SAR Compliance Test Report

Date of Report	14/08/2024	**Client's Contact person:**	Panasonic Corporation of North America Two Riverfront Plaza, 9th Floor Newark, 07102-5490, NJ USA
Number of pages:	31		
		Responsible Test engineer:	Ilari Kinnunen
Testing laboratory:	**Verkotan Oy** Elektroniikkatie 17 90590 Oulu Finland	**Client:**	**Panasonic Entertainment & Communication Co., Ltd.** 1-10-12 Yagumo-higashi-machi, Moriguchi City, Osaka 570-0021, Japan

Tested device	**KX-TGEA60**
Related reports:	-
Testing has been carried out in accordance with:	**47CFR §2.1093** Radiofrequency Radiation Exposure Evaluation: Portable Devices **447498 D04 Interim General RF Exposure Guidance v01** **648474 D04, Handset SAR v01r03** **865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04** **IEC/IEEE 62209-1528, 2020** Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices **RSS-102, Issue 5, 2015** Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
Documentation:	The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory
Test Results:	**The EUT complies with the requirements in respect of all parameters subject to the test.** The test results relate only to devices specified in this document

Date and signatures:

14.08.2024

Laboratory Manager

Miia Nurkkala

TABLE OF CONTENTS

1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Equipment under Test (DUT):

Product:	Cordless Phone
Manufacturer:	Panasonic
Model:	KX-TGEA60
Serial Number:	PRJ00561900002
FCC ID Number:	ACJ96NKX-TGEA60B
DUT Number:	20639
Battery Type used in testing:	Ni-MH Battery
State of the Sample:	Production sample

Testing information:

Testing performed:	6.5.2024
Notes:	-
Document history and changes:	This report replaces FCC_SAR report_KX-TGEA60_ID6640_12082024.docx Photos of the DUT removed to separate annex.
Document ID:	FCC_SAR report_KX-TGEA60_ID6640_14082024.docx
Temperature °C	22±2 / Controlled
Humidity RH%	30±20 / Controlled
Measurement performed by:	Ilari Kinnunen
FCC Test Firm Designation Number:	FI0005
ISED Company Number:	22218

1.2 Maximum Results

The maximum reported* SAR values for Head/Body-worn for transmitting systems are shown in a table below. The device conforms to the requirements of the standards when the maximum reported SAR value is less than or equal to the limit. The SAR limit specified in FCC 47 CFR part 2 (2.1093) and Health Canada's RF exposure guideline, Safety Code 6 for Head/Body SAR_{1g} is 1.6 W/kg.

1.2.1 Standalone SAR

System	Highest Reported* SAR_{1g}(W/kg) in Head Exposure Condition	Highest Reported* SAR_{1g}(W/kg) in Body-Worn Exposure Condition, 0mm separation distance	Result
DECT	0.04**	0.05**	PASS

* Reported SAR Values are scaled to upper limit of power tuning tolerance.
**Maximum output power for ISED is lower, thus reported SAR values for ISED are overestimated.

1.2.2 Maximum Drift

Maximum Drift During Measurements	1.23dB*

*Larger than 5% drifts included to scaling factors

1.2.3 Measurement Uncertainty

SAR 1g: 0.3 – 3 GHz:

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

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

The DUT is a cordless phone supporting DECT technology. Photos of the DUT are shown in annex A.

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]
	DECT	1920 – 1930

3. OUTPUT POWER

3.1 Maximum specified conducted output power

From the customer, including tune-up tolerances;

Technology	Max Output Power [dBm]
DECT	20.67*

*Maximum output power for ISED is lower, thus reported SAR values for ISED are overestimated.

3.2 Tested conducted power

Measured conducted output power at transmitting antenna connector;

Channel No.	Frequency (MHz)	Maximum Conducted Output Power (dBm)
4	1921.536	19.2
2	1924.992	19.4
0	1928.448	19.2

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. The system is verified by measuring a known source i.e. a verification dipole. The dipole is fed with cw signal using a setup shown in figure 2.

