# Calibration Laboratory of

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





Schweizerischer Kalibrierdienst Service suisse d'etalonnage Servizio svizzero di taratura

Swiss Calibration Service

Accreditation No.: SCS0108

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

Client

Emtek(Shenzhen)

Certificate No: D2600V2-1058\_Jun18

### CALIBRATION CERTIFICATE

Object D2600V2 - SN:1058

Calibration procedure(s) QA CAL-05.v10

Calibration procedure for dipole validation kits above 700 MHz

Calibration date: June 18,2022

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 :t: 3)°C and humidity <70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID#	Cal Date (CertificateNo.)	Scheduled Calibration
Power meter NAP	SN: 104778	04-Apr-18(No.217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No.217-02672)	Apr-19
Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 103245 SN: 5058(20k)	04-Apr-18 (No. 217-02673) 04-Apr-18 (No. 217-02682)	Apr-19 Apr-19
Type-N mismatch combination	SN: 5047.2 /06327	04-Apr-18 (No.217-02683)	Apr-19
Reference Probe EX3DV4	SN: 7349	30-Dec-17 (No. EX3·7349_Dec17)	Dec-18
DAE4	SN: 601	26-0ct-17 (No. DAE4-601_0ct17)	Oct-18
Secondary Standards	ID#	Check Date (inhouse)	ScheduledCheck
Power meter EPM-442A	SN:GB37480704	07-0ct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN:US37292783	07-0ct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP8481A	SN:MY41092317	07-0ct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN:US37390585	18-0ct-01 (in house check Oct-17)	In house check: Oct-18
	Name	Function	Sigoat,
Calibratedby:	Jeton Kastrati	LaboratoryTechnician	
Approvedby:	Katja Pokovic	TechnicalManager	61
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Issued: June 21, 2022

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

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# Calibration Laboratory of Schmid & Partner

#### **Engineering AG**

Zeughausstrasse 43,8004 Zurich, Switzerland





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service isone 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) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the PeakSpatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency rangeof 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "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)", March 2010
- d) KDB 865664, "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 itsfeed 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 thedipole 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 feedpoint. 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 theantenna 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 conf1guration, as far as not jiven on page 1.

	1	
DASY Version	DASY5	V52.10.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance DipoleCenter-TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz ± 1 MHz	

#### Head TSL parameters

The followm q parameters and calculations were appl"1ed

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0°C	39.0	1.96mho/m
Measured Head TSL parameters	(22.0 ±0.2) °C	37.4 ± 6 %	2.03 mho/m ±6 %
HeadTSL temperature change duringtest	<0.5°C	~:	

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.3 W/kg
SAR for nominal Head TSL parameters	normalizedto 1W	55.8 W/kg ::t 17.0%(k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW inputpower	6.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.1W/kg :t: 16.5% (k=2)

### Body TSL parameters

The following parameters and calculations were applied

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	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16mho/m
Measured Body TSL parameters	(22.0 ±0.2) °C	51.8±6%	2.22 mho/m ± 6%
Body TSL temperature change during test	<0.5 °C		

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1g) of BodyTSL	Condition	
SAR measured	250 mW input power	13.8 W/kg
SAR for nominal Body TSLparameters	normalized to 1W	544 W/kg ::t 170 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of BodyTSL	condition	
SAR measured	250 mW input power	6.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.4 W/kg ::t 16.5 % (k=2)

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

#### **Antenna Parameters with HeadTSL**

Impedance, transformed to feed point	49.7 Q - 7.5 jQ
Return Loss	- 22.4 dB

#### **Antenna Parameters with BodyTSL**

Impedance, transformed to teed point	45.3 Q - 6.9 jQ
Return Loss	- 21.1 dB

#### **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, smallend 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 on	August 14,2012

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#### **DASY5 Validation Report for HeadTSL**

Date: 19.06.2022

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1058

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

Medium parameters used: f = 2600 MHz; cr = 2.03 Sim; Er = 37.4;  $p = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

#### DASY52 Configuration:

• Probe: EX3DV4 - SN7349; ConvF(7.7, 7.7, 7.7) @ 2600 MHz; Calibrated: 30.03.2022

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn601; Calibrated: 26.04.2022

• Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001

• DASY52 52.10.1(1476); SEMCAD X14.6.11(7439)

