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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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System Validation from Original Equipment Supplier



Certificate No: D750V3-1015, Aug III. Page 1 of 8

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





S Schmitzerischer Kallbrierbiene C Service subse d'élatornege Servicie avizzere di terature S Seiss Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swisa Accreditation Service (SAS)

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

Glossary:

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

Callbration 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%.

Certificate No: D780V3 1016 Aug18

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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, d2. = 5 mm	
Frequency	750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 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 ³ (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 ¹ (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)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Imperdance, transformed in fixed point	53.4 (2 + 0.0)(2
Fletum Loss	- 29.6 dB.

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.2 (7 - 3.6 JC)	
Fleturn Loss	- 27.8 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.037 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole riest 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/m³ 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/kgMaximum value of SAR (measured) = 2.77 W/kg



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

Certificate No: D750V3-1015 Aug 18

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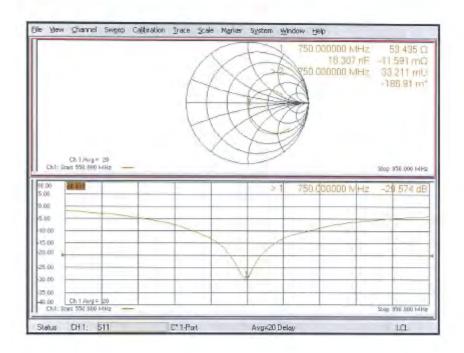
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Impedance Measurement Plot for Head TSL



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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/m³

Phantom section: Flat Section

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

DASY52 Configuration:

dB

- 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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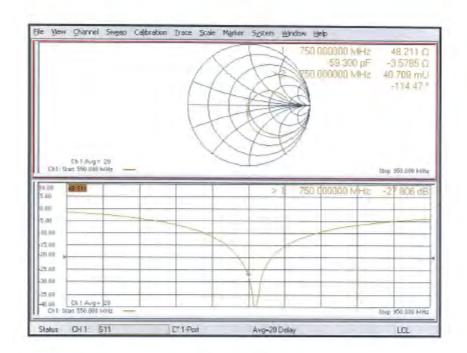
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Impedance Measurement Plot for Body TSL



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SGS-TW (Auden)

