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Appendix C

Phantom Description

Schmid & Partner Engineering AG

S D е а q

Zeughausstrasse 43, 8004 Zurich, Switzerland Phone +41 44 245 9700, Fax +41 44 245 9779 info@speag.com, http://www.speag.com

Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI 5.0
Type No	QD OVA 002 A
Series No	1108 and higher
Manufacturer	Untersee Composites
	Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Complete tests were made on the prototype units QD OVA 001 A, pre-series units QD OVA 001 B as well as on some series units QD OVA 001 B. Some tests are made on all series units QD OVA 002 A.

Test	Requirement	Details	Units tested
Shape	Internal dimensions, depth and sagging are compatible with standards	Bottom elliptical 600 x 400 mm, Depth 190 mm, dimension compliant with [1] for f > 375 MHz	Prototypes
Material thickness	Bottom: 2.0mm +/- 0.2mm	dimension compliant with [3] for f > 800 MHz	all
Material parameters	rel. permittivity 2 – 5, loss tangent ≤ 0.05, at f ≤ 6 GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material resistivity	Compatibility with tissue simulating liquids .	Compatible with SPEAG liquids. **	Phantoms, Material sample
Sagging	Sagging of the flat section in tolerance when filled with tissue simulating liquid.	within tolerance for filling height up to 155 mm	Prototypes, samples

Note: Compatibility restrictions apply certain liquid components mentioned in the standard, containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility.

Standards

- OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
 IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific
- Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
- IEC 62209-1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices Human models, instrumentation, and procedures Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)*, 2005-02-18
- IEC 62209–2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices Human models, instrumentation, and procedures Part 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)", 2010-03-30

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of body-worn SAR measurements and system performance checks as specified in [1 – 4] and further standards

25.7.2011

mid 8 Partner Engineering/AG gbayestresse 43, 8004 Josich, San Science ng/441-44/265-9708, 664-46 64-45 9779

Signature / Stamp

Doc No 881 - QD OVA 002 A - A

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System Validation from Original Equipment Supplier

Calibration Laboratory of Schmid & Partner Engineering AG rughausstrasse 43, 6004 Zurich, Switzerland





S Service suisse d'étalonnage Servizio svizzero di teratura S Sales Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Senace (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multitatural Agreement for the recognition of calibration perbficates

Certificate No: D2450V2-835 Jun19

Otied	D2450V2 - SN:8	35	
Coltration processions	QA CAL-05.V11		
	Calibration Proce	edure for SAR Validation Sources	between 0.7-3 GHz
Cultivation date	June 27, 2019		
		lional standards, which realize the physical uni	
The measurements and the union	facilitis will confidence p	probability are given on the following jurges an	id are part of the certificate
All calibrations vave been pormer	ney in the closed laborate	ry facility transmined temperature (22 ± 8) i	and humany a Time.
Calibration Equipment used (MAT	Ecilies for palitration)		
Primary Standards	10+	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NAP	SN: 104778	(D-Apr-19 (No. 217-0289/202886)	Alv-M3
Power sensor NRP Z91	6N 103244	US-Apr-19 (No. 217 ti2892)	Apr-20
Power sensor NRF-291	SN 103245	03 Apr. 19 (No. 217-02808)	Apr-80
	SN: 5058 (20k)	D4-Apr-19 (No. 217/02894)	Apr-20
Reference 20 dB Attenuator	AND THE PERSON NAMED IN		
Type N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02695)	Apr-20
Type-N mismatch combination Reference Probe EX30V4	SN: 7349	29-May-19 (No. EX3-7349_May19)	May-20
Type N mismatch combination	Charles and the second		
Type N miamaich combination Reference Probe EX30V4 DAE4 Secondary Standares	SN: 7349 SN: 601	39-May-19 (No. EX3-7349 JMay19) 30-Apr-19 (No. DAE4-601 JApr19) Check Date (In thouse)	May-20 Apt-20 Seneming Check
Type-N mismatch combination Reference Probe EX30V4 DAE4 Socondary Standards Power main €44180	SN: 7349 SN: 901 ID # SN: GB39612475	39-May-19 (No. EXX-7349 May19) 30-Apr-18 (No. DAE4-601 April 9) Check Bate (in house) 36-Oct-14 (in house check Feb-19)	May-20 Apr-20 Scheming Check In house phace: Oct-2:
Type-N mismetch combination Reference Probe EX30V4 DAC4 Secondary Standares Power mete E44160 Power recessor HP 8481A	SN: 7349 SN: 901 ID # SN: GB39512475 SN: US37292789	29-May-19 (No. EX3-7349 May19) 30-Apr-19 (No. DAE4-601 Apr-19) Check Date (in blosse) 35-Oct-14 (in house) 07-Oct-15 (in house check Oct-18)	May-20 Apr-20 Screaming Check In house phace Oct-2: In house phace Oct-2:
Type-N mismatch combination Reference Probe EX30V4 DAS4 Secondary Standards Power meter €44160 Power sersor HF 8481A Power sersor HF 8481A	SN: 7349 SN: 901 ID # SN: GB39612475 SN: US37292789 SN: WS41092317	39-May-19 (No. EXX-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house) 36-Oct-14 (in house check Feb-18) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	May-20 Apt-20 Scheming Check in house plack Oct-2 in house plack Oct-2 in house plack Oct-2
Type-N minimatch combination Reference Probe EX37V4 DAE4 Secondary Standaries Power meter E44180 Primor sonsor HF 8481A PF generator R&S SMT-38	SN: 7349 SN: 901 ID # SN: GB39512475 SN: US37292783 SN: M741392317 SN: 100972	39-May-19 (No. EXX-7349_May19) 30-Apr-18 (No. DAE4-601_Apr15) Check Bate (in house) 30-Oct-14 (in house check Pet-18) 07-Oct-15 (in house check Oct-18) 07-Uct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18)	May 20 Apt-20 Schemins Check In house check Oct-2 In house check Oct-2 In house sheek Oct-2
Type-N mismatch combination Reference Probe EX30V4 DAS4 Secondary Standards Power meter €44160 Power sersor HF 8481A Power sersor HF 8481A	SN: 7349 SN: 901 ID # SN: GB39512475 SN: US37292783 SN: M741392317 SN: 100972	39-May-19 (No. EXX-7349_May19) 30-Apr-19 (No. DAE4-601_Apr19) Check Date (in house) 36-Oct-14 (in house check Feb-18) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	May-20 Apt-20 Scheming Check In house check Oct-20 In house check Oct-20 In house sheek Oct-20 In house sheek Oct-20
Type-N mismatch combination Reference Probe EX30V4 DAE4 Secondary Standares Power meter E4418B Power sensor HP 8481A Pures sensor HP 8481A RF generator R&S SMT-3I Network Analyzer Agilini E3308A	SN: 7349 SN: 901 ID # SN: GB39512475 SN: US37292789 5N: HF41182317 SN: 109972 SN: US41080477 Name	39-May-19 (No. EXX-7349_May19) 30-Apr-18 (No. DAE4-601_Apr15) Check Bate (in house) 30-Oct-14 (in house check Pet-18) 07-Oct-15 (in house check Oct-18) 07-Uct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18)	May-20 Apr-20
Type-N minimatch combination Reference Probe EX37V4 DAE4 Secondary Standaries Power meter E44180 Primor sonsor HF 8481A PF generator R&S SMT-38	SN: 7349 SN: 901 ID # SN: GB39512475 SN: US37292783 SN: MY411382317 SN: 100972 SN: US41080477	39-May-19 (No. EXX-7349_May19] 30-Apr-18 (No. DAE4-601_Apr-19) Check Date (in blosse) 39-Oct-14 (in house check Feb-18) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-May-14 (in house check Oct-18)	May-20 Apt-20 Schemiller Check In house check Oct-2 In house check Oct-2 In house check Oct-3 In house check: Oct-3

