#### **Calibration Laboratory of** Schmid & Partner

**Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

- Service suisse d'étalonnage
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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

#### **Client Element**

Certificate No. D2450V2-882\_Feb24

Yongin, Republic of Korea

Object	D2450V2 - SN:88	82	
Calibration procedure(s)	QA CAL-05.v12 Calibration Proce	edure for SAR Validation Sources	s between 0.7-3 GHz
Calibration date:	February 08, 202	24	실무자 기술책임자 Ju Ju
This calibration certificate documer	nts the traceability to natio	onal standards, which realize the physical un	ی-عد- its of measurements (SI).
		robability are given on the following pages an	
All calibrations have been conducte	ed in the closed laborator	ry facility: environment temperature (22 ± 3)°C	C and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
	10		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
	ID # SN: 104778	Cal Date (Certificate No.) 30-Mar-23 (No. 217-03804/03805)	Scheduled Calibration Mar-24
ower meter NRP2			
Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244	30-Mar-23 (No. 217-03804/03805) 30-Mar-23 (No. 217-03804)	Mar-24 Mar-24
Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244 SN: 103245	30-Mar-23 (No. 217-03804/03805) 30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805)	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	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	30-Mar-23 (No. 217-03804/03805) 30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809)	Mar-24 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	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	30-Mar-23 (No. 217-03804/03805) 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 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 Secondary Standards	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	30-Mar-23 (No. 217-03804/03805) 30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 03-Nov-23 (No. EX3-7349_Nov23)	Mar-24 Mar-24 Mar-24 Mar-24 Mar-24 Nov-24
Power meter NRP2 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	30-Mar-23 (No. 217-03804/03805) 30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 03-Nov-23 (No. 217-03810) 03-Nov-23 (No. EX3-7349_Nov23) 30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22)	Mar-24 Mar-24 Mar-24 Mar-24 Mar-24 Nov-24 Jan-25
Power meter NRP2 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	30-Mar-23 (No. 217-03804/03805) 30-Mar-23 (No. 217-03804) 30-Mar-23 (No. 217-03805) 30-Mar-23 (No. 217-03809) 30-Mar-23 (No. 217-03810) 03-Nov-23 (No. EX3-7349_Nov23) 30-Jan-24 (No. DAE4-601_Jan24) 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 Mar-24 Mar-24 Nov-24 Jan-25 Scheduled Check
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Power meter NRP2 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: MY41093315 SN: 100972	30-Mar-23 (No. 217-03804/03805)         30-Mar-23 (No. 217-03804)         30-Mar-23 (No. 217-03805)         30-Mar-23 (No. 217-03809)         30-Mar-23 (No. 217-03809)         30-Mar-23 (No. 217-03810)         03-Nov-23 (No. 217-03810)         03-Nov-23 (No. EX3-7349_Nov23)         30-Jan-24 (No. DAE4-601_Jan24)         Check Date (in house)         30-Oct-14 (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 Mar-24 Mar-24 Nov-24 Jan-25 Scheduled Check 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
Power meter NRP2 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: WY41093315	30-Mar-23 (No. 217-03804/03805)         30-Mar-23 (No. 217-03804)         30-Mar-23 (No. 217-03805)         30-Mar-23 (No. 217-03809)         30-Mar-23 (No. 217-03810)         03-Nov-23 (No. 217-03810)         03-Nov-23 (No. EX3-7349_Nov23)         30-Jan-24 (No. DAE4-601_Jan24)         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 Mar-24 Mar-24 Nov-24 Jan-25 Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
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Power meter NRP2 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: MY41093315 SN: 100972 SN: US41080477	30-Mar-23 (No. 217-03804/03805)         30-Mar-23 (No. 217-03804)         30-Mar-23 (No. 217-03805)         30-Mar-23 (No. 217-03809)         30-Mar-23 (No. 217-03809)         30-Mar-23 (No. 217-03810)         03-Mar-23 (No. 217-03810)         03-Nov-23 (No. EX3-7349_Nov23)         30-Jan-24 (No. DAE4-601_Jan24)         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)	Mar-24 Mar-24 Mar-24 Mar-24 Mar-24 Nov-24 Jan-25 Scheduled Check In house check: Oct-24 In house check: Oct-24

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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.
- 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	38.2 ± 6 %	1.88 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		111 See 11

# 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	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.0 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	6.32 W/kg

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.0 Ω + 2.0 jΩ	
Return Loss	- 29.1 dB	

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

Electrical Delay (one direction)	1.156 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

#### Additional EUT Data

Manufactured by	SPEAG
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# **DASY5 Validation Report for Head TSL**

Date: 08.02.2024

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:882

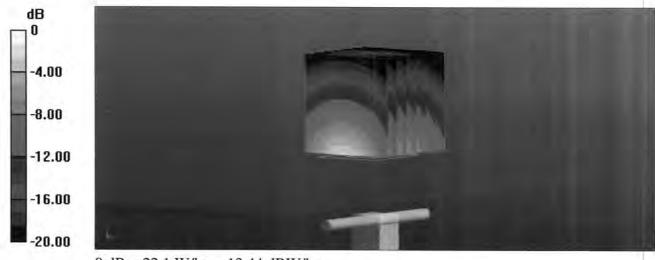
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.88 S/m;  $\epsilon_r$  = 38.2;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 03.11.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2024
- 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=5mm Reference Value = 117.2 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 27.1 W/kg **SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.32 W/kg** Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 50.7% Maximum value of SAR (measured) = 22.1 W/kg



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

# Impedance Measurement Plot for Head TSL

Ch 1 Avg = 20 Ch 1: Start 2.25000 GHz	Ch 1 Avg = 20 Ch 1 Avg = 20 Ch 1: Start 2 25000 GHz	<u>v</u>	liew	Channel	Sweep	Calibration	Trace	<u>S</u> cale	Marker	System	<u>W</u> indow	-	-	22		-	-
Ch1: Start 2.25000 GHz	Ch1: Start 2.25000 GHz						4	4	X	E A	A		131.	70 pH	61.1	2.02 4.87	273 ( 7 ml
.00 .00 0.00 5.00 5.00	.00 .00 .00 0.00 5.00 0.00 5.00 0.00 Ch 1 Avg = 20						f	T	X	Ě	I						
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# Client Element

Certificate No. D2450V2-945\_May24

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Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

Servizio svizzero di taratura

Swiss Calibration Service Accreditation No.: SCS 0108

Yongin, Republic of Korea

Calibration procedure(s)       QA CAL-05.v12 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz         Calibration date:       May 10, 2024         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 space 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 SNR P291       SN: 103245         SN: 103245       26-Mar-24 (No. 217-04036/04037)         Ower sensor NRP-291       SN: 103245         SN: 103245       26-Mar-24 (No. 217-04036)         Ower sensor NRP-291       SN: 103245         SN: 103245       26-Mar-24 (No. 217-04037)         Mar-25       Secondary Standards         Orget meter NRP2       SN: 103245         SN: 103245       26-Mar-24 (No. 217-04036)         Mar-25       Secondary Standards         SN: 103245       26-Mar-24 (No. 217-04037)         Mar-25       Secondary Standards         Orget meter NRP2       SN: 103245         SN: 103245       26-Mar-24 (No. 217-04037)         Mar-25	CALIBRATION C	ERTIFICATE			
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz         Light of the second sec	Object	D2450V2 - SN:94	<del>15</del>		
Calibration date:       May 10, 2024         Discription of the intervention of the interventinterventing of the intervention of the intervention of the interve	Calibration procedure(s)		dure for SAR Validation Sour	rces between 0.7-3 GHz	
5/3/2024         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%.				실무자 기술책임자	
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Power meter NRP2         SN: 104778         26-Mar-24 (No. 217-04036/04037)         Mar-25           Power sensor NRP-Z91         SN: 103244         26-Mar-24 (No. 217-04036)         Mar-25           Power sensor NRP-Z91         SN: 103245         26-Mar-24 (No. 217-04037)         Mar-25           Power sensor NRP-Z91         SN: 103245         26-Mar-24 (No. 217-04037)         Mar-25           Peterence 20 dB Attenuator         SN: BH9394 (20k)         26-Mar-24 (No. 217-04046)         Mar-25           Fype-N mismatch combination         SN: 310982 / 06327         26-Mar-24 (No. 217-04047)         Mar-25           Paeference Probe EX3DV4         SN: 103245         26-Mar-24 (No. 217-04047)         Mar-25           DAE4         SN: 310982 / 06327         26-Mar-24 (No. 217-04047)         Mar-25           DAE4         SN: 310982 / 06327         26-Mar-24 (No. 217-04047)         Mar-25           Secondary Standards         ID         #         Check Date (in house)         Nov-24           DAE4         SN: 601         30-Jan-24 (No. DAE4-601_Jan24)         Jan-25           Power sensor HP 8481A         SN: US37292783         07-Oct-15 (in house check Oct-22)         In house check: Oct-24           Power sensor HP 8481A         SN: 100972         15-Jun-15 (in house check Oct-22)         In house check: Oct-24 <t< td=""><td>The measurements and the uncert All calibrations have been conduct</td><td>ainties with confidence pr ed in the closed laborator</td><td>robability are given on the following page</td><td>al units of measurements (SI). es and are part of the certificate.</td><td></td></t<>	The measurements and the uncert All calibrations have been conduct	ainties with confidence pr ed in the closed laborator	robability are given on the following page	al units of measurements (SI). es and are part of the certificate.	
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DAE4       SN: 601       30-Jan-24 (No. DAE4-601_Jan24)       Jan-25         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         Power sensor HP 8481A       SN: 100972       15-Jun-15 (in house check Oct-22)       In house check: Oct-24         RF generator R&S SMT-06       SN: US41080477       31-Mar-14 (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         Calibrated by:       Name       Function       Signature         Approved by:       Sven Kühn       Technical Manager       Supervector Signature	Reference Probe EX3DV4				
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Name     Function     Signature       Calibrated by:     Jeffrey Katzman     Laboratory Technician       Approved by:     Sven Kühn     Technical Manager	RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24	
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Approved by: Sven Kühn Technical Manager		Name	Function	Signature	
	Calibrated by:	Jeffrey Katzman	Laboratory Technician	11_6/1	
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Issued: May 13, 2024	Approved by:	Sven Küh <b>n</b>	Technical Manager	Sez	
				Issued: May 13, 2024	

