

CERTIFICATE OF CALIBRATION

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

DATE OF ISSUE: 11/Oct/2021

CERTIFICATE NUMBER : 14030223JD01A



5772

UL INTERNATIONAL (UK) LTD
UNIT 1-3 HORIZON
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Email: LST.UK.Calibration@ul.com



Page 1 of 6

APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

UL LLC
12 Laboratory Dr.
RTP, NC 27709 USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	04/Oct/2021
Manufacturer:	Speag		
Type/Model Number:	D750V3		
Serial Number:	1139		
Calibration Date:	06/Oct/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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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
PRE0178314	Probe	SPEAG	EX3DV4	3995	16 Mar 2021	12
PRE0135601	Dipole	SPEAG	D750V3	SN1147	06 Oct 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
PRE0135028	Signal Generator	R&S	SME 06	831377/005	29 Mar 2021	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:	cDASY16.0.0.116
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	15 mm (with spacer)
Frequency:	750 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	750	20.9 °C	21.0 °C	21.8 °C	21.3 °C	ϵ_r	41.94	42.71	± 5%
						σ	0.89	0.91	± 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	2.04 W/Kg	8.12 W/Kg	+16.80 / -16.43%
	SAR averaged over 10g	1.36 W/Kg	5.41 W/Kg	+16.72 / -16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	46.64 2.23j Ω	± 3.01
	Return Loss	27.53	± 2.97

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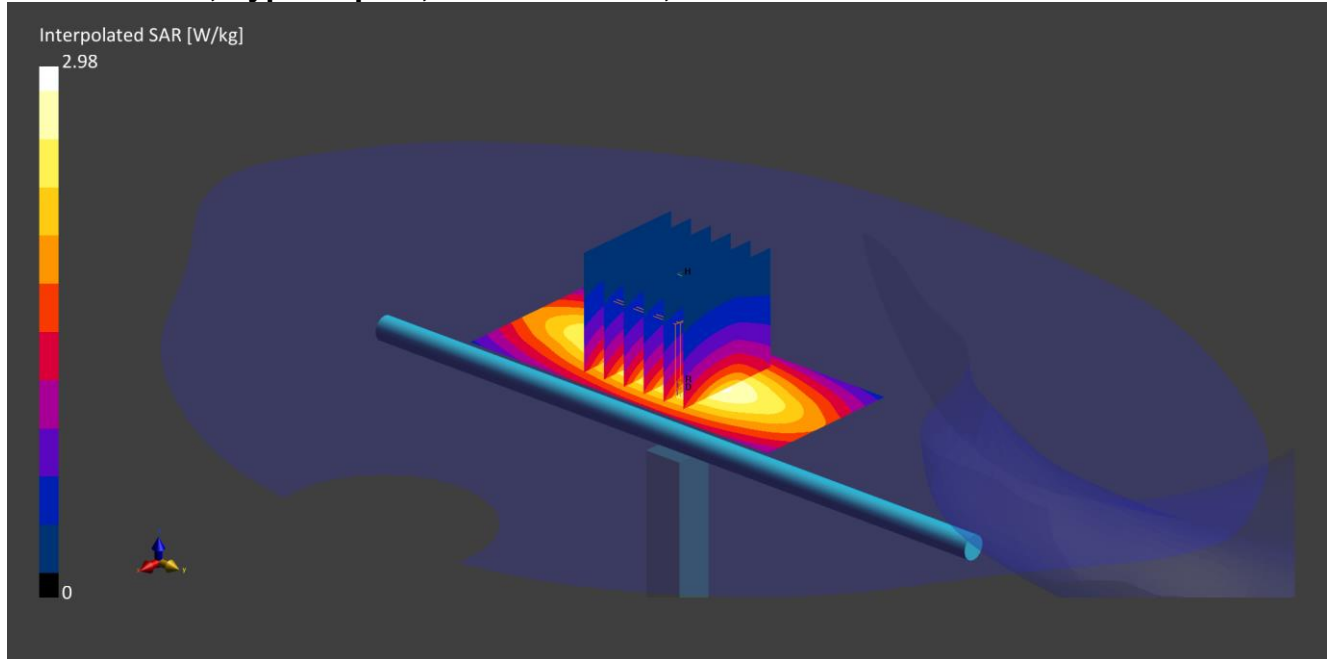
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D750V3; Type: Dipole; Serial: SN1139;



Communication System: CW UID: 0; Frequency: 750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_04Oct2021_115853_Head - 750 900 1750 2450 5250 5600 5750 5%;
Medium parameters used: $f = 750.0$ MHz; $\sigma = 0.905$ S/m; $\epsilon_r = 42.7$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 1.84$ %; $\Delta\sigma = 1.27$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(10.34, 10.34, 10.34); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 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 = 2.350 V/m; Power Drift = 0.01 dB

Minimum horizontal 3dB distance: 17.2 mm;

Vertical M2/M1 Ratio: 89.5 %;

SAR(1 g) = 2.040 W/kg; SAR(10 g) = 1.360 W/kg

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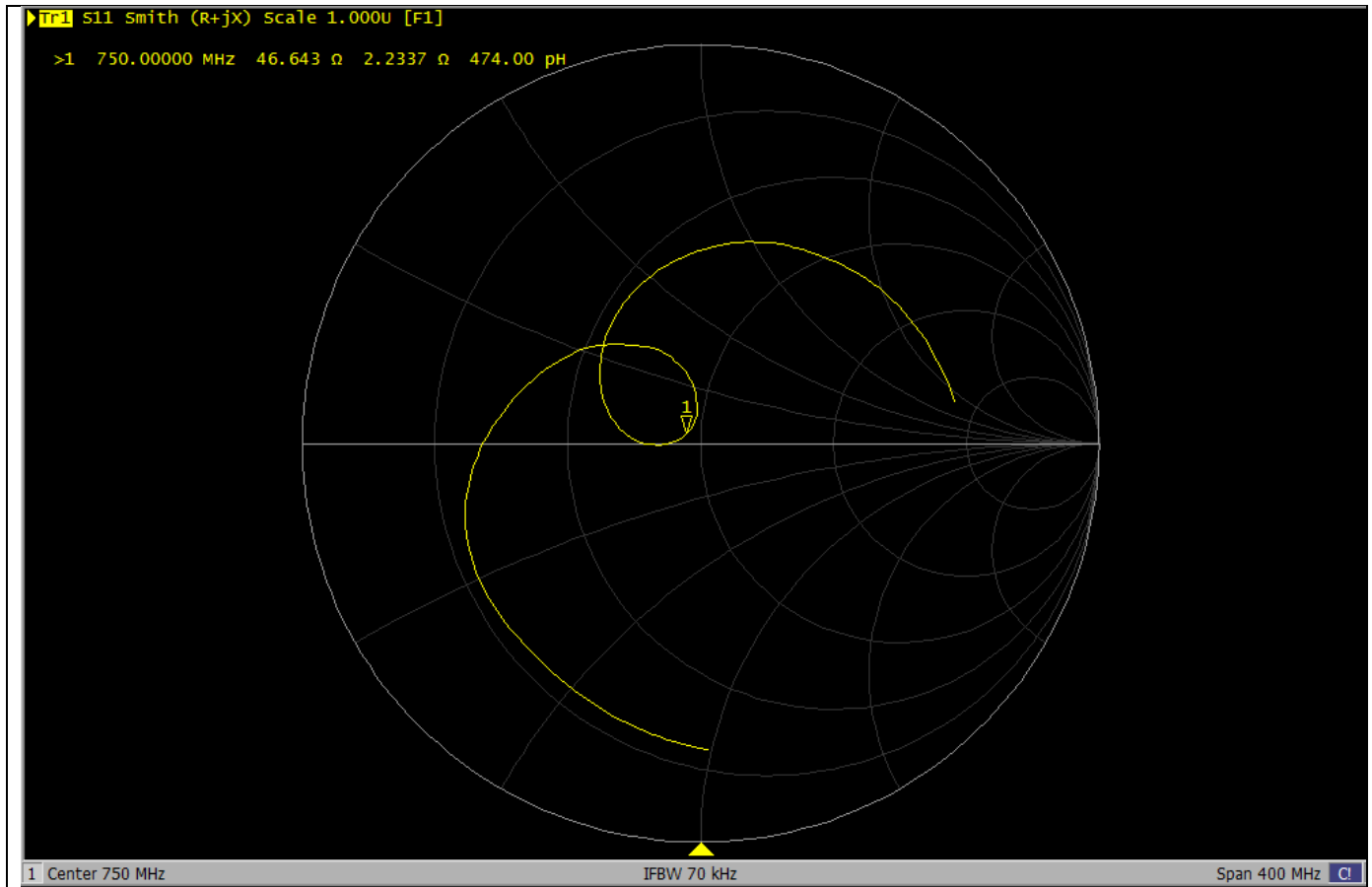
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)



