Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	4.80 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.60 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**85.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.1 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	34.3 ± 6 %	4.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**83.2 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	**23.7 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	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	34.1 ± 6 %	5.05 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm³ (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	**80.4 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (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	**22.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.0 ± 6 %	5.10 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**82.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.1 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.4 Ω - 6.5 jΩ
Return Loss	- 23.7 dB

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	47.7 Ω - 5.5 jΩ
Return Loss	- 24.3 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	46.2 Ω - 3.2 jΩ
Return Loss	- 25.8 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	50.0 Ω - 3.1 jΩ
Return Loss	- 30.1 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.6 Ω + 0.5 jΩ
Return Loss	- 29.2 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	51.9 Ω - 1.7 jΩ
Return Loss	- 32.1 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	51.2 Ω - 3.2 jΩ
Return Loss	- 29.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.202 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

DASY5 Validation Report for Head TSL

Date: 05.07.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1060

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5250 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.50 S/m; ε_r = 34.9; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5250 MHz; σ = 4.55 S/m; ε_r = 34.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 4.60 S/m; ε_r = 34.7; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 4.80 S/m; ε_r = 34.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.90 S/m; ε_r = 34.3; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5750 MHz; σ = 5.05 S/m; ε_r = 34.1; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.10 S/m; ε_r = 34.0; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.8, 5.8, 5.8) @ 5200 MHz, ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.49, 5.49, 5.49) @ 5300 MHz, ConvF(5.25, 5.25, 5.25) @ 5500 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- 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=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 74.40 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 27.9 W/kg
SAR(1 g) = 7.84 W/kg; SAR(10 g) = 2.26 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 69.1%
Maximum value of SAR (measured) = 17.6 W/kg

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 = 75.86 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 27.1 W/kg
SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.25 W/kg
Smallest distance from peaks to all points 3 dB below = 6.8 mm
Ratio of SAR at M2 to SAR at M1 = 69.8%
Maximum value of SAR (measured) = 17.4 W/kg

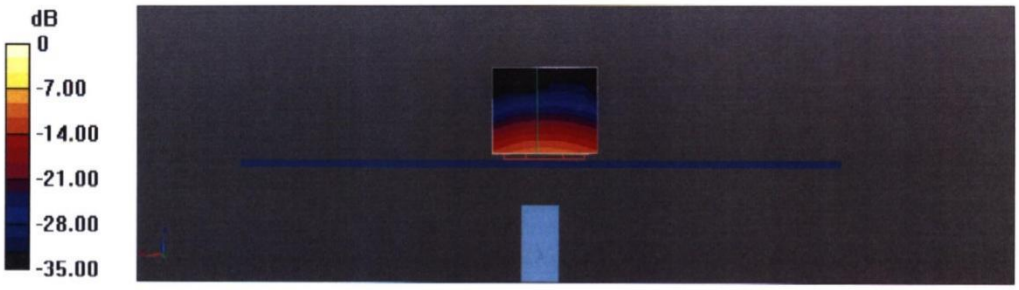
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 77.09 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 28.9 W/kg
SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.33 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 68.9%
Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 76.69 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 32.9 W/kg
SAR(1 g) = 8.60 W/kg; SAR(10 g) = 2.44 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 66.4%
Maximum value of SAR (measured) = 19.8 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 = 76.44 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 31.2 W/kg
SAR(1 g) = 8.39 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 = 67.3%
Maximum value of SAR (measured) = 19.3 W/kg

