

Test &amp; Certification Center (TCC) - Dallas

WR-834.003

28 October 2005

Accredited Laboratory Certificate  
Number: 1819-01

Ver 1.0

## FCC HAC Test Report

Test Report Number: WR-834.003

**Terminal device:** Type: Nokia RM-125, HW: 2001, SW: V AZ100\_05w21\_12.nep  
(Detailed information is listed in section 5).

Originator: Anu Balijepalli  
Function: TCC – Dallas  
Version/Status: 1.0 Approved  
Location: TCC Directories  
Date: 28 October 2005

### Change History:

| Version | Date            | Status   | Handled By      | Comments            |
|---------|-----------------|----------|-----------------|---------------------|
| 0.1     | 28 October 2005 | Draft    | Anu Balijepalli | Initial Draft       |
| 0.2     | 28 October 2005 | Review   | Anu Balijepalli | Submit for Approval |
| 1.0     | 28 October 2005 | Approved | Nerina Walton   | Approved            |

**Testing laboratory:**

Test & Certification Center (TCC)  
Dallas  
Nokia Inc  
6021 Connection Drive  
Irving, Texas 75039  
U.S.A.  
Tel. 972-894-5000  
Fax. 972-894-4988

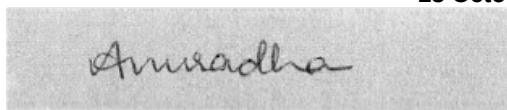
**Client:**

Nokia SanDeigo  
12278 Scripps Summit Drive  
San Deigo, California, 92131  
U.S.A.  
Tel. 858-831-5000  
Fax. 858-831-6500

**Date and signatures:**

For the Contents:

28 October 2005



Anu Balijepalli,  
Technical Review



Nerina Walton,  
Manager Review

## TABLE OF CONTENTS

|                                                                                   |           |
|-----------------------------------------------------------------------------------|-----------|
| <b>1. GENERAL .....</b>                                                           | <b>3</b>  |
| 1.1 OBJECTIVE .....                                                               | 3         |
| 1.2 TEST SUMMARY .....                                                            | 3         |
| <b>2. LIST OF ABBREVIATIONS, ACRONYMS AND TERMS .....</b>                         | <b>4</b>  |
| 2.1 ABBREVIATIONS .....                                                           | 4         |
| 2.2 ACRONYMS .....                                                                | 4         |
| 2.3 TERMS .....                                                                   | 4         |
| <b>3. STANDARDS BASIS .....</b>                                                   | <b>5</b>  |
| <b>4. TEST EQUIPMENT LIST .....</b>                                               | <b>5</b>  |
| <b>5. EQUIPMENT-UNDER-TEST (EUT) .....</b>                                        | <b>6</b>  |
| 5.1 DESCRIPTION OF TESTED DEVICE(S): .....                                        | 6         |
| 5.2 PHOTOGRAPH OF TESTED DEVICE(S): .....                                         | 6         |
| <b>6. TEST METHOD(S) AND SETUP(S) .....</b>                                       | <b>7</b>  |
| 6.1 PROBE DESCRIPTION .....                                                       | 7         |
| 6.2 SPEAG ROBOTIC SYSTEM .....                                                    | 12        |
| 6.3 TEST SETUP .....                                                              | 14        |
| <b>7. PASS/FAIL CRITERIA .....</b>                                                | <b>14</b> |
| <b>8. TEST PROCEDURE .....</b>                                                    | <b>15</b> |
| <b>9. SYSTEM VALIDATION .....</b>                                                 | <b>16</b> |
| <b>10. DETAILED TEST RESULTS .....</b>                                            | <b>25</b> |
| 10.1 NEAR FIELD E AND H RF EMISSIONS MEASUREMENTS .....                           | 25        |
| 10.1.1 Test Results .....                                                         | 25        |
| <b>11. MEASUREMENT UNCERTAINTY .....</b>                                          | <b>28</b> |
| <b>APPENDIX A: VALIDATIONS SCANS .....</b>                                        | <b>29</b> |
| <b>APPENDIX B: MEASUREMENT SCANS .....</b>                                        | <b>34</b> |
| <b>APPENDIX C: PROBE CALIBRATION REPORTS AND DIPOLE CALIBRATION REPORTS .....</b> | <b>47</b> |
| <b>APPENDIX D: TEST SETUP PICTURES</b>                                            |           |



## 1. GENERAL

### 1.1 Objective

This test is performed to ensure that the EUT meets the requirements required by the FCC Method of Measurement for near field E and H emissions. Please note that this report is only for near field emissions, not for the T-coil HAC testing.

### 1.2 Test Summary

**Test Results:** *The test result relates only to those tested devices mentioned in Section 5 of this test report.*

| Sample # | Test Performed                                                 | Reference   | Category |
|----------|----------------------------------------------------------------|-------------|----------|
| 1        | Near Field Emissions- E field<br>Near Field Emissions- H field | ANSI C63.19 | M3       |

## 2. LIST OF ABBREVIATIONS, ACRONYMS AND TERMS

### 2.1 Abbreviations

dB - decibel  
dBm - decibels per milliwatt (absolute measurement)  
MHz - megahertz or 1000000 Hertz  
V/m – Volts per meter  
A/m – Amps per meter

### 2.2 Acronyms

AMPS - Advanced Mobile Phone System  
BSS - Base Station Simulator  
CDMA - Code Division Multiple Access  
ESN - Electronic Serial Number  
EUT - Equipment under Test  
GSM - Global System for Mobile communications  
IMEI - International Mobile Equipment Identity  
PCS - Personal Communication System  
RF- Radio Frequency  
TDMA - Time Division Multiple Access

### 2.3 Terms

Base Station Simulator (BSS) - simulates all the necessary signals that a phone would experience while on a live network. There are many types of base station simulators catering for all current protocols, i.e., GSM, AMPS, TDMA, and CDMA.

Cellular - refers to a frequency in the 800MHz band.

PCS - refers to a frequency in the 1900MHz band.

Crest Factor - is the relation between the peak power and the average power in a signal.

### 3. STANDARDS BASIS

*Testing has been carried out in accordance with:*

| REF. | Code of the standard | Name of the standard |
|------|----------------------|----------------------|
| 1    | -                    | ANSI C63.19          |

Note: Unless otherwise stated, (by reference to a version number and a publication date), the latest version of the above documents applies.

*Deviations:*

Not Applicable.

### 4. TEST EQUIPMENT LIST

The listing below indicates the test equipment utilized for the test (s). Calibration interval on all items listed can be obtained from the Engineering Services Group within NMP, Product Creation - Dallas. Where relevant, measuring equipment is subjected to in-service checks between testing. TCC - Dallas shall notify clients promptly, in writing, of identification of defective measuring equipment that casts doubt on the validity of results given in this report.

| Test Equipment                           | NMP # | Calibration Interval | Calibration Expiry |
|------------------------------------------|-------|----------------------|--------------------|
| SPEAG DASY4 Robot System                 | 2056  | NA                   | NA                 |
| SPEAG Data Acquisition Electronics (DAE) | 2292  | 12 months            | Jan - 2006         |
| SPEAG E-field Probe ER3DV6               | 4036  | 12 months            | Jan - 2006         |
| SPEAG H-field Probe H3DV6                | 4037  | 12 months            | Feb-2006           |
| SPEAG 835MHz Dipole CD835V3              | 4050  | 12 months            | Apr-2006           |
| SPEAG 1880MHz Dipole CD1880V3            | 4049  | 12 months            | Jun-2006           |
| Signal Generator HP8648C                 | 0796  | 12 months            | Aug-2006           |
| Boonton Powermeter 4232A                 | 0147  | 12 months            | Nov-2005           |
| AR Power Amplifier 5S1G4                 | 0188  | NA                   | NA                 |
| R&S CMU 200                              | 3461  | 12 months            | Sep-2006           |
| R&S CMU 200                              | 4064  | 12 months            | Jul-2006           |
| R&S FSP                                  | 3459  | 12 months            | Jan-2006           |



## 5. EQUIPMENT-UNDER-TEST (EUT)

*The results in this report relate only to the items listed below:*

### 5.1 Description of Tested Device(s):

| Sample # | Mode of Operation            | Date of Receipt    | Condition of Sample | Item  | Identifying Information                                                                                                              |
|----------|------------------------------|--------------------|---------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1        | CDMA<br>800/1900<br>RC2, SO9 | 17 October<br>2005 | Good                | Phone | Type: RM-125<br>Model: 6165i<br>ESN: 03310858283<br>HW: 2001<br>SW: V AZ100_05w21_12.nep<br>Code: 0525911IM02MW<br>FCC ID: QMNRM-125 |

### 5.2 Photograph of Tested Device(s):

See Appendix C.

## 6. TEST METHOD(S) AND SETUP(S)

Testing was performed in accordance with ANSI C63.19.

### 6.1 Probe Description

#### E field Probe Description

##### 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:  $\pm 0.2$  dB (100 MHz to 3 GHz)

##### Directivity

$\pm 0.2$  dB in air (rotation around probe axis)

$\pm 0.4$  dB in air (rotation normal to probe axis)

##### Dynamic Range

2 V/m to  $> 1000$  V/m; Linearity:  $\pm 0.2$  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

##### Application

General near-field measurements up to 6 GHz

Field component measurements

Fast automatic scanning in phantoms



#### H field Probe Description

##### 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

$\pm 0.25$  dB (spherical isotropy error)

##### Dynamic Range

10 mA/m to 2 A/m at 1 GHz

##### E-Field Interference

$< 10\%$  at 3 GHz (for plane wave)

##### Dimensions

Overall length: 330 mm (Tip: 40 mm)

Tip diameter: 6 mm (Body: 12 mm)

Distance from probe tip to dipole centers: 3 mm

##### Application

General magnetic near-field measurements up to 3 GHz

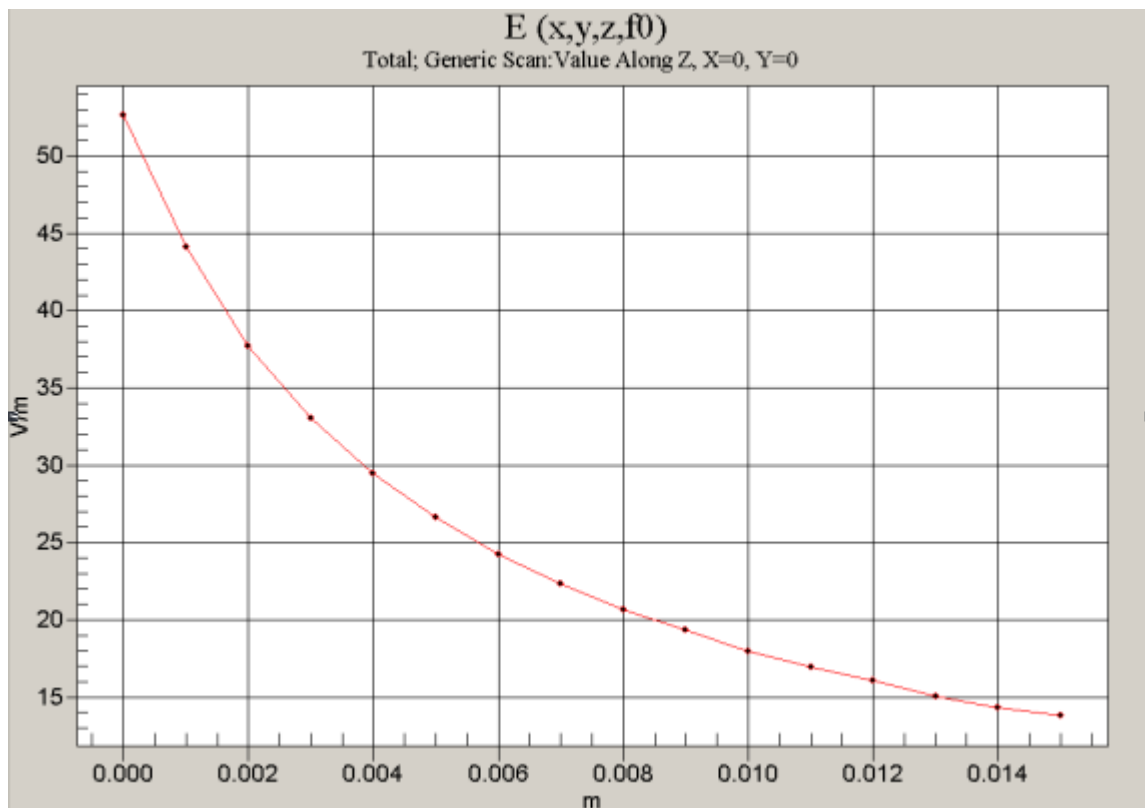


Field component measurements  
Surface current measurements  
Measurements in air or liquids  
Low interaction with the measured field

## 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. Magnetic field sensors are measuring the integral of the H-field across their sensor area surrounded by the loop. They are calibrated in precise, homogenous 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 center value. But it will be different from the field at the border of the loop.

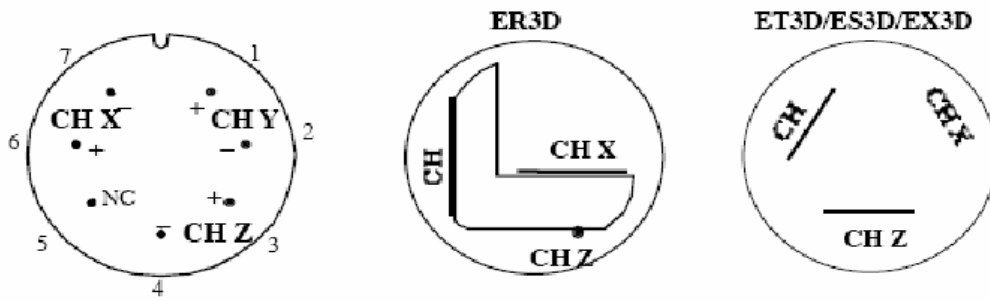
Consequently, two sensors with different loop diameters – both calibrated ideally – would give different results when measuring from the edge of the probe sensor elements. The behaviour for electrically small E-field sensors is equivalent. See below for distance plots from a WD, which show the conservative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



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

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. Their geometric center is at 2.5mm from the tip, and the element ends are 1.1mm closer to the tip.

## Connector Plan



The antistatic shielding inside the probe is connected to the probe connector case. It is recommended to connect the probes with the amplifier using a short and well-shielded cable and to connect the cable shielding with the connector case.

### Instrumentation Chain:

Conversion of Connector Voltage to E field

$$E_i = \sqrt{\frac{u_i + (u_i^2 \cdot CF) / (DCP)}{Norm_i \cdot ConvF}}$$

whereby

$E_i$  = Electric field in V/m

$u_i$  = Voltage of channel i at the connector in  $\mu V$

$Norm_i$  = Sensitivity of channel i in  $\mu V / (V / m)^2$

ConvF = enhancement factor in liquid (ConvF = 1 for Air)

DCP = Diode compression point in  $\mu V$

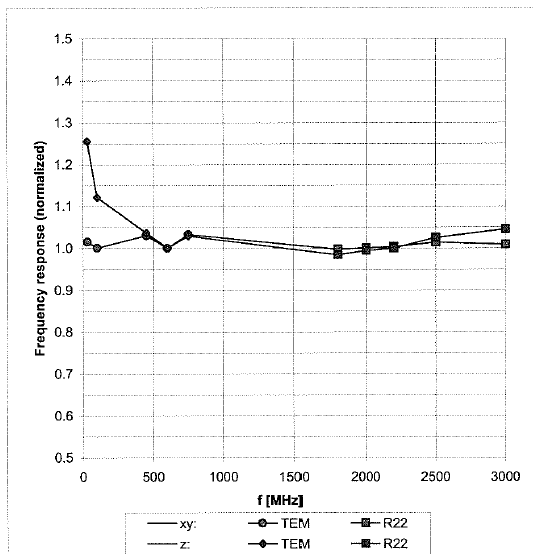
CF = Signal Crest Factor (peak power/average power)

### Probe Response to Frequency

The E-field sensors have inherently a very flat frequency response. They are calibrated with a number of frequencies resulting in a common calibration factor, with the frequency behaviour documented in the calibration certificate.

## Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide R22)

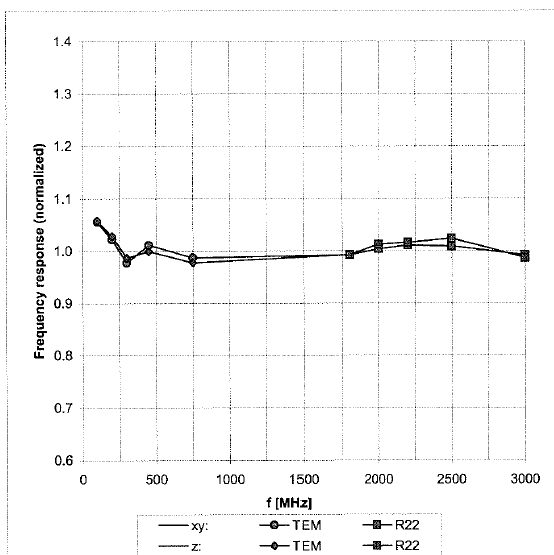


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

H-field sensors have frequency dependant sensitivity, which is evaluated for a series of frequencies also visible in the probe calibration certificate. The calibration factors result from a fitting algorithm. The proper conversion is calculated by the DASY4 software depending on the frequency setting in the procedure.

## Frequency Response of H-Field

(TEM-Cell:ifi110, Waveguide R22)



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



## Conversion to Peak

Peak is defined as Peak Envelope Power. All raw measurements from the HAC measurement system are RMS values. The DASY4 system incorporates the crest factor of the signal in the computation of the RMS values. Although the software also has capability to estimate the peak field by applying a square root of crest factor value to the readings, the probe modulation factor was applied manually instead per PC63.19 in the measurement tables in this report. The equation to convert the raw measurements in the data tables are:

$$\text{Peak Field} = 20 \log (\text{Raw} \times \text{PMF})$$

Where:

Peak Field = Peak field (in dBV/m or dBA/m)

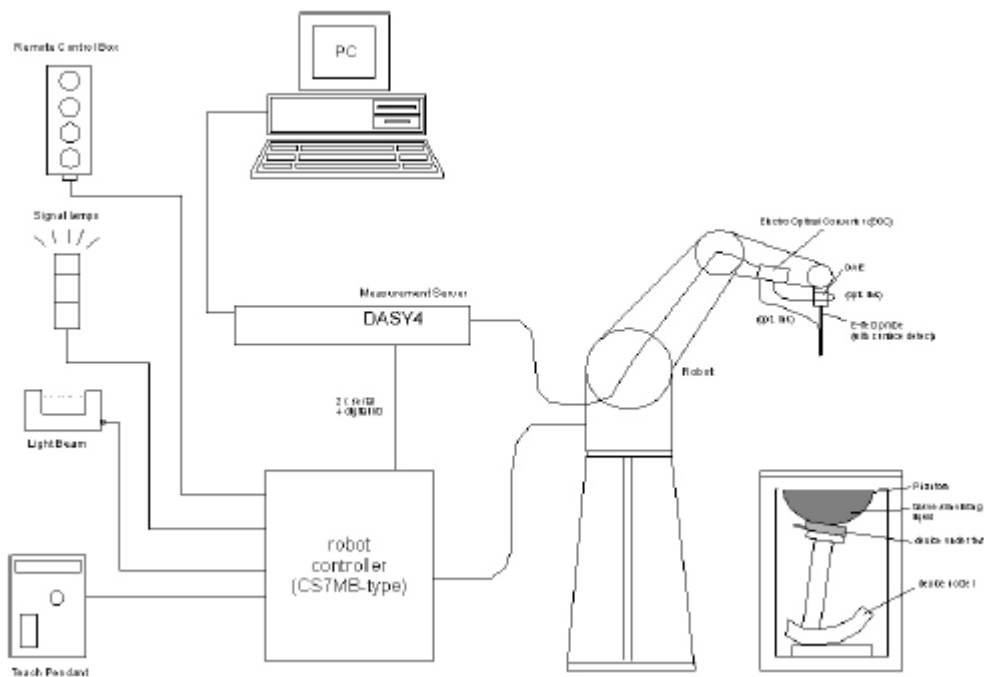
Raw = Raw field measurement from the measurement system (in V/m or A/m).

PMF = Probe Modulation Factor (in linear units).

## 6.2 Speag Robotic System

E-field and H-field measurements are performed using the DASY4 automated dosimetric assessment system. The DASY4 is made by Schmid & Partner Engineering AG (SPEAG) and consists of high precision robotics system (Staubli), robot controller, Pentium 4 computer, near- field probe, probe alignment sensor, and the HAC phantom. The robot is a six- axis industrial robot performing precise movements to the position the probe to the location of maximum EMF.

### System Hardware



A cell controller system contains the power supply, robot controller; teach pendant, and a remote control used to drive the robot motors. The PC consists of RF measurement system DASY4 V4.5 with HAC extension, A/D interface card, monitor, mouse and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD conversion, offset measurements, mechanical surface detection, collision detection, etc is connected to the Electro – optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

The 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 PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe-mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built- in VME-bus computer.

## Data Evaluation

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:

$$V_i = U_i + U_2 * (cf/dcpi)$$

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)  
 $dcpi$  = diode compression point (DASY parameter)

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

$$\text{E-field probes: } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \times \text{ConvF}}}$$

$$\text{H-field probes: } H_i = \sqrt{V_i} \times \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

with  $V_i$  = compensated signal of channel  $i$  ( $i = x, y, z$ )  
 $\text{Norm}_i$  = sensor sensitivity of channel  $i$  ( $i = x, y, z$ )  
 $\mu\text{V}/(\text{V/m})^2$  for E-field Probes  
 $\text{ConvF}$  = 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):

$$E_{\text{tot}} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

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 <5ms. In the current implementation, DASY4 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%.



## 6.3 Test Setup

See Appendix C.

