



Hearing Aid Compatibility (HAC) RF Emissions Test Report

APPLICANT : CT Asia
EQUIPMENT : GSM mobile phone
BRAND NAME : BLU
MODEL NAME : spark
FCC ID : YHLBLUSPARK
STANDARD : FCC 47 CFR §20.19
ANSI C63.19-2007
M CATEGORY : M3
OVERALL HAC RATING : M3/T3

The product was received on Sep. 17, 2011 and completely tested on Sep. 29, 2011. We, SPORTON INTERNATIONAL (KUNSHAN) 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 (KUNSHAN) INC., the test report shall not be reproduced except in full.

Reviewed by:

Jones Tsai / Manager



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Appendix A. Plots of System Performance Check

Appendix B. Plots of RF Emission Measurement

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Revision History

| REPORT NO. | VERSION | DESCRIPTION | ISSUED DATE |
|------------|---------|-------------------------|---------------|
| HA191701A | Rev. 01 | Initial issue of report | Nov. 03, 2011 |
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1. Statement of Compliance

The maximum results of RF Emission of Hearing Aid Compliance (HAC) found during testing for the **CT Asia GSM mobile phone BLU spark** are follows (with expanded uncertainty $\pm 30.4\%$ for E-field and $\pm 21.6\%$ for H-field):

| Band | HAC RF Emission Test Result | | M Rating |
|----------------|-----------------------------|--------|-----------|
| GSM850 | E-Field (V/m) | 148.8 | M4 |
| | H-Field (A/m) | 0.412 | M4 |
| GSM1900 | E-Field (V/m) | 42.457 | M4 |
| | H-Field (A/m) | 0.201 | M3 |

They are in compliance with HAC limits specified in guidelines FCC 47 CFR §20.19 and ANSI Standard ANSI C63.19 for HAC Rated category M3.

Results Summary : M Category = M3 (ANSI C63.19-2007)



2. Administration Data

2.1 Testing Laboratory

| | |
|---------------------------|--|
| Test Site | SPORTON INTERNATIONAL (KUNSHAN) INC. |
| Test Site Location | No. 3-2, PingXiang Road, Kunshan, Jiangsu Province, P.R.C. TEL: +86-0512-5790-0158 FAX: +86-0512-5790-0958 |
| Test Site No. | Sporton Site No. : SAR01-KS |

2.2 Applicant

| | |
|---------------------|---|
| Company Name | CT Asia |
| Address | RMA2011, 20/F, GOLDEN CENTRAL TOWER, NO.3037# JINTIAN ROAD, FUTIAN DISTRICT |

2.3 Manufacturer

| | |
|---------------------|--|
| Company Name | TINNO Electronics Technology Co., Ltd. |
| Address | RM 303, Building 53, Panda Group, Road No. 168 Long Pan Zhong Lu, Nanjing, Jiangsu, P.R.C. |

2.4 Application Details

| | |
|---------------------------------------|---------------|
| Date of Receipt of Application | Sep. 17, 2011 |
| Date of Start during the Test | Sep. 29, 2011 |
| Date of End during the Test | Sep. 29, 2011 |



3. General Information

3.1 Description of Device Under Test (DUT)

| Product Feature & Specification | |
|---------------------------------|--|
| DUT Type | GSM mobile phone |
| Brand Name | BLU |
| Model Name | spark |
| FCC ID | YHLBLUSPARK |
| Tx Frequency | GSM850 : 824 MHz ~ 849 MHz GSM1900 : 1850 MHz ~ 1910 MHz Bluetooth : 2400 MHz ~ 2483.5 MHz |
| Rx Frequency | GSM850 : 869 MHz ~ 894 MHz GSM1900 : 1930 MHz ~ 1990 MHz Bluetooth : 2400 MHz ~ 2483.5 MHz |
| Maximum Output Power to Antenna | GSM850 : 31.30 dBm GSM1900 : 28.33 dBm Bluetooth : 8.22 dBm |
| Antenna Type | WWAN : Fixed Internal Antenna Bluetooth : Dipole Antenna |
| HW Version | V0.10 |
| SW Version | E910_MP_F4_BLU_OPEN_01_02 |
| Type of Modulation | GSM / GPRS : GMSK Bluetooth (1Mbps) : GFSK Bluetooth EDR (2Mbps) : π/4-DQPSK Bluetooth EDR (3Mbps) : 8-DPSK |
| DUT Stage | Production Unit |

Remark:

1. The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. The Bluetooth is not available for HAC test.

3.2 Product Photos

Refer to Appendix D.



3.3 Applied Standards

The ANSI 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.

The following AWF factors shall be used for the standard transmission protocols:

| Standard | Technology | AWF (dB) |
|-----------------|---------------------|----------|
| TIA/EIA/IS-2000 | CDMA | 0 |
| TIA/EIA-136 | TDMA (50 Hz) | 0 |
| J-STD-007 | GSM (217) | -5 |
| T1/T1P1/3GPP | UMTS (WCDMA) | 0 |
| iDENTM | TDMA (22 and 11 Hz) | 0 |

Table 3.1 Articulation Weighting Factor (AWF)

| Category | Telephone RF Parameters | | |
|-------------|-------------------------|--------------------|-------------------|
| | Near Field | AWF | E-Field Emissions |
| < 960 MHz | | | |
| Category M1 | 0 | 631.0 – 1122.0 V/m | 1.91 – 3.39 A/m |
| | -5 | 473.2 – 841.4 V/m | 1.43 – 2.54 A/m |
| Category M2 | 0 | 354.8 – 631.0 V/m | 1.07 – 1.91 A/m |
| | -5 | 266.1 – 473.2 V/m | 0.80 – 1.43 A/m |
| Category M3 | 0 | 199.5 – 354.8 V/m | 0.6 – 1.07 A/m |
| | -5 | 149.6 – 266.1 V/m | 0.45 – 0.80 A/m |
| Category M4 | 0 | < 199.5 V/m | < 0.60 A/m |
| | -5 | < 149.6 V/m | < 0.45 A/m |
| > 960 MHz | | | |
| Category M1 | 0 | 199.5 – 354.8 V/m | 0.60 – 1.07 A/m |
| | -5 | 149.6 – 266.1 V/m | 0.45 – 0.80 A/m |
| Category M2 | 0 | 112.2 – 199.5 V/m | 0.34 – 0.60 A/m |
| | -5 | 84.1 – 149.6 V/m | 0.25 – 0.45 A/m |
| Category M3 | 0 | 63.1 – 112.2 V/m | 0.19 – 0.34 A/m |
| | -5 | 47.3 – 84.1 V/m | 0.14 – 0.25 A/m |
| Category M4 | 0 | < 63.1 V/m | < 0.19 A/m |
| | -5 | < 47.3 V/m | < 0.14 A/m |

Table 3.2 Telephone near-field categories in linear units



3.4 Test Conditions

3.4.1 Ambient Condition

| | |
|---------------------|-------------|
| Ambient Temperature | 20 to 24 °C |
| Humidity | < 60 % |

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 air link. Measurements were performed on the low, middle and high channels of both bands. The DUT was set from the emulator to radiate maximum output power during all tests.



4. Hearing Aid Compliance (HAC)

Introduction

The federal communication commission (FCC) adopted ANSI C63.19 as HAC test standard.

5. HAC RF Emission Measurement Setup

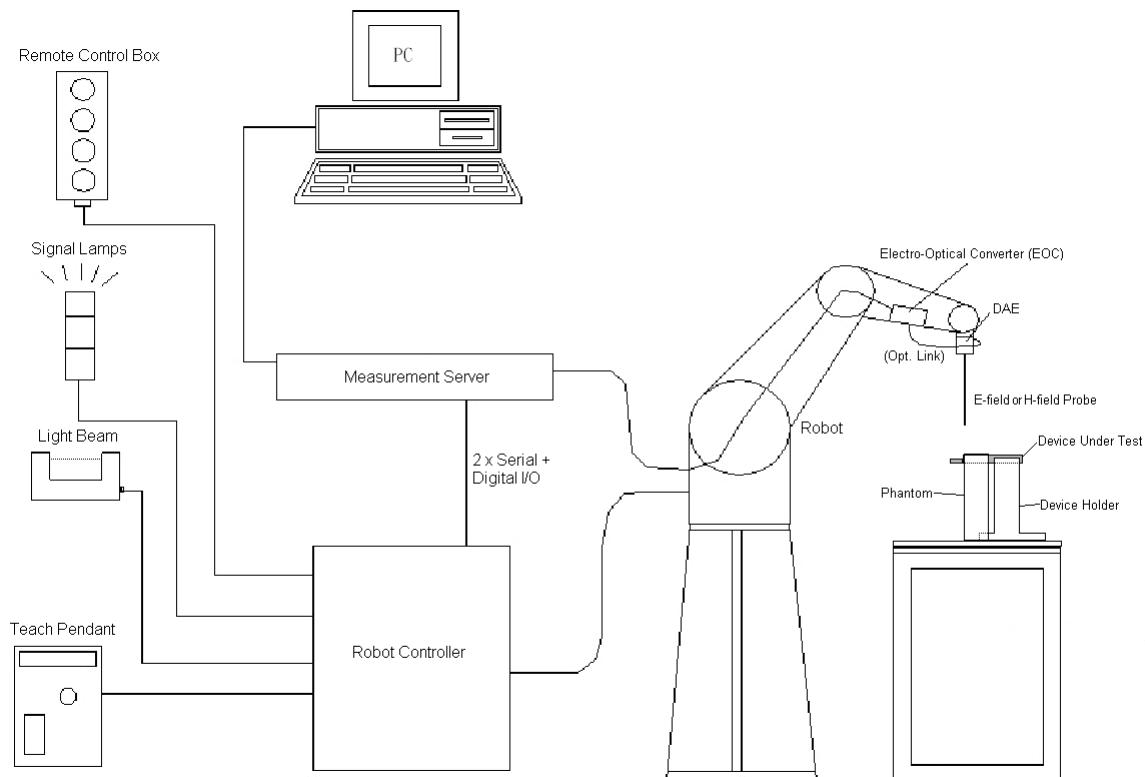


Fig 5.1 SPEAG DASY5 System Configurations

The DASY5 system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (ECO) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY5 software
- Remote 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.

5.1 E-Field and H-Field Probe System

The HAC measurement is conducted with the dosimetric probe ER3DV6 and H3DV6 (manufactured by SPEAG). The probe is specially designed and calibrated. This probe has a built in optical surface detection system to prevent from collision with DUT.

5.1.1 *E-Field Probe Specification*

<ER3DV6>

| | |
|----------------------|--|
| Construction | One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges |
| Calibration | In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$, k=2) |
| Frequency | 100 MHz to 6 GHz; Linearity: ± 2.0 dB (100 MHz to 3 GHz) |
| Directivity | ± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis) |
| Dynamic Range | 2 V/m to 1000 V/m (M3 or better device readings fall well below diode compression point) |
| Linearity | ± 0.2 dB |
| Dimensions | Overall length: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm |

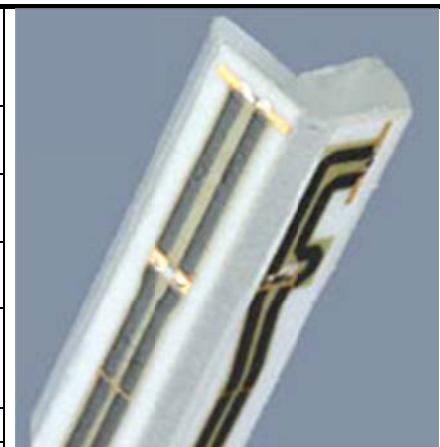


Fig 5.2 Photo of E-field Probe

5.1.2 *H-Field Probe Description*

<H3DV6>

| | |
|-----------------------------|---|
| Construction | Three concentric loop sensors with 3.8 mm loop diameters Resistively loaded detector diodes for linear response Built-in shielding against static charges |
| Frequency | 200 MHz to 3 GHz (absolute accuracy $\pm 6.0\%$, k=2); Output linearized |
| Directivity | ± 0.25 dB (spherical isotropy error) |
| Dynamic Range | 10 m A/m to 2 A/m at 1 GHz (M3 or better device readings fall well below diode compression point) |
| Dimensions | Overall length: 330 mm (Tip: 40 mm) Tip diameter: 6 mm (Body: 12 mm) Distance from probe tip to dipole centers: 3 mm |
| E-Field Interference | < 10% at 3 GHz (for plane wave) |

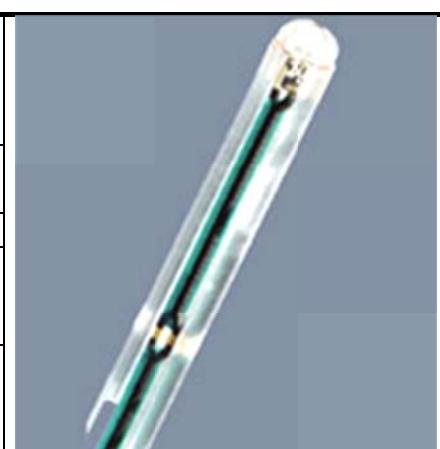


Fig 5.3 Photo of H-field Probe

5.1.3 Probe Tip Description

HAC field measurements take place in the close near field with high gradients. Increasing the measuring distance from the source will generally decrease the measured field values (in case of the validation dipole approx. 10% per mm).

Magnetic field sensors are measuring the integral of the H-field across their sensor area surrounded by the loop. They are calibrated in a precise, homogeneous field. When measuring a gradient field, the result will be very close to the field in the center of the loop which is equivalent to the value of a homogeneous field equivalent to the center value. But it will be different from the field at the border of the loop.

Consequently, two sensors with different loop diameters – both calibrated ideally – would give different results when measuring from the edge of the probe sensor elements. The behavior for electrically small E-field sensors is equivalent. See below for distance plots from a WD which show the conservative nature of field readings at the probe element center vs. measurements at the sensor end:

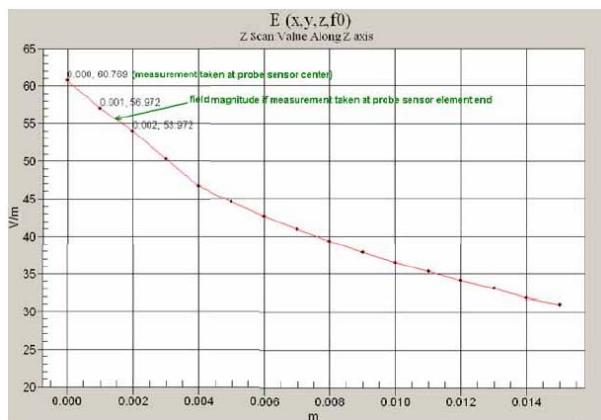


Fig 5.4 Z-Axis Scan at maximum point above a typical wireless device for E-field

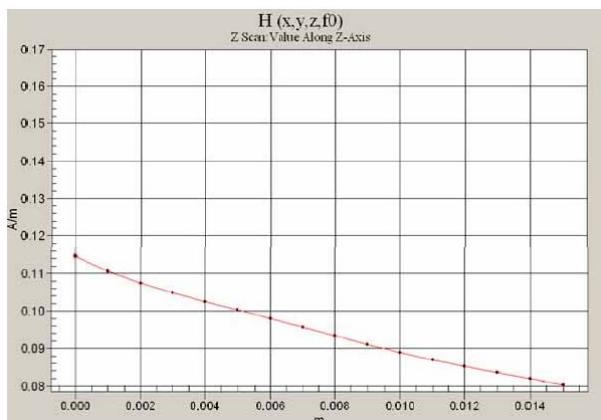


Fig 5.5 Z-Axis Scan at maximum point above a typical wireless device for H-field

The magnetic field loops of the H3D probes are concentric, with the center 3mm from the tip for H3DV6. Their radius is 1.9 mm.

The electric field probes have a more irregular internal geometry because it is physically not possible to have the 3 orthogonal sensors situated with the same center. The effect of the different sensor centers is accounted for in the HAC uncertainty budget ("sensor displacement"). Their geometric center is at 2.5 mm from the tip, and the element ends are 1.1 mm closer to the tip.

Where:

Peak Field = Peak field (in dB V/m or dB A/m)

Raw = Raw field measurement from the measurement system (in V/m or A/m).

PMF = Probe Modulation Factor (in Linear units). See Chapter 8 of test report.

5.2 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 5.6 Photo of DAE

5.3 Robot

The SPEAG DASY system uses the high precision robots (DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (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 5.7 Photo of DASY5

5.4 Measurement Server

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

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



Fig 5.8 Photo of Server for DASY5

5.5 Phone Positioner

The phone positioner shown in Fig. 5.11 is used to adjust DUT to the suitable position.



Fig 5.9 Phone Positioner

5.6 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



5.7 Data Storage and Evaluation

5.7.1 Data Storage

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings.

5.7.2 Data Evaluation

The DASY post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software :

| | | |
|----------------------------|---------------------------|---|
| Probe parameters : | - Sensitivity | Norm _i , a _{i0} , a _{i1} , a _{i2} |
| | - Conversion factor | ConvF _i |
| | - Diode compression point | dcp _i |
| Device parameters : | - Frequency | f |
| | - Crest factor | cf |
| Media parameters : | - Conductivity | σ |
| | - Density | ρ |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as :

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with V_i = compensated signal of channel i, ($i = x, y, z$)

U_i = input signal of channel i, ($i = x, y, z$)

cf = crest factor of exciting field (DASY parameter)

dcp_i = diode compression point (DASY parameter)



From the compensated input signals, the primary field data for each channel can be evaluated :

$$\text{E-field Probes : } \mathbf{E}_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}}$$

$$\text{H-field Probes : } \mathbf{H}_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with V_i = compensated signal of channel i, ($i = x, y, z$)

Norm_i = sensor sensitivity of channel i, ($i = x, y, z$), $\mu\text{V}/(\text{V}/\text{m})^2$ for E-field Probes

ConvF = sensitivity enhancement in solution

a_{ij} = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

E_i = electric field strength of channel i in V/m

H_i = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude) :

$$\mathbf{E}_{\text{tot}} = \sqrt{\mathbf{E}_x^2 + \mathbf{E}_y^2 + \mathbf{E}_z^2}$$

The primary field data are used to calculate the derived field units.

The measurement/integration time per point, as specified by the system manufacturer is > 500 ms. The signal response time is evaluated as the time required by the system to reach 90% of the expected final value after an on/off switch of the power source with an integration time of 500 ms and a probe response time of < 5 ms. In the current implementation, DASY waits longer than 100 ms after having reached the grid point before starting a measurement, i.e., the response time uncertainty is negligible.

If the device under test does not emit a CW signal, the integration time applied to measure the electric field at a specific point may introduce additional uncertainties due to the discretization. The tolerances for the different systems had the worst-case of 2.6%.