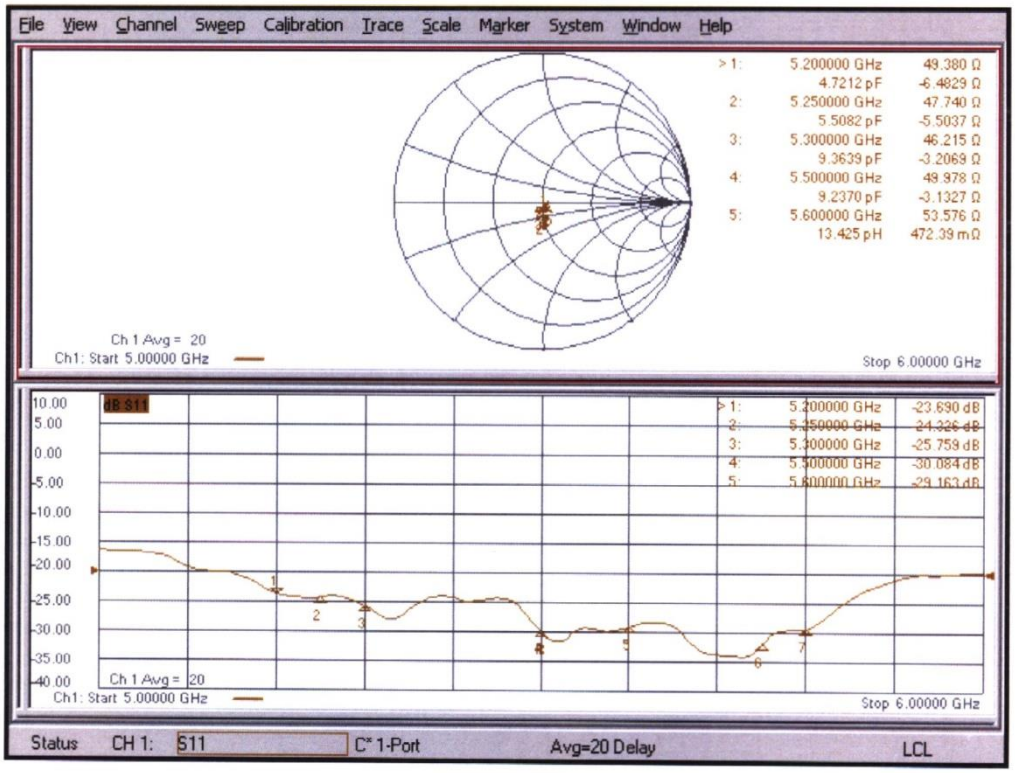
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.53 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 31.8 W/kg
SAR(1 g) = 8.12 W/kg; SAR(10 g) = 2.31 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 65.4%
Maximum value of SAR (measured) = 19.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 74.35 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 32.9 W/kg
SAR(1 g) = 8.27 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 = 65.2%
Maximum value of SAR (measured) = 19.4 W/kg

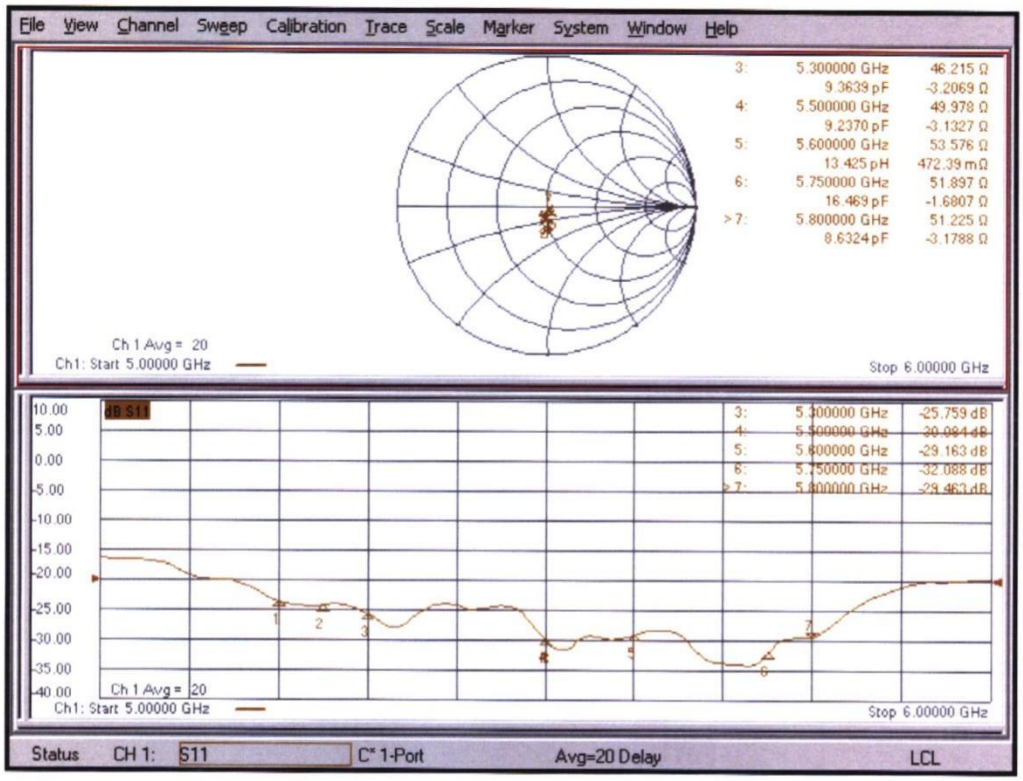


0 dB = 19.8 W/kg = 12.96 dBW/kg

Impedance Measurement Plot for Head TSL (5200, 5250, 5300, 5500, 5600 MHz)



