

Report No: HCT-SR-2312-FC001

Appendix G. – Dipole Calibration Data



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

Certificate No. CLA13-1016_Sep23

Object	CLA13 - SN: 101	:LA13 - SN: 1016		
Calibration procedure(s)	QA CAL-15:v10 Calibration Procedure for SAR Validation Sources bel		below 706 MHz	
Salibration date:	September 21, 20	023		
The measurements and the uncert	ainties with confidence produced in the closed laborator	onal standards, which realize the physical unit robability are given on the following pages an y facility: environment temperature $(22 \pm 3)^{\circ}$ C	d are part of the certificate.	
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration	
Power meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24	
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24	
Power sensor NRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)	Mar-24	
Reference 20 dB Attenuator	SN: CC2552 (20x)	30-Mar-23 (No. 217-03809)	Mar-24	
Type-N mismatch combination	SN: 310982 / 06327	30-Mar-23 (No. 217-03810)	Mar-24	
[1578] - N. C. S.	SN: 3877	06-Jan-23 (No. EX3-3877_Jan23)	Jan-24	
Helerence Probe EXJUV4	man mma	27-Jan-23 (No. DAE4-654 Jan23)	Jan-24	
	SN: 654			
DAE4	ID#		Scheduled Check	
DAE4 Secondary Standards	J-75230-0500	Check Date (in house)	Scheduled Check In house check: Dec-24	
DAE4 Secondary Standards Power meter NRP2	10 #			
DAE4 Secondary Standards Power meter NRP2 Power sensor NRP-Z91	ID # SN: 107193	Check Date (in house) 08-Nov-21 (in house check Dec-22)	in house check: Dec-24	
DAE4 Secondary Standards Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91	ID # SN: 107193 SN: 100922	Check Date (in house) 08-Nov-21 (in house check Dec-22) 15-Dec-09 (in house check Dec-22)	In house check: Dec-24 In house check: Dec-24	
DAE4 Secondary Standards Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 RF generator HP 8648C	ID # SN: 107193 SN: 100922 SN: 100418	Check Date (in house) 08-Nov-21 (in house check Dec-22) 15-Dec-09 (in house check Dec-22) 01-Jan-04 (in house check Dec-22)	In house check: Dec-24 In house check: Dec-24 In house check: Dec-24	
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter NRP-2 Power sensor NRP-Z91 Power sensor NRP-Z91 RF generator HP 8648C Network Analyzer Agilent EB358A	ID # SN: 107193 SN: 100922 SN: 100418 SN: US3642U01700	Check Date (in house) 08-Nov-21 (in house check Dec-22) 15-Dec-09 (in house check Dec-22) 01-Jan-04 (in house check Dec-22) 04-Aug-89 (in house check Jun-22)	In house check: Dec-24 In house check: Dec-24 In house check: Dec-24 In house check: Jun-24 In house check: Oct-24	
DAE4 Secondary Standards Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 RF generator HP 8648C	ID # SN: 107193 SN: 100922 SN: 100418 SN: US3642U01700 SN: US41080477	Check Date (in house) 08-Nov-21 (in house check Dec-22) 15-Dec-09 (in house check Dec-22) 01-Jan-04 (in house check Dec-22) 04-Aug-99 (in house check Jun-22) 31-Mar-14 (in house check Oct-22)	In house check: Dec-24 In house check: Dec-24 In house check: Dec-24 In house check: Jun-24	
DAE4 Secondary Standards Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 RF generator HP 8648C Network Analyzer Agillant E8368A Calibrated by:	ID # SN: 107193 SN: 100922 SN: 100418 SN: US3642U01700 SN: US41060477 Name Jeton Kastrati	Check Date (in house) 08-Nov-21 (in house check Dec-22) 15-Dec-09 (in house check Dec-22) 01-Jan-04 (in house check Dec-22) 04-Aug-89 (in house check Jun-22) 31-Mar-14 (in house check Oct-22) Function Laboratory Technician	In house check: Dec-24 In house check: Dec-24 In house check: Dec-24 In house check: Jun-24 In house check: Oct-24 Signature	
DAE4 Secondary Standards Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 RF generator HP 8648C Network Analyzer Agilant E8358A	ID # SN: 107193 SN: 100922 SN: 100418 SN: US3642U01700 SN: US41080477 Name	Check Date (in house) 08-Nov-21 (in house check Dec-22) 15-Dec-09 (in house check Dec-22) 01-Jan-04 (in house check Dec-22) 04-Aug-98 (in house check Jun-22) 31-Mar-14 (in house check Oct-22) Function	In house check: Dec-24 In house check: Dec-24 In house check: Dec-24 In house check: Jun-24 In house check: Oct-24	
DAE4 Secondary Standards Power meter NRP2 Power sensor NRP-Z91 Power sensor NRP-Z91 RF generator HP 8648C Network Analyzer Agillent EB358A Calibrated by: Approved by:	ID # SN: 107193 SN: 100922 SN: 100928 SN: US3642U01700 SN: US41090477 Name Jeton Kastrati Sven Kühn	Check Date (in house) 08-Nov-21 (in house check Dec-22) 15-Dec-09 (in house check Dec-22) 01-Jan-04 (in house check Dec-22) 04-Aug-89 (in house check Jun-22) 31-Mar-14 (in house check Oct-22) Function Laboratory Technician	In house check: Dec-24 In house check: Dec-24 In house check: Dec-24 In house check: Jun-24 In house check: Oct-24 Signature	



