SAR Compliance Test Report

Date of Report	28/02/2018	**Client's Contact person:**	Harri Salo
Number of pages:	28	**Responsible Test engineer:**	Ilpo Joensuu
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**Specim** Elektroniikkatie 13 FI-90590 Oulu Finland
Tested device	**Specim IQ**		
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** **RSS-102, Issue 5** Evaluation Procedure for Mobile and Portable Radio Transmitters with Respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields **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:	28.02.2018 Miia Nurkkala Digitally signed by Miia Nurkkala Date: 2018.02.28 14:40:38 +02'00' **Laboratory Manager**		

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Equipment under Test (EUT):

Product:	Specim IQ
Manufacturer:	Specim
Model:	0604675
Serial Number:	1000047
FCC ID Number:	2ALJ9-WL18SBMOD
ISED Number:	23244 -WL18SBMOD
Hardware Version:	0405
DUT Number:	23090, 23091
Battery Type used in testing:	KeepPower 26650
Portable/ Mobile device	Prototype
State of the Sample	0405

Testing information:

Testing performed:	16.2-24.2.2017
Notes:	-
Document ID:	FCC SAR report Specim IQ_28022018.docx
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Ilpo Joensuu

1.2 Maximum Results

The maximum reported* SAR values for Body-worn configurations is 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 and for Extremity SAR_{10g} it is 4.0 W/kg.

Equipment Class	System	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Condition	Highest Reported* SAR_{10g}(W/kg) for Extremity Condition	Result
DTS	**2.4 GHz WLAN**	**0.26**	**0.13**	**PASS**

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

1.2.1 Maximum Drift

Maximum Drift During Measurements	0.17 dB

1.2.2 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	±22.3 %

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

Device Category	Portable
Exposure Environment	Uncontrolled

The DUT is a camera that can be held in hands or used with a support structure.

2.1 Supported Frequency Bands and Operational Modes

Bands	Modes of Operation	Modulation Mode	Transmitter Frequency Range (MHz)
2450	Bluetooth	GFSK, π/4-DQPSK, 8-DPSK	2402 – 2480
2450	WLAN b/g/n	DSSS, OFDM	2412 – 2462

WLAN n mode is utilizing two TX antennas RFANT1 and RFANT2.

2.2 Antenna location and SAR test Exclusion

Since WLAN2450 and BT use same frequency and antenna, and the WLAN2450 tuning power is higher, and they cannot transmit simultaneously, the WLAN2450 standalone SAR is conservative estimation of BT SAR. Thus, BT SAR can be deemed to comply without further analysis or measurements.

SAR was not tested from the objective side of the camera as it is not foreseen that the user or bystander would be or touch close infront of the objective. Furthermore, the separation distance from the antennas to the objective is larger than to the front side and according to the test exclusion considerations in KDB 447498 D01 General RF Exposure Guidance v06, this side of the DUT does not need to be tested.

MIMO SAR multi-TX assessment is conservative estimate of the actual MIMO n-mode transmission. In reality RFANT1 and RFANT2 would transmit only at lower power n-mode in MIMO mode, but conservative DSSS mode and corresponding SAR value was chosen for multi-Tx assessment to optimize testing time.

3. OUTPUT POWER

3.1 Maximum specified conducted output power

From a Customer;

3.1.1 Bluetooth

Bluetooth	Upper Limit (dBm)
	10

3.1.2 WLAN

RFANT 1

Standard	Transmission mode	Modulation	Data rate [MBPS]	CH 1	CH 6	CH 11
802.11b	DSSS	BPSK	1	15.8	15.8	15.8

RFANT2

Standard	Transmission mode	Modulation	Data rate [MBPS]	CH 1	CH 6	CH 11
802.11b	DSSS	BPSK	1	16.9	16.9	16.9