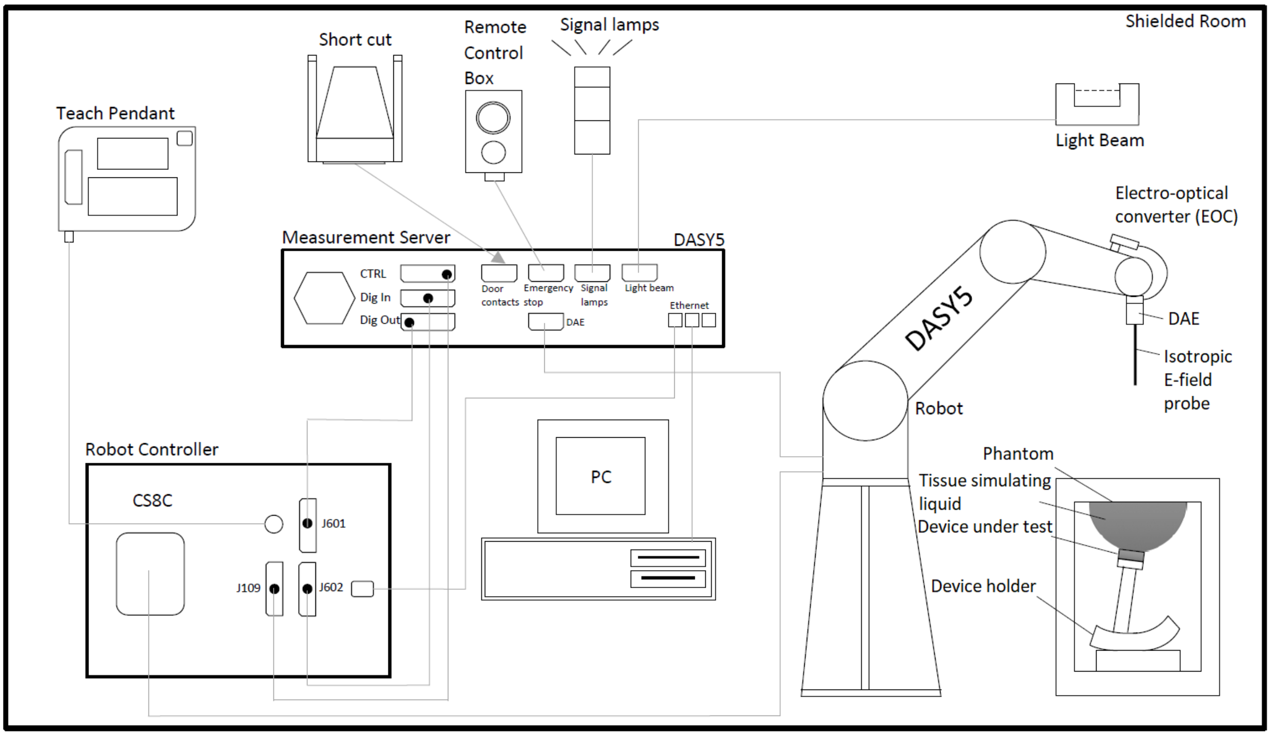


Figure 1 Schematic Laboratory Picture

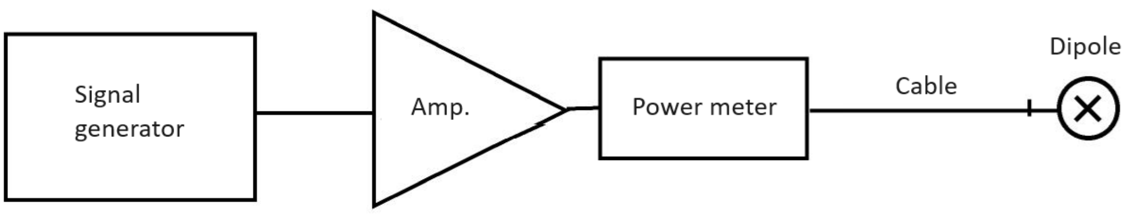


Figure 2 Signal source setup for system checks.

Figure 3 system setup. In system check the DUT is replaced by a verification dipole.

4.1 Test Equipment List

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

Test Equipment	Model	Serial Number	Calibration Date	Interval [years]
Amplifier, 800MHz-4200MHz, 10W	10S1G4A	320421	NA	NA
DAE4, converter	DAE4	710	10/2023	1
Directional Power sensor	NRT-Z44	107780	02/2024	1
Isotropic DOS probe	EX3DV4	3852	10/2023	1
Network Analyzer	E5071C	MY46102812	05/2023	1
Power reflection meter	NRT	835065/049	02/2024	3
System validation dipole	D1900V2	511	03/2023	3
Vector Signal Generator	MG3710E	6262028676	11/2023	1
DASY5 Software	52.8.8.1258	-	NA	NA

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

SAM Phantom:

The phantom used in SAR tests were the right and left head sections and flat phantom section of the twin-headed "SAM Phantom" manufactured by SPEAG. 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

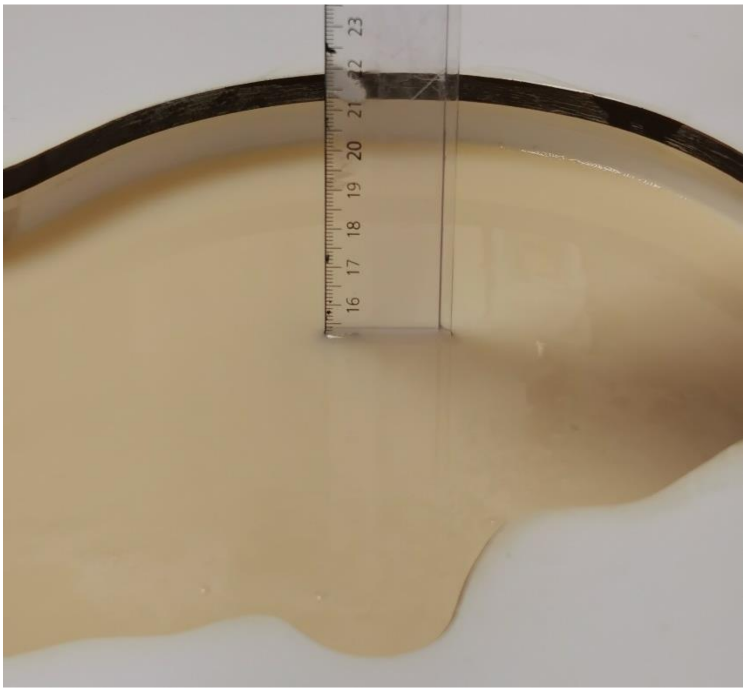


Figure 4 Tissue simulant depth.

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
1900	D1900V2-SN:511	EX3DV4 - SN: 3852	CW	DAE 4 / 710	38.24	1.38	11/2023

4.5 System Check

System checks were performed according to 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04.

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 #
06.05.2024	WB Head	22	1900	250	9.53	38.02	38.12	0.3	1

4.5.1 Tissue Simulant Verification

				Measured		Target		Deviation	
Date	Tissue Type	Tissue Temp [°C]	Frequency [MHz]	Dielectric Constant [ε] Target	Conductivity σ [S/m] Target	Dielectric Constant [ε]	Conductivity σ [S/m]	ε [%]	σ [%]
06.05.2024	WB Head	22	1900	40.0	1.40	39.2	1.42	-2.0	1.7

06.05.2024	WB Head	22	1921.54	40.0	1.40	39.2	1.43	-2.1	2.5
06.05.2024	WB Head	22	1924.99	40.0	1.40	39.1	1.44	-2.1	2.7
06.05.2024	WB Head	22	1928.45	40.0	1.40	39.1	1.44	-2.2	2.8

5. TEST PROCEDURE

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

Low, mid and high frequency channels for the configuration with the highest SAR value were tested as per ISED notice 2016-DRS001.

The DUT was set to transmit at maximum power and duty cycle (4.1%) using test software.

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 Against Phantom Head

Measurements were made in "cheek" and "tilt" positions on both the left hand and right-hand sides of the phantom.

The positions used in the measurements were according to 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".

Photos of the test positions are presented in appendix A.

5.2.2 Body-worn Configuration, 0mm separation distance

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

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: 300MHz - 3GHz range)

Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)
Measurement System Errors								
CF	Probe Calibration	±12.0%	N	√2	1	1	±6.0%	±6.0%
CF_{drift}	Probe Calibration Drift	±1.7%	R	√3	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	√3	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±3.0%	R	√3	1	1	±1.7%	±1.7%
ISO	Probe Isotropy	±7.6%	R	3	1	1	±4.4%	±4.4%
DAE	Data Acquisition	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δ_{sys}	Probe Positioning	±3.9%	N	1	0.14	0.14	±0.5%	±0.5%
DAT	Data Processing	±1.2%	N	1	1	1	±1.2%	±1.2%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)[DAK]	±2.5%	N	√1	0.78	0.71	±2.0%	±1.8%
LIQ(T_c)	Conductivity (temp.)[BB]	±3.3%	R	√3	0.78	0.71	±1.5%	±1.4%
EPS	Phantom Permittivity	±14.0%	R	3	0	0	±0%	±0%
DIS	Distance DUT - TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
D_{xyz}	Device Positioning (±0.5mm)	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	√1	1	1	±3.6%	±3.6%
MOD	DUT Modulation[m]	±2.4%	R	√3	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±2.6%	R	3	1	1	±1.5%	±1.5%
RF_{drift}	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.[val]	±0.0%	N	1	1	1	±0%	±0%
RF_{in}	Unc. Input Power[val]	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	√1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling[p]	±0%	R	3	1	1	±0%	±0%
u(ΔSAR)	Combined Uncertainty						±11.0%	±10.9%
U	**Expanded Uncertainty**						±22.1%	±21.9%

7. TEST RESULTS

7.1 SAR Results for Head Exposure Condition

Technology	Channel	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 #
DECT	2	1924.992	20.67****	19.4	Right Cheek	0.00977	0**	4.1%	1.97	0.02	
DECT	2	1924.992	20.67****	19.4	Right Tilt	0.0000145	0**	4.1%	1.82	0.00003	
DECT	2	1924.992	20.67****	19.4	Left Cheek	0.0239	-0.43	4.1%	1.48	0.04	2
DECT	2	1924.992	20.67****	19.4	Left Tilt	0.00509	0.3	4.1%	1.44	0.01	
DECT	4	1921.536	20.67****	19.2	Left Cheek	0.0226	-0.36	4.1%	1.52	0.03	
DECT	0	1928.448	20.67****	19.2	Left Cheek	0.0183	-0.36	4.1%	1.52	0.03	

**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
****Maximum output power for ISED is lower, thus reported SAR values for ISED are overestimated.
*****The scaling factor is calculated using formula 10^((Maximum power-(Conducted power-Power Drift))/10)

7.2 SAR Results for Body Exposure Condition with 0mm separation

Technology	Channel	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 #
DECT	2	1924.992	20.67****	19.4	Front	0.0192	0**	4.1%	1.34	0.03	
DECT	2	1924.992	20.67****	19.4	Back	0.0291	0.74	4.1%	1.59	0.05	3
DECT	2	1924.992	20.67****	19.4	Left	0*	0**	4.1%	1.34	0	
DECT	2	1924.992	20.67****	19.4	Right	0.0243	1.23	4.1%	1.78	0.04	
DECT	2	1924.992	20.67****	19.4	Top	0.00000471	0**	4.1%	1.34	0	
DECT	2	1924.992	20.67****	19.4	Bottom	0*	0**	4.1%	1.34	0	
DECT	4	1921.536	20.67****	19.2	Back	0.0323	0**	4.1%	1.40	0.05	
DECT	0	1928.448	20.67****	19.2	Back	0.0329	0.32	4.1%	1.51	0.05	

*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
****Maximum output power for ISED is lower, thus reported SAR values for ISED are overestimated.
*****The scaling factor is calculated using formula 10^((Maximum power-(Conducted power-Power Drift))/10)

7.3 IEC 62209-2 AMD1:2019

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

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

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

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

APPENDIX A: PHOTOS OF THE DUT

Annex A is provided as a separate document.

APPENDIX B: SYSTEM CHECK SCAN

Plot 1

Date/Time: 06/05/2024 08:33:17

Test Laboratory: Verkotan Oy

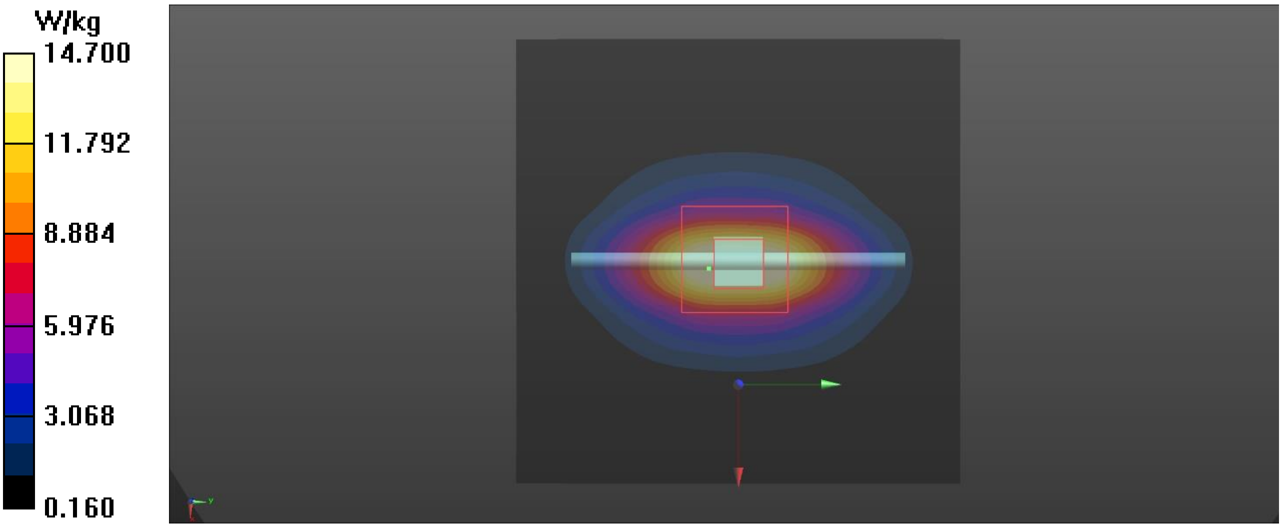
DUT: D1900V2 - SN511; Type: D1900V2; Serial: SN511

Communication System: UID 0, CW (0); Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;
Communication System PAR: 0 dB;
Medium parameters used: f = 1900 MHz; σ = 1.424 S/m; ε_r = 39.208; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(7.75, 7.66, 7.73) @ 1900 MHz; Calibrated: 23/10/2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
  - Electronics: DAE4 Sn710; Calibrated: 24/10/2023
  - Phantom: SAR2 frontTwin-SAM V4.0 (30deg probe tilt); Type: QD 000 P40 CC;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Configuration/1900 MHz System Check/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 15.7 W/kg
Configuration/1900 MHz System Check/Zoom Scan (7x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 108.4 V/m; Power Drift = -0.25 dB
Peak SAR (extrapolated) = 17.3 W/kg
SAR(1 g) = 9.53 W/kg; SAR(10 g) = 4.98 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 9.9 mm
Ratio of SAR at M2 to SAR at M1 = 55.3%
Maximum value of SAR (measured) = 14.7 W/kg



APPENDIX C: MEASUREMENT SCANS

Plot 2

Date/Time: 06/05/2024 09:10:07

Test Laboratory: Verkotan Oy

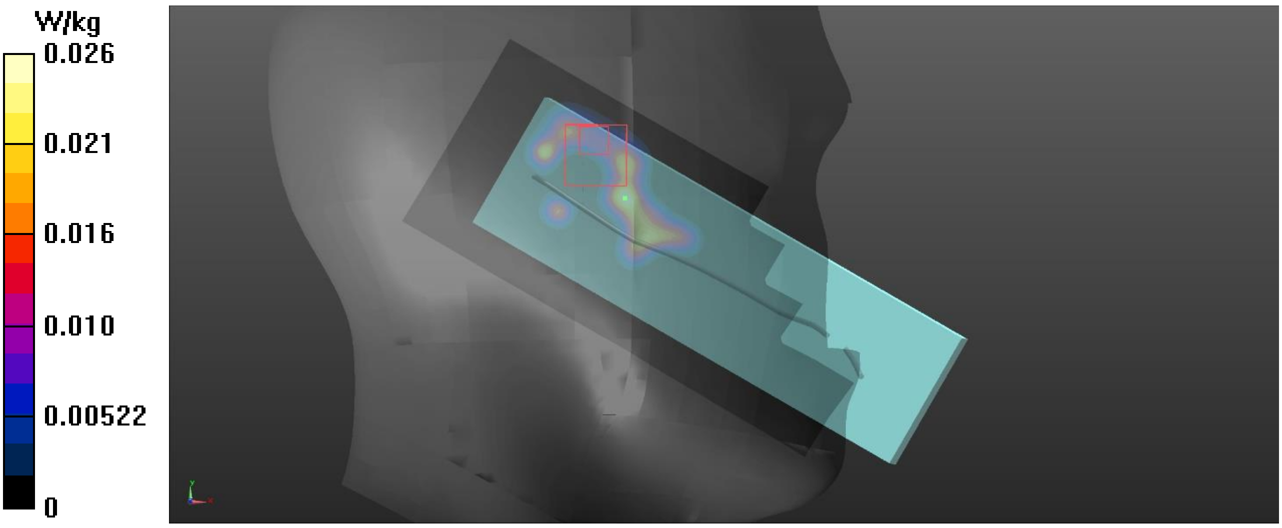
DUT: Panasonic

Communication System: UID 0, DECT (0); Communication System Band: FCC; Frequency: 1924.99 MHz;
Communication System PAR: 13.86 dB;
Medium parameters used: f = 1925 MHz; σ = 1.438 S/m; ε_r = 39.142; ρ = 1000 kg/m^3
Phantom section: Left Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(7.75, 7.66, 7.73) @ 1924.99 MHz; Calibrated: 23/10/2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = -4.0, 31.0
  - Electronics: DAE4 Sn710; Calibrated: 24/10/2023
  - Phantom: SAR2 frontTwin-SAM V4.0 (30deg probe tilt); Type: QD 000 P40 CC;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Head SAR Left/DECT 1924.992MHz, Left Cheek/Zoom Scan (9x10x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.540 V/m; Power Drift = -0.43 dB
Peak SAR (extrapolated) = 0.0570 W/kg
SAR(1 g) = 0.024 W/kg; SAR(10 g) = 0.00873 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 = 55.3%
Maximum value of SAR (measured) = 0.0301 W/kg
Head SAR Left/DECT 1924.992MHz, Left Cheek/Area Scan (51x121x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.0261 W/kg



Plot 3

Date/Time: 06/05/2024 14:09:20

Test Laboratory: Verkotan Oy

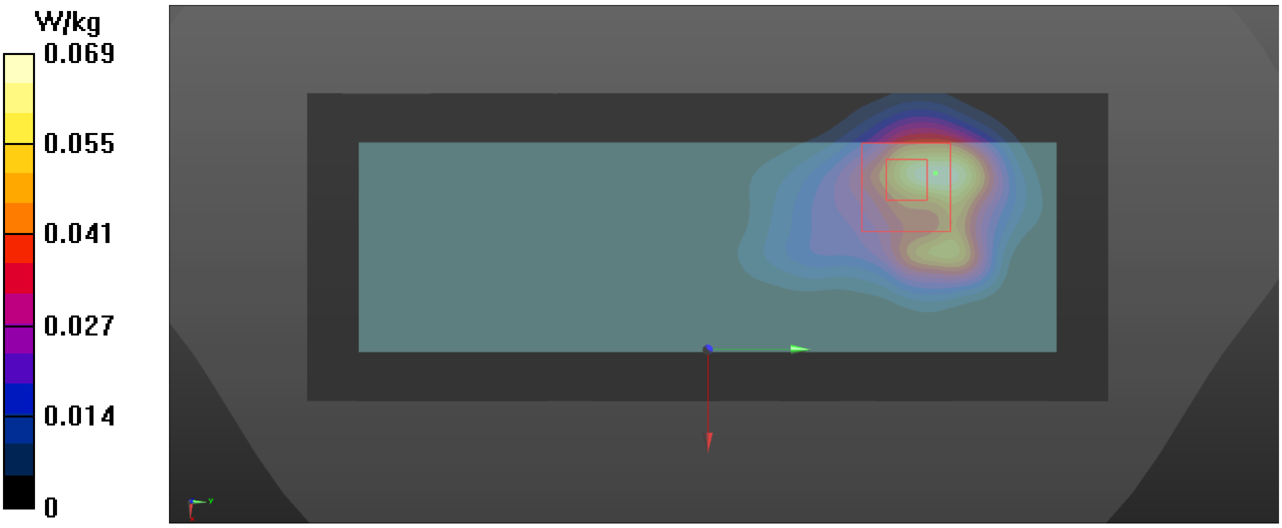
DUT: Panasonic

Communication System: UID 0, DECT (0); Communication System Band: FCC; Frequency: 1924.99 MHz;
Communication System PAR: 13.86 dB;
Medium parameters used: f = 1925 MHz; σ = 1.438 S/m; ε_r = 39.142; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY Configuration:

- Probe: EX3DV4 - SN3852; ConvF(7.75, 7.66, 7.73) @ 1924.99 MHz; Calibrated: 23/10/2023
  - Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 4mm (Mechanical Surface Detection), z = 31.0, -4.0
  - Electronics: DAE4 Sn710; Calibrated: 24/10/2023
  - Phantom: SAR2 frontTwin-SAM V4.0 (30deg probe tilt); Type: QD 000 P40 CC;
  - DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Body SAR/DECT 1924.992MHz, Back, 0mm/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.364 V/m; Power Drift = 0.74 dB
Peak SAR (extrapolated) = 0.0550 W/kg
SAR(1 g) = 0.029 W/kg; SAR(10 g) = 0.014 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 = 51.1%
Maximum value of SAR (measured) = 0.0460 W/kg
Body SAR/DECT 1924.992MHz, Back, 0mm/Area Scan (51x131x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.0686 W/kg



APPENDIX D: RELEVANT PAGES FROM PROBE AND DAE4 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**, Oulu, Finland

Certificate No.: **EX-3852_Oct23**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3852

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: October 23, 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	05-Oct-23 (OCP-DAK3.5-1249_Oct23)	Oct-24
OCP DAK-12	SN: 1016	05-Oct-23 (OCP-DAK12-1016_Oct23)	Oct-24
Reference 20 dB Attenuator	SN: CC2552 (20x)	30-Mar-23 (No. 217-03809)	Mar-24
DAE4	SN: 660	16-Mar-23 (No. DAE4-660_Mar23)	Mar-24
Reference Probe 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	Sven Kühn	Technical Manager	

Issued: October 23, 2023

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

Certificate No: EX-3852_Oct23 Page 1 of 21

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]	0.42	0.40	0.47	±10.1%
DCP (mV) [B]	102.6	101.5	101.2	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc[E] k = 2
0	CW	X	0.00	0.00	1.00	0.00	148.1	±1.2%	±4.7%
		Y	0.00	0.00	1.00		135.0		
		Z	0.00	0.00	1.00		125.7		
10352	Pulse Waveform (200Hz, 10%)	X	20.00	88.23	18.81	10.00	60.0	±2.9%	±9.6%
		Y	15.83	86.04	18.58		60.0		
		Z	20.00	89.60	19.58		60.0		
10353	Pulse Waveform (200Hz, 20%)	X	20.00	89.81	18.49	6.99	80.0	±1.6%	±9.6%
		Y	20.00	89.05	18.11		80.0		
		Z	20.00	91.94	19.69		80.0		
10354	Pulse Waveform (200Hz, 40%)	X	20.00	94.09	19.25	3.98	95.0	±1.2%	±9.6%
		Y	20.00	88.35	16.15		95.0		
		Z	20.00	93.97	19.35		95.0		
10355	Pulse Waveform (200Hz, 60%)	X	20.00	100.39	20.91	2.22	120.0	±1.2%	±9.6%
		Y	2.38	71.76	9.70		120.0		
		Z	20.00	97.37	19.68		120.0		
10387	QPSK Waveform, 1 MHz	X	1.64	66.74	15.13	1.00	150.0	±2.8%	±9.6%
		Y	1.57	65.66	14.38		150.0		
		Z	1.68	66.38	15.01		150.0		
10388	QPSK Waveform, 10 MHz	X	2.18	68.09	15.84	0.00	150.0	±0.9%	±9.6%
		Y	2.13	67.56	15.26		150.0		
		Z	2.26	68.28	15.80		150.0		
10396	64-QAM Waveform, 100 kHz	X	2.80	70.45	18.83	3.01	150.0	±0.7%	±9.6%
		Y	2.67	68.53	17.69		150.0		
		Z	2.75	69.32	18.17		150.0		
10399	64-QAM Waveform, 40 MHz	X	3.46	67.10	15.80	0.00	150.0	±2.2%	±9.6%
		Y	3.46	66.99	15.61		150.0		
		Z	3.55	67.36	15.87		150.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	4.78	65.65	15.56	0.00	150.0	±4.1%	±9.6%
		Y	4.86	65.73	15.56		150.0		
		Z	4.73	65.20	15.31		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 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:3852

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	40.1	298.39	35.39	12.42	0.00	5.06	1.30	0.18	1.01
y	45.2	342.83	36.51	8.80	0.45	5.06	0.00	0.49	1.01
z	44.9	336.32	35.73	13.60	0.00	5.08	0.53	0.35	1.01

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-56.9°
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:3852

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc ($k = 2$)
6	55.0	0.75	14.87	14.87	14.87	0.00	1.25	±13.3%
13	55.0	0.75	13.94	13.94	13.94	0.00	1.25	±13.3%
30	55.0	0.75	12.97	12.97	12.97	0.00	1.25	±13.3%
64	54.2	0.75	11.54	11.54	11.54	0.00	1.25	±13.3%
128	52.8	0.76	11.14	11.14	11.14	0.00	1.25	±13.3%
220	49.0	0.81	10.56	10.56	10.56	0.00	1.25	±13.3%
450	43.5	0.87	9.99	9.99	9.99	0.16	1.30	±13.3%
1300	40.8	1.14	8.19	7.92	8.28	0.48	1.27	±12.0%
1450	40.5	1.20	8.04	7.77	8.01	0.46	1.27	±12.0%
1640	40.2	1.31	8.04	7.69	8.00	0.43	1.27	±12.0%
1810	40.0	1.40	7.69	7.64	7.66	0.28	1.27	±12.0%
1900	40.0	1.40	7.75	7.66	7.73	0.28	1.27	±12.0%
2450	39.2	1.80	7.07	7.09	7.16	0.31	1.27	±12.0%
3300	38.2	2.71	6.76	6.56	6.80	0.32	1.27	±14.0%
3500	37.9	2.91	6.75	6.56	6.76	0.33	1.27	±14.0%
3700	37.7	3.12	6.56	6.40	6.58	0.34	1.27	±14.0%
3900	37.5	3.32	6.52	6.37	6.54	0.34	1.27	±14.0%
4100	37.2	3.53	6.23	6.14	6.27	0.35	1.27	±14.0%
5250	35.9	4.71	4.99	4.95	5.05	0.37	1.53	±14.0%
5600	35.5	5.07	4.54	4.50	4.60	0.37	1.75	±14.0%
5750	35.4	5.22	4.62	4.57	4.67	0.36	1.84	±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.

