SAR Compliance Test Report

Date of Report	10/08/2018	**Client's Contact person:**	Gordon Smith
Number of pages:	28	**Responsible Test engineer:**	Juho Tuohino
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**7HUGS LABS** 29 bd Romain Rolland 92120 Montrouge France
Tested device	Sevenhugs Smart Remote		
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 **RSS-102** Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)		
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:

For the contents:

10.08.2018

Miia Nurkkala

Digitally signed by Miia Nurkkala
Date: 2018.08.10 13:40:30 +03'00'

Laboratory Manager

TABLE OF CONTENTS

1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	Sevenhugs Smart Remote
Manufacturer:	7HUGS LABS
Serial Number:	80B10049B48B260139, 00A60149B48B260139
FCC ID Number:	2AEVC-SR1AI
IC ID Number:	20292-SR1AI
Model:	SR1AI
DUT Number:	22891, 22892
Battery Type used in testing:	Integrated battery
Portable/ Mobile device	Portable
State of the Sample	Production sample

Testing information:

Testing Performed:	18-20.7.2018
Notes:	-
Document ID:	FCC SAR report_Sevenhugs_ID2946_ 10082018 .docx
Temperature °C	22±2 / Controlled
Humidity RH%	20±20 / Controlled
Measurement performed by:	Juho Tuohino

1.2 Maximum Results

1.2.1 Standalone SAR

The maximum reported* SAR value for Body-worn configuration with 5 mm separation distance for transmitting systems 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) and RSS-102 for Body is SAR_{1g} 1.6 W/kg.

Modes of Operation	Equipment Class	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Condition, 5mm separation	Result
2.4 GHz WLAN	**DTS**	**0.29**	**PASS**
BT/BLE	**DTS**	**0.05**	**PASS**

* Reported SAR Values are scaled to maximum theoretical output power.

1.2.1 Simultaneous Transmission

Highest Simultaneous Transmission SAR	Highest Reported SAR_{1g}(W/kg) in Body-Worn Condition, 5mm separation	Result
2.4 GHz WLAN + Bluetooth	**0.34**	**PASS**

1.2.2 Maximum Drift

Maximum Drift During Measurements	0.53 dB*

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

1.2.3 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	23.4%

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

Device under testing is an smart remote controller. It can be used as hand-held device or held close to body.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

TX Frequency bands	Modes of Operation	Transmitter Frequency Range (MHz)
	2.4 GHz WLAN	**2412-2472**
	BT/BLE	**2402-2480**

All transmitter can operate simultaneously.

2.2 SAR test Exclusions

Due to the size and form factor of the DUT it can be body-worn or hand-held similarly to a mobile phone. Thus, based on footnote 26 in KDB447798, extremity SAR was not fully tested. Worst case verifications were made at 0 mm separation to verify extremity compliance.

3. OUTPUT POWER

3.1 Maximum Output Power

From a Customer;
WLAN: Maximum defined output power, including tolerance of ±1.5 dBm.

Standard	Transmission mode	Modulation	Data rate [MBPS]	Output power [dBm]		
				CH 1	CH 6	CH 11
802.11b	DSSS	BPSK	1	10.5	10.5	10.5
802.11b	DSSS	BPSK	2	12.5	12.5	12.5
802.11b	DSSS	BPSK	5.5	**15.5**	**15.5**	**15.5**
802.11b	DSSS	BPSK	11	15.5	15.5	15.5

Maximum tuning power defined for 802.11g/n mode is 14 dBm ±1.5 dBm thus 802.11b is selected for SAR testing.

Bluetooth: Maximum defined output power.

