

SAR Compliance Test Report

Date of Report	22/03/2021	Client's Contact person:	Gabriele Isola
Number of pages:	39	Responsible Test engineer:	Ilari Kinnunen
Testing laboratory:	Verkotan Oy Elektroniikkatie 17 90590 Oulu Finland	Client:	CAEN RFID srl Via Vetraria, 11 55049 Viareggio Italy
Tested device	skID R1280I		
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:

22.03.2021

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Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Equipment under Test (DUT):

Product:	skID
Manufacturer:	CAEN RFID
Model:	R1280I
Serial Number:	0001000120400417, 0001000120400413, 0001000120400410
FCC ID Number:	UVECAENRFID032
DUT Number:	22247, 22248, 22249
Battery Type used in testing:	Li-Ion Battery
State of the Sample	Production sample

Testing information:

Testing performed:	03.03. – 09.03.2021
Notes:	-
Document ID:	FCC SAR Report_skID R1280I_ID4630_22032021.pdf
Document history and changes	This report replaces FCC SAR Report_skID R1280I_ID4630_11032021 . Maximum specified conducted output power set to 29.1dBm and normal mode duty cycle of 66.8% has been applied to RFID.
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Ilari Kinnunen

1.2 Maximum Results

The maximum reported* SAR values 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 Standalone SAR

System	Highest Reported* SAR _{10g} (W/kg) in Extremity Condition, 0mm	Result
RFID	3.19	PASS
Bluetooth	0.21	PASS

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

1.2.2 Simultaneous Transmission SAR

Highest Simultaneous Transmission SAR	Highest Reported* SAR _{10g} (W/kg) in Extremity Condition	Result
RFID + Bluetooth	3.40	PASS

1.2.3 Maximum Drift

Maximum Drift During Measurements	-0.62dB*
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*Larger than 5% drifts included to scaling factors

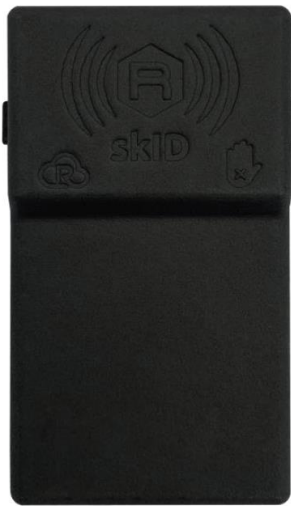
1.2.4 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	±22.2 %
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2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is a portable RAIN RFID reader of the easy2read© product line with integrated antenna for medium range applications. The reader hosts an internal rechargeable battery and can operate both in wired mode, using a USB cable, or in wireless mode through the Bluetooth® interface.

During normal use, the DUT is utilizing maximum duty cycle of 66.8% for RFID. SAR testing for RFID and Bluetooth was conducted with 100% duty cycle i.e. continuous transmission. Thus, the measured SAR results were scaled with the normal mode duty cycle of 66.8% for RFID.



Device Category	Portable
Exposure Environment	General population

2.1 Supported Frequency Bands and Operational Modes

TX Frequency bands	Modes of Operation	Transmitter Frequency Range [MHz]
	RFID	902.75 – 927.25 MHz
	Bluetooth	2400 – 2483.5 MHz

2.2 Simultaneous transmission

RFID and Bluetooth can be operated simultaneously.

3. OUTPUT POWER

3.1 Maximum specified conducted output power

From the customer, including tune-up tolerances;

Mode	Max Output Power [dBm]
RFID	29.1

Bluetooth	Max Output Power [dBm]
Bluetooth	12.0

3.2 Tested conducted power

Mode	Max Output Power [dBm]		
	902.75 MHz	915.25 MHz	927.25 MHz
RFID	27.1	27.0	26.97

Mode	Max Output Power [dBm]		
	2402 MHz	2440 MHz	2480 MHz
Bluetooth	9.59	9.55	9.92

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.

