APPENDIX K: PROBE AND DIPOLE CALIBRATION CERTIFICATES

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

Client PC Test

Certificate No: D750V3-1046_Feb21

CALIBRATION CERTIFICATE

Object	D750V3 - SN:104	16	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz BNV 3-2-20
Calibration date:	February 17, 202	1	5-4
The measurements and the uncerta	ainties with confidence p ed in the closed laborator	onal standards, which realize the physical un robability are given on the following pages an ry facility: environment temperature (22 ± 3)°C	d are part of the certificate.
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
The second s			
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
	SN: 104778 SN: 103244		
ower sensor NRP-Z91		01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101)	Apr-21 Apr-21 Apr-21
ower sensor NRP-Z91 ower sensor NRP-Z91	SN: 103244 SN: 103245	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101)	Apr-21 Apr-21
ower sensor NRP-Z91 ower sensor NRP-Z91 leference 20 dB Attenuator	SN: 103244 SN: 103245 SN: BH9394 (20k)	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106)	Apr-21 Apr-21 Apr-21
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	SN: 103244 SN: 103245	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104)	Apr-21 Apr-21
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106)	Apr-21 Apr-21 Apr-21 Apr-21
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. EX3-7349_Dec20)	Apr-21 Apr-21 Apr-21 Apr-21 Dec-21
ower sensor NRP-Z91 ower sensor NRP-Z91 Reference 20 dB Attenuator ype-N mismatch combination Reference Probe EX3DV4 OAE4 Secondary Standards	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. EX3-7349_Dec20) 02-Nov-20 (No. DAE4-601_Nov20)	Apr-21 Apr-21 Apr-21 Apr-21 Dec-21 Nov-21
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator ype-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Power meter E4419B	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. EX3-7349_Dec20) 02-Nov-20 (No. DAE4-601_Nov20) Check Date (in house)	Apr-21 Apr-21 Apr-21 Apr-21 Dec-21 Nov-21 Scheduled Check
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. 217-03104) 28-Dec-20 (No. EX3-7349_Dec20) 02-Nov-20 (No. DAE4-601_Nov20) Check Date (in house) 30-Oct-14 (in house check Oct-20)	Apr-21 Apr-21 Apr-21 Apr-21 Dec-21 Nov-21 Scheduled Check In house check: Oct-22
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator (ype-N mismatch combination Reference Probe EX3DV4 DAE4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. 217-03104) 28-Dec-20 (No. EX3-7349_Dec20) 02-Nov-20 (No. DAE4-601_Nov20) Check Date (In house) 30-Oct-14 (In house check Oct-20) 07-Oct-15 (In house check Oct-20)	Apr-21 Apr-21 Apr-21 Apr-21 Dec-21 Nov-21 Scheduled Check In house check: Oct-22 In house check: Oct-22
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4 DAE4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. EX3-7349_Dec20) 02-Nov-20 (No. DAE4-601_Nov20) Check Date (In house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Apr-21 Apr-21 Apr-21 Dec-21 Nov-21 Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: WY41092317 SN: 100972	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. EX3-7349_Dec20) 02-Nov-20 (No. DAE4-601_Nov20) 02-Nov-20 (No. DAE4-601_N	Apr-21 Apr-21 Apr-21 Apr-21 Dec-21 Nov-21 Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 28-Dec-20 (No. 217-03104) 28-Dec-20 (No. DAE4-601_Nov20) 02-Nov-20 (No. DAE4-601_Nov20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20)	Apr-21 Apr-21 Apr-21 Dec-21 Nov-21 Scheduled Check In house check: Oct-22 In house check: Oct-21

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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) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	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	
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	41.6 ± 6 %	0.89 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	مىد	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.59 W/kg ± 17.0 % (k=2)
SAB averaged over 10 cm ³ (10 g) of Head TSI	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	1.40 W/kg

Body TSL parameters The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55,5 ± 6 %	0.95 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.18 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.79 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.45 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.84 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	56.9 Ω + 1.9 jΩ	
Return Loss	- 23.5 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	53.0 Ω - 1.2 jΩ	
Return Loss	- 30.2 dB	

General Antenna Parameters and Design

	Electrical Delay (one direction)	1.037 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

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

Date: 15.02.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1046

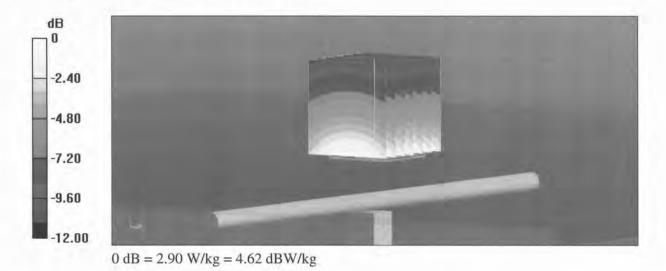
Communication System: UID 0 - CW; Frequency: 750 MHz Medium parameters used: f = 750 MHz; σ = 0.89 S/m; ϵ_r = 41.6; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.11, 10.11, 10.11) @ 750 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 60.15 V/m; Power Drift = -0.00 dB Peak SAR (extrapolated) = 3.30 W/kg **SAR(1 g) = 2.15 W/kg; SAR(10 g) = 1.40 W/kg Smallest distance from peaks to all points 3 dB below = 19.4 mm Ratio of SAR at M2 to SAR at M1 = 65.2\% Maximum value of SAR (measured) = 2.90 W/kg**