Standard	Output power [dBm]		
	2402 MHz	2441 MHz	2480 MHz
Bluetooth	8.0	8.0	8.0

3.2 Tested conducted power

Conducted output power;
WLAN:

Standard	Transmission mode	Modulation	Data rate [MBPS]	Output power [dBm]		
				CH 1	CH 6	CH 11
802.11b	DSSS	BPSK	5.5	**14.11**	13.98	13.63

Bluetooth:

Standard	Output power [dBm]		
	2402 MHz	2441 MHz	2480 MHz
Bluetooth	6.48	8.2*	**8.9***

*Measured conducted powers exceed nominal maximum power values due to test mode used in testing.

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.

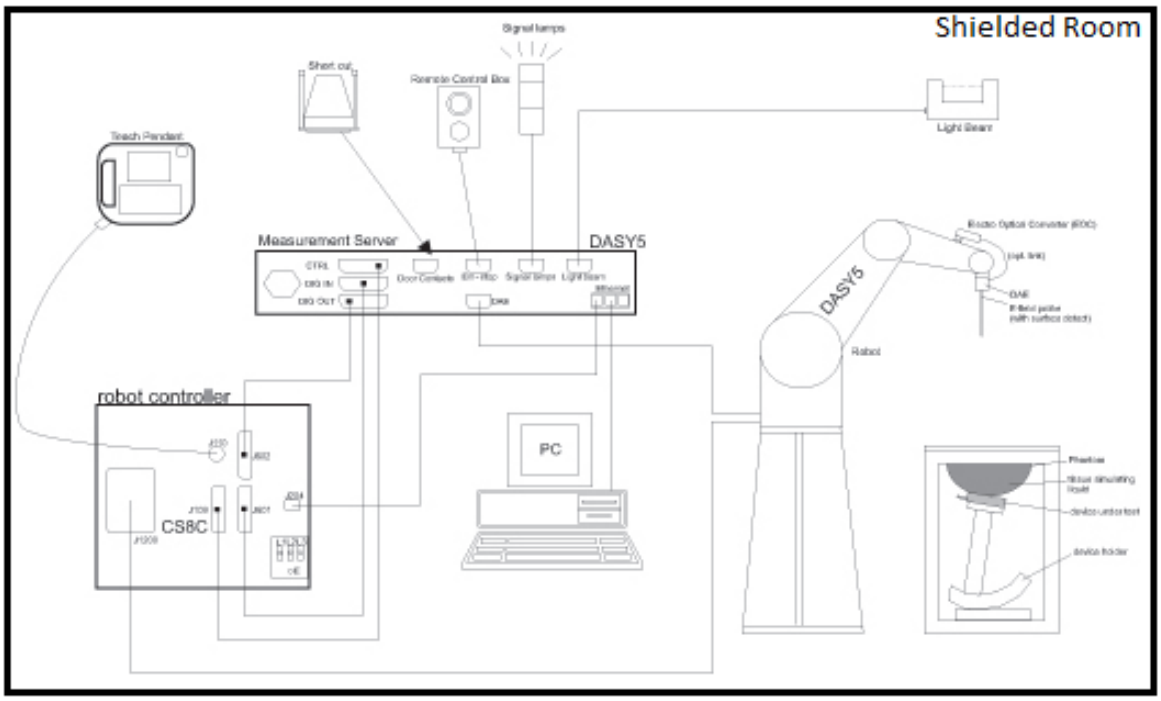


Figure 1 Schematic Laboratory Picture

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	03.2018
Dipole	D2450V2	729	07.2017
DASY5 Software	52.8.8.1258	-	NA
Signal Generator	SMIQ06B	835136042	NA
Amplifier	AR	320421	NA
Power meter	NRP-Z81	100792	06.2017

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

4.2 Phantoms

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.

