



Calibration Certificate of DASY

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 **Sporton (Auden)**

Certificate No: **CD835V3-1045_Sep07**

CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1045**

Calibration procedure(s) **QA CAL-20.v4
Calibration procedure for dipoles in air**

Calibration date: **September 25, 2007**

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 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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|---------------------------|-------------|---|------------------------|
| Power meter EPM-442A | GB37480704 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Power sensor HP 8481A | US37292783 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Probe ER3DV6 | SN: 2336 | 27-Dec-06 (SPEAG, No. ER3-2336_Dec06) | Dec-07 |
| Probe H3DV6 | SN: 6065 | 27-Dec-06 (SPEAG, No. H3-6065-Dec06) | Dec-07 |
| DAE4 | SN: 903 | 19-Sep-07 (SPEAG, No. DAE4-903_Sep07) | Sep-08 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter EPM-4419B | GB42420191 | 11-May-05 (SPEAG, in house check Nov-06) | In house check: Nov-07 |
| Power sensor HP 8482A | US37295597 | 11-May-05 (SPEAG, in house check Nov-06) | In house check: Nov-07 |
| Power sensor HP 8482H | 3318A09450 | 08-Jan-02 (SPEAG, in house check Nov-06) | In house check: Nov-07 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (SPEAG, in house check Oct-06) | In house check: Oct-07 |
| RF generator E4433B | MY 41310391 | 22-Nov-04 (SCV, TRS 001-021-0354) | In house check: Nov-07 |

| | | | |
|----------------|--------------------|-----------------------------------|---------------|
| Calibrated by: | Name Mike Meili | Function Laboratory Technician | Signature |
| Approved by: | Fin Bornholt | Technical Director | |

Issued: September 27, 2007

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

Certificate No: CD835V3-1045_Sep07

Page 1 of 6



Calibration Certificate of DASY

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**

References

- [1] ANSI-C63.19-2006
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 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.

| | | |
|------------------------------------|---------------------|----------------------|
| DASY Version | DASY4 | V4.7 B55 |
| DASY PP Version | SEMCAD | V1.8 B176 |
| Phantom | HAC Test Arch | SD HAC P01 BA, #1070 |
| Distance Dipole Top - Probe Center | 10 mm | |
| Scan resolution | dx, dy = 5 mm | area = 20 x 180 mm |
| Frequency | 835 MHz \pm 1 MHz | |
| Forward power at dipole connector | 20.0 dBm = 100mW | |
| Input power drift | < 0.05 dB | |

2 Maximum Field values

| H-field 10 mm above dipole surface | condition | interpolated maximum |
|------------------------------------|----------------------|----------------------|
| Maximum measured | 100 mW forward power | 0.453 A/m |

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

| E-field 10 mm above dipole surface | condition | Interpolated maximum |
|------------------------------------|----------------------|----------------------|
| Maximum measured above high end | 100 mW forward power | 168.2 V/m |
| Maximum measured above low end | 100 mW forward power | 165.9 V/m |
| Averaged maximum above arm | 100 mW forward power | 167.1 V/m |

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

3 Appendix

3.1 Antenna Parameters

| Frequency | Return Loss | Impedance |
|-----------|-------------|----------------------|
| 800 MHz | 15.4 dB | (41.9 – j13.5) Ohm |
| 835 MHz | 30.8 dB | (49.7 + j2.8) Ohm |
| 900 MHz | 17.1 dB | (55.1 – j13.9) Ohm |
| 950 MHz | 18.9 dB | (48.6 + j11.1) Ohm |
| 960 MHz | 15.0 dB | (54.9 + j18.3) Ohm |

