

SAR Compliance Test Report

Date of Report	16/02/2023	Client's Contact person:	Morten Kristensen
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Tested device	Tron SA20		
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 RSS-102, Issue 5 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: 16.02.2023
For the contents:

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Device under Test (DUT):

Product:	Personal Locator Beacon
Manufacturer:	JOTRON
Model:	Tron SA20
HW ID	2137
Serial Number:	158, 151
FCC ID Number:	VRVTRONSA20
ISED ID Number:	2131A-TRONSA20
DUT Number:	21424
Battery Type used in testing:	Lithium Metal
State of the Sample	Production sample

Testing information:

Testing Performed:	14.12.2022 – 20.12.2022
Notes:	-
Document ID:	FCC SAR report_Trone SA20_ID5305_03022023.docx
Document history & changes:	This report replaces "FCC SAR report_Trone SA20_ID5305_09012023". Changed 121.5MHz normal use duty cycle from 98% to 96%.
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Ilari Kinnunen, Kalle Orava
FCC Test Firm Designation Number:	FI0005
ISED Company Number:	22218

1.2 Maximum Results

The maximum reported* SAR values for Body-worn condition 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 Body SAR_{1g} is 1.6 W/kg.

System	Highest Reported* SAR _{1g} (W/kg) in Body-Worn Condition, 0mm separation	Result
121.5 MHz	0.04	PASS
406 MHz	0.25	PASS

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

1.2.1 Maximum Drift

Maximum Drift During Measurements	0.84dB*
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*Drifts >5% have been considered in the scaling factor

1.2.2 Measurement Uncertainty

4MHz – 300MHz:

Expanded Uncertainty (k=2) 95 %	±22.9%
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300MHz – 3000MHz:

Expanded Uncertainty (k=2) 95 %	±22.1%
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2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is an emergency locator beacon, which transmit emergency signals during distress situations.

Device operates at the following duty cycles:

121.5 MHz = 96%

406 MHz = 1%



Device Category	Portable
Exposure Environment	Uncontrolled

2.1 Supported Frequency Bands and Operational Modes

TX Frequency bands	Transmitter Frequency Range [MHz]
	121.5
	406

3. OUTPUT POWER

3.1 Maximum Output Power

From the Customer, maximum defined output power, including measurement equipment tolerance and production tuning tolerance.

TX Frequency [MHz]	Max Output Power [dBm]
121.5	21.3
406	37.3

3.2 Tested conducted power

Measured conducted output power at transmitting antenna connector. Power measurements were carried out by TÜV SÜD Product Service at Fareham office.

TX Frequency [MHz]	Max Output Power [dBm]
121.5	20.74
406	36.58

4. TEST EQUIPMENT

Dasy52 near field scanning systems, manufactured by SPEAG were used for SAR testing. The test system consists of high precision robotics system (Staubli), robot controller, computer, near-field probe, probe alignment sensor, and a phantom containing the tissue equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location of maximum electromagnetic field.

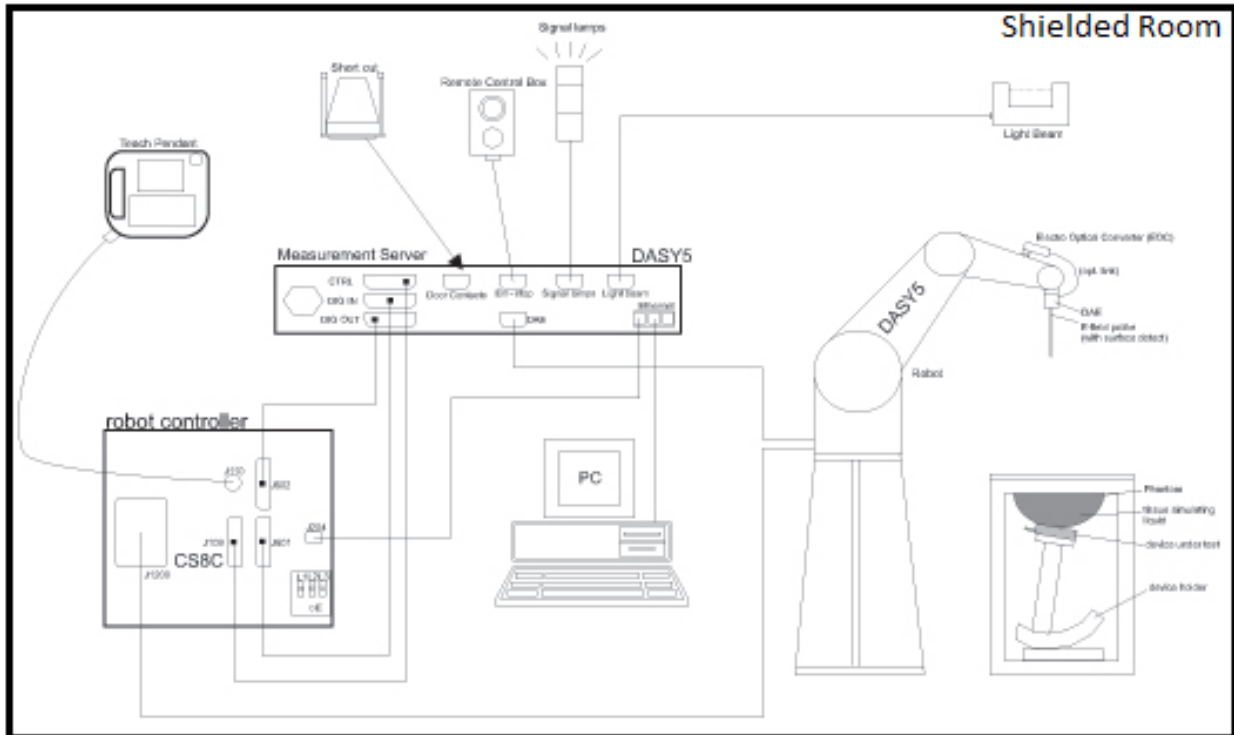


Figure 1 Schematic Laboratory Picture

4.1 Test Equipment List

Main used test system components are listed below. For full equipment list and calibration intervals, please contact the testing laboratory.

