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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Sporton-TW (Auden)**

Certificate No: **CD835V3-1045_Sep11**

CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1045**

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

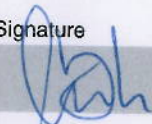
Calibration date: **September 20, 2011**


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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---------------------------|----------------|-----------------------------------|------------------------|
| Power meter EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Probe ER3DV6 | SN: 2336 | 29-Dec-10 (No. ER3-2336_Dec10) | Dec-11 |
| Probe H3DV6 | SN: 6065 | 29-Dec-10 (No. H3-6065_Dec10) | Dec-11 |
| DAE4 | SN: 781 | 20-Apr-11 (No. DAE4-781_Apr11) | Apr-12 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter Agilent 4419B | SN: GB42420191 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482H | SN: 3318A09450 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482A | SN: US37295597 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |
| RF generator E4433B | MY 41000675 | 03-Nov-04 (in house check Oct-09) | In house check: Oct-11 |

Calibrated by: **Claudio Leubler** (Name) **Laboratory Technician** (Function)  (Signature)

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

Issued: September 21, 2011

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

References

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

Methods Applied and Interpretation of Parameters:

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

Measurement Conditions

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

| | | |
|---|------------------------|---------|
| DASY Version | DASY5 | V52.6.2 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | HAC Test Arch | |
| Distance Dipole Top - Probe Center | 10 mm | |
| Scan resolution | dx, dy = 5 mm | |
| Frequency | 835 MHz \pm 1 MHz | |
| Input power drift | < 0.05 dB | |

Maximum Field values

| H-field 10 mm above dipole surface | condition | interpolated maximum |
|---|--------------------|---|
| Maximum measured | 100 mW input power | 0.461 A / m \pm 8.2 % (k=2) |

| E-field 10 mm above dipole surface | condition | Interpolated maximum |
|---|--------------------|--|
| Maximum measured above high end | 100 mW input power | 169.0 V / m |
| Maximum measured above low end | 100 mW input power | 161.2 V / m |
| Averaged maximum above arm | 100 mW input power | 165.1 V / m \pm 12.8 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| Frequency | Return Loss | Impedance |
|------------------|--------------------|---------------------------------|
| 800 MHz | 14.3 dB | 40.7 Ω - 15.0 j Ω |
| 835 MHz | 26.6 dB | 49.5 Ω + 4.6 j Ω |
| 900 MHz | 20.4 dB | 51.5 Ω - 9.6 j Ω |
| 950 MHz | 17.7 dB | 47.1 Ω + 12.3 j Ω |
| 960 MHz | 13.3 dB | 56.2 Ω + 22.6 j Ω |

3.2 Antenna Design and Handling

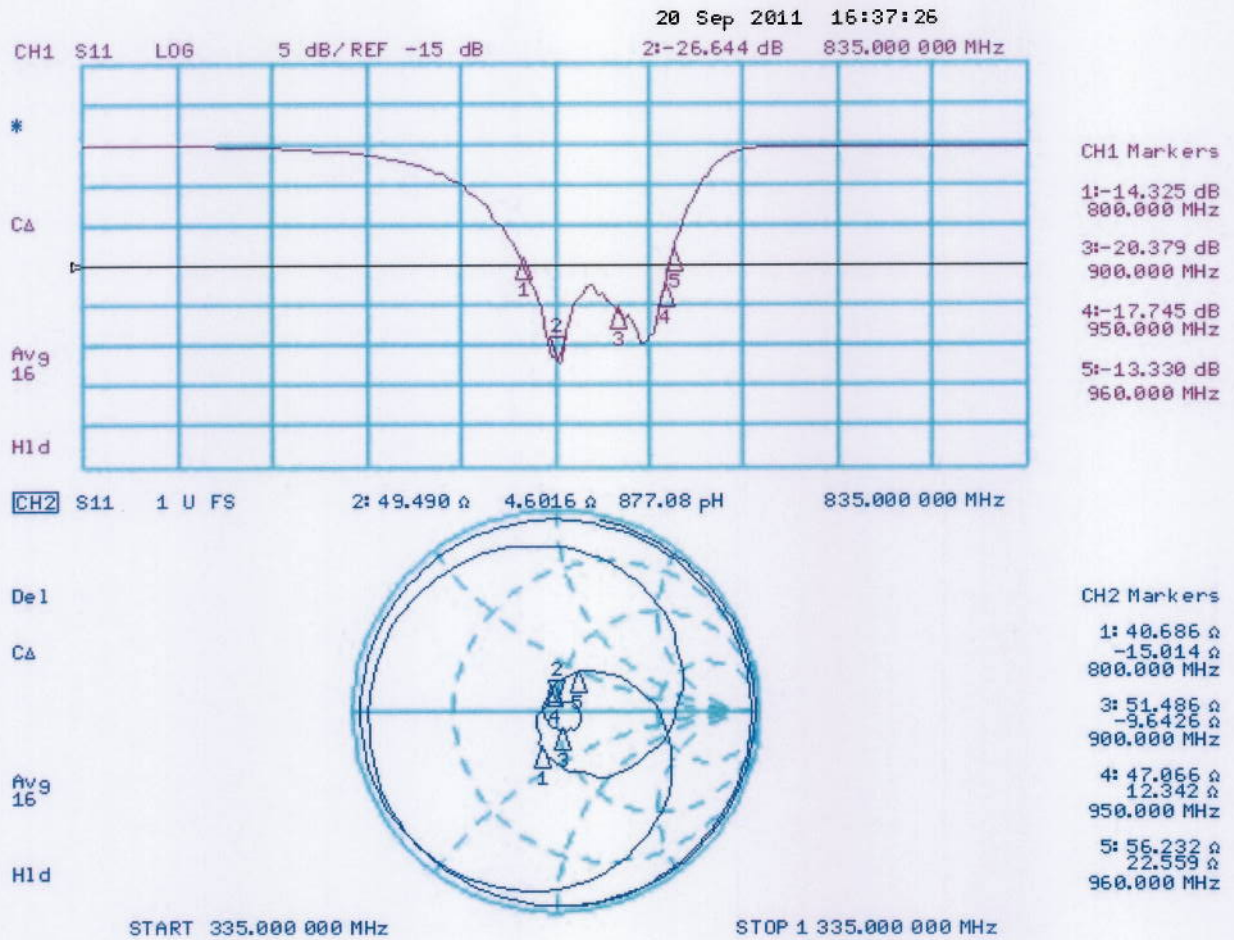
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

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.

