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# **Appendix C**

# **Phantom Description**

Schmid & Partner Engineering AG a

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

  [3] 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

Signature / Stamp

Doc No 881 - QD OVA 002 A - A

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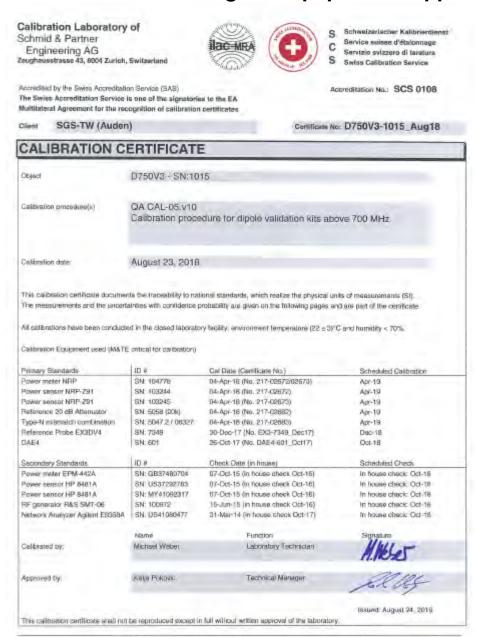
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# System Validation from Original Equipment Supplier



Certificate No: D750V3-1015, Aug III.

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Calibration Laboratory of Schmid & Partner Engineering AG Zeophoustrasse 43, 8004 Zürich, Switzerland





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Accreditation No.: SCS 0108

Accredited by the Swisa Accreditation Senice (SAS)

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

Glossary:

TSL fissue 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:

- 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
- EC 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 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	V52.10,1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spager
Zoom Scan Resolution	dx, dy, dz. = 5 mm	
Frequency	750 MHz ± 1 MHz	

#### Head TSL parameters

The following parameters and calculations were spolled.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mha/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 6 %	0.89 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		_

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.07 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.23 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>1</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.34 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	55,5	0.98 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.0 ± 6 %	0.96 mho/m ± 8 %
Body TSL temperature change during lest	< 0.5 °C	-	_

### SAR result with Body TSL

SAR averaged over 1 cm2 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.62 W/kg = 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Body TSL.	condition	
SAR measured	250 mW input power	1.43 W/kg
SAFI for nominal Body TSL parameters	normalized to 1W	5.71 W/kg ± 16.5 % (k=2)

Certificate No. D750V3-1015 Aug18

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### Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL

Impedance, transformed in field point	53.4 (2 + 0.0 )(2
Return Loss	- 29.6 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.2 (2 - 3.6 )(2	
Return Loss	= 27.8 dB	

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.037 ns

After long term use with HOOW 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 and 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 SARI 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 on	March 22, 2010	

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#### **DASY5 Validation Report for Head TSL**

Date: 22.08.2018

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;  $\sigma = 0.89$  S/m;  $\epsilon_r = 40.9$ ; p = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.22, 10.22, 10.22) @ 750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

#### 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 = 59.12 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 3.11 W/kg SAR(1 g) = 2.07 W/kg; SAR(10 g) = 1.34 W/kg Maximum value of SAR (measured) = 2.77 W/kg



0 dB = 2.77 W/kg = 4.42 dBW/kg

Certificate No: D750V3-1015\_Aug18

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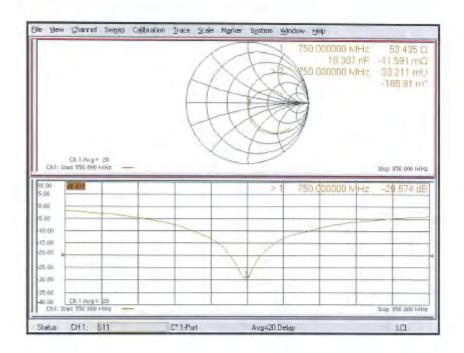
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#### Impedance Measurement Plot for Head TSL



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#### DASY5 Validation Report for Body TSL

Date: 23.08.2018

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;  $\sigma = 0.96$  S/m;  $\epsilon_r = 55$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.19, 10.19, 10.19) @ 750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