5.8 Test Equipment List

| Manufacturer | Name of Equipment | Type/Model | Serial Number | Calibration | |
|--------------|--------------------------------------|------------|---------------|---------------|---------------|
| | | | | Last Cal. | Due Date |
| SPEAG | Isotropic E-Field Probe | ER3DV6 | 2476 | Nov. 23, 2010 | Nov. 22, 2011 |
| SPEAG | Isotropic H-Field Probe | H3DV6 | 6300 | Nov. 25, 2010 | Nov. 24, 2011 |
| SPEAG | 835MHz Calibration Dipole | CD835V3 | 1171 | May 02, 2011 | May 01, 2012 |
| SPEAG | 1880MHz Calibration Dipole | CD1880V3 | 1155 | May 03, 2011 | May 02, 2012 |
| SPEAG | Data Acquisition Electronics | DAE4 | 1210 | Nov. 18, 2010 | Nov. 17, 2011 |
| SPEAG | HAC Phantom | N/A | 1105 | NCR | NCR |
| Agilent | Wireless Communication Test Set | E5515C | GB47050646 | Aug. 18, 2011 | Aug. 17, 2012 |
| R&S | Universal Radio Communication Tester | CMU200 | 116456 | Sep. 10, 2011 | Sep. 09, 2012 |
| AR | Amplifier | 551G4 | 333096 | NCR | NCR |
| R&S | Spectrum Analyzer | FSP30 | 101400 | Jun. 02, 2011 | Jun. 01, 2012 |
| R&S | Signal Generator | SMR40 | 100455 | Jan. 06, 2011 | Jan. 05, 2012 |

Table 5.1 Test Equipment List



6. Uncertainty Assessment

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty 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, manufacturer'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 6.1.

| Uncertainty Distributions | Normal | Rectangular | Triangular | U-Shape |
|------------------------------------|-------------|--------------|--------------|--------------|
| Multi-plying Factor ^(a) | $1/k^{(b)}$ | $1/\sqrt{3}$ | $1/\sqrt{6}$ | $1/\sqrt{2}$ |

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

Table 6.1 Multiplying Fractions 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 6.2.



| Error Description | Uncertainty Value (±%) | Probability Distribution | Divisor | Ci (E) | Ci (H) | Standard Uncertainty (E) | Standard Uncertainty (H) |
|--------------------------------------|---------------------------|--------------------------|------------|-----------|-----------|-----------------------------|-----------------------------|
| Measurement System | | | | | | | |
| Probe Calibration | 5.1 | Normal | 1 | 1 | 1 | ± 5.1 % | ± 5.1 % |
| Axial Isotropy | 4.7 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.7 % | ± 2.7 % |
| Sensor Displacement | 16.5 | Rectangular | $\sqrt{3}$ | 1 | 0.145 | ± 9.5 % | ± 1.4 % |
| Test Arch | 7.2 | Rectangular | $\sqrt{3}$ | 1 | 0 | ± 4.1 % | ± 0.0 % |
| Linearity | 4.7 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.7 % | ± 2.7 % |
| Scaling to Peak Envelope Power | 0.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.0 % | ± 0.0 % |
| System Detection Limit | 1.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Readout Electronics | 0.3 | Normal | 1 | 1 | 1 | ± 0.3 % | ± 0.3 % |
| Response Time | 0.8 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.5 % | ± 0.5 % |
| Integration Time | 2.6 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.5 % | ± 1.5 % |
| RF Ambient Conditions | 3.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.7 % | ± 1.7 % |
| RF Reflections | 12.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 6.9 % | ± 6.9 % |
| Probe Positioner | 1.2 | Rectangular | $\sqrt{3}$ | 1 | 0.67 | ± 0.7 % | ± 0.5 % |
| Probe Positioning | 4.7 | Rectangular | $\sqrt{3}$ | 1 | 0.67 | ± 2.7 % | ± 1.8 % |
| Extrap. and Interpolation | 1.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Test Sample Related | | | | | | | |
| Device Positioning Vertical | 4.7 | Rectangular | $\sqrt{3}$ | 1 | 0.67 | ± 2.7 % | ± 1.8 % |
| Device Positioning Lateral | 1.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Device Holder and Phantom | 2.4 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.4 % | ± 1.4 % |
| Power Drift | 5.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.9 % | ± 2.9 % |
| Phantom and Setup Related | | | | | | | |
| Phantom Thickness | 2.4 | Rectangular | $\sqrt{3}$ | 1 | 0.67 | ± 1.4 % | ± 0.9 % |
| Combined Standard Uncertainty | | | | | | ± 15.2 % | ± 10.8 % |
| Coverage Factor for 95 % | | | | | | K = 2 | |
| Expanded Uncertainty | | | | | | ± 30.4 % | ± 21.6 % |

Table 6.2 Uncertainty Budget of DASY

7. HAC RF Emission Measurement Evaluation

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the test Arch and a corresponding distance holder.

7.1 Purpose of System Performance Check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal HAC measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

7.2 System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave which comes from a signal generator. The calibrated dipole must be placed beneath the arch phantom. The equipment setup is shown below:

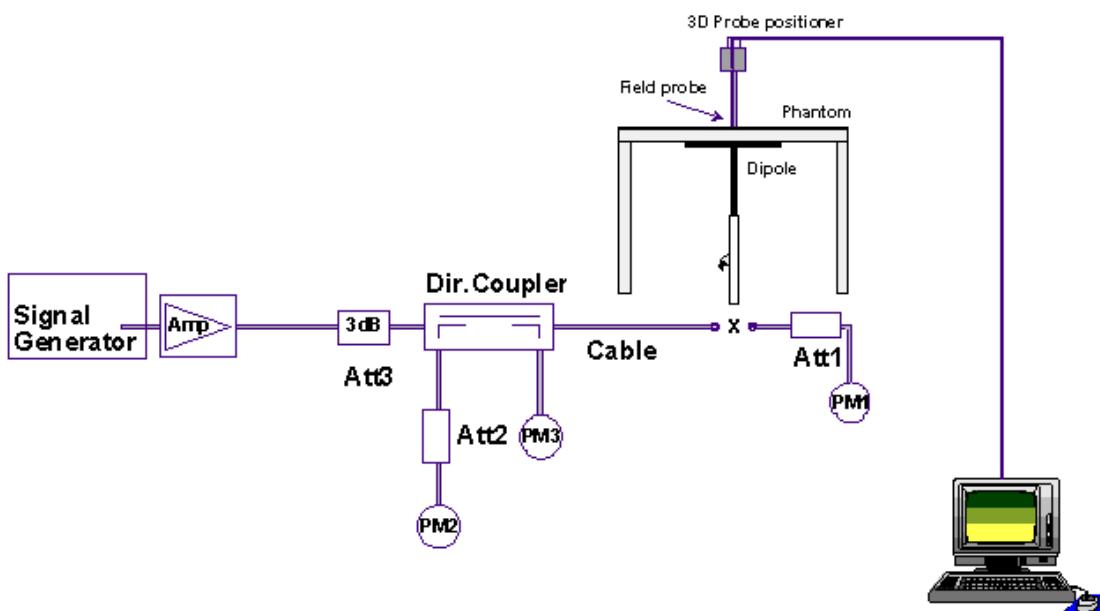


Fig. 7.1 System Setup of System Evaluation

1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. Calibrated Dipole

The output power on dipole port must be calibrated to 20dBm (100mW) before dipole is connected.



Fig 7.2 Dipole Setup

7.3 Validation Results

Comparing to the original E-field or H-field value provided by SPEAG, the validation data should be within its specification of 25 %. Table 7.1 shows the target value and measured value. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to appendix A of this report.

| Frequency (MHz) | Input Power (dBm) | Target Value (V/m) | E-Field 1 (V/m) | E-Field 2 (V/m) | Average Value (V/m) | Deviation (%) | Date |
|-----------------|-------------------|--------------------|-----------------|-----------------|---------------------|---------------|---------------|
| 835 | 20 | 165.3 | 166.2 | 158.7 | 162.45 | -1.72 | Sep. 29, 2011 |
| 1880 | 20 | 142 | 146.3 | 143.7 | 145 | 2.11 | Sep. 29, 2011 |
| Frequency (MHz) | Input Power (dBm) | Target Value (A/m) | H-Field (A/m) | | | Deviation (%) | Date |
| 835 | 20 | 0.474 | 0.482 | | | 1.69 | Sep. 29, 2011 |
| 1880 | 20 | 0.464 | 0.439 | | | -5.39 | Sep. 29, 2011 |

Table 7.1 Test Results of System Validation

Note: Deviation = ((E or H-field Result) - (Target field)) / (Target field) * 100%

8. RF Field Probe Modulation Factor

A calibration shall be made of the modulation response of the probe and its instrumentation chain. This calibration shall be performed with the field probe, attached to the instrumentation that is to be used with it during the measurement. The response of the probe system to a CW field at the frequency(s) of interest is compared to its response to a modulated signal with equal peak amplitude. The field level of the test signals shall be more than 10 dB above the ambient level and the noise floor of the instrumentation being used. The ratio of the CW reading to that taken with a modulated field shall be applied to the readings taken of modulated fields of the specified type.

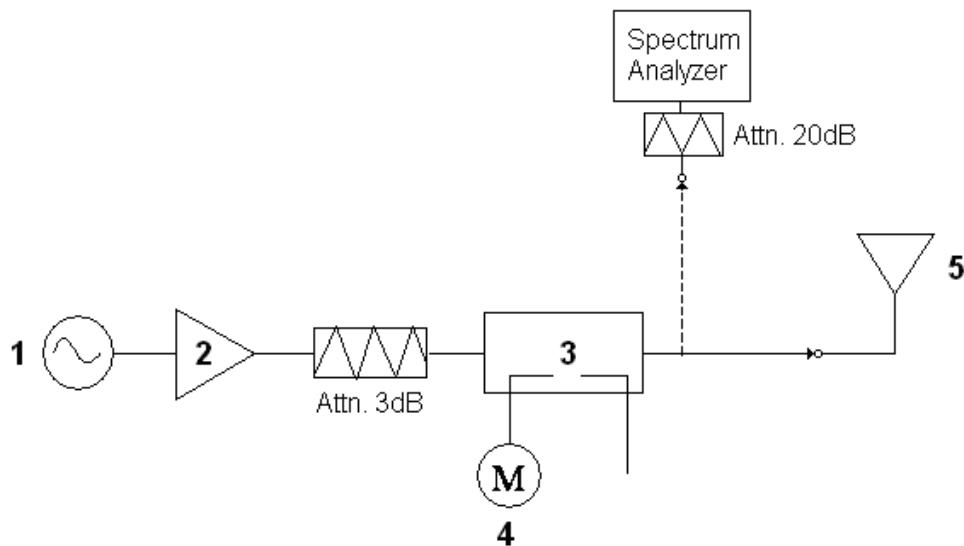


Fig. 8.1 System Calibration

This was done using the following procedure:

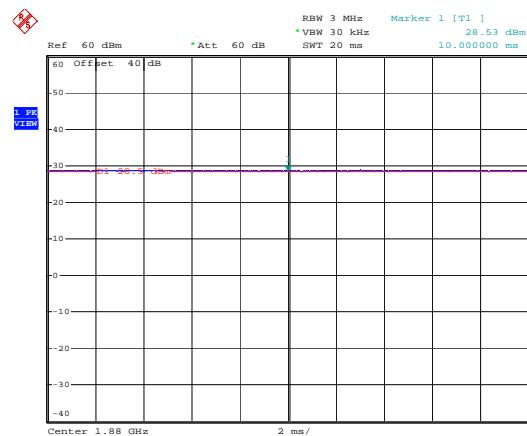
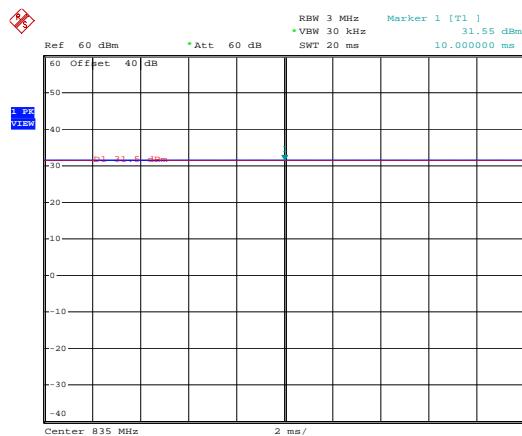
1. Fixing the probe in a set location relative to a field generating device.
2. Illuminate the probe with a CW signal at the intended measurement frequency.
3. Record the reading of the probe measurement system of the CW signal.
4. Determine the level of the CW signal being used to drive the field generating device.
5. Substitute a signal using the same modulation as that used by the intended WD for the CW signal.
6. Set the peak amplitude during transmission of the modulated signal to equal the amplitude of the CW signal.
7. Record the reading of the probe measurement system of the modulated signal.
8. The ratio of the CW to modulated signal reading is the modulation factor.
9. Repeat 2~8 steps at intended measurement frequency for both E and H field probe.



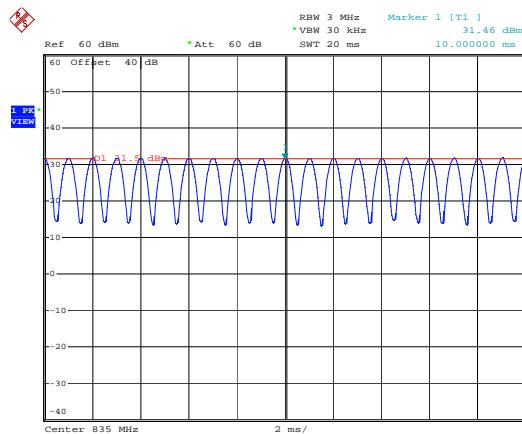
PMF Measurement Summary:

| Frequency (MHz) | Functions | E-field | H-field | PMF | |
|--------------------|-----------|---------|---------|---------|---------|
| | | V/m | A/m | E-field | H-field |
| 835 | CW | 630.0 | 1.703 | - | - |
| 835 | AM 80% | 393.5 | 1.350 | 1.60 | 1.26 |
| 835 | GSM | 234.0 | 1.081 | 2.69 | 1.58 |
| 1880 | CW | 416.7 | 1.368 | - | - |
| 1880 | AM 80% | 259.3 | 1.104 | 1.61 | 1.24 |
| 1880 | GSM | 153.0 | 0.983 | 2.72 | 1.39 |

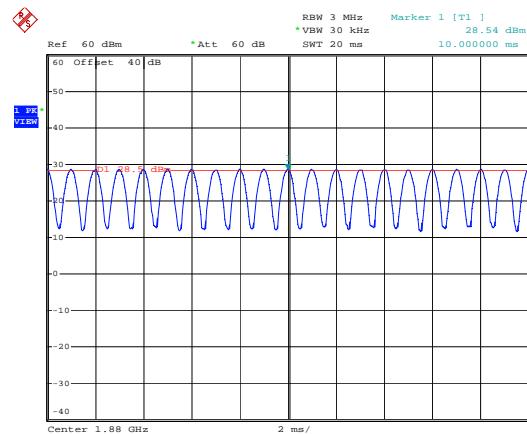
Zero span Spectrum Plots for RF Field Probe Modulation Factor



835MHz - CW



835MHz - 80% AM

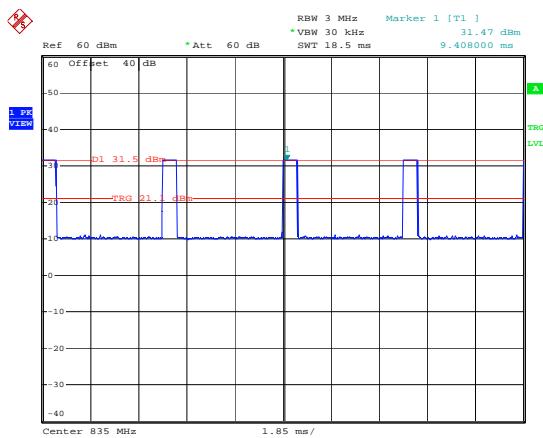


1880MHz - 80% AM

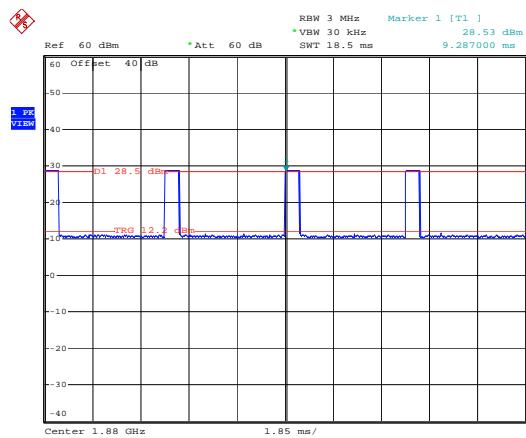


FCC HAC RF Emissions Test Report

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835MHz - GSM



1880MHz - GSM

9. Description for DUT Testing Position

The DUT was put on device holder and adjusted to the accurate and reliable position. Please refer to Appendix E for the Setup photographs.

Fig. 9.1 illustrate the references and reference plane that shall be used in a typical DUT emissions measurement. The principle of this section is applied to DUT with similar geometry.

- The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids.
- The grid is centered on the audio frequency output transducer of the DUT.
- The grid is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the DUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 15 mm in front of, the reference plane.



Fig 9.1 A typical DUT reference and plane for HAC measurements

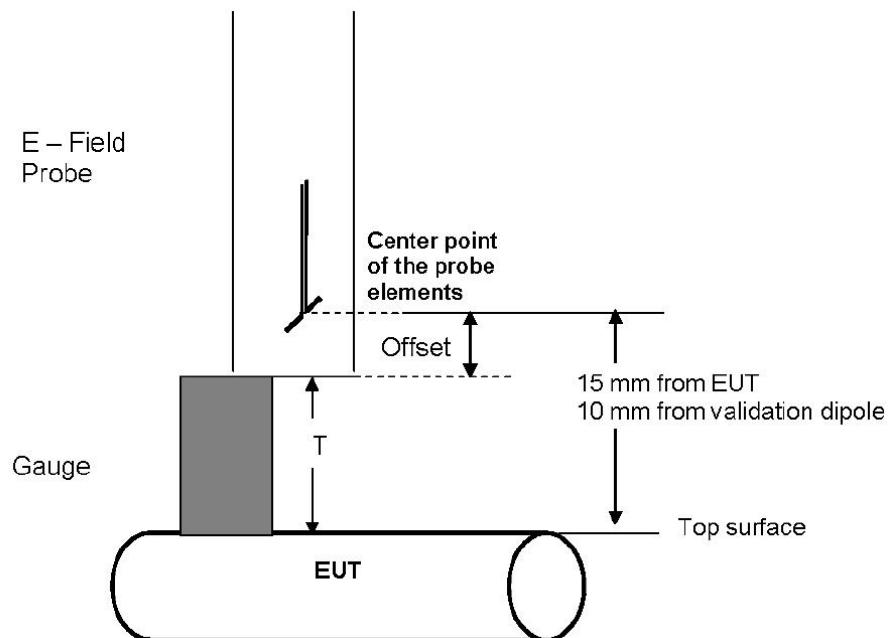


Fig. 9.2 Gauge block with E-field probe

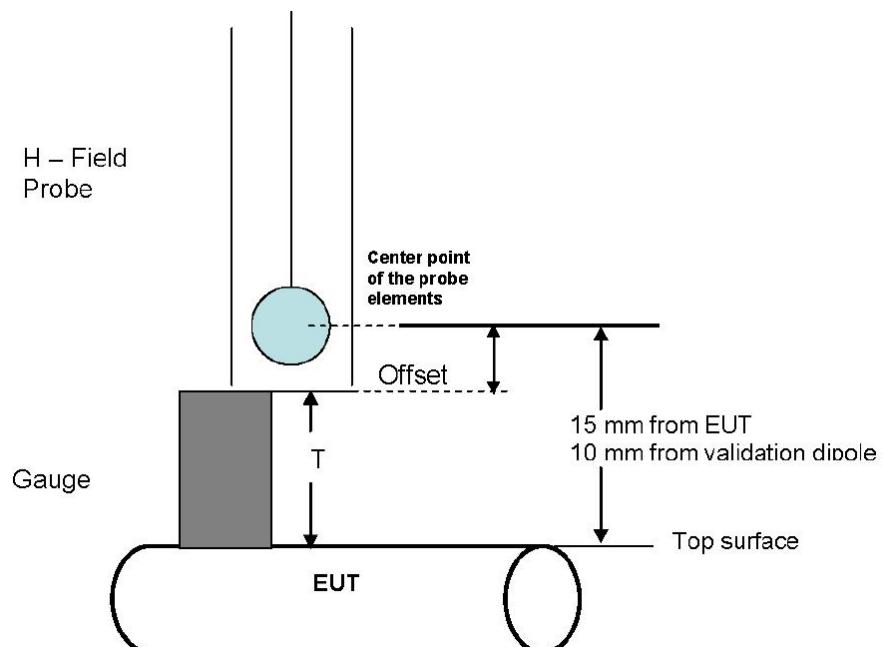


Fig. 9.3 Gauge block with H-field probe



10. RF Emissions Test Procedure

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

1. Proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed.
2. DUT is positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
3. The DUT operation for maximum rated RF output power was configured and confirmed with 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.
4. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The DUT audio output was positioned tangent (as physically possible) to the measurement plane.
5. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the test Arch.
6. The measurement system measured the field strength at the reference location.
7. Measurements at 5 mm increments in the 5 x 5 cm region were performed and recorded. A 360° rotation about the azimuth axis at the maximum interpolated position was measured. For the worst-case condition, the peak reading from this rotation was used in re-evaluating the HAC category.
8. The system performed a drift evaluation by measuring the field at the reference location.
9. Steps 1 ~ 8 were done for both the E and H-Field measurements.