Test Equipment	Model	Serial Number	Calibration Date
DAE	DAE4	710	10.2022
Probe	EX3DV4	3852	10.2022
Dipole	CLA128	3006	07.2022
Dipole	DIP 0G450	434	02.2022
DASY5 Software	52.8.8.1258	-	NA
Signal Generator	MG3710A	6261911026	02.2021
Power Sensor	MA24105A	2102058	11.2022
Power Sensor	NRP8S	1419.0006K02-108509-Zh	08.2021 (2-year calibration interval)

4.1.1 Isotropic E-field Probe Type EX3DV4

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	Calibration certificate in Appendix D
Frequency	10 MHz to >6 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 μ W/g to > 100 mW/g, Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 10 mm Body diameter: 12 mm 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

Eli Phantom:

The phantom used in SAR tests was an ELI phantom, manufactured by SPEAG. ELI phantom is used for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the to the requirements of IEEE 1528 and FCC published RF Exposure KDB Procedures.

4.3 Tissue Simulants

Recommended values for the dielectric parameters of the tissue simulants are given in IEEE 1528 and FCC published RF Exposure KDB Procedures. The dielectric parameters of the used tissue simulants were within $\pm 10\%$ of the recommended values in all frequencies used. A liquid compensation algorithm was used in DASYS 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 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] Head tissue simulant	Conductivity σ [S/m] Head tissue simulant	Validation Done
							Head tissue simulant
128	CLA 128 / 3006	EX3DV4 / 3852	CW	DAE 4 / 710	50.94	0.79	12.2022
450	DIP 0G450 / 434	EX3DV4 / 3852	CW	DAE 4 / 710	42.53	0.94	12.2022

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 #
14.12.2022	LB Head	22	450	250	1.19	4.67	4.44	-4.9	1
15.12.2022	LB Head	22	450	250	1.23	4.67	4.76	1.9	2
19.12.2022	LB Head	22	128	250	0.857	3.41	3.428	0.5	3

4.5.1 Tissue Simulant Verification

Date	Tissue Type	Tissue Temp [°C]	Frequency [MHz]	Target		Measured		Deviation	
				Dielectric Constant [ε] Target	Conductivity σ [S/m] Target	Dielectric Constant [ε]	Conductivity σ [S/m]	ε (%)	σ (%)
14.12.2022	WB Head	22	406	44.03	0.87	43.13	0.92	-2.0	5.4
14.12.2022	WB Head	22	450	43.5	0.87	42.53	0.94	-2.2	8.5
15.12.2022	WB Head	22	406	44.03	0.87	43.41	0.92	-1.4	5.3
15.12.2022	WB Head	22	450	43.5	0.87	42.84	0.94	-1.5	8.5
19.12.2022	WB Head	22	121.5	52.94	0.76	51.16	0.79	-3.4	3.6
19.12.2022	WB Head	22	128	52.8	0.76	50.94	0.79	-3.5	4.0

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publications 447498 D04 Interim General RF Exposure Guidance v01 and ISED Canada RSS-102, Issue 5.

The DUT was measured using control software. Frequency of 406MHz was measured with higher duty cycle of 10.5%. Reported SAR values of 406MHz are scaled to its normal operating duty cycle of 1%. 121.5MHz was measured using duty cycle of 98%, overestimating the results as normal use duty cycle is 96%.

5.1 Test Positions

5.1.1 Body-worn Configuration, 0mm separation distance

The DUT was tested from all six sides. For all the positions, the device was lifted towards the phantom until the distance between the phantom and the device was 0mm. The area of the antenna was also scanned in all other positions except on the right side of the DUT as the position provides 62mm separation distance to the antenna that has already been scanned at 0 mm separation in left side test position.

Photos of the test positions are presented in APPENDIX A.

5.2 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. 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.

5.3 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%
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 _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%
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%

DASY5 Uncertainty Budget According to IEC/IEEE 62209-1528 (Frequency band: 4MHz - 300MHz 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	±13.3%	N	√2	1	1	±6.65%	±6.65%
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	±0.8%	R	√3	1	1	±0.5%	±0.5%
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	0.14	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}	±5.4%	R	√3	0.78	0.71	±2.4%	±2.2%
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						±11.4%	±11.3%
U	Expanded Uncertainty						±22.9%	±22.6%

7. TEST RESULTS

7.1 SAR Results for Body-worn Condition with 0 mm separation distance

121.5MHz:

Frequency [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g* [W/kg]	Power Drift [dB]	Scaling Factor	Reported SAR1g [W/kg]	Plot #
121.5	Front	21.3	20.74	0.012	-0.24	1.20	0.01	
121.5	Back	21.3	20.74	0.011	0.84	1.38	0.01	
121.5	Left	21.3	20.74	0.010	-0.24	1.20	0.01	
121.5	Right	21.3	20.74	0.000002***	N/A**	1.14	0.000002***	
121.5	Top	21.3	20.74	0.0000002	N/A**	1.14	0.0000002	
121.5	Bottom	21.3	20.74	0.031	0.51	1.28	0.04	4

*Measured with 98% duty cycle

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

***Due to low E-field generated by DUT, the zoom scan measurement is not applicable

406MHz:

Frequency [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g* [W/kg]	Power Drift [dB]	Scaling Factor	Normal Duty Cycle [%]	Reported SAR1g [W/kg]	Plot #
406	Front	37.3	36.58	1.75	0.03	1.18	1	0.20	
406	Back	37.3	36.58	1.56	-0.31	1.27	1	0.20	
406	Left	37.3	36.58	2.13	0.06	1.18	1	0.25	5
406	Right	37.3	36.58	0.81	0.24	1.25	1	0.10	
406	Top	37.3	36.58	0.39	-0.16	1.18	1	0.05	
406	Bottom	37.3	36.58	0.38	-0.68	1.38	1	0.05	