## 7. PASS/FAIL CRITERIA

The EUT must meet the following M3 category standards –

| Category    | Wireless Device Parameters |                                 |                                 |
|-------------|----------------------------|---------------------------------|---------------------------------|
| Near field  | AWF                        | E-field Emissions<br>Peak – V/m | H-field Emissions<br>Peak – A/m |
| Category M3 | AWF =0 (TDMA, CDMA)        | 63.1 to 112.2                   | 0.19 to 0.34                    |
|             | AWF = -5 (GSM)             | 47.3 to 84.1                    | 0.15 to 0.25                    |
| Category M4 | AWF =0 (TDMA, CDMA)        | < 63.1                          | < 0.19                          |
|             | AWF = -5 (GSM)             | < 47.3                          | < 0.15                          |



## 8. TEST PROCEDURE

The following illustrates a typical RF emissions test scan over a wireless communication device:

- Proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed.
- WD is positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
- The WD 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.
- The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The WD audio output was positioned tangent (as physically possible) to the measurement plane.
- The measurement system measured the field strength at the reference location.
- Measurements at 2mm increments in the 5x5 cm region were performed and recorded. A 360 deg 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.
- The system performed a drift evaluation by measuring the field at the reference location.
- Same steps were done for both the E and H field measurements.

See Appendix C for pictures of the measurement grid and reference plane.

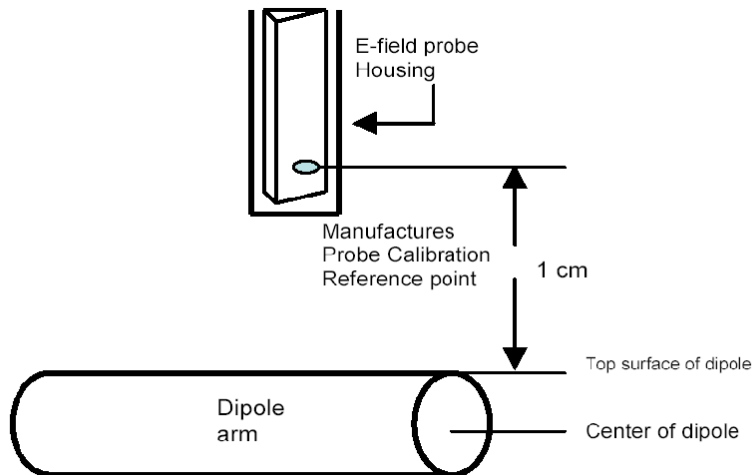
## 9. SYSTEM VALIDATION

The input signal was an unmodulated continuous wave. The following points were taken into consideration in performing the system validation:

Average Input Power = 100mW (20dBm RMS) after adjustment for return loss.

The test fixture must meet the 2-wavelength separation criterion.

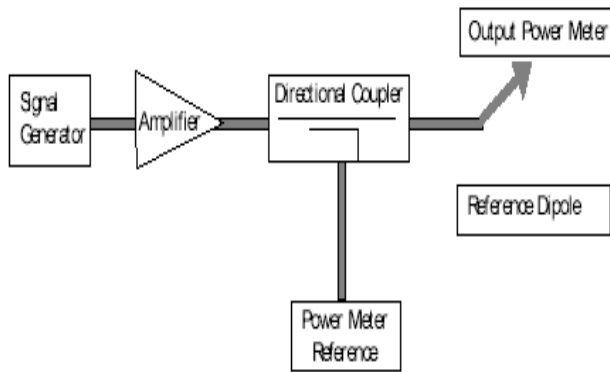
The proper measurement of the 1cm probe to dipole separation, which is measured from the top surface of the dipole to the calibration reference point of the sensor, defined by the probe manufacturer is shown in the following picture:



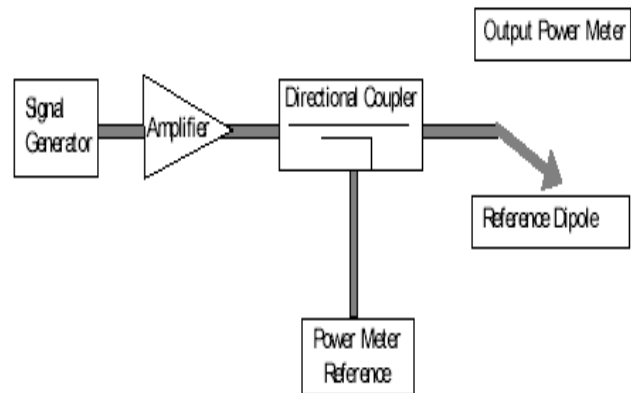
To assure proper operation of the near-field measurement probe the input power to the dipole shall be commensurate to with the full rated output power of the wireless device (eg. – for a cellular phone wireless device the average peak antenna input power will be on the order of 100mW (ie, 20dBm) RMS after adjustment for any mismatch.

A dipole antenna meeting the requirements in PC63.19 was placed in the position normally occupied by the WD. The length of the dipole was scanned with both E-field and H-field probes and the maximum values for each were recorded.

Using the near-field measurement system, scan the antenna over the radiating dipole and record the greatest field reading observed. Due to the nature of E-fields about freespace dipoles, the two E-field peaks measured over the dipole are averaged to compensate for non-parallelity of the setup, See manufacturer method on dipole calibration certificates, page 2. Field strength measurements shall be made only when the probe is stationary.



Setup for Desired Output Power to Dipole



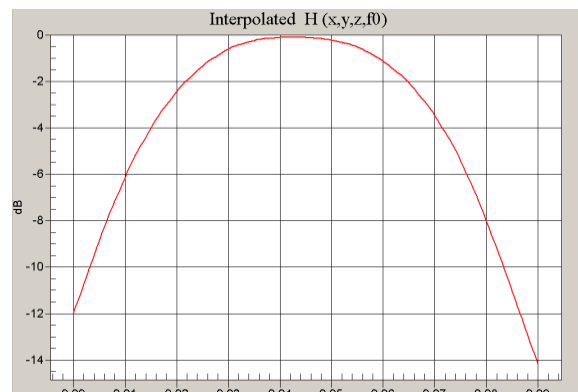
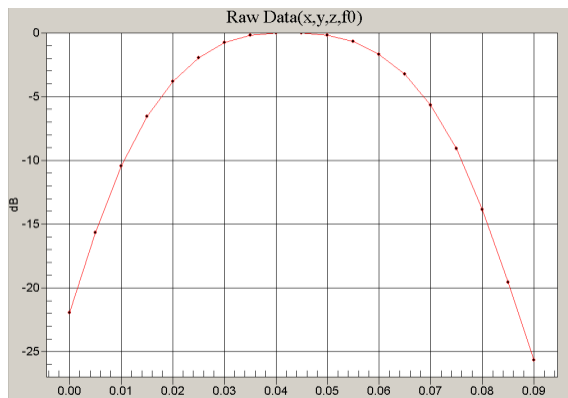
Setup to Dipole

Using this setup configuration, the signal generator was adjusted for the desired output power (100mW) at a specified frequency. The reference power from the coupled port of the directional coupler is recorded. Next, the output cable is connected to the reference dipole, as shown in the figure above.

The input signal was adjusted until the reference power from the coupled port of the directional coupler was the same as previously recorded, to compensate for the impedance mismatch between the output cable and the reference dipole.

To assure proper operation of the near-field measurement probe the input power to the reference dipole was verified to the full rated output power of the wireless device. The dipole was secured in a holder in a manner to meet the 20dB reflection. The near-field measurement probe was positioned over the dipole.

The antenna was scanned over the appropriate sized area to cover the dipole from end to end. SPEAG uses 2D interpolation algorithms between the measured points. Please see below two-dimensional plots showing that the interpolated values interpolate smoothly between 5mm steps for a free space RF dipole:





Validations were performed for CW at 20dBm peak power.

|          |         | Recorded | Target Value | % deviation |
|----------|---------|----------|--------------|-------------|
| 835 MHz  | E field | 156.7    | 162.1        | 3.33%       |
|          | H field | 0.427    | 0.451        | 5.32%       |
| 1880 MHz | E field | 125.7    | 137.6        | 8.65%       |
|          | H field | 0.421    | 0.452        | 6.86%       |

Note: Please see Appendix A for the Validation Scans



## MODULATION FACTOR

A calibration was made of the modulation response of the probe and its instrumentation chain. This calibration was performed with the field probe, attached to its instrumentation. The response of the probe system to a CW field at the frequency of interest is compared to its response to a modulated signal with equal peak amplitude to that of a CW signal. The field level of the test signals are ensured to be more than 10dB 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 reading was applied to the DUT measurements.

This was done using the following procedure:

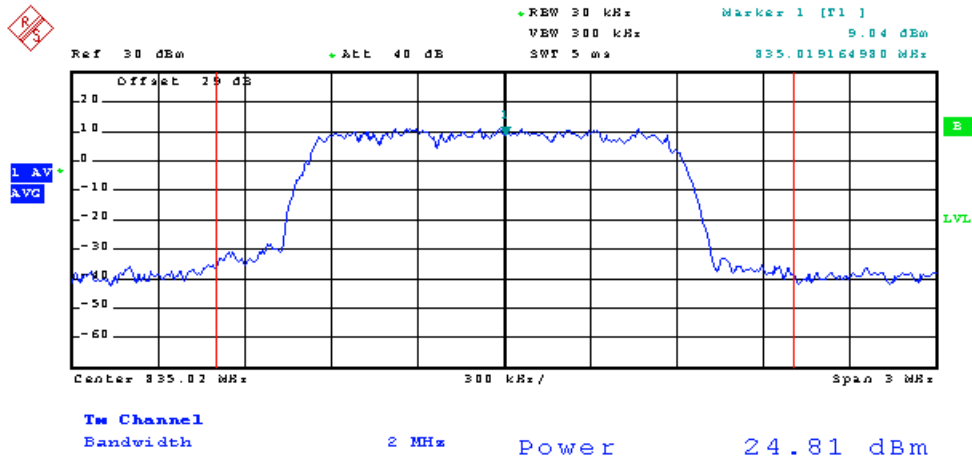
- The probe was illuminated with a CW signal at the intended measurement frequency.
- The probe was positioned at the field maxima over the dipole antenna (determined after an area scan over the dipole).
- The reading of the probe measurement system of the CW signal at the maximum point was recorded.
- Using a Spectrum Analyzer, the modulated signal adjusted with the same peak level of the CW signal was determined.
- The probe measurement system reading was recorded with the modulated signal.
- The ratio of the CW reading to the modulated signal reading is the probe modulation factor (PMF) for the modulation and field probe combination.
- Same steps are repeated at all frequency bands and for both E and H field probes.

The modulation factors obtained were applied to readings taken of the actual wireless device, in order to obtain an accurate peak field reading using the formula:

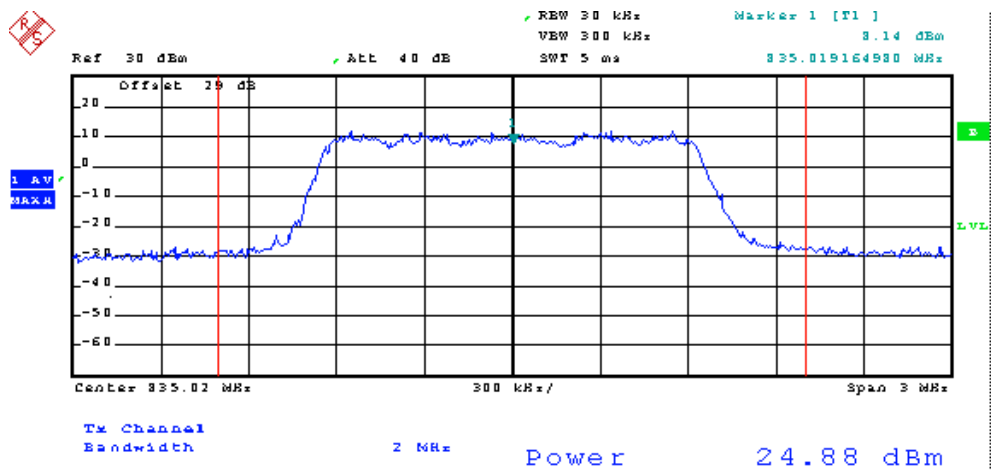
$$\text{Peak} = 20\log(\text{Raw} \times \text{PMF})$$

This method correlates well with the modulation using the DUT in the alternative substitution method. See below for correlation of signal:

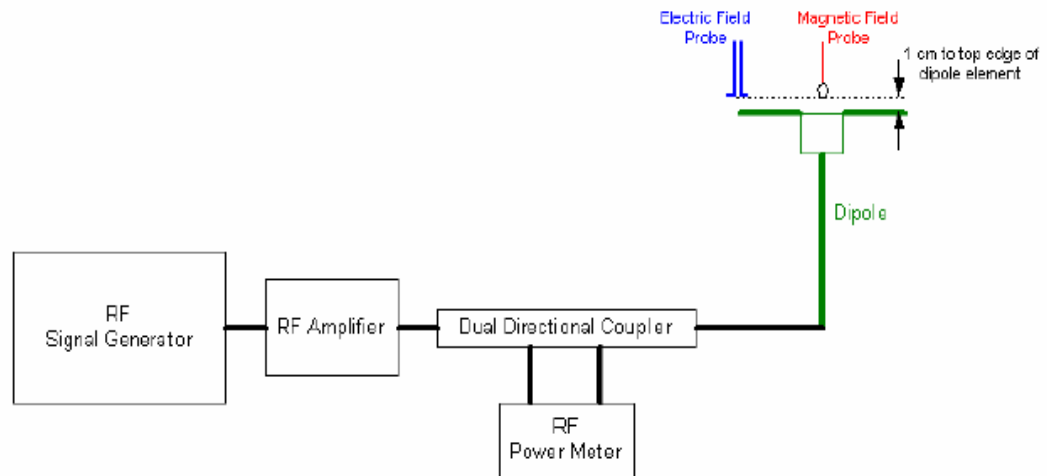
## Signal Generator Modulated Signal:



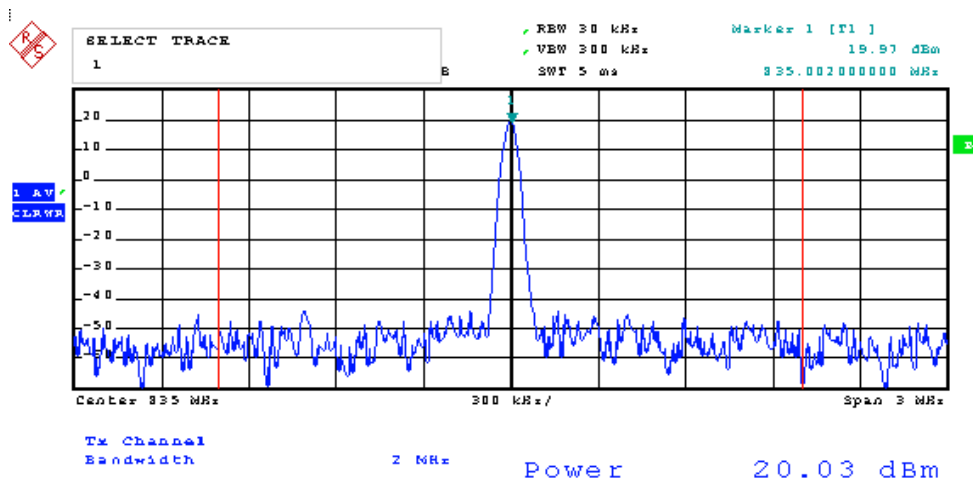
## Wireless Device Modulated Signal:



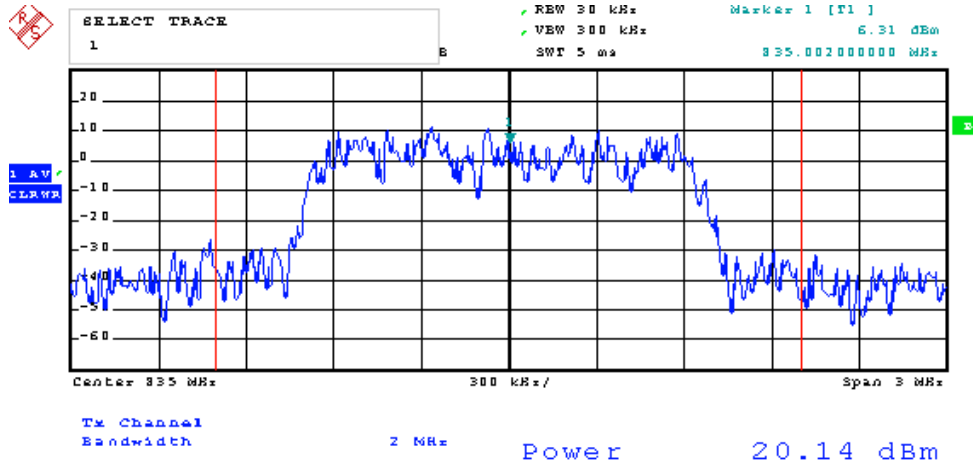
Modulation Factors were performed for CW, 80%AM and the modulated signal at 20dBm peak power, See below for the picture as well as the Spectrum Analyzer Plots.



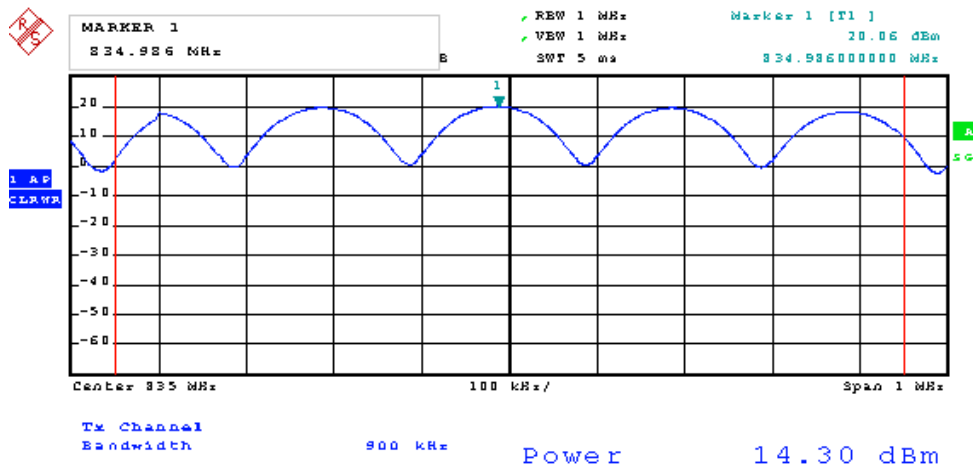
Determining Modulation Factor Probe Setup



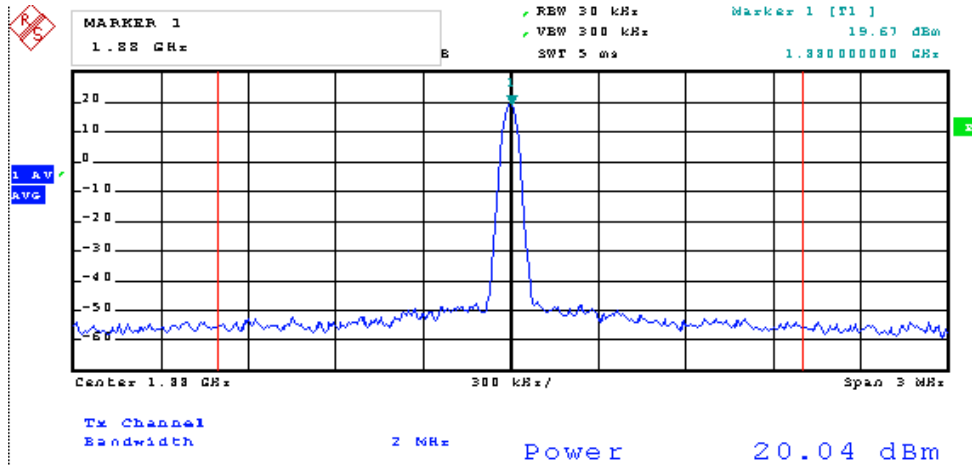
CW Signal for 850MHz band



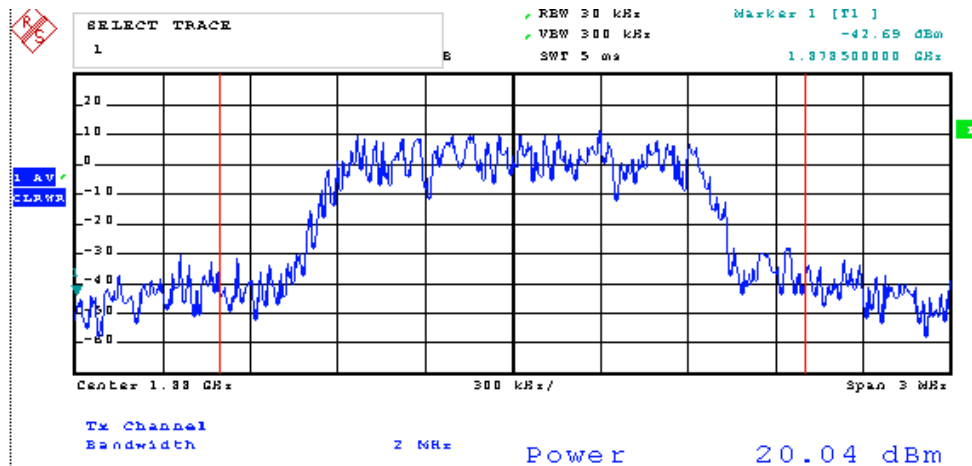
CDMA Signal for 850MHz band



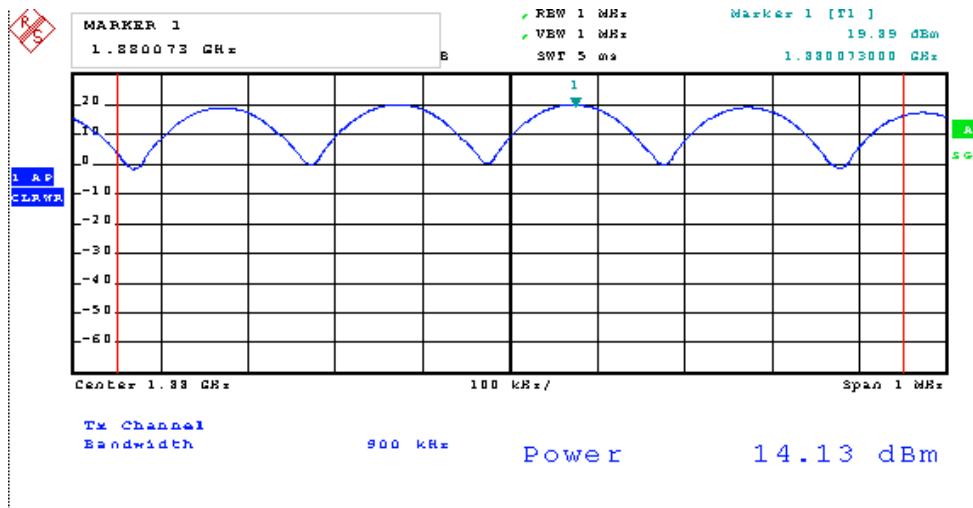
80%AM Signal for 850MHz band



CW Signal for 1900MHz band



CDMA Signal for 1900MHz band



80%AM Signal for 1900MHz band

| 835 MHz | E-Field<br>(V/m) | H-Field<br>(A/m) | Modulation<br>Factor (MF) for<br>E-field | Modulation<br>Factor (MF) for<br>H-field |
|---------|------------------|------------------|------------------------------------------|------------------------------------------|
| CDMA    | 152.2            | 0.43             | 1.0                                      | 1.0                                      |
| CW      | 152.0            | 0.41             |                                          |                                          |
| 80%AM   | 90.3             | 0.25             |                                          |                                          |

| 1880 MHz | E-Field<br>(V/m) | H-Field<br>(A/m) | Modulation<br>Factor (MF) for<br>E-field | Modulation<br>Factor (MF) for<br>H-field |
|----------|------------------|------------------|------------------------------------------|------------------------------------------|
| CDMA     | 118.3            | 0.57             | 1.0                                      | 0.7                                      |
| CW       | 115.0            | 0.38             |                                          |                                          |
| 80%AM    | 71.5             | 0.24             |                                          |                                          |

## 10. DETAILED TEST RESULTS

|                                   |                     |          |          |
|-----------------------------------|---------------------|----------|----------|
| Test Technician / Engineer        | Anu Balijepalli     |          |          |
| Date of Measurement               | October 21-24, 2005 |          |          |
| Temperature / Humidity / Pressure | 20-22°C             | 36-44%RH | 29-31 in |
| Test Result                       | Complies            |          |          |

### 10.1 Near Field E and H RF emissions measurements

#### 10.1.1 Test Results

Note: Testing was done at the antenna extended position and the Bluetooth was on. See Appendix B for the grids and plots of these cases.

