

SAR Compliance Test Report

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Tested device	MX Rugged B		
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:	20.04.2017		
For the contents:			

Miia Nurkkala Digitally signed by Miia Nurkkala
Date: 2017.04.20 10:51:52 +03'00'

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Equipment under Test (EUT):

Product:	Mx Rugged B
Manufacturer:	Bittium Wireless Ltd
Type:	SSD-52
Serial Number:	356244060507997, 356244060506840
FCC ID Number:	V27SSD-52
Hardware Version:	2201
DUT Number:	23103, 23099
Battery Type used in testing:	Li-Ion Polymer 9304569A01
Portable/ Mobile device	Portable
State of the Sample	Prototype

Testing information:

Testing performed:	11.1.2017 – 30.1.2017
Notes:	Verkotan ref ID451
Document name:	FCC_SAR_Report_MX Rugged B_20042017.docx
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Ilpo Joensuu/ Kirsi Kyllönen

1.2 Maximum Results

The maximum reported* SAR values for Head Exposure Condition and Body-worn configurations are reported 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 Head & Body is SAR_{1g} 1.6 W/kg,

Equipment Class	System	Highest Reported* SAR _{1g} (W/kg) in Head Exposure Condition	Highest Reported* SAR _{1g} (W/kg) in Body-Worn Condition	Result
TNE	Satellite	1.51	0.38	PASS
DSS	Bluetooth	0.012	0.029	PASS

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

1.2.1 Simultaneous Transmission SAR

Highest Simultaneous Transmission SAR	SAR _{1g} (W/kg) in Head Exposure Condition*	SAR _{1g} (W/kg) in Body-Worn Condition*	Result
TNE + DSS	1.52	0.41	PASS

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

1.2.2 Maximum Drift

Maximum Drift During Measurements	-0.272 ≤ dB
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*Larger than 5% drifts included to scaling factors

1.2.3 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	±24.5 %
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2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The Mexsat Rugged Basic is a mobile phone supporting satellite radio access technology. Satellite connection can be used as a Push-to-talk radio or against head.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

TX Frequency bands	Modes of Operation	Modulation Mode	Transmitter Frequency Range (MHz)
	Bluetooth	GFSK, $\pi/4$ -DQPSK, 8-DPSK	2402 - 2480
	Satellite GMR-1 3G	PI/2 BPSK / PI/4 QPSK	1626.5-1660.5

2.2 Simultaneous Transmission

The DUT is utilizing 2 different antennas for tested frequencies.

Possible Simultaneous TX combinations
Satellite + Bluetooth

2.3 SAR Test Exclusion

Bluetooth and Bluetooth Low Energy use the same frequency and antenna. Since Bluetooth tuning power is higher, Bluetooth SAR is a conservative estimation of Bluetooth Low Energy SAR. Thus, Bluetooth Low Energy SAR can be deemed to comply without further analysis or measurements. The maximum and tested conducted powers for BT and BLE are shown in chapter 3 of this report.

3. CONDUCTED POWERS

3.1 Tested conducted power

	Bluetooth		
	CH 0 2402 MHz	CH 38 2440 MHz	CH 78 2480 MHz
Conducted Power [dBm]	9.3	8.01	10.59

	Bluetooth Low Energy		
	CH 0 2402 MHz	CH 19 2440 MHz	CH 39 2480 MHz
Conducted Power [dBm]	0.65	-0.44	1.49

	Satellite		
	CH 1 1626.5 MHz	CH 220 1643.5 MHz	CH 43F 1660.5 MHz
Conducted Power [dBm]	29.63	29.68	29.7

3.2 Maximum conducted power

	Bluetooth			
	CH 0 2402 MHz	CH 38 2440 MHz	CH 78 2480 MHz	Max Tolerance* [dB]
Conducted Power [dBm]	9.3	8.01	10.59	+2.5
*the maximum power according to the manufacturer can be 2.5dB above nominal i.e. measured conducted power				

	Bluetooth Low Energy			
	CH 0 2402 MHz	CH 19 2442 MHz	CH 39 2480 MHz	Tolerance* [dB]
Conducted Power [dBm]	0.65	-0.44	1.49	+1
*the maximum power according to the manufacturer can be 1 dB above nominal i.e. measured conducted power				

Satellite	Target [dBm]	Tolerance [dB]
Waveform 0x29 – 31.25KHz PI/2 BPSK	29.5	+0.5/-1.5
Waveform 0x31 – 31.25KHz PI/4 QPSK	29.5	+0.5/-1.5
Waveform 0x39 – 62.5KHz PI/4 QPSK	29.5	+0.5/-1.5
Waveform 0x41 – 156.25KHz PI/4 QPSK	29.5	+0.5/-1.5

4. TEST EQUIPMENT

Dasy4 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 brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location of maximum electromagnetic field.