#### 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 = 57.93 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 3.17 W/kg

SAR(1 g) = 2.16 W/kg; SAR(10 g) = 1.43 W/kg

Maximum value of SAR (measured) = 2.85 W/kg



0 dB = 2.85 W/kg = 4.55 dBW/kg

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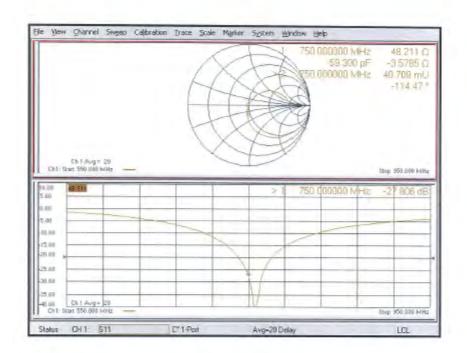
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#### Impedance Measurement Plot for Body TSL



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SGS-TW (Auden)

Certificate No: D1750V2-1008\_Aug18

Object	D1750V2 - SN:1	8008	
Calibration procedure(s)	QA CAL-05.v10 Cal oration proce	dure for dipole validation kits ab:	ove 700 MHz
Calibration date:	August 30, 2018		
The measurements and the uncert	ainties with confidence p	onal standards, which realize the physical un robability are given on the following pages or ry facility: environment temperature (22 ± 3)*1	ict are part of the certificate.
Calibration Equipment used (M&TE			CONTRACTOR OF THE PARTY OF THE
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	ID #	Car Date (Certificate No.)	Scheduled Calibration
lower meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
ower mater NRP ower sensor NRP-Z91	SN: 104778 SN: 103244	04-Apr-18 (No. 217-02672/02673) 04-Apr-18 (No. 217-02672)	Apr-19 Apr-19
ower meter NRP- ower sensor NRP-Z91 ower sensor NRP-Z91	SN: 104778 SN: 103244 SN: 103245	04-Apr-18 (No. 217-02672/02673) 04-Apr-18 (No. 217-02672) 04-Apr-18 (No. 217-02673)	Apr-19 Apr-19 Apr-18
Cower mater NRP Cower sensor NRP-Z91 Cower sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	04-Apr-16 (No. 217-02672/02673) 04-Apr-16 (No. 217-02672) 04-Apr-16 (No. 217-02673) 04-Apr-16 (No. 217-02682)	Apr-19 Apr-19 Apr-19 Apr-19
Cower mater NRP  Cower sensor NRP-Z91  Cower sensor NRP-Z91  Reference 20 dB Attenuator  ype-N mismatch combination	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327	(M4-Apr-16 (No. 217-02672/02673) (M4-Apr-16 (No. 217-02672) (M4-Apr-16 (No. 217-02673) (M4-Apr-16 (No. 217-02682) (M4-Apr-16 (No. 217-02683)	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19
Power mater NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reterence 20 dB Attenuator Typs-N mismatch combination Reterence Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	04-Apr-16 (No. 217-02672/02673) 04-Apr-16 (No. 217-02672) 04-Apr-16 (No. 217-02673) 04-Apr-16 (No. 217-02682)	Apr-19 Apr-19 Apr-19 Apr-19
Primary Standards Power mater NRP Power sensor NRP-291 Power sensor NRP-291 Reterence 20 dB Attenuator Type-N mismatch combination Reterence Probe EXSDV4 DAE4 Secondary Standards	SN: 104778 SN: 103244 SN: 103246 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	04-Apr-16 (No. 217-02672/02673) 04-Apr-16 (No. 217-02672) 04-Apr-16 (No. 217-02673) 04-Apr-16 (No. 217-02682) 04-Apr-16 (No. 217-02683) 30-Dec-17 (No. EXS-7349_Dec17)	Apr-19 Apr-19 Apr-19 Apr-19 Oec-18
Power mater NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2706327 SN: 7348 SN: 601	04-Apr-16 (No. 217-02672/02673) 04-Apr-16 (No. 217-02672) 04-Apr-16 (No. 217-02673) 04-Apr-16 (No. 217-02682) 04-Apr-16 (No. 217-02683) 30-Dec-17 (No. EXX-2348_Dec-17) 25-Oct-17 (No. DAE4-601_Oct17)	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18 Schedulart Check
Power mater NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power mater EPM-442A Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: 5038 (20k) SN: 5047.2706327 SN: 7348 SN: 601	(M4-Apr-16 (No. 217-02672/02673) (M4-Apr-16 (No. 217-02672) (M4-Apr-16 (No. 217-02673) (M4-Apr-16 (No. 217-02682) (M4-Apr-16 (No. 217-02683) (M4-Apr-16 (No. 217-0268	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18 Schedulad Check in house check: Oct-18
