

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.3 ± 6 %	1.40 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	1880	-0464

SAR result with Head TSL

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.97 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.2 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.0 W/kg ± 16.5 % (k=2)



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$50.2 \Omega + 6.8 j\Omega$		
Return Loss	- 23.4 dB		

General Antenna Parameters and Design

Electrical Delay (one direction)	1.182 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

Certificate No: D1900V2-5d032_Jan24

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DASY5 Validation Report for Head TSL

Date: 18.01,2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d032

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: f = 1900 MHz; $\sigma = 1.4 \text{ S/m}$; $\varepsilon_r = 41.3$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.43, 8.43, 8.43) @ 1900 MHz; Calibrated: 03.11.2023
- · 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=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

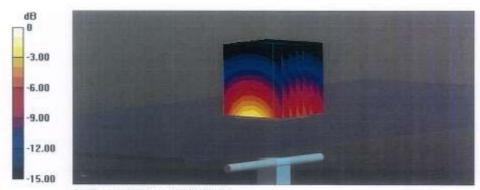
Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 109.9 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 18.3 W/kg

SAR(1 g) = 9.97 W/kg; SAR(10 g) = 5.22 W/kg

Smallest distance from peaks to all points 3 dB below = 9.8 mm

Ratio of SAR at M2 to SAR at M1 = 54.9% Maximum value of SAR (measured) = 15.5 W/kg



0 dB = 15.5 W/kg = 11.90 dBW/kg

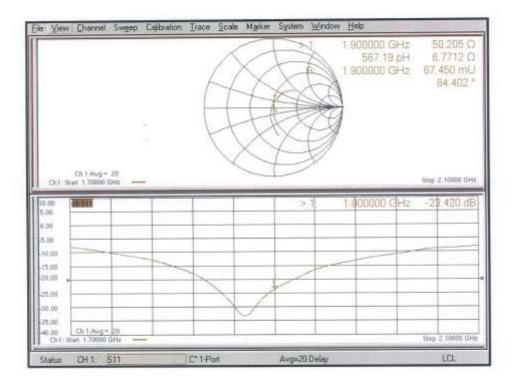
Certificate No: D1900V2-5d032_Jan24

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Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d032_Jan24

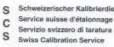
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Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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 HCT

Certificate No. D2300V2-1010_Jul23

CALIBRATION C	CHIFICAL				
Ottject	D2300V2 - SN:1	2 - SN:1010			
Calibration procedure(s)	QA CAL-05.v12 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz				
	Cambration Proce	dure for SAH Validation	1 Sources I	petween 0.7-3 GHz	
Calibration date:	July 19, 2023				
This calibration certificate docume	nts the traceability to net	onel standards, which realize the	physical units	of measurements (SI).	
The measurements and the uncert	ainties with confidence p	robability are given on the follow	ing pages and	are part of the certificate.	
All celibrations have been conduct	ed in the closed laborator	ry facility environment temperatu	me (22 + 30°C) r	and humidity = 70%	
		2	and the season of the	no marriage service	
Calibration Equipment used (M&TI	critical for calibration)				
Primary Standards	I so a	Put these (Proditions No.)		20000002100000	
Power meter NRP2	5N: 104778	Cal Date (Certificate No.) 30-Mar-23 (No. 217-03804/03	ane.	Scheduled Calibration Mar/24	-
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)		Mar-24	
Powar 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: 319982 / 06327			11100	
Reference Probe EX3DV4	SN: 7349	30-Mar-23 (No. 217-03810) 10-Jan-23 (No. EXS-7349 Jan-23)		Mar-24	
DAE4	SN: 001	19-Dec-22 (No. DAE4-601 D		Jan-24 Dec-23	
	3000	AN WAR OF THE PRESENT THE	activity.	Decrea	
Secondary Standards	1D #	Check Date (in house)		Scheduled Check	
Power meter E4419B	5N: 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 Oc	1-22)	In house check: Oct-24	
Power sensor HP 8481A	SN: MY41093316	07-Oct-15 (in house check Oc	1-22)	In house check: Oct-24	
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oc		in house check: Oct-24	
Network Analyzer Aglium E8358A	5N; US41080477	31-Mar-14 (in house check Ox	1-22)	In house check: Oct-24	
	Name	Function		Signatura	
	Paulo Pina	Laboratory Technician			
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Approved by: This calibration certificate shall not	Swen Kühn be reproduced except in	Technical Manage	*	S. 05	4
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Calibration Laboratory of

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





Schweizerischer Kalibrierdienst Service suisse d'étalonnege Servizio svizzero di taratura 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%.

