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Foundation for Research on Information Technologies in Society

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Dosimetric Assessment of the

Kathrein In-Ground-Antenna (TN: 80010233 / SN: D714407561)

in accordance with the requirements of

IEC 62209-2 Ed.1

IEC 62209 Ed.1 Part 2 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures - Part 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)" Edition 1.0 2010-03

Zurich, January 2015

The names of IT'IS and any of the researchers involved may be mentioned only in connection with statements or results from this report. The mention of names to third parties other than certification bodies may be done so only after written approval from Prof. Dr. N. Kuster.

Executive Summary

The Kathrein In-Ground-Antenna prototype from Swisscom Ltd., was tested by the IT'IS Foundation for Research in Society (referred to as IT'IS throughout this report) in accordance with the requirements for compliance testing as defined in IEC 62209 Ed.1 Part 2 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures - Part 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)" Edition 1.0 2010-03 [1].

The study was performed by the IT'IS laboratory in Zurich. The dosimetric scanner employed was the DASY5 V52 NEO from Schmid & Partner Engineering AG, Zurich. All equipment was appropriately calibrated, and the procedures employed were in accordance with all requirements of the above-mentioned standard.

In summary, the maximum SAR values for the device are:

Phantom	f (GHz)	Separation (mm)	SAR avg. mass	SAR $\frac{(\mathrm{W/kg})}{2\cdot\mathrm{W}}^{**}$
ELI4 Flat Phantom	1.82	0	10 g	$0.81 \pm 21.0\%^{*}$
ELI4 Flat Phantom	1.82	5	10 g	$0.80 \pm 21.0\%^{*}$
ELI4 Flat Phantom	1.82	10	10 g	$0.77 \pm 21.0\%^{*}$
ELI4 Flat Phantom	2.655	0	10 g	$0.768 \pm 21.0\%^{*}$
ELI4 Flat Phantom	2.655	5	10 g	$0.659 \pm 21.0\%^{*}$
ELI4 Flat Phantom	2.655	10	10 g	$0.482 \pm 21.0\%^{*}$

* Worst-case uncertainty of the DASY5 system ($\kappa = 2$)

** Measurements are normalized to 1 W forward power into each of the two antenna ports, i.e., 2 W total input power.

These maximum SAR values were obtained while the device was fed with 1 W continuous wave (CW) input power into each antenna input port, i.e., 2 W total input power.

In conclusion, the tested Kathrein In-Ground-Antenna was found to be in compliance with the recommendations for exposure of the general public with respect to the basic restrictions for peak 10g spatial average SAR as defined by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)" [2], and the Directive of the European Commission "On the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)" [3] for 1 W input power into each antenna port. Note: that the statements made are only valid under the prerequisite that the power balance remains 1:1 between the antenna input ports. Other power balances require additional assessment.

Contents

1 Purpose of the Study

The purpose of this study was to evaluate whether the equipment under test (EUT), as defined in Section 5 and evaluated based on the measurement procedures defined in IEC 62209 Ed.1 Part 2 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures - Part 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)" Edition 1.0 2010-03 [1], is in compliance with the ICNIRP "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)" [2], and the Directive of the European Commission "On the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)" [3].

2 Applicable Standards

The EUT, a fixed antenna used in road installations designed to be operated in cellular networks in Europe, was tested at 1.82 GHz and 2.655 GHz.
The evaluations were based on the following standard:

- IEC 62209 Ed.1 Part 2 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures - Part 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)" Edition 1.0 2010-03 [1]

Dosimetric compliance was thereby tested with the recommendations for SAR exposure in the trunk for the general public according to:

- ICNIRP "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)"[2]
- Directive of the European Commission "On the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)" [3]

3 Requirements for Compliance

The EUT was tested for compliance with respect to localized 10 g averaged SAR in the trunk. Averaged SAR limits for general public exposure of [2, 3] have the following maximum permissible emissions:

SAR avg. mass	**SAR limit**
10 g	2.0 W/kg

4 Measurement System

The measurements were performed with the automated Dosimetric Assessment SYstem Version 52 (DASY52) NEO from Schmid & Partner Engineering AG (SPEAG). The detailed specifications are provided in Tables 1 and 2. The study in [4] revealed that the probe employed is currently the state-of-the-art probe for dosimetric evaluation. The measurement system is displayed in Figure 1.

System	Type:	DASY52 NEO
	Software Version:	52.8.8.1222
	Postprocessor Version:	X 14.6.10.7331
Data Acquisition System	Type:	DAE4
	Serial No:	355
	Calibrated On:	12/6/2015
	Manufacturer:	Schmid & Partner Engineering AG (CH)
Positioner	Robot:	TX90L
	Serial No:	F11/5H1ZA1/A/01
	Range:	1.45 m
	Repeatability:	0.04 mm
	Controller:	CS8C
	Serial No:	F11/5H1ZA1/C/01
	Manufacturer:	Stäubli (France)
Phantom	Type:	Oval Phantom ELI4
	Serial No:	1070
	Manufacturer:	Schmid & Partner Engineering AG (CH)

Table 1: Measurement system for SAR measurements

Probe	Type:	EX3DV3, EX3DV4
	Serial Number:	3515, 7355
	Manufacturer:	Schmid & Partner Engineering AG (CH)
	Calibrated On:	12/06/2015, 28/10/2015
	Tip Diameter:	2.5 mm
	Frequency Range:	10 MHz to 6 GHz
	Dynamic Range:	5 μW/g to > 100 mW/g
	Dev. Axial Isotropy:	$\pm$ 0.10
	Dev. Spherical Isotropy:	$\pm$ 0.40
	Calibration Uncertainty:	$\pm$ 5.5% ($\kappa = 1$)

Table 2: Probe

Figure 1: DASY52 NEO dosimetric assessment system with SAM and elliptical flat phantoms for SAR assessments according to [1].

