SAR Compliance Test Report

Date of Report	23/03/2020	**Client's Contact person:**	Rauno Nikkilä
Number of pages:	41	**Responsible Test engineer:**	Kirsi Kyllönen
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	NORDIC ID GROUP Joensuunkatu 7 24100 Salo, FINLAND tel. +358 2 727 7700
Tested device	HH83 RFID ACD, Model 837-2A		
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:

23.03.2020

For the contents:

Miia Nurkkala

Digitally signed by Miia Nurkkala
Date: 2020.03.23 15:23:54 +02'00'

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	Nordic ID HH83
Manufacturer:	Nordic ID
SN Number:	K200300533, K200300531
FCC ID Number:	-
Model:	837-2A
DUT Number:	22562, 22563
Battery Type used in testing:	Lithium-ion battery PA_UL-LNB46.R001
Portable/ Mobile device	Portable
State of the Sample	Production sample

Testing information:

Testing Performed:	11.2. - 24.2.2020
Notes:	The performed test cases were agreed with FCC. This report replaces FCC SAR report HH83 1902 ID3555 25022020 report
Document ID:	FCC SAR report HH83 1902 ID3555 23032020
Temperature °C	22±2 / Controlled
Humidity RH%	20±20 / Controlled
Measurement performed by:	Kirsi Kyllönen, Ilari Kinnunen

1.2 Maximum Results

The maximum reported* SAR value for Extremity-configuration 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) for Extremity SAR_{10g} is 4.0 W/kg.

1.2.1 0mm Separation Distance

System	Equipment Class	Highest Reported* SAR_{10g}(W/kg) in Extremity Configuration, 0mm	Result
WLAN 2.4GHz	**NII**	**0.35**	**PASS**
WLAN 5GHz	**NII**	**1.5**	**PASS**

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

1.2.2 20mm Separation Distance

System	Equipment Class	Highest Reported* SAR_{10g}(W/kg) in Extremity Configuration, 20mm	Result
UHF RFID	**DSS, JBL**	**0.56**	**PASS**

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

1.2.3 Maximum Drift

Maximum Drift During Measurements	0.59 dB*

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

1.2.4 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	±23.3%

1.3 Simultaneous Transmission SAR

Highest Simultaneous Transmission SAR	Highest Reported* SAR_{10g}(W/kg) in Extremity Configuration	Result
WLAN + UHF	**2.06**	**PASS**

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The device is a data collector through UHF RFID or barcode reading. Device can transmit via WLAN.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

	Modes of Operation	**Transmitter Frequency Range (MHz)**
TX Frequency bands	UHF RFID	902-928
	2.4GHz WLAN	2412-2462
	5GHz WLAN	5210-5805
	Bluetooth	2402-2480

3. OUTPUT POWER

3.1.1 Maximum Output Power

From a Customer, maximum defined output power, including tune-up tolerance.

Mode	Upper Limit Peak Power (dBm)
UHF RFID	30

Mode	Standard	Rate	Max Output Power [dBm]
WLAN 2.4GHz	802.11b	1 Mbps	18.5
WLAN 5GHz	802.11a	6 Mbps	16.5
WLAN 5GHz	802.11a	54 Mbps	15.5
WLAN 5GHz	802.11n HT20	MCS0	17.5
WLAN 5GHz	802.11n HT20	MCS7	15.5
WLAN 5GHz	802.11n HT40	MCS0	17.5
WLAN 5GHz	802.11n HT40	MCS7	15.5
WLAN 5GHz	802.11ac VHT20	MCS0	17.5
WLAN 5GHz	802.11ac VHT20	MCS8	15.5
WLAN 5GHz	802.11ac VHT40	MCS0	16.5
WLAN 5GHz	802.11ac VHT40	MCS9	15.5
WLAN 5GHz	802.11ac VHT80	MCS0	15.5
WLAN 5GHz	802.11ac VHT80	MCS9	14.5

Mode	Max Output Power [dBm]
Bluetooth	1.8

3.2 Tested conducted power

Measured conducted output power at transmitting antenna connector.

Mode	Measured Peak Power (dBm)		
	CH 1 902.75 GHz	CH 25 914.75 GHz	CH 50 927.25 GHz
RFID	27.8	28.0	27.99

2.4GHz WLAN:

Standard	Transmission mode	Data rate [Mbps]	Output power [dBm]		
			CH 1 2412 MHz	CH 6 2437 MHz	CH 11 2462 MHz
802.11b	DSSS	1	17.6	17.22	17.97

5GHz WLAN:

Standard	Channel	Frequency [MHz]	Transmission mode	Data rate [Mbps]	Output power [dBm]
802.11n HT40	54	5270	OFDM	13.5	19.5
802.11n HT40	62	5310			19.17
802.11n HT40	102	5510			17.13
802.11n HT40	110	5550			16.97
802.11n HT40	118	5590			16.92
802.11n HT40	126	5630			20.29
802.11n HT40	134	5670			19.77
802.11n HT40	142	5710			15.75
802.11n HT40	151	5755			20.04
802.11n HT40	159	5795			18.63

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.

