APPENDIX 2: SAR Measurement data

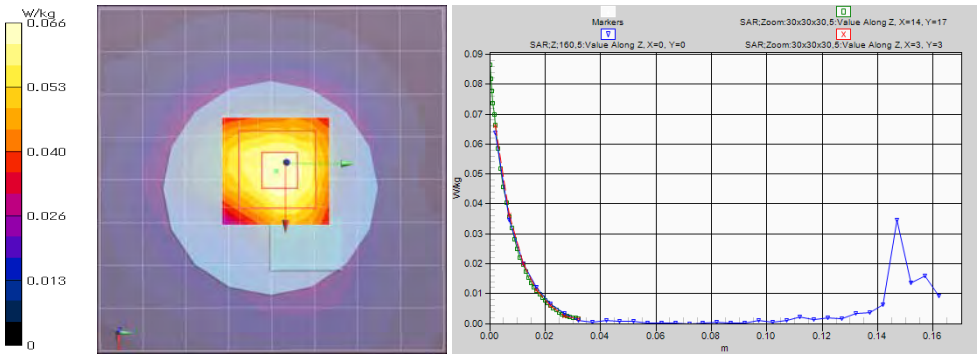
Worst Reported SAR(1g) Plot

Plot 1-1: Front & Gap=10 mm / 11b(1Mbps), 2437 MHz->Highest reported SAR(1g)
EUT: Wireless Module (host: Smart Watch); Model No.: GSW-H1000 (host: GSW-H1000); Serial: 237
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Wi-fi_2.4GHz (0), Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2437 MHz; Crest Factor: 1.0**
Medium: HSL2450(2005); Medium parameters used: f = 2437 MHz; σ = 1.846 S/m; ε_r = 38.29; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Electronics: DAE4 Sn626; Calibrated: 2019/10/15 / -Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section -DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474) / -Probe: EX3DV4 - SN3907; ConvF(7.26, 7.26, 7.26) @ 2437 MHz; Calibrated: 2020/04/27 -Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0

touch,head,front(no-usb),h24/24h7;2437,front&dgap10,b(1m)/
Area:96x96,12 (9x9x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.0663 W/kg
Area:96x96,12 (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.0670 W/kg
Z;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 0.0638 W/kg

Zoom:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 6.075 V/m; Power Drift = -0.17 dB; Maximum value of SAR (measured) = 0.0661 W/kg; Peak SAR (extrapolated) = 0.0860 W/kg
SAR(1 g) = 0.048 W/kg; SAR(10 g) = 0.027 W/kg (*. Ratio of SAR at M2 to SAR at M1 = 54.9%, *. Pk SAR: < 0.1 W/kg)



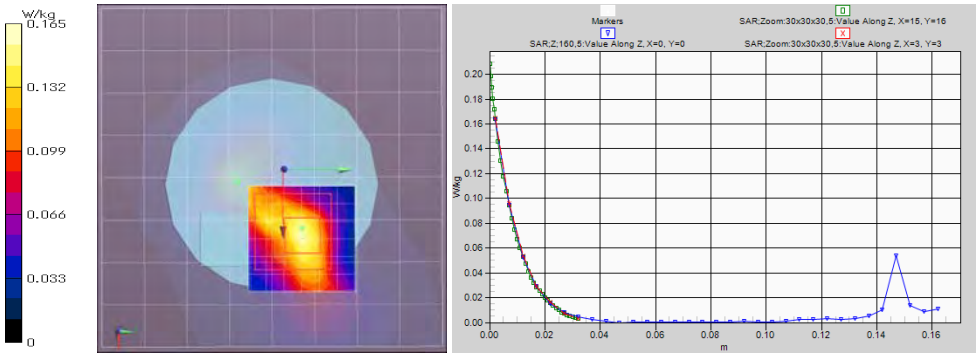
Remarks: *. Date tested: 2020/05/14; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 150 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (24~25) deg.C. / (50~70) %RH,
*. liquid temperature: 24.0(start)/24.0(end)/24.0(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Plot 2-1: Back & touch (gap=0 mm) / 11b(1Mbps), 2437 MHz->Highest reported SAR(10g)
EUT: Wireless Module (host: Smart Watch); Model No.: GSW-H1000 (host: GSW-H1000); Serial: 237
Mode: 11b(1Mbps, DBPSK/DSSS) (UID: 0, Wi-fi_2.4GHz (0), Frame Length in ms: 0; PAR: 0; PMF: 1); **Frequency: 2437 MHz; Crest Factor: 1.0**
Medium: M2450(2005); Medium parameters used: f = 2437 MHz; σ = 1.954 S/m; ε_r = 50.60; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Electronics: DAE4 Sn626; Calibrated: 2019/10/15 / -Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section -DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474) / -Probe: EX3DV4 - SN3907; ConvF(7.49, 7.49, 7.49) @ 2437 MHz; Calibrated: 2020/04/27 -Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0

touch,wrist,back,b24/24b1;2437,no-usb,back&d0,b(1m)/
Area:96x96,12 (9x9x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.139 W/kg
Area:96x96,12 (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.150 W/kg
Z;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 0.163 W/kg

Zoom:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 8.348 V/m; Power Drift = 0.20 dB; Maximum value of SAR (measured) = 0.165 W/kg; Peak SAR (extrapolated) = 0.208 W/kg
SAR(1 g) = 0.109 W/kg; SAR(10 g) = 0.052 W/kg (*. Smallest distance from peaks to all points 3 dB below = 8.5 mm; Ratio of SAR at M2 to SAR at M1 = 58.1%)



Remarks: *. Date tested: 2020/05/15; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 149 mm; Position: distance of EUT to phantom: 0 mm (2 mm to liquid); ambient: (22~24) deg.C. / (50~70) %RH,
*. liquid temperature: 23.0(start)/22.9(end)/22.9(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

