Variant Hearing Aid Compatibility (HAC) T-Coil Test Report

APPLICANT	:	**HTC Corporation**
EQUIPMENT	:	**Windows Phone**
MODEL NAME	:	**PI06110**
FCC ID	:	**NM8PI06110**
STANDARD	:	**FCC 47 CFR §20.19** **ANSI C63.19-2007**
T CATEGORY	:	**T3**

This is a variant report which is only valid together with the original test report. The product sample received on Aug. 17, 2011 and completely tested on Aug. 17, 2011. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and shown the compliance with the applicable technical standards.

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

Reviewed by:

Jones Tsai

Jones Tsai / Manager

Testing Laboratory
1190

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
HA181714	Rev. 01	This is a variant report by adding 2nd battery. All the test cases were performed on original report which can be referred to Sporton Report No. HA172303 as Appendix D. Base on original report, only the worst case was verified.	Aug. 22, 2011

1. Statement of Compliance

The Hearing Aid Compliance (HAC) maximum results found during testing for

the **HTC Corporation Windows Phone PI06110** are as follows (with expanded uncertainly ±8.1% for AMB1 and ±12.3% for AMB2):

Reference (63.19)	Description	Verdict	Section
7.3.1.1	Axial Field Intensity	Pass	9.2.1
7.3.1.2	Radial Field Intensity	Pass	9.2.2
7.3.2	Frequency Response	Pass	9.2.3
7.3.3	Signal Quality	T3	9.2.4

Band	(S+N)/N in dB	T Rating
GSM850	**28.4**	**T3**
GSM1900	**29.2**	**T3**
WCDMA Band II	**30.8**	**T4**
WCDMA Band IV	**30.9**	**T4**

They are in compliance with HAC limits (HAC Rated category T3) specified in guidelines FCC 47CFR §20.19 and ANSI Standard ANSI C63.19.

Results Summary : T Category = T3 (ANSI C63.19-2007)

2. Administration Data

2.1 Testing Laboratory

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No. :** SAR01-HY

2.2 Applicant

Company Name	HTC Corporation
Address	No. 23, Xinghua Rd., Taoyuan City, Taoyuan County 330, Taiwan (R.O.C.)

2.3 Manufacturer

Company Name	HTC Corporation
Address	No. 23, Xinghua Rd., Taoyuan City, Taoyuan County 330, Taiwan (R.O.C.)

2.4 Application Details

Date of Receipt of Application	Aug. 17, 2011
Date of Start during the Test	Aug. 17, 2011
Date of End during the Test	Aug. 17, 2011

3. General Information

3.1 Description of Device Under Test (DUT)

Product Feature & Specification	
DUT Type	Windows Phone
Model Name	PI06110
FCC ID	NM8PI06110
Tx Frequency	GSM850 : 824 MHz ~ 849 MHz GSM1900 : 1850 MHz ~ 1910 MHz WCDMA Band II : 1850 MHz ~ 1910 MHz WCDMA Band IV : 1710MHz ~ 1755 MHz
Rx Frequency	GSM850 : 869 MHz ~ 894 MHz GSM1900 : 1930 MHz ~ 1990 MHz WCDMA Band II : 1930 MHz ~ 1990 MHz WCDMA Band IV : 2110 MHz ~ 2155 MHz
Antenna Type	Fixed Internal Antenna
Type of Modulation	GMSK
DUT Stage	Identical Prototype

List of Accessory:

Specification of Accessory		
Battery 2	**Brand Name**	WTE
	Model Name	PI06110

Remark: The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

List of air interfaces / frequency bands

Air Interface	Band (MHz)	Voice/Data	C 63.19-2007 Tested	Concurrent connections	Reduced Power 20.19 (c)(1)
GSM	850,1900	Voice	Yes	WCDMA, WLAN, BT	No
WCDMA	1700,1900	Voice	Yes	WLAN, BT	No
WLAN	2450	Data (*)	No	GSM, WCDMA, BT	No
BT	2450	Data (*)	No	GSM, WCDMA, WLAN	No

Note:

1. (*): The voice function maybe be activated via 3rd party software application.
2. Per KDB 285076 D01 7)a), during T-Coil test, concurrent transmission is disabled.

3.2 Product Photos

Refer to Appendix C.

3.3 Applied Standards

The Standard ANSI C63.19:2007 represents performance requirements for acceptable interoperability of hearing aids with wireless communications devices. When these parameters are met, a hearing aid operates acceptably in close proximity to a wireless communications device.

3.4 Test Conditions

3.4.1 Ambient Condition

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

3.4.2 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. Hearing Aid Compliance (HAC)

4.1 Introduction

In September 2006, the T-Coil requirements of ANSI C63.19 Standard went into effect. The federal communication commission (FCC) adopted ANSI C63.19 as HAC test standard.

5. HAC T-Coil Measurement Setup

5.1 System Configuration

Fig. 5.1 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 (ECO) 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 XP
- 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.

5.2 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:

Frequency Range	0.1 ~ 20 kHz (RF sensitivity <-100dB, fully RF shielded)
Sensitivity	<-50dB A/m @ 1 kHz
Pre-amplifier	40 dB, symmetric
Dimensions	Tip diameter/ length: 6/ 290 mm, sensor according to ANSI-PC63.19

5.2.1 Probe Calibration in AMCC

The probe sensitivity at 1 kHz is 0.00742647 V/(A/m) (-21.29 dBV/(A/m)) was calibrated by AMCC coil for verification of setup performance. The evaluated probe sensitivity was able to be compared to the calibration of the AM1D probe. The frequency response and sensitivity was shown in Fig. 5.3. The probe signal is represented after application of an ideal integrator. The green curve represents the current though the AMCC, the blue curve the integrated probe signal. The DIFFERENCE between the two curves is equivalent to the frequency response of the probe system and shows the characteristics. The probe/system complies with the frequency response and linearity requirements in C63.19 according to the Speag's calibrated report as shown in Annex B (AM1D probe: SPAM100AF) (1)The frequency response has been tested within +/- 0.5 dB of ideal differentiator from 100 Hz to 10 kHz. (2)The linearity has also been tested within 0.1dB from 5 dB below limitation to 16 dB above noise level. The AMCC coil is qualified according to certificate report, SDHACPO02A as shown in Annex B.

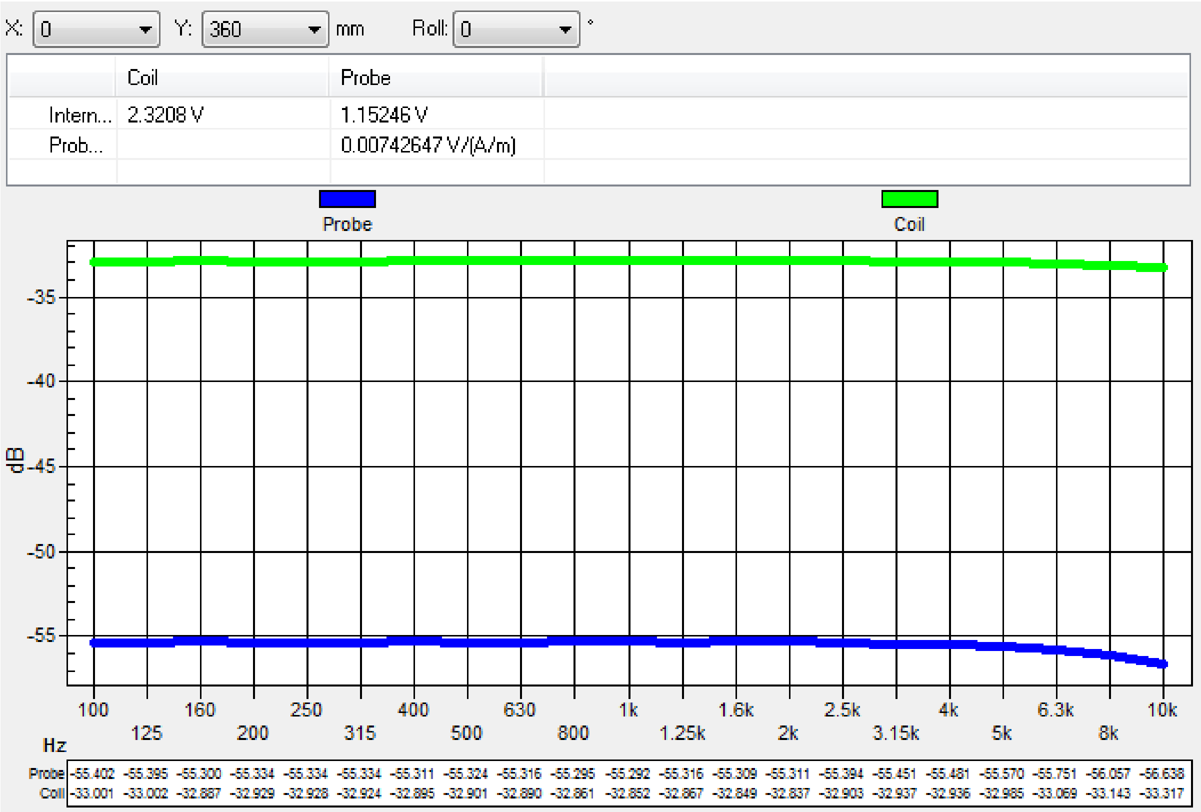


Fig. 5.3 The frequency response and sensitivity of AM1D probe

5.3 AMCC

The Audio Magnetic Calibration coil is a Helmholtz Coil designed for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction. The DC input resistance is adjusted by a series resistor to approximately 50Ohm, and a shunt resistor of 10 Ohm permits monitoring the current with a scale of 1:10.

Port description:

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

Specification:

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

5.4 AMMI

Fig. 5.4 AMMI front panel

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

Specification:

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

5.5 DATA Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. 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 of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Fig. 5.5 Photo of DAE

5.6 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90BL; DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

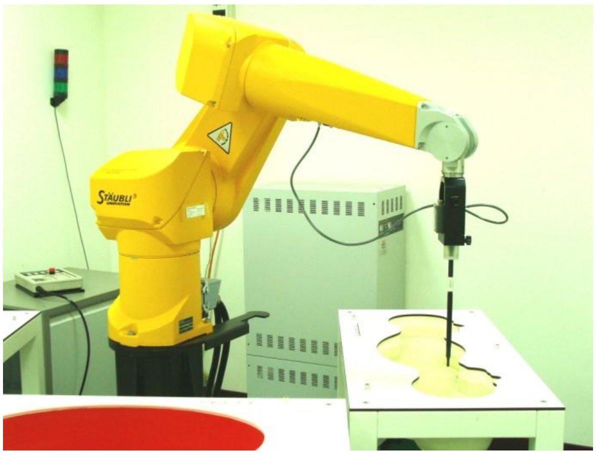


Fig. 5.6 Photo of DASY4

Fig. 5.7 Photo of DASY5

5.7 Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 128 MB), RAM (DASY4: 64 MB, DASY5: 128 MB). 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 DASY 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.

Fig. 5.8 Photo of Server for DASY4

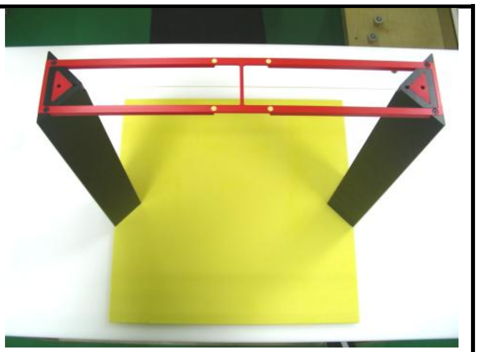
Fig. 5.9 Photo of Server for DASY5

5.8 Phone Positioner

The phone positioner shown in Fig. 5.10 is used to adjust DUT to the suitable position.

Fig. 5.10 Phone Positioner

5.9 Test Arch Phantom

Construction :	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.	 **Fig. 5.12 Photo of Arch Phantom**
Dimensions :	370 x 370 x 370 mm	

5.10 Cabling of System

The principal cabling of the T-Coil setup is shown in Fig. 5.6. All cables provided with the basic setup have a length of approximately 5 m.

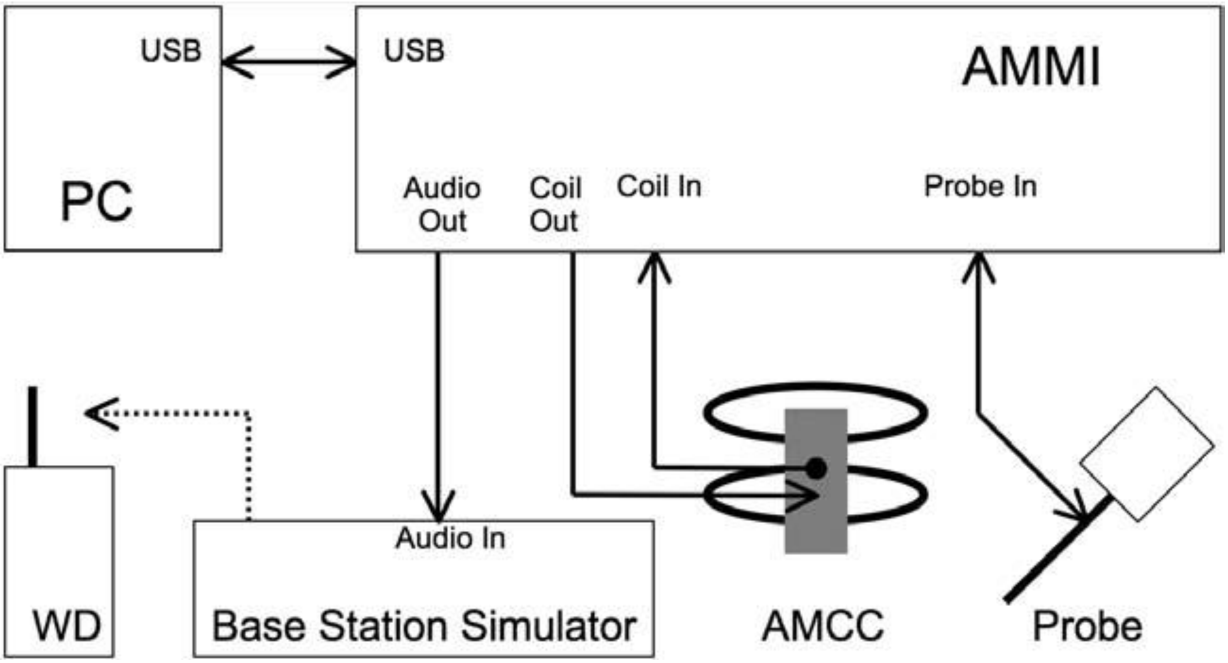


Fig. 5.7 T-Coil setup cabling

5.11 HAC Extension Software

Specification:

Precise teaching	Easy teaching with adaptive distance verification
Measurement area	Flexible selection of measurement area, predefined according to ANSI C63.19
Evaluation	ABM: spectral processing, filtering, weighting and evaluation according to ANSI C63.19
Report	Documentation ready for compliance report

5.12 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Audio Magnetic 1D Field Probe	AM1DV2	1038	Jan. 18, 2011	Jan. 17, 2012
SPEAG	Audio Magnetic Calibration Coil	AMCC	1049	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1041	NCR	NCR
SPEAG	Data Acquisition Electronics	DAE3	495	Apr. 28, 2011	Apr. 27, 2012
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positoiner	N/A	N/A	NCR	NCR
R&S	Universal Radio Communication Tester	CMU200	114256	Feb. 08, 2010	Feb. 07, 2012
Agilent	Dual Directional Coupler	778D	50422	NCR	NCR
AR	Power Amplifier	5S1G4M2	328767	NCR	NCR
R&S	Spectrum Analyzer	FSP30	101329	May. 03, 2011	May. 02, 2012

Table 5.1 Test Equipment List

5.13 Reference Input of Audio Signal Spectrum

With the reference job "use as reference" in the beginning of a procedure, measure the spectrum of the current when applied to the AMCC, i.e. the input magnetic field spectrum, as shown below Fig. 5.8 and Fig. 5.9. For this, the delay of the window shall be set to a multiple of the signal period and at least 2s. From the measurement on the device, using the same signal, the postprocessor deducts the input spectrum, so the result represents the net DUT response.

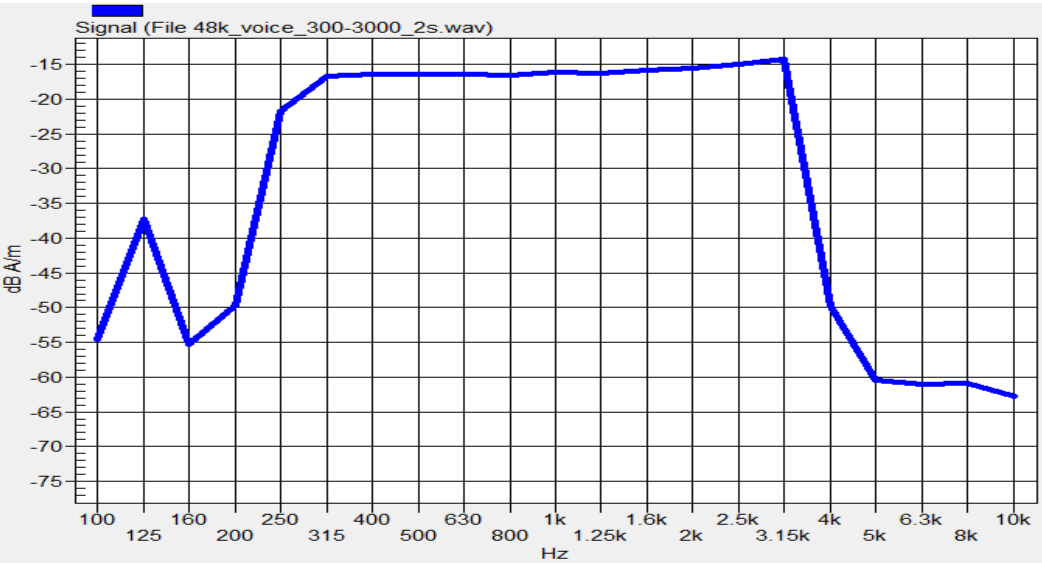


Fig. 5.8 Audio signal spectrum of the broadband signal (48kHz_voice_300Hz~3 kHz)

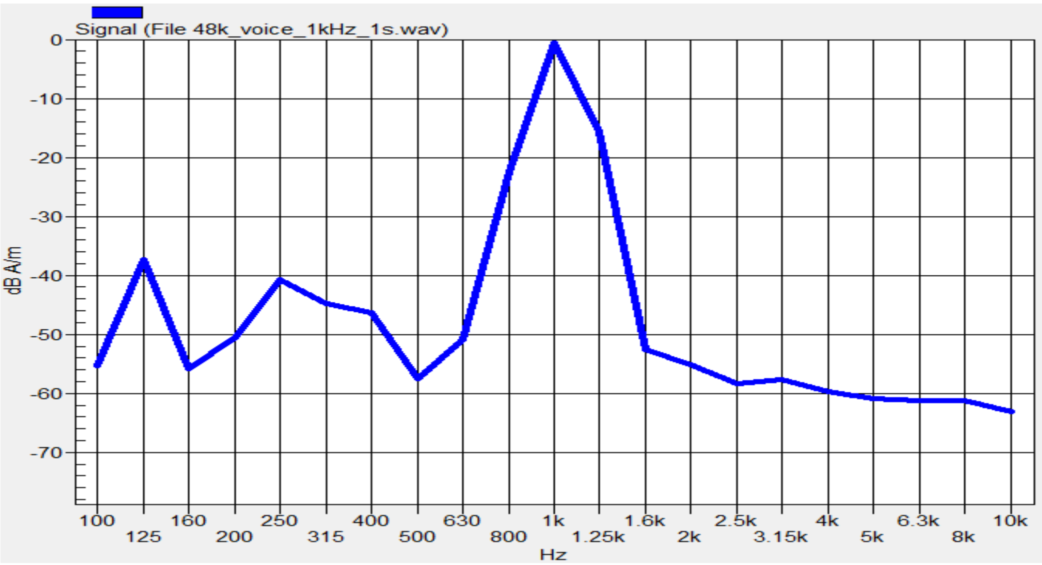


Fig. 5.9 Audio signal spectrum of the narrowband signal (48kHz_voice_1kHz)

5.14 Signal Verification

According to ANSI C63.19:2007 section 6.3.2.1, the normal speech input level for HAC T-coil tests shall be set to -16 dBm0 for GSM and UMTS (WCDMA), and to -18 dBm0 for CDMA. This technical note shows a possibility to evaluate and set the correct level with the HAC T-Coil setup with a Rohde&Schwarz communication tester CMU200 with audio option B52 and B85.

Establish a call from the CMU200 to a wireless device. Select CMU200 Network Bitstream ”Decoder Cal” to have a 1 kHz signal with a level of 3.14 dBm0 at the speech output. Run the measurement job and read the voltage level at the multi-meter display “Coil signal”. Read the RMS voltage corresponding to 3.14 dBm0 and note it. Calculate the desired signal levels of -16 dBm0:

3.14 dBm0 = -2.49 dBV
-16 dBm0 = -21.63 dBV

Determine the 1 kHz input level to generate the desired signal level of -16 dBm0. Select CMU200 Network Bitstream “Codec Cal” to loop the input via the codec to the output. Run the measurement job (AMMI 1 kHz signal with gain 10 inserted) and read the voltage level at the multimeter display “Coil signal”. Calculate the required gain setting for the above levels:

Gain 10 = -19.89 dBV
Difference for -16 dBm0 = -21.63 - (-19.89) = -1.74 dB
Gain factor = 10 ^ ((-1.74) / 20) = -0.818
Resulting Gain = 10 x 0.818 = 8.18

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

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz	1	16.2	-12.7	4.33	3.80
300Hz ~ 3kHz	2	21.6	-18.6	8.48	7.44

6. Description for DUT Testing Position

Fig.6.1 illustrate the references and reference plane that shall be used in a typical DUT emissions measurement. The principle of this section is applied to DUT with similar geometry. Please refer to Appendix D for the setup photographs.

- The area is 5 cm by 5 cm.
- The area is centered on the audio frequency output transducer of the DUT.
- 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 DUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 10 mm in front of, the reference plane.

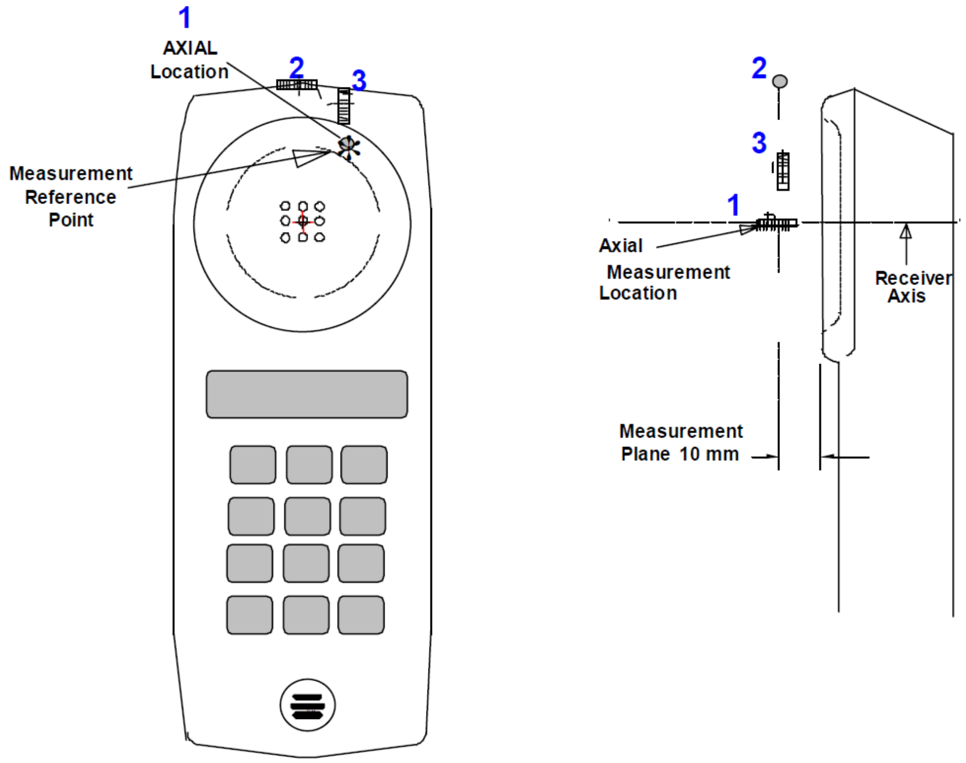


Fig 6.1 A typical DUT reference and plane for T-Coil measurements

7. T-Coil Test Procedure

The following illustrate a typical test scan over a wireless communications device:

1. Geometry and signal check: system probe alignment, proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the test Arch.
2. Set the reference drive level of signal voice defined in C63.19 per 6.3.2.1, as shown in this report of section 5.12.
3. The ambient and test system background noise (dB A/m) was measured as well as ABM2 over the full measurement. The maximum noise level must be at least 10dB below the limit of C63.19 per 7.3.2.
4. The DUT was positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
5. The DUT operation for maximum rated RF output power was configured and connected by using of coaxial cable connection to the base station simulator at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The DUT audio output was positioned tangent (as physically possible) to the measurement plane.
6. The DUT's RF emission field was eliminated from T-coil results by using a well RF-shielding of the probe, AM1D, and by using of coaxial cable connection to a Base Station Simulator. One test channel was pre-measurement to avoid this possibility.
7. Determined the optimal measurement locations for the DUT by following the three steps, coarse resolution scan, fine resolution scans, and point measurement, as described in C63.19 per 6.3.4.4. At each measurement locations, samples in the measurement window duration were evaluated to get ABM1 and the signal spectrum. The noise measurement was performed after the scan with the signal, the same happened, just with the voice signal switched off. The ABM2 was calculated from this second scan.

   (1) Coarse resolution scans (1 kHz signal at 50 x 50 mm grid area with 10 mm spacing). Only ABM1 was measured in order to find the location of T-Coil source.

   (2) Fine resolution scans (1 kHz signal at 10 x 10 mm grid area with 2 mm spacing). The positioned appropriately based on optimal AMB1 of coarse resolution scan. Both ABM1 and ABM2 were measured in order to find the location of the SNR point.

   (3) Point measurement (1 kHz signal) for ABM1 and ABM2 in axial, radial transverse and radial longitudinal. The positioned appropriately based on optimal SNR of fine resolution scan. The SNR was calculated for axial, radial transverse and radial longitudinal orientation.

   (4) Point measurement (300Hz to 3 kHz signal) for frequency response in axial. The positioned appropriately based on optimal SNR of fine resolution axial scan.

8. All results resulting from a measurement point in a T-Coil job were calculated from the signal samples during this window interval. ABM values were averaged over the sequence of these samples.
9. At an optimal point measurement, the SNR (ABM1/ABM2) was calculated for axial, radial transverse and radial longitudinal orientation, and the frequency response was measured in axial axis.
10. Corrected for the frequency response after the DUT measurement since the DASY system had known the spectrum of the input signal by using a reference job, as shown in this report of section 5.12.
11. In SEMCAD post-processing, the spectral points are in addition scaled with the high-pass (half-band) and the A-weighting, bandwidth compensated factor (BWC) and those results are final as shown in this report.
12. Classified the signal quality based on the table 8.1: T-Coil Signal Quality Categories.

8. 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 8.1. 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 8.1 T-Coil Signal Quality Categories

9. HAC T-Coil Test Results

9.1 Magnitude Result

The Table 9.1 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.