Impedance Measurement Plot for Head TSL

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0 1 1 10 10 10 10 10	tart 550,000					1 75	0.0000	00 MHz	_	

DASY5 Validation Report for Body TSL

Date: 17.02.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1046

Communication System: UID 0 - CW; Frequency: 750 MHz Medium parameters used: f = 750 MHz; σ = 0.95 S/m; ϵ_r = 55.5; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.23, 10.23, 10.23) @ 750 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 55.40 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 3.29 W/kg SAR(1 g) = 2.18 W/kg; SAR(10 g) = 1.45 W/kg Smallest distance from peaks to all points 3 dB below = 18.6 mm Ratio of SAR at M2 to SAR at M1 = 66.4%Maximum value of SAR (measured) = 2.90 W/kg



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

Impedance Measurement Plot for Body TSL

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Schweizerischer Kalibrierdienst Service suisse d'étalonnage

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Accreditation No.: SCS 0108

S Swiss Calibration Service

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Client PC Test

Certificate No: D835V2-4d119_Apr21

CALIBRATION CERTIFICATE

il 15, 2021 traceability to nation with confidence pro- he closed laboratory al for calibration) 104778 103244 103245 BH9394 (20k)	dure for SAR Validation Sour onal standards, which realize the physic obability are given on the following page y facility: environment temperature (22 : <u>Cal Date (Certificate No.)</u> 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292)	al units of mea es and are part ± 3)°C and hun So Ap	Br 4-2 asurements (SI). t of the certificate.
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il 15, 2021 traceability to nation with confidence pro- he closed laboratory al for calibration) 104778 103244 103245 BH9394 (20k)	onal standards, which realize the physic obability are given on the following page y facility: environment temperature (22 : <u>Cal Date (Certificate No.)</u> 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	al units of mea es and are part ± 3)°C and hun So Ap	Br 4-2 asurements (SI). t of the certificate. nidity < 70%. cheduled Calibration
e traceability to natio s with confidence provide the closed laboratory al for calibration) 104778 103244 103245 BH9394 (20k)	obability are given on the following page y facility: environment temperature (22 : <u>Cal Date (Certificate No.)</u> 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	es and are part ± 3)°C and hun Sc Ap Ap	asurements (SI). t of the certificate. nidity < 70%. cheduled Calibration pr-22 pr-22
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104778 103244 103245 BH9394 (20k)	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	Ap Ap	or-22 or-22
104778 103244 103245 BH9394 (20k)	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	Ap Ap	or-22 or-22
103244 103245 BH9394 (20k)	09-Apr-21 (No. 217-03291)	Ap	or-22
103245 BH9394 (20k)	the second se		
BH9394 (20k)	09-Apr-21 (No. 217-03292)	A.e.	22-10
		Ap	1 CC
	09-Apr-21 (No. 217-03343)		or-22
310982 / 06327	09-Apr-21 (No. 217-03344)		or-22
7349	28-Dec-20 (No. EX3-7349_Dec20)		ec-21
601	02-Nov-20 (No. DAE4-601_Nov20)		ov-21
	Check Date (in house)	Sc	cheduled Check
GB39512475	30-Oct-14 (in house check Oct-20)	In	house check: Oct-22
US37292783	07-Oct-15 (in house check Oct-20)	In	house check; Oct-22
MY41092317	07-Oct-15 (in house check Oct-20)	In	house check: Oct-22
100972	15-Jun-15 (in house check Oct-20)	In	house check: Oct-22
US41080477	31-Mar-14 (in house check Oct-20)	In	house check: Oct-21
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a Pokovic	Technical Manager		all
ŧ n	601 GB39512475 US37292783 MY41092317 100972 US41080477 ne dio Leubler	601 02-Nov-20 (No. DAE4-601_Nov20) Check Date (in house) GB39512475 30-Oct-14 (in house check Oct-20) US37292783 07-Oct-15 (in house check Oct-20) MY41092317 07-Oct-15 (in house check Oct-20) 100972 15-Jun-15 (in house check Oct-20) US41080477 31-Mar-14 (in house check Oct-20) ne Function dio Leubler Laboratory Technician	601 02-Nov-20 (No. DAE4-601_Nov20) No Check Date (in house) So GB39512475 30-Oct-14 (in house check Oct-20) In US37292783 07-Oct-15 (in house check Oct-20) In MY41092317 07-Oct-15 (in house check Oct-20) In 100972 15-Jun-15 (in house check Oct-20) In US41080477 31-Mar-14 (in house check Oct-20) In ne Function So dio Leubler Laboratory Technician So

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





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- Servizio svizzero di taratura
- S Swiss Calibration Service

Accreditation No.: SCS 0108

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

Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	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	
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	42.2 ± 6 %	0.92 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	- سبد	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.64 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	1.57 W/kg

Body TSL parameters The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.4 ± 6 %	0.99 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	iner.	

