SAR Compliance Test Report

Date of Report	7/09/2023	**Client's Contact person:**	Christopher Marx
Number of pages:	62		
		Responsible Test engineer:	Jesper Varis
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**TeraTron GmbH** Martin-Siebert-Str. 5, 51647 Gummersbach Germany
Tested device	**Mobile KeyReader Plus 2**		
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		
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:	07.09.2023 **Laboratory Manager** *Miia Nurkkala*		

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Equipment under Test (DUT):

Product:	Mobile KeyReader Plus 2
Manufacturer:	TeraTron GmbH
Model:	KRP0320
Serial Number:	251346, 251344
FCC ID Number:	QLXKRP0320
DUT Number:	21058, 21059
Battery Type used in testing:	Li-Ion Battery
State of the Sample:	Production sample

Testing information:

Testing performed:	15.03.2023 – 31.03.2023; 28.09.2023 – 29.09.2023
Notes:	-
Document history:	Initial version
Document ID:	FCC SAR report_KeyReader Plus ID5951_07092023.docx
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Jesper Varis, Kalle Orava
FCC Test Firm Designation Number:	FI0005
ISED Company Number:	22218

1.2 Maximum Results

The maximum reported* SAR values for 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) 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, 5mm separation distance	Result
2.4 GHz WLAN	**1.12**	**PASS**
5 GHz WLAN	**0.97**	**PASS**
NFC	**0.018**	**PASS**

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

1.2.2 Simultaneous Transmission SAR

Simultaneous Transmission	SAR_{1g}(W/kg) in Body-Worn Exposure Condition	Result
WLAN + NFC	**1.12**	**PASS**
WLAN + RFID	**1.14**	**PASS**

1.2.3 Maximum Drift

Maximum Drift During Measurements	-0.65 dB*

*Larger than 5% drifts included to scaling factors

1.2.4 Measurement Uncertainty

SAR 1g: 4 MHz – 0.3 GHz:

Expanded Uncertainty (k=2) 95 %	±22.9 %

SAR 1g: 300 MHz – 3 GHz:

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

SAR1g: 3 – 6 GHz:

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

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The Mobile KeyReader Plus 2 is a mobile device for reading out the vehicle data saved in the vehicle key. Supported technologies include 2.4 & 5.0 GHz WLAN, 125kHz RFID and 13.56 MHz NFC.

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]
	WLAN 2.4 GHz	2412 – 2462
	WLAN 5GHz	5180 – 5825
	NFC	13.56 MHz
	RFID	125 kHz

2.2 Simultaneous transmission

Possible simultaneous transmissions are:

- 5.0 GHz WLAN + RFID
- 5.0 GHz WLAN + NFC
- 2.4 GHz WLAN + RFID
- 2.4 GHz WLAN + NFC

2.3 Test Exemptions

2.3.1 FCC

Exemption power threshold for distances ≤5mm in mW for less than 100 MHz, was calculated using the following equation below, stated in 447498 D01 General RF Exposure Guidance DR05-44791:

$$P_{7X}(d_{mm}, f_{MHz}) = S_f(f_{MHz}) * P_{431a}(d_{mm}, f_{MHz}) + \left(1 - S_f(f_{MHz})\right) * S_d(d_{mm}) P_{431b1}(50., 100.) * \left((1 + \log_{10}\left(\frac{100.}{f_{MHz}}\right)\right)$$

(Equation 1)

where,

$$S_f(f_{MHz}) = -\frac{e^{(f_{MHz}-100)^2}}{250}$$ (Equation 2)

$$S_d(d_{mm}) = \frac{1}{2} + \frac{\frac{(d_{mm}-50)^2}{250}}{2}$$ (Equation 3)

$$P_{431a}(d_{mm}, f_{MHz}) = \frac{3\, d_{mm}}{\sqrt{f_{MHz}/1000}}$$ (Equation 4)

$$P_{431b1}(d_{mm}, f_{MHz}) = \frac{3\, d_{mm}}{\sqrt{f_{MHz}/1000}} + \frac{(d_{mm}-50)*f_{MHz}}{150}$$ (Equation 5)

Transmission mode	Frequency [MHz]	Separation distance [mm]	P_{7x} [mW]
RFID	**0.125**	**≤5**	**926**

2.3.1.1 Maximum defined Output Power and ERP

Maximum output power of the RFID is 30dBm and according to data sheet for KRP0320, antenna gain is 3dBi. Duty cycle of the transmission is 4.6%.

ERP is greater than the maximum output power, thus it is used for SAR test exclusion.

Transmission mode	Max Output power [dBm]	ERP Output power [dBm]	ERP Output power [mW]	Time averaged ERP Output power [mW]	P_{7x} [mW]
RFID @125 kHz	30	30.85	1216	56	926

ERP of the RFID is below the test exclusion threshold.

3. OUTPUT POWER

3.1 Maximum specified conducted output power

From the customer, including tune-up tolerances;

WLAN 2.4GHz	Max Output Power [dBm]
802.11b	15
802.11g	15
802.11n	15

WLAN 5GHz	Max Output Power [dBm]
802.11a	15
802.11n	15
802.11ac	15

NFC	Max Output Power [dBm]
13.56 MHz	28

3.2 Tested conducted power

Measured conducted output power at transmitting antenna connector;

WLAN 2.4 GHz:

Standard	Transmission mode	Data rate [Mbps]	Output power [dBm]		
			CH 1 2412 MHz	CH 6 2437 MHz	CH 11 2462 MHz
802.11b	DSSS	1	13.47	14.48	14.46

5GHz WLAN:

Standard	Channel	Frequency [MHz]	Transmission mode	Data Rate [Mbps]	Output power [dBm]
802.11a	52	5260	OFDM	6	14.2
802.11a	56	5280	OFDM	6	14.22
802.11a	60	5300	OFDM	6	14.27
802.11a	64	5320	OFDM	6	14.3
802.11a	100	5500	OFDM	6	13.56
802.11a	120	5600	OFDM	6	13.65
802.11a	124	5620	OFDM	6	13.62
802.11a	144	5720	OFDM	6	13.63
802.11a	149	5745	OFDM	6	14.05
802.11a	157	5785	OFDM	6	13.8
802.11a	165	5825	OFDM	6	13.64

NFC:

NFC	Max Output Power [dBm]
13.56 MHz	10.98

*Due to NFC integrated circuit impedance matching in the output and NFC antenna not being 50Ω, the measured conducted power underestimates the actual output power of the module. Mismatch with the cable for conducted power testing cable is larger than with the antenna. The measured conducted power value is used in scaling of the NFC SAR results thus the reported SAR values are overestimated.

4. TEST EQUIPMENT

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

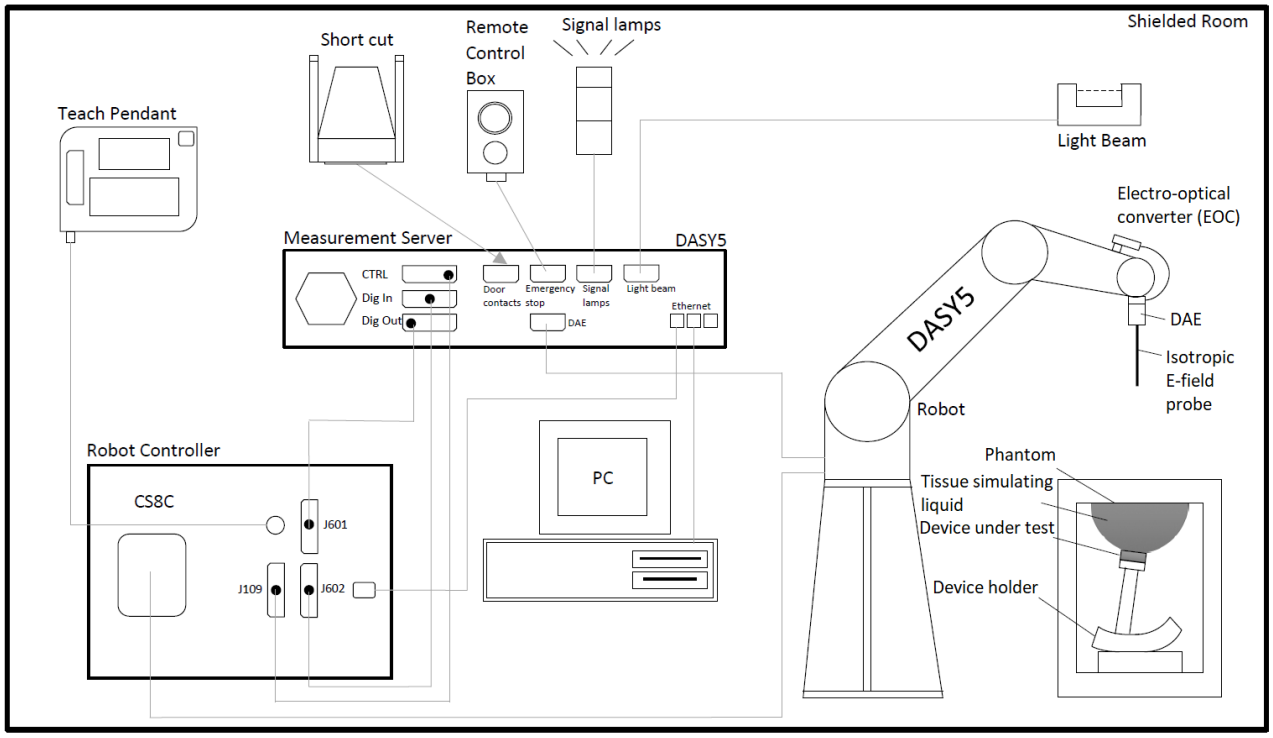


Figure 2 Schematic Laboratory Picture

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]
DASY5 Software	52.8.8.1258	-	NA	NA
DASY8 Software	16.2.4.2524	-	NA	NA
Amplifier, 500-8000MHz	ZX60-83LN12+	NA	NA	NA
Amplifier, 800MHz-4200MHz, 10W	10S1G4A	320421	NA	NA
DAE4, converter	DAE4	710	10/2022	1
DAE4, converter	DAE4	1332	02/2023	1
DAE4, converter	DAE4ip	1774	06/2023	1
Inline Peak Power Sensor	MA24105A	2102058	11/2022	1
Isotropic DOS probe	EX3DV4	7447	02/2023	1
Isotropic DOS probe	EX3DV4	3852	10/2022	1
Isotropic DOS probe	EX3DV4	7827	06/2023	1
Network Analyzer	E5071C	MY46102812	05/2023	1
Power Sensor	NRP-Z11	100265	12/2022	1
Radio Communication Analyzer	MT8820C	6200883099	10/2022	1
System validation dipole	D2450V2	729	07/2022	3
System validation dipole	D5GHzV2	1045	03/2023	3
System validation dipole	CLA13	1012	03/2021	3
Vector Signal Generator	MG3710A	6261911026	NA	1

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
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. 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 under 3GHz and ±5% at frequencies above 3GHz. A liquid compensation algorithm was used in DASY5 with which measured peak average SAR values were corrected for the deviation of used liquid. Depth of the tissue simulant was at least 15.0 cm from the inner surface of the flat phantom.

