

## ANNEX D PROBE CALIBRATION CERTIFICATE

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



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S Swiss Calibration Service

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client CTTL (Auden)

Certificate No: AM1DV2-1064\_Jul18

### CALIBRATION CERTIFICATE

Object	AM1DV2 - SN: 1064																		
Calibration procedure(s)	QA CAL-24.v4 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range																		
Calibration date:	July 17, 2018																		
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (<math>22 \pm 3</math>)°C and humidity &lt; 70%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p>																			
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Calibrated by:	Name Leif Klysner	Function Laboratory Technician	Signature 																
Approved by:	Katja Pokovic	Technical Manager																	
Issued: July 17, 2018 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] ANSI-C63.19-2011 American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [3] DASY5 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+2]. 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+2] 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 [3], 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°. 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	<b>AM1DV2</b> Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Serial No	<b>1064</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	40 dB

Manufacturer / Origin	Schmid & Partner Engineering AG, Zurich, Switzerland
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**Calibration data**

Connector rotation angle	(in DASY system)	<b>101.8 °</b>	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	<b>0.52 °</b>	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	<b>0.0657 V / (A/m)</b>	+/- 2.2 % (k=2)

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%.

## ANNEX E DAE CALIBRATION CERTIFICATE

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Accreditation No.: SCS 0108

Client CTTL (Auden)

Certificate No: DAE4-777\_Sep17

### CALIBRATION CERTIFICATE

Object DAE4 - SD 000 D04 BM - SN: 777

Calibration procedure(s) QA CAL-06.v29  
Calibration procedure for the data acquisition electronics (DAE)

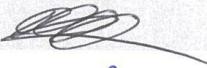
Calibration date: September 08, 2017

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	31-Aug-17 (No:21092)	Aug-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-17 (in house check)	In house check: Jan-18
Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-17 (in house check)	In house check: Jan-18

Calibrated by:	Name Dominique Steffen	Function Laboratory Technician	Signature 
Approved by:	Sven Kühn	Deputy Manager	

Issued: September 8, 2017

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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 =  $6.1\mu V$ , full range = -100...+300 mVLow 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	$405.400 \pm 0.02\% (k=2)$	$405.869 \pm 0.02\% (k=2)$	$405.579 \pm 0.02\% (k=2)$
Low Range	$3.96640 \pm 1.50\% (k=2)$	$3.96264 \pm 1.50\% (k=2)$	$4.00499 \pm 1.50\% (k=2)$

**Connector Angle**

Connector Angle to be used in DASY system	$97.0^\circ \pm 1^\circ$
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**Appendix (Additional assessments outside the scope of SCS0108)**

**1. DC Voltage Linearity**

High Range		Reading ( $\mu$ V)	Difference ( $\mu$ V)	Error (%)
Channel X	+ Input	200022.73	-12.42	-0.01
Channel X	+ Input	20003.49	-1.25	-0.01
Channel X	- Input	-19998.82	6.77	-0.03
Channel Y	+ Input	200025.10	-10.04	-0.01
Channel Y	+ Input	20007.22	2.54	0.01
Channel Y	- Input	-20002.34	3.30	-0.02
Channel Z	+ Input	200028.10	-6.82	-0.00
Channel Z	+ Input	20002.36	-2.19	-0.01
Channel Z	- Input	-20003.64	2.12	-0.01

Low Range		Reading ( $\mu$ V)	Difference ( $\mu$ V)	Error (%)
Channel X	+ Input	2000.54	-0.37	-0.02
Channel X	+ Input	201.37	0.50	0.25
Channel X	- Input	-199.19	-0.20	0.10
Channel Y	+ Input	1999.95	-0.89	-0.04
Channel Y	+ Input	200.04	-0.75	-0.37
Channel Y	- Input	-199.96	-0.85	0.43
Channel Z	+ Input	2001.05	0.20	0.01
Channel Z	+ Input	199.88	-0.86	-0.43
Channel Z	- Input	-200.02	-0.88	0.44

**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 ( $\mu$ V)	Low Range Average Reading ( $\mu$ V)
Channel X	200	5.45	3.79
	-200	3.93	0.83
Channel Y	200	7.70	7.39
	-200	-9.52	-8.90
Channel Z	200	7.51	6.49
	-200	-9.21	-8.71

**3. Channel separation**

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

	Input Voltage (mV)	Channel X ( $\mu$ V)	Channel Y ( $\mu$ V)	Channel Z ( $\mu$ V)
Channel X	200	-	-1.61	-2.84
Channel Y	200	8.30	-	0.46
Channel Z	200	6.69	5.02	-

