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



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- S **Swiss Calibration Service**

Accreditation No.: SCS 0108

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

Sporton Client

Certificate No: D2450V2-929_Nov19

CALIBRATION CERTIFICATE

,	D2450V2 - SN:929		
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	November 21, 20	19	
This calibration certificate documen The measurements and the uncerta	nts the traceability to nati ainties with confidence p	onal standards, which realize the physical un robability are given on the following pages an	its of measurements (SI). d are part of the certificate.
All calibrations have been conducte	ed in the closed laborato	y facility: environment temperature (22 \pm 3)°C	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	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 7349	29-May-19 (No. EX3-7349_May19)	May-20
DAE4	SN: 601	30-Apr-19 (No. DAE4-601_Apr19)	Apr-20
Secondary Standards	1D #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20
	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	UZ I
Approved by:	Katja Pokovic	Technical Manager	le les
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory.	Issued: November 25, 2019

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Glossarv:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end • of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed • point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. • No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power. •
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna • connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The 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%.

Accreditation No.: SCS 0108

Measurement Conditions

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

DASY Version	DASY5	V52.10.3
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.2 ± 6 %	1.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.1 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.24 W/kg

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.6 Ω + 5.2 jΩ
Return Loss	- 24.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.161 ns

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

DASY5 Validation Report for Head TSL

Date: 21.11.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:929

Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 1.84 S/m; ϵ_r = 38.2; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.9, 7.9, 7.9) @ 2450 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 117.5 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 26.8 W/kg **SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.24 W/kg** Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 50.9% Maximum value of SAR (measured) = 22.1 W/kg



0 dB = 22.1 W/kg = 13.44 dBW/kg

Impedance Measurement Plot for Head TSL



Appendix: Transfer Calibration at Four Validation Locations on SAM Head¹

Evaluation Condition

Phantom	SAM Head Phantom	For usage with cSAR3DV2-R/L
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SAR result with SAM Head (Top \cong C0)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	56.6 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	26.3 W/kg ± 16.9 % (k=2)

SAR result with SAM Head (Mouth \cong F90)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	57.7 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	27.6 W/kg ± 16.9 % (k=2)

SAR result with SAM Head (Neck \cong H0)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	54.4 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	25.2 W/kg ± 16.9 % (k=2)

SAR result with SAM Head (Ear \cong D90)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	34.8 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR for pominal Hoad TSL parameters	pormalized to 1W	$17.5 \frac{1}{k} + 16.0 \frac{1}{k} + 16.0 \frac{1}{k}$

¹ Additional assessments outside the current scope of SCS 0108



D2450V2, serial no. 929 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification of the extended calibration>

D 2450 V2 – serial no. 929						
	2450MHZ					
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
11.21.2019	24.026		52 560		5 2271	
(Cal. Report)	-24.920		52.569		5.2271	
11.20.2020	26.071	8.20	50.022	1 607	4 4757	0.7514
(extended)	-20.971	0.20	50.952	-1.037	4.4757	-0.7514

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



511 Log Mag 10.00dB/ Ref 0.000dB [F1] >1 2.4500000 GHz -26.971 dB 20.00 0.000 -30.00 -40.00 1 Start 2.25 GHz IFBW 70 kHz Stop 2.65 GHz Cor Tr1 511 Smith (R+jX) Scale 1.000U [F1 Del] >1 2.4500000 GHz 50.932 Ω 4.4757 Ω 290.75 pH 1 Start 2.25 GHz IFBW 70 kHz Stop 2.65 GHz Cor

<Dipole Verification Data> - D2450 V2, serial no. 929 (Data of Measurement : 11.20.2020) 2450 MHz - Head

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Accreditation No.: SCS 0108

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Certificate No: D5GHzV2-1128_Dec19

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1	128	
Calibration procedure(s)	QA CAL-22.v4 Calibration Proce	edure for SAR Validation Sources	s between 3-6 GHz
Calibration date:	December 16, 20	019	
This calibration certificate documer The measurements and the uncerta	nts the traceability to nat ainties with confidence p	ional standards, which realize the physical ur robability are given on the following pages ar	nits of measurements (SI). Ind are part of the certificate.
All calibrations have been conducte	ed in the closed laborato	ry 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	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 3503	25-Mar-19 (No. EX3-3503_Mar19)	Mar-20
DAE4	SN: 601	30-Apr-19 (No. DAE4-601_Apr19)	Apr-20
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20
	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	+100
Approved by:	Katja Pokovic	Technical Manager	ally
			Issued: December 17, 2019

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The 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%.