11. HAC RF Emission Test Results

11.1 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 | 31.20 | 31.23 | 31.30 | 28.11 | 28.21 | 28.33 |

11.2 E-Field Emission

| Plot No. | Band | Mode | Channel | PMF | Peak E-Field (V/m) | M-Rating |
|----------|----------------|------------|------------|-------------|--------------------|-----------|
| 7 | GSM850 | GSM | 128 | 2.42 | 102.0 | M4 |
| 8 | GSM850 | GSM | 189 | 2.48 | 120.5 | M4 |
| 9 | GSM850 | GSM | 251 | 2.55 | 148.8 | M4 |
| 10 | GSM1900 | GSM | 512 | 2.15 | 42.457 | M4 |
| 11 | GSM1900 | GSM | 661 | 2.14 | 40.951 | M4 |
| 12 | GSM1900 | GSM | 810 | 2.12 | 38.501 | M4 |

11.3 H-Field Emission

| Plot No. | Band | Mode | Channel | PMF | Peak H-Field (A/m) | M-Rating |
|----------|----------------|------------|------------|-------------|--------------------|-----------|
| 4 | GSM850 | GSM | 128 | 2.84 | 0.291 | M4 |
| 5 | GSM850 | GSM | 189 | 2.85 | 0.337 | M4 |
| 6 | GSM850 | GSM | 251 | 2.85 | 0.412 | M4 |
| 1 | GSM1900 | GSM | 512 | 2.93 | 0.201 | M3 |
| 2 | GSM1900 | GSM | 661 | 2.93 | 0.199 | M3 |
| 3 | GSM1900 | GSM | 810 | 2.93 | 0.196 | M3 |

Remark:

1. The volume was adjusted to maximum level and the backlight turned off during RF Emission testing.
2. There is no special HAC mode software on this DUT.
3. Test Engineer : Suhe Yin



12. 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 System Performance Check

The plots are shown as follows.

HAC_E_Dipole_835_110929**DUT: HAC Dipole 835 MHz**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

E Scan - measurement distance from the probe sensor center to CD835 Dipole =**10mm/Hearing Aid Compatibility Test (41x361x1):** Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 158.7 V/m

Probe Modulation Factor = 1.000

Reference Value = 111.2 V/m; Power Drift = 0.05 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

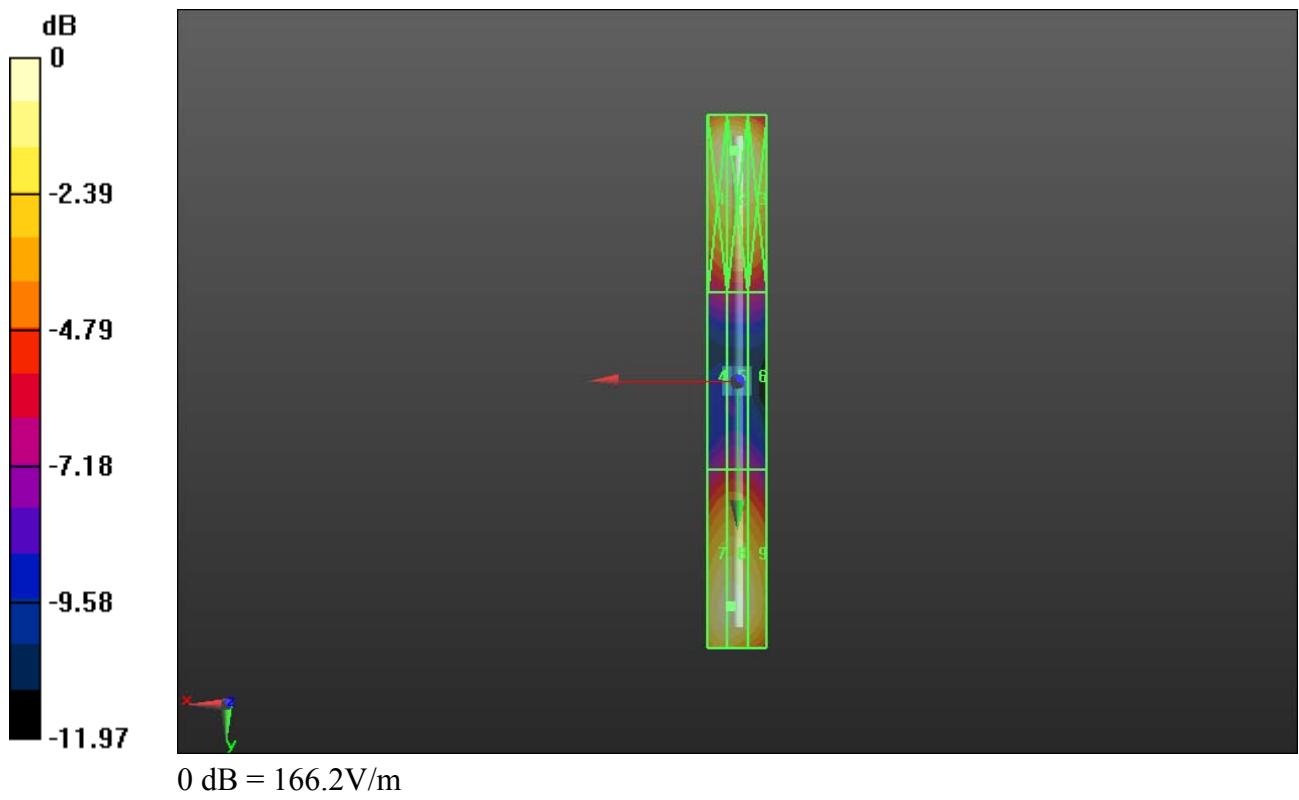
| Grid 1 | Grid 2 | Grid 3 |
|------------------|------------------|------------------|
| 164.1 M4 | 166.2 M4 | 158.5 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 80.397 M4 | 81.017 M4 | 80.536 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 158.4 M4 | 158.7 M4 | 149.5 M4 |

Cursor:

Total = 166.2 V/m

E Category: M4

Location: 1, -78, 4.7 mm



HAC_E_Dipole_1880_110929**DUT: HAC Dipole 1880 MHz**

Communication System: CW; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

E Scan - measurement distance from the probe sensor center to CD1880 Dipole =**10mm/Hearing Aid Compatibility Test (41x181x1):** Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 143.7 V/m

Probe Modulation Factor = 1.000

Reference Value = 145.3 V/m; Power Drift = -0.0046 dB

Hearing Aid Near-Field Category: M2 (AWF 0 dB)

Peak E-field in V/m

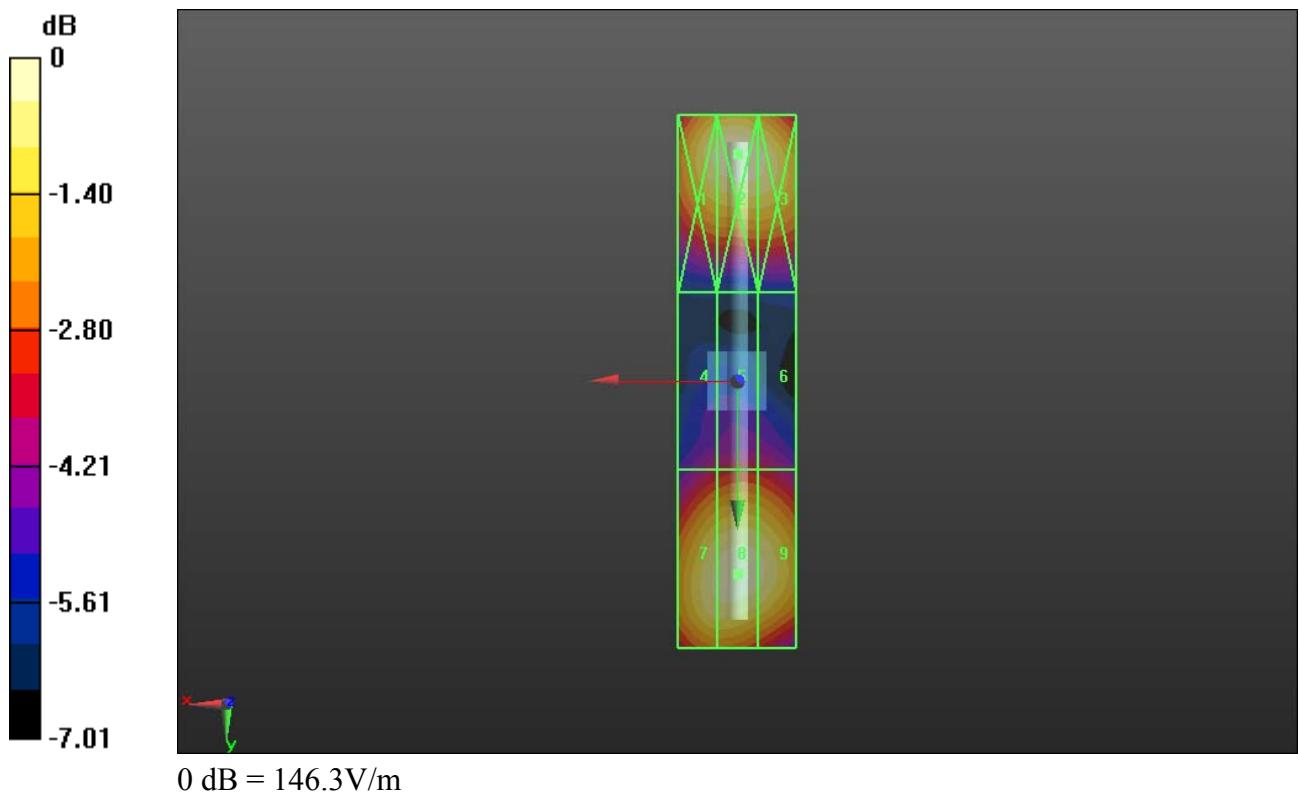
| Grid 1 | Grid 2 | Grid 3 |
|------------------|------------------|------------------|
| 141.3 M2 | 146.3 M2 | 142.2 M2 |
| Grid 4 | Grid 5 | Grid 6 |
| 95.790 M3 | 99.675 M3 | 98.185 M3 |
| Grid 7 | Grid 8 | Grid 9 |
| 140.8 M2 | 143.7 M2 | 140.9 M2 |

Cursor:

Total = 146.3 V/m

E Category: M2

Location: 0, -38.5, 4.7 mm



HAC_H_Dipole_835_110929**DUT: HAC Dipole 835 MHz**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

H Scan - measurement distance from the probe sensor center to CD835 Dipole =**10mm/Hearing Aid Compatibility Test (41x361x1):** Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.482 A/m

Probe Modulation Factor = 1.000

Reference Value = 0.511 A/m; Power Drift = 0.0033 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

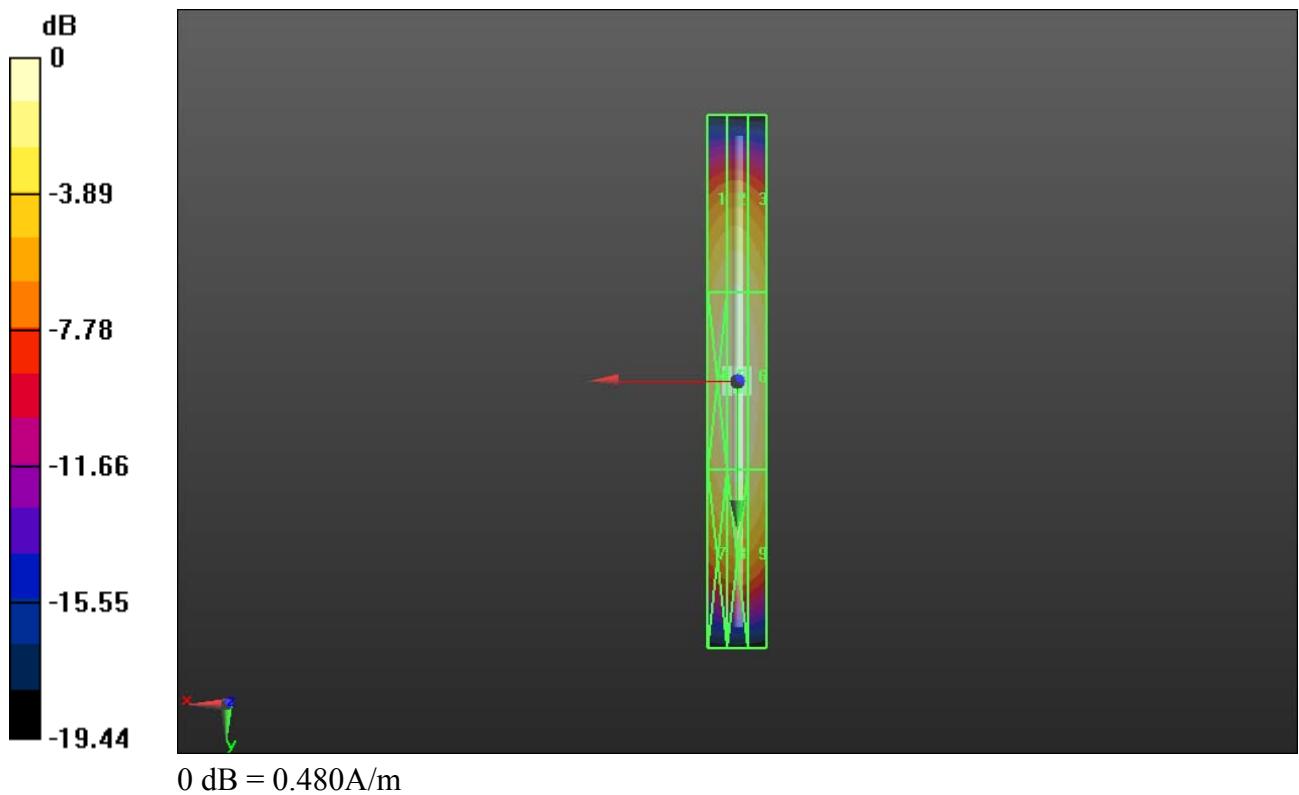
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.412 M4 | 0.426 M4 | 0.405 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.463 M4 | 0.482 M4 | 0.461 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.411 M4 | 0.433 M4 | 0.414 M4 |

Cursor:

Total = 0.482 A/m

H Category: M4

Location: 0, 2.5, 4.7 mm



HAC_H_Dipole_1880_110929**DUT: HAC Dipole 1880 MHz**

Communication System: CW; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

H Scan - measurement distance from the probe sensor center to CD1880 Dipole = 10mm/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm
 Maximum value of peak Total field = 0.439 A/m
 Probe Modulation Factor = 1.000
 Reference Value = 0.463 A/m; Power Drift = 0.00052 dB
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

Peak H-field in A/m

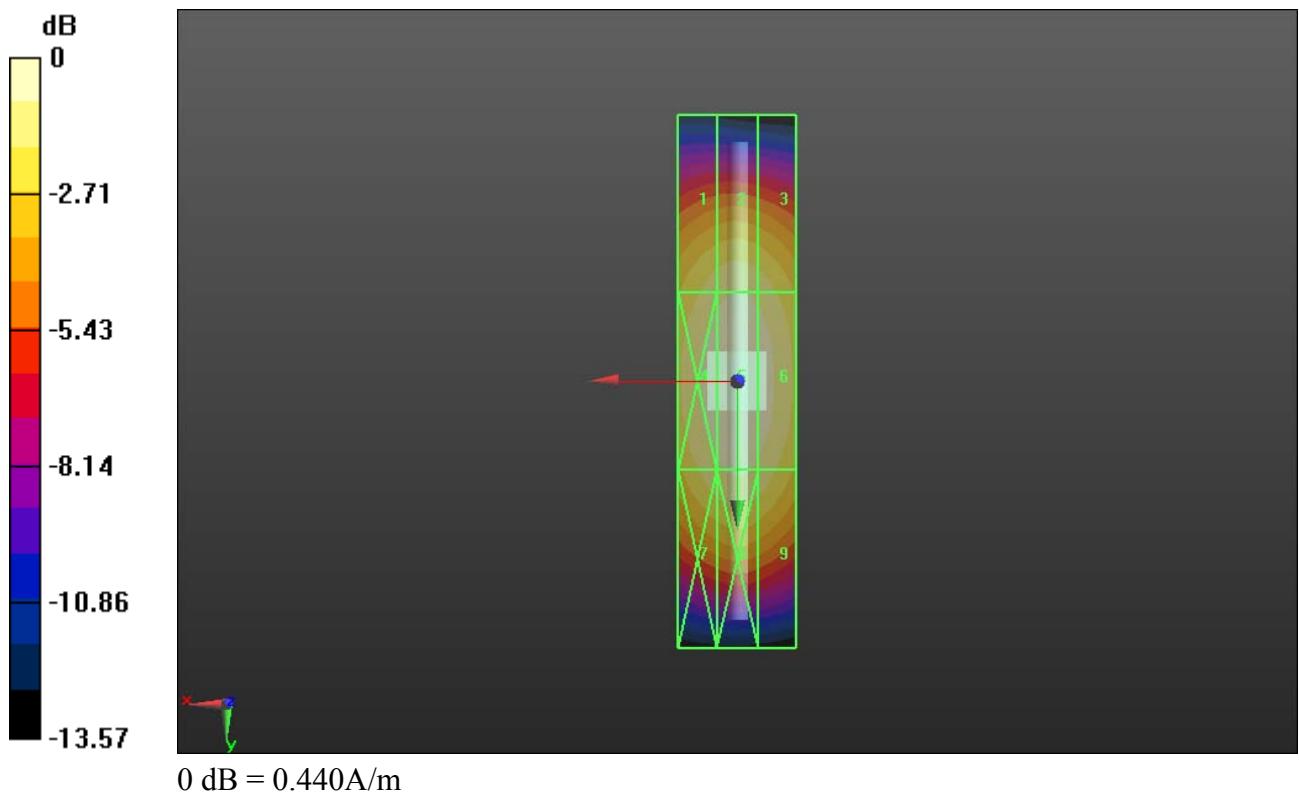
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.381 M2 | 0.398 M2 | 0.384 M2 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.424 M2 | 0.439 M2 | 0.422 M2 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.387 M2 | 0.403 M2 | 0.386 M2 |

Cursor:

Total = 0.439 A/m

H Category: M2

Location: 0, 0, 4.7 mm





Appendix B. Plots of RF Emission Measurement

The plots are shown as follows.

