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Client

Morlab

Certificate No:

Z21-60478

CALIBRATION CERTIFICATE

Object

D5GHzV2 - SN: 1176

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

December 19, 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)

ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
106277	24-Sep-21 (CTTL, No.J21X08326)	Sep-22
104291	24-Sep-21 (CTTL, No.J21X08326)	Sep-22
SN 7307	26-May-21(SPEAG,No.EX3-7307_May21)	May-22
SN 1556	15-Jan-21(SPEAG,No.DAE4-1556_Jan21)	Jan-22
ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
MY49071430	01-Feb-21 (CTTL, No.J21X00593)	Jan-22
MY46110673	14-Jan-21 (CTTL, No.J21X00232)	Jan-22
	106277 104291 SN 7307 SN 1556 ID# MY49071430	106277 24-Sep-21 (CTTL, No.J21X08326) 104291 24-Sep-21 (CTTL, No.J21X08326) SN 7307 26-May-21(SPEAG,No.EX3-7307_May21) SN 1556 15-Jan-21(SPEAG,No.DAE4-1556_Jan21) ID# Cal Date (Calibrated by, Certificate No.) MY49071430 01-Feb-21 (CTTL, No.J21X00593)

Calibrated by:

Name Function

Zhao Jing

SAR Test Engineer

Reviewed by:

Lin Hao

SAR Test Engineer

Approved by:

Qi Dianyuan

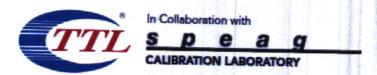
SAR Project Leader

Issued: December 27, 2021

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 / 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

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

DASY Version	DASY52	V50 10 1
Extrapolation	Advanced Extrapolation	V52.10.4
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 Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz	1.4 (2 direction)

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

applied.	2	
Temperature	Permittivity	Conductivity
22.0 °C	35.9	4.71 mho/m
(22.0 ± 0.2) °C	34.9 ± 6 %	4.72 mho/m ± 6 %
<1.0 °C	N. C.	4.72 11110/111 ± 6 %
<1.0 °C	-	
	Temperature 22.0 °C (22.0 ± 0.2) °C	22.0 °C 35.9 (22.0 ± 0.2) °C 34.9 ± 6 %

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	7.71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.7 W/kg ± 24.4 % (<i>k</i> =2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	11.19 = 24.4 /6 (K-2)
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.1 W/kg ± 24.2 % (k=2)

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Head TSL parameters at 5600 MHz

The following parameters and calculations were applied

g parameters and calculations were	applied.		
	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C		Tonadouvity
	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	5.10 mho/m ± 6 %
Head TSL temperature change during test		7,0	3.10 mno/m ± 6 %
to a competature change during test	<1.0 °C		
		- 1	

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	8.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.8 W/kg ± 24.4 % (k=2
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	M = 24.4 /0 (A-2
SAR measured	100 mW input power	2.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg ± 24.2 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

and dalodiations were	applied.		
A SECTION	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	34.4 ± 6 %	
Head TSL temperature change during test		34.4 £ 0 %	5.27 mho/m ± 6 %
	71.0 0		

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	7041111
SAR for nominal Head TSL parameters		7.91 W/kg
100 Call (100 Ca	normalized to 1W	78.7 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 24.2 % (k=2)

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	
Return Loss	49.3Ω - 7.38jΩ
	- 22.6dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	
Return Loss	53.7Ω - 0.82jΩ
Neturi Loss	- 28.8dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	50.00
Return Loss	52.2Ω - 3.36jΩ
	- 28.2dB

General Antenna Parameters and Design

Electrical Delay (one direction)	
	1.110 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

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DASY5 Validation Report for Head TSL

Date: 2021-11-19

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1176

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,

Medium parameters used: f = 5250 MHz; σ = 4.722 S/m; ϵ_r = 34.9; ρ = 1000 kg/m³, Medium parameters used: f = 5600 MHz; σ = 5.103 S/m; ϵ_r = 34.47; ρ = 1000 kg/m³, Medium parameters used: f = 5750 MHz; σ = 5.268 S/m; ϵ_r = 34.35; ρ =

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

Probe: EX3DV4 - SN7307; ConvF(5.69, 5.69, 5.69) @ 5250 MHz; ConvF(5.1, 5.1, 5.1) @ 5600 MHz; ConvF(5.05, 5.05, 5.05) @ 5750 MHz; Calibrated: 2021-05-26

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

DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,

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

Reference Value = 70.50 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 30.5 W/kg

SAR(1 g) = 7.71 W/kg; SAR(10 g) = 2.23 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 65.4%

Maximum value of SAR (measured) = 17.6 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan,

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

Reference Value = 70.77 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 34.6 W/kg