Accreditation No.: SCS 0108

Measurement Conditions

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

DASY Version	DASY5	V52.10.3
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm , dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.8 ± 6 %	4.48 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.9 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.3 ± 6 %	4.83 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.6 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5750 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	4.98 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.99 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.6 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	47.7 Ω - 6.4 jΩ
Return Loss	- 23.1 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.6 Ω - 3.5 jΩ
Return Loss	- 26.3 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	51.3 Ω - 3.5 jΩ
Return Loss	- 28.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.208 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
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DASY5 Validation Report for Head TSL

Date: 16.12.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1128

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz Medium parameters used: f = 5250 MHz; σ = 4.48 S/m; ϵ_r = 34.8; ρ = 1000 kg/m³, Medium parameters used: f = 5600 MHz; σ = 4.83 S/m; ϵ_r = 34.3; ρ = 1000 kg/m³, Medium parameters used: f = 5750 MHz; σ = 4.98 S/m; ϵ_r = 34.1; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.4, 5.4, 5.4) @ 5250 MHz, ConvF(4.95, 4.95, 4.95) @ 5600 MHz, ConvF(4.98, 4.98, 4.98) @ 5750 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 77.60 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 27.9 W/kg SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.32 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 69.9% Maximum value of SAR (measured) = 18.2 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=4mm, dy=4mm, dz=1.4mm Reference Value = 77.23 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 31.2 W/kg SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.39 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 67.1% Maximum value of SAR (measured) = 19.3 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=4mm, dy=4mm, dz=1.4mm Reference Value = 74.23 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 31.3 W/kg SAR(1 g) = 7.99 W/kg; SAR(10 g) = 2.29 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 65.7% Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 18.9 W/kg = 12.77 dBW/kg

Impedance Measurement Plot for Head TSL





D5000V2, serial no. 1128 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification of the extended calibration>

D 5000 V2 – serial no. 1128						
			525	OMHZ		
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
12.16.2019 (Cal. Report)	-23.113		47.684		-6.437	
12.15.2020 (extended)	-26.397	14.2	49.293	1.609	-5.405	1.032
	5600MHZ					
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
12.16.2019 (Cal. Report)	-26.278		53.636		-3.4803	
12.15.2020 (extended)	-27.417	4.33	54.448	0.812	-2.3368	1.1435
			575	OMHZ		
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
12.16.2019 (Cal. Report)	-28.611		51.3		-3.5295	
12.15.2020 (extended)	-25.773	-9.91	50.091	-1.209	-3.7769	-0.2474

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



511 Log Mag 10.00dB/ Ref 0.000dB [F1] 50.00 00 GHz -26.397 dB 00 GHz -27.417 dB 00 GHz -25.773 dB 2 0.000 -10.00 112 4 ÿ IFBW 70 kHz Stop 6 GHz Cor Start 5 GHz 1 511 Smith (R+jX) Scale 1.000U [F1 Del] GHZ GHZ GHZ 49.293 Ω -5.4050 Ω 5.6088 pF 54.448 Ω -2.3368 Ω 12.162 pF 50.091 Ω -3.7769 Ω 7.3284 pF 1 5.2500000 2 5.6000000 >3 5.7500000 1 Start 5 GHz Stop 6 GHz Cor IFBW 70 kHz

<Dipole Verification Data> - D5000 V2, serial no. 1128 (Data of Measurement : 12.15.2020) 5000 MHz - Head

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

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S Schweizerischer Kalibrierdienst

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- Servizio svizzero di taratura
- S Swiss Calibration Service

Accreditation No.: SCS 0108

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Certificate No: D6.5GHzV2-1003_Sep21