Certificate No: D2300V2-1010_Jul23

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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	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz ≈ 5 mm	
Frequency	2300 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.5	1.67 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "C	38.3 ± 6 %	1.68 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		1444

SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	12.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	48.3 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.96 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.6 W/kg ± 16.5 % (k=2)

Certificate No: D2300V2-1010_Jui23

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.4 Ω − 0.9 jΩ	
Return Lass	- 34.6 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.170 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 "Messurement 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

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Manufactured by	SPEAG
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Certificate No: D2300V2-1010_Jut23

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DASY5 Validation Report for Head TSL

Date: 19.07.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1010

Communication System: UID 0 - CW; Frequency: 2300 MHz

Medium parameters used: f = 2300 MHz; $\sigma = 1.68 \text{ S/m}$; $\epsilon_e = 38.3$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.98, 7.98, 7.98) @ 2300 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19:12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 115.7 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 21.7 W/kg

dB o

SAR(1 g) = 12.2 W/kg; SAR(10 g) = 5.95 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 56.5%

Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 18.9 W/kg = 12.76 dBW/kg

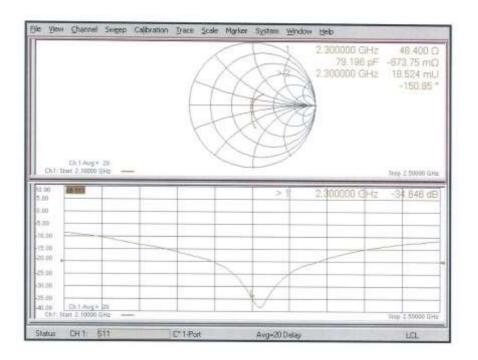
Certificate No: D2300V2-1010 Jul23

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Impedance Measurement Plot for Head TSL



Certificate No: D2300V2-1010_Jul23

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Certification of Calibration

Object D2300V2 - SN:1010

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

Extended Calibration date Jul.19, 2025

Description SAR Validation Dipole at 2300 MHz

Note: Calibrated Before Testing. Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. signal generator) to determine the losses of the measurement path.

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Dipole Calibration Extension

Per HDB 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:

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

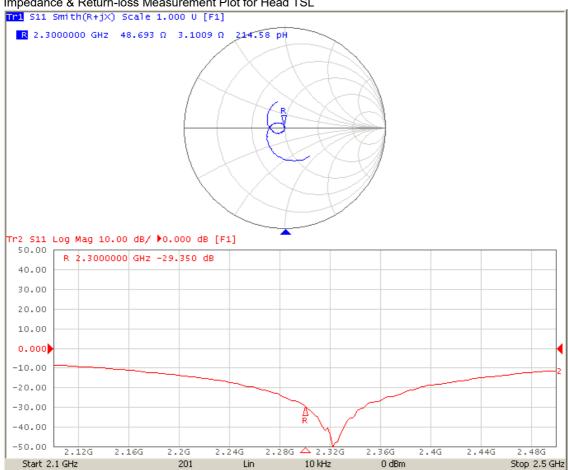
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

Calibration Date	Extenstion Date	Electrical	Target Head(1g)	Measured Head SAR(1g) W/kg@17.0dBm	Deviation	Certificate SAR Target Head(10g) W/kg@17.0dBm	SAR(10g)	Deviation 10=(9/)		Measured Impedance Head(Ohm) Real			Impedance	(Ohm)	Certificate ReturnLoss Head(dB)	Measured ReturnLoss Head(dB)	Deviation(%)	PASS/FAIL
07/19/2024	07/19/2025	1.17	2.415	2.4	-0.62	1.18	1.15	-2.54	48.4	48.693	-0.3	-0.9	3.1009	-4.0009	-34.6	-29.35	-15.17	PASS

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Result

Calibration Date	Extenstion Date	Electrical	Certificate SAR Target Head(1g) W/kg@17.0dBm	SAR(1g)	Deviation	Certificate SAR Target Head(10g) W/kg@17.0dBm	SAR(10g)	Deviation 10a(%)	Certificate Impedance Head(Ohm) Real			Certificate Impedance Head(Ohm) Imaginary		Difference (Ohm) Imaginary	Certificate ReturnLoss Head(dB)	Measured ReturnLoss Head(dB)	Deviation(%)	PASS/FAIL
07/19/2024	07/19/2025	1.17	2.415	2.4	-0.62	1.18	1.15	-2.54	48.4	48.693	-0.3	-0.9	3.1009	-4.0009	-34.6	-29.35	-15.17	PASS