#07 HAC_E_GSM850_Ch128**DUT: 191701**

Communication System: Generic GSM; Frequency: 824.2 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch128/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 102.0 V/m

Probe Modulation Factor = 2.420

Reference Value = 49.130 V/m; Power Drift = 0.12 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak E-field in V/m

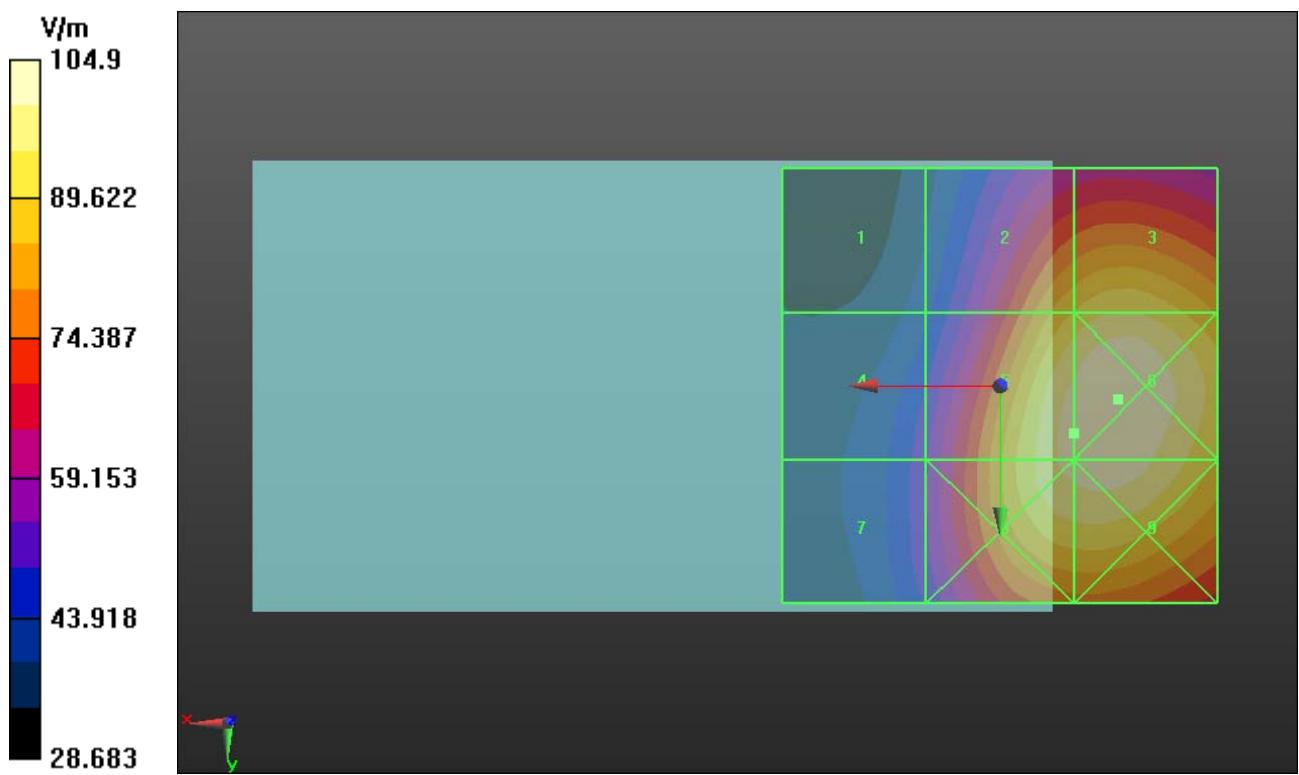
| Grid 1 | Grid 2 | Grid 3 |
|------------------|------------------|------------------|
| 43.241 M4 | 89.891 M4 | 94.847 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 53.553 M4 | 102.0 M4 | 104.9 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 54.128 M4 | 101.4 M4 | 102.9 M4 |

Cursor:

Total = 104.9 V/m

E Category: M4

Location: -13.5, 1.5, 8.7 mm



#08 HAC_E_GSM850_Ch189**DUT: 191701**

Communication System: Generic GSM; Frequency: 836.4 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch189/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 120.5 V/m

Probe Modulation Factor = 2.480

Reference Value = 57.079 V/m; Power Drift = -0.04 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak E-field in V/m

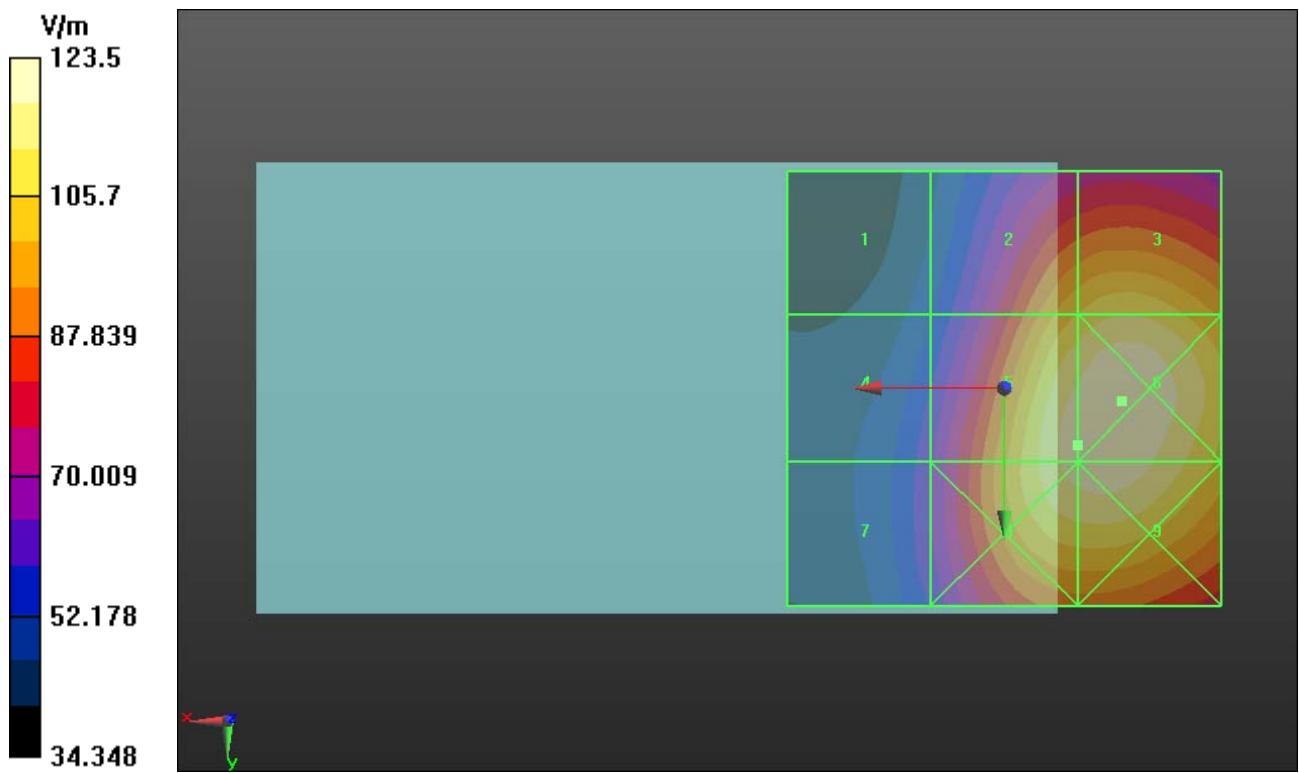
| Grid 1 | Grid 2 | Grid 3 |
|------------------|-----------------|-----------------|
| 51.601 M4 | 106.1 M4 | 111.5 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 63.233 M4 | 120.5 M4 | 123.5 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 64.100 M4 | 119.9 M4 | 121.5 M4 |

Cursor:

Total = 123.5 V/m

E Category: M4

Location: -13.5, 1.5, 8.7 mm



#09 HAC_E_GSM850_Ch251**DUT: 191701**

Communication System: Generic GSM; Frequency: 848.8 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch251/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 148.8 V/m

Probe Modulation Factor = 2.550

Reference Value = 68.242 V/m; Power Drift = -0.04 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak E-field in V/m

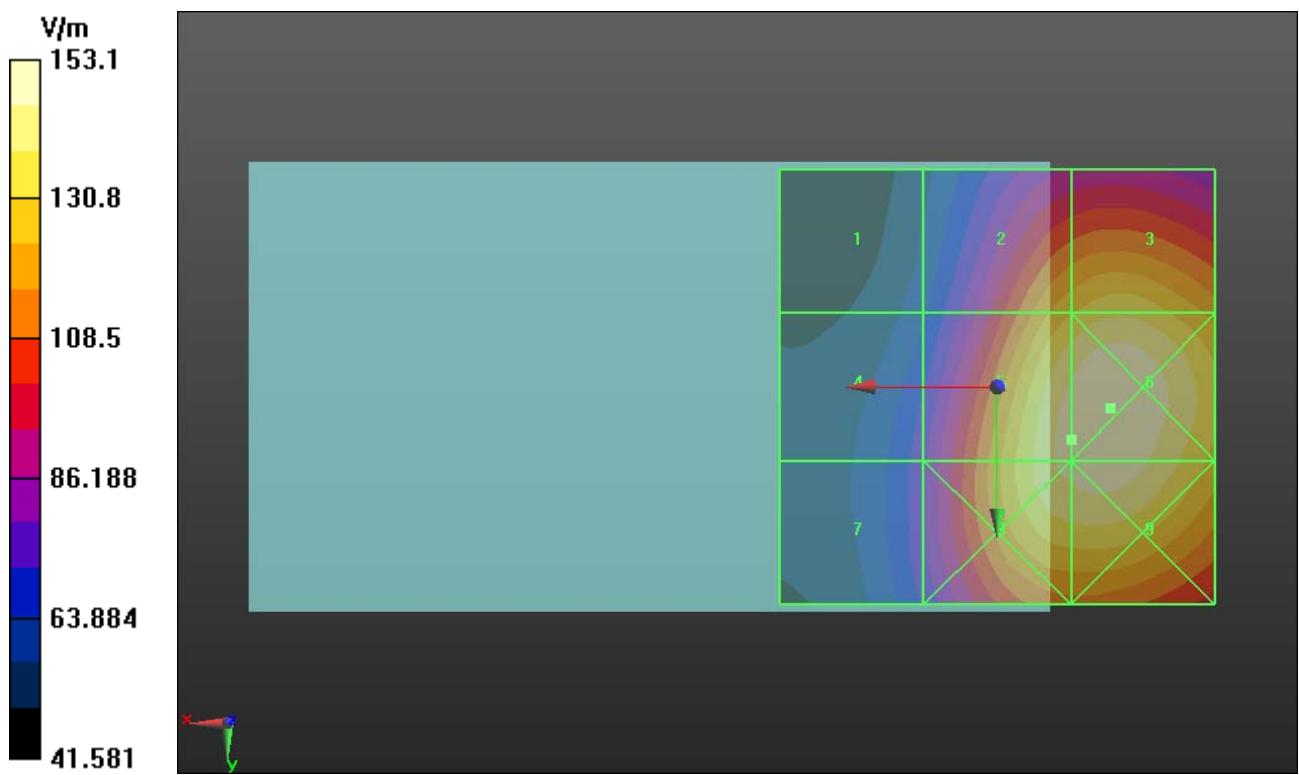
| Grid 1 | Grid 2 | Grid 3 |
|------------------|-----------------|-----------------|
| 63.035 M4 | 130.3 M4 | 137.2 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 77.212 M4 | 148.8 M4 | 153.1 M3 |
| Grid 7 | Grid 8 | Grid 9 |
| 78.164 M4 | 148.0 M4 | 150.4 M3 |

Cursor:

Total = 153.1 V/m

E Category: M3

Location: -13, 2.5, 8.7 mm



#10 HAC_E_GSM1900_Ch512**DUT: 191701**

Communication System: Generic GSM; Frequency: 1850.2 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch512/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 42.457 V/m

Probe Modulation Factor = 2.150

Reference Value = 16.967 V/m; Power Drift = 0.04 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak E-field in V/m

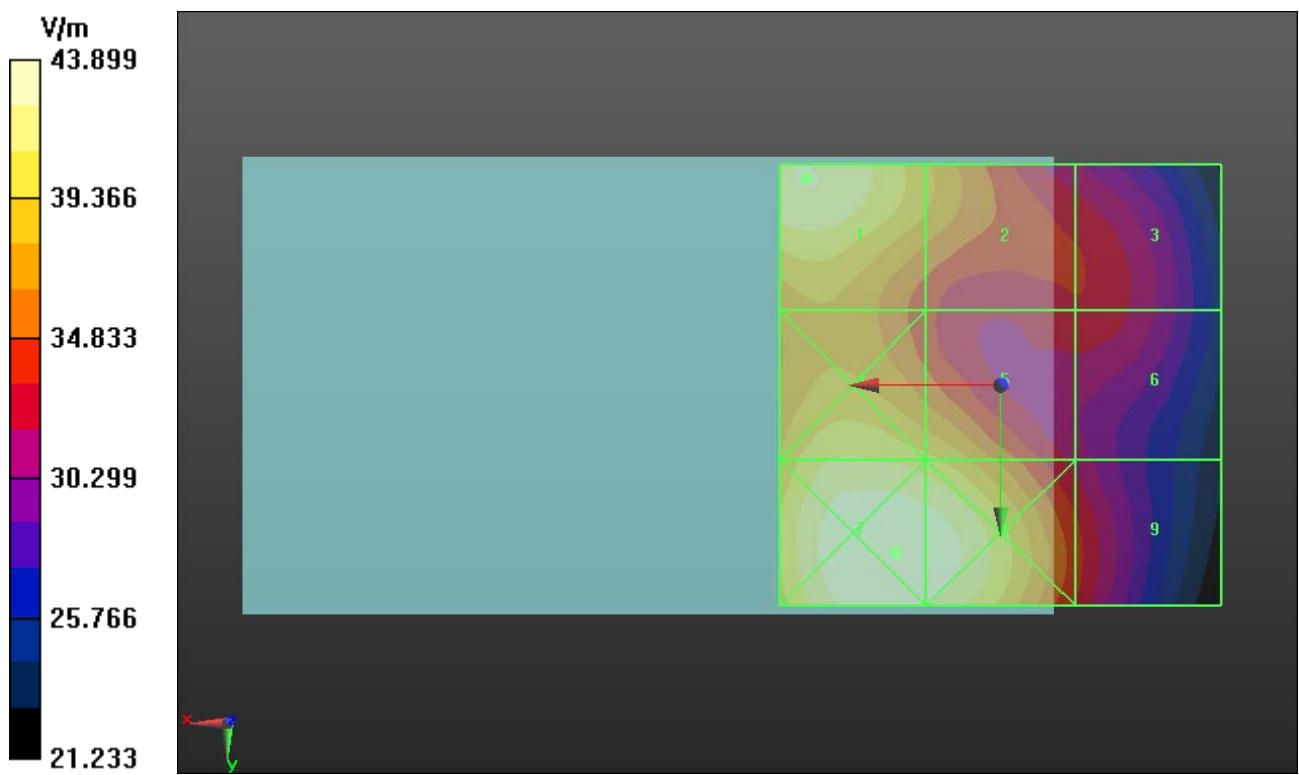
| Grid 1 | Grid 2 | Grid 3 |
|------------------|------------------|------------------|
| 42.457 M4 | 38.359 M4 | 33.517 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 41.084 M4 | 39.932 M4 | 33.069 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 43.899 M4 | 43.522 M4 | 34.088 M4 |

Cursor:

Total = 43.899 V/m

E Category: M4

Location: 12, 19, 8.7 mm



#11 HAC_E_GSM1900_Ch661**DUT: 191701**

Communication System: Generic GSM; Frequency: 1880 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch661/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 40.951 V/m

Probe Modulation Factor = 2.140

Reference Value = 15.666 V/m; Power Drift = -0.12 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak E-field in V/m

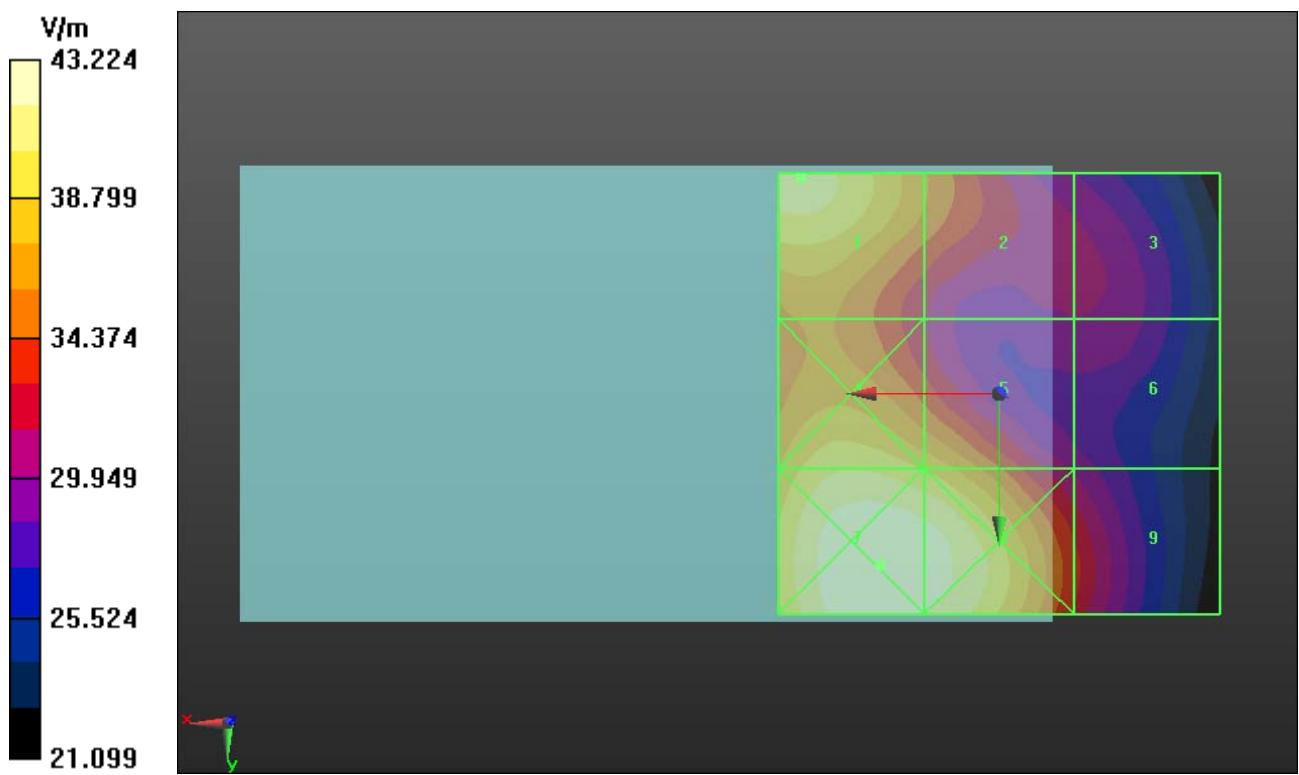
| Grid 1 | Grid 2 | Grid 3 |
|------------------|------------------|------------------|
| 40.951 M4 | 36.126 M4 | 30.630 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 40.196 M4 | 38.680 M4 | 29.966 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 43.224 M4 | 42.675 M4 | 33.498 M4 |

Cursor:

Total = 43.224 V/m

E Category: M4

Location: 13.5, 19.5, 8.7 mm



#12 HAC_E_GSM1900_Ch810**DUT: 191701**

Communication System: Generic GSM; Frequency: 1909.8 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2476; ConvF(1, 1, 1); Calibrated: 2010-11-23
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch810/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 38.501 V/m

Probe Modulation Factor = 2.120

Reference Value = 13.476 V/m; Power Drift = -0.0058 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak E-field in V/m

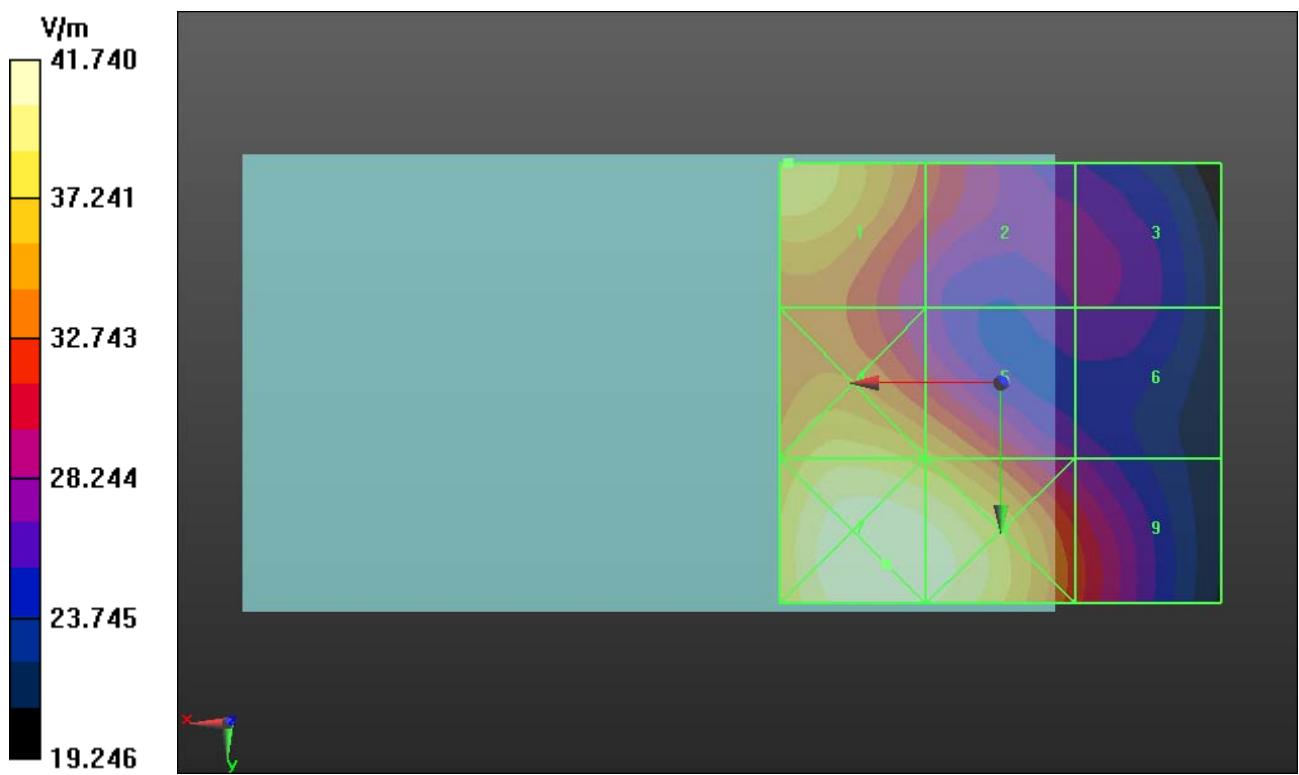
| Grid 1 | Grid 2 | Grid 3 |
|------------------|------------------|------------------|
| 38.501 M4 | 32.254 M4 | 27.309 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 38.304 M4 | 36.424 M4 | 27.070 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 41.740 M4 | 41.214 M4 | 32.134 M4 |