#### CDMA CELLULAR E - FIELD

| CDMA Cellular | Conducted Power (dBm) | Power Drift (dB) | E (V/m) | Modulation Factor | Peak Field (V/m) | Excluded Blocks |
|---------------|-----------------------|------------------|---------|-------------------|------------------|-----------------|
| Ch 1013       | 25.1                  | 0.276            | 69.6    | 1.0               | 69.6             | 1,2,4           |
| Ch 384        | 25.2                  | -0.329           | 76.6    | 1.0               | 76.6             | 1,4,7           |
| Ch 777        | 25.2                  | -0.107           | 71.4    | 1.0               | 71.4             | 1,4,7           |

#### CDMA CELLULAR H- FIELD

| CDMA Cellular | Conducted Power (dBm) | Power Drift (dB) | H (A/m) | Modulation Factor | Peak Field (A/m) | Excluded Blocks |
|---------------|-----------------------|------------------|---------|-------------------|------------------|-----------------|
| Ch 1013       | 25.1                  | 0.216            | 0.119   | 1.0               | 0.119            | 7,8,9           |
| Ch 384        | 25.2                  | -0.0784          | 0.119   | 1.0               | 0.119            | 7,8,9           |
| Ch 777        | 25.2                  | 0.116            | 0.116   | 1.0               | 0.116            | 7,8,9           |

**CDMA PCS E - FIELD**

| CDMA PCS | Conducted Power (dBm) | Power Drift (dB) | E (V/m) | Modulation Factor | Peak Field (V/m) | Excluded Blocks |
|----------|-----------------------|------------------|---------|-------------------|------------------|-----------------|
| Ch 25    | 22.8                  | -0.187           | 19.7    | 1.0               | 19.7             | 7,8,9           |
| Ch 600   | 22.9                  | -0.0294          | 25.2    | 1.0               | 25.2             | 1,4,7           |
| Ch 1175  | 22.9                  | -0.0532          | 31.0    | 1.0               | 31.0             | 1,4,7           |

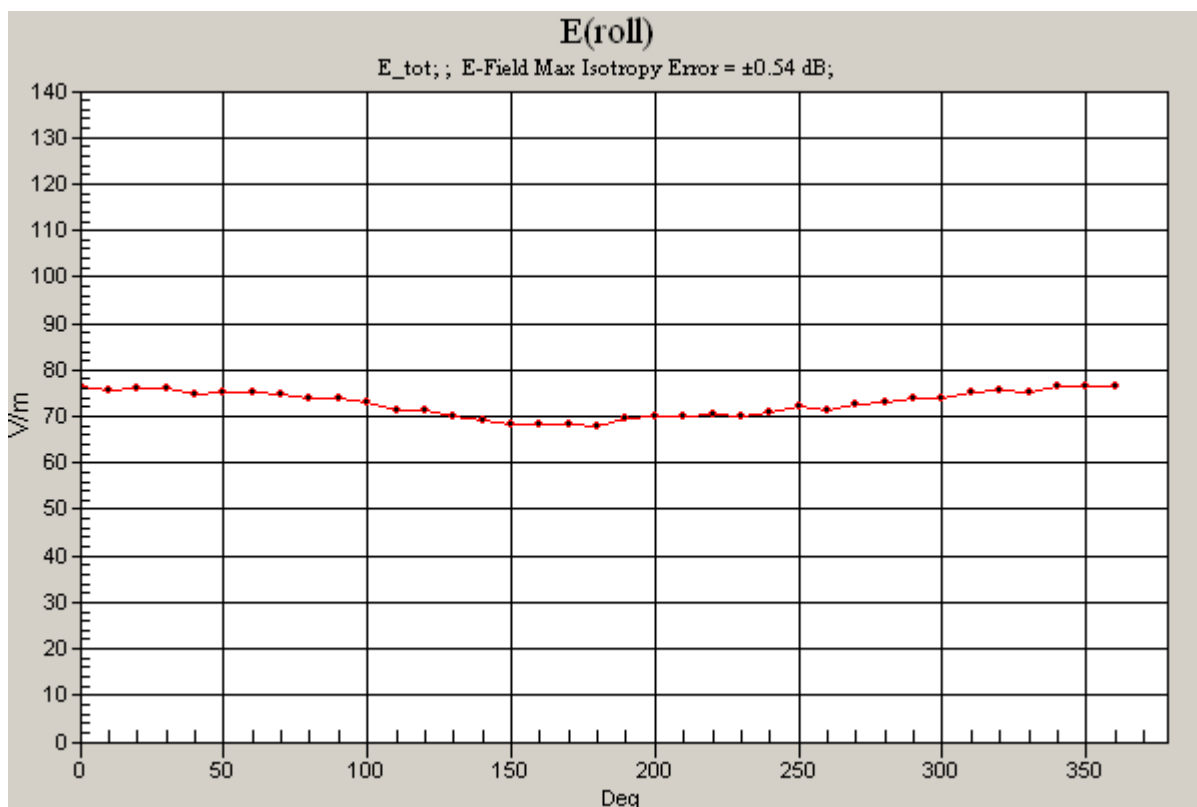
**CDMA PCS H - FIELD**

| CDMA PCS | Conducted Power (dBm) | Power Drift (dB) | H (A/m) | Modulation Factor | Peak Field (A/m) | Excluded Blocks |
|----------|-----------------------|------------------|---------|-------------------|------------------|-----------------|
| Ch 25    | 22.8                  | 0.187            | 0.071   | 0.7               | 0.0497           | 4,7,8           |
| Ch 600   | 22.9                  | -0.323           | 0.079   | 0.7               | 0.0553           | 7,8,9           |
| Ch 1175  | 22.9                  | 0.104            | 0.087   | 0.7               | 0.0609           | 7,8,9           |

## WORST CASE CONFIGURATION

| CDMA<br>Celluar | E (V/m) | Modulation<br>Factor | Peak Field<br>(V/m) | FCC M3 Limits<br>(V/m) | Category |
|-----------------|---------|----------------------|---------------------|------------------------|----------|
| Ch 384          | 77.9    | 1.0                  | 77.9                | 63.1 to 112.2          | M3       |

The probe rotation was done at the sub grid 2 for Channel 384, E field.



## 11. MEASUREMENT UNCERTAINTY

| HAC Uncertainty Budget                   |                   |             |        |        |        |             |             |           |           |
|------------------------------------------|-------------------|-------------|--------|--------|--------|-------------|-------------|-----------|-----------|
| Error Description                        | Uncertainty value | Prob. Dist. | Div.   | (ci) E | (ci) H | Std. Unc. E | Std. Unc. H | Squared E | Squared H |
| Measurement System                       |                   |             |        |        |        |             |             |           |           |
| Probe Calibration                        | 5.1               | N           | 1      | 1      | 1      | 5.1         | 5.1         | 26.0      | 26.0      |
| Axial Isotropy                           | 4.7               | R           | 1.7321 | 1      | 1      | 2.7         | 2.7         | 7.4       | 7.4       |
| Sensor Displacement                      | 16.5              | R           | 1.7321 | 1      | 0.145  | 9.5         | 1.4         | 90.7      | 1.9       |
| Boundary Effects                         | 2.4               | R           | 1.7321 | 1      | 1      | 1.4         | 1.4         | 1.9       | 1.9       |
| Linearity                                | 4.7               | R           | 1.7321 | 1      | 1      | 2.7         | 2.7         | 7.4       | 7.4       |
| Scaling to Peak Envelope Power           | 2                 | R           | 1.7321 | 1      | 1      | 1.2         | 1.2         | 1.3       | 1.3       |
| System Detection Limit                   | 1                 | R           | 1.7321 | 1      | 1      | 0.6         | 0.6         | 0.3       | 0.3       |
| Readout Electronics                      | 0.3               | N           | 1      | 1      | 1      | 0.3         | 0.3         | 0.1       | 0.1       |
| Response Time                            | 0.8               | R           | 1.7321 | 1      | 1      | 0.5         | 0.5         | 0.2       | 0.2       |
| Integration Time                         | 2.6               | R           | 1.7321 | 1      | 1      | 1.5         | 1.5         | 2.3       | 2.3       |
| RF Ambient Conditions                    | 3                 | R           | 1.7321 | 1      | 1      | 1.7         | 1.7         | 3.0       | 3.0       |
| RF Reflections                           | 12                | R           | 1.7321 | 1      | 1      | 6.9         | 6.9         | 48.0      | 48.0      |
| Probe Positioner                         | 1.2               | R           | 1.7321 | 1      | 0.67   | 0.7         | 0.5         | 0.5       | 0.2       |
| Probe Positioning                        | 4.7               | R           | 1.7321 | 1      | 0.67   | 2.7         | 1.8         | 7.4       | 3.3       |
| Extrap. And Interpolation                | 1                 | R           | 1.7321 | 1      | 1      | 0.6         | 0.6         | 0.3       | 0.3       |
| Test Sample Related                      |                   |             |        |        |        |             |             | 0.0       | 0.0       |
| Device Positioning Vertical              | 10                | R           | 1.7321 | 1      | 0.67   | 2.7         | 1.8         | 7.4       | 3.3       |
| Device Positioning Lateral               | 10                | R           | 1.7321 | 1      | 1      | 0.6         | 0.6         | 0.3       | 0.3       |
| Device Holder                            | 2.4               | R           | 1.7321 | 1      | 1      | 1.4         | 1.4         | 1.9       | 1.9       |
| Power Drift                              | 5                 | R           | 1.7321 | 1      | 1      | 2.9         | 2.9         | 8.3       | 8.3       |
| Phantom and Setup Related                |                   |             |        |        |        |             |             | 0.0       | 0.0       |
| Phantom Thickness                        | 2.4               | R           | 1.7321 | 1      | 0.67   | 1.4         | 0.9         | 1.9       | 0.9       |
| Combined Std. Uncertainty                |                   |             |        |        |        |             |             | 16.6      | 12.8      |
| Expanded Std. Uncertainty on Field (k=2) |                   |             |        |        |        |             |             | 33.2%     | 21.8%     |

# TCC

Test & Certification Center (TCC) - Dallas

Company Confidential

WR-834.003

28 October 2005



29 (47)

Accredited Laboratory Certificate  
Number: 1819-01

Ver 1.0

## APPENDIX A: VALIDATIONS SCANS

Date/Time: 10/20/2005 10:43:14 AM

Test Laboratory: TCC Dallas

## 835MHz, E field, CW Validation

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

bvDASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

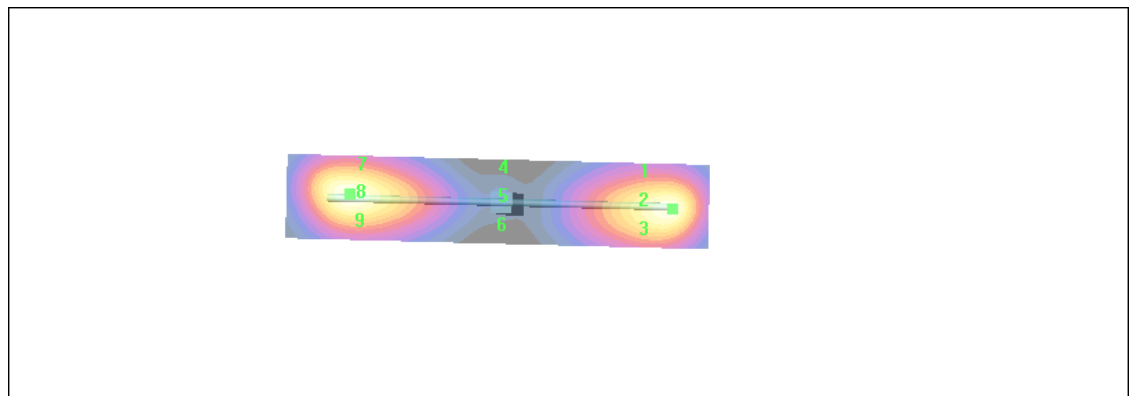
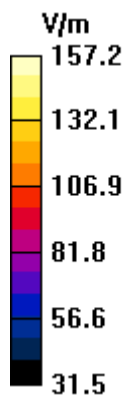
Power Drift = 0.0914 dB

**HAC Procedure/Hearing Aid Compatibility Test 0 deg (81x401x1):** Measurement grid: dx=5mm, dy=5mm

Maximum value of Total field (slot averaged) = 157.2 V/m

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

| E in V/m (Time averaged) |              |              | E in V/m (Slot averaged) |              |              |
|--------------------------|--------------|--------------|--------------------------|--------------|--------------|
| Grid 1                   | Grid 2       | Grid 3       | Grid 1                   | Grid 2       | Grid 3       |
| <b>131.3</b>             | <b>156.2</b> | <b>146.8</b> | <b>131.3</b>             | <b>156.2</b> | <b>146.8</b> |
| Grid 4                   | Grid 5       | Grid 6       | Grid 4                   | Grid 5       | Grid 6       |
| <b>87.8</b>              | <b>96.3</b>  | <b>88.1</b>  | <b>87.8</b>              | <b>96.3</b>  | <b>88.1</b>  |
| Grid 7                   | Grid 8       | Grid 9       | Grid 7                   | Grid 8       | Grid 9       |
| <b>146.6</b>             | <b>157.2</b> | <b>138.8</b> | <b>146.6</b>             | <b>157.2</b> | <b>138.8</b> |



Date/Time: 10/20/2005 11:51:28 AM

Test Laboratory: TCC Dallas

## 835MHz, H field, CW Validation

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

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.0536 dB

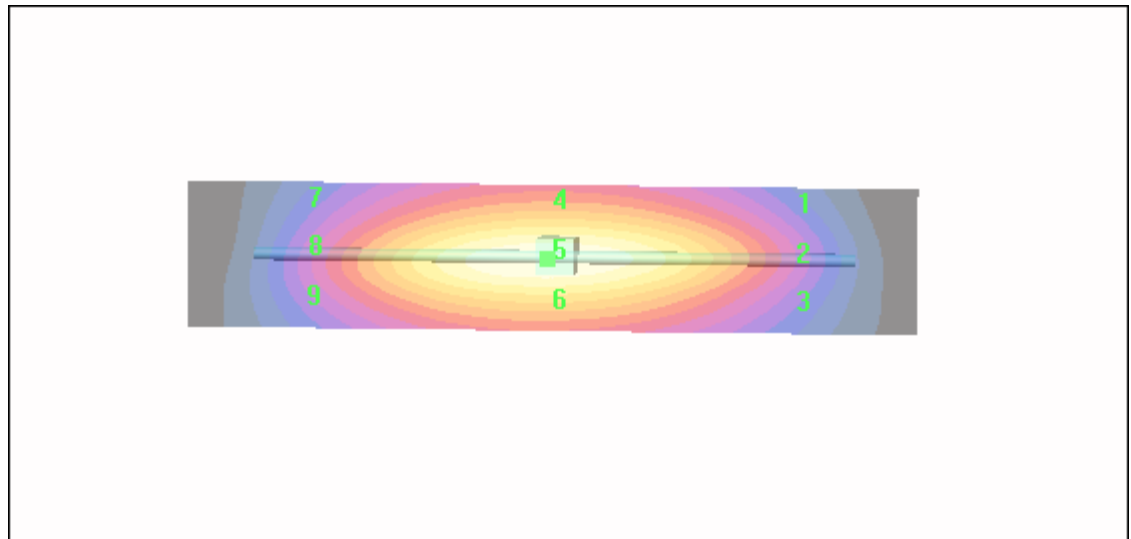
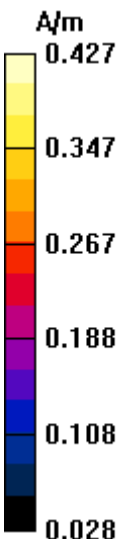
**HAC Procedure/Hearing Aid Compatibility Test 0 deg (81x401x1):** Measurement grid: dx=5mm, dy=5mm

Maximum value of Total field (slot averaged) = 0.427 A/m

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|                        |                        |                        |                        |                        |                        |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Grid 1<br><b>0.320</b> | Grid 2<br><b>0.363</b> | Grid 3<br><b>0.318</b> | Grid 1<br><b>0.320</b> | Grid 2<br><b>0.363</b> | Grid 3<br><b>0.318</b> |
| Grid 4<br><b>0.368</b> | Grid 5<br><b>0.427</b> | Grid 6<br><b>0.384</b> | Grid 4<br><b>0.368</b> | Grid 5<br><b>0.427</b> | Grid 6<br><b>0.384</b> |
| Grid 7<br><b>0.310</b> | Grid 8<br><b>0.369</b> | Grid 9<br><b>0.340</b> | Grid 7<br><b>0.310</b> | Grid 8<br><b>0.369</b> | Grid 9<br><b>0.340</b> |



Date/Time: 10/20/2005 2:45:45 PM

Test Laboratory: TCC Dallas

## 1880MHz, E field, CW Validation

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

DASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = -0.00513 dB

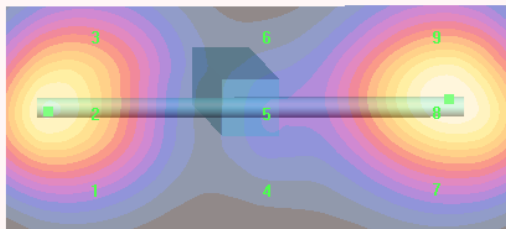
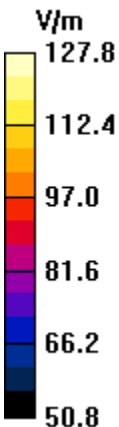
**HAC Procedure/Hearing Aid Compatibility Test 0 deg (81x181x1):** Measurement grid: dx=5mm, dy=5mm

Maximum value of Total field (slot averaged) = 127.8 V/m

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

E in V/m (Time averaged)      E in V/m (Slot averaged)

|                        |                        |                        |                        |                        |                        |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Grid 1<br><b>100.8</b> | Grid 2<br><b>123.5</b> | Grid 3<br><b>116.9</b> | Grid 1<br><b>100.8</b> | Grid 2<br><b>123.5</b> | Grid 3<br><b>116.9</b> |
| Grid 4<br><b>71.4</b>  | Grid 5<br><b>85.1</b>  | Grid 6<br><b>83.4</b>  | Grid 4<br><b>71.4</b>  | Grid 5<br><b>85.1</b>  | Grid 6<br><b>83.4</b>  |
| Grid 7<br><b>101.1</b> | Grid 8<br><b>127.8</b> | Grid 9<br><b>124.2</b> | Grid 7<br><b>101.1</b> | Grid 8<br><b>127.8</b> | Grid 9<br><b>124.2</b> |



Date/Time: 10/20/2005 1:42:34 PM

Test Laboratory: TCC Dallas

## 1880MHz, H field, CW Validation

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

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.0217 dB

**HAC Procedure/Hearing Aid Compatibility Test 0 deg (81x181x1):** Measurement grid: dx=5mm, dy=5mm

Maximum value of Total field (slot averaged) = 0.421 A/m

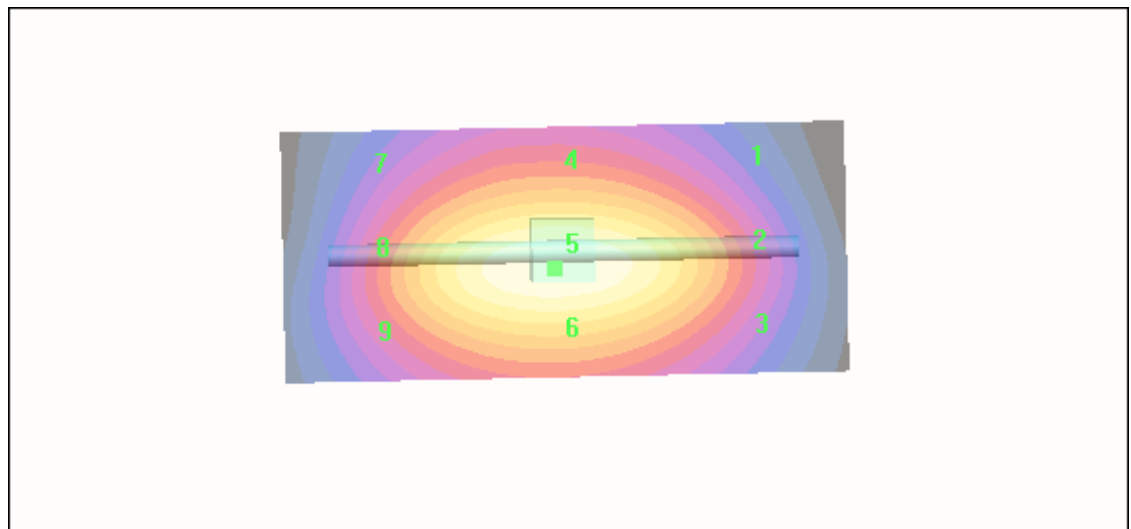
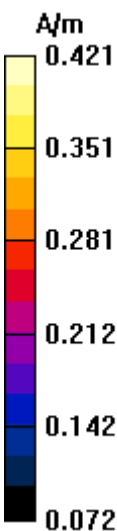
**Hearing Aid Near-Field Category: M2 (AWF 0 dB)**

