

Appendix C

Phantom Description

Schmid & Panner Engin	eering AG	S	p	e	a	g	1
Zeughausstrases 43, 80 Phone +41 1 245 9700, Info G eoreg corn. http://	Fax +41 1 245 9779						
	onformity / First Article In						
item	SAM Twin Phantom V	4.0	_				_
Type No.	QD 000 P40 C						
Series No	TP-1150 and higher						
In The Dates of Street and Designation of the Owner of Street and Designation of Street and Desi	the second se						

Type No	QD 000 P40 C
Series No	TP-1150 and higher
Manufacturer	SPEAG Zeughausstrasse 43 CH-8004 Zürich Switzerland

Tests

The series production process used allows the imitation to test of first articles. Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the sories first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series items (dalled samples) or are tested at each item.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness of shell	Compliant with the requirements according to the standards	2mm +/- 0.2mm in flat and specific areas of head section	First article, Samples, TP-1314 ff,
Material thickness at ERP	Compliant with the requirements according to the standarda	6mm +/- 0.2mm at ERP	First article, All items
Material parameters	Dielectric parameters for required Mequancies	300 MHz - 0 GHz; Relative permittivity < 5. Loss tangent < 0.05	Material samples
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe technical Note for material compatibility.	DEGMBE based simulating liquids	Pre-series, First article, Material samples
Sagging	Compliant with the requirements according to the standards. Sagging of the flat section when filled with tissue simulating figuid	< 1% typical < 0.6% if filed with 155mm of HSL900 and without OUT below	Prototypes, Sample testing

Standards

- 日間の時代
- CENELEC EN 50361 IEEE Std 1528-2003
- IEC 62209 Part 1
- FCC OET Builetin 65, Supplement C, Edition 01-01 The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standards [1] to [4]

07.07.2005

1000		
Date		

Signature / Stamp

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System Validation from Original Equipment Supplier

ccredited by the Swiss Accreditation he Swiss Accreditation Service i ultilateral Agreement for the rec lient SGS-TW (Auden			
lient SGS-TW (Auden		s to the EA	creditation No.: SCS 0108
the state of the s	i)	Certificate No	D750V3-1015_Aug19
CALIBRATION CI	ERTIFICATE		
Dbject	D750V3 - SN:10	15	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	edure for SAR Validation Sources	between 0.7-3 GHz
	Gansiation 1000		Domoon 0.7-0 Ciriz
Calibration date:	August 23, 2019		
Calibration Equipment used (M&TE	E critical for calibration)		
Primary Standards Power meter NRP	SN: 104778	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893)	Scheduled Calibration Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
	SN: 103245	03-Apr-19 (No. 217-02893)	
Power sensor NRP-Z91	314. 103245		Apr-20
	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20 Apr-20
Reference 20 dB Attenuator Type-N mismatch combination	SN: 5058 (20k) SN: 5047.2 / 06327		
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. EX3-7349_May19)	Apr-20 Apr-20 May-20
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 5058 (20k) SN: 5047.2 / 06327	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895)	Apr-20 Apr-20
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. EX3-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. EX3-7349_May19) 30-Apr-19 (No. EX4-7349_May19) Check Date (in house) 30-Oct-14 (in house check Feb-19)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. EX3-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary <u>Standards</u> Power sensor HP 8481A Power sensor HP 8481A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: G839512475 SN: US37292783 SN: WY41092317	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. CX5-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Cot-20 In house check: Cot-20 In house check: Cot-20
Reference 20 dB Attenuator Type-N mismatch combination Telerence Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. DA54-601_Apr19) 30-Apr-19 (No. DA54-601_Apr19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Reference 20 dB Attenuator Type-N mismatch combination Telerence Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	SN: 5058 (20k) SN: 5047.2.705327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: W141082317 SN: 100972 SN: US41080477	04-Apr-19 (No. 217-0284) 04-Apr-19 (No. 217-0284) 29-May-19 (No. 2X3-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house) 30-Oct-14 (in house check Reh-19) 07-Oct-15 (in house check Cot-18) 15-Jun-15 (in house check Cot-18) 31-Mar-14 (in house check Cot-18)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-19
Reference 20 dB Attenuator Type-N mismatch combination Reference Frobe EX8DV4 DAE4 Secondary Standards Power meter E44198 Power sensor HP 8481A Power sensor HP 8481A Re generator RES SMT-06 Network Analyzer Agitent E8358A	SN: 5058 (20k) SN: 5047 2 / 06327 SN: 7349 SN: 6B39512475 SN: US37292783 SN: 10537292783 SN: 10492317 SN: 100972 SN: US41080477 Name	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. DX2-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-18) 31-Mar-14 (in house check Oct-18)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power somor NRP-291 Reference 20 48 Attenuator Type-N mismatch combination Reference Probe EX8DV4 DDE4 Secondary Standards Power meter E44198 Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by:	SN: 5058 (20k) SN: 5047.2.705327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: W141082317 SN: 100972 SN: US41080477	04-Apr-19 (No. 217-0284) 04-Apr-19 (No. 217-0284) 29-May-19 (No. 2X3-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house) 30-Oct-14 (in house check Reh-19) 07-Oct-15 (in house check Cot-18) 15-Jun-15 (in house check Cot-18) 31-Mar-14 (in house check Cot-18)	Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-19

