

CERTIFICATE OF CALIBRATION

ISSUED BY UL INTERNATIONAL (UK) LTD

DATE OF ISSUE: 26/Feb/2021 CERTIFICATE NUMBER : 13685197JD01A



UL INTERNATIONAL (UK) LTD
UNIT 1-3 HORIZON
KINGSLAND PARK, WADE ROAD
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Email: LST.UK.Calibration@ul.com



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APPROVED SIGNATORY

A handwritten signature in black ink, appearing to read 'M. Nasir'.

.....
Naseer Mirza

Customer :

UL VS Inc
47173 Benicia Street
Fremont, CA 94538, USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	15/Feb/2021
Manufacturer:	Speag		
Type/Model Number:	D2450V2		
Serial Number:	748		
Calibration Date:	19/Feb/2021		
Calibrated By:	Masood Khan Test Engineer		
Signature:	A handwritten signature in black ink, appearing to read 'Masood Khan'.		

All Calibration have been conducted in the closed laboratory facility: Lab Temperature (22±3) °C and humidity < 70%

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Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025:2017 has been independently assessed.

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The calibration methods and procedures used were as detailed in:

1. **IEC 62209-1:2016**: 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)
2. **IEC 62209-2:2010**: 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)
3. **IEEE 1528: 2013**: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques
4. FCC KDB Publication Number: "KDB865664 D01 SAR Measurement 100 MHz to 6 GHz"
5. **DASY 6 System Handbook**
6. **Dipole Calibration Procedure V1.2**: Calibration performed as per internal procedure

The measuring equipment used to perform the calibration, documented in this certificate has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval (Months)
PRE0178317	Data Acquisition Electronics	SPEAG	DAE4	1542	17 Mar 2020	12
PRE0178313	Probe	SPEAG	EX3DV4	7497	24 Mar 2020	12
A1322	Dipole	SPEAG	D2450V2	725	08 Oct 2020	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	27 Mar 2020	12
PRE0151154	Vector Network Analyser	Rhode & Schwarz	ZND	100151	15 Jun 2020	12
PRE0158684	Calibration Kit	Rhode & Schwarz	ZV-Z135	102144	27 May 2020	12
PRE0178154	Signal Generator	Rhode & Schwarz	SMB100A	175325	10 Jun 2020	12

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SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F13/5SC6F1/A/01
DASY Version:	cDASY6.14.0.959
Phantom:	ELI Phantom
Distance Dipole Centre:	10mm (with spacer)
Frequency:	2450 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	2450	20.6 °C	20.4 °C	20.6°C	20.6°C	ϵ_r	39.2	39.60	± 5%
						σ	1.80	1.80	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	200 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	13.10 W/Kg	52.15 W/Kg	+ 16.80% / - 16.43%
	SAR averaged over 10g	6.15 W/Kg	24.48 W/Kg	+ 16.72% / - 16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	47.403 Ω +2.719 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	28.27	± 2.03 dB

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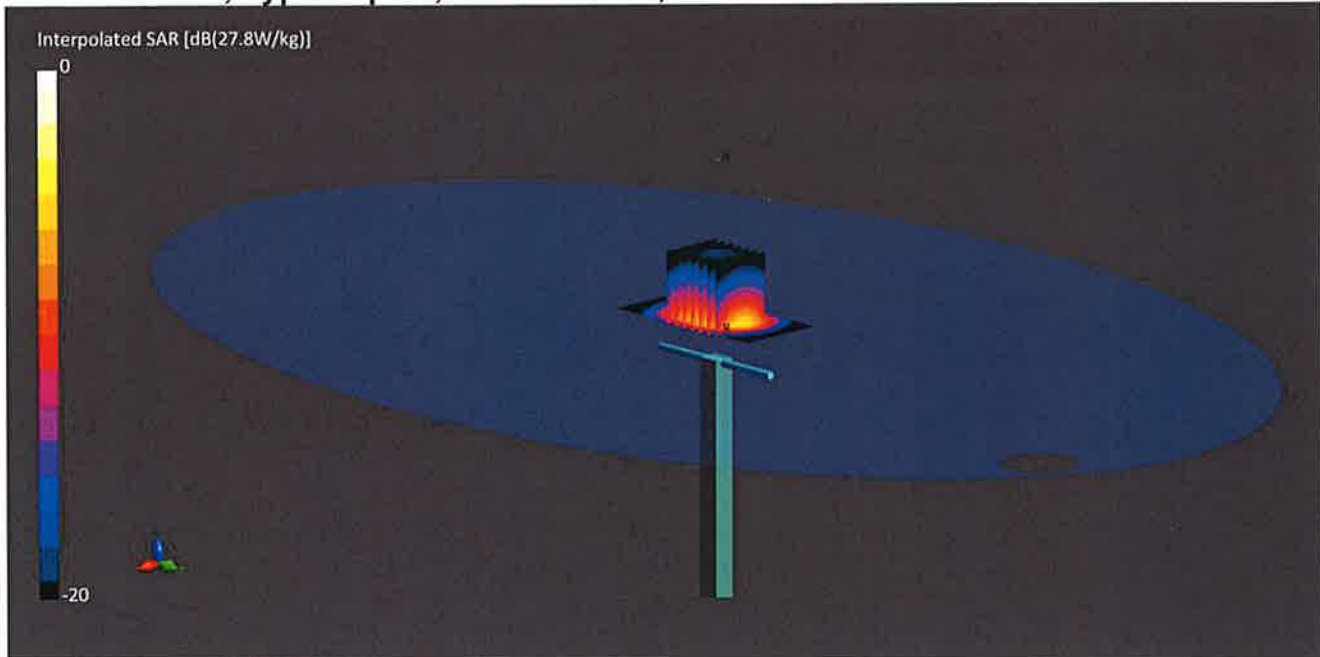
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D2450V2; Type: Dipole; Serial: SN748;



Communication System: CW UID: 0; Frequency: 2450.0 MHz; Duty Cycle: 1;
Medium: HSL; Site59_19Feb2021_104323_Head - 2450 5%; Medium parameters used: $f = 2450.0$ MHz; $\sigma = 1.8$ S/m; $\epsilon_r = 39.6$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 0.92$ %; $\Delta\sigma = 0.26$ %; No correction
Phantom section: Flat;
DASY 6 Configuration:

- Laboratory Name: Site59;
- Probe: EX3DV4 - SN7497; ConvF(7.62, 7.62, 7.62); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; All points
- Electronics: DAE4 - SN1542; Calibrated: 17 Mar 2020
- Phantom: ELI V8.0 (20deg probe tilt); Serial: 2100
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(30x30x30): Measurement grid: dx=5 mm, dy=5 mm, dz=1.5 mm; Grading Ratio: 1.5; Reference Value = 9.560 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 9.5 mm;

Vertical M2/M1 Ratio: 78.6 %;

SAR(1 g) = 13.100 W/kg; SAR(10 g) = 6.150 W/kg

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Impedance Measurement Plot for Head Stimulating Liquid (HSL)