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Calibration Laboratory of

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





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Multilateral Agreement for the recognition of calibration certificates

Glossary:

TSL tissue simulating liquid

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end
 of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- 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	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
EUT Positioning	Touch Position	
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	13 MHz ± 1 MHz	

Head TSL parameters

he following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	55.0	0.75 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	53.1 ± 6 %	0.72 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		- Carlo

SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	1 W input power	0.539 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	0.553 W/kg ± 18.4 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	1 W input power	0.335 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	0.343 W/kg ± 18.0 % (k=2)



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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.3 Ω + 0.0 jΩ	
Return Loss	- 37.8 dB	

Additional EUT Data

	Manufactured by	SPEAG
- 1	AND	

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DASY5 Validation Report for Head TSL

Date: 21.09.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA13; Type: CLA13; Serial: CLA13 - SN: 1016

Communication System: UID 0 - CW; Frequency: 13 MHz

Medium parameters used: f = 13 MHz; $\sigma = 0.72$ S/m; $\epsilon_r = 53.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

Probe: EX3DV4 - SN3877; ConvF(15.33, 15.33, 15.33) @ 13 MHz; Calibrated: 06.01.2023

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn654; Calibrated: 27.01.2023

Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2034

DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

CLA Calibration for HSL-LF Tissue/CLA-13, touch configuration, Pin=1W/Zoom Scan,

dist=1.4mm (8x10x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 30.91 V/m; Power Drift = 0.05 dB

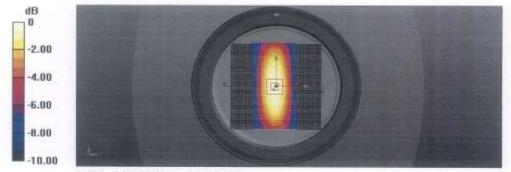
Peak SAR (extrapolated) = 1.09 W/kg

SAR(1 g) = 0.539 W/kg; SAR(10 g) = 0.335 W/kg

Smallest distance from peaks to all points 3 dB below = 17.6 mm

Ratio of SAR at M2 to SAR at M1 = 78.6%

Maximum value of SAR (measured) = 0.796 W/kg



0 dB = 0.796 W/kg = -0.99 dBW/kg

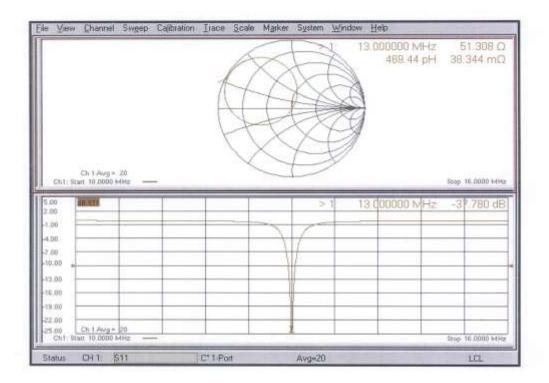
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Impedance Measurement Plot for Head TSL



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Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland

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

Accreditation No.: SCS 0108

Client HCT

Certificate No. D750V3-1014_May23

QA CAL-05.v12 Calibration Proce May 23, 2023 s the traceability to nation	dure for SAR Validation Sources	between 0.7-3 GHz
s the traceability to natio		
inties with confidence pr	robability are given on the following pages and y facility: environment temperature (22 \pm 3) $^{\circ}$ C	d are part of the certificate.
ID#	Cal Date (Certificate No.)	Scheduled Calibration
SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
SN: 103244	30-Mer-23 (No. 217-03804)	Mar-24
SN: 103245	30-Mar-23 (No. 217-03805)	Mar-24
SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
TANK DESCRIPTION OF THE PROPERTY OF THE PROPER	30-Mar-23 (No. 217-03810)	Mar-24
		Jan-24
SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23
ID#	Check Date (in house)	Scheduled Check
SN: QB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
SN; US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
SN: 100972	15-Jun-15 (in house check Oct-22)	In house check; Oct-24
SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
Name	Function	Signature
Michael Weber	Laboratory Technician	MINESES
Sven Kühn	Technical Manager	5.6
	9N: 104778 9N: 104778 9N: 103244 5N: 103245 5N: 819394 (20k) 5N: 310882 / 06327 5N: 7349 5N: 601 1D # 5N: 0B39512475 5N: US37282783 5N: W37282783 5N: W37282783 5N: US41080477 Name Michael Weber	Cal Date (Certificate No.) 9N: 104778



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





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Glossary:

TSL

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: D750V3-1014_May23

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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	The state of the s
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "C	40.7 ± 6 %	0.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.59 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.62 W/kg ± 16.5 % (k=2)

Certificate No: D750V3-1014_May23

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.7 Ω + 3.7 ΙΩ		
Return Loss	- 24.8 dB		

General Antenna Parameters and Design

A STATE OF THE PROPERTY OF THE	CHICAGO I CONT.
Electrical Delay (one direction)	1.038 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: D750V3-1014_May23

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Report No: HCT-SR-2312-FC001

DASY5 Validation Report for Head TSL

Date: 23.05.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1014

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: f = 750 MHz; $\sigma = 0.9 \text{ S/m}$; $\epsilon_r = 40.7$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(10.11, 10.11, 10.11) @ 750 MHz; Calibrated: 10.01.2023

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 19.12.2022

Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001

DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 61.58 V/m; Power Drift = -0.07 dB

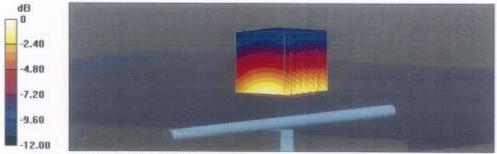
Peak SAR (extrapolated) = 3.34 W/kg

SAR(1 g) = 2.18 W/kg; SAR(10 g) = 1.42 W/kg

Smallest distance from peaks to all points 3 dB below = 17.1 mm

Ratio of SAR at M2 to SAR at M1 = 64.9%

Maximum value of SAR (measured) = 2.90 W/kg



0 dB = 2.90 W/kg = 4.62 dBW/kg

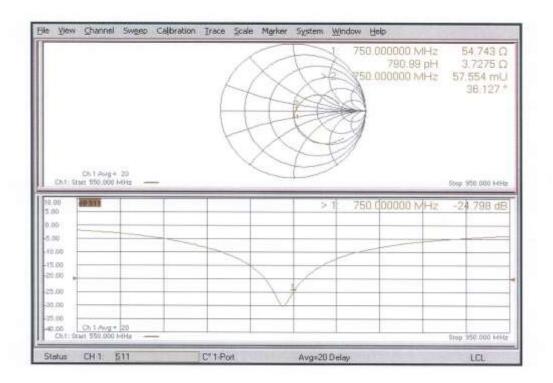
Certificate No: D750V3-1014_May23

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Report No: HCT-SR-2312-FC001

Impedance Measurement Plot for Head TSL



Certificate No: D750V3-1014_May23

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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

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Client HCT

Gyeonogi-do, Republic of Korea

Certificate No. D835V2-4d165_May23

Object	D835V2 - SN:4d1	165			
Calibration procedure(s)	QA CAL-05.v12				
	Calibration Procedure for SAR Validation Sources between 0.7-3 GHz				
Calibration date:	May 23, 2023				
		onal standards, which realize the physical uni			
The measurements and the uncertainty	ainties with confidence pr	obability 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 \pm 3)°C	and humidity < 70%.		
Calibration Equipment used (M&TE	critical for calibration)				
	lie z	ale or all the related users becomes that	Salara de la companya del companya del companya de la companya de		
Primary Standards Power meter NRP2	ID # SN: 104778	Cai Date (Certificate No.)	Scheduled Calibration		
		30-Mar-23 (No. 217-03804/03806)	Mar-24		
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24		
Power sensor NRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)	Mer-24		
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24		
Type-N mismatch combination	SN: 310082 / 06327	30-Mar-23 (No. 217-03810)	Mar-24		
Reference Probe EX3DV4	SN: 7349	10-Jan-23 (No. EX3-7349_Jan23)	Jan-24		
	SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23		
DAE4					
	ID#	Check Date (in house)	Scheduled Check		
Secondary Standards Power meter E4419B	ID # SN: GB39512475	Check Date (in house) 30-Oct-14 (in house check Oct-22)	Scheduled Check In house check: Oct-24		
Secondary Standards		Control of the Contro			
Secondary Standards Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24		
Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: GB39512475 SN: US37292783	30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	In house check: Oct-24 In house check: Oct-24		
Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: GB39512475 SN: US37292783 SN: MY41093315	30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	In house check: Oct-24 In house check: Oct-24 In house check: Oct-24		
Secondary Standards Power meter E4419B Power sensor HP 8481A	9N: GB39512475 5N: US37292783 SN: MY41093315 SN: 100972	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)	In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24		
Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	9N: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	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	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		
Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	9N: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	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)	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		
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:	9N: GB39512475 5N: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name Michael Weber	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 Laboratory Fechnician	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		
Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	9N: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	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	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		
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:	9N: GB39512475 5N: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name Michael Weber	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 Laboratory Fechnician	In house check: Oct-24 Signature		
Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agitent E8358A Calibrated by: Approved by:	9N: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name Michael Weber	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 Laboratory Fechnician	In house check: Oct-24 Signature Issued: May 23, 2023		
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: Approved by:	9N: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name Michael Weber	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 Laboratory Technician Technical Manager	In house check: Oct-24 Signature		



