

# Appendix C

# **Phantom Description**

Schmid & Partner Engineering AG

е a g S р

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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

#### 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 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 [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

speag Schmid & Partner-Engineering/AG Zeugbarestrasse 43, 8004 Zeich, Smithiand Phone/441 44/255 9708, Few-444 64 44 59779

Doc No 881 - QD OVA 002 A - A

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# System Validation from Original Equipment Supplier

The Swiss Accreditation Service Aultilateral Agreement for the		es to the EA	ccreditation No.: SCS 0108
Client SGS-TW (Aud			o: D2450V2-727 Apr22
CALIBRATION	CERTIFICATI		
Object	D2450V2 - SN:7	27	
Calibration procedure(s)	QA CAL-05.v11	edure for SAR Validation Sources	botween 0.7.9 CHr
	Galibration ( 1000		between 0.7-3 GHz
Calibration date:	April 25, 2022		
The measurements and the unc All calibrations have been condu	ertainties with confidence p cted in the closed laborato	ional standards, which realize the physical ur robability are given on the following pages ar ny facility: environment temperature $(22 \pm 3)^{\circ}$	nd are part of the certificate.
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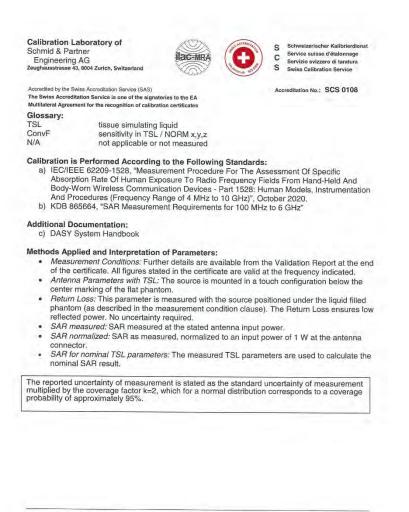
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#### **Measurement Conditions**

DASY Version	DASY52	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

	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		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.8 W/kg ± 17.0 % (k=2)
SAB averaged over 10 cm <sup>3</sup> (10 d) of Head TSI	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.34 W/kg

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.7 Ω + 3.0 jΩ
Return Loss	- 24.4 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 ns
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The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is diractly 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: 25.04.2022

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

Measurement grid: (x = 5mm, dy = 5mm, dz = 5mm)Reference Value = 115.6 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 26.5 W/kg SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.34 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51% Maximum value of SAR (measured) = 22.1 W/kg



Certificate No: D2450V2-727\_Apr22

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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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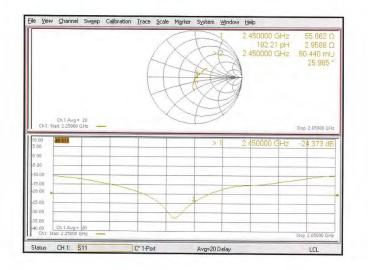
No.134,Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan/新北市五股區新北產業園區五工路 134 號 SGS Taiwan Ltd.

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Impedance Measurement Plot for Head TSL



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## Report No. : TESA2212000594ES Page: 8 of 34

eughausstrasse 43, 8004 Zurich	, Switzerland	BICMEA (C) S	Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
Accredited by the Swiss Accreditati The Swiss Accreditation Service Aultilateral Agreement for the red	is one of the signatorie	es to the EA	ccreditation No.: SCS 0108
Client SGS (Auden)	EDTIEICAT		o: D5GHzV2-1023_Jan22
CALIBRATION C	ERTIFICAT	E.	
Object	D5GHzV2 - SN:1	1023	
Calibration procedure(s)	QA CAL-22.v6 Calibration Proce	edure for SAR Validation Sources	s between 3-10 GHz
Calibration date:	January 27, 2022	2	
The measurements and the uncert	an ann a fairteach carb	,	
All calibrations have been conducte	ed in the closed laborator	ry facility: environment temperature $(22 \pm 3)^\circ$ C	
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Certificate No: D5GHzV2-1023\_Jan22

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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) 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. b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

c) 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). 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 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**

ASY system configuration, as far as no	ot given on page 1.	
DASY Version	DASY52	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 = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz	

#### Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	4.52 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (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	81.0 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 d) of Head TSI	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.34 W/kg

#### 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	34.4 ± 6 %	4.87 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	84.4 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.40 W/kg

Certificate No: D5GHzV2-1023\_Jan22

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#### Head TSL parameters at 5750 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.2 ± 6 %	5.02 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	****	

#### SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.0 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.31 W/kg

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

#### Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	52.0 Ω - 5.2 jΩ
Return Loss	- 25.3 dB

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

Impedance, transformed to feed point	54.7 Ω + 0.2 jΩ	
Return Loss	- 27.0 dB	

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	57.2 Ω + 2.1 jΩ
Return Loss	- 23.1 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.197 ns	
----------------------------------	----------	--

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

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

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

#### Additional EUT Data

Manufactured by	SPEAG

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

Date: 27 01 2022

Test Laboratory: SPEAG, Zurich, Switzerland

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

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz Medium parameters used: f = 5250 MHz;  $\sigma = 4.52 \text{ S/m}$ ;  $\varepsilon_r = 34.9$ ;  $\rho = 1000 \text{ kg/m}^3$ . Medium parameters used: f = 5600 MHz;  $\sigma = 4.87 \text{ S/m}$ ;  $\epsilon_r = 34.4$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used: f = 5750 MHz;  $\sigma = 5.02 \text{ S/m}$ ;  $\varepsilon_r = 34.2$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001 .
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 76.83 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 28.0 W/kg SAR(1 g) = 8.16 W/kg; SAR(10 g) = 2.34 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 70.7% Maximum value of SAR (measured) = 18.6 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 = 77.04 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 31.5 W/kg SAR(1 g) = 8.51 W/kg; SAR(10 g) = 2.40 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 68% Maximum value of SAR (measured) = 20.1 W/kg

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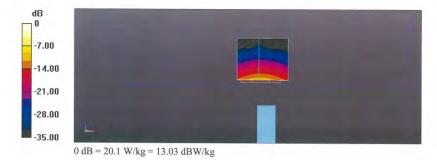
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Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 74.27 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 31.8 W/kg SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.31 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mmRatio of SAR at M2 to SAR at M1 = 66.3%Maximum value of SAR (measured) = 19.8 W/kg



Certificate No: D5GHzV2-1023 Jan22

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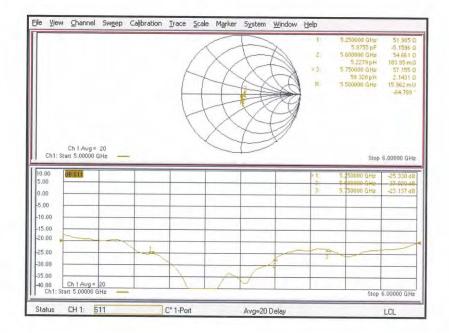
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### Impedance Measurement Plot for Head TSL



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Calibration Laboratory Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, 5			S Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura S swiss Calibration Service
Accredited by the Swiss Accreditation The Swiss Accreditation Service is Multilateral Agreement for the reco	one of the signatorie		Accreditation No.: SCS 0108
Client SGS (Auden)	-		ate No: D6.5GHzV2-1006_Aug22
CALIBRATION CI	ERTIFICAT	E	
Object	D6.5GHzV2 - SN	J:1006	
	QA CAL-22.v6 Calibration Proc	edure for SAR Validation So	urces between 3-10 GHz
Calibration date:	August 23, 2022		
	d in the closed laborato	robability are given on the following party facility: environment temperature (22	
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor R&S NRP33T	SN: 100967	01-Apr-22 (No. 217-03526)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Mismatch combination	SN: 84224 / 360D	26-Apr-21 (No. 217-03353)	Apr-24
Reference Probe EX3DV4 DAE4	SN: 7405 SN: 908	02-Jun-22 (No. EX3-7405_Jun22) 27-Jun-22 (No. DAE4-908_Jun22)	Jun-23 Jun-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G Network Analyzer Keysight E5063A	SN: 827 SN:MY54504221	18-Dec-18 (in house check Dec-21) 31-Oct-19 (in house check Oct-19)	In house check: Dec-23 In house check: Oct-22
	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	Seef The
Approved by:	Sven Kühn	Technical Manager	5.0
This calibration certificate shall not b	e reproduced except ir	full without written approval of the labo	Issued: August 28, 2022

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## Report No.: TESA2212000594ES Page: 17 of 34

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



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Accreditation No.: SCS 0108

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Glossary: TSL

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

### Calibration is Performed According to the Following Standards:

 a) 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 Aug22

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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	

#### 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	34.5 ± 6 %	6.19 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	292 W/kg ± 24.7 % (k=2)
SAR averaged over 8 cm <sup>3</sup> (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.58 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.8 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.8 W/kg ± 24.4 % (k=2)

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	45.7 Ω - 6.7 jΩ	
Return Loss	- 21.6 dB	

#### APD (Absorbed Power Density)

APD averaged over 1 cm <sup>2</sup>	Condition	
APD measured	100 mW input power	291 W/m <sup>2</sup>
APD measured	normalized to 1W	2910 W/m <sup>2</sup> ± 29.2 % (k=2)
	1444	
APD averaged over 4 cm <sup>2</sup>	condition	
APD averaged over 4 cm <sup>2</sup> APD measured	condition 100 mW input power	132 W/m <sup>2</sup>

\*The reported APD values have been derived using psSAR8g

#### 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

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## Report No. : TESA2212000594ES Page: 20 of 34

### **DASY6 Validation Report for Head TSL**

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

	Test Properties		2.1.2		a Serie a		
Name, Manuf		imensions	F	VIEI	DUT Typ	e	
D6.5GHz	1	.6.0 x 6.0 x	300.0 S	N: 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	5.50	6.19	34.5
Hardware Set	up						
Phantom	Т	SL		Probe, Calil	bration Date	DAE, Calib	bration Date
MFP V8.0 Cen	ter - 1182 F	BBL600-10	000V6	EX3DV4 - St	N7405, 2022-06-02	DAE4 Sn9	08, 2022-06-27
Scan Setup				Measureme	ent Results		
			Zoom Scar	1			Zoom Scan
Grid Extents	[mm]		22.0 x 22.0 x 22.0	) Date		2	022-08-23, 10:39
Grid Steps [n	nm]		3.4 x 3.4 x 1.4	psSAR1g [	W/Kg]		29.2
Sensor Surfa	ce [mm]		1.4	psSAR8g [\	W/Kg]		6.58
Graded Grid			Ye	s psSAR10g	[W/Kg]		5.38
Grading Ratio	D		1.4	Power Drif	ft [dB]		0.01
MAIA			N//	Power Sca	ling		Disabled
Surface Dete	ction		VMS + 6	Scaling Fac	ctor [dB]		
Scan Method	ł		Measured	d TSL Correc	tion		No correction
				M2/M1 [%	6]		50.6
				Dist 3dB P	eak [mm]		4.8



Certificate No: D6.5GHzV2-1006\_Aug22

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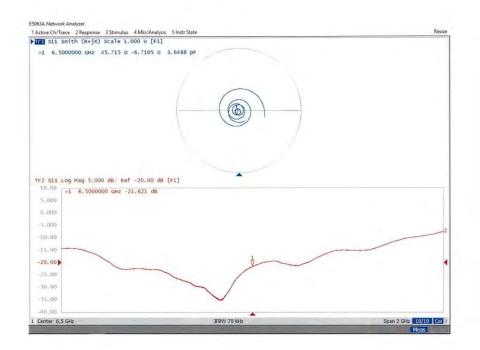
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Impedance Measurement Plot for Head TSL



Certificate No: D6.5GHzV2-1006 Aug22

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## Report No. : TESA2212000594ES Page: 22 of 34

Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

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Swiss Calibration Service

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ccredited by the Swiss Accreditation he Swiss Accreditation Service is ultilateral Agreement for the reco	one of the signatorie		Accreditation No.: SCS 0108
lient SGS (Auden)	gintion of canonation		No: D7GHzV2-1007_Aug2
CALIBRATION CI	ERTIFICAT	E	
Dbject	D7GHzV2 - SN:	007	
	QA CAL-22.v6 Calibration Proce	edure for SAR Validation Sourc	ces between 3-10 GHz
alibration date:	August 24, 2022		
		onal standards, which realize the physica robability are given on the following page:	
All calibrations have been conducted	d in the closed laborato	ry facility: environment temperature (22 $\pm$	3)°C and humidity < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
rimary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
ower sensor R&S NRP33T	SN: 100967	01-Apr-22 (No. 217-03526)	Apr-23
eference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
lismatch combination	SN: 84224 / 360D	26-Apr-21 (No. 217-03353)	Apr-24
Reference Probe EX3DV4	SN: 7405	02-Jun-22 (No. EX3-7405_Jun22)	Jun-23
AE4	SN: 908	27-Jun-22 (No. DAE4-908_Jun22)	Jun-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Dec-21)	In house check: Dec-23
letwork Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-19)	In house check: Oct-22
	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	Saftler
Approved by:	Sven Kühn	Technical Manager	S.L
			Issued: August 28, 2022

Certificate No: D7GHzV2-1007\_Aug22

Calibration Laboratory of

Engineering AG eughausstrasse 43, 8004 Zurich, Switzerland

Schmid & Partner

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### Report No. : TESA2212000594ES Page: 23 of 34

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



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Accreditation No.: SCS 0108

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#### Glossary

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

Multilateral Agreement for the recognition of calibration certificates

#### 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 Aug22

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#### **Measurement Conditions**

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 = 3.0 mm, dz = 1.2 mm	Graded Ratio = 1.2 (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	33.6 ± 6 %	6.81 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	27.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	278 W/kg ± 24.7 % (k=2)
SAR averaged over 8 cm <sup>3</sup> (8 g) of Head TSL	condition	
SAR measured	100 mW input power	6.03 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	60.2 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	4.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	49.3 W/kg ± 24.4 % (k=2)

Certificate No: D7GHzV2-1007\_Aug22

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#### Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.1 Ω - 6.1 jΩ	
Return Loss	- 24.0 dB	

APD (Absorbed Power Density)

APD averaged over 1 cm <sup>2</sup>	Condition	
APD measured	100 mW input power	277 W/m <sup>2</sup>
APD measured	normalized to 1W	2770 W/m2 ± 29.2 % (k=2)
APD averaged over 4 cm <sup>2</sup>	condition	
APD averaged over 4 cm <sup>2</sup> APD measured	condition 100 mW input power	121 W/m <sup>2</sup>

\*The reported APD values have been derived using psSAR8g.

#### 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

Certificate No: D7GHzV2-1007\_Aug22

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4.2

# **DASY6 Validation Report for Head TSL**

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

Device under	Test Properties							
Name, Manuf	acturer D	Dimensions [mm]		IEI	DUT Typ	e		
D7GHz	1	.4.0 x 6.0 x	297.0 SM	1: 1007	-			
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,	7000	5.80	6.81	33.6	
Hardware Set	up							
Phantom	TS	1		Probe, Cali	bration Date	DAE, Calib	oration Date	
MFP V8.0 Cen	ter - 1182 HE	BBL600-100	000V6		N7405, 2022-06-02		08, 2022-06-27	
Scan Setup				Measureme	ent Results			
			Zoom Scan				Zoom Scan	
Grid Extents	[mm]		22.0 x 22.0 x 22.0	Date		2	022-08-24, 09:46	
Grid Steps [n	nm]		3.0 x 3.0 x 1.2	psSAR1g [	W/Kg]		27.8	
Sensor Surfa	ce [mm]		1.4	psSAR8g [	W/Kg]		6.03	
Graded Grid			Yes	psSAR10g	[W/Kg]		4.94	
Grading Ratio	0		1.2	2 Power Drift [dB]		0.05		
MAIA			N/A	Power Sca	ling		Disabled	
Surface Dete	ction		VMS + 6p	Scaling Fac	ctor [dB]			
Scan Method	ł		Measured	TSL Correc	tion		No correction	
				M2/M1 [%	6]		52.1	

Dist 3dB Peak [mm]



Certificate No: D7GHzV2-1007\_Aug22

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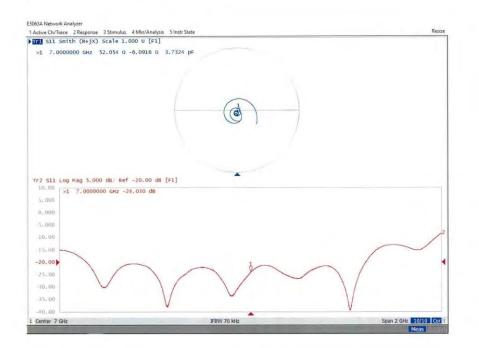
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#### Impedance Measurement Plot for Head TSL



Certificate No: D7GHzV2-1007\_Aug22

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Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland



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

Accreditation No.: SCS 0108

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Client SGS (Auden)

Certificate No: 5G-Veri10-1021\_Jan22

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Object	5G Verificatio	on Source 10 GHz - SN: 1021	
Calibration procedure(s)	QA CAL-45.v Calibration pr	z	
Calibration date:	January 24, 2		
The measurements and the unce	ertainties with confiden	p national standards, which realize the physical units c icce probability are given on the following pages and a pratory facility: environment temperature $(22 \pm 3)$ °C ar	re part of the certificate.
Calibration Equipment used (M&	TE critical for calibration	on)	
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Reference Probe EUmmWV3 DAE4ip	SN: 9374 SN: 1602	2021-12-21(No. EUmmWV3-9374_Dec21) 2021-06-25 (No. DAE4ip-1602_Jun21)	Dec-22 Jun-22
		ID # Check Date (in house)	
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Secondary Standards	ID # Name Leif Klysner	Check Date (in house) Function Laboratory Technician	Scheduled Check
	Name	Function	

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## Report No. : TESA2212000594ES Page: 29 of 34

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



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

Accreditation No.: SCS 0108

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Multilateral Agreement for the recognition of calibration certificates 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 radiated power is the forward power to the horn antenna minus ohmic and mismatch loss. The forward power 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 farfield 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 (1cm<sup>2</sup> and 4cm<sup>2</sup>) power density values at 10mm in front of the horn.
- 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  $(W/m^2)$  averaged over the surface area of 1 cm<sup>2</sup> and 4cm<sup>2</sup> 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%

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#### **Measurement Conditions**

DAST system configuration, as far as no	ot given on page 1.
DASY Version	cDASY6 Module mmWa

DAST VEISION	CDASY6 Module mmWave	V2.4
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**

	Prad <sup>r</sup> Max E-field (mW) (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m <sup>2</sup> )		Uncertainty (k = 2)	
				1 cm <sup>2</sup>	4 cm <sup>2</sup>	
10 mm	86.1	148	1.27 dB	55.2	51.7	1.28 dB

### Square Averaging

	Prad <sup>r</sup> Max E-field (mW) (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m <sup>2</sup> )		Uncertainty (k = 2)	
				1 cm <sup>2</sup>	4 cm <sup>2</sup>	
10 mm	86.1	148	1.27 dB	55.2	51.5	1.28 dB

<sup>1</sup> Assessed ohmic and mismatch loss plus numerical offset: 0.55 dB

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## Report No. : TESA2212000594ES Page: 31 of 34

#### **DASY Report**

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

#### **Device under Test Properties**

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type	
5G Verification Source 10 GHz	100.0 x 100.0 x 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

Phan Medium mmWave Phantom - 1002 Air

Probe, Calibration Date	
EUmmWV3 - SN9374_F1-55GHz,	
2021-12-21	

DAE, Calibration Date DAE4ip Sn1602, 2021-06-25

#### Scan Setup

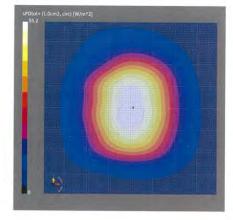
Grid Extents [mm] Grid Steps [lambda] Sensor Surface [mm] MAIA

1	20.0 x 120.0
	0.25 x 0.25
	10.0
M	AIA not used

Measurement Results
Date
Avg. Area [cm <sup>2</sup> ]
psPDn+ [W/m <sup>2</sup> ]
psPDtot+ [W/m <sup>2</sup> ]
psPDmod+ [W/m <sup>2</sup> ]

E<sub>max</sub> [V/m] Power Drift [dB]

5G Scan 2022-01-24, 11:01 1.00 55.0 55.2 55.4 148 0.01



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### Report No. : TESA2212000594ES Page: 32 of 34

#### **DASY Report**

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

Name, Manufacturer	Dimensions [mr	n]	IMEI	DUT Type	
5G Verification Source	10 GHz 100.0 x 100.0 x	172.0	SN: 1021		
Exposure Conditio	ns				
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 Phante mmWave Phantom - 1002

Medium

Air

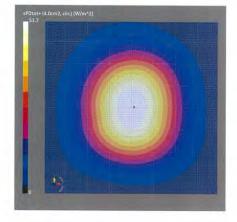
Probe, Calibration Date EUmmWV3 - SN9374\_F1-55GHz, 2021-12-21 DAE, Calibration Date DAE4ip Sn1602, 2021-06-25

Scan Setup

Grid Extents [mm] Grid Steps [lambda] Sensor Surface [mm] MAIA

Measurement Results 5G Scan 120.0 x 120.0 0.25 x 0.25 Date Date Avg. Area [cm<sup>2</sup>] psPDn+ [W/m<sup>2</sup>] psPDtot+ [W/m<sup>2</sup>] psPDmod+ [W/m<sup>2</sup>] E<sub>max</sub> [V/m] Power Drift [dB] 10.0 MAIA not used

5G Scan 56 Scan 2022-01-24, 11:01 4.00 51.5 51.7 51.8 148 0.01



Certificate No: 5G-Veri10-1021\_Jan22

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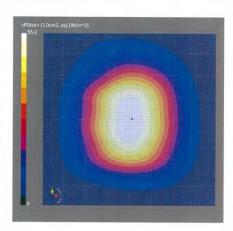


## Report No. : TESA2212000594ES Page: 33 of 34

#### **DASY Report**

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

Name, Manufacturer	Dimensions [mr	n]	IMEI	DUT Type	
5G Verification Source 10	GHz 100.0 x 100.0 x	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					
Phantom	Medium		Probe, Calib	ration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air			SN9374_F1-55GHz,	DAE4ip Sn1602,
			2021-12-21		2021-06-25
Scan Setup			Moscuron	nent Results	
		5G S		lent Results	5G Scan
Grid Extents [mm]		120.0 × 12			2022-01-24, 11:01
Grid Steps [lambda]		0.25 x 0		cm <sup>2</sup> ]	1.00
Sensor Surface [mm]			0.0 psPDn+ [W		55.0
MAIA		MAIA not u	sed psPDtot+ [\	W/m <sup>2</sup> ]	55.2
			psPDmod+	[W/m <sup>2</sup> ]	55.4
			E <sub>max</sub> [V/m]		148
			Power Drift	[dB]	0.01



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### Report No. : TESA2212000594ES Page: 34 of 34

#### **DASY Report**

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

Name, Manufacturer 5G Verification Source 10	Dimensions [mm GHz 100.0 x 100.0 x 1	·	IMEI SN: 1021	DUT Type	
Exposure Condition	s				
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 mmWave Phantom - 1002

Medium

Grid Extents [mm] Grid Steps [lambda]

Scan Setup

Sensor Surface [mm] MAIA

	Measurement Re
5G Scan	
120.0 x 120.0	Date
0.25 x 0.25	Avg. Area [cm <sup>2</sup> ]
10.0	psPDn+ [W/m <sup>2</sup> ]
MAIA not used	psPDtot+ [W/m <sup>2</sup> ] psPDmod+ [W/m <sup>2</sup> ] E <sub>max</sub> [V/m]

EUmmWV3 - SN9374\_F1-55GHz, 2021-12-21 easurement Results

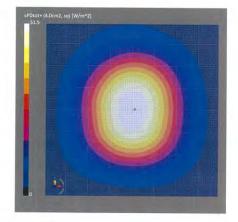
Probe, Calibration Date

Power Drift [dB]

5G Scan 2022-01-24, 11:01 4.00 51.3

DAE, Calibration Date DAE4ip Sn1602, 2021-06-25

51.5 51.7 148 0.01



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