





Impedance Measurement Plot for Head TSL (5200, 5250, 5300, 5500, 5600 MHz)

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Impedance Measurement Plot for Head TSL (5300, 5500, 5600, 5750, 5800 MHz)

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							/		_	3:	5.300000 GHz	46.215 Ω
						X	-	1-	X		9.3639 pF	-3.2069 Ω
						/	X	1-	XI	4:	5.500000 GHz 9.2370 pF	49.978 Ω
					/	/ /	\sim	1-	1-1	5:	5.600000 GHz	-3.1327 Ω 53.576 Ω
					1		\wedge	A	K-1	9.	13.425 pH	472.39 mΩ
					1	6		XX	LA	6:	5.750000 GHz	51.897 Q
									SAL		16.469 pF	-1.6807 Ω
					1	1	1	T	XU	>7:	5.800000 GHz 8.6324 pF	51.225 Ω -3.1788 Ω
					F	C	X	Ě	Į			
		Ch 4 4	00					1				
0.0	Ch1: Sta	Ch 1 Avg = art 5.00000		_						3:	5.\$00000 GHz	-25.759 dB
0.0	Ch1: Sta	rt 5.00000		_						4:	5.300000 GHz 5.500000 GHz	-25.759 dB 30.084 dB
10.0	0 0	rt 5.00000								-4: 5:	5.300000 GHz 5.500000 GHz 5.800000 GHz	-25.759 dB -20.094 dB -29.163 dB
10.0 5.00	0 0	rt 5.00000								4:	5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz	-25.759 dB 30.084 dB -29.163 dB -32.088 dB
10.0 5.00 0.00	0 0	rt 5.00000								4: 5: 6:	5.300000 GHz 5.500000 GHz 5.800000 GHz	-25.759 dB 30.084 dB -29.163 dB -32.088 dB
10.0 5.00 0.00	0 0	rt 5.00000								4: 5: 6:	5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz	-25.759 dB 30.084 dB -29.163 dB -32.088 dB
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(10.0 5.0 5.0 -10.0 -15.0 -20.0 -25.0 -25.0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	rt 5.00000		2						4: 5: 6:	5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz	-25.759 dB 30.084 dB -29.163 dB -32.088 dB
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10.0 5.00 5.00 5.00 -10.0 -15.0 -20.0 -25.0 -30.0	Ch1: Sta 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	rt 5.00000	SHz	1 2	3					4: 5: 6:	5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz 5.\$00000 GHz	-25.759 dB 30.084 dB -29.163 dB -32.088 dB
10.0 5.00 5.00 10.0 25.0 25.0 30.0 35.0	Ch1: Sta	IR \$1	20	1 2						4: 5: 6:	5.200000 GHz 5.500000 GHz 5.500000 GHz 5.50000 GHz 5.30000 GHz 5.30000 GHz 5.30000 GHz	-25.759 dB 30.084 dB -29.163 dB -32.088 dB

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3500 MHz Dipole Calibration Certificate