Calibration Laboratory of Schmid & Partner Engineering AG

Engineering AG Zoughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

Glossary:

TSL tissue simulating liquid

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Certificate No: D835V2-4d165_May23

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Report No: HCT-SR-2312-FC001

Measurement Conditions

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	111111111111111111111111111111111111111
Frequency	835 MHz ± 1 MHz	

Head TSL parameters
The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22,0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.5 ± 6 %	0.93 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	2.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.74 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.62 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.33 W/kg ± 16.5 % (k=2)



Report No: HCT-SR-2312-FC001

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.2 Ω - 3.2 Ω		
Return Loss	- 29.5 dB		

General Antenna Parameters and Design

	11.000000000000000000000000000000000000	31
Electrical Delay (one direction)	1.389 ns	Г

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: D835V2-4d165_May23

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Report No: HCT-SR-2312-FC001

DASY5 Validation Report for Head TSL

Date: 23.05.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d165

Communication System: UID 0 - CW; Frequency: 835 MHz.

Medium parameters used: f = 835 MHz; $\sigma = 0.93$ S/m; $\varepsilon_c = 40.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.69, 9.69, 9.69) @ 835 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 64.33 V/m; Power Drift = -0.04 dB

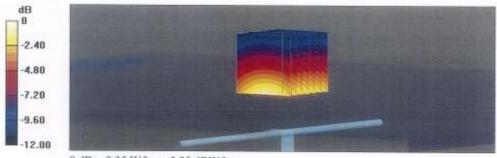
Peak SAR (extrapolated) = 3.79 W/kg

SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.62 W/kg

Smallest distance from peaks to all points 3 dB below = 16 mm

Ratio of SAR at M2 to SAR at M1 = 65.9%

Maximum value of SAR (measured) = 3.35 W/kg



0 dB = 3.35 W/kg = 5.25 dBW/kg

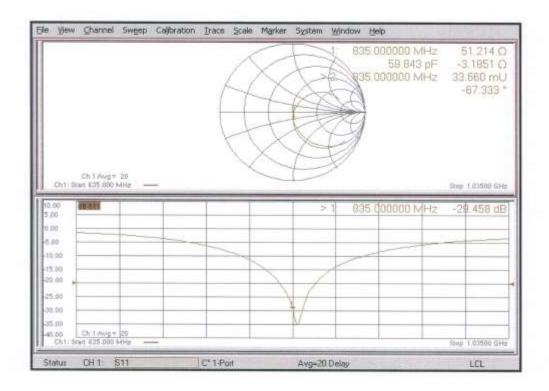
Certificate No: D835V2-4d165_May23

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Report No: HCT-SR-2312-FC001

Impedance Measurement Plot for Head TSL



Certificate No: D835V2-4d165_May23

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Report No: HCT-SR-2312-FC001

Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA

Multilateral Agreement for the recognition of calibration certificates

Client HCT

Certificate No. D1800V2-2d015_May23

Object	D1800V2 - SN:2d015				
Calibration procedure(s)	QA CAL-05.v12				
	Calibration Procedure for SAR Validation Sources between 0.7-3 GHz				
Calibration date:	May 17, 2023				
This calibration certificate documen			Problem of Language and the Charles	44 () () () () () () () () () (
The measurements and the uncerta	vinties with confidence pr	robability are given on the folio	wing pages and a	re part of the certificate.	
All calibrations have been conducte	ad in the closed taborator	ry facility: environment temper	ature (22 ± 31°C or	nd humidity < 70%.	
Calibration Equipment used (M&TE	critical for calibration)				
Primary Standards	ID#	Cal Date (Certificate No.)		Scheduled Calibration	
Power meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804)	03805)	Mar-24	
Power sensor NRP-Z91	5N: 103244	30-Mar-23 (No. 217-03804)		Mar-24	
Power sensor NRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)		Mar-24	
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)		Mar-24	
Type-N mismatch combination	SN: 310982 / 06327	30-Mar-23 (No. 217-03810)		Mar-24	
Reference Probe EX3DV4	SN: 7349	10-Jan-23 (No. EX3-7349		Jan-24	
DAE4	SN: 601	19-Dec-22 (No. DAE4-601		Dec-23	
Secondary Standards	ID#	Check Date (in house)		Scheduled Check	
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check	Oct-22)	In house check: Oct-24	
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check	Oct-22)	In house check: Oct-24	
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check	Oct-22)	In house check: Oct-24	
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check	Oct-22)	In house check: Oct-24	
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check	Oct-22)	In house check: Oct-24	
	Name	Function		Signature	
Calibrated by:	Paulo Pina	Laboratory Tec	hnician	1-1-3	
				im the	
Approved by:	Sven Kühn	Technical Mana		9-6-	
				January Mey 25, 2022	
This calibration certificate shall not	be reproduced except in	full without written approval of	the aboratory.)	Issued: May 25, 2023	
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Certificate No: D1800V2-2d015_	May23	Page 1 of 6	재 0	H188 25 19130	



