



TTI-P-G 158



Report

Dosimetric Assessment of the Siemens S-46 (FCC ID: PWX-S46) According to the FCC Requirements

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Executive Summary

The S-46 is a new mobile phone from Siemens operating in the 800 MHz, 900 MHz and 1900 MHz frequency range. The device has a helix antenna. The system concepts used are the TDMA 800, TDMA 1900, GSM 900 and PCS 1900 standards.

The objective of the measurements done by IMST was the dosimetric assessment of one device in the TDMA 800, TDMA 1900 and PCS 1900 standards. The examinations have been carried out with the dosimetric assessment system „DASY3“.

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.

The Siemens S-46 mobile phone (FCC ID: PWX-S46) is in compliance with the Federal Communications Commission (FCC) Guidelines [FCC 2001] for uncontrolled exposure. The phone was tested in the Body Worn configurations with the following accessories and combinations: “Belt Clip” with “Headset” and “Belt Clip” with “MP3 Player USB”.

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1 Subject of Investigation

The S-46 is a new mobile phone from Siemens operating in the 800 MHz, 900 MHz and 1900 MHz frequency range. The device has a helix antenna. The system concepts used are the TDMA 800, TDMA 1900, GSM 900 and PCS 1900 standards.



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 TDMA 800, TDMA 1900 and PCS 1900 standards. The examinations have been carried out with the dosimetric assessment system „DASY3“ 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:

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

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 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.

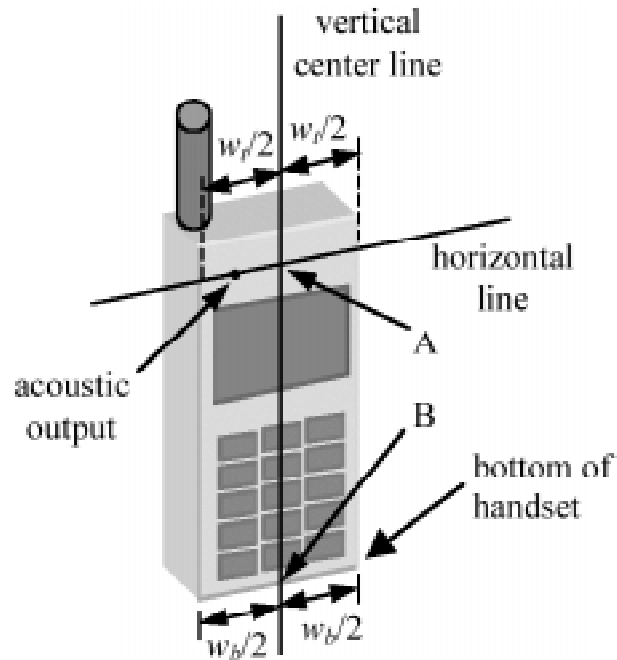


Fig. 2: Handset vertical and horizontal reference lines.

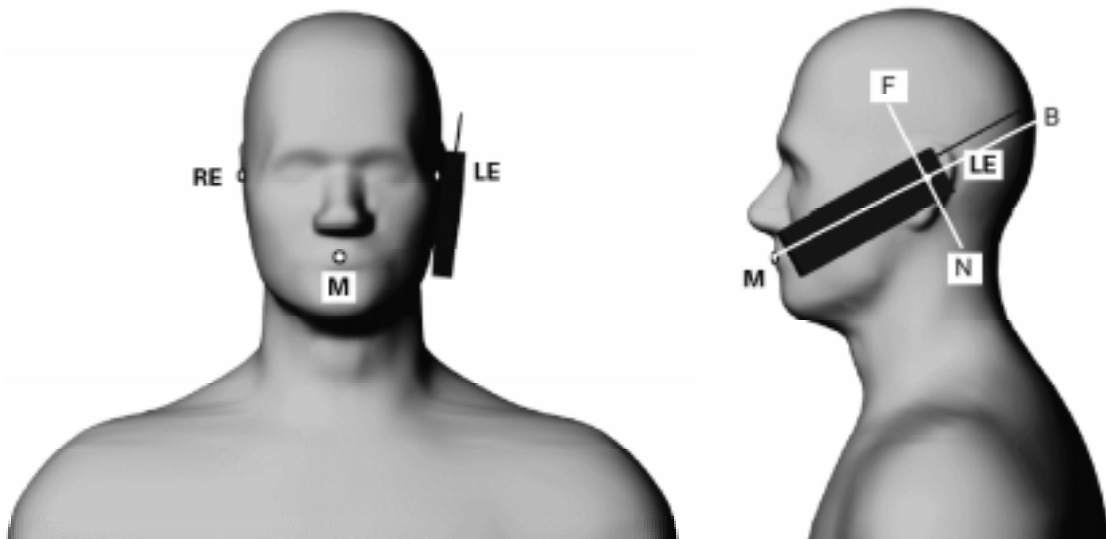


Fig. 3: Phantom reference points.

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.

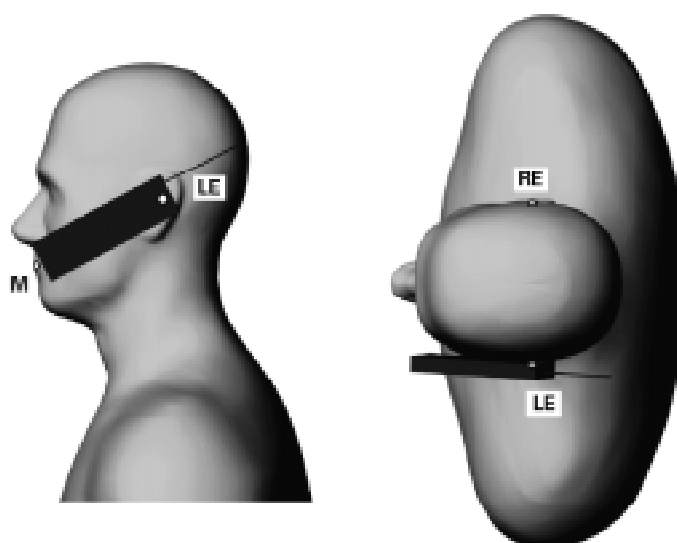


Fig. 4: The cheek position.

