

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



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Accreditation No.: **SCS 0108**

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Multilateral Agreement for the recognition of calibration certificates

Client **Sporton**
Shenzhen

Certificate No. **D6.5GHzV2-1026_Jan25**

CALIBRATION CERTIFICATE

Object **D6.5GHzV2 - SN:1026**

Calibration procedure(s) **QA CAL-22.v7**
Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: **January 28, 2025**

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
Power sensor R&S NRP33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Reference 20 dB Attenuator	SN: BH9394 (20k)	26-Mar-24 (No. 217-04046)	Mar-25
Mismatch combination	SN: 84224 / 360D	28-Mar-24 (No. 217-04050)	Mar-25
Reference Probe EX3DV4	SN: 7405	01-Jul-24 (No. EX3-7405_Jul24)	Jul-25
DAE4	SN: 908	27-Mar-24 (No. DAE4-908_Mar24)	Mar-25

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Jan-24)	In house check: Jan-25
Power sensor NRP-Z23	SN: 100169	10-Jan-19 (in house check Jan-24)	In house check: Jan-25
Power sensor NRP-18T	SN: 100950	28-Sep-22 (in house check Jan-24)	In house check: Jan-25
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Sep-24)	In house check: Sep-26

Calibrated by: **Claudio Leubler** Name: **Claudio Leubler** Function: **Laboratory Technician**

Approved by: **Sven Kühn** Name: **Sven Kühn** Function: **Technical Manager**

Signature: 


Issued: January 29, 2025

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Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range Of 4 MHz To 10 GHz)", October 2020.

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.
- The absorbed power density (APD):** The absorbed power density is evaluated according to Samaras T, Christ A, Kuster N, "Compliance assessment of the epithelial or absorbed power density above 6 GHz using SAR measurement systems", Bioelectromagnetics, 2021 (submitted). The additional evaluation uncertainty of 0.55 dB (rectangular distribution) is considered.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY6	V16.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	6500 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	34.5	6.07 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	34.6 $\pm$ 6 %	6.14 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	296 W/kg $\pm$ 24.7 % (k=2)

SAR averaged over 8 cm³ (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.68 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.8 W/kg $\pm$ 24.4 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.48 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	54.8 W/kg $\pm$ 24.4 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.9 Ω - 4.5 j Ω
Return Loss	- 26.9 dB

APD (Absorbed Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	296 W/m ²
APD measured	normalized to 1W	2960 W/m² $\pm$ 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	134 W/m ²
APD measured	normalized to 1W	1340 W/m² $\pm$ 28.9 % (k=2)

*The reported APD values have been derived using the psSAR1g and psSAR8g.

General Antenna Parameters and Design

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1026, UID 0 -, Channel 6500 (6500.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
D6.5GHz	16.0 x 6.0 x 300.0	SN: 1026	-

Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.14	6.14	34.6

Hardware Setup

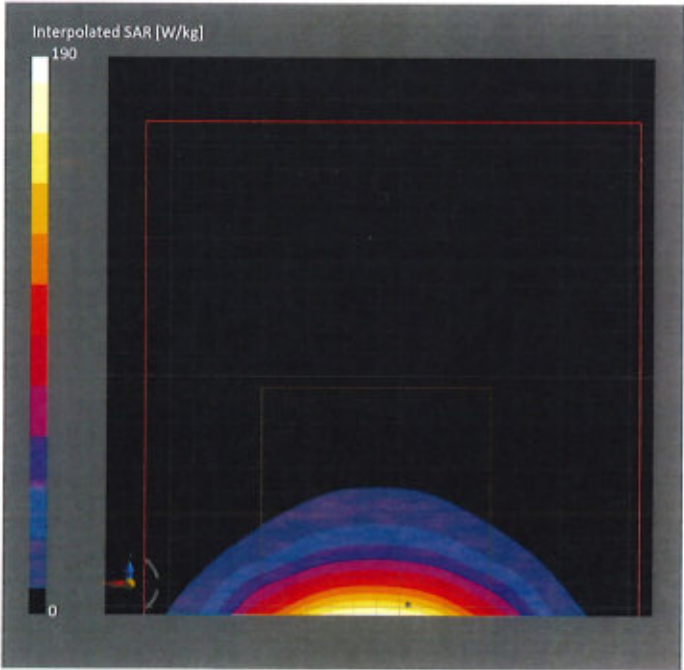
Phantom	TSL	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Center - 1182	HBBL600-10000V6	EX3DV4 - SN7405, 2024-07-01	DAE4 Sn908, 2024-03-27

