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Accreditation No.: **SCS 0108**

Client **UL CCS USA**

Certificate No: **D750V3-1019\_Mar17**

## CALIBRATION CERTIFICATE

Object **D750V3 - SN:1019**

Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **March 13, 2017**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Johannes Kurikka	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 14, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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**Glossary:**

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

**Calibration is Performed According to the Following Standards:**

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) IEC 62209-2, "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)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

<b>DASY Version</b>	DASY5	V52.8.8
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	15 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	750 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	41.9	0.89 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	40.9 $\pm$ 6 %	0.91 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	2.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>8.22 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	1.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>5.39 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	55.5	0.96 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	54.6 $\pm$ 6 %	0.99 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	2.25 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>8.76 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	1.48 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>5.80 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.4 $\Omega$ + 3.2 j $\Omega$
Return Loss	- 23.4 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.9 $\Omega$ + 0.3 j $\Omega$
Return Loss	- 34.4 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.038 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	November 11, 2010

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1019**

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used:  $f = 750$  MHz;  $\sigma = 0.91$  S/m;  $\epsilon_r = 40.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.17, 10.17, 10.17); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**

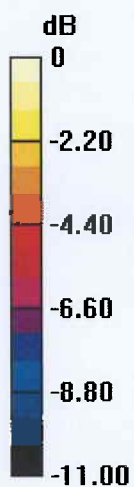
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.11 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.16 W/kg

**SAR(1 g) = 2.1 W/kg; SAR(10 g) = 1.37 W/kg**

Maximum value of SAR (measured) = 2.81 W/kg



0 dB = 2.81 W/kg = 4.49 dBW/kg

# Impedance Measurement Plot for Head TSL

13 Mar 2017 13:33:07

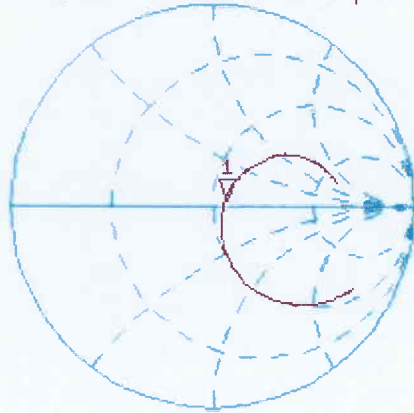
CH1 S11 1 U FS 1: 56.439  $\Omega$  3.2070  $\Omega$  680.55  $\mu\text{H}$  750.000 000 MHz

\*  
De1

CΔ

Avg  
16

H1d

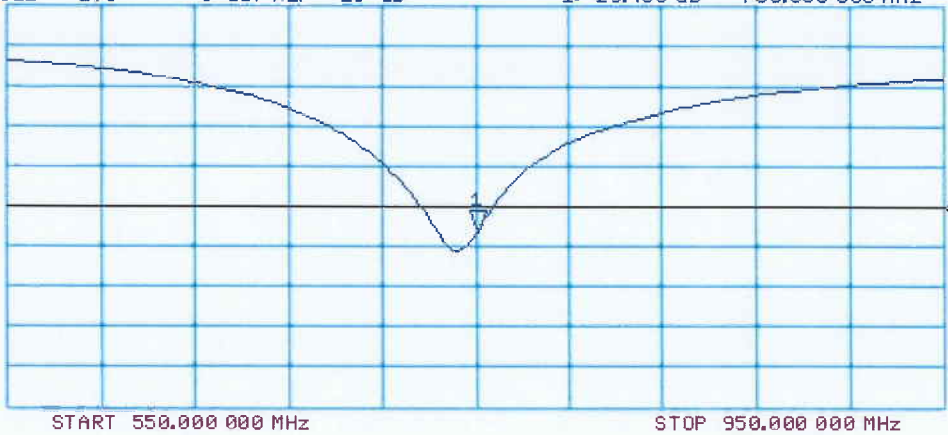


CH2 S11 LOG 5 dB/REF -20 dB 1: -23.405 dB 750.000 000 MHz

CΔ

Avg  
16

H1d



Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1019

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used:  $f = 750$  MHz;  $\sigma = 0.99$  S/m;  $\epsilon_r = 54.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

### DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.99, 9.99, 9.99); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

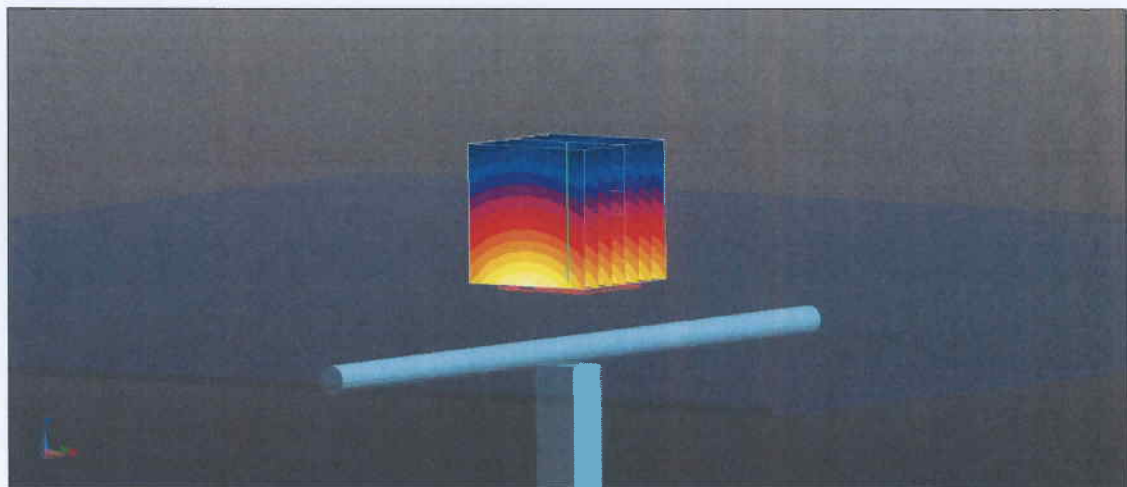
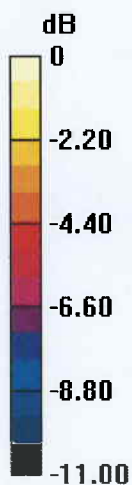
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.25 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.36 W/kg

**SAR(1 g) = 2.25 W/kg; SAR(10 g) = 1.48 W/kg**

Maximum value of SAR (measured) = 3.00 W/kg



0 dB = 3.00 W/kg = 4.77 dBW/kg

# Impedance Measurement Plot for Body TSL

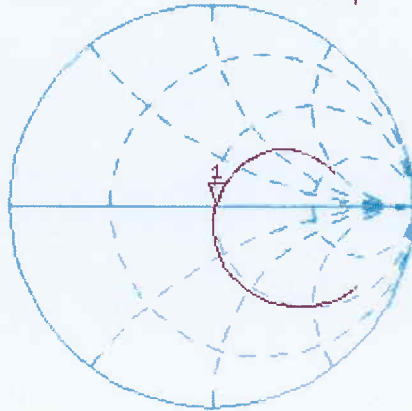
13 Mar 2017 11:56:16

CH1 S11 1 U FS

1: 51.916  $\Omega$  0.3184  $\Omega$  67.558 pF

750.000 000 MHz

\*  
De1  
CA



AVG  
16

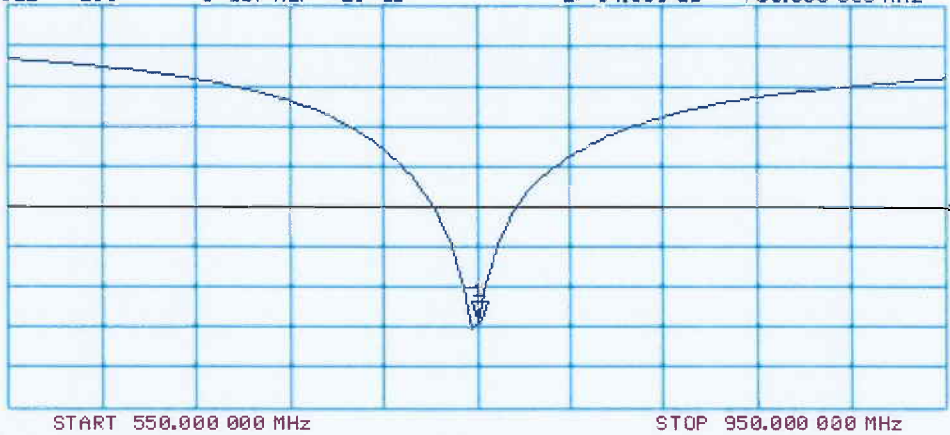
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -34.399 dB 750.000 000 MHz

CA

AVG  
16

H1d





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DATE OF ISSUE: 10/Oct/2017

CERTIFICATE NUMBER : 11903941JD01A



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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



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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:	29/Sep/2017
Manufacturer:	Speag		
Type/Model Number:	D900V2		
Serial Number:	1d143		
Calibration Date:	05/Oct/2017		
Calibrated By:	Chanthu Thevarajah Laboratory Engineer		

Signature:

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

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The calibration methods and procedures used were as detailed in:

1. **IEC 62209-1:2005**: 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
A2110	Data Acquisition Electronics	SPEAG	DAE4	431	18 Nov 2016	12
A2587	Probe	SPEAG	ES3DV3	3341	14 Aug 2017	12
A2201	Dipole	SPEAG	D900V2	035	14 Feb 2017	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	12
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	16 Nov 2016	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	22 Nov 2016	12
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947-Bt	02 Dec 2016	12
M1908	Signal Generator	Rhode & Schwarz	SMIQ 03B	1125.555.03	08 Nov 2016	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	23.0 °C	22.0 °C	20.0°C	22.0°C	$\epsilon_r$	41.50	41.34	± 5%
						$\sigma$	0.97	0.93	± 5%

### SAR Results – Head Simulating Liquid (HSL)

Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	2.58 W/Kg	10.27 W/Kg	± 17.57%
	SAR averaged over 10g	1.66 W/Kg	6.60 W/Kg	± 17.32%

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

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	51.089 $\Omega$ 1.01 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	30.67	± 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	22.0 °C	22.0 °C	22.0°C	22.0°C	$\epsilon_r$	55.00	53.32	± 5%
						$\sigma$	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	2.75 W/Kg	<b>10.94 W/Kg</b>	± 18.06%
	SAR averaged over 10g	1.79 W/Kg	<b>7.12 W/Kg</b>	± 17.44%

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

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	54.09 $\Omega$ 2.03 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	25.35	± 2.03 dB

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

DUT: Dipole 900 MHz; SN: 1d143; Type: D900V2; Serial: SN1d143



0 dB = 3.02 W/kg = 4.80 dBW/kg

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

Medium: 900 MHz HSL Medium parameters used:  $f = 900$  MHz;  $\sigma = 0.934$  S/m;  $\epsilon_r = 41.343$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3341; ConvF(6.32, 6.32, 6.32); Calibrated: 14/08/2017;

- 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) = 3.03 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 = 58.75 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 3.90 W/kg

