

CERTIFICATE OF CALIBRATION

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

DATE OF ISSUE: 06/Oct/2021

CERTIFICATE NUMBER : 13697410JD01A



5772

UL INTERNATIONAL (UK) LTD
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BASINGSTOKE, HAMPSHIRE
RG24 8AH, UK
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Email: LST.UK.Calibration@ul.com



Page 1 of 10

APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	24/Sep/2021
Manufacturer:	Speag		
Type/Model Number:	D900V2		
Serial Number:	1d143		
Calibration Date:	29/Sep/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%

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Page 2 of 10

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)
PRE0135115	Data Acquisition Electronics	SPEAG	DAE4	1438	12 Apr 2021	12
PRE0134817	Probe	SPEAG	ES3DV3	3335	14 Jan 2021	12
PRE0134199	Dipole	SPEAG	D900V2	SN035	15 Feb 2021	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	22 Mar 2021	12
M2028	Vector Network Analyser	Keysight Technologies	E5071C	MY46521873	20 Jul 2021	12
M2029	Calibration Kit	Keysight Technologies	N4691B	MY46181255	02 Aug 2021	12
PRE0134063	Signal Generator	HP	8648C	3537A01598	03 Mar 2021	12

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CERTIFICATE
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Page 3 of 10

SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F17/5ENYG1/A/01
DASY Version:	cDASY16.0.0.116
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	15 mm (with spacer)
Frequency:	900 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	900	21.1 °C	20.9 °C	20.8 °C	20.6 °C	ϵ_r	41.50	42.05	± 5%
						σ	0.97	0.95	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	2.69 W/Kg	10.71 W/Kg	+16.80 / -16.43%
	SAR averaged over 10g	1.75 W/Kg	6.97 W/Kg	+16.72 / -16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	48.64 - 0.027j Ω	± 3.01
	Return Loss	36.76	± 3.34

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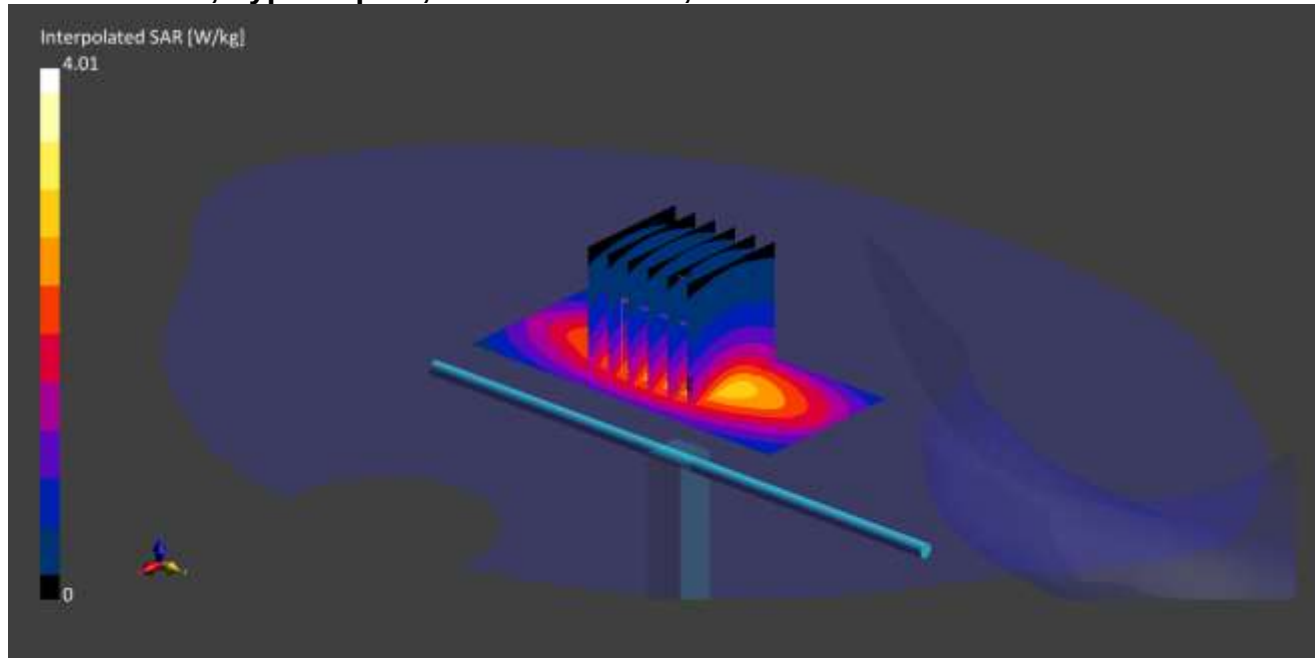
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CERTIFICATE
NUMBER :
13697410JD01A

Page 5 of 10

DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D900V2; Type: Dipole; Serial: SN1d143;



Communication System: CW UID: 0; Frequency: 900.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_28Sep2021_082639_Head - 900 1800 1900 2300 2600 5%; Medium
parameters used: $f = 900.0$ MHz; $\sigma = 0.946$ S/m; $\epsilon_r = 42.1$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 1.33$ %; $\Delta\sigma = -2.48$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: ES3DV3 - SN3335; ConvF(6.18, 6.18, 6.18); Calibrated: 14 Jan 2021
- Sensor-Surface: 3 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 12 Apr 2021
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY16.0.0.116

Area Scan (40x90): Interpolated grid: $dx=10$ mm, $dy=15$ mm

Zoom Scan1(30x30x30): Measurement grid: $dx=6$ mm, $dy=6$ mm, $dz=1.5$ mm; Grading Ratio: 1.5; Reference Value = 3.130 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 22.1 mm;

Vertical M2/M1 Ratio: 88.9 %;

SAR(1 g) = 2.690 W/kg; SAR(10 g) = 1.750 W/kg

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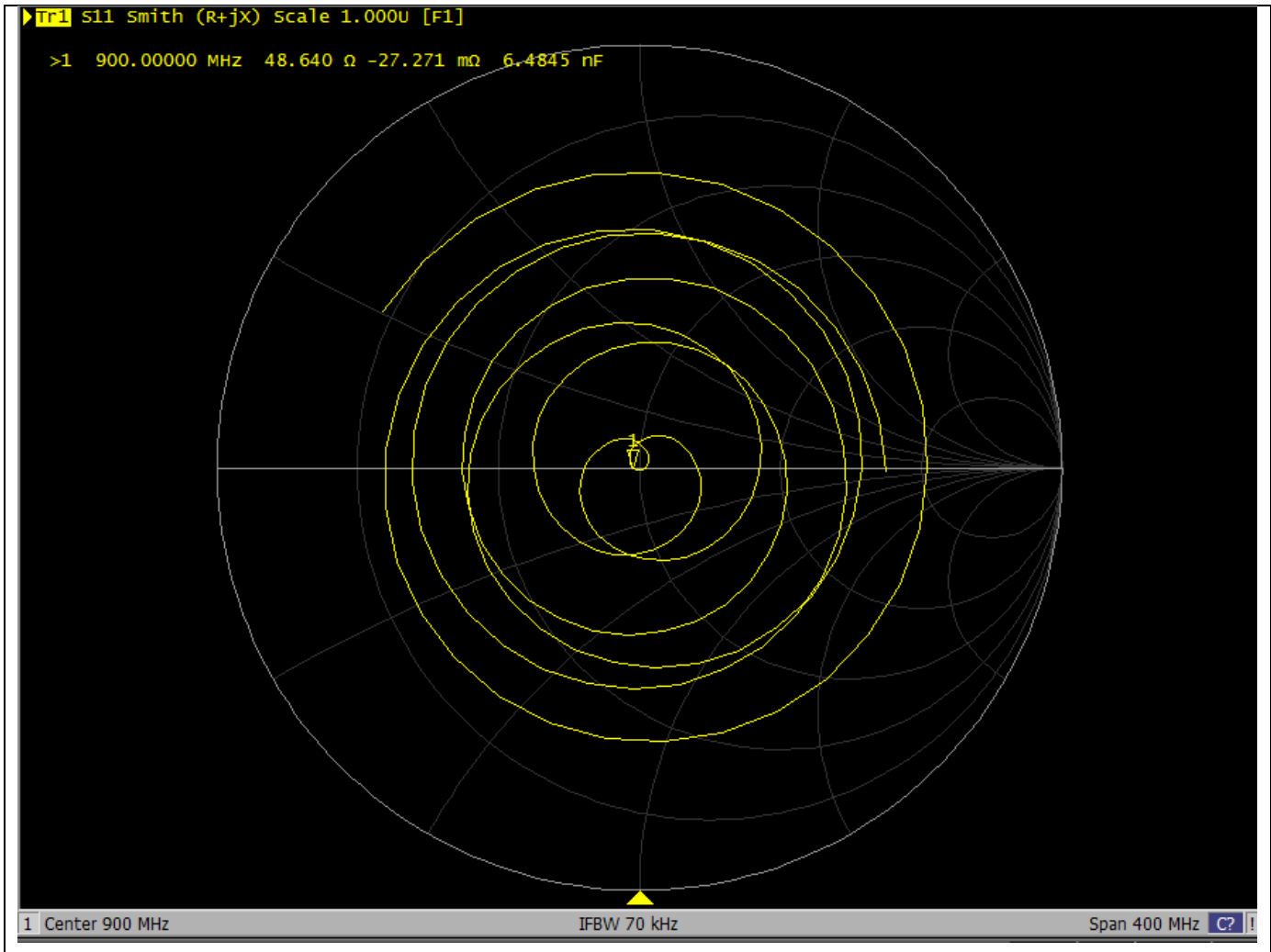
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Page 6 of 10