Power mater 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 EPM-442A Power sensor HP 8481A Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5057-27 / 06327 SN: 7346 SN: 601 JD # SN: GBS7480704 SN: US37296783 SN: MY41082317	04-Apr-16 (No: 217-02672/02673) 04-Apr-16 (No: 217-02672) 04-Apr-16 (No: 217-02673) 04-Apr-16 (No: 217-02673) 04-Apr-16 (No: 217-02682) 04-Apr-16 (No: 217-02682) 30-Dec-17 (No: EXX-7348_Dec17) 26-Oct-17 (No: EXX-7348_Dec17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Oct-18 Schedulad Check In house check: Oct-18 In house check: Oct-18
Power meter NRP Power sensor NRP-ZB1 Power sensor NRP-ZB1 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPR-442A Power sensor HP 8481A Rever sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2706327 SN: 7348 SN: 601 JD # SN: GIS37480704 GN: US37296783 SN: MY41082317 SN: 100872	(No. 217-02672/02673) 04-Apr-18 (No. 217-02672) 04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dec-17 (No. EXX-7348_Dec-17) 26-Oc-17 (No. DAE4-601_Oc-17) Check Date (in house) 07-Oc-15 (in house check Oc-16) 07-Oc-15 (in house check Oc-16) 15-Jun-15 (in house check Oc-16)	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18 Schedulad Chack in house chack: Oct-18 in house chack: Oct-18 in house chack: Oct-18 in house chack: Oct-18
Power mater 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 EPM-442A Power sensor HP 8481A Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5057-27 / 06327 SN: 7346 SN: 601 JD # SN: GBS7480704 SN: US37296783 SN: MY41082317	04-Apr-16 (No: 217-02672/02673) 04-Apr-16 (No: 217-02672) 04-Apr-16 (No: 217-02673) 04-Apr-16 (No: 217-02673) 04-Apr-16 (No: 217-02682) 04-Apr-16 (No: 217-02682) 30-Dec-17 (No: EXX-7348_Dec17) 26-Oct-17 (No: EXX-7348_Dec17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18 Schedulad Check in house check: Oct-18 in house check: Oct-18 in house check: Oct-18 in house check: Oct-18
Power mater 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 EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5058 (20k) SN: 601 JD # SN: 61537480704 SN: 01537282783 SN: MY:41082317 SN: 100972 SN: 0541080477 Name	04-Apr-16 (No. 217-02672/02673) 04-Apr-16 (No. 217-02672) 04-Apr-16 (No. 217-02673) 04-Apr-16 (No. 217-02682) 04-Apr-16 (No. 217-02682) 30-Dec-17 (No. 217-02683) 30-Dec-17 (No. EXX-7349_Dec-17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 31-Mar-14 (in house check Oct-17) Function	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18 Schedulad Check in house check: Oct-18 in house check: Oct-18 in house check: Oct-18 in house check: Oct-18
Power mater NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N inismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power mater EPM-442A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5058 (20k) SN: 7349 SN: 601 JD # SN: GIS37480704 SN: US37252783 SN: MY41082317 SN: 100972 SN: US41080477	04-Apr-16 (No. 217-02672/02673) 04-Apr-16 (No. 217-02672) 04-Apr-16 (No. 217-02673) 04-Apr-16 (No. 217-02673) 04-Apr-16 (No. 217-02683) 30-Dec-17 (No. EXS-7349_Dec-17) 26-Oct-17 (No. EXS-7349_Dec-17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 31-Mar-14 (in house check Oct-17)	Apr-19 Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18 Scheduled Check In house check: Oct-18