*Measured with 10.5% duty cycle

7.2 IEC 62209-2 AMD1:2019

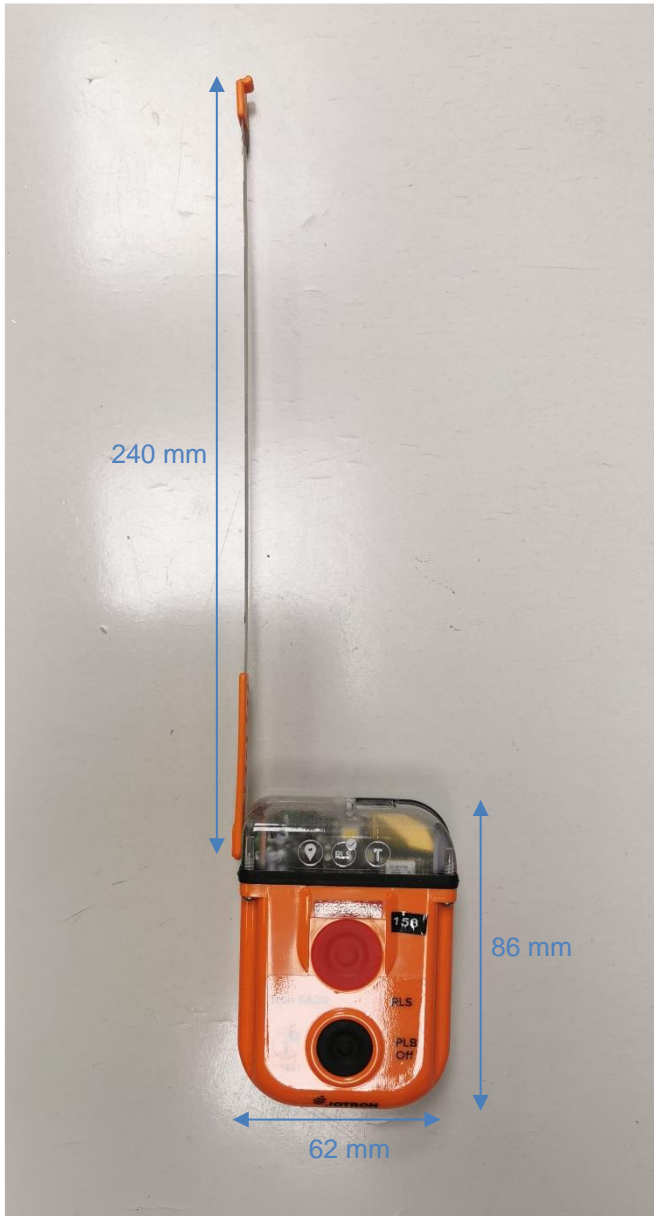
According to IEC 62209-2 AMD1:2019, the zoom scan complies if the peak spatial-average SAR is below 0.1 W/kg, or if the following criteria is met:

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 62209-2 AMD1:2019 is automatically verified by DASY5 software and all zoom scans in this test report do pass the criteria. The smallest horizontal distance and Ratio between measurement points M2 and M1 of the highest SAR results is available in Appendix C.

APPENDIX A: PHOTOS OF THE DUT

Length of the DUT is 62 x 86 x 32 mm with antenna diameter of 240mm.