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.51 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.90 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.65 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.52 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	49.9 Ω - 2.9 jΩ	
Return Loss	- 30.7 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.1 Ω - 4.7 jΩ
Return Loss	- 25.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.388 ns	
----------------------------------	----------	--

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

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

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

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 15.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d119

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz; $\sigma = 0.92$ S/m; $\varepsilon_r = 42.2$; $\rho = 1000$ 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: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

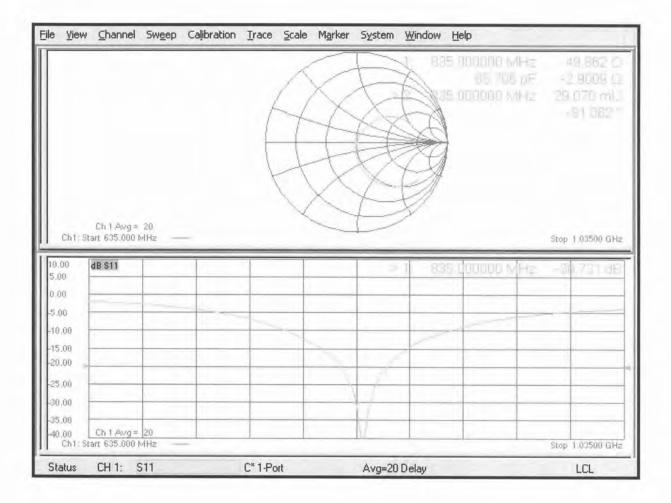
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 63.35 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 3.71 W/kg **SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.57 W/kg** Smallest distance from peaks to all points 3 dB below = 17 mm Ratio of SAR at M2 to SAR at M1 = 65.7% Maximum value of SAR (measured) = 3.27 W/kg



0 dB = 3.27 W/kg = 5.15 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d119

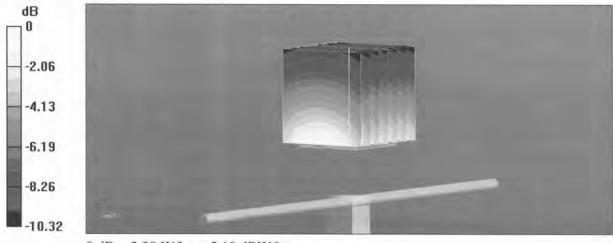
Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz; σ = 0.99 S/m; ϵ_r = 55.4; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.85, 9.85, 9.85) @ 835 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

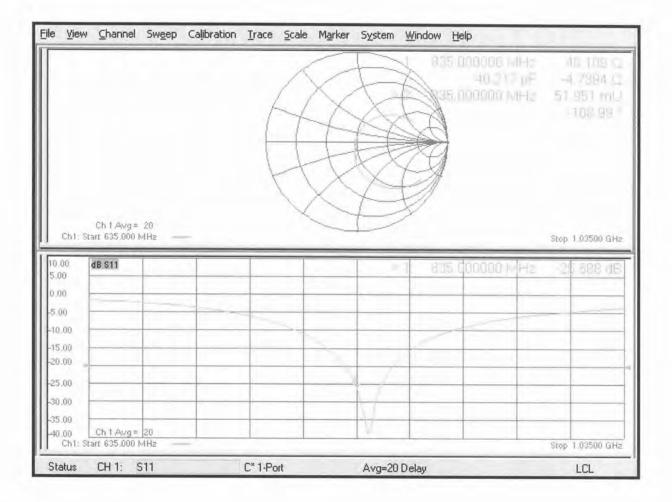
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 58.15 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.66 W/kg SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.65 W/kg Smallest distance from peaks to all points 3 dB below = 16 mm Ratio of SAR at M2 to SAR at M1 = 68.5%Maximum value of SAR (measured) = 3.30 W/kg



0 dB = 3.30 W/kg = 5.19 dBW/kg

Impedance Measurement Plot for Body TSL



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REPAIR REPORT – SPEAG Production Center

PRODUCT:	D835V2 Dipole	IN DATE:	7-A	pr-2021
SERIAL Nr.:	4d119	PRODUC	T Nr.: SA	AAD 083 BB
CUSTOMER:	PC - Test			
MATERIAL	WORK DESCRIPTION			WORKING TIME (h
Dipole Arm:	fixed X exchanged O		. 0	0.50 hours
Dipole Connector:	fixed O exchanged O		. 0	hours
Gold Plating:	fixed O exchanged O		. 0	hours
Housing:	fixed O exchanged O			hours
Disassemble / Clean:	fixed O exchanged O		. 0	hours
	fixed O exchanged O		. 0	hours
**e	fixed O exchanged O		. 0	hours
	fixed O exchanged O		. 0	hours
	fixed O exchanged O		. 0	hours
Analysis:	· · · · · · · · · · · · · · · · · · ·			0.50 hours
Final Assembly:	1			0.50 hours
Total hours	3	1		1.50 hours
	The dipole was returned for during the incoming inspect crack at the feedpoint of dip the feedponit was re-solder dipole will be newly calibrate	ion. A subsequent visi oole arms: In order to r ed. The SMA-connecto	ual inspection e-establish fu	found slightly Ill functionality,
CONDUCTED BY:	15-Apr-2021	APPROVED BY: DATE:		Apr-2021
REPAIR COST: MATERIAL REPAIR:	COST:	USD O	Euro	0
TOTAL COST:	free	QUOTATION Nr		
APPROVED BY:	15-Apr-2021	1.00		A A

860-SAAAD083_4d119_2104151-B.xlsx

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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

Certificate No: D1750V2-1148 May20	Certificate N	: D1750	/2-1148	Mav2	0
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CALIBRATION CERTIFICATE

Object	D1750V2 - SN:11	48	$\sum_{i=1}^{n} \left \left(\left $
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources b	etween 0.7-3 GHz
			BN
Calibration date:	May 12, 2020		BN 6-2-2020 BN 05-13-21
			BN 05-13-21
	=	onal standards, which realize the physical units robability are given on the following pages and a	
All calibrations have been conducte	ad in the closed laborator	ry facility: environment temperature (22 \pm 3)°C a	nd humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 7349	31-Dec-19 (No. EX3-7349_Dec19)	Dec-20
DAE4	SN: 601	27-Dec-19 (No. DAE4-601_Dec19)	Dec-20
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20
	Name	Function	Clanatura
Calibrated by	where the second states we are set	and the second states and the second	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	J. Kotus
Approved by:	Katja Pokovic	Technical Manager	Alle
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory.	Issued: May 13, 2020

Calibration Laboratory of

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





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rvice (SAS) e of the signatories to the EA

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) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 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%.