# **Calibration Laboratory of**

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
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

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	<u>1.80 mho/m</u>
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.9 ± 6 %	1.88 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	53.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	. 55111.
SAR measured	250 mW input power	6.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	√ 25.1 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	53.6 Ω + 2.9 jΩ	
Return Loss	( <sup>-</sup> 26.9 dB	

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

Electrical Delay (one direction)	1.159 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: 10.05.2024

Test Laboratory: SPEAG, Zurich, Switzerland

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

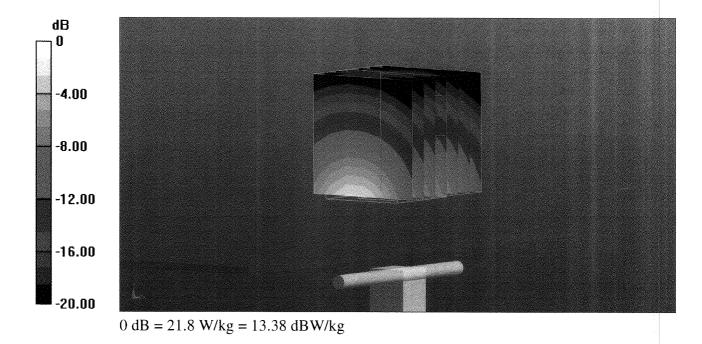
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.88$  S/m;  $\epsilon_r = 37.9$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 03.11.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2024
- 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 = 116.9 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 27.4 W/kg SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.38 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 50.9% Maximum value of SAR (measured) = 21.8 W/kg



# Impedance Measurement Plot for Head TSL

<u>F</u> ile	⊻iew	<u>C</u> hannel	Sw <u>e</u> ep	Calibration	<u>Trace</u> <u>S</u> cale	e M <u>a</u> rker	System	<u>W</u> indow	Help			
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#### **Calibration Laboratory of** Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland



Schweizerischer Kalibrierdienst

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Accreditation No.: SCS 0108

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Certificate No: D2450V2-750\_May22

Element

Client

<b>CALIBRATION C</b>	ERTIFICATI		
Object	D2450V2 - SN:7	50	VATUR 611 (2)
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	עאן איז
Calibration date:	Maγ 11, 2022		✓ YW 5/22/2023
			VW 5/31/2024
The measurements and the uncertain	ainties with confidence p ad in the closed laborator	onal standards, which realize the physical un robability are given on the following pages an y facility: environment temperature (22 ± 3)°(	id are part of the certificate.
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)	Арг-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: 7349	31-Dec-21 (No. EX3-7349 Dec21)	Dec-22
DAE4	SN: 601	02-May-22 (No. DAE4-601_May22)	May-23
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: MY41093315	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:	Aidonia Georgiadou	Laboratory Technician	MZ
Approved by:	Sven Kühn	Technical Manager	SLF-
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory	lssued: May 12, 2022

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





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#### Glossary:

wideed g	
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 0 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. 0
- 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 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	38.2 ± 6 %	1.85 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	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.6 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	6.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 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	51.5 ± 6 %	2.02 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	50.5 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	6.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.9 ₩/kg ± 16.5 % (k=2)

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

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.8 Ω + 8.1 jΩ
Return Loss	- 21.0 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8 Ω + 8.7 jΩ
Return Loss	- 21.3 dB

# General Antenna Parameters and Design

Electrical Delay (one direction)	1.153 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
	J JFLAG

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

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:750

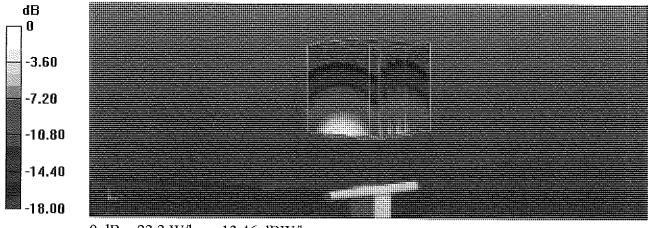
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.85$  S/m;  $\epsilon_r = 38.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- 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 = 116.5 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 26.8 W/kg SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.2 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 50% Maximum value of SAR (measured) = 22.2 W/kg



0 dB = 22.2 W/kg = 13.46 dBW/kg

# Impedance Measurement Plot for Head TSL

<u>Eile View Channel Swe</u> ep Calibra	on <u>T</u> race <u>S</u> cale Marker System <u>W</u> indow <u>H</u> elp
Ch 1 Avg = 20	1: 2.450000 GHz 54.753 Ω 527.78 pH 8.1248 Ω 2.450000 GHz 89.589 mU 55.235 °
Ch1: Start 2,25000 GHz	Stop 2.65000 GHz
10.00 <b>68 511</b> 5.00 0.00 5.00	> 1: 2.450000 CHz -20.955 dB
10.00 15.00 20.00	
-25.00 30.00 -35.00	
40.00 Ch 1 Avg = 20 Ch 1: Start 2.25000 GHz	Stop 2.65000 GHz
Status CH 1: S11	C <sup>*</sup> 1-Poit Avg=20 Delay

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

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:750

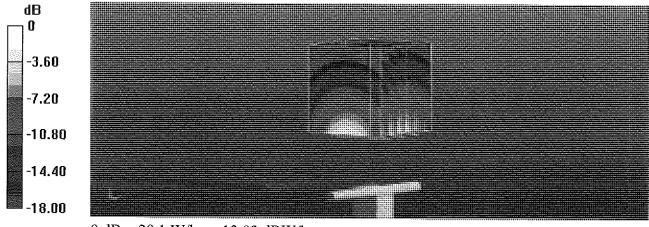
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 51.5$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- 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 = 106.7 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 24.3 W/kg SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.04 W/kg Smallest distance from peaks to all points 3 dB below = 8.9 mm Ratio of SAR at M2 to SAR at M1 = 54% Maximum value of SAR (measured) = 20.1 W/kg



0 dB = 20.1 W/kg = 13.03 dBW/kg

# Impedance Measurement Plot for Body TSL

		A	XXX		1	2.450000 562.1 2.450000	9 pH	85.	i0,764 ).6542 .904 m 80.04)
Ch 1 Avg = h1: Start 2.25000			·····					Stop	2.65000 0
	 			:> 1:	2	.450000 (	<u>GHz</u>	-2	.320 c
)				> 1	2	450000 (		-2	.320 (



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

D2450V2 - SN: 750

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

Extended Calibration date:

May 11, 2023

Description:

SAR Validation Dipole at 2450 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	5/19/2022	Annual	5/19/2023	106562
Rohde & Schwarz	NRP-Z81	Wide Band Power Sensor	5/19/2022	Annual	5/19/2023	106559
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	2/13/2023	Annual	2/13/2024	7427
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/15/2023	Annual	2/15/2024	1403

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

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

Object:	Date Issued:	Page 1 of 4
D2450V2 – SN: 750	05/11/2023	Page 1 of 4

# **DIPOLE CALIBRATION EXTENSION**

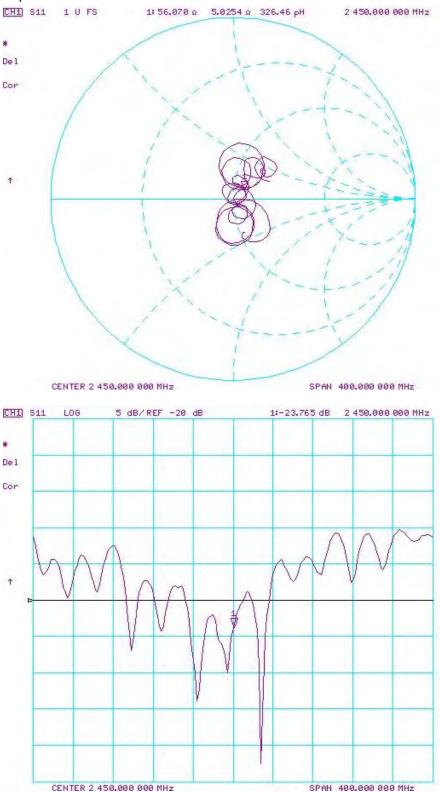
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 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 2-year calibration period from the calibration date:

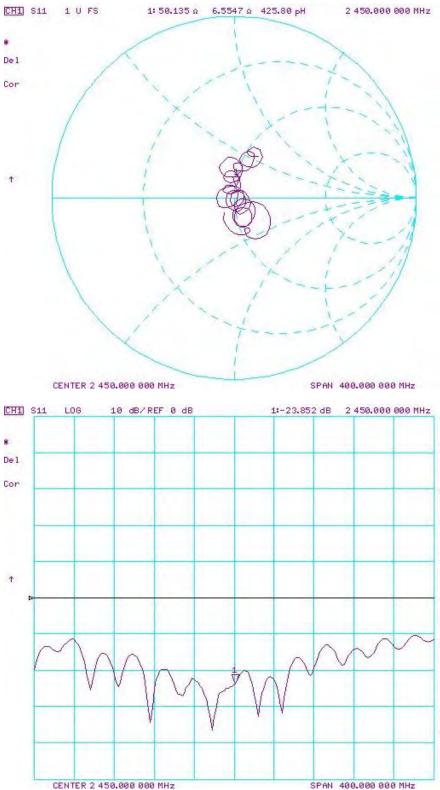
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	Measured Head	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real		Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary		Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
5/11/2022	5/11/2023	1.153	5.26	4.89	-7.03%	2.45	2.28	-6.94%	54.8	56.1	1.3	8.1	5	3.1	-21	-23.8	-13.20%	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		Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
5/11/2022	5/11/2023	1.153	5.05	4.76	-5.74%	2.39	2.26	-5.44%	50.8	50.1	0.7	8.7	6.6	2.1	-21.3	-23.9	-12.00%	PASS

Object:	Date Issued:	Page 2 of 4
D2450V2 – SN: 750	05/11/2023	Page 2 of 4



Impedance	ce &	Retu	rn-Loss Measu	irement F	Plot for	Head TS	L
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Object:	Date Issued:	Page 3 of 4
D2450V2 – SN: 750	05/11/2023	Page 3 of 4



Impedance & Return-Loss Measurement Plot for Body TSL

Object:	Date Issued:	Dage 4 of 4
D2450V2 – SN: 750	05/11/2023	Page 4 of 4



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



# **Certification of Calibration**

Object

D2450V2 – SN: 750

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

Extension Calibration date: May 11, 2024

Description:

SAR Validation Dipole at 2450 MHz.

### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	6/2/2023	Annual	6/12/2024	MY40003841
Agilent	E4438C	ESG Vector Signal Generator	11/15/2023	Annual	11/15/2024	MY45092078
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Anritsu	ML2496A	Power Meter	6/15/2023	Annual	6/15/2024	1138001
Anritsu	MA24106A	USB Power Sensor	4/15/2024	Annual	4/15/2025	2018527
Anritsu	MA24106A	USB Power Sensor	4/15/2024	Annual	4/15/2025	1827528
Control Company	4040	Therm./ Clock/ Humidity Monitor	4/15/2024	Biennial	4/15/2026	240310282
Control Company	4353	Ultra Long Stem Thermometer	10/24/2023	Annual	10/24/2024	200645916
Agilent	85033E	3.5mm Standard Calibration Kit	7/18/2023	Annual	7/18/2024	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	9/11/2023	Annual	9/11/2024	1045
SPEAG	EX3DV4	SAR Probe	3/11/2024	Annual	3/11/2025	7638
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/6/2024	Annual	3/6/2025	1408

Measurement Uncertainty = ±23% (k=2)

	Name	Function	Signature
Calibrated By:	Arturo Oliveros	Compliance Engineer	AS
Approved By:	Greg Snyder	Executive VP of Operations	Sugged Syl

Object:	Date Issued:	Page 1 of 3
D2450V2 – SN: 750	05/11/2024	Page 1 of 3

# **DIPOLE CALIBRATION EXTENSION**

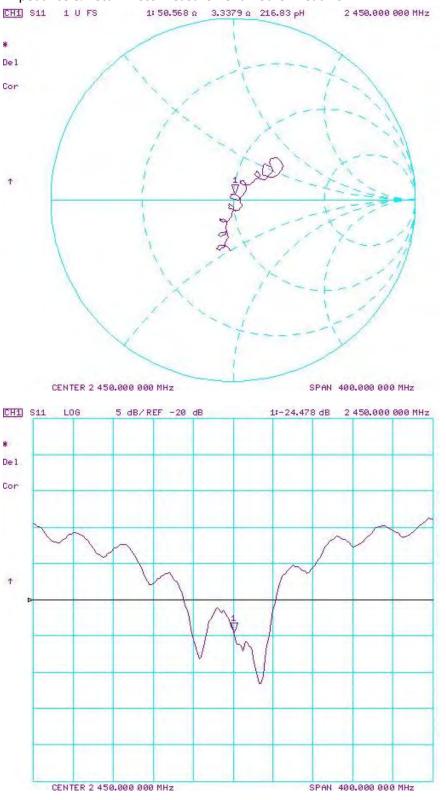
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 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 SAR Target Head (1g) W/kg @ 20.0 dBm		Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm		Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real		Certificate Impedance Head (Ohm) Imaginary		Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)
5/11/2022	5/11/2024	1.153	5.26	5.19	-1.33%	2.45	2.33	-4.90%	54.8	50.6	4.2	8.1	3.3	4.8	-21	-24.5	-16.60%

Object:	Date Issued:	Page 2 of 3
D2450V2 – SN: 750	05/11/2024	rage 2 01 5



Impedance & Return-Loss Measurement Plot for Head TSL

Object:	Date Issued:	Dogo 2 of 2
D2450V2 – SN: 750	05/11/2024	Page 3 of 3

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



S Schweizerischer Kalibrierdienst

- C Service suisse d'étaionnage
  - 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

Accreditation No.: SCS 0108

Client Element

Certificate No: D2450V2-855\_Nov22

CALIB	RATIC	N CE	RTIFI	CATE	r 1

Object	D2450V2 - SN:8	55	ATM
Calibration procedure(s)	QA CAL-05.v11		
	Calibration Proce	edure for SAR Validation Sources	s between 0.7-3 GHz
			2 6 27 √ YW 12/13/2023
Calibration date:	November 15, 20	)22	VW 12/13/2023
This calibration certificate documer The measurements and the uncerta	its the traceability to nati- ainties with confidence p	onal standards, which realize the physical un robability are given on the following pages an	its of measurements (SI). Id are part of the certificate.
All calibrations have been conducte	ed in the closed laborator	y facility: environment temperature (22 $\pm$ 3)°(	C and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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: 7349	31-Dec-21 (No. EX3-7349_Dec21)	Dec-22
DAE4	SN: 601	31-Aug-22 (No. DAE4-601_Aug22)	Aug-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 Ka <b>s</b> trati	Laboratory Technician	ZUU
Approved by:	Sven Kühn	Technical Manager	<u>Ģ</u> E
This calibration certificate shall not b	pe reproduced except in	full without written approval of the laboratory.	lssued: November 16, 2022

# **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

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:

<b> - - - - - - -</b>	
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	38.4 ± 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	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.4 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	6.24 W/kg

# **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52. <b>7</b>	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.7 ± 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	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.2 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	6.03 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	52.5 Ω + 6.3 jΩ
Return Loss	- 23.6 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.9 Ω + 7.9 jΩ
Return Loss	- 21.9 dB

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

- 1	Electrical Delay (one direction)	· · · · · · · · · · · · · · · · · ·
		1,157 ns
- 1	, , , ,	1.107/10

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: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855

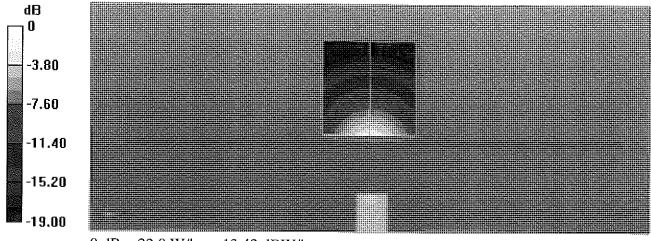
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.87$  S/m;  $\varepsilon_r = 38.4$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- 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 = 116.1 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 26.2 W/kg **SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.24 W/kg** Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51.1% Maximum value of SAR (measured) = 22.0 W/kg



0 dB = 22.0 W/kg = 13.42 dBW/kg

# Impedance Measurement Plot for Head TSL

File	<u>V</u> iew <u>C</u>	hannel	Sw <u>e</u> ep	Calibratio	n <u>T</u> ra	ce <u>S</u> cal	e M <u>a</u> rker	System	Window	Help				
	Ph	1 Avg =	20			A				2.450000 407.1 2.450000	99 pH	6 65.	2.487 ( .2805 ( 787 mi 84.891	
) c	h1:Start :							- <u> </u>		in and the first statute		Stop (	2.65000 G	-la
10.00 5.00 0.00 -5.00 -10.0	I)	SII 								2.450000	GHz	-23	).637 di	
5,00 0,00 5,00 -10,0 -15,0 -20,0 -25,0 -30,0	0	\$11 ``								2.450000		-23	).637 dl	
5,00 0,00 -5,00 -10,0 -15,0 -20,0 -25,0 -30,0 -35,0 -40,0		1 Awa =	20 Hz							2.450000			).637 d  	

# **DASY5 Validation Report for Body TSL**

Date: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855

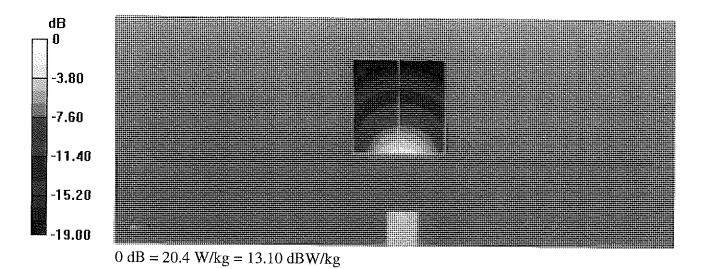
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 2.01 S/m;  $\epsilon_r$  = 51.7;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- 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 2/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 108.4 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 24.1 W/kg SAR(1 g) = 12.8 W/kg; SAR(10 g) = 6.03 W/kg Smallest distance from peaks to all points 3 dB below = 8.9 mm Ratio of SAR at M2 to SAR at M1 = 53.7% Maximum value of SAR (measured) = 20.4 W/kg



# Impedance Measurement Plot for Body TSL

ile <u>Vi</u> ev	v <u>C</u> hannel		Calibration	Irace Scale	Marker	System	1: 2 K	. 450000	9 pH	80.146	33 Q
Ch1: S 10.00 5.00 0.00	tart 2.25000 (						1 2	.450000	G <mark>I-1</mark> z	Stop 2.6500	00 GHz 2 dB
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-25,00 -30,00 -35,00						Z					
40,00	<u>Ch 1 Avg =</u> tart 2,25000 (	20								Stop 2.6500	



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

D2450V2 – SN: 855

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

Extension Calibration date: November 15, 2023

Description: SAR Valid

SAR Validation Dipole at 2450 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	6/2/2023	Annual	6/12/2024	MY40003841
Agilent	E4438C	ESG Vector Signal Generator	4/25/2023	Annual	4/25/2024	US41460739
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	Ultra Long Stem Thermometer	10/24/2023	Annual	10/24/2024	200645916
Agilent	85033E	3.5mm Standard Calibration Kit	7/18/2023	Annual	7/18/2024	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	5/9/2023	Annual	5/9/2024	1070
SPEAG	EX3DV4	SAR Probe	11/9/2023	Annual	11/9/2024	7639
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/14/2023	Annual	11/14/2024	1403

Measurement Uncertainty = ±23% (k=2)

	Name	Function	Signature
Calibrated By:	Arturo Oliveros	Compliance Engineer	AS
Approved By:	Greg Snyder	Executive VP of Operations	Lugg M. S.