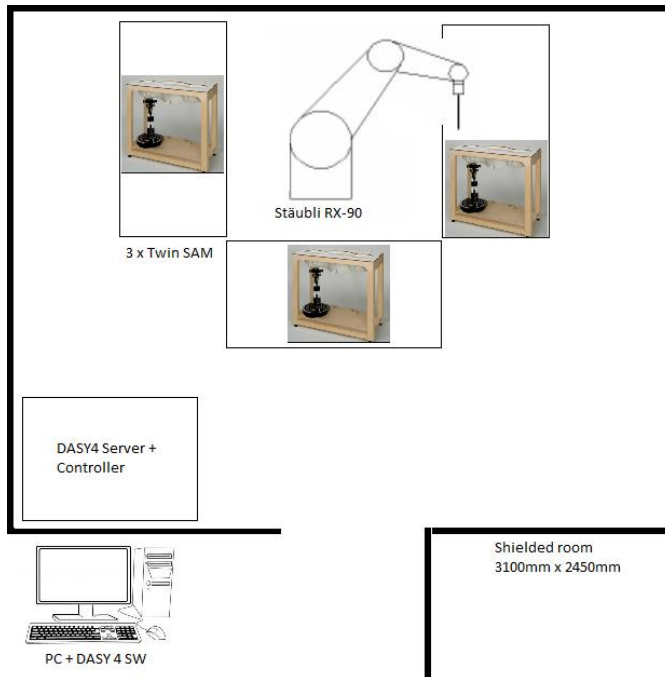


Figure 1 Schematic Laboratory Picture

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	Calibration Expiry
DAE	DAE3	371	04/2016	04/2017
Probe	ET3DV6	1381	09/2016	09/2017
Dipole	SID1640	37/16DIP1G640-433	09/2016	09/2019
DASY Software	v4.7	na	na	na
Signal Generator	SMIQ06B	834968/023	na	na
Amplifier	AR 5S1G4	27573	na	na
Power Sensor	NRT Z-11	100265	01/2016	01/2018

4.1.1 Isotropic E-field Probe Type ET3DV6

Construction	Symmetric design with triangular core Built-in optical fiber for surface detection system (ET3DV6 only) 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 – 2.3 GHz Linearity: ± 0.2 dB (30 MHz – 2.3 GHz)
Directivity	± 0.2 dB in TSL (rotation around probe axis) ± 0.4 dB in TSL (rotation normal to probe axis)
Dynamic Range	5 μ W/g – >100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 337 mm (tip: 16 mm) Tip diameter: 6.8 mm (body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm
Application	General dosimetric measurements up to 2.3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.2 Phantoms

The phantom used in SAR tests was 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 $\pm 5\%$ 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.

4.3.1 Recipes

1700 – 2000 MHz:

Ingredient (% by weight)	HEAD 1700 – 2000	BODY 1700 – 2000
Deionized Water	54.5	70.25
Tween 20	45.23	29.41
Salt	0.27	0.34

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
1640	SID1640/37/16DIP1G640-433	ET3DV6 / 1381	CW	DAE3 / 371	10/2016	10/2016

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 #
23.01.2017	H1900	21.7	1640	250mW	8.53	35.78	34.12	-4.6	10
24.01.2017	M1900	21.4	1640	250mW	8.3	35.66	33.2	-6.9	11

4.5.1 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 (%)
23.01.2017	H1900	22	1640	1.31	40.2	1.26	39.7	-3.8	-1.2
			1626.5	1.3	40.2	1.25	39.9	-3.8	-0.7
			1643.5	1.31	40.2	1.26	39.7	-3.8	-1.2
			1660.5	1.32	40.2	1.28	39.5	-3.0	-1.7
24.01.2017	M1900	22	1640	1.42	53.7	1.36	53.6	-4.2	-0.2
			1643.5	1.42	53.7	1.36	53.6	-4.2	-0.2

5. TEST PROCEDURE

The device output power was set to maximum power level for all tests. A fully charged battery was used for every test sequence.

5.1 Device Holder

The device was placed in the device holder that is supplied by SPEAG.



A custom-made spacer on the right, was used to position the device within the SPEAG holder. The spacer positions the device so that the holder has minimal effect on the test results but still holds the device securely. The spacer was removed before the tests.

5.2 Test Positions

See Appendix A for photos of the test positions.

5.2.1 Against Head Configuration

Measurements were made in “cheek” and “tilt” positions on both the left hand and right hand sides of the phantom as defined in IEEE 1528 “IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”.

5.2.2 In Front of Face Configuration, 25mm separation distance

The device was placed in the SPEAG device holder below the flat phantom, front of the device facing the phantom. The distance between the device and the flat phantom was 25mm as required in KDB 447498 D01 General RF Exposure Guidance, section 6.1.

5.2.3 Body-worn Configuration, 10 mm separation distance

The device was placed in the SPEAG device holder below the flat phantom. The distance between the device and the phantom was kept at the defined separation distance using a separate flat spacer that was removed before the start of the measurements. The device was oriented back and front side facing the phantom to find the highest results.

5.3 Scan Procedures

Area scans were first measured for the determination of the field distribution. Next, a zoom scan with 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. 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.