Accreditation No.: SCS 0108

Measurement Conditions

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

DASY Version	DASY5	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	1750 MHz ± 1 MHz	· · · · · · · · · · · · · · · · · · ·

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.3 ± 6 %	1.35 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	8.88 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	35.9 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	4.69 W/kg

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.1 ± 6 %	1.47 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	······
SAR measured	250 mW input power	8.98 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	36.3 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	4.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	19.3 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	49.2 Ω - 1.9 jΩ
Return Loss	- 33.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.0 Ω - 1.7 jΩ
Return Loss	- 25.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.222 ns

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

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

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

Additional EUT Data

Manufactured by		SPEAG

DASY5 Validation Report for Head TSL

Date: 12.05.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1148

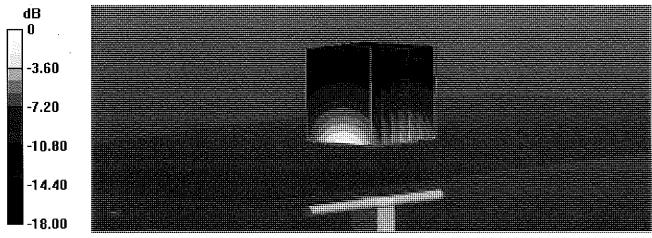
Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz; σ = 1.35 S/m; ϵ_r = 40.3; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.76, 8.76, 8.76) @ 1750 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 105.6 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 16.4 W/kg **SAR(1 g) = 8.88 W/kg; SAR(10 g) = 4.69 W/kg** Smallest distance from peaks to all points 3 dB below = 10 mm Ratio of SAR at M2 to SAR at M1 = 54.4% Maximum value of SAR (measured) = 13.8 W/kg



0 dB = 13.8 W/kg = 11.40 dBW/kg

Impedance Measurement Plot for Head TSL

File	⊻iew	⊆hannel	Sw <u>e</u> ep	Calibration	<u>Irace S</u> ca	ale M <u>a</u> rker	System	Window	Help			
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DASY5 Validation Report for Body TSL

Date: 12.05.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1148

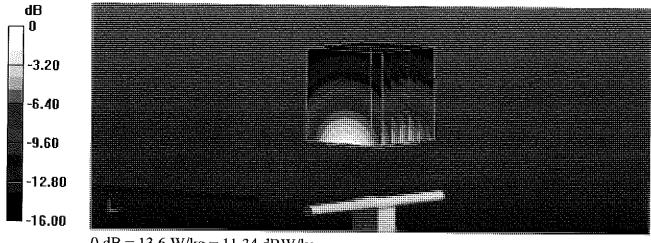
Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz; $\sigma = 1.47$ S/m; $\epsilon_r = 54.1$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.61, 8.61, 8.61) @ 1750 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 99.95 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 16.1 W/kg **SAR(1 g) = 8.98 W/kg; SAR(10 g) = 4.8 W/kg** Smallest distance from peaks to all points 3 dB below = 10 mm Ratio of SAR at M2 to SAR at M1 = 57.1% Maximum value of SAR (measured) = 13.6 W/kg



Impedance Measurement Plot for Body TSL

<u>File V</u> iev	v <u>C</u> hannel Sw <u>e</u> er	o Calibration	<u>T</u> race <u>S</u> cal	e M <u>a</u> rker	S <u>v</u> stem	<u>W</u> indow (Help			
	Ch 1 Avg = 20		A	XXX		A.	.750000 c 54.542 .750000 c	2 pF	45.048 -1.6674 54.971 m -160.39	Ω U
Cht:	Start 1.55000 GHz -						<u></u>		Stop 1.95000 G	Hz
10.00 5.00 6.00 -5.00 -10.00 -15.00 -20.00 -25.00 -30.00					3		.750000 C	Hz	-25.197 d	
-35.00 -40.00 Ch1: :	Ch I Avg = 20 Start 1.55000 GHz -								Stop 1.95000 GI	





Certification of Calibration

Object

D1750V2 - SN: 1148

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

05/12/2021

Extension Calibration date:

Description:

SAR Validation Dipole at 1750 MHz.

Calibration Equipment used:

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Control Company	4040	Therm./Clock/Humidity Monitor	6/29/2019	Biennial	6/29/2021	192291470
Control Company	4353	Long Stem Thermometer	10/28/2020	Biennial	10/28/2022	200670623
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433971
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Agilent	85033E	3.5mm Standard Calibration Kit	6/6/2020	Annual	6/6/2021	MY53402352
Rohde & Schwarz	ZNLE6	Vector Network Analyzer	9/29/2020	Annual	9/29/2021	101307
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/12/2020	Annual	5/12/2021	1070
Anritsu	MA2411B	Pulse Power Sensor	8/12/2020	Annual	8/12/2021	1207364
Anritsu	MA2411B	Pulse Power Sensor	9/22/2020	Annual	9/22/2021	1315051
Anritsu	ML2495A	Power Meter	11/3/2020	Annual	11/3/2021	1039008
Anritsu	ML2495A	Power Meter	1/18/2021	Annual	1/18/2022	941001
Agilent	N5182A	MXG Vector Signal Generator	5/13/2020	Annual	5/13/2021	MY47420603
Pasternack	NC-100	Torque Wrench	8/4/2020	Biennial	8/4/2022	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
MiniCircuits	ZHDC-16-63-S+	Bidirectional Coupler	CBT	N/A	CBT	N/A
SPEAG	EX3DV4	SAR Probe	10/20/2020	Annual	10/20/2021	7551
SPEAG	DAE4	Dasy Data Acquisition Electronics	10/16/2020	Annual	10/16/2021	1333

