

CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 16/Oct/2018

CERTIFICATE NUMBER : 12134285JD01A



5248

UL VS LTD
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APPROVED SIGNATORY

.....
Naseer Mirza

Customer :

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	08/Oct/2018
Manufacturer:	Speag		
Type/Model Number:	D900V2		
Serial Number:	1d143		
Calibration Date:	16/Oct/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		
Signature:			

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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. **SPEAG DASY4/ 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)
PRE0178318	Data Acquisition Electronics	SPEAG	DAE4	1543	08 Mar 2018	12
PRE0178315	Probe	SPEAG	ES3DV3	3360	17 Aug 2018	12
A2201	Dipole	SPEAG	D900V2	035	07 Feb 2018	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	12
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	05 Feb 2018	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	14 Dec 2017	12
PRE0151877	Calibration Kit	Rhode & Schwarz	ZV-Z135	102947-Bt	27 Apr 2018	12
PRE0178154	Signal Generator	Rhode & Schwarz	SMB 100A	175325	09 Apr 2018	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:	DASY 52 (v52.8.8.1258)
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	22.2 °C	22.5 °C	22.0°C	22.0°C	ϵ_r	41.50	41.28	± 5%
						σ	0.97	0.99	± 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	2.82 W/Kg	11.22 W/Kg	± 17.57%
	SAR averaged over 10g	1.80 W/Kg	7.16 W/Kg	± 17.32%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	47.832 Ω -1.93 $j\Omega$	± 0.28 Ω ± 0.044 $j\Omega$
	Return Loss	30.53	± 2.03 dB

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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	900	20.0 °C	21.5 °C	19.9°C	20.1°C	ϵ_r	55.00	54.68	± 5%
						σ	1.05	1.01	± 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	2.83 W/Kg	11.26 W/Kg	± 18.06%
	SAR averaged over 10g	1.84 W/Kg	7.32 W/Kg	± 17.44%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	53.70 Ω 1.59 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	28.20	± 2.03 dB

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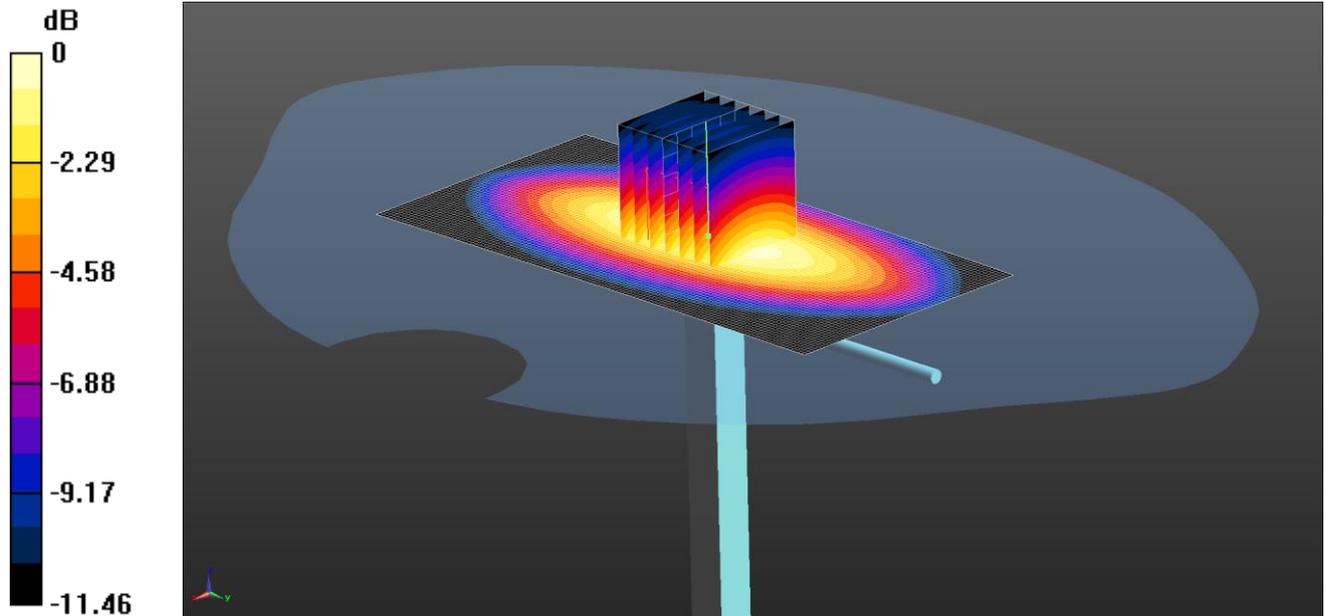
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D900V2 - SN1d143; Type: D900V2; Serial: SN01d143



