**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

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**Accreditation No.: SCS 108**

**Client** **Auden**

**Certificate No: CD835V3-1149_Dec11**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | CD835V3 - SN: 1149 |
| Calibration procedure(s) | QA CAL-20.v5<br>Calibration procedure for dipoles in air |
| Calibration date: | December 06, 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 | 05-Oct-11 (No. 217-01451) | Oct-12 |
| Power sensor HP 8481A | US37292783 | 05-Oct-11 ( No. 217-01451) | Oct-12 |
| 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-11) | In house check: Oct-12 |
| Power sensor HP 8482H | SN: 3318A09450 | 09-Oct-09 (in house check Oct-11) | In house check: Oct-12 |
| Power sensor HP 8482A | SN: US37295597 | 09-Oct-09 (in house check Oct-11) | In house check: Oct-12 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |
| RF generator E4433B | MY 41000675 | 03-Nov-04 (in house check Oct-11) | In house check: Oct-13 |

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

Issued: December 09, 2011

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.

**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 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.

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.0 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | HAC Test Arch | |
| **Distance Dipole Top - Probe Center** | 10 mm | |
| **Scan resolution** | dx, dy = 5 mm | |
| **Frequency** | 835 MHz ± 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 | **0.471 A / m ± 8.2 % (k=2)** |

| **E-field 10 mm above dipole surface** | condition | **Interpolated maximum** |
|---|---|---|
| Maximum measured above high end | 100 mW input power | 173.2 V / m |
| Maximum measured above low end | 100 mW input power | 168.7 V / m |
| Averaged maximum above arm | 100 mW input power | **171.0 V / m ± 12.8 % (k=2)** |

## Appendix

## Antenna Parameters with Head TSL

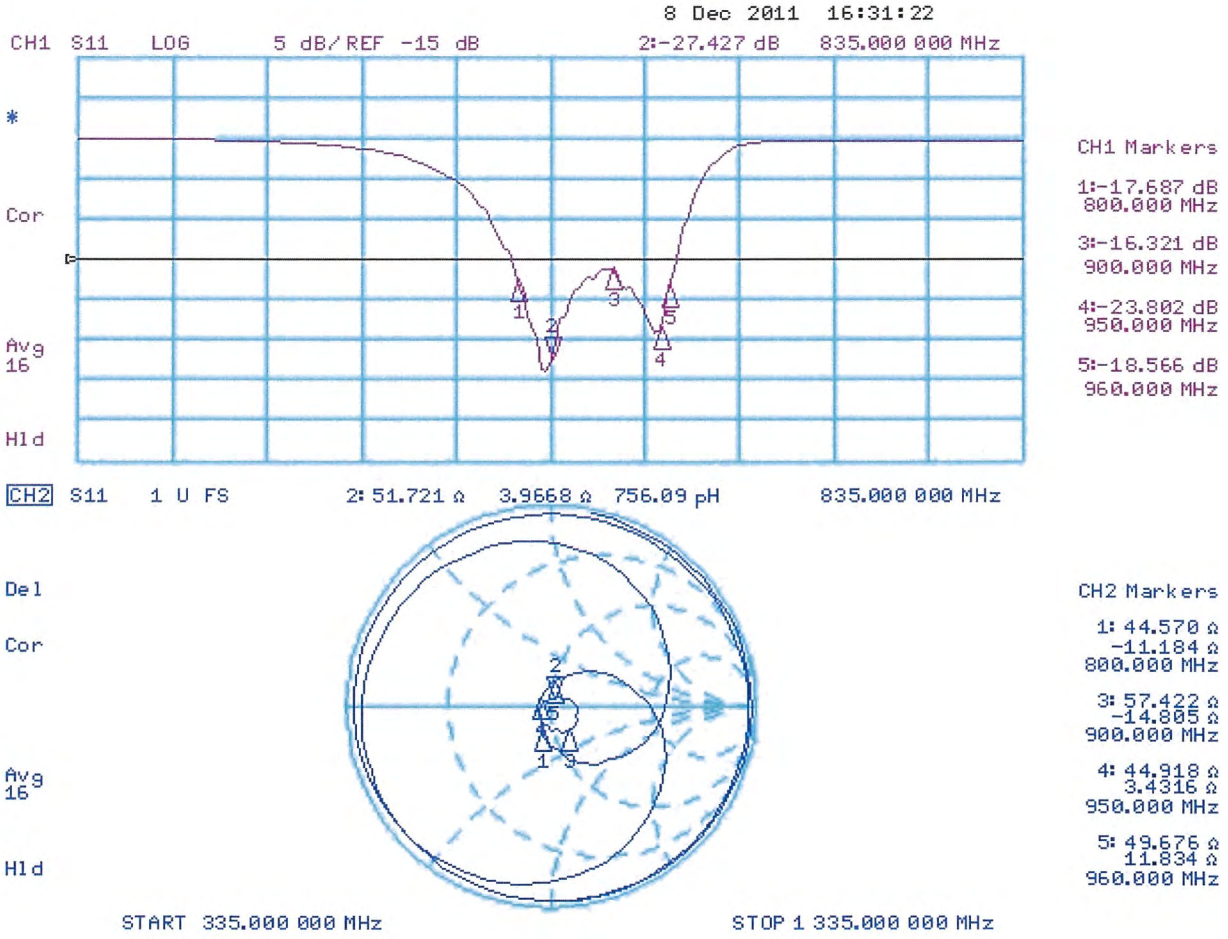
| **Frequency** | **Return Loss** | **Impedance** |
|---|---|---|
| 800 MHz | 17.7 dB | 44.6 Ω - 11.2 jΩ |
| 835 MHz | 27.4 dB | 51.7 Ω + 4.0 jΩ |
| 900 MHz | 16.3 dB | 57.4 Ω - 14.8 jΩ |
| 950 MHz | 23.8 dB | 44.9 Ω + 3.4 jΩ |
| 960 MHz | 18.6 dB | 49.7 Ω + 11.8 jΩ |