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

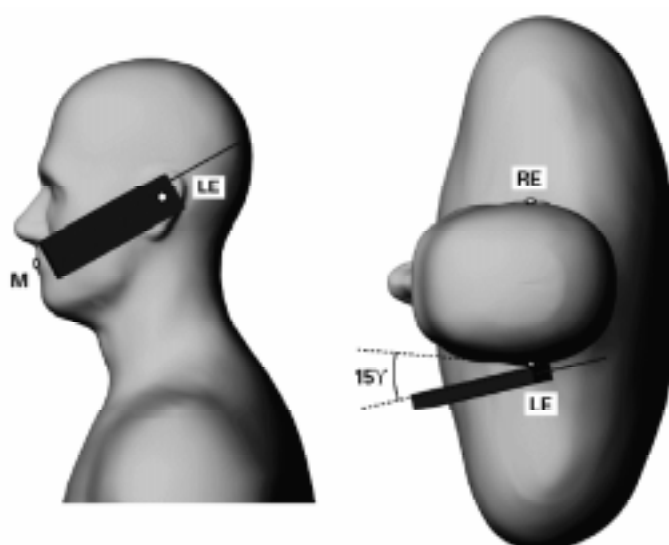


Fig. 5: The tilted position.

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 2.0 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 2.0 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. It consists of a robot, several field probes calibrated for use in liquids, a shell phantom, tissue simulating liquid and software. The software controls the robot and processes the measured data to compare them with safety levels with respect to human exposure to radio frequency electromagnetic fields. Fig. 6 shows the equipment, similar to the installations in other laboratories [DASY 1995].



Fig. 6: The measurement set-up with two phantoms containing tissue simulating liquid.

The mobile phone operating at the maximum power level is placed by a non metallic device holder 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. The system software is able to determine the averaged SAR values (averaging region 1 g or 10 g) for compliance testing.

This is done by two scans: first a coarse scan determines the region of the maximum SAR, afterwards the 1 g or 10 g averaged SAR is measured in a second fine scan. The measurement time takes about 20 minutes.

For the measurements the Specific Anthropomorphic Mannequin (SAM) is used. The phantom is a fibreglass shell integrated in a wooden table. The thickness of the phantom amounts to $2 \text{ mm} \pm 0.1 \text{ mm}$. It enables the dosimetric evaluation of left and right hand phone usage and includes an additional flat phantom part. The phantom set-up includes a coverage (polyethylene), which prevents the evaporation of the liquid.

4.1 Measurement Procedure

The following steps are used for each test position:

- Measurement of the local SAR 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 $15 \text{ mm} \times 15 \text{ mm}$ and a constant distance to the inner surface of the phantom. With interpolation of these values, the area of the maximum SAR is calculated.
- Around this point, a cube of $30 \text{ mm} \times 30 \text{ mm} \times 30 \text{ mm}$ is assessed by measuring $7 \times 7 \times 7$ points. With these data, the peak spatial-average SAR value is calculated.
- Repetition of the SAR measurement at the fixed location (P1) and repetition of the whole procedure if the two results differ by more than $\pm 5\%$.

4.2 Uncertainty Assessment

Table 2 includes the preliminary uncertainty budget suggested by the [IEEE 200x] and determined according to NIST TN1297 [NIST 1994]. The extended uncertainty (K=2) is assessed to be $\pm 24.1\%$. This uncertainty includes probe, calibration, positioning and evaluation errors as well as errors the correct dielectric parameters for the tissue simulating liquid, etc..

| Error Sources | Uncertainty Value | Probability Distribution | c_i | Standard Uncertainty |
|-------------------------------|-------------------|--------------------------|-------|----------------------|
| Measurement System | | | | |
| Probe calibration | $\pm 2.6 \%$ | Normal | 1 | $\pm 2.6 \%$ |
| Axial isotropy | $\pm 2.3 \%$ | Rectangular | 0.7 | $\pm 0.9 \%$ |
| Spherical isotropy | $\pm 5.9 \%$ | Rectangular | 0.7 | $\pm 2.4 \%$ |
| Spatial resolution | $\pm 0.5 \%$ | Rectangular | 1 | $\pm 0.3 \%$ |
| Boundary effect | $\pm 11.0 \%$ | Rectangular | 1 | $\pm 6.4 \%$ |
| Linearity | $\pm 4.7 \%$ | Rectangular | 1 | $\pm 2.7 \%$ |
| Detection limit | $\pm 2.0 \%$ | Rectangular | 1 | $\pm 1.2 \%$ |
| Readout electronics | $\pm 1.0 \%$ | Normal | 1 | $\pm 1.0 \%$ |
| RF ambient conditions | $\pm 3.0 \%$ | Rectangular | 1 | $\pm 1.7 \%$ |
| Mechanical robot constraints | $\pm 0.4 \%$ | Normal | 1 | $\pm 0.4 \%$ |
| Probe positioning | $\pm 5.0 \%$ | Rectangular | 1 | $\pm 2.9 \%$ |
| Extrapolation and integration | $\pm 3.9 \%$ | Rectangular | 1 | $\pm 2.3 \%$ |
| Test Sample Related | | | | |
| Device positioning | $\pm 6.0 \%$ | Normal | 1 | $\pm 6.0 \%$ |
| Power drift | $\pm 5.0 \%$ | Rectangular | 1 | $\pm 2.9 \%$ |
| Phantom and Set-up | | | | |
| Liquid conductivity (target) | $\pm 5.0 \%$ | Rectangular | 0.6 | $\pm 1.7 \%$ |
| Liquid conductivity (meas.) | $\pm 10.0 \%$ | Rectangular | 0.6 | $\pm 3.5 \%$ |
| Liquid permittivity (target) | $\pm 5.0 \%$ | Rectangular | 0.6 | $\pm 1.7 \%$ |
| Liquid permittivity (meas.) | $\pm 5.0 \%$ | Rectangular | 0.6 | $\pm 1.7 \%$ |
| Combined Uncertainties | | | | $\pm 12.05 \%$ |

Table 2: Uncertainty budget of DASY3.