4.3 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

4.4 System Validation Status

Frequency [MHz]	Test System	Dipole Type / SN	Probe Type / SN	Calibrated Signal Type	DAE Unit / SN	Dielectric Constant [ε] Body tissue simulant	Conductivity σ [S/m] Body tissue simulant	Validation Done
								Body tissue simulant
2450	SAR 1	D2450V2-SN:705	EX3DV4 - SN: 3892	CW	DAE 4 / 705	53.19	1.86	04.2018

4.5 System Check

Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Input Power	Measured SAR_{1g} [W/kg]	1 W Target SAR_{1g} [W/kg]	1 W Normalized SAR_{1g} [W/kg]	Deviation 1g (%)	Plot #
18.07.2018	M600-6000	22±2	2450	250mW	12.8	53.7	51.2	-4.6	1
19.07.2018	M600-6000	22±2	2450	250mW	12.6	53.7	50.4	-6.1	2

4.5.1 Tissue Simulant Verification

				Target		Measured			
Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Conductivity, σ [S/m]	Dielectric Constant [ε]	Conductivity σ [S/m]	Dielectric Constant [ε]	Deviation σ (%)	Deviation ε (%)
18.7.2018	M600-6000	22	2412	1.91	52.8	1.94	50.6	1.2	-4.1
			2450	1.95	52.7	1.96	50.5	0.7	-4.2
			2480	1.99	52.7	1.99	50.5	-0.2	-4.2

5. TEST PROCEDURE

The DUT was set to transmit continuously at a maximum power level using a manufacturer specified software.

5.1.1 *Body-worn Configuration*, 5 mm separation distance

The DUT was placed below the flat phantom using a SPEAG device holder. The DUT was lifted towards the phantom until 5mm separation distance was reached.

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 with 7x7x7 points covering a volume of 30x30x30mm 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 2.4GHz WLAN, 5 mm separation distance

Band	Channel	Test Position**	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Duty Cycle	Measured SAR_{1g} [mW/g]	Scaling Factor	Reported SAR_{1g} [mW/g]	Plot #
802.11b	1	Left side	15.5	14.11	-0.18	1	0.21	1.38	0.289	
802.11b	1	Right side	15.5	14.11	0.29*	1	0.04	1.47	0.059	
802.11b	1	Top side	15.5	14.11	-0.19	1	0.0103	1.38	0.014	
802.11b	1	Bottom side	15.5	14.11	0.13	1	0.00957	1.38	0.013	
802.11b	1	Front	15.5	14.11	-0.53*	1	0.126	1.56	0.196	
802.11b	1	Back	15.5	14.11	-0.22	1	0.211	1.38	0.291	3

*Drift considered in the scaling factor

**Picture of the test position is presented in appendix A.

7.2 Body-Worn Configuration Bluetooth, 5 mm separation distance

Band	Channel	Test Position**	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Duty Cycle	Measured SAR_{1g} [mW/g]	Scaling Factor	Reported SAR_{1g} [mW/g]	Plot #
2.45	78	Left side	8	8.9	NA***	1	0.00223	1.00	0.002	
2.45	78	Right side	8	8.9	0.3*	1	0.0384	1.07	0.041	
2.45	78	Top side	8	8.9	NA***	1	0.000217	1.00	0.000	
2.45	78	Bottom side	8	8.9	NA***	1	0.00195	1.00	0.002	
2.45	78	Front	8	8.9	-0.19	1	0.0307	1.00	0.031	
2.45	78	Back	8	8.9	0.11	1	0.00223	1.00	0.047	4

*Drift considered in the scaling factor

**The picture of the test position is presented in appendix A.

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

7.3 Limb Configuration checks, 0 mm separation distance

Band	Channel	Test Position**	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Dudy Cycle	Measured SAR_{10g} [mW/g]	Scaling Factor	Reported SAR_{10g} [mW/g]	Plot #
WLAN 2.4	1	Back side	15.5	14.11	0.27*	1	0.716	1.47	1.05	
BT 2.45	78	Back side	8.0	8.9	0.26*	1	0.215	1.06	0.23	

