SAR Compliance Test Report

Date of Report:	7/11/2024	**Client's Contact person:**	Arezki Guerrab
Number of pages:	38		
		Responsible Test engineer:	Ilari Kinnunen
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**PARROT DRONES** 174 quai de Jemmapes 75010 Paris France

Tested device:	**Skycontroller UKR**
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** **IEC/IEEE 62209-1528, 2020** Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices **RSS-102, Issue 6, 2023** Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
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:

07.11.2024

Miia Nurkkala

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	Skycontroller UKR
Manufacturer:	PARROT DRONES
Model:	MPP U2
Serial Number:	PI040507AA4E000059
Hardware Version:	HW_04
FCC ID Number:	2AG6IMPPU2 Contains FCC ID: VPYLBAA0QB1SJ
ISED ID Number:	21053-MPPU2 Contains IC: 772C-LBAA0QB1SJ
DUT Number:	20265
Battery Type used in testing:	Li-Ion Battery
State of the Sample:	Production sample

Testing information:

Testing performed:	28.10.2024 – 05.11.2024
Notes:	-
Document history & changes:	Initial version
Document ID:	FCC ISED_SAR report_Skycontroller UKR_ID6824_07112024.docx
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Ilari Kinnunen
FCC Test Firm Designation Number:	FI0005
ISED Company Number:	22218

1.2 Maximum Results

The maximum reported* Body-worn SAR values 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) and Health Canada's RF exposure guideline, Safety Code 6 for Head/Body SAR_{1g} is 1.6 W/kg.

1.2.1 Standalone SAR

System	Highest Reported* SAR_{1g}[W/kg] in Body-Worn Exposure Condition, 0mm separation distance	Result
2.4 GHz Mars	0.003	PASS
LoRa	0.02	PASS

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

1.2.2 Simultaneous Transmission SAR

1.2.2.1 FCC

Highest Simultaneous Transmission SAR	SAR_{1g}[W/kg] in Body-Worn Exposure Condition	Result
2.4 GHz Mars + LoRa	0.06	PASS

1.2.2.2 ISED

Highest Simultaneous Transmission SAR	SAR_{1g}[W/kg] in Body-Worn Exposure Condition	Result
2.4 GHz Mars + LoRa	0.57	PASS

1.2.3 Maximum Drift

Maximum Drift During Measurements	1.27dB*

*Larger than 5% drifts included to scaling factors

1.2.4 Measurement Uncertainty

SAR 1g: 0.3 – 3 GHz:

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

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is a drone controller that supports 2.4 GHz Mars and LoRa wireless technologies. The DUT supports two antennas for 2.4 GHz Mars, which cannot transmit simultaneously, and one antenna for LoRa. Antennas are located in the green highlighted area in the picture below.

According to "MPPUA2_Mars & LoRa_Radiation patterns_DRAFT_24042024" the maximum antenna gain for 2.4 GHz Mars is 8dBi and for Lora 2.5dBi.

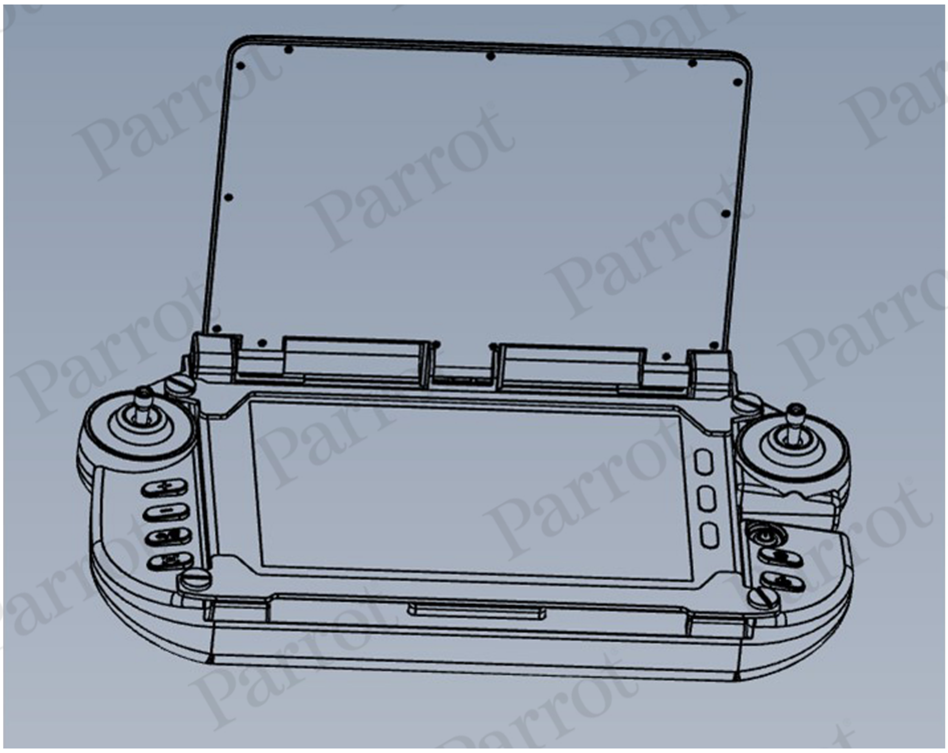


Figure 1. Overview of the DUT

Device Category	Portable
Exposure Environment	General population, uncontrolled

2.1 Supported Frequency Bands and Operational Modes

TX Frequency bands	Modes of Operation	Transmitter Frequency Range [MHz]
	LoRa	902.3 – 914.9
	2.4 GHz Mars	2402 – 2472