Impedance Measurement Plot for Head TSL (5300, 5500, 5600, 5750, 5800 MHz)



ANNEX I SPOT CHECK

I.1 Tissue and Verification

Table I.1-1: Dielectric Performance of Head Tissue Simulating Liquid

Measurement Date (yyyy-mm-dd)	Type	Frequency	Permittivity ε	Drift (%)	Conductivity σ (S/m)	Drift (%)
2022-12-5	Head	1900MHz	41.17	2.93	1.437	2.64
2022-12-8	Head	5750MHz	35.38	0.06	5.134	-1.65

Table I.1-2: System Validation of Head

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value(W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2022-12-5	1900MHz	20.7	39.7	20.9	39.9	1.06%	0.55%
2022-12-8	5750MHz	22.8	80.4	23.4	84.5	2.63%	5.10%

I.2 Measurement results

RF Exposure Conditions	Frequency Band	Channel Number	Frequency (MHz)	Mode/RB	Test Position	Distance	EUT Measured Power (dBm)	Tune up (dBm)	Measured SAR 1g (W/kg)	Reported SAR 1g (W/kg)	Measured SAR 10g (W/kg)	Reported SAR 10g (W/kg)	Power Drift	Duty Cycle
Hotspot	LTE Band2	18900	1880	1RB-Mid	Bottom	10mm	22.22	23	1.07	**1.28**	0.565	**0.68**	0.15	/
Head	WLAN 5G	165	5825	11a	Tilt Left	0mm	17.02	17.5	0.852	**0.97**	0.235	**0.26**	0.15	98.00%

I.3 Reported SAR Comparison

Table: Highest Reported SAR (1g)

Mode		Highest Reported SAR (1g)	
		Highest Reported SAR 1g(W/kg)	Reported SAR spot check SAR 1g(W/kg)
Head	GSM850	0.31	/
	GSM1900	0.14	/
	UMTS FDD 5	0.28	/
	UMTS FDD 4	0.26	/
	UMTS FDD 2	0.45	/
	LTE Band 2	0.37	/
	LTE Band 5	0.33	/
	LTE Band 12	0.24	/
	LTE Band 13	0.30	/
	LTE Band 41-PC2	<0.01	/
	LTE Band 41-PC3	0.04	/
	LTE Band 66	0.24	/
	LTE Band 71	0.26	/
	WLAN 2.4GHz	0.97	/
	WLAN 5GHz	1.12	0.97
	BT	0.11	/

Hotspot	GSM850	0.39	/
	GSM1900	1.00	/
	UMTS FDD 5	0.38	/
	UMTS FDD 4	1.06	/
	UMTS FDD 2	0.96	/
	LTE Band 2	1.31	1.28
	LTE Band 5	0.49	/
	LTE Band 12	0.46	/
	LTE Band 13	0.54	/
	LTE Band 41-PC2	1.22	/
	LTE Band 41-PC3	0.99	/
	LTE Band 66	0.91	/
	LTE Band 71	0.46	/
	WLAN 2.4GHz	0.54	/
	WLAN 5GHz	0.84	/
	BT	<0.01	/
Body-worn	GSM850	0.34	/
	GSM1900	0.49	/
	UMTS FDD 5	0.33	/
	UMTS FDD 4	0.98	/
	UMTS FDD 2	0.78	/
	LTE Band 2	0.76	/
	LTE Band 5	0.44	/
	LTE Band 12	0.45	/
	LTE Band 13	0.49	/
	LTE Band 41-PC2	0.91	/
	LTE Band 41-PC3	1.05	/
	LTE Band 66	0.88	/
	LTE Band 71	0.40	/
	WLAN 2.4GHz	0.28	/
	WLAN 5GHz	0.81	/
	BT	<0.01	/
Phablet	GSM850	/	/
	GSM1900	2.88	/
	UMTS FDD 5	/	/
	UMTS FDD 4	2.79	/
	UMTS FDD 2	3.02	/
	LTE Band 2	2.38	/
	LTE Band 5	/	/
	LTE Band 12	/	/
	LTE Band 13	/	/
	LTE Band 41-PC2	1.72	/
	LTE Band 41-PC3	1.75	/
	LTE Band 66	2.69	/
	LTE Band 71	/	/
	WLAN 2.4GHz	1.09	/
	WLAN 5GHz	1.18	/
	BT	0.16	/