Certificate No: D835V2-4d063 Aug18

	ERTIFICATE		
Otoject	D835V2 - SN:4d	063	
Calibration procedure(s)	QA CAL-05.v10 Cal bration proce	edure for dipole validation kits abo	ovs 700 MHz
Calibration date:	August 23, 2018		
The measurements and the uncort	ainties with confidence p	ional standards, which realize the physical un probability are given on the following pages ar ry facility, crivironment temperature (22 ± 3)*1	ict are part of the certificate
Calibration Equipment used (M&T)			August and Company
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
ower meter NRP	SN: 104778	04-Apr-15 (No. 217-02672/02673)	Apr.19
ower sensor NRP (291	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Power sensor NRP-Z91	1000		
Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-16 (No. 217-02682)	Apr-18
Power sensor NRP-Z81 Telerence 20 dB Attenuator Type-N mismatch combination	SN: 5058 (20k) SN: 5047.2 / 06327	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683)	April 19
Power sensor NRP-281 Telerence 20 dB Attenuator Type-N mismalith combination Telerence Probe EX3DV4	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dec-17 (No. EX3-7349, Dec-17)	Apr.19 Dec-18
Power sensor NRP-281 Telerence 20 dB Attenuator Type-N mismalith combination Telerence Probe EX3DV4	SN: 5058 (20k) SN: 5047.2 / 06327	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683)	Apr.19
Power sensor NRP-281 Reference 20 dB Attenuator Type-M internation combination Retainince Probe EX3DV4 DAE4	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	04-Apr-18 (No. 217-02802) 04-Apr-18 (No. 217-02883) 30-Dec-17 (No. EXS-7349, Dec-17) 28-Qoi-17 (No. DAE4-601, Oct17)	Apr.19 Dec-18
Power sensor NRP-281 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secundary Standards	SN: 5056 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dec-17 (No. EX3-7349, Dec-17)	Apr.19 Dec-18 Oct-18
Pawer sensor NRP-281 Reference 20 dB Attenustor Typo-N mismatch combination Reference Probe EX3DV4	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dac-17 (No. EXC-7349, Dec17) 26-Qch-17 (No. DAE-4-601_Och17) Check Date (in house)	Apr.19 Dec-18 Oct-16 Scheduled Check
Power sensor NRP-281 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secundary Standards Power mater EPM-442A	SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37490704	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dac-17 (No. EXS-7349, Dac-17) 26-Och-17 (No. DAE4-601_Och17) Check Cate (in house) 07-Och 15 (in house) check Och-18)	Aprit 9 Deb-18 Oct-18 Scheduled Check In house check: Oct-18
Power sensor NRP-281 Reference 20 dB Attenuator (type-N mismatch combination Retainince Probe EX3DV4 DAE4 Secundary Standards Power mater EPM-442A Power sensor HP 8481A Power sensor HP 8481A	SN: 5056 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37450704 SN: US37292783	04-Apr-16 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dac-17 (No. EXS-7349, Dac-17) 26-Oct-17 (No. DAE4-601_Oct17) Check Cate (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Aprit 9 Deb-18 Oct-16 Scheduled Check In house check: Oct-18 in house check: Oct-18
Power sensor NRP-281 Reference 20 dB Attenustor type-N mismatch combination Retainince Probe EX3DV4 JAE4 Securedary Standards Power muter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Regenerator R&B SMT-06	SN: 5056 (20k) SN: 5047.2 / D6327 SN: 7349 SN: 601 ID # SN: GB37450704 SN: WS37252783 SN: MY41082317	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dec-17 (No. EX-7348, Dec-17) 26-Oct-17 (No. DAE-4-601, Oct-17) Check Date Inhouse 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Aprit 9 Deb-18 Oct-16 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Power sensor NRP-281 Reference 20 dB Attenustor Reference 20 dB Attenustor Reference Probe EX3DV4 DAE4 Secondary Standards Power mater EPM-442A Power sensor HP 3481A	SN: 5056 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37450704 SN: US37292783 SN: MY41082317 SN: 106972 SN: US41080477	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dac-17 (No. EXC-7349, Dec17) 26-Qct-17 (No. DAE4-601_Oct17) Check Cate (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 31-Mar-14 (in house check Oct-17)	Apn 19 Deb 18 Oct-16 Scheduled Check In house check: Oct-18
Power sensor NRP-281 Reference 20 dB Attenustor Reference 20 dB Attenustor Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference RAS SMT-06 Reference Analyzer Aglent ERSSA4	SN: 5056 (20k) SN: 5047 2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: WS37292783 SN: MY41082317 SN: 106972 SN: US41080477 Nume	04-Apr-18 (No. 217-02882) 04-Apr-18 (No. 217-02883) 30-Bec-17 (No. EX9-7349, Dec-17) 26-Gol-17 (No. DAE-4-601, Oct17) Check Cate 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) 15-Jun-15 (in house check Oct-16) 15-Jun-14 (in house check Oct-17) Function	Apr.19 Deb-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Power sensor NRP-281 Reference 20 dB Attenustor Reference 20 dB Attenustor Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A Reference RAS SMT-06 Reference Analyzer Aglent ERSSA4	SN: 5056 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37450704 SN: US37292783 SN: MY41082317 SN: 106972 SN: US41080477	04-Apr-18 (No. 217-02682) 04-Apr-18 (No. 217-02683) 30-Dac-17 (No. EXC-7349, Dec17) 26-Qct-17 (No. DAE4-601_Oct17) Check Cate (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 31-Mar-14 (in house check Oct-17)	Apn 19 Deb 18 Oct-16 Scheduled Check In house check: Oct-18
Power sensor NRP-281 Reference 20 dB Attenuator Type-M internation combination Retainince Probe EX3DV4 DAE4 Secundary Standards Power mater EPM-442A Power sensor HP 8481A Proper gensor HP 8481A RF generator R&S SMT-06	SN: 5056 (20k) SN: 5047 2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: WS37292783 SN: MY41082317 SN: 106972 SN: US41080477 Nume	04-Apr-18 (No. 217-02882) 04-Apr-18 (No. 217-02883) 30-Bec-17 (No. EX9-7349, Dec-17) 26-Gol-17 (No. DAE-4-601, Oct17) Check Cate 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) 15-Jun-15 (in house check Oct-16) 15-Jun-14 (in house check Oct-17) Function	Apn 19 Deb 18 Oct-16 Scheduled Check In house check: Oct-18

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





S Schweizerischer Kalibri-diens C Service suisse d'Melonnège Servizio svizzero di lorobue S Seres Collegation Service

Accreditation No.: SCS 0108

According by the Swiss Actordistion Service (SAS)

The Swiss Accorditation Service is one of the signatories to the EA

Multilateral Agreement for the recognition of salibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- 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 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 fow
 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.