5 SAR Results

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

| Phantom Configuration | Test Position | SAR _{1g} [W/kg] (Drift[dB]) | | |
|-----------------------|---------------|---------------------------------------|---------------------------------------|---------------------------------------|
| | | Channel 991 824.04 MHz 25.7 dBm | Channel 383 836.49 MHz 25.8 dBm | Channel 799 848.97 MHz 25.9 dBm |
| Left Side of Head | Cheek | | 0.559 (-0.04) | |
| | Tilted | | 0.335 (0.01) | |
| Right Side of Head | Cheek | 0.588* (-0.03) | 0.606 (-0.06) | 0.622* (-0.04) |
| | Tilted | | 0.357 (0.06) | |

Table 3: Measured head phantom results for TDMA 800 for the Siemens S-46 (*Cube 1).

| Phantom Configuration | Test Position | SAR _{1g} [W/kg] (Drift[dB]) | | |
|-----------------------|---------------|---|---|---|
| | | Channel 0002 1850.04 MHz 26.0 dBm | Channel 1000 1879.98 MHz 26.0 dBm | Channel 1998 1909.92 MHz 26.0 dBm |
| Left Side of Head | Cheek | 0.854* (0.06) | 0.867* (0.01) | 0.834* (-0.02) |
| | Tilted | 0.981 (0.03) | 1.000 (0.02) | 0.973 (0.02) |
| Right Side of Head | Cheek | 1.030 (-0.01) | 1.030 (0.01) | 1.020 (-0.08) |
| | Tilted | 1.080 (0.0) | 1.120 (-0.01) | 1.100 (-0.01) |

Table 4: Measured head phantom results for TDMA 1900 for the Siemens S-46 (*Cube 1).

| Phantom Configuration | Test Position | SAR _{1g} [W/kg] (Drift[dB]) | | |
|-----------------------|---------------|--|--|--|
| | | Channel 512 1850.20 MHz 29.3 dBm | Channel 661 1880.00 MHz 29.3 dBm | Channel 810 1909.80 MHz 29.0 dBm |
| Left Side of Head | Cheek | | 0.724* (-0.01) | |
| | Tilted | | 0.809 (-0.01) | |
| Right Side of Head | Cheek | | 0.738* (0.01) | |
| | Tilted | 0.929 (0.02) | 0.918 (0.0) | 0.844 (-0.01) |

Table 5: Measured head phantom results for PCS 1900 for the Siemens S-46 (*Cube 1).

| Accessory | SAR _{1g} [W/kg] (Drift[dB]) | | |
|--|---------------------------------------|---------------------------------------|---------------------------------------|
| | Channel 991 824.04 MHz 25.7 dBm | Channel 383 836.49 MHz 25.8 dBm | Channel 799 848.97 MHz 25.9 dBm |
| S-46 with Belt Clip and Headset | 0.167 (-0.17) | 0.179 (-0.18) | 0.171 (-0.03) |
| S-46 with Belt Clip and MP3 Player USB | 0.228 (0.02) | 0.214 (0.04) | 0.278 (0.02) |

Table 6: Measurement results in body-worn configuration for TDMA 800 for the Siemens S-46 .

| Accessory | SAR _{1g} [W/kg] (Drift[dB]) | | |
|--|---|---|---|
| | Channel 0002 1850.04 MHz 26.0 dBm | Channel 1000 1879.98 MHz 26.0 dBm | Channel 1998 1909.92 MHz 26.0 dBm |
| S-46 with Belt Clip and Headset | 0.253* (-0.03) | 0.242 (0.01) | 0.225 (-0.05) |
| S-46 with Belt Clip and MP3 Player USB | 0.234 (-0.01) | 0.248* (-0.04) | 0.262* (-0.01) |

Table 7: Measurement results in body-worn configuration for TDMA 1900 for the Siemens S-46 (* Cube 1).

| Accessory | SAR _{1g} [W/kg] (Drift[dB]) | | |
|--|--|--|--|
| | Channel 512 1850.20 MHz 29.3 dBm | Channel 661 1880.00 MHz 29.3 dBm | Channel 810 1909.80 MHz 29.0 dBm |
| S-46 with Belt Clip and Headset | 0.219* (-0.07) | 0.197* (0.02) | 0.174* (0.02) |
| S-46 with Belt Clip and MP3 Player USB | 0.181* (0.0) | 0.179* (0.03) | 0.161(-0.01) |

Table 8: Measurement results in body-worn configuration for PCS 1900 for the Siemens S-46 (* Cube 1).

The above mentioned power values are conducted measured values. The power output was measured by the FCC accredited test lab TÜV Product Service, San Diego. The same unit was used for the SAR measurements.

Before the measurements the test side ambient conditions were checked performing SAR measurements with the phone powered off. The results were shown in the Appendix SAR Plots.

6 Evaluation

In Fig. 7 - 9 the head phantom SAR results for TDMA 800, TDMA 1900 and PCS 1900 given in Table 3 - 5 are summarized and compared to the limit. In Fig. 10 - 12 the SAR results in body-worn configuration for TDMA 800, TDMA 1900 and PCS 1900 given in Table 6 - 8 are summarized and compared to the limit.

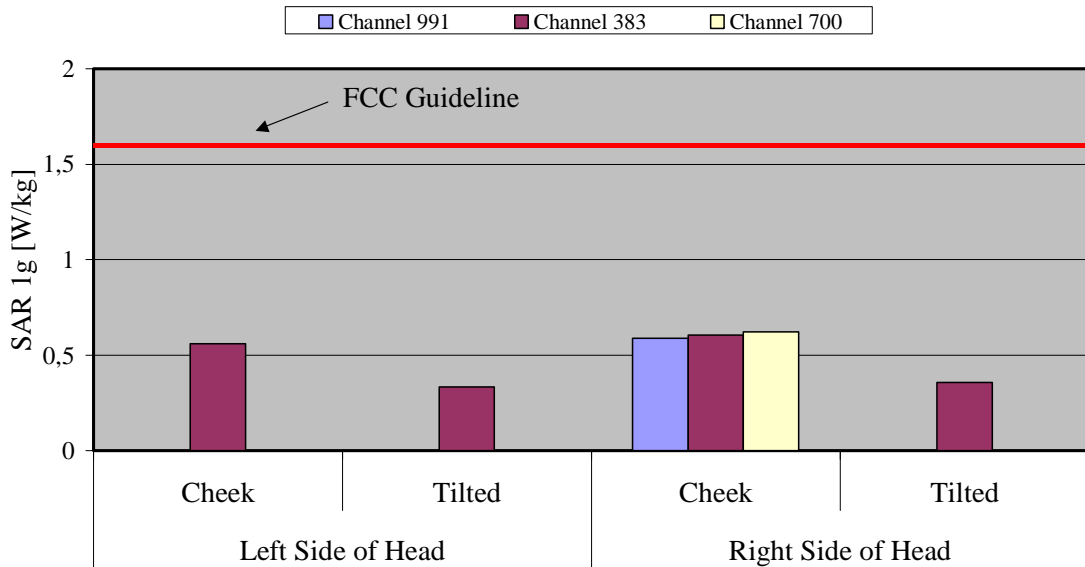


Fig. 7: The measured head phantom SAR values for the Siemens S-46 for TDMA 800 in comparison to the FCC exposure limit.

