



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



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Client Auden

Accreditation No.: SCS 108

Certificate No: AM1DV3-3067\_Nov10

CALIBRATION CERTIFICATE

Object: AM1DV3 - SN: 3067
Calibration procedure(s): QA CAL-24.v2 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range
Calibration date: November 29, 2010

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

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

Calibration Equipment used (M&TE critical for calibration)

Table with 4 columns: Primary Standards, ID #, Cal Date (Certificate No.), Scheduled Calibration. Includes entries for Keithley Multimeter Type 2001, Reference Probe AM1DV3, DAE4, and Secondary Standards AMCC.

Calibrated by: Mike Melli, Laboratory Technician
Approved by: Fin Bornholt, R&D Director

Issued: November 29, 2010

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] DAS Y4 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 DAS Y 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 DAS Y 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 10 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°. DAS Y 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      | <b>AM1DV3</b> Audio Magnetic 1D Field Probe |
| Type No   | SP AM1 001 BA                               |
| Serial No | <b>3067</b>                                 |

|                    |                                    |
|--------------------|------------------------------------|
| Overall length     | 296 mm                             |
| Tip diameter       | 6.0 mm (at the tip)                |
| Sensor offset      | 3.0 mm (centre of sensor from tip) |
| Internal Amplifier | 20 dB                              |

|                       |  |
|-----------------------|--|
| Manufacturer / Origin | Schmid & Partner Engineering AG, Zürich, Switzerland |
| Manufacturing date    | Feb-2009   |
| Last calibration date | Jan 4, 2010  |

**Calibration data**

|                          |                   |                          |                 |
|--------------------------|-------------------|--------------------------|-----------------|
| Connector rotation angle | (in DAS Y system) | <b>260.8 °</b>           | +/- 3.6 ° (k=2) |
| Sensor angle             | (in DAS Y system) | <b>0.64 °</b>            | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz     | (in DAS Y system) | <b>0.00738 V / (A/m)</b> | +/- 2.2 % (k=2) |





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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: DAE4-778\_Oct10

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BJ - SN: 778
Calibration procedure(s): QA CAL-06.v22 Calibration procedure for the data acquisition electronics (DAE)
Calibration date: October 22, 2010

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

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

Calibration Equipment used (M&TE critical for calibration)

Table with 4 columns: Standard Type, ID #, Date, and Check/Cal Date. Includes entries for Keithley Multimeter Type 2001 and Calibrator Box V1.1.

Calibrated by: Eric Hainfeld, Technician
Approved by: Fin Bornholt, R&D Director

Issued: October 22, 2010

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## Glossary

**DAE** data acquisition electronics  
**Connector angle** information used in DAS Y 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 DAS Y 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 = 6.1µV , 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          | 404.679 ± 0.1% (k=2) | 403.480 ± 0.1% (k=2) | 405.025 ± 0.1% (k=2) |
| Low Range           | 3.98633 ± 0.7% (k=2) | 3.96375 ± 0.7% (k=2) | 3.99940 ± 0.7% (k=2) |

**Connector Angle**

|   |              |
|---|--------------|
| Connector Angle to be used in DASY system | 64.5 ° ± 1 ° |
|---|--------------|



**Appendix**

**1. DC Voltage Linearity**

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 200004.4                  | 1.89                         | 0.00      |
| Channel X + Input | 20001.11                  | 1.41                         | 0.01      |
| Channel X - Input | -19998.36                 | 1.54                         | -0.01     |
| Channel Y + Input | 199996.1                  | 3.42                         | 0.00      |
| Channel Y + Input | 19999.75                  | 0.35                         | 0.00      |
| Channel Y - Input | -19999.92                 | -0.12                        | 0.00      |
| Channel Z + Input | 200002.7                  | 1.29                         | 0.00      |
| Channel Z + Input | 19996.85                  | -2.55                        | -0.01     |
| Channel Z - Input | -20004.31                 | -4.61                        | 0.02      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2000.0                    | 0.09                         | 0.00      |
| Channel X + Input | 200.02                    | 0.02                         | 0.01      |
| Channel X - Input | -198.62                   | 1.48                         | -0.74     |
| Channel Y + Input | 1999.6                    | -0.58                        | -0.03     |
| Channel Y + Input | 199.13                    | -0.57                        | -0.29     |
| Channel Y - Input | -200.71                   | -0.61                        | 0.31      |
| Channel Z + Input | 2000.1                    | -0.01                        | -0.00     |
| Channel Z + Input | 198.96                    | -1.14                        | -0.57     |
| Channel Z - Input | -200.98                   | -0.98                        | 0.49      |

**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 ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|--|---|
| Channel X | 200                            | -5.28  | -6.07                                       |
|           | - 200                          | 6.79   | 6.12  |
| Channel Y | 200                            | -1.80  | -1.60                                       |
|           | - 200                          | 0.97   | 0.35  |
| Channel Z | 200                            | -9.76  | -9.86                                       |
|           | - 200                          | 7.56   | 7.61  |

**3. Channel separation**

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | 1.86                        | -0.66                       |
| Channel Y | 200                | 2.28                        | -                           | 2.89                        |
| Channel Z | 200                | 1.68                        | -0.15                       | -                           |



**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 | 16056            | 16950           |
| Channel Y | 16153            | 13741           |
| Channel Z | 16441            | 16086           |

**5. Input Offset Measurement**

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

Input 10MΩ

|           | Average (μV) | min. Offset (μV) | max. Offset (μV) | Std. Deviation (μV) |
|-----------|--------------|------------------|------------------|---------------------|
| Channel X | 0.32         | -2.35            | 2.08             | 0.55                |
| Channel Y | -1.83        | -2.96            | -0.72            | 0.47                |
| Channel Z | -1.93        | -3.00            | -0.90            | 0.45                |

**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                |