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Accreditation No.: SCS 0108

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: D1800V2-2d015_May23

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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	1800 MHz ± 1 MHz	

Head TSL parameters

he 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	38.5 ± 6 %	1,37 mho/m ± 6 %
Head TSL temperature change during test	< 0,5 °C		-

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	37.8 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.92 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.7 W/kg ± 16.5 % (k=2)

Certificate No: D1800V2-2d015_May23

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Report No: HCT-SR-2312-FC001

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.9 Ω - 4.0 JΩ	
Return Loss	- 27.6 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.214 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: D1800V2-2d015_May23

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Report No: HCT-SR-2312-FC001

DASY5 Validation Report for Head TSL

Date: 17.05.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN:2d015

Communication System: UID 0 - CW; Frequency: 1800 MHz

Medium parameters used: f = 1800 MHz; $\sigma = 1.37$ S/m; $\epsilon_e = 38.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.63, 8.63, 8.63) @ 1800 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 = 109.2 V/m; Power Drift = -0.00 dB

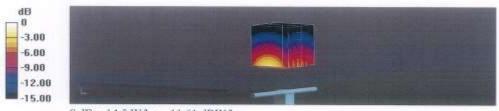
Peak SAR (extrapolated) = 17.3 W/kg

SAR(1 g) = 9.42 W/kg; SAR(10 g) = 4.92 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 54.8%

Maximum value of SAR (measured) = 14.5 W/kg



0 dB = 14.5 W/kg = 11.61 dBW/kg

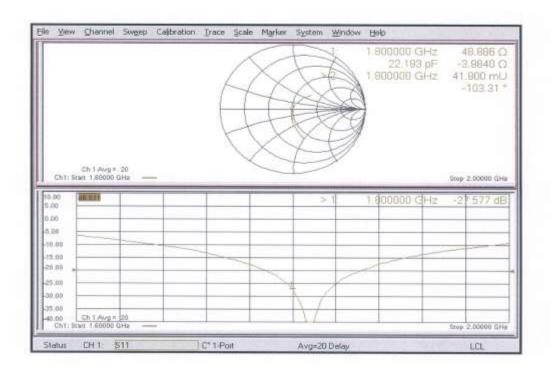
Certificate No: D1800V2-2d015_May23

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Report No: HCT-SR-2312-FC001

Impedance Measurement Plot for Head TSL



Certificate No: D1800V2-2d015_May23

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Report No: HCT-SR-2312-FC001

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Client HCT (Dymstec)

Certificate No: D1900V2-5d061_Jan23

Object	D1900V2 - SN:56	1061	
Calibration procedure(s)	QA CAL-05.v12 Calibration Proce	edure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	January 23, 2023		
The measurements and the uncert	ainties with confidence p	coal standards, which realize the physical uni- robability are given on the following pages an ry facility: environment temperature $(22\pm3)^{\circ}0$	d are part of the certificate.
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	5N: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	D4-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 7349	10-Jan-23 (No. EX3-7349 Jan23)	Jan-24
DAE4	SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23
Secondary Standards	ID#	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093316	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-08	SN: 100972	15-Jun-15 (In house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Paulo Pina	Laboratory Technician	Tall-
Approved by:	Sven Kühn	Technical Manager	Sila
Approved by:	Sven Kühn	Technical Manager	Issued: January 24, 2023



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Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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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:

- 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: D1900V2-5d061_Jan23

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Report No: HCT-SR-2312-FC001

Measurement Conditions

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	10
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	38.6 ± 6 %	1.39 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW Input power	9.77 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	38.9 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.3 W/kg ± 16.5 % (k=2)

Certificate No: D1900V2-5d061_Jan23

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Report No: HCT-SR-2312-FC001

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.2 Ω + 6.3 jΩ	
Return Loss	- 24.1 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.193 ns	
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

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Manufactured by	SPEAG

Certificate No: D1900V2-5d061_Jan23

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Report No: HCT-SR-2312-FC001

DASY5 Validation Report for Head TSL

Date: 23.01.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d061

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

Medium parameters used: f = 1900 MHz; $\sigma = 1.39$ S/m; $\epsilon_r = 38.6$; $\rho = 1000$ kg/m³

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: 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 = 109.1 V/m; Power Drift = 0.01 dB

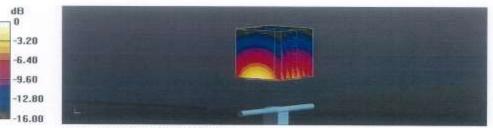
Peak SAR (extrapolated) = 18.1 W/kg

SAR(1 g) = 9.77 W/kg; SAR(10 g) = 5.09 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 54.6%