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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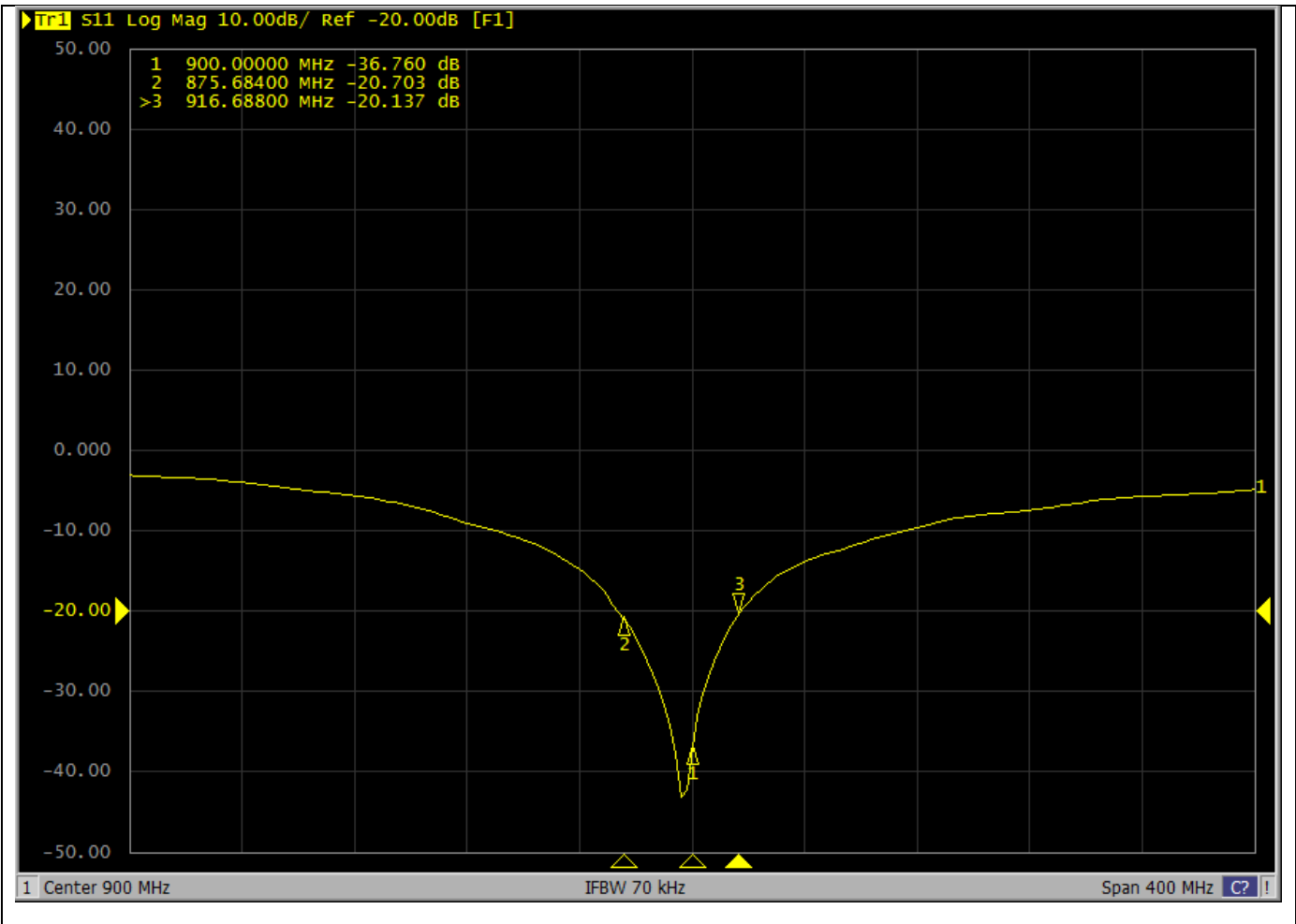
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Page 7 of 10

Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



Calibration Certificate Label:

	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697410JD01A Instrument ID: 1d143 Calibration Date: 29/Sep/2021 Calibration Due Date:
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	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697410JD01A Instrument ID: 1d143 Calibration Date: 29/Sep/2021 Calibration Due Date:
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	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697410JD01A Instrument ID: 1d143 Calibration Date: 29/Sep/2021 Calibration Due Date:
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CERTIFICATE OF CALIBRATION

ISSUED BY UL INTERNATIONAL (UK) LTD

DATE OF ISSUE: 13/April/2021 CERTIFICATE NUMBER : 13697411JD01A



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UL INTERNATIONAL (UK) LTD
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APPROVED SIGNATORY

Harmohan Sahota

Customer :

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	12/April/2021
Manufacturer:	Speag		
Type/Model Number:	D1750V2		
Serial Number:	1050		
Calibration Date:	13/April/2021		
Calibrated By:	Ravish Foolchund Laboratory Technician		

Signature:

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

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Page 2 of 6

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)
PRE0134060	Data Acquisition Electronics	SPEAG	DAE4	432	09 Oct 2020	12
PRE0134817	Probe	SPEAG	ES3DV3	3335	14 Jan 2021	12
PRE0131610	Dipole Antenna	SPEAG	D1800V2	2d009	16 Feb 2021	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rohde & Schwarz	NRP8S	102481	17 Apr 2020	12
PRE0151154	Vector Network Analyser	Rohde & Schwarz	ZND	100151	15 Jun 2020	12
PRE0158684	Calibration Kit	Rhode & Schwarz	ZV-Z135	102144	27 May 2020	12
PRE0178154	Signal Generator	Rohde & Schwarz	SMB 100A	175325	10 Jun 2020	12

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Page 3 of 6

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:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10mm (with spacer)
Frequency:	1750 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	1750	20.0 °C	19.8 °C	19.8°C	19.8°C	ϵ'	40.08	39.83	± 5%
						σ	1.37	1.35	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	9.31 W/Kg	37.06 W/Kg	+16.80% / -16.43%
	SAR averaged over 10g	4.99 W/Kg	19.87 W/Kg	+16.72% / -16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.19 Ω - 0.067 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	-54.08 dB	± 3.34 dB

