SAR Compliance Test Report

Date of Report	10/11/2023	**Client's Contact person:**	Fabian Parizel
Number of pages:	42	**Responsible Test engineer:**	Jesper Varis
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**Bioserenity** 20 Berbier du mets 75013 Paris France
Tested device	Neuronaute Plus		
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**		
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: 10.11.2023

For the contents: Miia Nurkkala

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	Neuronaute Plus
Manufacturer:	Bioserenity
Serial Number:	0002
FCC ID Number:	2A223-NNPRECV1 Contains FCC ID: 2AAQS-ISP1507 Contains FCC ID: 2A223-NNPV1
Model:	Neuronaute Plus, DB25 and IceCap Extender
DUT Number:	21420, 21417 ,21416
Battery Type used in testing:	Rechargeable Li-Polymer Battery
State of the Sample	Production sample

Testing information:

Testing Performed:	10.01.2023 – 20.01.2023
Notes:	-
Document ID:	FCC SAR report Neuronaute WiFi ID5908 03112023.docx
Document History	This report replaces FCC SAR report Neuronaute WiFi ID5908 19092023.docx. FCC ID corrected. BT estimated SAR updated according to 447498 D01 General RF Exposure Guidance v06. Section 5.2.1 updated with reference to 447498 D01.
Temperature °C	22±2 / Controlled
Humidity RH%	20±20 / Controlled
Measurement performed by:	Jesper Varis
FCC Test Firm Designation number	FI0005

1.2 Maximum Results

The maximum reported* SAR values in Body-worn 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) is SAR1g 1.6 W/kg.

System	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Condition, 5mm separation distance	Result
WLAN 2.4 GHz	**0.23**	**PASS**
WLAN 5 GHz	**0.45**	**PASS**

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

1.2.1 Simultaneous Transmission SAR

Highest Simultaneous Transmission SAR	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Condition, 5mm separation distance	Result
WLAN 5GHz + BLE	**0.56**	**PASS**

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

1.2.2 Maximum Drift

Maximum Drift During Measurements	-0.43dB*

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

1.2.3 Measurement Uncertainty

300MHz – 3GHz frequency range

Expanded Uncertainty (k=2) 95 %	±22.1%

3GHz – 6GHz frequency range

Expanded Uncertainty (k=2) 95 %	±24.0%

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is a medical device that enables the acquisition, recording, storage, transmission to help the healthcare professionals to analyze potential neurological disorders by using the electroencephalogram (EEG) records through the Wi-Fi 2.4GHz / 5GHz and Bluetooth Low Energy.

Datasheet of ISP1507 module states that the Bluetooth Low Energy's maximum antenna gain is 0.6 dBi.

Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

	Modes of Operation	**Transmitter Frequency Range [MHz]**
TX Frequency bands	**WLAN 2.4 GHz**	2412 – 2462
	WLAN 5 GHz	5180 – 5825
	Bluetooth Low Energy	2402 – 2480

2.2 Simultaneous Transmission

The DUT supports following simultaneous transmission combinations:
WLAN + BLE

2.3 Bluetooth Low Energy SAR Test Exclusions

According to Appendix A of 447498D01 the SAR test exclusion power threshold for 2450MHz is 10mW at ≤5mm separation distance. The maximum output power of the Bluetooth LE transmitter is 4 dBm i.e. 2.51 mW thus it is below the test exclusion threshold.

3. OUTPUT POWER

3.1 Maximum Output Power

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

WLAN 2.4 GHz	Max Output Power [dBm]
802.11b	16.3
802.11g	15.3
802.11n	11

WLAN 5 GHz	Max Output Power [dBm]
802.11a	15.1
802.11n	11

Bluetooth	Max Output Power [dBm]
BLE	4

3.2 Tested Conducted Power

2.4 GHz WLAN:

Standard	Transmission mode	Data rate [Mbps]	Output power [dBm]		
			CH 1 2412 MHz	CH 6 2437 MHz	CH 11 2462 MHz
802.11b	CCK	11	16.2	15.79	16.25

5 GHz WLAN:

Standard	Channel	Frequency [MHz]	Transmission mode	Data Rate [Mbps]	Output power [dBm]
802.11a	52	5260	OFDM	6	13.66
802.11a	56	5280			13.8
802.11a	60	5300			13.88
802.11a	64	5320			13.16
802.11a	100	5500			11.85
802.11a	116	5580			12.53
802.11a	124	5620			12.81
802.11a	132	5660			13.23
802.11a	144	5720			13.39
802.11a	149	5745			13.26
802.11a	157	5785			12.96
802.11a	165	5825			12.49

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.

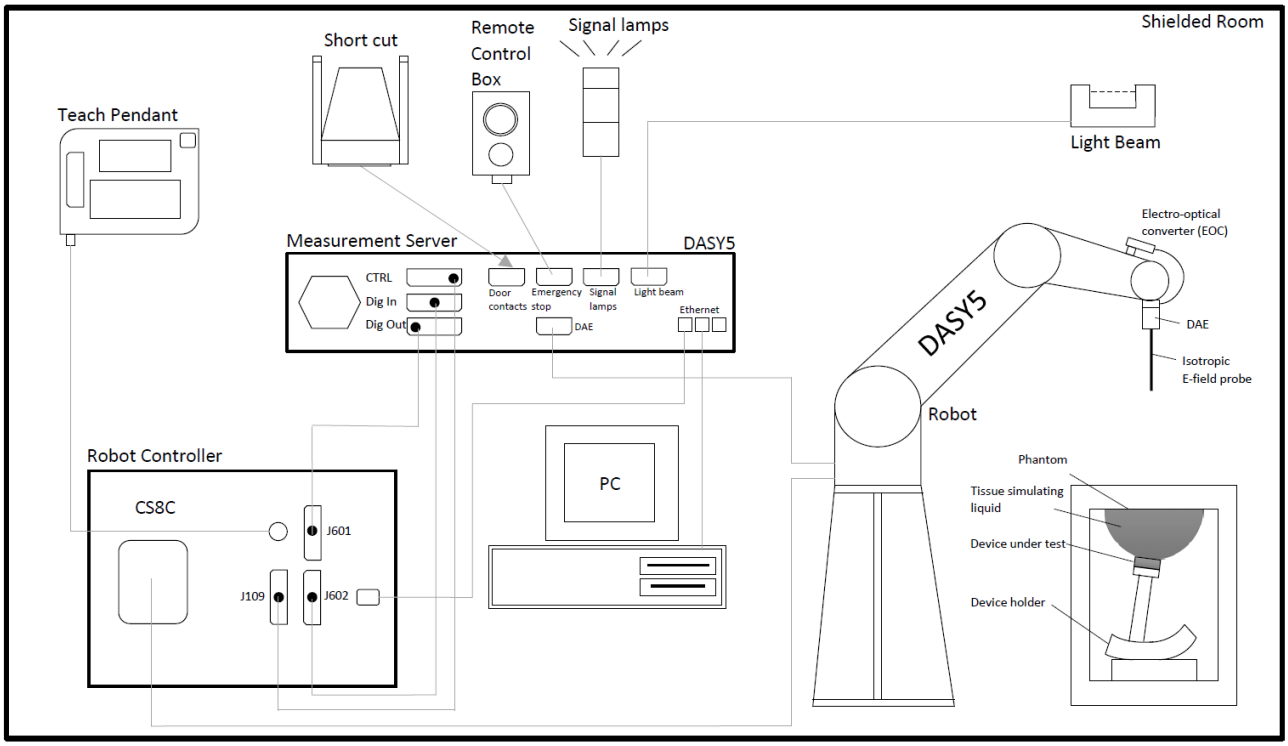


Figure 1 Schematic Laboratory Picture

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	Calibration Interval (years)
DAE	DAE4	705	04.2022	1
Probe	EX3DV4	7447	02.2022	1
System Validation Dipole	D2450V2	729	07.2022	3
System Validation Dipole	D5GHZV2	1014	03.2020	3
DASY5 Software	52.8.8.1258	-	NA	NA
Signal Generator	MG3710E	6262028676	NA	NA
Amplifier	Ophir 5163F	1022	NA	NA
Amplifier	5GHz	NA	NA	NA
Power Sensor	MA24105A	2102058	11.2022	1
Power Sensor	NRP-Z11	100265	12.2022	1

