

CERTIFICATE OF CALIBRATION

ISSUED BY UL VS LTD

DATE OF ISSUE: 29/Nov/2017

CERTIFICATE NUMBER : 11903932JD01C



5248

UL VS LTD
PAVILION A
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APPROVED SIGNATORY

A handwritten signature in black ink, appearing to read "N. Mirza".

Naseer Mirza

Customer :

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	20/Nov/2017
Manufacturer:	Speag		
Type/Model Number:	D900V2		
Serial Number:	108		
Calibration Date:	22/Nov/2017		
Calibrated By:	Chanthu Thevarajah Laboratory Engineer		
Signature:	A handwritten signature in black ink, appearing to read "Chanthu Thevarajah".		

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 62209-1:2005:** 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)
A2546	Data Acquisition Electronics	SPEAG	DAE4	1435	10 Feb 2017	12
A2545	Probe	SPEAG	ES3DV4	3395	04 May 2017	12
A2588	Dipole	SPEAG	D900V2	1d168	21 Sep 2017	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	12
M1855	Power Sensor	Rhode & Schwarz	NRP-Z51	103246	08 Nov 2017	12
M1015	Network Analyser	Agilent Technologies	8753ES	US39172406	10 Oct 2017	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	22 Nov 2016	24
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947-Bt	02 Dec 2016	12
M1838	Signal Generator	Rhode & Schwarz	SME06	831377/005	30 Mars 2017	12

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SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F14/5T5ZA1/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	21.0 °C	21.0 °C	20.5°C	21.0°C	ϵ_r	41.50	41.56	± 5%
						σ	0.97	0.97	± 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	2.69 W/Kg	10.70 W/Kg	± 17.57%
	SAR averaged over 10g	1.73 W/Kg	6.88 W/Kg	± 17.32%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.666 Ω 4.46 j Ω	± 0.28 Ω ± 0.044 j Ω
	Return Loss	27.83	± 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	21.0 °C	21.0 °C	21.0°C	21.0°C	ϵ_r	55.00	54.24	± 5%
						σ	1.05	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	2.73 W/Kg	10.86 W/Kg	± 18.06%
	SAR averaged over 10g	1.80 W/Kg	7.16 W/Kg	± 17.44%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	53.72 Ω 8.72 $j\Omega$	± 0.28 Ω ± 0.044 $j\Omega$
	Return Loss	21.25	± 2.03 dB

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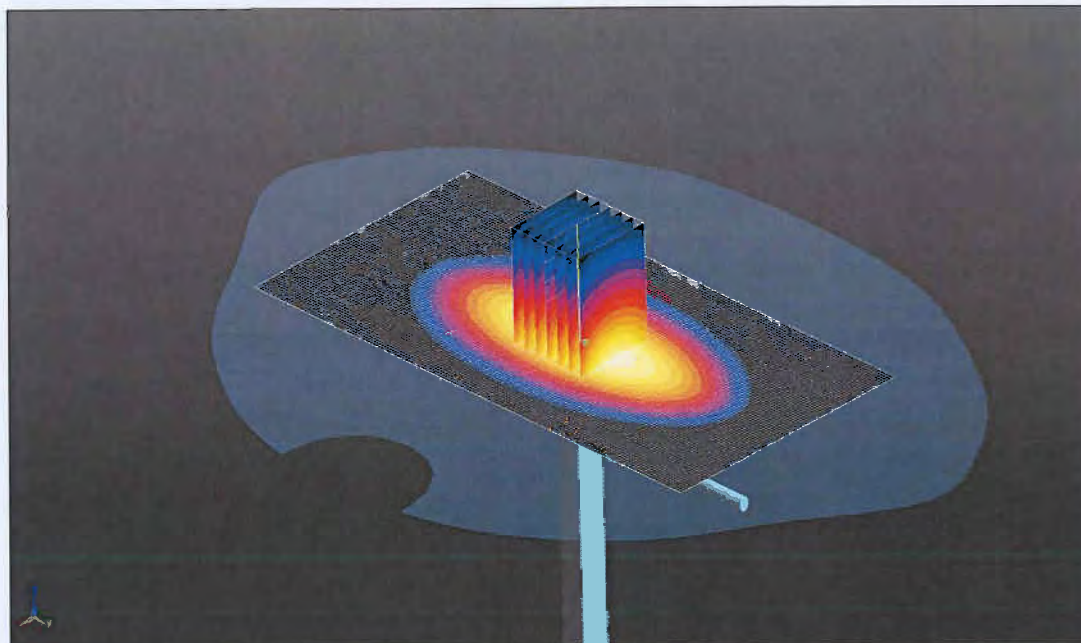
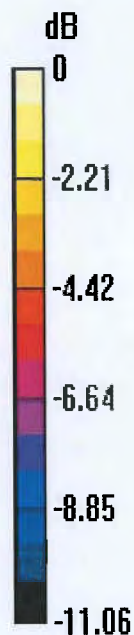
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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: Dipole 900 MHz; SN: 108; Type: D900V2; Serial: SN108