APPENDIX 3: Test instruments

Appendix 3-1: Equipment used

Test Name	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Calibration	
							Last Date	Interval (Month)
AT	KAT10-S3	144893	Attenuator	Keysight Technologies Inc	8490D 010	50924	2019/12/11	12
AT	KPM-08	145105	Power meter	ANRITSU	ML2495A	6K00003356	2019/09/09	12
AT	KPSS-04	144991	Power sensor	ANRITSU	MA2411B	12088	2019/09/09	12
AT	SRENT-09	150461	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46186392	2020/02/10	12
SAR	COTS-SSAR-02	144885	DASY52 software	Schmid&Partner Engineering AG	DASY5 PRO	Ver.52.10.3.1513	-	-
SAR	COTS-SSEP-02	144886	Dielectric assessment software	Schmid&Partner Engineering AG	DAK	Ver.DAK1.10.317.11	-	-
SAR	KAT10-P1	144882	Attenuator	Weinschel - API Technologies Corp	24-10-34	BY5927	2019/12/11	12
SAR	KCPL-07	146100	Directional Coupler	Pulsar Microwave Corp.	CCS30-B26	621	-	-
SAR	KDAE-01	144944	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	626	2019/10/15	12
SAR	KIU-08	145059	Power sensor	Rohde & Schwarz	NRV-Z4	100372	2019/09/09	12
SAR	KIU-09	145099	Power sensor	Rohde & Schwarz	NRV-Z4	100371	2019/09/09	12
SAR	KOS-13	144985	Digtal thermometer	HANNA	Checktemp-2	KOS-13	2019/12/20	12
SAR	KOS-14	144986	Thermo-Hygrometer data logger	SATO KEIRYOKI	SK-L200THIIα/SK-LTHIIα-2	015246/08169	2019/12/20	12
SAR	KPA-12	145359	RF Power Amplifier	Milmega	AS2560-50	1018582	-	-
SAR	KPFL-01	145560	Flat Phantom	Schmid&Partner Engineering AG	Oval flat phantom ELI 4.0	1059	2019/08/28	12
SAR	KPM-05	144988	Power meter	Keysight Technologies Inc	E4417A	GB41290718	2020/04/17	12
SAR	KPM-06	144989	Power Meter	Rohde & Schwarz	NRVD	101599	2019/09/09	12
SAR	KPSS-01	144990	Power sensor	Keysight Technologies Inc	E9327A	US40440544	2020/04/17	12
SAR	KRU-01	144993	Ruler(300mm)	SHINWA	13134	-	2020/02/26	12
SAR	KRU-05	145087	Ruler(100x50mm,L)	SHINWA	12101	-	2020/02/26	12
SAR	KSDA-01	145090	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	822	2020/01/15	12
SAR	KSDH-01	145596	Device holder	Schmid&Partner Engineering AG	Mounting device for transmitter	-	2019/09/26	12
SAR	KSG-08	145109	Signal Generator	Rohde & Schwarz	SMT06	100763	2019/09/09	12
SAR	SALC-01	146112	Primepure Ethanol	Kanto Chemical Co., Inc.	14032-79	-	-	-
SAR	SAT20-SARP1	160521	Attenuator	Weinschel - API Technologies Corp	4M-20	-	2019/12/11	12
SAR	SCC-SAR2	145405	Coaxial Cable	Huber+Suhner	SF104A/11PC3542/11N451/4M	MY699/4A	-	-
SAR	SEPP-02	145500	Dielectric probe	Schmid&Partner Engineering AG	DAK3.5	1129	2019/08/06	12
SAR	SOS-12	146320	Digtal thermometer	HANNA	Checktemp-4	SOS-12	2019/12/20	12
SAR	SOS-26	191844	Humidity Indicator	CUSTOM	CTH-201	-	2019/12/12	12
SAR	SOS-SAR1	146323	Digtal thermometer	LKMelectonic	DTM3000	3171	2019/10/08	12
SAR	SPB-02	146235	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3907	2020/04/27	12
SAR	SRU-06	150560	Measuring Tool, Ruler	SHINWA	14001	--	2020/02/26	12
SAR	SSA-04	146176	Spectrum Analyzer	ADVANTEST	R3272	101100994	-	-
SAR	SSAR-02	146177	SAR measurement system	Schmid&Partner Engineering AG	DASY5	1324	-	-
SAR	SSNA-01	146258	Network Analyzer	Keysight Technologies Inc	8753ES	US39171777	2019/12/11	12
SAR	SSRBT-02	145621	SAR robot	Schmid&Partner Engineering AG	TX60 Lspeag	F12/5L2QA1/A/01	2019/09/26	12
SAR	SWTR-03	146185	DI water	MonotaRo	34557433	-	-	-
SAR	KSLH245-01	145363	Tissue simulation liquid (2450MHz,head)	Schmid&Partner Engineering AG	HSL2450V2	SL AAH 245 BA	-	-
SAR	KSLM245-01	145365	Tissue simulation liquid (2450MHz,body)	Schmid&Partner Engineering AG	MSL2450V2	SL AAM 245 BA	-	-

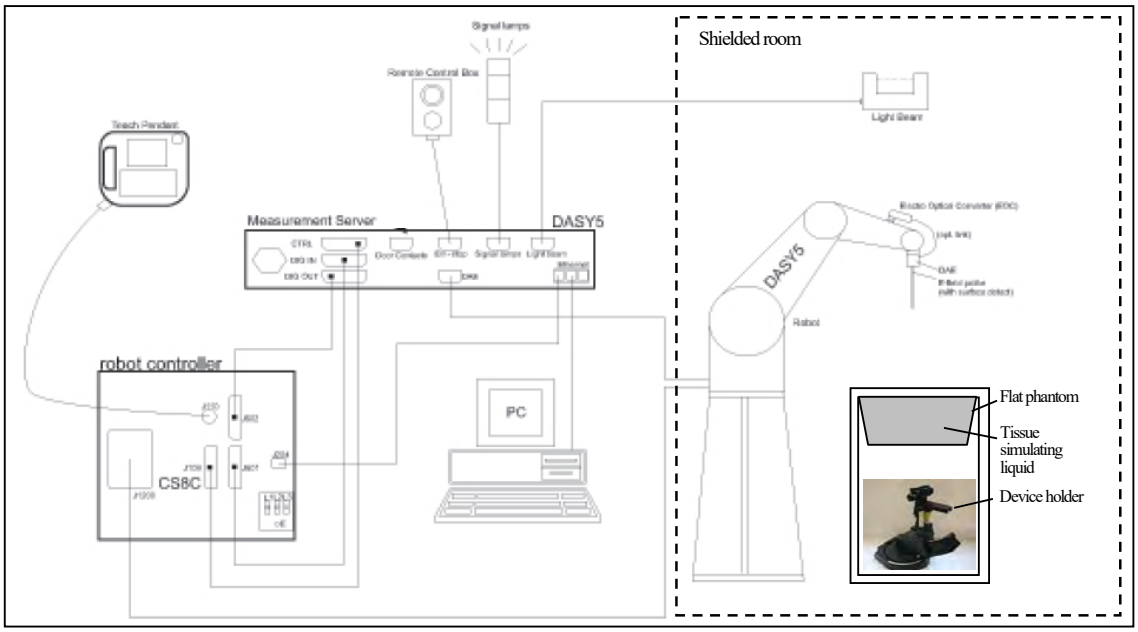
*. AT (antenna terminal conducted power measurement) was measured April 24, 2020. (Refer to Section 6 in this report.)