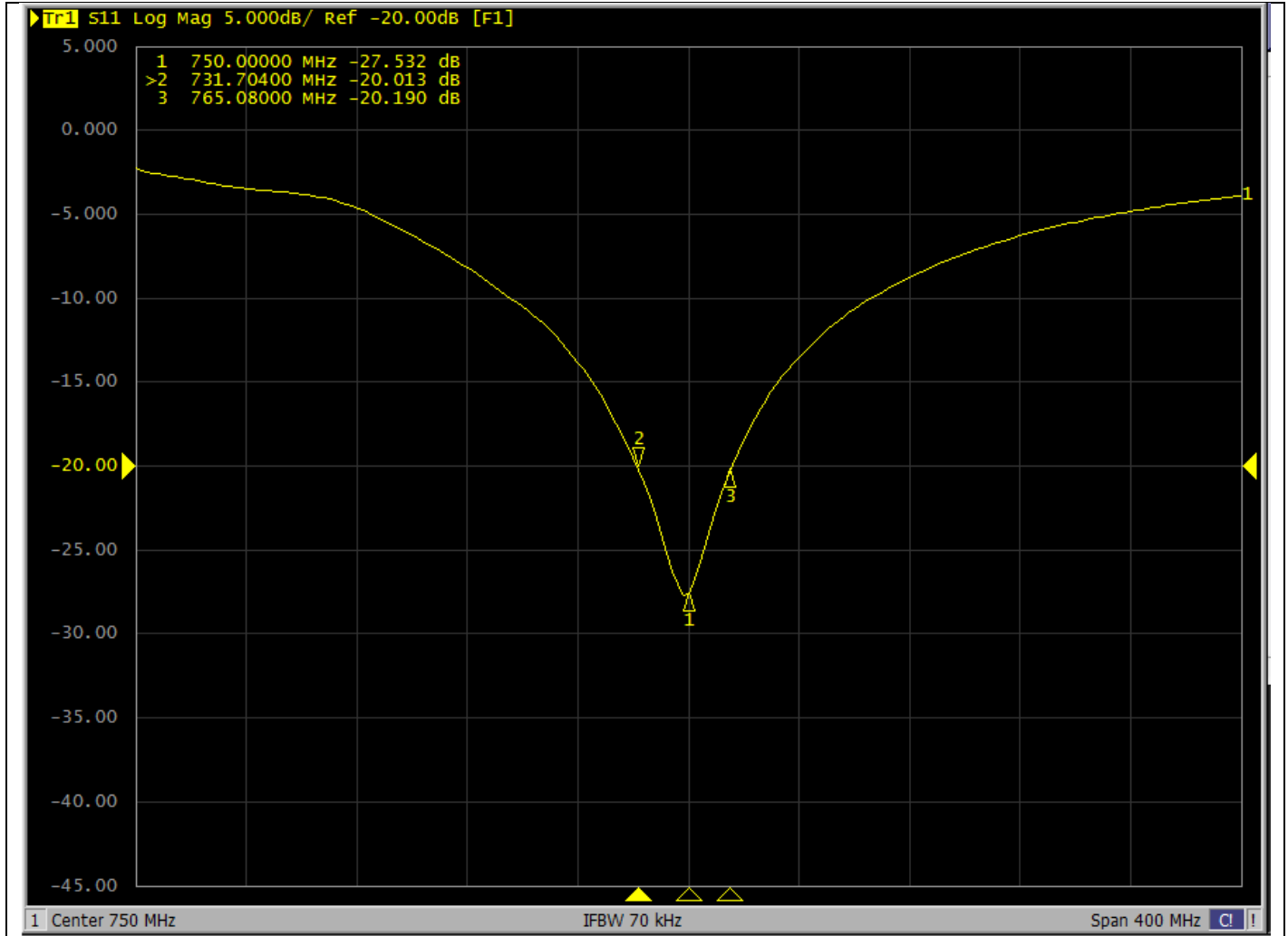
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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APPROVED SIGNATORY

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Naseer Mirza

Customer :

UL LLC
12 Laboratory Dr.
RTP, NC 27709 USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	04/Oct/2021
Manufacturer:	Speag		
Type/Model Number:	D900V2		
Serial Number:	1d180		
Calibration Date:	06/Oct/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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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
PRE0178314	Probe	SPEAG	EX3DV4	3995	16 Mar 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
PRE0135028	Signal Generator	R&S	SME 06	831377/005	29 Mar 2021	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:	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	21.8 °C	21.2 °C	ϵ_r	41.50	42.32	± 5%
						σ	0.97	0.96	± 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	2.67 W/Kg	10.63 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	47.97 -0.564j Ω	± 3.01
	Return Loss	33.79	± 3.34

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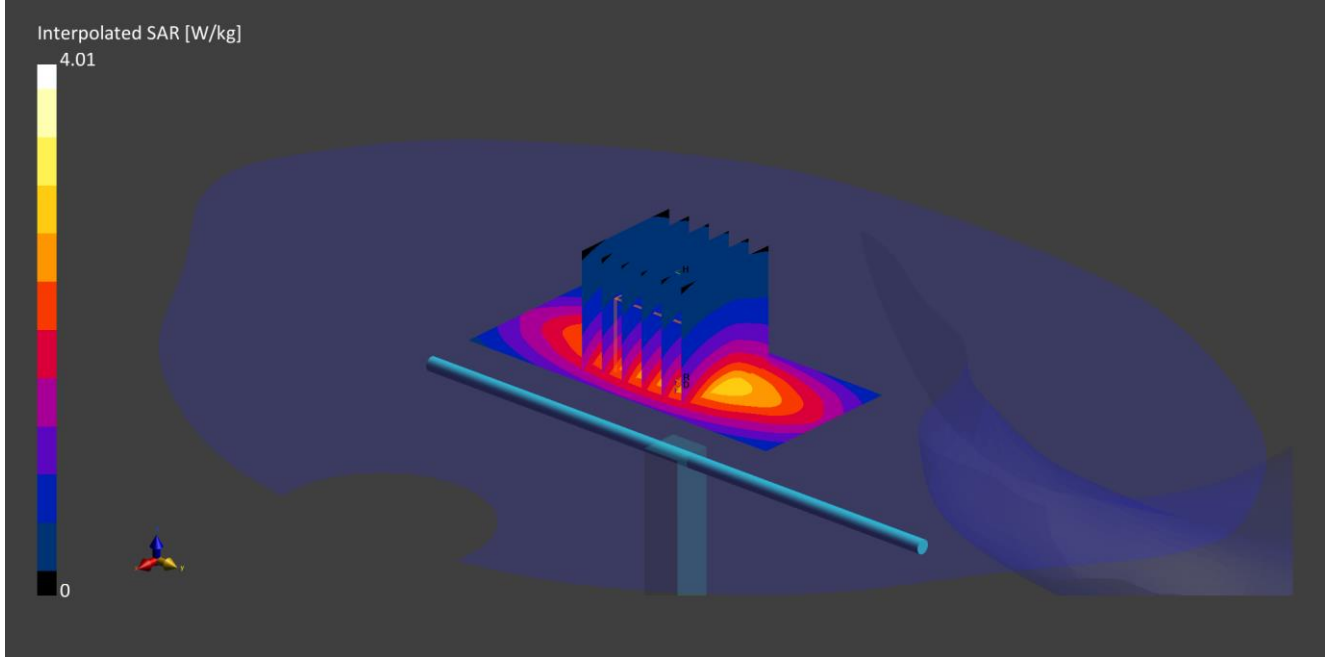
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D900V2; Type: Dipole; Serial: SN1d180;



Communication System: CW UID: 0; Frequency: 900.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_04Oct2021_115853_Head - 750 900 1750 2450 5250 5600 5750 5%;
Medium parameters used: $f = 900.0$ MHz; $\sigma = 0.96$ S/m; $\epsilon_r = 42.3$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 1.97$ %; $\Delta\sigma = -1.06$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(9.7, 9.7, 9.7); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 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 = 3.110 V/m; Power Drift = -0.02 dB

Minimum horizontal 3dB distance: 18.0 mm;

Vertical M2/M1 Ratio: 88.7 %;

SAR(1 g) = 2.670 W/kg; SAR(10 g) = 1.750 W/kg

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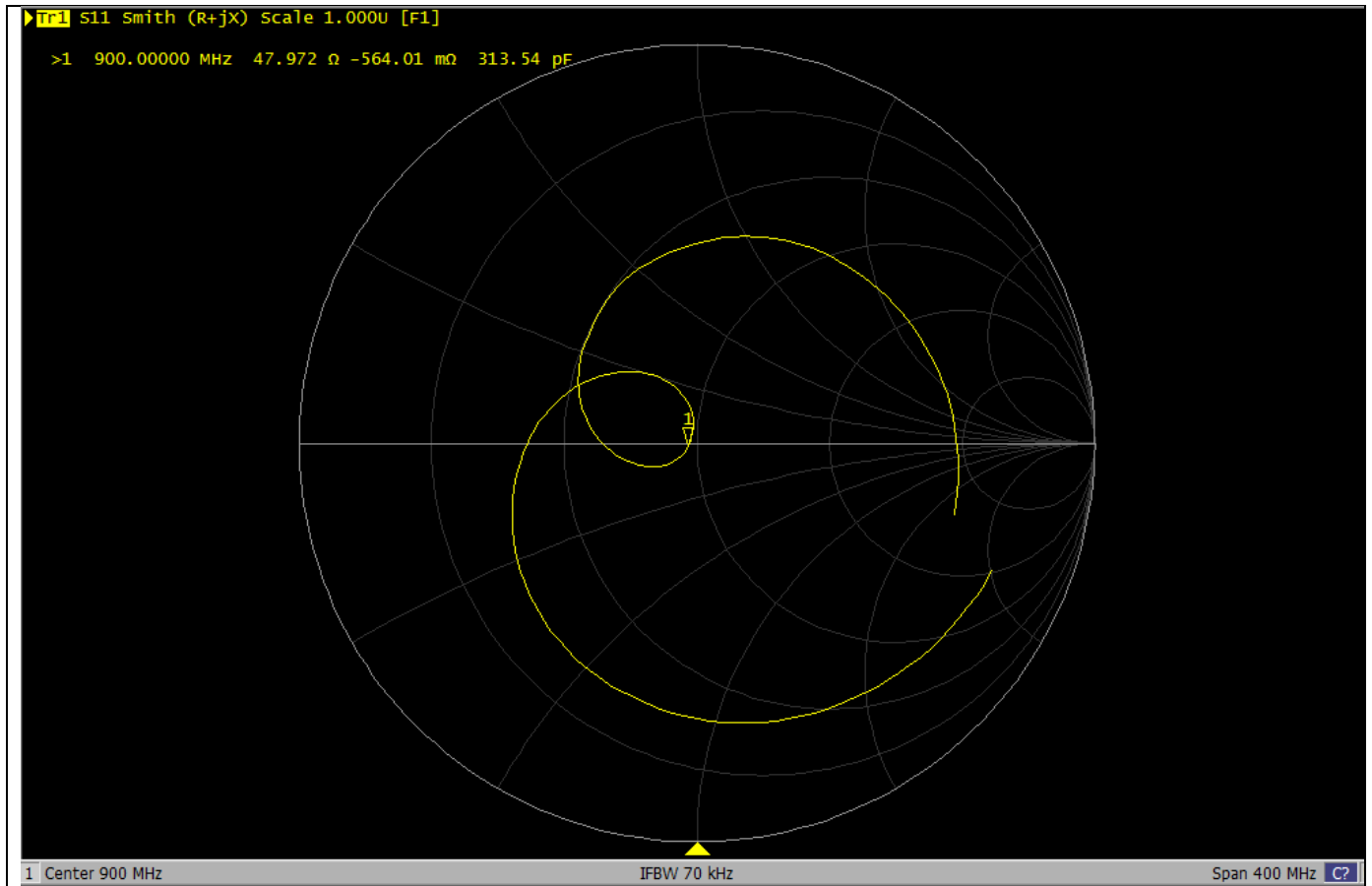
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)