Plot No.	Band	Channel	Probe Position	Coordinates (mm)	Ambient Noise (dB A/m)	ABM2 (dB A/m)	ABM1 (dB A/m)	SNR (dB)	T Rating
1	**GSM850**	**189**	Axial (Z)	0, 4.2	-36.52	-15.50	13.80	29.30	T3
			Radial 1 (X)	-9, -1.2	-42.38	-19.27	9.83	29.10	T3
			Radial 2 (Y)	**4.2, -7.2**	**-41.71**	**-17.90**	**10.50**	**28.40**	**T3**
2	**GSM1900**	**661**	Axial (Z)	0, 6.2	-36.50	-16.40	13.30	29.70	T3
			Radial 1 (X)	-10.2, -3	-42.48	-20.91	8.79	29.70	T3
			Radial 2 (Y)	**4.2, -7.2**	**-41.51**	**-18.40**	**10.80**	**29.20**	**T3**
3	**WCDMA Band II**	**9262**	Axial (Z)	0, 2.2	-36.53	-17.10	13.70	30.80	T4
			Radial 1 (X)	1.8, -1.2	-43.66	-18.60	12.20	30.80	T4
			Radial 2 (Y)	**7.2, 1.8**	**-41.21**	**-22.35**	**8.45**	**30.80**	**T4**
4	**WCDMA Band IV**	**1413**	Axial (Z)	-2, 8.2	-36.62	-20.00	10.90	30.90	T4
			Radial 1 (X)	-7.2, -7.2	-41.87	-20.40	10.50	30.90	T4
			Radial 2 (Y)	**7.2, 1.8**	**-41.15**	**-22.18**	**8.72**	**30.90**	**T4**

Table 9.1 Test Result for Various Positions

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.
3. Test Engineer：Ted Sun

9.2 Frequency Response Plots

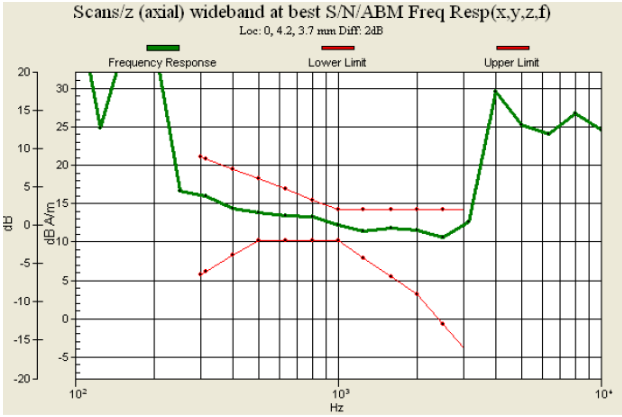


Fig. 9.1 GSM850 Ch128

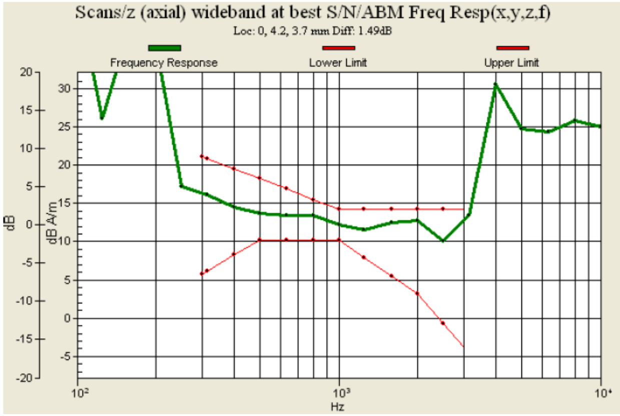


Fig. 9.2 GSM1900 Ch661

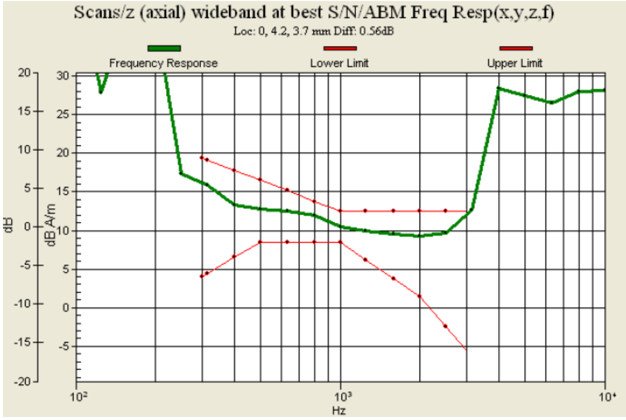


Fig. 9.3 WCDMA Band II Ch9262

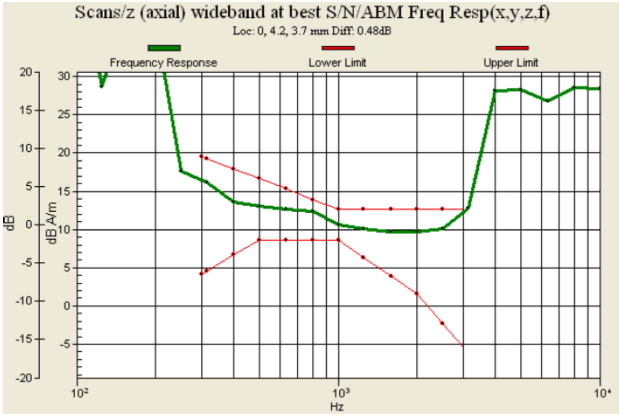


Fig. 9.4 WCDMA Band IV Ch1413

9.3 T-Coil Coupling Field Intensity

9.3.1 Axial Field Intensity

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-18	13.80	Pass
GSM1900	-18	13.30	Pass
WCDMA Band II	-18	13.70	Pass
WCDMA Band IV	-18	10.90	Pass

9.3.2 Radial Field Intensity

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-18	9.83	Pass
GSM1900	-18	8.79	Pass
WCDMA Band II	-18	8.45	Pass
WCDMA Band IV	-18	8.72	Pass

9.3.3 Frequency Response at Axial Measurement Point

Cell Phone Mode	Verdict
GSM850	Pass
GSM1900	Pass
WCDMA Band II	Pass
WCDMA Band IV	Pass

9.3.4 Signal Quality

Cell Phone Mode	Minimum limit (dB)				Minimum Result (dB)	Verdict
	T1	T2	T3	T4		
GSM850	0	10	20	>30	28.4	T3
GSM1900	0	10	20	>30	29.2	T3
WCDMA Band II	0	10	20	>30	30.8	T4
WCDMA Band IV	0	10	20	>30	30.9	T4

10. 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 10.1.

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

(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

Table 10.1 Multiplying Factions for Various Distributions

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 Table 10.2.

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 %
DUT 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 10.2 Uncertainty Budget of DASY

11. References

[1] ANSI C63.19 2007, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids", 8 June 2007

[2] SPEAG DASY System Handbook

Appendix A. Plots of T-Coil Measurement

The plots are shown as follows.

#01 T-Coil_GSM850_Voice_Ch189_Axial (Z)

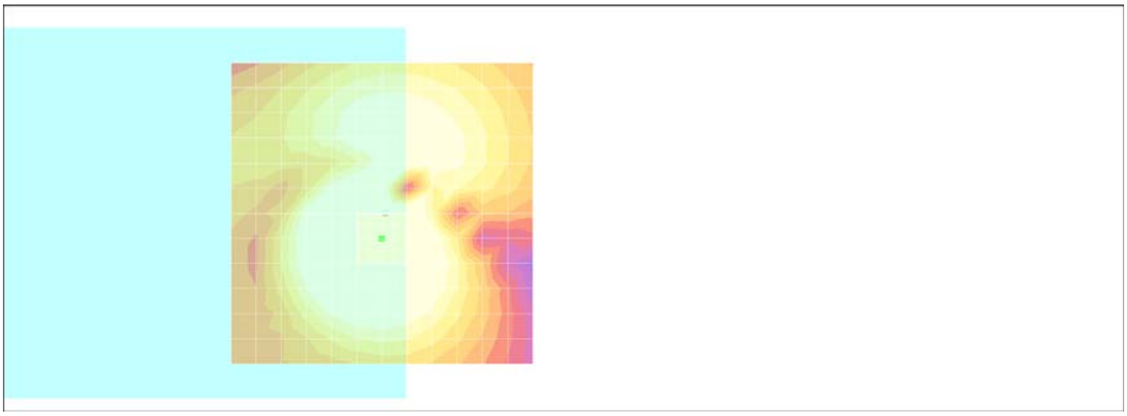
DUT: 181714

Communication System: GSM850; Frequency: 836.4 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

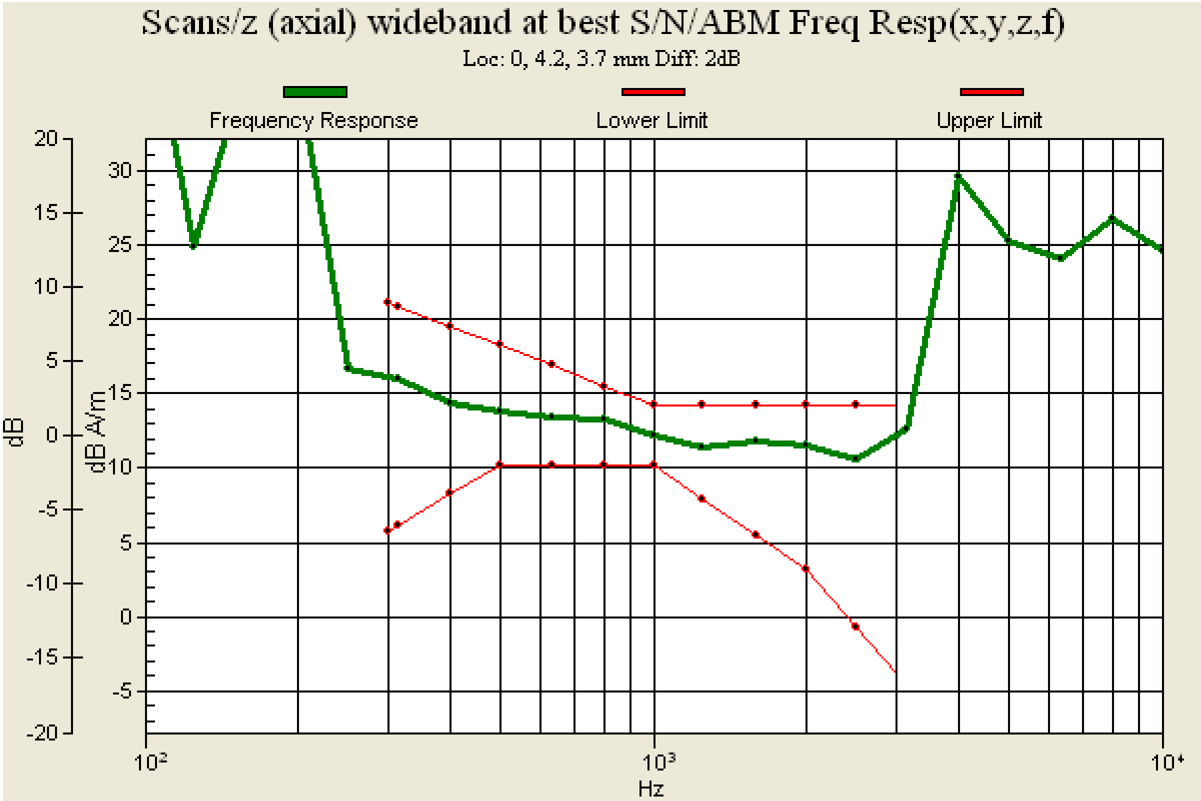
DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

ABM1/ABM2 = 29.3 dB
ABM1 comp = 13.8 dB A/m
Location: 0, 4.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 4.2, 3.7 mm Diff: 2dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

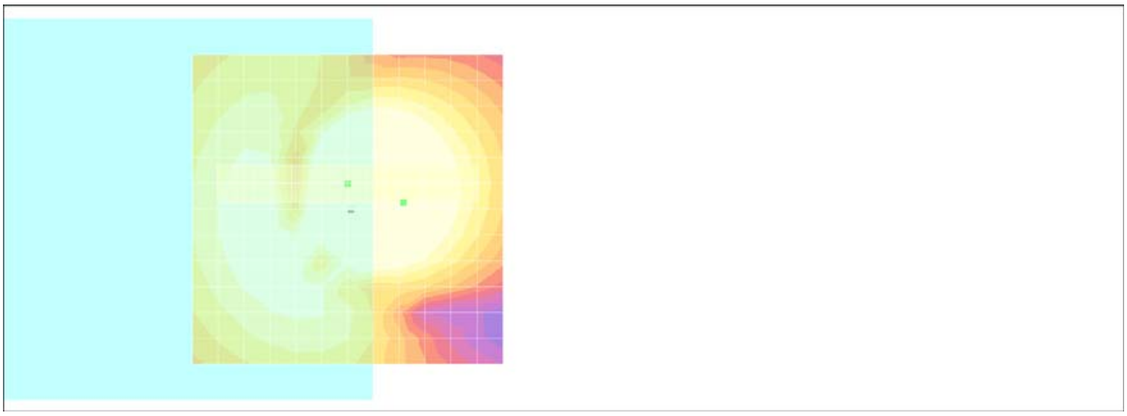
#01 T-Coil_GSM850_Voice_Ch189_Radial 1 (X)

DUT: 181714

Communication System: GSM850; Frequency: 836.4 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 29.1 dB
ABM1 comp = 9.83 dB A/m
Location: -9, -1.2, 3.7 mm



0 dB = 1.00A/m

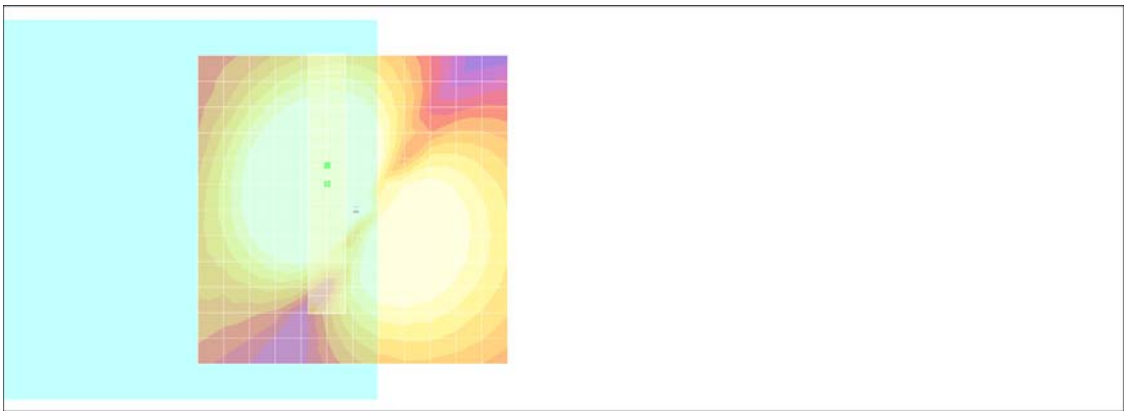
#01 T-Coil_GSM850_Voice_Ch189_Radial 2 (Y)

DUT: 181714

Communication System: GSM850; Frequency: 836.4 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 28.4 dB
ABM1 comp = 10.5 dB A/m
Location: 4.2, -7.2, 3.7 mm



0 dB = 1.00A/m

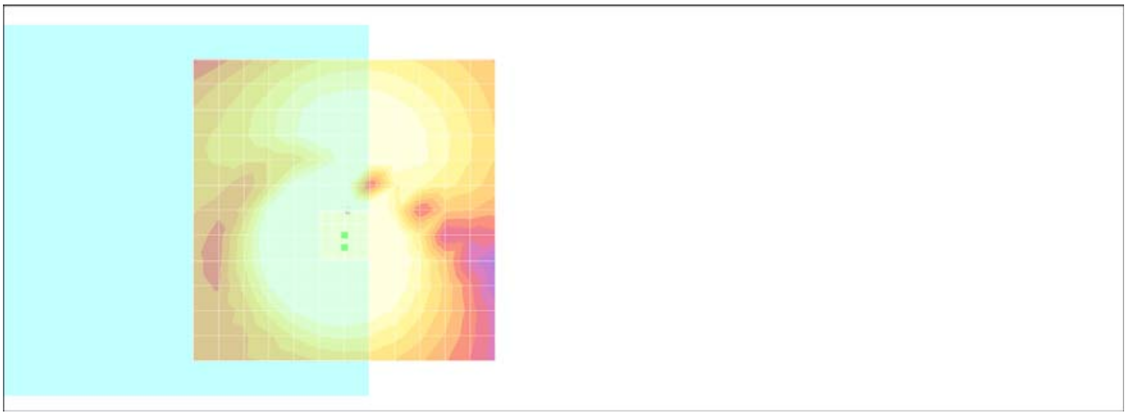
#02 T-Coil_GSM1900_Voice_Ch661_Axial (Z)

DUT: 181714

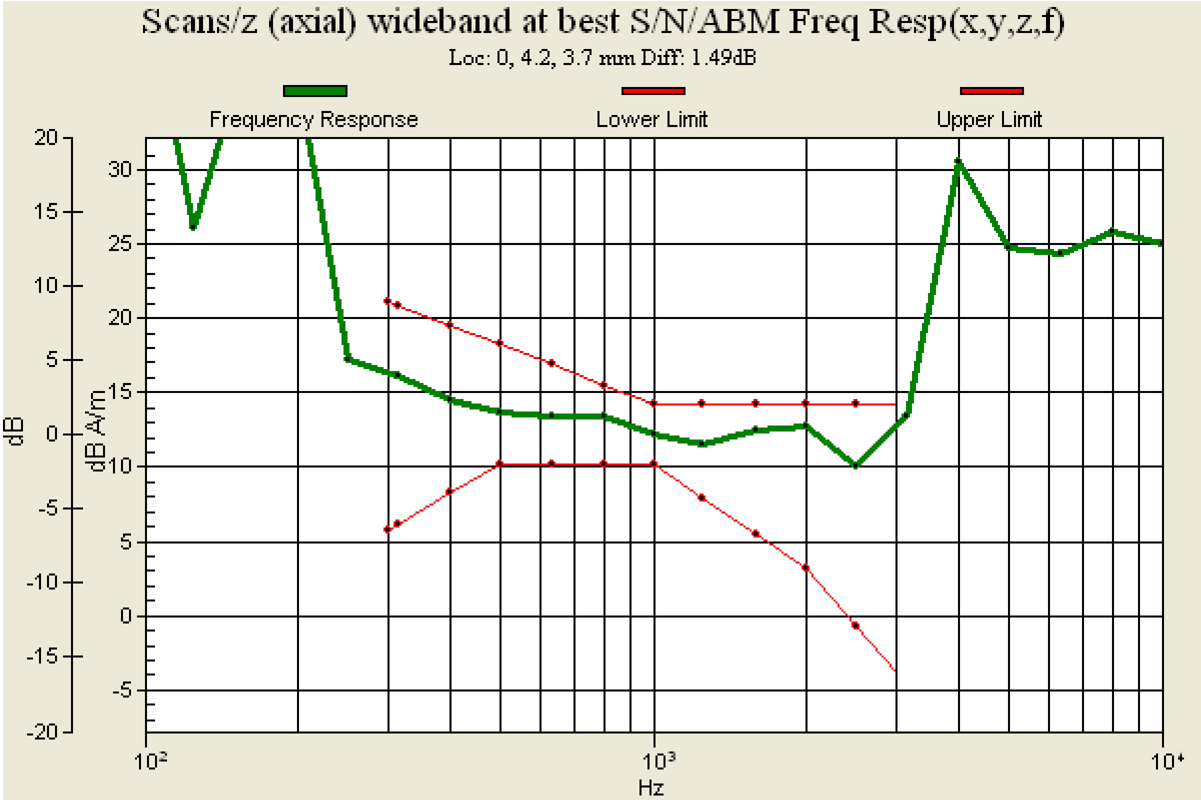
Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 29.7 dB
ABM1 comp = 13.3 dB A/m
Location: 0, 6.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 4.2, 3.7 mm Diff: 1.49dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

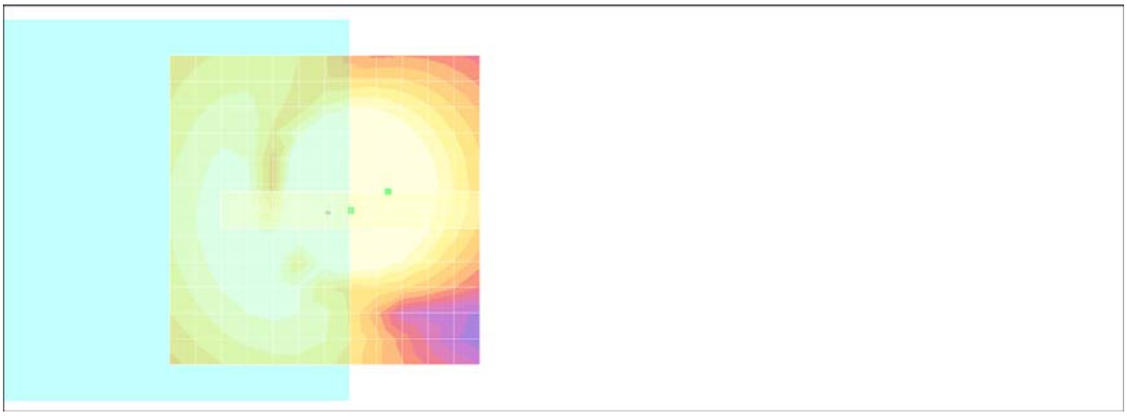
#02 T-Coil_GSM1900_Voice_Ch661_Radial 1 (X)

DUT: 181714

Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 29.7 dB
ABM1 comp = 8.79 dB A/m
Location: -10.2, -3, 3.7 mm



0 dB = 1.00A/m

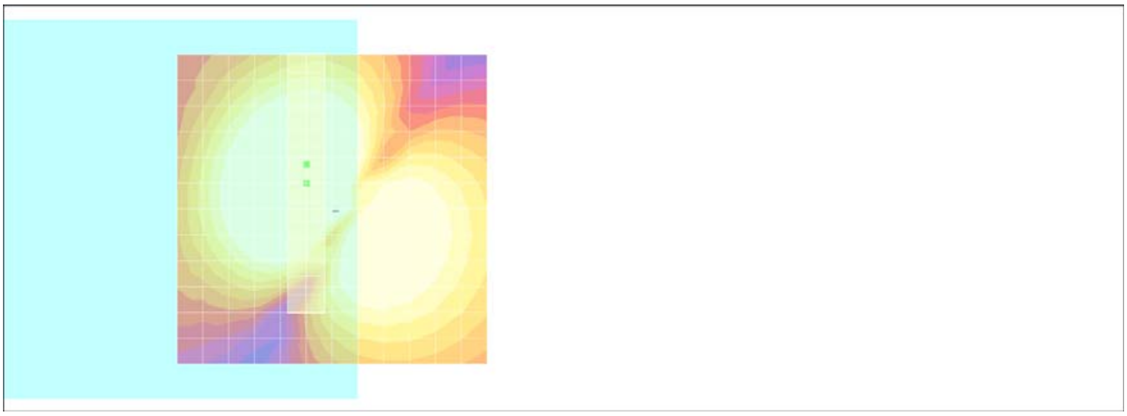
#02 T-Coil_GSM1900_Voice_Ch661_Radial 2 (Y)

DUT: 181714

Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 29.2 dB
ABM1 comp = 10.8 dB A/m
Location: 4.2, -7.2, 3.7 mm



0 dB = 1.00A/m

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2011/8/17

#03 T-Coil_WCDMA II_Voice_Ch9262_Axial (Z)

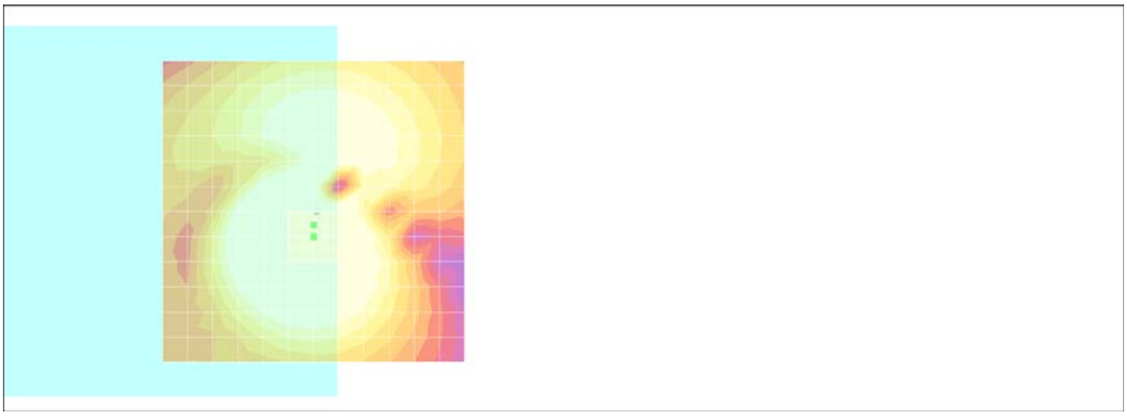
DUT: 181714

Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

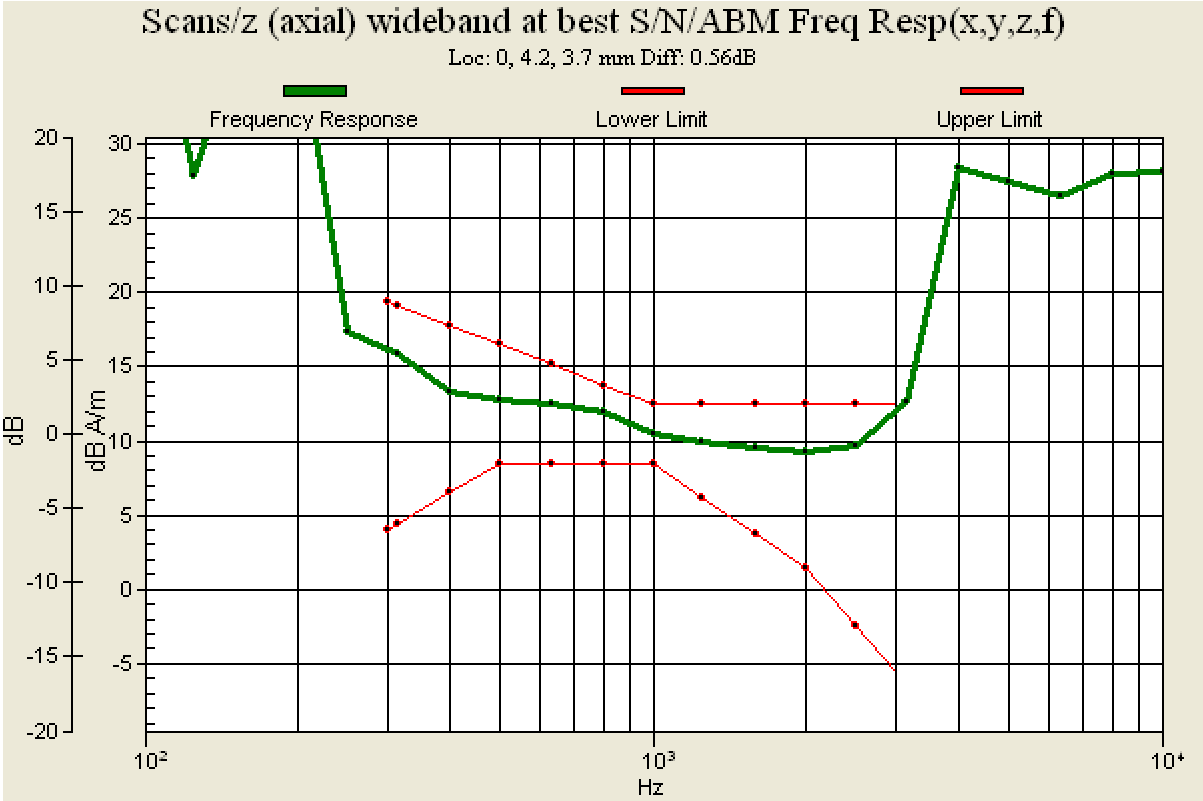
DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