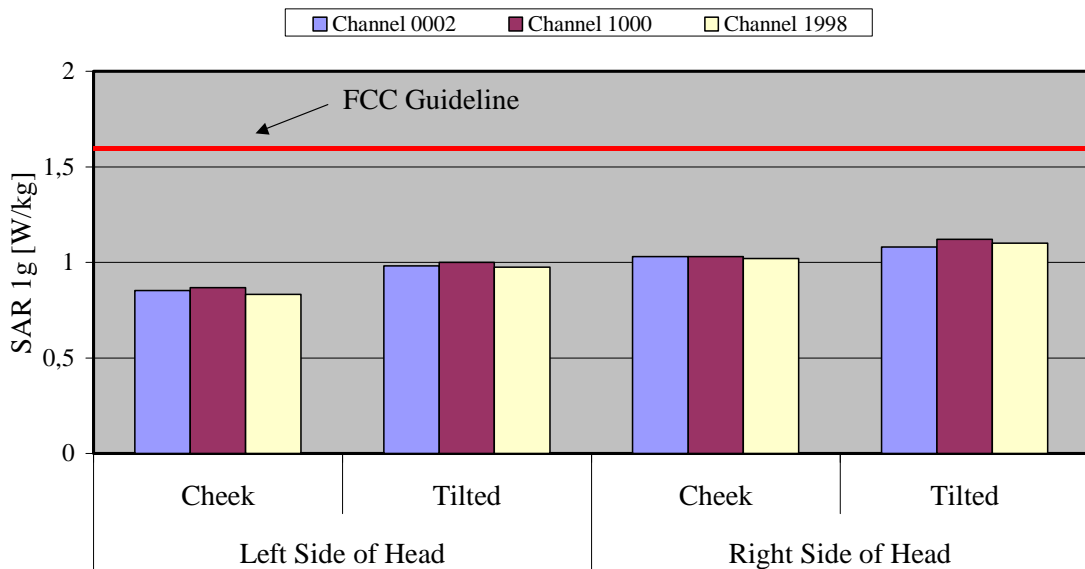


Fig. 8: The measured head phantom SAR values for the Siemens S-46 for TDMA 1900 in comparison to the FCC exposure limit.

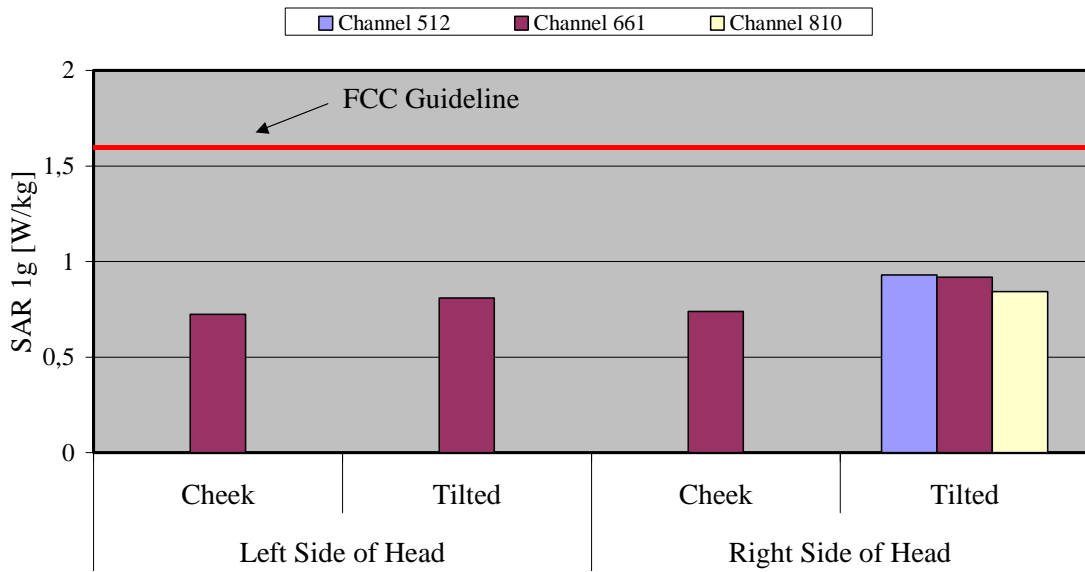


Fig. 9: The measured head phantom SAR values for the Siemens S-46 for PCS 1900 in comparison to the FCC exposure limit.

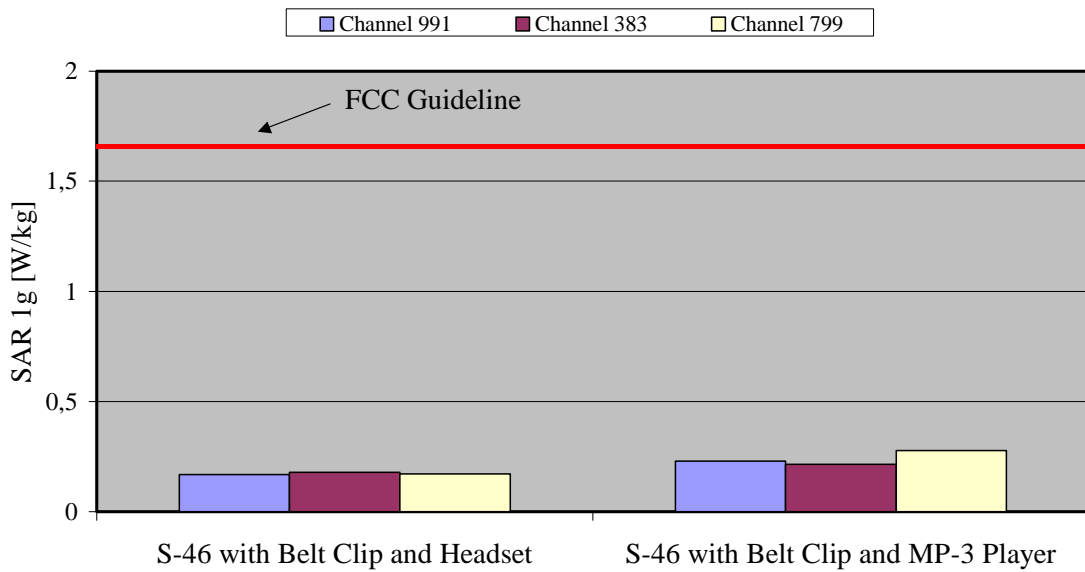


Fig. 10: The measured SAR values in body-worn configuration for the Siemens S-46 for TDMA 800 in comparison to the FCC exposure limit.

