APPENDIX 2: SAR Measurement data

Appendix 2-1: Evaluation procedure

The SAR evaluation was performed with the following procedure:

Step 1: Measurement of the E-field at a fixed location above the central position of flat phantom was used as a reference value for assessing the power drop.

Step 2: The SAR distribution at the exposed side of head or body position was measured at a distance of each device from the inner surface of the shell. The area covered the entire dimension of the antenna of EUT and suitable horizontal grid spacing of EUT. Based on these data, the area of the maximum absorption was determined by splines interpolation.

Step 3: Around this point found in the Step 2 (area scan), a volume of 30mm(X axis)×30mm(Y axis)×30mm(Z axis) (or more) was assessed by measuring 7×7×7 points (or more) under 3GHz.
And for any secondary peaks found in the Step2 which are within 2dB of the SAR limit (1.6W/kg), this Step3 (Zoom scan) is repeated.
On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

(1) The data at the surface were extrapolated, since the center of the dipoles is 1mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 2mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

(2) The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the "Not a knot"-condition (in x, y and z-directions). The volume was integrated with the trapezoidal-algorithm. One thousand points (10×10×10) were interpolated to calculate the average.

(3) All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the E-field at the same location as in Step 1 for the assessment of the power drift.

Step 5: Repeat Step 1-Step 4 with other condition or/and setup of EUT.

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Appendix 2-2: SAR measurement data / Platform (1)

Step 1: Change the setup positions

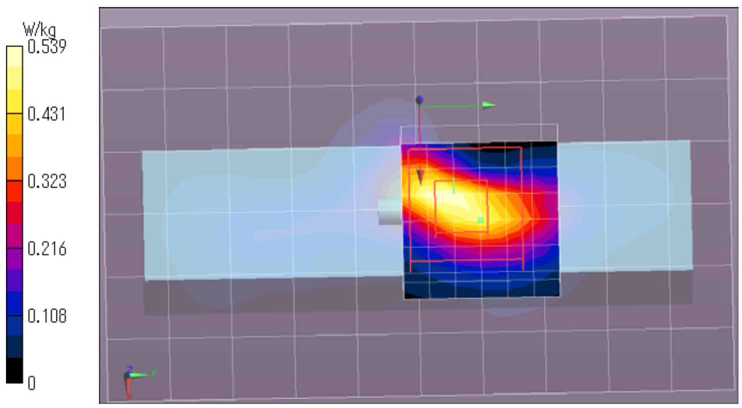
Step 1-1: Top-front & touch (separation distance=0mm) / 11b(1Mbps), 2462MHz (11ch.)

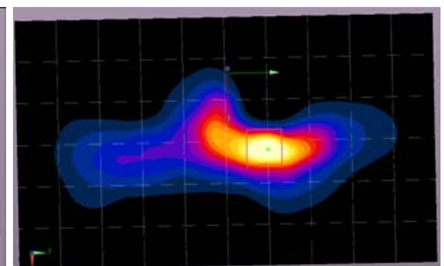
EUT: Wireless module/(in Digital camera); Type: WM223/(camera:PC2071); Serial: E8F1/(53)
Communication System: IEEE 802.11b(1Mbps, DBPSK/DSSS);
Frequency: 2462 MHz; Crest Factor: 1.0 (*. Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2462 MHz; σ = 1.991 S/m; ε_r = 50.67; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

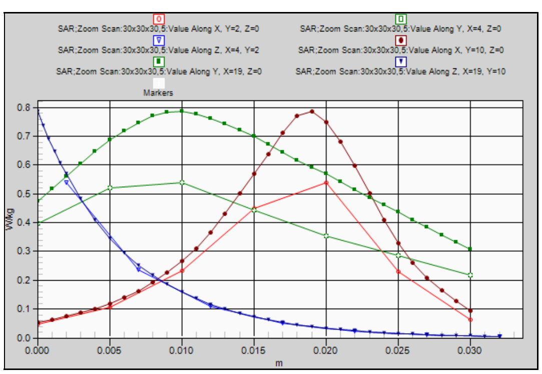
DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22;
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section
-DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

portable,wm223(e8f1)+dc1_pc2071(53)/m1;pos;top-frt(Lens)&touch(d0mm),11b(1m),m2462/
Area Scan:72x120,12 (7x11x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.528 W/kg
Area Scan:72x120,12 (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.635 W/kg
Fast SAR: SAR(1 g) = 0.319 mW/g;

Zoom Scan:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 15.913 V/m; Power Drift = -0.05 dB, Maximum value of SAR (measured) = 0.539 W/kg
Peak SAR (extrapolated) = 0.786 mW/g
SAR(1 g) = 0.329 mW/g; SAR(10 g) = 0.135 mW/g




(Shown with no transparency of area scan and a fast 1g-SAR plot)



Remarks: *. Date tested: 2013/10/04; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of EUT to phantom: 0mm (2mm to liquid); ambient: 23.5 ± 1.0deg.C. / 45 ± 10 %RH,
*.liquid temperature: 22.5(start)/22.4(end)/22.2(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

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Appendix 2-2: SAR measurement data / Platform (1) (cont'd)
Step 1: Change the setup positions (cont'd)

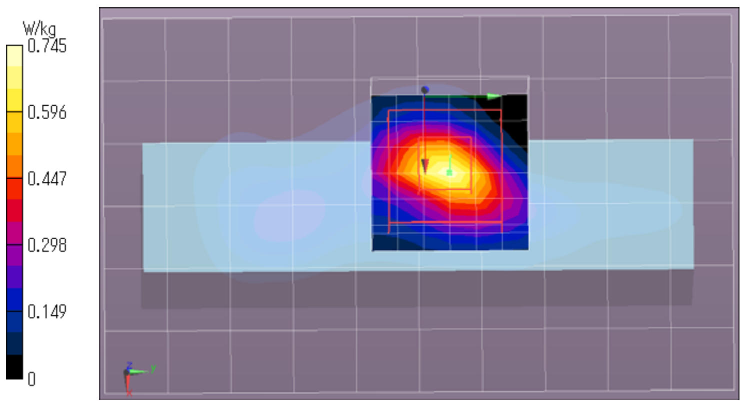
Step 1-2: Top-rear & touch (separation distance=0mm) / 11b(1Mbps), 2462MHz (11ch.)

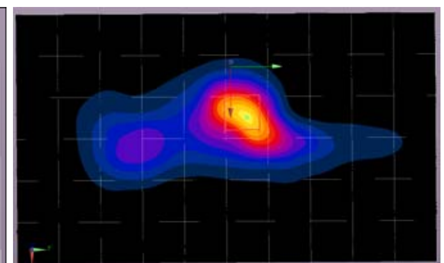
EUT: Wireless module/(in Digital camera); Type: WM223/(camera:PC2071); Serial: E8F1/(53)
Communication System: IEEE 802.11b(1Mbps, DBPSK/DSSS);
Frequency: 2462 MHz; Crest Factor: 1.0 (*. Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2462 MHz; σ = 1.991 S/m; ε_r = 50.67; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22;
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section
-DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

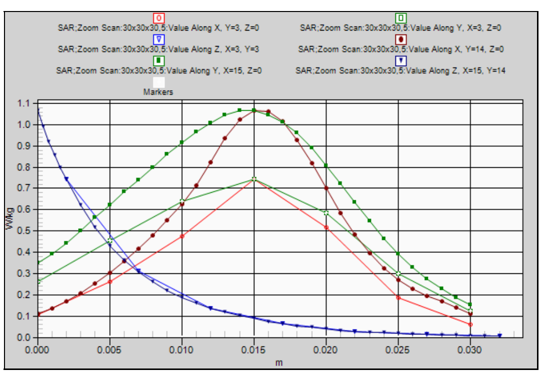
portable,wm223(e8f1)+dc1_pc2071(53)/m2;pos;top-rear(LCD)&touch(d0mm),11b(1m),m2462/
Area Scan:72x120,12 (7x11x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.436 W/kg
Area Scan:72x120,12 (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.619 W/kg
Fast SAR: SAR(1 g) = 0.360 mW/g;

Zoom Scan:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 19.672 V/m; Power Drift = -0.03 dB, Maximum value of SAR (measured) = 0.745 W/kg
Peak SAR (extrapolated) = 1.066 mW/g
SAR(1 g) = 0.420 mW/g; SAR(10 g) = 0.160 mW/g





(Shown with no transparency of area scan and a fast 1g-SAR plot)



Remarks: *. Date tested: 2013/10/04; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of EUT to phantom: 0mm (2mm to liquid); ambient: 23.5 ± 1.0deg.C. / 45 ± 10 %RH,
*.liquid temperature: 22.4(start)/22.4(end)/22.2(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 2-2: SAR measurement data / Platform (1) (cont'd)
Step 1: Change the setup positions (cont'd)

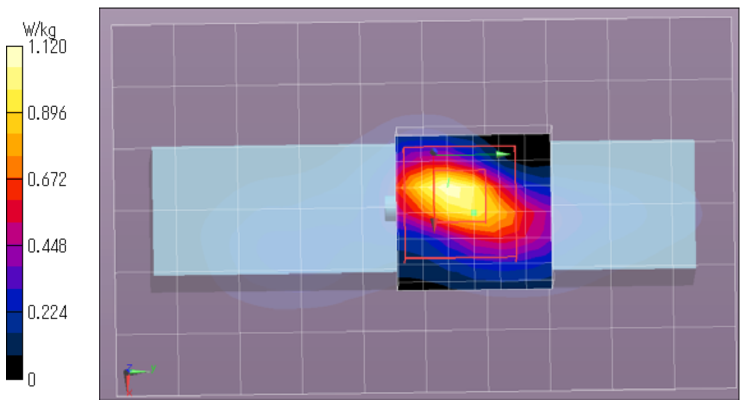
Step 1-3: Top & touch (separation distance=0mm) / 11b(1Mbps), 2462MHz (11ch.)