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





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S Swiss Calibration Service

Accreditation No.: SCS 0108

According by the Swas Accordance Service (SAS)

The Swas Accordination Service in one of the signaturies to the EA Multilitieral Agreement for the recognition of calibration certificines

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
- EC 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
- EC 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 Regulirements 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 an

DASY Version	DASYS	V52,10.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flad Pharmorn	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz; = 5 mm	
Frequency	1750 MHz ± I MHz	

### Head TSL parameters

on parameters and calculations were annual

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mholm
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.9 ± 6 %	1.34 mha/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	-10-	-

### SAR result with Head TSL

SAR averaged over 1 cm <sup>1</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.07 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	35.5 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.B1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.3 W/kg ± 16.5 % (k=2)

### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperatura	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mino/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.4 = 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW Input power	9.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.0 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm2 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	4.93 W/kg
SAR for nominal Body TSL parameters	normalized to TW	19.8 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	52.0 \Omega + 1.6 \mu	
Ratum Loss	+ 32.2 pH	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	#6.3 Ω ± 0.6 jΩ
Return Loss	- 34.7 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1:207 rs
minoritary solely forth distributions	1.207 113

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 enterms is therefore short-circuited for DC-signals. On some of the dipoles, small end cases 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 on	February 11, 2009

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#### DASY5 Validation Report for Head TSL

Date: 30.08.2018

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT; Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1008

Communication System: UID 0 - CW; Frequency: 1750 MHz.

Medium parameters used: f = 1750 MHz;  $\sigma = 1.34$  S/m;  $\epsilon_r = 38.9$ ; p = 1000 kg/m<sup>3</sup>

Phantom section: Flat Section

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

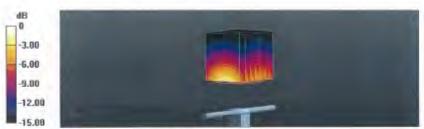
#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.5, 8.5, 8.5) @ 1750 MHz; Calibrated: 30.12.2017
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

### 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 = 107.6 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 16.3 W/kg

SAR(1 g) = 9.07 W/kg; SAR(10 g) = 4.81 W/kgMaximum value of SAR (measured) = 13.9 W/kg



0 dB = 13.9 W/kg = 11.43 dBW/kg

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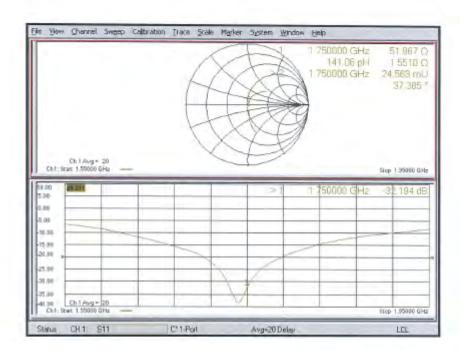
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### Impedance Measurement Plot for Head TSL



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#### DASY5 Validation Report for Body TSL

Date: 30.08.2018

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1008

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: f = 1750 MHz;  $\sigma = 1.47 \text{ S/m}$ ;  $\epsilon_c = 53.4$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.35, 8.35, 8.35) @ 1750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

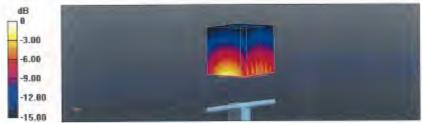
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 101.7 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 15.9 W/kg