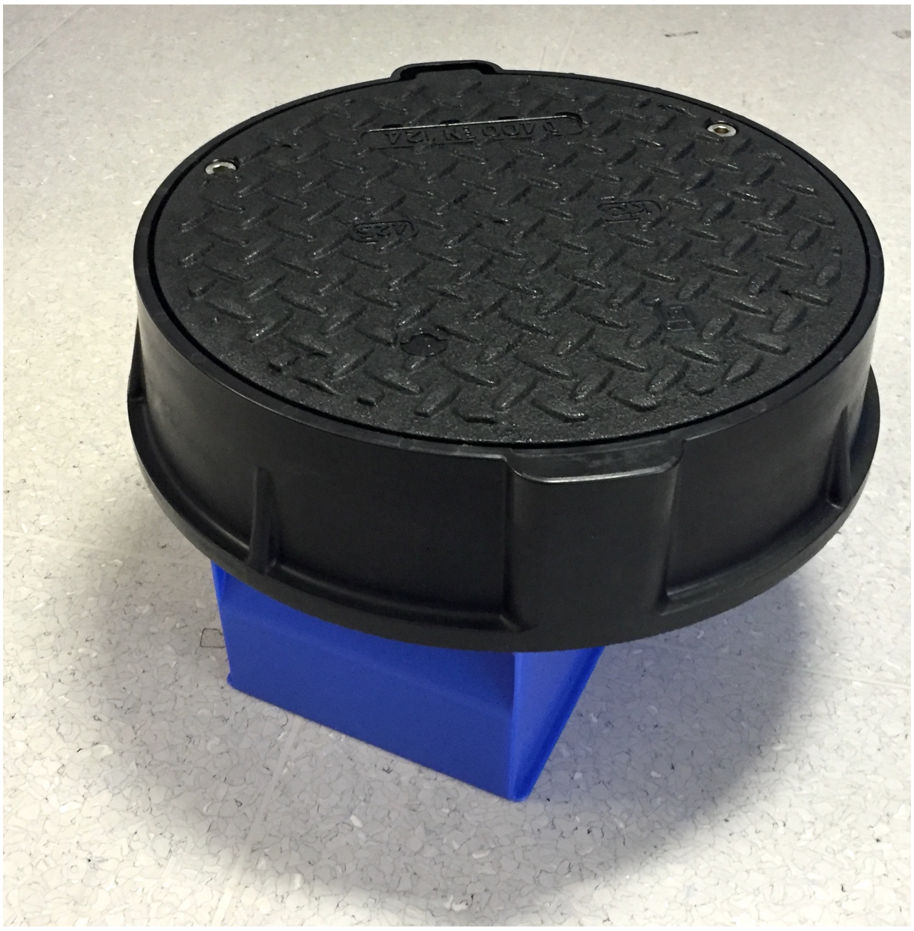
5 Equipment Under Test (EUT)

The EUT was the Kathrein In-Ground-Antenna (Figure 2) as described in Table 3, which was provided by Swisscom Ltd.. The device was evaluated as a black box, i.e., no further verification regarding appropriate function of the device was conducted by IT'IS.

Model Type:	Kathrein In-Ground-Antenna
Serial No.:	TN: 80010233 / SN: D714407561
Manufacturer:	Kathrein KG
Test Frequency	1.82 GHz & 2.655 GHz
Test Power	100 mW & 1000 mW

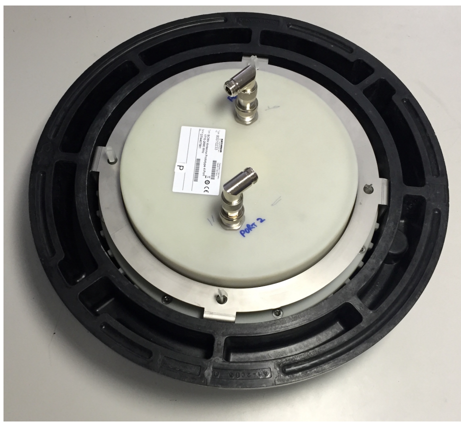
Table 3: Equipment under test (EUT)

The device was fed by means of a dual power meter setup with a directional coupler to ensure that the EUT input power was kept stable. The setup is shown in Figure 3. The power meter P1, including a 20 dB attenuator, measured the forward power at the point where the EUT should be connected (port 1 or port 2). The port that was not fed was terminated with a 50 Ω load (Fig. 4). The signal generator was adjusted for the desired forward power at EUT connector and the power meter P2 was read at that level. After disconnecting the P1 power meter and connecting the cable to the EUT, the signal generator was readjusted for the same reading at power meter P2, if needed. In this way, constant input power to the EUT was assured.



(a) Perspective view

(b) Top view



(c) Bottom view

Figure 2: Equipment under test (EUT)