3.2 Antenna Design and Handling

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

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

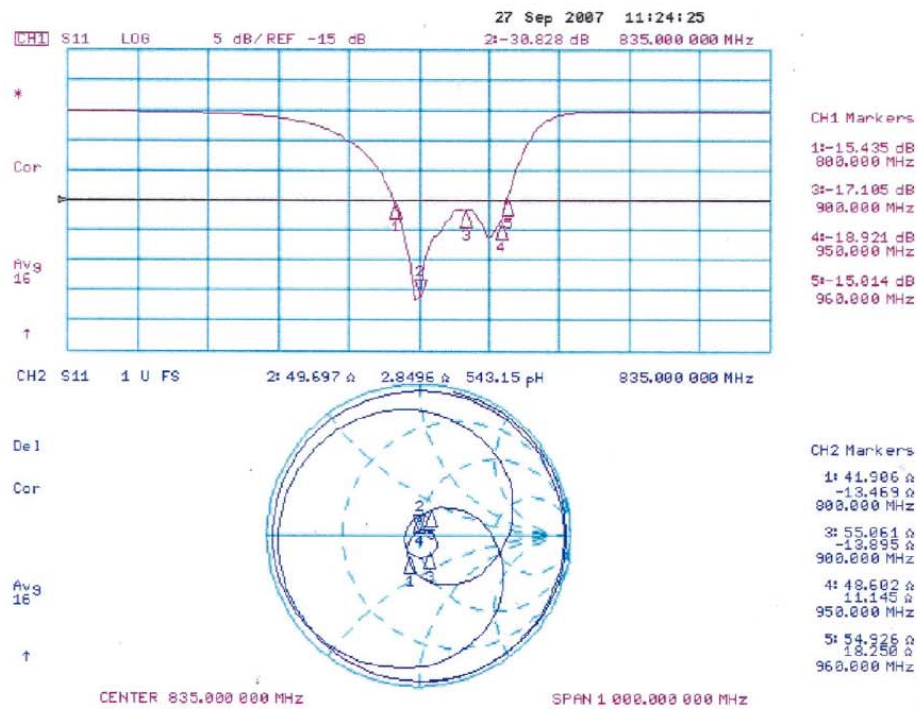
Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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



3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart





3.3.2 DASY4 H-field result

Date/Time: 25.09.2007 13:54:05

Test Laboratory: SPEAG Lab 2

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

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

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

Phantom section: H Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: H3DV6 - SN6065; Calibrated: 27.12.2006
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn903; Calibrated: 19.09.2007
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 176

H Scan - Sensor Center 10mm above CD835 Dipole/Hearing Aid Compatibility Test (41x361x1):

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

Maximum value of peak Total field = 0.453 A/m

Probe Modulation Factor = 1.00

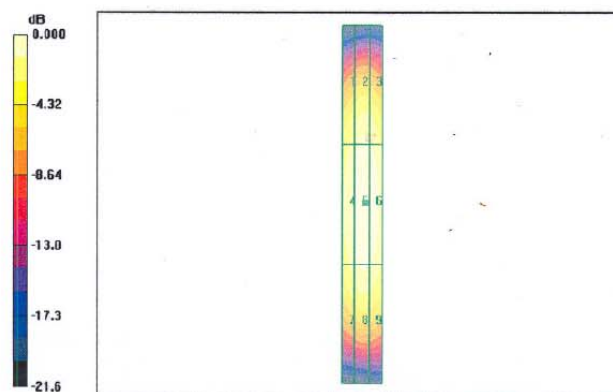
Device Reference Point: 0.000, 0.000, 354.7 mm

Reference Value = 0.477 A/m; Power Drift = 0.000 dB

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

Peak H-field in A/m

| | | |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 0.364 | 0.405 | 0.396 |
| M4 | M4 | M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 0.411 | 0.453 | 0.444 |
| M4 | M4 | M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 0.362 | 0.398 | 0.391 |
| M4 | M4 | M4 |



0 dB = 0.453 A/m



3.3.3 DASY4 E-Field result

Date/Time: 25.09.2007 11:58:13

Test Laboratory: SPEAG Lab 2

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1045

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

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

Phantom section: E Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 27.12.2006
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn903; Calibrated: 31.08.2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 176

E Scan - Sensor Center 10mm above CD835 Dipole/Hearing Aid Compatibility Test (41x361x1):