0 dB = 3.34 W/kg = 5.24 dBW/kg

Communication System: UID 0, CW (0); Frequency: 900 MHz; Duty Cycle: 1:1

Medium: 900, 1750, 1800, 2600 5% MHz HSL Medium parameters used: $f = 900$ MHz; $\sigma = 0.992$ S/m; $\epsilon_r = 41.281$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3360; ConvF(6.09, 6.09, 6.09); Calibrated: 17/08/2018;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1543; Calibrated: 08/03/2018
- Phantom: Twin SAM A (Site 65); Type: SAM 8.0; Serial: TP:1945
- ; SEMCAD X Version 14.6.10 (7417)

SAR/d=10mm, Pin=50 mW/Area Scan (61x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 3.30 W/kg

SAR/d=10mm, Pin=50 mW/Zoom Scan 2 2 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.90 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 4.34 W/kg

SAR(1 g) = 2.82 W/kg; SAR(10 g) = 1.8 W/kg

Maximum value of SAR (measured) = 3.34 W/kg

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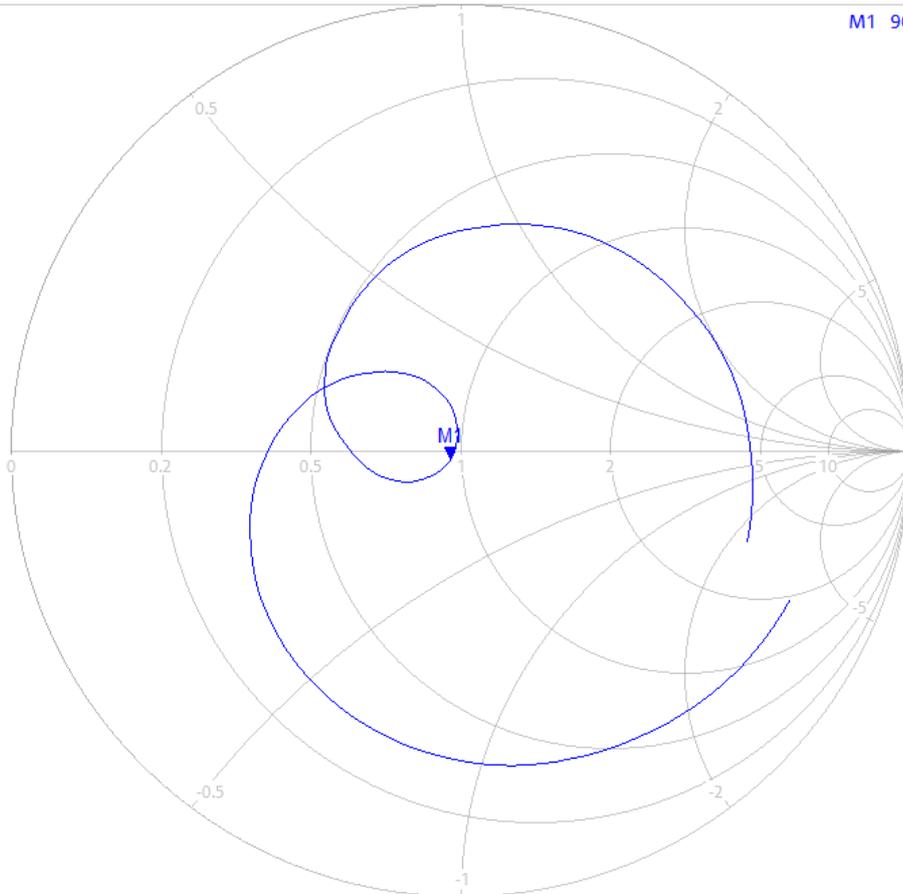
Impedance Measurement Plot for Head Stimulating Liquid (HSL)