SAR(1 g) = 9.16 W/kg; SAR(10 g) = 4.93 W/kg

Maximum value of SAR (measured) = 13.7 W/kg



0 dB = 13.7 W/kg = 11.37 dBW/kg

Cortificate No: D1750V2-1008\_Aug18

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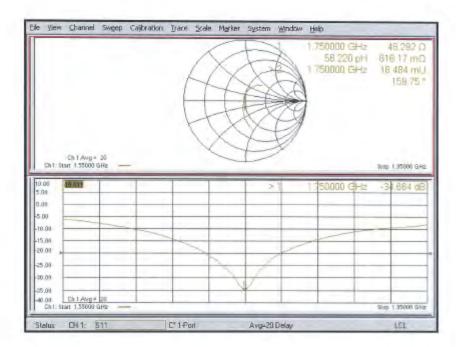
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#### Impedance Measurement Plot for Body TSL



Certificate No: D1750V2-1008\_Aug18

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





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Swiss Calibration Service

Accreditation No.: SCS 0108

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SGS-TW (Auden)

Certificate No: D1900V2-5d173\_Apr19

Object	D1900V2 - SN:50	1173	
	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	April 23, 2019		
This calibration certificate documen	its the traceability to nati	onal standards, which realize the physical uni robability are given on the following pages an	ts of measurements (SI). d are part of the certificate.
		ry facility: environment temperature (22 ± 3)°C	
Calibration Equipment used (M&TE			
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
	210 172010		
	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Reference 20 dB Attenuator	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	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	04-Apr-19 (No. 217-02895)	
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 5047.2 / 06327		Apr-20
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 5047.2 / 06327 SN: 7349	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18)	Apr-20 Dec-19
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)	Apr-20 Dec-19 Oct-19 Scheduled Check
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house)	Apr-20 Dec-19 Oct-19
Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Feb-19)	Apr-20 Dec-19 Oct-19 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 Power sensor HP 8481A	SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Oct-18)	Apr-20 Dec-19 Oct-19 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 Standards Power meter E4419B	SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20 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 RF generator R&S SMT-06	SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house)  07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	Apr-20 Dec-19 Oct-19 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 Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06	SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	04-Apr-19 (No. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (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) 31-Mar-14 (in house check Oct-18)	Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-18

Certificate No: D1900V2-5d173\_Apr19

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





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Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossary:

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

### 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
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

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

Certificate No: D1900V2-5d173\_Apr19

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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

nd 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	40.6 ± 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 <sup>3</sup> (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 <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.0 W/kg ± 16.5 % (k=2)

Certificate No: D1900V2-5d173\_Apr19

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## Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.3 \Omega + 5.1 j\Omega$	
Return Loss	- 25.3 dB	

## General Antenna Parameters and Design

A. Y	
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

Certificate No: D1900V2-5d173\_Apr19 Page 4 of 6

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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;  $\sigma$  = 1.38 S/m;  $\epsilon_r$  = 40.6;  $\rho$  = 1000 kg/m<sup>3</sup>

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

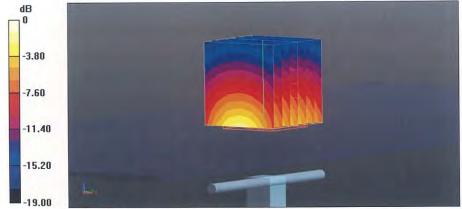
Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001

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

Certificate No: D1900V2-5d173\_Apr19

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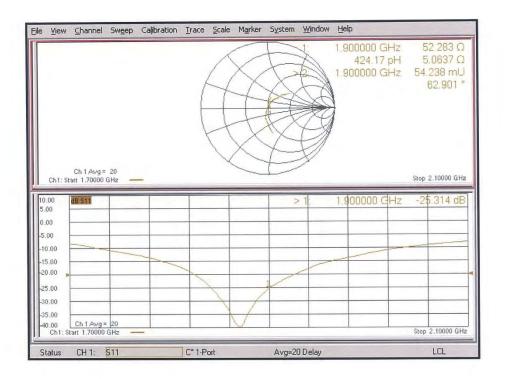
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#### Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d173\_Apr19 Page 6 of 6

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Accreditation No.: SCS 0108

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SGS-TW (Auden) Certificate No: D2450V2-727 Apr19

