

Appendix C

Phantom Description

Schmid & Partner/ Engineering AG

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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	

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а

Tests

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 standarda	Bottom elliptical 600 × 400 mm, Depth 190 mm, dimension compliant with [1] for t > 375 MHz	Prototypes
Material thickness	Bottom: 2.0mm +/- 0.2mm	dimension compliant with [3] for f > 800 MHz	ali
Material parameters	rel. permittivity 2 - 5, loss tangent < 0.05, at Y < 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
 [4] 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

Conformity

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.

Date 25.7.2011

Signature / Stamp



Doc No 881- QD OVA 002 A - A

1.01 Page

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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System Validation from Original Equipment Supplier

uginauaati aaae 40, 0004 zuiton,	Switzerland	Soundarian States States S	Swiss Calibration Service
ccredited by the Swiss Accreditation he Swiss Accreditation Service in ultilateral Agreement for the rec	is one of the signatorie	s to the EA	ccreditation No.: SCS 0108
SGS-TW (Auden			o: D2450V2-727_Apr21
Dbject	D2450V2 - SN:72		
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	s between 0.7-3 GHz
Calibration date:	April 14, 2021		
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Glossary.

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Certificate No: D2450V2-727_Apr21

Page 2 of 8

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Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	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	38.0 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.9 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL		
SAR averaged over to cin (to g) of head ISL	condition	
SAR averaged over 10 cm (10 g) of head TSL	250 mW input power	6.36 W/kg

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.4 ± 6 %	2.04 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.4 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 250 mW input power	6.15 W/kg

Certificate No: D2450V2-727_Apr21

Page 3 of 8

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.4 Ω + 2.9 jΩ	
Return Loss	- 23.6 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.9 Ω + 4.8 jΩ	
Return Loss	- 25.9 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.148 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: D2450V2-727 Apr21

Page 4 of 8

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DASY5 Validation Report for Head TSL

Date: 14.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

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

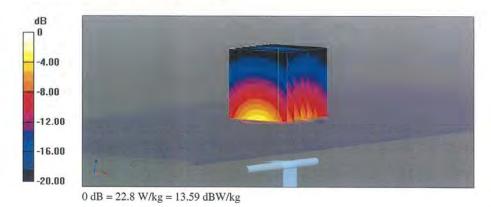
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; $\sigma = 1.87 \text{ S/m}$; $\varepsilon_r = 38.0$; $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection) •
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483) .

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 118.9 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 27.6 W/kg SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.36 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 49.9% Maximum value of SAR (measured) = 22.8 W/kg



Certificate No: D2450V2-727 Apr21

Page 5 of 8

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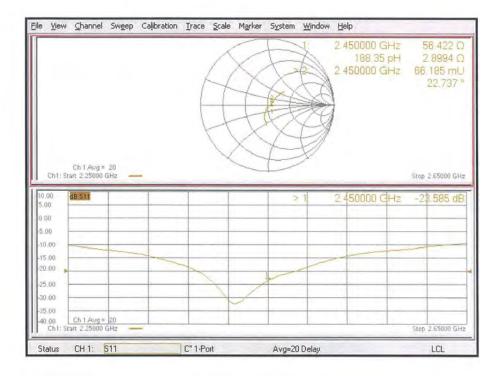
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Report No. :EN/2021/C0030 Rev: 01 Page: 7 of 43

Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-727_Apr21

Page 6 of 8

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DASY5 Validation Report for Body TSL

Date: 14.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

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

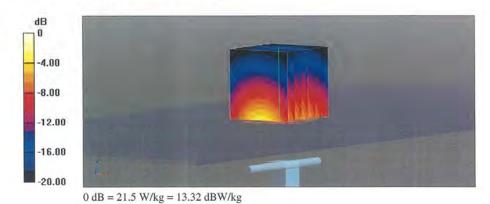
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; $\sigma = 2.04 \text{ S/m}$; $\varepsilon_t = 51.4$; $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection) ٠
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020 .
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002 .
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483) .

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 111.4 V/m; Power Drift = -0.00 dB Peak SAR (extrapolated) = 25.2 W/kg SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.15 W/kg Smallest distance from peaks to all points 3 dB below = 8 mm Ratio of SAR at M2 to SAR at M1 = 53.1% Maximum value of SAR (measured) = 21.5 W/kg



