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**Accreditation No.: SCS 0108**

**Client** **Morlab (Auden)**

**Certificate No: DAE4-480_Apr19**

# CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BJ - SN: 480

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

Calibration date: April 11, 2019

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 | 03-Sep-18 (No:23488) | Sep-19 |
| **Secondary Standards** | **ID #** | **Check Date (in house)** | **Scheduled Check** |
| Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 07-Jan-19 (in house check) | In house check: Jan-20 |
| Calibrator Box V2.1 | SE UMS 006 AA 1002 | 07-Jan-19 (in house check) | In house check: Jan-20 |

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

Issued: April 11, 2019

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

## 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** | 404.623 ± 0.02% (k=2) | 404.069 ± 0.02% (k=2) | 404.429 ± 0.02% (k=2) |
| **Low Range** | 3.95542 ± 1.50% (k=2) | 3.94990 ± 1.50% (k=2) | 3.93793 ± 1.50% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 138.0 ° ± 1 ° |

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

### 1. DC Voltage Linearity

| High Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 200025.15 | -7.75 | -0.00 |
| Channel X | + Input | 20010.70 | 5.66 | 0.03 |
| Channel X | - Input | -20002.29 | 3.03 | -0.02 |
| Channel Y | + Input | 200031.02 | -1.68 | -0.00 |
| Channel Y | + Input | 20009.03 | 4.11 | 0.02 |
| Channel Y | - Input | -20003.75 | 1.67 | -0.01 |
| Channel Z | + Input | 200037.99 | 5.34 | 0.00 |
| Channel Z | + Input | 20008.17 | 3.28 | 0.02 |
| Channel Z | - Input | -20003.72 | 1.83 | -0.01 |

| Low Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 2000.99 | -0.02 | -0.00 |
| Channel X | + Input | 201.69 | 0.59 | 0.29 |
| Channel X | - Input | -198.21 | 0.80 | -0.40 |
| Channel Y | + Input | 2000.23 | -0.68 | -0.03 |
| Channel Y | + Input | 200.41 | -0.59 | -0.29 |
| Channel Y | - Input | -199.51 | -0.44 | 0.22 |
| Channel Z | + Input | 2001.10 | 0.17 | 0.01 |
| Channel Z | + Input | 200.14 | -0.85 | -0.42 |
| Channel Z | - Input | -200.05 | -0.99 | 0.50 |

### 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 | 6.28 | 4.13 |
| | - 200 | -2.29 | -3.80 |
| Channel Y | 200 | -1.73 | -1.78 |
| | - 200 | 0.87 | 0.61 |
| Channel Z | 200 | 10.44 | 10.41 |
| | - 200 | -12.35 | -12.37 |

### 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 | - | 3.69 | -2.19 |
| Channel Y | 200 | 8.09 | - | 3.64 |
| Channel Z | 200 | 7.06 | 5.20 | - |

## 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** | 15805 | 17908 |
| **Channel Y** | 15802 | 17649 |
| **Channel Z** | 15727 | 16748 |

## 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** | 0.94 | -0.16 | 2.05 | 0.39 |
| **Channel Y** | 0.33 | -0.86 | 1.28 | 0.45 |
| **Channel Z** | 1.53 | 0.63 | 2.34 | 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 |