Scan Setup

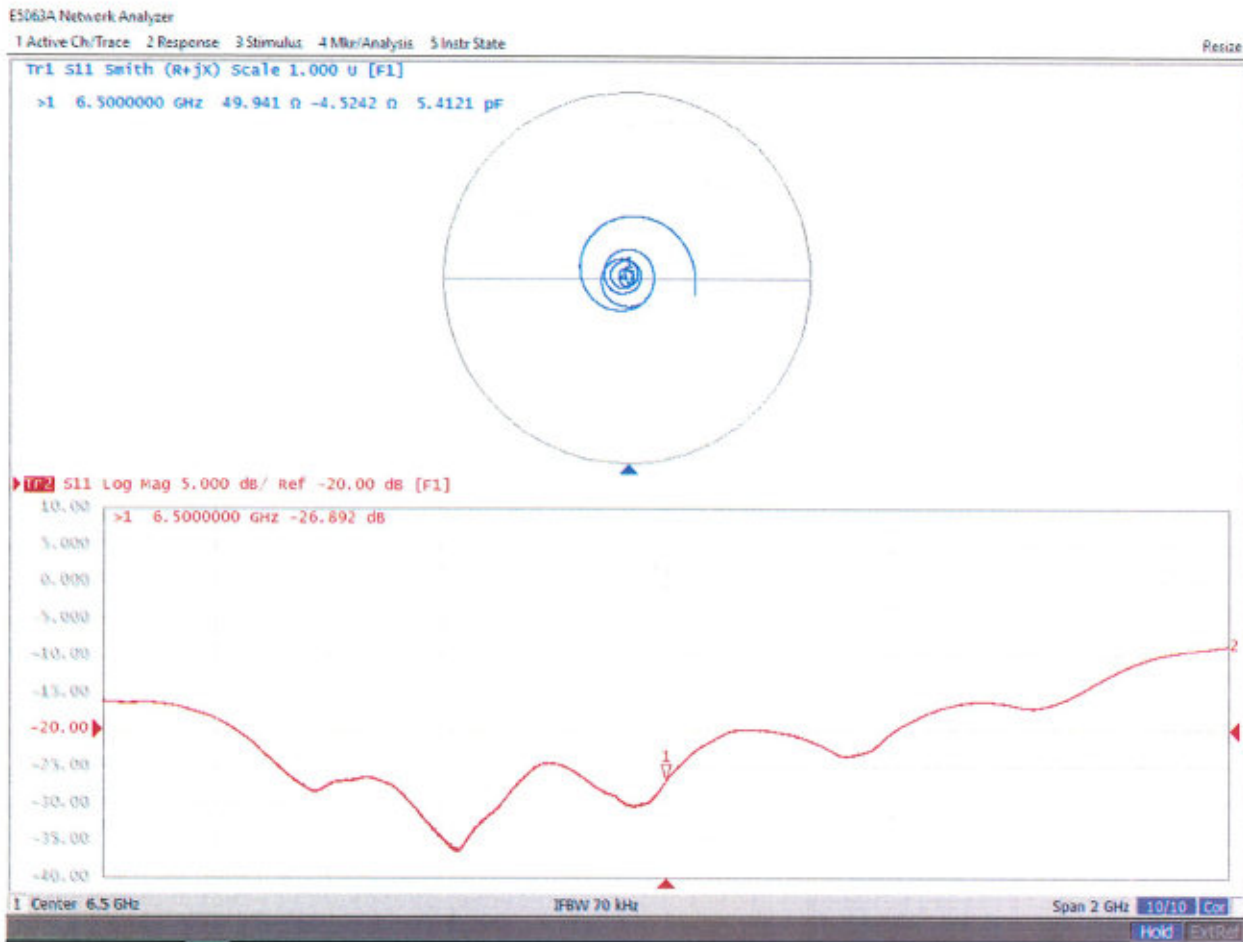
	Zoom Scan
Grid Extents [mm]	22.0 x 22.0 x 22.0
Grid Steps [mm]	3.4 x 3.4 x 1.4
Sensor Surface [mm]	1.4
Graded Grid	Yes
Grading Ratio	1.4
MAIA	N/A
Surface Detection	VMS + 6p
Scan Method	Measured

Measurement Results

	Zoom Scan
Date	2025-01-28, 10:51
psSAR1g [W/Kg]	29.6
psSAR8g [W/Kg]	6.68
psSAR10g [W/Kg]	5.48
Power Drift [dB]	-0.00
Power Scaling	Disabled
Scaling Factor [dB]	
TSL Correction	No correction
M2/M1 [%]	49.6
Dist 3dB Peak [mm]	4.8



Impedance Measurement Plot for Head TSL





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Accreditation No.: **SCS 0108**

Client

Sporton
Shenzhen

Certificate No.

