TTI-P-G 158

Report

Dosimetric Assessment of the Portable Device Siemens S65 (FCC ID: PWX-S65) According to the FCC Requirements

May 06, 2004

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Executive Summary

The S65 is a mobile phone (Portable Device) from Siemens operating in the 900 MHz, 1800 MHz and 1900 MHz frequency range. The device has an integrated antenna. The system concepts used are the GSM 900, GSM 1800 and PCS 1900 standards including Bluetooth and GPRS capability with 2 TX slots (Class 10).

The objective of the measurements done by IMST was the dosimetric assessment of one device in the PCS 1900 standard.

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 [FCC 2001] 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.

The Siemens S65 mobile phone (FCC ID: PWX-S65) is in compliance with the Federal Communications Commission (FCC) Guidelines [FCC 2001] for uncontrolled exposure.

The phone was tested for the following configurations:

- **Body Worn with the following accessories and combinations with 2.2 cm distance:**

  GSM mode (1 TX slot) with headset

  GPRS mode (2 TX slots, Class 10)

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1 Subject of Investigation

The S65 is a mobile phone (Portable Device) from Siemens operating in the 900 MHz, 1800 MHz and 1900 MHz frequency range. The device has an integrated antenna. The system concepts used are the GSM 900, GSM 1800 and PCS 1900 standards including Bluetooth and GPRS capability with 2 TX slots (Class 10).

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 PCS 1900 standard. The examinations have been carried out with the dosimetric assessment system „DASY4“ described below.

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

In the USA the recent FCC exposure criteria [FCC 2001] are based upon the IEEE Standard C95.1 [IEEE 1999]. The IEEE standard C95.1 sets limits for human exposure to radio frequency electromagnetic fields in the frequency range 3 kHz to 300 GHz.

2.1 Distinction Between Exposed Population, Duration of Exposure and Frequencies

The American Standard [IEEE 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 σ and the mass density ρ of the biological tissue:

$$SAR = \sigma \frac{E^2}{\rho} = c \left. \frac{\partial T}{\partial t} \right|_{t \to 0+} \quad . \tag{1}$$

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 American 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	In force	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 1st of August 1996 [FCC 1996], 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 [FCC 2001].

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.

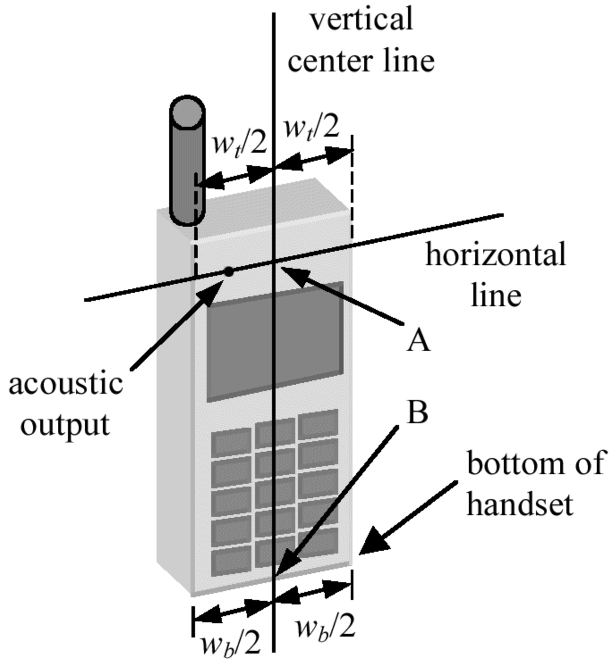

Fig. 2: Handset vertical and horizontal reference lines.

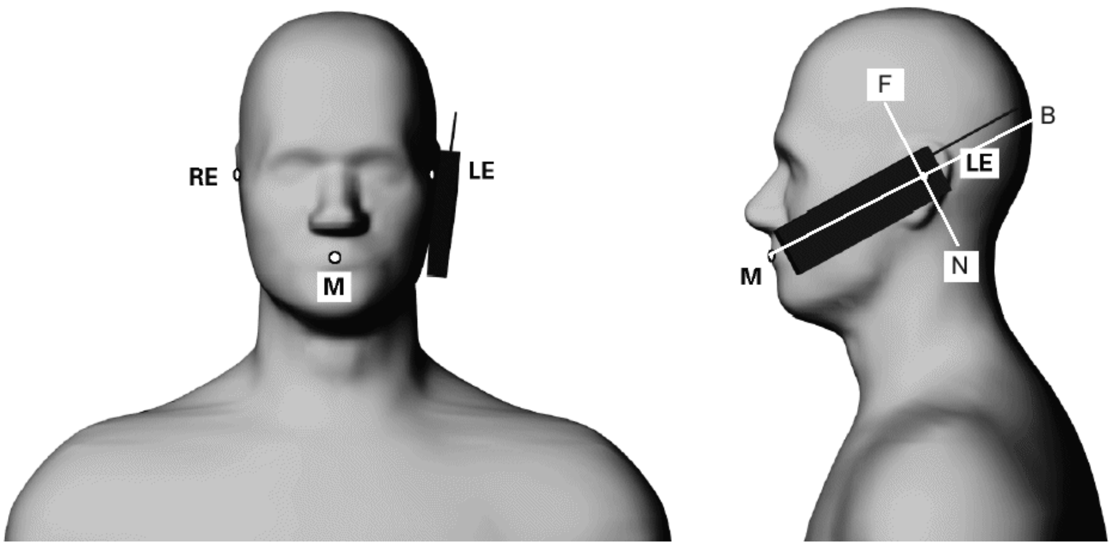

Fig. 3: Phantom reference points.