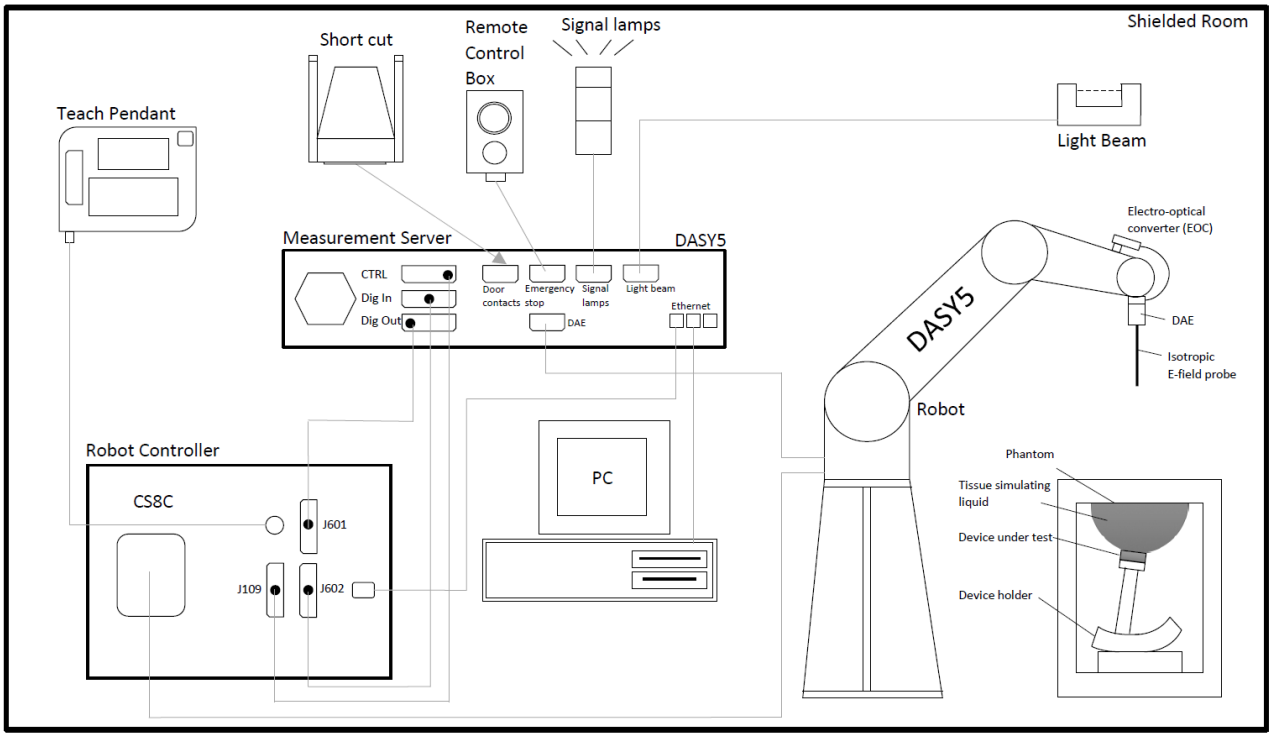


Figure 1 Schematic Laboratory Picture

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	705	04.2019
Probe	EX3DV4	7447	03.2019
Dipole	D835V2	473	12.2018
Dipole	D2450V2	729	06.2017
Dipole	D5GHZV2	1045	06.2017
DASY5 Software	52.8.8.1258	-	NA
Signal generator	R&S SMIQ 06B	1125.5555.06	NA
Amplifier	AR	10S1G4A	NA
Power Reflection Meter	NRT	835065/049	02.2019
Directional Power Sensor	NRT-Z44	835374/021	02.2019
Power Sensor	NRP-Z11	100265	12.2019

Dipole calibration period supporting data:

		Measured on 08/2019			Calibrated		
Dipole and serial number	**Frequency (MHz)**	**Return loss (dB)**	**Impedance (Ω)**		**Return loss (dB)**	**Impedance (Ω)**	
DIP 0G835-473 51/18	835	-28.88	49.34	3.52	-30.0	51.7	2.6
D2450V2	2450	-30.509	52.906	0.986	-25.75	51.2	5.1
D5GHZV2	5250	-24.806	53.238	4.9806	-21.94	55.91	6.17
D5GHZV2	5600	-25.653	45.702	-2.5419	-25.45	45	-0.09
D5GHZV2	5750	-22.603	55.036	5.9429	-24.13	55.43	3.64

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

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. 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 ±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.

Head 600-3000 MHz tissue simulant liquid Ingredients
Deionized Water, oil, emulsifiers, salt

4.4 System Validation Status

Frequency [MHz]	Dipole Type / SN	Probe Type / SN	Calibrated Signal Type	DAE Unit / SN	Dielectric Constant [ε] Head tissue simulant	Conductivity σ [S/m] Head tissue simulant	Validation Done
							Head tissue simulant
835	D835V2 - SN: 455	EX3DV4 - SN: 7447	CW	DAE 4 / 756	39.8	0.95	04.2019
2450	D2450V2 - SN: 729	EX3DV4 - SN: 7447	CW	DAE 4 / 756	40.10	1.93	04.2019
5250	D5GHzV2 - SN: 1045	EX3DV4 - SN: 7447	CW	DAE 4 / 756	34.00	4.80	04.2019
5600	D5GHzV2 - SN: 1045	EX3DV4 - SN: 7447	CW	DAE 4 / 756	33.20	5.20	04.2019
5750	D5GHzV2 - SN: 1045	EX3DV4 - SN: 7447	CW	DAE 4 / 756	32.90	5.30	04.2019

4.5 System Check

Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Input Power [mW]	Measured SAR_{1g} [W/kg]	1 W Target SAR_{1g} [W/kg]	1 W Normalized SAR_{1g} [W/kg]	Deviation 1g [%]	Plot #
10.2.2020	WB Head	22±2	**2450**	250	12.8	53.43	51.2	-4.2	1
11.2.2020	WB Head	22±2	**5250**	100	7.8	76.81	78	1.6	
11.2.2020	WB Head	22±2	**5600**	100	8.38	80.85	83.8	3.7	
11.2.2020	WB Head	22±2	**5750**	100	7.82	76.57	78.2	2.1	2
12.2.2020	WB Head	22±2	**5250**	100	7.87	76.81	78.7	2.5	3
12.2.2020	WB Head	22±2	**5600**	100	8.49	80.85	84.9	5.0	4
24.2.2020	WB Head	22±2	**835**	250	2.19	9.63	8.76	-9.0	5

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 (%)**
10.2.2020	**WB Head**	22	2412	39.3	1.77	38.9	1.79	-0.8	1.4
10.2.2020	**WB Head**	22	2437	39.2	1.79	38.9	1.81	-0.8	1.2
10.2.2020	**WB Head**	22	2450	39.2	1.80	38.9	1.82	-0.8	1.2
10.2.2020	**WB Head**	22	2462	39.2	1.81	38.9	1.83	-0.8	0.9
11.2.2020	**WB Head**	22	5250	35.9	4.71	34.7	4.60	-3.3	-2.3
11.2.2020	**WB Head**	22	5270	35.9	4.73	34.7	4.62	-3.4	-2.3
11.2.2020	**WB Head**	22	5600	35.5	5.07	34.1	4.99	-4.0	-1.5
11.2.2020	**WB Head**	22	5630	35.5	5.10	34.0	5.02	-4.1	-1.5
11.2.2020	**WB Head**	22	5750	35.4	5.22	33.8	5.16	-4.4	-1.1
11.2.2020	**WB Head**	22	5755	35.4	5.22	33.8	5.17	-4.4	-1.1
24.2.2020	**WB Head**	22	835	41.6	0.91	40.3	0.93	-3.0	1.7
24.2.2020	**WB Head**	22	902	41.5	0.97	40.1	0.95	-3.3	-2.2
24.2.2020	**WB Head**	22	914	41.5	0.98	40.1	0.95	-3.4	-2.2
24.2.2020	**WB Head**	22	927	41.5	0.98	40.1	0.96	-3.4	-2.3

5. TEST PROCEDURE

Test cases were agreed with FCC via an inquiry. On other parts the testing was carried out in accordance with FCC KDB Publications 447498 D01 and 248227 D0.

Photos of the test positions are presented in Appendix A.

5.1 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan with 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.