Dipole calibration period supporting data:

		Measured on 10/2022			Calibrated		
Dipole and serial number	Frequency (MHz)	Return loss (dB)	Impedance (Ω)		Return loss (dB)	Impedance (Ω)	
D5GHzV2 - SN: 1014	5250	-26.7	49.9	-4.6	-25.81	52.5	-4.4
D5GHzV2 - SN: 1014	5600	-24.0	48.0	-5.8	-21.7	49	-8.1
D5GHzV2 - SN: 1014	5750	-22.6	43.1	-0.5	-27.71	46.1	1.4

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. The shell thickness of the bottom plate is 2±0.2mm. The dimensions are 308x192x182mm and filling volume is 9.2 liters giving a filling height of 155mm.

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 for frequencies below 3 GHz and ±5% for frequencies between 3 – 6 GHz. 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 600-6000 MHz 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] Head tissue simulant	Conductivity σ [S/m] Head tissue simulant	Validation Done
2450	D2450V2 / 758	EX3DV4 / 7447	CW / DSSS	DAE 4 / 1332	37.82	1.79	03/2022
5250	D5GHzV2 / 1014	EX3DV4 / 7447	CW	DAE 4 / 1332	35.42	4.64	03/2022
5600	D5GHzV2 / 1014	EX3DV4 / 7447	CW / OFDM	DAE 4 / 1332	34.77	5.03	03/2022
5750	D5GHzV2 / 1014	EX3DV4 / 7447	CW	DAE 4 / 1332	34.5	5.2	03/2022

4.5 System Check

Date	Tissue Type	Tissue Temp. [°C]	Frequency [MHz]	Input Power [mW]	Measured SAR1g [W/kg]	1 W Target SAR1g [W/kg]	1 W Normalized SAR1g [W/kg]	Deviation 1g [%]	Plot #
11.01.2023	WB Head	22	5250	100	7.41	77.65	74.1	-4.57	1
16.01.2023	WB Head	22	2450	250	12.5	52.3	50	-4.40	2
16.01.2023	WB Head	22	5600	100	7.63	83.31	76.3	-8.41	3
17.01.2023	WB Head	22	5750	100	7.19	75.18	71.9	-4.36	4
18.01.2023	WB Head	22	5750	100	7.36	75.18	73.6	-2.10	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 (%)
11.01.2023	WB Head	22	5250.0	35.95	4.71	37.68	4.59	4.8	-2.5
11.01.2023	WB Head	22	5300.0	35.9	4.76	37.58	4.65	4.7	-2.2
16.01.2023	WB Head	22	2450.0	39.2	1.8	42.46	1.78	8.3	-0.9
16.01.2023	WB Head	22	2462.0	39.18	1.81	42.44	1.79	8.3	-1.1
17.01.2023	WB Head	22	5720.0	35.38	5.19	35.55	5.03	0.5	-3.1
17.01.2023	WB Head	22	5750.0	35.35	5.22	35.5	5.06	0.4	-3.0
18.01.2023	WB Head	22	5720.0	35.38	5.19	36.38	5.14	2.8	-1.0
18.01.2023	WB Head	22	5745.0	35.35	5.21	36.33	5.17	2.7	-0.8
18.01.2023	WB Head	22	5750.0	35.35	5.22	36.32	5.18	2.7	-0.8

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publication 447498 D01. Testing was done from all six sides of the DUT.

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

The WLAN transmission modes for testing were selected according to power, largest channel bandwidth configuration, lowest order modulation and lowest data rate. 2.4GHz WLAN was tested with 802.11b standard with data rate of 11 Mbit/s, 5GHz was tested with 802.11a standard with data rate of 6 Mbit/s.

The DUT can be used with two different extenders, DB25 Extender and IceCap Extender. The DUT was measured with both extenders using a channel that has highest conducted power to see the effects of the extenders. DB25 Extender has a higher SAR value, thus the SAR measurements were made by using DB25 Extender.

Mode	Channel	Freq [MHz]	Data Rate [Mbps]	Test position	Extender	Measured SAR1g [W/kg]
802.11b	6	2437	11	Front 0mm	DB25	**0.47**
802.11b	6	2437	11	Front 0mm	IceCap	0.40
802.11a	64	5320	6	Front 0mm	DB25	**1.01**
802.11a	64	5320	6	Front 0mm	IceCap	0.99

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

Photos of the test positions are presented in appendix A

5.2.1 Body-worn, 5mm separation distance

The device was placed in the SPEAG holder and lifted towards the phantom until the distance between the phantom and the device was 5mm.

According to FCC KDB Publication 447498 D01, devices that are designed to operate on the body of users using straps, lanyards or without requiring additional body-worn accessories must be tested for SAR compliance using a conservative minimum test separation distance ≤5mm to support compliance.

The DUT can be carried in a holding band that is comparable to a strap, thus test separation distance of 5mm was used.

5.3 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.

5.4 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

DASY5 Uncertainty Budget According to IEC/IEEE 62209-1528 (Frequency band: 300MHz - 3GHz range)								
Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)
Measurement System Errors								
CF	Probe Calibration	±12.0%	N	√2	1	1	±6.0%	±6.0%
CFdrift	Probe Calibration Drift	±1.7%	R	√3	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	√3	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±3.0%	R	√3	1	1	±1.7%	±1.7%
ISO	Probe Isotropy	±7.6%	R	3	1	1	±4.4%	±4.4%
DAE	Data Acquisition	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δsys	Probe Positioning	±3.9%	N	1	0.14	0.14	±0.5%	±0.5%
DAT	Data Processing	±1.2%	N	1	1	1	±1.2%	±1.2%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)^{DAK}	±2.5%	N	√1	0.78	0.71	±2.0%	±1.8%
LIQ(T_σ)	Conductivity (temp.)^{BB}	±3.3%	R	√3	0.78	0.71	±1.5%	±1.4%
EPS	Phantom Permittivity	±14.0%	R	3	0	0	±0%	±0%
DIS	Distance DUT - TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
Dxyz	Device Positioning (±0.5mm)	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	√1	1	1	±3.6%	±3.6%
MOD	DUT Modulation^{m}	±2 ,.4%	R	√3	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±2.6%	R	3	1	1	±1.5%	±1.5%
RFdrift	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.^{val}	±0.0%	N	1	1	1	±0%	±0%
RF_{in}	Unc. Input Power^{val}	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	√1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling^{p}	±0%	R	3	1	1	±0%	±0%
u(ΔSAR)	Combined Uncertainty						±11.0%	±10.9%
U	**Expanded Uncertainty**						±22.1%	±21.9%

DASY5 Uncertainty Budget

According to IEC/IEEE 62209-1528

(Frequency band: 3GHz - 6GHz range)

Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)
Measurement System Errors								
CF	Probe Calibration	±14.0%	N	√2	1	1	±7.0%	±7.0%
CF*drift*	Probe Calibration Drift	±1.7%	N	√3	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	√3	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±2.6%	R	√3	1	1	±1.5%	±1.5%
ISO	Probe Isotropy	±7.6%	R	3	1	1	±4.4%	±4.4%
DAE	Data Acquisition	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δ*sys*	Probe Positioning	±3.9%	N	1	0.33	0.33	±1.3%	±1.3%
DAT	Data Processing	±2.3%	N	1	1	1	±2.3%	±2.3%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)^{DAK}	±2.5%	N	√1	0.78	0.71	±2.0%	±1.8%
LIQ(T_σ)	Conductivity (temp.)^{BB}	±3.4%	R	√3	0.78	0.71	±1.5%	±1.4%
EPS	Phantom Permittivity	±14.0%	R	3	0.25	0.25	±2.0%	±2.0%
DIS	Distance DUT - TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
D*xyz*	Device Positioning (±0.5mm)	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	√1	1	1	±3.6%	±3.6%
MOD	DUT Modulation^{m}	±2.4%	R	√3	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±2.6%	R	3	1	1	±1.5%	±1.5%
RF*drift*	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.^{val}	±0.0%	N	1	1	1	±0%	±0%
RF_{in}	Unc. Input Power^{val}	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	√1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling^{p}	±0%	R	3	1	1	±0%	±0%
u(ΔSAR)	Combined Uncertainty						±12.0%	±11.9%
U	**Expanded Uncertainty**						±24.0%	±23.8%

7. TEST RESULTS

7.1 SAR Results Body-worn Condition, 5 mm separation distance

2.4GHz WLAN:

Mode	Channel	Freq [MHz]	Data Rate	Bandwidth [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [W/kg]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR1g [W/kg]	Plot #
802.11b	11	2462	11	20	Front	16.3	16.25	0.202	0.52*	1.14	1:1	0.23	6
802.11b	11	2462	11	20	Back	16.3	16.25	0.01	0.1	1.01	1:1	0.01	
802.11b	11	2462	11	20	Left	16.3	16.25	0.14	-0.02	1.01	1:1	0.14	
802.11b	11	2462	11	20	Right	16.3	16.25	0.001	0.24*	1.07	1:1	0.001	
802.11b	11	2462	11	20	Top	16.3	16.25	0.002	-0.16	1.01	1:1	0.002	
802.11b	11	2462	11	20	Bottom	16.3	16.25	0.011	0.11	1.01	1:1	0.01	

*Larger than 5% drifts included to scaling factor

5GHz WLAN:

Mode	Channel	Freq [MHz]	Data Rate	Bandwidth [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [W/kg]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR1g [W/kg]	Plot #
802.11a	60	5300	6	20	Front	15.1	13.88	0.22	-0.01	1.32	1:1	0.29	7
802.11a	60	5300	6	20	Back	15.1	13.88	0.003	0.07	1.32	1:1	0.004	
802.11a	60	5300	6	20	Left	15.1	13.88	0.048	-0.12	1.32	1:1	0.06	
802.11a	60	5300	6	20	Right	15.1	13.88	0.001	NA**	1.32	1:1	0.002	
802.11a	60	5300	6	20	Top	15.1	13.88	0.0008	0.11	1.32	1:1	0.001	
802.11a	60	5300	6	20	Bottom	15.1	13.88	0.002	0.06	1.32	1:1	0.002	

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

Mode	Channel	Freq [MHz]	Data Rate	Bandwidth [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [W/kg]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR1g [W/kg]	Plot #
802.11a	144	5720	6	20	Front	15.1	13.39	0.29	-0.16	1.48	1:1	0.44	8
802.11a	144	5720	6	20	Back	15.1	13.39	0.006	0.05	1.48	1:1	0.01	
802.11a	144	5720	6	20	Left	15.1	13.39	0.1	0.21	1.48	1:1	0.15	
802.11a	144	5720	6	20	Right	15.1	13.39	0.006	0.05	1.48	1:1	0.01	
802.11a	144	5720	6	20	Top	15.1	13.39	0.005	-0.4*	1.63	1:1	0.01	
802.11a	144	5720	6	20	Bottom	15.1	13.39	0.026	0.1	1.48	1:1	0.04	

*Larger than 5% drifts included to scaling factor

Mode	Channel	Freq [MHz]	Data Rate	Bandwidth [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [W/kg]	Power Drift [dB]	Scaling Factor	Duty Cycle	Reported SAR1g [W/kg]	Plot #
802.11a	149	5745	6	20	Front	15.1	13.26	0.296	-0.08	1.53	1:1	0.45	9
802.11a	149	5745	6	20	Back	15.1	13.26	0.010	0.12	1.53	1:1	0.02	
802.11a	149	5745	6	20	Left	15.1	13.26	0.157	0.16	1.53	1:1	0.24	
802.11a	149	5745	6	20	Right	15.1	13.26	0.010	-0.43*	1.69	1:1	0.02	
802.11a	149	5745	6	20	Top	15.1	13.26	0.012	0.3*	1.64	1:1	0.02	
802.11a	149	5745	6	20	Bottom	15.1	13.26	0.033	0.21	1.53	1:1	0.05	

*Larger than 5% drifts included to scaling factor

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

7.2 Calculated Bluetooth Low Energy SAR results

7.2.1 FCC

For simultaneous transmission evaluation the Bluetooth LE standalone SAR value is estimated according to the following equation:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)/x] W/kg, where x = 7.5 for 1-g SAR.

Bluetooth LE SAR_{1g}= (2.51mW/5mm)*$(2.4835GHz)^{1/2}$/7.5= 0.11 W/kg

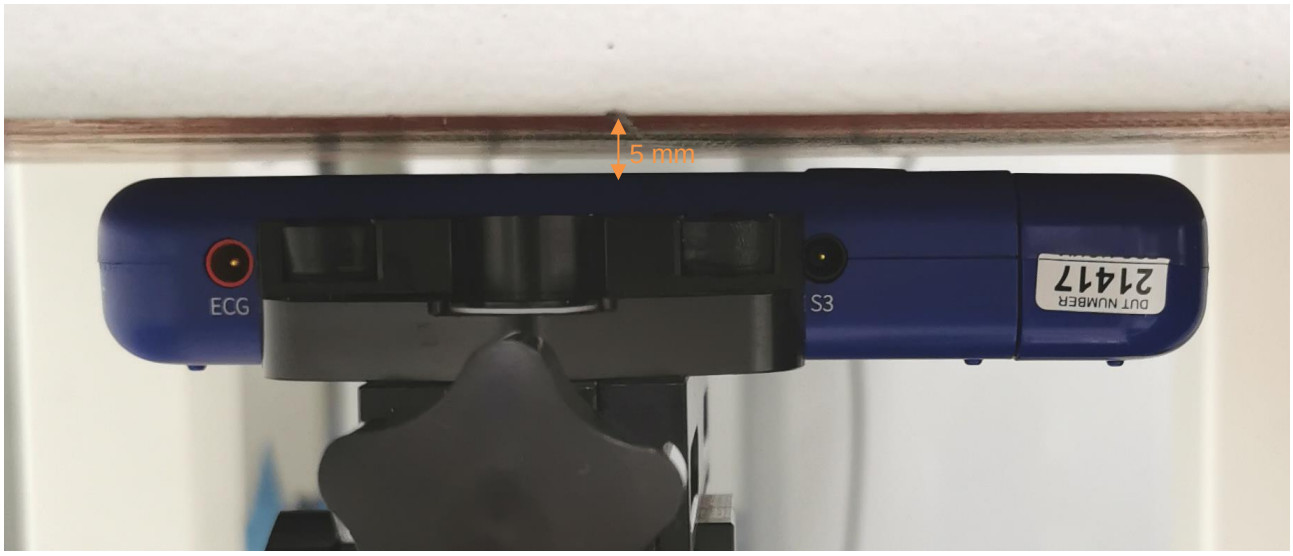
7.3 Simultaneous Transmission Analysis

Simultaneous transmission analysis for WLAN SAR, maximum Bluetooth Low Energy SAR, is in a table below. Direct summation of SAR results was performed.