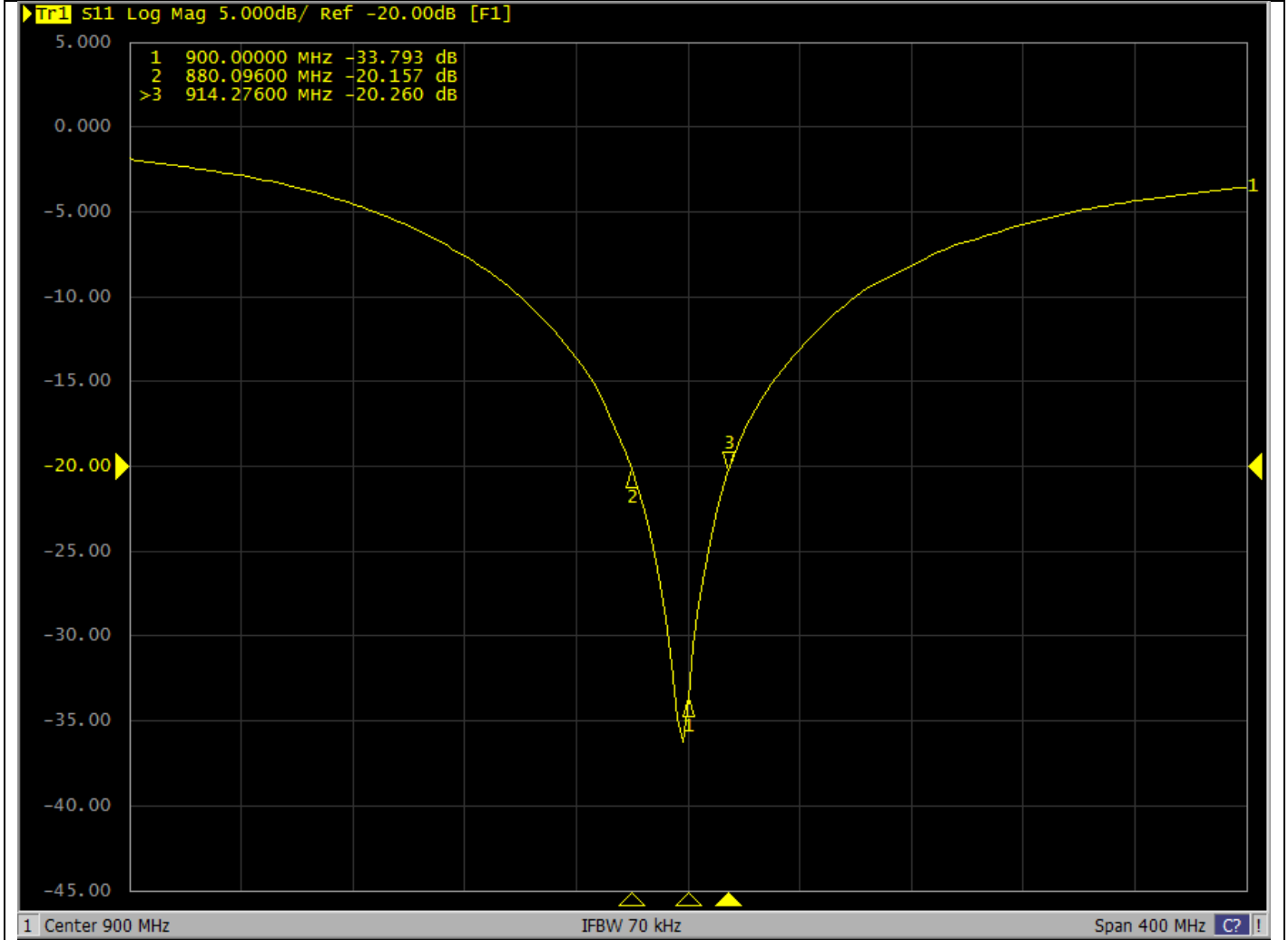
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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Email: LST.UK.Calibration@ul.com



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APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

UL LLC
12 Laboratory Dr.
RTP, NC 27709 USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	04/Oct/2021
Manufacturer:	Speag		
Type/Model Number:	D1750V2		
Serial Number:	1136		
Calibration Date:	12/Oct/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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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
PRE0178314	Probe	SPEAG	EX3DV4	3995	16 Mar 2021	12
PRE0178321	Dipole	SPEAG	D1800V2	SN2d218	09 Mar 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
PRE0135028	Signal Generator	R&S	SME 06	831377/005	29 Mar 2021	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:	cDASY16.0.0.116
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (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	21.2 °C	20.6 °C	21.5 °C	21.0 °C	ϵ_r	40.08	40.89	± 5%
						σ	1.37	1.32	± 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	8.65 W/Kg	34.44 W/Kg	+16.80 / -16.43%
	SAR averaged over 10g	4.68 W/Kg	18.63 W/Kg	+16.72 / -16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.78 0.15j Ω	± 3.01
	Return Loss	42.08	± 3.34

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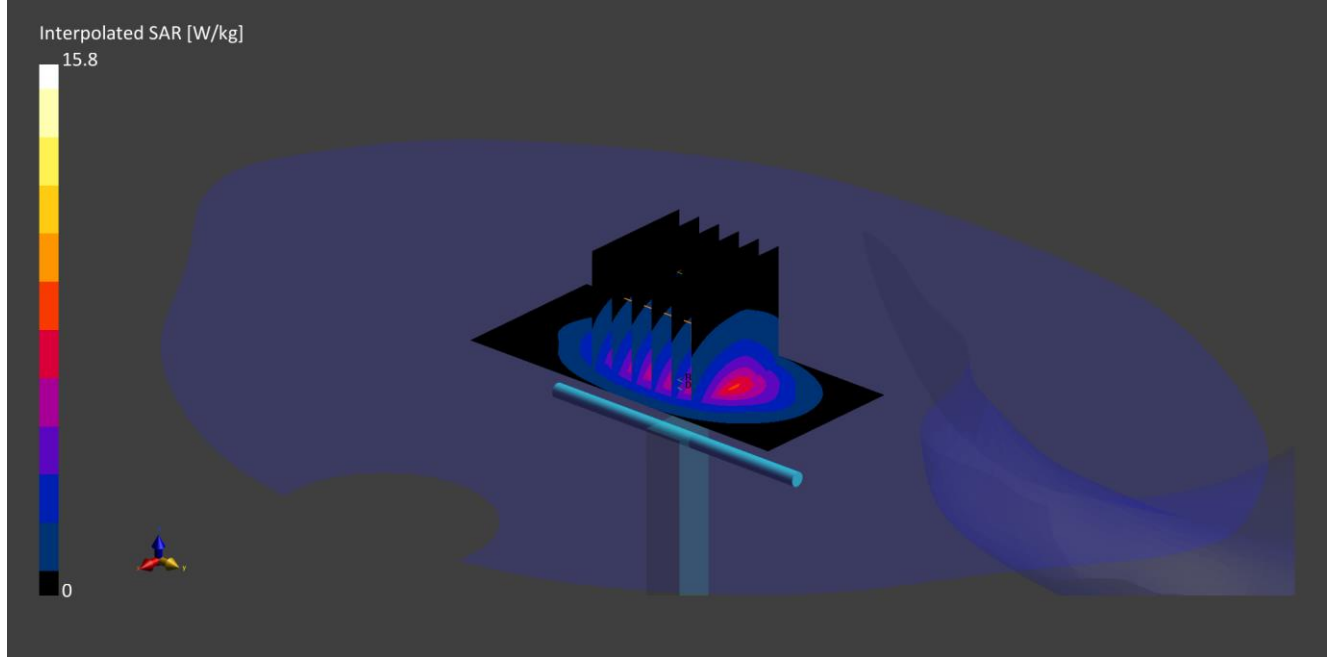
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1750V2; Type: Dipole; Serial: SN1136;



Communication System: CW UID: 0; Frequency: 1750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_11Oct2021_131452_Head - 1800 1900 5GHz 5%; Medium parameters
used: $f = 1750.0$ MHz; $\sigma = 1.32$ S/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 2.03$ %; $\Delta\sigma = -3.37$ %; No
correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(8.7, 8.7, 8.7); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 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 = 10.660 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 9.6 mm;

Vertical M2/M1 Ratio: 83.1 %;