10/12/2018 11:06:39 AM
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

M1 900.000000 MHz 47.832 Ω
-j1.929 Ω
91.656 pF



Ch1 Center 900 MHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

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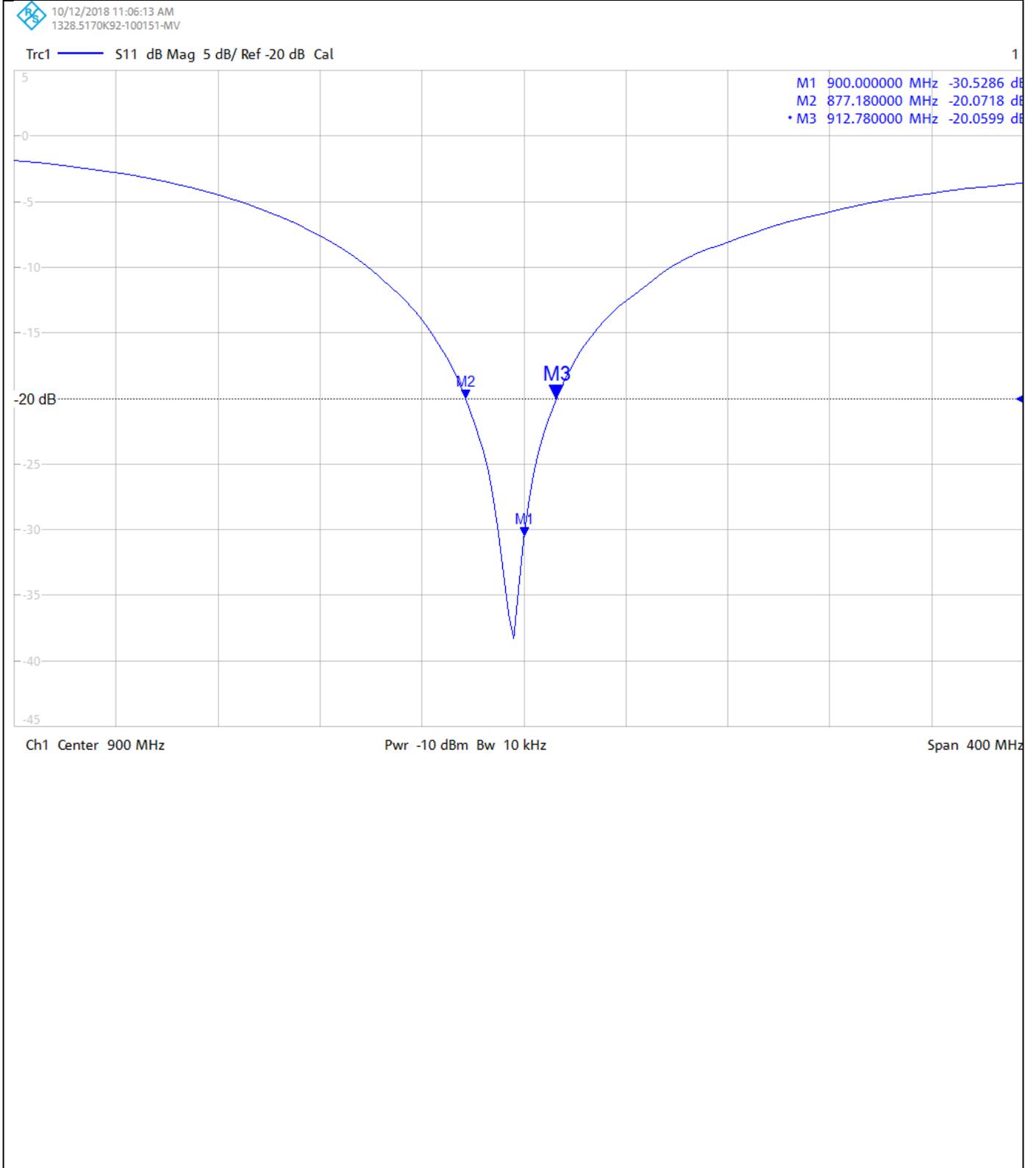
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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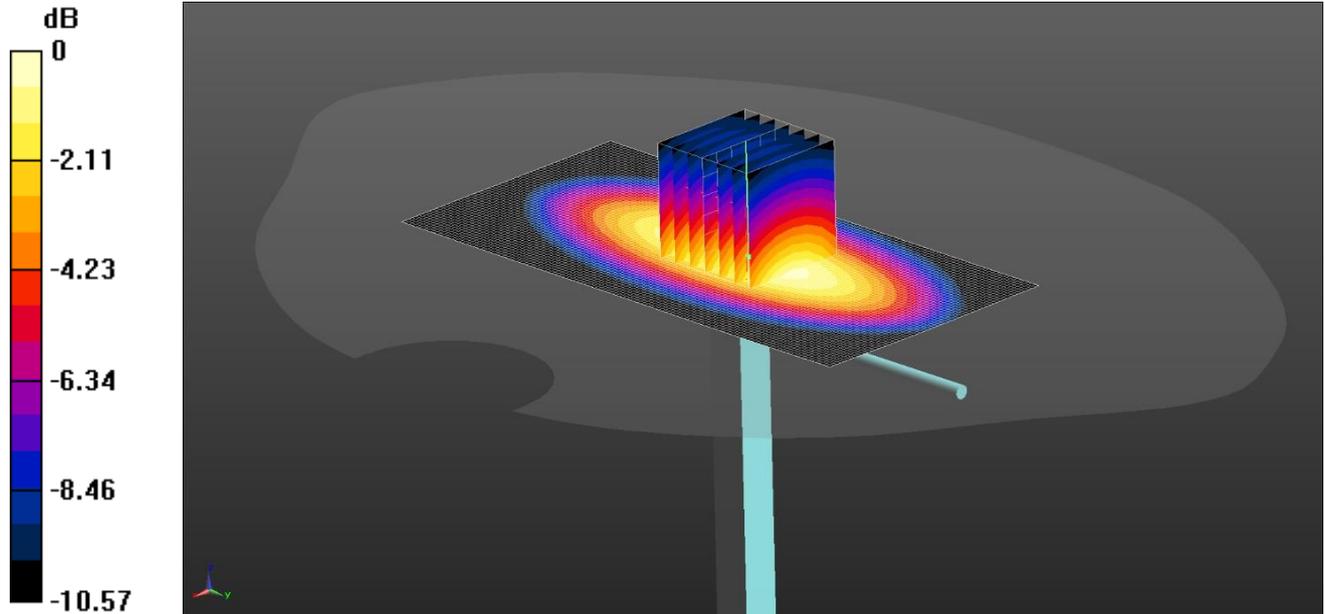
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DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D900V2 - SN1d143; Type: D900V2; Serial: SN1d143



0 dB = 3.32 W/kg = 5.21 dBW/kg

Communication System: UID 0, CW (0); Frequency: 900 MHz; Duty Cycle: 1:1
Medium: 900, 1750, 1800, 1900 5% MHz MSL Medium parameters used: $f = 900$ MHz; $\sigma = 1.007$ S/m; $\epsilon_r = 54.679$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3360; ConvF(6.25, 6.25, 6.25); Calibrated: 17/08/2018;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1543; Calibrated: 08/03/2018
- Phantom: Twin SAM A (Site 65); Type: SAM 5.0; Serial: TP:1836
- ; SEMCAD X Version 14.6.10 (7417)

