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Client **Morlab (Auden)**

Accreditation No.: **SCS 0108**

Certificate No: **D6.5GHzV2-1054_Nov22**

CALIBRATION CERTIFICATE

Object **D6.5GHzV2 - SN:1054**

Calibration procedure(s) **QA CAL-22.v6**
 Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: **November 01, 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
Power meter NRP	SN: 104778	09-Apr-22 (No. 217-03291/03292)	Apr-23
Power sensor NRP-Z91	SN: 103244	09-Apr-22 (No. 217-03291)	Apr-23
Power sensor NRP-Z91	SN: 103245	09-Apr-22 (No. 217-03292)	Apr-23
Power sensor R&S NRP33T	SN: 100967	08-Apr-22 (No. 217-03293)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-22 (No. 217-03343)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-22 (No. 217-03344)	Apr-23
Reference Probe EX3DV4	SN: 7405	30-Dec-21 (No. EX3-7405_Dec21)	Dec-22
DAE4	SN: 908	24-Jun-22 (No. DAE4-908_Jun22)	Jun-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 669	28-Mar-18 (in house check Dec-19)	In house check: Dec-22
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-20 (in house check Oct-20)	In house check: Oct-23

Calibrated by: Name **Jeton Kastrati** Function **Laboratory Technician**

Approved by: Name **Katja Pokovic** Function **Technical Manager**

Issued: November 2, 2022

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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Glossary:

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

Calibration is Performed According to the Following Standards:

- 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:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.
- The absorbed power density (APD):* The absorbed power density is evaluated according to Samaras T, Christ A, Kuster N, "Compliance assessment of the epithelial or absorbed power density above 6 GHz using SAR measurement systems", Bioelectromagnetics, 2022 (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%.

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	$dx, dy = 3.4 \text{ mm}, dz = 1.4 \text{ mm}$	Graded Ratio = 1.4 (Z direction)
Frequency	$6500 \text{ MHz} \pm 1 \text{ MHz}$	

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 \pm 0.2) °C	32.7 \pm 6 %	6.03 mho/m \pm 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	29.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	288 W/kg \pm 24.7 % (k=2)

SAR averaged over 10 cm ³ (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	53.1 W/kg \pm 24.4 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.1 Ω - 3.1 $j\Omega$
Return Loss	- 29.9 dB

APD (Absorbed Power Density)

APD averaged over 1 cm^2	Condition	
APD measured	100 mW input power	287 W/m^2
APD measured	normalized to 1W	2870 $\text{W/m}^2 \pm 29.2\% \text{ (k=2)}$

APD averaged over 4 cm^2	condition	
APD measured	100 mW input power	131 W/m^2
APD measured	normalized to 1W	1310 $\text{W/m}^2 \pm 28.9\% \text{ (k=2)}$

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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DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1054, 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: 1054	-

Exposure Conditions

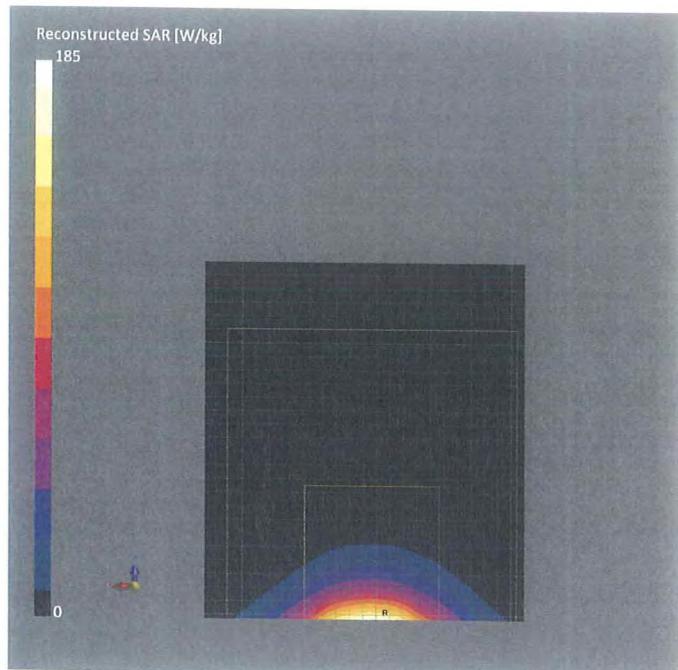
Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.75	6.03	32.7

