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

| | |
|---|---|
| APPLICANT | : Sony Mobile Communications AB |
| EQUIPMENT | : Smart phone |
| BRAND NAME | : Sony |
| MODEL NAME | : PM-0261-BV |
| MARKETING NAME | : C1604 |
| FCC ID | : PY7PM-0261 |
| STANDARD | : FCC 47 CFR §20.19<br>ANSI C63.19-2007 |
| T CATEGORY | : T3 |

**The product sample completely tested on Oct. 04, 2012. 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

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

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# Revision History

| REPORT NO. | VERSION | DESCRIPTION | ISSUED DATE |
|---|---|---|---|
| HA290405B | Rev. 01 | Initial issue of report | Nov. 09, 2012 |
| HA290405B | Rev. 02 | Remove Battery picture | Nov. 26, 2012 |
| HA290405B | Rev. 03 | Add WLAN and BT functionality and Revise rule of KDB 285076 | Nov. 30, 2012 |
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# 1. Statement of Compliance

The Hearing Aid Compliance (HAC) maximum results found during testing for the **Sony Mobile Communications AB Smart phone Sony PM-0261-BV C1604** 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** | **24.89** | **T3** |
| **GSM1900** | **21.32** | **T3** |
| **WCDMA V** | **28.7** | **T3** |
| **WCDMA II** | **28.33** | **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,<br>Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.<br>TEL: +886-3-327-3456<br>FAX: +886-3-328-4978 |
| **Test Site No.** | **Sporton Site No. :**<br>SAR01-HY |

## 2.2 Applicant

| | |
|---|---|
| **Company Name** | Sony Mobile Communications AB |
| **Address** | Nya Vattentornet, 22188 Lund, Sweden |

## 2.3 Manufacturer

| | |
|---|---|
| **Company Name** | Arima Communications Corp. |
| **Address** | 6F., No. 866, Jhongjheng Rd., Jhonghe Dist., New Taipei City 23586, Taiwan |

## 2.4 Application Details

| | |
|---|---|
| **Date of Start during the Test** | Oct. 04, 2012 |
| **Date of End during the Test** | Oct. 04, 2012 |

# 3. General Information

## 3.1 Description of Equipment Under Test (EUT)

| Product Feature & Specification | |
|---|---|
| **EUT Type** | Smart phone |
| **Brand Name** | Sony |
| **Model Name / Marketing Name** | PM-0261-BV |
| **FCC ID** | PY7PM-0261 |
| **EUT Serial No** | WUJ012D9FC |
| **IMEI Code** | 004402146213651 |
| **Tx Frequency** | GSM850 : 824.2 MHz ~ 848.8 MHz<br>GSM1900 : 1850.2 MHz ~ 1909.8 MHz<br>WCDMA Band V : 826.4 MHz ~ 846.6 MHz<br>WCDMA Band II : 1852.4 MHz ~ 1907.6 MHz<br>WLAN2.4G: 2412 MHz ~ 2462 MHz<br>Bluetooth : 2402 MHz ~ 2480 MHz |
| **Rx Frequency** | GSM850 : 869.2 MHz ~ 893.8 MHz<br>GSM1900 : 1930.2 MHz ~ 1989.8 MHz<br>WCDMA Band V : 869.2 MHz ~ 893.8 MHz<br>WCDMA Band II : 1932.4 MHz ~ 1987.6 MHz<br>WLAN2.4G: 2412 MHz ~ 2462 MHz<br>Bluetooth : 2402 MHz ~ 2480 MHz |
| **Measure Maximum Average Output Power to Antenna** | GSM850 : 33.82 dBm<br>GSM1900 : 30.90 dBm<br>WCDMA Band V : 24.85 dBm<br>WCDMA Band II : 23.38 dBm<br>802.11b : 15.59 dBm<br>802.11g : 15.10 dBm<br>802.11n-HT20 (2.4GHz) : 12.71 dBm<br>Bluetooth: 5.65 dBm |
| **Antenna Type** | WWAN: PIFA Antenna<br>WLAN: PIFA Antenna<br>Bluetooth: PIFA Antenna |
| **HW Version** | SP |
| **SW Version** | 11.1.A.0.21 |
| **Type of Modulation** | GSM : GMSK<br>WCDMA : QPSK (Uplink)<br>802.11b : DSSS (BPSK / QPSK / CCK)<br>802.11g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM)<br>Bluetooth : GFSK<br>Bluetooth EDR : π/4-DQPSK, 8-DPSK |
| **EUT Stage** | Production Unit |

**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 | WLAN, BT | No |
| WCDMA | 850, 1900 | Voice | Yes | WLAN, BT | No |
| WLAN | 2450 | Data (*) | No | GSM, WCDMA | No |
| BT | 2450 | Data (*) | No | GSM, WCDMA, | No |

**Note:**

1. (*): The voice function maybe be activated via 3rd party software application.
2. Per KDB 285076 D01 v03)10)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 EUT 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 (EOC) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows 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 0.06556 V/(A/m) (-23.66 dBV/(A/m)) was calibrated by AMCC coil for verification of setup performance. The evaluated probe sensitivity was able to be compared to the calibration of the AM1D probe. The frequency response and sensitivity was shown in Fig. 5.2. 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.

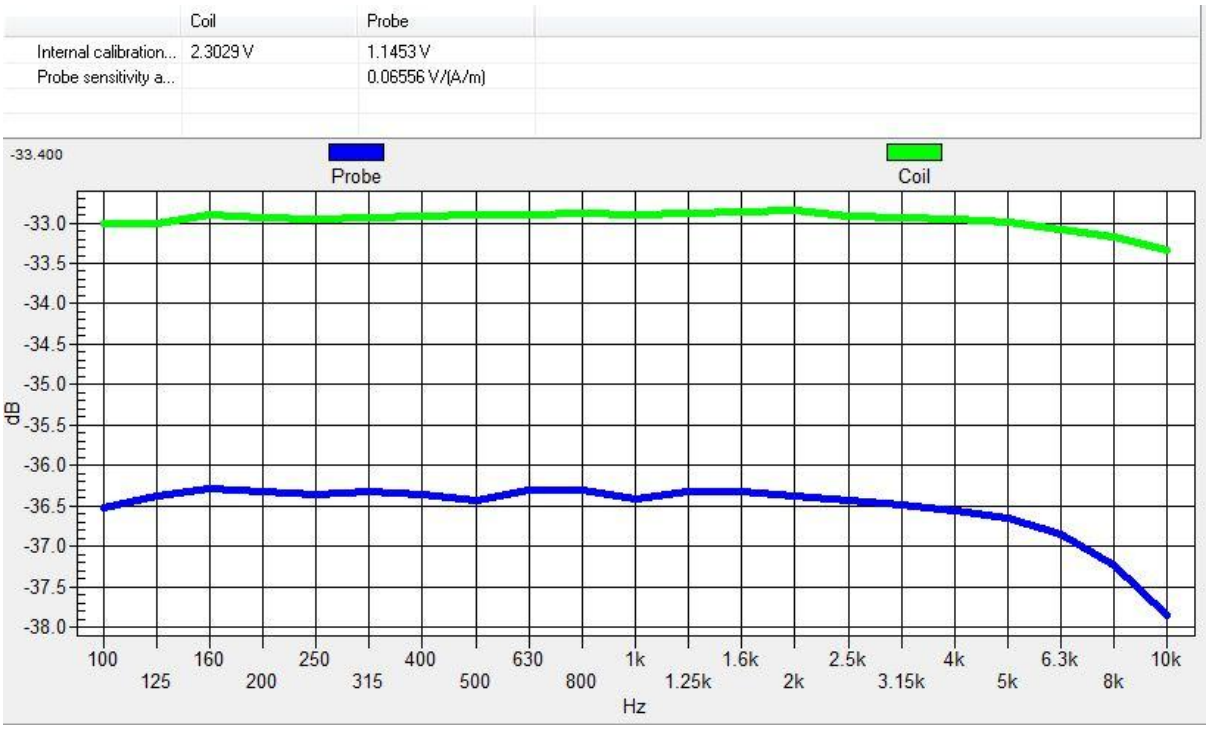



**Fig. 5.2 The frequency response and sensitivity of AM1D probe**

## 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. 5.3 AMMI front panel**

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

**Specification:**

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

## 5.5 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. 5.4 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

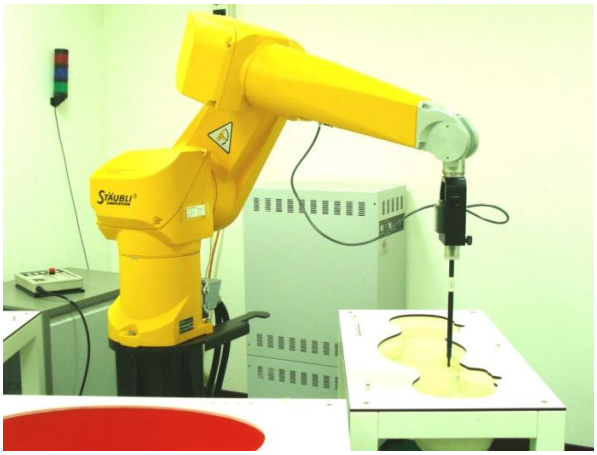


**Fig. 5.5 Photo of DASY4**

**Fig. 5.6 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. 5.7 Photo of Server for DASY4**

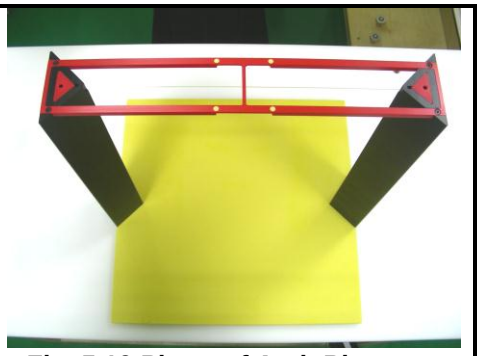
**Fig. 5.8 Photo of Server for DASY5**

## 5.8 Phone Positioner

The phone positioner shown in Fig. 5.9 is used to adjust EUT to the suitable position.

**Fig. 5.9 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. 5.10 Photo of Arch Phantom** |

## 5.10 Cabling of System

The principal cabling of the T-Coil setup is shown in Fig. 5.11. All cables provided with the basic setup have a length of approximately 5 m.

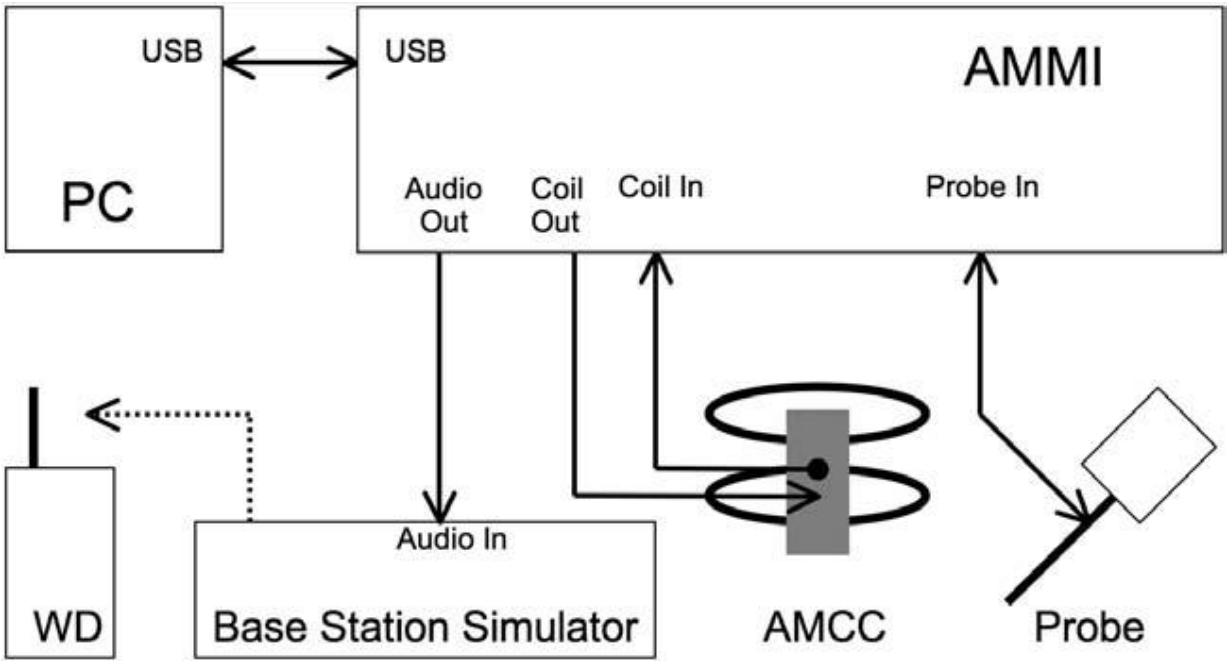



**Fig. 5.11 T-Coil setup cabling**

## 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. 23, 2012 | Jan. 22, 2013 |
| SPEAG | Audio Magnetic Calibration Coil | AMCC | 1049 | NCR | NCR |
| SPEAG | Audio Measuring Instrument | AMMI | 1041 | NCR | NCR |
| SPEAG | Data Acquisition Electronics | DAE4 | 1279 | May 03, 2012 | May 02, 2013 |
| Wisewind | Thermometer | ETP-101 | N/A | Nov. 16, 2011 | Nov. 15, 2012 |
| SPEAG | Test Arch Phantom | N/A | N/A | NCR | NCR |
| SPEAG | Phone Positoiner | N/A | N/A | NCR | NCR |
| Agilent | Network Analyzer | E5071C | MY46101588 | May 11, 2012 | May 10, 2013 |
| Agilent | ESG Vector Series Signal Generator | E4438C | MY49070755 | Oct. 02, 2012 | Oct. 01, 2013 |
| Anritsu | Radio Communication Analyzer | MT8820C | 6201074414 | Dec. 21, 2011 | Dec. 20, 2012 |
| Agilent | Wireless Communication Test Set | E5515C | MY48360820 | Jan. 05, 2012 | Jan. 04, 2014 |
| R&S | Universal Digital Radio communication Tester | CMU200 | 106656 | Jun. 28, 2012 | Jun. 27, 2013 |

**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. 5.12 and Fig. 5.13. For this, the delay of the window shall be set to a multiple of the signal period and at least 2s. From the measurement on the device, using the same signal, the postprocessor deducts the input spectrum, so the result represents the net EUT response.

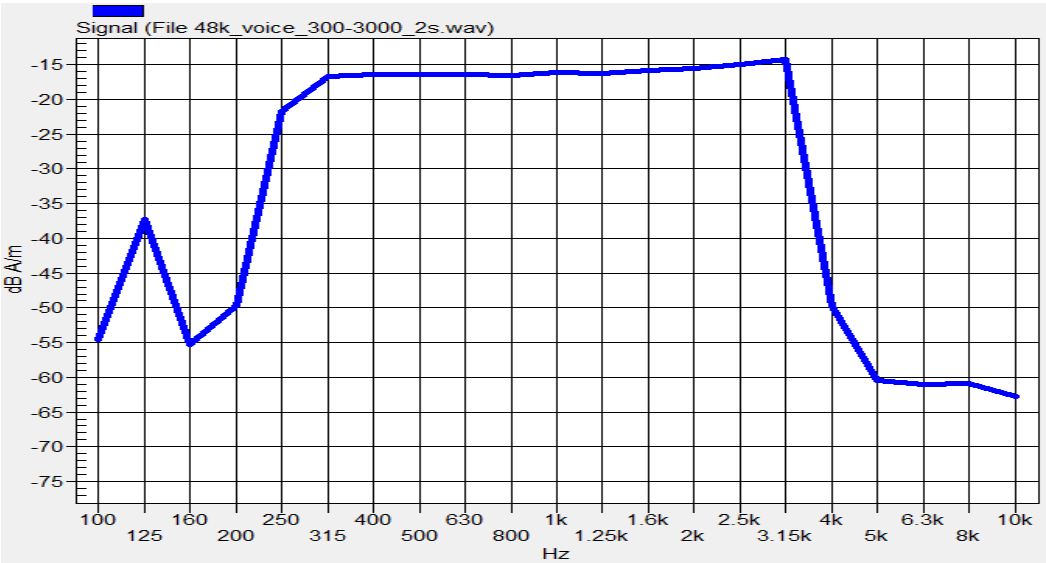



**Fig. 5.12 Audio signal spectrum of the broadband signal (48kHz_voice_300Hz~3 kHz)**

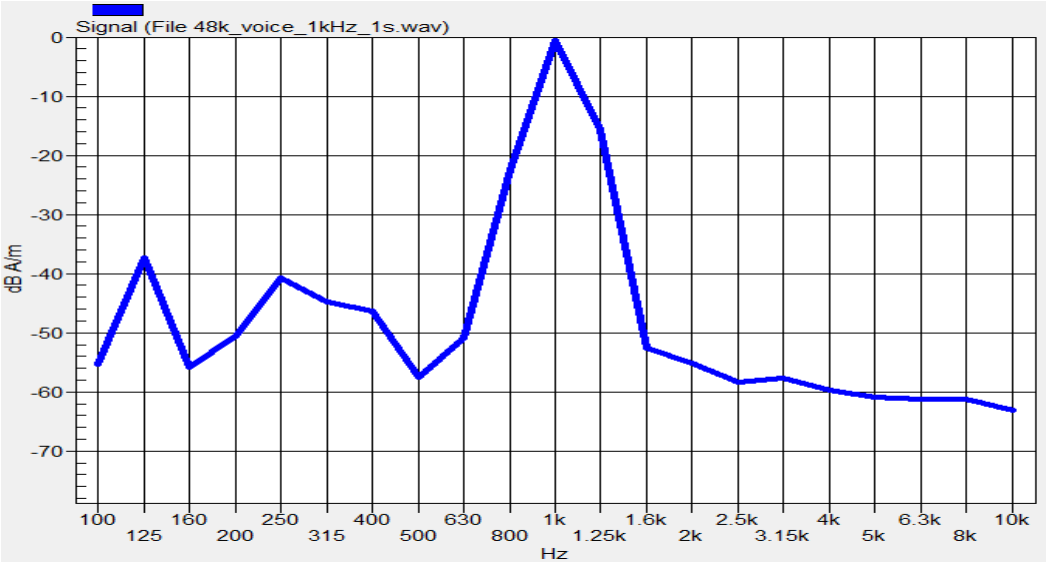



**Fig. 5.13 Audio signal spectrum of the narrowband signal (48kHz_voice_1kHz)**

## 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 = -2.78 dBV
-16 dBm0 = -21.92 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 = -20.18 dBV
Difference for -16 dBm0 = -21.92 - (-20.18) = -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 | 35.44 |
| 300Hz ~ 3kHz | 2 | 21.6 | -18.6 | 8.48 | 69.41 |

# 6. Description for EUT Testing Position

Fig.6.1 illustrate the references and reference plane that shall be used in a typical EUT emissions measurement. The principle of this section is applied to EUT with similar geometry. Please refer to Appendix 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 EUT.
- The area is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the EUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 10 mm in front of, the reference plane.