ccredited by the Swiss Accreditation he Swiss Accreditation Service ultilateral Agreement for the rec	is one of the signatorie	s to the EA	ccreditation No.: SCS 0108
client CTTL (Auden)			: D3500V2-1016_Jul22
CALIBRATION C	ERTIFICATI		
Object	D3500V2 - SN:10	016	
Calibration procedure(s)	QA CAL-22.v6		
	Calibration Proce	dure for SAR Validation Sources	between 3-10 GHz
Calibration date:	July 01, 2022		
This calibration certificate documer	nts the traceability to natio	onal standards, which realize the physical uni	ts of measurements (SI).
The measurements and the uncertain	ainties with confidence pr	robability are given on the following pages an	d are part of the certificate.
All calibrations have been conducte	ed in the closed laborator	y facility: environment temperature (22 ± 3)°C	c and humidity < 70%.
All calibrations have been conducte	ed in the closed laborator	y facility: environment temperature (22 ± 3)°C	C and humidity < 70%.
		y facility: environment temperature (22 \pm 3)°C	c and humidity < 70%.
		y facility: environment temperature (22 ± 3)°C	C and humidity < 70%.
Calibration Equipment used (M&TE	E critical for calibration)		
Calibration Equipment used (M&TE Primary Standards	critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Calibration Equipment used (M&TE Primary Standards Power meter NRP	Critical for calibration)	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524)	Scheduled Calibration Apr-23
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91	critical for calibration)	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524)	Scheduled Calibration Apr-23 Apr-23
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	E critical for calibration) ID # SN: 104778 SN: 103244	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525)	Scheduled Calibration Apr-23 Apr-23 Apr-23
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524)	Scheduled Calibration Apr-23 Apr-23
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 3503 SN: 601	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 08-Mar-22 (No. EX3-3503_Mar22) 02-May-22 (No. DAE4-601_May22)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Mar-23 Mar-23 May-23
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	ID # SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 310982 / 06327 SN: 601 ID #	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 08-Mar-22 (No. DAE4-601_May22) 02-May-22 (No. DAE4-601_May22)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Mar-23 Mar-23 May-23 Scheduled Check
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 601 ID # SN: GB39512475	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 08-Mar-22 (No. EX3-3503_Mar22) 02-May-22 (No. DAE4-601_May22) Check Date (in house) 30-Oct-14 (in house check Oct-20)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Mar-23 Mar-23 May-23 Scheduled Check In house check: Oct-22
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	ID # SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 310982 / 06327 SN: 601 ID # SN: GB39512475 SN: US37292783	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 08-Mar-22 (No. EX3-3503_Mar22) 02-May-22 (No. DAE4-601_May22) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Mar-23 May-23 Scheduled Check In house check: Oct-22 In house check: Oct-22
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	ID # SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 310982 / 06327 SN: 3503 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 08-Mar-22 (No. 217-03528) 08-Mar-22 (No. EX3-3503_Mar22) 02-May-22 (No. DAE4-601_May22) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Mar-23 May-23 Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 3503 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 08-Mar-22 (No. EX3-3503_Mar22) 02-May-22 (No. DAE4-601_May22) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Mar-23 May-23 Scheduled Check In house check: Oct-22 In house check: Oct-22
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Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

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) KDR 265664, "SAR Measurements Feedback For 100 MHz to 6 CHz".
- 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%.

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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	3400 MHz ± 1 MHz 3500 MHz ± 1 MHz 3600 MHz ± 1 MHz	

Head TSL parameters at 3400 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	38.0	2.81 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.3 ± 6 %	2.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 3400 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.85 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	68.0 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	2.57 W/kg

Head TSL parameters at 3500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.9	2.91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.2 ± 6 %	2.92 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 3500 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.79 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	67.5 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSI	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.54 W/kg

SAR for nominal Head TSL parameters	normalized to 1W	25.3 W/kg ± 19.5 % (k=2)

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Head TSL parameters at 3600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.8	3.02 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.1 ± 6 %	2.99 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 3600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.4 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	2.49 W/kg

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 3400 MHz

Impedance, transformed to feed point	46.4 Ω - 8.7 jΩ	
Return Loss	- 20.2 dB	

Antenna Parameters with Head TSL at 3500 MHz

Impedance, transformed to feed point	55.1 Ω - 3.7 jΩ	
Return Loss	- 24.5 dB	

Antenna Parameters with Head TSL at 3600 MHz

Impedance, transformed to feed point	59.5 Ω - 0.4 jΩ	
Return Loss	- 21.2 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.137 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

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DASY5 Validation Report for Head TSL

Date: 01.07.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1016

Communication System: UID 0 - CW; Frequency: 3500 MHz, Frequency: 3400 MHz, Frequency: 3600 MHz

Medium parameters used: f = 3500 MHz; σ = 2.92 S/m; ϵ_r = 37.2; ρ = 1000 kg/m³, Medium parameters used: f = 3400 MHz; σ = 2.84 S/m; ϵ_r = 37.3; ρ = 1000 kg/m³, Medium parameters used: f = 3600 MHz; σ = 2.99 S/m; ϵ_r = 37.1; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.91, 7.91, 7.91) @ 3500 MHz, ConvF(7.97, 7.97, 7.97) @ 3400 MHz, ConvF(7.91, 7.91, 7.91) @ 3600 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3500MHz/Zoom Scan,

dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.69 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 18.5 W/kg SAR(1 g) = 6.79 W/kg; SAR(10 g) = 2.54 W/kg Smallest distance from peaks to all points 3 dB below = 8.6 mm Ratio of SAR at M2 to SAR at M1 = 74.7% Maximum value of SAR (measured) = 13.1 W/kg

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3400MHz/Zoom Scan,

dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 70.52 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 18.5 W/kg SAR(1 g) = 6.85 W/kg; SAR(10 g) = 2.57 W/kg Smallest distance from peaks to all points 3 dB below = 8.4 mm Ratio of SAR at M2 to SAR at M1 = 75.4% Maximum value of SAR (measured) = 12.9 W/kg