5.2 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 neighboring 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

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 SAR Results for Extremity Configuration:

WLAN 2.4GHz, 0mm separation distance:

Mode	Data Rate [Mbps]	Freq [MHz]	Channel	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR_{10g} [W/kg]	Power Drift [dB]*	Scaling Factor	Duty Cycle	Reported SAR10g [W/kg]	Plot #
802.11b	1	2412	1	Left	18.5	17.6	0.253	0.55	1.40	1:1	0.35	6
802.11b	1	2437	6	Left	18.5	17.22	0.159	0.59	1.54	1:1	0.24	
802.11b	1	2462	11	Left	18.5	17.97	0.131	0.38	1.23	1:1	0.16	

*Larger than 5% drifts included to scaling factors

WLAN 5GHz, 0mm separation distance:

Mode	Data Rate [Mbps]	Freq [MHz]	Channel	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR_{10g} [W/kg]	Power Drift [dB]*	Scaling Factor	Duty Cycle	Reported SAR10g [W/kg]	Plot #
802.11n HT40	13.5	5270	54	Left	17.5	19.5	1.5	0.12	1	1:1	1.5	7
802.11n HT40	13.5	5630	126	Left	17.5	20.29	0.75	0.04	1	1:1	0.75	8
802.11n HT40	13.5	5755	151	Left	17.5	20.04	0.40	-0.18	1	1:1	0.40	9

UHF, 20mm separation distance:

Mode	Freq [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR_{10g} [W/kg]	Power Drift [dB]*	Scaling Factor	Duty Cycle	Reported SAR10g [W/kg]	Plot #
UHF	914.75	Top	30	28.0	0.352	0.01	1.58	1:1	0.56	10

The pictures of the test positions are presented in appendix A.

7.2 Simultaneous Transmission Analysis

Simultaneous transmission analysis for maximum WLAN SAR and maximum UHF SAR is in a table below. Direct summation of SAR results was performed.

Exposure condition	Extremity SAR_{10g} [W/kg]
WLAN 2.4GHz	0.35
WLAN 5GHz	1.5
Maximum WLAN SAR	1.5
Maximum UHF SAR	0.56
SAR Summation	**2.06**

APPENDIX A: PHOTOS OF THE DUT

Size of the device is: H:212 x W:83/72 x D:133/29 mm

Front of the device


Side of the device

Top of the device

The left side of the device against the phantom with 0mm separation for WLAN testing

RFID reader's top side against the phantom with 20mm separation distance.

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 10.2.2020 11:54:09

Test Laboratory: Verkotan Oy

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2;

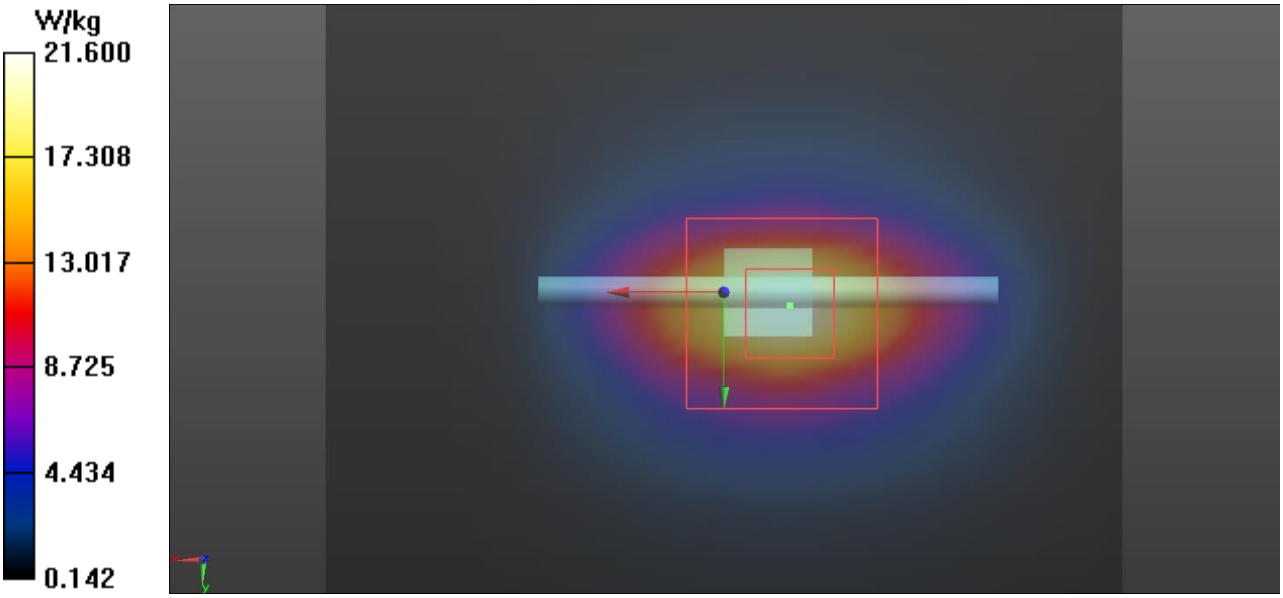
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 1.821 S/m; ε_r = 38.894; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.03, 8.03, 8.03); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

system check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 102.9 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 26.5 W/kg
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.97 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 21.6 W/kg

system check/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 22.8 W/kg



Date/Time: 11.2.2020 11:18:05

Test Laboratory: Verkotan Oy

DUT: Dipole D5GHzV2; Type: D5GHzV2;

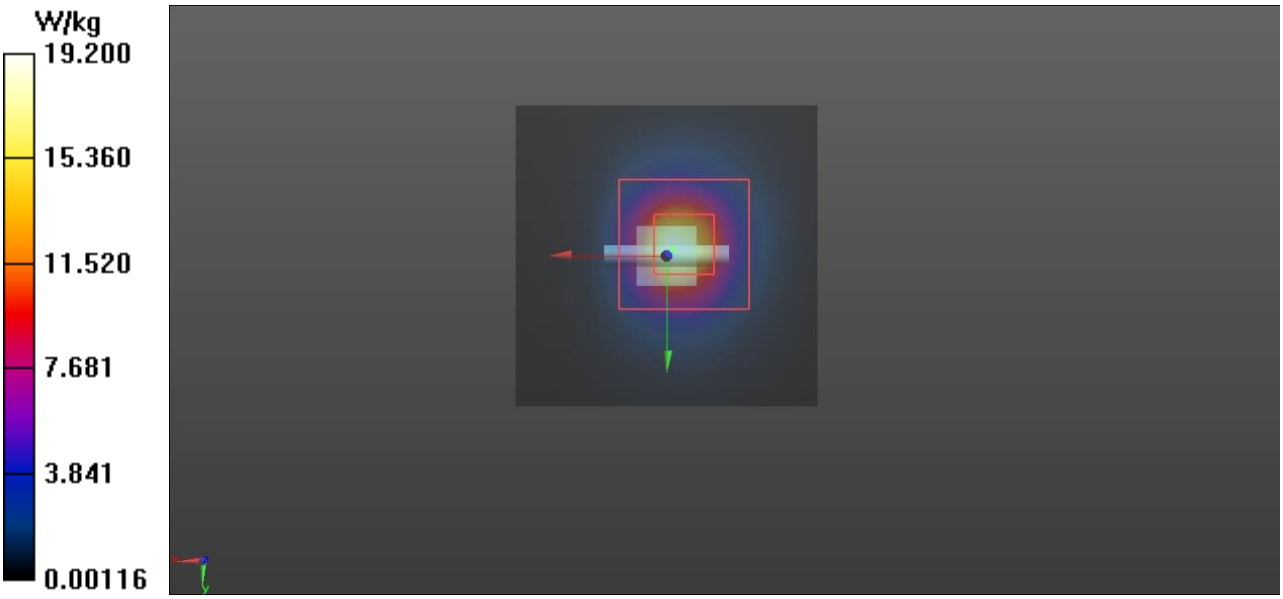
Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5750 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5750 MHz; σ = 5.16 S/m; ε_r = 33.819; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.75, 4.75, 4.75); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 25.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