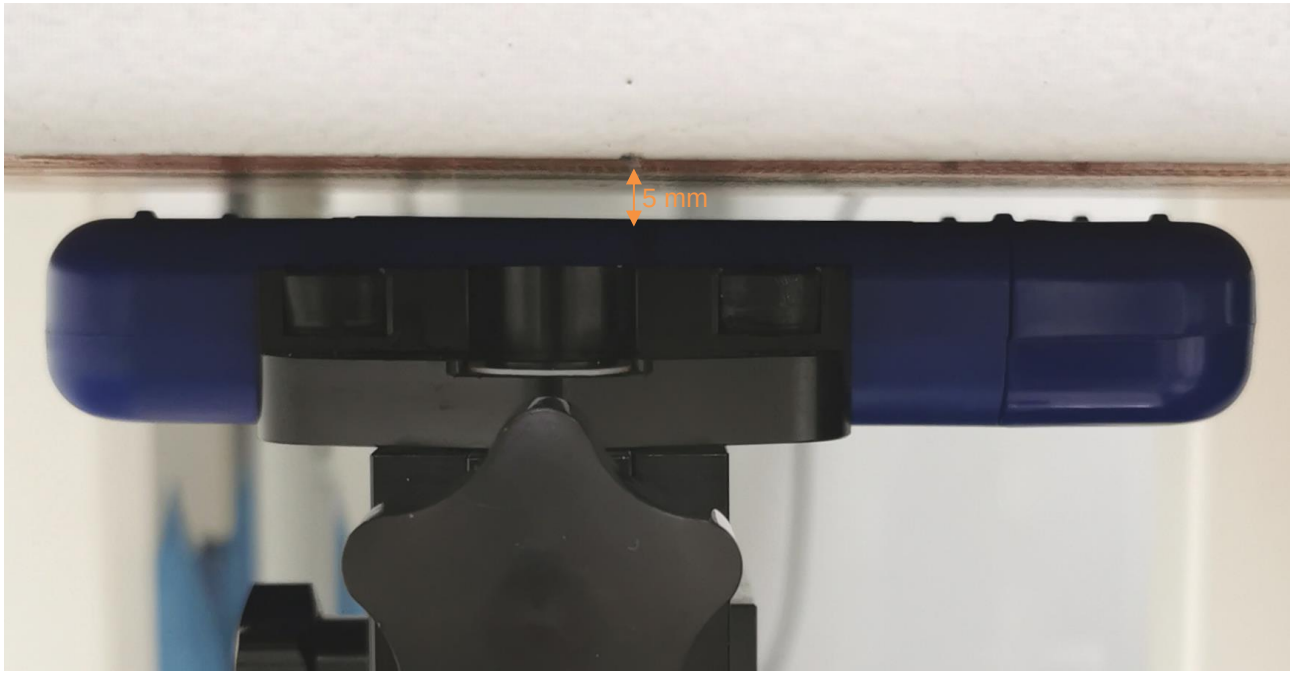
Exposure Condition	Body SAR_{1g} [W/kg]					
Test Position	Front	Back	Left	Right	Top	Bottom
WLAN 2.4GHz	0.23	0.01	0.14	0.001	0.002	0.01
WLAN 5GHz	0.45	0.02	0.24	0.02	0.02	0.05
Maximum WLAN	0.45	0.02	0.24	0.02	0.02	0.05
Bluetooth	0.11	0.11	0.11	0.11	0.11	0.11
SAR Summation WLAN + BT	**0.56**	**0.13**	**0.35**	**0.13**	**0.13**	**0.16**

APPENDIX A: PHOTOS OF THE DUT

Size of the DUT is: 155 x 77 x 25 mm

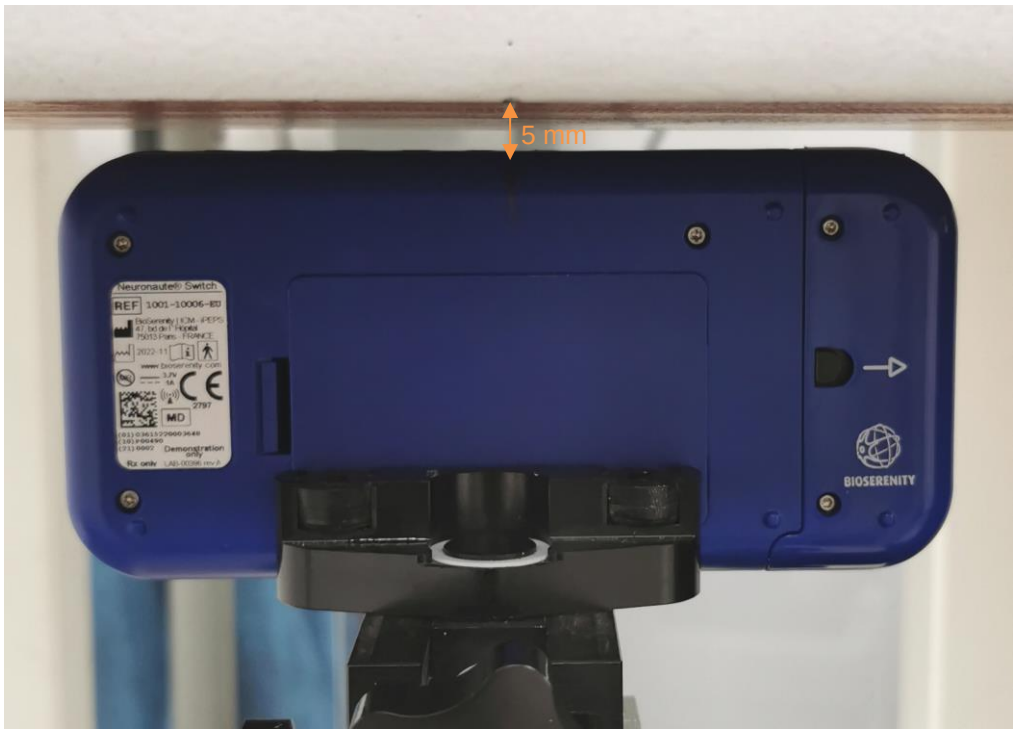


Front side of the DUT against the phantom, 0mm separation distance



Back side of the DUT against the phantom, 0mm separation distance

Left side of the DUT against the phantom, 0mm separation distance



Right side of the DUT against the phantom, 0mm separation distance

Top side of the device against the phantom, 0mm separation distance

Bottom side of the device against the phantom, 0mm separation distance

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 11.1.23 13:14:07

Test Laboratory: Verkotan Oy

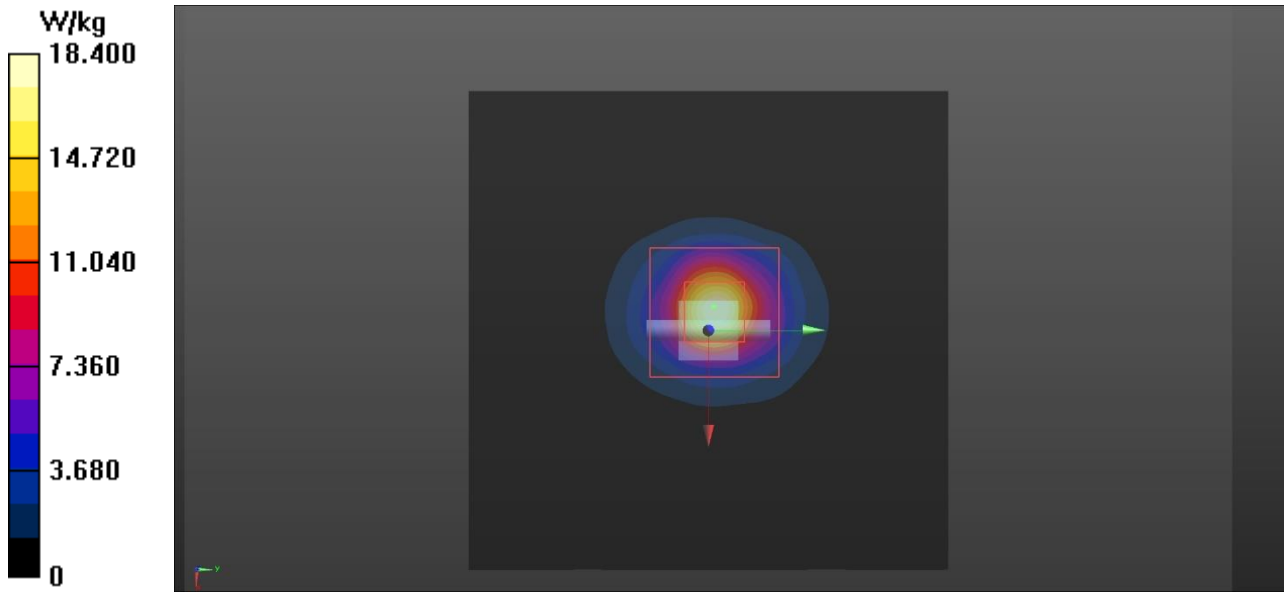
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1014