Hardware Setup

Phantom	TSL	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Center - 1182	HBBL600-10000V6	EX3DV4 - SN7405, 2021-12-30	DAE4 Sn908, 2022-06-24

Scan Setup

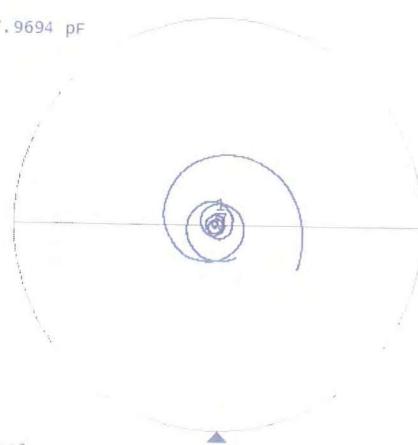
	Zoom Scan	Zoom Scan
Grid Extents [mm]	22.0 x 22.0 x 22.0	Date
Grid Steps [mm]	3.4 x 3.4 x 1.4	psSAR1g [W/Kg]
Sensor Surface [mm]	1.4	psSAR10g [W/Kg]
Graded Grid	Yes	Power Drift [dB]
Grading Ratio	1.4	Power Scaling
MAIA	N/A	Scaling Factor [dB]
Surface Detection	VMS + 6p	TSL Correction
Scan Method	Measured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



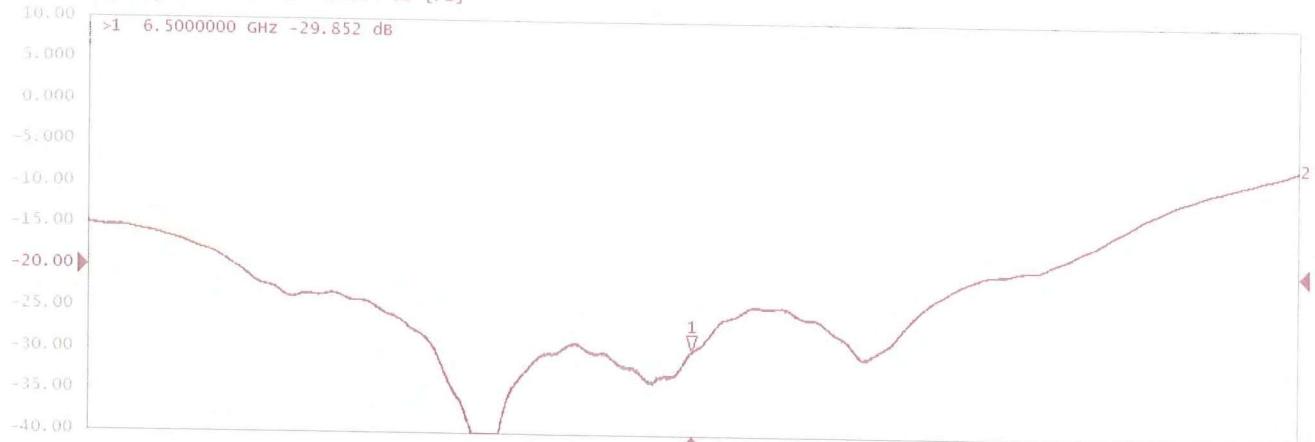
Impedance Measurement Plot for Head TSL

► Tr1 S11 Smith (R+jX) scale 1.000 U [F1]

>1 6.500000 GHz 51.067 Ω -3.0724 Ω 7.9694 pF



Tr2 S11 Log Mag 5.000 dB/ Ref -20.00 dB [F1]





Appendix Annual validation for Test Lab.

General calibration information

Date	2023.10.28
Test Laboratory	ShenZhen Morlab Communications Technology Co., Ltd.
Antenna serial No.	D6.5GHzV2-SN: 1054

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.949 Ω -2.169j Ω
Return Loss	-32.599dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.276 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feed point 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 arm, because they might bend or the soldered connections near the feed point may be damaged.



Annual validation for test lab.