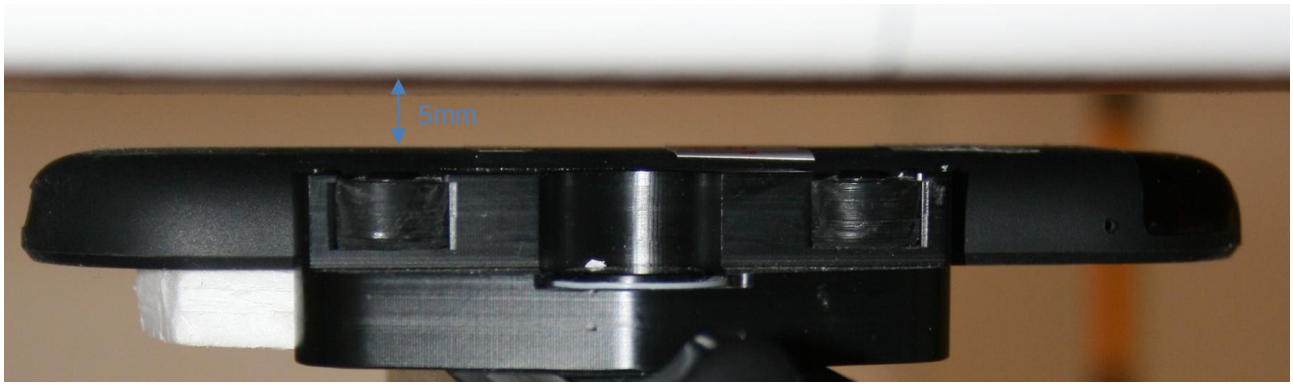
*Drift considered in the scaling factor

7.4 Simultaneous transmission evaluation

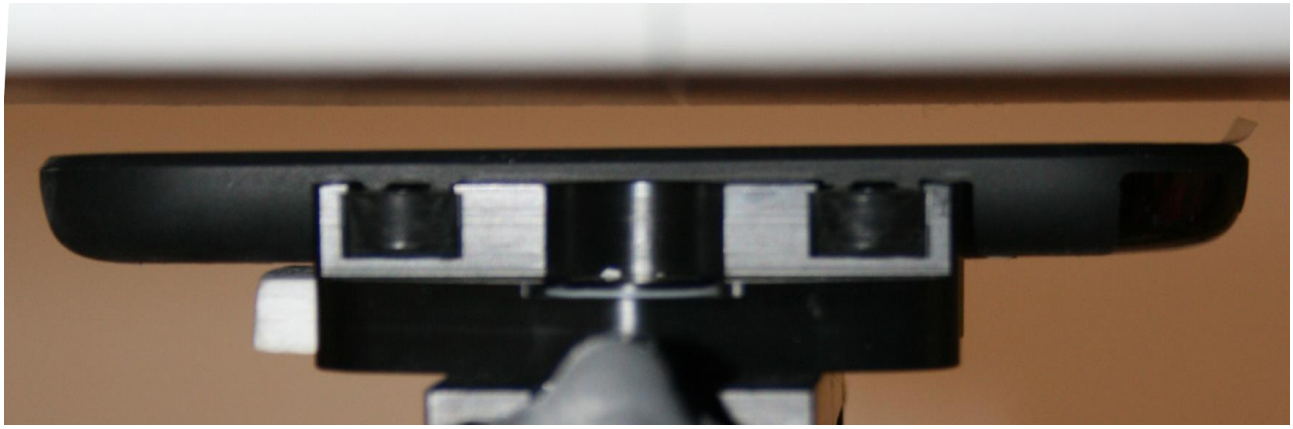
Exposure Condition	Body SAR_{1g} [mW/g]					
Test Position	**Left**	**Right**	**Top**	**Bottom**	**Front**	**Back**
WLAN 2.4 GHZ	0.29	0.06	0.01	0.01	0.20	0.29
Bluetooth 2.45 GHZ	0.002	0.041	0.000	0.002	0.031	0.047
SAR Summation	0.29	0.10	0.01	0.02	0.23	0.34

APPENDIX A: PHOTOS OF THE DUT

Size of the DUT is: 135 x 40 x 10 mm



Back of the DUT toward the phantom.



