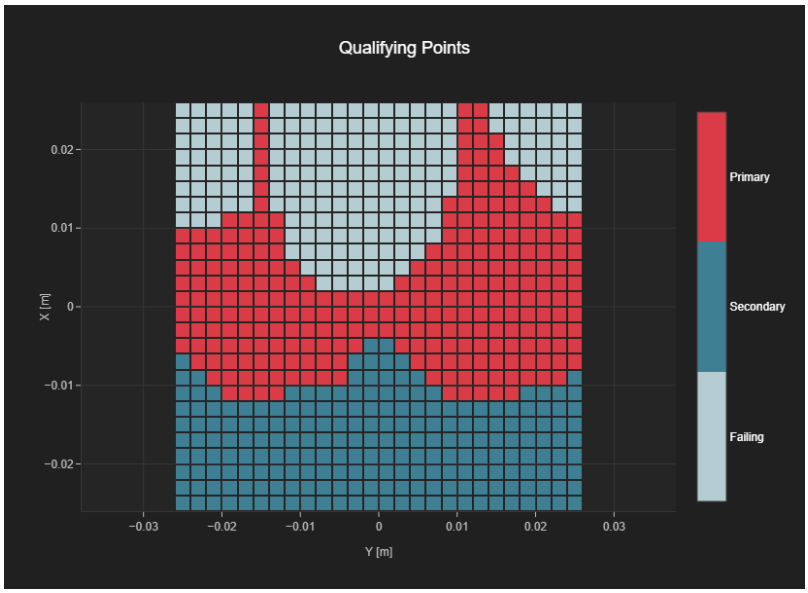
# T-Coil Coupling Mode Test Report

## Results

| Primary Group Contiguous Point Count | Secondary Group Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 269 | 483 | 26 | 26 |



# 10_LTE Band 13_10M_16QAM_1RB_0Offset_EVS WB 5.9Kbps_Ch23230

Measurement performed on March 18, 2024

## Device Under Test

| Manufacturer | Model | Dimensions [mm] | Speaker Position [mm] |
|---|---|---|---|
| | | 146.2 x 71.8 x 7.5 | 144.3 |

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3106 | December 13, 2023 | DAE4 Sn1664 | June 06, 2023 |

## Communication Systems

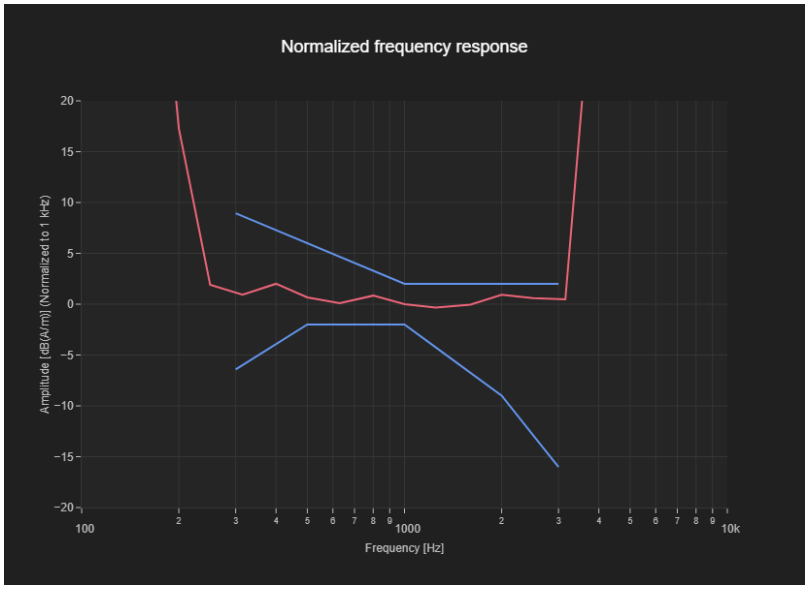
| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band 13, E-UTRA/FDD | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM) | 23230 | 782.0 |