DASY5	V52.10.1
Advanced Extrapolation	
Modular Flat Phantóm	
15 mm	with Spacer
dx, dy, dz = 5 mm	
835 MHz = 1 MHz	
	Advanced Extrapolation Modular Flat Phantom 15 mm dx, dy, dx = 5 mm

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 ℃	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.7 ± fi %	0.92 mho/m ± 8 %
Head TSL temperature change during test	< 0.5 °C	_	

SAR result with Head TSL

SAR averaged over 1 cm ¹ (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	9.48 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm² (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6,10 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	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.9±6%	0.99 mha/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.43 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.58 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.59 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.28 W/kg ± 16.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Projectance, transformed to feed point.	51.3 Ω - 1.8 <u>Ι</u> Ω
Relum Loss	- 33.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point:	47.7 Ω – 4.4 jΩ	
Return Loss	-25,8 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.393 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the leedpoint 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 digore 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	November 27, 2006	

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DASY5 Validation Report for Head TSL

Date: 22.08.2018

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; $\sigma = 0.92 \text{ S/m}$; $\varepsilon_c = 40.7$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.9, 9.9, 9.9) @ 835 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)

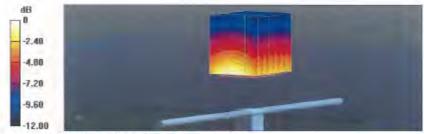
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 62,96 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 3.70 W/kg

SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.55 W/kg

Maximum value of SAR (measured) = 3.25 W/kg



0 dB = 3.25 W/kg = 5.12 dBW/kg

Certificate No: D835V2-4d063_Aug18

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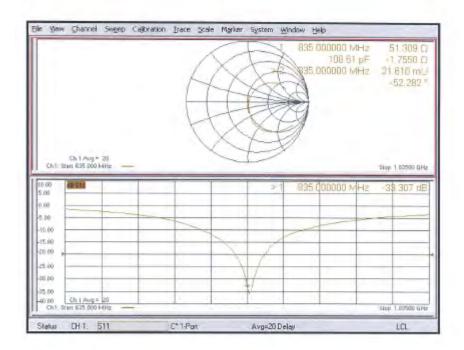
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Impedance Measurement Plot for Head TSL



Certificate No: D635V2-4d063_Aug18

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DASY5 Validation Report for Body TSL

Date: 23.08.2018

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; $\sigma = 0.99$ S/m; $\epsilon_0 = 54.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

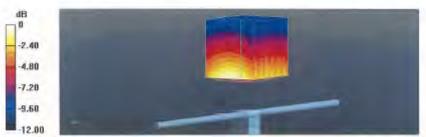
DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.05, 10.05, 10.05) @ 835 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 = 60.67 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 3.61 W/kg

SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.59 W/kgMaximum value of SAR (measured) = 3.23 W/kg



0 dB = 3.23 W/kg = 5.09 dBW/kg

Certificate No: D635V2-4d063_Aug18

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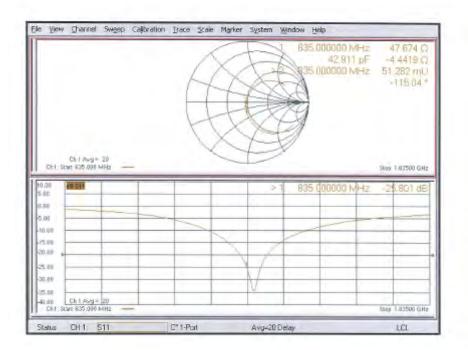
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Impedance Measurement Plot for Body TSL