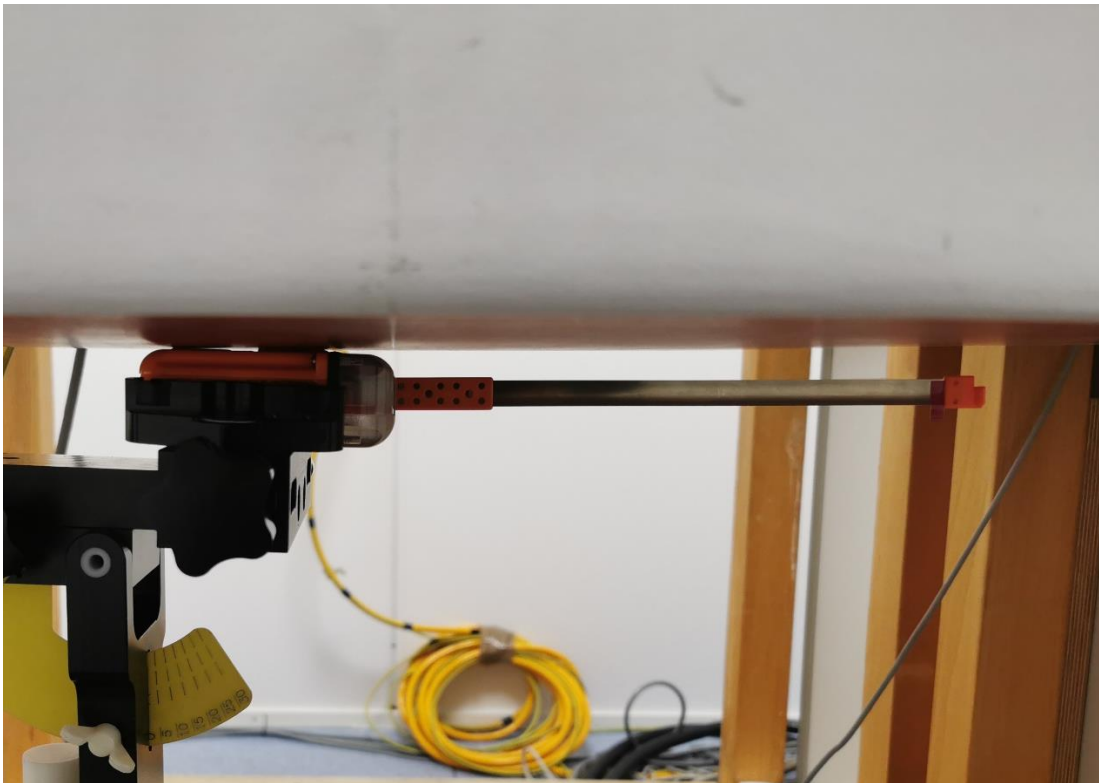


Figure 2. Front of the DUT facing phantom, 0mm

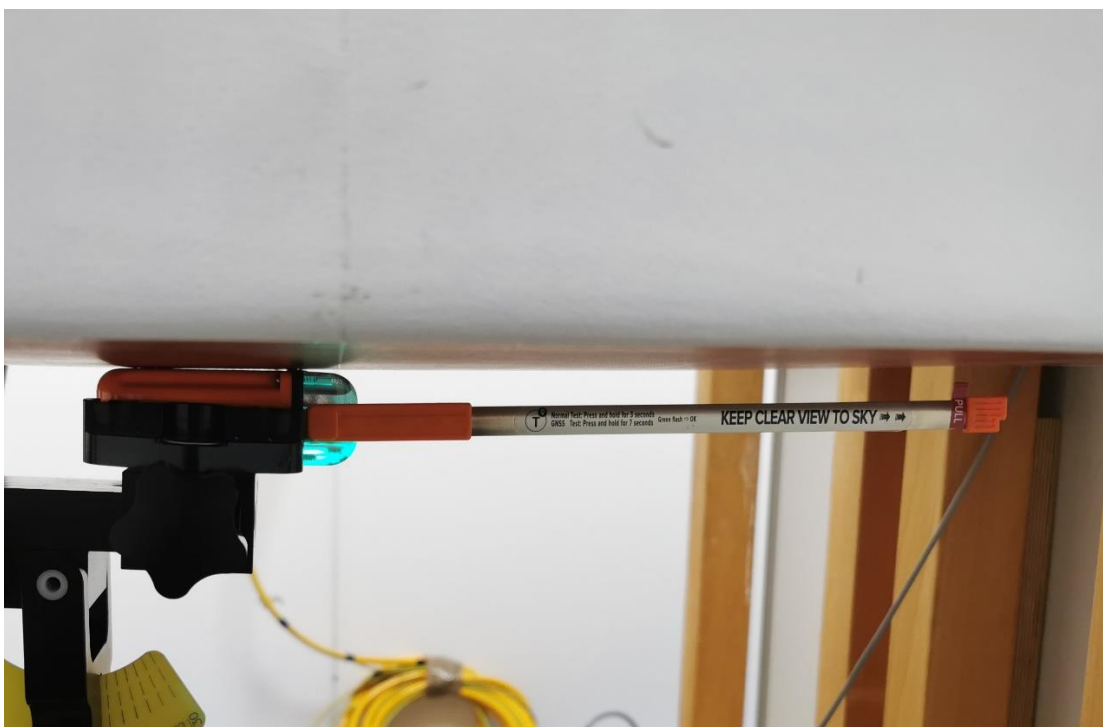


Figure 3. Back of the DUT facing phantom, 0mm

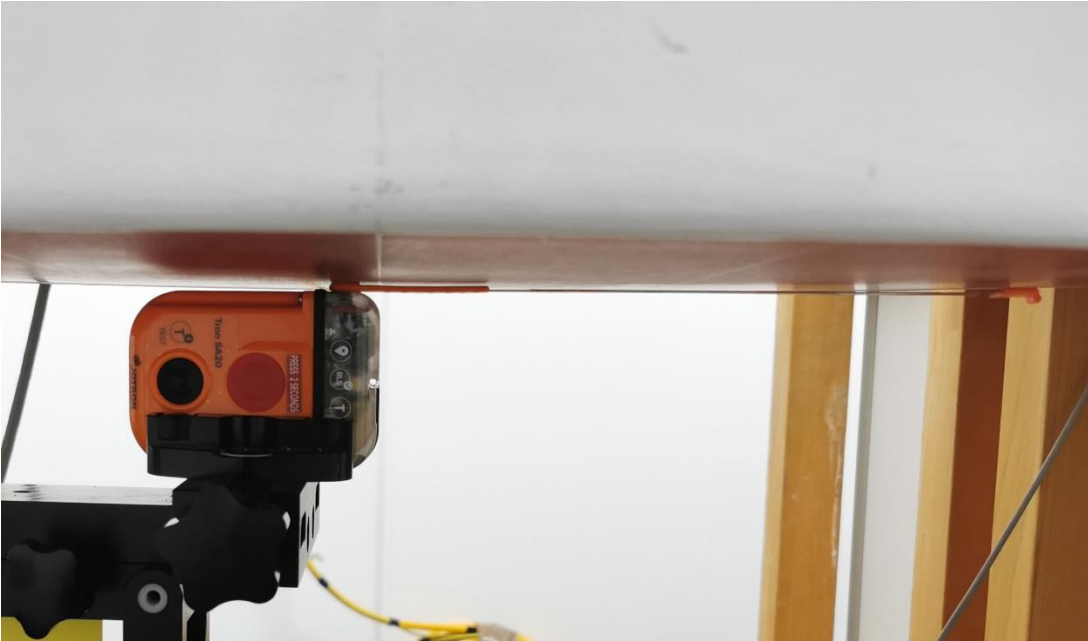


Figure 4. Left side of the DUT facing phantom, 0mm



Figure 5. Right side of the DUT facing phantom, 0mm



Figure 6. Top side of the DUT facing phantom, 0mm



Figure 7. Bottom side of the device, 0mm

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 14.12.2022 9.17.04

Test Laboratory: Verkotan Oy

DUT: Dipole 450 MHz D450V2; Type: D450V2; Serial: D450V2 - SN: 434

Communication System: UID 0, CW (0); Communication System Band: D450 (450.0 MHz); Frequency: 450 MHz;

Communication System PAR: 0 dB;