## Grid Settings

| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

## Results

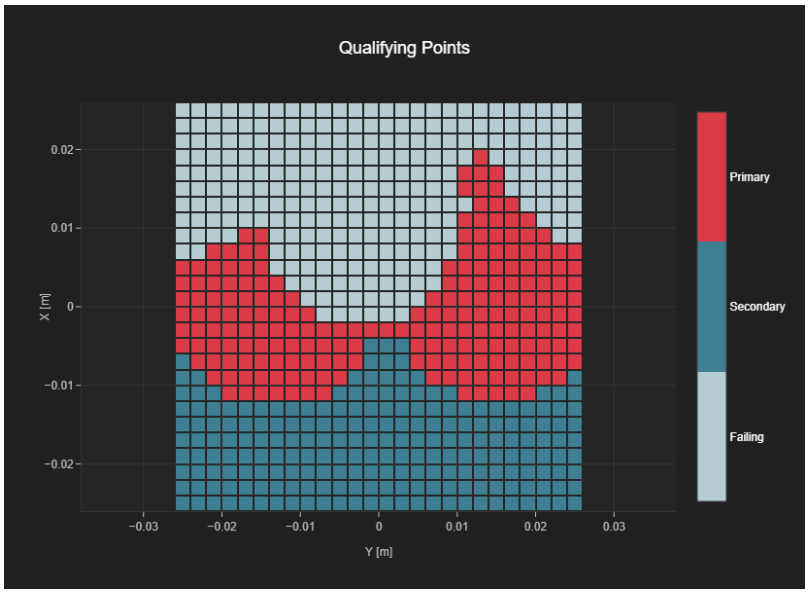
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.08 | 2.0 |



# T-Coil Coupling Mode Test Report

## Results

| Primary Group Contiguous Point Count | Secondary Group Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 205 | 416 | 23 | 26 |



# 11_LTE Band 66_20M_16QAM_1RB_0Offset_EVS WB 5.9Kbps_Ch132322

Measurement performed on March 18, 2024

## Device Under Test

| Manufacturer | Model | Dimensions [mm] | Speaker Position [mm] |
|---|---|---|---|
| | | 146.2 x 71.8 x 7.5 | 144.3 |

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3106 | December 13, 2023 | DAE4 Sn1664 | June 06, 2023 |

## Communication Systems

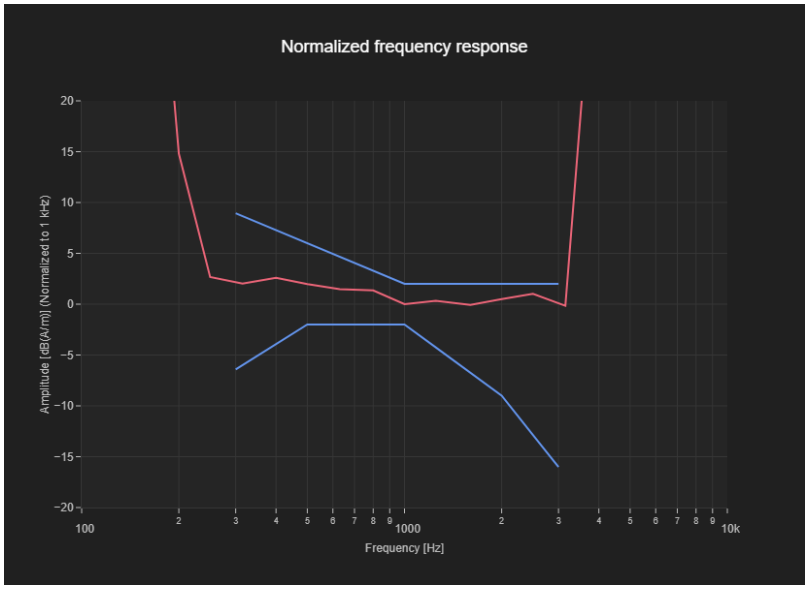
| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band 66, E-UTRA/FDD | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM) | 132322 | 1745.0 |

## Grid Settings

| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

## Results

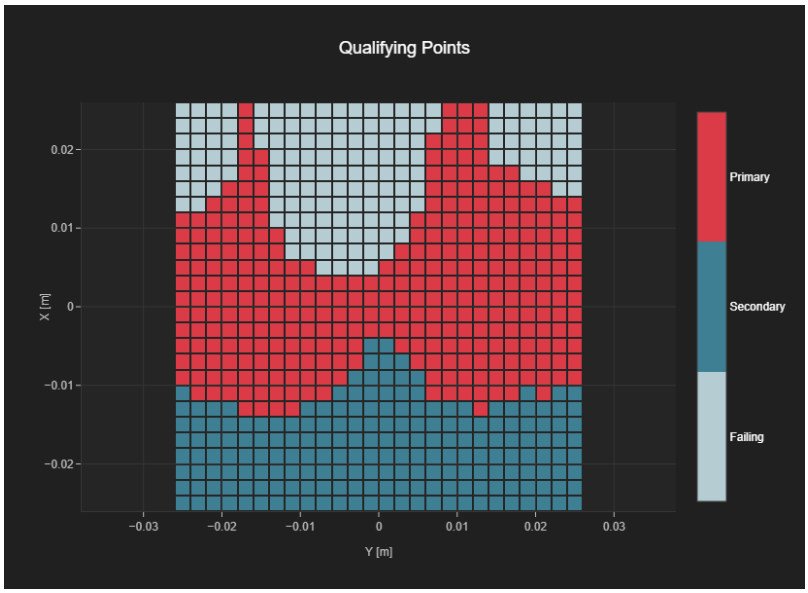
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 0.98 | 2.0 |



