

CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 31/May/2020 CERTIFICATE NUMBER : 13252593JD01B



5248

UL VS LTD
UNIT 1-3 HORIZON
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RG24 8AH, UK
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FAX: +44 (0) 1256 312001
Email: LST.UK.Calibration@ul.com



Page 1 of 10

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.....
Naseer Mirza

Customer :

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	07/May/2020
Manufacturer:	Speag		
Type/Model Number:	D835V2		
Serial Number:	4d117		
Calibration Date:	29/May/2020		
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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CERTIFICATE
NUMBER :
13252593JD01B

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. **DASY5 System Handbook**

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
PRE0178314	Probe	SPEAG	EX3DV4	7496	24 Mar 2020	12
PRE0134199	Dipole	SPEAG	D900V2	035	11 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
M2052	Vector Network Analyser	Rhode & Schwarz	ZNB 8	106625	1 Aug 2019	12
PRE0151877	Calibration Kit	Rhode & Schwarz	ZV-Z135	102947	17 Oct 2019	12
PRE0178154	Signal Generator	HP	8648C	3537A01598	22 Jan 2020	12

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UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE
NUMBER :
13252593JD01B

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:	DASY 52 (v52.10.0.1446)
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	15 mm (with spacer)
Frequency:	835 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	835	20.4 °C	20.6 °C	19.8°C	20.0°C	ϵ_r	41.50	41.24	± 5%
						σ	0.90	0.93	± 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	2.44 W/Kg	9.71 W/Kg	± 17.57%
	SAR averaged over 10g	1.59 W/Kg	6.32 W/Kg	± 17.32%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	47.291 Ω + 0.17 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	28.76	± 2.03 dB

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CERTIFICATE
NUMBER :
13252593JD01B

Page 4 of 10

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	835	20.4 °C	20.0 °C	21.7°C	21.6°C	ϵ_r	55.20	54.18	± 5%
						σ	0.97	1.02	± 5%

SAR Results – Body Simulating Liquid (MSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	2.60 W/Kg	10.35 W/Kg	± 18.06%
	SAR averaged over 10g	1.71 W/Kg	6.80 W/Kg	± 17.44%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	46.38 Ω +5.10 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	24.85	± 2.03 dB

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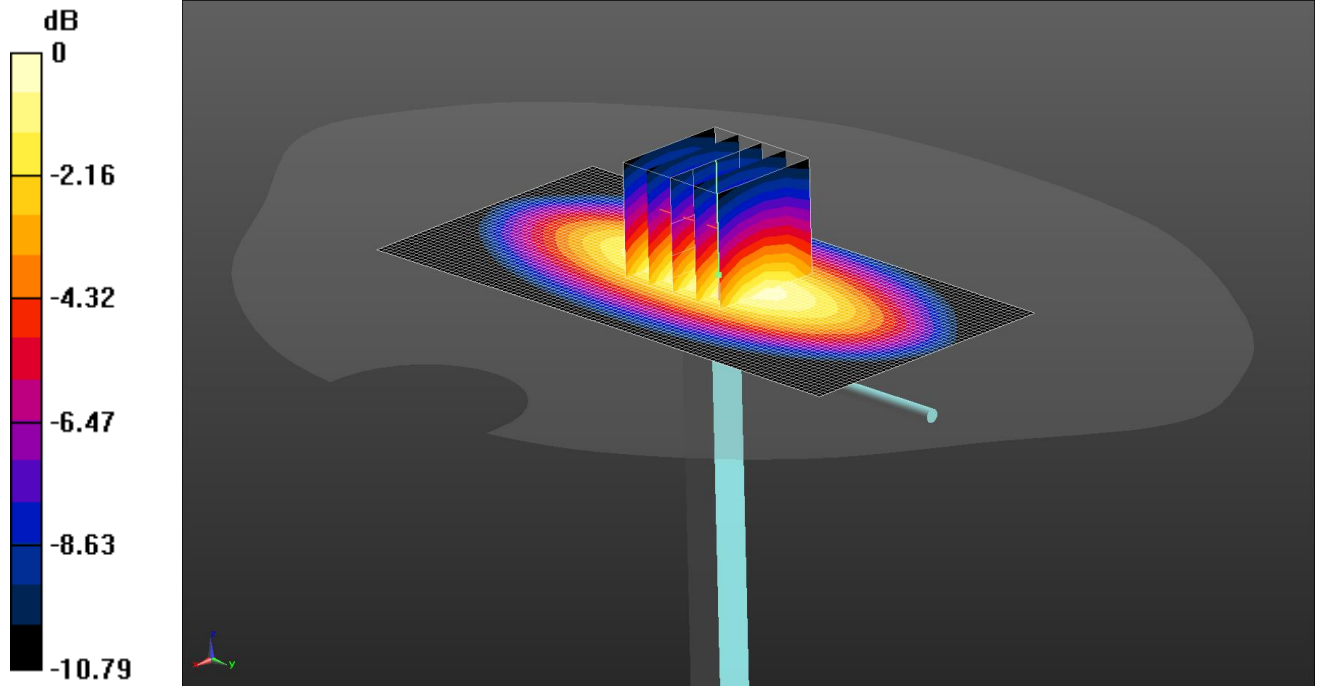
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NUMBER :
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Page 5 of 10

DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D900V2 - SN4d117; Type: D900V2; Serial: SN4d117



0 dB = 2.85 W/kg = 4.55 dBW/kg

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1;
Medium: Site65_28May2020_160250_Head - 750 835 900 5%; Medium parameters used (interpolated): $f = 835$ MHz; $\sigma = 0.927$ S/m; $\epsilon_r = 41.244$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section ;

DASY5 Configuration:

- Probe: EX3DV4 - SN7496; ConvF(9.9, 9.9, 9.9); Calibrated: 24/03/2020;
- Sensor-Surface: 3mm (Mechanical Surface Detection);
- Electronics: DAE4 Sn1542; Calibrated: 17/03/2020;
- Phantom: Twin SAM A (Site 65); Type: SAM 8.0; Serial: SN1949;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417) ;

SAR/d=10mm, Pin=50 mW 2/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 2.83 W/kg

SAR/d=10mm, Pin=50 mW 2/Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=4mm

Reference Value = 55.87 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.65 W/kg

SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.59 W/kg

Maximum value of SAR (measured) = 2.85 W/kg

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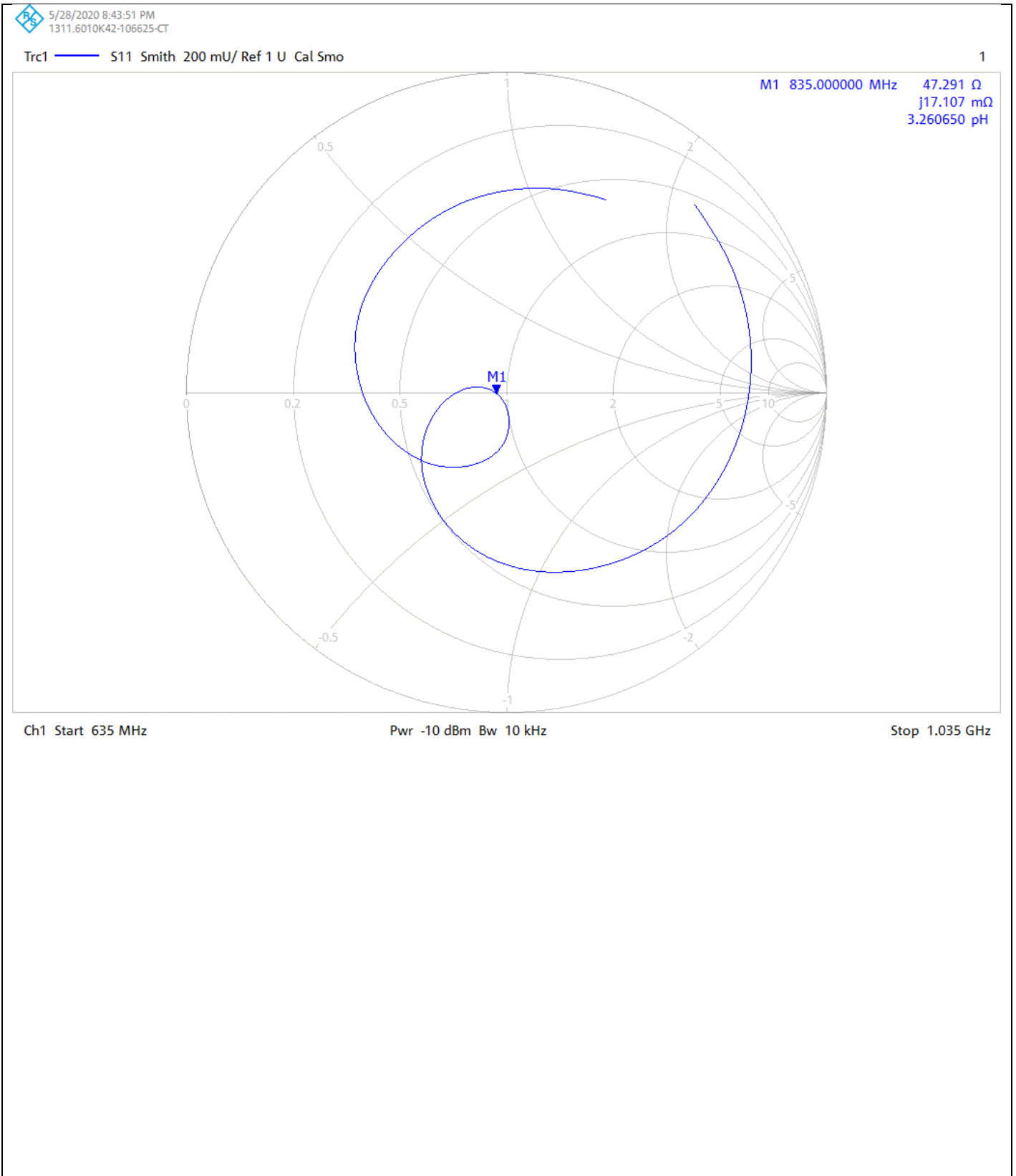
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Page 6 of 10

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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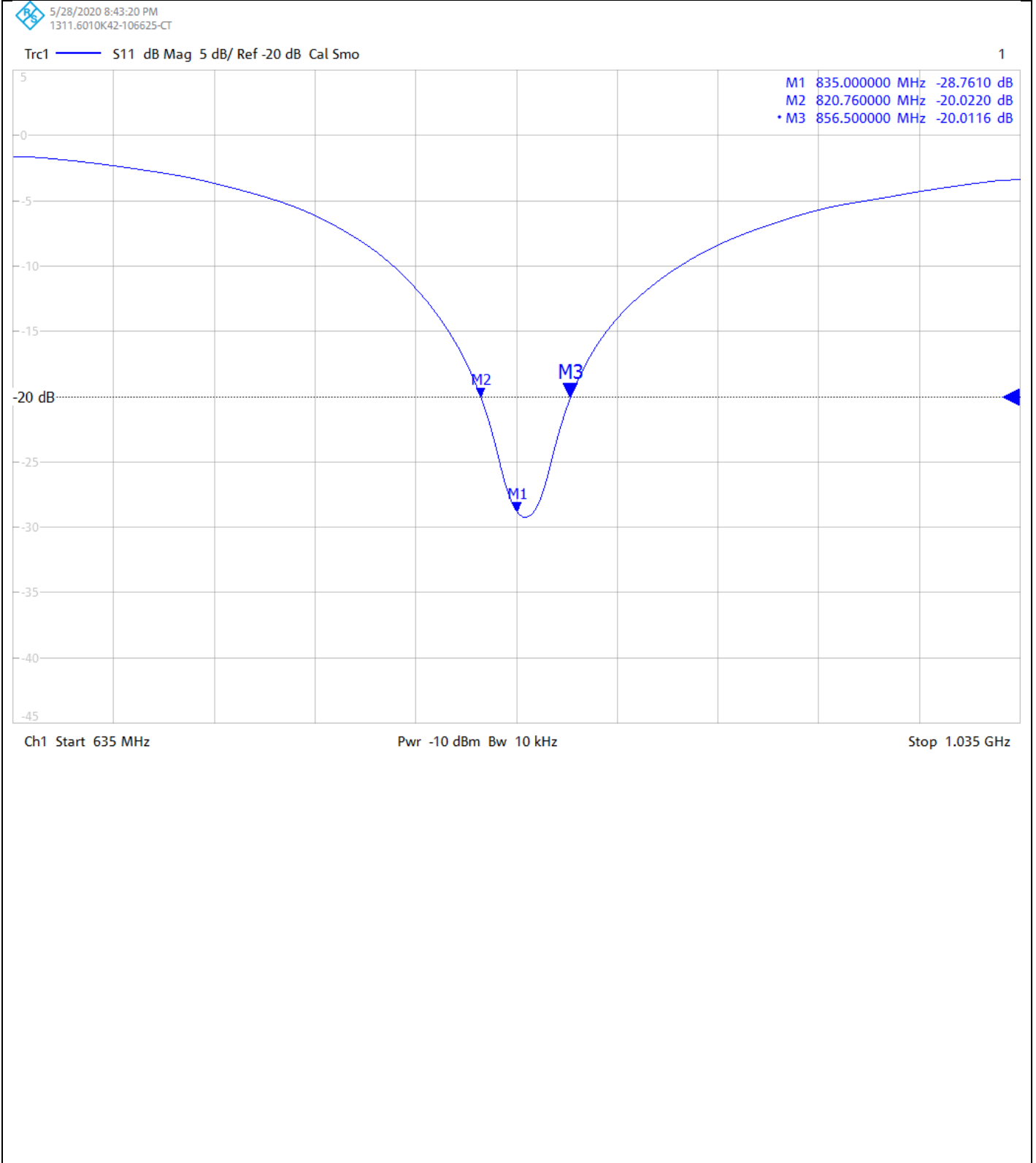
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Page 7 of 10

Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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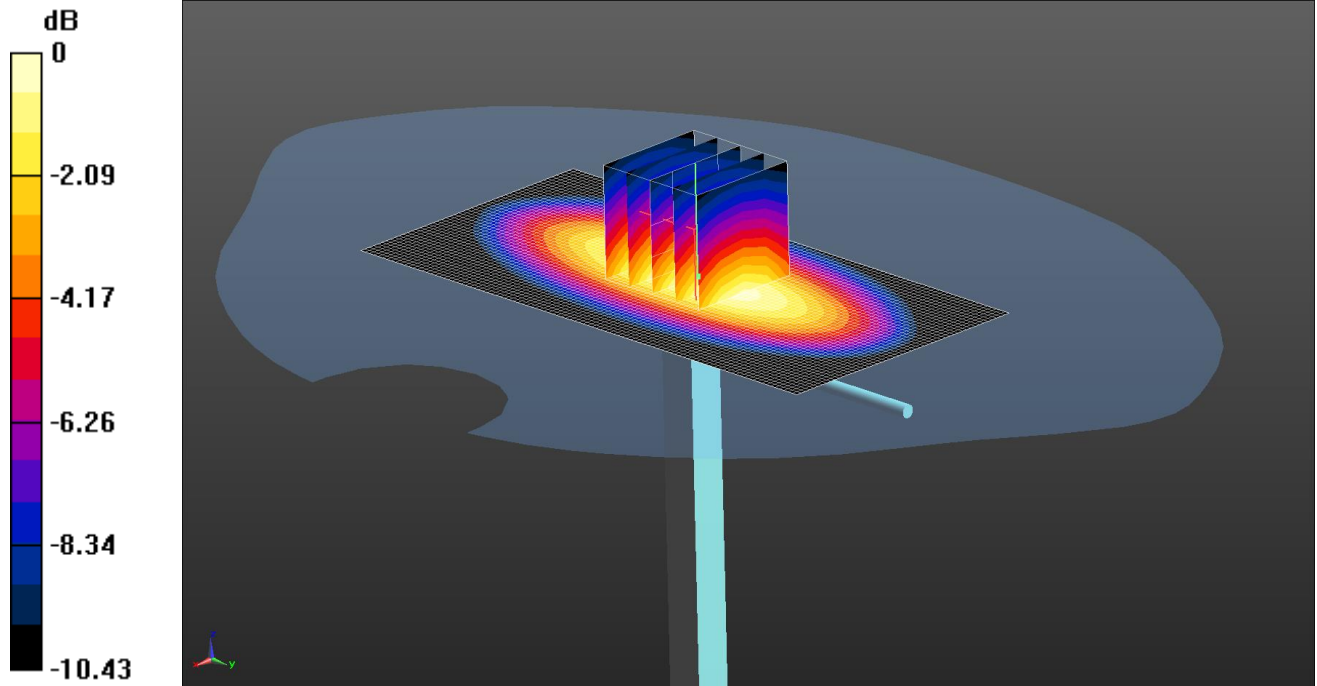
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CERTIFICATE
NUMBER :
13252593JD01B

Page 8 of 10

DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D900V2 - SN4d117; Type: D900V2; Serial: SN4d117



Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1;
Medium: Site65_28May2020_162340_Body - 750 835 900 5%; Medium parameters used (interpolated): $f = 835$ MHz; $\sigma = 1.016$ S/m; $\epsilon_r = 54.175$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section ;

DASY5 Configuration:

- Probe: EX3DV4 - SN7496; ConvF(9.81, 9.81, 9.81); Calibrated: 24/03/2020;
- Sensor-Surface: 3mm (Mechanical Surface Detection);
- Electronics: DAE4 Sn1542; Calibrated: 17/03/2020;
- Phantom: Twin SAM A (Site 65); Type: SAM 5.0; Serial: SN1818;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417) ;

SAR/d=10mm, Pin=50 mW 2/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 3.03 W/kg

SAR/d=10mm, Pin=50 mW 2/Zoom Scan (5x5x5)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=4mm

Reference Value = 54.80 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.88 W/kg

SAR(1 g) = 2.6 W/kg; SAR(10 g) = 1.71 W/kg

Maximum value of SAR (measured) = 3.04 W/kg

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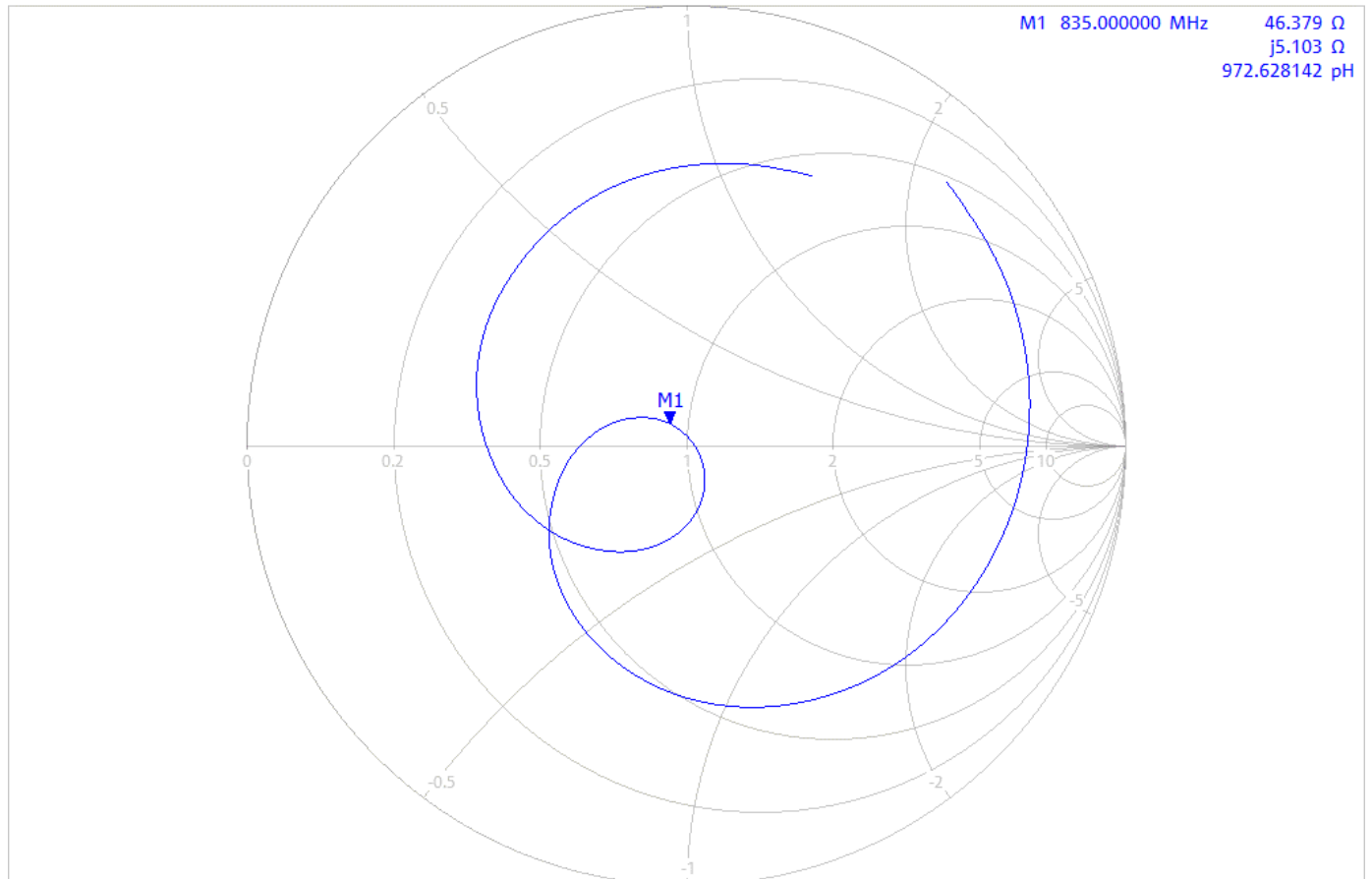
Page 9 of 10

Impedance Measurement Plot for Body Stimulating Liquid (MSL)

5/28/2020 8:41:06 PM
1311.6010K42-106625-CT

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

1



Ch1 Start 635 MHz

Pwr -10 dBm Bw 10 kHz

Stop 1.035 GHz

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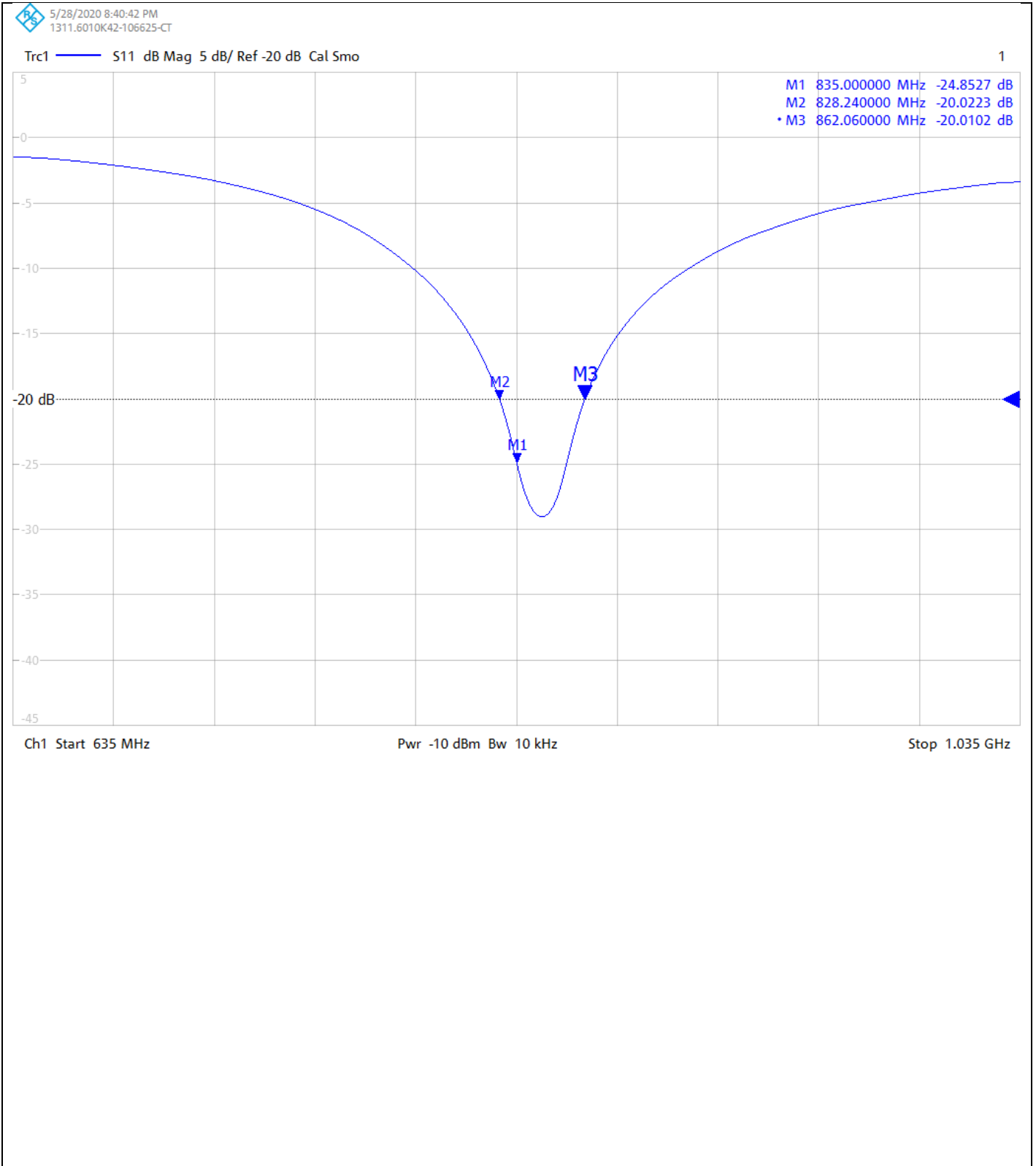
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Page 10 of 10


Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



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CERTIFICATE OF CALIBRATION

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

DATE OF ISSUE: 29/Oct/2020

CERTIFICATE NUMBER : 13252590JD01D



UL INTERNATIONAL (UK) LTD
UNIT 1-3 HORIZON
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Page 1 of 10

APPROVED SIGNATORY

A handwritten signature in black ink, appearing to read 'Harmohan Sahota', is written over a horizontal line.