Certificate No: D2450V2-727_Apr21

Page 7 of 8

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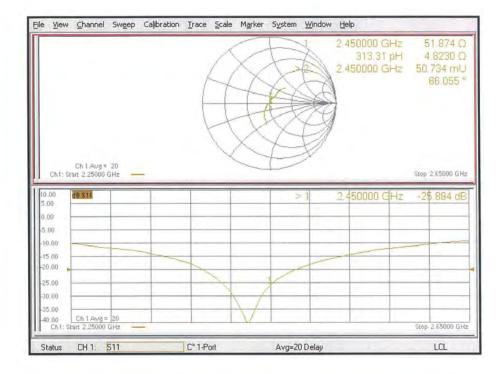
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Report No. : EN/2021/C0030 Rev: 01 Page: 9 of 43

Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-727_Apr21

Page 8 of 8

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Client SGS-TW (Aud		Land Long Land	No: D5GHzV2-1023_Jan21
CALIBRATION	CERTIFICAT	E	
Object	D5GHzV2 - SN:	1023	
Calibration procedure(s)	QA CAL-22.v5 Calibration Proc	edure for SAR Validation Source	s between 3-10 GHz
Calibration date:	January 26, 202	1	
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Certificate No: D5GHzV2-1023_Jan21

Page 1 of 15

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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

- 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"

TSL ConvF N/A

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 obtains are evaluated in the valuation in the valuation in the certificate are valuated in the certificate are valuated
- point exactly below the center marking of the flat phantom section, with the arms oriented
- point exactly below the center marking of the nat 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: D5GHzV2-1023 Jan21

Page 2 of 15

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Measurement Conditions

DASY	system	configuration,	as f	ar a	s not	given	on	page	٩.,

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 10.0 mm, dz = 10.0 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

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.1 ± 6 %	4.46 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		(mente)

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.84 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	77.9 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.24 W/kg

Certificate No: D5GHzV2-1023 Jan21

Page 3 of 15

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Head TSL parameters at 5300 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.0 ± 6 %	4.56 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 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 averaged over 10 cm ² (10 g) of Head TSL SAR measured	condition 100 mW input power	2.30 W/kg
		2.30 W/kg 22.8 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	34.5 ± 6 %	4.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

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	8.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.9 W/kg ± 19.9 % (k=2)
SAP averaged over 10 cm ³ (10 c) of Head TCI	and differe	,
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	,
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.39 W/kg

Certificate No: D5GHzV2-1023 Jan21

Page 4 of 15

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Head TSL parameters at 5800 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.2 ± 6 %	5.07 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		in the second

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	8.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.9 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	2.28 W/kg

Certificate No: D5GHzV2-1023 Jan21

Page 5 of 15

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Body TSL parameters at 5200 MHz

and the second sec	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.4 ± 6 %	5.44 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	73.9 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 a) of Body TSI	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 100 mW input power	2.04 W/kg

Body TSL parameters at 5300 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.2 ± 6 %	5.57 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	-	

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.32 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	73.4 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 100 mW input power	2.02 W/kg

Certificate No: D5GHzV2-1023 Jan21

Page 6 of 15

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Body TSL parameters at 5600 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.7 ± 6 %	5.99 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.79 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	78.1 W/kg ± 19.9 % (k=2)
CAR		
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
	condition 100 mW input power	2.13 W/kg
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured SAR for nominal Body TSL parameters		2.13 W/kg 21.4 W/kg ± 19.5 % (k≕

Body TSL parameters at 5800 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.3 ± 6 %	6.27 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.36 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	73.8 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 100 mW input power	2.00 W/kg

Certificate No: D5GHzV2-1023 Jan21

Page 7 of 15

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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	49.5 Ω - 6.9 jΩ
Return Loss	- 23.2 dB
enna Parameters with Head TSL at 5300 MH	łz
Impedance, transformed to feed point	51.3 Ω - 3.0 jΩ
Return Loss	- 29.8 dB
enna Parameters with Head TSL at 5600 MH	Iz
Impedance, transformed to feed point	53.3 Ω + 0.1 jΩ
Return Loss	- 29.9 dB
Return Loss	54.1 Ω + 2.7 jΩ - 26.6 dB
Impedance, transformed to feed point	54.1 Ω + 2.7 jΩ
enna Parameters with Body TSL at 5200 MH	-
The and the second with body TOL at 5200 With	12
Impedance, transformed to feed point	51.8 Ω - 6.0 jΩ
Impedance, transformed to feed point Return Loss	51.8 Ω - 6.0 jΩ - 24.2 dB
	- 24.2 dB
Return Loss	-24.2 dB
Return Loss	- 24.2 dB
Return Loss Pnna Parameters with Body TSL at 5300 MH Impedance, transformed to feed point	- 24.2 dB z 51.9 Ω - 1.0 jΩ - 33.6 dB
Return Loss Impadance, transformed to feed point Return Loss	- 24.2 dB z 51.9 Ω - 1.0 jΩ - 33.6 dB