Front of the DUT toward the phantom.

Right side of the DUT toward the phantom.

Left side of the DUT toward the phantom.

Bottom side of the DUT toward the phantom.

Top side of the DUT toward the phantom.

APPENDIX B: SYSTEM CHECK SCANS

Plot 1

Date/Time: 18.7.2018 14:31:36

Test Laboratory: Verkotan Oy

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:729

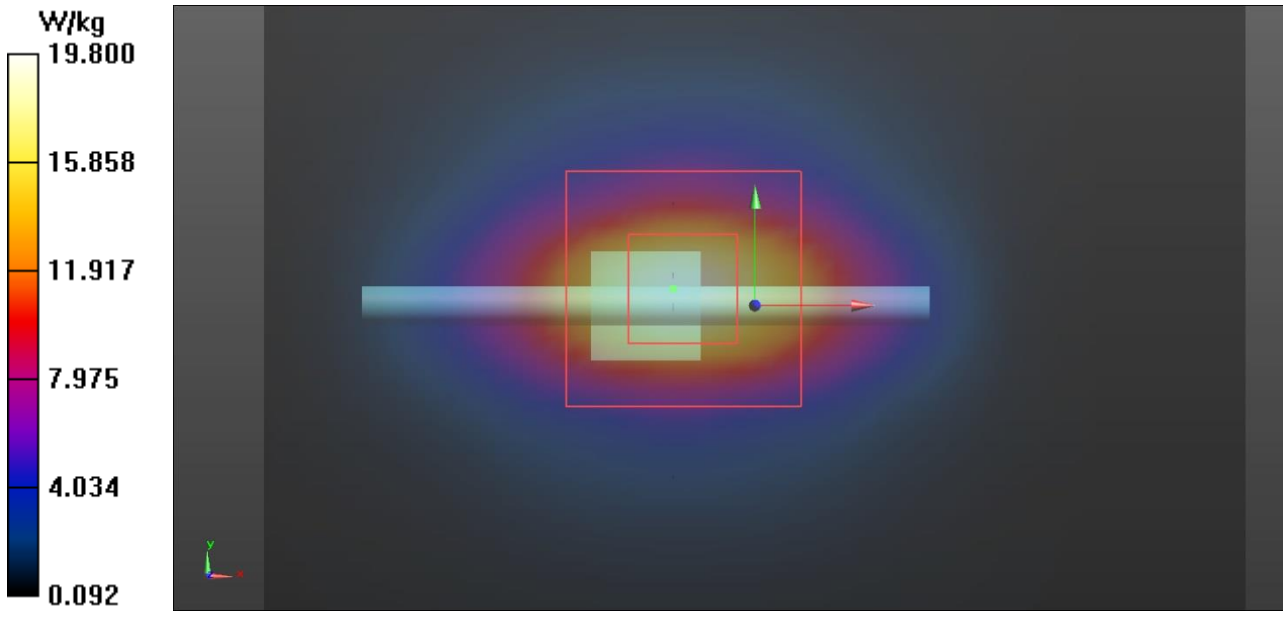
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 1.964 S/m; ε_r = 50.49; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.52, 7.52, 7.52); Calibrated: 20.4.2018;
- Sensor-Surface: 2mm (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 Pin=250 mW/Zoom Scan (7x9x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.36 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 26.4 W/kg
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.98 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 19.8 W/kg

Configuration Pin=250 mW/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 21.3 W/kg



