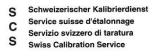


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#### Glossarv

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.

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## **DC Voltage Measurement**

A/D - Converter Resolution nominal

 $\begin{array}{lll} \mbox{High Range:} & \mbox{1LSB} = & 6.1 \mu \mbox{V} \,, & \mbox{full range} = & -100...+300 \mbox{ mV} \\ \mbox{Low Range:} & \mbox{1LSB} = & 61 \mbox{nV} \,, & \mbox{full range} = & -1......+3 \mbox{mV} \\ \mbox{DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec} \end{array}$ 

Calibration Factors	X	Υ	Z.
High Range	405.265 ± 0.02% (k=2)	403,974 ± 0.02% (k=2)	405.092 ± 0.02% (k=2)
Low Range	3.99534 ± 1.50% (k=2)	3.99508 ± 1.50% (k=2)	4.01015 ± 1.50% (k=2)

#### **Connector Angle**

30.0 ° ± 1 °

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

1. DC Voltage Linearity

C Voltage Linearity	1 - 11 / 10		= : 10(1)
High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	199994.45	1.62	0,00
Channel X + Input	20004,58	2.22	0.01
Channel X - Input	-20000.14	1.12	-0.01
Channel Y + Input	199994.72	1.98	0.00
Channel Y + Input	20001.22	-1.00	-0:00
Channel Y - Input	-20003.05	-1.67	0.01
Channel Z + Input	199992.64	0.19	0,00
Channel Z + Input	20003.09	0.98	0.00
Channel Z - Input	-20001.73	-0.27	0.00

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2001.91	0.41	0.02
Channel X + Input	202.54	0.65	0:32
Channel X - Input	-197.86	0.07	<b>-</b> 0.04
Channel Y + Input	2002.05	0.58	0.03
Channel Y + Input	201.27	-0.57	-0.28
Channel Y - Input	-198.23	-0.06	0.03
Channel Z + Input	2001.36	0.08	0.00
Channel Z + Input	200.09	-1,53	-0.76
Channel Z - Input	-199.85	-1.57	0.79

### 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	-5.87	-7.69
	- 200	9:12	7.79
Channel Y	200	-8.68	-9.28
	- 200	8.52	8.36
Channel Z	200	-5:36	-5.60
	- 200	3.58	3.08

## 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	-	4,07	-3.14
Channel Y	200	9.36	<b>2</b> .	4.27
Channel Z	200	10.11	7.14	j .

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## 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	15984	17040
Channel Y	16562	15768
Channel Z	16035	15958

### 5. Input Offset Measurement

DASY measurement parameters; Auto Zero Time: 3 sec; Measuring time: 3 sec Input  $10 M\Omega$ 

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	1.00	-0.15	1.93	0.45
Channel Y	-0.18	-1.28	0.94	0.45
Channel Z	-0.58	-2.61	0.58	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)

Tower Consumption (Typicar 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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## 3. EX3DV4 - SN 3801



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Auden Client

Certificate No: EX3-3801\_Jul21

### **CALIBRATION CERTIFICATE**

EX3DV4 - SN:3801

Calibration procedure(s)

QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5,

QA CAL-25.v7

Calibration procedure for dosimetric E-field probes

Calibration date:

July 26, 2021

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
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: CC2552 (20x)	09-Apr-21 (No. 217-03343)	Apr-22
DAE4	SN: 660	23-Dec-20 (No. DAE4-660 Dec20)	Dec-21
Reference Probe ES3DV2	SN: 3013	30-Dec-20 (No. ES3-3013_Dec20)	Dec-21
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Name	Function	Signature
Jeffrey Katzman	Laboratory Technician	S. Koth
Katja Pokovic	Technical Manager	May
		Issued: July 28, 2021
	Jeffrey Katzman Katja Pokovic	Jeffrey Katzman Laboratory Technician

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#### Glossary:

TSL tissue simulating liquid
NORMx,y,z sensitivity in free space
ConvF sensitivity in TSL / NORMx,y,z
DCP diode compression point

CF crest factor (1/duty\_cycle) of the RF signal A, B, C, D modulation dependent linearization parameters

Polarization  $\phi$   $\phi$  rotation around probe axis

Polarization 9 9 rotation around an axis that is in the plane normal to probe axis (at measurement center).

i.e., 9 = 0 is normal to probe axis

Connector Angle information used in DASY system to align probe sensor X to the robot coordinate system

## Calibration is Performed According to the Following Standards:

- a) 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.
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)x,y,z = NORMx,y,z \* frequency\_response (see Frequency Response Chart). This linearization is
  implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included
  in the stated uncertainty of ConvF.
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx,y,z \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORMx (no
  uncertainty required).