SAR(1 g) = 8.650 W/kg; SAR(10 g) = 4.680 W/kg

CERTIFICATE OF CALIBRATION

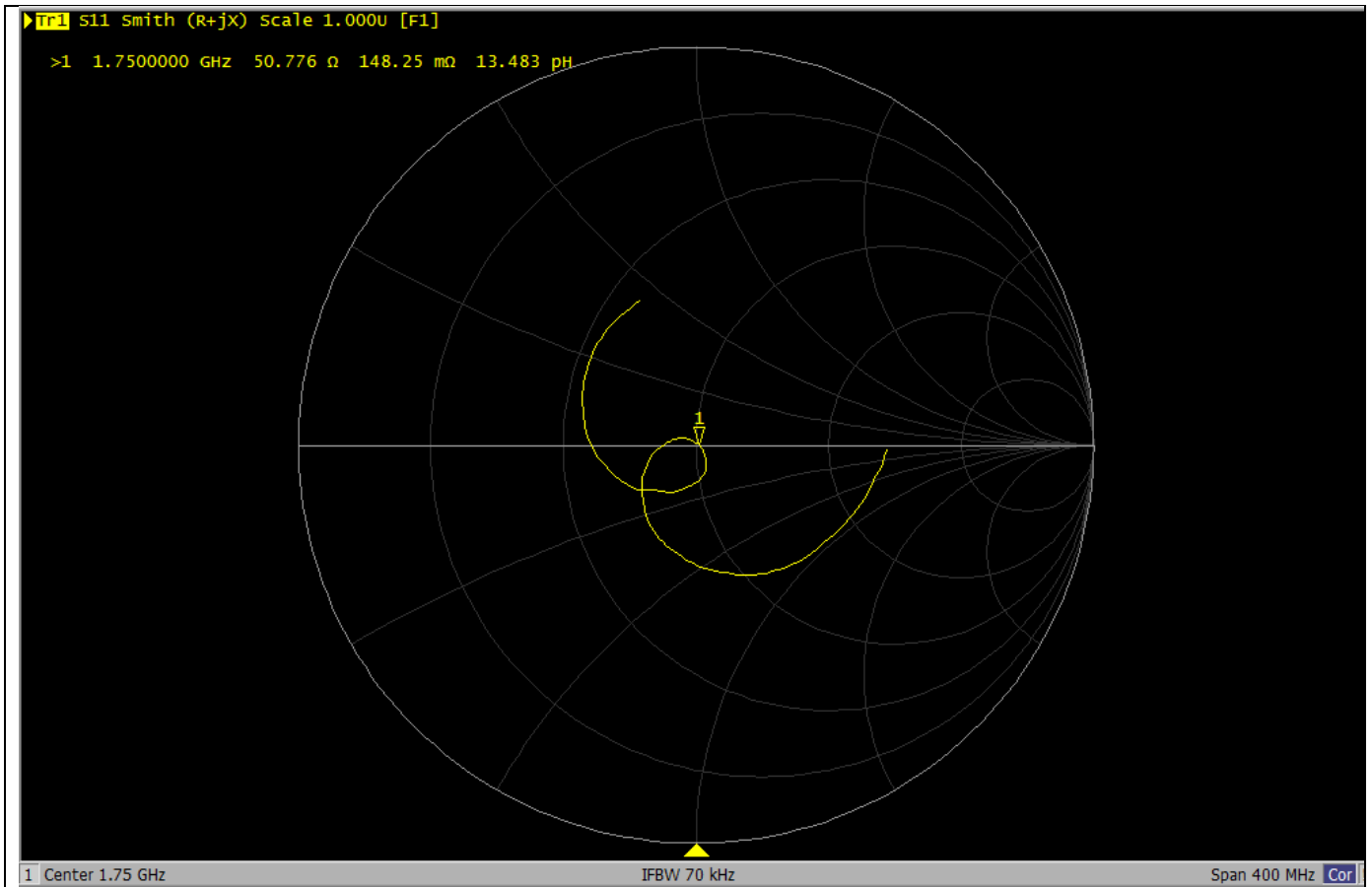
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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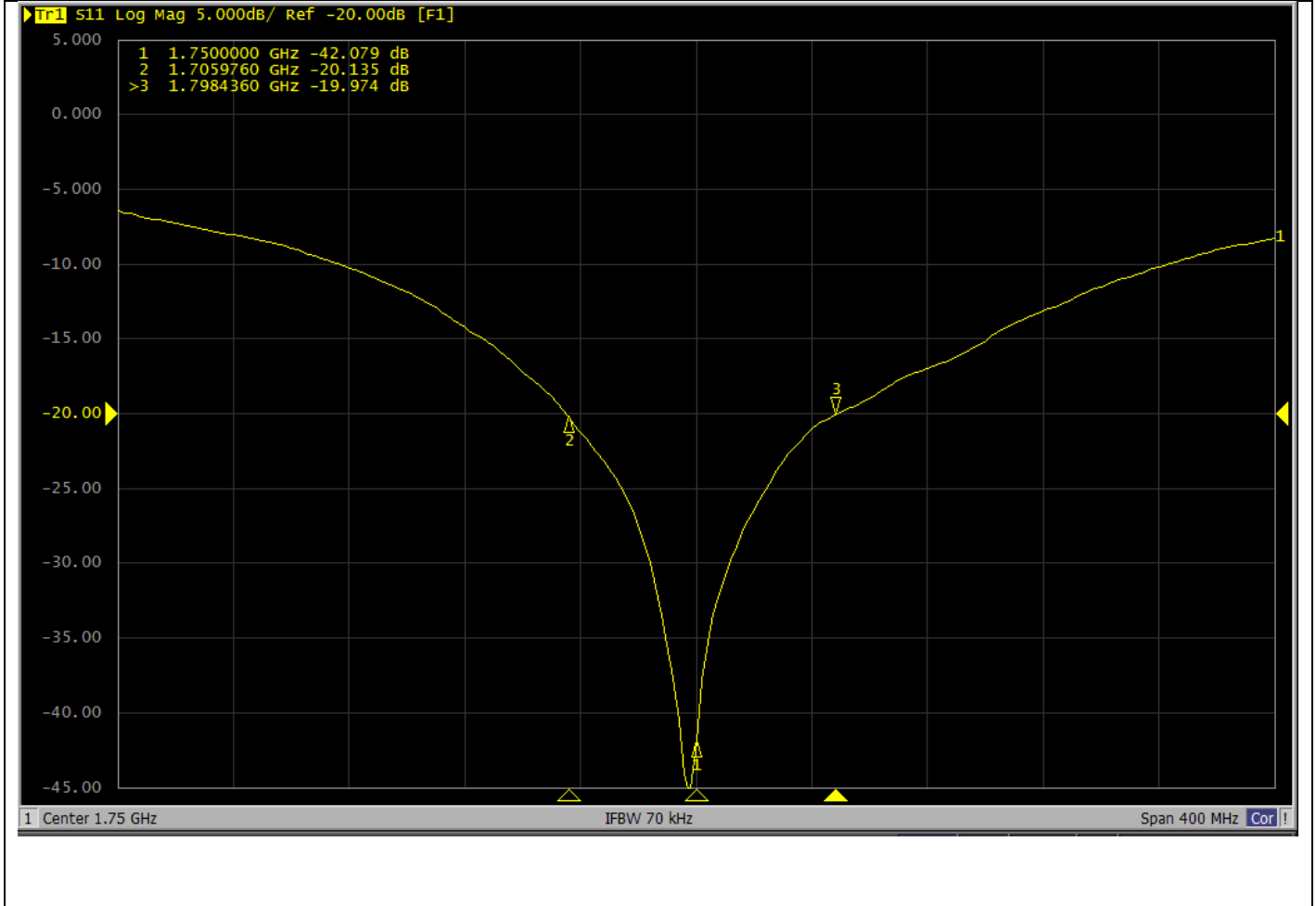
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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 <p>UKAS CALIBRATION 5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01C</p> <p>Instrument ID: 1136</p> <p>Calibration Date: 12/Oct/2021</p> <p>Calibration Due Date:</p>
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 <p>UKAS CALIBRATION 5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01C</p> <p>Instrument ID: 1136</p> <p>Calibration Date: 12/Oct/2021</p> <p>Calibration Due Date:</p>
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CERTIFICATE OF CALIBRATION

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DATE OF ISSUE: 11/Oct/2021

CERTIFICATE NUMBER : 14030223JD01D



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Email: LST.UK.Calibration@ul.com



Page 1 of 6

APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

UL LLC
12 Laboratory Dr.
RTP, NC 27709 USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	04/Oct/2021
Manufacturer:	Speag		
Type/Model Number:	D1900V2		
Serial Number:	5d202		
Calibration Date:	06/Oct/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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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
PRE0178314	Probe	SPEAG	EX3DV4	3995	16 Mar 2021	12
PRE0134198	Dipole	SPEAG	D1900V2	537	16 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
PRE0135028	Signal Generator	R&S	SME 06	831377/005	29 Mar 2021	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:	cDASY16.0.0.116
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (with spacer)
Frequency:	1900 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	1900	21.4 °C	20.8 °C	21.4 °C	20.9 °C	ϵ_r	40.00	40.17	± 5%
						σ	1.40	1.37	± 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	9.51 W/Kg	37.86 W/Kg	+16.80 / -16.43%
	SAR averaged over 10g	5.09 W/Kg	20.26 W/Kg	+16.72 / -16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	51.95 -4.40j Ω	± 3.01
	Return Loss	26.34	± 2.97

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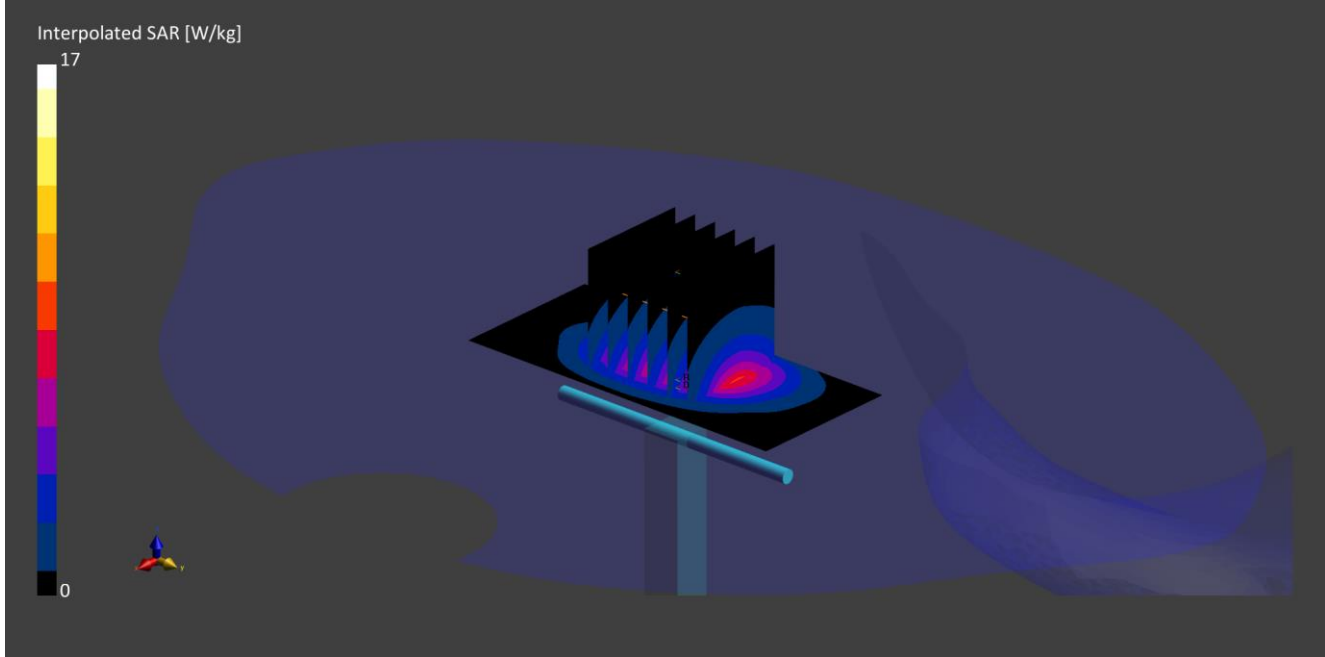
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1900V2; Type: Dipole; Serial: SN5d202;



Communication System: CW UID: 0; Frequency: 1900.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_04Oct2021_122256_Head - 1900 2100 5%; Medium parameters used: $f = 1900.0$ MHz; $\sigma = 1.37$ S/m; $\epsilon_r = 40.2$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 0.44$ %; $\Delta\sigma = -1.83$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(8.4, 8.4, 8.4); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 12 Apr 2021
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- 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 = 13.320 V/m; Power Drift = -0.03 dB