0 dB = 3.15 W/kg = 4.98 dBW/kg

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

Medium: 750,835,900,1800,1900 MHz HSL Medium parameters used: $f = 900$ MHz; $\sigma = 0.967$ S/m; $\epsilon_r = 41.565$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3995; ConvF(10.1, 10.1, 10.1); Calibrated: 04/05/2017;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1435; Calibrated: 10/02/2017
- Phantom: SAM (30deg probe tilt) with CRP v5.0; Type: QD000P40CD; Serial: TP:xxxx
- ; SEMCAD X Version 14.6.10 (7372)

Configuration/d=15mm, Pin=250mW 2 2/Area Scan (81x161x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 3.17 W/kg

Configuration/d=15mm, Pin=250mW 2 2/Zoom Scan (5x5x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.39 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 4.11 W/kg

SAR(1 g) = 2.69 W/kg; SAR(10 g) = 1.73 W/kg

Maximum value of SAR (measured) = 3.15 W/kg

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Impedance Measurement Plot for Head Stimulating Liquid (HSL)

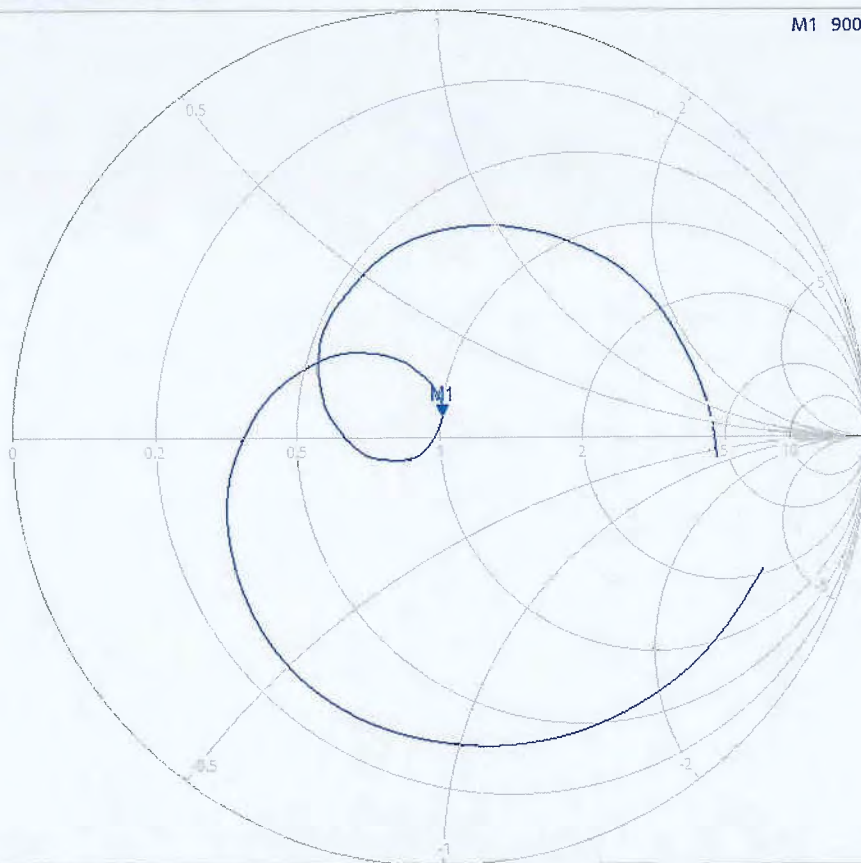


11/28/2017 1:55:22 PM
1328.5170K92-100151-MV

