

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	45.5 $\Omega$ - 12.4 $j\Omega$
Return Loss	- 17.3 dB

### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	52.1 $\Omega$ - 10.7 $j\Omega$
Return Loss	- 19.5 dB

### Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	51.6 $\Omega$ - 12.5 $j\Omega$
Return Loss	- 18.2 dB

### Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	46.9 $\Omega$ - 11.2 $j\Omega$
Return Loss	- 18.5 dB

### Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	53.0 $\Omega$ - 8.6 $j\Omega$
Return Loss	- 21.1 dB

### Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	54.4 $\Omega$ - 11.5 $j\Omega$
Return Loss	- 18.6 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.200 ns
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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
Manufactured on	October 30, 2013

# DASY5 Validation Report for Head TSL

Date: 20.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1167**

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz  
Medium parameters used:  $f = 5250 \text{ MHz}$ ;  $\sigma = 4.55 \text{ S/m}$ ;  $\epsilon_r = 34.4$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5600 \text{ MHz}$ ;  $\sigma = 4.89 \text{ S/m}$ ;  $\epsilon_r = 33.9$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5750 \text{ MHz}$ ;  $\sigma = 5.04 \text{ S/m}$ ;  $\epsilon_r = 33.7$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.45, 5.45, 5.45); Calibrated: 30.12.2014, ConvF(4.92, 4.92, 4.92); Calibrated: 30.12.2014, ConvF(4.91, 4.91, 4.91); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 66.19 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 29.4 W/kg

**SAR(1 g) = 8.13 W/kg; SAR(10 g) = 2.34 W/kg**

Maximum value of SAR (measured) = 18.3 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 65.81 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 32.5 W/kg

**SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.37 W/kg**

Maximum value of SAR (measured) = 19.6 W/kg

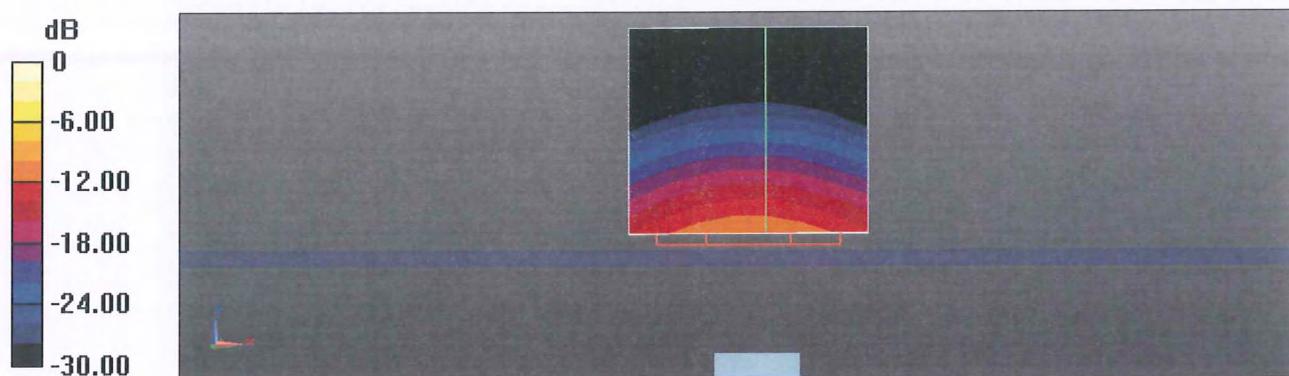
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 63.40 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 31.9 W/kg

