SAR Compliance Test Report

Date of Report	2/03/2022	**Client's Contact person:**	Mark Newton
Number of pages:	37	**Responsible Test engineer:**	Ilari Kinnunen
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**Ocean Signal Ltd.** Unit 4, Ocivan Way CT9 4NN Margate United Kingdom
Tested device	PLB3		
Related reports:	75950037 Report 03 Issue 1		
Testing has been carried out in accordance with:	**47CFR §2.1093** Radiofrequency Radiation Exposure Evaluation: Portable Devices **FCC KDB Publications 447498 D04.**		
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:

02.03.2022

Miia Nurkkala

Digitaalinen allekirjoittaja: Miia Nurkkala
Päiväys: 2022.03.02 09:15:16 +02'00'

Laboratory Manager

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Equipment under Test (DUT):

Product:	Personal Locator Beacon
Manufacturer:	Ocean Signal
Model:	PLB3
Serial Number:	TA000010
FCC ID Number:	XYEPLB3
DUT Number:	21660
Battery Type used in testing:	Lithium/Iron Disulfide
State of the Sample	Production sample

Testing information:

Testing performed:	01.02.2022 – 03.02.2022
Notes:	-
Document ID:	FCC SAR report PLB3 ID5276 02032022.docx
Document history & changes:	-
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
FCC Test Firm Designation Number	FI00005
Measurement performed by:	Ilari Kinnunen

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 Body-worn SAR_{1g} is 1.6 W/kg.

System	Highest Reported* SAR_{1g}(W/kg) in Body-worn Condition, 5mm separation distance	Result
121.5 MHz	**0.27**	**PASS**
162 MHz	**0****	**PASS**

* Reported SAR Values are scaled to upper limit of power tuning tolerance. **SAR is below detection limit of the test system

1.2.1 Maximum Drift

Maximum Drift During Measurements	0.89dB

*Larger than 5% drifts included to scaling factors

1.2.2 Measurement Uncertainty

Expanded Uncertainty (k=2) 95 %	±22.3 %

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is a Personal Locator Beacon with AIS and RLS, transmitting at frequencies of 121.5MHz, 162MHz and 406MHz.

From the customer:

In normal operating mode the device uses following duty cycles:

121.5MHz = 48s / 50s = 96%
162MHz = 0.2128s / 60s = 0.35%
406MHz = 0.5s / 50s = 1%

The frequency of 121.5MHz was measured using normal operating mode. For 162MHz frequency, a special test mode was used to set the DUT transmit at duty cycle of 2.66% instead of normal use duty cycle of 0.35%.

The DUT does not support simultaneous transmission.

Device Category	Portable
Exposure Environment	General population

2.1 Supported Frequency Bands and Operational Modes

TX Frequency bands	Transmitter Frequency Range (MHz)
	121.5
	162
	406

2.2 Test Exclusions

According to appendix A of 447498 D04 Interim General RF Exposure Guidance the SAR test exclusion power threshold for 406 MHz is 224mW at 50mm separation distance. The maximum time-averaged output power of the 406MHz transmission is 100mW thus it is below the test exclusion threshold.

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

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

where

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

and f is in GHz, d is the separation distance (cm), and ERP20cm is per Equation 3 (B.1) below.

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

Transmission frequency [MHz]	Separation distance [cm]	P_{th} [mW]
406	5	224

3. OUTPUT POWER

3.1 Maximum specified conducted output power

From the customer;

TX Frequency [MHz]	Max Output Power [dBm]
121.5	18.75
162	32.25
406	36.75

3.2 Tested conducted power

From the TUV test report "75950037 Report 03 Issue 1":