Plot 2

Date/Time: 19.7.2018 15:05:05

Test Laboratory: Verkotan Oy

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:729

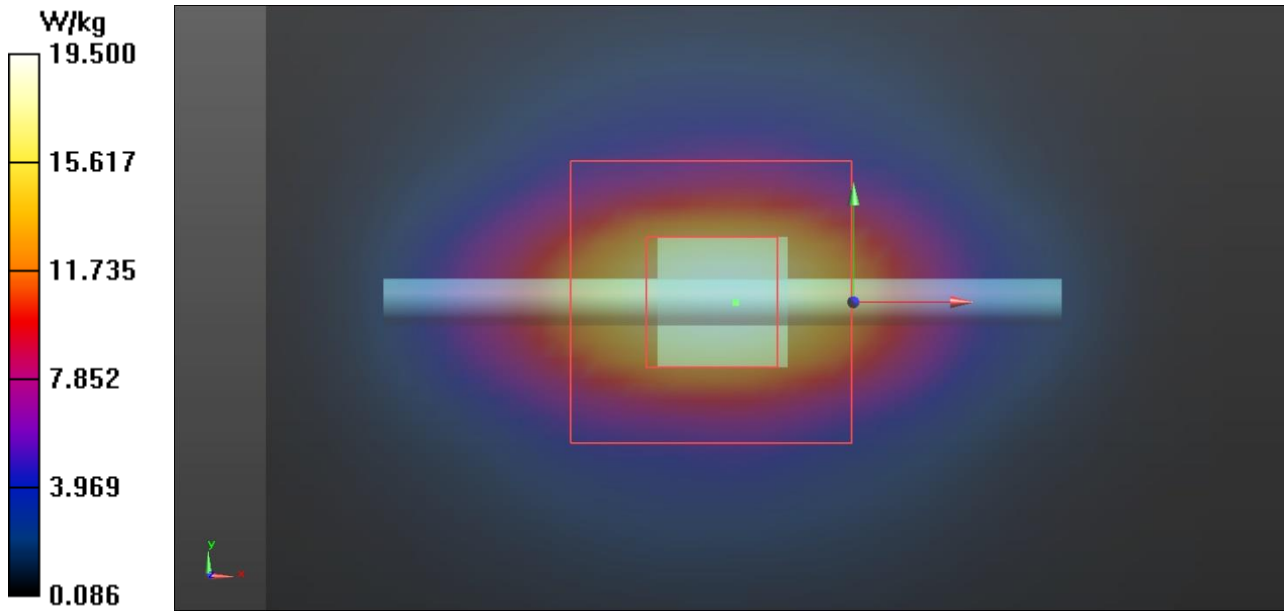
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 1.964 S/m; ε_r = 50.49; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.52, 7.52, 7.52); Calibrated: 20.4.2018;
- Sensor-Surface: 2mm (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 Pin=250 mW/Zoom Scan (7x9x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 86.71 V/m; Power Drift = 0.25 dB
Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.87 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 19.5 W/kg

Configuration Pin=250 mW/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 21.3 W/kg