3.2 Tested conducted power

RFANT1

Standard	Transmission mode	Modulation	Data rate [MBPS]	CH 1	CH 6	CH 11
802.11b	DSSS	BPSK	1	15	**15**	14.65
802.11b	DSSS	BPSK	1	14.7	14.75	14.6
802.11b	DSSS	QPSK	2	14.9	15	14.7
802.11b	DSSS	QPSK	5.5	15.45	15.25	14.9
802.11b	DSSS	QPSK	11	15.4	15.15	14.9
802.11g	OFDM	BPSK	6	12.35	14.85	11.8
802.11g	OFDM	BPSK	9	12.4	14.85	11.85
802.11g	OFDM	QPSK	12	12.3	14.85	11.85
802.11g	OFDM	QPSK	18	12.2	14.9	11.9
802.11g	OFDM	16QAM	24	12.2	14	11.8
802.11g	OFDM	16QAM	36	12.55	13.3	11.9
802.11g	OFDM	64QAM	48	12.5	12.5	11.65
802.11g	OFDM	64QAM	54	12	11.8	11.4
802.11n	OFDM	BPSK	6.5	12.1	13.9	11.8
802.11n	OFDM	QPSK	13.0	12.4	14	11.9
802.11n	OFDM	QPSK	19.5	12.3	13.9	11.85
802.11n	OFDM	16QAM	26.0	12.5	14.1	11.95
802.11n	OFDM	16QAM	39.0	12.35	13.3	11.9
802.11n	OFDM	64QAM	52.0	12.5	12.2	11.95
802.11n	OFDM	64QAM	58.5	12.05	11.65	11.4
802.11n	OFDM	64QAM	65.0	11.05	10.8	10.45

RFANT2

Standard	Transmission mode	Modulation	Data rate [MBPS]	CH 1	CH 6	CH 11
802.11b	DSSS	BPSK	1	16.9	**16.9**	16.8
802.11n	OFDM	BPSK	6.5	14.15	15.9	13.85
802.11n	OFDM	QPSK	13.0	14.3	16.05	13.95
802.11n	OFDM	QPSK	19.5	14.3	16.05	13.9
802.11n	OFDM	16QAM	26.0	14.45	16.1	14.05
802.11n	OFDM	16QAM	39.0	14.35	15.2	14
802.11n	OFDM	64QAM	52.0	14.4	14.6	14.1
802.11n	OFDM	64QAM	58.5	14	13.9	13.65
802.11n	OFDM	64QAM	65.0	12.8	12.5	12.55

4. TEST EQUIPMENT

Dasy52 near field scanning system, manufactured by SPEAG was 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.