Cursor:

Total = 41.740 V/m

E Category: M4

Location: 13, 20.5, 8.7 mm



#04 HAC_H_GSM850_Ch128**DUT: 191701**

Communication System: Generic GSM; Frequency: 824.2 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch128/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.291 A/m

Probe Modulation Factor = 2.840

Reference Value = 0.098 A/m; Power Drift = -0.02 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak H-field in A/m

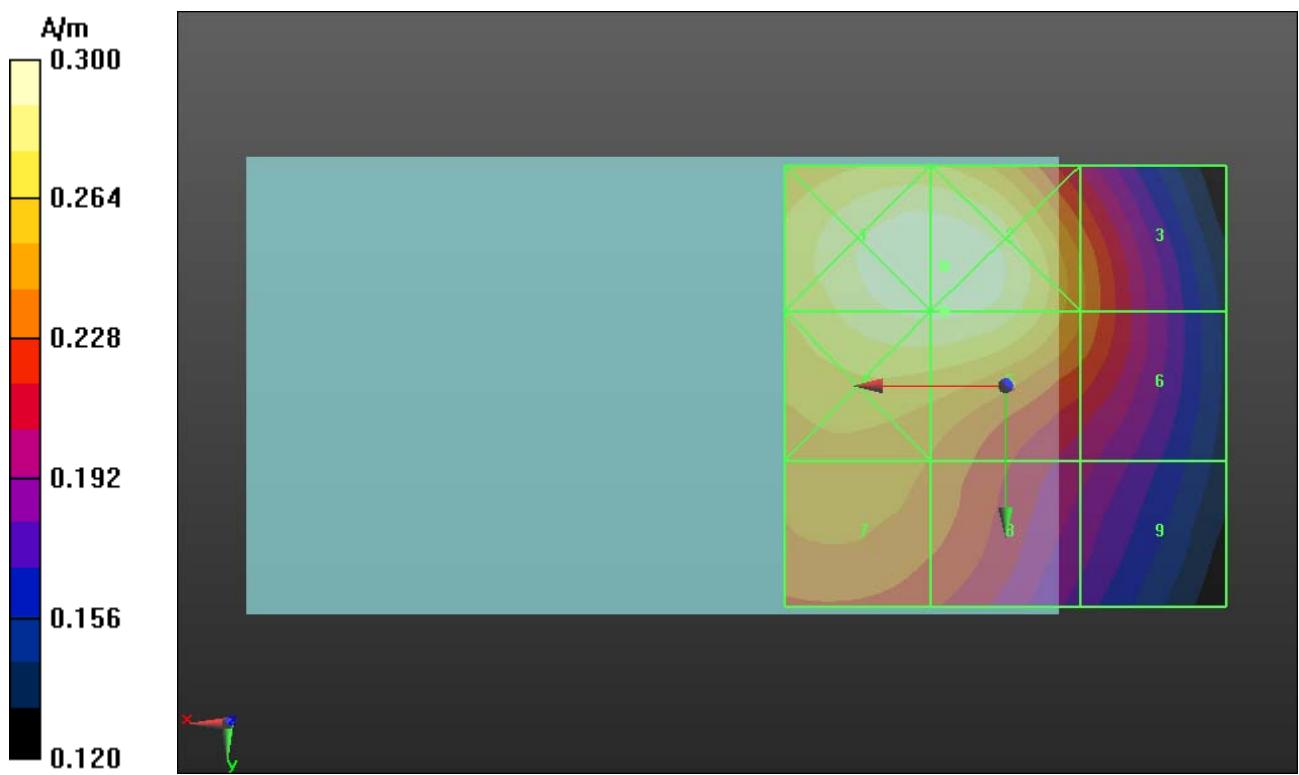
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.299 M4 | 0.300 M4 | 0.243 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.291 M4 | 0.291 M4 | 0.242 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.249 M4 | 0.239 M4 | 0.197 M4 |

Cursor:

Total = 0.300 A/m

H Category: M4

Location: 7, -13.5, 8.7 mm



#05 HAC_H_GSM850_Ch189**DUT: 191701**

Communication System: Generic GSM; Frequency: 836.4 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch189/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.337 A/m

Probe Modulation Factor = 2.850

Reference Value = 0.111 A/m; Power Drift = 0.01 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak H-field in A/m

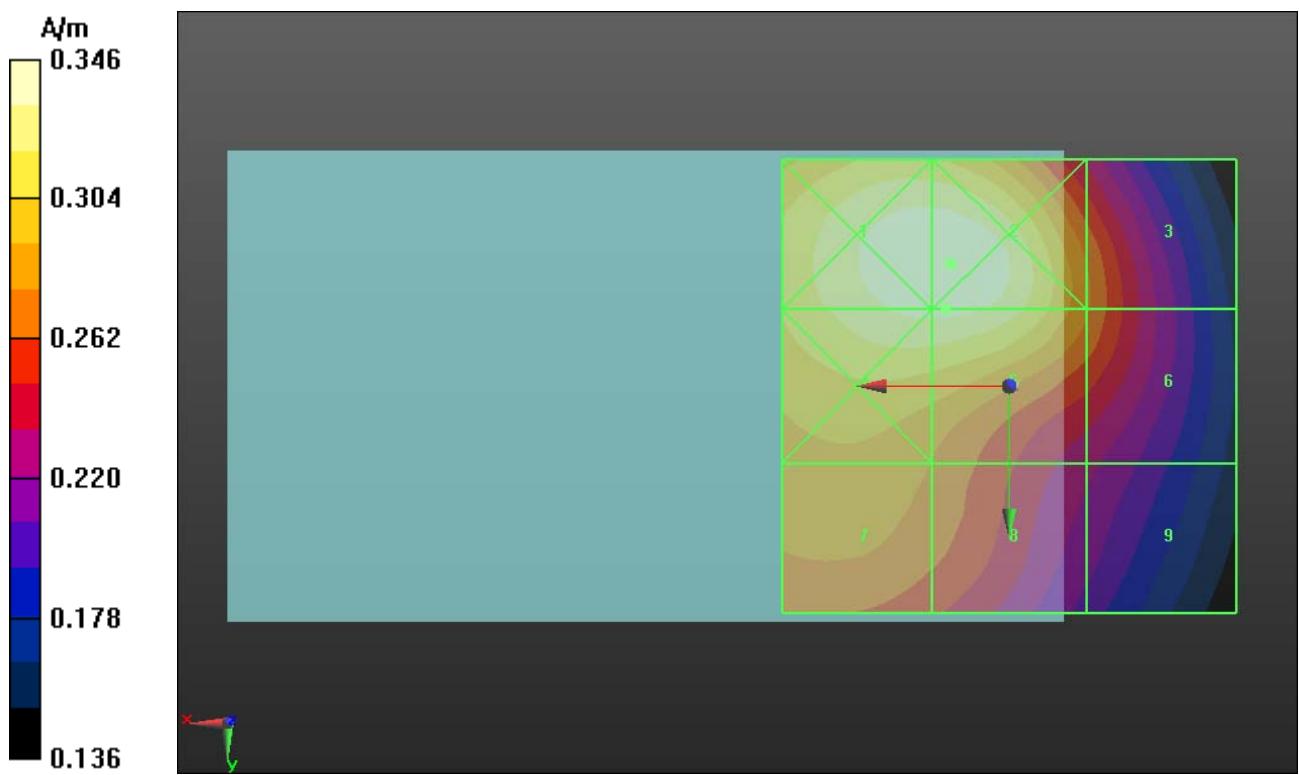
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.345 M4 | 0.346 M4 | 0.280 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.336 M4 | 0.337 M4 | 0.278 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.288 M4 | 0.276 M4 | 0.225 M4 |

Cursor:

Total = 0.346 A/m

H Category: M4

Location: 6.5, -13.5, 8.7 mm



#06 HAC_H_GSM850_Ch251**DUT: 191701**

Communication System: Generic GSM; Frequency: 848.8 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch251/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.412 A/m

Probe Modulation Factor = 2.850

Reference Value = 0.133 A/m; Power Drift = 0.06 dB

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

Peak H-field in A/m

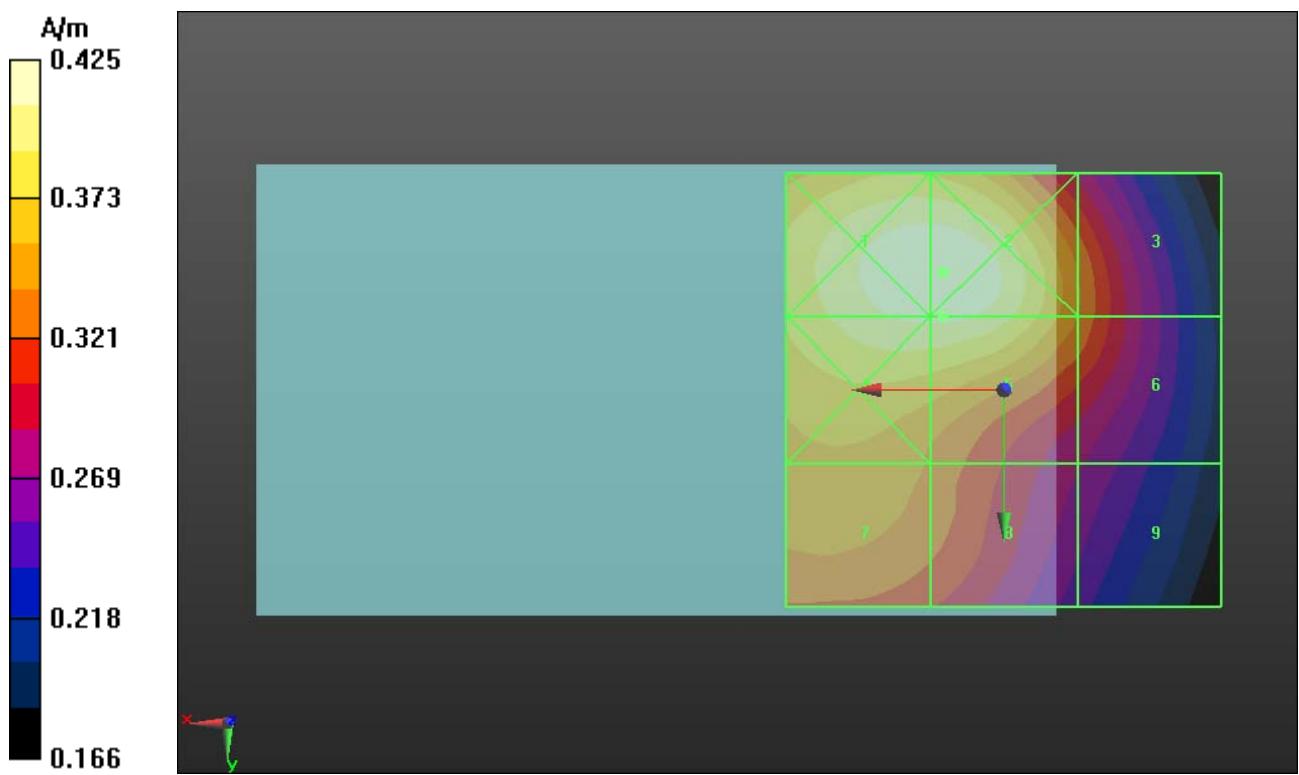
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.424 M4 | 0.425 M4 | 0.341 M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.412 M4 | 0.412 M4 | 0.338 M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.354 M4 | 0.336 M4 | 0.272 M4 |

Cursor:

Total = 0.425 A/m

H Category: M4

Location: 7, -13.5, 8.7 mm



#01 HAC_H_GSM1900_Ch512**DUT: 191701**

Communication System: Generic GSM; Frequency: 1850.2 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch512/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.201 A/m

Probe Modulation Factor = 2.930

Reference Value = 0.105 A/m; Power Drift = -0.03 dB

Hearing Aid Near-Field Category: M3 (AWF -5 dB)

Peak H-field in A/m

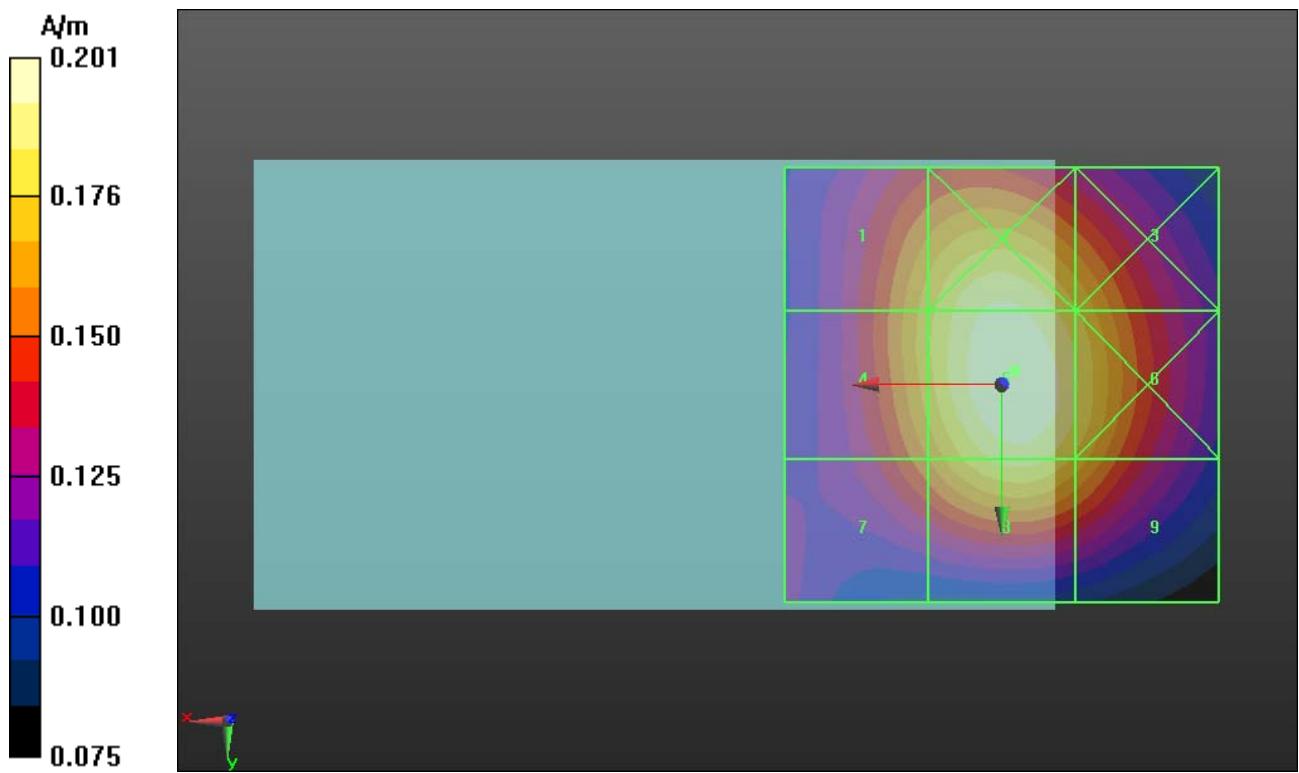
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.172 M3 | 0.195 M3 | 0.177 M3 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.174 M3 | 0.201 M3 | 0.185 M3 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.159 M3 | 0.188 M3 | 0.174 M3 |

Cursor:

Total = 0.201 A/m

H Category: M3

Location: -1.5, -1.5, 8.7 mm



#02 HAC_H_GSM1900_Ch661

DUT: 191701

Communication System: Generic GSM; Frequency: 1880 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch661/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.199 A/m

Probe Modulation Factor = 2.930

Reference Value = 0.103 A/m; Power Drift = 0.01 dB

Hearing Aid Near-Field Category: M3 (AWF -5 dB)

Peak H-field in A/m

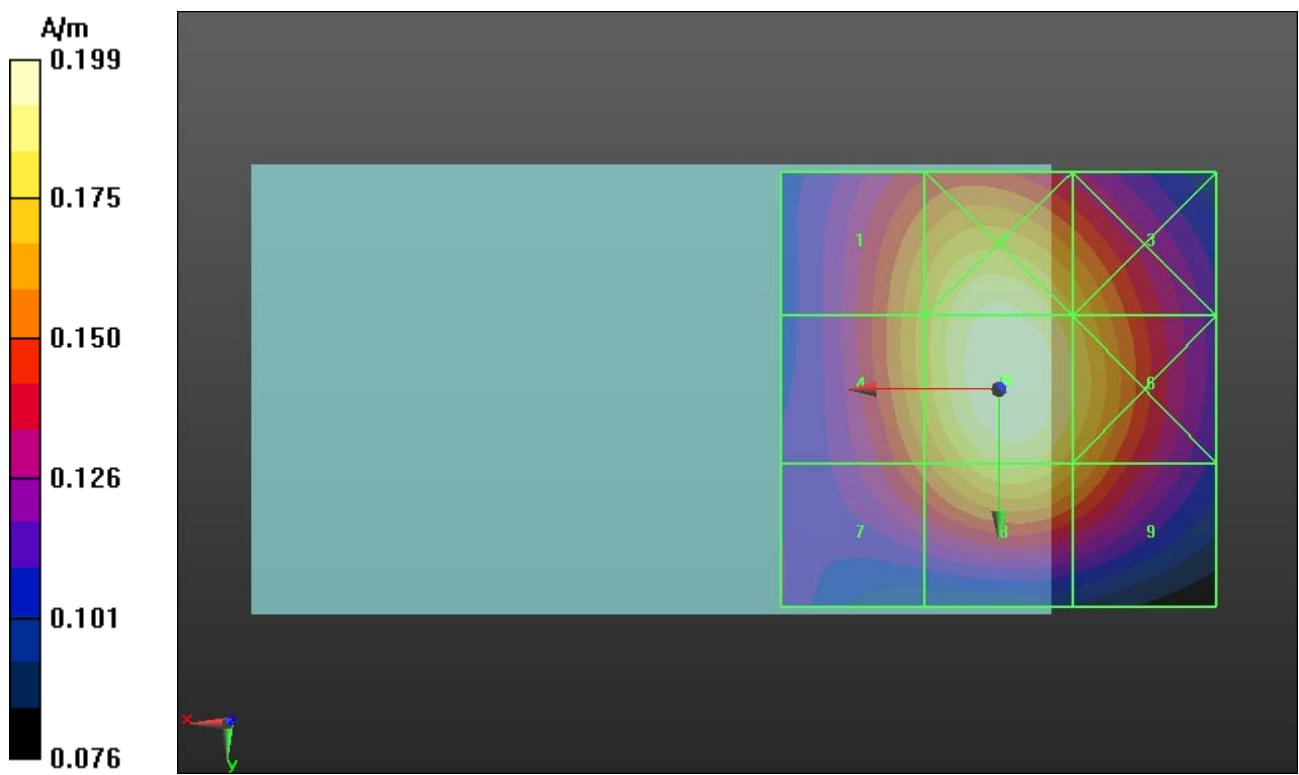
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.171 M3 | 0.194 M3 | 0.176 M3 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.172 M3 | 0.199 M3 | 0.184 M3 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.156 M3 | 0.185 M3 | 0.170 M3 |

Cursor:

Total = 0.199 A/m

H Category: M3

Location: -1, -1, 8.7 mm



#03 HAC_H_GSM1900_Ch810**DUT: 191701**

Communication System: Generic GSM; Frequency: 1909.8 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 0 \text{ kg/m}^3$

Ambient Temperature : 22.4 °C

DASY5 Configuration:

- Probe: H3DV6 - SN6300; ; Calibrated: 2010-11-25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1210; Calibrated: 2010-11-18
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

Ch810/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.196 A/m

Probe Modulation Factor = 2.930

Reference Value = 0.103 A/m; Power Drift = -0.06 dB

Hearing Aid Near-Field Category: M3 (AWF -5 dB)

Peak H-field in A/m

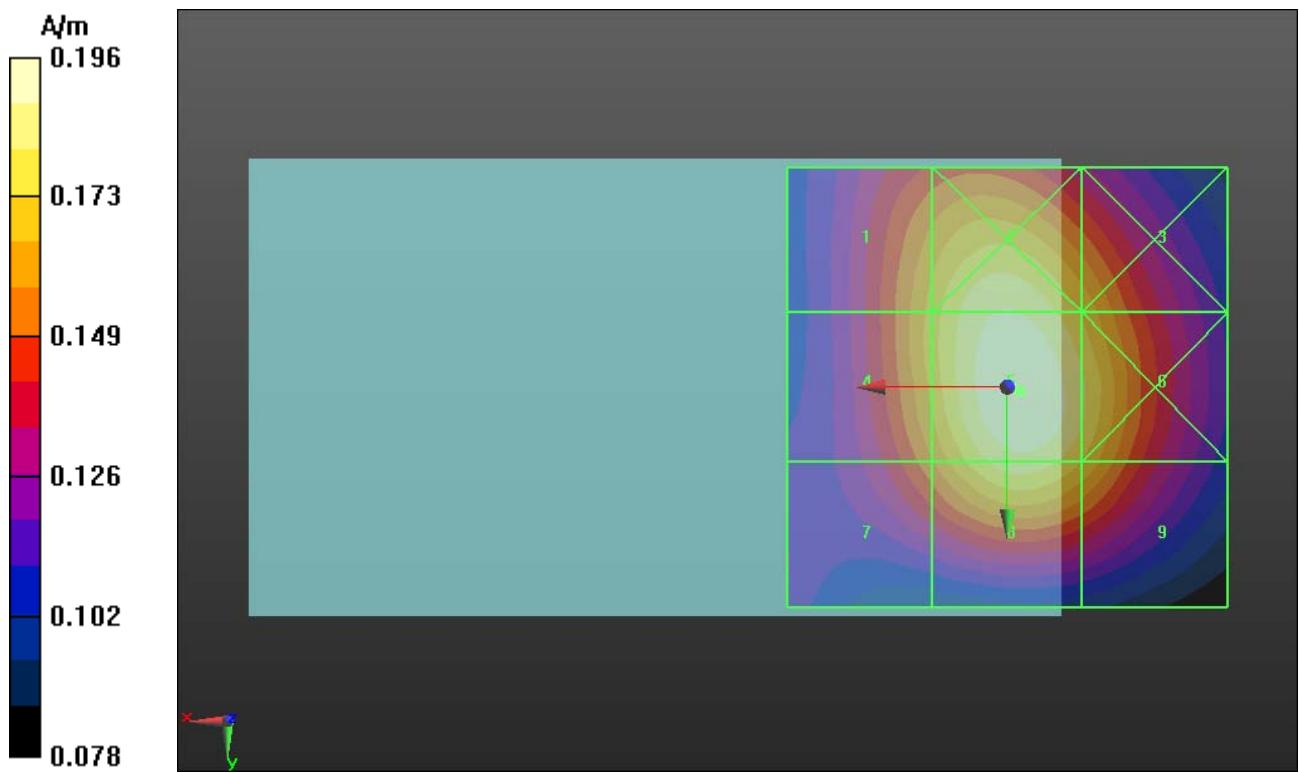
| Grid 1 | Grid 2 | Grid 3 |
|-----------------|-----------------|-----------------|
| 0.169 M3 | 0.189 M3 | 0.171 M3 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.170 M3 | 0.196 M3 | 0.182 M3 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.156 M3 | 0.186 M3 | 0.172 M3 |

Cursor:

Total = 0.196 A/m

H Category: M3

Location: -1.5, 0.5, 8.7 mm





Appendix C. DASY Calibration Certificate

The DASY calibration certificates are shown as follows.



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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Sporton Kunshan (Auden)**

Certificate No: **CD835V3-1171_May11**

CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1171**

Calibration procedure(s) **QA CAL-20.v5**
 Calibration procedure for dipoles in air

Calibration date: **May 02, 2011**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
 All calibrations have been conducted in the closed laboratory facility: environment temperature ($22 \pm 3^\circ\text{C}$) and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-----------------------|------------|--------------------------------|-----------------------|
| Power meter EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Probe ER3DV6 | SN: 2336 | 29-Dec-10 (No. ER3-2336_Dec10) | Dec-11 |
| Probe H3DV6 | SN: 6065 | 29-Dec-10 (No. H3-6065_Dec10) | Dec-11 |
| DAE4 | SN: 781 | 20-Apr-11 (No. DAE4-781_Apr11) | Apr-12 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---------------------------|----------------|-----------------------------------|------------------------|
| Power meter Agilent 4419B | SN: GB42420191 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482H | SN: 3318A09450 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482A | SN: US37295597 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |
| RF generator E4433B | MY 41000675 | 03-Nov-04 (in house check Oct-09) | In house check: Oct-11 |

Calibrated by: Name **Jeton Kastrati** Function **Laboratory Technician**

Approved by: Name **Fin Bomholt** Function **R&D Director**

Issued: May 9, 2011

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



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The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

References

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

Methods Applied and Interpretation of Parameters:

- *Coordinate System:* y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the top edge of the dipole arms.
- *Measurement Conditions:* Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- *Antenna Positioning:* The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- *Feed Point Impedance and Return Loss:* These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- *E-field distribution:* E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelism to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

1 Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|---|------------------|----------------------|
| DASY Version | DASY5 | V52.6.2 (424) |
| DASY PP Version | SEMCAD X | V14.4.4 (2829) |
| Phantom | HAC Test Arch | SD HAC P01 BA, #1070 |
| Distance Dipole Top - Probe Center | 10 mm | |
| Scan resolution | dx, dy = 5 mm | area = 20 x 180 mm |
| Frequency | 835 MHz ± 1 MHz | |
| Forward power at dipole connector | 20.0 dBm = 100mW | |
| Input power drift | < 0.05 dB | |

2 Maximum Field values

| H-field 10 mm above dipole surface | condition | interpolated maximum |
|---|----------------------|-----------------------------|
| Maximum measured | 100 mW forward power | 0.474 A/m |

Uncertainty for H-field measurement: 8.2% (k=2)

| E-field 10 mm above dipole surface | condition | Interpolated maximum |
|---|----------------------|-----------------------------|
| Maximum measured above high end- | 100 mW forward power | 168.0 V/m |
| Maximum measured above low end | 100 mW forward power | 162.5 V/m |
| Averaged maximum above arm | 100 mW forward power | 165.3 V/m |

Uncertainty for E-field measurement: 12.8% (k=2)

3 Appendix

3.1 Antenna Parameters

| Frequency | Return Loss | Impedance |
|------------------|--------------------|----------------------------|
| 800 MHz | 17.2 dB | (43.2 – j11.1) Ohm |
| 835 MHz | 24.6 dB | (48.9 + j5.7) Ohm |
| 900 MHz | 16.7 dB | (58.2 – j13.7) Ohm |
| 950 MHz | 22.9 dB | (46.3 + j5.9) Ohm |
| 960 MHz | 17.0 dB | (52.4 + j14.4) Ohm |

3.2 Antenna Design and Handling

The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

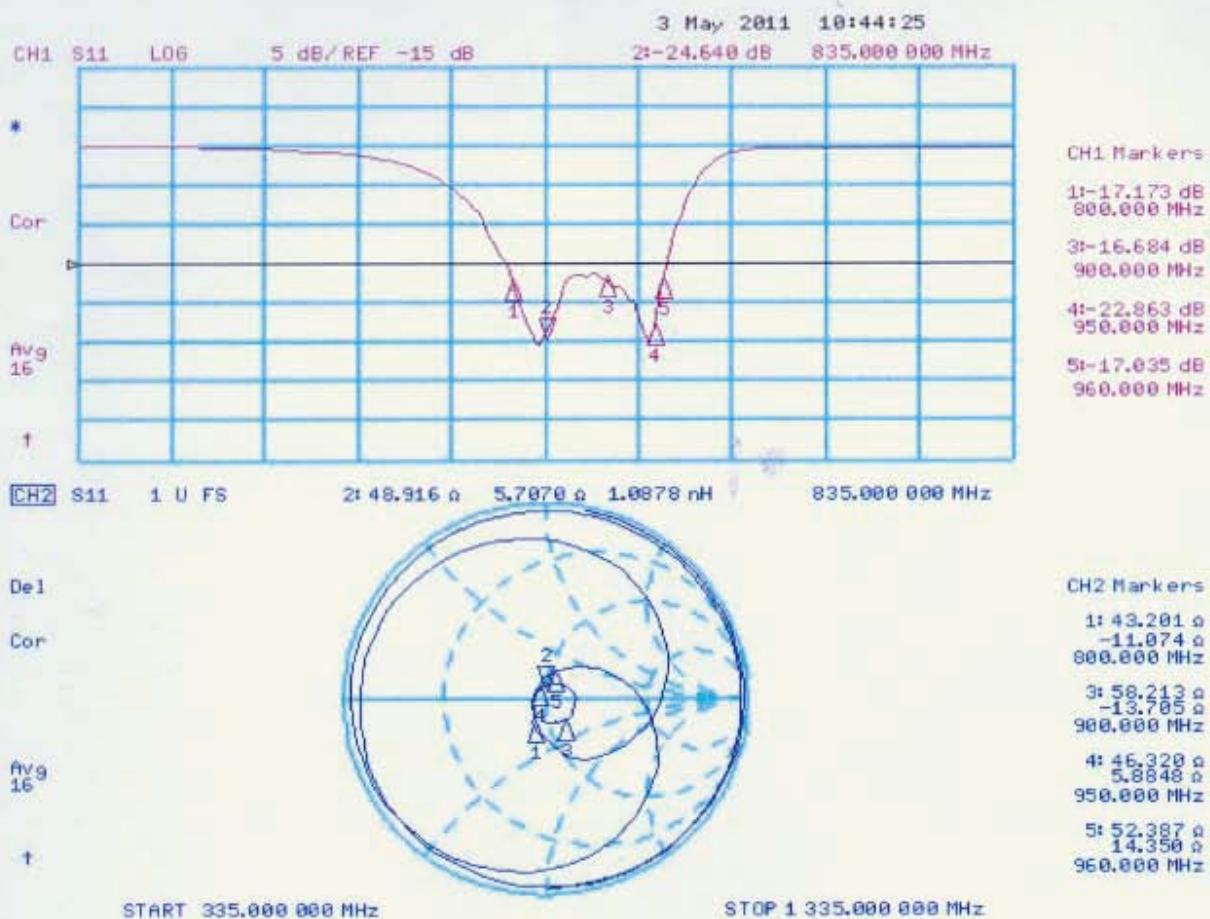
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-field Result

Date/Time: 02.05.2011 14:16:10

Test Laboratory: SPEAG Lab2

HAC RF_CD835_1171_H_110502_CL

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: 1171

Communication System: CW; Frequency: 835 MHz

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6.2 Build (424)
- Postprocessing SW: SEMCAD X, V14.4.4 Build (2829)

Dipole H-Field measurement @ 835MHz/H Scan - measurement distance from the probe sensor center to CD835

Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.474 A/m

Probe Modulation Factor = 1.000

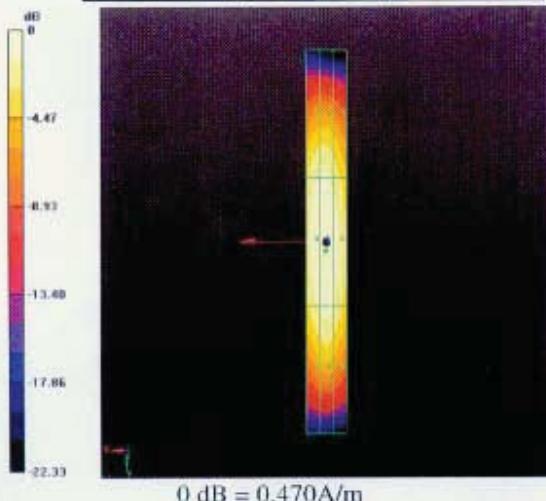
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.503 A/m; Power Drift = 0.03 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

| Grid 1 | Grid 2 | Grid 3 |
|--------------|--------------|--------------|
| 0.403 | 0.415 | 0.383 |
| M4 | M4 | M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.456 | 0.474 | 0.442 |
| M4 | M4 | M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.403 | 0.424 | 0.397 |
| M4 | M4 | M4 |



3.3.3 DASY4 E-field Result

Date/Time: 02.05.2011 11:43:42

Test Laboratory: SPEAG Lab2

HAC RF_CD835_1171_E_110502_CL

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: 1171

Communication System: CW; Frequency: 835 MHz

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6.2 Build (424)
- Postprocessing SW: SEMCAD X, V14.4.4 Build (2829)

Dipole E-Field measurement @ 835MHz/E Scan - measurement distance from the probe sensor center to CD835

Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 168.0 V/m

Probe Modulation Factor = 1.000

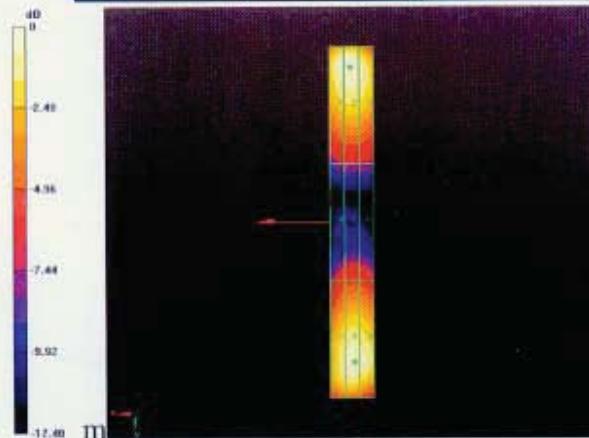
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 125.4 V/m; Power Drift = -0.02 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

| Grid 1 | Grid 2 | Grid 3 |
|----------------------------|----------------------------|----------------------------|
| 164.0 M4 | 168.0 M4 | 162.2 M4 |
| 86.716 M4 | 91.288 M4 | 89.980 M4 |
| 153.2 M4 | 162.5 M4 | 159.9 M4 |





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Accreditation No.: SCS 108

Client Sporton Kunshan (Auden)

Certificate No: CD1880V3-1155_May11

CALIBRATION CERTIFICATE

Object CD1880V3 - SN: 1155

Calibration procedure(s) QA CAL-20.v5
 Calibration procedure for dipoles in air

Calibration date: May 03, 2011

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). 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 |
|-----------------------|------------|--------------------------------|-----------------------|
| Power meter EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Probe ER3DV6 | SN: 2336 | 29-Dec-10 (No. ER3-2336_Dec10) | Dec-11 |
| Probe H3DV6 | SN: 6065 | 29-Dec-10 (No. H3-6065_Dec10) | Dec-11 |
| DAE4 | SN: 781 | 20-Apr-11 (No. DAE4-781_Apr11) | Apr-12 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---------------------------|----------------|-----------------------------------|------------------------|
| Power meter Agilent 4419B | SN: GB42420191 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482H | SN: 3318A09450 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482A | SN: US37295597 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |
| RF generator E4433B | MY 41000675 | 03-Nov-04 (in house check Oct-09) | In house check: Oct-11 |

Calibrated by: Name Jeton Kastrati Function Laboratory Technician

Approved by: Katja Pokovic Technical Manager

Issued: May 10, 2011

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References

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

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the top edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- **H-field distribution:** H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

1. Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|---|-------------------------|----------------------|
| DASY Version | DASY5 | V52.6.2 (424) |
| DASY PP Version | SEMCAD X | V14.4.4 (2829) |
| Phantom | HAC Test Arch | SD HAC P01 BA, #1070 |
| Distance Dipole Top - Probe Center | 10 mm | |
| Scan resolution | dx, dy = 5 mm | area = 20 x 90 mm |
| Frequency | 1880 MHz ± 1 MHz | |
| Forward power at dipole connector | 20.0 dBm = 100mW | |
| Input power drift | < 0.05 dB | |

2. Maximum Field values

| H-field 10 mm above dipole surface | condition | Interpolated maximum |
|---|----------------------|-----------------------------|
| Maximum measured | 100 mW forward power | 0.464 A/m |

Uncertainty for H-field measurement: 8.2% (k=2)

| E-field 10 mm above dipole surface | condition | Interpolated maximum |
|---|----------------------|-----------------------------|
| Maximum measured above high end | 100 mW forward power | 145.7 V/m |
| Maximum measured above low end | 100 mW forward power | 138.3 V/m |
| Averaged maximum above arm | 100 mW forward power | 142.0 V/m |

Uncertainty for E-field measurement: 12.8% (k=2)

3. Appendix

3.1 Antenna Parameters

| Frequency | Return Loss | Impedance |
|------------------|--------------------|----------------------------|
| 1730 MHz | 34.6 dB | (51.5 - j1.2) Ohm |
| 1880 MHz | 18.9 dB | (43.4 + j8.3) Ohm |
| 1900 MHz | 19.0 dB | (45.5 + j9.7) Ohm |
| 1950 MHz | 23.7 dB | (49.6 + j6.5) Ohm |
| 2000 MHz | 19.4 dB | (43.1 + j7.3) Ohm |

3.2 Antenna Design and Handling

The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

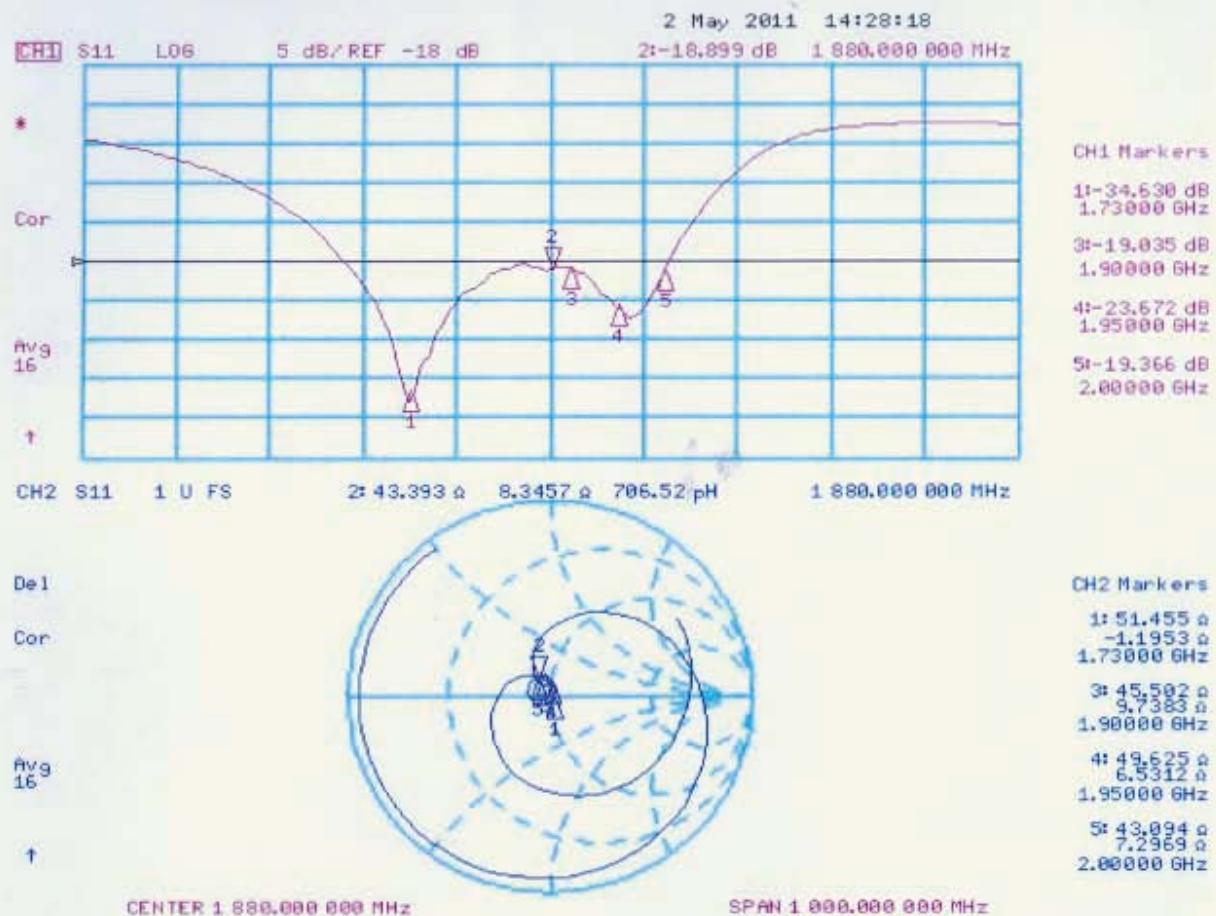
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-Field Result