APPENDIX C: MEASUREMENT SCAN

Plot 3

Test Laboratory: Verkotan Oy

DUT: 7Hugs

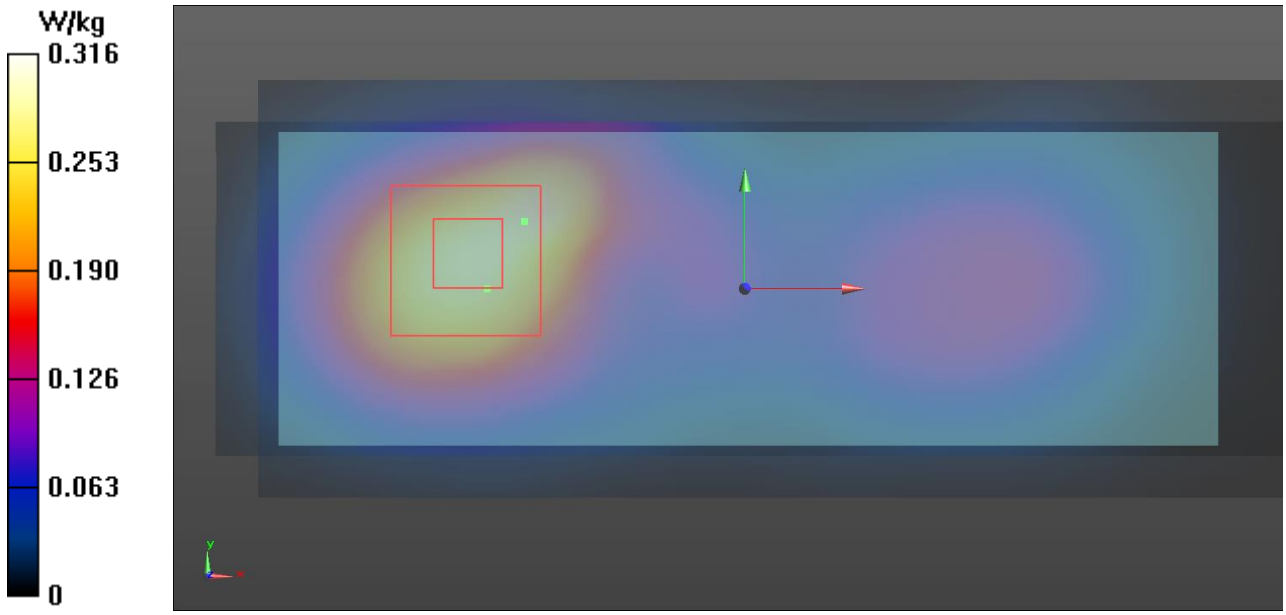
Communication System: UID 0, WLAN 2.4 (0); Communication System Band: WLAN2.4GHz; Frequency: 2412 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.937 S/m; ε_r = 50.583; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.52, 7.52, 7.52); Calibrated: 20.4.2018;
- Sensor-Surface: 2mm Sensor-Surface: 2mm (Mechanical Surface Detection), z = -4.0, 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/WLAN low 5mm Back side/Area Scan (131x41x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.316 W/kg

Configuration/WLAN low 5mm Back side/Zoom Scan 2 (7x7x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 10.69 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.400 W/kg
SAR(1 g) = 0.211 W/kg; SAR(10 g) = 0.119 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.292 W/kg



Plot 4

Date/Time: 19.7.2018 15:30:57

Test Laboratory: Verkotan Oy

DUT: 7Hugs

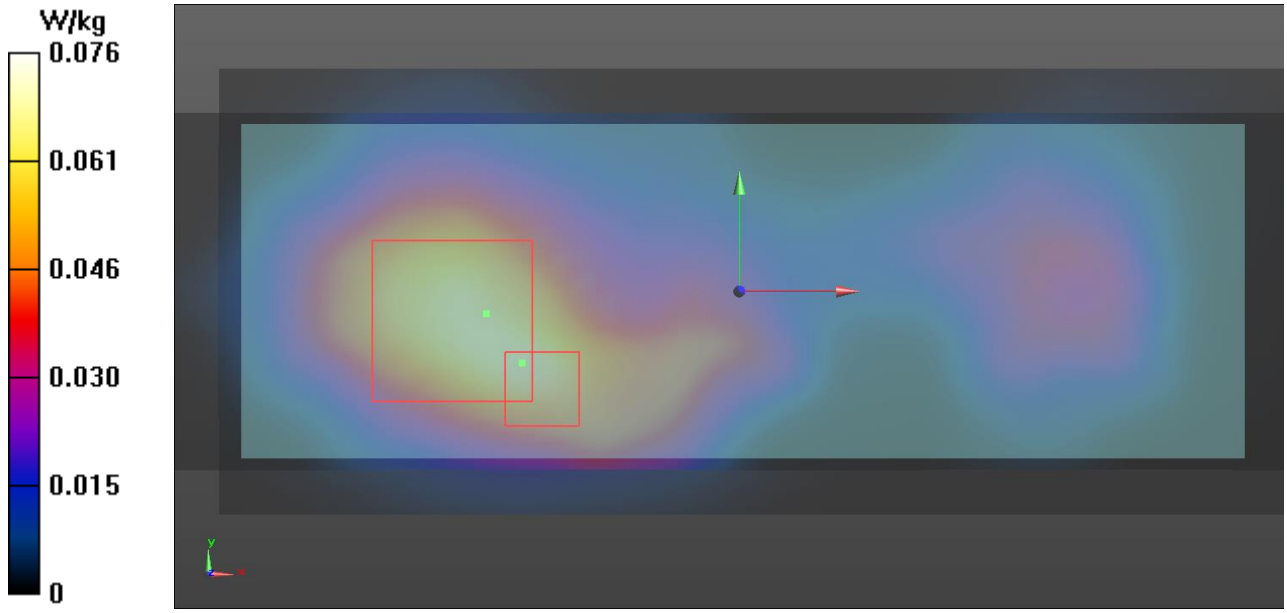
Communication System: UID 0, Bluetooth (0); Communication System Band: Bluetooth; Frequency: 2480 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2480 MHz; σ = 1.988 S/m; ε_r = 50.455; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.52, 7.52, 7.52); Calibrated: 20.4.2018;
- Sensor-Surface: 2mm z = -4.0, 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/BT high 5mm Back side/Area Scan (131x41x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0760 W/kg