Certificate No: D5GHzV2-1023 Jan21

Page 8 of 15

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Antenna Parameters with Body TSL at 5800 MHz

mpedance, transformed to feed point	56.2 Ω + 5.1 jΩ
Return Loss	~ 22.5 dB
ral Antenna Parameters and Design	

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: D5GHzV2-1023 Jan21 Page 9 of 15

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Date: 25.01.2021

DASY5 Validation Report for Head TSL

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: 5800 MHz MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz; $\sigma = 4.46$ S/m; $\epsilon_r = 35$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5500 MHz; $\sigma = 4.56$ S/m; $\epsilon_r = 34$, $\rho = 1000$ kg/m³, Medium parameters used: f = 5600 MHz; $\sigma = 4.86$ S/m; $\epsilon_r = 34.5$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5600 MHz; $\sigma = 4.86$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5800 MHz; $\sigma = 4.86$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5800 MHz; $\sigma = 0.07$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.8, 5.8, 5.8) @ 5200 MHz, ConvF(5.49, 5.49, 5.49) @ 5300 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 30,12,2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=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 = 78.88 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 27.4 W/kg SAR(1 g) = 7.84 W/kg; SAR(10 g) = 2.24 W/kg Smallest distance from peaks to all points 3 dB below = 6.9 mmRatio of SAR at M2 to SAR at M1 = 69.2%

Maximum value of SAR (measured) = 17.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, bipote Cantoration for Head Tissde/Pin=100m/w, dist=10mm, r=5300 M dist=1.4mm (8x8x7)/Cube 0; Measurement grid; dx=4mm, dy=4mm, dz=1.4mm Reference Value = 77.25 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 28.6 W/kg SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.3 W/kg Smallest distance from peaks to all points 3 dB below = 6.9 mm Ratio of SAR at M2 to SAR at M1 = 68.9% Maximum value of SAR (measured) = 18.1 W/kg

Certificate No: D5GHzV2-1023 Jan21

Page 10 of 15

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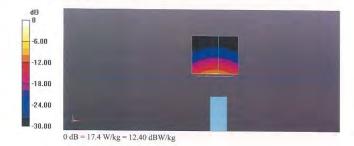
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Report No. : EN/2021/C0030 Rev: 01 Page: 20 of 43

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 = 78.54 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 31.0 W/kg SAR(1 g) = 8.46 W/kg; SAR(10 g) = 2.39 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 67.5%Maximum value of SAR (measured) = 19.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 M dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 75.89 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 32.1 W/kg SAR(1 g) = 8.16 W/kg; SAR(10 g) = 2.28 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 65.2% Maximum value of SAR (measured) = 19.1 W/kg



Certificate No: D5GHzV2-1023 Jan21 Page 11 of 15

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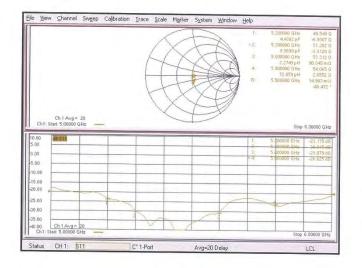
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Impedance Measurement Plot for Head TSL



Certificate No: D5GHzV2-1023 Jan21 Page 12 of 15

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Date: 26.01.2021

DASY5 Validation Report for Body TSL

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

Communication system. Or 0.5×0.5 , requeries, 5205 MHz, requeries, 5205 MHz, Frequency: 5800 MHz MHz, Frequency: 5800 MHz Medium parameters used: f = 5200 MHz; $\sigma = 5.44$ S/m; $c_r = 49.4$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5300 MHz; $\sigma = 5.57$ S/m; $c_r = 49.2$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5600 MHz; $\sigma = 6.27$ S/m; $c_r = 48.3$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.29, 5.29, 5.29) @ 5200 MHz, ConvF(5.23, 5.23, 5.23) @ 5300 MHz, ConvF(4.79, 4.79, 4.79) @ 5600 MHz, ConvF(4.62, 4.62, 4.62) @ 5800 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601: Calibrated: 02 11 2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6,14(7483)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, by Dot California (i) Solve 1: Subset in From w, dist-1011111, 1-3200 MI dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 67.79 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 28.2 W/kg SAR(1 g) = 7.37 W/kg; SAR(10 g) = 2.04 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 67%

Maximum value of SAR (measured) = 17.3 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, Dipote Calibration for Body Tissue/Pin=100mW, dist=10mm, i=5300 M, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 66.64 V/m; Power Drift = -0.02 dBPeak SAR (extrapolated) = 29.2 W/kgSAR(1 g) = 7.32 W/kg; SAR(10 g) = 2.02 W/kgSmallest distance from peaks to all points 3 dB below = 6.8 mmRatio of SAR at M2 to SAR at M1 = 65.4%Maximum value of SAR (measured) = 17.7 W/kg

