Calibration Laboratory of

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





S

Schweizerischer Kalibrierdienst

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

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

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

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





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 - **Swiss Calibration Service**

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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	⁽ 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 ³ (1 g) of Head TSL	Condition	2.1. ^{1.1} .4.
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 ³ (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 ³ (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 Delay (c	ne 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

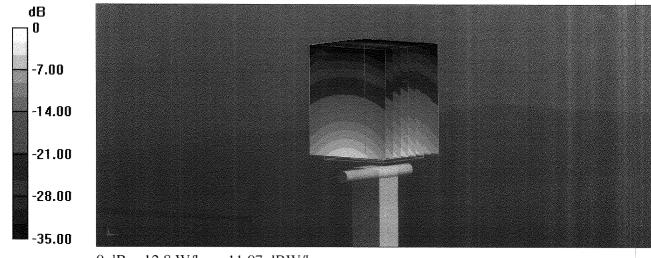
DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1029

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/m³ 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	3.700000 C 5.5801 3.700000 C	pН	45.009 Ω 129.73 ΦΩ 52.546 mU 178.43 °
		Ch 1 Avg = at 0.50000 G		a 							Stop 3.90000 GHz
10.0 5.00 -5.0 -10, -15, -20, -25, -30, -35, -35, -40,		Ch 1 Awg = rt 3.50000 C	20 3Hz						3.700000 C	Hz	-(25.589 dB
Sta	itus	CH 1: §	311		C* 1-Port		Avg=20	Delay			LCL

DASY5 Validation Report for Body TSL

Date: 12.12.2023

Test Laboratory: SPEAG, Zurich, Switzerland

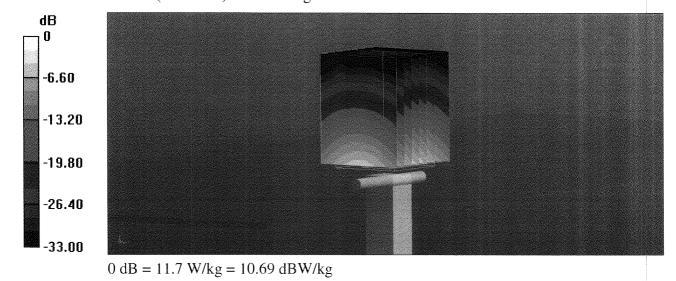
DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1029

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/m³ 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> in	idow <u>H</u> elp		
		Ch 1 Avg =	20		<u></u>			4!	000 GHz 5.171 pH 000 GHz	42,840 Ω (1.0501 Ω 77.946 mU 171.01 °
	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 3H2				> 1:	3.700		-22.164 dB
Sta	atus	CH 1: E	311		C* 1-Port		Avg=20 Delay	,		LCL

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Servizio svizzero di taratura

Accreditation No.: SCS 0108

Certificate Not D3700V2-1067 Jan 23

Client Element

ALIBRATION C	ERTIFICAT		
Dbject	D3700V2 - SN:10)67	
Calibration procedure(s)	QA CAL-22.v7 Calibration Proce	edure for SAR Validation Sour	ces between 3-10 GHz BN 430/2023
Calibration date:	January 13, 2023	5	SRS 01/16/24
This calibration certificate documer	ate the traceability to nativ	onal standards, which realize the physica	Limite of maggingmonth (CI)
		robability are given on the following pages	
		y facility: environment temperature (22 ±	
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)	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: 3503	08-Mar-22 (No. EX3-3503_Mar22)	Mar-23
DAE4	SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Jeton Kastrati		+ UC
Approved by:	Sven Kühn	Technical Manager	5-6-
			Issued: January 16, 2023
This calibration certificate shall not I	be reproduced except in	full without written approval of the laboration	tory.

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Closes

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





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- 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

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 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	3700 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.7	3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	3.09 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	6.67 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.9 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.43 W/kg

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	51.0	3.55 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.7 ± 6 %	3.54 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	900
SAR measured	100 mW input power	6.42 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	64.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.0 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	48.7 Ω + 0.5 jΩ
Return Loss	- 37.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.0 Ω + 3.0 jΩ
Return Loss	- 28.6 dB

General Antenna Parameters and Design

Electrical Delay (and direction)	
Electrical Delay (one direction)	1.140 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: 13.01.2023

Test Laboratory: SPEAG, Zurich, Switzerland

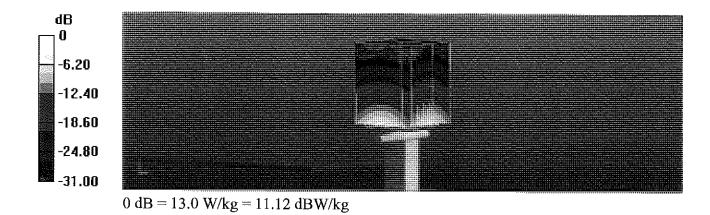
DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1067

Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz; $\sigma = 3.09$ S/m; $\varepsilon_r = 37.8$; $\rho = 1000$ kg/m³ 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: 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=3700MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.52 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 18.4 W/kg SAR(1 g) = 6.67 W/kg; SAR(10 g) = 2.43 W/kg Smallest distance from peaks to all points 3 dB below = 8.2 mm Ratio of SAR at M2 to SAR at M1 = 74.9% Maximum value of SAR (measured) = 13.0 W/kg



Impedance Measurement Plot for Head TSL

<u>File</u>	⊻iew	<u>⊂</u> hannel	Sw <u>e</u> ep	Calibration	<u>T</u> race	<u>5</u> cale	M <u>a</u> rker	S <u>y</u> stem	<u>Wi</u> ndow	<u>H</u> elp				
	Ch1: Sra	Ch 1 Avg ≈ art 3.50000 /								21	00 GHz .130 pH 00 GHz	491 14.	8.701 Ω I.22 mΩ 074 mU 159.01 °	
												Stop :	3.90000 GHz	2
10.(5.0 -5.0 -10. -15. -20. -25. -30. -35.	0 - 00 - 00 - 00 - 00 - 00 - 00 - 00 -									3.7000		-33	2.032 dB	
-40.	.00 L Ch1: Sta	<u>Ch 1 Avg =</u> at 3.50000 (20 GHz					<u>[</u>	<u> </u>	l		Stop :	3.90000 GHz	
Lancester	atus	CH 1: §	311		C* 1-Port					A CONTRACTOR OF THE OWNER OF THE				_

DASY5 Validation Report for Body TSL

Date: 10.01.2023

Test Laboratory: SPEAG, Zurich, Switzerland

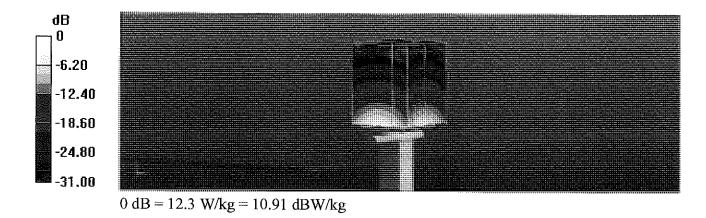
DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1067

Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz; $\sigma = 3.54$ S/m; $\epsilon_r = 50.7$; $\rho = 1000$ kg/m³ 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: 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=3700MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 63.25 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 17.4 W/kg SAR(1 g) = 6.42 W/kg; SAR(10 g) = 2.30 W/kg Smallest distance from peaks to all points 3 dB below = 7.9 mm Ratio of SAR at M2 to SAR at M1 = 75.5% Maximum value of SAR (measured) = 12.3 W/kg



Eile ⊻ieu	w <u>C</u> hannel	Sw <u>e</u> ep	Calibration	<u>Trace</u> <u>S</u>	cale	M <u>a</u> rker	S <u>y</u> stem	<u>W</u> indow	Help					
	Ch 1 Avg =	20								0000 C 128.50 0000 C	pН	2. 36.9	7.951 (9874 (963 ml 122.69	Ω U
[] Ch1:	Start 3.50000 (GHz		668.00000000000000000000000000000000000								Stop 3	.90000 GI	-le
10.00	Contractor and	1												
5.00 6.00 -5.00 -10.00 -15.00 -20.00 -25.00 -30.00 -35.00 -40.00	Image: Ch 1 Avg = Start 3.50000 C	20 BHz 2000555							3.700				.645 d	



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

D3700V2 – SN: 1067

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

Extension Calibration date: 01/12/2024

Description:

SAR Validation Dipole at 3700 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	Tho Tong
Approved By:	Greg Snyder	Executive VP of Operations, Regulatory	Luggelligh

Object:	Date Issued:	Page 1 of 3
D3700V2 – SN: 1067	01/12/2024	rage 1015

DIPOLE CALIBRATION EXTENSION

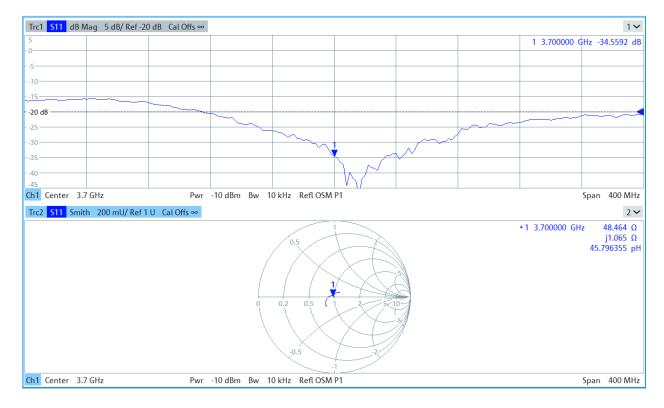
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

- 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 5Ω 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
1/13/2023	1/12/2024	1.14	6.69	6.89	2.99%	2.43	2.53	4.12%	48.7	48.5	0.2	0.5	1.1	0.6	-37	-34.6	6.60%	PASS

Object:	Date Issued:	Page 2 of 3
D3700V2 – SN: 1067	01/12/2024	rage 2 01 5



Impedance & Return-Loss Measurement Plot for Head TSL

Object:	Date Issued:	Dogo 2 of 2
D3700V2 – SN: 1067	01/12/2024	Page 3 of 3

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





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Accreditation No.: SCS 0108

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Multilateral Agreement for the recognition of calibration certificates

Client Element

Columbia, USA

Certificate No. D3900V2-

D3900V2-1056_Oct23

CALIBRATION CERTIFICATE

Object	D3900V2 - SN:1056
Calibration procedure(s)	QA CAL-22.v7 Calibration Procedure for SAR Validation Sources between 3-10 GHz
Calibration date:	SRS October 19, 2023 [2-07-2023

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
Secondary Standards	ID#	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Paulo Pina	Laboratory Technician	400
Approved by:	Sven Kühn	Technical Manager	5 /
			2 · CZ
			Issued: October 19, 2023
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory	1.

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





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- S Swiss Calibration Service

Accreditation No.: SCS 0108

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

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 V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3900 MHz ± 1 MHz 4100 MHz ± 1 MHz	

Head TSL parameters at 3900 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.5	3.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.9 ± 6 %	3.26 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 3900 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.78 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	68.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	· · · · · · · · · · · · · · · · · · ·
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 W/kg ± 19.5 % (k=2)

Head TSL parameters at 4100 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.2	3.53 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	3.44 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 4100 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.63 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg ± 19.5 % (k=2)

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

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	50.8	3.78 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.4 ± 6 %	3.71 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL at 3900 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.49 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	65.3 W/kg ± 19.9 % (k=2)
	····	
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body ISL SAR measured	condition 100 mW input power	2.25 W/kg

Body TSL parameters at 4100 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	50.5	4.01 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.2 ± 6 %	3.95 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL at 4100 MHz

SAR averaged over 1 cm ³ (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	62.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.6 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 3900 MHz

Impedance, transformed to feed point	47.8 Ω - 6.8 jΩ
Return Loss	- 22.8 dB

Antenna Parameters with Head TSL at 4100 MHz

Impedance, transformed to feed point	59.5 Ω - 1.2 jΩ
Return Loss	- 21.2 dB

Antenna Parameters with Body TSL at 3900 MHz

Impedance, transformed to feed point	46.8 Ω - 4.1 jΩ
Return Loss	- 25.4 dB

Antenna Parameters with Body TSL at 4100 MHz

Impedance, transformed to feed point	59.2 Ω + 1.7 jΩ
Return Loss	- 21.3 dB

General Antenna Parameters and Design

lectrical Delay (one direction)	1.102 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

|--|

DASY5 Validation Report for Head TSL

Date: 16.10.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1056

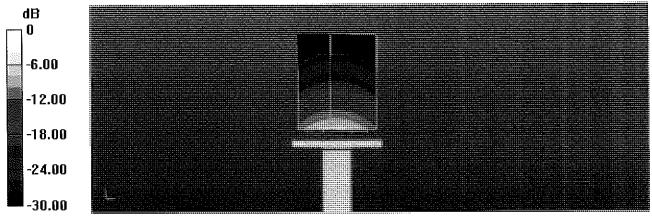
Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz Medium parameters used: f = 3900 MHz; σ = 3.26 S/m; ϵ_r = 37.9; ρ = 1000 kg/m³ Medium parameters used: f = 4100 MHz; σ = 3.44 S/m; ϵ_r = 37.7; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.39, 7.39, 7.39) @ 3900 MHz, ConvF(7.26, 7.26, 7.26) @ 4100 MHz; Calibrated: 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)