5.4 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 According to IEEE 1528-2013 and IEC 62209-1/201x (3 - 6 GHz range)								
Error Description	Uncert. value	Prob. Dist.	Div.	(c _i) 1g	(c _i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v _i) <i>v_{eff}</i>
Measurement System								
Probe Calibration	±6.55 %	N	1	1	1	±6.55 %	±6.55 %	∞
Axial Isotropy	±4.7 %	R	$\sqrt{2}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{2}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±2.0 %	R	$\sqrt{2}$	1	1	±1.2 %	±1.2 %	∞
Linearity	±4.7 %	R	$\sqrt{2}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{2}$	1	1	±0.6 %	±0.6 %	∞
Modulation Response ^m	±2.4 %	R	$\sqrt{2}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	$\sqrt{2}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{2}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	$\sqrt{2}$	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	$\sqrt{2}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.8 %	R	$\sqrt{2}$	1	1	±0.5 %	±0.5 %	∞
Probe Positioning	±6.7 %	R	$\sqrt{2}$	1	1	±3.9 %	±3.9 %	∞
Max. SAR Eval.	±4.0 %	R	$\sqrt{2}$	1	1	±2.3 %	±2.3 %	∞
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	$\sqrt{2}$	1	1	±2.9 %	±2.9 %	∞
Power Scaling ^p	±0 %	R	$\sqrt{2}$	1	1	±0.0 %	±0.0 %	∞
Phantom and Setup								
Phantom Uncertainty	±6.6 %	R	$\sqrt{2}$	1	1	±3.8 %	±3.8 %	∞
SAR correction	±1.9 %	R	$\sqrt{2}$	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.) ^{DAK}	±2.5 %	R	$\sqrt{2}$	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.) ^{DAK}	±2.5 %	R	$\sqrt{2}$	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity ^{BB}	±3.4 %	R	$\sqrt{2}$	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity ^{BB}	±0.4 %	R	$\sqrt{2}$	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±12.3 %	±12.2 %	748
Expanded STD Uncertainty						±24.6 %	±24.5 %	

7. TEST RESULTS

7.1 SAR Results for Head Exposure Condition

Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Antenna	Duty Cycle	Measured SAR 1g [mW/g]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
SAT L	1	30	29.63	0.169	Right Cheek	EXT	1:6.64	0.46	1.09	0.50	
SAT L	1	30	29.63	-0.11	Right Tilted	EXT	1:6.64	1.33	1.09	1.45	
SAT L	1	30	29.63	-0.07	Left Cheek	EXT	1:6.64	0.23	1.09	0.25	
SAT L	1	30	29.63	-0.15	Left Tilted	EXT	1:6.64	0.613	1.09	0.67	
SAT L	220	30	29.68	-0.102	Right Cheek	EXT	1:6.64	0.464	1.08	0.50	
SAT L	220	30	29.68	-0.01	Right Tilted	EXT	1:6.64	1.37	1.08	1.47	
SAT L	220	30	29.68	-0.18	Left Cheek	EXT	1:6.64	0.24	1.08	0.26	
SAT L	220	30	29.68	-0.12	Left Tilted	EXT	1:6.64	0.72	1.08	0.78	
SAT L	43F	30	29.7	0.15	Right Cheek	EXT	1:6.64	0.597	1.07	0.64	
SAT L	43F	30	29.7	0.17	Right Tilted	EXT	1:6.64	1.41	1.07	1.51	3
SAT L	43F	30	29.7	0.15	Left Cheek	EXT	1:6.64	0.283	1.07	0.30	
SAT L	43F	30	29.7	-0.12	Left Tilted	EXT	1:6.64	0.791	1.07	0.85	

Repeated measurements											
Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Antenna	Duty Cycle	Measured SAR 1g [mW/g]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
SAT L	1	30	29.63	-0.08	Right Tilted	EXT	1:6.64	1.18	1.09	1.28	
SAT L	220	30	29.68	-0.21	Right Tilted	EXT	1:6.64	1.37	1.08	1.47	
SAT L	43F	30	29.7	0.03	Right Tilted	EXT	1:6.64	1.37	1.07	1.47	

Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Duty Cycle	Measured SAR 1g [mW/g]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
BT	38	10.51	8.01	0.18	Right Cheek	1:1.3	0.00133	1.78	0.002	
BT	38	10.51	8.01	-0.245*	Right Tilted	1:1.3	0.00296	1.88	0.006	
BT	38	10.51	8.01	0	Left Cheek	1:1.3	0.0053	1.78	0.012	4
BT	38	10.51	8.01	-0.272*	Left Tilted	1:1.3	0.00187	1.89	0.003	

*Drift considered in scaling factor

In Front of Face, 25mm separation distance

Band	Channel	Maximun Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Antenna	Duty Cycle	Measured SAR 1g [mW/g]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
SAT L	220	30	29.68	-0.0324	In front of Face	EXT	1:6.64	0.104	1.08	0.11	5

7.2 SAR Results for Body-Worn Configuration, 10 mm separation distance

Band	Channel	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Duty Cycle	Measured SAR 1g [mW/g]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
BT	38	10.51	8.01	-0.08	Front	1:1.3	0.00187	1.78	0.003	
BT	38	10.51	8.01	0.17	Back	1:1.3	0.0161	1.78	0.029	6

Band	Channel	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Test Position	Antenna	Duty Cycle	Measured SAR 1g [mW/g]	Scaling Factor	Reported SAR 1g [mW/g]	Plot #
SAT L	220	30	29.68	-0.08	Front	EXT	1:6.64	0.323	1.08	0.35	
SAT L	220	30	29.68	-0.02	Back	EXT	1:6.64	0.354	1.08	0.38	7