System Performance Check Report for 6.5GHz

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
Device,	n/a x n/a x n/a		Phone

Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor	TSL Conductivity [S/m]	TSL Permittivity
Flat, HSL	5	CW, 0--		6500.0, 0	5.0	6.08	34.0

Hardware Setup

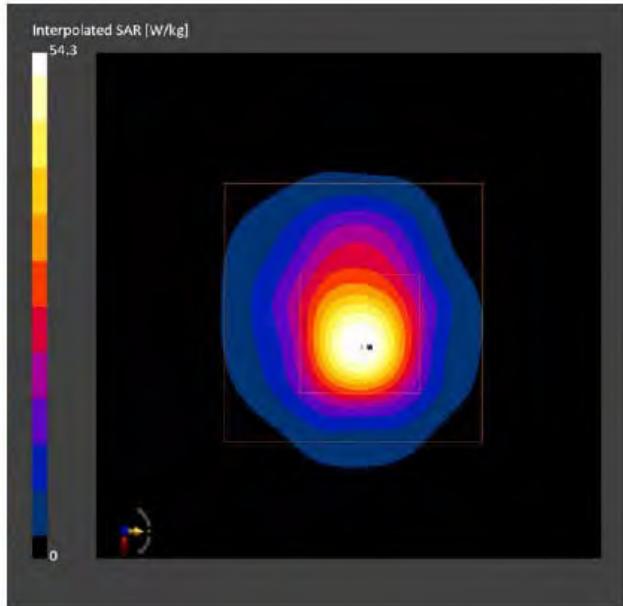
Phantom	TSL, Measured Date	Probe, Calibration Date	DAE, Calibration Date
Twin-SAM V8.0 (30deg probe tilt) - 2020	HBBL-600-10000 Charge:xxxx, --	EX3DV4 - SN3823, 2023-03-04	DAE4 Sn480, 2023-09-19

Scans Setup

	Area Scan	Zoom Scan
Grid Extents [mm]	51.0 x 85.0	22.0 x 22.0 x 22.0
Grid Steps [mm]	8.5 x 8.5	3.4 x 3.4 x 1.4
Sensor Surface [mm]	3.0	1.4
Graded Grid	n/a	Yes
Grading Ratio	n/a	1.4
MAIA	N/A	N/A
Surface Detection	VMS + 6p	VMS + 6p
Scan Method	Measured	Measured

