Validation Report
No. VAL_0284_EF 2019-11

Kind of doc.:
QM Template

EUROFINS PRODUCT SERVICE GmbH
Storkower Str. 38c, 15526 Reichenwalde, Germany

5 Results

5.1 General:

(e.g. measurement results, user instructions such as handling, transport, storage, preparation; checks to be made before the work started; information about how to install (operations)-, to maintain-, to train and to use; safety measures etc.)

	Original measurement	Verification measurement	Margin
Impedance, transformend to feed point	46.3 Ω + 8.6 jΩ	48.28 Ω + 4.9 jΩ	2.02 Ω – 4.3jΩ
Return Loss	-20.2 dB	-25.58 dB	-5.56 dB
Tissue Validation εr	52.7	52.492	-0.39 %
Tissue Validation σ [S/m]	1.95	2.01	3.08 %
System validation	13.0 W/kg (1g)	12.8 W/kg (1g)	5.82 %
Date:	04.09.2018	07.11.2019	

5.2 Measurement uncertainty

The reported expanded uncertainty of measurement is stated as the standard uncertainty multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.
+/- 2.5 %

5.3 Results of Validation

Validated ☒
Not validated ☐

6 Operator

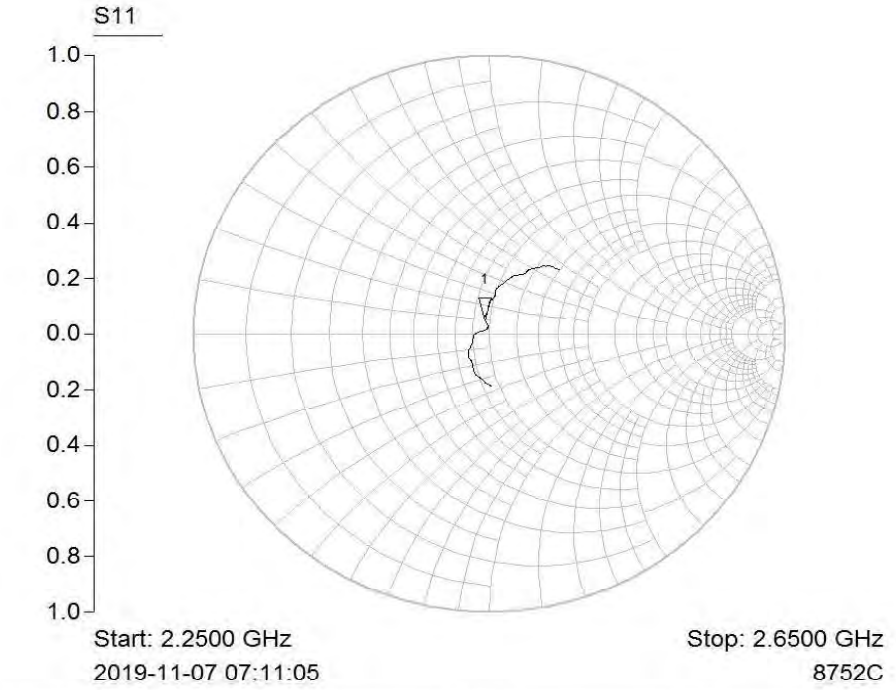