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5250 MHz;
Communication System PAR: 0 dB;
Medium parameters used (interpolated): f = 5250 MHz; σ = 4.594 S/m; ε_r = 37.683; 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) @ 5250 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 25.0, -4.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5250MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 40.00 V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 28.4 W/kg
SAR(1 g) = 7.41 W/kg; SAR(10 g) = 2.14 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.1 mm
Ratio of SAR at M2 to SAR at M1 = 66.4%
Maximum value of SAR (measured) = 18.4 W/kg
Configuration/system check 5250MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 18.6 W/kg



Plot 2

Date/Time: 16.1.23 08:37:37

Test Laboratory: Verkotan Oy

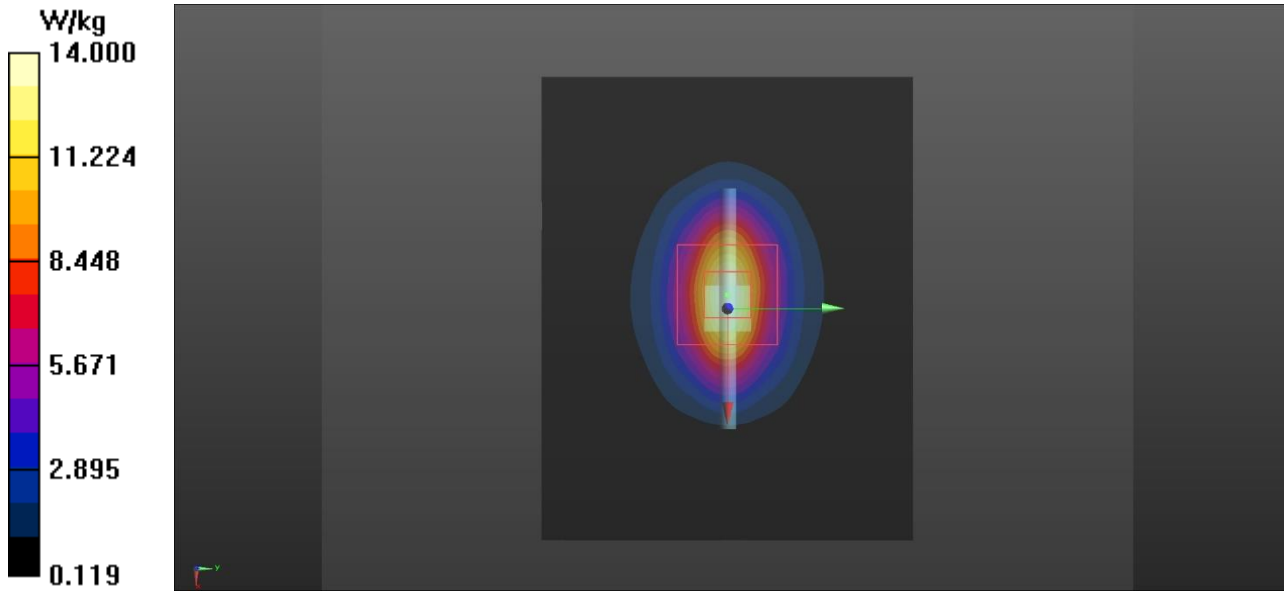
DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:729

Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;
Communication System PAR: 0 dB;
Medium parameters used (interpolated): f = 2450 MHz; σ = 1.784 S/m; ε_r = 42.459; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.77, 7.77, 7.77) @ 2450 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/System check 2450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 88.26 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 24.9 W/kg
SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.82 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 10 mm
Ratio of SAR at M2 to SAR at M1 = 51.1%
Maximum value of SAR (measured) = 14.0 W/kg
Configuration/System check 2450MHz/Area Scan (101x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 21.1 W/kg



Plot 3

Date/Time: 16.1.23 13:52:30

Test Laboratory: Verkotan Oy

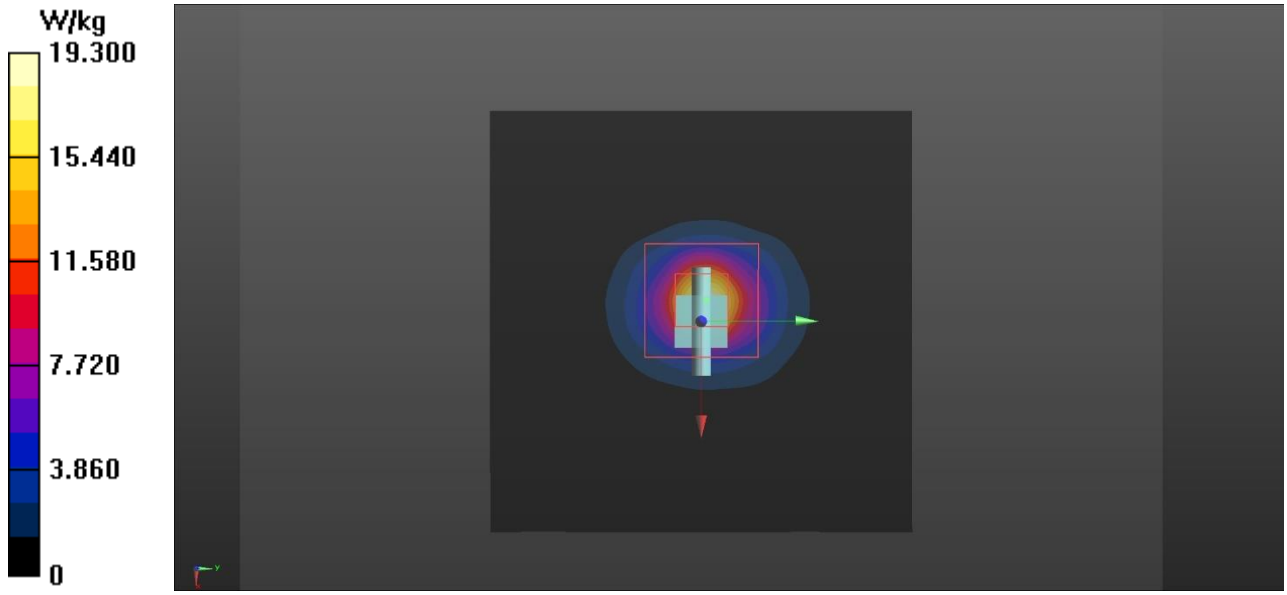
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1014

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5600 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 5600 MHz; σ = 4.918 S/m; ε_r = 36.45; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.5, 4.5, 4.5) @ 5600 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 25.0, -4.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5600MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 38.42 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 32.0 W/kg
SAR(1 g) = 7.63 W/kg; SAR(10 g) = 2.21 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.5 mm
Ratio of SAR at M2 to SAR at M1 = 63.1%
Maximum value of SAR (measured) = 19.3 W/kg
Configuration/system check 5600MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 18.3 W/kg