Note: The spot check results marked blue are larger than the original result.

I.4 List of Main Instruments

Table I.4-1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	January 4, 2022	One year
02	Power sensor	NRP110T	101139	January 13, 2022	One year
03	Power sensor	NRP110T	101159		
04	Signal Generator	E4438C	MY49071430	January 13, 2022	One Year
05	Amplifier	60S1G4	0331848	No Calibration Requested	
06	BTS	CMW500	159890	January 24, 2022	One year
07	DAE	SPEAG DAE4	777	January 07, 2022	One year
08	E-field Probe	SPEAG EX3DV4	7673	July 08，2022	One year
09	Dipole Validation Kit	SPEAG D1900V2	5d101	July 26,2022	One year
10	Dipole Validation Kit	SPEAG D5GHzV2	1060	July 5,2022	One year

I.5 Graph Results

WIFI5G Head

Date/Time: 12/8/2022

Electronics: DAE4 Sn777

Medium: H700-6000M

Medium parameters used: f = 5825 MHz; σ = 5.214 S/m; εr = 35.295; ρ = 1000 kg/m3

Ambient Temperature:23.3oC Liquid Temperature: 22.5oC

Communication System: UID 0, WLan 11a (0) Frequency: 5825 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN7673 ConvF(4.7, 4.7, 4.7)

Area Scan (81x141x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 3.51 W/kg

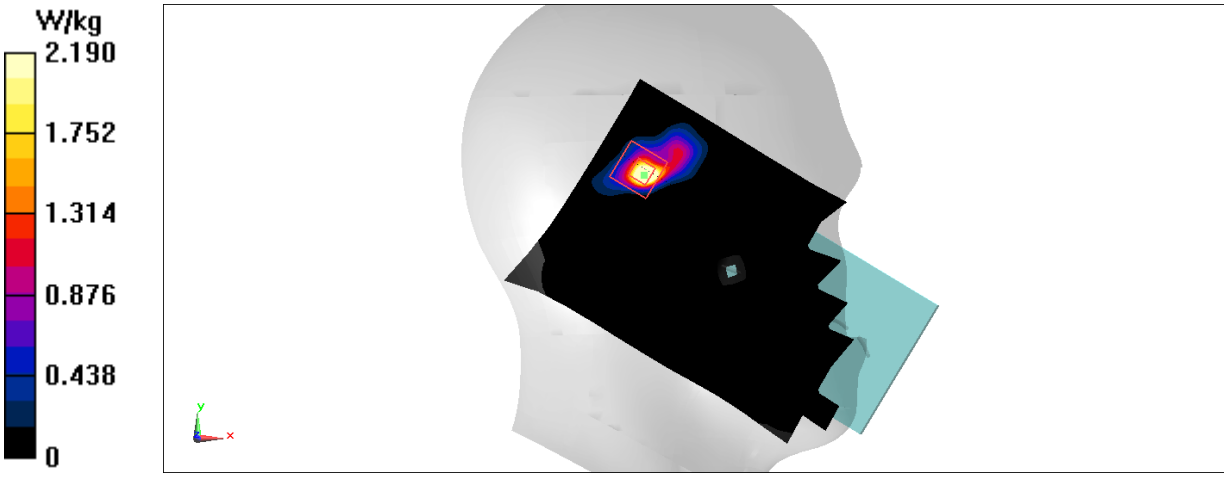
Zoom Scan (8x9x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 1.651 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 3.80 W/kg