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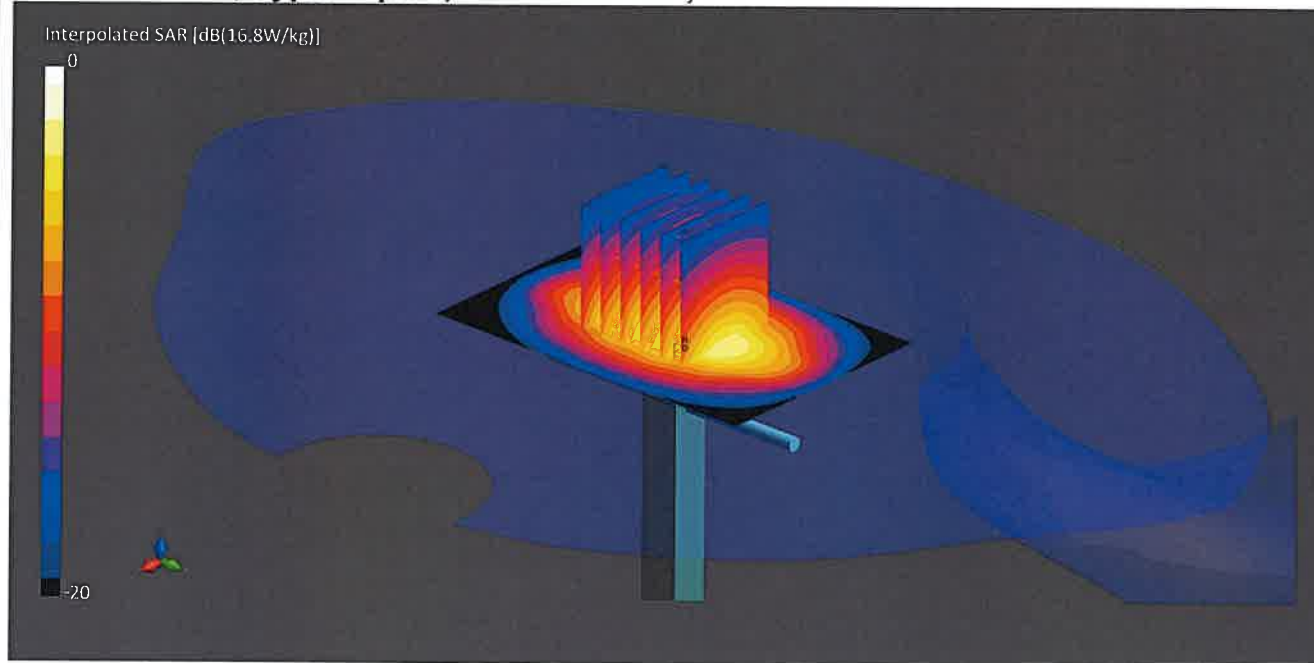
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CERTIFICATE
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Page 4 of 6

DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1750V2; Type: Dipole; Serial: SN1050;



Communication System: CW UID: 0; Frequency: 1750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_12Apr2021_115940_Head - 1750 1800 1900 2300 2450 2600 5%;
Medium parameters used: $f = 1750.0$ MHz; $\sigma = 1.35$ S/m; $\epsilon_r = 39.8$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -0.62$ %; $\Delta\sigma = -1.80$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: ES3DV3 - SN3335; ConvF(5.25, 5.25, 5.25); Calibrated: 14 Jan 2021
- Sensor-Surface: 3 mm; VMS + 6p
- Electronics: DAE4 - SN432; Calibrated: 09 Oct 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (60x90): Interpolated grid: $dx=15$ mm, $dy=15$ mm

Zoom Scan1(30x30x30): Measurement grid: $dx=6$ mm, $dy=6$ mm, $dz=1.5$ mm; Grading Ratio: 1.5; Reference Value = 11.810 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 10.8 mm;

Vertical M2/M1 Ratio: 84.6 %;

SAR(1 g) = 9.310 W/kg; SAR(10 g) = 4.990 W/kg

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Page 5 of 6

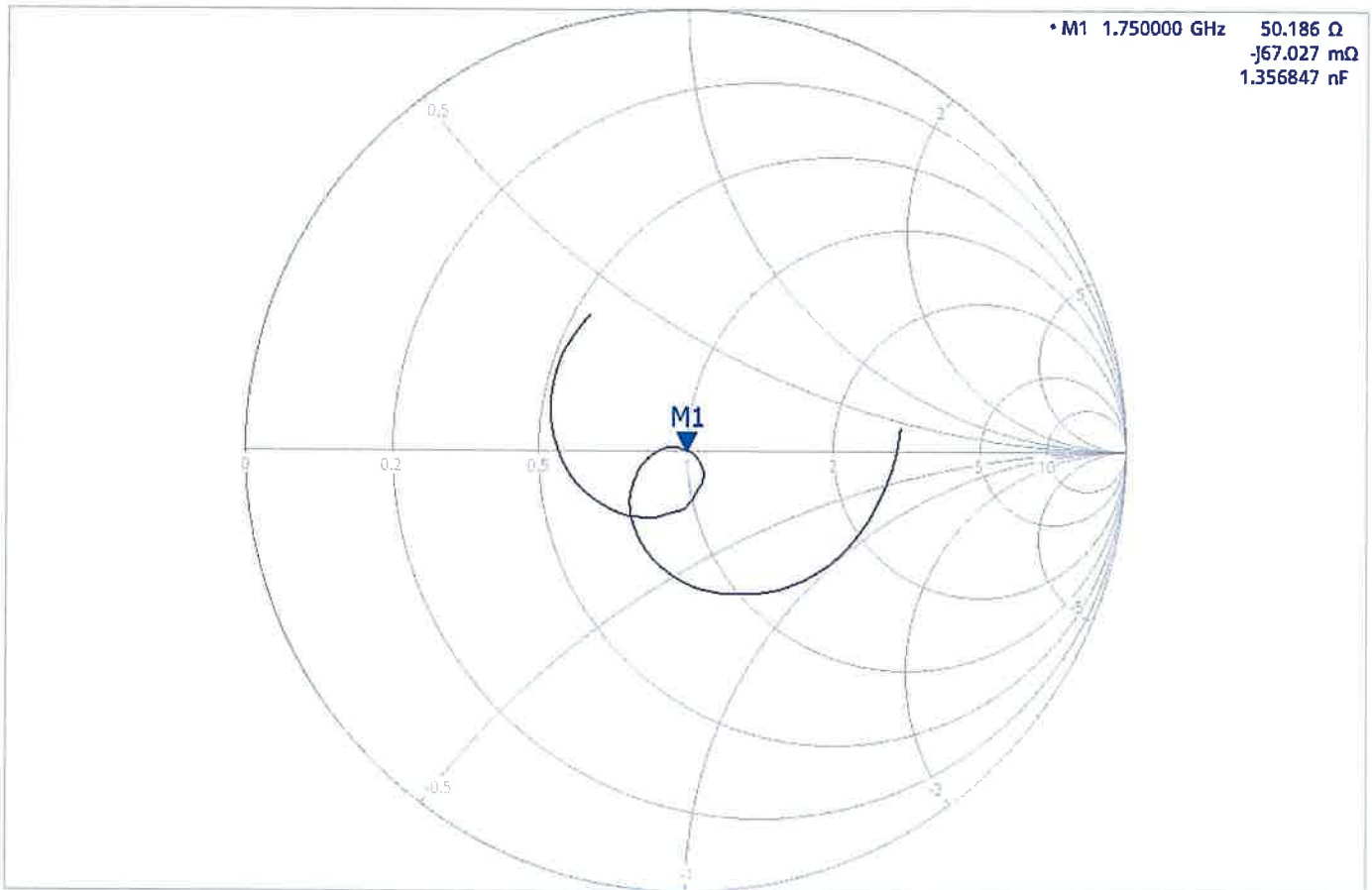
Impedance Measurement Plot for Head Stimulating Liquid (HSL)