5750 system check/Zoom Scan (9x9x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 64.89 V/m; Power Drift = 0.28 dB
Peak SAR (extrapolated) = 33.0 W/kg
SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.23 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 19.2 W/kg

5750 system check/Area Scan (51x51x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 25.0 W/kg



Date/Time: 12.2.2020 16:19:36

Test Laboratory: Verkotan Oy

DUT: Dipole D5GHzV2; Type: D5GHzV2;

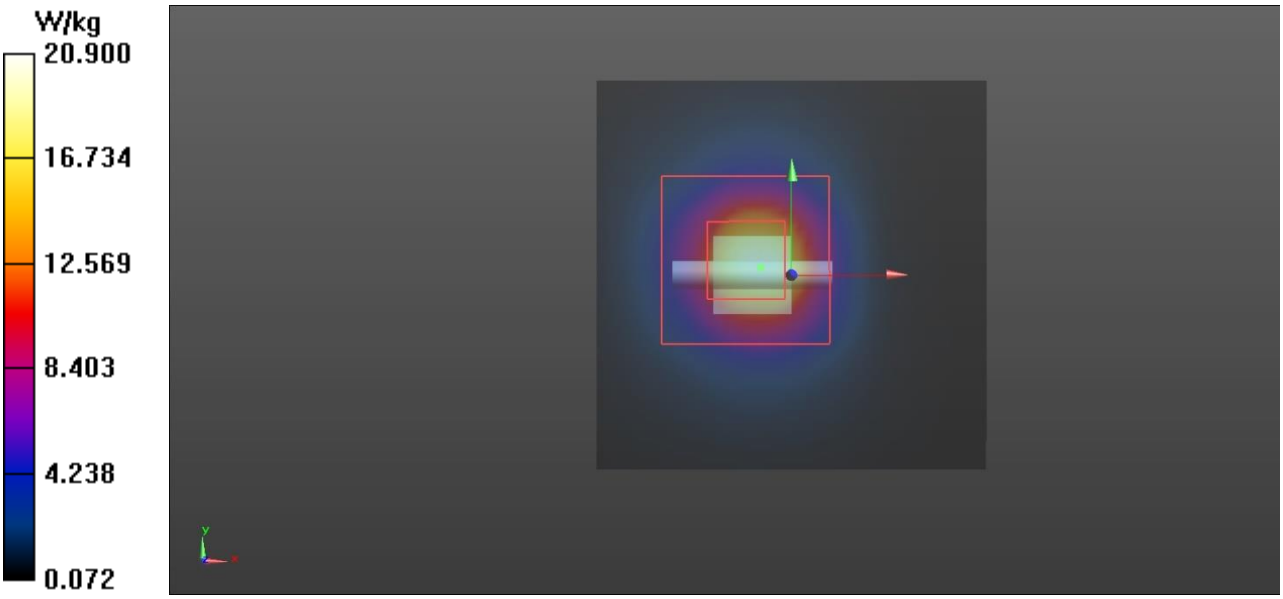
Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5250 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5250 MHz; σ = 4.598 S/m; ε_r = 34.743; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(5.2, 5.2, 5.2); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

5250 system check 2/Area Scan (51x51x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 20.9 W/kg

5250 system check 2/Zoom Scan (9x9x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 57.83 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 33.6 W/kg
SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.24 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 20.1 W/kg



Date/Time: 12.2.2020 16:45:35

Test Laboratory: Verkotan Oy

DUT: Dipole D5GHzV2; Type: D5GHzV2

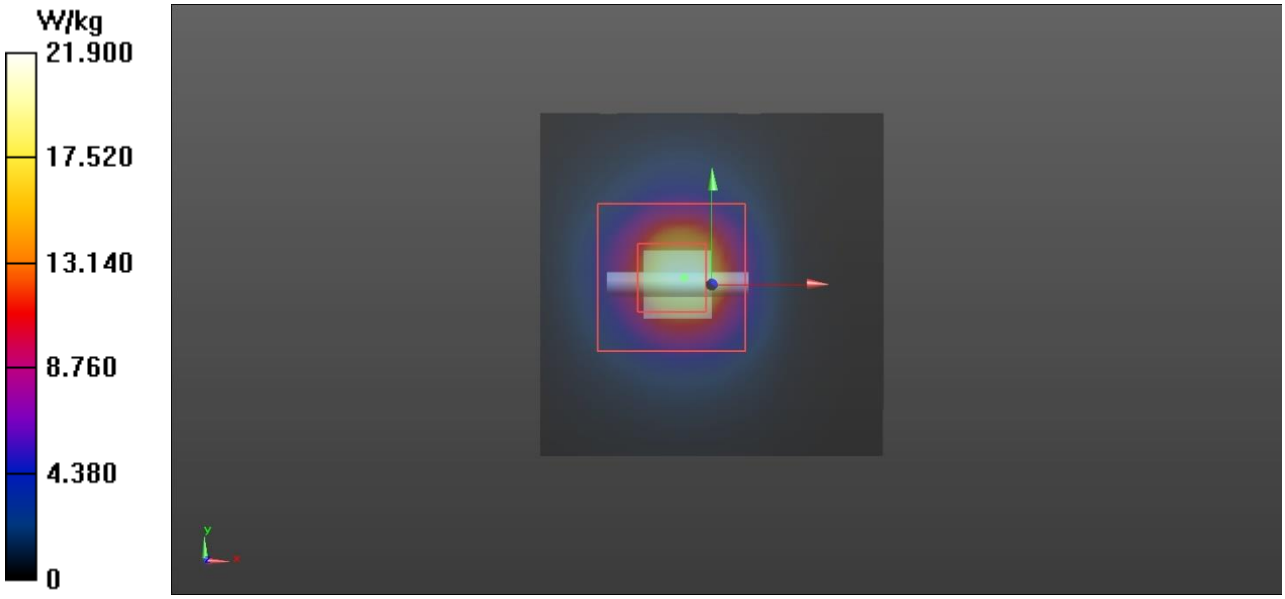
Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5600 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5600 MHz; σ = 4.987 S/m; ε_r = 34.093; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.61, 4.61, 4.61); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 25.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

5600 system check 2 2/Zoom Scan (9x9x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 59.59 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 39.6 W/kg
SAR(1 g) = 8.49 W/kg; SAR(10 g) = 2.42 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 21.9 W/kg