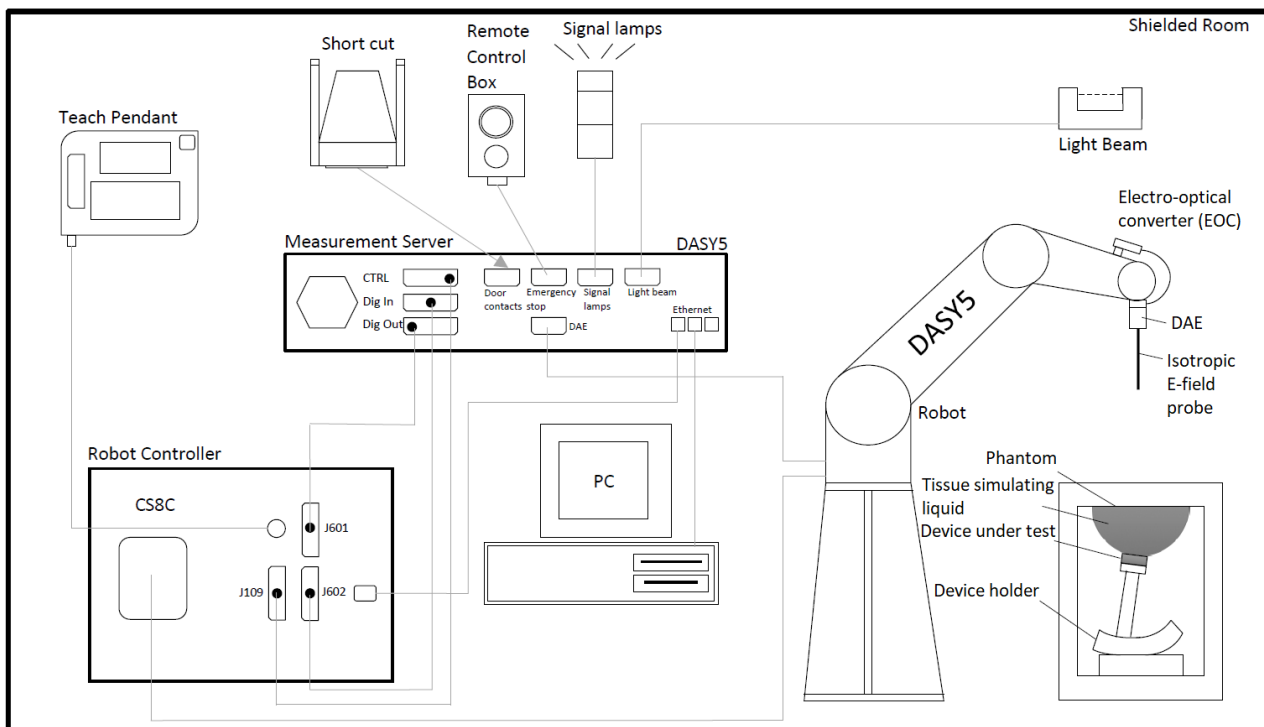


Figure 1 Schematic Laboratory Picture

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	756	03.2020
Probe	EX3DV4	7447	03.2020
Probe	EX3DV4	3892	04.2020
Dipole	D835V2	448	03.2020
Dipole	D2450V2	758	03.2020
DASY5 Software	52.8.8.1258	-	NA
Signal Generator	E4438C	MY42082527	NA
Amplifier	BLMA 0842-10	1912417	NA
Power meter	NRT	835065/049	02.2021
Directional Power Sensor	NRT-Z44	835374/021	02.2021
Power Sensor	NRP-Z11	100265	12.2020

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 μ W/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

Modular flat phantom:

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. The shell thickness of the bottom plate is 2 ± 0.2 mm. The dimensions are 308x192x182 mm and filling volume is 9.2 liters giving a filling height of 155 mm.

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 $\pm 10\%$ of the recommended values. 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.

Tissue simulant liquid Ingredients
Deionized Water, oil, salt, emulsifiers

4.4 System Validation Status

Frequency [MHz]	Dipole Type / SN	Probe Type / SN	Calibrated Signal Type	DAE Unit / SN	Dielectric Constant ϵ	Conductivity, σ [S/m]	Validation Done
							Head tissue simulant
835	51/18 DIP 0G835-473	EX3DV4 / 7447	CW/GMSK	DAE 4 / 756	40.962	0.887	6.4.2020
835	D835V2 / 448	EX3DV4 / 3892	CW/GMSK	DAE 4 / 705	42.032	0.946	7.5.2020
2450	D2450V2 / 729	EX3DV4 / 7447	CW/DSSS	DAE 4 / 756	39.503	1.858	2.4.2020

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 (%)	Plot #
3.3.2021	WB Head	22	835	250	2.26	9.38	9.04	-3.6	1
4.3.2021	WB Head	22	2450	250	13.4	55.34	53.6	-3.1	2
9.3.2021	WB Head	22	835	250	2.28	9.38	9.12	-2.8	3

4.5.1 Tissue Simulant Verification

				Target		Measured		Deviation	
Date	Tissue Type	Tissue Temp [°C]	Frequency [MHz]	Dielectric Constant [ε] Target	Conductivity σ [S/m] Target	Dielectric Constant [ε]	Conductivity σ [S/m]	ε (%)	σ (%)
2.3.2021	WB Head	22	835	41.55	0.91	43.24	0.94	4.1	3.5
2.3.2021	WB Head	22	903	41.50	0.97	43.07	0.97	3.8	-0.3
2.3.2021	WB Head	22	915	41.48	0.98	43.04	0.97	3.8	-0.5
2.3.2021	WB Head	22	927	41.46	0.98	43.01	0.98	3.7	-0.5
4.3.2021	WB Head	22	2402	39.29	1.76	40.05	1.84	2.0	4.8
4.3.2021	WB Head	22	2440	39.22	1.79	39.99	1.87	2.0	4.5
4.3.2021	WB Head	22	2450	39.20	1.80	39.98	1.88	2.0	4.5
4.3.2021	WB Head	22	2480	39.16	1.83	39.93	1.90	2.0	3.9
8.3.2021	WB Head	22	2440	39.29	1.76	40.01	1.84	1.8	4.7
9.3.2021	WB Head	22	835	41.55	0.91	42.18	0.93	1.5	2.6
9.3.2021	WB Head	22	915	41.48	0.98	41.97	0.96	1.2	-1.4

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publications 447498 D01.

Since the device is held in hand, Extremity SAR was tested from all sides of the device at 0mm separation distance. The part of the DUT that contains the RFID antenna (shown in the picture below) was not measured because in user manual it is insisted not to cover the antenna with hand, there is also a clear indicator on the DUT.



A control software was used to set the DUT to transmit at maximum power.

5.1 Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the Dasy system.



Device holder supplied by SPEAG

5.2 Test Positions

5.2.1 Extremity Condition, 0mm separation distance

Extremity SAR was tested from all sides of the device. The device was placed in the SPEAG device holder and lifted towards the phantom until the distance between the phantom and the device was 0mm.

Photos of the test positions are presented in appendix A.

5.3 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan was performed around the highest E-field value to determine the averaged SAR value. 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 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 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	√ ₂	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	√ ₂	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	√ ₂	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	√ ₂	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	√ ₂	1	1	±0.6 %	±0.6 %	∞
Modulation Response ^m	±2.4 %	R	√ ₂	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	√ ₂	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	√ ₂	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	√ ₂	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	√ ₂	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	√ ₂	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	√ ₂	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±2.0 %	R	√ ₂	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	√ ₂	1	1	±2.9 %	±2.9 %	∞
Power Scaling ^p	±0 %	R	√ ₂	1	1	±0.0 %	±0.0 %	∞
Phantom and Setup								
Phantom Uncertainty	±6.1 %	R	√ ₂	1	1	±3.5 %	±3.5 %	∞
SAR correction	±1.9 %	R	√ ₂	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.) ^{DAK}	±2.5 %	R	√ ₂	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.) ^{DAK}	±2.5 %	R	√ ₂	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity ^{BB}	±3.4 %	R	√ ₂	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity ^{BB}	±0.4 %	R	√ ₂	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 Extremity Condition with 0mm separation

Mode	Frequency [MHz]	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]*	Test Position	Test Duty Cycle	Measured SAR _{10g} [W/kg]	Scaling Factor	Normal Duty Cycle [%]	Reported SAR _{10g} [W/kg]	Plot #
RFID	915.25	29.1	27.0	-0.04	Front	1:1	2.94	1.62	66.8	3.19	4
RFID	915.25	29.1	27.0	-0.62	Back	1:1	0.645	1.87	66.8	0.81	
RFID	915.25	29.1	27.0	-0.5	Left	1:1	1.81	1.82	66.8	2.20	
RFID	915.25	29.1	27.0	-0.38	Right	1:1	1.22	1.77	66.8	1.44	
RFID	915.25	29.1	27.0	-0.25	Top	1:1	1.17	1.72	66.8	1.34	
RFID	915.25	29.1	27.0	-0.09	Bottom	1:1	0.19	1.62	66.8	0.21	
RFID	902.75	29.1	27.1	0	Front	1:1	1.26	1.58	66.8	1.33	
RFID	927.25	29.1	26.97	-0.06	Front	1:1	0.956	1.63	66.8	1.04	