Maximum value of SAR (measured) = 15.1 W/kg



0 dB = 15.1 W/kg = 11.79 dBW/kg

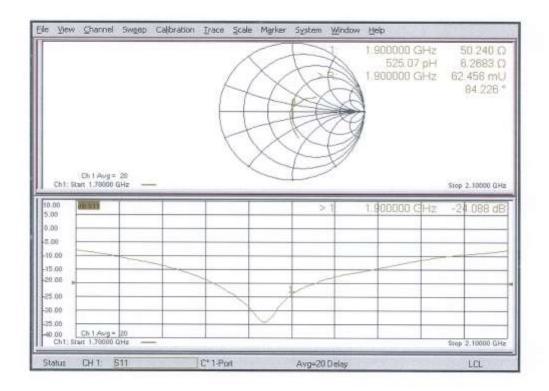
Certificate No: D1900V2-5d061_Jan23

Page 5 of 6



Report No: HCT-SR-2312-FC001

Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d061_Jan23

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Report No: HCT-SR-2312-FC001

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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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Client HCT

Certificate No. D2450V2-1049_Apr23

CALIBRATION C			
Object	D2450V2 - SN:1	049	
Calibration procedure(s)	QA CAL-05.v12		
	Calibration Proce	edure for SAR Validation Sources	s between 0.7-3 GHz
Calibration date:	April 25, 2023		
The measurements and the uncert All calibrations have been conduct	ed in the closed laborator	conal standards, which realize the physical uni- robability are given on the following pages an ry facility: environment temperature (22 ± 3) $^{\circ}$ C	ed are part of the certificate.
Calibration Equipment used (M&T) Primary Standards	E critical for calibration)		
Power meter NRP2	SN: 104778	Gai Date (Certificate No.) 30-Mar-23 (No. 217-03804/03805)	Scheduled Calibration
Power sensor NRP-291	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24 Mar-24
Power sensor NRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)	Mar-24
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
Type-N mismatch combination	SN: 310982 / 06327	30-Mar-23 (No. 217-03810)	Mar-24
Reference Probe EX3DV4	SN: 7349	10-Jan-23 (No. EX3-7349 Jan23)	Jan-24
DAE4	SN: 601	19-Dec-22 (No: DAE4-601_Dec22)	Dec-23
Secondary Standards	ID#	Check Date (in house)	Scheduled Check
	SN: GB39512475		ownedured Chark
ower meter E4419B	GRV. GID30012475	30-Oct-14 (in house check Oct-22)	In houses check: The O.L.
	SN: US37292783	30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A Power sensor HP 8481A		07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A Power sensor HP 8481A	SN: US37292783		In house check: Oct-24 In house check: Oct-24
Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: US37292763 SN: MY41093315	07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: US37292783 SN: MY41093315 SN: 100972	07-Oct-16 (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)	In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by:	SN: US37292763 SN: MY41093315 SN: 100972 SN: US41090477	07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22)	In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Pawer sansor HP 8481A Pawer sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilant E8358A	SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	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	In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by: Approved by:	SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name Michael Weber	07-Oct-16 (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 Technical Manager	In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by: Approved by:	SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name Michael Weber	07-Oct-16 (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	In house check: Oct-24 Signature
Pawer sensor HP 8481A Power sensor HP 8481A IF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by:	SN: US37292783 SN: MY41093915 SN: 100972 SN: US41080477 Name Michael Weber Sven Kühn	07-Oct-16 (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 Technical Manager	In house check: Oct-24 In signature:



Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienat Service suisse d'étaionnage Servizio svizzero di tarature 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: D2450V2-1049_Apr23

Page 2 of 7



Report No: HCT-SR-2312-FC001 FCC ID: A3LSMM156B

Measurement Conditions

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters
The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.6 W/kg ± 16.5 % (k=2)

Certificate No: D2450V2-1049_Apr23



Report No: HCT-SR-2312-FC001

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.1 Ω + 8.8 jΩ	
Return Loss	- 21.0 dB	

General Antenna Parameters and Design

The second of th	
Electrical Delay (one direction)	1.160 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: D2450V2-1049_Apr23

Page 4 of 7



DASY5 Validation Report for Head TSL

Date: 25.04.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 1049

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

Medium parameters used: f = 2450 MHz; $\sigma = 1.86$ S/m; $\varepsilon_c = 37.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

dB

Probe: EX3DV4 - SN7349; ConvF(7.88, 7.88, 7.88) @ 2450 MHz; Calibrated: 10.01.2023

- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 117.0 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.23 W/kg

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

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

Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.50 dBW/kg

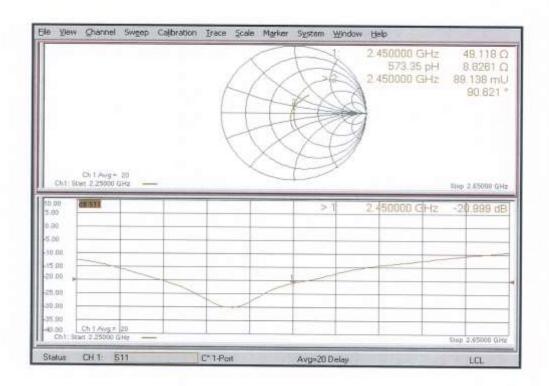
Certificate No: D2450V2-1049_Apr23

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Report No: HCT-SR-2312-FC001

Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-1049_Apr23

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Report No: HCT-SR-2312-FC001