Certificate No: D750V3-1015_Aug19

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Calibration Laboratory of Schmid & Partner Engineering AG



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Accreditation No.: SCS 0108

credited 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) 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 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 c)
- 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%.

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Measurement Conditions

DASY Version	DASY5	V52.10.2
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	42.7 ± 6 %	0.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.60 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	1.42 W/kg

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.1 Ω - 0.6 jΩ
Return Loss	- 30.4 dB

1.037 ns

General Antenna Parameters and Design

Electrical Delay (one direction)

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force more the 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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Date: 23.08.2019

DASY5 Validation Report for Head TSL

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1015

Communication System: UID 0 - CW; Frequency: 750 MHz Medium parameters used: $f=750~MHz;\,\sigma=0.9~S/m;\,\epsilon_e=42.7;\,\rho=1000~kg/m^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

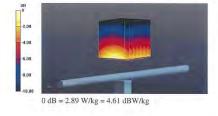
DASY52 Configuration

- Probe: EX3DV4 SN7349; ConvF(10.07, 10.07, 10.07) @ 750 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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 = 59.91 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 3.25 W/kg SAR(1 g) = 2.16 W/kg; SAR(10 g) = 1.42 W/kg

Maximum value of SAR (measured) = 2.89 W/kg





Certificate No: D750V3-1015_Aug19

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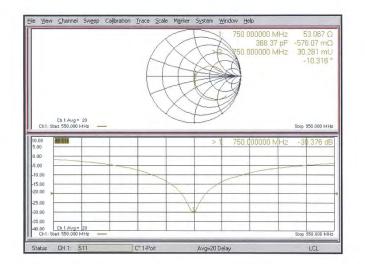
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Impedance Measurement Plot for Head TSL