Certificate No: D5GHzV2-1023 Jan21

Page 13 of 15

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Report No. : EN/2021/C0030 Rev: 01 Page: 23 of 43

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, Dipote Cantor atom for Body 11stder/hm=100m/w, dist=10mm, r=5600 M dist=1.4mm (8x8x7)/Cobb 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 66.51 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 33.7 W/kg SAR(1 g) = 7.79 W/kg; SAR(10 g) = 2.13 W/kg Smallest distance from peaks to all points 3 dB below = 6.8 mm Ratio of SAR at M2 to SAR at M1 = 62.8%Maximum value of SAR (measured) = 19.3 W/kg

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

by the calibration for bury result in 100 m/s, dist=10 mm, i=5800 M dist=1.4 mm (8x8x7)/Cube 0: Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm Reference Value = 64.18 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 32.5 W/kg SAR(1 g) = 7.36 W/kg; SAR(10 g) = 2 W/kg Smallest distance from peaks to all points 3 dB below = 6.8 mmRatio of SAR at M2 to SAR at M1 = 62.2%Maximum value of SAR (measured) = 18.4 W/kg



Certificate No: D5GHzV2-1023 Jan21 Page 14 of 15

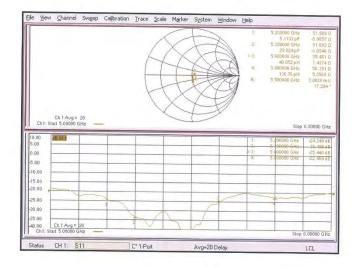
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Impedance Measurement Plot for Body TSL



Page 15 of 15

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accredited by the Swiss Accreditati The Swiss Accreditation Service			creditation No.: SCS 0100
fultilateral Agreement for the red	cognition of calibration	certificates	
Client SGS (Auden)		Certificate No	: D6.5GHzV2-1006_Aug21
CALIBRATION C	ERTIFICATE		
Object	D6.5GHzV2 - SN	1:1006	
Calibration procedure(s)	QA CAL-22.v6 Calibration Proce	edure for SAR Validation Sources	between 3-10 GHz
Calibration date:	August 26, 2021		
The measurements and the uncert	taintles with confidence p	ional standards, which realize the physical un robability are given on the following pages ar ny facility: environment temperature $(22 \pm 3)^{\circ}$	nd are part of the certificate.
The measurements and the uncert All calibrations have been conduct Calibration Equipment used (M&TI	tainties with confidence p ed in the closed laborato E critical for calibration)	robability are given on the following pages ar ny facility: environment temperature $(22 \pm 3)^{\circ}$	nd are part of the certificate. C and humidity < 70%.
The measurements and the uncert	tainties with confidence p ed in the closed laborato	robability are given on the following pages ar	nd are part of the certificate.
The measurements and the uncert All calibrations have been conduct Calibration Equipment used (M&TI Primary Standards Power meter NRP	tainties with confidence p ed in the closed laborato E critical for calibration)	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration
The measurements and the uncert All calibrations have been conduct Calibration Equipment used (M&TI Primary Standards Power meter NRP Power sensor NRP-291	tainties with confidence p ed in the closed laborato E critical for calibration) ID # SN: 104778	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)°/ Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-22
The measurements and the uncert All calibrations have been conduct Calibration Equipment used (M&TI Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	tainties with confidence p ed in the closed laborato E critical for calibration) ID # SN: 104778 SN: 103244	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-22 Apr-22
The measurements and the uncert All calibrations have been conduct Calibration Equipment used (M&TI Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Power sensor R&S NRP33T	tainties with confidence p ed in the closed laborato E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245	robability are given on the following pages ar ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292)	nd are part of the certificate. C and humidity < 70%. Scheduled Calibration Apr-22 Apr-22 Apr-22 Apr-22
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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 - Swiss Calibration Service

Accreditation No.: SCS 0108

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

b) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The 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.
- 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 absorbed power density (APD): The absorbed power density is evaluated according to Samaras T, Christ A, Kuster N, "Compliance assessment of the epithelial or absorbed power density above 6 GHz using SAR measurement systems", Bioelectromagnetics, 2021 (submitted). The additional evaluation uncertainty of 0.55 dB (rectangular distribution) is considered.