Appendix: Transfer Calibration at Four Validation Locations on SAM Head¹

Evaluation Condition

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

SAR result with SAM Head (Top ≅ C0)

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	56.2 W/kg ± 17.5 % (k=2)
510		
SAR averaged over 10 cm ³ (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	57.3 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ² (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	54.0 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 cm ² (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	34.6 W/kg ± 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

Certificate No: D2450V2-1049_Apr23

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¹ Additional assessments outside the current scope of SCS 0108



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Client HCT

Gyeonggi-do, Republic of Korea



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

Accreditation No.: SCS 0108

Certificate No. D2600V2-1106_May23

Object	D2600V2 - SN:1106		
Calibration procedure(s)	QA CAL-05,v12 Calibration Proce	edure for SAR Validation Sources	s between 0.7-3 GHz
Calibration date:	May 24, 2023		
This calibration certificate documer The measurements and the uncerts	its the traceability to nati	onal standards, which realize the physical un robability are given on the following pages ar	its of measurements (Si). Id are part of the certificate.
		y facility: environment temperature (22 \pm 3)*	C and humidity < 70%,
Calibration Equipment used (M&TE	(Color		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power 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
Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 103245	30-Mar-23 (No. 217-03805)	Mar-24
Type-N mismatch combination	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
ype-N mismatch combination leference Probe EX3DV4	SN: 310962 / 06327 SN: 7349	30-Mar-23 (No. 217-03810)	Mar-24
DAE4	SN: 7349 SN: 601	10-Jan-23 (No. EX3-7349_Jan23) 19-Dec-22 (No. DAE4-601_Dec22)	Jan-24 Dec-23
Secondary Standards	ID#	Charle Date Hall	
Power meter E4419B	1000	Check Date (in house)	Scheduled Check
ower meter E44198 ower sensor HP 8481A	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
ower sensor HP 8481A	SN: US37292783 SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: MY41093315 SN: 100972	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	In house check: Oct-24 In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Paulo Pina	Laboratory Technicien	
			7 - 61-
Approved by:	Sven Kühn	Technical Manager	5.4
			90000 S 420 WELF 2014
			Issued: May 24, 2023
This calibration certificate shall not	be reproduced except in	full without written approval of the jabbratory	Issued: May 24, 2023 당자 화인자
		= /	Issued: May 24, 2023
This calibration certificate shall not ertificate No: D2600V2-1106_N		Page 1 of 6	ISSUEC. May 24, 2023

F-TP22-03 (Rev.00) 39 / 55 HCT CO.,LTD.



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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland





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C Service suisse d'étalonnage
Servizio sylzzero di taratura
Swiss Calibration Service

Accreditation No.: SCS 0108

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Multilateral Agreement for the recognition of calibration certificates

Glossary:

N/A

TSL tissue simulating liquid
ConvF sensitivity in TSL / NORM x,y,z

Calibration is Performed According to the Following Standards:

not applicable or not measured

- 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: D2600V2-1106_May23

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Measurement Conditions

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

Head TSL parameters
The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.1 ± 6 %	2.00 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	****	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	55.6 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.1 W/kg ± 16.5 % (k=2)



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.9 Ω - 6.8 jΩ	
Return Loss	- 23,1 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 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: D2600V2-1106_May23

Page 4 of 6



DASY5 Validation Report for Head TSL

Date: 24.05.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1106

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

Medium parameters used: f = 2600 MHz; $\sigma = 2 \text{ S/m}$; $\varepsilon_r = 37.1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(7.68, 7.68, 7.68) @ 2600 MHz; Calibrated: 10.01.2023

- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 117.6 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 27.7 W/kg

SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.37 W/kg

Smallest distance from peaks to all points 3 dB below = 8.9 mm

Ratio of SAR at M2 to SAR at M1 = 51.4% Maximum value of SAR (measured) = 23.0 W/kg



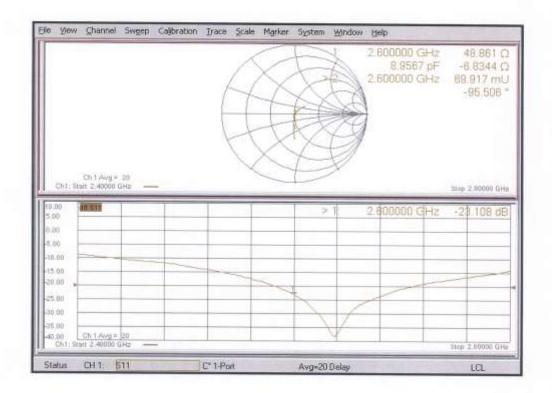
0 dB = 23.0 W/kg = 13.62 dBW/kg

Certificate No: D2600V2-1106_May23

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Report No: HCT-SR-2312-FC001

Impedance Measurement Plot for Head TSL



Certificate No: D2600V2-1106_May23

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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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Client HCT