Medium parameters used: $f = 450 \text{ MHz}$; $\sigma = 0.944 \text{ S/m}$; $\epsilon_r = 42.529$; $\rho = 1000 \text{ kg/m}^3$, Medium parameters used: $\sigma = 0 \text{ S/m}$, $\epsilon_r = 1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(10.16, 10.16, 10.16) @ 450 MHz; Calibrated: 21.10.2021
 - Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), $z = -4.0, 31.0$
 - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
 - Phantom: SAR2_Phantom1_ELI; Type: QD OVA 002 AA;
 - DASYS2 52.10.4(1527); SEMCAD X 14.6.14(7483)

System Check/Area Scan 2 (101x151x1): Interpolated grid: $dx=2.000 \text{ mm}$, $dy=2.000 \text{ mm}$

Maximum value of SAR (interpolated) = 1.70 W/kg

System Check/Zoom Scan 2 (9x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 44.50 V/m; Power Drift = -0.01 dB

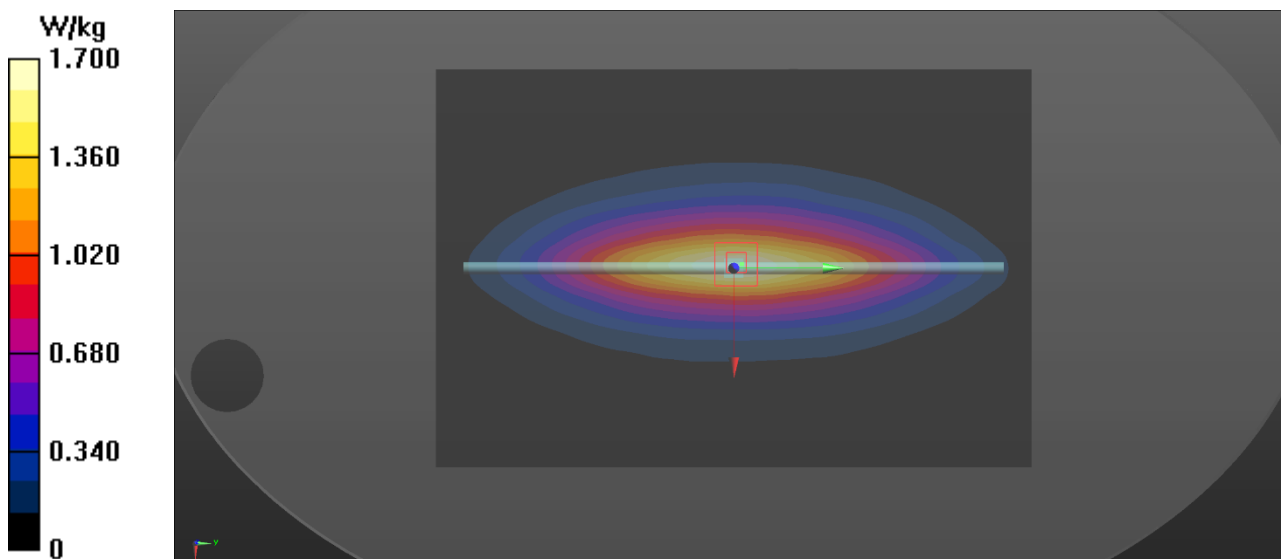
Peak SAR (extrapolated) = 2.06 W/kg

SAR(1 g) = 1.19 W/kg; SAR(10 g) = 0.782 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 = 61.9%

Maximum value of SAR (measured) = 1.77 W/kg



Plot 2

Date/Time: 15.12.2022 9.44.18

Test Laboratory: Verkotan Oy

DUT: Dipole 450 MHz D450V2; Type: D450V2; Serial: D450V2 - SN: 434

Communication System: UID 0, CW (0); Communication System Band: D450 (450.0 MHz); Frequency: 450 MHz;

Communication System PAR: 0 dB;

Medium parameters used: $f = 450$ MHz; $\sigma = 0.944$ S/m; $\epsilon_r = 42.837$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(10.2, 10.2, 10.2) @ 450 MHz; Calibrated: 27.10.2022
 - Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = -4.0, 31.0$
 - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
 - Phantom: SAR2_Phantom1_EL1; Type: QD OVA 002 AA;
 - DASYS2 52.10.4(1527); SEMCAD X 14.6.14(7483)

System Check/Area Scan (141x201x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 1.76 W/kg