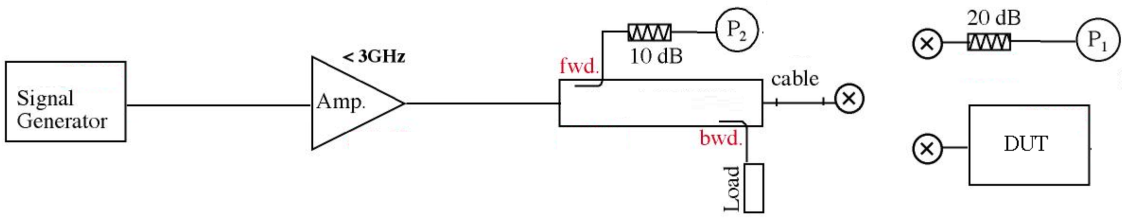


Figure 3: Test setup used for feeding the antenna

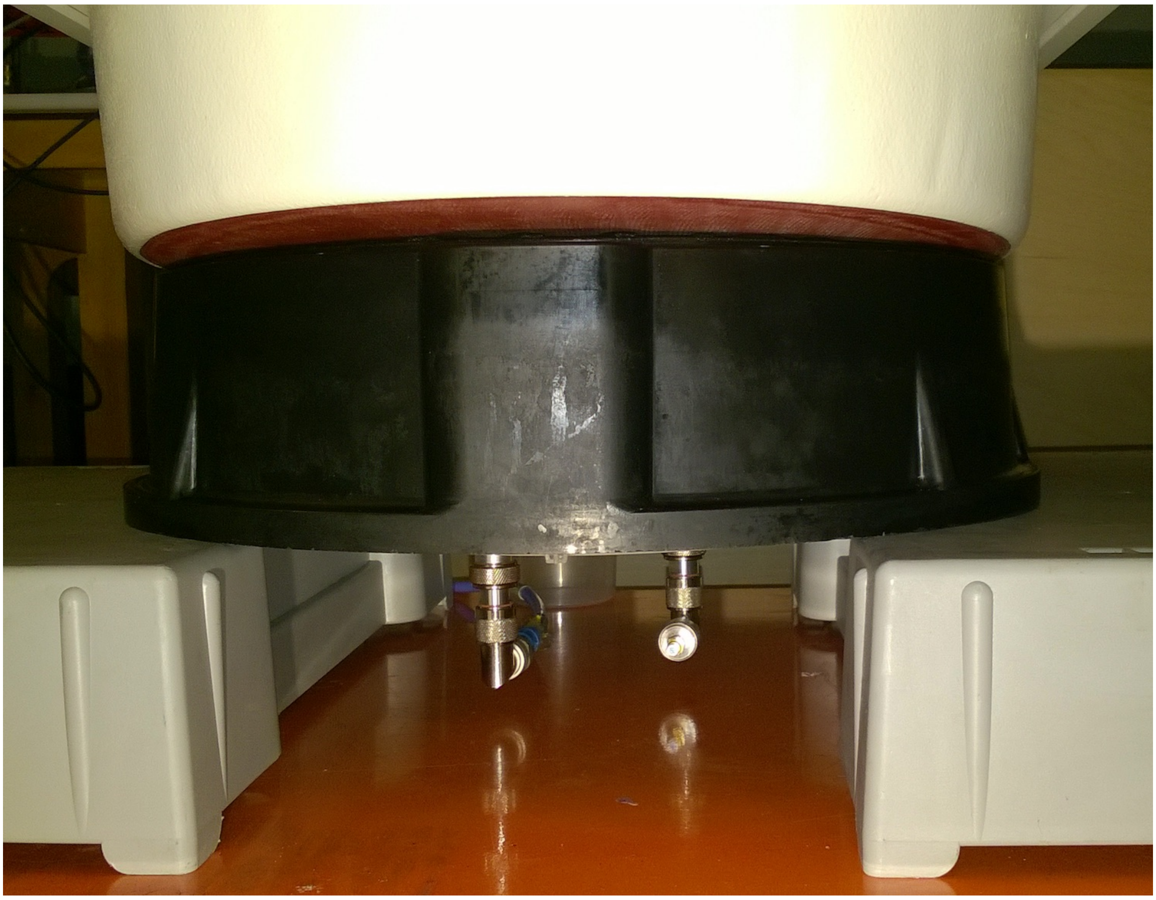


Figure 4: SAR test setup with port 1 connected to the feed cable and port 2 terminated.

6 Measurement Procedure

The measurement procedure employed for the SAR measurement was according to the protocol described in clause 6.3.2.5 of [1].

- **Step 1:** A volume encompassing all peak spatial SAR maxima for each individual feed port was determined.
- **Step 2:** For each antenna port fed individually the volumetric SAR was assessed following the requirements of clause 6.3. of [1].
- **Step 3:** The field distributions obtained in Step 2 were summed spatially according to [1].
- **Step 4:** For determining the cube with the highest average SAR, the following algorithm was used:
  - extraction of the measured data from the combined (step 3) volume scan (grid and values)
  - calculation of the SAR at each measured point
  - generation of a high-resolution mesh within the measured volume
  - interpolation of the measured values from the measured grid to the high-resolution grid with a combination of a least-square fitted function method and a weighted average method
  - extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
  - calculation of the averaged SAR over the masses of 1 g and 10 g

7 Test Conditions

7.1 Ambient Environment

The noise level was periodically verified by conducting measurements without the EUT. The recorded ambient parameters are displayed in Table 4.

Temperature (evaluation):	22 ± 2°C
Temperature (liquid measurement):	22 ± 2°C
Humidity:	20 − 50%
SAR Noise:	$< 1\,\mu$W/g

Table 4: Environmental parameters

7.2 Tissue Simulating Liquid

For measurements at the frequency of 1.82 GHz and 2.655 GHz, the tissue simulating liquid "HBBL600-6000V6" according to IEC 62209-2 Ed.1 was chosen. The parameters of the actual liquid were determined with the SPEAG Dielectric Assessment Kit (DAK3.5) (an open-ended coaxial probe) prior to the dosimetric evaluation. The results are compared with those of the tissue parameters of IEC 62209-2 [1] in Table 5.

	f	IEC 62209-2		Measured		Deviation from target	
	MHz	$\varepsilon_r^{'}$	σ	$\varepsilon_r^{'}$	σ	$\varepsilon_r^{'}$	σ
HBBL600-6000V6	1820	40.0	1.4	$42.0 \pm 2.5\%$	$1.41 \pm 2.5\%$	5.0%	0.7%
HBBL600-6000V6	2655	39.0	2.02	$42.3 \pm 2.5\%$	$2.00 \pm 2.5\%$	8.5%	1.0%

Table 5: Measured dielectric parameters of the tissue simulating liquid compared to human brain tissue. The uncertainty of the measurement of $|\varepsilon_r|$ was estimated to be $\pm 2.5\%$. A worst-case density of $1000\,\mathrm{kg/m^3}$ was used for the evaluation.

8 Measurement Uncertainty

The uncertainty budget (Table 6) was determined for the DASY5 measurement system according to clause 7 of IEC 62209-2 Part 2 IEC 62209-2 Ed.1. The expanded uncertainty ($\kappa = 2$) for 10 g averaged SAR was assessed to be $\pm 21.0\%$.