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SGS-TW (Auden)

Certificate No: D1750V2-1008_Aug18

Object	D1750V2 - SN:11	800	
Delibration procedure(s)	QA CAL-05.v10 Cal bratien proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	August 30, 2018		
The measurements and the uncer	tainties with confidence p	ional standards, which realize the physical un robublity are given on the following pages an ry facility: enwronment temperature (22 ± 3)° (id are part of the certificate.
Primary Standards	IDE	Car Date (Certificate No.)	Scheduled Calibration
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 (204) SN: 5047.2706327 SN: 7349 SN: 601	04-Apr-18 (No. 217-02672/02673) 04-Apr-18 (No. 217-02672) 04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-02682) 04-Apr-16 (No. 217-02683) 30-Dec-17 (No. EXS-7349, Dec-17) 26-Det-17 (No. DAE4-601_Oc117)	Apr-19 Apr-19 Apr-19 Apr-19 Dec-18 Oct-18
	ID #	Chack Date (in house)	Scheduled Check
Secondary Standards			In house check: Oct-18 In house check: Oct-18
Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A TF generator R&S SMT-06 Network Analyzer Agilant E8388A	SN: GB37490704 GN: UB37292783 SN: MY41082317 SN: 100872 SN: US41080477	87-0ct-15 (in house check Oct-15) 87-0ct-15 (in house check Oct-16) 47-0ct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-17)	In house check: Oct-18 In house check: Oct-18
Power meter EFM-442A Power sensor HF 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: US37232783 SN: MY41082317 SN: 100972	87-Oct-15 (in house check Oct-16) 87-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-18)	In house check: Oct-18
Power meter EFM-442A Power sensor HF 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: US37292783 SN: MY41082317 SN: 100972 SN: US41080477	97-0ct-15 (in house check Oct-16) 97-0ct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-17)	In house check: Oct-18 In house check: Oct-18

Certificate No: D1750V2-1008_Aug18

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





5 Schweizerischer Kalibrierdienwi Service suissa d'élatonnege C Servizio svizzero di teratura Swiss Calibration Service

Accreditation No.: SCS 0108

According by the Swigs Accordington Service (SAS). The Swiss Accreditation Service in one of the signatories to the EA Mullilateral 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
- 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 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.
- Anienna 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 priented 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%.

Certificate No: D1750V2-1008_Aup18

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No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803/新北市五股區新北產業園區五工路 134 號 t (886-2) 2299-3279 f (886-2) 2298-0488

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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

	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 ¹ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.07 W/kg
SAR for cominal Head TSL parameters	normalized to 1W	36.5 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.B1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.3 W/kg ± 16.5 % (k=2)

Body TSL parameters

ng parameters and calculations were applied.

	Temperatura	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/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 ³ (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 \O + 1.6 JQ	
Ratum Loss	+ 32.2 pH	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.3 Ω ± 0.6 jΩ	
Return Loss	- 34.7 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1:207 ns
The state of the s	(140)

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

Certificate No. D1750V2-1008_Aug18

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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/m³

Phantom section: Flat Section

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

DASY52 Configuration:

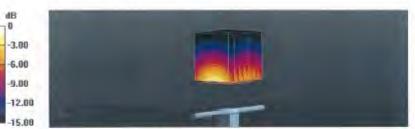
- Probe: EX3DV4 SN7349; ConvF(8.5, 8.5, 8.5) @ 1750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

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

Certificate No: D1750V2-1008_Aug18

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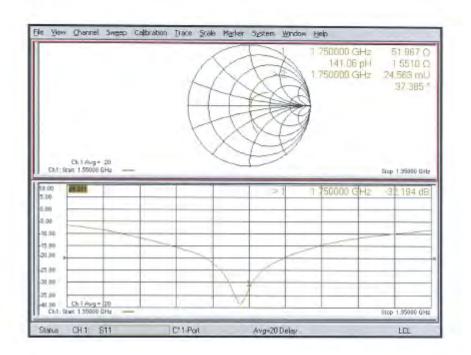
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Impedance Measurement Plot for Head TSL



Certificate No: D1750V2-1008_Aug18

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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)