4/13/2021 9:12:49 AM
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1



Ch1 Center 1.75 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

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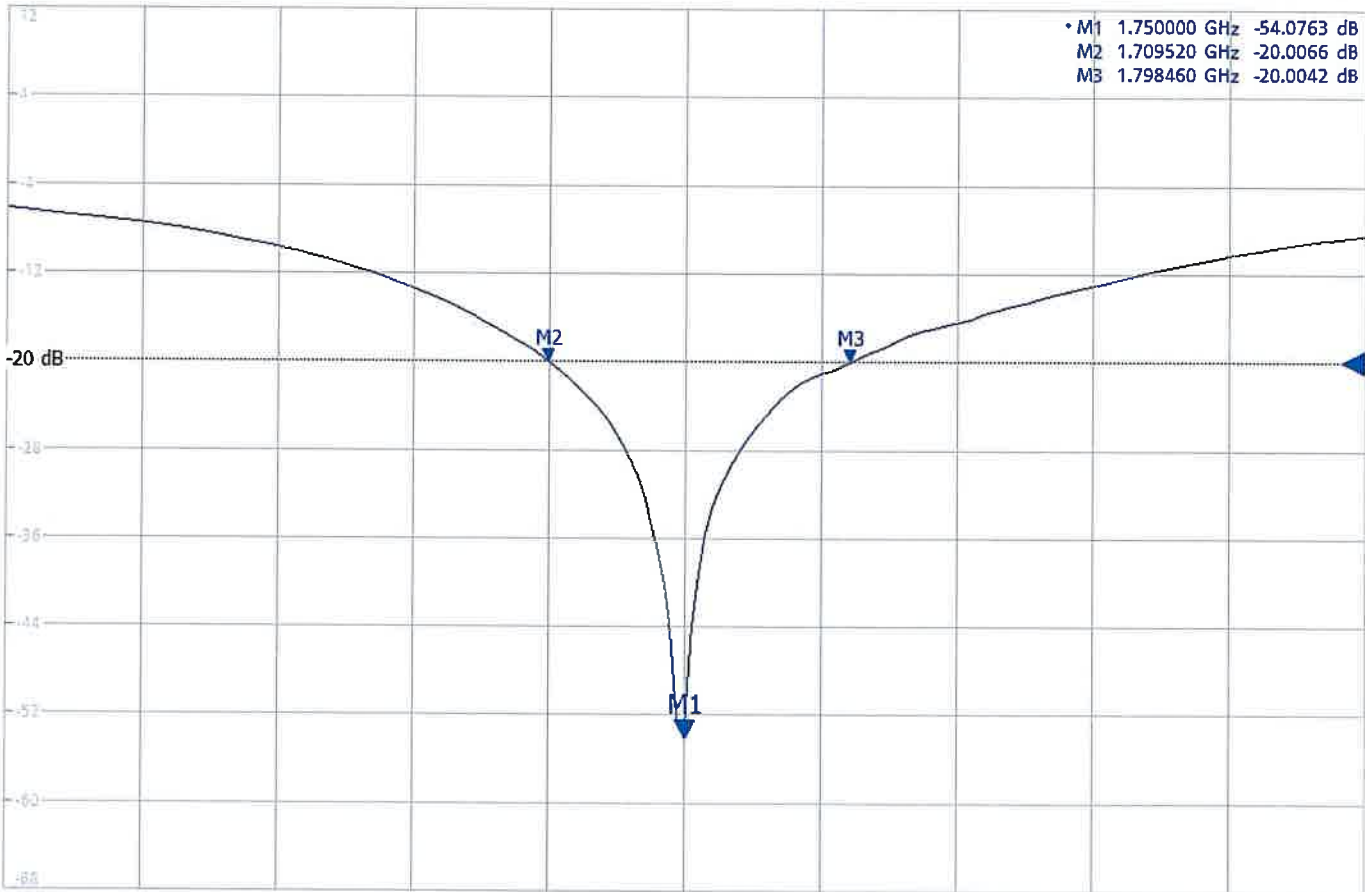
Page 6 of 6

Return Loss Measurement Plot for Head Stimulating Liquid (HSL)

4/13/2021 9:05:46 AM
1328.5170K92-100151-MV

Trc1 — S11 dB Mag 8 dB/ Ref -20 dB Cal

1



Ch1 Center 1.75 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

Calibration Certificate Label:

 5772	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697411JD01A Instrument ID: 1050 Calibration Date: 13/April/2021 Calibration Due Date:
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 5772	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697411JD01A Instrument ID: 1050 Calibration Date: 13/April/2021 Calibration Due Date:

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ISSUED BY UL INTERNATIONAL (UK) LTD

DATE OF ISSUE: 26/Feb/2021

CERTIFICATE NUMBER : 13685197JD01A



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Page 1 of 6

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:	D2450V2		
Serial Number:	748		
Calibration Date:	19/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%

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Page 2 of 6

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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Page 3 of 6

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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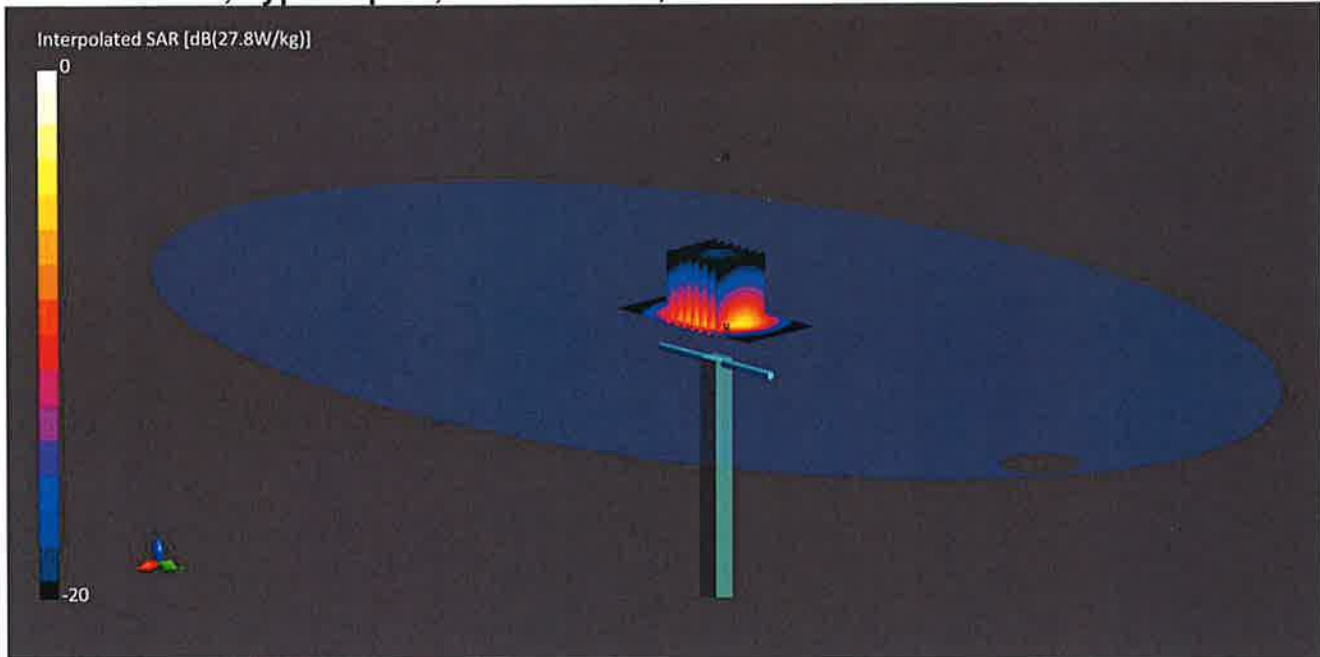
CERTIFICATE
NUMBER :
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Page 4 of 6