Tissue simulant liquid Ingredients
Deionized Water, 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
13	CLA 13 - SN: 1012	EX3DV4 - SN: 7447	CW	DAE 4 / 1332	50.57	0.78	03/2023
5250	D5GHzV2 - SN: 1045	EX3DV4 - SN: 7447	CW	DAE 4 / 1332	34.53	4.77	03/2023
5600	D5GHzV2 - SN: 1045	EX3DV4 - SN: 7447	CW	DAE 4 / 1332	34.06	5.07	03/2023
5750	D5GHzV2 - SN: 1014	EX3DV4 - SN: 7447	CW	DAE 4 / 1332	35.02	4.98	03/2023
2450	D2450V2 - SN: 758	EX3DV4 - SN: 3852	CW	DAE 4 / 710	40.46	1.75	11/2022
5250	D5GHzV2 - SN: 1014	EX3DV4 - SN: 3852	CW	DAE 4 / 710	37.44	4.66	11/2022
5600	D5GHzV2 - SN: 1014	EX3DV4 - SN: 3852	CW	DAE 4 / 710	36.79	5.07	11/2022
5750	D5GHzV2 - SN: 1014	EX3DV4 - SN: 3852	CW	DAE 4 / 710	36.62	5.19	11/2022
2450	D2450V2 - SN: 729	EX3DV4 - SN: 7827	SMC	DAE4ip / 1774	38.89	1.69	07/2023

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 #
17.03.2023	WB Head	22	5250	250	7.62	77.65	76.2	-1.87	1
20.03.2023	WB Head	22	5250	250	7.44	77.65	74.4	-4.19	2
20.03.2023	WB Head	22	5250	250	8.34	77.65	83.4	7.41	3
20.03.2023	WB Head	22	5600	250	7.72	83.31	77.2	-7.33	4
22.03.2023	WB Head	22	5600	250	8.19	83.31	81.9	-1.69	5
23.03.2023	WB Head	22	5750	250	7.12	75.18	71.2	-5.29	6
27.03.2023	WB Head	22	5750	250	7.47	69.05	74.7	8.18	7
31.03.2023	WB Head	22	13	250	0.134	0.555	0.536	-3.42	8
28.08.2023	WB Head	22	2450	250	11.8	52.3	47.2	-9.75	9

4.5.1 Tissue Simulant Verification

				Target		Measured		Deviation	
Date	**Tissue Type**	**Tissue Temp [°C]**	**Frequency [MHz]**	**Dielectric Constant [ε] Target**	**Conductivity σ [S/m] Target**	**Dielectric Constant [ε]**	**Conductivity σ [S/m]**	**ε [%]**	**σ [%]**
15.03.2023	WB Head	21.4	2412.0	39.27	1.77	37.45	1.67	-4.6	-5.3
15.03.2023	WB Head	21.4	2442.0	39.21	1.79	37.42	1.7	-4.6	-5.3
15.03.2023	WB Head	21.4	2450.0	39.2	1.8	37.41	1.7	-4.6	-5.4
15.03.2023	WB Head	21.4	2472.0	39.17	1.82	37.38	1.72	-4.6	-5.7
17.03.2023	WB Head	21.4	5250.0	35.95	4.71	36.36	4.54	1.1	-3.7
17.03.2023	WB Head	21.4	5260.0	35.94	4.72	36.35	4.55	1.1	-3.6
20.03.2023	WB Head	21.4	5180.0	36.02	4.64	36.02	4.43	0.0	-4.5
20.03.2023	WB Head	21.4	5250.0	35.95	4.71	35.9	4.5	-0.1	-4.4
20.03.2023	WB Head	21.4	5260.0	35.94	4.72	35.88	4.52	-0.2	-4.3
20.03.2023	WB Head	21.4	5300.0	35.9	4.76	35.81	4.56	-0.3	-4.2
20.03.2023	WB Head	21.4	5320.0	35.88	4.78	35.78	4.58	-0.3	-4.2
22.03.2023	WB Head	21.4	5500.0	35.65	4.96	35.25	4.76	-1.1	-4.1
22.03.2023	WB Head	21.4	5600.0	35.5	5.07	35.08	4.88	-1.2	-3.7
22.03.2023	WB Head	21.4	5720.0	35.38	5.19	34.86	5.02	-1.5	-3.4
23.03.2023	WB Head	22.2	5745.0	35.35	5.22	35.03	4.97	-0.9	-4.6
23.03.2023	WB Head	22.2	5750.0	35.35	5.22	35.02	4.98	-0.9	-4.6
23.03.2023	WB Head	22.2	5785.0	35.32	5.26	34.96	5.02	-1.0	-4.4
23.03.2023	WB Head	22.2	5825.0	35.28	5.3	34.9	5.07	-1.1	-4.4
27.03.2023	WB Head	22	5745.0	35.35	5.22	36.49	5.32	3.2	2.0
27.03.2023	WB Head	22	5750.0	35.35	5.22	36.49	5.33	3.2	2.1
27.03.2023	WB Head	22	5785.0	35.32	5.26	36.44	5.37	3.2	2.2
31.03.2023	WB Head	22	13.0	55.0	0.75	50.57	0.78	-8.1	4.2
31.03.2023	WB Head	22	13.56	55.0	0.75	50.69	0.78	-7.8	4.2
28.08.2023	WB Head	20.2	2412.0	39.27	1.76	38.23	1.65	-2.6	-6.3
28.08.2023	WB Head	20.2	2437.0	39.23	1.79	38.19	1.67	-2.6	-6.6
28.08.2023	WB Head	20.2	2450.0	39.2	1.8	38.18	1.68	-2.6	-6.7
28.08.2023	WB Head	20.2	2462.0	39.19	1.81	38.16	1.69	-2.6	-6.9

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publications 447498 D04 Interim General RF Exposure Guidance v01 and 248227 D01 802.11 Wi-Fi SAR.

A control software for WLAN & NFC was used to set the DUT to transmit at maximum power.

The WLAN transmission modes for testing were selected according to largest channel bandwidth configuration, lowest order modulation and lowest data rate.
WLAN 2.4GHz was tested with 802.11b standard with data rate of 1Mbit/s and WLAN 5GHz was tested with 802.11a standard with data rate of 6Mbit/s.

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 Configuration, 5mm separation distance

Body SAR was tested from all the six sides of the device. The device was placed in the SPEAG holder and lifted towards the phantom until the distance between the phantom and the device was 5mm. The distance between the device and the phantom was kept at 5mm using a separate flat spacer that was removed before the start of the measurements.

Photos of the test positions are presented in appendix A

5.3 Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan was performed around the highest E-field value to determine the averaged SAR value. Drift was determined by measuring the same point at the start of the area scan and again at the end of the zoom scan.

5.4 SAR Averaging Methods

The maximum SAR value was averaged over a cube of tissue using interpolation and extrapolation.

The interpolation, extrapolation and maximum search routines within Dasy52 are all based on the modified Quadratic Shepard's method (Robert J. Renka," Multivariate Interpolation of Large Sets of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148).
The interpolation scheme combines a least-square fitted function method with a weighted average method. A trivariate 3-D / bivariate 2-D quadratic function is computed for each measurement point and fitted to neighboring points by a least-square method. For the zoom scan, inverse distance weighting is incorporated to fit distant points more accurately. The interpolating function is finally calculated as a weighted average of the quadratics.

In the zoom scan, the interpolation function is used to extrapolate the Peak SAR from the deepest measurement points to the inner surface of the phantom.