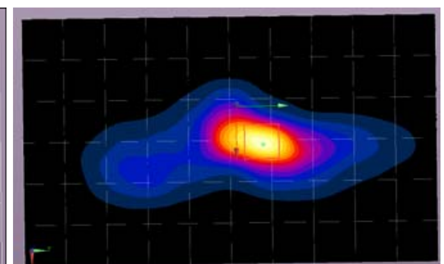
EUT: Wireless module/(in Digital camera); Type: WM223/(camera:PC2071); Serial: E8F1/(53)
Communication System: IEEE 802.11b(1Mbps, DBPSK/DSSS);
Frequency: 2462 MHz; Crest Factor: 1.0 (*. Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2462 MHz; σ = 1.991 S/m; ε_r = 50.67; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

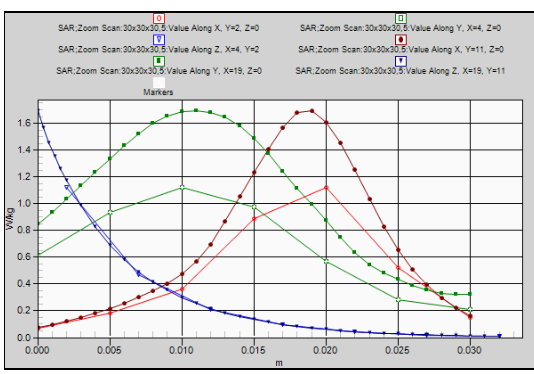
DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22;
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section
-DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

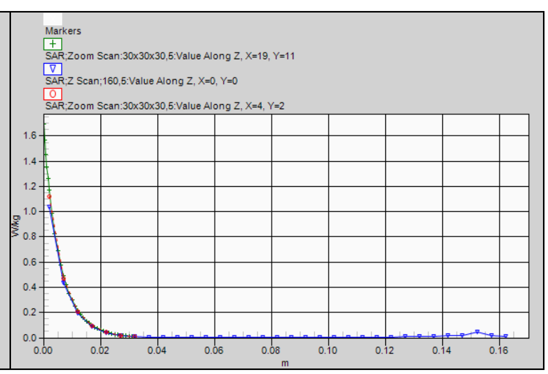
portable,wm223(e8f1)+dc1_pc2071(53)/m3;pos;top&touch(d0mm),11b(1m),m2462/
Area Scan:72x120,12 (7x11x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 1.03 W/kg
Area Scan:72x120,12 (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 1.09 W/kg
Z Scan;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 1.04 W/kg
Fast SAR: SAR(1 g) = 0.638 mW/g;

Zoom Scan:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 22.889 V/m; Power Drift = -0.20 dB, Maximum value of SAR (measured) = 1.12 W/kg
Peak SAR (extrapolated) = 1.692 mW/g (*.required to evaluate multi channels)
SAR(1 g) = 0.658 mW/g; SAR(10 g) = 0.249 mW/g




(Shown with no transparency of area scan and a fast 1g-SAR plot)





Remarks: *. Date tested: 2013/10/04; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of EUT to phantom: 0mm (2mm to liquid); ambient: 23.5 ± 1.0deg.C. / 45 ± 10 %RH,
*.liquid temperature: 22.4(start)/22.4(end)/22.2(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 2-2: SAR measurement data / Platform (1) (cont'd)
Step 1: Change the setup positions (cont'd)

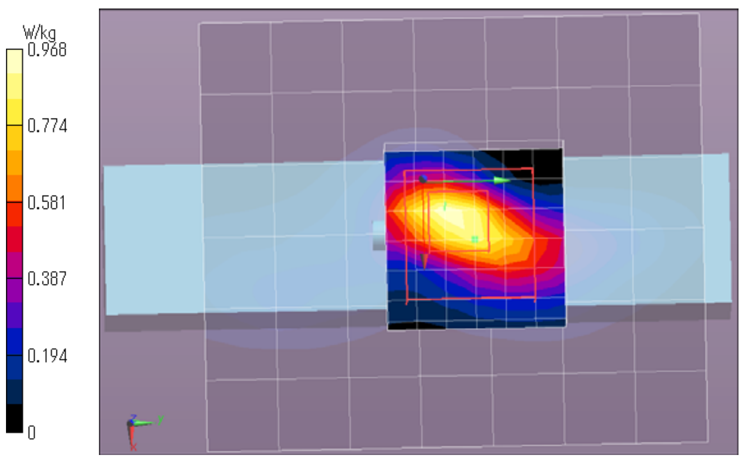
Step 1-4: 2437MHz (6ch.), 11b(1Mbps) / Top & touch (separation distance=0mm)

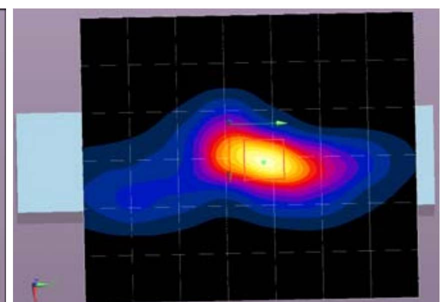
EUT: Wireless module/(in Digital camera); Type: WM223/(camera:PC2071); Serial: E8F1/(53)
Communication System: IEEE 802.11b(1Mbps, DBPSK/DSSS);
Frequency: 2437 MHz; Crest Factor: 1.0 (*.Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2437 MHz; σ = 1.957 S/m; ε_r = 50.74; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

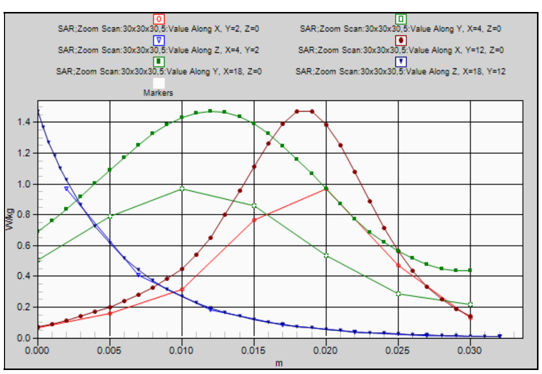
DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section
-DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

portable,wm223(e8f1)+dc1_pc2071(53)/m4;ch;top&touch(d0mm),11b(1m),m2437/
Area Scan:72x84,12 (7x8x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.885 W/kg
Area Scan:72x84,12 (61x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.933 W/kg
Z Scan;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 0.968 W/kg
Fast SAR: SAR(1 g) = 0.549 mW/g;

Zoom Scan:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 21.416 V/m; Power Drift = 0.03 dB, Maximum value of SAR (measured) = 0.968 W/kg
Peak SAR (extrapolated) = 1.470 mW/g
SAR(1 g) = 0.580 mW/g; SAR(10 g) = 0.224 mW/g




(Shown with no transparency of area scan and a fast 1g-SAR plot)



Remarks: *. Date tested: 2013/10/04; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of EUT to phantom: 0mm (2mm to liquid); ambient: 23.5 ± 1.0deg.C. / 45 ± 10 %RH,
*.liquid temperature: 22.4(start)/22.4(end)/22.2(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 2-2: SAR measurement data / Platform (1) (cont'd)
Step 1: Change the setup positions (cont'd)

