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## Report

# Dosimetric Assessment of the UHF Handheld Transceiver (portable device) Thrane & Thrane SAILOR SP3550 (FCC ID: TCOSP3550)

## According to the FCC Requirements

January 09, 2008  
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## Executive Summary

The SAILOR SP3550 is an UHF handheld transceiver (portable device) from Thrane & Thrane operating in the 440 MHz – 470 MHz frequency range.

The objective of the measurements done by IMST was the dosimetric assessment of one device in the 440 MHz – 470 MHz frequency range. The handset was set to use one specific frequency during the measurements.

The examinations have been carried out with the dosimetric assessment system „DASY4“.

The measurements were made according to the Supplement C to OET Bulletin 65 of the Federal Communications Commission (FCC) Guidelines [OET 65] for evaluating compliance of mobile and portable devices with FCC limits for human exposure (general population) to radiofrequency emissions. All measurements have been performed in accordance to the recommendations given by SPEAG.

## Compliance statement

The Thrane & Thrane SAILOR SP3550 UHF handheld transceiver (FCC ID: TCOSP3550) is in compliance with the Federal Communications Commission (FCC) Guidelines [OET 65] for uncontrolled exposure.

The handset was tested in the following configurations:

- Push to Talk (display towards the phantom, distance 25 mm)
- Body Worn with belt clip and leather case in different configurations

The measurements were done with a cw signal which represents a worst case scenario. The measured SAR values were scaled to the duty cycle of 15/30 as stated by the manufacturer.

Maximum SAR <sub>1g</sub>	
Push to Talk	0.712 W/kg
Body Worn	0.679 W/kg

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## 1 Subject of Investigation

The SAILOR SP3550 is an UHF handheld transceiver (portable device) from Thrane & Thrane operating in the 440 MHz – 470 MHz frequency range.



Fig. 1: Picture of the device under test.

The objective of the measurements done by IMST was the dosimetric assessment of one device in the 440 MHz – 470 MHz frequency range. The handset was set to use one specific frequency during the measurements.

## 2 The IEEE Standard C95.1-1999 and the FCC Exposure Criteria

In the USA the FCC exposure criteria [OET 65] are based on the withdrawn IEEE Standard C95.1-1999 [IEEE C95.1-1999]. This version was replaced by the IEEE Std C95.1-2005 in October, 2005.

Both IEEE standards sets limits for human exposure to radio frequency electromagnetic fields in the frequency range 3 kHz to 300 GHz. One of the major differences in the newly revised C95.1 is the change in the basic restrictions for localized exposure, from 1.6 W/kg averaged over 1 g tissue to 2.0 W/kg averaged over 10 g tissue, which is now identical to the ICNIRP guidelines [ICNIRP 1998].

### 2.1 Distinction Between Exposed Population, Duration of Exposure and Frequencies

The American Standard [IEEE C95.1-1999] distinguishes between controlled and uncontrolled environment. Controlled environments are locations where there is exposure that may be incurred by persons who are aware of the potential for exposure as a concomitant of employment or by other cognizant persons. Uncontrolled environments are locations where there is the exposure of individuals who have no knowledge or control of their exposure. The exposures may occur in living quarters or workplaces. For exposure in controlled environments higher field strengths are admissible. In addition the duration of exposure is considered.

Due to the influence of frequency on important parameters, as the penetration depth of the electromagnetic fields into the human body and the absorption capability of different tissues, the limits in general vary with frequency.

## 2.2 Distinction between Maximum Permissible Exposure and SAR Limits

The biological relevant parameter describing the effects of electromagnetic fields in the frequency range of interest is the specific absorption rate SAR (dimension: power/mass). It is a measure of the power absorbed per unit mass. The SAR may be spatially averaged over the total mass of an exposed body or its parts. The SAR is calculated from the r.m.s. electric field strength  $E$  inside the human body, the conductivity  $\sigma$  and the mass density  $\rho$  of the biological tissue:

$$SAR = \sigma \frac{E^2}{\rho} = c \frac{\partial T}{\partial t} \Big|_{t \rightarrow 0+} \quad (1)$$

The specific absorption rate describes the initial rate of temperature rise  $\partial T / \partial t$  as a function of the specific heat capacity  $c$  of the tissue. A limitation of the specific absorption rate prevents an excessive heating of the human body by electromagnetic energy.

As it is sometimes difficult to determine the SAR directly by measurement (e.g. whole body averaged SAR), the standard specifies more readily measurable maximum permissible exposures in terms of external electric  $E$  and magnetic field strength  $H$  and power density  $S$ , derived from the SAR limits. The limits for  $E$ ,  $H$  and  $S$  have been fixed so that even under worst case conditions, the limits for the specific absorption rate SAR are not exceeded.

For the relevant frequency range the maximum permissible exposure may be exceeded if the exposure can be shown by appropriate techniques to produce SAR values below the corresponding limits.

## 2.3 SAR Limit

In this report the comparison between the FCC exposure limits and the measured data is made using the spatial peak SAR; the power level of the device under test guarantees that the whole body averaged SAR is not exceeded.

Having in mind a worst case consideration, the SAR limit is valid for uncontrolled environment and mobile respectively portable transmitters. According to Table 1 the SAR values have to be averaged over a mass of 1 g ( $SAR_{1g}$ ) with the shape of a cube.

Standard	Status	SAR limit [W/kg]
IEEE C95.1-1999	Replaced	1.6

Table 1: Relevant spatial peak SAR limit averaged over a mass of 1 g.

### 3 The FCC Measurement Procedure

The Federal Communications Commission (FCC) has published a report and order on the 1<sup>st</sup> of August 1996 [FCC 96-326], which requires routine dosimetric assessment of mobile telecommunications devices, either by laboratory measurement techniques or by computational modeling, prior to equipment authorization or use. In 2001 the Commission's Office of Engineering and Technology has released Edition 01-01 of Supplement C to OET Bulletin 65. This revised edition, which replaces Edition 97-01, provides additional guidance and information for evaluating compliance of mobile and portable devices with FCC limits for human exposure to radiofrequency emissions [OET 65].

#### 3.1 General Requirements

The test shall be performed in a laboratory with an environment which avoids influence on SAR measurements by ambient EM sources and any reflection from the environment itself. The ambient temperature shall be in the range of 20°C to 26°C and 30-70% humidity.

#### 3.2 Device Operating Next to a Person's Ear

##### 3.2.1 Phantom Requirements

The phantom is a simplified representation of the human anatomy and comprised of material with electrical properties similar to the corresponding tissues. The physical characteristics of the phantom model shall resemble the head and the neck of a user since the shape is a dominant parameter for exposure.

##### 3.2.2 Test Positions

As it cannot be expected that the user will hold the mobile phone exactly in one well defined position, different operational conditions shall be tested. The Supplement C to OET Bulletin 65 requires two test positions. For an exact description helpful geometrical definitions are introduced and shown in Fig. 2 - 3.

There are two imaginary lines on the mobile, the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width  $w_t$  of the handset at the level of the acoustic output (point A on Fig. 2), and the midpoint of the width  $w_b$  of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Fig. 2). The two lines intersect at point A.

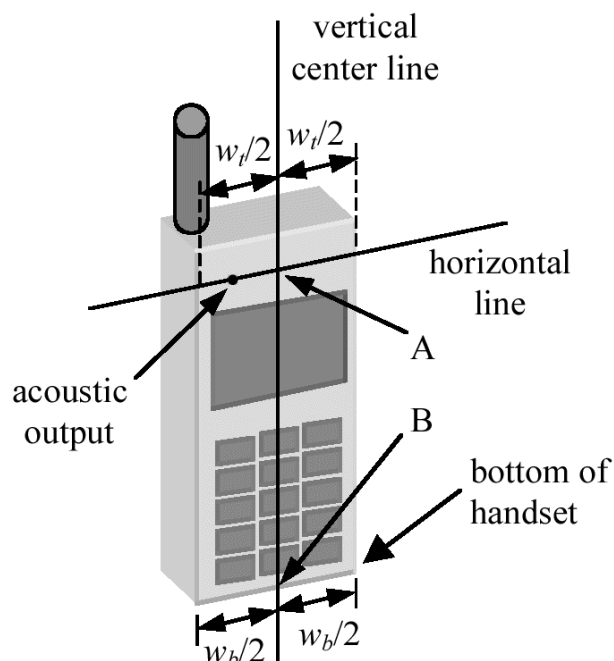


Fig. 2: Handset vertical and horizontal reference lines.

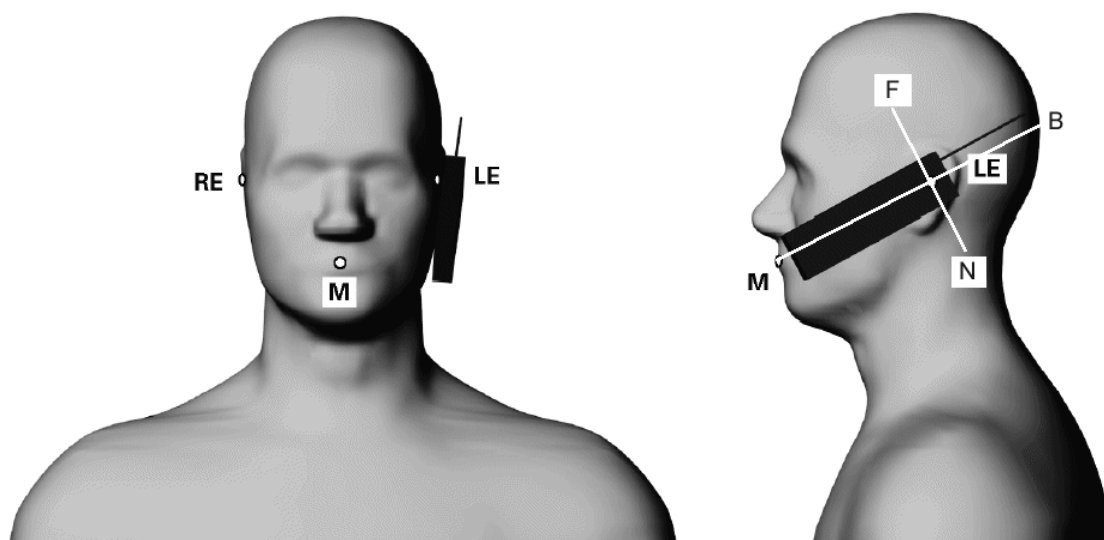


Fig. 3: Phantom reference points.

According to Fig. 3 the human head position is given by means of the following three reference points: auditory canal opening of both ears (RE and LE) and the center of the closed mouth (M). The ear reference points are 15-17 mm above the entrance to the ear canal along the BM line (back-mouth), as shown in Fig. 3. The plane passing through the two ear canals and M is defined as the reference plane. The line NF (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the reference pivoting line. Line BM is perpendicular to the NF line. With this definitions the test positions are given by



- **Cheek position (see Fig. 4):**

Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Fig. 3), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom. Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear. While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane). Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the ear.

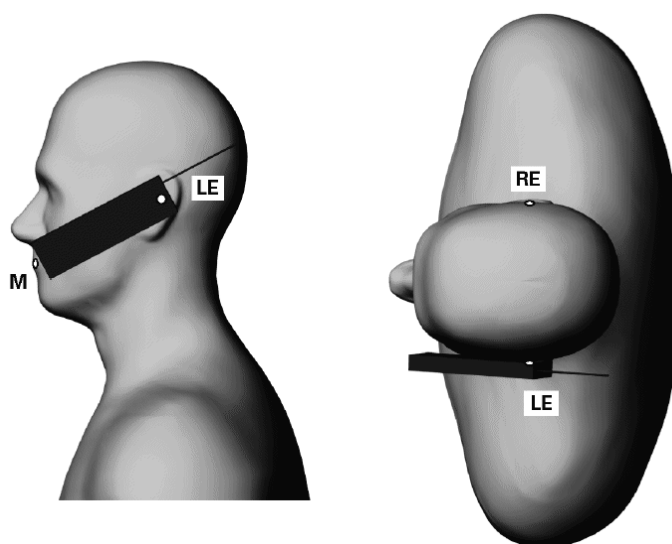


Fig. 4: The cheek position.

- **Tilted position (see Fig. 5):**

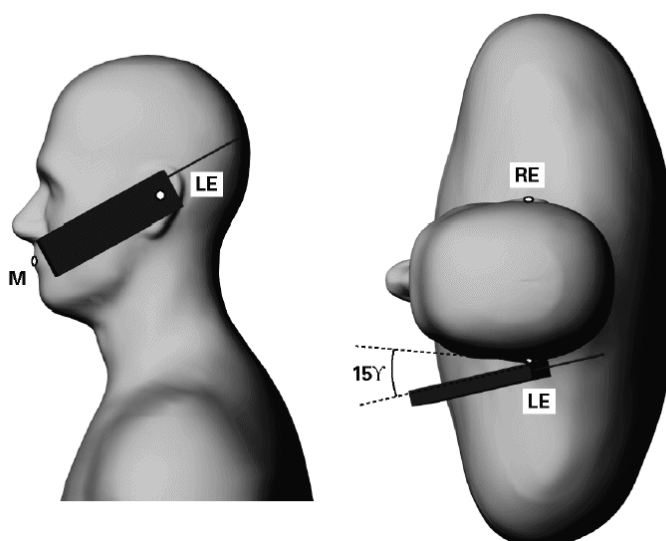


Fig. 5: The tilted position.

While maintaining the orientation of the phone retract the phone parallel to the reference plane far enough to enable a rotation of the phone by 15°. Rotate the phone around the horizontal line by 15°. While maintaining the orientation of the phone, move the phone parallel to the reference plane until any part of the phone touches the head. In this position, point A will be located on the line RE-LE.

### 3.2.3 Test to be Performed

The SAR test shall be performed with both phone positions described above, on the left and right side of the phantom. The device shall be measured for all modes operating when the device is next to the ear, even if the different modes operate in the same frequency band.

For devices with retractable antenna the SAR test shall be performed with the antenna fully extended and fully retracted. Other factors that may affect the exposure shall also be tested. For example, optional antennas or optional battery packs which may significantly change the volume, lengths, flip open/closed, etc. of the device, or any other accessories which might have the potential to considerably increase the peak spatial-average SAR value.

The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at the middle channel for each test configuration is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional.

## 4 Body-worn Configurations

The body-worn configurations shall be tested with the supplied accessories (belt-clips, holsters, etc.) attached to the device in normal use configuration. Devices with a headset output shall be tested with a connected headset.

For purpose of determining test requirements, accessories may be divided into two categories: those that do not contain metallic components and those that do. For multiple accessories that do not contain metallic components, the device may be tested only with that accessory which provides the closest spacing to the body.

For multiple accessories that contain metallic components, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component, only the accessory that provides the closest spacing to the body must be tested.

If the manufacturer provides none body-worn accessories a separation distance of 1.5 cm between the back of the device and the flat phantom is recommended. Other separation distances may be used, but they shall not exceed 2.5 cm.

#### 4.1 PoC (PTT) Position

The PoC (PTT) configurations shall be tested with the front of the device positioned at 25 mm from a flat phantom (display towards the phantom).

#### 4.2 Phantom Requirements

For body-worn and other configurations a flat phantom shall be used which is comprised of material with electrical properties similar to the corresponding tissues.

#### 4.3 Test to be Performed

For devices with retractable antenna the SAR test shall be performed with the antenna fully extended and fully retracted. Other factors that may affect the exposure shall also be tested. For example, optional antennas or optional battery packs which may significantly change the volume, lengths, flip open/closed, etc. of the device, or any other accessories which might have the potential to considerably increase the peak spatial-average SAR value.

The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at the middle channel for each test configuration is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional

### 5 The Measurement System

DASY is an abbreviation of „Dosimetric Assessment System“ and describes a system that is able to determine the SAR distribution inside a phantom of a human being according to different standards. The DASY4 system consists of the following items as shown in Fig: 6. Additional Fig: 7 shows the equipment, similar to the installations in other laboratories.

- Fully compliant with all current measurement standards as stated in Fig. 16
- High precision robot with controller
- Measurement server (for surveillance of the robot operation and signal filtering)
- Data acquisition electronics DAE (for signal amplification and filtering)
- Field probes calibrated for use in liquids
- Electro-optical converter EOC (conversion from the optical into a digital signal)
- Light beam (improving of the absolute probe positioning accuracy)
- Two SAM phantoms filled with tissue simulating liquid
- DASY4 software
- SEMCAD

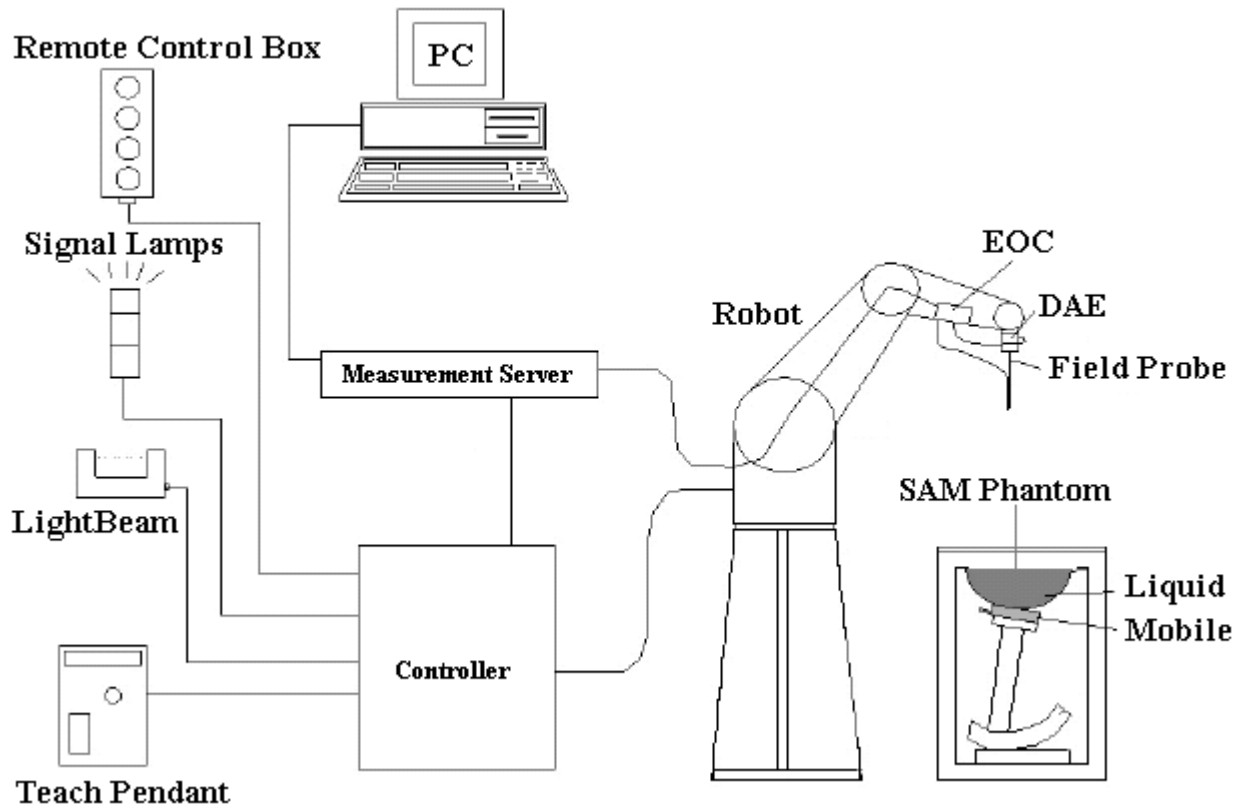


Fig. 6: The DASY4 measurement system.



Fig. 7: The measurement set-up with two SAM phantoms containing tissue simulating liquid.

The mobile phone operating at the maximum power level is placed by a non metallic device holder (delivered from Schmid & Partner) in the above described positions at a shell phantom of a human being. The distribution of the electric field strength  $E$  is measured in the tissue simulating liquid within the shell phantom. For this miniaturised field probes with high sensitivity and low field disturbance are used. Afterwards the corresponding SAR values are calculated with the known electrical conductivity  $\sigma$  and the mass density  $\rho$  of the tissue in the SEMCAD FDTD software. The software is able to determine the averaged SAR values (averaging region 1 g or 10 g) for compliance testing.

The measurements are done by two scans: first a coarse scan determines the region of the maximum SAR, afterwards the averaged SAR is measured in a second scan within the shape of a cube. The measurement time takes about 20 minutes.

## 5.1 Phantom

For the measurements the ELI4 phantom defined by the IEC standard [IEC 62209-2] and delivered by Schmid & Partner Engineering AG is used. The phantom is a fibreglass shell integrated in a wooden table. The thickness of the phantom amounts to  $2 \text{ mm} \pm 0.2 \text{ mm}$  and enables a flat area for the system performance check and body worn measurements. The phantom set-up includes a coverage (polyethylene), which prevents the evaporation of the liquid. The details and the Certificate of conformity can be found in Fig. 17.

## 5.2 Probe

For the measurements the Dosimetric E-Field Probes ET3DV6R or EX3DV4 with following specifications are used. They are manufactured and calibrated in accordance with FCC [OET 65] and IEEE [IEEE 1528-2003] recommendations annually by Schmid & Partner Engineering AG.

ET3DV6:

- Dynamic range:  $5\mu\text{W/g}$  to  $> 100\text{mW/g}$
- Tip diameter: 6.8 mm
- Probe linearity:  $\pm 0.2 \text{ dB}$  (30 MHz to 3 GHz)
- Axial isotropy:  $\pm 0.2 \text{ dB}$
- Spherical isotropy:  $\pm 0.4 \text{ dB}$
- Distance from probe tip to dipole centers: 2.7 mm
- Calibration range: 450 MHz / 900MHz / 1800MHz / 1900MHz / 1950 MHz / 2450MHz for head and body simulating liquid
- Angle between probe axis (evaluation axis) and surface normal line: less than  $30^\circ$

EX3DV4:

- Dynamic range:  $10\mu\text{W/g}$  to  $> 100\text{mW/g}$  (noise typically  $< 1\mu\text{W/g}$ )
- Tip diameter: 2.5 mm
- Probe linearity:  $\pm 0.2$  dB (30 MHz to 3 GHz)
- Axial isotropy:  $\pm 0.2$  dB
- Spherical isotropy:  $\pm 0.4$  dB
- Distance from probe tip to dipole centers: 1.0 mm
- Calibration range: : 900MHz / 1800MHz / 1900MHz / 1950 MHz / 2450MHz for head and body simulating liquid
- Angle between probe axis (evaluation axis) and surface normal line: less than  $30^\circ$

### 5.3 Measurement Procedure

The following steps are used for each test position:

- Establish a call with the maximum output power with a base station simulator. The connection between the mobile phone and the base station simulator is established via air interface.
- Measurement of the local E-field value at a fixed location (P1). This value serves as a reference value for calculating a possible power drift.
- Measurement of the SAR distribution with a grid spacing of 15 mm x 15 mm and a constant distance to the inner surface of the phantom. Since the sensors can not directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With this values the area of the maximum SAR is calculated by a interpolation scheme (combination of a least-square fitted function and a weighted average method). Additional all peaks within 2 dB of the maximum SAR are searched.
- Around this points, a cube of 30 mm x 30 mm x 30 mm is assessed by measuring 7 x 7 x 7 points whereby the first two measurement points are within the required 10 mm of the surface. With these data, the peak spatial-average SAR value can be calculated within the SEMCAD software.
- The used extrapolation and interpolation routines are all based on the modified Quadratic Shepard's method [DASY4].
- Repetition of the E-field measurement at the fixed location (P1) and repetition of the whole procedure if the two results differ by more than  $\pm 0.21\text{dB}$ .

## 5.4 Uncertainty Assessment

Table 2 includes the worst case uncertainty budget suggested by the [IEEE 1528-2003] and determined by Schmid & Partner Engineering AG. The expanded uncertainty (K=2) is assessed to be  $\pm 21.7\%$  and is valid up to 3.0 GHz.

Error Sources	Uncertainty Value	Probability Distribution	Divisor	$c_i$	Standard Uncertainty	$v_i^2$ or $v_{\text{eff}}$
<b>Measurement System</b>						
Probe calibration	$\pm 5.9 \%$	Normal	1	1	$\pm 5.9 \%$	$\infty$
Axial isotropy	$\pm 4.7 \%$	Rectangular	$\sqrt{3}$	0.7	$\pm 1.9 \%$	$\infty$
Hemispherical isotropy	$\pm 9.6 \%$	Rectangular	$\sqrt{3}$	0.7	$\pm 3.9 \%$	$\infty$
Boundary effects	$\pm 1.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	$\infty$
Linearity	$\pm 4.7 \%$	Rectangular	$\sqrt{3}$	1	$\pm 2.7 \%$	$\infty$
System detection limit	$\pm 1.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	$\infty$
Readout electronics	$\pm 1.0 \%$	Normal	1	1	$\pm 1.0 \%$	$\infty$
Response time	$\pm 0.8 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.5 \%$	$\infty$
Integration time	$\pm 2.6\%$	Rectangular	$\sqrt{3}$	1	$\pm 1.5 \%$	$\infty$
RF ambient conditions	$\pm 3.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 1.7 \%$	$\infty$
Probe positioner	$\pm 0.4 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.2 \%$	$\infty$
Probe positioning	$\pm 2.9 \%$	Rectangular	$\sqrt{3}$	1	$\pm 1.7 \%$	$\infty$
Algorithm for max SAR eval.	$\pm 1.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	$\infty$
<b>Test Sample Related</b>						
Device positioning	$\pm 2.9 \%$	Normal	1	1	$\pm 2.9 \%$	145
Device holder	$\pm 3.6 \%$	Normal	1	1	$\pm 3.6 \%$	5
Power drift	$\pm 5.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 2.9 \%$	$\infty$
<b>Phantom and Set-up</b>						
Phantom uncertainty	$\pm 4.0 \%$	Rectangular	$\sqrt{3}$	1	$\pm 2.3 \%$	$\infty$
Liquid conductivity (target)	$\pm 5.0 \%$	Rectangular	$\sqrt{3}$	0.64	$\pm 1.8 \%$	$\infty$
Liquid conductivity (meas.)	$\pm 2.5 \%$	Normal	1	0.64	$\pm 1.6 \%$	$\infty$
Liquid permittivity (target)	$\pm 5.0 \%$	Rectangular	$\sqrt{3}$	0.6	$\pm 1.7 \%$	$\infty$
Liquid permittivity (meas.)	$\pm 2.5 \%$	Normal	1	0.6	$\pm 1.5 \%$	$\infty$
<b>Combined Uncertainty</b>					$\pm 10.8 \%$	

Table 2: Uncertainty budget of DASY4.

## 6 SAR Results

The Tables below contain the measured SAR values averaged over a mass of 1 g.

Push To Talk Configuration					
Frequency: 457.575 MHz	SAR <sub>1g</sub> [W/kg] (Drift[dB]) P = 36.45 dB	SAR <sub>1g</sub> scaled [W/kg] (incl. drift) P = 36.45 dB	SAR <sub>1g</sub> calculated [W/kg] (duty cycle: 15/30) P = 36.45 dB	Temperature	
				Ambient [° C]	Liquid [° C]
PTT Configuration	1.240 (-0.602)	1.424	0.712	22.2	21.3

Table 3: Measurement results in PTT configuration for the Thrane & Thrane SAILOR SP3550.

Body Worn Configuration (with belt clip)					
Frequency: 457.575 MHz	SAR <sub>1g</sub> [W/kg] (Drift[dB]) P = 36.45 dB	SAR <sub>1g</sub> scaled [W/kg] (incl. drift) P = 36.45 dB	SAR <sub>1g</sub> calculated [W/kg] (duty cycle: 15/30) P = 36.45 dB	Temperature	
				Ambient [° C]	Liquid [° C]
Configuration 1	0.934* (-0.521)	1.053	0.527	21.2	20.5
Configuration 2	0.811 (-0.578)	0.926	0.463	21.2	20.5
Configuration 3	0.751 (-0.307)	0.806	0.403	21.2	20.5
Configuration 4	0.759* (-0.206)	0.795	0.398	21.2	20.5
Configuration 5	0.709* (-0.460)	0.788	0.394	21.2	20.5
Configuration 6	0.759* (-0.631)	0.878	0.439	21.2	20.5

Table 4: Measurement results in body-worn configuration for the Thrane & Thrane SAILOR SP3550 with belt clip, display towards the ground.



Body Worn Configuration (with leather case)					
Frequency: 457.575 MHz	SAR <sub>1g</sub> [W/kg] (Drift[dB]) P = 36.45 dB	SAR <sub>1g</sub> scaled [W/kg] (incl. drift) P = 36.45 dB	SAR <sub>1g</sub> calculated [W/kg] (duty cycle: 15/30) P = 36.45 dB	Temperature	
				Ambient [° C]	Liquid [° C]
Configuration 1	1.080* (-0.087)	1.101	0.551	21.5	20.9
Configuration 2	1.160* (-0.684)	1.357	0.679	21.5	20.9
Configuration 3	1.060* (-0.528)	1.196	0.598	21.5	20.9
Configuration 4	1.060* (-0.674)	1.237	0.619	21.5	20.9
Configuration 5	1.090* (-0.286)	1.164	0.582	21.5	20.9
Configuration 6	1.060* (-0.487)	1.186	0.593	21.5	20.9

Table 5: Measurement results in body-worn configuration for the Thrane & Thrane SAILOR SP3550 with leather case, display towards the ground.

Body Worn Configuration (with leather case)					
Frequency: 457.575 MHz	SAR <sub>1g</sub> [W/kg] (Drift[dB]) P = 36.45 dB	SAR <sub>1g</sub> scaled [W/kg] (incl. drift) P = 36.45 dB	SAR <sub>1g</sub> calculated [W/kg] (duty cycle: 15/30) P = 36.45 dB	Temperature	
				Ambient [° C]	Liquid [° C]
Configuration 1	1.010* (-0.604)	1.161	0.580	21.5	20.9
Configuration 2	0.901* (-0.543)	1.021	0.510	21.5	20.9
Configuration 3	0.907* (-0.441)	1.005	0.503	21.5	20.9
Configuration 4	0.942 (-0.699)	1.106	0.553	21.5	20.9
Configuration 5	0.836* (-0.532)	0.945	0.473	21.5	20.9
Configuration 6	0.969 (-0.308)	1.040	0.520	21.5	20.9

Table 6: Measurement results in body-worn configuration for the Thrane & Thrane SAILOR SP3550 with leather case, display towards the phantom.

The “\* Max Cube” labeling indicates that during the grid scanning an additional peak was found which was within 2.0 dB of the highest peak. The value of the highest cube is given in the tables above, the value from the second assessed cube is given in the SAR distribution plots (see appendix).

The accessory configuration for body worn configuration is given by the manufacturer and shown in Fig. 8

The above mentioned power values are “conducted” power values, they were measured on the same sample which was prepared for the FCC approval. The values were delivered by **IMST GmbH**. To control the output power stability during the SAR test the used DASY4 system calculates the power drift by measuring the e-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in the above tables labeled as: (Drift[dB]). This ensures that the power drift during one measurement is within 5%.

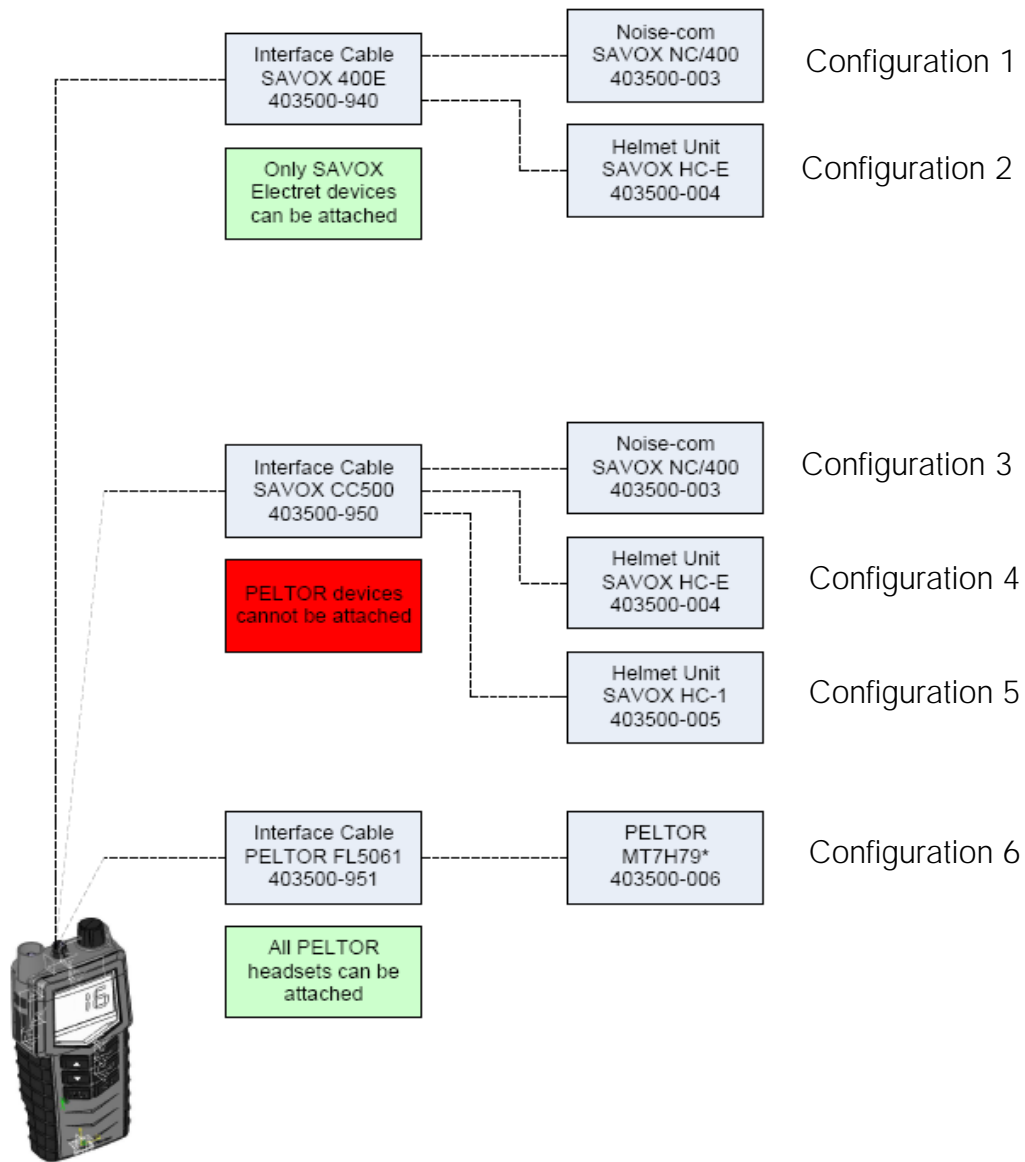


Fig. 8: Combination of accessory for body worn configuration for the Thrane & Thrane SAILOR SP3550.

## 7 Evaluation

In Fig. 9 - Fig. 12 the head phantom SAR results and the SAR results in body-worn configuration given in Table 3 - Table 6 are summarized and compared to the limit.

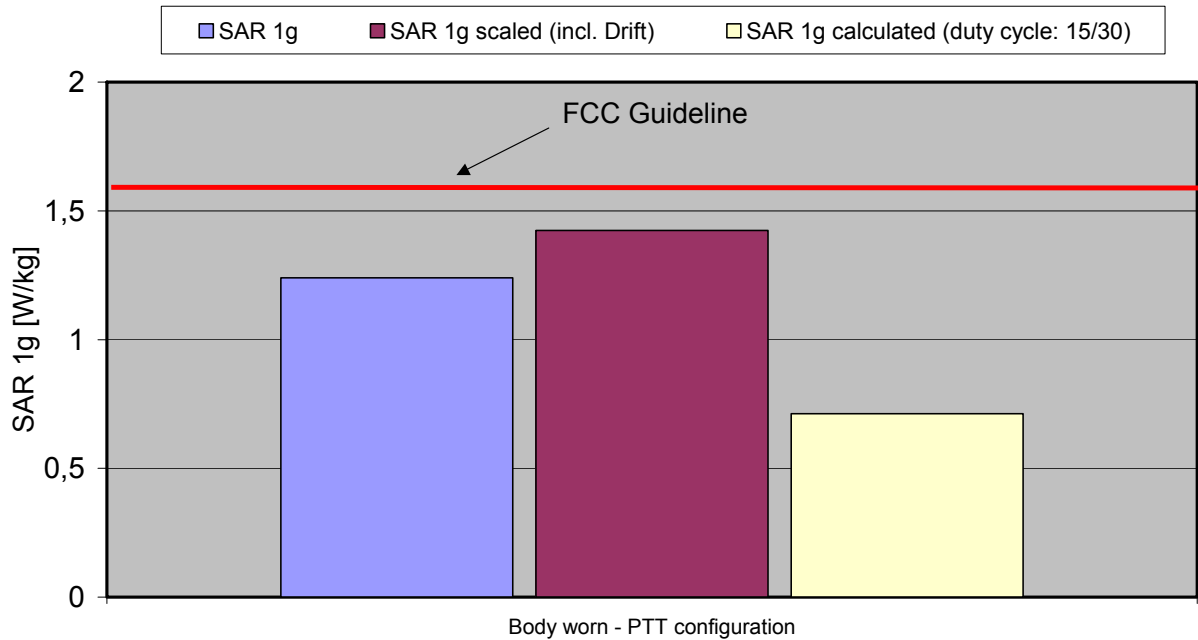


Fig. 9: The measured SAR values in PTT configuration for the Thrane & Thrane SAILOR SP3550 in comparison to the FCC exposure limit.

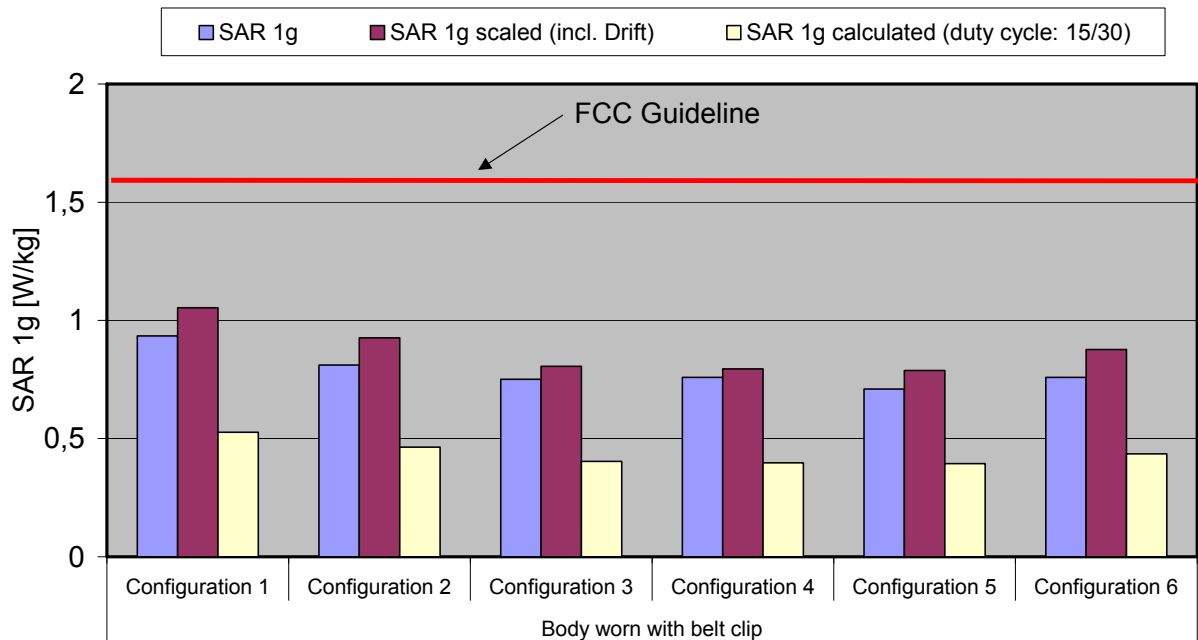


Fig. 10: The measured SAR values in body worn configuration (with belt clip), display towards the ground for the Thrane & Thrane SAILOR SP3550 in comparison to the FCC exposure limit.

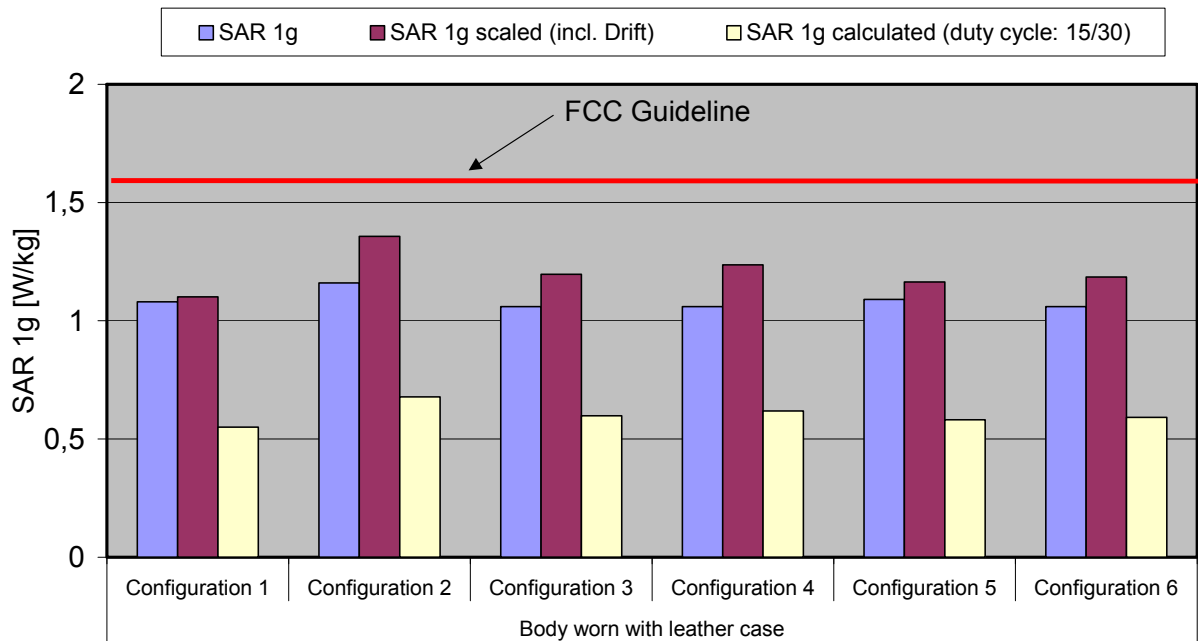


Fig. 11: The measured SAR values in body worn configuration (with leather case), display towards the ground for the Thrane & Thrane SAILOR SP3550 in comparison to the FCC exposure limit.

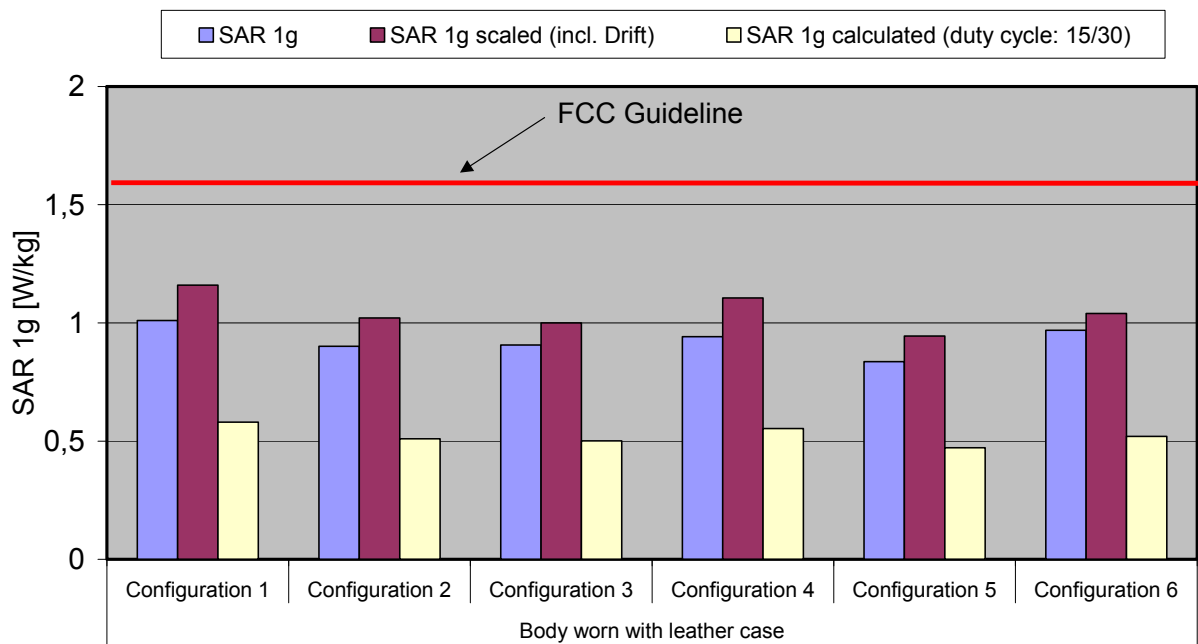


Fig. 12: The measured SAR values in body worn configuration (with leather case), display towards the phantom for the Thrane & Thrane SAILOR SP3550 in comparison to the FCC exposure limit.

The Thrane & Thrane SAILOR SP3550 UHF handheld transceiver (FCC ID: TCOSP3550) is in compliance with the Federal Communications Commission (FCC) Guidelines [OET 65] for uncontrolled exposure.

The handset was tested in the following configurations:

- Push to Talk (display towards the phantom, distance 25 mm)
- Body Worn with belt clip and leather case in different configurations

The measurements were done with a cw signal which represents a worst case scenario. The measured SAR values were scaled to the duty cycle of 15/30 as stated by the manufacturer.

Maximum SAR <sub>1g</sub>	
Push to Talk	0.712 W/kg
Body Worn	0.679 W/kg

## 8 Appendix

### 8.1 Administrative Data

Date of validation: 450 MHz, Head (PTT): October 02, 2007  
 450 MHz, Body (with belt clip): January 03, 2008  
 450 MHz, Body (with case): January 07, 2008  
 Date of measurement: October 02, 2007 - January 07, 2008  
 Data stored: Nemko\_6620\_656

### 8.2 Device under Test and Test Conditions

MTE: Thrane & Thrane SAILOR SP3550, identical prototype  
 Date of receipt: September 28, 2007  
 SN: 1234560014  
 FCC ID: TCOSP3550  
 Equipment class: Portable device  
 RF exposure environment: uncontrolled environment  
 Power supply: Internal Battery (Other batteries not available)  
 Antenna: helix  
 Tested Accessories, Body: belt clip, leather case  
 Method to establish a call: PTT  
 Crest Factor: 1  
 TX range: 440.00 MHz – 470.00 MHz  
 RX range: 440.00 MHz – 470.00 MHz  
 Used TX Channels: 440.00 MHz, 457.575 MHz, 470.00 MHz  
 Used Phantom: ELI4 phantom, as defined by the IEC draft standard 62209-2 and delivered by Schmid & Partner Engineering AG  
 Liquid depth: At least 15 cm

### 8.3 Tissue Recipes

The following recipes are provided in percentage by weight.

450.00 MHz, Head:	56.93%	Sugar
	38.91%	De-Ionized Water
	3.79%	Salt
	0.25%	Hydroxyetyl-cellulose
	0.12%	Preventol D7
450 MHz, Body:	51.17%	Sugar
	46.31%	De-Ionized Water
	2.34%	Salt
	0.18%	Hydroxyetyl-cellulose
	0.08%	Preventol D7

#### 8.4 Material Parameters

For the measurement of the following parameters the HP 85070B dielectric probe kit is used, representing the open-ended coaxial probe measurement procedure. The measured values should be within  $\pm 5\%$  of the recommended values given by the FCC.

Frequency		$\epsilon_r$	$\sigma$ [S/m]	Temperature	
				Ambient [° C]	Liquid [° C]
450 MHz (Head, Validation; October 02, 2007)	Recommended Value	$43.50 \pm 2.20$	$0.87 \pm 0.04$	20.0 - 26.0	-
	Measured Value	44.90	0.89	22.2	21.3
450 MHz (Body, Validation; January 03, 2008)	Recommended Value	$56.70 \pm 2.80$	$0.94 \pm 0.05$	20.0 - 26.0	-
	Measured Value	57.30	0.91	21.1	20.5
450 MHz (Body, Validation; January 07, 2008)	Recommended Value	$56.70 \pm 2.80$	$0.94 \pm 0.05$	20.0 - 26.0	-
	Measured Value	58.08	0.93	21.5	20.9

Table 7: Parameters of the tissue simulating liquids (validation).

Frequency [MHz]		$\epsilon_r$	$\sigma$ [S/m]	Temperature	
				Ambient [° C]	Liquid [° C]
450.000	Recommended Value	$43.50 \pm 2.20$	$0.87 \pm 0.04$	20.0 - 26.0	-
440.000	Measured Value	45.20	0.89	22.2	21.3
457.575	Measured Value	44.70	0.91	22.2	21.3
470.000	Measured Value	44.40	0.91	22.2	21.3

Table 8: Parameters of the tissue simulating liquids (measurements head)  
October 02, 2007.



Frequency [MHz]		$\epsilon_r$	$\sigma$ [S/m]	Temperature	
				Ambient [°C]	Liquid [°C]
450.000	Recommended Value	$56.70 \pm 2.80$	$0.94 \pm 0.05$	20.0 - 26.0	-
440.000	Measured Value	57.30	0.90	21.1	20.5
457.575	Measured Value	57.10	0.92	21.1	20.5
470.000	Measured Value	56.80	0.92	21.1	20.5

Table 9: Parameters of the tissue simulating liquids (measurements body)  
January 03, 2008

Frequency [MHz]		$\epsilon_r$	$\sigma$ [S/m]	Temperature	
				Ambient [°C]	Liquid [°C]
450.000	Recommended Value	$56.70 \pm 2.80$	$0.94 \pm 0.05$	20.0 - 26.0	-
440.000	Measured Value	58.15	0.93	21.5	20.9
457.575	Measured Value	58.00	0.93	21.5	20.9
470.000	Measured Value	57.77	0.94	21.5	20.9

Table 10: Parameters of the tissue simulating liquids (measurements body)  
January 07, 2008.

## 8.5 Simplified Performance Checking

The simplified performance check was realized using the dipole validation kit. The input power of the dipole antenna was 250 mW (cw signal) and it was placed under the ELI4 phantom with 15 mm distance between dipole center and tissue simulating liquid. The target and measured results are listed in the Table 11 - 12 and shown in Fig. 13 - 15. The target values were adopted from the manufactures calibration certificates which are attached in the appendix. Table 13 includes the uncertainty assessment for the system performance checking which was suggested by the [IEEE 1528-2003] and determined by Schmid & Partner Engineering AG. The expanded uncertainty (K=2) is assessed to be  $\pm 16.8\%$ .

Available Dipole		SAR <sub>1g</sub> [W/kg] P <sub>in</sub> = 250 mW	SAR <sub>1g</sub> [W/kg] P <sub>in</sub> = 398 mW	ε <sub>r</sub>	σ [S/m]
D450V2, SN #1014	Target Values Head	1.28	2.04	43.60	0.86
D450V2, SN #1014	Target Values Body	1.19	1.90	55.90	0.94

Table 11: Dipole target results as given by the manufactures calibration certificate.

Used Dipole		SAR <sub>1g</sub> [W/kg] P <sub>in</sub> = 250 mW	ε <sub>r</sub>	σ [S/m]	Temperature	
					Ambient [° C]	Liquid [° C]
D450V2, SN #1014 (October 02, 2007)	Measured Values Head	1.32	44.90	0.89	22.0	21.1
D450V2, SN #1014 (January 03, 2008)	Measured Values Body	1.21	57.30	0.91	21.1	20.5
D450V2, SN #1014 (January 07, 2008)	Measured Values Body	1.23	58.08	0.93	21.5	20.9

Table 12: Measured dipole validation results.

**Test Laboratory:** Imst GmbH, DASY Yellow (II); **File Name:** [021007\\_y\\_1669\\_ELI4.da4](#)

**DUT:** Dipole 450 MHz SN1014; **Type:** D450V2; **Serial:** D450V2 - SN:1014

**Program Name:** System Performance Check at 450 MHz

Communication System: CW; Frequency: 450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.89$  mho/m;  $\epsilon_r = 44.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(7.32, 7.32, 7.32); Calibrated: 15.02.2007
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 17.09.2007
- Phantom: ELI 4; Type: ELI 4;
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=10mm, Pin=250mW/Area Scan (7x7x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 1.32 mW/g

**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 39.5 V/m; Power Drift = 0.035 dB

Peak SAR (extrapolated) = 2.03 W/kg

**SAR(1 g) = 1.32 mW/g; SAR(10 g) = 0.90 mW/g**

Maximum value of SAR (measured) = 1.41 mW/g

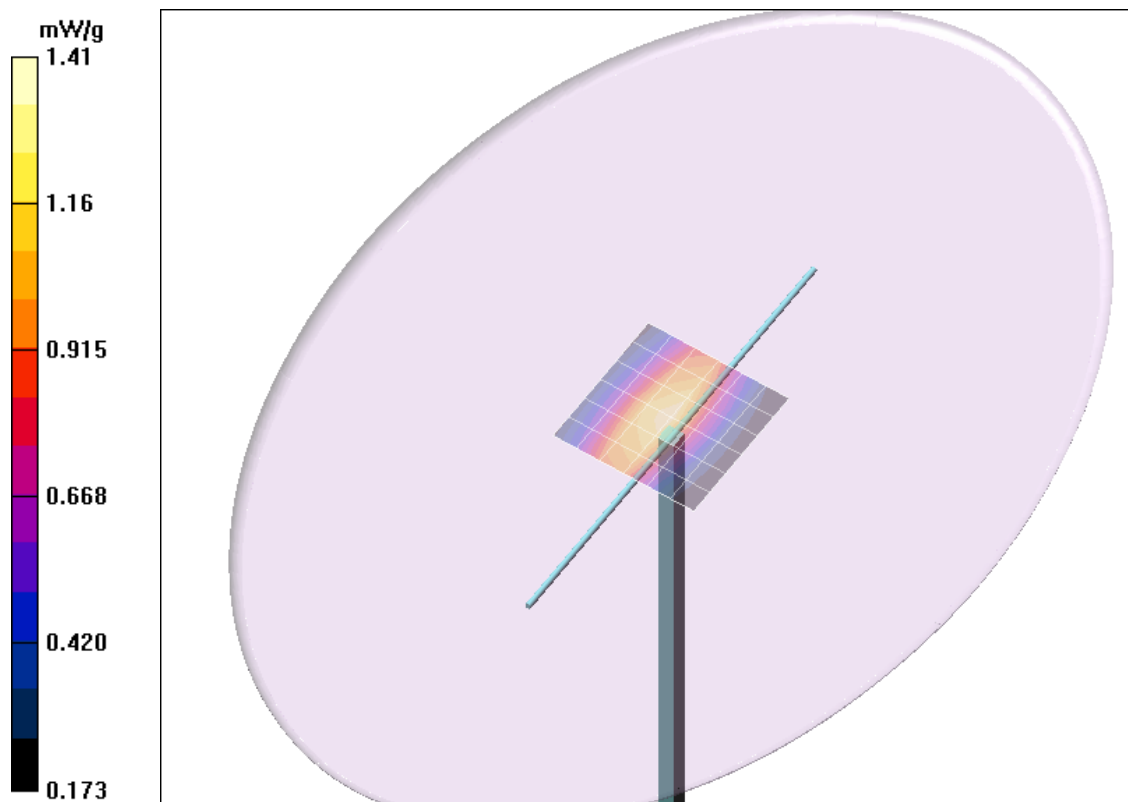


Fig. 13: Validation measurement 450 MHz Head (October 02, 2008), coarse grid. Ambient Temperature: 22.2° C, Liquid Temperature: 21.3° C.

**Test Laboratory: IMST GmbH, DASY Blue (I); File Name: [030108 b 1669 ELI4.da4](#)**

**DUT: Dipole 450 MHz SN1014; Type: D450V2; Serial: D450V2 - SN:1014**

**Program Name: System Performance Check at 450 MHz**

Communication System: CW; Frequency: 450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.91$  mho/m;  $\epsilon_r = 57.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(7.83, 7.83, 7.83); Calibrated: 15.02.2007
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 17.09.2007
- Phantom: ELI 4; Type: ELI 4;
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=10mm, Pin=250mW/Area Scan (7x7x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 1.25 mW/g

**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 37.5 V/m; Power Drift = 0.064 dB

Peak SAR (extrapolated) = 1.85 W/kg

**SAR(1 g) = 1.21 mW/g; SAR(10 g) = 0.827 mW/g**

Maximum value of SAR (measured) = 1.29 mW/g

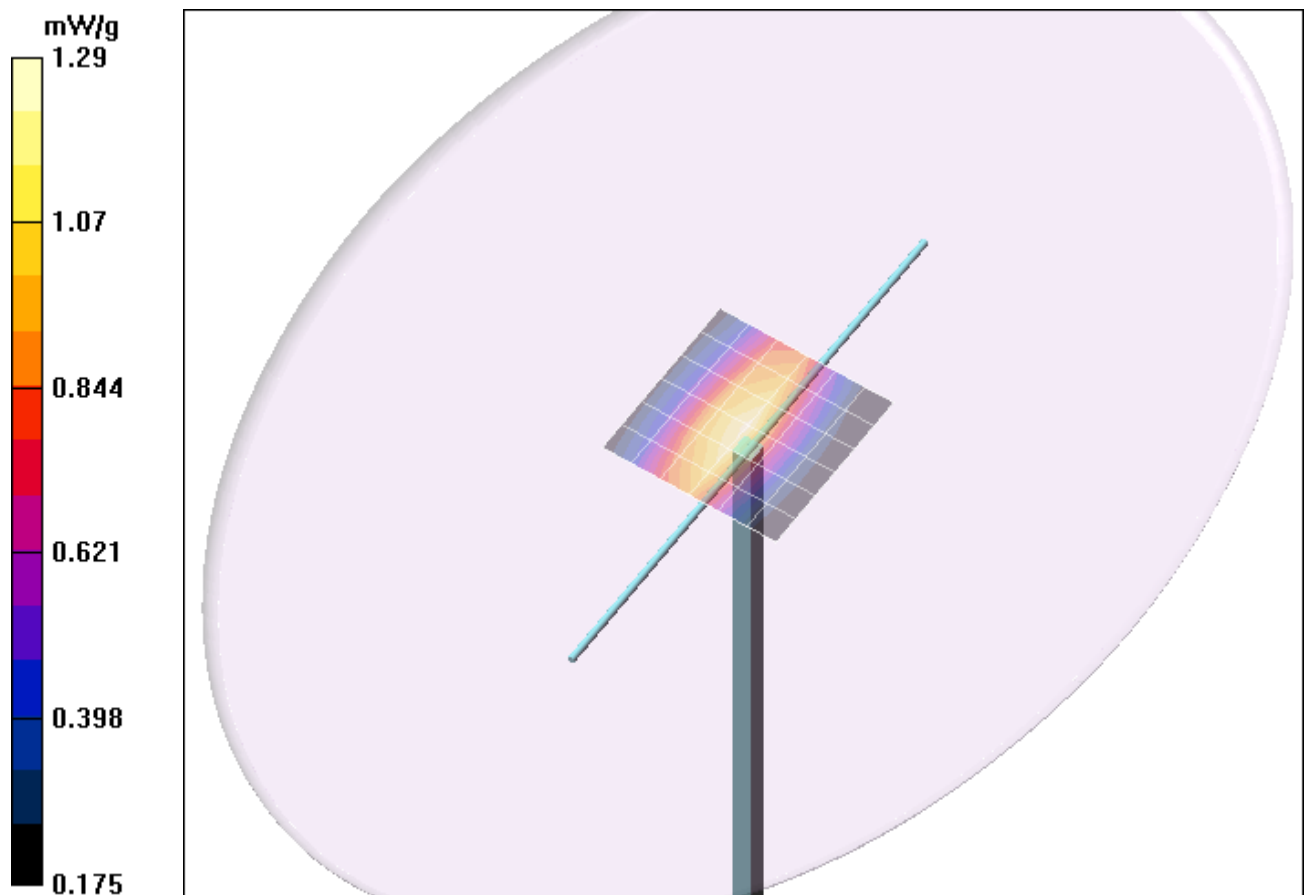


Fig. 14: Validation measurement 450 MHz body (January 03, 2008), coarse grid.  
Ambient Temperature: 21.1° C, Liquid Temperature: 20.5° C.

**Test Laboratory: IMST GmbH, DASY Blue (I); File Name: [070108 b 1669 ELI4.da4](#)**

**DUT: Dipole 450 MHz SN1014; Type: D450V2; Serial: D450V2 - SN:1014**

**Program Name: System Performance Check at 450 MHz**

Communication System: CW; Frequency: 450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.93$  mho/m;  $\epsilon_r = 58.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(7.83, 7.83, 7.83); Calibrated: 15.02.2007

- Sensor-Surface: 4mm (Mechanical Surface Detection)

- Electronics: DAE4 Sn631; Calibrated: 17.09.2007

- Phantom: ELI 4; Type: ELI 4;

- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=10mm, Pin=250mW/Area Scan (7x7x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 1.19 mW/g

**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 36.0 V/m; Power Drift = -0.047 dB

Peak SAR (extrapolated) = 1.87 W/kg

**SAR(1 g) = 1.23 mW/g; SAR(10 g) = 0.836 mW/g**

Maximum value of SAR (measured) = 1.30 mW/g

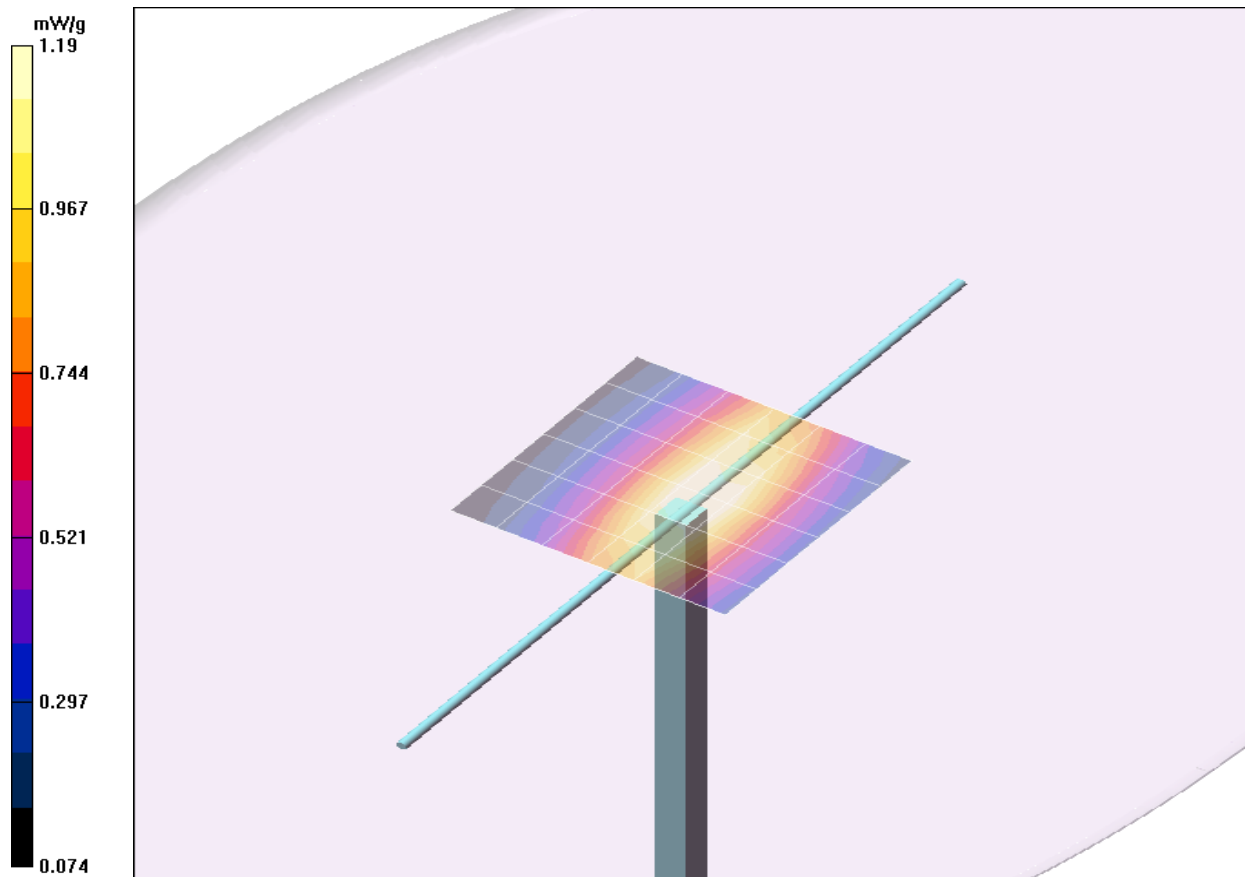


Fig. 15: Validation measurement 450 MHz body (January 07, 2008), coarse grid.  
Ambient Temperature: 21.5° C, Liquid Temperature: 20.9° C.

Error Sources	Uncertainty Value	Probability Distribution	Divisor	$c_i$	Standard Uncertainty	$v_i^2$ or $v_{eff}$
<b>Measurement System</b>						
Probe calibration	± 4.8 %	Normal	1	1	± 4.8 %	∞
Axial isotropy	± 4.7 %	Rectangular	√3	1	± 2.7 %	∞
Hemispherical isotropy	± 0 %	Rectangular	√3	1	± 0 %	∞
Boundary effects	± 1.0 %	Rectangular	√3	1	± 0.6 %	∞
Linearity	± 4.7 %	Rectangular	√3	1	± 2.7 %	∞
System detection limit	± 1.0 %	Rectangular	√3	1	± 0.6 %	∞
Readout electronics	± 1.0 %	Normal	1	1	± 1.0 %	∞
Response time	± 0 %	Rectangular	√3	1	± 0 %	∞
Integration time	± 0%	Rectangular	√3	1	± 0 %	∞
RF ambient conditions	± 3.0 %	Rectangular	√3	1	± 1.7 %	∞
Probe positioner	± 0.4 %	Rectangular	√3	1	± 0.2 %	∞
Probe positioning	± 2.9 %	Rectangular	√3	1	± 1.7 %	∞
Algorithms for max SAR eval.	± 1.0 %	Rectangular	√3	1	± 0.6 %	∞
<b>Dipole</b>						
Dipole Axis to Liquid Distance	± 2.0 %	Rectangular	1	1	± 1.2 %	∞
Input power and SAR drift mea.	± 4.7 %	Rectangular	√3	1	± 2.7 %	∞
<b>Phantom and Set-up</b>						
Phantom uncertainty	± 4.0 %	Rectangular	√3	1	± 2.3 %	∞
Liquid conductivity (target)	± 5.0 %	Rectangular	√3	0.64	± 1.8 %	∞
Liquid conductivity (meas.)	± 2.5 %	Normal	1	0.64	± 1.6 %	∞
Liquid permittivity (target)	± 5.0 %	Rectangular	√3	0.6	± 1.7 %	∞
Liquid permittivity (meas.)	± 2.5 %	Normal	1	0.6	± 1.5 %	∞
<b>Combined Uncertainty</b>					± 8.4 %	

Table 13: Uncertainty budget for the system performance check.

## 8.6 Environment

To comply with the required noise level (less than 12 mW/kg) periodically measurements without a DUT were conducted.

Humidity: 40%  $\pm$  5 %

## 8.7 Test Equipment

Test Equipment	Model	Serial Number	Last Calibration	Next Calibration
<b>DASY4 Systems</b>				
Software Versions DASY4	V4.7	N/A	N/A	N/A
Software Versions SEMCAD	V1.8	N/A	N/A	N/A
Dosimetric E-Field Probe	ET3DV6	1669	02/2007	02/2008
Data Acquisition Electronics	DAE 4	631	09/2007	09/2008
Phantom	ELI4	1004	N/A	N/A
<b>Dipole</b>				
Validation Dipole	D450V2	1014	12/2006	12/2008
<b>Material Measurement</b>				
Network Analyzer	HP8753D	3410A06555	12/2006	12/2008
Dielectric Probe Kit	HP85070B	US33020263	N/A	N/A

Table 14: SAR equipment.

Test Equipment	Model	Serial Number	Last Calibration	Next Calibration
<b>Power Meters</b>				
Power Meter, Agilent	E4416A	GB41050414	12/2006	12/2008
Power Meter, Agilent	E4417A	GB41050441	12/2006	12/2008
Power Meter, Anritsu	ML2487A	6K00002319	12/2007	12/2009
Power Meter, Anritsu	ML2488A	6K00002078	12/2007	12/2009
<b>Power Sensors</b>				
Power Sensor, Agilent	E9301H	US40010212	12/2006	12/2008
Power Sensor, Agilent	E9301A	MY41495584	12/2006	12/2008
Power Sensor, Anritsu	MA2481B	031600	12/2007	12/2009
Power Sensor, Anritsu	MA2490A	031565	12/2007	12/2009
<b>RF Sources</b>				
Network Analyzer	HP8753D	3410A06555	12/2006	12/2008
Rohde & Schwarz	SME300	100142	N/A	N/A
<b>Amplifiers</b>				
Mini Circuits	ZHL-42	D012296	N/A	N/A
Mini Circuits	ZHL-42	D031104#01	N/A	N/A
Mini Circuits	ZVE-8G	D031004	N/A	N/A
<b>Radio Tester</b>				
Rohde & Schwarz	CMU200	835305/050	01/2007	01/2008
Willtek	4202S	0813151	N/A	N/A

Table 15: Test equipment, General.



## 8.8 Certificates of conformity

Schmid & Partner Engineering AG

**s p e a g**

Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 44 245 9700, Fax +41 44 245 9779  
info@speag.com, http://www.speag.com

### Certificate of conformity

Item	Dosimetric Assessment System DASY4
Type No	SD 000 401A, SD 000 402A
Software Version No	4.7
Manufacturer / Origin	Schmid & Partner Engineering AG Zeughausstrasse 43, CH-8004 Zürich, Switzerland

### References

- [1] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
- [2] EN 50361:2001, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz)", July 2001
- [3] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
- [4] IEC 62209 – 2, Draft Version 0.9, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", December 2004
- [5] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
- [6] ANSI-C63.19-2007, "American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids", June 2007

### Conformity

We certify that this **system is designed to be fully compliant** with the standards [1 – 6] for RF emission tests of wireless devices.

### Uncertainty

The uncertainty of the measurements with this system was evaluated according to the above standards and is documented in the applicable chapters of the DASY4 system handbook.

The uncertainty values represent current state of methodology and are subject to changes. They are applicable to all laboratories using DASY4 provided the following requirements are met (responsibility of the system end user):

- 1) the system is used by an experienced engineer who follows the manual and the guidelines taught during the training provided by SPEAG,
- 2) the probe and validation dipoles have been calibrated for the relevant frequency bands and media within the requested period,
- 3) the DAE has been calibrated within the requested period,
- 4) the "minimum distance" between probe sensor and inner phantom shell and the radiation source is selected properly,
- 5) the system performance check has been successful,
- 6) the operational mode of the DUT is CW, CDMA, FDMA or TDMA (GSM, DCS, PCS, IS136, PDC) and the measurement/integration time per point is  $\geq 500$  ms,
- 7) the dielectric parameters of the liquid are conformant with the standard requirement,
- 8) the DUT has been positioned as described in the manual.
- 9) the uncertainty values from the calibration certificates, and the laboratory and measurement equipment dependent uncertainties, are updated by end user accordingly.

Date 15.8.2007

Signature / Stamp

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info@speag.com, http://www.speag.com

Fig. 16: Certificate of conformity for the used DASY4 system

Schmid &amp; Partner Engineering AG

**s p e e g**

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**Certificate of Conformity / First Article Inspection**

Item	Oval Flat Phantom ELI 4.0
Type No	QD OVA 001 B
Series No	1003 and higher
Manufacturer	SPEAG Zeughausstrasse 43 CH-8004 Zürich Switzerland

**Tests**

Complete tests were made on the prototype units QD OVA 001 AA 1001, QD OVA 001 AB 1002, pre-series units QD OVA 001 BA 1003-1005 as well as on the series units QD OVA 001 BB, 1006 ff.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the standard IEC 62209 – 2 [1] requirements	Dimensions of bottom for 300 MHz – 6 GHz: longitudinal = 600 mm (max. dimension) width = 400 mm (min dimension) depth = 190 mm Shape: ellipse	Prototypes, Samples
Material thickness	Compliant with the standard IEC 62209 – 2 [1] requirements	Bottom plate: 2.0mm +/- 0.2mm	Prototypes, All items
Material parameters	Dielectric parameters for required frequencies	300 MHz – 6 GHz Rel. permittivity = 4 +/-1, Loss tangent ≤ 0.05	Material sample
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe Technical Note for material compatibility.	DEGMBE based simulating liquids	Equivalent phantoms, Material sample
Sagging	Compliant with the requirements according to the standard. Sagging of the flat section when filled with tissue simulating liquid	< 1% typical < 0.8% if filled with 155mm of HSL900 and without DUT below	Prototypes, Sample testing

**Standards**

- [1] IEC 62209 – 2, Draft Version 0.9, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures  
 Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", December 2004

**Conformity**

Based on the sample tests above, we certify that this item is in compliance with the standard [1].

Date 07.07.2005

**s p e e g**

Signature / Stamp

Schmid & Partner Engineering AG  
 Zeughausstrasse 43, 8004 Zurich, Switzerland  
 Phone +41 1 245 9700, Fax +41 1 245 9779  
 info@speag.com, http://www.speag.com

Fig. 17: Certificate of conformity for the used ELI4 phantom.

### 8.9 Pictures of the device under test

Fig. 18 – 21 shows the device under test and the used accessories.



Fig. 18: Picture of the device under test



Fig. 19: Used leather case.



Fig. 20: Used belt clip.

Configuration 1



Configuration 2



Configuration 3



Configuration 4







Fig. 21: Used headset configuration 1 – 6 according to Fig. 8.

**8.10 Test Positions for the Device under Test**

Fig. 22 - 25 shows the test positions for the SAR measurements.

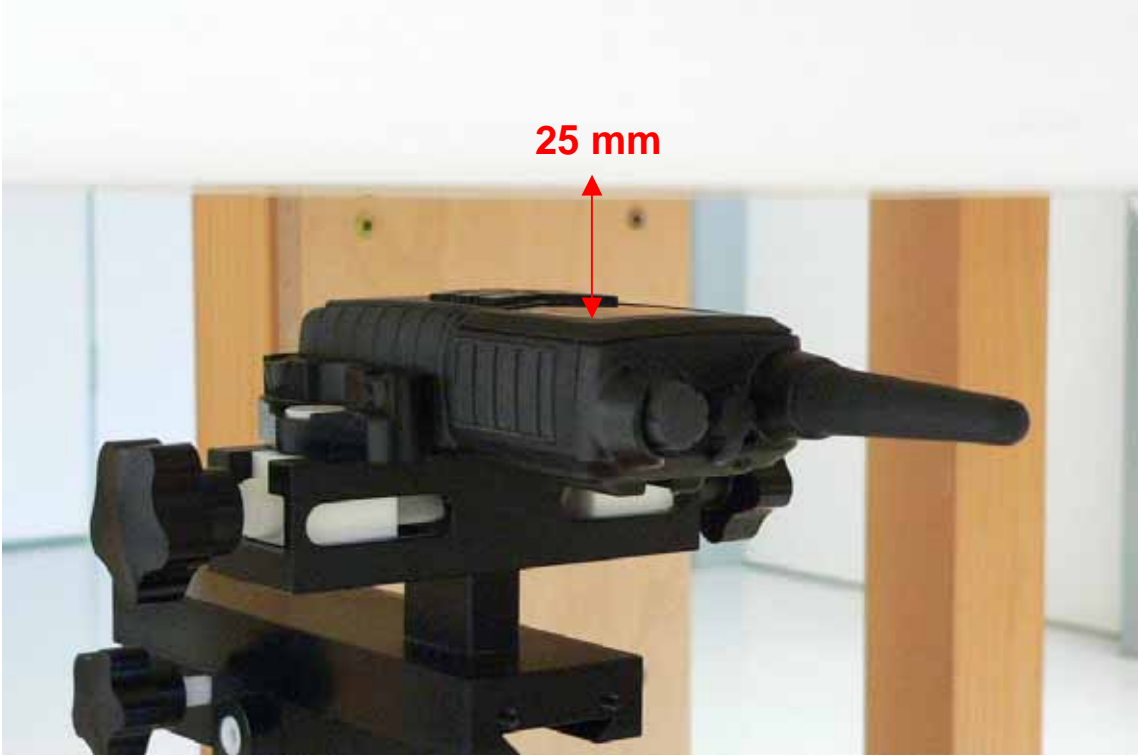


Fig. 22: PTT configuration, 25 mm distance.

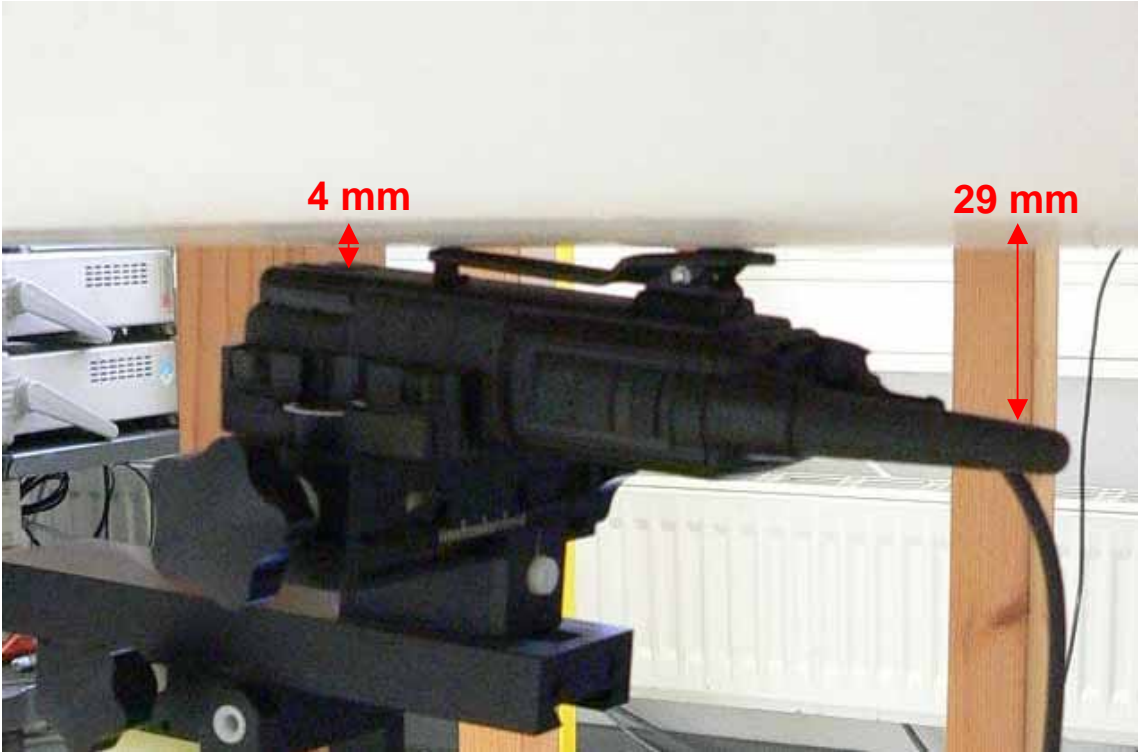


Fig. 23: Body worn with belt clip.



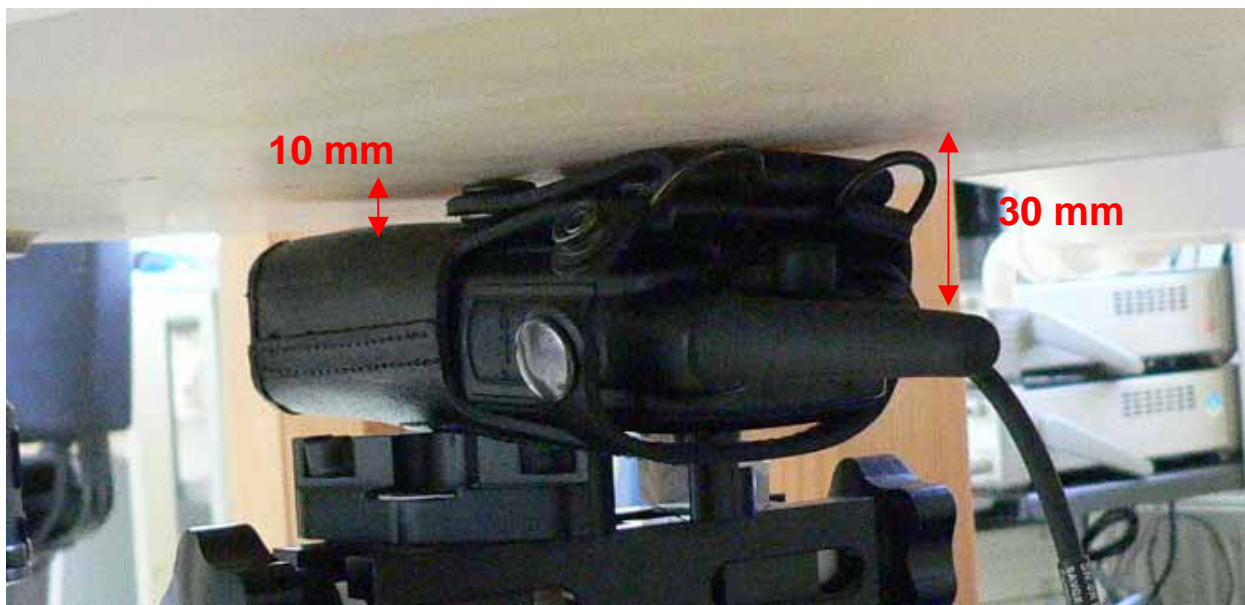


Fig. 24: Body worn with leather case, display towards the ground.



Fig. 25: Body worn with leather case, display towards the phantom.

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