DASY5 Uncertainty Budget According to IEC 62209-2 Ed.1 [1]								
Error Description	Uncertainty Value	Prob. Dist.	Div.	(c_i) 1 g	(c_i) 10 g	Std. Unc. (1 g)	Std. Unc. (10 g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	± 5.5%	N	1	1	1	± 5.5%	± 5.5%	∞
Axial Isotropy	± 4.7%	R	$\sqrt{3}$	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical Isotropy	± 9.6%	R	$\sqrt{3}$	0.7	0.7	± 3.9%	± 3.9%	∞
Boundary Effects	± 1.0%	R	$\sqrt{3}$	1	1	± 0.6%	± 0.6%	∞
Linearity	± 4.7%	R	$\sqrt{3}$	1	1	± 2.7%	± 2.7%	∞
System Detection Limits	± 1.0%	R	$\sqrt{3}$	1	1	± 0.6%	± 0.6%	∞
Readout Electronics	± 0.3%	N	1	1	1	± 0.3%	± 0.3%	∞
Response Time	± 0.8%	R	$\sqrt{3}$	1	1	± 0.5%	± 0.5%	∞
Integration Time	± 2.6%	R	$\sqrt{3}$	1	1	± 1.5%	± 1.5%	∞
RF Ambient Conditions	± 3.0%	R	$\sqrt{3}$	1	1	± 1.7%	± 1.7%	∞
RF Ambient Reflections	± 3.0%	R	$\sqrt{3}$	1	1	± 1.7%	± 1.7%	∞
Probe Positioner Mech. Restr.	± 0.4%	R	$\sqrt{3}$	1	1	± 0.2%	± 0.2%	∞
Probe Positioning	± 2.9%	R	$\sqrt{3}$	1	1	± 1.7%	± 1.7%	∞
Post-Processing	± 1.0%	R	$\sqrt{3}$	1	1	± 0.6%	± 0.6%	∞
Max. SAR Eval.	± 1%	R	$\sqrt{3}$	1	1	± 0.6%	± 0.6%	∞
Test Sample Related								
Test Sample Positioning	± 2.9%	N	1	1	1	± 2.9%	± 2.9%	145
Device Holder Uncertainty	± 3.6%	N	1	1	1	± 3.6%	± 3.6%	5
Drift of Output Power	± 5.0%	R	$\sqrt{3}$	1	1	± 2.9%	± 2.9%	∞
Phantom and Setup								
Phantom Uncertainty	± 4.0%	R	$\sqrt{3}$	1	1	± 2.3%	± 2.3%	∞
Liquid Conductivity (target)	± 5.0%	R	$\sqrt{3}$	0.78	0.71	± 2.3%	± 2.0%	∞
Liquid Conductivity (meas.)	± 2.5%	N	1	0.78	0.71	± 2.0%	± 1.8%	∞
Liquid Permittivity (target)	± 5.0%	R	$\sqrt{3}$	0.23	0.26	± 0.7%	± 0.8%	∞
Liquid Permittivity (meas.)	± 2.5%	N	1	0.23	0.26	± 0.6%	± 0.7%	∞
Temp. unc.-Conductivity	± 1.7%	R	$\sqrt{3}$	0.78	0.71	± 0.8%	± 0.7%	∞
Temp. unc.-Permitivity	± 0.3%	R	$\sqrt{3}$	0.23	0.26	± 0.0%	± 0.0%	∞
Combined Std. Uncertainty						± 10.6%	± 10.5%	387
Expanded Uncertainty ($\kappa = 2$)						**± 21.2%**	**± 21.0%**	

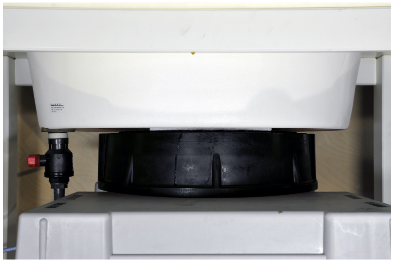
Table 6: Worst-case uncertainty budget for DASY5 NEO assessed according to IEC 62209-2 Part 2 [1]. The budget is valid for the frequency range 300 MHz – 3 GHz and represents a worst-case analysis. Due to the use of a CW signal, the modulation response error is not included in this uncertainty budget.

9 Test Results

9.1 Device and Test Conditions

The device was fed as described in Section 5 of this report. SAR measurements were conducted according to clause 6.3.2.5 of IEC 62209-2 [1], with the top of the EUT positioned parallel to the phantom shell. Four different separation distances, 0, 5, and 10 mm were tested. Low loss, low dielectric constant Rohacell spacers were used to ensure the accuracy of the EUT separation (Fig. 5).

(a) Test setup without spacer



(b) Test setup with 5 mm spacer

(c) Test setup with 10 mm spacer

Figure 5: SAR test setups

9.2 Spatial Peak SAR

The results of the SAR measurements for the Kathrein In-Ground-Antenna are summarized in Table 7. Plots of the SAR distributions, which reveal information about the location of the maximum SAR, are included in Appendix A.

Phantom	f (GHz)	Separation (mm)	SAR avg. mass	SAR $\frac{(\mathrm{W/kg})}{2\cdot\mathrm{W}}$**
ELI4 Flat Phantom	1.82	0	10 g	0.81 ± 21.0%*
ELI4 Flat Phantom	1.82	5	10 g	0.80 ± 21.0%*
ELI4 Flat Phantom	1.82	10	10 g	0.77 ± 21.0%*
ELI4 Flat Phantom	2.655	0	10 g	0.768 ± 21.0%*
ELI4 Flat Phantom	2.655	5	10 g	0.659 ± 21.0%*
ELI4 Flat Phantom	2.655	10	10 g	0.482 ± 21.0%*

* Worst-case uncertainty of the DASY5 system ($\kappa = 2$)

** Measurements are normalized to 1 W antenna forward power into each of the two antenna ports, i.e., 2 W total input power.

Table 7: SAR test results.