ABM1/ABM2 = 30.8 dB
ABM1 comp = 13.7 dB A/m
Location: 0, 2.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 4.2, 3.7 mm Diff: 0.56dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

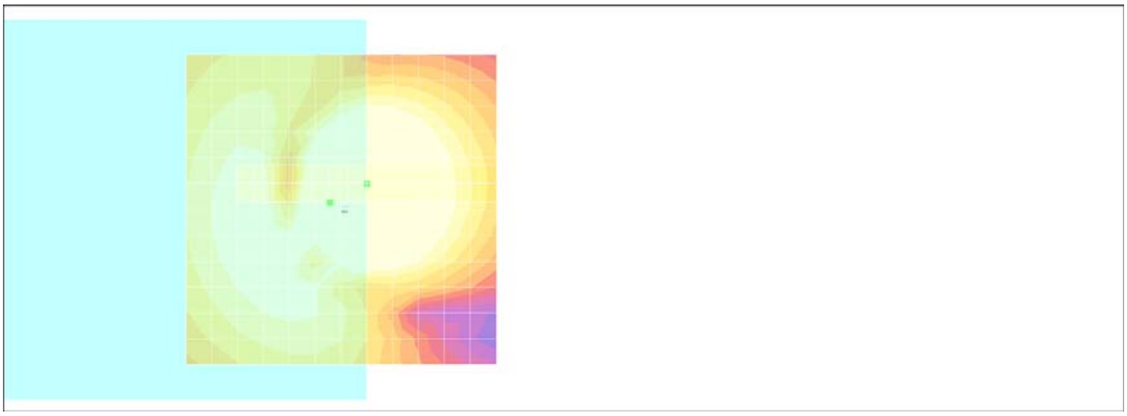
#03 T-Coil_WCDMA II_Voice_Ch9262_Radial 1 (X)

DUT: 181714

Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.8 dB
ABM1 comp = 12.2 dB A/m
Location: 1.8, -1.2, 3.7 mm



0 dB = 1.00A/m

#03 T-Coil_WCDMA II_Voice_Ch9262_Radial 2 (Y)

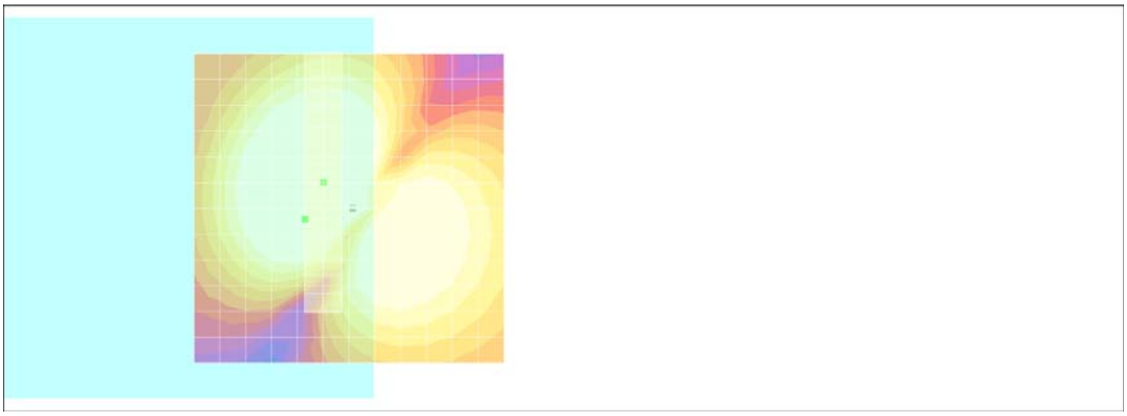
DUT: 181714

Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):

ABM1/ABM2 = 30.8 dB
ABM1 comp = 8.45 dB A/m
Location: 7.2, 1.8, 3.7 mm



0 dB = 1.00A/m

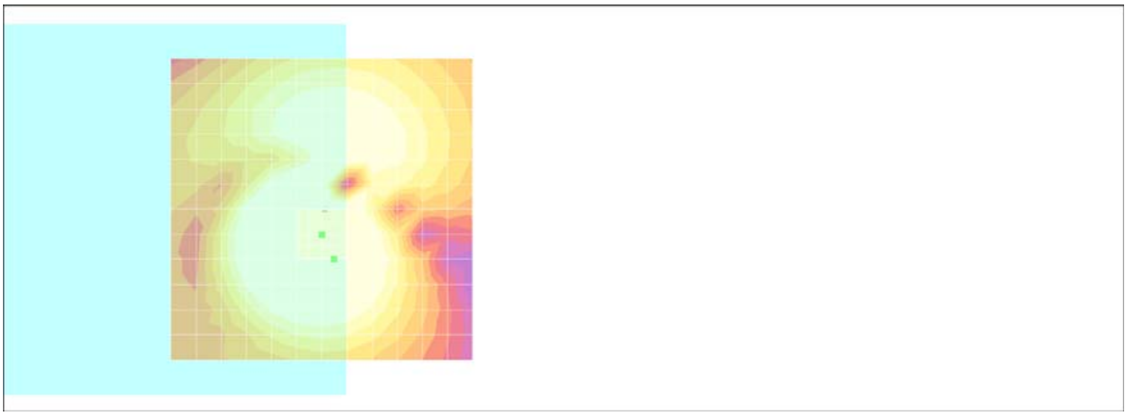
#04 T-Coil_WCDMA IV_Voice_Ch1413_Axial (Z)

DUT: 181714

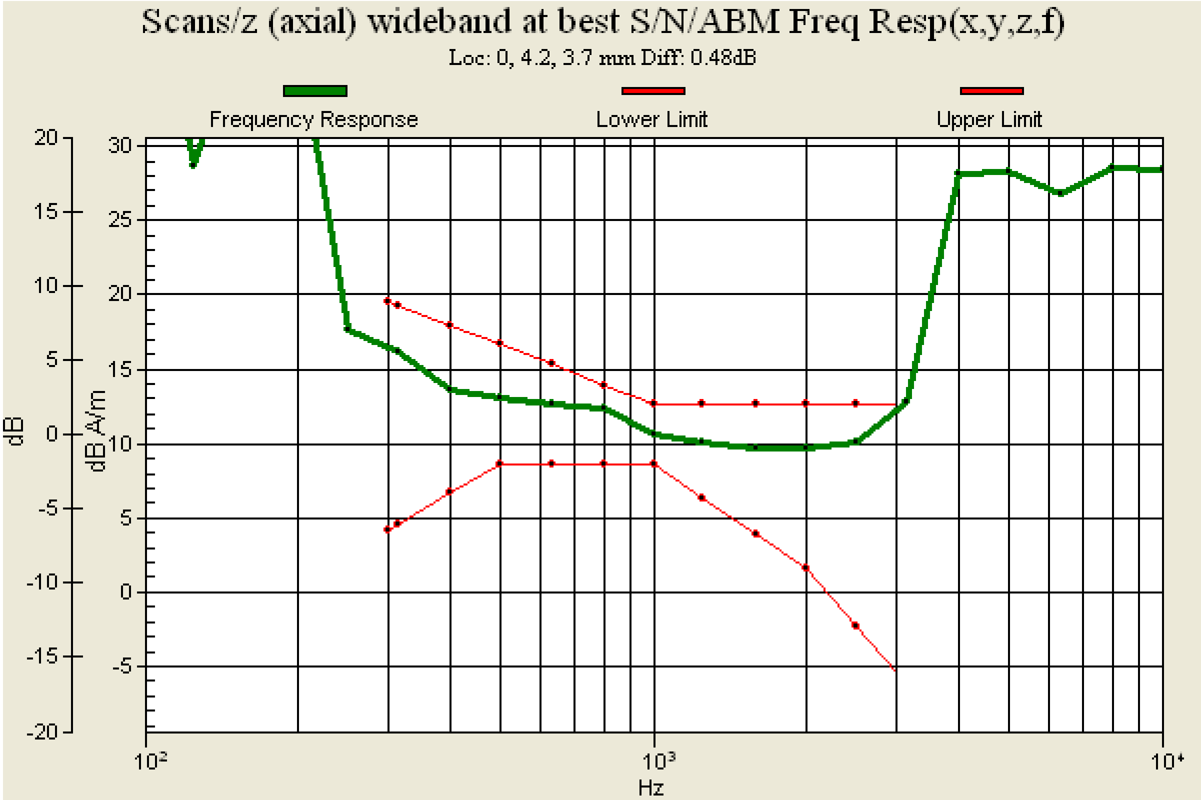
Communication System: WCDMA; Frequency: 1732.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 30.9 dB
ABM1 comp = 10.9 dB A/m
Location: -2, 8.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 4.2, 3.7 mm Diff: 0.48dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

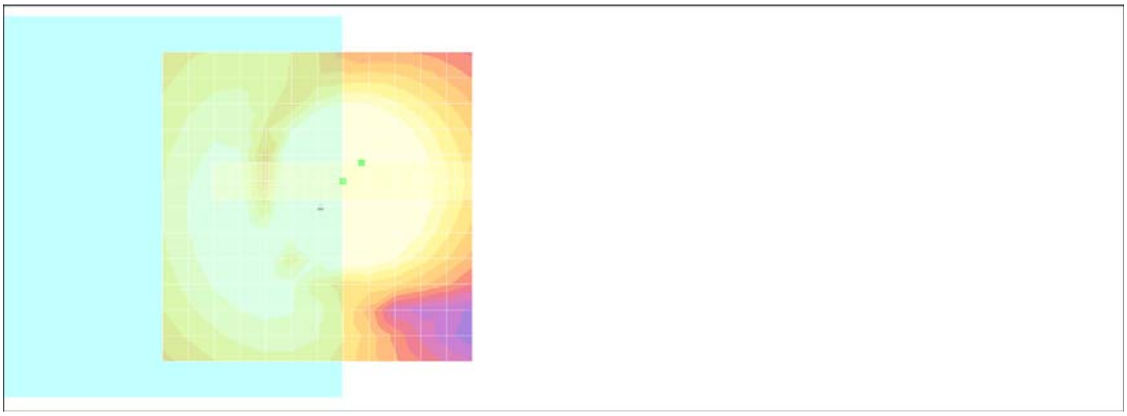
#04 T-Coil_WCDMA IV_Voice_Ch1413_Radial 1 (X)

DUT: 181714

Communication System: WCDMA; Frequency: 1732.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.9 dB
ABM1 comp = 10.5 dB A/m
Location: -7.2, -7.2, 3.7 mm



0 dB = 1.00A/m

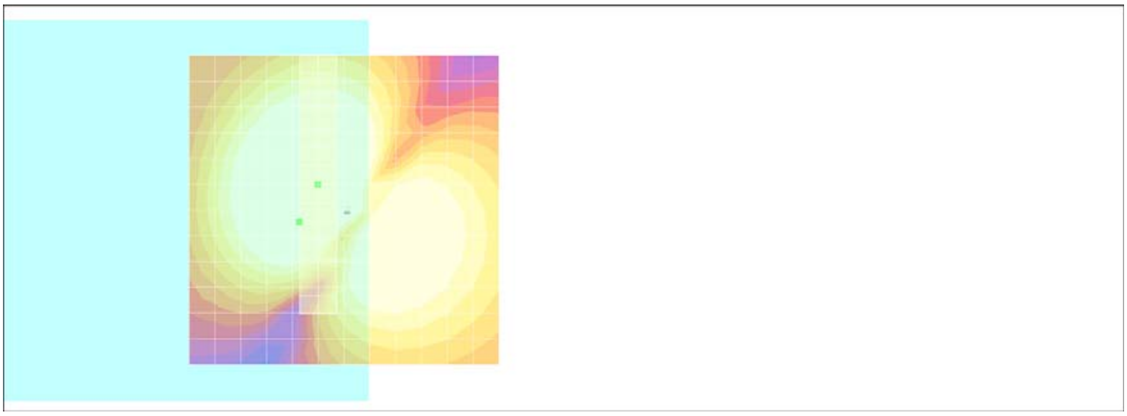
#04 T-Coil_WCDMA IV_Voice_Ch1413_Radial 2 (Y)

DUT: 181714

Communication System: WCDMA; Frequency: 1732.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 30.9 dB
ABM1 comp = 8.72 dB A/m
Location: 7.2, 1.8, 3.7 mm



0 dB = 1.00A/m

Appendix B. Calibration Data

The DASY calibration certificates are shown as follows.

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 108**

Client **Sporton-TW (Auden)**

Certificate No: **AM1DV2-1038_Jan11**

CALIBRATION CERTIFICATE

Object	AM1DV2 - SN: 1038
Calibration procedure(s)	QA CAL-24.v2 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range
Calibration date:	January 18, 2011

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	28-Sep-10 (No:10376)	Sep-11
Reference Probe AM1DV2	SN: 1008	18-Jan-11 (No. AM1D-1008_Jan11)	Jan-12
DAE4	SN: 781	20-Oct-10 (No. DAE4-781_Oct10)	Oct-11

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	1050	15-Oct-09 (in house check Oct-09)	Oct-11

	Name	Function	Signature
Calibrated by:	Mike Meili	Laboratory Technician	M. Meili
Approved by:	Fin Bomholt	R&D Director	F. Bomholt

Issued: January 19, 2011

References

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

[2] DASY4 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]. 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] 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 [2], 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	**AM1DV2** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Serial No	**1038**

Overall length	296 mm
Tip diameter	6.0 mm (at the tip)
Sensor offset	3.0 mm (centre of sensor from tip)
Internal Amplifier	40 dB

Manufacturer / Origin	Schmid & Partner Engineering AG, Zurich, Switzerland
Manufacturing date	Sep-2006
Last calibration date	January 21, 2010

Calibration data

Connector rotation angle	(in DASY system)	**39.1** °	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**2.83** °	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.0664 V / (A/m)**	+/- 2.2 % (k=2)

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 108

Client **Amphenol CN (Auden)**

Certificate No: DAE3-495_Apr11

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AD - SN: 495
Calibration procedure(s)	QA CAL-06.v22 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	April 28, 2011

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	28-Sep-10 (No:10376)	Sep-11
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Calibrator Box V1.1	SE UMS 006 AB 1004	07-Jun-10 (in house check)	In house check: Jun-11

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	R&D Director	i.v.

Issued: April 28, 2011

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

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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.

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	404.324 ± 0.1% (k=2)	405.291 ± 0.1% (k=2)	405.622 ± 0.1% (k=2)
Low Range	3.95043 ± 0.7% (k=2)	3.97613 ± 0.7% (k=2)	3.95159 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	227.5 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199993.1	-2.74	-0.00
Channel X	+ Input	20001.66	1.46	0.01
Channel X	- Input	-19994.94	5.16	-0.03
Channel Y	+ Input	200006.0	1.16	0.00
Channel Y	+ Input	20002.16	1.86	0.01
Channel Y	- Input	-19997.98	2.02	-0.01
Channel Z	+ Input	200005.6	1.57	0.00
Channel Z	+ Input	20003.05	3.05	0.02
Channel Z	- Input	-19998.31	1.59	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.3	0.26	0.01
Channel X	+ Input	199.66	-0.24	-0.12
Channel X	- Input	-200.28	-0.38	0.19
Channel Y	+ Input	2001.0	1.06	0.05
Channel Y	+ Input	200.75	0.85	0.42
Channel Y	- Input	-202.12	-2.12	1.06
Channel Z	+ Input	1999.0	-1.13	-0.06
Channel Z	+ Input	198.35	-1.65	-0.82
Channel Z	- Input	-200.94	-1.04	0.52

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	2.91	1.12
	- 200	0.15	-1.40
Channel Y	200	-0.69	-0.74
	- 200	-0.12	-0.47
Channel Z	200	2.83	2.71
	- 200	-4.22	-4.44

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	-	2.33	0.36
Channel Y	200	2.17	-	4.08
Channel Z	200	3.22	-0.54	-

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	15791	16416
Channel Y	15742	16582
Channel Z	15883	16533

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	-1.87	-3.03	-0.77	0.45
Channel Y	-1.74	-2.98	-0.06	0.56
Channel Z	-1.44	-2.79	-0.14	0.61

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

Appendix D. Original Report

Please refer to Sporton report number HA172303 as below.

Hearing Aid Compatibility (HAC) T-Coil Test Report

APPLICANT	:	HTC Corporation
EQUIPMENT	:	Windows Phone
MODEL NAME	:	PH06110
FCC ID	:	NM8PH06110
STANDARD	:	FCC 47 CFR §20.19 ANSI C63.19-2007
T CATEGORY	:	T3

The product sample received on Aug. 11, 2011 and completely tested on Aug. 11, 2011. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and shown the compliance with the applicable technical standards.

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

Reviewed by:

Jones Tsai

Jones Tsai / Manager

ilac-MRA

TAF Testing Laboratory 1190

SPORTON INTERNATIONAL INC.
No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.

Table of Contents

Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
HA172303	Rev. 01	Initial issue of report	Aug. 16, 2011

1. Statement of Compliance

The Hearing Aid Compliance (HAC) maximum results found during testing for the **HTC Corporation Windows Phone PH06110** are as follows (with expanded uncertainly ±8.1% for AMB1 and ±12.3% for AMB2):

Reference (63.19)	Description	Verdict	Section
7.3.1.1	Axial Field Intensity	Pass	9.2.1
7.3.1.2	Radial Field Intensity	Pass	9.2.2
7.3.2	Frequency Response	Pass	9.2.3
7.3.3	Signal Quality	T3	9.2.4

Band	(S+N)/N in dB	T Rating
GSM850	**25.7**	**T3**
GSM1900	**28.4**	**T3**
WCDMA Band II	**29.9**	**T3**
WCDMA Band IV	**30**	**T3**

They are in compliance with HAC limits (HAC Rated category T3) specified in guidelines FCC 47CFR §20.19 and ANSI Standard ANSI C63.19.

Results Summary : T Category = T3 (ANSI C63.19-2007)

2. Administration Data

2.1 Testing Laboratory

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No. :** SAR01-HY

2.2 Applicant

Company Name	HTC Corporation
Address	No. 23, Xinghua Rd., Taoyuan City, Taoyuan County 330, Taiwan (R.O.C.)

2.3 Manufacturer

Company Name	HTC Corporation
Address	No. 23, Xinghua Rd., Taoyuan City, Taoyuan County 330, Taiwan (R.O.C.)

2.4 Application Details

Date of Receipt of Application	Aug. 11, 2011
Date of Start during the Test	Aug. 11, 2011
Date of End during the Test	Aug. 11, 2011

3. General Information

3.1 Description of Device Under Test (DUT)

Product Feature & Specification	
DUT Type	Windows Phone
Model Name	PH06110
FCC ID	NM8PH06110
Tx Frequency	GSM850 : 824 MHz ~ 849 MHz GSM1900 : 1850 MHz ~ 1910 MHz WCDMA Band II : 1850 MHz ~ 1910 MHz WCDMA Band IV : 1710MHz ~ 1755 MHz
Rx Frequency	GSM850 : 869 MHz ~ 894 MHz GSM1900 : 1930 MHz ~ 1990 MHz WCDMA Band II : 1930 MHz ~ 1990 MHz WCDMA Band IV : 2110 MHz ~ 2155 MHz
Antenna Type	Fixed Internal Antenna
Type of Modulation	GMSK
DUT Stage	Identical Prototype

List of Accessory:

Specification of Accessory		
Battery	**Brand Name**	TWS
	Model Name	BG58100

Remark: The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

List of air interfaces / frequency bands

Air Interface	Band (MHz)	Voice/Data	C 63.19-2007 Tested	Concurrent connections	Reduced Power 20.19 (c)(1)
GSM	850,1900	Voice	Yes	WCDMA, WLAN, BT	No
WCDMA	1700,1900	Voice	Yes	WLAN, BT	No
WLAN	2450	Data (*)	No	GSM, WCDMA, BT	No
BT	2450	Data (*)	No	GSM, WCDMA, WLAN	No

Note:

1. (*): The voice function maybe be activated via 3rd party software application.
2. Per KDB 285076 D01 7)a), during T-Coil test, concurrent transmission is disabled.

3.2 Product Photos

Refer to Appendix C.

3.3 Applied Standards

The Standard ANSI C63.19:2007 represents performance requirements for acceptable interoperability of hearing aids with wireless communications devices. When these parameters are met, a hearing aid operates acceptably in close proximity to a wireless communications device.

3.4 Test Conditions

3.4.1 Ambient Condition

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

3.4.2 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. Hearing Aid Compliance (HAC)

4.1 Introduction

In September 2006, the T-Coil requirements of ANSI C63.19 Standard went into effect. The federal communication commission (FCC) adopted ANSI C63.19 as HAC test standard.

5. HAC T-Coil Measurement Setup

5.1 System Configuration

Fig. 5.1 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 (ECO) 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 XP
- 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.

5.2 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:

Frequency Range	0.1 ~ 20 kHz (RF sensitivity <-100dB, fully RF shielded)
Sensitivity	<-50dB A/m @ 1 kHz
Pre-amplifier	40 dB, symmetric
Dimensions	Tip diameter/ length: 6/ 290 mm, sensor according to ANSI-PC63.19

5.2.1 Probe Calibration in AMCC

The probe sensitivity at 1 kHz is 0.00742647 V/(A/m) (-21.29 dBV/(A/m)) was calibrated by AMCC coil for verification of setup performance. The evaluated probe sensitivity was able to be compared to the calibration of the AM1D probe. The frequency response and sensitivity was shown in Fig. 5.3. The probe signal is represented after application of an ideal integrator. The green curve represents the current though the AMCC, the blue curve the integrated probe signal. The DIFFERENCE between the two curves is equivalent to the frequency response of the probe system and shows the characteristics. The probe/system complies with the frequency response and linearity requirements in C63.19 according to the Speag's calibrated report as shown in Annex B (AM1D probe: SPAM100AF) (1)The frequency response has been tested within +/- 0.5 dB of ideal differentiator from 100 Hz to 10 kHz. (2)The linearity has also been tested within 0.1dB from 5 dB below limitation to 16 dB above noise level. The AMCC coil is qualified according to certificate report, SDHACPO02A as shown in Annex B.

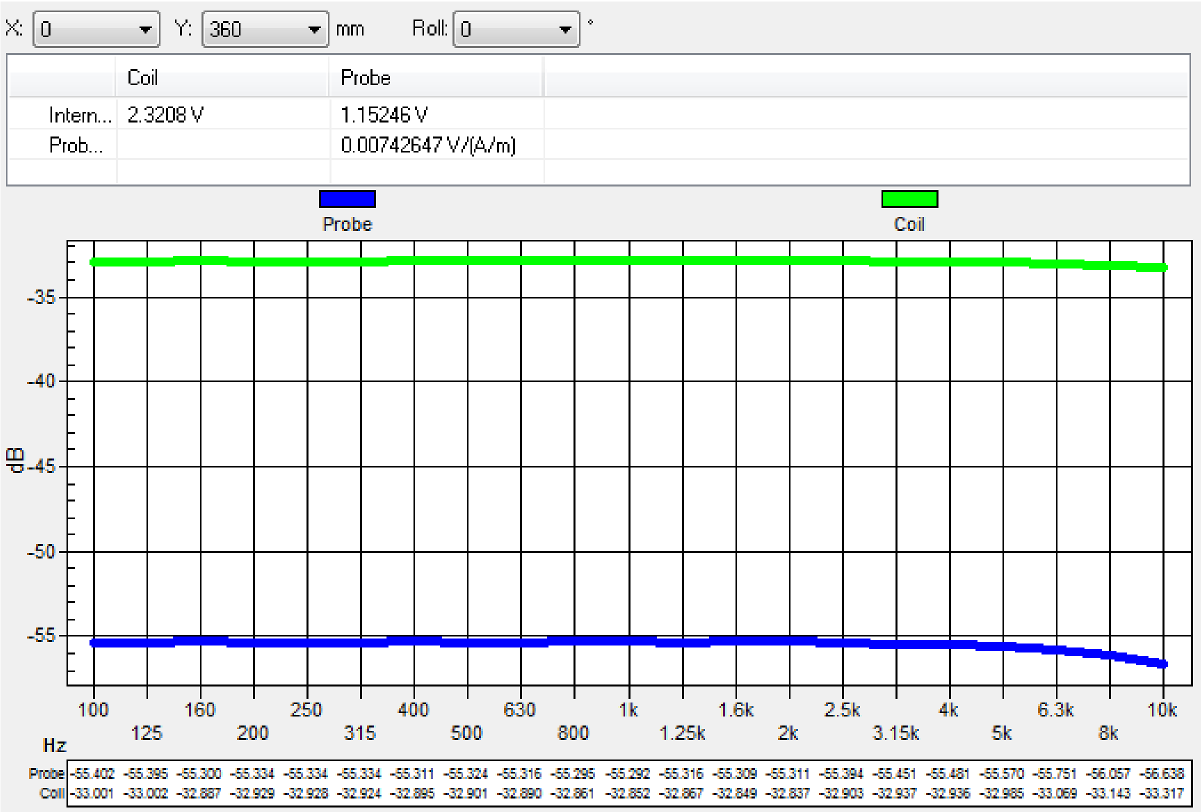


Fig. 5.3 The frequency response and sensitivity of AM1D probe

5.3 AMCC

The Audio Magnetic Calibration coil is a Helmholtz Coil designed for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction. The DC input resistance is adjusted by a series resistor to approximately 50Ohm, and a shunt resistor of 10 Ohm permits monitoring the current with a scale of 1:10.

Port description:

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

Specification:

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

5.4 AMMI

Fig. 5.4 AMMI front panel

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

Specification:

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

5.5 DATA Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. 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 of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Fig. 5.5 Photo of DAE

5.6 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90BL; DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

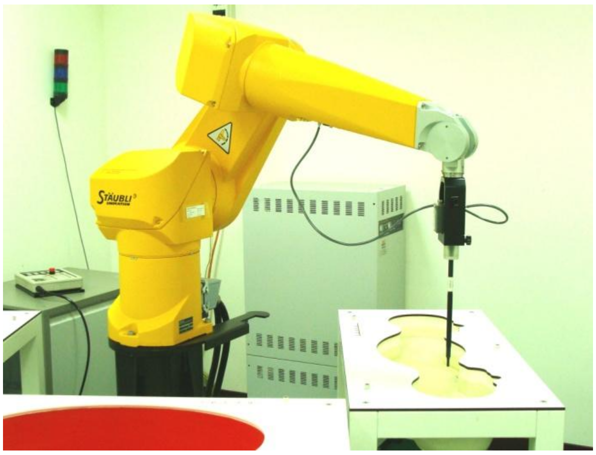


Fig. 5.6 Photo of DASY4

Fig. 5.7 Photo of DASY5

5.7 Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 128 MB), RAM (DASY4: 64 MB, DASY5: 128 MB). 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 DASY 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.