The expiration date of calibration is the end of the expired month.
As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chain of calibrations.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.
*. Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.

[Test Item] SAR: Specific Absorption Rate, AT: Antenna terminal conducted power

Appendix 3-2: Configuration and peripherals

These measurements were performed with the automated near-field scanning system DASY5 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the dosimetry probes EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.



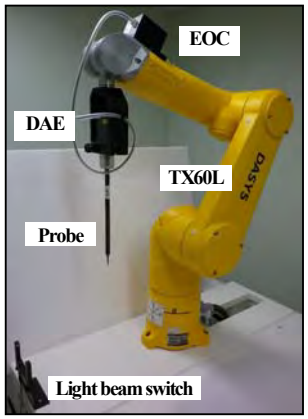
The DASY5 system for performing compliance tests consist of the following items:

1	A standard high precision 6-axis robot (Stäubli TX/RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
2	An isotropic field probe optimized and calibrated for the targeted measurement.
3	A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4	The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
5	The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
6	The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
7	A computer running Win7 professional operating system and the DASY5 software.
8	R Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
9	The phantom.
10	The device holder for EUT. (low-loss dielectric palette) (*. when it was used.)
11	Tissue simulating liquid mixed according to the given recipes.
12	Validation dipole kits allowing to validate the proper functioning of the system.

Appendix 3-3: Test system specification

TX60 Lsepag robot/CS8Csepag-TX60 robot controller

•Number of Axes : 6 •Repeatability : ±0.02 mm
•Manufacture : Stäubli Unimation Corp.



DASY5 Measurement server

•Features : The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV Celeron, 128MB chip-disk and 128MB RAM. The necessary circuits for communication with the DAE4 electronics box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY5 I/O board, which is directly connected to the PC/104 bus of the CPU board.
•Calibration : No calibration required.
•Manufacture : Schmid & Partner Engineering AG

Data Acquisition Electronic (DAE)

•Features : Signal amplifier, multiplexer, A/D converter and control logic.
Serial optical link for communication with DASY5 embedded system (fully remote controlled). 2 step probe touch detector for mechanical surface detection and emergency robot stop (not in -R version)
•Measurement Range : 1 µV to > 200 mV (16bit resolution and 2 range settings: 4 mV, 400 mV)
•Input Offset voltage : < 1 µV (with auto zero)
•Input Resistance : 200 MΩ
•Battery Power : > 10 hrs. of operation (with two 9 V battery)
•Manufacture : Schmid & Partner Engineering AG

Electro-Optical Converter (EOC61)

•Manufacture : Schmid & Partner Engineering AG

Light Beam Switch (LB5/80)

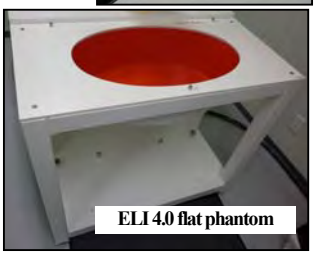
•Manufacture : Schmid & Partner Engineering AG

SAR measurement software

•Item : Dosimetric Assessment System DASY5
•Software version : Refer to Appendix 3-1 (Equipment used)
•Manufacture : Schmid & Partner Engineering AG

E-Field Probe

•Model : EX3DV4 (serial number: 3907)
•Construction : Symmetrical design with triangular core.
Built-in shielding against static charges.
PEEK enclosure material (resistant to organic solvents, e.g., DGBE).
•Frequency : 10MHz to 6GHz, Linearity: ±0.2 dB (30MHz to 6GHz)
•Conversion Factors (CF) : Head: (2.45, 5.2, 5.25, 5.5, 5.6, 5.75, 5.8) GHz
: Body: (2.45, 5.25, 5.6, 5.75, 5.8) GHz
•Directivity : ±0.3 dB in HSL (rotation around probe axis)
±0.5 dB in tissue material (rotation normal to probe axis)
•Dynamic Range : 10µW/g to > 100 mW/g; Linearity: ±0.2 dB (noise: typically < 1 µW/g)
•Dimension : Overall length: 330 mm (Tip: 20 mm)
Tip diameter: 2.5 mm (Body: 12 mm)
Typical distance from probe tip to dipole centers: 1mm
•Application : High precision dosimetric measurement in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6GHz with precision of better 30%.
•Manufacture : Schmid & Partner Engineering AG



Phantom

•Model Number : **ELI 4.0 oval flat phantom**
•Shell Material : Fiberglass •Shell Thickness : Bottom plate: 2 ±0.2 mm
•Dimensions : Bottom elliptical: 600×400 mm, Depth: 190 mm (Volume: Approx. 30 liters)
•Manufacture : Schmid & Partner Engineering AG

Device Holder

☒ Urethane foam
☒ KSDH-01: In combination with the ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Transmitter devices can be easily and accurately positioned. The low-loss dielectric urethane foam was used for the mounting section of device holder.
•Material : Polyoxymethylene (POM) •Manufacture : Schmid & Partner Engineering AG
☐ SSDH-02: A simple but effective and easy-to-use extension for the Mounting Device; facilitates testing of larger devices (e.g., laptops, cameras, etc.) according to IEC 62209-2.
•Material : Polyoxymethylene (POM), PET-G, Foam
•Manufacture : Schmid & Partner Engineering AG

Data storage and evaluation (postprocessing)

The DASY5 software stores the measured voltage acquired by the Data Acquisition Electronics (DAE) as raw data together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and communication system parameters) in measurement files with the extension ".da5x". The postprocessing software evaluates the data every time the data is visualized or exported.
The fields and SAR are calculated from the measured voltage (probe voltage acquired by the DAE) and the following parameters:

Probe parameters:	- Sensitivity	*normi, ai0, ai1, ai2*
	- Conversion Factor	*convFi*
	- Diode Compression Point	*dcpi*
	- Probe Modulation Response Factors	*ai, bi, ci, d*
Device parameters:	- Frequency	*f*
	- Crest factor	*cf*
Media parameters:	- Conductivity	σ
	- Relative Permittivity	ρ

This parameters are stored in the DASY5 V52 measurement file.
These parameters must be correctly set in the DASY5 V52 software setup. They are available as configuration file and can be imported into the measurement file. The values displayed in the multimeter window are assessed using the parameters of the actual system setup. In the scan visualization and export modes, the parameters stored in the measurement file are used.
The measured voltage is not proportional to the exciting. It must be first linearized.