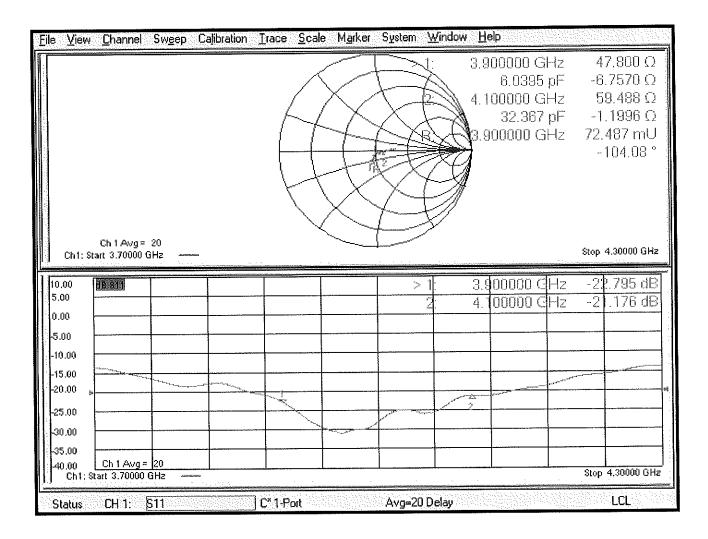
Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.51 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 19.1 W/kg SAR(1 g) = 6.78 W/kg; SAR(10 g) = 2.37 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 74.1% Maximum value of SAR (measured) = 13.2 W/kg

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=4100MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 67.87 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 18.8 W/kg SAR(1 g) = 6.63 W/kg; SAR(10 g) = 2.3 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 74% Maximum value of SAR (measured) = 13.0 W/kg



0 dB = 13.2 W/kg = 11.21 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 19.10.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1056

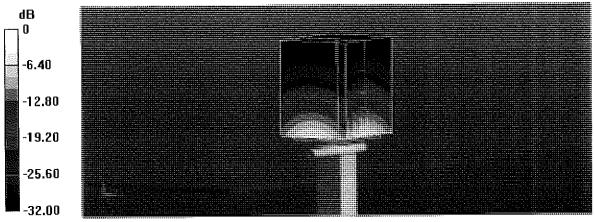
Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz Medium parameters used: f = 3900 MHz; σ = 3.71 S/m; ϵ_r = 51.4; ρ = 1000 kg/m³ Medium parameters used: f = 4100 MHz; σ = 3.95 S/m; ϵ_r = 51.2; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.18, 7.18, 7.18) @ 3900 MHz, ConvF(6.88, 6.88, 6.88) @ 4100 MHz; Calibrated: 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)

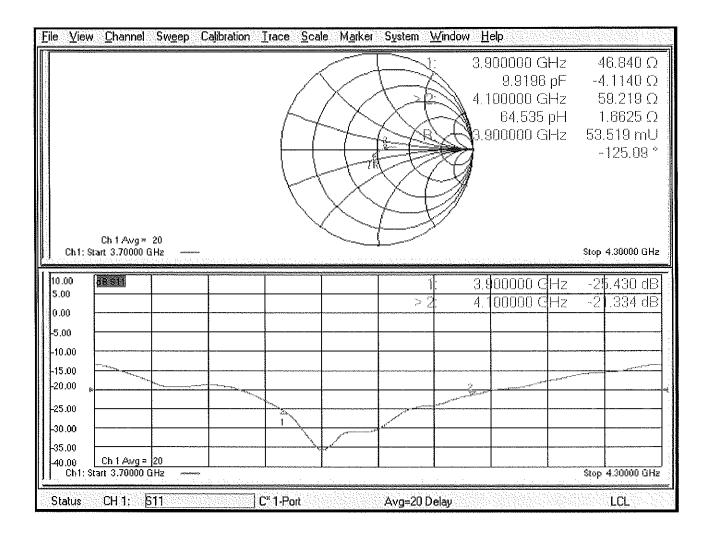
Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan , dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 62.88 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 18.7 W/kg SAR(1 g) = 6.49 W/kg; SAR(10 g) = 2.25 W/kg Smallest distance from peaks to all points 3 dB below = 7.6 mm Ratio of SAR at M2 to SAR at M1 = 73.6%Maximum value of SAR (measured) = 12.8 W/kg

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm, f=4100MHz/Zoom Scan , dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 61.50 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 18.9 W/kg SAR(1 g) = 6.26 W/kg; SAR(10 g) = 2.15 W/kg Smallest distance from peaks to all points 3 dB below = 7.9 mm Ratio of SAR at M2 to SAR at M1 = 72.1% Maximum value of SAR (measured) = 12.5 W/kg



0 dB = 12.8 W/kg = 11.06 dBW/kg

Impedance Measurement Plot for Body TSL



Calibration Laboratory of

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 - Swiss Calibration Service

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Client E

Client Element Yongin, Republic of Ke	prea	Certificate No	D5GHzV2-1237_Apr24
CALIBRATION CI	ERTIFICATE		
Object	D5GHzV2 - SN:1	237	실무자 기술책임자
Calibration procedure(s)	QA CAL-22.v7 Calibration Proce	dure for SAR Validation Source	5/위2 1 s between 3-10 GHz
Calibration date:	April 09, 2024		
		onal standards, which realize the physical un robability are given on the following pages a	
All calibrations have been conducte	d 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 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
Reference 20 dB Attenuator	SN: BH9394 (20k)	26-Mar-24 (No. 217-04046)	Mar-25
Type-N mismatch combination	SN: 310982 / 06327	26-Mar-24 (No. 217-04047)	Mar-25
Reference Probe EX3DV4	SN: 3503	07-Mar-24 (No. EX3-3503_Mar24)	Mar-25
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
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:	Aidonia Georgiadou	Laboratory Technician	the
Approved by:	Sven Kühn	Technical Manager	50

Issued: April 9, 2024

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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	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5850 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.4 ± 6 %	4.60 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.00 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.9 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.8 ± 6 %	4.99 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	177	

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg ± 19.5 % (k=2)

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

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.6 ± 6 %	5.16 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.92 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.5 ± 6 %	5.25 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.03 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.4 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.28 W/kg

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	48.4 Ω - 3.5 jΩ	
Return Loss	- 28.2 dB	

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	52.8 Ω + 1.6 jΩ
Return Loss	- 30.0 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	53.8 Ω + 3.9 jΩ	
Return Loss	- 25.5 dB	

Antenna Parameters with Head TSL at 5850 MHz

Impedance, transformed to feed point	53.9 Ω + 1.4 jΩ	
Return Loss	- 28.1 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.191 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

SPEAG

DASY5 Validation Report for Head TSL

Date: 09.04.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1237

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5850 MHz Medium parameters used: f = 5250 MHz; $\sigma = 4.6$ S/m; $\varepsilon_r = 36.4$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5600 MHz; $\sigma = 4.99$ S/m; $\varepsilon_r = 35.8$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5750 MHz; $\sigma = 5.16$ S/m; $\varepsilon_r = 35.6$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5850 MHz; $\sigma = 5.25$ S/m; $\varepsilon_r = 35.5$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5850 MHz; $\sigma = 5.25$ S/m; $\varepsilon_r = 35.5$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.39, 5.39, 5.39) @ 5250 MHz, ConvF(5, 5, 5) @ 5600 MHz, ConvF(4.98, 4.98, 4.98) @ 5750 MHz, ConvF(4.89, 4.89, 4.89) @ 5850 MHz; Calibrated: 07.03.2024
- 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=100mW, dist=10mm, f=5250 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 72.98 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 27.4 W/kg SAR(1 g) = 8.0 W/kg; SAR(10 g) = 2.28 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 70.4% Maximum value of SAR (measured) = 18.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 73.06 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 30.3 W/kg SAR(1 g) = 8.19 W/kg; SAR(10 g) = 2.33 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 67.9% Maximum value of SAR (measured) = 19.6 W/kg

