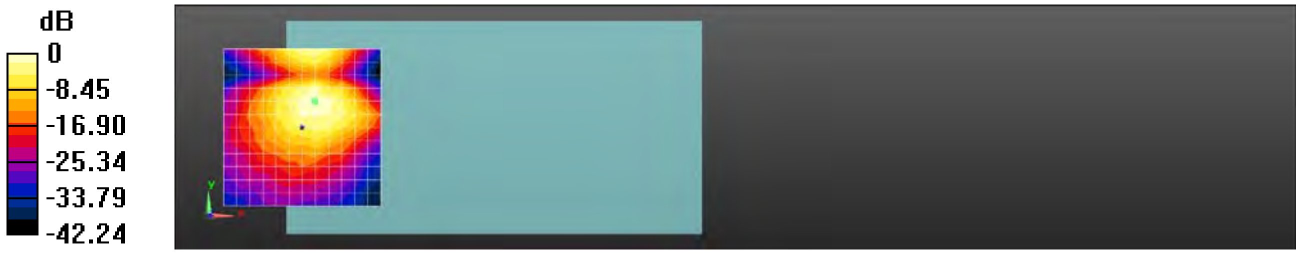
Cursor:

ABM1/ABM2 = 41.77 dB

ABM1 comp = -5.72 dBA/m

BWC Factor = 0.14 dB

Location: 4.2, 8.3, 3.7 mm



0 dB = 122.6 = 41.77 dB

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15. DAE & Probe Calibration Certificate

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **SGS - TW (Auden)**

Certificate No: **DAE4-547_Mar14**

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 547

Calibration procedure(s): QA CAL-06.v26
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: March 26, 2014

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	01-Oct-13 (No:13976)	Oct-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

	Name	Function	Signature
Calibrated by:	Eric Hainfeld	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	i.V.

Issued: March 26, 2014

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Certificate No: DAE4-547_Mar14 Page 1 of 5

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Accreditation No.: SCS 108

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.

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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	404.032 ± 0.02% (k=2)	404.058 ± 0.02% (k=2)	404.202 ± 0.02% (k=2)
Low Range	3.95713 ± 1.50% (k=2)	3.96202 ± 1.50% (k=2)	3.97561 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	158.0 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199995.43	-0.60	-0.00
Channel X	+ Input	20004.43	4.15	0.02
Channel X	- Input	-19997.69	3.25	-0.02
Channel Y	+ Input	199994.87	-1.15	-0.00
Channel Y	+ Input	19998.43	-1.93	-0.01
Channel Y	- Input	-20001.87	-0.85	0.00
Channel Z	+ Input	199997.48	1.41	0.00
Channel Z	+ Input	20001.10	0.79	0.00
Channel Z	- Input	-20003.63	-2.53	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.64	0.17	0.01
Channel X	+ Input	201.77	0.85	0.42
Channel X	- Input	-199.11	-0.24	0.12
Channel Y	+ Input	2000.97	0.62	0.03
Channel Y	+ Input	200.19	-0.69	-0.34
Channel Y	- Input	-199.95	-0.97	0.49
Channel Z	+ Input	2000.53	0.21	0.01
Channel Z	+ Input	200.38	-0.40	-0.20
Channel Z	- Input	-199.62	-0.59	0.29

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	19.65	17.65
	- 200	-14.62	-15.76
Channel Y	200	-6.89	-7.43
	- 200	3.98	4.06
Channel Z	200	20.93	20.96
	- 200	-22.42	-22.42

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	-	2.53	-2.12
Channel Y	200	9.67	-	3.63
Channel Z	200	5.84	6.75	-

Certificate No: DAE4-547_Mar14 Page 4 of 5

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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	16141	15478
Channel Y	16453	16523
Channel Z	15984	17120

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	2.01	0.79	3.52	0.47
Channel Y	-0.51	-1.15	0.66	0.34
Channel Z	-0.87	-1.96	0.11	0.45

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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **SGS-TW (Auden)**

Certificate No: **AM1DV3-3115_Mar14**

CALIBRATION CERTIFICATE

Object: AM1DV3 - SN: 3115

Calibration procedure(s): QA CAL-24.v3
Calibration procedure for AM1D magnetic field probes and TMFS in the audio range

Calibration date: March 18, 2014

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	01-Oct-13 (No 13976)	Oct-14
Reference Probe AM1DV2	SN: 1008	14-Jan-14 (No. AM1D-1008_Jan14)	Jan-15
DAE4	SN: 781	13-Sep-13 (No. DAE4-781_Sep13)	Sep-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	1050	01-Oct-13 (in house check Oct-13)	Oct-15
AMMI Audio Measuring Instrument	1062	26-Sep-12 (in house check Sep-12)	Sep-14

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: March 19, 2014

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Certificate No: AM1DV3-3115_Mar14 Page 1 of 3

[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.

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AM1D probe identification and configuration data

Item	**AM1DV3** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 BB
Serial No	**3115**

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	November 15, 2011
Last calibration date	March 25, 2013

Calibration data

Connector rotation angle	(in DASY system)	**259.7 °**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**0.60 °**	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.00791 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%.

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16. Uncertainty Budget

Uncertainty of Audio Band Magnetic Measurements

Error Description	Unc. Value	Prob. Dist.	Div.	(c_i) ABM1	(c_i) ABM2	Std. Unc. ABM1	Std. Unc. ABM2
Probe Sensitivity							
Reference Level	±3.0 %	N	1	1	1	±3.0 %	±3.0 %
AMCC Geometry	±0.4 %	R	$\sqrt{3}$	1	1	±0.2 %	±0.2 %
AMCC Current	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Probe Positioning during Calibr.	±0.1 %	R	$\sqrt{3}$	1	1	±0.1, %	±0.1 %
Noise Contribution	±0.7 %	R	$\sqrt{3}$	0.0143	1	±0.0 %	±0.4 %
Frequency Slope	±5.9 %	R	$\sqrt{3}$	0.1	1.0	±0.3 %	±3.5 %
Probe System							
Repeatability / Drift	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Linearity / Dynamic Range	±0.6 %	R	$\sqrt{3}$	1	1	±0.4 %	±0.4 %
Acoustic Noise	±1.0 %	R	$\sqrt{3}$	0.1	1	±0.1 %	±0.6 %
Probe Angle	±2.3 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %
Spectral Processing	±0.9 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %
Integration Time	±0.6 %	N	1	1	5	±0.6 %	±3.0 %
Field Disturbation	±0.2 %	R	$\sqrt{3}$	1	1	±0.1 %	±0.1 %
Test Signal							
Ref. Signal Spectral Response	±0.6 %	R	$\sqrt{3}$	0	1	±0.0 %	±0.4 %
Positioning							
Probe Positioning	±1.9 %	R	$\sqrt{3}$	1	1	±1.1 %	±1.1 %
Phantom Thickness	±0.9 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %
DUT Positioning	±1.9 %	R	$\sqrt{3}$	1	1	±1.1 %	±1.1 %
External Contributions							
RF Interference	±0.0 %	R	$\sqrt{3}$	1	0.3	±0.0 %	±0.0 %
Test Signal Variation	±2.0 %	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %
Combined Uncertainty							
Combined Std. Uncertainty (ABM Field)						±4.1 %	±6.1 %
Expanded Std. Uncertainty						**±8.1 %**	**±12.3 %**

End of 1st part of report