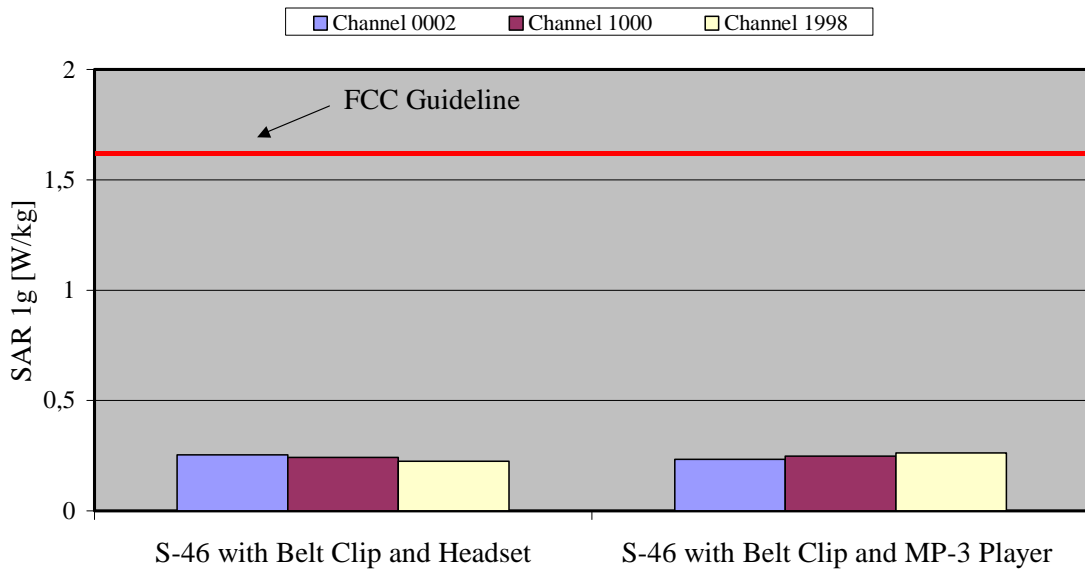


Fig. 11: The measured SAR values in body-worn configuration for the Siemens S-46 for TDMA 1900 in comparison to the FCC exposure limit.

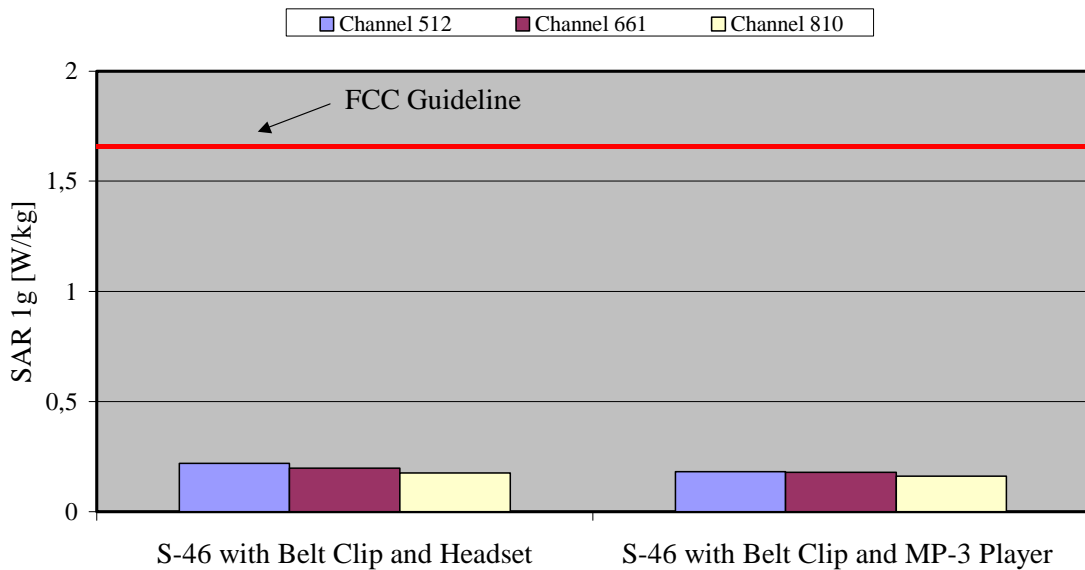


Fig. 12: The measured SAR values in body-worn configuration for the Siemens S-46 for PCS 1900 in comparison to the FCC exposure limit.

The Siemens S-46 mobile phone (FCC ID: PWX-S46) is in compliance with the Federal Communications Commission (FCC) Guidelines [FCC 2001] for uncontrolled exposure. The phone was tested in the Body Worn configurations with the following accessories and combinations: “Belt Clip” with “Headset” and “Belt Clip” with “MP3 Player USB”.

7 Appendix

7.1 Administrative Data

| | |
|----------------------|---|
| Date of validation: | 835 MHz, Head: October 30, 2001 835 MHz, Body: November 01, 2001 1900 MHz, Head: October 31, 2001 1900 MHz, Body: November 02, 2001 |
| Date of measurement: | TDMA 800, Head: October 30, 2001 TDMA 800, Body: November 01, 2001 TDMA 1900, Head: October 31, 2001 TDMA 1900, Body: November 02, 2001 PCS 1900, Head: October 31, 2001 PCS 1900, Body: November 02, 2001 |
| Data stored: | Siemens_6575_190 |

Since the measurements were done with two phantoms, different designations in the SAR distribution plots were used. The phantom used for the 800 MHz measurements is marked as SAM, the phantom used for the 1900 MHz measurements (TDMA 1900 and PCS 1900) is marked as GSM 1800.

7.2 Device under Test and Test Conditions

| | |
|--------------------------|--|
| MTE: | Siemens S-46, Production Line Unit |
| Date of receipt: | October 30, 2001 |
| IMEI: | 004999510947962 |
| FCC ID: | PWX-S46 |
| Device Category: | Mobile device |
| RF exposure environment: | General Population/Uncontrolled |
| Power supply: | Internal Battery (Other batteries not available) |
| Antenna: | Antenna Typ: Helix |
| Measured Standards: | TDMA 800 (Internal Testmode), TDMA 1900 (Internal Testmode), PCS 1900 (Basestation Simualtor) |
| Modulation: | TDMA, GMSK |
| Crest Factor: | TDMA: 3, PCS 1900: 8 |
| TX range: | TDMA 800 : 824.04 MHz – 848.97 MHz TDMA 1900 : 1850.04 MHz – 1909.92 MHz PCS 1900 : 1850.2 MHz – 1909.8 MHz |
| RX range: | TDMA 800 : 869.04 MHz – 893.97 MHz TDMA 1900 : 1930.08 MHz – 1989.96 MHz PCS 1900 : 1930.2 MHz – 1989.8 MHz |
| Used TX Channels: | TDMA 800: low: ch. 991, center: ch. 383, high: ch. 799 TDMA 1900: low: ch. 0002, center: ch. 1000, high: ch. 1998 PCS 1900: low: ch. 512, center: ch. 661, high: ch. 810 |