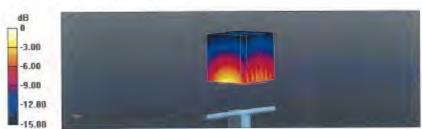
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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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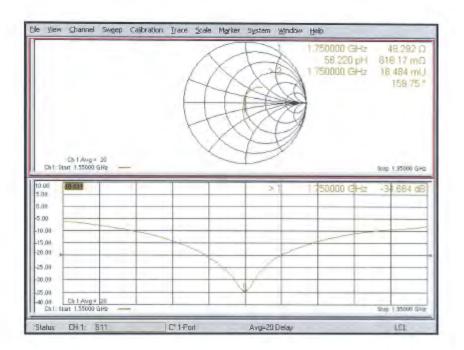
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Impedance Measurement Plot for Body TSL



Certificate No: D1750V2-1008_Aug18

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Accreditation No.: SCS 0108

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SGS-TW (Auden)

Certificate No: D1900V2-5d173_Apr19

Object	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		
		ional standards, which realize the physical uni robability are given on the following pages an	
All calibrations have been conducted Calibration Equipment used (M&TE		ry facility: environment temperature (22 \pm 3)°C	and humidity < 70%.
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
ower meter NRP			
	Carrie Control Control		
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 103244 SN: 103245	03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893)	Apr-20 Apr-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 103244 SN: 103245 SN: 5058 (20k)	03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894)	Apr-20 Apr-20 Apr-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327	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
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 103244 SN: 103245 SN: 5058 (20k)	03-Apr-19 (No. 217-02892) 03-Apr-19 (No. 217-02893) 04-Apr-19 (No. 217-02894)	Apr-20 Apr-20 Apr-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349	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 Dec-19
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	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 Dec-19 Oct-19 Scheduled Check
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	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 sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	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 Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	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 Dec-19 Oct-19
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 RF generator R&S SMT-06	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) 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 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 RF generator R&S SMT-06 Network Analyzer Agilent E8358A	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) 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) 15-Jun-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
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: 103244 SN: 103245 SN: 5058 (20K) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	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)	Apr-20 Apr-20 Apr-20 Apr-20 Dec-19 Oct-19 Scheduled Check In house check: Oct-20

Certificate No: D1900V2-5d173_Apr19

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





Schweizerischer Kalibrierdienst C

Service suisse d'étalonnage

Servizio svizzero di taratura Swiss Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

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 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 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)

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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

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; 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

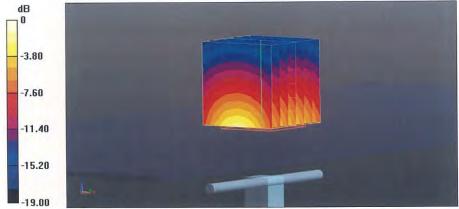
Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001

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

Certificate No: D1900V2-5d173_Apr19

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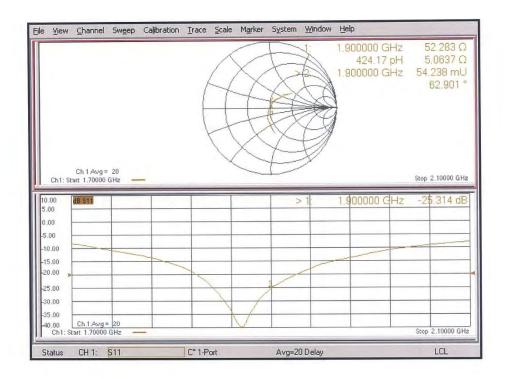
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Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d173_Apr19 Page 6 of 6

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SGS-TW (Auden)