Pudell
Name

Signature B. Pudell

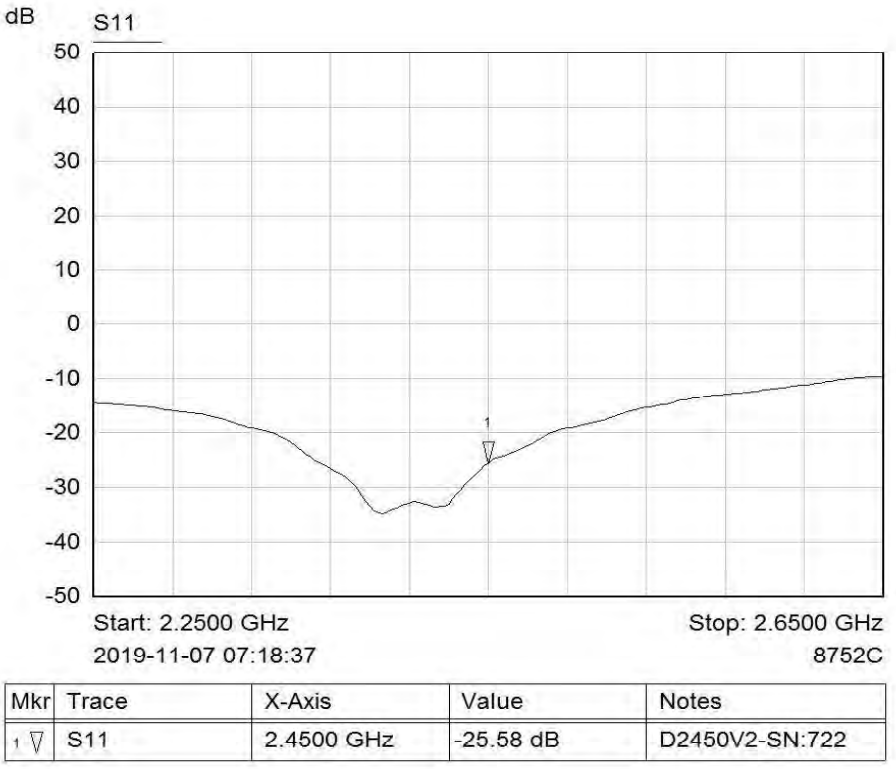
Place and Date of Verification: Reichenwalde, 07.11.2019

Attachment:

Impedance, Return Loss, System validierung



Mkr	Trace	X-Axis	Value	Notes
1 ▽	S11	2.4500 GHz	48.28 + j4.89 ohms	D2450V2-SN:722



Mkr	Trace	X-Axis	Value	Notes
1 ▽	S11	2.4500 GHz	-25.58 dB	D2450V2-SN:722

EUROFINS PRODUCT SERVICE GmbH
Storkower Str. 38c, 15526 Reichenwalde, Germany

Date/Time: 07.11.2019 08:20:45

Test Laboratory: Eurofins Product Service GmbH

Dipol Valid.2450 (m)_250mW ELI4_07.11.2019

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: SN: 722

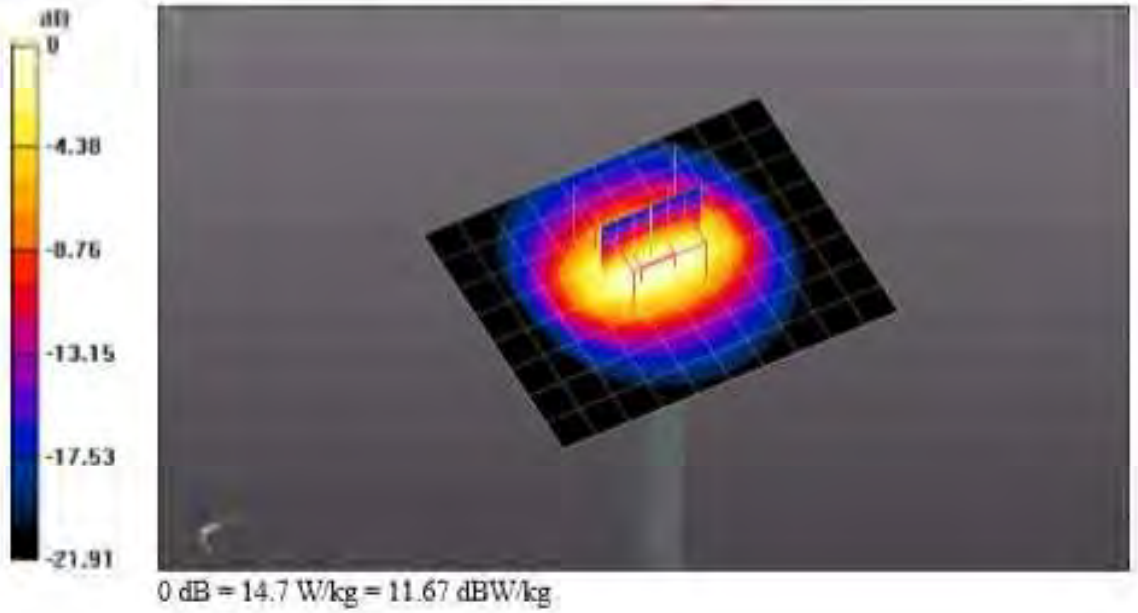
Communication System: UID 0, CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2450 MHz; σ = 2.011 S/m; ε_r = 52.492; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(7.79, 7.79, 7.79) @ 2450 MHz; Calibrated: 20.09.2019
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 11.09.2019
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1013
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7470)