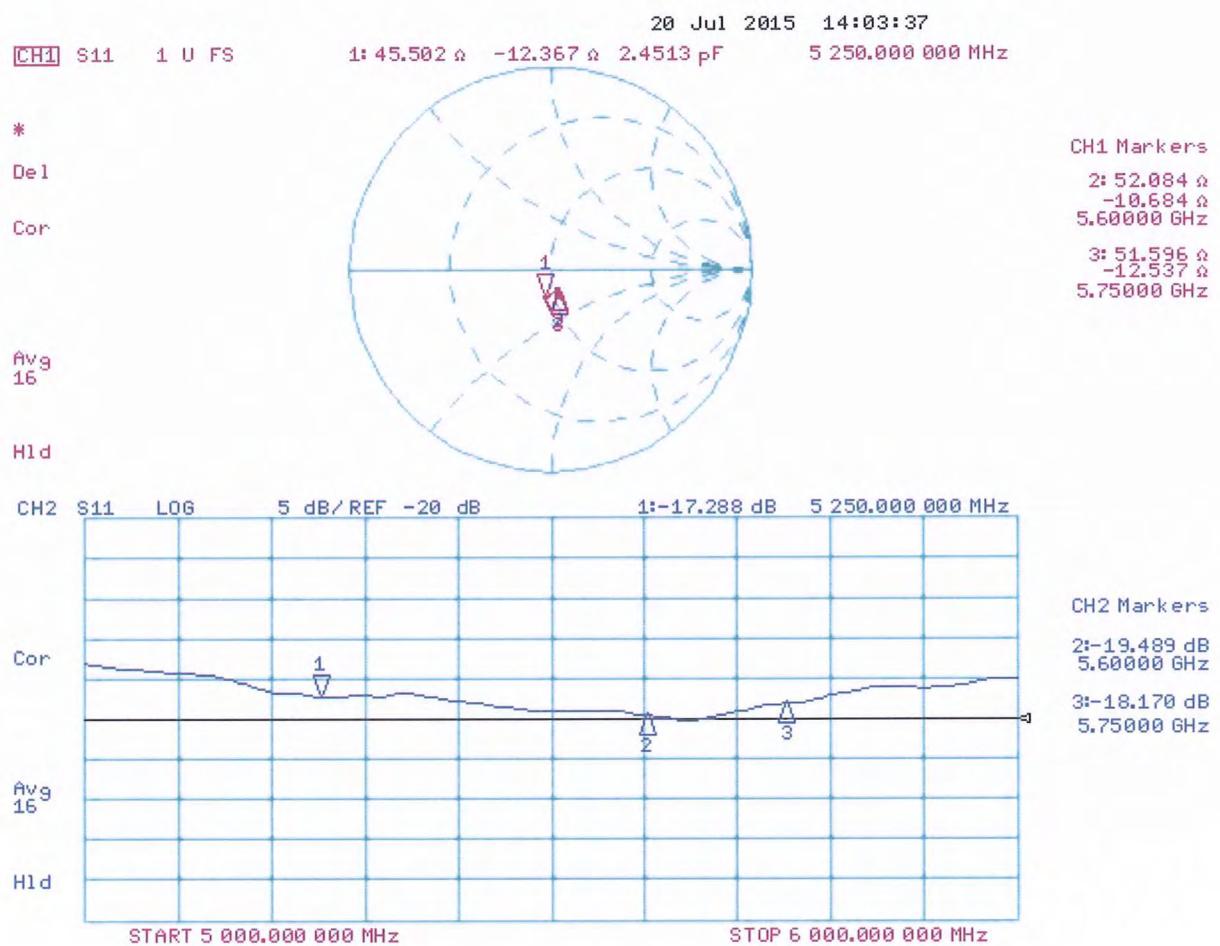
**SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.27 W/kg**

Maximum value of SAR (measured) = 18.9 W/kg



$$0 \text{ dB} = 18.9 \text{ W/kg} = 12.76 \text{ dBW/kg}$$

## Impedance Measurement Plot for Head TSL



# DASY5 Validation Report for Body TSL

Date: 27.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1167**

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz  
Medium parameters used:  $f = 5250 \text{ MHz}$ ;  $\sigma = 5.53 \text{ S/m}$ ;  $\epsilon_r = 47$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5600 \text{ MHz}$ ;  $\sigma = 6 \text{ S/m}$ ;  $\epsilon_r = 46.3$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5750 \text{ MHz}$ ;  $\sigma = 6.22 \text{ S/m}$ ;  $\epsilon_r = 46.1$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.9, 4.9, 4.9); Calibrated: 30.12.2014, ConvF(4.35, 4.35, 4.35);  
Calibrated: 30.12.2014, ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 59.45 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 30.1 W/kg

**SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.15 W/kg**

Maximum value of SAR (measured) = 18.0 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 58.75 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 35.1 W/kg