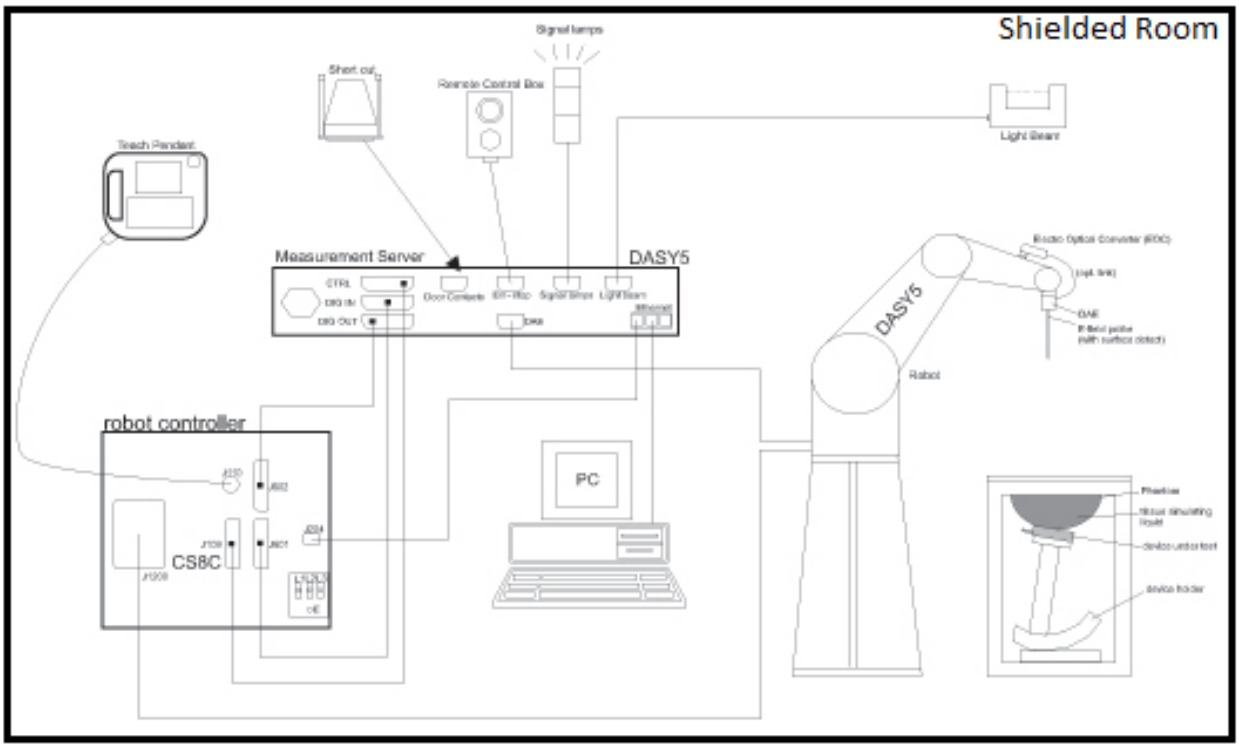


Figure 1 Schematic Laboratory Picture

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	1332	03.2016
Probe	EX3DV4	3892	03.2016
Dipole	D2450V2	758	01.2016
DASY5 Software	52.8.8.1258	-	NA

Signal Generator	SMIQ06B	8349681023	NA
Amplifier	AR	27573	NA
Power Sensor	NRP-Z11	100265	1.2016
Radio Communication Tester	Anritsu MT8820C	6200951734	04.2015

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
Application	General dosimetry up to 6 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.2 Phantoms

4.2.1 Twin-SAM Phantom

The phantom used in SAR tests was the flat phantom section of the twin-headed "SAM Phantom", manufactured by SPEAG. The phantom conforms to the requirements of IEEE 1528 and FCC published RF Exposure KDB Procedures.

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 ±5% of the recommended values in all frequencies used. SAR testing was carried out within 24 hours of measuring the dielectric parameters. Depth of the tissue simulant was at least 15.0 cm from the inner surface of the flat phantom.

4.4 System Validation Status

Frequency [MHz]	Dipole Type / SN	Probe Type / SN	Calibrated Signal Type	DAE Unit / SN	Validation Done	
					Head tissue simulant	Body tissue simulant
2450	D2450V2 / 758	EX3DV4 / 3892	CW	DAE4 / 1332	01/2017	01/2017

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 (%)	Plot #
20.2.1017	**M2450**	21.7	2450	250mW	12.5	**51.2**	50.0	-2.3	1
24.2.2017	**M2450**	22.2	2450	250mW	12.4	**51.2**	49.6	-3.1	2

Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Input Power	Measured SAR_{10g} [W/kg]	1 W Target SAR_{10g} [W/kg]	1 W Normalized SAR_{10g} [W/kg]	Deviation (%)	Plot #
20.2.1017	**M2450**	21.7	2450	250mW	5.82	24.1	23.28	-3.4	1
24.2.2017	**M2450**	22.2	2450	250mW	5.81	**24.1**	23.24	-3.6	2

4.5.1 Tissue Simulant Verification

				Target		Measured		Deviation	
Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Dielectric Constant [ε]	Conductivity, σ [S/m]	Dielectric Constant [ε]	Conductivity, σ [S/m]	ε (%)	σ (%)
20.2.1017	**M2450**	22	2437	**51.1**	**1.90**	51.9	1.94	+1.5	2
20.2.1017	**M2450**	22	2450	**52.7**	**1.95**	51.8	1.95	-1.7	0
24.2.2017	**M2450**	22	2437	**51.1**	**1.90**	51.2	1.90	+0.1	0
24.2.2017	**M2450**	22	2450	**52.7**	**1.95**	51.1	1.91	-3.0	-1.9

5. TEST PROCEDURE

The DUT was set to transmit at a maximum power by using a test software. WLAN was tested in b mode with 1Mbps as the configuration was tested to have the highest conducted output power. SAR was tested for each utilized antenna separately and summed to represent SAR in MIMO mode.

5.1 Test Positions

5.1.1 Body-Worn Configuration, 0mm separation

The device was placed below the flat phantom using a Rohacell support. The distance between the device and the phantom was kept at the separation distance indicated in Section 1.2 The device was oriented with all sides facing the phantom to find the highest results. Extremity SAR was tested in the same position i.e same measurement covers body and extremity SAR.