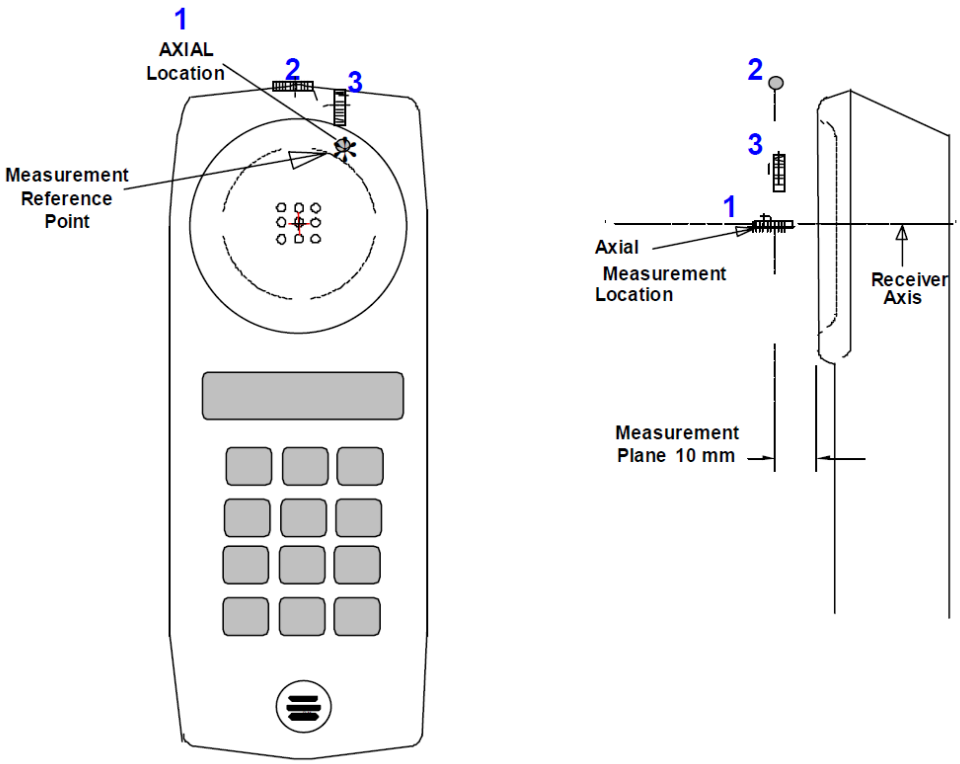



**Fig 6.1 A typical EUT reference and plane for T-Coil measurements**

# 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 EUT was positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
5. The EUT 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 EUT audio output was positioned tangent (as physically possible) to the measurement plane.
6. The EUT'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 EUT 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 EUT 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 Conducted Power (Unit: dBm)

| Band | GSM850 | | | GSM1900 | | |
|---|---|---|---|---|---|---|
| Channel | 128 | 189 | 251 | 512 | 661 | 810 |
| Frequency (MHz) | 824.2 | 836.4 | 848.8 | 1850.2 | 1880.0 | 1909.8 |
| GSM | 33.82 | 33.75 | 33.60 | 30.90 | 30.75 | 30.63 |

| Band | WCDMA Band V | | | WCDMA Band II | | |
|---|---|---|---|---|---|---|
| Channel | 4132 | 4182 | 4233 | 9262 | 9400 | 9538 |
| Frequency (MHz) | 826.4 | 836.4 | 846.6 | 1852.4 | 1880.0 | 1907.6 |
| RMC 12.2K | 24.85 | 24.60 | 24.72 | 23.35 | 23.38 | 23.20 |

## 9.2 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. | Plot No. | Band | Channel | Probe Position | Ambient Noise (dB A/m) | Signal ABM1 (dB A/m) | Signal to Noise | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ABM1 (dB A/m) | ABM2 (dB A/m) | SNR (dB) | T Rating |
| 1 | GSM850 | Voice | 128 | Axial (Z) | -56.78 | 7.69 | 4.64 | 27.74 | 32.38 | T4 |
| | | | | Radial 1 (X) | -51.02 | 5.80 | -9.81 | 35.53 | 25.72 | T3 |
| | | | | Radial 2 (Y) | -41.16 | -0.37 | -4.57 | 33.56 | 28.99 | T3 |
| 2 | GSM850 | Voice | 189 | Axial (Z) | -52.82 | 7.85 | 5.00 | 27.48 | 32.48 | T4 |
| | | | | Radial 1 (X) | -51.02 | 5.89 | -10.83 | 36.65 | 25.82 | T3 |
| | | | | Radial 2 (Y) | -41.18 | 5.86 | 1.67 | 27.58 | 29.25 | T3 |
| **3** | **GSM850** | **Voice** | **251** | Axial (Z) | -56 | 7.58 | 4.51 | 27.68 | 32.19 | T4 |
| | | | | **Radial 1 (X)** | **-51.25** | **5.73** | **-12.88** | **37.77** | **24.89** | **T3** |
| | | | | Radial 2 (Y) | -41.04 | -0.67 | -5.16 | 34.05 | 28.89 | T3 |
| **4** | **GSM1900** | **Voice** | **512** | Axial (Z) | -51.46 | 7.28 | 7.28 | 23.54 | 30.82 | T4 |
| | | | | **Radial 1 (X)** | **-50.78** | **-0.56** | **-15.92** | **37.24** | **21.32** | **T3** |
| | | | | Radial 2 (Y) | -38.3 | -6.86 | -9.05 | 34.42 | 25.37 | T3 |
| 5 | GSM1900 | Voice | 661 | Axial (Z) | -58.73 | 5.64 | 2.54 | 28.64 | 31.18 | T4 |
| | | | | Radial 1 (X) | -50.85 | 3.60 | -11.86 | 37.23 | 25.37 | T3 |
| | | | | Radial 2 (Y) | -47.66 | -2.59 | -6.45 | 35.69 | 29.24 | T3 |
| 6 | GSM1900 | Voice | 810 | Axial (Z) | -57.77 | 7.19 | 4.34 | 28.97 | 33.31 | T4 |
| | | | | Radial 1 (X) | -51.53 | 5.46 | -9.25 | 37.55 | 28.30 | T3 |
| | | | | Radial 2 (Y) | -48.17 | 5.29 | 2.80 | 28.46 | 31.26 | T4 |

| Plot No. | Plot No. | Band | Channel | Probe Position | Ambient Noise (dB A/m) | Signal ABM1 (dB A/m) | Signal to Noise | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ABM1 (dB A/m) | ABM2 (dB A/m) | SNR (dB) | T Rating |
| **7** | **WCDMA V** | **Voice** | **4132** | Axial (Z) | -63.01 | 2.19 | -9.17 | 39.19 | 30.02 | T4 |
| | | | | **Radial 1 (X)** | **-56.11** | **-1.53** | **-3.33** | **32.03** | **28.70** | **T3** |
| | | | | Radial 2 (Y) | -46.78 | -0.97 | -0.97 | 30.36 | 29.39 | T3 |
| 8 | WCDMA V | Voice | 4182 | Axial (Z) | -61.01 | 1.78 | -10.38 | 40.21 | 29.83 | T3 |
| | | | | Radial 1 (X) | -56.98 | -7.82 | -9.85 | 38.68 | 28.83 | T3 |
| | | | | Radial 2 (Y) | -46.55 | -7.30 | -7.30 | 36.57 | 29.27 | T3 |
| 9 | WCDMA V | Voice | 4233 | Axial (Z) | -60.98 | 1.96 | -8.12 | 38.04 | 29.92 | T3 |
| | | | | Radial 1 (X) | -55.19 | -7.81 | -7.82 | 36.65 | 28.83 | T3 |
| | | | | Radial 2 (Y) | -45.37 | -7.29 | -9.31 | 38.52 | 29.21 | T3 |
| **10** | **WCDMA II** | **Voice** | **9262** | Axial (Z) | -63.05 | 1.89 | -0.90 | 30.63 | 29.73 | T3 |
| | | | | **Radial 1 (X)** | **-55.24** | **-1.69** | **-3.57** | **31.90** | **28.33** | **T3** |
| | | | | Radial 2 (Y) | -46.01 | -1.21 | -1.21 | 30.36 | 29.15 | T3 |
| 11 | WCDMA II | Voice | 9400 | Axial (Z) | -63.05 | 1.74 | -0.89 | 30.48 | 29.59 | T3 |
| | | | | Radial 1 (X) | -56.01 | -1.71 | -4.35 | 32.76 | 28.41 | T3 |
| | | | | Radial 2 (Y) | -46.11 | -1.40 | -3.18 | 31.91 | 28.73 | T3 |
| 12 | WCDMA II | Voice | 9538 | Axial (Z) | -62.01 | 8.12 | -4.45 | 34.08 | 29.63 | T3 |
| | | | | Radial 1 (X) | -55.98 | -1.59 | -3.87 | 32.43 | 28.56 | T3 |
| | | | | Radial 2 (Y) | -45.87 | -1.22 | -1.22 | 30.21 | 28.99 | T3 |

**Table 9.1 Test Result for Various Positions**

**Remark:**

1. There is no special HAC mode software on this EUT.
2. The volume was adjusted to maximum level and the backlight turned off during T-Coil testing.
3. Test Engineer：Aaron Chen