H in A/m (Time averaged)

|              |              |              |
|--------------|--------------|--------------|
| Grid 1       | Grid 2       | Grid 3       |
| <b>0.300</b> | <b>0.373</b> | <b>0.351</b> |
| Grid 4       | Grid 5       | Grid 6       |
| <b>0.341</b> | <b>0.421</b> | <b>0.400</b> |
| Grid 7       | Grid 8       | Grid 9       |
| <b>0.314</b> | <b>0.389</b> | <b>0.370</b> |

H in A/m (Slot averaged)

|              |              |              |
|--------------|--------------|--------------|
| Grid 1       | Grid 2       | Grid 3       |
| <b>0.300</b> | <b>0.373</b> | <b>0.351</b> |
| Grid 4       | Grid 5       | Grid 6       |
| <b>0.341</b> | <b>0.421</b> | <b>0.400</b> |
| Grid 7       | Grid 8       | Grid 9       |
| <b>0.314</b> | <b>0.389</b> | <b>0.370</b> |



# TCC

Test & Certification Center (TCC) - Dallas

Company Confidential

WR-834.003

28 October 2005



34 (47)

Accredited Laboratory Certificate  
Number: 1819-01

Ver 1.0

## APPENDIX B: MEASUREMENT SCANS

Date/Time: 10/21/2005 2:17:17 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA800, Ch1013, Whip Extend position, E field, BT Active

Communication System: CDMA800; Frequency: 824.7 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.276 dB

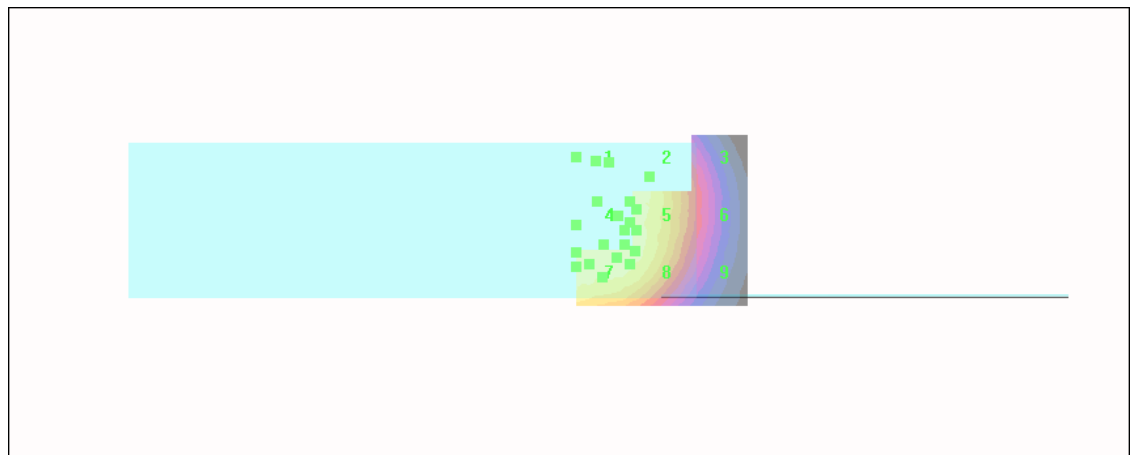
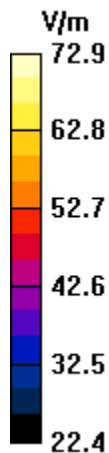
**HAC Procedure/Hearing Aid Compatibility Test (251x251x1):** Measurement grid: dx=2mm, dy=2mm  
Maximum value of Total field (slot averaged) = 69.6 V/m

**Hearing Aid Near-Field Category: M3 (AWF 0 dB)**

E in V/m (Time averaged)      E in V/m (Slot averaged)

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 72.9   | 69.7   | 51.6   |
| Grid 4 | Grid 5 | Grid 6 |
| 68.9   | 68.6   | 52.0   |
| Grid 7 | Grid 8 | Grid 9 |
| 69.6   | 67.7   | 48.4   |

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 72.9   | 69.7   | 51.6   |
| Grid 4 | Grid 5 | Grid 6 |
| 68.9   | 68.6   | 52.0   |
| Grid 7 | Grid 8 | Grid 9 |
| 69.6   | 67.7   | 48.4   |



Date/Time: 10/21/2005 1:58:38 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA800, Ch 384, Whip Extend position, E field, BT Active

Communication System: CDMA800; Frequency: 836.52 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = -0.329 dB

## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

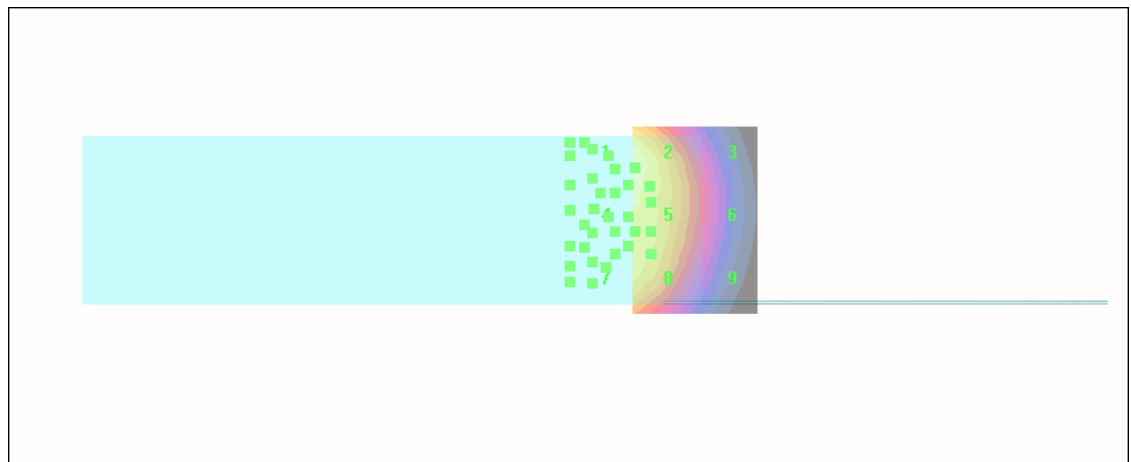
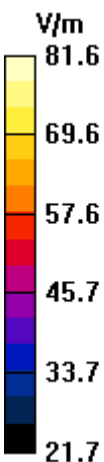
Maximum value of Total field (slot averaged) = 76.6 V/m

Hearing Aid Near-Field Category: **M3 (AWF 0 dB)**

E in V/m (Time averaged)    E in V/m (Slot averaged)

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 81.6   | 76.6   | 54.7   |
| Grid 4 | Grid 5 | Grid 6 |
| 76.3   | 75.0   | 55.1   |
| Grid 7 | Grid 8 | Grid 9 |
| 77.3   | 73.2   | 50.4   |

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 81.6   | 76.6   | 54.7   |
| Grid 4 | Grid 5 | Grid 6 |
| 76.3   | 75.0   | 55.1   |
| Grid 7 | Grid 8 | Grid 9 |
| 77.3   | 73.2   | 50.4   |



Date/Time: 10/21/2005 2:53:44 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA800, Ch 777, Whip Extend position, E field, BT Active

Communication System: CDMA800; Frequency: 848.31 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = -0.107 dB

## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

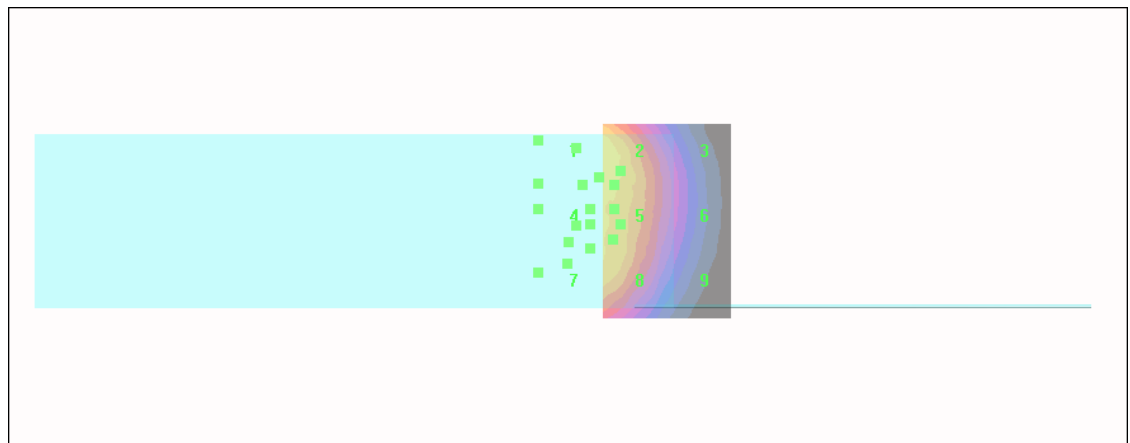
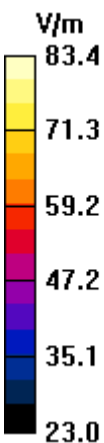
Maximum value of Total field (slot averaged) = 71.4 V/m

Hearing Aid Near-Field Category: **M3 (AWF 0 dB)**

E in V/m (Time averaged)    E in V/m (Slot averaged)

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 83.4   | 71.4   | 49.2   |
| Grid 4 | Grid 5 | Grid 6 |
| 75.1   | 69.0   | 49.3   |
| Grid 7 | Grid 8 | Grid 9 |
| 76.3   | 68.1   | 44.4   |

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 83.4   | 71.4   | 49.2   |
| Grid 4 | Grid 5 | Grid 6 |
| 75.1   | 69.0   | 49.3   |
| Grid 7 | Grid 8 | Grid 9 |
| 76.3   | 68.1   | 44.4   |



Date/Time: 10/24/2005 3:07:18 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA800, Ch1013, Whip Extend position, H field, BT Active

Communication System: CDMA800; Frequency: 824.7 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.216 dB

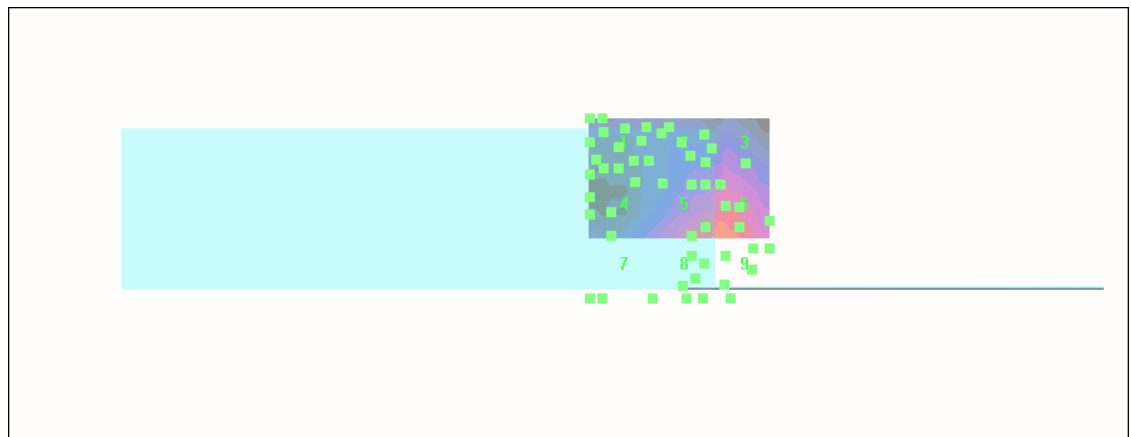
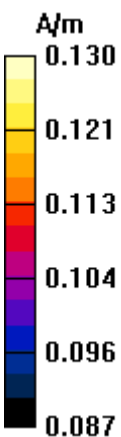
## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of Total field (slot averaged) = 0.112 A/m

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|                        |                        |                        |                        |                        |                        |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Grid 1<br><b>0.094</b> | Grid 2<br><b>0.100</b> | Grid 3<br><b>0.103</b> | Grid 1<br><b>0.094</b> | Grid 2<br><b>0.100</b> | Grid 3<br><b>0.103</b> |
| Grid 4<br><b>0.099</b> | Grid 5<br><b>0.110</b> | Grid 6<br><b>0.112</b> | Grid 4<br><b>0.099</b> | Grid 5<br><b>0.110</b> | Grid 6<br><b>0.112</b> |
| Grid 7<br><b>0.130</b> | Grid 8<br><b>0.124</b> | Grid 9<br><b>0.119</b> | Grid 7<br><b>0.130</b> | Grid 8<br><b>0.124</b> | Grid 9<br><b>0.119</b> |



Date/Time: 10/24/2005 2:48:43 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA800, Ch384, Whip Extend position, H field, BT Active

Communication System: CDMA800; Frequency: 836.52 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = -0.0784 dB

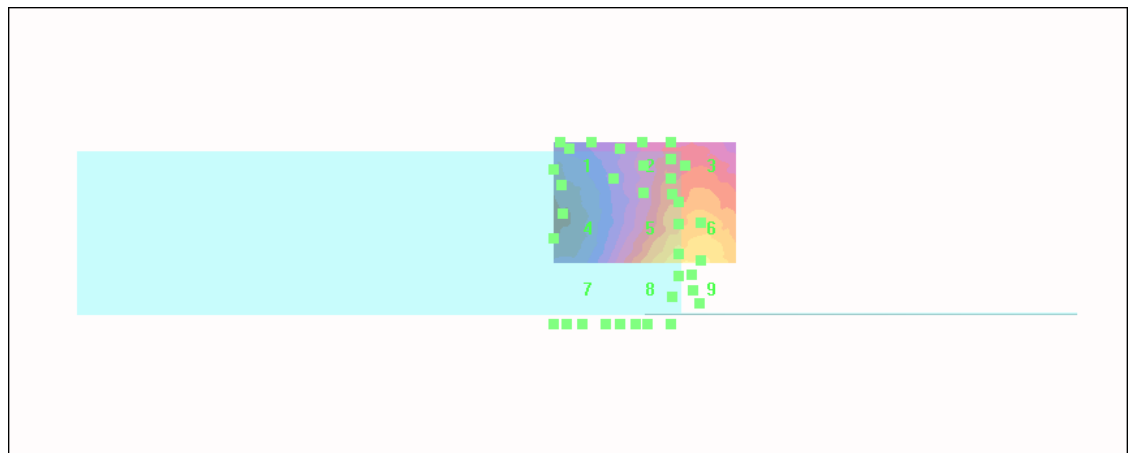
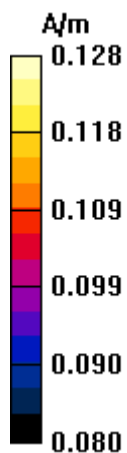
## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of Total field (slot averaged) = 0.119 A/m

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|                        |                        |                        |                        |                        |                        |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Grid 1<br><b>0.096</b> | Grid 2<br><b>0.109</b> | Grid 3<br><b>0.111</b> | Grid 1<br><b>0.096</b> | Grid 2<br><b>0.109</b> | Grid 3<br><b>0.111</b> |
| Grid 4<br><b>0.099</b> | Grid 5<br><b>0.118</b> | Grid 6<br><b>0.119</b> | Grid 4<br><b>0.099</b> | Grid 5<br><b>0.118</b> | Grid 6<br><b>0.119</b> |
| Grid 7<br><b>0.127</b> | Grid 8<br><b>0.128</b> | Grid 9<br><b>0.126</b> | Grid 7<br><b>0.127</b> | Grid 8<br><b>0.128</b> | Grid 9<br><b>0.126</b> |



Date/Time: 10/24/2005 3:26:38 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA800, Ch777, Whip Extend position, H field, BT Active

Communication System: CDMA800; Frequency: 848.31 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.0349 dB

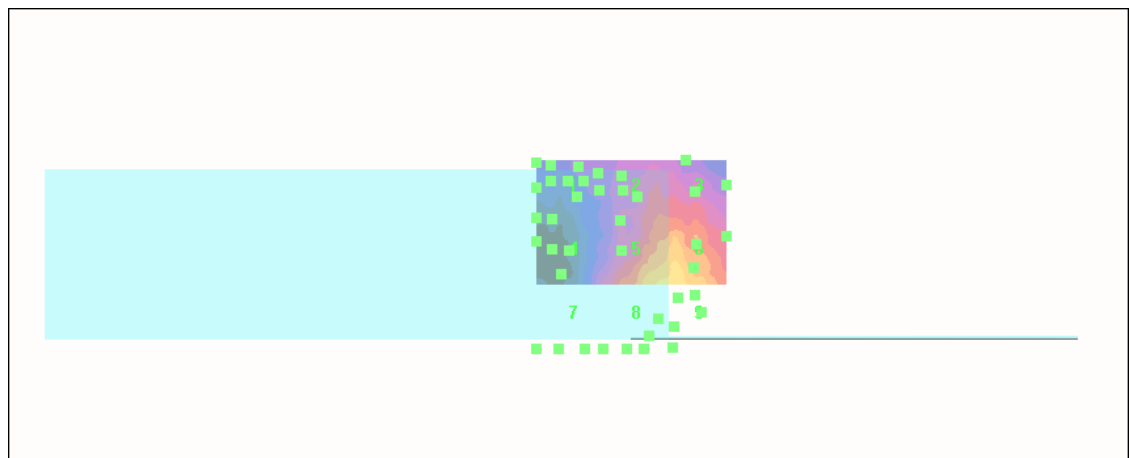
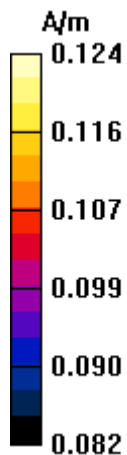
## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of Total field (slot averaged) = 0.116 A/m

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|                        |                        |                        |                        |                        |                        |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Grid 1<br><b>0.096</b> | Grid 2<br><b>0.105</b> | Grid 3<br><b>0.105</b> | Grid 1<br><b>0.096</b> | Grid 2<br><b>0.105</b> | Grid 3<br><b>0.105</b> |
| Grid 4<br><b>0.098</b> | Grid 5<br><b>0.114</b> | Grid 6<br><b>0.116</b> | Grid 4<br><b>0.098</b> | Grid 5<br><b>0.114</b> | Grid 6<br><b>0.116</b> |
| Grid 7<br><b>0.124</b> | Grid 8<br><b>0.122</b> | Grid 9<br><b>0.120</b> | Grid 7<br><b>0.124</b> | Grid 8<br><b>0.122</b> | Grid 9<br><b>0.120</b> |



Date/Time: 10/21/2005 4:01:58 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA1900, Ch25, Whip Extend position, E field, BT Active

Communication System: CDMA1900; Frequency: 1851.25 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = -0.187 dB

## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

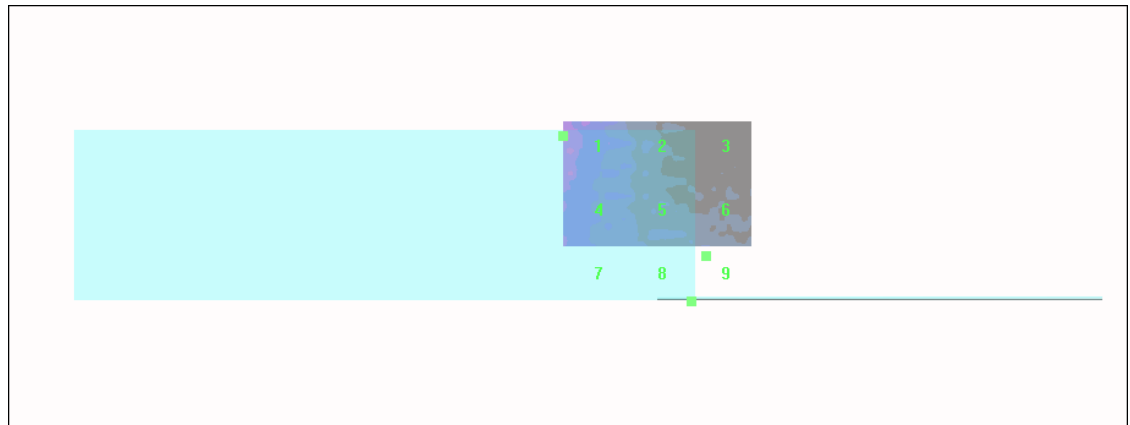
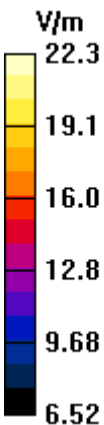
Maximum value of Total field (slot averaged) = 19.7 V/m

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

E in V/m (Time averaged)    E in V/m (Slot averaged)

|             |             |             |
|-------------|-------------|-------------|
| Grid 1      | Grid 2      | Grid 3      |
| <b>19.7</b> | <b>9.92</b> | <b>7.67</b> |
| Grid 4      | Grid 5      | Grid 6      |
| <b>11.6</b> | <b>9.81</b> | <b>9.12</b> |
| Grid 7      | Grid 8      | Grid 9      |
| <b>11.2</b> | <b>14.2</b> | <b>22.3</b> |

|             |             |             |
|-------------|-------------|-------------|
| Grid 1      | Grid 2      | Grid 3      |
| <b>19.7</b> | <b>9.92</b> | <b>7.67</b> |
| Grid 4      | Grid 5      | Grid 6      |
| <b>11.6</b> | <b>9.81</b> | <b>9.12</b> |
| Grid 7      | Grid 8      | Grid 9      |
| <b>11.2</b> | <b>14.2</b> | <b>22.3</b> |



Date/Time: 10/21/2005 3:42:21 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA1900, Ch600, Whip Extend position, E field, BT Active

Communication System: CDMA1900; Frequency: 1880 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.0294 dB