Plot 4

Date/Time: 17.1.23 11:56:14

Test Laboratory: Verkotan Oy

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1014

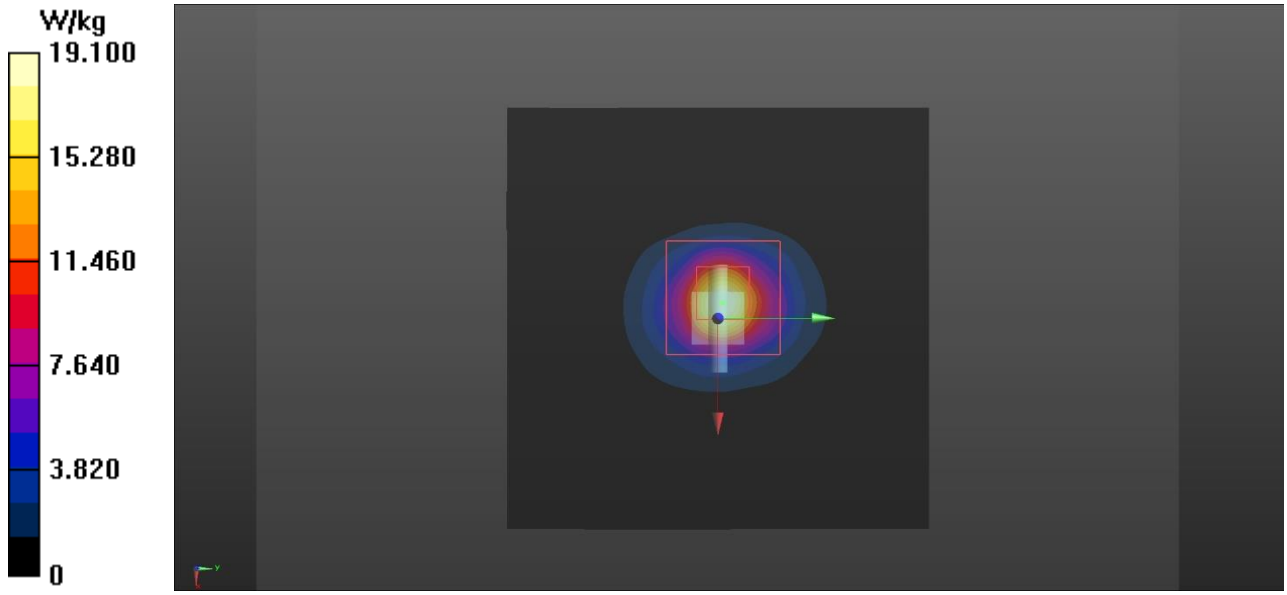
Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5750 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 5750 MHz; σ = 5.064 S/m; ε_r = 35.505; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.6, 4.6, 4.6) @ 5750 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5750MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 19.1 W/kg

Configuration/system check 5750MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 36.51 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 32.2 W/kg
SAR(1 g) = 7.19 W/kg; SAR(10 g) = 2.06 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.4 mm
Ratio of SAR at M2 to SAR at M1 = 60.7%
Maximum value of SAR (measured) = 18.3 W/kg



Plot 5

Date/Time: 18.1.23 13:19:34

Test Laboratory: Verkotan Oy

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1014

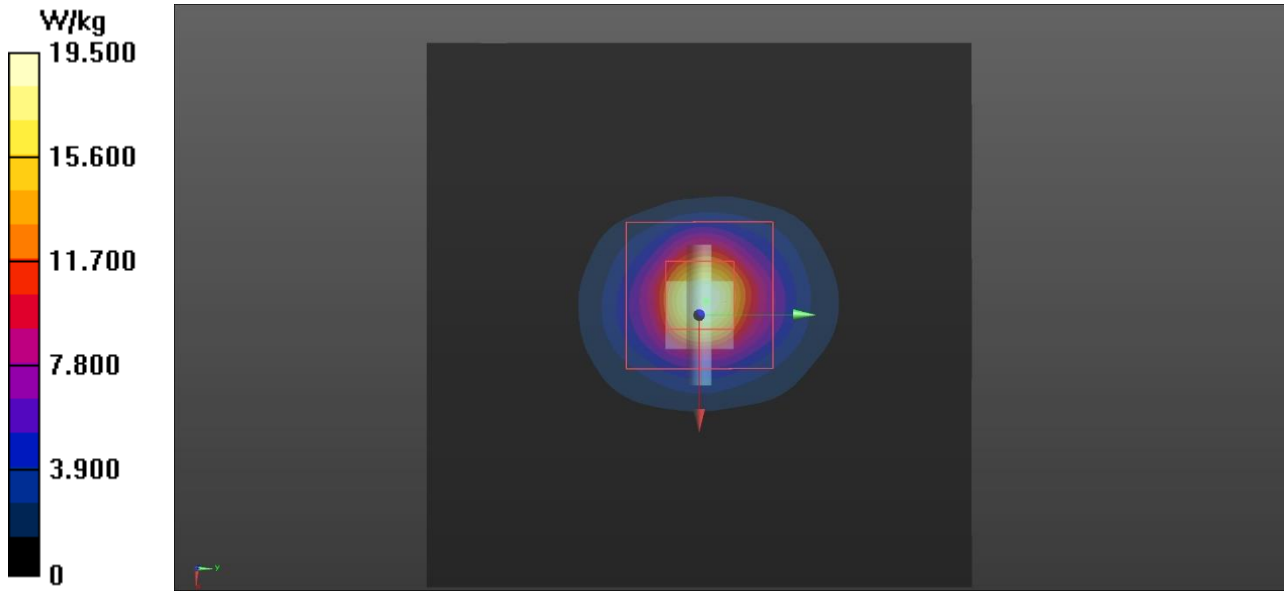
Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5750 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 5750 MHz; σ = 5.177 S/m; ε_r = 36.322; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.6, 4.6, 4.6) @ 5750 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5750MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 19.5 W/kg

Configuration/system check 5750MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 39.87 V/m; Power Drift = -0.41 dB
Peak SAR (extrapolated) = 32.9 W/kg
SAR(1 g) = 7.36 W/kg; SAR(10 g) = 2.1 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.5 mm
Ratio of SAR at M2 to SAR at M1 = 61.8%
Maximum value of SAR (measured) = 19.1 W/kg



APPENDIX C: MEASUREMENT SCAN

Plot 6

Date/Time: 16.1.23 09:39:40

Test Laboratory: Verkotan Oy

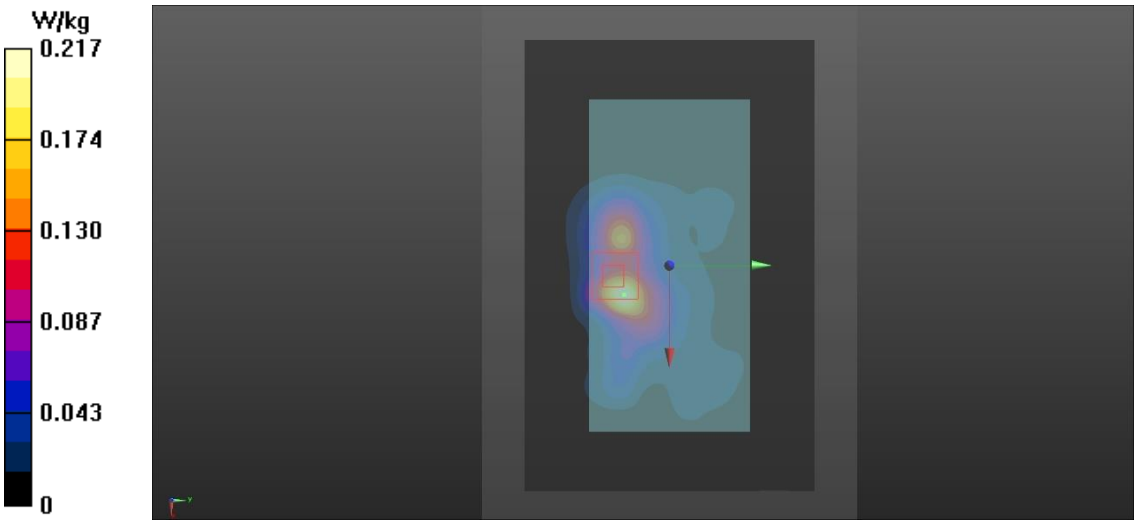
DUT: Neuronaute Plus

Communication System: UID 0, WLAN 2.4 (0); Communication System Band: WLAN2.4GHz; Frequency: 2462 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 2462 MHz; σ = 1.793 S/m; ε_r = 42.441; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.77, 7.77, 7.77) @ 2462 MHz; Calibrated: 28.2.22
  - 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: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