Approximated Probe Response Linearization using Crest Factor;
This linearization method is enabled when a custom defined communication system is measured. The compensation applied is a function of the measured voltage, the detector diode compression point and the crest factor of the measured signal.

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with	V_i	= linearized voltage of channel i in uV	(i =x,y,z)
	U_i	= measured voltage of channel i in uV	(i =x,y,z)
	cf	= crest factor of exciting field	(DASY parameter)
	dcp_i	= diode compression point of channel i in uV	(Probe parameter, i = x,y,z)

The resulting linearized voltage is only approximated because the probe is not calibrated to this specific signal.

Field and SAR Calculation
The primary field data for each channel are calculated using the linearized voltage:

$$\mathrm{E-fieldprobes}: \qquad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with	V_i	= linearized voltage of channel i in uV	(i =x,y,z)
	$Norm_i$	= sensor sensitivity of channel i in μV/(V/m)2 for E-field Probes	(i =x,y,z)
	ConvF	= sensitivity enhancement in solution	
	E_i	= electric field strength of channel i in V/m	(i = x,y,z)

The RMS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

with	SAR	= local specific absorption rate in mW/g
	Etot	= total field strength in V/m
	σ	= conductivity in [mho/m] or [Siemens/m]
	ρ	= equivalent tissue density in g/cm3

Appendix 3-4: Simulated tissue composition and parameter confirmation

Liquid type	Body	Head
Control No.	KSLM245-01	KSLH245-01
Model No. / Product No.	MSL2450V2 / SL AAM 245 BA	HSL2450V2 / SL AAH 245 BA
Ingredient: Mixture [%]	Water: (52~75) %, DGBE: (25~48) %, NaCl: < 1.0 %	Water: (52~75) %, DGBE: (25~48) %, NaCl: < 1.0 %
Temperature gradients [% / deg.C]	permittivity: +0.16 / conductivity: -2.58 (at 2.5 GHz) (*1)	permittivity: +0.42 / conductivity: -2.08 (at 2.5 GHz) (*1)
Manufacture	Schmid & Partner Engineering AG	Note: *1. Temperature_Gradient_tsl2450v2&tsl5000_16.01.2011

*. The dielectric parameters were checked prior to assessment using the DAK3.5 dielectric probe kit.

Measured date	Frequency [MHz]	Liquid type	Ambient [deg.C.] /[%RH]	Liquid Temperature [deg.C.]	Liquid Depth [mm]	Liquid parameters (*a)							ΔSAR	
						Permittivity (εr) [-]				Conductivity [S/m]				
						Target	Measured		Limit	Target	Measured		Limit	(1g) [%] (*b)	(10g) [%] (*b)
							Meas.	Δεr[%]			Meas.	Δσ[%]			
May 14, 2020	2450	Head	24 / 45	24.0	(150)	***39.2***	38.26	-2.4	±5%	***1.80***	1.861	+3.4	±5%	+2.16	+1.26
May 15, 2020	2450	Body	23 / 50	22.8	(149)	***52.7***	50.56	-4.1	±5%	***1.95***	1.971	+1.1	±5%	+1.44	+0.93

*a. The target value is a parameter defined in Appendix A of KDB 865664 D01 (v01r04), the dielectric parameters are given at (2000, 2450 and 3000) MHz. Parameters for the frequencies between 2000 MHz and 3000 MHz were obtained using linear interpolation.

Standard														
f	Head Tissue		Body Tissue		f	Head Tissue		Body Tissue		f	Head Tissue		Body Tissue	
(MHz)	εr [-]	σ [S/m]	εr [-]	σ [S/m]	(MHz)	εr [-]	σ [S/m]	εr [-]	σ [S/m]	(MHz)	εr [-]	σ [S/m]	εr [-]	σ [S/m]
(1800-)2000	**40.0**	**1.40**	**53.3**	**1.52**	2450	**39.2**	**1.80**	**52.7**	**1.95**	3000	**38.5**	**2.40**	**52.0**	**2.73**

*b. The coefficients are parameters defined in IEEE Std. 1528-2013.

$\Delta SAR(1g) = C\varepsilon r \times \Delta\varepsilon r + C\sigma \times \Delta\sigma$, $C\varepsilon r = -7.854E\text{-}4 \times f^3 + 9.402E\text{-}3 \times f^2 - 2.742E\text{-}2 \times f + 0.2026$ / $C\sigma = 9.804E\text{-}3 \times f^3 - 8.661E\text{-}2 \times f^2 + 2.981E\text{-}2 \times f + 0.7829$

$\Delta SAR(10g) = C\varepsilon r \times \Delta\varepsilon r + C\sigma \times \Delta\sigma$, $C\varepsilon r = 3.456 \times 10^{-3} \times f^3 - 3.531 \times 10^{-2} \times f^2 + 7.675 \times 10^{-2} \times f - 0.1860$ / $C\sigma = 4.479 \times 10^{-3} \times f^3 - 1.586 \times 10^{-2} \times f^2 - 0.1972 \times f + 0.7717$

Appendix 3-5: Daily check results

Prior to the SAR assessment of EUT, the daily check (system check) was performed to test whether the SAR system was operating within its target of ±10%. The daily check results are in the table below. (*. Refer to Appendix 3-6 of measurement data.)