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

Maximum value of peak Total field = 168.2 V/m

Probe Modulation Factor = 1.00

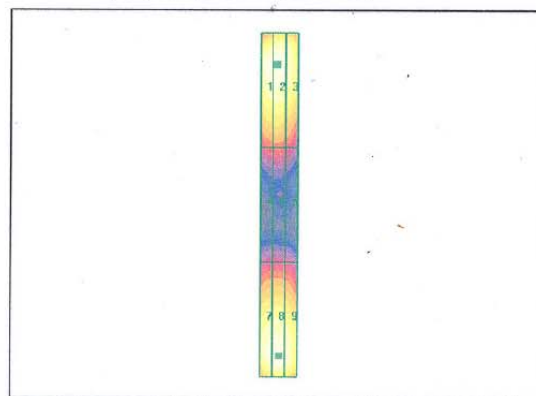
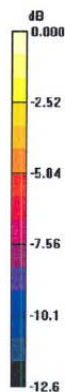
Device Reference Point: 0.000, 0.000, 354.7 mm

Reference Value = 109.0 V/m; Power Drift = -0.007 dB

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

Peak E-field in V/m

| | | |
|--------|--------|--------|
| Grid 1 | Grid 2 | Grid 3 |
| 164.2 | 165.9 | 157.1 |
| M4 | M4 | M4 |
| Grid 4 | Grid 5 | Grid 6 |
| 87.2 | 88.4 | 84.0 |
| M4 | M4 | M4 |
| Grid 7 | Grid 8 | Grid 9 |
| 163.2 | 168.2 | 161.1 |
| M4 | M4 | M4 |



0 dB = 168.2V/m



Calibration Certificate of DASY

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 **Sporton (Auden)**

Certificate No: **CD1880V3-1038_Sep07**

CALIBRATION CERTIFICATE

Object **CD1880V3 - SN: 1038**

Calibration procedure(s) **QA CAL-20.v4**
Calibration procedure for dipoles in air

Calibration date: **September 27, 2007**

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 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 EPM-442A | GB37480704 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Power sensor HP 8481A | US37292783 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Probe ER3DV6 | SN: 2336 | 27-Dec-06 (SPEAG, No. ER3-2336_Dec06) | Dec-07 |
| Probe H3DV6 | SN: 6065 | 27-Dec-06 (SPEAG, No. H3-6065-Dec06) | Dec-07 |
| DAE4 | SN: 903 | 19-Sep-07 (SPEAG, No. DAE4-903_Sep07) | Sep-08 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter EPM-4419B | GB42420191 | 11-May-05 (SPEAG, in house check Nov-06) | In house check: Nov-07 |
| Power sensor HP 8482A | US37295597 | 11-May-05 (SPEAG, in house check Nov-06) | In house check: Nov-07 |
| Power sensor HP 8482H | 3318A09450 | 08-Jan-02 (SPEAG, in house check Nov-06) | In house check: Nov-07 |
| Network Analyzer HP 8753E | US37390565 | 18-Oct-01 (SPEAG, in house check Oct-06) | In house check: Oct-07 |
| RF generator E4433B | MY 41310391 | 22-Nov-04 (SCV, TRS 001-021-0354) | In house check: Nov-07 |

| | | | |
|----------------|-----------------|-----------------------|-----------|
| | Name | Function | Signature |
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Fin Bornholt | Technical Director | |

Issued: September 28, 2007

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

Certificate No: CD1880V3-1038_Sep07

Page 1 of 6



Calibration Certificate of DASY

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**

References

- [1] ANSI-C63.19-2006
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 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 eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- H-field distribution:** H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.