5G-Veri10-2002_Feb25/2

CALIBRATION CERTIFICATE (Replacement of No: 5G-Veri10-2002_Feb25)

Object

5G Verification Source 10 GHz - SN: 2002

Calibration procedure(s)

QA CAL-45.v5
Calibration procedure for sources in air > 6 GHz

Calibration date

February 20, 2025

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 Cal
Reference Probe SPEAG EUmmWV3	SN: 9374	28-Aug-24 (No. Eumm_9374_Aug24)	Aug-25
DAE4ip	SN: 1602	06-Nov-24 (No. DAE4ip-1602_Nov24)	Nov-25

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Signal Generator R&S SMF100A	SN: 100184	26-Nov-24 (No. 5G-Source-Cal-IHC-202411)	Nov-25
Power Sensor R&S NRP18S-10	SN: 101258	26-Nov-24 (No. 5G-Source-Cal-IHC-202411)	Nov-25
Network Analyzer Keysight E5063A	SN: MY54504221	30-Sept-24 (No. 675-CAL18-S4489-Sep24)	Sep-26

	Name	Function	Signature
Calibrated by	Joanna Lleshaj	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	
Issued: March 24, 2025			
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Glossary

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45, Calibration procedure for sources in air above 6 GHz.
- IEC/IEEE 63195-1, "Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz)", May 2022

Methods Applied and Interpretation of Parameters

- *Coordinate System:* z-axis in the waveguide horn boresight, x-axis is in the direction of the E-field, y-axis normal to the others in the field scanning plane parallel to the horn flare and horn flange.
- *Measurement Conditions:* (1) 10 GHz: The radiated power is the forward power to the horn antenna minus ohmic and mismatch loss. The forward power is measured prior and after the measurement with a power sensor. During the measurements, the horn is directly connected to the cable and the antenna ohmic and mismatch losses are determined by far-field measurements. (2) 30, 45, 60 and 90 GHz: The verification sources are switched on for at least 30 minutes. Absorbers are used around the probe cub and at the ceiling to minimize reflections.
- *Horn Positioning:* The waveguide horn is mounted vertically on the flange of the waveguide source to allow vertical positioning of the EUmmW probe during the scan. The plane is parallel to the phantom surface. Probe distance is verified using mechanical gauges positioned on the flare of the horn.
- *E-field distribution:* The E-field is measured in two x-y-planes (10mm, 10mm + $\lambda/4$) with a vectorial E-field probe. The E-field value stated as calibration value represents the E-field-maxima and the averaged (1cm² and 4cm²) power density values at 10mm in front of the horn.
- *Field polarization:* Above the open horn, linear polarization of the field is expected. This is verified graphically in the field representation.

Calibrated Quantity

- Local peak E-field (V/m) and average of peak spatial components of the poynting vector (W/m²) averaged over the surface area of 1 cm² and 4cm² at the nominal operational frequency of the verification source. Both square and circular averaging results are listed.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY8 Module mmWave	V3.2
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
Number of measured planes	2 (10mm, 10mm + $\lambda/4$)	
Frequency	10.0 GHz $\pm$ 10 MHz	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	138.0	286	1.27 dB	213	169	1.28 dB

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	138.0	286	1.27 dB	212, 213, 215	167, 168, 172	1.28 dB

Square Averaging

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	138.0	286	1.27 dB	213	168	1.28 dB

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	138.0	286	1.27 dB	212, 213, 215	166, 167, 172	1.28 dB

