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Appendix C

Phantom Description

Zeughautstrasse 43, 8004 Zurich, Switzerland Phone +41 44 245 9700, Fan +41 44 245 9779 info@spisag.com, N/Itp://www.spisag.com

Certificate of Conformity / First Article Inspection

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

Complete tests were made on the prototype units QD QVA 001 A, pre-series units QD QVA 001 B as well as on some series units QD QVA 001 B. Some tests are made on all series units QD QVA 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 t > 375 MHz	Prototypes
Material thickness	Botton: 2 0mm +/- 0 2mm	dimension compliant with [3] for f > 800 MHz	all.
Material parameters	rel. permittivity 2 - 5, loss tangent s 0.05, at f s 6 GHz	rel. permittivity 3,5 +/- 0,5 loss tangent ≤ 0,05	Material samples
Material realistivity	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.

- 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
- Absorption Nate (SAR) in the Human Head from Wireless Communications Devices: Measurement, Techniques, December 2003.

 [3] IEC 62209–1 eq.1.0, "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 ed.1.0, "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

25.7.2011

Signature / Stamp

peag

Doc No. 881 - QD OVA 002 A - A

1111

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System Validation from Original Equipment Supplier



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Glossary:

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

- Calibration is Performed According to the Following Standards: a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013 b) IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human
- exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low
- reflected power. No uncertainty required.

 Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

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

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In Collaboration with p e CALIBRATION LABORATORY

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Measurement Conditions

as far as not given on page 1

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz ± 1 MHz	

Head TSL parameters

and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	42.0	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.5 ± 6 %	0.90 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		-

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.51 W/kg ± 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.59 W/kg ± 18.7 % (k=2)

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.7Ω+ 0.24jΩ
Return Loss	- 29,0dB

General Antenna Parameters and Design

Electrical Delay (one direction)	0.943 ns
----------------------------------	----------

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

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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Date: 10.14.2021

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DASY5 Validation Report for Head TSL

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1015

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 750 MHz; σ = 0.9 S/m; ϵ_r = 41.52; ρ = 1000 kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 SN7517; ConvF(9.81, 9.81, 9.81) @ 750 MHz; Calibrated: 2021-02-03
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7501)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm,

dy=5mm. dz=5mm

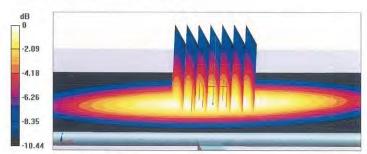
Reference Value = 55.71 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.34 W/kg SAR(1 g) = 2.15 W/kg; SAR(10 g) = 1.41 W/kg

Smallest distance from peaks to all points 3 dB below = 21.2 mm

Ratio of SAR at M2 to SAR at M1 = 64.6%

Maximum value of SAR (measured) = 2.91 W/kg



0 dB = 2.91 W/kg = 4.64 dBW/kg

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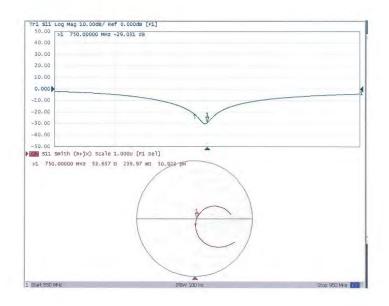


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Impedance Measurement Plot for Head TSL



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Certificate No: Z21-60368 SGS Client CALIBRATION CERTIFICATE Object D835V2 - SN: 4d063 Calibration Procedure(s) FF-Z11-003-01 Calibration Procedures for dipole validation kits Calibration date: October 18, 2021 This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility; environment temperature (22±3)°C and humidity<70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Calibrated by, Certificate No.) Scheduled Calibration Power Meter NRP2 106277 24-Sep-21 (CTTL, No.J21X08326) Sep-22 Power sensor NRP8S 104291 24-Sep-21 (CTTL, No.J21X08326) Sep-22 Reference Probe EX3DV4 SN 7517 03-Feb-21(CTTL-SPEAG,No.Z21-60001) Feb-22 DAE4 SN 1556 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Jan-22 Secondary Standards Cal Date (Calibrated by, Certificate No.) Scheduled Calibration Signal Generator E4438C MY49071430 01-Feb-21 (CTTL, No.J21X00593) Jan-22 NetworkAnalyzer E5071C MY46110673 14-Jan-21 (CTTL, No.J21X00232) Jan-22 Name Function Signature Calibrated by: Zhao Jing SAR Test Engineer 公室 Reviewed by: Lin Hao SAR Test Engineer Approved by: Qi Dianyuan SAR Project Leader Issued: October 24, 2021 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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Glossarv:

TSL tissue simulating liquid ConvF sensitivity in TSL / NORMx,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 assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to
- 6GHz)", July 2016 c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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Measurement Conditions

F 15 AVA 1 A	No. As the CS
DASY52	V52.10.4
Advanced Extrapolation	
Triple Flat Phantom 5.1C	
15 mm	with Spacer
dx, dy, dz = 5 mm	
835 MHz + 1 MHz	
	Triple Flat Phantom 5.1C

Head TSL parameters

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 6 %	0.89 mho/m ± 6 %
Hand TSI townsonting above advaluation	-1000		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.64 W/kg ± 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.56 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.29 W/kg ± 18.7 % (k=2)

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.1Ω- 3.03jΩ
Return Loss	- 29.9dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1,299 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly onnected to the second arm of the dipole. The charter conductor of the feeding fine 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
Manufactured by	SPEAG

Certificate No: Z21-60368

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Date: 10.18.2021

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DASY5 Validation Report for Head TSL

Test Laboratory: CTTL, Beijing, China DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d063

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1 Medium parameters used: f = 835 MHz; $\sigma = 0.886$ S/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³

Phantom section: Right Section DASY5 Configuration:

> • Probe: EX3DV4 - SN7517; ConvF(9.81, 9.81, 9.81) @ 835 MHz; Calibrated: 2021-02-03

- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7501)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm,

dy=5mm, dz=5mm Reference Value = 59.22 V/m; Power Drift = -0.01 dB

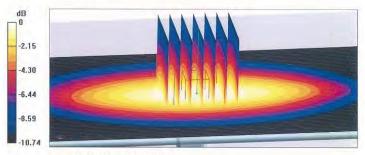
Peak SAR (extrapolated) = 3.68 W/kg

SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.56 W/kg

Smallest distance from peaks to all points 3 dB below = 20.6 mm

Ratio of SAR at M2 to SAR at M1 = 64.8%

Maximum value of SAR (measured) = 3.24 W/kg



0 dB = 3.24 W/kg = 5.11 dBW/kg

Certificate No: Z21-60368

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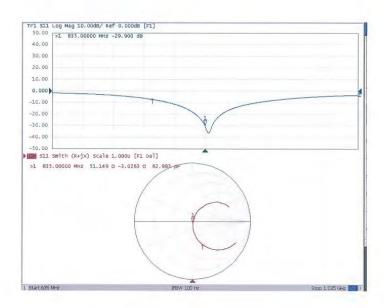


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Impedance Measurement Plot for Head TSL