**SAR(1 g) = 2.58 W/kg; SAR(10 g) = 1.66 W/kg**

Maximum value of SAR (measured) = 3.02 W/kg

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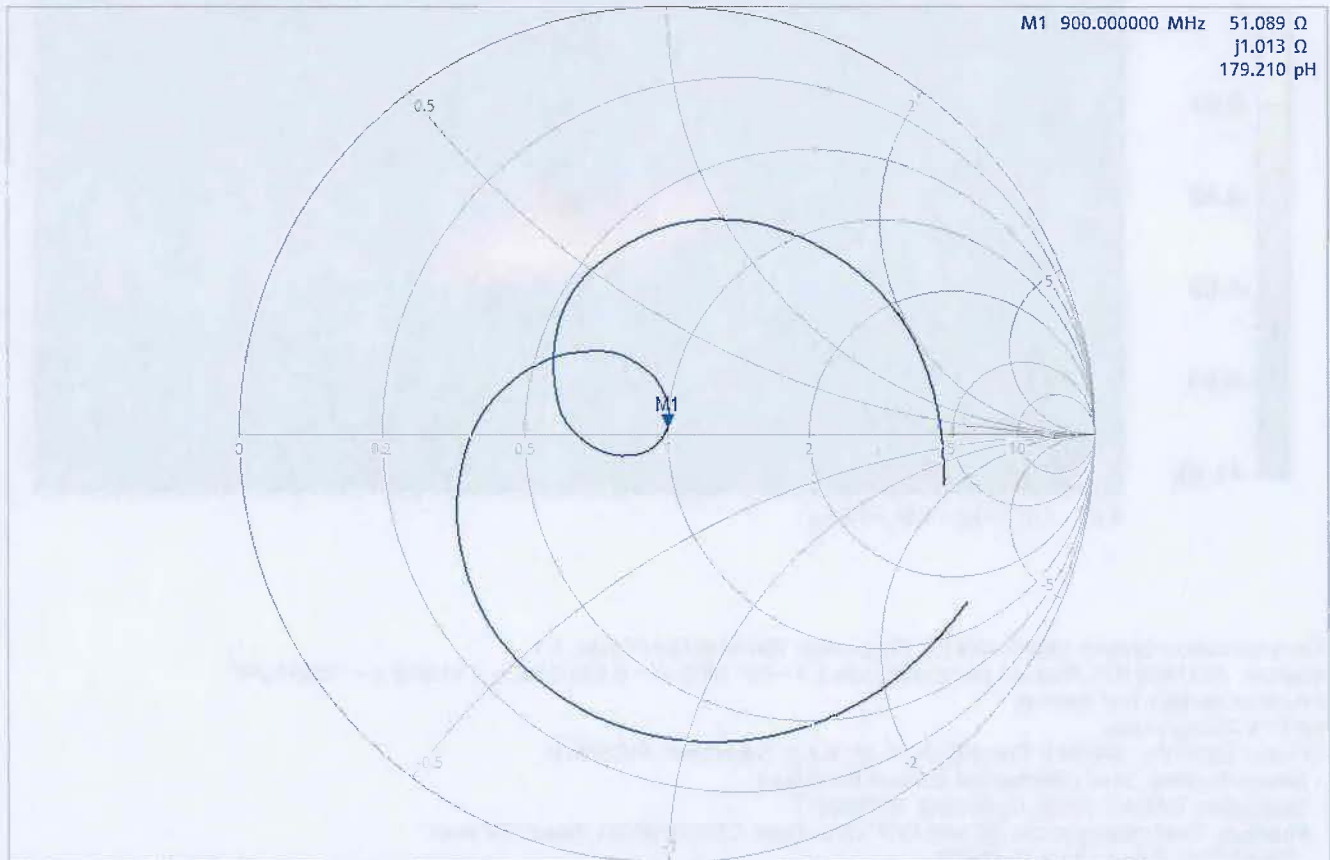
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### Impedance Measurement Plot for Head Stimulating Liquid (HSL)

10/10/2017 8:09:16 AM  
1326.5170K92-100151-MV

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

1



Ch1 Start 700 MHz

Pwr -10 dBm Bw 10 kHz

Stop 1.1 GHz

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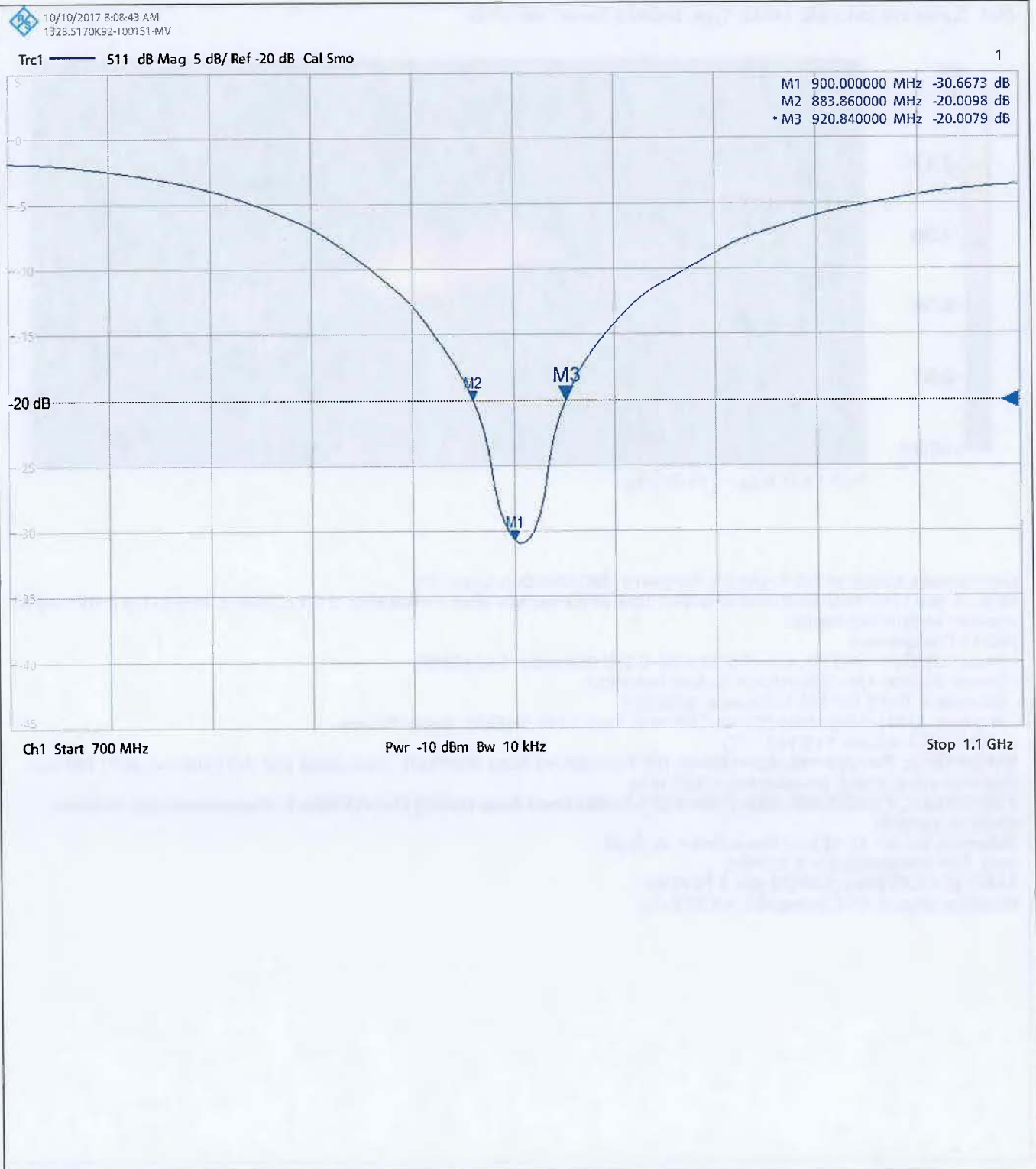
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### Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



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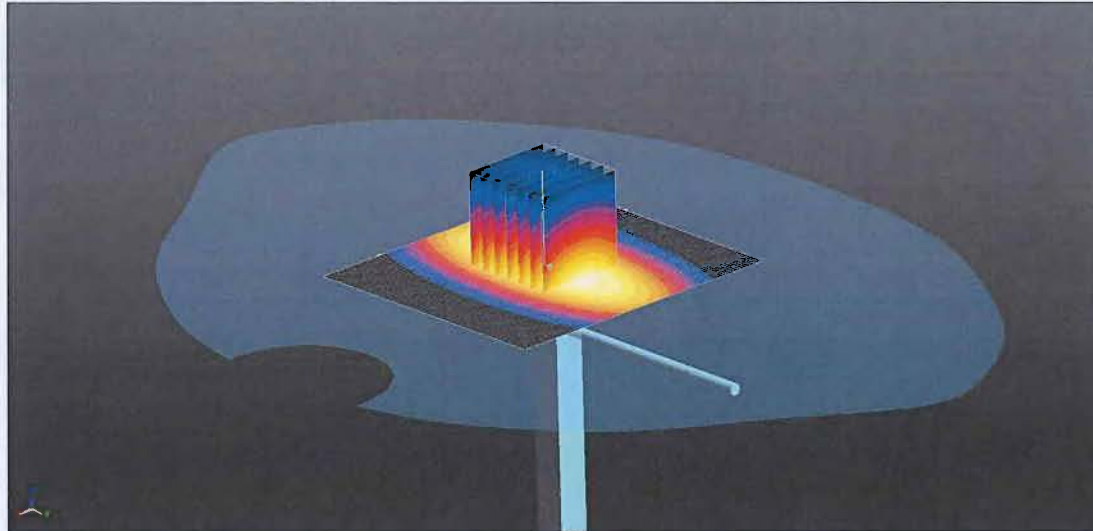
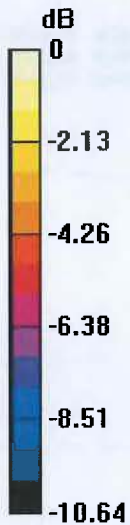
CERTIFICATE  
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### DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: Dipole 900 MHz; SN: 1d143; Type: D900V2; Serial: SN 1d143



0 dB = 2.97 W/kg = 4.73 dBW/kg

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

Medium: 900, 1750, 1800, 1900, 2600 MHz MSL Medium parameters used:  $f = 900$  MHz;  $\sigma = 1.02$  S/m;  $\epsilon_r = 53.317$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3341; ConvF(6.24, 6.24, 6.24); Calibrated: 14/08/2017;

- Sensor-Surface: 4mm (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)

**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) = 3.00 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 = 55.18 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 4.12 W/kg