#### Dipole Calibration for Head Tissue/Pin=250 mW, d=lOmm/Zoom Scan (7x7x7)/Cube0:

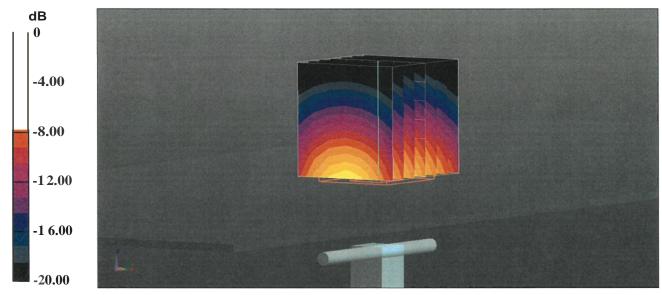
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 117.8 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 28.5 W/kg

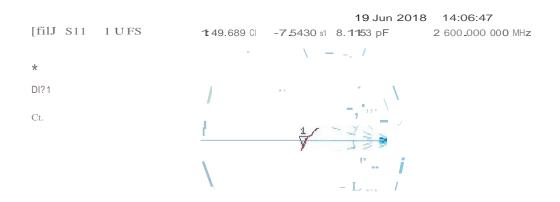
SAR(lg) = 14.3W/kg; SAR(lOg) = 6.38W/kg

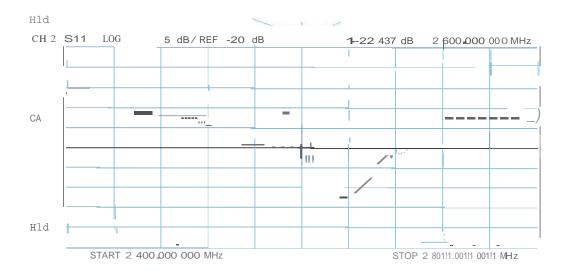
Maximum value of SAR (measured) = 23.8 W/kg



O dB = 23.8 W/kg = 13.77 dBW/kg

### Impedance Measurement Plot for HeadTSL





#### **DASY5 Validation Report for BodyTSL**

Date: 19.06.2022

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1058

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

Medi um parameters used: f = 2600 MHz; < J = 2.22 Sim; er = 51.8;  $p = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY S (IBEE/IEC/ANSI C63.19-2011)

#### DASY52Configuration:

Probe: EX3DV4-SN7349; ConvF(7.81,7.81,7.81) @ 2600MHz; Calibrated: 30.03.2022

• Sensor-Surface: L.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn601; Calibrated: 26.04.2022

• Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002

• DASY52 52.10.1 (1476); SEMCAD X 14.6.11(7439)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=lOmm/Zoom Scan (7x7x7)/Cube 0:

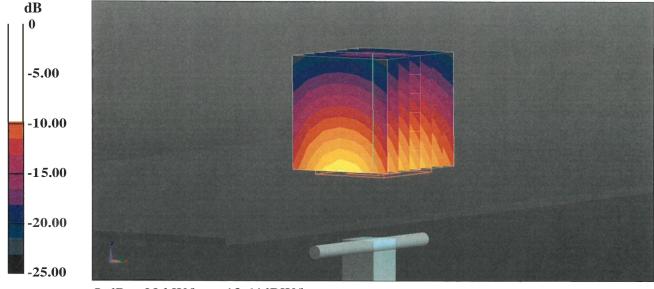
Measurement grid: dx=5mm, dy=5mm, dz=Smm

Reference Value = 107.8 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 28.0 W/kg

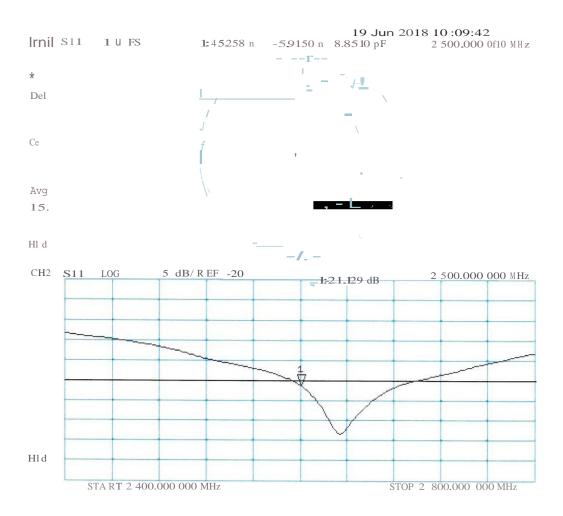
SAR(lg)=13.8W/kg;SAR(lOg)=6.15W/kg

Maximum value of SAR (measured) = 23.1 W/kg



O dB = 23.1 W/kg = 13.64dBW/kg

### Impedance Measurement Plot for BodyTSL









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Client

Emtek(Shenzhen)