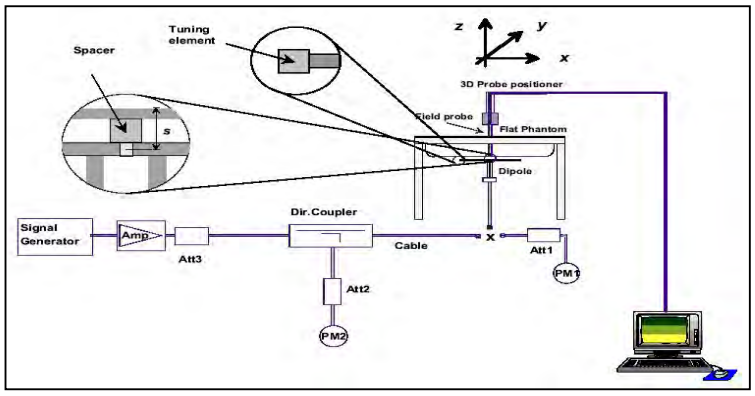
Daily check results																					
Measured date	Frequency [MHz]	Liquid type	Input power [mW]	Daily check target & measured																	
				SAR (1g) [W/kg]										SAR (10g) [W/kg]								
				Measured	ΔSAR-correct	1W scaled (*c)	Target		Deviation		Limit [%]	Judge	Measured	ΔSAR-correct	1W scaled (*c)	Target		Deviation		Limit [%]	Judge
							Cal. (*d)	STD (*e)	Cal. [%]	STD [%]						Cal. (*d)	STD (*e)	Cal. [%]	STD [%]		
May 14, 2020	2450	Head	250	13.3	13.01	52.04	52.9	52.4	-1.6	-0.7	±10	Pass	6.16	6.08	24.32	24.6	24.0	-1.1	+1.3	±10	Pass
May15, 2020	2450	Body	250	12.2	12.02	48.08	51.3	n/a	-6.3	n/a	±10	Pass	5.71	5.66	22.64	24.2	n/a	-6.4	n/a	±10	Pass

*. Calculating formula: ΔSAR corrected SAR (1g,10g) (W/kg) = (Measured SAR(1g,10g) (W/kg)) × (100 - (ΔSAR(%)) / 100

*c. The measured SAR value of Daily check was compensated for tissue dielectric deviations (ΔSAR) and scaled to 1W of output power in order to compare with the manufacture's calibration target value which was normalized.

*d. The target value is a parameter defined in the calibration data sheet of D2450V2 (sn:822) dipole calibrated by Schmid & Partner Engineering AG (Certification No. D2450V2-822_Jan20/02, the data sheet was filed in this report).

*e. The target value (normalized to 1W) is defined in IEEE Std.1528.



Test setup for the system performance check

Appendix 3-6: Daily check measurement data

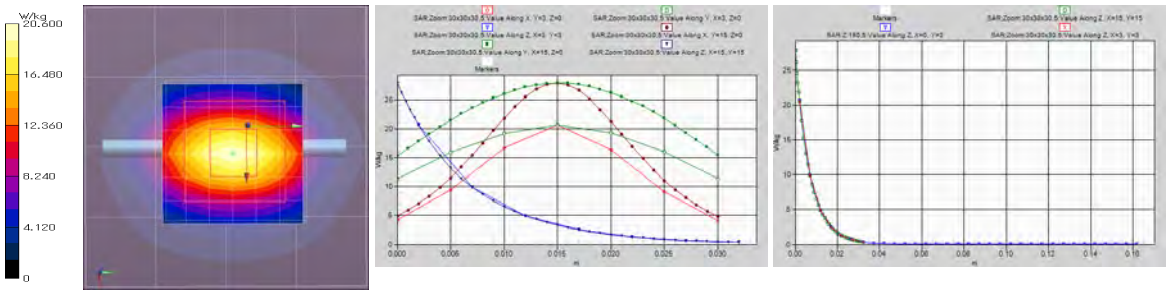
Photographs of Liquid depth	
150 mm (Head, 2.4GHz, May 14, 2020)	149 mm (Body, 2.4GHz, May 15, 2020)

(May 14, 2020) EUT: Dipole(2.45GHz); Model No.: D2450V2; Serial: 822; Forward input power: 250 mW
Communication System: CW (*. UID:0; Frame Length in ms: 0; PAR: 0; PMF: 1)**; Frequency: 2450 MHz; Crest Factor: 1.0**
Medium: HSL2450(2005); Medium parameters used: f = 2450 MHz; σ = 1.861 S/m; ε_r = 38.26; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Electronics: DAE4 Sn626; Calibrated: 2019/10/15 / -Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section -DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474) / -Probe: EX3DV4 - SN3907; ConvF(7.26, 7.26, 7.26) @ 2450 MHz; Calibrated: 2020/04/27 -Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0

Area:60x60,15 (5x5x1): Measurement grid: dx=15mm, dy=15mm; Maximum value of SAR (measured) = 19.7 W/kg
Area:60x60,15 (41x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm; Maximum value of SAR (interpolated) = 20.0 W/kg
Z;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 20.7 W/kg

Zoom:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 104.5 V/m; Power Drift = 0.03 dB; Maximum value of SAR (measured) = 20.6 W/kg; Peak SAR (extrapolated) = 27.9 W/kg
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.16 W/kg (*. Smallest distance from peaks to all points 3 dB below = 9.5 mm; Ratio of SAR at M2 to SAR at M1 = 48.1%)



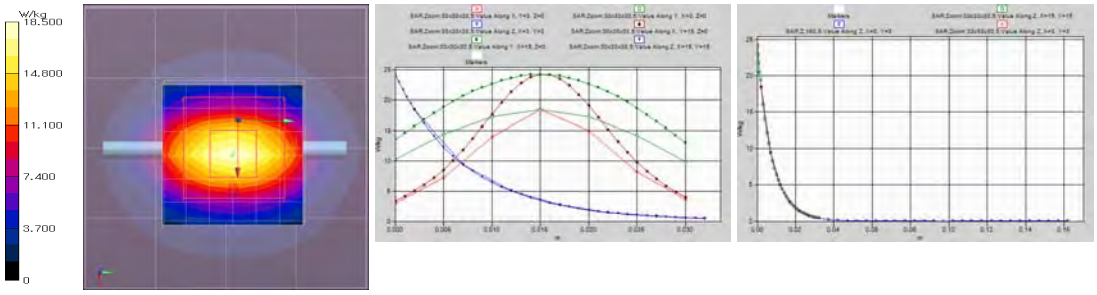
Remarks: *. Date tested: 2020/05/14; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 150 mm; Position: distance of dipole to phantom: 8mm (10mm to liquid); ambient: (24~25) deg.C. / (50~65) %RH,
*. liquid temperature: 23.8(start)/23.8(end)/24.0(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

(May 15, 2020) EUT: Dipole(2.45GHz); Model No.: D2450V2; Serial: 822; Forward input power: 250 mW
Communication System: CW (*. UID:0; Frame Length in ms: 0; PAR: 0; PMF: 1)**; Frequency: 2450 MHz; Crest Factor: 1.0**
Medium: M2450(2005); Medium parameters used: f = 2450 MHz; σ = 1.971 S/m; ε_r = 50.56; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Electronics: DAE4 Sn626; Calibrated: 2019/10/15 / -Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section -DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474) / -Probe: EX3DV4 - SN3907; ConvF(7.49, 7.49, 7.49) @ 2450 MHz; Calibrated: 2020/04/27 -Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0