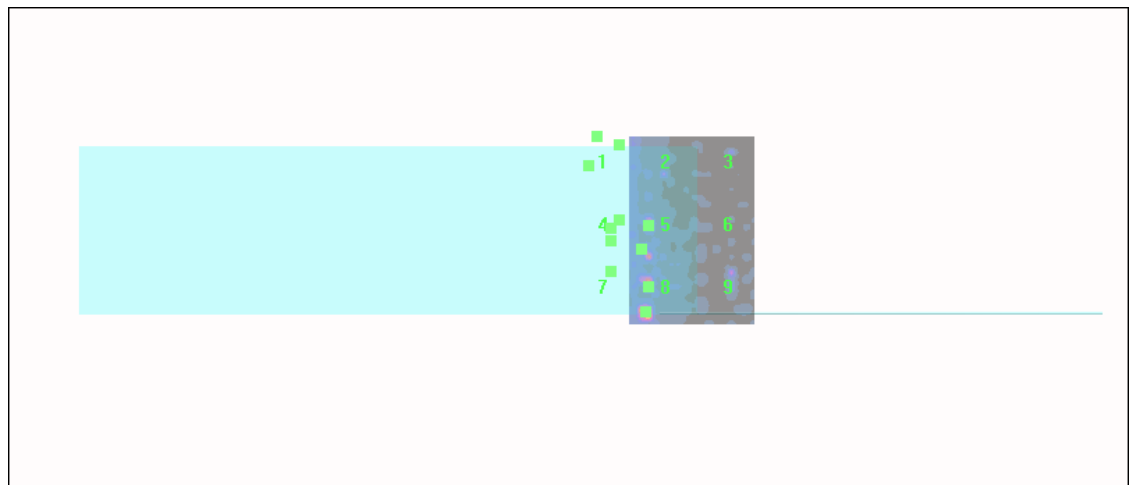
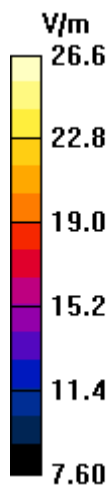
## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of Total field (slot averaged) = 25.2 V/m

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

E in V/m (Time averaged)      E in V/m (Slot averaged)

|                       |                       |                       |                       |                       |                       |
|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Grid 1<br><b>26.6</b> | Grid 2<br><b>13.6</b> | Grid 3<br><b>12.6</b> | Grid 1<br><b>26.6</b> | Grid 2<br><b>13.6</b> | Grid 3<br><b>12.6</b> |
| Grid 4<br><b>24.6</b> | Grid 5<br><b>24.6</b> | Grid 6<br><b>9.85</b> | Grid 4<br><b>24.6</b> | Grid 5<br><b>24.6</b> | Grid 6<br><b>9.85</b> |
| Grid 7<br><b>20.0</b> | Grid 8<br><b>25.2</b> | Grid 9<br><b>14.6</b> | Grid 7<br><b>20.0</b> | Grid 8<br><b>25.2</b> | Grid 9<br><b>14.6</b> |



Date/Time: 10/26/2005 11:21:31 AM

Test Laboratory: TCC Dallas

## RM-125, CDMA1900, Ch1175, Whip Extend position, E field, BT Active

Communication System: CDMA1900; Frequency: 1908.75 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: ER3DV6 - SN2337; ConvF(1, 1, 1); Calibrated: 1/31/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = -0.0532 dB

## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

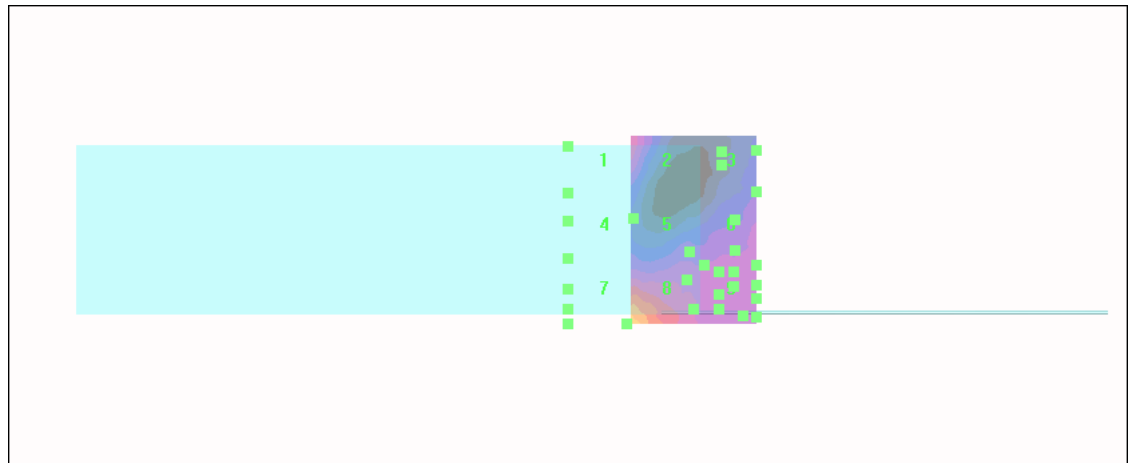
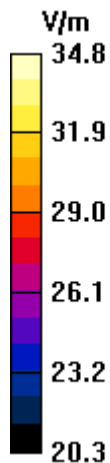
Maximum value of Total field (slot averaged) = 31.0 V/m

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

E in V/m (Time averaged)    E in V/m (Slot averaged)

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 34.7   | 27.0   | 24.4   |
| Grid 4 | Grid 5 | Grid 6 |
| 32.0   | 25.2   | 25.8   |
| Grid 7 | Grid 8 | Grid 9 |
| 34.8   | 31.0   | 26.4   |

|        |        |        |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 34.7   | 27.0   | 24.4   |
| Grid 4 | Grid 5 | Grid 6 |
| 32.0   | 25.2   | 25.8   |
| Grid 7 | Grid 8 | Grid 9 |
| 34.8   | 31.0   | 26.4   |



Date/Time: 10/24/2005 12:35:16 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA1900, Ch25, Whip Extend position, H field, BT Active

Communication System: CDMA1900; Frequency: 1851.25 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.187 dB

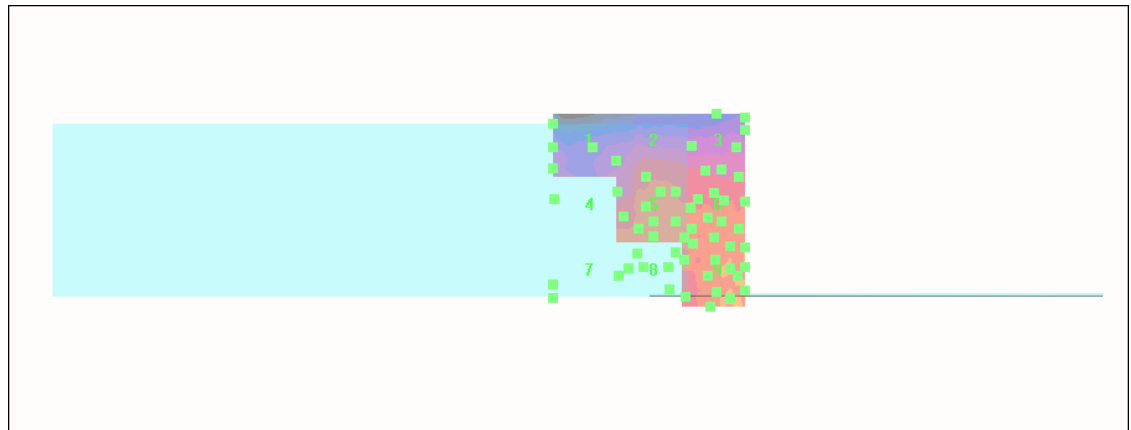
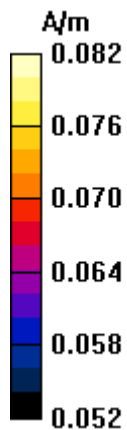
## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of Total field (slot averaged) = 0.071 A/m

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|                        |                        |                        |                        |                        |                        |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Grid 1<br><b>0.065</b> | Grid 2<br><b>0.068</b> | Grid 3<br><b>0.067</b> | Grid 1<br><b>0.065</b> | Grid 2<br><b>0.068</b> | Grid 3<br><b>0.067</b> |
| Grid 4<br><b>0.071</b> | Grid 5<br><b>0.070</b> | Grid 6<br><b>0.070</b> | Grid 4<br><b>0.071</b> | Grid 5<br><b>0.070</b> | Grid 6<br><b>0.070</b> |
| Grid 7<br><b>0.082</b> | Grid 8<br><b>0.072</b> | Grid 9<br><b>0.071</b> | Grid 7<br><b>0.082</b> | Grid 8<br><b>0.072</b> | Grid 9<br><b>0.071</b> |



Date/Time: 10/24/2005 12:16:39 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA1900, Ch600, Whip Extend position, H field, BT Active

Communication System: CDMA1900; Frequency: 1880 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

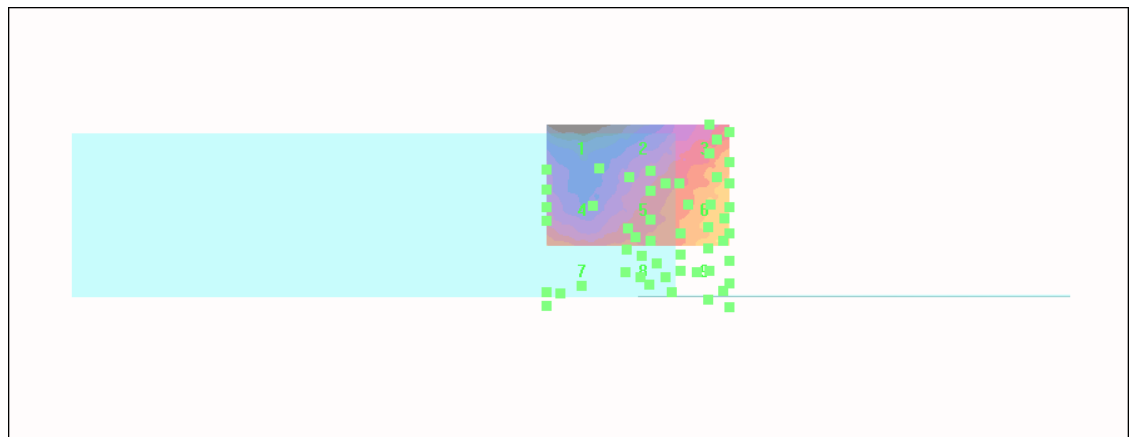
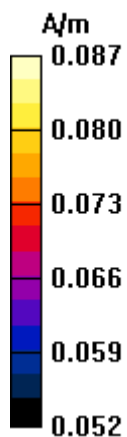
Power Drift = -0.323 dB

## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of Total field (slot averaged) = 0.079 A/m

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

| H in A/m (Time averaged) |              |              | H in A/m (Slot averaged) |              |              |
|--------------------------|--------------|--------------|--------------------------|--------------|--------------|
| Grid 1                   | Grid 2       | Grid 3       | Grid 1                   | Grid 2       | Grid 3       |
| <b>0.066</b>             | <b>0.070</b> | <b>0.077</b> | <b>0.066</b>             | <b>0.070</b> | <b>0.077</b> |
| Grid 4                   | Grid 5       | Grid 6       | Grid 4                   | Grid 5       | Grid 6       |
| <b>0.073</b>             | <b>0.072</b> | <b>0.079</b> | <b>0.073</b>             | <b>0.072</b> | <b>0.079</b> |
| Grid 7                   | Grid 8       | Grid 9       | Grid 7                   | Grid 8       | Grid 9       |
| <b>0.087</b>             | <b>0.077</b> | <b>0.079</b> | <b>0.087</b>             | <b>0.077</b> | <b>0.079</b> |



Date/Time: 10/24/2005 1:17:11 PM

Test Laboratory: TCC Dallas

## RM-125, CDMA1900, Ch1175, Whip Extend position, H field, BT Active

Communication System: CDMA1900; Frequency: 1908.75 MHz; Duty Cycle: 1:1

DASY4 Configuration:

- Probe: H3DV6 - SN6155; ; Calibrated: 2/16/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn389; Calibrated: 1/12/2005
- Phantom: SAM3 Cover FreeSpace Only; Phantom section: Table Section
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

Power Drift = 0.104 dB

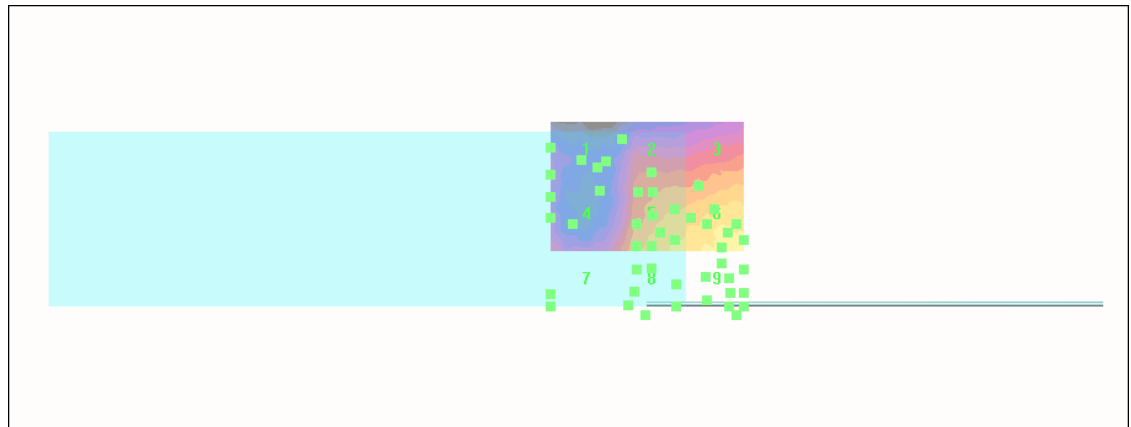
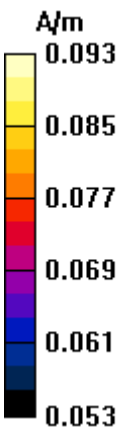
## HAC Procedure/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of Total field (slot averaged) = 0.087 A/m

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|                        |                        |                        |                        |                        |                        |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Grid 1<br><b>0.068</b> | Grid 2<br><b>0.077</b> | Grid 3<br><b>0.080</b> | Grid 1<br><b>0.068</b> | Grid 2<br><b>0.077</b> | Grid 3<br><b>0.080</b> |
| Grid 4<br><b>0.072</b> | Grid 5<br><b>0.083</b> | Grid 6<br><b>0.087</b> | Grid 4<br><b>0.072</b> | Grid 5<br><b>0.083</b> | Grid 6<br><b>0.087</b> |
| Grid 7<br><b>0.093</b> | Grid 8<br><b>0.084</b> | Grid 9<br><b>0.089</b> | Grid 7<br><b>0.093</b> | Grid 8<br><b>0.084</b> | Grid 9<br><b>0.089</b> |



# TCC

Test & Certification Center (TCC) - Dallas

Company Confidential

WR-834.003

28 October 2005



47 (47)

Accredited Laboratory Certificate  
Number: 1819-01

Ver 1.0

## APPENDIX C: PROBE CALIBRATION REPORTS AND DIPOLE CALIBRATION REPORTS

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

Accredited by the Swiss Federal Office of Metrology and Accreditation  
 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 **Nokia TX**

Certificate No: **ER3-2337\_Jan05**

## CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2337**

Calibration procedure(s) **QA CAL-02.v4**  
**Calibration procedure for E-field probes optimized for close near field evaluations in air**

Calibration date: **January 31, 2005**

Condition of the calibrated item **In Tolerance**

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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID #            | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-------------------------------------------|-----------------------|
| Power meter E4419B         | GB41293874      | 5-May-04 (METAS, No. 251-00388)           | May-05                |
| Power sensor E4412A        | MY41495277      | 5-May-04 (METAS, No. 251-00388)           | May-05                |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 10-Aug-04 (METAS, No. 251-00403)          | Aug-05                |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 3-May-04 (METAS, No. 251-00389)           | May-05                |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 10-Aug-04 (METAS, No. 251-00404)          | Aug-05                |
| Reference Probe ER3DV6     | SN: 2328        | 6-Oct-04 (SPEAG, No. ER3-2328_Oct04)      | Oct-05                |
| DAE4                       | SN: 617         | 19-Jan-05 (SPEAG, No. DAE4-617_Jan05)     | Jan-06                |

| Secondary Standards       | ID #         | Check Date (in house)                    | Scheduled Check        |
|---------------------------|--------------|------------------------------------------|------------------------|
| Power sensor HP 8481A     | MY41092180   | 18-Sep-02 (SPEAG, in house check Oct-03) | In house check: Oct 05 |
| RF generator HP 8648C     | US3642U01700 | 4-Aug-99 (SPEAG, in house check Dec-03)  | In house check: Dec-05 |
| Network Analyzer HP 8753E | US37390585   | 18-Oct-01 (SPEAG, in house check Nov-04) | In house check: Nov 05 |

|                |               |                   |           |
|----------------|---------------|-------------------|-----------|
|                | Name          | Function          | Signature |
| Calibrated by: | Katja Pokovic | Technical Manager |           |

|              |              |                 |           |
|--------------|--------------|-----------------|-----------|
|              | Name         | Function        | Signature |
| Approved by: | Niels Kuster | Quality Manager |           |

Issued: February 19, 2005

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



Accredited by the Swiss Federal Office of Metrology and Accreditation  
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 <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                            |
| DCP                      | diode compression point                                                                                                                              |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                    |
| Polarization $\vartheta$ | $\vartheta$ 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 1309-1996, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", 1996.

**Methods Applied and Interpretation of Parameters:**

- *NORM<sub>x,y,z</sub>*: 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)<sub>x,y,z</sub>* = *NORM<sub>x,y,z</sub>* \* *frequency\_response* (see Frequency Response Chart).
- *DCP<sub>x,y,z</sub>*: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency.
- *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 *NORM<sub>x</sub>* (no uncertainty required).

# Probe ER3DV6

## SN:2337

|               |                   |
|---------------|-------------------|
| Manufactured: | September 9, 2003 |
| Calibrated:   | January 31, 2005  |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

**DASY - Parameters of Probe: ER3DV6 SN:2337**Sensitivity in Free Space [ $\mu\text{V}/(\text{V}/\text{m})^2$ ]Diode Compression<sup>A</sup>NormX      **1.51  $\pm$  10.1 % (k=2)**DCP X      **95 mV**NormY      **1.43  $\pm$  10.1 % (k=2)**DCP Y      **95 mV**NormZ      **1.58  $\pm$  10.1 % (k=2)**DCP Z      **97 mV**

Frequency Correction

X      **0.0**Y      **0.0**Z      **0.0**

Sensor Offset

(Probe Tip to Sensor Center)

X      **2.5 mm**Y      **2.5 mm**Z      **2.5 mm**

Connector Angle

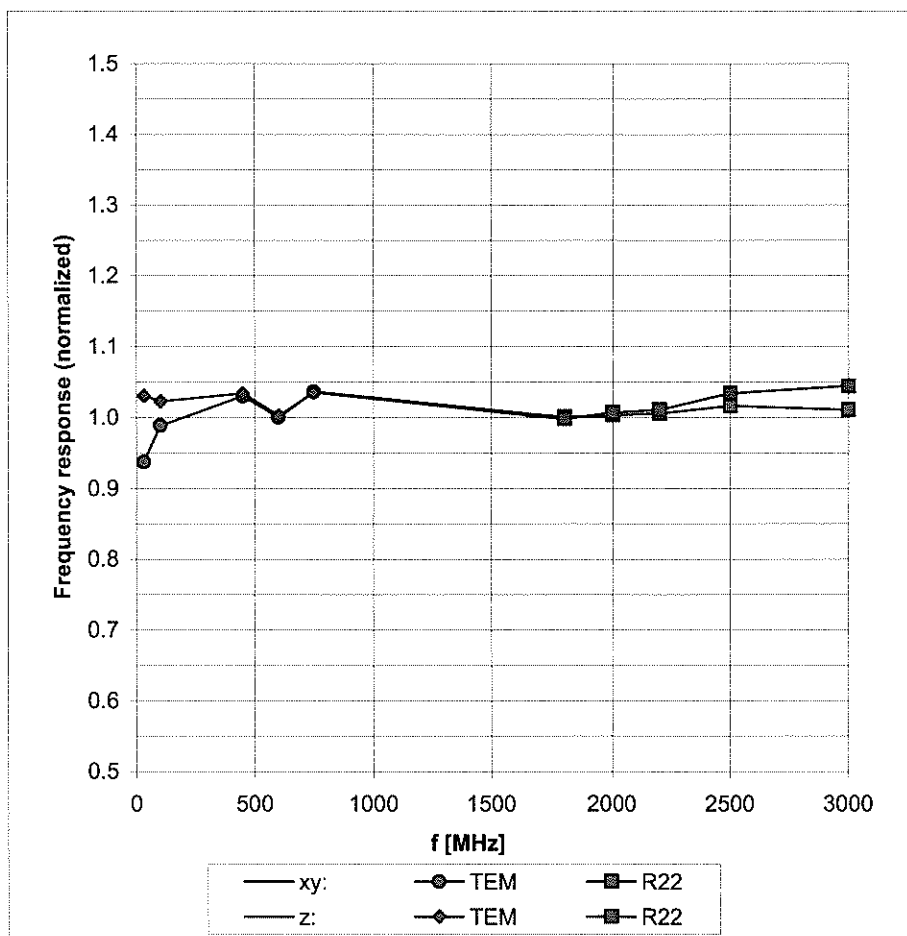
**-25 °**

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%.