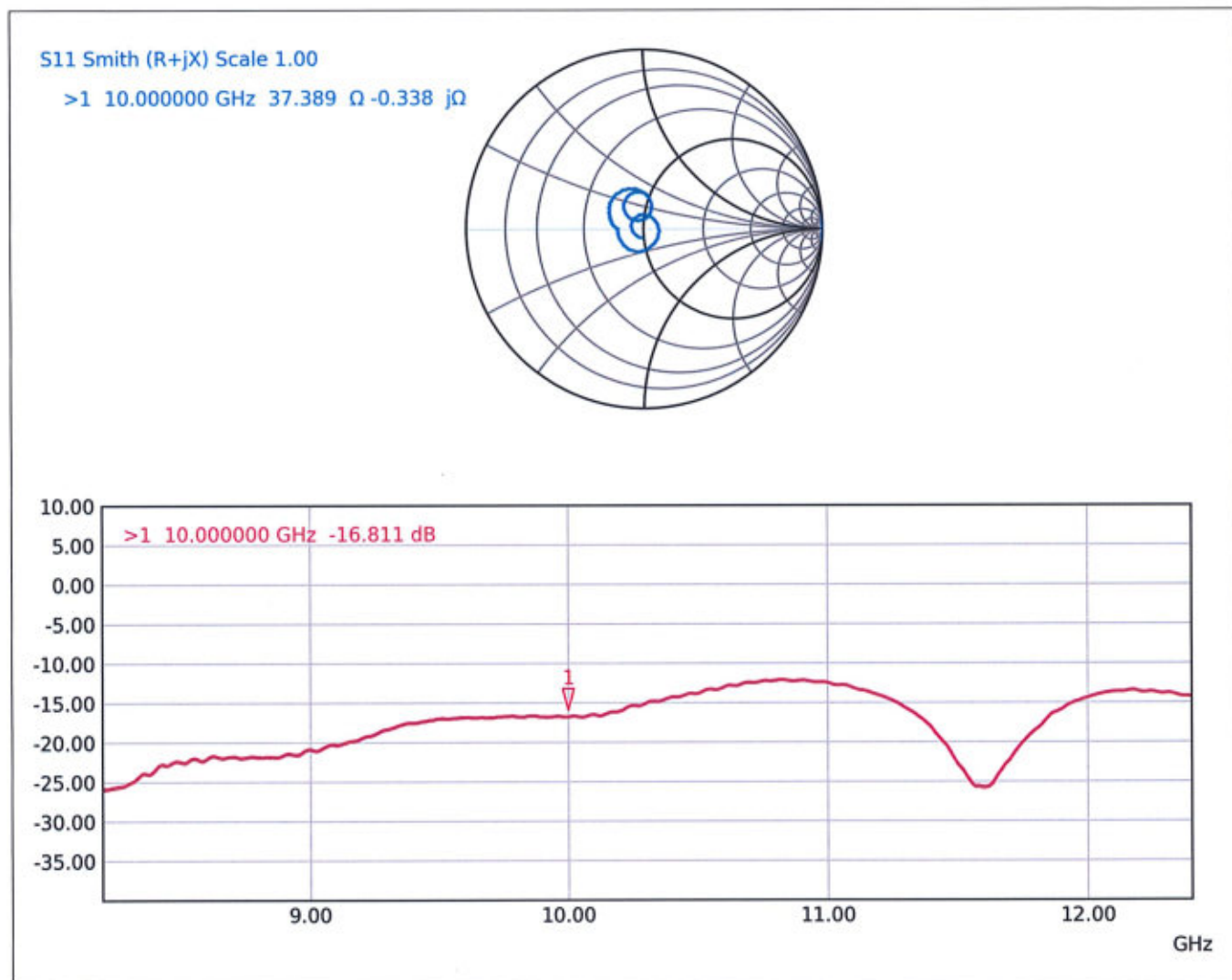
Max Power Density

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Max Power Density Sn, Stot, Stot (W/m ²)	Uncertainty (k = 2)
10 mm	138.0	286	1.27 dB	231, 232, 232	1.28 dB

¹ Assessed ohmic and mismatch loss plus numerical offset: 0.60 dB

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters**

Impedance, transformed to feed point	37.4 Ω - 0.3 j Ω
Return Loss	-16.8 dB

Impedance Measurement Plot

DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 --, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 100.0	SN: 2002	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
SG --	10.0 mm	Validation band	CW, 0--	10000.0,10000	1.0

Hardware Setup

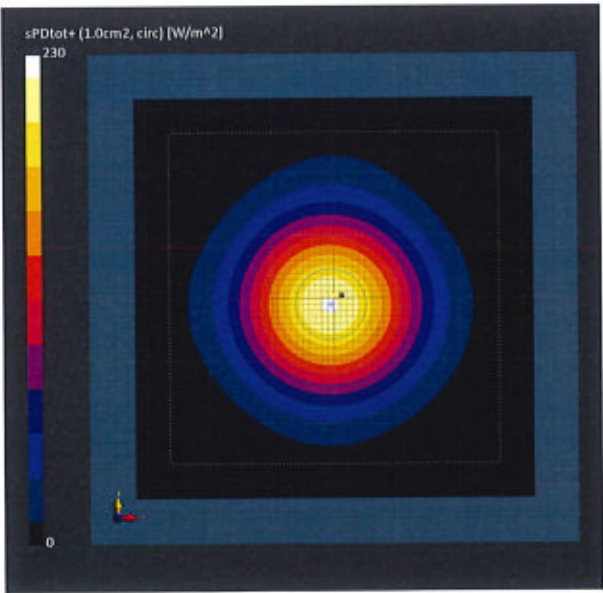
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom --	Air --	EUMmWV3 -- SN9374_F1--55GHz, 2024-08-28	DAE4ip -- SN1602, 2024-11-06