Area:60x60,15 (5x5x1): Measurement grid: dx=15mm, dy=15mm; Maximum value of SAR (measured) = 18.0 W/kg
Area:60x60,15 (41x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm; Maximum value of SAR (interpolated) = 18.1 W/kg
Z;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 18.5 W/kg

Zoom:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 97.64 V/m; Power Drift = 0.01 dB; Maximum value of SAR (measured) = 18.5 W/kg; Peak SAR (extrapolated) = 24.3 W/kg
SAR(1 g) = 12.2 W/kg; SAR(10 g) = 5.71 W/kg (*. Smallest distance from peaks to all points 3 dB below = 9 mm; Ratio of SAR at M2 to SAR at M1 = 51.2%)



Remarks: *. Date tested: 2020/05/15; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*. liquid depth: 149 mm; Position: distance of dipole to phantom: 8mm (10mm to liquid); ambient: 23 deg.C. / (45~55) %RH,
*. liquid temperature: 23.0(start)/23.0(end)/22.9(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4)

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 **UL Japan (RCC)** Certificate No: **EX3-3907_Apr20**

CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3907

Calibration procedure(s) QA CAL-01.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7
Calibration procedure for dosimetric E-field probes

Calibration date: April 27, 2020

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
DAE4	SN: 660	27-Dec-19 (No. DAE4-660_Dec19)	Dec-20
Reference Probe ES3DV2	SN: 3013	31-Dec-19 (No. ES3-3013_Dec19)	Dec-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 E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 27, 2020

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

Certificate No: EX3-3907_Apr20 Page 1 of 10

Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

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
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

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

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"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Certificate No: EX3-3907_Apr20 Page 2 of 10

Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4 – SN:3907 April 27, 2020

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.45	0.58	0.55	± 10.1 %
DCP (mV)[B]	103.3	102.6	99.4	

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	157.9	± 2.5 %	± 4.7 %
		Y	0.0	0.0	1.0		155.3		
		Z	0.0	0.0	1.0		149.4		

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] 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.

Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	37.3
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

Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3907 April 27, 2020

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

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)
2450	39.2	1.80	7.26	7.26	7.26	0.40	0.80	± 12.0 %
5200	36.0	4.66	5.23	5.23	5.23	0.40	1.80	± 13.1 %
5250	35.9	4.71	5.08	5.08	5.08	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.66	4.66	4.66	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.51	4.51	4.51	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.68	4.68	4.68	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.55	4.55	4.55	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 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3907 April 27, 2020

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3907

Calibration Parameter Determined in Body Tissue Simulating Media

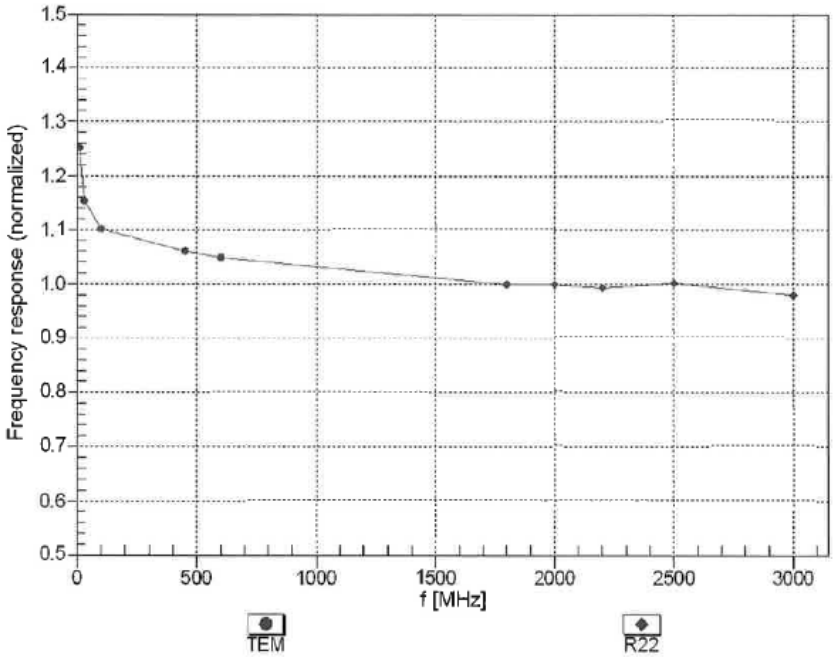
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
2450	52.7	1.95	7.49	7.49	7.49	0.44	0.85	± 12.0 %
5250	48.9	5.36	4.50	4.50	4.50	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.87	3.87	3.87	0.50	1.90	± 13.1 %
5750	48.3	5.94	4.07	4.07	4.07	0.50	1.90	± 13.1 %
5800	48.2	6.00	3.98	3.98	3.98	0.50	1.90	± 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 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3907 April 27, 2020

Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)

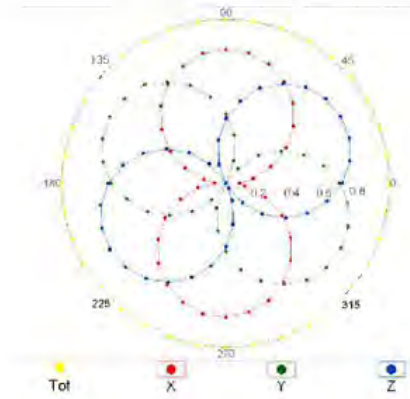


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

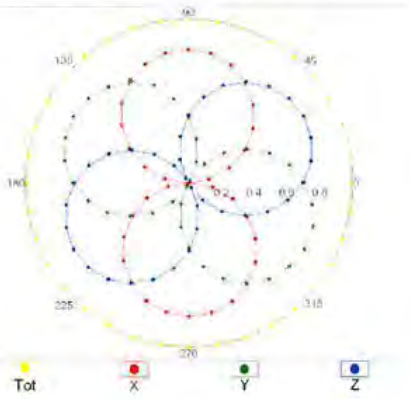
Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

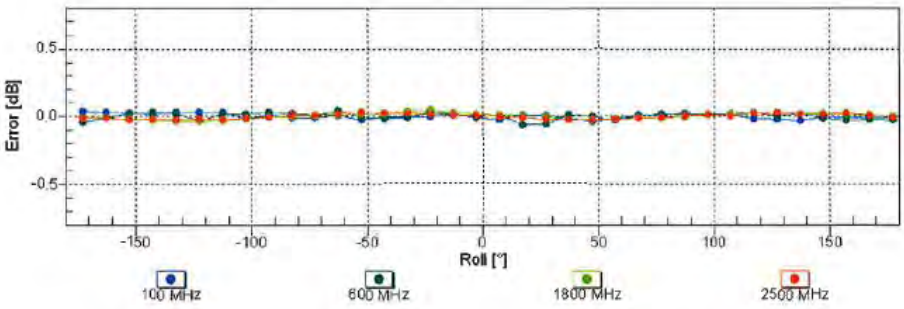
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

