

# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 08/Jun/2018

CERTIFICATE NUMBER : 12134282JD01A



5248

UL VS LTD  
UNIT 1 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**

.....  
Naseer Mirza

**Customer :**

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

**Equipment Details:**

Description:	Dipole Validation Kit	Date of Receipt:	14/May/2018
Manufacturer:	Speag		
Type/Model Number:	D750V3		
Serial Number:	1024		
Calibration Date:	16/May/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		

Signature:

.....

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

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01A

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 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)
PRE0178316	Data Acquisition Electronics	SPEAG	DAE4	1542	06 Mar 2018	12
A2544	Probe	SPEAG	EX3DV4	3994	19 Mar 2018	12
A2545	Probe	SPEAG	EX3DV4	3995	24 Apr 2018	12
A2765	Dipole	SPEAG	D750V3	1147	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	14 Dec 2017	12
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947	27 April 2018	12
M1838	Signal Generator	Rhode & Schwarz	SME06	831377/005	22 Mar 2018	12

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01A

Page 3 of 10

### SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F17/5ENYG1/C/01
DASY Version:	DASY 52 (v52.8.8.1258)
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	21.4 °C	21.0 °C	20.9°C	21.0°C	$\epsilon_r$	41.96	40.13	± 5%
						$\sigma$	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	2.08 W/Kg	<b>8.28 W/Kg</b>	± 17.57%
	SAR averaged over 10g	1.36 W/Kg	<b>5.41 W/Kg</b>	± 17.32%

### Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	45.724 $\Omega$ 0.14 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	25.37	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01A

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	750	22.0 °C	21.0 °C	21.2°C	21.0°C	$\epsilon_r$	55.55	55.78	± 5%
						$\sigma$	0.96	0.95	± 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	2.27 W/Kg	<b>9.03 W/Kg</b>	± 18.06%
	SAR averaged over 10g	1.52 W/Kg	<b>6.05 W/Kg</b>	± 17.44%

### Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	50.93 $\Omega$ 3.17 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	30.69	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

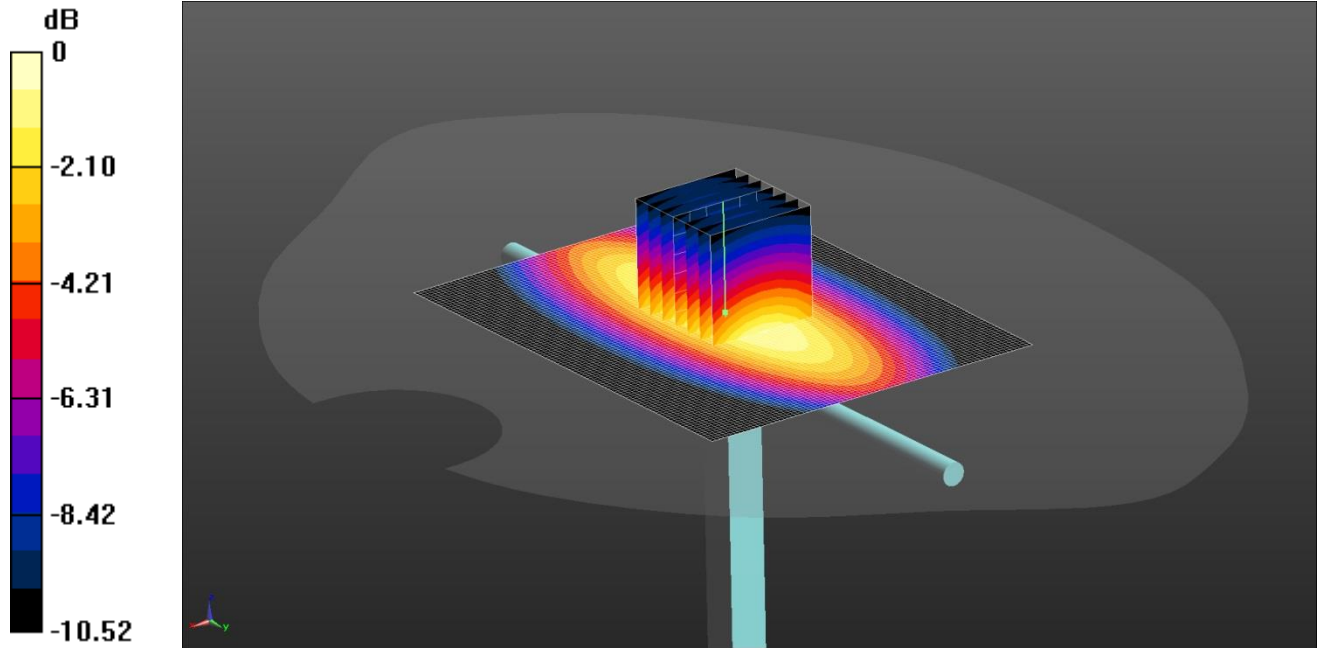
CERTIFICATE  
NUMBER :  
12134282JD01A

UKAS Accredited Calibration Laboratory No. 5248

Page 5 of 10

### DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D750V3 - SN1024; Type: D750V3; Serial: SN1024



0 dB = 2.64 W/kg = 4.22 dBW/kg

Communication System: UID 0, CW (0); Frequency: 750 MHz; Duty Cycle: 1:1

Medium: 750 835 900 MHz HSL Medium parameters used:  $f = 750$  MHz;  $\sigma = 0.909$  S/m;  $\epsilon_r = 40.131$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3994; ConvF(10.53, 10.53, 10.53); Calibrated: 19/03/2018;
- Sensor-Surface: 3mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1542; Calibrated: 06/03/2018
- Phantom: Twin-SAM V8.0 (20deg probe tilt); Type: QD 000 P41 Ax; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7417)

**Configuration/d=10mm, Pin=250mW/Area Scan (81x101x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 2.45 W/kg

**Configuration/d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 52.75 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 3.10 W/kg

**SAR(1 g) = 2.08 W/kg; SAR(10 g) = 1.36 W/kg**

Maximum value of SAR (measured) = 2.64 W/kg

# CERTIFICATE OF CALIBRATION

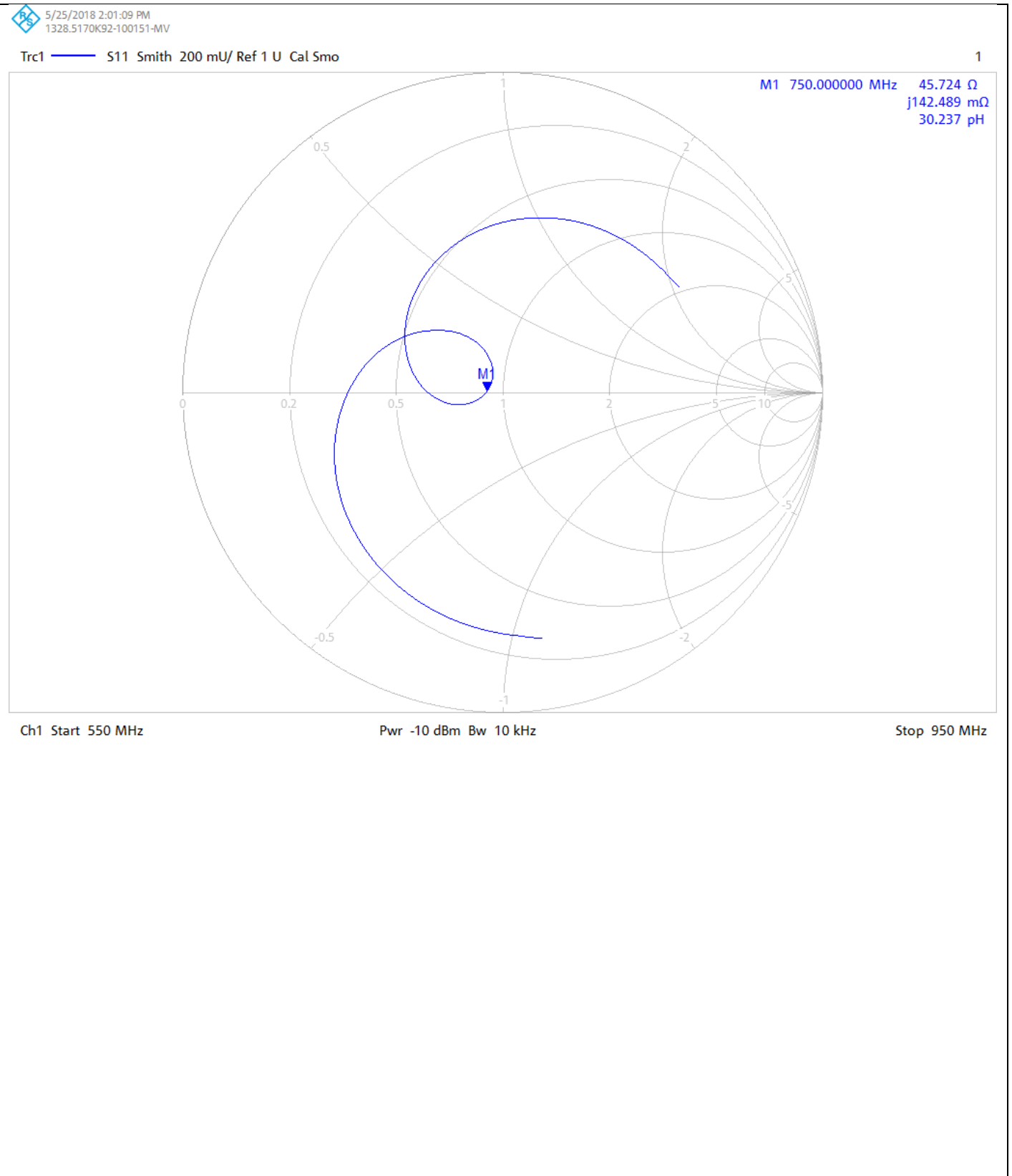
## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
12134282JD01A

UKAS Accredited Calibration Laboratory No. 5248

Page 6 of 10

### Impedance Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

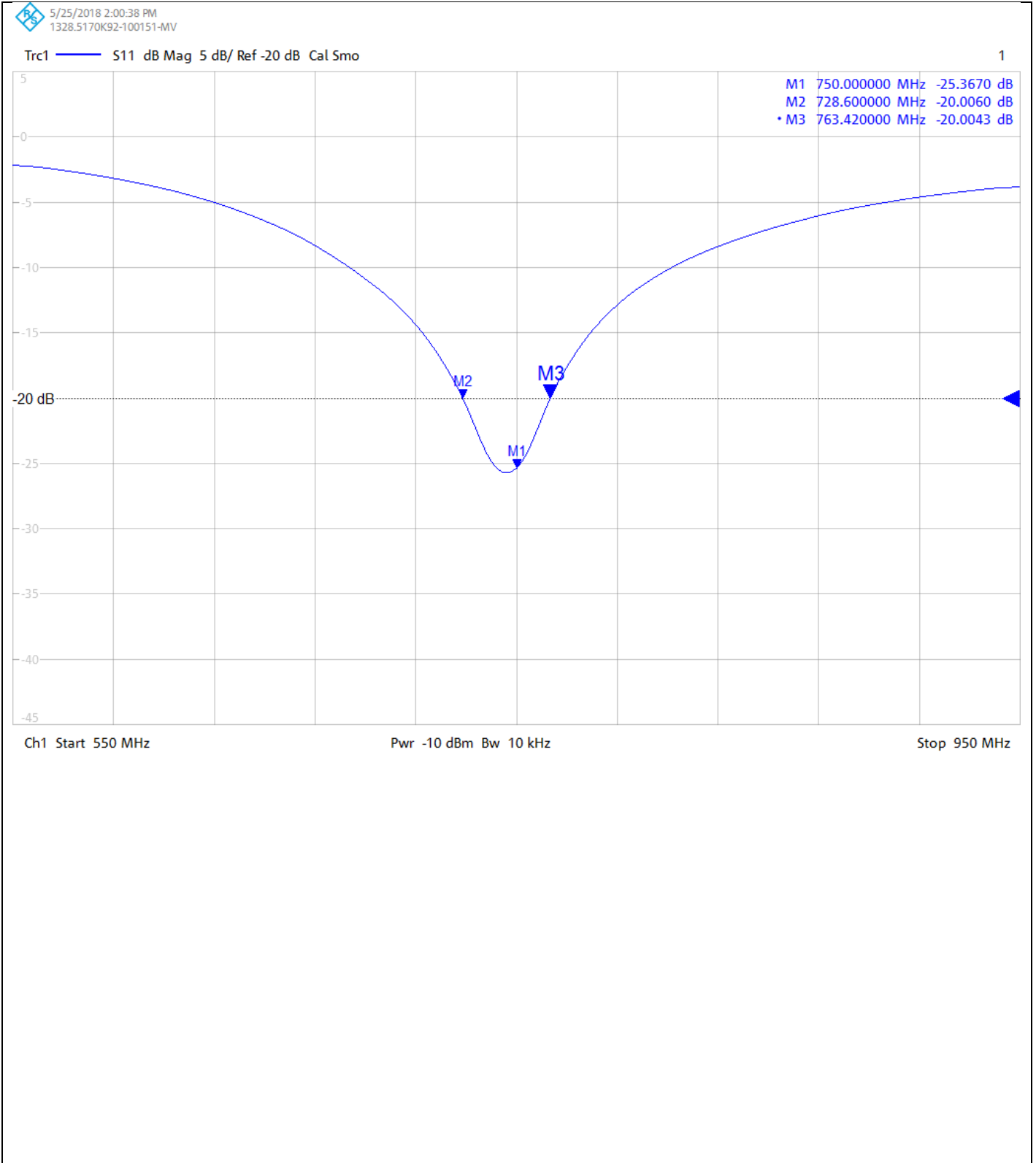
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01A

Page 7 of 10

### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

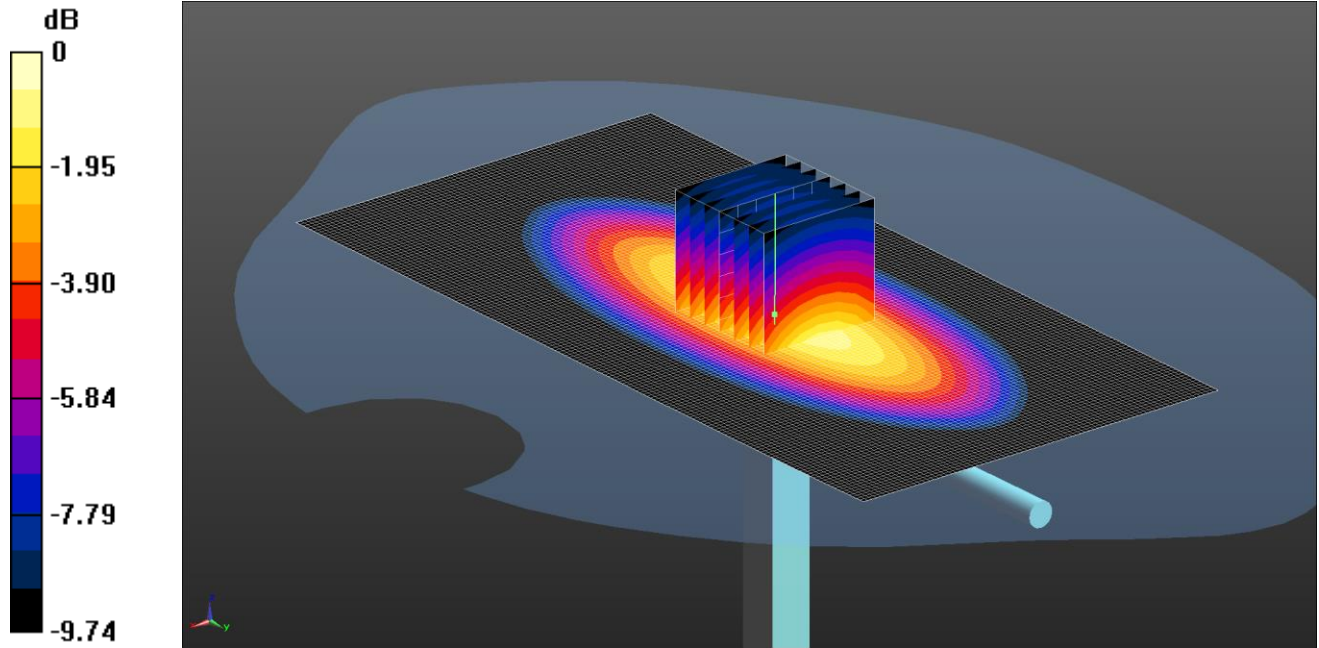
CERTIFICATE  
NUMBER :  
12134282JD01A

UKAS Accredited Calibration Laboratory No. 5248

Page 8 of 10

### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D750V3 - SN1024; Type: D750V3; Serial: SN1024



0 dB = 2.86 W/kg = 4.56 dBW/kg

Communication System: UID 0, CW (0); Frequency: 750 MHz; Duty Cycle: 1:1

Medium: 3500 MHz MSL Medium parameters used:  $f = 750$  MHz;  $\sigma = 0.951$  S/m;  $\epsilon_r = 55.781$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3995; ConvF(10.26, 10.26, 10.26); Calibrated: 24/04/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1542; Calibrated: 06/03/2018
- Phantom: Twin SAM A (Site 65); Type: SAM 4.0; Serial: TP:1020
- ; SEMCAD X Version 14.6.10 (7417)

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

Maximum value of SAR (interpolated) = 2.42 W/kg

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

Reference Value = 50.42 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.36 W/kg

**SAR(1 g) = 2.27 W/kg; SAR(10 g) = 1.52 W/kg**

Maximum value of SAR (measured) = 2.86 W/kg



# CERTIFICATE OF CALIBRATION

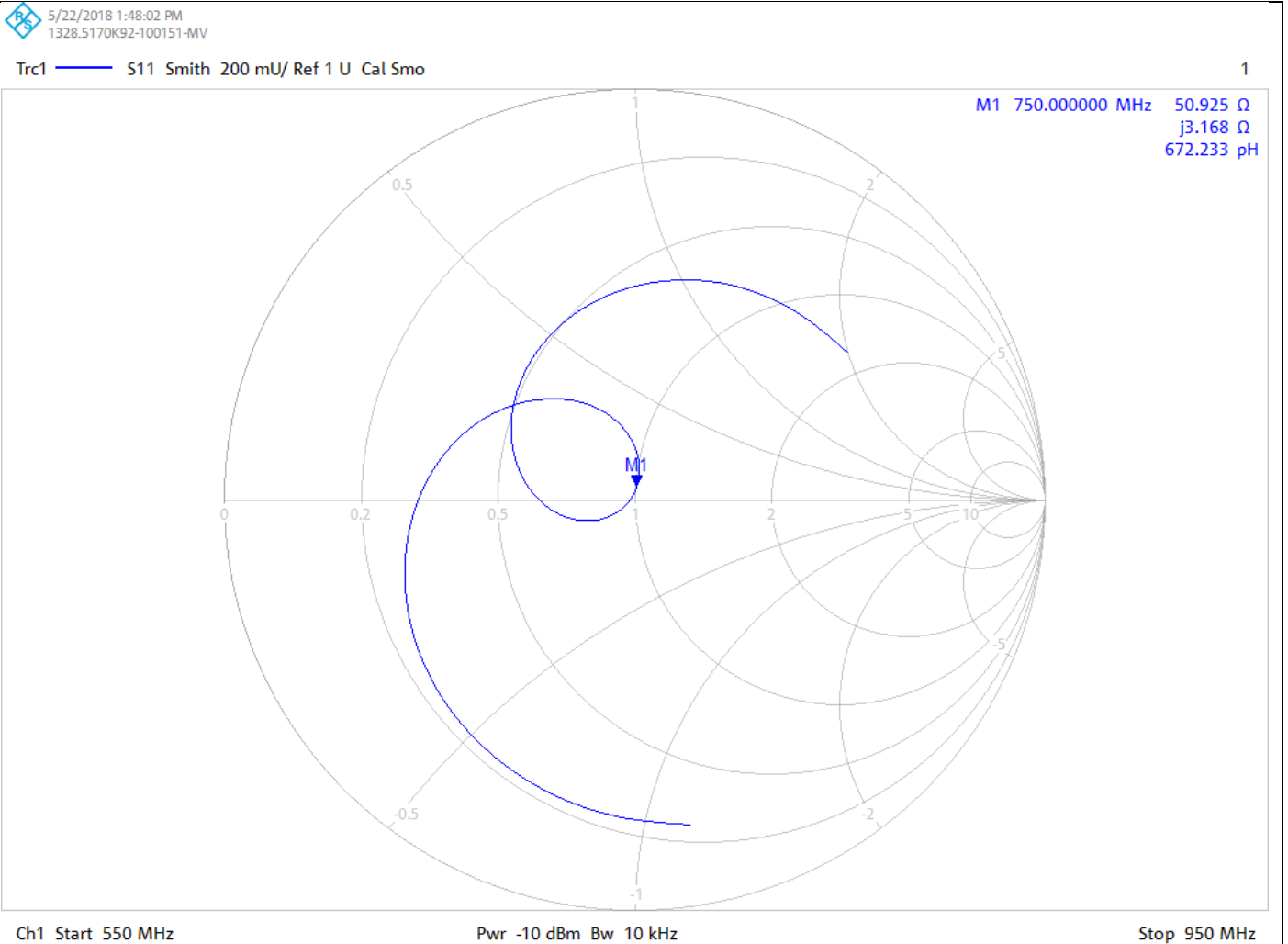
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01A