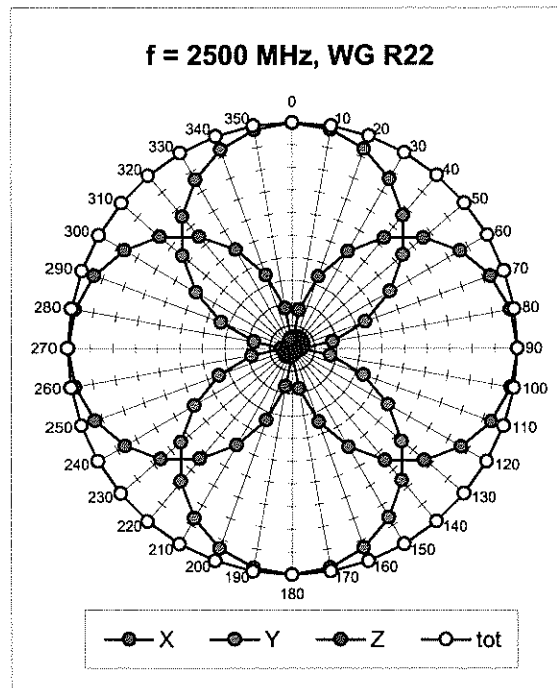
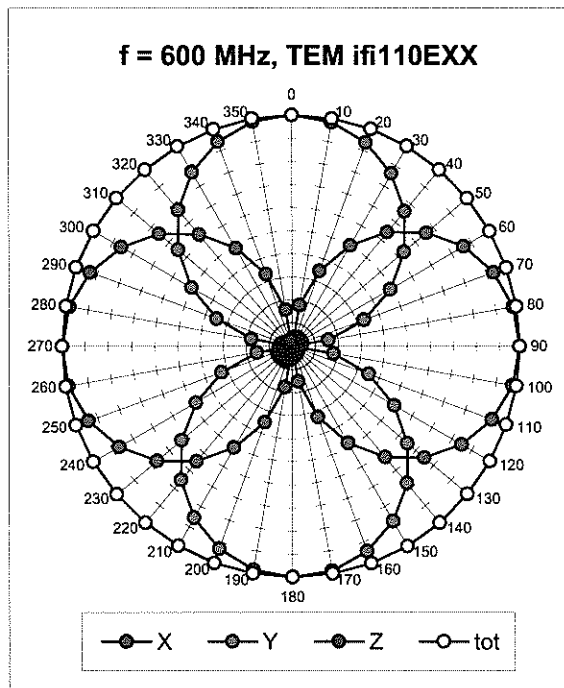
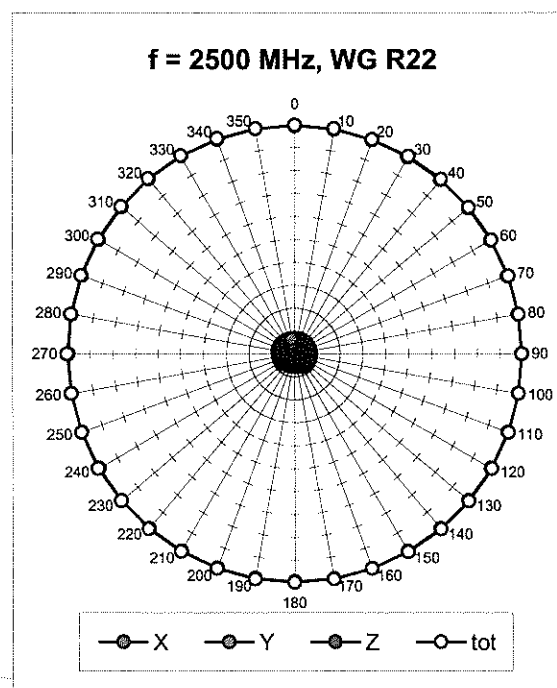
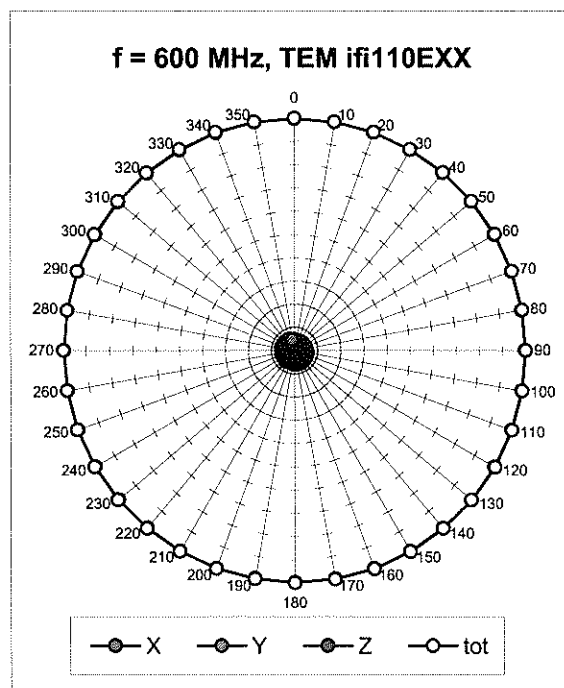
<sup>A</sup> numerical linearization parameter: uncertainty not required

## Frequency Response of E-Field

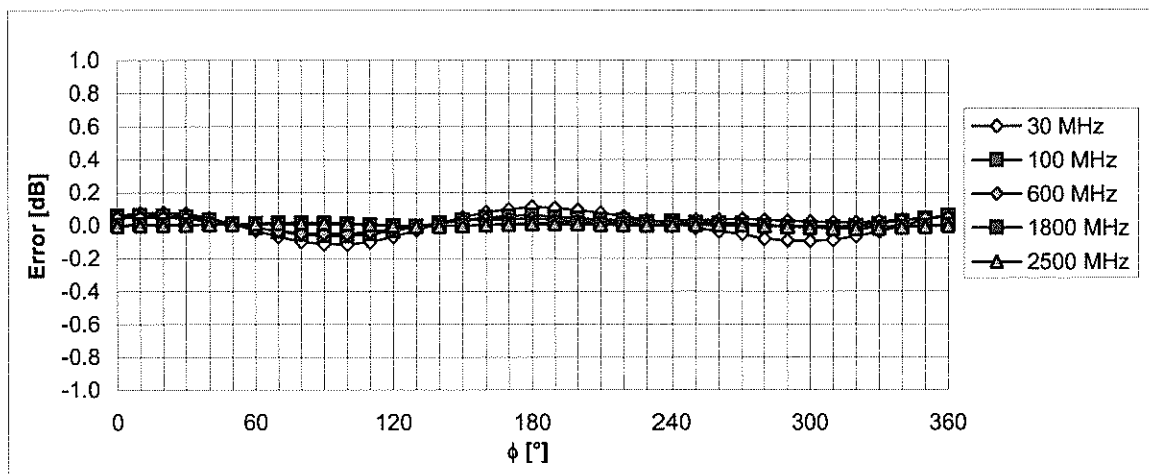
(TEM-Cell:ifi110 EXX, Waveguide R22)



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

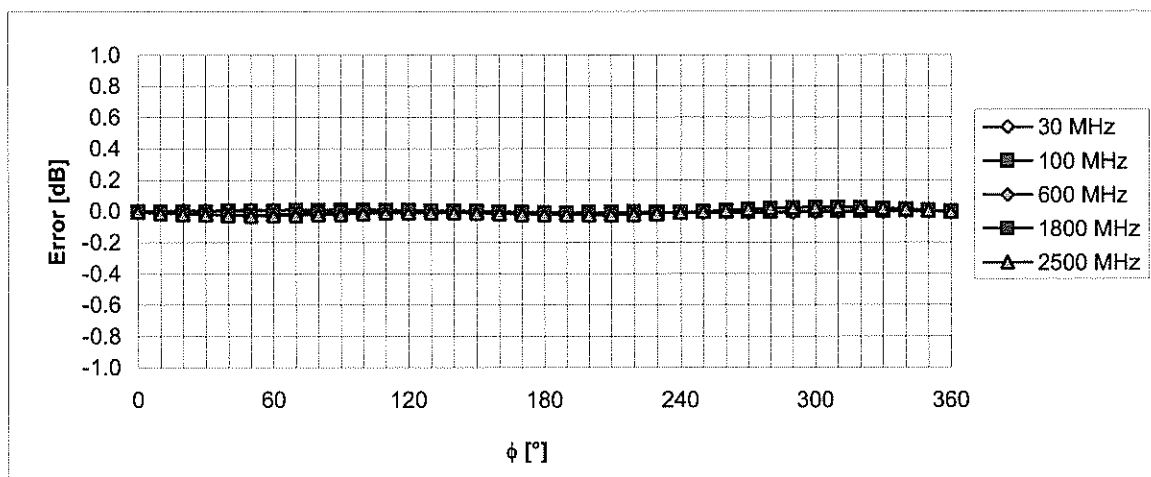
**Receiving Pattern ( $\phi$ ),  $\vartheta = 0^\circ$** **Receiving Pattern ( $\phi$ ),  $\vartheta = 90^\circ$** 

### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



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

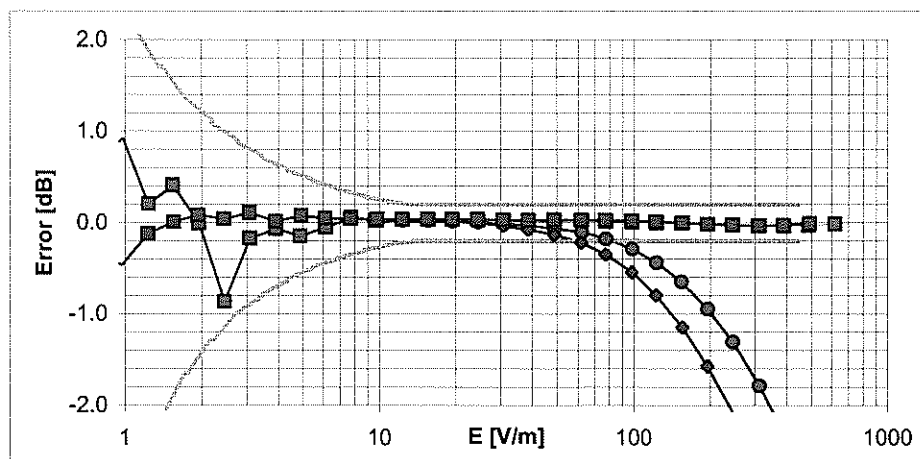
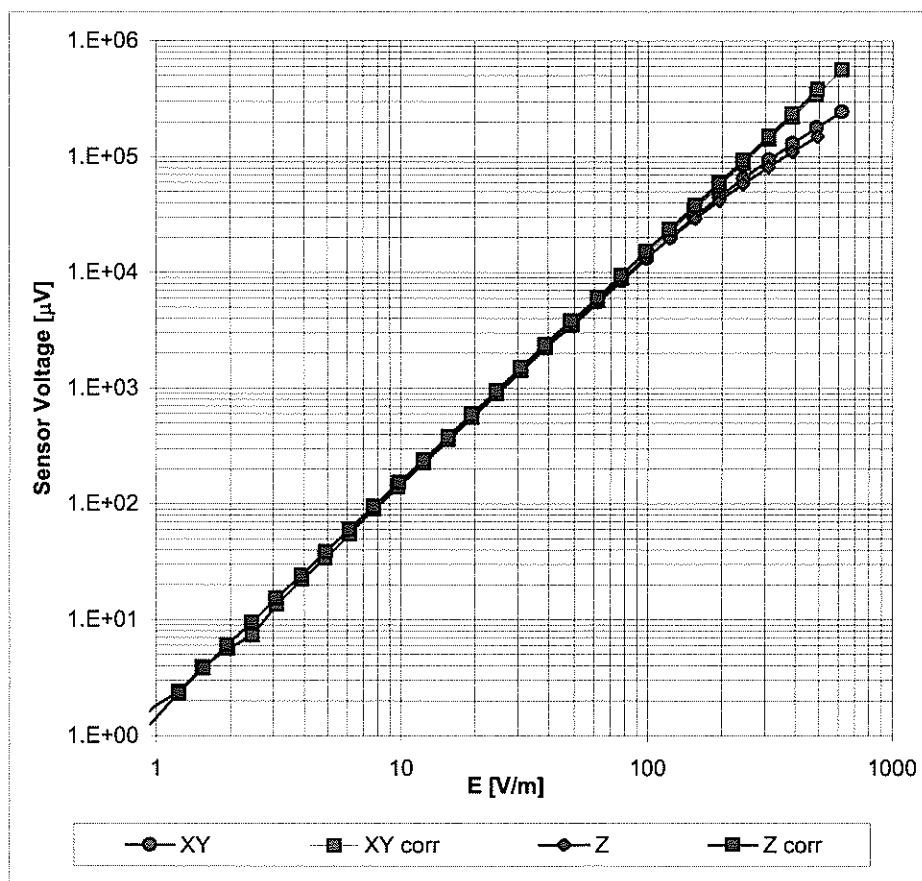
### Receiving Pattern ( $\phi$ ), $\vartheta = 90^\circ$



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

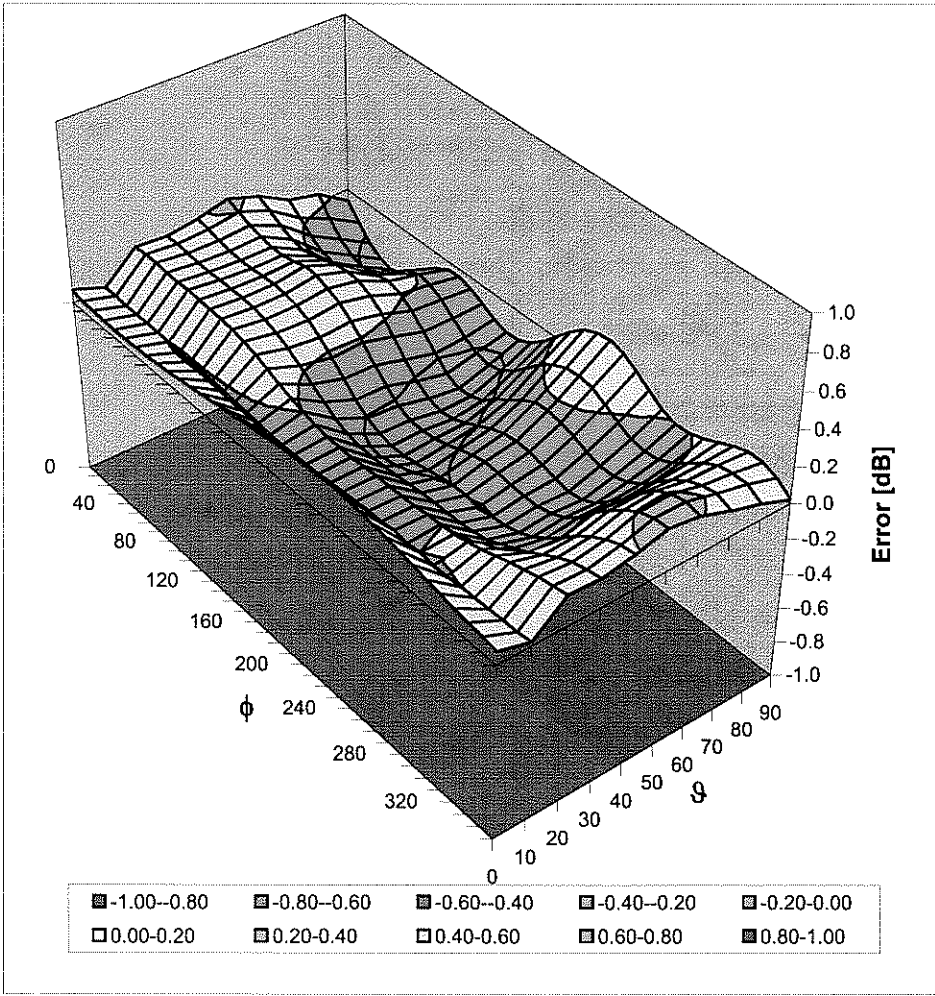
## Dynamic Range f(E-field)

(Waveguide R22,  $f = 1800$  MHz)



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

Deviation from Isotropy in Air  
Error ( $\phi, \vartheta$ ) ,  $f = 900 \text{ MHz}$



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

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



**S** Schweizerischer Kalibrierdienst  
**S** Service suisse d'étalonnage  
**C** Servizio svizzero di taratura  
**S** Swiss Calibration Service

Accredited by the Swiss Federal Office of Metrology and Accreditation  
 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 **Nokia TX**

Certificate No: **H3-6155\_Feb05**

## CALIBRATION CERTIFICATE

Object **H3DV6 - SN:6155**

Calibration procedure(s) **QA CAL-03.v4**  
**Calibration procedure for H-field probes optimized for close near field evaluations in air**

Calibration date: **February 16, 2005**

Condition of the calibrated item **In Tolerance**

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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID #            | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-------------------------------------------|-----------------------|
| Power meter E4419B         | GB41293874      | 5-May-04 (METAS, No. 251-00388)           | May-05                |
| Power sensor E4412A        | MY41495277      | 5-May-04 (METAS, No. 251-00388)           | May-05                |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 10-Aug-04 (METAS, No. 251-00403)          | Aug-05                |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 3-May-04 (METAS, No. 251-00389)           | May-05                |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 10-Aug-04 (METAS, No. 251-00404)          | Aug-05                |
| Reference Probe H3DV6      | SN: 6182        | 6-Oct-04 (SPEAG, No. H3-6182_Oct04)       | Oct-05                |
| DAE4                       | SN: 617         | 19-Jan-05 (SPEAG, No. DAE4-617_Jan05)     | Jan-06                |

| Secondary Standards       | ID #         | Check Date (in house)                    | Scheduled Check        |
|---------------------------|--------------|------------------------------------------|------------------------|
| Power sensor HP 8481A     | MY41092180   | 18-Sep-02 (SPEAG, in house check Oct-03) | In house check: Oct 05 |
| RF generator HP 8648C     | US3642U01700 | 4-Aug-99 (SPEAG, in house check Dec-03)  | In house check: Dec-05 |
| Network Analyzer HP 8753E | US37390585   | 18-Oct-01 (SPEAG, in house check Nov-04) | In house check: Nov 05 |

|                |               |                   |           |
|----------------|---------------|-------------------|-----------|
|                | Name          | Function          | Signature |
| Calibrated by: | Katja Pokovic | Technical Manager |           |
| Approved by:   | Niels Kuster  | Quality Manager   |           |

Issued: February 19, 2005

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



Accredited by the Swiss Federal Office of Metrology and Accreditation  
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 <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                            |
| DCP                      | diode compression point                                                                                                                              |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                    |
| Polarization $\vartheta$ | $\vartheta$ 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 1309-1996, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", 1996.

### **Methods Applied and Interpretation of Parameters:**

- $X, Y, Z_{a0a1a2}$ : Assessed for E-field polarization  $\vartheta = 90$  for XY sensors and  $\vartheta = 0$  for Z sensor ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).
- $X, Y, Z(f)_{a0a1a2} = X, Y, Z_{a0a1a2} \cdot \text{frequency\_response}$  (see Frequency Response Chart).
- $DCP_{x,y,z}$ : DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency.
- *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).

# Probe H3DV6

## SN:6155

|               |                   |
|---------------|-------------------|
| Manufactured: | June 22, 2004     |
| Calibrated:   | February 16, 2005 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

**DASY - Parameters of Probe: H3DV6 SN:6155**Sensitivity in Free Space [A/m /  $\sqrt{(\mu\text{V})}$ ]

|   | a0        | a1        | a2                          |
|---|-----------|-----------|-----------------------------|
| X | 2.719E-03 | -7.681E-5 | 3.643E-5 $\pm$ 5.1 % (k=2)  |
| Y | 2.743E-03 | 1.819E-5  | -1.877E-5 $\pm$ 5.1 % (k=2) |
| Z | 2.974E-03 | -4.287E-5 | -1.156E-5 $\pm$ 5.1 % (k=2) |

Diode Compression<sup>1</sup>

|       |       |
|-------|-------|
| DCP X | 86 mV |
| DCP Y | 86 mV |
| DCP Z | 85 mV |

Sensor Offset (Probe Tip to Sensor Center)

|   |        |
|---|--------|
| X | 3.0 mm |
| Y | 3.0 mm |
| Z | 3.0 mm |

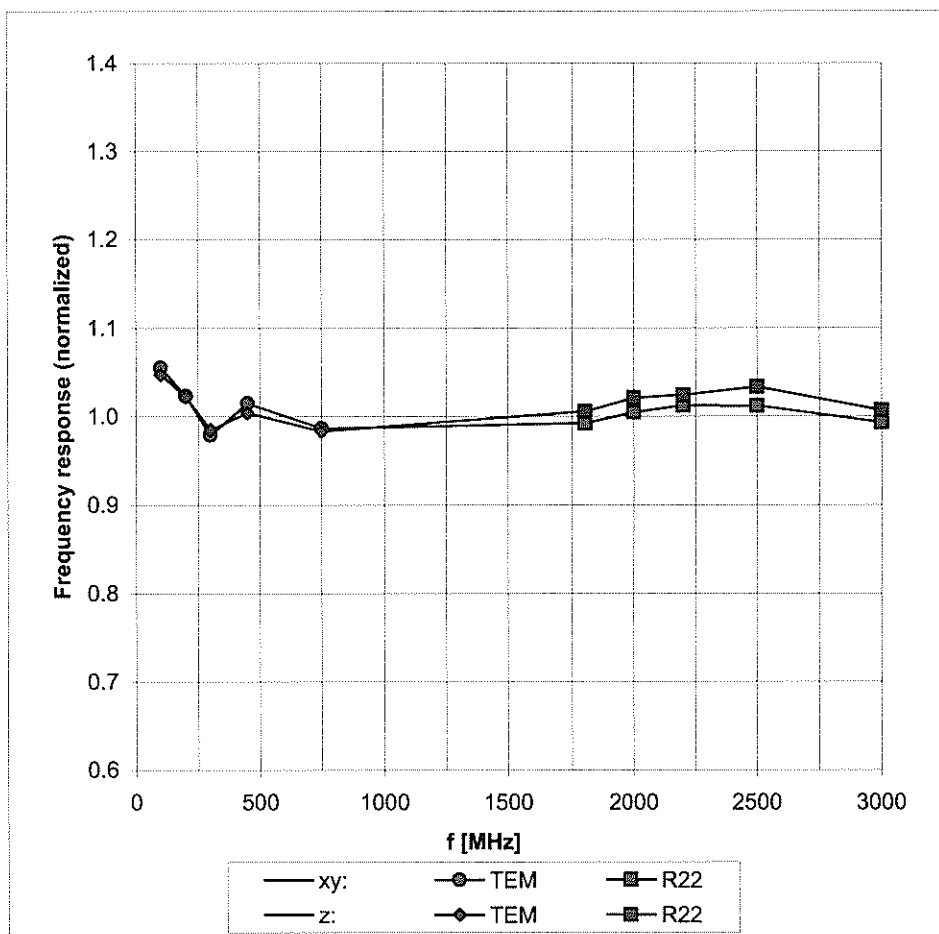
Connector Angle 319 °

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%.