#### 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	15919	14652
Channel Y	16343	14477
Channel Z	16033	14911

#### 5. Input Offset Measurement

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

Input  $10M\Omega$

	Average ( $\mu V$ )	min. Offset ( $\mu V$ )	max. Offset ( $\mu V$ )	Std. Deviation ( $\mu V$ )
Channel X	-0.50	-2.04	0.95	0.51
Channel Y	1.56	0.40	2.80	0.48
Channel Z	0.26	-0.78	1.16	0.42

#### 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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Accreditation No.: **SCS 0108**

Client **CTTL - BJ (Auden)**

Certificate No: **DAE4-1555\_Aug18**

## **CALIBRATION CERTIFICATE**

Object **DAE4 - SD 000 D04 BN - SN: 1555**

Calibration procedure(s) **QA CAL-06.v29**  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **August 20, 2018**

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 ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
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Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit Calibrator Box V2.1	SE UWS 053 AA 1001 SE UMS 006 AA 1002	04-Jan-18 (in house check) 04-Jan-18 (in house check)	In house check: Jan-19 In house check: Jan-19

Calibrated by:	Name	Function	Signature
	Adrian Gehring	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	

Issued: August 20, 2018

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### DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB =  $6.1\mu V$ , 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	$404.540 \pm 0.02\% (k=2)$	$404.077 \pm 0.02\% (k=2)$	$405.023 \pm 0.02\% (k=2)$
Low Range	$3.92909 \pm 1.50\% (k=2)$	$3.94558 \pm 1.50\% (k=2)$	$3.97891 \pm 1.50\% (k=2)$

### Connector Angle

Connector Angle to be used in DASY system	$104.0^\circ \pm 1^\circ$
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**Appendix (Additional assessments outside the scope of SCS0108)**

**1. DC Voltage Linearity**

High Range	Reading ( $\mu$ V)	Difference ( $\mu$ V)	Error (%)
Channel X + Input	199994.32	-1.11	-0.00
Channel X + Input	20004.21	2.27	0.01
Channel X - Input	-19994.21	6.72	-0.03
Channel Y + Input	199991.01	-4.74	-0.00
Channel Y + Input	19999.15	-2.66	-0.01
Channel Y - Input	-19999.37	1.70	-0.01
Channel Z + Input	199997.50	1.46	0.00
Channel Z + Input	19998.75	-3.06	-0.02
Channel Z - Input	-20003.08	-1.96	0.01

Low Range	Reading ( $\mu$ V)	Difference ( $\mu$ V)	Error (%)
Channel X + Input	2001.23	-0.12	-0.01
Channel X + Input	201.73	0.03	0.02
Channel X - Input	-197.79	0.32	-0.16
Channel Y + Input	2001.22	0.00	0.00
Channel Y + Input	201.15	-0.62	-0.31
Channel Y - Input	-198.47	-0.28	0.14
Channel Z + Input	2001.41	0.23	0.01
Channel Z + Input	200.99	-0.67	-0.33
Channel Z - Input	-199.42	-1.11	0.56

**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 ( $\mu$ V)	Low Range Average Reading ( $\mu$ V)
Channel X	200	-10.02	-11.33
	-200	12.53	10.76
Channel Y	200	10.66	10.40
	-200	-12.33	-12.29
Channel Z	200	-2.18	-2.52
	-200	0.20	-0.09

**3. Channel separation**

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

	Input Voltage (mV)	Channel X ( $\mu$ V)	Channel Y ( $\mu$ V)	Channel Z ( $\mu$ V)
Channel X	200	-	-0.85	-2.68
Channel Y	200	8.65	-	0.04
Channel Z	200	6.10	6.93	-

#### 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	15635	14959
Channel Y	15850	16040
Channel Z	16635	16604

#### 5. Input Offset Measurement

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

Input  $10M\Omega$

	Average ( $\mu V$ )	min. Offset ( $\mu V$ )	max. Offset ( $\mu V$ )	Std. Deviation ( $\mu V$ )
Channel X	0.40	-0.72	1.60	0.48
Channel Y	0.06	-0.99	1.84	0.46
Channel Z	-0.76	-2.17	0.18	0.48

#### 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

**The photos of HAC test are presented in the additional document:**

Appendix to test report no. I87Z62245-SEM04/05

The photos of HAC test