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

Accreditation No.: SCS 0108

Client HCT

Gyeonggi-do, Republic of Korea

Certificate No. D2450V2-743_Mar24

CALIBHATION	ERTIFICAT	E 결 보보	지 하이지						
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Object	D2450V2 - SN:74	43	12W (1 1942)						
		11 4 2014 84	the state of the s						
Calibration procedure(s1	QA CAL-05.v12	01-43	1004 1204704						
construct processing again	Calibration Procedure for SAR Validation Sources between 0.7-3 GHz								
Calibration date:	March 14, 2024								
	Action of the second								
his calibration certificate documer	its the traceability to nati	onal standards, which realize the physical	units of measurements (SI).						
he measurements and the uncert	ainties with confidence p	robability are given on the following pages	and are part of the certificate.						
All calibrations have been been	and the street of the con-	Water of the same							
All calibrations have been conducts	ed in the closed laborator	ry facility: environment temperature (22 x 3)"C and humidity < 70%.						
Calibration Equipment used (M&TE	critical for calibration								
-manuscript Edinfinition (1900 (Mills 11	_ umadrius saluration)								
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration						
ower meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24						
Ower sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24						
ower sensor NRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)	Mnr-24						
leterence 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24						
	Carrier Court of the Carrier C								
Type-N mismatch combination	SN: 310982 / 06327	30-Mar-23 (No. 217-03810)	Mar-24						
	SN: 310982 / 06327 SN: 7349	4 16 3 4 16 16 16 17 18 18 18 18 18 18 18 18 18 18 18 18 18	Mar-24 Nov-24						
Reference Probe EX3DV4	The state of the s	30-Mar-23 (No. 217-03810) 03-Nov-23 (No. EX3-7349_Nov23) 30-Jan-24 (No. DAE4-801_Jan24)	(17 Table 19 19 19 19 19 19 19 19 19 19 19 19 19						
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 7349	03-Nov-23 (No. EX3-7349_Nov23) 30-Jan-24 (No. DAE4-801_Jan24)	Nov-24 Jan-25						
Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 7349 SN: 601	03-Nov-23 (No. EX3-7349, Nov23) 30-Jan-24 (No. DAE4-801_Jan24) Check Date (in house)	Nov-24 Jan-25 Scheduled Check						
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E44198	SN: 7349 SN: 601	03-Nov-23 (No. EX3-7349, Nov23) 30-Jan-24 (No. DAE4-801_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22)	Nov-24 Jan-25 Scheduled Check In house check: Oct-24						
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292763	03-Nov-23 (No. EX3-7349, Nov23) 30-Jan-24 (No. DAE4-801_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Nov-24 Jan-25 Scheduled Check In house check: Oct-2- In house check: Oct-2-						
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E44198 Power sensor HP 8481A Power sensor HP 8481A	SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	03-Nov-23 (No. EX3-7349, Nov23) 30-Jan-24 (No. DAE4-801, Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Nov-24 Jan-25 Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24						
Reference Probe EX3DV4 DAE4 Recondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A Rependence RAS SMT-06	SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292763	03-Nov-23 (No. EX3-7349, Nov23) 30-Jan-24 (No. DAE4-801_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Nov-24 Jan-25 Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24						
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41090477	03-Nov-23 (No. EX3-7349, Nov23) 30-Jan-24 (No. DAE4-801_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	Nov-24 Jan-25 Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24						
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Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by:	SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41090477 Name Krešimir Franjić	03-Nov-23 (No. EX3-7349, Nov23) 30-Jan-24 (No. DAE4-801_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22) Function	Nov-24 Jan-25 Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24						
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Certificate No: D2450V2-743_Mar24

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Calibration Laboratory of

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





S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
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 ConvF N/A 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%.

Certificate No: D2450V2-743_Mar24

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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	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.5 ± 6 %	1.83 mha/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	****	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.8 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.2 W/kg ± 16.5 % (k=2)



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.5 Ω + 6.1 jΩ			
Return Loss	- 22.8 dB			

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns

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

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

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

Additional EUT Data

Certificate No: D2450V2-743 Mar24

Manufactured by	SPEAG

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DASY5 Validation Report for Head TSL

Date: 14.03.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:743

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: f = 2450 MHz; $\sigma = 1.83$ S/m; $\epsilon_c = 38.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 03.11,2023
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2024
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 115.1 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 26.4 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.09 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 50.1%

Maximum value of SAR (measured) = 21.4 W/kg



0 dB = 21.4 W/kg = 13.30 dBW/kg

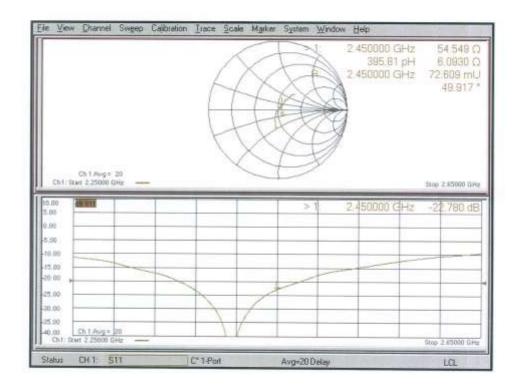
Certificate No: D2450V2-743_Mar24

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Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-743_Mar24

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Appendix: Transfer Calibration at Four Validation Locations on SAM Head¹

Evaluation Condition

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Phantom	SAM Head Phantom	For usage with cSAR3DV2-R/L
	No attraction of the state of	

SAR result with SAM Head (Top ≅ C0)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	55.2 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	condition	

SAR result with SAM Head (Mouth ≅ F90)

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	56.3 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

SAR result with SAM Head (Neck ≅ H0)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	53.0 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

SAR result with SAM Head (Ear D90)

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	34.0 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	17.1 W/kg ± 16.9 % (k=2)

Certificate No: D2450V2-743_Mar24

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Additional assessments outside the current scope of SCS 0108



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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

Client HCT

Gyeonggi-do, Republic of Korea

Certificate No. D2600V2-1015_Apr24

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ower sensor NRP-Z91	SN: 103244	26-Mar-24 (No. 217-04036		Mar-25
ower sensor NRP-Z91	SN: 103245	26-Mar-24 (No. 217-0403)		Mar-25
Reference 20 dB Attenuator	5N: BH9394 (20k)	26-Mar-24 (No. 217-04046	(5)	Mar-25
Type-N mismatch combination	SN: 310982 / 06327	26-Mar-24 (No. 217-0404)		Mar-25 Mar-25
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econdary Standards ower meter E44198 ower sensor HP 8481A ower sensor HP 8481A F generator R&S SMT-06 etwork Analyzer Aglient E8358A alibrated by:	SN: GB99512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name Joanna Eleshaj	30-Oct-14 (in house check 07-Oct-15 (in house check 07-Oct-15 (in house check 15-Jun-15 (in house check 31-Mar-14 (in house check Function Laboratory Ta	Oct-22} Oct-22} Oct-22) Oct-22}	In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
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Certificate No: D2600V2-1015_Apr24

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Calibration Laboratory of

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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%.