*Larger than 5% drifts included to scaling factors

RFID repeated measurement:

Mode	Frequency [MHz]	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]*	Test Position	Test Duty Cycle	Measured SAR _{10g} [W/kg]	Scaling Factor	Normal Duty Cycle [%]	Reported SAR _{10g} [W/kg]	Plot #
RFID	915.25	29.1	27.0	-0.16	Front	1:1	2.92	1.62	66.8	3.16	

*Larger than 5% drifts included to scaling factors

Mode	Frequency [MHz]	Maximum Power [dBm]	Conducted Power [dBm]	Power Drift [dB]*	Test Position	Duty Cycle	Measured SAR _{10g} [W/kg]	Scaling Factor	Reported SAR _{10g} [W/kg]	Plot #
Bluetooth	2440	12	9.55	0.01	Front	1:1	0.118	1.76	0.21	5
Bluetooth	2440	12	9.55	0.2	Back	1:1	0.0403	1.76	0.07	
Bluetooth	2440	12	9.55	N/A**	Left	1:1	0.00856	1.76	0.02	
Bluetooth	2440	12	9.55	-0.03	Right	1:1	0.0987	1.76	0.17	
Bluetooth	2440	12	9.55	0.04	Top	1:1	0.00544	1.76	0.01	
Bluetooth	2440	12	9.55	0.05	Bottom	1:1	0.00421	1.76	0.01	

*Larger than 5% drifts included to scaling factors

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

7.2 Simultaneous Transmission Analysis

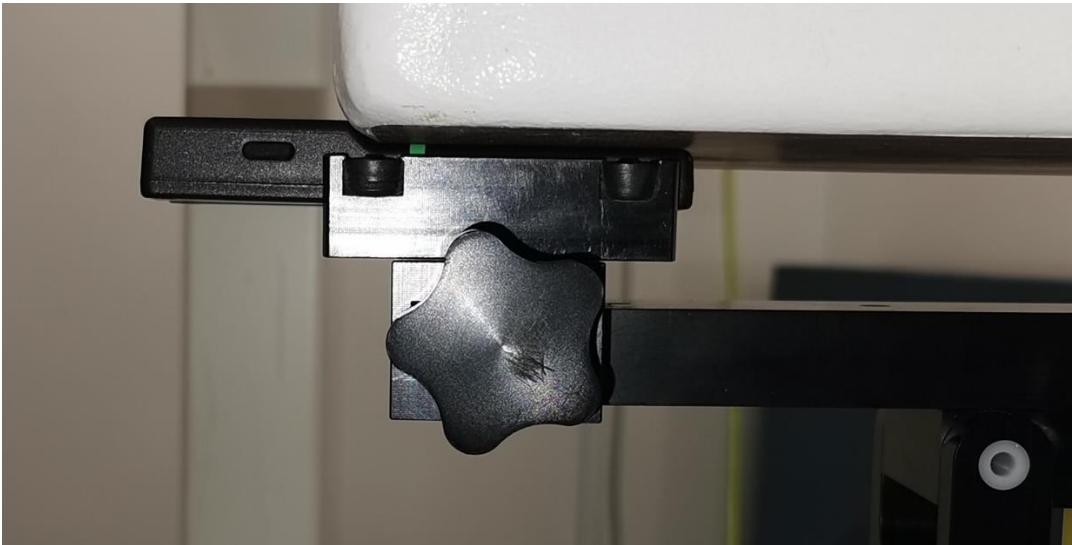
Simultaneous transmission analysis for the maximum RFID SAR and the maximum Bluetooth SAR is in the table below. Direct summation of SAR results was performed.

Transmission Mode	Exposure Condition
	Maximum Extremity SAR _{10g} [W/kg]
Maximum RFID SAR	3.19
Maximum BT SAR	0.21
SAR Summation:	3.40