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Client SGS-TW (Auder	ר)	Certificate N	o: D835V2-4d063_Aug19
CALIBRATION C	ERTIFICATE		
Object	D835V2 - SN:4d	063	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	edure for SAR Validation Sources	s between 0.7-3 GHz
Calibration date:	August 23, 2019	(1)	
All calibrations have been conduct Calibration Equipment used (M&TE		ry facility: environment temperature (22 \pm 3)°	C and humidity < 70%.
Calibration Equipment used (M&TE Primary Standards		ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.)	C and humidity < 70%. Scheduled Calibration
Calibration Equipment used (M&TE Primary Standards Power meter NRP	E critical for calibration)		
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-291	E critical for calibration)	Cal Date (Certificate No.) 03-Apr-18 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892)	Scheduled Calibration
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893)	Scheduled Calibration Apr-20 Apr-20 Apr-20
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Altenuator	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20
Calibration Equipment used (M&TE Primary Standards Power meter NRP- Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Altenuator Type-N mismatch combination	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Apr-20
Calibration Equipment used (M&TE Primary Standards Power neter NRP Power sensor NRP-201 Power sensor NRP-201 Reference 70 dB Alternuator Type-N mismatch combination Reference Prote EX30V4	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20
Calibration Equipment used (M&TE Primary Standards Power renter NRP Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	Critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) ID #	Cal Date (Certificate No.) 03-Apr.19 (No. 217-02892/02893) 03-Apr.19 (No. 217-02892) 03-Apr.19 (No. 217-02892) 04-Apr.19 (No. 217-02895) 04-Apr.19 (No. 217-02895) 29-May.19 (No. 523-7349, May18)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20
Calibration Equipment used (M&TE Primary Standards Power meter NRP Powers ensor NRP-Z91 Powers ensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	E critical for calibration) ID # SN: 103245 SN: 103245 SN: 503245 SN: 5047.2 / 06327 SN: 5349 SN: 601 ID # SN: 6B39512475	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895) 29-May-19 (No. 217-02895) 30-Apr-19 (No. DAE4-601, Apr19) Check Date (in house) 30-Oct-14 (in house check Feb-19)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check Oct-20
Calibration Equipment used (M&TE Primary Standards Power meater NRP Power sonsor NRP-Z91 Reference 20 dB Altenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power metor E419B Power sensor HP 4847A	E ortical for calibration) ID # SN: 104778 SN: 103244 SN: 5056 (20k) SN: 5067.2 / 06327 SN: 5047.2 / 06327 SN: 601 ID # SN: 6830512475 SN: US37292783	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02895) 29-May-19 (No. 217-02895) 39-May-19 (No. 2K3-7349, May19) 30-Apr-19 (No. DAE4-601, Apr19) Check Date (in house) 07-021-15 (in house check Feb-19) 07-021-15 (in house check Fcb-19)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20 May-20 Scheduled Check In house check: Oct-20 In house check: Oct-20
Calibration Equipment used (M&TE Primary Standards Power relater NRP Power sensor NRP-291 Reference 20 48 Attenuator Reference 20 48 Attenuator Reference Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 8481A Power sensor HP 8481A	E critical for calibration) 1D # SN: 103244 SN: 103244 SN: 103245 SN: 5047.2 / 06327 SN: 5047.2 / 06327 SN: 5047.2 / 06327 SN: 5047.2 / 06327 SN: 6830512475 SN: U\$37292783 SN: W741092317	Cal Date (Certificate No.) (3-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 04-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02894) 29-May-19 (No. 217-02895) 29-May-19 (No. 224-049) 30-Apr-19 (No. DAE4-601, Apr19) Check Date (in house) 30-Oct-14 (in house check Cet-18) 07-Oct-15 (in house check Cct-18)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20 Scheduled Check In house check: Oct-20 In house check: Oct-20
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-I mismatch combination Reference Probe EX3DV4 DAE4 Secondary End4188 Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 5058 (20k) SN:	Cal Date (Certificate No.) 03-Apr.19 (No. 217-02892/02893) 03-Apr.19 (No. 217-02892) 03-Apr.19 (No. 217-02892) 04-Apr.19 (No. 217-02893) 04-Apr.19 (No. 217-02895) 29-May.19 (No. EX7-3249, JMay19) 30-Apr.19 (No. EX7-3249, JMay19) 30-Apr.	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-I mismatch combination Reference Probe EX3DV4 DAE4 Secondary End4188 Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 5058 (20k) SN: 1037292783 SN: W37292783 SN: W3729783 SN: W372978 SN: W3729783 SN: W3729785 SN: W3729785 SN: W3729785 SN: W37297785 SN: W37297785 SN: W3729778	Cal Date (Certificate No.) (3-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 04-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02894) 29-May-19 (No. 217-02895) 29-May-19 (No. 224-049) 30-Apr-19 (No. DAE4-601, Apr19) Check Date (in house) 30-Oct-14 (in house check Cet-18) 07-Oct-15 (in house check Cct-18)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20 Scheduled Check In house check: Oct-20 In house check: Oct-20
Calibration Equipment used (M&TE Primary Standards Power melet NRP Power sensor NRP-Z91 Reference 20 dB Altenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power metor E44198 Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Reg generator R&S SMT-06 Network Analyzer Agitent E8358A	E ortilcal for calibration) ID # SN: 104778 SN: 103244 SN: 50647.27 06327 SN: 50647.27 06327 SN: 5047.27 06327 SN: 7349 SN: 601 ID # SN: 6839512475 SN: US37292783 SN: W741092317 SN: W741092317 SN: US41080477 Name	Cal Date (Certificate No.) (3-Apr-19 (No. 217-02892/02893) (33-Apr-19 (No. 217-02892) (33-Apr-19 (No. 217-02893) (4-Apr-19 (No. 217-02896) (29-May-19 (No. 217-02896) (29-May-19 (No. 2K3-7349, May19) (30-Apr-19 (No. 2K3-744, May19) (31-Apr-19 (No. 2K3-74	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Celibration Equipment used (M&T1 Primary Standards Power melor NRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary StrE4418 Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 5058 (20k) SN: 1037292783 SN: W37292783 SN: W3729783 SN: W372978 SN: W3729783 SN: W3729785 SN: W3729785 SN: W3729785 SN: W37297785 SN: W37297785 SN: W3729778	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02894) 04-Apr-19 (No. DA54-601 Apr19) 30-Apr-19 (No. DA54-601 Apr19) Check Date (in house) 30-Oct-14 (in house check Fob-19) 07-Oct-15 (in house check Fob-19) 07-Oct-15 (in house check Cot-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-18)	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20
Calibration Equipment used (M&TH Primary Standards Powar meter NRP Powar sensor NRP-Z91 Reference 20 dB Altenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Powar meter E4419B Powar sensor HP 8481A Powar sensor HP 8481A Reg generator R&S SMT-06 Network Analyzer Agitent E8358A	E ortilcal for calibration) ID # SN: 104778 SN: 103244 SN: 50647.27 06327 SN: 50647.27 06327 SN: 5047.27 06327 SN: 7349 SN: 601 ID # SN: 6839512475 SN: US37292783 SN: W741092317 SN: W741092317 SN: US41080477 Name	Cal Date (Certificate No.) (3-Apr-19 (No. 217-02892/02893) (33-Apr-19 (No. 217-02892) (33-Apr-19 (No. 217-02893) (4-Apr-19 (No. 217-02896) (29-May-19 (No. 217-02896) (29-May-19 (No. 2K3-7349, May19) (30-Apr-19 (No. 2K3-744, May19) (31-Apr-19 (No. 2K3-74	Scheduled Calibration Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 May-20 Apr-20 Scheduled Check In house check: Oct-20 In house check: Oct-20