SAR/d=10mm, Pin=50 mW 2/Area Scan (61x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 3.30 W/kg

SAR/d=10mm, Pin=50 mW 2/Zoom Scan 2 2 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.07 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 4.26 W/kg

SAR(1 g) = 2.83 W/kg; SAR(10 g) = 1.84 W/kg

Maximum value of SAR (measured) = 3.32 W/kg

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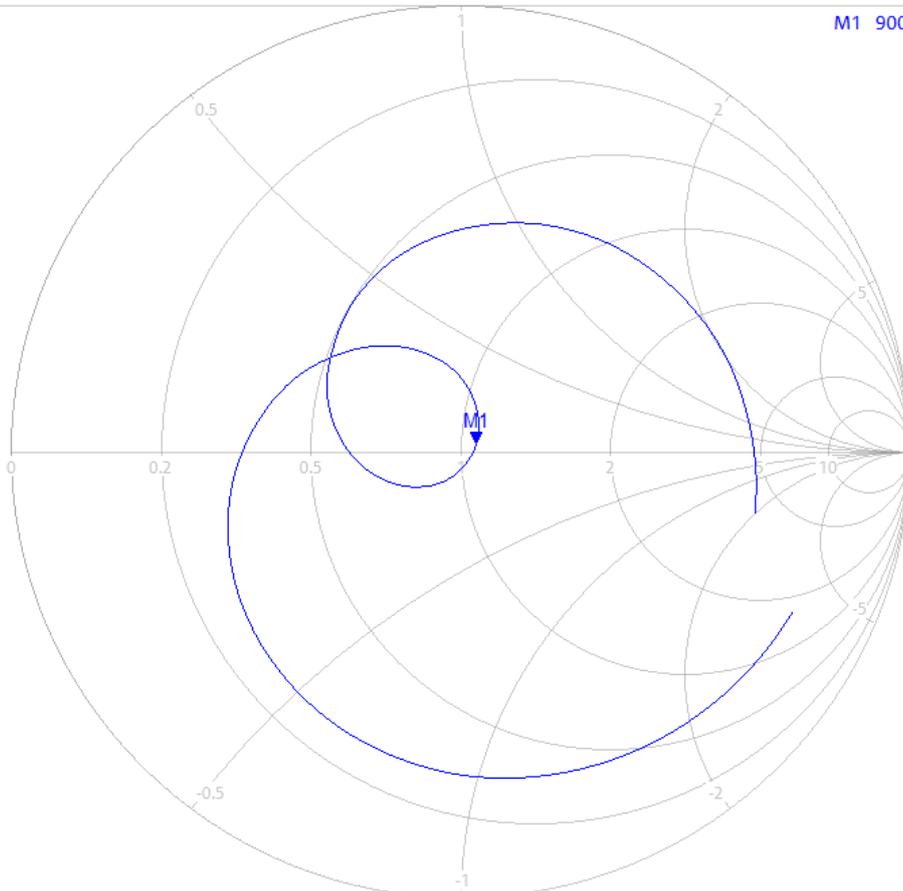
Impedance Measurement Plot for Body Stimulating Liquid (MSL)