Fig. 5.8 Photo of Server for DASY4

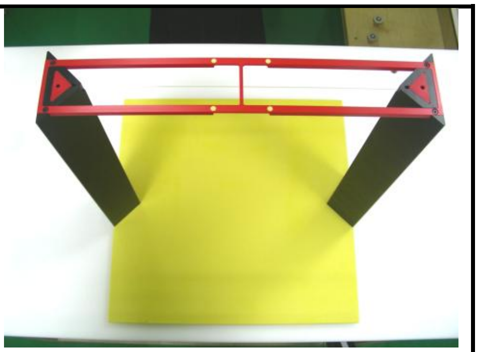
Fig. 5.9 Photo of Server for DASY5

5.8 Phone Positioner

The phone positioner shown in Fig. 5.10 is used to adjust DUT to the suitable position.

Fig. 5.10 Phone Positioner

5.9 Test Arch Phantom

Construction :	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.	
Dimensions :	370 x 370 x 370 mm	**Fig. 5.12 Photo of Arch Phantom**

5.10 Cabling of System

The principal cabling of the T-Coil setup is shown in Fig. 5.6. All cables provided with the basic setup have a length of approximately 5 m.

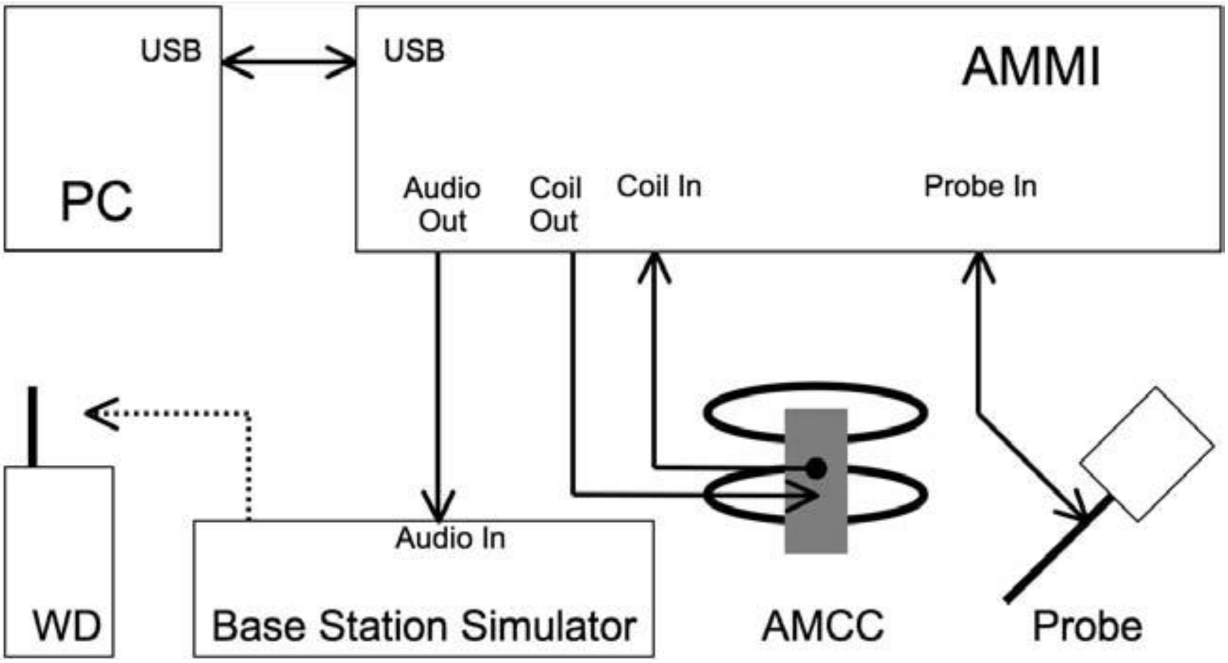


Fig. 5.7 T-Coil setup cabling

5.11 HAC Extension Software

Specification:

Precise teaching	Easy teaching with adaptive distance verification
Measurement area	Flexible selection of measurement area, predefined according to ANSI C63.19
Evaluation	ABM: spectral processing, filtering, weighting and evaluation according to ANSI C63.19
Report	Documentation ready for compliance report

5.12 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Audio Magnetic 1D Field Probe	AM1DV2	1038	Jan. 18, 2011	Jan. 17, 2012
SPEAG	Audio Magnetic Calibration Coil	AMCC	1049	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1041	NCR	NCR
SPEAG	Data Acquisition Electronics	DAE3	495	Apr. 28, 2011	Apr. 27, 2012
SPEAG	Data Acquisition Electronics	DAE4	1279	Jun. 17, 2011	Jun. 16, 2012
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positoiner	N/A	N/A	NCR	NCR
R&S	Universal Radio Communication Tester	CMU200	114256	Feb. 08, 2010	Feb. 07, 2012
Agilent	Dual Directional Coupler	778D	50422	NCR	NCR
AR	Power Amplifier	5S1G4M2	328767	NCR	NCR
R&S	Spectrum Analyzer	FSP30	101329	May. 03, 2011	May. 02, 2012

Table 5.1 Test Equipment List

5.13 Reference Input of Audio Signal Spectrum

With the reference job "use as reference" in the beginning of a procedure, measure the spectrum of the current when applied to the AMCC, i.e. the input magnetic field spectrum, as shown below Fig. 5.8 and Fig. 5.9. For this, the delay of the window shall be set to a multiple of the signal period and at least 2s. From the measurement on the device, using the same signal, the postprocessor deducts the input spectrum, so the result represents the net DUT response.

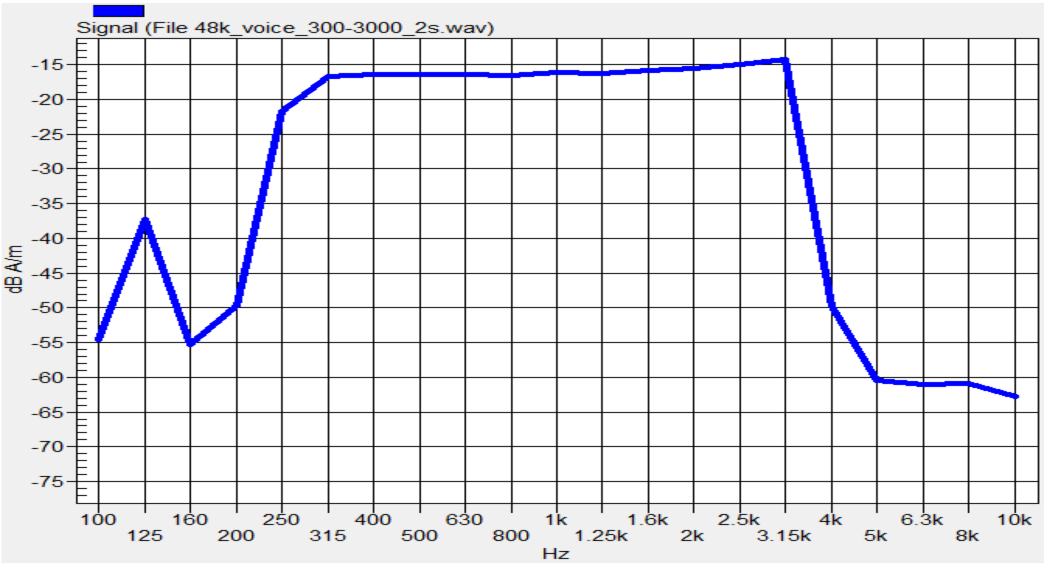


Fig. 5.8 Audio signal spectrum of the broadband signal (48kHz_voice_300Hz~3 kHz)

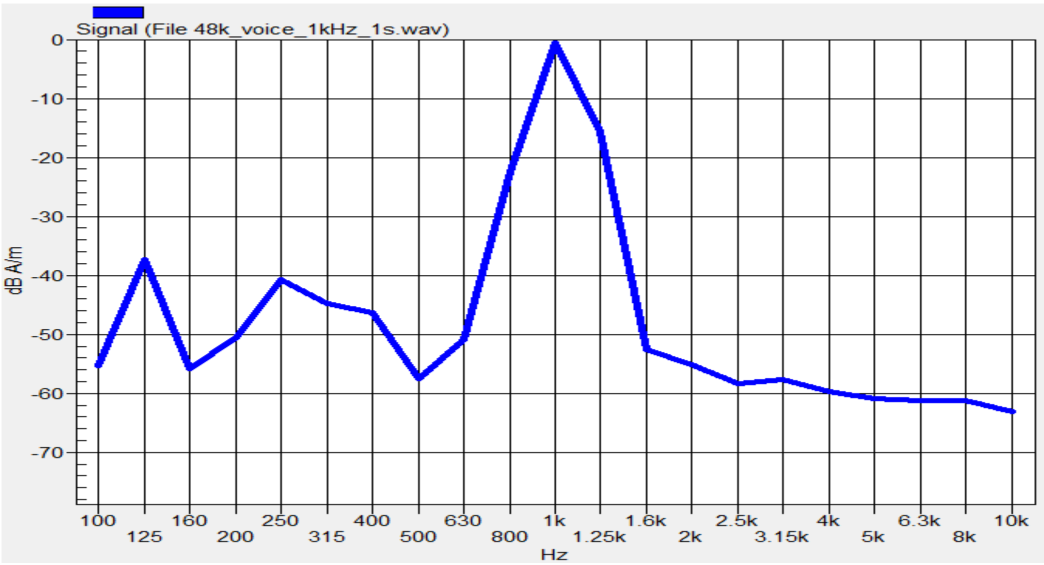


Fig. 5.9 Audio signal spectrum of the narrowband signal (48kHz_voice_1kHz)

5.14 Signal Verification

According to ANSI C63.19:2007 section 6.3.2.1, the normal speech input level for HAC T-coil tests shall be set to -16 dBm0 for GSM and UMTS (WCDMA), and to -18 dBm0 for CDMA. This technical note shows a possibility to evaluate and set the correct level with the HAC T-Coil setup with a Rohde&Schwarz communication tester CMU200 with audio option B52 and B85.

Establish a call from the CMU200 to a wireless device. Select CMU200 Network Bitstream "Decoder Cal" to have a 1 kHz signal with a level of 3.14 dBm0 at the speech output. Run the measurement job and read the voltage level at the multi-meter display "Coil signal". Read the RMS voltage corresponding to 3.14 dBm0 and note it. Calculate the desired signal levels of -16 dBm0:

3.14 dBm0 = -2.39 dBV
-16 dBm0 = -21.53 dBV

Determine the 1 kHz input level to generate the desired signal level of -16 dBm0. Select CMU200 Network Bitstream "Codec Cal" to loop the input via the codec to the output. Run the measurement job (AMMI 1 kHz signal with gain 10 inserted) and read the voltage level at the multimeter display "Coil signal". Calculate the required gain setting for the above levels:

Gain 10 = -19.72 dBV
Difference for -16 dBm0 = -21.53 - (-19.72) = -1.81 dB
Gain factor = 10 ^ ((-1.81) / 20) = -0.812
Resulting Gain = 10 x 0.812 = 8.12

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

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz	1	16.2	-12.7	4.33	3.80
300Hz ~ 3kHz	2	21.6	-18.6	8.48	7.44

6. Description for DUT Testing Position

Fig.6.1 illustrate the references and reference plane that shall be used in a typical DUT emissions measurement. The principle of this section is applied to DUT with similar geometry. Please refer to Appendix D for the setup photographs.

- The area is 5 cm by 5 cm.
- The area is centered on the audio frequency output transducer of the DUT.
- 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 DUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 10 mm in front of, the reference plane.

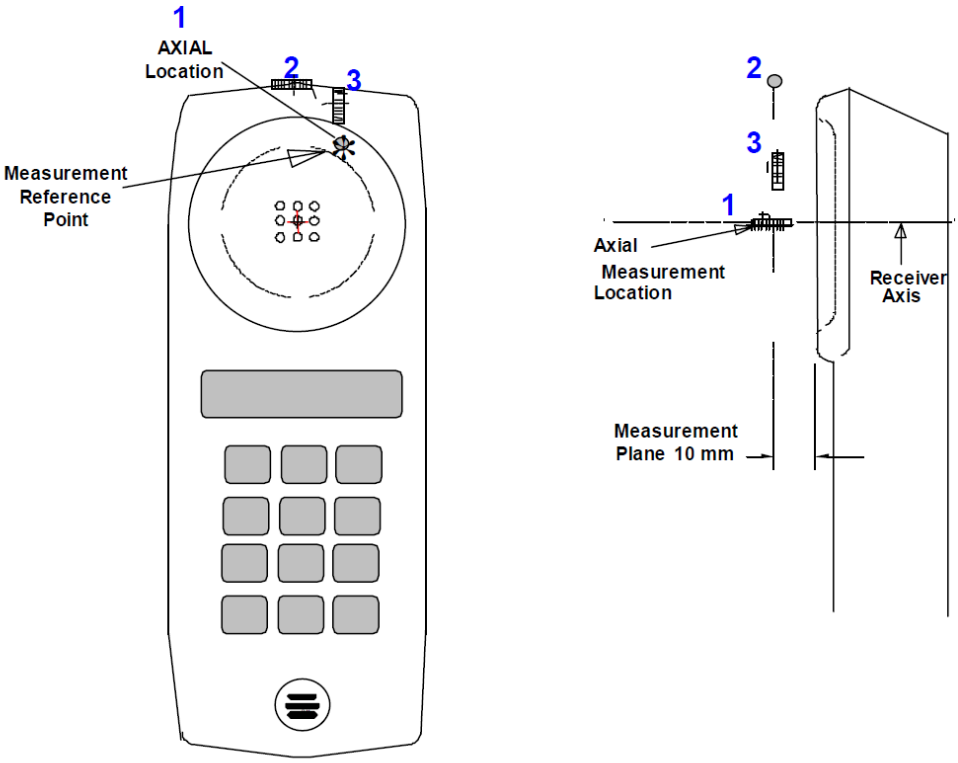


Fig 6.1 A typical DUT reference and plane for T-Coil measurements

7. T-Coil Test Procedure

The following illustrate a typical test scan over a wireless communications device:

1. Geometry and signal check: system probe alignment, proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the test Arch.
2. Set the reference drive level of signal voice defined in C63.19 per 6.3.2.1, as shown in this report of section 5.12.
3. The ambient and test system background noise (dB A/m) was measured as well as ABM2 over the full measurement. The maximum noise level must be at least 10dB below the limit of C63.19 per 7.3.2.
4. The DUT was positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
5. The DUT operation for maximum rated RF output power was configured and connected by using of coaxial cable connection to the base station simulator at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The DUT audio output was positioned tangent (as physically possible) to the measurement plane.
6. The DUT's RF emission field was eliminated from T-coil results by using a well RF-shielding of the probe, AM1D, and by using of coaxial cable connection to a Base Station Simulator. One test channel was pre-measurement to avoid this possibility.
7. Determined the optimal measurement locations for the DUT by following the three steps, coarse resolution scan, fine resolution scans, and point measurement, as described in C63.19 per 6.3.4.4. At each measurement locations, samples in the measurement window duration were evaluated to get ABM1 and the signal spectrum. The noise measurement was performed after the scan with the signal, the same happened, just with the voice signal switched off. The ABM2 was calculated from this second scan.

   (1) Coarse resolution scans (1 kHz signal at 50 x 50 mm grid area with 10 mm spacing). Only ABM1 was measured in order to find the location of T-Coil source.

   (2) Fine resolution scans (1 kHz signal at 10 x 10 mm grid area with 2 mm spacing). The positioned appropriately based on optimal AMB1 of coarse resolution scan. Both ABM1 and ABM2 were measured in order to find the location of the SNR point.

   (3) Point measurement (1 kHz signal) for ABM1 and ABM2 in axial, radial transverse and radial longitudinal. The positioned appropriately based on optimal SNR of fine resolution scan. The SNR was calculated for axial, radial transverse and radial longitudinal orientation.

   (4) Point measurement (300Hz to 3 kHz signal) for frequency response in axial. The positioned appropriately based on optimal SNR of fine resolution axial scan.

8. All results resulting from a measurement point in a T-Coil job were calculated from the signal samples during this window interval. ABM values were averaged over the sequence of these samples.
9. At an optimal point measurement, the SNR (ABM1/ABM2) was calculated for axial, radial transverse and radial longitudinal orientation, and the frequency response was measured in axial axis.
10. Corrected for the frequency response after the DUT measurement since the DASY system had known the spectrum of the input signal by using a reference job, as shown in this report of section 5.12.
11. In SEMCAD post-processing, the spectral points are in addition scaled with the high-pass (half-band) and the A-weighting, bandwidth compensated factor (BWC) and those results are final as shown in this report.
12. Classified the signal quality based on the table 8.1: T-Coil Signal Quality Categories.

8. 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 8.1. 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 8.1 T-Coil Signal Quality Categories

9. HAC T-Coil Test Results

9.1 Magnitude Result

The Table 9.1 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.

Plot No.	Band	Channel	Probe Position	Coordinates (mm)	Ambient Noise (dB A/m)	ABM2 (dB A/m)	ABM1 (dB A/m)	SNR (dB)	T Rating
#01	GSM850	189	Axial (Z)	-2, 4.2	-37.94	-26.10	1.60	27.70	T3
			Radial 1 (X)	-12, 1.2	-43.28	-33.24	-4.54	28.70	T3
			Radial 2 (Y)	0, -7.8	-42.04	-27.57	-1.67	25.90	T3
#02	**GSM850**	**251**	Axial (Z)	-2, 4.2	-38.14	-25.58	1.92	27.50	T3
			Radial 1 (X)	-12, 1.2	-44.33	-32.26	-4.16	28.10	T3
			Radial 2 (Y)	**0, -7.8**	**-41.21**	**-26.83**	**-1.13**	**25.70**	**T3**
#03	GSM850	128	Axial (Z)	-2, 4.2	-40.38	-25.68	2.02	27.70	T3
			Radial 1 (X)	-12, 1.2	-43.83	-32.70	-4.10	28.60	T3
			Radial 2 (Y)	0, -7.8	-44.07	-26.56	-0.86	25.70	T3
#04	GSM1900	512	Axial (Z)	-4, 6.2	-40.68	-30.28	-0.38	29.90	T3
			Radial 1 (X)	-9, 1.2	-44.05	-30.42	-0.32	30.10	T4
			Radial 2 (Y)	0, -7.8	-43.98	-30.07	-1.17	28.90	T3
#05	**GSM1900**	**661**	Axial (Z)	-4, 6.2	-40.53	-30.05	-0.25	29.80	T3
			Radial 1 (X)	-9, 1.2	-43.83	-30.02	0.29	30.30	T4
			Radial 2 (Y)	**0, -4.8**	**-44.26**	**-29.25**	**-0.85**	**28.40**	**T3**
#06	GSM1900	810	Axial (Z)	0, 6.2	-40.41	-26.85	3.05	29.90	T3
			Radial 1 (X)	-9, 1.2	-43.69	-30.64	-0.34	30.30	T4
			Radial 2 (Y)	0, -7.8	-43.45	-29.83	-1.23	28.60	T3
#07	**WCDMA II**	**9262**	Axial (Z)	2.2, 4.2	-38.34	-15.90	14.10	30.00	T3
			Radial 1 (X)	-1.8, 4.2	-42.80	-18.90	11.20	30.10	T4
			Radial 2 (Y)	**4.2, -7.8**	**-42.85**	**-19.90**	**10.00**	**29.90**	**T3**
#08	WCDMA II	9400	Axial (Z)	2.2, 6.2	-40.39	-16.40	13.70	30.10	T4
			Radial 1 (X)	-4.8, 4.2	-44.01	-19.50	10.60	30.10	T4
			Radial 2 (Y)	4.2, -1.8	-43.52	-19.10	10.90	30.00	T3
#09	WCDMA II	9538	Axial (Z)	-4, 6.2	-38.77	-21.01	9.19	30.20	T4
			Radial 1 (X)	0, 7.2	-43.55	-27.51	2.89	30.40	T4
			Radial 2 (Y)	-3, 10.2	-42.75	-27.78	2.42	30.20	T4
#10	WCDMA IV	1312	Axial (Z)	2, 6.2	-38.65	-16.60	13.60	30.20	T4
			Radial 1 (X)	-3, 7.2	-43.48	-25.08	5.12	30.20	T4
			Radial 2 (Y)	0, -4.8	-42.42	-21.30	8.70	30.00	T3
#11	**WCDMA IV**	**1413**	Axial (Z)	0, 2.2	-38.19	-16.60	13.50	30.10	T4
			Radial 1 (X)	-3, 4.2	-43.26	-19.00	11.10	30.10	T4
			Radial 2 (Y)	**-3, 10**	**-42.09**	**-27.81**	**2.19**	**30.00**	**T3**
#12	WCDMA IV	1513	Axial (Z)	0, 4.2	-38.31	-17.20	13.50	30.70	T4
			Radial 1 (X)	-3, 4.2	-43.43	-19.70	11.10	30.80	T4
			Radial 2 (Y)	-3, 10.2	-42.03	-28.65	2.05	30.70	T4

Table 9.1 Test Result for Various Positions

Remark:

1. This device does not support HAC and V.O.I.P. function. It means that the functions of WLAN and Bluetooth do not have voice capability in the held to ear mode.
2. There is no special HAC mode software on this DUT.
3. The volume was adjusted to maximum level and the backlight turned off during T-Coil testing.
4. Test Engineer：Ted Sun and San Lin