Impedance Measurement Plot



DASY4 H-field Result

Date/Time: 20.09.2011 10:55:01

Test Laboratory: SPEAG Lab2

CD835_1045_H_110920_CL

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1045

Communication System: CW; Communication System Band: CD835 (835.0 MHz)

Frequency: 835 MHz; Communication System PAR: 0 dB;

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: RF Section

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

DASY5 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

Dipole H-Field measurement @ 835MHz/H Scan - measurement distance from the probe sensor center to CD835 Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1):

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

Maximum value of peak Total field = 0.461 A/m

Probe Modulation Factor = 1.000

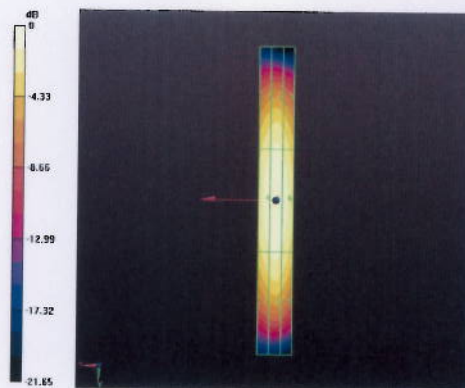
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.490 A/m; Power Drift = 0.02 dB

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

Peak H-field in A/m

| | | |
|-------------------------------------|-------------------------------------|-------------------------------------|
| Grid 1 0.389 M4 | Grid 2 0.407 M4 | Grid 3 0.383 M4 |
| Grid 4 0.434 M4 | Grid 5 0.461 M4 | Grid 6 0.439 M4 |
| Grid 7 0.385 M4 | Grid 8 0.408 M4 | Grid 9 0.387 M4 |



0 dB = 0.460A/m

DASY4 E-field Result

Date/Time: 20.09.2011 15:56:33

Test Laboratory: SPEAG Lab2

CD835_1045_E_110920_CL

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1045

Communication System: CW; Communication System Band: CD835 (835.0 MHz);

Frequency: 835 MHz; Communication System PAR: 0 dB;

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: RF Section

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

DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

Dipole E-Field measurement @ 835MHz/E Scan - measurement distance from the probe sensor center to CD835 Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1):

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

Maximum value of peak Total field = 169.0 V/m

Probe Modulation Factor = 1.000

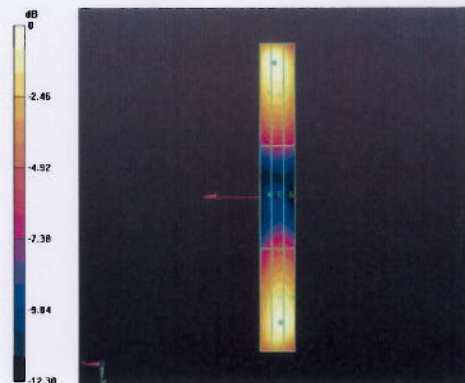
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 120.1 V/m; Power Drift = -0.01 dB

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

Peak E-field in V/m

| | | |
|--------------------------------------|--------------------------------------|--------------------------------------|
| Grid 1 167.3 M4 | Grid 2 169.0 M4 | Grid 3 159.2 M4 |
| Grid 4 82.038 M4 | Grid 5 87.254 M4 | Grid 6 86.516 M4 |
| Grid 7 148.8 M4 | Grid 8 161.2 M4 | Grid 9 160.1 M4 |



0 dB = 169.0V/m



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Accreditation No.: **SCS 108**

Client **Sporton-TW (Auden)**

Certificate No: **CD1880V3-1038_Sep11**

CALIBRATION CERTIFICATE

Object **CD1880V3 - SN: 1038**

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

Calibration date: **September 20, 2011**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---------------------------|----------------|-----------------------------------|------------------------|
| Power meter EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Probe ER3DV6 | SN: 2336 | 29-Dec-10 (No. ER3-2336_Dec10) | Dec-11 |
| Probe H3DV6 | SN: 6065 | 29-Dec-10 (No. H3-6065_Dec10) | Dec-11 |
| DAE4 | SN: 781 | 20-Apr-11 (No. DAE4-781_Apr11) | Apr-12 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter Agilent 4419B | SN: GB42420191 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482H | SN: 3318A09450 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Power sensor HP 8482A | SN: US37295597 | 09-Oct-09 (in house check Oct-10) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |
| RF generator E4433B | MY 41000675 | 03-Nov-04 (in house check Oct-09) | In house check: Oct-11 |

Calibrated by: **Claudio Leubler** Name: Claudio Leubler Function: Laboratory Technician

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

Signature

Issued: September 21, 2011

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Accreditation No.: **SCS 108**

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

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

Measurement Conditions

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

| | | |
|------------------------------------|------------------------|---------|
| DASY Version | DASY5 | V52.6.2 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | HAC Test Arch | |
| Distance Dipole Top - Probe Center | 10 mm | |
| Scan resolution | dx, dy = 5 mm | |
| Frequency | 1880 MHz \pm 1 MHz | |
| Input power drift | < 0.05 dB | |

Maximum Field values

| H-field 10 mm above dipole surface | condition | interpolated maximum |
|------------------------------------|--------------------|-------------------------------|
| Maximum measured | 100 mW input power | 0.465 A / m \pm 8.2 % (k=2) |

| E-field 10 mm above dipole surface | condition | Interpolated maximum |
|------------------------------------|--------------------|--------------------------------|
| Maximum measured above high end | 100 mW input power | 139.2 V / m |
| Maximum measured above low end | 100 mW input power | 136.5 V / m |
| Averaged maximum above arm | 100 mW input power | 137.9 V / m \pm 12.8 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| Frequency | Return Loss | Impedance |
|-----------|-------------|--------------------------------|
| 1730 MHz | 22.2 dB | 51.0 Ω + 7.8 j Ω |
| 1880 MHz | 22.2 dB | 53.9 Ω + 7.0 j Ω |
| 1900 MHz | 22.2 dB | 55.9 Ω + 5.8 j Ω |
| 1950 MHz | 26.4 dB | 53.6 Ω - 3.4 j Ω |
| 2000 MHz | 19.5 dB | 40.5 Ω + 0.2 j Ω |

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.

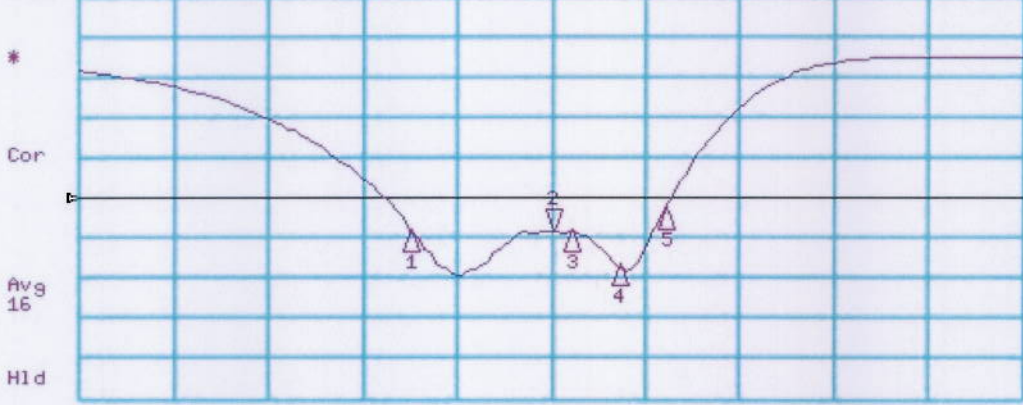
Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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

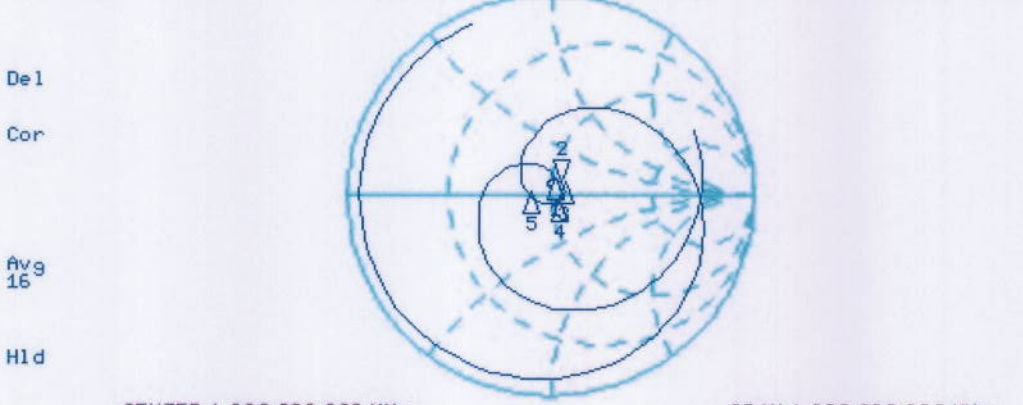
Impedance Measurement Plot

20 Sep 2011 16:41:51

CH1 S11 L06 5 dB/REF -18 dB 2:-22.222 dB 1 880.000 000 MHz



CH2 S11 1 U FS 2: 53.924 Ω 7.0430 Ω 596.24 pH 1 880.000 000 MHz



DASY4 H-field Result

Date/Time: 20.09.2011 11:41:12

Test Laboratory: SPEAG Lab2

CD1880_1038_H_110920_CL

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1038

Communication System: CW; Communication System Band: CD1880 (1880.0 MHz)

Frequency: 1880 MHz; Communication System PAR: 0 dB;

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: RF Section

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

DASY5 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

Dipole H-Field measurement @ 1880MHz/H Scan - measurement distance from the probe sensor center to CD1880 Dipole = 10mm/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 0.465 A/m

Probe Modulation Factor = 1.000

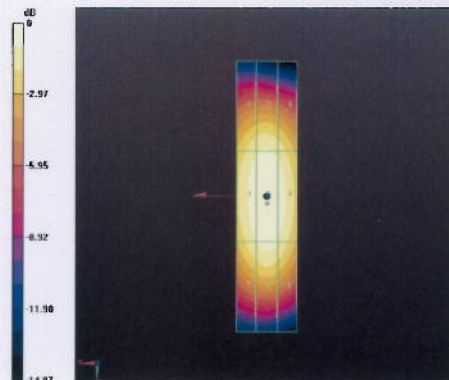
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.492 A/m; Power Drift = 0.0046 dB

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

Peak H-field in A/m

| | | |
|------------------------------|------------------------------|------------------------------|
| Grid 1 0.402 M2 | Grid 2 0.419 M2 | Grid 3 0.398 M2 |
| Grid 4 0.443 M2 | Grid 5 0.465 M2 | Grid 6 0.445 M2 |
| Grid 7 0.410 M2 | Grid 8 0.433 M2 | Grid 9 0.411 M2 |



0 dB = 0.460A/m

DASY4 E-field Result

Date/Time: 20.09.2011 14:28:56

Test Laboratory: SPEAG Lab2

CD1880_1038_E_110920_CL

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1038

Communication System: CW; Communication System Band: CD1880 (1880.0 MHz)

Frequency: 1880 MHz; Communication System PAR: 0 dB;

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: RF Section

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

DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

Dipole E-Field measurement @ 1880MHz/E Scan - measurement distance from the probe sensor center to CD1880 Dipole = 10mm/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 139.2 V/m

Probe Modulation Factor = 1.000

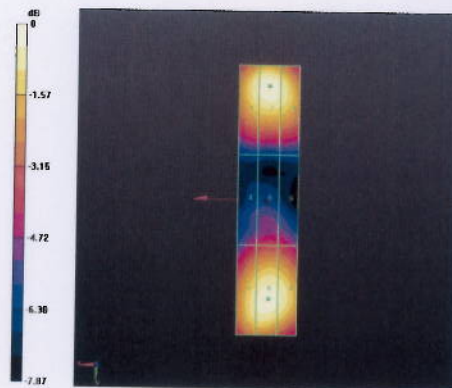
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 140.6 V/m; Power Drift = -0.0011 dB

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

Peak E-field in V/m

| | | |
|-------------------------------|-------------------------------|-------------------------------|
| Grid 1 133.8 M2 | Grid 2 139.2 M2 | Grid 3 133.3 M2 |
| Grid 4 85.645 M3 | Grid 5 90.689 M3 | Grid 6 89.552 M3 |
| Grid 7 130.9 M2 | Grid 8 136.5 M2 | Grid 9 133.9 M2 |



0 dB = 139.2V/m

IMPORTANT NOTICE

USAGE OF THE DAE 4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

Important Note:

Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:

Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:

To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.



Accredited by the Swiss Accreditation Service (SAS)
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Accreditation No.: **SCS 108**

Client **Sporton (Auden)**

Certificate No: **DAE4-1279_Jun11**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BJ - SN: 1279**

Calibration procedure(s) **QA CAL-06.v23
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **June 17, 2011**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278 | 28-Sep-10 (No:10376) | Sep-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Calibrator Box V1.1 | SE UMS 006 AB 1004 | 08-Jun-11 (in house check) | In house check: Jun-12 |

Calibrated by:

| | | |
|-------------------|------------|-----------|
| Name | Function | Signature |
| Dominique Steffen | Technician | |

Approved by:

| | | |
|-------------|--------------|-----------|
| Name | Function | Signature |
| Fin Bomholt | R&D Director | |

Issued: June 17, 2011

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



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Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

| Calibration Factors | X | Y | Z |
|---------------------|--------------------------|--------------------------|--------------------------|
| High Range | 405.162 \pm 0.1% (k=2) | 404.963 \pm 0.1% (k=2) | 404.302 \pm 0.1% (k=2) |
| Low Range | 3.98709 \pm 0.7% (k=2) | 3.98815 \pm 0.7% (k=2) | 3.99781 \pm 0.7% (k=2) |

Connector Angle

| | |
|---|--------------------------|
| Connector Angle to be used in DASY system | 118.0 \pm 1 $^{\circ}$ |
|---|--------------------------|

Appendix

1. DC Voltage Linearity

| High Range | Reading (μV) | Difference (μV) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 200002.8 | -4.26 | -0.00 |
| Channel X + Input | 20001.11 | 0.81 | 0.00 |
| Channel X - Input | -19998.30 | 1.20 | -0.01 |
| Channel Y + Input | 199995.9 | -0.67 | -0.00 |
| Channel Y + Input | 20000.72 | 0.62 | 0.00 |
| Channel Y - Input | -19999.63 | -0.23 | 0.00 |
| Channel Z + Input | 199995.6 | 0.15 | 0.00 |
| Channel Z + Input | 20000.35 | 0.35 | 0.00 |
| Channel Z - Input | -20000.36 | -0.96 | 0.00 |

| Low Range | Reading (μV) | Difference (μV) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 1999.5 | -0.70 | -0.04 |
| Channel X + Input | 200.23 | 0.03 | 0.02 |
| Channel X - Input | -198.52 | 1.58 | -0.79 |
| Channel Y + Input | 1999.8 | -0.15 | -0.01 |
| Channel Y + Input | 198.26 | -1.84 | -0.92 |
| Channel Y - Input | -200.72 | -0.62 | 0.31 |
| Channel Z + Input | 1999.8 | 0.10 | 0.00 |
| Channel Z + Input | 199.24 | -0.86 | -0.43 |
| Channel Z - Input | -200.82 | -0.92 | 0.46 |

2. Common mode sensitivity

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

| | Common mode Input Voltage (mV) | High Range Average Reading (μV) | Low Range Average Reading (μV) |
|-----------|--------------------------------|--|---|
| Channel X | 200 | 16.73 | 15.44 |
| | - 200 | -15.03 | -16.55 |
| Channel Y | 200 | 7.99 | 7.96 |
| | - 200 | -9.76 | -9.79 |
| Channel Z | 200 | -0.47 | -0.96 |
| | - 200 | -0.90 | -0.88 |

3. Channel separation

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

| | Input Voltage (mV) | Channel X (μV) | Channel Y (μV) | Channel Z (μV) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200 | - | 2.87 | -0.12 |
| Channel Y | 200 | 2.95 | - | 4.72 |
| Channel Z | 200 | 0.64 | -1.17 | - |

4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 15670 | 15865 |
| Channel Y | 16434 | 16415 |
| Channel Z | 15919 | 15447 |

5. Input Offset Measurement

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

Input 10M Ω

| | Average (μ V) | min. Offset (μ V) | max. Offset (μ V) | Std. Deviation (μ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | 0.19 | -0.98 | 1.40 | 0.51 |
| Channel Y | -0.58 | -2.05 | 0.62 | 0.61 |
| Channel Z | -1.53 | -3.41 | 0.30 | 0.56 |

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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



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SCS Schweizerischer Kalibrierdienst, Service suisse d'etalonnage, Servizio svizzero di taratura, Swiss Calibration Service

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Accreditation No.: SCS 108

Client Sporton-TW (Auden)

Certificate No: ER3-2358_Jan11

CALIBRATION CERTIFICATE

Object: ER3DV6 - SN:2358
Calibration procedure(s): QA CAL-02.v6, QA CAL-25.v3
Calibration date: January 14, 2011
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).

Table with 4 columns: Primary Standards, ID, Cal Date (Certificate No.), Scheduled Calibration. Lists various power meters, attenuators, and standards with their respective IDs and calibration dates.

Calibrated by: Marcel Fehr, Laboratory Technician
Approved by: Katja Pokovic, Technical Manager
Issued: January 25, 2011
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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



ER3DV6 – SN:2358

January 14, 2011

Probe ER3DV6

SN:2358

Manufactured: July 7, 2005
Calibrated: January 14, 2011

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



ER3DV6- SN:2358

January 14, 2011

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2358

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) | 1.72 | 1.56 | 1.59 | $\pm 10.1\%$ |
| DCP (mV) ^b | 98.6 | 97.8 | 99.6 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 151.8 | $\pm 1.6\%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 153.3 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 138.4 | |

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

^b Numerical linearization parameter; uncertainty not required.

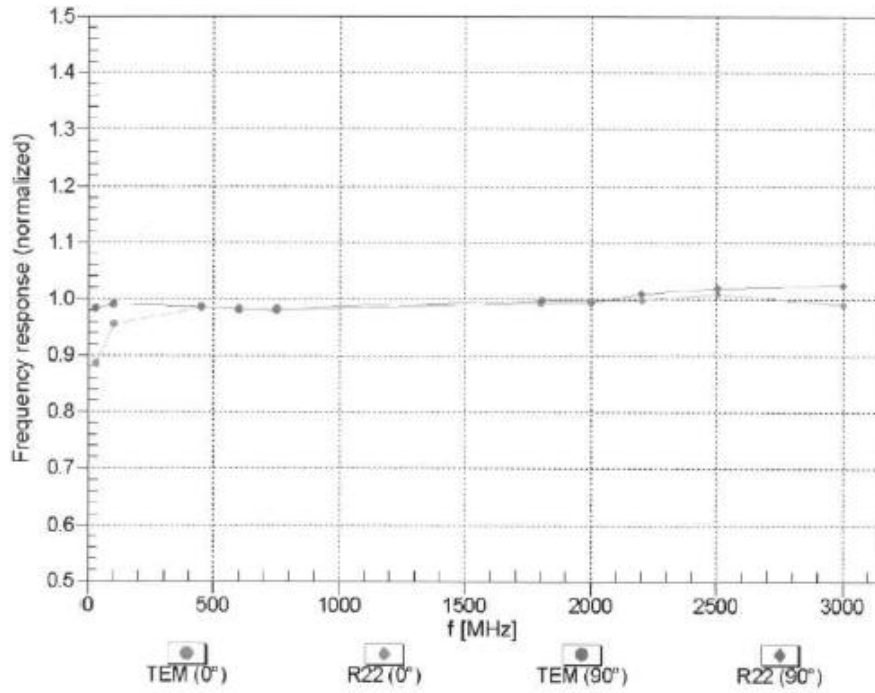
^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



ER3DV6- SN:2358

January 14, 2011

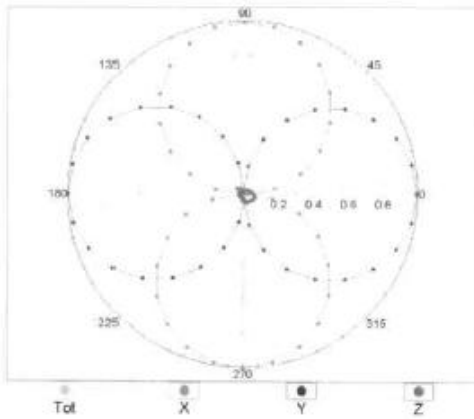
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



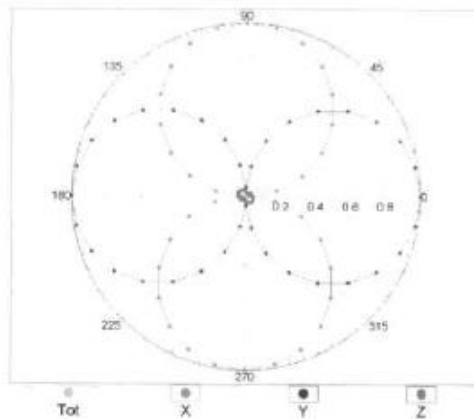
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM, 0°

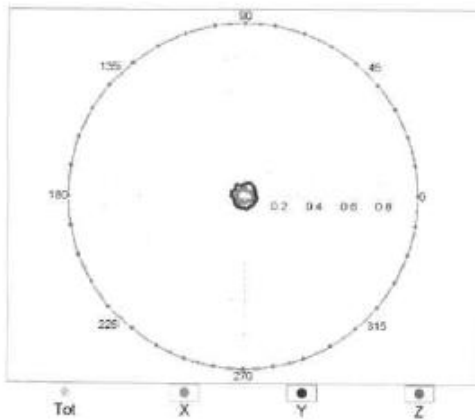


f=2500 MHz, R22, 0°

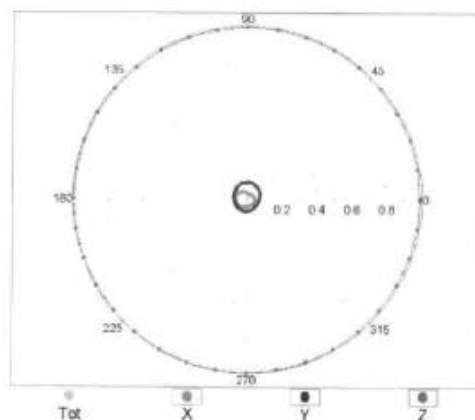


Receiving Pattern (ϕ), $\vartheta = 90^\circ$

f=600 MHz, TEM, 90°

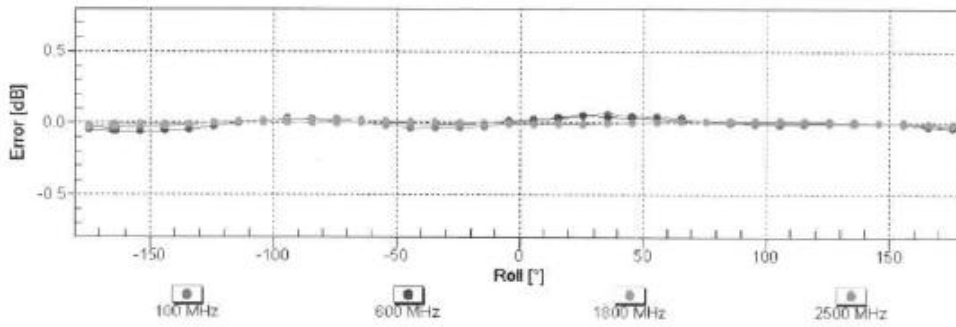


f=2500 MHz, R22, 90°



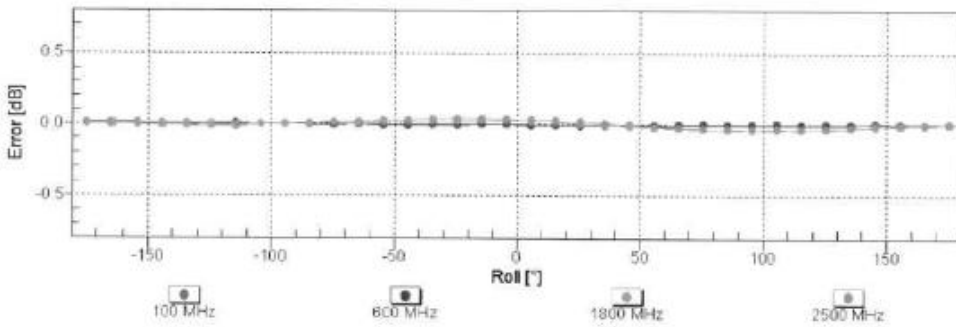


Receiving Pattern (ϕ), $\vartheta = 0^\circ$



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

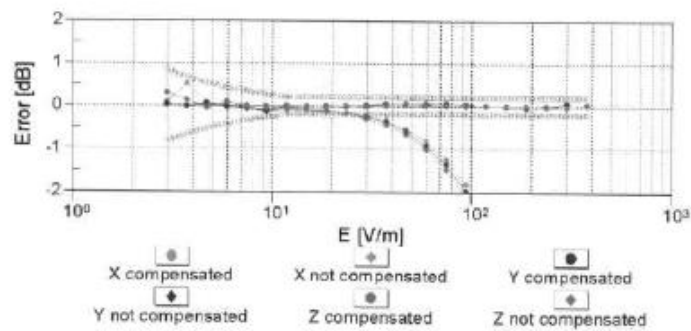
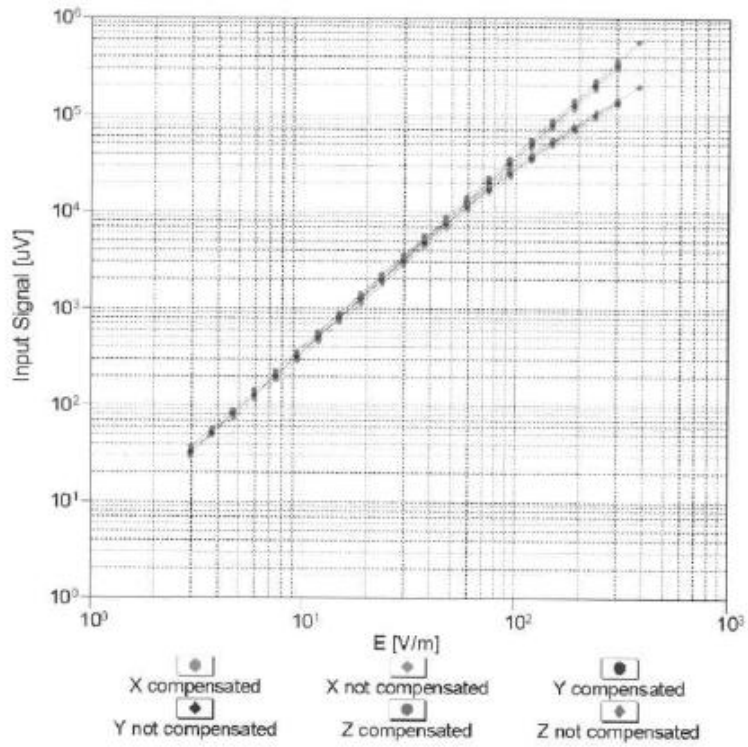
Receiving Pattern (ϕ), $\vartheta = 90^\circ$



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



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



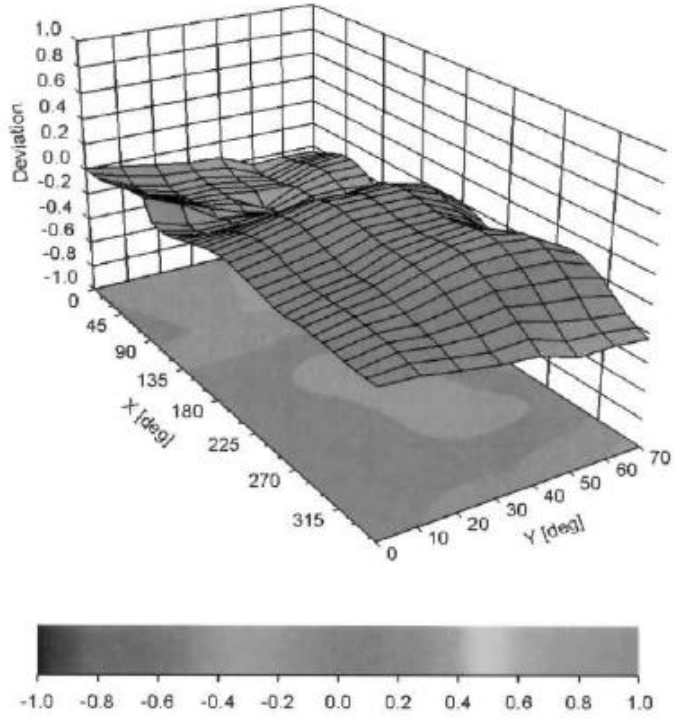
Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)



ER3DV6- SN:2358

January 14, 2011

Deviation from Isotropy in Air Error (ϕ , θ), $f = 900$ MHz



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



ER3DV6- SN:2358

January 14, 2011

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2358

Other Probe Parameters

| | |
|---|-------------|
| Sensor Arrangement | Rectangular |
| Connector Angle (°) | 115.6 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 8 mm |
| Probe Tip to Sensor X Calibration Point | 2.5 mm |
| Probe Tip to Sensor Y Calibration Point | 2.5 mm |
| Probe Tip to Sensor Z Calibration Point | 2.5 mm |



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Accreditation No.: SCS 108

Client Sporton-TW (Auden)

Certificate No: H3-6184_Jan11

CALIBRATION CERTIFICATE

Object: H3DV6 - SN:6184, Calibration procedure(s): QA CAL-03.v6, QA CAL-25.v3, Calibration date: January 25, 2011. This calibration certificate documents the traceability to national standards...

Table with 4 columns: Primary Standards, ID, Cal Date (Certificate No.), Scheduled Calibration. Lists various power meters, sensors, attenuators, and probes with their respective IDs and calibration dates.

Calibrated by: Marcel Fehr, Laboratory Technician; Approved by: Katja Pokovic, Technical Manager. Issued: January 25, 2011. This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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



H3DV6 – SN:6184

January 25, 2011

Probe H3DV6

SN:6184

Manufactured: June 8, 2004
Calibrated: January 25, 2011

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



H3DV6- SN:6184

January 25, 2011

DASY/EASY - Parameters of Probe: H3DV6 - SN:6184

Basic Calibration Parameters

| | | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------|----|------------|------------|------------|--------------|
| Norm (A/m / $\sqrt{(mV)}$) | a0 | 2.53E-003 | 2.58E-003 | 3.00E-003 | $\pm 5.1 \%$ |
| Norm (A/m / $\sqrt{(mV)}$) | a1 | -2.60E-005 | -9.54E-005 | -1.07E-004 | $\pm 5.1 \%$ |
| Norm (A/m / $\sqrt{(mV)}$) | a2 | 1.54E-005 | 2.86E-006 | 6.42E-005 | $\pm 5.1 \%$ |
| DCP (mV) ^B | | 91.0 | 90.6 | 91.7 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 251.5 | $\pm 1.6 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 252.0 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 238.8 | |

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

^B Numerical linearization parameter: uncertainty not required.

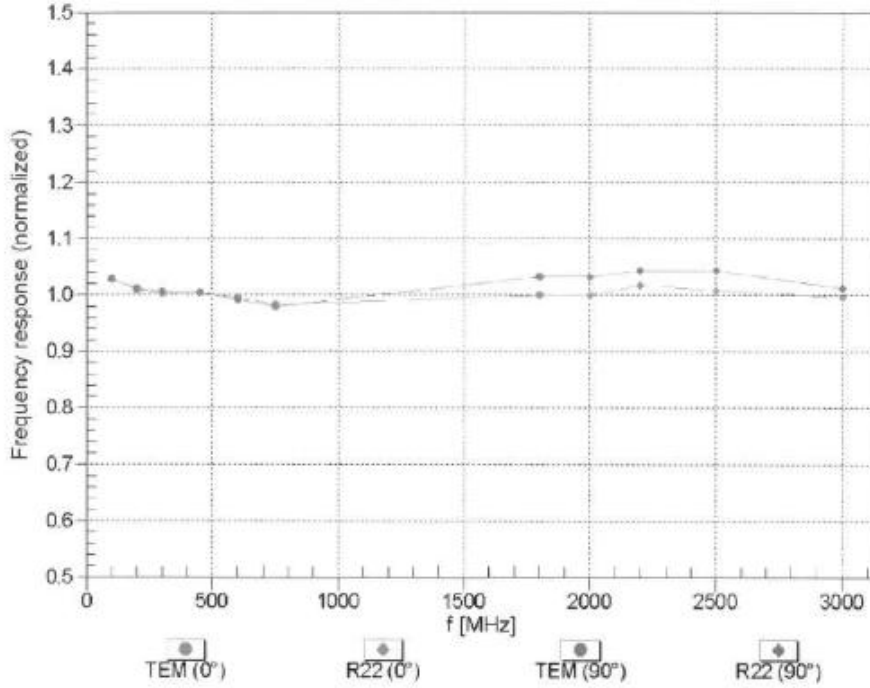
^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



H3DV6- SN:6184

January 25, 2011

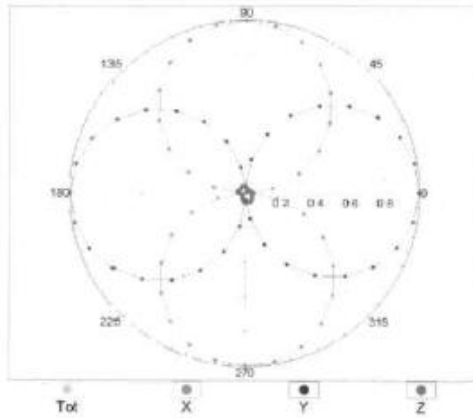
Frequency Response of H-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



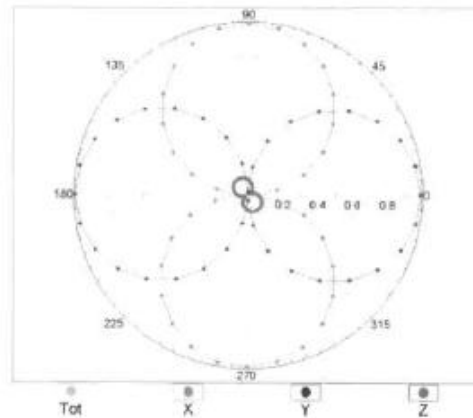
Uncertainty of Frequency Response of H-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM,0°

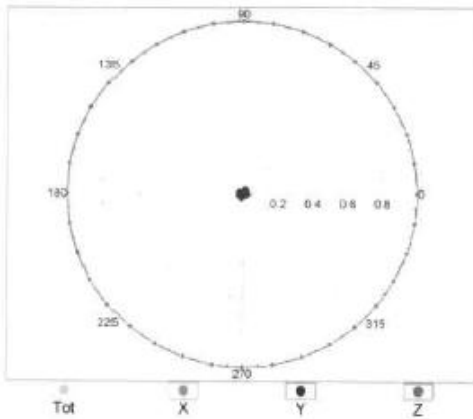


f=2500 MHz,R22,0°

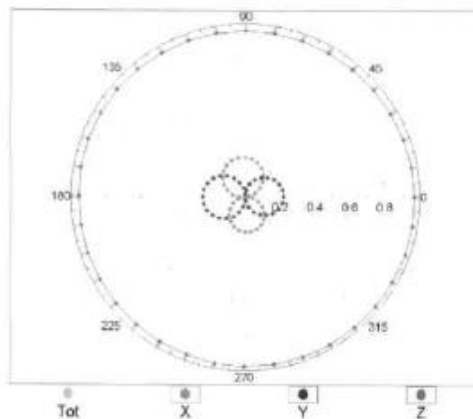


Receiving Pattern (ϕ), $\vartheta = 90^\circ$

f=600 MHz,TEM,90°



f=2500 MHz,R22,90°

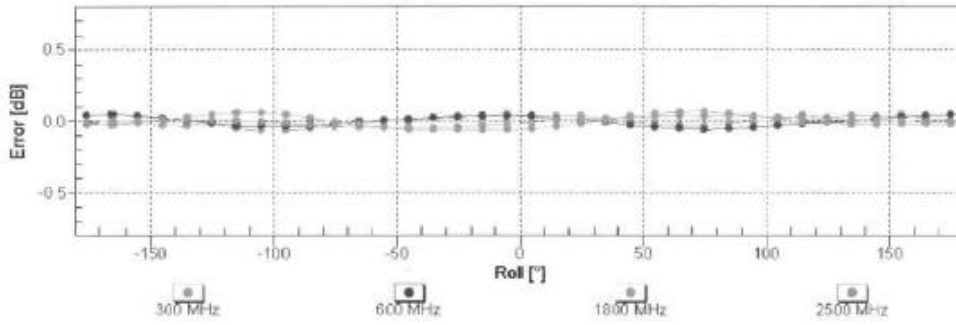




H3DV6- SN:6184

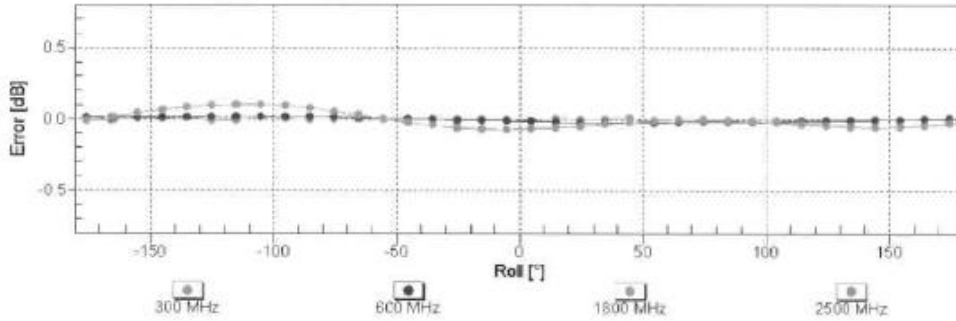
January 25, 2011

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



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

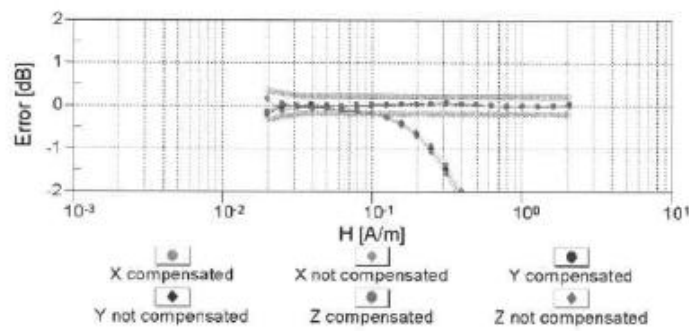
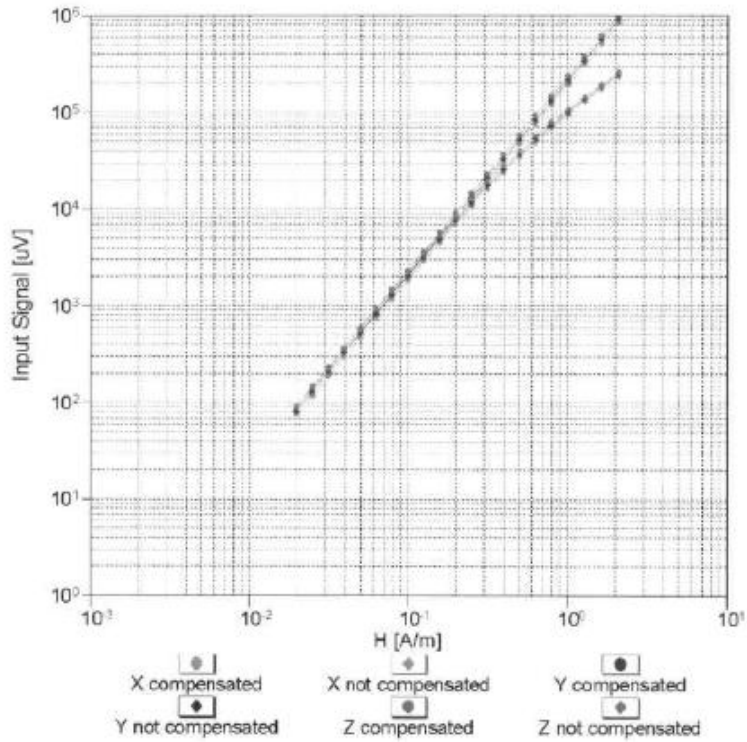
Receiving Pattern (ϕ), $\vartheta = 90^\circ$



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



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



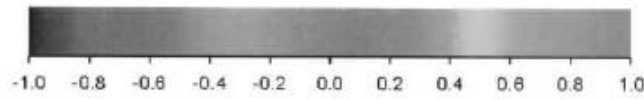
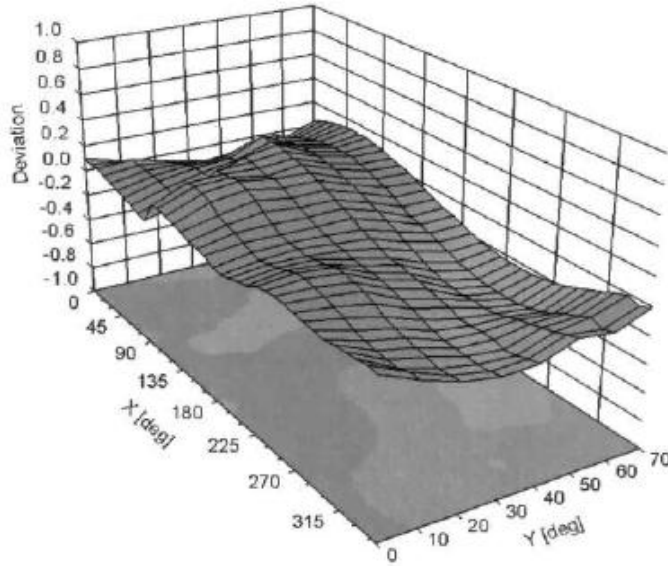
Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

H3DV6- SN:6184

January 25, 2011

Deviation from Isotropy in Air

Error (ϕ , θ), $f = 900$ MHz



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



H3DV6- SN:6184

January 25, 2011

DASY/EASY - Parameters of Probe: H3DV6 - SN:6184

Other Probe Parameters

| | |
|---|-------------|
| Sensor Arrangement | Rectangular |
| Connector Angle (°) | -65.4 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 20 mm |
| Tip Diameter | 6 mm |
| Probe Tip to Sensor X Calibration Point | 3 mm |
| Probe Tip to Sensor Y Calibration Point | 3 mm |
| Probe Tip to Sensor Z Calibration Point | 3 mm |