1 Measurement Conditions

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

| | | |
|------------------------------------|----------------------|----------------------|
| DASY Version | DASY4 | V4.7 B55 |
| DASY PP Version | SEMCAD | V1.8 B176 |
| Phantom | HAC Test Arch | SD HAC P01 BA, #1002 |
| Distance Dipole Top - Probe Center | 10 mm | |
| Scan resolution | dx, dy = 5 mm | area = 20 x 90 mm |
| Frequency | 1880 MHz \pm 1 MHz | |
| Forward power at dipole connector | 20.0 dBm = 100mW | |
| Input power drift | < 0.05 dB | |

2 Maximum Field values

| H-field 10 mm above dipole surface | condition | Interpolated maximum |
|------------------------------------|----------------------|----------------------|
| Maximum measured | 100 mW forward power | 0.471 A/m |

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

| E-field 10 mm above dipole surface | condition | Interpolated maximum |
|------------------------------------|----------------------|----------------------|
| Maximum measured above high end | 100 mW forward power | 138.9 V/m |
| Maximum measured above low end | 100 mW forward power | 138.8 V/m |
| Averaged maximum above arm | 100 mW forward power | 138.9 V/m |

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

3 Appendix

3.1 Antenna Parameters

| Frequency | Return Loss | Impedance |
|-----------|-------------|----------------------|
| 1710 MHz | 19.2 dB | (48.9 + j10.9) Ohm |
| 1880 MHz | 22.1 dB | (53.8 + j7.2) Ohm |
| 1900 MHz | 22.1 dB | (56.5 + j5.2) Ohm |
| 1950 MHz | 26.1 dB | (54.3 - j2.9) Ohm |
| 2000 MHz | 19.1 dB | (40.1 + j0.4) 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.

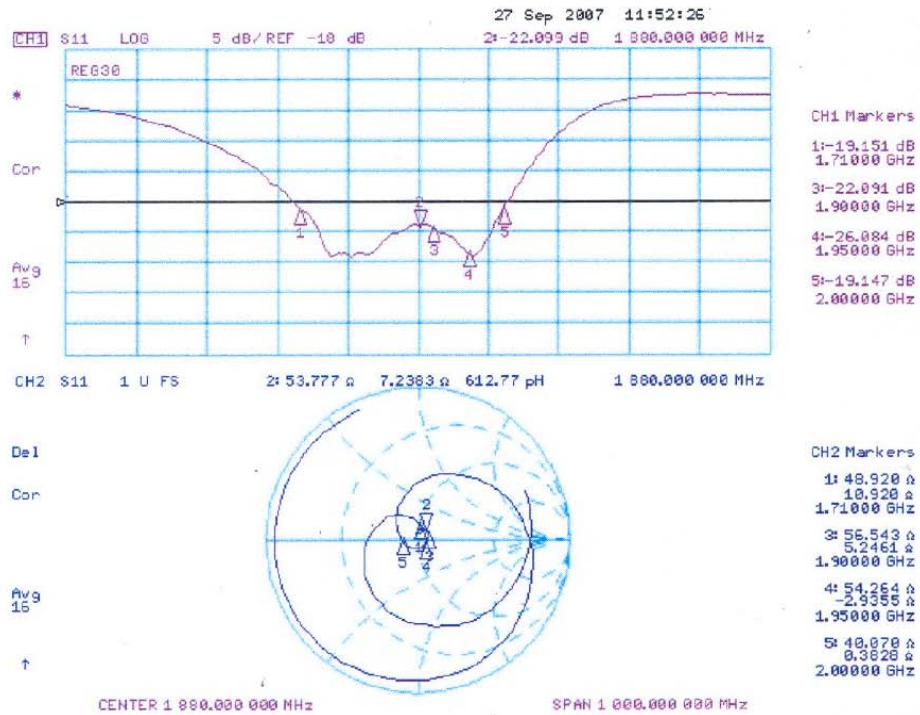
Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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: 25.09.2007 15:53:23

Test Laboratory: SPEAG Lab 2

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

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

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

Phantom section: H Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 27.12.2006
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn903; Calibrated: 19.09.2007
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 176

H Scan - Sensor Center 10mm above CD1880V3 Dipole/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 0.471 A/m