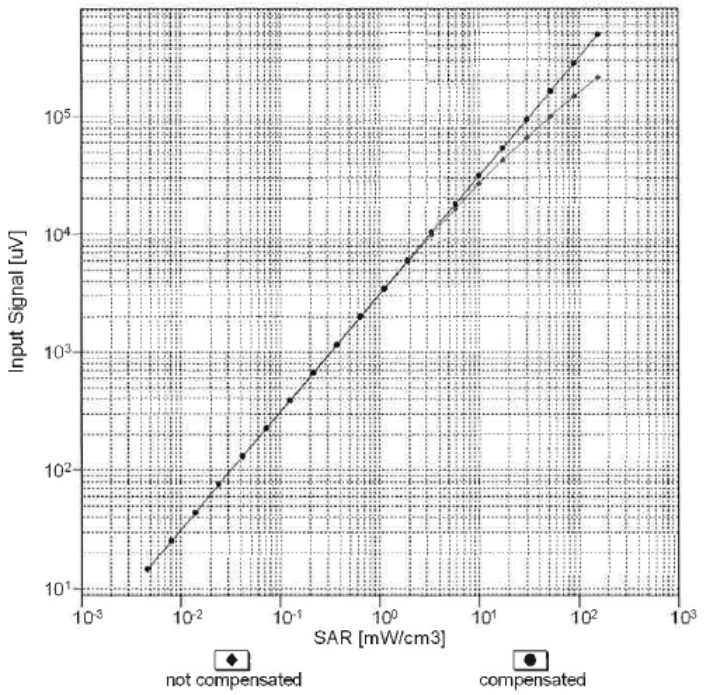


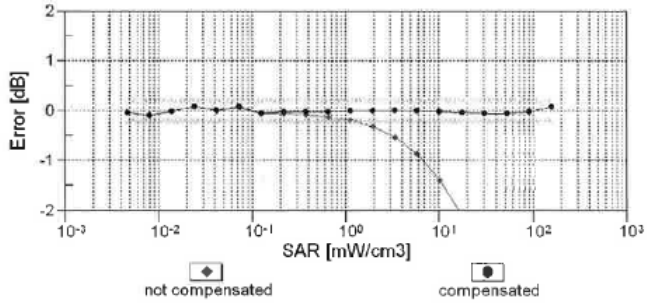


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)





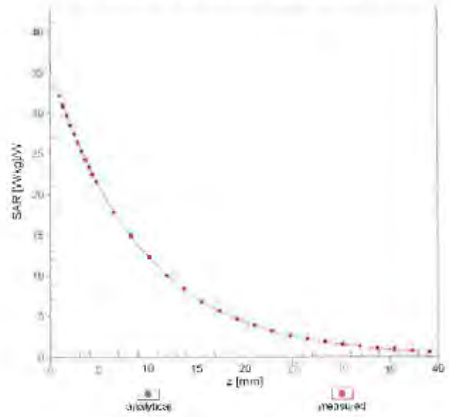
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Appendix 3-7: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

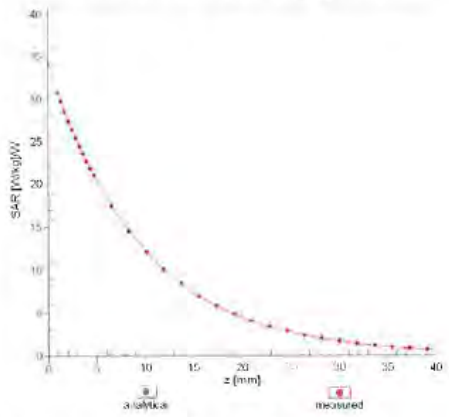
EX3DV4– SN:3907 April 27, 2020

Conversion Factor Assessment

f = 2450 MHz,WGLS R22 (H_convF)

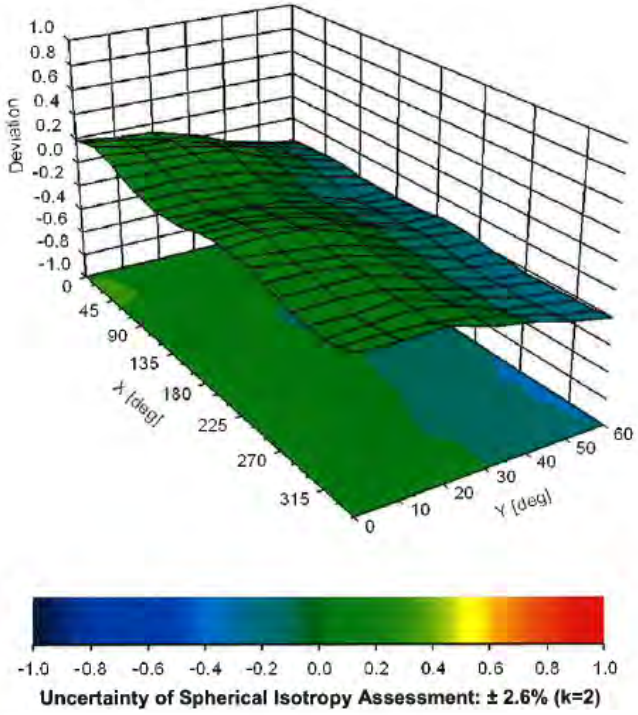


f = 2450 MHz,WGLS R22 (M_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

Certificate No: EX3-3907_Apr20 Page 10 of 10

Appendix 3-8: Calibration certificate: Dipole (D2450V2)

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 UL Japan (KYCOM)

Certificate No: D2450V2-822_Jan20/2

CALIBRATION CERTIFICATE (Replacement of D2450V2-822_Jan20)

Object D2450V2 - SN:822

Calibration procedure(s) QA CAL-05.v11
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz

Calibration date: January 15, 2020

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: 5058 (20k)	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: 7349	31-Dec-19 (No. EX3-7349_Dec19)	Dec-20
DAE4	SN: 601	27-Dec-19 (No. DAE4-601_Dec19)	Dec-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 30, 2020

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

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Appendix 3-8: Calibration certificate: Dipole (D2450V2) (cont'd)

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

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 dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. 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%.