Certificate No: D2600V2-1015_Apr24

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Measurement Conditions

DASY system configuration, as far as not given on open 1

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mha/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.4 ± 6 %	2.04 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	-	

SAR result with Head TSL

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.2 W/kg ± 16.5 % (k=2)

Certificate No: D2600V2-1015_Apr24

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.4 Ω - 5.1 jΩ	
Return Loss	- 25.2 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.150 ns
----------------------------------	----------

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

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

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

Additional EUT Data

C.	
Manufactured by	SPEAG

Certificate No: D2600V2-1015_Apr24

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DASY5 Validation Report for Head TSL

Date: 22.04.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1015

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: f = 2600 MHz; $\sigma = 2.04$ S/m; $\epsilon_r = 37.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 03.11.2023
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2024
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

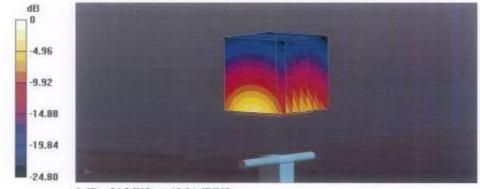
Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 119.3 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 29.4 W/kg

SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.41 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 49.4% Maximum value of SAR (measured) = 24.2 W/kg



0 dB = 24.2 W/kg = 13.84 dBW/kg

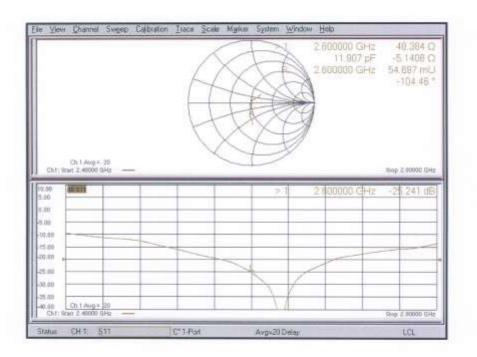
Certificate No: D2600V2-1015_Apr24

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Impedance Measurement Plot for Head TSL



Certificate No: D2600V2-1015_Apr24

Page 6 of 6

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Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S Schweizerischer Kalibrierdienst
C Service sulsse d'étalonnage
Servizio svizzero di taratura
S Swiss Calibration Service

Accreditation No.: SCS 0108

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

Client

HCT

Gyeonggi-do, Republic of Korea

Certificate No.

D3500V2-1040_Jan25

CALIBRATION CERTIFICATE

Object

D3500V2 - SN: 1040

Calibration procedure(s)

QA CAL-22.v7

Calibration Procedure for SAR Validation Sources between 3 - 10 GHz

Calibration date

January 16, 2025

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	ĬĎ	Cal Date (Certificate No.)	Scheduled Cal
Power Sensor R&S NRP-33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Power Sensor R&S NRP18A	SN: 101859	22-Jul-24 (No. 4030A315008547)	Jul-25
Spectrum Analyzer R&S FSV40	SN: 101832	25-Jan-24 (No. 4030-315007551)	Jan-25
Mismatch; Short [S4188] Attenuator [S4423]	SN: 1152	28-Mar-24 (No. 217-04050)	Mar-25
OGP DAK-12	SN: 1016	24-Sept-24 (No. OCP-DAK12-1016 Sep24)	Sep-25
OCP DAK-3.5	SN: 1249	23-Sept-24 (No. OCP-DAK3.5-1249_Sep24)	Sep-25
Reference Probe EX3DV4	SN: 7349	10-Jan-25 (No. EX3-7349 Jan25)	Jan-26
DAE4ip	SN: 1836	28-Oct-24 (No. DAE4ip-1836_Oct24)	Oct-25

Secondary Standards	ID.	Check Date (in house)	Scheduled Check
ACAD Source Box	SN: 1000	28-May-24 (No. 675-ACAD Source Box-240528)	May-25
Signal Generator R&S SMB100A	SN: 182081	28-May-24 (No. 675-CAL16-S4588-240528)	May-25
Mismatch; SMA	SN: 1102	22-May-24 (No. 675-Mismatch_SMA-240522)	May-25

Name Function Signature

Calibrated by Paulo Pina Laboratory Technician Function

Approved by Sven Kühn Technical Manager

Issued: January 16, 2025

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

Certificate No: D3500V2-1040...Jan25

Page 1 of 6

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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)

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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

- 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.
- . KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation

· DASY System Handbook

Methods Applied and Interpretation of Parameters

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

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

Certificate No: D3500V2-1040_Jan25 Page 2 of 6

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D3500V2 - SN: 1040 January 16, 2025

Measurement Conditions

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

DASY Version	DASY8 Module SAR	16.4.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with spacer
Zoom Scan Resolution	dx, dy = 5mm, dz = 1.4mm	Graded Ratio = 1.5 mm (Z direction)
Frequency	3500MHz ±1MHz	