Probe Modulation Factor = 1.00

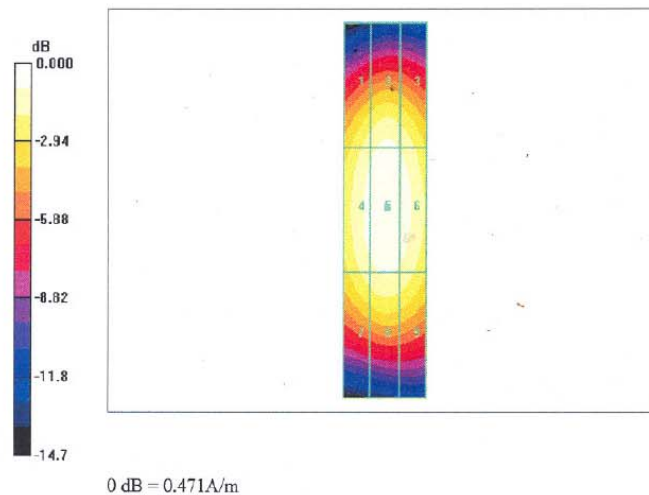
Device Reference Point: 0.000, 0.000, 354.7 mm

Reference Value = 0.498 A/m; Power Drift = 0.009 dB

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

Peak H-field in A/m

| | | |
|---------------------------|---------------------------|---------------------------|
| Grid 1 0.404 M2 | Grid 2 0.435 M2 | Grid 3 0.418 M2 |
| Grid 4 0.442 M2 | Grid 5 0.471 M2 | Grid 6 0.454 M2 |
| Grid 7 0.402 M2 | Grid 8 0.426 M2 | Grid 9 0.410 M2 |



3.3.3 DASY4 E-Field Result

Date/Time: 27.09.2007 12:27:44

Test Laboratory: SPEAG Lab 2

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

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

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

Phantom section: E Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 27.12.2006
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn903; Calibrated: 19.09.2007
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 174

E Scan - Sensor Center 10mm above CD1880V3 Dipole/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 138.9 V/m

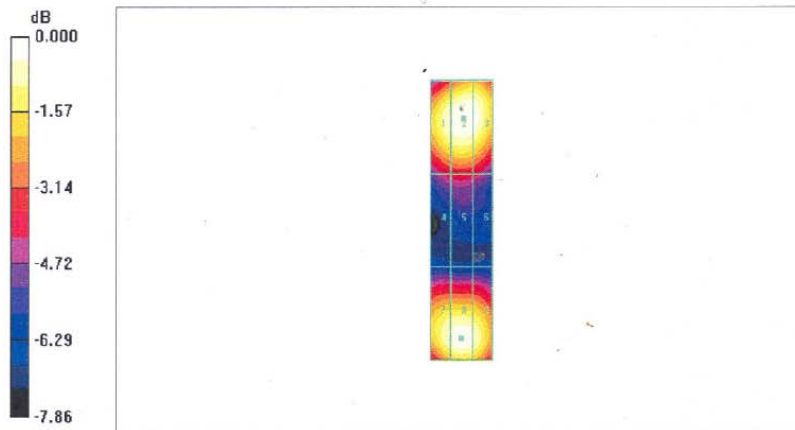
Probe Modulation Factor = 1.00

Reference Value = 156.3 V/m; Power Drift = 0.002 dB

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

Peak E-field in V/m

| | | |
|---------------------------|---------------------------|---------------------------|
| Grid 1 133.8 M2 | Grid 2 138.9 M2 | Grid 3 137.0 M2 |
| Grid 4 89.9 M3 | Grid 5 92.3 M3 | Grid 6 89.1 M3 |
| Grid 7 133.4 M2 | Grid 8 138.8 M2 | Grid 9 133.8 M2 |



0 dB = 138.9V/m



Calibration Certificate of DASY

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

Accreditation No.: **SCS 108**

Client **Sporton (Auden)**

Certificate No: **DAE4-778_Sep08**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BG - SN: 778**

Calibration procedure(s) **QA CAL-06.v12**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **September 22, 2008**