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

	Name	Function	Signature
Calibrated By:	Hyun Kim	Test Engineer	Hyun Kim
Approved By:	Kaitlin O'Keefe	Senior Technical Manager	KOK

DIPOLE CALIBRATION EXTENSION

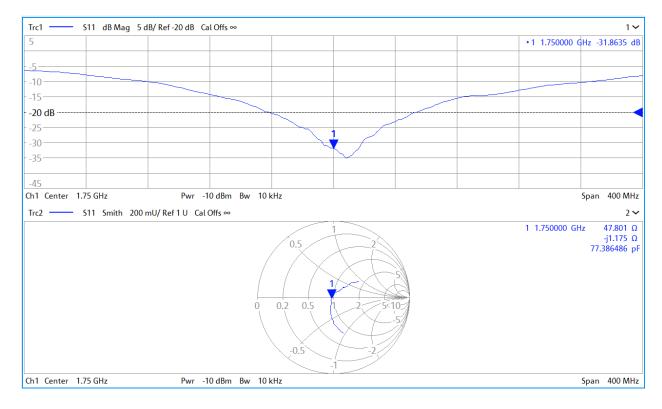
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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

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

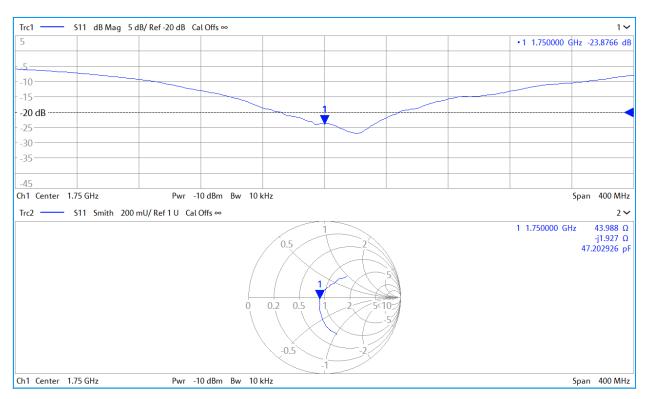
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Head (1g) W/kg @ 20.0 dBm	Measured Head SAR (1g) W/kg @ 20.0 dBm		Certificate SAR Target Head (10g) W/kg @ 20.0 dBm	(10a) W/ka @	Deviation 10g (%)	Certificate Impedance Head (Ohm) Real	Measured Impedance Head (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head (Ohm) Imaginary	Measured Impedance Head (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Head (dB)	Measured Return Loss Head (dB)	Deviation (%)	
5/12/2021	5/12/2021	1.222	3.59	3.48	-3.06%	1.89	1.85	-2.12%	49.2	47.8	1.4	-1.9	-1.2	0.7	-33.6	-31.9	5.20%	PASS
Calibration Date	Extension Date	Certificate Electrical Delay (ns)	Certificate SAR Target Body (1g) W/kg @ 20.0 dBm	Measured Body SAR (1g) W/kg @ 20.0 dBm			(10a) W/ka @	Deviation 10g (%)	Certificate Impedance Body (Ohm) Real	Measured Impedance Body (Ohm) Real	Difference (Ohm) Real	Certificate Impedance Body (Ohm) Imaginary	Measured Impedance Body (Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate Return Loss Body (dB)	Measured Return Loss Body (dB)	Deviation (%)	PASS/FAIL
5/12/2021	5/12/2021	1.222	3.63	3.84	5.79%	1.93	2.02	4.66%	45.0	44.0	1	-1.7	-1.9	0.2	-25.2	-23.9	5.30%	PASS

Object:	Date Issued:	Page 2 of 4
D1750V2 – SN: 1148	05/12/2021	Fage 2 014



Impedance & Return-Loss Measurement Plot for Head TSL

Object:	Date Issued:	Page 3 of 4
D1750V2 – SN: 1148	05/12/2021	Fage 5 01 4



Impedance & Return-Loss Measurement Plot for Body TSL

Object:	Date Issued:	Page 4 of 4
D1750V2 – SN: 1148	05/12/2021	Faye 4 01 4

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PC Test

Client

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Certificate No: D1900V2-5d080_Oct21