7.3 SAR Results for simultaneous transmission

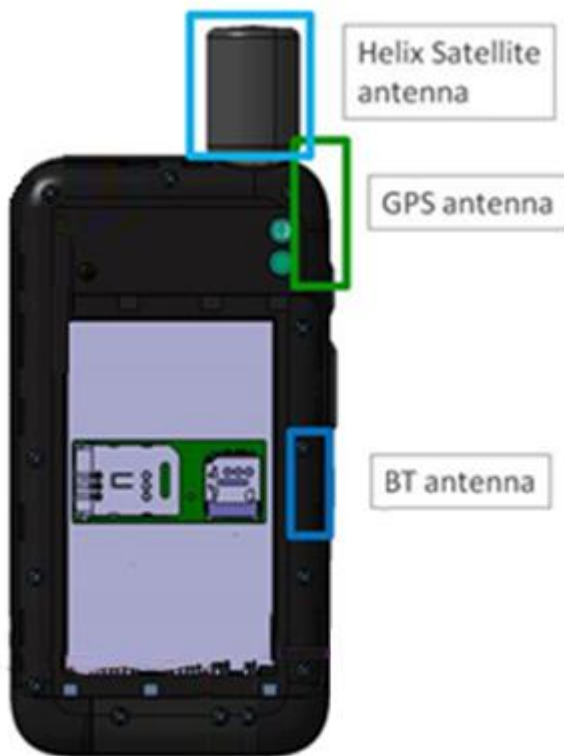
Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR_{1g} of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR_{1g} 1.6 W/kg), the simultaneous transmission SAR is not required.

When the sum of SAR_{1g} is greater than the SAR limit (SAR_{1g} 1.6 W/kg), SAR test exclusion is determined by the SPLSR.

	Exposure Condition	Head				Body	
	Test Position	Right Cheek	Right Tilt	Left Cheek	Left Tilt	Front	Back
Satellite		0.64	1.51	0.30	0.85	0.35	0.38
Bluetooth		0.002	0.006	0.012	0.003	0.003	0.029
SAR Summation		0.642	1.516	0.312	0.853	0.353	0.409
SPLSR Analysis		Σ SAR < 1.6, Analysis Not Required					

APPENDIX A: PHOTOS OF THE DUT

Dimension of the DUT are 152mm x 47mm x 24.5mm



Front of the DUT:



Back of the DUT:



Head Exposure Condition:

Right cheek position



Right tilt position



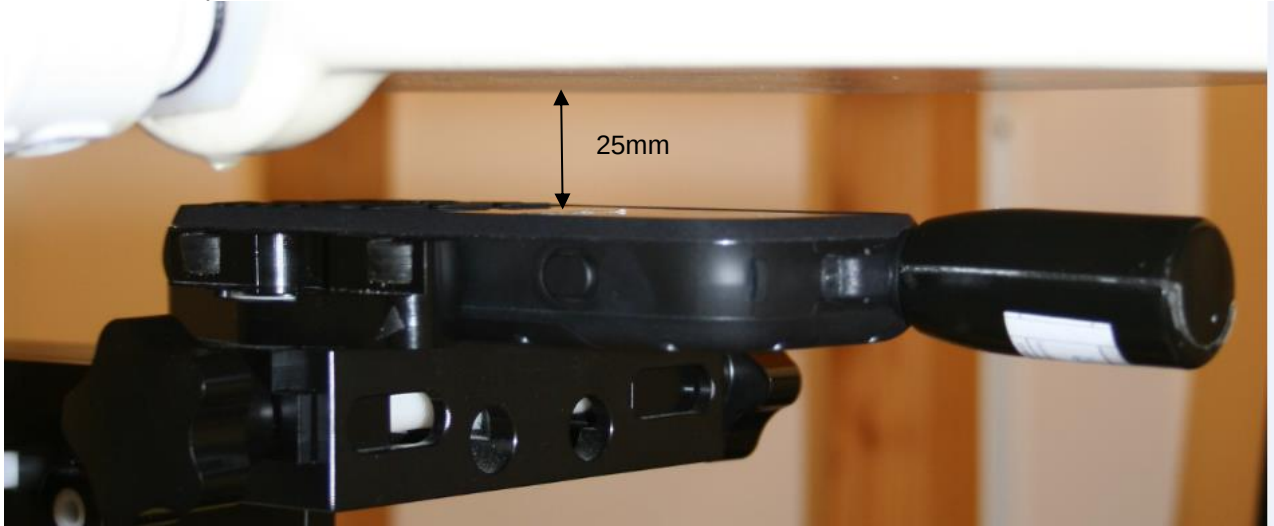
Left cheek position



Left tilt position



Front of the face position



Body-worn Exposure Condition:

Backside toward phantom



Frontside toward phantom



APPENDIX B: SYSTEM CHECK SCANS

Date/Time: 23.01.2017 12:14:48

Test Laboratory: Verkotan Oy

Plot 1

DUT: Dipole 1640 MHz; Type: DIP1G640-433; Serial: SN 37/16 DIP 1G640-433
Program Name: System Performance Check at 1640 MHz