Page 9 of 10

### Impedance Measurement Plot for Body Stimulating Liquid (MSL)



# CERTIFICATE OF CALIBRATION

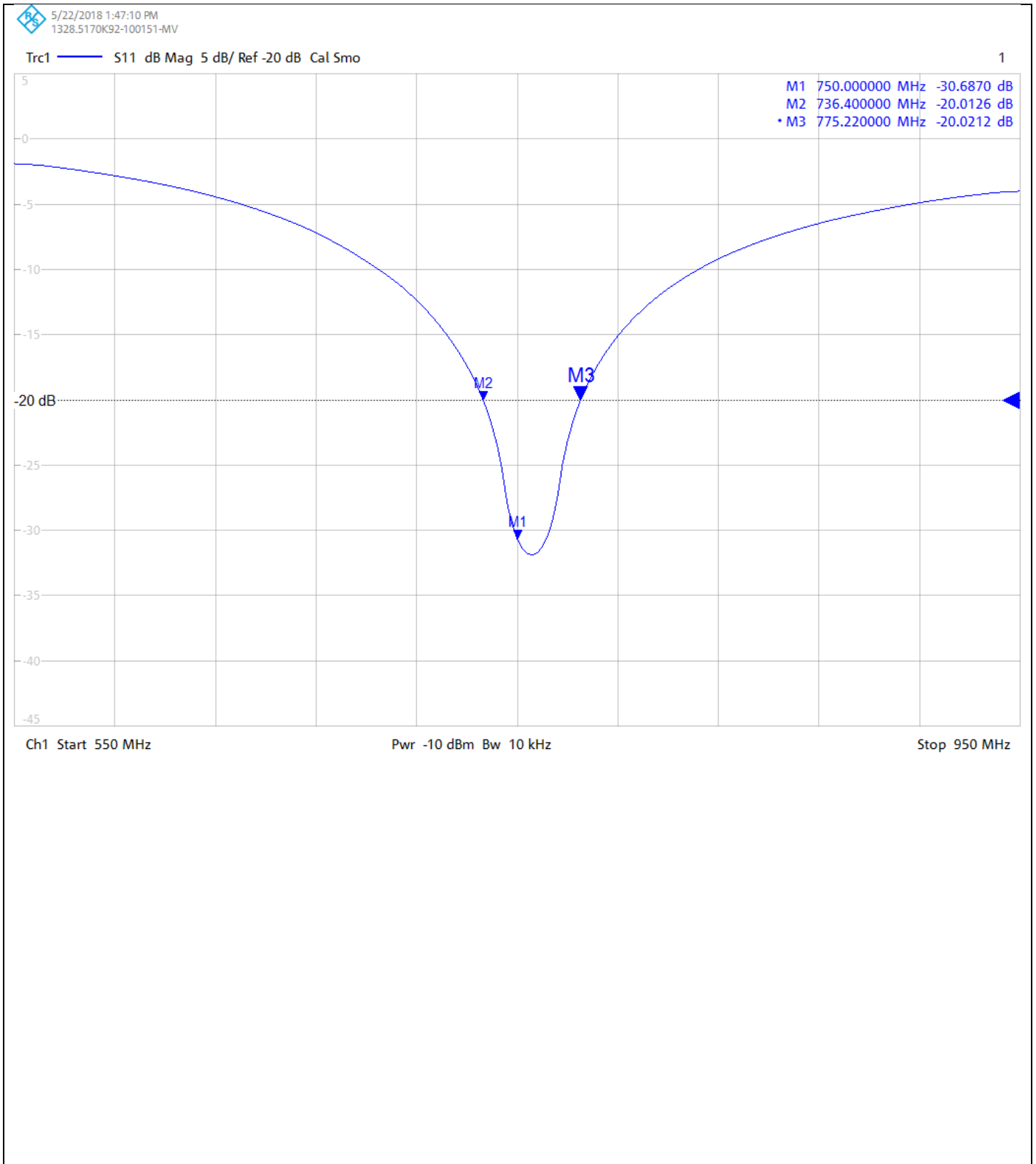
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248


CERTIFICATE  
NUMBER :  
12134282JD01A


Page 10 of 10


### Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



**Calibration Certificate Label:**

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134282JD01A</p> <p>Instrument ID: 1024</p> <p>Calibration Date: 08/Jun/2018</p> <p>Calibration Due Date:</p>
--	---

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134282JD01A</p> <p>Instrument ID: 1024</p> <p>Calibration Date: 08/Jun/2018</p> <p>Calibration Due Date:</p>
--	---

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134282JD01A</p> <p>Instrument ID: 1024</p> <p>Calibration Date: 08/Jun/2018</p> <p>Calibration Due Date:</p>
--	---

# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 08/Jun/2018

CERTIFICATE NUMBER : 12134282JD01B



5248

UL VS LTD  
UNIT 1 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. Naseer'.

.....  
Naseer Mirza

## Customer :

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

## Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	14/May/2018
Manufacturer:	Speag		
Type/Model Number:	D835V2		
Serial Number:	4d117		
Calibration Date:	16/May/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		

Signature:

A handwritten signature in black ink, appearing to be a stylized 'C' followed by 'T'.

.....

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

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01B

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 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)
PRE0178316	Data Acquisition Electronics	SPEAG	DAE4	1542	06 Mar 2018	12
A2544	Probe	SPEAG	EX3DV4	3994	19 Mar 2018	12
A2545	Probe	SPEAG	EX3DV4	3995	24 Apr 2018	12
A2115	Dipole	SPEAG	D835V2	438	28 Apr 2018	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	14 Dec 2017	12
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947	27 April 2018	12
M1838	Signal Generator	Rhode & Schwarz	SME06	831377/005	22 Mar 2018	12

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01B

Page 3 of 10

### SAR System Specification

<b>Robot System Positioner:</b>	Stäubli Unimation Corp. Robot Model: TX60L
<b>Robot Serial Number:</b>	F17/5ENYG1/C/01
<b>DASY Version:</b>	DASY 52 (v52.8.8.1258)
<b>Phantom:</b>	Flat section of SAM Twin Phantom
<b>Distance Dipole Centre:</b>	15 mm (with spacer)
<b>Frequency:</b>	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	21.4 °C	21.0 °C	20.9°C	21.0°C	$\epsilon_r$	41.50	39.89	± 5%
						$\sigma$	0.90	0.94	± 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	2.48 W/Kg	<b>9.87 W/Kg</b>	± 17.57%
	SAR averaged over 10g	1.61 W/Kg	<b>6.40 W/Kg</b>	± 17.32%

### Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	46.016 $\Omega$ .98 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	27.61	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01B

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	22.0 °C	21.0 °C	21.2°C	21.0°C	$\epsilon_r$	55.20	55.65	± 5%
						$\sigma$	0.97	0.98	± 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	2.59 W/Kg	<b>10.31 W/Kg</b>	± 18.06%
	SAR averaged over 10g	1.72 W/Kg	<b>6.84 W/Kg</b>	± 17.44%

### Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	45.10 $\Omega$ 5.69 $j\Omega$	± 0.28 $\Omega$ ± 0.044 $j\Omega$
	Return Loss	23.07	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

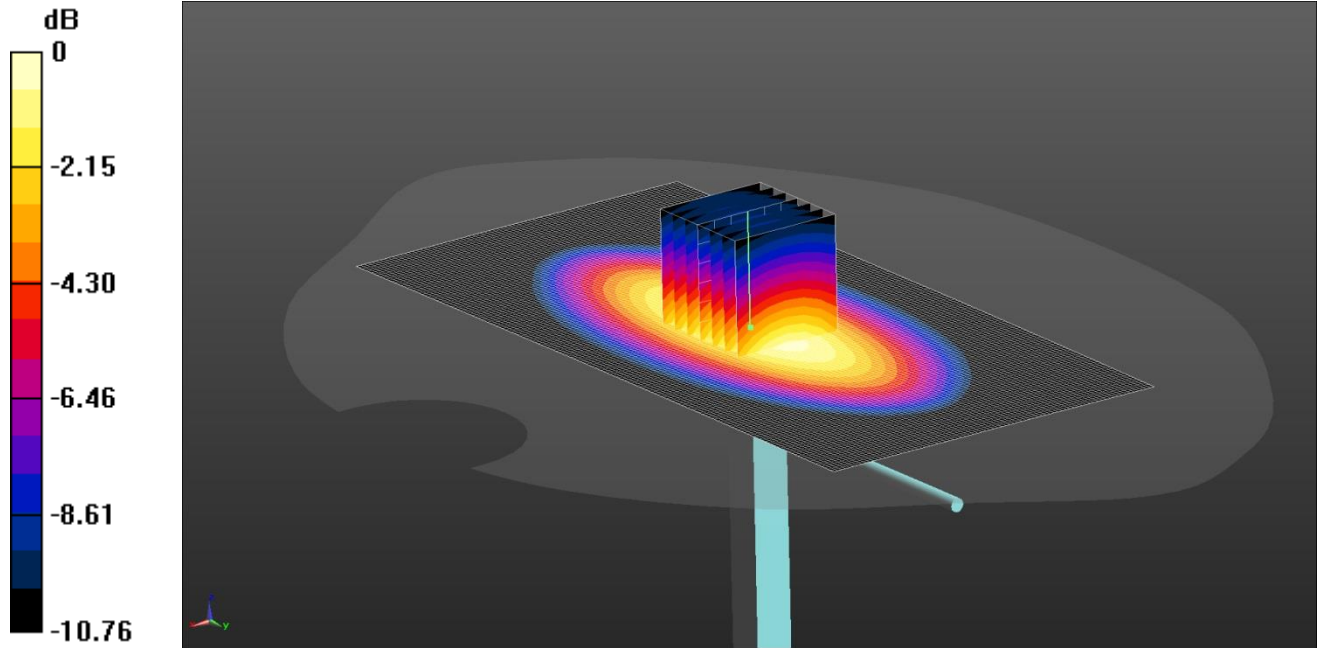
UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01B

Page 5 of 10

### DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D835V2 - SN4d117; Type: D835V2; Serial: SN4d117



0 dB = 2.92 W/kg = 4.65 dBW/kg

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1

Medium: 750 835 900 MHz HSL Medium parameters used (interpolated):  $f = 835$  MHz;  $\sigma = 0.941$  S/m;  $\epsilon_r = 39.893$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3994; ConvF(10.05, 10.05, 10.05); Calibrated: 19/03/2018;

- Sensor-Surface: 3mm (Mechanical Surface Detection)

- Electronics: DAE4 Sn1542; Calibrated: 06/03/2018

- Phantom: Twin-SAM V8.0 (20deg probe tilt); Type: QD 000 P41 Ax; Serial: xxxx

- ; SEMCAD X Version 14.6.10 (7417)

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

Maximum value of SAR (interpolated) = 2.91 W/kg

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

Reference Value = 56.09 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 3.76 W/kg

**SAR(1 g) = 2.48 W/kg; SAR(10 g) = 1.61 W/kg**

Maximum value of SAR (measured) = 2.92 W/kg



# CERTIFICATE OF CALIBRATION

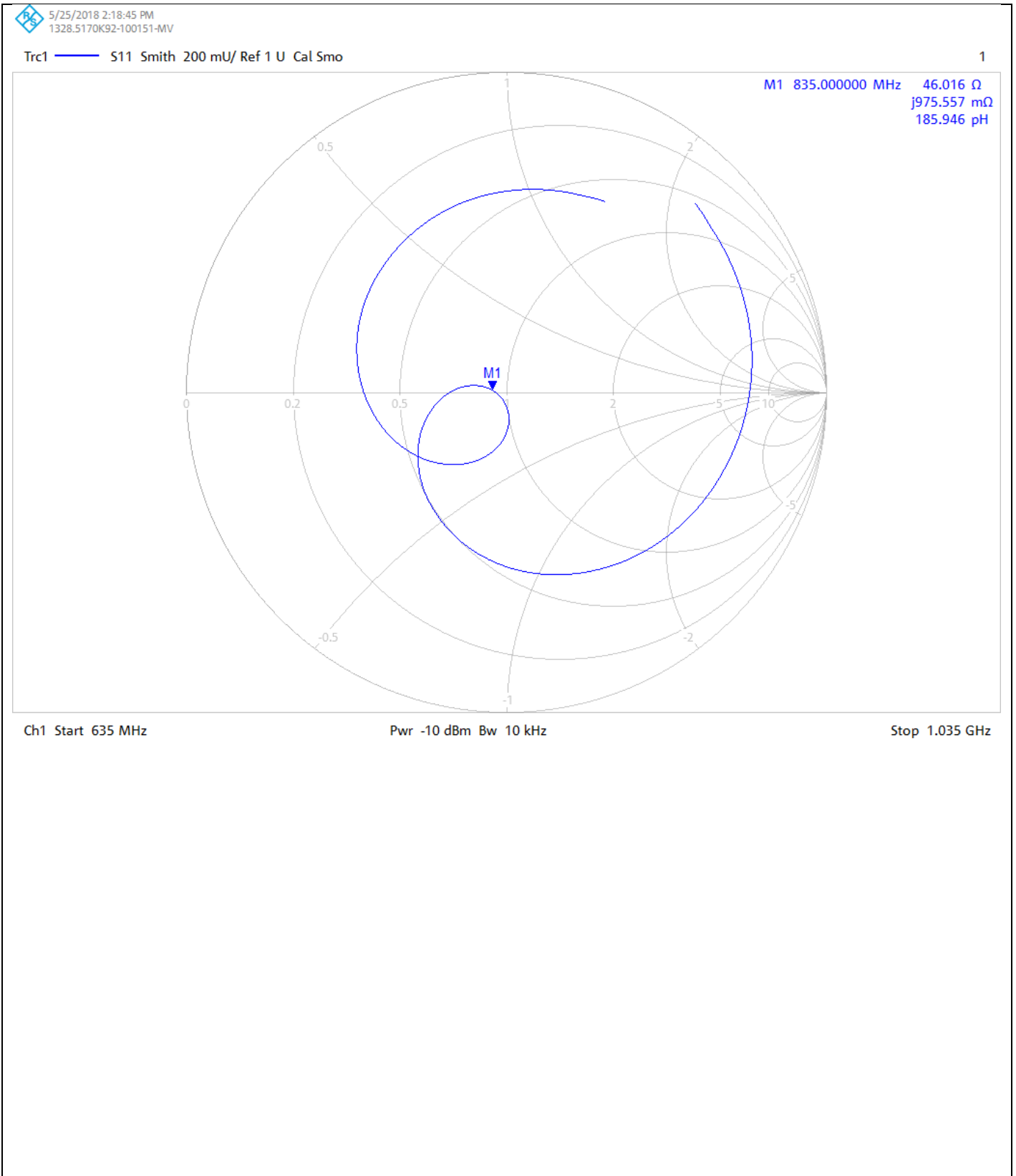
## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
12134282JD01B

UKAS Accredited Calibration Laboratory No. 5248

Page 6 of 10

### Impedance Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

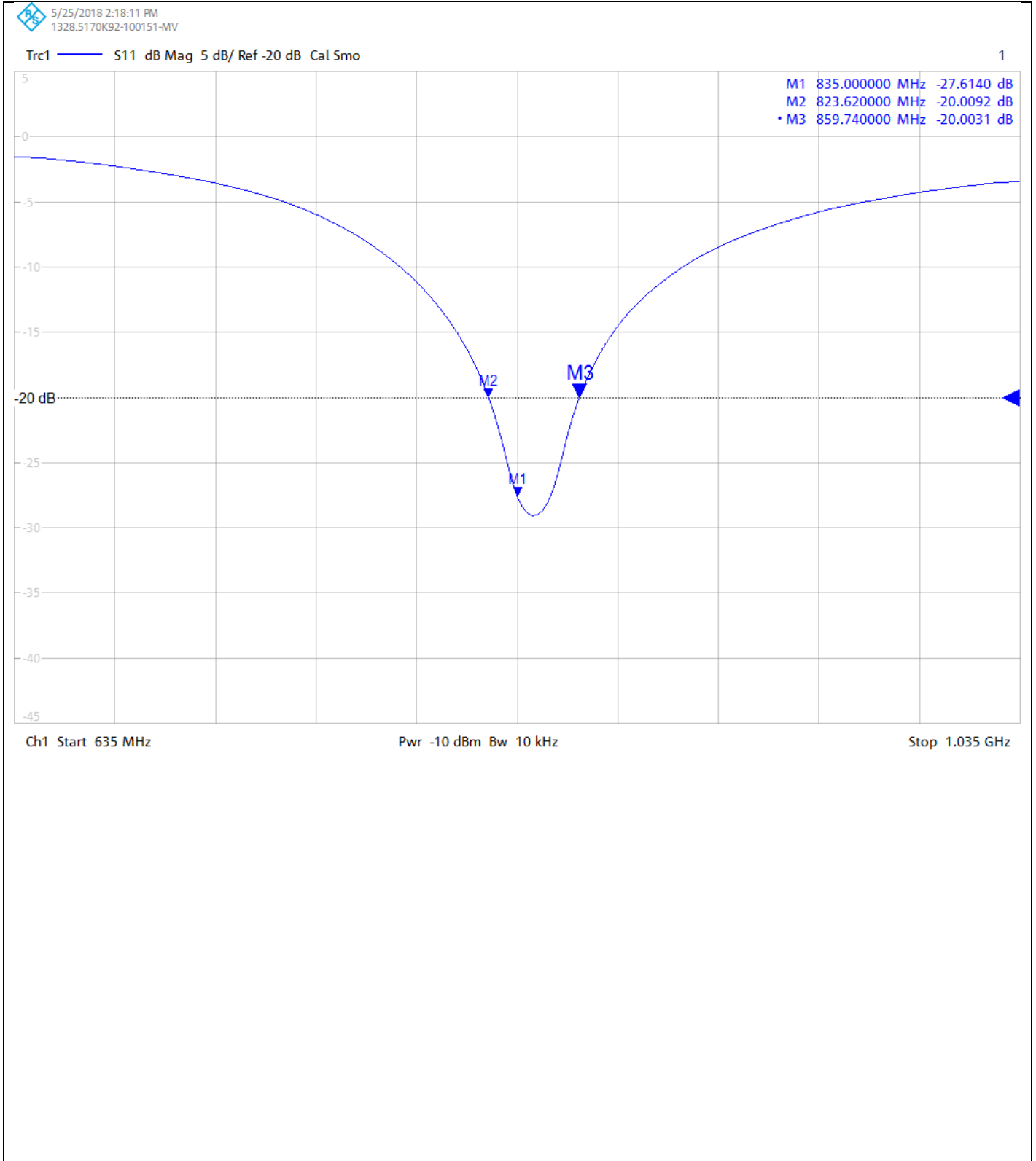
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01B

Page 7 of 10

### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

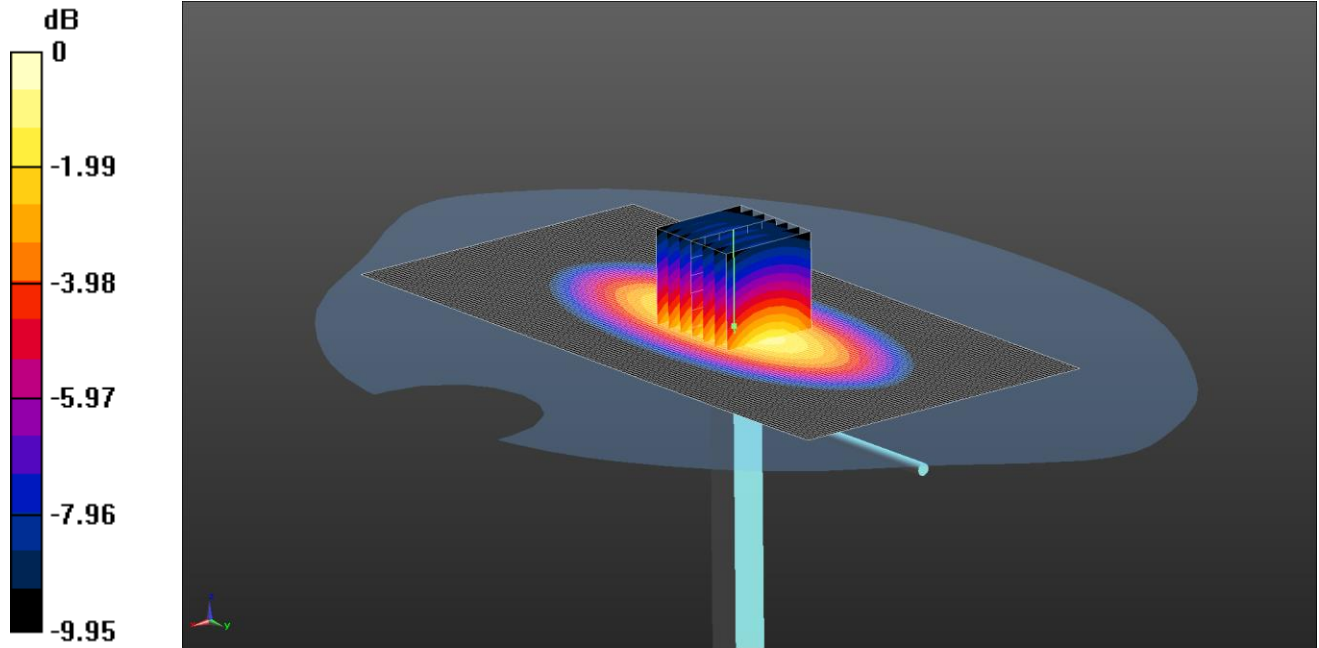
UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01B

Page 8 of 10

### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D835V2 - SN4d117; Type: D835V2; Serial: SN4d117