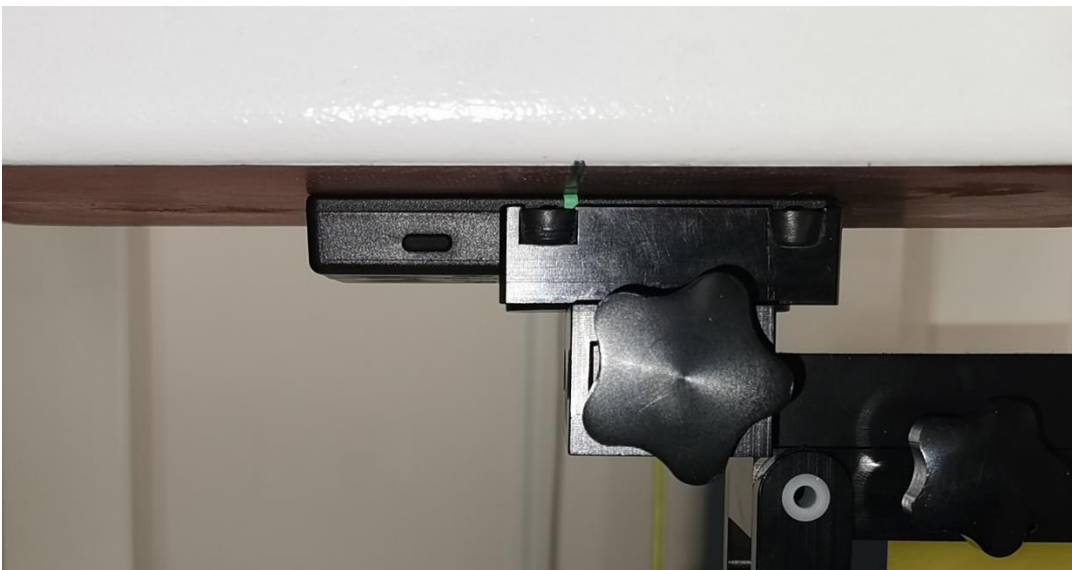
APPENDIX A: PHOTOS OF THE DUT

Size of the DUT is: 112 x 62 x 16 mm





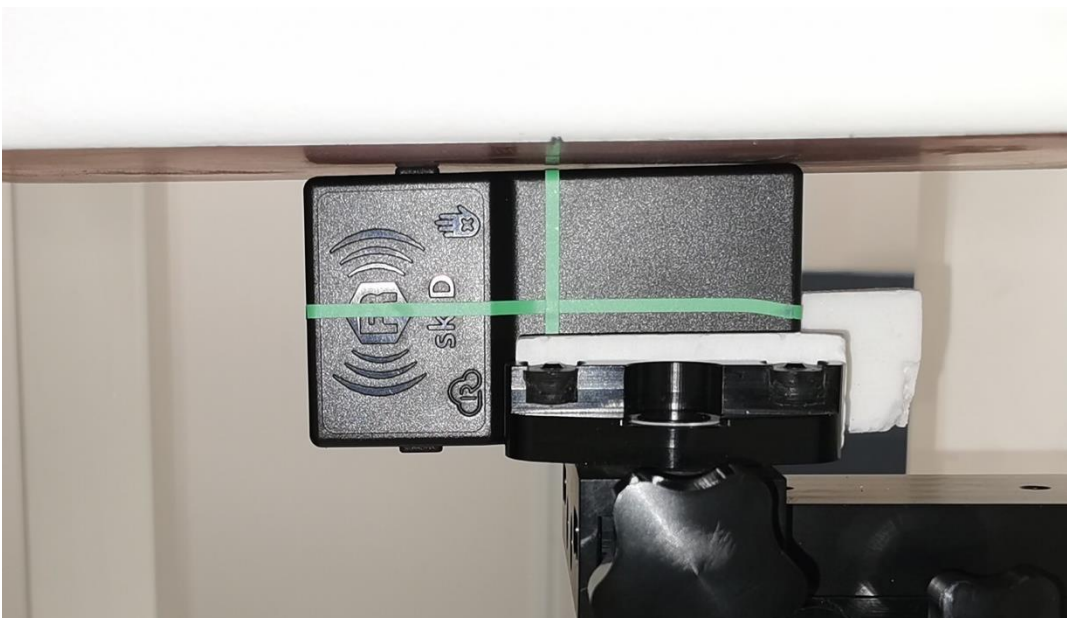
Front test position, Extremity 0mm separation distance



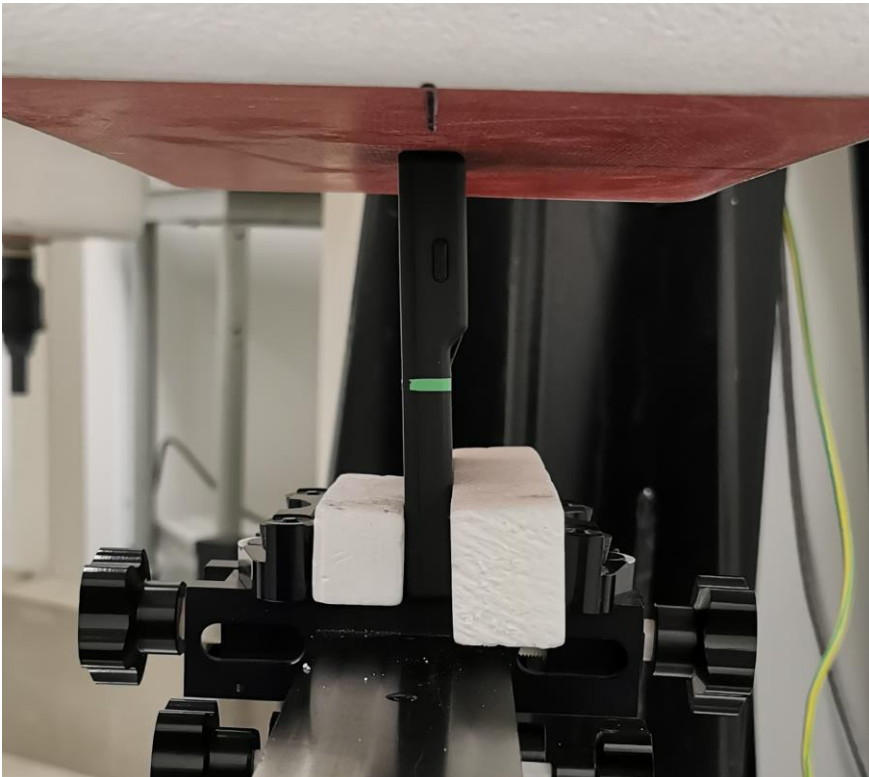
Back test position, Extremity 0mm separation distance



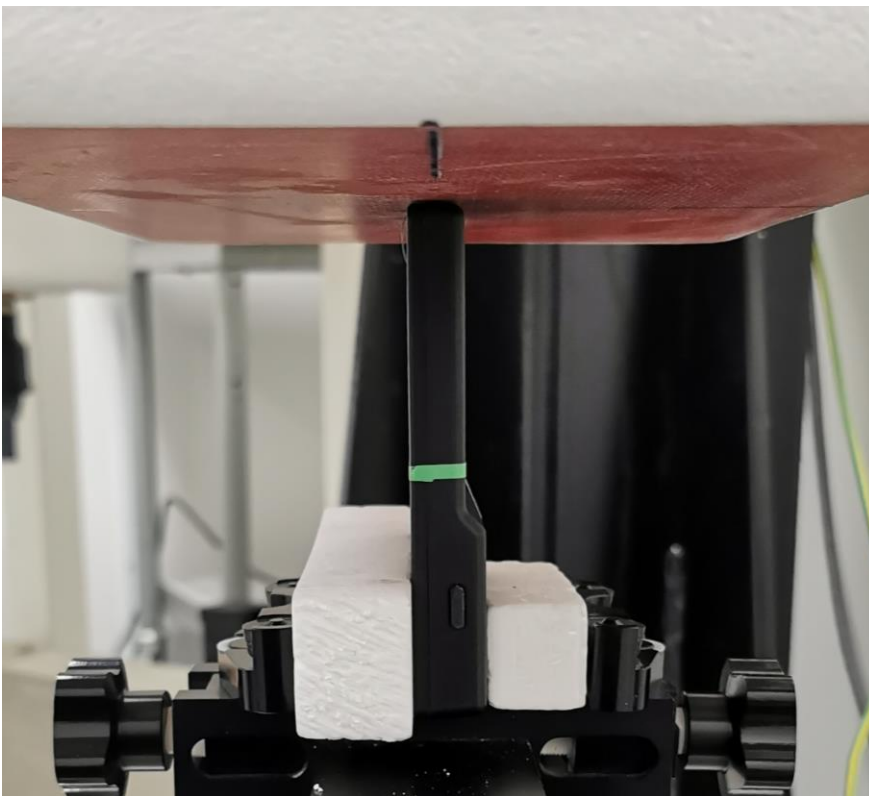
Left test position, Extremity 0mm separation distance