Certificate No: D2300V2-1023 Aug 18

CALIBRATION C	ERTIFICATI		
Object	D2300V2 - SN-1023		
Calibration procedure(s)	QA CAL-05.v10 Calibration proce	edure for dipole validation kits ab	оvв 700 MHz
Calibration date:	August 24, 2018		
The measurements and the uncert	ainties with confidence of	ional standards, which realize the physical or probability are given on the following pages a my facility: environment temperature (22 ± 3)	nd are part of the certificate.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
ower meter NRP	SN: 104776	04-Apr-18 (No. 217-02672/02673)	Apr-19
ower sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
ower sensor NRP-ZBT	SN: 103245	04-Apr-18 (No. 217-02073)	Apr-19
elerence 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19
ype-N mismatch combination eterence Probe EX3DV4	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-18
AE4	SN: 7849 SN: 601	30-Dec-17 (No. EX3-7349_Dec17) 28-Det-17 (No. DAE4-601_Oct17)	Dec-18 Oct-18
econdary Standards	ID#	Check Date (in house)	Scheduled Check
ower meter EPM-442A	SN: GB37480704	97-Oct-15 (in house check Oct-15)	In house check: Oct-16
ower sensor HP 8481A.	BN: US37292753	07-Oct-16 (in house check Oct-16)	in house check; Oct-18
ower sensor HP 8481A.	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check Oct-16
Figenerator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-16
etwork Analyzer Agilem EB358A	SN: US41080477	31-Mar-14 (in house check Oct-17)	In house check: Oct-16
	Name	Function	Signature
alteraled by:	Manu Seitz	Laboratory Technician	Alis-
pproved by:	Kalla Politisis	Ceclinical Manager	Tom.
			Issued: August 24, 201

Certificate No: D2300V2-1023_Aug18

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Engineering AG
Zeughausstrasse 49, 1904 Zurich, Switzerland





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S Swisk 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:

- 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
- ib) 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 priented
 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%.

Certificate No: D2300V2-1023 Aug 18

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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 Phantem	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz =5 mm	
Frequency	2300 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.5	1.67 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.2 ± 6 %	1.70 mho/m ± 6 %
Head TSL temperature change during test	× 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW Input power	12.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	48.4 W/kg a 17.0 % (k=2)

SAR averaged over 10 cm ² (10 g) of Head TSL	condition	
SAR measured	250 mW Input power	5.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 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	52.9	1,81 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.2 ± 6 %	1.85 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	12.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	47.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ² (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.86 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.2 W/kg ± 15.5 % (k=2)

Certificate No: D2300V2-1023_Aug18

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.5 Ω - 2.1 jΩ	
Relum Loss	-33.5 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point.	45.4 Ω - 0.9 Ω
Return Loss	: 26,1 dB

General Antenna Parameters and Design

Eléctrical Delay (one direction)	1.171 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 somittigd coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antanna is therefore shart-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 band or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG	
Manufactured on	March 30, 2009	

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DASY5 Validation Report for Head TSL

Date: 23.08.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1023

Communication System: UID 0 - CW; Frequency: 2300 MHz

Medium parameters used: f = 2300 MHz; $\sigma = 1.7$ S/m; $\epsilon_r = 38.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.08, 8.08, 8.08) @ 2300 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 = 114.4 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 23.7 W/kg

SAR(1 g) = 12.3 W/kg; SAR(10 g) = 5.93 W/kg

Maximum value of SAR (measured) = 19.8 W/kg



0 dB = 19.8 W/kg = 12.97 dBW/kg

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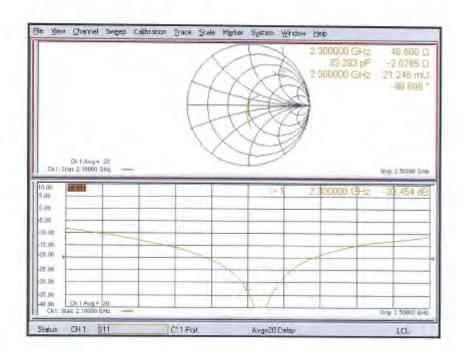
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Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 24.08.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1023

Communication System: UID 0 - CW; Frequency: 2300 MHz

Medium parameters used: f = 2300 MHz; $\sigma = 1.85 \text{ S/m}$; $\varepsilon_r = 52.2$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

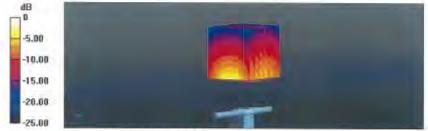
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.08, 8.08, 8.08) @ 2300 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 = 108.1 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 22.8 W/kg SAR(1 g) = 12.1 W/kg; SAR(10 g) = 5.86 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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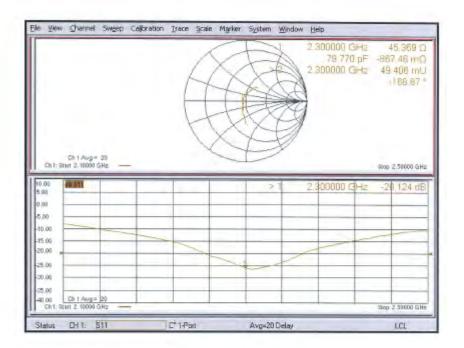
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Impedance Measurement Plot for Body TSL