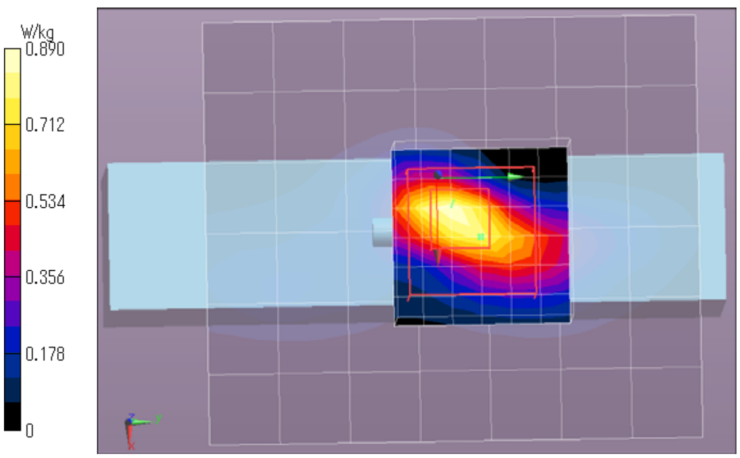
Step 1-5: 2412MHz (1ch.), 11b(1Mbps) / Top & touch (separation distance=0mm)

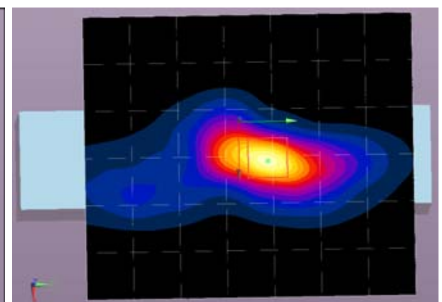
EUT: Wireless module/(in Digital camera); Type: WM223/(camera:PC2071); Serial: E8F1/(53)
Communication System: IEEE 802.11b(1Mbps, DBPSK/DSSS);
Frequency: 2412 MHz; Crest Factor: 1.0 (*.Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2412 MHz; σ = 1.927 S/m; ε_r = 50.80; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

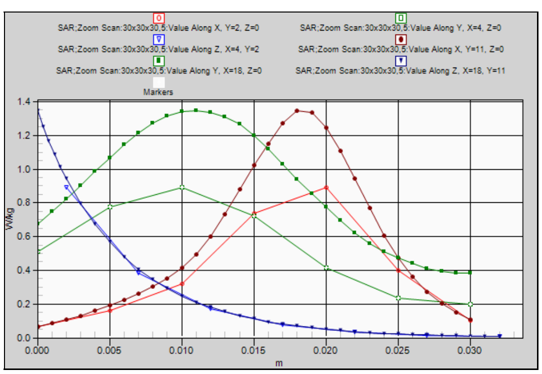
DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22;
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section
-DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

portable,wm223(e8f1)+dc1_pc2071(53)/m5;ch;top&touch(d0mm),11b(1m),m2412/
Area Scan:72x84,12 (7x8x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.820 W/kg
Area Scan:72x84,12 (61x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.859 W/kg
Z Scan;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 0.896 W/kg
Fast SAR: SAR(1 g) = 0.503 mW/g;

Zoom Scan:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 20.739 V/m; Power Drift = 0.03 dB, Maximum value of SAR (measured) = 0.890 W/kg
Peak SAR (extrapolated) = 1.346 mW/g
SAR(1 g) = 0.531 mW/g; SAR(10 g) = 0.205 mW/g




(Shown with no transparency of area scan and a fast 1g-SAR plot)



Remarks: *. Date tested: 2013/10/04; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of EUT to phantom: 0mm (2mm to liquid); ambient: 23.5 ± 1.0deg.C. / 45 ± 10 %RH,
*.liquid temperature: 22.4(start)/22.4(end)/22.2(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 2-2: SAR measurement data / Platform (1) (cont'd)
Step 1: Change the setup positions (cont'd)

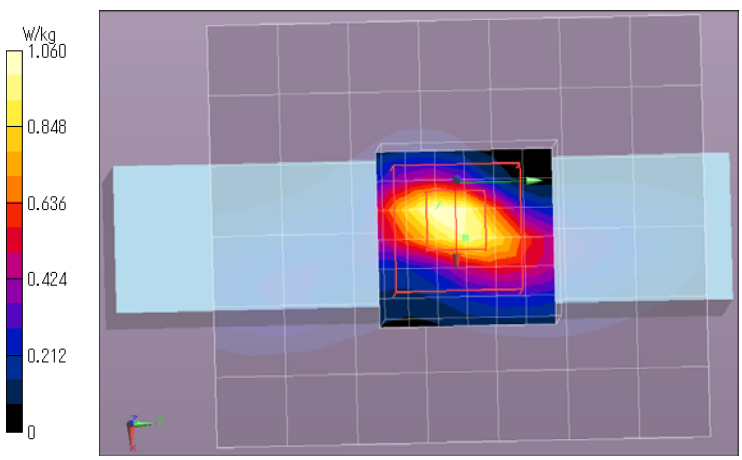
Step 1-6: Battery type: MB-6LH, Top & touch (separation distance=0mm) / 11b(1Mbps), 2462MHz (11ch.)

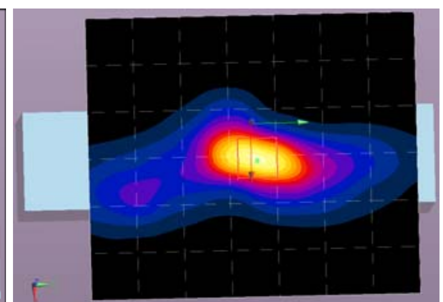
EUT: Wireless module/(in Digital camera); Type: WM223/(camera:PC2071); Serial: E8F1/(53)
Communication System: IEEE 802.11b(1Mbps, DBPSK/DSSS);
Frequency: 2462 MHz; Crest Factor: 1.0 (*.Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2462 MHz; σ = 1.991 S/m; ε_r = 50.67; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

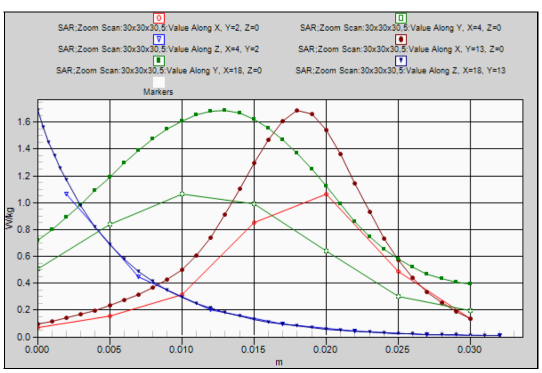
DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22;
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section
-DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

portable,wm223(e8f1)+dc1_pc2071(53)/m6;bty-type;top(bty=LH)&touch(d0mm),11b(1m),m2462/
Area Scan:72x84,12 (7x8x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.892 W/kg
Area Scan:72x84,12 (61x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 1.01 W/kg
Z Scan;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 1.06 W/kg
Fast SAR: SAR(1 g) = 0.590 mW/g;

Zoom Scan:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 22.584 V/m; Power Drift = 0.06 dB, Maximum value of SAR (measured) = 1.06 W/kg
Peak SAR (extrapolated) = 1.686 mW/g
SAR(1 g) = 0.645 mW/g; SAR(10 g) = 0.242 mW/g




(Shown with no transparency of area scan and a fast 1g-SAR plot)



Remarks: *. Date tested: 2013/10/04; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of EUT to phantom: 0mm (2mm to liquid); ambient: 23.5 ± 1.0deg.C. / 45 ± 10 %RH,
*.liquid temperature: 22.4(start)/22.4(end)/22.2(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 2-2: Measurement data / Platform (1) (cont'd)

Step 2: Change the operation mode

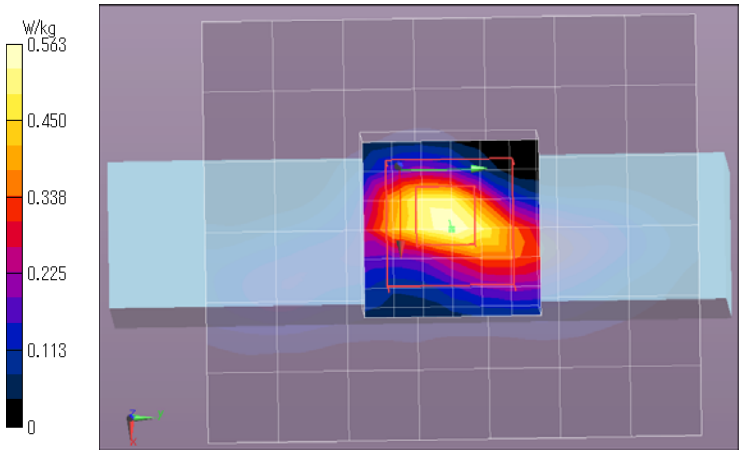
Step 2-1: 11n(40HT)(MCS0), 2452MHz (9ch.) / Top & touch (separation distance=0mm)