**SAR(1 g) = 2.75 W/kg; SAR(10 g) = 1.79 W/kg**

Maximum value of SAR (measured) = 2.97 W/kg



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

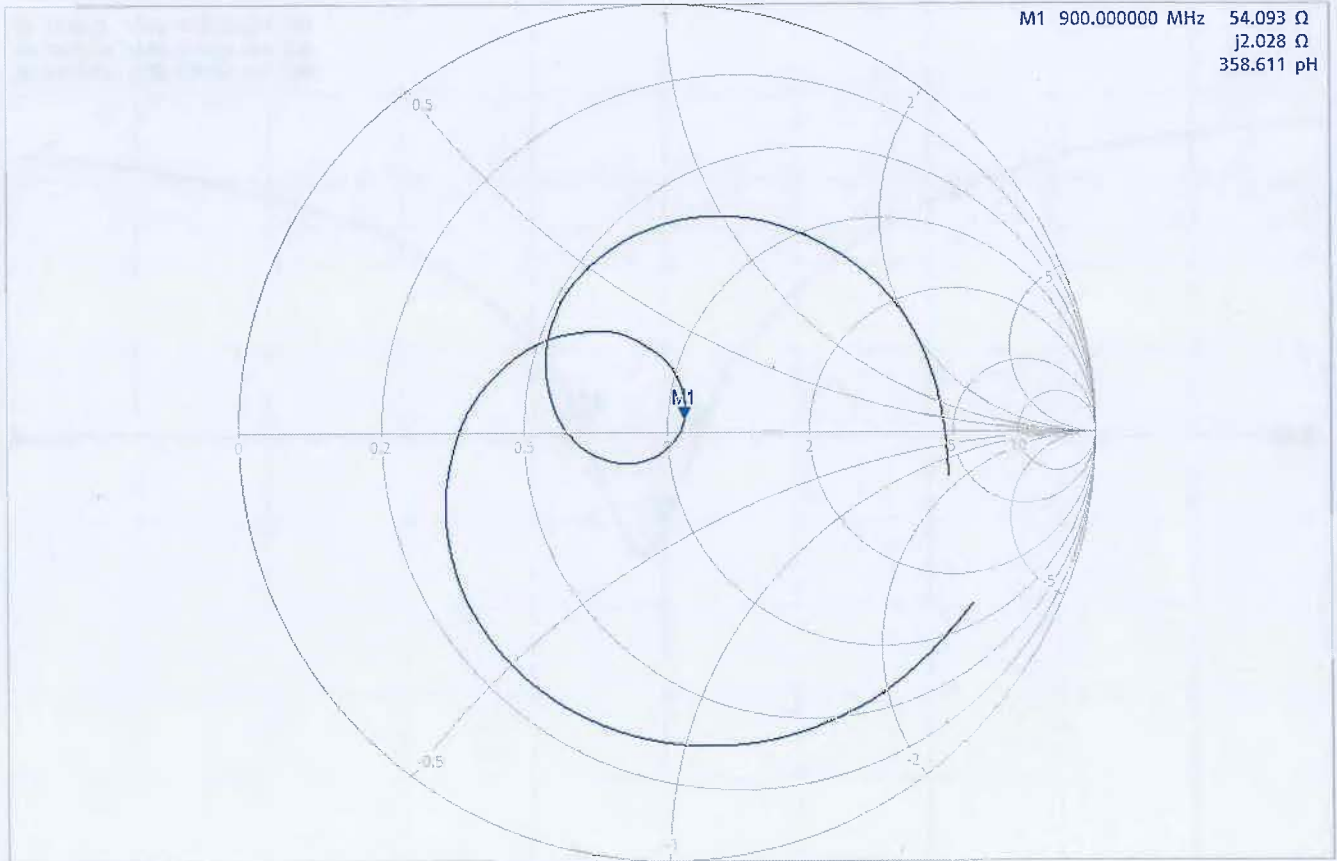


10/9/2017 2:34:21 PM  
1328.5170K92-100151-MV

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

1

M1 900.000000 MHz 54.093 Ω  
j2.028 Ω  
358.611 pF



Ch1 Start 700 MHz

Pwr -10 dBm Bw 10 kHz

Stop 1.1 GHz

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11903941JD01A

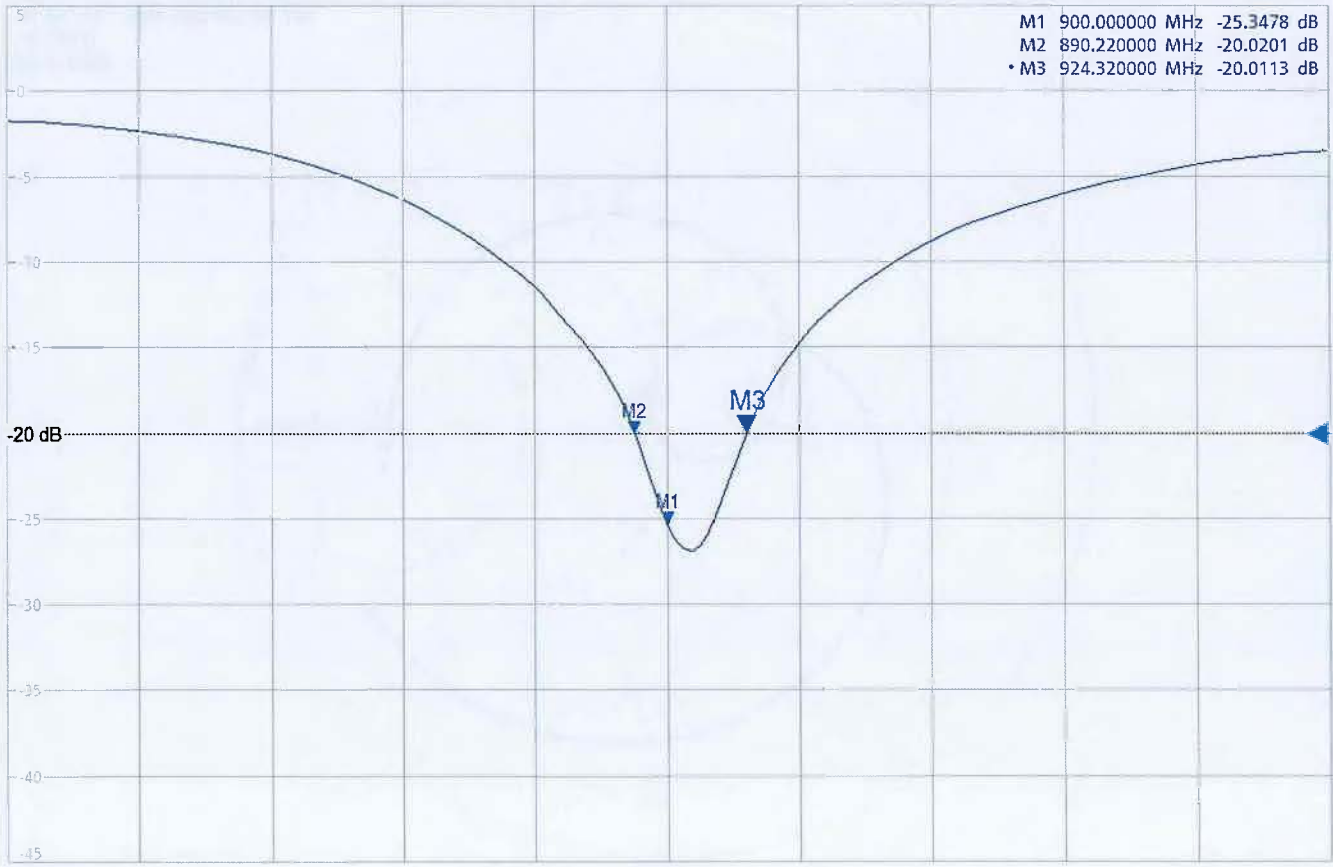
Page 10 of 10

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

10/9/2017 2:33:24 PM  
1328.5170K92-100151-MV

Trc1 — S11 dB Mag 5 dB/ Ref -20 dB Cal Smo

1




Ch1 Start 700 MHz


Pwr -10 dBm Bw 10 kHz

Stop 1.1 GHz

**Calibration Certificate Label:**

 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 11903941JD01A</p> <p>Instrument ID: 1d143</p> <p>Calibration Date: 05/Oct/2017</p> <p>Calibration Due Date:</p>
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 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 11903941JD01A</p> <p>Instrument ID: 1d143</p> <p>Calibration Date: 05/Oct/2017</p> <p>Calibration Due Date:</p>
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 <p>UKAS CALIBRATION 5248</p>	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 11903941JD01A</p> <p>Instrument ID: 1d143</p> <p>Calibration Date: 05/Oct/2017</p> <p>Calibration Due Date:</p>
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# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 10/Oct/2017

CERTIFICATE NUMBER : 11903941JD01B



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**

.....  
Naseer Mirza

**Customer :**

UL VS Ltd  
Pavilion A, Ashwood Park, Ashwood Way  
Basingstoke, RG23 8BG, England

**Equipment Details:**

Description:	Dipole Validation Kit	Date of Receipt:	29/Sep/2017
Manufacturer:	Speag		
Type/Model Number:	D1750V2		
Serial Number:	1077		
Calibration Date:	05/Oct/2017		
Calibrated By:	Chanthu Thevarajah Laboratory Engineer		

Signature:

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

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

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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
A2587	Probe	SPEAG	ES3DV3	3341	14 Aug 2017	12
A1236	Dipole	SPEAG	D1800V2	2d009	09 Feb 2017	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	12
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	16 Nov 2016	12
M1015	Network Analyser	Agilent Technologies	8753ES	US39172406	26 Sept 2016	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	22 Nov 2016	12
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947-Bt	02 Dec 2016	12
M1908	Signal Generator	Rhode & Schwarz	SMIQ 03B	1125.555.03	08 Nov 2016	12

# CERTIFICATE OF CALIBRATION

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NUMBER :  
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UKAS Accredited Calibration Laboratory No. 5248

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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:	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	23.0 °C	23.0 °C	20.0°C	20.0°C	$\epsilon_r$	40.10	40.38	± 5%
						$\sigma$	1.37	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	9.11 W/Kg	<b>36.26 W/Kg</b>	± 17.57%
	SAR averaged over 10g	4.86 W/Kg	<b>19.34 W/Kg</b>	± 17.32%

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

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	49.21 $\Omega$ -0.63 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	-36.48	± dB

# CERTIFICATE OF CALIBRATION

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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	1750	22.0 °C	22.0 °C	22.0°C	22.0°C	$\epsilon_r$	53.40	52.41	± 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	9.38 W/Kg	<b>37.34 W/Kg</b>	± 18.06%
	SAR averaged over 10g	5.02 W/Kg	<b>19.98 W/Kg</b>	± 17.44%

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

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	49.29 $\Omega$ 3.26 $j\Omega$	± 0.28 $\Omega$ ± 0.044 $j\Omega$
	Return Loss	-29.63	± 2.03 dB



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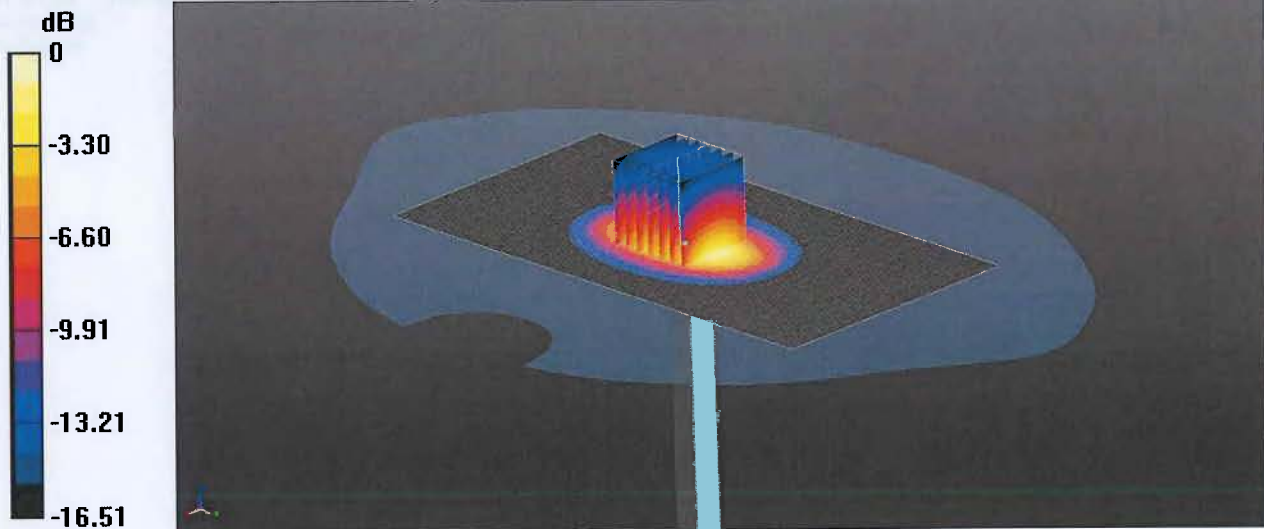
CERTIFICATE  
NUMBER :  
11903941JD01B

UKAS Accredited Calibration Laboratory No. 5248

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

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



0 dB = 11.4 W/kg = 10.57 dBW/kg

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

Medium: 1750 1800 MHz HSL Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.393$  S/m;  $\epsilon_r = 40.378$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3341; ConvF(5.47, 5.47, 5.47); Calibrated: 14/08/2017;

- 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=10mm, Pin=250mW 2/Area Scan (81x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 11.7 W/kg

**Configuration/d=10mm, Pin=250mW 2/Zoom Scan (5x5x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.81 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 16.3 W/kg