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Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3600MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 68.51 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 18.5 W/kg SAR(1 g) = 6.66 W/kg; SAR(10 g) = 2.49 W/kg Smallest distance from peaks to all points 3 dB below = 8.4 mm Ratio of SAR at M2 to SAR at M1 = 74.3%

Maximum value of SAR (measured) = 12.9 W/kg



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

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File View Channel Sweep Calibration Trace Scale Marker System Window Help 3.500000 GHz 55.115 Ω 12.370 pF -3.6760 Ω 3.400000 GHz 46.417 Ω 5.3807 pF -8.7011 Ω 600000 GHz 59.498 Ω 112.71 pF -394.54 mΩ 3.500000 GHz 59.886 mU -33.701 ° Ch 1 Avg = 20 Ch1: Start 3.20000 GHz Stop 3.80000 GHz 10.00 3.500000 GHz 453 dB 5.00 3.400000 GHz -20.247 dB > 2 0.00 -21.229 dB 3.600000 GHz 5.00 -10.00 -15.00 -20.00 -0 -25.00 -30.00 -35.00 40.00 Ch 1 Avg = 20 Ch 1: Start 3.20000 GHz Stop 3.80000 GHz S11 C* 1-Port Status CH 1: Avg=20 Delay LCL

Impedance Measurement Plot for Head TSL

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3700 MHz Dipole Calibration Certificate

chmid & Partner Engineering AG ughausstrasse 43, 8004 Zurich,	of Switzerland	S S S S S S S S S S S S S S S S S S S	Service suisse d'étalonnage Servizio svizzero di taratura
ccredited by the Swiss Accreditation he Swiss Accreditation Service			Accreditation No.: SCS 0108
Iultilateral Agreement for the rec	cognition of calibration		lo: D3700V2-1004_Jul22
CALIBRATION C	ERTIFICATE		
Object	D3700V2 - SN:10	004	
Calibration procedure(s)	QA CAL-22.v6		
	Calibration Proce	dure for SAR Validation Source	s between 3-10 GHz
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This calibration certificate documents and the uncert All calibrations have been conduct Calibration Equipment used (M&TI Primary Standards Power meter NRP Power sensor NRP-Z91	nts the traceability to nati- tainties with confidence p ed in the closed laborator E critical for calibration) ID # SN: 104778 SN: 103244	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524)	C and humidity < 70%. Scheduled Calibration Apr-23 Apr-23
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This calibration certificate documents and the uncert All calibrations have been conduct Calibration Equipment used (M&TI Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	nts the traceability to nati- tainties with confidence pre- ed in the closed laborator E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527)	C and humidity < 70%. C and humidity < 70%. Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

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%.

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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	3700 MHz ± 1 MHz 3800 MHz ± 1 MHz	

Head TSL parameters at 3700 MHz

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	37.0 ± 6 %	3.07 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 3700 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.74 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	24.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 3800 MHz

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.6	3.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.8 ± 6 %	3.15 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 3800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 W/kg ± 19.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 3700 MHz

Impedance, transformed to feed point	48.6 Ω - 6.6 jΩ	
	- 23.3 dB	
Return Loss	20.0 40	

Antenna Parameters with Head TSL at 3800 MHz

57.5 Ω - 5.9 jΩ	
- 21.0 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.138 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

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DASY5 Validation Report for Head TSL

Date: 01.07.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1004

Communication System: UID 0 - CW; Frequency: 3700 MHz, Frequency: 3800 MHz Medium parameters used: f = 3700 MHz; σ = 3.07 S/m; ϵ_r = 37; ρ = 1000 kg/m³, Medium parameters used: f = 3800 MHz; σ = 3.15 S/m; ϵ_r = 36.8; ρ = 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, ConvF(7.73, 7.73, 7.73) @ 3800 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=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 = 69.98 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 19.1 W/kg SAR(1 g) = 6.74 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 = 73.9% Maximum value of SAR (measured) = 13.1 W/kg

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3800MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 68.05 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 18.9 W/kg SAR(1 g) = 6.57 W/kg; SAR(10 g) = 2.40 W/kg Smallest distance from peaks to all points 3 dB below = 8.2 mm Ratio of SAR at M2 to SAR at M1 = 73.1% Maximum value of SAR (measured) = 13.0 W/kg

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