**SAR(1 g) = 8.12 W/kg; SAR(10 g) = 2.25 W/kg**

Maximum value of SAR (measured) = 19.7 W/kg

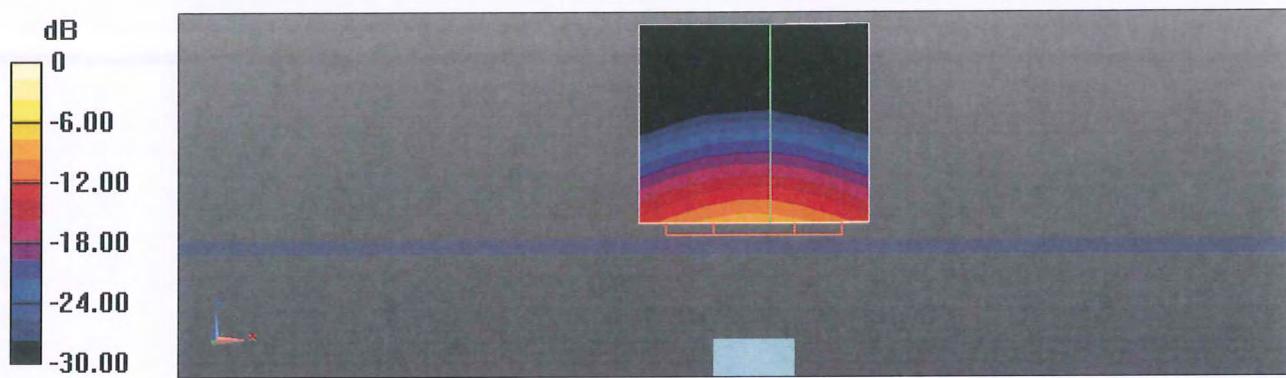
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 55.94 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 34.5 W/kg

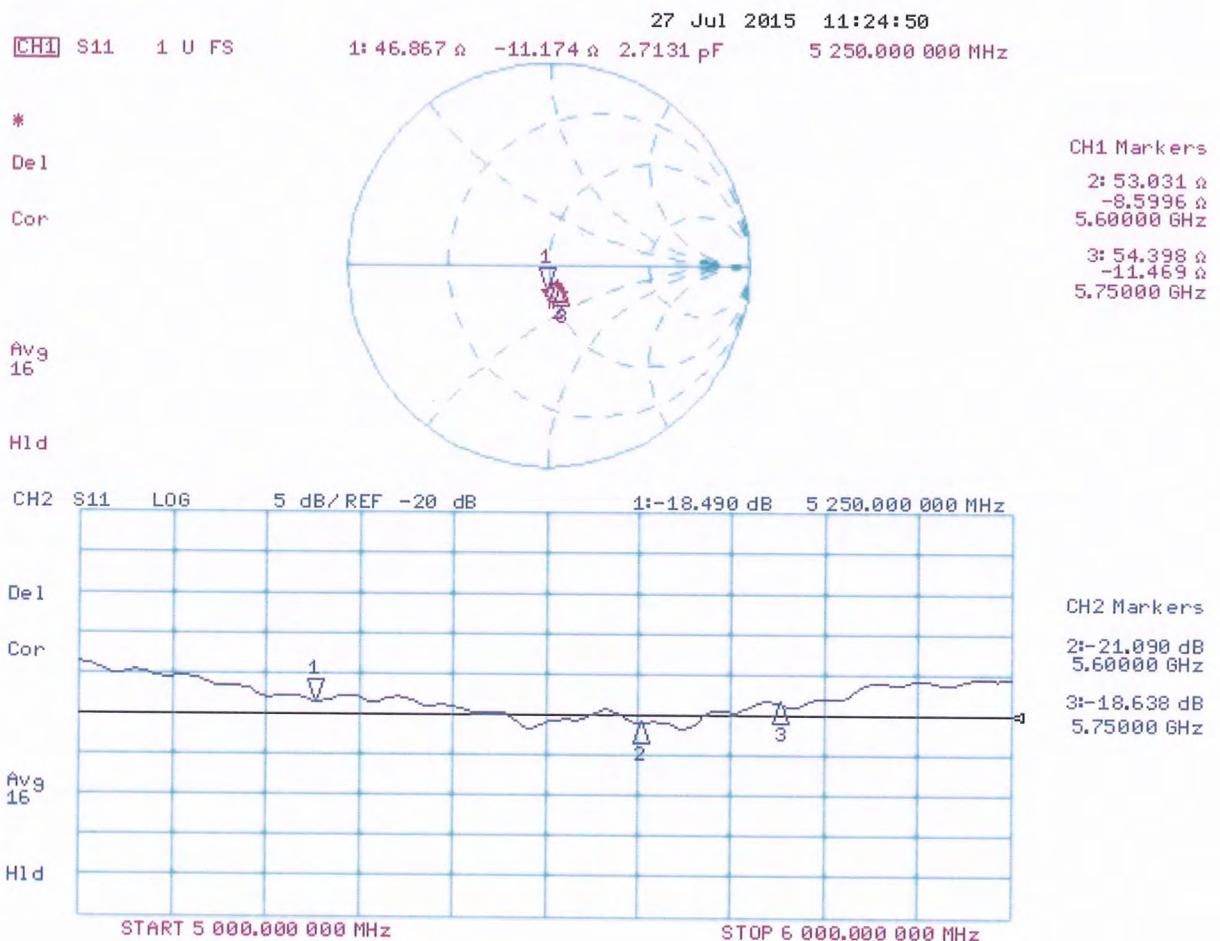
**SAR(1 g) = 7.62 W/kg; SAR(10 g) = 2.11 W/kg**