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

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 70.78 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 31.0 W/kg SAR(1 g) = 7.92 W/kg; SAR(10 g) = 2.25 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 65.9% Maximum value of SAR (measured) = 19.5 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5850 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 70.72 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 32.3 W/kg SAR(1 g) = 8.03 W/kg; SAR(10 g) = 2.28 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 64.8% Maximum value of SAR (measured) = 19.9 W/kg



0 dB = 19.9 W/kg = 12.99 dBW/kg

Impedance Measurement Plot for Head TSL

e ⊻iew	<u>C</u> hannel	Sweep	Calibration	Irace	<u>S</u> cale	Marker	System	₩indow	Help		_
				É	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XA			* 1. 2: 3: 4:	5.250000 GHz 8.7578 pF 5.600000 GHz 45.540 pH 5.750000 GHz 108.45 pH 5.850000 GHz 37.396 pH	48.394 Ω _3.4615 Ω 52.811 Ω 1.6024 Ω _3.840 Ω _3.9181 Ω _53.866 Ω _1.3746 Ω
-	Ch 1 Avg = art 5.00000 (66 \$11		-				Ð		> 1: 2: 3: 4:	Stop 5.250000 GHz 5.200000 GHz 5.750000 GHz 5.350000 GHz	6.00000 GHz 28.232 dB 20.043 dB 25.548 dB 28.068 dB
10.00											

Calibration Laboratory of

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

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Client Element

Columbia, USA

Certificate No. D5GHzV2-1057_Feb24

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1	057	5R5 03111124
Calibration procedure(s)	QA CAL-22.v7 Calibration Proce	dure for SAR Validation Sources	between 3-10 GHz
Calibration date:	February 21, 202	4	
The measurements and the uncerta	ainties with confidence pr ed in the closed laborator	onal standards, which realize the physical uni obability are given on the following pages an y facility: environment temperature (22 ± 3)°C	d are part of the certificate.
	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Primary Standards 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	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
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Paulo Pina	Laboratory Technician	tate 1
Approved by:	Niels Kuster	Quality Manager	NRS
This calibration certificate shall not	t be reproduced except in	full without written approval of the laboratory	Issue February 26, 2024



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Accreditation No.: SCS 0108

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Glossarv:

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

Calibration is Performed According to the Following Standards:

- a) 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%.

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 V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5850 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.2 ± 6 %	4.61 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.0 7 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.6 ± 6 %	5.00 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		······

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.8 W/kg ± 19.9 % (k=2)

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

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	5.16 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		••••

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.99 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5850 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	5.25 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.0 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	48.7 Ω - 3.4 jΩ
Return Loss	- 28.6 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.9 Ω - 0.3 jΩ	
Return Loss	- 25.0 dB	

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	53.5 Ω + 4.0 jΩ
Return Loss	- 25.8 dB

Antenna Parameters with Head TSL at 5850 MHz

Impedance, transformed to feed point	52.2 Ω - 2.2 jΩ	
Return Loss	- 30.4 dB	

General Antenna Parameters and Design

Electrical Delay (one dire	ction)	1.202 ns
	,	

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

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

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

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 21.02.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1057

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5850 MHz Medium parameters used: f = 5250 MHz; $\sigma = 4.61$ S/m; $\epsilon_r = 36.2$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5600 MHz; $\sigma = 5.00$ S/m; $\epsilon_r = 35.6$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5750 MHz; $\sigma = 5.16$ S/m; $\epsilon_r = 35.3$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5850 MHz; $\sigma = 5.25$ S/m; $\epsilon_r = 35.2$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5850 MHz; $\sigma = 5.25$ S/m; $\epsilon_r = 35.2$; $\rho = 1000$ kg/m³

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(4.99, 4.99, 4.99) @ 5850 MHz; Calibrated: 07.03.2023
- 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=100mW, dist=10mm, f=5250 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 71.92 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 26.9 W/kg SAR(1 g) = 7.93 W/kg; SAR(10 g) = 2.27 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 70.5% Maximum value of SAR (measured) = 18.1 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 71.29 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 30.4 W/kg SAR(1 g) = 8.28 W/kg; SAR(10 g) = 2.36 W/kg Smallest distance from peaks to all points 3 dB below = 7.5 mm Ratio of SAR at M2 to SAR at M1 = 67.7% Maximum value of SAR (measured) = 19.4 W/kg

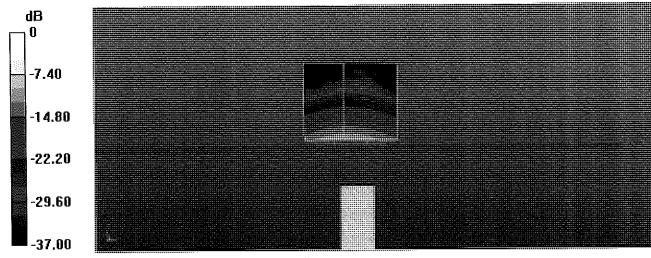
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.35 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 31.1 W/kg SAR(1 g) = 7.99 W/kg; SAR(10 g) = 2.27 W/kg Smallest distance from peaks to all points 3 dB below = 7.5 mm Ratio of SAR at M2 to SAR at M1 = 66% Maximum value of SAR (measured) = 19.1 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5850 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 68.94 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 32.6 W/kg SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.31 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 65.2%

Maximum value of SAR (measured) = 19.9 W/kg



0 dB = 19.9 W/kg = 12.99 dBW/kg

Impedance Measurement Plot for Head TSL

<u>File</u>	⊻iew	<u>C</u> hannel	Sw <u>e</u> ep Ca	alibration	<u>Trace</u> <u>S</u> cale	e M <u>a</u> rker S <u>v</u>	stem <u>W</u> indow	<u>H</u> elp		
						T		1: 2:	5.250000 GHz 8.8406 pF 5.600000 GHz	48.687 Ω -3.4291 Ω 55.943 Ω -251.07 mΩ
					A	\bigtriangleup		3;	113.20 pF 5.750000 GHz 110.77 pH	53.489 Ω 4.0018 Ω
						~~		> 4: 1	5,850000 GHa 12,644.pF	52.224 Ω -2.1518 Ω
					H	X	SI	R:	5,500000 GHz	25,390 mU -123,42 °
		Ch 1 Avg = art 5,00000 G	iHz							6.00000 GHz
10.	.00	d B S11						1:	5.250000 GHz	-28,593 dB -25,007 dB
5.0								3:	5, 50000 GHz 5, 50000 GHz	-25.304 dB -30.381 dB
5.0									0.00000 0110	
),00 F									
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	5.00 D.00 🙀	**************************************								
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-20 -25 -30 -35	0.00 » 5.00 - 0.00 - 5.00 - 0.00 -	<u>Ch I Avg =</u> art 5.00000	20 GHz	1						6.00000 GHz