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

CERTIFICATE OF CALIBRATION

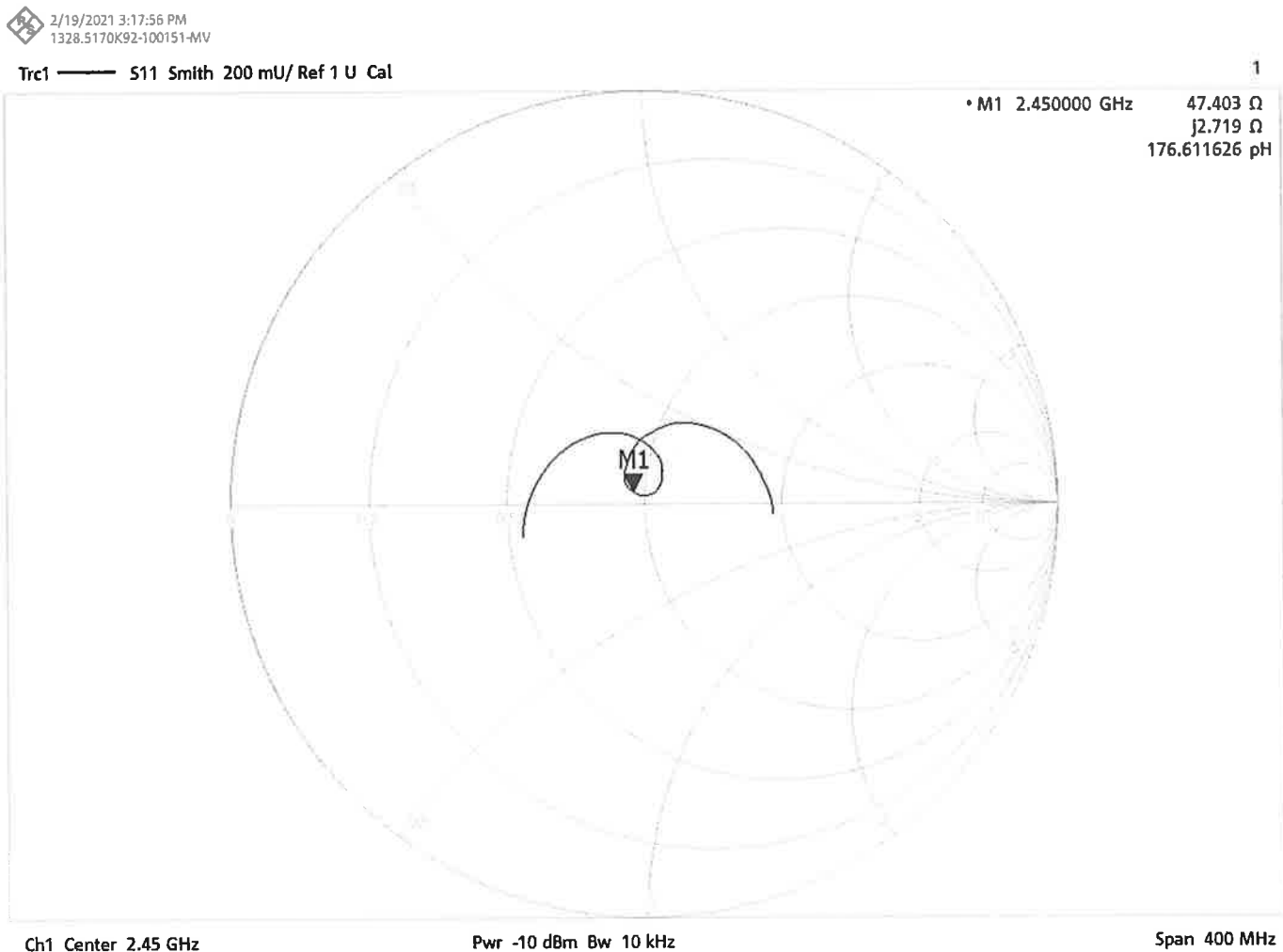
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Page 5 of 6

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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Page 6 of 6

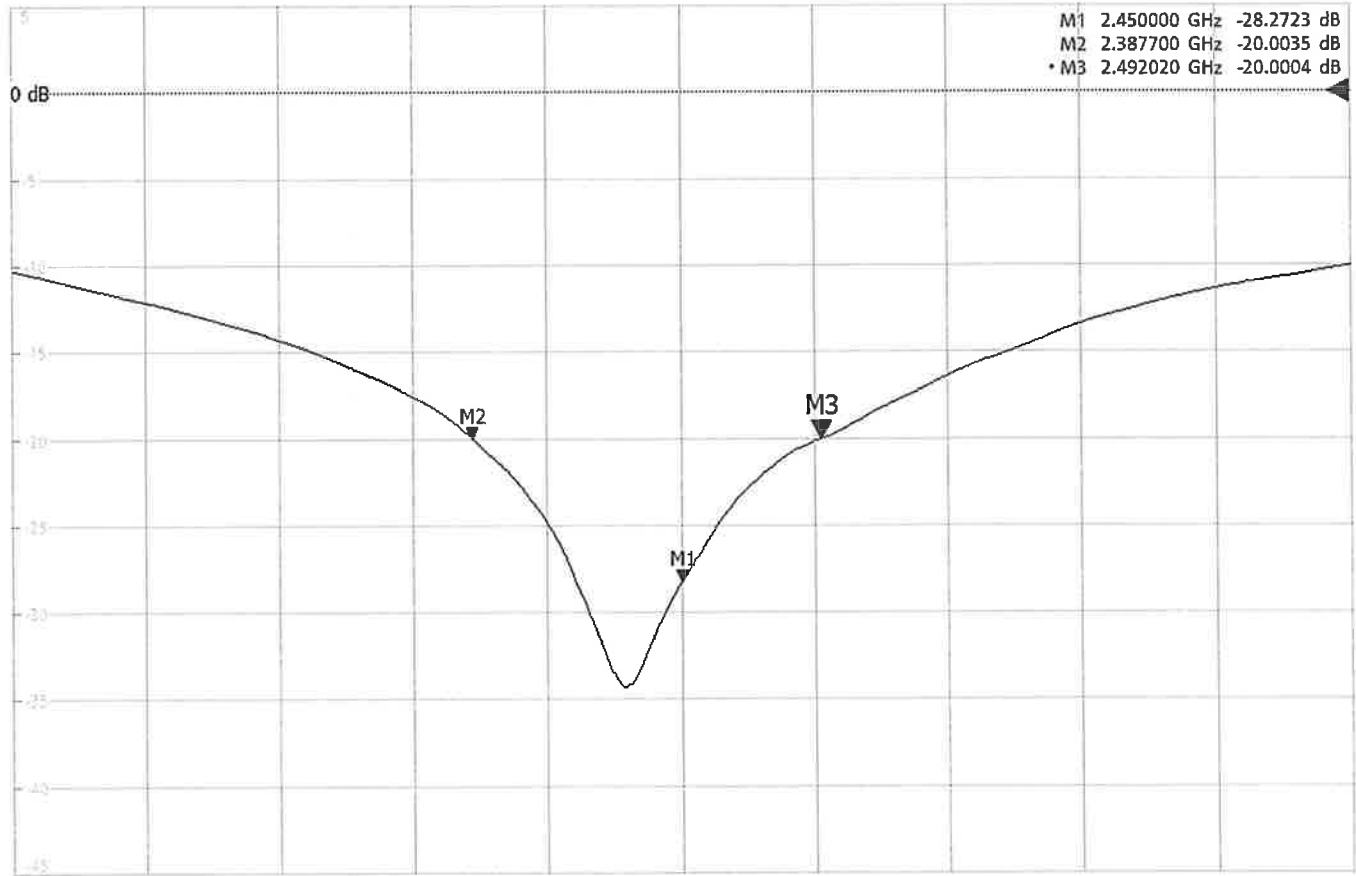
Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



2/19/2021 3:20:07 PM
1328.5170K92-100151-MV

Trc1 — 511 dB Mag 5 dB/ Ref 0 dB Cal

1



Ch1 Center 2.45 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

Calibration Certificate Label:

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

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

DATE OF ISSUE: 15/April/2021 CERTIFICATE NUMBER : 13697411JD01G



UL INTERNATIONAL (UK) LTD
UNIT 1-3 HORIZON
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FAX: +44 (0) 1256 312001
Email: LST.UK.Calibration@ul.com



Page 1 of 6

APPROVED SIGNATORY

Harmohan Sahota

Customer :

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	12/April/2021
Manufacturer:	Speag		
Type/Model Number:	D3500V2		
Serial Number:	1011		
Calibration Date:	15/April/2021		
Calibrated By:	Ravish Foolchund Laboratory Technician		
Signature:			

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.