## 9.3 Frequency Response Plots

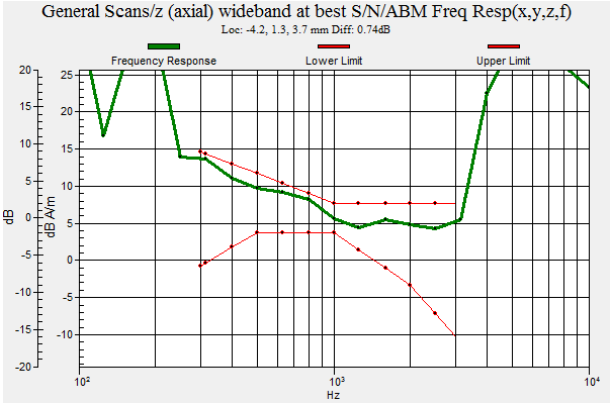



Fig 9.1 GSM850 Ch128

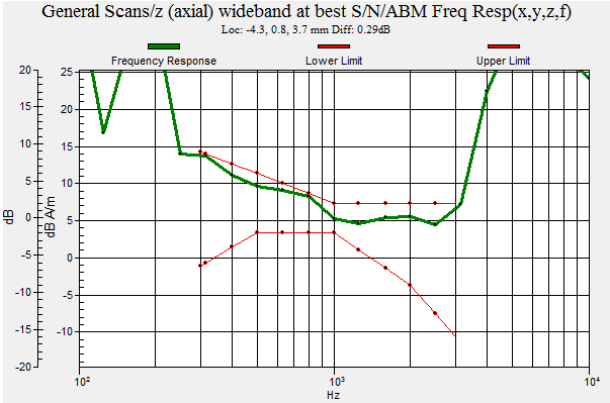



Fig 9.2 GSM850 Ch189

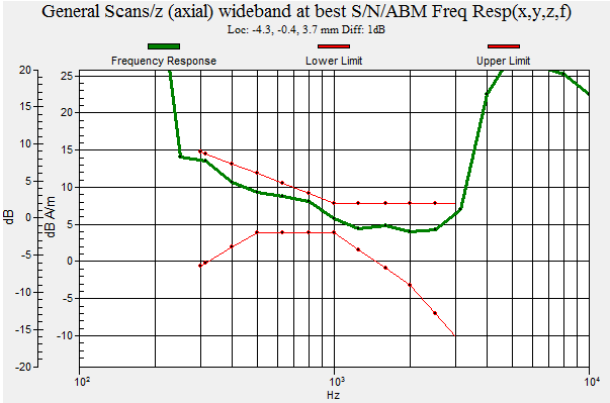



Fig 9.3 GSM850 Ch251

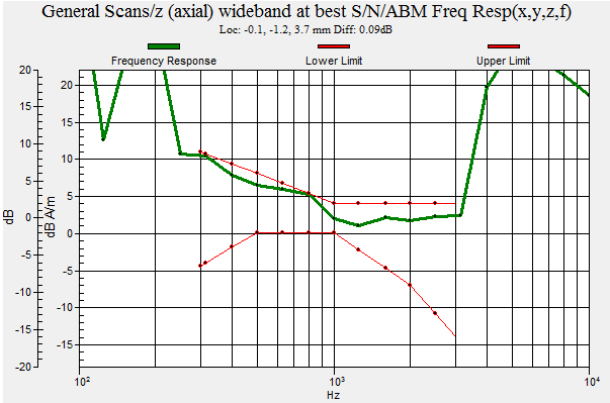



Fig 9.4 GSM1900 Ch512

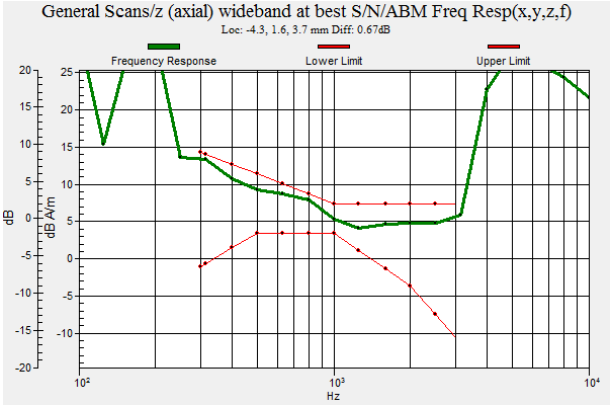



Fig 9.5 GSM1900 Ch661

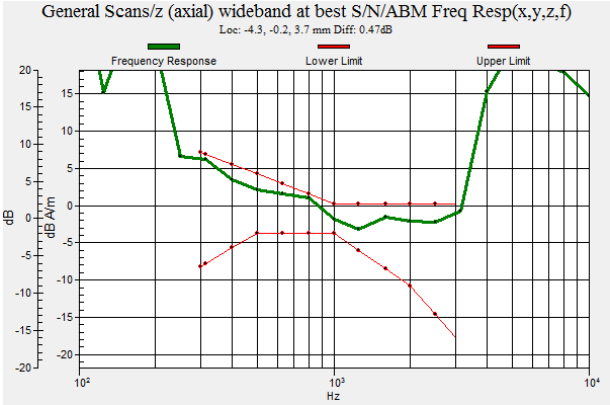



Fig 9.6 GSM1900 Ch810

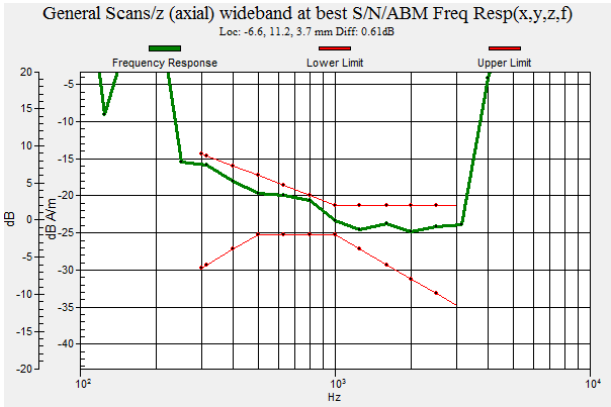



Fig 9.7 WCDMA Band V Ch4132

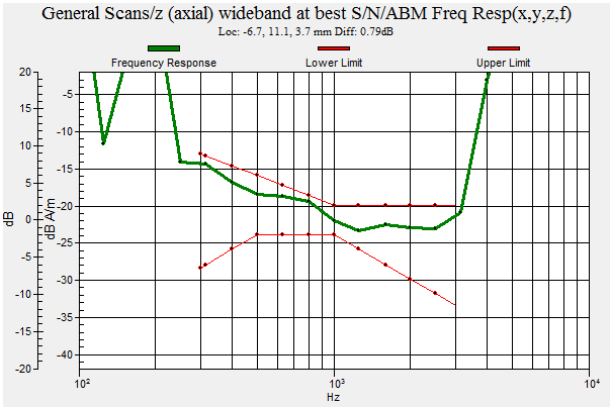



Fig 9.8 WCDMA Band V Ch4182

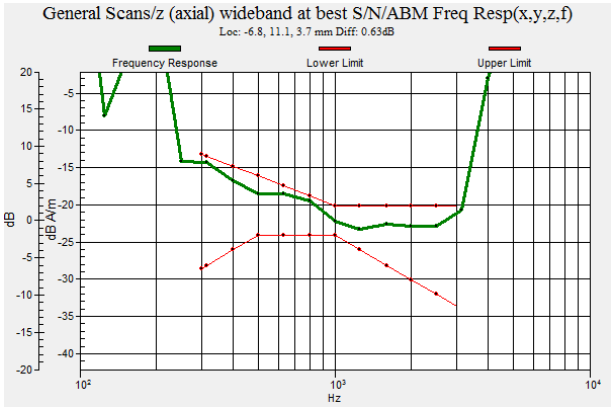



Fig 9.9 WCDMA Band V Ch4233

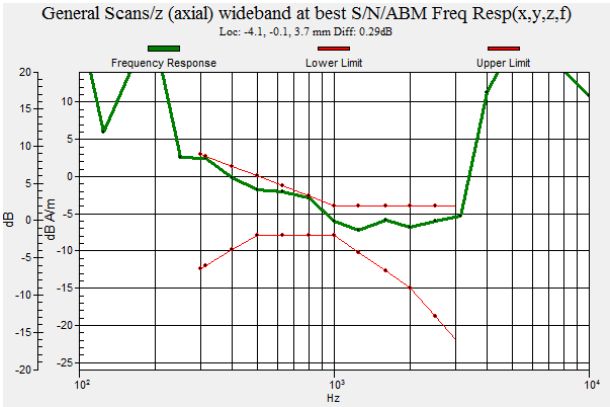



Fig 9.10 WCDMA Band II Ch9262

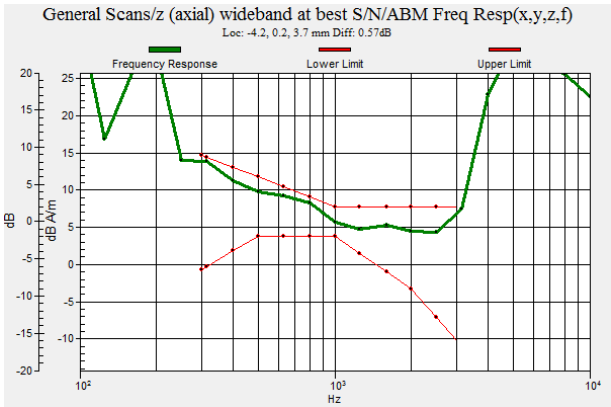



Fig 9.11 WCDMA Band II Ch9400

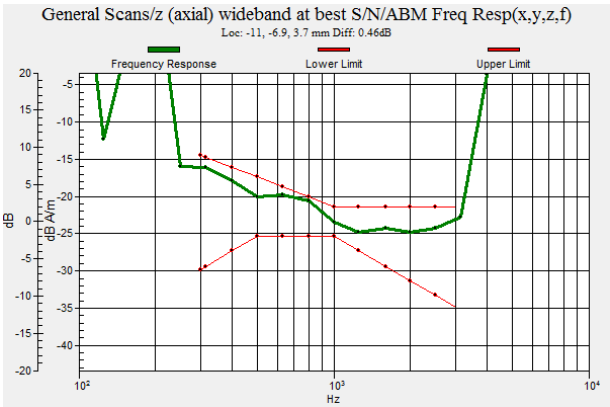



Fig 9.12 WCDMA Band II Ch9538

## 9.4 T-Coil Coupling Field Intensity

### 9.4.1 Axial Field Intensity

| Cell Phone Mode | Minimum limit (dB A/m) | Result (dB A/m) | Verdict |
|---|---|---|---|
| GSM850 | -18 | 4.51 | Pass |
| GSM1900 | -18 | 2.54 | Pass |
| WCDMA V | -18 | -10.38 | Pass |
| WCDMA II | -18 | -4.45 | Pass |

### 9.4.2 Radial Field Intensity

| Cell Phone Mode | Minimum limit (dB A/m) | Result (dB A/m) | Verdict |
|---|---|---|---|
| GSM850 | -18 | -12.88 | Pass |
| GSM1900 | -18 | -15.92 | Pass |
| WCDMA V | -18 | -9.85 | Pass |
| WCDMA II | -18 | -4.35 | Pass |

### 9.4.3 Frequency Response at Axial Measurement Point

| Cell Phone Mode | Verdict |
|---|---|
| GSM850 | Pass |
| GSM1900 | Pass |
| WCDMA V | Pass |
| WCDMA II | Pass |

### 9.4.4 Signal Quality

| Cell Phone Mode | Minimum limit (dB) | | | | Minimum Result (dB) | Verdict |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | | |
| GSM850 | 0 | 10 | 20 | >30 | 24.89 | T3 |
| GSM1900 | 0 | 10 | 20 | >30 | 21.32 | T3 |
| WCDMA V | 0 | 10 | 20 | >30 | 28.7 | T3 |
| WCDMA II | 0 | 10 | 20 | >30 | 28.33 | 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) $\kappa$ 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 % |
| EUT Positioning | 1.9 | Rectangular | √3 | 1 | 1 | ± 1.1 % | ± 1.1 % |
| **External Contributions** | | | | | | | |
| RF Interference | 0.0 | Rectangular | √3 | 1 | 0.3 | ± 0.0 % | ± 0.0 % |
| Test Signal Variation | 2.0 | Rectangular | √3 | 1 | 1 | ± 1.2 % | ± 1.2 % |
| **Combined Standard Uncertainty** | | | | | | ± 4.1 % | ± 6.1 % |
| **Coverage Factor for 95 %** | | | | | | K = 2 | |
| **Expanded Uncertainty** | | | | | | **± 8.1 %** | **± 12.3 %** |

**Table 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: 290405**

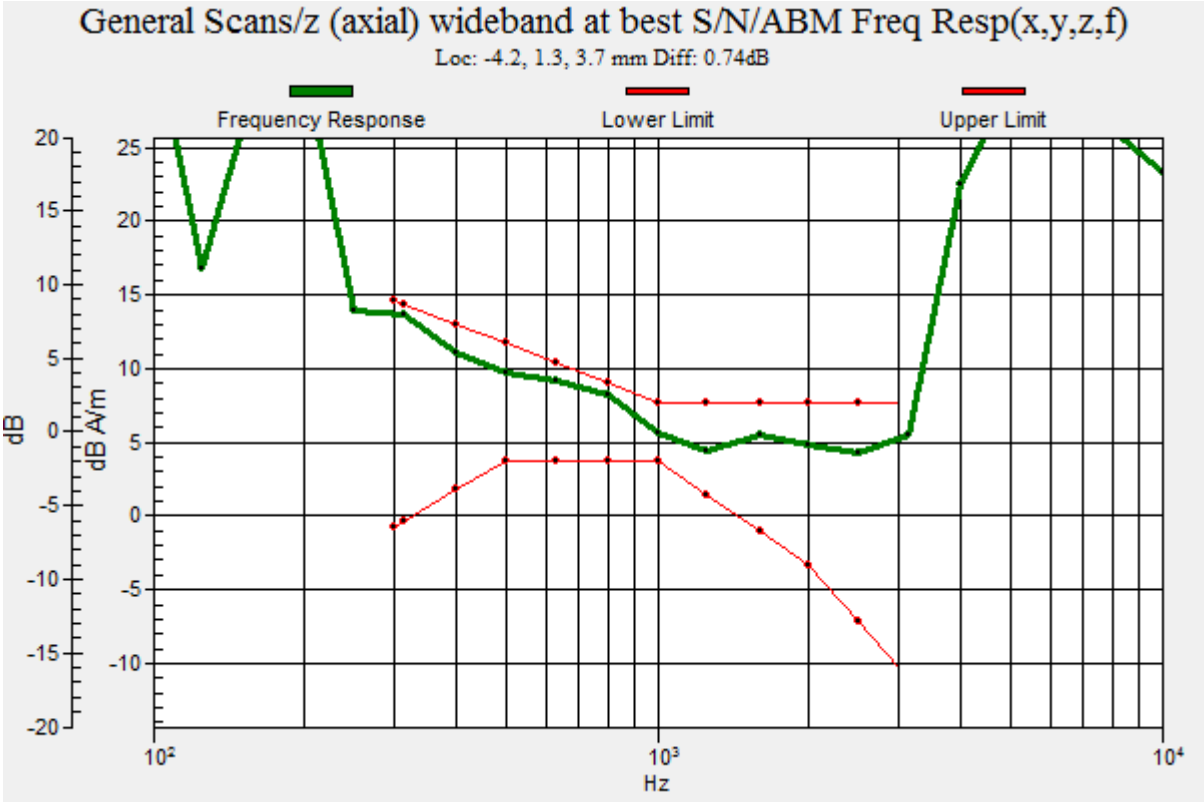
Communication System: GSM850; Frequency: 824.2 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：22.5 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 7.69 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 32.38 dB
ABM1 comp = 4.64 dB A/m
Location: -4.2, 0, 3.7 mm

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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.2, 1.3, 3.7 mm Diff: 0.74dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #01 T-Coil_GSM850_Voice_Ch128_Radial 1 (X)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 5.80 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 25.72 dB
ABM1 comp = -9.81 dB A/m
Location: -25, 4.2, 3.7 mm

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

## #01 T-Coil_GSM850_Voice_Ch128_Radial 2 (Y)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -0.37 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.99 dB
ABM1 comp = -4.57 dB A/m
Location: -4.2, -4.2, 3.7 mm

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

## #02 T-Coil_GSM850_Voice_Ch189_Axial (Z)

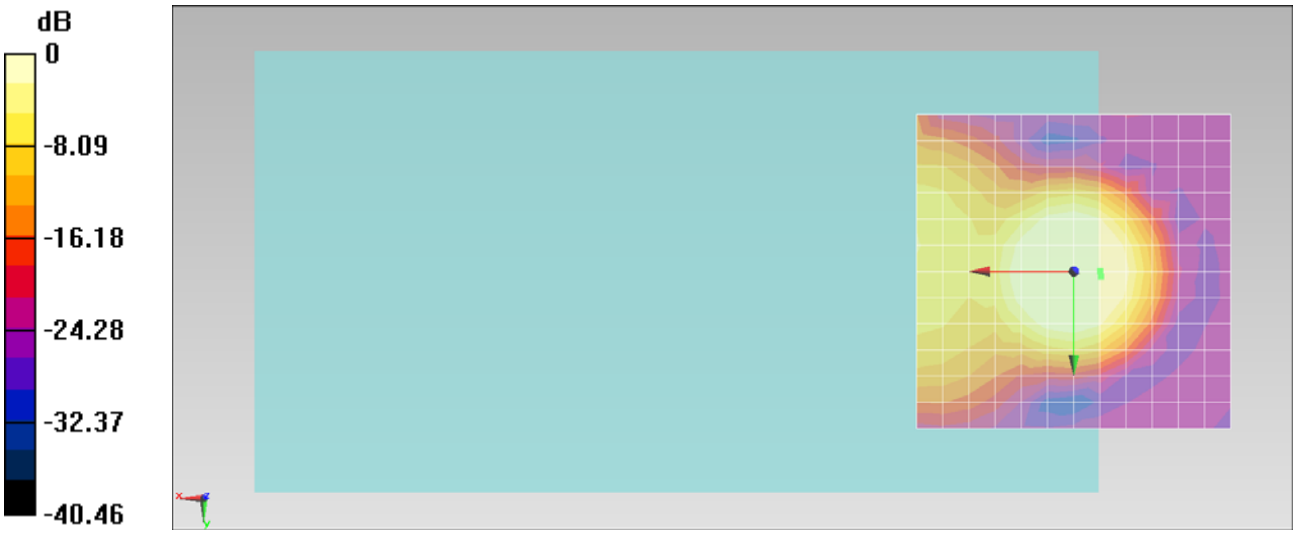
**DUT: 290405**

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 ℃

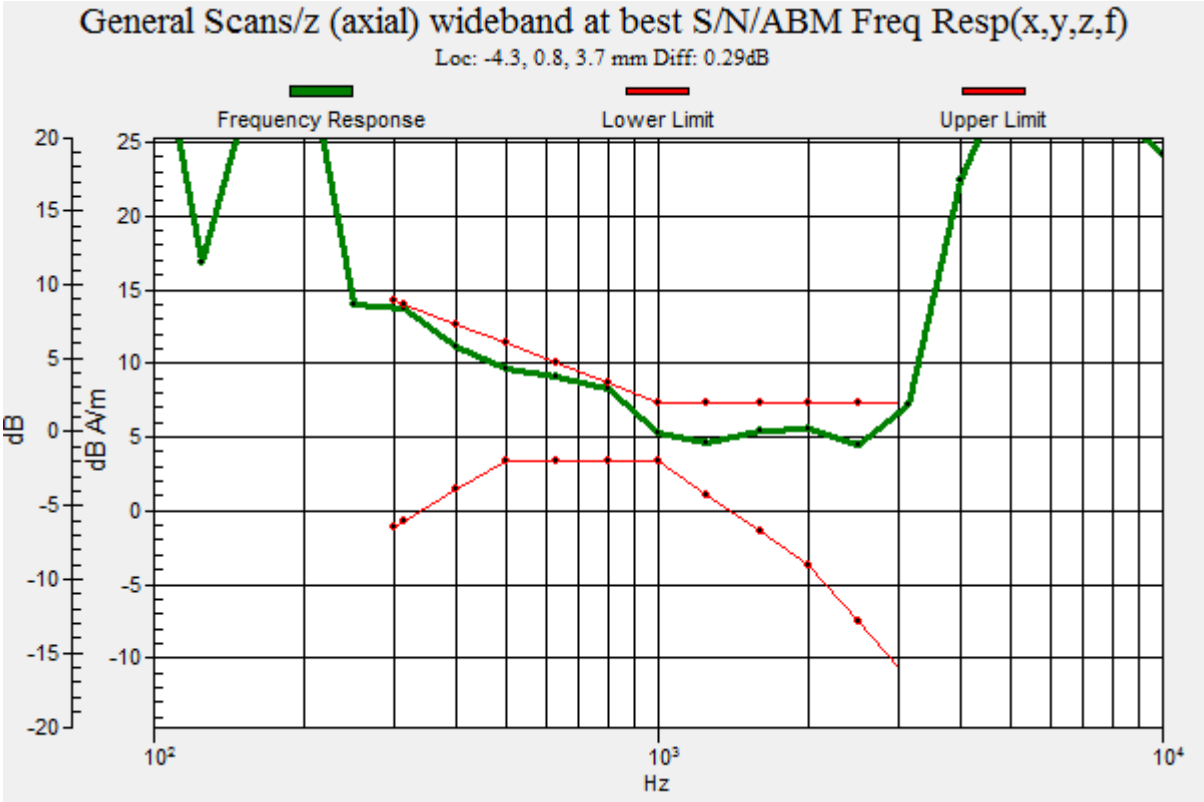
DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