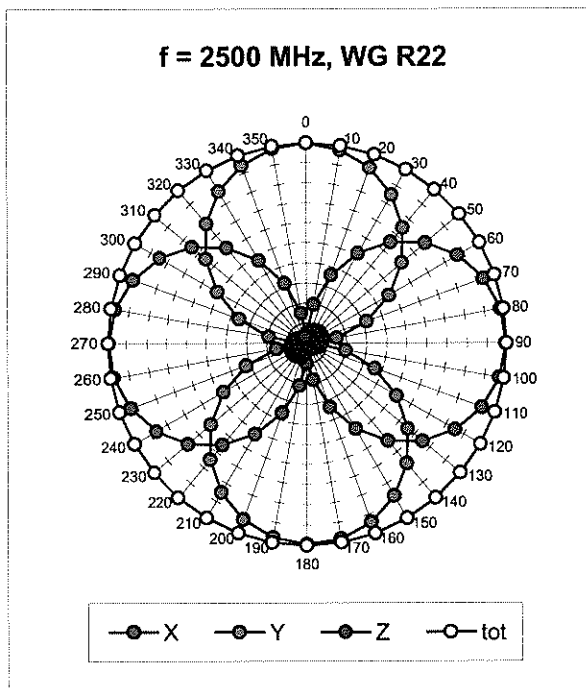
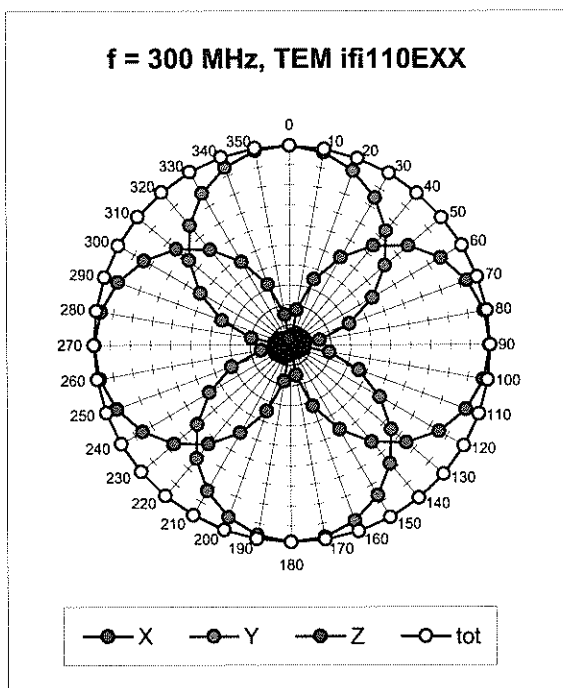
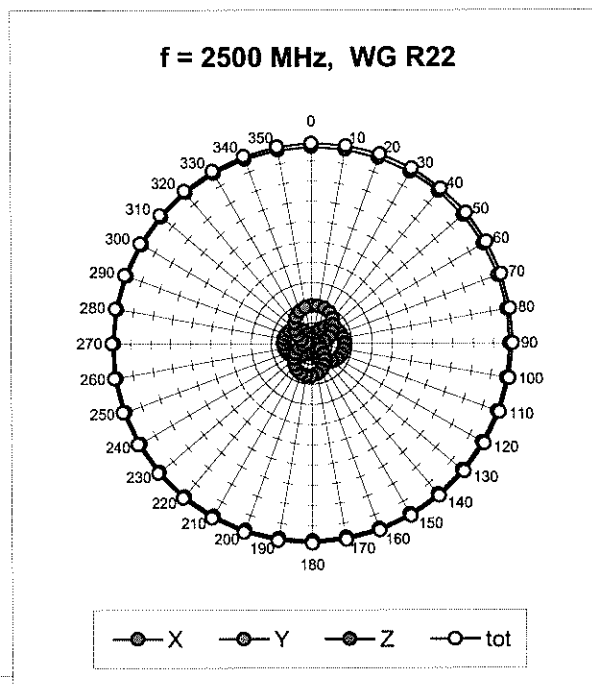
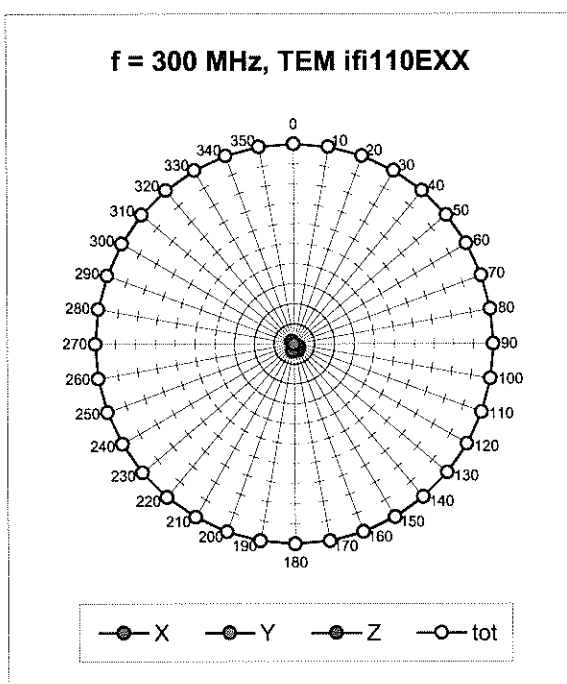
<sup>1</sup> numerical linearization parameter: uncertainty not required

## Frequency Response of H-Field

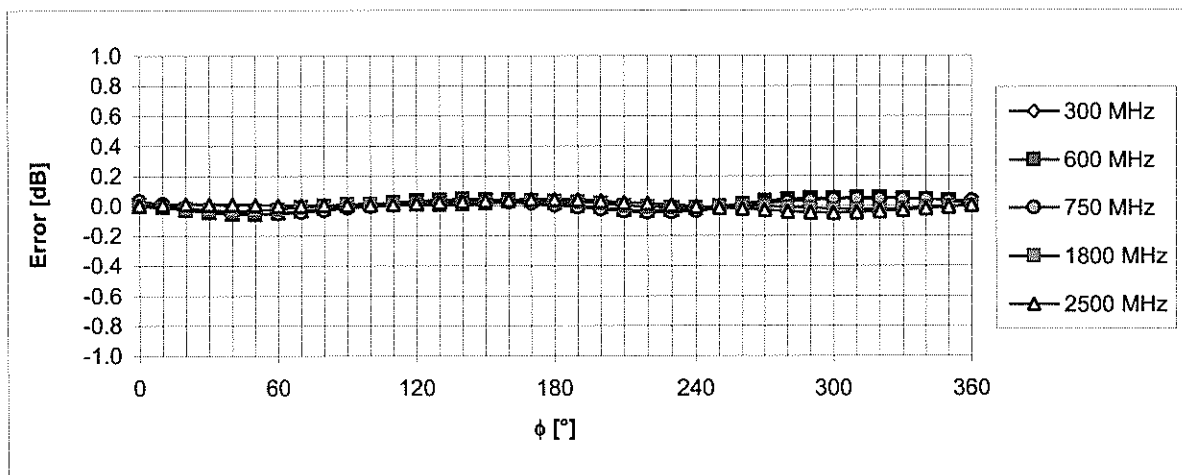
(TEM-Cell:ifi110, Waveguide R22)



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

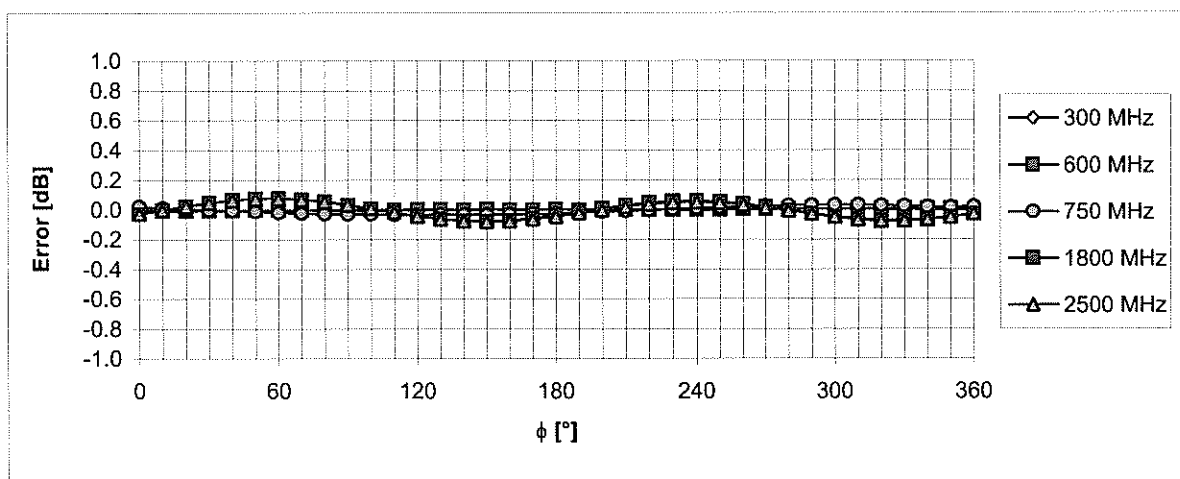
Receiving Pattern ( $\phi$ ),  $\vartheta = 90^\circ$ Receiving Pattern ( $\phi$ ),  $\vartheta = 0^\circ$ 

### Receiving Pattern ( $\phi$ ), $\vartheta = 90^\circ$



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

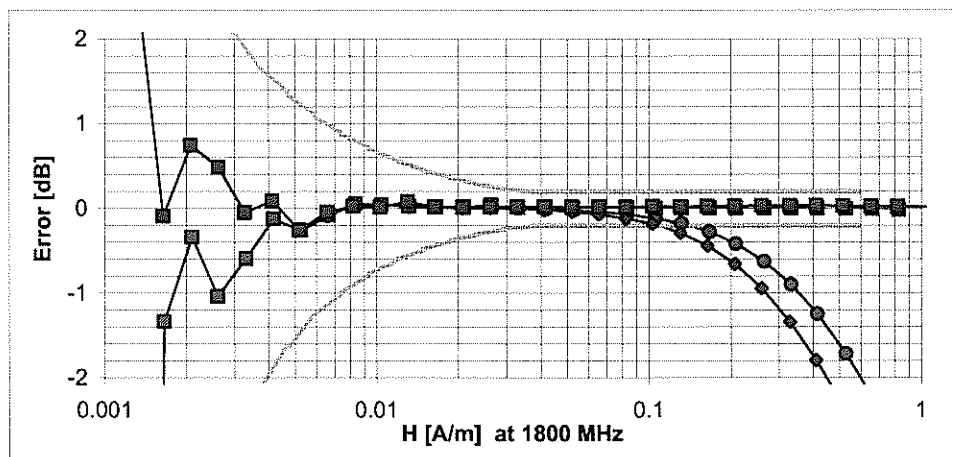
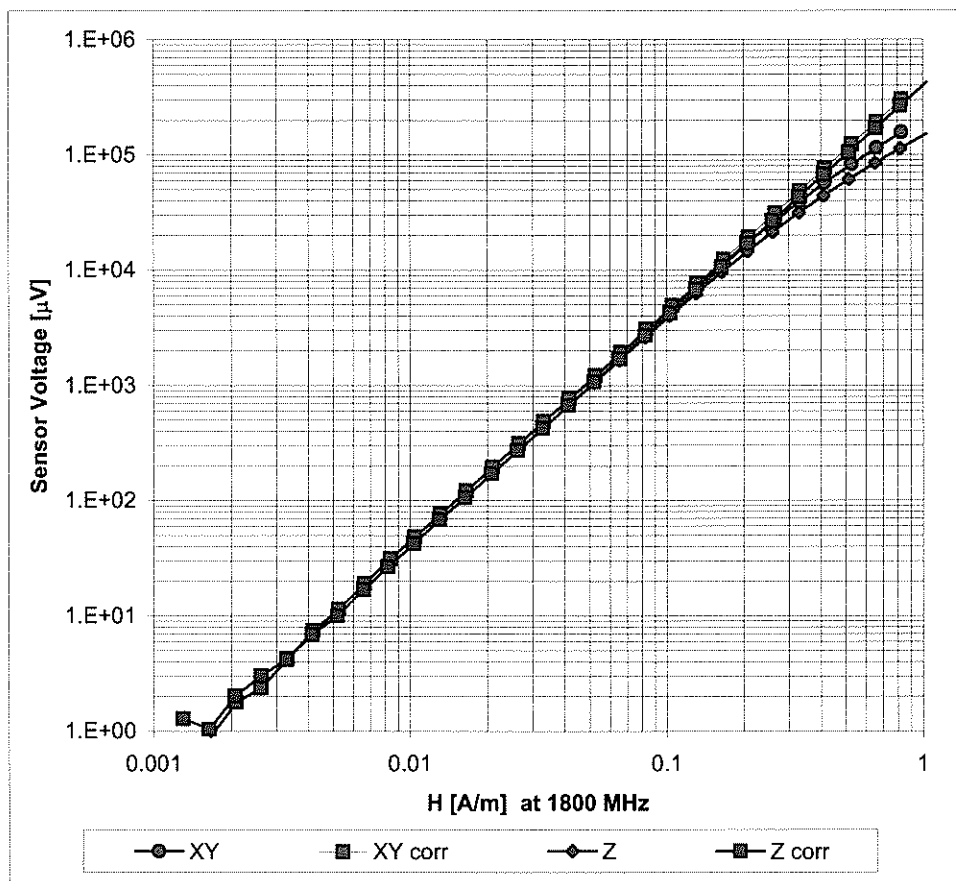
### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



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

## Dynamic Range f(H-field)

(Waveguide R22,  $f = 1800$  MHz)



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

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

Client **Nokia TX**

Certificate No: **CD835V3-1032\_Apr05**

## CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1032**

Calibration procedure(s) **QA CAL-20.v3**  
**Calibration procedure for dipoles in air**

Calibration date: **April 27, 2005**

Condition of the calibrated item **In Tolerance**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
 All calibrations have been conducted at an environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards     | ID #             | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-----------------------|------------------|-------------------------------------------|-----------------------|
| Power meter EPM-442A  | GB37480704       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                |
| Power sensor HP 8481A | US37292783       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                |
| 20 dB Attenuator      | SN: 5086 (20g)   | 10-Aug-04 (METAS, No 251-00402)           | Aug-05                |
| 10 dB Attenuator      | SN: 5047.2 (10r) | 10-Aug-04 (METAS, No 251-00402)           | Aug-05                |

| Secondary Standards       | ID #         | Check Date (in house)                    | Scheduled Check        |
|---------------------------|--------------|------------------------------------------|------------------------|
| Power meter EPM-4419B     | GB43310788   | 10-Aug-03 (SPEAG, in house check Jan-04) | In house check: Oct-05 |
| Power sensor HP 8481A     | MY41092312   | 10-Aug-03 (SPEAG, in house check Jan-04) | In house check: Oct-05 |
| Power sensor HP 8481A     | MY41093315   | 10-Aug-03 (SPEAG, in house check Jan-04) | In house check: Oct-05 |
| Network Analyzer HP 8753E | US37390585   | 18-Oct-01 (SPEAG, in house check Nov-04) | In house check: Nov-05 |
| RF generator R&S SMT06    | 1039.2000.06 | 26-Jul-04 (SPEAG, in house check Jul-04) | In house check: Jan-06 |
| DAE4                      | SN: 901      | 29-Jun-04 (SPEAG, No. DAE4-901_Jun04)    | Calibration, Jun-05    |
| Probe ER3DV6              | SN: 2336     | 20-Jan-05 (SPEAG, No. ER3-2336_Jan05)    | Calibration, Jan-06    |
| Probe H3DV6               | SN: 6065     | 10-Dec-04 (SPEAG, No. H3-6065-Dec04)     | Calibration, Dec-05    |

Calibrated by: **Name** **Mike Meili** **Function** **Laboratory Technician**

Signature

*M. Meili*

Approved by: **Fin Bomholt** **Technical Director**

*F. Bomholt*

Issued: June 13, 2005

This calibration certificate is issued as an intermediate solution until the specific calibration procedure is accepted in the frame of the accreditation of the Calibration Laboratory of Schmid & Partner Engineering AG (based on ISO/IEC 17025 International Standard)

## References

- [1] ANSI-PC63.19-2001 (Draft 3.x, 2005)  
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 standard [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the 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 DASY4 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 eliminating 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.

|                                           |                     |                      |
|-------------------------------------------|---------------------|----------------------|
| <b>DASY Version</b>                       | DASY4               | V4.5 B19             |
| <b>DASY PP Version</b>                    | SEMCAD              | V1.8 B149            |
| <b>Phantom</b>                            | HAC Test Arch       | SD HAC P01 BA, #1002 |
| <b>Distance Dipole Top - Probe Center</b> | 10 mm               |                      |
| <b>Scan resolution</b>                    | dx, dy = 5 mm       | area = 20 x 180 mm   |
| <b>Frequency</b>                          | 835 MHz $\pm$ 1 MHz |                      |
| <b>Forward power at dipole connector</b>  | 20.0 dBm = 100mW    |                      |
| <b>Input power drift</b>                  | < 0.05 dB           |                      |

## 2 Maximum Field values

| <b>H-field 10 mm above dipole surface</b> | condition            | interpolated maximum |
|-------------------------------------------|----------------------|----------------------|
| Maximum measured                          | 100 mW forward power | <b>0.451 A/m</b>     |

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

| <b>E-field 10 mm above dipole surface</b> | condition            | Interpolated maximum |
|-------------------------------------------|----------------------|----------------------|
| Maximum measured above high end           | 100 mW forward power | 163.8 V/m            |
| Maximum measured above low end            | 100 mW forward power | 160.4 V/m            |
| Averaged maximum above arm                | 100 mW forward power | <b>162.1 V/m</b>     |

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

## 3 Appendix

### 3.1 Antenna Parameters

| <b>Frequency</b> | <b>Return Loss</b> | <b>Impedance</b>           |
|------------------|--------------------|----------------------------|
| 800 MHz          | 17.1 dB            | ( 40.6. - j8.5 ) Ohm       |
| <b>835 MHz</b>   | <b>27.5 dB</b>     | <b>( 51.1 + j4.1 ) Ohm</b> |
| 900 MHz          | 17.2 dB            | ( 49.5 - j13.9 ) Ohm       |
| 950 MHz          | 18.7 dB            | ( 55.2 + j11.1 ) Ohm       |
| 960 MHz          | 14.0 dB            | ( 67.6 + j15.6 ) 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.

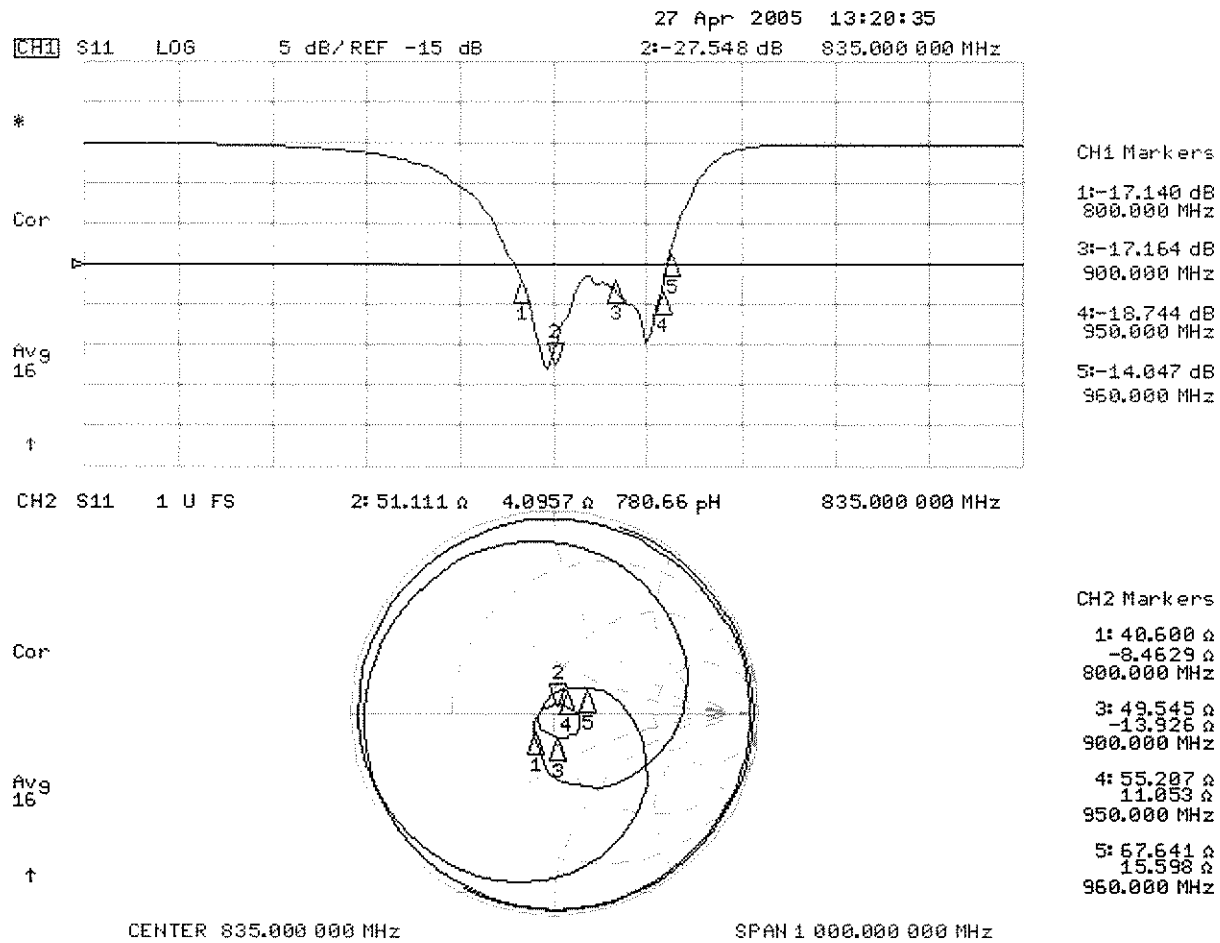
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

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: 27.04.2005 14:21:13

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1032**

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

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1$  kg/m<sup>3</sup>

Phantom section: H Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 10.12.2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 149