### 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: 06.12.2011

Test Laboratory: SPEAG Lab2

**DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1149**

Communication System: CW; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

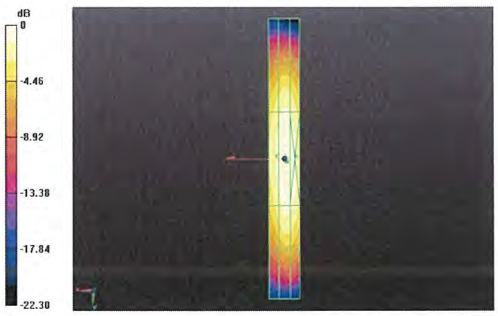
DASY5 Configuration:

- Probe: H3DV6 - SN6065; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

**Dipole H-Field measurement @ 835MHz/H-Scan - 835MHz d=10mm/Hearing Aid Compatibility Test (41x361x1):**
Measurement grid: dx=5mm, dy=5mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 0.50 V/m; Power Drift = -0.01 dB
PMR not calibrated. PMF = 1.000 is applied.
H-field emissions = 0.47 A/m
**Near-field category: M4 (AWF 0 dB)**

PMF scaled H-field

| | | |
|---|---|---|
| Grid 1 **M4** **0.38 A/m** | Grid 2 **M4** **0.41 A/m** | Grid 3 **M4** **0.40 A/m** |
| Grid 4 **M4** **0.43 A/m** | Grid 5 **M4** **0.47 A/m** | Grid 6 **M4** **0.46 A/m** |
| Grid 7 **M4** **0.37 A/m** | Grid 8 **M4** **0.42 A/m** | Grid 9 **M4** **0.41 A/m** |




0 dB = 0.470A/m = -6.56 dB A/m

## DASY4 E-field Result

Date: 06.12.2011

Test Laboratory: SPEAG Lab2

**DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1149**

Communication System: CW; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m$^3$
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

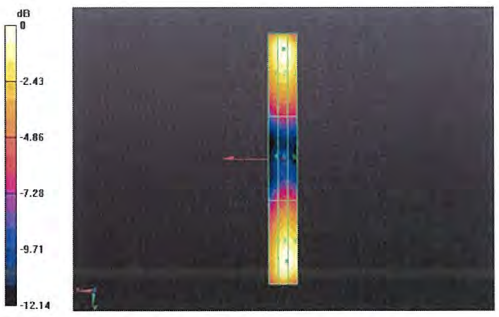
DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.04.2011
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

**Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=10mm/Hearing Aid Compatibility Test (41x361x1):**
Measurement grid: dx=5mm, dy=5mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 125.0 V/m; Power Drift = 0.01 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 173.2 V/m
**Near-field category: M4 (AWF 0 dB)**

PMF scaled E-field

| | | |
|---|---|---|
| Grid 1 **M4** **163.3 V/m** | Grid 2 **M4** **173.2 V/m** | Grid 3 **M4** **168.5 V/m** |
| Grid 4 **M4** **82.83 V/m** | Grid 5 **M4** **91.79 V/m** | Grid 6 **M4** **91.39 V/m** |
| Grid 7 **M4** **149.1 V/m** | Grid 8 **M4** **168.7 V/m** | Grid 9 **M4** **168.2 V/m** |




0 dB = 173.2V/m = 44.77 dB V/m