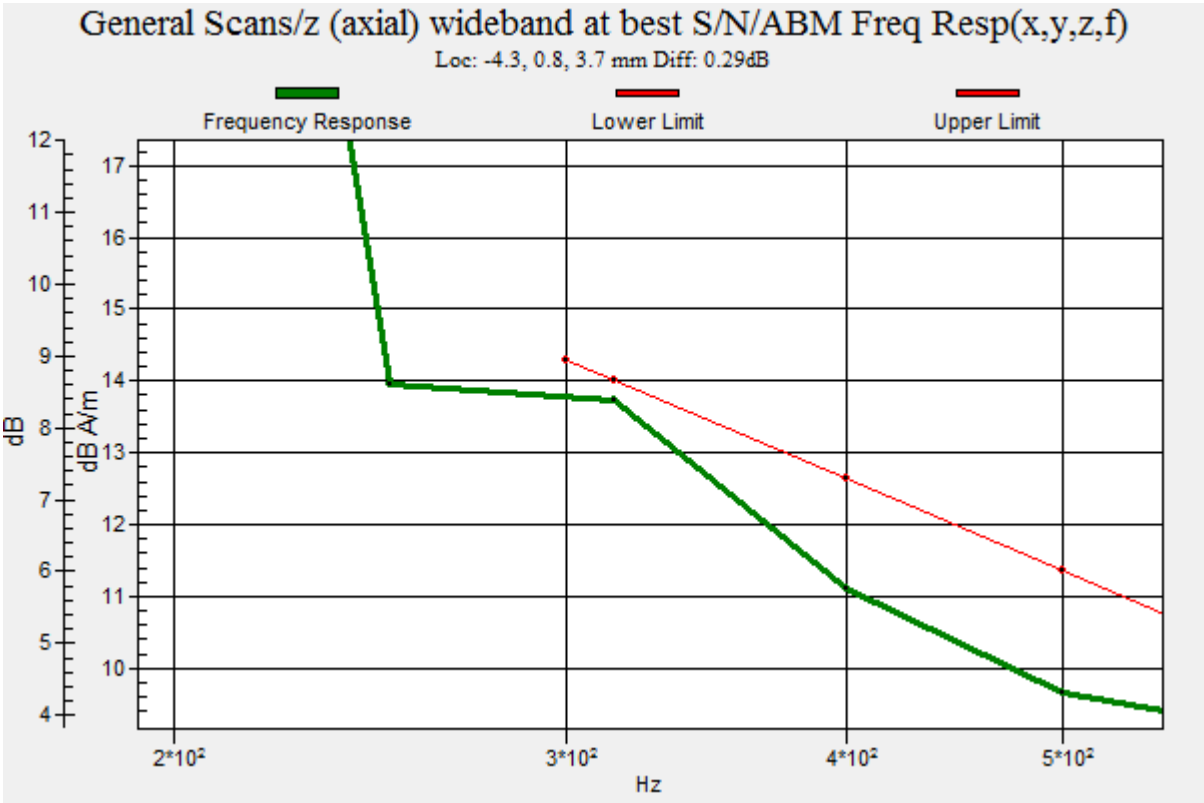
### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 7.85 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 32.48 dB
ABM1 comp = 5.00 dB A/m
Location: -4.2, 0, 3.7 mm




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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.3, 0.8, 3.7 mm Diff: 0.29dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.3, 0.8, 3.7 mm Diff: 0.29dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #02 T-Coil_GSM850_Voice_Ch189_Radial 1 (X)

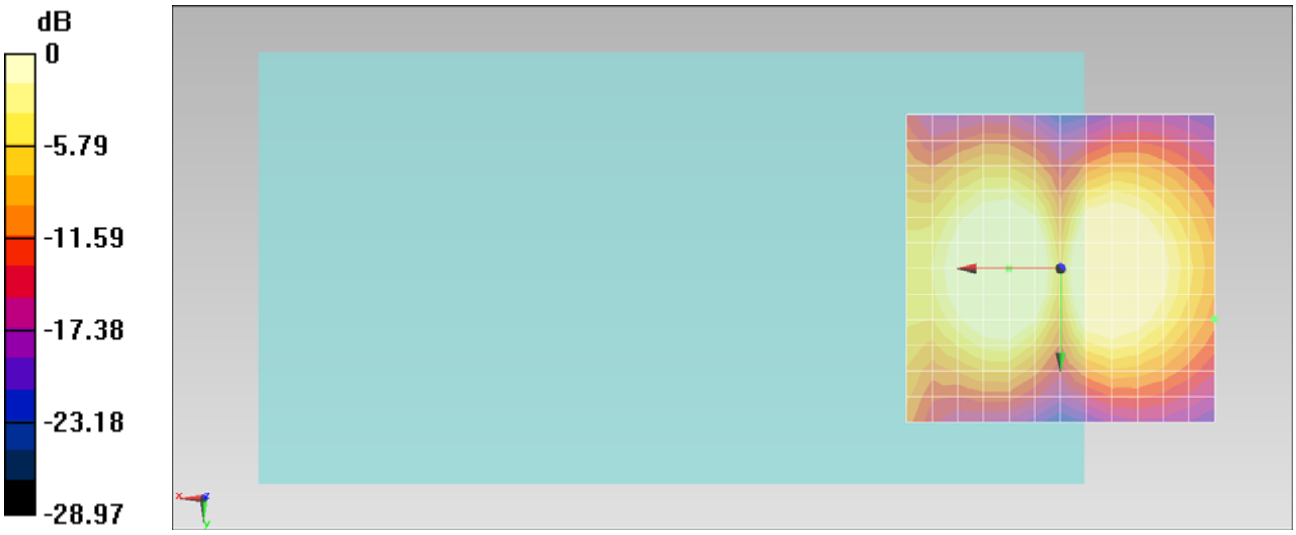
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 5.89 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 25.82 dB
ABM1 comp = -10.83 dB A/m
Location: -25, 8.3, 3.7 mm




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

## #02 T-Coil_GSM850_Voice_Ch189_Radial 2 (Y)

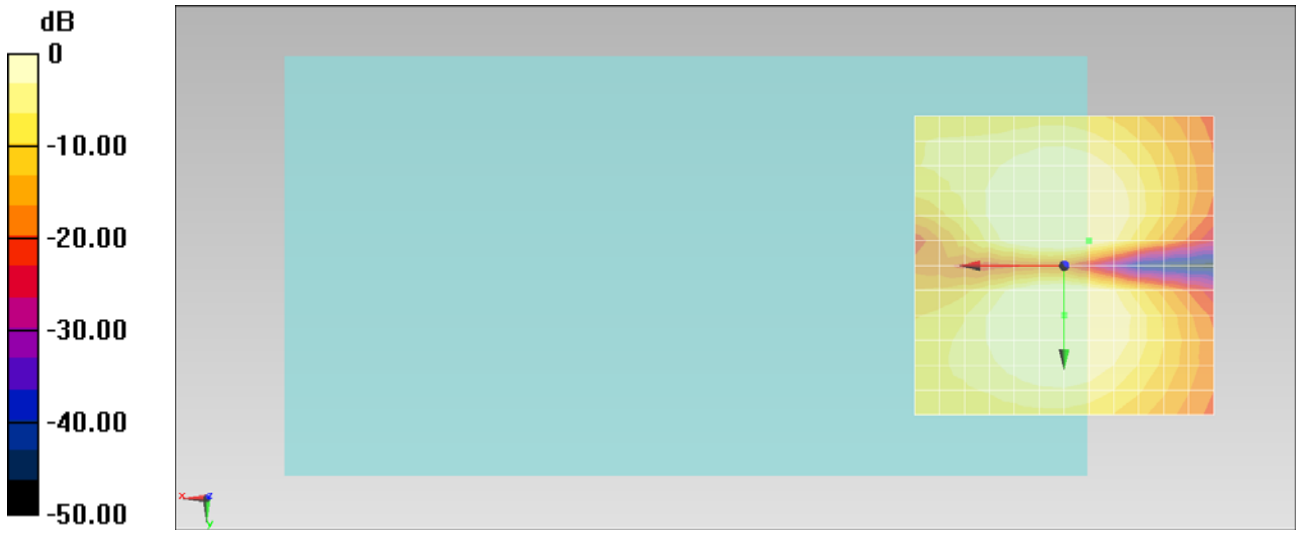
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 5.86 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.25 dB
ABM1 comp = 1.67 dB A/m
Location: -4.2, -4.2, 3.7 mm




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

## #03 T-Coil_GSM850_Voice_Ch251_Axial (Z)

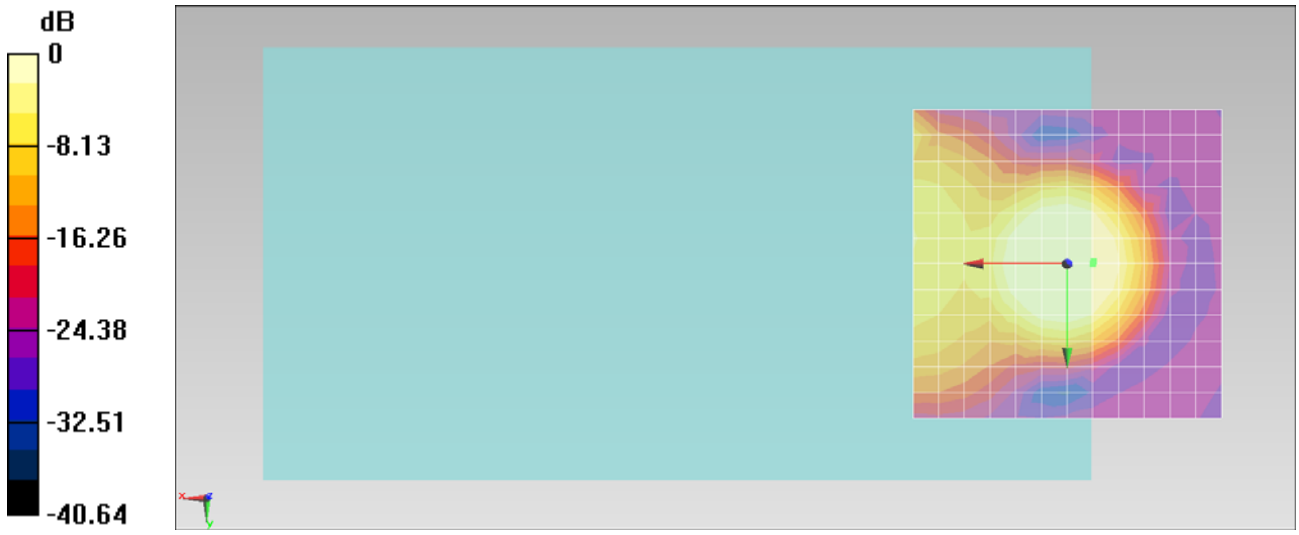
**DUT: 290405**

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 ℃

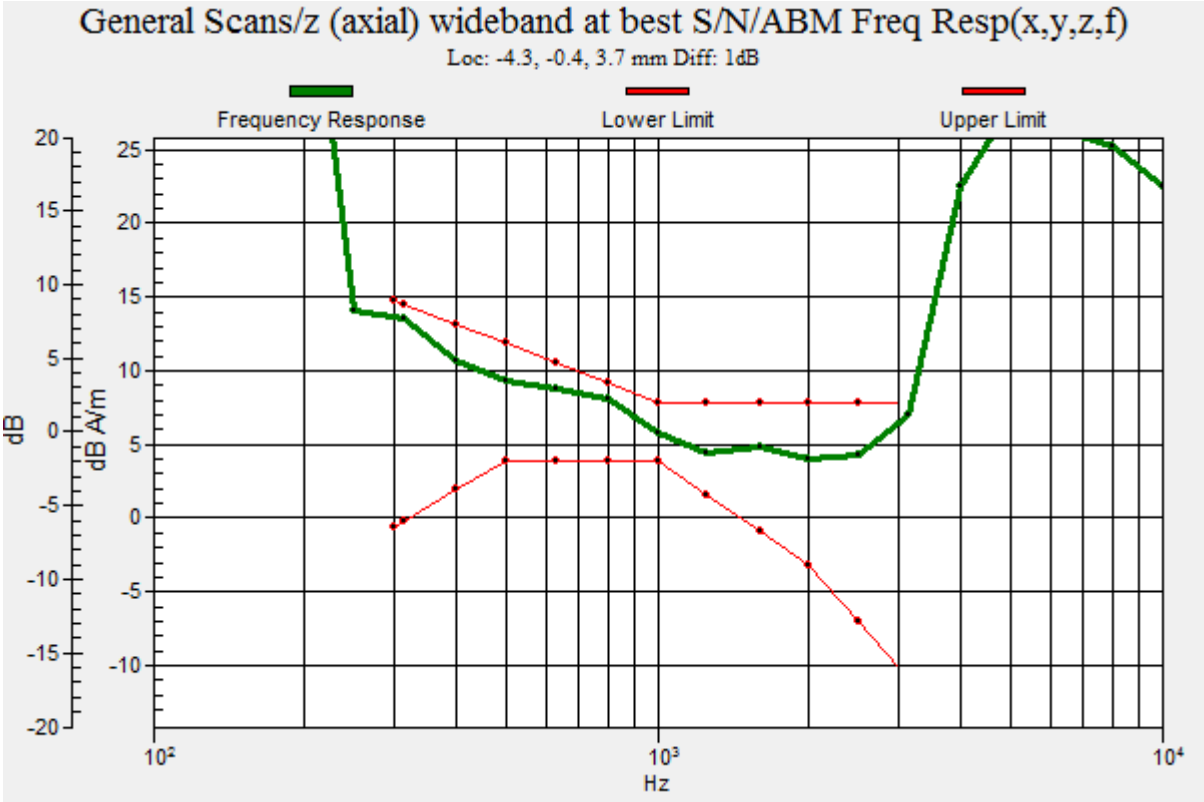
DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 7.58 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 32.19 dB
ABM1 comp = 4.51 dB A/m
Location: -4.2, 0, 3.7 mm




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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.3, -0.4, 3.7 mm Diff: 1dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz
20
15
10
5
0
-5
-10
-15
-20
25
20
15
10
5
0
-5
-10
$10^2$
$10^3$
$10^4$

## #03 T-Coil_GSM850_Voice_Ch251_Radial 1 (X)

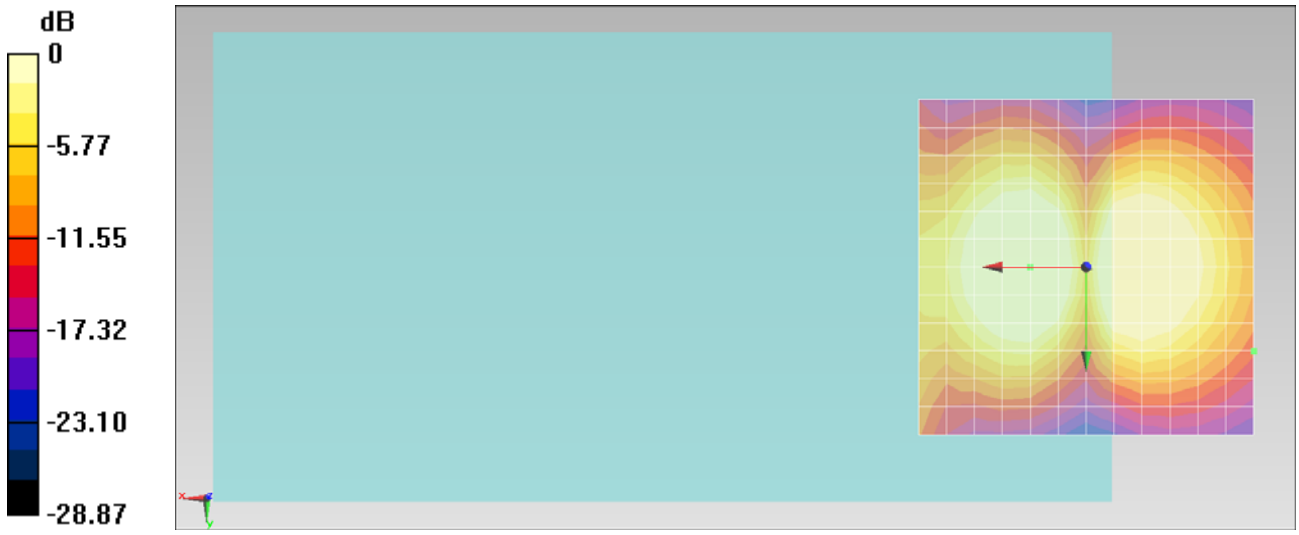
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 5.73 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 24.89 dB
ABM1 comp = -12.88 dB A/m
Location: -25, 12.5, 3.7 mm




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

## #03 T-Coil_GSM850_Voice_Ch251_Radial 2 (Y)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -0.67 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.89 dB
ABM1 comp = -5.16 dB A/m
Location: -4.2, -4.2, 3.7 mm