SAR(1 g) = 0.852 W/kg; SAR(10 g) = 0.235 W/kg

Maximum value of SAR (measured) = 2.19 W/kg

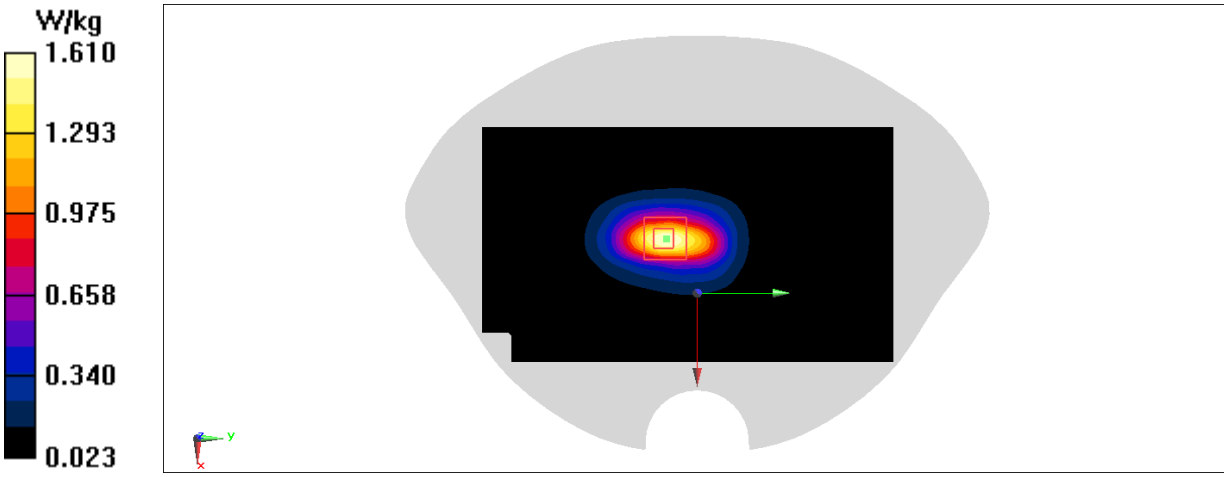


LTE Band2 Body

Date/Time: 12/5/2022
Electronics: DAE4 Sn777
Medium: H700-6000M
Medium parameters used: f = 1880 MHz; σ = 1.423 S/m; εr = 41.225; ρ = 1000 kg/m3
Ambient Temperature:23.3oC Liquid Temperature: 22.5oC
Communication System: UID 0, LTE Band2(20MB) (0) Frequency: 1880 MHz Duty Cycle: 1:1
Probe: EX3DV4 - SN7673 ConvF(8.07, 8.07, 8.07)

Area Scan (81x141x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.65 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 24.43 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 1.93 W/kg
SAR(1 g) = 1.07 W/kg; SAR(10 g) = 0.565 W/kg
Maximum value of SAR (measured) = 1.61 W/kg



I.6 System Verification Results

1900MHz

Date/Time: 12/5/2022

Electronics: DAE4 Sn777

Medium: H700-6000M

Medium parameters used: f = 1900 MHz; σ = 1.437 S/m; εr = 41.17; ρ = 1000 kg/m3

Ambient Temperature:23.3℃ Liquid Temperature: 22.5℃

Communication System: UID 0, CW (0) Frequency: 1900 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN7673 ConvF(8.07, 8.07, 8.07)

Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 15.6 W/kg

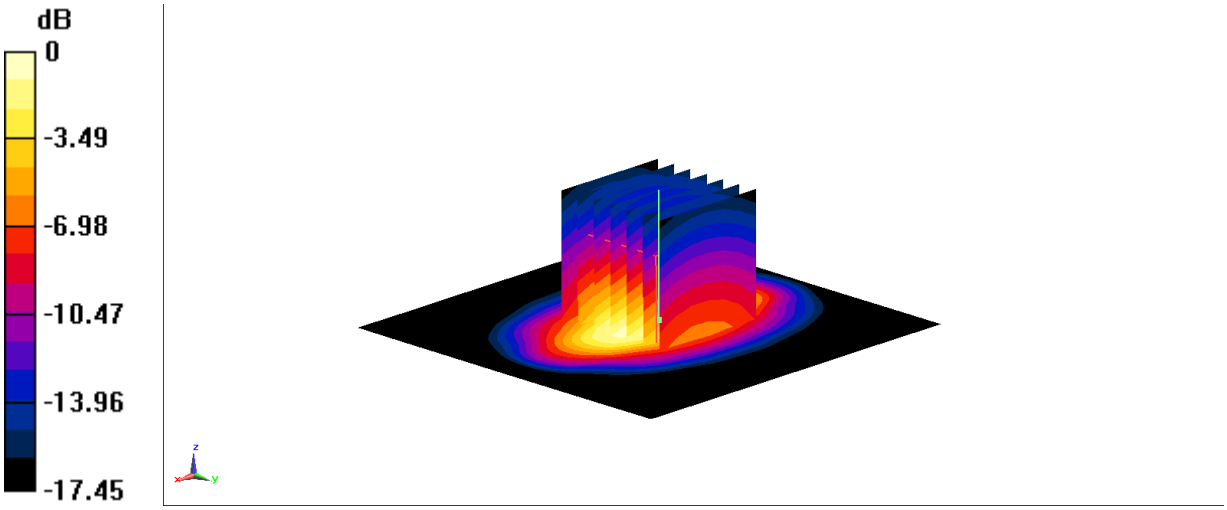
Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 102.3 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 18.6 W/kg

SAR(1 g) = 9.98 W/kg; SAR(10 g) = 5.23 W/kg

Maximum value of SAR (measured) = 15.6 W/kg



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

5750MHz

Date/Time: 12/8/2022

Electronics: DAE4 Sn777

Medium: H700-6000M

Medium parameters used: f = 5750 MHz; σ = 5.134 S/m; εr = 35.38; ρ = 1000 kg/m3

Ambient Temperature:23.3℃ Liquid Temperature: 22.5℃

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

Probe: EX3DV4 - SN7673 ConvF(4.7, 4.7, 4.7)

System Performance Check/d=10mm, Pin=100mW, f=5750 MHz/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 22.2 W/kg

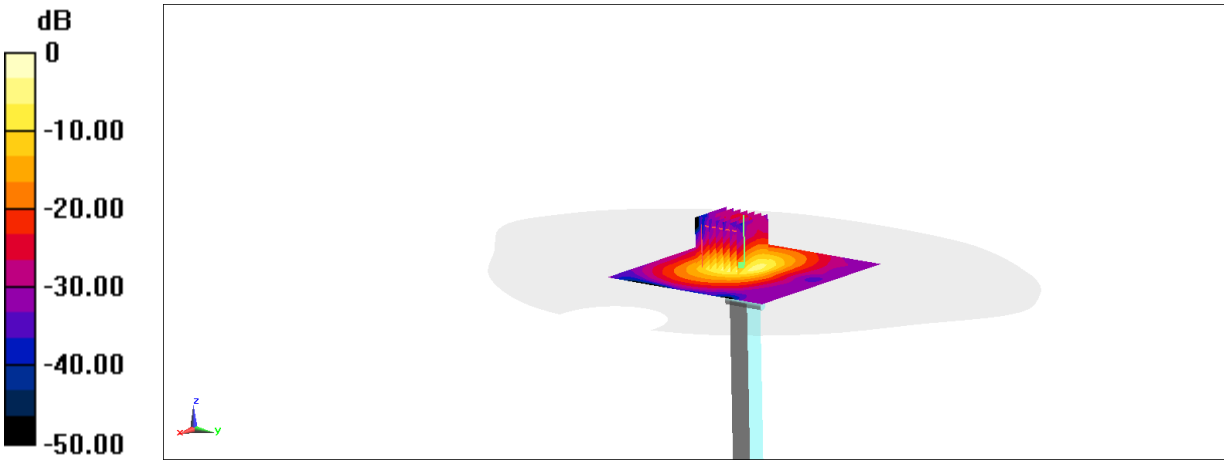
System Performance Check/d=10mm, Pin=100mW, f=5750 MHz/Zoom Scan 2 (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 41.82 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 37.4 W/kg

SAR(1 g) = 8.45 W/kg; SAR(10 g) = 2.34 W/kg

Maximum value of SAR (measured) = 22.1 W/kg



0 dB = 22.1 W/kg = 13.44 dBW/kg

ANNEX J Accreditation Certificate

United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 600118-0

Telecommunication Technology Labs, CAICT
Beijing
China

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2022-10-01 through 2023-09-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program