5600 system check 2 2/Area Scan (51x51x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 23.7 W/kg



Plot 5

Date/Time: 24.2.2020 10:09:01

Test Laboratory: Verkotan Oy

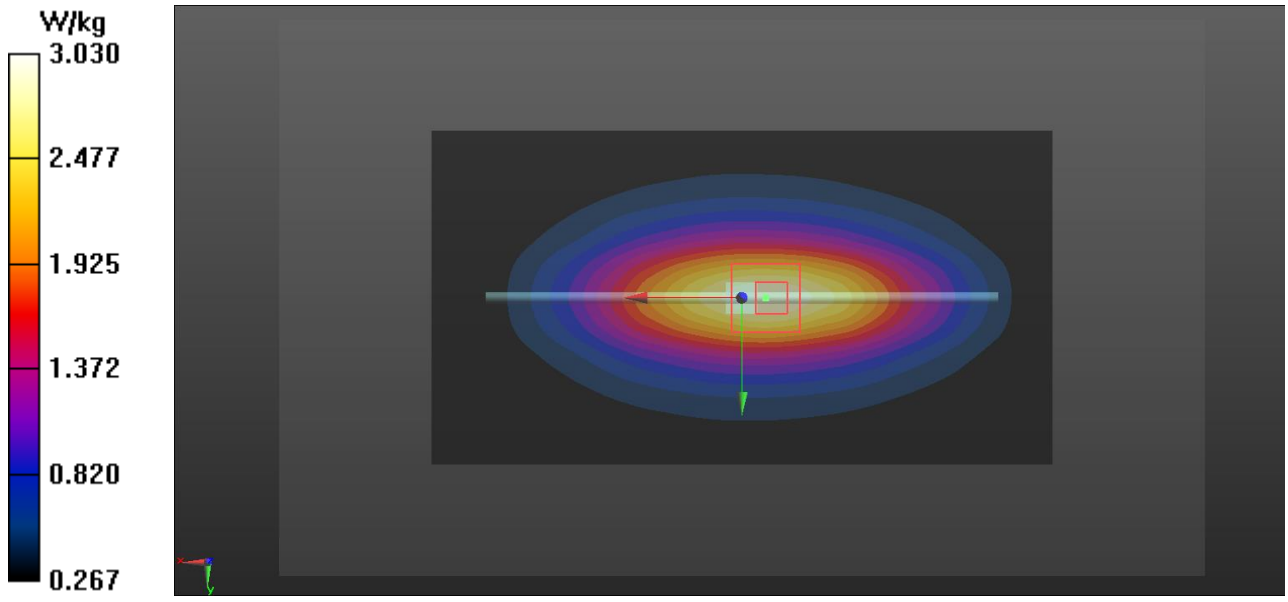
DUT: Dipole 835 MHz D835V2; Type: D835V2

Communication System: UID 0, CW (0); Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 835 MHz; σ = 0.926 S/m; ε_r = 40.301; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.17, 10.17, 10.17); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System check/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 61.39 V/m; Power Drift = -0.36 dB
Peak SAR (extrapolated) = 3.40 W/kg
SAR(1 g) = 2.19 W/kg; SAR(10 g) = 1.44 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 3.03 W/kg
System check/Area Scan (131x71x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.03 W/kg



APPENDIX C: MEASUREMENT SCAN

Plot 6

Date/Time: 10.2.2020 18:03:33

Test Laboratory: Verkotan Oy

DUT: HH83

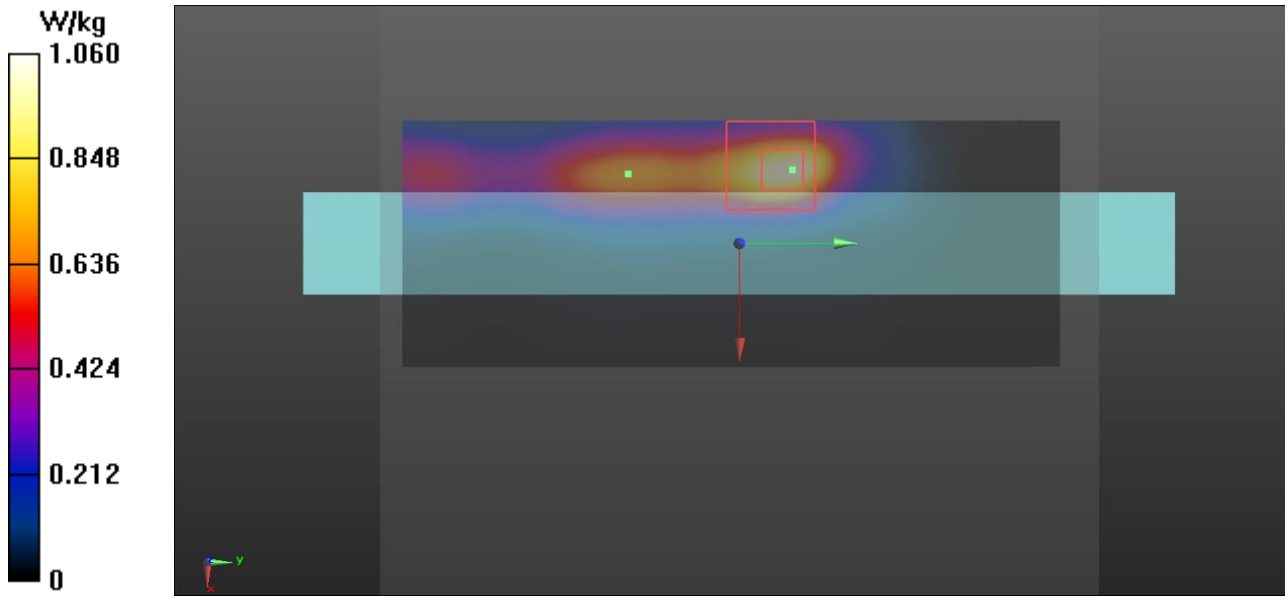
Communication System: UID 0, WLAN 2.4 (0); Communication System Band: WLAN2.4GHz; Frequency: 2412 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2412 MHz; σ = 1.792 S/m; ε_r = 38.949; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.03, 8.03, 8.03); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (61x171x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.06 W/kg

Zoom Scan (7x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.109 V/m; Power Drift = 0.55 dB
Peak SAR (extrapolated) = 1.18 W/kg
SAR(1 g) = 0.552 W/kg; SAR(10 g) = 0.253 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.930 W/kg