10 Conclusion

The tested Kathrein In-Ground-Antenna was found to be in compliance with the recommendations for exposure of the general public with respect to the basic restrictions for peak spatial average SAR of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)" [2], and the Directive of the European Commission "On the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)" [3] for 1 W input power fed into each antenna port, i.e., 2 W total power. Note: that the statements made are only valid under the prerequisite that the power balance remains 1:1 between the antenna input ports. Other power balances require additional assessment. In summary, the maximum SAR values for the device are:

Phantom	f (GHz)	Separation (mm)	SAR avg. mass	SAR $\frac{(\mathrm{W/kg})}{2\cdot\mathrm{W}}^{**}$
ELI4 Flat Phantom	1.82	0	10 g	$0.81 \pm 21.0\%^*$
ELI4 Flat Phantom	1.82	5	10 g	$0.80 \pm 21.0\%^*$
ELI4 Flat Phantom	1.82	10	10 g	$0.77 \pm 21.0\%^*$
ELI4 Flat Phantom	2.655	0	10 g	$0.768 \pm 21.0\%^*$
ELI4 Flat Phantom	2.655	5	10 g	$0.659 \pm 21.0\%^*$
ELI4 Flat Phantom	2.655	10	10 g	$0.482 \pm 21.0\%^*$

* Worst-case uncertainty of the DASY5 system ($\kappa = 2$)

** Measurements are normalized to 1 W forward power into each of the two antenna ports, i.e., 2 W total input power.

Sven Kühn, December 2015

References

[1] International Electrotechnical Commission (IEC). *IEC 62209-2 Ed.1 Part 2, Human exposure to radio frequency fields from handheld and body-mounted wireless communication devices - Human models, instrumentation and procedures, Part 2: Procedure to determine the specific absorption aate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz).* April 2010.

[2] International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Physics*, 74(4):494–522, April 1998.

[3] European Commission (EC). EC1999/519/ec/1999, on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz). Technical report, European Commission, 1999.

[4] Katja Poković. “Advanced Electromagnetic Probes for Near-Field Evaluations". PhD thesis, Diss. ETH Nr. 13334, ETH, Zurich, 1999.

A SAR Distribution

Plots of the measured SAR distributions inside the phantom for all tested configurations are given in this Appendix. The SAR values were assessed with the procedure described in the report.

A.1 SAR Distribution 1820 MHz - Separation 0 mm

Multi-Band Average SAR1820Mhz 0mm

Multi-Band Configurations:

DASY Configuration for E-field touch 1820MHz port 1/Swisscom_touch_0mm_20dBm /Volume Scan:

Date/Time: 18.11.2015 14:02:25
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_27112015.da53:0
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 1820 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used: f = 1820 MHz; σ = 1.41 mho/m; ε_r = 42; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

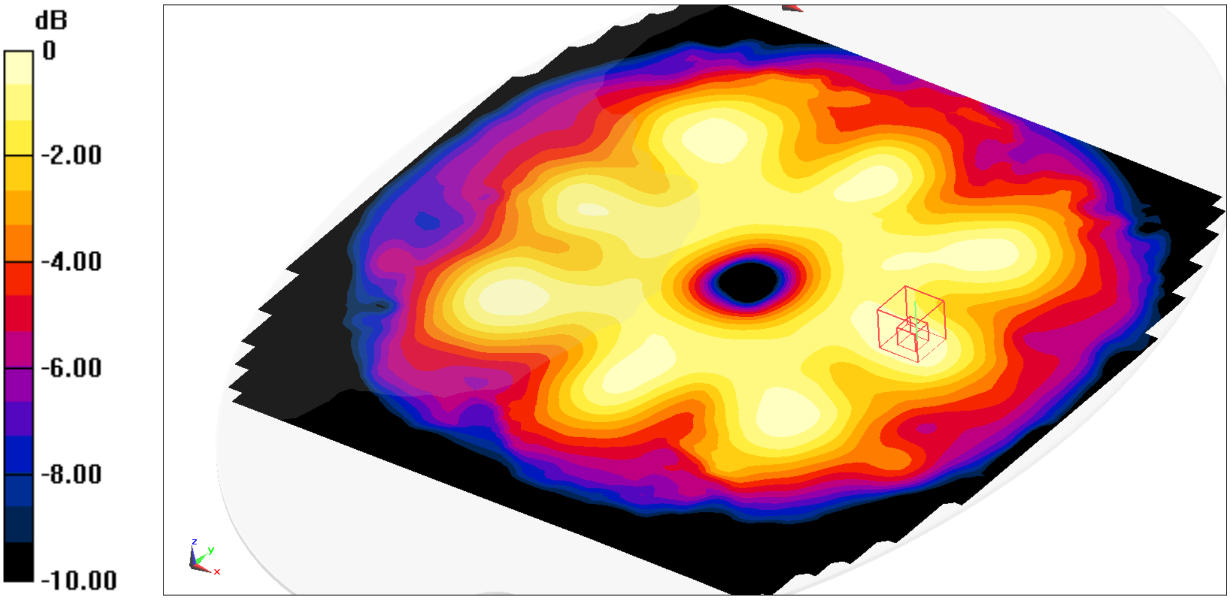
- Probe: EX3DV3 - SN3515; ConvF(9.27, 9.27, 9.27); Calibrated: 26.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

DASY Configuration for E-field touch 1820MHz port 2/Swisscom_touch_0mm_20dBm /Volume Scan:

Date/Time: 17.11.2015 16:13:26
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_27112015.da53:4
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 1820 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used: f = 1820 MHz; σ = 1.41 mho/m; ε_r = 42; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

- Probe: EX3DV3 - SN3515; ConvF(9.27, 9.27, 9.27); Calibrated: 26.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

Multi Band Result:
SAR(1 g) = 0.124 mW/g; SAR(10 g) = 0.081 mW/g (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 0.185 mW/g



0 dB = 0.180mW/g = -7.45 dB mW/g

A.2 SAR Distribution 1820 MHz - Separation 5 mm

Multi-Band Average SAR1820MHz 5mm

Multi-Band Configurations:

DASY Configuration for E-field touch 1820MHz port 1/Swisscom_5mm_20dBm/Volume Scan:

Date/Time: 19.11.2015 21:00:04
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_27112015.da53:0
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 1820 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used: f = 1820 MHz; σ = 1.41 mho/m; ε_r = 42; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

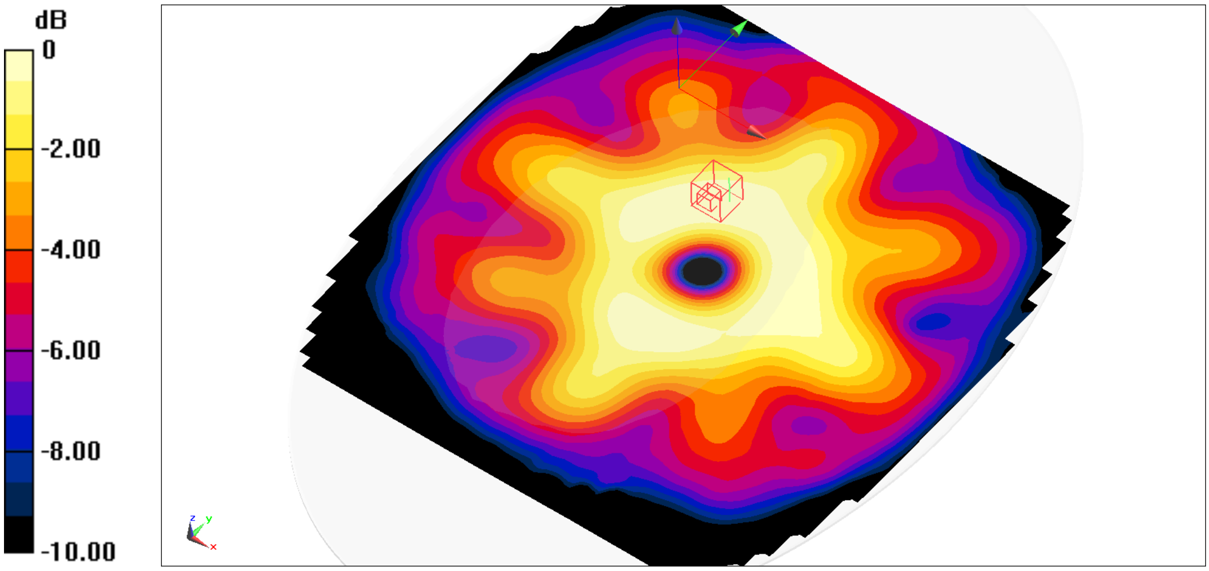
- Probe: EX3DV3 - SN3515; ConvF(9.27, 9.27, 9.27); Calibrated: 26.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

DASY Configuration for E-field touch 1820MHz port 2/Swisscom_5mm_20dBm/Volume Scan:

Date/Time: 19.11.2015 11:26:17
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_27112015.da53:4
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 1820 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used: f = 1820 MHz; σ = 1.41 mho/m; ε_r = 42; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

- Probe: EX3DV3 - SN3515; ConvF(9.27, 9.27, 9.27); Calibrated: 26.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

Multi Band Result:
SAR(1 g) = 0.119 mW/g; SAR(10 g) = 0.080 mW/g (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 0.174 mW/g



0 dB = 0.170mW/g = -7.70 dB mW/g

A.3 SAR Distribution 1820 MHz - Separation 10 mm

Multi-Band Average SAR 1820MHz 10mm

Multi-Band Configurations:

DASY Configuration for E-field touch 1820MHz port 1/Swisscom_10mm_20dBm/Volume Scan:

Date/Time: 26.11.2015 10:18:36
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_27112015.da53:0
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 1820 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used: f = 1820 MHz; σ = 1.41 mho/m; ε_r = 42; ϱ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

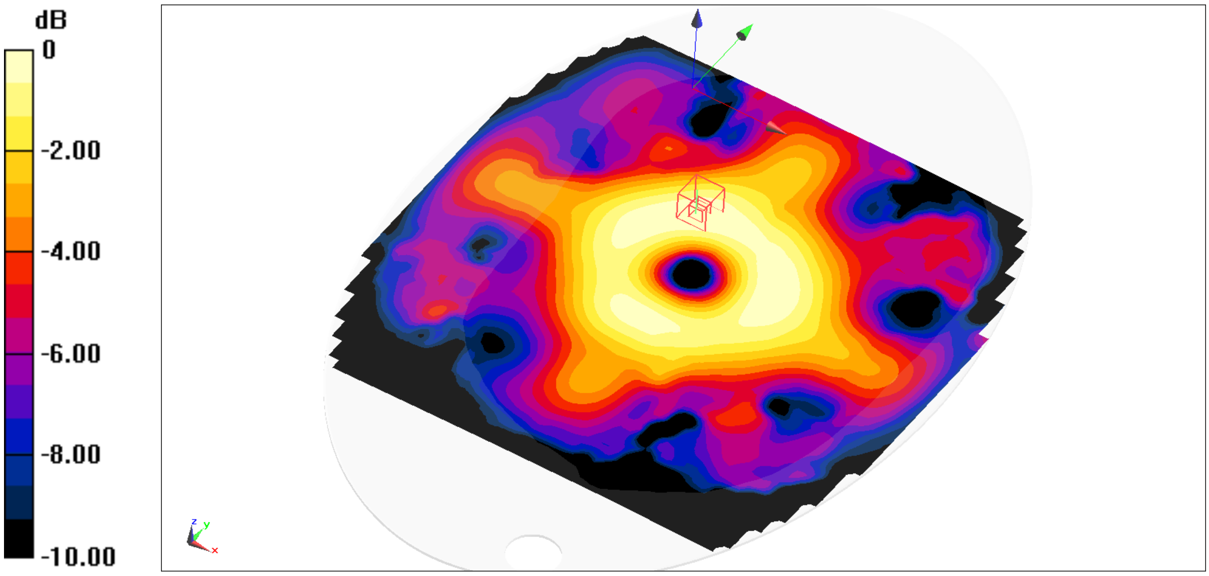
- Probe: EX3DV3 - SN3515; ConvF(9.27, 9.27, 9.27); Calibrated: 26.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