.....
Harmohan Sahota

Customer :

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	15/Oct/2020
Manufacturer:	Speag		
Type/Model Number:	D1900V2		
Serial Number:	5d163		
Calibration Date:	22/Oct/2020		
Calibrated By:	Kaan Corbacioglu Laboratory Technician		

Signature:

A handwritten signature in black ink, appearing to read 'Kaan Corbacioglu', is written over a horizontal line.

.....

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

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CERTIFICATE
NUMBER :
13252590JD01D

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. **DASY5/6 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	14 Apr 2020	12
PRE0178314	Probe	SPEAG	EX3DV4	7496	24 Mar 2020	12
PRE0134198	Dipole	SPEAG	D1900V2	537	12 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	Rhode & Schwarz	SMB100A	175325	10 Jun 2020	12

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UKAS Accredited Calibration Laboratory No. 5772

CERTIFICATE
NUMBER :
13252590JD01D

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:	cDASY6.14.0.959
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	20.1 °C	20.3 °C	20.0 °C	20.0 °C	ϵ_r	40.00	39.61	± 5%
						σ	1.40	1.43	± 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	10.00 W/Kg	39.81 W/Kg	± 17.57%
	SAR averaged over 10g	5.20 W/Kg	20.70 W/Kg	± 17.32%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	49.832 Ω - 3.79j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	28.42	± 2.03 dB

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CERTIFICATE
NUMBER :
13252590JD01D

Page 4 of 10

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	1900	20.1 °C	20.3 °C	20.1 °C	20.2 °C	ϵ_r	53.30	54.78	± 5%
						σ	1.52	1.59	± 5%

SAR Results – Body Simulating Liquid (MSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	10.40 W/Kg	41.40 W/Kg	± 18.06%
	SAR averaged over 10g	5.48 W/Kg	21.82 W/Kg	± 17.44%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	53.77 Ω - 6.42j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	22.90	± 2.03 dB

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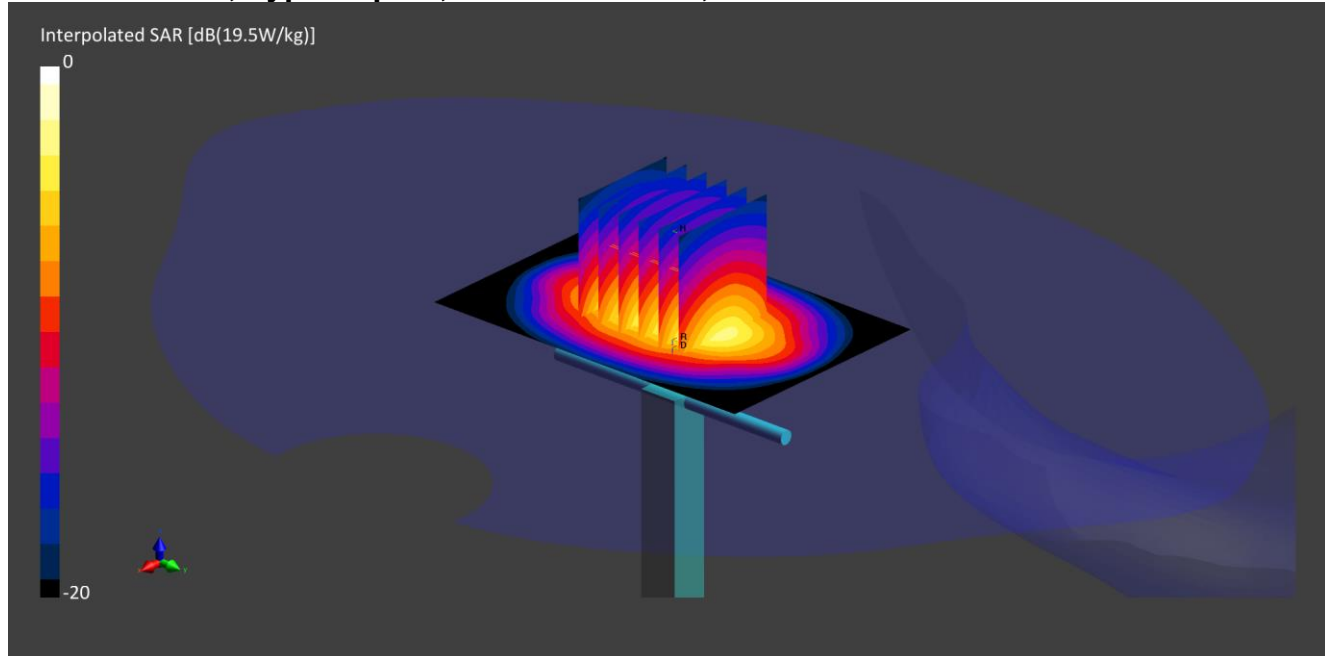
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Page 5 of 10

DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1900V2; Type: Dipole; Serial: SN5d173;



Communication System: CW UID: 0; Frequency: 1900.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_21Oct2020_085903_Head - 900 1900 2300 5%; Medium parameters
used: $f = 1900.0$ MHz; $\sigma = 1.43$ S/m; $\epsilon_r = 39.6$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -0.97$ %; $\Delta\sigma = 2.14$ %; No
correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(8.53, 8.53, 8.53); 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 (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 = 12.900 V/m; Power Drift = -0.09 dB

Minimum horizontal 3dB distance: 9.6 mm;

Vertical M2/M1 Ratio: 81.2 %;

SAR(1 g) = 10.000 W/kg; SAR(10 g) = 5.200 W/kg

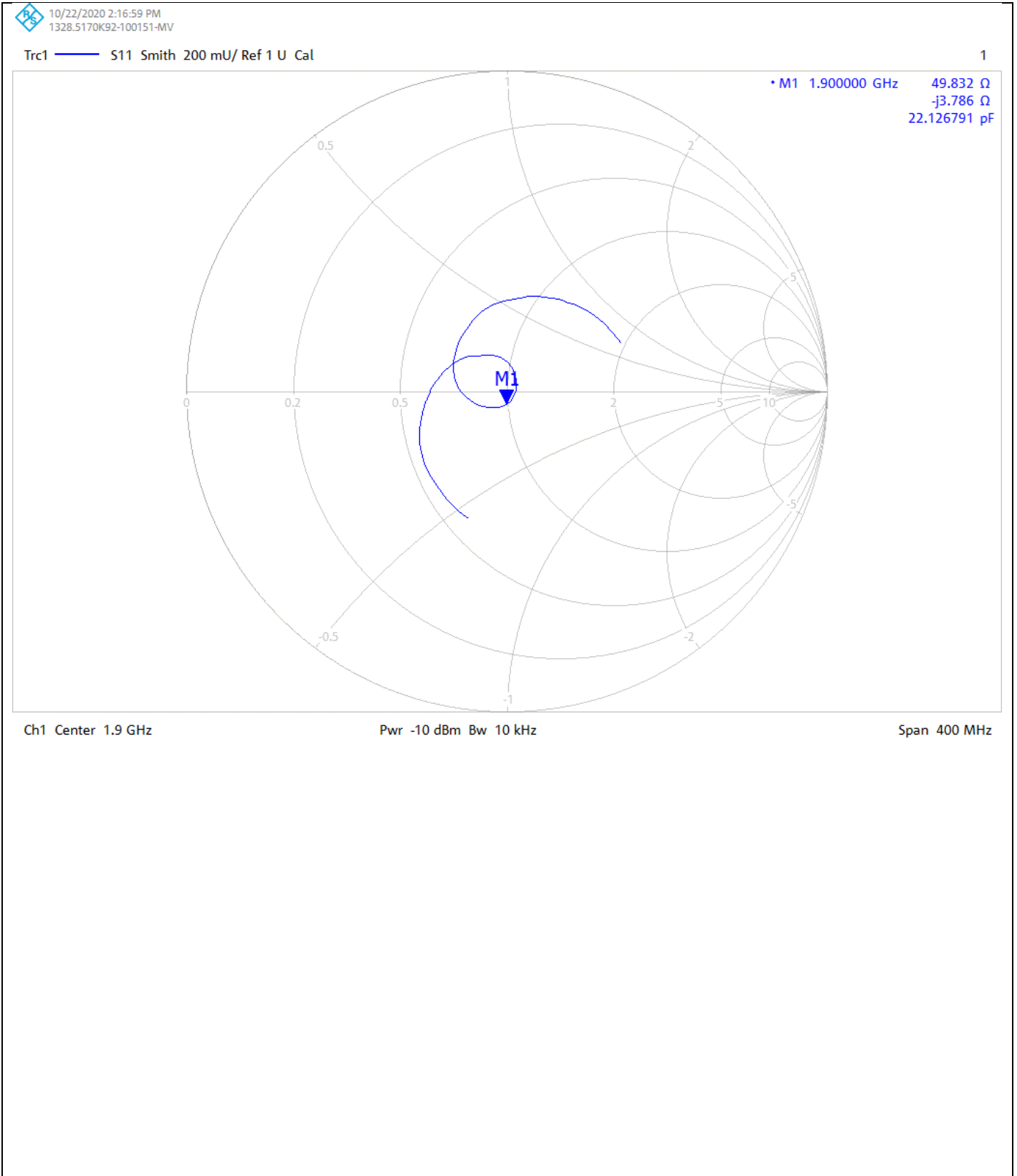
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Page 6 of 10

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



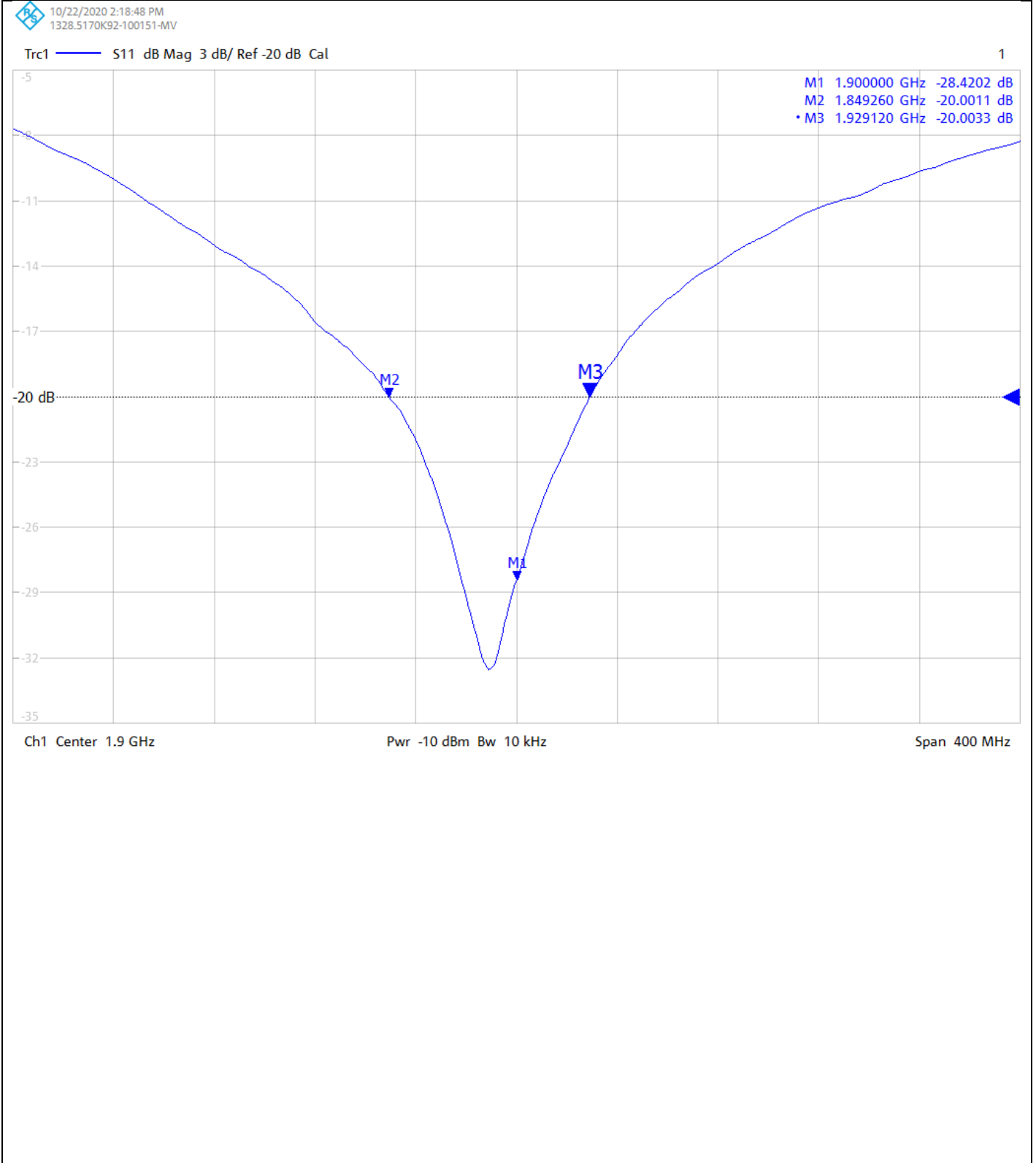
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Page 7 of 10

Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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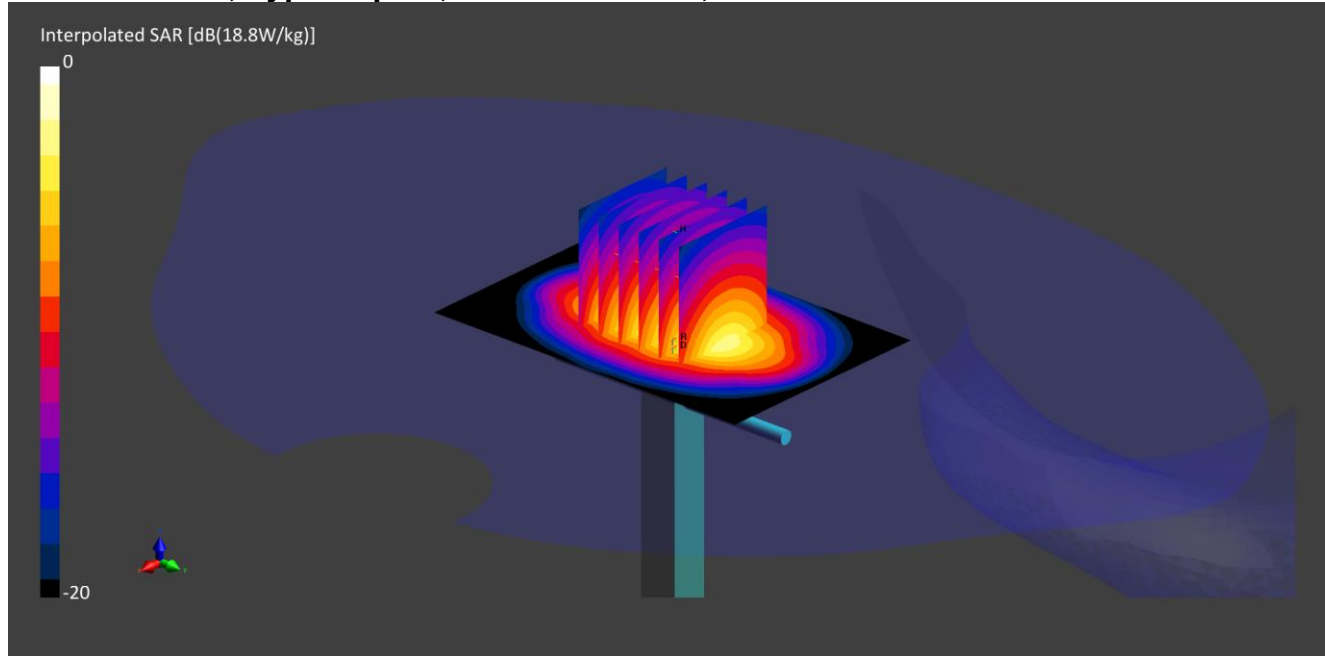
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CERTIFICATE
NUMBER :
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Page 8 of 10

DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D1900V2; Type: Dipole; Serial: SN5d173;



Communication System: CW UID: 0; Frequency: 1900.0 MHz; Duty Cycle: 1;
Medium: MSL; Site65_21Oct2020_162814_Body - 1900 5%; Medium parameters used: $f = 1900.0$ MHz; $\sigma = 1.59$ S/m; $\epsilon_r = 54.8$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 2.77$ %; $\Delta\sigma = 4.38$ %; No correction
Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(8.03, 8.03, 8.03); 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 (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 = 13.030 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 9.6 mm;

Vertical M2/M1 Ratio: 84.7 %;

SAR(1 g) = 10.400 W/kg; SAR(10 g) = 5.480 W/kg

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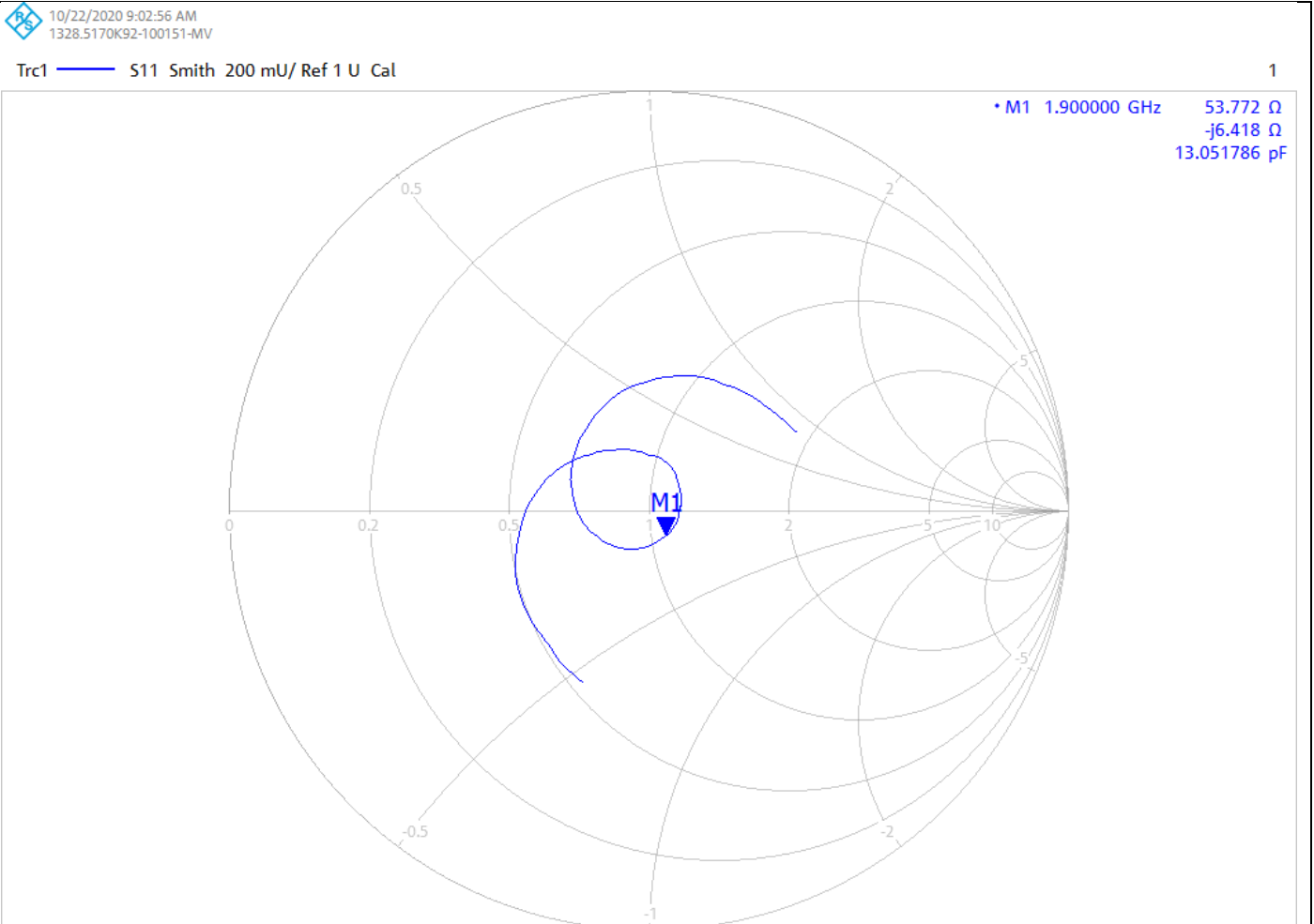
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Page 9 of 10

Impedance Measurement Plot for Body Stimulating Liquid (MSL)



Ch1 Center 1.9 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

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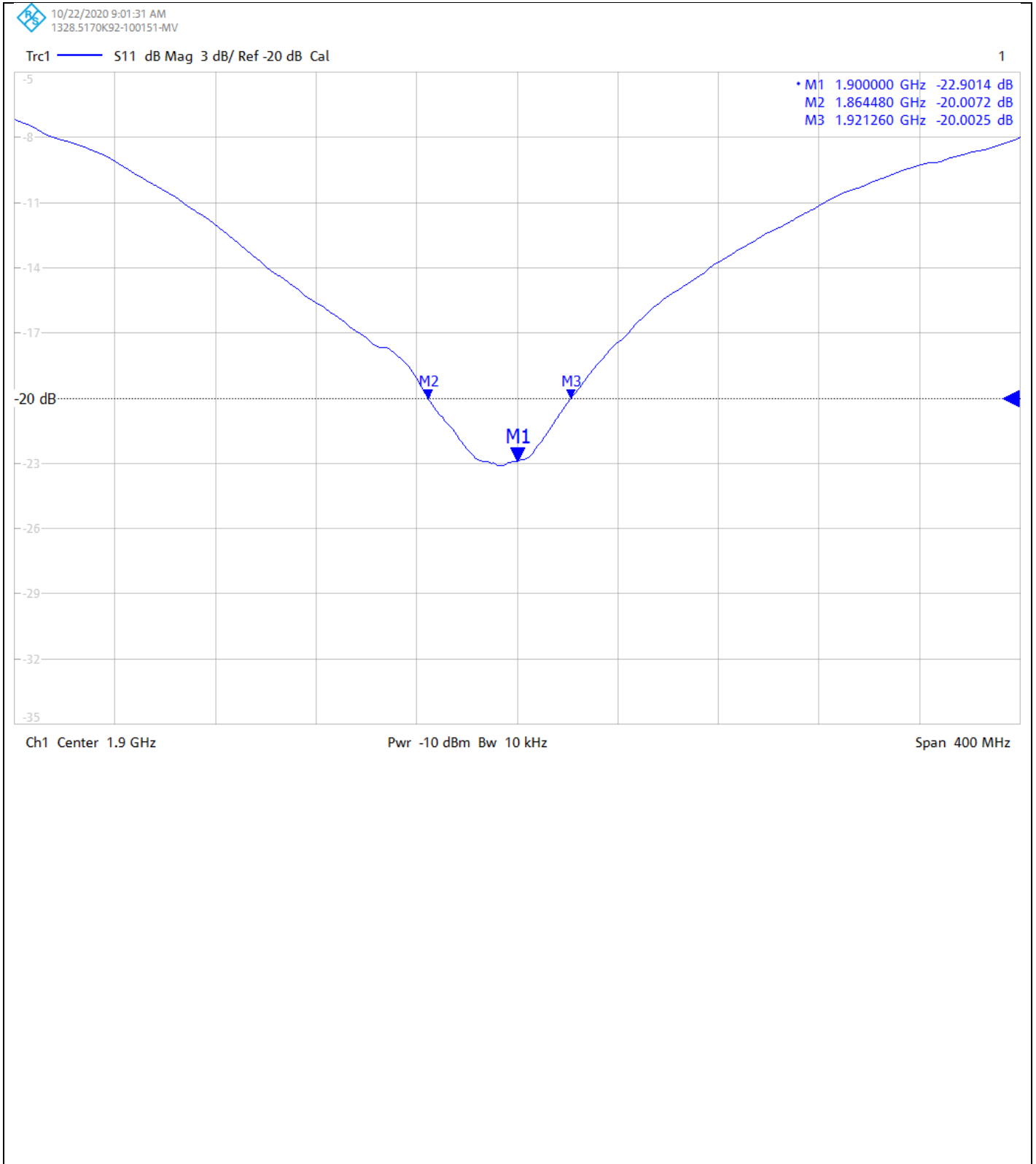
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Page 10 of 10


Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



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	<p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252590JD01D</p> <p>Instrument ID: 5d163</p> <p>Calibration Date: 22/Oct/2020</p> <p>Calibration Due Date:</p>
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ISSUED BY **UL VS LTD**

DATE OF ISSUE: 20/Apr/2020

CERTIFICATE NUMBER : 13252595JD01C



5248

UL VS LTD
UNIT 1-3 HORIZON
KINGSLAND PARK, WADE ROAD
BASINGSTOKE, HAMPSHIRE
RG24 8AH, UK
TEL: +44 (0) 1256 312000
FAX: +44 (0) 1256 312001
Email: LST.UK.Calibration@ul.com



Page 1 of 10

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:	14/Apr/2020
Manufacturer:	Speag		
Type/Model Number:	D2450V2		
Serial Number:	899		
Calibration Date:	17/Apr/2020		
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.