CALIBRATION CERTIFICATE			
Object	D6.5GHzV2 - SN	1003	
Calibration procedure(s) QA CAL-22.v6 Calibration Procedure for SAR Validation Sources between 3-10 GHz			
Calibration date:	September 24, 20	021	
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
Power sensor R&S NRP33T	SN: 100967	08-Apr-21 (No. 217-03293)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7405	30-Dec-20 (No. EX3-7405 Dec20)	Dec-21
DAE4	SN: 908	24-Jun-21 (No. DAE4-908_Jun21)	Jun-22
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 669	28-Mar-17 (in house check Dec-18)	In house check: Dec-21
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-19)	In house check: Oct-22
2	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	your
Approved by:	Katja Pokovic	Technical Manager	delles
This calibration certificate shall not b	e reproduced except in	full without written approval of the laboratory.	Issued: September 27, 2021

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Glossary:

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

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.

Additional Documentation:

b) DASY System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY6	V16.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	6500 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	34.5	6.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.6 ± 6 %	6.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition		
SAR measured	100 mW input power	29.4 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	292 W/kg ± 24.7 % (k=2)	
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition		
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20052540 201525200 J	March 15 Jonated Printed M	

SAR measured	100 mW input power	5.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.8 W/kg ± 24.4 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.4 Ω - 1.9 jΩ		
Return Loss	- 26.8 dB		

APD (Absorbed Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	292 W/m ²
APD measured	normalized to 1W	2920 W/m ² ± 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	132 W/m ²
APD measured	normalized to 1W	1320 W/m ² ± 28.9 % (k=2)

General Antenna Parameters and Design

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

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

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

Additional EUT Data

Manufactured by	SPEAG

DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1003, UID 0 -, Channel 6500 (6500.0MHz)

Device under Te	est Properties						
Name, Manufa	cturer	Dimensions [mm] IN	ЛЕI	DUT Typ	e	
D6.5GHz		16.0 x 6.0 x 3	800.0 SI	N: 1003	9 8 1		
Exposure Cond	itions						
Phantom Section, TSL	Position, Tes Distance [mm]	st Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.75	6.11	33.6
Hardware Setu Phantom	p	TSL		Probe, Calil	bration Date	DAE, Calib	oration Date
MFP V8.0 Cente	er - 1182	HBBL600-10	000V6	EX3DV4 - SI	N7405, 2020-12-30	DAE4 Sn9	08, 2021-06-24
Scan Setup				Measureme	ent Results		
			Zoom Scar	ı			Zoom Scan
Grid Extents [mm]		22.0 x 22.0 x 22.0	D Date			2021-09-24, 9:30
Grid Steps [m	m]		3.4 x 3.4 x 1.4	4 psSAR1g ['	W/Kg]		29.4
Sensor Surfac	e [mm]		1.4	4 psSAR10g	[W/Kg]		5.42
Graded Grid			Ye	s Power Dri	ft [dB]		-0.02
Grading Ratio	i		1.4	4 Power Sca	lling		Disabled
MAIA			N//	A Scaling Fa	ctor [dB]		
Surface Detec	ction		VMS + 6	p TSL Correc	ction		No correction
Scan Method			Measure	d M2/M1 [9	6]		55.6
				Dist 3dB P	eak [mm]		4.6



Impedance Measurement Plot for Head TSL



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Client Sporton

Certificate No: 5G-Veri10-1020_Jan21

CALIBRATION CERTIFICATE

Object	5G Verification Source 10 GHz - SN: 1020							
Calibration procedure(s)	QA CAL-45.v3 Calibration procedure for sources in air above 6 GHz							
Calibration date:	January 18, 202	21	~					
This calibration certificate docume The measurements and the uncert	ents the traceability to na rtainties with confidence	tional standards, which realize the physical units o probability are given on the following pages and ar	f measurements (SI). re part of the certificate.					
Calibration Equipment used (M&T	E critical for calibration)		a hamaiy < 70%.					
Drimon: Standarda		Cal Data (Cartificata Na.)	Schodulod Calibration					
Primary Standards	SNI: 0274	20 Dec 20 (No. Elimm)40/2 0274 Dec20)	Dec 21					
	SN. 9374	11 Aug 20 (No. DAE Ain 1602 Aug 20)						
Secondary Standards	ID #	Check Date (in house)	Scheduled Check					
Calibrated by:	Name Michael Weber	Function Laboratory Technician	Signature					
			M.Mose					
Approved by:	Katja Pokovic	Technical Manager	Ray					
This calibration certificate shall no	ot be reproduced except i	n full without written approval of the laboratory.	Issued: January 25, 2021					