0 dB = 3.27 W/kg = 5.15 dBW/kg

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1

Medium: 835 MHz MSL Medium parameters used (interpolated):  $f = 835$  MHz;  $\sigma = 0.985$  S/m;  $\epsilon_r = 55.65$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3995; ConvF(10.04, 10.04, 10.04); Calibrated: 24/04/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1542; Calibrated: 06/03/2018
- Phantom: Twin SAM A (Site 65); Type: SAM 4.0; Serial: TP:1020
- ; SEMCAD X Version 14.6.10 (7417)

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

Maximum value of SAR (interpolated) = 2.79 W/kg

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

Reference Value = 52.96 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.84 W/kg

**SAR(1 g) = 2.59 W/kg; SAR(10 g) = 1.72 W/kg**

Maximum value of SAR (measured) = 3.27 W/kg

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134282JD01B

Page 9 of 10

### Impedance Measurement Plot for Body Stimulating Liquid (MSL)



# CERTIFICATE OF CALIBRATION

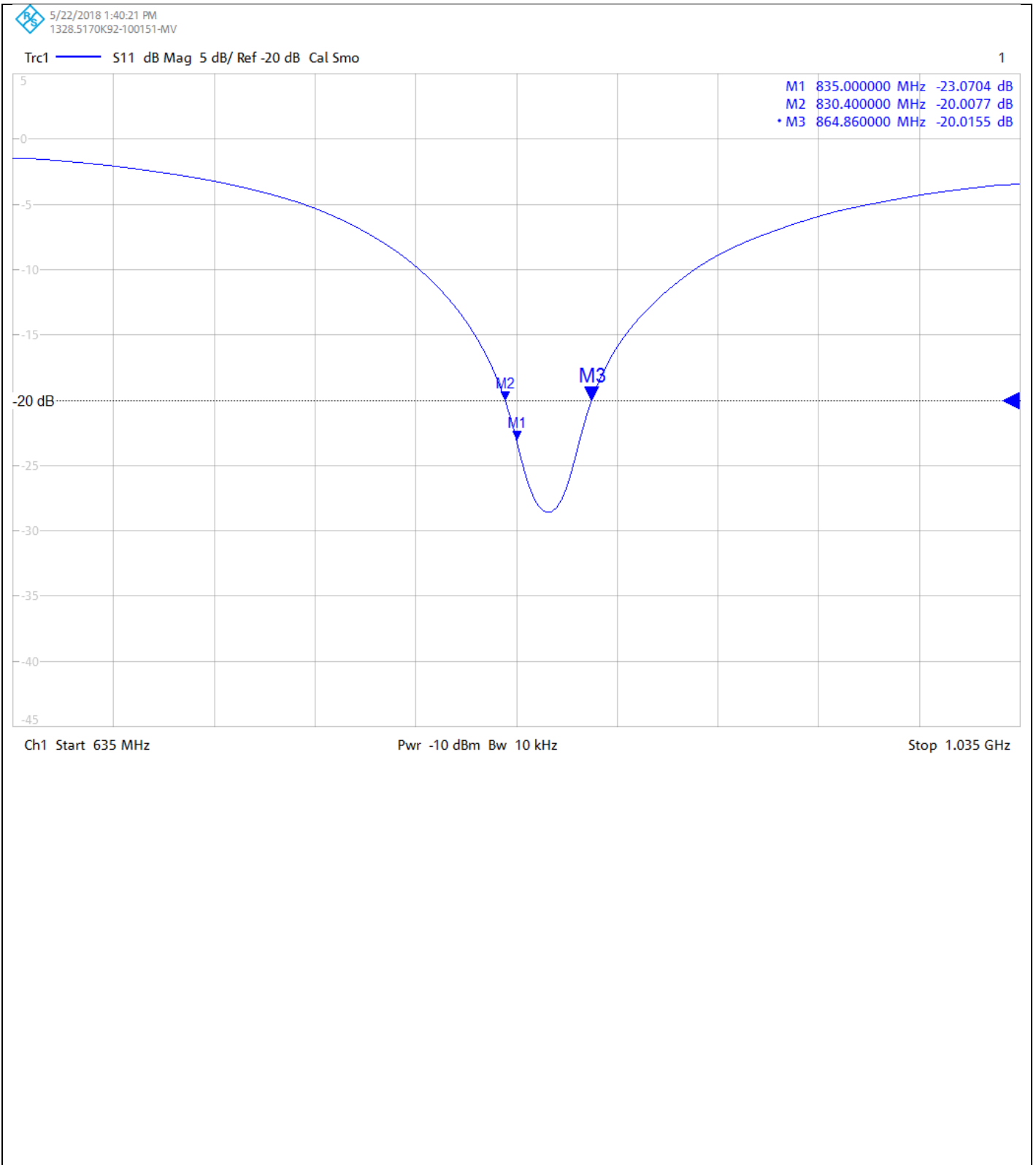
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248


CERTIFICATE  
NUMBER :  
12134282JD01B


Page 10 of 10


### Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



**Calibration Certificate Label:**

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134282JD01B</p> <p>Instrument ID: 4d117</p> <p>Calibration Date: 08/Jun/2018</p> <p>Calibration Due Date:</p>
--	--

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134282JD01B</p> <p>Instrument ID: 4d117</p> <p>Calibration Date: 08/Jun/2018</p> <p>Calibration Due Date:</p>
--	--

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134282JD01B</p> <p>Instrument ID: 4d117</p> <p>Calibration Date: 08/Jun/2018</p> <p>Calibration Due Date:</p>
--	--

# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 12/Apr/2018

CERTIFICATE NUMBER : 12134278JD01A



5248

UL VS LTD  
PAVILION A  
ASHWOOD PARK, ASHWOOD WAY  
BASINGSTOKE, HAMPSHIRE  
RG23 8BG, 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. Naseer'.

.....  
Naseer Mirza

## Customer :

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

## Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	10/Apr/2018
Manufacturer:	Speag		
Type/Model Number:	D1750V2		
Serial Number:	1050		
Calibration Date:	10/Apr/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		

Signature:

A handwritten signature in black ink, appearing to be a stylized 'C' followed by 'T'.

.....

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

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

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 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)
A2110	Data Acquisition Electronics	SPEAG	DAE4	431	08 Nov 2017	12
A2077	Probe	SPEAG	EX3DV4	3814	28 Sep 2017	12
A1236	Dipole	SPEAG	D1800V2	2d009	06 Feb 2018	12
PRE0151451	Power Monitoring Kit	Art-Fi SAS	ART 100850-01	0001	Cal as part of System	12
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	05 Feb 2018	12
M1015	Network Analyser	Agilent Technologies	8753ES	US39172406	12 Oct 2017	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	14 Dec 2017	12
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947-Bt	09 May 2017	12
M1838	Signal Generator	Rhode & Schwarz	SME06	831377/005	22 Mar 2018	12



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

Page 3 of 10

### 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:	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	21.0 °C	22.0 °C	21.0°C	21.0°C	$\epsilon_r$	40.10	40.34	± 5%
						$\sigma$	1.37	1.36	± 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	9.17 W/Kg	<b>36.50 W/Kg</b>	± 17.57%
	SAR averaged over 10g	4.88 W/Kg	<b>19.42 W/Kg</b>	± 17.32%

### Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.755 $\Omega$ 1.33 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	34.43	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

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	1750	22.0 °C	22.0 °C	21.4°C	21.5°C	$\epsilon_r$	53.40	53.92	± 5%
						$\sigma$	1.49	1.49	± 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	9.34 W/Kg	<b>37.18 W/Kg</b>	± 18.06%
	SAR averaged over 10g	4.96 W/Kg	<b>19.74 W/Kg</b>	± 17.44%

### Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	51.45 $\Omega$ 4.19 $j\Omega$	± 0.28 $\Omega$ ± 0.044 $j\Omega$
	Return Loss	26.60	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

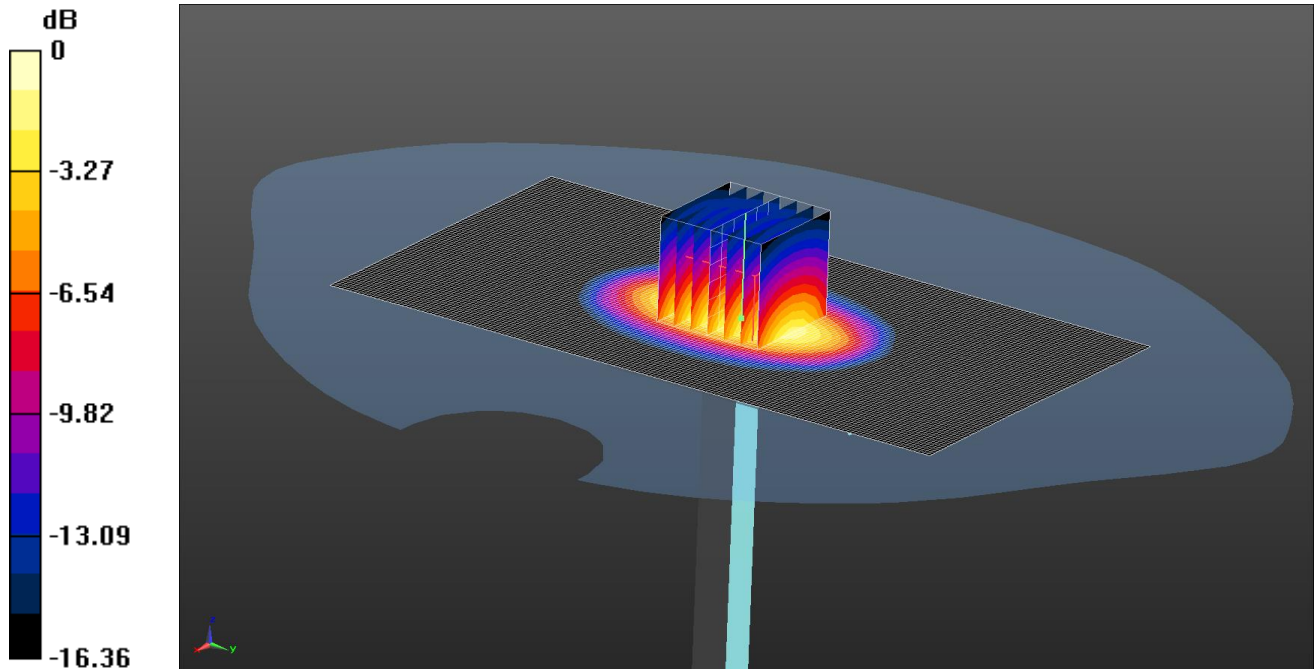
UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

Page 5 of 10

### DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1750V2 - SN1050; Type: D1750V2; Serial: SN1050



0 dB = 11.6 W/kg = 10.64 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1750 MHz; Duty Cycle: 1:1  
Medium: 1800 MHz HSL Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.365$  S/m;  $\epsilon_r = 40.338$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
DASY4 Configuration:  
- Probe: EX3DV4 - SN3814; ConvF(8.11, 8.11, 8.11); Calibrated: 28/09/2017;  
- Sensor-Surface: 3mm (Mechanical Surface Detection)  
- Electronics: DAE4 Sn431; Calibrated: 08/11/2017  
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CC; Serial: TP:1832  
- ; SEMCAD X Version 14.6.10 (7372)

**Configuration/d=10mm, Pin=250mW/Area Scan (81x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm  
Maximum value of SAR (interpolated) = 11.8 W/kg  
**Configuration/d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 91.06 V/m; Power Drift = 0.05 dB  
Peak SAR (extrapolated) = 16.7 W/kg  
**SAR(1 g) = 9.17 W/kg; SAR(10 g) = 4.88 W/kg**  
Maximum value of SAR (measured) = 11.6 W/kg

# CERTIFICATE OF CALIBRATION

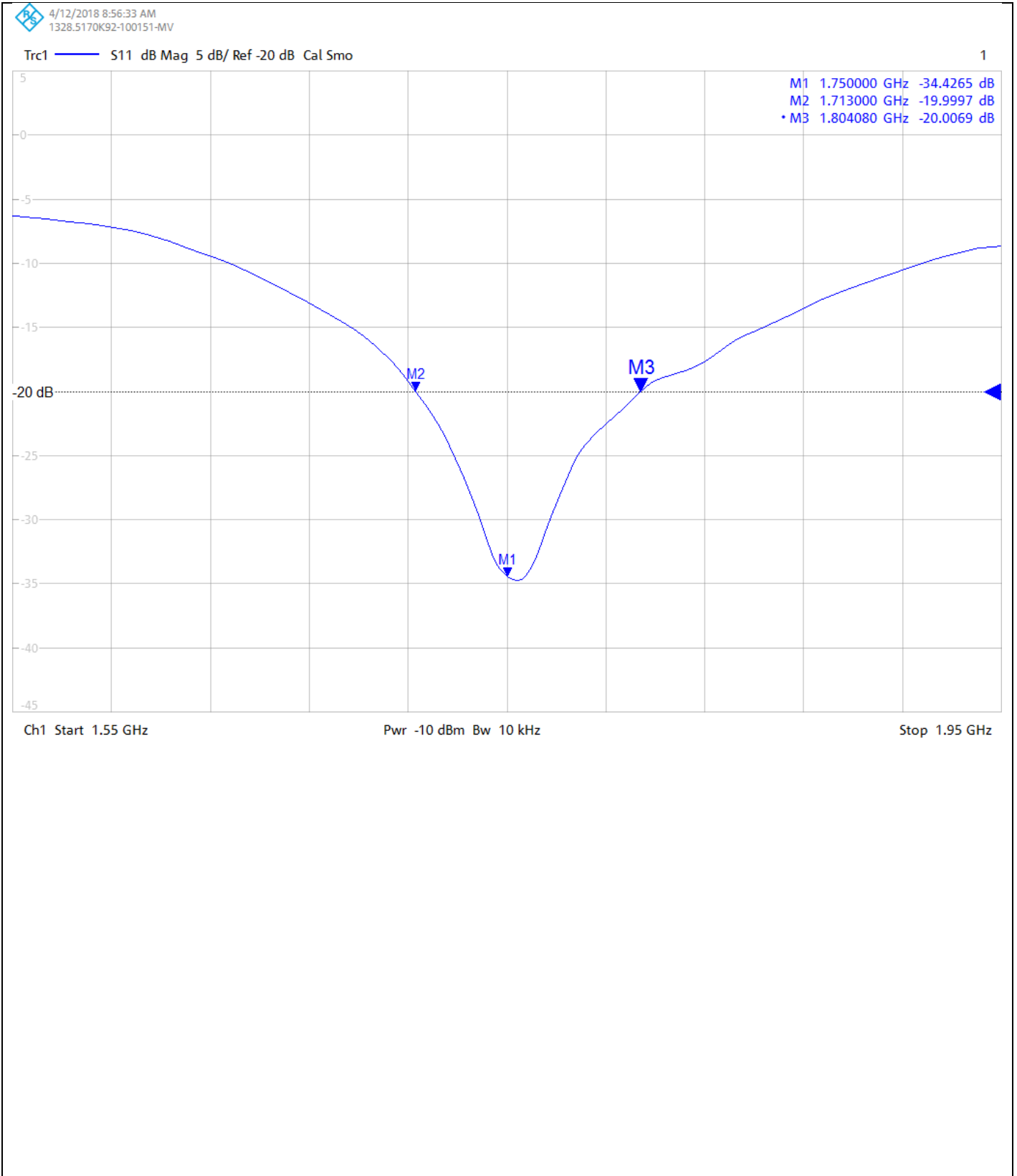
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

Page 6 of 10

### Impedance Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

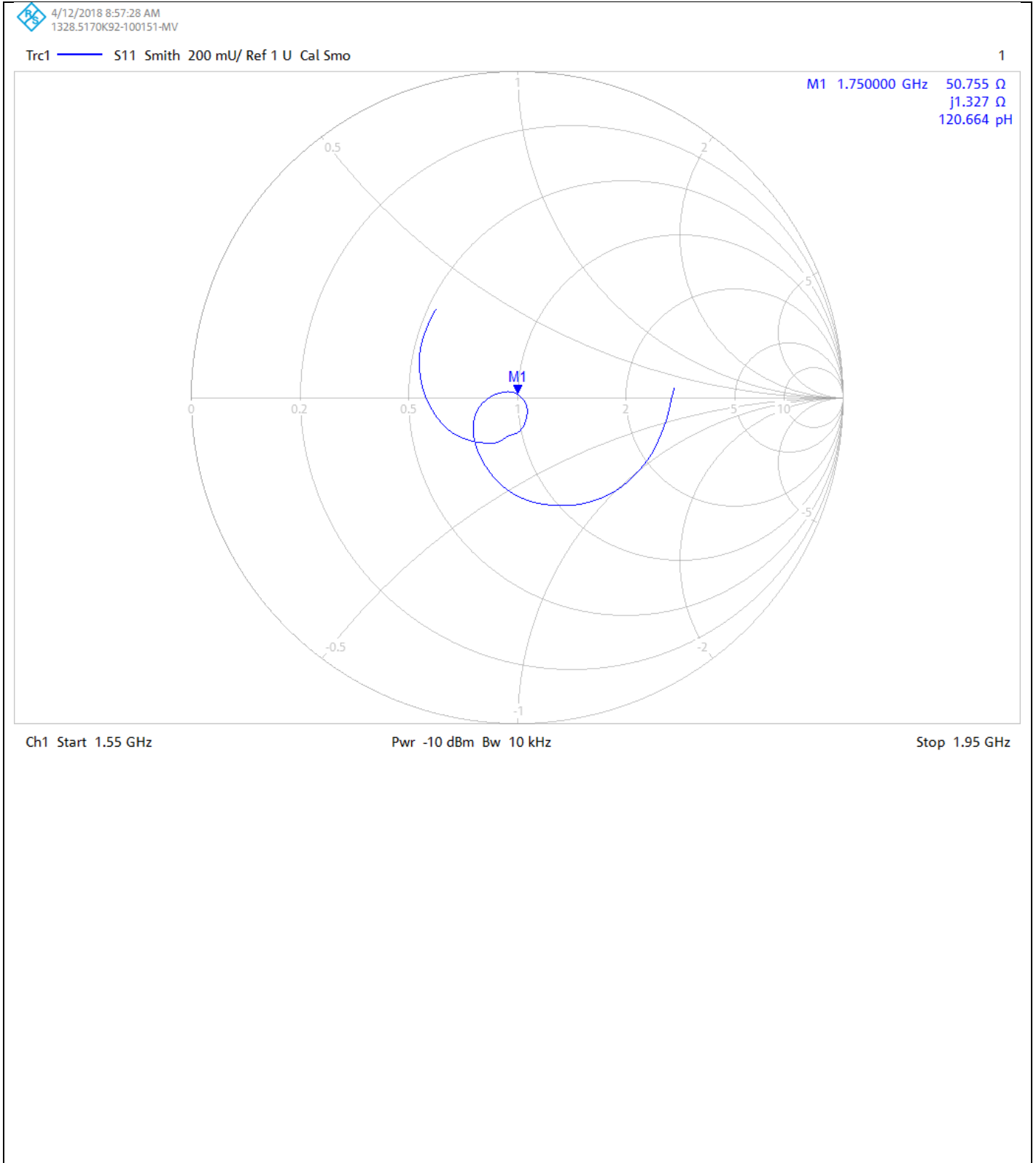
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

Page 7 of 10

### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

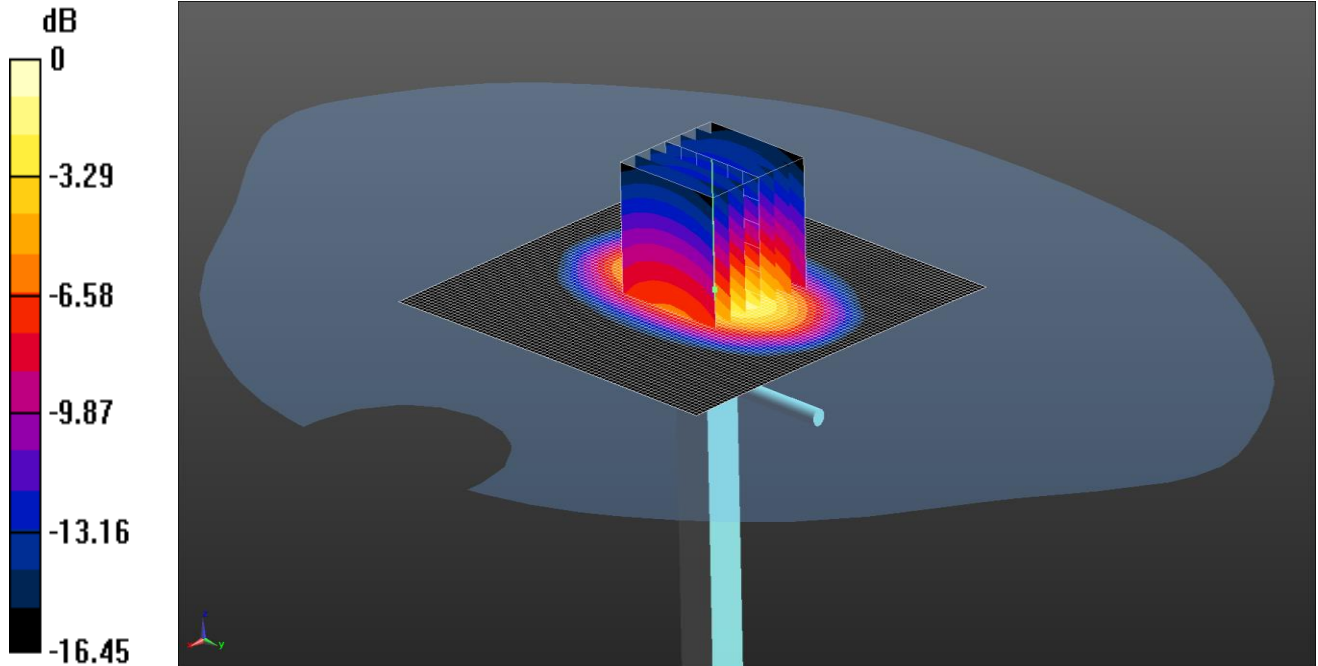
UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