Object	D2450V2 - SN:727			
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz			
Calibration date:	April 24, 2019			
This calibration certificate docume	ents the traceability to nat	ional standards, which realize the physical un	nits of measurements (SI).	
The measurements and the uncer	tainties with confidence p	probability are given on the following pages ar	nd are part of the certificate.	
All calibrations have been conduct	ted in the closed laborato	ry facility: environment temperature (22 ± 3)°(	C and humidity < 70%.	
			***************************************	
Calibration Equipment used (M&T	E critical for calibration)			
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration	
	ID # SN: 104778	Cal Date (Certificate No.) 03-Apr-19 (No. 217-02892/02893)	Scheduled Calibration Apr-20	
Power meter NRP Power sensor NRP-Z91				
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244	03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892)	Apr-20 Apr-20	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	SN: 104778 SN: 103244 SN: 103245	03-Apr-19 (No. 217-02892/02893) 03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893)	Apr-20 Apr-20 Apr-20	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	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)	Apr-20 Apr-20 Apr-20 Apr-20	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327	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. 217-02895)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20	
Primary Standards 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	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19	
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	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check	
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	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20	
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	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	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. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20	
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	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Oct-18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20	
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	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Oct-18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20	
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	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (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) 31-Mar-14 (in house check Oct-18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Probe EX3DV4 PAE4 Recondary Standards Power meter E4419B Power sensor HP 8481A Regenerator R&S SMT-06 Retwork Analyzer Agilent E8358A	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: US41080477 Name	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (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) 31-Mar-14 (in house check Oct-18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20	
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: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: US41080477	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (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) 31-Mar-14 (in house check Oct-18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: US41080477 Name	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. 217-02895) 31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)  Check Date (in house) 07-Oct-15 (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) 31-Mar-14 (in house check Oct-18)	Apr-20 Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20	

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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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#### 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
- 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
- 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	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		4-4-1

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (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 <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.7 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	$55.8 \Omega + 2.9 j\Omega$	
Return Loss	- 24.2 dB	

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 ns

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

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

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

#### **Additional EUT Data**

Manufactured by	SPEAG	
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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

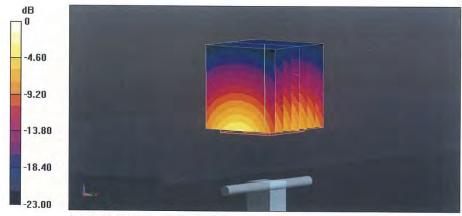
Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001

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/kgSAR(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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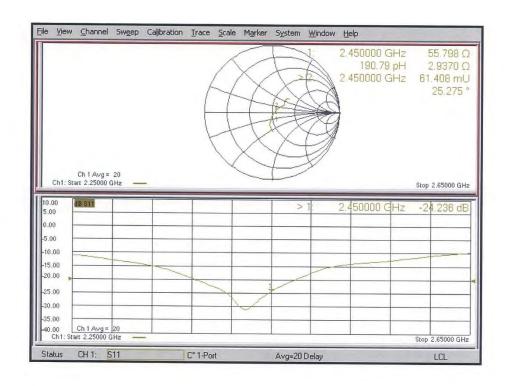
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#### Impedance Measurement Plot for Head TSL



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SGS-TW (Auden)

Certificate No: D5GHzV2-1023\_Jan19

#### **CALIBRATION CERTIFICATE** D5GHzV2 - SN:1023 Object QA CAL-22.v4 Calibration procedure(s) Calibration Procedure for SAR Validation Sources between 3-6 GHz January 30, 2019 Calibration date: This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Cal Date (Certificate No.) Scheduled Calibration Primary Standards ID# SN: 104778 04-Apr-18 (No. 217-02672/02673) Apr-19 Power meter NRF Power sensor NRP-Z91 SN: 103244 04-Apr-18 (No. 217-02672) Apr-19 Power sensor NRP-Z91 SN: 103245 04-Apr-18 (No. 217-02673) Apr-19 Reference 20 dB Attenuator SN: 5058 (20k) 04-Apr-18 (No. 217-02682) Apr-19 Type-N mismatch combination SN: 5047.2 / 06327 04-Apr-18 (No. 217-02683) Apr-19 Reference Probe EX3DV4 SN: 3503 31-Dec-18 (No. EX3-3503\_Dec18) Dec-19 DAE4 SN: 601 04-Oct-18 (No. DAE4-601\_Oct18) Oct-19 ID# Check Date (in house) Scheduled Check Secondary Standards Power meter EPM-442A SN: GB37480704 07-Oct-15 (in house check Oct-18) 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-18) In house check: Oct-19 Function Name Michael Weber Laboratory Technician Calibrated by: Technical Manager Katja Pokovic Approved by: Issued: January 30, 2019 This calibration certificate shall not be reproduced except in full without written approval of the laboratory

