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



standing states

Schweizerischer Kalibrierdienst

- Service suisse d'étalonnage
- Servizio svizzero di taratura

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

Client Element Yongin, Republic of I	Korea	Certificate No.	D2450V2-945_May23
CALIBRATION C	ERTIFICAT		
Object	D2450V2 - SN:9	45	
Calibration procedure(s)	QA CAL-05.v12 Calibration Proce	edure for SAR Validation Sources	i between 0.7-3 GHz 실무자 기술책임자
Calibration date:	May 11, 2023		Tre 1/8 6/9/200
		onal standards, which realize the physical uni robability are given on the following pages an	
All calibrations have been conduct	ed in the closed laborato	ry facility: environment temperature (22 ± 3)°C	C and humidity < 70%.
Calibration Equipment used (M&TI	E critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24
Power sensor NRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)	Mar-24
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
Type-N mismatch combination	SN: 310982 / 06327	30-Mar-23 (No. 217-03810)	Mar-24
Reference Probe EX3DV4	SN: 7349	10-Jan-23 (No. EX3-7349_Jan23)	Jan-24
DAE4	SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Paulo Pina	Laboratory Technician	June D
Approved by:	Sven Kühn	Technical Manager	5.15
			Issued: May 16, 2023
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory.	•

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





S

Schweizerischer Kalibrierdienst

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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

## 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) 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"

## Additional Documentation:

c) 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). 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 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	DASY52	V52.10.4
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	37.7 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.9 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.23 W/kg

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.6 ± 6 %	2.02 mho/m ± 6 %
Body ⊺SL temperature change during test	< 0.5 °C		

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.9 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.01 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.8 W/kg ± 16.5 % (k=2)

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.4 Ω + 1.8 jΩ
Return Loss	- 26.8 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.4 Ω + 4.8 jΩ
Return Loss	- 26.4 dB

#### **General Antenna Parameters and Design**

	Electrical Delay (one direction)		
- 1		1.157 ns	
	,	1.107 115	

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
	SPEAG

## **DASY5 Validation Report for Head TSL**

Date: 11.05.2023

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:945

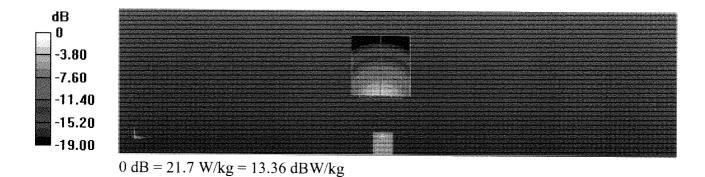
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.86$  S/m;  $\epsilon_r = 37.7$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.9, 7.9, 7.9) @ 2450 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 115.4 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 25.8 W/kg **SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.23 W/kg** Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51.7% Maximum value of SAR (measured) = 21.7 W/kg



## Impedance Measurement Plot for Head TSL

File	⊻iew	Channel	Sw <u>e</u> ep	Calibration	<u>T</u> race	<u>S</u> cale	Marker	System	<u>W</u> indow	Help		an General Constant of State			somer
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		Ch 1 Avg =	20			$\sim$	•••••••	-	J.						
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10.0 5.0	Ch1: Sta 20   0	art 2.25000 ( <b>18 \$11</b>							1	2.45	0000 (	GHz		65000 GI 839 di	
10.0	Ch1:Sta D0   0   0									2.45	0000 (	GHz			
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10.0 5.0 0.0 -5.0	Ch1: Sta 00 - 00 - 00 - 00 - 00 -								1	2.45	0000(	CH2			
10.0 5.0 0.0 -5.0 -10 -15	Ch1: Sta 0 - 0 - 0 - 0 - 0 - 0 - 0 - 0 -							>		2.45		GHz			
10.0 5.0 -5.0 -10 -15 -20	Ch1:Sta 0 - 0 - 00 - 00 - 00 - 00 - 00 -								1	2.45	0000 (	GHz			
10.0 5.0 -5.0 -10. -15. -20. -25. -30. -35.	Ch1:Sta 0 - 0 - 0 - 00 - 00 - 00 - 00 - 00 - 0		îHz							2.45		GHz			
10.0 5.0 -5.0 -10. -15. -20. -25. -30. -35. -40.	Ch1:Sta 0 - 0 - 00 - 00 - 00 - 00 - 00 - 00 -		20							2.45		GHz	26		

## **DASY5 Validation Report for Body TSL**

#### Date: 09.05.2023

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:945

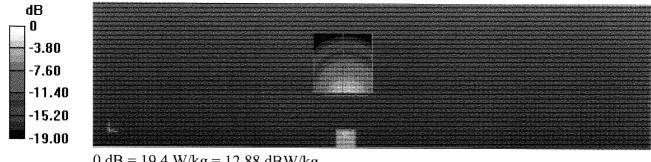
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 2.02 \text{ S/m}$ ;  $\varepsilon_r = 52.6$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

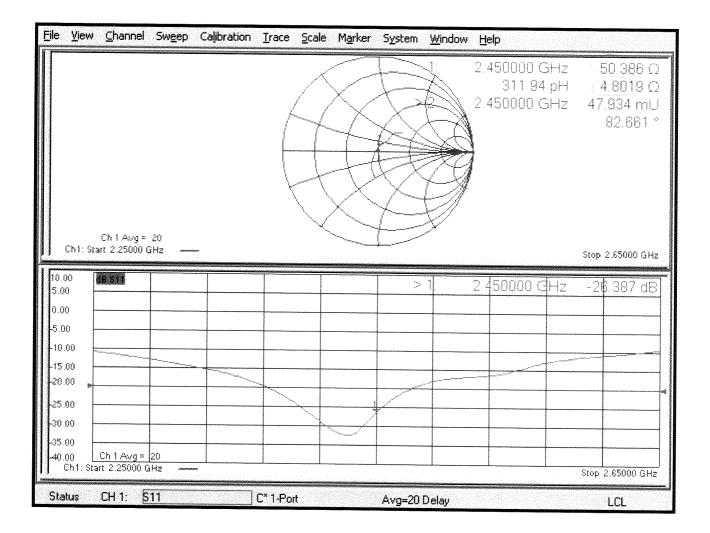
- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 10.01.2023 •
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022 •
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501) ٠

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 107.6 V/m; Power Drift = -0.09 dBPeak SAR (extrapolated) = 23.4 W/kgSAR(1 g) = 12.7 W/kg; SAR(10 g) = 6.01 W/kgSmallest distance from peaks to all points 3 dB below = 8.9 mmRatio of SAR at M2 to SAR at M1 = 55.9%Maximum value of SAR (measured) = 19.4 W/kg



0 dB = 19.4 W/kg = 12.88 dBW/kg



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

Client



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  - Servizio svizzero di taratura
- 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

PC Test

# Certificate No: D2450V2-981\_Nov21

Object	D2450V2 - SN:98	81 <sup>0000000</sup>	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	edure for SAR Validation Sources	s between 0.7-3 GHz ,
			BN12-09-2
Calibration date:	November 25, 20	021 abbedracte a trac	BN12-09-2 BN11-25-22
This calibration certificate docum	ents the traceability to nati	ional standards, which realize the physical un	hits of measurements (SI).
	atamies with confidence p	robability are given on the following pages an	id are part of the certificate.
All calibrations have been condu	cted 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
	ID # SN: 104778	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292)	Scheduled Calibration
Power meter NRP			
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	Apr-22 Apr-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244 SN: 103245	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292)	Apr-22 Apr-22 Apr-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343)	Apr-22 Apr-22 Apr-22 Apr-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Nov-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Nov-22 Scheduled Check
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Nov-22 Scheduled Check In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22
Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358/	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778     SN: 103244     SN: 103245     SN: 103245     SN: 103245     SN: 103245     SN: 103245     SN: 310982 / 06327     SN: 7349     SN: 601     ID #     SN: GB39512475     SN: US37292783     SN: MY41092317     SN: 100972     A	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 28-Dec-20 (No. EX3-7349_Dec20) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22

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





Schweizerischer Kalibrierdienst

S Service suisse d'étalonnage С

Servizio svizzero di taratura

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

## **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) 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"

## Additional Documentation:

c) 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). 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 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	DASY52	V52.10.4
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	39.1 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.9 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.4 W/kg ± 16.5 % (k=2)

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.2 ± 6 %	2.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.3 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.00 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.7 W/kg ± 16.5 % (k=2)

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

#### **Antenna Parameters with Head TSL**

Impedance, transformed to feed point	53.8 Ω + 5.8 jΩ
Return Loss	- 23.6 dB

#### **Antenna Parameters with Body TSL**

Impedance, transformed to feed point	50.4 Ω + 8.5 jΩ
Return Loss	- 21.5 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction) 1.163 ns		
	Electrical Delay (one direction)	

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
	4

## **DASY5 Validation Report for Head TSL**

Date: 25.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 981

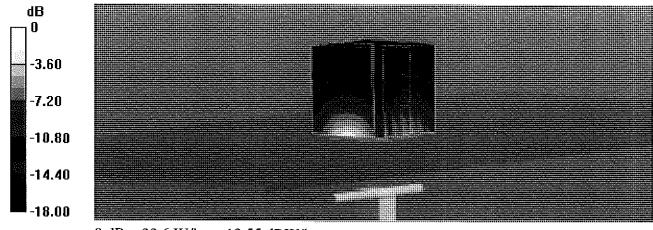
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.87$  S/m;  $\epsilon_r = 39.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 118.7 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 27.1 W/kg SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.42 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51.1% Maximum value of SAR (measured) = 22.6 W/kg



0 dB = 22.6 W/kg = 13.55 dBW/kg

## Impedance Measurement Plot for Head TSL

File	⊻iew	<u>C</u> hannel	Sw <u>e</u> ep	Calibration	<u>Trace S</u> cale	M <u>a</u> rker	System	<u>W</u> indow	<u>H</u> elp		
								2	450000 G⊢ 374.71 p 450000 G⊢		i3.773 Ω i.7682 Ω .318 mU 53.629 °
	Ch1:St	Ch 1 Avg = art 2.25000 #	3Hz	NEL			<u></u>	lika ayarda iya		Stop	2,65000 GHz
-20 -25 -30 -35 -40	00 - 00 00 - 00 00 - 00, ∞ 00 - 00, 00 - 00, 00 - 00,	<b>Ch</b> 1 Avg = art 2.25000 i	20						450000 Cl-		9.587 dB
	atus	CH 1: §			C* 1-Port		Avg=20 D	elau		stop	2.65000 GH2

## **DASY5 Validation Report for Body TSL**

Date: 25.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 981

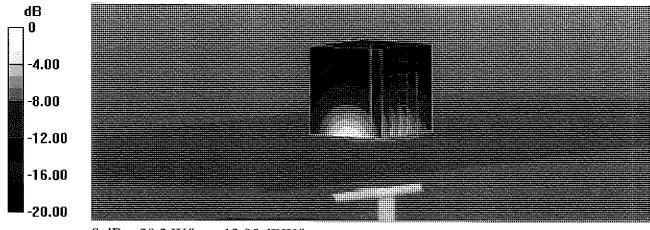
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 2.01$  S/m;  $\epsilon_r = 51.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 108.0 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 24.3 W/kg **SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6 W/kg** Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 54.1% Maximum value of SAR (measured) = 20.2 W/kg



0 dB = 20.2 W/kg = 13.05 dBW/kg

# Impedance Measurement Plot for Body TSL

Eile Yiew	Channel	Sweep	Calibration	<u>Trace S</u> cal	e M <u>a</u> rker	System	<u>W</u> indow	Help			
	Ch 1 Avg ≈			A			$\Delta$	2.450000 ( 551.61 2.450000 (	рΗ	8. 84.3	).350 Ω 4914 Ω )88 mU  2.801 °
Chi:S	tart 2,25000 i	20 GHz		·	· · · · · · · · · · · · · · · · · · ·			<u></u>		Stop 2	.65000 GHz
10.00 5.00 0.00 -5.00 -10.00 -15.00 -20.00 , -25.00						> 		2.450000 (		-21.	474 dB
30.00 35.00 40.00 Ch1: S	Ch 1 Avg = tart 2.25000 t	20 GHz 611		C* 1-Port		Avg=20	Delay				.65000 GHz



**ELEMENT MATERIALS TECHNOLOGY** 

(formerly PCTEST) 7185 Oakland Mills Road, Columbia, MD 21046 USA Tel. +1.410.290.6652 / Fax +1.410.290.6654 http://www.element.com



# **Certification of Calibration**

Object

D2450V2 - SN: 981

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extension Calibration date: 11/24/2022

Description:

SAR Validation Dipole at 2450 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	N5182A	MXG Vector Signal Generator	1/12/2022	Annual	1/12/2023	MY47420837
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343971
Anritsu	MA2411B	Pulse Power Sensor	3/28/2022	Annual	3/28/2023	1339007
Anritsu	MA2411B	Pulse Power Sensor	3/2/2022	Annual	3/2/2023	1126066
Anritsu	ML2496A	Power Meter	3/31/2022	Annual	3/31/2023	1138001
Anritsu	ML2496A	Power Meter	3/17/2022	Annual	3/17/2023	941001
Control Company	4040	Therm./ Clock/ Humidity Monitor	3/12/2021	Biennial	3/12/2023	210202100
Control Company	4352	Ultra Long Stem Thermometer	1/21/2022	Annual	1/21/2023	160508097
Control Company	4352	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774678
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Pasternack	PE5011-1	Torque Wrench	12/21/2021	Biennial	12/21/2023	82475
Mini-Circuits	ZHDC-16-63-S+	Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	ZNLE6	Vector Network Analyzer	10/21/2022	Annual	10/21/2023	101307
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/12/2022	Annual	5/12/2023	1070
Keysight Technologies	85033E	Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm)	6/21/2022	Annual	6/21/2023	MY53402352
SPEAG	EX3DV4	SAR Probe	2/21/2022	Annual	2/21/2023	7488
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/23/2022	Annual	2/23/2023	1415
SPEAG	EX3DV4	SAR Probe	6/16/2022	Annual	6/16/2023	7409
SPEAG	DAE4	Dasy Data Acquisition Electronics	6/14/2022	Annual	6/14/2023	1334

Measurement Uncertainty =  $\pm 23\%$  (k=2)

	Name	Function	Signature
Calibrated By:	Tho Tong	Test Engineer	Tho Tong
Approved By:	Kaitlin O'Keefe	Senior Technical Manager	ROK

Object:	Date Issued:	Page 1 of 4
D2450V2 – SN: 981	11/24/2022	Fage 1014

# **DIPOLE CALIBRATION EXTENSION**

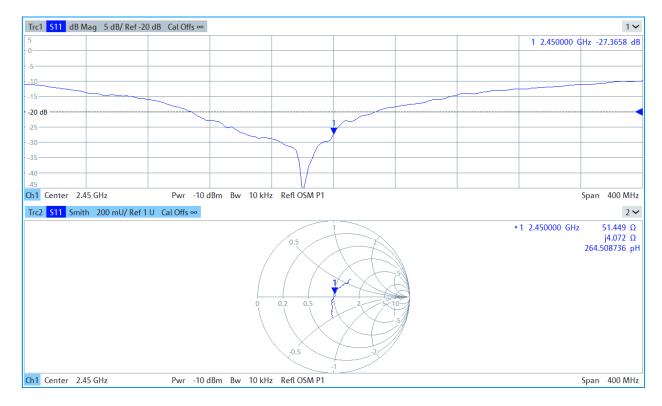
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance does not deviate more than  $5\Omega$  from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

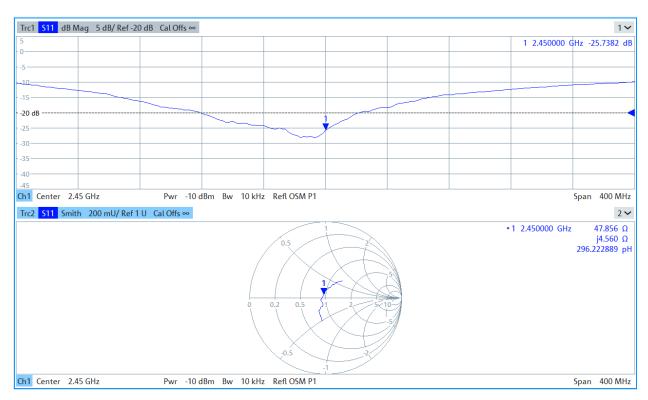
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm		Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	(10a) W/ka @	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
11/25/2021	11/24/2022	1.163	5.39	5.22	-3.15%	2.54	2.43	-4.33%	53.8	51.4	2.4	5.8	4.1	1.7	-23.6	-27.4	-16.00%	PASS
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Body (1g) W/kg @ 20.0 dBm	Measured Body SAR (1g) W/kg @ 20.0 dBm			(10a) W/ka @	Deviation 10g (%)	Certificate Impedance Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Body (Ohm) Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
11/25/2021	11/24/2022	1.163	5.03	4.88	-2.98%	2.37	2.27	-4.22%	50.4	47.9	2.5	8.5	4.6	3.9	-21.5	-25.7	-19.70%	PASS