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

1

M1 900.000000 MHz 50.666 Ω
j4.458 Ω
788.363 pH



Ch1 Start 700 MHz

Pwr -10 dBm Bw 10 kHz

Stop 1.1 GHz

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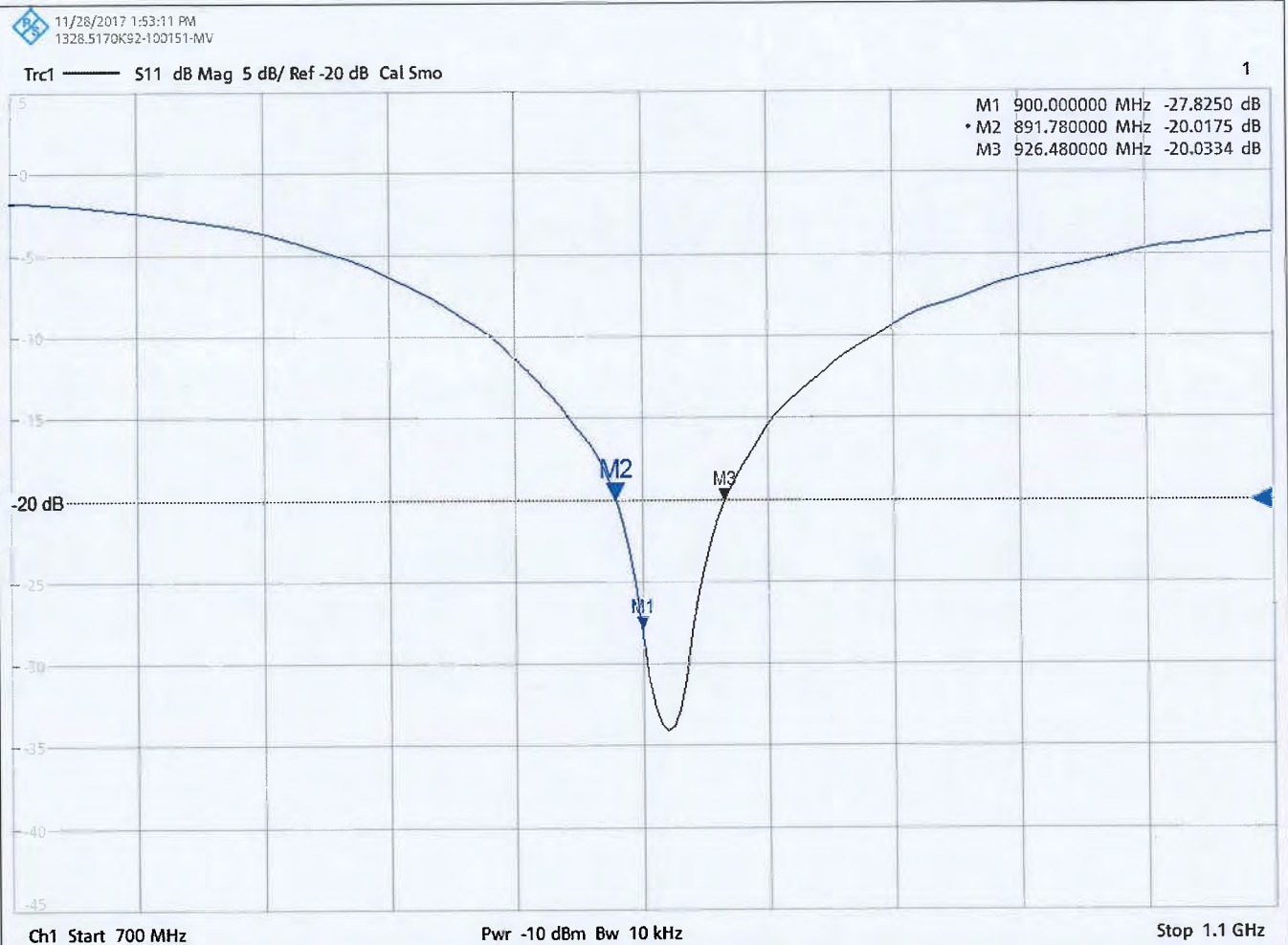
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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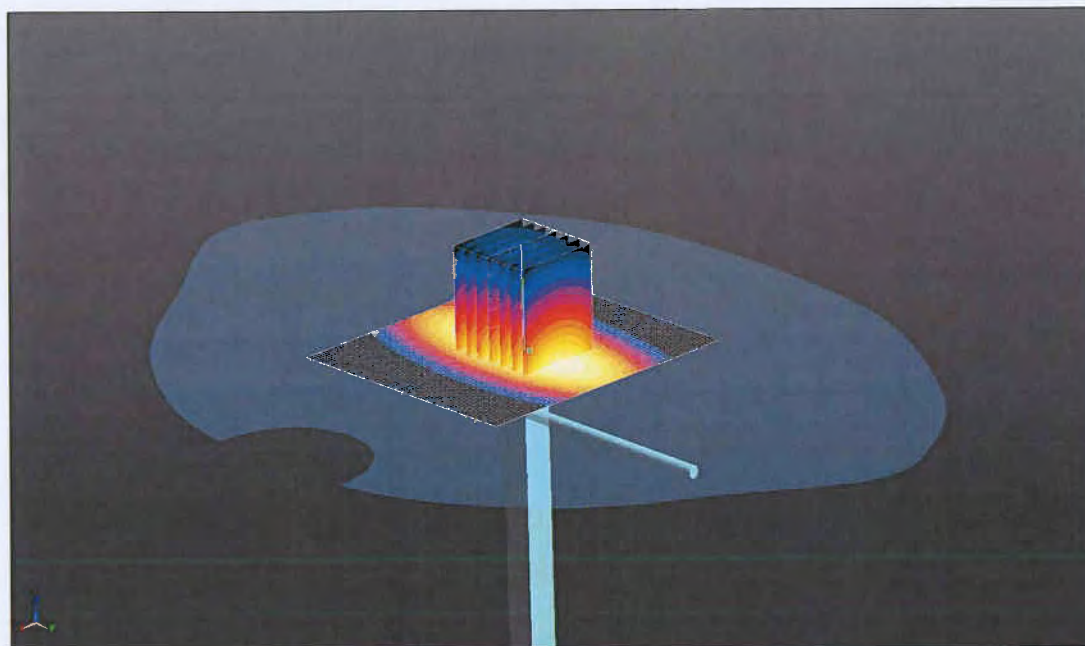
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DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: Dipole 900 MHz; SN: 108; Type: D900V2; Serial: SN108