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: D6.5GHzV2-1006_Aug21

Page 2 of 6

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Measurement Conditions

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

DASY Version	DASY6	V16.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	6500 MHz ± 1 MHz	the second second second

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	34.5	6.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.6 ± 6 %	6.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	2	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	291 W/kg ± 24.7 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	5.39 W/kg

Certificate No: D6.5GHzV2-1006_Aug21

Page 3 of 6

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Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	45.7 Ω - 6.6 jΩ
Return Loss	- 21.7 dB

APD (Absorbed Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	291 W/m ²
APD measured	normalized to 1W	2910 W/m ² ± 29.2 % (k=2)
APD averaged over 4 cm ²	e and this	
APD averaged over 4 cm	condition	
APD averaged over 4 cm APD measured	100 mW input power	132 W/m ²

General Antenna Parameters and Design

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

Manufasting d bu	NAT 21
Manufactured by	SPEAG

Certificate No: D6.5GHzV2-1006_Aug21

Page 4 of 6

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DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1006, UID 0 -, Channel 6500 (6500.0MHz)

	Test Properties						
Name, Manuf	acturer D	imensions	[mm] IN	1EI	DUT Typ	e	
D6.5GHz	4	16.0 x 6.0 x	300.0 SN	1: 1006	-		
Exposure Con	ditions						
Phantom	Position, Test	Band	Group,	Frequency	Conversion	TSL Cond.	TSL
Section, TSL	Distance [mm]		UID	[MHz]	Factor	[S/m]	Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.75	6.11	33.6
Hardware Set	up						
Phantom		SL		Probe, Calil	bration Date	DAE, Calib	oration Date
MFP V8.0 Cent	ter - 1182 H	BBL600-10	000V6	EX3DV4 - SI	N7405, 2020-12-30	DAE4 Sn90	08, 2021-06-24
Scan Setup				Measureme	ent Results		
			Zoom Scan				Zoom Sca
Grid Extents			22.0 x 22.0 x 22.0	Date		2	021-08-26, 10:5
Grid Steps [m			3.4 x 3.4 x 1.4	psSAR1g [W/Kg]		29.
Sensor Surfac	ce [mm]		1.4	psSAR10g	[W/Kg]		5.3
Graded Grid			Yes	Power Drif	ft [dB]		0.0
Grading Ratio	0		1.4	Power Sca	ling		Disable
MAIA			N/A	Scaling Fac	ctor [dB]		
Surface Deter	ction		VMS + 6p	TSL Correc	tion		No correctio
Scan Method	D.		Measured	M2/M1 [%	5]		50.
				Dist 3dB P	eak [mm]		4.



Certificate No: D6.5GHzV2-1006_Aug21

Page 5 of 6

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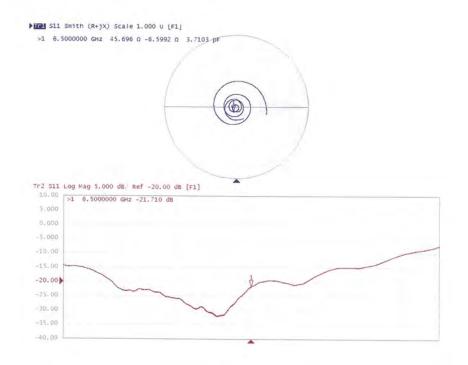
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Report No. :EN/2021/C0030 Rev: 01 Page: 30 of 43

Impedance Measurement Plot for Head TSL



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Page 6 of 6

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CALIBRATION C	ERTIFICATE		
Dbject	D7GHzV2 - SN:1	007	
Calibration procedure(s)	QA CAL-22.v6 Calibration Proce	edure for SAR Validation Sources	s between 3-10 GHz
Calibration date:	August 26, 2021		
All calibrations have been conduct	ed in the closed laborato	ry facility: environment temperature (22 \pm 3)°	C and humidity < 70%.
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor R&S NRP33T Reference 20 dB Attenuator Type-N mismatch combination	Critical for calibration)	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 08-Apr-21 (No. 217-03293) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344)	Scheduled Calibration Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor R&S NRP33T Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 100967 SN: BH9394 (20k)	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 08-Apr-21 (No. 217-03293) 09-Apr-21 (No. 217-03343)	Scheduled Calibration Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Power sensor R&S NRP33T Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	Critical for calibration)	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 08-Apr-21 (No. 217-03293) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 30-Dec-20 (No. EX3-7405_Dec20)	Scheduled Calibration Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21
All calibrations have been conduct Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor R&S NRP33T Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards RF generator Anapico APSIN20G Network Analyzer R&S ZVL13	Critical for calibration)	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 08-Apr-21 (No. 217-03293) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 30-Dec-20 (No. EX3-7405_Dec20) 24-Jun-21 (No. DAE4-908_Jun21)	Scheduled Calibration Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Jun-22
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor R&S NRP33T Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards RF generator Anapico APSIN20G Network Analyzer R&S ZVL13	Critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 100967 SN: BH9394 (20k) SN: 3H9394 (20k) SN: 3H9394 (20k) SN: 7405 SN: 908 ID # SN: 669	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 08-Apr-21 (No. 217-03293) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 30-Dec-20 (No. EX3-7405_Dec20) 24-Jun-21 (No. DAE4-908_Jun21) Check Date (in house) 28-Mar-17 (in house check Dec-18)	Scheduled Calibration Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Jun-22 Scheduled Check In house check: Dec-21
Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor R&S NRP33T Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards RF generator Anapico APSIN20G	Critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 100967 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7405 SN: 908 ID # SN: 669 SN: 101093 Name	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03293) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 30-Dec-20 (No. EX3-7405_Dec20) 24-Jun-21 (No. DAE4-908_Jun21) Check Date (in house) 28-Mar-17 (in house check Dec-18) 10-May-12 (in house check Dec-18)	Scheduled Calibration Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21 Jun-22 Scheduled Check In house check: Dec-21 In house check: Dec-21