Object:	Date Issued:	Page 2 of 4
D2450V2 – SN: 981	11/24/2022	Fage 2 014



#### Impedance & Return-Loss Measurement Plot for Head TSL

Object:	Date Issued:	Daga 2 of 4
D2450V2 – SN: 981	11/24/2022	Page 3 of 4



#### Impedance & Return-Loss Measurement Plot for Body TSL

Object:	Date Issued:	Page 4 of 4
D2450V2 – SN: 981	11/24/2022	Fage 4 01 4

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





Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura

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

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Certificate No. D2600V2-1126\_Aug23

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Yongin, Republic of Korea

Dbject	D2600V2 - SN:11:	26	
Calibration procedure(s)	QA CAL-05.v12		
	Calibration Procee	dure for SAR Validation Source	s between 0.7-3 GHz
Calibration date:	August 10, 2023	<u>실무</u>	자 기술책임자
and allott date.	August IV, ZVL9		ACATA
	j"	h	$\sim 10^{-10}$
his calibration certificate documer	nts the traceability to nation	nal standards, which realize the physical ur	nits of measurements (SI).
		bability are given on the following pages a	
I calibrations have been conducted	ed in the closed laboratory	r 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
,		,	
ower meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
	SN: 104778 SN: 103244	30-Mar-23 (No. 217-03804/03805) 30-Mar-23 (No. 217-03804)	Mar-24 Mar-24
ower sensor NRP-Z91			
Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 103244 SN: 103245	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805)	Mar-24 Mar-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Fype-N mismatch combination	SN: 103244 SN: 103245 SN: BH9394 (20k)	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809)	Mar-24 Mar-24 Mar-24
Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810)	Mar-24 Mar-24 Mar-24 Mar-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22)	Mar-24 Mar-24 Mar-24 Mar-24 Jan-24 Dec-23
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house)	Mar-24 Mar-24 Mar-24 Mar-24 Jan-24 Dec-23 Scheduled Check
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house) 30-Oct-14 (in house check Oct-22)	Mar-24 Mar-24 Mar-24 Jan-24 Jan-24 Dec-23 Scheduled Check In house check: Oct-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Mar-24 Mar-24 Mar-24 Jan-24 Jan-24 Dec-23 Scheduled Check In house check: Oct-24 In house check: Oct-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Mar-24 Mar-24 Mar-24 Jan-24 Jec-23 Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A Re generator R&S SMT-06	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22)	Mar-24 Mar-24 Mar-24 Jan-24 Jan-24 Dec-23 Schedùled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Mar-24 Mar-24 Mar-24 Jan-24 Jan-24 Dec-23 Schedùled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22)	Mar-24 Mar-24 Mar-24 Jan-24 Jan-24 Dec-23 Schedùled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A Regenerator R&S SMT-06 Network Analyzer Agilent E8358A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22) Function	Mar-24 Mar-24 Mar-24 Jan-24 Jan-24 Dec-23 <u>Scheduled Check</u> In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
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Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S

Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

С Servizio svizzero di taratura

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

#### **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) 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"

### **Additional Documentation:**

c) 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 source is mounted in a touch configuration below the . center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). 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 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	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz ± 1 MHz	

#### Head TSL parameters

The following parameters and calculations were applied.

U	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	2.02 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.0 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.3 W/kg ± 16.5 % (k=2)

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.1 ± 6 %	2.19 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	53.6 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	6.12 W/kg

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	47.8 Ω - 7.6 jΩ
Return Loss	- 21.9 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	🤄 44.7 Ω - 5.3 jΩ
Return Loss	- 22.1 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.152 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: 10.08.2023

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1126

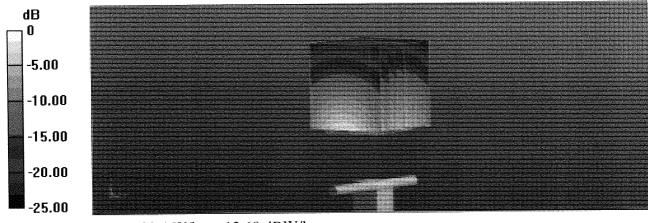
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = (37.7; \rho = 1000 \text{ kg/m}^3 \text{ Phantom section: Flat Section}$ Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.68, 7.68, 7.68) @ 2600 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 117.5 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 27.7 W/kg SAR(1 g) = 14.3 W/kg; SAR(10 g) = 6.4 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51.4% Maximum value of SAR (measured) = 23.4 W/kg



0 dB = 23.4 W/kg = 13.69 dBW/kg

## Impedance Measurement Plot for Head TSL

Eile	⊻jew	<u>C</u> hannel	Sw <u>e</u> ep	Calibration	<u>I</u> race <u>S</u> cale	Marker	System ⊻	⊻indow	<u>H</u> elp		
					Æ			Ale and a second	2.600000 G 8.0787 2.600000 G	pF <u>7</u> Hz 80.	2,800 Ω 5772 Ω 434 mU 101.76 °
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0.											
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	5.00 3.00										
	3.00 5.00						<u> </u>	<u> </u>			
	0.00	Ch 1 Avg = tart 2.40000	= 20 GHz	989999				<u> </u>		Stop	2.80000 GHz
SI	tatus	CH 1:	S11		] C* 1-Port		Avg=20 D	elay			LCL

## **DASY5** Validation Report for Body TSL

Date: 04.08.2023

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1126

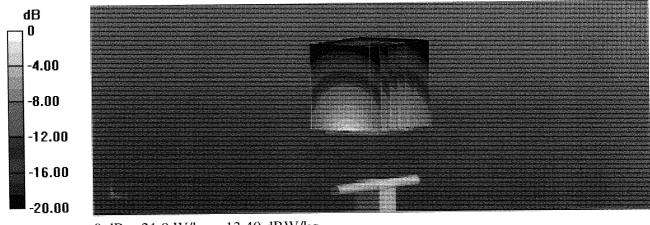
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 2.19$  S/m;  $\epsilon_r = 52.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.83, 7.83, 7.83) @ 2600 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 108.9 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 25.7 W/kg SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.12 W/kg Smallest distance from peaks to all points 3 dB below = 8.2 mm Ratio of SAR at M2 to SAR at M1 = 53.4% Maximum value of SAR (measured) = 21.9 W/kg



0 dB = 21.9 W/kg = 13.40 dBW/kg

# Impedance Measurement Plot for Body TSL

jle	⊻iew	Channel	Sweep	Calibration	<u>Trace</u> <u>S</u> cale	Marker	System	<u>W</u> indow	Help			
					A				2.60000 11. 2.60000	535 pF	44.722 5.3069 78.897 r -131.6	id nU
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	0.00	Ch 1 Avg Start 2.40000	= 20 ) GHz -=	2239/1534M		1					Stop 2.8000	0 GHz

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland BC-MRA



S Schweizerischer Kalibrierdienst

- C Service suisse d'étalonnage
  - Servizio svizzero di taratura

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

#### Client Element

Certifi

<sup>cate No.</sup> D2600V2-1009_Jun	23	
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Yongin, Republic of Korea

Calibration procedure(s)   QA CAL-05.v12 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz     Calibration date:   June 12, 2023     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 calibration shave 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 #     Calibration RP-291   SN: 104778     SN: 104243   30-Mar-23 (No. 217-03804)     Power sensor NRP-291   SN: 103244     SN: 103244   30-Mar-23 (No. 217-03805)     Mar-24   Power sensor NRP-291     SN: 103245   30-Mar-23 (No. 217-03805)     Mar-24   SN: 601     Power sensor NRP-291   SN: 103245     SN: 6101   19-De-22 (No. DAE4-601 Dec22)     DAE4   SN: 601   19-De-22 (No. DAE4-601 Dec22)     DAE4   SN: 61393512475   30-Oct-14 (in house check Oct-22)     Power sensor HP 8431A   SN: W141093315   07-Oct-15 (in house check Oct-22)     Power sensor HP 8431A   SN: W14109315   <	Object	D2600V2 - SN:1	009	
Calibration date:   June 12, 2023     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 procedure(s)		edure for SAR Validation Source	s between 0.7-3 GHz
Calibration date:   June 12, 2023   June 12, 2023     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%.				실무자 기수 레이 <b>고</b> 다
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 date:	June 12, 2023	The second secon	~ franka 6-28-2
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 NRP2   SN: 104778   30-Mar-23 (No. 217-03804/03805)   Mar-24     Power sensor NRP-Z91   SN: 103245   30-Mar-23 (No. 217-03804)   Mar-24     Power sensor NRP-Z91   SN: 103245   30-Mar-23 (No. 217-03805)   Mar-24     Reference 20 dB Attenuator   SN: BH9394 (20k)   30-Mar-23 (No. 217-03809)   Mar-24     SN: 010982 / 06327   30-Mar-23 (No. 217-03809)   Mar-24     Vpve-N mismatch combination   SN: 310982 / 06327   30-Mar-23 (No. 217-03809)   Mar-24     SAE4   SN: 601   19-Dec-22 (No. DAE4-601_Dec22)   Dec-23     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     Power meter E4419B   SN: GB39512475   30-Oct-14 (in house check Oct-22)   In house check: Oct-24     Power sensor HP 8481A   SN: W141093315   07-Oct-15 (in house check Oct-22)   In house check: Oct-24     Power sensor HP 8481A   SN: US41080477   31-Mar-14 (in house check Oct-22)   In house check	This calibration certificate documen	nts the traceability to nati tainties with confidence p	onal standards, which realize the physical ur	hits of measurements (SI).
Calibration Equipment used (M&TE critical for calibration)     Primary Standards   ID #   Cal Date (Certificate No.)   Scheduled Calibration     Power meter NRP2   SN: 104778   30-Mar-23 (No. 217-03804/03805)   Mar-24     Power sensor NRP-Z91   SN: 103244   30-Mar-23 (No. 217-03804)   Mar-24     Power sensor NRP-Z91   SN: 103245   30-Mar-23 (No. 217-03805)   Mar-24     Power sensor NRP-Z91   SN: 103245   30-Mar-23 (No. 217-03809)   Mar-24     Power sensor NRP-Z91   SN: 310982 / 06327   30-Mar-23 (No. 217-03809)   Mar-24     Ype-N mismatch combination   SN: 310982 / 06327   30-Mar-23 (No. 217-03809)   Mar-24     AEference Probe EX3DV4   SN: 7349   10-Jan-23 (No. EX3-7349_Jan23)   Jan-24     OAE4   SN: 601   19-Dec-22 (No. DAE4-601_Dec22)   Dec-23     Secondary Standards   ID #   Check Date (in house)   Scheduled Check     Power sensor HP 8481A   SN: US37292783   07-Oct-15 (in house check Oct-22)   In house check: Oct-24     Power sensor HP 8481A   SN: US41080477   31-Jun-15 (in house check Oct-22)   In house check: Oct-24     Power sensor HP 8481A   SN: US41080477   31-Mar-14 (in house check Oct-22)				
Primary StandardsID #Cal Date (Certificate No.)Scheduled CalibrationPower meter NRP2SN: 10477830-Mar-23 (No. 217-03804/03805)Mar-24Power sensor NRP-Z91SN: 10324430-Mar-23 (No. 217-03804)Mar-24Power sensor NRP-Z91SN: 10324530-Mar-23 (No. 217-03805)Mar-24Reference 20 dB AttenuatorSN: BH9394 (20k)30-Mar-23 (No. 217-03809)Mar-24Sype-N mismatch combinationSN: 310982 / 0632730-Mar-23 (No. 217-03810)Mar-24Secondary StandardsSN: 734910-Jan-23 (No. EX3-7349_Jan23)Jan-24DAE4SN: 60119-Dec-22 (No. DAE4-601_Dec22)Dec-23Secondary StandardsID #Check Date (in house)Scheduled CheckPower sensor HP 8481ASN: US3729278307-Oct-15 (in house check Oct-22)In house check: Oct-24Power sensor HP 8481ASN: 1097215-Jun-15 (in house check Oct-22)In house check: Oct-24SN: 10097215-Jun-15 (in house check Oct-22)In house check: Oct-24SN: US4108047731-Mar-14 (in house check Oct-22)In house check: Oct-24SN: US4108047731-Mar-14 (in house check Oct-22)In house check: Oct-24Calibrated by:NameFunctionSignature	All calibrations have been conducted	ed in the closed laborato	ry facility: environment temperature (22 $\pm$ 3)°	C and humidity < 70%.
Power meter NRP2     SN: 104778     30-Mar-23 (No. 217-03804/03805)     Mar-24       Power sensor NRP-Z91     SN: 103244     30-Mar-23 (No. 217-03804)     Mar-24       Power sensor NRP-Z91     SN: 103245     30-Mar-23 (No. 217-03805)     Mar-24       Power sensor NRP-Z91     SN: 103245     30-Mar-23 (No. 217-03805)     Mar-24       Reference 20 dB Attenuator     SN: BH9394 (20k)     30-Mar-23 (No. 217-03809)     Mar-24       Vipe-N mismatch combination     SN: 310982 / 06327     30-Mar-23 (No. 217-03809)     Mar-24       Reference Probe EX3DV4     SN: 7349     10-Jan-23 (No. EX3-7349_Jan23)     Jan-24       OAE4     SN: 601     19-Dec-22 (No. DAE4-601_Dec22)     Dec-23       Secondary Standards     ID #     Check Date (in house)     Scheduled Check       Power sensor HP 8481A     SN: US37292783     07-Oct-14 (in house check Oct-22)     In house check: Oct-24       Power sensor HP 8481A     SN: US41080477     31-Mar-14 (in house check Oct-22)     In house check: Oct-24       Power sensor HP 8481A     SN: US41080477     31-Mar-14 (in house check Oct-22)     In house check: Oct-24       Power sensor HP 8481A     SN: US41080477     31-Mar-14 (in house che	Calibration Equipment used (M&TE	E critical for calibration)		
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Power sensor HP 8481A   SN: MY41093315   07-Oct-15 (in house check Oct-22)   In house check: Oct-24     RF generator R&S SMT-06   SN: 100972   15-Jun-15 (in house check Oct-22)   In house check: Oct-24     Network Analyzer Agilent E8358A   SN: US41080477   31-Mar-14 (in house check Oct-22)   In house check: Oct-24     Name   Function   Signature     Calibrated by:   Paulo Pina   Laboratory Technician	ower meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
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letwork Analyzer Agilent E8358A   SN: US41080477   31-Mar-14 (in house check Oct-22)   In house check: Oct-24     Name   Function   Signature     Calibrated by:   Paulo Pina   Laboratory Technician		SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Name Function Signature   Calibrated by: Paulo Pina Laboratory Technician	-	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Calibrated by: Paulo Pina Laboratory Technician	letwork Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
Calibrated by: Paulo Pina Laboratory Technician		Name	Function	Signature
Approved by: Sven Kühn Technical Manager : A. A. Kerbbell	Calibrated by:	Paulo Pina	Laboratory Technician	
Approved by: Sven Kühn Technical Manager				And a second second
		Swan Kriba	Technical Manager	
	Approved by:	Sven Kunn		1 led 1

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





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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

## Glossary:

TSL	tissue simulating liquid
	sensitivity in TSL / NORM x,y,z
N/A	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.
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## **Additional Documentation:**

c) 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). 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 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	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	1999 - San
Frequency	2600 MHz ± 1 MHz	

#### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.4 ± 6 %	1.97 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		The second

### SAR result with Head TSL

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	(14.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.3 W/kg ± 17.0 % (k=2)
		Contraction of the second seco
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.48 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.8 W/kg ± 16.5 % (k=2)
	······································	and the second

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.1 ± 6 %	2.15 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	(13.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	54.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.6 W/kg ± 16.5 % (k=2)

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.1 Ω - 4.2 jΩ
Return Loss	- 26.5 dB

## Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.7 Ω - 2.8 jΩ
Return Loss	- 23.9 dB

## **General Antenna Parameters and Design**

Electrical Delay (one direction)		
Lieuliua Delay (one direulion)	1.153 ns	
,	1.100 113	

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

1	Manufactured by	SPEAG

## **DASY5 Validation Report for Head TSL**

Date: 09.06.2023

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1009

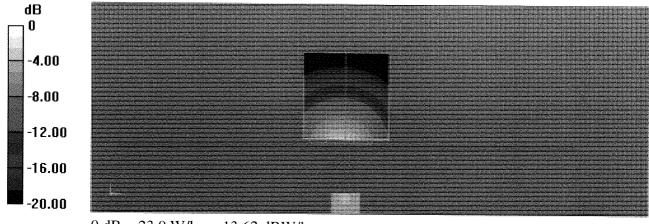
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 1.97$  S/m;  $\varepsilon_r = 38.4$ ; p = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.68, 7.68, 7.68) @ 2600 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 119.0 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 28.1 W/kg SAR(1 g) = 14.4 W/kg; SAR(10 g) = 6.48 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51.6% Maximum value of SAR (measured) = 23.0 W/kg