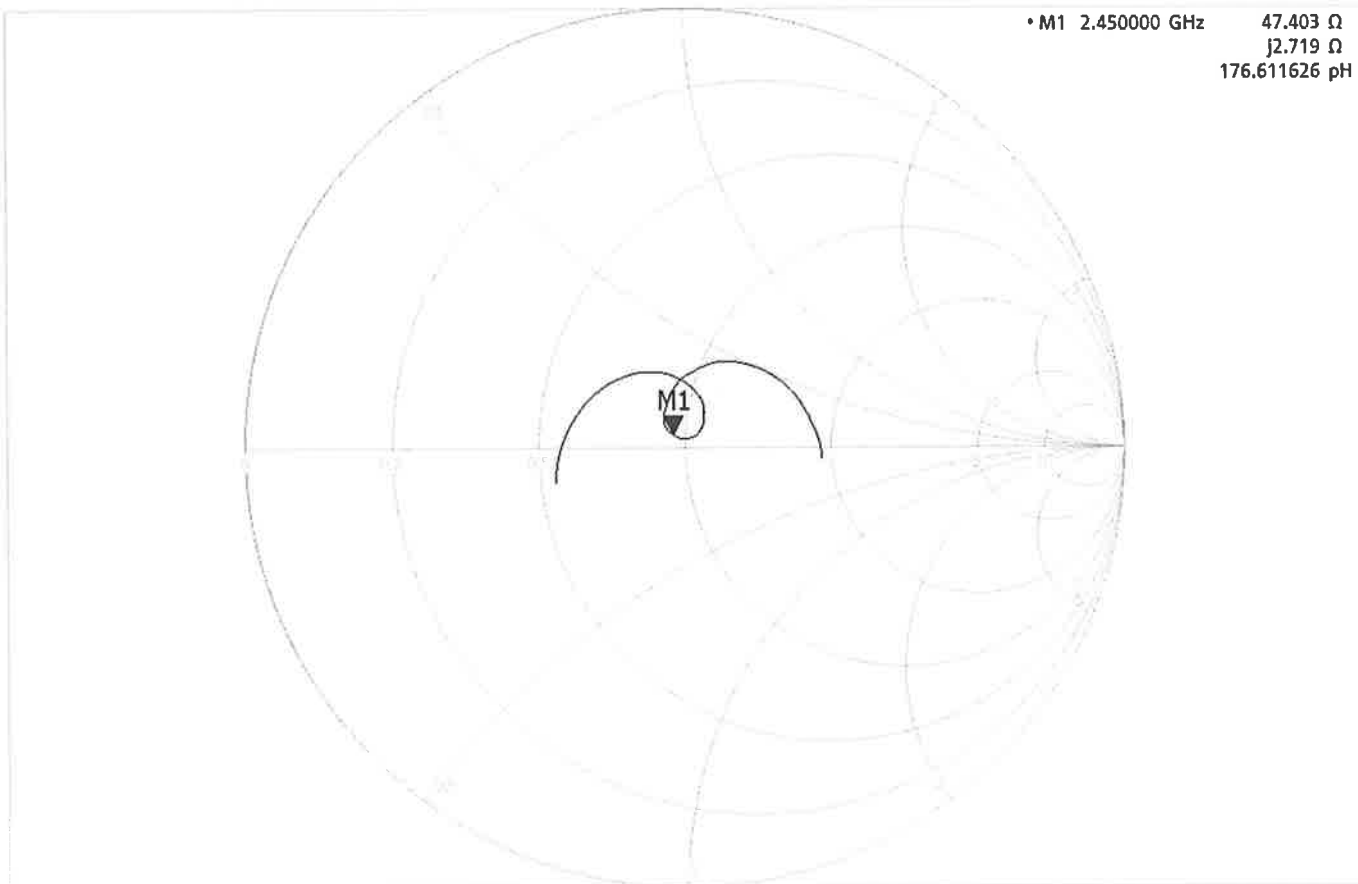


2/19/2021 3:17:56 PM
1328.5170K92-100151-MV

Trc1 — 511 Smith 200 mU/ Ref 1 U Cal

1

• M1 2.450000 GHz 47.403 Ω
j2.719 Ω
176.611626 pH



Ch1 Center 2.45 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

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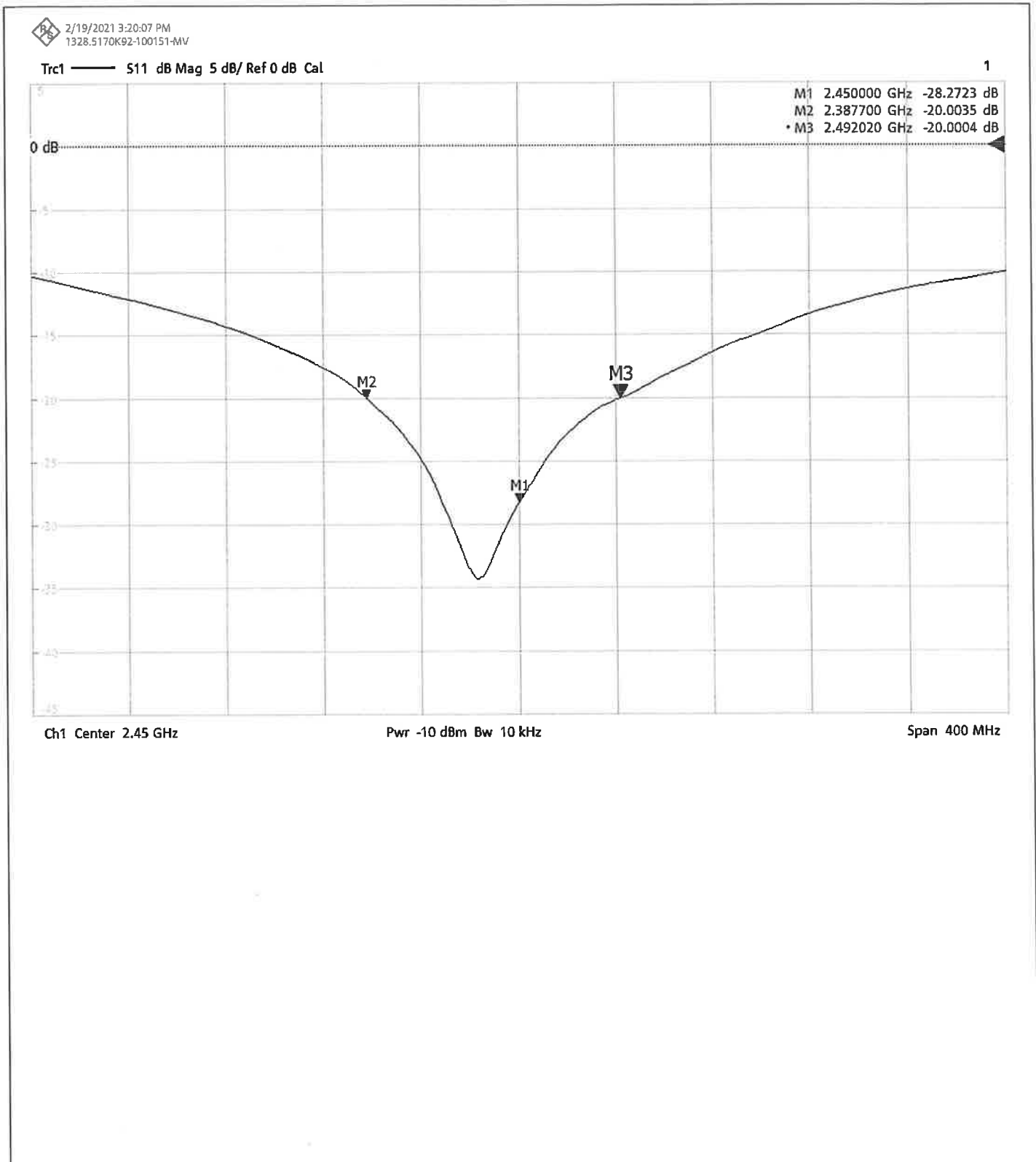
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



Calibration Certificate Label:

 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13685197JD01A</p> <p>Instrument ID: 748</p> <p>Calibration Date: 19/Feb/2021</p> <p>Calibration Due Date:</p>
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 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13685197JD01A</p> <p>Instrument ID: 748</p> <p>Calibration Date: 19/Feb/2021</p> <p>Calibration Due Date:</p>
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 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13685197JD01A</p> <p>Instrument ID: 748</p> <p>Calibration Date: 19/Feb/2021</p> <p>Calibration Due Date:</p>
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CERTIFICATE OF CALIBRATION

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DATE OF ISSUE: 27/Nov/2020 CERTIFICATE NUMBER : 13252589JD01F



5772

UL INTERNATIONAL (UK) LTD
UNIT 1-3 HORIZON
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APPROVED SIGNATORY

A handwritten signature in black ink, appearing to read 'M. Nasir'.

.....
Naseer Mirza

Customer :

UL VS Inc
47173 Benicia Street
Fremont, CA 94538, USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	26/Nov/2020
Manufacturer:	SPEAG		
Type/Model Number:	D5GHzV2		
Serial Number:	1168		
Calibration Date:	27/Nov/2020		
Calibrated By:	Masood Khan Test Engineer		

Signature:

A handwritten signature in black ink, appearing to read 'Masood Khan'.

.....
All Calibration have been conducted in the closed laboratory facility: Lab Temperature (22±3) °C and humidity < 70%

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The calibration methods and procedures used were as detailed in:

1. **IEC 62209-1:2016**: 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)
2. **IEC 62209-2:2010**: 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)
3. **IEEE 1528: 2013**: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques
4. FCC KDB Publication Number: **"KDB865664 D01 SAR Measurement 100 MHz to 6 GHz"**
5. **DASY6 System Handbook**
6. **Dipole Calibration Procedure V1.2**: Calibration performed as per internal procedure

The measuring equipment used to perform the calibration, documented in this certificate has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval (Months)
PRE0135115	Data Acquisition Electronics	SPEAG	DAE4	1438	14 Apr 2020	12
PRE0178314	Probe	SPEAG	EX3DV4	7496	24 Mar 2020	12
PRE0132081	Dipole	SPEAG	D5GHzV2	1016	18 Feb 2020	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	27 Mar 2020	12
PRE0151154	Vector Network Analyser	Rhode & Schwarz	ZNB 8	100151	15 Jun 2020	12
PRE0158684	Calibration Kit	Rhode & Schwarz	ZV-Z135	102144	27 May 2020	12
PRE0178154	Signal Generator	HP	8648C	3537A01598	22 Jan 2020	12

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SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F17/5ENYG1/A/01
DASY Version:	cDASY6.14.0.959
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (with spacer)

Frequency: 5250 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	5250	20.3 °C	20.3 °C	21.4 °C	21.4 °C	ϵ_r	35.93	35.77	± 5%
						σ	4.71	4.69	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	8.08 W/Kg	80.8 W/Kg	± 18.75%
	SAR averaged over 10g	2.33 W/Kg	23.3 W/Kg	± 18.63%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	59.368 Ω +3.959 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	20.57	± 2.23 dB

Frequency: 5600 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	5600	20.3 °C	20.3 °C	21.4 °C	21.4 °C	ϵ_r	35.53	35.10	± 5%
						σ	5.07	5.07	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	8.61 W/Kg	86.1 W/Kg	± 18.75%
	SAR averaged over 10g	2.45 W/Kg	24.5 W/Kg	± 18.63%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	46.438 Ω +5.066 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	23.78	± 2.23 dB

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Frequency: 5750 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	5750	20.3 °C	20.3 °C	21.4°C	21.4°C	ϵ_r	35.36	34.81	± 5%
						σ	5.22	5.24	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	7.80 W/Kg	78.0 W/Kg	± 18.75%
	SAR averaged over 10g	2.24 W/Kg	22.4 W/Kg	± 18.63%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	58.790 Ω -2.037 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	21.77	± 2.23 dB

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Frequency: 5250 MHz

Dielectric Property Measurements – Body Simulating Liquid (MSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Body	5250	20.9 °C	20.9 °C	21.0°C	21.0°C	ϵ_r	48.95	47.85	± 5%
						σ	5.36	5.38	± 5%

SAR Results – Body Simulating Liquid (MSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	7.26 W/Kg	72.6 W/Kg	± 18.53%
	SAR averaged over 10g	2.04 W/Kg	20.4 W/Kg	± 18.61%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	58.323 Ω +3.270 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	21.54	± 2.23 dB

Frequency: 5600 MHz

Dielectric Property Measurements – Body Simulating Liquid (MSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Body	5600	20.3 °C	20.3 °C	21.4°C	21.4°C	ϵ_r	48.47	47.09	± 5%
						σ	5.77	5.86	± 5%

SAR Results – Body Simulating Liquid (MSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	7.76 W/Kg	77.6 W/Kg	± 18.53%
	SAR averaged over 10g	2.17 W/Kg	21.7 W/Kg	± 18.61%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	45.652 Ω +4.355 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	23.77	± 2.23 dB

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Frequency: 5750 MHz

Dielectric Property Measurements – Body Simulating Liquid (MSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Body	5750	20.9 °C	20.9 °C	21.0°C	21.0°C	ϵ_r	48.3	46.78	± 5%
						σ	5.94	6.07	± 5%

SAR Results – Body Simulating Liquid (MSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	7.14 W/Kg	71.4 W/Kg	± 18.53%
	SAR averaged over 10g	2.01 W/Kg	20.1 W/Kg	± 18.61%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	59.598 Ω -1.316 $j\Omega$	± 0.28 Ω ± 0.044 $j\Omega$
	Return Loss	21.19	± 2.23 dB