Certificate No: D835V2-4d063_Aug19

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editation 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) 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: Weasurement 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 6.612", June 2016
 - 300 MHz to 6 GHz)", July 2016 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 c)
 - 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%.

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Measurement Conditions

DASY Version	DASY5	V52.10.2
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

the bada. The second seco	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	42.5 ± 6 %	0.92 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	2.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.57 W/kg ± 17.0 % (k=2)
SAB 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

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.6 Ω - 2.2 jΩ
Return Loss	- 32.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction) 1.391 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 leedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured by	SPEAG

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Date: 23.08.2019

DASY5 Validation Report for Head TSL

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d063

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz; $\sigma = 0.92$ S/m; $\epsilon_r = 42.5$; $\rho = 1000$ kg/m³ Phantom section: Flat Section

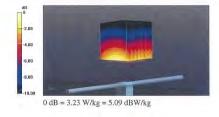
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.89, 9.89, 9.89) @ 835 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601: Calibrated: 30.04.2019
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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 = 63.04 V/m; Power Drift = -0.00 dB

 $\begin{array}{l} \mbox{Peak SAR (extrapolated)} = 3.64 \ \mbox{W/kg} \\ \mbox{SAR(1 g)} = 2.42 \ \mbox{W/kg}; \mbox{SAR(10 g)} = 1.57 \ \mbox{W/kg} \end{array}$ Maximum value of SAR (measured) = 3.23 W/kg



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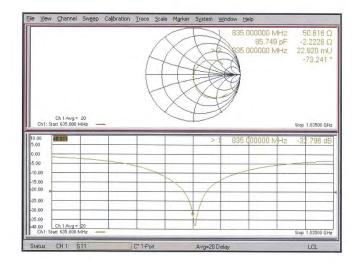
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Impedance Measurement Plot for Head TSL



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CALIBRATION (CERTIFICATE		
Dbject	D1900V2 - SN:50	1173	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	April 23, 2019		
The measurements and the unc All calibrations have been condu	certainties with confidence p ucted in the closed laborato	ional standards, which realize the physical un robability are given on the following pages an ry facility: environment temperature $(22 \pm 3)^{\circ}($	d are part of the certificate.
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Calibration Laboratory of Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland



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Swiss Calibration Service

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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) 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%.