TX Frequency [MHz]	Max Output Power [dBm]
121.5	13.3
162	31.46

4. TEST EQUIPMENT

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

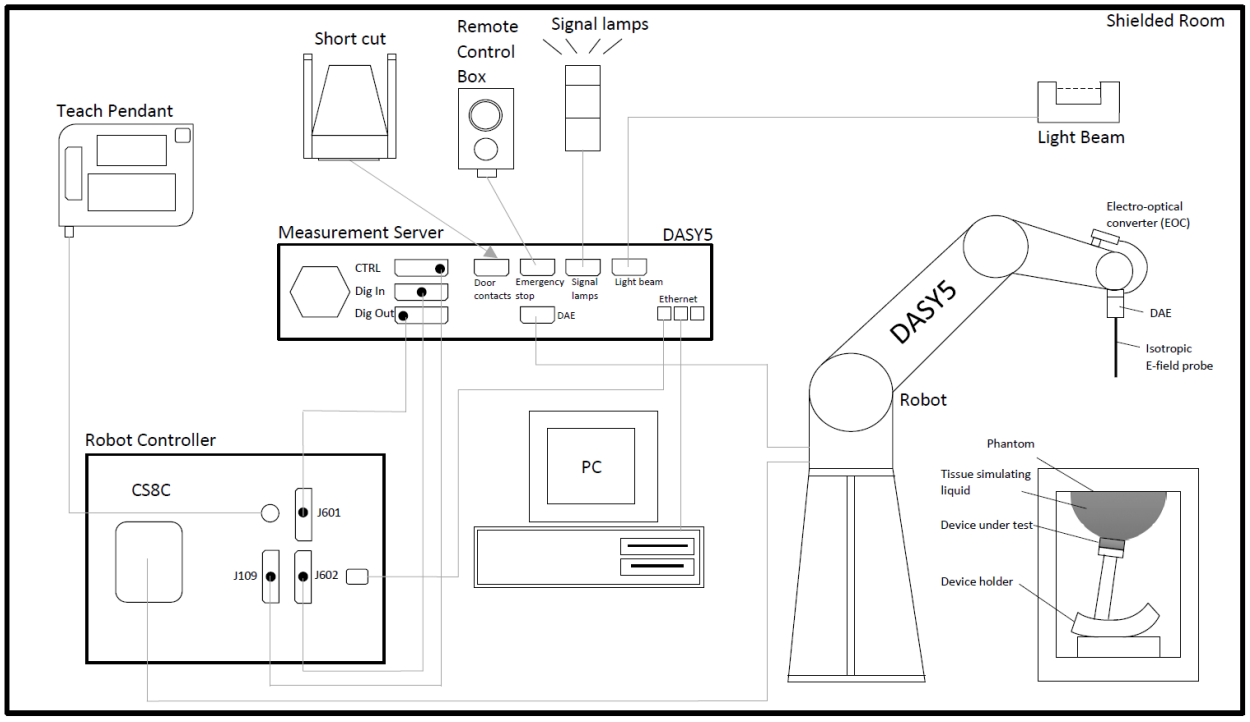


Figure 1 Schematic Laboratory Picture

4.1 Test Equipment List

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

Test Equipment	Model	Serial Number	Calibration Date
DAE	DAE4	705	04.2021
Probe	EX3DV4	3852	10.2021
CLA	CLA-128	3006	07.2019
CLA	CLA-150	4027	07.2019
DASY5 Software	52.8.8.1258	-	NA
Signal Generator	Agilent E4438C	MY42082527	NA
Amplifier	128MHz	NA	NA
Amplifier	150MHz	NA	NA
Power Sensor	NRP-Z11	100265	12.2021
Power Sensor	NRP-Z81	100792	06.2021

Dipole calibration period supporting data:

		Measured on 01/2022			Calibrated		
Antenna and serial number	Frequency (MHz)	Return loss (dB)	Impedance (Ω)		Return loss (dB)	Impedance (Ω)	
CLA-128, SN: 3006	128	-25.39	55.44	-1.71	-22.26	56.40	-5.14
CLA-150, SN: 4027	150	-32.63	52.20	1.02	-28.85	49.88	-3.61

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. 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 ±10% of the recommended values below 3 GHz and ±5% above 3 GHz frequency. 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 consists of:

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	Validation Signal Type	DAE Unit /SN	Dielectric Constant ε	Conductivity, σ [S/m]	Validation Done
								Head tissue simulant
128	CLA 128 - SN: 3006	EX3DV4 - SN: 3852	CW	CW	DAE 4 / 705	49.9	0.75	01.2022
150	CLA 150 - SN: 4027	EX3DV4 - SN: 3852	CW	CW	DAE 4 / 705	49.7	0.77	01.2022

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 #
01.02.2022	LB Head	22	128	250	0.794	3.48	3.176	-8.7	1
03.02.2022	LB Head	22	150	250	0.854	3.64	3.416	-6.2	2

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 (%)
01.02.2022	LB Head	22	122	52.9	0.8	49.5	0.69	-6.4	-8.6
01.02.2022	LB Head	22	128	52.8	0.8	49.4	0.69	-6.4	-8.4
03.02.2022	LB Head	22	150	52.3	0.76	48.6	0.69	-7.1	-8.9
03.02.2022	LB Head	22	162	51.7	0.77	48.4	0.70	-6.5	-9.3

5. TEST PROCEDURE

Testing was carried out in accordance with FCC KDB Publications 447498 D04.

A special test mode was used to set the DUT transmit at the frequency of 162MHz at duty cycle of 2.66% instead of normal use duty cycle of 0.35%.

The DUT does not support simultaneous transmission.

5.1 Test Positions

5.1.1 Body-worn Configuration, 5mm separation distance

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

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. 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

Uncertainty Budget
According to IEEE 1528-2013 and IEC 62209-1/201x (0.3 - 3 GHz range)

Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.0 %	N	1	1	1	±6.0 %	±6.0 %	∞
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Modulation Response^{m}	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	$\sqrt{3}$	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±2.0 %	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift $_{p}$	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
Power Scaling	±0 %	R	$\sqrt{3}$	1	1	±0.0 %	±0.0 %	∞
Phantom and Setup								
Phantom Uncertainty	±6.1 %	R	$\sqrt{3}$	1	1	±3.5 %	±3.5 %	∞
SAR correction $_{DAK}$	±1.9 %	R	$\sqrt{3}$	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.)	±2.5 %	R	$\sqrt{3}$	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.) ^{DAK}	±2.5 %	R	$\sqrt{3}$	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity ^{BB}	±3.4 %	R	$\sqrt{3}$	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity ^{BB}	±0.4 %	R	$\sqrt{3}$	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±11.2 %	±11.1 %	361
Expanded STD Uncertainty						**±22.3 %**	**±22.2 %**	

7. TEST RESULTS

7.1 SAR Results for Body-Worn Condition with 5mm separation

Frequency [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [W/kg]	Power Drift* [dB]	Scaling Factor	Duty Cycle [%]	Reported SAR1g [W/kg]	Plot #
121.5	Handle Back	18.75	13.3	0.000722	0.89	4.31	96	0.003	-
121.5	Handle Left	18.75	13.3	0.00611	N/A**	3.51	96	0.02	-
121.5	Handle Right	18.75	13.3	0.00529	N/A**	3.51	96	0.02	-
121.5	Antenna Left	18.75	13.3	0.0756	N/A**	3.51	96	0.27	3
121.5	Antenna Right	18.75	13.3	0.0112	N/A**	3.51	96	0.04	-