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

Reference Value = 46.91 V/m; Power Drift = -0.51 dB

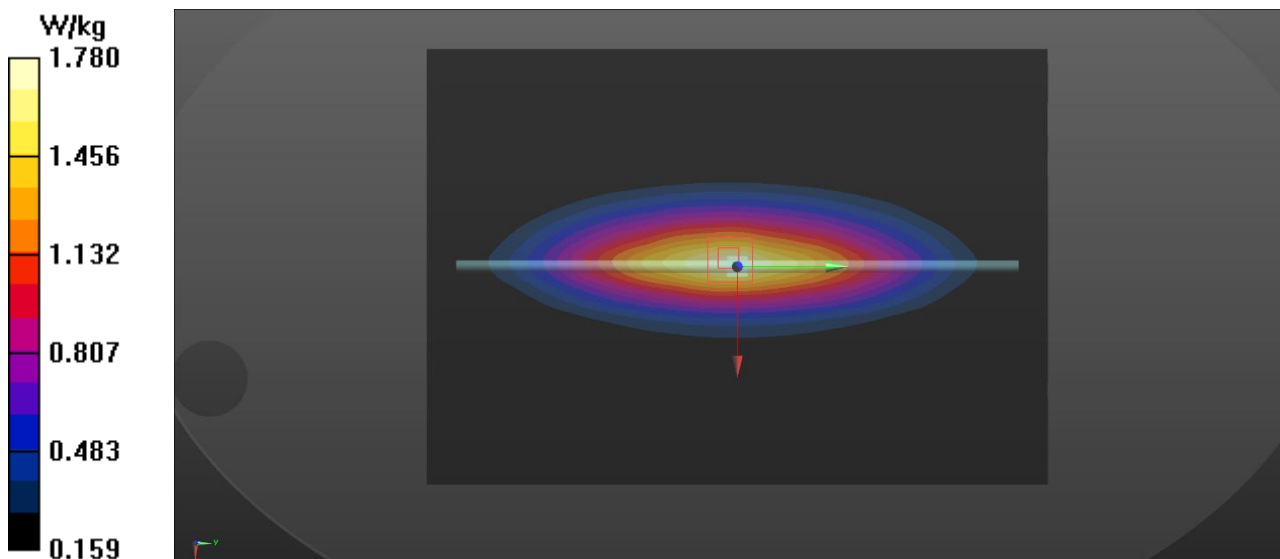
Peak SAR (extrapolated) = 2.09 W/kg

SAR(1 g) = 1.23 W/kg; SAR(10 g) = 0.809 W/kg (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 = 63.1%

Maximum value of SAR (measured) = 1.78 W/kg



Test Laboratory: Verkotan Oy

DUT: CLA-128 - SN3006; Type: CLA-128; Serial: SN3006

Communication System: UID 0, CW (0); Communication System Band: CLA128 (128.0 MHz); Frequency: 128 MHz;

Communication System PAR: 0 dB;

Medium parameters used: $f = 128 \text{ MHz}$; $\sigma = 0.789 \text{ S/m}$; $\epsilon_r = 50.937$; $\rho = 1000 \text{ kg/m}^3$, Medium parameters used: $\sigma = 0 \text{ S/m}$, $\epsilon_r = 1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(11.57, 11.57, 11.57) @ 128 MHz; Calibrated: 27.10.2022
 - Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), $z = -4.0, 1.0, 31.0$
 - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
 - Phantom: SAR2_Phantom1_ELI; Type: QD OVA 002 AA;
 - DASYS2 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/Step A, B Pin=250 mW/Area Scan (121x121x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 1.24 W/kg

Configuration/Step A, B Pin=250 mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=7.5\text{mm}$, $dy=7.5\text{mm}$, $dz=5\text{mm}$

Reference Value = 23.87 V/m; Power Drift = 0.00 dB

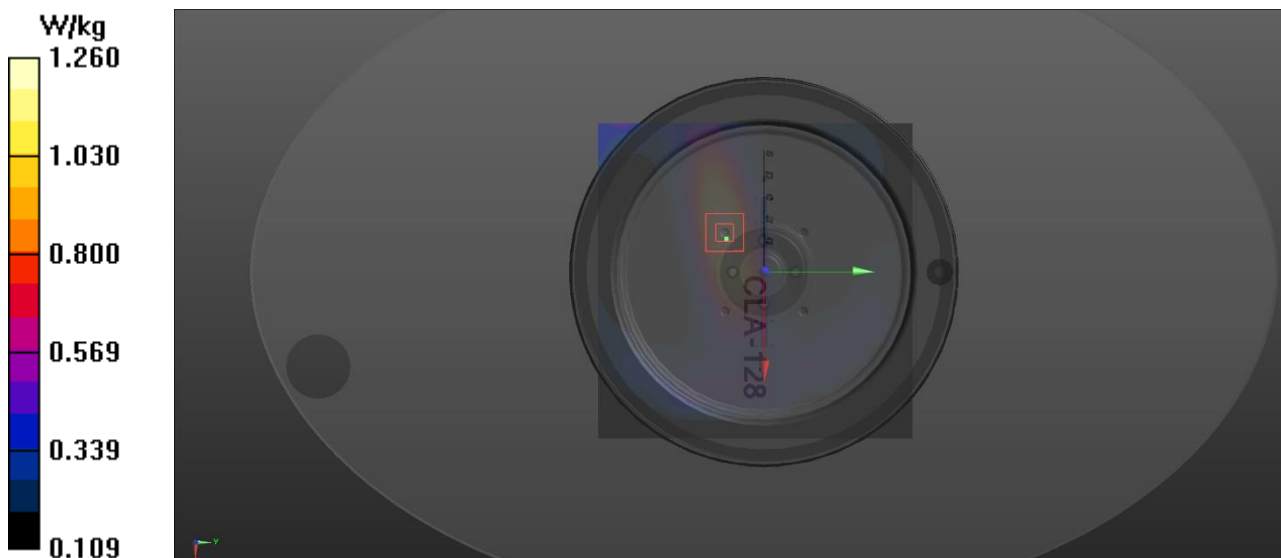
Peak SAR (extrapolated) = 1.53 W/kg

SAR(1 g) = 0.857 W/kg; SAR(10 g) = 0.557 W/kg (SAR corrected for target medium)

Smallest distance from peaks to all points 3 dB below = 16.1 mm

Ratio of SAR at M2 to SAR at M1 = 59%

Maximum value of SAR (measured) = 1.26 W/kg



APPENDIX C: MEASUREMENT SCAN

Plot 4

Date/Time: 19.12.2022 15.31.41

Test Laboratory: Verkotan Oy

DUT: Tron SA20 PLB

Communication System: UID 0, 121.5MHz (0); Communication System Band: 121.5MHz; Frequency: 121.5 MHz;
Communication System PAR: 0.088 dB;
Medium parameters used (interpolated): $f = 121.5$ MHz; $\sigma = 0.785$ S/m; $\epsilon_r = 51.158$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(11.57, 11.57, 11.57) @ 121.5 MHz; Calibrated: 27.10.2022
 - Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = -4.0, 31.0$
 - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
 - Phantom: SAR2_Phantom1_EL1; Type: QD OVA 002 AA;
 - DASYS2 52.10.4(1527); SEMCAD X 14.6.14(7483)

Tron SA20 PLB, 121.5MHz, Bottom/Area Scan 2 (51x91x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.0880 W/kg

Tron SA20 PLB, 121.5MHz, Bottom/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 6.131 V/m; Power Drift = 0.51 dB