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NUMBER :
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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. **SPEAG DASY5 System Handbook**

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
PRE0178314	Probe	SPEAG	EX3DV4	7496	24 Mar 2020	12
PRE0134944	Dipole	SPEAG	D2440V2	701	14 Feb 2020	12
PRE0131118	Power Sensor	Rhode & Schwarz	NRV-Z1	826515/015	27 Jan 2020	12
PRE0134023	Power Sensor	Rhode & Schwarz	NRV-Z1	860462/016	27 Jan 2020	12
PRE0151154	Vector Network Analyser	Rhode & Schwarz	ZND	100151	30 Jan 2020	12
PRE0151877	Calibration Kit	Rhode & Schwarz	ZV-Z135	102947	17 Oct 2019	12
PRE0178154	Signal Generator	Rhode & Schwarz	SMIQ 03B	1125.555.03	23 Jan 2020	12

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CERTIFICATE
NUMBER :
13252595JD01C

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:	DASY 52 (v52.8.8.1258)
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	20.5 °C	21.0 °C	20.9°C	21.1°C	ϵ_r	39.20	40.15	± 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	13.00 W/Kg	51.75 W/Kg	± 17.57%
	SAR averaged over 10g	6.06 W/Kg	24.12 W/Kg	± 17.32%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	43.662 Ω 1.47 $j\Omega$	± 0.28 Ω ± 0.044 $j\Omega$
	Return Loss	-23.19	± dB

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Page 4 of 10

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	2450	21.5 °C	21.1 °C	21.0°C	21.0°C	εr	52.70	52.22	± 5%
						σ	1.95	1.99	± 5%

SAR Results – Body Simulating Liquid (MSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	13.00 W/Kg	51.75 W/Kg	± 18.06%
	SAR averaged over 10g	6.03 W/Kg	24.00 W/Kg	± 17.44%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	43.82 Ω -0.368 jΩ	± 0.28 Ω ± 0.044 jΩ
	Return Loss	-23.63	± 2.03 dB

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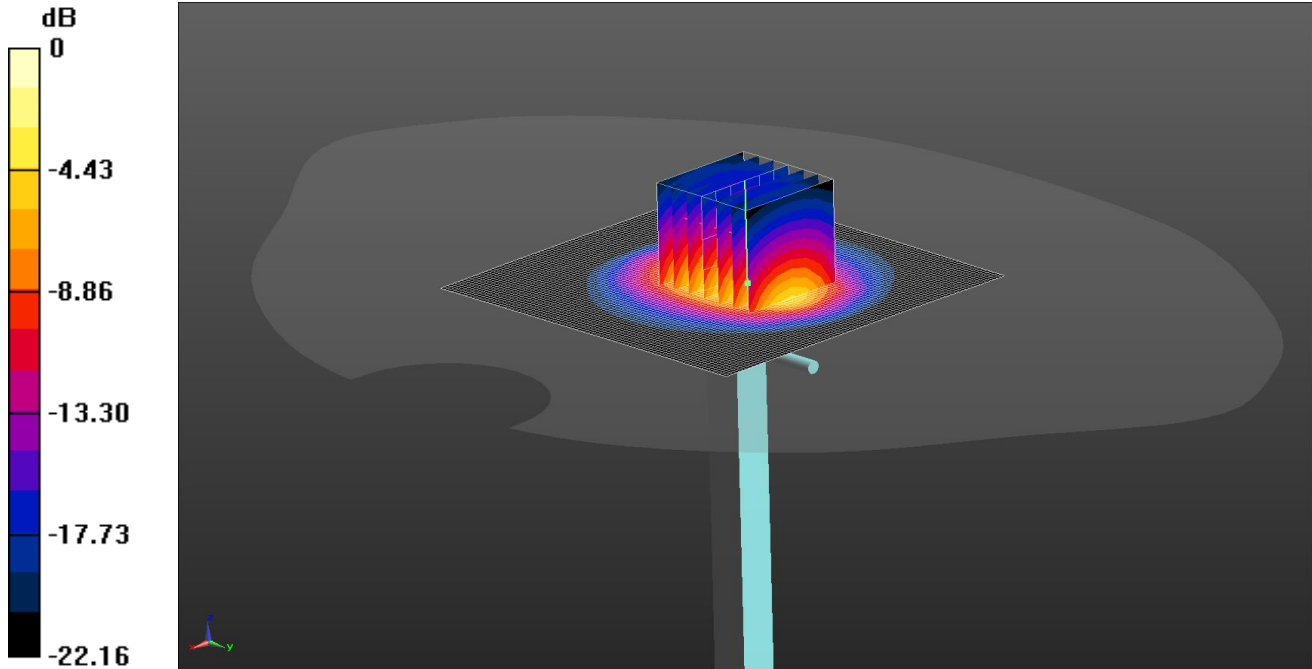
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Page 5 of 10

DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D2450V2 - SN899; Type: D2450V2; Serial: SN899



0 dB = 21.6 W/kg = 13.34 dBW/kg

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1;
Medium: Site65_14Apr2020_180909_Head - 750 2300 2450 2600; Medium parameters used: $f = 2450$ MHz; $\sigma = 1.818$ S/m; $\epsilon_r = 40.149$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section ;

DASY5 Configuration:

- Probe: EX3DV4 - SN7496; ConvF(7.78, 7.78, 7.78); Calibrated: 24/03/2020;
- Sensor-Surface: 3mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection);
- Electronics: DAE4 Sn1542; Calibrated: 17/03/2020;
- Phantom: Twin-SAM B (Site 65); Type: QD 000 P40 CC; Serial: 1945;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417) ;

Configuration/d=10mm, Pin=250mW 2/Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 17.7 W/kg

Configuration/d=10mm, Pin=250mW 2/Zoom Scan (7x7x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=4mm

Reference Value = 89.18 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 26.8 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 6.06 W/kg

Maximum value of SAR (measured) = 21.6 W/kg

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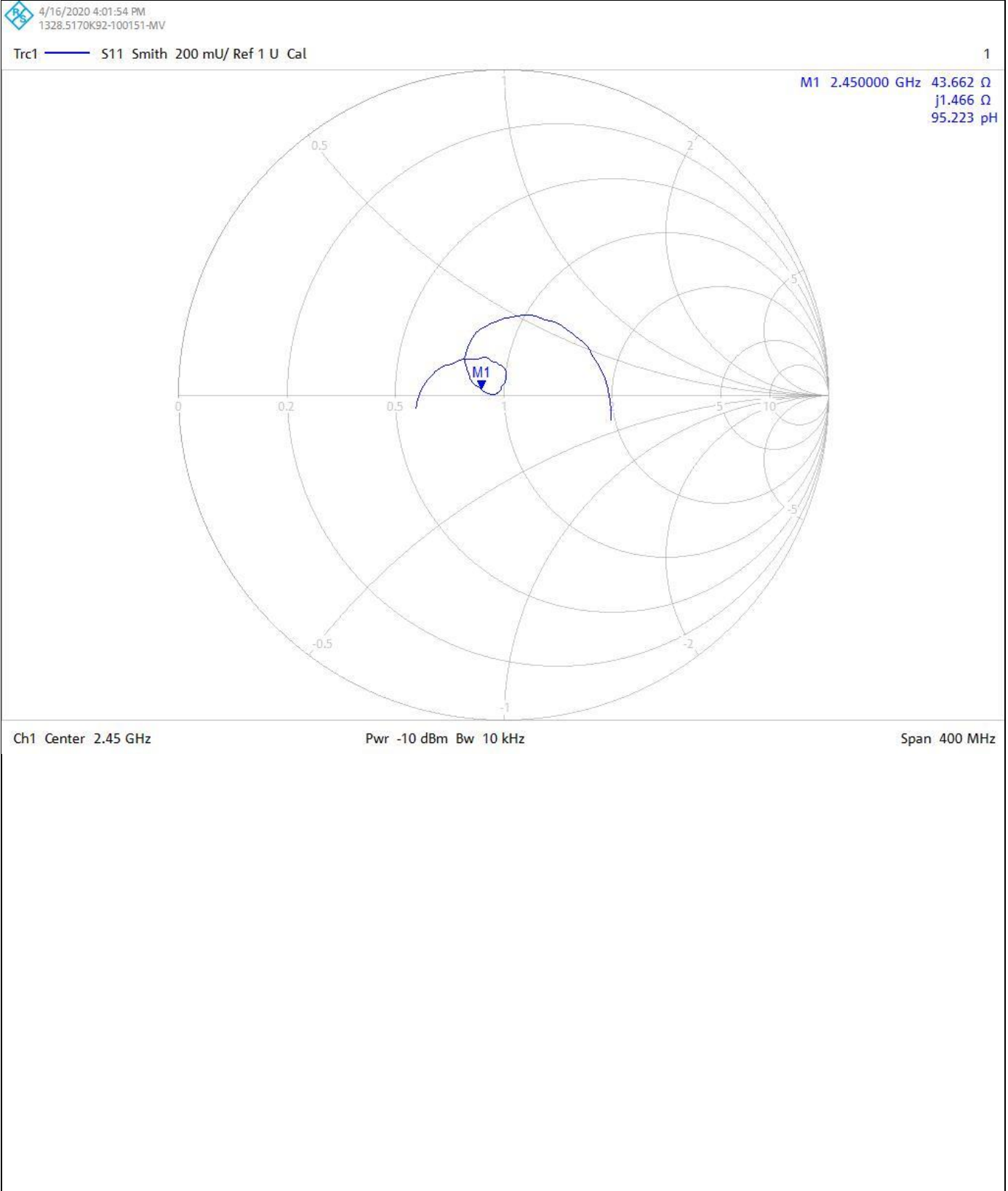
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Page 6 of 10

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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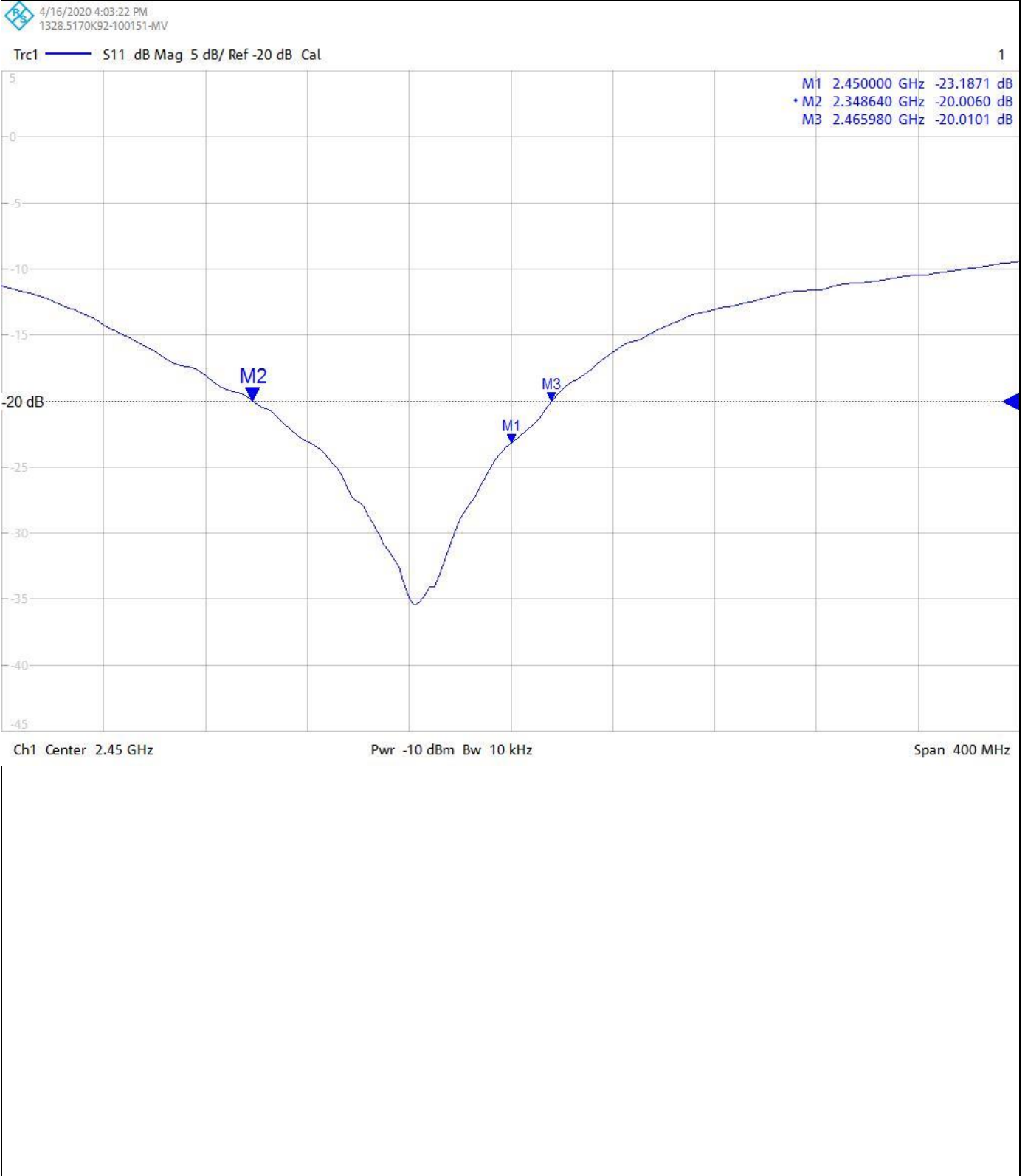
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Page 7 of 10

Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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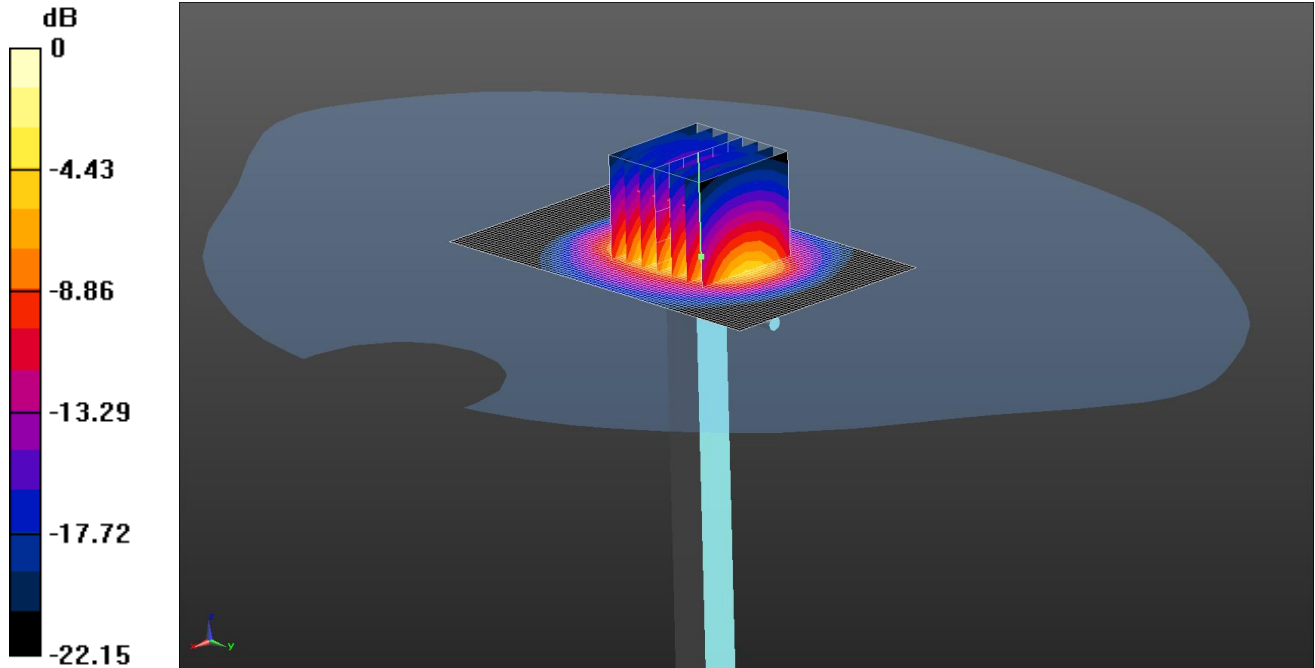
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Page 8 of 10

DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D2440V2 - SN899; Type: D2440V2; Serial: SN899



0 dB = 21.5 W/kg = 13.32 dBW/kg

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1;

Medium: Site65_15Apr2020_140023_Body - 750 2300 2450 2600 5%; Medium parameters used: $f = 2450$ MHz; $\sigma = 1.993$ S/m; $\epsilon_r = 52.221$; $\rho = 1000$ kg/m³ ;

Phantom section: Flat Section ;

DASY5 Configuration:

- Probe: EX3DV4 - SN7496; ConvF(7.75, 7.75, 7.75); Calibrated: 24/03/2020;

- Sensor-Surface: 3mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection);

- Electronics: DAE4 Sn1542; Calibrated: 17/03/2020;

- Phantom: Twin SAM A (Site 65); Type: SAM 5.0; Serial: SN1818;

- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417) ;

2450/d=10mm, Pin=250mW/Area Scan (51x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 18.4 W/kg

2450/d=10mm, Pin=250mW/Zoom Scan (7x7x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=4mm

Reference Value = 86.25 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 6.03 W/kg

Maximum value of SAR (measured) = 21.5 W/kg

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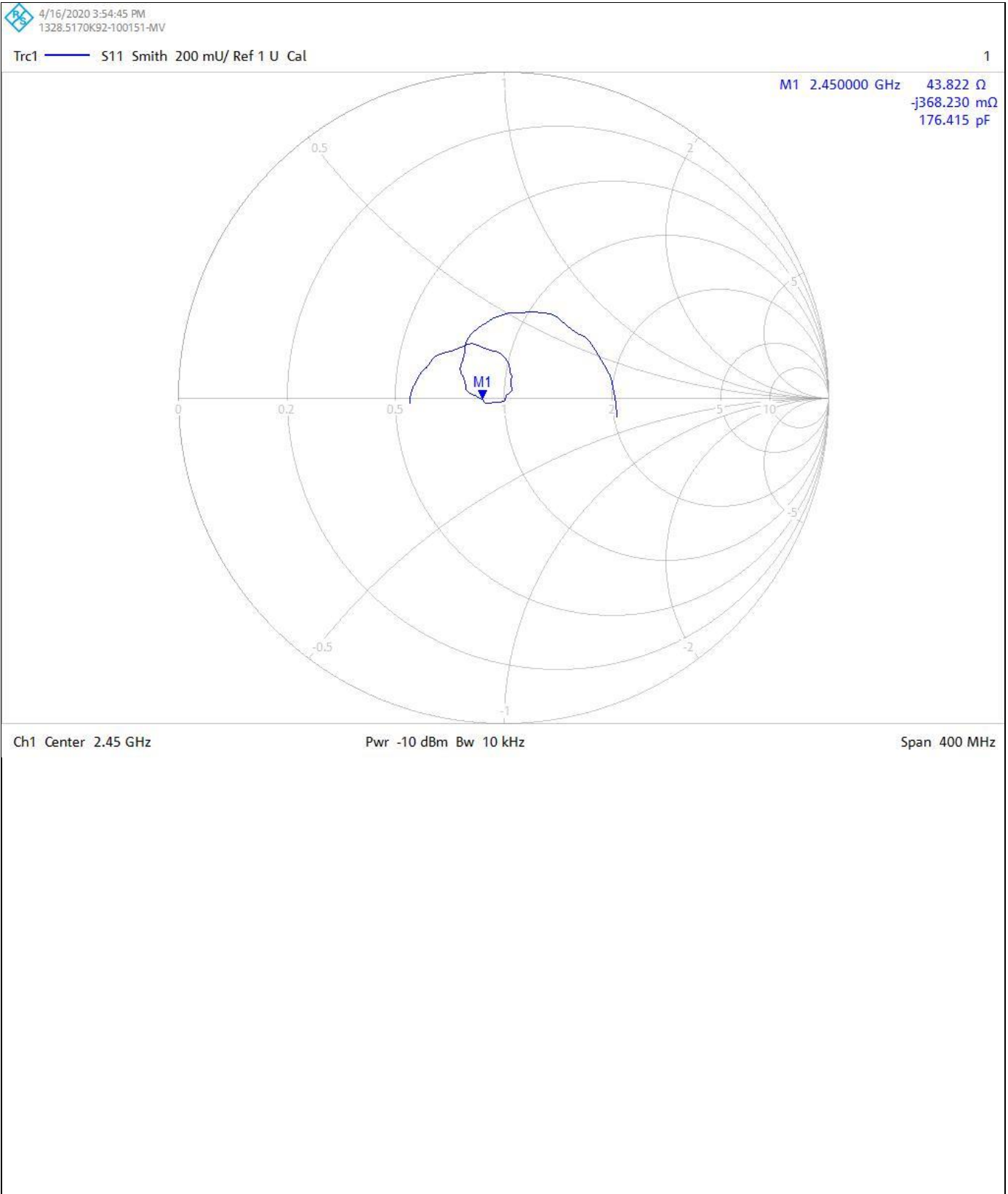
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Page 9 of 10

Impedance Measurement Plot for Body Stimulating Liquid (MSL)



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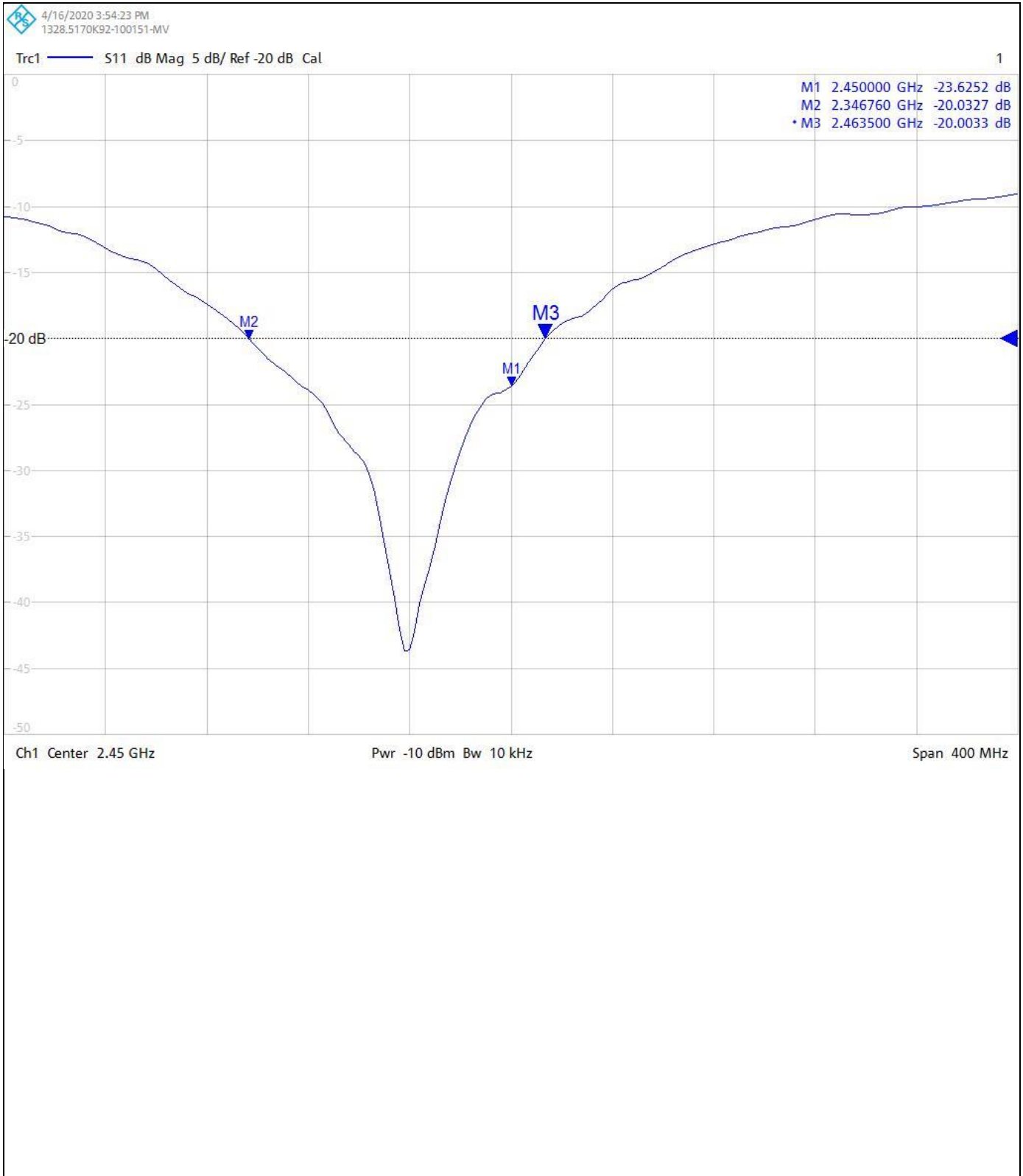
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Page 10 of 10


Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



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 <p>UKAS CALIBRATION 5248</p>	<p>UL VS LTD - Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252595JD01C</p> <p>Instrument ID: 899</p> <p>Calibration Date: 17/Apr/2020</p> <p>Calibration Due Date:</p>
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 <p>UKAS CALIBRATION 5248</p>	<p>UL VS LTD - Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252595JD01C</p> <p>Instrument ID: 899</p> <p>Calibration Date: 17/Apr/2020</p> <p>Calibration Due Date:</p>
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DATE OF ISSUE: 17/Apr/2020

CERTIFICATE NUMBER : 13252595JD01D



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UL VS LTD
UNIT 1-3 HORIZON
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FAX: +44 (0) 1256 312001
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:	14/Apr/2020
Manufacturer:	Speag		
Type/Model Number:	D2600V2		
Serial Number:	1036		
Calibration Date:	17/Apr/2020		
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.