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CALIBRATION C	ERTIFICAT	E	
2. 2	- Continues on the Cont		
Object	D1750\	/2 - SN: 1008	
Calibration Procedure(s)			
		-003-01 tion Procedures for dipole validation kits	
	Calibra	tion Procedures for dipole validation kits	
Calibration date:	Octobe	r 19, 2021	
measurements (SI). The me pages and are part of the ce All calibrations have been humidity<70%.	easurements and ertificate.	traceability to national standards, which rea the uncertainties with confidence probability a the closed laboratory facility: environment t	are given on the following
Calibration Equipment used	(M&TE critical fo	or calibration)	
Calibration Equipment used Primary Standards	ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
			Scheduled Calibration Sep-22
Primary Standards Power Meter NRP2 Power sensor NRP8S	ID# 106277 104291	Cal Date (Calibrated by, Certificate No.)	
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4	ID# 106277 104291 SN 7517	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001)	Sep-22
Primary Standards Power Meter NRP2 Power sensor NRP8S	ID# 106277 104291	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326)	Sep-22 Sep-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4	ID# 106277 104291 SN 7517	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.)21X08326) 24-Sep-21 (CTTL, No.)21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001)	Sep-22 Sep-22 Feb-22 Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4	ID# 106277 104291 SN 7517 SN 1556	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)	Sep-22 Sep-22 Feb-22 Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards	ID# 106277 104291 SN 7517 SN 1556 ID# MY49071430	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21 (CTTL-SPEAG,No.Z21-60001) 15-Jan-21 (SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	ID# 106277 104291 SN 7517 SN 1556 ID# MY49071430	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21 (CTTL-SPEAG,No.Z21-60001) 15-Jan-21 (SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	ID# 106277 104291 SN 7517 SN 1556 ID# MY49071430 MY46110673	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	ID# 106277 104291 SN 7517 SN 1556 ID# MY49071430 MY46110673	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C Calibrated by:	ID# 106277 104291 SN 7517 SN 1556 ID# MY49071430 MY46110673 Name Zhao Jing	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21 (CTTL-SPEAG,No.Z21-60001) 15-Jan-21 (SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232) Function SAR Test Engineer	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22

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Glossary:

tissue simulating liquid TSL ConvE sensitivity in TSL / NORMx,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 assessment of specific absorption rate of human
- exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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Measurement Conditions

ASY system configuration, as far as	not given on page 1.	
DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz ± 1 MHz	

Head TSL parameters

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.8 ± 6 %	1.38 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

SAR result with Head TSL

Condition	
250 mW input power	9.23 W/kg
normalized to 1W	36.6 W/kg ± 18.8 % (k=2)
Condition	
250 mW input power	4.83 W/kg
normalized to 1W	19.2 W/kg ± 18.7 % (k=2)
	250 mW input power normalized to 1W Condition 250 mW input power

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.1Ω+ 0.76jΩ
Return Loss	- 37.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.128 ns

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

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: 10.19.2021

Test Laboratory: CTTL, Beijing, China DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1008

Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1750 MHz; $\sigma = 1.382$ S/m; $\epsilon_r = 39.76$; $\rho = 1000$ kg/m³ Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 SN7517; ConvF(8.22, 8.22, 8.22) @ 1750 MHz; Calibrated: 2021-02-03
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7501)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.81 V/m; Power Drift = -0.02 dB

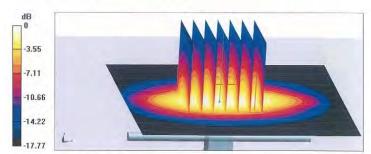
Peak SAR (extrapolated) = 17.5 W/kg

SAR(1 g) = 9.23 W/kg; SAR(10 g) = 4.83 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 53%

Maximum value of SAR (measured) = 14.4 W/kg



0 dB = 14.4 W/kg = 11.58 dBW/kg

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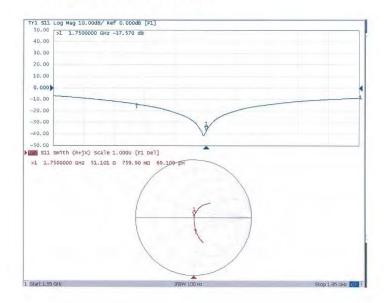


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Impedance Measurement Plot for Head TSL



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Accreditation No.: SCS 0108

SGS-TW (Auden)

Certificate No: D1900V2-5d173 Apr22 CALIBRATION CERTIFICATE Object D1900V2 - SN:5d173 Calibration procedure(s) QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz Calibration date: April 28, 2022 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI), The measurements and the uncertainties with confidence probability are given on the following pages and are part of the partificate: All calibrations have been conducted in the closed laboratory facility; environment temperature (22 ± 3)°C and humidity < 70% Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Certificate No.) Scheduled Calibration Power mater NRP SN: 104778 04-Apr-22 (No. 217-03525/03524) Anr-23 Power sensor NRP-Z91 SN: 103244 04-Apr-22 (No. 217-03524) Apr-23 Power sensor NRP-Z91 SN: 103245 04-Apr-22 (No. 217-03525) Apr-23 Reference 20 dB Attenuator SN: BH9394 (20k) 04-Apr-22 (No. 217-03527) Apr-23 Type-N mismatch combination SN: 310982 / 06327 04-Apr-22 (No. 217-03528) Apr-23 Reference Probe EX3DV4 SN: 7349 31-Dec-21 (No. EX3-7349 Dec21) Dec-22 DAE4 SN: 601 01-Nov-21 (No. DAE4-601 Nov21) Nov-22 Secondary Standards Check Date (in house) Scheduled Check Power meter E4419B SN: GB39512475 30-Oct-14 (in house check Oct-20) In house check: Oct-22 Power sensor HP 8481A SN: US37292783 07-Oct-15 (in house check Oct-20) In house check: Oct-22 Power sensor HP 8481A SN: MY41093315 07-Oct-15 (in house check Oct-20) In house check: Oct-22 RF generator R&S SMT-06 SN: 100972 15-Jun-15 (in house check Oct-20) In house check: Oct-22 Network Analyzer Agilent E8358A SN: US41080477 31-Mar-14 (in house check Oct-20) in house check: Oct-22 Function Signature Aldonia Georgiadou Calibrated by: Laboratory Technician Sven Kühn Approved by: Technical Manager Issued: May 2, 2022 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D1900V2-5d173 Apr22

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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA.

Multilateral Agreement for the recognition of calibration certificates 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
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

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

Certificate No: D1900V2-5d173_Apr22

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Measurement Conditions

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

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	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.1 = 6 %	1.41 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		-

SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	39,6 W/kg ± 17,0 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.8 W/kg ± 16.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$51.7 \Omega + 5.0 j\Omega$
Return Loss	- 25 7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.198 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

SPEAG	
	SPEAG

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DASY5 Validation Report for Head TSL

Date: 28.04.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d173

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: f = 1900 MHz; $\sigma = 1.41$ S/m; $\epsilon_r = 39.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(8.43, 8.43, 8.43) @ 1900 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: dx=5mm, dy=5mm, dz=5mm

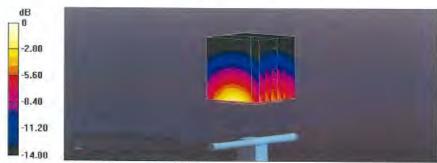
Reference Value = 110.1 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 18.6 W/kg

SAR(1 g) = 10 W/kg; SAR(10 g) = 5.22 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 54.3% Maximum value of SAR (measured) = 15.6 W/kg



0 dB = 15.6 W/kg = 11.93 dBW/kg

Certificate No: D1900V2-5d173_Apr22

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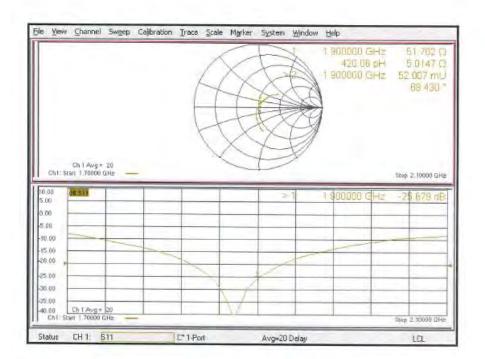
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Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d173 Apr22