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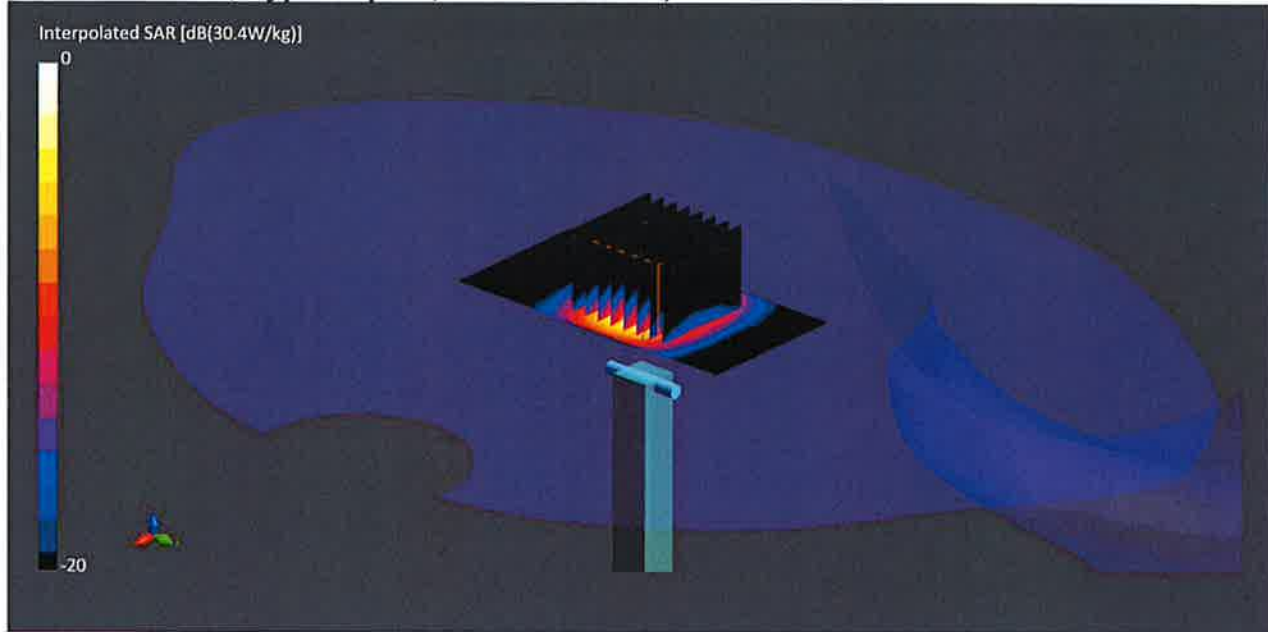
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5250.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_26Nov2020_102813_Head - 5Ghz 5%; Medium parameters used: $f = 5250.0$ MHz; $\sigma = 4.69$ S/m; $\epsilon_r = 35.8$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -0.44$ %; $\Delta\sigma = -0.42$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(5.18, 5.18, 5.18); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(22x22x22): Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm; Grading Ratio: 1.4; Reference Value = 12.150 V/m; Power Drift = 0.01 dB

Minimum horizontal 3dB distance: 6.9 mm;

Vertical M2/M1 Ratio: 65.9 %;

SAR(1 g) = 8.080 W/kg; SAR(10 g) = 2.330 W/kg

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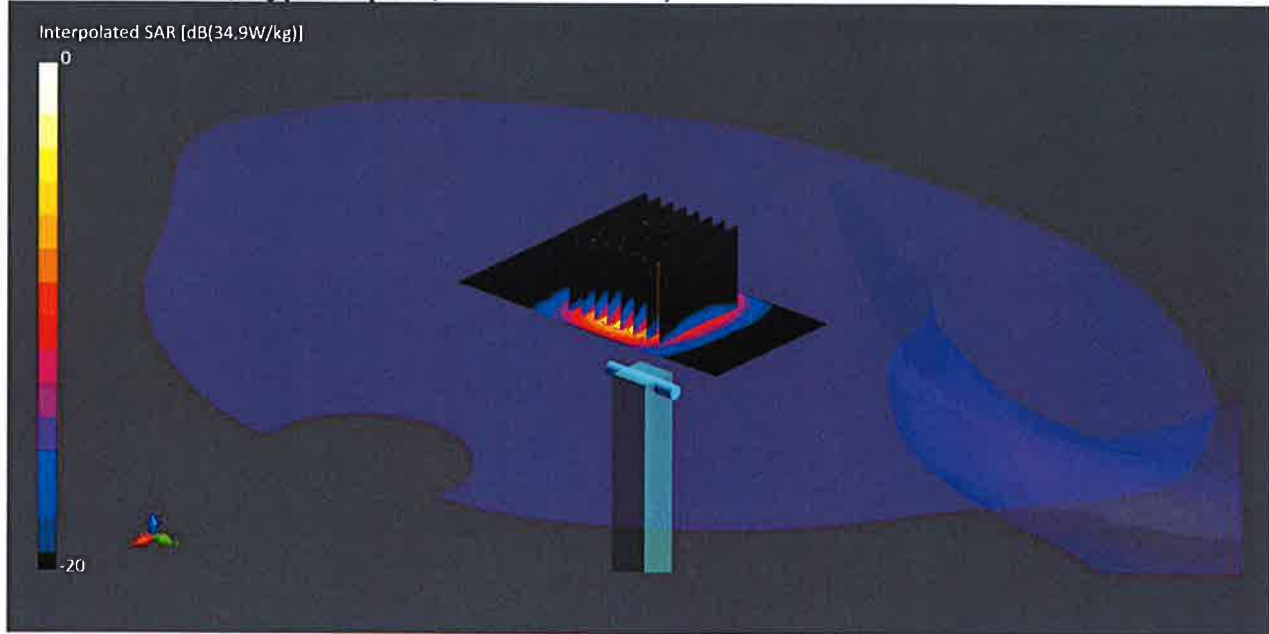
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5600.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_26Nov2020_102813_Head - 5Ghz 5%; Medium parameters used: $f = 5600.0$ MHz; $\sigma = 5.07$ S/m; $\epsilon_r = 35.1$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -1.22$ %; $\Delta\sigma = 0.14$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.65, 4.65, 4.65); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: $dx=10$ mm, $dy=10$ mm

Zoom Scan1(22x22x22): Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=1.4$ mm; Grading Ratio: 1.4; Reference Value = 13.300 V/m; Power Drift = 0.02 dB

Minimum horizontal 3dB distance: 7.4 mm;

Vertical M2/M1 Ratio: 63.3 %;

SAR(1 g) = 8.610 W/kg; SAR(10 g) = 2.450 W/kg

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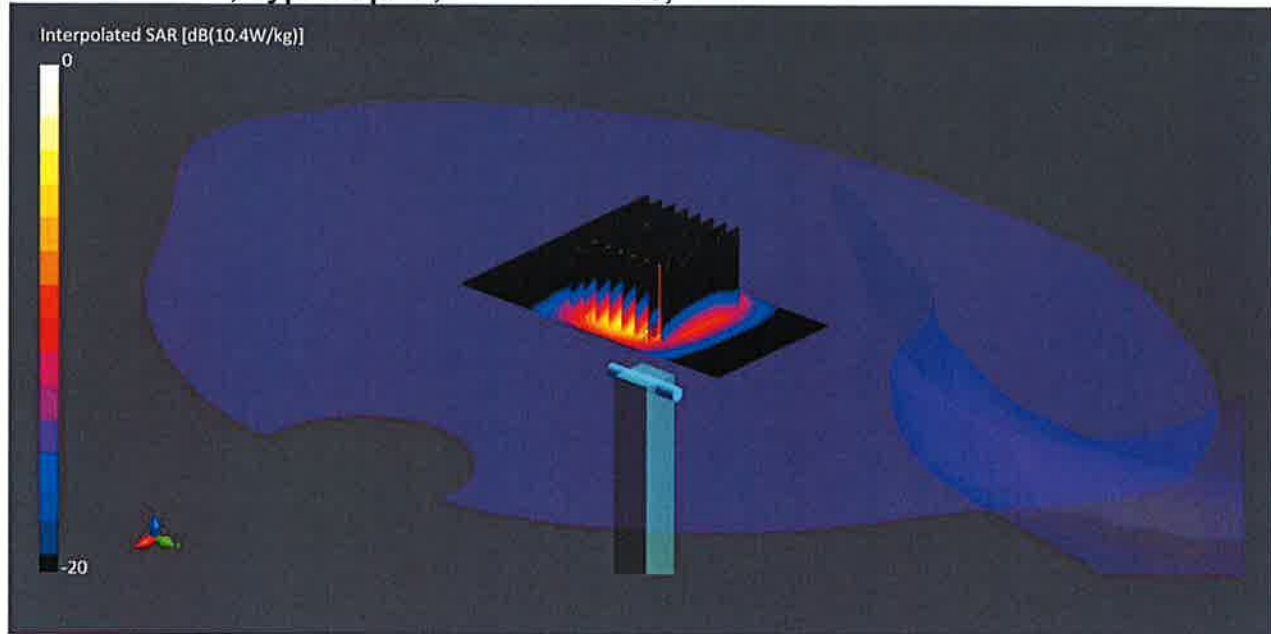
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_26Nov2020_102813_Head - 5Ghz 5%; Medium parameters used: $f = 5750.0$ MHz; $\sigma = 5.24$ S/m; $\epsilon_r = 34.8$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -1.56$ %; $\Delta\sigma = 0.45$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.8, 4.8, 4.8); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: $dx=10$ mm, $dy=10$ mm

Zoom Scan1(22x22x22): Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=1.4$ mm; Grading Ratio: 1.4; Reference Value = 11.300 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 7.5 mm;

Vertical M2/M1 Ratio: 62.1 %;