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	37.9 ±6%	2.93 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 for nominal Head TSL parameters	20 dBm input power	6.52 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.2 W/kg ±19.9% (k = 2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	2.47 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.7 W/kg ±19.5% (k = 2)

Certificate No: D3500V2-1040_Jan25

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D3500V2 - SN: 1040

Appendix (Additional assessments outside the scope of SCS 0108)

January 16, 2025

Antenna Parameters with Head TSL at 3500 MHz

Impedance	53.9 Ω – 3.2 jΩ
Return Loss	-26.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.14 ns
The state of the s	1117710

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

Certificate No: D3500V2-1040_Jan25

Manufactured by	SPEAG	

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D3500V2 - SN: 1040 January 16, 2025

System Performance Check Report

Summary							
Dipole			Frequency (MI	(z) TSL	Power [dBm]		
D3500V2 - 5N1048			3500	HSL	20		
Exposure Condition	ıs						
Phantom Section, TSL	Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor	TSL Conductivity (S/m)	TSL Permittivity
Flat	10		CW, 0	3500, 0	6.63	2.93	37,9
Hardware Setup							
Phantom	TSL, Measured	asured Date Probe, Calibration Date		DAE,	Calibration Date		
MFF V8.0 Center	HSL, 2025-01-	HSL, 2025-01-16 EX3DV4 - SN7349, 2025-01-10		DAE4ip Se1836, 2024-10-28			

	Zoom Scan
Grid Extents [mm]	28 × 26 × 28
Grid Steps (mm)	5.0 x 5.0 x 1.4
Sensor Surface (mm)	1,4
Graded Grid	Yes
Grading Ratio	1.5
MAIA	N/A
Surface Detection	VMS + 6p
Scan Method	Measured

	Zoom Scar
Date	2025-01-11
psSARTg (W/Kg)	6.53
psSAR10g (W/Kg)	2,4
Power Drift [dB]	-0.00
Power Scaling	Disables
Scaling Factor (db)	
TSI. Correction	Positive / Negative



0 dB = 17.1 W/Kg

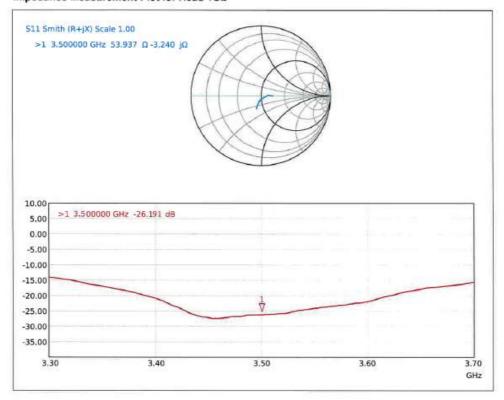
Certificate No: D3500V2-1040_Jan25 Page 5 of 6

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D3500V2 - SN: 1040 January 16, 2025

Impedance Measurement Plot for Head TSL



Certificate No: D3500V2-1040_Jan25

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Accreditation No.: SCS 0108

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Client

HCT

Gyeonggi-do, Republic of Korea

Certificate No.

D3700V2-1105_Sep24

CALIBRATION C	ERTIFICATE	결 보고 MMAI 기 기 기 기 기 기 기 기 기 기 기 기 기 기 기 기 기 기
Object	D3700V2 - SN: 1105	7 7 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1
Calibration procedure(s)	QA CAL-22.v7 Calibration Procedure for	or SAR Validation Sources between 3 - 10 GHz
Calibration date	September 18, 2024	
		tandards, which realize the physical units of measurements (SI). If y are given on the following pages and are part of the certificate.
All orthodisms how bons so	nducted in the closed laboratory facili	ity: environment temperature (22 ± 3)°C and humidity < 70%.
All Calibrations have been co		

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Cal
Power Sensor R&S NRP-33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Power Sensor R&S NRP18A	SN: 101859	22-Jul-24 (No. 4030A315008547)	Jul-25
Spectrum Analyzer R&S FSV40	SN: 101832	25-Jan-24 (No. 4030-315007551)	Jan-25
Mismatch; Short [S4188] Attenuator [S4423]	SN: 1152	28-Mar-24 (No. 217-04050)	Mar-25
OCP DAK-12	SN: 1016	05-Oct-23 (No. OCP-DAK12-1016_Oct23)	Oct-24
OCP DAK-3.5	SN: 1249	05-Oct-23 (No. OCP-DAK3.5-1249_Oct23)	Oct-24
Reference Probe EX3DV4	SN: 7349	03-Jun-24 (No. EX3-7349 Jun24)	Jun-25
DAE4ip	SN: 1836	10-Jan-24 (No. DAE4ip-1836, Jan24)	Jan-25

Secondary Standards	ID.	Check Date (in house)	Scheduled Check
ACAD Source Box	SN: 1000	28-May-24 (No. 675-ACAD_Source_Box-240528)	May-25
Signal Generator R&S SMB100A	SN: 182081	28-May-24 (No. 675-CAL16-S4588-240528)	May-25
Mismatch; SMA	SN: 1102	22-May-24 (No. 675-Mismatch SMA-240522)	May-25

	Name	Function	Signature
Calibrated by	Krešimir Franjić	Laboratory Technician	7
Approved by	Sven Kühn	Technical Manager	3/6
		full without written approval of the lab	Issued: September 18, 2024

Certificate No: D3700V2-1105_Sep24

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Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 0108

Glossary

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

Calibration is Performed According to the Following Standards

- 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.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz."