Minimum horizontal 3dB distance: 9.9 mm;

Vertical M2/M1 Ratio: 85.2 %;

SAR(1 g) = 9.510 W/kg; SAR(10 g) = 5.090 W/kg

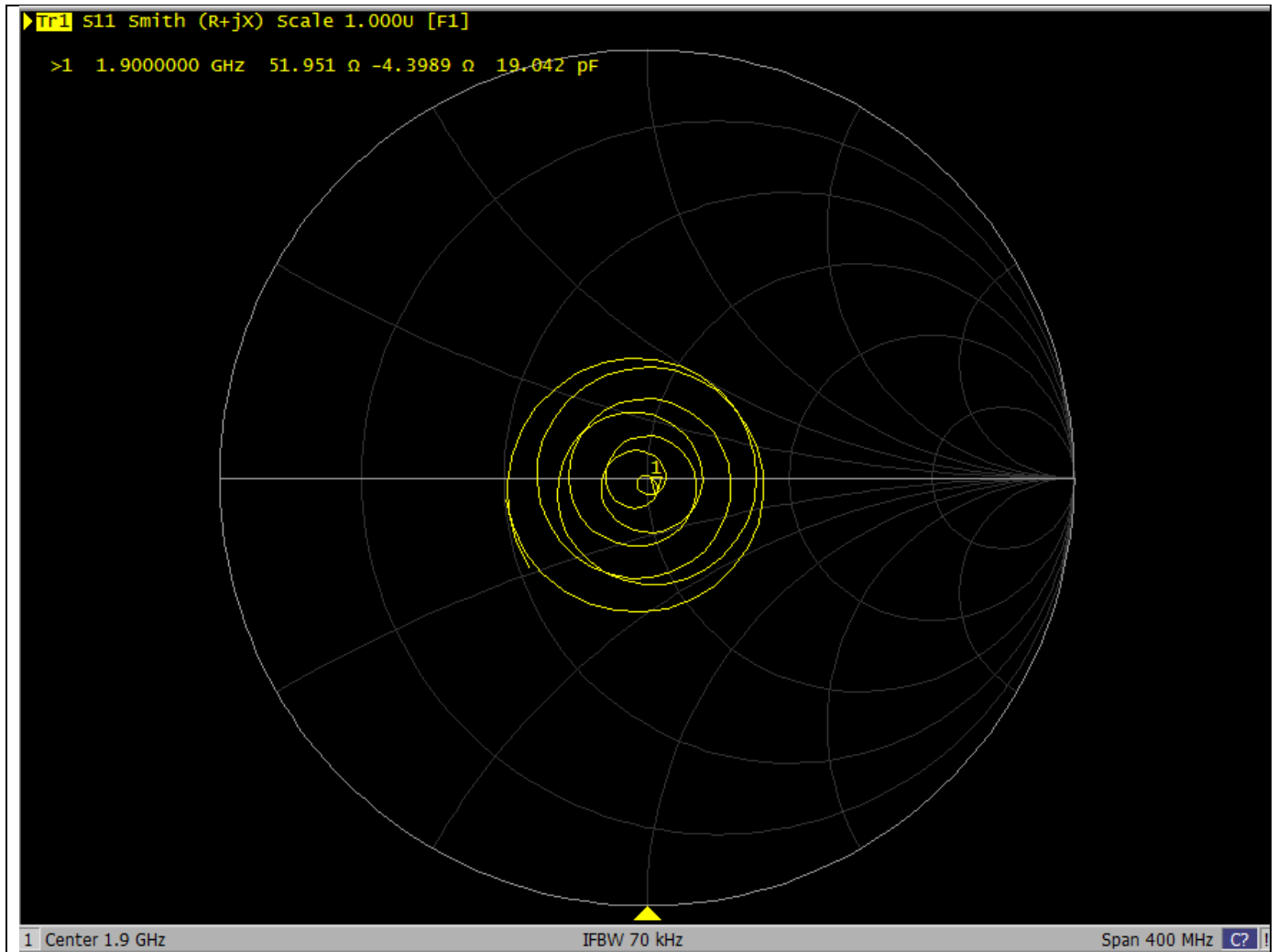
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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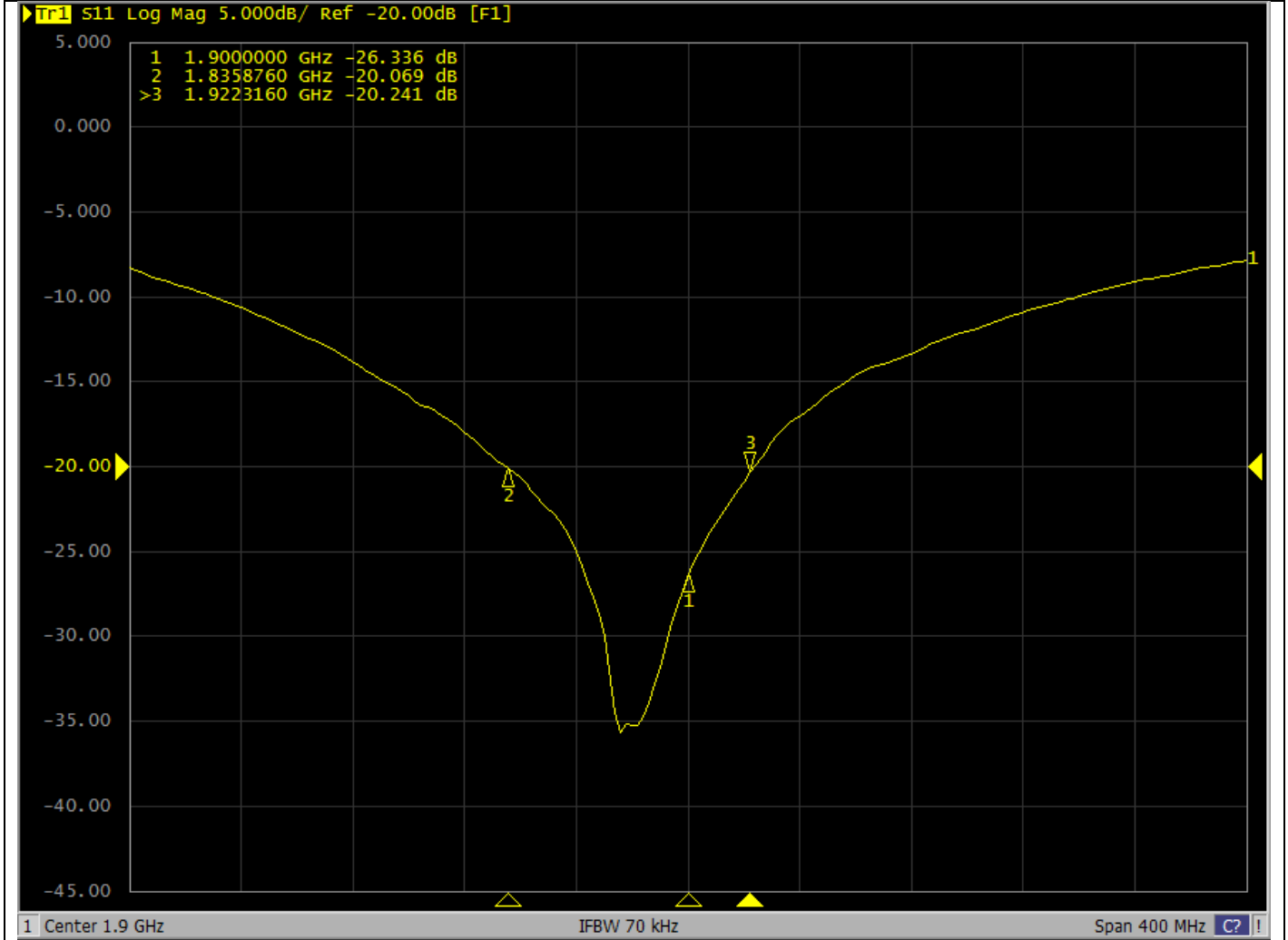
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



Calibration Certificate Label:

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	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01D</p> <p>Instrument ID: 5d202</p> <p>Calibration Date: 06/Oct/2021</p> <p>Calibration Due Date:</p>
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	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01D</p> <p>Instrument ID: 5d202</p> <p>Calibration Date: 06/Oct/2021</p> <p>Calibration Due Date:</p>
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APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

UL LLC
12 Laboratory Dr.
RTP, NC 27709 USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	04/Oct/2021
Manufacturer:	Speag		
Type/Model Number:	D2450V2		
Serial Number:	963		
Calibration Date:	06/Oct/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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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
PRE0178314	Probe	SPEAG	EX3DV4	3995	16 Mar 2021	12
PRE0131865	Dipole	SPEAG	D2450V2	725	07 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	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
PRE0135028	Signal Generator	R&S	SME 06	831377/005	29 Mar 2021	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:	cDASY16.0.0.116
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (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	21.3 °C	20.8 °C	21.0 °C	20.6 °C	ϵ_r	39.20	39.74	± 5%
						σ	1.80	1.82	± 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	12.9 W/Kg	51.36 W/Kg	+16.80 / -16.43%
	SAR averaged over 10g	6.17 W/Kg	24.56 W/Kg	+16.72 / -16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	48.70 0.29j Ω	± 3.01
	Return Loss	37.20	± 3.34