Object	D1900V2 - SN:50	1080	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz √
			between 0.7-3 GHz V BNI II-0A-2
Calibration date:	October 22, 2021		IFON
This calibration certificate documer	nts the traceability to natio	onal standards, which realize the physical uni	ts of measurements (SI)
		robability are given on the following pages an	
			· ·
NI calibrations have been conducted	ed in the closed laborator	y facility: environment temperature (22 ± 3)°C	C and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
rimary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
ower meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
ower sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Арг-22
ower sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	A pr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
ype-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
oference Broke EV2DV/4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20)	Dec-21
Reference Probe EX3DV4		02-Nov-20 (No. DAE4-601_Nov20)	N
	SN: 601	024100-20 (110, DAE4-001_110020)	Nov-21
AE4	SN: 601	,	
AE4 econdary Standards		Check Date (in house)	Scheduled Check
AE4 econdary Standards ower meter E4419B	ID #	Check Date (in house) 30-Oct-14 (in house check Oct-20)	Scheduled Check In house check: Oct-22
AE4 econdary Standards ower meter E4419B ower sensor HP 8481A	ID # SN: GB39512475	Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Scheduled Check In house check: Oct-22 In house check: Oct-22
AE4 econdary Standards ower meter E4419B ower sensor HP 8481A ower sensor HP 8481A	ID # SN: GB39512475 SN: US37292783	Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
DAE4 Gecondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	ID # SN: GB39512475 SN: US37292783 SN: MY41092317	Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Scheduled Check In house check: Oct-22 In house check: Oct-22
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	ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20)	Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
DAE4 Gecondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20)	Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
AE4 econdary Standards ower meter E4419B ower sensor HP 8481A ower sensor HP 8481A F generator R&S SMT-06 letwork Analyzer Agilent E8358A	ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 Name	Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20) Function	Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22



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Accreditation No.: SCS 0108

S Swiss Calibration Service

Calibration Laboratory of

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- S Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled ٠ 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	<u></u>
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	40.4 ± 6 %	1.40 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	10.1 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	40.5 W/kg ± 17.0 % (k=2)	
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition		
SAR averaged over 10 cm ^o (10 g) of Head ISL SAR measured	condition 250 mW input power	5.26 W/kg	

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.4 ± 6 %	1.48 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.30 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.4 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	51.3 Ω + 6.3 jΩ
Return Loss	- 24.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.6 Ω + 6.7 jΩ
Return Loss	- 22.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.192 ns

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

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

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

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 20.10.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d080

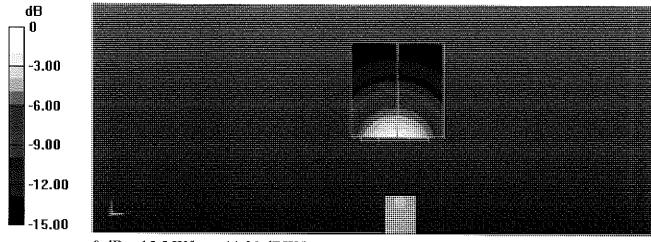
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; $\sigma = 1.4$ S/m; $\epsilon_r = 40.4$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.43, 8.43, 8.43) @ 1900 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 110.3 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 18.6 W/kg **SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.26 W/kg** Smallest distance from peaks to all points 3 dB below = 10 mm Ratio of SAR at M2 to SAR at M1 = 55.1% Maximum value of SAR (measured) = 15.5 W/kg



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

Impedance Measurement Plot for Head TSL

.

<u>File Vi</u>	ew <u>C</u> hannel	Sw <u>e</u> ep C	alibration	<u>T</u> race <u>S</u> cale	M <u>a</u> rker	S <u>y</u> stem	Window	Help	
								1.900000 GHz 527.70 pH 1.900000 GHz	51.286 Ω 8.2997 Ω 63.357 mU 74.907 °
Ch1	Ch 1 Avg = : Start 1.70000 (20 3Hz			····-				Stop 2.10000 GHz
10.00 5.00 -5.00 -10.00 -15.00 -20.00 -25.00 -30.00 -35.00 -40.00 Ch1	IB S11 Image: Start 1.70000 ft CH 1:	GHz		C* 1-Port		>		1.90000 CHz	-23.984 dB

DASY5 Validation Report for Body TSL

Date: 22,10,2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d080

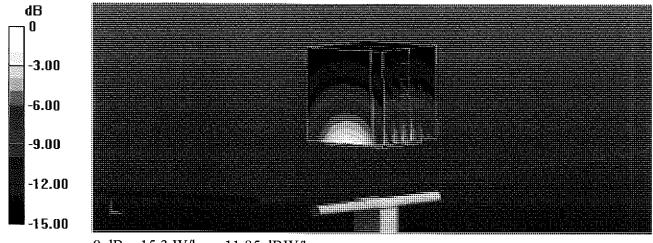
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; $\sigma = 1.48$ S/m; $\epsilon_r = 53.4$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.42, 8.42, 8.42) @ 1900 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 104.7 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 18.3 W/kg **SAR(1 g) = 10.0 W/kg; SAR(10 g) = 5.30 W/kg** Smallest distance from peaks to all points 3 dB below = 9.2 mm Ratio of SAR at M2 to SAR at M1 = 56% Maximum value of SAR (measured) = 15.3 W/kg



0 dB = 15.3 W/kg = 11.85 dBW/kg

Impedance Measurement Plot for Body TSL

564.91 pH 8.74 2. 1.900000 GHz 77.848	
Ch 1 Avg = 20	
Ch1: Start 1,70000 GHz Stop 2,100	JQ GHz
10.00 30.00 > 1 1.908000 CHz -22.17 0.00 -0.00 -0.00 -0.00 -0.00 -10.00 -0.00 -0.00 -0.00 -0.00 -20.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -30.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -25.00 -0.00 -0.00 -0.00 -0.00 -20.00 -0.00 -0.00 -0.00 -0.00 -20.00 -0.00 -0.00 -0.00 -0.00 -20.00 -0.00 -0.00 -0.00 -0.00 -20.00	