Additional Documentation

· DASY System Handbook

Methods Applied and Interpretation of Parameters

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

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

Certificate No: D3700V2-1105_Sep24

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D3700V2 - SN: 1105

September 18, 2024

Measurement Conditions

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

DASY Version	DASY8 Module SAR	16.4.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with spacer
Zoom Scan Resolution	dx, $dy = 5mm$, $dz = 1.4mm$	Graded Ratio = 1.5 mm (Z direction
Frequency	3700MHz ±1MHz	

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 mha/m
Measured Head TSL parameters	(22.0 ±0.2)°C	37.4 ±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 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	6.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	69.3 W/kg ±19.9% (k = 2)

SAR averaged over 10 cm ² (10 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	2.54 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.4 W/kg ±19.5% (k = 2)

Certificate No: D3700V2-1105_Sep24

Page 3 of 6



D3700V2 - SN: 1105

September 18, 2024

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 3700 MHz

Impedance	47.0 Ω – 1.4 jΩ
Return Loss	-29.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.139 ns
The second secon	100000000000000000000000000000000000000

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

Certificate No: D3700V2-1105_Sep24

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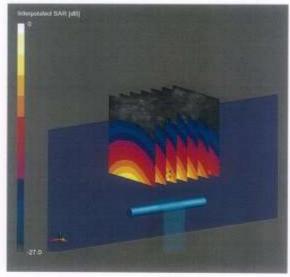
D3700V2 - SN: 1105 September 18, 2024

System Performance Check Report

Summary								
Dipole			Frequency (Mi	(z)	TSL	Power (dilm)		
D3700VJ - SN1105			3700		HSA	20		
Exposure Condition	is							
Phantom Section, TSL	Test Distance [mm]	Stand	Group, UID	Fraguency (MHz)	Channel Number	Conversion Factor	TSL Conductivity (5/m)	TSL Permittivity
Flat	10		CW, D	3700,0		6.34	3.07	354
Hardware Setup	TSL, Measured	Date	-	Probe, Calibration I	Sobe	DAE	Calibration Date	
MEP VE.O Carrier	HSL, 2024-09-	18	-	X3DV4 - SN7349,	2024-05-03	DAR	Np Sn1836, 2024-01-10	
Scans Setup					Measuremer	nt Results		
				Zoom Scan				Zoom Scan
Crid Extents [mm]			12	28 × 28 × 28	Date			2024-09-18

Zoom Scan	
28 × 28 × 28	
5.0 x 5.0 x 1.4	
T.A	
Yes	
1.3	
N/A	
VMS + Ep	
Measured	

lts	
	Zoom Scan
	2024-09-18
	6.93
	2.54
	-0.01
	Disabled
	Positive / Negative



0 d8 = 18.7 W/Kg

Certificate No: D3700V2-1105_Sep24

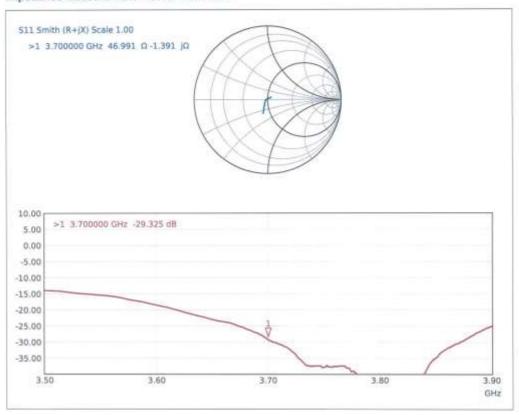
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D3700V2 - SN: 1105 September 18, 2024

Impedance Measurement Plot for Head TSL



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Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 0108