6. MEASUREMENT UNCERTAINTY

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%

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%

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%
$LIQ(T_\alpha)$	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 5mm separation

2.4GHz WLAN:

Mode	Data Rate [Mbps]	Frequency [MHz]	Channel	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR_{1g} [W/kg]	Power Drift** [dB]	Scaling Factor	Duty Cycle	Reported SAR_{1g} [W/kg]	Plot #
802.11b	1	2437	6	Front, 5mm	15	14.48	0.30	0	1.13	1:1	0.34	
802.11b	1	2437	6	Back, 5mm	15	14.48	0.56	-0.01	1.13	1:1	0.63	
802.11b	1	2437	6	Left, 5mm	15	14.48	0.80	0.02	1.13	1:1	0.91	
802.11b	1	2437	6	Left, 5mm	15	14.48	1.00	0.08	1.13	1:1	1.12	10
802.11b	1	2437	6	Right, 5mm	15	14.48	0*	0***	1.13	1:1	0*	
802.11b	1	2437	6	Top, 5mm	15	14.48	0.01	0	1.13	1:1	0.009	
802.11b	1	2437	6	Bottom, 5mm	15	14.48	0.07	0.15	1.13	1:1	0.074	
802.11b	1	2462	11	Left, 5mm	15	14.46	0.80	0.03	1.13	1:1	0.90	
802.11b	1	2412	1	Left, 5mm	15	13.47	0.68	0.03	1.42	1:1	0.97	

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

5GHz WLAN:

Mode	Data Rate [Mbps]	Frequency [MHz]	Channel	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR_{1g} [W/kg]	Power Drift* [dB]	Scaling Factor	Duty Cycle	Reported SAR_{1g} [W/kg]	Plot #
802.11a	6	5320	64	Front, 5mm	15	14.3	0.37	-0.06	1.17	1:1	0.43	
802.11a	6	5320	64	Back, 5mm	15	14.3	0.46	-0.12	1.17	1:1	0.54	
802.11a	6	5320	64	Left, 5mm	15	14.3	0.50	-0.11	1.17	1:1	0.59	
802.11a	6	5320	64	Right, 5mm	15	14.3	0.0001	0	1.17	1:1	0.00	
802.11a	6	5320	64	Top, 5mm	15	14.3	0.013	-0.17	1.17	1:1	0.01	
802.11a	6	5320	64	Bottom, 5mm	15	14.3	0.042	0.22	1.24	1:1	0.05	
802.11a	6	5260	52	Left, 5mm	15	14.2	0.46	-0.23	1.27	1:1	0.58	
802.11a	6	5300	60	Left, 5mm	15	14.27	0.50	-0.01	1.18	1:1	0.59	11

*Larger than 5% drifts included to scaling factors

Mode	Data Rate [Mbps]	Frequency [MHz]	Channel	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR_{1g} [W/kg]	Power Drift* [dB]	Scaling Factor	Duty Cycle	Reported SAR_{1g} [W/kg]	Plot #
802.11a	6	5600	120	Front, 5mm	15	13.65	0.31	-0.12	1.36	1:1	0.43	
802.11a	6	5600	120	Back, 5mm	15	13.65	0.46	-0.13	1.36	1:1	0.63	
802.11a	6	5600	120	Left, 5mm	15	13.65	0.70	-0.11	1.36	1:1	0.95	
802.11a	6	5600	120	Right, 5mm	15	13.65	0.01	-0.72	1.61	1:1	0.01	
802.11a	6	5600	120	Top, 5mm	15	13.65	0.02	-2.71	2.55	1:1	0.04	
802.11a	6	5600	120	Bottom, 5mm	15	13.65	0.12	-0.12	1.36	1:1	0.17	
802.11a	6	5500	100	Left, 5mm	15	13.56	0.63	0	1.39	1:1	0.87	
802.11a	6	5720	144	Left, 5mm	15	13.63	0.71	-0.08	1.37	1:1	0.97	12

*Larger than 5% drifts included to scaling factors

Mode	Data Rate [Mbps]	Frequency [MHz]	Channel	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR_{1g} [W/kg]	Power Drift*** [dB]	Scaling Factor	Duty Cycle	Reported SAR_{1g} [W/kg]	Plot #
802.11a	6	5745	149	Front, 5mm	15	14.05	0.290	-0.12	1.24	1:1	0.36	
802.11a	6	5745	149	Back, 5mm	15	14.05	0.361	-0.2	1.24	1:1	0.45	
802.11a	6	5745	149	Left, 5mm	15	14.05	0.590	-0.65	1.45	1:1	0.85	
802.11a	6	5745	149	Right, 5mm	15	14.05	0*	0**	1.24	1:1	0*	
802.11a	6	5745	149	Top, 5mm	15	14.05	0.007	-4.78	3.74	1:1	0.03	
802.11a	6	5745	149	Bottom, 5mm	15	14.05	0.090	-0.06	1.24	1:1	0.11	
802.11a	6	5785	157	Left, 5mm	15	13.8	0.665	0.02	1.32	1:1	0.88	13
802.11a	6	5825	165	Left, 5mm	15	13.64	0.606	-0.04	1.37	1:1	0.83	

*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

NFC:

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 #
NFC	13.56	28	10.98	Front, 0mm	0.0002	0***	2	50.35	0.0002	
NFC	13.56	28	10.98	Back, 0mm	0.017	-0.23	2	53.09	0.018	14
NFC	13.56	28	10.98	Left, 0mm	0*	0***	2	50.35	0*	
NFC	13.56	28	10.98	Right, 0mm	0*	0***	2	50.35	0*	
NFC	13.56	28	10.98	Top, 0mm	0*	0***	2	50.35	0*	
NFC	13.56	28	10.98	Bottom, 0mm	0.0037	0.43	2	55.59	0.004	

*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 Estimated RFID SAR

7.2.1 FCC

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

$$SAR_{estimated} = 0.4 * Pant/Pth \ [w/kg] \quad \text{(Equation 6)}$$

Estimated RFID SAR = 0.4*(56/926) = 0.024 W/kg

7.3 Simultaneous Transmission Analysis

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

7.3.1 WLAN + NFC

Body SAR:

	Exposure Condition	Body SAR_{1g} [W/kg]					
	Test Position	**Front**	**Back**	**Left**	**Right**	**Top**	**Bottom**
2.4 GHz WLAN		0.34	0.63	1.12	0	0.009	0.074
5.0 GHz WLAN		0.43	0.63	0.97	0.01	0.04	0.17
Maximum WLAN		0.43	0.63	1.12	0.01	0.04	0.17
NFC		0.0002	0.018	0	0	0	0.004
SAR Summation: EN 62209-1 6.4.3.2.2 Alternative 1		0.4302	0.648	**1.12**	0.01	0.04	0.174

7.3.2 WLAN + RFID

Body SAR:

Maximum WLAN SAR + Estimated RFID SAR = 1.12W/kg + 0.024W/kg = 1.14W/kg

APPENDIX A: PHOTOS OF THE DUT

Size of the DUT is: 150 x 85 x 15 mm

Figure 3. Right side of the DUT, 5mm

Figure 4. Left side of the DUT, 5mm

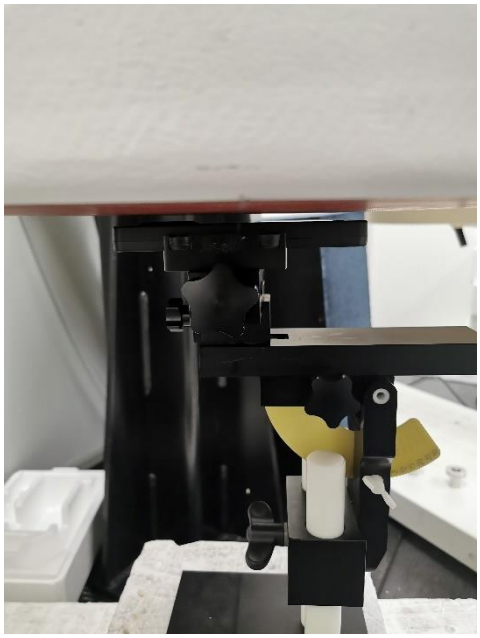


Figure 5. Front side of the DUT, 5mm

Figure 6. Bottom side of the DUT, 5mm

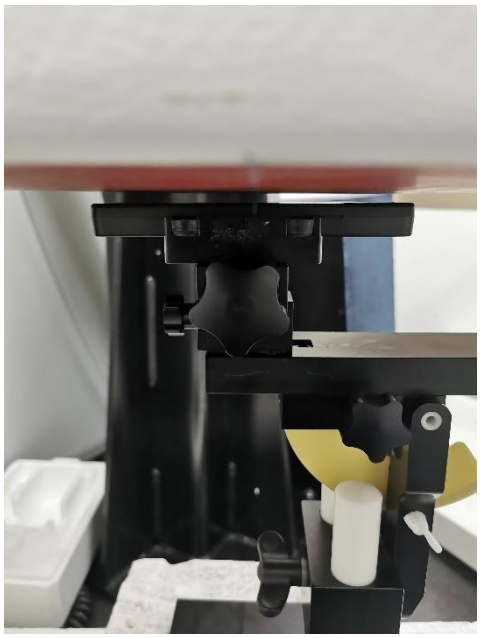


Figure 7. Back side of the DUT, 5mm

Figure 8. Top side of the DUT, 5mm

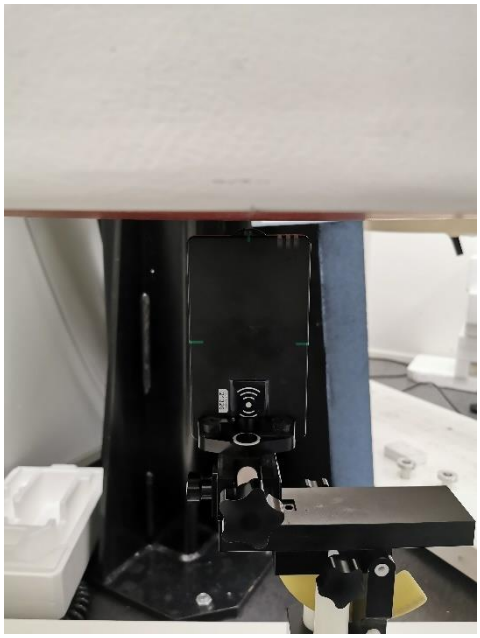


Figure 9. Top side of the DUT, 5mm

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 17.3.2023 8.50.52

Test Laboratory: Verkotan Oy

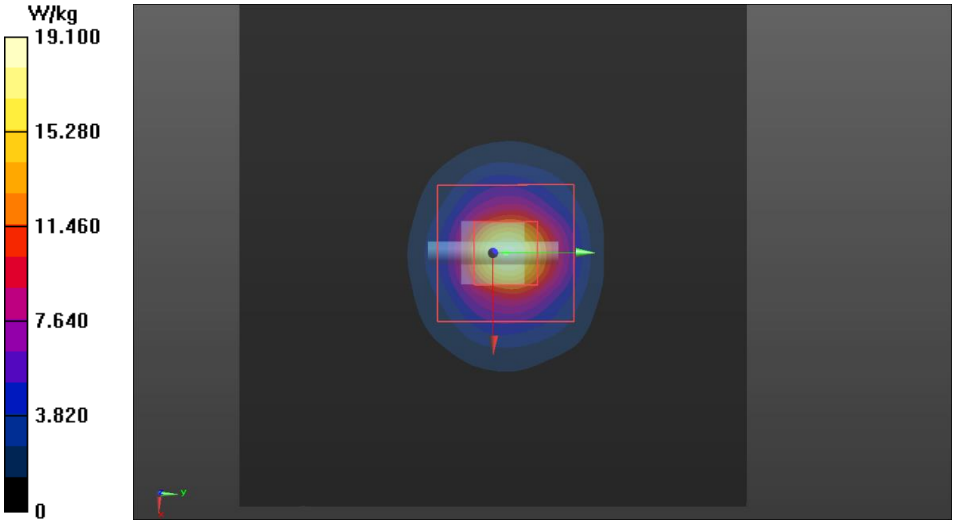
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1045

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: f = 5250 MHz; σ = 4.537 S/m; ε_r = 36.363; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(4.9, 4.9, 4.9) @ 5250 MHz; Calibrated: 27.10.2022
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5250MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 18.2 W/kg
Configuration/system check 5250MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 44.66 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 29.2 W/kg
SAR(1 g) = 7.62 W/kg; SAR(10 g) = 2.19 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 = 66.6%
Maximum value of SAR (measured) = 19.1 W/kg



Plot 2

Date/Time: 20.3.2023 8.11.12

Test Laboratory: Verkotan Oy

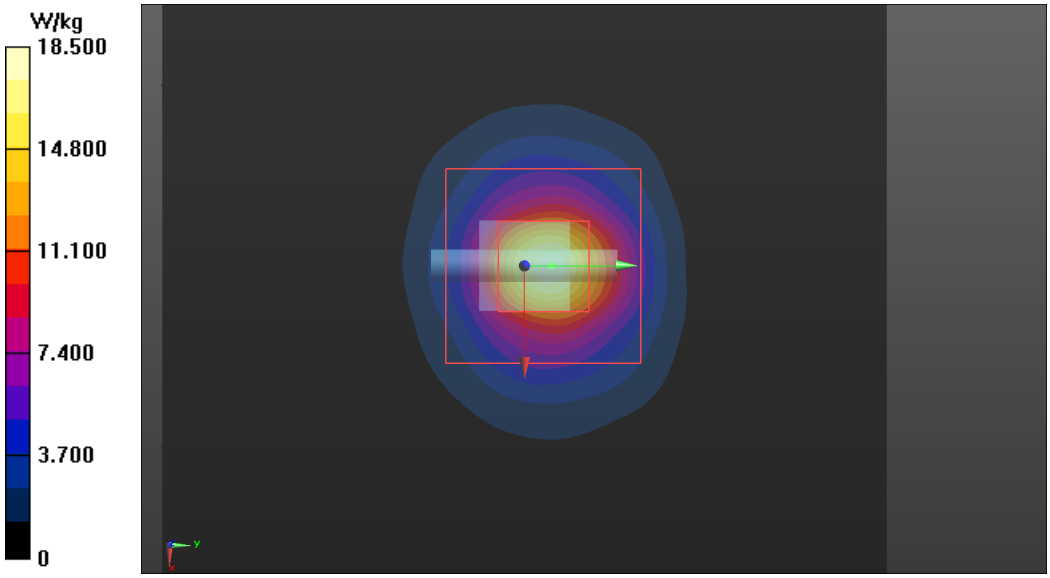
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1045

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: f = 5250 MHz; σ = 4.504 S/m; ε_r = 35.899; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(4.9, 4.9, 4.9) @ 5250 MHz; Calibrated: 27.10.2022
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5250MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 18.0 W/kg
Configuration/system check 5250MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 43.64 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 28.4 W/kg
SAR(1 g) = 7.44 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) = 18.5 W/kg



Plot 3

Date/Time: 20.3.2023 14.52.16

Test Laboratory: Verkotan Oy

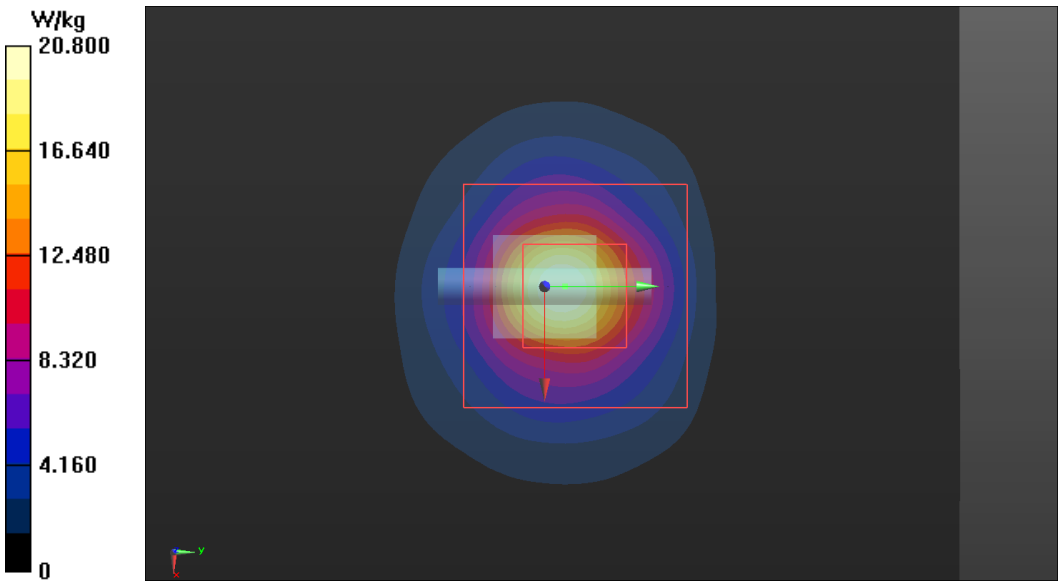
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1045

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: f = 5250 MHz; σ = 4.504 S/m; ε_r = 35.899; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(5.18, 4.99, 5.17) @ 5250 MHz; Calibrated: 17.2.2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5250MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 21.0 W/kg
Configuration/system check 5250MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 45.04 V/m; Power Drift = -0.20 dB
Peak SAR (extrapolated) = 33.6 W/kg
SAR(1 g) = 8.34 W/kg; SAR(10 g) = 2.37 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 = 65.3%
Maximum value of SAR (measured) = 20.8 W/kg



Plot 4

Date/Time: 20.3.2023 8.39.33

Test Laboratory: Verkotan Oy

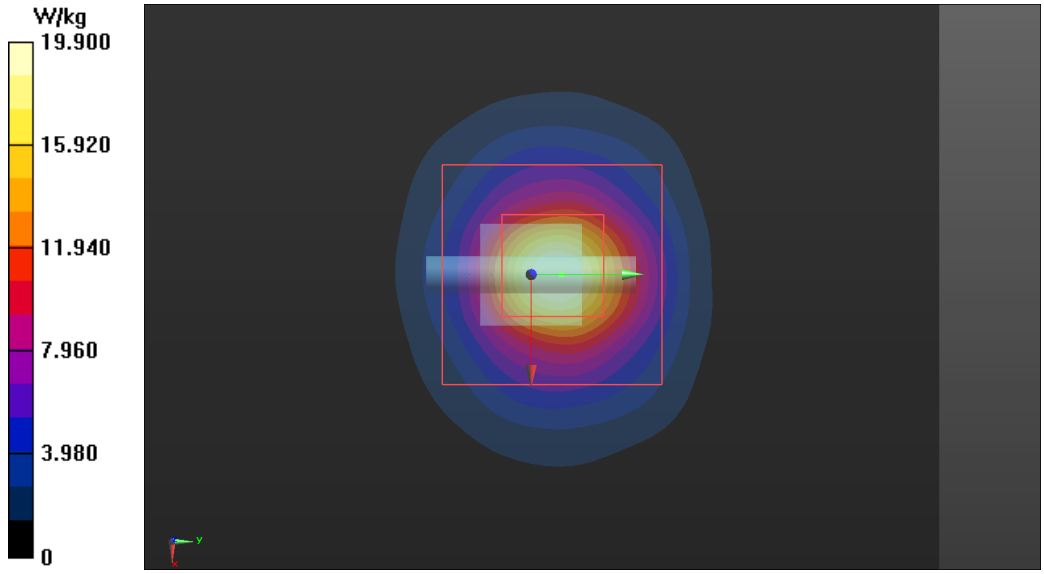
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1045

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 = 4.885 S/m; ε_r = 35.286; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(4.61, 4.61, 4.61) @ 5600 MHz; Calibrated: 27.10.2022
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn710; Calibrated: 19.10.2022
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5600MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 20.4 W/kg
Configuration/system check 5600MHz/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 41.73 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 32.0 W/kg
SAR(1 g) = 7.72 W/kg; SAR(10 g) = 2.2 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 63.8%
Maximum value of SAR (measured) = 19.9 W/kg