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Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

b) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The 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.
- 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 absorbed power density (APD): The absorbed power density is evaluated according to Samaras T, Christ A, Kuster N, "Compliance assessment of the epithelial or absorbed power density above 6 GHz using SAR measurement systems", Bioelectromagnetics, 2021 (submitted). The additional evaluation uncertainty of 0.55 dB (rectangular distribution) is considered.

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: D7GHzV2-1007 Aug21

Page 2 of 6

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Measurement Conditions

DASY system configuration, as far as not given on pa	age	Ť.
------------------------------------------------------	-----	----

DASY Version	DASY6	V16.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	7000 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	33.9	6.65 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	32.7 ± 6 %	6.71 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	100 mW input power	27.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	275 W/kg ± 24.7 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 100 mW input power	4.78 W/kg

Certificate No: D7GHzV2-1007_Aug21

Page 3 of 6

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Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.9 Ω - 3.8 jΩ
Return Loss	- 26.6 dB

APD (Absorbed Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	274 W/m ²
APD measured	normalized to 1W	2740 $W/m^2 \pm 29.2 \%$ (k=2)
400 1 2	condition	
APD averaged over 4 cm ²	CONCINION	
APD averaged over 4 cm ⁻ APD measured	100 mW input power	119 W/m ²

General Antenna Parameters and Design

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
Manulactured by	SPEAG

Certificate No: D7GHzV2-1007_Aug21

Page 4 of 6

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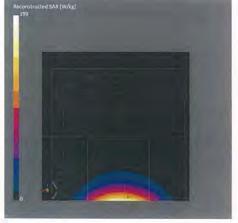
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DASY6 Validation Report for Head TSL

Measurement Report for D7GHz-1007, UID 0 -, Channel 7000 (7000.0MHz)

Name, Manufa	acturer D	imensions	[mm] IN	IEI	DUT Typ	e	
D7GHz	1	4.0 x 6.0 x	297.0 SN	1: 1007			
Exposure Cond	ditions						
Phantom	Position, Test	Band	Group,	Frequency	Conversion	TSL Cond.	TSL
ection, TSL	Distance [mm]		UID	[MHz]	Factor	[S/m]	Permittivity
lat, HSL	5.00	Band	CW,	7000	6.09	6.71	32.7
Hardware Set	up						
Phantom		SL		Probe, Calil	bration Date	DAE, Calib	oration Date
MFP V8.0 Cent	ter - 1182 H	HBBL600-10000V6 EX3DV4 - SN7405, 2020-12-30		DAE4 Sn908, 2021-06-2			
Scan Setup				Measureme	ent Results		
			Zoom Scan				Zoom Scar
Grid Extents	(mm)		22.0 x 22.0 x 22.0			021-08-26, 14:14	
Grid Steps [m	nm]		3.0 x 3.0 x 1.4	psSAR1g [W/Kg]			27.1
Sensor Surfac	ce [mm]		1.4	psSAR10g [W/Kg]		4.	
Graded Grid			Yes	Power Dri	ft [dB]		0.0
Grading Ratio			1.4		0		Disable
MAIA			N/A	0			
Surface Dete	ction	VMS + 6p				No correcti	
Scan Method	1		Measured				46.9
				Dist 3dB P	eak [mm]		4.6



Certificate No: D7GHzV2-1007_Aug21

Page 5 of 6

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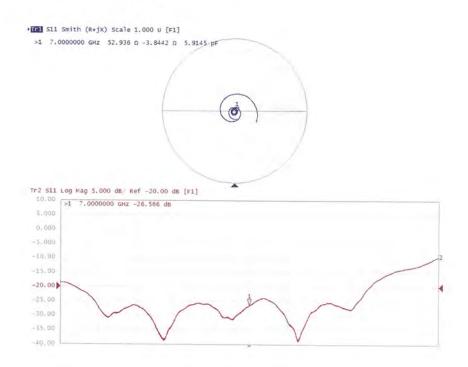
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Impedance Measurement Plot for Head TSL



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Page 6 of 6

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SGS-TW (Aude	en)	Certificate No: 5	G-Veri10-1021_Jan21
CALIBRATION	CERTIFICA	TE	
Object	5G Verification	Source 10 GHz - SN: 1021	
Calibration procedure(s)	QA CAL-45.v3 Calibration pro-	cedure for sources in air above 6 GH	z
Calibration date:	January 18, 20	21	
		ational standards, which realize the physical units on a probability are given on the following pages and a	
All calibrations have been condu	cted in the closed labora	atory facility: environment temperature (22 \pm 3)°C and	nd humidity < 70%.
Calibration Equipment used (M&	TE critical for calibration)	
Calibration Equipment used (M& Primary Standards) Cal Date (Certificate No.)	nd humidity < 70%. Scheduled Calibration Dec-21
Calibration Equipment used (M& Primary Standards Reference Probe EummWV3	TE critical for calibration)	Scheduled Calibration
All calibrations have been condu Calibration Equipment used (M& Primary Standards Reference Probe EummWV3 DAE4ip Secondary Standards	TE critical for calibration ID # SN: 9374) Cal Date (Certificate No.) 30-Dec-20 (No. EUmmWV3-9374_Dec20)	Scheduled Calibration Dec-21
Calibration Equipment used (M& Primary Standards Reference Probe EummWV3 DAE4ip	TE critical for calibration ID # SN: 9374 SN: 1602 ID #) Cal Date (Certificate No.) 30-Dec-20 (No. EUmmWV3-9374_Dec20) 11-Aug-20 (No. DAE4ip-1602_Aug20) Check Date (in house)	Scheduled Calibration Dec-21 Aug-21 Scheduled Check
Calibration Equipment used (M& Primary Standards Reference Probe EummWV3 DAE4ip Secondary Standards	TE critical for calibration ID # SN: 9374 SN: 1602) Cal Date (Certificate No.) 30-Dec-20 (No. EUmmWV3-9374_Dec20) 11-Aug-20 (No. DAE4ip-1602_Aug20)	Scheduled Calibration Dec-21 Aug-21 Scheduled Check
Calibration Equipment used (M& Primary Standards Reference Probe EummWV3 DAE4ip Secondary Standards	TE critical for calibration ID # SN: 9374 SN: 1602 ID # Name) Cal Date (Certificate No.) 30-Dec-20 (No. EUmmWV3-9374_Dec20) 11-Aug-20 (No. DAE4ip-1602_Aug20) Check Date (in house) Function	Scheduled Calibration Dec-21 Aug-21 Scheduled Check
Calibration Equipment used (M& Primary Standards Reference Probe EummWV3 DAE4ip	TE critical for calibration ID # SN: 9374 SN: 1602 ID #) Cal Date (Certificate No.) 30-Dec-20 (No. EUmmWVV3-9374_Dec20) 11-Aug-20 (No. DAE4ip-1602_Aug20) Check Date (in house) Function Laboratory Technician	Scheduled Calibration Dec-21 Aug-21 Scheduled Check

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Page 1 of 7

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Glossary

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45-5Gsources
- IEC TR 63170 ED1, "Measurement procedure for the evaluation of power density related to • human exposure to radio frequency fields from wireless communication devices operating between 6 GHz and 100 GHz", January 2018

Methods Applied and Interpretation of Parameters

- Coordinate System: z-axis in the waveguide horn boresight, x-axis is in the direction of the E-field, y-axis normal to the others in the field scanning plane parallel to the horn flare and horn flange.
- Measurement Conditions: (1) 10 GHz: The forward power to the horn antenna is measured prior and after the measurement with a power sensor. During the measurements, the horn is directly connected to the cable and the antenna ohmic and mismatch losses are determined by far-field measurements. (2) 30, 45, 60 and 90 GHz: The verification sources are switched on for at least 30 minutes. Absorbers are used around the probe cub and at the ceiling to minimize reflections.
- Horn Positioning: The waveguide horn is mounted vertically on the flange of the waveguide source to allow vertical positioning of the EUmmW probe during the scan. The plane is parallel to the phantom surface. Probe distance is verified using mechanical gauges positioned on the flare of the horn.
- E- field distribution: E field is measured in two x-y-plane (10mm, 10mm + $\lambda/4$) with a vectorial E-field probe. The E-field value stated as calibration value represents the E-fieldmaxima and the averaged (1cm² and 4cm²) power density values at 10mm in front of the hom.
- Field polarization: Above the open horn, linear polarization of the field is expected. This is verified graphically in the field representation.

Calibrated Quantity

Local peak E-field (V/m) and average of peak spatial components of the poynting vector (W/m²) averaged over the surface area of 1 cm² and 4cm² at the nominal operational frequency of the verification source. Both square and circular averaging results are listed.

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: 5G-Veri10-1021_Jan21

Page 2 of 7

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Measurement Conditions

DASY Version	cDASY6 Module mmWave	V2.2
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
XY Scan Resolution	dx, dy = 7.5 mm	
Number of measured planes	2 (10mm, 10mm + λ/4)	
Frequency	10 GHz ± 10 MHz	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture to Measured Plane	Prad¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
		T		1 cm ²	4 cm ²	
10 mm	74.0	134	1.27 dB	45.0	42.3	1.28 dB

Square Averaging

Distance Horn Aperture to Measured Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1 cm ²	4 cm ²	
10 mm	74.0	134	1.27 dB	45.1	42.2	1.28 dB

Assessed ohmic and mismatch loss: 0.45 dB

Certificate No: 5G-Veri10-1021_Jan21 Page 3 of 7

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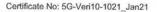
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Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Pro	operties				
Name, Manufacturer	Dimensions [mm	IMEI		DUT Type	
5G Verification Source 10 G	Hz 100.0 x 100.0 x 1	172.0 SN: 1	.021	-	
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band G		uency [MHz], nnel Number	Conversion Factor
5G -	10.0 mm	Validation band C	W 1000 1000	00.0, 00	1.0
Hardware Setup					
Phantom	Medium		Probe, Calibration Date		DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 - SN9374 F1-78	GHz,	DAE4ip Sn1602.
			2020-12-30		2020-08-11
Scan Setup			Measurement Results		
occur occup		5G Scan	Wiedsurement Nesures		5G Scan
Grid Extents [mm]		120.0 x 120.0	Date		2021-01-18, 16:23
Grid Steps [lambda]		0.25 x 0.25	Avg. Area [cm ²]		2021-01-18, 10.25
Sensor Surface [mm]		10.0	psPDn+ [W/m ²]		44.9
MAIA		MAIA not used	psPDtot+ [W/m ²]		45.0
		ininina not used	psPDmod+ [W/m ²]		45.2
			Emix [V/m]		134
			Power Drift [dB]		0.04
				_	
	sPDtot+ (1.0	lcm2, circ) [W/m^2]			
				-	



Page 4 of 7

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Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Factor
te
5G Scan
-01-18, 16:23
4.00
42.2
42.3
42.5
134
0.04



Certificate No: 5G-Veri10-1021_Jan21

Page 5 of 7

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Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Pro Name, Manufacturer	Dimensions (mm	1	IMEI	DUT Type	
5G Verification Source 10 G			SN: 1021		
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0
Hardware Setup					
Phantom	Medium		Probe, Calibrat	tion Date	DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 - S 2020-12-30	N9374_F1-78GHz,	DAE4ip Sn1602, 2020-08-11
Scan Setup			Measureme	ent Results	
		5G S			5G Scar
Grid Extents [mm]		120.0 × 12		21	2021-01-18, 16:23
Grid Steps [lambda] Sensor Surface [mm]		0.25 × 0			1.00
MAIA		MAIA not u	.0.0 psPDn+ [W/n sed psPDtot+ [W]		44.5
MIAIA		IVIAIA NOL U	psPDmod+ [V		45.2
			Emax [V/m]	ayın 1	134
			Power Drift	181	0.04
	sPDtot+ (1.0 45.1)cm2, sq) [W/m^2]			



Page 6 of 7

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Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

Device under Test Pro Name, Manufacturer			IMEI	DUT Type	
G Verification Source 10 Gl	Dimensions [mm] 5Hz 100.0 x 100.0 x 172.0			DOT Type	
G verification source 10 Gi	HZ 100.0 X 100.0 X 1	172.0	SN: 1021		
Exposure Conditions					
Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW	10000.0, 10000	1.0
Hardware Setup					
hantom	Medium		Probe, Calil	oration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air		EUmmWV3 2020-12-30	- SN9374_F1-78GHz,	DAE4ip Sn1602, 2020-08-11
Scan Setup				ment Results	
A.11.5		5G S			5G Scar
Grid Extents [mm] Grid Steps [lambda]		120.0 x 12 0.25 x 0		1	2021-01-18, 16:23
Sensor Surface [mm]			10.0 psPDn+ [\		4.00
MAIA		MAIA not u			42.3
			psPDmod		42.4
			Emax [V/m]		134
			Power Dri	ft [dB]	0.04
	sPDtor+ (4.0cm2, tel) [W/m*2] 42.3				

Certificate No: 5G-Veri10-1021_Jan21

Page 7 of 7

- End of report -

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