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Accreditation No.: SCS 0108

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Multilateral Agr	eement for the reco	ognition of calibration	certificates				
Client Elem Colun	nent nbia, USA		Certificate N	^{40.} D5GHzV2-1191_Jan24			
CALIBR	ATION CI	ERTIFICATE					
Object		D5GHzV2 - SN:1	191 - ²⁰ ¹ -	SRS 01/30/24			
Calibration procedure(s)		QA CAL-22.v7 Calibration Procedure for SAR Validation Sources between 3-10 GHz					
Calibration date	9;	January 17, 2024					
			onal standards, which realize the physical obability are given on the following pages				
All calibrations	have been conducte	d in the closed laborator	y facility: environment temperature (22 \pm 3	3)°C and humidity < 70%.			
Calibration Equ	ipment used (M&TE	critical for calibration)					
Primary Standa	ırds	ID #	Cal Date (Certificate No.)	Scheduled Calibration			
Power meter N	RP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24			
Power sensor N	NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24			
Power sensor N	IRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)	Mar-24			
Reference 20 d		SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24			
Type-N mismat		SN: 310982 / 06327	30-Mar-23 (No. 217-03810)	Mar-24			
Reference Prob	e EX3DV4	SN: 3503	07-Mar-23 (No. EX3-3503_Mar23)	Mar-24			
DAE4		SN: 601	03-Oct-23 (No. DAE4-601_Oct23)	Oct-24			
Secondary Star	ndards	ID #	Check Date (in house)	Scheduled Check			
Power meter E	4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24			
Power sensor H	IP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24			
Power sensor H	IP 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 Analyz	er Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24			
		Name	Function	Signature			
Calibrated by:		Paulo Pina	Laboratory Technician	Temer -			
Approved by:		Sven Kühn	Technical Manager	Sur			
				Issued: January 18, 2024			
This calibration	certificate shall not l	be reproduced except in	full without written approval of the laborat	tory.			

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S Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

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

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5850 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.5 ± 6 %	4.65 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	20 mil 10 mil	BU dia lais bin

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

-	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.1 ± 6 %	5.04 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.0 ± 6 %	5.18 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.86 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.8 ± 6 %	5.27 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.86 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	51.7 Ω - 8.5 jΩ
Return Loss	- 21.5 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.9 Ω - 7.9 jΩ
Return Loss	- 21.1 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	55.2 Ω - 1.6 jΩ	
Return Loss	- 25.8 dB	

Antenna Parameters with Head TSL at 5850 MHz

Impedance, transformed to feed point	51.3 Ω - 5.5 jΩ	
Return Loss	- 25.0 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.203 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: 17.01.2024

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5850 MHz Medium parameters used: f = 5250 MHz; $\sigma = 4.65$ S/m; $\varepsilon_r = 36.5$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5600 MHz; $\sigma = 5.04$ S/m; $\varepsilon_r = 36.1$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5750 MHz; $\sigma = 5.18$ S/m; $\varepsilon_r = 36.0$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5850 MHz; $\sigma = 5.27$ S/m; $\varepsilon_r = 35.8$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5850 MHz; $\sigma = 5.27$ S/m; $\varepsilon_r = 35.8$; $\rho = 1000$ kg/m³

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(4.99, 4.99, 4.99) @ 5850 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=100mW, dist=10mm, f=5250 MHz/Zoom Scan,

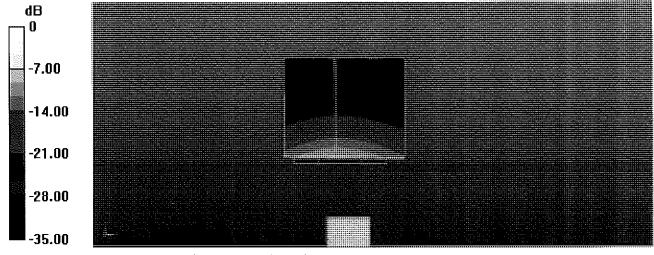
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 73.66 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 26.6 W/kg SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.27 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 71% Maximum value of SAR (measured) = 18.2 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 73.16 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 30.3 W/kg SAR(1 g) = 8.27 W/kg; SAR(10 g) = 2.38 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 68% Maximum value of SAR (measured) = 19.7 W/kg

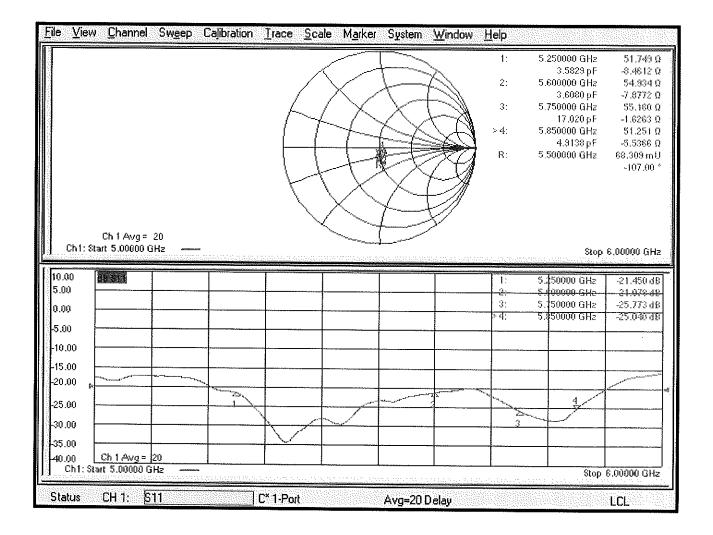
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 70.39 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 30.6 W/kg SAR(1 g) = 7.86 W/kg; SAR(10 g) = 2.23 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 66.2% Maximum value of SAR (measured) = 19.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5850 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 70.63 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 31.1 W/kg SAR(1 g) = 7.86 W/kg; SAR(10 g) = 2.24 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 65.5% Maximum value of SAR (measured) = 19.4 W/kg



0 dB = 19.7 W/kg = 12.94 dBW/kg



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





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S Swiss Calibration Service

Accreditation No.: SCS 0108

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

Client Element Columbia, USA

Certificate No. D6.5GHzV2-1111_Feb24

CALIBRATION CERTIFICATE

Object	D6.5GHzV2 - SN	l:111 1	SPS 03104124		
	QA CAL-22.v7 Calibration Procedure for SAR Validation Sources between 3-10 GHz				
Calibration date:	February 22, 2024				
This calibration certificate document The measurements and the uncertain	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.				
		ry facility: environment temperature (22 \pm 3)°C ar	nd humidity < 70%.		
Calibration Equipment used (M&TE	critical for calibration)				
Primary Standards	D#	Cal Date (Certificate No.)	Scheduled Calibration		
Power sensor R&S NRP33T	SN: 100967	03-Apr-23 (No. 217-03806)	Apr-24		
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24		
Mismatch combination	SN: 84224 / 360D	03-Apr-23 (No. 217-03812)	Apr-24		
Reference Probe EX3DV4	SN: 7405	12-Jun-23 (No. EX3-7405_Jun23)	Jun-24		
DAE4	SN: 908	03-Jul-23 (No. DAE4-908_Jul23)	Jul-24		
Secondary Standards	ID #	Check Date (in house)	Scheduled Check		
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Jan-24)	In house check: Jan-25		
Power sensor NRP-Z23	SN: 100169	10-Jan-19 (in house check Jan-24)	In house check: Jan-25		
Power sensor NRP-18T	SN: 100950	28-Sep-22 (in house check Jan-24)	In house check: Jan-25		
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25		
	Name	Function	Signature		
Calibrated by:	Aldonia Georgiadou	Laboratory Technician	Aler		
Approved by:	Sven Kühn	Technical Manager	52		
This calibration certificate shall not b	Issued: February 23, 2024 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.				