SAR(1 g) = 7.800 W/kg; SAR(10 g) = 2.240 W/kg

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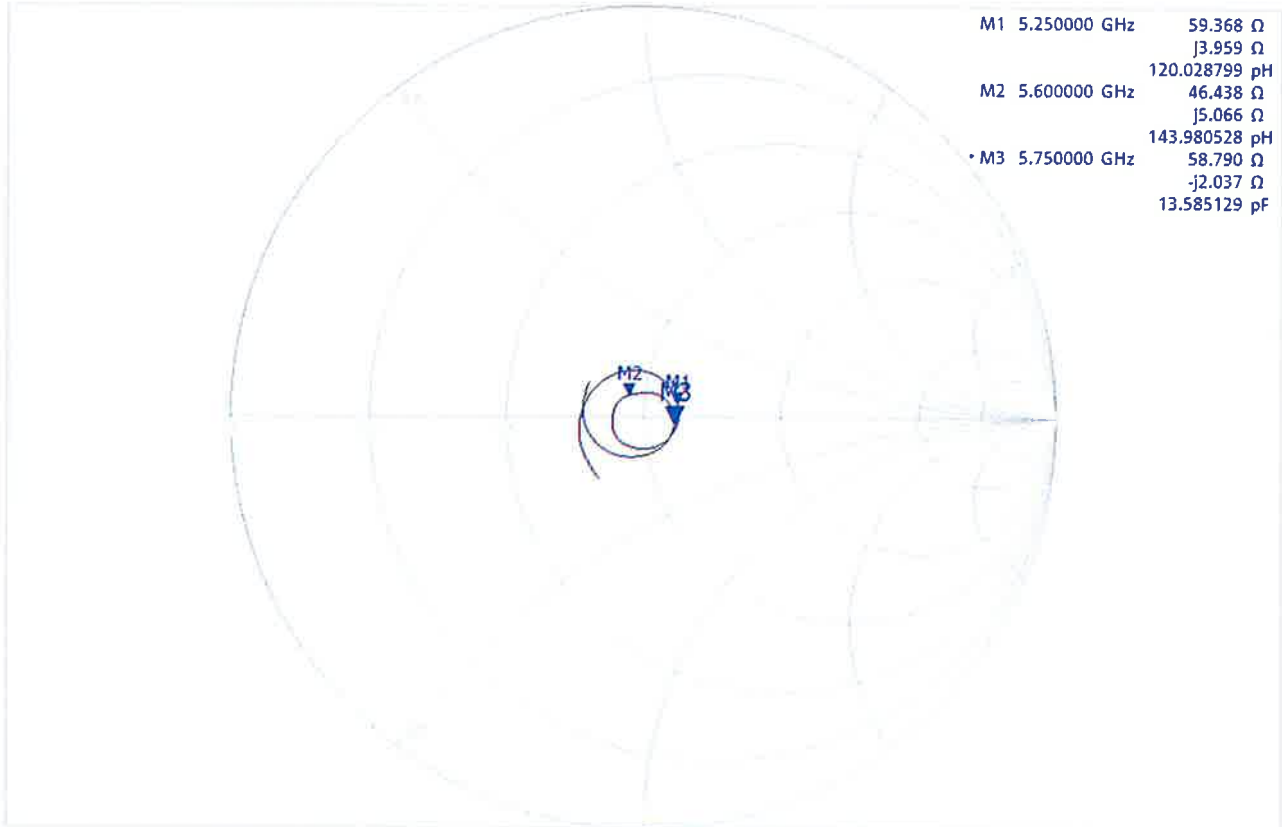
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)

11/27/2020 10:51:38 AM
1328.5170K92-100151-MV

Trc1 — S11 Sm1th 200 mU/ Ref 1 U Cal Smo

1



Ch1 Start 5 GHz

Pwr -10 dBm Bw 10 kHz

Stop 6 GHz

CERTIFICATE OF CALIBRATION

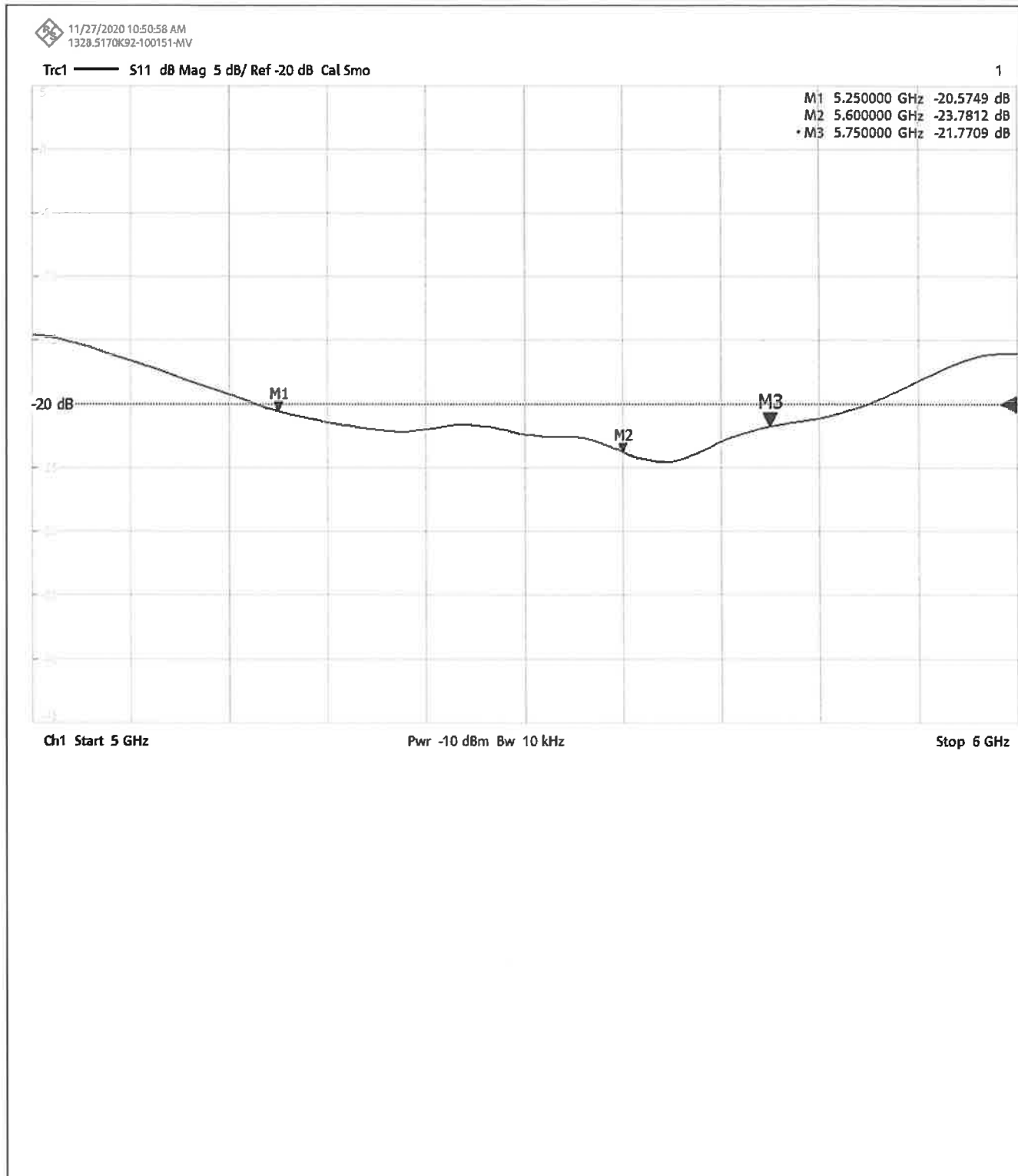
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NUMBER :
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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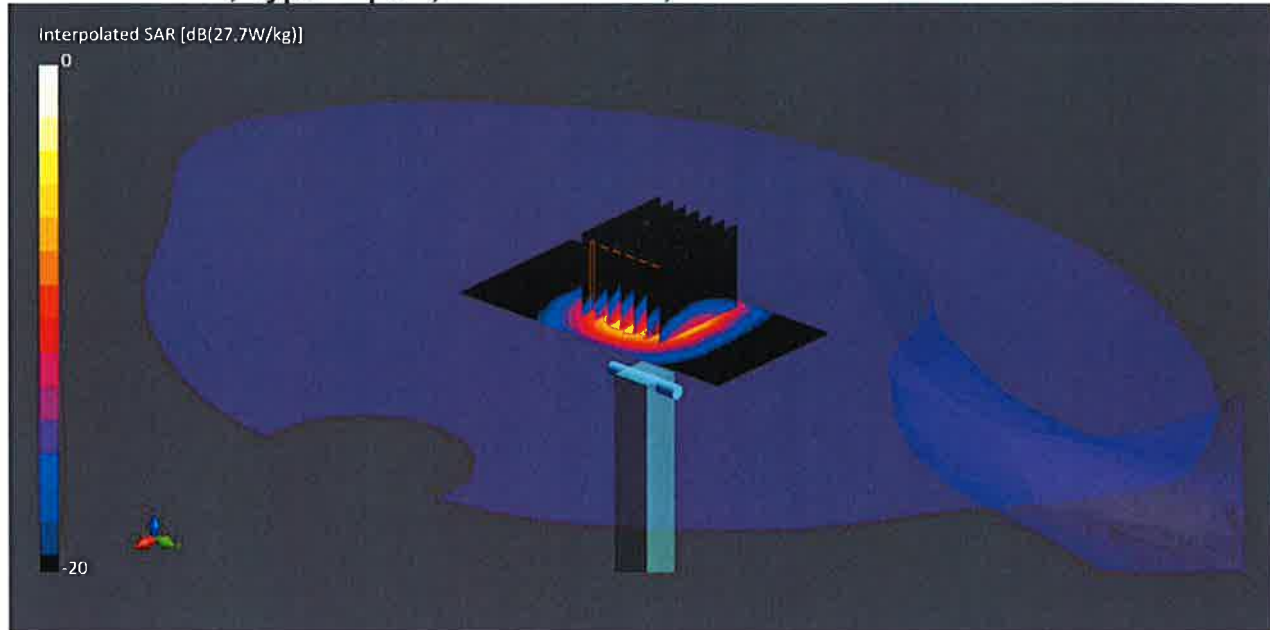
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13252589JD01F

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DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5250.0 MHz; Duty Cycle: 1;
Medium: MSL; Site65_27Nov2020_101444_Body - 5GHz 5%; Medium parameters used: $f = 5250.0$ MHz; $\sigma = 5.38$ S/m; $\epsilon_r = 47.8$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -2.24$ %; $\Delta\sigma = 0.51$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.75, 4.75, 4.75); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: $dx=10$ mm, $dy=10$ mm

Zoom Scan1(22x22x22): Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=1.4$ mm; Grading Ratio: 1.4; Reference Value = 11.310 V/m; Power Drift = 0.02 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 65.2 %;