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CALIBRATION CI	ERTIFICAT	E	
Object	D2300\	/2 - SN: 1023	
Calibration Procedure(s)	FF-Z11-		
Calibration date:		tion Procedures for dipole validation kits	
Calibration date.	October	r 20, 2021	
measurements (SI). The me pages and are part of the ce All calibrations have been humidity<70%,	asurements and ertificate. conducted in the	raceability to national standards, which re the uncertainties with confidence probability ne closed laboratory facility: environment	are given on the following
Calibration Equipment used	(INI F CLITICAL IC	or campration)	
Calibration Equipment used Primary Standards	ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
			Scheduled Calibration Sep-22
Primary Standards	ID#	Cal Date (Calibrated by, Certificate No.)	
Primary Standards Power Meter NRP2	ID# 106277 104291	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326)	Sep-22
Primary Standards Power Meter NRP2 Power sensor NRP8S	ID# 106277 104291	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326)	Sep-22 Sep-22 Feb-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4	ID# 106277 104291 SN 7517	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001)	Sep-22 Sep-22 Feb-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4	ID# 106277 104291 SN 7517 SN 1556	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)	Sep-22 Sep-22 Feb-22 Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards	ID# 106277 104291 SN 7517 SN 1556 ID#	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	ID# 106277 104291 SN 7517 SN 1556 ID# MY49071430	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.)21X08326) 24-Sep-21 (CTTL, No.)21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.)21X00593)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	ID # 106277 104291 SN 7517 SN 1556 ID # MY49071430 MY46110673	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	ID # 106277 104291 SN 7517 SN 1556 ID # MY49071430 MY46110673	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232)	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22
Primary Standards Power Meter NRP2 Power sensor NRP8S Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C Calibrated by:	ID# 106277 104291 SN 7517 SN 1556 ID# MY49071430 MY46110673 Name Zhao Jing	Cal Date (Calibrated by, Certificate No.) 24-Sep-21 (CTTL, No.J21X08326) 24-Sep-21 (CTTL, No.J21X08326) 03-Feb-21(CTTL-SPEAG,No.Z21-60001) 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) Cal Date (Calibrated by, Certificate No.) 01-Feb-21 (CTTL, No.J21X00593) 14-Jan-21 (CTTL, No.J21X00232) Function SAR Test Engineer	Sep-22 Sep-22 Feb-22 Jan-22 Scheduled Calibration Jan-22 Jan-22

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Glossary:

tissue simulating liquid sensitivity in TSL / NORMx,y,z ConvF 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 assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504 http://www.chinattl.cn

Measurement Conditions

ASY system configuration, as far as	not given on page 1.	
DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2300 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.5	1.67 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.2 ± 6 %	1.66 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	12.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	48.0 W/kg ± 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.62 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 18.7 % (k=2)

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.2Ω- 1.51jΩ	
Return Loss	- 35.4dB	

General Antenna Parameters and Design

	1022	
Electrical Delay (one direction)	1.077 ns	

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

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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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504 https://www.chinattl.cn

DASY5 Validation Report for Head TSL

Date: 10.20.2021

Test Laboratory: CTTL, Beijing, China DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN: 1023

Communication System: UID 0, CW; Frequency: 2300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2300 MHz; σ = 1.662 S/m; ϵ_r = 39.17; ρ = 1000 kg/m³

Phantom section: Right Section DASY5 Configuration:

- Probe: EX3DV4 SN7517; ConvF(7.58, 7.58, 7.58) @ 2300 MHz; Calibrated:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7501)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 107.1 V/m; Power Drift = -0.01 dB

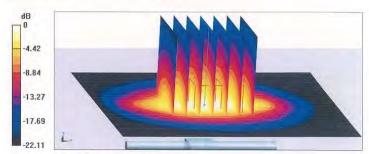
Peak SAR (extrapolated) = 24.9 W/kg

SAR(1 g) = 12 W/kg; SAR(10 g) = 5.62 W/kg

Smallest distance from peaks to all points 3 dB below = 9.1 mm

Ratio of SAR at M2 to SAR at M1 = 48.3%

Maximum value of SAR (measured) = 20.2 W/kg



0 dB = 20.2 W/kg = 13.05 dBW/kg

Certificate No: Z21-60371

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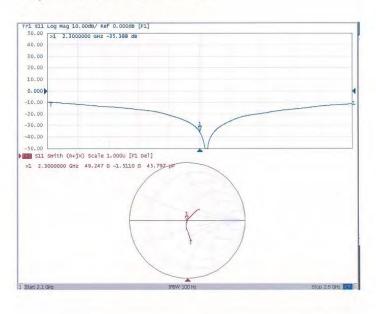


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Impedance Measurement Plot for Head TSL



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





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Accreditation No.: SCS 0108

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

SGS-TW (Auden)

Certificate No: D2450V2-727 Apr22

	D2450V2 - SN:72	27	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	April 25, 2022		
The measurements and the uncer	tainties with confidence p	ional standards, which realize the physical un robability are given on the following pages an ny facility: environment temperature (22 \pm 3)° (d are part of the certificate.
	De a	Section Commence (sec.	
Primary Standards	10.4		
	ID# SN: 104778	Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
ower meter NRP ower sensor NRP-Z91	177	04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524)	Apr-23 Apr-23
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 104778 SN: 103244 SN: 103245	04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525)	Apr-23 Apr-23 Apr-23
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k)	04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527)	Apr-23 Apr-23 Apr-23 Apr-23
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	SN: 104778 SN: 103244 SN: 103245	04-Apr-22 (No. 217-03525;03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528)	Арг-23 Арг-23 Арг-23 Арг-23 Арг-23
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 310982 / 06327	04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527)	Apr-23 Apr-23 Apr-23 Apr-23
Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenustor Type-N mismatch combination Reference Probe EXSDV4 DAE4 Secondary Standards	SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 310982 / 06327 SN: 7349	04-Apr-22 (No. 217-03525(03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EX3-7349_Dec21)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22
Power meter NRP Power siensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenustor Type-N mismatch combination Reference Probe EXSDV4 DAE4 Secondary Standards	SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	04-Apr-22 (No. 217-03525(03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EXS-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22 Nov-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EXSDV4 DAE4 Secondary Standards Power meter E4419B	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	04-Apr-22 (No. 217-03525(03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22 Nov-22 Scheduled Check
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Selerence 20 dB Attenuator Type-N mismatch combination Reterance Probe EXSDV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	04-Apr-22 (No. 217-03525(03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Selerence 20 dB Attenuator Type-N mismatch combination seletrance Probe EXSDV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: 819394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292763	04-Apr-22 (No. 217-03525(03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22 In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 910982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	04-Apr-22 (No. 217-03525(03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22 Nov-22 Scheduled Check In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Refurance Probe EXSDV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 601 ID # SN: GB39512475 SN: US37292763 SN: MY41093315 SN: 100972	04-Apr-22 (No. 217-03525(03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EXS-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22 Nov-22 Scheduled Check In house check: Oct-22
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EXSDV4 DAE4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292763 SN: MY41093315 SN: 100972 SN: US41090477	04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20)	Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22 Now-22 Scheduled Check In house check: Oct-22

Certificate No: D2450V2-727_Apr22

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Accreditation No.: SCS 0108

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) 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

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

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

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	- Cabir	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.8 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ² (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg ± 16.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

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

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
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Certificate No: D2450V2-727_Apr22

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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

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

Medium parameters used: f = 2450 MHz; $\sigma = 1.87$ S/m; $\epsilon_r = 37.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021

- 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: dx=5mm, dy=5mm, dz=5mm Reference Value = 115.6 V/m; Power Drift = 0.09 dB