# T-Coil Coupling Mode Test Report

## Results

| Primary Group Contiguous Point Count | Secondary Group Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 321 | 518 | 26 | 26 |



# 12_LTE Band 71_20M_16QAM_1RB_0Offset_EVS WB 5.9Kbps_Ch133297

Measurement performed on March 18, 2024

## Device Under Test

| Manufacturer | Model | Dimensions [mm] | Speaker Position [mm] |
|---|---|---|---|
| | | 146.2 x 71.8 x 7.5 | 144.3 |

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3106 | December 13, 2023 | DAE4 Sn1664 | June 06, 2023 |

## Communication Systems

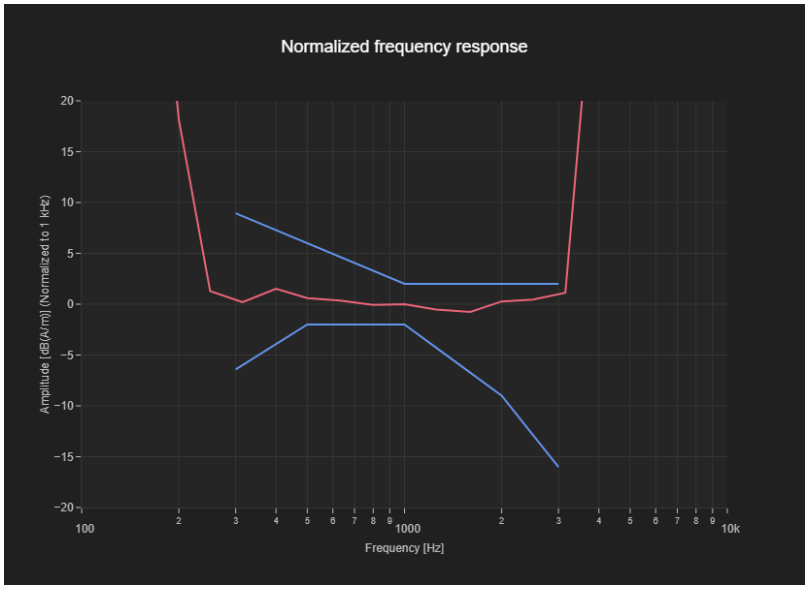
| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| Band 71, E-UTRA/FDD | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM) | 133297 | 680.5 |

## Grid Settings

| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

## Results

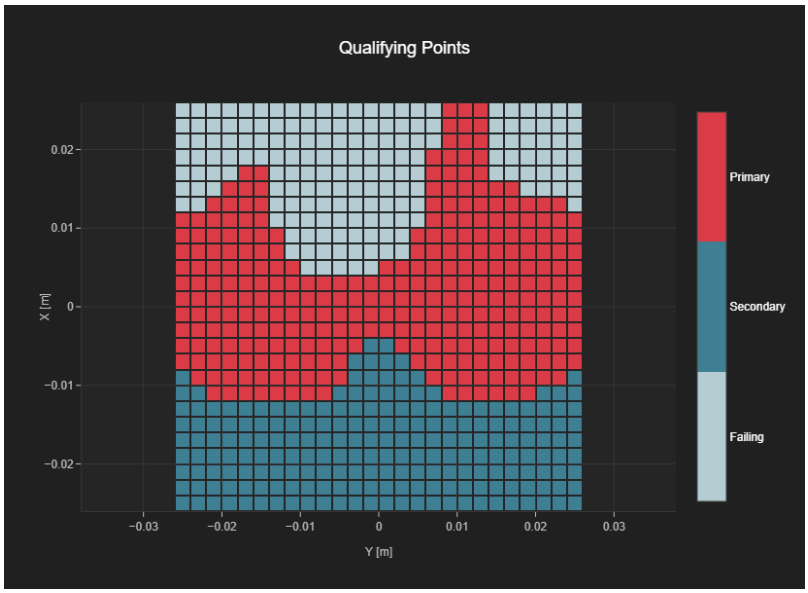
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.03 | 1.92 |