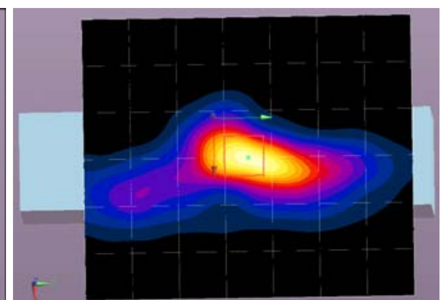
EUT: Wireless module/(in Digital camera); Type: WM223/(camera:PC2071); Serial: E8F1/(53)
Communication System: IEEE 802.11n(40HT)(MCS0, BPSK/OFDM);
Frequency: 2452 MHz; Crest Factor: 1.0 (*.Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2452 MHz; σ = 1.979 S/m; ε_r = 50.72; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

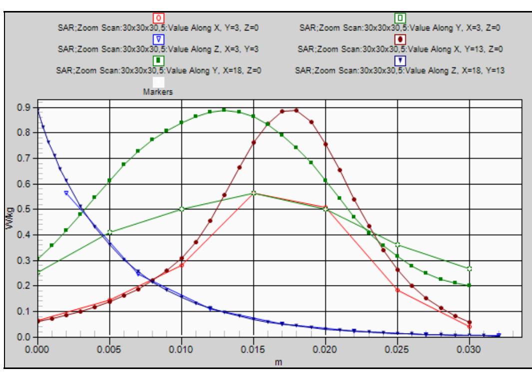
DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22;
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section
-DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

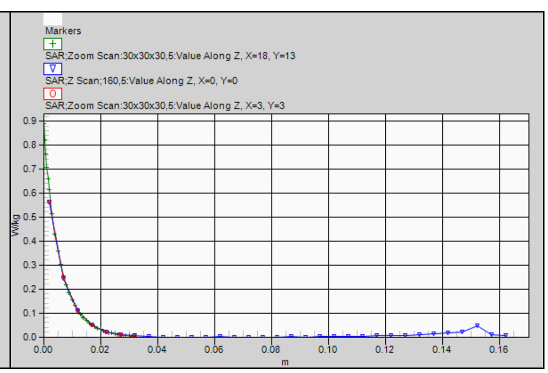
portable,wm223(e8f1)+dc1_pc2071(53)/m7;mode;top&touch(d0mm),n40(m0),m2452/
Area Scan:72x84,12 (7x8x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 0.489 W/kg
Area Scan:72x84,12 (61x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 0.547 W/kg
Z Scan;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 0.561 W/kg
Fast SAR: SAR(1 g) = 0.327 mW/g;

Zoom Scan:30x30x30,5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 17.148 V/m; Power Drift = 0.04 dB, Maximum value of SAR (measured) = 0.563 W/kg
Peak SAR (extrapolated) = 0.888 mW/g
SAR(1 g) = 0.346 mW/g; SAR(10 g) = 0.134 mW/g




(Shown with no transparency of area scan and a fast 1g-SAR plot)





Remarks: *. Date tested: 2013/10/04; Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of EUT to phantom: 0mm (2mm to liquid); ambient: 23.5 ± 1.0deg.C. / 45 ± 10 %RH,
*.liquid temperature: 22.4(start)/22.5(end)/22.2(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

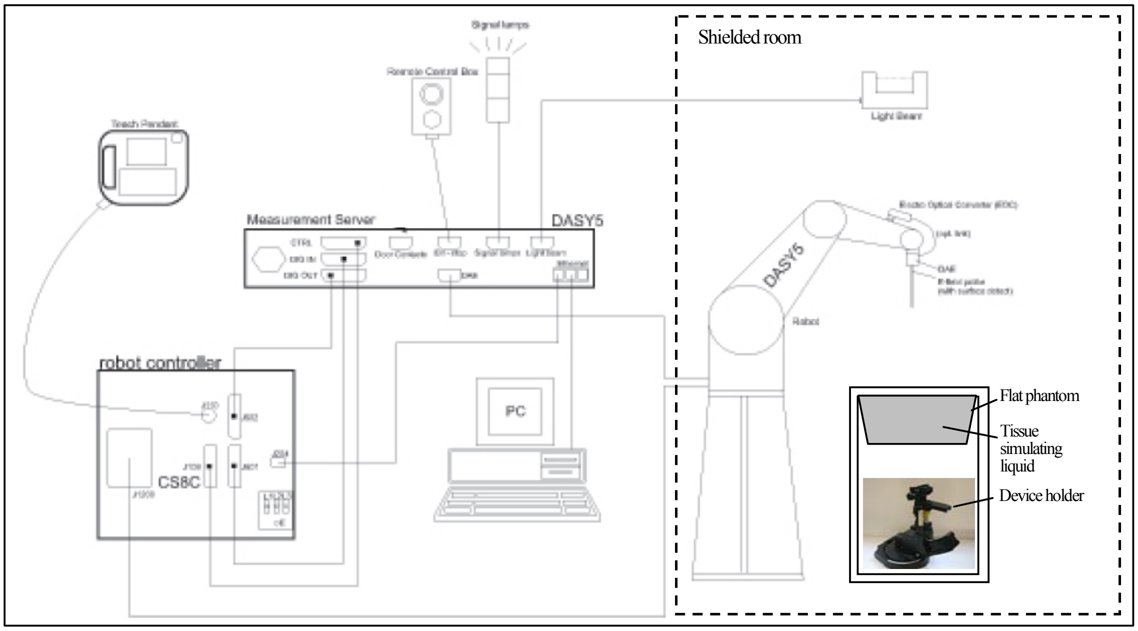
Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
COTS-SSAR-02	DASY52	Schmid&Partner Engineering AG	DASY52 V8.2 B969	-	SAR	-
COTS-SSEP-02	Dielectric assessment kit	Schmid&Partner Engineering AG	DAK	-	SAR	-
SSAR-02	SAR measurement system	Schmid&Partner Engineering AG	DASY5	1324	SAR	Pre Check
SSRBT-02	SAR robot	Schmid&Partner Engineering AG	TX60 Lspeag	F12/5L2QA1/A/01	SAR	2013/09/02 * 12
KDAE-01	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	626	SAR	2013/09/17 * 12
KPB-01	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3679	SAR	2013/07/13 * 12
KSDA-01	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	822	SAR(daily)	2013/01/08 * 12
KPFL-01	Flat Phantom	Schmid&Partner Engineering AG	Oval flat phantom ELI 4.0	1059	SAR	2012/10/31 * 12
SSNA-01	Network Analyzer	Agilent	8753ES	US39171777	SAR	2012/12/29 * 12
SEPP-02	Dielectric probe	Schmid&Partner Engineering AG	DAK3.5	1129	SAR	2013/08/24 * 12
KSG-08	Signal Generator	Rohde & Schwarz	SMT06	100763	SAR(daily)	2013/07/31 * 12
KPA-12	RF Power Amplifier	MILMEGA	AS2560-50	1018582	SAR(daily)	Pre Check
KCPL-07	Directional Coupler	Pulsar Microwave Corp.	CCS30-B26	0621	SAR(daily)	Pre Check
KPM-06	Power Meter	Rohde & Schwarz	NRVD	101599	SAR(daily)	2013/09/03 * 12
KIU-08	Power sensor	Rohde & Schwarz	NRV-Z4	100372	SAR(daily)	2013/09/03 * 12
KIU-09	Power sensor	Rohde & Schwarz	NRV-Z4	100371	SAR(daily)	2013/09/03 * 12
KAT10-P1	Attenuator	Weinschel	24-10-34	BY5927	SAR(daily)	2013/02/27 * 12
KPM-05	Power meter	Agilent	E4417A	GB41290718	SAR(daily)	2013/04/18 * 12
KPSS-01	Power sensor	Agilent	E9327A	US40440544	SAR(daily)	2013/04/18 * 12
SAT20-SAR1	Attenuator	TME	SFA-01AXPJ-20	-	SAR(daily)	2013/04/05 * 12
KRU-01	Ruler(300mm)	Shinwa	13134	-	SAR	2013/03/25 * 12
KRU-05	Ruler(100x50mm,L)	Shinwa	12101	-	SAR	2013/05/27 * 12
KOS-13	Digtal thermometer	HANNA	Checktemp-2	KOS-13	SAR	2013/01/31 * 12
KOS-14	Thermo-Hygrometer data logger	SATO KEIRYOKI	SK-L200THII α / SK-LTHII α -2	015246/08169	SAR	2013/01/31 * 12
SOS-SAR1	Digtal thermometer	LKMelectonic	DTM3000	3171	SAR	2013/10/01 * 12
SOS-11	Humidity Indicator	A&D	AD-5681	4063424	SAR	2013/02/27 * 12
SOS-12	Digtal thermometer	HANNA	Checktemp-4	SOS-12	SAR	2013/02/25 * 12
KPM-08	Power meter	Anritsu	ML2495A	6K00003356	Ant.pwr	2013/09/04 * 12
KPSS-04	Power sensor	Anritsu	MA2411B	012088	Ant.pwr	2013/09/04 * 12
KAT10-S3	Attenuator	Agilent	8490D 010	50924	Ant.pwr	2013/02/19 * 12
SSA-04	Spectrum Analyzer	Advantest	R3272	101100994	SAR(moni.)	2012/12/17 * 12
KSDH-01	Device holder	Schmid&Partner Engineering AG	Mounting device for transmitter	-	SAR	2013/09/02 * 12
SWTR-03	DI water	MonotaRo	34557433	-	SAR	Pre Check
KSLM245-01	Tissue simulation liqud (2450MHz,body)	Schmid&Partner Engineering AG	SL AAM 245	-	SAR	(Daily check) Target value ±5%
No.7 Shielded room	SAR shielded room (2.76m(W)x3.76m(D)x2.4m(H))	TDK	-	-	SAR	*(Daily check) Ambient noise: < 12mW/kg*

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 chains of calibrations.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

[Test Item] SAR: Specific Absorption Rate, Ant.pwr: 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.