*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

Frequency [MHz]	Test position	Maximum Power [dBm]	Conducted Power [dBm]	Measured SAR1g [W/kg]	Power Drift* [dB]	Scaling Factor	Duty Cycle [%]	Reported SAR1g [W/kg]	Plot #
162	Handle Back	32.25	31.46	0***	N/A**	1.20	2.66	0	-
162	Handle Left	32.25	31.46	0***	N/A**	1.20	2.66	0	-
162	Handle Right	32.25	31.46	0***	N/A**	1.20	2.66	0	-
162	Antenna Left	32.25	31.46	0***	N/A**	1.20	2.66	0	-
162	Antenna Right	32.25	31.46	0***	N/A**	1.20	2.66	0	-

*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
*** SAR is below the detection limit of the test system

7.2 406 MHz Test Exclusion

According to Appendix A at 447498D04 Interim General RF Exposure Guidance, the equation (B.2.) defines the thresholds for available maximum time-averaged power or maximum time-averaged ERP, whichever is greater. Since the ERP is greater than the maximum output power of the DUT, it is used for SAR test exclusion.

Transmission frequency [MHz]	Output power [dBm]	Power Gain of Antenna [dBi]	EIRP Output power [dBm]	ERP Output power [dBm]	ERP Output power [mW]	Duty Cycle [%]	Time-averaged ERP Output Power [mW]	P_{th} [mW]
406	36.75	5.4	42.15	40.0	10000	1	100	224

APPENDIX A: PHOTOS OF THE DUT

Size of the DUT is 200 × 36 × 22mm with antenna stowed.

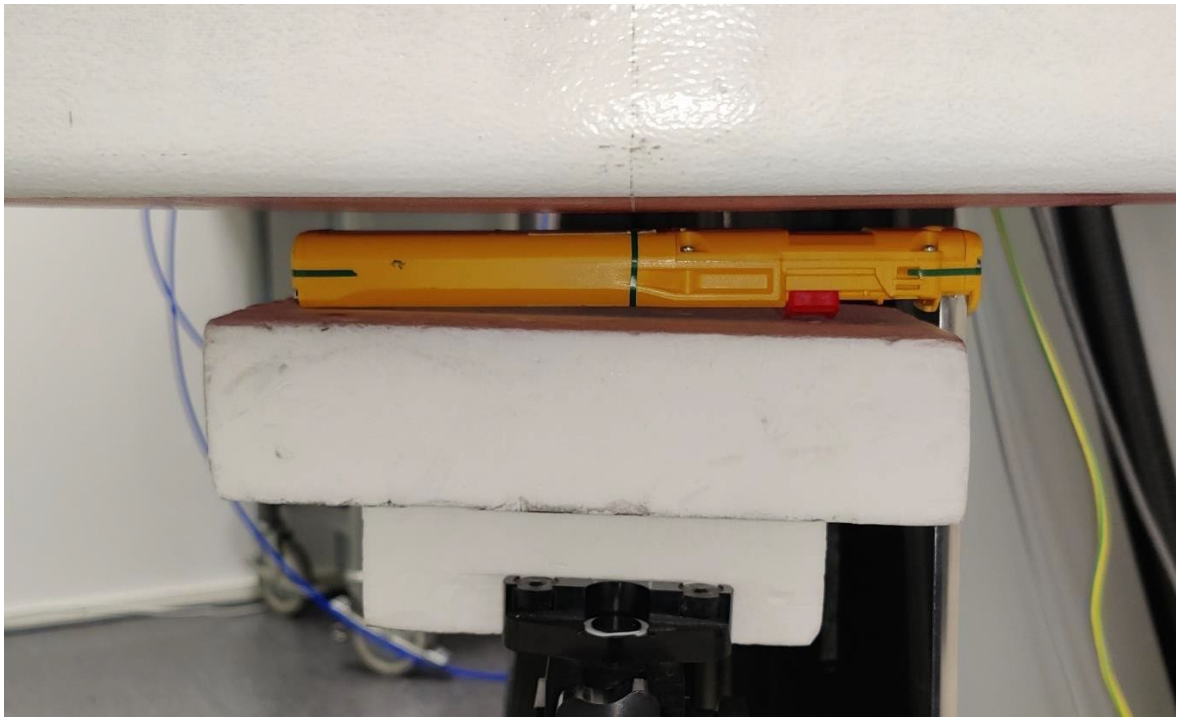


Figure 2 DUT in Handle Back Test position

Figure 3 DUT in Handle Left Test position

Figure 4 DUT in Handle Right Test position

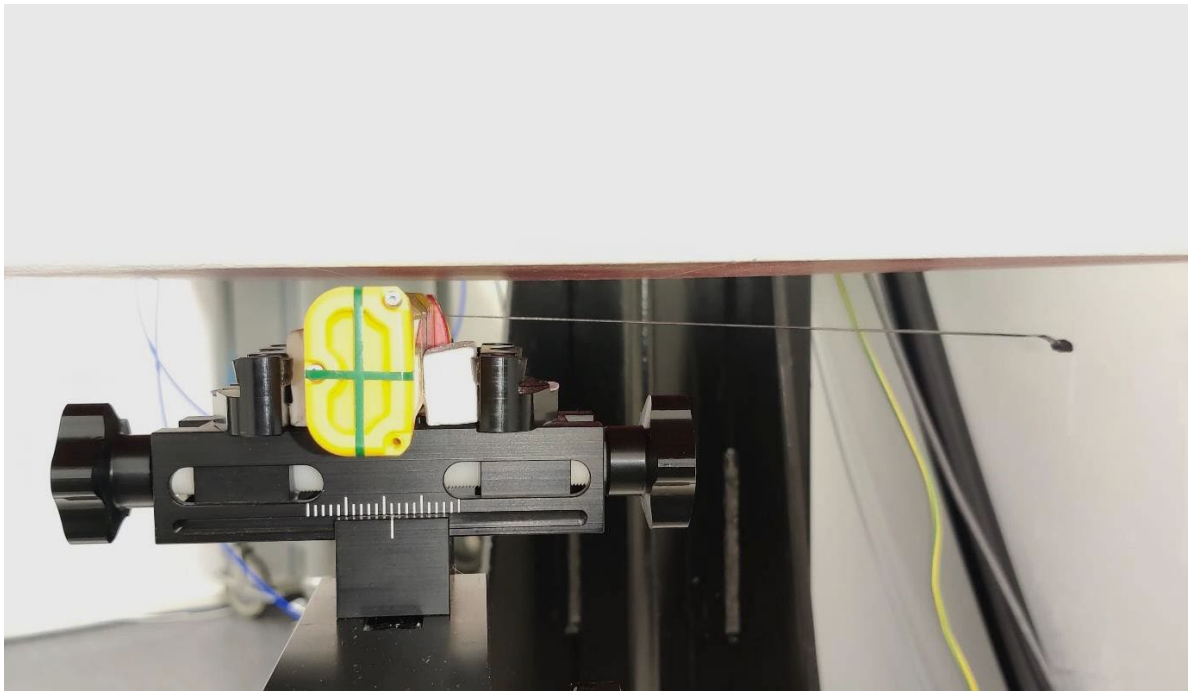


Figure 5 DUT in Antenna Left Test position

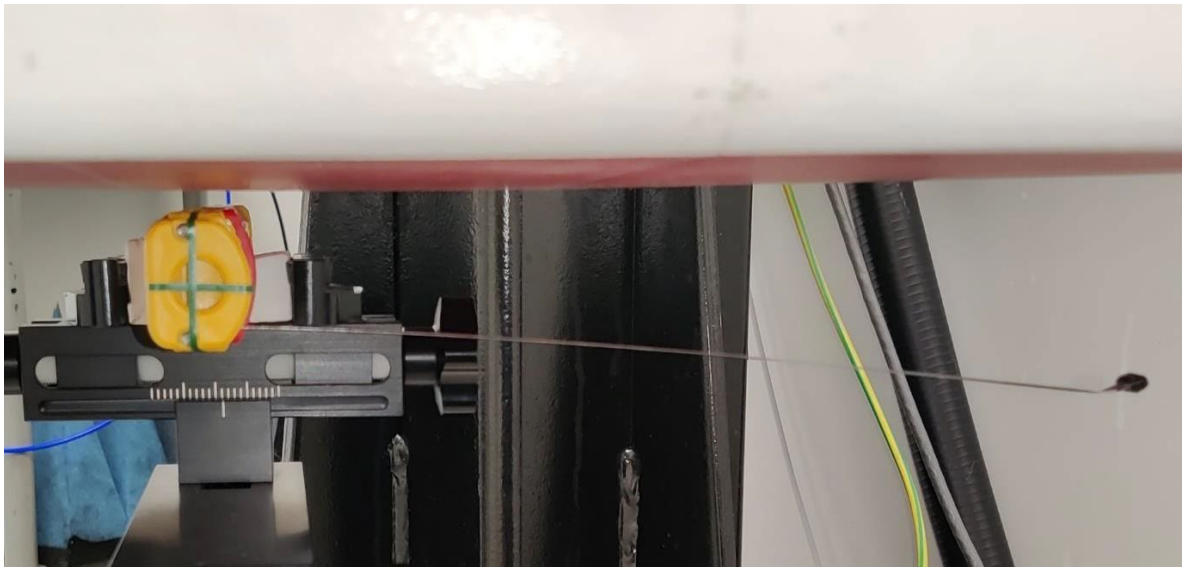


Figure 6 DUT in Antenna Right Test position

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 01/02/2022 15.10.30

Test Laboratory: Verkotan Oy

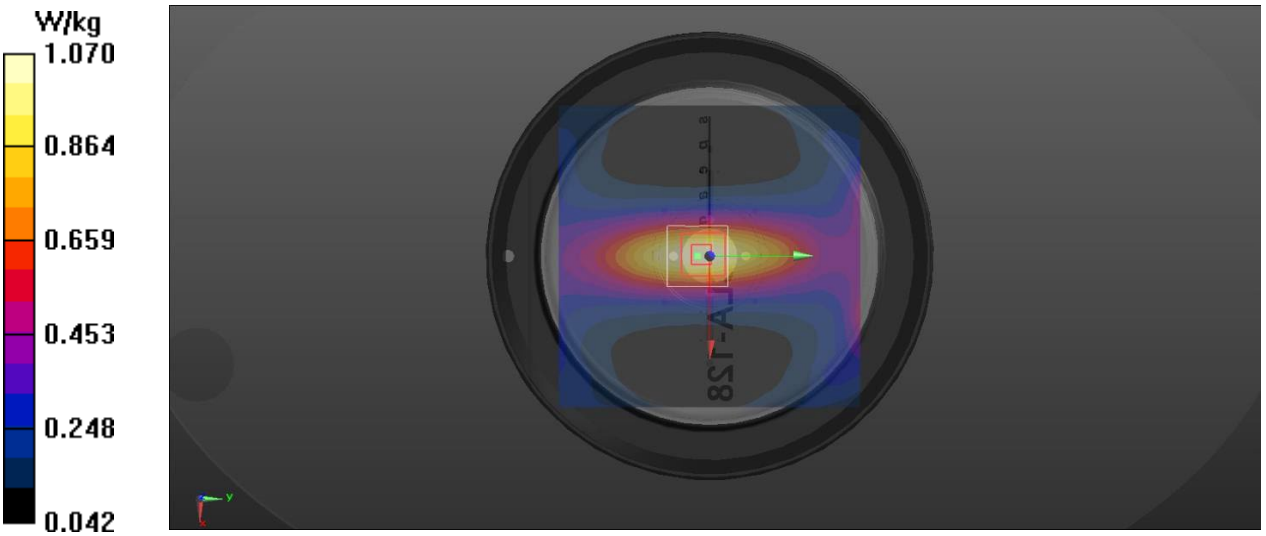
DUT: CLA-128; Type: CLA-128; Serial: 3006

Communication System: UID 0, CW (0); Communication System Band: CLA128 (128.0 MHz); Frequency: 128 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 128 MHz; σ = 0.695 S/m; ε_r = 49.408; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(11.62, 11.62, 11.62) @ 128 MHz; Calibrated: 21/10/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 26/04/2021
- Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

System check/128MHz system check/Zoom Scan (7x7x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 37.42 V/m; Power Drift = -0.20 dB
Peak SAR (extrapolated) = 1.28 W/kg
SAR(1 g) = 0.794 W/kg; SAR(10 g) = 0.524 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 = 59.7%
Maximum value of SAR (measured) = 1.06 W/kg
System check/128MHz system check/Area Scan (101x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.07 W/kg



Plot 2

Date/Time: 03/02/2022 11.49.08

Test Laboratory: Verkotan Oy

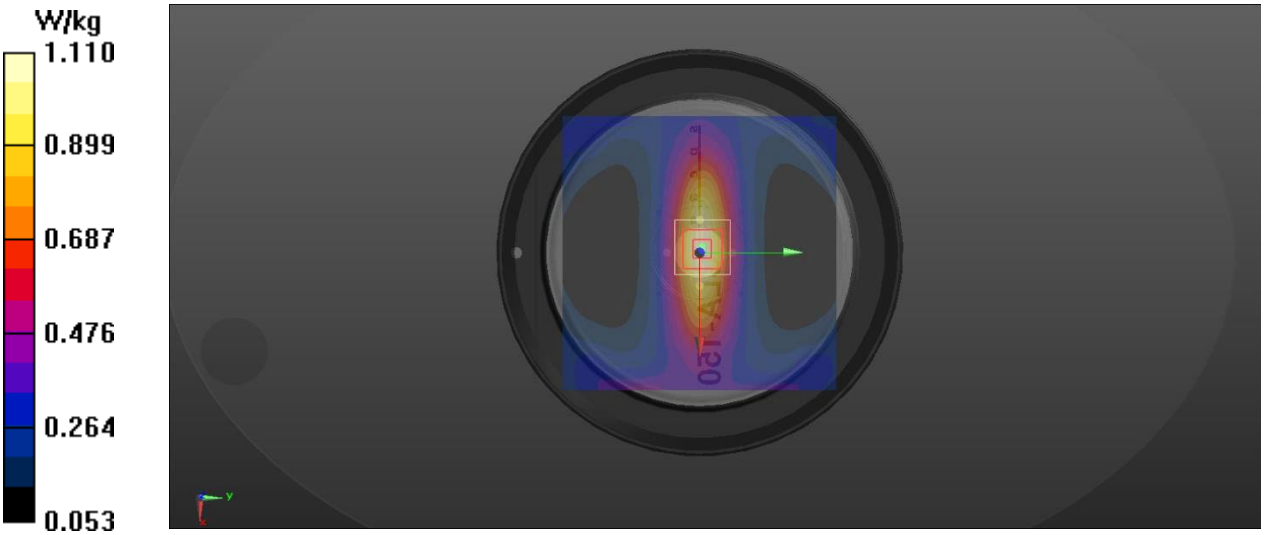
DUT: CLA-150; Type: CLA-150; Serial: 4027

Communication System: UID 0, CW (0); Communication System Band: CLA150 (150.0 MHz); Frequency: 150 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 150 MHz; σ = 0.692 S/m; ε_r = 48.578; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(11.62, 11.62, 11.62) @ 150 MHz; Calibrated: 21/10/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
- Electronics: DAE4 Sn705; Calibrated: 26/04/2021
- Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

System check/150MHz system check/Area Scan (101x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.11 W/kg
System check/150MHz system check/Zoom Scan (7x7x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 39.05 V/m; Power Drift = -0.30 dB
Peak SAR (extrapolated) = 1.36 W/kg
SAR(1 g) = 0.854 W/kg; SAR(10 g) = 0.568 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 = 60.5%
Maximum value of SAR (measured) = 1.13 W/kg



APPENDIX C: MEASUREMENT SCANS

Plot 3

Date/Time: 02/02/2022 12.11.21

Test Laboratory: Verkotan Oy

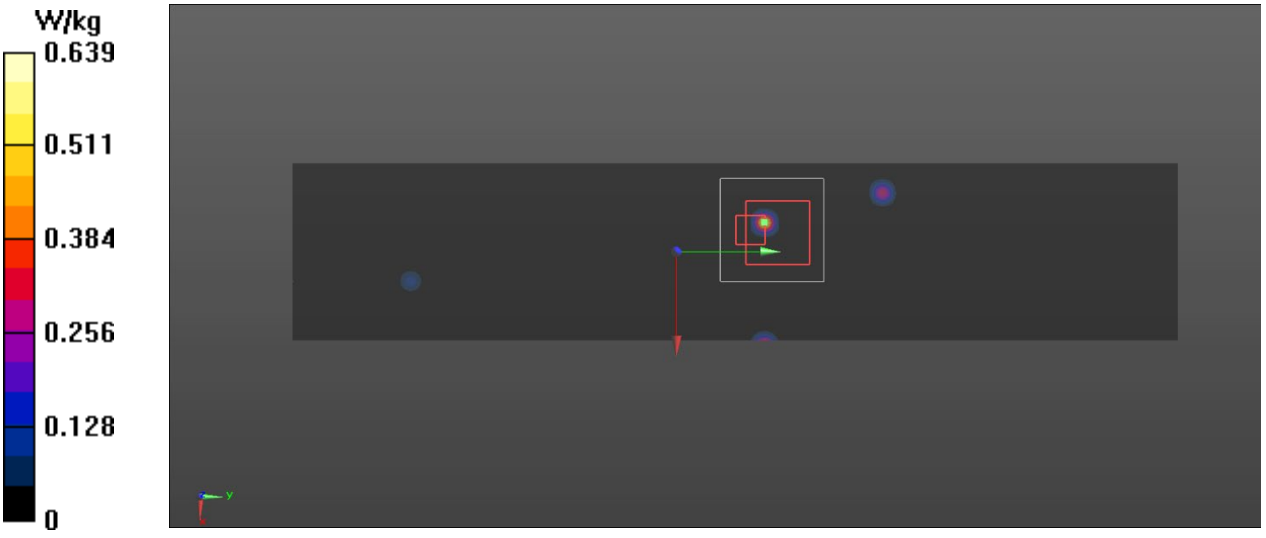
DUT: PLB3

Communication System: UID 0, 121.5MHz (0); Communication System Band: 121.5MHz; Frequency: 121.5 MHz;Communication System PAR: 0.177 dB
Medium parameters used (interpolated): f = 121.5 MHz; σ = 0.692 S/m; ε_r = 49.546; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(11.62, 11.62, 11.62) @ 121.5 MHz; Calibrated: 21/10/2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 31.0, -4.0
- Electronics: DAE4 Sn705; Calibrated: 26/04/2021
- Phantom: SAR1_Phantom1_ELI; Type: QD OVA 002 AA
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Antenna, Left, 121.5MHz/Zoom Scan (8x8x5)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 0.1830 V/m; Power Drift = 7.59 dB
Peak SAR (extrapolated) = 1.63 W/kg
SAR(1 g) = 0.076 W/kg; SAR(10 g) = 0.00969 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 2 mm
Ratio of SAR at M2 to SAR at M1 = 0%
Maximum value of SAR (measured) = 1.12 W/kg
Antenna, Left, 121.5MHz/Area Scan (61x301x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm.
Maximum value of SAR (interpolated) = 0.639 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION REPORTS

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

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Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
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Accreditation No.: SCS 0108

Client Verkotan

Certificate No: EX3-3852_Oct21

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 21, 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	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: CC2552 (20x)	09-Apr-21 (No. 217-03343)	Apr-22
DAE4	SN: 660	23-Dec-20 (No. DAE4-660_Dec20)	Dec-21
Reference Probe ES3DV2	SN: 3013	30-Dec-20 (No. ES3-3013_Dec20)	Dec-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 E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: October 23, 2021

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3852

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.41	0.39	0.46	± 10.1 %
DCP (mV)[B]	100.3	100.7	98.7	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	144.7	±2.5 %	± 4.7 %
		Y	0.0	0.0	1.0		136.0		
		Z	0.0	0.0	1.0		132.6		

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] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

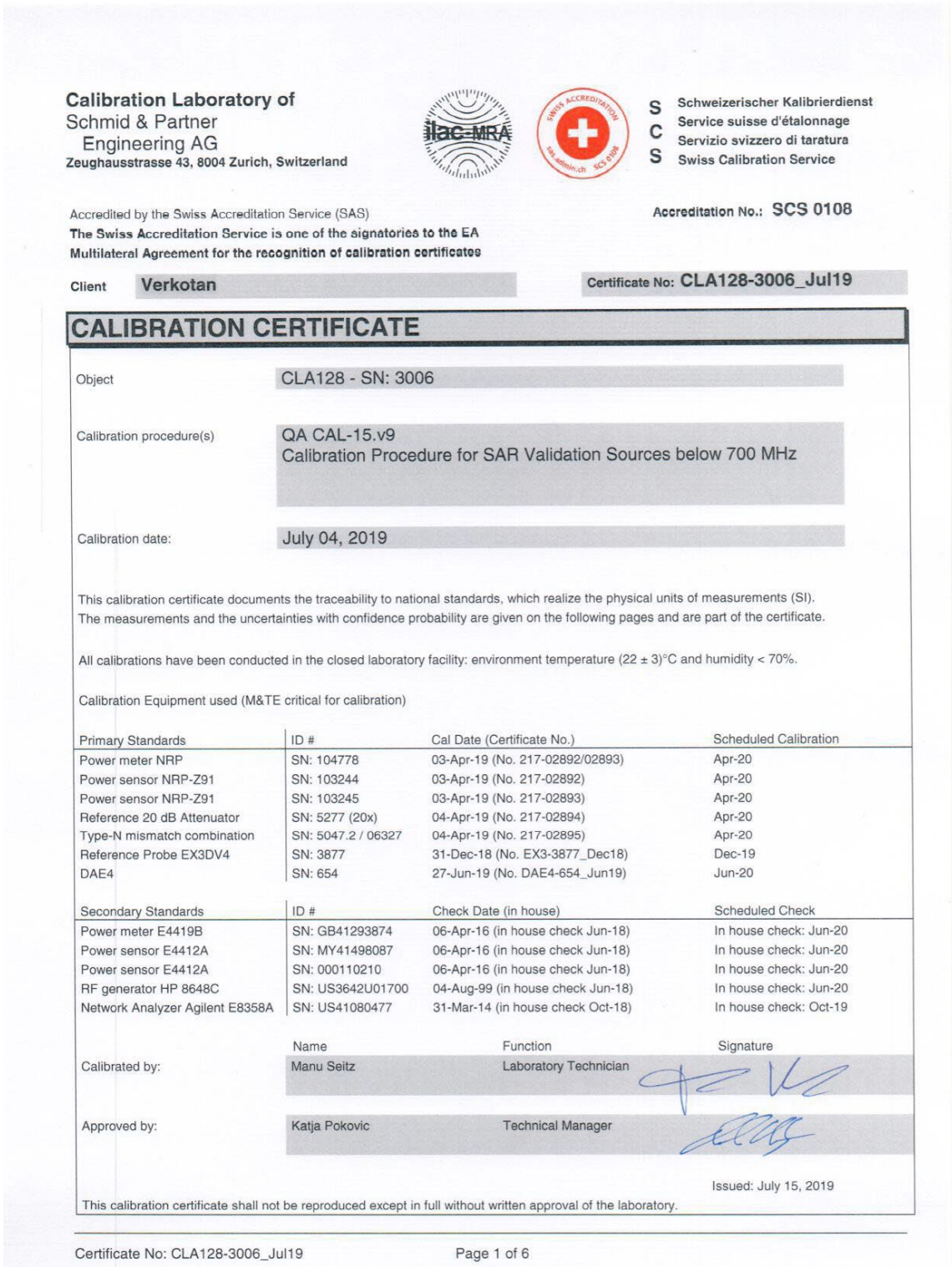
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3852

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
30	55.0	0.75	13.53	13.53	13.53	0.00	1.00	± 13.3 %
64	54.2	0.75	12.08	12.08	12.08	0.00	1.00	± 13.3 %
128	52.8	0.76	11.62	11.62	11.62	0.00	1.00	± 13.3 %
220	49.0	0.81	11.12	11.12	11.12	0.00	1.00	± 13.3 %
450	43.5	0.87	10.16	10.16	10.16	0.16	1.30	± 13.3 %
1300	40.8	1.14	8.79	8.79	8.79	0.27	0.80	± 12.0 %
1450	40.5	1.20	8.68	8.68	8.68	0.33	0.80	± 12.0 %
1640	40.2	1.31	8.48	8.48	8.48	0.26	0.86	± 12.0 %
3500	37.9	2.91	6.90	6.90	6.90	0.30	1.35	± 13.1 %
3700	37.7	3.12	6.70	6.70	6.70	0.30	1.35	± 13.1 %
3900	37.5	3.32	6.44	6.44	6.44	0.40	1.60	± 13.1 %
4100	37.2	3.53	6.25	6.25	6.25	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	4.69	4.69	4.69	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



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Accreditation No.: SCS 0108

Client Verkotan **Certificate No: CLA128-3006_Jul19**

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 04, 2019

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	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 3877	31-Dec-18 (No. EX3-3877_Dec18)	Dec-19
DAE4	SN: 654	27-Jun-19 (No. DAE4-654_Jun19)	Jun-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

	Name	Function	Signature
Calibrated by:	Manu Seitz	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 15, 2019

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

Certificate No: CLA128-3006_Jul19 Page 1 of 6

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Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.2
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	51.6 ± 6 %	0.76 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	3.50 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**3.48 W/kg ± 18.4 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	1 W input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**2.32 W/kg ± 18.0 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.4 Ω - 5.1 jΩ
Return Loss	- 22.3 dB

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 04.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA128; Type: CLA128; Serial: CLA128 - SN: 3006

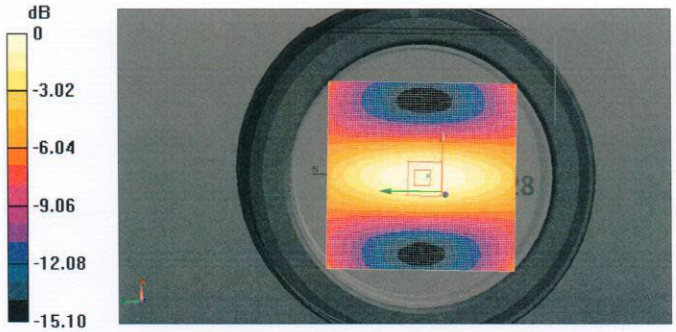
Communication System: UID 0 - CW; Frequency: 128 MHz
Medium parameters used: f = 128 MHz; σ = 0.76 S/m; ε_r = 51.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(12.4, 12.4, 12.4) @ 128 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 27.06.2019
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

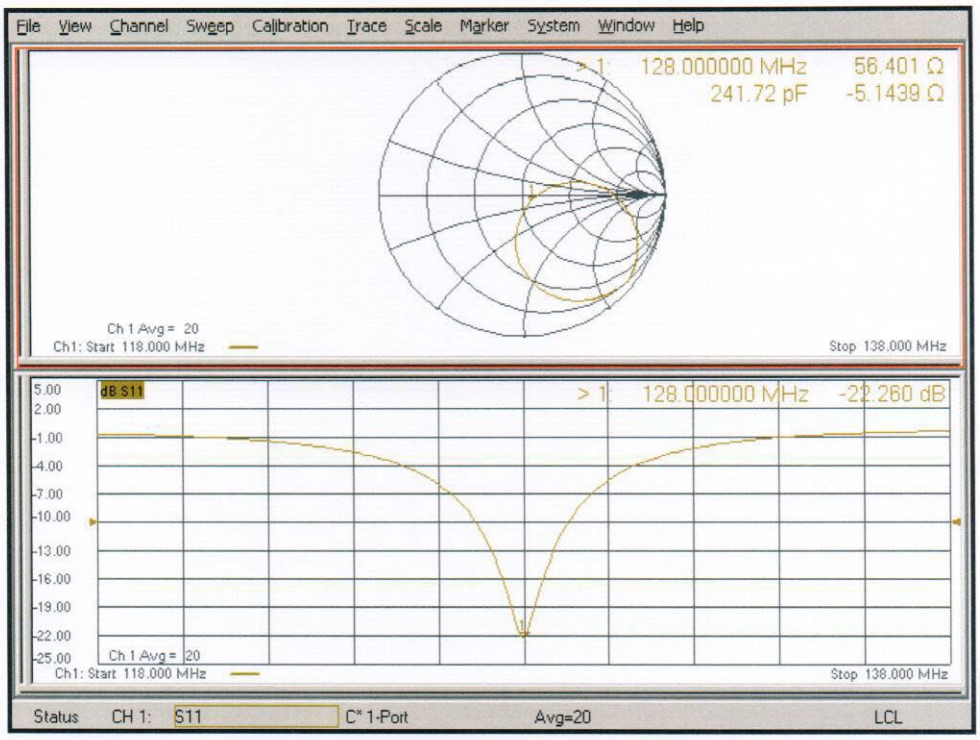
CLA Calibration for HSL-LF Tissue/CLA128, touch configuration, Pin=1W/Area Scan (81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 4.97 W/kg

CLA Calibration for HSL-LF Tissue/CLA128, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x10x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 75.83 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 6.62 W/kg
SAR(1 g) = 3.5 W/kg; SAR(10 g) = 2.33 W/kg
Maximum value of SAR (measured) = 4.87 W/kg



0 dB = 4.97 W/kg = 6.96 dBW/kg

Impedance Measurement Plot for Head TSL



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Accreditation No.: **SCS 0108**

Client Verkotan

Certificate No: CLA150-4027_Jul19

CALIBRATION CERTIFICATE

Object	CLA150 - SN: 4027
Calibration procedure(s)	QA CAL-15.v9 Calibration Procedure for SAR Validation Sources below 700 MHz
Calibration date:	July 10, 2019

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	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 3877	31-Dec-18 (No. EX3-3877_Dec18)	Dec-19
DAE4	SN: 654	27-Jun-19 (No. DAE4-654_Jun19)	Jun-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 11, 2019

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Accreditation No.: SCS 0108

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.10.2
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	150 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	52.3	0.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	51.2 ± 6 %	0.77 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	3.69 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**3.64 W/kg ± 18.4 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	1 W input power	2.49 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**2.46 W/kg ± 18.0 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.9 Ω - 3.6 jΩ
Return Loss	- 28.8 dB

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 10.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4027

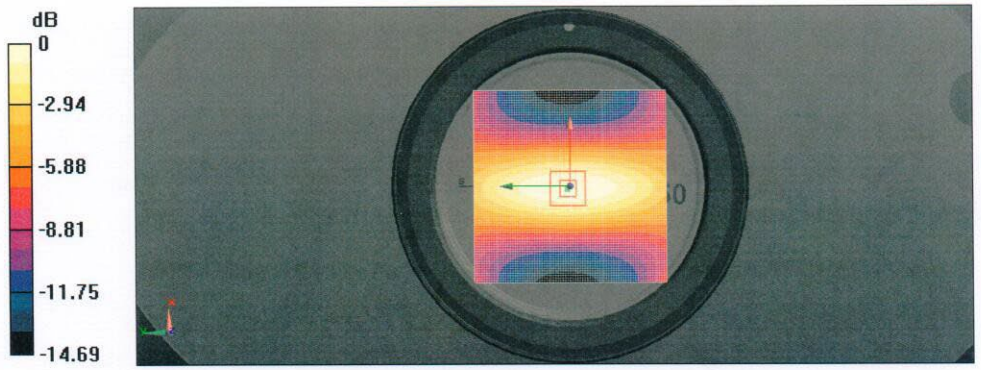
Communication System: UID 0 - CW; Frequency: 150 MHz
Medium parameters used: f = 150 MHz; σ = 0.77 S/m; ε_r = 51.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(12.4, 12.4, 12.4) @ 150 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 27.06.2019
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.18 W/kg

CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x10x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 81.85 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 6.77 W/kg
SAR(1 g) = 3.69 W/kg; SAR(10 g) = 2.49 W/kg
Maximum value of SAR (measured) = 5.08 W/kg



0 dB = 5.18 W/kg = 7.14 dBW/kg

Impedance Measurement Plot for Head TSL