**SAR(1 g) = 9.11 W/kg; SAR(10 g) = 4.86 W/kg**

Maximum value of SAR (measured) = 11.4 W/kg

# CERTIFICATE OF CALIBRATION

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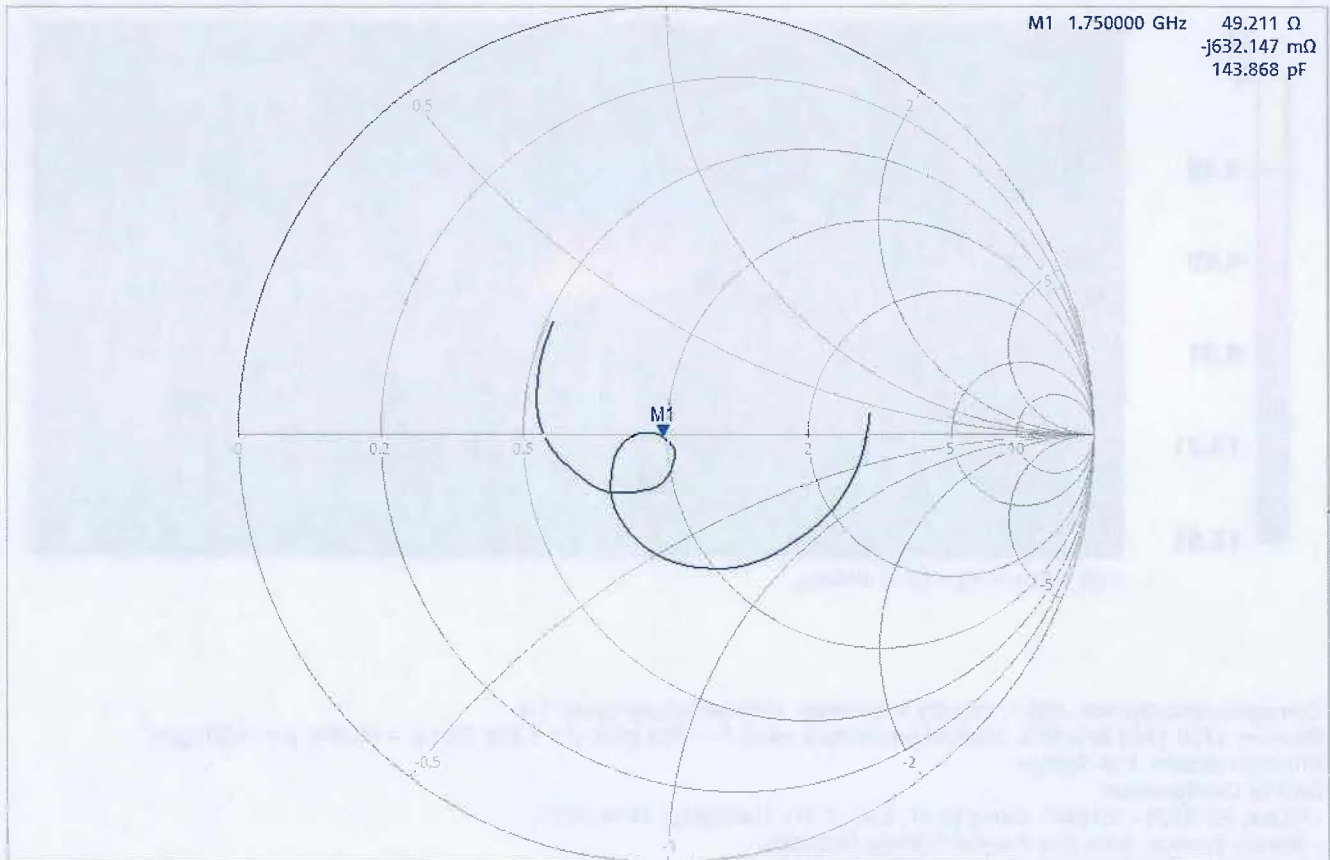
Page 6 of 10

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

10/10/2017 9:09:15 AM  
1326.5170K92-100151-MV

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

1



Ch1 Start 1.55 GHz

Pwr -10 dBm Bw 10 kHz

Stop 1.95 GHz

# CERTIFICATE OF CALIBRATION

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NUMBER :  
11903941JD01B

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

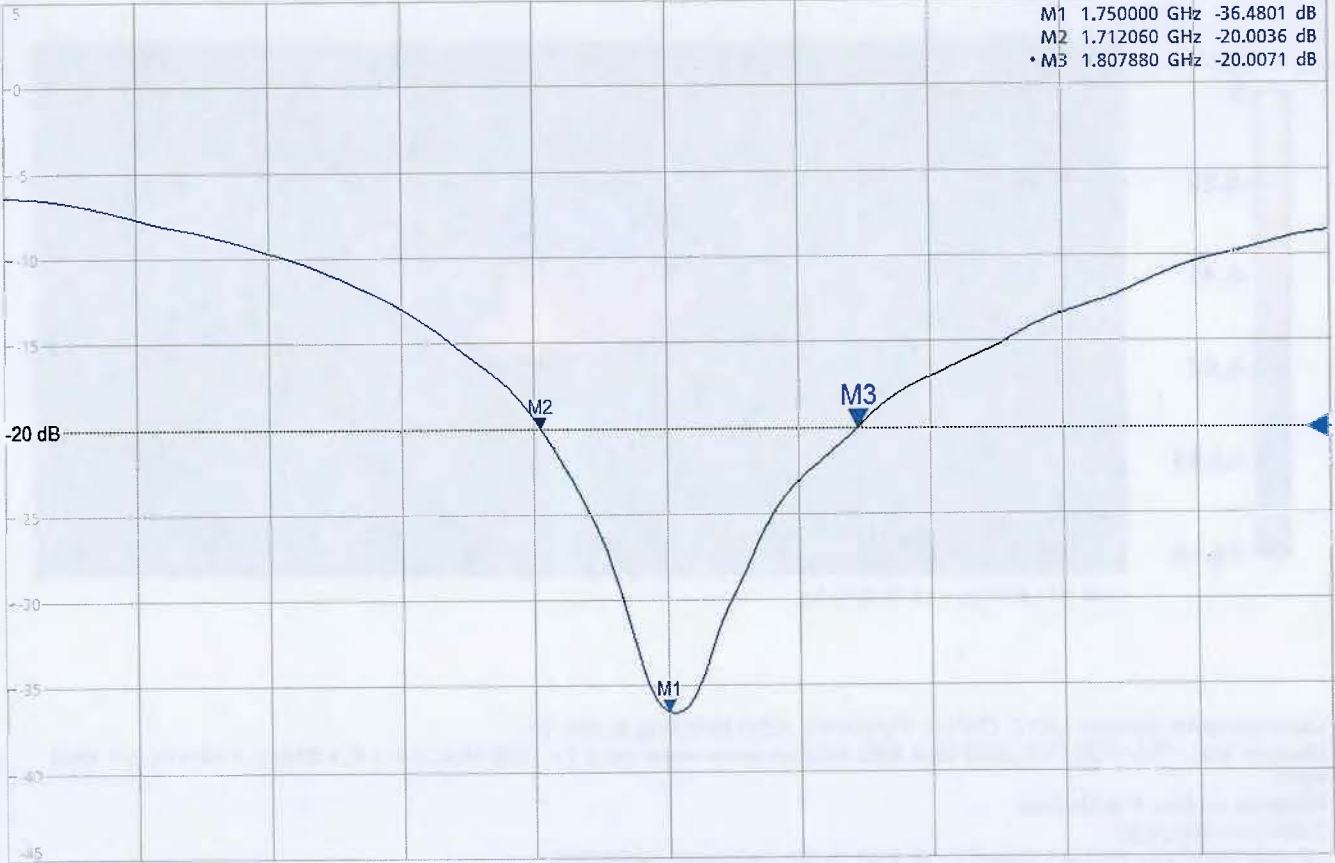


10/10/2017 9:08:41 AM  
1326.5170K92-100151-MV

Trc1 — 511 dB Mag 5 dB/ Ref -20 dB Cal Smo

1

M1	1.750000 GHz	-36.4801 dB
M2	1.712060 GHz	-20.0036 dB
M3	1.807880 GHz	-20.0071 dB



Ch1 Start 1.55 GHz

Pwr -10 dBm Bw 10 kHz

Stop 1.95 GHz

# CERTIFICATE OF CALIBRATION

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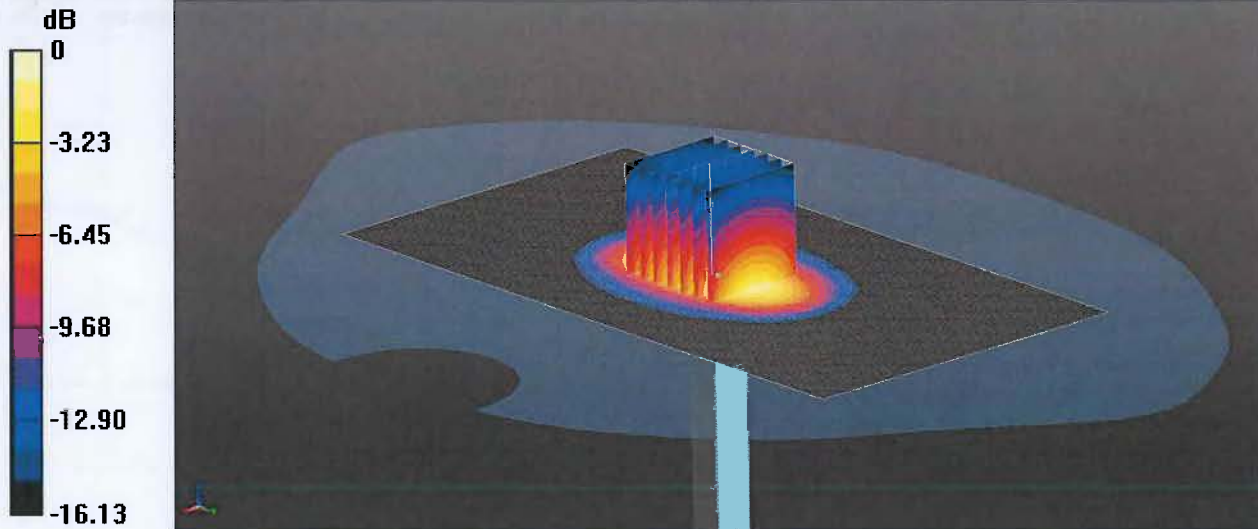
UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
11903941JD01B

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

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



0 dB = 11.8 W/kg = 10.72 dBW/kg

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

Medium: 900,1750,1800,1900,2600 MHz MSL Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.474$  S/m;  $\epsilon_r = 52.411$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3341; ConvF(5.12, 5.12, 5.12); Calibrated: 14/08/2017;
- 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=10mm, Pin=250mW 2 2 2 2/Area Scan (81x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 12.1 W/kg

**Configuration/d=10mm, Pin=250mW 2 2 2 2/Zoom Scan (5x5x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 92.81 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 16.5 W/kg