Maximum value of SAR (measured) = 18.7 W/kg



$$0 \text{ dB} = 18.7 \text{ W/kg} = 12.72 \text{ dBW/kg}$$

## Impedance Measurement Plot for Body TSL



914

## IMPORTANT NOTICE

### USAGE OF THE DAE 4

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 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 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 M $\Omega$  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.**



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 Multilateral Agreement for the recognition of calibration certificates

Client **Auden**

Accreditation No.: **SCS 0108**

Certificate No: **DAE4-914\_Jan16**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BK - SN: 914**

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

Calibration date: **January 07, 2016**

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	09-Sep-15 (No:17153)	Sep-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-16 (in house check)	In house check: Jan-17
Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-16 (in house check)	In house check: Jan-17

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

Issued: January 7, 2016

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



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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 =  $6.1\mu\text{V}$  , full range =  $-100...+300\text{ mV}$

Low Range: 1LSB =  $61\text{nV}$  , full range =  $-1.....+3\text{mV}$

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

Calibration Factors	X	Y	Z
High Range	$405.024 \pm 0.02\% \text{ (k=2)}$	$404.222 \pm 0.02\% \text{ (k=2)}$	$403.803 \pm 0.02\% \text{ (k=2)}$
Low Range	$3.99003 \pm 1.50\% \text{ (k=2)}$	$3.98754 \pm 1.50\% \text{ (k=2)}$	$3.98947 \pm 1.50\% \text{ (k=2)}$

## Connector Angle

Connector Angle to be used in DASY system	$63.5^\circ \pm 1^\circ$
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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	200025.25	-6.23	-0.00
Channel X	+ Input	20003.31	-0.90	-0.00
Channel X	- Input	-20002.82	2.18	-0.01
Channel Y	+ Input	200027.17	-4.52	-0.00
Channel Y	+ Input	20001.38	-2.72	-0.01
Channel Y	- Input	-20006.40	-1.25	0.01
Channel Z	+ Input	200030.04	-1.76	-0.00
Channel Z	+ Input	20000.65	-3.37	-0.02
Channel Z	- Input	-20006.66	-1.45	0.01

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2000.55	-0.24	-0.01
Channel X	+ Input	200.60	-0.28	-0.14
Channel X	- Input	-199.11	0.02	-0.01
Channel Y	+ Input	2000.45	-0.25	-0.01
Channel Y	+ Input	200.18	-0.64	-0.32
Channel Y	- Input	-200.07	-0.82	0.41
Channel Z	+ Input	2000.64	0.02	0.00
Channel Z	+ Input	199.79	-0.89	-0.44
Channel Z	- Input	-200.51	-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	-12.39	-14.33
	-200	15.37	13.59
Channel Y	200	-5.04	-5.76
	-200	4.74	4.11
Channel Z	200	5.26	5.29
	-200	-7.05	-7.88