0 dB = 23.0 W/kg = 13.62 dBW/kg

## Impedance Measurement Plot for Head TSL

Ch 1 Avg = 20   2 600000 GHz   48 061 C     Ch 1 Avg = 20   2 600000 GHz   47 177 mL     Ch 1 Avg = 20   3top 2 80000 GHz   -112.31 1     Ch 1 Avg = 20   3top 2 80000 GHz   -26 525 dE     0 00   10.00   12 800000 GHz   -26 525 dE     5 00   10.00   10.00   10.00   10.00     15 00   20.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     15 00   10.00   10.00   10.00   10.00     1	<u>-</u> jle	⊻iew	Channel	Sw <u>e</u> ep	Calibration	Irace	<u>S</u> cale	Marker	System	Window	Help				
Ch 1 Avg = 20   Stop 2.80000 GHz     Ch 1 Avg = 20   Stop 2.80000 GHz     10.00   1   2.800000 GHz   -28.525 dE     0.00   1   2.800000 GHz   -28.525 dE     0.00   1   1   2.80000 GHz   -28.525 dE     10.00   1   1   1   1   1     10.00   1   1   1   1   1   1     10.00   1						4	$\langle \langle \rangle$	$\sim$		2		14,558	pF	(-4) 47	2048 ( 177 ml
Ch1: Start 2.40000 GHz Stop 2.80000 GHz   10.00 10.00   5.00 1   0.00 1   5.00 1   10.00 1   2.800000 GHz -26.525 dE   0.00 1   5.00 1   10.00 1   10.00 1   25.00 1   25.00 1   30.00 1   25.00 1   30.00 1   25.00 1   25.00 1   30.00 1   25.00 1   30.00 1   25.00 1   25.00 1   30.00 1   25.00 1   30.00 1   25.00 1   30.00 1   25.00 1   30.00 1   25.00 1   30.00 1   25.00 1   30.00 1   20.00 1   20.00 1   20.00 1   30.00 1   20.00 1   30.00 1   30.00 1 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>ł</td> <td>X</td> <td></td> <td>Ì</td> <td></td> <td></td> <td></td> <td></td> <td></td>							ł	X		Ì					
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25.00 -30.00 -35.00 -40.00 Ch 1 Avg = 20 Ch 1: Start 2.40000 GHz Stop 2.80000 GHz	10.0 5.0 0.0	Ch1: Sra 10   0   0	art 2.40000							1	2.800	)000 G	Hz		
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	10.0 5.0 -5.0 -10, -15, -20, -25,	Ch1:Sta 0 - 0 - 0 - 00 - 00 - 00 - 00 - 00 - 0	art 2.40000							1:	2.600	)000 C	Hz		
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## **DASY5 Validation Report for Body TSL**

Date: 12.06.2023

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1009

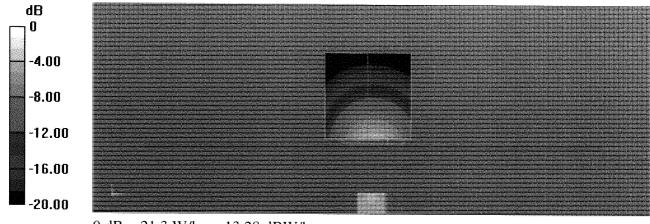
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 2.15$  S/m;  $\varepsilon_r = 52.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.83, 7.83, 7.83) @ 2600 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 107.6 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 26.2 W/kg SAR(1 g)  $\neq$  13.6 W/kg; SAR(10 g) = 6.15 W/kg Smallest distance from peaks to all points 3 dB below = 8.5 mm Ratio of SAR at M2 to SAR at M1 = 53.4% Maximum value of SAR (measured) = 21.3 W/kg



0 dB = 21.3 W/kg = 13.28 dBW/kg

## Impedance Measurement Plot for Body TSL

File	⊻iew	Channel	Sw <u>e</u> ep	Calibration	<u>Trace</u> <u>S</u> cal	e M <u>a</u> rker	System	Window	Help				Winnersteine
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#### Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland

**PC Test** 

Client





S

Schweizerischer Kalibrierdienst

- C Service suisse d'étalonnage
- Servizio svizzero di taratura
- 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

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### **CALIBRATION CERTIFICATE**

			/			
Object	D3500V2 - SN:11	126	ATH			
		KT ✓ 09/13/2022	119121			
Callbration procedure(s)	QA CAL-22.v6 Calibration Proce	dure for SAR Validation Sources	between 3-10 GHz			
			VW 8/16/2023			
Calibration date:	June 09, 2021		V 1 VV 0/10/2023			
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)	Арг-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: 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: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21			
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21			
	1					
Secondary Standards	ID#	Check Date (in house)	Scheduled Check			
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22			
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22			
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22			
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22			
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21			
	Name	Function	Signature			
Calibrated by:	Michael Weber	Laboratory Technician	Miller-			
Approved by:	Katja Pokovic	Technical Manager	MAG			

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

#### Calibration Laboratory of

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





Schweizerischer Kalibrierdienst

S Service suisse d'étalonnage С

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Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Glossanv

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	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3500 MHz ± 1 MHz	

#### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.9	2.91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.1 ± 6 %	2.92 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		·····

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.73 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	67.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	· · · · · · · · · · · · · · · · · · ·
SAR measured	100 mW input power	2.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg ± 19.5 % (k=2)

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	51.3	3.31 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.6 ± 6 %	3.29 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.34 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	63.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	Maan Annaha Anna Anna Anna
SAR measured	100 mW input power	2.36 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.6 W/kg ± 19.5 % (k=2)

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.4 Ω - 1.7 jΩ
Return Loss	- 35.0 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	54.2 Ω + 0.8 jΩ
Return Loss	- 27.8 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1 405
	1.135 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
	SFEAG

#### **DASY5 Validation Report for Head TSL**

Date: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

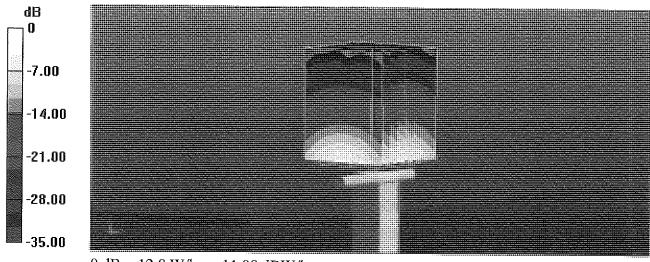
### DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1126

Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma = 2.92$  S/m;  $\epsilon_r = 37.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.91, 7.91, 7.91) @ 3500 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3500MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 72.49 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 18.3 W/kg **SAR(1 g) = 6.73 W/kg; SAR(10 g) = 2.51 W/kg** Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 73.8% Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.08 dBW/kg

# Impedance Measurement Plot for Head TSL

	<u>/</u> iew	Channel	Sw <u>e</u> ep	Calibration	Trace	Scale	M <u>a</u> rker	System	™indow	He	Яр				:
		Ch 1 Avg =	20		(-						500000 26.1 500000	55 pF		50.42 1.738 7.812 -75.3	18 Ω mU
Ch	1: Sta	n 3.30000	GHz				·						Ston	3.7000	2010
															J G H2
10.00		r sii						>		3,5	00000	i dHz		1.986	- inr
5.00 0.00		<u>BSII</u>						>		3,5	00000	IGHz			- inr
5.00 0.00 -5.00		<u>B S11</u>						>		3,8	00000	I GHz			- inr
5.00 0.00		B SM						>		3,5	00000	I GHz			- inr
5.00 0.00 -5.00 -10.00		<u>B SITI</u>						>		3.5	00000	I EHz			- inr
5.00 0.00 -5.00 -10.00 -15.00 -20.00 -25.00		R SII						>	1	3,5	00000	I GHz			- inr
5.00 0.00 -5.00 -10.00 -15.00 -20.00 -25.00 -30.00		R SII						>		3.5	00000	I GHz			- inr
5.00 0.00 -5.00 -10.00 -15.00 -25.00 -25.00 -35.00 -35.00 -40.00		Ch 1 Avg ≈	20							3.3		I GHz			- inr
5.00 0.00 -5.00 -10.00 -15.00 -25.00 -25.00 -35.00 -35.00 -40.00			20 3Hz							3.5		I CHz	-3		

### **DASY5 Validation Report for Body TSL**

Date: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

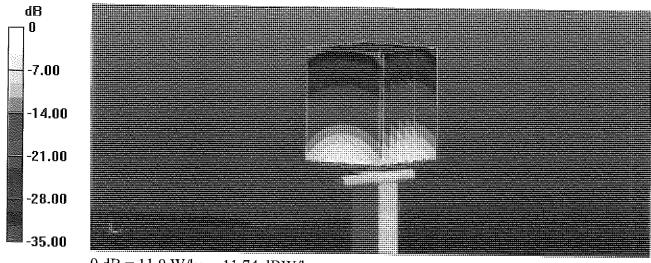
### DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1126

Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma = 3.29$  S/m;  $\epsilon_r = 51.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.46, 7.46, 7.46) @ 3500 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm, f=3500MHz/Zoom Scan , dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 64.24 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 17.0 W/kg SAR(1 g) = 6.34 W/kg; SAR(10 g) = 2.36 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 75.5% Maximum value of SAR (measured) = 11.9 W/kg



0 dB = 11.9 W/kg = 11.74 dBW/kg

# Impedance Measurement Plot for Body TSL

<u>File Viev</u>	W <u>C</u> hannel	<u> 5weep</u>	Calibration	<u>T</u> race <u>S</u> ca	e M <u>a</u> rker	System	Window	Help				
	Ch 1 Avg=	20					$\mathcal{A}$	3.500000 34.2 3.500000	16 pH	752 40	4.154 Ω 2.44 mΩ 532 mU 9.8529 °	
Ch1: :	Start 3.30000 (	GHz				<u>}</u>				Stop 3	3.70000 GHz	
10.00	THE REAL PROPERTY											
5.00	dB \$11			_		>		3.90000	ICH2	-21	.844 dB	
5,00 0.00 -5.00						2		3.500000	ICH2	-21	.844 dB	
5.00 0.00								3.800000	I CHz	-27	.844 dB	
5.00 0.00 -5.08 -10.00 -15.00 -20.00								3.500000	ICH2	-27	.844 dB	
5.00 0.00 -5.00 -10.00 -15.00								3.500000		-27	.844 dB	
5.00 0.00 -5.00 -10.00 -15.00 -20.00 -25.00 -25.00 -35.00 -35.00	Ch 1 Avg =	20						3.500000		~2?	.844 dB	
5.00 0.00 -5.00 -10.00 -15.00 -20.00 -25.00 -25.00 -35.00 -35.00	Ch 1 Avg =	20 3Hz		C* 1-Port				3.500000			.844 dB	





# **Certification of Calibration**

Object

D3500V2 - SN: 1126

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

June 9, 2022

Extended Calibration date:

Description:

SAR Validation Dipole at 3500 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	2/11/2022	Annual	2/11/2023	MY40003841
Agilent	N5182A	MXG Vector Signal Generator	5/6/2022	Annual	5/6/2023	MY51240479
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Anritsu	MA2411B	Pulse Power Sensor	3/2/2022	Annual	3/2/2023	1126066
Anritsu	MA2411B	Pulse Power Sensor	3/28/2022	Annual	3/28/2023	1339007
Anritsu	ML2495A	Power Meter	3/31/2022	Annual	3/31/2023	1138001
Control Company	4353	Long Stem Thermometer	10/28/2020	Biennial	10/28/2022	200670623
Control Company	4040	Therm./Clock/Humidity Monitor	3/12/2021	Biennial	3/12/2023	210202100
Agilent	85033E	3.5mm Standard Calibration Kit	44384	Annual	44749	MY53402352
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Mini-Circuits	ZHDC-16-63-S+	Coupler	CBT	N/A	CBT	F709401716
Seekonk	NC-100	Torque Wrench	7/30/2020	Biennial	7/30/2022	22217
SPEAG	DAK-3.5	Portable Dielectric Assessment Kit	10/7/2021	Annual	10/7/2022	1045
SPEAG	EX3DV4	SAR Probe	11/16/2021	Annual	11/16/2022	7639
SPEAG	EX3DV4	SAR Probe	4/22/2022	Annual	4/22/2023	7532
SPEAG	DAE4	Data Acquisition Electronics	11/11/2021	Annual	11/11/2022	1646
SPEAG	DAE4	Data Acquisition Electronics	4/13/2022	Annual	4/13/2023	501

Measurement Uncertainty = ±23% (k=2)

	Name	Function	Signature
Calibrated By:	Parker Jones	Department Manager	Parker Jones
Approved By:	Kaitlin O'Keefe	Managing Director	ROK

Object:	Date Issued:	Page 1 of 4
D3500V2 – SN: 1126	6/9/2022	Fage 1014

# **DIPOLE CALIBRATION EXTENSION**

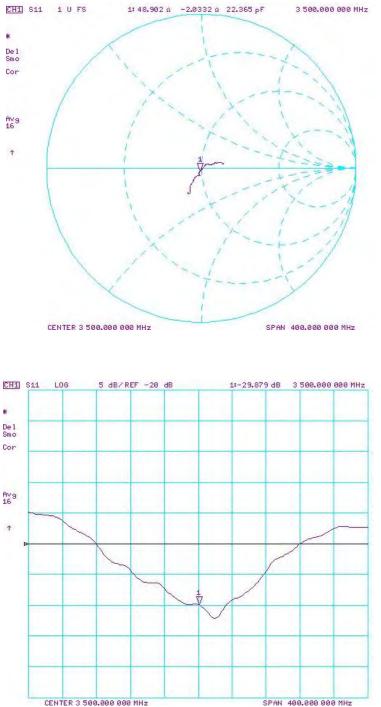
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance does not deviate more than  $5\Omega$  from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

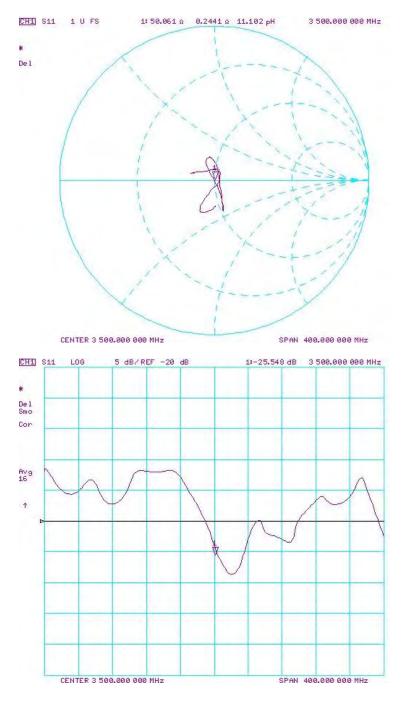
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm	(9()		Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
6/9/2021	6/9/2022	1.135	6.7	6.65	-0.75%	2.5	2.53	1.20%	50.4	48.9	1.5	-1.7	-2	0.3	-35	-29.9	14.60%	PASS
Date	Extension Date		Body (1g) W/kg @ 20.0 dBm	Measured Body SAR (1g) W/kg @ 20.0 dBm	(%)	Body (10g) W/kg @ 20.0 dBm	(10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm) Real	Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Body (dB)	Deviation (%)	
6/9/2021	6/9/2022	1.135	6.36	6.64	4.40%	2.36	2.45	3.81%	54.2	50.1	4.1	0.8	0.2	0.6	-27.8	-25.5	8.10%	PASS

Object:	Date Issued:	Page 2 of 4
D3500V2 – SN: 1126	6/9/2022	Fage 2 014



Impedance & Return-Loss Measurement Plot for Head TSL

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D3500V2 – SN: 1126	6/9/2022	rage 5 01 4



#### Impedance & Return-Loss Measurement Plot for Body TSL

Object:	Date Issued:	Page 4 of 4
D3500V2 – SN: 1126	6/9/2022	Faye 4 01 4



ELEMENT MATERIALS TECHNOLOGY

(formerly PCTEST) 18855 Adams Ct, Morgan Hill, CA 95037 USA Tel. +1.408.538.5600 http://www.element.com



# **Certification of Calibration**

Object

D3500V2 – SN: 1126

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extension Calibration date: June 09, 2023

Description:

SAR Validation Dipole at 3500 MHz.

Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	6/14/2022	Annual	6/14/2023	US39170118
Agilent	E4438C	ESG Vector Signal Generator	11/17/2022	Annual	11/17/2023	MY45093852
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Rohde & Schwarz	NRX	Power Meter	1/11/2023	Annual	1/11/2024	102583
Rohde & Schwarz	NRP-Z81	Wide Band Power Sensor	1/19/2023	Annual	1/19/2024	106563
Rohde & Schwarz	NRP-Z81	Wide Band Power Sensor	1/11/2023	Annual	1/11/2024	106564
Traceable	4040 90080-06	Therm./ Clock/ Humidity Monitor	5/11/2022	Biennial	5/11/2024	221514974
Control Company	4353	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774685
Agilent	85033E	3.5mm Standard Calibration Kit	6/21/2022	Annual	6/21/2023	MY53402352
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Mini-Circuits	ZHDC-16-63-S+	50-6000MHz Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	NC-100	Torque Wrench	12/5/2022	Biennial	12/5/2024	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	8/15/2022	Annual	8/15/2023	1041
SPEAG	EX3DV4	SAR Probe	1/17/2023	Annual	1/17/2024	3837
SPEAG	EX3DV4	SAR Probe	12/9/2022	Annual	12/9/2023	7490
SPEAG	DAE4	Dasy Data Acquisition Electronics	12/13/2022	Annual	12/13/2023	1644
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/17/2023	Annual	1/17/2024	793

Measurement Uncertainty = ±23% (k=2)

	Name	Function	Signature
Calibrated By:	Arturo Oliveros	Compliance Engineer	AC
Approved By:	Greg Snyder	Executive VP of Operations	Lugg Ml Syl

Object:	Date Issued:	Page 1 of 4
D3500V2 – SN: 1126	06/09/2023	Fage 1014

# **DIPOLE CALIBRATION EXTENSION**

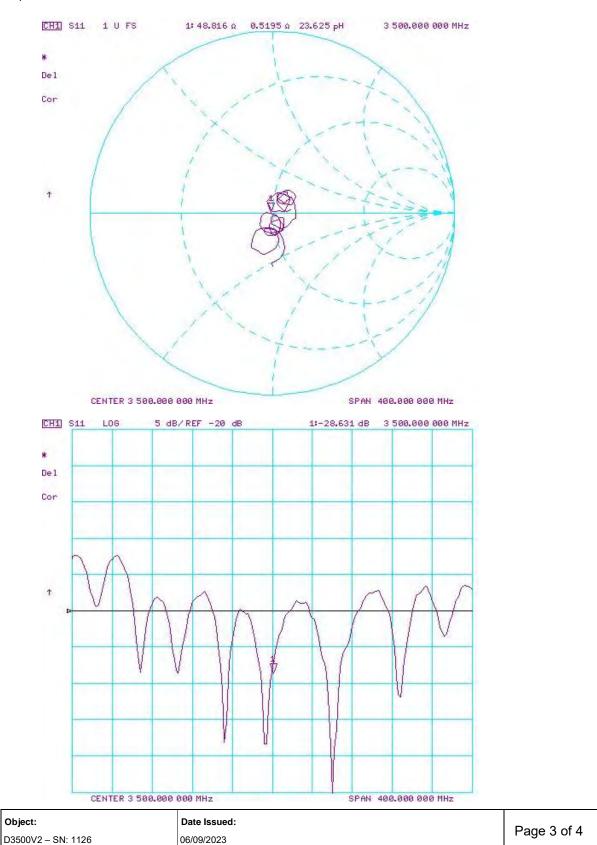
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance does not deviate more than  $5\Omega$  from the previous measurement.

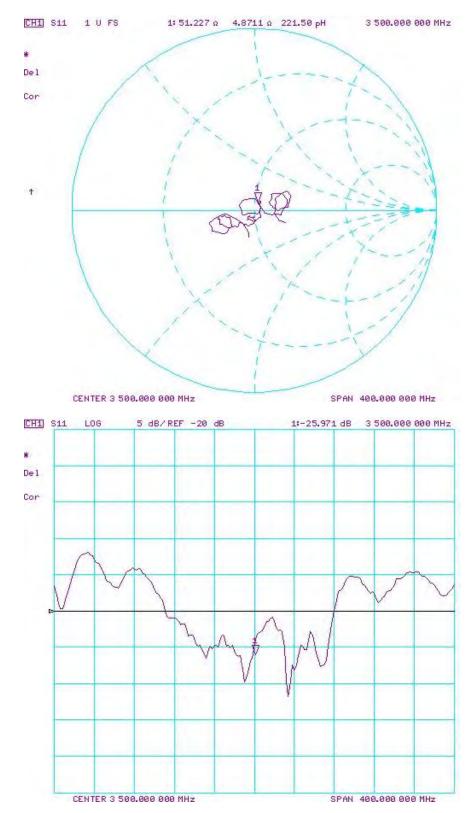
The following dipole was checked to pass the above 3 requirements to have 3-year calibration period from the calibration date:

Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
6/9/2021	6/9/2023	1.135	6.70	6.41	-4.33%	2.50	2.45	-2.00%	50.4	48.8	1.6	-1.7	0.5	2.2	-35.0	-28.6	18.20%	PASS
Calibration Date	Extension Date	Certificate Electrical Delay (ns)		Measured Body SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Body (10g) W/kg @ 20.0 dBm		Deviation 10g (%)	Certificate Impedance Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Body (Ohm) Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
6/9/2021	6/9/2023	1.135	6.36	6.02	-5.35%	2.36	2.25	-4.66%	54.2	51.2	3.0	0.8	4.9	4.1	-27.8	-26.0	6.60%	PASS

Object:	Date Issued:	Page 2 of 4
D3500V2 – SN: 1126	06/09/2023	Page 2 of 4



#### Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL

Object:	Date Issued:	Dage 4 of 4
D3500V2 – SN: 1126	06/09/2023	Page 4 of 4

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

PC Test

Client



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Accreditation No.: SCS 0108

S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Certificate No: D3700V2-1097\_Jun21

# **CALIBRATION CERTIFICATE**

Object	D3700V2 - SN:10	997	VATA				
Calibration procedure(s)	OA CAL-22.46 Calbraton Pros	dure for SAR Validation Sources	013124 10000000 3-10 CH2				
			, ATM				
Calibration date:	June 09, 2021		6/9/2022				
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 conducto	ed in the closed laborator	y facility: environment temperature (22 ± 3)°(	C and humidity < 70%.				
Calibration Equipment used (M&TE	E 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: 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: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21				
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21				
Secondary Standards	ID #	Check Date (in house)	Scheduled Check				
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check; Oct-22				
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	in house check: Oct-22				
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22				
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22				
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22				
	Name	Function	Signature				
Calibrated by:	Michael Weber	Laboratory Technician	Milleser				
Approved by:	Katja Pokovic	Technical Manager	fllly				
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory	Issued: June 10, 2021				

#### Calibration Laboratory of

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





S

Schweizerischer Kalibrierdienst

C Service suisse d'étalonnage

Servizio svizzero di taratura

Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### 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) 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	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3700 MHz ± 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.7	3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.9 ± 6 %	3.08 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.82 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	68.1 W/kg ± 19.9 % (k=2)
SAR averaged over $10 \text{ cm}^3$ (10 g) of Head TSI	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.46 W/kg

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	51.0	3.55 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.3 ± 6 %	3.50 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.20 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	62.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.2 W/kg ± 19.5 % (k=2)

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	47.3 Ω + 0.9 jΩ
Return Loss	- 30.6 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.6 Ω + 1.8 jΩ
Return Loss	- 26.1 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.132 ns
,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1.132 IIS

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
	SPEAG

#### **DASY5 Validation Report for Head TSL**

Date: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

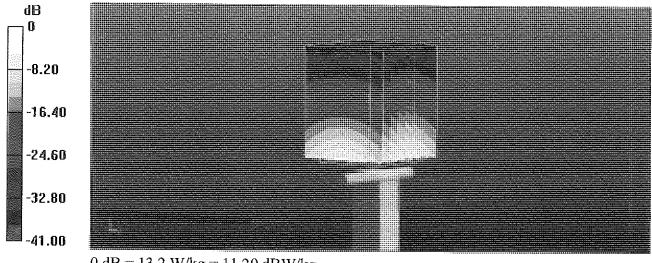
#### DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1097

Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz;  $\sigma = 3.08$  S/m;  $\epsilon_r = 36.9$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.73, 7.73, 7.73) @ 3700 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3700MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 72.08 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 19.5 W/kg SAR(1 g) = 6.82 W/kg; SAR(10 g) = 2.46 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 73.7% Maximum value of SAR (measured) = 13.2 W/kg



0 dB = 13.2 W/kg = 11.20 dBW/kg

File	⊻iew	⊆hannel	Sw <u>e</u> ep	Calibration	<u>T</u> race <u>S</u> cale	Marker	System	<u>W</u> indow	Help				
	Ch1: Sra	Ch 1 Avg ≃ rt 3.50000	20 GHz						37	00 GHz .086 pH 00 GHz	86 : 29	17.275 Ω 2.16 mΩ .386 mU 161.94 °	19
Ľ											Stop	3.90000 GHz	
10.0 5.0 -5.0 -10, -15, -20, -25, -30, -35, -40,	0 - 00 - 00 - 00 - 00 - 00 - 00 - 00 -	E \$11	20						3.7000	00 (Hz	-31	0.637 dB	
	oo L Ch1: Sta	<u>ca 1 Avg -</u> rt 3.50000 (	<u>120</u> 3Hz	~ <b>!</b>	<u> </u>						Stop	3.90000 GHz	
Sta	tus	CH 1: 🔅	311		C* 1-Port		Avg=20	Delay				LCL	=1

#### **DASY5 Validation Report for Body TSL**

Date: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

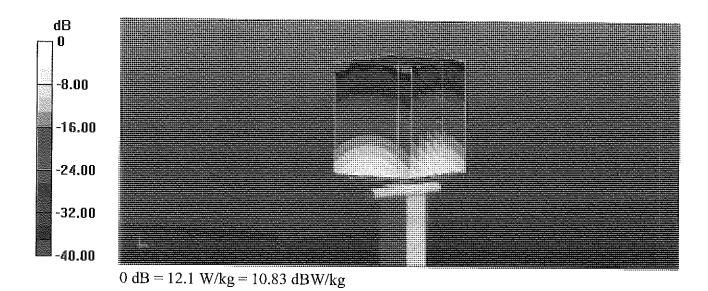
### DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN: 1097

Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz;  $\sigma = 3.5$  S/m;  $\epsilon_r = 51.3$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.31, 7.31, 7.31) @ 3700 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm, f=3700MHz/Zoom Scan , dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 64.18 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 17.1 W/kg SAR(1 g) = 6.2 W/kg; SAR(10 g) = 2.22 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 74.7% Maximum value of SAR (measured) = 12.1 W/kg



# Impedance Measurement Plot for Body TSL

Eile	⊻iew	⊆hannel	Sw <u>e</u> ep	Calibration	Trace	Scale	Marker	System	<u>W</u> indow	Help			
		Ch 1 Avg =	20						A	3.700000 ( 77.284 3.700000 (	i pH	45.616 C 1.7967 C 49.539 mU 156.64 *	
	Ch1:Sta	nt 3.50000 (	GHz					ļ			9	≹op 3.90000 GHz	
	. 17	Mildow Barris			- 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 199								2
10.0 5.00 -5.00 -10.0 -15.0 -20.0 -25.0 -30.0 -35.0	)									3.700000 (	Hz	-26.101 dB	
5.00 0.00 -5.00 -10.0 -15.0 -25.0 -25.0 -30.0 -35.0 -40.0	)	Ch 1 Avg =	20				······································			3.700000 (		-26.101 dB	
5.00 0.00 -5.00 -10.0 -15.0 -25.0 -25.0 -30.0 -35.0 -40.0	)	<u>Ch 1 Avg =</u> rt 3.50000 G	20 6Hz		C* 1-Port			> 					



Element Materials Technology Morgan Hill 18855 Adams Ct, Morgan Hill, CA 95037 USA Tel. +1.410.290.6652 / Fax +1.410.290.6654 http://www.element.com



# **Certification of Calibration**

Object

D3700V2 - SN: 1097

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

June 09, 2022

Extended Calibration date:

Description: SAR Validation Dipole at 3700 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	12/17/2021	Annual	12/17/2022	MY40000670
Agilent	E4438C	ESG Vector Signal Generator	3/24/2022	Annual	3/24/2023	MY45093678
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Anritsu	ML2495A	Power Meter	3/17/2022	Annual	3/17/2023	0941001
Anritsu	MA2411B	Pulse Power Sensor	3/2/2022	Annual	3/2/2023	1126066
Anritsu	MA2411B	Pulse Power Sensor	3/28/2022	Annual	3/28/2023	1339007
Traceable	4040 90080-06	Therm./ Clock/ Humidity Monitor	5/11/2022	Biennial	5/11/2024	221514974
Control Company	4353	Long Stem Thermometer	10/28/2020	Biennial	10/28/2022	200670633
Agilent	85033E	3.5mm Standard Calibration Kit	7/7/2021	Annual	7/7/2022	MY53402352
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Mini-Circuits	ZHDC-16-63-S+	50-6000MHz Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	NC-100	Torque Wrench	3/19/2022	Annual	3/19/2023	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	10/7/2021	Annual	10/7/2022	1045
SPEAG	EX3DV4	SAR Probe	11/16/2021	Annual	11/16/2022	7639
SPEAG	EX3DV4	SAR Probe	4/22/2022	Annual	4/22/2023	7532
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/11/2021	Annual	11/11/2022	1646
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/13/2022	Annual	4/13/2023	501

Measurement Uncertainty =  $\pm 23\%$  (k=2)

	Name	Function	Signature
Calibrated By:	Parker Jones	Department Manager	Parker Jones
Approved By:	Kaitlin O'Keefe	Managing Director	ROK

# **DIPOLE CALIBRATION EXTENSION**

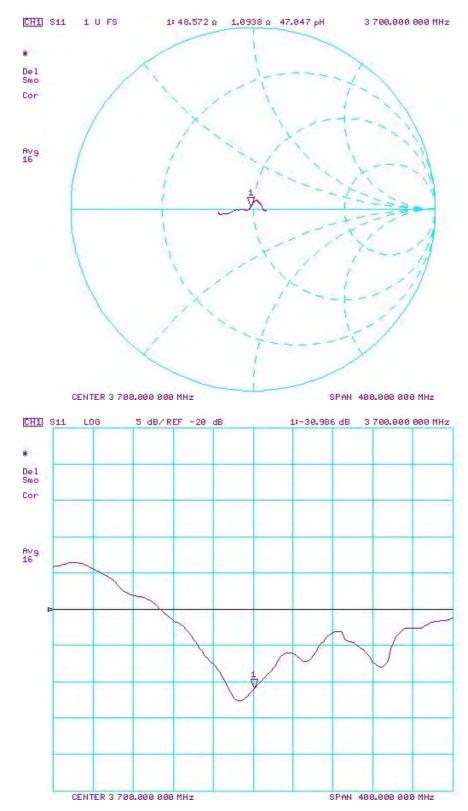
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance does not deviate more than  $5\Omega$  from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

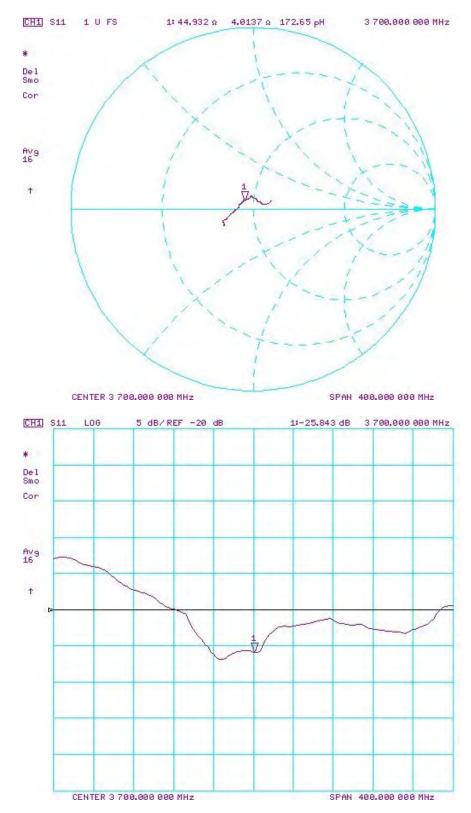
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real			Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)			PASS/FAIL
6/9/2021	6/9/2022	1.132	6.81	6.54	-3.96%	2.45	2.4	-2.04%	47.3	48.6	1.3	0.9	1.1	0.2	-30.6	-31	-1.30%	PASS
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Body (1g) W/kg @ 20.0 dBm	Measured Body SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Body (10g) W/kg @ 20.0 dBm	Measured Body SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Body (Ohm) Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)			PASS/FAIL
6/9/2021	6/9/2022	1.132	6.23	6.57	5.46%	2.22	2.37	6.76%	45.6	44.9	0.7	1.8	4	2.2	-26.1	-25.8	1.10%	PASS

Object:	Date Issued:	Page 2 of 4
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Impedance & Return-Loss Measurement Plot for Head TSL

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Impedance & Return-Loss Measurement Plot for Body TSL

Object:	Date Issued:	Dogo 4 of 4
D3700V2 – SN: 1097	06/09/2022	Page 4 of 4



ELEMENT MATERIALS TECHNOLOGY

(formerly PCTEST) 18855 Adams Ct, Morgan Hill, CA 95037 USA Tel. +1.408.538.5600 http://www.element.com



# **Certification of Calibration**

Object

D3700V2 – SN: 1097

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extension Calibration date: June 09, 2023

Description:

SAR Validation Dipole at 3700 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	6/14/2022	Annual	6/14/2023	US39170118
Agilent	E4438C	ESG Vector Signal Generator	11/17/2022	Annual	11/17/2023	MY45093852
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Rohde & Schwarz	NRX	Power Meter	1/11/2023	Annual	1/11/2024	102583
Rohde & Schwarz	NRP-Z81	Wide Band Power Sensor	1/19/2023	Annual	1/19/2024	106563
Rohde & Schwarz	NRP-Z81	Wide Band Power Sensor	1/11/2023	Annual	1/11/2024	106564
Traceable	4040 90080-06	Therm./ Clock/ Humidity Monitor	5/11/2022	Biennial	5/11/2024	221514974
Control Company	4353	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774685
Agilent	85033E	3.5mm Standard Calibration Kit	6/21/2022	Annual	6/21/2023	MY53402352
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Mini-Circuits	ZHDC-16-63-S+	50-6000MHz Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	NC-100	Torque Wrench	12/5/2022	Biennial	12/5/2024	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	8/15/2022	Annual	8/15/2023	1041
SPEAG	EX3DV4	SAR Probe	1/17/2023	Annual	1/17/2024	3837
SPEAG	EX3DV4	SAR Probe	12/9/2022	Annual	12/9/2023	7490
SPEAG	DAE4	Dasy Data Acquisition Electronics	12/13/2022	Annual	12/13/2023	1644
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/17/2023	Annual	1/17/2024	793

Measurement Uncertainty = ±23% (k=2)

	Name	Function	Signature
Calibrated By:	Arturo Oliveros	Compliance Engineer	AC
Approved By:	Greg Snyder	Executive VP of Operations	Lugo del

Object:	Date Issued:	Page 1 of 4
D3700V2 – SN: 1097	06/09/2023	Page 1 of 4

# **DIPOLE CALIBRATION EXTENSION**

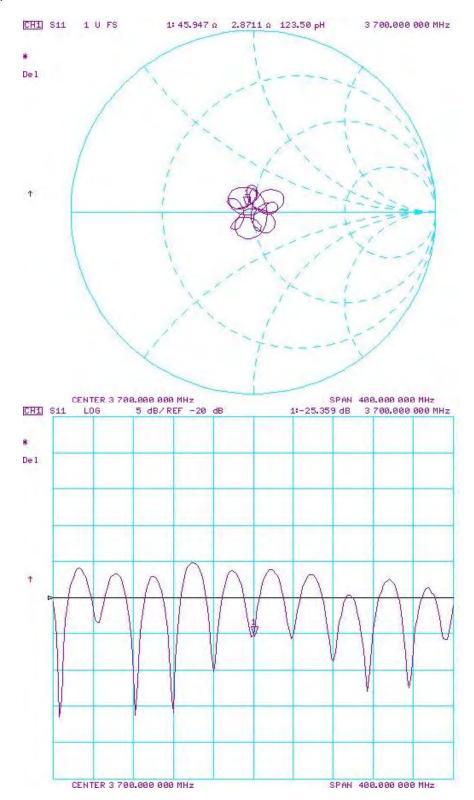
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance does not deviate more than  $5\Omega$  from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 3-year calibration period from the calibration date:

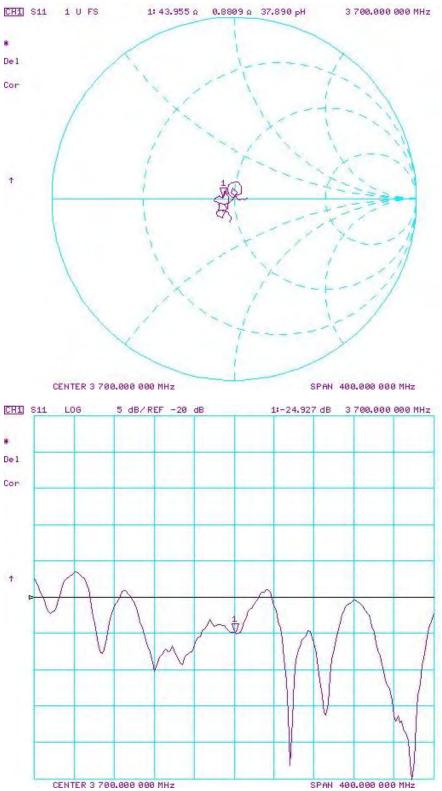
Calibration Date	Extension Date	Certificate Electrical Delay (ns)		Measured Head SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)		Measured Impedance Head (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
6/9/2021	6/9/2023	1.132	6.81	6.62	-2.79%	2.45	2.45	0.00%	47.3	46	1.3	0.9	2.9	2	-30.6	-25.4	17.10%	PASS
Calibration Date	Extension Date	Certificate Electrical Delay (ns)		Measured Body SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Body (10g) W/kg @ 20.0 dBm		Deviation 10g (%)	Certificate Impedance Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Body (Ohm) Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
6/9/2021	6/9/2023	1.132	6.23	6.04	-3.05%	2.22	2.19	-1.35%	45.6	44	1.6	1.8	0.9	0.9	-26.1	-24.9	4.50%	PASS

Object:	Date Issued:	Page 2 of 4
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#### Impedance & Return-Loss Measurement Plot for Head TSL

Object:	Date Issued:	Daga 2 of 4
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#### Impedance & Return-Loss Measurement Plot for Body TSL

Object:	Date Issued:	Dogo 4 of 4
D3700V2 – SN: 1097	06/09/2023	Page 4 of 4

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



Schweizerischer Kalibrierdienst

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- S Swiss Calibration Service

S

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Accreditation No.: SCS 0108

Certificate No: D3900V2-1062\_Nov20

Client PC Test

CALIBRATION C	ERTIFICATE		/
Object	D3900V2 - SN:10	)62	VATA
Calibration procedure(s)	QA CAL-22.v5 Calibration Proce	dure for SAR Validation Sources	e between 3-10 GHz 1/30/み
			🗸 KT 01/25/22
Calibration date:	November 13, 20	20	VW 01/25/23
The measurements and the unce	rtaintles with confidence p	onal standards, which realize the physical ur robability are given on the following pages ar y facility: environment temperature (22 ± 3)°	nd are part of the certificate.
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217- <b>0</b> 3100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 3503	31-Dec-19 (No. EX3-3503_Dec19)	Dec-20
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22

Certificate No: D3900V2-1062\_Nov20

SN: MY41092317

SN: US41080477

**Claudio Leubler** 

Katja Pokovic

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

SN: 100972

Name

Power sensor HP 8481A

Calibrated by:

Approved by:

RF generator R&S SMT-06

Network Analyzer Agilent E8358A

07-Oct-15 (in house check Oct-20)

15-Jun-15 (in house check Oct-20)

31-Mar-14 (in house check Oct-20)

Function

Laboratory Technician

Technical Manager

Issued: November 13, 2020

In house check: Oct-22

In house check: Oct-22

In house check: Oct-21

Signature

#### **Calibration Laboratory of**

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





Schweizerischer Kalibrierdienst

- S Service suisse d'étalonnage С
  - Servizio svizzero di taratura
- S **Swiss Calibration Service**

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### **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	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Fiat 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	3900 MHz ± 1 MHz 4100 MHz ± 1 MHz	

Head TSL parameters at 3900 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.5	3.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.3 ± 6 %	3.25 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 3900 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.88 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	68.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 W/kg ± 19.5 % (k=2)

# Head TSL parameters at 4100 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.2	3.53 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.0 ± 6 %	3.42 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 4100 MHz

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.67 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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	23.1 W/kg ± 19.5 % (k=2)

.

#### Body TSL parameters at 3900 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	50.8	3.78 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.4 ± 6 %	3.71 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 3900 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.65 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	66.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	······
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.1 W/kg ± 19.5 % (k=2)

#### Body TSL parameters at 4100 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	50.5	4.01 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.1 ± 6 %	3.95 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 4100 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.51 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	64.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Body 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 3900 MHz

Impedance, transformed to feed point	47.8 Ω - 6.8 jΩ
Return Loss	- 22.7 dB

#### Antenna Parameters with Head TSL at 4100 MHz

Impedance, transformed to feed point	60.2 Ω - 2.2 jΩ
Return Loss	- 20.5 dB

#### Antenna Parameters with Body TSL at 3900 MHz

Impedance, transformed to feed point	47.6 Ω - 4.9 jΩ
Return Loss	- 25.0 dB

#### Antenna Parameters with Body TSL at 4100 MHz

Impedance, transformed to feed point	61.1 Ω + 0.4 jΩ
Return Loss	- 20.0 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.103 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
individual by	

#### **DASY5 Validation Report for Head TSL**

Date: 13.11.2020

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1062

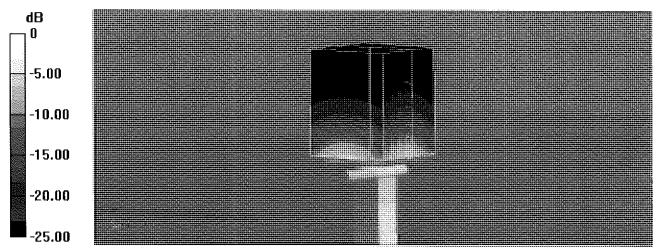
Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz Medium parameters used: f = 3900 MHz;  $\sigma$  = 3.25 S/m;  $\varepsilon_r$  = 36.3;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 4100 MHz;  $\sigma$  = 3.42 S/m;  $\varepsilon_r$  = 36;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.39, 7.39, 7.39) @ 3900 MHz, ConvF(7.26, 7.26, 7.26) @ 4100 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 72.02 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 19.4 W/kg SAR(1 g) = 6.88 W/kg; SAR(10 g) = 2.4 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 73.9% Maximum value of SAR (measured) = 13.3 W/kg

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=4100MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.83 V/m; Power Drift = -0.00 dB Peak SAR (extrapolated) = 18.9 W/kg SAR(1 g) = 6.67 W/kg; SAR(10 g) = 2.32 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 73.7% Maximum value of SAR (measured) = 13.1 W/kg



0 dB = 13.3 W/kg = 11.24 dBW/kg

,

### Impedance Measurement Plot for Head TSL

<u>File View</u>	<u>C</u> hannel Sw <u>e</u> ep Cu	alibration <u>Trace S</u> cale M	i <u>a</u> rker S <u>y</u> stem <u>W</u> indow <u>H</u> elp	
			1: 3.900000 G 5.9691 4.100000 G 17.881 3.900000 G	pF -6.8381 Ω Hz 60.216 Ω pF -2.1709 Ω
Ch1: Si	Ch 1 Awg = 20 tart 3.70000 GHz	·····		Stop 4.30009 GHz
10,00 5.00 0.00 -5.00 -10.00 -15.00 -20.00 -25.00 -30.00 -35.00 -40.00	<b>HE S11</b>		> 1: 3.900000 G 2: 4.100000 G	Hz -20.469 dB
Ch1: S	tart 3.70000 GHz			Stop 4.30000 GHz
Status	CH 1: S11	C* 1-Port	Avg=20 Delay	LCL

#### **DASY5 Validation Report for Body TSL**

Date: 11.11.2020

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1062

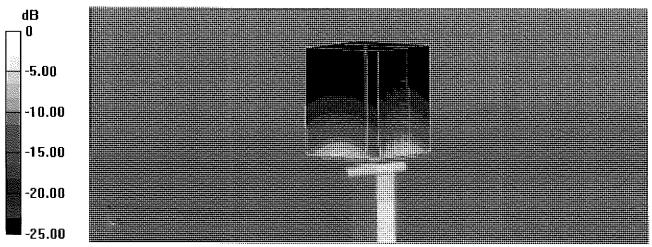
Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz Medium parameters used: f = 3900 MHz;  $\sigma$  = 3.71 S/m;  $\varepsilon_r$  = 49.4;  $\rho$  = 1000 kg/m<sup>3</sup>, Medium parameters used: f = 4100 MHz;  $\sigma$  = 3.95 S/m;  $\varepsilon_r$  = 49.1;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.18, 7.18, 7.18) @ 3900 MHz, ConvF(6.88, 6.88, 6.88) @ 4100 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan , dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 64.53 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 18.6 W/kg SAR(1 g) = 6.65 W/kg; SAR(10 g) = 2.32 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 74.7% Maximum value of SAR (measured) = 13.1 W/kg

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm, f=4100MHz/Zoom Scan , dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 62.68 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 18.8 W/kg SAR(1 g) = 6.51 W/kg; SAR(10 g) = 2.27 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 73.5% Maximum value of SAR (measured) = 13.0 W/kg



0 dB = 13.1 W/kg = 11.17 dBW/kg

### Impedance Measurement Plot for Body TSL

<u>File V</u> iew	Channel	Sw <u>e</u> ep	Calibration	<u>I</u> race <u>S</u> cale	M <u>a</u> rker	System	<u>W</u> indow	<u>H</u> elp			
				A				3.900000 G 8.2512 4.100000 G 14.232 3.900000 G	! pF 과Hz pH	-4.9 61 386.1 56.4	.567 Ω 3490 Ω .085 Ω 81 mΩ 50 mU 13.27 °
Ch1: S	Ch 1 Avg = tart 3.70000 (				·····		1997 - Standard Barrison, and Standard Barrison (1997)			Stop 4,	30000 GHz
10.00 5.00 0.00 -5.00 -10.00	dB \$11							3.900000 C 4. 00000 C		- the second second	970 dB 013 dB
-15.00 -20.00 -25.00 -30.00 -35.00 -40.00	Ch 1 Avg =										
Status		311	_	C* 1-Port		Avg=20	Delay				30000 GHz .CL





## **Certification of Calibration**

Object

D3900V2 - SN:1062

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

November 13, 2021

Extended Calibration date:

Description:

SAR Validation Dipole at 3900 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	2/2/2021	Annual	2/2/2022	US39170122
Agilent	E4438C	ESG Vector Signal Generator	10/17/2021	Annual	10/17/2022	MY45093852
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Anritsu	ML2495A	Power Meter	1/18/2021	Annual	1/18/2022	0941001
Anritsu	MA2411B	Pulse Power Sensor	2/5/2021	Annual	2/5/2022	0846215
Anritsu	MA2411B	Pulse Power Sensor	8/10/2021	Annual	8/10/2022	1207364
Control Company	4040	Therm./ Clock/ Humidity Monitor	2/23/2021	Annual	2/23/2022	160574418
Control Company	4353	Long Stem Thermometer	2/28/2020	Biennial	2/28/2022	170330160
Agilent	85033E	3.5mm Standard Calibration Kit	7/7/2021	Annual	7/7/2022	MY53402352
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Keysight Technologies	772D	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	NC-100	Torque Wrench	8/4/2020	Biennial	8/4/2022	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/12/2021	Annual	5/12/2022	1070
SPEAG	EX3DV4	SAR Probe	7/21/2021	Annual	7/21/2022	7546
SPEAG	EX3DV4	SAR Probe	9/6/2021	Annual	9/6/2022	7674
SPEAG	DAE4	Dasy Data Acquisition Electronics	7/14/2021	Annual	7/14/2022	1402
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/6/2021	Annual	8/6/2022	1683

Measurement Uncertainty =  $\pm 23\%$  (k=2)

	Name	Function	Signature
Calibrated By:	Parker Jones	Team Lead Engineer	Parker Jones
Approved By:	Kaitlin O'Keefe	Managing Director	ROK

Object:	Date Issued:	Page 1 of 6
D3900V2 – SN:1062	11/13/2021	Fage 1010

## **DIPOLE CALIBRATION EXTENSION**

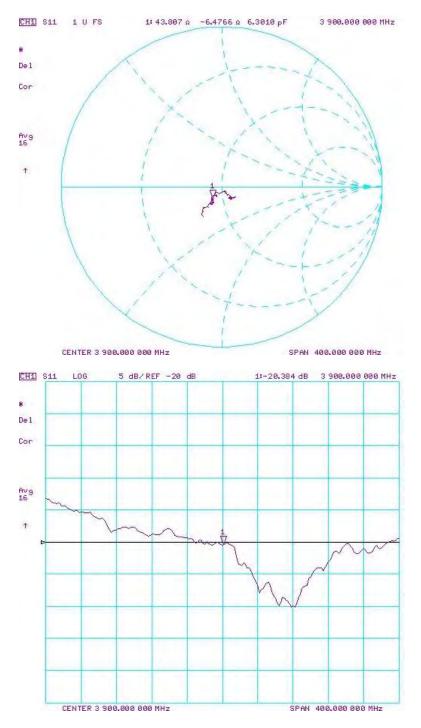
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance does not deviate more than  $5\Omega$  from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