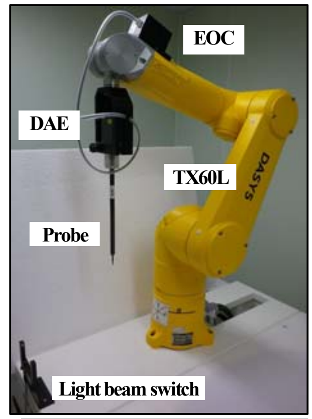
The DASY5 system for performing compliance tests consist of the following items:

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 : ±0.02mm
- •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 : 1μV to > 200mV (16bit resolution and 2 range settings: 4mV, 400mV)
- •Input Offset voltage : < 1μV (with auto zero)
- •Input Resistance : 200MΩ
- •Battery Power : > 10hr of operation (with two 9V 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 : DASY52, V8.2 B969
- •Manufacture : Schmid & Partner Engineering AG

E-Field Probe

- •Model : **EX3DV4 (serial number: 3679)**
- •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 : 2450, 5200, 5300, 5500, 5600, 5800MHz (Head and Body)
- •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 < 1μW/g)
- •Dimension : Overall length: 330mm (Tip: 20mm) Tip diameter: 2.5mm (Body: 12mm) 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

- •Type : **ELI 4.0 oval flat phantom**
- •Shell Material : Fiberglass •Shell Thickness : Bottom plate: 2 ±0.2mm
- •Dimensions : Bottom elliptical: 600×400mm, Depth: 190mm (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 : POM •Manufacture : Schmid & Partner Engineering AG

Appendix 3-4: Simulated tissue composition and parameter confirmation

Liquid type used	☒used / Body, MSL 2450
M/N / Control No.	SL AAM 245 / KSLM245-01
Ingredient	**Mixture (%)**
Water	52-75 %
$C_8H_{18}O_3$ (DGBE, .Diethylene glycol monobutyl ether)	25-48%
NaCl	<1.0%
Manufacture	Schmid&Partner Engineering AG

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

Dielectric parameter measurement results (Body tissue)														
Date	Frequency [MHz] (Liquid)	Ambient	Temperature Liquid [deg.C.]		Liquid Depth [mm]	Parameters Relative permittivity: εr Conductivity: σ	Target value		Measured	ΔSAR (1g) [%] (*3)	Deviation for #1 (Std.)[%]	Limit [%]	Deviation for #2 (Cal.)[%]	Limit [%] (*2)
			Before	After			#1:Std. (*1)	#2:Cal. (*2)						
October 4, 2013	2450 (Body)	22.2deg.C. / 52%RH	22.2	22.2	(155)	εr [-]	**52.7**	**50.5**	50.70	(+1.41)	**-3.8**	±5	**+0.4**	±5
						σ [S/m]	**1.95**	**2.01**	1.972		**+1.2**	±5	**-1.9**	±5

*1. The target value is a parameter defined in Appendix A of KDB865664 D01 (v01r01).
*2. 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_Jan13, the data sheet was filed in this report.).
*3. The number of ΔSAR(1g) of body simulated tissue was reference purpose only. ΔSAR correction was only applied to head simulated tissue. The coefficients are parameters defined in Annex F, IEC 62209-2:2010.

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

Decision on Simulated Tissues of 2450MHz; In the KDB865664, the dielectric parameters suggested for head and body tissue simulating liquid are given at 2000, 2450 and 3000MHz. As an intermediate solution, dielectric parameters for the frequencies between 2000-2450 and 2450-3000 were obtained using linear interpolation.

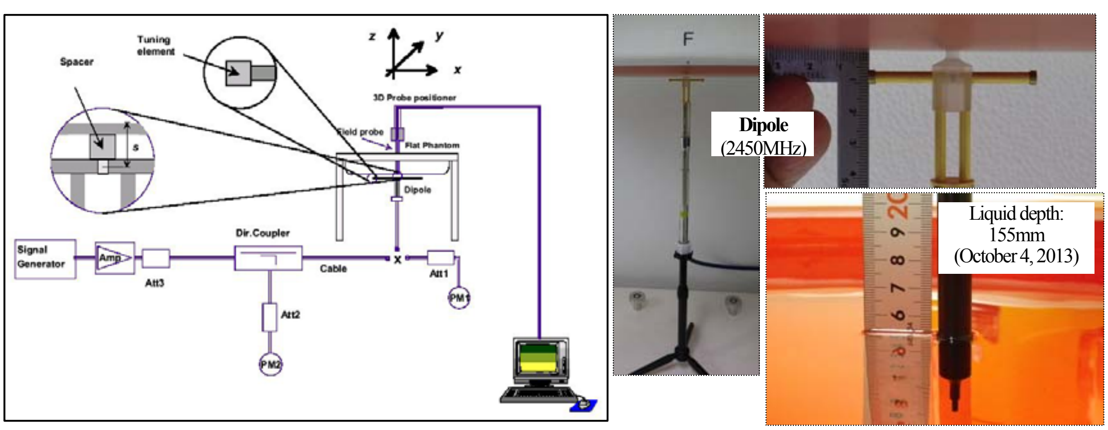
Standard					*Interpolated*				
f(MHz)	Head Tissue		Body Tissue		f(MHz)	Head Tissue		Body Tissue	
	εr	σ [S/m]	εr	σ [S/m]		εr	σ [S/m]	εr	σ [S/m]
(1800-)2000	**40.0**	**1.40**	**53.3**	**1.52**	*2412*	*39.27*	*1.766*	*52.75*	*1.914*
2450	**39.2**	**1.80**	**52.7**	**1.95**	*2437*	*39.22*	*1.788*	*52.72*	*1.938*
3000	**38.5**	**2.40**	**52.0**	**2.73**	*2452*	*39.20*	*1.802*	*52.70*	*1.953*
					2462	*39.18*	*1.813*	*52.68*	*1.967*

Appendix 3-5: Daily check results

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

Daily check results														
Date	Freq. [MHz]	Liquid Type	Ambient	Liquid Temp. [deg.C.]			Liquid Depth [mm]	Dielectric parameter		Power drift [dB]	Daily check target & measured			
											SAR 1g [W/kg]		Deviation [%]	Limit [%]
				Check	Before	After		εr [-]	σ [S/m]		Target	Measured		
October 4, 2013	2450	Body	23.3 deg.C ./49 %RH	22.2	22.8	22.7	155	50.70	1.972	0.01	**n/a** (*4)	**50.4** (1W scaled)	-	-
											12.8 (*5)	(12.6 (250mW)->ΔSAR-corrected: n/a)	**-1.6**	±10

*. n/a: not applicable, not applied.
*4. The target value (normalized to 1W) is defined in IEEE Std.1528.
*5. The target value (250mW input power) is a parameter defined in the calibration data sheet of D2450V2 (sn:822) dipole calibrated by Schmid & Partner Engineering AG (Certification No. D2450V2-822_Jan13, the data sheet was filed in this report.).
*. We performed the Daily check based on FCC requirement, "The 1g or 10g SAR values measured using the required tissue dielectric parameters should be within 10% of manufacturer calibrated dipole SAR values. However these manufacturer calibrated dipole target SAR values should be substantially similar to those defined in IEEE Std.1528." and FCC permits "SAR system verification with the actual liquid used for EUT's SAR measurement, should be the default operating procedures." We confirmed the this dipole manufacturer's validation data for head is within 5% against IEEE Std.1528 (manufacture's cal.: 52.5W/kg (+0.2%, vs. standard=52.4W/kg). so we can only use Body liquid validation data for our Daily check procedure