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Measurement Conditions

DASY Version	DASY5	V52.10.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

3 -	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	40.6 ± 6 %	1.38 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	9.92 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	5.22 W/kg

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.3 Ω + 5.1 jΩ
Return Loss	- 25.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.201 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: 23.04.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d173

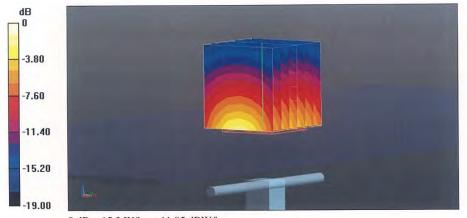
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; σ = 1.38 S/m; ϵ_r = 40.6; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.26, 8.26, 8.26) @ 1900 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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 = 110.1 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 18.1 W/kg SAR(1 g) = 9.92 W/kg; SAR(10 g) = 5.22 W/kg Maximum value of SAR (measured) = 15.3 W/kg



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

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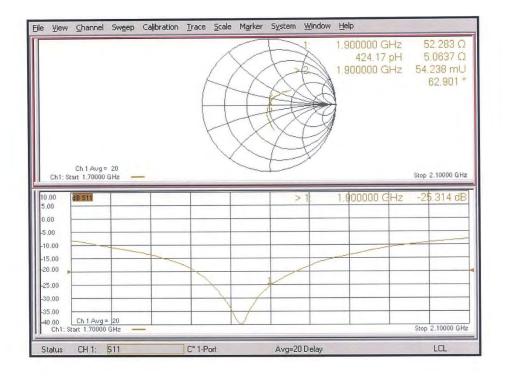
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Impedance Measurement Plot for Head TSL



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	N: 5047.2 / 06327 04	-Apr-19 (No. 217-02895)	Apr-20
	N: 7349 31	-Dec-18 (No. EX3-7349_Dec18)	Dec-19
DAE4 SN:	N: 601 04	-Oct-18 (No. DAE4-601_Oct18)	Oct-19
econdary Standards ID #) # Cł	neck Date (in house)	Scheduled Check
		-Oct-15 (in house check Feb-19)	In house check: Oct-20
		-Oct-15 (in house check Oct-18)	In house check: Oct-20
THE FAM IS RECORDER AND A RECEIPTION		-Oct-15 (in house check Oct-18)	In house check: Oct-20
		-Jun-15 (in house check Oct-18)	In house check: Oct-20
letwork Analyzer Agilent E8358A SN:	N: US41080477 31	-Mar-14 (in house check Oct-18)	In house check: Oct-19
	ame	Function	Signature
Calibrated by: Clau	audio Leubler	Laboratory Technician	
			VA

Certificate No: D2450V2-727_Apr19

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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

Glossarv:

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

Calibration is Performed According to the Following Standards:

- a) 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%.

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Measurement Conditions

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

DASY Version	DASY5	V52.10.2
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	37.8 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	فككد	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.0 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	6.28 W/kg

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.8 Ω + 2.9 jΩ	
Return Loss	- 24.2 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

Manufactured by	SPEAG

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DASY5 Validation Report for Head TSL

Date: 24.04.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:727

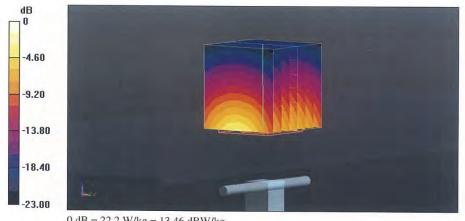
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; $\sigma = 1.87 \text{ S/m}$; $\varepsilon_r = 37.8$; $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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 = 116.3 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 26.9 W/kg SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.28 W/kg Maximum value of SAR (measured) = 22.2 W/kg