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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. **SPEAG DASY5 System Handbook**

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
PRE0178314	Probe	SPEAG	EX3DV4	7496	24 Mar 2020	12
PRE0135603	Dipole	SPEAG	D2600V2	1109	14 Feb 2020	12
PRE0131118	Power Sensor	Rhode & Schwarz	NRV-Z1	826515/015	27 Jan 2020	12
PRE0134023	Power Sensor	Rhode & Schwarz	NRV-Z1	860462/016	27 Jan 2020	12
PRE0151154	Vector Network Analyser	Rhode & Schwarz	ZND	100151	30 Jan 2020	12
PRE0151877	Calibration Kit	Rhode & Schwarz	ZV-Z135	102947	17 Oct 2019	12
PRE0178154	Signal Generator	Rhode & Schwarz	SMIQ 03B	1125.555.03	23 Jan 2020	12

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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:	DASY 52 (v52.10.0.1446)
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (with spacer)
Frequency:	2600 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	2600	20.5 °C	21.0 °C	20.9°C	21.1°C	ϵ_r	39.00	39.88	± 5%
						σ	1.96	1.93	± 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	14.20 W/Kg	56.53 W/Kg	± 17.57%
	SAR averaged over 10g	6.34 W/Kg	25.23 W/Kg	± 17.32%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	51.234 Ω ± -4.85 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	-26.09	± 2.03 dB

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Page 4 of 10

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	2600	21.5 °C	21.0 °C	21.0°C	21.1°C	ϵ_r	52.50	52.07	± 5%
						σ	2.16	2.12	± 5%

SAR Results – Body Simulating Liquid (MSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	14.30 W/Kg	56.92 W/Kg	± 18.06%
	SAR averaged over 10g	6.33 W/Kg	25.20 W/Kg	± 17.44%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	47.60 Ω ± 4.39 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	-25.81	± 2.03 dB

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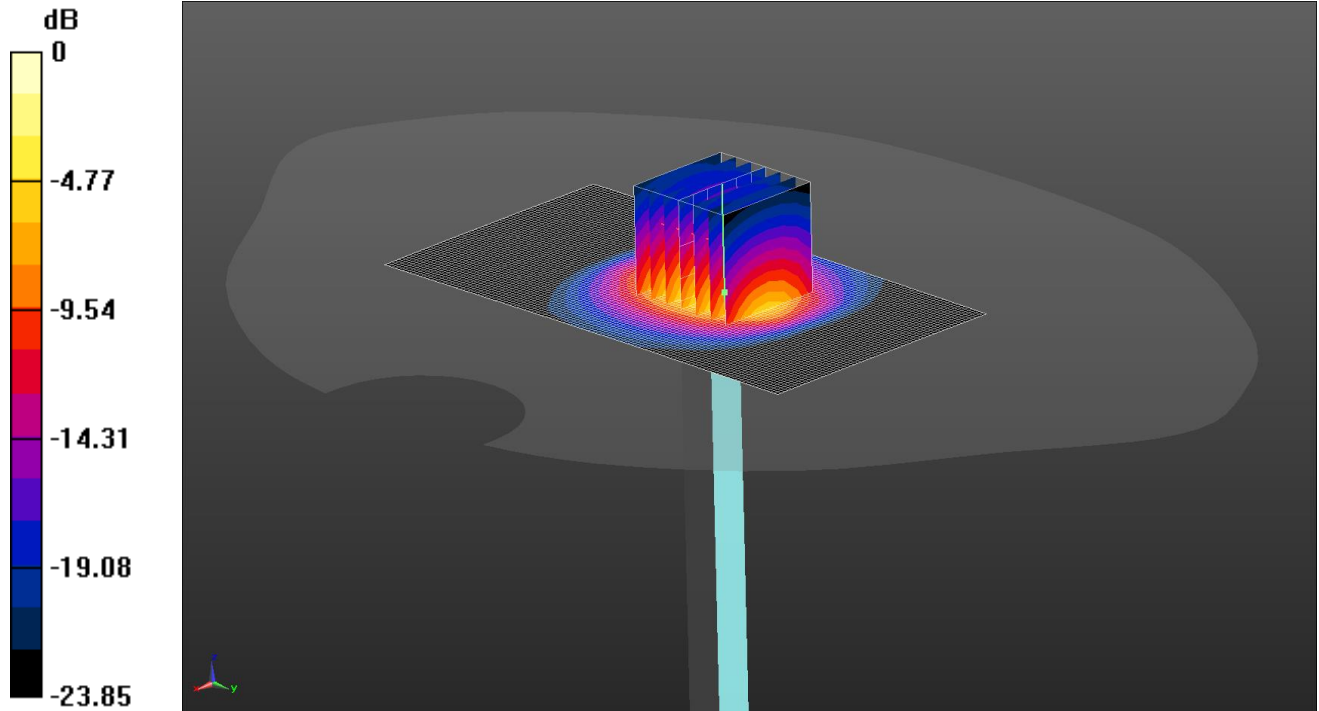
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13252595JD01D

Page 5 of 10

DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D2600V2 - SN1036; Type: D2600V2; Serial: SN1036



0 dB = 24.5 W/kg = 13.89 dBW/kg

Communication System: UID 0, CW (0); Frequency: 2600 MHz; Duty Cycle: 1:1;
Medium: Site65_14Apr2020_180909_Head - 750 2300 2450 2600; Medium parameters used: $f = 2600$ MHz; $\sigma = 1.935$ S/m; $\epsilon_r = 39.884$; $\rho = 1000$ kg/m³;

Phantom section: Flat Section ;

DASY5 Configuration:

- Probe: EX3DV4 - SN7496; ConvF(7.6, 7.6, 7.6); Calibrated: 24/03/2020;
- Sensor-Surface: 3mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection);
- Electronics: DAE4 Sn1542; Calibrated: 17/03/2020;
- Phantom: Twin-SAM B (Site 65); Type: QD 000 P40 CC; Serial: 1945;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417) ;

2600/d=10mm, Pin=250 mW 2/Area Scan (61x111x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 19.4 W/kg

2600/d=10mm, Pin=250 mW 2/Zoom Scan (7x7x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=4mm

Reference Value = 87.99 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 31.2 W/kg

SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.34 W/kg

Maximum value of SAR (measured) = 24.5 W/kg

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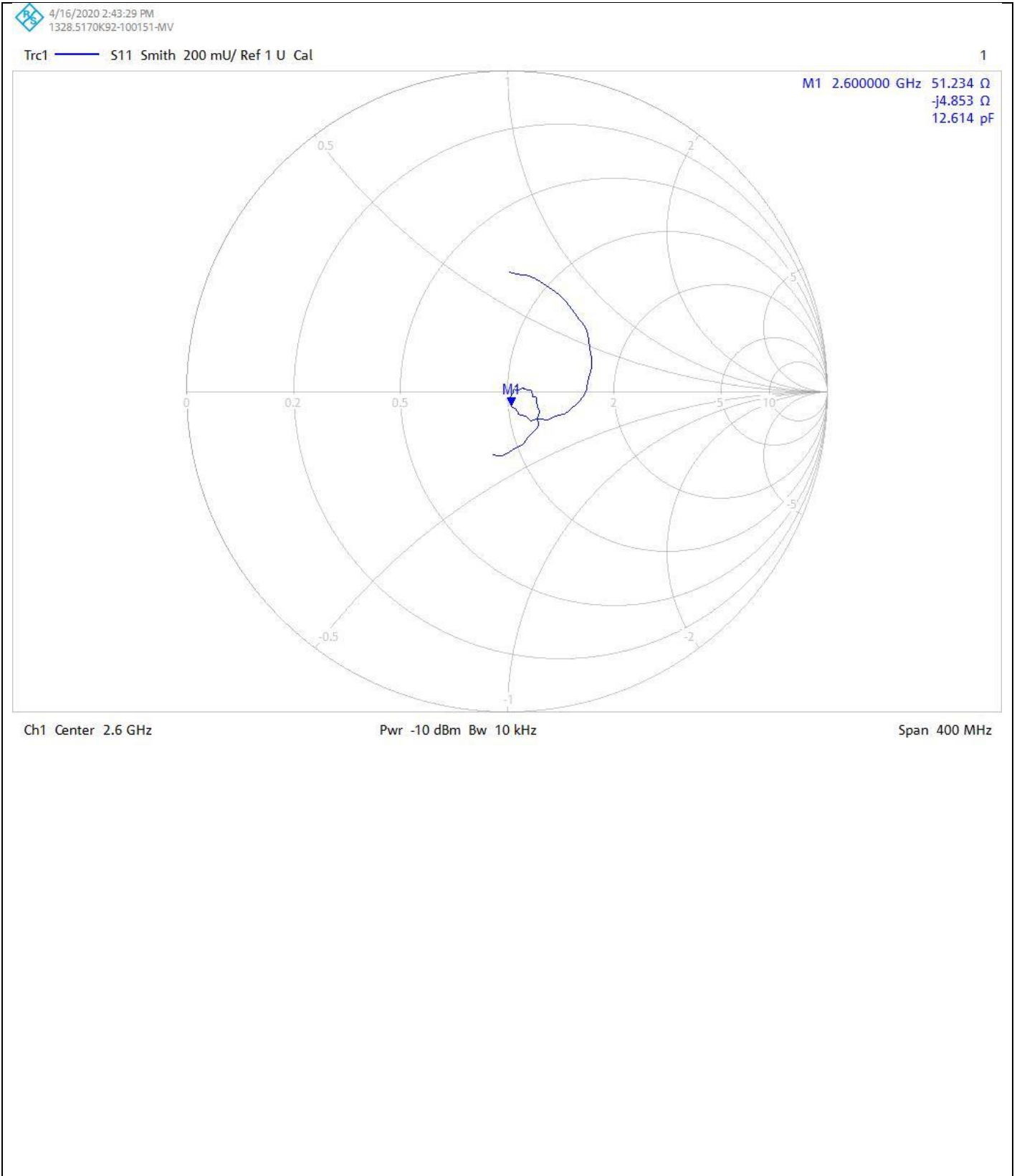
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Page 6 of 10

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



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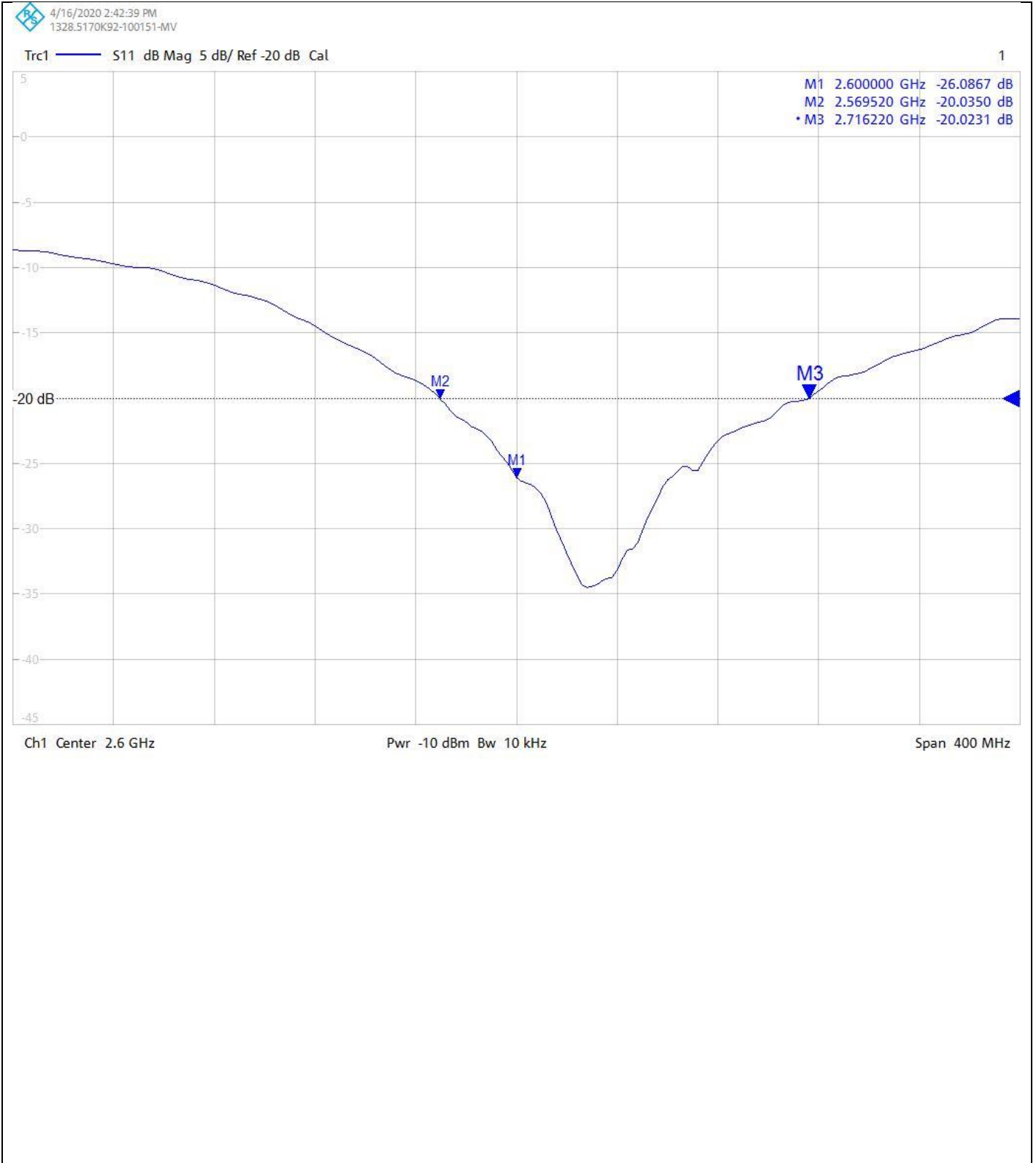
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Page 7 of 10

Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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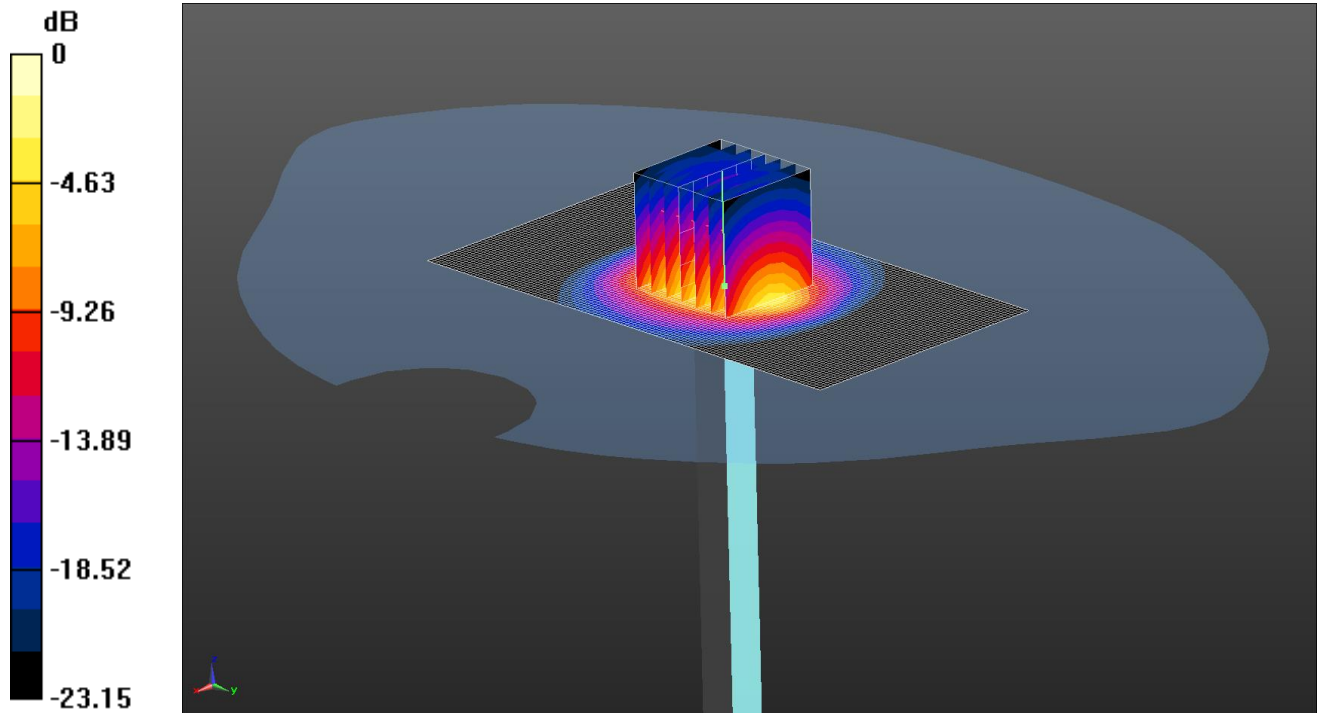
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Page 8 of 10

DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D2600V2 - SN1036; Type: D2600V2; Serial: SN1036



0 dB = 24.6 W/kg = 13.91 dBW/kg

Communication System: UID 0, CW (0); Frequency: 2600 MHz; Duty Cycle: 1:1;
Medium: Site65_15Apr2020_140023_Body - 750 2300 2450 2600 5%; Medium parameters used: $f = 2600$ MHz; $\sigma = 2.125$ S/m; $\epsilon_r = 52.07$; $\rho = 1000$ kg/m³;

Phantom section: Flat Section ;

DASY5 Configuration:

- Probe: EX3DV4 - SN7496; ConvF(7.58, 7.58, 7.58); Calibrated: 24/03/2020;

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

- Electronics: DAE4 Sn1542; Calibrated: 17/03/2020;

- Phantom: Twin SAM A (Site 65); Type: SAM 5.0; Serial: SN1818;

- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417) ;

2600/d=10mm, Pin=250 mW 2/Area Scan (61x111x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 26.1 W/kg

2600/d=10mm, Pin=250 mW 2/Zoom Scan (7x7x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=4mm

Reference Value = 111.4 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 14.3 W/kg; SAR(10 g) = 6.33 W/kg

Maximum value of SAR (measured) = 24.6 W/kg

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Page 9 of 10

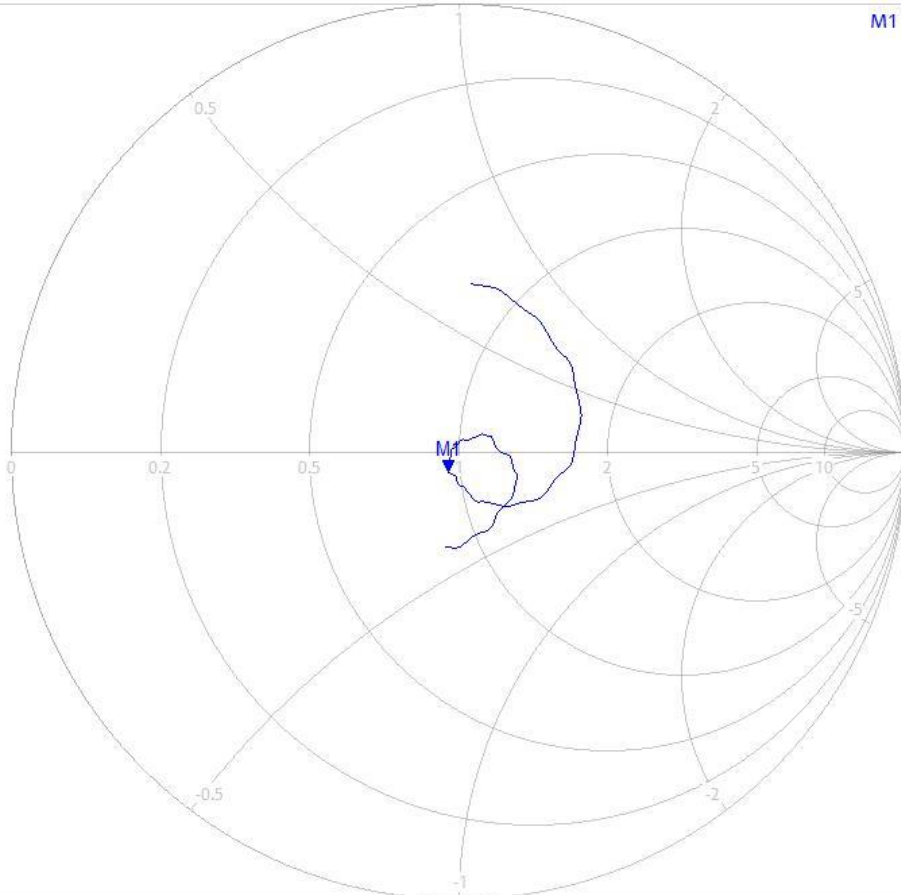
Impedance Measurement Plot for Body Stimulating Liquid (MSL)

4/16/2020 2:53:40 PM
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

M1 2.600000 GHz 47.603 Ω
-j4.392 Ω
13.938 pF



Ch1 Center 2.6 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

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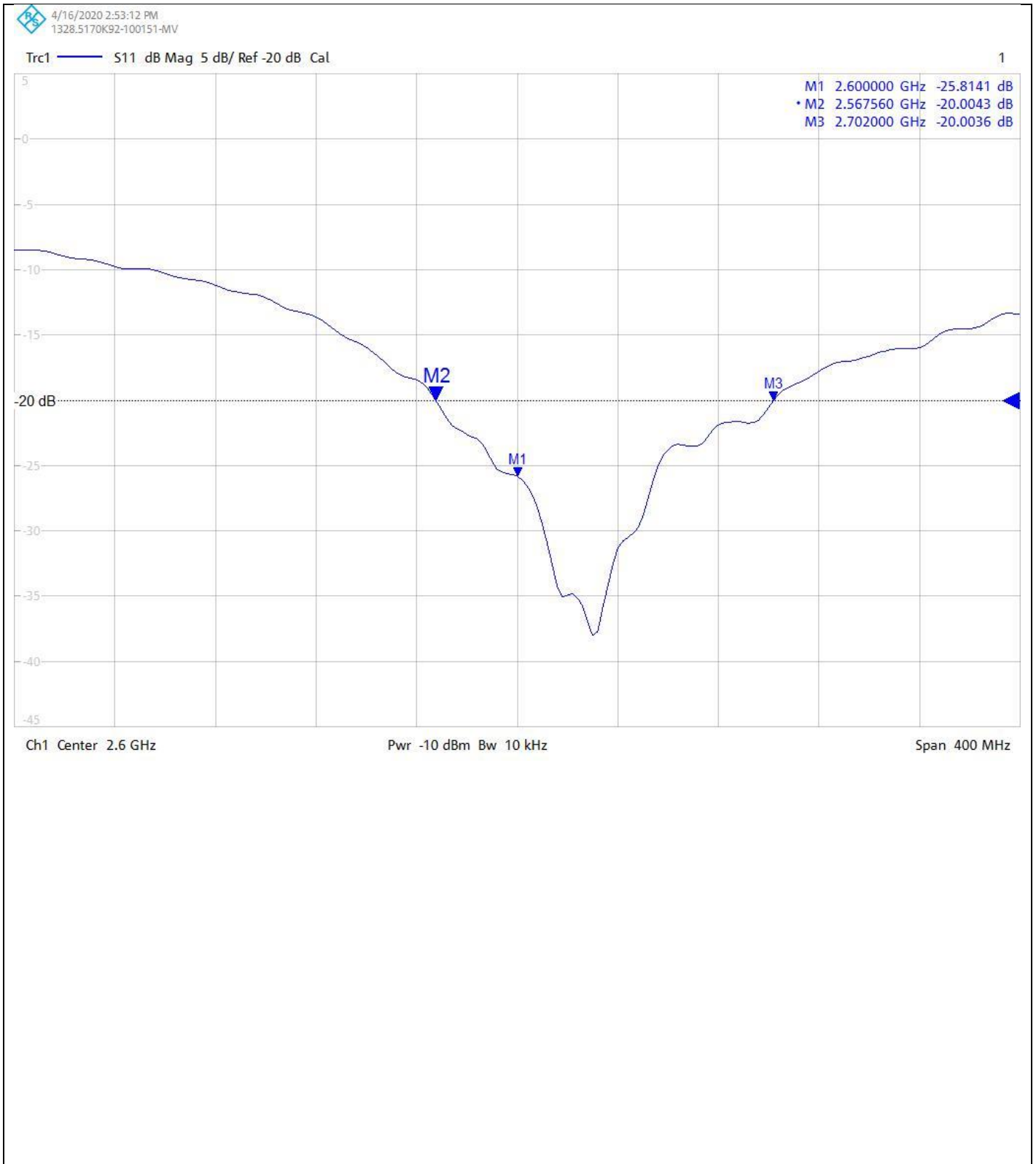
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Page 10 of 10


Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



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 <p>UKAS CALIBRATION 5248</p>	<p>UL VS LTD - Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252595JD01D</p> <p>Instrument ID: 1036</p> <p>Calibration Date: 17/Apr/2020</p> <p>Calibration Due Date:</p>
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 <p>UKAS CALIBRATION 5248</p>	<p>UL VS LTD - Tel: +44 (0) 1256312000</p> <p>Certificate Number: 13252595JD01D</p> <p>Instrument ID: 1036</p> <p>Calibration Date: 17/Apr/2020</p> <p>Calibration Due Date:</p>
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