SAR(1 g) = 8.12 W/kg; SAR(10 g) = 2.35 W/kg

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 63%

Maximum value of SAR (measured) = 19.1 W/kg



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Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.00 V/m; Power Drift = -0.03 dB

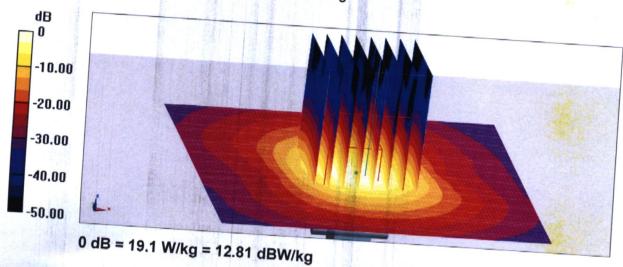
Peak SAR (extrapolated) = 35.4 W/kg

SAR(1 g) = 7.91 W/kg; SAR(10 g) = 2.27 W/kg

Smallest distance from peaks to all points 3 dB below = 7.5 mm

Ratio of SAR at M2 to SAR at M1 = 61.8%

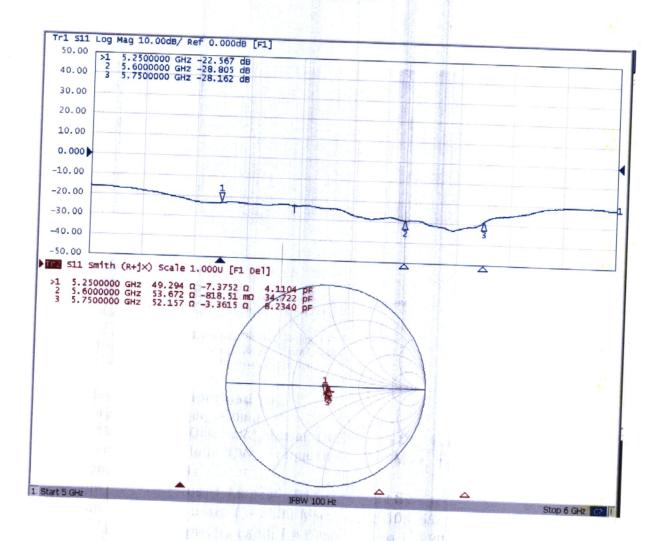
Maximum value of SAR (measured) = 19.1 W/kg





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Impedance Measurement Plot for Head TSL



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Appendix Annual validation for Test Lab.

General calibration information

Date	2022.12.15
Test Laboratory	ShenZhen Morlab Communications Technology Co., Ltd.
Antenna serial No.	D5250V2-SN: 1176

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.068Ω +1.05jΩ
Return Loss	-32.818dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.276 ns
----------------------------------	----------

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.



Date: 2022.12.15 Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd.

System Check_5250MHz_Head

Communication System: UID 0, CW (0); Frequency: 5250 MHz; Duty Cycle: 1:1

Medium: HSL_5250 Medium parameters used: f = 5250 MHz; $\sigma = 4.714$ S/m; $\epsilon_r = 36.322$; $\rho = 1000$

kg/m3

Ambient Temperature: 23.2 °C; Liquid Temperature: 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 SN7608; ConvF(5.16, 5.16, 5.16) @ 5250 MHz; Calibrated: 2022.01.12
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
 Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

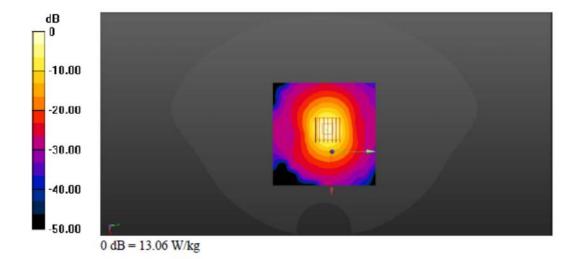
CW5250/Area Scan (101x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm Maximum value of SAR (interpolated) = 13.52 W/kg

CW5250/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 55.31 V/m; Power Drift = 0.03 dB

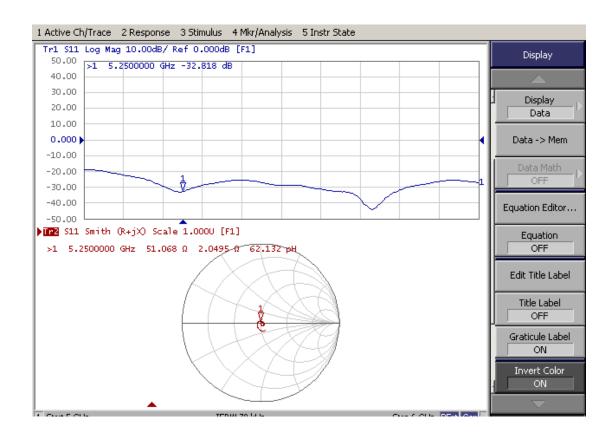
Peak SAR (extrapolated) = 21.2 W/kg

SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.25 W/kgMaximum value of SAR (measured) = 13.06 W/kg





Appendix Impedance Measurement Plot for Head TSL





Appendix Annual validation for Test Lab.