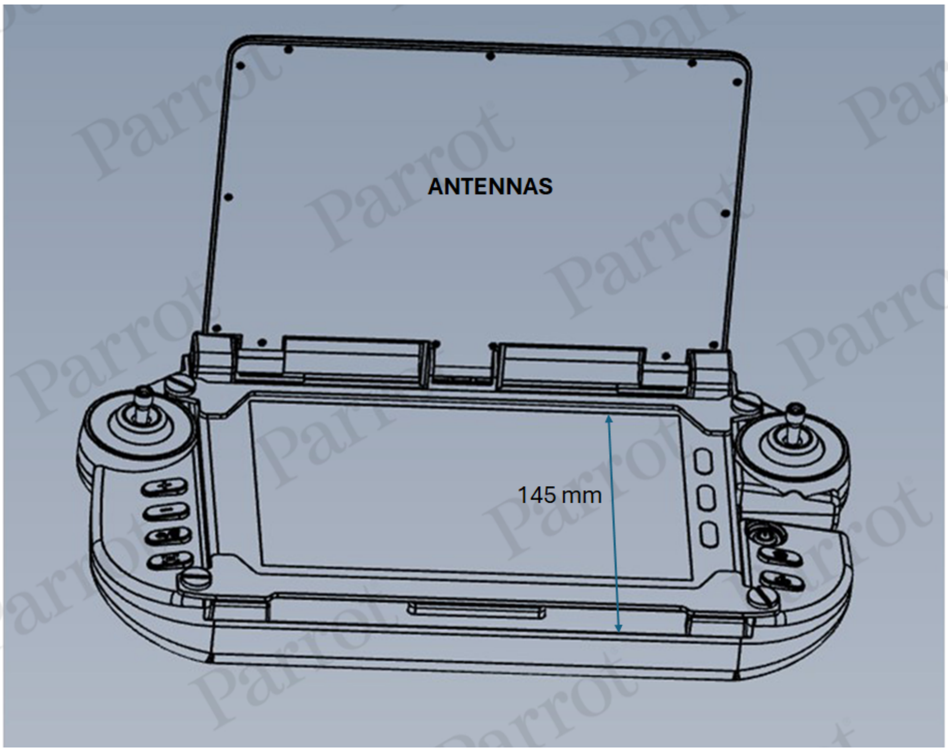
2.2 Simultaneous transmission

LoRa and 2.4GHz Mars can be operated simultaneously. Following simultaneous transmission combinations are supported:

LoRa + 2.4GHz Mars antenna 1
LoRa + 2.4GHz Mars antenna 2

2.3 Test Exemptions

The bottom side of the DUT is exempt from SAR testing due to 14.5cm separation distance.



2.3.1 FCC

300 MHz – 6 GHz:

FCC SAR test exclusion threshold is calculated according to 447498D04 Interim General RF Exposure Guidance, equation B.2 and B.1:

$$Pth\ (mW) = \begin{cases} ERP_{20\ cm}\ (d\ /\ 20cm)^{x} & d \leq 20cm \\ ERP_{20\ cm} & 20cm < d \leq 40cm \end{cases} \qquad \text{(Equation 1)}$$

where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \qquad \text{(Equation 2)}$$

and frequency f is in GHz, d is the separation distance (cm), and ERP20cm is per Equation (B.1) below.

$$ERP20cm\ (mW) = \begin{cases} 2040f & 0.3 \leq f < 1.5GHz \\ 3060 & 1.5GHz \leq f \leq 6GHz \end{cases} \qquad \text{(Equation 3)}$$

Transmission mode	Frequency [GHz]	Test Position	Separation distance [cm]	P_{th} [mW]
2.4 GHz Mars	2.472	Bottom	14.5	1659
LoRa	0.9023	Bottom	14.5	1149

2.3.1.1 Maximum defined Output Power and ERP

According to Appendix A at 447498D04 Interim General RF Exposure Guidance, the equation (B.2.) defines the thresholds for available maximum time-averaged power or maximum time-averaged ERP, whichever is greater. Since the ERP is higher than the maximum output power of the DUT for 2.4GHz Mars and LoRa, it is used for SAR test exclusion. Mars and LoRa use maximum duty cycles of 11.1% and 56.2% respectively.

Transmission mode	Output power [dBm]	Output power [mW]	Time-Averaged Output power [dBm]	Time-Averaged Output Power [mW]	Power Gain of Antenna, G [dBi]	ERP Output power [dBm]	ERP Output power [mW]	P_{th} [mW]
2.4 GHz Mars	25	316	15.5	35	8	21.3	**135**	**1659**
LoRa	22	1588	19.5	89	2.5	19.8	**97**	**1149**

Maximum time-averaged ERP of the DUT’s 2.4 GHz Mars transmitter is 21.3 dBm i.e. 135 mW and LoRa transmitter is 19.8 dBm i.e. 97 mW.

The maximum ERP for 2.4 GHz Mars and LoRa is below the test exclusion threshold.

2.3.2 ISED

SAR test exemption output power limits based on frequency and separation distance are from RSS-102, Issue 6, 2023:

Table 11: Power limits for exemption from routine SAR evaluation based on the separation distance

Frequency (MHz)	≤ 5 mm (mW)	10 mm (mW)	15 mm (mW)	20 mm (mW)	25 mm (mW)	30 mm (mW)	35 mm (mW)	40 mm (mW)	45 mm (mW)	> 50 mm (mW)
≤ 300	45	116	139	163	189	216	246	280	319	362
450	32	71	87	104	124	147	175	208	248	296
835	21	32	41	54	72	96	129	172	228	298
1900	6	10	18	33	57	92	138	194	257	323
2450	3	7	16	32	56	89	128	170	209	245
3500	2	6	15	29	50	72	94	114	134	158
5800	1	5	13	23	32	41	54	74	102	128

Transmission mode	Frequency [GHz]	Test Position	Separation distance [cm]	P_{th} [mW]
2.4 GHz Mars	2.472	Bottom	>5	243
LoRa	0.9023	Bottom	>5	300

2.3.2.1 Maximum defined Output Power and EIRP

According to RSS-102, Issue 6, Table 11 defines the thresholds for available maximum time-averaged power or maximum time-averaged EIRP, whichever is greater. Since EIRP is higher than the maximum output power of the DUT for 2.4GHz Mars and LoRa, it is used for SAR test exclusion. Mars and LoRa use maximum duty cycles of 11.1% and 56.2% respectively.

Transmission mode	Output power [dBm]	Output power [mW]	Time-Averaged Output Power [dBm]	Time-Averaged Output Power [mW]	Power Gain of Antenna, G [dBi]	EIRP Output power [dBm]	EIRP Output power [mW]	P_{th} [mW]
2.4 GHz Mars	25	316.2	15.5	35	8	23.5	**221**	**243**
LoRa	22	158.5	19.5	89	2.5	22.0	**158**	**300**

Maximum time-averaged output power of the DUT's 2.4 GHz transmitter is 23.45 dBm i.e. 221.5 mW and LoRa transmitter is 22.0 dBm i.e. 158.4 mW.