**SAR(1 g) = 9.38 W/kg; SAR(10 g) = 5.02 W/kg**

Maximum value of SAR (measured) = 11.8 W/kg

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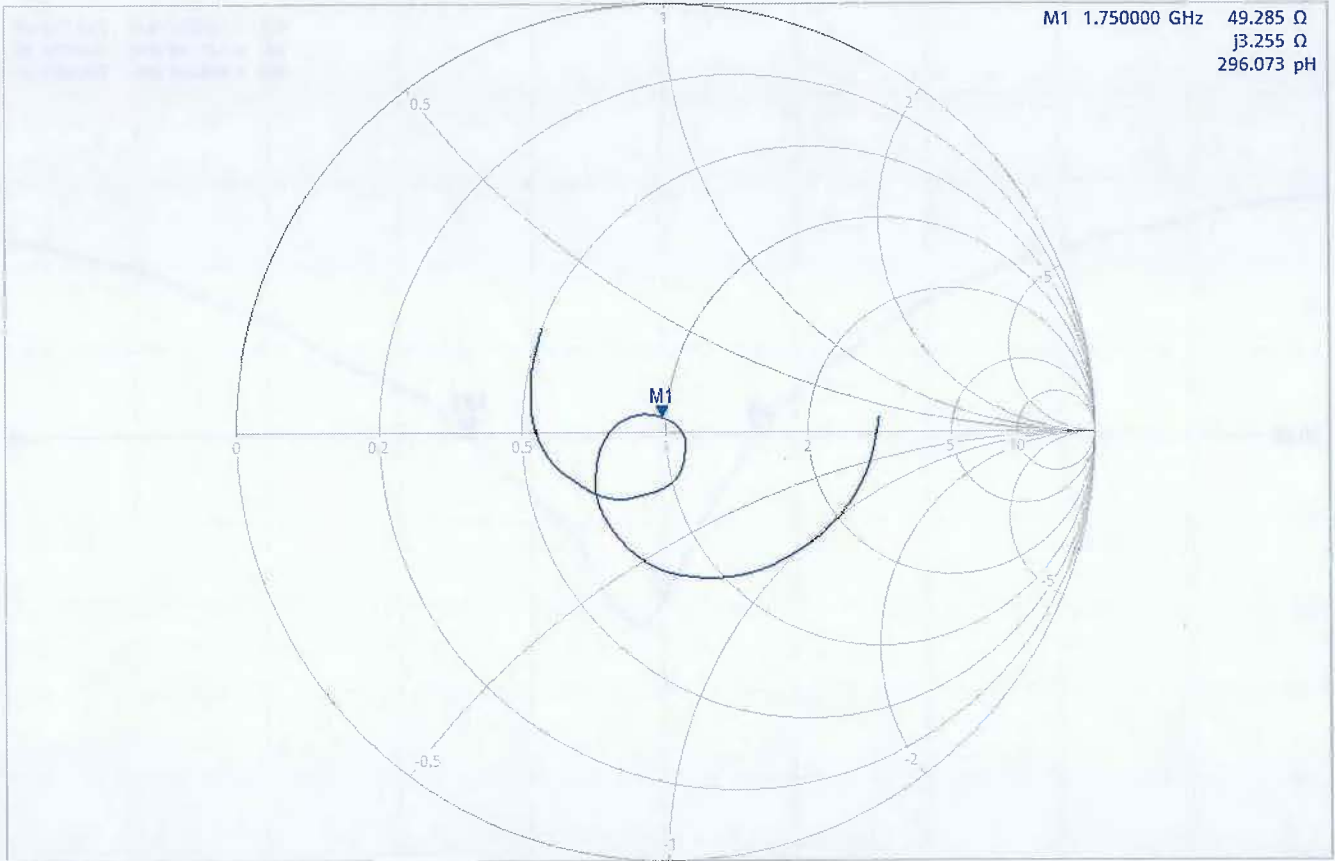
### Impedance Measurement Plot for Body Stimulating Liquid (MSL)

10/9/2017 2:16:47 PM  
1328.5170K92-100151-MV

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

1

M1 1.750000 GHz 49.285  $\Omega$   
j3.255  $\Omega$   
296.073 pF



Ch1 Start 1.55 GHz

Pwr -10 dBm Bw 10 kHz

Stop 1.95 GHz

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

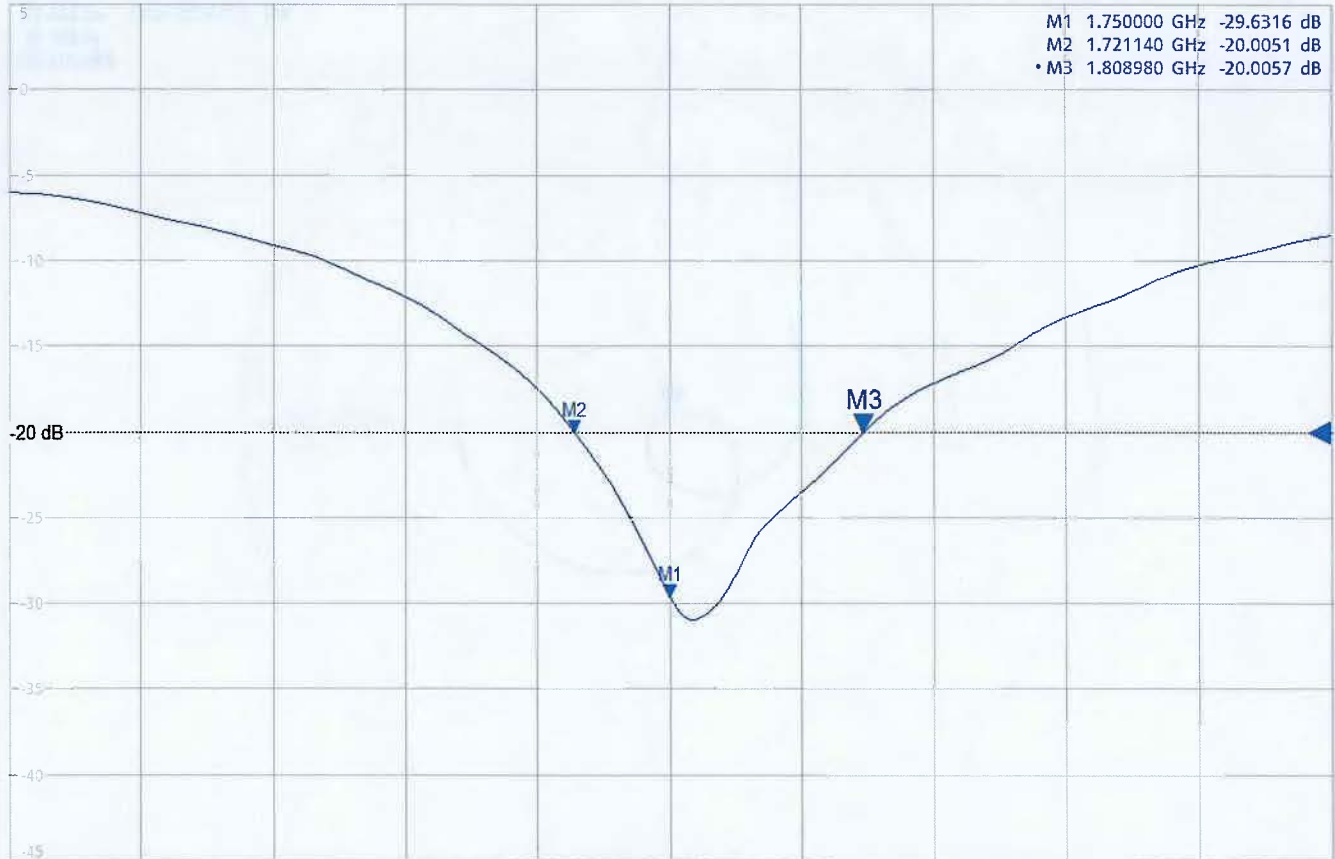


10/9/2017 2:15:13 PM  
1326.5170K92-100151-MV

Trc1 — S11 dB Mag 5 dB/Ref -20 dB Cal Smo

1

M1	1.750000 GHz	-29.6316 dB
M2	1.721140 GHz	-20.0051 dB
M3	1.808980 GHz	-20.0057 dB





Ch1 Start 1.55 GHz


Pwr -10 dBm Bw 10 kHz

Stop 1.95 GHz

**Calibration Certificate Label:**

	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 11903941JD01B</p> <p>Instrument ID: 1077</p> <p>Calibration Date: 05/Oct/2017</p> <p>Calibration Due Date:</p>
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	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 11903941JD01B</p> <p>Instrument ID: 1077</p> <p>Calibration Date: 05/Oct/2017</p> <p>Calibration Due Date:</p>
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	<p><b>UL VS LTD - Tel: +44 (0) 1256312000</b></p> <p>Certificate Number: 11903941JD01B</p> <p>Instrument ID: 1077</p> <p>Calibration Date: 05/Oct/2017</p> <p>Calibration Due Date:</p>
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# CERTIFICATE OF CALIBRATION

ISSUED BY **UL VS LTD**

DATE OF ISSUE: 10/Oct/2017

CERTIFICATE NUMBER : 11903941JD01D



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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

.....  
Naseer Mirza

## Customer :

UL VS Ltd  
Pavilion A, Ashwood Park, Ashwood Way  
Basingstoke, RG23 8BG, England

## Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	29/Sep/2017
Manufacturer:	Speag		
Type/Model Number:	D1900V2		
Serial Number:	5d163		
Calibration Date:	05/Oct/2017		
Calibrated By:	Chanthu Thevarajah Laboratory 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.

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Page 2 of 10

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
A2587	Probe	SPEAG	ES3DV3	3341	14 Aug 2017	12
A2200	Dipole	SPEAG	D1900V2	537	09 Feb 2017	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	12
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	16 Nov 2016	12
M1015	Network Analyser	Agilent Technologies	8753ES	US39172406	26 Sept 2016	12
PRE0151154	Network Analyser	Rhode & Schwarz	ZND8	100151	22 Nov 2016	12
PRE0151877	Calibration Kit	Rhode & Schwarz	Z135	102947-Bt	02 Dec 2016	12
M1908	Signal Generator	Rhode & Schwarz	SMIQ 03B	1125.555.03	08 Nov 2016	12

# CERTIFICATE OF CALIBRATION

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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:	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	23.0 °C	22.0 °C	21.0°C	22.0°C	$\epsilon_r$	40.00	39.71	± 5%
						$\sigma$	1.40	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	9.74 W/Kg	<b>38.77 W/Kg</b>	± 17.57%
	SAR averaged over 10g	5.05 W/Kg	<b>20.10 W/Kg</b>	± 17.32%

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

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.143 $\Omega$ -3.33 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	29.77	± 2.03 dB

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11903941JD01D

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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	1900	22.0 °C	22.0 °C	22.0°C	22.0°C	$\epsilon_r$	53.30	52.22	± 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	10.80 W/Kg	<b>42.99 W/Kg</b>	± 18.06%
	SAR averaged over 10g	5.52 W/Kg	<b>21.97 W/Kg</b>	± 17.44%

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

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	52.90 $\Omega$ -5.74 j $\Omega$	± 0.28 $\Omega$ ± 0.044 j $\Omega$
	Return Loss	24.03	± 2.03 dB

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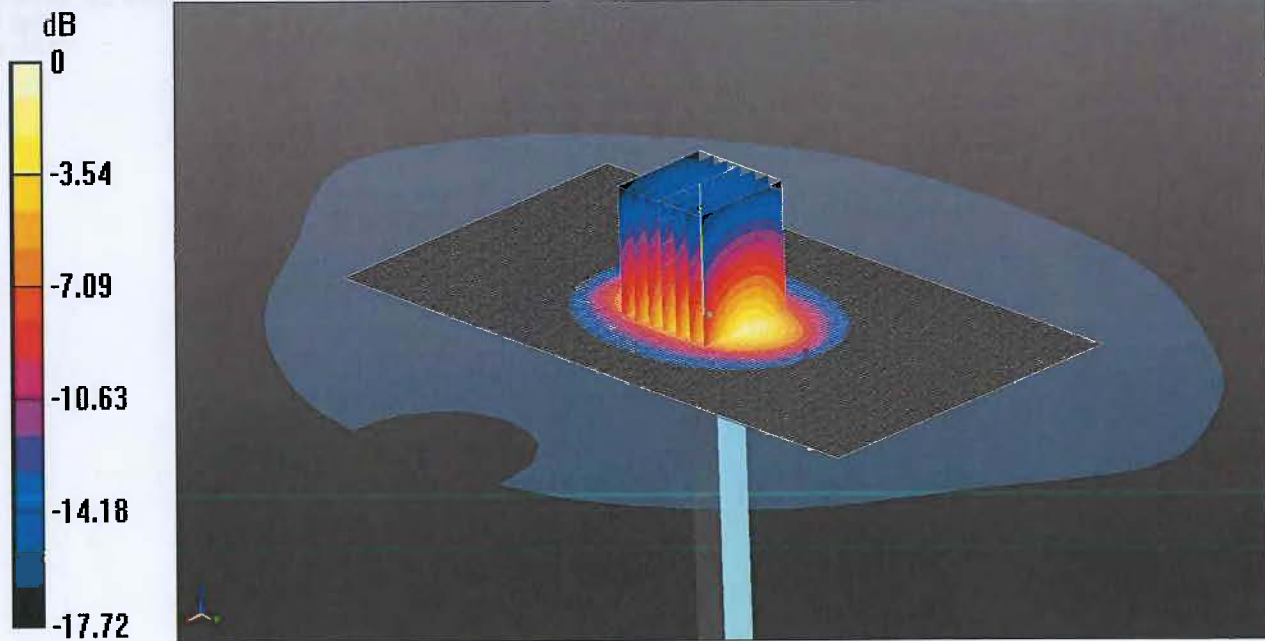
CERTIFICATE  
NUMBER :  
11903941JD01D