Certificate No:

Z22-60037

# **CALIBRATION CERTIFICATE**

Object

D5GHzV2 - SN: 1169

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

February 15, 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 (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 7307	26-May-21(SPEAG,No.EX3-7307 May21)	May-22
DAE4	SN 1556	12-Jan-22(CTTL-SPEAG,No.Z22-60007)	Jan-23
Secondary Standards	ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL, No. J22X00409)	Jan-23
Network Analyzer E5071C	MY46110673	14-Jan-22 (CTTL, No.J22X00406)	Jan-23

Calibrated by:

Name **Function** Zhao Jing SAR Test Engineer

Reviewed by:

Lin Hao SAR Test Engineer

Approved by:

Qi Dianyuan SAR Project Leader

Issued: February 21, 2022

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

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Glossary:

TSL ConvF tissue simulating liquid

sensitivity in TSL / NORMx,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-mounted 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) 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%.





#### **Measurement Conditions**

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

DASY Version	DASY52	52.10.4
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 Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz	

### Head TSL parameters at 5250MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	4.65 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

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

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	7.68 W/kg
SAR measured	250 mW input power	
SAR for nominal Head TSL parameters	normalized to 1W	76.5 W/kg ± 24.4 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.4 W/kg ± 24.2 % (k=2)





Head TSL parameters at 5600MHz

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	34.7 ± 6 %	5.02 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

#### SAR result with Head TSL at 5600MHz

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	7.91 W/kg
SAR for nominal Head TSL parameters	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	250 mW input power	2.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.0 W/kg ± 24.2 % (k=2)

Head TSL parameters at 5750MHz

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	34.5 ± 6 %	5.18 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

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

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	7.56 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	75.2 W/kg ± 24.4 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.0 W/kg ± 24.2 % (k=2)





### Appendix (Additional assessments outside the scope of CNAS L0570)

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

Impedance, transformed to feed point	48.8Ω- 5.12jΩ	
Return Loss	- 25.5dB	

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

Impedance, transformed to feed point	55.4Ω- 0.92jΩ	
Return Loss	- 25.7dB	

### Antenna Parameters with Head TSL at 5750MHz

Impedance, transformed to feed point	54.6Ω- 3.79jΩ	
Return Loss	- 24.8dB	

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.112 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 arms, because they might bend or the soldered connections near the feed-point may be damaged.

#### Additional EUT Data

Management	
Manufactured by	SPEAG





Date: 2022-02-15

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

**DASY5 Validation Report for Head TSL** 

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1169

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

Frequency: 5750 MHz Duty Cycle: 1:1

Medium parameters used: f = 5250 MHz;  $\sigma$  = 4.645 S/m;  $\epsilon_r$  = 35.33;  $\rho$  = 1000 kg/m³ Medium parameters used: f = 5600 MHz;  $\sigma$  = 5.02 S/m;  $\epsilon_r$  = 34.74;  $\rho$  = 1000 kg/m³ Medium parameters used: f = 5750 MHz;  $\sigma$  = 5.182 S/m;  $\epsilon_r$  = 34.52;  $\rho$  = 1000 kg/m³

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: 2022-01-12

 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 = 67.00 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 32.3 W/kg

SAR(1 g) = 7.68 W/kg; SAR(10 g) = 2.15 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 64.1%

Maximum value of SAR (measured) = 18.3 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 = 66.60 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 36.8 W/kg

SAR(1 g) = 7.91 W/kg; SAR(10 g) = 2.21 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 60.8%

Maximum value of SAR (measured) = 19.5 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 = 68.28 V/m; Power Drift = -0.02 dB

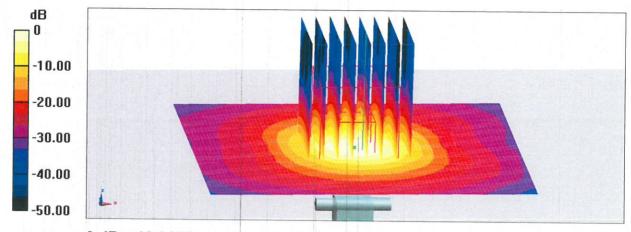
Peak SAR (extrapolated) = 37.1 W/kg

SAR(1 g) = 7.56 W/kg; SAR(10 g) = 2.11 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 59%

Maximum value of SAR (measured) = 19.0 W/kg



0 dB = 19.0 W/kg = 12.79 dBW/kg





## Impedance Measurement Plot for Head TSL