The maximum EIRP for 2.4 GHz Mars and LoRa is below the test exclusion threshold.

3. OUTPUT POWER

3.1 Maximum specified conducted output power

From the customer, including tune-up tolerances;

Technology	Max Output Power [dBm]
LoRa	22

Technology	Max Output Power [dBm]
2.4 GHz Mars	25

3.2 Tested conducted power

Measured conducted output power at transmitting antenna connector;

Technology	Antenna	Frequency [MHz]	Output Power [dBm]
2.4 GHz Mars	1	2407	24.03
2.4 GHz Mars	1	2437	23.95
2.4 GHz Mars	1	2467	23.95
2.4 GHz Mars	2	2407	24.4
2.4 GHz Mars	2	2437	24.71
2.4 GHz Mars	2	2467	24.81

Technology	Frequency [MHz]	Output Power [dBm]
LoRa	902.4	20.44
LoRa	914.2	20.19

4. TEST EQUIPMENT

Dasy 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.

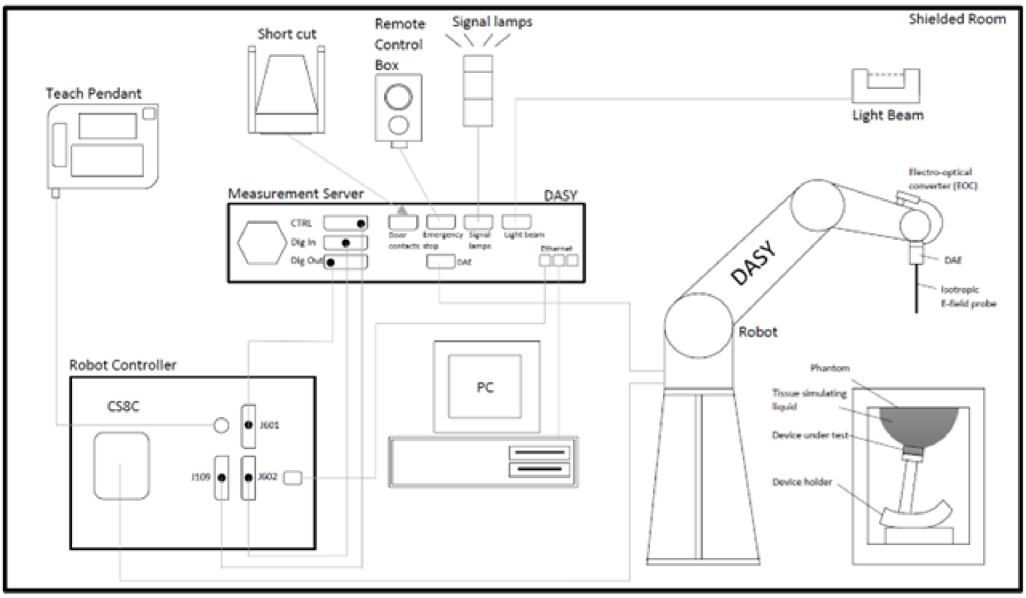


Figure 2 Schematic Laboratory Picture

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	Interval [years]
Amplifier, 800MHz-4200MHz, 10W	10S1G4A	320421	NA	NA
Amplifier, 500-8000MHz	ZX60-83LN12+	NA	NA	NA
DAE4, converter	DAE4	1332	02/2024	1
Directional Power sensor	NRT-Z44	107780	02/2024	1
Inline Peak Power Sensor	MA24105A	2102058	10/2023	1
Power Sensor	NRP8S	1419.0006K02-108508-HC	09/2023	2
Power Sensor	NRP8S	1419.0006K02-108509-Zh	03/2024	2
Isotropic DOS probe	EX3DV4	7447	02/2024	1
Network Analyzer	E5071B	MY42301191	03/2024	1
Power reflection meter	NRT	835065/049	02/2024	3
System validation dipole	D2450V2	729	07/2022	3
System validation dipole	D900V2	059	03/2023	3
Vector Signal Generator	MG3710E	6262028676	11/2023	1
Vector Signal Generator	MG3710A	6201502519	NA	NA

Dipole calibration period supporting data:

		Measured on 09/2024			Calibrated		
Dipole and Serial Number	Frequency [MHz]	Return Loss [dB]	Impedance [Ω]		Return Loss [dB]	Impedance [Ω]	
D900V2-SN:059	900	-23.9	55.4	4.0	-23.57	50.4	6.7
D2450V2-729	2450	-32.1	50.4	-2.5	-30.1	53.1	0.8

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	4 MHz to 10 GHz (dosimetry) Linearity: ± 0.2 dB (30 MHz to 10 GHz)
Directivity (typical)	±0.1 dB in TSL (rotation around probe axis) ±0.3 dB in TSL (rotation normal to probe axis)
Dynamic Range	10 µW/g – >100 mW/g Linearity: ±0.2 dB (noise: typically <1 µW/g)
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 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 IEC/IEEE 62209-1528 and FCC published RF Exposure KDB Procedures.

4.3 Tissue Simulants

Recommended values for the dielectric parameters of the tissue simulants are given in IEC/IEEE 62209-1528 and FCC published RF Exposure KDB Procedures. The dielectric parameters of the used tissue simulants were within ±10% of the recommended values at frequencies below 3GHz. A liquid compensation algorithm was used in DASY 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, tween, salt

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]	Date
900	D900V2 - SN: 120	EX3DV4 - SN: 7447	CW	DAE 4 /1332	39.98	0.92	03/24
2450	D2450V2 - SN: 729	EX3DV4 - SN: 7447	CW	DAE 4 / 1332	36.41	1.67	03/2024

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 #
28.10.24	WB Head	22	2450	250	12.2	52.3	48.8	-6.7%	1
30.10.24	WB Head	22	2450	250	12	52.3	48.0	-8.2%	2
31.10.24	WB Head	22	2450	100	5.4	52.3	54.0	3.3%	3
04.11.24	WB Head	22	900	250	2.76	10.54	11.04	4.7	4