Date/Time: 11.2.2020 16:02:15

Test Laboratory: Verkotan Oy

DUT: HH83

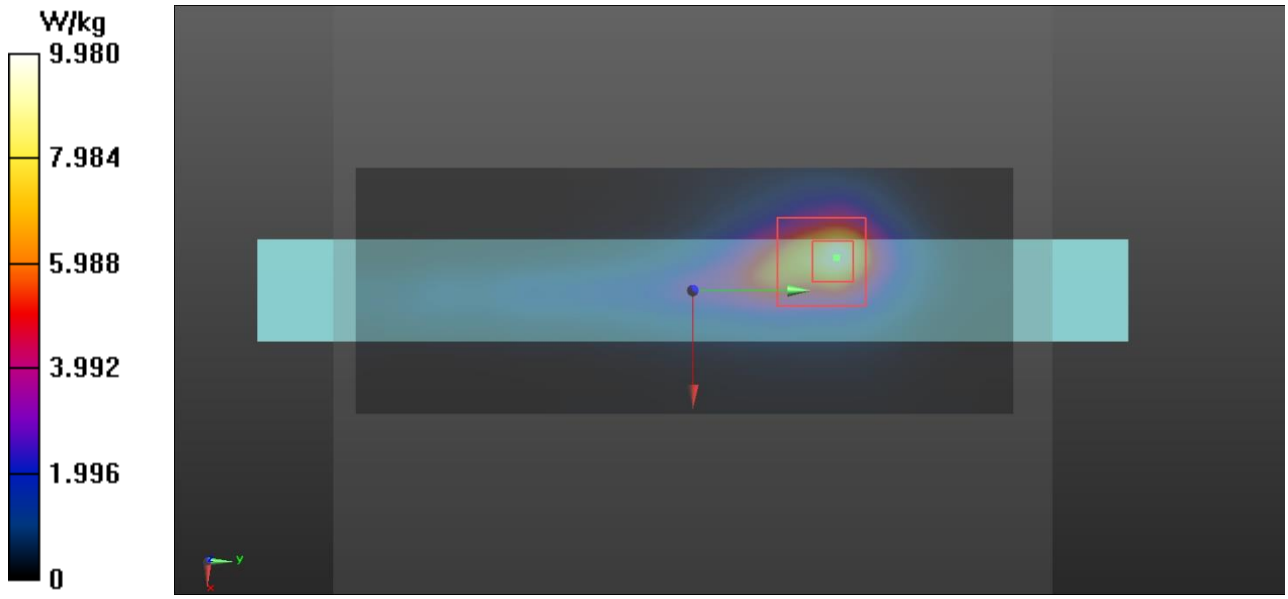
Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5270 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used: f = 5270 MHz; σ = 4.618 S/m; ε_r = 34.699; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(5.2, 5.2, 5.2); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (61x171x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 9.98 W/kg

Zoom Scan (9x9x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 17.98 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 17.5 W/kg
SAR(1 g) = 4.39 W/kg; SAR(10 g) = 1.5 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 10.8 W/kg



Date/Time: 11.2.2020 16:44:30

Test Laboratory: Verkotan Oy

DUT: HH83

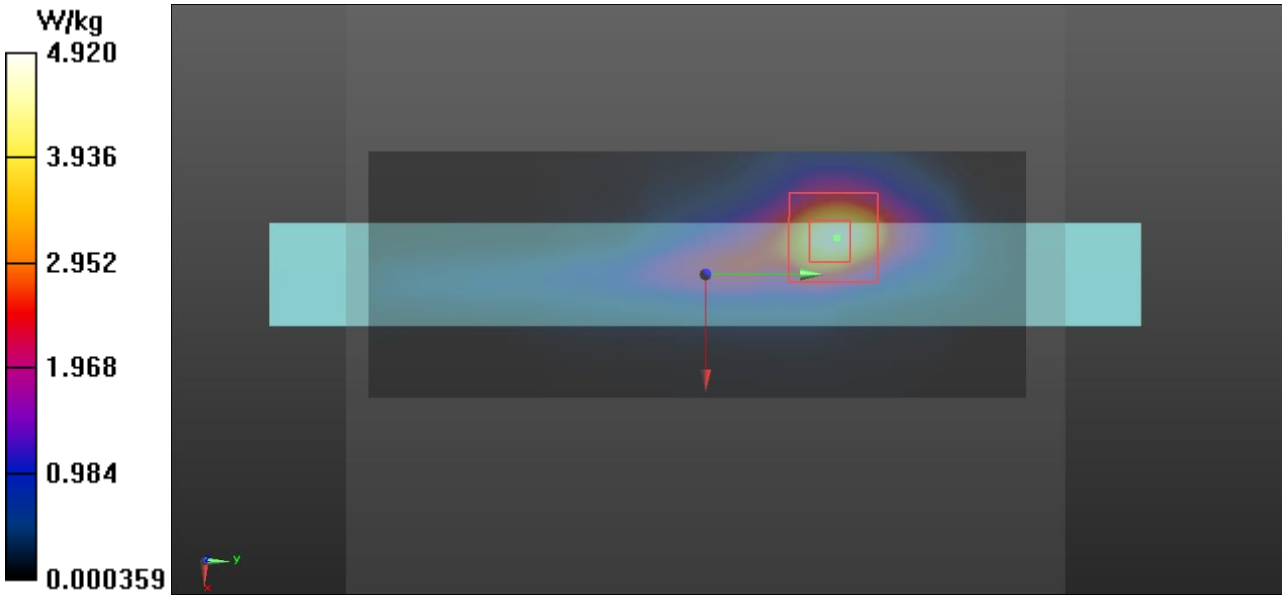
Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5630 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used: f = 5630 MHz; σ = 5.021 S/m; ε_r = 34.04; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.61, 4.61, 4.61); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 25.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Zoom Scan (9x9x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 13.48 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 7.89 W/kg
SAR(1 g) = 2.11 W/kg; SAR(10 g) = 0.751 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 4.92 W/kg

Area Scan (61x171x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 4.78 W/kg