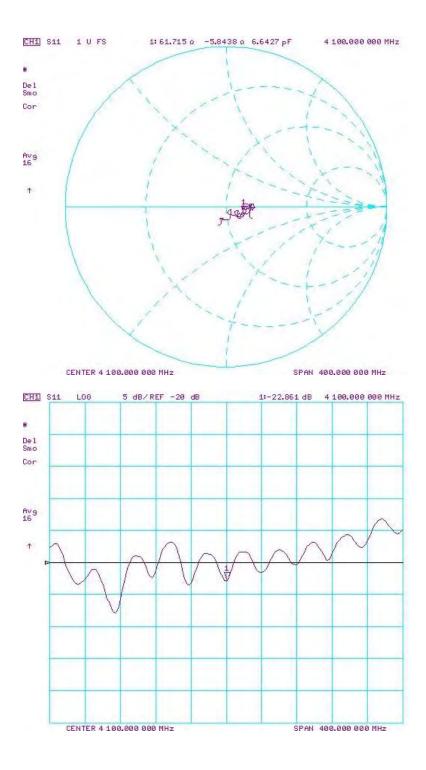
Frequency (MHz)	Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Retum Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
3900	11/13/2020	11/13/2021	1.103	6.86	7.28	6.12%	2.38	2.56	7.56%	47.8	43.8	4.0	-6.8	-6.5	0.3	-22.7	-20.4	10.20%	PASS
4100	11/13/2020	11/13/2021	1.103	6.65	6.89	3.61%	2.31	2.45	6.06%	60.2	61.7	1.5	-2.2	-5.8	3.6	-20.5	-22.9	-11.50%	PASS
Frequency (MHz)	Calibration Date	Extension Date	Certificate Electrical Delay (ns)		Measured Body SAR (1g) W/kg @ 20.0 dBm		Certificate SAR Target Body (10g) W/kg @ 20.0 dBm	Measured Body SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Body (Ohm) Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
3900	11/13/2020	11/13/2021	1.103	6.63	6.77	2.11%	2.31	2.31	0.00%	47.6	44.7	2.9	-4.9	-4.2	0.7	-25.0	-23.3	-2.80%	PASS
4100	11/13/2020	11/13/2021	1.103	6.48	6.66	2.78%	2.26	2.32	2.65%	61.1	60.1	1.0	0.4	-1.1	1.5	-20.0	-20.4	-2.20%	PASS

Object:	Date Issued:	Page 2 of 6
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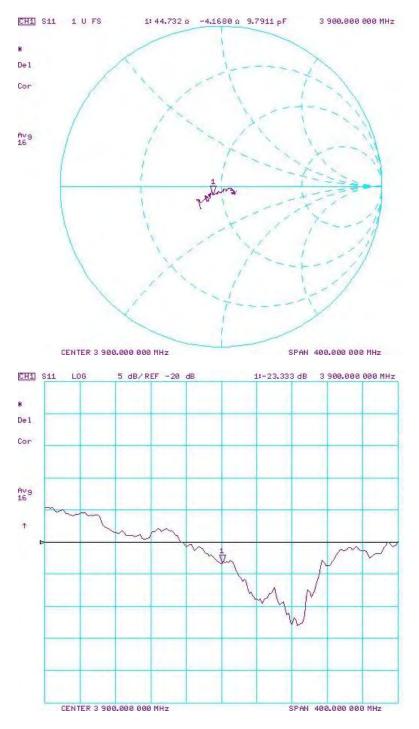


#### Impedance & Return-Loss Measurement Plot for Head TSL

Object:	Date Issued:	Page 3 of 6
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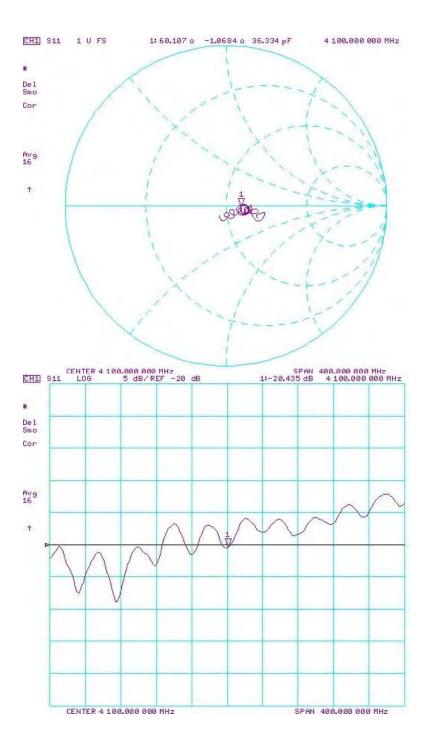


Object:	Date Issued:	Page 4 of 6
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#### Impedance & Return-Loss Measurement Plot for Body TSL

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Element Materials Technology Morgan Hill 18855 Adams Ct, Morgan Hill, CA 95037 USA Tel. +1.410.290.6652 / Fax +1.410.381.1520 http://www.element.com



## **Certification of Calibration**

Object

D3900V2 - SN: 1062

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date:

November 13, 2022

Description:

SAR Validation Dipole at 3900 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	12/17/2021	Annual	12/17/2022	MY40000670
Agilent	E4438C	ESG Vector Signal Generator	3/24/2022	Annual	3/24/2023	MY45093678
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Anritsu	ML2495A	Power Meter	3/17/2022	Annual	3/17/2023	0941001
Anritsu	MA2411B	Pulse Power Sensor	3/2/2022	Annual	3/2/2023	1126066
Anritsu	MA2411B	Pulse Power Sensor	3/28/2022	Annual	3/28/2023	1339007
Traceable	4040 90080-06	Therm./ Clock/ Humidity Monitor	5/11/2022	Biennial	5/11/2024	221514974
Control Company	4352	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774678
Agilent	85033E	3.5mm Standard Calibration Kit	6/21/2022	Annual	6/21/2023	MY53402352
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Mini-Circuits	ZHDC-16-63-S+	50-6000MHz Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	NC-100	Torque Wrench	3/19/2022	Annual	3/19/2023	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/16/2022	Annual	5/16/2023	1070
SPEAG	EX3DV4	SAR Probe	1/19/2022	Annual	1/19/2023	3837
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/13/2022	Annual	1/13/2023	793

Measurement Uncertainty =  $\pm 23\%$  (k=2)

	Name	Function	Signature
Calibrated By:	Arturo Oliveros	Associate Compliance Engineer	AG
Approved By:	Kaitlin O'Keefe	Managing Director	XOK

## **DIPOLE CALIBRATION EXTENSION**

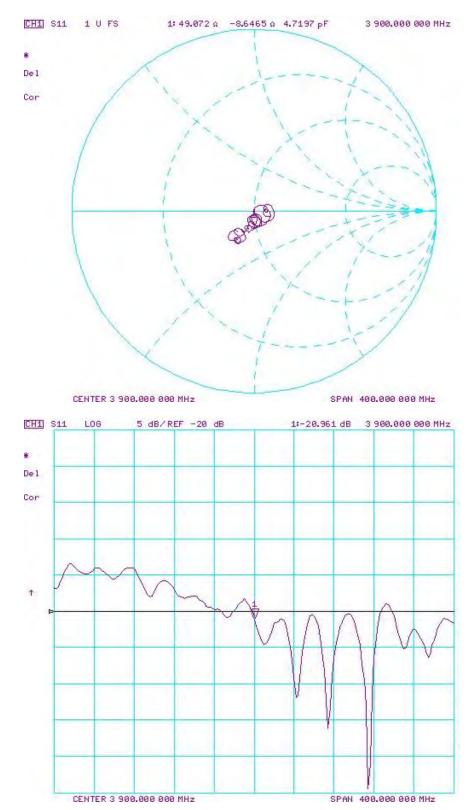
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance does not deviate more than  $5\Omega$  from the previous measurement.

The following dipole was checked to pass the above 3 requirements to have 3-year calibration period from the calibration date:

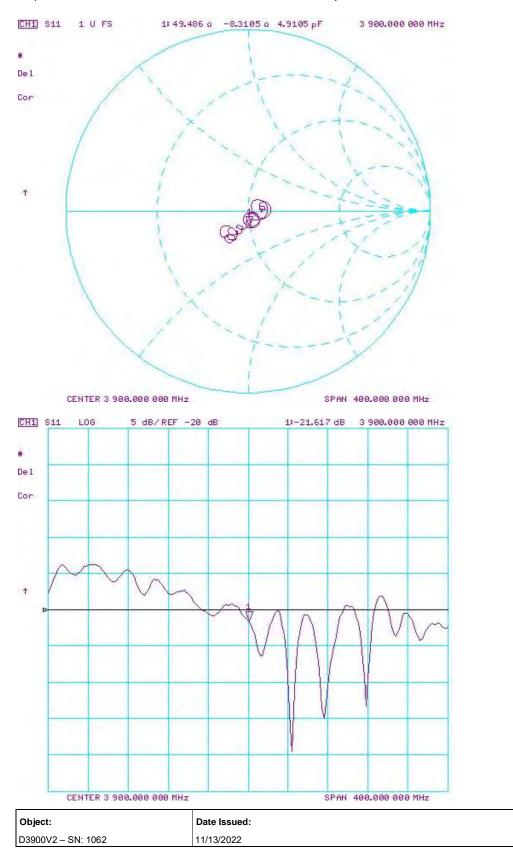
(MHz)	Date	Extension Date	(ns)	Target Head (1g) W/kg @ 20.0 dBm	Head SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	(Ohm) Real	Head (Ohm) Real	Difference (Ohm)	Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Loss Head (dB)	Deviation (%)	PASS/FAIL
3900	11/13/2020	11/13/2022	1.103	6.86	7.27	5.98%	2.38	2.55	7.14%	47.8	49.1	1.3	-6.8	-8.6	1.8	-22.7	-21	7.70%	PASS
Frequency (MHz)	Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Body (1g) W/kg @ 20.0	Measured Body SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Body (10g) W/kg @ 20.0 dBm	Measured Body SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm)	Certificate Impedance Body (Ohm) Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
3900	11/13/2020	11/13/2022	1.103	6.63	6.77	2.11%	2.31	2.35	1.73%	47.6	49.5	1.9	-4.9	-8.3	3.4	-25	-21.6	13.50%	PASS

Object:	Date Issued:	Page 2 of 4
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Impedance & Return-Loss Measurement Plot for Head TSL

Object:	Date Issued:	Daga 2 of 4
D3900V2 – SN: 1062	11/13/2022	Page 3 of 4



#### Impedance & Return-Loss Measurement Plot for Body TSL

### **Calibration Laboratory of**

Element

Client

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

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

Certificate No: D5GHzV2-1191\_Jan23

### **CALIBRATION CERTIFICATE**

Object	D5GHzV2 - SN:1	191	landijelar (A.B. Sana) sela
Calibration procedure(s)	QA CAL-22.v7 Calibration Proce	dure for SAR Validation Source	s between 3-10 GHz
Calibration date:	January 18, 2023		8N 1/30/2023
The measurements and the uncerta	ainties with confidence pr	onal standards, which realize the physical up obability are given on the following pages a	nd are part of the certificate.
Calibrations have been conducte		y facility: environment temperature (22 $\pm$ 3)	"G and humidity < 70%.
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 3503	08-Mar-22 (No. EX3-3503_Mar22)	Mar-23
DAE4	SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	to la
Approved by:	Sven Kühn	Technical Manager	Ś. <del>z.</del>
This calibration certificate shall not	he reproduced except in	full without written approval of the laborato	lssued: January 19, 2023
This calibration certificate shall flot	se reproduced except in	ion mation matter approval of the aborato	י <u>י</u> י



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С

Schweizerischer Kalibrierdienst Service suisse d'étalonnage

- Servizio svizzero di taratura
- S **Swiss Calibration Service**

Accreditation No.: SCS 0108



#### Calibration Laboratory of

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





Schweizerischer Kalibrierdienst

- S Service suisse d'étalonnage С
  - Servizio svizzero di taratura
- 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

#### **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) 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"

#### Additional Documentation:

c) 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled • phantom (as described in the measurement condition clause). 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 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	DASY52	V52.10.4
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	5200 MHz ± 1 MHz 5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.5 ± 6 %	4.56 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.77 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.3 W/kg ± 19.5 % (k=2)

## 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	36.4 ± 6 %	4.61 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 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	35.9 ± 6 %	4.98 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 <sup>3</sup> (1 g) of Head TSL	Condition	,
SAR measured	100 mW input power	8.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 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	35.7 ± 6 %	5.14 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.83 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.4 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.23 W/kg

#### Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.6 ± 6 %	5.19 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.89 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.3 W/kg ± 19.5 % (k=2)

#### Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.0 ± 6 %	5.42 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	72.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.02 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.2 W/kg ± 19.5 % (k=2)

#### Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.0 ± 6 %	5.51 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.45 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.7 W/kg ± 19.5 % (k=2)

#### Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5. <b>77</b> mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.6 ± 6 %	6.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.84 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	78.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.8 W/kg ± 19.5 % (k=2)

#### Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.3 ± 6 %	6.18 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.48 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.7 W/kg ± 19.5 % (k=2)

# Body TSL parameters at 5800 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body ⊺SL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.2 ± 6 %	6.24 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.21 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	72.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.00 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.0 W/kg ± 19.5 % (k=2)

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

#### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	50.6 Ω - 9.9 jΩ
Return Loss	- 20.1 dB

#### Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	52.4 Ω - 6.7 jΩ
Return Loss	- 23.2 dB

#### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.9 Ω - 7.7 jΩ
Return Loss	- 21.6 dB

#### Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	54.3 Ω - 1.9 jΩ
Return Loss	- 26.9 dB

#### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	50.9 Ω - 2.1 jΩ
Return Loss	- 32.8 dB

## Antenna Parameters with Body TSL at 5200 MHz

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	Impedance, transformed to feed point	48.8 Ω - 9.4 jΩ
	Return Loss	10/0 80 0.7 j32
I		- 20.4 dB

## Antenna Parameters with Body TSL at 5250 MHz

	50.2 Ω - 5.1 ίΩ
Return Loss	- 25.9 dB

## Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	
	55.6 Ω - 3.2 ίΩ
Return Loss	
	- 24.3 dB

## Antenna Parameters with Body TSL at 5750 MHz

Impedance	e, transformed to feed point	59.0.0 + 2.0.10
Return Los	S	59.0 Ω + 3.0 jΩ
		- 21.3 dB

## Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	
	56:4 Ω + 2,7 ϳΩ
Return Loss	
	- 23.7 dB

## General Antenna Parameters and Design

	Electrical Delay (one direction)	1 000	
4		1.202 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 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

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Manufactured by	
	SPEAG

#### **DASY5 Validation Report for Head TSL**

Date: 09.01.2023

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1191

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma = 4.56$  S/m;  $\varepsilon_r = 36.5$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5250 MHz;  $\sigma = 4.61$  S/m;  $\varepsilon_r = 36.4$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5600 MHz;  $\sigma = 4.98$  S/m;  $\varepsilon_r = 35.9$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5750 MHz;  $\sigma = 5.14$  S/m;  $\varepsilon_r = 35.7$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5800 MHz;  $\sigma = 5.19$  S/m;  $\varepsilon_r = 35.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5800 MHz;  $\sigma = 5.19$  S/m;  $\varepsilon_r = 35.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.8, 5.8, 5.8) @ 5200 MHz, ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

#### Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 74.37 V/m; Power Drift = -0.03 dBPeak SAR (extrapolated) = 27.1 W/kg SAR(1 g) = 7.77 W/kg; SAR(10 g) = 2.22 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 70.1% Maximum value of SAR (measured) = 17.4 W/kg

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 = 75.89 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 27.1 W/kg SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.30 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 71% Maximum value of SAR (measured) = 17.9 W/kg

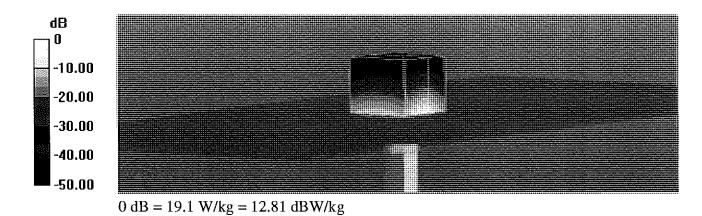
#### Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 74.82 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 30.1 W/kg SAR(1 g) = 8.18 W/kg; SAR(10 g) = 2.33 W/kg Smallest distance from peaks to all points 3 dB below = 7.5 mm Ratio of SAR at M2 to SAR at M1 = 68% Maximum value of SAR (measured) = 19.1 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 = 72.59 V/m; Power Drift = -0.04 dBPeak SAR (extrapolated) = 30.1 W/kgSAR(1 g) = 7.83 W/kg; SAR(10 g) = 2.23 W/kgSmallest distance from peaks to all points 3 dB below = 7.5 mmRatio of SAR at M2 to SAR at M1 = 66.4%Maximum value of SAR (measured) = 18.6 W/kg

#### Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 72.58 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 30.9 W/kg SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.23 W/kg Smallest distance from peaks to all points 3 dB below = 7.5 mm Ratio of SAR at M2 to SAR at M1 = 65.9% Maximum value of SAR (measured) = 18.9 W/kg



### Impedance Measurement Plot for Head TSL

<u>F</u> ile	⊻lew	⊆hannel	Sw <u>e</u> ep C	alibration	<u>T</u> race <u>S</u> cale	e M <u>a</u> rker	S <u>y</u> stem <u>V</u>	<u>V</u> indow <u>H</u> el	p			
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## Appendix: Transfer Calibration at Four Validation Locations on SAM Head<sup>1</sup>

## Evaluation Conditions (f=5200 MHz)

Phantom		
Filantom	SAM Head Phantom	
	University of the add Finantom	For usage with cSAR3DV2-R/L

## SAR result with SAM Head (Top)

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**F** 

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	82.4 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	

## SAR result with SAM Head (Mouth)

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	86.3 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	

## SAR result with SAM Head (Neck)

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	82.3 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	

