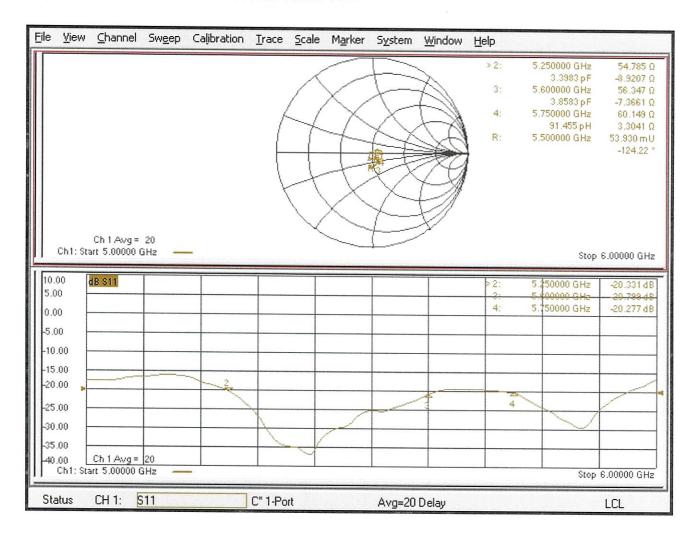
Impedance Measurement Plot for Head TSL



Zeughausstrasse 43, 8004 Zurich, Switzerland Phone +41 44 245 9700, Fax +41 44 245 9779 www.speag.swiss, info@speag.swiss

IMPORTANT NOTICE

USAGE OF THE DAE4

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 fixed 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 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.

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Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service

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Client

Sporton

Certificate No: DAE4-778_May21

Accreditation No.: SCS 0108

CALIBRATION CERTIFICATE

Object

DAE4 - SD 000 D04 BM - SN: 778

Calibration procedure(s)

QA CAL-06.v30

Calibration procedure for the data acquisition electronics (DAE)

Calibration date:

May 21, 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 ± 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	07-Sep-20 (No:28647)	Sep-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-21 (in house check)	In house check: Jan-22
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-21 (in house check)	In house check: Jan-22

Calibrated by:

Name

Eupotion

Signature

Calibrated by.

Adrian Gehring

Laboratory Technician

Approved by:

Sven Kühn

Deputy Manager

Issued: May 21, 2021

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Certificate No: DAE4-778_May21

Page 1 of 5

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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.

Certificate No: DAE4-778_May21 Page 2 of 5

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range:

6.1μV , 1LSB =

full range = -100...+300 mV

Low Range:

1LSB = 61nV ,

-1.....+3mV full range =

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

Calibration Factors	Х	Υ	Z
High Range	404.696 ± 0.02% (k=2)	403.494 ± 0.02% (k=2)	405.039 ± 0.02% (k=2)
Low Range	3.98819 ± 1.50% (k=2)	3.96514 ± 1.50% (k=2)	3.99984 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	270.0 ° ± 1 °

Certificate No: DAE4-778_May21

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

Reading (μV)	Difference (μV)	Error (%)
200029.05	-4.67	-0.00
20006.24	0.54	0.00
-20003.34	2.50	-0.01
200031.24	-2.72	-0.00
20005.33	-0.19	-0.00
-20005.91	0.12	-0.00
200030.38	-7.59	-0.00
20003.71	-1.85	-0.01
-20007.61	-1.54	0.01
	200029.05 20006.24 -20003.34 200031.24 20005.33 -20005.91 200030.38 20003.71	200029.05 -4.67 20006.24 0.54 -20003.34 2.50 200031.24 -2.72 20005.33 -0.19 -20005.91 0.12 200030.38 -7.59 20003.71 -1.85

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X + Inpu	t	2001.61	0.40	0.02
Channel X + Inpu	t	201.42	0.13	0.06
Channel X - Inpu	t	-199.37	-0.67	0.34
Channel Y + Inpu	t	2000.52	-0.64	-0.03
Channel Y + Inpu	t	200.47	-0.63	-0.32
Channel Y - Inpu	t	-199.68	-0.88	0.44
Channel Z + Inpu	it	2001.12	-0.03	-0.00
Channel Z + Inpu	ıt	199.67	-1.42	-0.71
Channel Z - Inpu	t	-200.01	-1.24	0.62

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	-4.58	-5.43
	- 200	5.50	4.30
Channel Y	200	-1.36	-1.66
	- 200	-0.08	-0.73
Channel Z	200	-9.77	-9.99
	- 200	8.77	8.38

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	-	-0.90	-1.98
Channel Y	200	8.78	=	0.42
Channel Z	200	4.28	6.85	-

4. AD-Converter Values with inputs shorted

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

5, (e)	High Range (LSB)	Low Range (LSB)
Channel X	16059	17081
Channel Y	16188	17159
Channel Z	16438	15682