Configuration/BT high 5mm Back side/Zoom Scan 2 (7x6x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 5.161 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 0.106 W/kg
SAR(1 g) = 0.047 W/kg; SAR(10 g) = 0.026 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.0739 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION REPORTS

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

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

Client: Verkotan — **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

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

Certificate No: EX3-3892_Apr18 Page 1 of 11

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.165.32.17.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 2450 MHZ
SERIAL NO.: D2450V2-729

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

ilac-MRA A2LA ACCREDITED Calibration CERT #2166.02

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.

SAR REFERENCE DIPOLE CALIBRATION REPORT Ref: ACR.165.32.17.SATU.A

	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 %	PASS	1.80 ±5 %	PASS
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

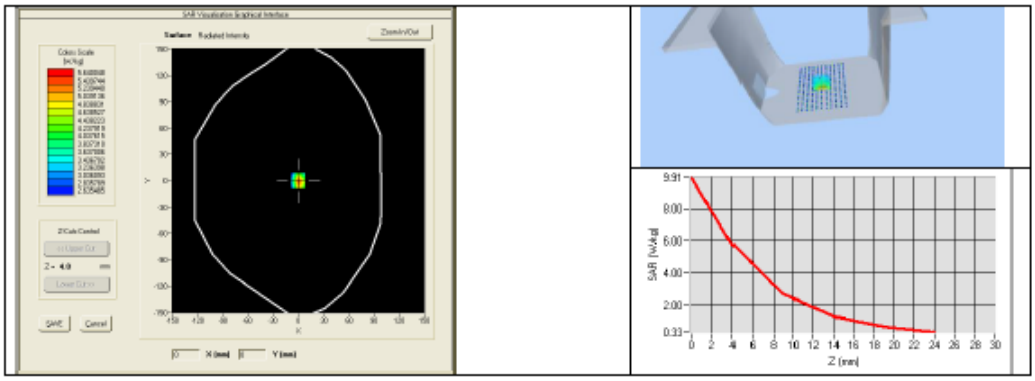
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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' : 37.5 sigma : 1.80
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm
Frequency	2450 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		20.5	
1950	40.5		20.9	

2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4	53.43 (5.34)	24	24.05 (2.41)
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	



7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε,')		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %	PASS	1.95 ±5 %	PASS
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	

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' : 53.2 sigma : 1.89
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm
Frequency	2450 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
2450	53.69 (5.37)	24.72 (2.47)