SAR(1 g) = 7.260 W/kg; SAR(10 g) = 2.040 W/kg

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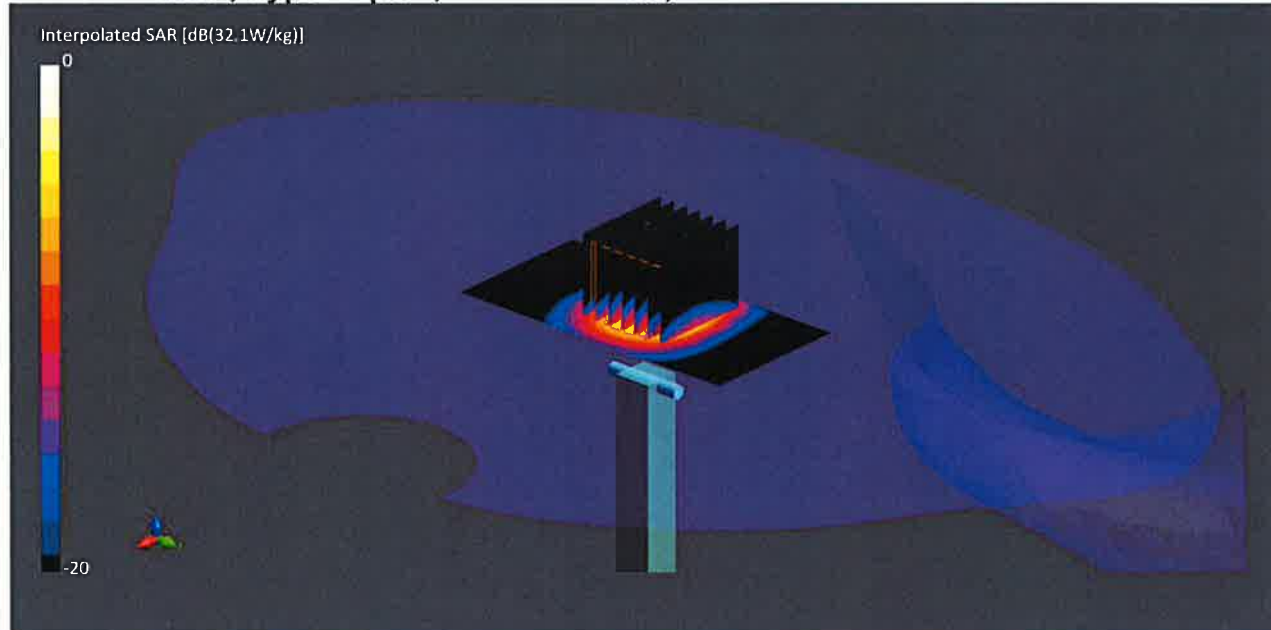
UKAS Accredited Calibration Laboratory No. 5772

CERTIFICATE
NUMBER :
13252589JD01F

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DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5600.0 MHz; Duty Cycle: 1;
Medium: MSL; Site65_27Nov2020_101444_Body - 5GHz 5%; Medium parameters used: $f = 5600.0$ MHz; $\sigma = 5.86$ S/m; $\epsilon_r = 47.1$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -2.85$ %; $\Delta\sigma = 1.67$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.18, 4.18, 4.18); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(22x22x22): Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm; Grading Ratio: 1.4; Reference Value = 11.940 V/m; Power Drift = -0.02 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 62.3 %;

SAR(1 g) = 7.760 W/kg; SAR(10 g) = 2.170 W/kg

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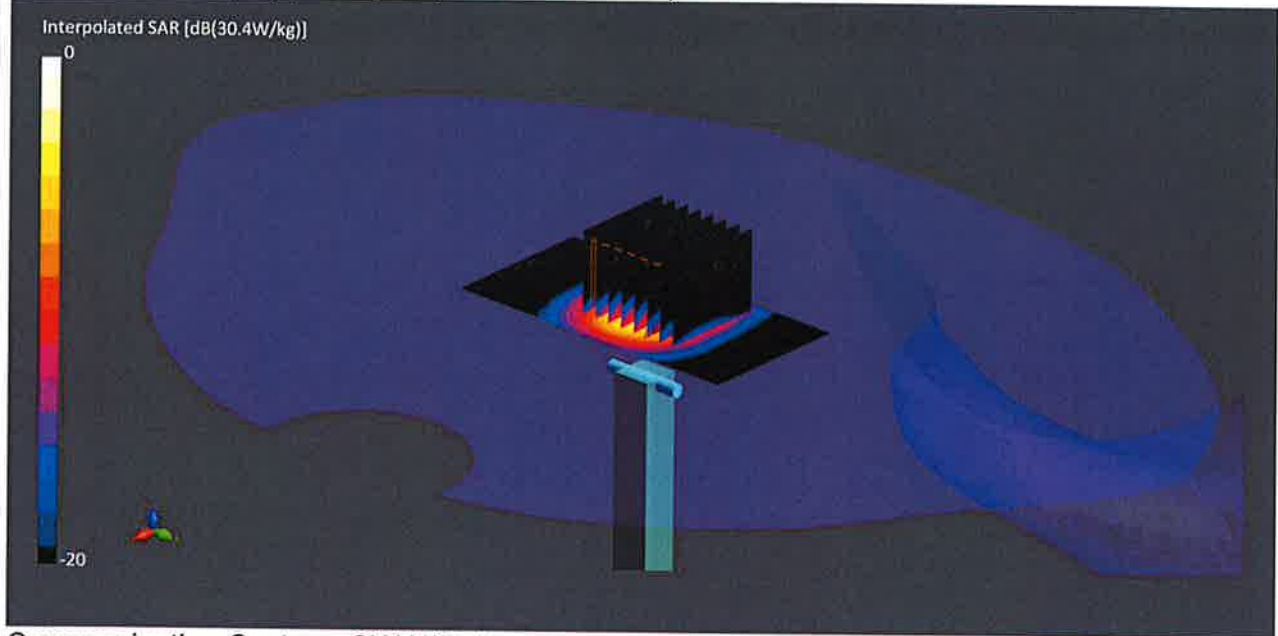
UKAS Accredited Calibration Laboratory No. 5772

CERTIFICATE
NUMBER :
13252589JD01F

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DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5750.0 MHz; Duty Cycle: 1;
Medium: MSL; Site65_27Nov2020_101444_Body - 5GHz 5%; Medium parameters used: $f = 5750.0$ MHz; $\sigma = 6.07$ S/m; $\epsilon_r = 46.8$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -3.09$ %; $\Delta\sigma = 2.12$ %; No correction
Phantom section: Flat;

DASY 6 Configuration:

- Probe: EX3DV4 - SN7496; ConvF(4.21, 4.21, 4.21); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(22x22x22): Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm; Grading Ratio: 1.4; Reference Value = 10.460 V/m; Power Drift = -0.01 dB

Minimum horizontal 3dB distance: 7.4 mm;

Vertical M2/M1 Ratio: 60.9 %;

SAR(1 g) = 7.140 W/kg; SAR(10 g) = 2.010 W/kg

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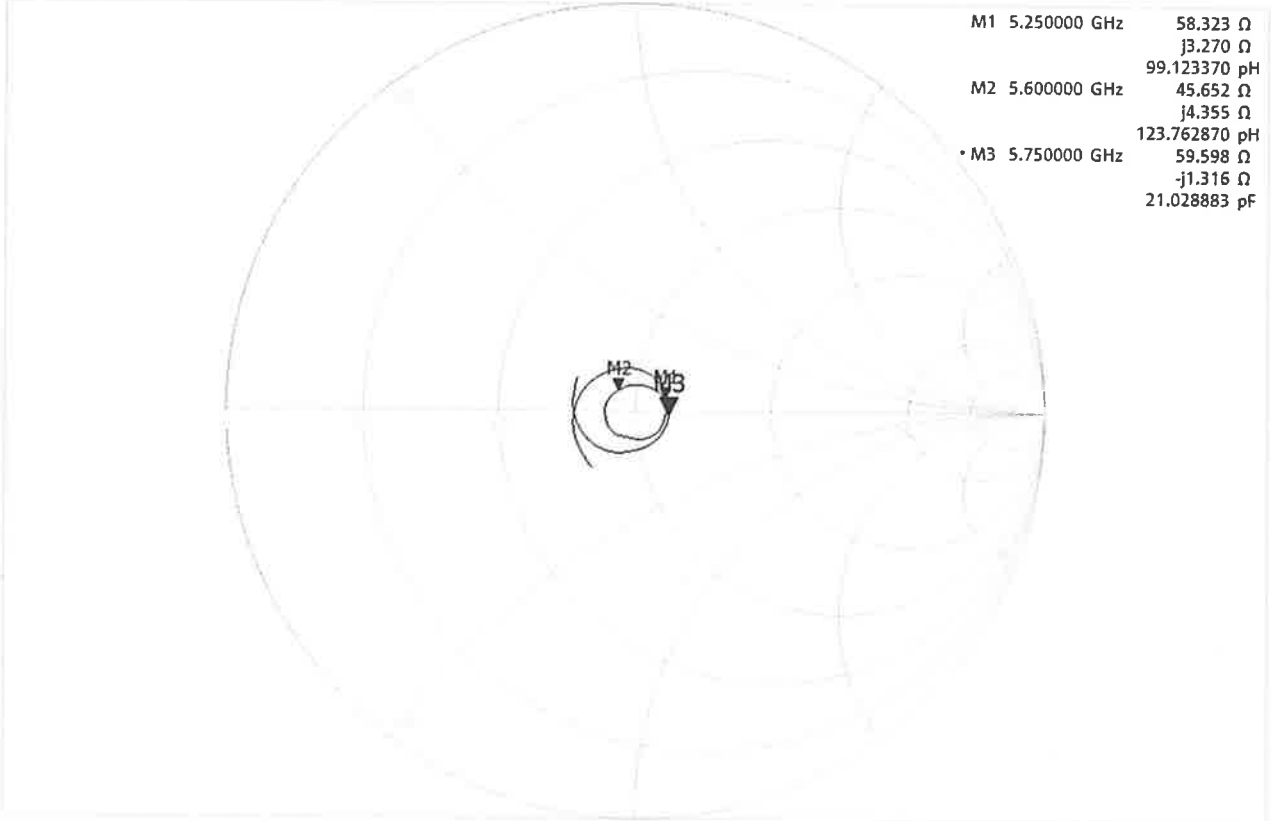
Page 15 of 16

Impedance Measurement Plot for Body Stimulating Liquid (MSL)

11/27/2020 10:53:38 AM
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal Smo

1



M1	5.250000 GHz	58.323 Ω
		$j3.270 \Omega$
		99.123370 pF
M2	5.600000 GHz	45.652 Ω
		$j4.355 \Omega$
		123.762870 pF
M3	5.750000 GHz	59.598 Ω
		$-j1.316 \Omega$
		21.028883 pF

Ch1 Start 5 GHz

Pwr -10 dBm Bw 10 kHz

Stop 6 GHz

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CERTIFICATE
NUMBER :
13252589JD01F