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Area Scan (9x11x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 16.2 W/kg

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 78.85 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 26.6 W/kg
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.87 W/kg
Maximum value of SAR (measured) = 14.7 W/kg



0 dB = 14.7 W/kg = 11.67 dBW/kg

Calibration Laboratory of
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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 **Eurofins**

Certificate No: DAE3-522_Sep18

CALIBRATION CERTIFICATE

Object: DAE3 - SD 000 D03 AA - SN: 522

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

Calibration date: September 17, 2018

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 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	04-Jan-18 (in house check)	In house check: Jan-19
Calibrator Box V2.1	SE UMS 006 AA 1002	04-Jan-18 (in house check)	In house check: Jan-19

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

Issued: September 17, 2018

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	404.479 ± 0.02% (k=2)	404.153 ± 0.02% (k=2)	404.993 ± 0.02% (k=2)
Low Range	3.95965 ± 1.50% (k=2)	3.93902 ± 1.50% (k=2)	3.99701 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	327.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200000.93	2.49	0.00
Channel X	+ Input	20003.02	1.18	0.01
Channel X	- Input	-20000.43	1.21	-0.01
Channel Y	+ Input	200000.57	2.19	0.00
Channel Y	+ Input	20001.94	0.18	0.00
Channel Y	- Input	-20002.78	-1.04	0.01
Channel Z	+ Input	199997.72	-1.25	-0.00
Channel Z	+ Input	20000.11	-1.62	-0.01
Channel Z	- Input	-20003.62	-1.73	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.45	-0.77	-0.04
Channel X	+ Input	201.58	0.14	0.07
Channel X	- Input	-197.77	0.63	-0.32
Channel Y	+ Input	2000.43	-0.72	-0.04
Channel Y	+ Input	200.83	-0.57	-0.28
Channel Y	- Input	-197.79	0.68	-0.34
Channel Z	+ Input	2001.66	0.63	0.03
Channel Z	+ Input	200.31	-1.07	-0.53
Channel Z	- Input	-200.03	-1.38	0.70

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	-3.80	-5.29
	- 200	6.14	4.50
Channel Y	200	-2.04	-2.59
	- 200	1.39	1.67
Channel Z	200	15.93	16.20
	- 200	-17.00	-17.81

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	-	-0.12	-4.75
Channel Y	200	7.03	-	1.00
Channel Z	200	8.67	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	15771	17023
Channel Y	15724	15708
Channel Z	16045	14942

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	0.18	-2.21	2.02	0.68
Channel Y	-1.24	-2.88	0.22	0.58
Channel Z	-0.67	-2.91	1.12	0.63

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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CUSTOMER COPY

DAE REPAIR REPORT – SPEAG Production Center

PRODUCT	DAE3 - Data Acquisition Electronics		
SERIAL Nr.:	SN 522	IN DATE:	3-Sep-2018
CUSTOMER:	Eurofins		