Page 8 of 10

### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D1750V2 - SN1050; Type: D1750V2; Serial: SN1050



0 dB = 13.3 W/kg = 11.24 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1750 MHz; Duty Cycle: 1:1  
Medium: 1800 MHz MSL Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.491$  S/m;  $\epsilon_r = 53.919$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
DASY4 Configuration:  
- Probe: EX3DV4 - SN3814; ConvF(7.83, 7.83, 7.83); Calibrated: 28/09/2017;  
- Sensor-Surface: 4mm (Mechanical Surface Detection), Sensor-Surface: 2mm (Mechanical Surface Detection)  
- Electronics: DAE4 Sn431; Calibrated: 08/11/2017  
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CC; Serial: TP:1832  
- ; SEMCAD X Version 14.6.10 (7372)

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

Maximum value of SAR (interpolated) = 10.7 W/kg

**Configuration/d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 83.86 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 16.8 W/kg

**SAR(1 g) = 9.34 W/kg; SAR(10 g) = 4.96 W/kg**

Maximum value of SAR (measured) = 13.3 W/kg

# CERTIFICATE OF CALIBRATION

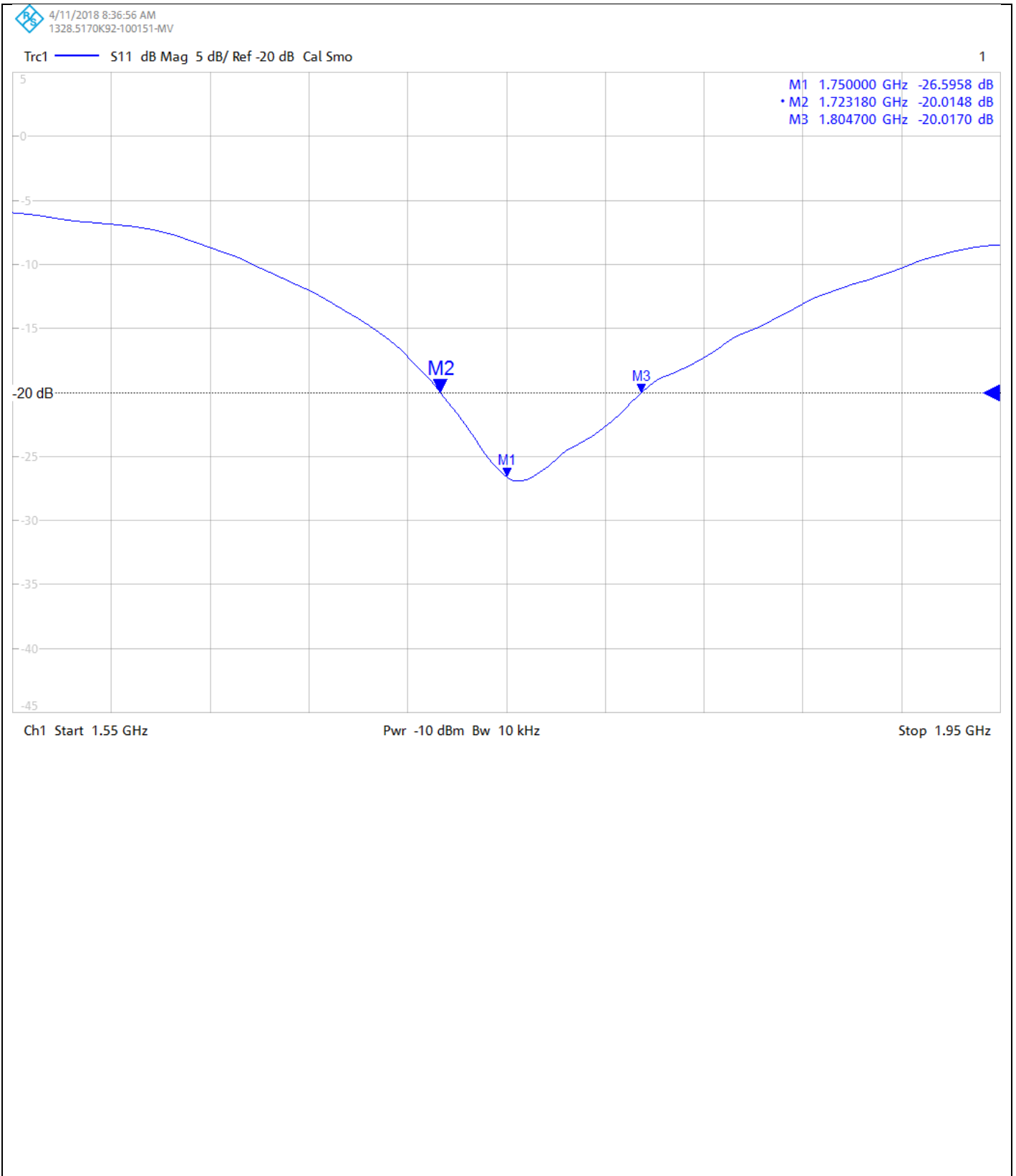
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A

Page 9 of 10

### Impedance Measurement Plot for Body Stimulating Liquid (MSL)



# CERTIFICATE OF CALIBRATION

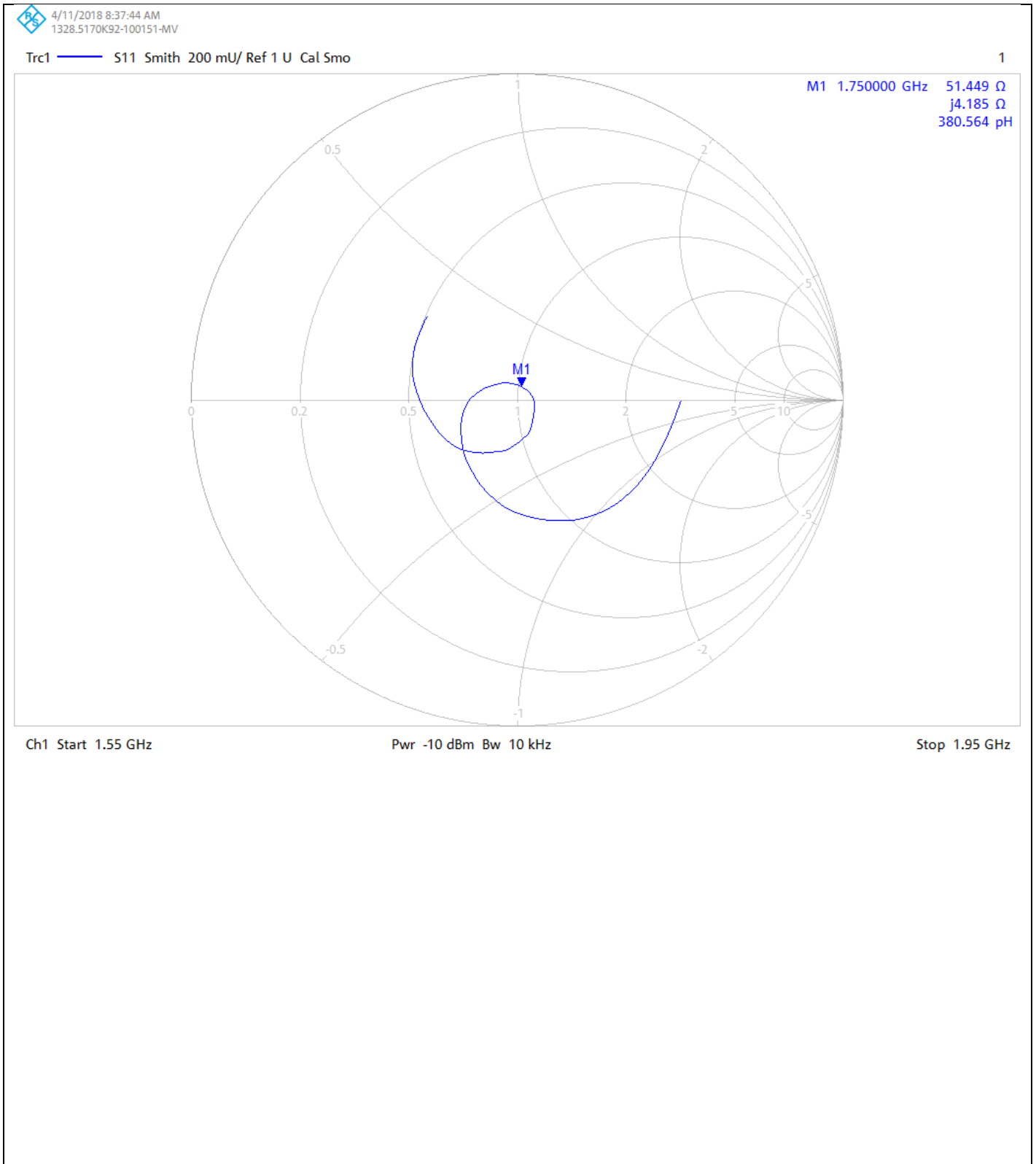
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01A


Page 10 of 10


### Return Loss Measurement Plot for Body Stimulating Liquid (MSL)






**Calibration Certificate Label:**

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134278JD01A</p> <p>Instrument ID: 1050</p> <p>Calibration Date: 10/Apr/2018</p> <p>Calibration Due Date:</p>
--	---

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134278JD01A</p> <p>Instrument ID: 1050</p> <p>Calibration Date: 10/Apr/2018</p> <p>Calibration Due Date:</p>
--	---

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134278JD01A</p> <p>Instrument ID: 1050</p> <p>Calibration Date: 10/Apr/2018</p> <p>Calibration Due Date:</p>
--	---

# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 16/Oct/2018

CERTIFICATE NUMBER : 12134285JD01B



**5248**

UL VS LTD  
UNIT 1 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**

.....  
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:	D1750V2		
Serial Number:	1077		
Calibration Date:	16/Oct/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		

Signature:

.....

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

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01B

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 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
A1236	Dipole	SPEAG	D1800V2	2d009	06 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

# CERTIFICATE OF CALIBRATION

## ISSUED BY **UL VS LTD**

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01B

Page 3 of 10

### SAR System Specification

<b>Robot System Positioner:</b>	Stäubli Unimation Corp. Robot Model: TX60L
<b>Robot Serial Number:</b>	F17/5ENYG1/A/01
<b>DASY Version:</b>	DASY 52 (v52.8.8.1258)
<b>Phantom:</b>	Flat section of SAM Twin Phantom
<b>Distance Dipole Centre:</b>	10 mm (with spacer)
<b>Frequency:</b>	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	22.2 °C	22.5 °C	22.0°C	22.0°C	$\epsilon_r$	40.10	39.65	± 5%
						$\sigma$	1.37	1.40	± 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	9.72 W/Kg	<b>38.69 W/Kg</b>	± 17.57%
	SAR averaged over 10g	5.14 W/Kg	<b>20.46 W/Kg</b>	± 17.32%

### Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.453 $\Omega$ -1.52 $j\Omega$	± 0.28 $\Omega$ ± 0.044 $j\Omega$
	Return Loss	36.26	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY **UL VS LTD**

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01B

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	1750	20.0 °C	21.0 °C	19.9°C	20.2°C	$\epsilon_r$	53.40	53.30	± 5%
						$\sigma$	1.49	1.47	± 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	9.87 W/Kg	<b>39.29 W/Kg</b>	± 18.06%
	SAR averaged over 10g	5.29 W/Kg	<b>21.05 W/Kg</b>	± 17.44%

### Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	49.46 $\Omega$ 4.07 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	27.66	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

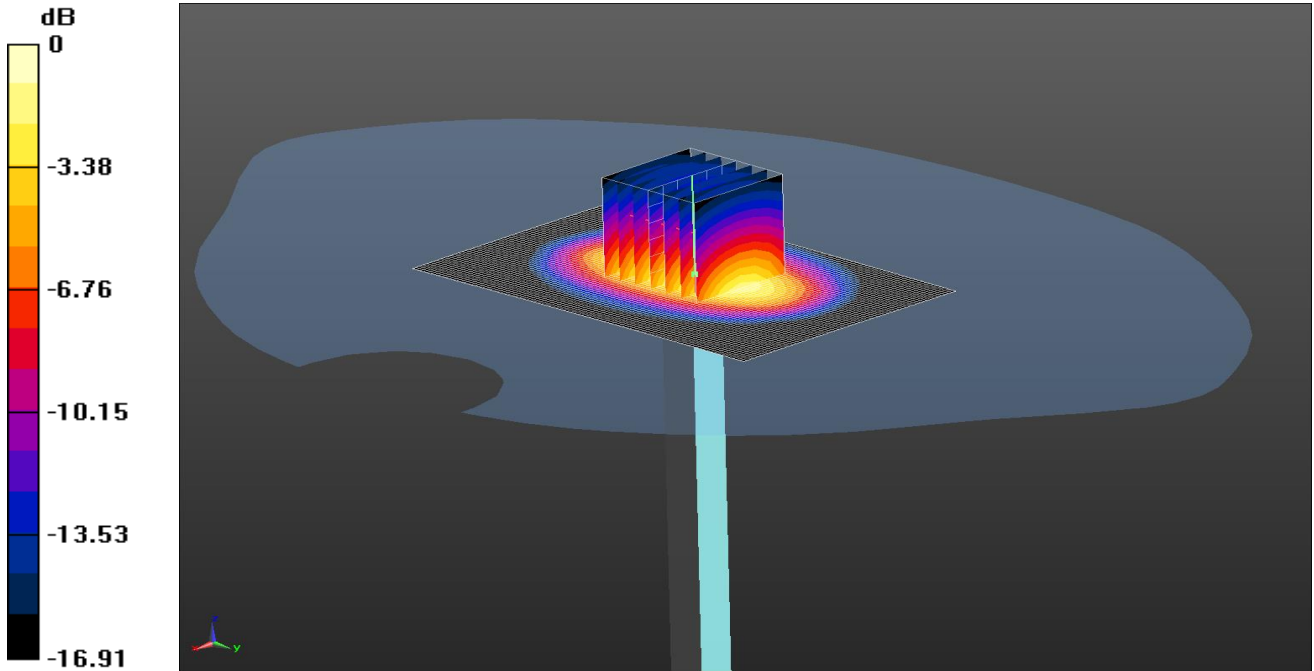
CERTIFICATE  
NUMBER :  
12134285JD01B

UKAS Accredited Calibration Laboratory No. 5248

Page 5 of 10

### DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1750V2 - SN1077; Type: D1750V2; Serial: SN1077



0 dB = 12.4 W/kg = 10.93 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1750 MHz; Duty Cycle: 1:1

Medium: 900, 1750, 1800, 2600 5% MHz HSL Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.399$  S/m;  $\epsilon_r = 39.653$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3360; ConvF(5.27, 5.27, 5.27); 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 2/Area Scan (61x91x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 12.4 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 = 97.18 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 17.8 W/kg

**SAR(1 g) = 9.72 W/kg; SAR(10 g) = 5.14 W/kg**

Maximum value of SAR (measured) = 12.4 W/kg

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
12134285JD01B

UKAS Accredited Calibration Laboratory No. 5248

Page 6 of 10

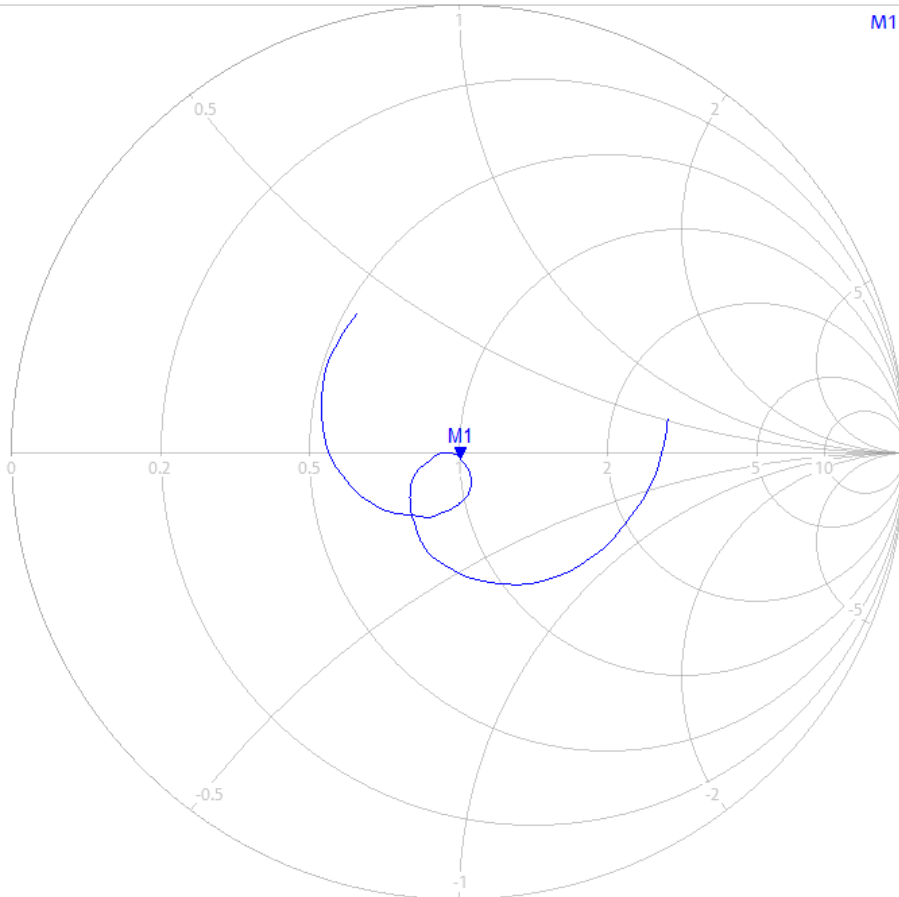
### Impedance Measurement Plot for Head Stimulating Liquid (HSL)

10/12/2018 10:56:31 AM  
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

M1 1.750000 GHz 50.453  $\Omega$   
-j1.521  $\Omega$   
59.778 pF



Ch1 Center 1.75 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

# CERTIFICATE OF CALIBRATION

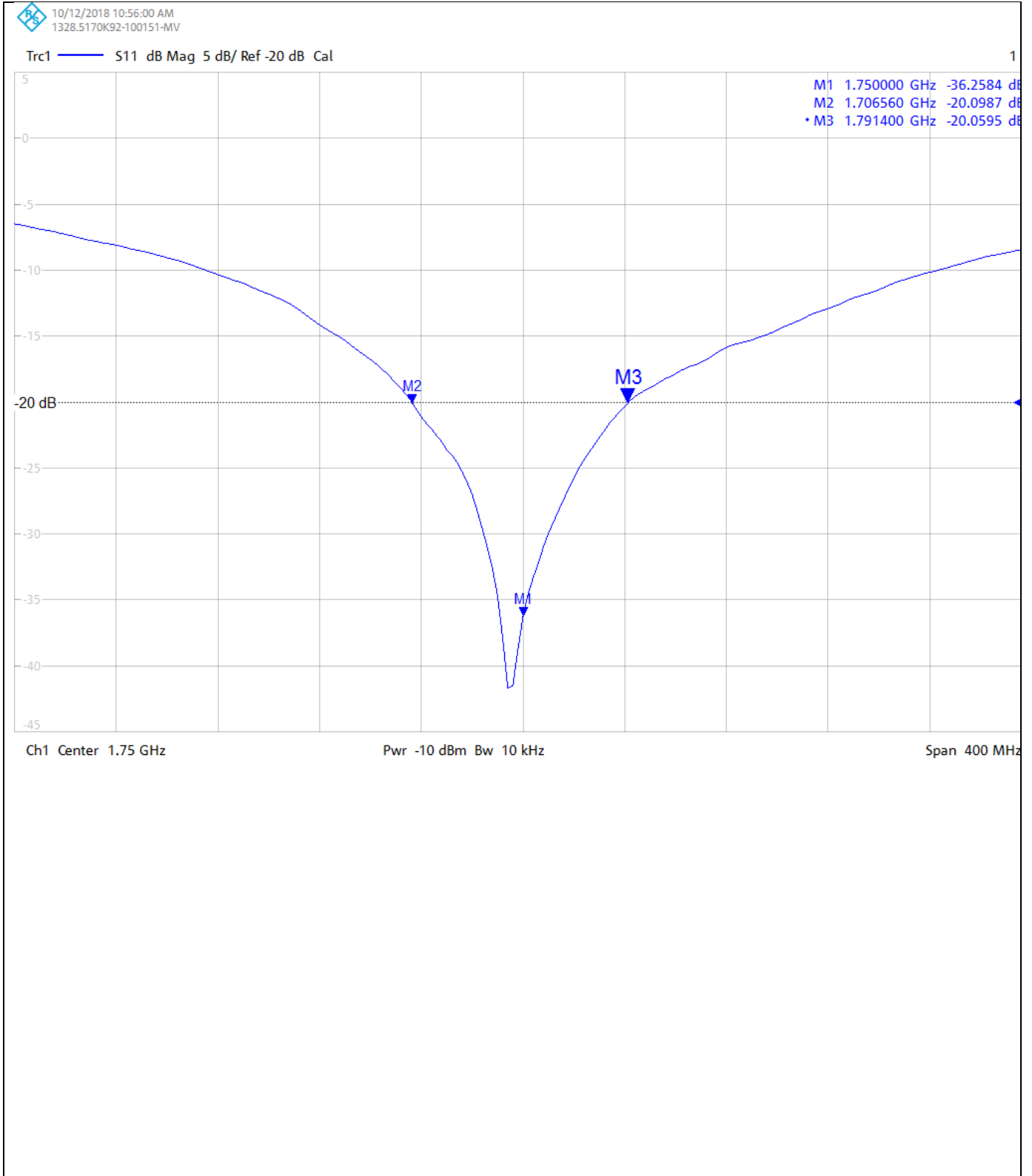
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01B