4.6 Tissue Simulant Verification

				Measured		Target		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 [%]
28.10.24	WB Head	22	2450	39.2	1.80	41.1	1.89	4.9	5.1
28.10.24	WB Head	22	2407	39.3	1.76	41.2	1.86	4.9	5.6
28.10.24	WB Head	22	2437	39.2	1.79	41.1	1.88	4.9	5.3
28.10.24	WB Head	22	2467	39.2	1.82	41.1	1.90	4.9	4.8
30.10.24	WB Head	22	2450	39.2	1.80	40.0	1.88	2.1	4.2
30.10.24	WB Head	22	2407	39.3	1.76	40.1	1.85	2.1	4.7
30.10.24	WB Head	22	2437	39.2	1.79	40.1	1.87	2.1	4.4
30.10.24	WB Head	22	2467	39.2	1.82	40.0	1.89	2.1	3.8
31.10.24	WB Head	22	2450	39.2	1.80	40.6	1.88	3.6	4.3
31.10.24	WB Head	22	2407	39.3	1.76	40.7	1.85	3.6	4.9
31.10.24	WB Head	22	2437	39.2	1.79	40.6	1.87	3.6	4.5
31.10.24	WB Head	22	2467	39.2	1.82	40.6	1.89	3.5	3.9
04.11.24	WB Head	22	900	41.5	0.97	43.7	1.04	5.3	7.2
04.11.24	WB Head	22	902.4	41.5	0.97	43.7	1.04	5.3	7.2
04.11.24	WB Head	22	914.2	41.5	0.98	43.6	1.05	5.2	7.2

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publications 447498 D04 Interim General RF Exposure Guidance v01 and RSS-102, Issue 6.

Test configurations for SAR testing were selected based on conducted power measurements. Low, mid and high frequency channels for the configuration with the highest SAR value were tested as per ISED notice 2016-DRS001.

The DUT was set to transmit at maximum power and duty cycle using test software. 2.4 GHz Mars and LoRa use maximum duty cycles of 11.1% and 56.2% respectively.

Controller joysticks were removed for the SAR testing to enable 0mm separation distance to the SAR phantom.

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 Body-worn exposure condition, 0mm separation distance

Body SAR was tested from the front, back, left and right side of the device. The device was placed in the SPEAG holder/on the top of a Rohacell and lifted towards the phantom until the distance between the phantom and the device was 0mm.

The bottom side of the DUT was exempt from SAR testing due to separation distance of 14.5cm from the antennas.

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 Dasy 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.

Verkotan

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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%
CF_{drift}	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%
Δ_{sys}	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_c)	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%
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						±11.0%	±10.9%
U	**Expanded Uncertainty**						±22.1%	±21.9%

7. TEST RESULTS

7.1 SAR Results for Body Exposure Condition with 0mm separation

Band	Frequency [MHz]	Maximum Power [dBm]	Conducted Power [dBm]	Test position	Measured SAR_{1g} [W/kg]	Power Drift [dB]***	Duty Cycle [%]	Scaling Factor	Reported SAR_{1g} [W/kg]	Plot #
2.4 GHz Mars	2407	25	24.03	Front	0.00222	0**	11.1	1.25	0.003	5
2.4 GHz Mars	2407	25	24.03	Back	0*	0**	11.1	1.25	0*	
2.4 GHz Mars	2407	25	24.03	Left	0.000904	-0.57	11.1	1.43	0.001	
2.4 GHz Mars	2407	25	24.03	Right	0*	0**	11.1	1.25	0*	
2.4 GHz Mars	2437	25	23.95	Front	0*	0**	11.1	1.27	0*	
2.4 GHz Mars	2467	25	23.95	Front	0.00115	-0.91	11.1	1.57	0.002	
2.4 GHz Mars	2467	25	24.81	Front	0.00105****	-0.04	11.1	1.04	0.001	
2.4 GHz Mars	2467	25	24.81	Back	0*	0**	11.1	1.04	0*	
2.4 GHz Mars	2467	25	24.81	Left	0*	0**	11.1	1.04	0*	
2.4 GHz Mars	2467	25	24.81	Right	0*	0**	11.1	1.04	0*	
2.4 GHz Mars	2407	25	2407	Front	0.00239	0**	11.1	1.00	0.002	
2.4 GHz Mars	2437	25	2437	Front	0.000249	0.79	11.1	1.00	0.0002	

*Due to low e-field generated by DUT, the measurements are not applicable
**Due to low e-field generated by DUT at the location of drift measurement, the measurements are not applicable
***Larger than 5% drifts included to scaling factors
****Due to the low E-field, only area scan result is available

Band	Frequency [MHz]	Maximum Power [dBm]	Conducted Power [dBm]	Test position	Measured SAR_{1g} [W/kg]	Power Drift [dB]***	Duty Cycle [%]	Scaling Factor	Reported SAR_{1g} [W/kg]	Plot #
LoRa	902.4	22	20.44	Front	0.0115	0**	56.2	1.43	0.02	6
LoRa	902.4	22	20.44	Back	0.000551	0**	56.2	1.43	0.001	
LoRa	902.4	22	20.44	Left	0.00573	0.66	56.2	1.67	0.01	
LoRa	902.4	22	20.44	Right	0.00637	0**	56.2	1.43	0.01	
LoRa	914.2	22	20.32	Front	0*	0**	56.2	1.47	0*	

*Due to low e-field generated by DUT, the measurements are not applicable
**Due to low e-field generated by DUT at the location of drift measurement, the measurements are not applicable
***Larger than 5% drifts included to scaling factors

7.2 Zoom Scan Compliance

According to IEC/IEEE 62209-1528:2020, subclause 7.4.2 d.4), the zoom scan complies if the peak spatial-average SAR is below 0.1 W/kg, or if the following criteria is met:

1. The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak is larger than the horizontal grid step.

2. Ratio of SAR at the second measured point (M2) to the SAR at the closest measured point (M1) at the x-y location of the measured maximum is at least 30%.

Zoom scan compliance according to IEC/IEEE 62209-1528:2020 is automatically verified by DASY software and all zoom scans in this test report do pass the criteria. The horizontal distance and Ratio between measurement points M2 and M1 of the highest SAR results is available in Appendix C.