Right test position, Extremity 0mm separation distance



Top test position, Extremity 0mm separation distance



Bottom test position, Extremity 0mm separation distance

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 3.3.2021 8:40:27

Test Laboratory: Verkotan Oy

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN:448

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; $\sigma = 0.942$ S/m; $\epsilon_r = 43.243$; $\rho = 1000$ kg/m³

Phantom section: Center Section

Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(9.97, 9.97, 9.97) @ 835 MHz; Calibrated: 25.3.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = -4.0, 31.0$
- Electronics: DAE4 Sn756; Calibrated: 17.3.2020
- Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 28_March_2017
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

System Check 835MHz/Area Scan (131x71x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 3.02 W/kg

System Check 835MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=7.5$ mm, $dy=7.5$ mm, $dz=5$ mm

Reference Value = 60.35 V/m; Power Drift = -0.03 dB

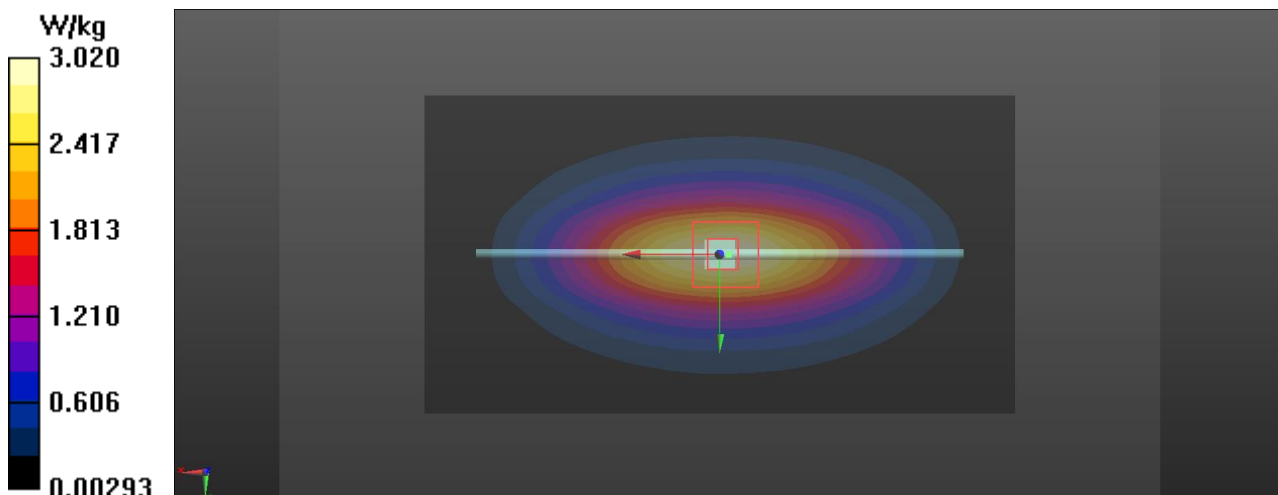
Peak SAR (extrapolated) = 3.45 W/kg

SAR(1 g) = 2.26 W/kg; SAR(10 g) = 1.49 W/kg (SAR corrected for target medium)

Smallest distance from peaks to all points 3 dB below = 25.8 mm

Ratio of SAR at M2 to SAR at M1 = 66.7%

Maximum value of SAR (measured) = 3.08 W/kg



Plot 2

Date/Time: 4.3.2021 12:38:08

Test Laboratory: Verkotan Oy

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; $\sigma = 1.88$ S/m; $\epsilon_r = 39.981$; $\rho = 1000$ kg/m³

Phantom section: Center Section

Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.83, 7.83, 7.83) @ 2450 MHz; Calibrated: 25.3.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = -4.0, 31.0$
- Electronics: DAE4 Sn756; Calibrated: 17.3.2020
- Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 28_March_2017
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

System Check 2450MHz/Area Scan (71x61x1): Interpolated grid: $dx=1.200$ mm, $dy=1.200$ mm

Maximum value of SAR (interpolated) = 23.7 W/kg

System Check 2450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 110.1 V/m; Power Drift = 0.07 dB

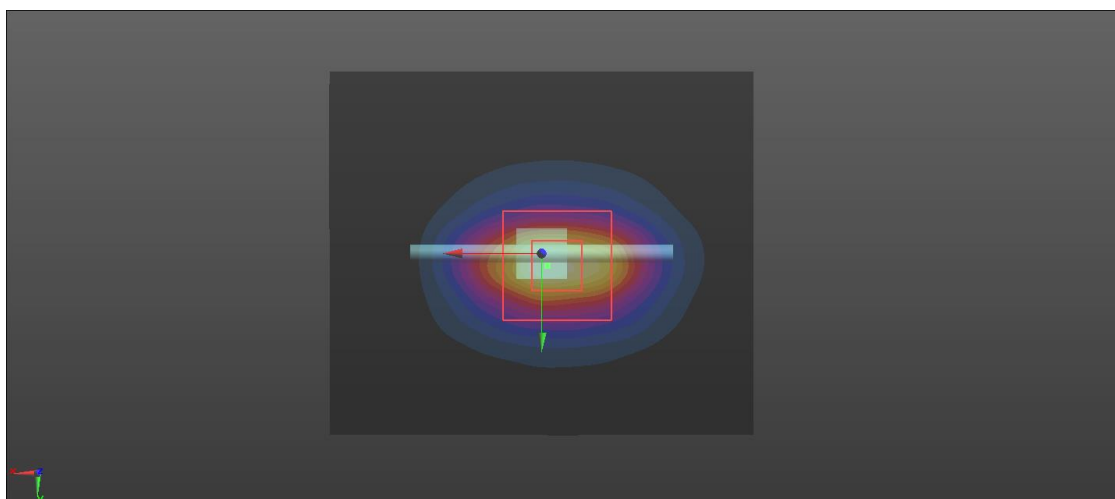
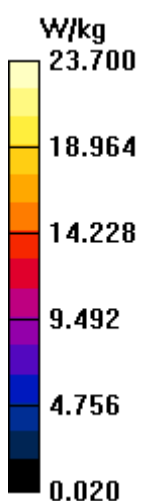
Peak SAR (extrapolated) = 28.4 W/kg

SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.26 W/kg (SAR corrected for target medium)

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 48.3%

Maximum value of SAR (measured) = 22.9 W/kg



Plot 3

Date/Time: 9.3.2021 10:33:45

Test Laboratory: Verkotan Oy

DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN:448

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; $\sigma = 0.934$ S/m; $\epsilon_r = 42.177$; $\rho = 1000$ kg/m³
Phantom section: Center Section
Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3892; ConvF(9.95, 9.95, 9.95) @ 835 MHz; Calibrated: 28.4.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = -4.0, 31.0$
- Electronics: DAE4 Sn756; Calibrated: 17.3.2020
- Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 28_March_2017
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

System Check 835MHz/Area Scan (131x71x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 3.22 W/kg

System Check 835MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=7.5$ mm, $dy=7.5$ mm, $dz=5$ mm

Reference Value = 61.57 V/m; Power Drift = -0.14 dB

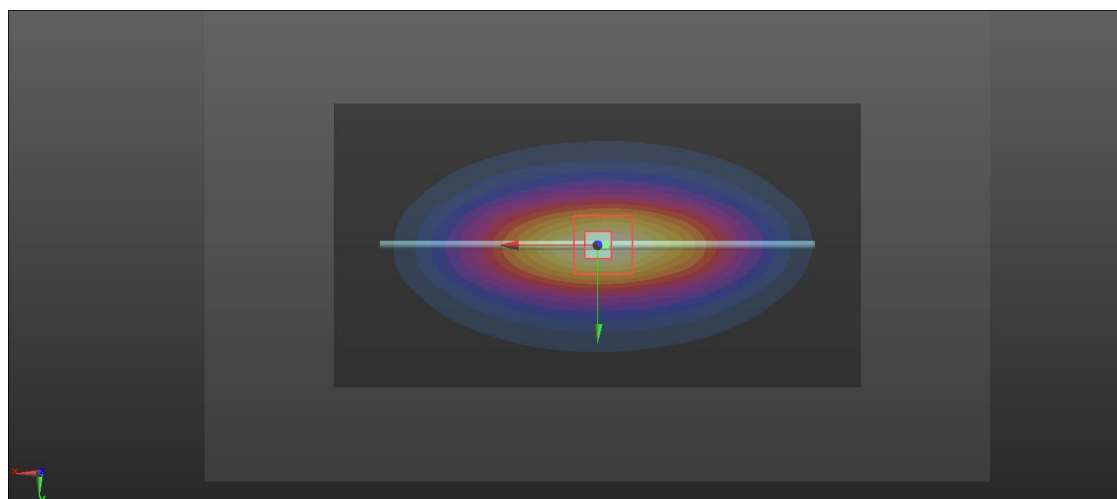
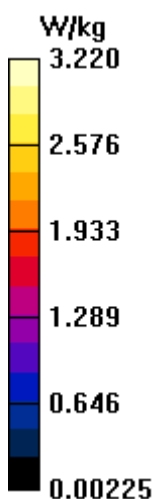
Peak SAR (extrapolated) = 3.49 W/kg

SAR(1 g) = 2.28 W/kg; SAR(10 g) = 1.5 W/kg (SAR corrected for target medium)

Smallest distance from peaks to all points 3 dB below = 17.5 mm

Ratio of SAR at M2 to SAR at M1 = 66.7%

Maximum value of SAR (measured) = 3.11 W/kg



APPENDIX C: MEASUREMENT SCANS

Plot 4

Date/Time: 3.3.2021 15:11:02

Test Laboratory: Verkotan Oy

DUT: skID R1280I

Communication System: UID 0, CW (0); Communication System Band: RFID; Frequency: 915.25 MHz; Communication System PAR: 0 dB; PMF: 1

Medium parameters used (interpolated): $f = 915.25$ MHz; $\sigma = 0.973$ S/m; $\epsilon_r = 43.038$; $\rho = 1000$ kg/m³

Phantom section: Center Section

Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(9.97, 9.97, 9.97) @ 915.25 MHz; Calibrated: 25.3.2020
- Sensor-Surface: 1.4mm (Fix Surface), Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = 31.0, -4.0$
- Electronics: DAE4 Sn756; Calibrated: 17.3.2020
- Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 28_March_2017
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

RFID, mid, front, DUT22249/Zoom Scan (7x6x7)/Cube 0: Measurement grid: $dx=7.5$ mm, $dy=7.5$ mm, $dz=5$ mm

Reference Value = 63.49 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 6.70 W/kg

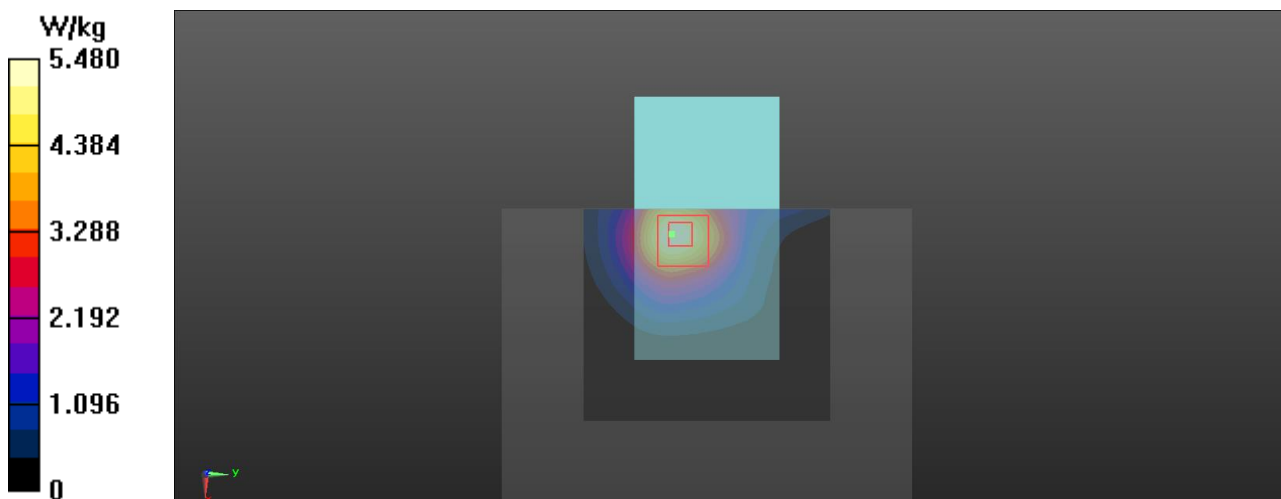
SAR(1 g) = 4.13 W/kg; SAR(10 g) = 2.94 W/kg (SAR corrected for target medium)