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 (Certificate No.) | Scheduled Calibration |
|-----------------------------------|--------------------|----------------------------|------------------------|
| Fluke Process Calibrator Type 702 | SN: 6295803 | 04-Oct-07 (No: 6467) | Oct-08 |
| Keithley Multimeter Type 2001 | SN: 0810278 | 03-Oct-07 (No: 6465) | Oct-08 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Calibrator Box V1.1 | SE UMS 006 AB 1004 | 06-Jun-08 (in house check) | In house check: Jun-09 |

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

Issued: September 22, 2008

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

Certificate No: **DAE4-778_Sep08**

Page 1 of 5

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

Accreditation No.: **SCS 108**

Glossary

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:** 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 | 404.686 \pm 0.1% (k=2) | 403.490 \pm 0.1% (k=2) | 405.045 \pm 0.1% (k=2) |
| Low Range | 3.99455 \pm 0.7% (k=2) | 3.96369 \pm 0.7% (k=2) | 3.99417 \pm 0.7% (k=2) |

Connector Angle

| | |
|---|-----------------|
| Connector Angle to be used in DASY system | 309 ° \pm 1 ° |
|---|-----------------|

Appendix
1. DC Voltage Linearity

| High Range | Input (μV) | Reading (μV) | Error (%) |
|-------------------|-------------------------|---------------------------|-----------|
| Channel X + Input | 200000 | 200000.3 | 0.00 |
| Channel X + Input | 20000 | 20004.24 | 0.02 |
| Channel X - Input | 20000 | -20002.46 | 0.01 |
| Channel Y + Input | 200000 | 200000.4 | 0.00 |
| Channel Y + Input | 20000 | 20002.60 | 0.01 |
| Channel Y - Input | 20000 | -20002.26 | 0.01 |
| Channel Z + Input | 200000 | 200000.6 | 0.00 |
| Channel Z + Input | 20000 | 20000.78 | 0.00 |
| Channel Z - Input | 20000 | -20005.75 | 0.03 |

| Low Range | Input (μV) | Reading (μV) | Error (%) |
|-------------------|-------------------------|---------------------------|-----------|
| Channel X + Input | 2000 | 2000 | 0.00 |
| Channel X + Input | 200 | 199.37 | -0.31 |
| Channel X - Input | 200 | -200.28 | 0.14 |
| Channel Y + Input | 2000 | 2000 | 0.00 |
| Channel Y + Input | 200 | 199.63 | -0.19 |
| Channel Y - Input | 200 | -200.88 | 0.44 |
| Channel Z + Input | 2000 | 2000.1 | 0.00 |
| Channel Z + Input | 200 | 198.60 | -0.70 |
| Channel Z - Input | 200 | -201.07 | 0.53 |

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 | -7.46 | -6.40 |
| | - 200 | 10.00 | 6.86 |
| Channel Y | 200 | -2.73 | -2.45 |
| | - 200 | 0.84 | 0.43 |
| Channel Z | 200 | -10.91 | -10.94 |
| | - 200 | 7.89 | 8.22 |

3. Channel separation

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

| | Input Voltage (mV) | Channel X (μV) | Channel Y (μV) | Channel Z (μV) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200 | - | 3.08 | -1.34 |
| Channel Y | 200 | 1.18 | - | 4.64 |
| Channel Z | 200 | -1.74 | 1.44 | - |

4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 16048 | 16021 |
| Channel Y | 16167 | 15166 |
| Channel Z | 16416 | 15977 |

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 | -0.13 | -0.88 | 0.92 | 0.33 |
| Channel Y | -0.88 | -2.47 | 0.72 | 0.55 |
| Channel Z | -1.16 | -2.17 | -0.19 | 0.42 |

6. Input Offset Current

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

7. Input Resistance

| | Zeroing (MOhm) | Measuring (MOhm) |
|-----------|----------------|------------------|
| Channel X | 0.2000 | 201.1 |
| Channel Y | 0.2000 | 201.0 |
| Channel Z | 0.2001 | 201.7 |

8. Low Battery Alarm Voltage (verified during pre test)

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

9. Power Consumption (verified during pre test)

| Typical values | Switched off (mA) | Stand by (mA) | Transmitting (mA) |
|----------------|-------------------|---------------|-------------------|
| Supply (+ Vcc) | +0.0 | +6 | +14 |
| Supply (- Vcc) | -0.01 | -8 | -9 |