5.2 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan, a minimum of 5x5x7 points covering a volume of at least 30x30x30mm, was performed around the highest E-field value to determine the averaged SAR value. Drift was determined by measuring the same point at the start of the area scan and again at the end of the zoom scan. Fast SAR is measured according to the KDB 447498 D01 General RF Exposure Guidance v05r01.

5.3 SAR Averaging Methods

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

The interpolation, extrapolation and maximum search routines within Dasy52 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).

The interpolation scheme combines a least-square fitted function method with a weighted average method. A trivariate 3-D / bivariate 2-D quadratic function is computed for each measurement point and fitted to neighbouring points by a least-

square method. For the zoom scan, inverse distance weighting is incorporated to fit distant points more accurately. The interpolating function is finally calculated as a weighted average of the quadratics.

In the zoom scan, the interpolation function is used to extrapolate the Peak SAR from the deepest measurement points to the inner surface of the phantom.

6. MEASUREMENT UNCERTAINTY

DASY5 Uncertainty Budget According to IEEE 1528-2013 and IEC 62209-1/201x (0.3 - 3 GHz range)								
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	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Modulation Response^{m}	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	$\sqrt{3}$	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±2.0 %	R	$\sqrt{3}$	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	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
Power Scaling^{p}	±0 %	R	$\sqrt{3}$	1	1	±0.0 %	±0.0 %	∞
Phantom and Setup								
Phantom Uncertainty	±6.1 %	R	$\sqrt{3}$	1	1	±3.5 %	±3.5 %	∞
SAR correction	±1.9 %	R	$\sqrt{3}$	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.) ^{DAK}	±2.5 %	R	$\sqrt{3}$	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.) ^{DAK}	±2.5 %	R	$\sqrt{3}$	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity ^{BB}	±3.4 %	R	$\sqrt{3}$	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity ^{BB}	±0.4 %	R	$\sqrt{3}$	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±11.2 %	±11.1 %	361
Expanded STD Uncertainty						**±22.3 %**	**±22.2 %**	

7. TEST RESULTS

7.1 SAR Results for Body-Worn Condition, 0 mm separation distance

SISO SAR, RFANT1 active.

Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Dudy Cycle	Measured SAR_{1g} [mW/g]	Scaling Factor	Reported SAR_{1g} [mW/g]	Plot #
802.11b	6	15.8	15.0	-0.16	Front Face	1:1	0.03	1.20	0.04	
802.11b	6	15.8	15.0	0.04	Right Side	1:1	0.11	1.20	0.13	
802.11b	6	15.8	15.0	0.12	Left Side	1:1	0.01	1.20	0.01	
802.11b	6	15.8	15.0	-0.05	Top Side	1:1	0.19	1.20	**0.23**	3
802.11b	6	15.8	15.0	0.17	Bottom Side	1:1	0.08	1.20	0.10	

RFANT2 active

Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Dudy Cycle	Measured SAR_{1g} [mW/g]	Scaling Factor	Reported SAR_{1g} [mW/g]	Plot #
802.11b	6	16.9	16.9	0.13	Front Face	1:1	0.08	1	**0.08**	4
802.11b	6	16.9	16.9	0	Right Side	1:1	0	1	0	
802.11b	6	16.9	16.9	-0.06	Left Side	1:1	0.01	1	0.01	
802.11b	6	16.9	16.9	0.03	Top Side	1:1	0.03	1	0.03	
802.11b	6	16.9	16.9	0	Bottom Side	1:1	0.01	1	0.02	

MIMO SAR, RFANT1+RFANT2 active

Explosure Condition	Body-Worn Condition				
Test Position	Front Face	Right Side	Left Side	Top Side	Bottom Side
RFANT1	0.04	0.13	0.01	**0.23**	0.10
RFANT2	0.08	0	0.01	0.03	0.02
SAR Summation	0.12	0.13	0.02	**0.26**	0.12