0 dB = 22.2 W/kg = 13.46 dBW/kg

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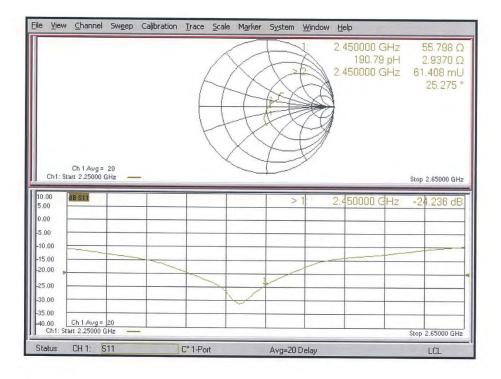
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Impedance Measurement Plot for Head TSL



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Object	D5GHzV2 - SN:1	1023	
Calibration procedure(s)	QA CAL-22.v4 Calibration Proce	edure for SAR Validation Source	es between 3-6 GHz
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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S Swiss Calibration Service

Accreditation No.: SCS 0108

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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
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless C) 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%.

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Measurement Conditions

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

DASY Version	DASY5	V52.10.3
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	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	4.49 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSI	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.28 W/kg

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Head TSL parameters at 5300 MHz

ne	tollowing	parameters	and	calculations	were	applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	4.59 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.8 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.35 W/kg

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	34.8 ± 6 %	4.89 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	السلا	

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	8.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 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	34.5 ± 6 %	5.10 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	-	-

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.4 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.29 W/kg

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	50,6 Ω - 8.0 jΩ
Return Loss	- 22.0 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	52.4 Ω - 4.7 jΩ	
Return Loss	- 25.8 dB	

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.9 Ω - 1.1 jΩ
Return Loss	- 25.0 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.2 Ω + 2.9 jΩ	
Return Loss	- 23.8 dB	

General Antenna Parameters and Design

Electrical Delay (one direction) 1.199 ns	Electrical Delay (one direction)	1.199 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
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DASY5 Validation Report for Head TSL

Date: 28.01.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1023

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz; σ = 4.49 S/m; ϵ_r = 35.3; ρ = 1000 kg/m³, Medium parameters used: f = 5300 MHz; $\sigma = 4.59 \text{ S/m}$; $\varepsilon_r = 35.2$; $\rho = 1000 \text{ kg/m}^3$ Medium parameters used: f = 5600 MHz; σ = 4.89 S/m; ϵ_r = 34.8; ρ = 1000 kg/m³. Medium parameters used: f = 5800 MHz; $\sigma = 5.1 \text{ S/m}$; $\varepsilon_r = 34.5$; $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.8, 5.8, 5.8) @ 5200 MHz, ConvF(5.49, 5.49, 5.49) @ 5300 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 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 52.10.3(1513); SEMCAD X 14.6.13(7474)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 77.00 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 28.9 W/kg SAR(1 g) = 8.05 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 = 68.9% Maximum value of SAR (measured) = 18.6 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 77.20 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 30.2 W/kg SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.35 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 68.8% Maximum value of SAR (measured) = 19.4 W/kg

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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 = 77.04 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 31.6 W/kg SAR(1 g) = 8.36 W/kg; SAR(10 g) = 2.37 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 67.1% Maximum value of SAR (measured) = 19.9 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 = 75.51 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 33.1 W/kg SAR(1 g) = 8.19 W/kg; SAR(10 g) = 2.29 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 65.2% Maximum value of SAR (measured) = 19.8 W/kg



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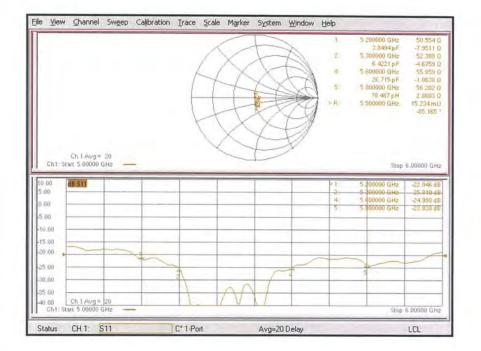
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Impedance Measurement Plot for Head TSL



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- End of report -

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