CERTIFICATE OF CALIBRATION

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UKAS Accredited Calibration Laboratory No. 5772

CERTIFICATE
NUMBER :
13697411JD01G

Page 2 of 6

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)
PRE0134060	Data Acquisition Electronics	SPEAG	DAE4	432	09 Oct 2020	12
PRE0134817	Probe	SPEAG	ES3DV3	3335	14 Jan 2021	12
PRE0135600	Dipole Antenna	SPEAG	D3500V2	1044	11 Feb 2021	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rohde & Schwarz	NRP8S	102481	17 Apr 2020	12
PRE0151154	Vector Network Analyser	Rohde & Schwarz	ZND	100151	15 Jun 2020	12
PRE0158684	Calibration Kit	Rhode & Schwarz	ZV-Z135	102144	27 May 2020	12
PRE0178154	Signal Generator	Rohde & Schwarz	SMB 100A	175325	10 Jun 2020	12

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UKAS Accredited Calibration Laboratory No. 5772

Page 3 of 6

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:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10mm (with spacer)
Frequency:	3500 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	3500	20.0 °C	20.2 °C	22.0°C	22°C	ϵ_r	37.93	37.27	± 5%
						σ	2.91	2.97	± 5%

SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	15.80 W/Kg	62.90 W/Kg	+16.77% / -16.70%
	SAR averaged over 10g	5.88 W/Kg	23.41 W/Kg	±16.70%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	55.51 Ω - 1.96 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	-25.12 dB	± 2.97 dB

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NUMBER :
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Page 4 of 6

DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D3500V2; Type: Dipole; Serial: SN1011;



Communication System: CW UID: 0; Frequency: 3500.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_14Apr2021_183123_Head - 3500 5%; Medium parameters used: $f = 3500.0$ MHz; $\sigma = 2.97$ S/m; $\epsilon_r = 37.3$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -1.72$ %; $\Delta\sigma = 2.03$ %; No correction
Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: ES3DV3 - SN3335; ConvF(4.09, 4.09, 4.09); Calibrated: 14 Jan 2021
- Sensor-Surface: 3 mm; VMS + 6p
- Electronics: DAE4 - SN432; Calibrated: 09 Oct 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(28x28x28): Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=1.4$ mm; Grading Ratio: 1.5; Reference Value = 23.010 V/m; Power Drift = 0.01 dB

Minimum horizontal 3dB distance: 8.9 mm;

Vertical M2/M1 Ratio: 73.9 %;

SAR(1 g) = 15.800 W/kg; SAR(10 g) = 5.880 W/kg

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Page 5 of 6

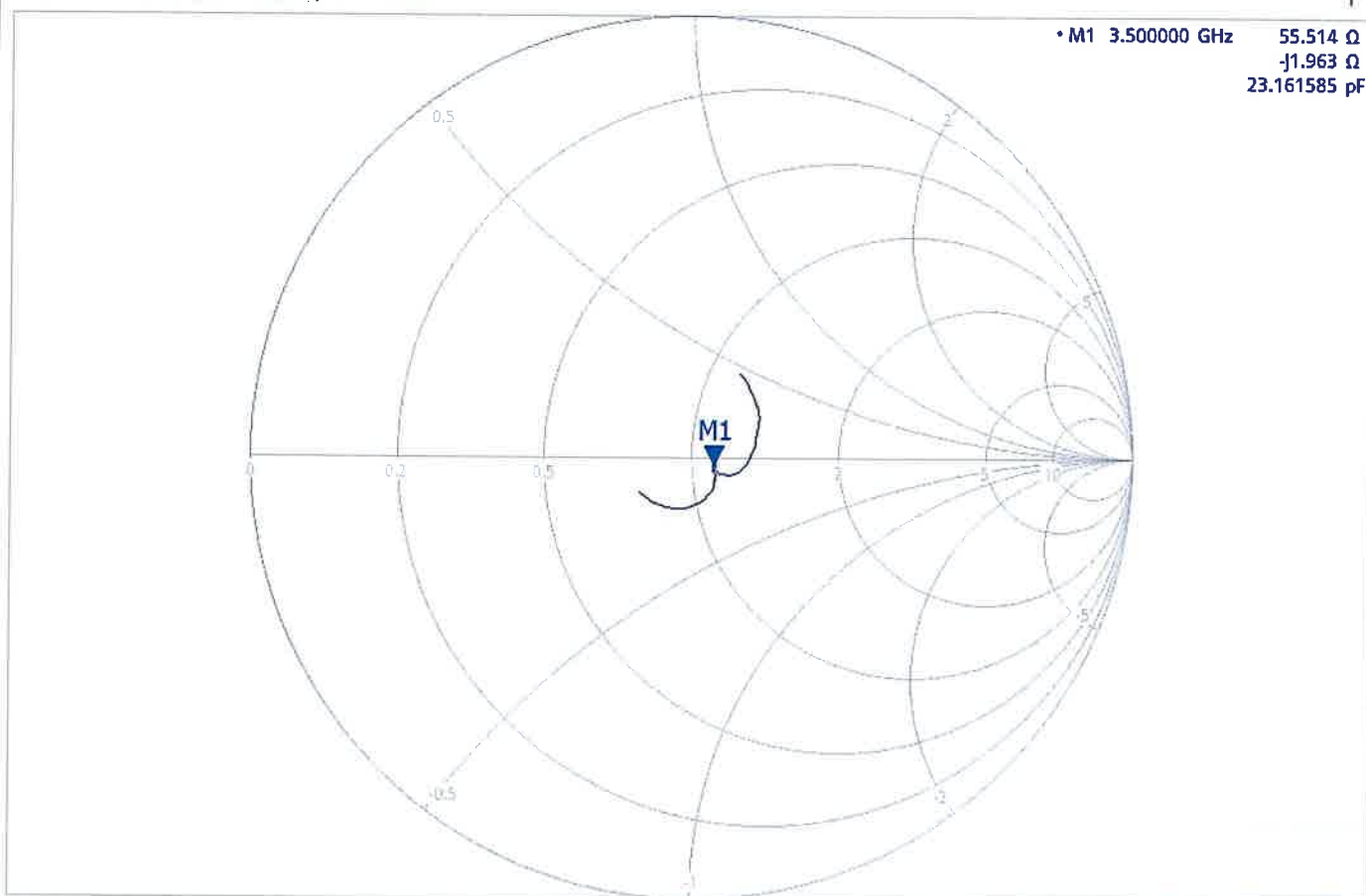
Impedance Measurement Plot for Head Stimulating Liquid (HSL)