7.2 SAR Results for Extremity Condition, 0 mm separation distance

RFANT1

Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Dudy Cycle	Measured SAR_{10g} [mW/g]	Scaling Factor	Reported SAR_{10g} [mW/g]	Plot #
802.11b	6	15.8	15.0	-0.16	Front Face*	1:1	0.01	1.20	0.012	
802.11b	6	15.8	15.0	0.04	Right Side	1:1	0.05	1.20	0.06	
802.11b	6	15.8	15.0	0.12	Left Side	1:1	0.00	1.20	0	
802.11b	6	15.8	15.0	-0.05	Top Side	1:1	0.1	1.20	**0.12**	3
802.11b	6	15.8	15.0	0.17	Bottom Side	1:1	0.03	1.20	0.036	

*Front face is the display face of the DUT

RFANT2

Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Dudy Cycle	Measured SAR_{10g} [mW/g]	Scaling Factor	Reported SAR_{10g} [mW/g]	Plot #
802.11b	6	16.9	16.9	0.13	Front Face	1:1	0.03	1	0.03	4
802.11b	6	16.9	16.9	0	Right Side	1:1	0.00	1	0.00	
802.11b	6	16.9	16.9	-0.06	Left Side	1:1	0.01	1	0.01	
802.11b	6	16.9	16.9	0.03	Top Side	1:1	0.01	1	0.01	
802.11b	6	16.9	16.9	0	Bottom Side	1:1	0.00	1	0.00	

MIMO SAR, RFANT1+RFANT2 active

Explosure Condition	Extremity Condition				
Test Position	Front Face	Right Side	Left Side	Top Side	Bottom Side
RFANT1	0.012	0.06	0	0.12	0.036
RFANT2	0.03	0	0.01	0.01	0
SAR Summation	0.042	0.060	0.010	0.130	0.036

APPENDIX A: PHOTOS OF THE DUT

RFANT1

RFANT2

Test position for front face.

Test position for left and right sides.

Test Position for bottom side.

Test Position for top side.

APPENDIX B: SYSTEM CHECK SCAN

Date/Time: 20.2.2017 11:57:27

Test Laboratory: Verkotan Oy

Plot 1

SystemPerformanceCheck-D2450 Body

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:758

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 = 1.953 S/m; ε_r = 51.823; ρ = 1000 kg/m^3

Phantom section: Flat Section

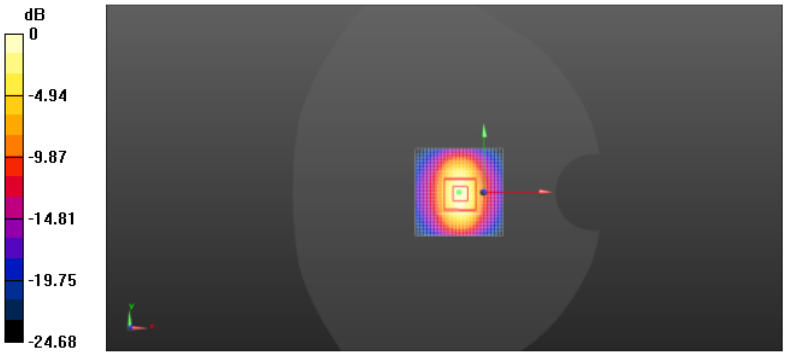
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.35, 7.35, 7.35); Calibrated: 11.3.2016;
  - Modulation Compensation:
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1332; Calibrated: 8.3.2016
- Phantom: Twin-SAM V4.0 (20deg probe tilt); Type: QD 000 P40 CB; Serial: TP-1289
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System Performance Check 2450 MHz 20.02.2017/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Area Scan (51x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Reference Value = 99.35 V/m; Power Drift = 0.02 dB
Fast SAR: SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.35 W/kg (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 22.6 W/kg

System Performance Check 2450 MHz 20.02.2017/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 99.35 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 25.2 W/kg
SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.82 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 18.7 W/kg