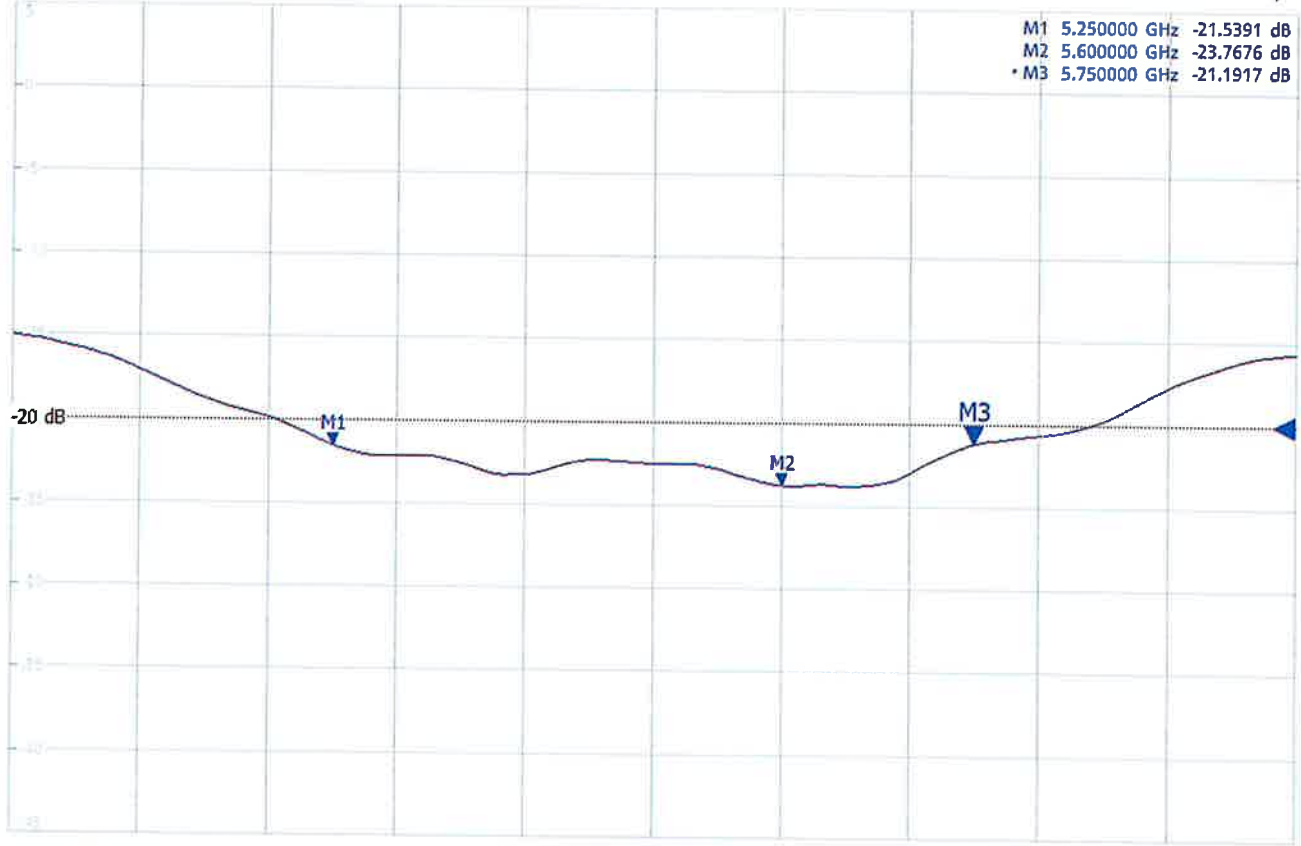
Page 16 of 16

Return Loss Measurement Plot for Body Stimulating Liquid (MSL)

11/27/2020 10:54:19 AM
1328.5170K92-100151-MV

Trc1 — 511 dB Mag 5 dB/ Ref -20 dB Cal 5mo

1





Ch1 Start 5 GHz


Pwr -10 dBm Bw 10 kHz

Stop 6 GHz

Calibration Certificate Label:

 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252589JD01F</p> <p>Instrument ID: 1168</p> <p>Calibration Date: 27/Nov/2020</p> <p>Calibration Due Date:</p>
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 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252589JD01F</p> <p>Instrument ID: 1168</p> <p>Calibration Date: 27/Nov/2020</p> <p>Calibration Due Date:</p>
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 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252589JD01F</p> <p>Instrument ID: 1168</p> <p>Calibration Date: 27/Nov/2020</p> <p>Calibration Due Date:</p>
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CERTIFICATE OF CALIBRATION

ISSUED BY **UL INTERNATIONAL (UK) LTD**

DATE OF ISSUE: 04/May/2021 CERTIFICATE NUMBER : 13685197JD01C



UL INTERNATIONAL (UK) LTD
UNIT 1-3 HORIZON
KINGSLAND PARK, WADE ROAD
BASINGSTOKE, HAMPSHIRE
RG24 8AH, UK
TEL: +44 (0) 1256 312100
FAX: +44 (0) 1256 312001
Email: LST.UK.Calibration@ul.com



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APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

UL VS Inc
47173 Benicia Street
Fremont, CA 94538, USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	15/Feb/2021
Manufacturer:	Speag		
Type/Model Number:	D5GHzV2		
Serial Number:	1003		
Calibration Date:	17/Feb/2021		
Calibrated By:	Masood Khan Test Engineer		
Signature:			

All Calibration have been conducted in the closed laboratory facility: Lab Temperature (22±3) °C and humidity < 70%

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025:2017 has been independently assessed.

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The calibration methods and procedures used were as detailed in:

1. **IEC 62209-1:2016:** 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)
2. **IEC 62209-2:2010:** 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)
3. **IEEE 1528: 2013:** IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques
4. FCC KDB Publication Number: “**KDB865664 D01 SAR Measurement 100 MHz to 6 GHz**”
5. **DASY 6 System Handbook**
6. **Dipole Calibration Procedure V1.2:** Calibration performed as per internal procedure

The measuring equipment used to perform the calibration, documented in this certificate has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval (Months)
PRE0178316	Data Acquisition Electronics	SPEAG	DAE4	1541	17 Mar 2020	12
PRE0178266	Probe	SPEAG	EX3DV4	7495	24 Mar 2020	12
PRE0178323	Dipole	SPEAG	D5GHzV2	1274	13 Mar 2020	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	27 Mar 2020	12
PRE0151154	Vector Network Analyser	Rhode & Schwarz	ZND	100151	15 Jun 2020	12
PRE0158684	Calibration Kit	Rhode & Schwarz	ZV-Z135	102144	27 May 2020	12
PRE0178154	Signal Generator	Rhode & Schwarz	SMB100A	175325	10 Jun 2020	12

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SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F17/5ENYG1/A/01
DASY Version:	cDASY6.14.0.959
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10mm (with spacer)
Frequency:	5GHz

Frequency :5250 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	5250	20.0 °C	19.8 °C	20.4°C	20.4°C	ϵ_r	35.93	36.39	± 5%
						σ	4.71	4.78	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	7.71 W/Kg	77.1 W/Kg	+16.77% / -16.70%
	SAR averaged over 10g	2.22 W/Kg	22.2 W/Kg	± 16.70%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	58.749 Ω +3.909 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	21.10	± 2.03 dB

Frequency :5600 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	5600	20.0 °C	19.8 °C	20.4°C	20.4°C	ϵ_r	35.53	35.71	± 5%
						σ	5.10	5.20	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	8.47 W/Kg	84.7 W/Kg	+16.77% / -16.70%
	SAR averaged over 10g	2.42 W/Kg	24.2 W/Kg	± 16.70%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	46.857 Ω +1.626 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	28.75	± 2.03 dB

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Frequency :5750 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	5750	20.0 °C	19.8 °C	20.4°C	20.4°C	ϵ_r	35.36	35.42	± 5%
						σ	5.22	5.38	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	100 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	7.57 W/Kg	75.7 W/Kg	+16.77% / -16.70%
	SAR averaged over 10g	2.18 W/Kg	21.8 W/Kg	± 16.70%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	59.697 Ω + 0.126 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	21.07	± 2.03 dB

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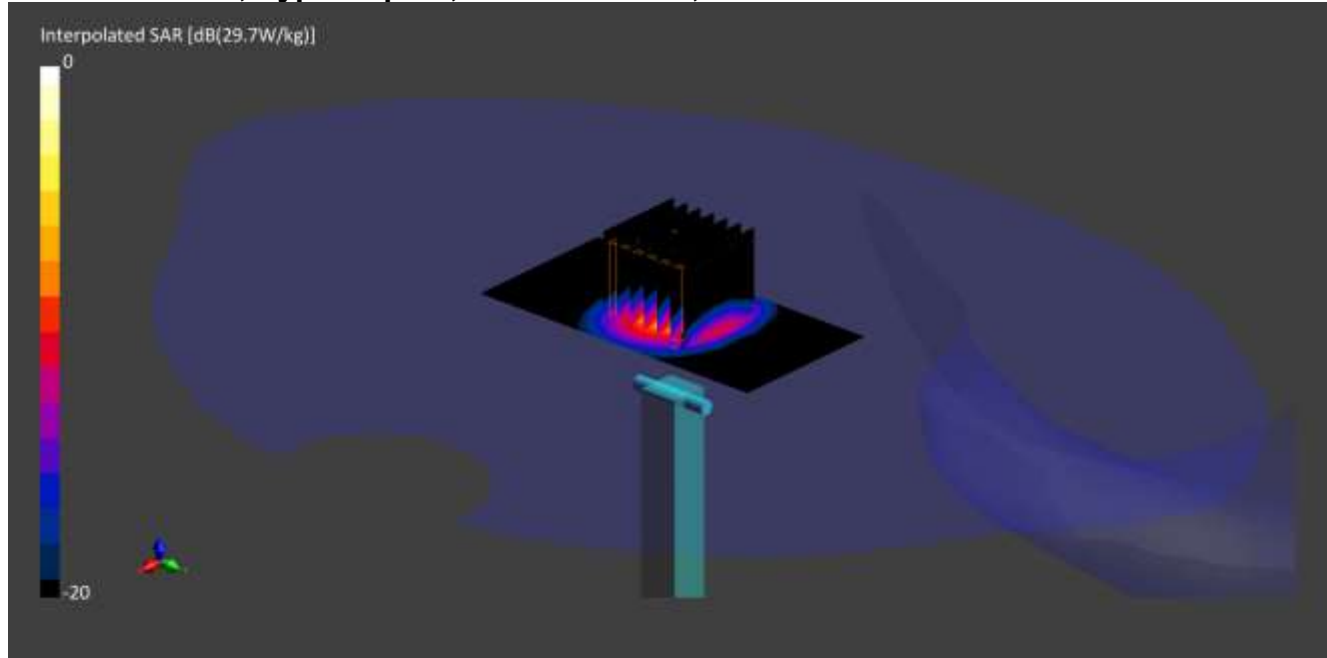
UKAS Accredited Calibration Laboratory No. 5772

