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

ilac-MRA

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client	**Quietek-TW (Auden)**		Certificate No: **AM1DV2-1085_May14**

CALIBRATION CERTIFICATE

Object	AM1DV2 - SN: 1085
Calibration procedure(s)	**QA CAL-24.v3** **Calibration procedure for AM1D magnetic field probes and TMFS in the audio range**
Calibration date:	**May 20, 2014**

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	01-Oct-13 (No:13976)	Oct-14
Reference Probe AM1DV2	SN: 1008	14-Jan-14 (No. AM1D-1008_Jan14)	Jan-15
DAE4	SN: 781	13-Sep-13 (No. DAE4-781_Sep13)	Sep-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	1050	01-Oct-13 (in house check Oct-13)	Oct-15
AMMI Audio Measuring Instrument	1062	26-Sep-12 (in house check Sep-12)	Sep-14

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	i.V.

Issued: May 20, 2014

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[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	**AM1DV2** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Serial No	**1085**

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, Zürich, Switzerland
Manufacturing date	October 30, 2008
Last calibration date	May 30, 2013

Calibration data

Connector rotation angle	(in DASY system)	**197.8 °**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**0.19 °**	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.0665 V / (A/m)**	+/- 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%.

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Accreditation No.: **SCS 108**

Client   **Sporton - TW (Auden)**

Certificate No: **DAE3-495_May14**

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AD - SN: 495
Calibration procedure(s)	**QA CAL-06.v26** Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	May 19, 2014

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	01-Oct-13 (No:13976)	Oct-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: May 19, 2014

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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 =	6.1µV ,	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	404.385 ± 0.02% (k=2)	405.359 ± 0.02% (k=2)	405.713 ± 0.02% (k=2)
Low Range	3.95160 ± 1.50% (k=2)	3.99165 ± 1.50% (k=2)	3.96622 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	77.0 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	200034.33	-4.40	-0.00
Channel X	+ Input	20007.03	2.57	0.01
Channel X	- Input	-20001.24	3.51	-0.02
Channel Y	+ Input	200034.04	-0.65	-0.00
Channel Y	+ Input	20005.84	1.63	0.01
Channel Y	- Input	-20002.32	2.64	-0.01
Channel Z	+ Input	200038.21	3.22	0.00
Channel Z	+ Input	20008.03	3.75	0.02
Channel Z	- Input	-20002.39	2.50	-0.01

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2000.81	-0.32	-0.02
Channel X	+ Input	201.28	0.10	0.05
Channel X	- Input	-198.05	0.61	-0.31
Channel Y	+ Input	2000.54	-0.54	-0.03
Channel Y	+ Input	201.02	-0.05	-0.02
Channel Y	- Input	-199.81	-1.07	0.54
Channel Z	+ Input	2000.48	-0.52	-0.03
Channel Z	+ Input	199.62	-1.35	-0.67
Channel Z	- Input	-199.45	-0.67	0.34

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	4.33	2.52
	- 200	-1.22	-2.61
Channel Y	200	0.12	-0.32
	- 200	-0.79	-1.02
Channel Z	200	2.31	2.30
	- 200	-4.76	-4.84

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	-	-1.27	-2.19
Channel Y	200	8.58	-	-0.77
Channel Z	200	5.25	6.26	-

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	15815	17196
Channel Y	15764	17349
Channel Z	15898	16472

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	-0.27	-1.43	0.67	0.49
Channel Y	-0.09	-1.79	1.08	0.58
Channel Z	-1.01	-2.74	0.55	0.60

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