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.

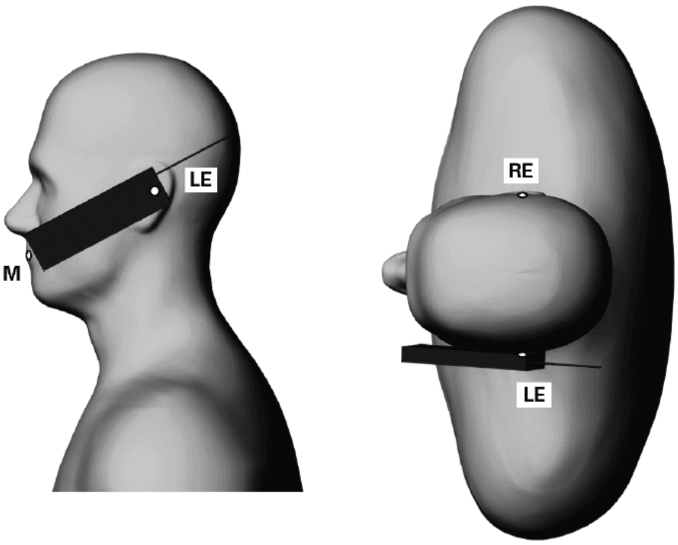

Fig. 4: The cheek position.

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

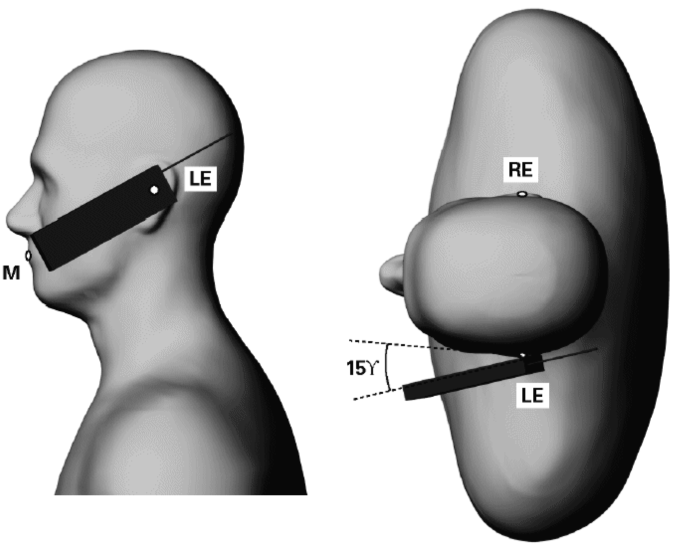

Fig. 5: The tilted position.

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.

3.3 Body-worn and Other Configurations

3.3.1 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.

3.3.2 Test Position

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.

3.3.3 Test to be Performed

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. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.

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 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.

- 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

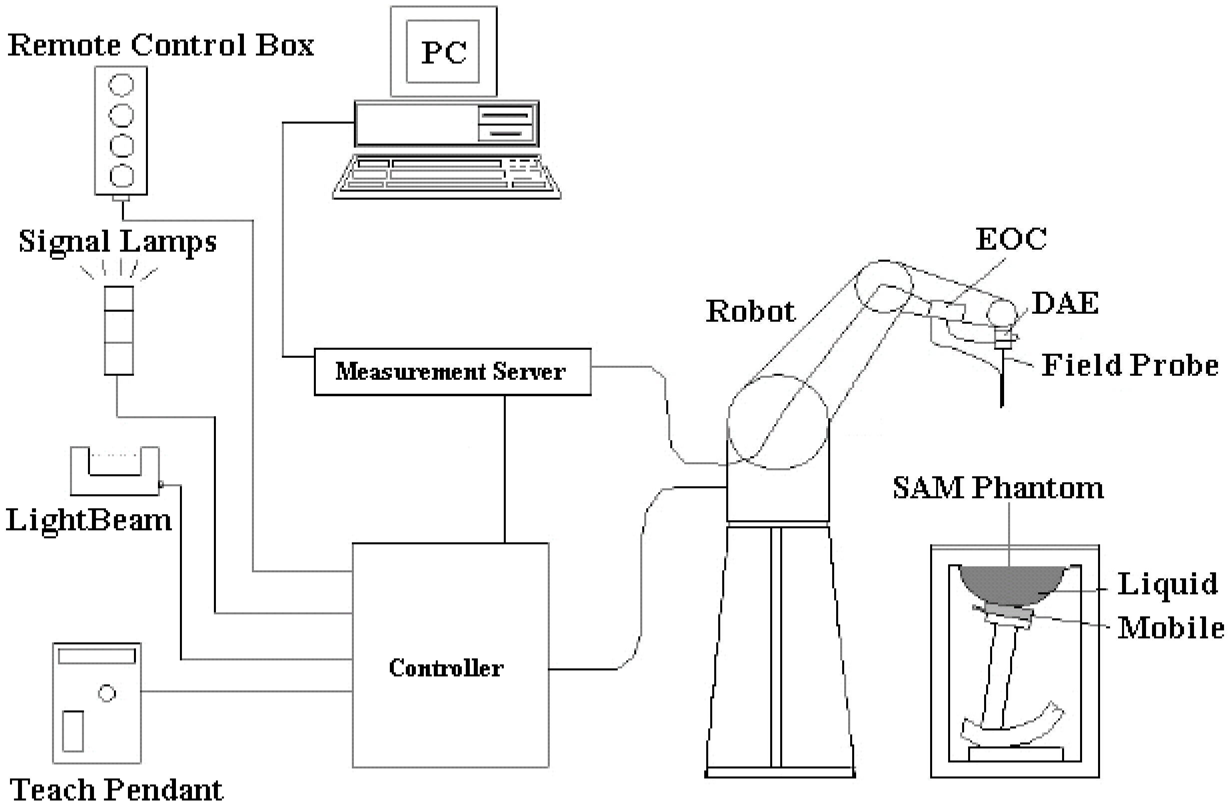

Fig. 6: The DASY4 measurement system.