Page 7 of 10

### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)





# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

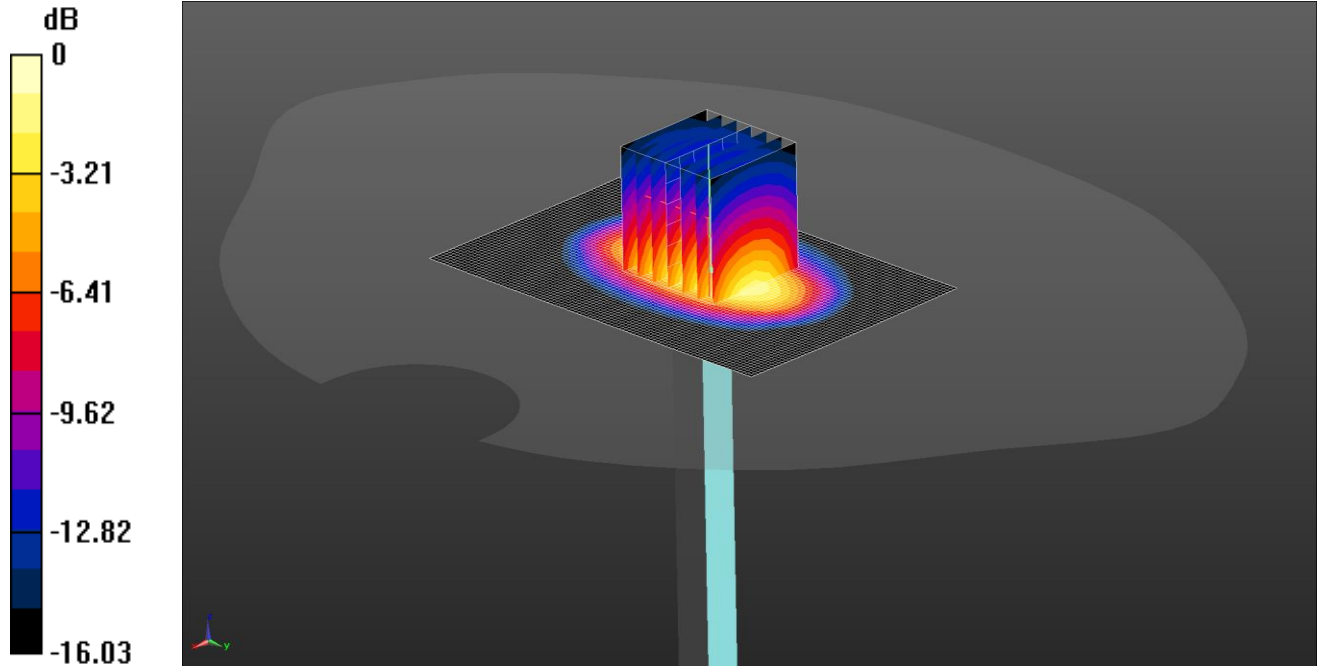
CERTIFICATE  
NUMBER :  
12134285JD01B

UKAS Accredited Calibration Laboratory No. 5248

Page 8 of 10

### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D1750V2 - SN1077; Type: D1750V2; Serial: SN1077



0 dB = 12.5 W/kg = 10.97 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1750 MHz; Duty Cycle: 1:1  
Medium: 900, 1750, 1800, 1900 5% MHz MSL Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.477$  S/m;  $\epsilon_r = 53.299$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3360; ConvF(4.92, 4.92, 4.92); 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 2 /Area Scan (61x91x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 13.0 W/kg

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

Reference Value = 94.90 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 17.5 W/kg

**SAR(1 g) = 9.87 W/kg; SAR(10 g) = 5.29 W/kg**

Maximum value of SAR (measured) = 12.5 W/kg

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
12134285JD01B

UKAS Accredited Calibration Laboratory No. 5248

Page 9 of 10

### Impedance Measurement Plot for Body Stimulating Liquid (MSL)

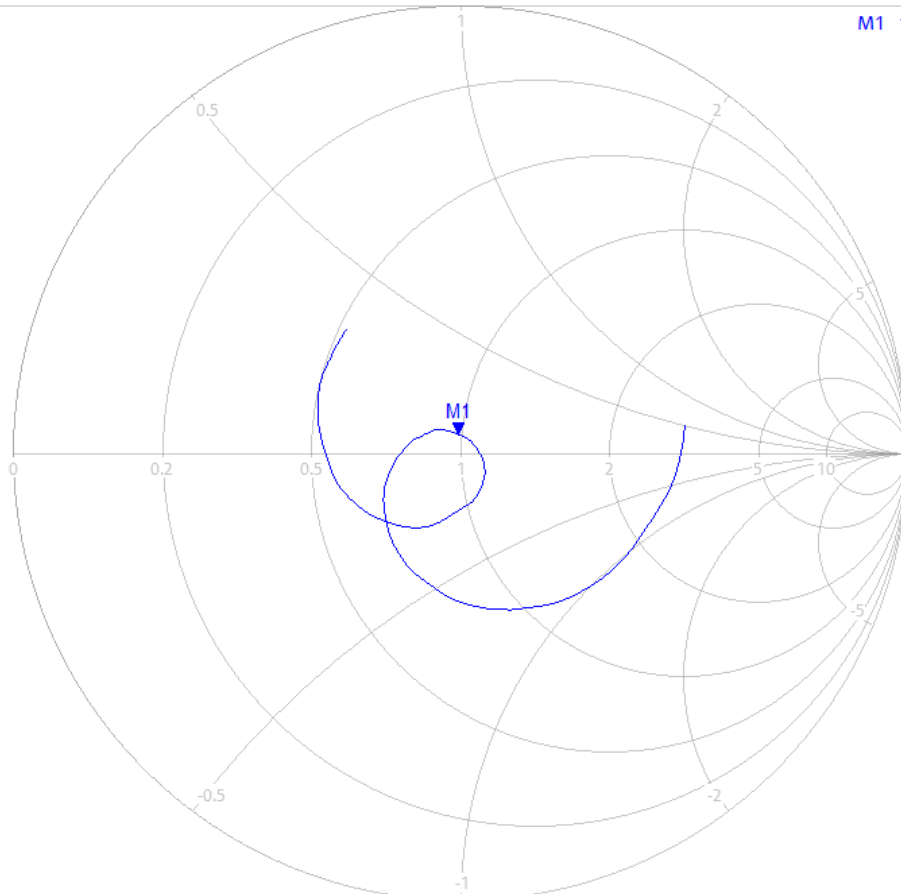


10/15/2018 2:17:54 PM  
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

M1 1.750000 GHz 49.460  $\Omega$   
j4.073  $\Omega$   
370.398 pF



Ch1 Center 1.75 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

# CERTIFICATE OF CALIBRATION

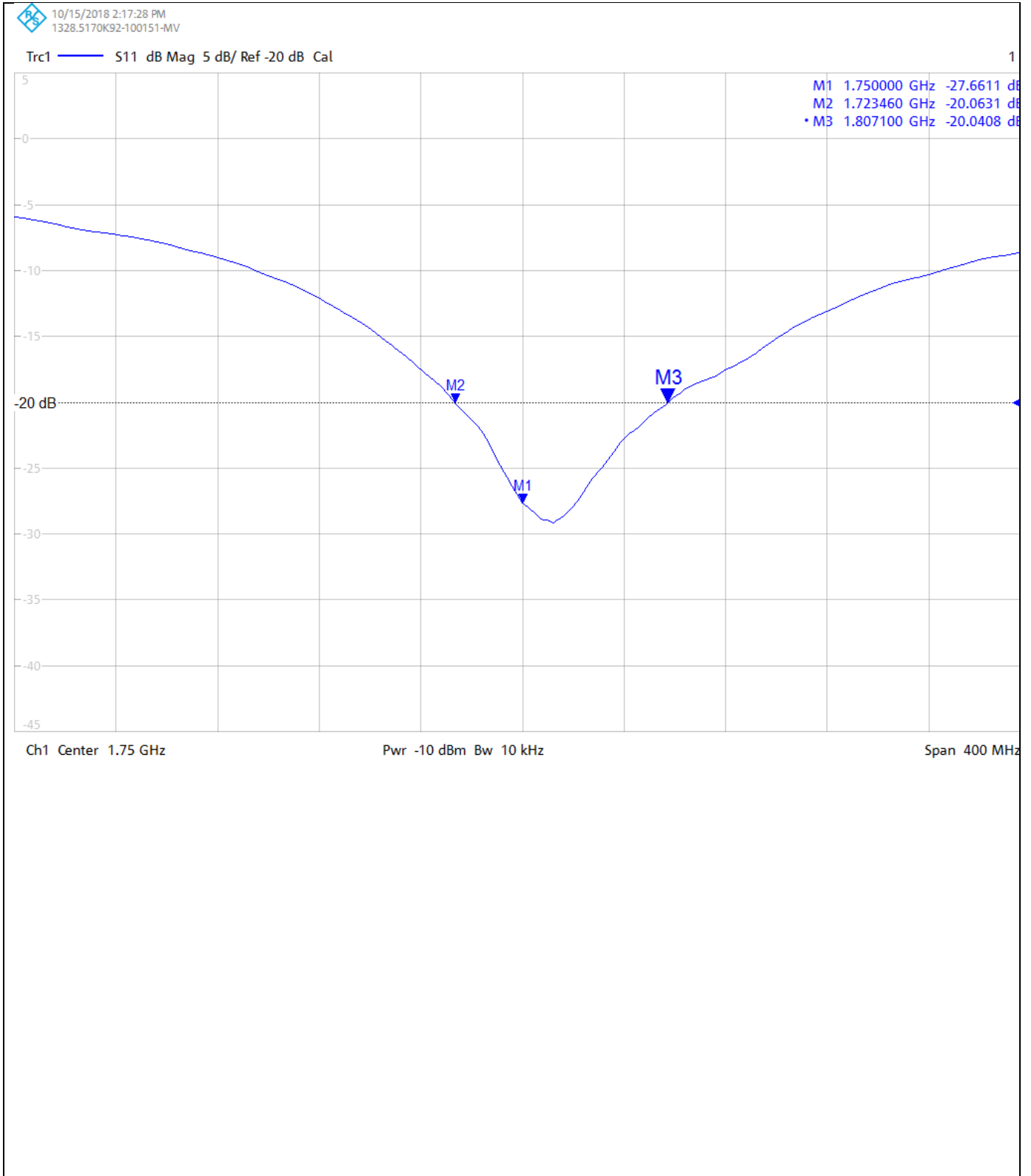
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248


CERTIFICATE  
NUMBER :  
12134285JD01B


Page 10 of 10


### Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



**Calibration Certificate Label:**

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134285JD01B</p> <p>Instrument ID: 1077</p> <p>Calibration Date: 16/Oct/2018</p> <p>Calibration Due Date:</p>
--	---

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134285JD01B</p> <p>Instrument ID: 1077</p> <p>Calibration Date: 16/Oct/2018</p> <p>Calibration Due Date:</p>
--	---

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134285JD01B</p> <p>Instrument ID: 1077</p> <p>Calibration Date: 16/Oct/2018</p> <p>Calibration Due Date:</p>
--	---

# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 16/Oct/2018

CERTIFICATE NUMBER : 12134285JD01D



5248

UL VS LTD  
UNIT 1 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**

.....  
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:	D1900V2		
Serial Number:	5d163		
Calibration Date:	16/Oct/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		

Signature:

.....

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

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01D

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 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
PRE0178326	Dipole	SPEAG	D1900V2	5d227	07 Mar 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

# CERTIFICATE OF CALIBRATION

## ISSUED BY **UL VS LTD**

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01D

Page 3 of 10

### SAR System Specification

<b>Robot System Positioner:</b>	Stäubli Unimation Corp. Robot Model: TX60L
<b>Robot Serial Number:</b>	F17/5ENYG1/A/01
<b>DASY Version:</b>	DASY 52 (v52.8.8.1258)
<b>Phantom:</b>	Flat section of SAM Twin Phantom
<b>Distance Dipole Centre:</b>	10 mm (with spacer)
<b>Frequency:</b>	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	22.0 °C	22.0 °C	21.1 °C	21.5 °C	$\epsilon_r$	40.00	39.71	± 5%
						$\sigma$	1.40	1.44	± 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	10.60 W/Kg	<b>42.19 W/Kg</b>	± 17.57%
	SAR averaged over 10g	5.46 W/Kg	<b>21.73 W/Kg</b>	± 17.32%

### Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	47.246 $\Omega$ -3.29 $j\Omega$	± 0.28 $\Omega$ ± 0.044 $j\Omega$
	Return Loss	27.20	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01D

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	20.0 °C	21.0 °C	19.9°C	20.5°C	$\epsilon_r$	53.30	53.10	± 5%
						$\sigma$	1.52	1.58	± 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	10.70 W/Kg	<b>42.59 W/Kg</b>	± 18.06%
	SAR averaged over 10g	5.57 W/Kg	<b>22.17 W/Kg</b>	± 17.44%

### Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	52.08 $\Omega$ -5.44 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	25.11	± 2.03 dB



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

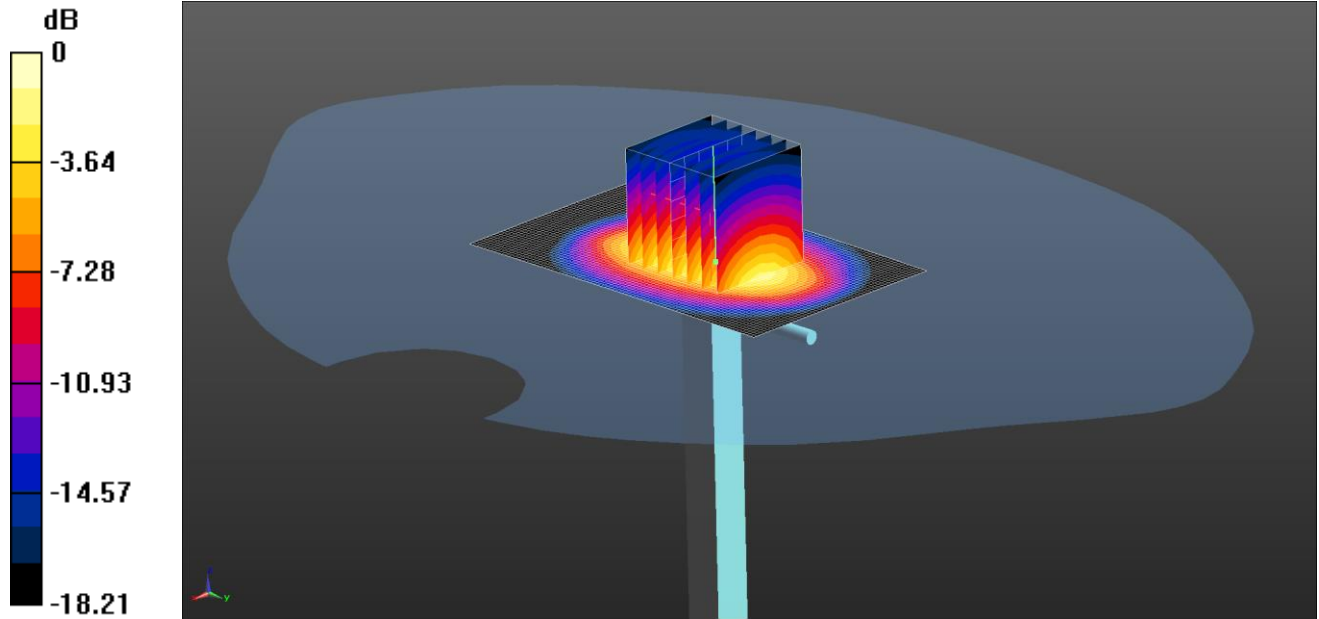
CERTIFICATE  
NUMBER :  
12134285JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 5 of 10

### DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1900V2 - SN5d163; Type: D1900V2; Serial: SN5d163



0 dB = 13.5 W/kg = 11.30 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium: 1900 5% MHz HSL Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.444$  S/m;  $\epsilon_r = 39.709$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3360; ConvF(5.11, 5.11, 5.11); 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=250mW/Area Scan (51x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 13.8 W/kg

**SAR/d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.1 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 19.9 W/kg

**SAR(1 g) = 10.6 W/kg; SAR(10 g) = 5.46 W/kg**

Maximum value of SAR (measured) = 13.5 W/kg

# CERTIFICATE OF CALIBRATION ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
12134285JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 6 of 10

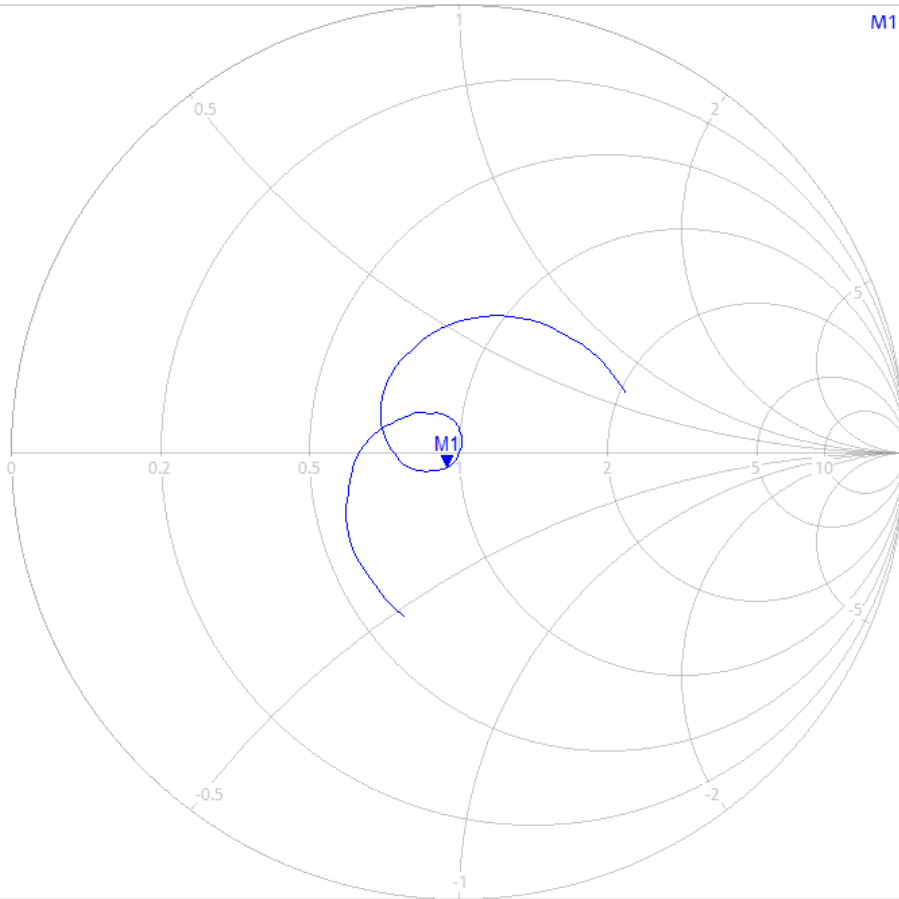
## Impedance Measurement Plot for Head Stimulating Liquid (HSL)

