Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **Apple USA**

Certificate No: DAE4-1263_Oct20

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 1263
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	October 08, 2020

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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	07-Sep-20 (No:28647)	Sep-21
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	09-Jan-20 (in house check)	In house check: Jan-21
Calibrator Box V2.1	SE UMS 006 AA 1002	09-Jan-20 (in house check)	In house check: Jan-21

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: October 8, 2020

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range:	1LSB =	6.1μV ,	full range =	-100...+300 mV
Low Range:	1LSB =	61nV ,	full range =	-1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.492 ± 0.02% (k=2)	404.750 ± 0.02% (k=2)	404.794 ± 0.02% (k=2)
Low Range	3.96972 ± 1.50% (k=2)	3.99510 ± 1.50% (k=2)	3.99243 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	16.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200036.35	-3.10	-0.00
Channel X	+ Input	20007.90	2.03	0.01
Channel X	- Input	-20000.78	5.15	-0.03
Channel Y	+ Input	200031.97	-4.06	-0.00
Channel Y	+ Input	20004.01	-1.68	-0.01
Channel Y	- Input	-20009.57	-3.48	0.02
Channel Z	+ Input	200034.44	-1.47	-0.00
Channel Z	+ Input	20003.13	-2.66	-0.01
Channel Z	- Input	-20007.69	-1.62	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.36	-0.98	-0.05
Channel X	+ Input	200.78	-0.70	-0.35
Channel X	- Input	-198.48	0.07	-0.04
Channel Y	+ Input	2000.98	-0.17	-0.01
Channel Y	+ Input	200.53	-0.69	-0.34
Channel Y	- Input	-199.98	-1.29	0.65
Channel Z	+ Input	2002.21	1.15	0.06
Channel Z	+ Input	200.58	-0.61	-0.31
Channel Z	- Input	-199.27	-0.47	0.24

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-16.68	-17.65
	- 200	18.53	17.12
Channel Y	200	0.12	-0.14
	- 200	-2.11	-2.50
Channel Z	200	12.10	11.97
	- 200	-14.80	-14.88

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	0.20	-3.63
Channel Y	200	8.15	-	3.16
Channel Z	200	10.21	5.87	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16416	15846
Channel Y	15997	15255
Channel Z	15745	16611

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.15	-1.13	1.25	0.49
Channel Y	-0.26	-1.69	1.62	0.69
Channel Z	-0.20	-1.90	1.79	0.74

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

Schmid & Partner Engineering AG

s p e a g

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IMPORTANT NOTICE

USAGE OF THE DAE4ip

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

Important Note:
Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:
Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:
To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.

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Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **Apple USA**

Certificate No: DAE4ip-1642_Dec20

CALIBRATION CERTIFICATE

Object: DAE4ip - SD 000 D14 AB - SN: 1642

Calibration procedure(s): QA CAL-06.v30
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: December 01, 2020

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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	07-Sep-20 (No:28647)	Sep-21
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	09-Jan-20 (in house check)	In house check: Jan-21
Calibrator Box V2.1	SE UMS 006 AA 1002	09-Jan-20 (in house check)	In house check: Jan-21

	Name	Function	Signature
Calibrated by:	Eric Hainfeld	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	

Issued: December 1, 2020

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range:	1LSB =	6.1μV ,	full range =	-100...+300 mV
Low Range:	1LSB =	61nV ,	full range =	-1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	405.005 ± 0.02% (k=2)	405.016 ± 0.02% (k=2)	404.879 ± 0.02% (k=2)
Low Range	3.96775 ± 1.50% (k=2)	3.98575 ± 1.50% (k=2)	3.98236 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	156.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200036.27	2.78	0.00
Channel X	+ Input	20006.18	0.57	0.00
Channel X	- Input	-20004.54	0.95	-0.00
Channel Y	+ Input	200028.12	-5.40	-0.00
Channel Y	+ Input	20002.57	-2.95	-0.01
Channel Y	- Input	-20006.35	-0.77	0.00
Channel Z	+ Input	200030.78	-2.70	-0.00
Channel Z	+ Input	20003.01	-2.52	-0.01
Channel Z	- Input	-20006.18	-0.54	0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.00	-0.45	-0.02
Channel X	+ Input	201.31	-0.11	-0.05
Channel X	- Input	-198.61	0.05	-0.03
Channel Y	+ Input	2000.74	-0.58	-0.03
Channel Y	+ Input	199.87	-1.29	-0.64
Channel Y	- Input	-199.33	-0.58	0.29
Channel Z	+ Input	2001.23	-0.15	-0.01
Channel Z	+ Input	200.36	-0.87	-0.43
Channel Z	- Input	-199.53	-0.79	0.40

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	6.14	5.13
	- 200	-4.33	-6.09
Channel Y	200	-7.55	-7.66
	- 200	5.89	5.55
Channel Z	200	-1.89	-1.67
	- 200	-0.69	-0.00

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-1.13	-3.62
Channel Y	200	6.44	-	1.27
Channel Z	200	9.65	3.52	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16031	16561
Channel Y	16112	16780
Channel Z	16091	16870

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	-0.29	-1.61	0.44	0.34
Channel Y	-0.70	-1.86	1.30	0.47
Channel Z	-0.61	-1.38	0.07	0.30

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

CERTIFICATE OF CALIBRATION

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

DATE OF ISSUE: 13/April/2021 CERTIFICATE NUMBER : 13697411JD01C

5772

UL INTERNATIONAL (UK) LTD
UNIT 1-3 HORIZON
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APPROVED SIGNATORY

Harmohan Sahota

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	12/April/2021
Manufacturer:	Speag		
Type/Model Number:	D1900V2		
Serial Number:	5d140		
Calibration Date:	13/April/2021		
Calibrated By:	Ravish Foolchund Laboratory Technician		
Signature:			

All Calibration have been conducted in the closed laboratory facility: Lab Temperature (22±3) ^{0}C and humidity < 70%

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. **DASY 6 System Handbook**
6. **Dipole Calibration Procedure V1.2:** Calibration performed as per internal procedure

The measuring equipment used to perform the calibration, documented in this certificate has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval (Months)
PRE0134060	Data Acquisition Electronics	SPEAG	DAE4	432	09 Oct 2020	12
PRE0134817	Probe	SPEAG	ES3DV3	3335	14 Jan 2021	12
PRE0134198	Dipole Antenna	SPEAG	D1900V2	537	16 Feb 2021	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rohde & Schwarz	NRP8S	102481	17 Apr 2020	12
PRE0151154	Vector Network Analyser	Rohde & Schwarz	ZND	100151	15 Jun 2020	12
PRE0158684	Calibration Kit	Rhode & Schwarz	ZV-Z135	102144	27 May 2020	12
PRE0178154	Signal Generator	Rohde & Schwarz	SMB 100A	175325	10 Jun 2020	12

SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F13/5SC6F1/A/01
DASY Version:	cDASY6.14.0.959
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10mm (with spacer)
Frequency:	1900 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

Simulant Liquid	Frequency (MHz)	Room Temp		Liquid Temp		Parameters	Target Value	Measured Value	Uncertainty (%)
		Start	End	Start	End				
Head	1900	20.0 °C	19.8 °C	19.8°C	19.8°C	**εr**	40.00	39.53	± 5%
						σ	1.40	1.44	± 5%

SAR Results – Head Simulating Liquid (HSL)

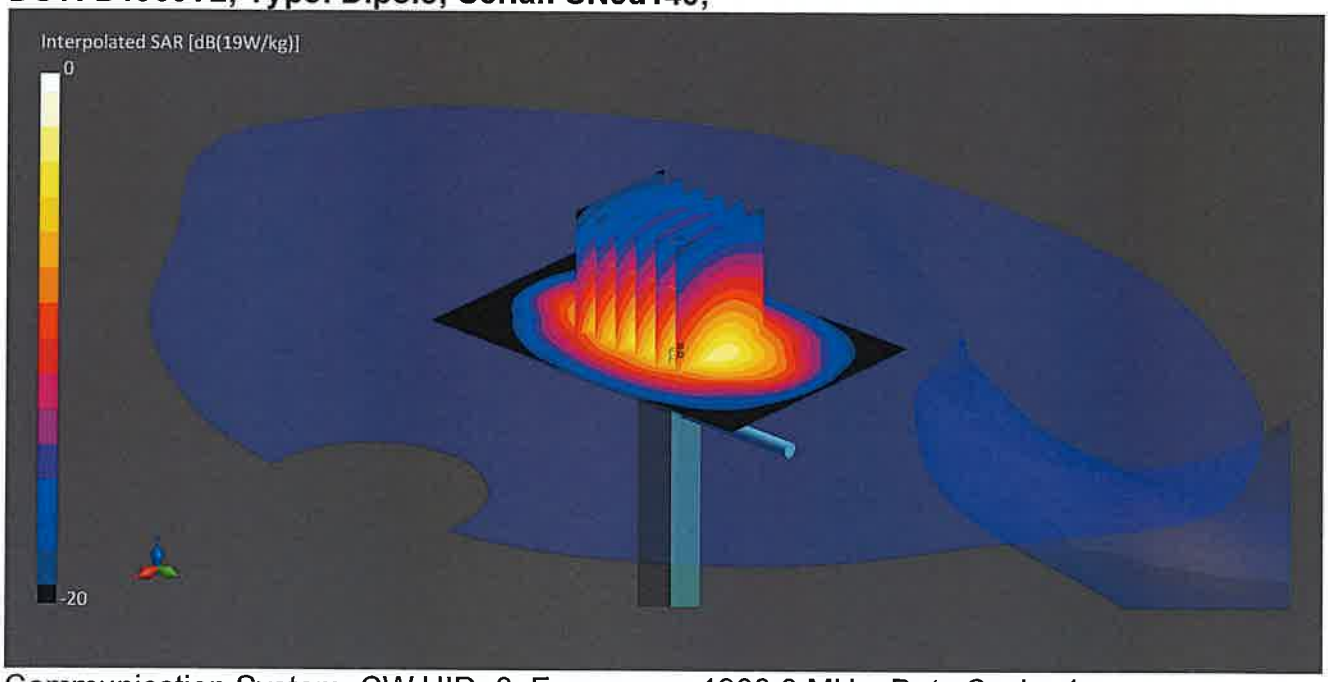
Simulant Liquid	SAR Measured	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Head	SAR averaged over 1g	10.40 W/Kg	**41.40 W/Kg**	+16.80% / -16.43%
	SAR averaged over 10g	5.40 W/Kg	**21.50 W/Kg**	+16.72% / -16.42%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	49.47 Ω - 4.77 jΩ	± 0.28 Ω ± 0.044 jΩ
	Return Loss	-26.34 dB	± 2.97 dB

DASY Validation Scan for Head Stimulating Liquid (HSL)

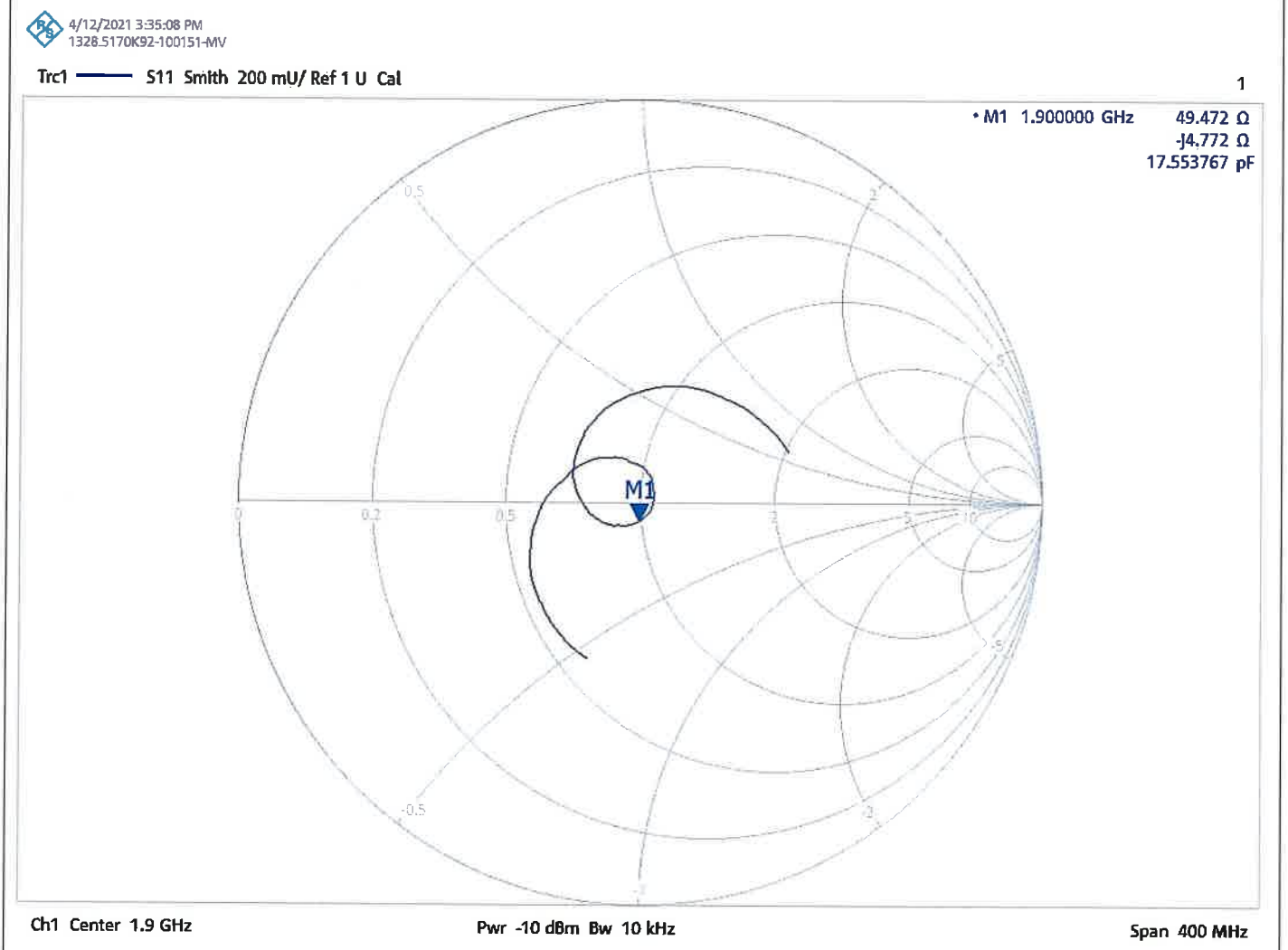
DUT: D1900V2; Type: Dipole; Serial: SN5d140;



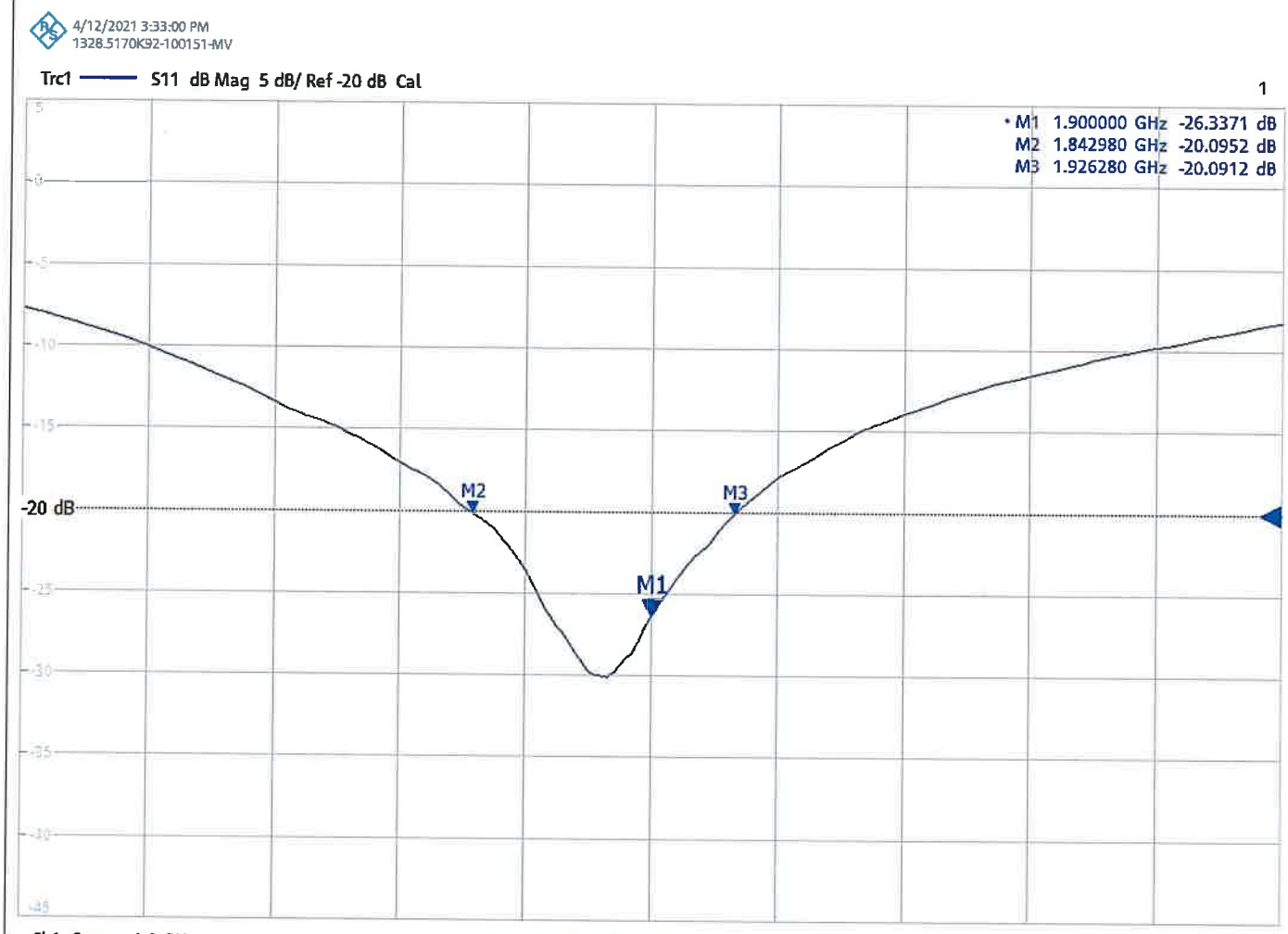
Communication System: CW UID: 0; Frequency: 1900.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_12Apr2021_115940_Head - 1750 1800 1900 2300 2450 2600 5%;
Medium parameters used: f = 1900.0 MHz; σ = 1.44 S/m; ε_r = 39.5; ρ = 1000 kg/m3; $\Delta\varepsilon_r$ = -1.17 %; $\Delta\sigma$ = 2.77 %; No correction
Phantom section: Flat;
DASY 6 Configuration:
- Laboratory Name: Site65;
- Probe: ES3DV3 - SN3335; ConvF(5.13, 5.13, 5.13); Calibrated: 14 Jan 2021
- Sensor-Surface: 3 mm; VMS + 6p
- Electronics: DAE4 - SN432; Calibrated: 09 Oct 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (60x90): Interpolated grid: dx=15 mm, dy=15 mm
Zoom Scan1(30x30x30): Measurement grid: dx=6 mm, dy=6 mm, dz=1.5 mm; Grading Ratio: 1.5; Reference Value = 13.240 V/m; Power Drift = 0.01 dB
Minimum horizontal 3dB distance: 10.8 mm;
Vertical M2/M1 Ratio: 84.2 %;
SAR(1 g) = 10.400 W/kg; SAR(10 g) = 5.400 W/kg

Impedance Measurement Plot for Head Stimulating Liquid (HSL)



Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



Calibration Certificate Label:

5772	**UL INTERNATIONAL (UK) LTD** **Tel: +44 (0) 1256312000** Certificate Number: 13697411JD01C Instrument ID: 5d140 Calibration Date: 13/April/2021 Calibration Due Date:

5772	**UL INTERNATIONAL (UK) LTD** **Tel: +44 (0) 1256312000** Certificate Number: 13697411JD01C Instrument ID: 5d140 Calibration Date: 13/April/2021 Calibration Due Date:

5772	**UL INTERNATIONAL (UK) LTD** **Tel: +44 (0) 1256312000** Certificate Number: 13697411JD01C Instrument ID: 5d140 Calibration Date: 13/April/2021 Calibration Due Date:

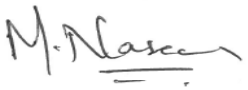
CERTIFICATE OF CALIBRATION

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

DATE OF ISSUE: 29/Oct/2020 CERTIFICATE NUMBER : 13252592JD01B

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

APPROVED SIGNATORY



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Naseer Mirza

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

Equipment Details:

Description:	Dipole Validation Kit	Date of Receipt:	15/Oct/2020
Manufacturer:	Speag		
Type/Model Number:	D1750V2		
Serial Number:	1053		
Calibration Date:	16/Oct/2020		
Calibrated By:	Harmohan Sahota Laboratory Engineer		
Signature:			

.....

All Calibration have been conducted in the closed laboratory facility: Lab Temperature (22±3) ^{0}C and humidity < 70%

The calibration methods and procedures used were as detailed in:

1. **IEC 62209-1:2016**: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)
2. **IEC 62209-2:2010:** Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)
3. **IEEE 1528: 2013:** IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques
4. FCC KDB Publication Number**: "KDB865664 D01 SAR Measurement 100 MHz to 6 GHz"**
5. **DASY5/6 System Handbook**
6. **Dipole Calibration Procedure V1.2:** Calibration performed as per internal procedure

The measuring equipment used to perform the calibration, documented in this certificate has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

UL No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval (Months)
PRE0135115	Data Acquisition Electronics	SPEAG	DAE4	1438	14 Apr 2020	12
PRE0178314	Probe	SPEAG	EX3DV4	7496	24 Mar 2020	12
PRE0131610	Dipole	SPEAG	D1800V2	2d009	12 Feb 2020	12
PRE0151451	Power Monitoring Kit	Art-Fi	ART 100850-01	0001	Cal as part of System	-
PRE0151441	Power Sensor	Rhode & Schwarz	NRP8S	102481	27 Mar 2020	12
PRE0151154	Vector Network Analyser	Rhode & Schwarz	ZNB 8	100151	15 Jun 2020	12
PRE0158684	Calibration Kit	Rhode & Schwarz	ZV-Z135	102144	27 May 2020	12
PRE0178154	Signal Generator	Rhode & Schwarz	SMB100A	175325	10 Jun 2020	12

SAR System Specification

Robot System Positioner:	Stäubli Unimation Corp. Robot Model: TX60L
Robot Serial Number:	F17/5ENYG1/A/01
DASY Version:	cDASY6.14.0.959
Phantom:	Flat section of SAM Twin Phantom
Distance Dipole Centre:	10 mm (with spacer)
Frequency:	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	22.0 ℃	22.2 ℃	22.0℃	22.1℃	**εr**	40.08	40.06	± 5%
						σ	1.37	1.37	± 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	8.98 W/Kg	**35.75 W/Kg**	± 17.57%
	SAR averaged over 10g	4.82 W/Kg	**19.19 W/Kg**	± 17.32%

Antenna Parameters – Head Simulating Liquid (HSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Head	Impedance	50.18 Ω - 0.024j Ω	± 0.28 Ω ± 0.044j Ω
	Return Loss	54.78	± 2.03 dB

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	21.3 ℃	21.2℃	19.9℃	20.1℃	**εr**	53.43	54.47	± 5%
						σ	1.49	1.53	± 5%

SAR Results – Body Simulating Liquid (MSL)

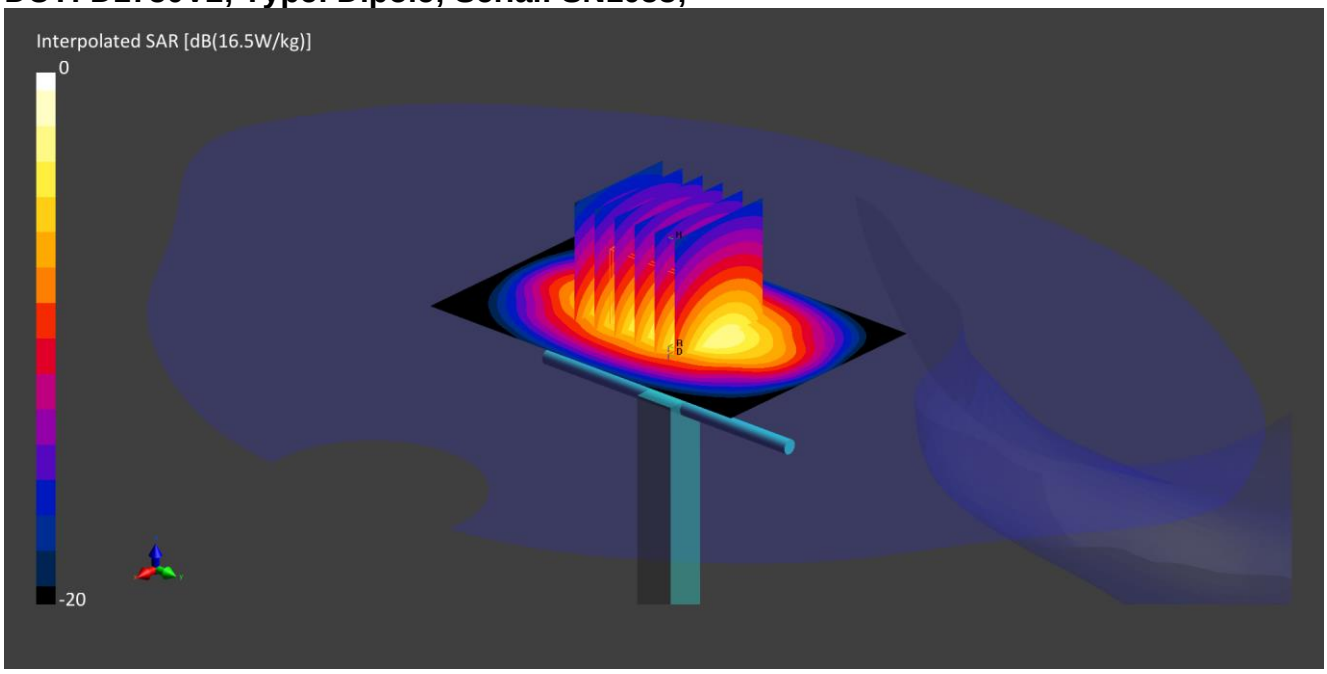
Simulant Liquid	**SAR Measured**	250 mW input Power	Normalised to 1.00 W	Uncertainty (%)
Body	SAR averaged over 1g	9.51 W/Kg	**37.86 W/Kg**	± 18.06%
	SAR averaged over 10g	5.11 W/Kg	**20.34 W/Kg**	± 17.44%

Antenna Parameters – Body Simulating Liquid (MSL)

Simulant Liquid	Parameter	Measured Level	Uncertainty (%)
Body	Impedance	51.39 Ω + 4.51j Ω	± 0.28 Ω ± 0.044j Ω
	Return Loss	26.65	± 2.03 dB

DASY Validation Scan for Head Stimulating Liquid (HSL)

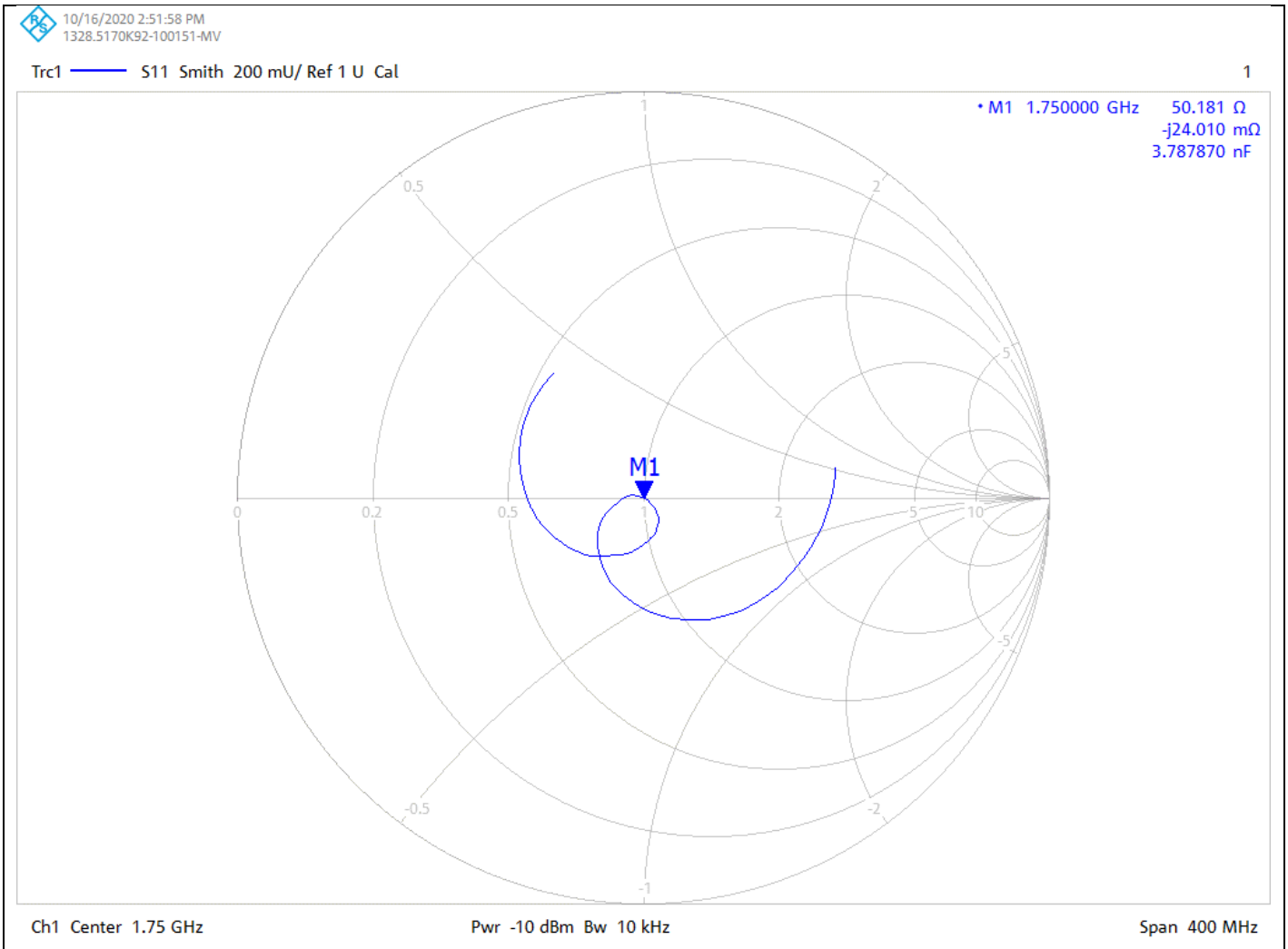
DUT: D1750V2; Type: Dipole; Serial: SN1053;



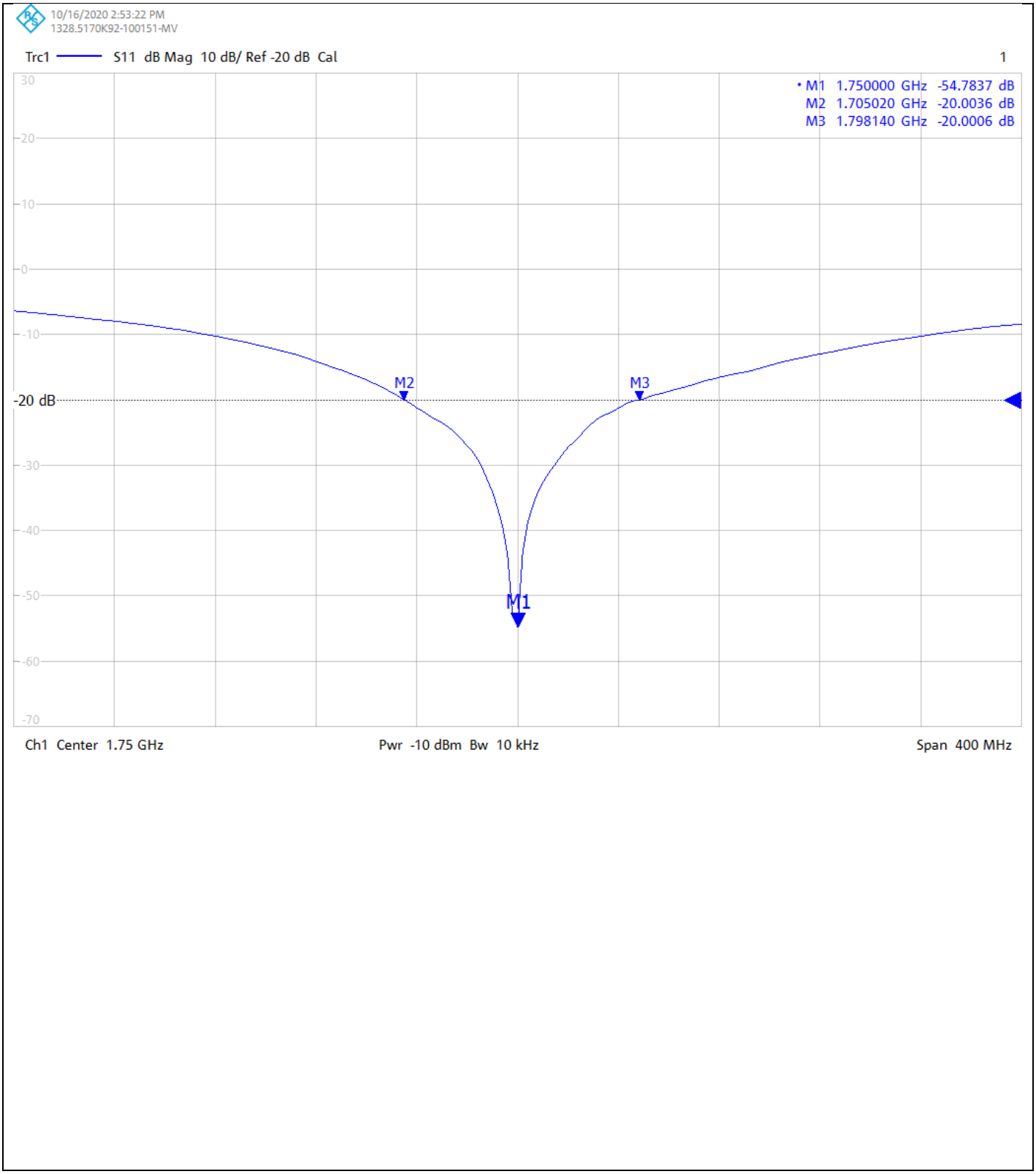
Communication System: CW UID: 0; Frequency: 1750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_15Oct2020_093903_Head - 1750 1800 5%; Medium parameters used: f = 1750.0 MHz; σ = 1.37 S/m; ε_r = 40.1; ρ = 1000 kg/m3; $\Delta\varepsilon_r$ = -0.04 %; $\Delta\sigma$ = 0.16 %; No correction
Phantom section: Flat;
DASY 6 Configuration:
- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(8.79, 8.79, 8.79); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (60x90): Interpolated grid: dx=15 mm, dy=15 mm
Zoom Scan1(30x30x30): Measurement grid: dx=6 mm, dy=6 mm, dz=1.5 mm; Grading Ratio: 1.5; Reference Value = 11.470 V/m; Power Drift = -0.02 dB
Minimum horizontal 3dB distance: 9.7 mm;
Vertical M2/M1 Ratio: 82.4 %;
SAR(1 g) = 8.980 W/kg; SAR(10 g) = 4.820 W/kg

Impedance Measurement Plot for Head Stimulating Liquid (HSL)

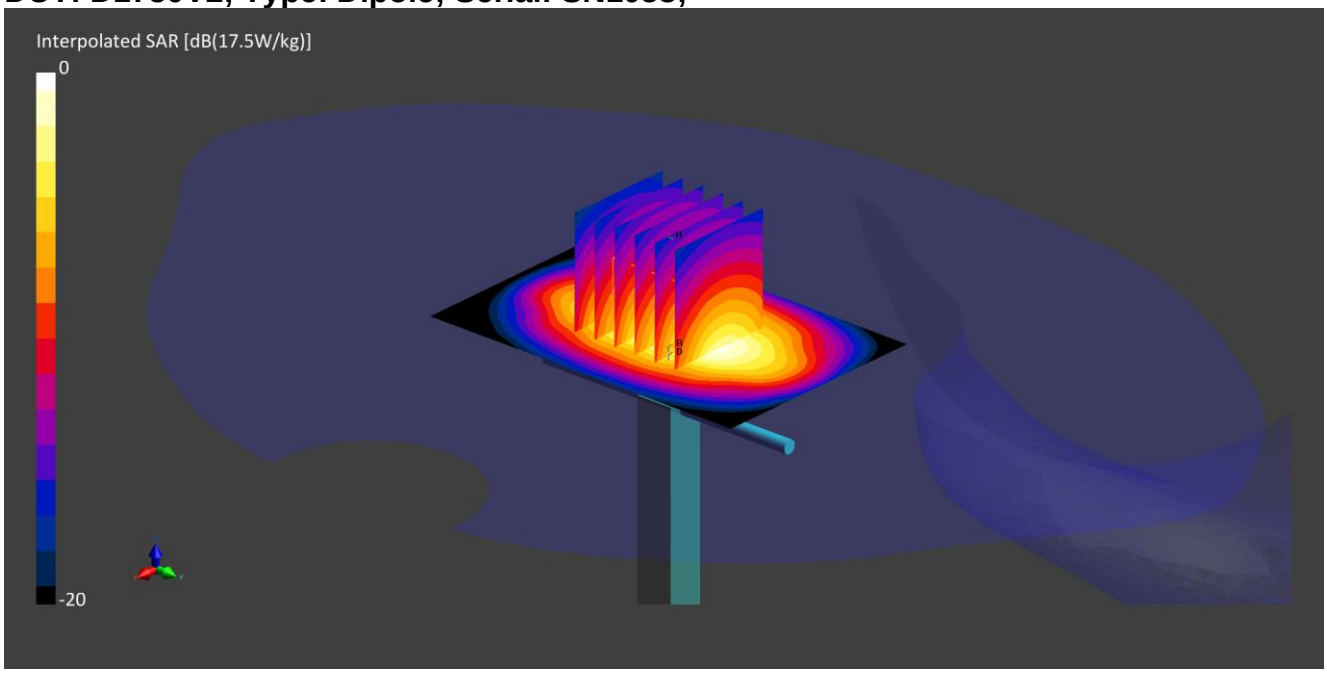


Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



DASY Validation Scan for Body Stimulating Liquid (MSL)

DUT: D1750V2; Type: Dipole; Serial: SN1053;

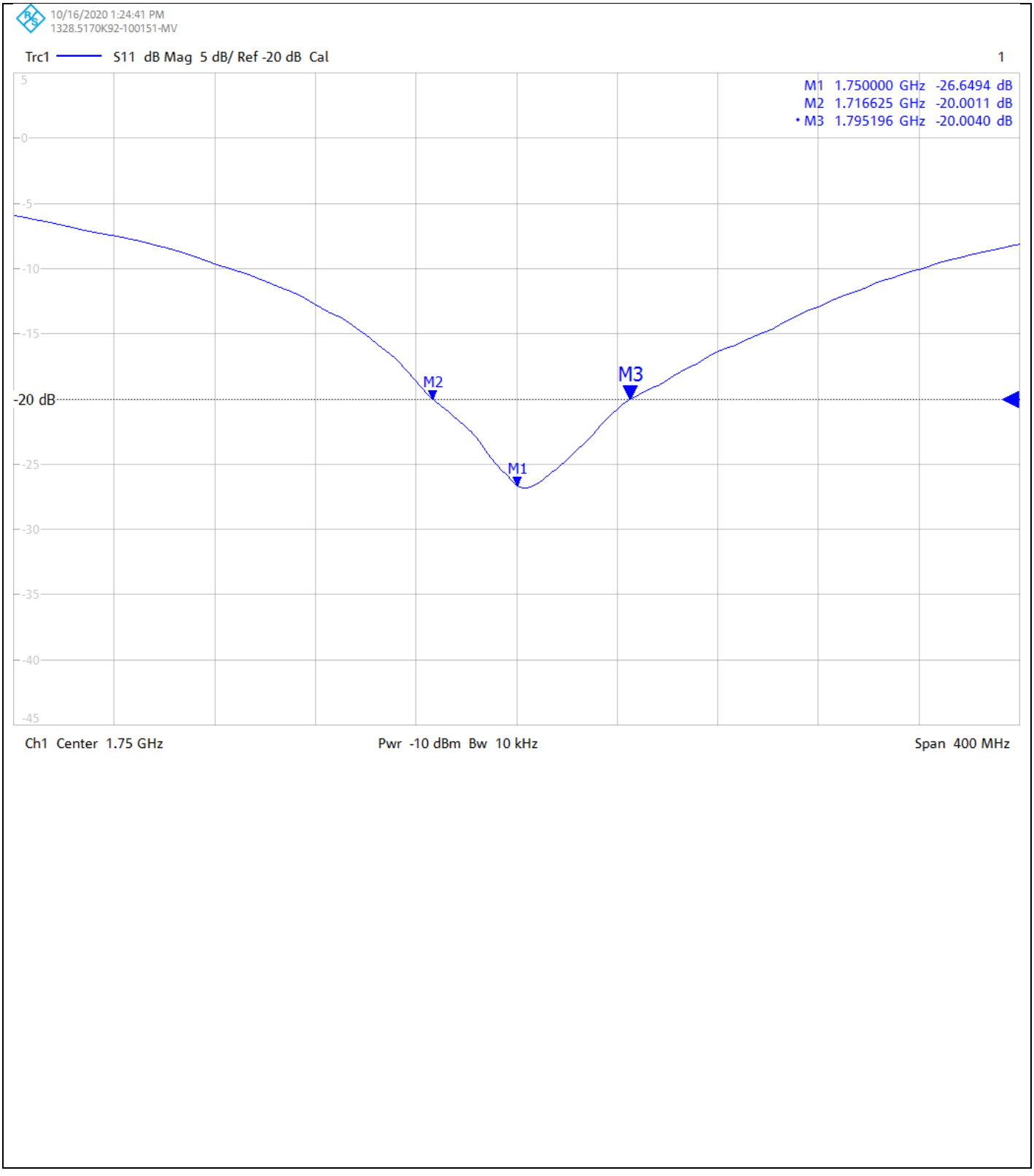


Communication System: CW UID: 0; Frequency: 1750.0 MHz; Duty Cycle: 1;
Medium: MSL; Site65_15Oct2020_125932_Body - 1800 5%; Medium parameters used: f = 1750.0 MHz; σ = 1.53 S/m; ε_r = 54.5; ρ = 1000 kg/m3; $\Delta\varepsilon_r$ = 1.95 %; $\Delta\sigma$ = 2.49 %; No correction
Phantom section: Flat;
DASY 6 Configuration:
- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(8.34, 8.34, 8.34); Calibrated: 24 Mar 2020
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 14 Apr 2020
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- Measurement SW: cDASY6.14.0.959

Area Scan (60x90): Interpolated grid: dx=15 mm, dy=15 mm
Zoom Scan1(30x30x30): Measurement grid: dx=6 mm, dy=6 mm, dz=1.5 mm; Grading Ratio: 1.5; Reference Value = 11.830 V/m; Power Drift = 0.00 dB
Minimum horizontal 3dB distance: 9.6 mm;
Vertical M2/M1 Ratio: 83.3 %;
SAR(1 g) = 9.510 W/kg; SAR(10 g) = 5.110 W/kg

Impedance Measurement Plot for Body Stimulating Liquid (MSL)

Return Loss Measurement Plot for Body Stimulating Liquid (MSL)



Calibration Certificate Label:

UL INTERNATIONAL (UK) LTD
Tel: +44 (0) 1256312000

Certificate Number: 13252592JD01B

Instrument ID: 1053

Calibration Date: 16/Oct/2020

Calibration Due Date:

UL INTERNATIONAL (UK) LTD
Tel: +44 (0) 1256312000

Certificate Number: 13252592JD01B

Instrument ID: 1053

Calibration Date: 16/Oct/2020

Calibration Due Date:

UL INTERNATIONAL (UK) LTD
Tel: +44 (0) 1256312000

Certificate Number: 13252592JD01B

Instrument ID: 1053

Calibration Date: 16/Oct/2020

Calibration Due Date:

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client Apple USA

Certificate No: EUmmWV3-9357_Sep20

CALIBRATION CERTIFICATE

Object: EUmmWV3 - SN:9357

Calibration procedure(s): QA CAL-02.v9, QA CAL-25.v7, QA CAL-42.v2
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: September 14, 2020

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 ± 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	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
Reference Probe ER3DV6	SN: 2328	05-Oct-19 (No. ER3-2328_Oct19)	Oct-20
DAE4	SN: 789	27-Dec-19 (No. DAE4-789_Dec19)	Dec-20
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-19)	In house check: Oct-20

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

Issued: September 21, 2020