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NUMBER :
13685197JD01C

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1003;



Communication System: CW UID: 0; Frequency: 5250.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_17Feb2021_110903_Head - 3500 5250 5600 5750 5%; Medium
parameters used: $f = 5250.0$ MHz; $\sigma = 4.78$ S/m; $\epsilon_r = 36.4$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 1.27$ %; $\Delta\sigma = 1.65$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7495; ConvF(5.17, 5.17, 5.17); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1541; Calibrated: 17 Mar 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(22x22x22): Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm; Grading Ratio: 1.4; Reference Value = 10.780 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 64.8 %;

SAR(1 g) = 7.710 W/kg; SAR(10 g) = 2.220 W/kg

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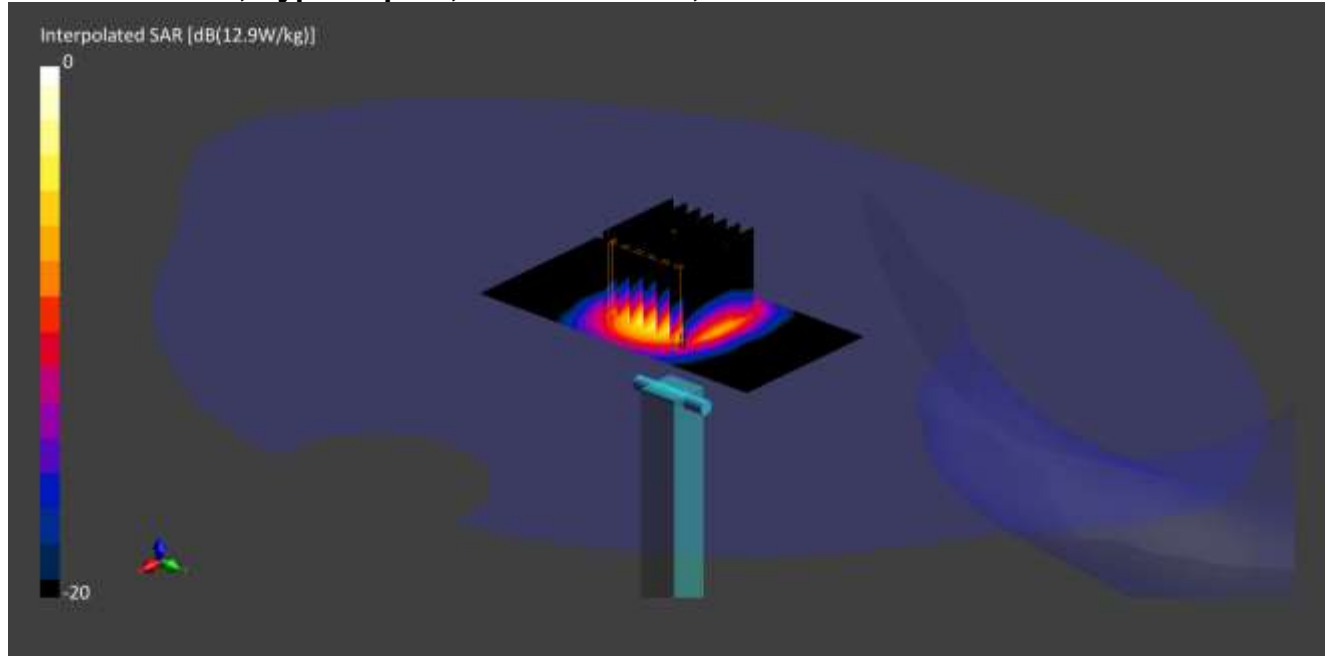
UKAS Accredited Calibration Laboratory No. 5772

CERTIFICATE
NUMBER :
13685197JD01C

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1003;



Communication System: CW UID: 0; Frequency: 5600.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_17Feb2021_110903_Head - 3500 5250 5600 5750 5%; Medium
parameters used: $f = 5600.0$ MHz; $\sigma = 5.2$ S/m; $\epsilon_r = 35.7$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 0.50$ %; $\Delta\sigma = 2.66$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7495; ConvF(4.66, 4.66, 4.66); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1541; Calibrated: 17 Mar 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(22x22x22): Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm; Grading Ratio:
1.4; Reference Value = 12.690 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 61.8 %;

SAR(1 g) = 8.470 W/kg; SAR(10 g) = 2.420 W/kg

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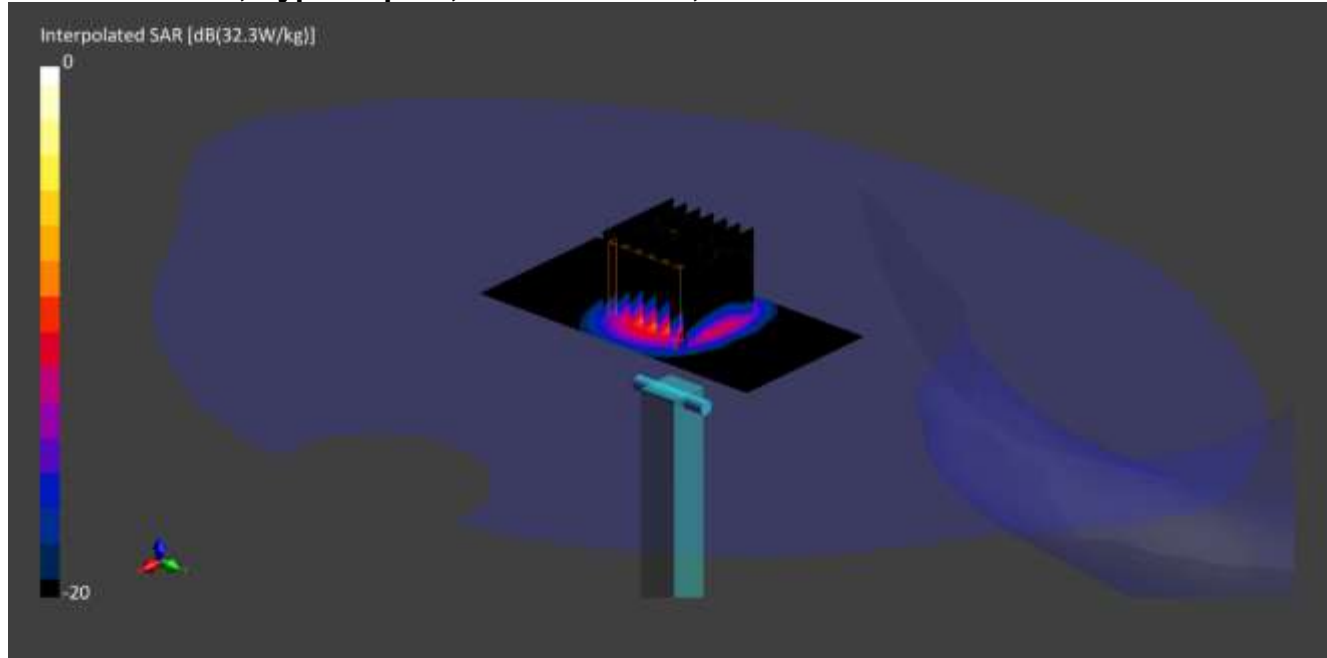
UKAS Accredited Calibration Laboratory No. 5772

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NUMBER :
13685197JD01C

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1003;



Communication System: CW UID: 0; Frequency: 5750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_17Feb2021_110903_Head - 3500 5250 5600 5750 5%; Medium
parameters used: $f = 5750.0$ MHz; $\sigma = 5.38$ S/m; $\epsilon_r = 35.4$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 0.17$ %; $\Delta\sigma = 3.17$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7495; ConvF(4.89, 4.89, 4.89); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1541; Calibrated: 17 Mar 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(22x22x22): Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm; Grading Ratio:
1.4; Reference Value = 11.320 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 7.5 mm;

Vertical M2/M1 Ratio: 60.3 %;

SAR(1 g) = 7.570 W/kg; SAR(10 g) = 2.180 W/kg

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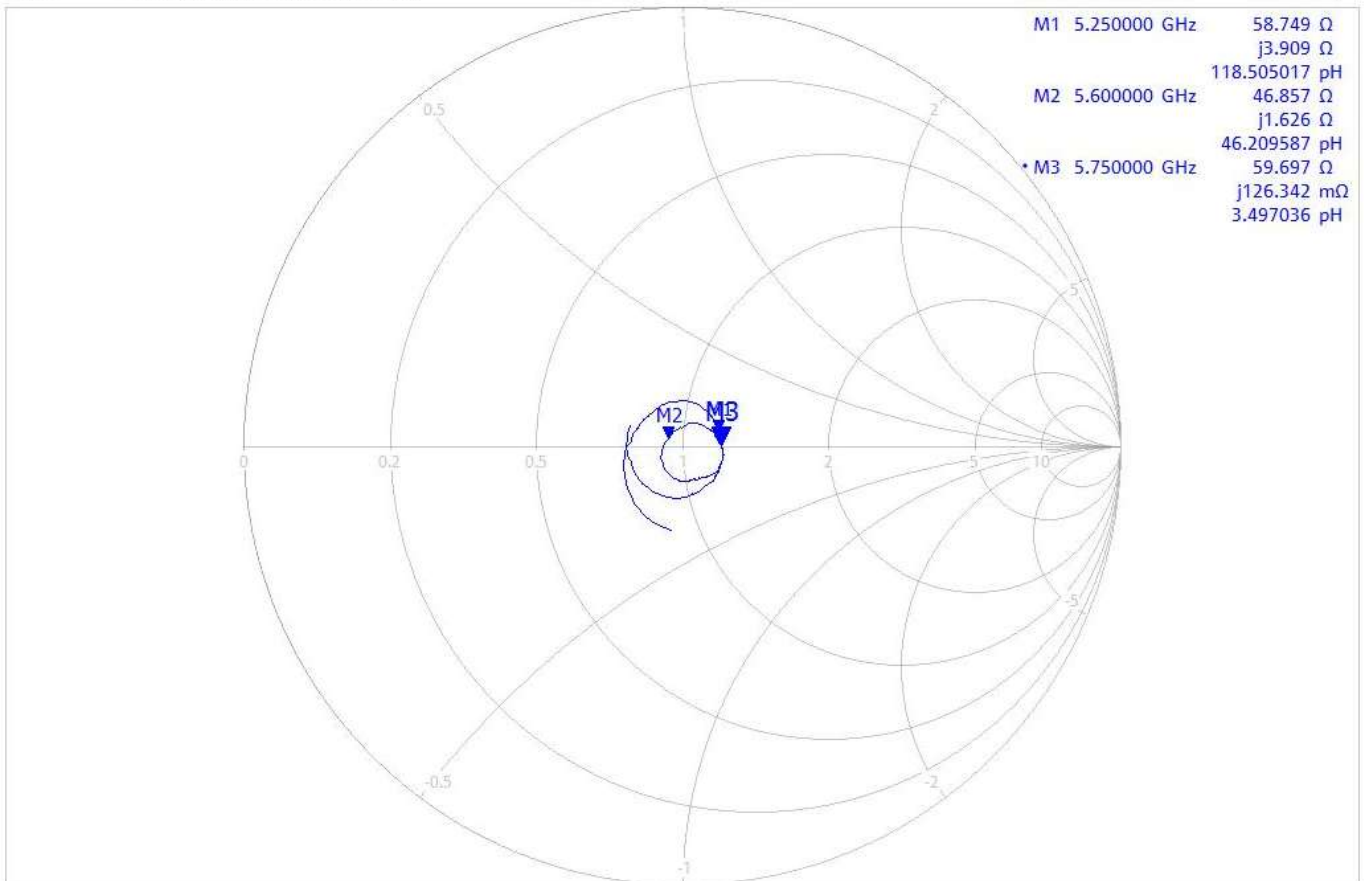
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)