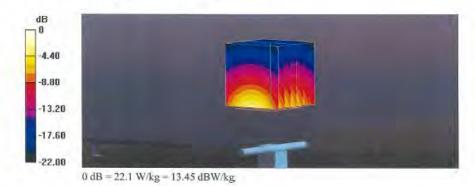
Peak SAR (extrapolated) = 26.5 W/kg

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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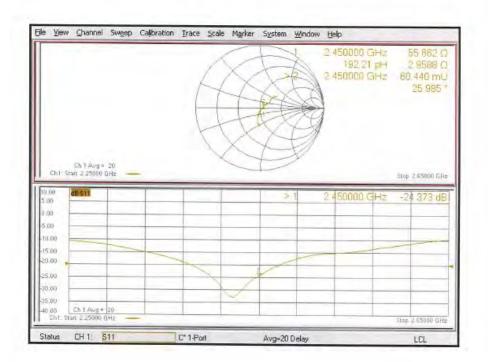
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Impedance Measurement Plot for Head TSL



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





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

Accreditation No.: SCS 0108

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

SGS (Auden) Certificate No: D2600V2-1005 Jan22

Object	D2600V2 - SN:1005			
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz			
Calibration date:	January 18, 2022	2		
This calibration certificate docume	nts the traceability to nati	onal standards, which realize the physical un	its of measurements (SI).	
The measurements and the uncert	tainties with confidence p	robability are given on the following pages ar	nd are part of the certificate.	
All calibrations have been conduct	ed in the closed laborator	y facility: environment temperature (22 ± 3)°C	C and humidity < 70%.	
Calibration Equipment used (M&TE	E critical for calibration)			
D	100.0	0.10	P. S. S. C. S.	
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration	
	SN: 104778	Cal Date (Certificate No.) 09-Apr-21 (No. 217-03291/03292)	Scheduled Calibration Apr-22	
Power meter NRP Power sensor NRP-Z91			Scheduled Calibration Apr-22 Apr-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	Apr-22 Apr-22	
Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292)	Apr-22 Apr-22 Apr-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21)	Apr-22 Apr-22 Apr-22 Apr-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310962 / 06327 SN: 7349 SN: 601 ID# SN: GB39512475	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check In house check: Oct-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310962 / 06327 SN: 7349 SN: 601 ID# SN: GB39512475 SN: US37292783	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check In house check: Oct-22 In house check: Oct-22 In house check: Oct-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID# SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check In house check: Oct-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 15-Jun-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check In house check: Oct-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check In house check: Oct-22	
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 31-Dec-21 (No. EX3-7349_Dec21) 01-Nov-21 (No. DAE4-601_Nov21) Check Date (in house) 30-Oct-14 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 07-Oct-15 (in house check Oct-20) 31-Mar-14 (in house check Oct-20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-22 Nov-22 Scheduled Check In house check: Oct-22	

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





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Glossary:

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

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%.

Certificate No: D2600V2-1005 Jan22

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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

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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	2600 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	2.02 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.8 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.4 W/kg ± 16.5 % (k=2)

Certificate No: D2600V2-1005_Jan22

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.4 Ω - 4.4 jΩ
Return Loss	- 26.9 dB

General Antenna Parameters and Design

Planted Balletin and the second	
Electrical Delay (one direction)	1.158 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: D2600V2-1005_Jan22

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DASY5 Validation Report for Head TSL

Date: 18.01.2022

Test Laboratory: SPEAG, Zurich, Switzerland

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

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

Medium parameters used: f = 2600 MHz; σ = 2.02 S/m; ϵ_r = 37.7; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 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:

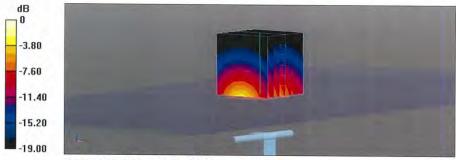
Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 120.0 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 28.6 W/kg

SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.42 W/kg

Smallest distance from peaks to all points 3 dB below = 8.9 mm

Ratio of SAR at M2 to SAR at M1 = 50.4% Maximum value of SAR (measured) = 24.0 W/kg



0 dB = 24.0 W/kg = 13.80 dBW/kg

Certificate No: D2600V2-1005_Jan22

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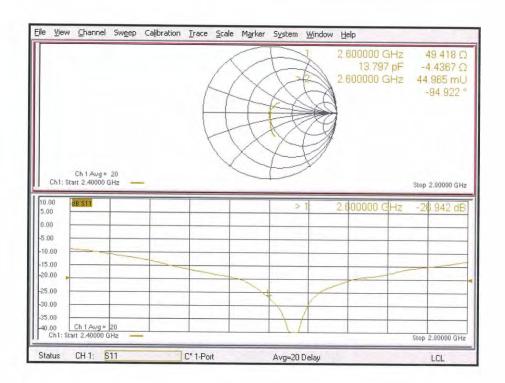
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Impedance Measurement Plot for Head TSL



Certificate No: D2600V2-1005_Jan22

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SGS Certificate No: Z21-60372 Client

CALIBRATION CERTIFICATE

Object D3500V2 - SN. 1009

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date: October 21 2021

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility; environment temperature (22±3)°C and humidity<70%

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID#	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	24-Sep-21 (CTTL, No.J21X08326)	Sep-22
Power sensor NRP8S	104291	24-Sep-21 (CTTL, No.J21X08326)	Sep-22
ReferenceProbe EX3DV4	SN 7517	03-Feb-21(CTTL-SPEAG,No.Z21-60001)	Feb-22
DAE4	SN 1556	15-Jan-21(SPEAG,No.DAE4-1556_Jan21)	Jan-22
Secondary Standards	ID#	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-21 (CTTL, No.J21X00593)	Jan-22
NetworkAnalyzerE5071C	MY46110673	14-Jan-21 (CTTL, No.J21X00232)	Jan-22

	Name	Function	Signature
Calibrated by	Zhao Jing	SAR Test Engineer	-Lik
Reviewed by:	Lin Hao	SAR Test Engineer	林光
Approved by	Qi Dianyuan	SAR Project Leader	da
			Issued: October 27 2021

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Certificate No: Z21-60372

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)*, July 2016
- c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- d) KDB865664, 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: Z21-60372

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Measurement Conditions

DASY Version	DASY52	V52.10.4
DAS I VEISION	DASTOZ	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Rat o = 1 4 (Z direction)
Frequency	3500 MHz ± 1 MHz	

Head TSL parameters

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.9	2,91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	2.86 mha/m ± 8 %
Head TSL temperature change during test	<1.0 °C	-	

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.53 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	65.5 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.48 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.8 W/kg ± 24.2 % (k=2)

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.8Q - 6.00jQ
Return Loss	- 22.2dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1,040 ns
- Constitution of Constitution	

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

Daniel of
SPEAG

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Date: 10.21.2021



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DASY5 Validation Report for Head TSL

Test Laboratory: CTTL, Beijing, China

DUT: Dipole D3500V2; Type: D3500V2; Serial: D3500V2 - SN: 1009

Communication System; CW; Frequency: 3500 MHz,

Medium parameters used: f = 3500 MHz; $\sigma = 2.857 \text{ S/m}$; $\epsilon_r = 37.72$; $\rho = 1000 \text{ MHz}$

kg/m3

Phantom section: Center Section

DASY5 Configuration:

 Probe: EX3DV4 - SN7517; ConvF(6.65, 6.65, 6.65) @ 3500 MHz; Calibrated: 2021-02-03

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1556; Calibrated: 2021-01-15

Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial:

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7501)