9.2 Frequency Response Plots

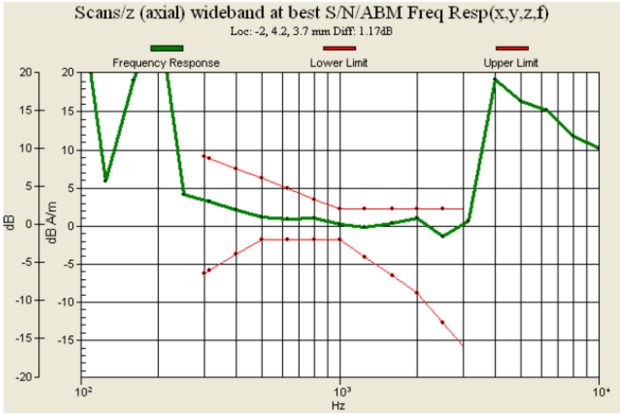


Fig. 9.1 GSM850 Ch128

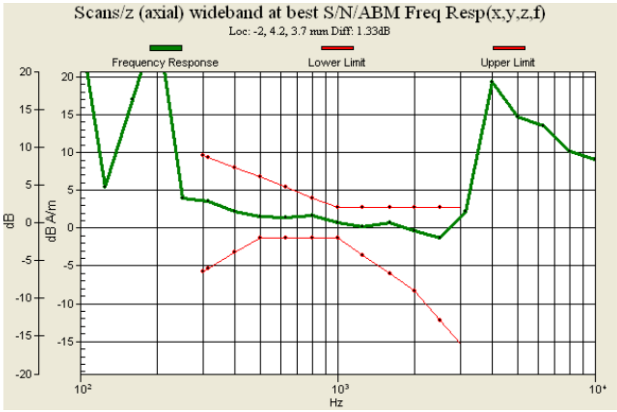


Fig. 9.2 GSM850 Ch189

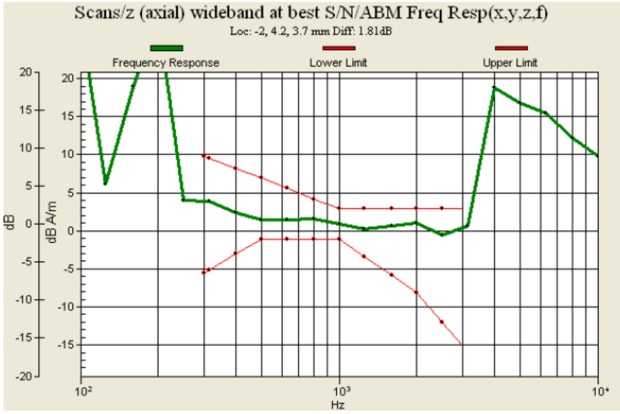


Fig. 9.3 GSM850 Ch251

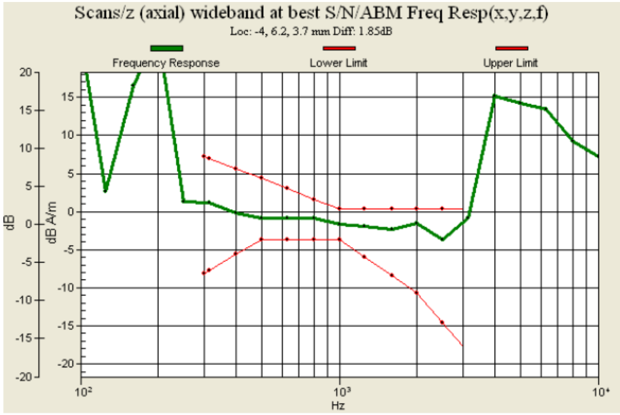


Fig. 9.4 GSM1900 Ch512

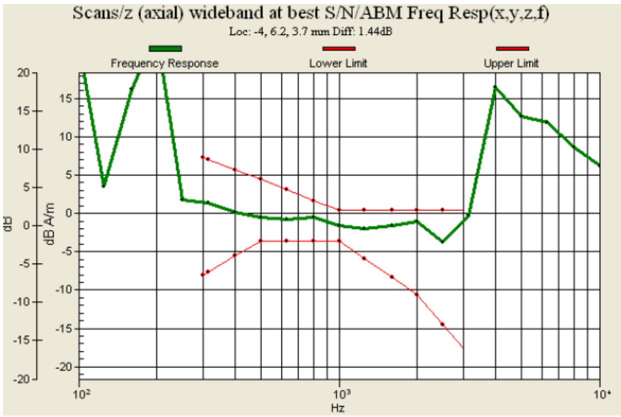


Fig. 9.5 GSM1900 Ch661

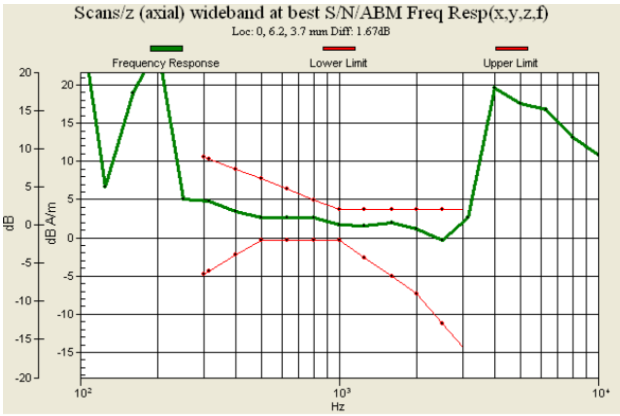


Fig. 9.6 GSM1900 Ch810

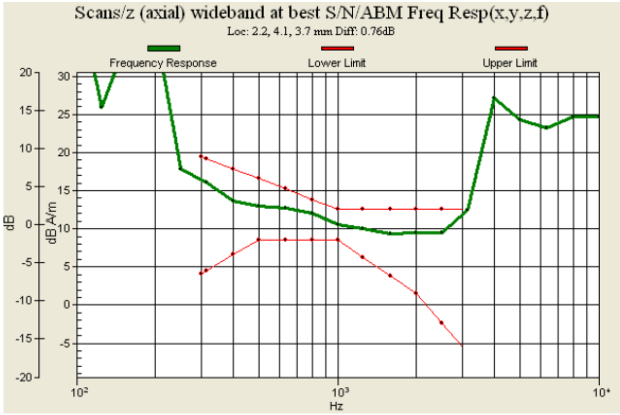


Fig. 9.1 WCDMA Band II Ch9262

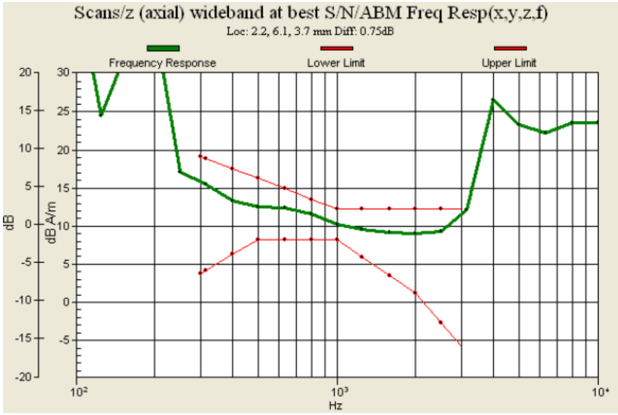


Fig. 9.2 WCDMA Band II Ch 9400

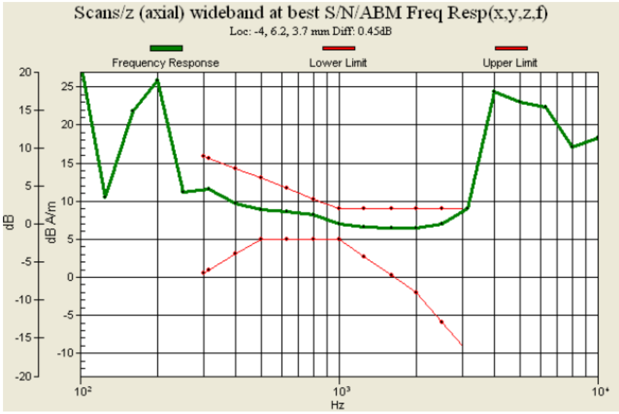


Fig. 9.3 WCDMA Band II Ch 9538

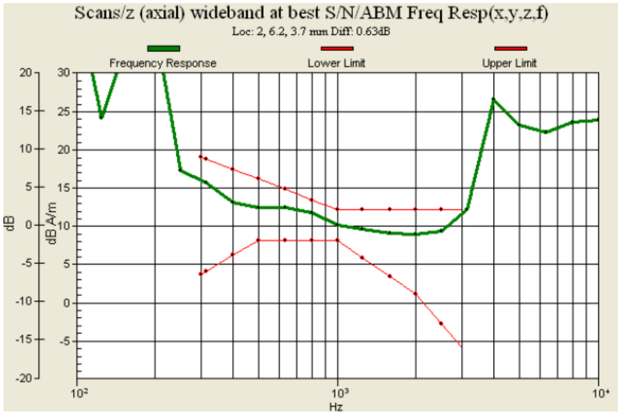


Fig. 9.4 WCDMA Band IV Ch1312

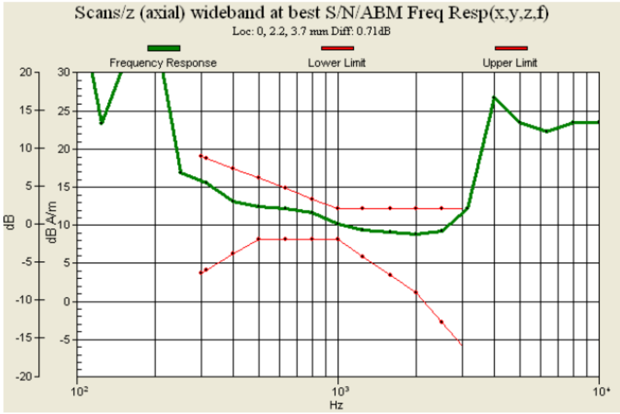


Fig. 9.5 WCDMA Band IV Ch1413

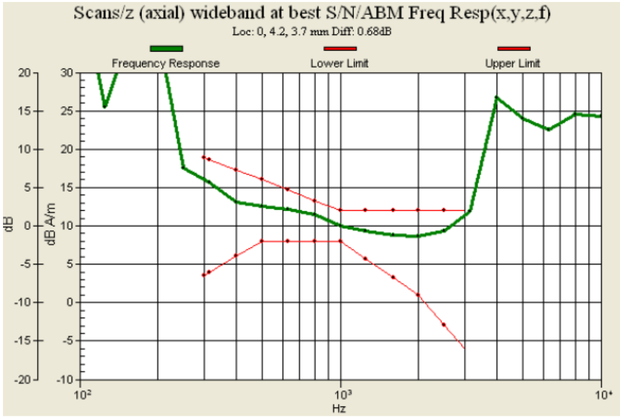


Fig. 9.6 WCDMA Band IV Ch1513

9.3 T-Coil Coupling Field Intensity

9.3.1 Axial Field Intensity

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-18	1.60	Pass
GSM1900	-18	-0.38	Pass
WCDMA Band II	-18	9.19	Pass
WCDMA Band IV	-18	13.50	Pass

9.3.2 Radial Field Intensity

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-18	-4.54	Pass
GSM1900	-18	-1.23	Pass
WCDMA Band II	-18	2.42	Pass
WCDMA Band IV	-18	2.05	Pass

9.3.3 Frequency Response at Axial Measurement Point

Cell Phone Mode	Verdict
GSM850	Pass
GSM1900	Pass
WCDMA Band II	Pass
WCDMA Band IV	Pass

9.3.4 Signal Quality

Cell Phone Mode	Minimum limit (dB)				Minimum Result (dB)	Verdict
	T1	T2	T3	T4		
GSM850	0	10	20	>30	**25.7**	T3
GSM1900	0	10	20	>30	**28.4**	T3
WCDMA Band II	0	10	20	>30	**29.9**	T3
WCDMA Band IV	0	10	20	>30	**30**	T3

10. 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 10.1.

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

(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

Table 10.1 Multiplying Factions for Various Distributions

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 Table 10.2.

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 %
DUT 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 10.2 Uncertainty Budget of DASY

11. References

[1] ANSI C63.19 2007, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids", 8 June 2007

[2] SPEAG DASY System Handbook

Appendix A. Plots of T-Coil Measurement

The plots are shown as follows.

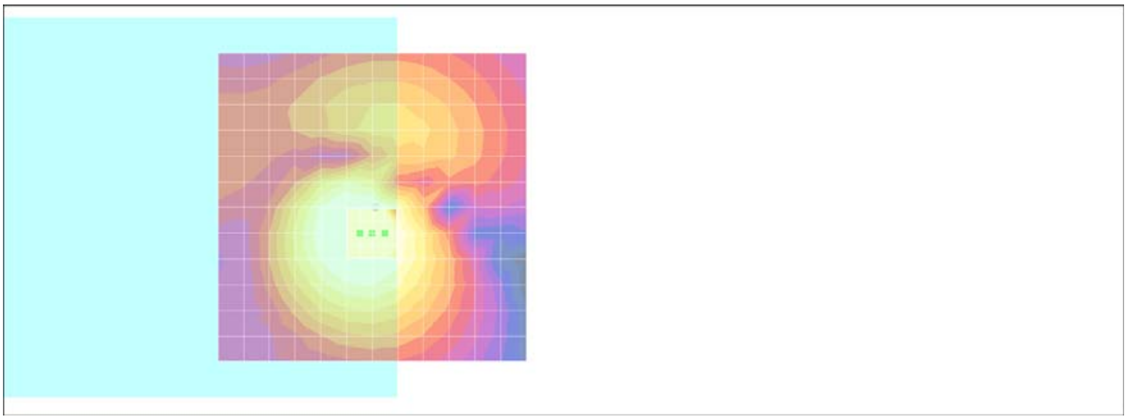
#01 T-Coil_GSM850_Voice_Ch128_Axial (Z)

DUT: 172303

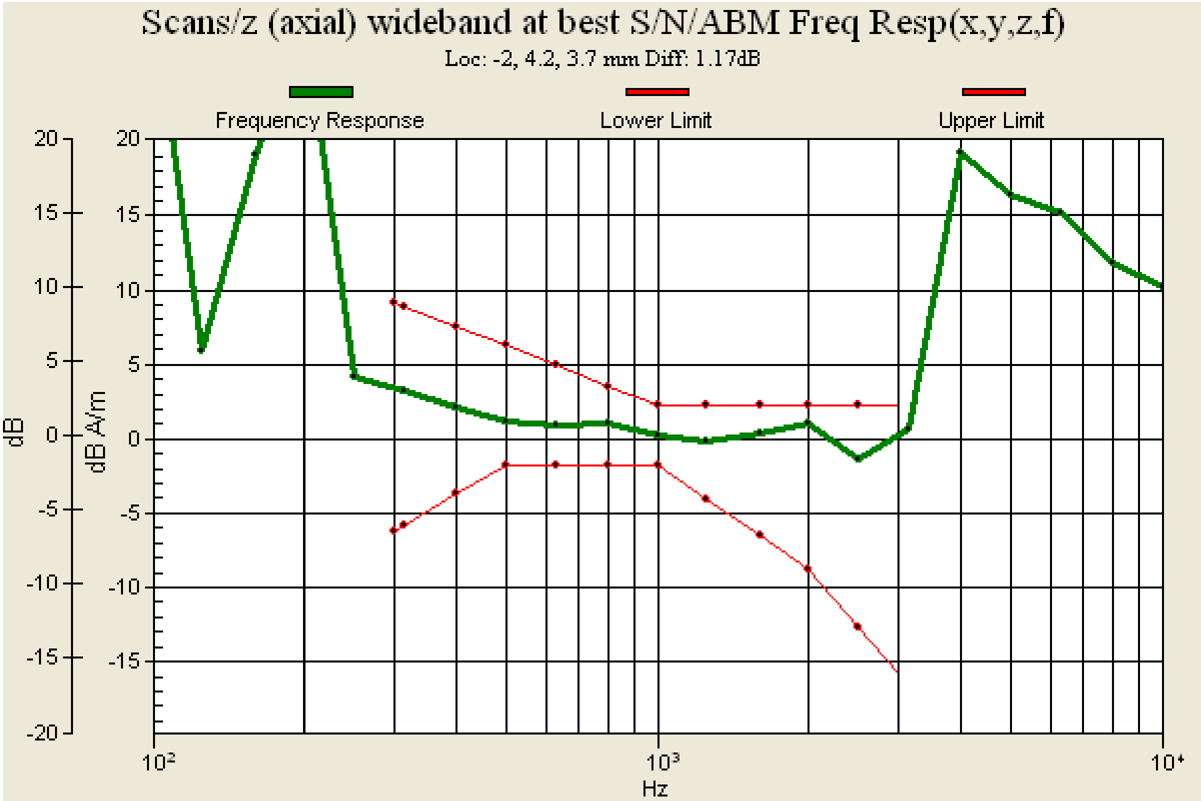
Communication System: GSM850; Frequency: 824.2 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 27.7 dB
ABM1 comp = 1.60 dB A/m
Location: -2, 4.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -2, 4.2, 3.7 mm Diff: 1.17dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
20
15
10
5
0
-5
-10
-15
-20
10^2
10^3
10^4
Hz

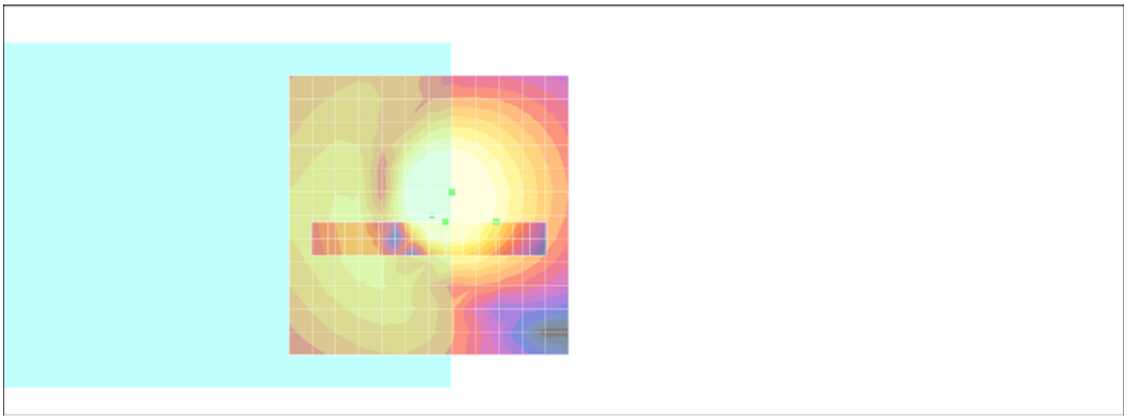
#01 T-Coil_GSM850_Voice_Ch128_Radial 1 (X)

DUT: 172303

Communication System: GSM850; Frequency: 824.2 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 28.7 dB
ABM1 comp = -4.54 dB A/m
Location: -12, 1.2, 3.7 mm



0 dB = 1.00A/m

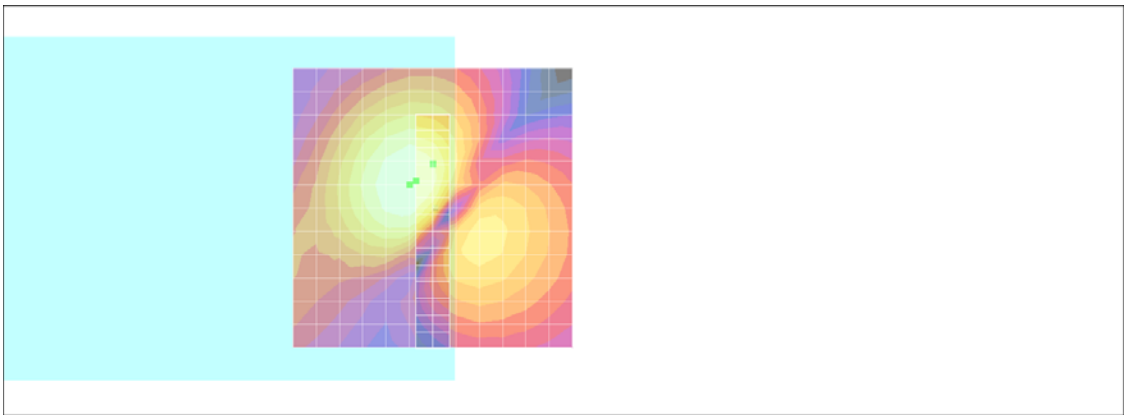
#01 T-Coil_GSM850_Voice_Ch128_Radial 2 (Y)

DUT: 172303

Communication System: GSM850; Frequency: 824.2 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 25.9 dB
ABM1 comp = -1.67 dB A/m
Location: 0, -7.8, 3.7 mm



0 dB = 1.00A/m

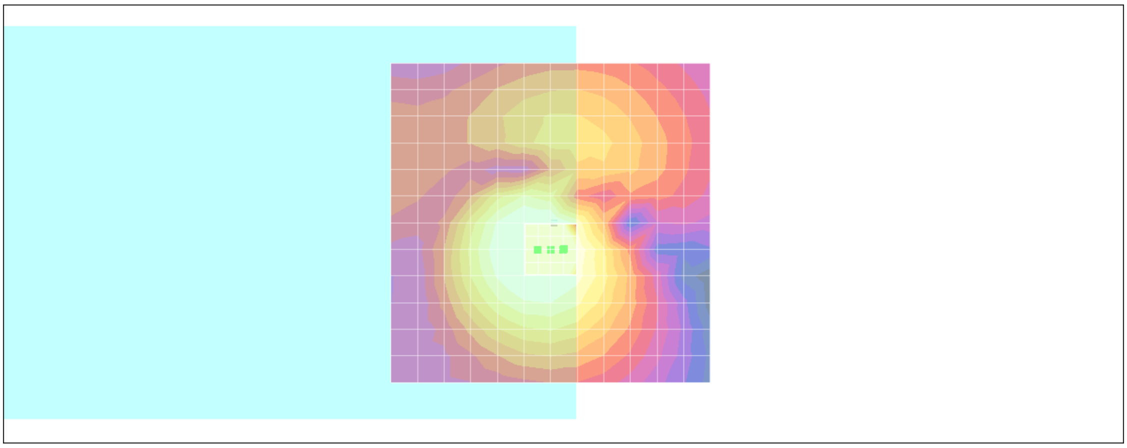
#02 T-Coil_GSM850_Voice_Ch189_Axial (Z)

DUT: 172303

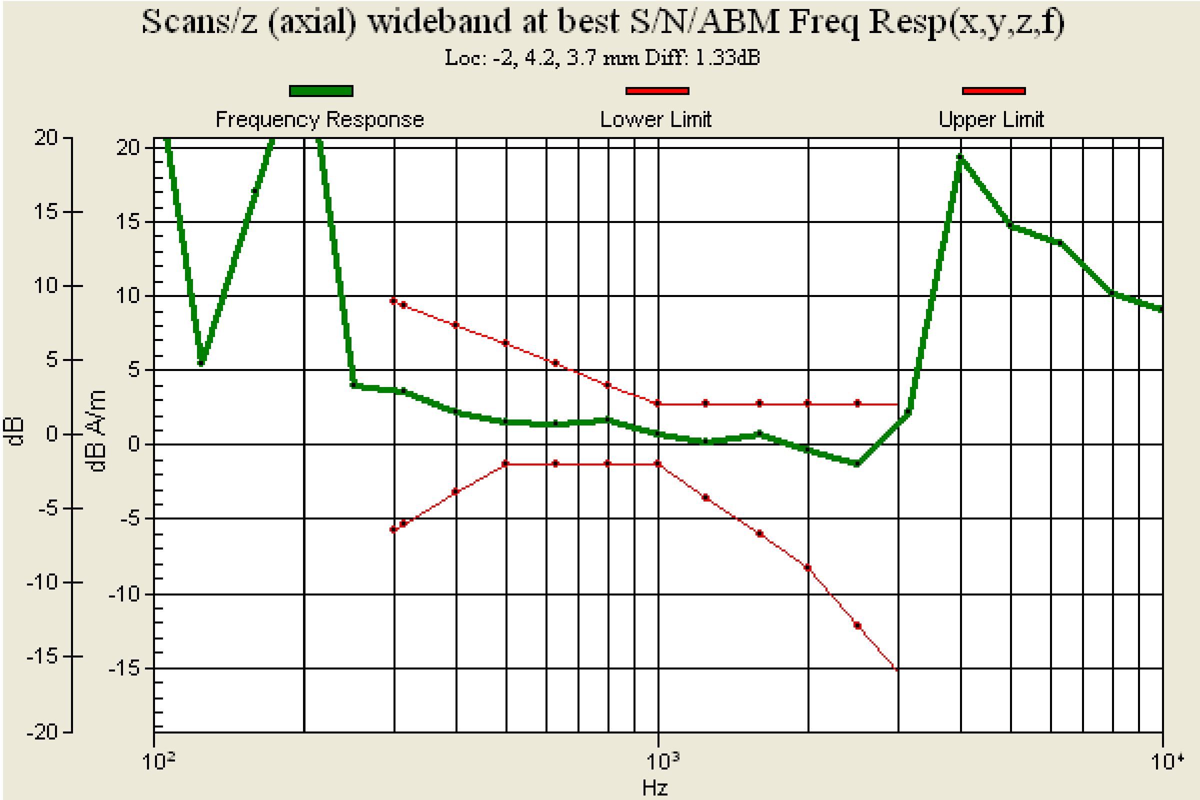
Communication System: GSM850; Frequency: 836.4 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 27.5 dB
ABM1 comp = 1.92 dB A/m
Location: -2, 4.2, 3.7 mm



0 dB = 1.00A/m


Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -2, 4.2, 3.7 mm Diff: 1.33dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

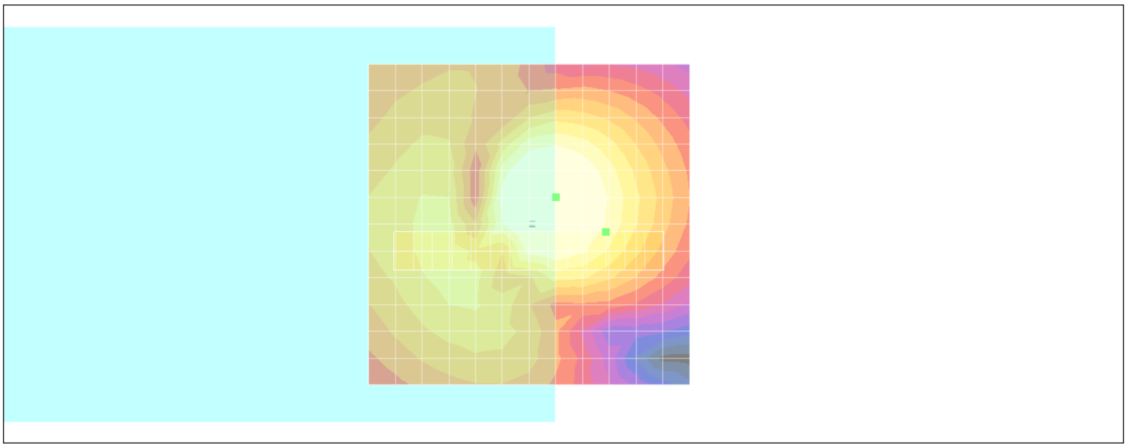
#02 T-Coil_GSM850_Voice_Ch189_Radial 1 (X)

DUT: 172303

Communication System: GSM850; Frequency: 836.4 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 28.1 dB
ABM1 comp = -4.16 dB A/m
Location: -12, 1.2, 3.7 mm



0 dB = 1.00A/m

#02 T-Coil_GSM850_Voice_Ch189_Radial 2 (Y)

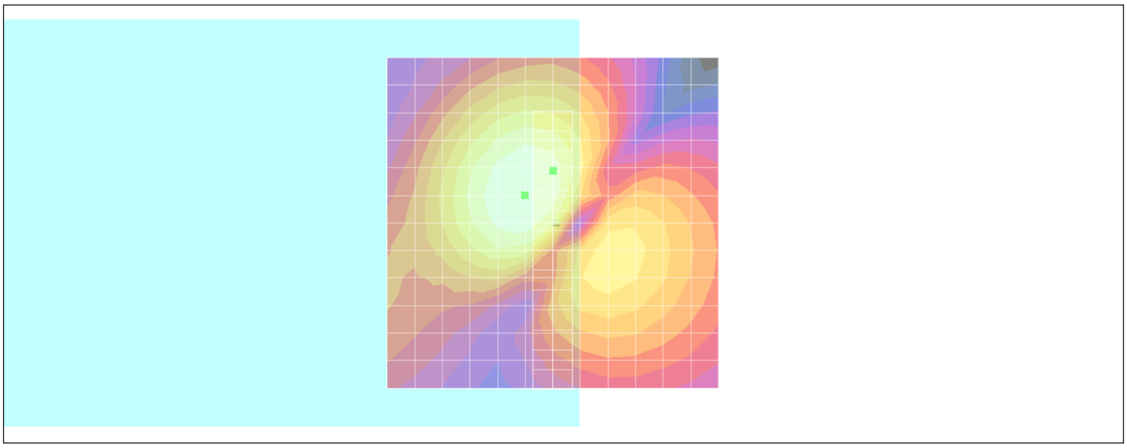
DUT: 172303

Communication System: GSM850; Frequency: 836.4 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):

ABM1/ABM2 = 25.7 dB
ABM1 comp = -1.13 dB A/m
Location: 0, -7.8, 3.7 mm



0 dB = 1.00A/m

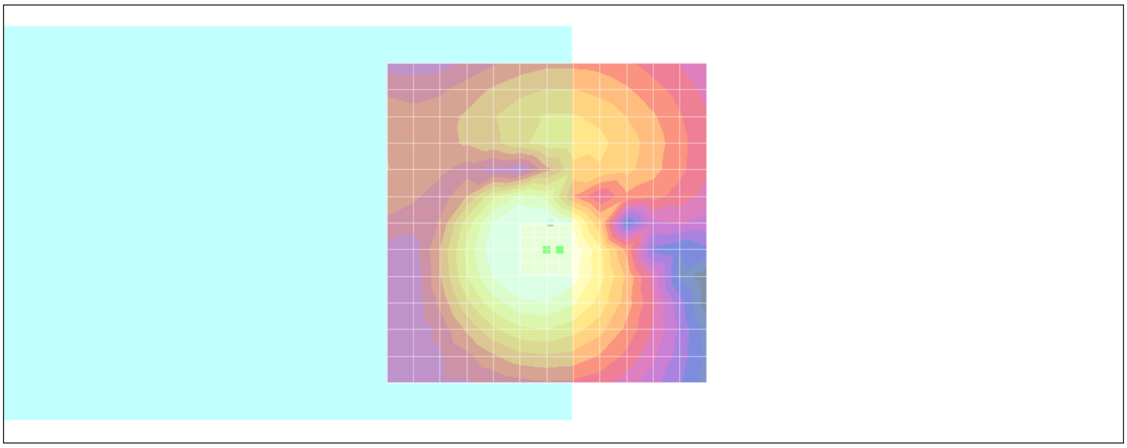
#03 T-Coil_GSM850_Voice_Ch251_Axial (Z)

DUT: 172303

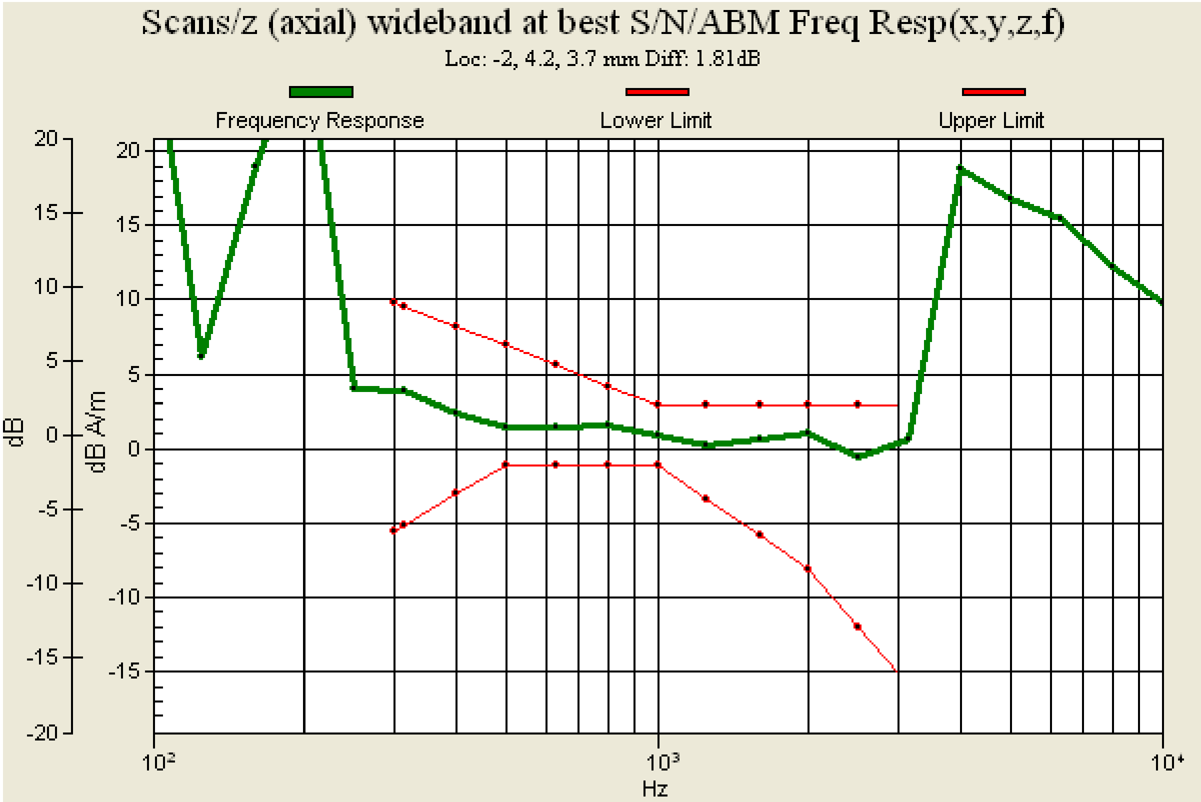
Communication System: GSM850; Frequency: 848.8 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 27.7 dB
ABM1 comp = 2.02 dB A/m
Location: -2, 4.2, 3.7 mm