## SAR result with SAM Head (Ear)

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	52.4 W/kg ± 20.3 % (k=2)
SAP overend and a star		

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition		
SAR for nominal Head TSL parameters	normalized to 1W	17.8 W/kg ± 19.9 % (k=2)	

<sup>&</sup>lt;sup>1</sup> Additional assessments outside the current scope of SCS 0108

## Appendix: Transfer Calibration at Four Validation Locations on SAM Head<sup>2</sup>

## Evaluation Conditions (f=5800 MHz)

Dhomton		
Phantom	SAM Head Phantom	
	SAW Head Phantom	For usage with cSAR3DV2-R/L

## SAR result with SAM Head (Top)

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SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	82.1 W/kg ± 20.3 % (k=2)
SAD and the second second		
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	

## SAR result with SAM Head (Mouth)

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition		
SAR for nominal Head TSL parameters	normalized to 1W	88.7 W/kg ± 20.3 % (k=2)	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition		
SAR for nominal Head TSL parameters	normalized to 1W	25.2 W/kg ± 19.9 % (k=2)	

## SAR result with SAM Head (Neck)

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	79.2 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL		
- in a conget over to chir (to g) of Head TSL	condition	

## SAR result with SAM Head (Ear)

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	56.4 W/kg ± 20.3 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition		
SAR for nominal Head TSL parameters	normalized to 1W	18.9 W/kg ± 19.9 % (k=2)	

<sup>&</sup>lt;sup>2</sup> Additional assessments outside the current scope of SCS 0108

Date: 18.01.2023

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1191

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz;  $\sigma = 5.42$  S/m;  $\varepsilon_r = 49.0$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5250 MHz;  $\sigma = 5.51$  S/m;  $\varepsilon_r = 49.0$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5600 MHz;  $\sigma = 6.00$  S/m;  $\varepsilon_r = 48.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5750 MHz;  $\sigma = 6.18$  S/m;  $\varepsilon_r = 48.3$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5800 MHz;  $\sigma = 6.24$  S/m;  $\varepsilon_r = 48.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5800 MHz;  $\sigma = 6.24$  S/m;  $\varepsilon_r = 48.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.29, 5.29, 5.29) @ 5200 MHz, ConvF(5.26, 5.26, 5.26) @ 5250 MHz, ConvF(4.79, 4.79, 4.79) @ 5600 MHz, ConvF(4.66, 4.66, 4.66) @ 5750 MHz, ConvF(4.62, 4.62, 4.62) @ 5800 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 63.91 V/m; Power Drift = -0.03 dBPeak SAR (extrapolated) = 26.6 W/kg SAR(1 g) = 7.23 W/kg; SAR(10 g) = 2.02 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 68.4% Maximum value of SAR (measured) = 17.3 W/kg

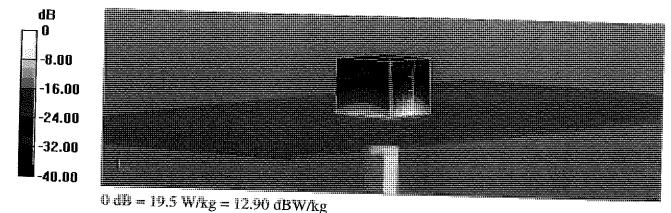
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 64.43 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 28.3 W/kg SAR(1 g) = 7.45 W/kg; SAR(10 g) = 2.07 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 67.3% Maximum value of SAR (measured) = 18.1 W/kg

#### Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 64.35 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 32.6 W/kg SAR(1 g) = 7.84 W/kg; SAR(10 g) = 2.18 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 64.1% Maximum value of SAR (measured) = 19.5 W/kg

## Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 62.17 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 32.8 W/kg SAR(1 g) = 7.48 W/kg; SAR(10 g) = 2.07 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 62.4%Maximum value of SAR (measured) = 19.0 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 61.89 V/m; Power Drift = -0.02 dBPeak SAR (extrapolated) = 30.6 W/kg SAR(1 g) = 7.21 W/kg; SAR(10 g) = 2.00 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 63.5% Maximum value of SAR (measured) = 18.2 W/kg



## Impedance Measurement Plot for Body TSL

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# **Calibration Laboratory of**

Element

Client

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

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

Certificate No: D6.5GHzV2-1018\_Dec22

Object	D6.5GHzV2 SN:1018				
	QA CAL-22.v7 Calibration Proce	edure for SAR Validation Sources	between 3-10 GHz √ PN 12/21/		
Calibration date:	December 07, 20	022 ···································	12/21/		
Fhis calibration certificate document Fhe measurements and the uncerta	s the traceability to nati inties with confidence p	ional standards, which realize the physical unit probability are given on the following pages and	s of measurements (SI). I are part of the certificate.		
All calibrations have been conducted	d in the closed laborato	ry facility: environment temperature (22 ± 3)°C	and humidity < 70%.		
Calibration Equipment used (M&TE	critical for calibration)				
Primary Standards	1D #	Cal Date (Certificate No.)	Scheduled Calibration		
Power sensor R&S NRP33T	SN: 100967	01-Apr-22 (No. 217-03526)	Apr-23		
eference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23		
lismatch combination	SN: 84224 / 360D	26-Apr-22 (No. 217-03545)	Apr-23		
eference Probe EX3DV4	SN: 7405	02-Jun-22 (No. EX3-7405_Jun22)	Jun-23		
DAE4	SN: 908	27-Jun-22 (No. DAE4-908_Jun22)	Jun-23		
Secondary Standards	ID #	Check Date (in house)	Scheduled Check		
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Dec-21)	In house check: Dec-23		
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25		
	Name	Function	Signature		
Calibrated by:	Leif Klysner	Laboratory Technician	Seef Thejen		
Approved by:	Sven Kühn	Technical Manager	ŚŚ		
			Issued: December 10, 2022		

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



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Servizio svizzero di taratura

Accreditation No.: SCS 0108

# **Calibration Laboratory of**

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





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- S **Swiss Calibration Service**

Accreditation No.: SCS 0108

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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) 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 reauired.
- SAR measured: SAR measured at the stated antenna input power. 0
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector. ۰
- 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	V16.2
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	35.0 ± 6 %	6.16 mho/m ± 6 %	
Head TSL temperature change during test	< 0.5 °C			

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	293 W/kg ± 24.7 % (k=2)

SAR averaged over 8 cm <sup>3</sup> (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.9 W/kg ± 24.4 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	54.1 W/kg ± 24.4 % (k=2)

## Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.0 Ω - 5.1 jΩ
Return Loss	- 25.9 dB

### APD (Absorbed Power Density)

APD averaged over 1 cm <sup>2</sup>	Condition	
APD measured	100 mW input power	293 W/m <sup>2</sup>
APD measured	normalized to 1W	2930 W/m² ± 29.2 % (k=2)

APD averaged over 4 cm <sup>2</sup>	condition	
APD measured	100 mW input power	131 W/m²
APD measured	normalized to 1W	1310 W/m <sup>2</sup> ± 28.9 % (k=2)

\*The reported APD values have been derived using the psSAR1g and psSAR8g.

#### **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.

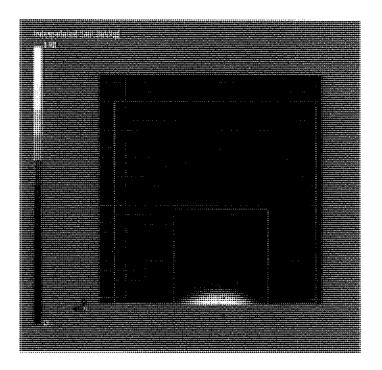
## Additional EUT Data

Manufactured by	SPEAG

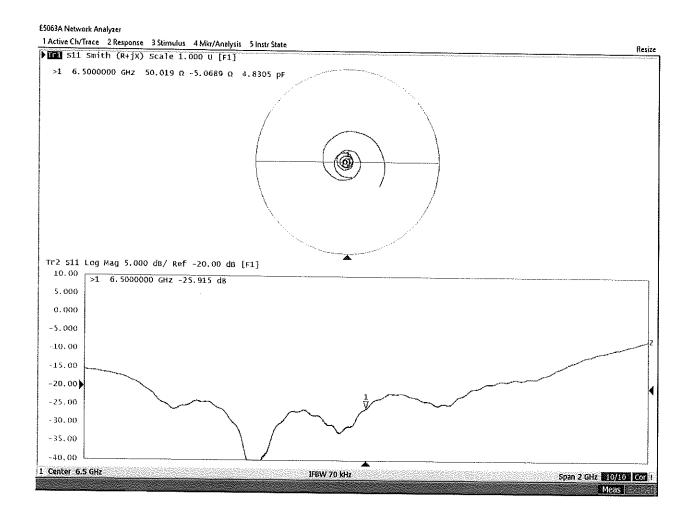
# **DASY6 Validation Report for Head TSL**

Measurement Report for D6.5GHz-1018, UID 0 -, Channel 6500 (6500.0MHz)

Device under To Name, Manufa D6.5GHz	cturer D	<b>)imensions  </b> 16.0 x 6.0 x 3	-	<b>ИЕІ</b> N: 1018	DUT Typ -	e	
Exposure Cond Phantom Section, TSL	itions Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.50	6.16	35.0
Hardware Setu Phantom MFP V8.0 Cente	Т	<b>-SL</b> 1BBL600-100	000V6	-	<b>Dration Date</b> 17405, 2022-06-02		oration Date 08, 2022-06-27
Scan Setup				Measureme	nt Results		
			Zoom Scar	1			Zoom Scan
Grid Extents (r	-		22.0 x 22.0 x 22.0	) Date		2	022-12-07, 09:37
Grid Steps [mr	-		3.4 x 3.4 x 1.4	l psSAR1g [\	N/Kg]		29.3
Sensor Surface	e [m <b>m</b> ]		1.4	l psSAR8g [\	N/Kg]		6.S7
Graded Grid			Yes	,	[W/Kg]		5.39
Grading Ratio			1.4				0.03
MAIA			N/A		-		Disabled
Surface Detect	tion		VMS + 6p	0			
Scan Method			Measured				No correction
				M2/M1 [%	-		50.2
				Dist 3dB P	eak [mm]		4.8



# Impedance Measurement Plot for Head TSL



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

Element

Client



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Swiss Calibration Service

Accreditation No.: SCS 0108

S

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

# Certificate No: D6.5GHzV2-1020\_Jan23

# **CALIBRATION CERTIFICATE**

Object	D6.5GHzV2 - SN	1:1020	
	QA CAL-22.v7 Calibration Proce	edure for SAR Validation Sour	ces between 3-10 GHz
			실무자 <b>기술책</b> 일자
Calibration date:	January 12, 2023	3	The Mark 2-6-20
The measurements and the uncertai	nties with confidence p	onal standards, which realize the physica robability are given on the following page ry facility: environment temperature (22 ±	es and are part of the certificate.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor R&S NRP33T	SN: 100967	01-Apr-22 (No. 217-03526)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Mismatch combination	SN: 84224 / 360D	26-Apr-22 (No. 217-03545)	Apr-23
Reference Probe EX3DV4	SN: 7405	02-Jun-22 (No. EX3-7405_Jun22)	Jun-23
DAE4	SN: 908	27-Jun-22 (No. DAE4-908_Jun22)	Jun-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Dec-21)	In house check: Dec-23
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25
	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	Sef Algen
Approved by:	Sven Kühn	Technical Manager	5. 5
		full without written approval of the labora	Issued: January 17, 2023

# Calibration Laboratory of

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





S

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C Service suisse d'étalonnage

Servizio svizzero di taratura 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

# 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) 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	V16.2	
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	35.0 ± 6 %	6.16 mho/m ± 6 %	
Head TSL temperature change during test	< 0.5 °C	and the second sec		

# SAR result with Head TSL

\_

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29,5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	296 W/kg ± 24.7 % (k=2)
		· · · · · · · · · · · · · · · · · · ·
SAR averaged over 8 cm <sup>3</sup> (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.63 W/kg

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	54.5 W/kg ± 24.4 % (k=2)

# Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.7 Ω - 2.6 jΩ
Return Loss	- 31.4 dB

## APD (Absorbed Power Density)

APD averaged over 1 cm <sup>2</sup>	Condition	
APD measured	100 mW input power	295 W/m <sup>2</sup>
APD measured	normalized to 1W	2950 W/m <sup>2</sup> ± 29.2 % (k=2)

APD averaged over 4 cm <sup>2</sup>	condition			
APD measured	100 mW input power	133 W/m <sup>2</sup>		
APD measured	normalized to 1W	1330 W/m <sup>2</sup> ± 28.9 % (k=2)		

\*The reported APD values have been derived using the psSAR1g and psSAR8g.

## **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.

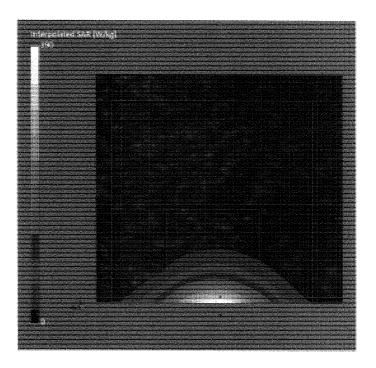
#### **Additional EUT Data**

Manufactured by	CDEAO
indialactured by	SPEAG

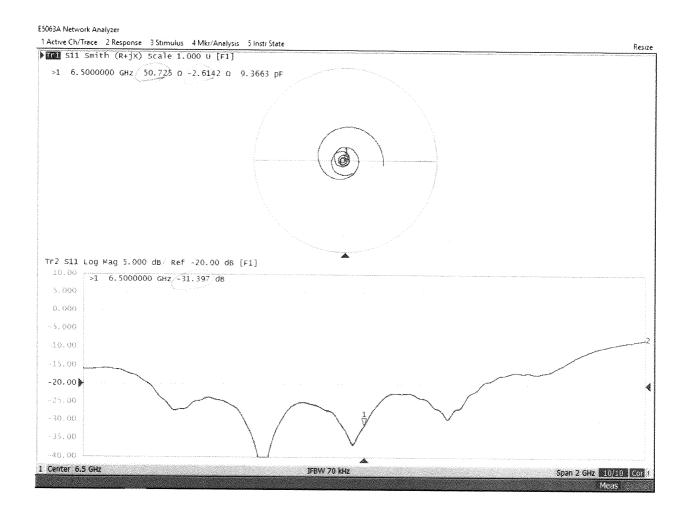
# **DASY6 Validation Report for Head TSL**

#### Measurement Report for D6.5GHz-1020, UID 0 -, Channel 6500 (6500.0MHz)

perties					
Dimen	ions [mm]	IMEI	DUT Ty	/pe	
16.0 x	6.0 x 300.0	SN: 1020	-		
nce	nd Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Bar	nd CW,	6500	5.50	6.16	35.0
<b>TSL</b> 2 HBBL60	00-10000V6	EX3DV4 - S	5N7405, 2022-06-0		bration Date 08, 2022-06-27
	700m		ent Results		Zoom Scan
	3.4 x 3.4 VMS	x 1.4 psSAR1g 1.4 psSAR8g Yes psSAR10g 1.4 Power Dr N/A Power Sc 5 + 6p Scaling Fa sured TSL Corre M2/M1 [	[W/Kg] g [W/Kg] ift [dB] aling actor [dB] action %]	2	023-01-12, 12:01 29,5 6.63 5.43 -0.00 Disabled No correction 50.4 4.8
	16.0 x i ion, Test Bar nce Bar Bar	Dimensions [mm]       16.0 x 6.0 x 300.0       ion, Test     Band       Group,       nce     UID       Band     CW,       S2     HBBL600-10000V6       Zoom       22.0 x 22.0 x       3.4 x 3.4	Dimensions [mm]IMEI16.0 x 6.0 x 300.0SN: 1020ion, TestBandGroup, UIDFrequency [MHz]BandCW,6500TSLProbe, Cal EX3DV4 - S52HBBL600-10000V6EX3DV4 - SMeasurem 2.0 x 22.0 x 22.03.4 x 3.4 x 1.4 9 sSAR1g 1.4 Yes 1.4psSAR1g 1.4 Power Dr N/A1.4 Power Dr N/APower Dr N/AVMS + 6p MeasuredScaling Fa Measured	Dimensions [mm]IMEIDUT Ty $16.0 \times 6.0 \times 300.0$ SN: $1020$ -ion, TestBandGroup, UIDFrequency [MHz]Conversion FactorBandCW, $6500$ $5.50$ TSL BandProbe, Calibration Date EX3DV4 - SN7405, 2022-06-0.Measurement Results22HBBL600-10000V6Measurement ResultsZoom Scan $22.0 \times 22.0 \times 22.0$ 24Date $3.4 \times 3.4 \times 1.4$ psSAR1g [W/Kg] $1.4$ 1.4psSAR8g [W/Kg] YesN/A Power Drift [dB] N/AN/APower Scaling VMS + 6pScaling Factor [dB]	Dimensions [mm]IMEIDUT Type16.0 x 6.0 x 300.0SN: 1020-ion, TestBandGroup, UIDFrequency [MHz]Conversion FactorTSL Cond. [S/m]BandCW,65005.506.16TSL BandCW,65005.50ConversionTSL Cond. [S/m]bandCW,65005.506.16Com Scan 22.0 x 22.0 x 22.0DateDAE, Calili DAE4 Sn9Zoom Scan 22.0 x 22.0 x 22.0Date23.4 x 3.4 x 1.4psSAR1g [W/Kg] 1.4Power Drift [dB] N/A2N/APower Scaling VMS + 6pScaling Factor [dB] TSL Correction M2/M1 [%]14

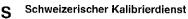


# Impedance Measurement Plot for Head TSL



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





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Accreditation No.: SCS 0108

Element Client Morgan Hill, USA Certificate No. D8GHzV2-1006\_May23

6/6/2023

Issued: May 12, 2023

# CALIBRATION CERTIFICATE

Object
--------

D8GHzV2 - SN:1006

Calibration procedure(s)

QA CAL-22.v7 Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date:

May 11, 2023

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)

	1		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor R&S NRP33T	SN: 100967	03- <b>A</b> pr-23 (No. 217-03806)	Apr-24
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
Mismatch combination	SN: 84224 / 360D	03-Apr-23 (No. 217-03812)	Apr-24
Reference Probe EX3DV4	SN: 7405	02-Jun-22 (No. EX3-7405_Jun22)	Jun-23
DAE4	SN: 908	27-Jun-22 (No. DAE4-908_Jun22)	Jun-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Dec-21)	In house check: Dec-23
Power sensor NRP-Z23	SN: 100169	10-Jan-19 (in house check Nov-22)	In house check: Nov-23
Power sensor NRP-18T	SN: 100950	28-Sep-22 (in house check Nov-22)	In house check: Nov-23
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25
	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	Seif They
Approved by:	Sven Kühn	Technical Manager	

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

## **Calibration Laboratory of**

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





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Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### 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) 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. 8
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna 0 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%.