Dipole Calibration /Pin=100mW, d=10mm, f=3500 MHz/Zoom Scan,

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

Reference Value = 69.21 V/m; Power Drift = -0.04 dB

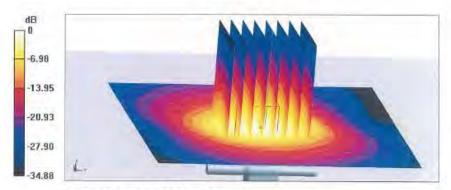
Peak SAR (extrapolated) = 17.3 W/kg

SAR(1 g) = 6.53 W/kg; SAR(10 g) = 2.48 W/kg

Smallest distance from peaks to all points 3 dB below = 8.6 mm

Ratio of SAR at M2 to SAR at M1 = 75.1%

Maximum value of SAR (measured) = 12.5 W/kg



0 dB = 12.5 W/kg = 10.97 dBW/kg

Certificate No: Z21-60372

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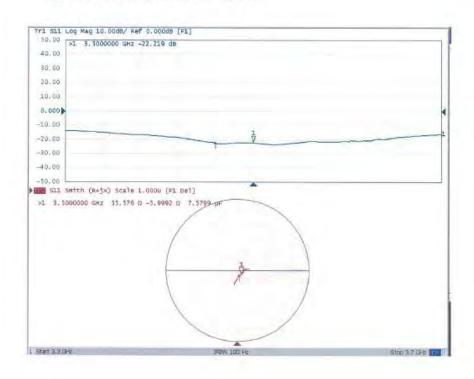
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Impedance Measurement Plot for Head TSL



Certificate No: Z21-60372 Page 6 of 6

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





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Certificate No: D3700V2-1057_Nov21

Accreditation No.: SCS 0108

CALIBRATION CERTIFICATE

D3700V2 - SN:1057 Object

Calibration procedure(s) QA CAL-22.v6

Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: November 23, 2021

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (Si). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the confidence

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21
DAE4	SN: 601	01-Nov-21 (No. DAE4-601_Nov21)	Nov-22
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In frouse check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	in house check: Oct-22
	Name	Function	Signature
Calibrated by	Jeton Kastrati	Leboratory Technician	10.11
Approved by:	Niels Kuster	Quality Manager	1

Certificate No: D3700V2-1057_Nov21

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





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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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Glossary:

TSL ConvF N/A

tissue simulating liquid

sensitivity in TSL / NORM x,y,z not applicable or not measured

Calibration is Performed According to the Following Standards:

- a) 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
- 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. D3700V2-1057 Nov21

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Measurement Conditions

DASY system configuration, as far as not 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 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3700 MHz ± 1 MHz	

Head TSL parameters at 3700 MHz

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.7	3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) "C	37.9 ± 6 %	3.10 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	-	- Mary

SAR result with Head TSL at 3700 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6,61 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg ± 19.5 % (k=2)

Body TSL parameters at 3700 MHz

The following parameters and calculations w

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	51.0	3.55 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.2 ± 6 %	3.48 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL at 3700 MHz

SAR averaged over 1 cm3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	62.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW Input power	2.26 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.6 W/kg ± 19.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 3700 MHz

Impedance, transformed to feed point	$47.6 \Omega + 1.5 j\Omega$		
Return Loss	-30.8 dB		

Antenna Parameters with Body TSL at 3700 MHz

Impedance, transformed to feed point	47.4 Ω + 1.9 jΩ		
Return Loss	- 29.6 dB		

General Antenna Parameters and Design

Electrical Delay (one direction)	1.137 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: 22.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1057

Communication System: UID 0 - CW; Frequency: 3700 MHz

Medium parameters used: f = 3700 MHz; $\sigma = 3.10 \text{ S/m}$; $\varepsilon_r = 37.9$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN3503; ConvF(7.73, 7.73, 7.73) @ 3700 MHz; Calibrated: 30.12.2020

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=100 mW, d=10mm 3700/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.71 V/m; Power Drift = -0.03 dB

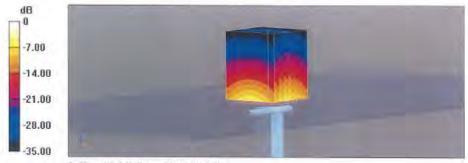
Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 6.61 W/kg; SAR(10 g) = 2.40 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 74.3%

Maximum value of SAR (measured) = 12.6 W/kg



0 dB = 12.6 W/kg = 11.00 dBW/kg

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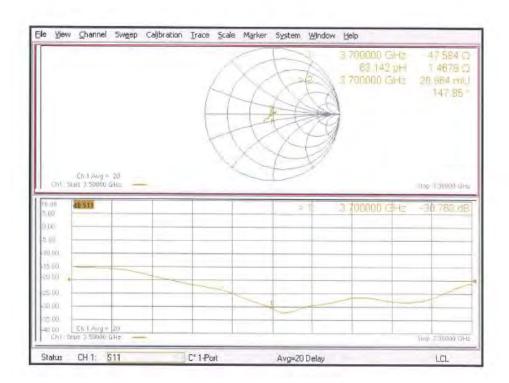
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Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 23.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1057

Communication System: UID 0 - CW; Frequency: 3700 MHz

Medium parameters used: f = 3700 MHz; $\sigma = 3.48$ S/m; $\varepsilon_r = 51.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.31, 7.31, 7.31) @ 3700 MHz; Calibrated; 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm 3700/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.19 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 16.6 W/kg

SAR(1 g) = 6.24 W/kg; SAR(10 g) = 2.26 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 75.9%

Maximum value of SAR (measured) = 11.8 W/kg



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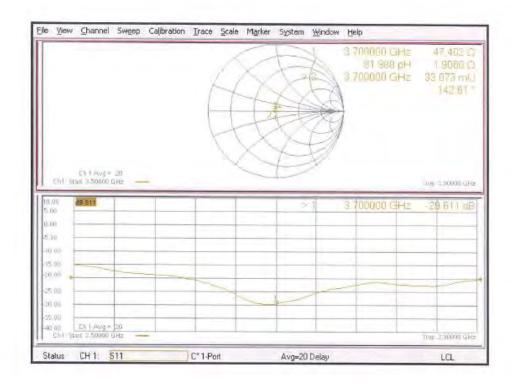
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Impedance Measurement Plot for Body TSL



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





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Power meter E4419B SN: GB3 Power sensor HF 8481A SN: US3 Power sensor HF 8481A SN: MY4 RF generator R&S SMT-06 Network Analyzer Aglient E8358A Name		Nov-21 (No. DAE4-601_Nov21)	Nov-22
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RF generator R&S SMT-06 SN: 1009 Network Analyzer Agillent E8358A SN: US4 Name		Oct-15 (in house check Oct-20)	In house check: Oct-22
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Accreditation No.: SCS 0108

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Glossary:

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

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

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

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Measurement Conditions

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flet Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, $dy = 4$ mm, $dz = 1.4$ mm	Graded Ratio = 1,4 (Z direction)
Frequency	3900 MHz ± 1 MHz 4100 MHz ± 1 MHz	

Head TSL parameters at 3900 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.5	3.32 mha/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6.%	3.27 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	_	hase

SAR result with Head TSL at 3900 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.98 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	70.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 4100 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.2	3.53 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.5 ± 6 %	3.44 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	Case	_

SAR result with Head TSL at 4100 MHz

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.79 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	68.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.7 W/kg ± 19.5 % (k=2)

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Body TSL parameters at 3900 MHz

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	50.8	3.78 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.0 ± 6 %	3.71 mha/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	The second	-

SAR result with Body TSL at 3900 MHz

SAR averaged over 1 cm2 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.43 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	64.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm2 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2:23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.3 W/kg ± 19.5 % (k=2)

Body TSL parameters at 4100 MHz

he following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22,0 °C	50.5	4.01 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) "C	50.7 ± 6 %	3.94 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	170	1986

SAR result with Body TSL at 4100 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	6.34 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	63.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.18 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.9 W/kg ± 19.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 3900 MHz

Impedance, transformed to feed point	47.2 Ω - 6.0 μΩ	
Return Loss	- 23.4 dB	

Antenna Parameters with Head TSL at 4100 MHz

Impedance, transformed to feed point	58.7 Ω - 3.5 JΩ	
Return Loss	-21.3 dB	

Antenna Parameters with Body TSL at 3900 MHz

Impedance, transformed to feed point	47.9 Ω = 5.2 JΩ	
Return Loss	- 24.9 dB	

Antenna Parameters with Body TSL at 4100 MHz

Impedance, transformed to feed point	50.9 Ω - 0.1 (Ω
Return Loss	- 20.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.106 hs