Date/Time: 03.05.2011 11:59:33

Test Laboratory: SPEAG Lab2

HAC_RF_CD1880_1155_H_110503_JK

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1155

Communication System: CW; Frequency: 1880 MHz

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: H3DV6 - SN6065; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6.2 Build (424)
- Postprocessing SW: SEMCAD X, V14.4.4 Build (2829)

Dipole H-Field measurement @ 1880MHz/H Scan - measurement distance from the probe sensor center to CD1880

Dipole = 10mm/Hearing Aid Compatibility Test (41x181x1):

Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.464 A/m

Probe Modulation Factor = 1.000

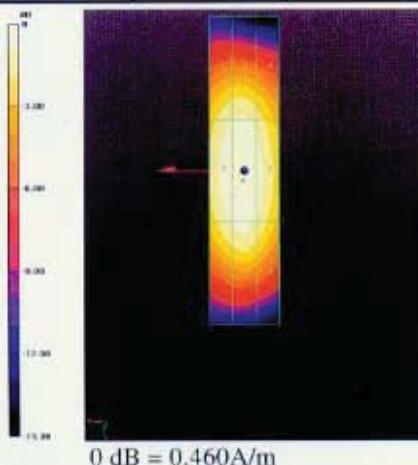
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.492 A/m; Power Drift = -0.01 dB

Hearing Aid Near-Field Category: M2 (AWF 0 dB)

Peak H-field in A/m

| Grid 1 | Grid 2 | Grid 3 |
|--------------|--------------|--------------|
| 0.408 | 0.419 | 0.391 |
| M2 | M2 | M2 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.449 | 0.464 | 0.435 |
| M2 | M2 | M2 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.416 | 0.433 | 0.406 |
| M2 | M2 | M2 |



3.3.3 DASY4 E-Field Result

Date/Time: 03.05.2011 10:35:18

Test Laboratory: SPEAG Lab2

HAC_RF_CD1880_1155_E_110503_JK

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1155

Communication System: CW; Frequency: 1880 MHz

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6.2 Build (424)
- Postprocessing SW: SEMCAD X, V14.4.4 Build (2829)

Dipole H-Field measurement @ 1880MHz/H Scan - measurement distance from the probe sensor center to CD1880

Dipole = 10mm @ /Hearing Aid Compatibility Test (41x181x1):

Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 145.7 V/m

Probe Modulation Factor = 1.000

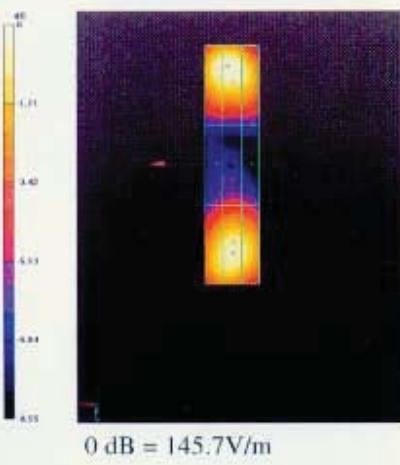
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 143.3 V/m; Power Drift = -0.02 dB

Hearing Aid Near-Field Category: M2 (AWF 0 dB)

Peak E-field in V/m

| Grid 1 | Grid 2 | Grid 3 |
|---------------|---------------|---------------|
| 143.6 | 145.7 | 137.7 |
| M2 | M2 | M2 |
| Grid 4 | Grid 5 | Grid 6 |
| 83.236 | 87.574 | 85.990 |
| M3 | M3 | M3 |
| Grid 7 | Grid 8 | Grid 9 |
| 133.2 | 138.3 | 134.9 |
| M2 | M2 | M2 |





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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: DAE4-1210_Nov10

CALIBRATION CERTIFICATE

Object DAE4 - SD 000 D04 BJ - SN: 1210

Calibration procedure(s) QA CAL-06.v22
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: November 18, 2010

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-------------------------------|---------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278 | 28-Sep-10 (No:1037B) | Sep-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Calibrator Box V1.1 | SE UMS 006 AB 100-1 | 07-Jun-10 (in house check) | In house check: Jun-11 |

| | | | |
|----------------|-----------------------|------------------------|---------------|
| Calibrated by: | Name Andrea Guntli | Function Technician | Signature |
| Approved by: | Fin Bomholt | R&D Director | |

Issued: November 18, 2010

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Accreditation No.: SCS 108

Glossary

| | |
|-----------------|---|
| DAE | data acquisition electronics |
| Connector angle | information used in DASY system to align probe sensor X to the robot coordinate system. |

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
 - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
 - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
 - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
 - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
 - *Power consumption:* Typical value for information. Supply currents in various operating modes.



Calibration Certificate of DASY

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = $6.1\mu V$, full range = $-100...+300 mV$

Low Range: 1LSB = $61nV$, full range = $-1.....+3mV$

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

| Calibration Factors | X | Y | Z |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range | $404.092 \pm 0.1\% (k=2)$ | $404.921 \pm 0.1\% (k=2)$ | $405.027 \pm 0.1\% (k=2)$ |
| Low Range | $3.99932 \pm 0.7\% (k=2)$ | $3.98397 \pm 0.7\% (k=2)$ | $3.99953 \pm 0.7\% (k=2)$ |

Connector Angle

| | |
|---|--------------------------|
| Connector Angle to be used in DASY system | $68.0^\circ \pm 1^\circ$ |
|---|--------------------------|



Calibration Certificate of DASY

Appendix

1. DC Voltage Linearity

| High Range | | Reading (μ V) | Difference (μ V) | Error (%) |
|------------|---------|--------------------|-----------------------|-----------|
| Channel X | + Input | 200001.5 | -1.32 | -0.00 |
| Channel X | + Input | 20000.95 | 0.95 | 0.00 |
| Channel X | - Input | -19998.31 | 1.39 | -0.01 |
| Channel Y | + Input | 200000.7 | -1.08 | -0.00 |
| Channel Y | + Input | 200000.03 | 0.23 | 0.00 |
| Channel Y | - Input | -19999.95 | -0.35 | 0.00 |
| Channel Z | + Input | 200010.3 | -0.33 | -0.00 |
| Channel Z | + Input | 19997.81 | -2.89 | -0.01 |
| Channel Z | - Input | -20001.02 | -1.32 | 0.01 |

| Low Range | | Reading (μ V) | Difference (μ V) | Error (%) |
|-----------|---------|--------------------|-----------------------|-----------|
| Channel X | + Input | 1999.6 | -0.26 | -0.01 |
| Channel X | + Input | 199.98 | -0.02 | -0.01 |
| Channel X | - Input | -200.01 | -0.01 | 0.00 |
| Channel Y | + Input | 2000.6 | 0.54 | 0.03 |
| Channel Y | + Input | 199.17 | -1.03 | -0.51 |
| Channel Y | - Input | -200.54 | -0.84 | 0.42 |
| Channel Z | + Input | 1999.9 | -0.05 | -0.00 |
| Channel Z | + Input | 199.17 | -0.93 | -0.47 |
| Channel Z | - Input | -201.25 | -1.15 | 0.58 |

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 (μ V) | Low Range Average Reading (μ V) |
|-----------|-----------------------------------|--|---|
| Channel X | 200 | -6.04 | -7.77 |
| | -200 | 8.97 | 7.28 |
| Channel Y | 200 | -8.99 | -8.75 |
| | -200 | 7.60 | 7.00 |
| Channel Z | 200 | 12.34 | 11.86 |
| | -200 | -14.01 | -14.18 |

3. Channel separation

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

| | Input Voltage (mV) | Channel X (μ V) | Channel Y (μ V) | Channel Z (μ V) |
|-----------|--------------------|----------------------|----------------------|----------------------|
| Channel X | 200 | - | 3.24 | 0.60 |
| Channel Y | 200 | 1.78 | - | 3.29 |
| Channel Z | 200 | 1.92 | -0.13 | - |



Calibration Certificate of DASY

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 | 15945 | 17239 |
| Channel Y | 15959 | 16297 |
| Channel Z | 15874 | 17186 |

5. Input Offset Measurement

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

Input 10MO

| | Average (μ V) | min. Offset (μ V) | max. Offset (μ V) | Std. Deviation (μ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | 0.14 | -1.10 | 1.73 | 0.40 |
| Channel Y | -0.64 | -1.49 | 0.23 | 0.33 |
| Channel Z | -1.30 | -2.71 | 0.16 | 0.44 |

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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

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Client **Sporton CN (Auden)**

Accreditation No.: **SCS 108**

Certificate No: **ER-2476_Nov10**

CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2476**

Calibration procedure(s) **QA CAL-02.v5, QA CAL-25.v2**
 Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: **November 23, 2010**

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 |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41495277 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41498087 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 30-Mar-10 (No. 217-01159) | Mar-11 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 30-Mar-10 (No. 217-01161) | Mar-11 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 30-Mar-10 (No. 217-01160) | Mar-11 |
| Reference Probe ER3DV6 | SN: 2328 | 4-Oct-10 (No. ER3-2328_Oct10) | Oct-11 |
| DAE4 | SN: 789 | 31-Aug-10 (No. DAE4-789_Aug10) | Aug-11 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

Calibrated by: Name **Jeton Kastrati** Function **Laboratory Technician** Signature

Approved by: Name **Katja Pokovic** Function **Technical Manager** Signature

Issued: November 25, 2010

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Accreditation No.: **SCS 108**

Glossary:

| | |
|--------------------------|--|
| NORM x,y,z | sensitivity in free space |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005.

Methods Applied and Interpretation of Parameters:

- $NORMx,y,z$: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- $NORM(f)x,y,z = NORMx,y,z * frequency_response$ (see Frequency Response Chart).
- $DCPx,y,z$: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- $Ax,y,z; Bx,y,z; Cx,y,z, VRx,y,z$: A, B, C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide setup.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the $NORMx$ (no uncertainty required).

Probe ER3DV6

SN:2476

Manufactured: March 31, 2009
Calibrated: November 23, 2010

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2476

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) | 1.97 | 1.74 | 2.28 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 98.2 | 97.0 | 98.0 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 184.4 | $\pm 4.06 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 156.8 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 170.9 | |

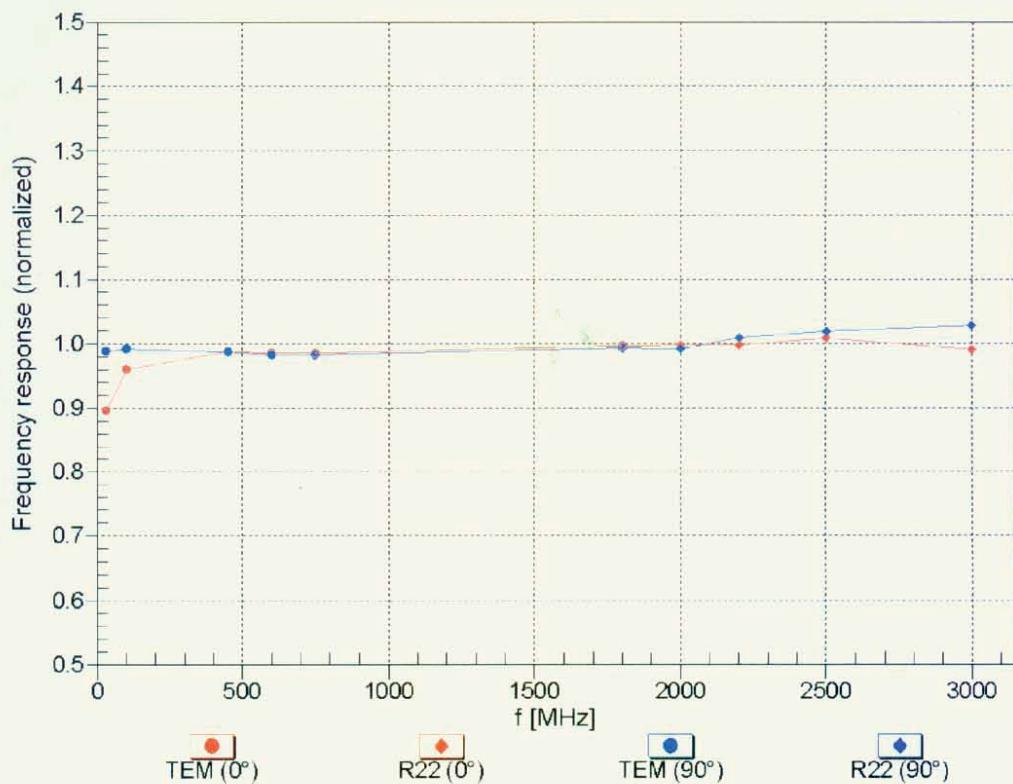
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Frequency Response of E-Field

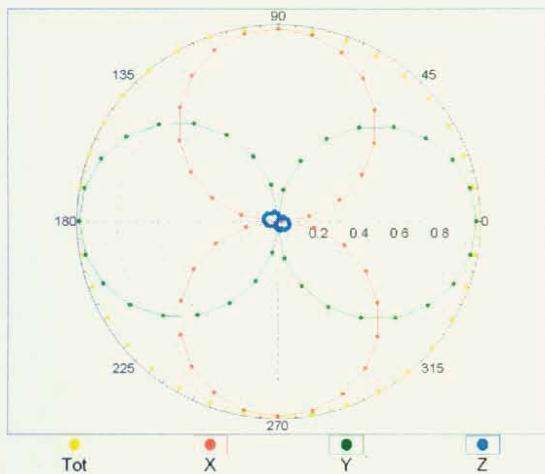
(TEM-Cell:ifi110 EXX, Waveguide: R22)



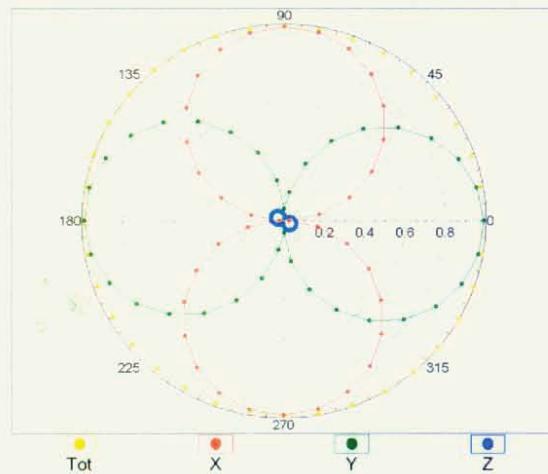
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