Plot 5

Date/Time: 22.3.2023 17.55.23

Test Laboratory: Verkotan Oy

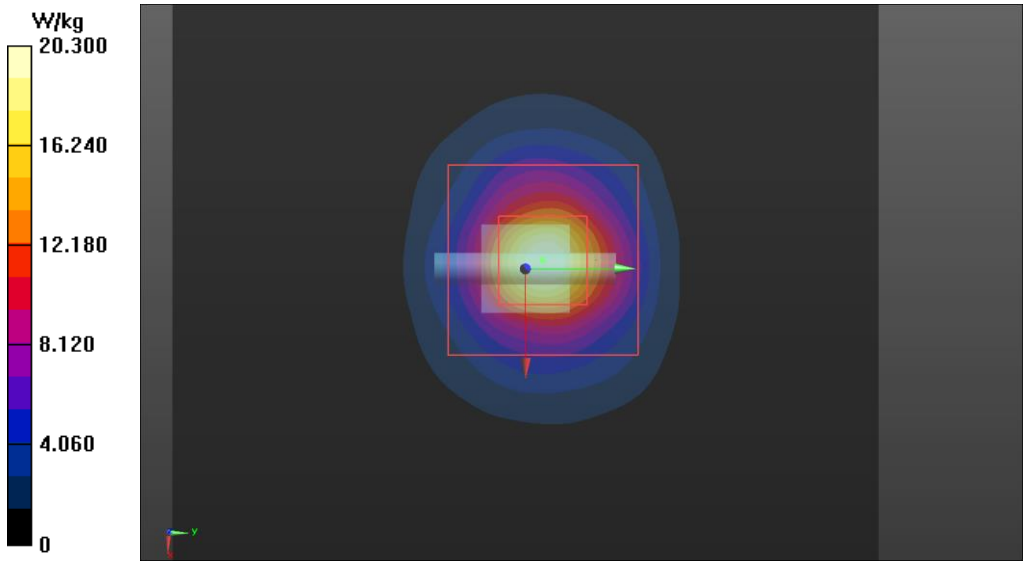
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1045

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 = 4.881 S/m; ε_r = 35.079; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.4, 4.29, 4.43) @ 5600 MHz; Calibrated: 17.2.2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 25.0, -4.0
  - Electronics: DAE4 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - 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 = 44.08 V/m; Power Drift = -0.27 dB
Peak SAR (extrapolated) = 34.8 W/kg
SAR(1 g) = 8.19 W/kg; SAR(10 g) = 2.31 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 = 63.6%
Maximum value of SAR (measured) = 21.4 W/kg
Configuration/system check 5600MHz/Area Scan (81x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 20.3 W/kg



Plot 6

Date/Time: 23.3.2023 17.23.53

Test Laboratory: Verkotan Oy

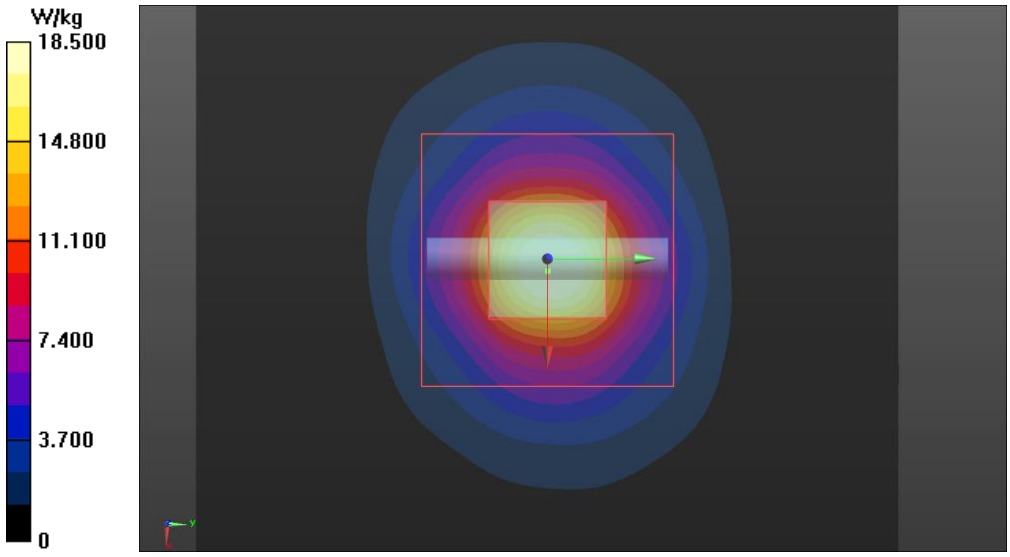
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1045

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 = 4.979 S/m; ε_r = 35.02; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.47, 4.33, 4.53) @ 5750 MHz; Calibrated: 17.2.2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5750Mhz/Area Scan (61x61x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 18.7 W/kg
Configuration/system check 5750Mhz/Zoom Scan (11x7x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.02 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 30.4 W/kg
SAR(1 g) = 7.12 W/kg; SAR(10 g) = 2.03 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 = 62.8%
Maximum value of SAR (measured) = 18.5 W/kg



Plot 7

Date/Time: 27.3.2023 10.18.49

Test Laboratory: Verkotan Oy

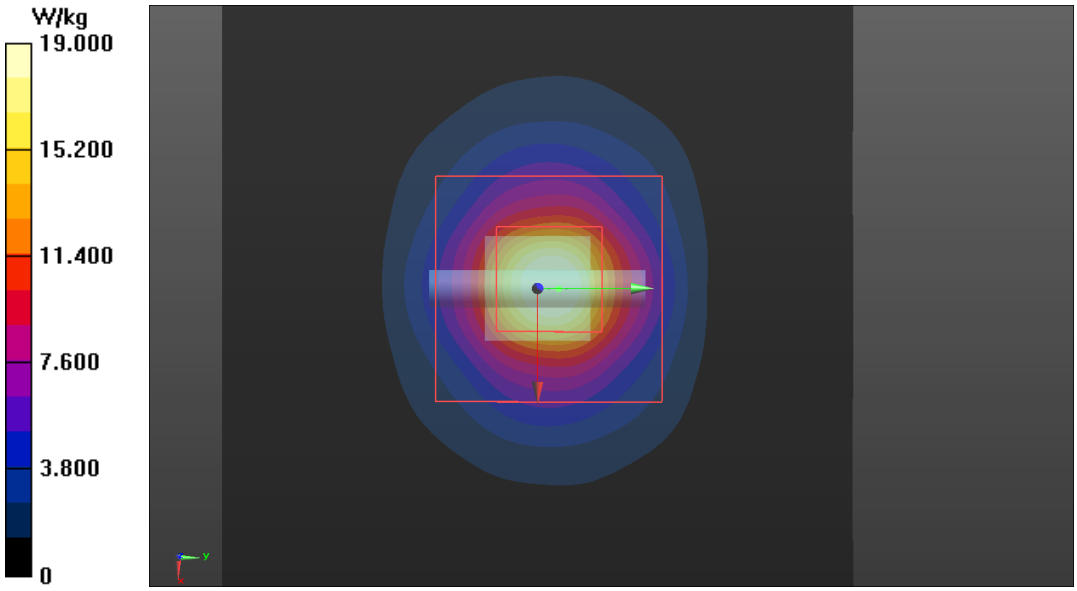
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1045

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 = 5.328 S/m; ε_r = 36.488; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.47, 4.33, 4.53) @ 5750 MHz; Calibrated: 17.2.2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 25.0
  - Electronics: DAE4 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/system check 5750Mhz/Area Scan (61x61x1): 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 (9x9x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 57.93 V/m; Power Drift = -0.23 dB
Peak SAR (extrapolated) = 33.1 W/kg
SAR(1 g) = 7.47 W/kg; SAR(10 g) = 2.12 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 7.6 mm
Ratio of SAR at M2 to SAR at M1 = 61%
Maximum value of SAR (measured) = 19.0 W/kg



Plot 8

Date/Time: 31.3.2023 14.06.42

Test Laboratory: Verkotan Oy

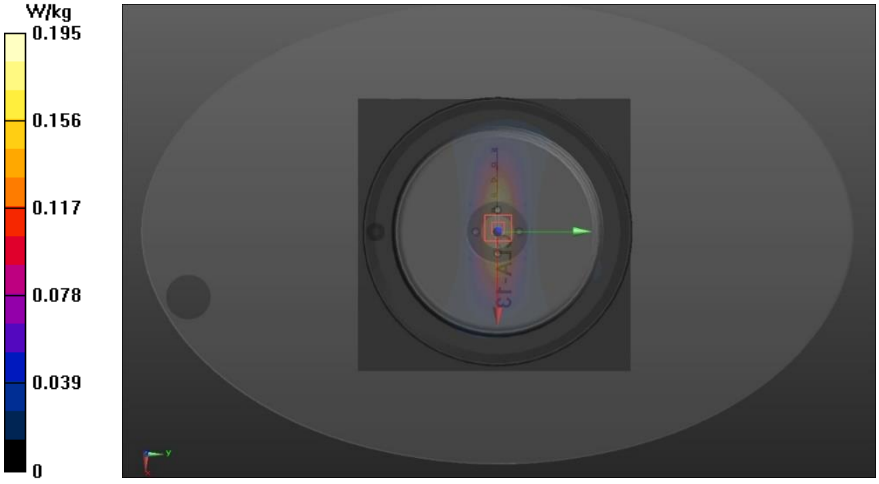
DUT: CLA-13 - SN1012; Type: CLA-13; Serial: SN1007