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



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Swiss Calibration Service

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

b) DASY System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY6	V16.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	6500 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	34.5	6.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	6.32 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	291 W/kg ± 24.7 % (k=2)

SAR averaged over 8 cm ³ (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.50 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.3 W/kg ± 24.4 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.5 W/kg ± 24.4 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.8 Ω + 3.1 jΩ	
Return Loss	- 29.1 dB	

APD (Absorbed Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	290 W/m²
APD measured	normalized to 1W	2900 W/m² ± 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	130 W/m²
APD measured	normalized to 1W	1300 W/m² ± 28.9 % (k=2)

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

General Antenna Parameters and Design

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

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

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

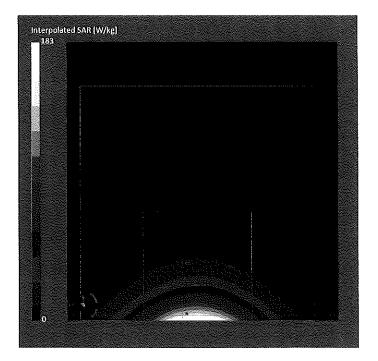
Additional EUT Data

Manufactured by	SPEAG
-	

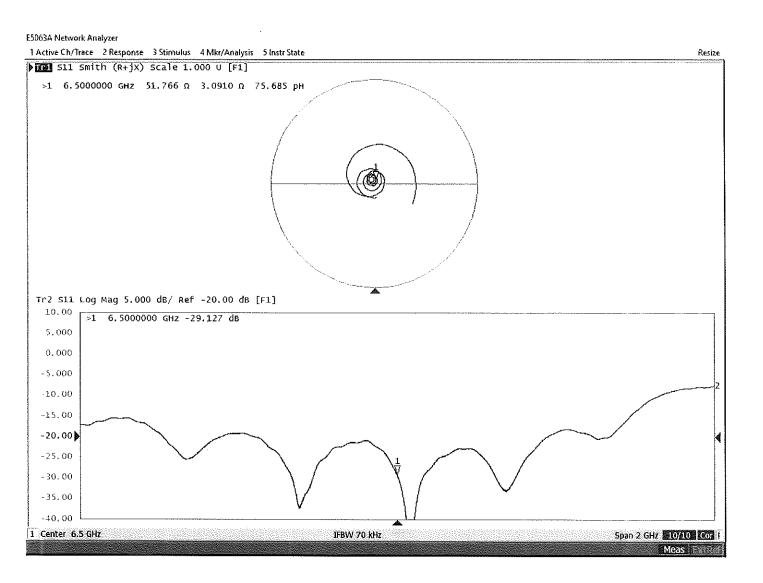
DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1111, UID 0 -, Channel 6500 (6500.0MHz)

Device under Te Name, Manufac D6.5GHz	turer	Dimensions [1 16.0 x 6.0 x 30		1EI I: 1111	DUT Type	2	
Exposure Condi Phantom Section, TSL	tions Position, Te Distance [mm]	st Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.50	6.32	35.3
Hardware Setuj Phantom MFP V8.0 Cente Scan Setup		TSL HBBL600-100	00V6	Probe, Calibr EX3DV4 - 5N Measuremen	7405, 2023-06-12	DAE, Calib ı DAE4 Sn90	ration Date 8, 2023-07-03
Grid Extents [r Grid Steps [mr Sensor Surface Graded Grid Grading Ratio MAIA Surface Detect Scan Method	n] 2 [mm]		Zoom Scan 22.0 x 22.0 x 22.0 3.4 x 3.4 x 1.4 1.4 Yes 1.4 N/A VMS + 6p Measured	Date psSAR1g [W psSAR8g [W psSAR10g [V Power Drift Power Scali Scaling Fact	//Kg] //Kg] W/Kg] [dB] ng tor (dB] ion	20	Zoom Scan 224-02-22, 16:52 29.0 6.50 5.32 0.01 Disabled No correction SS.4 4.6



Impedance Measurement Plot for Head TSL



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





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Accreditation No.: SCS 0108

Certificate No. D6.5GHzV2-1018_Jan24

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 Columbia, USA

	D6.5GHzV2 - SN	•1018	< 7C
bject	D0.3GHZVZ - SIN	, IV IO	SRS 01/30/24
	QA CAL-22.v7 Calibration Proce	dure for SAR Validation Sources	between 3-10 GHz
calibration date:	January 10, 2024	1	
	-	onal standards, which realize the physical uni robability are given on the following pages an	
All calibrations have been conducted	d in the closed laborator	ry facility: environment temperature (22 \pm 3)°C	C and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor R&S NRP33T	SN: 100967	03-Apr-23 (No. 217-03806)	Apr-24
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
lismatch combination	SN: 84224 / 360D	03-Apr-23 (No. 217-03812)	Apr-24
Reference Probe EX3DV4	SN: 7405	12-Jun-23 (No. EX3-7405_Jun23)	Jun-24
DAE4	SN: 908	03-Jul-23 (No. DAE4-908_Jul23)	Jui-24
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Jan-24)	In house check: Jan-25
Power sensor NRP-Z23	SN: 100169	10-Jan-19 (in house check Jan-24)	In house check: Jan-25
Power sensor NRP-18T	SN: 100950	28-Sep-22 (in house check Jan-24)	In house check: Jan-25
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25
	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	A. 45
			3 / 1 /
Approved by:	Sven Kühn	Technical Manager	S-





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Swiss Calibration Service

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

b) DASY System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY6	V16.2	
Extrapolation	Advanced Extrapolation		
Phantom	Modular Flat Phantom		
Distance Dipole Center - TSL	5 mm	with Spacer	
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)	
Frequency	6500 MHz ± 1 MHz		

Head TSL parameters

The following parameters and calculations were applied.