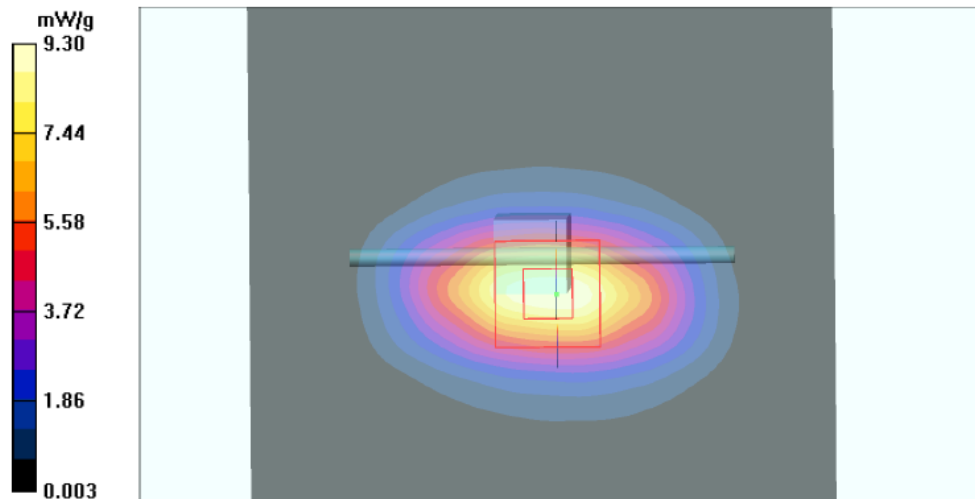
Communication System: CW; Frequency: 1640 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1640$ MHz; $\sigma = 1.26$ mho/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1381; ConvF(5.56, 5.56, 5.56); Calibrated: 15.09.2016
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_2; Type: SAM Twin; Serial: TP-1142
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 9.30 mW/g

d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 79.3 V/m; Power Drift = 0.030 dB
Peak SAR (extrapolated) = 13.7 W/kg
SAR(1 g) = 8.53 mW/g; SAR(10 g) = 4.77 mW/g
Maximum value of SAR (measured) = 9.61 mW/g



Date/Time: 24.01.2017 13:36:28

Test Laboratory: Verkotan Oy

Plot 2

DUT: Dipole 1640 MHz; Type: DIP1G640-433; Serial: SN 37/16 DIP 1G640-433
Program Name: System Performance Check at 1640 MHz

Communication System: CW; Frequency: 1640 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1640 \text{ MHz}$; $\sigma = 1.36 \text{ mho/m}$; $\epsilon_r = 53.6$; $\rho = 1000 \text{ kg/m}^3$

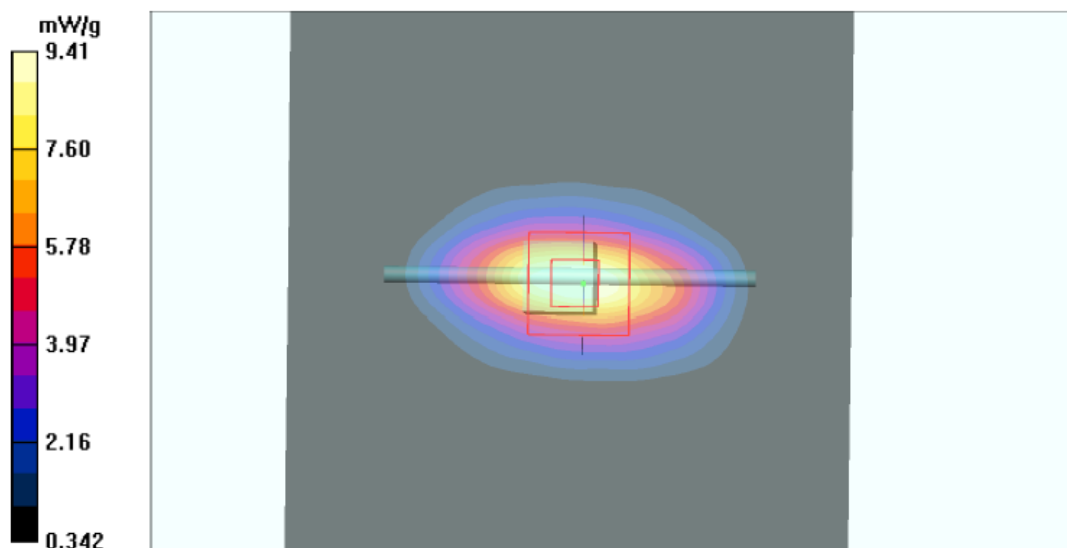
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1381; ConvF(5.19, 5.19, 5.19); Calibrated: 15.09.2016
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_1; Type: SAM Twin; Serial: TP-1128
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 9.62 mW/g

d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 90.1 V/m; Power Drift = -0.019 dB
Peak SAR (extrapolated) = 12.6 W/kg
SAR(1 g) = 8.3 mW/g; SAR(10 g) = 4.67 mW/g
Maximum value of SAR (measured) = 9.41 mW/g



APPENDIX C: MEASUREMENT SCAN

Date/Time: 23.01.2017 19:52:37

Test Laboratory: Verkotan Oy

Plot 3

DUT: Mexsat Rugged; Type: Phone; Serial: 356244060507997
Program Name: Head Exposure Condition

Communication System: Satellite; Frequency: 1660.5 MHz; Duty Cycle: 1:6.64

Medium parameters used (interpolated): $f = 1660.5 \text{ MHz}$; $\sigma = 1.28 \text{ mho/m}$; $\epsilon_r = 39.5$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1381; ConvF(5.56, 5.56, 5.56); Calibrated: 15.09.2016
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_2; Type: SAM Twin; Serial: TP-1142
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Right Tilted 5/Area Scan (61x151x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 1.74 mW/g