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

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



0 dB = 12.3 W/kg = 10.90 dBW/kg

Communication System: UID 0, CW (0); Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 MHz HSL Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.36$  S/m;  $\epsilon_r = 39.711$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3341; ConvF(5.28, 5.28, 5.28); Calibrated: 14/08/2017;

- 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=10mm, Pin=250mW 2/Area Scan (81x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 12.7 W/kg

**Configuration/d=10mm, Pin=250mW 2/Zoom Scan (5x5x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.37 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 17.9 W/kg

**SAR(1 g) = 9.74 W/kg; SAR(10 g) = 5.05 W/kg**

Maximum value of SAR (measured) = 12.3 W/kg

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

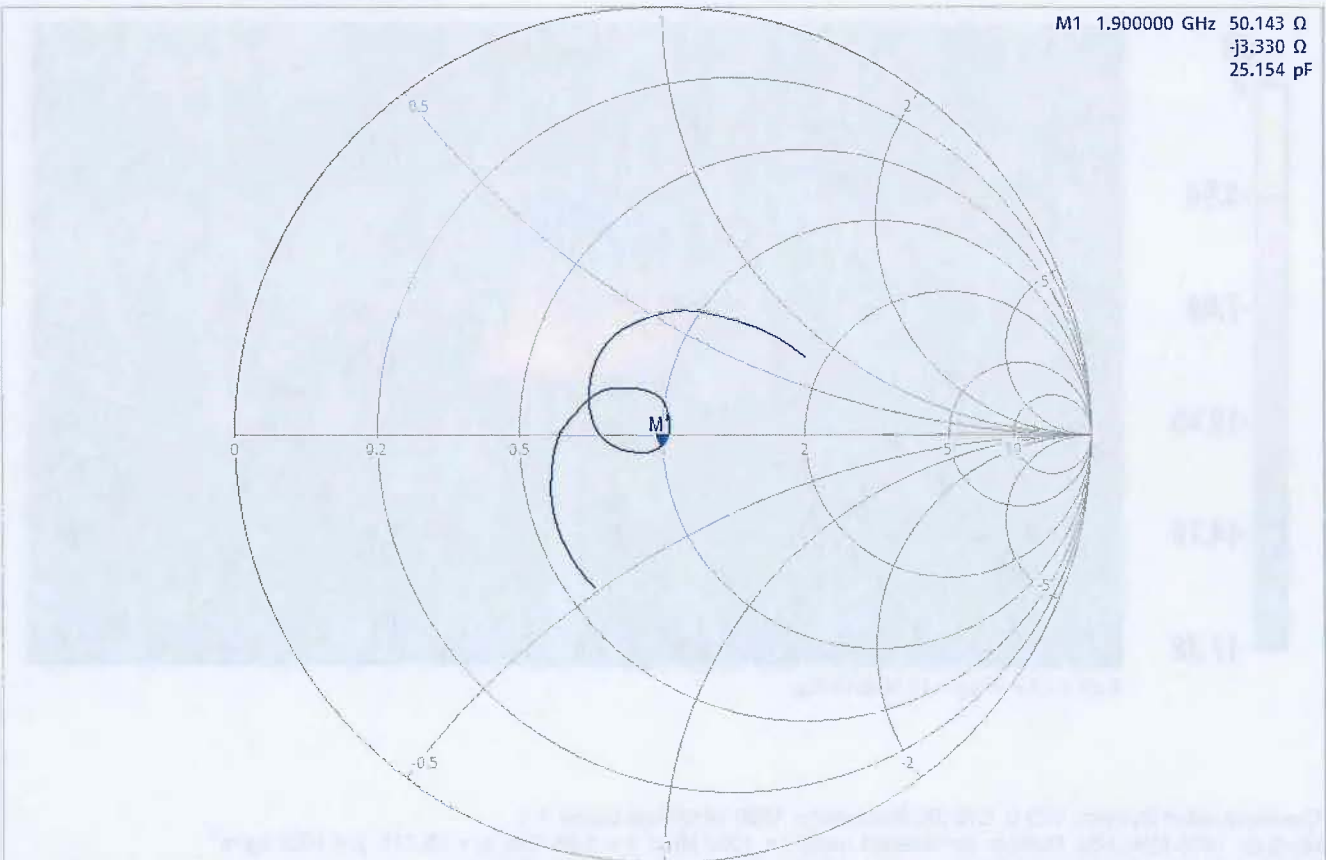


10/10/2017 1:00:08 PM  
1325.5170K92-100151-MV

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

1

M1 1.90000 GHz 50.143  $\Omega$   
-j3.330  $\Omega$   
25.154 pF



Ch1 Start 1.7 GHz

Pwr -10 dBm Bw 10 kHz

Stop 2.1 GHz

# CERTIFICATE OF CALIBRATION

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UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
11903941JD01D

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

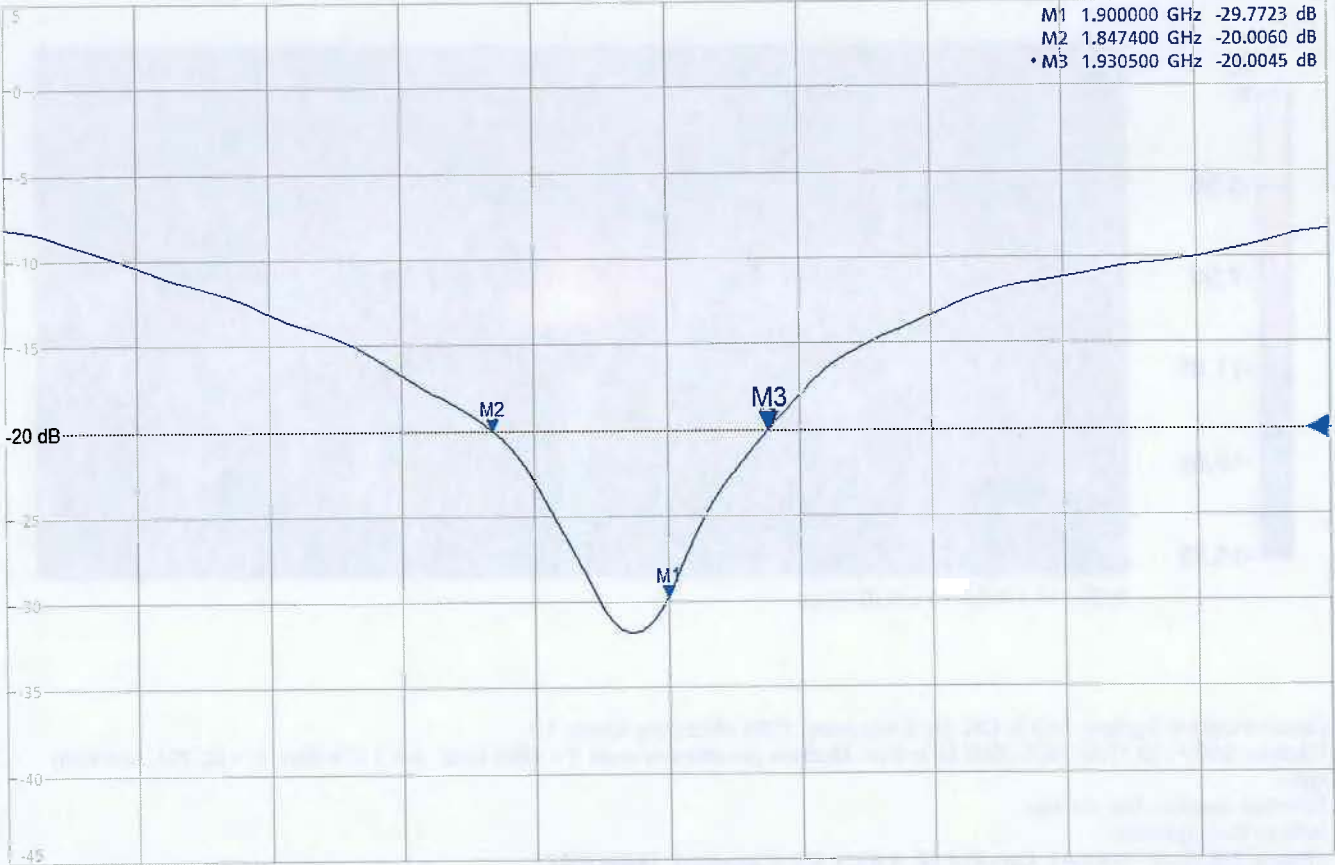


10/10/2017 12:55:05 PM  
1328.5170K92-100151-MV

Trc1 — 511 dB Mag 5 dB/ Ref -20 dB Cal Smo

1

M1	1.900000 GHz	-29.7723 dB
M2	1.847400 GHz	-20.0060 dB
M3	1.930500 GHz	-20.0045 dB



Ch1 Start 1.7 GHz

Pwr -10 dBm Bw 10 kHz

Stop 2.1 GHz

# CERTIFICATE OF CALIBRATION

## ISSUED BY UL VS LTD

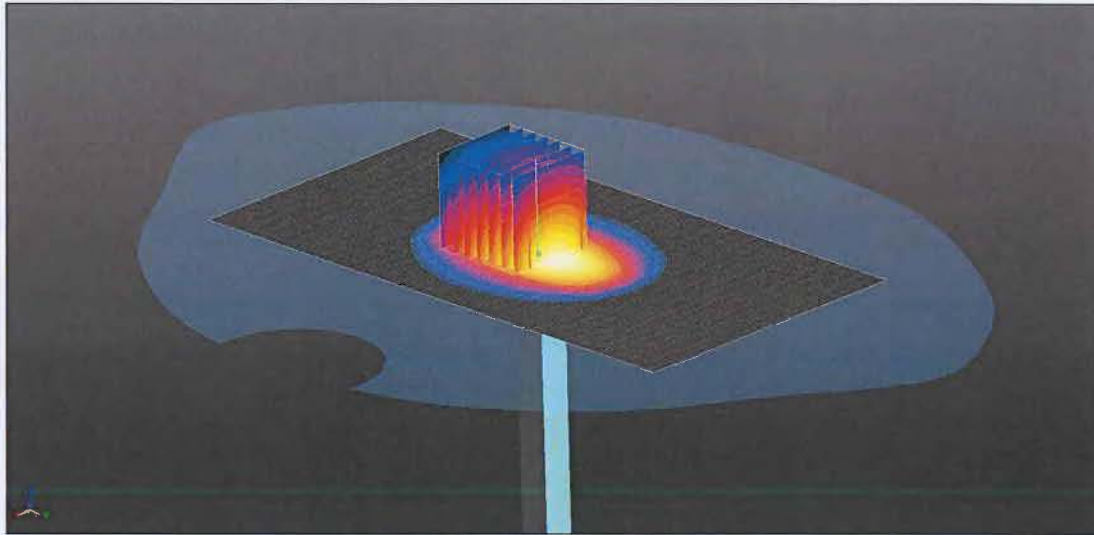
CERTIFICATE  
NUMBER :  
11903941JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 8 of 10

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

DUT: Dipole 1900 MHz; 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: 900,1750,1800,1900,2600 MHz MSL Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.576$  S/m;  $\epsilon_r = 52.221$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3341; ConvF(4.92, 4.92, 4.92); Calibrated: 14/08/2017;
- 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)

**SAR/d=10mm, Pin=250mW 2/Area Scan (81x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

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

**SAR/d=10mm, Pin=250mW 2/Zoom Scan (5x5x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.36 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 19.5 W/kg