10/12/2018 10:39:17 AM  
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

M1 1.900000 GHz 47.246  $\Omega$   
-j3.287  $\Omega$   
25.480 pF



Ch1 Start 1.7 GHz

Pwr -10 dBm Bw 10 kHz

Stop 2.1 GHz

# CERTIFICATE OF CALIBRATION

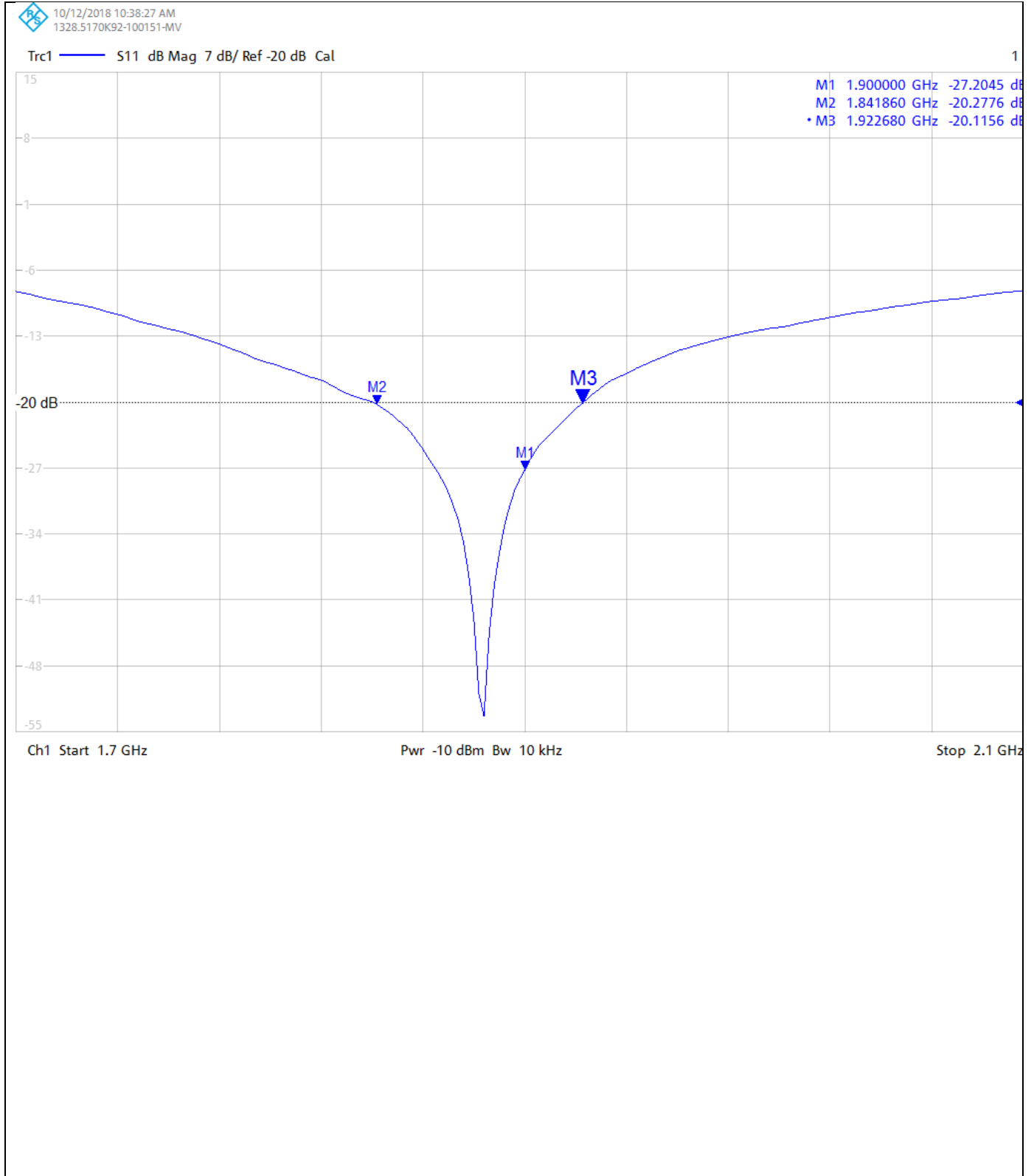
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134285JD01D

Page 7 of 10

### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

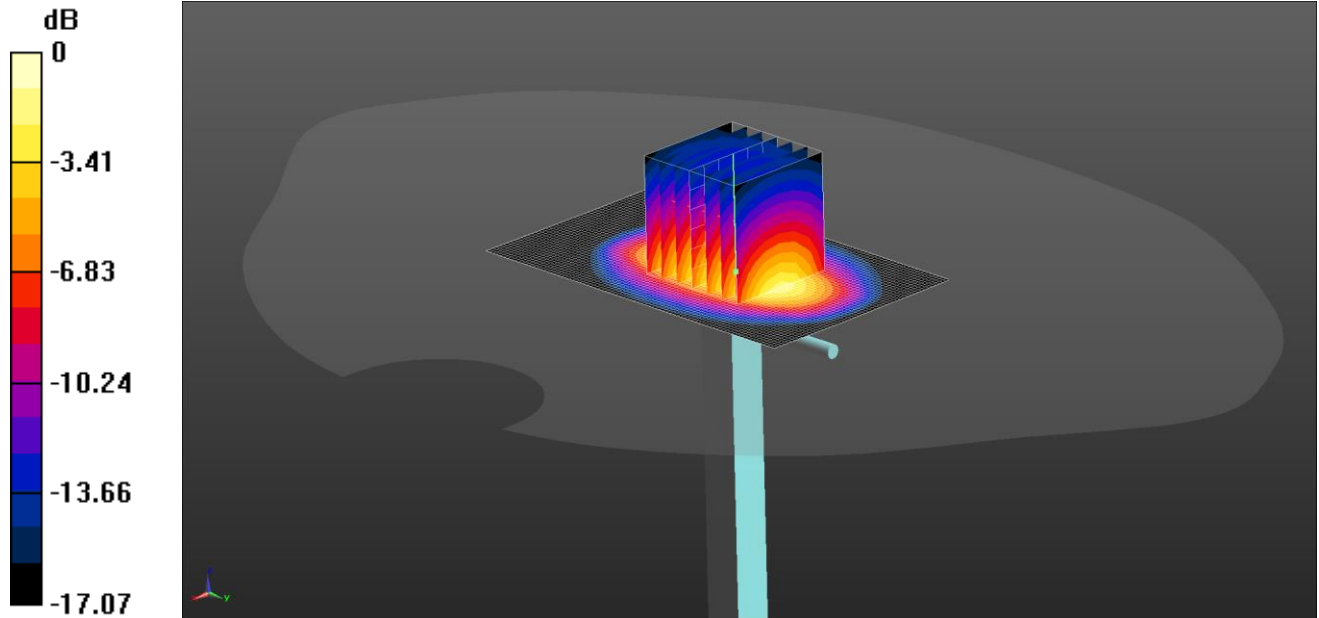
CERTIFICATE  
NUMBER :  
12134285JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 8 of 10

### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D1900V2 - SN5d163; Type: D1900V2; Serial: SN5d163



0 dB = 13.7 W/kg = 11.37 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium: 900, 1750, 1800, 1900 5% MHz MSL Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.583$  S/m;  $\epsilon_r = 53.097$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3360; ConvF(4.77, 4.77, 4.77); 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=250mW/Area Scan (51x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 14.3 W/kg

**SAR/d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 3.856 V/m; Power Drift = 0.19 dB

Peak SAR (extrapolated) = 19.2 W/kg

**SAR(1 g) = 10.7 W/kg; SAR(10 g) = 5.57 W/kg**

Maximum value of SAR (measured) = 13.7 W/kg

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
12134285JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 9 of 10

### Impedance Measurement Plot for Body Stimulating Liquid (MSL)

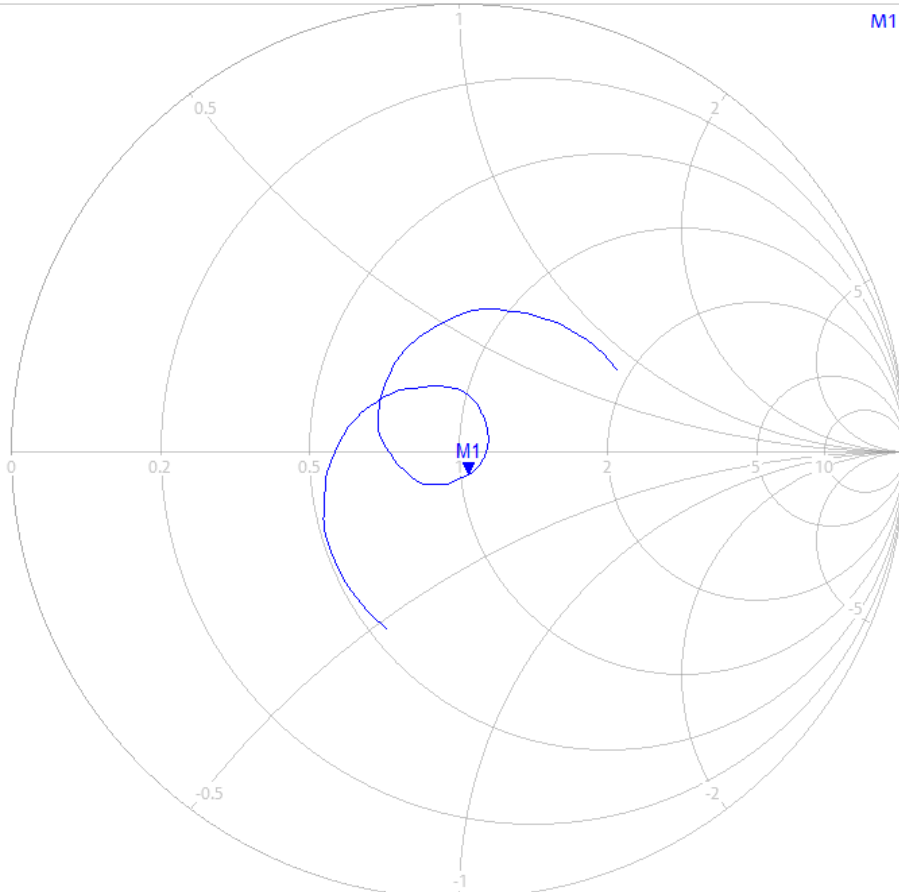


10/15/2018 2:06:28 PM  
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

M1 1.900000 GHz 52.082  $\Omega$   
-j5.437  $\Omega$   
15.408 pF



Ch1 Center 1.9 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

# CERTIFICATE OF CALIBRATION

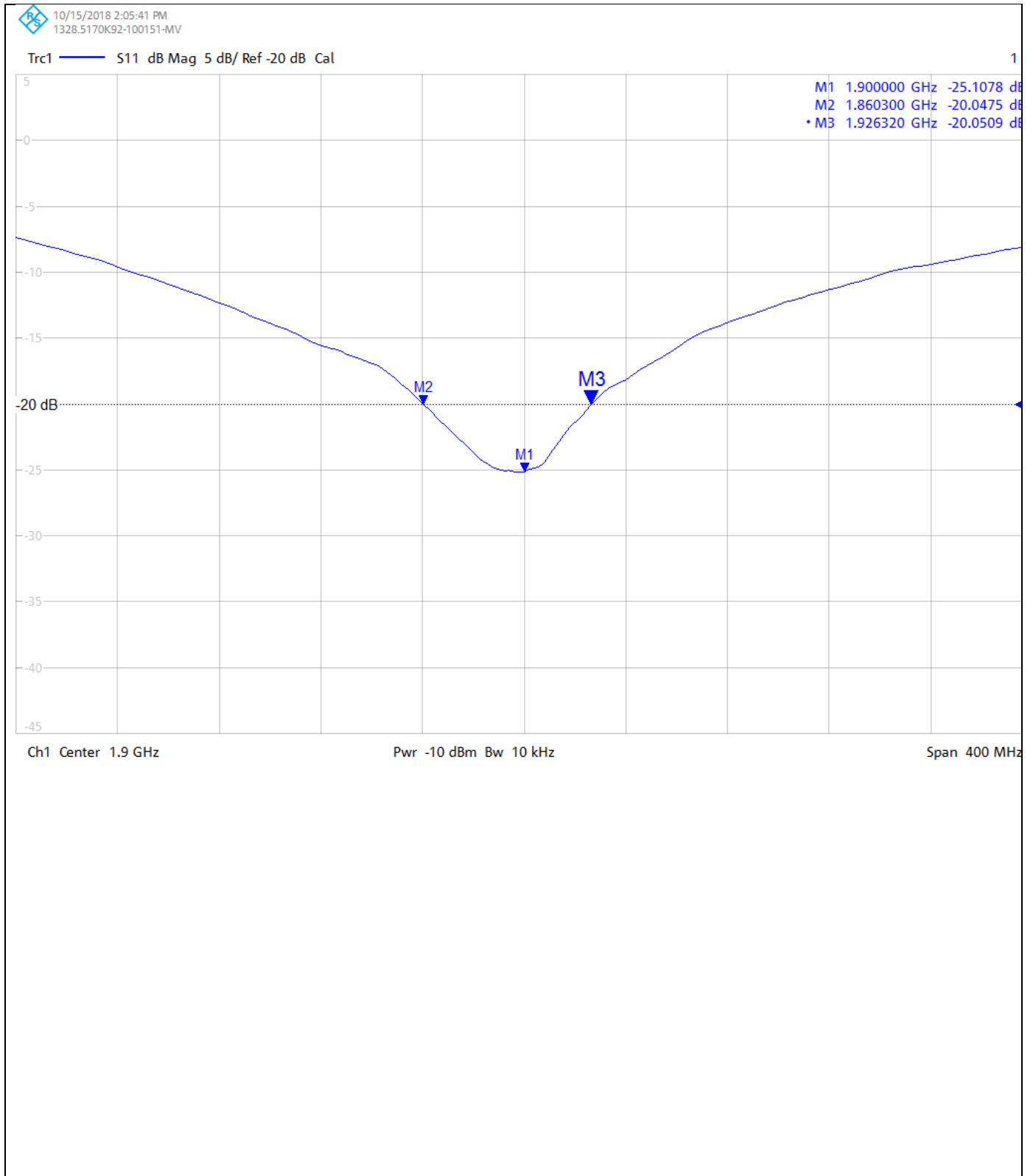
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248


CERTIFICATE  
NUMBER :  
12134285JD01D


Page 10 of 10


### Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



**Calibration Certificate Label:**

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134285JD01D</p> <p>Instrument ID: 5d163</p> <p>Calibration Date: 16/Oct/2018</p> <p>Calibration Due Date:</p>
--	--

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134285JD01D</p> <p>Instrument ID: 5d163</p> <p>Calibration Date: 16/Oct/2018</p> <p>Calibration Due Date:</p>
--	--

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134285JD01D</p> <p>Instrument ID: 5d163</p> <p>Calibration Date: 16/Oct/2018</p> <p>Calibration Due Date:</p>
--	--

# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 12/Apr/2018

CERTIFICATE NUMBER : 12134278JD01C



5248

UL VS LTD  
PAVILION A  
ASHWOOD PARK, ASHWOOD WAY  
BASINGSTOKE, HAMPSHIRE  
RG23 8BG, 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. Naseer'.

.....  
Naseer Mirza

## Customer :

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

## Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	10/Apr/2018
Manufacturer:	Speag		
Type/Model Number:	D1900V2		
Serial Number:	5d140		
Calibration Date:	11/Apr/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		

Signature:

A handwritten signature in black ink, appearing to be a stylized 'C' followed by 'T'.

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

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

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 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)
A2110	Data Acquisition Electronics	SPEAG	DAE4	431	08 Nov 2017	12
A2077	Probe	SPEAG	EX3DV4	3814	28 Sep 2017	12
A1237	Dipole	SPEAG	D1900V2	540	20 Sep 2018	12
PRE0151451	Power Monitoring Kit	Art-Fi SAS	ART 100850-01	0001	Cal as part of System	12
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	05 Feb 2018	12
M1015	Network Analyser	Agilent Technologies	8753ES	US39172406	12 Oct 2017	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	14 Dec 2017	12
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947-Bt	09 May 2017	12
M1838	Signal Generator	Rhode & Schwarz	SME06	831377/005	22 Mar 2018	12

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

Page 3 of 10

### 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:	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	22.0 °C	22.0 °C	24.0°C	22.0°C	$\epsilon_r$	40.00	39.15	± 5%
						$\sigma$	1.40	1.39	± 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	9.78 W/Kg	<b>38.93 W/Kg</b>	± 17.57%
	SAR averaged over 10g	5.06 W/Kg	<b>20.14 W/Kg</b>	± 17.32%

### Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	49.954 $\Omega$ -4.22 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	27.13	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

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	22.0 °C	22.0 °C	21.5°C	21.5°C	$\epsilon_r$	53.30	51.78	± 5%
						$\sigma$	1.52	1.57	± 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	10.30 W/Kg	<b>41.00 W/Kg</b>	± 18.06%
	SAR averaged over 10g	5.29 W/Kg	<b>21.05 W/Kg</b>	± 17.44%

### Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	52.40 $\Omega$ -5.72 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	23.22	± 2.03 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

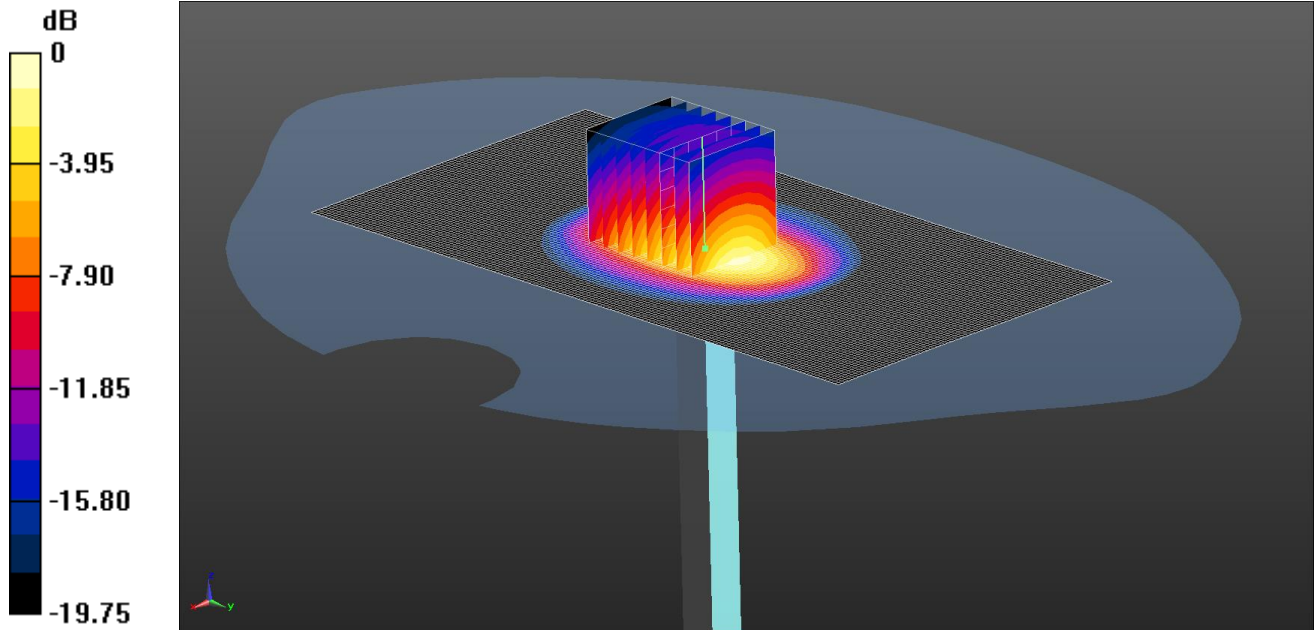
UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

Page 5 of 10

### DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D1900V2 - SN5d140; Type: D1900V2; Serial: SN5d140



0 dB = 12.4 W/kg = 10.93 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium: 1900 MHz MSL Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.392$  S/m;  $\epsilon_r = 39.154$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3814; ConvF(7.84, 7.84, 7.84); Calibrated: 28/09/2017;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn431; Calibrated: 08/11/2017
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CC; Serial: TP:1832
- ; SEMCAD X Version 14.6.10 (7372)

**SAR/d=10mm, Pin=250mW/Area Scan (81x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 12.9 W/kg

**SAR/d=10mm, Pin=250mW/Zoom Scan (5x5x7) (7x8x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.54 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 18.3 W/kg

**SAR(1 g) = 9.78 W/kg; SAR(10 g) = 5.06 W/kg**

Maximum value of SAR (measured) = 12.4 W/kg

# CERTIFICATE OF CALIBRATION

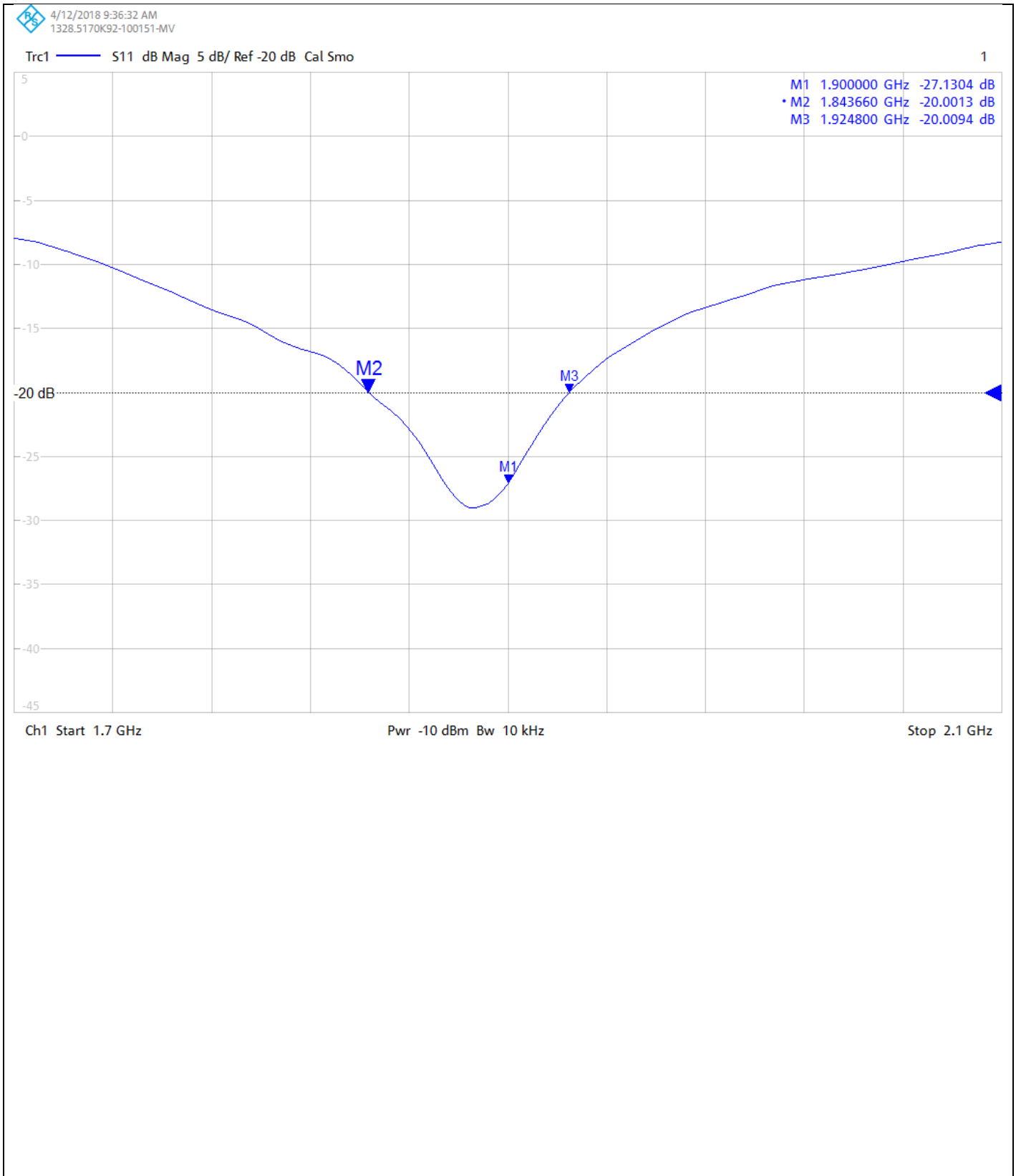
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