Object:	Date Issued:	Page 1 of 3
D2450V2 – SN: 855	11/15/2023	Fage 1015

# **DIPOLE CALIBRATION EXTENSION**

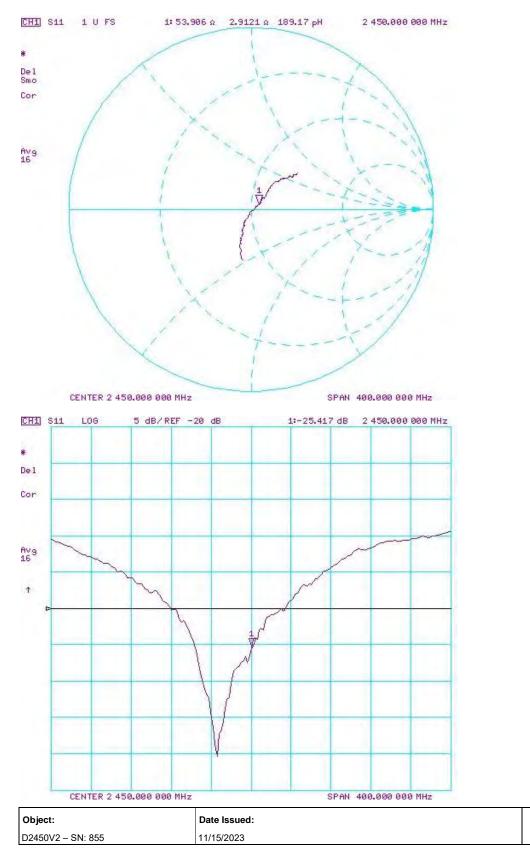
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 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	Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real		Certificate Impedance Head (Ohm) Imaginary			Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)
11/15/2022	11/15/2023	1.157	5.24	5.13	-2.10%	2.46	2.38	-3.25%	52.5	53.9	1.4	6.3	2.9	3.4	-23.6	-25.4	-7.70%

Object:	Date Issued:	Page 2 of 3
D2450V2 – SN: 855	11/15/2023	rage 2 01 5



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

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

Element

Client



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

Certificate No: D2600V2-1042\_May22

#### **ALIBRATION CERTIFICATE** C

Object	D2600V2 - SN:10	042	VATM
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	edure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	May 11, 2022		<ul><li>✓ YW 5/22/2023</li><li>✓ YW 6/11/2024</li></ul>
		onal standards, which realize the physical uni obability are given on the following pages and	
All calibrations have been conducte	ed in the closed laborator	y facility: environment temperature (22 ± 3)°C	C and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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: 7349	31-Dec-21 (No. EX3-7349_Dec21)	Dec-22
DAE4	SN: 601	02-May-22 (No. DAE4-601_May22)	May-23
		- · · · · · · · · · · · · · · · · · · ·	-
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: MY41093315	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:	Aldonia Georgiadou	Laboratory Technician	AIZ
Approved by:	Sven Kühn	Technical Manager	Ser
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory.	Issued: May 12, 2022

# **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:

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

## Calibration is Performed According to the Following Standards:

- a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- 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 8 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. 0
- 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	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.

	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	37.6 ± 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 $^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	55.8 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	6.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.9 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	51.1 ± 6 %	2.20 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	53.7 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	6.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.0 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	47.5 Ω - 8.9 jΩ
Return Loss	- 20.5 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.2 Ω - 7.2 jΩ
Return Loss	- 20.2 dB

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

Electrical Delay (one direction)	1.150 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

- 1		
	Manufactured by	SPEAG

# **DASY5 Validation Report for Head TSL**

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1042

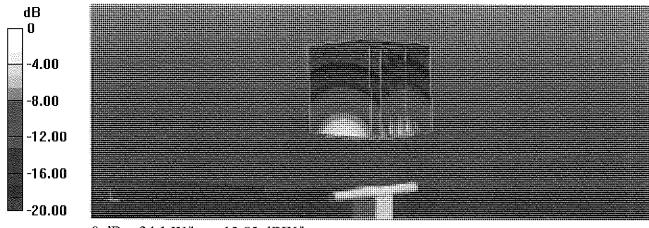
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 37.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- 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 = 117.1 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 28.9 W/kg **SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.3 W/kg** Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 49.3% Maximum value of SAR (measured) = 24.1 W/kg



0 dB = 24.1 W/kg = 13.83 dBW/kg

# Impedance Measurement Plot for Head TSL

File	<u>⊻</u> iew	⊆hannel	Sweep	Calibration	<u>Trace</u> 5	cale	M <u>a</u> rker	S <u>y</u> stem	<u>W</u> indow (	<u>t</u> elp				
		Ch 1 Avg =	20		K				A	.600000 ( 6.911) .600000 (	3 pF	-8. 94.0	7.483 Ω 8584 Ω 362 mU 00.67 °	
	Ch1: Sta	at 2.40000						.j				Stop 2	.80000 GHa	2
10.( 5.0 -5.0 -5.0 -10. -15. -20. -25.	0 - 0 - 10 - 00 - 00 -							>	1: 2			-20.	532 dB	Sector Sect
-30. -35. -40	.00 .09 .00	<u>Ch 1 Avg =</u> nt 2.48000 (	20 3Hz									Stop 2	.80000 GHz	
Sta	itus	CH 1: §	311		C* 1-Port		and the second	Avg=20	Delay				LCL	<u>البريمينييني</u>

# **DASY5 Validation Report for Body TSL**

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1042

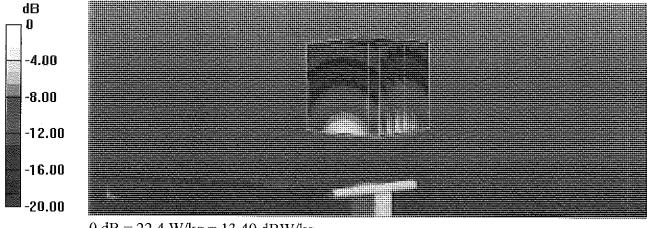
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 2.2$  S/m;  $\epsilon_r = 51.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.91, 7.91, 7.91) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- 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 = 107.5 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 27.0 W/kg SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.04 W/kg Smallest distance from peaks to all points 3 dB below = 8.5 mm Ratio of SAR at M2 to SAR at M1 = 50.9% Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.49 dBW/kg

# Impedance Measurement Plot for Body TSL

<u>File Yiew</u>	<u>⊂</u> hannel	Sw <u>e</u> ep C	ajibration ]	[race <u>S</u> cale	e M <u>a</u> rker	System <u>W</u>	indow <u>H</u> e	elp		
					XXX			600000 G 8.4441 600000 G	рF	44.240 Ω -7.2493 Ω 7.962 mU -124.07 °
Ch1:S	Ch 1 Avg ≈ tart 2.40000 0				~~~ <u>~</u>		-		Sto	op 2,80000 GHz
10.00 5.00 0.00	dB \$11					>	2.6	00000 G	Hz -	20.179 dB
-5.00 -10.00 -15.00 -20.00			w		······				1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.	
-25.00 -30.00										
35.00 40.00 Ch1: \$	Ch 1 Avg = tart 2.40000 C						~		Ste	p 2.80000 GHz
Status	CH 1: [5	11	C	* 1-Port		Avg=20 Del	ay			LCL



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

D2600V2 - SN: 1042

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

May 11, 2023

Extended Calibration date:

Description: SAR Validation Dipole at 2600 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	5/19/2022	Annual	5/19/2023	106562
Rohde & Schwarz	NRP-Z81	Wide Band Power Sensor	5/19/2022	Annual	5/19/2023	106559
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	2/13/2023	Annual	2/13/2024	7427
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/15/2023	Annual	2/15/2024	1403

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

	Name	Function	Signature
Calibrated By:	Arturo Oliveros	Compliance Engineer I	AC
Approved By:	Greg Snyder	Executive VP of Operations	Sugged Sol

Object:	Date Issued:	Dage 1 of 4
D2600V2 – SN: 1042	05/11/2023	Page 1 of 4

# **DIPOLE CALIBRATION EXTENSION**

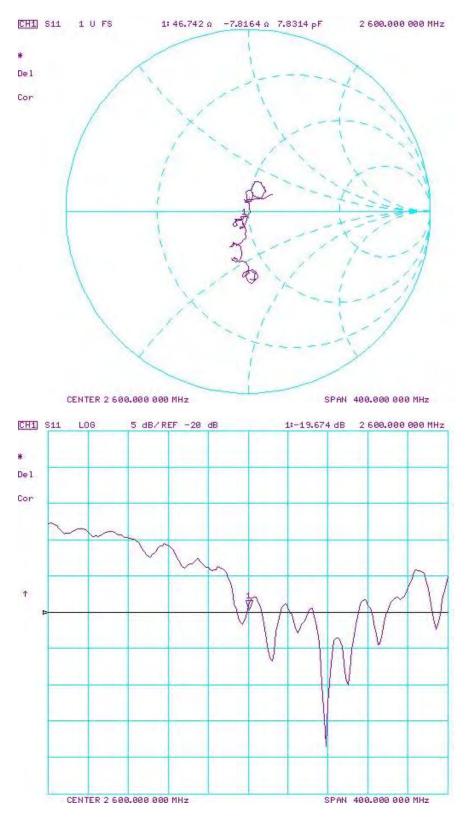
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 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 2-year calibration period from the calibration date:

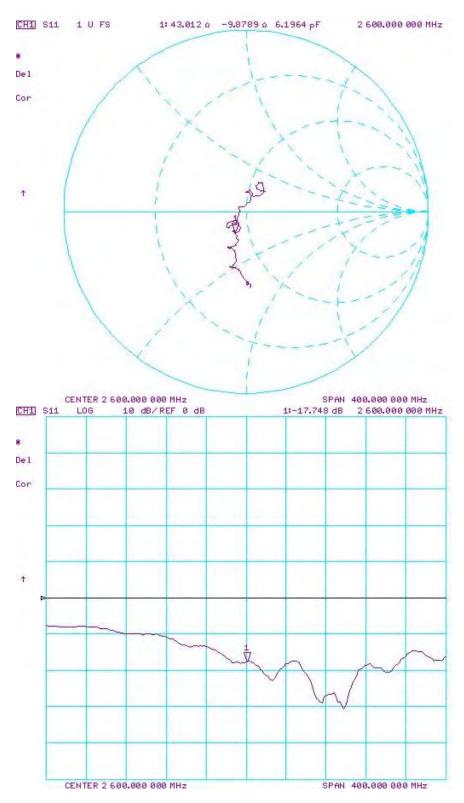
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary		Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
5/11/2022	5/11/2023	1.15	5.58	5.63	0.90%	2.49	2.52	1.20%	47.5	46.7	0.8	-8.9	-7.8	1.1	-20.5	-19.7	4.00%	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	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		Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
5/11/2022	5/11/2023	1.15	5.37	5.53	2.98%	2.4	2.54	5.83%	44.2	43	1.2	-7.2	-9.9	2.7	-20.2	-17.7	12.10%	PASS

Object:	Date Issued:	Page 2 of 4
D2600V2 – SN: 1042	05/11/2023	raye 2 014



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

Object:	Date Issued:	Page 3 of 4
D2600V2 – SN: 1042	05/11/2023	Page 5 01 4



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

Object:	Date Issued:	Daga 4 of 4
D2600V2 – SN: 1042	05/11/2023	Page 4 of 4



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# **Certification of Calibration**

Object

D2600V2 – SN: 1042

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

Extension Calibration date: May 11, 2024

Description: SAR Validation Dipole at 2600 MHz.

# Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	6/2/2023	Annual	6/12/2024	MY40003841
Agilent	E4438C	ESG Vector Signal Generator	11/15/2023	Annual	11/15/2024	MY45092078
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Anritsu	ML2496A	Power Meter	6/15/2023	Annual	6/15/2024	1138001
Anritsu	MA24106A	USB Power Sensor	4/15/2024	Annual	4/15/2025	2018527
Anritsu	MA24106A	USB Power Sensor	4/15/2024	Annual	4/15/2025	1827528
Control Company	4040	Therm./ Clock/ Humidity Monitor	4/15/2024	Biennial	4/15/2026	240310282
Control Company	4353	Ultra Long Stem Thermometer	10/24/2023	Annual	10/24/2024	200645916
Agilent	85033E	3.5mm Standard Calibration Kit	7/18/2023	Annual	7/18/2024	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	9/11/2023	Annual	9/11/2024	1045
SPEAG	EX3DV4	SAR Probe	3/11/2024	Annual	3/11/2025	7638
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/6/2024	Annual	3/6/2025	1408

Measurement Uncertainty = ±23% (k=2)

	Name	Function	Signature
Calibrated By:	Arturo Oliveros	Compliance Engineer	AS
Approved By:	Greg Snyder	Executive VP of Operations	Sugged Syl

Object:	Date Issued:	Page 1 of 3
D2600V2 – SN: 1042	05/11/2024	Page 1 of 3

# **DIPOLE CALIBRATION EXTENSION**

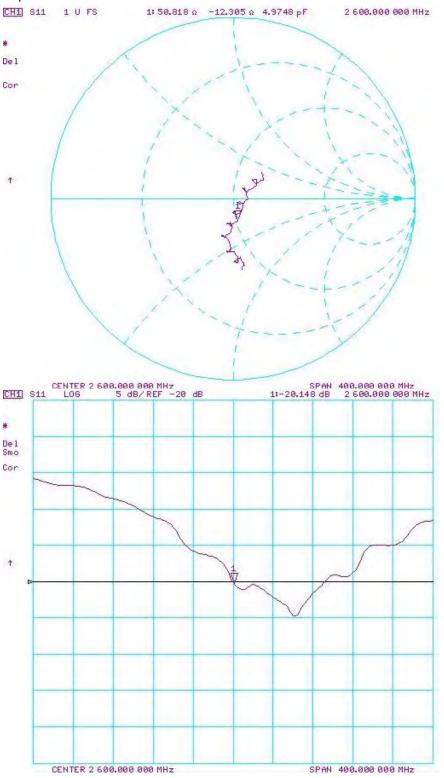
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

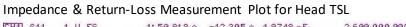
- 1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
- 2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
- 3. The measurement of real or imaginary parts of impedance 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		Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)
5/11/2022	5/11/2024	1.15	5.58	5.61	0.54%	2.49	2.55	2.41%	47.5	50.8	3.3	-8.9	-12.3	3.4	-20.5	-20.1	1.70%

Object:	Date Issued:	Page 2 of 3
D2600V2 - SN: 1042	05/11/2024	Page 2 of 3





Object:	Date Issued:	Daga 2 of 2
D2600V2 – SN: 1042	05/11/2024	Page 3 of 3

# **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: D2600V2-1068\_Nov22

# **CALIBRATION CERTIFICATE**

Object	D2600V2 - SN:1068
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz $\mathcal{W}/\mathcal{U}\mathcal{V}$
Calibration date:	November 15, 2022 VW 12/28/2023
	its the traceability to national standards, which realize the physical units of measurements (SI). ainties with confidence probability are given on the following pages and are part of the certificate.
All calibrations have been conducte	ed in the closed laboratory facility: environment temperature (22 $\pm$ 3)°C and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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: 7349	31-Dec-21 (No. EX3-7349_Dec21)	Dec-22
DAE4	SN: 601	31-Aug-22 (No. DAE4-601_Aug22)	Aug-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	ZIM
Approved by:	Sven Kühn	Technical Manager	S.G.
			lssued: November 16, 2022

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



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# **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

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.

	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	37.8 ± 6 %	2.03 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	14.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.5 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	6.43 W/kg

#### **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	51.3±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	13.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	53.9 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	6.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.1 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	47.8 Ω - 5.9 jΩ
Return Loss	- 23.9 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.5 Ω - 5.0 jΩ
Return Loss	- 22.1 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.148 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: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1068

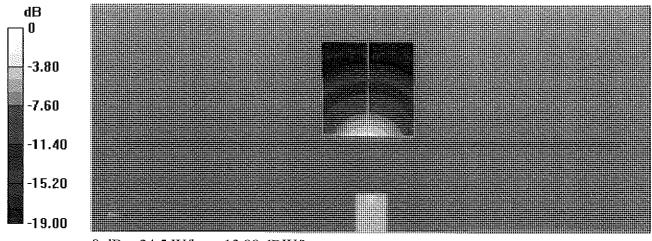
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma$  = 2.03 S/m;  $\epsilon_r$  = 37.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- 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 = 118.5 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 29.2 W/kg SAR(1 g) = 14.4 W/kg; SAR(10 g) = 6.43 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 49.4% Maximum value of SAR (measured) = 24.5 W/kg



0 dB = 24.5 W/kg = 13.88 dBW/kg

# Impedance Measurement Plot for Head TSL

File	Yiew	⊆hannel	Sw <u>e</u> ep	Calibration	<u>T</u> race <u>S</u> cal	e M <u>a</u> rker	System '	<u>W</u> indow	Help			
					A			2 million and a second	2,600000 10,46 2,600000	3 pF		
	Ch1: Sta	Ch 1 Avg = nt 2,40000 (	20 GHz				L_am <sup>anan</sup>			·	Stop 2.80000 6	iHz
10.0 5.00 5.00 -10.1 -15.0 -20.0 -25.0 -30.0 -35.0 -40.0	) - () ) - () () - ()	18 \$11	20						2.600000		-23.908 c	
		n 2.40000 I		*	<u> </u>		·				Stop 2,80000 6	iHz
Stal	tus	CH 1:	511		C* 1-Port		Avg=20 D	)elay			LCL	

# **DASY5 Validation Report for Body TSL**

Date: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1068

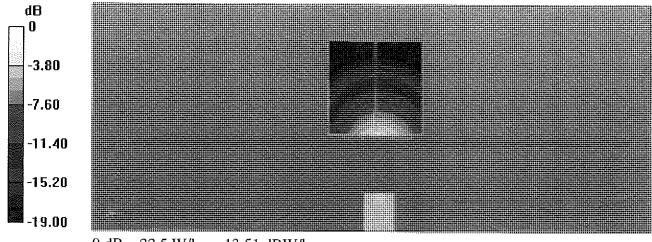
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 2.19$  S/m;  $\varepsilon_r = 51.3$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.91, 7.91, 7.91) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- 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 = 107.9 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 27.0 W/kg SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.07 W/kg Smallest distance from peaks to all points 3 dB below = 8.5 mm Ratio of SAR at M2 to SAR at M1 = 51.2% Maximum value of SAR (measured) = 22.5 W/kg



0 dB = 22.5 W/kg = 13.51 dBW/kg

# Impedance Measurement Plot for Body TSL

<u>File Vie</u>	w <u>C</u> hannel	Sw <u>e</u> ep Ca	libration	<u>Trace S</u> cal	e M <u>a</u> rker	System \	<u>W</u> indow H	lelp			
				A	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		1. J.	600000 ( 12.15) 600000 (	3 pF	-5.0 78.4	.543 Ω )369 Ω 41 mU 34.24 °
Ch1:	Ch 1 Avg = Start 2.40000 0					 -		all in the line		Stop 2.4	80000 GHz
10.00 5.00 0.00 -5.00 -10.00 -15.00 -20.00	<b>CB_S11</b>					> 1	: 2.	800000 (	Hz	-22.	109 dB
-25,00 -30,00											
-35,00 -40,00 Ch1:	Ch 1.Avg = Start 2.40000 0	20 3Hz						·		Stop 2,8	30000 GHz



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# **Certification of Verification**

Object	D2600V2 – SN: 1068
Calibration procedure(s)	Procedure for Calibration Extension for SAR Dipoles.
Calibration Date:	November 15, 2022
Extension Calibration date:	November 15, 2023
Description:	SAR Validation Dipole at 2600 MHz.

Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8753ES	S-Parameter Vector Network Analyzer	6/2/2023	Annual	6/12/2024	MY40003841
Agilent	E4438C	ESG Vector Signal Generator	4/25/2023	Annual	4/25/2024	US41460739
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	Ultra Long Stem Thermometer	10/24/2023	Annual	10/24/2024	200645916
Agilent	85033E	3.5mm Standard Calibration Kit	7/18/2023	Annual	7/18/2024	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	5/9/2023	Annual	5/9/2024	1070
SPEAG	EX3DV4	SAR Probe	11/9/2023	Annual	11/9/2024	7639
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/14/2023	Annual	11/14/2024	1403

Measurement Uncertainty = ±23% (k=2)

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

Object:	Date Issued:	Page 1 of 3
D2600V2 – SN: 1068	11/15/2023	Page 1 of 3

# **DIPOLE CALIBRATION EXTENSION**

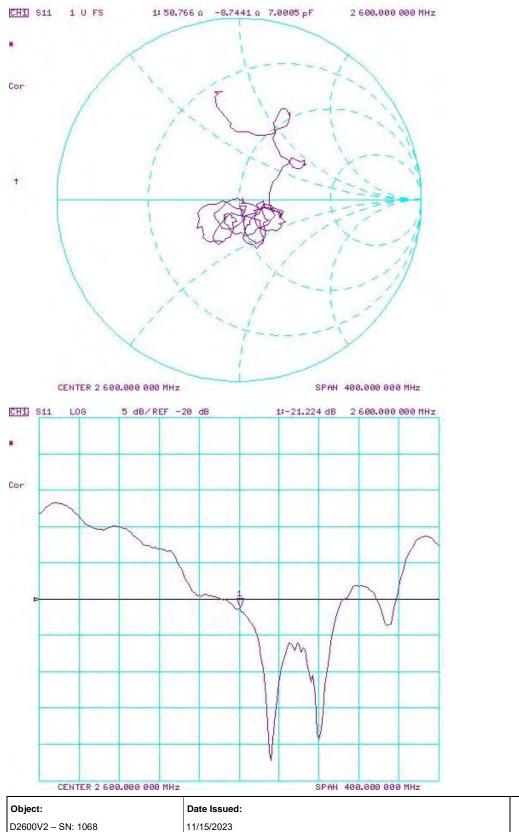
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 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	Electrical	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	W/kg @ 20.0	Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm		Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real	Difference (Ohm) Real			Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)
11/15/2022	11/15/2023	1.148	5.65	5.2	-7.96%	2.54	2.35	-7.48%	47.8	50.8	3	-5.9	-8.7	2.8	-23.9	-21.2	11.20%

Object:	Date Issued:	Page 2 of 3
D2600V2 – SN: 1068	11/15/2023	rage 2 01 5



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

# **Calibration Laboratory of**

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



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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

#### Client Element

Certificate No. D2600V2-1009\_Jun24

Yongin,	Republic of Korea	

Object	D2600V2 - SN:10	009	
Calibration procedure(s)	QA CAL-05.v12 Calibration Proce	edure for SAR Validation Sources	between 0.7-3 GHz
			실무자 기술책임자
Calibration date:	June 14, 2024		Max fre
The measurements and the uncerta	ainties with confidence pr	onal standards, which realize the physical unit robability are given on the following pages and y facility: environment temperature (22 ± 3)°C	d are part of the certificate.
Calibration Equipment used (M&TE			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
ower meter NRP2	SN: 104778	26 Mar 24 (No 017 04026/04027)	11.05
		26-Mar-24 (No. 217-04036/04037)	Mar-25
ower sensor NRP-Z91	SN: 103244	26-Mar-24 (No. 217-04036)	Mar-25
ower sensor NRP-Z91 ower sensor NRP-Z91	SN: 103244 SN: 103245	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037)	Mar-25 Mar-25
ower sensor NRP-Z91 ower sensor NRP-Z91 eference 20 dB Attenuator	SN: 103244 SN: 103245 SN: BH9394 (20k)	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046)	Mar-25 Mar-25 Mar-25
ower sensor NRP-Z91 ower sensor NRP-Z91 leference 20 dB Attenuator ype-N mismatch combination	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047)	Mar-25 Mar-25 Mar-25 Mar-25
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 103244 SN: 103245 SN: BH9394 (20k)	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046)	Mar-25 Mar-25 Mar-25
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	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 PAE4 Recondary Standards	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24) Check Date (in house)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25 Scheduled Check
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator ype-N mismatch combination Reference Probe EX3DV4 PAE4 Recondary Standards Power meter E4419B	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24) Check Date (in house) 30-Oct-14 (in house check Oct-22)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator ype-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary 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	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24) Check Date (in house)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25 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 Power sensor HP 8481A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25 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 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: WY41093315	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24) 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)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25 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 RF generator 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	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04046) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25 Scheduled Check 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
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 SN: US41080477	26-Mar-24 (No. 217-04036) 26-Mar-24 (No. 217-04037) 26-Mar-24 (No. 217-04047) 26-Mar-24 (No. 217-04047) 03-Nov-23 (No. EX3-7349_Nov23) 22-May-24 (No. DAE4-601_May24) 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)	Mar-25 Mar-25 Mar-25 Mar-25 Nov-24 May-25 Scheduled Check In house check: Oct-24 In house check: Oct-24

# Calibration Laboratory of

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
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 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%.

# **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.

Sector a production of a sector	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	37.3 ± 6 %	2.02 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	****	1

# 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	14.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.6 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	6.47 W/kg

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.5 Ω - 5.2 jΩ	
Return Loss	- 25.3 dB	1 1

## **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.154 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

### Additional EUT Data

Manufactured by	SPEAG
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# **DASY5 Validation Report for Head TSL**

#### Date: 14.06.2024

Test Laboratory: SPEAG, Zurich, Switzerland

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

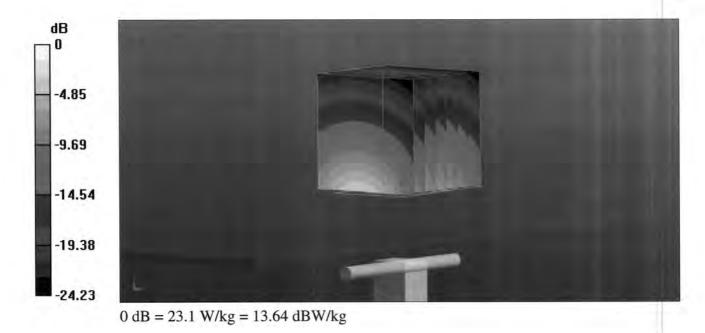
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 37.3$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 03.11.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 22.05.2024
- 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=5mm Reference Value = 115.9 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 29.0 W/kg SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.47 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 50.5% Maximum value of SAR (measured) = 23.1 W/kg



# Impedance Measurement Plot for Head TSL

View	v <u>C</u> l	hannel	Sweep	Calibration	Irace	<u>S</u> cale	Marker	System	Window	<u>H</u> elp	6			_	
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					F	T	X	X	Ì						
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00		2.40000 0		-	1			~	1	2.60	0000	GHz	_	2.80000 ( 5.267 (	_
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00 0 0 0 00	Start 2	2.40000 0						~	1	2.60	0000	GHz	_	_	_
00 0 0 0	Start 2	2.40000 0						>	1	2.60	0000	GHz	_	_	_
00 0 0 00 .00	Start 2	2.40000 0		-				> 	1	2.60	0000	GHz	_	_	_
00 0 0 00 .00 .00	Start 2	2.40000 0								2.60	0000	GHz	_	_	_
00 0 0 .00 .00 .00 .00 .00	dB s	2.40000 C	iHz							2.60		GHz	_	_	_
00 0 0 00 00 .00 .00 .00 .00	dB S	2.40000 0	20							2.60		GHz	-2!	_	

# **Calibration Laboratory of** 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



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Accreditation No.: SCS 0108

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Client	Element		Certificate No: D3500V2-1097_Jan23	
CAL	<b>BRATION C</b>	ERTIFICATE		
Object		D3500V2 - SN:1097		
Calibratio	on procedure(s)	QA CAL-22.v7 Calibration Procedure for SAR Val	idation Sources between 3-10 GHz	3
Calibratic	on date:	January 10, 2023	BNV 2/30/202 SRS 01/16/2	24
		nts the traceability to national standards, which re tainties with confidence probability are given on th		
All calibra	ations have been conduct	ed in the closed laboratory facility: environment te	emperature (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	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	Sigņature
Calibrated by:	Aidonia Georgiadou	Laboratory Technician	X52
Approved by	o. 1830		
Approved by:	Sven Kühn	Technical Manager	Sa
			Issued: January 16, 2023
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory	<b>2</b>