Test setup for the system performance check

Appendix 3-6: System check measurement data

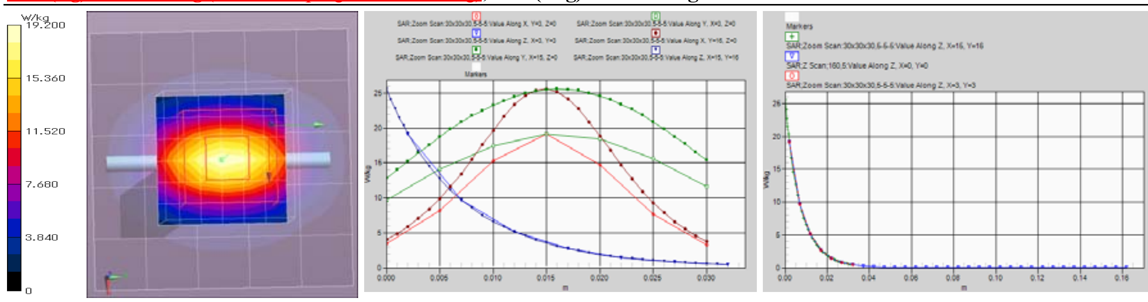
2450MHz System check (Body tissue) / Forward conducted power: 250mW

EUT: Dipole(2.45GHz); Type: D2450V2; Serial: 822
Communication System: CW; Frequency: 2450 MHz; Crest Factor: 1.0 (*. Frame Length in ms: 0; Communication System PAR: 0 dB; PMF: 1)
Medium: M2450; Medium parameters used: f = 2450 MHz; σ = 1.972 S/m; ε_r = 50.70; ρ = 1000 kg/m^3
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration: -Probe: EX3DV4 - SN3679; ConvF(6.82, 6.82, 6.82); Calibrated: 2013/07/22; -DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)
-Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 31.0, 161.0 -Electronics: DAE4 Sn626; Calibrated: 2013/09/17
-Phantom: ELI v4.0; Type: QDOVA001BA; Serial: 1059; Phantom section: Flat Section

Area Scan:60x60,12 (6x6x1): Measurement grid: dx=12mm, dy=12mm; Maximum value of SAR (measured) = 13.1 W/kg
Area Scan:60x60,12 (51x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm; Maximum value of SAR (interpolated) = 20.9 W/kg
Z Scan;160,5 (1x1x33): Measurement grid: dx=20mm, dy=20mm, dz=5mm; Maximum value of SAR (measured) = 19.2 W/kg
Fast SAR: SAR(1 g) (*. Polynomial fit)= 13.2 mW/g (+4.8%, vs. Z/S)**; SAR(10 g) = 5.87 mW/g** (-0.3%, vs. Z/S);

Zoom Scan:30x30x30,5-5-5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm;
Reference Value = 100.2 V/m; Power Drift = 0.01 dB, Maximum value of SAR (measured) = 19.2 W/kg
Peak SAR (extrapolated) = 25.568 mW/g (-1.7%, vs. std.-IEC62209-2=26.0 W/kg)
SAR(1 g) = 12.6 mW/g (-1.6%, vs. speag-cal.=12.8 W/kg)**; SAR(10 g) = 5.89 mW/g**



Remarks: *. Date tested: 2013/10/04, Tested by: Hiroshi Naka; Tested place:No.7 shielded room,
*.liquid depth: 155mm; Position: distance of dipole to phantom: 8mm (10mm to liquid); ambient: 22.3 deg.C. / 49 %RH,
*.liquid temperature: 22.8(start)/22.7(end)/22.2(in check) deg.C.; *.White cubic: zoom scan area, Red cubic: big=SAR(10g)/small=SAR(1g)

Appendix 3-7: Daily check uncertainty

Uncertainty of system daily check (~6GHz) (Body liquid, 2.4-6GHz, ε', σ: ≤5%, DAK3.5) (v07)	1g SAR	10g SAR
Combined measurement uncertainty of the measurement system (k=1)	± 12.7 %	± 12.4 %
Expanded uncertainty (k=2)	± 25.4 %	± 24.8 %

	Error Description (v07)	Uncertainty Value	Probability distribution	Divisor	ci (1g)	ci (10g)	ui (1g)	ui (10g)	Vi, veff
A	**Measurement System** (DASY5)						(std. uncertainty)	(std. uncertainty)	
1	Probe Calibration Error (2.45,5.2,5.3,5.5,5.6,5.8GHz±100MHz)	±6.55 %	Normal	1	1	1	±6.55 %	±6.55 %	∞
2	Axial isotropy	±4.7 %	Rectangular	√3	0.7	0.7	±1.9 %	±1.9 %	∞
3	Hemispherical isotropy (*flat phantom, <5°)	±9.6 %	Rectangular	√3	0.7	0.7	±3.9 %	±3.9 %	∞
4	Boundary effects	±4.8 %	Rectangular	√3	1	1	±2.8 %	±2.8 %	∞
5	Probe linearity	±4.7 %	Rectangular	√3	1	1	±2.7 %	±2.7 %	∞
6	Probe modulation response (CW)	±0.0 %	Rectangular	√3	1	1	±0.0 %	±0.0 %	∞
7	System detection limit	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
8	Response Time Error (<5ms/100ms wait)	±0.0 %	Rectangular	√3	1	1	±0.0 %	±0.0 %	∞
9	Integration Time Error (CW)	±0.0 %	Rectangular	√3	1	1	±0.0 %	±0.0 %	∞
10	System readout electronics (DAE)	±0.3 %	Normal	1	1	1	±0.3 %	±0.3 %	∞
11	RF ambient conditions-noise	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
12	RF ambient conditions-reflections	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
13	Probe positioner mechanical tolerance	±3.3 %	Rectangular	√3	1	1	±1.9 %	±1.9 %	∞
14	Probe positioning with respect to phantom shell	±6.7 %	Rectangular	√3	1	1	±3.9 %	±3.9 %	∞
15	Max.SAR evaluation	±4.0 %	Rectangular	√3	1	1	±2.3 %	±2.3 %	∞
B	**Test Sample Related**								
16	Deviation of the experimental source	±5.5 %	Normal	1	1	1	±5.5 %	±5.5 %	∞
17	Dipole to liquid distance (10mm±0.2mm,<2deg.)	±2.0 %	Rectangular	√3	1	1	±1.2 %	±1.2 %	∞
18	Drift of output power (measured, <0.2dB)	±2.5 %	Rectangular	√3	1	1	±1.4 %	±1.4 %	∞
C	**Phantom and Setup**								
19	Phantom uncertainty	±2.0 %	Rectangular	√3	1	1	±1.2 %	±1.2%	∞
20	Liquid conductivity (target) (≤5%)	±5.0 %	Rectangular	√3	0.64	0.43	±1.8 %	±1.2 %	∞
21	Liquid conductivity (meas.) (DAK3.5)	±3.1 %	Normal	1	0.64	0.43	±2.0 %	±1.3 %	∞
22	Liquid permittivity (target) (≤5%)	±5.0 %	Rectangular	√3	0.6	0.49	±1.7 %	±1.4 %	∞
23	Liquid permittivity (meas.) (DAK3.5)	±2.9%	Normal	1	0.6	0.49	±1.7 %	±1.4 %	∞
24	Liquid Conductivity-temp.uncertainty (≤2deg.C.)	±5.2 %	Rectangular	√3	0.78	0.71	±2.3 %	±2.1 %	∞
25	Liquid Permittivity-temp.uncertainty (≤2deg.C.)	±0.8 %	Rectangular	√3	0.23	0.26	±0.1 %	±0.1 %	∞
	Combined Standard Uncertainty						**±12.7 %**	**±12.4 %**	
	Expanded Uncertainty (k=2)						**±25.4 %**	**±24.8 %**	

*. This measurement uncertainty budget is suggested by IEEE 1528, IEC 62209-2 and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget).

Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4)

Calibration Laboratory of
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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: **SCS 108**

Client UL Japan (PTT)

Certificate No: **EX3-3679_Jul13**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3679
Calibration procedure(s)	QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	July 22, 2013

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 E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 23, 2013

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Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

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Accreditation No.: **SCS 108**

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

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.

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Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

Probe EX3DV4

SN:3679

Manufactured: September 9, 2008
Calibrated: July 22, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

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Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3679

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m)^2)[A]	0.58	0.54	0.53	± 10.1 %
DCP (mV)[B]	96.0	99.1	102.2	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√µV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	185.2	±2.7 %
		Y	0.0	0.0	1.0		163.9	
		Z	0.0	0.0	1.0		173.5	

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 NormX,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.