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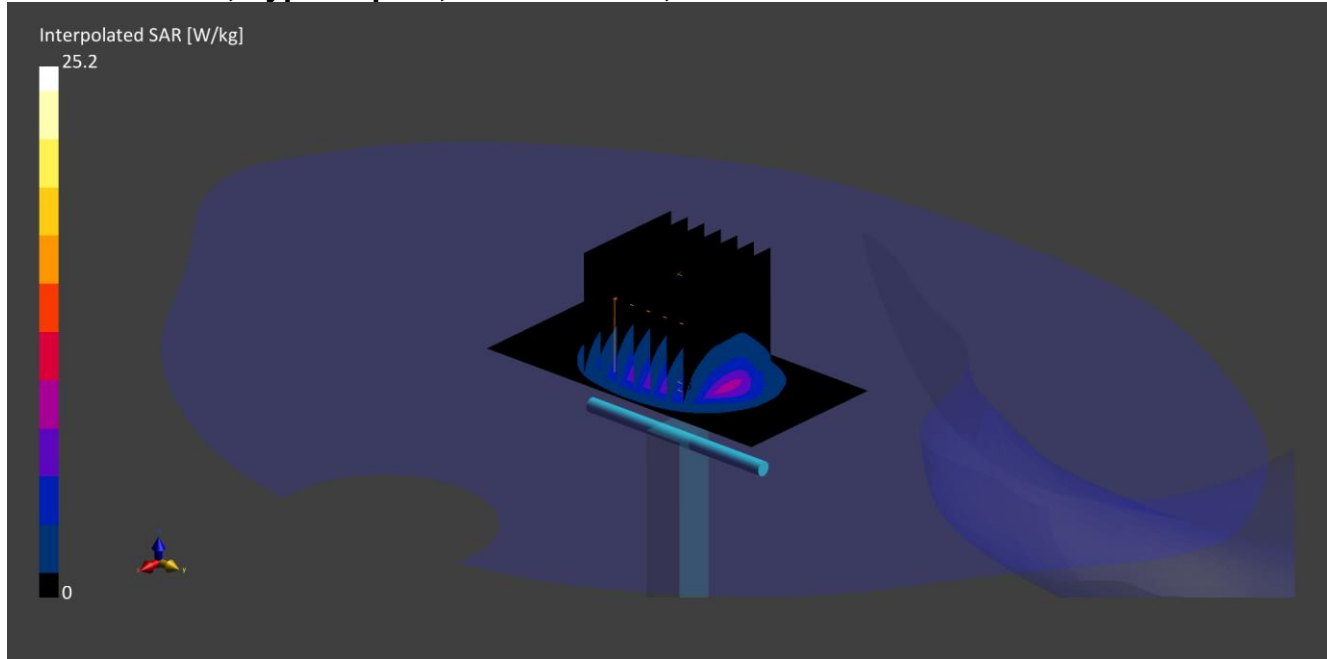
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D2450V2; Type: Dipole; Serial: SN963;



Communication System: CW UID: 0; Frequency: 2450.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_04Oct2021_115853_Head - 750 900 1750 2450 5250 5600 5750 5%;
Medium parameters used: $f = 2450.0$ MHz; $\sigma = 1.83$ S/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 1.38$ %; $\Delta\sigma = 1.62$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(7.84, 7.84, 7.84); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 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 (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 = 16.850 V/m; Power Drift = 0.01 dB

Minimum horizontal 3dB distance: 9.0 mm;

Vertical M2/M1 Ratio: 82.2 %;

SAR(1 g) = 12.900 W/kg; SAR(10 g) = 6.170 W/kg

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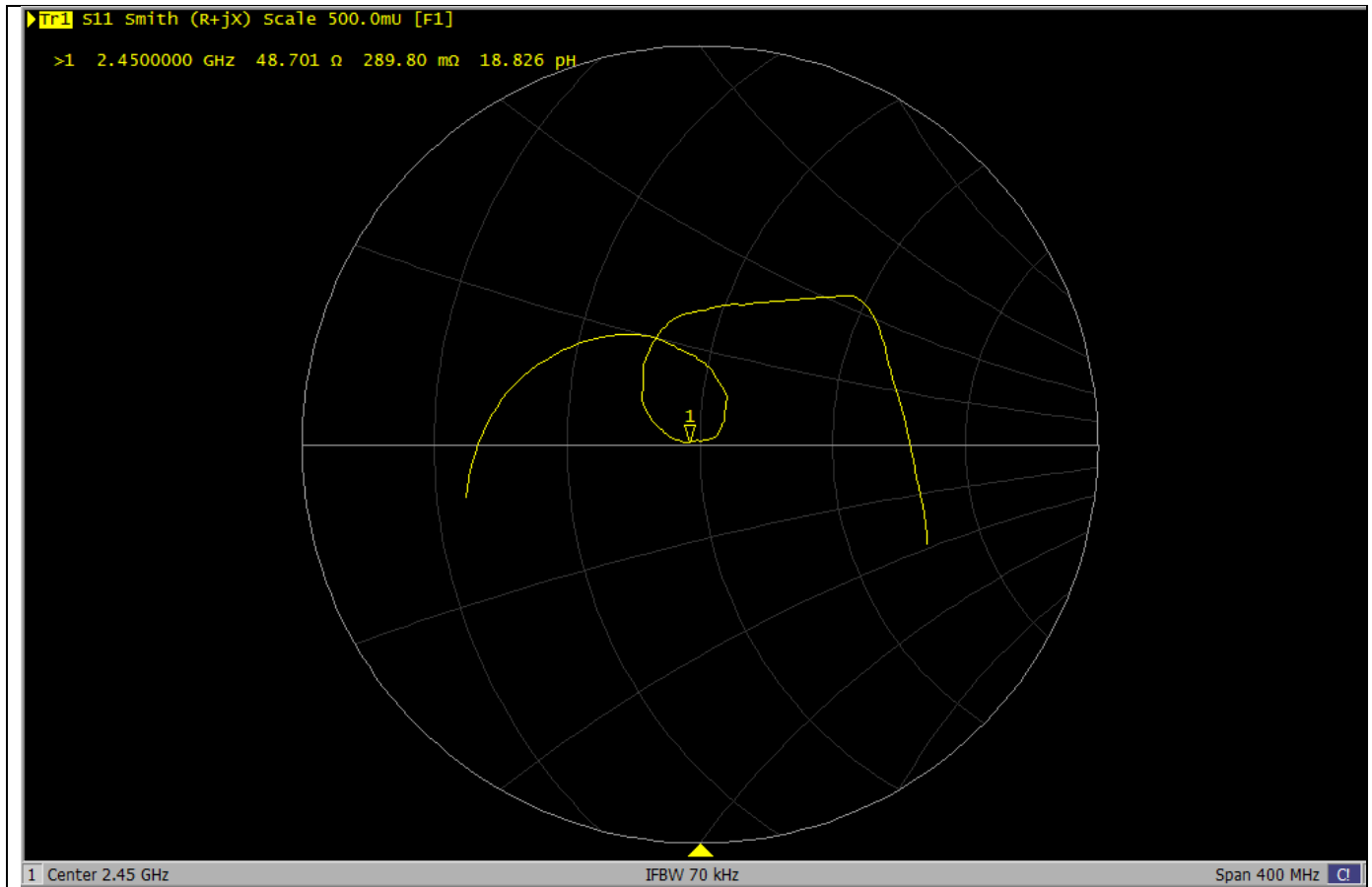
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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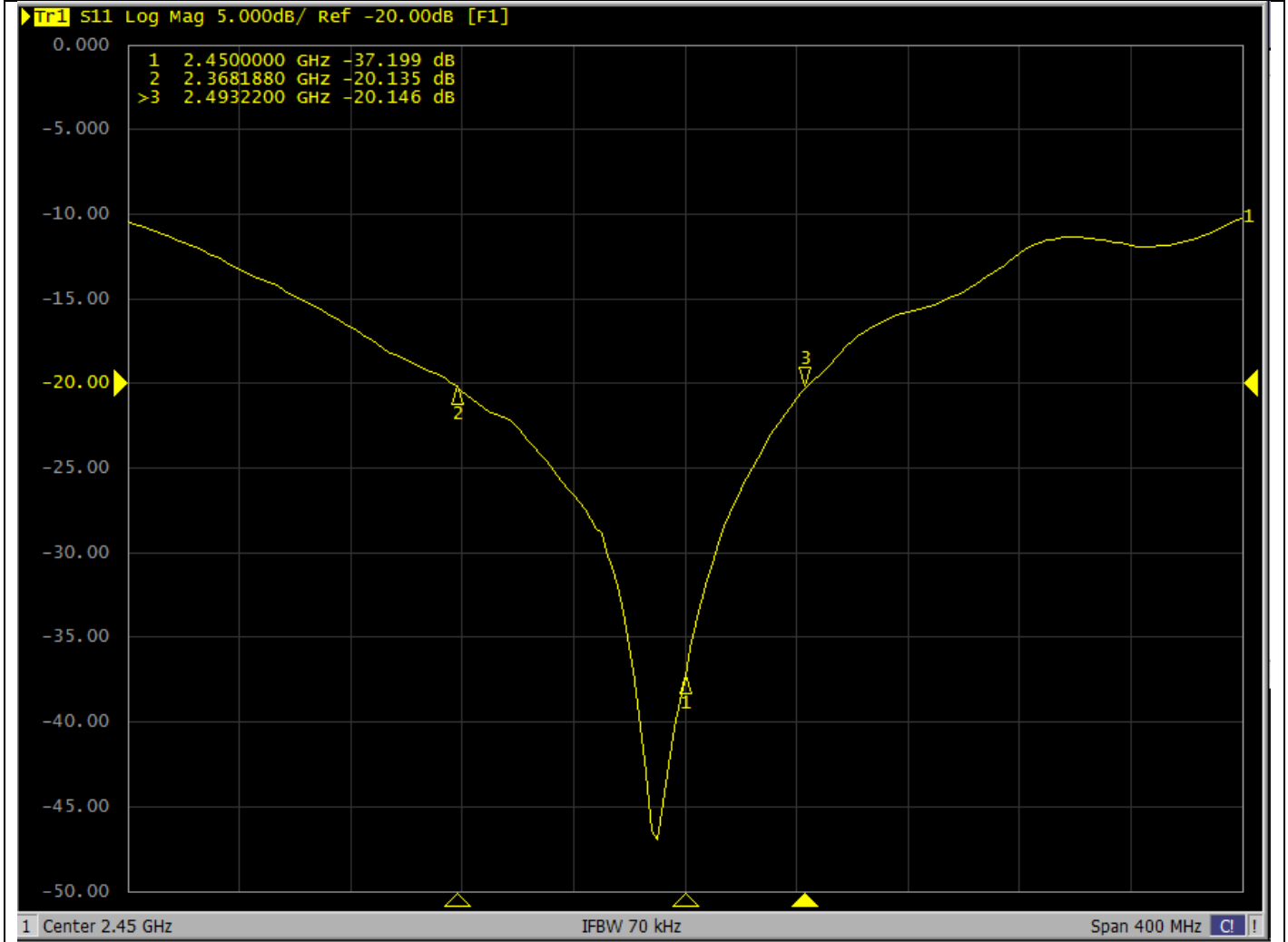
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



Calibration Certificate Label:

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 <p>UKAS CALIBRATION 5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01F</p> <p>Instrument ID: 963</p> <p>Calibration Date: 06/Oct/2021</p> <p>Calibration Due Date:</p>
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 <p>UKAS CALIBRATION 5772</p>	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01F</p> <p>Instrument ID: 963</p> <p>Calibration Date: 06/Oct/2021</p> <p>Calibration Due Date:</p>
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DATE OF ISSUE: 14/Oct/2021