2/18/2021 2:18:03 PM
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1



Ch1 Center 5.5 GHz

Pwr -10 dBm Bw 10 kHz

Span 1 GHz

CERTIFICATE OF CALIBRATION ISSUED BY UL INTERNATIONAL (UK) LTD

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13685197JD01C

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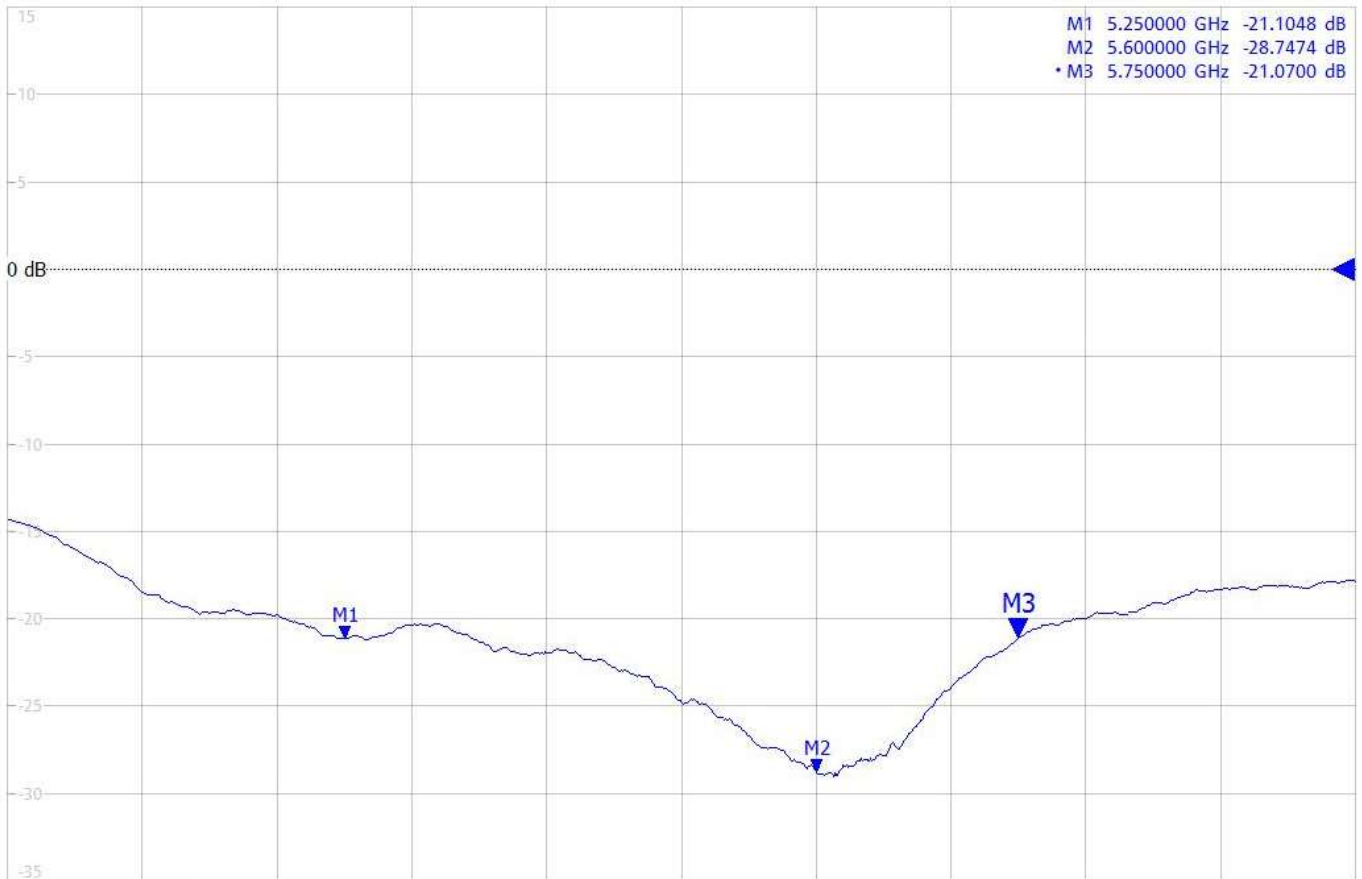
Return Loss Measurement Plot for Head Stimulating Liquid (HSL)

2/18/2021 2:25:45 PM
1328.5170K92-100151-MV

Trc1 — S11 dB Mag 5 dB/ Ref 0 dB Cal

1

M1 5.250000 GHz -21.1048 dB
M2 5.600000 GHz -28.7474 dB
M3 5.750000 GHz -21.0700 dB





Ch1 Center 5.5 GHz


Pwr -10 dBm Bw 10 kHz

Span 1 GHz

Calibration Certificate Label:

 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13685197JD01C</p> <p>Instrument ID: 1003</p> <p>Calibration Date: 17/Feb/2021</p> <p>Calibration Due Date:</p>
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 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13685197JD01C</p> <p>Instrument ID: 1003</p> <p>Calibration Date: 17/Feb/2021</p> <p>Calibration Due Date:</p>
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 <p>5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13685197JD01C</p> <p>Instrument ID: 1003</p> <p>Calibration Date: 17/Feb/2021</p> <p>Calibration Due Date:</p>
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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

Accreditation No.: **SCS 0108**

Client **UL USA**

Certificate No: **D5GHzV2-1138_Aug20**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1138**

Calibration procedure(s) **QA CAL-22.v5
Calibration Procedure for SAR Validation Sources between 3-10 GHz**

Calibration date: **August 17, 2020**

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	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 3503	31-Dec-19 (No. EX3-3503_Dec19)	Dec-20
DAE4	SN: 601	27-Dec-19 (No. DAE4-601_Dec19)	Dec-20
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

Calibrated by:	Name Jeffrey Katzman	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	

Issued: August 17, 2020

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



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) 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 the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 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 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	DASY5	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 = 10.0 mm, dz = 10.0 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

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	34.6 ± 6 %	4.48 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.07 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.8 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	34.2 ± 6 %	4.83 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	8.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 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	33.9 ± 6 %	5.03 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	50.0 Ω - 6.1 j Ω
Return Loss	- 24.3 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	56.9 Ω - 2.4 j Ω
Return Loss	- 23.3 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	54.9 Ω - 1.9 j Ω
Return Loss	- 26.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.201 ns
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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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Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1138

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: $f = 5250$ MHz; $\sigma = 4.48$ S/m; $\epsilon_r = 34.6$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5600$ MHz; $\sigma = 4.83$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5800$ MHz; $\sigma = 5.03$ S/m; $\epsilon_r = 33.9$; $\rho = 1000$ 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(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 76.68 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 28.4 W/kg

SAR(1 g) = 8.07 W/kg; SAR(10 g) = 2.31 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 69.9%

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 = 77.08 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 31.5 W/kg

SAR(1 g) = 8.36 W/kg; SAR(10 g) = 2.38 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 67.6%

Maximum value of SAR (measured) = 19.9 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 = 73.94 V/m; Power Drift = -0.07 dB

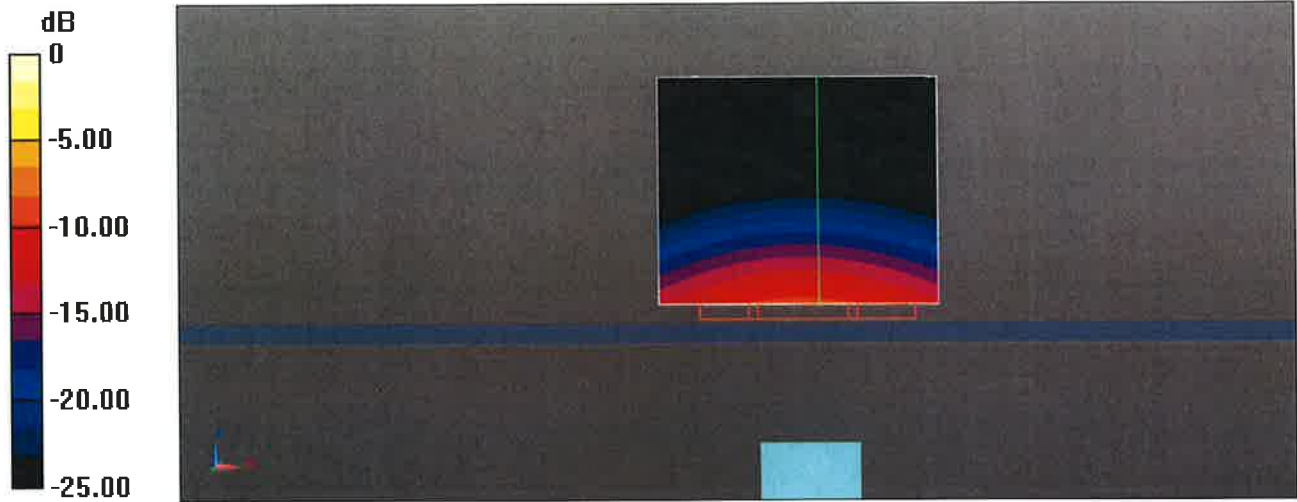
Peak SAR (extrapolated) = 32.7 W/kg

SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.30 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 65.1%

Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.9 W/kg = 12.99 dBW/kg

Impedance Measurement Plot for Head TSL