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Glossary

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45-5Gsources
- IEC TR 63170 ED1, "Measurement procedure for the evaluation of power density related to human exposure to radio frequency fields from wireless communication devices operating between 6 GHz and 100 GHz", January 2018

Methods Applied and Interpretation of Parameters

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

Calibrated Quantity

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

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

Measurement Conditions

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

DASY Version	cDASY6 Module mmWave	V2.2
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
XY Scan Resolution	dx, dy = 7.5 mm	
Number of measured planes	2 (10mm, 10mm + λ/4)	
Frequency	10 GHz ± 10 MHz	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture	Prad ¹	Max E-field	Uncertainty	Avg Powe	er Density	Uncertainty
to Measured Plane	(mW)	(V/m)	(k = 2)	Avg (psPDn+, psPDtot+, psPDmod+)		(k = 2)
				(W	/m²)	
				1 cm ²	4 cm ²	
10 mm	74.0	134	1.27 dB	45.1	42.2	1.28 dB

Square Averaging

Distance Horn Aperture	Prad ¹	Max E-field	Uncertainty	Avg Powe	er Density	Uncertainty
to Measured Plane	(mW)	(V/m)	(k = 2)	Avg (psPDn+, psl	PDtot+, psPDmod+)	(k = 2)
				(W.	/m²)	
				1 cm ²	4 cm ²	
10 mm	74.0	134	1.27 dB	45.1	42.1	1.28 dB

¹ Assessed ohmic and mismatch loss: 0.45 dB

MAIA

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	172.0	SN: 1020	-	
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0
Hardware Setup					
Phantom	Medium		Probe, Cali	bration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 2020-12-30	8 - SN9374_F1-78GHz, D	DAE4ip Sn1602, 2020-08-11
Scan Setup			Measure	ment Results	
		5G 5	ican		5G Scan
Grid Extents [mm]		120.0 x 1	20.0 Date		2021-01-18, 14:59
Grid Steps [lambda]		0.25 x	0.25 Avg. Area	[cm ²]	1.00
Sensor Surface [mm]			10.0 psPDn+ [\	N/m²]	44.9

MAIA not used

psPDtot+ [W/m²] psPDmod+ [W/m²]

Power Drift [dB]

E_{max} [V/m]

45.0 45.3

134

0.06

<text>

Certificate No: 5G-Veri10-1020_Jan21

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Pro	operties				
Name, Manufacturer	Dimensions [mm	1]	IMEI	DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	172.0	SN: 1020	-	
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0
Hardware Setup					
Phantom	Medium		Probe, Calib	bration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 2020-12-30	- SN9374_F1-78GHz,)	DAE4ip Sn1602, 2020-08-11
Scan Setup			Measure	ment Results	
		5G S	can		5G Scan
Grid Extents [mm]		120.0 x 12	0.0 Date		2021-01-18, 14:59
Grid Steps [lambda]		0.25 x 0	.25 Avg. Area	[cm ²]	4.00
Sensor Surface [mm]		1	0.0 psPDn+ [V	W/m²]	42.0
MAIA		MAIA not u	sed psPDtot+	[W/m ²]	42.2
			psPDmod	+ [W/m²]	. 42.3
			E _{max} [V/m]	1	134
			Power Dri	ft [dB]	0.06



Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm	J	IMEI	DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	172.0	SN: 1020	-	
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0
Hardware Setup	Madium		Proba Calib	wation Data	DAE Collibration Data
mmWave Phantom - 1002	Air		EUmmWV3 2020-12-30	- SN9374_F1-78GHz,	DAE4ip Sn1602, 2020-08-11
Scan Setup		50.0	Measurer	ment Results	50 fee
Grid Extents [mm]		120 0 × 12	can 20.0 Date		56 Sca 2021-01-18 14 5
		120.0 % 12	Loio Dute	1 21	2021 01 10, 140