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Accreditation No.: SCS 0108

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PC Test Client

Certificate No: D2450V2-719_Aug21

IBRATION CERTIFICATE CAL

Object	D2450V2 - SN:71	9	
Calibration procedure(s)	QA CAL-05.v11	dure for SAR Validation Sources	hetween 0.7-3 GHz
	Calibration Floce	dure for SATT validation Sources	
			BN
			1)1 .
Calibration date:	August 18, 2021		BN' 9-3-202
		onal standards, which realize the physical uni	
he measurements and the uncerta	ainties with confidence p	robability are given on the following pages an	d are part of the certificate.
		(2
All calibrations have been conducte	ed in the closed laborator	ry facility: environment temperature (22 \pm 3)°C	c and humidity < 70%.
	- evitical fay calibration)		
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21
	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	tole
			1 ve
	Katja Pokovic	Technical Manager	Re
Approved by:			may
Approved by:			Issued: August 18, 2021

Calibration Laboratory of

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





Schweizerischer Kalibrierdienst

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S **Swiss Calibration Service**

Accreditation No.: SCS 0108

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
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	37.9 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	55.0 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	6.53 W/kg

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.0 ± 6 %	2.03 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	52.0 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.7 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	55.9 Ω + 6.0 jΩ	
Return Loss	- 22.0 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.3 Ω + 8.4 jΩ	
Return Loss	- 21.5 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 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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DASY5 Validation Report for Head TSL

Date: 17.08.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:719

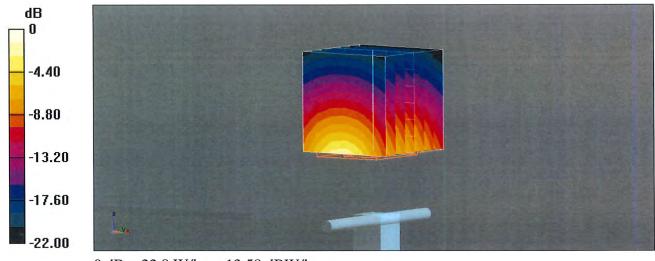
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 1.87 S/m; ϵ_r = 37.9; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

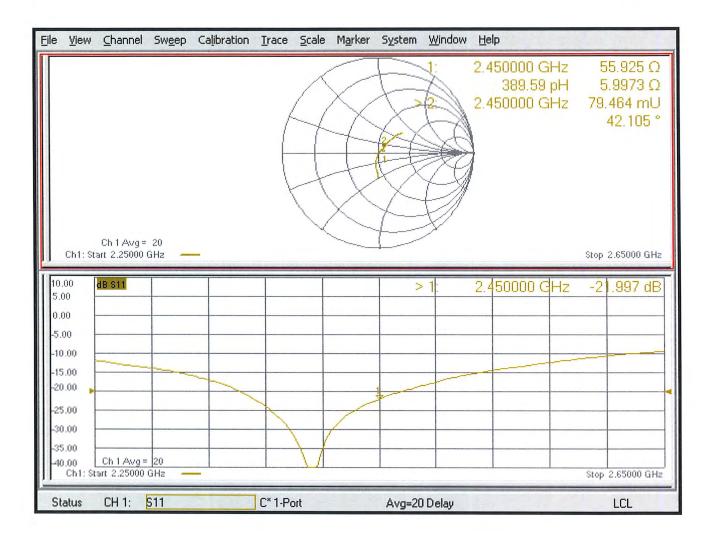
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 119.5 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 28.1 W/kg SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.53 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 50.5% Maximum value of SAR (measured) = 22.8 W/kg



0 dB = 22.8 W/kg = 13.58 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 18.08.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:719

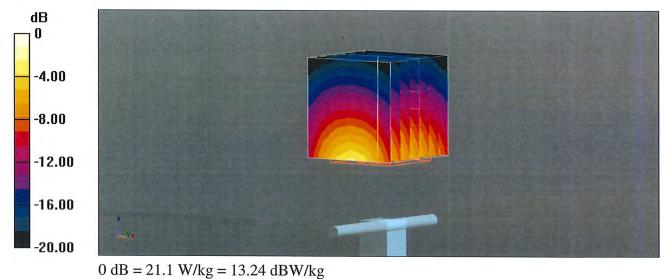
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 2.03 S/m; ϵ_r = 52; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

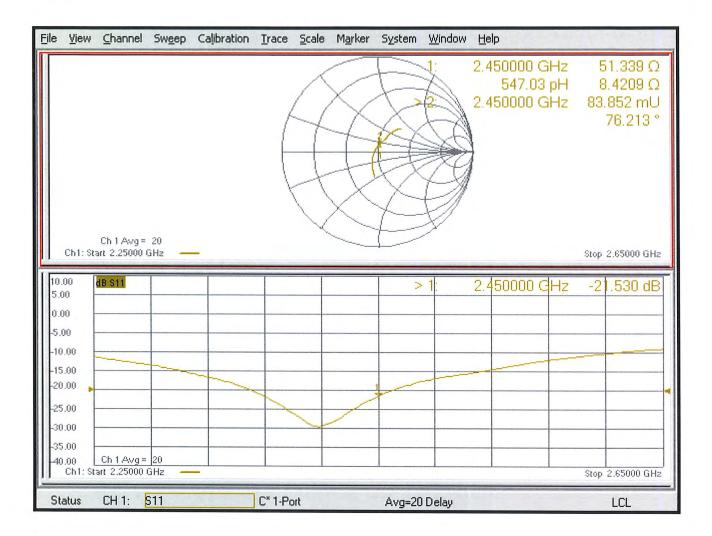
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 111.3 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 24.8 W/kg **SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.26 W/kg** Smallest distance from peaks to all points 3 dB below = 8.2 mm Ratio of SAR at M2 to SAR at M1 = 54.6% Maximum value of SAR (measured) = 21.1 W/kg