CERTIFICATE NUMBER : 14030223JD01G



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Email: LST.UK.Calibration@ul.com



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APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

UL LLC
12 Laboratory Dr.
RTP, NC 27709 USA

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	04/Oct/2021
Manufacturer:	Speag		
Type/Model Number:	D5GHZV2		
Serial Number:	1213		
Calibration Date:	12/Oct/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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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
PRE0178314	Probe	SPEAG	EX3DV4	3995	16 Mar 2021	12
PRE0178323	Dipole	SPEAG	D5GHzV2	1274	08 Mar 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
PRE0135028	Signal Generator	R&S	SME 06	831377/005	29 Mar 2021	12

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UKAS Accredited Calibration Laboratory No. 5772

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NUMBER :
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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:	cDASY16.0.0.116
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	21.4 °C	20.9 °C	21.2 °C	20.6 °C	ϵ_r	35.92	35.22	± 5%
						σ	4.71	4.56	± 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	7.62 W/Kg	76.20 W/Kg	+16.77 / -16.70%
	SAR averaged over 10g	2.23 W/Kg	22.30 W/Kg	± 16.70%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	49.89 1.46j Ω	± 3.01
	Return Loss	36.68	± 3.34

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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:	cDASY16.0.0.116
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (with spacer)
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	21.4 °C	21.1 °C	21.2 °C	20.8 °C	ϵ_r	35.52	34.59	± 5%
						σ	5.06	4.95	± 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	8.18 W/Kg	81.80 W/Kg	+16.77 / -16.70%
	SAR averaged over 10g	2.36 W/Kg	23.60 W/Kg	± 16.70%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.87 - 3.73j Ω	± 3.01
	Return Loss	28.42	± 2.97

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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:	cDASY16.0.0.116
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (with spacer)
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	21.5 °C	21.1 °C	21.3 °C	21.0 °C	ϵ_r	35.36	34.34	± 5%
						σ	5.22	5.13	± 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	7.55 W/Kg	75.50 W/Kg	+16.77 / -16.70%
	SAR averaged over 10g	2.20 W/Kg	22.00 W/Kg	± 16.70%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	44.97 2.12j Ω	± 3.01
	Return Loss	24.82	± 2.93

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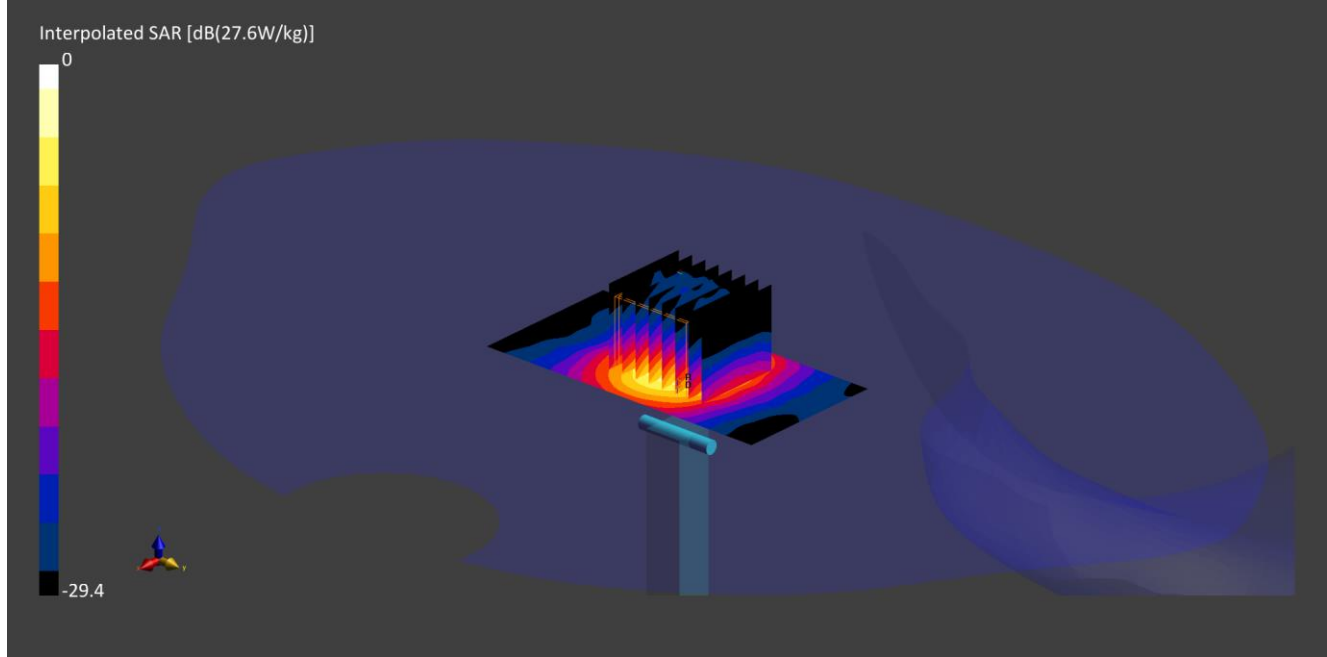
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NUMBER :
14030223JD01G

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1213;



Communication System: CW UID: 0; Frequency: 5250.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_11Oct2021_131452_Head - 1800 1900 5GHz 5%; Medium parameters
used: $f = 5250.0$ MHz; $\sigma = 4.56$ S/m; $\epsilon_r = 35.2$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -1.97$ %; $\Delta\sigma = -3.08$ %;
No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(5.24, 5.24, 5.24); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 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 (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 = 10.740 V/m; Power Drift = -0.01 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 66.7 %;

SAR(1 g) = 7.620 W/kg; SAR(10 g) = 2.230 W/kg

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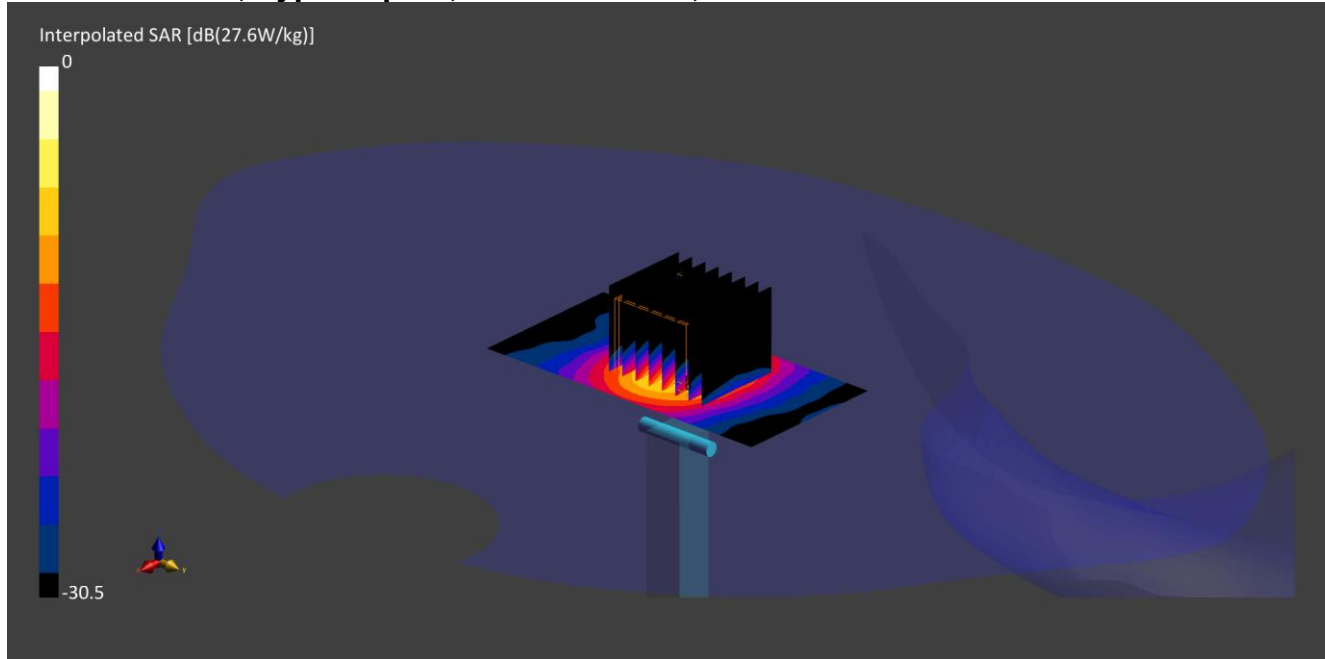
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NUMBER :
14030223JD01G

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1213;



Communication System: CW UID: 0; Frequency: 5600.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_11Oct2021_131452_Head - 1800 1900 5GHz 5%; Medium parameters used: $f = 5600.0$ MHz; $\sigma = 4.96$ S/m; $\epsilon_r = 34.6$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -2.62$ %; $\Delta\sigma = -2.17$ %;
No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.7, 4.7, 4.7); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 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 (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 = 11.280 V/m; Power Drift = 0.03 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 64.1 %;