DASY Configuration for E-field touch 1820MHz port 2/Swisscom_10mm_20dBm/Volume Scan:

Date/Time: 24.11.2015 10:13:44
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_27112015.da53:4
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 1820 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used: f = 1820 MHz; σ = 1.41 mho/m; ε_r = 42; ϱ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

- Probe: EX3DV3 - SN3515; ConvF(9.27, 9.27, 9.27); Calibrated: 26.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

Multi Band Result:
SAR(1 g) = 0.115 mW/g; SAR(10 g) = 0.077 mW/g (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 0.169 mW/g



0 dB = 0.170mW/g = -7.70 dB mW/g

A.4 SAR Distribution 2655 MHz - Separation 0 mm

Multi-Band Average SAR 2655MHz 0mm

Multi-Band Configurations:

DASY Configuration for E-field touch 2655MHz port 2/Swisscom_touch_0mm_30dBm /Volume Scan:

Date/Time: 11.12.2015 09:33:09
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_13122015_2655MHz.da53:0
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 2655 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used (interpolated): f = 2655 MHz; σ = 2.001 mho/m; ε_r = 42.268; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

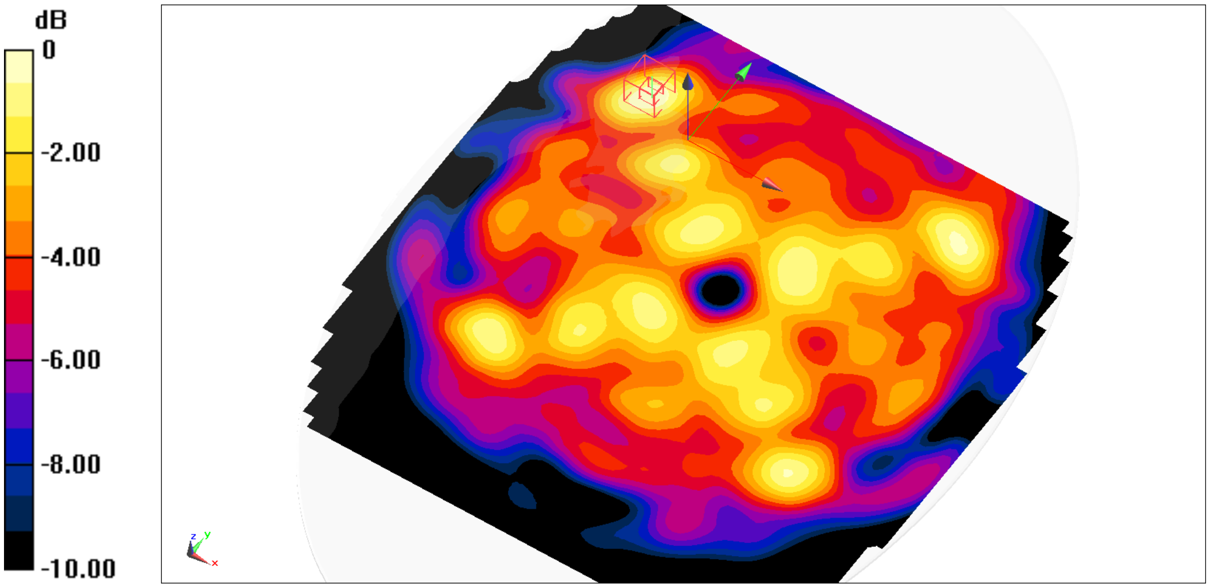
- Probe: EX3DV4 - SN7355; ConvF(7.38, 7.38, 7.38); Calibrated: 28.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

DASY Configuration for E-field touch 2655MHz port 1/Swisscom_touch_0mm_30dBm /Volume Scan:

Date/Time: 13.12.2015 08:37:05
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_13122015_2655MHz.da53:1
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 2655 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used (interpolated): f = 2655 MHz; σ = 2.001 mho/m; ε_r = 42.268; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

- Probe: EX3DV4 - SN7355; ConvF(7.38, 7.38, 7.38); Calibrated: 28.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

Multi Band Result:
SAR(1 g) = 1.38 mW/g; SAR(10 g) = 0.768 mW/g (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 2.341 mW/g



0 dB = 2.340mW/g = 3.69 dB mW/g

A.5 SAR Distribution 2655 MHz - Separation 5 mm

Multi-Band Average SAR 2655MHz 5mm

Multi-Band Configurations:

DASY Configuration for E-field touch 2655MHz port 2/Swisscom_5mm_30dBm/Volume Scan:

Date/Time: 11.12.2015 16:55:16
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_13122015_2655MHz.da53:0
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 2655 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used (interpolated): f = 2655 MHz; σ = 2.001 mho/m; ε_r = 42.268; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

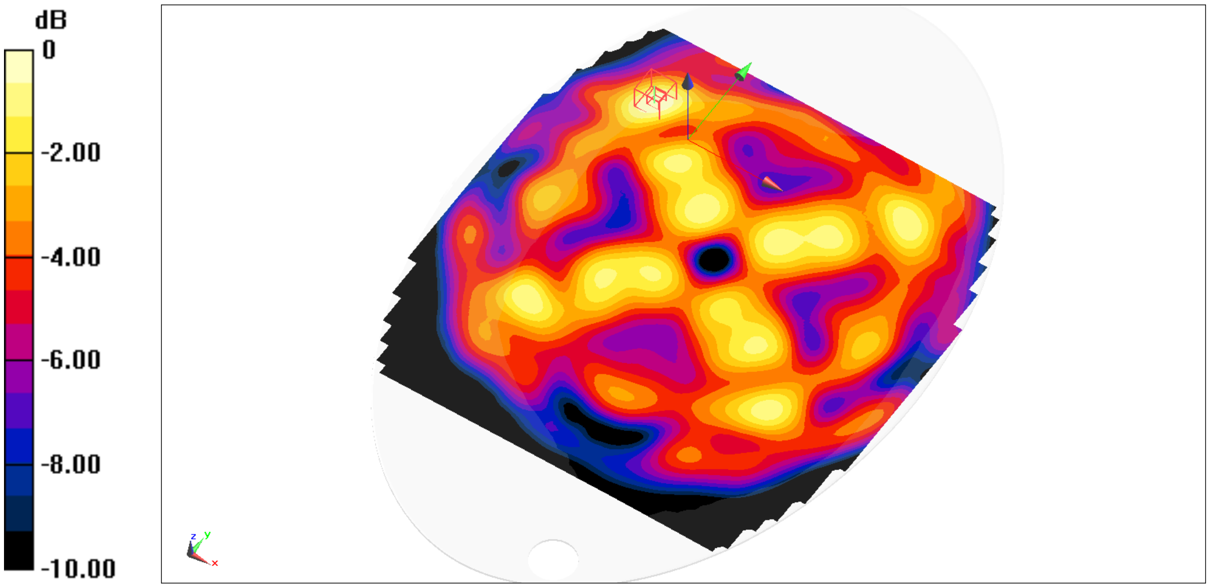
- Probe: EX3DV4 - SN7355; ConvF(7.38, 7.38, 7.38); Calibrated: 28.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