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Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3679

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	Depth (mm)	Unct. (k=2)
2450	39.2	1.80	6.81	6.81	6.81	0.57	0.67	± 12.0 %
5200	36.0	4.66	4.86	4.86	4.86	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.81	4.81	4.81	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.66	4.66	4.66	0.30	1.80	± 13.1 %
5600	35.5	5.07	4.40	4.40	4.40	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.49	4.49	4.49	0.35	1.80	± 13.1 %

[C] Frequency validity 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.
[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.

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Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3679

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	Depth (mm)	Unct. (k=2)
2450	52.7	1.95	6.82	6.82	6.82	0.72	0.62	± 12.0 %
5200	49.0	5.30	4.30	4.30	4.30	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.16	4.16	4.16	0.40	1.90	± 13.1 %
5500	48.6	5.65	3.83	3.83	3.83	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.84	3.84	3.84	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.14	4.14	4.14	0.45	1.90	± 13.1 %

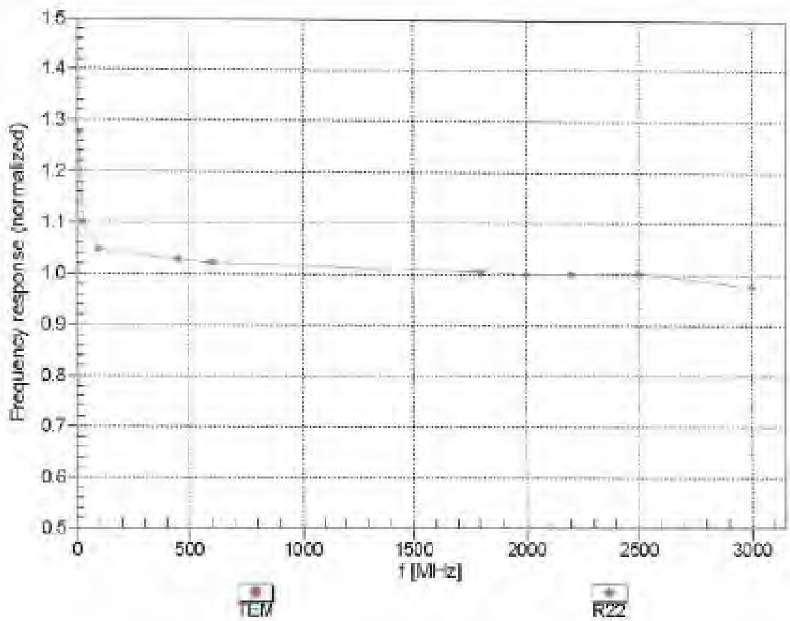
[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of 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.

Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3679 July 22, 2013

Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

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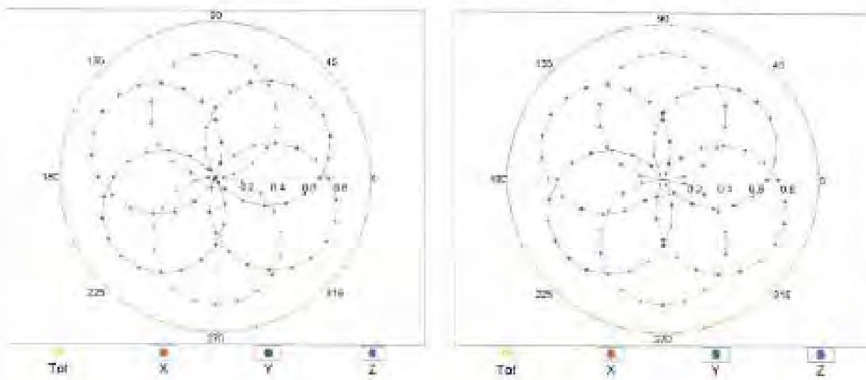
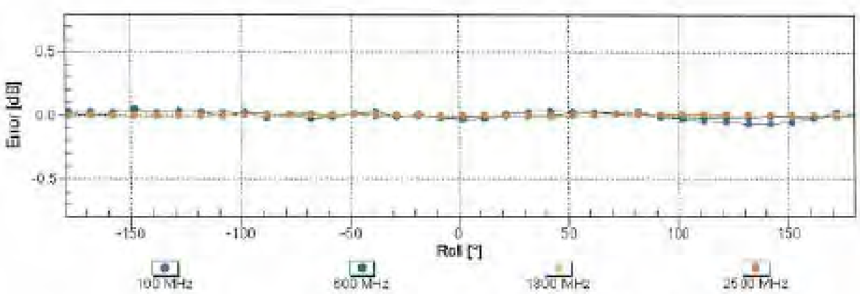
Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3679 July 22, 2013

Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM f=1800 MHz,R22





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

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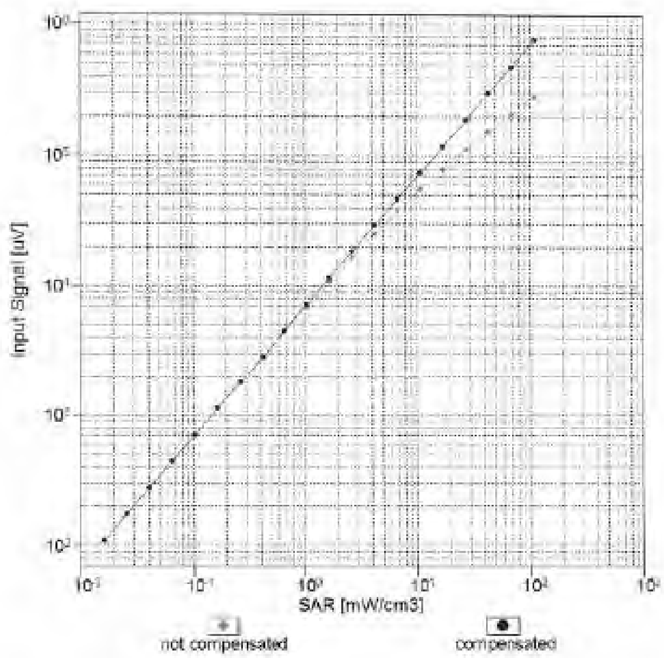
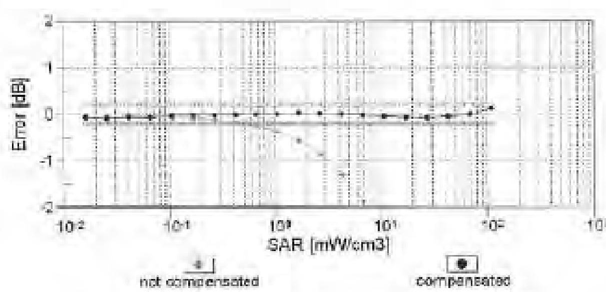
Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3679 July 22, 2013

Dynamic Range f(SAR$_{head}$)

(TEM cell , f = 900 MHz)





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

Certificate No: EX3-3679_Jul13 Page 9 of 11

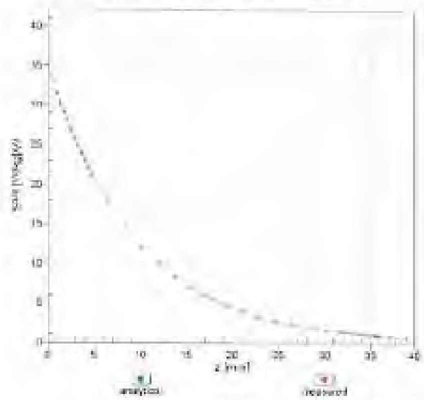
Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

EX3DV4– SN:3679

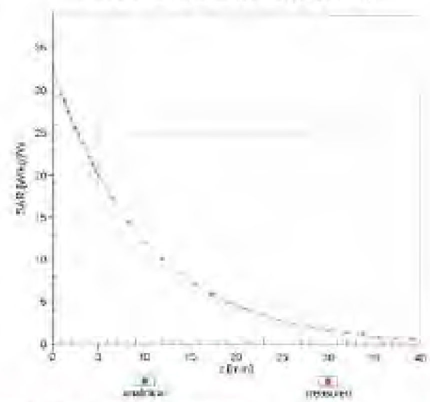
July 22, 2013

Conversion Factor Assessment

f = 2450 MHz,WGLS R22 (H_convF)