Date/Time: 12.2.2020 10:17:40

Test Laboratory: Verkotan Oy

DUT: HH83

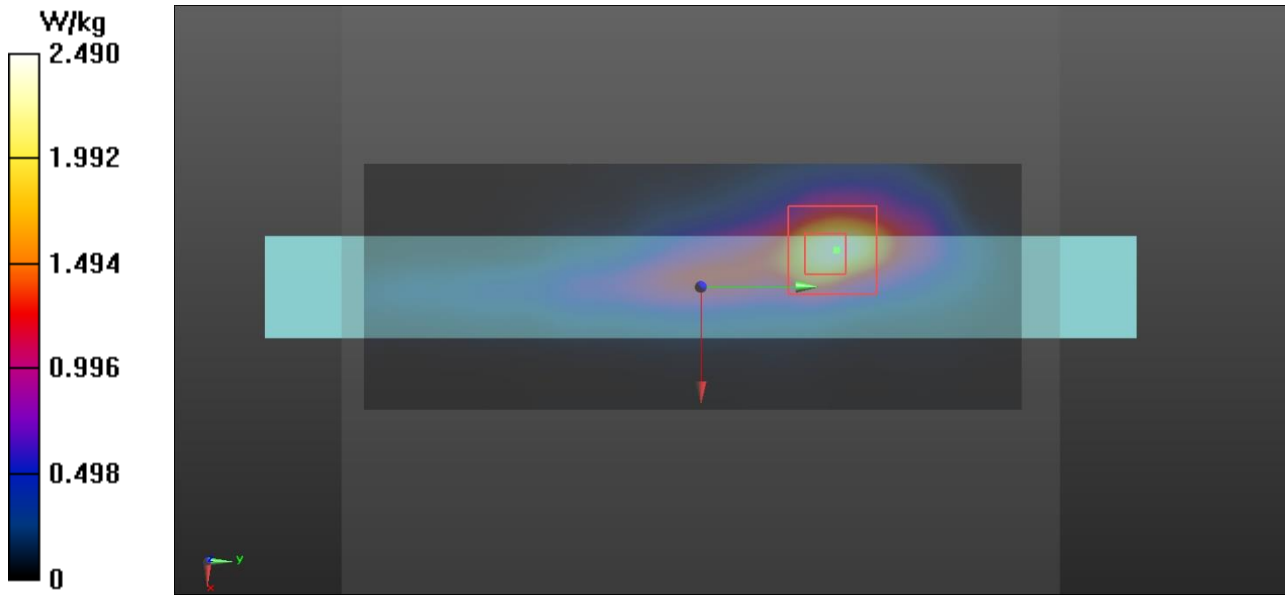
Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5755 MHz;Communication System PAR: 0 dB; PMF: 1.12202e-005
Medium parameters used (interpolated): f = 5755 MHz; σ = 5.166 S/m; ε_r = 33.806; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.75, 4.75, 4.75); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 25.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Zoom Scan (9x9x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 10.91 V/m; Power Drift = -0.18 dB
Peak SAR (extrapolated) = 4.17 W/kg
SAR(1 g) = 1.1 W/kg; SAR(10 g) = 0.401 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 2.49 W/kg

Area Scan (61x171x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 2.58 W/kg



Plot 10

Date/Time: 24.2.2020 11:49:57

Test Laboratory: Verkotan Oy

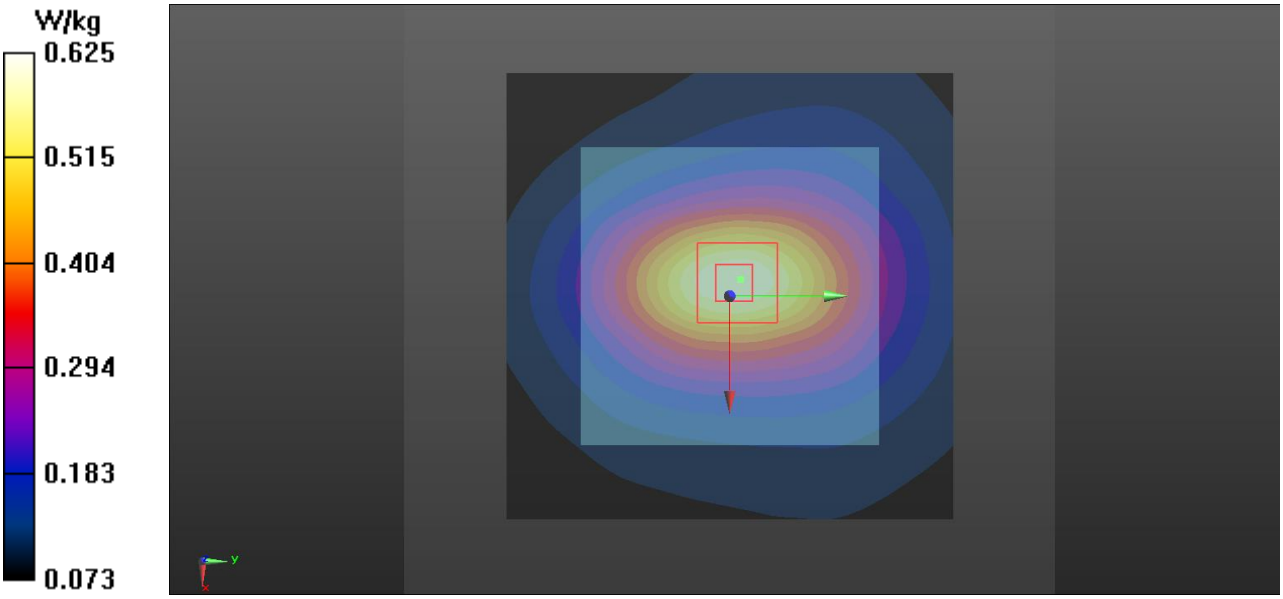
DUT: HH83

Communication System: UID 0, CW (0); Communication System Band: RFID; Frequency: 914.75 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 915 MHz; σ = 0.955 S/m; ε_r = 40.089; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(10.17, 10.17, 10.17); Calibrated: 25.3.2019;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 15.4.2019
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: xxxx
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Mid/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 23.33 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.687 W/kg
SAR(1 g) = 0.503 W/kg; SAR(10 g) = 0.352 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.625 W/kg
Mid/Area Scan (81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.638 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION

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
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client: Verkotan

Certificate No: EX3-7447_Mar19

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:7447

Calibration procedure(s): QA CAL-01.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7
Calibration procedure for dosimetric E-field probes

Calibration date: March 25, 2019

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
DAE4	SN: 660	19-Dec-18 (No. DAE4-660_Dec18)	Dec-19
Reference Probe ES3DV2	SN: 3013	31-Dec-18 (No. ES3-3013_Dec18)	Dec-19
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

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

Issued: March 26, 2019

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7447

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.41	0.42	0.42	± 10.1 %
DCP (mV)[B]	94.3	96.1	98.8	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	162.0	±2.5 %	± 4.7 %
		Y	0.0	0.0	1.0		168.4		
		Y	0.0	0.0	1.0		164.6		