Grid Steps [lambda] Sensor Surface [mm] MAIA 5G Scan 120.0 x 120.0 0.25 x 0.25 10.0 MAIA not used Date Avg. Area [cm²] psPDn+ [W/m²] psPDtot+ [W/m²] psPDmod+ [W/m²] E_{max} [V/m] Power Drift [dB]

5G Scan 2021-01-18, 14:59 1.00 45.0 45.1 45.3 134 0.06



Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Pro	operties				
Name, Manufacturer	Dimensions [mm	1]	IMEI	DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	172.0	SN: 1020	-	
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0
Hardware Setup					
Phantom	Medium		Probe, Calibra	ation Date	DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 - 2020-12-30	SN9374_F1-78GHz,	DAE4ip Sn1602, 2020-08-11
Scan Setup			Measurem	ent Results	
		5G S	can		5G Scan
Grid Extents [mm]		120.0 x 12	20.0 Date	22	2021-01-18, 14:59
Grid Steps [lambda]		0.25 x 0).25 Avg. Area [c	m²]	4.00
Sensor Surface [mm]		1	10.0 psPDn+[W/	m²]	42.0
MAIA		IVIAIA not u	sed psPDtot+[w	V/m²]	42.1
			E [V/m]		42.3
			Power Drift	[dB]	0.06



Certificate No: 5G-Veri10-1020_Jan21

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Sporton Client

Certificate No: DAE4-699_Feb21

Accreditation No.: SCS 0108

Object	DAE4 - SD 000 D0	04 BO - SN: 699	
Calibration procedure(s)	QA CAL-06.v30 Calibration proced	lure for the data acquisition elect	tronics (DAE)
Calibration date:	February 16, 2021		
This calibration certificate docum The measurements and the unce	ents the traceability to nation ertainties with confidence pro	nal standards, which realize the physical uni bability are given on the following pages an	ts of measurements (SI). d are part of the certificate.
All calibrations have been condu	cted 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	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
	Name	Function	Signature
Calibrated by:	Name Adrian Gehring	Function Laboratory Technician	Signature
Calibrated by: Approved by:	Name Adrian Gehring Sven Kühn	Function Laboratory Technician Deputy Manager	Signature A San W.S. Currow

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Glossarv

DAE data acquisition electronics information used in DASY system to align probe sensor X to the robot Connector angle 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 mVLow Range:1LSB =61nV ,full range =-1.....+3mVDASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	x	Y	Z
High Range	404.698 ± 0.02% (k=2)	403.331 \pm 0.02% (k=2)	404.500 ± 0.02% (k=2)
Low Range	3.93322 ± 1.50% (k=2)	3.94917 ± 1.50% (k=2)	3.97686 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	170.0 ° ± 1 °
o	

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199987.98	-2.79	-0.00
Channel X	+ Input	20000.61	-0.79	-0.00
Channel X	- Input	-19997.00	4.51	-0.02
Channel Y	+ Input	199987.66	-3.18	-0.00
Channel Y	+ Input	19999.26	-2.15	-0.01
Channel Y	- Input	-20000.61	0.98	-0.00
Channel Z	+ Input	199987.69	-2.80	-0.00
Channel Z	+ Input	19997.98	-3.40	-0.02
Channel Z	- Input	-19999.60	1.99	-0.01

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2001.02	0.12	0.01
Channel X	+ Input	200.79	-0.50	-0.25
Channel X	- Input	-198.40	0.14	-0.07
Channel Y	+ Input	2001.51	0.67	0.03
Channel Y	+ Input	201.26	0.03	0.02
Channel Y	- Input	-198.52	0.03	-0.01
Channel Z	+ Input	2001.27	0.41	0.02
Channel Z	+ Input	200.87	-0.37	-0.18
Channel Z	- Input	-199.69	-1.10	0.56