**H Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1):**

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

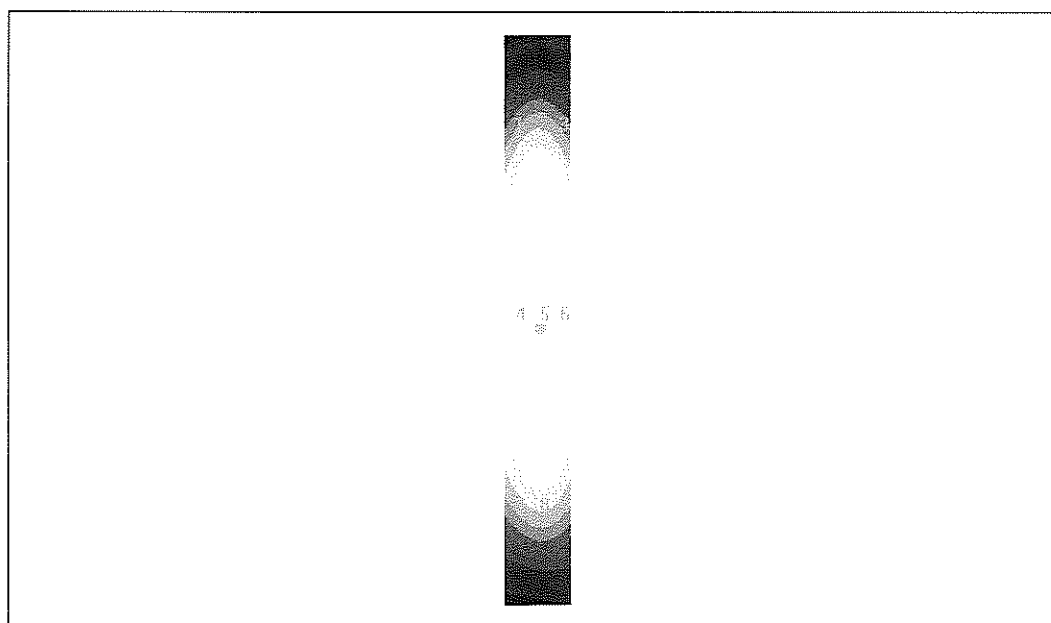
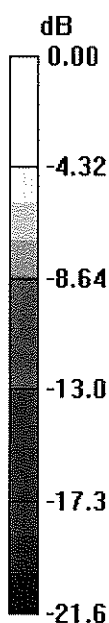
Maximum value of Total field (slot averaged) = 0.451 A/m

Reference Value = 0.473 A/m; Power Drift = -0.01 dB

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|              |              |              |              |              |              |
|--------------|--------------|--------------|--------------|--------------|--------------|
| Grid 1       | Grid 2       | Grid 3       | Grid 1       | Grid 2       | Grid 3       |
| <b>0.365</b> | <b>0.397</b> | <b>0.380</b> | <b>0.365</b> | <b>0.397</b> | <b>0.380</b> |
| Grid 4       | Grid 5       | Grid 6       | Grid 4       | Grid 5       | Grid 6       |
| <b>0.415</b> | <b>0.451</b> | <b>0.433</b> | <b>0.415</b> | <b>0.451</b> | <b>0.433</b> |
| Grid 7       | Grid 8       | Grid 9       | Grid 7       | Grid 8       | Grid 9       |
| <b>0.363</b> | <b>0.395</b> | <b>0.380</b> | <b>0.363</b> | <b>0.395</b> | <b>0.380</b> |



0 dB = 0.451 A/m

### 3.3.3 DASY4 E-Field result

Date/Time: 27.04.2005 14:55:54

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1032**

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

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: E Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 20.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 149

**E Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1):**

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

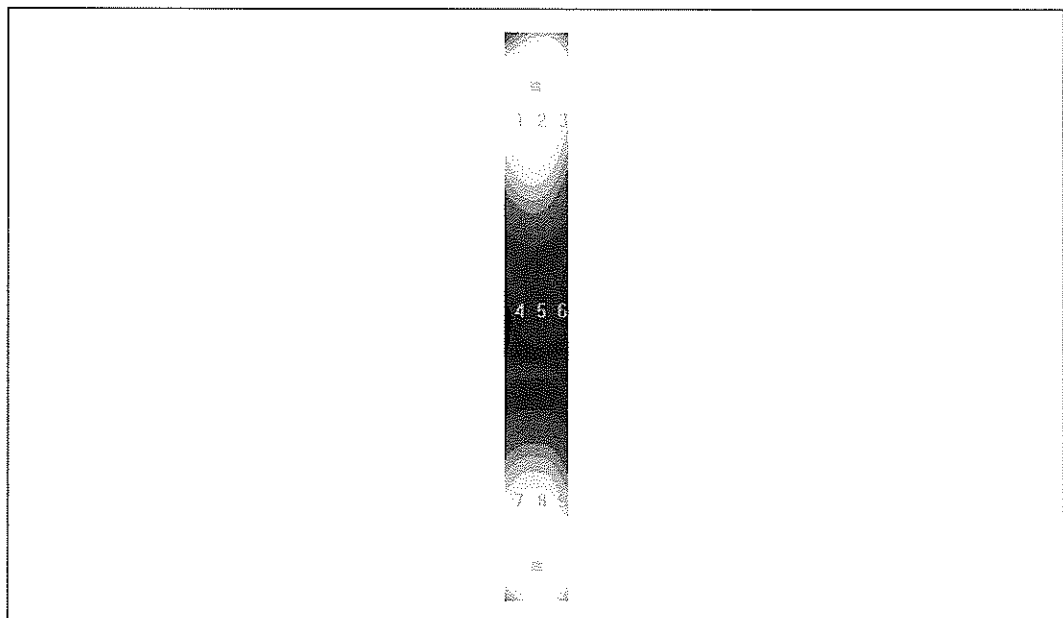
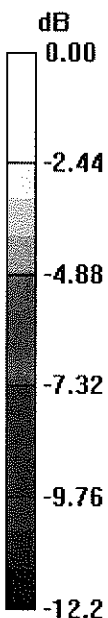
Maximum value of Total field (slot averaged) = 163.8 V/m

Reference Value = 102.7 V/m; Power Drift = -0.017 dB

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

E in V/m (Time averaged)      E in V/m (Slot averaged)

|        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 | Grid 1 | Grid 2 | Grid 3 |
| 156.6  | 160.4  | 153.8  | 156.6  | 160.4  | 153.8  |
| Grid 4 | Grid 5 | Grid 6 | Grid 4 | Grid 5 | Grid 6 |
| 85.9   | 88.0   | 84.1   | 85.9   | 88.0   | 84.1   |
| Grid 7 | Grid 8 | Grid 9 | Grid 7 | Grid 8 | Grid 9 |
| 157.9  | 163.8  | 159.6  | 157.9  | 163.8  | 159.6  |



0 dB = 163.8V/m

04049

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

Client **Nokia TX**

Certificate No: **CD1880V3-1025\_Jun05**

## CALIBRATION CERTIFICATE

Object **CD1880V3 - SN: 1025**

Calibration procedure(s) **QA CAL-20.v3**  
**Calibration procedure for dipoles in air**

Calibration date: **June 2, 2005**

Condition of the calibrated item **In Tolerance**

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards         | ID #             | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration  |
|---------------------------|------------------|-------------------------------------------|------------------------|
| Power meter EPM-442A      | GB37480704       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                 |
| Power sensor HP 8481A     | US37292783       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                 |
| 20 dB Attenuator          | SN: 5086 (20g)   | 10-Aug-04 (METAS, No 251-00402)           | Aug-05                 |
| 10 dB Attenuator          | SN: 5047.2 (10r) | 10-Aug-04 (METAS, No 251-00402)           | Aug-05                 |
| Secondary Standards       | ID #             | Check Date (in house)                     | Scheduled Check        |
| Network Analyzer HP 8753E | US37390585       | 18-Oct-01 (SPEAG, in house check Nov-04)  | In house check: Nov-05 |
| RF generator R&S SML-03   | 100698           | 27-Mar-02 (SPEAG, in house check Dec-03)  | In house check: Dec-05 |
| DAE4                      | SN: 901          | 29-Jun-04 (SPEAG, No. DAE4-901_Jun04)     | Calibration, Jun-05    |
| Probe ER3DV6              | SN: 2336         | 20-Jan-05 (SPEAG, No. ER3-2336_Jan05)     | Calibration, Jan-06    |
| Probe H3DV6               | SN: 6065         | 10-Dec-04 (SPEAG, No. H3-6065-Dec04)      | Calibration, Dec-05    |

Calibrated by: **Name** **Function**  
**Mike Meili** **Laboratory Technician**

Signature

*M. Meili*

Approved by: **Fin Bomholt** **Technical Director**

*F. Bomholt*

Issued: June 13, 2005

This calibration certificate is issued as an intermediate solution until the specific calibration procedure is submitted and accepted in the frame of the accreditation of the Calibration Laboratory of Schmid & Partner Engineering AG (based on ISO/IEC 17025 International Standard)

## References

- [1] ANSI-PC63.19-2001 (Draft 3.x, 2005)  
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 standard [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the 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 DASY4 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 eliminating 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.

|                                           |                                        |                      |
|-------------------------------------------|----------------------------------------|----------------------|
| <b>DASY Version</b>                       | DASY4                                  | V4.5 B31             |
| <b>DASY PP Version</b>                    | SEMCAD                                 | V1.8 B149            |
| <b>Phantom</b>                            | HAC Test Arch                          | SD HAC P01 BA, #1002 |
| <b>Distance Dipole Top - Probe Center</b> | 10 mm                                  |                      |
| <b>Scan resolution</b>                    | dx, dy = 5 mm                          | area = 20 x 90 mm    |
| <b>Frequency</b>                          | <b>1880 MHz <math>\pm</math> 1 MHz</b> |                      |
| <b>Forward power at dipole connector</b>  | 20.0 dBm = 100mW                       |                      |
| <b>Input power drift</b>                  | < 0.05 dB                              |                      |

## 2 Maximum Field values

| <b>H-field 10 mm above dipole surface</b> | condition            | interpolated maximum |
|-------------------------------------------|----------------------|----------------------|
| Maximum measured                          | 100 mW forward power | <b>0.452 A/m</b>     |

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

| <b>E-field 10 mm above dipole surface</b> | condition            | interpolated maximum |
|-------------------------------------------|----------------------|----------------------|
| Maximum measured above high end           | 100 mW forward power | 139.4 V/m            |
| Maximum measured above low end            | 100 mW forward power | 135.8 V/m            |
| Averaged maximum above arm                | 100 mW forward power | <b>137.6 V/m</b>     |

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

## 3 Appendix

### 3.1 Antenna Parameters

| <b>Frequency</b> | <b>Return Loss</b> | <b>Impedance</b>           |
|------------------|--------------------|----------------------------|
| 1710 MHz         | 19.9 dB            | ( 61.2 – j0.7 ) Ohm        |
| <b>1880 MHz</b>  | <b>20.9 dB</b>     | <b>( 58.6 – j4.7 ) Ohm</b> |
| 1900 MHz         | 21.7 dB            | ( 55.5 – j6.7 ) Ohm        |
| 1950 MHz         | 30.4 dB            | ( 49.0 – j2.8 ) Ohm        |
| 2000 MHz         | 21.0 dB            | ( 54.0 + j8.4 ) 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.

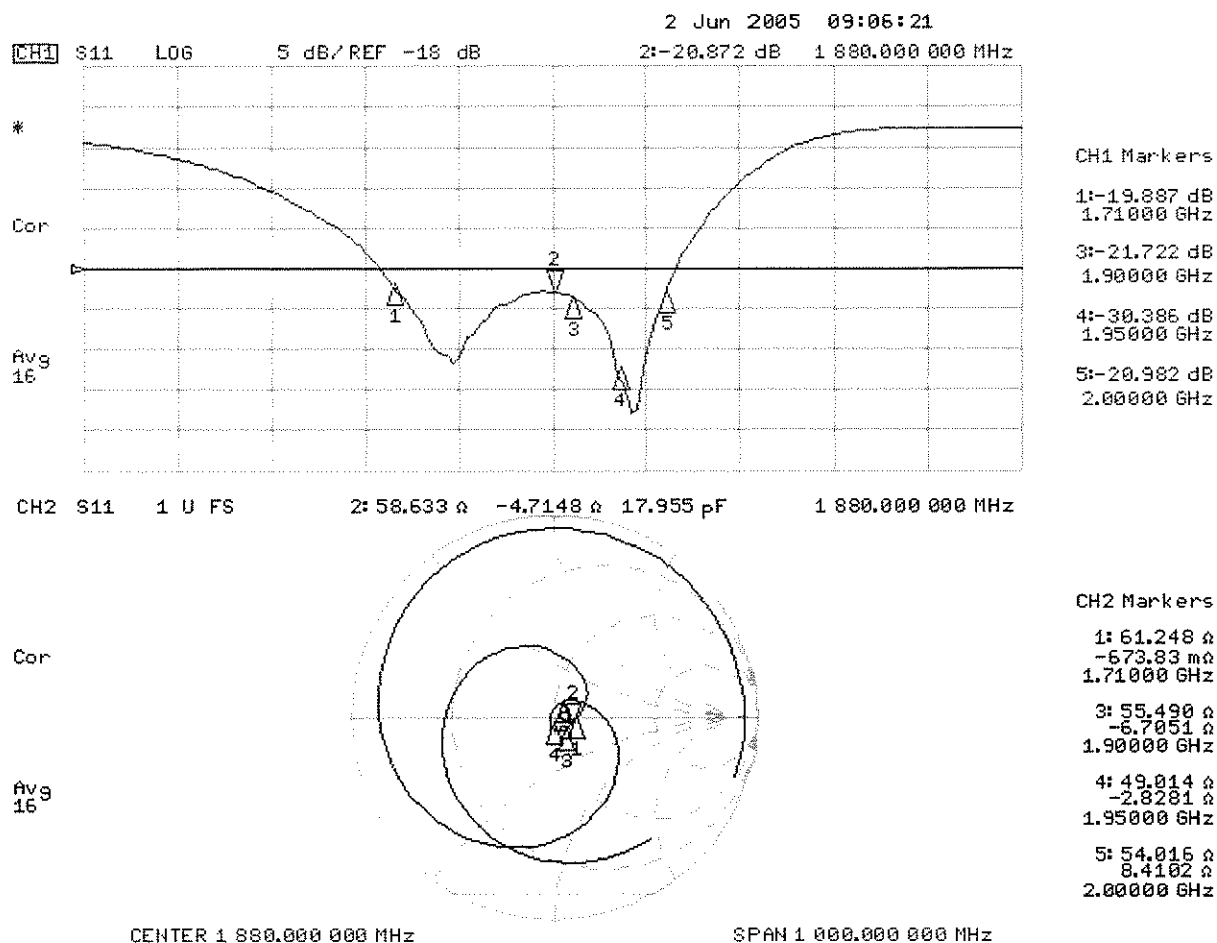
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

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: 6/2/2005 6:15:52 PM

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1025**

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

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1$  kg/m<sup>3</sup>

Phantom section: H Dipole Section

DASY4 Configuration:

- Probe: H3DV6 - SN6065; Calibrated: 12/10/2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 6/29/2004
- Phantom: HAC Test Arch; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 31; Postprocessing SW: SEMCAD, V1.8 Build 149

**H Scan 10mm above CD1880V3/Hearing Aid Compatibility Test (41x181x1):**

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

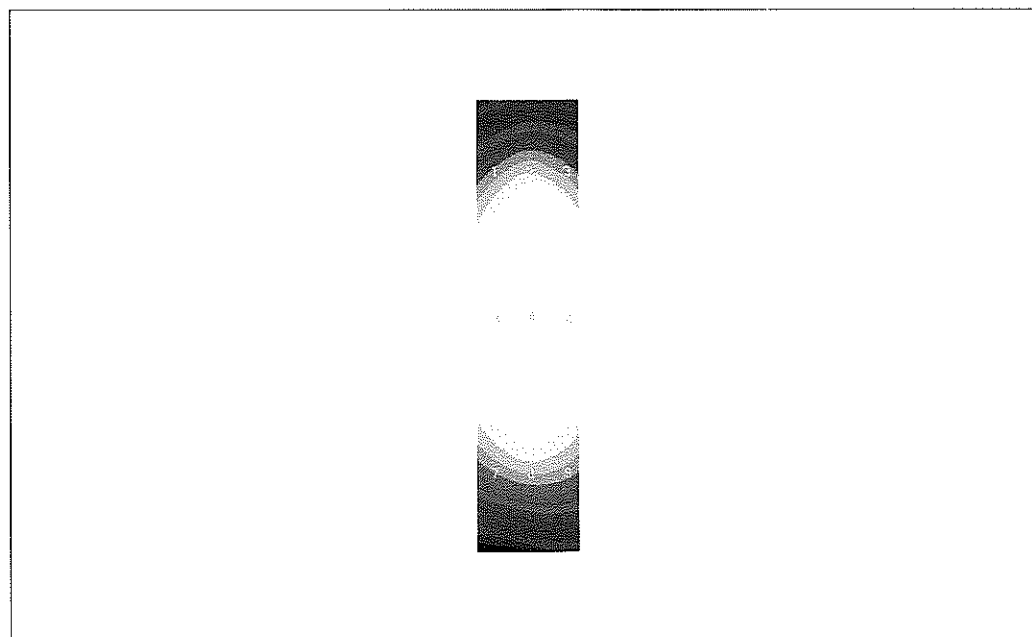
Maximum value of Total field (slot averaged) = 0.452 A/m

Reference Value = 0.478 A/m; Power Drift = -0.034 dB

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

H in A/m (Time averaged)      H in A/m (Slot averaged)

|              |              |              |              |              |              |
|--------------|--------------|--------------|--------------|--------------|--------------|
| Grid 1       | Grid 2       | Grid 3       | Grid 1       | Grid 2       | Grid 3       |
| <b>0.391</b> | <b>0.425</b> | <b>0.408</b> | <b>0.391</b> | <b>0.425</b> | <b>0.408</b> |
| Grid 4       | Grid 5       | Grid 6       | Grid 4       | Grid 5       | Grid 6       |
| <b>0.419</b> | <b>0.452</b> | <b>0.437</b> | <b>0.419</b> | <b>0.452</b> | <b>0.437</b> |
| Grid 7       | Grid 8       | Grid 9       | Grid 7       | Grid 8       | Grid 9       |
| <b>0.372</b> | <b>0.401</b> | <b>0.389</b> | <b>0.372</b> | <b>0.401</b> | <b>0.389</b> |



0 dB = 0.452A/m

### 3.3.3 DASY4 E-Field result

Date/Time: 6/2/2005 2:45:27 PM

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1025**

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

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: E Dipole Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 1/20/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 6/29/2004
- Phantom: HAC Test Arch; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 31; Postprocessing SW: SEMCAD, V1.8 Build 149

**E Scan 10mm above CD1880V3/Hearing Aid Compatibility Test (41x181x1):**

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

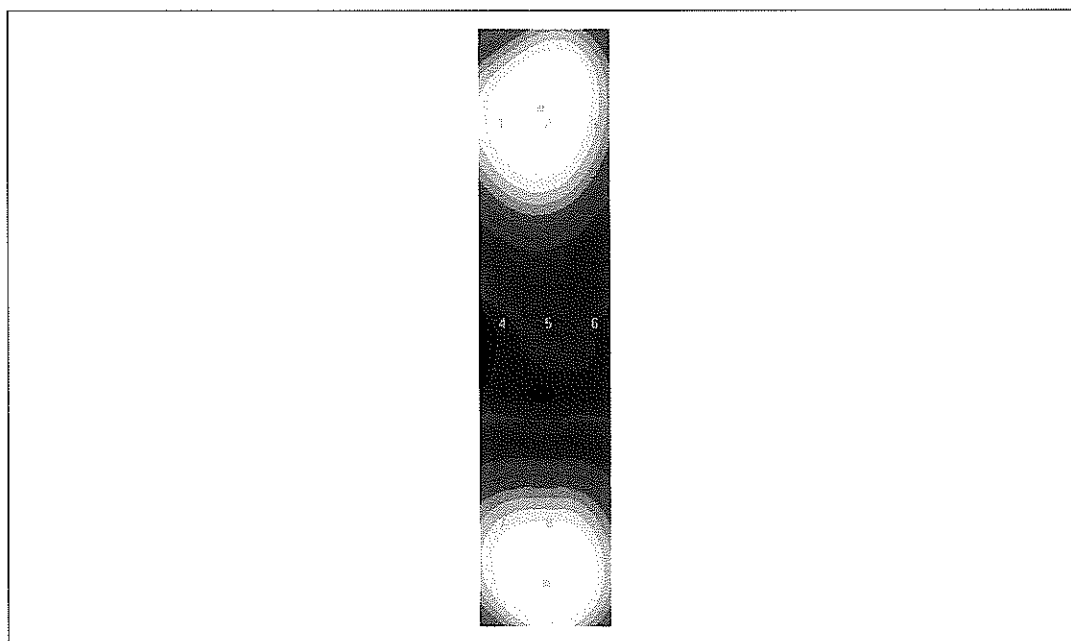
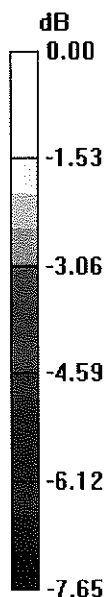
Maximum value of Total field (slot averaged) = 139.4 V/m

Reference Value = 157.2 V/m; Power Drift = 0.013 dB

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

E in V/m (Time averaged)      E in V/m (Slot averaged)

|              |              |              |              |              |              |
|--------------|--------------|--------------|--------------|--------------|--------------|
| Grid 1       | Grid 2       | Grid 3       | Grid 1       | Grid 2       | Grid 3       |
| <b>131.9</b> | <b>135.8</b> | <b>130.9</b> | <b>131.9</b> | <b>135.8</b> | <b>130.9</b> |
| Grid 4       | Grid 5       | Grid 6       | Grid 4       | Grid 5       | Grid 6       |
| <b>90.0</b>  | <b>91.6</b>  | <b>87.1</b>  | <b>90.0</b>  | <b>91.6</b>  | <b>87.1</b>  |
| Grid 7       | Grid 8       | Grid 9       | Grid 7       | Grid 8       | Grid 9       |
| <b>131.8</b> | <b>139.4</b> | <b>135.3</b> | <b>131.8</b> | <b>139.4</b> | <b>135.3</b> |



0 dB = 139.4V/m