Right Tilted 5/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

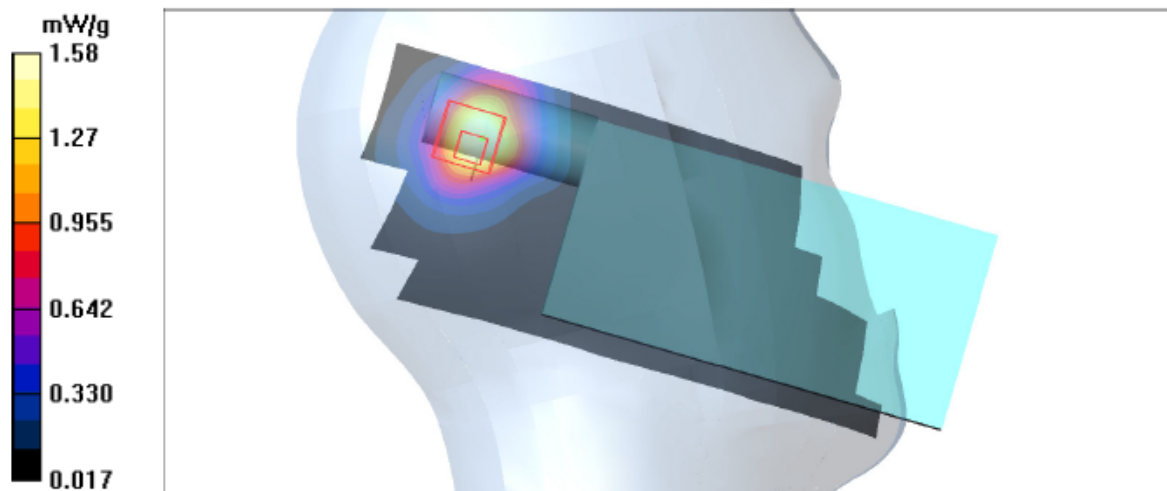
Reference Value = 4.20 V/m; Power Drift = 0.170 dB

Peak SAR (extrapolated) = 2.68 W/kg

SAR(1 g) = 1.41 mW/g; SAR(10 g) = 0.788 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 1.58 mW/g



Date/Time: 17.01.2017 10:35:08

Test Laboratory: Verkotan Oy

Plot 4

DUT: Mexsat Rugged; Type: Phone; Serial: 356244060507997
Program Name: Head Exposure Condition

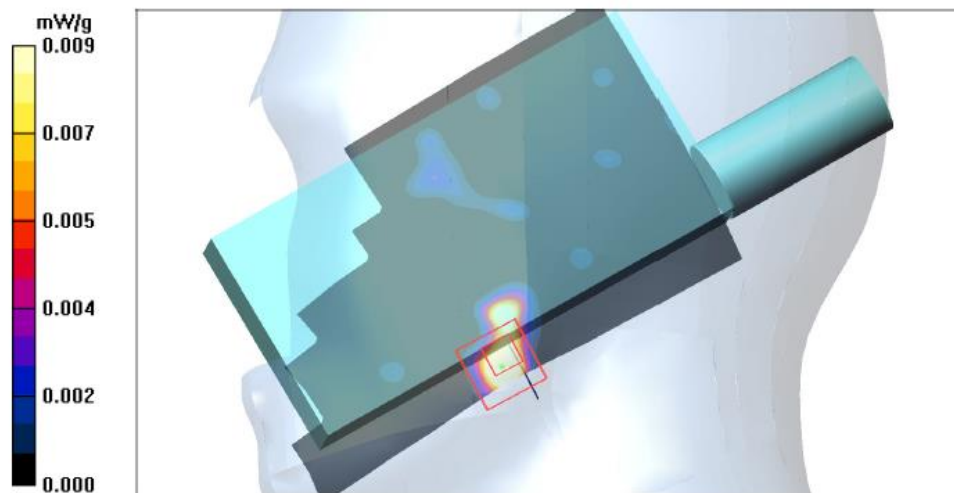
Communication System: Bluetooth; Frequency: 2440 MHz; Duty Cycle: 1:1.3
Medium parameters used: $f = 2440 \text{ MHz}$; $\sigma = 1.82 \text{ mho/m}$; $\epsilon_r = 39.4$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Left Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.22, 7.22, 7.22); Calibrated: 11.03.2016
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_2; Type: SAM Twin; Serial: TP-1142
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Left Cheek/Area Scan (81x131x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$
Maximum value of SAR (interpolated) = 0.020 mW/g

Left Cheek/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
Reference Value = 0.755 V/m ; Power Drift = 0.028 dB
Peak SAR (extrapolated) = 0.018 W/kg
 $\text{SAR}(1 \text{ g}) = 0.0053 \text{ mW/g}$; $\text{SAR}(10 \text{ g}) = 0.00197 \text{ mW/g}$
Maximum value of SAR (measured) = 0.009 mW/g



Date/Time: 24.01.2017 09:28:38

DUT: Mexsat Rugged; Type: Phone; Serial: 356244060507997
Program Name: In-Front of Face

Plot 5

Communication System: Satellite; Frequency: 1643.5 MHz; Duty Cycle: 1:6.64
Medium parameters used (interpolated): $f = 1643.5$ MHz; $\sigma = 1.26$ mho/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1381; ConvF(5.56, 5.56, 5.56); Calibrated: 15.09.2016
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_2; Type: SAM Twin; Serial: TP-1142
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Front Face 25mm/Area Scan (61x151x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.111 mW/g