WLAN 2.4, CH11, 802.11b Front 5mm DB25 extender/Area Scan (141x91x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.217 W/kg
WLAN 2.4, CH11, 802.11b Front 5mm DB25 extender/Zoom Scan (9x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.664 V/m; Power Drift = 0.52 dB
Peak SAR (extrapolated) = 0.487 W/kg
SAR(1 g) = 0.202 W/kg; SAR(10 g) = 0.083 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 6.3 mm
Ratio of SAR at M2 to SAR at M1 = 47.9%
Maximum value of SAR (measured) = 0.363 W/kg



Test Laboratory: Verkotan Oy

DUT: Neuronaute Plus

Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5300 MHz;
Communication System PAR: 0 dB;
Medium parameters used (interpolated): f = 5300 MHz; σ = 4.654 S/m; ε_r = 37.581; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

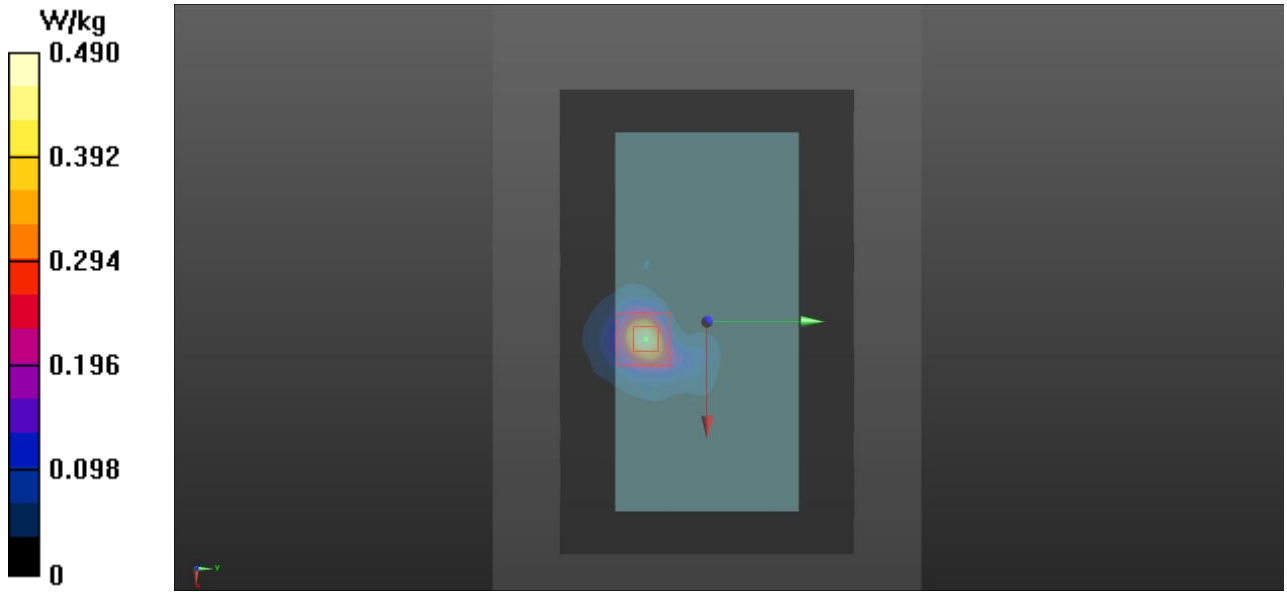
DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(5.2, 5.2, 5.2) @ 5300 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 15.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

WLAN 5GHz, CH60, 802.11a Front 5mm/Zoom Scan (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 10.40 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.823 W/kg
SAR(1 g) = 0.217 W/kg; SAR(10 g) = 0.068 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 6.8 mm
Ratio of SAR at M2 to SAR at M1 = 64.4%
Maximum value of SAR (measured) = 0.490 W/kg

WLAN 5GHz, CH60, 802.11a Front 5mm/Area Scan (191x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.502 W/kg



Date/Time: 19.1.23 08:20:39

Test Laboratory: Verkotan Oy

DUT: Neuronaute Plus

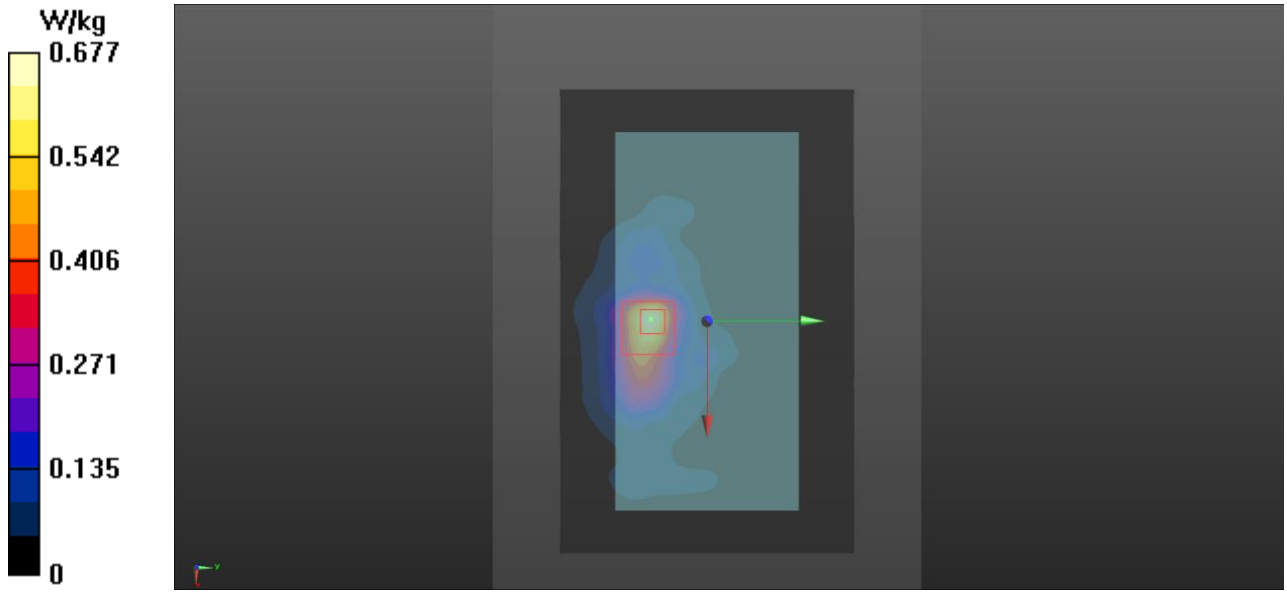
Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5720 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 5720 MHz; σ = 5.14 S/m; ε_r = 36.382; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.6, 4.6, 4.6) @ 5720 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 15.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