5. Input Offset Measurement

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

Input $10M\Omega$

nput 10MΩ	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.08	-1.13	0.82	0.39
Channel Y	-0.41	-2.27	2.44	0.63
Channel Z	-0.20	-1.48	0.85	0.49

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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Client Sporton Certificate No: DAE4-1311_Aug21

Accreditation No.: SCS 0108

CALIBRATION CERTIFICATE

Object DAE4 - SD 000 D04 BM - SN: 1311

Calibration procedure(s) QA CAL-06.v30

Calibration procedure for the data acquisition electronics (DAE)

Calibration date: August 20, 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards Keithley Multimeter Type 2001	ID # SN: 0810278	Cal Date (Certificate No.) 07-Sep-20 (No:28647)	Scheduled Calibration Sep-21
Secondary Standards Auto DAE Calibration Unit Calibrator Box V2.1	ID # SE UWS 053 AA 1001 SE UMS 006 AA 1002	Check Date (in house) 07-Jan-21 (in house check) 07-Jan-21 (in house check)	Scheduled Check In house check: Jan-22 In house check: Jan-22

Name Function Calibrated by: Dominique Steffen

Laboratory Technician

Approved by: Sven Kühn Deputy Manager

Issued: August 20, 2021

Signature

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

Certificate No: DAE4-1311_Aug21

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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.

Certificate No: DAE4-1311_Aug21 Page 2 of 5

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

Х	Υ	7
405.510 ± 0.02% (k=2)	405.047 ± 0.02% (k=2)	404.821 ± 0.02% (k=2)
0.00000	0.00100	1 = 0.0270 (K-Z)
	405.510 ± 0.02% (k=2)	405.510 ± 0.02% (k=2) 405.047 ± 0.02% (k=2)

Connector Angle

Connector Angle to be used in DASY system	
The state of the disea in DASY system	222.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	F (04)
Channel X	+ Input	200031.77		Error (%)
Channel X	+ Input	20006.58	-5.20	-0.00
Channel X	<u> </u>		0.39	0.00
	- Input	-20002.34	3.46	-0.02
Channel Y	+ Input	200032.86	-4.26	-0.00
Channel Y	+ Input	20001.39	-4.67	
Channel Y	- Input	-20005.28	0.77	-0.02
Channel Z	+ Input	200032.31		-0.00
Channel Z			-5.12	-0.00
	+ Input	20004.31	-1.66	-0.01
Channel Z	- Input	-20004.31	1.82	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (0/)
Channel X + I	nput	2001.11		Error (%)
Channel X + I	nput	201.74	-0.37	-0.02
01	-	201.74	0.40	0.20
01	put	-197.72	0.81	-0.41
Channel Y + Ir	put	2001.85	0.48	and the second
Channel Y + Ir	put	200.73	-0.57	0.02
Channel Y - In	put	-200.26		-0.28
01			-1.56	0.79
• •	put	2001.67	0.41	0.02
Channel Z + In	put	201.03	-0.17	
Channel Z - Inj	out	400.00	0.17	-0.09
	, u t	-199.06	-0.31	0.15

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	13.39	11.44
	- 200	-10.26	
Channel Y	200	-13.63	-12.53 -13.74
	- 200	12.59	12.05
Channel Z	200	-18.60	-18.48
	- 200	17.68	17.19

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)		Channel Z (μV)
Channel X	200	_	924 2020	Onamie Z (μν)
Channel Y	200		3.58	-2.54
Channel Z		8.76	-	5.69
Charmer Z	200	9.62	6.67	140

Certificate No: DAE4-1311_Aug21

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	15446	16713
Channel Y	16320	15746
Channel Z	16580	17710

5. Input Offset Measurement

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

	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
0.50	-0.98	1.81	0.67
-0.01	-1.13	1.26	0.57
0.08	-1 25		0.57
	-0.01	-0.01 -1.13	-0.01 -1.13 1.26

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

0 1	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	
	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

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 fixed 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 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 Schmid & Partner

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Schweizerischer Kalibrierdienst Service suisse d'étalonnage C Servizio svizzero di taratura **Swiss Calibration Service**

Accreditation No.: SCS 0108

Certificate No: EX3-7350 Dec21

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Client

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CALIBRATION CERTIFICATE

EX3DV4 - SN:7350 Object

QA CAL-01.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure(s)

Calibration procedure for dosimetric E-field probes

December 20, 2021 Calibration date:

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
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-22

Signature Name Function Leif Klysner Laboratory Technician Calibrated by: **Quality Manager** Approved by: Niels Kuster

Issued: December 21, 2021

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Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossary:

TSL NORMx,y,z tissue simulating liquid sensitivity in free space

ConvF DCP sensitivity in TSL / NORMx,y,z diode compression point

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

Polarization φ

Φ 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 θ = 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 MHz.
- 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).