 $0 \text{ d} \mathbf{D} = 21.1 \text{ W/kg} = 15.24 \text{ d} \mathbf{D} \text{ W}$

Impedance Measurement Plot for Body TSL



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



Schweizerischer Kalibrierdienst Service suisse d'étalonnage

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S Swiss Calibration Service

S

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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 PC Test

Certificate No: D2600V2-1004_Apr21

CALIBRATION CERTIFICATE	
CALIBRATION CERTIFICATE	
CALIBRATION CENTIFICATE	リョミーニー・ハョミー

Object	D2600V2 - SN:10	04	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz
			BNV 4-27-202
Calibration date:	April 14, 2021		4-27-202
		onal standards, which realize the physical uni robability are given on the following pages and	. ,
All calibrations have been conducte	ed in the closed laborator	y facility: environment temperature (22 \pm 3)°C	c and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21
	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	J. Life
Approved by:	Katja Pokovic	Technical Manager	lag
		full without written approval of the laboratory.	lssued: April 14, 2021

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:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	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	37.5 ± 6 %	2.03 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.8 W/kg ± 17.0 % (k=2)
	T	
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	6.52 W/kg

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.0 ± 6 %	2.22 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	14.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	55.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.8 W/kg ± 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.9 Ω - 4.8 jΩ
Return Loss	- 26.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.9 Ω - 3.6 jΩ
Return Loss	- 25.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction) 1.150 ns	Electrical Delay (one direction)	1.150 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG	

DASY5 Validation Report for Head TSL

Date: 14.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1004

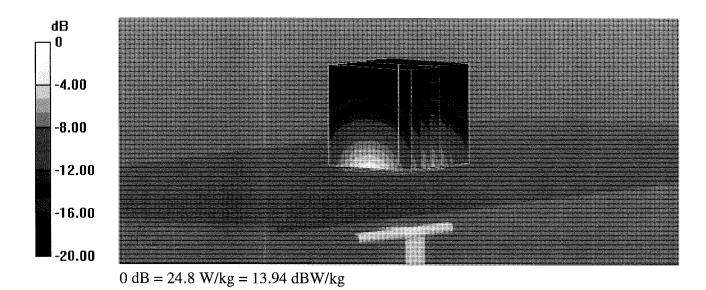
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz; σ = 2.03 S/m; ϵ_r = 37.5; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 120.6 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 29.8 W/kg SAR(1 g) = 14.8 W/kg; SAR(10 g) = 6.52 W/kg Smallest distance from peaks to all points 3 dB below = 8.5 mm Ratio of SAR at M2 to SAR at M1 = 49.5% Maximum value of SAR (measured) = 24.8 W/kg



Impedance Measurement Plot for Head TSL

File	<u>V</u> iew	Channel	Sw <u>e</u> ep	Calibration	<u>T</u> race <u>S</u> cale	M <u>a</u> rker	S <u>y</u> stem	<u>W</u> indow	Help				
										10000 G 12.743 10000 G	рF	-4. 49.	8.885 Ω 8038 Ω 812 mU 100.28 °
	Ch1: St	Ch 1 Avg = art 2,40000				``I						Stop :	2,80000 GHz
-15 -20 -25 -30 -35)0)0 ,00 ,00 ,00 ,00 ,00	dB S11	= 20 GHz				>		2.60				i.053 dB
St	atus	CH 1:	S11		C* 1-Port		Avg=20	Delay					LCL

DASY5 Validation Report for Body TSL

Date: 14.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1004

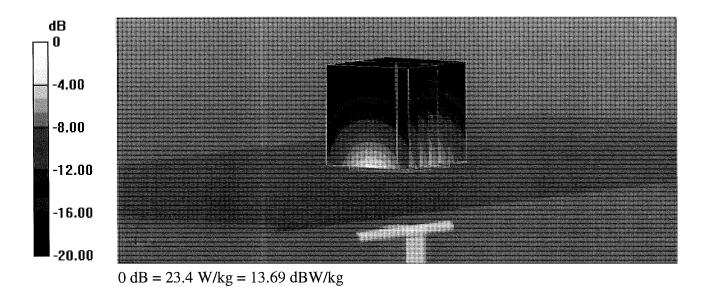
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz; σ = 2.22 S/m; ϵ_r = 51.0; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.91, 7.91, 7.91) @ 2600 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 111.6 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 28.1 W/kg **SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.26 W/kg** Smallest distance from peaks to all points 3 dB below = 8.2 mm Ratio of SAR at M2 to SAR at M1 = 51% Maximum value of SAR (measured) = 23.4 W/kg



Impedance Measurement Plot for Body TSL

File	⊻iew	<u>C</u> hannel	Sw <u>e</u> ep	Ca <u>l</u> ibration	<u>T</u> race <u>S</u> cale	M <u>a</u> rker	System	<u>W</u> indow	Help			
					A				2.600000 G 17.056 2.600000 C	i pF	-3.58 56.543	4
	Ch1: St	Ch 1 Avg = art 2.40000		31940							Stop 2.800	100 GHz
-15 -20 -25 -30 -35	00 - 00 00 - 00 00, - 00, - 00, - 00, - 00, - 00, -	<u>AB S11</u> <u>Ch 1 Avg =</u> art 2,40000	20 GHz						2.600000 (Hz	-24.95	
St	atus	CH 1:	S11		C* 1-Port		Avg=20	Delay			LCI	