Certificate No: D2450V2-822_Jan20/2 Page 2 of 8

Appendix 3-8: Calibration certificate: Dipole (D2450V2) (cont'd)

Measurement Conditions

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

DASY Version	DASY5	V52.10.3
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	38.9 ± 6 %	1.87 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	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.9 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.6 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.2 ± 6 %	2.04 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**51.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**24.2 W/kg ± 16.5 % (k=2)**

Appendix 3-8: Calibration certificate: Dipole (D2450V2) (cont'd)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.8 Ω + 3.2 jΩ
Return Loss	- 26.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.0 Ω + 7.0 jΩ
Return Loss	- 23.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.126 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG

Appendix 3-8: Calibration certificate: Dipole (D2450V2) (cont'd)

DASY5 Validation Report for Head TSL

Date: 06.01.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:822

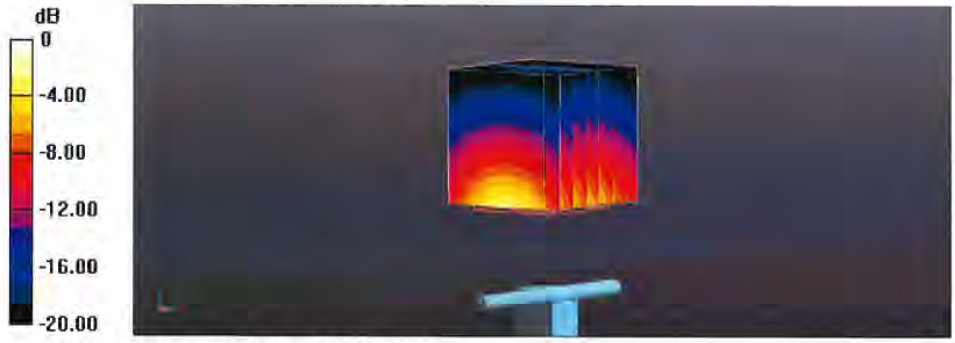
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.87 S/m; ε_r = 38.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.98, 7.98, 7.98) @ 2450 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

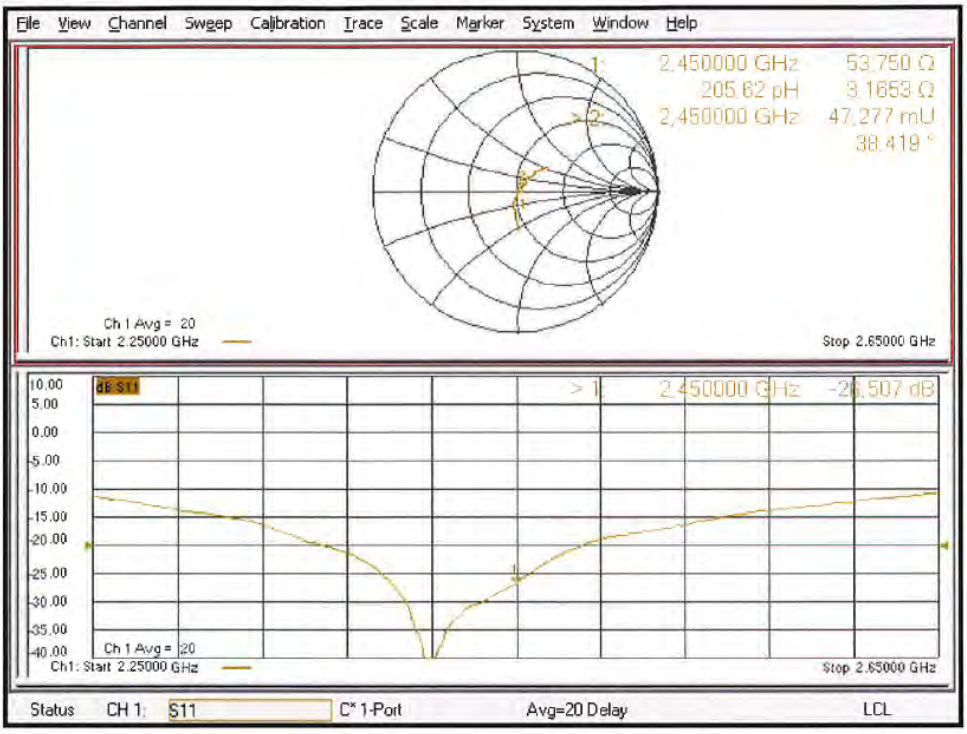
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 117.2 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 27.0 W/kg
SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.23 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 50.2%
Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.50 dBW/kg

Appendix 3-8: Calibration certificate: Dipole (D2450V2) (cont'd)

Impedance Measurement Plot for Head TSL



Appendix 3-8: Calibration certificate: Dipole (D2450V2) (cont'd)

DASY5 Validation Report for Body TSL

Date: 15.01.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:822

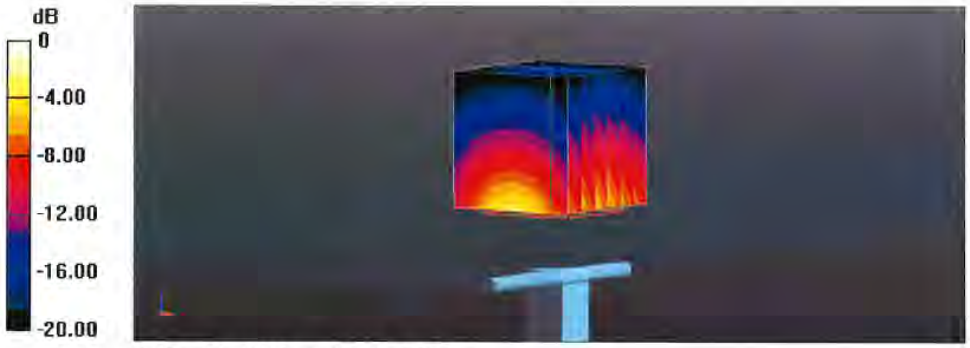
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.04 S/m; ε_r = 51.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.02, 8.02, 8.02) @ 2450 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 110.3 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 25.3 W/kg
SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.14 W/kg
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 52.9%
Maximum value of SAR (measured) = 21.4 W/kg



0 dB = 21.4 W/kg = 13.30 dBW/kg

Appendix 3-8: Calibration certificate: Dipole (D2450V2) (cont'd)

Impedance Measurement Plot for Body TSL