General calibration information

Date	2022.12.15
Test Laboratory	ShenZhen Morlab Communications Technology Co., Ltd.
Antenna serial No.	D5600V2-SN: 1176

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.89Ω -2.58jΩ
Return Loss	-31.355dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.276 ns
----------------------------------	----------

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.



Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd.

Date: 2022.12.15

System Check_5600MHz_Head

Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1 Medium: HSL_5600 Medium parameters used: f = 5600 MHz; $\sigma = 5.11$ S/m; $\epsilon_r = 35.521$; $\rho = 1000$ kg/m3

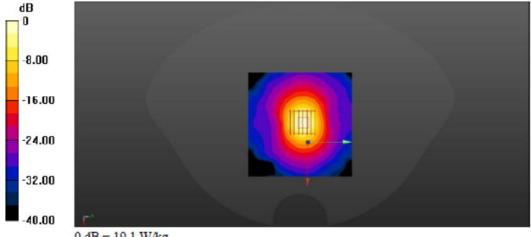
Ambient Temperature : 23.2 °C; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 SN7608; ConvF(4.74, 4.74, 4.74) @ 5600 MHz; Calibrated: 2022.01.12
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
 Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

CW5600/Area Scan (101x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm Maximum value of SAR (interpolated) = 19.24 W/kg

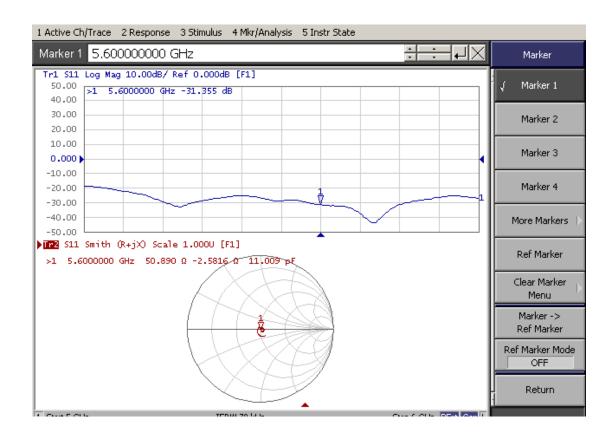
CW5600/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 49.70 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 21.0 W/kg SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.37 W/kg Maximum value of SAR (measured) = 19.1 W/kg



0 dB = 19.1 W/kg



Appendix Impedance Measurement Plot for Head TSL





Appendix Annual validation for Test Lab.

General calibration information

Date	2022.12.15
Test Laboratory	ShenZhen Morlab Communications Technology Co., Ltd.
Antenna serial No.	D5750V2-SN: 1176

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.962Ω +1.96jΩ
Return Loss	-40.247dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.276 ns
----------------------------------	----------

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.



Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd.

Date: 2022.12.15

System Check_5750MHz_Head

Communication System: UID 0, CW (0); Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: HSL_5750 Medium parameters used: f = 5750 MHz; $\sigma = 5.355$ S/m; $\varepsilon_r = 35.127$; $\rho = 1000$

kg/m3

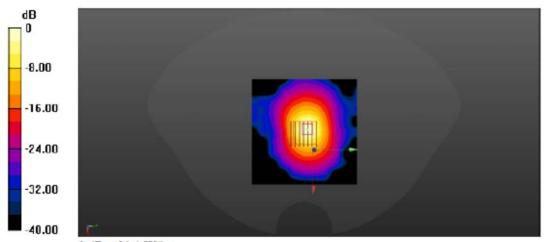
Ambient Temperature: 23.2 °C; Liquid Temperature: 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 SN3823; ConvF(4.45, 4.45, 4.45) @ 5750 MHz; Calibrated: 2022.03.04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
 Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

CW5750/Area Scan (101x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm Maximum value of SAR (interpolated) = 21.6 W/kg

CW5750/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm Reference Value = 56.28 V/m; Power Drift = 0.12 dB Peak SAR (extrapolated) = 36.5 W/kg SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.35 W/kgMaximum value of SAR (measured) = 21.1 W/kg



0 dB = 21.1 W/kg



Appendix Impedance Measurement Plot for Head TSL