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

## #04 T-Coil_GSM1900_Voice_Ch512_Axial (Z)

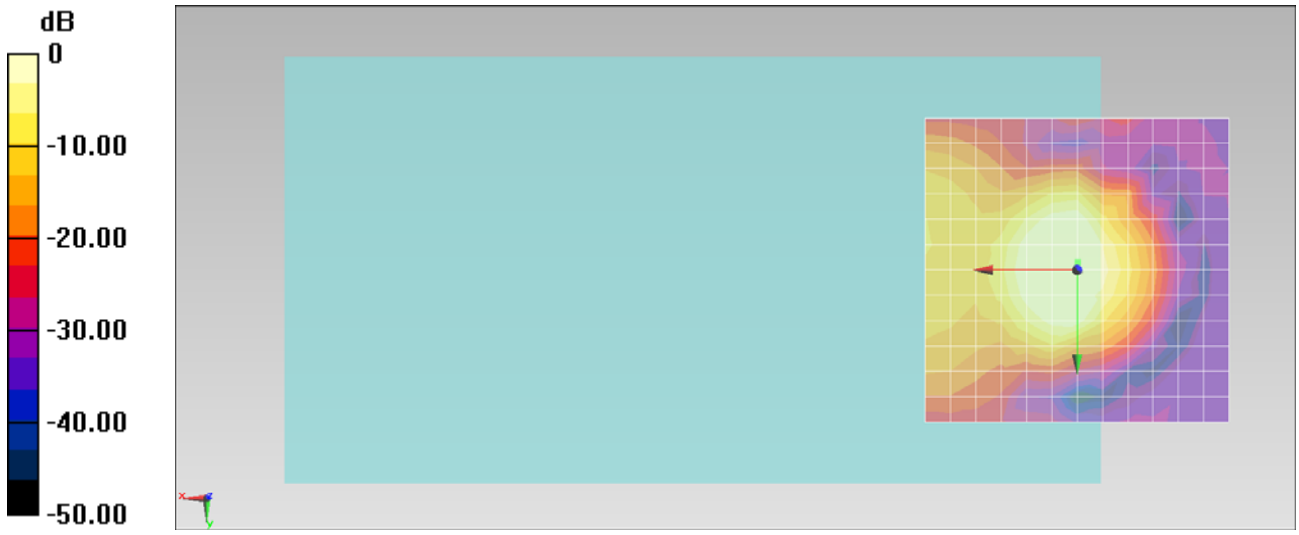
**DUT: 290405**

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 ℃

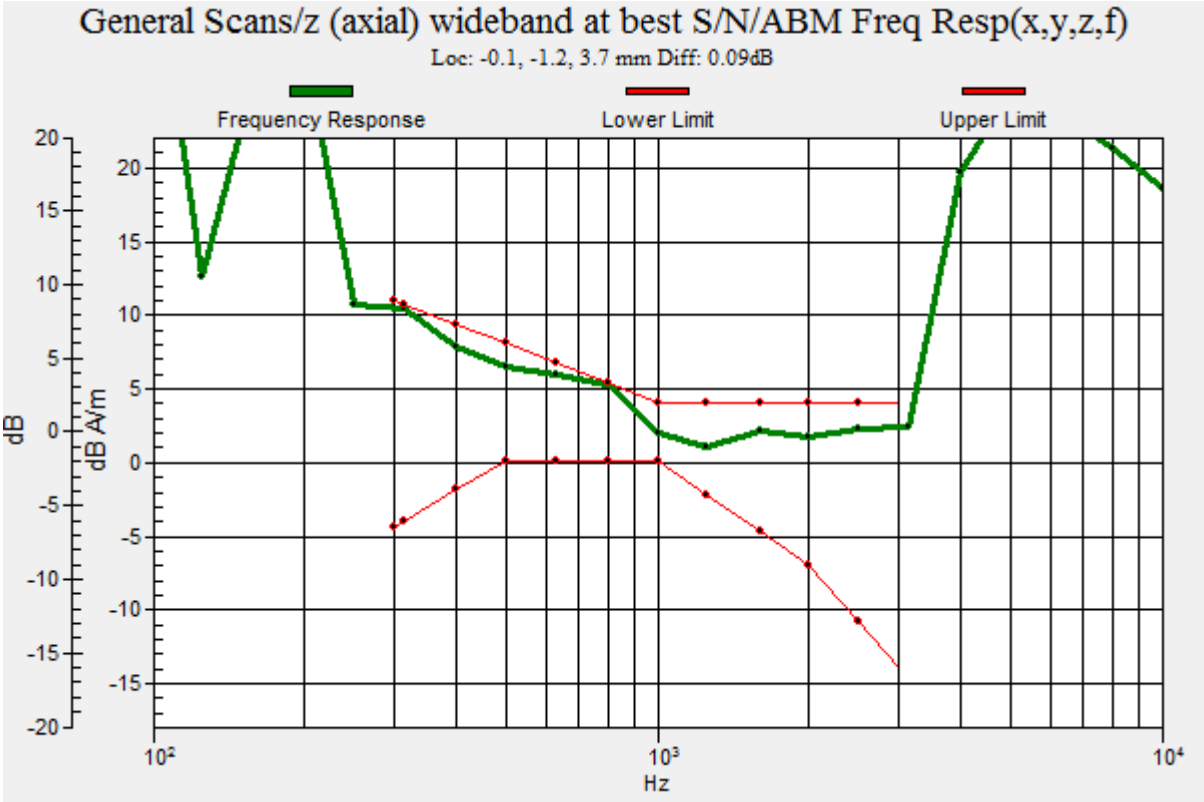
DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

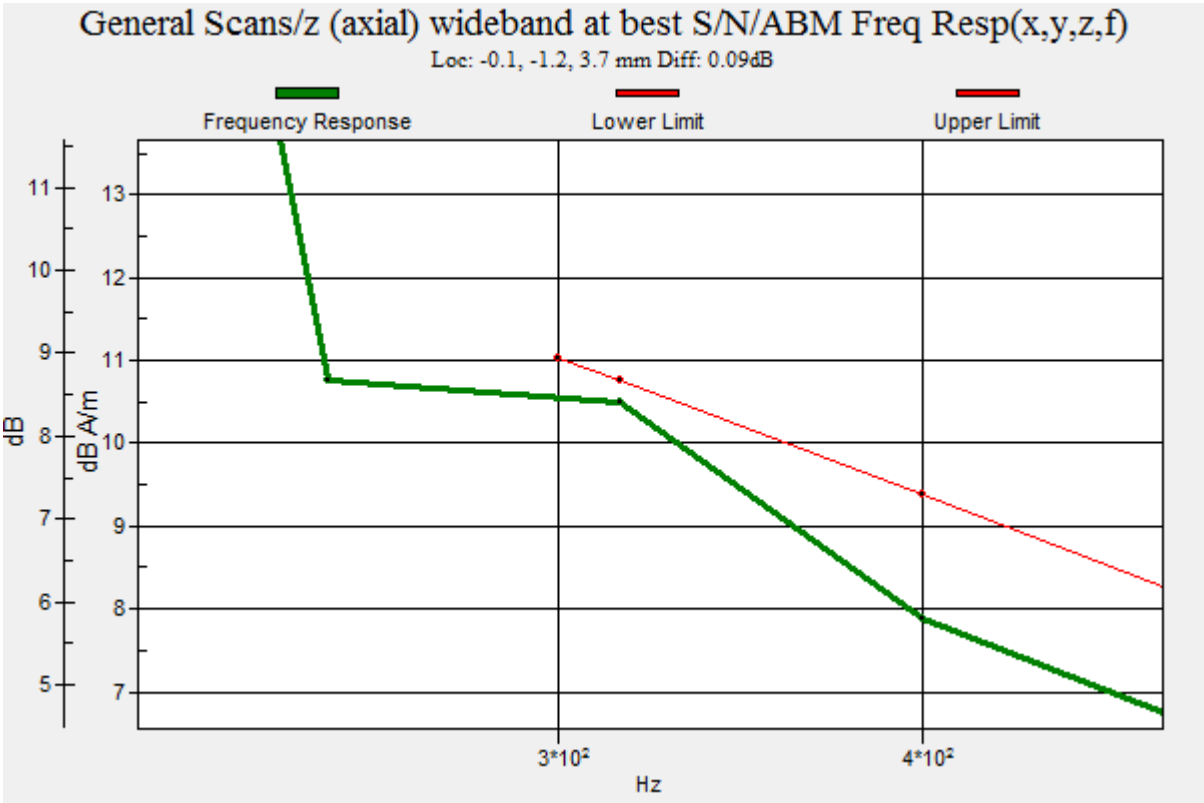
### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 7.28 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 30.82 dB
ABM1 comp = 7.28 dB A/m
Location: 0, 0, 3.7 mm




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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -0.1, -1.2, 3.7 mm Diff: 0.09dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -0.1, -1.2, 3.7 mm Diff: 0.09dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #04 T-Coil_GSM1900_Voice_Ch512_Radial 1 (X)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -0.56 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 21.32 dB
ABM1 comp = -15.92 dB A/m
Location: -25, 4.2, 3.7 mm

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

## #04 T-Coil_GSM1900_Voice_Ch512_Radial 2 (Y)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -6.86 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 25.37 dB
ABM1 comp = -9.05 dB A/m
Location: 0, -4.2, 3.7 mm

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

## #05 T-Coil_GSM1900_Voice_Ch661_Axial (Z)

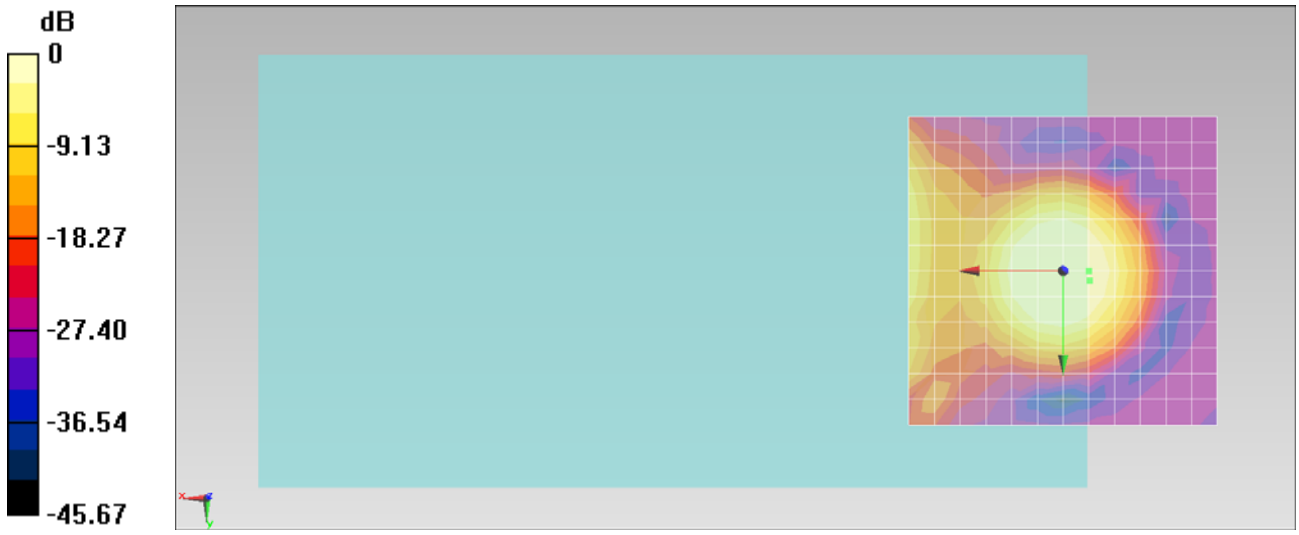
**DUT: 290405**

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 ℃

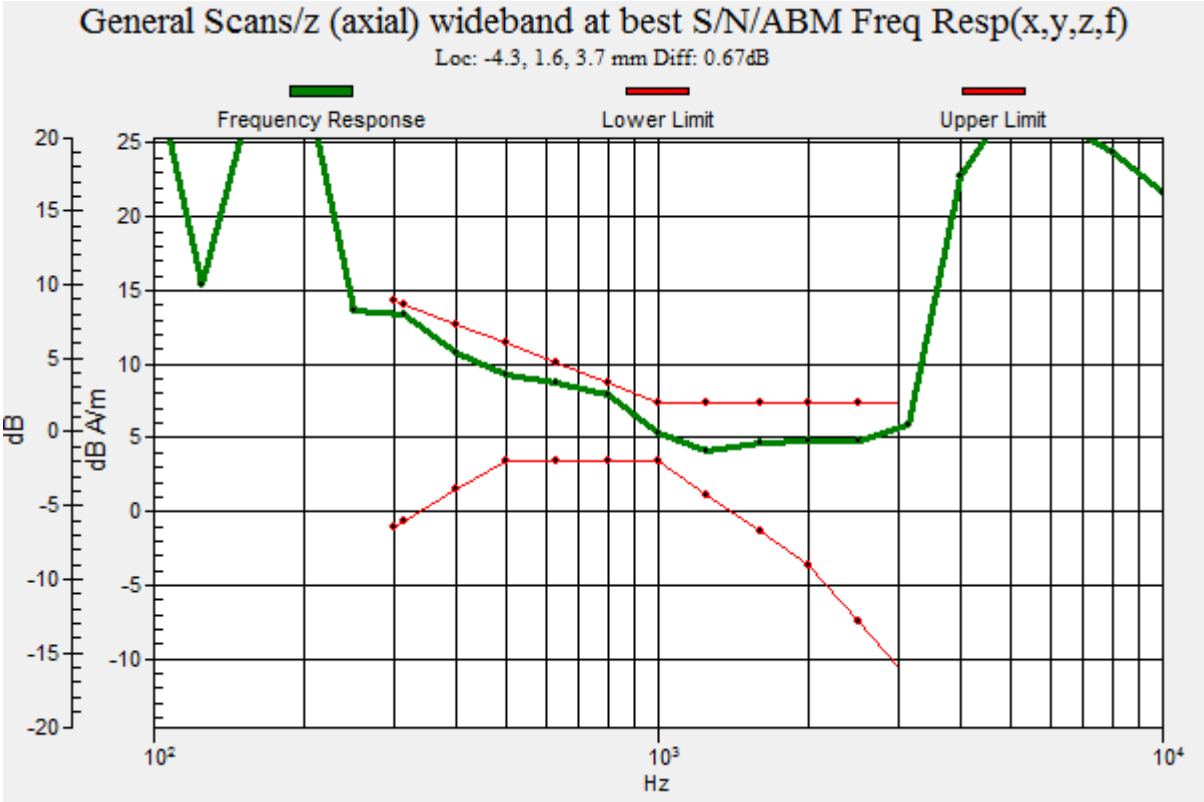
DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 5.64 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 31.18 dB
ABM1 comp = 2.54 dB A/m
Location: -4.2, 0, 3.7 mm




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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.3, 1.6, 3.7 mm Diff: 0.67dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #05 T-Coil_GSM1900_Voice_Ch661_Radial 1 (X)

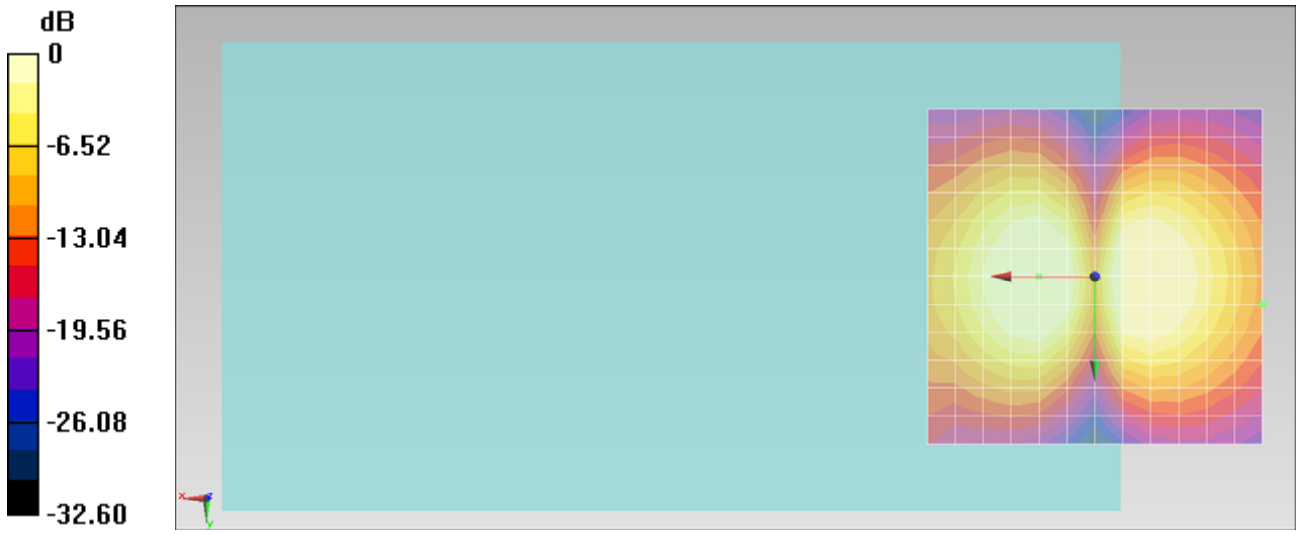
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 3.60 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 25.37 dB
ABM1 comp = -11.86 dB A/m
Location: -25, 4.2, 3.7 mm




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

## #05 T-Coil_GSM1900_Voice_Ch661_Radial 2 (Y)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -2.59 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.24 dB
ABM1 comp = -6.45 dB A/m
Location: -4.2, -4.2, 3.7 mm