0 dB = 22.6 W/kg = 13.54 dBW/kg

Date/Time: 24.2.2017 8:44:05

Test Laboratory: Verkotan Oy

Plot 2

SystemPerformanceCheck-D2450

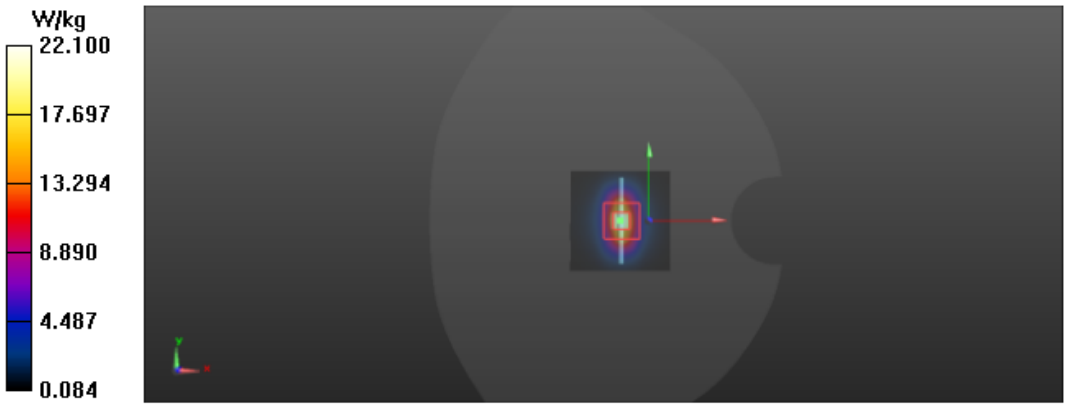
DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:758

Communication System: UID 0, CW (0); Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.912 S/m; ε_r = 51.123; ρ = 1000 kg/m^3
Phantom section: Flat Section
DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.35, 7.35, 7.35); Calibrated: 11.3.2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1332; Calibrated: 8.3.2016
- Phantom: Twin-SAM V4.0 (20deg probe tilt); Type: QD 000 P40 CB; Serial: TP-1289
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System Performance Check 2450 MHz 24.02.2017/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Area Scan (51x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Reference Value = 100.1 V/m; Power Drift = 0.02 dB
Fast SAR: SAR(1 g) = 12.4 W/kg; SAR(10 g) = 5.22 W/kg (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 22.1 W/kg

System Performance Check 2450 MHz 24.02.2017/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.1 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 25.0 W/kg
SAR(1 g) = 12.4 W/kg; SAR(10 g) = 5.81 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 18.7 W/kg



APPENDIX C: MEASUREMENT SCAN

Plot 3
RFANT1

Date/Time: 20.2.2017 13:29:49

Test Laboratory: Verkotan Oy

DUT: Specim; Type: Camera;

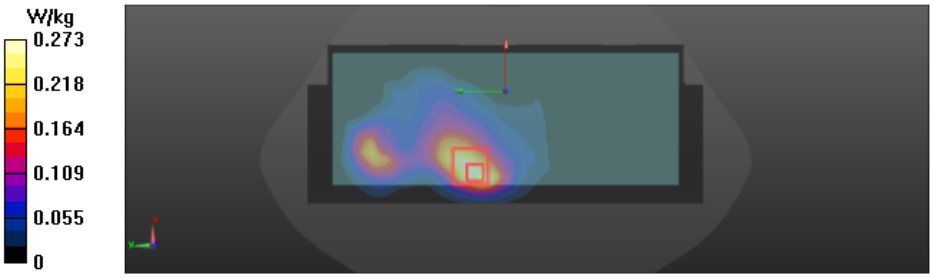
Communication System: UID 0, WLAN (0); Communication System Band: WLAN2.4GHz; Frequency: 2437 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used: f = 2437 MHz; σ = 1.937 S/m; ε_r = 51.851; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.35, 7.35, 7.35); Calibrated: 11.3.2016;
  - Modulation Compensation:
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = -19.0, 31.0
- Electronics: DAE4 Sn1332; Calibrated: 8.3.2016
- Phantom: Twin-SAM V4.0 (20deg probe tilt); Type: QD 000 P40 CB; Serial: TP-1289
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Body-Worn Configuration/Top side 0mm 801.11b 1Mbps Main antenna/Area Scan (81x201x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Reference Value = 4.345 V/m; Power Drift = -0.05 dB
Fast SAR: SAR(1 g) = 0.198 W/kg; SAR(10 g) = 0.103 W/kg (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 0.304 W/kg

Body-Worn Configuration/Top side 0mm 801.11b 1Mbps Main antenna/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.345 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 0.364 W/kg
SAR(1 g) = 0.191 W/kg; SAR(10 g) = 0.100 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.273 W/kg