# Calibration Laboratory of

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





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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	er en er en	
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	38.8 ± 6 %	2.95 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

### SAR result with Head TSL

SAR averaged over 1 cm $^3$ (1 g) of Head TSL	Condition		
SAR measured	100 mW input power	6.53 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	65.4 W/kg ± 19.9 % (k=2)	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL			
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head 15L	condition		
SAR measured	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	51.3	3.31 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.0 ± 6 %	3.33 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	6.33 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	63.1 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	2.36 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	50.0 Ω + 2.5 jΩ
Return Loss	- 31.9 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.0 Ω + 5.5 jΩ
Return Loss	- 24.5 dB

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

Electrical Delay (one direction)	
Electrical Delay (one direction)	1.133 ns
, (,	1.100115

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

F		
	Manufactured by	SPEAG

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

Date: 09.01.2023

Test Laboratory: SPEAG, Zurich, Switzerland

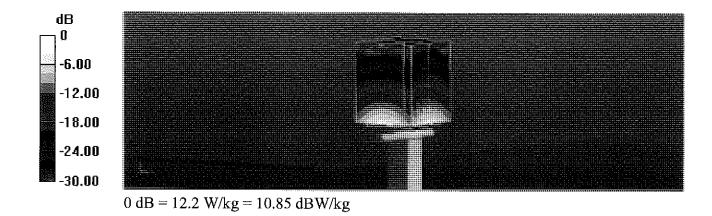
#### DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1097

Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma = 2.95$  S/m;  $\varepsilon_r = 38.8$ ;  $\rho = 1000$  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: 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=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 = 68.50 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 17.4 W/kg SAR(1 g) = 6.53 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 = 75.2% Maximum value of SAR (measured) = 12.2 W/kg



# Impedance Measurement Plot for Head TSL

	Trace         Scale         Marker         System         Window         Help           1         3.500000 GHz         49.97           115.73 pH         2.545           3.500000 GHz         25.449           89.0	0Ω mU
Ch 1 Avg = 20 Ch 1: Start 3.30000 GHz	Stop 3.7000 > 1: 3.900000 CHz - 3 .887	
-5.00 -10.00 -15.00 -29.00		
30.00 -35.00 -40.00 Ch 1 Avg = 20 Ch1: Start 3.30000 GHz Status CH 1: \$11	Stop 3.70001 C* 1-Port Avg=20 Delay LCL	D GHz

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

Date: 10.01.2023

Test Laboratory: SPEAG, Zurich, Switzerland

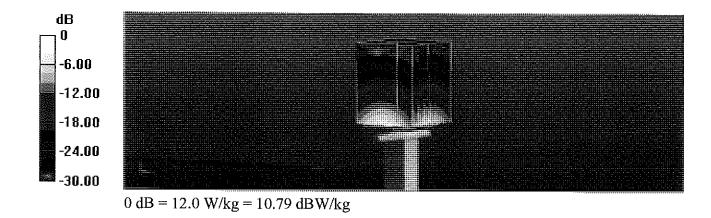
## DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1097

Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma = 3.33$  S/m;  $\varepsilon_r = 51$ ;  $\rho = 1000$  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: 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=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 = 64.09 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 16.8 W/kg SAR(1 g) = 6.33 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 = 75.6% Maximum value of SAR (measured) = 12.0 W/kg



# Impedance Measurement Plot for Body TSL

			248	30 GHz 3.92 pH 30 GHz	47.980 Ω 5.4741 Ω 59.459 mU 107.08 °
Ch1: Star	Ch 1 Avg = 20 t 3.380000 GHz		1: 3.\$0000	10 GHz	stop 3.70000 GH≥
5.00 -10.00 -15.00 -20.00					
-30.00 —	h 1 Avg = 20 3.30000 GHz				Stop 3.70000 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

D3500V2 – SN: 1097

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

Extension Calibration date: 01/09/2024

Description:

SAR Validation Dipole at 3500 MHz.

#### Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	N5182A	MXG Vector Signal Generator	4/1/2023	Annual	4/1/2024	MY47420837
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343971
Anritsu	MA24106A	Pulse Power Sensor	4/21/2023	Annual	4/21/2024	1349503
Control Company	4040	Therm./ Clock/ Humidity Monitor	1/17/2023	Biennial	1/17/2024	160574418
Control Company	4353	Long Stem Thermometer	9/15/2022	Biennial	9/15/2024	221767767
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	NC-100	Torque Wrench	12/5/2022	Biennial	12/5/2024	1240
Mini-Circuits	ZHDC-16-63-S+	Coupler	CBT	N/A	CBT	N/A
Rohde & Schwarz	ZNLE6	Vector Network Analyzer	10/25/2023	Annual	10/25/2024	101307
SPEAG	DAK-3.5	Dielectric Assessment Kit	11/13/2023	Annual	11/13/2024	1277
Keysight Technologies	85033E	3.5mm Standard Calibration Kit	7/18/2023	Annual	7/18/2024	MY53402352
SPEAG	EX3DV4	SAR Probe	6/14/2023	Annual	6/14/2024	7661
SPEAG	DAE4	Dasy Data Acquisition Electronics	5/11/2023	Annual	5/11/2024	728

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

	Name	Function	Signature
Calibrated By:	Tho Tong	Test Engineer	The Tong
Approved By:	Greg Snyder	Executive VP of Operations, Regulatory	Sugar U.S.

# **DIPOLE CALIBRATION EXTENSION**

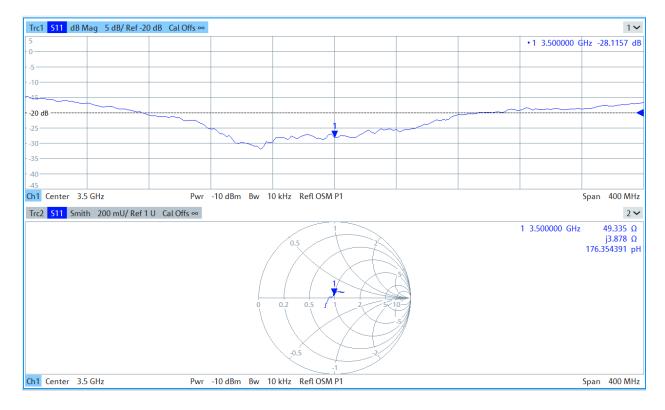
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 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		Deviation 1g (%)	Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	Measured Head SAR (10g) W/kg @ 20.0 dBm	Deviation 10g (%)			Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary		Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	PASS/FAIL
1/10/2023	1/9/2024	1.133	6.54	6.62	1.22%	2.47	2.49	0.81%	50	49.3	0.7	2.5	3.9	1.4	-31.9	-28.1	11.90%	PASS

Object:	Date Issued:	Page 2 of 3
D3500V2 – SN: 1097	01/09/2024	Page 2 of 3



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

Object:	Date Issued:	Dogo 2 of 2
D3500V2 – SN: 1097	01/09/2024	Page 3 of 3

## **Calibration Laboratory of**

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

Accredited by the Swiss Accreditation Service (SAS)



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Swiss Calibration Service

Accreditation No.: SCS 0108

THOITI

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

#### Element Certificate No. D3500V2-1068\_Dec23 Yongin, Republic of Korea CALIBRATION CERTIFICATE 10 TI Object D3500V2 - SN:1068 21 Calibration procedure(s) QA CAL-22.v7 Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date:

Client

December 13, 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 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: 3503	07-Mar-23 (No. EX3-3503_Mar23)	Mar-24
DAE4	SN: 601	03-Oct-23 (No. DAE4-601_Oct23)	Oct-24
			001-24
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:	Krešimir Franjić	Laboratory Technician	Signature
,			K
Approved by:	Sven Kühn	Technical Manager	
			Ser
			Issued: December 13, 2023

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

## **Calibration Laboratory of**

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





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- 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

#### Accreditation No.: SCS 0108

#### 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 = 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	38.5) ± 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	6.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.3 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	( 2.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.7 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	52.0 ± 6 %	3.26 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	63.9 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	2.39 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.0 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	< 52.0 Ω - 4.7 jΩ
Return Loss	- 26.0 dB

## Antenna Parameters with Body TSL

Impedance, transformed to feed point	$(52.1 \Omega + 3.1 \mu)$
Return Loss	(- 28.8 dB

# **General Antenna Parameters and Design**

Electrical Delay (one direction)	
	1.130 ns
	1.100 HS

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

Monute above allow		
Manufactured by	SPEAC	
- /	SPEAG	

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

Date: 13.12.2023

Test Laboratory: SPEAG, Zurich, Switzerland

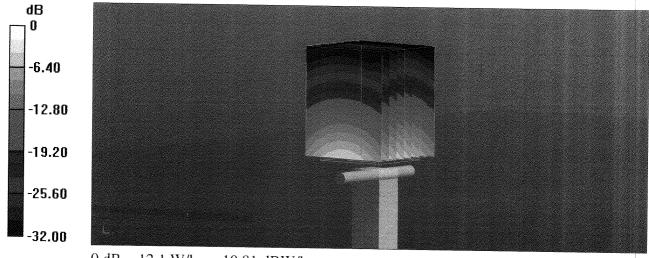
# DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1068

Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma \neq 2.92$  S/m;  $\epsilon_r \neq 38.5$ ;  $\rho = 1000$  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: 07.03.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 03.10.2023
- 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=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 = 67.15 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 17.3 W/kg SAR(1 g) = 6.51 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 = 75.4% Maximum value of SAR (measured) = 12.1 W/kg