0 dB = 1.00A/m


Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -2, 4.2, 3.7 mm Diff: 1.81dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
20
15
10
5
0
-5
-10
-15
-20
10^2
10^3
10^4
Hz

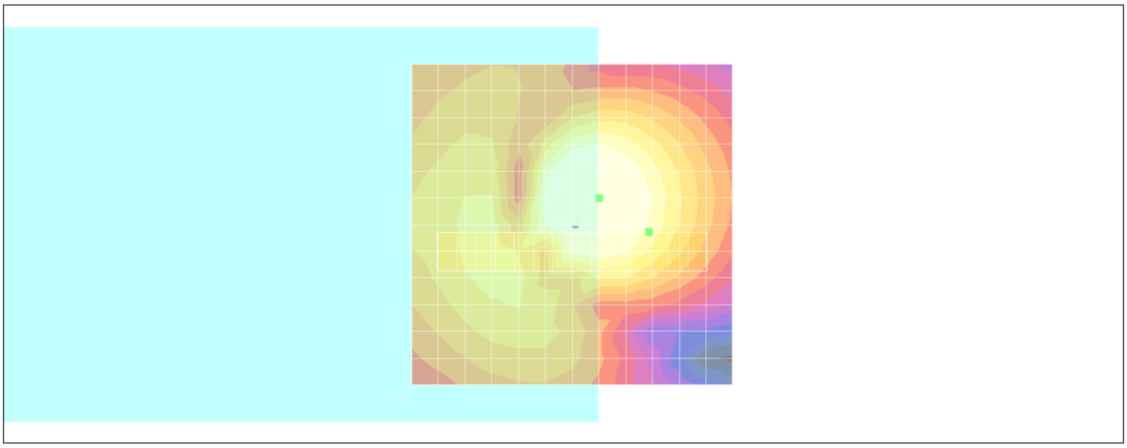
#03 T-Coil_GSM850_Voice_Ch251_Radial 1 (X)

DUT: 172303

Communication System: GSM850; Frequency: 848.8 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 28.6 dB
ABM1 comp = -4.10 dB A/m
Location: -12, 1.2, 3.7 mm



0 dB = 1.00A/m

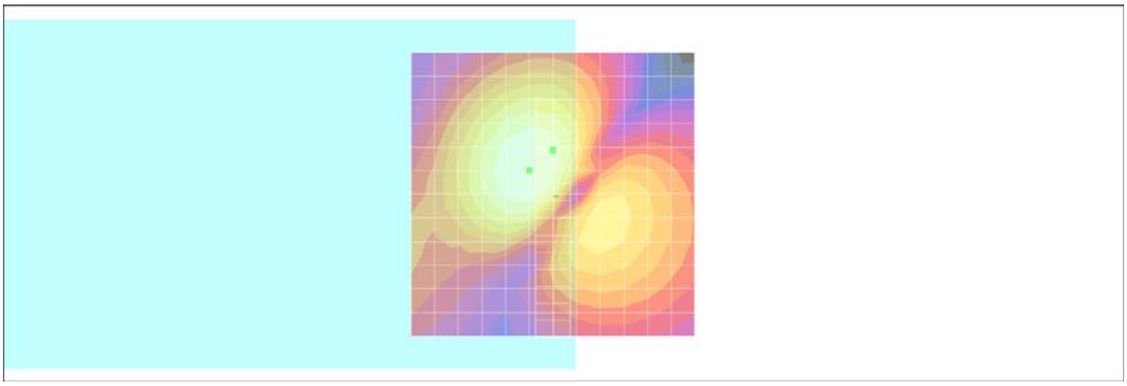
#03 T-Coil_GSM850_Voice_Ch251_Radial 2 (Y)

DUT: 172303

Communication System: GSM850; Frequency: 848.8 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 25.7 dB
ABM1 comp = -0.859 dB A/m
Location: 0, -7.8, 3.7 mm



0 dB = 1.00A/m

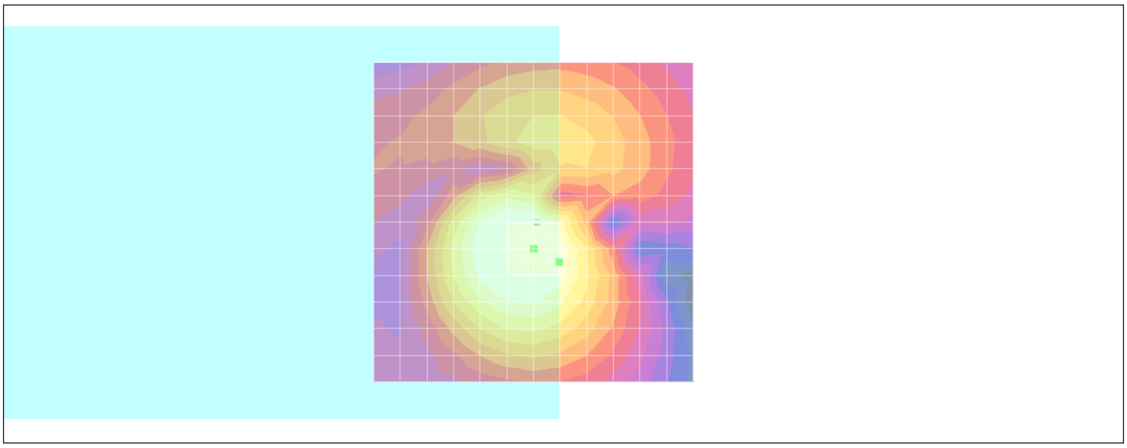
#04 T-Coil_GSM1900_Voice_Ch512_Axial (Z)

DUT: 172303

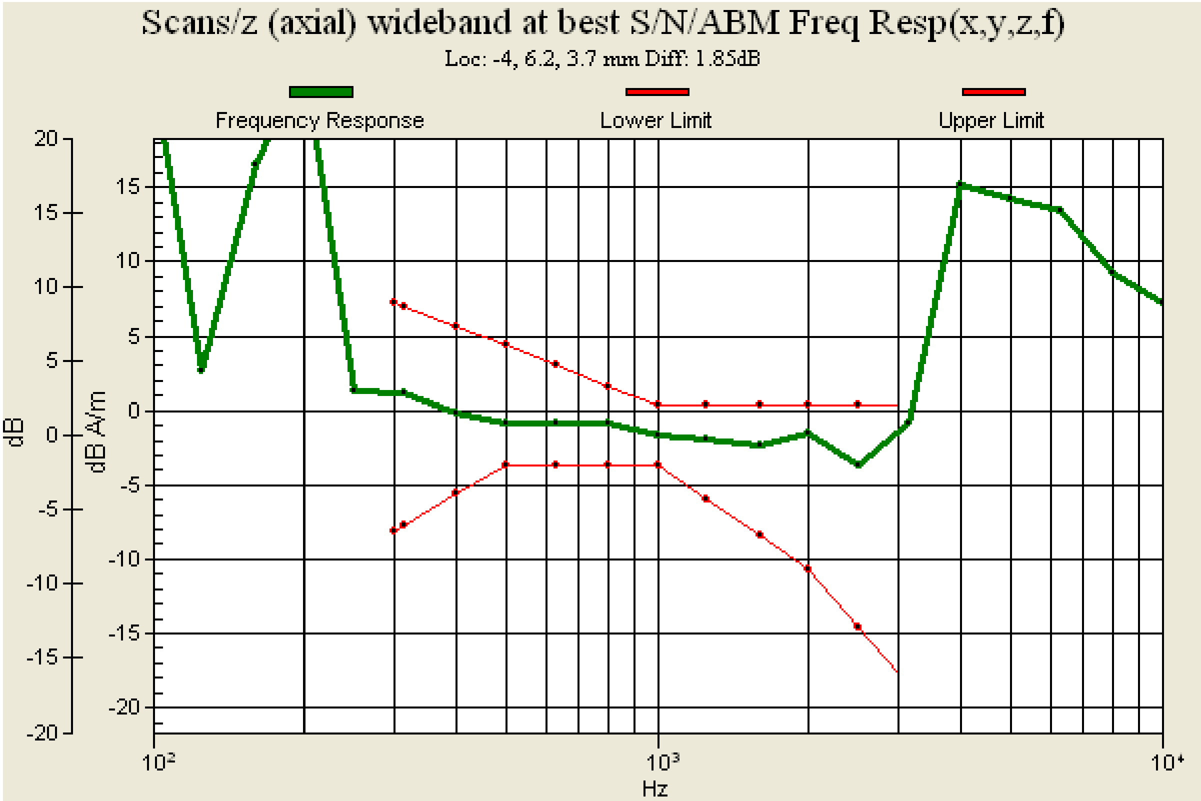
Communication System: PCS; Frequency: 1850.2 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 29.9 dB
ABM1 comp = -0.384 dB A/m
Location: -4, 6.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4, 6.2, 3.7 mm Diff: 1.85dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

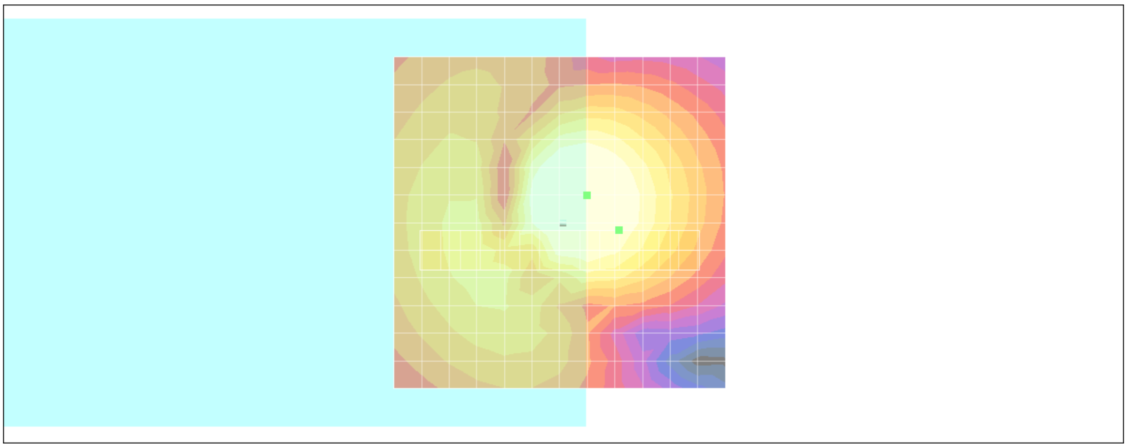
#04 T-Coil_GSM1900_Voice_Ch512_Radial 1 (X)

DUT: 172303

Communication System: PCS; Frequency: 1850.2 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.1 dB
ABM1 comp = -0.323 dB A/m
Location: -9, 1.2, 3.7 mm



0 dB = 1.00A/m

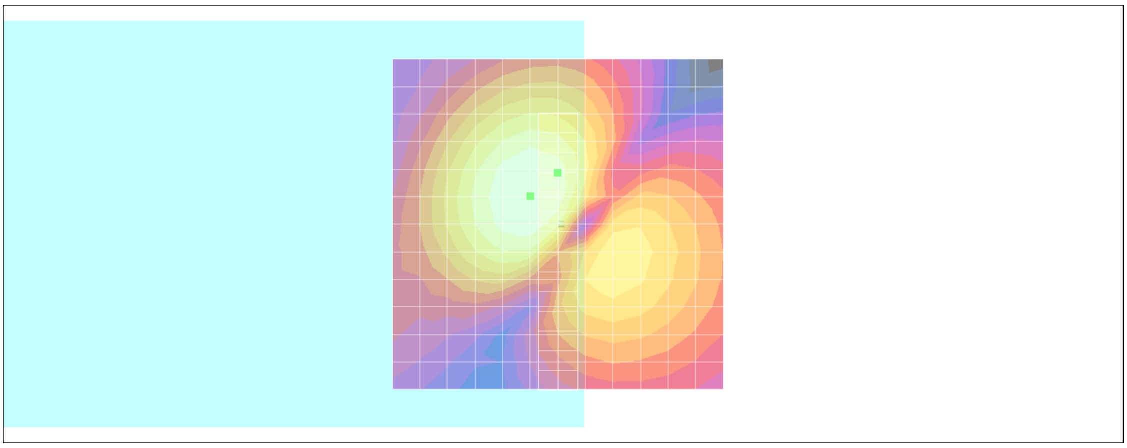
#04 T-Coil_GSM1900_Voice_Ch512_Radial 2 (Y)

DUT: 172303

Communication System: PCS; Frequency: 1850.2 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 28.9 dB
ABM1 comp = -1.17 dB A/m
Location: 0, -7.8, 3.7 mm



0 dB = 1.00A/m

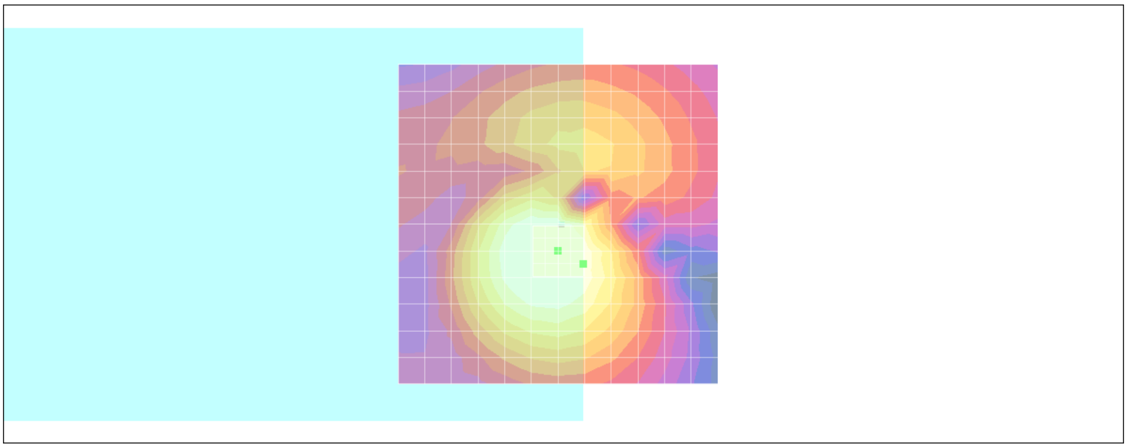
#05 T-Coil_GSM1900_Voice_Ch661_Axial (Z)

DUT: 172303

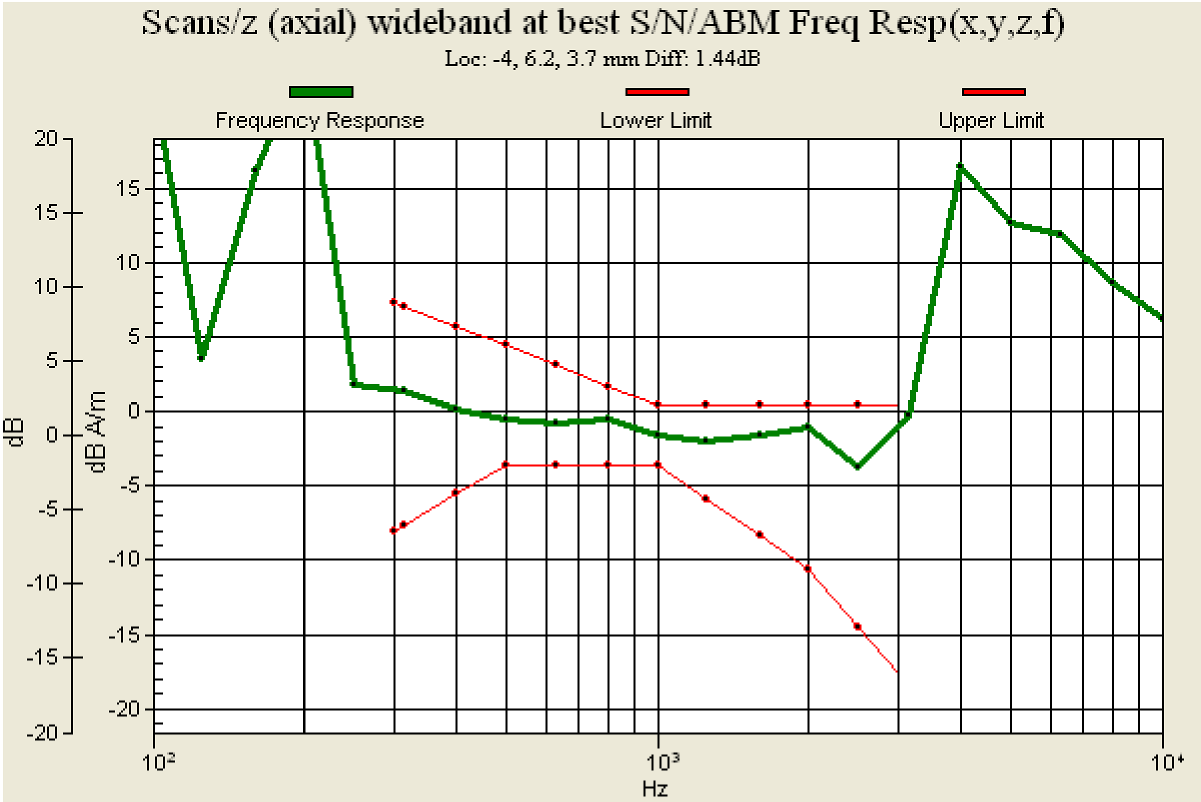
Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 29.8 dB
ABM1 comp = -0.247 dB A/m
Location: -4, 6.2, 3.7 mm



0 dB = 1.00A/m


Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4, 6.2, 3.7 mm Diff: 1.44dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
20
15
10
5
0
-5
-10
-15
-20
10^2
10^3
10^4
Hz

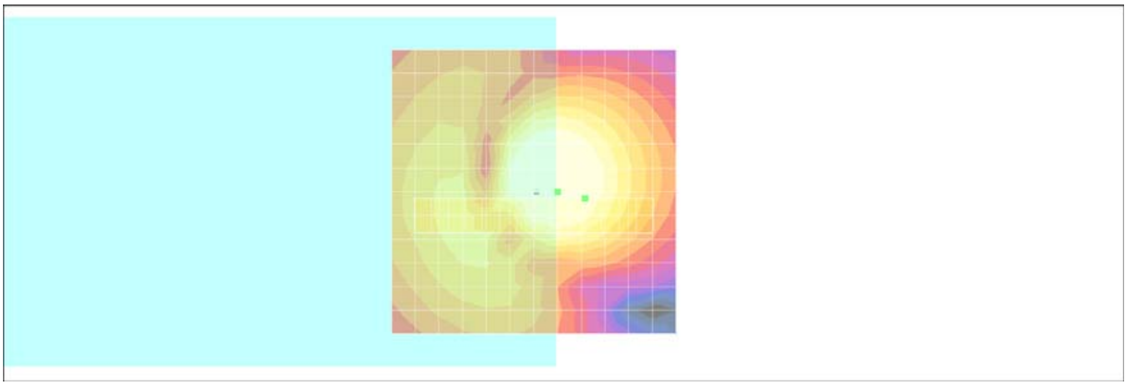
#05 T-Coil_GSM1900_Voice_Ch661_Radial 1 (X)

DUT: 172303

Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.3 dB
ABM1 comp = 0.285 dB A/m
Location: -9, 1.2, 3.7 mm



0 dB = 1.00A/m

#05 T-Coil_GSM1900_Voice_Ch661_Radial 2 (Y)

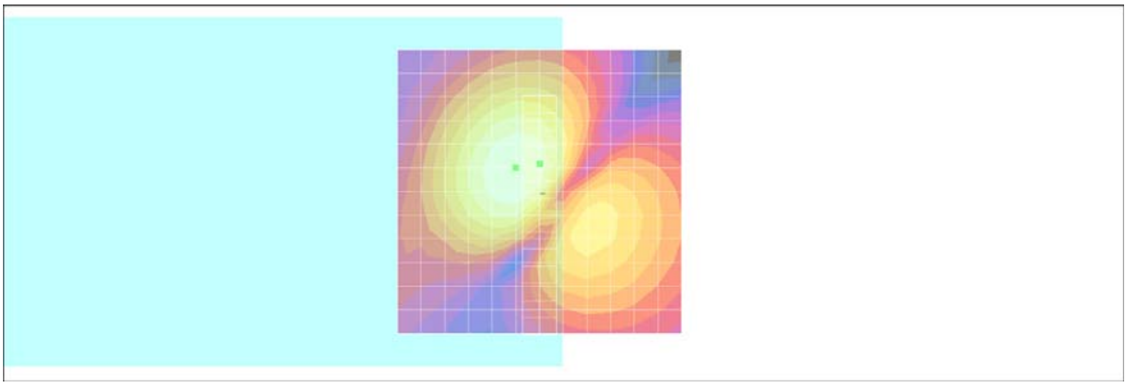
DUT: 172303

Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):

ABM1/ABM2 = 28.4 dB
ABM1 comp = -0.848 dB A/m
Location: 0, -4.8, 3.7 mm



0 dB = 1.00A/m

#06 T-Coil_GSM1900_Voice_Ch810_Axial (Z)

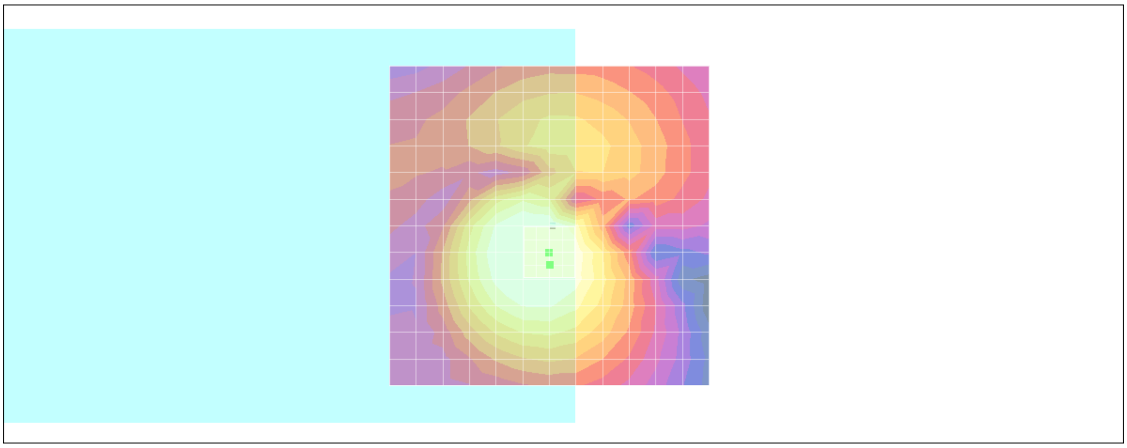
DUT: 172303

Communication System: PCS; Frequency: 1909.8 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

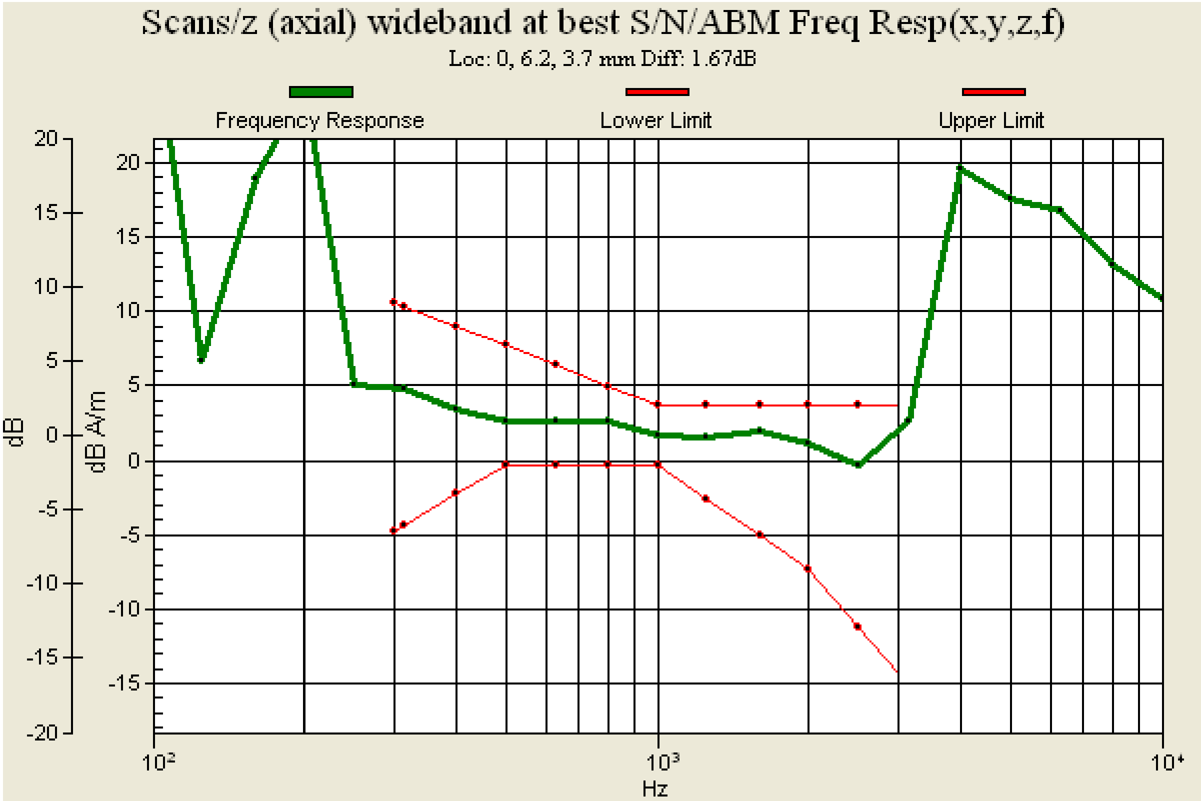
DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

ABM1/ABM2 = 29.9 dB
ABM1 comp = 3.05 dB A/m
Location: 0, 6.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 6.2, 3.7 mm Diff: 1.67dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

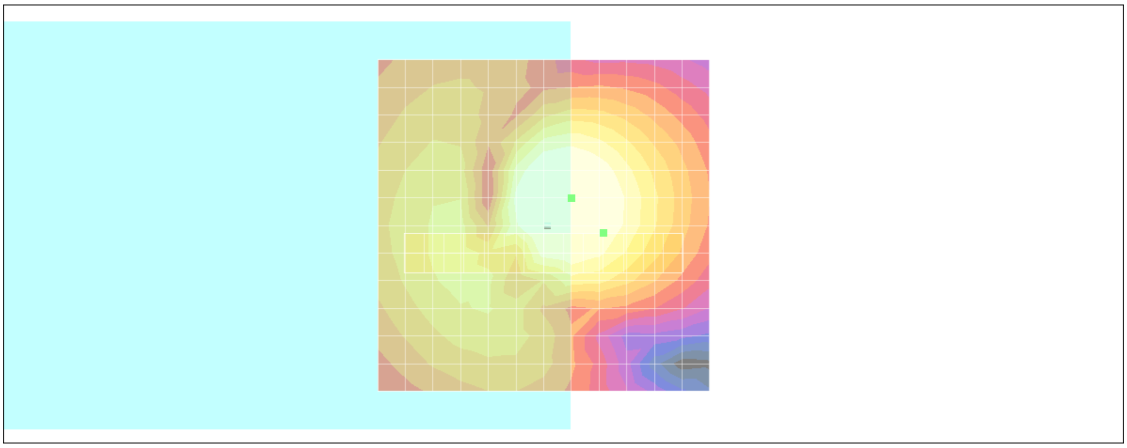
#06 T-Coil_GSM1900_Voice_Ch810_Radial 1 (X)