Communication System: UID 0, CW (0); Communication System Band: CLA13 (13.0MHz); Frequency: 13 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 13 MHz; σ = 0.781 S/m; ε_r = 50.566; ρ = 1000 kg/m^3 , Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(17.42, 17.42, 17.42) @ 13 MHz; Calibrated: 17.2.2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 31.0, -4.0
  - Electronics: DAE4 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR2_Phantom1_ELI back; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/System check/Zoom Scan (7x7x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 16.74 V/m; Power Drift = -1.01 dB
Peak SAR (extrapolated) = 0.244 W/kg
SAR(1 g) = 0.134 W/kg; SAR(10 g) = 0.083 W/kg
Smallest distance from peaks to all points 3 dB below = 15 mm
Ratio of SAR at M2 to SAR at M1 = 55.2%
Maximum value of SAR (measured) = 0.198 W/kg
Configuration/System check/Generic Scan (1x1x1): Measurement grid: dx=10mm, dy=10mm, dz=10mm
Maximum value of Total (measured) = 8.117 V/m
Configuration/System check/Area Scan (151x151x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.195 W/kg



Plot 9

Date/Time: 2023-08-28, 11:18

Test Laboratory: Verkotan Oy

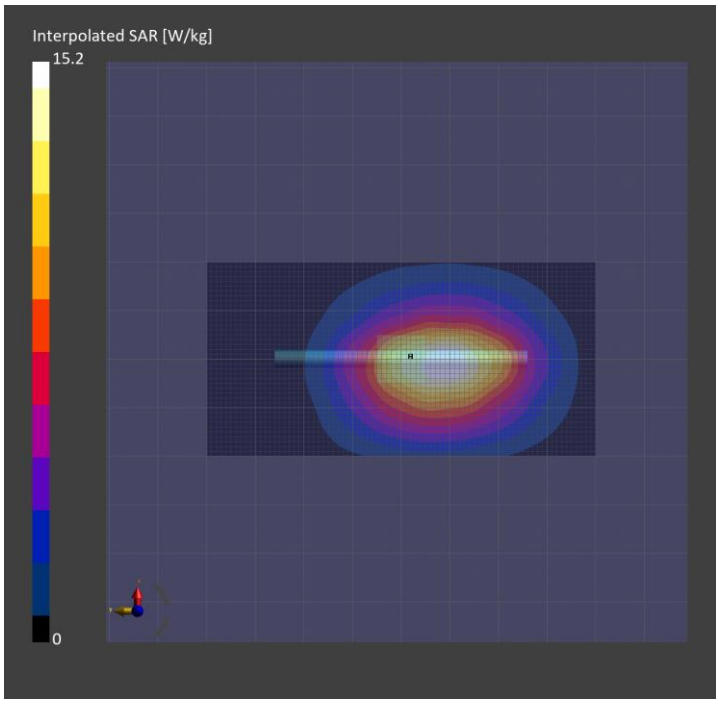
DUT: D2450V2

Communication System: UID 0, CW; Communication System Band: ; Frequency 2450.000 MHz;
Medium parameters used: f= 2450.000; σ = 1.68 S/m; ε_r = 38.2; HSL;
Phantom section: Flat section
Measurement Standard: DASY8 (IEC/IECC)

DASY Configuration:

- Probe: EX3DV4 - SN7827; ConvF(7.5, 7.4, 7.2); Calibrated: 2023-06-04
  - Sensor-Surface: 1.4 mm (VMS + 6p), Mother scan peak deviation; 0.09; Mother scan avg offset: 0.93;
  - Electronics: DAE4ip - SN1774; Calibrated: 2023-06-02
  - Phantom: ELI V8.0 (20deg probe tilt)
  - DASY8 16.2.4.2524

Area Scan: Measurement grid: (40.0 mm x 80.0 mm)
Zoom Scan: Measurement grid: (30.0 mm x 30.0 mm x 30.0 mm)
Reference Value = 10.43 V/m; Power Drift = 0.02 dB
SAR(1 g) = 11.5 W/kg; SAR(10g) = 5.48 W/kg (No correction)
Smallest distance from peaks to all points 3dB below = 9.0 mm
Ratio of SAR at M2 to SAR at M1 = 81.0%



APPENDIX C: MEASUREMENT SCANS

Plot 10

Date/Time: 2023-08-28, 16:07

Test Laboratory: Verkotan Oy

DUT: Keyreader Plus2

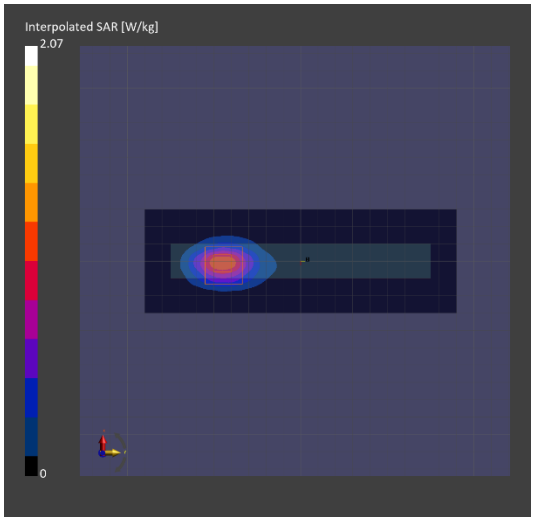
Communication System: UID 10415, WLAN; Communication System Band: WLAN 2.4GHz; Frequency 2437.000 MHz;
Communication System PAR: ;
Medium parameters used: f= 2437.000; σ = 1.67 S/m; ε_r = 38.2; HSL;
Phantom section: Flat section
Measurement Standard: DASY8 (IEC/IECC)

DASY Configuration:

- Probe: EX3DV4 - SN7827; ConvF(7.5, 7.4, 7.2); Calibrated: 2023-06-04
  - Sensor-Surface: 1.4 mm (VMS + 6p), Mother scan peak deviation; 0.07; Mother scan avg offset: 0.61;
  - Electronics: DAE4ip - SN1774; Calibrated: 2023-06-02
  - Phantom: ELI V8.0 (20deg probe tilt)
  - DASY8 16.2.4.2524

Measurement Group:
WLAN 2.4GHz, IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle), CH6, EDGE LEFT, 5.00 mm

Area Scan: Measurement grid: (60.0 mm x 180.0 mm)
Zoom Scan: Measurement grid: (30.0 mm x 30.0 mm x 30.0 mm)
Reference Value = 0.75 V/m; Power Drift = 0.08 dB
SAR(1 g) = 0.969 W/kg; SAR(10g) = 0.443 W/kg (No correction)
Smallest distance from peaks to all points 3dB below = 8.3 mm
Ratio of SAR at M2 to SAR at M1 = 78.7%



Plot 11

Date/Time: 22.3.2023 17.04.00

Test Laboratory: Verkotan Oy

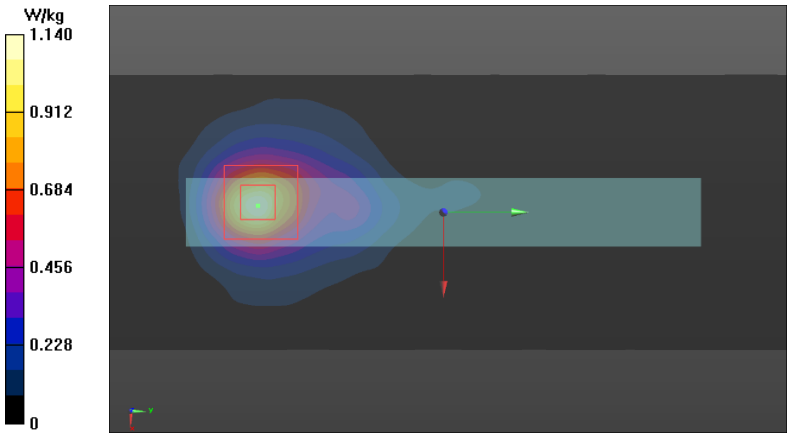
DUT: Keyreader Plus2

Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5300 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 5300 MHz; σ = 4.56 S/m; ε_r = 35.807; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(5.18, 4.99, 5.17) @ 5300 MHz; Calibrated: 17.2.2023
  - 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 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/FCC WLAN 5GHz, CH60, 802.11a Left 5mm/Zoom Scan (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 13.78 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 1.74 W/kg
SAR(1 g) = 0.498 W/kg; SAR(10 g) = 0.179 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 10.4 mm
Ratio of SAR at M2 to SAR at M1 = 65.9%
Maximum value of SAR (measured) = 1.12 W/kg
Configuration/FCC WLAN 5GHz, CH60, 802.11a Left 5mm/Area Scan 3 (81x211x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.14 W/kg



Plot 12

Date/Time: 23.3.2023 14.43.10

Test Laboratory: Verkotan Oy

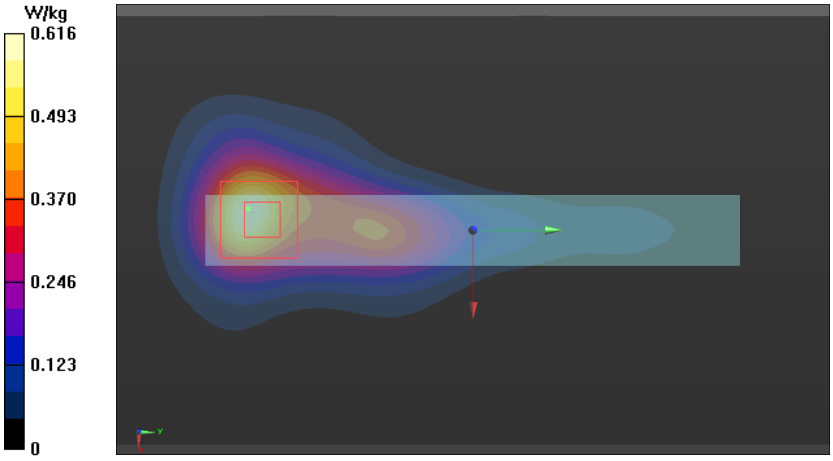
DUT: Keyreader Plus2

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 = 5.016 S/m; ε_r = 34.863; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.47, 4.33, 4.53) @ 5720 MHz; Calibrated: 17.2.2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), z = 15.0, -4.0
  - Electronics: DAE4 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/FCC WLAN 5GHz, CH144, 802.11a Left 5mm/Zoom Scan (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 11.14 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 2.70 W/kg
SAR(1 g) = 0.710 W/kg; SAR(10 g) = 0.246 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 9.8 mm
Ratio of SAR at M2 to SAR at M1 = 63.8%
Maximum value of SAR (measured) = 1.66 W/kg
Configuration/FCC WLAN 5GHz, CH144, 802.11a Left 5mm/Area Scan 3 (81x211x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.26 W/kg