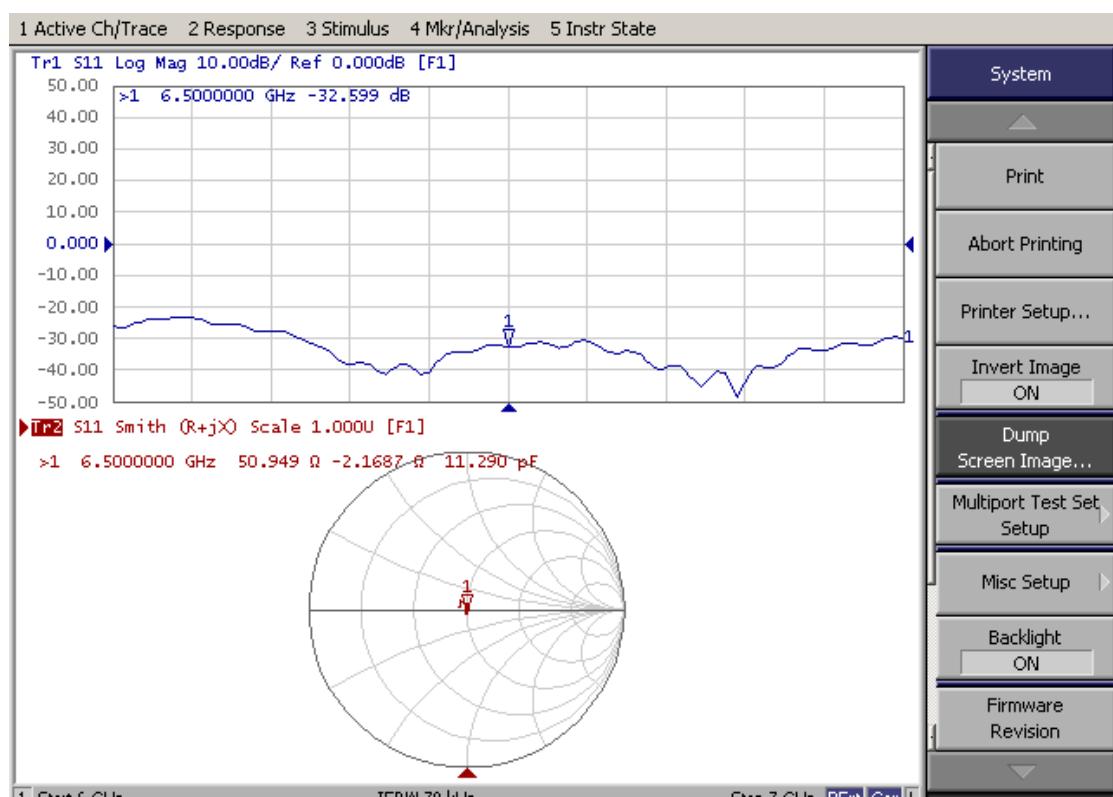
Measurement Results

	Area Scan	Zoom Scan
Date	2023-10-28, 11:20	2023-10-28, 11:31
psSAR1g [W/kg]	25.6	31.4
psSAR10g [W/kg]	5.14	5.73
psAPD (1.0cm ² , sq) [W/m ²]		314
psAPD (4.0cm ² , sq) [W/m ²]		144
Power Drift [dB]	-0.01	-0.18
Power Scaling	Disabled	Disabled
Scaling Factor [dB]		
TSL Correction	No correction	No correction
M2/M1 [%]		52.8
Dist 3dB Peak [mm]		4.9





Appendix Impedance Measurement Plot for Head TSL





Appendix Annual validation for Test Lab.

General calibration information

Date	2024.10.15
Test Laboratory	ShenZhen Morlab Communications Technology Co., Ltd.
Antenna serial No.	D6.5GHzV2-SN: 1054

Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.013 Ω -7.382j Ω
Return Loss	-22.182dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.276 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feed point 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 arm, because they might bend or the soldered connections near the feed point may be damaged.



Annual validation for test lab.

System Performance Check Report for 6.5GHz

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
Device,	n/a x n/a x n/a		Phone

Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band, Group, UID	Frequency [MHz], Channel Number	Conversion Factor	TSL Conductivity [S/m]	TSL Permittivity
Flat, -	5	, 0--	6500.0, 0	5.17	6.18	34.66

Hardware Setup

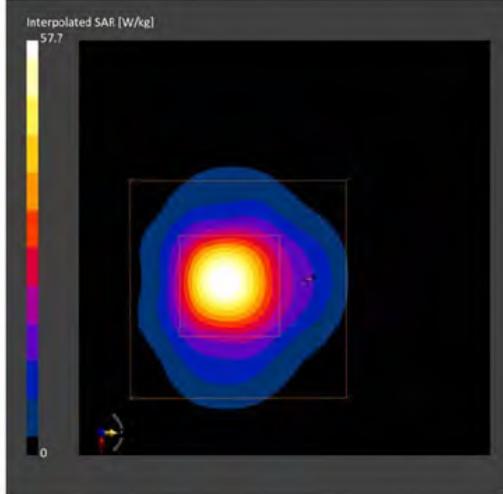
Phantom	TSL, Measured Date	Probe, Calibration Date	DAE, Calibration Date
Twin-SAM V9.0 (30deg probe tilt) - 2020 HBBL-600-10000 Change:xxxx, --		EX9DV4 - SN7608, 2024-03-21	DAE4 Sn1324, 2024-07-05

Scans Setup

	AreaScan	Zoom Scan
Grid Extents [mm]	51.0 x 85.0	22.0 x 22.0 x 22.0
Grid Steps [mm]	8.5 x 8.5	3.4 x 3.4 x 1.4
Sensor Surface [mm]	9.0	1.4
Graded Grid	n/a	Yes
Grading Ratio	n/a	1.4
MAIA	N/A	N/A
Surface Detection	VMS + 6p	VMS + 6p
Scan Method	Measured	Measured

Measurement Results

	AreaScan	ZoomScan
Date	2024-10-15, 00:55	2024-10-15, 01:20
psSAR1g [W/kg]	2.51	30.4
psSAR10g [W/kg]	5.44	5.29
psAPD (1.0cm ² , sc) [W/m ²]		307
psAPD (4.0cm ² , sc) [W/m ²]		141
Power Drift [dB]	0.16	0.14
Power Scaling	Disabled	Disabled
Scaling Factor [dB]		
TSL Correction	No correction	No correction
M2/M1 [%]		59.4
Dist 3dB Peak [mm]		5.0



Appendix Impedance Measurement Plot for Head TSL