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: 22.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1032

Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz Medium parameters used: f = 3900 MHz; $\sigma = 3.27 \text{ S/m}$; $\epsilon_t = 37.7$; $\rho = 1000 \text{ kg/m}^3$. Medium parameters used; f = 4100 MHz; $\sigma = 3.44 \text{ S/m}$; $\epsilon_r = 37.5$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7,39, 7,39, 7,39) @ 3900 MHz, ConvF(7,26, 7,26) @ 4100 MHz; Calibrated: 30.12.2020
- 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=100 mW, d=10mm 3900/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 71.12 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 19.4 W/kg

SAR(1 g) = 6.98 W/kg; SAR(10 g) = 2.44 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 74,9%

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

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm 4100/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 68.64 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 19.0 W/kg

SAR(1 g) = 6.79 W/kg; SAR(10 g) = 2.36 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 74.9%Maximum value of SAR (measured) = 13.3 W/kg

Certificate No: D3900V2-1032_Nov21

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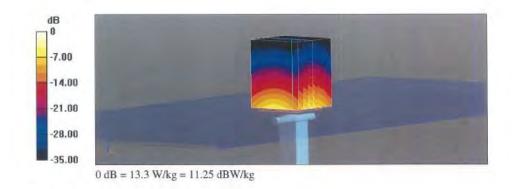
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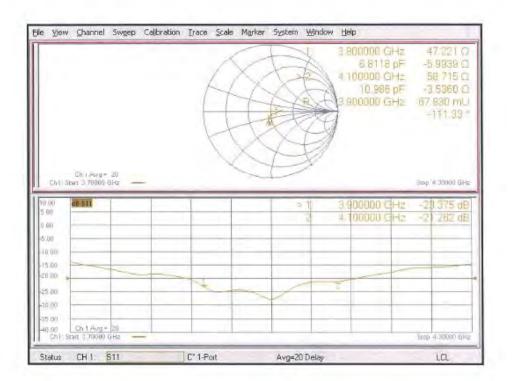
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Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 23.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1032

Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz Medium parameters used: f = 3900 MHz; $\sigma = 3.71 \text{ S/m}$; $\varepsilon_i = 51$; $\rho = 1000 \text{ kg/m}^3$. Medium parameters used: f = 4100 MHz; $\sigma = 3.94 \text{ S/m}$; $\epsilon_r = 50.7$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.18, 7.18, 7.18) @ 3900 MHz, ConvF(6.88, 6.88, 6.88) @ 4100 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002.
- DASY52 52,10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm 3900/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 61.82 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 18.6 W/kg

SAR(1 g) = 6.43 W/kg; SAR(10 g) = 2.23 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 73.6%

Maximum value of SAR (measured) = 12.8 W/kg

Dipole Calibration for Body Tissue/Pin=100 mW, d=10mm 4100/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1,4mm

Reference Value = 60.50 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 19.0 W/kg

SAR(1 g) = 6.34 W/kg; SAR(10 g) = 2.18 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 72.3%Maximum value of SAR (measured) = 12.9 W/kg

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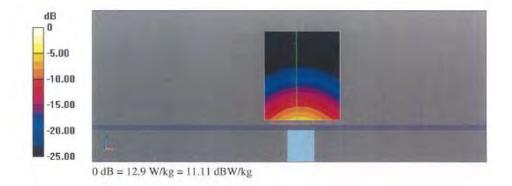
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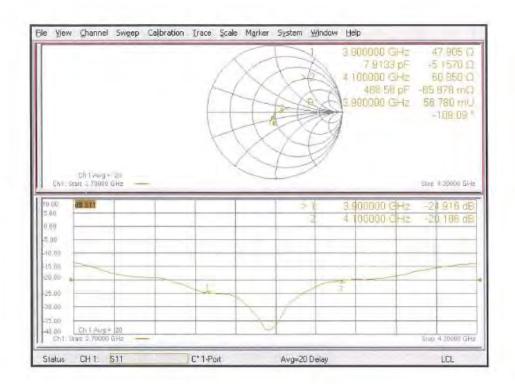
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Impedance Measurement Plot for Body TSL



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





Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura

Swiss Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

SGS (Auden)

Certificate No: D5GHzV2-1023_Jan22

CALIBRATION CERTIFICATE D5GHzV2 - SN:1023 Object QA CAL-22.v6 Calibration procedure(s) Calibration Procedure for SAR Validation Sources between 3-10 GHz Calibration date: January 27, 2022 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards Cal Date (Certificate No.) Scheduled Calibration SN: 104778 Power meter NRP 09-Apr-21 (No. 217-03291/03292) Apr-22 Power sensor NRP-Z91 SN: 103244 09-Apr-21 (No. 217-03291) Apr-22 Power sensor NRP-Z91 SN: 103245 09-Apr-21 (No. 217-03292) Apr-22 Reference 20 dB Attenuator SN: BH9394 (20k) 09-Apr-21 (No. 217-03343) Apr-22 Type-N mismatch combination SN: 310982 / 06327 09-Apr-21 (No. 217-03344) Apr-22 Reference Probe EX3DV4 SN: 3503 31-Dec-21 (No. EX3-3503_Dec21) Dec-22 DAF4 SN: 601 01-Nov-21 (No. DAE4-601_Nov21) Nov-22 Secondary Standards Check Date (in house) Scheduled Check Power meter E4419B SN: GB39512475 30-Oct-14 (in house check Oct-20) In house check: Oct-22 Power sensor HP 8481A SN: US37292783 07-Oct-15 (in house check Oct-20) In house check: Oct-22 Power sensor HP 8481A SN: MY41093315 07-Oct-15 (in house check Oct-20) In house check: Oct-22 RF generator R&S SMT-06 SN: 100972 15-Jun-15 (in house check Oct-20) In house check: Oct-22 Network Analyzer Agilent E8358A SN: US41080477 31-Mar-14 (in house check Oct-20) In house check: Oct-22 Calibrated by: Aldonia Georgiadou Laboratory Technician Approved by: Sven Kühn Deputy Manager Issued: January 27, 2022 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D5GHzV2-1023_Jan22

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





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

Accreditation No.: SCS 0108

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

Glossary:

TSI ConvF

N/A

tissue simulating liquid

sensitivity in TSL / NORM x,v,z 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%.

Certificate No: D5GHzV2-1023 Jan22

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Measurement Conditions

ASY system configuration, as far as no	r given on page 1.	The state of the s
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)
F	5250 MHz ± 1 MHz	
Frequency	5600 MHz ± 1 MHz 5750 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

A SECTION OF THE RESIDENCE OF THE SECTION OF THE SE	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 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	81.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	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 ³ (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 ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 W/kg ± 19.5 % (k=2)

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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 ³ (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 ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.9 W/kg ± 19.5 % (k=2)

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 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	$54.7 \Omega + 0.2 j\Omega$	
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; $\sigma = 4.52$ S/m; $\epsilon_r = 34.9$; $\rho = 1000$ kg/m³, Medium parameters used: f = 5600 MHz; $\sigma = 4.87 \text{ S/m}$; $\varepsilon_r = 34.4$; $\rho = 1000 \text{ kg/m}^3$, Medium parameters used: f = 5750 MHz; $\sigma = 5.02$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³

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

Certificate No: D5GHzV2-1023 Jan22

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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