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Client HCT

Gyeonggi-do, Republic of Korea

Certificate No. D3900V2-1086_May24

CALIBRATION	ERTIFICATE		P 15 (8 D (1) 15
		12	
Object	D3900V2 - SN:10	286	Munty Ja
	and the second	100	CV /
		M-07/2/11	2024 06.05 2024.06.05
Calibration procedure(s)	QA CAL-22.v7	13.11	-VAT- VI.
	Calibration Proce	dure for SAR Validation Sou	rces between 3-10 GHz
	E 10 10 FE		
Calibration date:	May 21, 2024		
	West with severy		
This calibration certificate documen	its the traceability to natio	onal standards, which realize the physic	ai units of measurements (SI).
The measurements and the uncerta	ainties with confidence pr	robability are given on the following pag	es and are part of the certificate.
All calibrations have been conducte	ed in the closed laborator	y facility: environment temperature (22	± 3)*C and humidity < 70%.
			SAME SAME OF SAME
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
	SN: 310982 / 06327	26-Mar-24 (No. 217-04047)	Mar-25
	THE RESERVE THE PARTY OF THE PA		
Type-N mismatch combination Reference Probe EX3DV4	SN: 3503	07-Mar-24 (No. EX3-3503_Mar24)	Mar-25
Reference Probe EX3DV4	SN: 3503 SN: 781	07-Mar-24 (No. EX3-3503_Mar24) 16-Feb-24 (No. DAE4-781_Feb24)	Mar-25 Feb-25
Reference Probe EX3DV4 DAE4	2018/12/2017		
Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 781	16-Feb-24 (No. DAE4-781_Feb24)	Feb-25
	SN: 781	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house)	Feb-25 Scheduled Check
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E44198	SN: 781 ID# SN: GB39512475	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22)	Feb-25 Scheduled Check In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 781 ID # SN: G839512475 SN: US37292783	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Feb-25 Scheduled Check In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 781 ID # SN: G839512475 SN: US37292783 SN: MY41093315	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Feb-25 Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-08	SN: 781 ID # SN: G839612475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	Feb-25 Scheduled Check In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-08 Network Analyzer Agilent E8358A	SN: 781 ID # SN: G839512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22) Function	Scheduled Check In house check: Oct-24 Signature
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-08 Network Analyzer Agilent E8358A	SN: 781 ID # SN: G839612475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	Feb-25 Scheduled Check In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-08 Network Analyzer Agilant E8358A	SN: 781 ID # SN: G839512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22) Function	Scheduled Check In house check: Oct-24 Signature
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-08	SN: 781 ID # SN: G839512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22) Function	Scheduled Check In house check: Oct-24 Signature
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E44198 Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-08 Network Analyzer Agilent E8358A Calibrated by:	SN: 781 ID # SN: G839512475 SN: US37292783 SN: MY41083315 SN: 100972 SN: US41080477 Name Leif Klysner	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22) Function Laboratory Technician	Scheduled Check In house check: Oct-24 Signature
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E44198 Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-08 Network Analyzer Agilent E8358A Calibrated by:	SN: 781 ID # SN: G839512475 SN: US37292783 SN: MY41083315 SN: 100972 SN: US41080477 Name Leif Klysner	16-Feb-24 (No. DAE4-781_Feb24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22) Function Laboratory Technician	Scheduled Check In house check: Oct-24 Signature

Certificate No: D3900V2-1086_May24

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Calibration Laboratory of

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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA

Multilateral Agreement for the recognition of calibration certificates

Glossary:

TSL tissue simulating liquid

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

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

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



Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3900 MHz ± 1 MHz	

Head TSL parameters

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	38.1 ± 6 %	3.26 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	17112	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.72 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	67.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2,35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.6 W/kg ± 19.5 % (k=2)



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	44.0 Ω - 5.7 jΩ	
Return Loss	- 21,1 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.099 ns
Electrical Delay (one direction)	1.099 115

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

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

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

Additional EUT Data

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Manu	factured by	SPEAG

Certificate No: D3900V2-1086_May24

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DASY5 Validation Report for Head TSL

Date: 21.05.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1086

Communication System: UID 0 - CW; Frequency: 3900 MHz

Medium parameters used: f = 3900 MHz; $\sigma = 3.26$ S/m; $\epsilon_r = 38.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.32, 7.32, 7.32) @ 3900 MHz; Calibrated: 07.03.2024
- Sensor-Surface: I.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn781; Calibrated: 16.02.2024
- 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=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 = 69.07 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 18.4 W/kg

SAR(1 g) = 6.72 W/kg; SAR(10 g) = 2.35 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 74.9%

Maximum value of SAR (measured) = 13.0 W/kg



0 dB = 13.0 W/kg = 11.15 dBW/kg

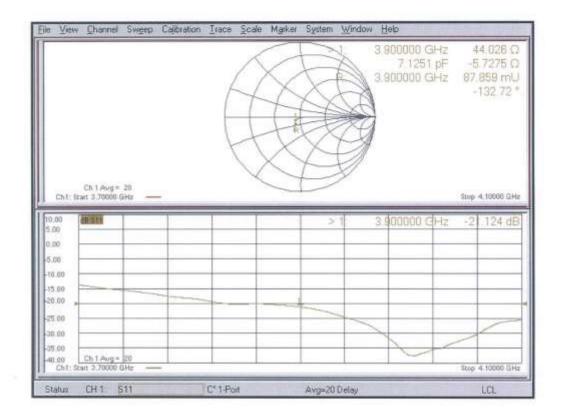
Certificate No: D3900V2-1086_May24

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Impedance Measurement Plot for Head TSL



Certificate No: D3900V2-1086_May24

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Calibration Laboratory of Schmid & Partner Engineering AG

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Accreditation No.: SCS 0108

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Client HCT

Gyeonggi-do, Republic of Korea

Certificate No. D5GHzV2-1107_Apr24

	ERTIFICAT		
Object	D5GHzV2 - SN:1	107 2 2 5	A.
Calibration procedure(s)	QA CAL-22.v7 Calibration Proce	edure for SAR Validation Sources	3 2024 4713
Calibration date:	April 19, 2024		
The measurements and the uncert	ainties with confidence p	conal standards, which realize the physical uni- robability are given on the following pages an ry facility: environment temperature $(22 \pm 3)^{\circ}$ C	d are part of the certificate.
Primary Standards	ID#	Call 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
	SN: 310962 / 06327	26-Mar-24 (No. 217-04047)	Mar-25
Type-N mismatch combination			Mar-25
	SN: 3503	07-Mar-24 (No. EX3-3503 Mar24)	
Reference Probe EX3DV4	SN: 3503 SN: 601	07-Mar-24 (No. EX3-3503_Mar/24) 30-Jan-24 (No. DAE4-601_Jan/24)	Jan-25
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	-5311115-1177		Jan-25 Scheduled Check
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	SN: 601	30-Jan-24 (No. DAE4-601_Jan24)	1997,000
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 601	30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house)	Scheduled Check
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22)	Scheduled Check In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972	30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Aglient E8358A	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Aglient E8358A	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	30-Jan-24 (No. DAE4-601_Jan24) Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24

Certificate No: D5GHzV2-1107_Apr24

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Calibration Laboratory of

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Swiss Calibration Service

Accreditation No.: SCS 0108

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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 N/A 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%.