Plot 13

Date/Time: 24.3.2023 13.29.25

Test Laboratory: Verkotan Oy

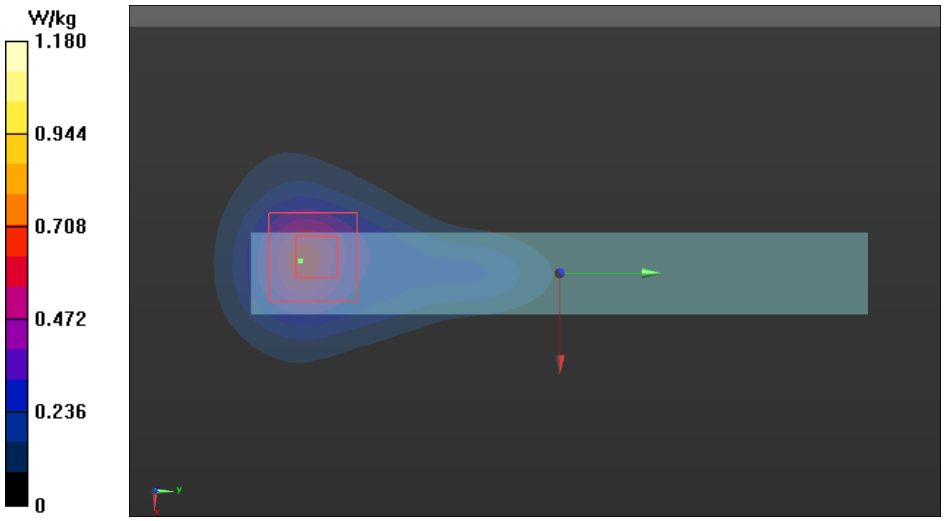
DUT: Keyreader Plus2

Communication System: UID 0, WLAN5GHz (0); Communication System Band: 5GHz; Frequency: 5785 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 5785 MHz; σ = 5.023 S/m; ε_r = 34.956; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(4.47, 4.33, 4.53) @ 5785 MHz; Calibrated: 17.2.2023
  - 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 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/FCC WLAN 5GHz, CH157, 802.11a Left 5 mm/Area Scan (41x71x1): Interpolated grid: dx=3.000 mm, dy=3.000 mm
Maximum value of SAR (interpolated) = 0.612 W/kg
Configuration/FCC WLAN 5GHz, CH157, 802.11a Left 5 mm/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) = 2.60 W/kg
SAR(1 g) = 0.665 W/kg; SAR(10 g) = 0.226 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 9.6 mm
Ratio of SAR at M2 to SAR at M1 = 62.7%
Maximum value of SAR (measured) = 1.54 W/kg



Plot 14

Date/Time: 31.3.2023 15.05.01

Test Laboratory: Verkotan Oy

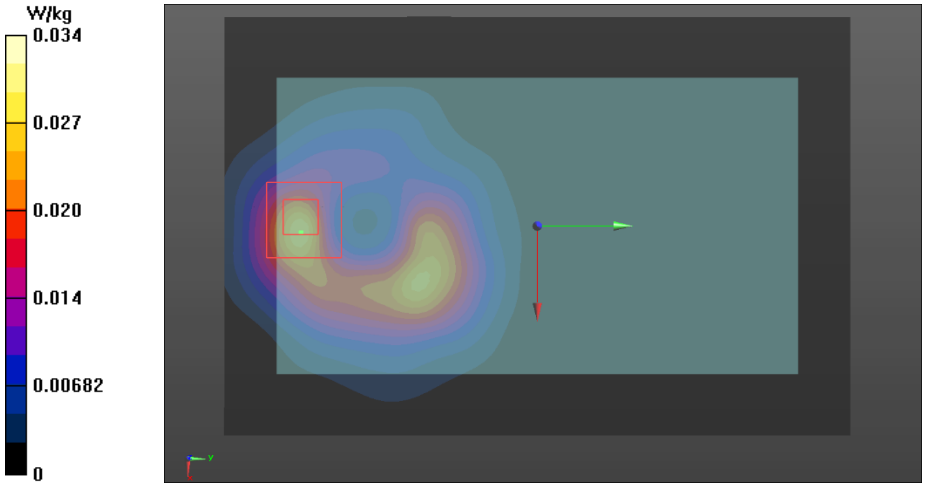
DUT: Keyreader Plus2

Communication System: UID 0, NFC 13.56MHz (0); Communication System Band: NFC; Frequency: 13.56 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 14 MHz; σ = 0.781 S/m; ε_r = 50.691; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN7447; ConvF(17.42, 17.42, 17.42) @ 13.56 MHz; Calibrated: 17.2.2023
  - 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 Sn1332; Calibrated: 15.2.2023
  - Phantom: SAR2_Phantom1_ELI back; Type: QD OVA 002 AA;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/NFC 13.56MHz Backt 0mm 2/Area Scan (61x91x1): Interpolated grid: dx=2.000 mm, dy=2.000 mm
Maximum value of SAR (interpolated) = 0.0296 W/kg
Configuration/NFC 13.56MHz Backt 0mm 2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 5.684 V/m; Power Drift = -0.23 dB
Peak SAR (extrapolated) = 0.0490 W/kg
SAR(1 g) = 0.017 W/kg; SAR(10 g) = 0.00732 W/kg
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid
Ratio of SAR at M2 to SAR at M1 = 32.7%
Maximum value of SAR (measured) = 0.0341 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION REPORTS

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

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

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

Accreditation No.: **SCS 0108**

Client	Verkotan	Certificate No	EX-7447_Feb23

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 17, 2023

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	06-Jan-23 (No. ES3-3013_Jan23)	Jan-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	Joanna Lleshaj	Laboratory Technician	
Approved by	Niels Kuster	Quality Manager	

Issued: February 21, 2023

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

Certificate No: EX-7447_Feb23 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]	0.43	0.43	0.43	±10.1%
DCP (mV) [B]	90.0	91.0	96.0	±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	130.7	±2.3%	±4.7%
		Y	0.00	0.00	1.00		130.1		
		Z	0.00	0.00	1.00		134.6		

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.

Parameters of Probe: EX3DV4 - SN:7447

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-139.3°
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:7447

February 17, 2023

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	17.42	17.42	17.42	0.00	1.25	±13.3%
750	41.9	0.89	9.91	8.74	9.52	0.31	1.27	±12.0%
900	41.5	0.97	9.37	8.45	8.89	0.32	1.27	±12.0%
1750	40.1	1.37	8.45	7.97	8.40	0.25	1.27	±12.0%
1950	40.0	1.40	8.05	7.59	7.97	0.29	1.27	±12.0%
2150	39.7	1.53	8.01	7.58	7.90	0.28	1.27	±12.0%
2300	39.5	1.67	7.85	7.46	7.80	0.28	1.27	±12.0%
2450	39.2	1.80	7.70	7.50	7.63	0.28	1.27	±12.0%
2600	39.0	1.96	7.55	7.37	7.73	0.28	1.27	±12.0%
3300	38.2	2.71	7.02	6.71	7.02	0.34	1.27	±14.0%
5250	35.9	4.71	5.18	4.99	5.17	0.39	1.53	±14.0%
5600	35.5	5.07	4.40	4.29	4.43	0.38	1.77	±14.0%
5750	35.4	5.22	4.47	4.33	4.53	0.38	1.85	±14.0%

[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 TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

[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.

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Accreditation No.: SCS 0108

Client	Verkotan Oulu, Finland	Certificate No.	EX-7827_Jun23

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7827
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	June 04, 2023

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	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)	30-Mar-23 (No. 217-03809)	Mar-24
DAE4	SN: 660	16-Mar-23 (No. DAE4-660_Mar23)	Mar-24
Reference Probe ES3DV2	SN: 3013	06-Jan-23 (No. ES3-3013_Jan23)	Jan-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	Jeton Kastrati	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: June 06, 2023

Parameters of Probe: EX3DV4 - SN:7827

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ($k = 2$)
Norm ($\mu V/(V/m)^2$) [A]	0.68	0.59	0.64	±10.1%
DCP (mV) [B]	105.2	106.9	108.4	±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	131.5	±1.6%	±4.7%
		Y	0.00	0.00	1.00		140.7		
		Z	0.00	0.00	1.00		126.6		
10352	Pulse Waveform (200Hz, 10%)	X	1.54	60.55	6.12	10.00	60.0	±3.5%	±9.6%
		Y	1.45	60.21	5.80		60.0		
		Z	1.40	60.00	5.79		60.0		
10353	Pulse Waveform (200Hz, 20%)	X	0.79	60.00	4.61	6.99	80.0	±2.8%	±9.6%
		Y	0.81	60.00	4.49		80.0		
		Z	0.86	60.00	4.73		80.0		
10354	Pulse Waveform (200Hz, 40%)	X	0.07	141.02	0.21	3.98	95.0	±2.8%	±9.6%
		Y	0.03	131.64	0.01		95.0		
		Z	0.41	159.30	18.09		95.0		
10355	Pulse Waveform (200Hz, 60%)	X	3.45	131.09	9.75	2.22	120.0	±1.7%	±9.6%
		Y	3.12	159.98	2.74		120.0		
		Z	7.70	82.24	0.21		120.0		
10387	QPSK Waveform, 1 MHz	X	0.45	64.23	13.07	1.00	150.0	±3.0%	±9.6%
		Y	0.38	61.88	11.02		150.0		
		Z	0.47	64.93	13.22		150.0		
10388	QPSK Waveform, 10 MHz	X	1.27	66.90	13.96	0.00	150.0	±0.9%	±9.6%
		Y	1.09	64.87	12.54		150.0		
		Z	1.28	67.25	13.88		150.0		
10396	64-QAM Waveform, 100 kHz	X	1.60	63.90	15.81	3.01	150.0	±1.1%	±9.6%
		Y	1.70	65.07	16.17		150.0		
		Z	1.73	65.26	16.18		150.0		
10399	64-QAM Waveform, 40 MHz	X	2.72	66.63	15.27	0.00	150.0	±2.6%	±9.6%
		Y	2.62	66.09	14.81		150.0		
		Z	2.75	67.08	15.37		150.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	3.72	66.83	15.55	0.00	150.0	±4.0%	±9.6%
		Y	3.65	66.57	15.27		150.0		
		Z	3.61	66.64	15.34		150.0		

Note: For details on UID parameters see Appendix

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

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] 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.