**SAR(1 g) = 10.8 W/kg; SAR(10 g) = 5.52 W/kg**

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



# CERTIFICATE OF CALIBRATION

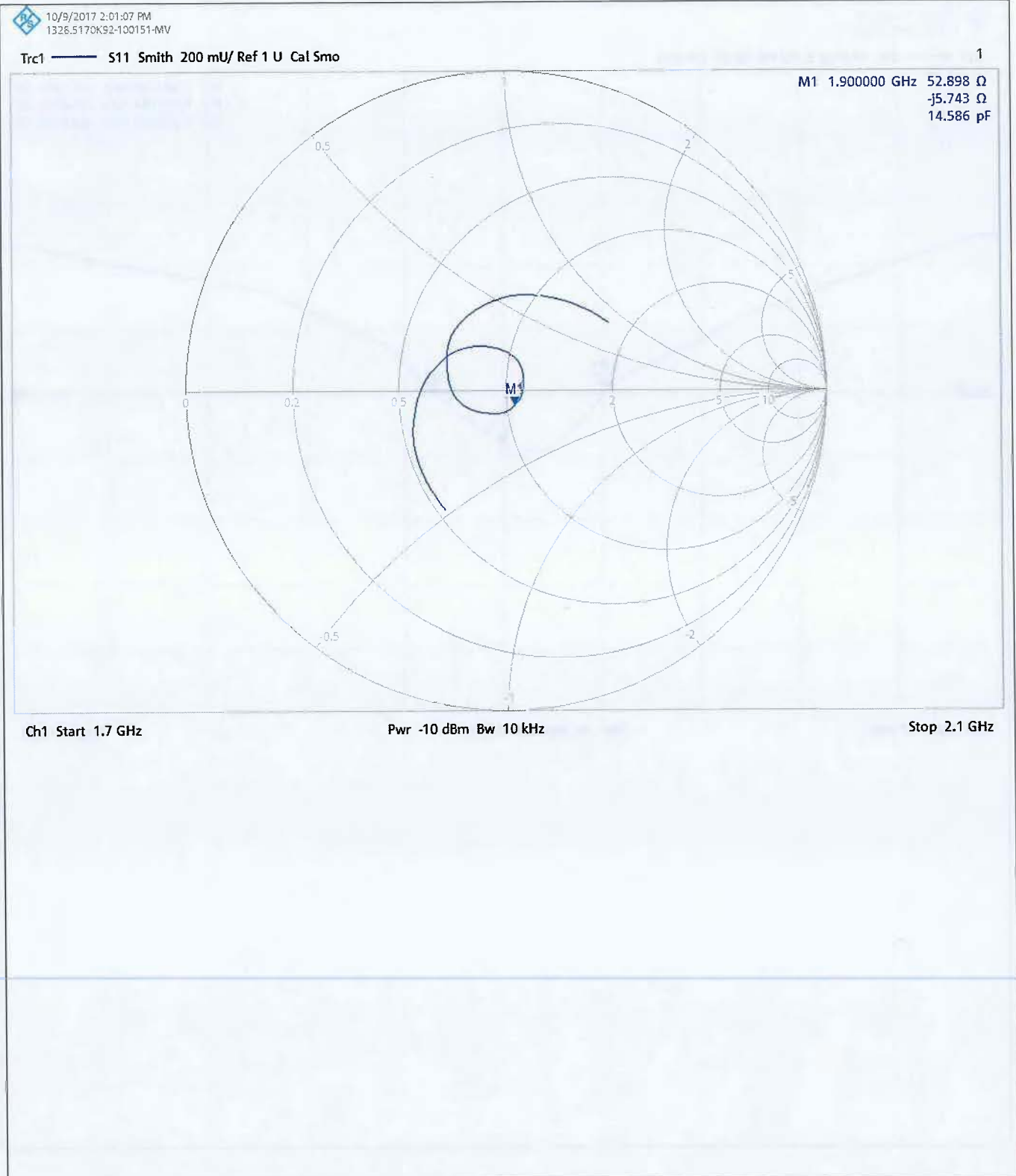
## ISSUED BY UL VS LTD

CERTIFICATE  
NUMBER :  
11903941JD01D

UKAS Accredited Calibration Laboratory No. 5248

Page 9 of 10

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



# CERTIFICATE OF CALIBRATION

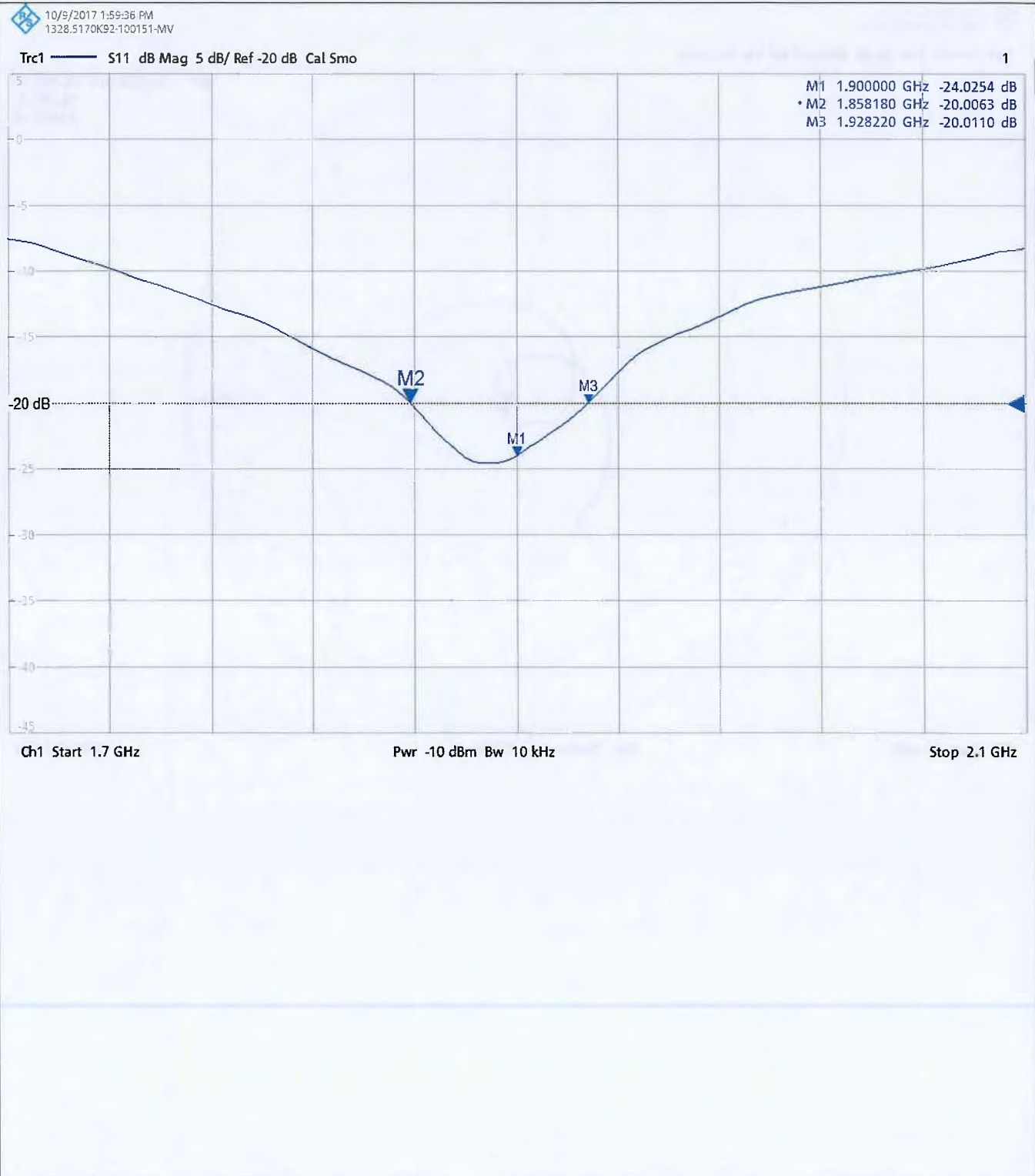
## ISSUED BY UL VS LTD

UKAS Accredited Calibration Laboratory No. 5248

CERTIFICATE  
NUMBER :  
11903941JD01D

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: 11903941JD01D</p> <p>Instrument ID: 5d163</p> <p>Calibration Date: 05/Oct/2017</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: 11903941JD01D</p> <p>Instrument ID: 5d163</p> <p>Calibration Date: 05/Oct/2017</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: 11903941JD01D</p> <p>Instrument ID: 5d163</p> <p>Calibration Date: 05/Oct/2017</p> <p>Calibration Due Date:</p>
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Multilateral Agreement for the recognition of calibration certificates**

Accreditation No.: **SCS 0108**

Client **UL CCS USA**

Certificate No: **D2450V2-748\_Feb17**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN:748**

Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **February 08, 2017**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 9, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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Accreditation No.: **SCS 0108**

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### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "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)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

<b>DASY Version</b>	DASY5	V52.8.8
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	2450 MHz ± 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	39.2	1.80 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	37.5 ± 6 %	1.87 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>52.1 W/kg ± 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	6.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.2 W/kg ± 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	52.7	1.95 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	51.6 ± 6 %	2.02 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>51.3 W/kg ± 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	6.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>23.9 W/kg ± 16.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 $\Omega$ - 1.1 j $\Omega$
Return Loss	- 28.1 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.6 $\Omega$ + 1.8 j $\Omega$
Return Loss	- 34.5 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.154 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 01, 2003



Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:748**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.87$  S/m;  $\epsilon_r = 37.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

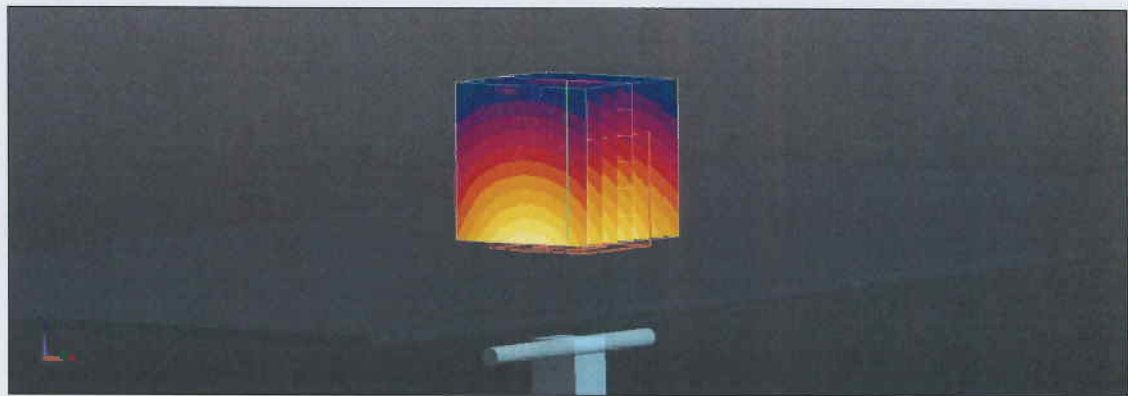
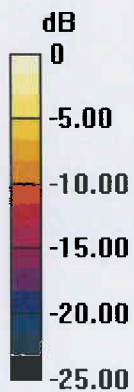
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 113.6 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 27.9 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.16 W/kg**