7.3 Tissue Recipes

The following recipes are provided in percentage by weight.

| | |
|-----------------|---------------------------------------|
| 835 MHz, Head: | 41.45 % De-Ionized Water |
| | 1.45 % Salt |
| | 56.00 % Sugar |
| | 00.10 % Preventol D7 |
| | 01.00 % Hydroxyetyl-Cellulose |
| 835 MHz, Body: | 52.40 % De-Ionized Water |
| | 01.50 % Salt |
| | 45.00 % Sugar |
| | 00.10 % Preventol D7 |
| | 01.00 % Hydroxyetyl-Cellulose |
| 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

| Frequency | | ϵ_r | σ [S/m] |
|--------------------|-------------------|----------------|-----------------|
| 835 MHz (Head) | Recommended Value | 41.5 ± 2.0 | 0.90 ± 0.07 |
| | Measured Value | 43.0 ± 2.2 | 0.90 ± 0.09 |
| 835 MHz (Body) | Recommended Value | 55.2 ± 2.7 | 0.97 ± 0.08 |
| | Measured Value | 55.1 ± 2.8 | 0.99 ± 0.10 |
| 1900 MHz (Head) | Recommended Value | 40.0 ± 2.0 | 1.40 ± 0.07 |
| | Measured Value | 38.9 ± 1.9 | 1.45 ± 0.15 |
| 1900 MHz (Body) | Recommended Value | 53.3 ± 2.7 | 1.52 ± 0.08 |
| | Measured Value | 53.1 ± 2.7 | 1.57 ± 0.16 |

Table 9: Parameters of the tissue simulating liquid, 835 MHz.

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 and they were placed under the flat part of the SAM phantom. The results are listed in the Table 10-11 and shown in Fig. 13-16

| Frequency | | SAR_{1g} [W/kg] | ϵ_r | σ [S/m] |
|-------------------|----------------|-------------------|--------------|----------------|
| 835 MHz (Head) | Target Value | 2.67 | 43.00 | 0.91 |
| | Measured Value | 2.57 | 43.00 | 0.90 |
| 835 MHz (Body) | Target Value | 2.57 | 55.30 | 0.92 |
| | Measured Value | 2.66 | 55.10 | 0.99 |

Table 10: Validation results, 835 MHz.

| Frequency | | SAR_{1g} [W/kg] | ϵ_r | σ [S/m] |
|--------------------|----------------|-------------------|--------------|----------------|
| 1900 MHz (Head) | Target Value | 10.8 | 39.20 | 1.47 |
| | Measured Value | 10.9 | 38.90 | 1.45 |
| 1900 MHz (Body) | Target Value | 10.2 | 53.50 | 1.46 |
| | Measured Value | 11.2 | 53.10 | 1.57 |

Table 11: Validation results, 1900 MHz.

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Dipole 835 MHz

SAM; Flat

Probe: ET3DV6 - SN1579, CorvF(6.90,6.90,6.90), Crest factor: 1.0, Brain 835 MHz, $\sigma = 0.90$ mho/m, $\epsilon_r = 43.0$, $\rho = 1.00$ g/cm³
 Cubes (2): Peak: 4.38 mW/g \pm 0.41 dB, SAR (1g): 2.57 mW/g \pm 0.08 dB, SAR (10g): 1.64 mW/g \pm 0.07 dB, (Worst-case extrapolation)
 Penetration depth: 12.2 (11.0, 13.8) [mm]



Fig. 13: Validation measurement 835 MHz Head, coarse grid.

Dipole 835 MHz

SAM: Flat

Probe: ET3DV6 - SNI1579, ConvF(6.60,6.60,6.60); Crest factor: 1.0; body 835 MHz: $\sigma = 0.99$ mho/m $\epsilon_r = 55.1$ $\rho = 1.00$ g/cm³
Cubes (2): Peak: 4.20 mW/g ± 0.04 dB, SAR (1g): 2.66 mW/g ± 0.00 dB, SAR (10g): 1.70 mW/g ± 0.01 dB, (Worst-case extrapolation)
Penetration depth: 12.5 (11.2, 14.1) [mm]