DUT: 172303

Communication System: PCS; Frequency: 1909.8 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.3 dB
ABM1 comp = -0.344 dB A/m
Location: -9, 1.2, 3.7 mm



0 dB = 1.00A/m

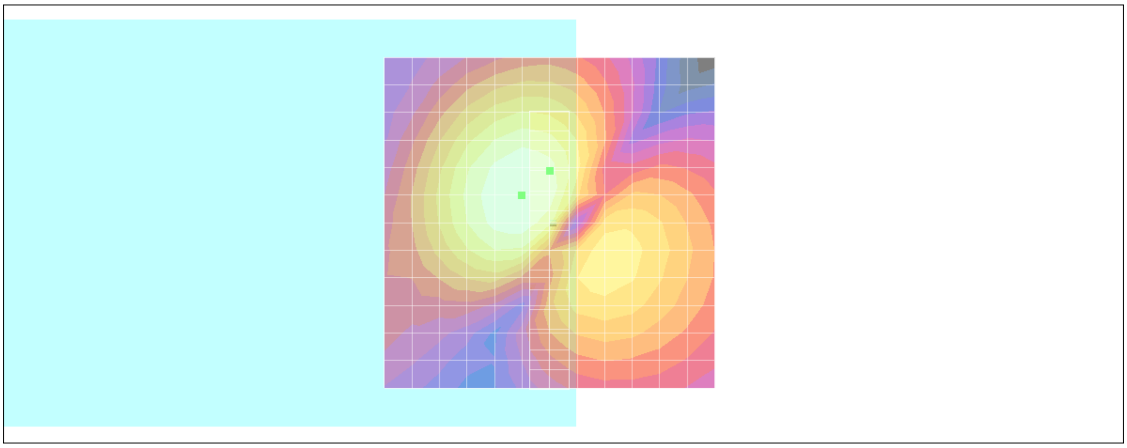
#06 T-Coil_GSM1900_Voice_Ch810_Radial 2 (Y)

DUT: 172303

Communication System: PCS; Frequency: 1909.8 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 28.6 dB
ABM1 comp = -1.23 dB A/m
Location: 0, -7.8, 3.7 mm



0 dB = 1.00A/m

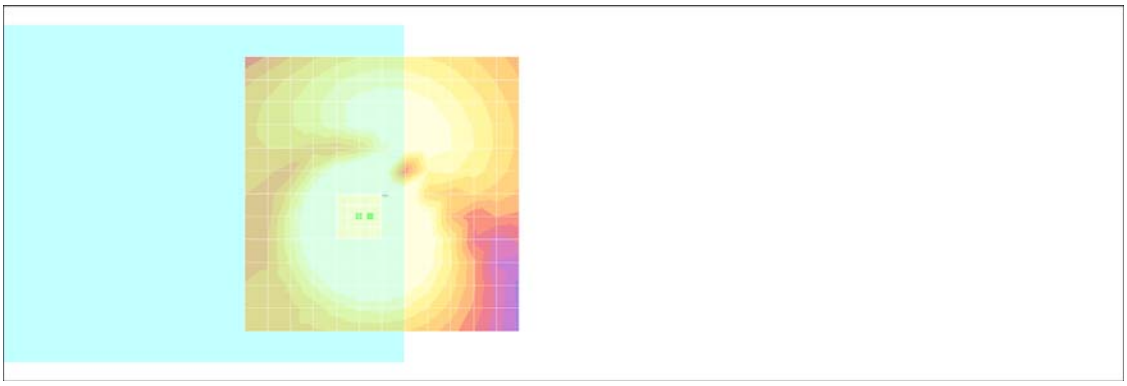
#07 T-Coil_WCDMA II_Voice_Ch9262_Axial (Z)

DUT: 172303

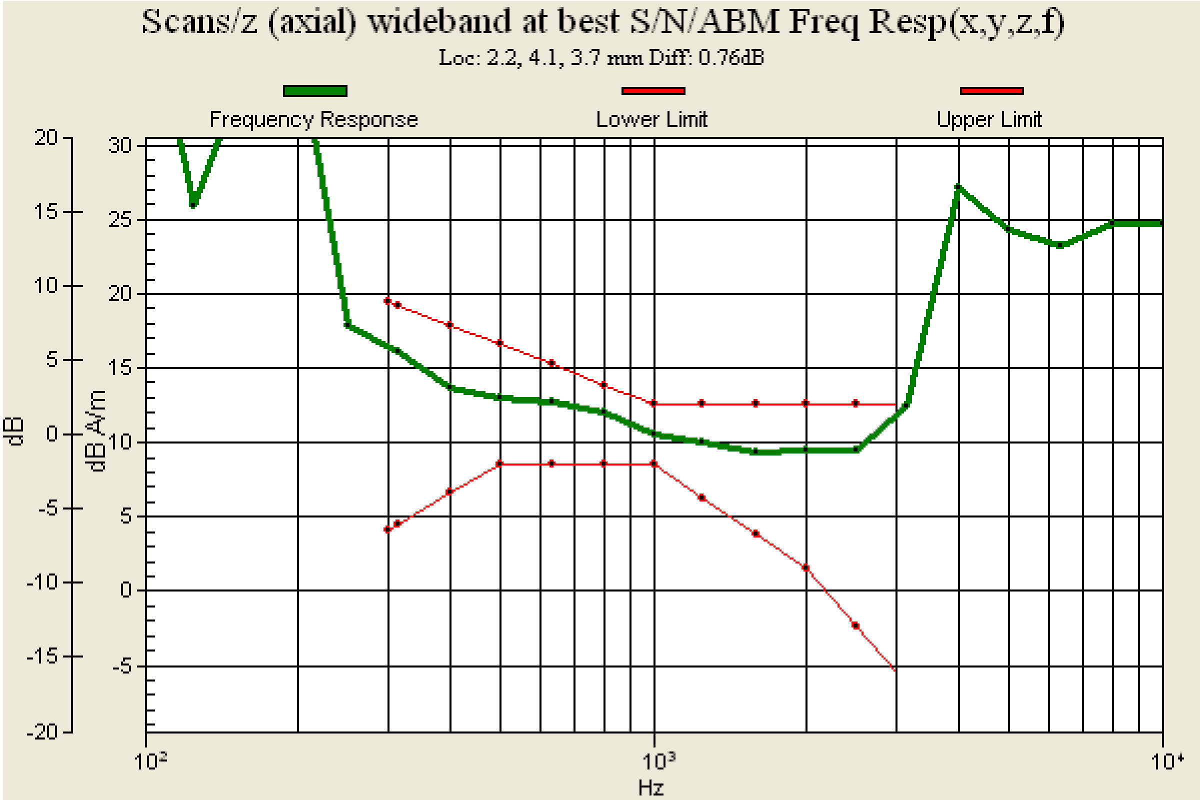
Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 30.0 dB
ABM1 comp = 14.1 dB A/m
Location: 2.2, 4.2, 3.7 mm



0 dB = 1.00A/m


Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 2.2, 4.1, 3.7 mm Diff: 0.76dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz
20
15
10
5
0
-5
-10
-15
-20
30
25
20
15
10
5
0
-5
10²
10³
10⁴

#07 T-Coil_WCDMA II_Voice_Ch9262_Radial 1 (X)

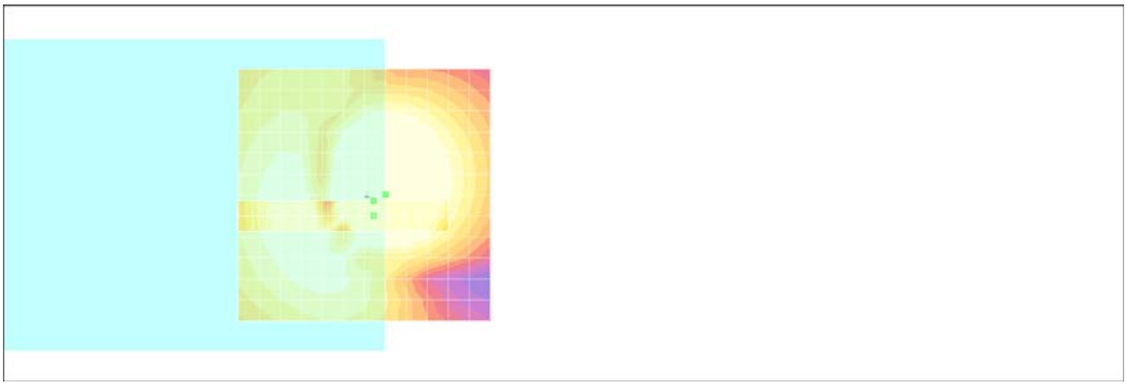
DUT: 172303

Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):

ABM1/ABM2 = 30.1 dB
ABM1 comp = 11.2 dB A/m
Location: -1.8, 4.2, 3.7 mm



0 dB = 1.00A/m

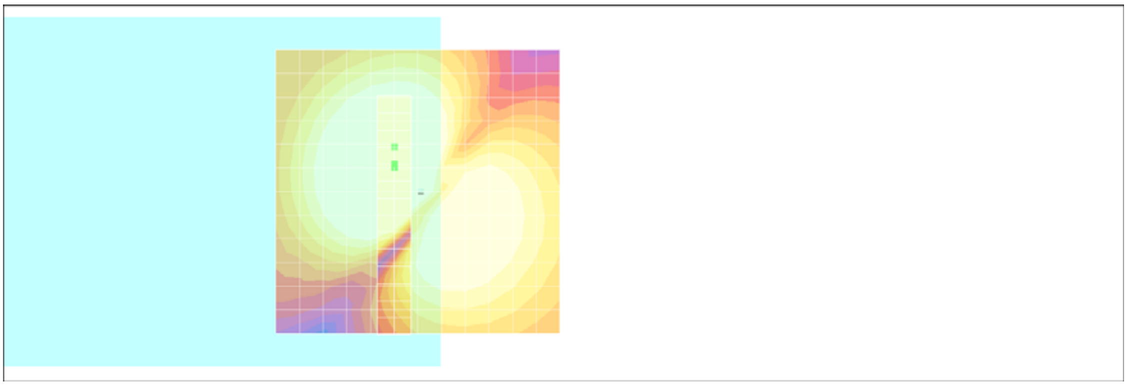
#07 T-Coil_WCDMA II_Voice_Ch9262_Radial 2 (Y)

DUT: 172303

Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 29.9 dB
ABM1 comp = 10.0 dB A/m
Location: 4.2, -7.8, 3.7 mm



0 dB = 1.00A/m

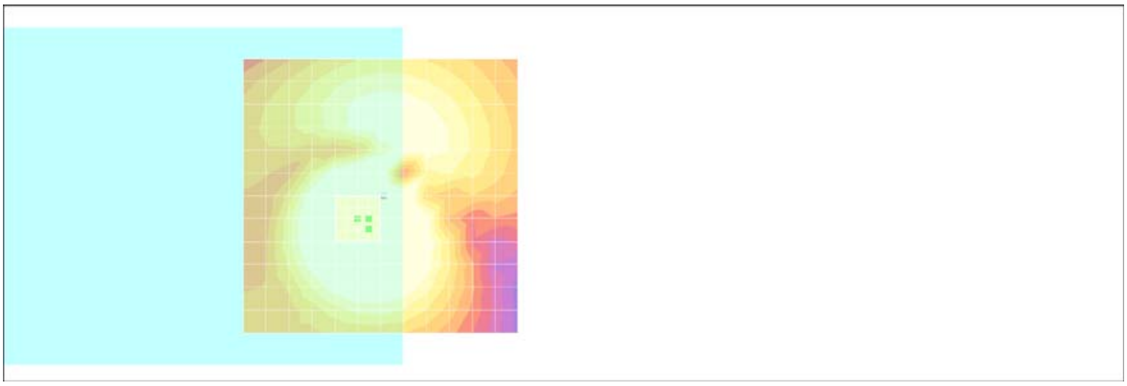
#08 T-Coil_WCDMA II_Voice_Ch9400_Axial (Z)

DUT: 172303

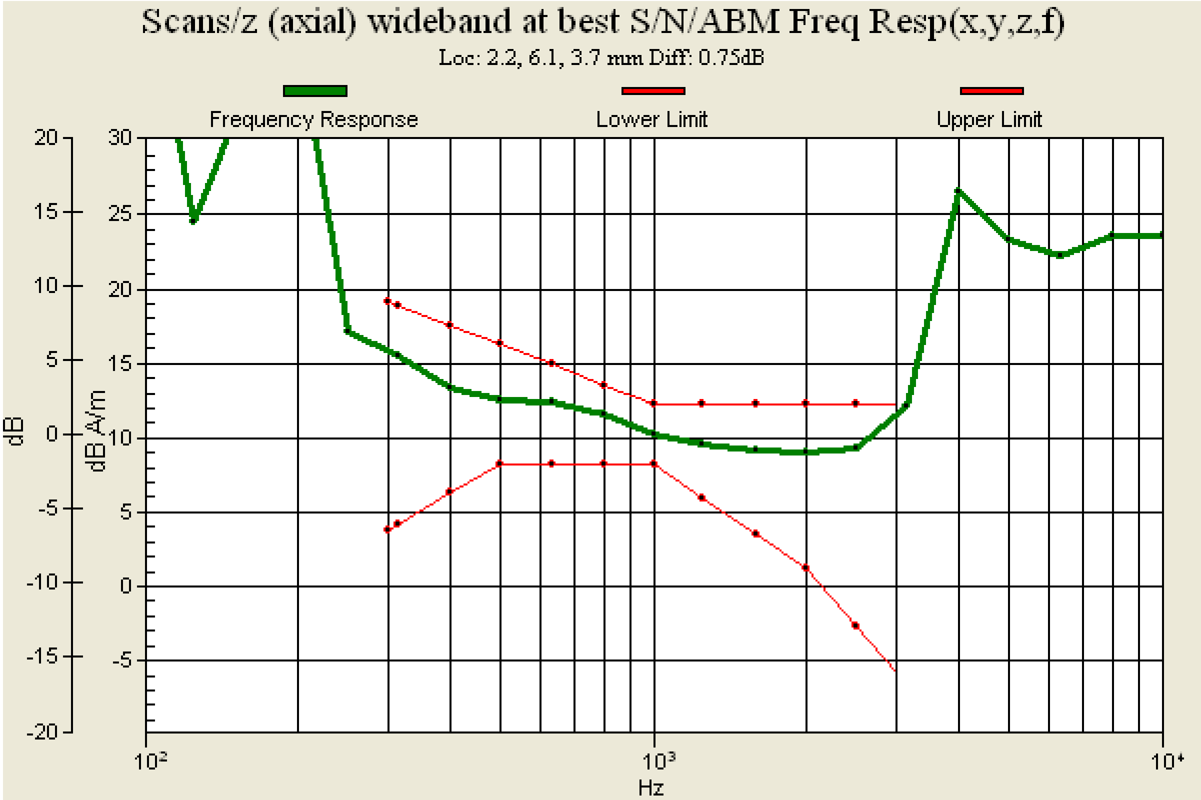
Communication System: WCDMA; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 30.1 dB
ABM1 comp = 13.7 dB A/m
Location: 2.2, 6.2, 3.7 mm



0 dB = 1.00A/m


Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 2.2, 6.1, 3.7 mm Diff: 0.75dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz
20
15
10
5
0
-5
-10
-15
-20
30
25
20
15
10
5
0
-5
10^2
10^3
10^4

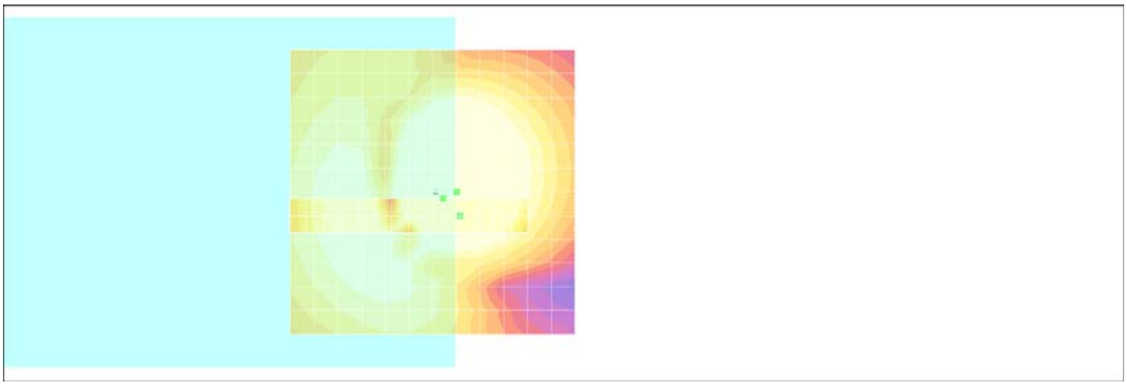
#08 T-Coil_WCDMA II_Voice_Ch9400_Radial 1 (X)

DUT: 172303

Communication System: WCDMA; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.1 dB
ABM1 comp = 10.6 dB A/m
Location: -4.8, 4.2, 3.7 mm



0 dB = 1.00A/m

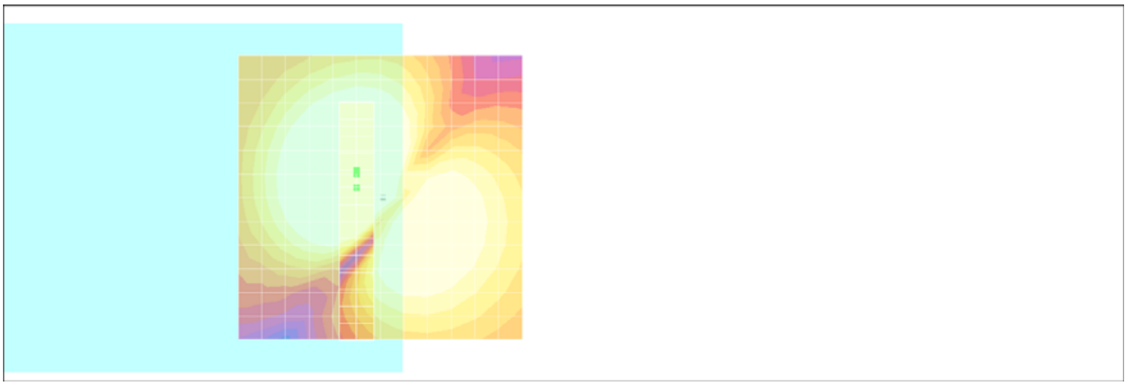
#08 T-Coil_WCDMA II_Voice_Ch9400_Radial 2 (Y)

DUT: 172303

Communication System: WCDMA; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 30.0 dB
ABM1 comp = 10.9 dB A/m
Location: 4.2, -1.8, 3.7 mm



0 dB = 1.00A/m

#09 T-Coil_WCDMA II_Voice_Ch9538_Axial (Z)

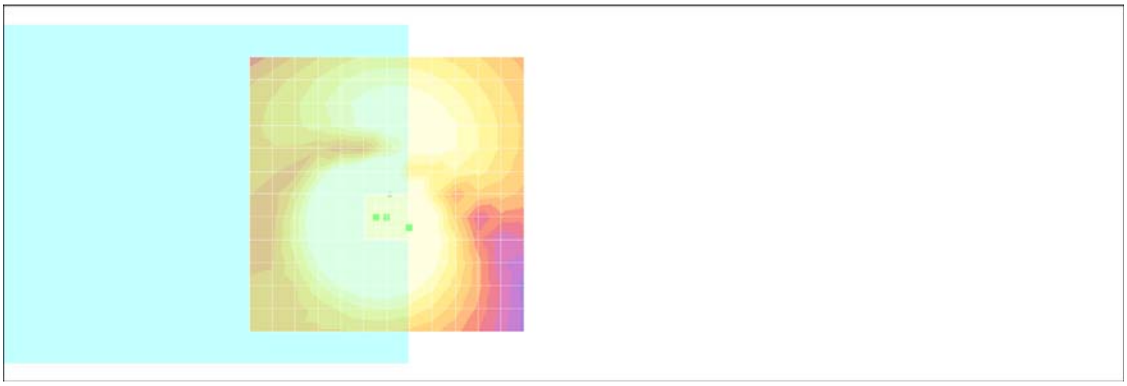
DUT: 172303

Communication System: WCDMA; Frequency: 1907.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

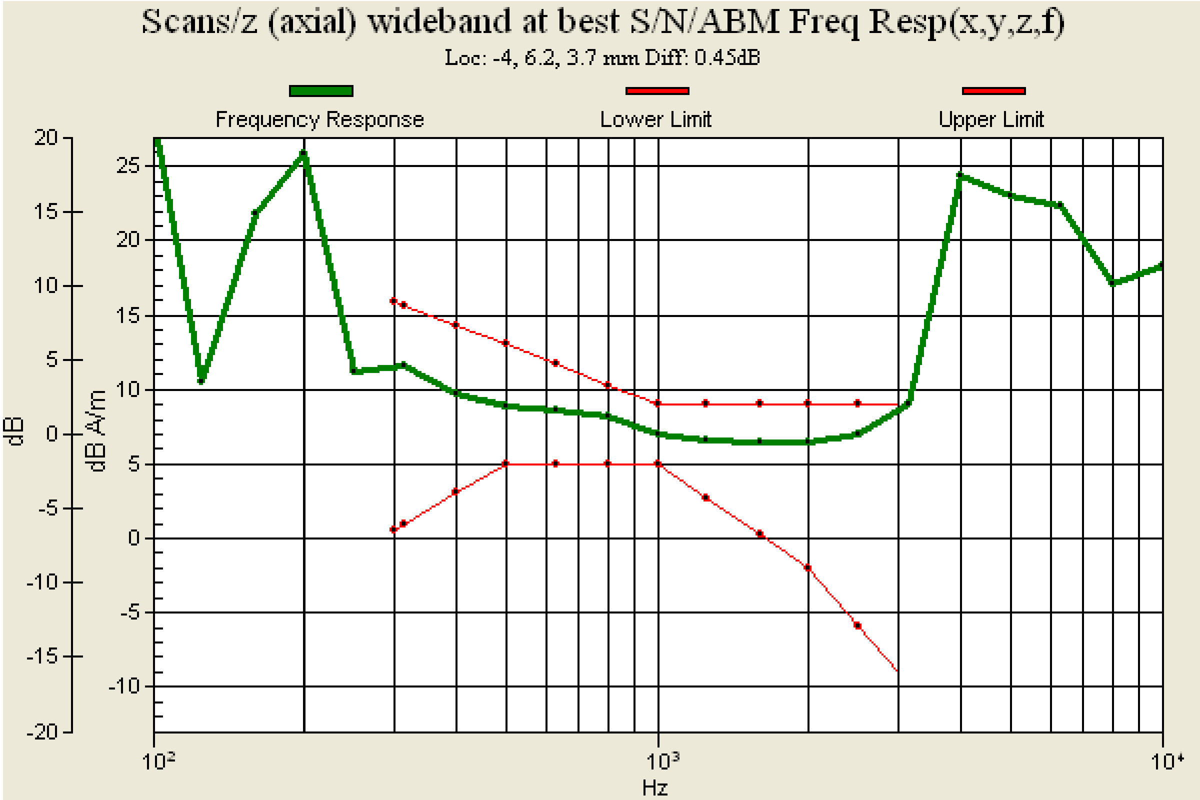
DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

ABM1/ABM2 = 30.2 dB
ABM1 comp = 9.19 dB A/m
Location: -4, 6.2, 3.7 mm



0 dB = 1.00A/m


Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4, 6.2, 3.7 mm Diff: 0.45dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz
10²
10³
10⁴
20
15
10
5
0
-5
-10
-15
-20
25
20
15
10
5
0
-5
-10

#09 T-Coil_WCDMA II_Voice_Ch9538_Radial 1 (X)

DUT: 172303

Communication System: WCDMA; Frequency: 1907.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.4 dB
ABM1 comp = 2.89 dB A/m
Location: 0, 7.2, 3.7 mm

0 dB = 1.00A/m

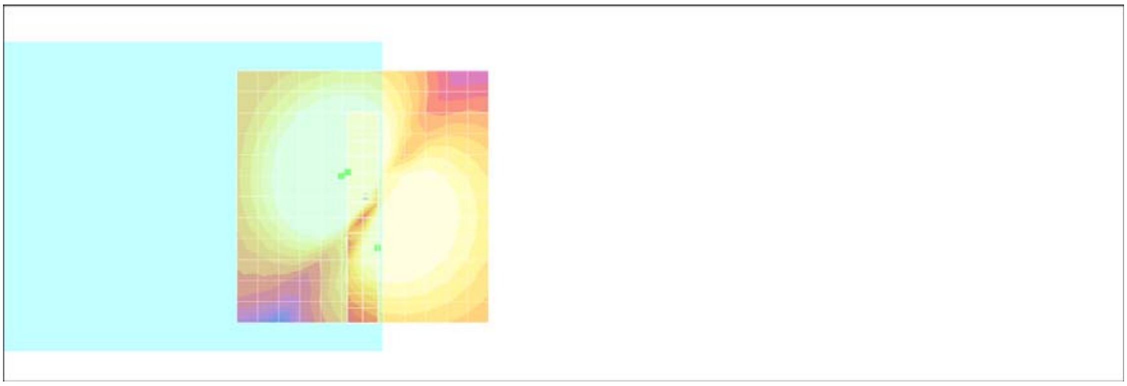
#09 T-Coil_WCDMA II_Voice_Ch9538_Radial 2 (Y)

DUT: 172303

Communication System: WCDMA; Frequency: 1907.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
Measurement grid: dx=10mm, dy=10mm
ABM1/ABM2 = 30.2 dB
ABM1 comp = 2.42 dB A/m
Location: -3, 10.2, 3.7 mm



0 dB = 1.00A/m

#10 T-Coil_WCDMA IV_Voice_Ch1312_Axial (Z)

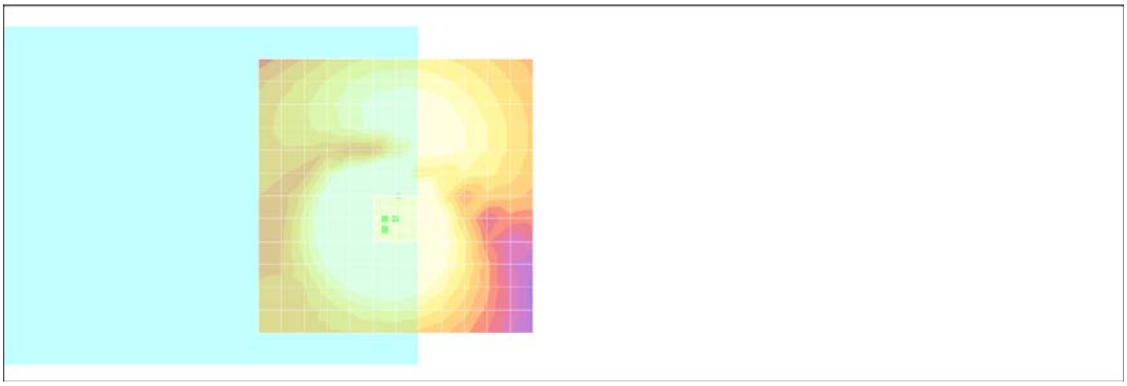
DUT: 172303

Communication System: WCDMA; Frequency: 1712.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