Ratio of SAR at M2 to SAR at M1 = 62.8%

Maximum value of SAR (measured) = 5.48 W/kg

RFID, mid, front, DUT22249/Area Scan (61x71x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 5.17 W/kg



Plot 5

Date/Time: 8.3.2021 10:38:52

Test Laboratory: Verkotan Oy

DUT: skID R1280I

Communication System: UID 0, Bluetooth (0); Communication System Band: Bluetooth; Frequency: 2440 MHz; Communication System
PAR: 3.98 dB; PMF: 1.26488
Medium parameters used: $f = 2440$ MHz; $\sigma = 1.871$ S/m; $\epsilon_r = 39.947$; $\rho = 1000$ kg/m³
Phantom section: Center Section
Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.83, 7.83, 7.83) @ 2440 MHz; Calibrated: 25.3.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = -4.0, 31.0$
- Electronics: DAE4 Sn756; Calibrated: 17.3.2020
- Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx; Serial: 28_March_2017
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

BT, mid, front, DUT22247/Area Scan (71x81x1): Interpolated grid: $dx=1.200$ mm, $dy=1.200$ mm

Maximum value of SAR (interpolated) = 0.490 W/kg

BT, mid, front, DUT22247/Zoom Scan (10x10x7)/Cube 0: Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=5$ mm

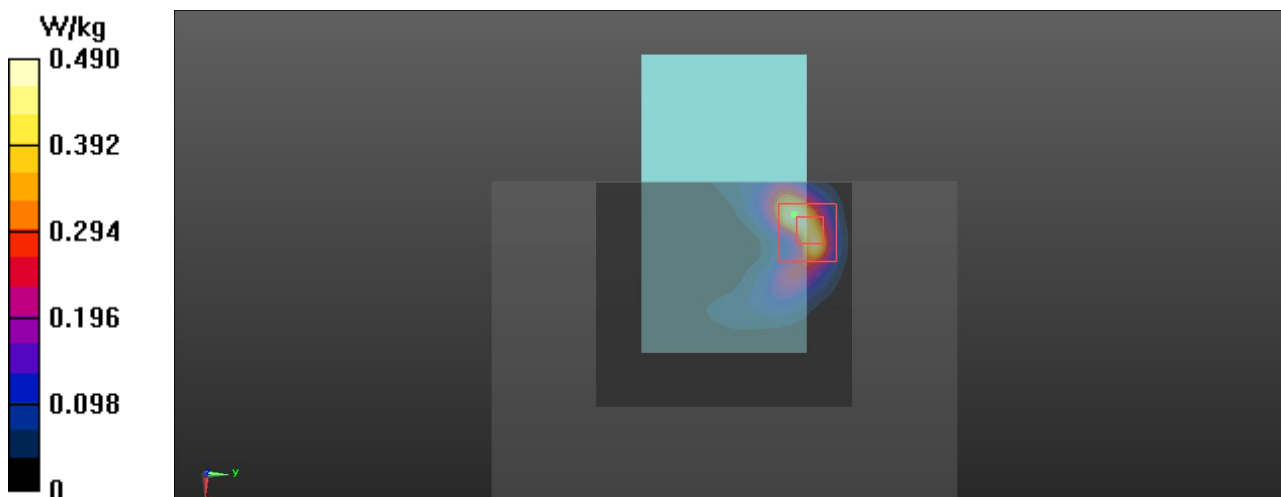
Reference Value = 4.379 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 1.04 W/kg

SAR(1 g) = 0.311 W/kg; SAR(10 g) = 0.118 W/kg (SAR corrected for target medium)

Ratio of SAR at M2 to SAR at M1 = 33%

Maximum value of SAR (measured) = 0.688 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
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: **EX3-7447_Mar20**

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, 2020**

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 $(22 \pm 3)^\circ\text{C}$ 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	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: S6277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
DAE4	SN: 680	27-Dec-19 (No. DAE4-660_Dec19)	Dec-20
Reference Probe ES3DV2	SN: 3013	31-Dec-19 (No. ES3-3013_Dec19)	Dec-20
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-19)	In house check: Oct-20

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Ketja Pokovic	Technical Manager	
			Issued: March 27, 2020
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

EX3DV4 – SN:7447

March 25, 2020

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.41	0.42	0.42	± 10.1 %
DCP (mV) ^B	98.5	91.0	100.2	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	197.2	± 2.7 %	± 4.7 %
		Y	0.0	0.0	1.0		185.8		
		Z	0.0	0.0	1.0		172.3		

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 E²-field uncertainty inside TSL (see Page 5).

^B Numerical linearization parameter: uncertainty not required.

^C Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:7447

March 25, 2020

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	10.38	10.38	10.38	0.52	0.88	± 12.0 %
900	41.5	0.97	9.97	9.97	9.97	0.31	1.05	± 12.0 %
1750	40.1	1.37	8.65	8.65	8.65	0.29	0.88	± 12.0 %
1950	40.0	1.40	8.29	8.29	8.29	0.23	0.98	± 12.0 %
2150	39.7	1.53	8.21	8.21	8.21	0.29	0.88	± 12.0 %
2300	39.5	1.67	8.05	8.05	8.05	0.30	1.00	± 12.0 %
2450	39.2	1.80	7.83	7.83	7.83	0.29	1.00	± 12.0 %
2600	39.0	1.96	7.64	7.64	7.64	0.19	1.20	± 12.0 %
3300	38.2	2.71	7.00	7.00	7.00	0.30	1.30	± 13.1 %
5250	35.9	4.71	5.18	5.18	5.18	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.56	4.56	4.56	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.70	4.70	4.70	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.