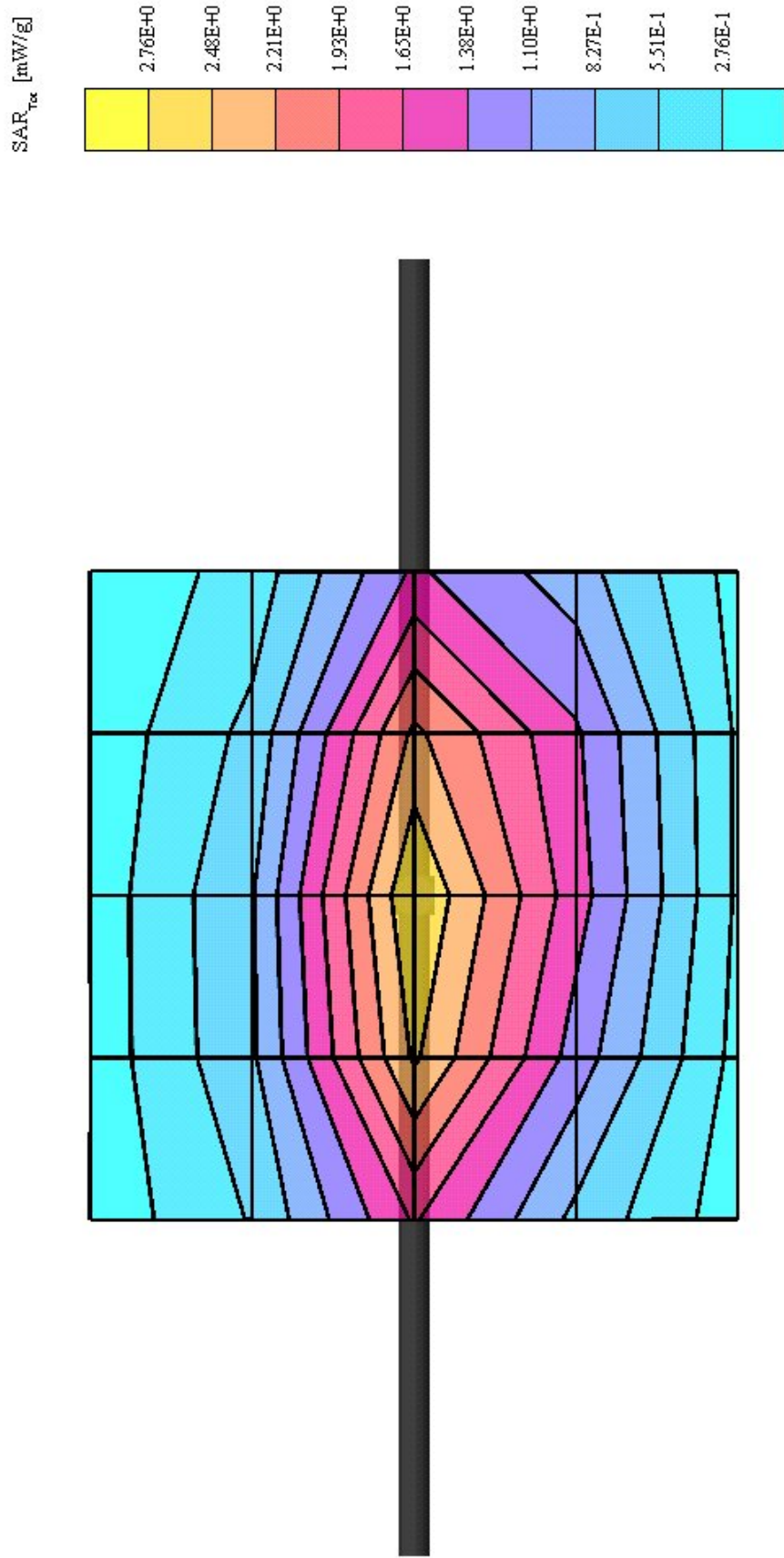


Fig. 14: Validation measurement 835 MHz Body, coarse grid.

Dipol 1900

GSM1800; Flat

Probe: ET3DY6 - SN1579; ConvF(5.40,5.40,5.40); Crest factor: 1.0; Brain 1900MHz: $\sigma = 1.45$ mho/m, $\epsilon_r = 38.9$, $\rho = 1.00$ g/cm³
 Cubes (2): Peak: 20.9 mW/g \pm 0.01 dB; SAR (1g): 10.9 mW/g \pm 0.00 dB; SAR (10g): 5.52 mW/g \pm 0.01 dB; (Worst-case extrapolation)
 Penetration depth: 7.8 (7.4, 8.8) [mm]

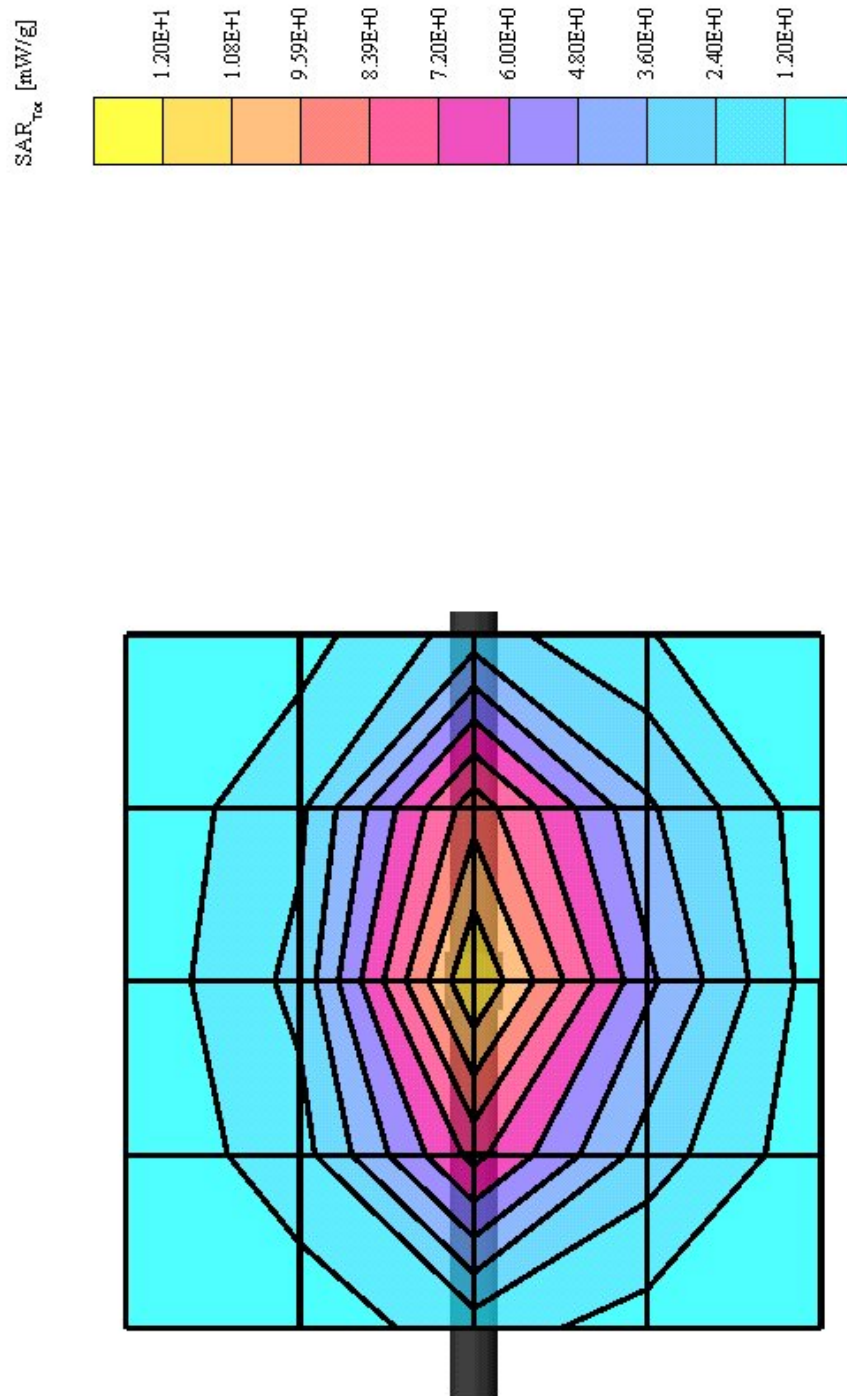


Fig. 15: Validation measurement 1900 MHz Head, coarse grid.