Accreditation No.: SCS 0108

# **Measurement Conditions**

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

DASY Version	DASY6	V16.2	
Extrapolation	Advanced Extrapolation		
Phantom	Modular Flat Phantom		
Distance Dipole Center - TSL	5 mm	with Spacer	
Zoom Scan Resolution	dx, dy = 2.7 mm, dz = 1.2 mm	Graded Ratio = 1.2 (Z direction)	
Frequency	8000 MHz ± 1 MHz		

# Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity	
Nominal Head TSL parameters	22.0 °C	32.7	7.84 mho/m	
Measured Head TSL parameters	(22.0 ± 0.2) °C	31.4 ± 6 %	7.99 mho/m ± 6 %	
Head TSL temperature change during test	< 0.5 °C			

# SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	, , , , , , , , , , , , , , , , , , ,
SAR measured	100 mW input power	27.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	270 W/kg ± 24.7 % (k=2)

SAR averaged over 1 cm <sup>3</sup> (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	5.62 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	55.6 W/kg ± 24.4 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	4.59 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	45.4 W/kg ± 24.4 % (k=2)

# Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.9 Ω + 4.2 jΩ
Return Loss	- 22.5 dB

## APD (Absorbed Power Density)

APD averaged over 1 cm <sup>2</sup>	Condition	
APD measured	100 mW input power	270 W/m <sup>2</sup>
APD measured	normalized to 1W	2700 W/m² ± 29.2 % (k=2)

APD averaged over 4 cm <sup>2</sup>	condition	
APD measured	100 mW input power	112 W/m <sup>2</sup>
APD measured	normalized to 1W	1120 W/m² ± 28.9 % (k=2)

\* The reported APD values have been derived using the psSAR1g and psSAR8g.

## **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.

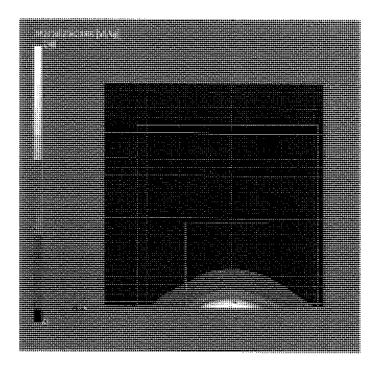
# Additional EUT Data

· · · · · · · · · · · · · · · · · · ·	
Manufactured by	SPEAG

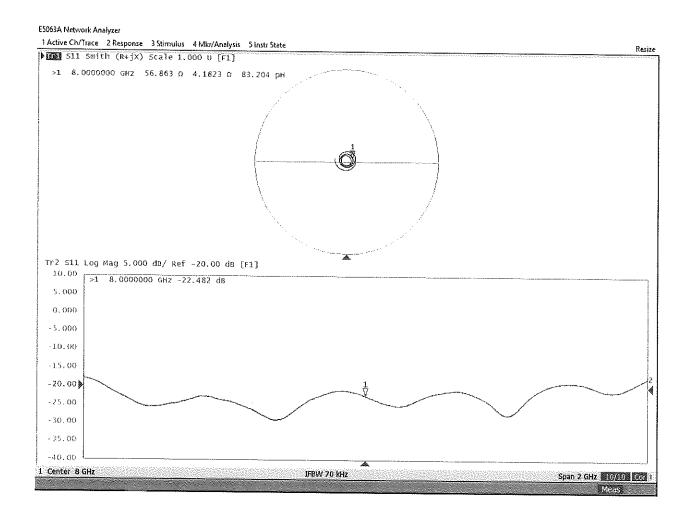
# **DASY6 Validation Report for Head TSL**

Measurement Report for D8GHz-1006, UID 0 -, Channel 8000 (8000.0MHz)

Device under 1	<b>Fest Properties</b>						
Name, Manufa	acturer Di	mensions	[mm] IⅣ	161	DUT Typ	e	
D8GHz	. 1	6.0 x 6.0 x	300.0 SN	I: 1006	-		
Exposure Cond	litions						
Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	8000	5.65	7.99	31.4
Hardware Setu Phantom MFP V8.0 Cent	Τ.	SL BBL600-10	000V6		bration Date N7405, 2022-06-02		oration Date 08, 2022-06-27
Scan Setup				Measureme	ent Results		
			Zoom Scan				Zoom Scan
Grid Extents [			28.0 x 28.0 x 24.0			20	023-05-11, 16:12
Grid Steps [m			2.7 x 2.7 x 1.2	1 U I			27.2
Sensor Surfac	e [mm]		1.4	1 -01			5.62
Graded Grid			Yes	1 0			4.\$9
Grading Ratio	)		1.2		• •		0.00
			N/A		0		Disabled
Surface Detec			VMS + 6p	0			
Scan Method			Measured				Enabled
				M2/M1 [%	-		47.5
				Dist 3dB P	eak [mm]		4.2



# Impedance Measurement Plot for Head TSL



## **Calibration Laboratory of**

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

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**CALIBRATION CERTIFICATE** 

#### Client Element Columbia, USA

Object (	5G Verification S	ource 10 GHz - SN: 1004	MABS 10/4/23
	QA CAL-45.v4 Calibration proce	dure for sources in air above 6 Gł	
Calibration date:	August 11, 2023		
		onal standards, which realize the physical units robability are given on the following pages and	
All calibrations have been conducted	l 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
Reference Probe EUmmWV3	SN: 9374	22-May-23 (No. EUmm-9374_May23)	May-24
DAE4ip	SN: 1602	05-Jul-23 (No. DAE4ip-1602_Jul23)	Jul-24
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMF100A	SN: 100184	19-May-22 (in house check Nov-22)	In house check: Nov-23
Power sensor R&S NRP18S-10	SN: 101258	31-May-22 (in house check Nov-22)	In house check: Nov-23
Network Analyzer Keysight E5063A	SN: MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25
	Name	Function	Signature
Calibrated by:	Joanna Lleshaj	Laboratory Technician	Hollisty
Approved by:	Niels Kuster	Quality Manager	K
			Issued: August 14, 2023
inis calibration certificate shall not t	e reproduced except i	n full without written approval of the laboratory.	

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Accreditation No.: SCS 0108

Certificate No. 5G-Veri10-1004\_Aug23

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





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#### Glossary

CW

Continuous wave

# **Calibration is Performed According to the Following Standards**

- Internal procedure QA CAL-45, Calibration procedure for sources in air above 6 GHz.
- IEC/IEEE 63195-1, "Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz)", May 2022

# 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 radiated power is the forward power to the horn antenna minus ohmic and mismatch loss. The forward power 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 (1cm<sup>2</sup> and 4cm<sup>2</sup>) 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/m<sup>2</sup>) averaged over the surface area of 1 cm<sup>2</sup> and 4cm<sup>2</sup> 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	DASY8 Module mmWave	V3.2
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
Number of measured planes	2 (10mm, 10mm + λ/4)	
Frequency	10 GHz ± 10 MHz	

# Calibration Parameters, 10 GHz

#### **Circular Averaging**

Distance Horn Aperture to Measured Plane	Prad <sup>1</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m <sup>2</sup> )		Uncertainty (k = 2)
				1 cm <sup>2</sup>	<b>4</b> cm <sup>2</sup>	
10 mm	93.3	156	1.27 dB	60.3	56.1	1.28 dB

Distance Horn Aperture to Measured Plane	Prad' (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m²)		Uncertainty (k = 2)
				1 cm <sup>2</sup>	<b>4</b> cm <sup>2</sup>	
10 mm	93.3	156	1.27 dB	60.1, 60.3, 60.5	55.8, 56.1, 56.4	1.28 dB

#### **Square Averaging**

Distance Horn Aperture to	Prad <sup>1</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+)		Uncertainty (k = 2)
Measured Plane				(W/m²)		
				1 cm <sup>2</sup>	4 cm <sup>2</sup>	
10 mm	93.3	156	1.27 dB	60.3	56.0	1.28 dB
Distance Horn	Prad <sup>1</sup>	Max E-field	Uncertainty	Power	Density	Uncertainty
Aperture to Measured Plane	(mW)	(V/m)	(k = 2)	psPDn+, psPDtot+, psPDmod+ (W/m²)		(k = 2)
				<b>1</b> cm <sup>2</sup>	4 cm <sup>2</sup>	
10 mm	93.3	156	1.27 dB	60.2, 60.3, 60.5	55.7, 56.0, 56.3	1.28 dB

#### **Max Power Density**

Distance Horn Aperture to Measured Plane	Prad <sup>1</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Max Power Density Sn, Stot,  Stot  (W/m²)	Uncertainty (k = 2)
10 mm	93.3	156	1.27 dB	61.7, 61.8, 62.0	1.28 dB

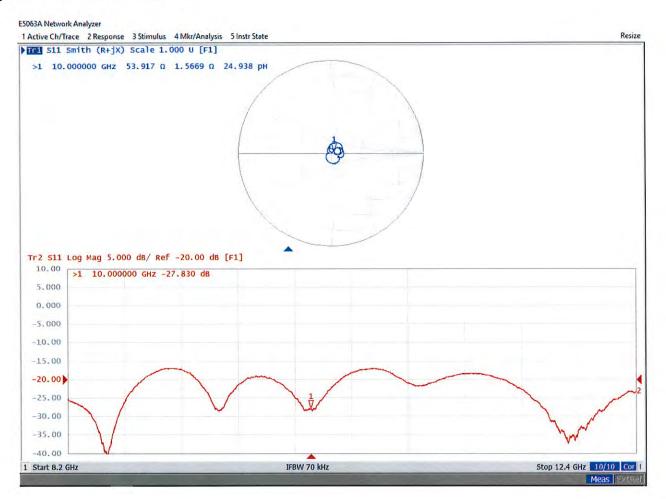
 $<sup>^{\</sup>rm 1}$  Assessed ohmic and mismatch loss plus numerical offset: 0.30 dB

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

#### **Antenna Parameters**

Impedance, transformed to feed point	53.9 Ω + 1.6 jΩ	
Return Loss	- 27.8 dB	

## **Impedance Measurement Plot**



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

#### **Device under Test Properties**

Name, Manufacturer	Dimensions [mm	1]	IMEI	DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	172.0	SN: 1004	-	
<b>Exposure Conditions</b>					
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	Medium		Probe, Calib	ration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air			- SN9374_F1-55GHz,	DAE4ip Sn1602,

#### Scan Setup

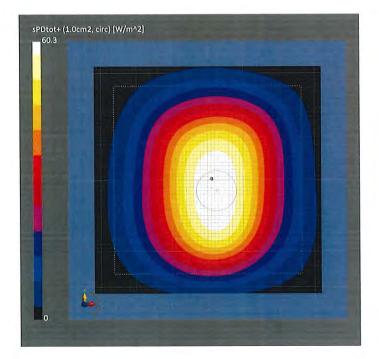
	5G Scan
Sensor Surface [mm]	10.0
MAIA	MAIA not used
MAIA	WAANOCUS

EUmmWV3 - SN9374\_F1-55GHz, 2023-05-22

#### **Measurement Results**

	5G Scan
Date	2023-08-11, 11:52
Avg. Area [cm <sup>2</sup> ]	1.00
Avg. Type	Circular Averaging
psPDn+ [W/m <sup>2</sup> ]	60.1
psPDtot+ [W/m <sup>2</sup> ]	60.3
psPDmod+ [W/m <sup>2</sup> ]	60.5
Max(Sn) [W/m <sup>2</sup> ]	61.7
Max(Stot) [W/m <sup>2</sup> ]	61.8
Max( Stot ) [W/m <sup>2</sup> ]	62.0
E <sub>max</sub> [V/m]	156
Power Drift [dB]	-0.02

2023-07-05



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

Device under Test Pro	perties				
Name, Manufacturer	Dimensions [mm	] IME	1	DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	.72.0 SN:	1004		
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band C	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band 0	CW .	10000.0, 10000	1.0
Hardware Setup					
Phantom	Medium		Probe, Calibration Da	ate	DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 - SN9374 2023-05-22	_F1-55GHz,	DAE4ip Sn1602, 2023-07-05
Scan Setup			Measurement R	esults	
		5G Scan			5G Scar
Sensor Surface [mm]		10.0	Date		2023-08-11, 11:52
MAIA		MAIA not used	Avg. Area [cm <sup>2</sup> ]		4.00
			Avg. Type		Circular Averaging
			psPDn+ [W/m <sup>2</sup> ]		55.8
			psPDtot+ [W/m <sup>2</sup> ]		56.1
			psPDmod+ [W/m <sup>2</sup> ]		56.4
			Max(Sn) [W/m <sup>2</sup> ]		61.7
			Max(Stot) [W/m <sup>2</sup> ]		61.8
			Max( Stot ) [W/m <sup>2</sup>	2]	62.0
			E <sub>max</sub> [V/m]		156
			Power Drift [dB]		-0.02



# 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	0 GHz 100.0 x 100.0 x 1	.72.0	SN: 1004	-	
Exposure Condition	IS				
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

5G Scan

#### **Hardware Setup**

Phantom mmWave Phantom - 1002

#### Scan Setup

	Sebeun
Sensor Surface [mm]	10.0
MAIA	MAIA not used

Medium

Air

Probe, Calibration Date EUmmWV3 - SN9374\_F1-55GHz, 2023-05-22

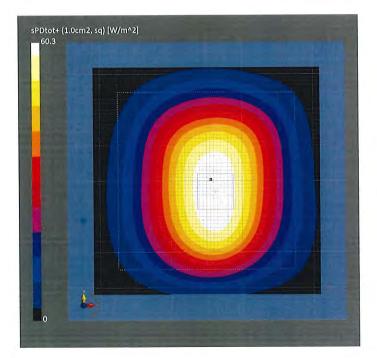
#### **Measurement Results**

	5G Scan	
Date	2023-08-11, 11:52	
Avg. Area [cm <sup>2</sup> ]	1.00	
Avg. Type	Square Averaging	
psPDn+ [W/m²]	60.2	
psPDtot+ [W/m <sup>2</sup> ]	60.3	
psPDmod+ [W/m <sup>2</sup> ]	60.5	
Max(Sn) [W/m <sup>2</sup> ]	61.7	
Max(Stot) [W/m <sup>2</sup> ]	61.8	
Max( Stot ) [W/m <sup>2</sup> ]	62.0	
E <sub>max</sub> [V/m]	156	
Power Drift [dB]	-0.02	

DAE, Calibration Date

DAE4ip Sn1602,

2023-07-05



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

Name, Manufacturer	Dimensions [mm	]	IMEI	DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	172.0	SN: 1004		
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	<b>Conversion Factor</b>
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0
Hardware Setup					
Phantom	Medium		Probe, Calibr	ation Date	DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 - 2023-05-22	SN9374_F1-55GHz,	DAE4ip Sn1602, 2023-07-05
Scan Setup			Measurem	nent Results	
		5G S	an		5G Scan
Sensor Surface [mm]			LO.0 Date		2023-08-11, 11:52
ΜΑΙΑ		MAIA not u		cm²]	4.00
			Avg. Type		Square Averaging
			psPDn+ [W		55.7
			psPDtot+ [\		56.0
			psPDmod+		56.3
			Max(Sn) [W		61.7
			Max(Stot) [		61.8
			Max(Stot)	) [W/m <sup>2</sup> ]	62.0
			E <sub>max</sub> [V/m]		156