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	-2.78	-4.10
	- 200	4.38	2.84
Channel Y	200	22.58	22.65
	- 200	-24.12	-23.77
Channel Z	200	7.20	7.46
	- 200	-9.22	-9.24

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	-	-1.76	-3.19
Channel Y	200	7.37	-	-1.62
Channel Z	200	4.11	5.36	-

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	16103	15078
Channel Y	16420	14959
Channel Z	16290	15287

5. Input Offset Measurement

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

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (µV)
Channel X	0.42	-0.83	1.55	0.48
Channel Y	-0.50	-1.42	0.63	0.44
Channel Z	-0.48	-1.69	0.38	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

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



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Client Sporton

Certificate No: DAE4-854_Aug21

Accreditation No.: SCS 0108

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CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 854				
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)				
Calibration date:	August 19, 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 $(22 \pm 3)^{\circ}C$ and humidity < 70%.					
Primany Standarde	l ID #	Col Data (Costificate No.)	Opheskulad Optilizedian		
Keithley Multimeter Type 2001	SN: 0810278	07-Sep-20 (No:28647)	Scheduled Calibration		
	line		noncon estatute dan a		
Secondary Standards	ID #	Check Date (in house)	Scheduled Check		
Calibrator Box V2.1	SE UMS 006 AA 1007	07-Jan-21 (in house check)	In house check: Jan-22		
	Name	Function	Signature		
Calibrated by:	Adrian Gehring	Laboratory Technician	Aga		
Approved by:	Sven Kühn	Deputy Manager	id. & Illur		
This calibration certificate shall not	be reproduced except in f	ull without written approval of the laboratory.	Issued: August 19, 2021		

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Glossary

DAE Connector angle data acquisition electronics 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 ۲ 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	404.924 ± 0.02% (k=2)	404.719 ± 0.02% (k=2)	405.792 ± 0.02% (k=2)
Low Range	3.97094 ± 1.50% (k=2)	3.94896 ± 1.50% (k=2)	3.95243 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	38.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199995.86	-0.36	-0.00
Channel X + Input	20001.15	-0.92	-0.00
Channel X - Input	-19998.64	3.05	-0.02
Channel Y + Input	199996.87	1.16	0.00
Channel Y + Input	20000.19	-1.82	-0.01
Channel Y - Input	-20002.52	-0.80	0.00
Channel Z + Input	199995.58	-0.72	-0.00
Channel Z + Input	19999.38	-2.62	-0.01
Channel Z - Input	-20000.10	1.67	-0.01

1. DC Voltage Linearity

Low Range	Reading (μV)	Difference (µV)	Error (%)
Channel X + Input	2001.24	0.00	0.00
Channel X + Input	201.65	0.19	0.10
Channel X - Input	-198.55	-0.09	0.04
Channel Y + Input	2001.09	0.00	0.00
Channel Y + Input	201.10	-0.27	-0.13
Channel Y - Input	-198.97	-0.32	0.16
Channel Z + Input	2000.93	-0.00	-0.00
Channel Z + Input	200.52	-0.74	-0.37
Channel Z - Input	-199.63	-0.97	0.49

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	-16.13	-17.47
	- 200	18.92	17.38
Channel Y	200	-8.32	-8.43
	- 200	7.13	6.87
Channel Z	200	24.44	23.63
	- 200	-26.65	-26.79

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	-	2.64	-1.93
Channel Y	200	6.75	2	4.26
Channel Z	200	8.36	4.54	19

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	16140	16106
Channel Y	15974	17194
Channel Z	15813	16335

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	0.27	-0.57	1.09	0.36
Channel Y	-0.61	-1.37	0.14	0.33
Channel Z	-0.38	-1.41	0.32	0.30

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)	
Supply (+ Vcc)	+7.9	
Supply (- Vcc)	-7.6	

9. **Power Consumption** (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)	
Supply (+ Vcc)	+0.01	+6	+14	
Supply (- Vcc)	-0.01	-8	-9	

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IMPORTANT NOTICE

USAGE OF THE DAE4

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 Estop 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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Client :

Auden

Certificate No: Z20-60488

CALIBRATION CERTIFICATE Object DAE4 - SN: 917 Calibration Procedure(s) FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx) Calibration date: December 22, 2020 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(Calibrated by, Certificate No.) Scheduled Calibration Process Calibrator 753 1971018 16-Jun-20 (CTTL, No.J20X04342) Jun-21 Name Function Signature Calibrated by: Yu Zongying SAR Test Engineer Reviewed by: Lin Hao SAR Test Engineer Approved by: Qi Dianyuan SAR Project Leader Issued: December 24, 2020 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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Glossary: DAE Connector angle

data acquisition electronics 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 report provide only calibration results for DAE, it does not contain other performance test results.