Date/Time: 24.2.2017 10:49:13

Test Laboratory: Verkotan Oy

Plot 4

DUT: Specim; Type: Camera;

Communication System: UID 0, WLAN (0); Communication System Band: WLAN2.4GHz; Frequency: 2437 MHz;Communication System PAR: 0 dB; PMF: 1

Medium parameters used: f = 2437 MHz; σ = 1.896 S/m; ε_r = 51.17; ρ = 1000 kg/m^3

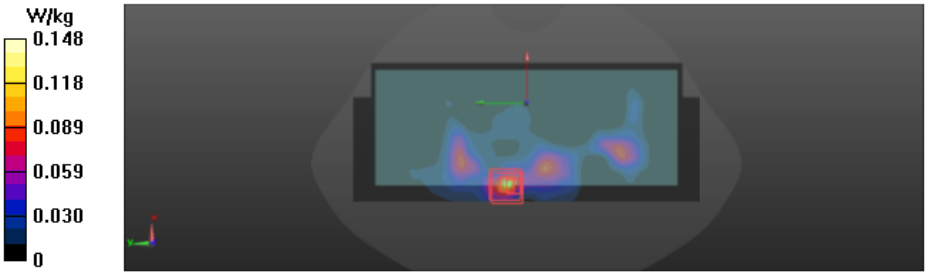
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.35, 7.35, 7.35); Calibrated: 11.3.2016;
  - Modulation Compensation:
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = -19.0, 31.0
- Electronics: DAE4 Sn1332; Calibrated: 8.3.2016
- Phantom: Twin-SAM V4.0 (20deg probe tilt); Type: QD 000 P40 CB; Serial: TP-1289
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Body-Worn Configuration MIMO/Display side 0mm 801.11b 1Mbps MIMO/Area Scan (81x201x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Reference Value = 2.503 V/m; Power Drift = 0.13 dB
Fast SAR: SAR(1 g) = 0.072 W/kg; SAR(10 g) = 0.030 W/kg (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 0.119 W/kg

Body-Worn Configuration MIMO/Display side 0mm 801.11b 1Mbps MIMO/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.503 V/m; Power Drift = 0.13 dB
Peak SAR (extrapolated) = 0.211 W/kg
SAR(1 g) = 0.083 W/kg; SAR(10 g) = 0.028 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.148 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION REPORTS

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
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 **TCC Microsoft**

Certificate No: **EX3-3892_Mar16**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3892
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	March 11, 2016

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 E4419B	GB41293874	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660_Dec15)	Dec-16
Secondary Standards	**ID**	**Check Date (in house)**	**Scheduled Check**
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

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

Issued: March 12, 2016

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

Certificate No: EX3-3892_Mar16 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	10.08	10.08	10.08	0.41	0.88	± 12.0 %
835	41.5	0.90	9.53	9.53	9.53	0.41	0.80	± 12.0 %
1750	40.1	1.37	8.32	8.32	8.32	0.32	0.80	± 12.0 %
1900	40.0	1.40	8.02	8.02	8.02	0.32	0.80	± 12.0 %
2300	39.5	1.67	7.54	7.54	7.54	0.31	0.80	± 12.0 %
2450	39.2	1.80	7.22	7.22	7.22	0.27	0.97	± 12.0 %
2600	39.0	1.96	7.08	7.08	7.08	0.30	0.95	± 12.0 %
5250	35.9	4.71	4.79	4.79	4.79	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.37	4.37	4.37	0.45	1.80	± 13.1 %
5750	35.4	5.22	4.53	4.53	4.53	0.45	1.80	± 13.1 %

[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

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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 **Verkotan**

Certificate No: D2450V2-758_Jan16

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 758
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	January 14, 2016

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 EPM-442A	GB37480704	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	31-Dec-15 (No. EX3-7349_Dec15)	Dec-16
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 15, 2016

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

Certificate No: D2450V2-758_Jan16 Page 1 of 8

Measurement Conditions

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

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

Head TSL parameters

The following parameters and calculations were applied.

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

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.1 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.1 ± 6 %	2.04 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**51.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**24.2 W/kg ± 16.5 % (k=2)**