Certificate No: D5GHzV2-1107_Apr24

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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	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5800 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	37.1 ± 6 %	4.65 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	7.97 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL.	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg ± 19.5 % (k=2)



Head TSL parameters at 5600 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35,5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.5 ± 6 %	5.05 mha/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	110	

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 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	36.3 ± 6 %	5.22 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	7.95 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.8 W/kg ± 19.5 % (k=2)



Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35,3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.2 ± 6 %	5.27 mha/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.89 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 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 5250 MHz

Impedance, transformed to feed point	49.0 Ω − 2.7 jΩ	
Return Loss	- 30.8 dB	

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.2 Ω + 1.9 jΩ
Return Loss	~27.1 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.1 Ω + 1.6 μΩ	
Return Loss	- 24.6 dB	

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.3 Ω + 0.5 jΩ	
Return Loss	- 25.9 dB	

General Antenna Parameters and Design

PARTICIPATE OF THE PARTICIPATE O	1710-975
Electrical Delay (one direction)	1.196 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

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Certificate No: D5GHzV2-1107_Apr24

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DASY5 Validation Report for Head TSL

Date: 19.04.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1107

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750

MHz, Frequency: 5800 MHz

Medium parameters used: f = 5250 MHz; $\sigma = 4.65$ S/m; $\epsilon_r = 37.1$; $\rho = 1000$ kg/m³,

Medium parameters used: f = 5600 MHz; $\sigma = 5.05$ S/m; $\varepsilon_r = 36.5$; $\rho = 1000$ kg/m³,

Medium parameters used: f = 5750 MHz; $\sigma = 5.22$ S/m; $\epsilon_r = 36.3$; $\rho = 1000$ kg/m³,

Medium parameters used: f = 5800 MHz; $\sigma = 5.27$ S/m; $\varepsilon_t = 36.2$; $\rho = 1000$ 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(4.86, 4.86, 4.86) @ 5800 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 = 73.63 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.29 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 70.9%

Maximum value of SAR (measured) = 18.2 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.81 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 30.3 W/kg

SAR(1 g) = 8.17 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 = 68%

Maximum value of SAR (measured) = 19.4 W/kg

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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 = 71.06 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 30.9 W/kg

SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.26 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) = 19.1 W/kg

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

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 71.08 V/m; Power Drift = 0.08 dB

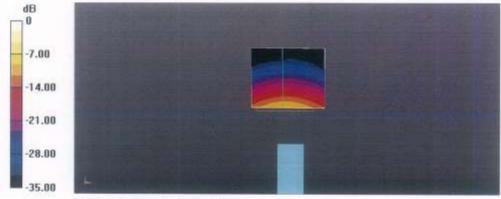
Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 7.89 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 = 65.8%

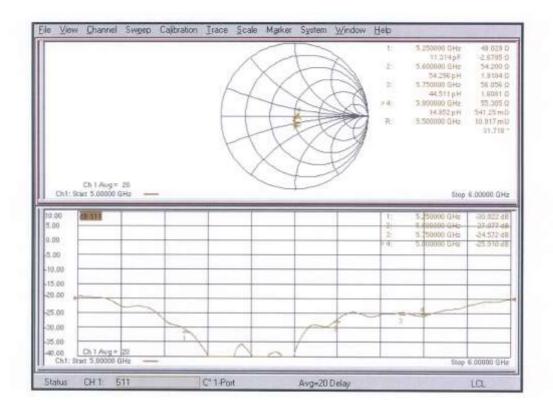
Maximum value of SAR (measured) = 19,2 W/kg



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



Impedance Measurement Plot for Head TSL



Certificate No: D5GHzV2-1107_Apr24

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Appendix: Transfer Calibration at Four Validation Locations on SAM Head¹

Evaluation Conditions (f=5250 MHz)

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

SAR result with SAM Head (Top)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	85.8 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

SAR result with SAM Head (Mouth)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	85.0 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	condition	

SAR result with SAM Head (Neck)

Condition	
normalized to 1W	83.1 W/kg ± 20.3 % (k=2)
condition	

SAR result with SAM Head (Ear)

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	53.8 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	18.3 W/kg ± 19.9 % (k=2)

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Additional assessments outside the current scope of SCS 0108



Appendix: Transfer Calibration at Four Validation Locations on SAM Head²

Evaluation Conditions (f=5800 MHz)

Phantom	SAM Head Phantom	For usage with cSAR3DV2-R/L
1 CARDOS CONTROL CO		

SAR result with SAM Head (Top)

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

SAR result with SAM Head (Mouth)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	89.1 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

SAR result with SAM Head (Neck)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	79.5 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

SAR result with SAM Head (Ear)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	56.6 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	condition	

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 $^{^{2}}$ Additional assessments outside the current scope of SCS 0108