Scans Setup

Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

Scan Type	SG Scan
Date	2025-02-20
Avg. Area [cm ²]	1.00
Avg. Type	Circular Averaging
psPDn+ [W/m ²]	212
psPDtot+ [W/m ²]	213
psPDmod+ [W/m ²]	215
Max(Sn) [W/m ²]	231
Max(Stot) [W/m ²]	232
Max(Stot) [W/m ²]	232
E _{max} [V/m]	286
Power Drift [dB]	0.0



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 --, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 100.0	SN: 2002	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
SG --	10.0 mm	Validation band	CW, 0--	10000.0,10000	1.0

Hardware Setup

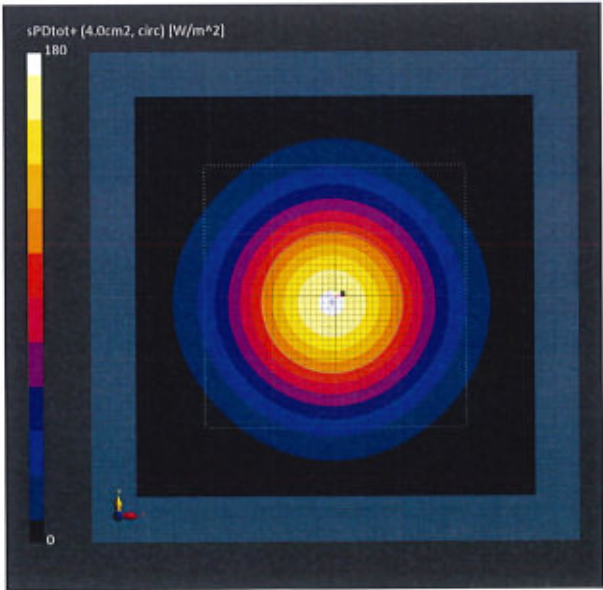
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom --	Air --	EUmmWV3 -- SN9374_F1--55GHz, 2024-08-28	DAE4ip -- SN1602, 2024-11-06

Scans Setup

Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

Scan Type	SG Scan
Date	2025-02-20
Avg. Area [cm ²]	4.00
Avg. Type	Circular Averaging
psPDn+ [W/m ²]	167
psPDtot+ [W/m ²]	168
psPDmod+ [W/m ²]	172
Max(Sn) [W/m ²]	231
Max(Stot) [W/m ²]	232
Max(Stot) [W/m ²]	232
E _{max} [V/m]	286
Power Drift [dB]	0.0



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 --, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 100.0	SN: 2002	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G --	10.0 mm	Validation band	CW, 0--	10000.0,10000	1.0

Hardware Setup

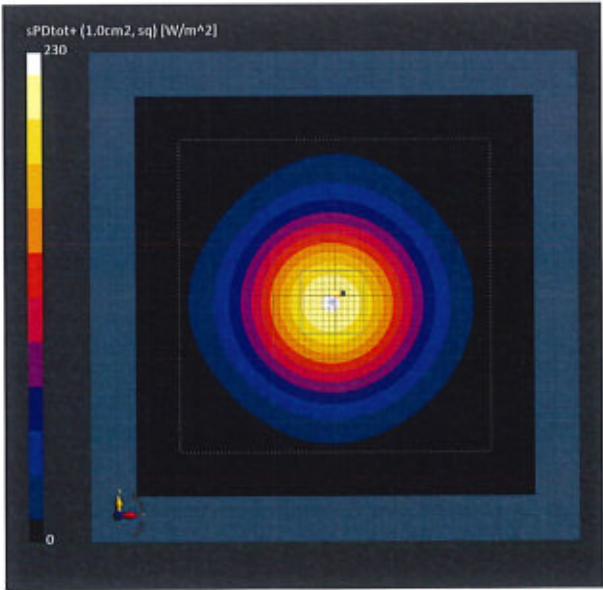
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom --	Air --	EUmmWV3 -- SN9374_F1-55GHz, 2024-08-28	DAE4ip -- SN1602, 2024-11-06

Scans Setup

Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

Scan Type	5G Scan
Date	2025-02-20
Avg. Area [cm ²]	1.00
Avg. Type	Square Averaging
psPDn+ [W/m ²]	212
psPDtot+ [W/m ²]	213
psPDmod+ [W/m ²]	215
Max(Sn) [W/m ²]	231
Max(Stot) [W/m ²]	232
Max(Stot) [W/m ²]	232
E _{max} [V/m]	286
Power Drift [dB]	0.0



DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 --, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 100.0	SN: 2002	--

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G --	10.0 mm	Validation band	CW, 0--	10000.0,10000	1.0

Hardware Setup

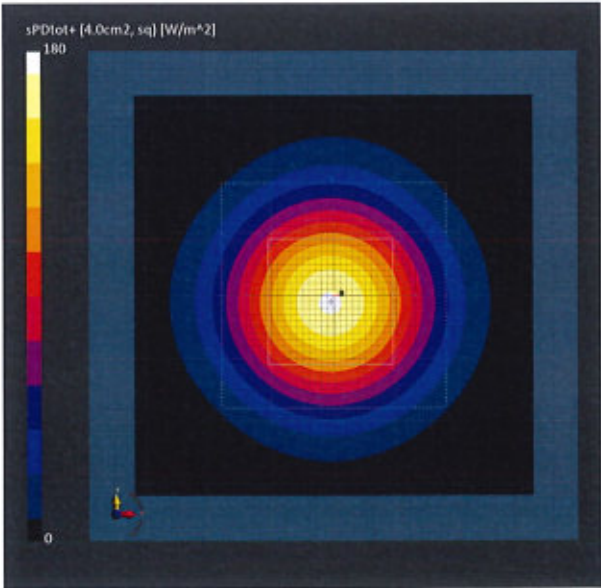
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom --	Air --	EUmmWV3 -- SN9374_F1--55GHz, 2024--08--28	DAE4lp -- SN1602, 2024--11--06

Scans Setup

Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

Scan Type	5G Scan
Date	2025--02--20
Avg. Area [cm ²]	4.00
Avg. Type	Square Averaging
psPDn+ [W/m ²]	166
psPDtot+ [W/m ²]	167
psPDmod+ [W/m ²]	172
Max(Sn) [W/m ²]	231
Max(Stot) [W/m ²]	232
Max(Stot) [W/m ²]	232
E _{max} [V/m]	286
Power Drift [dB]	0.0



IMPORTANT NOTICE

USAGE OF THE DAE4 SN: 1338

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 must be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed 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 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 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.

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Accreditation No.: **SCS 0108**

Client **Sporton**
Kunshan City

Certificate No: **DAE4-1338_Mar25**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1338**

Calibration procedure(s) **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **March 18, 2025**

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	27-Aug-24 (No:40547)	Aug-25
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	23-Jan-25 (in house check)	In house check: Jan-26
Calibrator Box V2.1	SE UMS 006 AA 1002	23-Jan-25 (in house check)	In house check: Jan-26

Calibrated by: **Name**
Adrian Gehring **Function**
Laboratory Technician

Approved by: **Sven Kühn** **Technical Manager**

Signature

Issued: March 18, 2025

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Schmid & Partner
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Zeughausstrasse 43, 8004 Zurich, Switzerland



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

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 μ V , full range = -100...+300 mV

Low Range: 1LSB = 61 nV , full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	403.704 $\pm$ 0.02% (k=2)	404.285 $\pm$ 0.02% (k=2)	404.239 $\pm$ 0.02% (k=2)
Low Range	3.97308 $\pm$ 1.50% (k=2)	3.97869 $\pm$ 1.50% (k=2)	3.97584 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	239.0 $^{\circ}$ $\pm$ 1 $^{\circ}$
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Appendix (Additional assessments outside the scope of SCS0108)**1. DC Voltage Linearity**

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199992.53	-0.29	-0.00
Channel X	+ Input	20001.00	-0.52	-0.00
Channel X	- Input	-20000.47	2.46	-0.01
Channel Y	+ Input	199989.42	-3.35	-0.00
Channel Y	+ Input	19999.32	-2.30	-0.01
Channel Y	- Input	-20004.61	-1.78	0.01
Channel Z	+ Input	199990.56	-1.87	-0.00
Channel Z	+ Input	20000.01	-1.69	-0.01
Channel Z	- Input	-20004.74	-1.78	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.46	0.18	0.01
Channel X	+ Input	200.70	0.23	0.12
Channel X	- Input	-199.07	0.31	-0.16
Channel Y	+ Input	2000.44	0.23	0.01
Channel Y	+ Input	199.92	-0.31	-0.15
Channel Y	- Input	-199.83	-0.35	0.18
Channel Z	+ Input	1999.70	-0.37	-0.02
Channel Z	+ Input	198.87	-1.31	-0.65
Channel Z	- Input	-200.96	-1.37	0.68

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	7.70	6.22
	- 200	-5.51	-6.62
Channel Y	200	-20.79	-21.30
	- 200	20.69	20.30
Channel Z	200	-3.10	-3.08
	- 200	1.18	0.72

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	-	3.71	-3.70
Channel Y	200	8.36	-	4.83
Channel Z	200	9.23	5.81	-

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	16206	15582
Channel Y	16277	15386
Channel Z	16104	15088

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	1.07	-0.06	2.70	0.43
Channel Y	-0.29	-1.54	0.58	0.38
Channel Z	-0.55	-1.50	0.19	0.35

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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IMPORTANT NOTICE

USAGE OF THE DAE4 SN: 1358

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 must be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed 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 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 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.