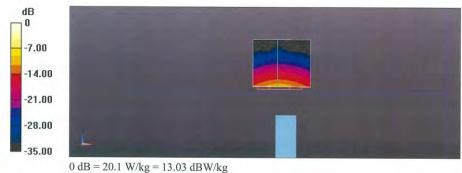
Peak SAR (extrapolated) = 31.8 W/kg

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 mm

Ratio of SAR at M2 to SAR at M1 = 66.3%

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



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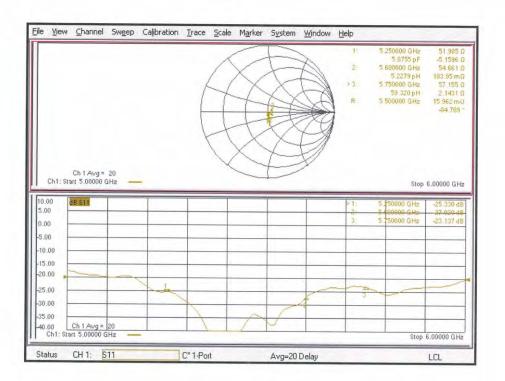
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Impedance Measurement Plot for Head TSL



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





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SGS (Auden)

Certificate No: D6.5GHzV2-1006_Aug21

Accreditation No.: SCS 0108

CALIBRATION CERTIFICATE D6.5GHzV2 - SN:1006 Object Calibration procedure(s) QA CAL-22.v6 Calibration Procedure for SAR Validation Sources between 3-10 GHz Calibration date: August 26, 2021 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Certificate No.) Scheduled Calibration Power meter NRP SN: 104778 09-Apr-21 (No. 217-03291/03292) Power sensor NRP-Z91 SN: 103244 09-Apr-21 (No. 217-03291) Apr-22 Power sensor NRP-791 SN: 103245 09-Apr-21 (No. 217-03292) Apr-22 Power sensor R&S NRP33T SN: 100967 08-Apr-21 (No. 217-03293) Apr-22 Reference 20 dB Attenuator SN: BH9394 (20k) 09-Apr-21 (No. 217-03343) Apr-22 Type-N mismatch combination SN: 310982 / 06327 09-Apr-21 (No. 217-03344) Apr-22 Reference Probe EX3DV4 SN: 7405 30-Dec-20 (No. EX3-7405_Dec20) Dec-21 DAE4 SN: 908 24-Jun-21 (No. DAE4-908_Jun21) Jun-22 Secondary Standards ID# Check Date (in house) Scheduled Check RF generator Anapico APSIN20G SN: 669 28-Mar-17 (in house check Dec-18) In house check: Dec-21 Network Analyzer R&S ZVL 13 SN: 101093 10-May-12 (in house check Dec-18) In house check: Dec-21 Name Function Signature Calibrated by: Jeton Kastrati Laboratory Technician Approved by: Katja Pokovic Technical Manager Issued: August 27, 2021 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D6.5GHzV2-1006_Aug21

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Accreditation No.: SCS 0108

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Glossary:

TSL ConvF

N/A

tissue simulating liquid

sensitivity in TSL / NORM x,y,z not applicable or not measured

Calibration is Performed According to the Following Standards:

a) 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
- 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%.

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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	33.6 ± 6 %	6.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	4444	

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 cm3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.5 W/kg ± 24.4 % (k=2)

Certificate No: D6.5GHzV2-1006_Aug21

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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/m²
APD measured	normalized to 1W	2910 W/m ² ± 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	132 W/m ²
APD measured	normalized to 1W	1320 W/m ² ± 28.9 % (k=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

Certificate No: D6.5GHzV2-1006_Aug21

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Zoom Scan 2021-08-26, 10:54

> 29.3 5.39 0.03 Disabled No correction 50.3

> > 48

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DASY6 Validation Report for Head TSL

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

Device under Test Properties

Name, Manufacturer Dimensions [mm] IMEI **DUT Type** D6.5GHz 16.0 x 6.0 x 300.0 SN: 1006

Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.75	6.11	33.6

Hardware Setup

Phantom TSL Probe, Calibration Date DAE, Calibration Date MFP V8.0 Center - 1182 HBBL600-10000V6 EX3DV4 - SN7405, 2020-12-30 DAE4 Sn908, 2021-06-24

Monsuroment Desults

Scan Setun

Jean Jetup		ivieasurement Results	
	Zoom Scan		
Grid Extents [mm]	22.0 x 22.0 x 22.0	Date	
Grid Steps [mm]	$3.4 \times 3.4 \times 1.4$	psSAR1g [W/Kg]	
Sensor Surface [mm]	1.4	psSAR10g [W/Kg]	
Graded Grid	Yes	Power Drift [dB]	
Grading Ratio	1.4	Power Scaling	
MAIA	N/A	Scaling Factor [dB]	
Surface Detection	VMS + 6p	TSL Correction	
Scan Method	Measured	M2/M1 [%]	
		Dist 3dB Peak [mm]	



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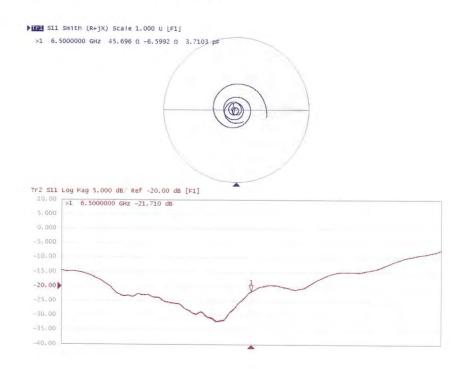
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Impedance Measurement Plot for Head TSL



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Accreditation No.: SCS 0108

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Certificate No: D7GHzV2-1007_Aug21 SGS (Auden) **CALIBRATION CERTIFICATE** D7GHzV2 - SN:1007 Object QA CAL-22.v6 Calibration procedure(s) Calibration Procedure for SAR Validation Sources between 3-10 GHz August 26, 2021 Calibration date: This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Certificate No.) Scheduled Calibration Power meter NRP SN: 104778 09-Apr-21 (No. 217-03291/03292) Power sensor NRP-791 SN: 103244 09-Apr-21 (No. 217-03291) Apr-22 Power sensor NRP-Z91 SN: 103245 09-Apr-21 (No. 217-03292) Apr-22 Power sensor R&S NRP33T SN: 100967 08-Apr-21 (No. 217-03293) Apr-22 Reference 20 dB Attenuator SN: BH9394 (20k) 09-Apr-21 (No. 217-03343) Apr-22 Type-N mismatch combination SN: 310982 / 06327 09-Apr-21 (No. 217-03344) Apr-22 Reference Probe EX3DV4 SN: 7405 30-Dec-20 (No. EX3-7405_Dec20) Dec-21 DAE4 SN: 908 24-Jun-21 (No. DAE4-908_Jun21) Jun-22 Secondary Standards ID# Check Date (in house) Scheduled Check RF generator Anapico APSIN20G SN: 669 28-Mar-17 (in house check Dec-18) In house check: Dec-21 Network Analyzer R&S ZVL13 SN: 101093 10-May-12 (in house check Dec-18) In house check: Dec-21 Name Function Signature Calibrated by: Jeton Kastrati Laboratory Technician Katja Pokovic Approved by: Technical Manage Issued: August 27, 2021 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D7GHzV2-1007 Aug21

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Glossary:

tissue simulating liquid TSL

sensitivity in TSL / NORM x,y,z ConvF 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
- 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
- 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

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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 = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	7000 MHz ± 1 MHz	

Head TSL parameters

ng 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 measured	100 mW input power	4.78 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	47.4 W/kg ± 24.4 % (k=2)

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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 ± 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	119 W/m ²
APD measured	normalized to 1W	1190 W/m ² ± 28.9 % (k=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
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No correction

46.9

4.6

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DASY6 Validation Report for Head TSL

Device under Test Properties

Hardware Setup

Surface Detection

Scan Method

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

Name, Manufa	acturer Di	mensions	[mm]	IMEI	DUTTY	pe	
D7GHz		4.0 x 6.0 x	297.0	SN: 1007	+		
Exposure Cond	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	6.09	6.71	32.7