### 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	-	2.80	-4.55
Channel Y	200	7.46	-	2.27
Channel Z	200	9.82	6.12	-

#### 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	16120	13481
Channel Y	16152	16047
Channel Z	16020	15100

#### 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	0.63	-0.53	2.61	0.40
Channel Y	0.30	-1.10	1.51	0.48
Channel Z	-0.02	-1.03	1.18	0.40

#### 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 DAE 4**

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**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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**Important Note:**

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**Important Note:**

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**Important Note:**

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Client **Sporton-SZ (Auden)**

Certificate No: **DAE4-1338\_Nov15**

## CALIBRATION CERTIFICATE

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

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

Calibration date: **November 23, 2015**

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 ( $22 \pm 3$ )°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	09-Sep-15 (No:17153)	Sep-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	06-Jan-15 (in house check)	In house check: Jan-16
Calibrator Box V2.1	SE UMS 006 AA 1002	06-Jan-15 (in house check)	In house check: Jan-16

Calibrated by:	Name	Function	Signature
	R.Mayoraz	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: November 23, 2015

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Accreditation No.: SCS 0108

## Glossary

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  - *Common mode sensitivity*: Influence of a positive or negative common mode voltage on the differential measurement.
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  - *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 =  $6.1\mu\text{V}$ , full range =  $-100...+300\text{ mV}$

Low Range: 1LSB =  $61\text{nV}$ , full range =  $-1.....+3\text{mV}$

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

Calibration Factors	X	Y	Z
High Range	$403.662 \pm 0.02\% \text{ (k=2)}$	$404.235 \pm 0.02\% \text{ (k=2)}$	$404.194 \pm 0.02\% \text{ (k=2)}$
Low Range	$3.97130 \pm 1.50\% \text{ (k=2)}$	$3.97825 \pm 1.50\% \text{ (k=2)}$	$3.97412 \pm 1.50\% \text{ (k=2)}$

## Connector Angle

Connector Angle to be used in DASY system	$62.0^\circ \pm 1^\circ$
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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	199994.84	-1.56	-0.00
Channel X	+ Input	20001.54	-0.10	-0.00
Channel X	- Input	-19998.47	2.04	-0.01
Channel Y	+ Input	199993.67	-2.48	-0.00
Channel Y	+ Input	19999.70	-1.90	-0.01
Channel Y	- Input	-20002.82	-2.26	0.01
Channel Z	+ Input	199995.95	-0.55	-0.00
Channel Z	+ Input	20000.88	-0.58	-0.00
Channel Z	- Input	-20002.95	-2.33	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.37	-0.14	-0.01
Channel X	+ Input	201.69	-0.16	-0.08
Channel X	- Input	-197.50	0.60	-0.30
Channel Y	+ Input	2001.29	-0.22	-0.01
Channel Y	+ Input	200.52	-1.30	-0.64
Channel Y	- Input	-199.22	-1.12	0.57
Channel Z	+ Input	2001.23	-0.22	-0.01
Channel Z	+ Input	201.13	-0.51	-0.25
Channel Z	- Input	-198.97	-0.75	0.38

### 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	7.57	6.22
	-200	-5.91	-6.92
Channel Y	200	-21.79	-21.83
	-200	19.87	19.54
Channel Z	200	-1.99	-2.50
	-200	1.07	0.74

### 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	-	3.36	-3.29
Channel Y	200	8.54	-	5.39
Channel Z	200	9.72	5.56	-

#### 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	16209	15622
Channel Y	16284	15842
Channel Z	16115	15938

#### 5. Input Offset Measurement

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

Input  $10M\Omega$

	Average ( $\mu V$ )	min. Offset ( $\mu V$ )	max. Offset ( $\mu V$ )	Std. Deviation ( $\mu V$ )
Channel X	-0.14	-1.38	1.34	0.57
Channel Y	-0.88	-1.78	0.19	0.43
Channel Z	-0.31	-1.48	1.02	0.43

#### 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

1386

## IMPORTANT NOTICE

### USAGE OF THE DAE 4

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 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 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 M $\Omega$  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.**