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

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

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

Accreditation No.: SCS 0108

Client **Verkotan**
Oulu, Finland

Certificate No: DAE4-710_Oct23

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 710
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	October 24, 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
Keithley Multimeter Type 2001	SN: 0810278	29-Aug-23 (No:37421)	Aug-24
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	27-Jan-23 (in house check)	In house check: Jan-24
Calibrator Box V2.1	SE UMS 006 AA 1002	27-Jan-23 (in house check)	In house check: Jan-24

	Name	Function	Signature
Calibrated by:	Adrian Gehring	Laboratory Technician	
Approved by:	Sven Kühn	Technical Manager	

Issued: October 24, 2023

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

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100…+300 mV

Low Range: 1LSB = 61nV , full range = -1…….+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	403.489 ± 0.02% (k=2)	403.630 ± 0.02% (k=2)	403.790 ± 0.02% (k=2)
Low Range	3.95386 ± 1.50% (k=2)	3.95941 ± 1.50% (k=2)	3.98294 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	348.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200036.47	-2.57	-0.00
Channel X	+ Input	20003.58	-3.79	-0.02
Channel X	- Input	-20005.57	-0.23	0.00
Channel Y	+ Input	200037.33	-1.59	-0.00
Channel Y	+ Input	20006.19	-0.94	-0.00
Channel Y	- Input	-20000.51	4.99	-0.02
Channel Z	+ Input	200035.92	-2.91	-0.00
Channel Z	+ Input	20004.26	-2.95	-0.01
Channel Z	- Input	-20003.74	1.84	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2002.29	-0.15	-0.01
Channel X	+ Input	202.60	0.39	0.20
Channel X	- Input	-199.14	-1.53	0.77
Channel Y	+ Input	2003.02	0.81	0.04
Channel Y	+ Input	202.06	-0.02	-0.01
Channel Y	- Input	-198.45	-0.73	0.37
Channel Z	+ Input	2002.44	0.22	0.01
Channel Z	+ Input	202.31	0.25	0.12
Channel Z	- Input	-197.76	-0.05	0.03

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	21.54	19.50
	- 200	-18.41	-20.09
Channel Y	200	3.59	3.00
	- 200	-3.69	-4.30
Channel Z	200	6.85	6.63
	- 200	-6.66	-7.04

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-2.56	-1.31
Channel Y	200	7.12	-	0.08
Channel Z	200	4.90	4.94	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16568	13901
Channel Y	15697	16612
Channel Z	16047	13868

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	-1.93	-4.03	-0.29	0.67
Channel Y	-0.73	-2.35	1.14	0.66
Channel Z	0.35	-1.17	2.13	0.64

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

Verkotan

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

APPENDIX E: RELEVANT PAGES FROM DIPOLE CALIBRATION REPORTS

mvg

SAR Reference Dipole Calibration Report

Ref : ACR.68.5.23.BES.A

VERKOTAN OY
ELEKTRONIIKKATIE 17
90590, OULU, FINLAND
SAR REFERENCE DIPOLE
FREQUENCY: 1900 MHZ
SERIAL NO.: 511

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

cofrac
ETALONNAGE

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.

	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 15:01:12 +01'00'

	Customer Name
Distribution :	Verkotan Oy

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

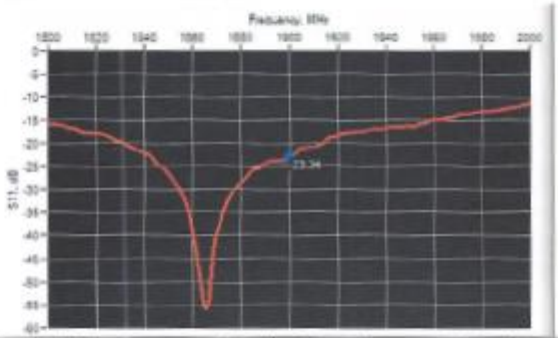
6 CALIBRATION RESULTS

6.1 MECHANICAL DIMENSIONS

L mm		h mm		d mm	
Measured	Required	Measured	Required	Measured	Required
-	68.00 +/- 2%	-	39.50 +/- 2%	-	3.60 +/- 2%

6.2 S11 PARAMETER

6.2.1 S11 parameter in Head Liquid



Frequency (MHz)	S11 parameter (dB)	Requirement (dB)	Impedance
1900	-23.34	-20	48.5Ω - 6.6jΩ

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: eps' : 40.4 sigma : 1.40
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	1900 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
1900 MHz	3.80	38.02	39.70	1.94	19.41	20.50