# T-Coil Coupling Mode Test Report

## Results

| Primary Group Contiguous Point Count | Secondary Group Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 297 | 504 | 26 | 26 |



# 13_WLAN2.4GHz_802.11b 1Mbps_EVS WB 5.9Kbps_Ch6

Measurement performed on March 21, 2024

## Device Under Test

| Manufacturer | Model | Dimensions [mm] | Speaker Position [mm] |
|---|---|---|---|
| | | 146.2 x 71.8 x 7.5 | 144.3 |

## Hardware Setup

| Probe Name | Probe Calibration Date | DAE Name | DAE Calibration Date |
|---|---|---|---|
| AM1DV3 - 3106 | December 13, 2023 | DAE4 Sn1664 | June 06, 2023 |

## Communication Systems

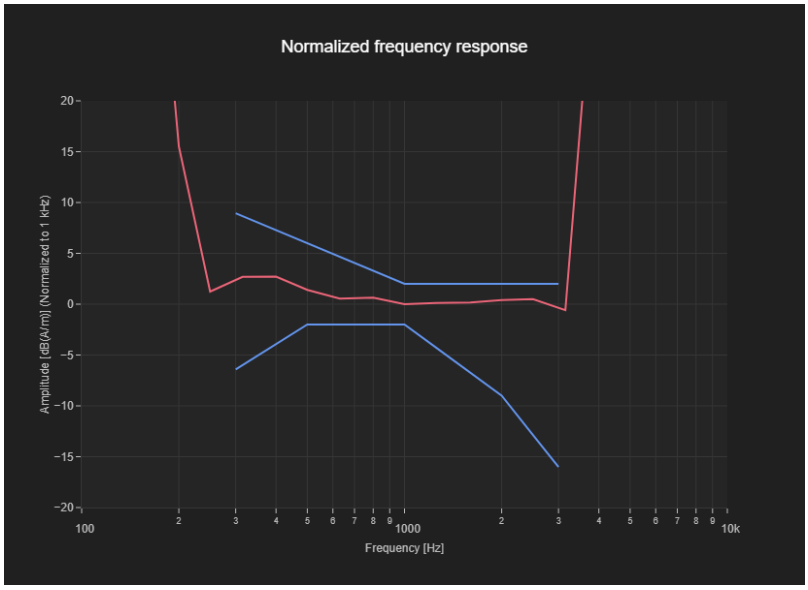
| Band Name | Communication Systems Name | Channel | Frequency [MHz] |
|---|---|---|---|
| WLAN 2.4GHz | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps) | 6 | 2437.0 |

## Grid Settings

| Extent X [mm] | Extent Y [mm] | Step X [mm] | Step Y [mm] | Distance [mm] |
|---|---|---|---|---|
| 52.0 | 52.0 | 4.0 | 4.0 | 10.0 |

## Results

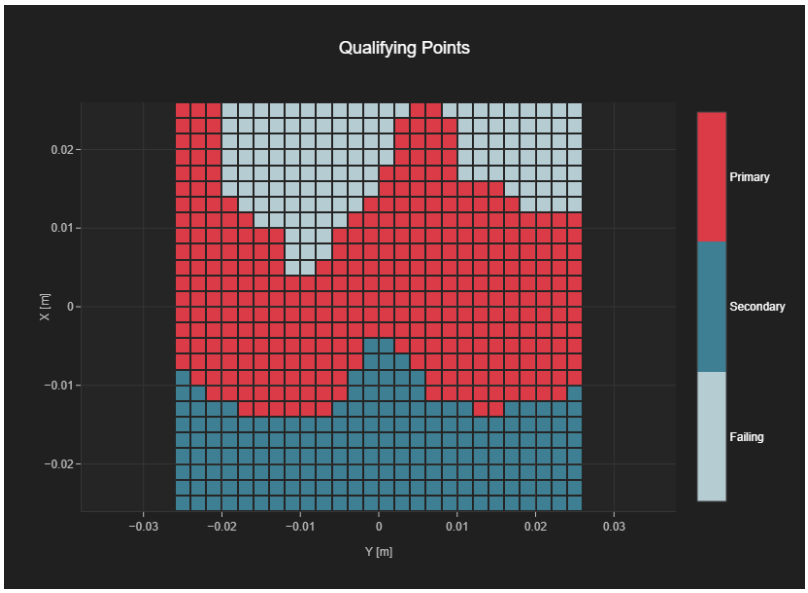
| Audio File | Measurement Duration [s] | Margin Upper Bound [dB] | Margin Lower Bound [dB] |
|---|---|---|---|
| 48k_voice_300-3000_2s.wav | 2.0 | 1.5 | 2.0 |



# T-Coil Coupling Mode Test Report

## Results

| Primary Group Contiguous Point Count | Secondary Group Point Count | Secondary Group Max Longitudinal | Secondary Group Max Transverse |
|---|---|---|---|
| 346 | 539 | 26 | 26 |



# Appendix B. Calibration Data

The DASY calibration certificates are shown as follows.

**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
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 0108**

**Client** **Sporton**
**Shenzhen City**

**Certificate No.** **AM1DV3-3106_Dec23**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | AM1DV3 - SN: 3106 |
| Calibration procedure(s) | QA CAL-24.v4<br>Calibration procedure for AM1D magnetic field probes and TMFS in the audio range |
| Calibration date: | December 13, 2023 |

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 | 29-Aug-23 (No. 37421) | Aug-24 |
| Reference Probe AM1DV2 | SN: 1008 | 20-Dec-22 (No. AM1DV2-1008_Dec22) | Dec-23 |
| DAE4 | SN: 781 | 03-Jan-23 (No. DAE4-781_Jan23) | Jan-24 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| AMCC | SN: 1050 | 01-Oct-13 (in house check Sep-23) | Sep-26 |
| AMMI Audio Measuring Instrument | SN: 1062 | 26-Sep-12 (in house check Sep-23) | Sep-26 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Sven Kühn | Technical Manager | |

Issued: December 13, 2023

## References


[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

[2] ANSI-C63.19-2019 (ANSI-C63.19-2011)
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

[3] DASY System Handbook


## 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 | **AM1DV3** Audio Magnetic 1D Field Probe |
| Type No | SP AM1 001 BB |
| Serial No | **3106** |

| | |
|---|---|
| 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, Zurich, Switzerland |

## Calibration data

| | | | |
|---|---|---|---|
| Connector rotation angle | (in DASY system) | **54.3** ° | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | **-0.01** ° | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz | (in DASY system) | **0.00787 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%.

Schmid & Partner Engineering AG
s p e a g
Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
www.speag.swiss, info@speag.swiss

# IMPORTANT NOTICE

## USAGE OF THE DAE4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

**Battery Exchange**: The battery cover of the DAE4 unit is fixed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

**Shipping of the DAE**: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

**E-Stop Failures**: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

**Repair**: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

**DASY Configuration Files:** Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

**Important Note:**
**Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.**

**Important Note:**
**Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.**

**Important Note:**
**To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.**

**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
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 0108**

**Client** **Sporton**
**Shenzhen City**

**Certificate No: DAE4-1664_Jun23**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SD 000 D04 BO - SN: 1664 |
| Calibration procedure(s) | QA CAL-06.v30<br>Calibration procedure for the data acquisition electronics (DAE) |
| Calibration date: | June 06, 2023 |

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 | 29-Aug-22 (No:34389) | Aug-23 |
| **Secondary Standards** | **ID #** | **Check Date (in house)** | **Scheduled Check** |
| Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 27-Jan-23 (in house check) | In house check: Jan-24 |
| Calibrator Box V2.1 | SE UMS 006 AA 1002 | 27-Jan-23 (in house check) | In house check: Jan-24 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Adrian Gehring | Laboratory Technician | |
| Approved by: | Sven Kühn | Technical Manager | |

Issued: June 6, 2023

## 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** | 404.897 ± 0.02% (k=2) | 404.795 ± 0.02% (k=2) | 405.064 ± 0.02% (k=2) |
| **Low Range** | 4.01050 ± 1.50% (k=2) | 4.00216 ± 1.50% (k=2) | 4.00196 ± 1.50% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 103.5 ° ± 1 ° |