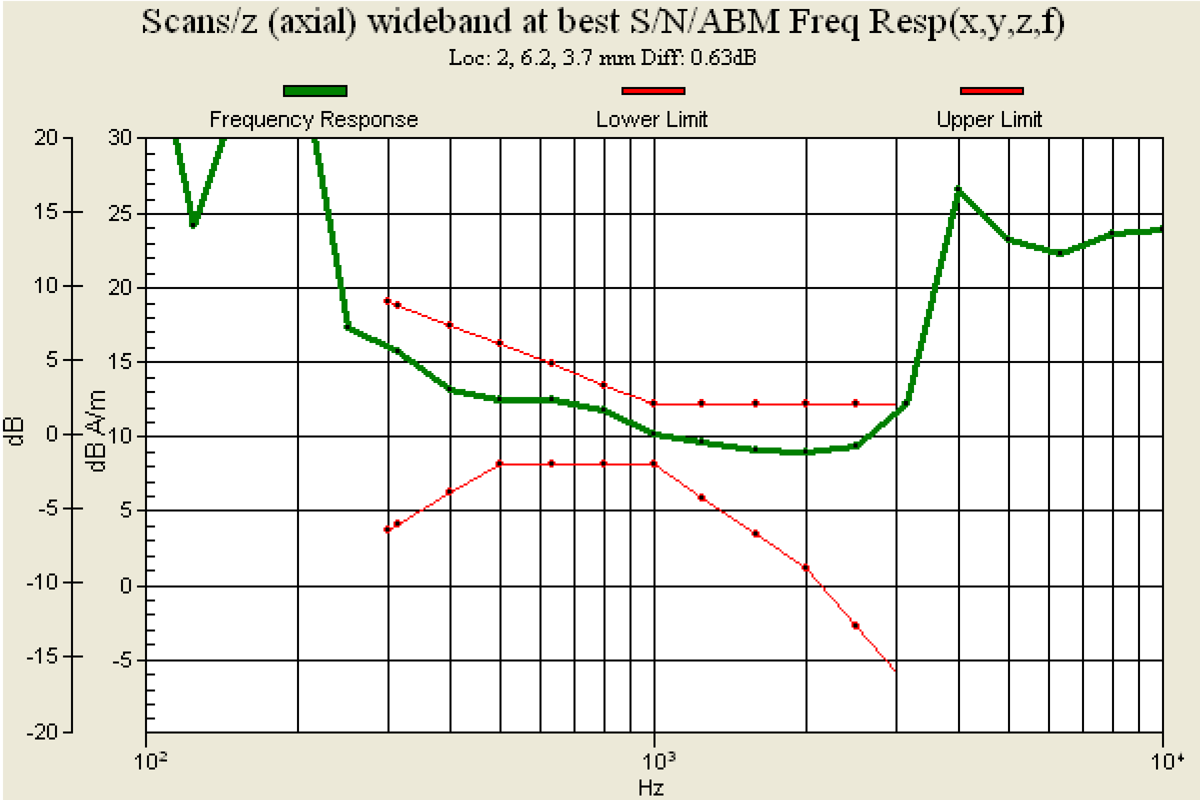
DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

ABM1/ABM2 = 30.2 dB
ABM1 comp = 13.6 dB A/m
Location: 2, 6.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 2, 6.2, 3.7 mm Diff: 0.63dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz
20
15
10
5
0
-5
-10
-15
-20
30
25
20
15
10
5
0
-5
10^2
10^3
10^4

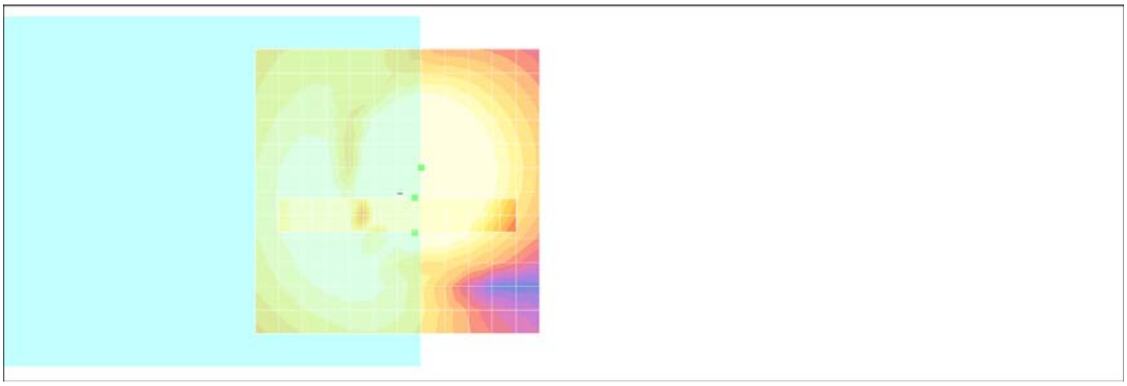
#10 T-Coil_WCDMA IV_Voice_Ch1312_Radial 1 (X)

DUT: 172303

Communication System: WCDMA; Frequency: 1712.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.2 dB
ABM1 comp = 5.12 dB A/m
Location: -3, 7.2, 3.7 mm



0 dB = 1.00A/m

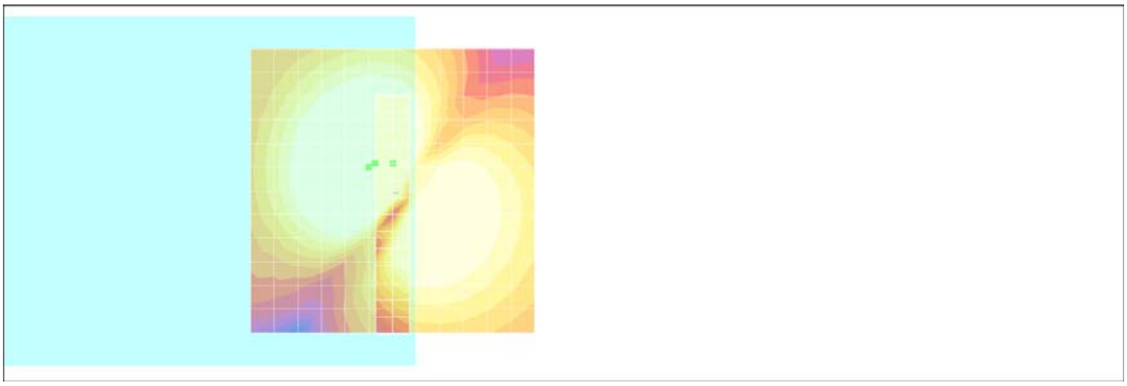
#10 T-Coil_WCDMA IV_Voice_Ch1312_Radial 2 (Y)

DUT: 172303

Communication System: WCDMA; Frequency: 1712.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 30.0 dB
ABM1 comp = 8.70 dB A/m
Location: 0, -4.8, 3.7 mm



0 dB = 1.00A/m

#11 T-Coil_WCDMA IV_Voice_Ch1413_Axial (Z)

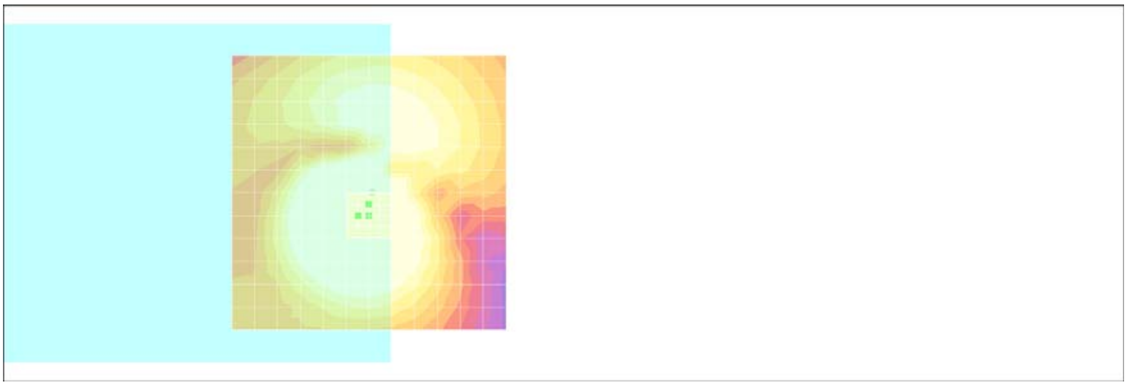
DUT: 172303

Communication System: WCDMA; Frequency: 1732.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

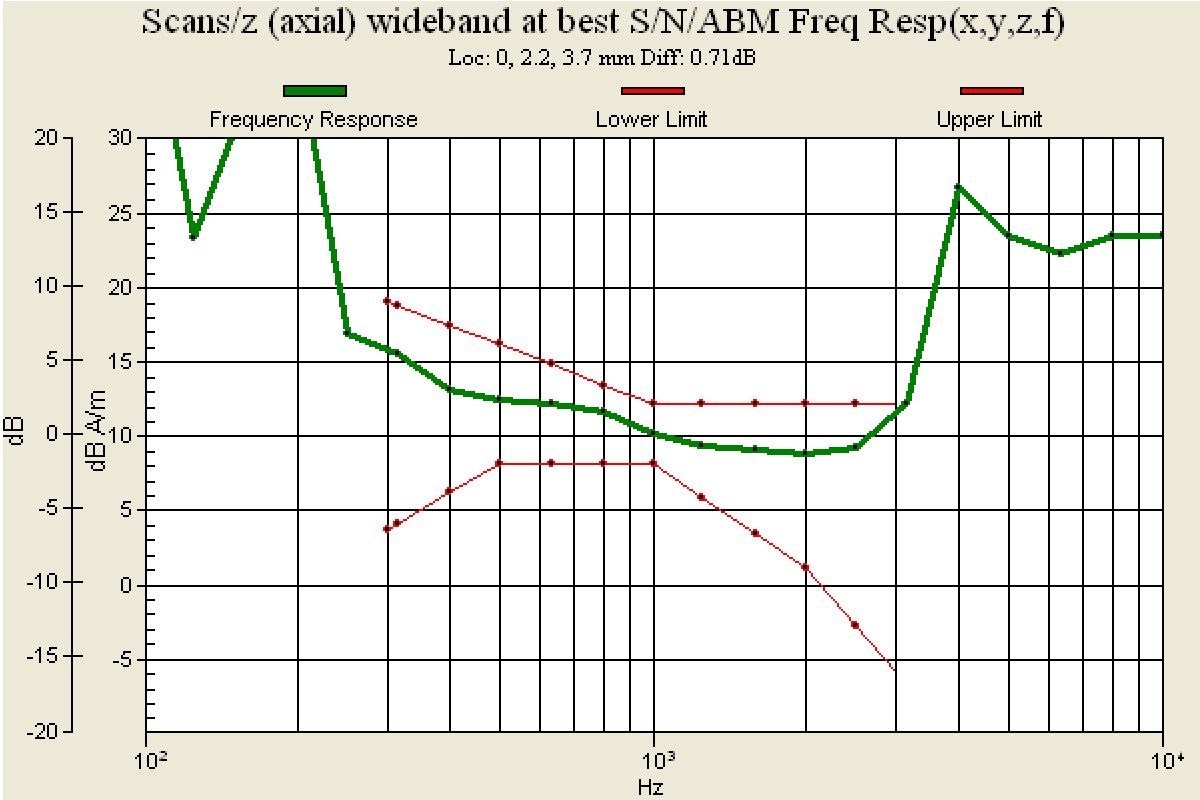
DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):

ABM1/ABM2 = 30.1 dB
ABM1 comp = 13.5 dB A/m
Location: 0, 2.2, 3.7 mm



0 dB = 1.00A/m


Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 2.2, 3.7 mm Diff: 0.71dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz
20
15
10
5
0
-5
-10
-15
-20
30
25
20
15
10
5
0
-5
10^2
10^3
10^4

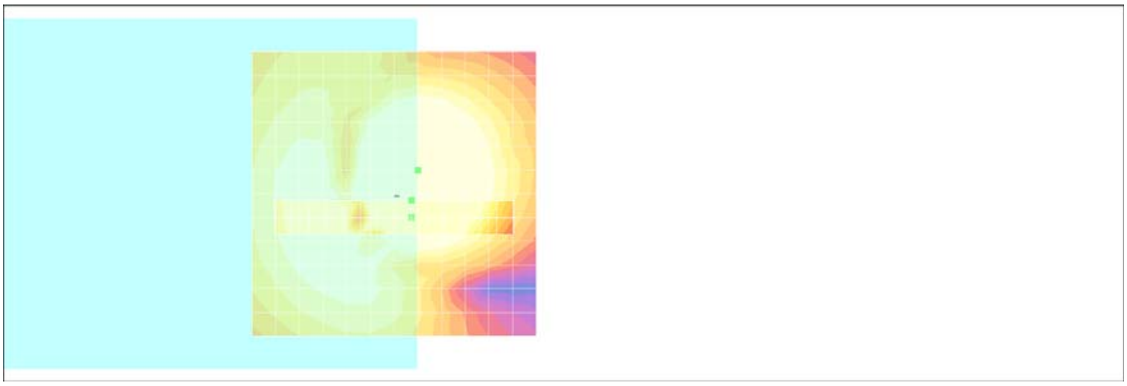
#11 T-Coil_WCDMA IV_Voice_Ch1413_Radial 1 (X)

DUT: 172303

Communication System: WCDMA; Frequency: 1732.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.1 dB
ABM1 comp = 11.1 dB A/m
Location: -3, 4.2, 3.7 mm



0 dB = 1.00A/m

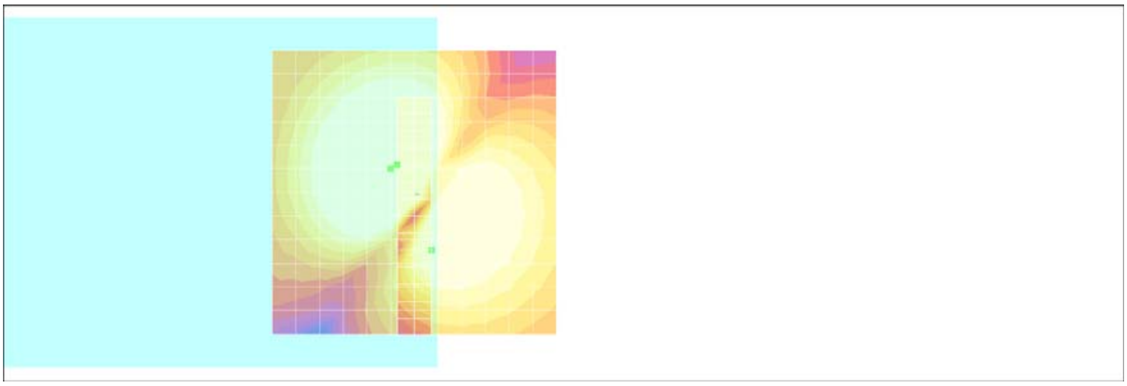
#11 T-Coil_WCDMA IV_Voice_Ch1413_Radial 2 (Y)

DUT: 172303

Communication System: WCDMA; Frequency: 1732.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 30.0 dB
ABM1 comp = 2.19 dB A/m
Location: -3, 10.2, 3.7 mm



0 dB = 1.00A/m

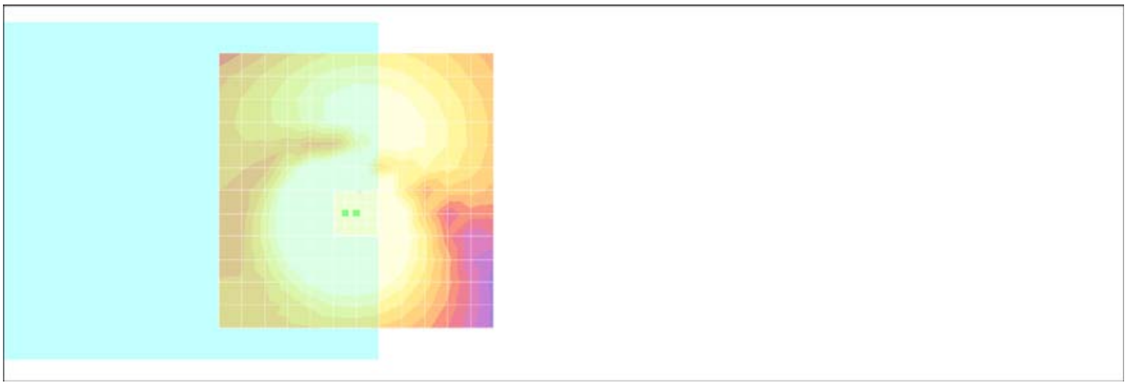
#12 T-Coil_WCDMA IV_Voice_Ch1513_Axial (Z)

DUT: 172303

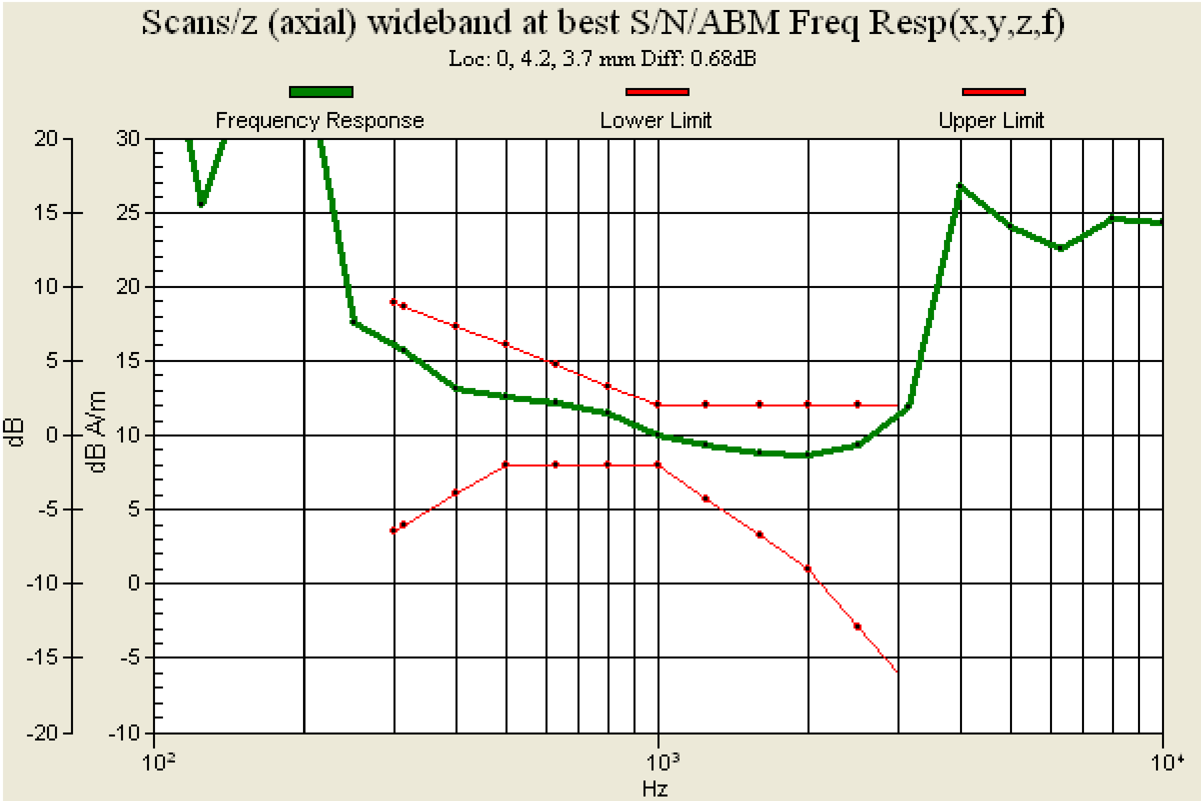
Communication System: WCDMA; Frequency: 1752.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/z (axial) fine 2mm 8 x 8/ABM SNR(x,y,z) (5x5x1):
ABM1/ABM2 = 30.7 dB
ABM1 comp = 13.5 dB A/m
Location: 0, 4.2, 3.7 mm



0 dB = 1.00A/m



Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: 0, 4.2, 3.7 mm Diff: 0.68dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

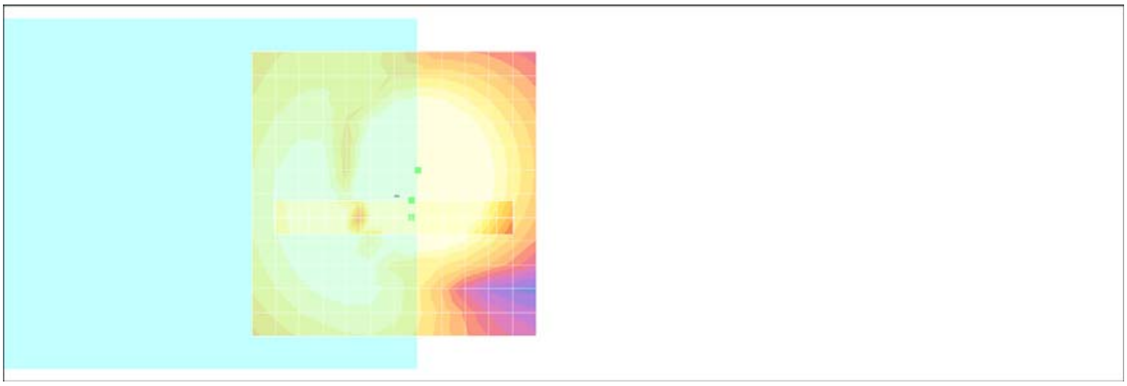
#12 T-Coil_WCDMA IV_Voice_Ch1513_Radial 1 (X)

DUT: 172303

Communication System: WCDMA; Frequency: 1752.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/x (longitudinal) fine 3mm 42 x 6/ABM SNR(x,y,z) (15x3x1):
ABM1/ABM2 = 30.8 dB
ABM1 comp = 11.1 dB A/m
Location: -3, 4.2, 3.7 mm



0 dB = 1.00A/m

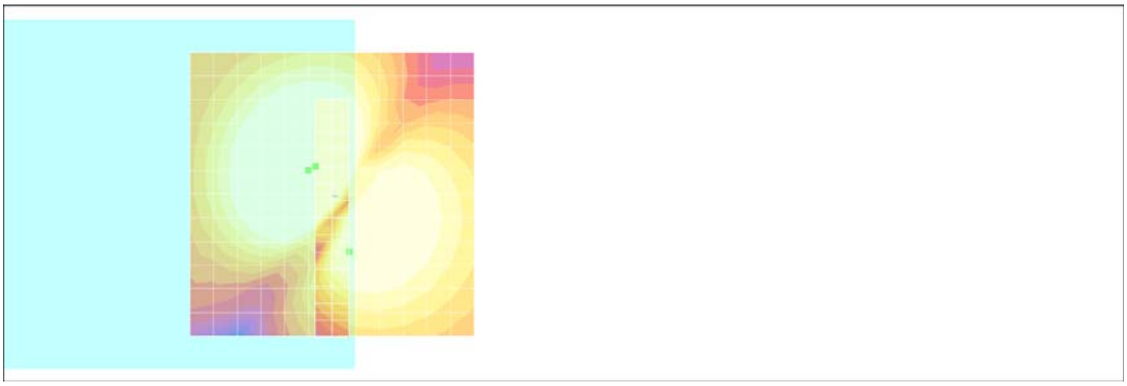
#12 T-Coil_WCDMA IV_Voice_Ch1513_Radial 2 (Y)

DUT: 172303

Communication System: WCDMA; Frequency: 1752.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.5 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2011/1/18
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Scans/y (transversal) fine 3mm 6 x 42/ABM SNR(x,y,z) (3x15x1):
ABM1/ABM2 = 30.7 dB
ABM1 comp = 2.05 dB A/m
Location: -3, 10.2, 3.7 mm



0 dB = 1.00A/m

Appendix B. Calibration Data

The DASY calibration certificates are shown as follows.

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 108**

Client **Sporton-TW (Auden)**

Certificate No: **AM1DV2- 1038_Jan11**

CALIBRATION CERTIFICATE

Object	AM1DV2 - SN: 1038
Calibration procedure(s)	QA CAL-24.v2 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range
Calibration date:	January 18, 2011

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	28-Sep-10 (No:10376)	Sep-11
Reference Probe AM1DV2	SN: 1008	18-Jan-11 (No. AM1D-1008_Jan11)	Jan-12
DAE4	SN: 781	20-Oct-10 (No. DAE4-781_Oct10)	Oct-11

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	1050	15-Oct-09 (in house check Oct-09)	Oct-11

	Name	Function	Signature
Calibrated by:	Mike Meili	Laboratory Technician	M Meili
Approved by:	Fin Bomholt	R&D Director	F. Bomholt

Issued: January 19, 2011

References

[1] ANSI C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
[2] DASY4 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]. 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] 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 [2], 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	**AM1DV2** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Serial No	**1038**

Overall length	296 mm
Tip diameter	6.0 mm (at the tip)
Sensor offset	3.0 mm (centre of sensor from tip)
Internal Amplifier	40 dB

Manufacturer / Origin	Schmid & Partner Engineering AG, Zurich, Switzerland
Manufacturing date	Sep-2006
Last calibration date	January 21, 2010

Calibration data

Connector rotation angle	(in DASY system)	**39.1** °	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**2.83** °	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.0664 V / (A/m)**	+/- 2.2 % (k=2)

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 108

Client **Amphenol CN (Auden)**

Certificate No: DAE3-495_Apr11

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AD - SN: 495
Calibration procedure(s)	QA CAL-06.v22 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	April 28, 2011

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	28-Sep-10 (No:10376)	Sep-11
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Calibrator Box V1.1	SE UMS 006 AB 1004	07-Jun-10 (in house check)	In house check: Jun-11

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	R&D Director	i.V.

Issued: April 28, 2011

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 = $6.1\mu V$, 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	404.324 ± 0.1% (k=2)	405.291 ± 0.1% (k=2)	405.622 ± 0.1% (k=2)
Low Range	3.95043 ± 0.7% (k=2)	3.97613 ± 0.7% (k=2)	3.95159 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	227.5 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199993.1	-2.74	-0.00
Channel X	+ Input	20001.66	1.46	0.01
Channel X	- Input	-19994.94	5.16	-0.03
Channel Y	+ Input	200006.0	1.16	0.00
Channel Y	+ Input	20002.16	1.86	0.01
Channel Y	- Input	-19997.98	2.02	-0.01
Channel Z	+ Input	200005.6	1.57	0.00
Channel Z	+ Input	20003.05	3.05	0.02
Channel Z	- Input	-19998.31	1.59	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.3	0.26	0.01
Channel X	+ Input	199.66	-0.24	-0.12
Channel X	- Input	-200.28	-0.38	0.19
Channel Y	+ Input	2001.0	1.06	0.05
Channel Y	+ Input	200.75	0.85	0.42
Channel Y	- Input	-202.12	-2.12	1.06
Channel Z	+ Input	1999.0	-1.13	-0.06
Channel Z	+ Input	198.35	-1.65	-0.82
Channel Z	- Input	-200.94	-1.04	0.52

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	2.91	1.12
	- 200	0.15	-1.40
Channel Y	200	-0.69	-0.74
	- 200	-0.12	-0.47
Channel Z	200	2.83	2.71
	- 200	-4.22	-4.44

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	-	2.33	0.36
Channel Y	200	2.17	-	4.08
Channel Z	200	3.22	-0.54	-

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	15791	16416
Channel Y	15742	16582
Channel Z	15883	16533

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	-1.87	-3.03	-0.77	0.45
Channel Y	-1.74	-2.98	-0.06	0.56
Channel Z	-1.44	-2.79	-0.14	0.61

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