7.3 Estimated SAR

7.3.1 FCC

For simultaneous transmission evaluation the estimated standalone SAR values are calculated according to the following equation below.

$$\mathrm{SARestimated} = 0.4 * \mathrm{Pant/Pth}\ [\mathrm{w/kg}] \qquad \text{(Equation 4)}$$

Estimated 2.4 GHz Mars SAR = 0.4*(135/1659) = 0.03 W/kg

Estimated LoRa SAR = 0.4*(97/1149) = 0.03 W/kg

7.3.2 ISED

The estimated SAR value is evaluated according to the following equation stated in RSS-102, Issue 6, Section "7.1.8. SAR estimation for exempted transmitters":

$$SARestimated = \frac{Pmax}{Pmax, exemption} * 0.25 * SARlimit\ W/kg$$

where:

- $Pmax$ is the maximum power level including tune-up tolerance for the exempted transmitter
- $Pmax,exemption$ is the maximum power level of exemption at the same frequency and distance for the exempted transmitter
- $SARlimit$ is the applicable SAR limit (e.g. 1.6 W/kg for 1 g or 4 W/kg for 10 g)

Estimated 2.4 GHz Mars SAR = (221/243)*0.25*1.6 = 0.36 W/kg

Estimated LoRa SAR = (158/300)*0.25*1.6 = 0.21 W/kg

7.4 Simultaneous Transmission Analysis

7.4.1 FCC

Simultaneous transmission analysis for the maximum LoRa SAR and 2.4 GHz Mars SAR is in the table below. Direct summation of SAR results was performed.

Body SAR:

Exposure Condition	Body SAR_{10g} [W/kg]				
Test Position	Front	Back	Left	Right	Bottom
Maximum LoRa SAR	0.003	0*	0.001	0*	0.03
Maximum 2.4 GHz Mars SAR	0.02	0.001	0.01	0.01	0.03
SAR Summation	0.02	0.001	0.01	0.01	**0.06**

*Due to low e-field generated by DUT, the measurements are not applicable

7.4.2 ISED

Simultaneous transmission analysis for the maximum LoRa SAR and 2.4 GHz Mars SAR is in the table below. Direct summation of SAR results was performed.

Body SAR:

Exposure Condition	Body SAR_{10g} [W/kg]				
Test Position	Front	Back	Left	Right	Bottom
Maximum LoRa SAR	0.003	0*	0.001	0*	0.36
Maximum 2.4 GHz Mars SAR	0.02	0.001	0.01	0.01	0.21
SAR Summation	0.02	0.001	0.01	0.01	**0.57**

*Due to low e-field generated by DUT, the measurements are not applicable

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 28.10.24 14:05:36

Test Laboratory: Verkotan Oy

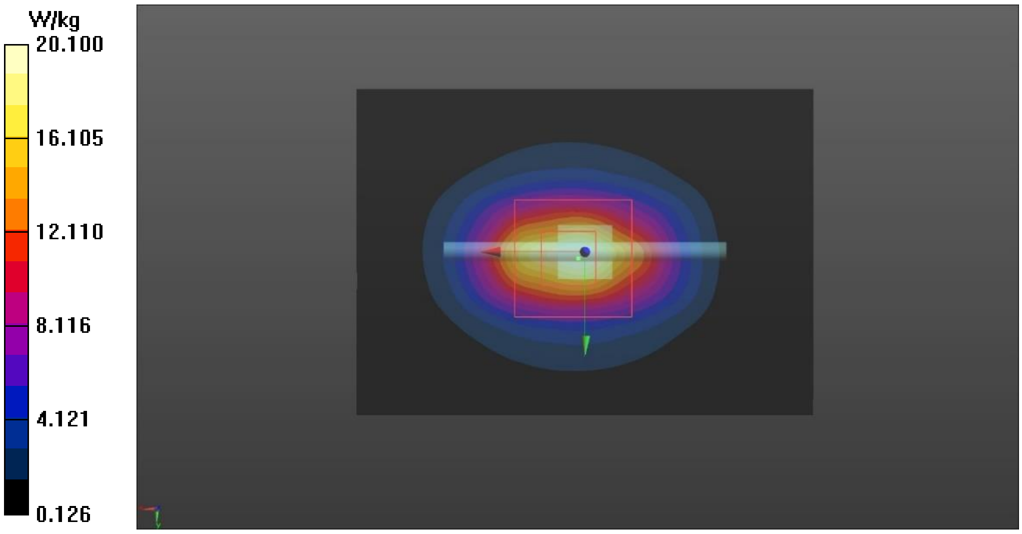
DUT: Dipole 2450 MHz D2450V2

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 = 1.892 S/m; ε_r = 41.126; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.59, 7.49, 7.65) @ 2450 MHz; Calibrated: 23.2.24
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
  - Electronics: DAE4 Sn1332; Calibrated: 14.2.24
  - Phantom: SAR1_Phantom 1_triple flat right; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/System check 2450 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 87.71 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 24.4 W/kg
SAR(1 g) = 12.2 W/kg; SAR(10 g) = 5.78 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 = 50.6%
Maximum value of SAR (measured) = 20.1 W/kg
Configuration/System check 2450 MHz/Area Scan (71x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 22.5 W/kg