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7447

Calibration Parameter Determined in Head Tissue Simulating Media

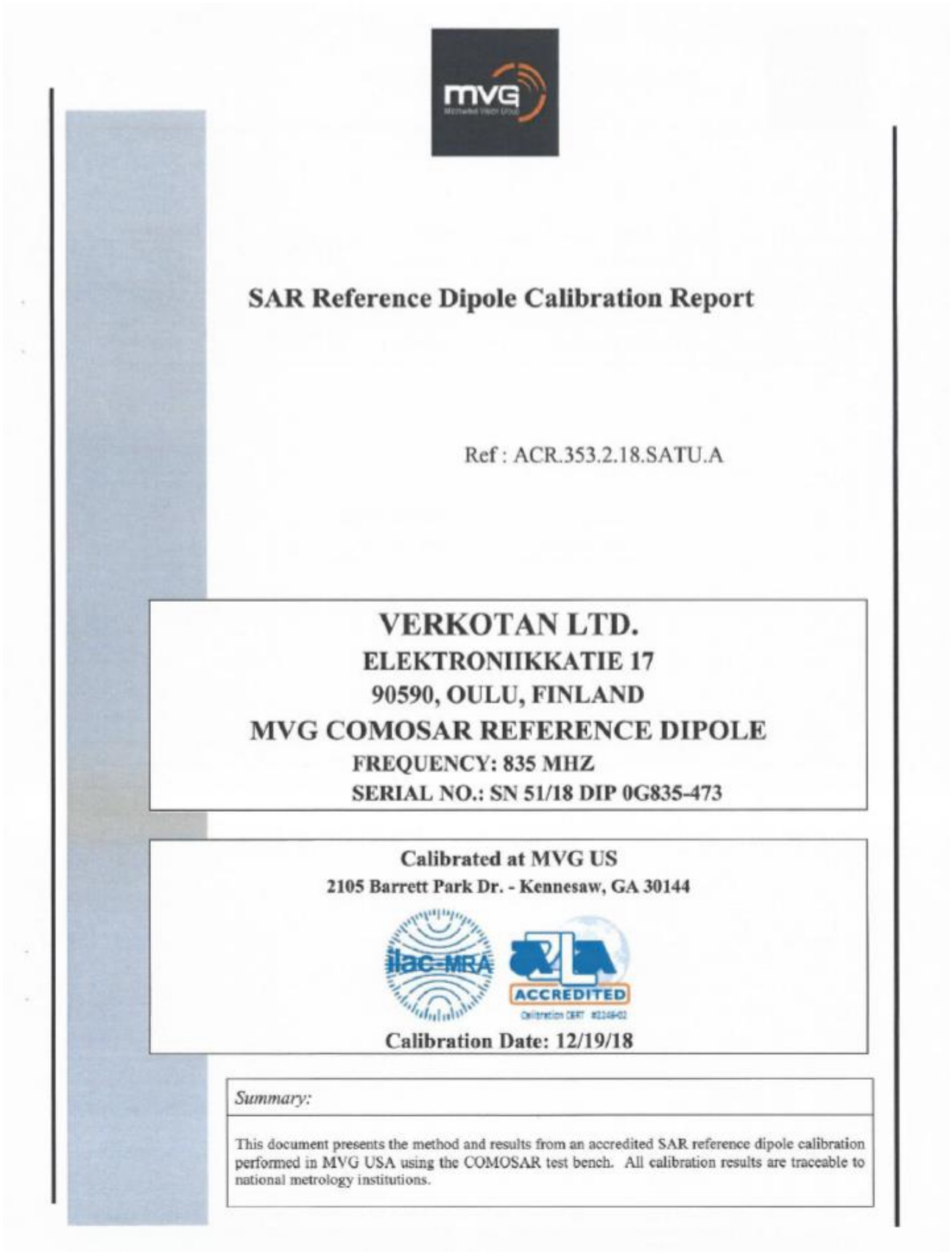
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	41.9	0.89	10.78	10.78	10.78	0.35	0.93	± 12.0 %
900	41.5	0.97	10.17	10.17	10.17	0.44	0.85	± 12.0 %
1750	40.1	1.37	8.90	8.90	8.90	0.32	0.84	± 12.0 %
1950	40.0	1.40	8.85	8.85	8.85	0.29	0.85	± 12.0 %
2150	39.7	1.53	8.78	8.78	8.78	0.28	0.86	± 12.0 %
2300	39.5	1.67	8.58	8.58	8.58	0.29	0.88	± 12.0 %
2450	39.2	1.80	8.03	8.03	8.03	0.32	0.86	± 12.0 %
2600	39.0	1.96	7.76	7.76	7.76	0.25	1.06	± 12.0 %
5250	35.9	4.71	5.20	5.20	5.20	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.61	4.61	4.61	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.75	4.75	4.75	0.40	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. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. 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.353.2.18.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 835 MHZ
SERIAL NO.: SN 51/18 DIP 0G835-473

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

ACCREDITED

Calibration Date: 12/19/18

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.

1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

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

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56	9.63 (0.96)	6.22	6.19 (0.62)
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	

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

ACCREDITED

Calibration Date: 06/14/17

Summary:

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

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

	Customer Name
Distribution :	Verkotan Ltd.

Issue	Date	Modifications
A	6/14/2017	Initial release

1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %	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 %	

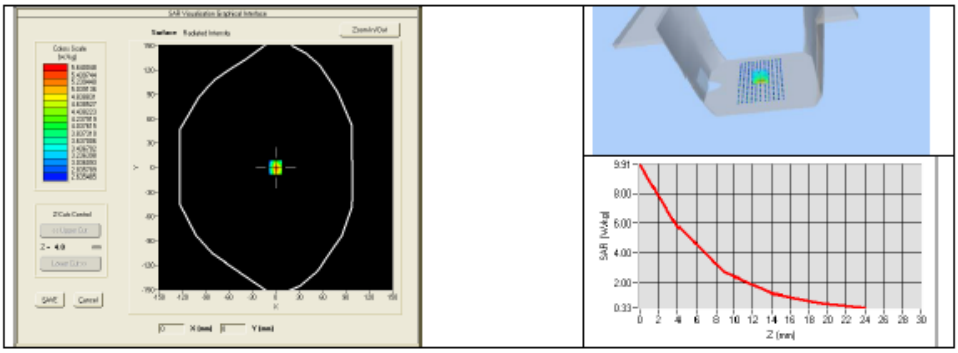
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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 %	

SAR Reference Dipole Calibration Report

Ref : ACR.165.33.17.SATU.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 5000 MHZ
SERIAL NO.: D5GHZV2-1045

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

Calibration Date: 06/14/17

Summary:

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

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

	Customer Name
Distribution :	Verkotan Ltd.

Issue	*Date*	*Modifications*
A	6/14/2017	Initial release

900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	
1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
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 %	
5000	36.2 ±10 %		4.45 ±10 %	
5100	36.1 ±10 %		4.56 ±10 %	
5200	36.0 ±10 %		4.66 ±10 %	
5300	35.9 ±10 %		4.76 ±10 %	
5400	35.8 ±10 %		4.86 ±10 %	
5500	35.6 ±10 %		4.97 ±10 %	
5600	35.5 ±10 %	PASS	5.07 ±10 %	PASS
5700	35.4 ±10 %		5.17 ±10 %	
5800	35.3 ±10 %		5.27 ±10 %	
5900	35.2 ±10 %		5.38 ±10 %	
6000	35.1 ±10 %		5.48 ±10 %	

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 5250 MHz: eps' :35.46 sigma : 4.69 Head Liquid Values 5600 MHz: eps' :36.66 sigma : 5.17 Head Liquid Values 5750 MHz: eps' :35.55 sigma : 5.30
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=4mm/dy=4mm/dz=2mm
Frequency	5250 MHz 5600 MHz

	5750 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		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
5200	76.5		21.6	
5250	-	76.81 (7.68)	-	22.78 (2.28)
5500	83.3		23.4	
5600	-	80.85 (8.08)	-	23.65 (2.36)
5750	-	76.57 (7.66)	-	22.51 (2.25)
5800	78.0		21.9	