DAE REPAIR MATERIAL	WORK DESCRIPTION						WORKING TIME (h)	
Emergency stop:	fixed	O	exchanged	O	6 new magnets	O		hours
DAE Connector:	fixed	O	exchanged	X	.....	O	0.50	hours
DAE Battery Cover:	fixed	O	exchanged	O	.....	O		hours
AD Converter Print:	fixed	O	exchanged	O	.....	O		hours
Battery Connector:	fixed	O	exchanged	O	.....	O		hours
Battery Con. PCB:	fixed	O	exchanged	O	.....	O		hours
Modification B-C	fixed	O	exchanged	O	.....	O		hours
Logic PCB:	fixed	O	exchanged	O	.....	O		hours
Input PCB:	fixed	O	exchanged	O	.....	O		hours
Analysis:							1.50	hours
Final Assembly:								hours
Total hours							2.00	hours

COMMENTS: This DAE was returned to SPEAG for calibration. The initial inspection found one broken pin in the DAE probe connector. Since there was only a single pin broken and the other pins remained straight, we consider this breakage a fatigue breakage. The connector has therefore been replaced for free. The DAE will be newly calibrated after this repair.

CONDUCTED BY:		APPROVED BY:	
DATE:	13-Sep-2018	DATE:	13-Sep-2018

REPAIR COST:

		USD	Euro
MATERIAL COST:	free	O	O
REPAIR:	free	O	O

TOTAL COST: free	QUOTATION #: -

APPROVED BY:	
DATE:	13-Sep-2018

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IMPORTANT NOTICE

USAGE OF THE DAE 3

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 DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply outmost caution not to bend or damage the connector when changing batteries.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration the customer shall 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 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, 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
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Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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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 Eurofins

Certificate No: DAE3-522_Sep19

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 522
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	September 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-19 (No:25949)	Sep-20
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:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: September 11, 2019

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	404.466 ± 0.02% (k=2)	404.137 ± 0.02% (k=2)	404.986 ± 0.02% (k=2)
Low Range	3.95998 ± 1.50% (k=2)	3.94027 ± 1.50% (k=2)	3.99746 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	327.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200036.62	-2.59	-0.00
Channel X	+ Input	20008.76	2.53	0.01
Channel X	- Input	-20003.81	2.10	-0.01
Channel Y	+ Input	200040.05	-0.17	-0.00
Channel Y	+ Input	20005.09	-1.06	-0.01
Channel Y	- Input	-20006.72	-0.61	0.00
Channel Z	+ Input	200037.47	-1.41	-0.00
Channel Z	+ Input	20005.33	-0.80	-0.00
Channel Z	- Input	-20006.69	-0.55	0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2002.34	0.91	0.05
Channel X	+ Input	201.04	-0.31	-0.15
Channel X	- Input	-198.29	0.24	-0.12
Channel Y	+ Input	2001.93	0.70	0.03
Channel Y	+ Input	201.25	0.14	0.07
Channel Y	- Input	-198.96	-0.23	0.12
Channel Z	+ Input	2001.67	0.44	0.02
Channel Z	+ Input	200.99	-0.14	-0.07
Channel Z	- Input	-199.81	-1.20	0.60

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	-3.87	-4.98
	- 200	6.29	4.56
Channel Y	200	0.53	-0.36
	- 200	-1.17	-0.60
Channel Z	200	15.87	16.15
	- 200	-17.32	-18.14

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	-	-0.36	-4.25
Channel Y	200	7.64	-	1.04
Channel Z	200	9.49	5.41	-

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	15761	16023
Channel Y	15720	15278
Channel Z	16038	14273

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	0.18	-1.44	1.89	0.62
Channel Y	-0.82	-2.10	0.64	0.55
Channel Z	0.99	-0.48	2.49	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

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IMPORTANT NOTICE

USAGE OF THE DAE3

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 DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply outmost caution not to bend or damage the connector when changing batteries.

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 exa ct 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.