4/15/2021 9:59:14 AM
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1



Ch1 Center 3.5 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

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CERTIFICATE
NUMBER :
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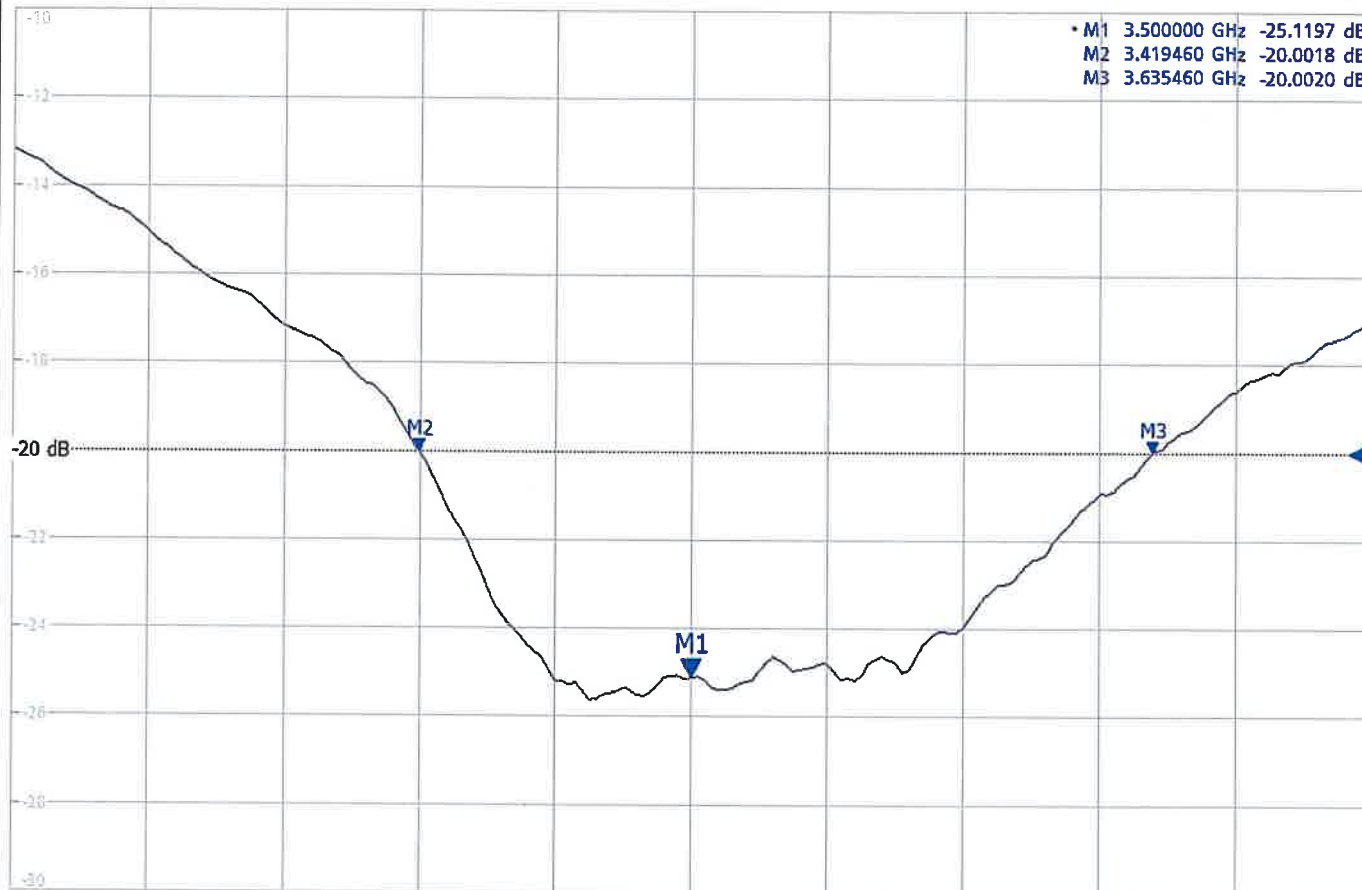
Page 6 of 6

Return Loss Measurement Plot for Head Stimulating Liquid (HSL)

4/15/2021 9:56:53 AM
132B.5170K92-100151-MV

Trc1 — S11 dB Mag 2 dB/ Ref -20 dB Cal

1



Ch1 Center 3.5 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

Calibration Certificate Label:

 5772	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697411JD01G Instrument ID: 1011 Calibration Date: 15/April/2021 Calibration Due Date:
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 5772	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697411JD01G Instrument ID: 1011 Calibration Date: 15/April/2021 Calibration Due Date:
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 5772	UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000 Certificate Number: 13697411JD01G Instrument ID: 1011 Calibration Date: 15/April/2021 Calibration Due Date:
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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
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RG24 8AH, UK
TEL: +44 (0) 1256 312100
FAX: +44 (0) 1256 312001
Email: LST.UK.Calibration@ul.com



Page 1 of 9

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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Page 2 of 9

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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Page 3 of 9

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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Page 4 of 9

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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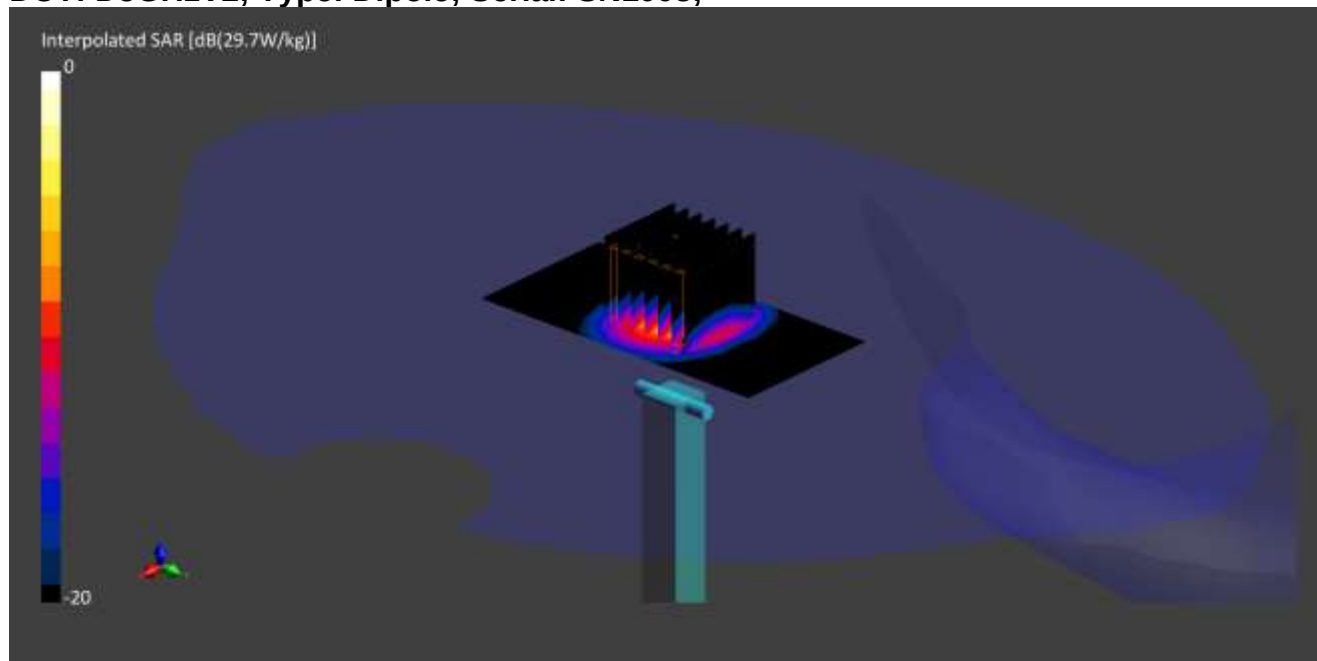
UKAS Accredited Calibration Laboratory No. 5772

CERTIFICATE
NUMBER :
13685197JD01C

Page 5 of 9

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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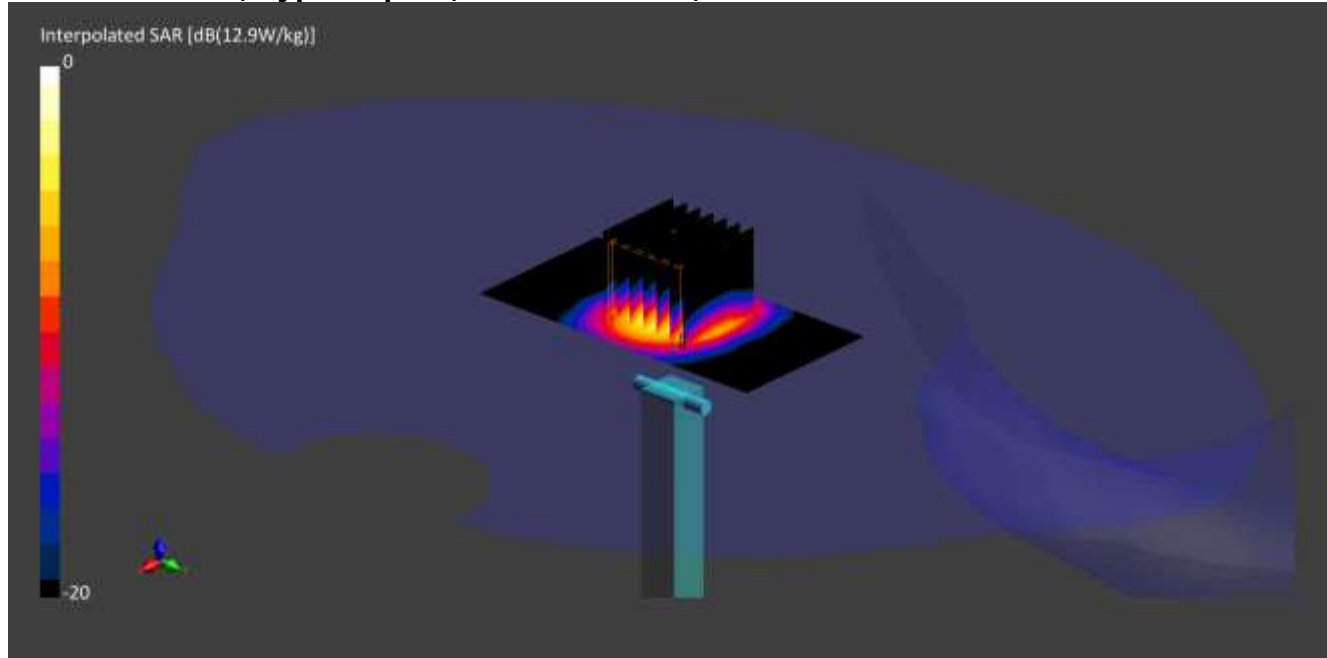
UKAS Accredited Calibration Laboratory No. 5772