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

## #06 T-Coil_GSM1900_Voice_Ch810_Axial (Z)

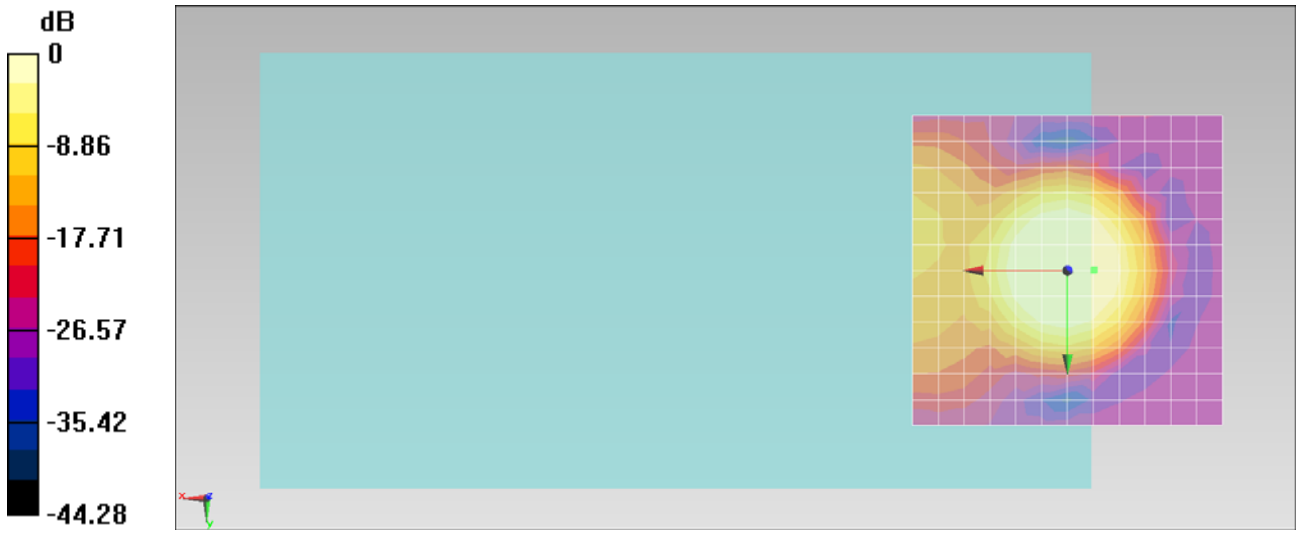
**DUT: 290405**

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 ℃

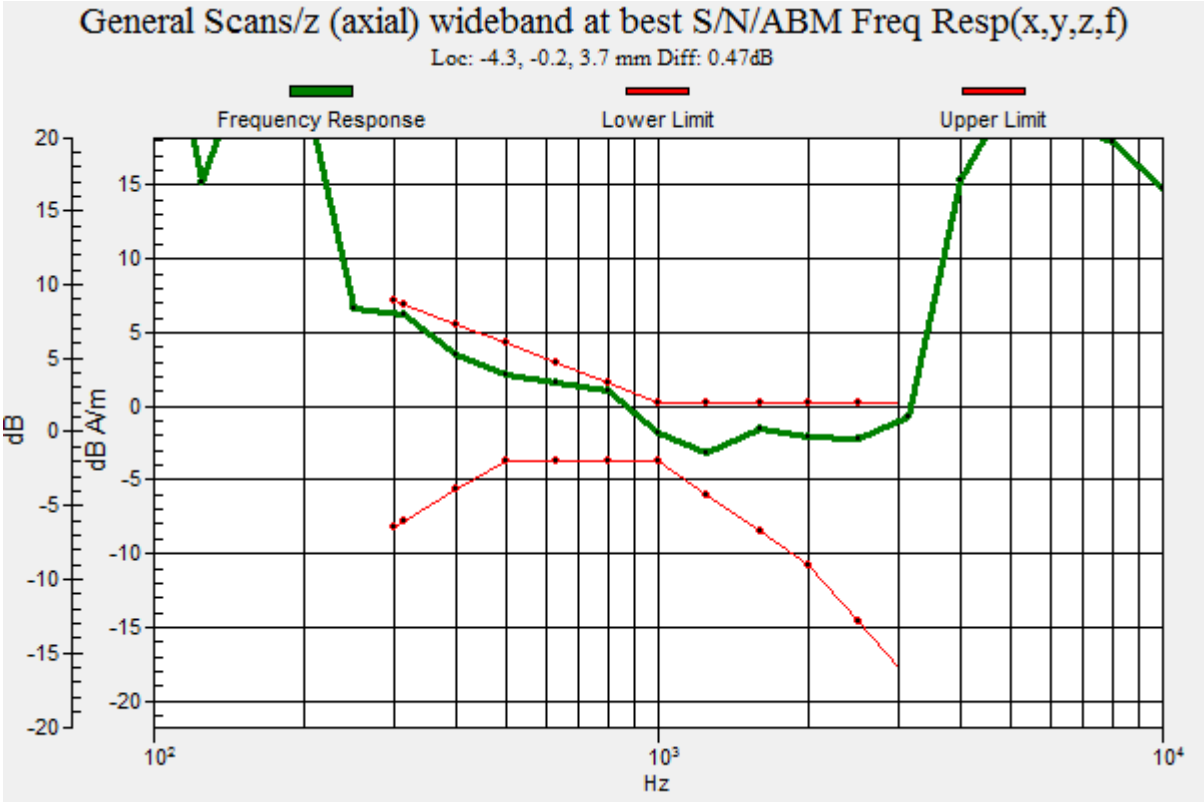
DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 7.19 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 33.31 dB
ABM1 comp = 4.34 dB A/m
Location: -4.2, 0, 3.7 mm




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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.3, -0.2, 3.7 mm Diff: 0.47dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz
20
15
10
5
0
-5
-10
-15
-20
$10^2$
$10^3$
$10^4$

## #06 T-Coil_GSM1900_Voice_Ch810_Radial 1 (X)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 5.46 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.30 dB
ABM1 comp = -9.25 dB A/m
Location: -25, 0, 3.7 mm

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

## #06 T-Coil_GSM1900_Voice_Ch810_Radial 2 (Y)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 5.29 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 31.26 dB
ABM1 comp = 2.80 dB A/m
Location: 0, -4.2, 3.7 mm

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

## #07 T-Coil_WCDMA V_Voice_Ch4132_Axial (Z)

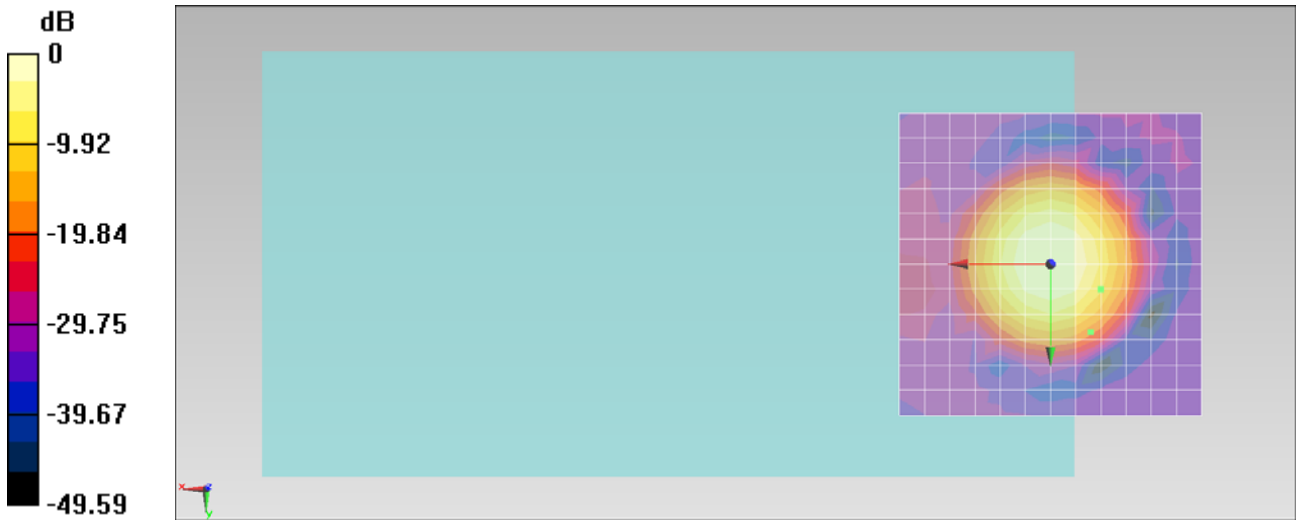
**DUT: 290405**

Communication System: WCDMA; Frequency: 826.4 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 ℃

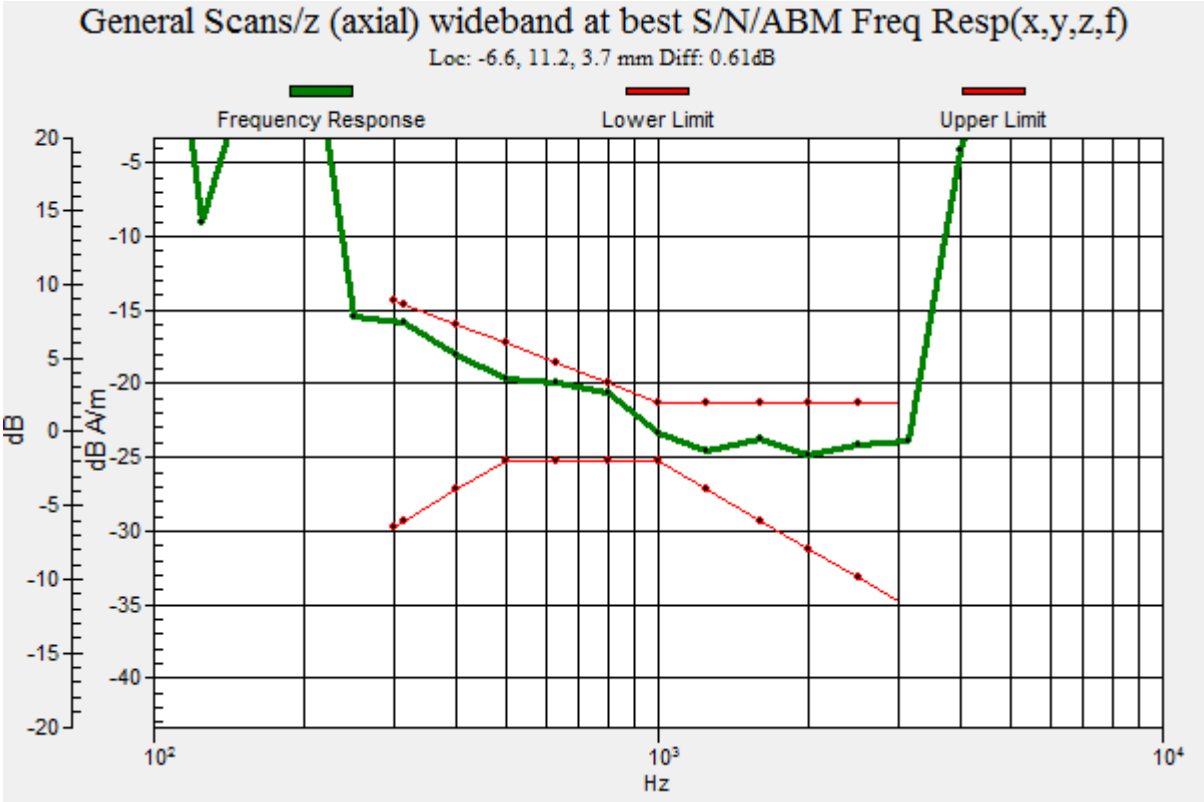
DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 2.19 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 30.02 dB
ABM1 comp = -9.17 dB A/m
Location: -8.3, 4.2, 3.7 mm




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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -6.6, 11.2, 3.7 mm Diff: 0.61dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #07 T-Coil_WCDMA V_Voice_Ch4132_Radial 1 (X)

**DUT: 290405**

Communication System: WCDMA; Frequency: 826.4 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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -1.53 dB A/m
Location: -8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.70 dB
ABM1 comp = -3.33 dB A/m
Location: -12.5, 0, 3.7 mm

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

## #07 T-Coil_WCDMA V_Voice_Ch4132_Radial 2 (Y)

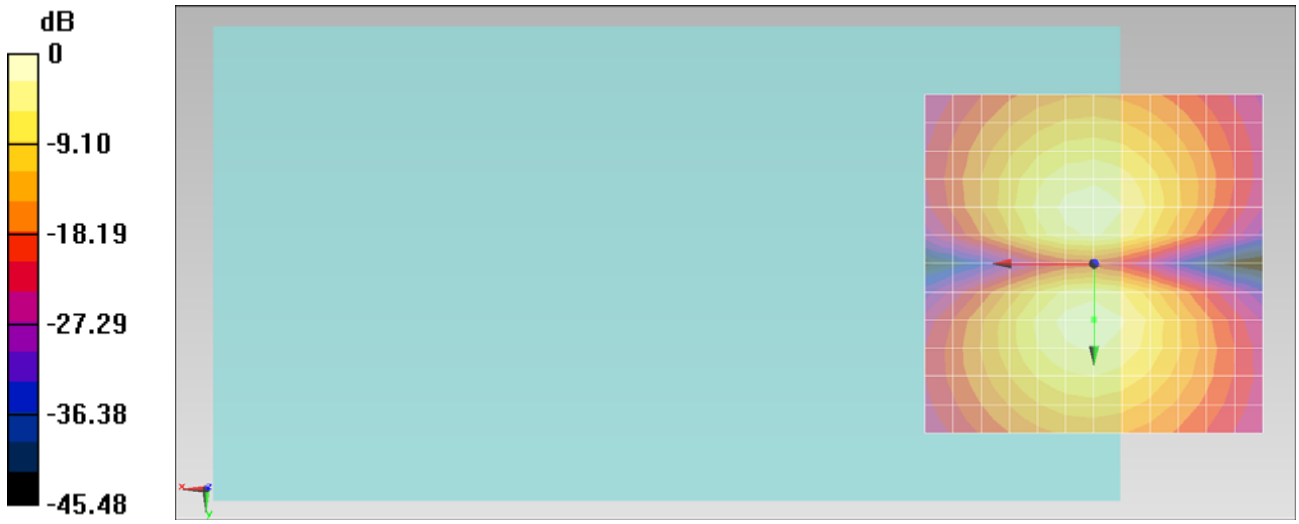
**DUT: 290405**

Communication System: WCDMA; Frequency: 826.4 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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -0.97 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.39 dB
ABM1 comp = -0.97 dB A/m
Location: 0, 8.3, 3.7 mm




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

## #08 T-Coil_WCDMA V_Voice_Ch4182_Axial (Z)

**DUT: 290405**

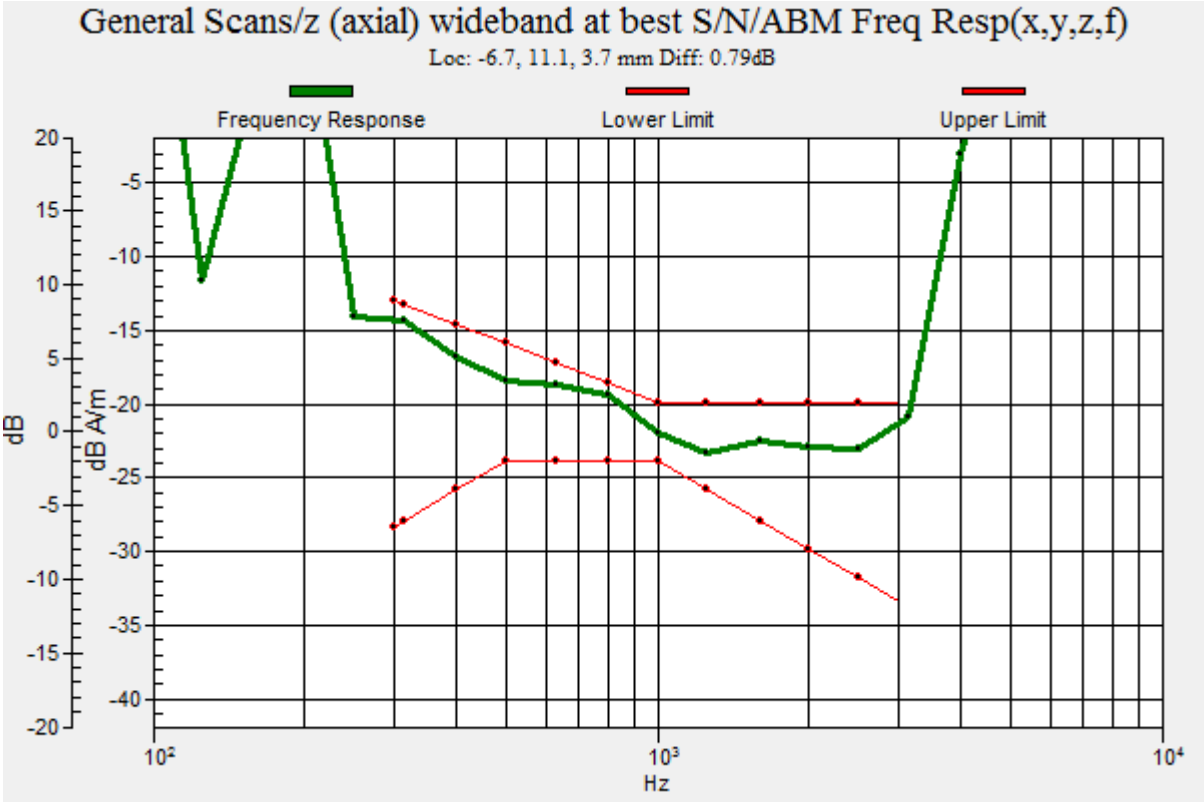
Communication System: WCDMA; Frequency: 836.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：22.5 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 1.78 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.83 dB
ABM1 comp = -10.38 dB A/m
Location: -8.3, 4.2, 3.7 mm

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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -6.7, 11.1, 3.7 mm Diff: 0.79dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #08 T-Coil_WCDMA V_Voice_Ch4182_Radial 1 (X)

**DUT: 290405**

Communication System: WCDMA; Frequency: 836.4 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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -7.82 dB A/m
Location: -8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.83 dB
ABM1 comp = -9.85 dB A/m
Location: -12.5, 0, 3.7 mm

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

## #08 T-Coil_WCDMA V_Voice_Ch4182_Radial 2 (Y)

**DUT: 290405**

Communication System: WCDMA; Frequency: 836.4 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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -7.30 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.27 dB
ABM1 comp = -7.30 dB A/m
Location: 0, 8.3, 3.7 mm