10/15/2018 3:14:39 PM
1328.5170K92-100151-MV

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

1

M1 900.000000 MHz 53.701 Ω
j1.589 Ω
281.022 pF



Ch1 Center 900 MHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

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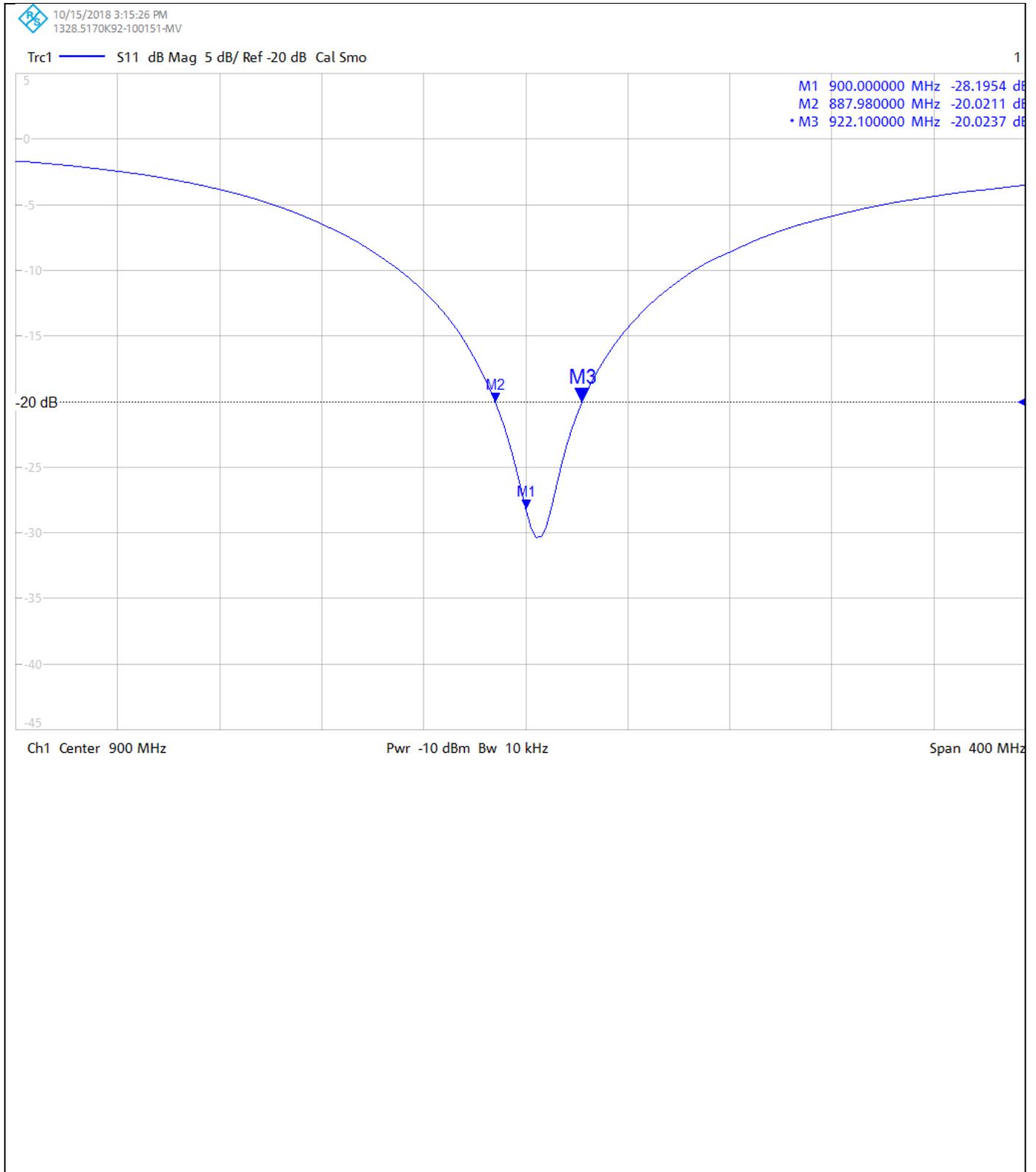
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Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



Calibration Certificate Label:

 <p>UKAS CALIBRATION 5248</p>	<p>UL VS LTD - Tel: +44 (0) 1256312000</p> <p>Certificate Number: 12134285JD01A</p> <p>Instrument ID: 1d143</p> <p>Calibration Date: 16/Oct/2018</p> <p>Calibration Due Date:</p>
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