0 dB = 2.94 W/kg = 4.68 dBW/kg

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

Medium: MSL(750,835,900,1800,1900,5G) Medium parameters used: $f = 900$ MHz; $\sigma = 1.018$ S/m; $\epsilon_r = 54.24$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3995; ConvF(9.81, 9.81, 9.81); Calibrated: 04/05/2017;

- Sensor-Surface: 4mm (Mechanical Surface Detection)

- Electronics: DAE4 Sn1435; Calibrated: 10/02/2017

- Phantom: SAM (20deg probe tilt) with CRP v4.0; Type: QD000P40CC; Serial: TP:xxxx

- ; SEMCAD X Version 14.6.10 (7372)

SAR/d=15mm, Pin=250 mW, dist=10.0mm (ET-Probe)/Area Scan (81x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 3.21 W/kg

SAR/d=15mm, Pin=250 mW, dist=10.0mm (ET-Probe)/Zoom Scan (5x5x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.69 V/m; Power Drift = -0.77 dB

Peak SAR (extrapolated) = 4.04 W/kg

SAR(1 g) = 2.73 W/kg; SAR(10 g) = 1.8 W/kg

Maximum value of SAR (measured) = 2.94 W/kg

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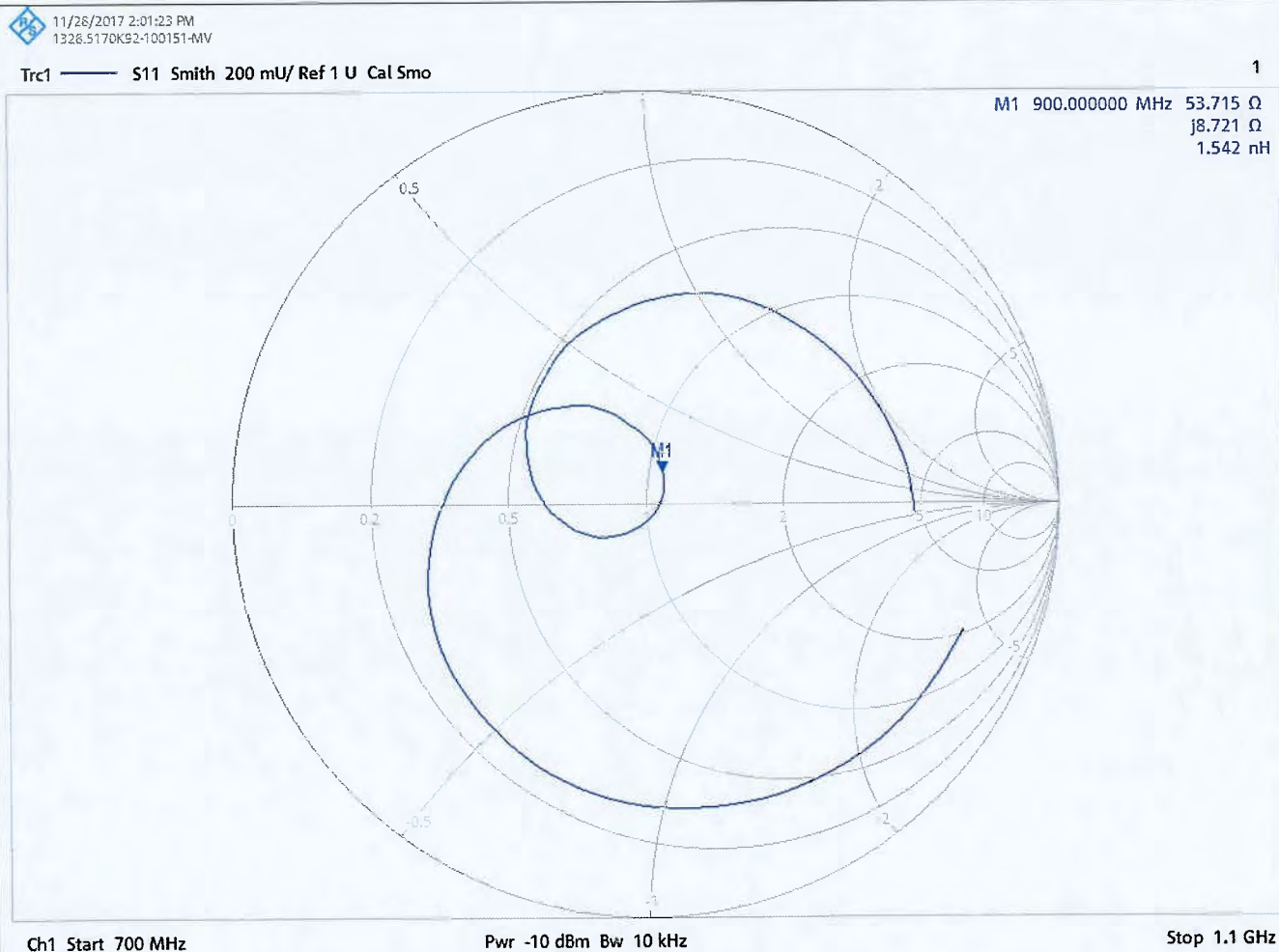
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Impedance Measurement Plot for Body Stimulating Liquid (MSL)