## Appendix (Additional assessments outside the scope of SCS0108)

### 1. DC Voltage Linearity

| High Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 199996.49 | 1.23 | 0.00 |
| Channel X | + Input | 20003.73 | 1.27 | 0.01 |
| Channel X | - Input | -20000.04 | 1.60 | -0.01 |
| Channel Y | + Input | 199995.81 | 0.34 | 0.00 |
| Channel Y | + Input | 20002.06 | -0.36 | -0.00 |
| Channel Y | - Input | -20002.46 | -0.66 | 0.00 |
| Channel Z | + Input | 199995.02 | -0.07 | -0.00 |
| Channel Z | + Input | 20001.24 | -1.05 | -0.01 |
| Channel Z | - Input | -20002.15 | -0.27 | 0.00 |

| Low Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 2001.54 | 0.04 | 0.00 |
| Channel X | + Input | 201.62 | -0.05 | -0.02 |
| Channel X | - Input | -198.09 | 0.08 | -0.04 |
| Channel Y | + Input | 2001.73 | 0.37 | 0.02 |
| Channel Y | + Input | 200.69 | -0.93 | -0.46 |
| Channel Y | - Input | -199.64 | -1.44 | 0.73 |
| Channel Z | + Input | 2001.50 | 0.19 | 0.01 |
| Channel Z | + Input | 201.01 | -0.48 | -0.24 |
| Channel Z | - Input | -198.99 | -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 | -3.60 | -5.77 |
| | - 200 | 7.18 | 5.56 |
| Channel Y | 200 | 6.87 | 6.45 |
| | - 200 | -8.88 | -9.42 |
| Channel Z | 200 | 10.81 | 10.07 |
| | - 200 | -12.23 | -12.25 |

### 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 | - | 2.19 | -2.29 |
| Channel Y | 200 | 7.21 | - | 4.40 |
| Channel Z | 200 | 8.40 | 3.86 | - |

## 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** | 15994 | 15578 |
| **Channel Y** | 16016 | 16505 |
| **Channel Z** | 16025 | 13608 |

## 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** | 0.83 | -1.42 | 2.59 | 0.60 |
| **Channel Y** | -0.68 | -2.31 | 0.41 | 0.40 |
| **Channel Z** | -0.14 | -0.90 | 0.93 | 0.36 |

## 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 |

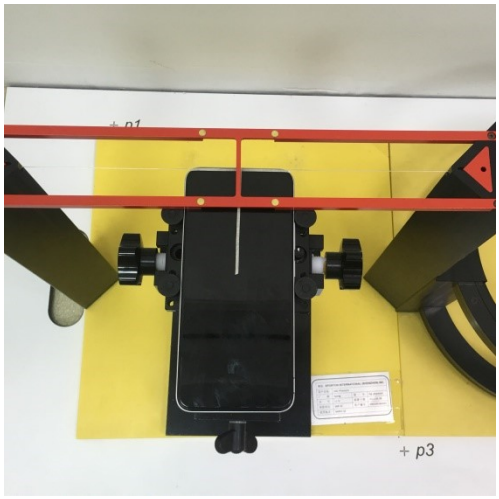
## 8. Low Battery Alarm Voltage (Typical values for information)

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

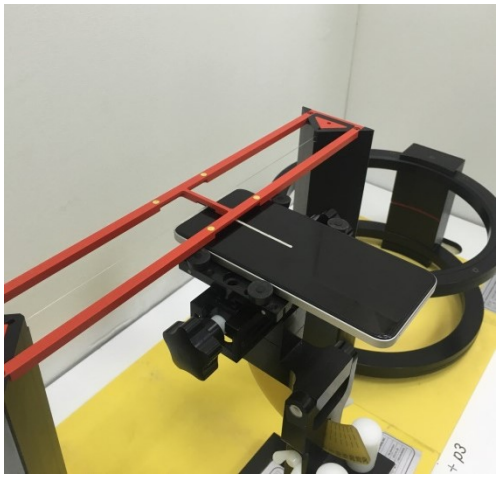
## 9. Power Consumption (Typical values for information)

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

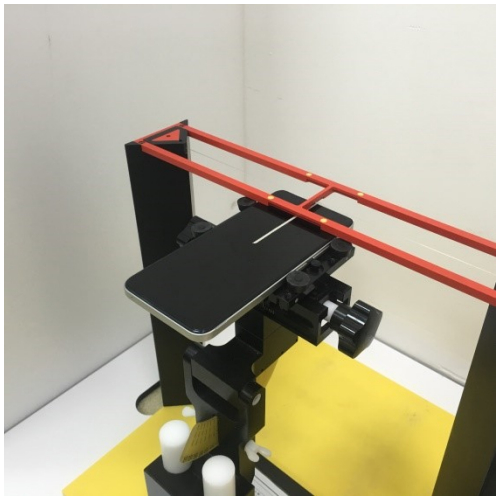
# Appendix C. Test Setup Photos




**Front View**



**Left Side View**



**Right Side View**