Page 6 of 10

### Impedance Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

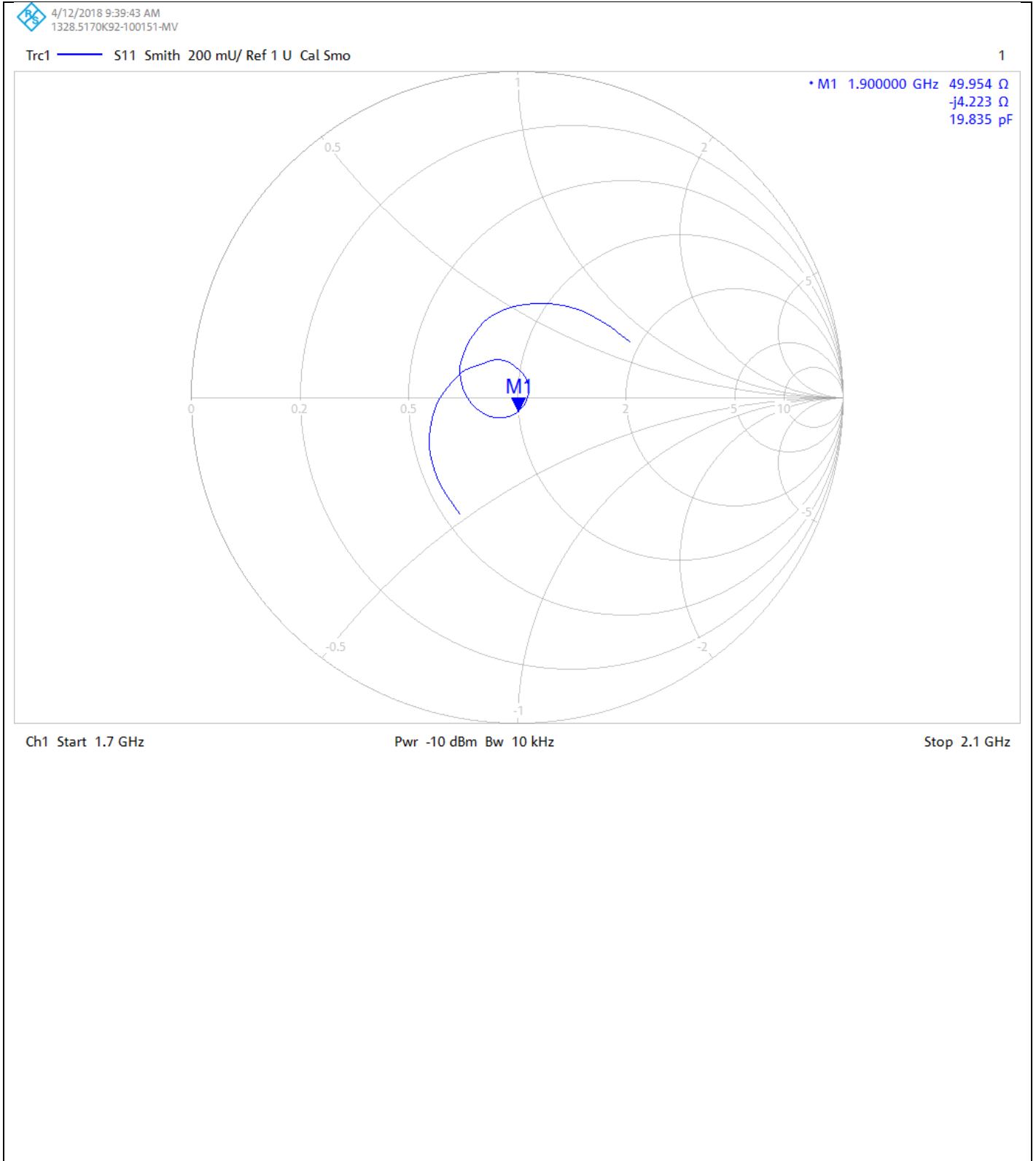
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

Page 7 of 10

### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

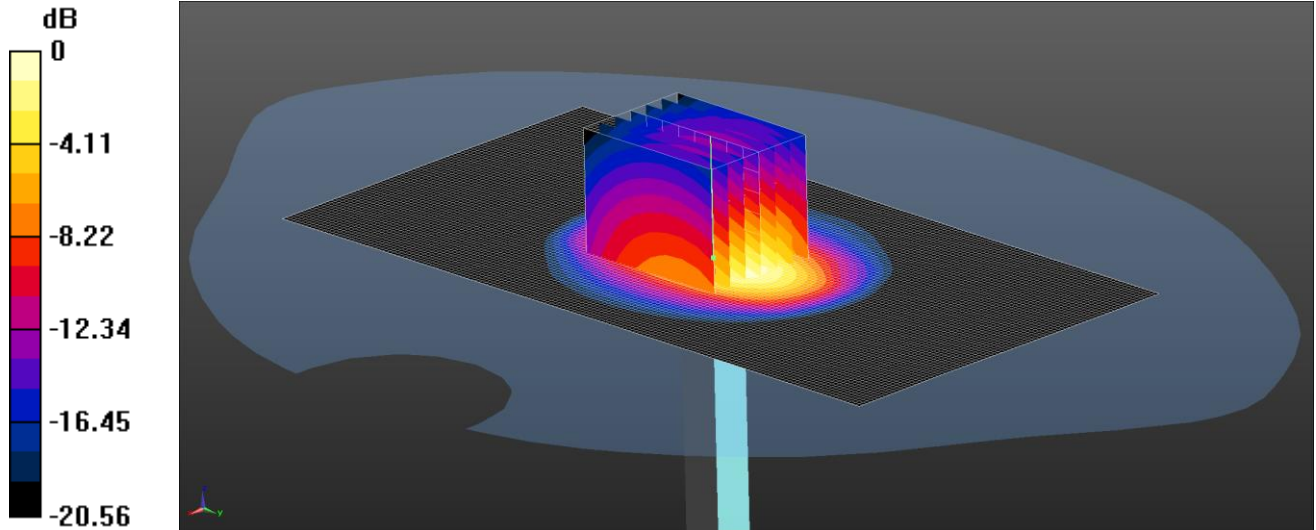
UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

Page 8 of 10

### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D1900V2 - SN5d140; Type: D1900V2; Serial: SN5d140



0 dB = 13.1 W/kg = 11.17 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium: 1900 MHz MSL Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.568$  S/m;  $\epsilon_r = 51.783$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
DASY4 Configuration:  
- Probe: EX3DV4 - SN3814; ConvF(7.57, 7.57, 7.57); Calibrated: 28/09/2017;  
- Sensor-Surface: 3mm (Mechanical Surface Detection)  
- Electronics: DAE4 Sn431; Calibrated: 08/11/2017  
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CC; Serial: TP:1832  
- ; SEMCAD X Version 14.6.10 (7372)

**SAR/d=10mm, Pin=250mW/Area Scan (81x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm  
Maximum value of SAR (interpolated) = 13.6 W/kg

**SAR/d=10mm, Pin=250mW/Zoom Scan (5x5x7) (7x9x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 91.82 V/m; Power Drift = 0.03 dB  
Peak SAR (extrapolated) = 19.1 W/kg  
**SAR(1 g) = 10.3 W/kg; SAR(10 g) = 5.29 W/kg**  
Maximum value of SAR (measured) = 13.1 W/kg

# CERTIFICATE OF CALIBRATION

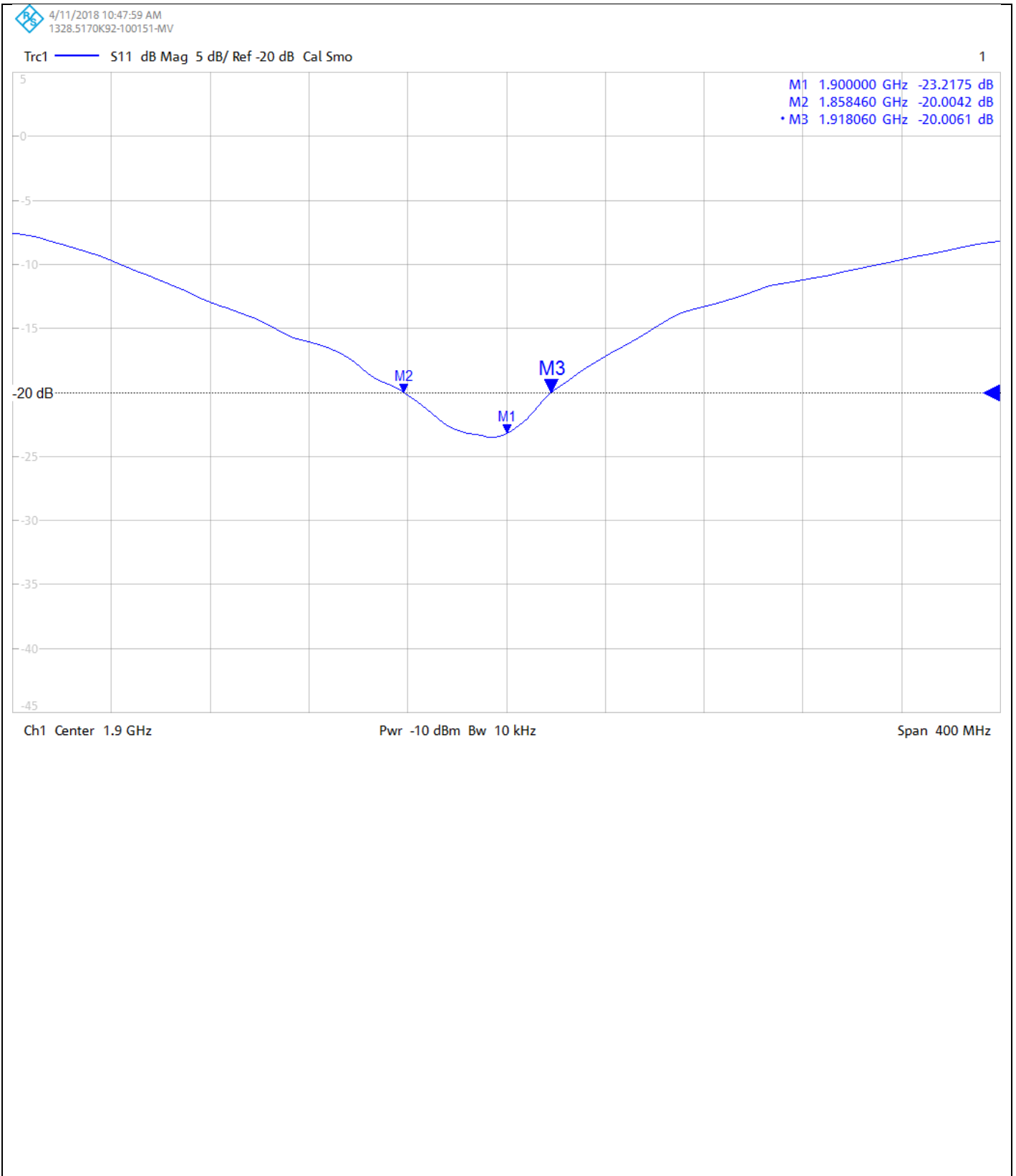
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
12134278JD01C

Page 9 of 10

### Impedance Measurement Plot for Body Stimulating Liquid (MSL)





# CERTIFICATE OF CALIBRATION

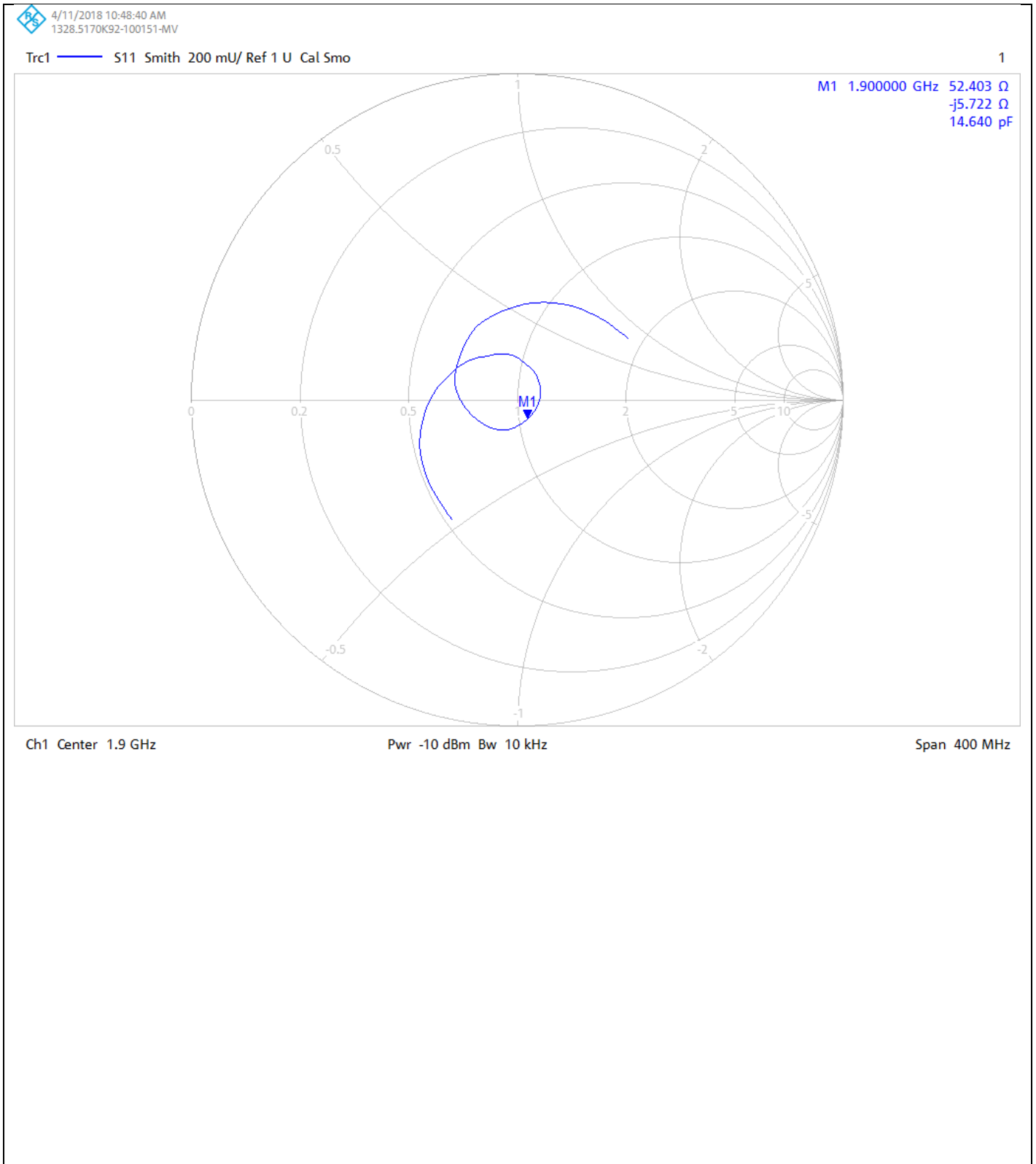
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248


CERTIFICATE  
NUMBER :  
12134278JD01C


Page 10 of 10


### Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



**Calibration Certificate Label:**

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134278JD01C</p> <p>Instrument ID: 5d140</p> <p>Calibration Date: 11/Apr/2018</p> <p>Calibration Due Date:</p>
--	--

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134278JD01C</p> <p>Instrument ID: 5d140</p> <p>Calibration Date: 11/Apr/2018</p> <p>Calibration Due Date:</p>
--	--

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 12134278JD01C</p> <p>Instrument ID: 5d140</p> <p>Calibration Date: 11/Apr/2018</p> <p>Calibration Due Date:</p>
--	--

# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 03/Oct/2018

CERTIFICATE NUMBER : 11903949JD01D



5248

UL VS LTD  
UNIT 1 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

.....  
Naseer Mirza

## Customer :

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

## Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	07/Sep/2018
Manufacturer:	Speag		
Type/Model Number:	D2300V2		
Serial Number:	1058		
Calibration Date:	02/Oct/2018		
Calibrated By:	Chanthu Thevarajah Senior Engineer		
Signature:			

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

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
11903949JD01D

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 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
A2489	Dipole	SPEAG	D2300V2	1036	05 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	103246	05 Feb 2018	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	14 Dec 2017	24
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947	27 Apr 2018	12
PRE0178154	Signal Generator	Rhode & Schwarz	SMB 100A	175325	09 Apr 2018	12

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
11903949JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 3 of 10

### SAR System Specification

<b>Robot System Positioner:</b>	Stäubli Unimation Corp. Robot Model: TX60L
<b>Robot Serial Number:</b>	F17/5ENYG1/C/01
<b>DASY Version:</b>	DASY 52 (v52.8.8.1258)
<b>Phantom:</b>	Flat section of SAM Twin Phantom
<b>Distance Dipole Centre:</b>	10 mm (with spacer)
<b>Frequency:</b>	2300 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	2300	22.2 °C	22.2 °C	22.4°C	22.4°C	<b><math>\epsilon_r</math></b>	39.50	37.53	± 5%
						<b><math>\sigma</math></b>	1.67	1.72	± 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	<b>51.75 W/Kg</b>	± 17.57%
	SAR averaged over 10g	6.16 W/Kg	<b>24.52 W/Kg</b>	± 17.32%

### Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.192 $\Omega$ + 2.53 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	31.81	2.03 ± dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
11903949JD01D

UKAS Accredited Calibration Laboratory No. 5248

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	2300	22.2 °C	22.2 °C	21.0°C	21.0°C	$\epsilon_r$	52.90	51.30	± 5%
						$\sigma$	1.81	1.88	± 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	12.90 W/Kg	<b>51.35 W/Kg</b>	± 18.06%
	SAR averaged over 10g	6.14 W/Kg	<b>24.44 W/Kg</b>	± 17.44%

### Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	54.23 $\Omega$ + 6.05 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	23.05	± 1.27 dB

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

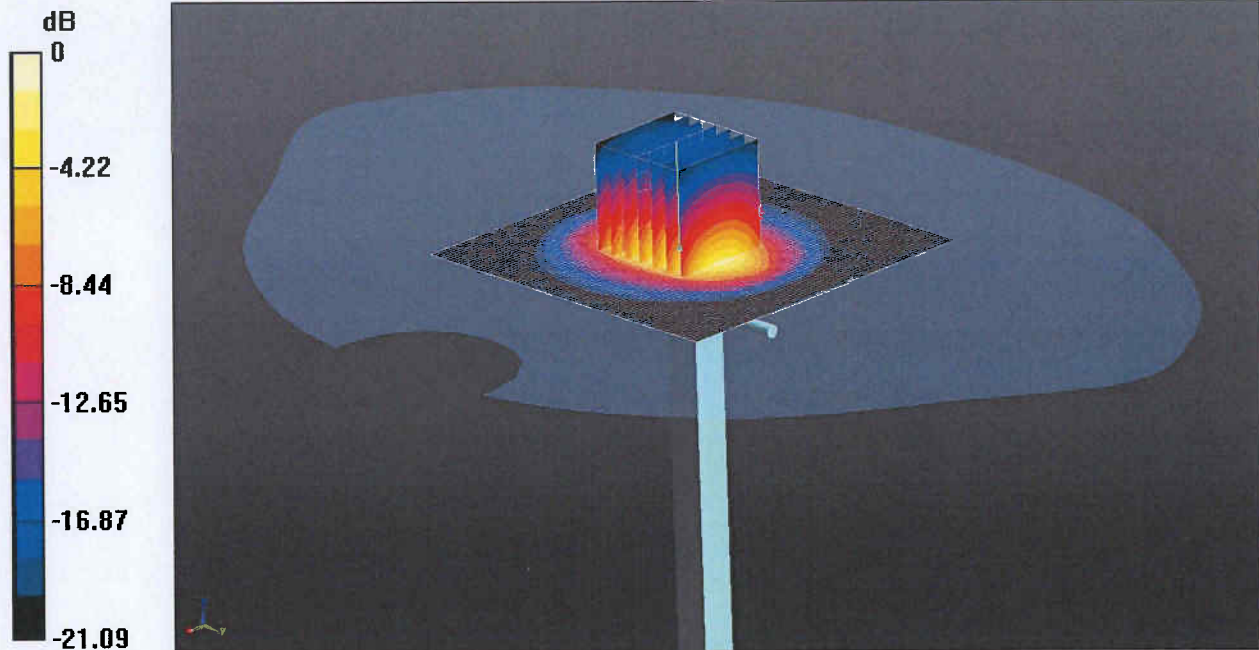
CERTIFICATE  
NUMBER :  
11903949JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 5 of 10

### DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D2300V2 - SN1058; Type: D2300V2; Serial: SN1058



0 dB = 17.0 W/kg = 12.30 dBW/kg

Communication System: UID 0, CW (0); Frequency: 2300 MHz; Duty Cycle: 1:1  
Medium: 1450, 1750, 2300 5% MHz HSL Medium parameters used:  $f = 2300$  MHz;  $\sigma = 1.719$  S/m;  $\epsilon_r = 37.534$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
DASY4 Configuration:  
- Probe: ES3DV3 - SN3360; ConvF(4.95, 4.95, 4.95); 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 4.0; Serial: 1031  
-; SEMCAD X Version 14.6.10 (7417)

**Configuration/d=10mm, Pin=250mW/Area Scan (81x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm  
Maximum value of SAR (interpolated) = 17.0 W/kg

**Configuration/d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 102.4 V/m; Power Drift = 0.01 dB  
Peak SAR (extrapolated) = 26.0 W/kg  
**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.16 W/kg**  
Maximum value of SAR (measured) = 17.0 W/kg

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
11903949JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 6 of 10

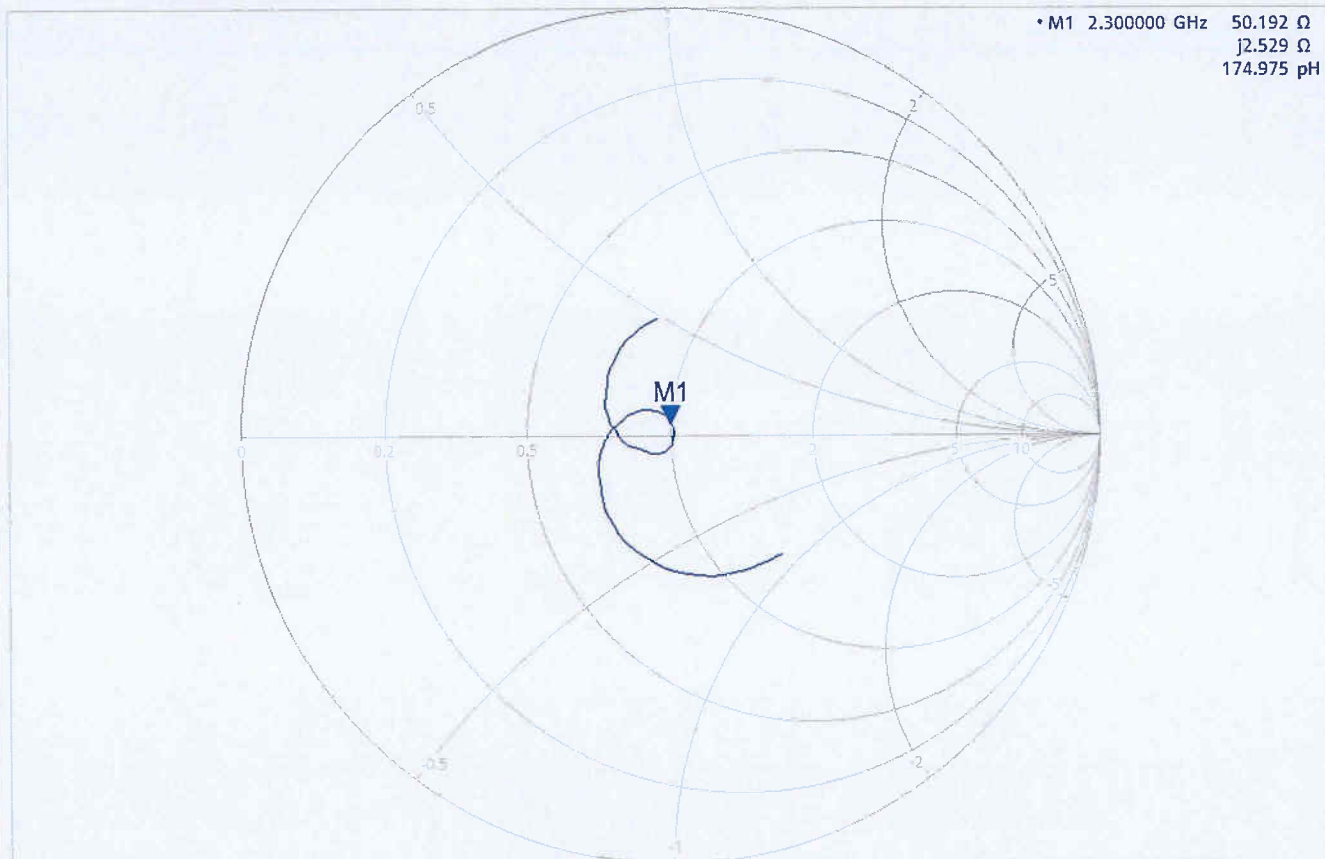
### Impedance Measurement Plot for Head Stimulating Liquid (HSL)

9/28/2018 10:57:47 PM  
1326.5170KS2-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

• M1 2.300000 GHz 50.192  $\Omega$   
j2.529  $\Omega$   
174.975 pF



Ch1 Center 2.3 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz



# CERTIFICATE OF CALIBRATION

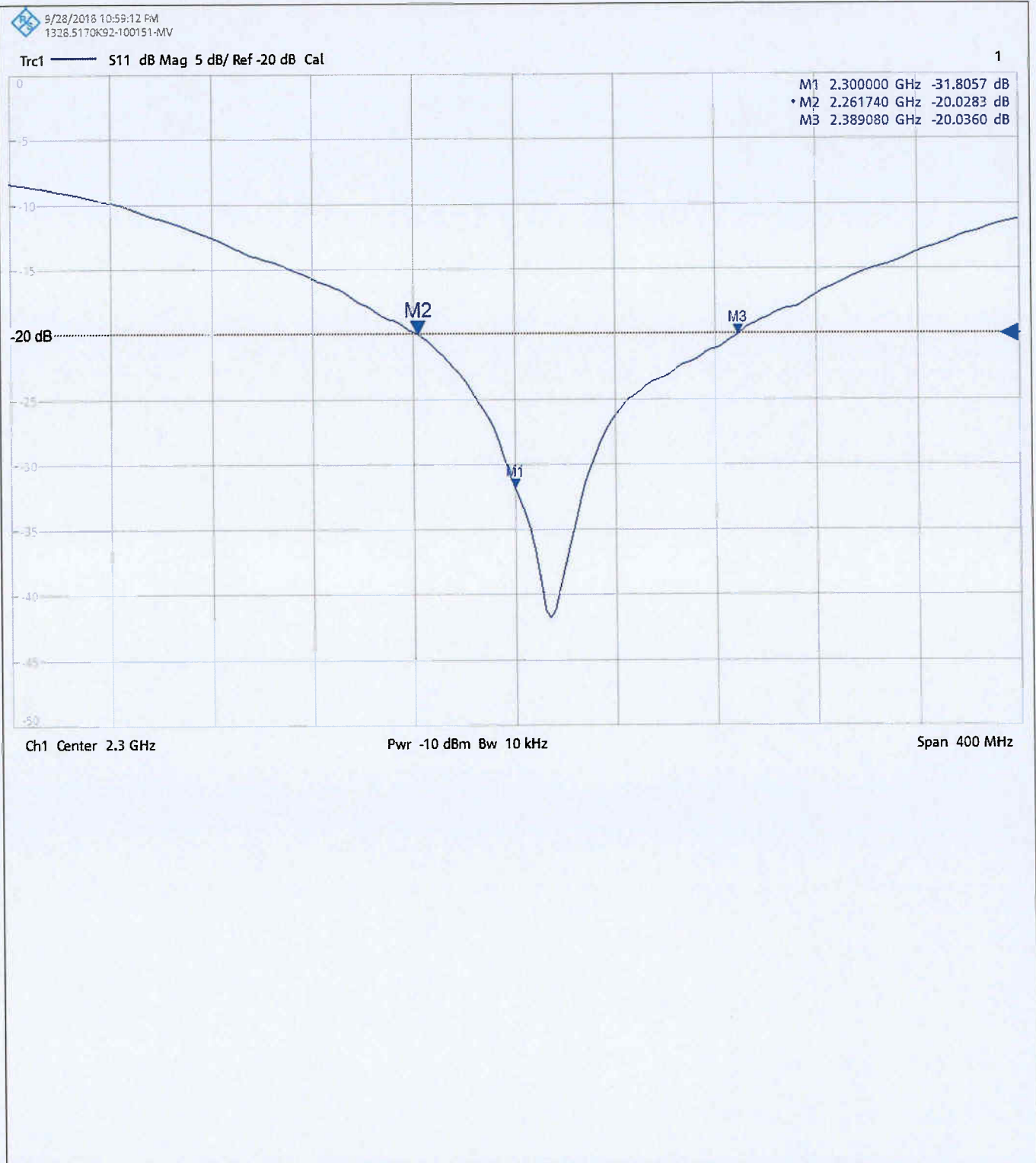
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
11903949JD01D

Page 7 of 10

### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

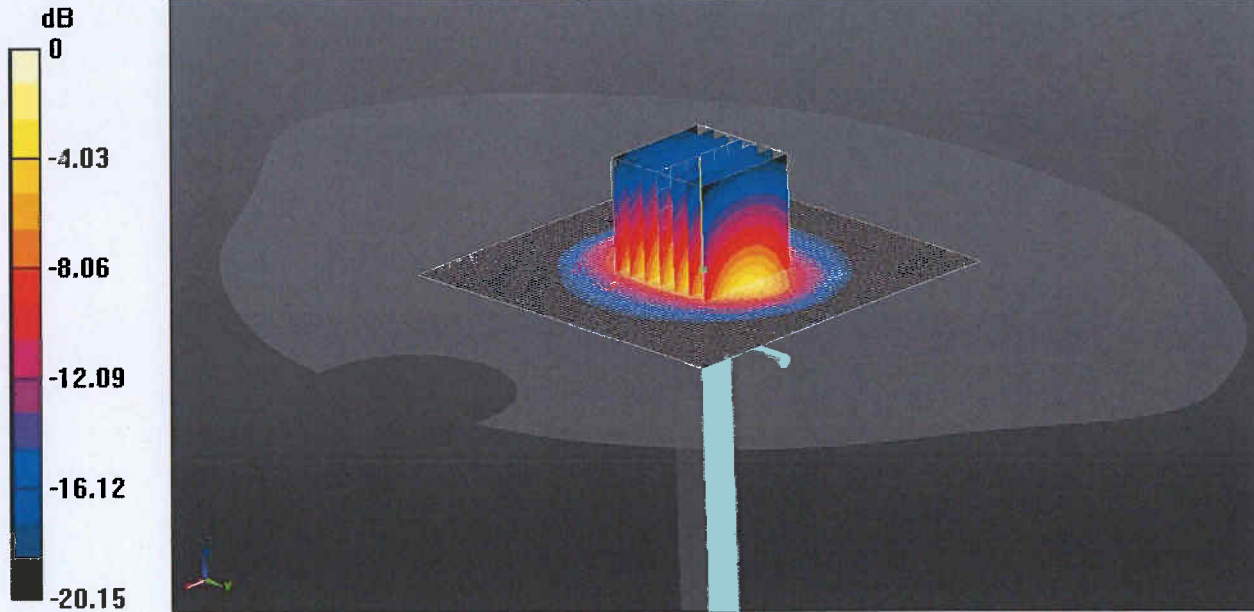
CERTIFICATE  
NUMBER :  
11903949JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 8 of 10

### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D2300V2 - SN1058; Type: D2300V2; Serial: SN1058



0 dB = 16.9 W/kg = 12.28 dBW/kg

Communication System: UID 0, CW (0); Frequency: 2300 MHz; Duty Cycle: 1:1

Medium: 1450, 1750, 2300 5% MHz MSL Medium parameters used:  $f = 2300$  MHz;  $\sigma = 1.884$  S/m;  $\epsilon_r = 51.297$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3360; ConvF(4.62, 4.62, 4.62); Calibrated: 17/08/2018;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1543; Calibrated: 08/03/2018
- Phantom: Twin SAM B (Site 65); Type: SAM 8.0; Serial: 1945
- ; SEMCAD X Version 14.6.10 (7417)

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

Maximum value of SAR (interpolated) = 16.9 W/kg

**Configuration/d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.93 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 25.8 W/kg

**SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.14 W/kg**

Maximum value of SAR (measured) = 16.9 W/kg

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
11903949JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 9 of 10

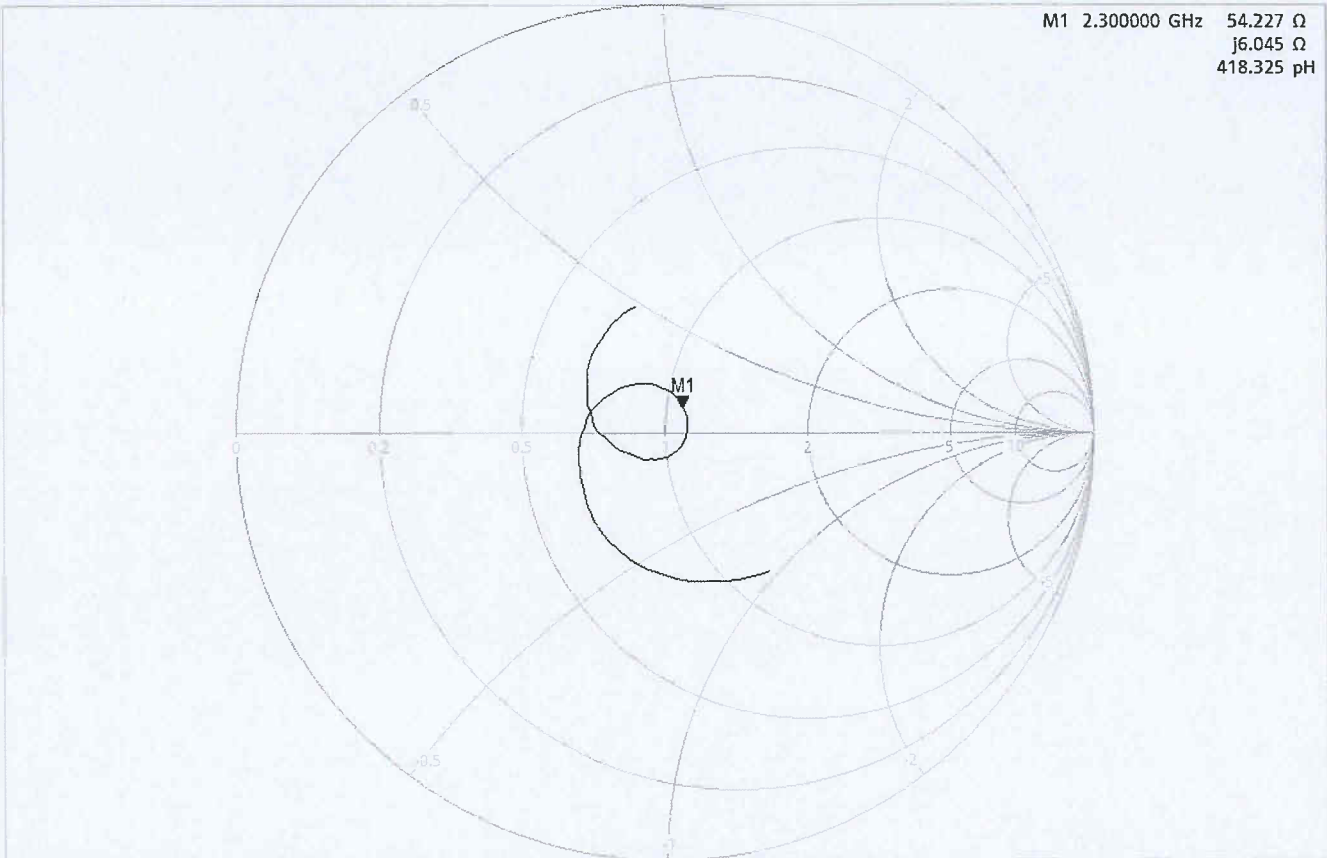
### Impedance Measurement Plot for Body Stimulating Liquid (MSL)

10/2/2018 2:54:33 PM  
1326\_5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1

M1 2.300000 GHz 54.227  $\Omega$   
j6.045  $\Omega$   
418.325 pF



Ch1 Center 2.3 GHz

Pwr -10 dBm Bw 10 kHz

Span 400 MHz

# CERTIFICATE OF CALIBRATION

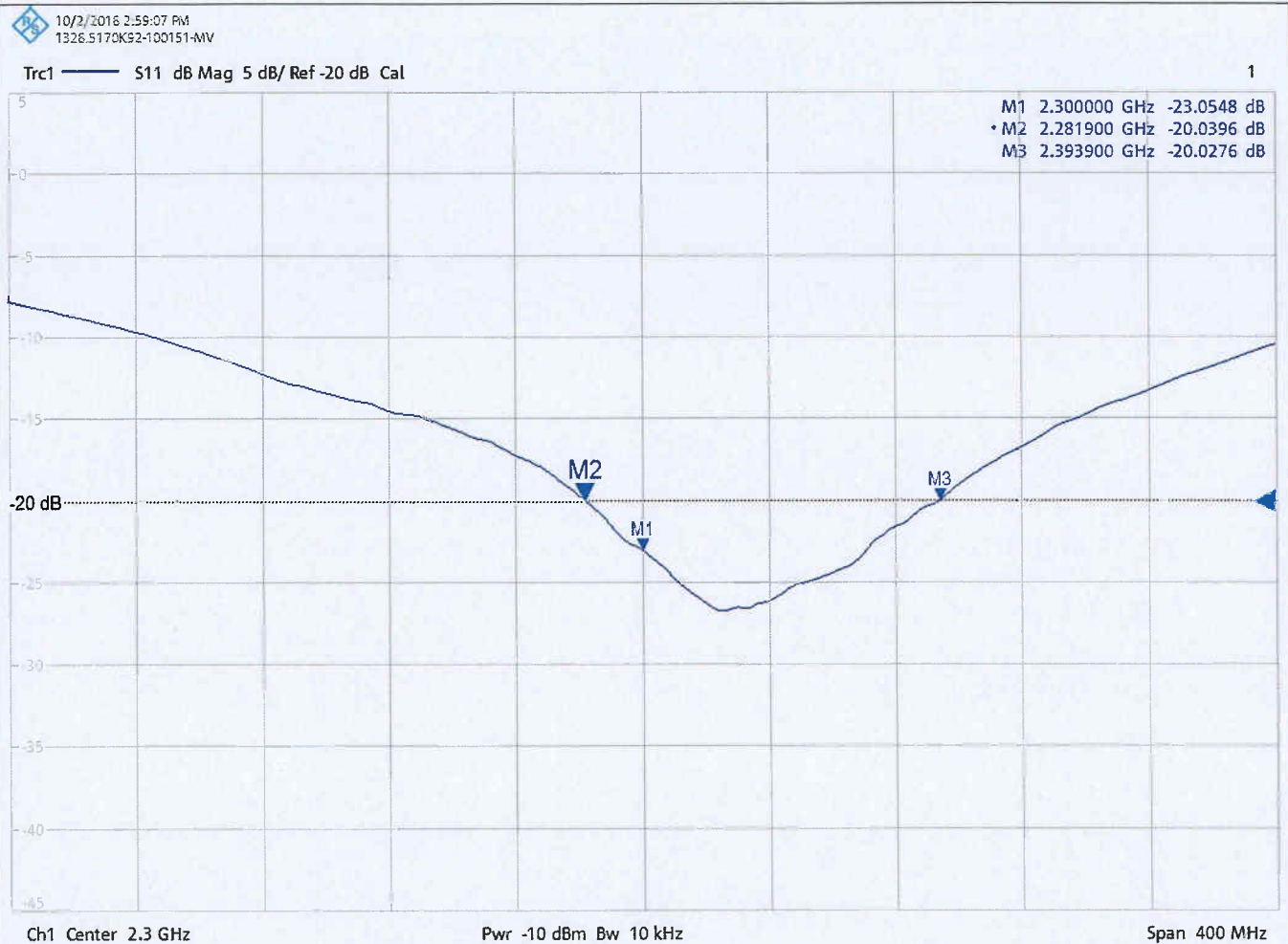
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248


CERTIFICATE  
NUMBER :  
11903949JD01D


Page 10 of 10


### Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



**Calibration Certificate Label:**

	<b>UL VS LTD - Tel: +44 (0) 1256312000</b>
	Certificate Number: 11903949JD01D
	Instrument ID: 1058
	Calibration Date: 02/Oct/2018
	Calibration Due Date:

	<b>UL VS LTD - Tel: +44 (0) 1256312000</b>
	Certificate Number: 11903949JD01D
	Instrument ID: 1058
	Calibration Date: 02/Oct/2018
	Calibration Due Date:

	<b>UL VS LTD - Tel: +44 (0) 1256312000</b>
	Certificate Number: 11903949JD01D
	Instrument ID: 1058
	Calibration Date: 02/Oct/2018
	Calibration Due Date: