SAR Compliance Test Report

Date of Report	9/03/2020	**Client's Contact person:**	Pierluigi Freni
Number of pages:	27		
		Responsible Test engineer:	Juho Tuohino
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**Sherlock** Corso Castelfidardo 30/A I-10129 Torino Italy
Tested device	Sherlock Bike		
Related reports:	-		
Testing has been carried out in accordance with:	**47CFR §2.1093** Radiofrequency Radiation Exposure Evaluation: Portable Devices **FCC published RF exposure KDB procedures** **IEEE 1528 - 2013** IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Technique		
Documentation:	The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory		
Test Results:	**The EUT complies with the requirements in respect of all parameters subject to the test.** The test results relate only to devices specified in this document		

Date and signatures:

09.03.2020

For the contents:

Miia Nurkkala

Digitally signed by Miia Nurkkala
Date: 2020.03.09 14:57:56 +02'00'

Laboratory Manager

TABLE OF CONTENTS

1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	Sherlock Bike V1.0
Manufacturer:	Sherlock
Serial Number:	861359033086784
FCC ID Number:	2AMAYSHBK01
Model:	Sherlock Bike
DUT Number:	22843
Battery Type used in testing:	Integrated ICR10430, 3.7V, 330mah
Portable/ Mobile device	Portable
State of the Sample	Production sample

Testing information:

Testing Performed:	30.11. 2018 – 03.12.2018
Notes:	Tested sample was modified with sim tray to support test sim card.
Document ID:	FCC SAR report_Sherlock_ID2420_09032020
Temperature °C	22±2 / Controlled
Humidity RH%	20±20 / Controlled
Measurement performed by:	Juho Tuohino

1.2 Maximum Results

The maximum reported* SAR values for Body-worn configuration are shown in a table below. The device conforms to the requirements of the standards when the maximum reported SAR value is less than or equal to the limit. The SAR limit specified in FCC 47 CFR part 2 (2.1093) for Body and Head SAR_{1g} is 1.6 W/kg.

1.2.1 Standalone SAR

Equipment Class	System	Highest Reported* SAR_{1g}(W/kg) in Body-Worn	Result
PCE	GPRS 850	0.06	PASS
	GPRS 1900	0.52	PASS

* Reported SAR Values are scaled to upper limit of power tuning tolerance.

1.2.2 Simultaneous transmission SAR

Highest Simultaneous Transmission SAR	SAR_{1g}(W/kg) in Body-Worn Condition 0 mm	Result
GPRS 1900+BLE	**0.52+0.18 = 0.7**	**PASS**

1.2.3 Maximum Drift

Maximum Drift During Measurements	0.65dB*

*Drifts >5% have been considered in the scaling factor

1.2.4 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	23.4%

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is antitheft tracker for a bike. It is intended to be mounted inside a bike handlebar.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

Bands	Modes of Operation	Duty Cycle	Transmitter Frequency Range (MHz)
850	GPRS	1/8 to 4/8	824 – 849
1900	GPRS	1/8 to 4/8	1850 – 1910
2400	BLE	1	2400 -2483.5

BLE and GPRS can transmit simultaneously.

2.1.1 Test exclusions

According to appendix A of 447498D01 the SAR test exclusion power threshold for 2450MHz is 10mW at ≤5mm separation distance. The maximum output power of the BLE transmitter is 2.51mW thus it is below the test exclusion threshold.

For simultaneous transmission evaluation the BLE standalone SAR value is estimated according to the following equation:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)/x] W/kg, where x = 7.5 for 1-g SAR.

BLE SAR_{1g}= (2.51mW/3mm)*(2.4835GHz)$^{1/2}$/7.5=0.18 W/kg

3mm minimum separation distance was selected based on the BLE antenna location. BLE antenna is located 3mm from the DUT plastic cover. Antenna locations are presented in appendix A.

3. OUTPUT POWER

3.1 Maximum Output Power

From a Customer;

BLE maximum power is 4dbm.

Slot Configuration Info	GSM 850	GSM 1900
GPRS (GMSK, 1Tx-slot)	35	32
GPRS (GMSK, 2Tx-slot)	35	32
GPRS (GMSK, 3Tx-slot)	35	32
GPRS (GMSK, 4Tx-slot)	32.5	29.5

3.2 Tested conducted power

Conducted output power at transmitting antenna connector;

Slot Configuration Info	GSM 850 CH 128 824.2 MHz	GSM 850 CH 189 836.6 MHz	GSM 850 CH 251 848.8 MHz	GSM 1900 CH 512 1850.2 MHz	GSM 1900 CH 661 1880.0 MHz	GSM 1900 CH 810 1909.8 MHz
GPRS (GMSK, 1Tx-slot)	32.28	32.11	31.92	29.19	28.91	28.43
GPRS (GMSK, 2Tx-slot)	32.22	32.05	31.86	29.11	28.89	28.41
GPRS (GMSK, 3Tx-slot)	30.61	30.41	30.21	28.04	28.01	27.8
GPRS (GMSK, 4Tx-slot)	29.67	29.45	29.24	27.92	27.89	27.77

Time averaged power:

Slot Configuration	GSM850 CH 128 824.2 MHz	GSM 850 CH 190 836.6 MHz	GSM 850 CH 251 848.8MHz	GSM 1900 CH 512 1850.2 MHz	GSM 1900 CH 661 1880.0 MHz	GSM 1900 CH 810 1909.8 MHz
GPRS 1-slot	23.28	23.11	22.92	20.19	19.91	19.43
GPRS 2-slot	26.22	26.05	25.86	23.11	22.89	22.41
GPRS 3-slot	26.35	26.15	25.95	23.78	23.75	23.54
GPRS 4-slot	**26.67**	**26.45**	**26.24**	**24.92**	**24.89**	**24.77**

GPRS 4-slots was selected for SAR testing due to highest time averaged power.

4. TEST EQUIPMENT

Dasy52 near field scanning systems, manufactured by SPEAG were used for SAR testing. The test system consists of high precision robotics system (Staubli), robot controller, computer, near-field probe, probe alignment sensor, and a phantom containing the tissue equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location of maximum electromagnetic field.

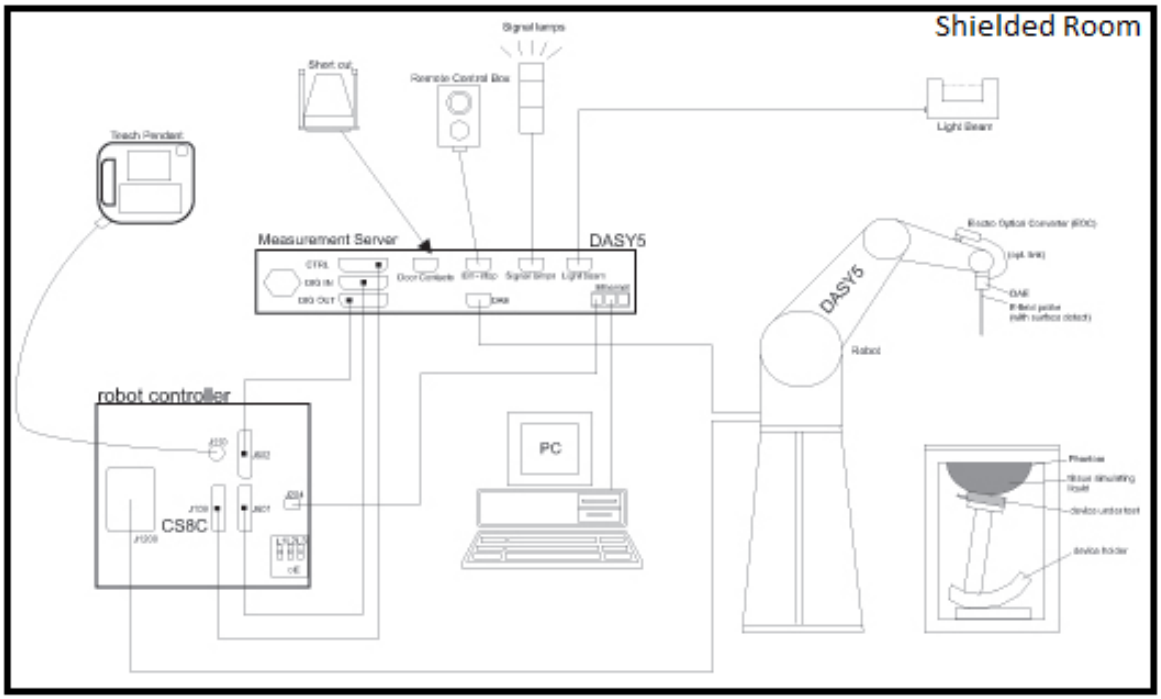


Figure 1 Schematic Laboratory Picture

4.1 Test Equipment List

Main used test system components are listed below. For full equipment list and calibration intervals, please contact the testing laboratory.

Test Equipment	Model	Serial Number	Calibration Date
DAE	DAE4	756	03.2018
Probe	EX3DV4	3892	04.2018
Dipole	D2450V2	729	07.2017
DASY5 Software	52.8.8.1258	-	NA
Signal Generator	Agilent E4438C	MY41000121	NA
Amplifier	AR25S1G4A	0322650	NA
Power meter	NRP-Z81	101128	07.2018

4.1.1 Isotropic E-field Probe Type EX3DV4

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	Calibration certificate in Appendix D
Frequency	10 MHz to >6 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g, Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 10 mm Body diameter: 12 mm Tip diameter: 2.5 mm Distance from probe tip to dipole centers: 1.0 mm
Application	General dosimetry up to 6 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.1.2 Modular Flat Phantom (MFP)

The Triple Modular Phantom consists of three identical modules that can be installed and removed separately without emptying the liquid. It is used for compliance testing of small wireless devices in body-worn configurations.

4.1.3 Tissue Simulants

Recommended values for the dielectric parameters of the tissue simulants are given in IEEE 1528 and FCC published RF Exposure KDB Procedures. The dielectric parameters of the used tissue simulants were within ±10% of the recommended values in all frequencies used. A liquid compensation algorithm was used in DASY5 with which measured peak average SAR values were corrected for the deviation of used liquid. Depth of the tissue simulant was at least 15.0 cm from the inner surface of the flat phantom.

Body 600-6000 MHz tissue simulant liquid Ingredients
Deionized Water, tween, salt

4.2 System Validation Status

Frequency [MHz]	Dipole Type / SN	Probe Type / SN	Calibrated Signal Type	DAE Unit / SN	Dielectric Constant ε	Conductivity σ [S/m]	Validation Done
							Body tissue simulant
835	D835V2 SN: 455	EX3DV4 / SN3982	CW/GMSK	DAE4 / 705	56.0	1.00	04/2018
1900	D1900V2 SN: 5D004	EX3DV4 / SN3982	CW/GMSK	DAE4 / 705	53.95	1.49	05/2018

4.3 System Check

Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Input Power [mW]	Measured SAR_{1g} [W/kg]	1 W Target SAR_{1g} [W/kg]	1 W Normalized SAR_{1g} [W/kg]	Deviation (%)	Plot #
29.11.2018	M900	20.4	835	250	2.51	9.84	10.04	2.0	1
3.12.2018	M1900	21.9	1900	250	9.71	40.3	38.84	-2.5	2

4.3.1 Tissue Simulant Verification

				Target		Measured		Deviation	
Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Conductivity, σ [S/m]	Dielectric Constant [ε]	Conductivity, σ [S/m]	Dielectric Constant [ε]	σ (%)	ε (%)
29.11.2018	M900	**22**	835	0.97	55.2	1.04	53.0	7.6	-4.0
3.12.2018	M1900	**22**	1900	1.52	53.3	1.52	49.8	-0.1	-6.5

5. TEST PROCEDURE

The DUT was set to transmit continuously at a maximum power level using a communication tester.

5.1 Test Positions

The DUT was placed below the flat phantom using an adjustable support. The DUT was lifted towards the phantom until 0mm separation distance was reached for body worn configuration.

The surface of the DUT was scanned from 6 different sides and from the top without a bike handlebar. Area scans were used to determine the worst-case test position. Full SAR measurement was performed in the worst-case position. Area scans were also run in the worst-case position with the DUT mounted in to a handlebar of a bike.

Photos of the test positions are presented in appendix A.

5.2 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan was performed around the highest E-field value to determine the averaged SAR value. Power drift was determined by measuring the same point at the start of the area scan and again at the end of the zoom scan.

5.3 SAR Averaging Methods

The maximum SAR value is averaged over a cube of tissue using interpolation and extrapolation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation.

The interpolation, extrapolation and maximum search routines within Dasy47 are all based on the modified Quadratic Shepard's method (Robert J. Renka," Multivariate Interpolation of Large Sets of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148).

6. MEASUREMENT UNCERTAINTY

Uncertainty Budget
IEEE 1528-2013

Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.0 %	N	1	1	1	±6.0 %	±6.0 %	∞
Axial Isotropy	±4.7 %	R		0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	1.73	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	1.73	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	1.73	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	1.73	1	1	±0.6 %	±0.6 %	∞
Modulation Response^m	±2.4 %	R	1.73	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	1.73	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	1.73	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	1.73	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	1.73	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	1.73	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	1.73	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±2.0 %	R	1.73	1	1	±1.2 %	±1.2 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	1.73	1	1	±2.9 %	±2.9 %	∞
Power Scaling	±6 %	R	1.73	1	1	±3.5 %	± 3.5%	∞
Phantom and Setup								
Phantom Uncertainty	±6.1 %	R	1.73	1	1	±3.5 %	±3.5 %	∞
SAR correction	±1.9 %	R	1.73	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.)	±2.5 %	R	1.73	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.)	±2.5 %	R	1.73	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity	±3.4 %	R	1.73	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity	±0.4 %	R	1.73	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±11.7 %	±11.6 %	361
Expanded STD Uncertainty						**±23.4 %**	**±23.3 %**	

7. TEST RESULTS

7.1 Body-Worn Configuration GSM 850, 4-slot, channel 190, 0mm separation distance

Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Duty Cycle	Area scan SAR1g [mW/g]	Measured SAR1g [mW/g]	Scaling Factor	Reported SAR1g [mW/g]	Plot #
32.5	29.45	NA*	Side1	1:2	0.012				
32.5	29.45	NA*	Side2	1:2	0.024				
32.5	29.45	0.65**	Side3	1:2	**0.037**	0.026	2.34	**0.06**	3
32.5	29.45	NA*	Side4	1:2	0.006				
32.5	29.45	NA*	Side5	1:2	0.000				
32.5	29.45	NA*	Side6	1:2	0.000				
32.5	29.45	NA*	Top	1:2	0.000				
32.5	29.45	NA*	Top Tube	1:2	0.000				
32.5	29.45	NA*	Side Tube	1:2	0.000				

* Due to low e-field generated by DUT at the location of drift measurement, the measurement is not applicable
** Drift considered in the scaling factor
TUBE = DUT inside a handlebar

7.2 Body-Worn Configuration GPRS 1900, 4-slot, channel 661, 0mm separation distance

Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Duty Cycle	Area scan SAR1g [mW/g]	Measured SAR1g [mW/g]	Scaling Factor	Reported SAR1g [mW/g]	Plot #
29.5	27.89	NA*	Side1	1:2	0.287				
29.5	27.89	0	Side2	1:2	**0.365**	0.357	1.45	**0.52**	4
29.5	27.89	NA*	Side3	1:2	0.145				
29.5	27.89	NA*	Side4	1:2	0.029				
29.5	27.89	NA*	Side5	1:2	0.023				
29.5	27.89	NA*	Side6	1:2	0.156				
29.5	27.89	NA*	Top	1:2	0.000				
29.5	27.89	NA*	Top Tube	1:2	0.000				
29.5	27.89	NA*	Side Tube	1:2	0.111				

* Due to low e-field generated by DUT at the location of drift measurement, the measurement is not applicable

APPENDIX A: PHOTOS OF THE DUT

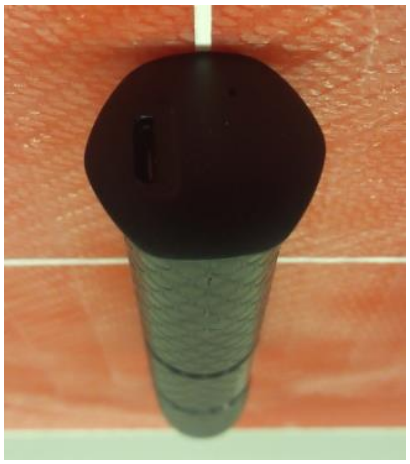

Side1


Side2

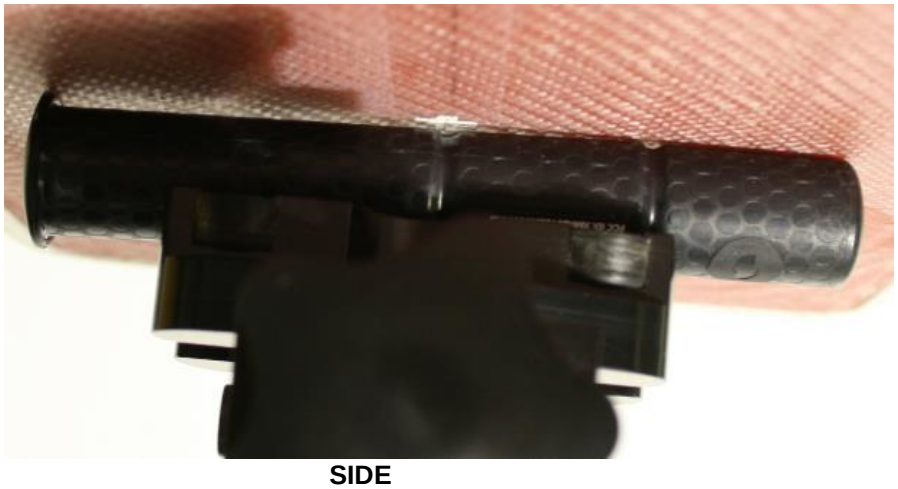

Side3


Side4


Side5

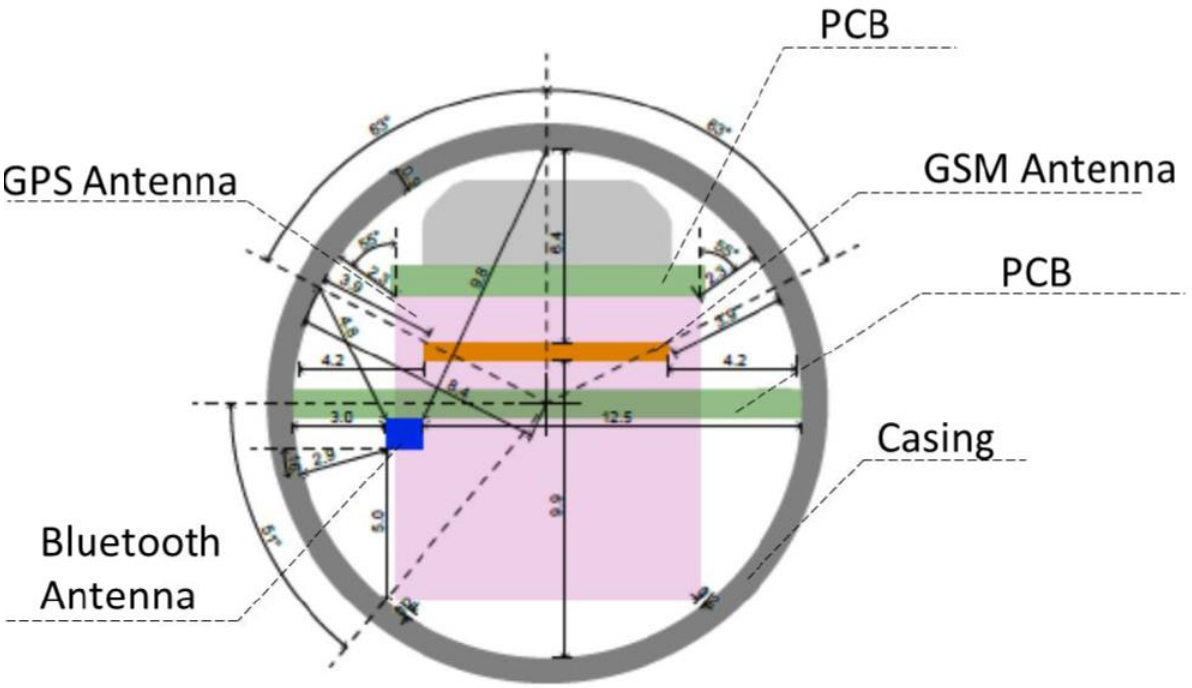

Side6


TOP


SIDE

Side Tube

Top Tube



APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 29.11.2018 16:25:17

Test Laboratory: Verkotan Oy

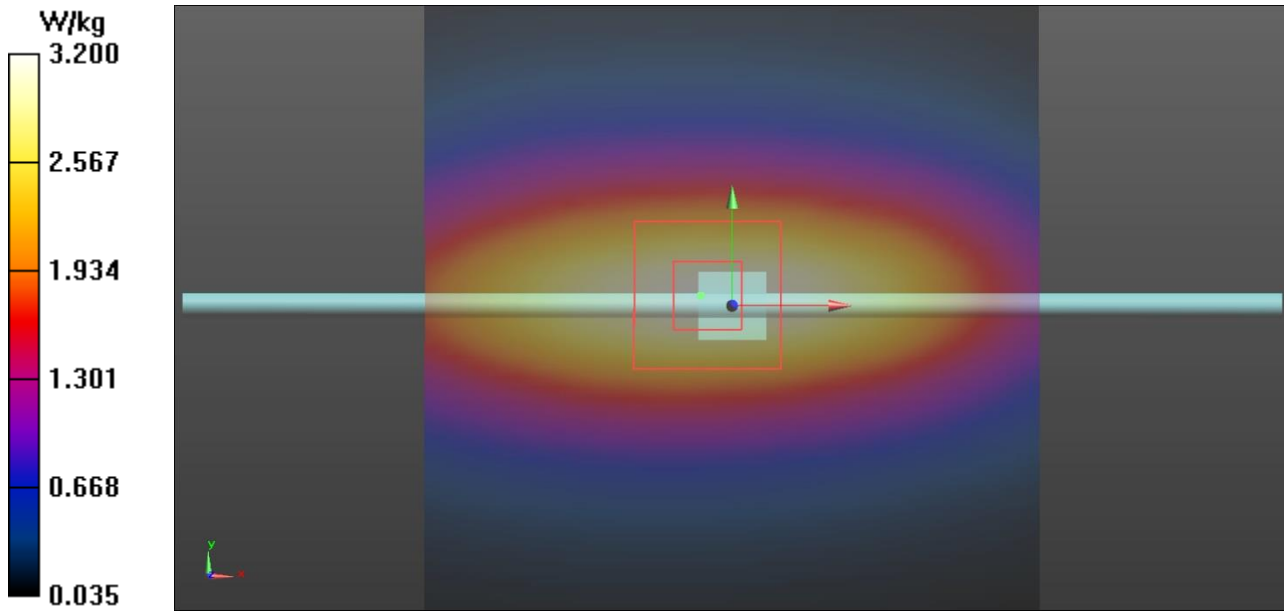
DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN:455

Communication System: UID 0, CW (0); Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 835 MHz; σ = 1.043 S/m; ε_r = 52.978; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.08, 10.08, 10.08); Calibrated: 20.4.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn756; Calibrated: 8.3.2018
- Phantom: SAR2_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 03_May_2017
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/Step A, B Pin=250 mW/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.20 W/kg
Configuration/Step A, B Pin=250 mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 57.68 V/m; Power Drift = -0.37 dB
Peak SAR (extrapolated) = 3.75 W/kg
SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.63 W/kg
Maximum value of SAR (measured) = 3.23 W/kg



Plot 2

Date/Time: 3.12.2018 12:08:11

Test Laboratory: Verkotan Oy

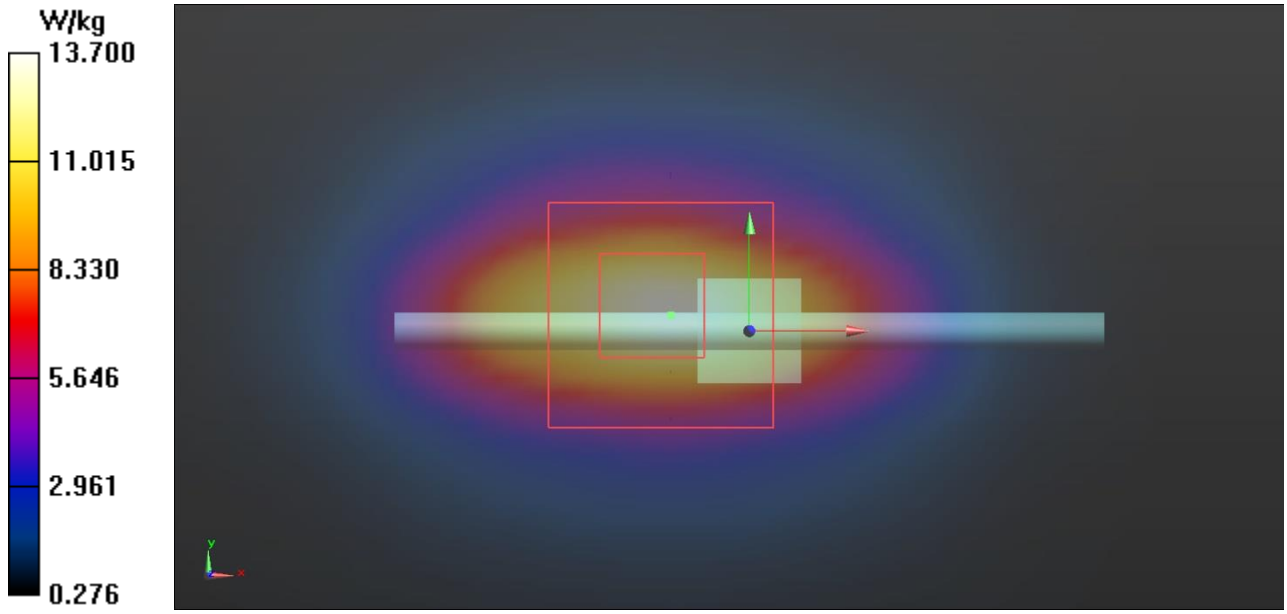
DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 – SN5D004

Communication System: UID 0, CW (0); Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1900 MHz; σ = 1.518 S/m; ε_r = 49.822; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.93, 7.93, 7.93); Calibrated: 20.4.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn756; Calibrated: 8.3.2018
- Phantom: SAR2_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 03_May_2017
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration/System Check 2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 79.42 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 17.3 W/kg
SAR(1 g) = 9.71 W/kg; SAR(10 g) = 5.09 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 13.7 W/kg
Configuration/System Check 2/Area Scan (81x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 14.7 W/kg



APPENDIX C: MEASUREMENT SCANS

Plot 3

Date/Time: 30.11.2018 15:54:18

Test Laboratory: Verkotan Oy

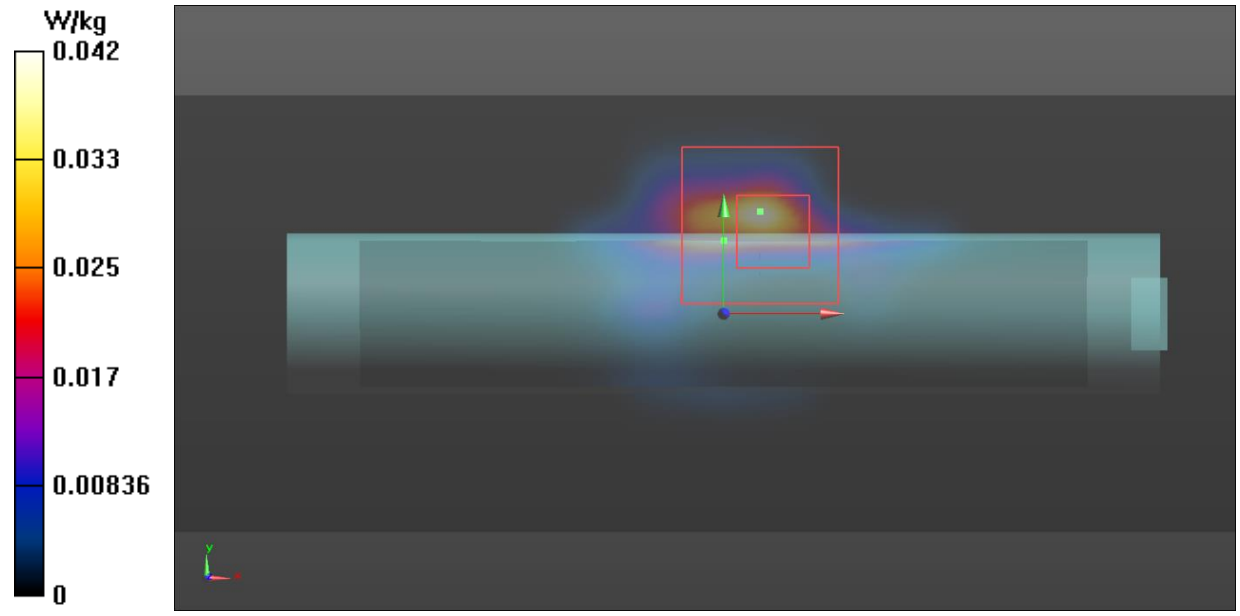
DUT: Sherlock Bike

Communication System: UID 0, GPRS 850,900 4slots (0); Communication System Band: GPRS 850 4slots; Frequency: 836.4 MHz;Communication System PAR: 3.356 dB
Medium parameters used (interpolated): f = 836.4 MHz; σ = 1.044 S/m; ε_r = 52.972; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(10.08, 10.08, 10.08); Calibrated: 20.4.2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn756; Calibrated: 8.3.2018
- Phantom: SAR2_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 03_May_2017
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration 850/Side3_notube/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 5.953 V/m; Power Drift = 0.65 dB
Peak SAR (extrapolated) = 0.0620 W/kg
SAR(1 g) = 0.026 W/kg; SAR(10 g) = 0.010 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.0325 W/kg
Configuration 850/Side3_notube/Area Scan (161x61x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.0804 W/kg



Date/Time: 3.12.2018 19:17:09

Test Laboratory: Verkotan Oy

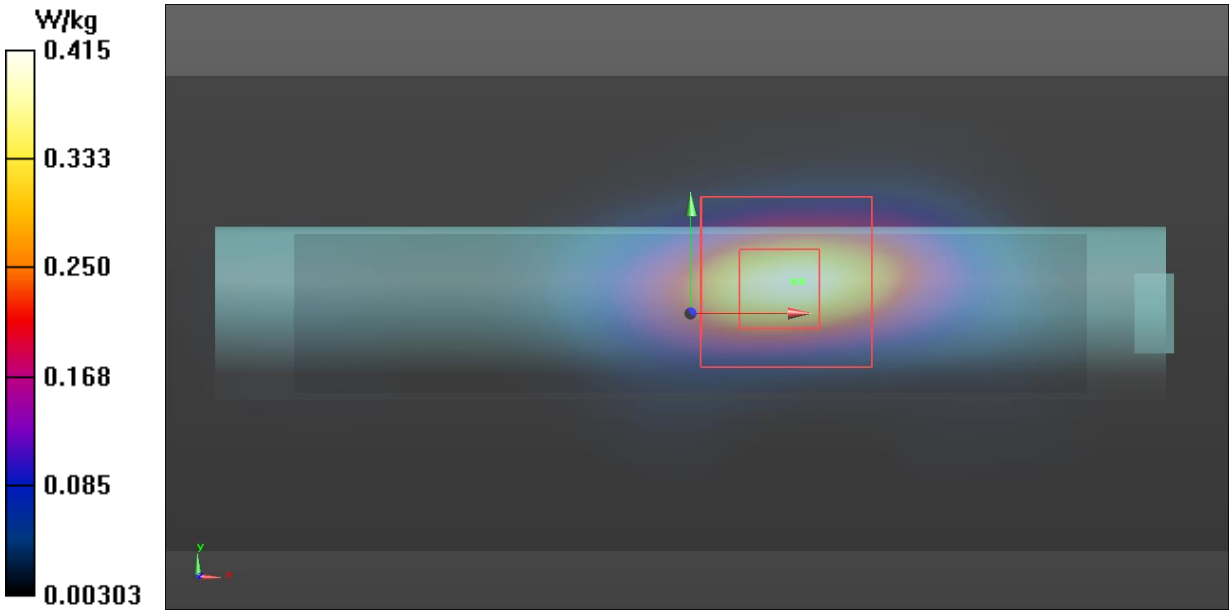
DUT: Sherlock Bike

Communication System: UID 0, GPRS 1800,1900 4 slots (0); Communication System Band: 1900 4 slots; Frequency: 1880 MHz;Communication System PAR: 3.356 dB
Medium parameters used: f = 1880 MHz; σ = 1.512 S/m; ε_r = 49.768; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.93, 7.93, 7.93); Calibrated: 20.4.2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection), z = 31.0
- Electronics: DAE4 Sn756; Calibrated: 8.3.2018
- Phantom: SAR2_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 03_May_2017
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Configuration 1900/Side2_notube/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 15.85 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 0.790 W/kg
SAR(1 g) = 0.357 W/kg; SAR(10 g) = 0.152 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.415 W/kg
Configuration 1900/Side2_notube/Area Scan (161x61x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.493 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION REPORTS

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

ilac-MRA

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

Certificate No: EX3-3892_Apr18

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3892
Calibration procedure(s)	QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	April 20, 2018

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	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-18 (No. 217-02682)	Apr-19
Reference Probe ES3DV2	SN: 3013	30-Dec-17 (No. ES3-3013_Dec17)	Dec-18
DAE4	SN: 660	21-Dec-17 (No. DAE4-660_Dec17)	Dec-18
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-17)	In house check: Oct-18

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

Issued: April 20, 2018

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3892

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	41.9	0.89	10.51	10.51	10.51	0.49	0.80	± 12.0 %
900	41.5	0.97	9.85	9.85	9.85	0.49	0.82	± 12.0 %
1750	40.1	1.37	8.59	8.59	8.59	0.35	0.80	± 12.0 %
1900	40.0	1.40	8.33	8.33	8.33	0.31	0.80	± 12.0 %
2450	39.2	1.80	7.46	7.46	7.46	0.30	0.85	± 12.0 %
2600	39.0	1.96	7.35	7.35	7.35	0.25	1.04	± 12.0 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3892

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	55.5	0.96	10.03	10.03	10.03	0.52	0.80	± 12.0 %
900	55.0	1.05	10.08	10.08	10.08	0.45	0.85	± 12.0 %
1750	53.4	1.49	8.21	8.21	8.21	0.38	0.85	± 12.0 %
1900	53.3	1.52	7.93	7.93	7.93	0.35	0.83	± 12.0 %
2450	52.7	1.95	7.52	7.52	7.52	0.33	0.93	± 12.0 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

APPENDIX E: RELEVANT PAGES FROM DIPOLE CALIBRATION REPORTS

mvg Microwave Vision Group

SAR Reference Dipole Calibration Report

Ref : ACR.165.29.17.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 835 MHZ
SERIAL NO.: D835V2-455

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

ilac-MRA A2LA ACCREDITED Calibration CERT #2360.02

Calibration Date: 06/14/17

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 40.0 sigma : 0.90
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56	9.46 (0.95)	6.22	6.08 (0.61)
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	

SAR Reference Dipole Calibration Report

Ref : ACR.165.31.17.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 1900 MHZ
SERIAL NO.: D1900V2-5D004

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration Date: 06/14/17

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	6/14/2017	
Checked by :	Jérôme LUC	Product Manager	6/14/2017	
Approved by :	Kim RUTKOWSKI	Quality Manager	6/14/2017	

	Customer Name
Distribution :	Verkotan Ltd.

Issue	Date	Modifications
A	6/14/2017	Initial release

1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 38.5 sigma : 1.45
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1900 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7	39.74 (3.97)	20.5	20.44 (2.04)
1950	40.5		20.9	

3500	51.3 ±5 %		3.31 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
5800	48.2 ±10 %		6.00 ±10 %	

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps' : 53.3 sigma : 1.56
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1900 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
1900	39.84 (3.98)	20.71 (2.07)