Calibration Certificate of DASY

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 Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Client **Sporton (Auden)**

Certificate No: **AM1DV2-1038_Jan09**

CALIBRATION CERTIFICATE

Object **AM1DV2 - SN: 1038**

Calibration procedure(s) **QA CAL-24.v2**
Calibration procedure for AM1D magnetic field probes and TMFS in the
audio range

Calibration date: **January 12, 2009**

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 (Certificate No.) | Scheduled Calibration |
|-------------------------------|-------------|---------------------------------|-----------------------|
| Keithley Multimeter Type 2001 | SN: 0810278 | 30-Sep-08 (No: 7670) | Sep-09 |
| Reference Probe AM1DV2 | SN: 1008 | 12-Jan-09 (No: AM1D-1008_Jan09) | Jan-10 |
| DAE4 | SN: 781 | 03-Oct-08 (No: DAE4-781_Oct08) | Oct-09 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---------------------|------|-----------------------------------|-----------------|
| AMCC | 1050 | 15-Aug-08 (in house check Aug-08) | Aug-09 |

| | Name | Function | Signature |
|----------------|--------------|---------------|-----------|
| Calibrated by: | Mike Meili | RF Technician | |
| Approved by: | Fin Bornholt | R&D Director | |

Issued: January 13, 2009

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



References

- [1] ANSI C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [2] DASY4 manual, Chapter: Hearing Aid Compatibility (HAC) T-Coil Extension

Description of the AM1D probe

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1]. The probe includes a symmetric low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface.

The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted nominally 35.3° above the measurement plane, using the connector rotation and sensor angle stated below.

The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1] without additional shielding.

Handling of the item

The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in a DASY system, the probe must be operated with the special probe cup provided (larger diameter).

Methods Applied and Interpretation of Parameters

- *Coordinate System:* The AM1D probe is mounted in the DASY system for operation with a HAC Test Arch phantom with AMCC Helmholtz calibration coil according to [2], with the tip pointing to "southwest" orientation.
- *Functional Test:* The functional test preceding calibration includes test of
Noise level
RF immunity (1kHz AM modulated signal). The shield of the probe cable must be well connected.
Frequency response verification from 100 Hz to 5 kHz.
- *Connector Rotation:* The connector at the end of the probe does not carry any signals and is used for fixation to the DAE only. The probe is operated in the center of the AMCC Helmholtz coil using a 1 kHz magnetic field signal. Its angle is determined from the two minima at nominally +120° and -120° rotation, so the sensor in the tip of the probe is aligned to the vertical plane in z-direction, corresponding to the field maximum in the AMCC Helmholtz calibration coil.
- *Sensor Angle:* The sensor tilting in the vertical plane from the ideal vertical direction is determined from the two minima at nominally +120° and -120°. DASY system uses this angle to align the sensor for radial measurements to the x and y axis in the horizontal plane.
- *Sensitivity:* With the probe sensor aligned to the z-field in the AMCC, the output of the probe is compared to the magnetic field in the AMCC at 1 kHz. The field in the AMCC Helmholtz coil is given by the geometry and the current through the coil, which is monitored on the precision shunt resistor of the coil.

AM1D probe identification and configuration data

| | |
|-----------|---|
| Item | AM1DV2 Audio Magnetic 1D Field Probe |
| Type No | SP AM1 001 AF |
| Serial No | 1038 |

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

| | |
|-----------------------|--|
| Manufacturer / Origin | Schmid & Partner Engineering AG, Zurich, Switzerland |
| Manufacturing date | Sep-2006 |
| Last calibration date | January 23, 2008 |

Calibration data

| | | | |
|--------------------------|------------------|-------------------------|-----------------|
| Connector rotation angle | (in DASY system) | 42.9 ° | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | 2.01 ° | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz | (in DASY system) | 0.0664 V / (A/m) | +/- 2.2 % (k=2) |