Parameters of Probe: EX3DV4 - SN:7827

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms V^{-2}$	T2 $ms V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
x	7.4	53.86	33.74	1.85	0.00	4.90	0.00	0.05	1.00
y	7.2	52.61	33.58	3.25	0.00	4.90	0.53	0.00	1.00
z	7.0	50.07	32.48	5.09	0.00	4.90	0.67	0.00	1.00

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-76.3°
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.

Parameters of Probe: EX3DV4 - SN:7827

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 ($k = 2$)
750	41.9	0.89	9.60	9.47	9.21	0.39	1.27	±12.0%
900	41.5	0.97	9.32	8.86	8.61	0.38	1.27	±12.0%
1750	40.1	1.37	8.35	8.24	7.90	0.26	1.27	±12.0%
1950	40.0	1.40	7.98	7.87	7.60	0.28	1.27	±12.0%
2100	39.8	1.49	7.88	7.77	7.55	0.29	1.27	±12.0%
2300	39.5	1.67	7.80	7.69	7.48	0.30	1.27	±12.0%
2450	39.2	1.80	7.50	7.40	7.20	0.29	1.27	±12.0%
2600	39.0	1.96	7.43	7.31	7.12	0.29	1.27	±12.0%
3300	38.2	2.71	7.07	7.00	6.81	0.35	1.27	±14.0%
3500	37.9	2.91	6.96	6.89	6.71	0.36	1.27	±14.0%
3700	37.7	3.12	6.88	6.80	6.63	0.36	1.27	±14.0%
3900	37.5	3.32	6.83	6.75	6.59	0.37	1.27	±14.0%
4100	37.2	3.53	6.60	6.50	6.36	0.37	1.27	±14.0%
5250	35.9	4.71	5.60	5.58	5.42	0.39	1.53	±14.0%
5600	35.5	5.07	4.95	4.87	4.73	0.38	1.67	±14.0%
5750	35.4	5.22	5.14	5.02	4.94	0.38	1.75	±14.0%

[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 4–8 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 TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

[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.

Parameters of Probe: EX3DV4 - SN:7827

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 ($k = 2$)
6500	34.5	6.07	4.95	4.87	4.85	0.20	2.50	±18.6%

[C] Frequency validity at 6.5 GHz is −600/+700 MHz, and ±700 MHz at or above 7 GHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ε and σ by less than ±10% from the target values (typically better than ±6%) and are valid for TSL with deviations of up to ±10%.
[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, below ±2% for frequencies between 3–6 GHz, and below ±4% for frequencies between 6–10 GHz at any distance larger than half the probe tip diameter from the boundary.

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Accreditation No.: SCS 0108

Client	Verkotan Oulu, Finland	Certificate No.	EX-3892_Apr23

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3892
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	April 20, 2023

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	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)	30-Mar-23 (No. 217-03809)	Mar-24
DAE4	SN: 660	16-Mar-23 (No. DAE4-660_Mar23)	Mar-24
Reference Probe ES3DV2	SN: 3013	06-Jan-23 (No. ES3-3013_Jan23)	Jan-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	Jeffrey Katzman	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: April 22, 2023

Parameters of Probe: EX3DV4 - SN:3892

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ($k = 2$)
Norm ($\mu V/(V/m)^2$) [A]	0.47	0.39	0.49	±10.1%
DCP (mV) [B]	102.4	105.3	102.6	±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	120.0	±1.1%	±4.7%
		Y	0.00	0.00	1.00		141.8		
		Z	0.00	0.00	1.00		123.2		

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.

Parameters of Probe: EX3DV4 - SN:3892

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	29.4°
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.

Parameters of Probe: EX3DV4 - SN:3892

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 ($k = 2$)
450	43.5	0.87	10.79	10.79	10.79	0.16	1.30	±13.3%
600	42.7	0.88	10.21	10.21	10.21	0.10	1.25	±13.3%
750	41.9	0.89	9.64	9.72	9.33	0.37	1.27	±12.0%
900	41.5	0.97	9.30	9.64	8.99	0.35	1.27	±12.0%
1750	40.1	1.37	8.12	8.30	8.01	0.24	1.27	±12.0%
1900	40.0	1.40	7.94	8.14	7.80	0.28	1.27	±12.0%
2450	39.2	1.80	7.09	7.31	6.98	0.26	1.27	±12.0%
2600	39.0	1.96	7.18	7.37	7.04	0.26	1.27	±12.0%
4400	36.9	3.84	6.14	6.32	6.02	0.36	1.27	±14.0%
4800	36.4	4.25	5.96	6.13	5.83	0.36	1.27	±14.0%

[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 4–8 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 TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

[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

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Accreditation No.: SCS 0108

Client Verkotan

Certificate No: CLA13-1012_Mar21

CALIBRATION CERTIFICATE

Object: CLA13 - SN: 1012

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

Calibration date: March 11, 2021

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	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 3877	30-Dec-20 (No. EX3-3877_Dec20)	Dec-21
DAE4	SN: 654	26-Jun-20 (No. DAE4-654_Jun20)	Jun-21

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 Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 12, 2021

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

Certificate No: CLA13-1012_Mar21 Page 1 of 6

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	13 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	55.0	0.75 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	53.8 ± 6 %	0.72 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	1 W input power	0.540 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**0.555 W/kg ± 18.4 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	1 W input power	0.337 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**0.346 W/kg ± 18.0 % (k=2)**

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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:	Aldonia 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.

Certificate No: D2450V2-729_Jul22 Page 1 of 6

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)**

SAR Reference Dipole Calibration Report

Ref : ACR.68.8.23.BES.A

VERKOTAN OY
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 5200-5800 MHZ
SERIAL NO.: 1045

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.

mvg

SAR REFERENCE DIPOLE CALIBRATION REPORT Ref: ACR.60.8.23.BES.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Cyrille ONNEE	Measurement Responsible	3/9/2023	
Checked & approved by:	Jérôme Luc	Technical Manager	3/9/2023	
Authorized by:	Yann Toutain	Laboratory Director	3/9/2023	

Yann Toutain ID
Signature numérique de Yann Toutain ID
Date : 2023.03.09 15:05:03 +01'00'

	Customer Name
Distribution :	Verkotan Oy

Issue	*Name*	*Date*	*Modifications*
A	Cyrille ONNEE	3/9/2023	Initial release

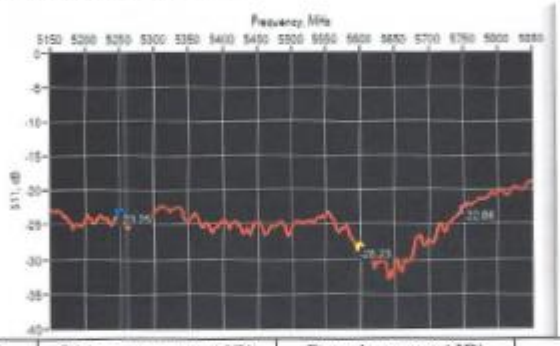
6 CALIBRATION RESULTS

6.1 MECHANICAL DIMENSIONS

L mm		h mm		d mm	
Measured	Required	Measured	Required	Measured	Required
-	20.60 +/- 2%	-	40.30 +/- 2%	-	3.60 +/- 2%

6.2 S11 PARAMETER

6.2.1 S11 parameter in Head Liquid



Frequency (MHz)	S11 parameter (dB)	Requirement (dB)	Impedance
5250	-23.25	-20	47.8Ω + 6.4jΩ
5600	-28.23	-20	48.5Ω - 3.5jΩ
5750	-22.86	-20	46.7Ω + 6.1jΩ

6.3 SAR

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

6.3.1 SAR 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.

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values @ 5250 MHz: eps' : 34.3 sigma : 4.67 Head Liquid Values @ 5600 MHz: eps' : 33.6 sigma : 5.05 Head Liquid Values @ 5750 MHz: eps' : 32.9 sigma : 5.46
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=4mm/dy=4mm/dz=2mm
Frequency	5250 MHz 5600 MHz 5750 MHz
Input power	20 dBm
Liquid Temperature	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
5250 MHz	7.31	73.09	-	2.11	21.12	-
5600 MHz	7.29	72.92	78.30	2.13	21.29	23.20
5750 MHz	6.91	69.05	-	2.03	20.27	-

SAR MEASUREMENT PLOTS @ 5250 MHz