DASY Configuration for E-field touch 2655MHz port 1/Swisscom_5mm_30dBm/Volume Scan:

Date/Time: 12.12.2015 10:45:01
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_13122015_2655MHz.da53:1
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 2655 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used (interpolated): f = 2655 MHz; σ = 2.001 mho/m; ε_r = 42.268; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

- Probe: EX3DV4 - SN7355; ConvF(7.38, 7.38, 7.38); Calibrated: 28.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

Multi Band Result:
SAR(1 g) = 1.18 mW/g; SAR(10 g) = 0.659 mW/g (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 2.032 mW/g



0 dB = 2.030mW/g = 3.07 dB mW/g

A.6 SAR Distribution 2655 MHz - Separation 10 mm

Multi-Band Average SAR 2655MHz 10mm

Multi-Band Configurations:

DASY Configuration for E-field touch 2655MHz port 2/Swisscom_10mm_30dBm/Volume Scan:

Date/Time: 10.12.2015 17:33:24
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_13122015_2655MHz.da53:0
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 2655 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used (interpolated): f = 2655 MHz; $\sigma = 2.001$ mho/m; $\varepsilon_r = 42.268$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

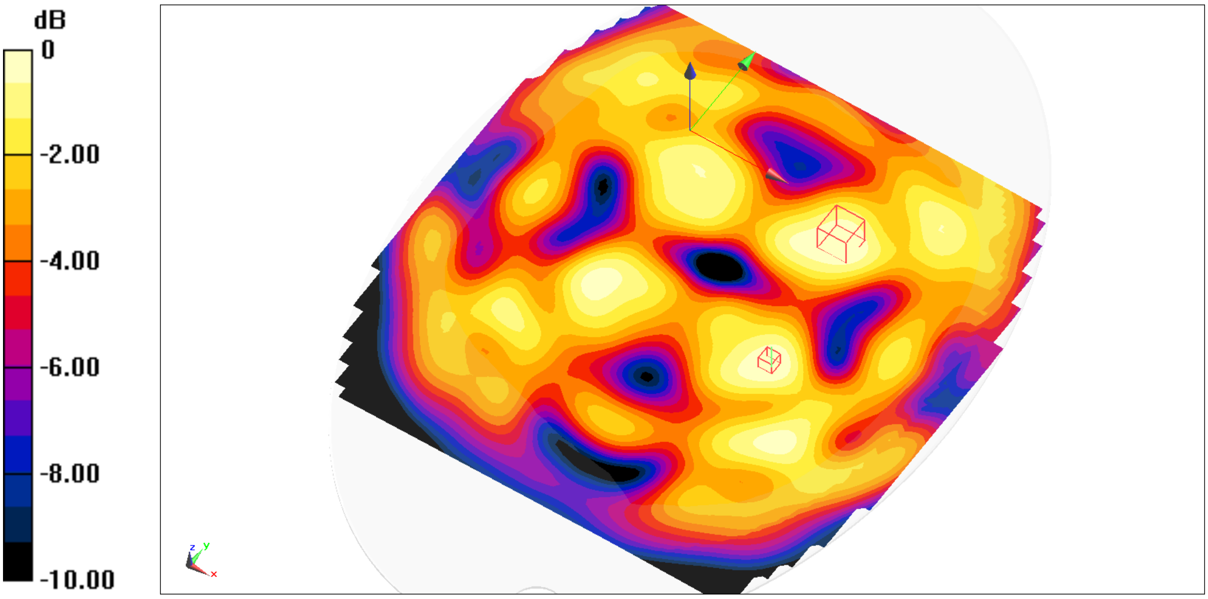
- Probe: EX3DV4 - SN7355; ConvF(7.38, 7.38, 7.38); Calibrated: 28.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

DASY Configuration for E-field touch 2655MHz port 1/Swisscom_10mm_30dBm/Volume Scan:

Date/Time: 07.12.2015 22:49:32
Test Laboratory: IT'IS Foundation for Research on Information Technologies in Society
File Name: Swisscom_measurements_13122015_2655MHz.da53:1
DUT: Kathrein In-Ground-Antenna; Type: 80010233; Serial: D714407561
Communication System: CW (0); Frequency: 2655 MHz; Duty Cycle: 1:1; PMF: 1
Medium: HBBL600-6000V6 Medium parameters used (interpolated): f = 2655 MHz; $\sigma = 2.001$ mho/m; $\varepsilon_r = 42.268$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

- Probe: EX3DV4 - SN7355; ConvF(7.38, 7.38, 7.38); Calibrated: 28.10.2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn355; Calibrated: 12.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP: 1070
- Measurement SW: DASY52, Version 52.8 (8)

Multi Band Result:
SAR(1 g) = 0.820 mW/g; SAR(10 g) = 0.482 mW/g (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 1.382 mW/g



0 dB = 1.380mW/g = 1.40 dB mW/g