Plot 2

Date/Time: 30.10.24 07:57:36

Test Laboratory: Verkotan Oy

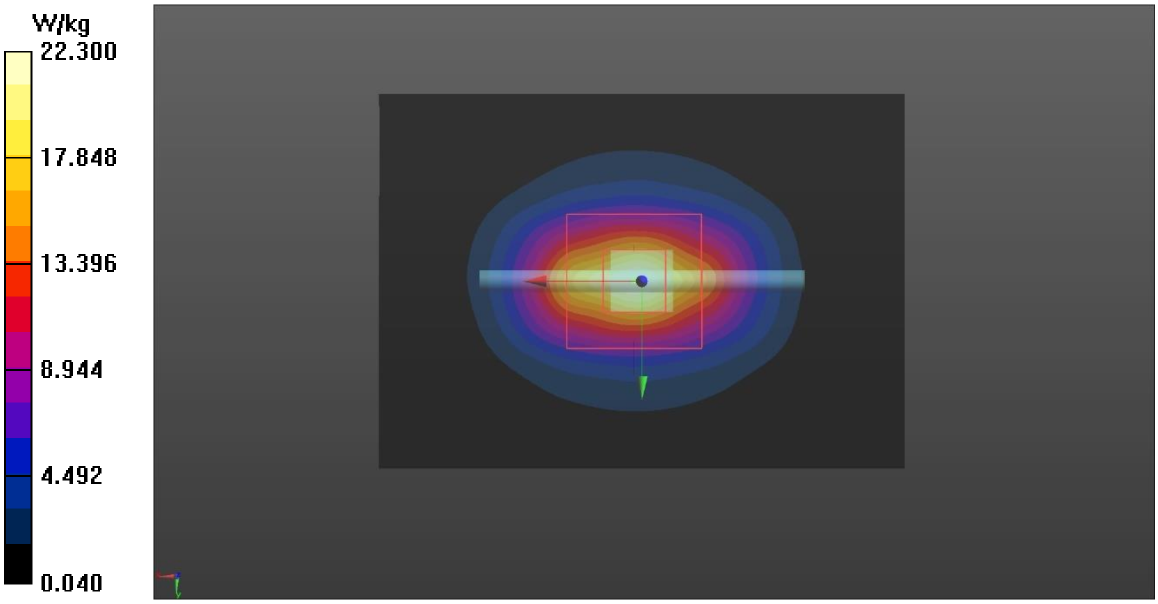
DUT: Dipole 2450 MHz D2450V2

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 = 1.876 S/m; ε_r = 40.034; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.59, 7.49, 7.65) @ 2450 MHz; Calibrated: 23.2.24
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
  - Electronics: DAE4 Sn1332; Calibrated: 14.2.24
  - Phantom: SAR1_Phantom 1_triple flat right; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/System check 2450 MHz/Area Scan (71x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 22.3 W/kg
Configuration/System check 2450 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 87.00 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 24.0 W/kg
SAR(1 g) = 12 W/kg; SAR(10 g) = 5.67 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 = 51%
Maximum value of SAR (measured) = 20.0 W/kg



Date/Time: 31.10.24 08:57:46

Test Laboratory: Verkotan Oy

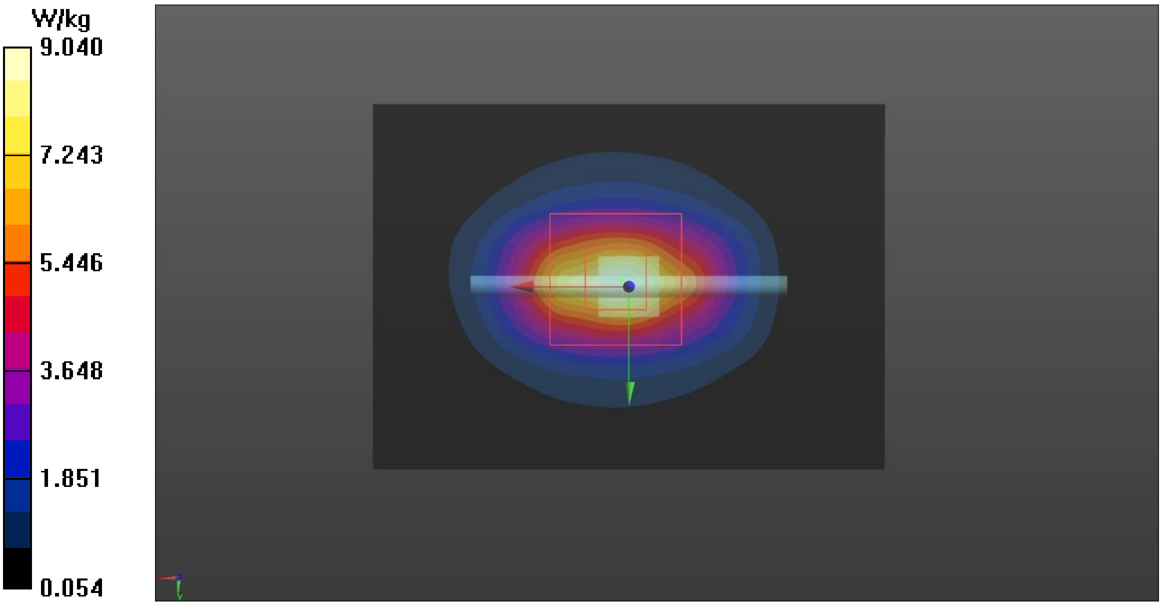
DUT: Dipole 2450 MHz D2450V2

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 = 1.878 S/m; ε_r = 40.594; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.59, 7.49, 7.65) @ 2450 MHz; Calibrated: 23.2.24
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
  - Electronics: DAE4 Sn1332; Calibrated: 14.2.24
  - Phantom: SAR1_Phantom 1_triple flat right; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/System check 2450 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 58.60 V/m; Power Drift = -0.18 dB
Peak SAR (extrapolated) = 10.9 W/kg
SAR(1 g) = 5.4 W/kg; SAR(10 g) = 2.54 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 = 50.7%
Maximum value of SAR (measured) = 9.04 W/kg
Configuration/System check 2450 MHz/Area Scan (71x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 9.78 W/kg