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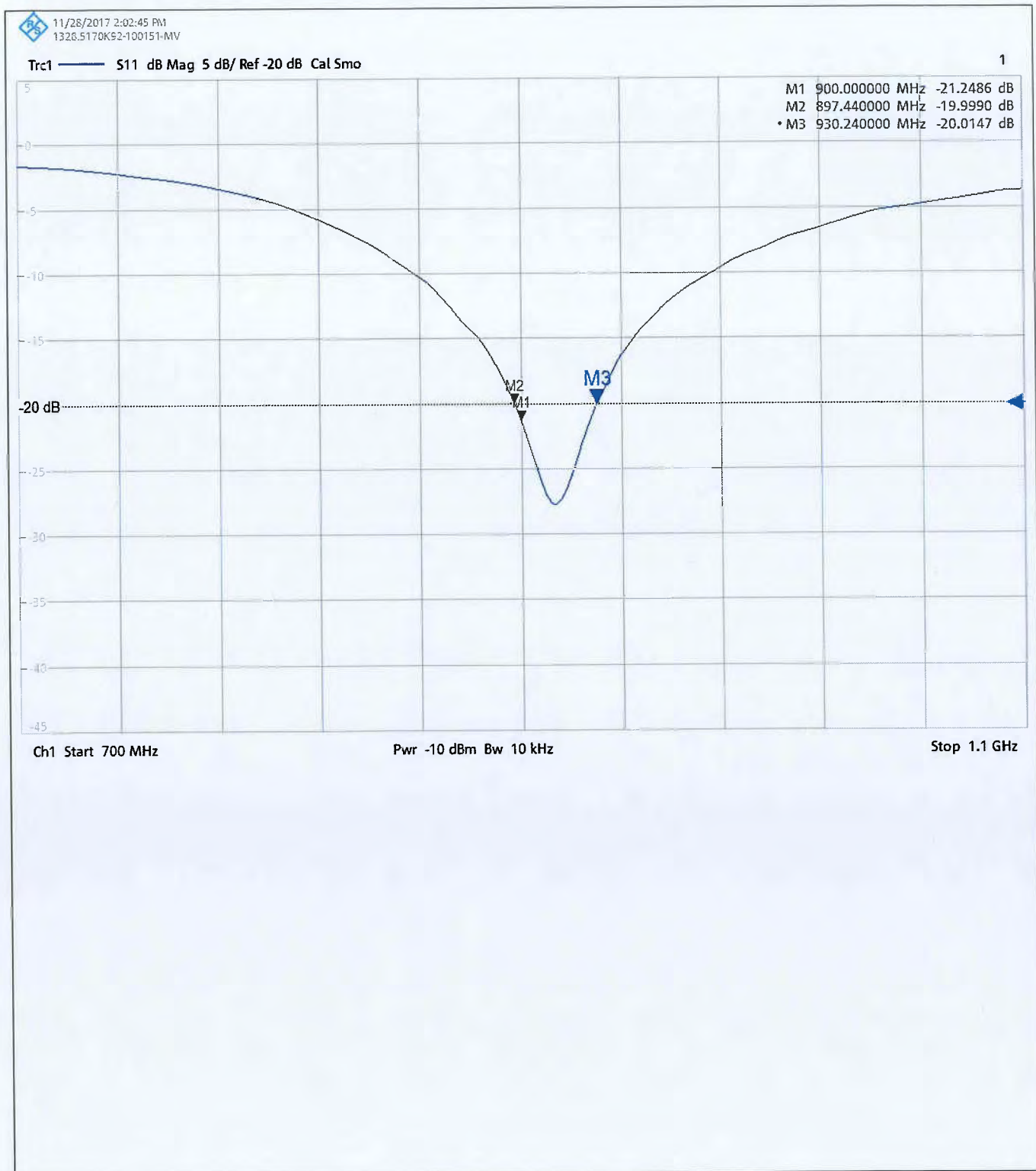
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Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



Calibration Certificate Label:

 UKAS CALIBRATION 5248	UL VS LTD - Tel: +44 (0) 1256312000 Certificate Number: 11903932JD01C Instrument ID: 108 Calibration Date: 22/Nov/2017 Calibration Due Date:
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