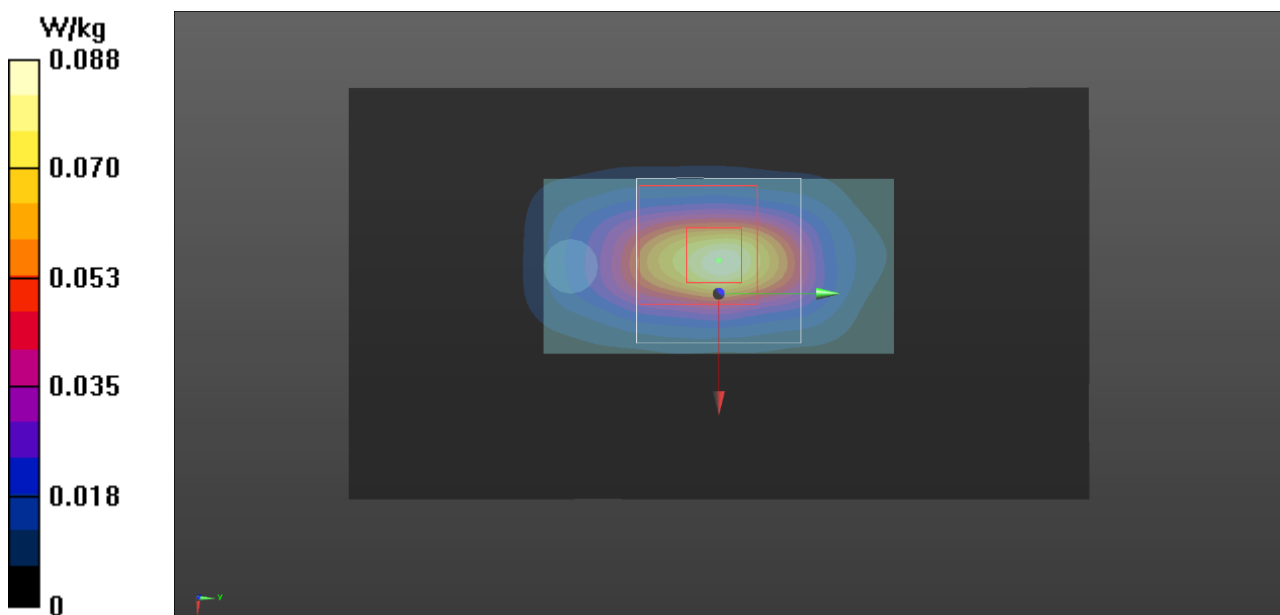
Peak SAR (extrapolated) = 0.122 W/kg

SAR(1 g) = 0.031 W/kg; SAR(10 g) = 0.013 W/kg (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 = 23.2%

Maximum value of SAR (measured) = 0.0716 W/kg



Test Laboratory: Verkotan Oy

DUT: Tron SA20 PLB

Communication System: UID 0, 406MHz (0); Communication System Band: 406 MHz; Frequency: 406 MHz;
Communication System PAR: 0.177 dB;
Medium parameters used: $f = 406 \text{ MHz}$; $\sigma = 0.917 \text{ S/m}$; $\epsilon_r = 43.413$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section
Measurement Standard: DASYS (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(10.2, 10.2, 10.2) @ 406 MHz; Calibrated: 27.10.2022
 - Sensor-Surface: 1.4mm (Mechanical Surface Detection), $z = -4.0, 31.0$
 - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
 - Phantom: SAR2_Phantom1_EL1; Type: QD OVA 002 AA;
 - DASYS2 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/Tron SA20 PLB, 406MHz,Left/Area Scan (51x221x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$
Maximum value of SAR (interpolated) = 3.63 W/kg

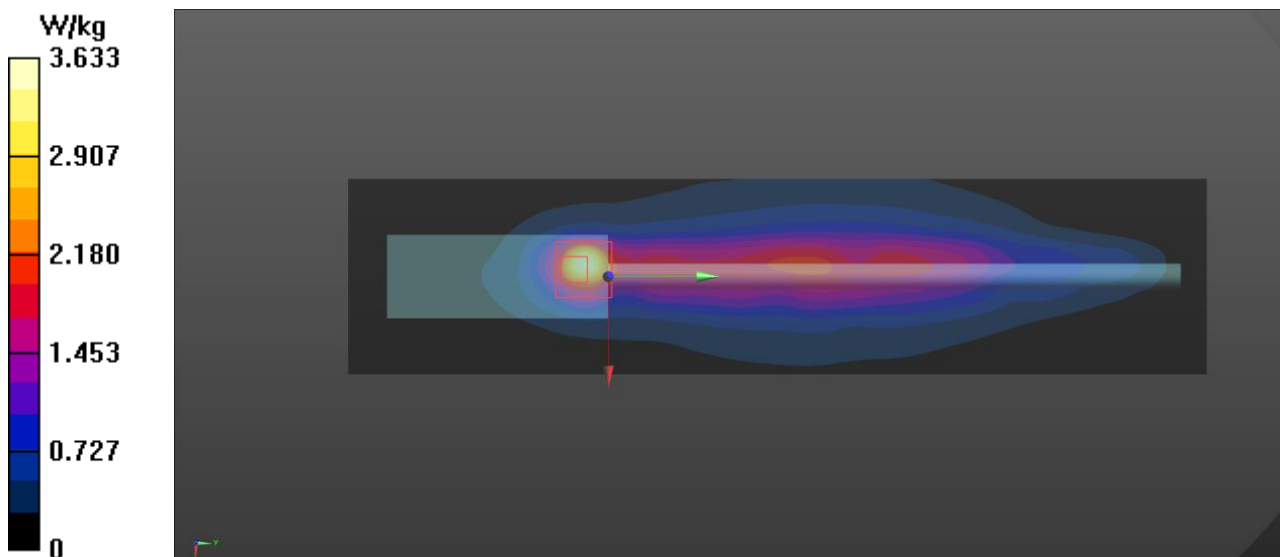
Configuration/Tron SA20 PLB, 406MHz,Left/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
Reference Value = 48.89 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 8.16 W/kg