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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 404.249 ± 0.15% (k=2) 3.99341 ± 0.7% (k=2)	
High Range	$404.236 \pm 0.15\% \text{ (k=2)}$	404.238 ± 0.15% (k=2)		
Low Range	$3.96973 \pm 0.7\%$ (k=2)	4.00589 ± 0.7% (k=2)		

Connector Angle

Connector Angle to be used in DAOV	
osimeetor Angle to be used in DASY system	249 + 4 0
	34 I I

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Accreditation No.: SCS 0108

Certificate No: EX3-3642 Apr21

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Accredited by the Swiss Accreditation Service (SAS)

Client Sporton

 CALIBRATION CERTIFICATE

 Object
 EX3DV4 - SN:3642

 Calibration procedure(s)
 QA CAL-01.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes

 Calibration date:
 April 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 ± 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
Calibrated by:	Jeton Kastrati	Laboratory Technician	File
Approved by:	Katja Pokovic	Technical Manager	delas
This calibration certificate	e shall not be reproduced except in fu	Il without written approval of the laboratory	Issued: May 4, 2021

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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 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) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from handheld and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) 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 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).

Certificate No: EX3-3642_Apr21

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.31	0.31	0.37	± 10.1 %
DCP (mV) ^B	97.4	104.8	101.7	

Calibration Results for Modulation Response

UID	Communication System Name		Α	B	С	D	VR	Max	Max
	100		dB	dBõV		dB	mV	dev.	UncE
									(k=2)
0	CW	X	0.00	0.00	1.00	0.00	150.4	± 3.3 %	± 4.7 %
		Y	0.00	0.00	1.00		158.3		
		Z	0.00	0.00	1.00		144.2		
10352-	Pulse Waveform (200Hz, 10%)	X	2.45	65.10	10.98	10.00	60.0	± 3.3 %	± 9.6 %
AAA	4 G	Y	20.00	89.91	19.54		60.0		
		Z	7.48	77.90	16.05		60.0		
10353-	Pulse Waveform (200Hz, 20%)	X	2.14	67.08	10.63	6.99	80.0	± 2.2 %	± 9.6 %
AAA		Y	20.00	92.77	19.76		80.0		
		Z	20.00	89.67	18.40		80.0		
10354-	Pulse Waveform (200Hz, 40%)	X	1.59	68.33	9.93	3.98	95.0	± 1.0 %	± 9.6 %
AAA		Y	20.00	100.66	22.20		95.0		
		Z	20.00	92.33	18.18		95.0		
10355-	Pulse Waveform (200Hz, 60%)	X	4.24	76.81	11.53	2.22	120.0	± 1.2 %	± 9.6 %
AAA		Y	20.00	111.57	26.00		120.0	1	
		Z	20.00	96.83	19.11	1	120.0		
10387-	QPSK Waveform, 1 MHz	X	1.66	68.45	15.68	1.00	150.0	± 2.2 %	± 9.6 %
AAA		Y	1.64	65.69	14.79		150.0		0.0000000000000000000000000000000000000
		Z	1.56	65.04	14.16		150.0		
10388-	QPSK Waveform, 10 MHz	X	2.14	68.46	16.16	0.00	150.0	± 1.0 %	± 9.6 %
AAA	<i></i>	Y	2.15	67.22	15.43	1	150.0	1	
		Z	2.05	66.49	14.87		150.0	1	
10396-	64-QAM Waveform, 100 kHz	X	2.31	67.84	17.66	3.01	150.0	± 0.8 %	± 9.6 %
AAA		Y	2.59	69.10	18.09		150.0		
		Z	2.63	69.10	17.97	1	150.0	1	
10399-	64-QAM Waveform, 40 MHz	X	3.48	67.39	16.05	0.00	150.0	± 0.7 %	± 9.6 %
AAA		Y	3.48	66.83	15.64		150.0		
		Z	3.43	66.62	15.40	1	150.0		
10414-	WLAN CCDF, 64-QAM, 40MHz	X	4.74	65.93	15.80	0.00	150.0	± 1.9 %	± 9.6 %
AAA	C. 0	Y	4.84	65.55	15.47	1	150.0		
		Z	4.81	65.55	15.37	1	150.0	1	