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

## #09 T-Coil_WCDMA V_Voice_Ch4233_Axial (Z)

**DUT: 290405**

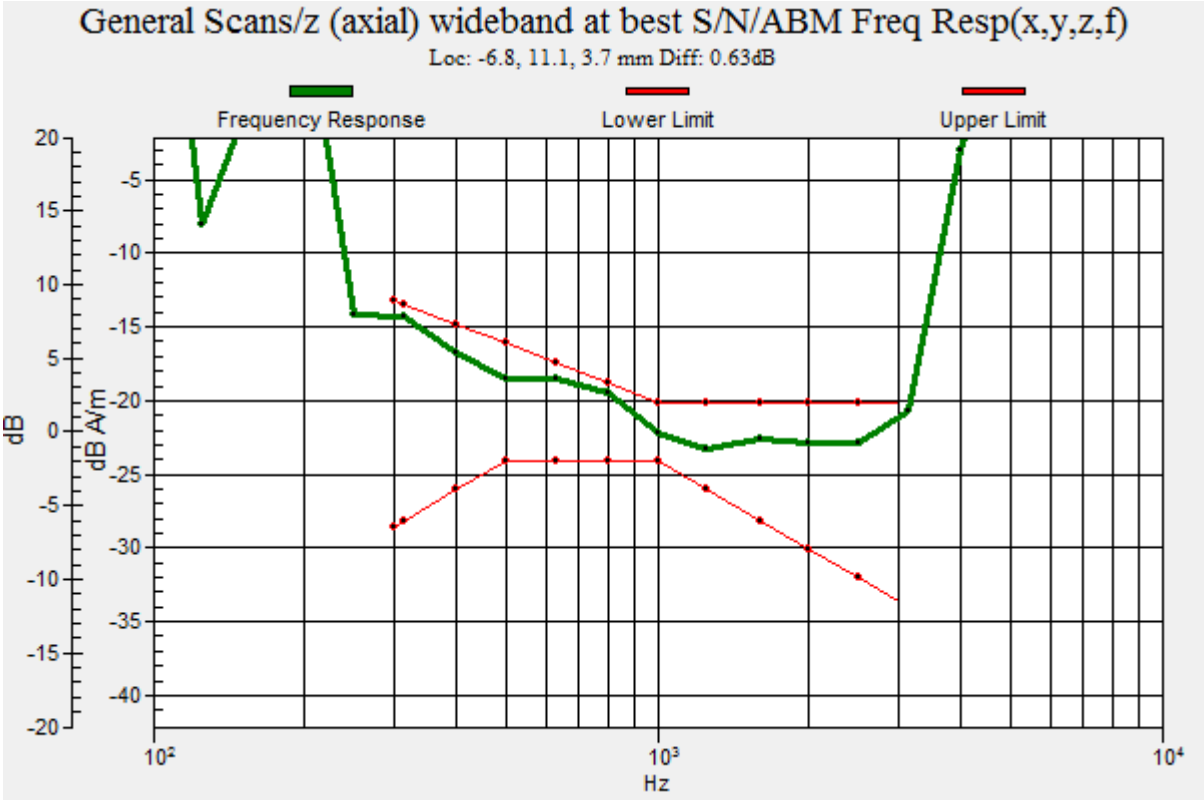
Communication System: WCDMA; Frequency: 846.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：22.5 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 1.96 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.92 dB
ABM1 comp = -8.12 dB A/m
Location: -8.3, 0, 3.7 mm

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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -6.8, 11.1, 3.7 mm Diff: 0.63dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #09 T-Coil_WCDMA V_Voice_Ch4233_Radial 1 (X)

**DUT: 290405**

Communication System: WCDMA; Frequency: 846.6 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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -7.81 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.83 dB
ABM1 comp = -7.82 dB A/m
Location: -8.3, 0, 3.7 mm

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

## #09 T-Coil_WCDMA V_Voice_Ch4233_Radial 2 (Y)

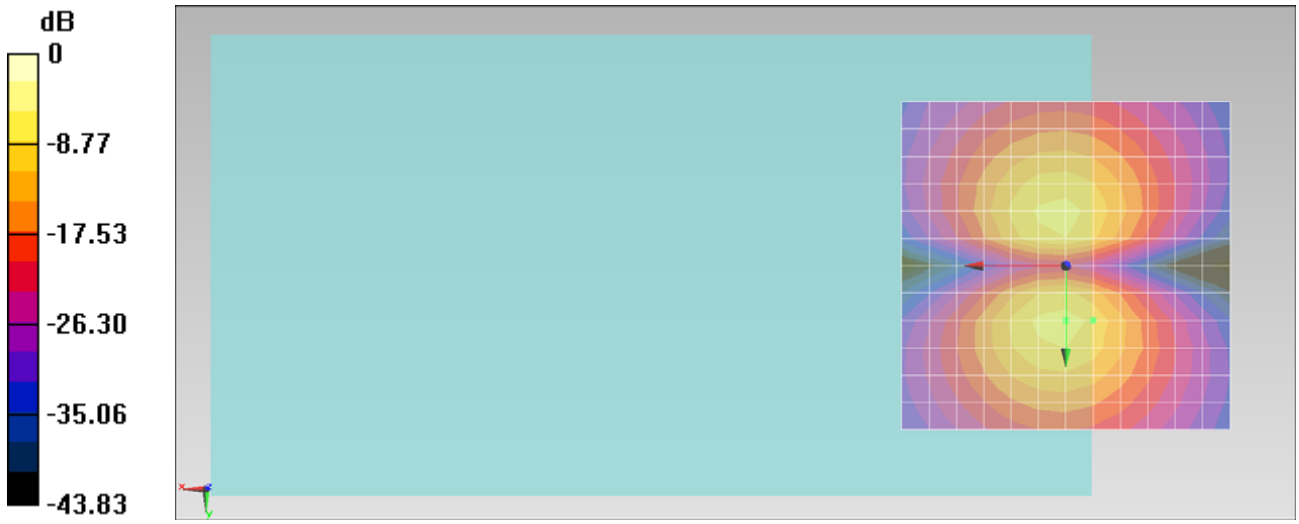
**DUT: 290405**

Communication System: WCDMA; Frequency: 846.6 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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -7.29 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.21 dB
ABM1 comp = -9.31 dB A/m
Location: -4.2, 8.3, 3.7 mm




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

## #10 T-Coil_WCDMA II_Voice_Ch9262_Axial (Z)

**DUT: 290405**

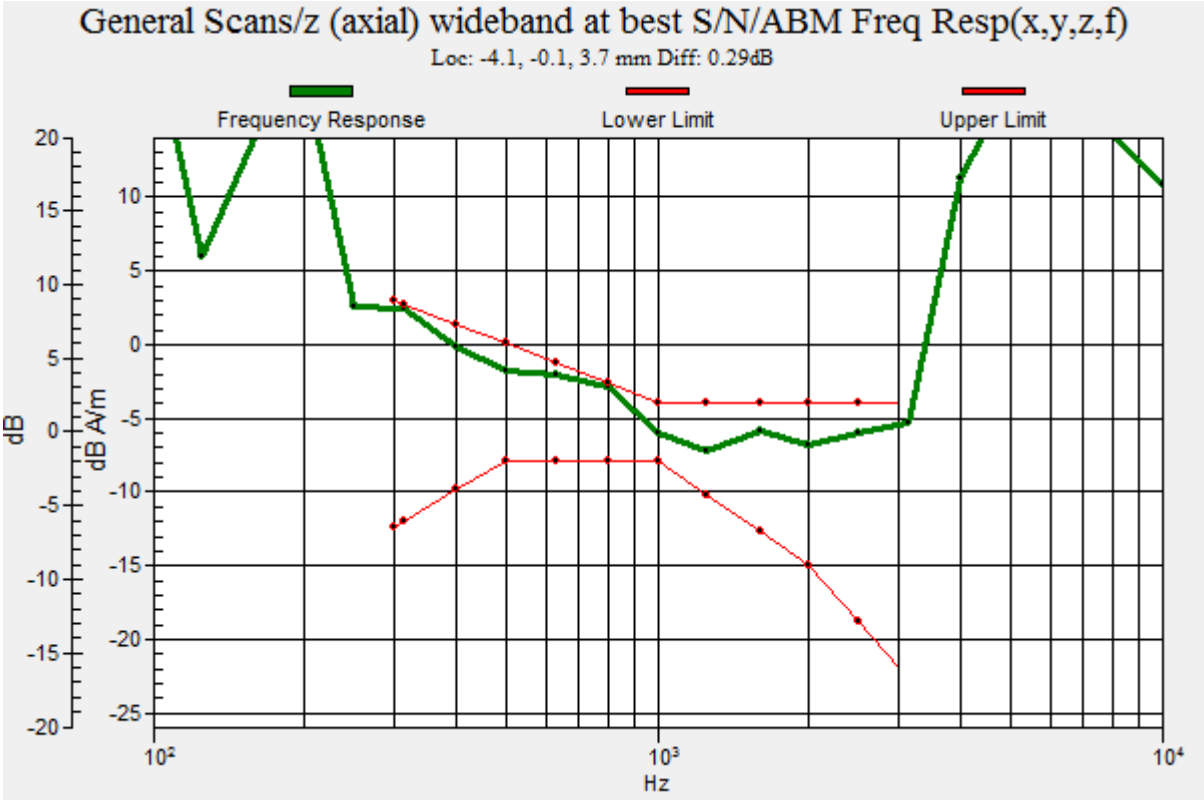
Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：22.5 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 1.89 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.73 dB
ABM1 comp = -0.90 dB A/m
Location: -4.2, 0, 3.7 mm

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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.1, -0.1, 3.7 mm Diff: 0.29dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #10 T-Coil_WCDMA II_Voice_Ch9262_Radial 1 (X)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -1.69 dB A/m
Location: -8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.33 dB
ABM1 comp = -3.57 dB A/m
Location: -12.5, 0, 3.7 mm

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

## #10 T-Coil_WCDMA II_Voice_Ch9262_Radial 2 (Y)

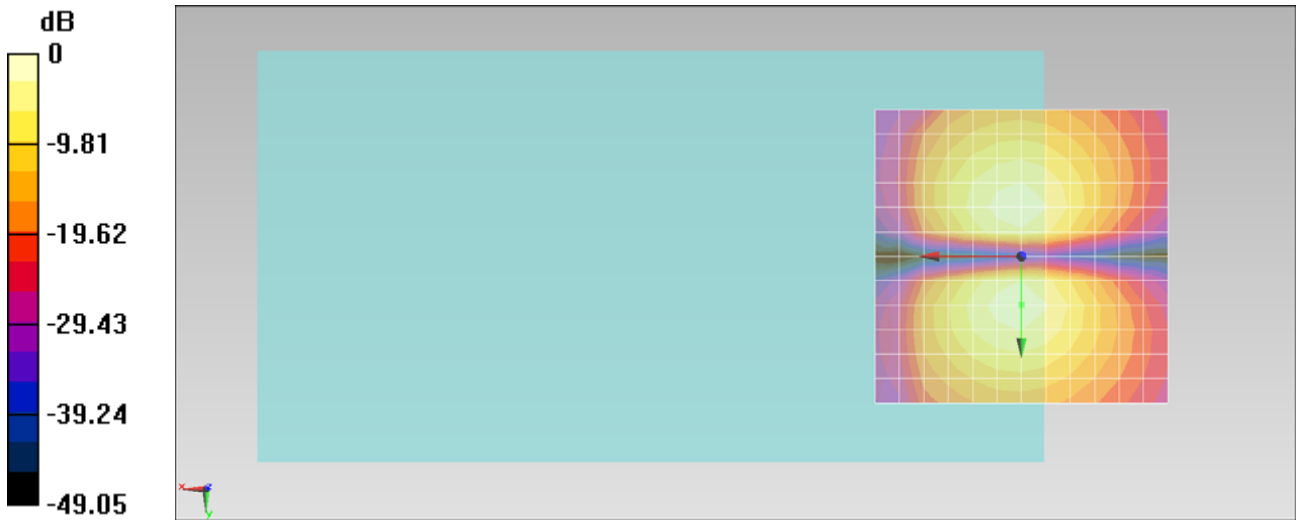
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -1.21 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.15 dB
ABM1 comp = -1.21 dB A/m
Location: 0, 8.3, 3.7 mm




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

## #11 T-Coil_WCDMA II_Voice_Ch9400_Axial (Z)

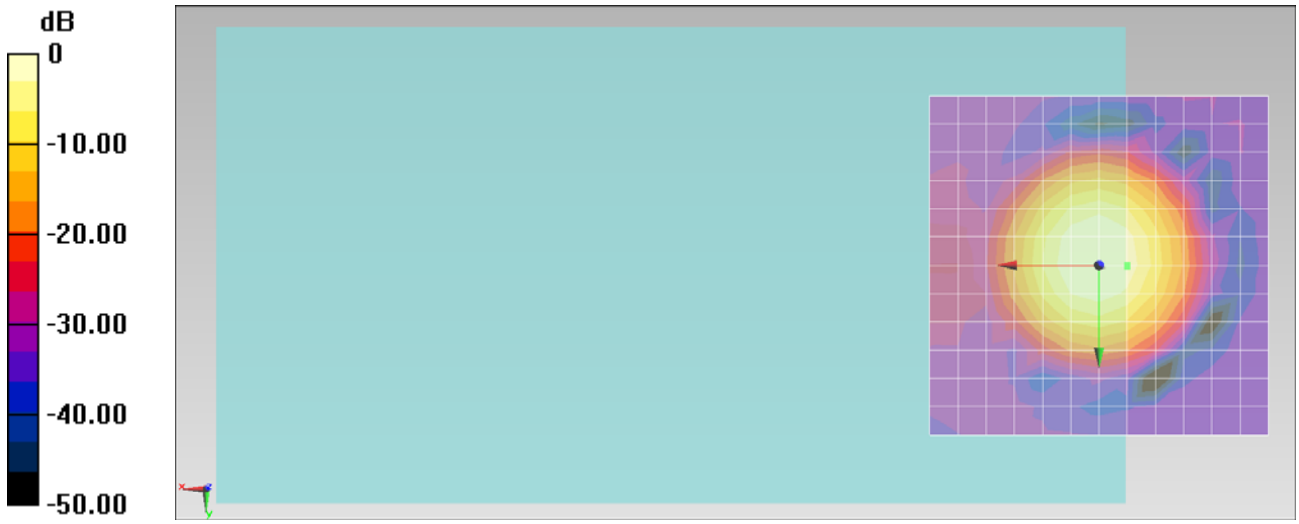
**DUT: 290405**

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 ℃

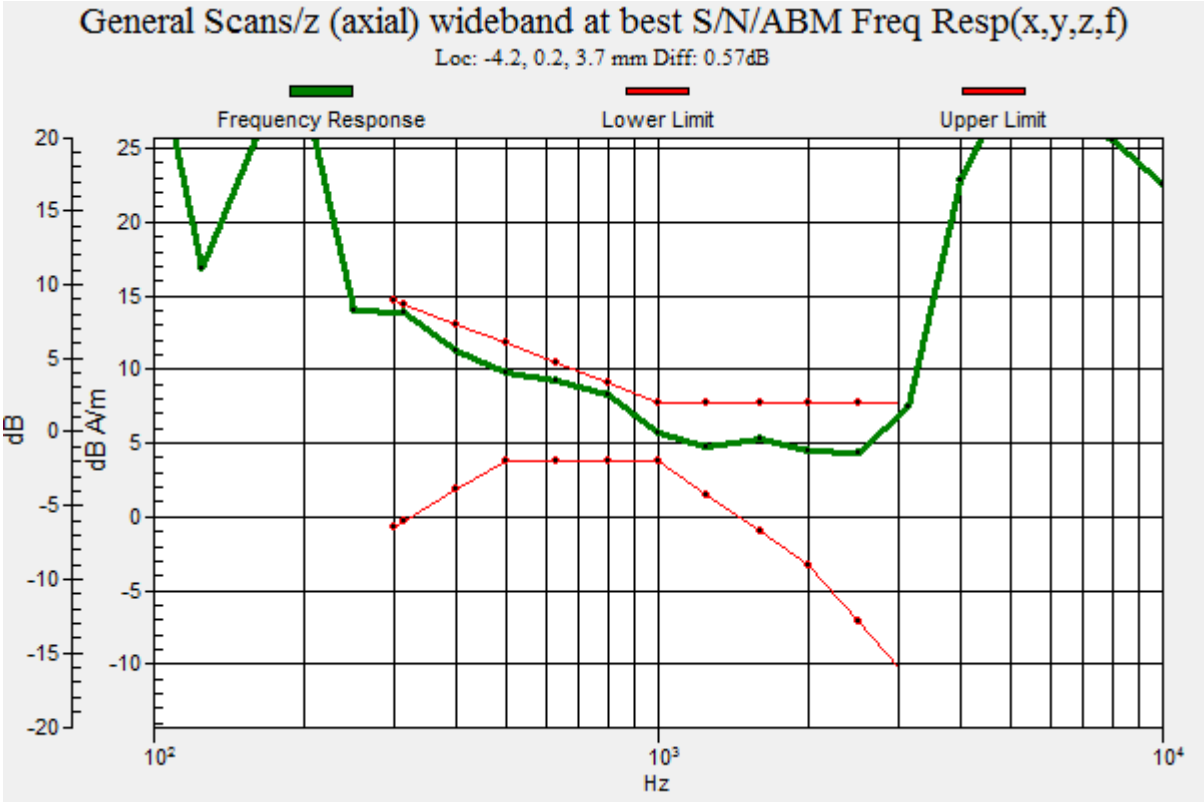
DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 1.74 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.59 dB
ABM1 comp = -0.89 dB A/m
Location: -4.2, 0, 3.7 mm