**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 **Verkotan**

Certificate No: **EX3-3892_Apr20**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3892**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA
CAL-25.v7
Calibration procedure for dosimetric E-field probes**

Calibration date: **April 28, 2020**

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 $(22 \pm 3)^\circ\text{C}$ 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	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
DAE4	SN: 660	27-Dec-19 (No. DAE4-660_Dec19)	Dec-20
Reference Probe ES3DV2	SN: 3013	31-Dec-19 (No. ES3-3013_Dec19)	Dec-20
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-19)	In house check: Oct-20

Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	
Issued: April 28, 2020			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

EX3DV4 – SN:3892

April 28, 2020

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.48	0.38	0.48	± 10.1 %
DCP (mV) ^B	105.1	104.6	101.1	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	159.4	± 2.7 %	± 4.7 %
		Y	0.0	0.0	1.0		144.1		
		Z	0.0	0.0	1.0		140.1		

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 E²-field uncertainty inside TSL (see Page 5).

^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.

EX3DV4- SN:3892

April 28, 2020

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)
600	42.7	0.88	10.46	10.46	10.46	0.10	1.20	± 13.3 %
750	41.9	0.89	10.21	10.21	10.21	0.39	0.96	± 12.0 %
900	41.5	0.97	9.95	9.95	9.95	0.38	0.92	± 12.0 %
1750	40.1	1.37	8.52	8.52	8.52	0.28	0.80	± 12.0 %
1900	40.0	1.40	8.26	8.26	8.26	0.36	0.80	± 12.0 %
2450	39.2	1.80	7.48	7.48	7.48	0.33	0.90	± 12.0 %
2600	39.0	1.96	7.33	7.33	7.33	0.34	0.90	± 12.0 %
4400	36.9	3.84	5.98	5.98	5.98	0.40	1.60	± 13.1 %
4600	36.7	4.04	5.77	5.77	5.77	0.35	1.80	± 13.1 %
4800	36.4	4.25	5.51	5.51	5.51	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.84.3.20.MVGB.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 835 MHZ
SERIAL NO.: SN 448

Calibrated at MVG
Z.I. de la pointe du diable
Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 03/23/2020



Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed at MVG, using the COMOSAR test bench. The test results covered by accreditation are traceable to the International System of Units (SI).



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.84.3.20.MVGB.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Technical Manager	3/24/2020	
Checked by :	Jérôme LUC	Technical Manager	3/24/2020	
Approved by :	Yann Toutain	Laboratory Director	3/24/2020	

	Customer Name
Distribution :	Verkotan Ltd.

Issue	Name	Date	Modifications
A	Jérôme LUC	3/24/2020	Initial release

Page: 2/10

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.84.3.20.MVGB.A

3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 MEASUREMENT CONDITION

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPG0333
Liquid	Head Liquid Values: ϵ_{ps} : 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	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-80 %

7.2 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_r)		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±10 %		0.87 ±10 %	
450	43.5 ±10 %		0.87 ±10 %	
750	41.9 ±10 %		0.89 ±10 %	
835	41.5 ±10 %	40.0	0.90 ±10 %	0.90
900	41.5 ±10 %		0.97 ±10 %	
1450	40.5 ±10 %		1.20 ±10 %	
1500	40.4 ±10 %		1.23 ±10 %	
1640	40.2 ±10 %		1.31 ±10 %	
1750	40.1 ±10 %		1.37 ±10 %	
1800	40.0 ±10 %		1.40 ±10 %	
1900	40.0 ±10 %		1.40 ±10 %	
1950	40.0 ±10 %		1.40 ±10 %	
2000	40.0 ±10 %		1.40 ±10 %	
2100	39.8 ±10 %		1.49 ±10 %	

Page: 7/10

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.84.3.20.MVGB.A

2300	39.5 ±10 %		1.67 ±10 %	
2450	39.2 ±10 %		1.80 ±10 %	
2600	39.0 ±10 %		1.96 ±10 %	
3000	38.5 ±10 %		2.40 ±10 %	
3500	37.9 ±10 %		2.91 ±10 %	

7.3 MEASUREMENT RESULT

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.

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	9.38 (0.94)	6.22	5.94 (0.59)
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	

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SAR Reference Dipole Calibration Report

Ref : ACR.84.6.20.MVGB.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 2450 MHZ
SERIAL NO.: SN 758

Calibrated at MVG
Z.I. de la pointe du diable
Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 03/23/2020



Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed at MVG, using the COMOSAR test bench. The test results covered by accreditation are traceable to the International System of Units (SI).



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.84.6.20.MVGB.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Technical Manager	3/24/2020	
Checked by :	Jérôme LUC	Technical Manager	3/24/2020	
Approved by :	Yann Toutain	Laboratory Director	3/24/2020	

	Customer Name
Distribution :	Verkotan Ltd.

Issue	Name	Date	Modifications
A	Jérôme LUC	3/24/2020	Initial release

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.84.6.20.MVGB.A

3000	41.5 ±1 %		25.0 ±1 %		3.6 ±1 %	
3500	37.0±1 %		26.4 ±1 %		3.6 ±1 %	
3700	34.7±1 %		26.4 ±1 %		3.6 ±1 %	

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 MEASUREMENT CONDITION

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPG0333
Liquid	Head Liquid Values: ϵ_r' : 37.5 σ : 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	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-80 %

7.2 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±10 %		0.87 ±10 %	
450	43.5 ±10 %		0.87 ±10 %	
750	41.9 ±10 %		0.89 ±10 %	
835	41.5 ±10 %		0.90 ±10 %	
900	41.5 ±10 %		0.97 ±10 %	
1450	40.5 ±10 %		1.20 ±10 %	
1500	40.4 ±10 %		1.23 ±10 %	
1640	40.2 ±10 %		1.31 ±10 %	
1750	40.1 ±10 %		1.37 ±10 %	
1800	40.0 ±10 %		1.40 ±10 %	
1900	40.0 ±10 %		1.40 ±10 %	
1950	40.0 ±10 %		1.40 ±10 %	
2000	40.0 ±10 %		1.40 ±10 %	
2100	39.8 ±10 %		1.49 ±10 %	

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.84.6.20.MVGB.A

2300	39.5 ±10 %		1.67 ±10 %	
2450	39.2 ±10 %	37.5	1.80 ±10 %	1.80
2600	39.0 ±10 %		1.96 ±10 %	
3000	38.5 ±10 %		2.40 ±10 %	
3500	37.9 ±10 %		2.91 ±10 %	

7.3 MEASUREMENT RESULT

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.

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	55.34 (5.53)	24	24.43 (2.44)
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	

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