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%.

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

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

Sensor Model Parameters

	C1 fF	C2 fF	α V ⁻¹	T1 ms.V ⁻²	T2 ms.V ⁻¹	T3 ms	T4 V ⁻²	T5 V ⁻¹	Т6
Х	32.1	242.85	36.45	5.04	0.68	4.97	0.75	0.17	1.00
Y	42.9	315.70	34.70	8.49	0.00	5.03	1.73	0.04	1.00
Z	40.9	300.50	34.45	6.44	0.37	4.99	1.53	0.09	1.01

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-69.5
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.

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k=2)
750	41.9	0.89	9.09	9.09	9.09	0.55	0.80	± 12.0 %
835	41.5	0.90	8.92	8.92	8.92	0.41	0.91	± 12.0 %
900	41.5	0.97	8.74	8.74	8.74	0.48	0.80	± 12.0 %
1450	40.5	1.20	8.53	8.53	8.53	0.48	0.80	± 12.0 %
1750	40.1	1.37	8.21	8.21	8.21	0.37	0.80	± 12.0 %
1900	40.0	1.40	7.97	7.97	7.97	0.36	0.86	± 12.0 %
2000	40.0	1.40	7.82	7.82	7.82	0.31	0.85	± 12.0 %
2300	39.5	1.67	7.51	7.51	7.51	0.36	0.90	± 12.0 %
2450	39.2	1.80	7.43	7.43	7.43	0.34	0.90	± 12.0 %
2600	39.0	1.96	7.13	7.13	7.13	0.39	0.90	± 12.0 %
3300	38.2	2.71	6.87	6.87	6.87	0.30	1.30	± 14.0 %
3500	37.9	2.91	6.80	6.80	6.80	0.30	1.30	± 14.0 %
3700	37.7	3.12	6.59	6.59	6.59	0.30	1.30	± 14.0 %
3900	37.5	3.32	6.33	6.33	6.33	0.30	1.50	± 14.0 %
4100	37.2	3.53	6.25	6.25	6.25	0.30	1.50	± 14.0 %
4400	36.9	3.84	6.13	6.13	6.13	0.40	1.60	± 14.0 %
4600	36.7	4.04	5.69	5.69	5.69	0.30	1.70	± 14.0 %
4800	36.4	4.25	5.53	5.53	5.53	0.30	1.80	± 14.0 %
4950	36.3	4.40	5.20	5.20	5.20	0.40	1.80	± 14.0 %
5250	35.9	4.71	4.42	4.42	4.42	0.40	1.80	± 14.0 %
5600	35.5	5.07	4.17	4.17	4.17	0.40	1.80	± 14.0 %
5750	35.4	5.22	4.18	4.18	4.18	0.40	1.80	± 14.0 %
5850	35.2	5.32	4.06	4.06	4.06	0.55	0.80	± 14.0 %

^c Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz. ^F At frequencies up to 6 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than \pm 1% for frequencies below 3 GHz and below \pm 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k=2)
6500	34.5	6.07	4.95	4.95	4.95	0.28	2.80	± 18.6 %

Calibration Parameter Determined in Head Tissue Simulating Media

^c Frequency validity above 6GHz is ± 700 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies 6-10 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters. ^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than \pm 1% for frequencies below 3 GHz; below \pm 2% for frequencies between 3-6 GHz; and below \pm 4% for frequencies between 6-10 GHz at any distance larger than half the probe tip diameter from the boundary.



Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)