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





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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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Multilateral Agreement for the recognition of calibration certificates

SGS-TW (Auden) Certificate No: D2450V2-727_Apr19 CALIBRATION CERTIFICATE 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 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) 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 Reference 20 dB Attenuator SN: 5058 (20k) 04-Apr-19 (No. 217-02894) Apr-20 Type-N mismatch combination SN: 5047.2 / 06327 04-Apr-19 (No. 217-02895) Apr-20 Reference Probe EX3DV4 SN: 7349 31-Dec-18 (No. EX3-7349_Dec18) Dec-19 DAE4 SN: 601 04-Oct-18 (No. DAE4-601_Oct18) Oct-19 Secondary Standards ID# Check Date (in house) Scheduled Check Power meter E4419B SN: GB39512475 07-Oct-15 (in house check Feb-19) In house check: Oct-20 Power sensor HP 8481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Oct-20 Power sensor HP 8481A SN: MY41092317 07-Oct-15 (in house check Oct-18) In house check: Oct-20 RF generator R&S SMT-06 SN: 100972 15-Jun-15 (in house check Oct-18) In house check: Oct-20 Network Analyzer Agilent E8358A SN: US41080477 31-Mar-14 (in house check Oct-18) In house check: Oct-19 Name Function Calibrated by: Claudio Leubler Laboratory Technician Katja Pokovic Approved by: Technical Manager Issued: April 24, 2019 This calibration certificate shall not be reproduced except in full without written approval of the laboratory

Certificate No: D2450V2-727_Apr19 Page 1 of 6

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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

Glossary:

TSL

tissue simulating liquid

ConvF N/A

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	2542	****

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 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 Ω + 2.9 jΩ	
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

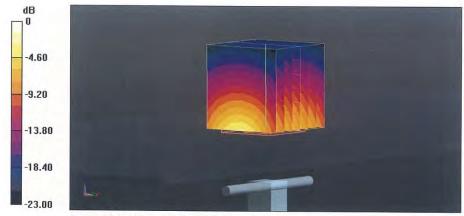
Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001

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

Certificate No: D2450V2-727_Apr19

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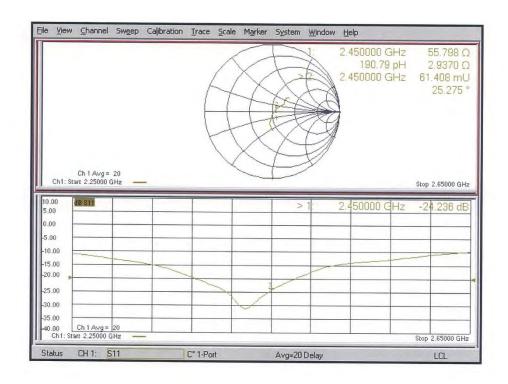
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Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-727_Apr19 Page 6 of 6

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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

SGS-TW (Auden)