Receiving Pattern (ϕ), $\theta = 0^\circ$

f=600 MHz, TEM, 0°

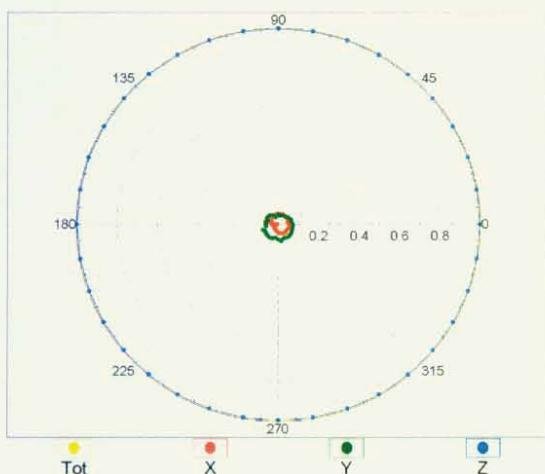


f=2500 MHz, R22, 0°

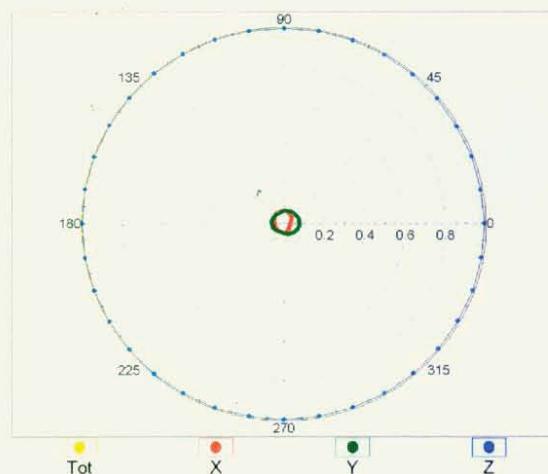


Receiving Pattern (ϕ), $\theta = 90^\circ$

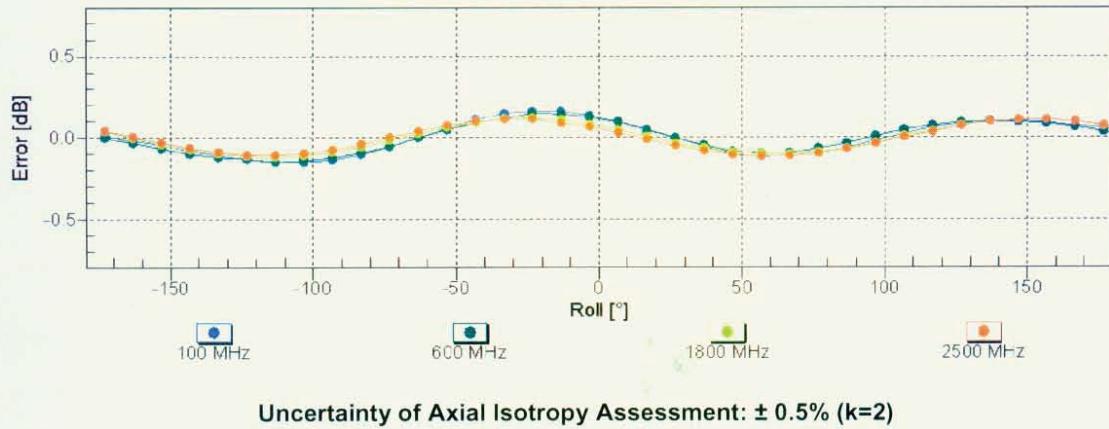
f=600 MHz, TEM, 90°



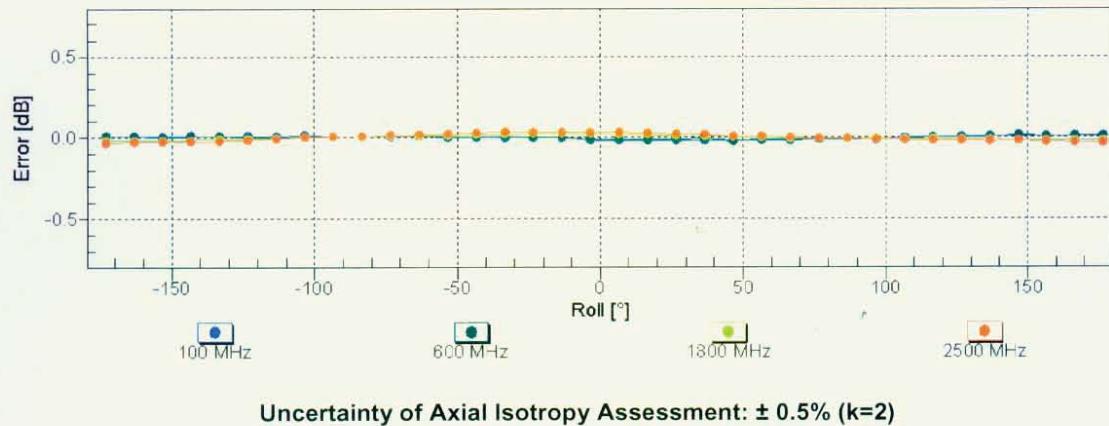
f=2500 MHz, R22, 90°



Receiving Pattern (ϕ), $\theta = 0^\circ$

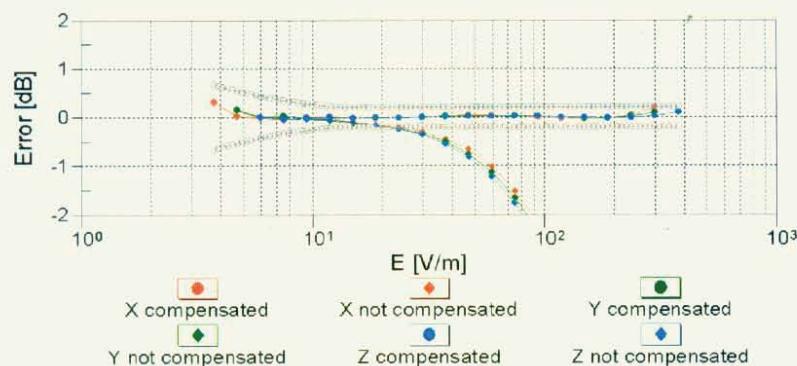
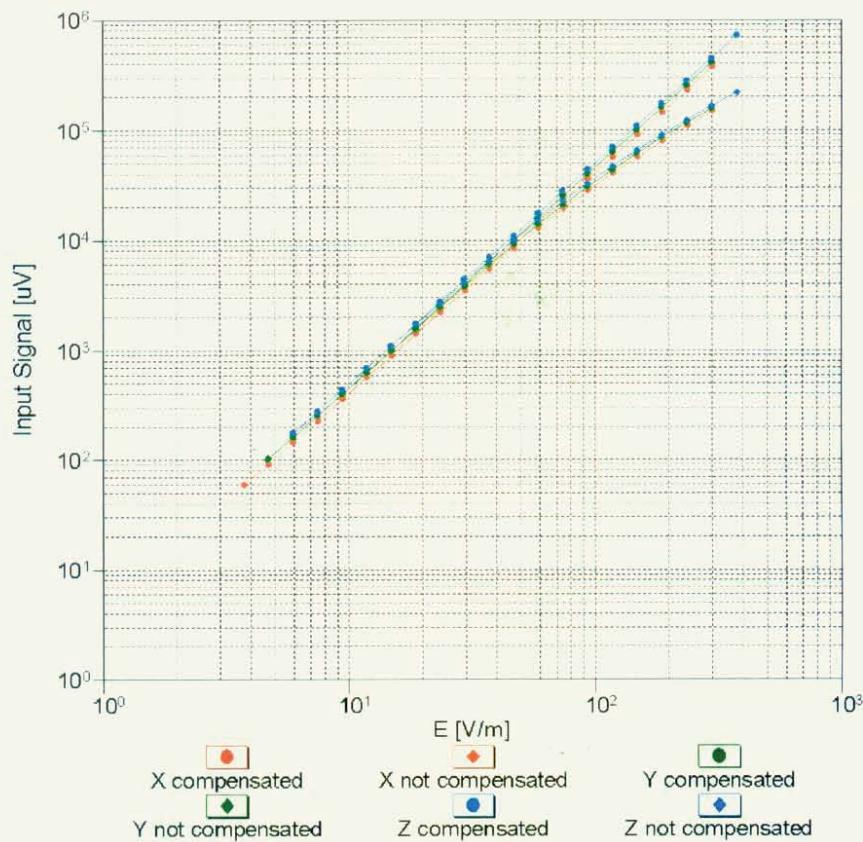


Receiving Pattern (ϕ), $\theta = 90^\circ$



Dynamic Range f(E-field)

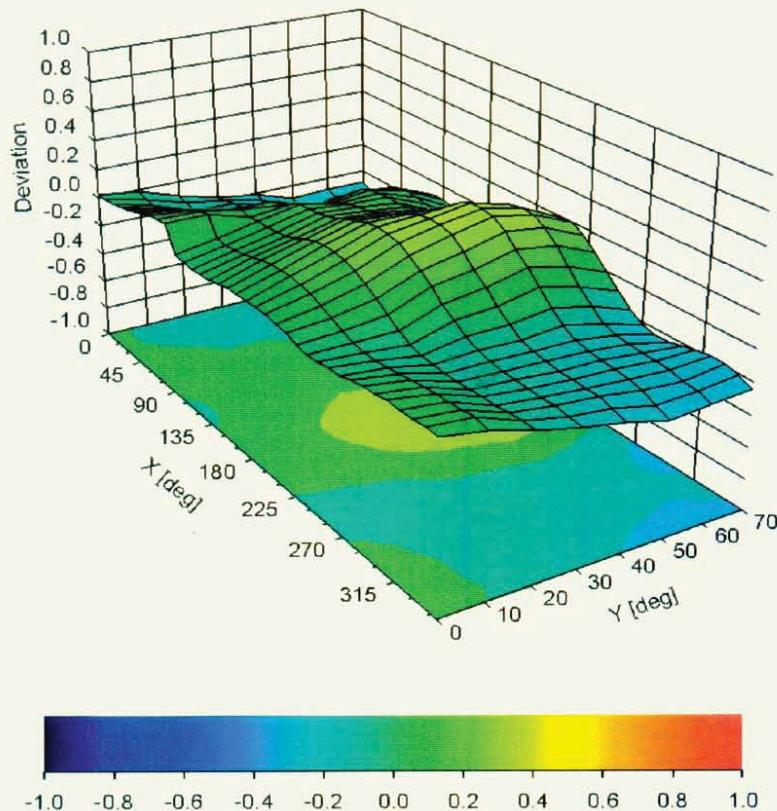
(TEM cell , f = 900 MHz)



Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Deviation from Isotropy in Air

Error (ϕ , 9), $f = 900$ MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ ($k=2$)

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2476

Other Probe Parameters

| | |
|---|-------------|
| Sensor Arrangement | Rectangular |
| Connector Angle (°) | -163.3 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 8 mm |
| Probe Tip to Sensor X Calibration Point | 2.5 mm |
| Probe Tip to Sensor Y Calibration Point | 2.5 mm |
| Probe Tip to Sensor Z Calibration Point | 2.5 mm |



Calibration Certificate of DASY

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



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C Service suisse d'étalonnage
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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 CN (Auden)

Certificate No.: H3-6300_Nov10

CALIBRATION CERTIFICATE

| | |
|--------------------------|--|
| Object | H3DV6 - SN:6300 |
| Calibration procedure(s) | QA CAL-03.v5, QA CAL-25.v2 Calibration procedure for H-field probes optimized for close near field evaluations in air |
| Calibration date: | November 25, 2010 |

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 |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41495277 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41498087 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 30-Mar-10 (No. 217-01159) | Mar-11 |
| Reference 20 dB Attenuator | SN: S5088 (20b) | 30-Mar-10 (No. 217-01161) | Mar-11 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 30-Mar-10 (No. 217-01160) | Mar-11 |
| Reference Probe H3DV6 | SN: 6182 | 4-Oct-10 (No. H3-6182_Oct10) | Oct-11 |
| DAE4 | SN: 789 | 31-Aug-10 (No. DAE4-789_Aug10) | Aug-11 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8848C | US3642U01700 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

| | | | |
|---------------|-----------------------|---------------------------------|------------|
| Calibrated by | Name: Claudio Leubler | Function: Laboratory Technician | Signature: |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: November 25, 2010

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

Certificate No: H3-6300_Nov10

Page 1 of 10



Calibration Certificate of DASY

Calibration Laboratory of
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S 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

Glossary:

| | |
|----------------------|--|
| NORM x,y,z | sensitivity in free space. |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| Polarization ϕ | ϕ rotation around probe axis |
| Polarization β | β rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\beta = 0$ is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005.

Methods Applied and Interpretation of Parameters:

- $NORMx,y,z$: Assessed for E-field polarization $\beta = 0$ for XY sensors and $\beta = 90$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- $X,Y,Z(f)_a0a1a2 = X,Y,Z_a0a1a2 * frequency_response$ (see Frequency Response Chart).
- $DCPx,y,z$: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- $Ax,y,z; Bx,y,z; Cx,y,z; VRx,y,z$: A, B, C are numerical linearization parameters assessed based on the data of power swoop for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide setup.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the X_a0a1a2 (no uncertainty required).



H3DV6 – SN 6300

November 25, 2010

Probe H3DV6

SN:6300

Manufactured: December 16, 2008
Calibrated: November 25, 2010

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)



Calibration Certificate of DASY

H3DV6-SN:6300

November 25, 2010

DASY/EASY - Parameters of Probe: H3DV6 - SN:6300

Basic Calibration Parameters

| | | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------|----|------------|-----------|-----------|-------------|
| Norm (A/m / $\sqrt{\text{mV}}$) | a0 | 2.50E-003 | 2.47E-003 | 3.18E-003 | $\pm 5.1\%$ |
| Norm (A/m / $\sqrt{\text{mV}}$) | a1 | -6.06E-005 | 2.44E-006 | 1.26E-005 | $\pm 5.1\%$ |
| Norm (A/m / $\sqrt{\text{mV}}$) | a2 | -1.56E-005 | 2.59E-006 | 2.61E-005 | $\pm 5.1\%$ |
| DCP (mV) ^b | | 91.3 | 91.3 | 91.0 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | A dB | B dB | C dB | VR mV | Unc ^c (k=2) |
|-------|---------------------------|------|-----------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X 0.00 | 0.00 | 1.00 | 194.2 | $\pm 5.16\%$ |
| | | | Y 0.00 | 0.00 | 1.00 | 191.9 | |
| | | | Z 0.00 | 0.00 | 1.00 | 208.0 | |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^b Numerical linearization parameter: uncertainty not required.

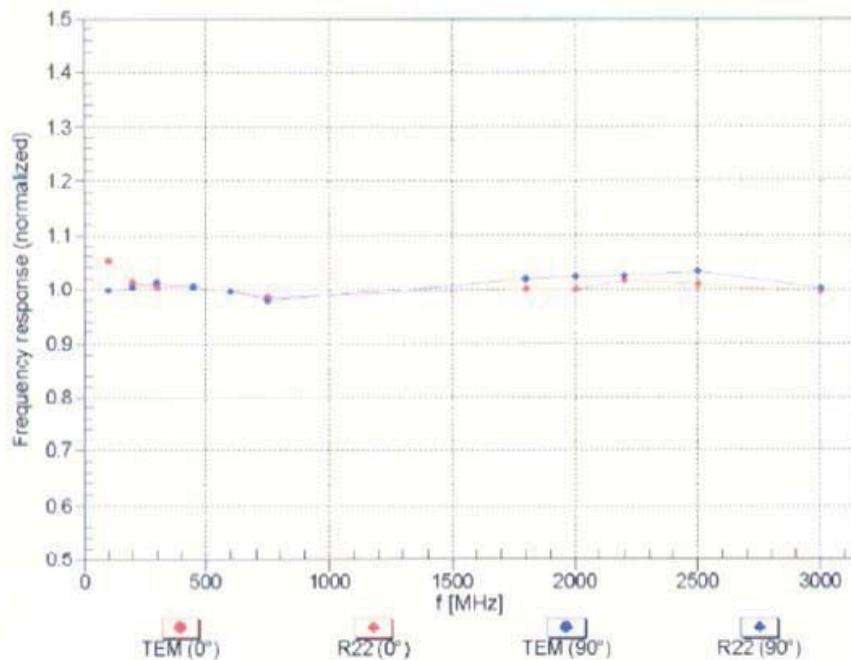
^c Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



H3DVG-SN.6300

November 25, 2010

Frequency Response of H-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of H-field: $\pm 6.3\%$ ($k=2$)

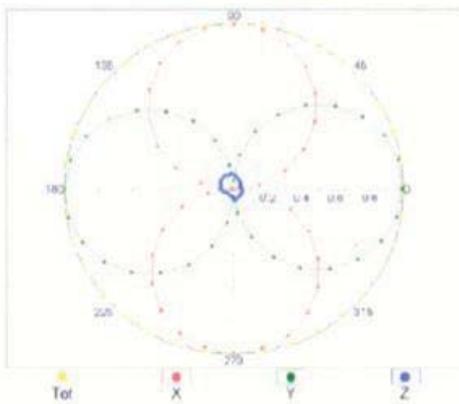


H3DV6-SN:6300

November 25, 2010

Receiving Pattern (ϕ), $\theta = 0^\circ$

f=600 MHz, TEM, 0°

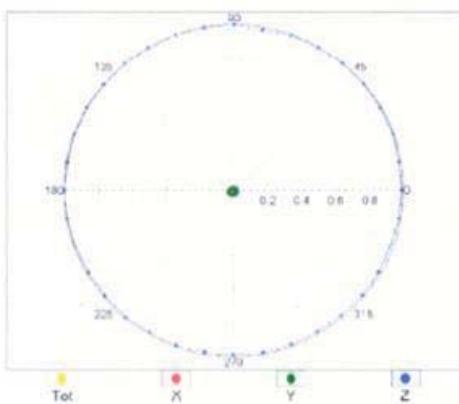


f=2500 MHz, R22, 0°

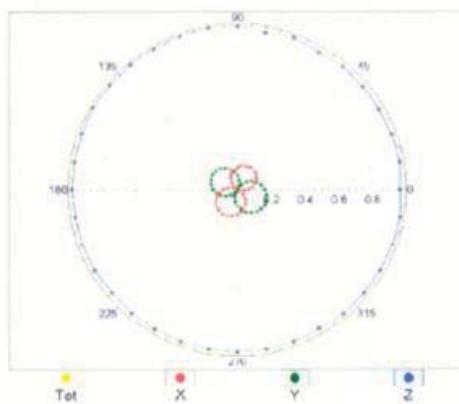


Receiving Pattern (ϕ), $\theta = 90^\circ$

f=600 MHz, TEM, 90°



f=2500 MHz, R22, 90°

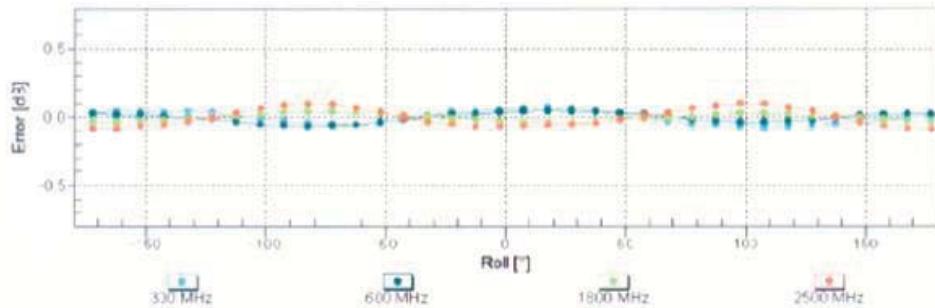




H3DV6-SN:6300

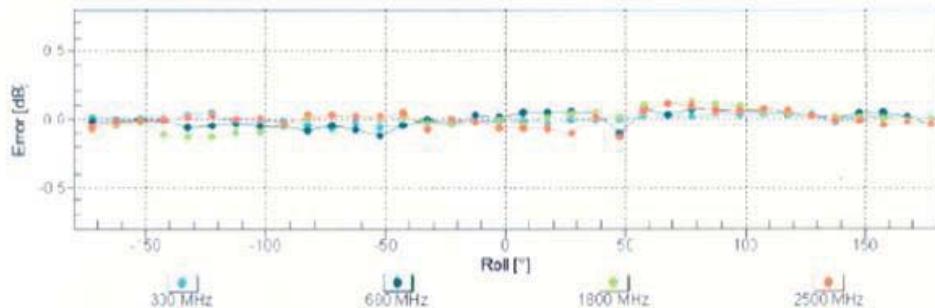
November 25, 2010

Receiving Pattern (ϕ), $\theta = 0^\circ$



Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Receiving Pattern (ϕ), $\theta = 90^\circ$



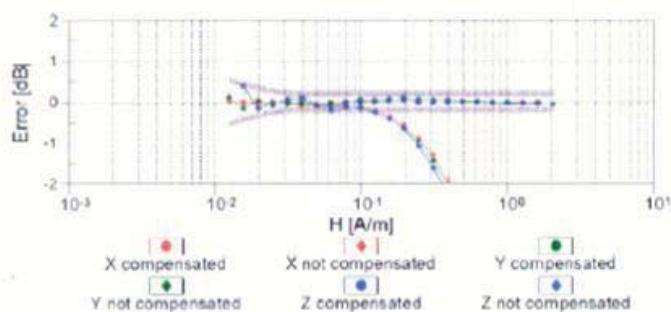
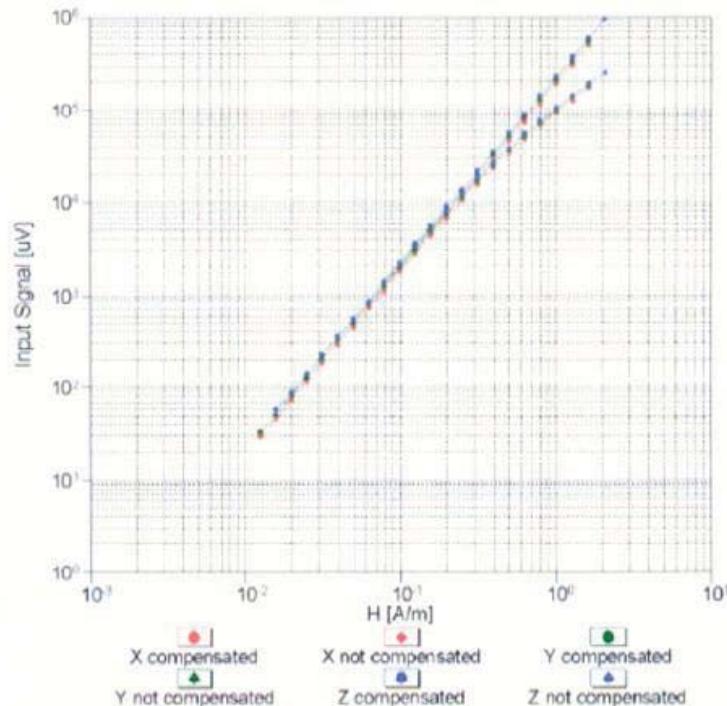
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)



H3DV6-SN:6300

November 25, 2010

Dynamic Range f(H-field)
(TEM cell, $f = 900$ MHz)



Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

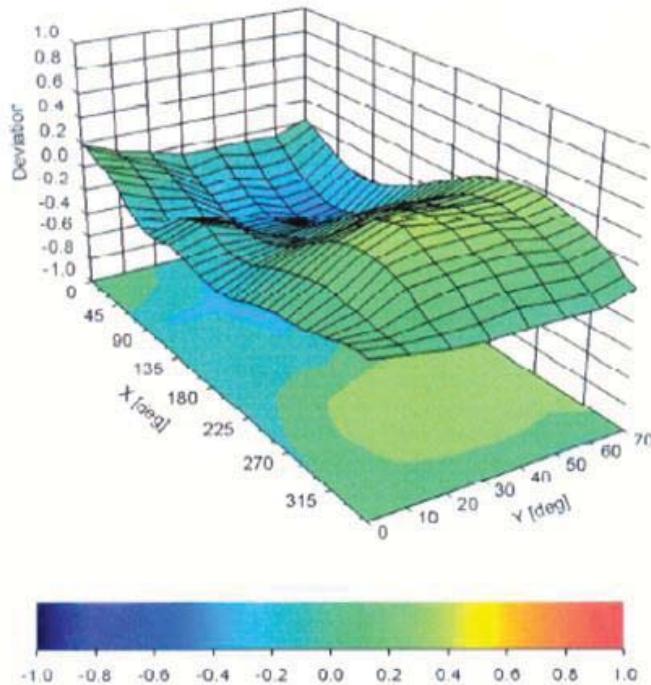


H3DV6-SN:6300

November 25, 2010

Deviation from Isotropy in Air

Error (ϕ, θ), $f = 900$ MHz





Calibration Certificate of DASY

H3DV6 - SN:6300

November 25, 2010

DASY/EASY - Parameters of Probe: H3DV6 - SN:6300

Other Probe Parameters

| | |
|---|-------------|
| Sensor Arrangement | Rectangular |
| Connector Angle (°) | -32.5 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 20 mm |
| Tip Diameter | 6 mm |
| Probe Tip to Sensor X Calibration Point | 3 mm |
| Probe Tip to Sensor Y Calibration Point | 3 mm |
| Probe Tip to Sensor Z Calibration Point | 3 mm |