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EX3DV4 - SN:3801 July 26, 2021

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)	
Norm $(\mu V/(V/m)^2)^A$	0.51	0.59	0.41	± 10.1 %	
DCP (mV) <sup>B</sup>	102.5	98.9	99.9		

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dBõV	С	D dB	VR mV	Max dev.	Max Unc <sup>E</sup> (k=2)
0	CW	X	0.00	0.00	1.00	0.00	142.7	± 3.0 %	± 4.7 %
		Y	0.00	0.00	1.00		156.4		
		Z	0.00	0.00	1.00	1	152.1	1	
10352-	Pulse Waveform (200Hz, 10%)	X	20.00	94.62	22.88	10.00	60.0	± 3.9 %	± 9.6 %
AAA		Y	20.00	93.70	22.50		60.0		
		Z	20.00	91.97	21.56		60.0		
10353-	Pulse Waveform (200Hz, 20%)	X	20.00	95.81	22.41	6.99	80.0	± 1.8 %	± 9.6 %
AAA		Y	20.00	94.59	22.11		80.0		
		Z	20.00	92.88	20.81		80.0		
10354- Pulse	Pulse Waveform (200Hz, 40%)	X	20.00	100.01	23.14	3.98	95.0	± 0.9 %	± 9.6 %
		Y	20.00	99.13	23.15		95.0		
		Z	20.00	96.07	20.99		95.0		
10355- Pulse W	Pulse Waveform (200Hz, 60%)	X	20.00	105.91	24.65	2.22	120.0	± 1.0 %	± 9.6 %
		Y	20.00	106.15	25.23		120.0		
		Z	20.00	101.87	22.54		120.0		
10387- QPSK V	QPSK Waveform, 1 MHz	X	1.63	65.20	14.46	1.00	150.0	± 1.9 %	± 9.6 %
		Y	1.74	65.97	15.16		150.0		
		Z	1.75	65.86	15.02		150.0		
AAA	QPSK Waveform, 10 MHz	X	2.14	66.92	15.13	0.00	150.0	± 1.2 %	± 9.6 %
		Y	2.29	68.10	15.84		150.0		
		Z	2.29	67.99	15.69		150.0		
10396-	64-QAM Waveform, 100 kHz	X	2.91	70.01	18.57	3.01	150.0	± 0.7 %	± 9.6 %
AAA		Y	3.39	72.89	20.09		150.0		
		Z	3.14	71.65	19.30		150.0		
AAA	64-QAM Waveform, 40 MHz	X	3.49	66.78	15.53	0.00	150.0	± 0.8 %	± 9.6 %
		Y	3.56	67.18	15.83		150.0		
		Z	3.43	66.56	15.46		150.0		
10414-	WLAN CCDF, 64-QAM, 40MHz	X	4.68	64.89	15.07	0.00	150.0	± 2.1 %	± 9.6 %
AAA		Y	4.93	65.65	15.54		150.0		
		Z	4.81	65.26	15.26		150.0		

Note: For details on UID parameters see Appendix

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%.

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A The uncertainties of Norm X,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 5).

B Numerical linearization parameter: uncertainty not required.

Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value



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EX3DV4-SN:3801

July 26, 2021

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

### Sensor Model Parameters

	C1 fF	C2 fF	α V <sup>-1</sup>	T1 ms.V <sup>-2</sup>	T2 ms.V <sup>-1</sup>	T3 ms	T4 V <sup>-2</sup>	T5 V <sup>-1</sup>	T6
X	45.0	331.74	34.63	16.33	0.22	5.07	1.23	0.23	1.01
Y	50.1	369.92	34.91	24.17	0.09	5.10	1.74	0.19	1.01
Z	50.1	364.65	34.00	13.98	0.45	5.03	1.50	0.17	1.01

## Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	152.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

Note: Measurement distance from surface can be increased to 3-4 mm for an Area Scan job.

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