Certificate No: D2600V2-1005_Jan19

	ERTIFICATE		
Object	D2600V2 - SN:10	005	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	edure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	January 28, 2019)	
This calibration certificate document	nts the traceability to nat	ional standards, which realize the physical un	its of measurements (SI).
The measurements and the uncert	ainties with confidence p	probability are given on the following pages an	nd are part of the certificate.
All calibrations have been conducted	ed in the closed laborato	ry facility: environment temperature (22 ± 3)°0	C and humidity < 70%.
Calibration Equipment used (M&TE	E critical for calibration)		
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
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
Deference OO dD Attancetor	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19
Hererence 20 dB Attenuator	ON: FO 47 O / OCCOT		
Reference 20 dB Attenuator Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19
Type-N mismatch combination	SN: 5047.27 06327 SN: 7349	04-Apr-18 (No. 217-02683) 31-Dec-18 (No. EX3-7349_Dec18)	Apr-19 Dec-19
Type-N mismatch combination Reference Probe EX3DV4	Erro Barrado acama		
Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 7349	31-Dec-18 (No. EX3-7349_Dec18)	Dec-19
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 7349 SN: 601	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18)	Dec-19 Oct-19
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A	SN: 7349 SN: 601	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house)	Dec-19 Oct-19 Scheduled Check
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A	SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Oct-18)	Dec-19 Oct-19 Scheduled Check In house check: Oct-20
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A RF generator R&S SMT-06	SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A RF generator R&S SMT-06	SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	Dec-19 Oct-19 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
	SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	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
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: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Oct-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)	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 In house check: Oct-19
Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by:	SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 Name Manu Seitz	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 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) Function Laboratory Technician	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 In house check: Oct-19
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: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	31-Dec-18 (No. EX3-7349_Dec18) 04-Oct-18 (No. DAE4-601_Oct18) Check Date (in house) 07-Oct-15 (in house check Oct-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-Mar-14 (in house check Oct-18)	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 In house check: Oct-19

Certificate No: D2600V2-1005_Jan19

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Glossarv:

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 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

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

Certificate No: D2600V2-1005 Jan19 Page 2 of 6

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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	2600 MHz ± 1 MHz) ————————————————————————————————————

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.3 ± 6 %	2.03 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	55.3 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.27 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	49.4 Ω - 4.0 jΩ
Return Loss	- 27.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 ns
The state of the s	

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
iviality by	SI EAG

Certificate No: D2600V2-1005 Jan19

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DASY5 Validation Report for Head TSL

Date: 28.01.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1005

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

Medium parameters used: f = 2600 MHz; $\sigma = 2.03$ S/m; $\varepsilon_r = 37.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(7.74, 7.74, 7.74) @ 2600 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 = 118.2 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 28.9 W/kg SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.27 W/kg

SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.27 W/kg Maximum value of SAR (measured) = 23.9 W/kg



0 dB = 23.9 W/kg = 13.78 dBW/kg

Certificate No: D2600V2-1005_Jan19

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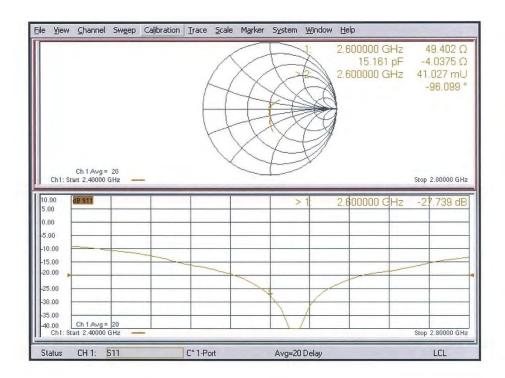
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Impedance Measurement Plot for Head TSL



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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

Certificate No: D5GHzV2-1023_Jan19

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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA

Multilateral Agreement for the recognition of calibration certificates

Glossary:

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
- 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
- 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 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 ³ (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 ³ (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	1000	

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	8.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	85.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (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 ³ (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 ³ (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

Electrical Delay (one direction)	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,

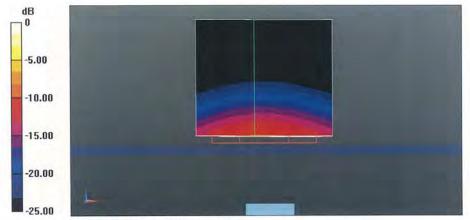
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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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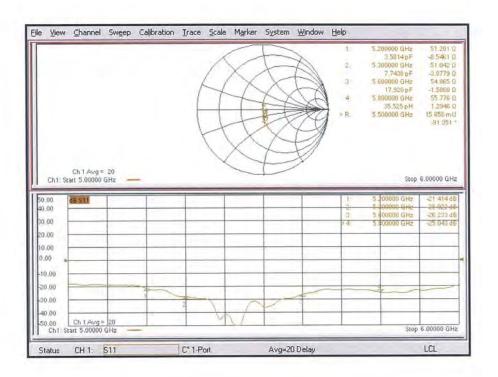
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Impedance Measurement Plot for Head TSL



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- End of report -

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