Front Face 25mm/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

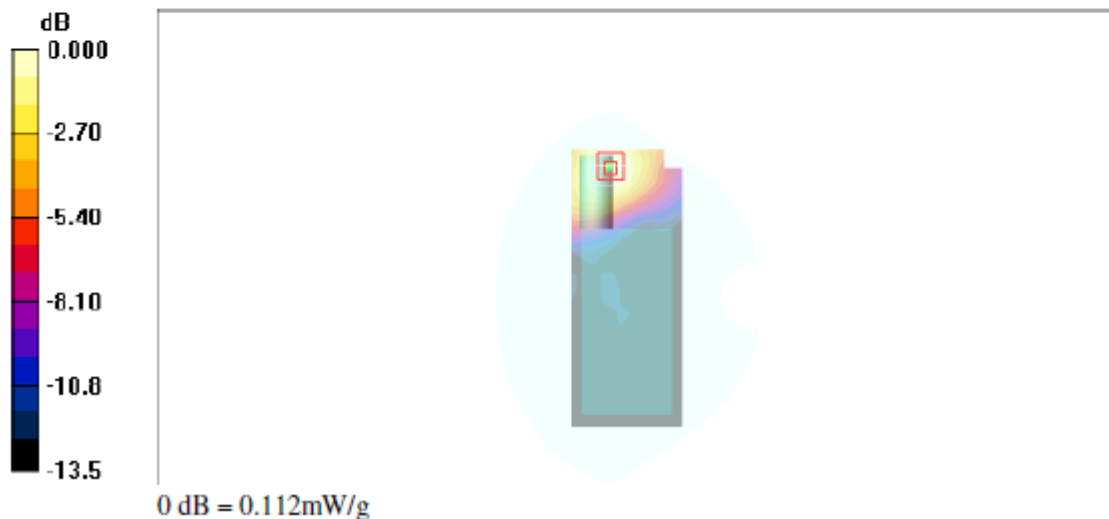
Reference Value = 10.1 V/m; Power Drift = -0.033 dB

Peak SAR (extrapolated) = 0.149 W/kg

SAR(1 g) = 0.104 mW/g; SAR(10 g) = 0.069 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.112 mW/g



Date/Time: 17.01.2017 10:07:03

Test Laboratory: Verkotan Oy

Plot 6

DUT: Mexsat Rugged; Type: Phone; Serial: 356244060507997
Program Name: Body-Worn Condition

Communication System: Bluetooth; Frequency: 2440 MHz; Duty Cycle: 1:1.3

Medium parameters used: $f = 2440 \text{ MHz}$; $\sigma = 1.92 \text{ mho/m}$; $\epsilon_r = 52.2$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3892; ConvF(7.35, 7.35, 7.35); Calibrated: 11.03.2016
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_1; Type: SAM Twin; Serial: TP-1128
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Back 10mm 2/Area Scan (81x131x1): Measurement grid: $dx=12\text{mm}$, $dy=12\text{mm}$

Maximum value of SAR (interpolated) = 0.022 mW/g

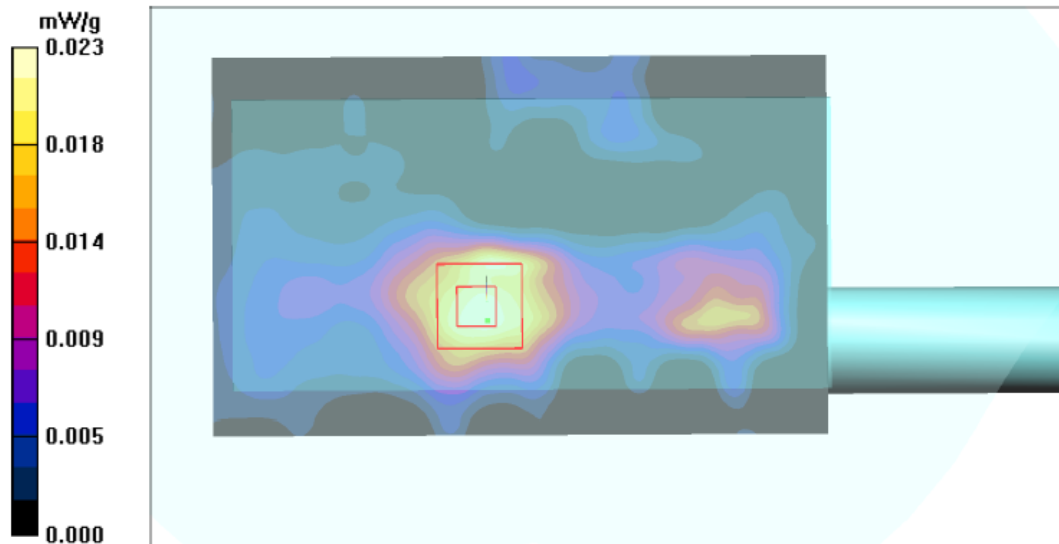
Back 10mm 2/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 1.97 V/m; Power Drift = 0.172 dB

Peak SAR (extrapolated) = 0.052 W/kg

SAR(1 g) = 0.016 mW/g; SAR(10 g) = 0.00798 mW/g

Maximum value of SAR (measured) = 0.023 mW/g



Date/Time: 24.01.2017 14:35:47

Test Laboratory: Verkotan Oy

DUT: Mexsat Rugged; Type: Phone; Serial: 356244060507997
Program Name: Body-Worn Condition