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Sporton**
Kunshan City

Certificate No: **DAE4-1358_Jul25**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BN - SN: 1358**

Calibration procedure(s) **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **July 15, 2025**

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	27-Aug-24 (No:40547)	Aug-25
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	23-Jan-25 (in house check)	In house check: Jan-26
Calibrator Box V2.1	SE UMS 006 AA 1002	23-Jan-25 (in house check)	In house check: Jan-26

Calibrated by: **Name** **Function**
Dominique Steffen **Laboratory Technician**

Signature

Approved by: **Sven Kühn** **Technical Manager**

Issued: July 15, 2025

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

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Accreditation No.: **SCS 0108**

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 μ V, full range = -100...+300 mV

Low Range: 1LSB = 61 nV, full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	403.469 $\pm$ 0.02% (k=2)	403.501 $\pm$ 0.02% (k=2)	403.499 $\pm$ 0.02% (k=2)
Low Range	3.96117 $\pm$ 1.50% (k=2)	3.98728 $\pm$ 1.50% (k=2)	3.99352 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	334.5 $^{\circ}$ $\pm$ 1 $^{\circ}$
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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199997.49	-0.24	-0.00
Channel X	+ Input	20005.31	2.55	0.01
Channel X	- Input	-20001.15	1.45	-0.01
Channel Y	+ Input	200000.19	2.95	0.00
Channel Y	+ Input	20003.28	0.72	0.00
Channel Y	- Input	-20003.81	-0.94	0.00
Channel Z	+ Input	200000.03	2.73	0.00
Channel Z	+ Input	20001.61	-0.92	-0.00
Channel Z	- Input	-20002.31	0.51	-0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.18	0.13	0.01
Channel X	+ Input	202.30	1.07	0.53
Channel X	- Input	-197.60	0.97	-0.49
Channel Y	+ Input	2001.06	0.14	0.01
Channel Y	+ Input	200.96	-0.05	-0.03
Channel Y	- Input	-199.28	-0.58	0.29
Channel Z	+ Input	2001.03	0.15	0.01
Channel Z	+ Input	200.00	-1.07	-0.53
Channel Z	- Input	-199.87	-1.22	0.61

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	23.05	21.62
	- 200	-19.87	-21.46
Channel Y	200	-27.28	-27.47
	- 200	26.83	26.58
Channel Z	200	-11.92	-11.89
	- 200	9.64	9.63

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	-	2.98	-3.37
Channel Y	200	8.54	-	3.84
Channel Z	200	10.07	5.84	-

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	15581	16862
Channel Y	16044	14767
Channel Z	16065	15457

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	1.30	0.08	2.48	0.43
Channel Y	-0.11	-0.85	0.83	0.36
Channel Z	-1.95	-3.18	-1.06	0.44

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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IMPORTANT NOTICE

USAGE OF THE DAE4 SN: 690

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 must be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed 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 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 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.

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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Sporton**
 Kunshan City

Certificate No: **DAE4-690_Oct25**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 690**

Calibration procedure(s) **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **October 22, 2025**

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	15-Aug-25 (No:43873)	Aug-26
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	23-Jan-25 (in house check)	In house check: Jan-26
Calibrator Box V2.1	SE UMS 006 AA 1002	23-Jan-25 (in house check)	In house check: Jan-26

Calibrated by:	Name Timo Rott	Function Laboratory Technician	Signature
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Approved by:	Sven Kühn	Technical Manager	
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Issued: October 22, 2025

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Accreditation No.: **SCS 0108**

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Multilateral Agreement for the recognition of calibration certificates