CERTIFICATE
NUMBER :
13685197JD01C

Page 6 of 9

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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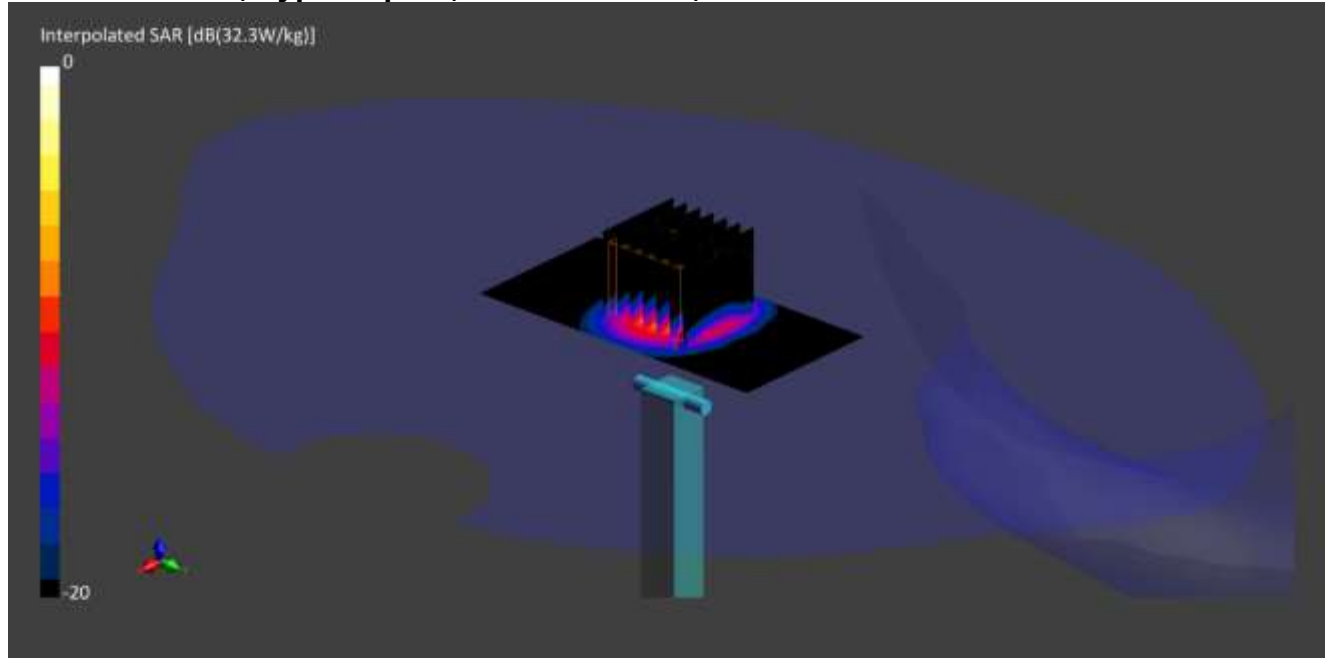
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CERTIFICATE
NUMBER :
13685197JD01C

Page 7 of 9

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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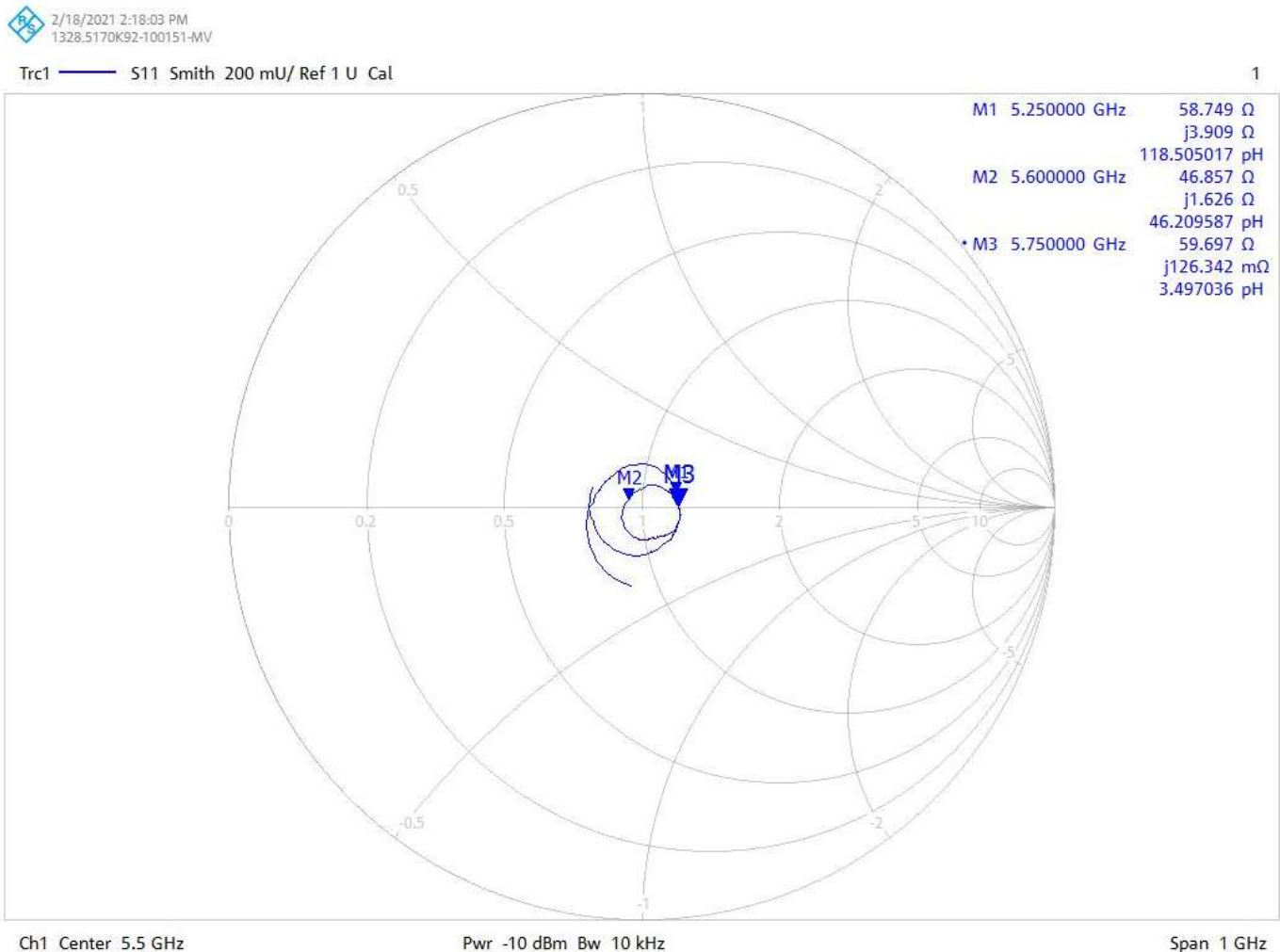
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Page 8 of 9

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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UKAS Accredited Calibration Laboratory No. 5772

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NUMBER :
13685197JD01C

Page 9 of 9

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:

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