SAR(1 g) = 8.180 W/kg; SAR(10 g) = 2.360 W/kg

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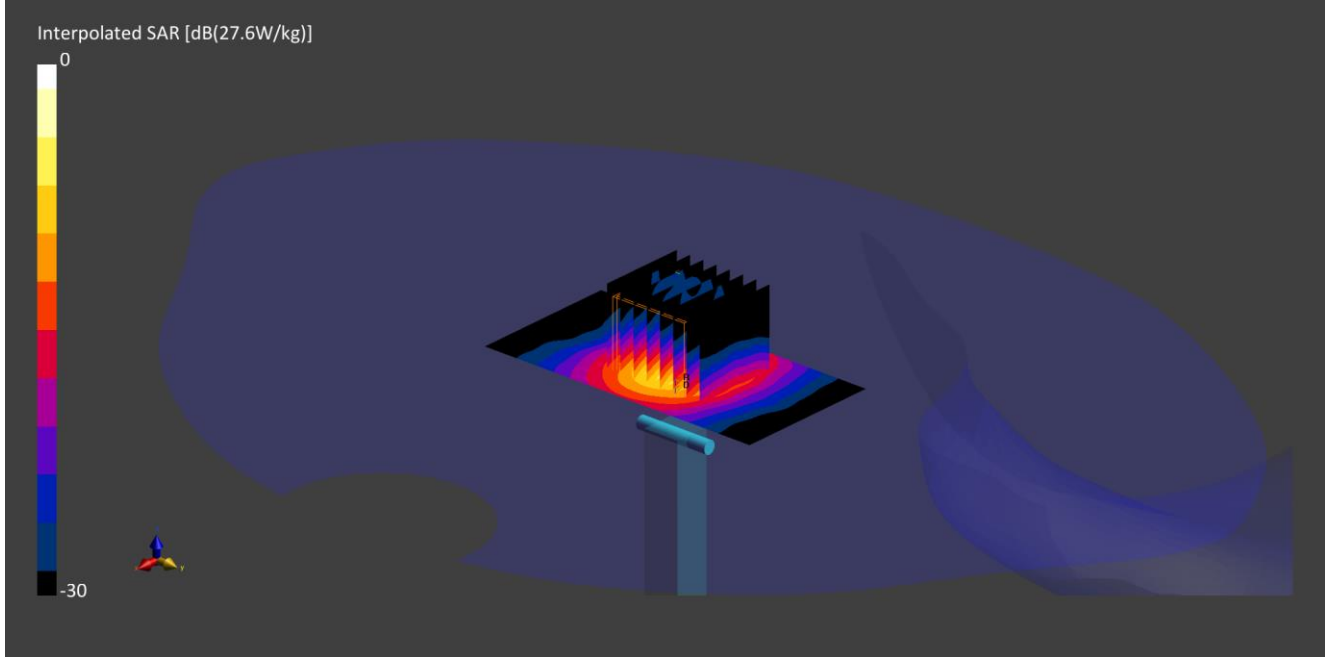
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHzV2; Type: Dipole; Serial: SN1213;



Communication System: CW UID: 0; Frequency: 5750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_11Oct2021_131452_Head - 1800 1900 5GHz 5%; Medium parameters used: $f = 5750.0$ MHz; $\sigma = 5.13$ S/m; $\epsilon_r = 34.3$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -2.89$ %; $\Delta\sigma = -1.64$ %;
No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.79, 4.79, 4.79); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 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 (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 = 11.060 V/m; Power Drift = 0.03 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 62.5 %;

SAR(1 g) = 7.550 W/kg; SAR(10 g) = 2.200 W/kg

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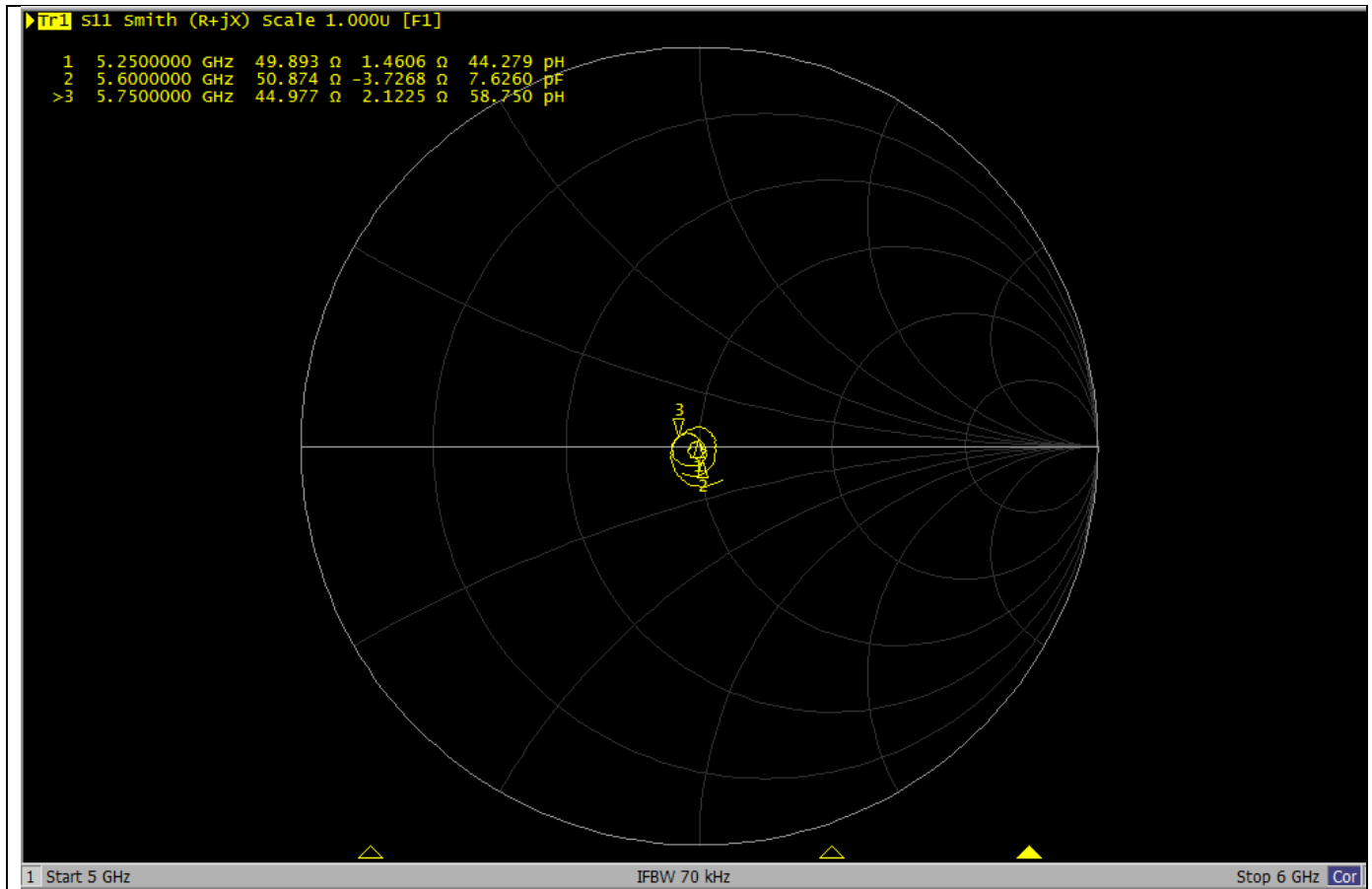
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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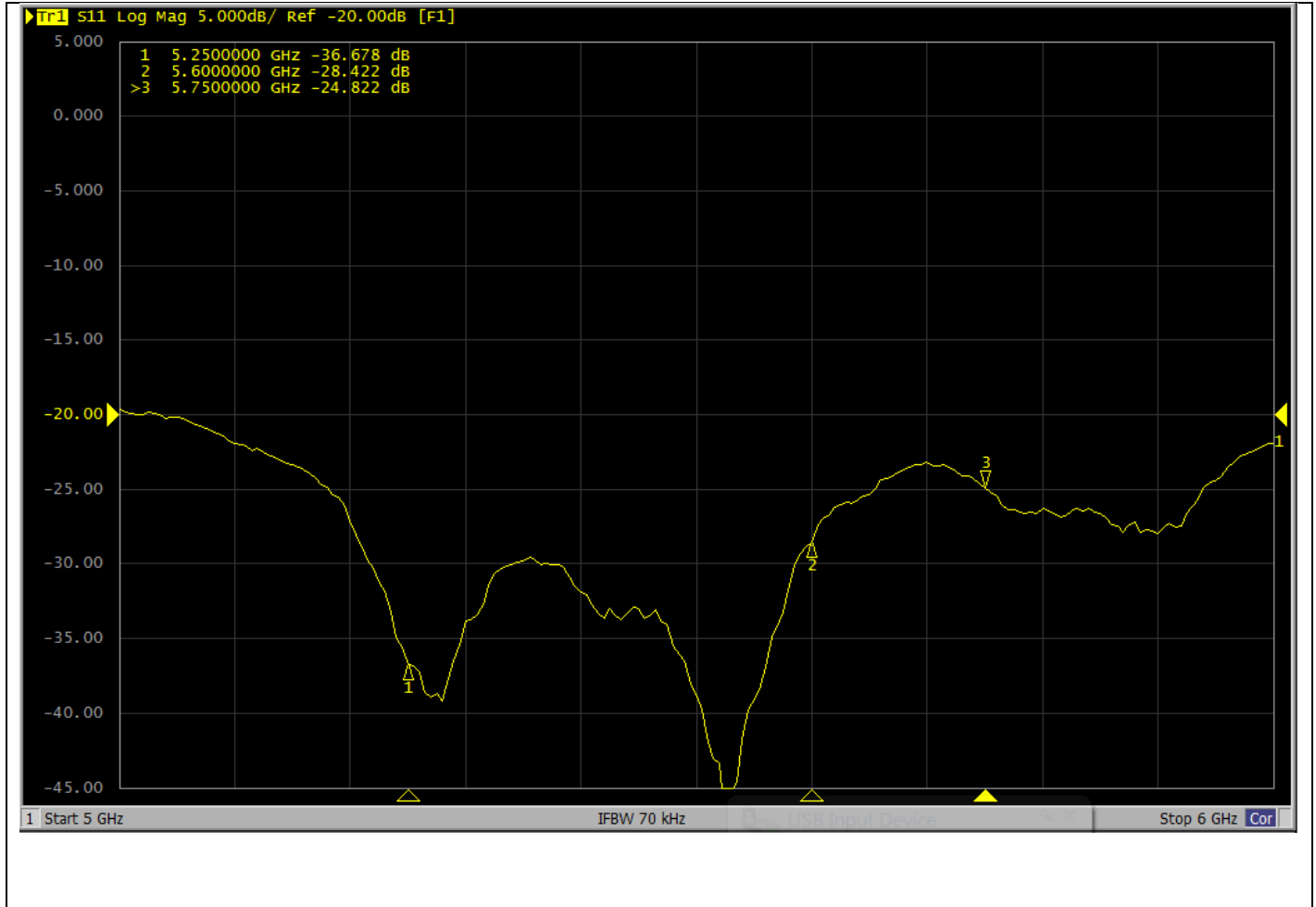
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



Calibration Certificate Label:

	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01G</p> <p>Instrument ID: 1213</p> <p>Calibration Date: 12/Oct/2021</p> <p>Calibration Due Date:</p>
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	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01G</p> <p>Instrument ID: 1213</p> <p>Calibration Date: 12/Oct/2021</p> <p>Calibration Due Date:</p>
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	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 14030223JD01G</p> <p>Instrument ID: 1213</p> <p>Calibration Date: 12/Oct/2021</p> <p>Calibration Due Date:</p>
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