Plot 7

Communication System: Satellite; Frequency: 1643.5 MHz; Duty Cycle: 1:6.64

Medium parameters used (interpolated): $f = 1643.5$ MHz; $\sigma = 1.36$ mho/m; $\epsilon_r = 53.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1381; ConvF(5.19, 5.19, 5.19); Calibrated: 15.09.2016
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn371; Calibrated: 22.04.2016
- Phantom: SAM_1; Type: SAM Twin; Serial: TP-1128
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Back 10mm/Area Scan (61x151x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.361 mW/g

Back 10mm/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

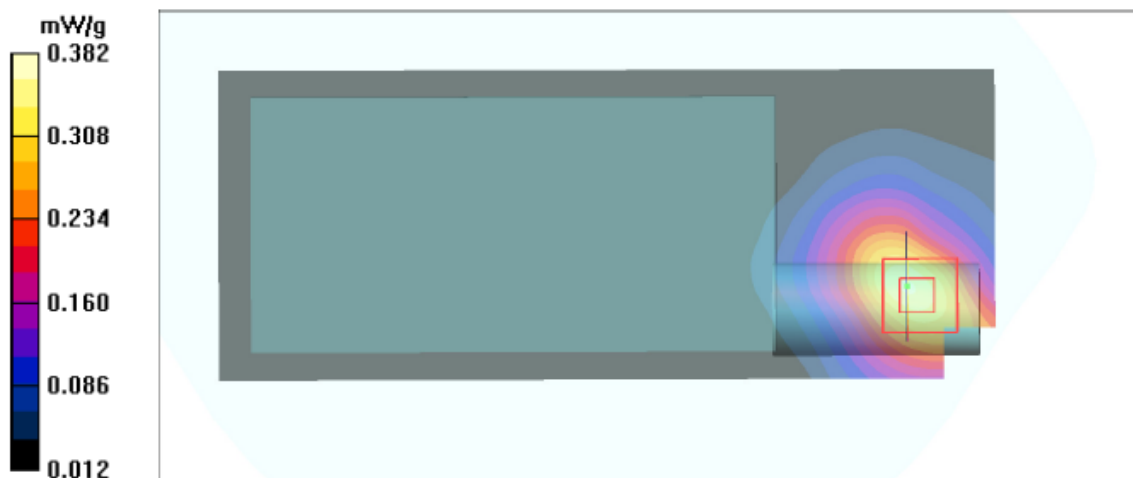
Reference Value = 8.57 V/m; Power Drift = -0.025 dB

Peak SAR (extrapolated) = 0.505 W/kg

SAR(1 g) = 0.354 mW/g; SAR(10 g) = 0.214 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.382 mW/g



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
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: ET3-1381_Sep16

CALIBRATION CERTIFICATE

Object ET3DV6 - SN:1381

Calibration procedure(s) QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

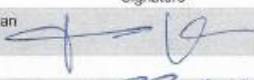
Calibration date: September 15, 2016

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 NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
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
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-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
			Issued: September 17, 2016

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

ET3DV6- SN:1381

September 15, 2016

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1381

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)
150	52.3	0.76	7.94	7.94	7.94	0.18	2.80	± 13.3 %
450	43.5	0.87	7.29	7.29	7.29	0.29	2.87	± 13.3 %
1640	40.3	1.29	5.56	5.56	5.56	0.75	2.22	± 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



SAR Reference Dipole Calibration Report

Ref : ACR.264.2.16.SATU.A

VERKOTAN LTD.
ELEKTRONIKKATIE 17
90590, OULU, FINLAND
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 1640 MHZ
SERIAL NO.: SN 37/16 DIP 1G640-433

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



Calibration Date: 09/16/16

Summary:

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



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.262.2.16.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	9/20/2016	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	9/20/2016	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	9/20/2016	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Verkotan Ltd.

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	9/20/2016	Initial release

Page: 2/11

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.262.2.16.SATU.A

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: ϵ_{ps}' : 40.1 sigma : 1.32
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	1640 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	35.78 (3.58)	18.4	19.04 (1.90)
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	

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SAR REFERENCE DIPOLE CALIBRATION REPORT

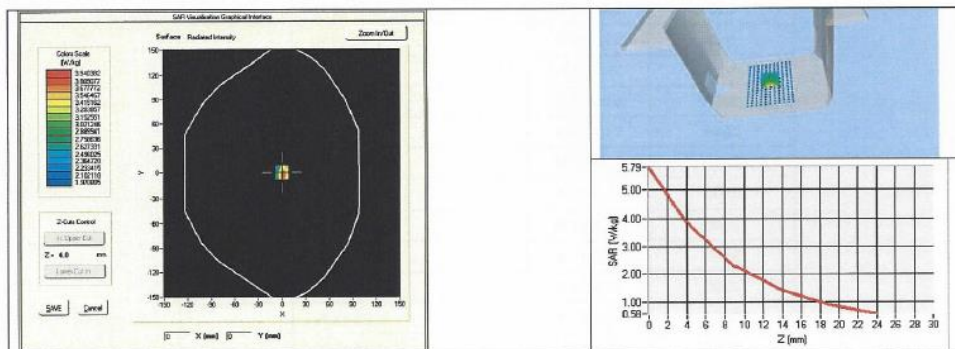
Ref: ACR.262.2.16.SATU.A

3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
3700	51.0 ±5 %		3.55 ±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' : 54.1 sigma : 1.41
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	1640 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
1640	35.66 (3.57)	19.13 (1.91)



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