Maximum value of SAR (measured) = 21.9 W/kg



0 dB = 21.9 W/kg = 13.40 dBW/kg

# Impedance Measurement Plot for Head TSL

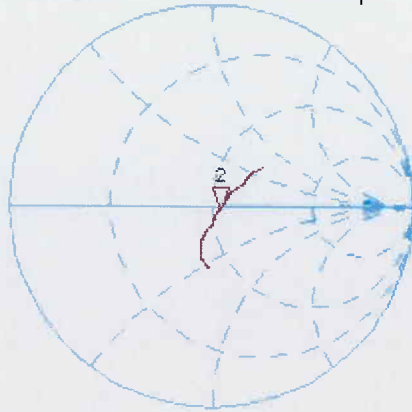
8 Feb 2017 16:48:07

CH1 S11 1 U FS

2: 53.924  $\Omega$  -1.0957  $\Omega$  59.287  $\mu$ F

2 450.000 000 MHz

\*  
Del  
CA



Avg  
16

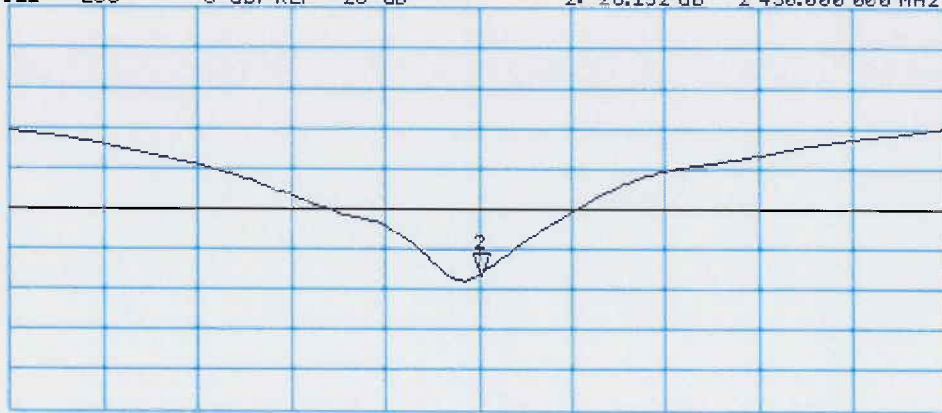
H1d

CH2 S11 LOG 5 dB/REF -20 dB 2:-28.132 dB 2 450.000 000 MHz

CA

Avg  
16

H1d



START 2 250.000 000 MHz

STOP 2 650.000 000 MHz

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:748**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 51.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

## Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

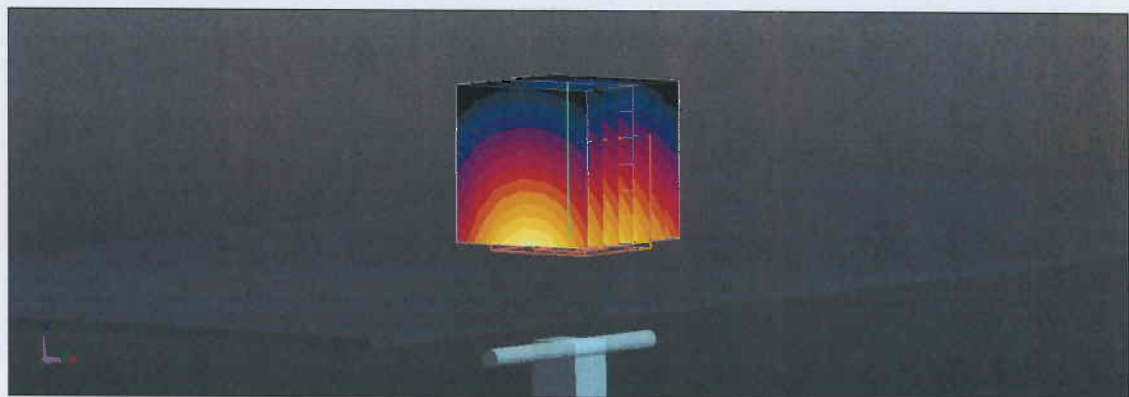
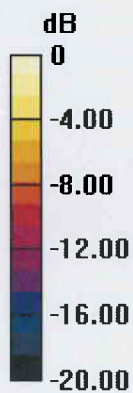
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.7 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 26.8 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.06 W/kg**

Maximum value of SAR (measured) = 21.1 W/kg



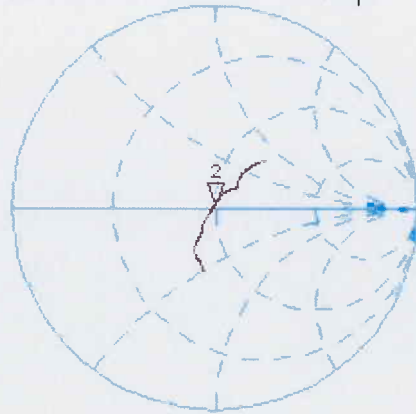
0 dB = 21.1 W/kg = 13.24 dBW/kg

# Impedance Measurement Plot for Body TSL

8 Feb 2017 16:47:21

CH1 S11 1 U FS 2: 49.561  $\Omega$  1.8281  $\Omega$  118.76  $\mu\text{H}$  2 450.000 000 MHz

\*  
De1  
CA



Avg  
16

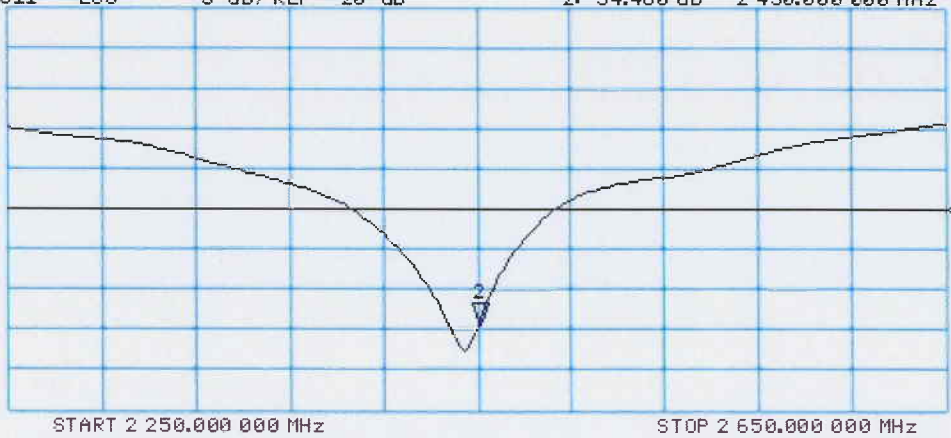
H1d

CH2 S11 LOG 5 dB/REF -20 dB 2:-34.480 dB 2 450.000 000 MHz

CA

Avg  
16

H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **UL CCS USA**

Certificate No: **D2450V2-899\_Mar17**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN:899**

Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **March 10, 2017**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 14, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "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)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	37.8 $\pm$ 6 %	1.87 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>52.6 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.6 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.2 $\pm$ 6 %	2.03 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>50.3 W/kg <math>\pm</math> 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.97 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>23.7 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.3 $\Omega$ + 7.9 j $\Omega$
Return Loss	- 21.3 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.5 $\Omega$ + 9.5 j $\Omega$
Return Loss	- 20.6 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.161 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	June 19, 2012



# DASY5 Validation Report for Head TSL

Date: 10.03.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:899**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.87$  S/m;  $\epsilon_r = 37.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

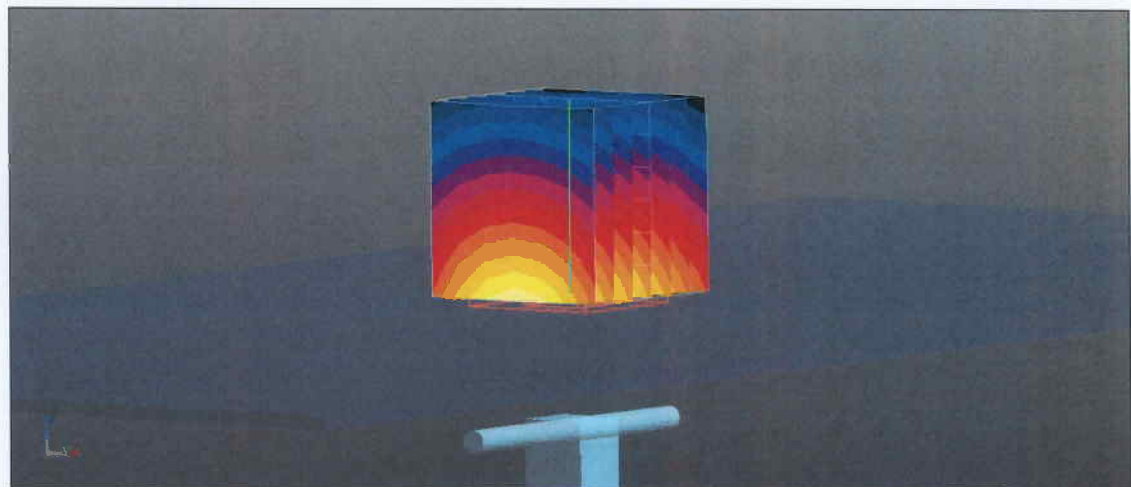
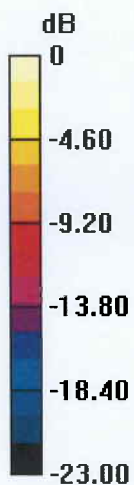
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 116.1 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 27.6 W/kg

**SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.25 W/kg**

Maximum value of SAR (measured) = 22.3 W/kg



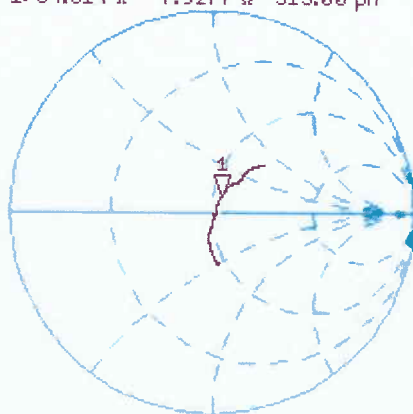
0 dB = 22.3 W/kg = 13.48 dBW/kg

# Impedance Measurement Plot for Head TSL

10 Mar 2017 13:51:52

CH1 S11 1 U FS 1: 54.314  $\Omega$  7.9277  $\Omega$  515.00  $\mu\text{H}$  2 450.000 000 MHz

\*  
Del  
CA



Avg  
16

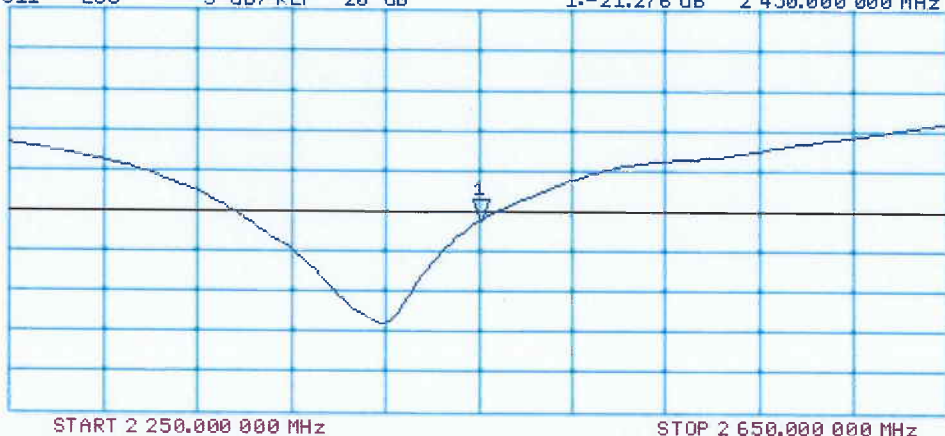
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-21.276 dB 2 450.000 000 MHz

CA

Avg  
16

H1d



Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:899**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 53.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.8 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 25.3 W/kg

**SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.97 W/kg**

Maximum value of SAR (measured) = 20.1 W/kg



0 dB = 20.1 W/kg = 13.03 dBW/kg

# Impedance Measurement Plot for Body TSL

10 Mar 2017 13:51:03

CH1 S11 1 U FS

1: 50.494  $\Omega$  9.4551  $\Omega$  614.21 pF

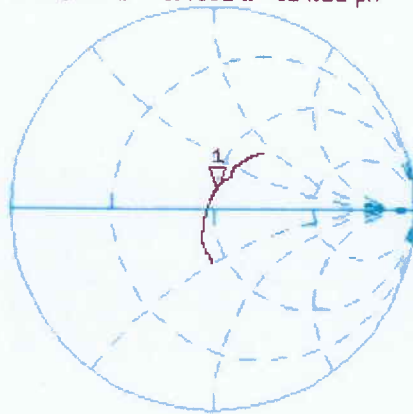
2 450.000 000 MHz

\*  
Del

CA

Avg  
16

H1d



CH2 S11 LOG

5 dB/REF -20 dB

1: -20.557 dB 2 450.000 000 MHz

CA

Avg  
16

H1d