Phantom	TSL	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Center - 1182	HBBL600-10000V6	EX3DV4 - SN7405, 2020-12-30	DAE4 Sn908, 2021-06-24
Scan Setup		Measurement Results	
	Zoom Scan		Zoom Scan
Grid Extents [mm]	22.0 x 22.0 x 22.0	Date	2021-08-26, 14:14
Grid Steps [mm]	3.0 x 3.0 x 1.4	psSAR1g [W/Kg]	27.7
Sensor Surface [mm]	1.4	psSAR10g [W/Kg]	4.78
Graded Grid	Yes	Power Drift [dB]	0.05
Grading Ratio	1.4	Power Scaling	Disabled
MAIA	N/A	Scaling Factor [dB]	

TSL Correction

Dist 3dB Peak [mm]

M2/M1 [%]

VMS + 6p

Measured



Certificate No: D7GHzV2-1007_Aug21

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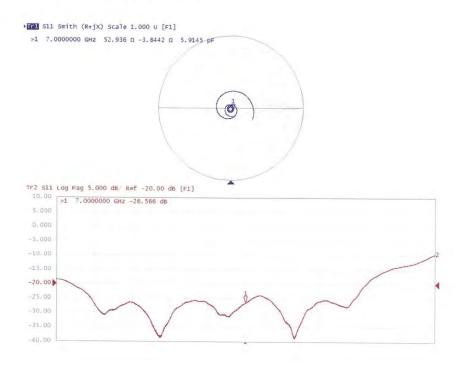
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Impedance Measurement Plot for Head TSL



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SGS (Auden)

Certificate No: 5G-Veri10-1021_Jan22 **CALIBRATION CERTIFICATE** Object 5G Verification Source 10 GHz - SN: 1021 Calibration procedure(s) QA CAL-45.v3 Calibration procedure for sources in air above 6 GHz Calibration date: January 24, 2022 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Certificate No.) Scheduled Calibration Reference Probe EUmmWV3 SN: 9374 2021-12-21(No. EUmmWV3-9374 Dec21) Dec-22 DAE4ip SN: 1602 2021-06-25 (No. DAE4ip-1602 Jun21) Jun-22 Secondary Standards ID# Check Date (in house) Scheduled Check Function Signature Calibrated by: Leif Klysner Laboratory Technician Approved by: Sven Kühn Deputy Manager Issued: January 26, 2022 This calibration certificate shall not be reproduced except in full without written approval of the laboratory

Certificate No: 5G-Veri10-1021_Jan22

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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
- 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 + λ /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
- 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 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_Jan22

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Measurement Conditions

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

DASY Version	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 + \(\lambda \text{/4} \)	
Frequency	10 GHz ± 10 MHz	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture to Measured Plane	Prad¹ (mW)		Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m²)		Uncertainty (k = 2)
				1 cm ²	4 cm ²	
10 mm	86.1	148	1.27 dB	55.2	51.7	1.28 dB

Square Averaging

Distance Horn Aperture to Measured Plane	Prad ¹ Max E-field (mW) (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m²)		Uncertainty (k = 2)	
				1 cm ²	4 cm ²	
10 mm	86.1	148	1.27 dB	55.2	51.5	1.28 dB

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Assessed ohmic and mismatch loss plus numerical offset: 0.55 dB



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DASY Report

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

Device under Test Properties

Dimensions [mm] Name, Manufacturer IMEL 5G Verification Source 10 GHz 100.0 x 100.0 x 172.0 SN: 1021

Exposure Conditions

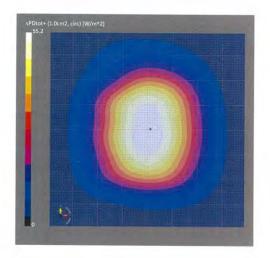
Phantom Section Position, Test Distance Group, Frequency [MHz]. Conversion Factor [mm] Channel Nu 10.0 mm Validation band CW 10000.0, 1.0

Hardware Setup

Medium Probe, Calibration Date DAE, Calibration Date mmWave Phantom - 1002 Air EUmmWV3 - SN9374_F1-55GHz, DAE4ip Sn1602, 2021-12-21 2021-06-25

Scan Setup Measurement Results

5G Scan 5G Scan Grid Extents [mm] Grid Steps [lambda] 120.0 x 120.0 2022-01-24, 11:01 0.25 x 0.25 10.0 Avg. Area [cm²] psPDn+ [W/m²] 1.00 Sensor Surface [mm] 55.0 MAIA not used psPDtot+ [W/m²] psPDmod+ [W/m²] 55.2 55.4 Emax [V/m] 148 0.01 Power Drift [dB]



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DASY Report

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

Device under Test Properties

Name, Manufacturer 5G Verification Source 10 GHz

Dimensions [mm] 100.0 x 100.0 x 172.0 IMEI SN: 1021 **DUT Type**

Exposure Conditions

Phantom Section

Position, Test Distance

Group Validation band

Frequency [MHz], 10000.0,

Conversion Factor

10000

Hardware Setup

5G -

mmWave Phantom - 1002

Medium

10.0 mm

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

DAE, Calibration Date DAE4ip Sn1602,

1.0

Scan Setup

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

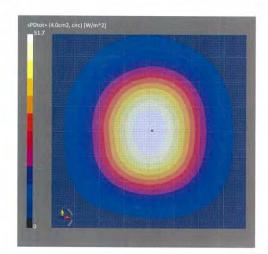
120.0 x 120.0 0.25 x 0.25 10.0

Measurement Results MAIA not used

Avg. Area [cm²] psPDn+ [W/m²] psPDtot+ [W/m²] psPDmod+ [W/m2] E_{max} [V/m] Power Drift [dB]

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

0.01



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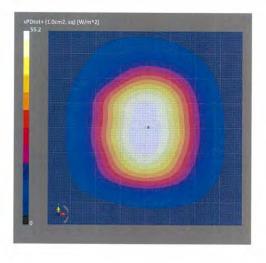
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DASY Report Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz) **Device under Test Properties** Name, Manufacturer Dimensions [mm] IMFI 5G Verification Source 10 GHz 100.0 x 100.0 x 172.0 SN: 1021 **Exposure Conditions** Position, Test Distance Group, Frequency [MHz]. Conversion Factor [mm] Channel Number 5G -10.0 mm Validation band CW 10000.0, 1.0 10000 Hardware Setup Medium Probe, Calibration Date DAE, Calibration Date mmWave Phantom - 1002 EUmmWV3 - SN9374_F1-55GHz, DAE4ip Sn1602, 2021-12-21 2021-06-25 Scan Setup Measurement Results 5G Scan Grid Extents [mm] 120.0 x 120.0 2022-01-24, 11:01 0.25 x 0.25 10.0 Avg. Area [cm²] psPDn+ [W/m²] Grid Steps [lambda] 1.00 Sensor Surface [mm] MAIA 55.0 psPDtot+ [W/m²] psPDmod+ [W/m²] 55.2 55.4 MAIA not used Emax [V/m] 148 Power Drift [dB] 0.01



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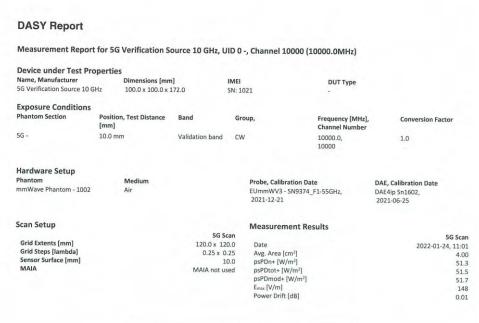
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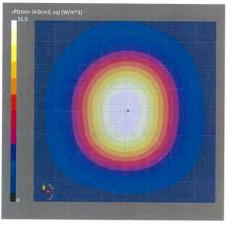
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- End of report -

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