Plot 4

Date/Time: 4.11.24 10:57:43

Test Laboratory: Verkotan Oy

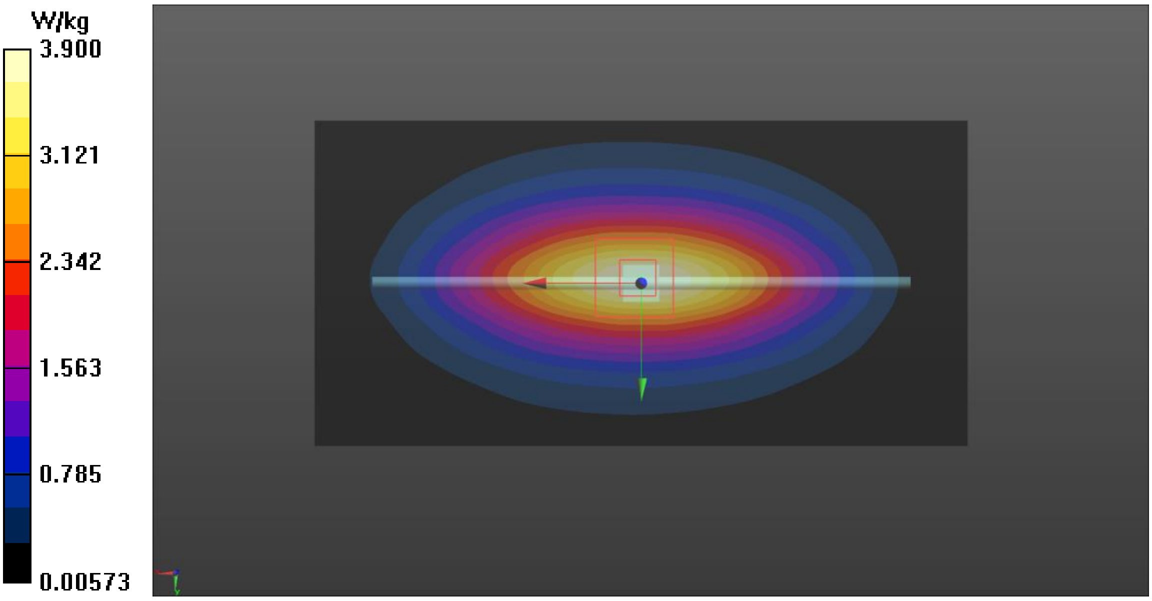
DUT: D900V2 - SN059

Communication System: UID 0, CW (0); Communication System Band: D900 (900.0 MHz); Frequency: 900 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 900 MHz; σ = 1.04 S/m; ε_r = 43.705; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.89, 9.05, 8.92) @ 900 MHz; Calibrated: 23.2.24
    - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
    - Electronics: DAE4 Sn1332; Calibrated: 14.2.24
    - Phantom: SAR1_Phantom 1_triple flat right; Type: QD 000 P51 Cx;
    - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

System check 900 MHz/Area Scan (121x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.90 W/kg
System check 900 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.79 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 4.25 W/kg
SAR(1 g) = 2.76 W/kg; SAR(10 g) = 1.79 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 18 mm
Ratio of SAR at M2 to SAR at M1 = 67.1%
Maximum value of SAR (measured) = 3.84 W/kg



APPENDIX C: MEASUREMENT SCANS

Plot 5

Date/Time: 29.10.24 08:17:28

Test Laboratory: Verkotan Oy

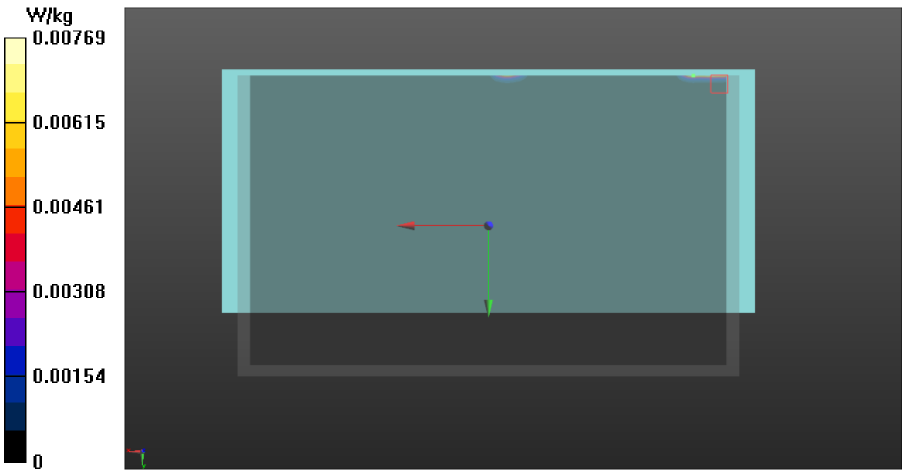
DUT: Skycontroller UKR

Communication System: UID 0, 2.4 GHz Proprietary (0); Communication System Band: 2.4 GHz Proprietary; Frequency: 2407 MHz; Communication System PAR: 9.508 dB;
Medium parameters used: f = 2407 MHz; σ = 1.861 S/m; ε_r = 41.201; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(7.59, 7.49, 7.65) @ 2407 MHz; Calibrated: 23.2.24
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Fix Surface), z = -4.0, 31.0
  - Electronics: DAE4 Sn1332; Calibrated: 14.2.24
  - Phantom: SAR1_Phantom 1_triple flat right; Type: QD 000 P51 Cx;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

FCC, 2.4 GHz Mars, 2407MHz, Antenna 1, Front 0mm/Area Scan (231x141x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.00769 W/kg
FCC, 2.4 GHz Mars, 2407MHz, Antenna 1, Front 0mm/Zoom Scan (9x10x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.441 V/m; Power Drift = -1.59 dB
Peak SAR (extrapolated) = 0.0190 W/kg
SAR(1 g) = 0.00222 W/kg; SAR(10 g) = n.a. (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 68.3%
Maximum value of SAR (measured) = 0.00751 W/kg