⊂ ·	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	34.5	6.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	6.17 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	293 W/kg ± 24.7 % (k=2)

SAR averaged over 8 cm ³ (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.7 W/kg ± 24.4 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.9 W/kg ± 24.4 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.6 Ω - 4.1 jΩ		
Return Loss	- 27.7 dB		

APD (Absorbed Power Density)

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

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

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

General Antenna Parameters and Design

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

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

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

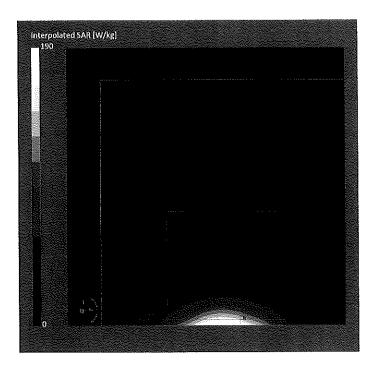
Additional EUT Data

Manufactured by	SPEAG

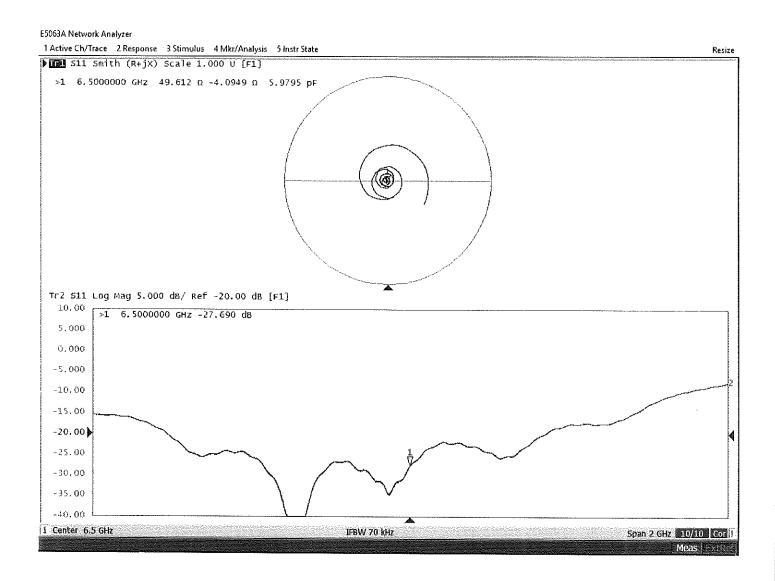
DASY6 Validation Report for Head TSL

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

Device under T Name, Manufa D6.5GHz	cturer Di	i mensions 6.0 x 6.0 x 3		VIEI N: 1018	DUT Typ -	e	
Exposure Cond Phantom	itions Position, Test	Band	Group.	Frequency	Conversion	TSL Cond.	TSL
Section, TSL	Distance [mm]	Build	UID	[MHz]	Factor	[5/m]	Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.50	6.17	34.9
Hardware Setu	ıp						
Phantom	т	SL		Probe, Cali	bration Date	-	pration Date
MFP V8.0 Cent	er - 1182 H	IBBL600-10	000V6	EX3DV4 - S	N7405, 2023-06-12	DAE4 Sn9	08, 2023-07-03
Scan Setup				Measurem	ent Results		
			Zoom Sca	n			Zoom Scan
Grid Extents [mm]		22.0 x 22.0 x 22.	0 Date		2	024-01-10, 13:38
Grid Steps (m	m]		3.4 x 3.4 x 1.				29.2
Sensor Surfac	e [mm]		1.	·			6.55
Graded Grid			Ye				5.37
Grading Ratio	1		1.				0.02
MAIA			N/		-		Disabled
Surface Detec			VMS + 6		• •		NI
5can Method			Measure				No correction 49.6
				M2/M1 [9	-		49.6
				DIST 30B F	Peak [mm]		4.0



Impedance Measurement Plot for Head TSL



Calibration Laboratory of

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



S Schweizerischer Kalibrierdienst

C Service suisse d'étalonnage

S Servizio svizzero di taratura Swiss Calibration Service

Accreditation No.: SCS 0108

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

Client Element Columbia, USA

Certificate No. 5G-Veri10-1002_Mar24

CALIBRATION CERTIFICATE

Object S	5G Verification So	SRS	03 25 24					
	QA CAL-45.v5 Calibration procedure for sources in air above 6 GHz							
Calibration date:	March 05, 2024							
		nal standards, which realize the physical units of bability are given on the following pages and are						
All calibrations have been conducted	l in the closed laboratory	facility: environment temperature (22 \pm 3)°C and	humidity < 70	%.				
Calibration Equipment used (M&TE of	critical for calibration)							
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled	Calibration				
Reference Probe EUmmWV3	SN: 9374	04-Dec-23 (No. EUmm-9374_Dec23)	Dec-24					
DAE4ip	SN: 1602	08-Nov-23 (No. DAE4ip-1602_Nov23)	Nov-24					
Secondary Standards	ID #	Check Date (in house)	Scheduled	Check				
RF generator R&S SMF100A	SN: 100184 29-Nov-23 (in house check Nov-23)		In house check: Nov-24					
Power sensor R&S NRP18S-10	SN: 101258	29-Nov-23 (in house check Nov-23)	In house check: Nov-24					
Network Analyzer Keysight E5063A	SN: MY54504221	31-Oct-19 (in house check Oct-22)	In house ch	eck: Oct-25				
	Name	Function	Signature					
Calibrated by:	Leif Klysner	Laboratory Technician	Seif Mym					
Approved by:	Sven Kühn	Technical Manager	Sm					
		full without written approval of the laboratory.	Issued: Mai	ch 7, 2024				

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





Schweizerischer Kalibrierdienst

S Service suisse d'étalonnage С

Servizio svizzero di taratura S

Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossarv

CW

Continuous wave

Calibration is Performed According to the Following Standards

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

Methods Applied and Interpretation of Parameters

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

Calibrated Quantity

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

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

Measurement Conditions

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

DASY Version	DASY8 Module mmWave	V3.2
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
Number of measured planes	2 (10mm, 10mm + λ/4)	
Frequency	10 GHz ± 10 MHz	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn	Prad ¹	Max E-field	Uncertainty	Avg Power Density		Uncertainty	
Aperture to	(mW)	(V/m)	(k = 2) Avg (psPDn+, psPDtot+, psPDmod+)		•		(k = 2)
Measured Plane				(W/m²)			
				1 cm ²	4 cm ²		
10 mm	93.3	151	1.27 dB	58.7	54.9	1.28 dB	

Distance Horn Aperture to Measured Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m²)		Uncertainty (k = 2)
				1 cm ²	4 cm ²	
10 mm	93.3	151	1.27 dB	58.5, 58.7, 58.8	54.6, 54.9, 55.1	1.28 dB

Square Averaging

Distance Horn	Prad	Max E-field	Uncertainty	-	er Density	Uncertainty
Aperture to Measured Plane	(mW)	(V/m)	(k = 2)	• •	PDtot+, psPDmod+) //m ²)	(k = 2)
				1 cm ²	4 cm ²	
10 mm	93.3	151	1.27 dB	58.7	54.8	1.28 dB
Distance Horn . Aperture to	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)		Density tot+, psPDmod+	Uncertainty (k = 2)
Measured Plane	(1110)	(*/11)	(K – Z)		//m²)	(((- 2)
				1 cm ²	4 cm ²	1

Max Power Density

10 mm

Distance Horn Aperture to Measured Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Max Power Density Sn, Stot, Stot (W/m²)	Uncertainty (k = 2)
10 mm	93.3	151	1.27 dB	59.9, 60.0, 60.2	1.28 dB