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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

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:

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
- 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 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	36.8 ± 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 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.89 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 19.5 % (k=2)

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### Head TSL parameters at 5300 MHz

The following 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	36.6 ± 6 %	4.59 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	1,000	Sec.

#### SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.6 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 W/kg ± 19.5 % (k=2)

### Head TSL parameters at 5600 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.2 ± 6 %	4.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	1444	

### SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	85.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.4 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	35.9 ± 6 %	5.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	- Consider	Take 1

#### SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

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#### Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	51.2 Ω - 8.5 jΩ
Return Loss	- 21.4 dB

#### Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	51.0 Ω - 3.9 jΩ
Return Loss	- 28.0 dB

#### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.9 Ω - 1.6 jΩ
Return Loss	- 26.2 dB

#### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	$55.8 \Omega + 1.3 j\Omega$	
Return Loss	- 25.0 dB	

### General Antenna Parameters and Design

1.199 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: 30.01.2019

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;  $\sigma = 4.49 \text{ S/m}$ ;  $\varepsilon_r = 36.8$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used: f = 5300 MHz;  $\sigma = 4.59 \text{ S/m}$ ;  $\epsilon_r = 36.6$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used: f = 5600 MHz;  $\sigma = 4.9 \text{ S/m}$ ;  $\varepsilon_r = 36.2$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used: f = 5800 MHz;  $\sigma = 5.11 \text{ S/m}$ ;  $\varepsilon_r = 35.9$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.69, 5.69, 5.69) @ 5200 MHz, ConvF(5.45, 5.45, 5.45) @ 5300 MHz, ConvF(5, 5, 5) @ 5600 MHz, ConvF(4.96, 4.96, 4.96) @ 5800 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=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 = 75.39 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 28.7 W/kg

SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 18.0 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 = 76.71 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 29.9 W/kg

SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.34 W/kg

Maximum value of SAR (measured) = 18.8 W/kg

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

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

Reference Value = 76.95 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 32.9 W/kg

SAR(1 g) = 8.55 W/kg; SAR(10 g) = 2.43 W/kg

Maximum value of SAR (measured) = 20.1 W/kg

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

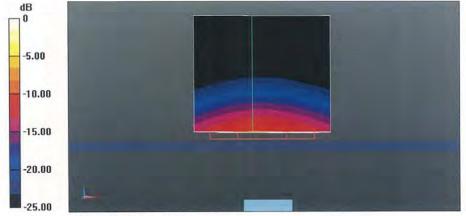
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 74.52 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 32.1 W/kg

SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.26 W/kg

Maximum value of SAR (measured) = 19.1 W/kg



0 dB = 19.1 W/kg = 12.81 dBW/kg

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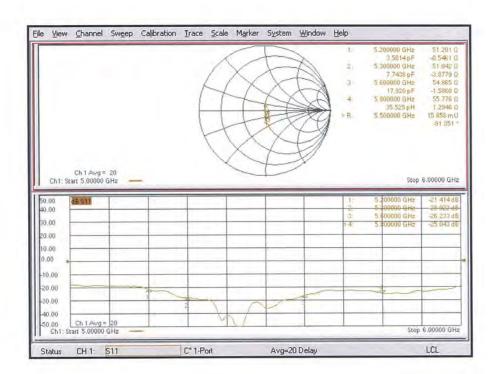
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#### Impedance Measurement Plot for Head TSL



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# - End of report -

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