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 μ 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	404.736 $\pm$ 0.02% (k=2)	404.345 $\pm$ 0.02% (k=2)	405.304 $\pm$ 0.02% (k=2)
Low Range	3.98063 $\pm$ 1.50% (k=2)	3.99722 $\pm$ 1.50% (k=2)	3.93838 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	33.0 ° $\pm$ 1 °
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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199996.45	0.77	0.00
Channel X	+ Input	20004.96	3.04	0.02
Channel X	- Input	-20000.97	2.33	-0.01
Channel Y	+ Input	199996.02	-0.09	-0.00
Channel Y	+ Input	20001.46	-0.42	-0.00
Channel Y	- Input	-20002.81	0.58	-0.00
Channel Z	+ Input	199995.01	-1.04	-0.00
Channel Z	+ Input	20002.02	0.07	0.00
Channel Z	- Input	-20002.96	0.34	-0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.33	0.02	0.00
Channel X	+ Input	201.16	0.54	0.27
Channel X	- Input	-198.31	0.93	-0.47
Channel Y	+ Input	2000.26	0.07	0.00
Channel Y	+ Input	199.95	-0.57	-0.29
Channel Y	- Input	-200.60	-1.36	0.68
Channel Z	+ Input	2000.22	-0.12	-0.01
Channel Z	+ Input	199.50	-1.12	-0.56
Channel Z	- Input	-200.03	-0.78	0.39

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	15.65	13.78
	- 200	-12.81	-14.27
Channel Y	200	4.20	3.65
	- 200	-4.69	-5.38
Channel Z	200	2.23	1.74
	- 200	0.25	-0.73

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	-	-2.05	-2.72
Channel Y	200	7.67	-	-0.78
Channel Z	200	7.78	5.48	-

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	16110	15648
Channel Y	16060	16881
Channel Z	16014	16275

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	0.28	-0.75	2.00	0.46
Channel Y	-1.00	-2.62	-0.04	0.47
Channel Z	0.39	-1.96	2.92	0.74

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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IMPORTANT NOTICE

USAGE OF THE DAE4 SN: 1649

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 must be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed 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.

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Repair: Minor repairs are performed at no extra cost during the 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 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**
Kunshan City

Certificate No: **DAE4-1649_Aug25**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BO - SN: 1649**

Calibration procedure(s) **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **August 27, 2025**

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	15-Aug-25 (No:43873)	Aug-26
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	23-Jan-25 (in house check)	In house check: Jan-26
Calibrator Box V2.1	SE UMS 006 AA 1002	23-Jan-25 (in house check)	In house check: Jan-26

Calibrated by: **Name** **Function**
Adrian Gehring **Laboratory Technician**

Approved by: **Sven Kühn** **Technical Manager**

Signature

Issued: August 27, 2025

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



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Accreditation No.: **SCS 0108**

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 μ 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	404.686 $\pm$ 0.02% (k=2)	404.667 $\pm$ 0.02% (k=2)	404.476 $\pm$ 0.02% (k=2)
Low Range	3.95016 $\pm$ 1.50% (k=2)	3.98665 $\pm$ 1.50% (k=2)	3.97675 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	99.0 ° $\pm$ 1 °
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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199997.63	-0.47	-0.00
Channel X	+ Input	20002.33	-1.10	-0.01
Channel X	- Input	-20000.09	1.59	-0.01
Channel Y	+ Input	199997.38	-0.79	-0.00
Channel Y	+ Input	20000.28	-3.06	-0.02
Channel Y	- Input	-20003.30	-1.47	0.01
Channel Z	+ Input	199998.86	0.22	0.00
Channel Z	+ Input	20000.51	-2.78	-0.01
Channel Z	- Input	-20003.73	-1.86	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.95	0.19	0.01
Channel X	+ Input	202.70	0.76	0.38
Channel X	- Input	-197.21	0.54	-0.27
Channel Y	+ Input	2001.65	-0.08	-0.00
Channel Y	+ Input	200.95	-0.82	-0.40
Channel Y	- Input	-198.63	-0.77	0.39
Channel Z	+ Input	2001.77	0.16	0.01
Channel Z	+ Input	201.25	-0.57	-0.28
Channel Z	- Input	-198.50	-0.60	0.30

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	3.59	2.19
	- 200	-0.67	-2.40
Channel Y	200	-7.24	-6.97
	- 200	4.99	4.61
Channel Z	200	0.34	0.26
	- 200	-1.95	-1.67

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	-	0.30	-3.48
Channel Y	200	6.92	-	2.52
Channel Z	200	10.37	3.75	-

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	15986	15781
Channel Y	16054	16165
Channel Z	16191	16667

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	0.97	-0.33	1.69	0.35
Channel Y	-0.46	-1.58	1.10	0.43
Channel Z	-0.43	-1.47	0.81	0.41

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

IMPORTANT NOTICE

USAGE OF THE DAE4 SN: 1691

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 must be given to the following points:

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

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