58.5, 58.7, 58.8

1.27 dB

54.5, 54.8, 55.0

1.28 dB

93.3

151

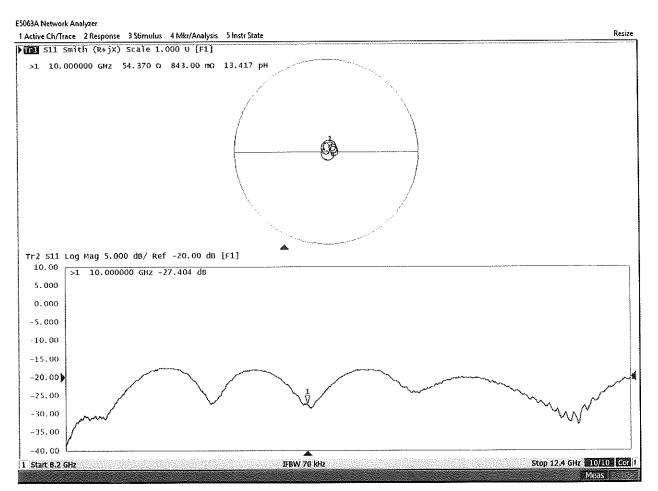
 $^{^{\}rm 1}$ Assessed ohmic and mismatch loss plus numerical offset: 0.30 dB

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Impedance, transformed to feed point	54.4 Ω + 0.8 jΩ
Return Loss	- 27.4 dB

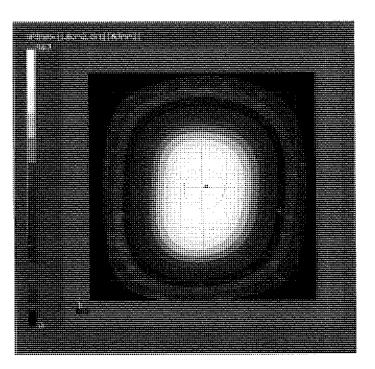
Impedance Measurement Plot



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

Device under Test Properties

Name, Manufacturer	Dimensions [mm]		IMEI		DUT Type	
5G Verification Source 10 GH	iz 100.0 x 100.0 x 1	72.0	SN: 100	02	-	
Exposure Conditions						
Phantom Section	Position, Test Distance [mm]	Band	Grou	ıp,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	cW		10000.0, 10000	1.0
Hardware Setup	Medium			Probe, Calibration Dat	1 0	DAE, Calibration Date
Phantom mmWave Phantom - 1002	Air			EUmmWV3 - SN9374_ 2023-12-04		DAE4ip Sn1602, 2023-11-08
Scan Setup				Measurement Re	sults	
			5can			5G Scan
Sensor Surface [mm]			10.0	Date		2024-03-05, 10:32 1.00
MAIA		MAIA not	used	Avg. Area [cm ²]		Circular Averaging
				Avg. Type psPDn+ [W/m²]		58.5
				psPDtot+ [W/m ²]		58.7
				psPDmod+ (W/m ²)		58.8
				Max(Sn) [W/m ²]		59.9
				Max(Stot) [W/m ²]		60.0
				(10+1)		60.2



Max(|Stot|) [W/m²]

Power Drift [dB]

E_{max} [V/m]

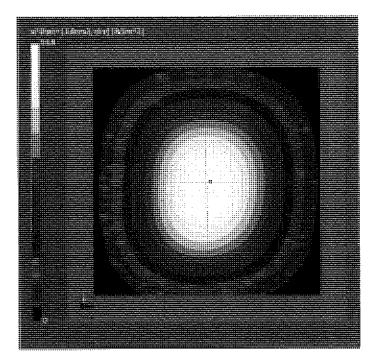
60.2

151

-0.00

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

Device under Test Pro Name, Manufacturer 5G Verification Source 10 G	Dimensions (mm	-	IMEI SN: 1002	DUT Type -	
Exposure Conditions Phantom Section	Position, Test Distance	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	(mm) 10.0 mm	Validation band	cw	10000.0, 10000	1.0
Hardware Setup Phantom mmWave Phantom - 1002	Medium Air		EUn	be, Calibration Date 1mWV3 - SN9374_F1-55GHz, 3-12-04	DAE, Calibration Date DAE4ip Sn1602, 2023-11-08
Scan Setup			Me	asurement Results	
-		5G :	Scan		5G Scan
Sensor Surface [mm] MAIA		MAIA not	used Av Av ps ps M M M En	ate yg. Area [cm ²] yg. Type IPDn+ [W/m ²] IPDnod+ [W/m ²] ax(Sn) [W/m ²] ax(Stot] [W/m ²] ax(Stot] [W/m ²] ax([Stot]) [W/m ²] max [V/m] ower Drift [dB]	2024-03-05, 10:32 4.00 Circular Averaging 54.6 54.9 55.1 59.9 60.0 60.2 151 -0.00



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

		SN: 1002	-	
Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
10.0 mm	Validation band	cw	10000.0, 10000	1.0
Medium Air		•		DAE, Calibration Date DAE4ip Sn1602, 2023-11-08
	1	ican 10.0 Date Ised Avg. Area [cm²] Avg. Type psPDn+ [W/m²]	esults	5G Scan 2024-03-05, 10:32 1.00 Square Averaging 58.5 58.7
	[mm] 10.0 mm Medium	[mm] 10.0 mm Validation band Medium Air 5G S	[mm] 10.0 mm Validation band CW Medium Probe, Calibration Da Air EUmmWV3 - SN9374 2023-12-04 Measurement Re 5G Scan 10.0 Date MAIA not used Avg. Area [cm ²] Avg. Type	Imm] Channel Number 10.0 mm Validation band CW 10000.0, 10000 Medium Probe, Calibration Date EUmmWV3 - SN9374_F1-55GHz, 2023-12-04 Measurement Results SG Scan 10.0 Date MAIA not used Avg. Area [cm²] Avg. Type psPDn+ [W/m²]

psPDmod+ [W/m²]

Max(Sn) [W/m²]

Power Drift [dB]

 $\begin{array}{l} Max(Stot) \left[W/m^2\right] \\ Max(|Stot|) \left[W/m^2\right] \\ E_{max} \left[V/m\right] \end{array}$

58.8

59.9 60.0

60.2 151

-0.00

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

Device under Test Pro Name, Manufacturer 5G Verification Source 10 Gi	Dimensions [mm	ies Dimensions [mm] 100.0 x 100.0 x 172.0		02	DUT Type -		
Exposure Conditions Phantom Section	Position, Test Distance [mm]	nce Band		up,	Frequency [MHz], Channel Number	Conversion Factor	
5G -	10.0 mm	Validation band	CW		10000.0, 10000	1.0	
Hardware Setup Phantom mmWave Phantom - 1002	Medium Air			Probe, Calibration Da EUmmWV3 - SN9374_ 2023-12-04		DAE, Calibration Date DAE4ip Sn1602, 2023-11-08	
Scan Setup				Measurement Re	sults		
		-	Scan			5G Scan	
Sensor Surface [mm] MAIA			10.0	Date		2024-03-05, 10:32	
WAIA		MAIA not	usea	Avg. Area [cm²] Avg. Type		4.00 Square Averaging	
				psPDn+ [W/m ²]		54uare Averaging 54.5	
				psPDtot+ [W/m ²]		54.8	
				psPDmod+ [W/m²]		55.0	
				Max(Sn) [W/m ²]		59.9	
				Max(Stot) [W/m ²] Max(Stot) [W/m ²]		60.0 60.2	
				E _{max} [V/m]		00.2	
				Power Drift [dB]		-0.00	