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

The Swiss Accreditation Service is one of the signatories to the EA  
 Multilateral Agreement for the recognition of calibration certificates

Client **Sporton - SZ (Auden)**

Certificate No: **DAE4-1386\_Feb16**

## **CALIBRATION CERTIFICATE**

Object **DAE4 - SD 000 D04 BM - SN: 1386**

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

Calibration date: **February 16, 2016**

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	09-Sep-15 (No:17153)	Sep-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-16 (in house check)	In house check: Jan-17
Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-16 (in house check)	In house check: Jan-17

Calibrated by: **Name** **Function** **Signature**  
 Eric Hainfeld Technician

Approved by: **Fin Bomholt** **Deputy Technical Manager**

Issued: February 16, 2016

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



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**

## 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 =  $6.1\mu\text{V}$ , full range = -100...+300 mV

Low Range: 1LSB =  $61\text{nV}$ , full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	$404.500 \pm 0.02\% \text{ (k=2)}$	$404.594 \pm 0.02\% \text{ (k=2)}$	$404.110 \pm 0.02\% \text{ (k=2)}$
Low Range	$4.01903 \pm 1.50\% \text{ (k=2)}$	$4.01362 \pm 1.50\% \text{ (k=2)}$	$4.01168 \pm 1.50\% \text{ (k=2)}$

## Connector Angle

Connector Angle to be used in DASY system	$332.5^\circ \pm 1^\circ$
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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	199994.02	1.15	0.00
Channel X	+ Input	20001.95	0.55	0.00
Channel X	- Input	-19999.57	0.87	-0.00
Channel Y	+ Input	199993.78	0.08	0.00
Channel Y	+ Input	20000.41	-0.91	-0.00
Channel Y	- Input	-20001.87	-1.32	0.01
Channel Z	+ Input	199991.70	-1.76	-0.00
Channel Z	+ Input	20000.56	-0.65	-0.00
Channel Z	- Input	-20000.99	-0.35	0.00

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2001.30	-0.02	-0.00
Channel X	+ Input	202.01	0.19	0.09
Channel X	- Input	-197.81	0.17	-0.08
Channel Y	+ Input	2001.46	0.09	0.00
Channel Y	+ Input	201.04	-0.73	-0.36
Channel Y	- Input	-198.97	-0.92	0.47
Channel Z	+ Input	2001.01	-0.25	-0.01
Channel Z	+ Input	201.14	-0.53	-0.26
Channel Z	- Input	-199.03	-0.83	0.42

### 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	-17.22
	-200	18.08	16.87
Channel Y	200	-9.43	-9.88
	-200	7.82	7.49
Channel Z	200	-6.03	-5.67
	-200	3.95	3.98

### 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	-	4.24	-2.97
Channel Y	200	8.83	-	6.74
Channel Z	200	8.43	6.41	-

#### 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	16017	15176
Channel Y	16073	17171
Channel Z	16067	13620

#### 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	-0.10	-0.96	0.63	0.31
Channel Y	-0.65	-1.34	0.86	0.38
Channel Z	-1.23	-2.12	0.48	0.42

#### 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

1303

## **IMPORTANT NOTICE**

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**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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Client **Sporton-SZ (Auden)**

Certificate No: **DAE4-1303\_Nov15**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1303**

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

Calibration date: **November 24, 2015**

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
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Calibrator Box V2.1	SE UMS 006 AA 1002	06-Jan-15 (in house check)	In house check: Jan-16

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

Approved by: **Fin Bomholt** **Deputy Technical Manager**

Issued: November 24, 2015

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Accreditation No.: SCS 0108

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## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 $\mu$ 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	$405.572 \pm 0.02\% \text{ (k=2)}$	$403.443 \pm 0.02\% \text{ (k=2)}$	$404.889 \pm 0.02\% \text{ (k=2)}$
Low Range	$3.96499 \pm 1.50\% \text{ (k=2)}$	$3.99171 \pm 1.50\% \text{ (k=2)}$	$4.01448 \pm 1.50\% \text{ (k=2)}$

## Connector Angle

Connector Angle to be used in DASY system	$185.0^\circ \pm 1^\circ$
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