SAR(1 g) = 2.13 W/kg; SAR(10 g) = 0.857 W/kg (SAR corrected for target medium)

Smallest distance from peaks to all points 3 dB below = 5.8 mm

Ratio of SAR at M2 to SAR at M1 = 30.1%

Maximum value of SAR (measured) = 4.61 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION

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



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

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

Accreditation No.: **SCS 0108**

Client **Verkotan**

Certificate No **EX-3852_Oct22**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3852
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	October 27, 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
OCP DAK-3.5 (weighted)	SN: 1249	20-Oct-22 (OCP-DAK3.5-1249_Oct22)	Oct-23
OCP DAK-12	SN: 1016	20-Oct-22 (OCP-DAK12-1016_Oct22)	Oct-23
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
DAE4	SN: 660	10-Oct-22 (No. DAE4-660_Oct22)	Oct-23
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-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	Michael Weber	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: October 27, 2022

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

EX3DV4 - SN:3852

October 27, 2022

Parameters of Probe: EX3DV4 - SN:3852

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k = 2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.41	0.39	0.46	±10.1%
DCP (mV) ^B	99.8	98.2	99.9	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Max Unc ^E k = 2
0	CW	X	0.00	0.00	1.00	0.00	147.5	±2.5%	±4.7%
		Y	0.00	0.00	1.00		138.0		
		Z	0.00	0.00	1.00		137.1		

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

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Page 5).

^B 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:3852

October 27, 2022

Parameters of Probe: EX3DV4 - SN:3852

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	126.7°
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.

EX3DV4 - SN:3852

October 27, 2022

Parameters of Probe: EX3DV4 - SN:3852

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)
6	55.0	0.75	15.18	15.18	15.18	0.00	1.00	±13.3%
30	55.0	0.75	13.34	13.34	13.34	0.00	1.00	±13.3%
64	54.2	0.75	11.88	11.88	11.88	0.00	1.00	±13.3%
128	52.8	0.76	11.57	11.57	11.57	0.00	1.00	±13.3%
220	49.0	0.81	10.92	10.92	10.92	0.00	1.00	±13.3%
450	43.5	0.87	10.20	10.20	10.20	0.16	1.30	±13.3%
900	41.5	0.97	8.82	8.82	8.82	0.44	0.94	±12.0%
1300	40.8	1.14	8.54	8.54	8.54	0.27	1.22	±12.0%
1450	40.5	1.20	8.63	8.63	8.63	0.39	0.80	±12.0%
1640	40.2	1.31	8.33	8.33	8.33	0.34	0.90	±12.0%
1810	40.0	1.40	7.90	7.90	7.90	0.38	0.90	±12.0%
1900	40.0	1.40	7.72	7.72	7.72	0.36	0.90	±12.0%
2450	39.2	1.80	7.48	7.48	7.48	0.41	0.90	±12.0%
3300	38.2	2.71	6.85	6.85	6.85	0.30	1.30	±13.1%
3500	37.9	2.91	6.83	6.83	6.83	0.30	1.35	±13.1%
3700	37.7	3.12	6.65	6.65	6.65	0.30	1.35	±13.1%
3900	37.5	3.32	6.38	6.38	6.38	0.40	1.60	±13.1%
4100	37.2	3.53	6.19	6.19	6.19	0.40	1.60	±13.1%
5250	35.9	4.71	4.90	4.90	4.90	0.40	1.80	±13.1%
5600	35.5	5.07	4.61	4.61	4.61	0.40	1.80	±13.1%
5750	35.4	5.22	4.65	4.65	4.65	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: **CLA128-3006_Jul22**

CALIBRATION CERTIFICATE

Object: **CLA128 - SN: 3006**

Calibration procedure(s): **QA CAL-15.v9
Calibration Procedure for SAR Validation Sources below 700 MHz**

Calibration date: **July 18, 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: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 08327	04-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 3877	31-Dec-21 (No. EX3-3877_Dec21)	Dec-22
DAE4	SN: 654	26-Jan-22 (No. DAE4-654_Jan22)	Jan-23

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	08-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 Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

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

Issued: July 20, 2022

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
EUT Positioning	Touch Position	
Zoom Scan Resolution	$dx, dy = 4.0$ mm, $dz = 1.4$ mm	Graded Ratio = 1.4 (Z direction)
Frequency	128 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	52.8	0.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	51.0 ± 6 %	0.74 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	1 W input power	3.36 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	3.41 W/kg ± 18.4 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	1 W input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	2.27 W/kg ± 18.0 % (k=2)



SAR Reference Dipole Calibration Report

Ref : ACR.53.5.22.BES.A

VERKOTAN LTD.
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 450 MHZ
SERIAL NO.: SN 37/16 DIP 0G450-434

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

Calibration date: 02/22/2022

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.



7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±10 %		0.87 ±10 %	
450	43.5 ±10 %	42.8	0.87 ±10 %	0.91
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 %	
3300	38.2 ±10 %		2.71 ±10 %	
3500	37.9 ±10 %		2.91 ±10 %	
3700	37.7 ±10 %		3.12 ±10 %	
3900	37.5 ±10 %		3.32 ±10 %	
4200	37.1 ±10 %		3.63 ±10 %	
4600	36.7 ±10 %		4.04 ±10 %	
4900	36.3 ±10 %		4.35 ±10 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.53.5.22.BES.A

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values: ϵ_{ps}^* : 42.8 σ : 0.91
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	450 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

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	4.67 (0.47)	3.06	3.08 (0.31)
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	
3300	-		-	
3500	67.1		25	
3700	67.4		24.2	
3900	-		-	
4200	-		-	
4600	-		-	
4900	-		-	

Page: 9/11

Template_ACR.DDD.N.YY.MVGB.ISSUE_SAR Reference Dipole vJ

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