0 dB = 12.1 W/kg = 10.81 dBW/kg

# Impedance Measurement Plot for Head TSL

			,		12		3.500000 9 635		(-4.71)	
			4			E DE	3.500000	GHz	50,109	) ml
				1-4-	¥¥	AZ			-64.6	561
					根表	洌				
				てス	$\sim$	SA.				
			N.	X	+	Ì				
	h 1 Avg = -2 3 20000 cu			No. and the second seco		<i>Y</i>				
Ch1: Start	3.30000 GH								Stop 3.700(	00 GH
Ch1: Start							.500000 (	GHz	Stop 3.700	
Ch1: Start 1.00 .00 .00	3.30000 GH					3	.\$00000 (	<u>SH2</u>		
Ch1: Start 000 00 00 00	3.30000 GH					3	.\$00000 (	GHz		
Ch1: Start .00  00 00 00 00 00 00 00 00 00 00 00 00	3.30000 GH					3	.\$00000 (	3Hz		
Ch1: Start 000 00 00 00	3.30000 GH					3	.\$00000 (	GHz		
Ch1: Start .000 00 00 00 00 00 00 00 00 00 00 00 0	3.30000 GH						.500000 (	3Hz		
Ch1: Start .00 <b>88</b> 00	3.30000 GH					3	.\$00000 (	GHz		
Ch1: Start 00 00 00 00 00 00 00 00 0.00 00 5.00 00	3.30000 GH						.500000 (	GHz		

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

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1068

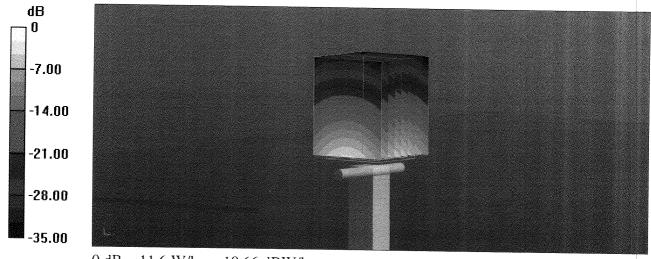
Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma = 3.26$  S/m;  $\epsilon_r = 52$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.46, 7.46, 7.46) @ 3500 MHz; Calibrated: 07.03.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 03.10.2023
- 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=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 = 62.82 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 16.5 W/kg SAR(1 g) = 6.34/W/kg; SAR(10 g) = 2.39 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 76.1%Maximum value of SAR (measured) = 11.6 W/kg



0 dB = 11.6 W/kg = 10.66 dBW/kg

Date: 12.12.2023

# Impedance Measurement Plot for Body TSL

	$\sim$	P	3.500000 GH	F 3.0629 G
			3.500000 GH	z 36.252 ml -54.104
Ch 1 Avg = 20 Ch1. Start 3.30000 GHz				Stop 3,70000 GH
		> 1	3.500000 dHa	z (-28.8 <u>1/</u> 3 dE
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00 00 00 00 00 00 00 00 00 00 00 00 00				

## **Calibration Laboratory of**

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





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S Swiss Calibration Service

Certificate No. D3700V2-1029 Dec23

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 Korea CALIBRATION CERTIFICATE D3700V2 - SN:1029 Object  $\mathcal{X}$ QA CAL-22.v7 Calibration procedure(s) Calibration Procedure for SAR Validation Sources between 3-10 GHz December 13, 2023\_\_\_\_ Calibration date: This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Scheduled Calibration Cal Date (Certificate No.) Primary Standards ID # Mar-24 30-Mar-23 (No. 217-03804/03805) SN: 104778 Power meter NRP2 Mar-24 30-Mar-23 (No. 217-03804) Power sensor NRP-Z91 SN: 103244 Mar-24 SN: 103245 30-Mar-23 (No. 217-03805) Power sensor NRP-Z91 30-Mar-23 (No. 217-03809) Mar-24 SN: BH9394 (20k) Reference 20 dB Attenuator Mar-24 30-Mar-23 (No. 217-03810) SN: 310982 / 06327 Type-N mismatch combination Mar-24 07-Mar-23 (No. EX3-3503\_Mar23) Reference Probe EX3DV4 SN: 3503 Oct-24 DAE4 SN: 601 03-Oct-23 (No. DAE4-601\_Oct23) Check Date (in house) Scheduled Check ID # Secondary Standards In house check: Oct-24 30-Oct-14 (in house check Oct-22) SN: GB39512475 Power meter E4419B In house check: Oct-24 07-Oct-15 (in house check Oct-22) Power sensor HP 8481A SN: US37292783 In house check: Oct-24 SN: MY41093315 07-Oct-15 (in house check Oct-22) Power sensor HP 8481A 15-Jun-15 (in house check Oct-22) In house check: Oct-24 RF generator R&S SMT-06 SN: 100972 In house check: Oct-24 SN: US41080477 31-Mar-14 (in house check Oct-22) Network Analyzer Agilent E8358A Function Signature Name Krešimir Franjić Laboratory Technician Calibrated by: **Technical Manager** Sven Kühn Approved by: Issued: December 13, 2023

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## **Calibration Laboratory of**

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





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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

# **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. 0
- 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 = 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	<sup>(</sup> 3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.2 ± 6 %	3.07 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	6.69 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	67.3 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	2.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 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	51.0	3.55 mho/m		
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.7 ± 6 %	3.47 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	6.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	63,1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 $cm^3$ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.7 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	(45.0 Ω + 0.1)jΩ
Return Loss	- 25.6 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	42.8 Ω + 1.1 jΩ
Return Loss	- 22.2 dB

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

Electrical Delay (one direction) 1.138 ns	Electrical Dela	ay (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	

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

Date: 13.12.2023

Test Laboratory: SPEAG, Zurich, Switzerland

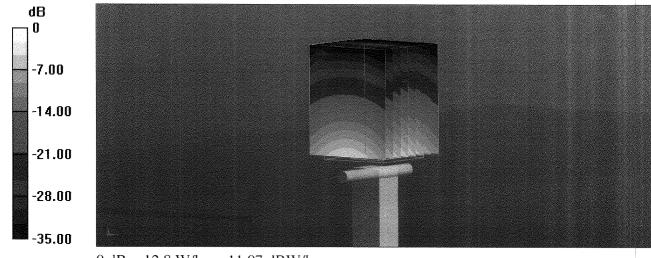
#### DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1029

Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz;  $\sigma = 3.07$  S/m;  $\epsilon_r \neq 38.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.73, 7.73, 7.73) @ 3700 MHz; Calibrated: 07.03.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 03.10.2023
- 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=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 = 68.19 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 18.5 W/kg SAR(1 g) = 6.69 W/kg; SAR(10 g) = 2.44 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 74.5% Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.07 dBW/kg

# Impedance Measurement Plot for Head TSL

Eile	⊻iew	<u>C</u> hannel	Sw <u>e</u> ep	Calibration	<u>Irace</u> <u>S</u> cale	M <u>a</u> rker	System	<u>W</u> indow	Help		
					<u></u>			À	8.700000 C 5.5801 8.700000 C	pН	45.009 Ω 129.73 ΏΩ 52.546 mU 178.43 °
		Ch 1 Avg = at 3.50000 G		•		·····					Stop 3.90000 GHz
10.0 5.00 -5.0 -10, -15, -20, -25, -30, -35, -35, -40,		Ch 1 Avg = rt 3.50000 C	20 3Hz			1			3. 700000 C	Hz	-25.589 dB
Sta	itus	CH 1: §	:11		C* 1-Port		Avg=20	Delay			LCL

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

Date: 12.12.2023

Test Laboratory: SPEAG, Zurich, Switzerland

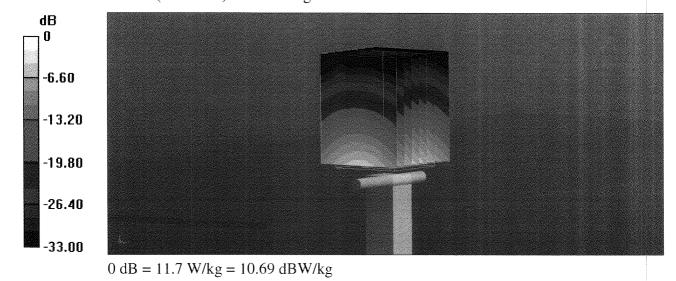
#### DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1029

Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz;  $\sigma = 3.47$  S/m;  $\epsilon_r = 51.7$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.31, 7.31, 7.31) @ 3700 MHz; Calibrated: 07.03.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 03.10.2023
- 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=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 = 62.38 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 16.6 W/kg SAR(1 g) = 6.26 W/kg; SAR(10 g)  $\neq$  2.26 W/kg Smallest distance from peaks to all points 3 dB below = 7.6 mm Ratio of SAR at M2 to SAR at M1 = 76.2% Maximum value of SAR (measured) = 11.7 W/kg



Certificate No: D3700V2-1029\_Dec23

# Impedance Measurement Plot for Body TSL

File	⊻iew	Channel	Sw <u>e</u> ep	Calibration	<u>Irace</u> <u>S</u> cale	M <u>a</u> rker	System <u>W</u> ir	ndow <u>H</u> e	elp			
		Ch 1 Avg =	20		<u>A</u>			N	00000 G 45.171 00000 G	рН	42,841 (1.050) 77.946 ( 171.0	1Ω mU
	Ch1: Sta	art 3,50000 0		-							Stop 3.90000	GHz
10.0 5.0 -5.0 -10 -15 -20 -25 -30 -35 -40	0 - 0 10 - 00 - 00 - 00 - 00 - 00 -	d8 \$11	20 21 21				> 1:	3.7		Hz	522.164	
Sta	atus	CH 1: E	311		C* 1-Port		Avg=20 Dela	y			LCL	