Certificate No: D2450V2-835_Jun 19

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Calibration Laboratory of

Schmid & Partner Engineering AG cotronac 43, #804 Zurich, Switzetland





S Service suisse d'étalores C Servizio evizzero di teralura wire Calibration Service

Accreditation No.: SCS 0108

Accountment by the Swiss Accountment Swivice (SWS)

The Swine Accreditation Service is one of the signatures to the EA Multilateral Agreement for the recognition of calibration certification

Glossary:

tissue simulating liquid TSL. 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 865864, 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 ligures 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%.

Confront No. D045092-895_Jun19

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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	37.9 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		time :

SAR result with Head TSL

SAR averaged over 1 cm3 (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	53.1 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.9 W/kg ± 16.5 % (k=2)

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	51.0 ± 6 %	2.03 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.0 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ² (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.2 W/kg ± 16.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.0 Ω + 5.3 jΩ
Return Loss	- 23.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω + 7.3 jΩ
Return Loss	- 22.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.16) 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: 27.06.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:835

Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; n = 1.86 S/m; $\epsilon_r = 37.9$; $p = 1000 \text{ kg/m}^3$ Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.9, 7.9, 7.9) @ 2450 MHz; Calibrated: 29.05.2010
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type; QD 000 P50 AA: Serial: 1001
- DASY52 52:10:2(1504); SEMCAD X 14:6:12(7470)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 117.6 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 26.8 W/kg

SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.3 W/kgMaximum value of SAR (measured) = 22.3 W/kg



0 dB = 22.3 W/kg = 13.48 dBW/kg

Certificate No. D2450V2-635_Jun19

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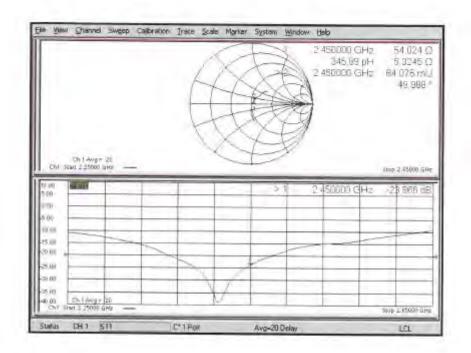
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Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 27.06.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:835

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

Medium parameters used: f = 2450 MHz, $\sigma = 2.03 \text{ S/m}$; $\epsilon_s = 51$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.94, 7.94, 7.94) @ 2450 MHz; Calibrated: 29.05,2019
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019.
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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

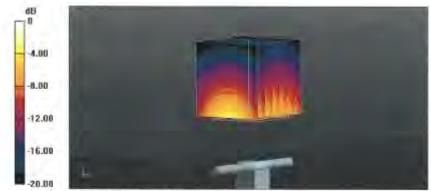
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 108.4 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 25.6 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.14 W/kg

Maximum value of SAR (measured) = 21.1 W/kg



0 dB = 21.1 W/kg = 13.24 dBW/kg

Certificate No. D2450V2-835 Jun 19

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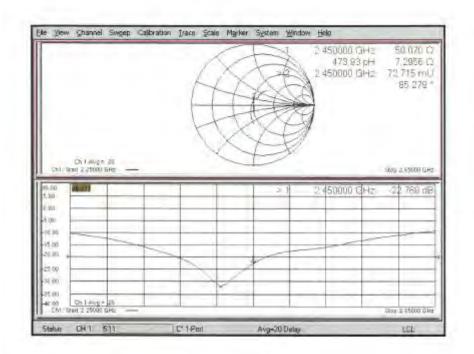
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Impedance Measurement Plot for Body TSL



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- End of report -

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