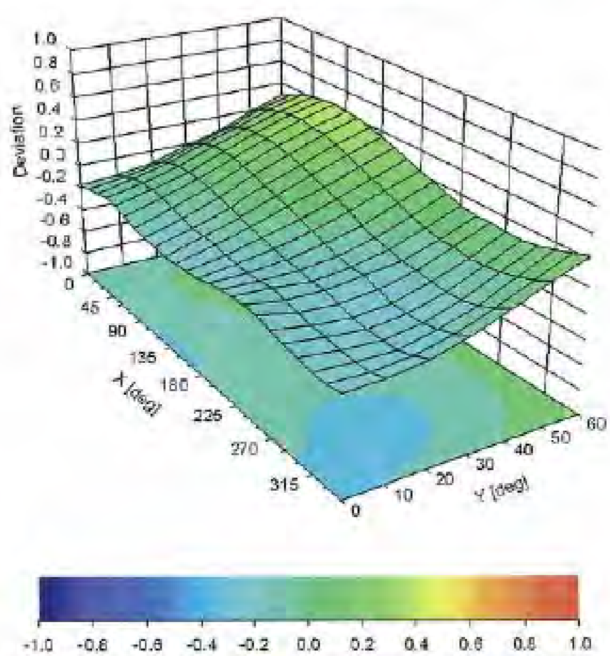


f = 2450 MHz,WGLS R22 (M_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

Certificate No: EX3-3679_Jul13 Page 10 of 11

Appendix 3-8: Calibration certificate: E-Field Probe (EX3DV4) (cont'd)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3679

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	11.8
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	2 mm

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Appendix 3-9: Calibration certificate: Dipole (D2450V2)

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Accreditation No.: SCS 108

Client UL Japan Shonan (PTT)

Certificate No: D2450V2-822_Jan13

CALIBRATION CERTIFICATE

Object: D2450V2 - SN: 822

Calibration procedure(s): QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: January 08, 2013

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 EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Katja Pokovic	Technical Manager	[signature]

Issued: January 8, 2013

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Certificate No: D2450V2-822_Jan13 Page 1 of 8

Appendix 3-9: Calibration certificate: Dipole (D2450V2) (cont'd)

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Accreditation No.: **SCS 108**

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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

d) 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%.

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Appendix 3-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Measurement Conditions

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

DASY Version	DASY5	V52.8.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.9 ± 6 %	1.85 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.5 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (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	50.5 ± 6 %	2.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.93 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.4 W/kg ± 16.5 % (k=2)**

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Appendix 3-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω + 3.5 jΩ
Return Loss	- 26.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.4 Ω + 5.2 jΩ
Return Loss	- 25.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 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
Manufactured on	December 11, 2008

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Appendix 3-9: Calibration certificate: Dipole (D2450V2) (cont'd)

DASY5 Validation Report for Head TSL

Date: 08.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

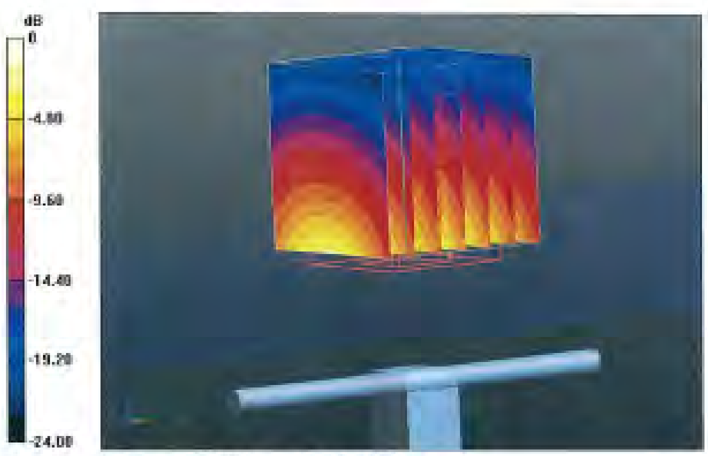
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 822

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.85 S/m; ε_r = 37.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

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 = 99.521 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 27.9 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.23 W/kg
Maximum value of SAR (measured) = 17.0 W/kg

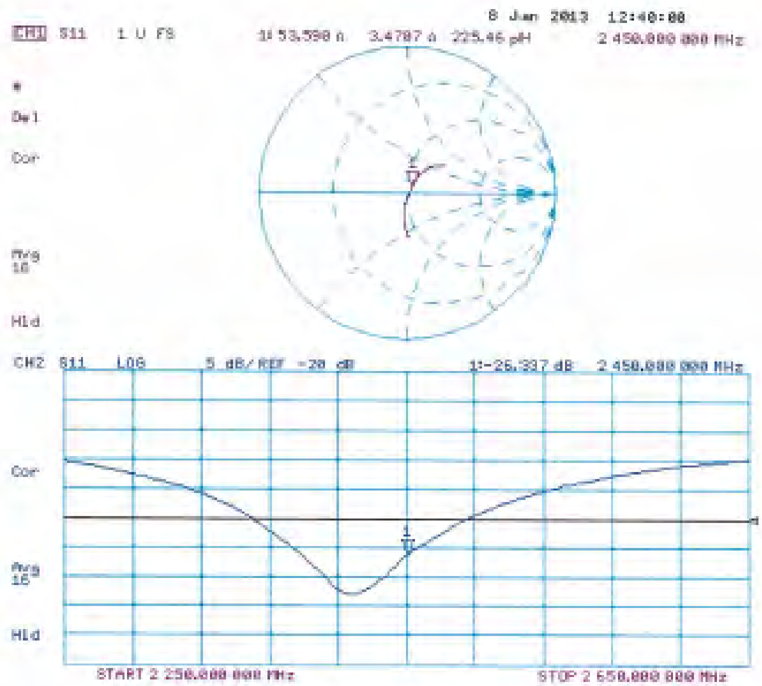


0 dB = 17.0 W/kg = 12.30 dBW/kg

Certificate No: D2450V2-822_Jan13 Page 5 of 8

Appendix 3-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-822_Jan13 Page 6 of 8

Appendix 3-9: Calibration certificate: Dipole (D2450V2) (cont'd)

DASY5 Validation Report for Body TSL

Date: 08.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

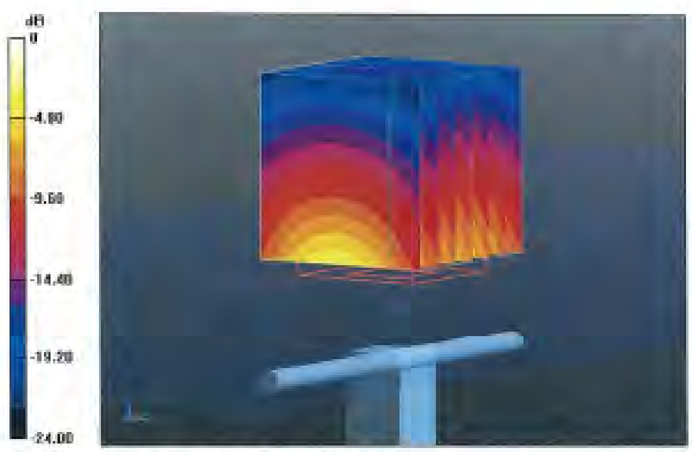
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 822

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.01 S/m; ε_r = 50.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.4(1052); SEMCAD X 14.6.8(7028)

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 = 93.977 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.0 W/kg
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.93 W/kg
Maximum value of SAR (measured) = 16.7 W/kg



0 dB = 16.7 W/kg = 12.23 dBW/kg

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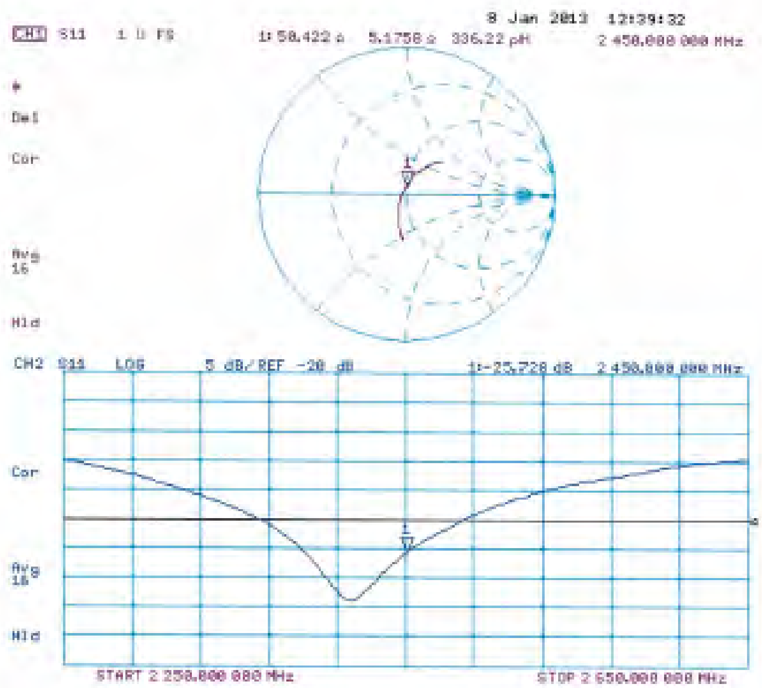
Appendix 3-9: Calibration certificate: Dipole (D2450V2) (cont'd)

Impedance Measurement Plot for Body TSL



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