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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -4.2, 0.2, 3.7 mm Diff: 0.57dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #11 T-Coil_WCDMA II_Voice_Ch9400_Radial 1 (X)

**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -1.71 dB A/m
Location: -8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.41 dB
ABM1 comp = -4.35 dB A/m
Location: -12.5, -4.2, 3.7 mm

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

## #11 T-Coil_WCDMA II_Voice_Ch9400_Radial 2 (Y)

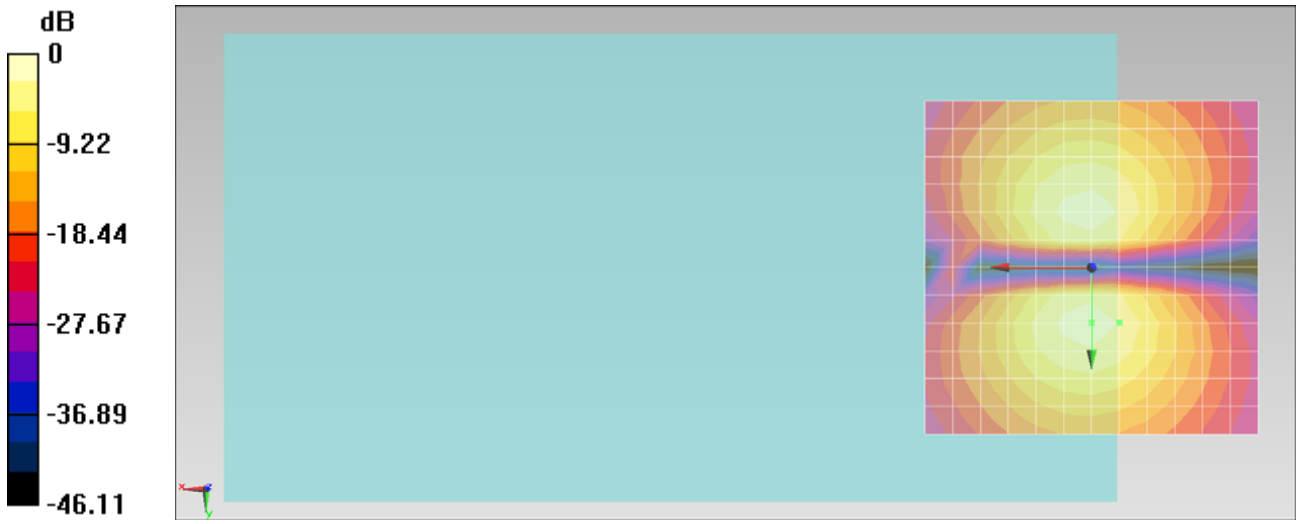
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -1.40 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.73 dB
ABM1 comp = -3.18 dB A/m
Location: -4.2, 8.3, 3.7 mm




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

## #12 T-Coil_WCDMA II_Voice_Ch9538_Axial (Z)

**DUT: 290405**

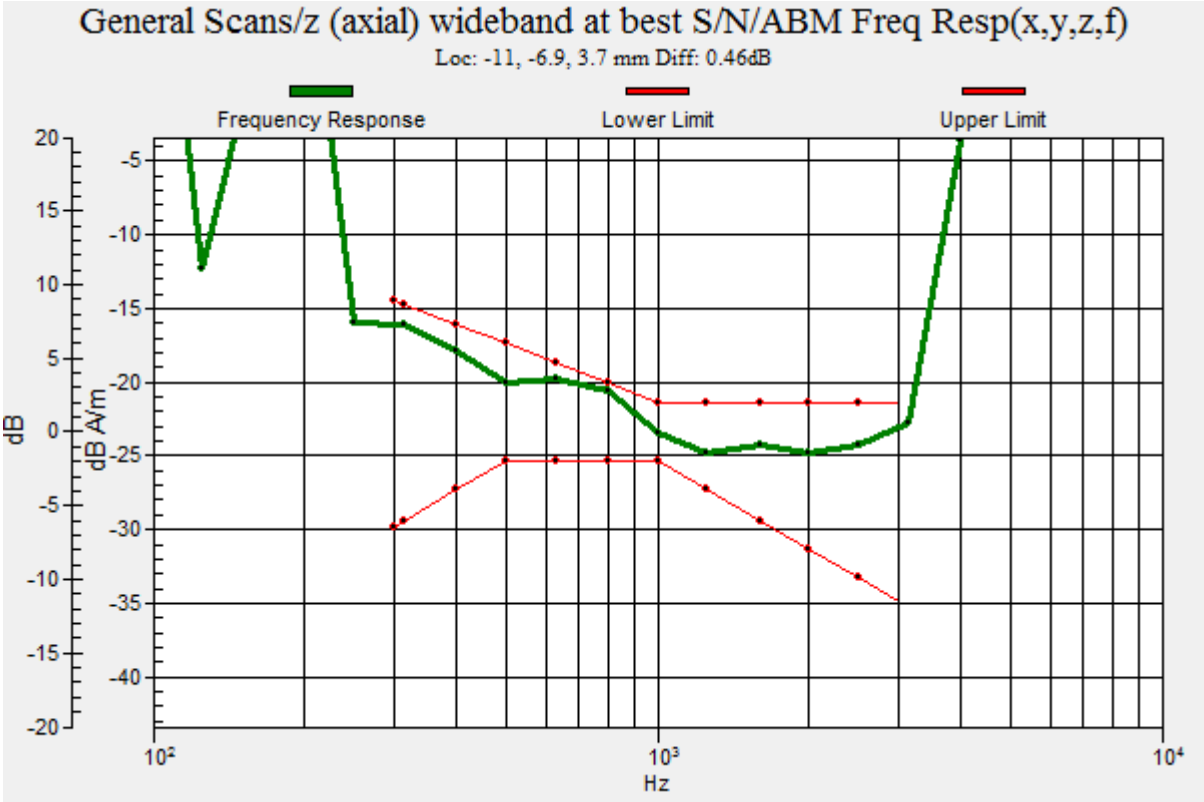
Communication System: WCDMA; Frequency: 1907.6 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：22.5 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/z (axial) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = 8.12 dB A/m
Location: 0, 0, 3.7 mm

### General Scans/z (axial) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 29.63 dB
ABM1 comp = -4.45 dB A/m
Location: -8.3, 4.2, 3.7 mm

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


General Scans/z (axial) wideband at best S/N/ABM Freq Resp(x,y,z,f)
Loc: -11, -6.9, 3.7 mm Diff: 0.46dB
Frequency Response
Lower Limit
Upper Limit
dB
dB A/m
Hz

## #12 T-Coil_WCDMA II_Voice_Ch9538_Radial 1 (X)

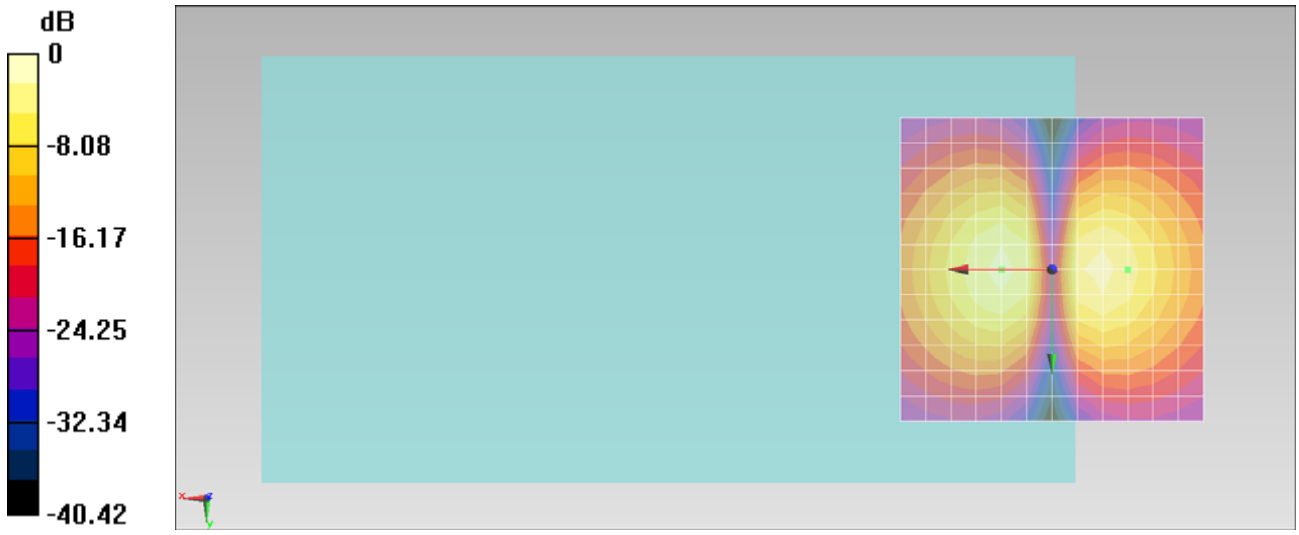
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -1.59 dB A/m
Location: 8.3, 0, 3.7 mm

### General Scans/x (longitudinal) (2007) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.56 dB
ABM1 comp = -3.87 dB A/m
Location: -12.5, 0, 3.7 mm




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

## #12 T-Coil_WCDMA II_Voice_Ch9538_Radial 2 (Y)

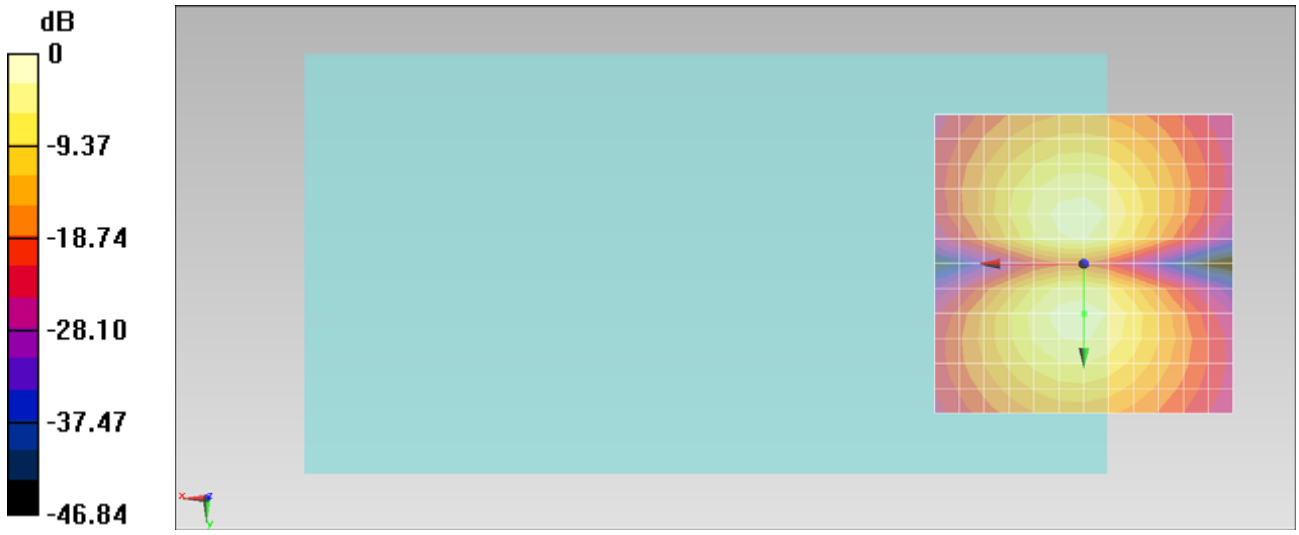
**DUT: 290405**

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 ℃

DASY5 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 2012/1/23
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1279; Calibrated: 2012/5/3
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6477)

### General Scans/y (transversal) 4.2mm 50 x 50/ABM Signal(x,y,z) (13x13x1):
ABM1 comp = -1.22 dB A/m
Location: 0, 8.3, 3.7 mm

### General Scans/y (transversal) 4.2mm 50 x 50/ABM SNR(x,y,z) (13x13x1):
ABM1/ABM2 = 28.99 dB
ABM1 comp = -1.22 dB A/m
Location: 0, 8.3, 3.7 mm




0 dB = 1.000 A/m = 0.00 dB A/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 (Auden)**

Certificate No: **AM1DV2-1038_Jan12**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | AM1DV2 - SN: 1038 |
| Calibration procedure(s) | QA CAL-24.v3<br>Calibration procedure for AM1D magnetic field probes and TMFS in the audio range |
| Calibration date: | January 23, 2012 |

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-11 (No:11450) | Sep-12 |
| Reference Probe AM1DV2 | SN: 1008 | 12-Jan-12 (No. AM1D-1008_Jan12) | Jan-13 |
| DAE4 | SN: 781 | 20-Apr-11 (No. DAE4-781_Apr11) | Apr-12 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| AMCC | 1050 | 12-Oct-11 (in house check Oct-11) | Oct-13 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Dimce Iliev | Laboratory Technician | D. Iliev |
| Approved by: | Fin Bomholt | R&D Director | F. Bomholt |

Issued: January 24, 2012

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

## References


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

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


## Description of the AM1D probe

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1]. 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 18, 2011 |

## Calibration data

| | | | |
|---|---|---|---|
| Connector rotation angle | (in DASY system) | **42.1 °** | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | **2.59 °** | +/- 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
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 (Auden)**

**Certificate No: DAE4-1279_May12**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SD 000 D04 BJ - SN: 1279 |
| Calibration procedure(s) | QA CAL-06.v24<br>Calibration procedure for the data acquisition electronics (DAE) |
| Calibration date: | May 03, 2012 |

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-11 (No:11450) | Sep-12 |
| **Secondary Standards** | **ID #** | **Check Date (in house)** | **Scheduled Check** |
| Calibrator Box V2.1 | SE UWS 053 AA 1001 | 05-Jan-12 (in house check) | In house check: Jan-13 |

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

Issued: May 3, 2012

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

## 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** | 405.179 ± 0.1% (k=2) | 404.974 ± 0.1% (k=2) | 404.316 ± 0.1% (k=2) |
| **Low Range** | 3.98658 ± 0.7% (k=2) | 3.98731 ± 0.7% (k=2) | 3.99734 ± 0.7% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 117.0 ° ± 1 ° |

## Appendix

### 1. DC Voltage Linearity

| High Range | | Reading (µV) | Difference (µV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 199991.33 | -3.98 | -0.00 |
| Channel X | + Input | 20000.42 | 1.05 | 0.01 |
| Channel X | - Input | -20000.99 | 0.62 | -0.00 |
| Channel Y | + Input | 199992.57 | -2.48 | -0.00 |
| Channel Y | + Input | 20000.37 | 1.13 | 0.01 |
| Channel Y | - Input | -20001.77 | -0.06 | 0.00 |
| Channel Z | + Input | 199995.61 | 0.39 | 0.00 |
| Channel Z | + Input | 19999.27 | 0.00 | 0.00 |
| Channel Z | - Input | -20002.85 | -1.22 | 0.01 |

| Low Range | | Reading (µV) | Difference (µV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 1999.48 | -0.32 | -0.02 |
| Channel X | + Input | 200.41 | 0.23 | 0.11 |
| Channel X | - Input | -199.28 | 0.50 | -0.25 |
| Channel Y | + Input | 2000.24 | 0.55 | 0.03 |
| Channel Y | + Input | 200.58 | 0.44 | 0.22 |
| Channel Y | - Input | -199.75 | -0.01 | 0.00 |
| Channel Z | + Input | 1998.83 | -0.82 | -0.04 |
| Channel Z | + Input | 198.55 | -1.51 | -0.75 |
| Channel Z | - Input | -201.15 | -1.30 | 0.65 |

### 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 | 17.08 | 15.93 |
| | - 200 | -15.69 | -16.88 |
| Channel Y | 200 | 8.48 | 8.38 |
| | - 200 | -9.22 | -9.58 |
| Channel Z | 200 | -0.67 | -0.84 |
| | - 200 | -0.62 | -0.65 |

### 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 | - | 3.17 | -3.15 |
| Channel Y | 200 | 7.76 | - | 3.57 |
| Channel Z | 200 | 8.98 | 6.44 | - |

## 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** | 15658 | 14778 |
| **Channel Y** | 16426 | 15731 |
| **Channel Z** | 15918 | 15544 |

## 5. Input Offset Measurement

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

| | Average (µV) | min. Offset (µV) | max. Offset (µV) | Std. Deviation (µV) |
|---|---|---|---|---|
| **Channel X** | 0.78 | -0.61 | 2.27 | 0.58 |
| **Channel Y** | 0.16 | -1.45 | 2.45 | 0.76 |
| **Channel Z** | -0.63 | -2.21 | 0.54 | 0.54 |

## 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 |