Date/Time: 4.11.24 13:06:17

Test Laboratory: Verkotan Oy

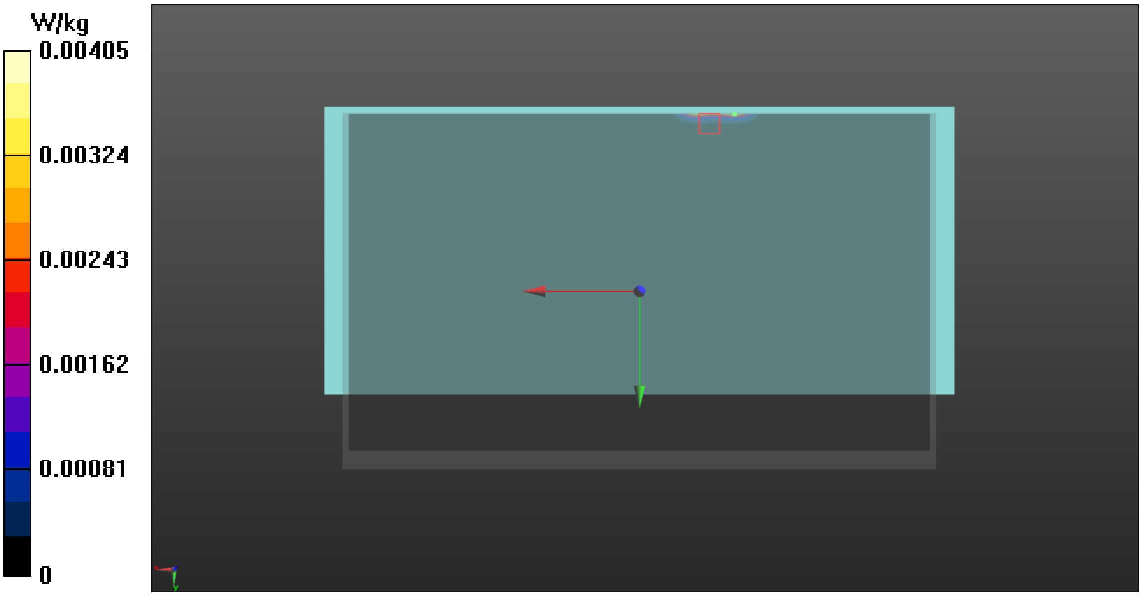
DUT: Skycontroller UKR

Communication System: UID 0, LoRA (0); Communication System Band: FCC; Frequency: 902.4 MHz;
Communication System PAR: 2.503 dB;
Medium parameters used (interpolated): f = 902.4 MHz; σ = 1.041 S/m; ε_r = 43.695; ρ = 1000 kg/m^3
Phantom section: Center Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(8.89, 9.05, 8.92) @ 902.4 MHz; Calibrated: 23.2.24
    - Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Fix Surface), z = -4.0, 31.0
    - Electronics: DAE4 Sn1332; Calibrated: 14.2.24
    - Phantom: SAR1_Phantom 1_triple flat right; Type: QD 000 P51 Cx;
    - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

FCC, LoRa, 902.4MHz, Front 0mm/Area Scan (191x111x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.00405 W/kg
FCC, LoRa, 902.4MHz, Front 0mm/Zoom Scan (9x10x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 0 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 0.0270 W/kg
SAR(1 g) = 0.011 W/kg; SAR(10 g) = n.a. (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 50.5%
Maximum value of SAR (measured) = 0.0237 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
C 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**
Oulu, Finland

Certificate No. **EX-7447_Feb24**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:7447

Calibration procedure(s): QA CAL-01.v10, QA CAL-12.v10, QA CAL-14.v7, QA CAL-23.v6, QA CAL-25.v8
Calibration procedure for dosimetric E-field probes

Calibration date: February 23, 2024

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 NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24
OCP DAK-3.5 (weighted)	SN: 1249	05-Oct-23 (OCP-DAK3.5-1249_Oct23)	Oct-24
OCP DAK-12	SN: 1016	05-Oct-23 (OCP-DAK12-1016_Oct23)	Oct-24
Reference 20 dB Attenuator	SN: CC2552 (20x)	30-Mar-23 (No. 217-03809)	Mar-24
DAE4	SN: 660	16-Mar-23 (No. DAE4-660_Mar23)	Mar-24
Reference Probe EX3DV4	SN: 7349	03-Nov-23 (No. EX3-7349_Nov23)	Nov-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-22)	In house check: Jun-24
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

	Name	Function	Signature
Calibrated by	Aidonia Georgiadou	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: February 23, 2024

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

Certificate No: EX-7447_Feb24 Page 1 of 9

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]	0.42	0.42	0.43	±10.1%
DCP (mV) [B]	93.9	92.0	99.2	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc[E] $k = 2$
0	CW	X	0.00	0.00	1.00	0.00	132.1	±2.0%	±4.7%
		Y	0.00	0.00	1.00		134.8		
		Z	0.00	0.00	1.00		127.6		

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

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Page 5).
[B] Linearization parameter uncertainty for maximum specified field strength.
[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:7447 February 23, 2024

Parameters of Probe: EX3DV4 - SN:7447

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	40.2°
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

Note: Measurement distance from surface can be increased to 3–4 mm for an Area Scan job.

Certificate No: EX-7447_Feb24 Page 4 of 9

Parameters of Probe: EX3DV4 - SN:7447

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc (k = 2)
13	55.0	0.75	17.59	17.59	17.59	0.00	1.25	±13.3%
750	41.9	0.89	9.63	9.05	9.58	0.34	1.27	±11.0%
900	41.5	0.97	8.89	9.05	8.92	0.34	1.27	±11.0%
1750	40.1	1.37	8.35	8.14	8.40	0.25	1.27	±11.0%
1950	40.0	1.40	7.96	7.80	8.03	0.27	1.27	±11.0%
2150	39.7	1.53	7.80	7.68	7.86	0.29	1.27	±11.0%
2300	39.5	1.67	7.75	7.61	7.75	0.29	1.27	±11.0%
2450	39.2	1.80	7.59	7.49	7.65	0.29	1.27	±11.0%
2600	39.0	1.96	7.53	7.40	7.55	0.28	1.27	±11.0%
5250	35.9	4.71	5.27	5.32	5.36	0.35	1.62	±13.1%
5600	35.5	5.07	4.42	4.45	4.52	0.35	1.75	±13.1%
5750	35.4	5.22	4.62	4.68	4.75	0.34	1.83	±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] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ε and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10% if SAR correction is applied.
[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.68.4.23.BES.A

VERKOTAN OY
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 900 MHZ
SERIAL NO.: 059

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

Calibration date: 03/09/2023

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

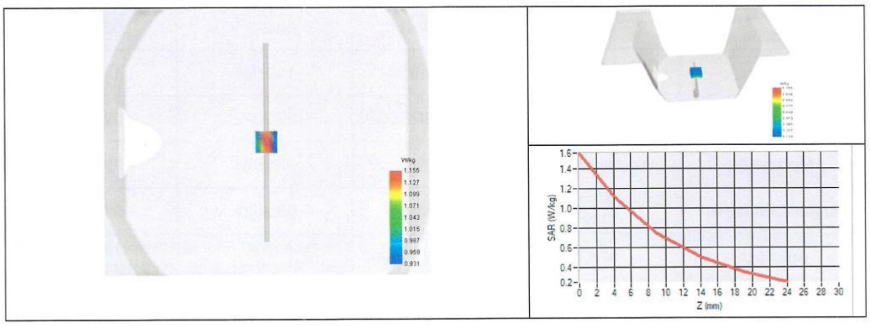
Summary:

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

Page: 1/8

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values: eps' : 43.9 sigma : 0.92
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	900 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

Frequency	1g SAR (W/kg)			10g SAR (W/kg)		
	Measured	Measured normalized to 1W	Target normalized to 1W	Measured	Measured normalized to 1W	Target normalized to 1W
900 MHz	1.05	10.54	10.90	0.67	6.73	6.99



Verkotan

FINAS
Finnish Accreditation Service
T287 (EN ISO/IEC 17025)

ilac-MRA

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

ilac-MRA

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

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

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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 cm^3 (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 cm^3 (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)**