Gyeonggi-do, Republic of Korea

Certificate No. D5GHzV2-1317_May23

CALIBRATION CERTIFICATE D5GHzV2 - SN:1317 Object QA CAL-22.v7 Calibration procedure(s) Calibration Procedure for SAR Validation Sources between 3-10 GHz May 17, 2023 Calibration date:

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24
Power sensor NRP-Z91	SN: 103245	30-Mar-23 (No. 217-03805)	Mar-24
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
Type-N mismatch combination	SN: 310982 / 06327	30-Mar-23 (No. 217-03810)	Mar-24
Reference Probe EX3DV4	SN: 3503	07-Mar-23 (No. EX3-3503_Mar23)	Mar-24
DAE4	SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23
Secondary Standards	ID#	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: U\$37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41090477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24
	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	1. West
Approved by:	Sven Kühn	Technical Manager	0/

Certificate No: D5GHzV2-1317_May23

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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

Glossary:

TSL 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
- 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

ASY system confiduration, as far as no	A 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	34.8 ± 6 %	4.60 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		-

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.6 W/kg ± 19.5 % (k=2)

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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	34.6 ± 6 %	4.97 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		13 -113 ,5

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.0 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	34.4 ± 6 %	5.08 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		****

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.79 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.1 W/kg ± 19.5 % (k=2)

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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	34.3 ± 6 %	5.11 mha/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	2000	

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	7.75 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.8 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	44.6 Ω - 2.0 μΩ
Return Loss	- 24.3 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	48.0 Ω - 0.3 jΩ
Return Loss	- 33.6 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	47.2 Ω + 1.2 jΩ
Return Loss	- 30,0 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	46.0 Ω + 0.8 jΩ
Return Loss	- 27.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.191 ns

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

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

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

Additional EUT Data

process and the second	
Manufactured by	SPEAG

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DASY5 Validation Report for Head TSL

Date: 17.05.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1317

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

MHz, Frequency: 5800 MHz

Medium parameters used: f = 5250 MHz; σ = 4.6 S/m; $ε_r = 34.8$; ρ = 1000 kg/m³ Medium parameters used: f = 5600 MHz; σ = 4.97 S/m; $ε_r = 34.6$; ρ = 1000 kg/m³ Medium parameters used: f = 5750 MHz; σ = 5.08 S/m; $ε_r = 34.4$; ρ = 1000 kg/m³ Medium parameters used: f = 5800 MHz; σ = 5.11 S/m; $ε_r = 34.3$; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 07.03.2023
- 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=100mW, dist=10mm, f=5250 MHz/Zoom Scan,

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

Reference Value = 75.29 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.28 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 71.8%

Maximum value of SAR (measured) = 17.6 W/kg

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

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

Reference Value = 74.66 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 30.1 W/kg

SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.32 W/kg

Smallest distance from peaks to all points 3 dB below = 6.8 mm

Ratio of SAR at M2 to SAR at M1 = 68.8%

Maximum value of SAR (measured) = 18.8 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 = 72.14 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 29.8 W/kg

SAR(1 g) = 7.79 W/kg; SAR(10 g) = 2.23 W/kg

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 66.1%

Maximum value of SAR (measured) = 18.2 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 = 71.84 V/m; Power Drift = 0.00 dB

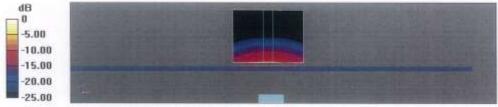
Peak SAR (extrapolated) = 30.2 W/kg

SAR(1 g) = 7.75 W/kg; SAR(10 g) = 2.2 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 65.5%

Maximum value of SAR (measured) = 18.3 W/kg

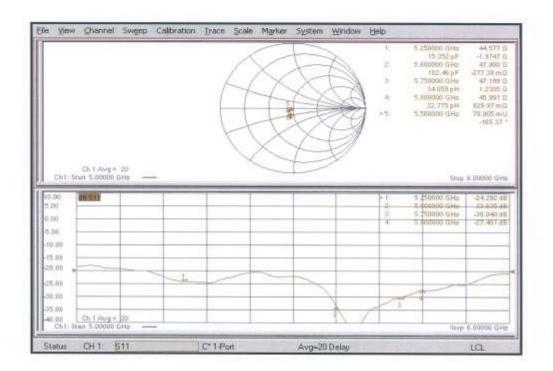


0 dB = 18.8 W/kg = 12.74 dBW/kg



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Impedance Measurement Plot for Head TSL



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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
The second secon		

SAR result with SAM Head (Top)

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	84.3 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	83.5 W/kg ± 20.3 % (kw2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

SAR result with SAM Head (Neck)

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	81.7 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ² (10 g) of Head TSL	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	52.8 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
ornitaringed over 10 cm (10 g) of field 10c	SOLUTION STATE	

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Additional assessments outside the current scope of SCS 0108



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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
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SAR result with SAM Head (Top)

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	79.9 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	86.4 W/kg ± 20.3 % (k=2)
	LUMBO AND STREET STREET STREET	
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	77.1 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ² (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	54.9 W/kg ± 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	

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² Additional assessments outside the current scope of SCS 0108