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 σ and the mass density ρ 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.

4.1 Phantom

For the measurements the Specific Anthropomorphic Mannequin (SAM Twin Phantom V4.0) defined by the IEEE SCC-34/SC2 group 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 mm ± 0.2 mm. It enables the dosimetric evaluation of left and right hand phone usage and includes an additional flat phantom part for the simplified performance check. 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. 12.

4.2 Probe

For the measurements the Dosimetric E-Field Probe ET3DV6 with following specifications is used. It is manufactured and calibrated in accordance with FCC [FCC 2001] and IEEE [IEEE 1528-2003] recommendations annually by Schmid & Partner Engineering AG.

- Dynamic range: 5µW/g to > 100mW/g
- Tip diameter: 6.8 mm
- Distance between probe tip and sensor center: 2.7 mm
- Distance between sensor center and the inner phantom surface: 4 mm (repeatability better than ± 1.0 mm)
- Boundary effect compensation included within the SEMCAD software
- Probe linearity: ± 0.2 dB (30 MHz to 3 GHz)
- Axial isotropy: ± 0.2 dB
- Spherical isotropy: ± 0.4 dB
- Calibration range: 835MHz/1900 MHz for head & body simulating liquid
- Angle between probe axis (evaluation axis) and surface normal line: less than 30°

4.3 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 ± 0.21dB.

4.4 Uncertainty Assessment

Table 2 includes the uncertainty budget suggested by the [IEEE 1528-2003] and determined by Schmid & Partner Engineering AG. The expanded uncertainty (K=2) is assessed to be ± 20.6%.

Error Sources	Uncertainty Value	Probability Distribution	Divisor	c_i	Standard Uncertainty	v_i
Measurement System						
Probe calibration	± 4.8 %	Normal	1	1	± 4.8 %	∞
Axial isotropy	± 4.7 %	Rectangular	√3	0.7	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√3	0.7	± 3.9 %	∞
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	± 0.8 %	Rectangular	√3	1	± 0.5 %	∞
Integration time	± 2.6%	Rectangular	√3	1	± 1.5 %	∞
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 %	∞
Test Sample Related						
Device positioning	± 2.9 %	Normal	1	1	± 2.9 %	145
Device holder	± 3.6 %	Normal	1	1	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√3	1	± 2.9 %	∞
Phantom and Set-up						
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 %	∞
Combined Uncertainty					± 10.3 %	

Table 2: Uncertainty budget of DASY4.

5 SAR Results

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

Phantom Configuration ((Liquid depth = 16.4 cm)	Test Position	SAR_{1g} [W/kg] (Drift[dB])			Temperature	
		Channel 512 1850.2 MHz 28.9 dBm	Channel 661 1880.0 MHz 29.0 dBm	Channel 810 1909.8 MHz 29.2 dBm	Ambient [° C]	Liquid [° C]
Left Side	Cheek		0.375 (0.00788)		20.4	19.5
	Tilted		0.233 (0.0841)		20.5	19.5
Right Head	Cheek		0.388* (0.0305)		20.6	19.5
	Tilted		0.203 (0.0618)		20.6	19.6

Table 3: Measured head phantom results for PCS 1900 for the Siemens S65 without Flash (*Max Cube).

Phantom Configuration ((Liquid depth = 16.4 cm)	Test Position	SAR_{1g} [W/kg] (Drift[dB])			Temperature	
		Channel 512 1850.2 MHz 28.9 dBm	Channel 661 1880.0 MHz 29.0 dBm	Channel 810 1909.8 MHz 29.2 dBm	Ambient [° C]	Liquid [° C]
Left Side	Cheek		0.270*(0.189)		20.5	19.4
	Tilted		0.278 (0.0219)		20.6	19.5
Right Head	Cheek		0.243* (-0.0651)		20.6	19.4
	Tilted		0.178 (0.0985)		20.6	19.4

Table 4: Measured head phantom results for PCS 1900 for the Siemens S65 with Flash (*Max Cube).

Phantom Configuration ((Liquid depth = 16.4 cm)	Test Position	SAR_{1g} [W/kg] (Drift[dB])			Temperature	
		Channel 512 1850.2 MHz 28.9 dBm	Channel 661 1880.0 MHz 29.0 dBm	Channel 810 1909.8 MHz 29.2 dBm	Ambient [° C]	Liquid [° C]
Right Side	Cheek, without flash		0.432* (0.0717)		20.6	19.5

Table 5: Measured head phantom results for PCS 1900 for the Siemens S65, worst case position, with Bluetooth headset (*Max Cube).

Accessory (Liquid depth = 16.3 cm)	SAR_{1g} [W/kg] (Drift[dB])			Temperature	
	Channel 512 1850.2 MHz 28.9 dBm	Channel 661 1880.0 MHz 29.0 dBm	Channel 810 1909.8 MHz 29.2 dBm	Ambient [° C]	Liquid [° C]
S65, antenna towards the phantom with headset		0.131* (0.1)		20.1	19.1

Table 6: Measurement results in body-worn configuration for PCS 1900 for the Siemens S65 in GSM mode, 1 TX slot (gap = 2.2 cm) (*Max Cube).

Accessory (Liquid depth = 16.3 cm)	SAR_{1g} [W/kg] (Drift[dB])			Temperature	
	Channel 512 1850.2 MHz 28.9 dBm	Channel 661 1880.0 MHz 29.0 dBm	Channel 810 1909.8 MHz 29.2 dBm	Ambient [° C]	Liquid [° C]
S65, antenna towards the phantom		0.275* (-0.02)		20.2	19.1
S65, antenna towards the phantom & activated Bluetooth		0.263* (-0.02)		20.2	19.1

Table 7: Measurement results in body-worn configuration for PCS 1900 for the Siemens S65 in GPRS mode, 2 TX slots (gap = 2.2 cm) (*Max Cube).

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 (appendix).

The above mentioned power values are "conducted" power values, they were measured on the same sample which was used for the SAR measurements. The values were measured by IMST GmbH, Kamp-Lintfort and also verified during the SAR test.

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%. Please note that we add the measured "power drift" values from the DASY4 system since the used CMU 200 delivers only 1 usable position after decimal point and therefore only one power level is listed in the above tables.

6 Evaluation

In Fig. 8 the head phantom SAR results for PCS 1900 given in Table 3 - 5 are summarized and compared to the limit. In Fig. 9 the SAR results in body-worn configuration for PCS 1900 given in Table 6 - 7 are summarized and compared to the limit.

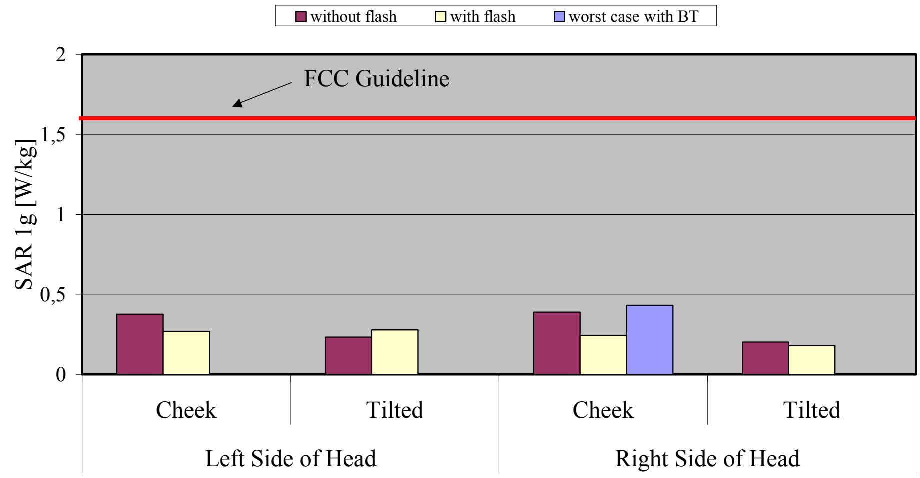

Fig. 8: The measured head phantom SAR values for the Siemens S65 without and with flash for PCS 1900 in comparison to the FCC exposure limit.

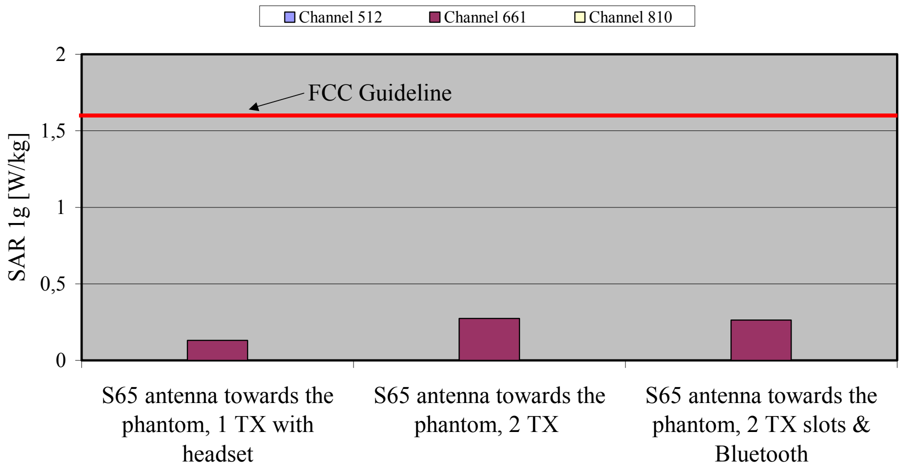

Fig. 9: The measured SAR values in body-worn configuration for the Siemens S65 for PCS 1900 (1 TX and 2 TX slots, gap = 2.2 cm) in comparison to the FCC exposure limit.

The Siemens S65 mobile phone (FCC ID: PWX-S65) is in compliance with the Federal Communications Commission (FCC) Guidelines [FCC 2001] for uncontrolled exposure.

The phone was tested for the following configurations:

- **Body Worn with the following accessories and combinations with 2.2 cm distance:**

  GSM mode (1 TX slot) with headset

  GPRS mode (2 TX slots, Class 10)

7 Appendix

7.1 Administrative Data

Date of validation:	1900 MHz, Head: May 03, 2004
	1900 MHz, Body: May 06, 2004
Date of measurement:	1900 MHz, Head May 03, 2004
	1900 MHz, Body: May 06, 2004
Data stored:	Siemens_6620_413

7.2 Device under Test and Test Conditions

MTE:	Siemens S65, Production Line Unit
Date of receipt:	April 28, 2004
IMEI:	004999002869310
FCC ID:	PWX-S65
Equipment class:	Portable device
Power Class:	PCS 1900: 1, tested with power level 0
RF exposure environment:	General Population/Uncontrolled
Power supply:	Internal Battery (Other batteries not available)
Antenna:	Antenna Type: integrated
Tested Accessories, Body:	headset
Measured Standards:	PCS 1900
Method to establish a call:	PCS 1900: Basestation simulator, using the air interface
Modulation:	GMSK
Crest Factor:	Talk Mode: 8.3; GPRS: 4 (Class 10)
TX range:	PCS 1900 : 1850.2 MHz – 1909.8 MHz
RX range:	PCS 1900 : 1930.2 MHz – 1989.8 MHz
Used TX Channels:	PCS 1900: low: ch. 512, center: ch. 661, high: ch. 810
Used Phantom:	SAM Twin Phantom V4.0, as defined by the IEEE SCC-34/SC2 group and delivered by Schmid & Partner Engineering AG

7.3 Tissue Recipes

The following recipes are provided in percentage by weight.

1900 MHz, Head:	45.65%	Diethylenglykol-monobutylether
	54.00%	De-Ionized Water
	0.35%	Salt
1900 MHz, Body:	29.68%	Diethylenglykol-monobutylether
	70.00%	De-Ionized Water
	0.32%	Salt

7.4 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.

Frequency		ε_r	σ [S/m]	Temperature	
				Ambient [° C]	Liquid [° C]
1900 MHz (Head)	Recommended Value	40.00 ± 2.00	1.40 ± 0.07	20.0 - 26.0	-
	Measured Value	39.10 ± 2.00	1.45 ± 0.15	20.3	19.4
1900 MHz (Body)	Recommended Value	53.30 ± 2.67	1.52 ± 0.08	20.0 - 26.0	-
	Measured Value	51.80 ± 2.60	1.58 ± 0.16	20.1	19.1

Table 8: Parameters of the tissue simulating liquids.

7.5 Simplified Performance Checking

The simplified performance check was realized using the dipole validation kits. The input power of the dipole antennas were 250 mW (cw signal) and they were placed under the flat part of the SAM phantom. The results are listed in the Table 9 and shown in Fig. 10-11. The target values were adopted from the manufactures calibration certificates which are attached in the appendix. Table 10 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 ± 16.8%.

Frequency		SAR_{1g} [W/kg]	ε_r	σ [S/m]	Temperature	
					Ambient [° C]	Liquid [° C]
1900 MHz (Head)	Target Value	10.20	39.75	1.45	20.0 - 26.0	-
	Measured Value	10.30	39.10	1.45	20.3	19.4
1900 MHz (Body)	Target Value	10.30	52.15	1.57	20.0 - 26.0	-
	Measured Value	10.50	51.80	1.58	20.1	19.1

Table 9: Validation results, 1900 MHz.

Test Laboratory: IMST GmbH; File Name: 030504_1669.da4

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN535

Program Name: System Performance Check at 1900 MHz

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1

Medium parameters used: f = 1900 MHz; σ = 1.45 mho/m; ε_r = 39.1; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1669; ConvF(5.19, 5.19, 5.19); Calibrated: 18.03.2004
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn335; Calibrated: 26.04.2004
- Phantom: SAM Glycol; Type: Speag; Serial: 1176
- Measurement SW: DASY4, V4.2 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 112

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

Reference Value = 95.6 V/m; Power Drift = -0.003 dB

Maximum value of SAR (measured) = 11.7 mW/g

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

Reference Value = 95.6 V/m; Power Drift = -0.003 dB

Maximum value of SAR (measured) = 11.7 mW/g

Peak SAR (extrapolated) = 18.1 W/kg

SAR(1 g) = 10.3 mW/g; SAR(10 g) = 5.38 mW/g

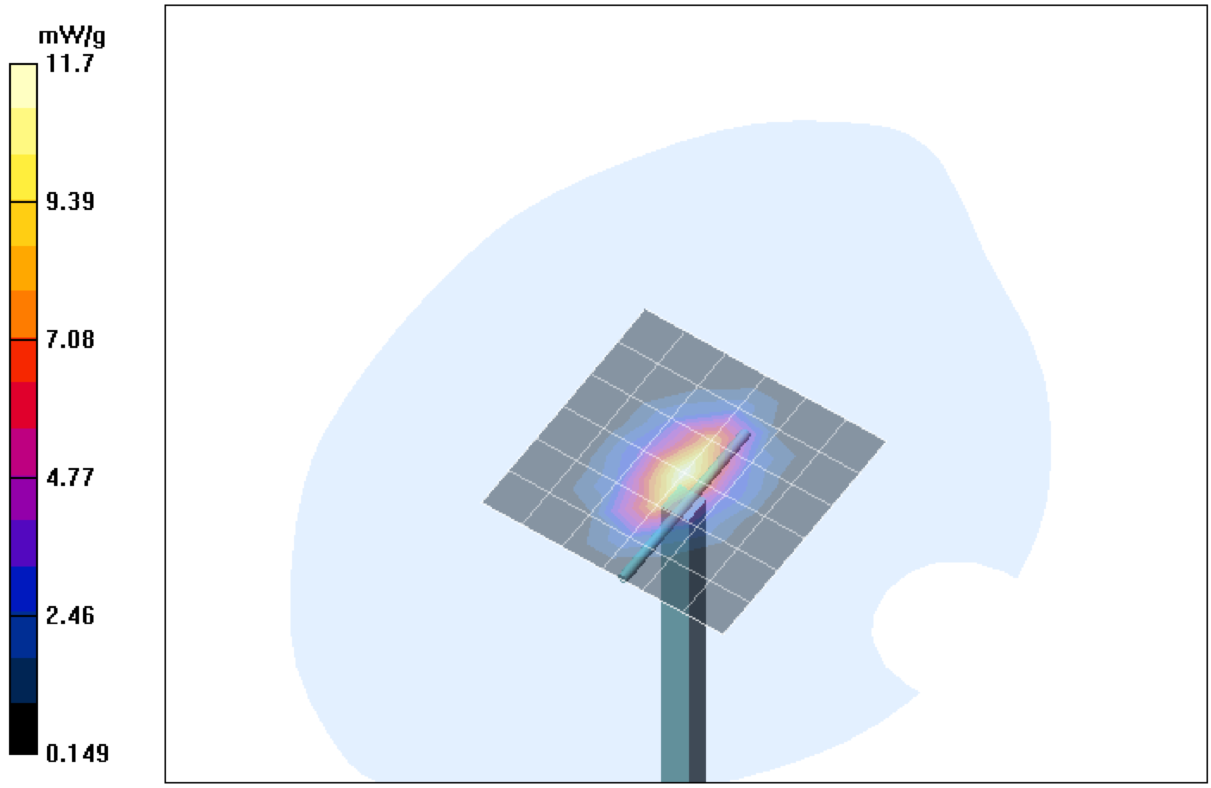

Fig. 10: Validation measurement 1900 MHz Head (May 03, 2004), coarse grid. Ambient Temperature: 20.3° C, Liquid Temperature: 19.4° C.

Test Laboratory: IMST GmbH; File Name: 060504_1579.da4

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN535

Program Name: System Performance Check at 1900 MHz

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1

Medium parameters used: σ = 1.58; mho/m, ε_r = 51.8; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1579; ConvF(4.8, 4.8, 4.8); Calibrated: 15.05.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn335; Calibrated: 26.04.2004
- Phantom: SAM Glycol; Type: Speag; Serial: 1176
- Measurement SW: DASY4, V4.2 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 112

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

Reference Value = 92.2 V/m; Power Drift = -0.009 dB

Maximum value of SAR (measured) = 11.9 mW/g

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

Reference Value = 92.2 V/m; Power Drift = -0.009 dB

Maximum value of SAR (measured) = 11.9 mW/g

Peak SAR (extrapolated) = 19 W/kg

SAR(1 g) = 10.5 mW/g; SAR(10 g) = 5.46 mW/g

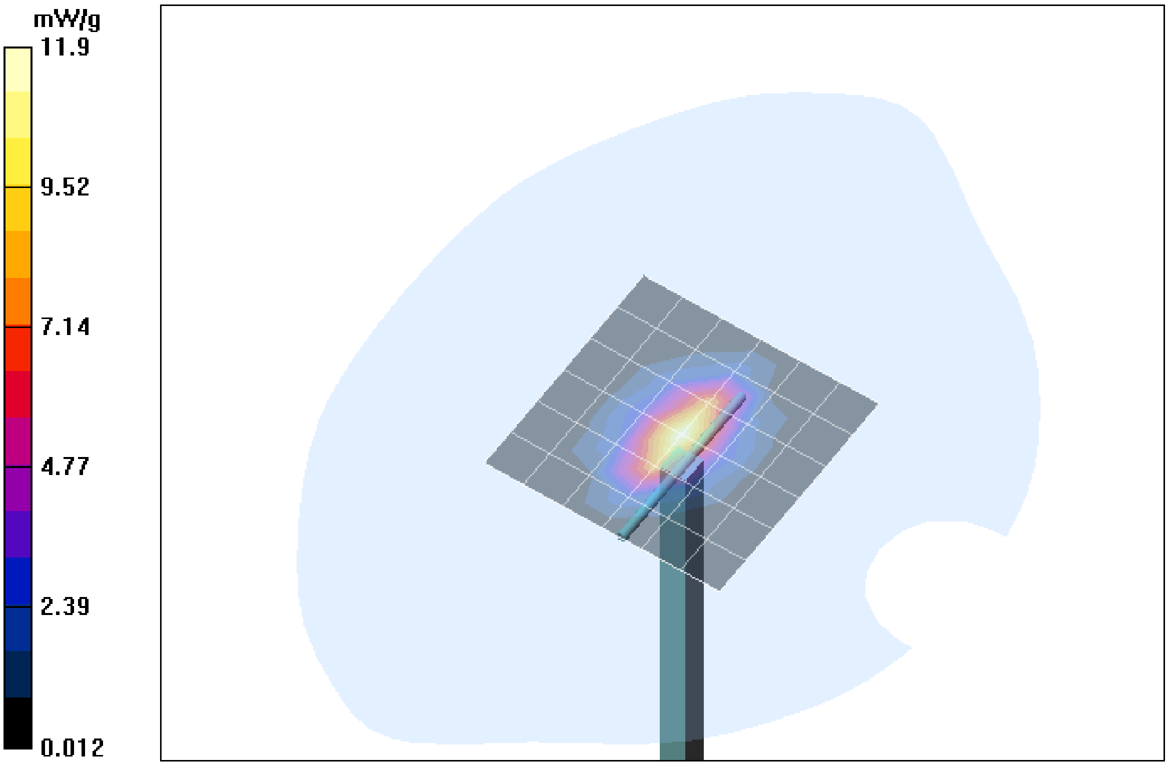

Fig. 11: Validation measurement 1900 MHz body (May 06, 2004), coarse grid.
Ambient Temperature: 20.1° C, Liquid Temperature: 19.1° C.

Error Sources	Uncertainty Value	Probability Distribution	Divisor	c_i	Standard Uncertainty	v_i
Measurement System						
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 %	∞
Dipole						
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 %	∞
Phantom and Set-up						
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 %	∞
Combined Uncertainty					± 8.4 %	

Table 10: Uncertainty budget for the system performance check.

7.6 Environment

To comply with the required noise level (less than 12 mW/kg) periodically measurements without a DUT were conducted.
Humidity: 37% ± 5 %

7.7 Test Equipment

Test Equipment	Model	Serial Number	Last Calibration	Next Calibration
DASY4 System				
Software Version	V4.2	N/A	N/A	N/A
Dosimetric E-Field Probe	ET3DV6	1669	03/2004	03/2005
Dosimetric E-Field Probe	ET3DV6	1579	05/2003	05/2004
Data Acquisition Electronics	DAE3 V1	335	04/2004	04/2005
Phantom	SAM	1176	N/A	N/A
Performance Checking				
System Validation Dipole, Head	D1900V2	535	11/2002	11/2004
System Validation Dipole, Body	D1900V2	535	11/2002	11/2004
Power Meter, Agilent	E4416A	GB41050414	12/2003	12/2004
Power Sensor, Agilent	E9301H	US40010212	12/2003	12/2004
Power Meter, Agilent	E4417A	GB41050441	12/2003	12/2004
Power Sensor, Agilent	E9301A	MY41495584	12/2003	12/2004
RF Source (Network Analyzer)	HP8753D	3410A06555	12/2003	12/2004
RF Amplifier, Mini-Circuits	ZHL-42	D012296	N/A	N/A
Material Measurement				
Network Analyzer	HP8753D	3410A06555	12/2003	12/2004
Dielectric Probe Kit	HP85070B	US33020263	N/A	N/A
General				
Radio Tester, Rohde & Schwarz	CMU200	837586/043	03/2004	03/2005

Table 11: Test equipment.

7.8 Certificates of conformity

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 BA
Series No	TP-1002 and higher
Manufacturer / Origin	Untersee Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland

Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness	Compliant with the requirements according to the standards	2mm +/- 0.2mm in specific areas	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample TP 104-5
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards	Liquid type HSL 1800 and others according to the standard.	Pre-series, First article

Standards

[1] CENELEC EN 50361
[2] IEEE P1528-200x draft 6.5
[3] IEC PT 62209 draft 0.9
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date 18.11.2001

Signature / Stamp

Schmid & Partner
Engineering AG
Zeughausstrasse 43, CH-8004 Zurich
Tel. +41 1 245 97 00, Fax +41 1 245 97 79

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Fig. 12: Certificate of conformity for the used SAM phantom

7.9 Pictures of the device under test

Fig. 13 – 17 show the device under test and the used accessories.

Fig. 13: Front view of the device.

Fig. 14: Back view of the device.

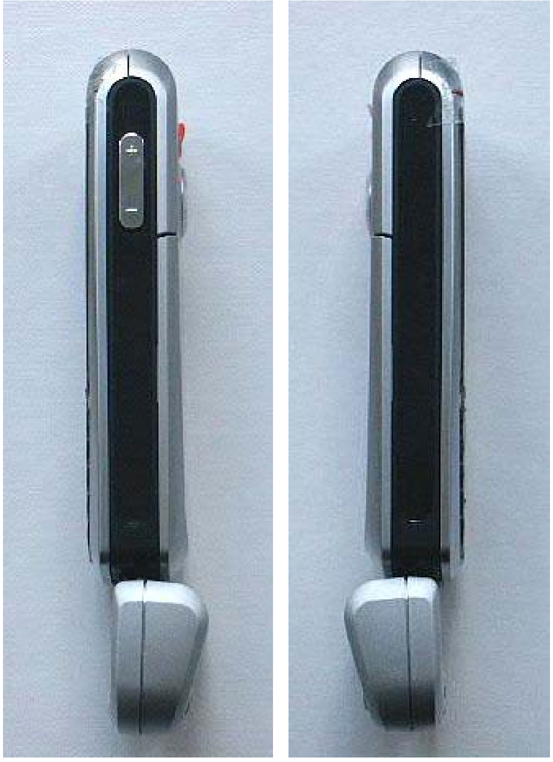

Fig. 15: Side view of the device.

Fig. 16: Used headset.

Fig. 17: Used data cable.

7.10 Test Positions for the Device under Test

Fig. 18 – Fig. 27 shown the test positions for the SAR measurements.

Fig. 18: Cheek position, left side.

Fig. 19: Tilted position, left side.

Fig. 20: Cheek position, right side.

Fig. 21: Tilted position, right side

Fig. 22: Cheek position, left side with flash.

Fig. 23: Tilted position, left side with flash.

Fig. 24: Cheek position, right side with flash.

Fig. 25: Tilted position, right side with flash

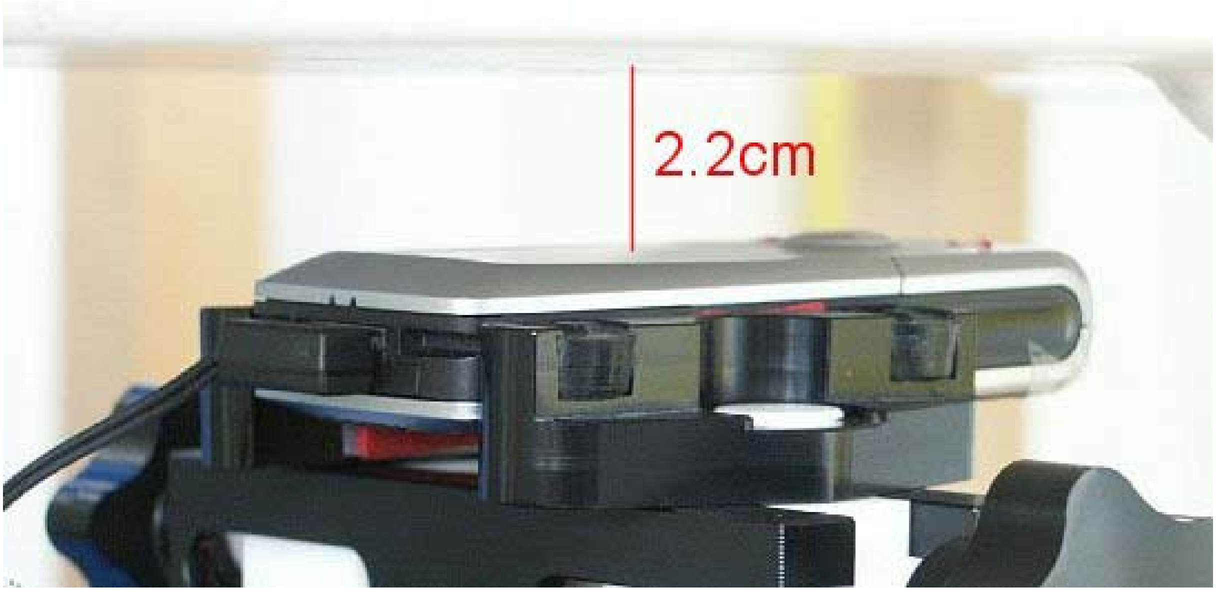

Fig. 26: Body worn configuration, GSM mode (1 TX) with headset, antenna towards the phantom.

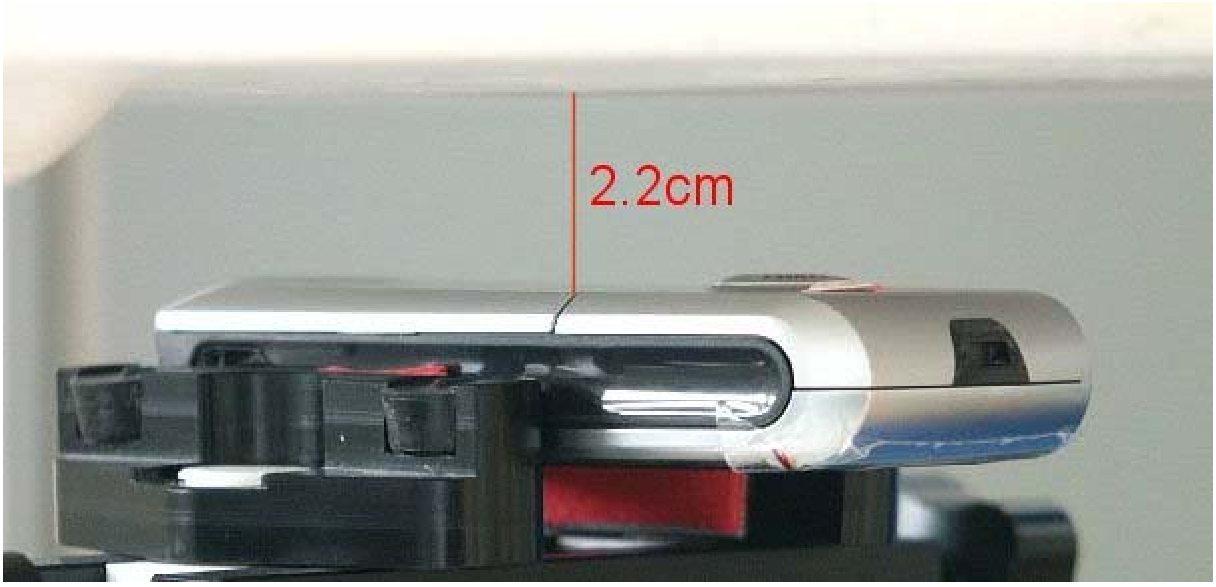

Fig. 27: Body worn configuration, GPRS mode (2 TX slot), antenna towards the phantom.

7.11 Pictures to demonstrate the required liquid depth

Fig. 28 show the liquid depth in the used SAM phantoms.

Fig. 28: Liquid depth for PCS 1900 Head and Body measurements.

8 References

[FCC 2001] Federal Communications Commission: Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01), FCC, 2001.

[IEEE 1999] IEEE Std C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, Inst. of Electrical and Electronics Engineers, Inc., 1999.

[IEEE 1528-2003] IEEE Std 1528-2003: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques. 1528-2003, December 19, 2003, The Institute of Electrical and Electronics Engineers.

[NIST 1994] NIST: Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, Technical Note 1297 (TN1297), United States Department of Commerce Technology Administration, National Institute of Standards and Technology, 1994.

[DASY4] Schmid & Partner Engineering AG: DASY4 Manual. February 2004