WLAN 5GHz, CH144, 802.11a Front 5mm/Zoom Scan (9x9x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 10.92 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 1.19 W/kg
SAR(1 g) = 0.294 W/kg; SAR(10 g) = 0.102 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 9.1 mm
Ratio of SAR at M2 to SAR at M1 = 60.5%
Maximum value of SAR (measured) = 0.677 W/kg

WLAN 5GHz, CH144, 802.11a Front 5mm/Area Scan (191x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.557 W/kg



Date/Time: 19.1.23 13:39:01

Test Laboratory: Verkotan Oy

DUT: Neuronaute Plus

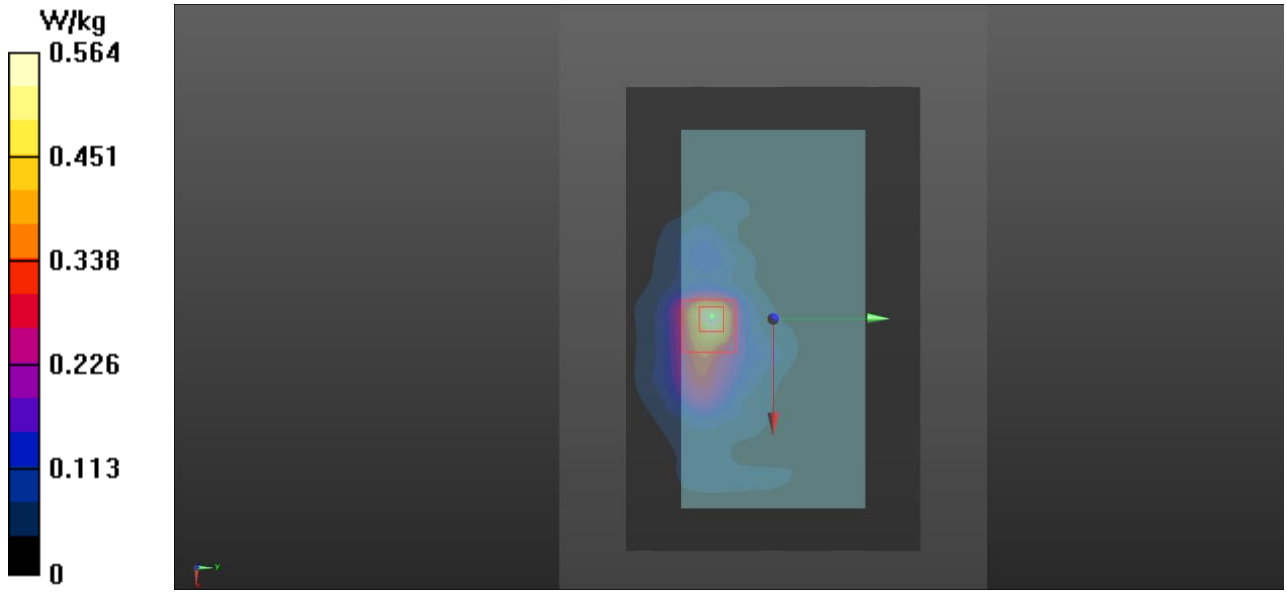
Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5745 MHz;
Communication System PAR: 0 dB;
Medium parameters used (interpolated): f = 5745 MHz; σ = 5.173 S/m; ε_r = 36.327; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.6, 4.6, 4.6) @ 5745 MHz; Calibrated: 28.2.22
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 15.0
  - Electronics: DAE4 Sn705; Calibrated: 12.4.22
  - Phantom: SAR1_Phantom 1_triple flat; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

WLAN 5GHz, CH149, 802.11a Front 5mm/Area Scan (191x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.564 W/kg

WLAN 5GHz, CH149, 802.11a Front 5mm/Zoom Scan (9x9x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 11.13 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 1.20 W/kg
SAR(1 g) = 0.296 W/kg; SAR(10 g) = 0.103 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 8.8 mm
Ratio of SAR at M2 to SAR at M1 = 60.4%
Maximum value of SAR (measured) = 0.692 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION

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

S C S **Schweizerischer Kalibrierdienst**
Service suisse d'étalonnage
Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client Verkotan **Certificate No: EX3-7447_Feb22**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7447
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes
Calibration date:	February 28, 2022

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	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: CC2552 (20x)	09-Apr-21 (No. 217-03343)	Apr-22
DAE4	SN: 660	13-Oct-21 (No. DAE4-660_Oct21)	Oct-22
Reference Probe ES3DV2	SN: 3013	27-Dec-21 (No. ES3-3013_Dec21)	Dec-22
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Aidonia Georgiadou	Laboratory Technician	
Approved by:	Niels Kuster	Quality Manager	

Issued: March 1, 2022

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]	0.40	0.43	0.44	± 10.1 %
DCP (mV)[B]	93.5	95.0	96.2	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	155.9	±2.5 %	± 4.7 %
		Y	0.0	0.0	1.0		167.3		
		Z	0.0	0.0	1.0		159.8		

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 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.

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)
13	55.0	0.75	15.43	15.43	15.43	0.00	1.00	± 13.3 %
750	41.9	0.89	10.39	10.39	10.39	0.42	0.80	± 12.0 %
900	41.5	0.97	9.90	9.90	9.90	0.45	0.80	± 12.0 %
1750	40.1	1.37	8.42	8.42	8.42	0.28	0.85	± 12.0 %
1950	40.0	1.40	8.13	8.13	8.13	0.26	0.85	± 12.0 %
2150	39.7	1.53	8.14	8.14	8.14	0.25	0.85	± 12.0 %
2300	39.5	1.67	8.09	8.09	8.09	0.21	0.90	± 12.0 %
2450	39.2	1.80	7.77	7.77	7.77	0.15	0.90	± 12.0 %
2600	39.0	1.96	7.61	7.61	7.61	0.24	0.90	± 12.0 %
3300	38.2	2.71	6.85	6.85	6.85	0.30	1.30	± 13.1 %
5250	35.9	4.71	5.20	5.20	5.20	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.50	4.50	4.50	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.60	4.60	4.60	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

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: D2450V2-729_Jul22**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:729
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz
Calibration date:	July 15, 2022

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-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 7349	31-Dec-21 (No. EX3-7349_Dec21)	Dec-22
DAE4	SN: 601	02-May-22 (No. DAE4-601_May22)	May-23

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Aidonia Georgiadou	Laboratory Technician	
Approved by:	Niels Kuster	Quality Manager	

Issued: July 19, 2022

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.9 ± 6 %	1.85 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.5 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.1 Ω + 0.8 jΩ
Return Loss	- 30.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.147 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG

SAR Reference Dipole Calibration Report

Ref : ACR.84.7.20.MVGB.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 5000 MHZ
SERIAL NO.: SN 1014

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

ilac-MRA cofrac ETALONNAGE

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

0.0Summary:

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).

	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

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 %.	
5000-6000	20.6±1 %.	-	40.3 ±1 %.	-	d1 - 3.6 ±1 %. d2 – 2.1 ±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 EPGO333
Liquid	Head Liquid Values 5250 MHz: eps' :35.64 sigma : 4.67 Head Liquid Values 5600 MHz: eps' :36.66 sigma : 5.17 Head Liquid Values 5750 MHz: eps' :35.31 sigma : 5.21
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=4mm/dy=4m/dz=2mm
Frequency	5250 MHz 5600 MHz 5750 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,')		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 %	
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 %	
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 %	36.66	5.07 ±10 %	5.17
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 %	

7.3 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		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
5200	76.5		21.6	
5250	-	77.65 (7.77)	-	22.22 (2.22)
5500	83.3		23.4	
5600	-	83.31 (8.33)	-	24.02 (2.40)
5750	-	75.18 (7.52)	-	21.96 (2.20)
5800	78.0		21.9	