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Dipol 1900

GSM1800, Flat

Probe: ET3DV6 - SN1579; ConvF(490,490,490); Crest factor: 1.0; body 1900 MHz: $\sigma = 1.57$ mho/m $\epsilon_r = 53.1$ $\rho = 1.00$ g/cm³

Cubes (2): Peak: 21.3 mW/g ± 0.01 dB, SAR (1g): 11.2 mW/g ± 0.01 dB, SAR (10g): 5.77 mW/g ± 0.01 dB, (Worst-case extrapolation)

Penetration depth: 8.6 (7.8, 9.9) [mm]

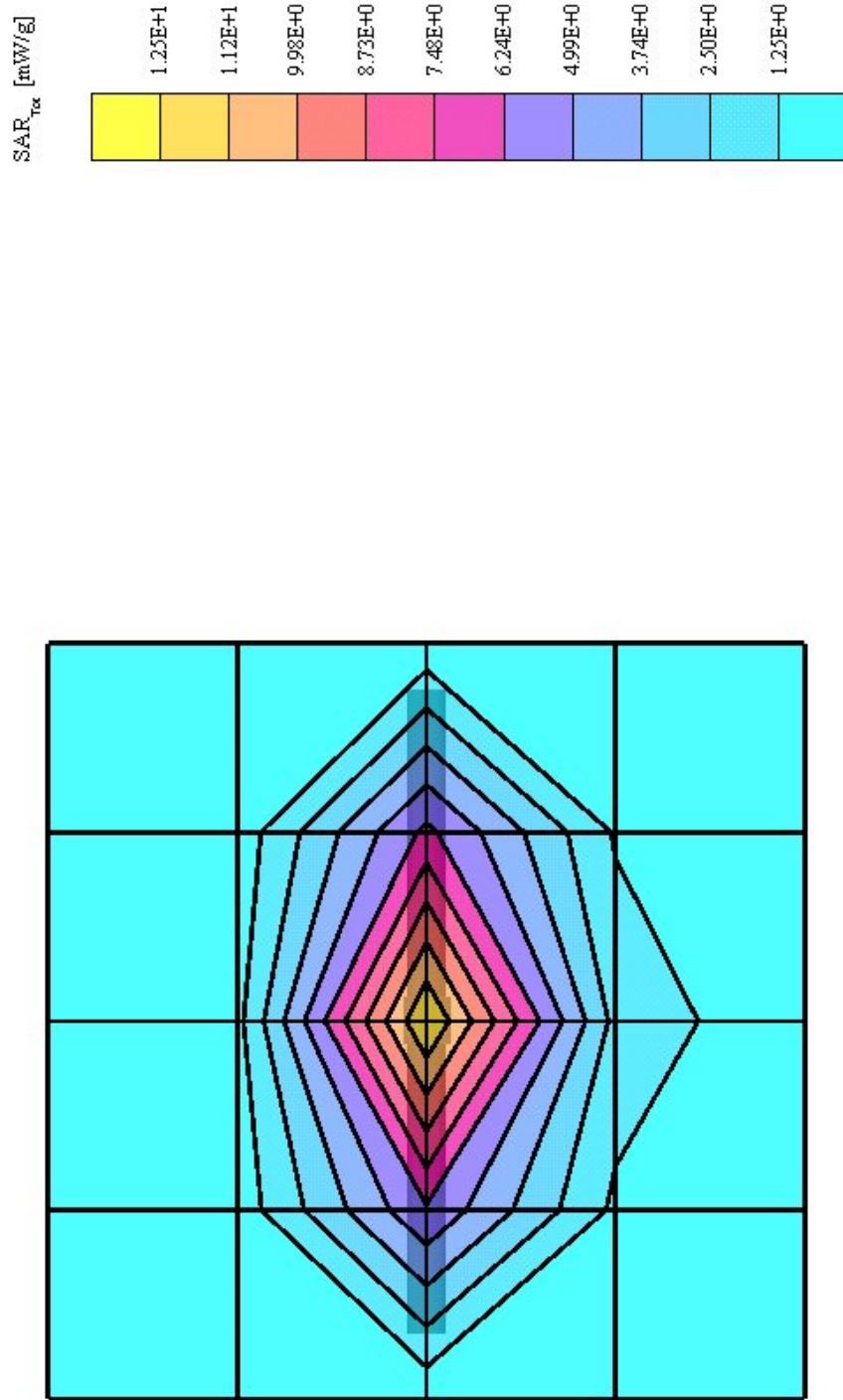


Fig. 16: Validation measurement 1900 Body, coarse grid.

7.6 Environment

Ambient temperature: 23 °C ± 1.0 °C
 Liquid temperature: 22 °C ± 1.0 °C
 Humidity: 50 % ± 5 %

7.7 Test Equipment

| Test Equipment | Model | Serial Number | Calibration |
|---------------------------------|----------|---------------|-------------|
| DASY3 System | | | |
| Software Version | V3.1D | N/A | N/A |
| Dosimetric E-Field Probe | ET3DV6 | 1579 | 05/2001 |
| Data Acquisition Electronics | DAE3 V1 | 410 | 01/2001 |
| Phantom (marked as SAM) | SAM | 1059 | N/A |
| Phantom (marked as GSM 1800) | SAM | 1073 | N/A |
| Performance Checking | | | |
| System Validation Dipole, Head | D835V2 | 437 | 04/2001 |
| System Validation Dipole, Body | D835V2 | 437 | 08/2001 |
| System Validation Dipole, Head | D1900V2 | 535 | 04/2001 |
| System Validation Dipole, Body | D1900V2 | 535 | 08/2001 |
| Power Meter, Agilent | E4426A | GB41050414 | 06/2001 |
| Power Sensor, Agilent | E9301H | U40010212 | 06/2001 |
| Power Meter, Gigatronics | 8541B | 1830892 | 12/2000 |
| Power Sensor, Gigatronics | 80401A | 1829437 | 12/2000 |
| RF Source (Network Analyzer) | HP8753D | 3410A06555 | 12/2000 |
| RF Amplifier, Mini-Circuits | ZHL-42 | D012296 | N/A |
| Material Measurement | | | |
| Network Analyzer | HP8753D | 3410A06555 | 12/2000 |
| Dielectric Probe Kit | HP85070B | US33020263 | N/A |
| General | | | |
| Base Station Simulator, Wavetek | 4032 | 1388073 | N/A |

Table 12: Test equipment.

7.8 Pictures of the device under test

Fig. 17 – 20 show the device under test and the used accessories.



Fig. 17: Front and back view of the device.



Fig. 18: Side views of the device.



Fig. 19: Phone with used Belt Clip.



Fig. 20: Used Headset respectively MP3 Player USB .

7.9 Test Positions for the Device under Test

Fig. 21 – Fig. 26 shown the test positions for the SAR measurements.

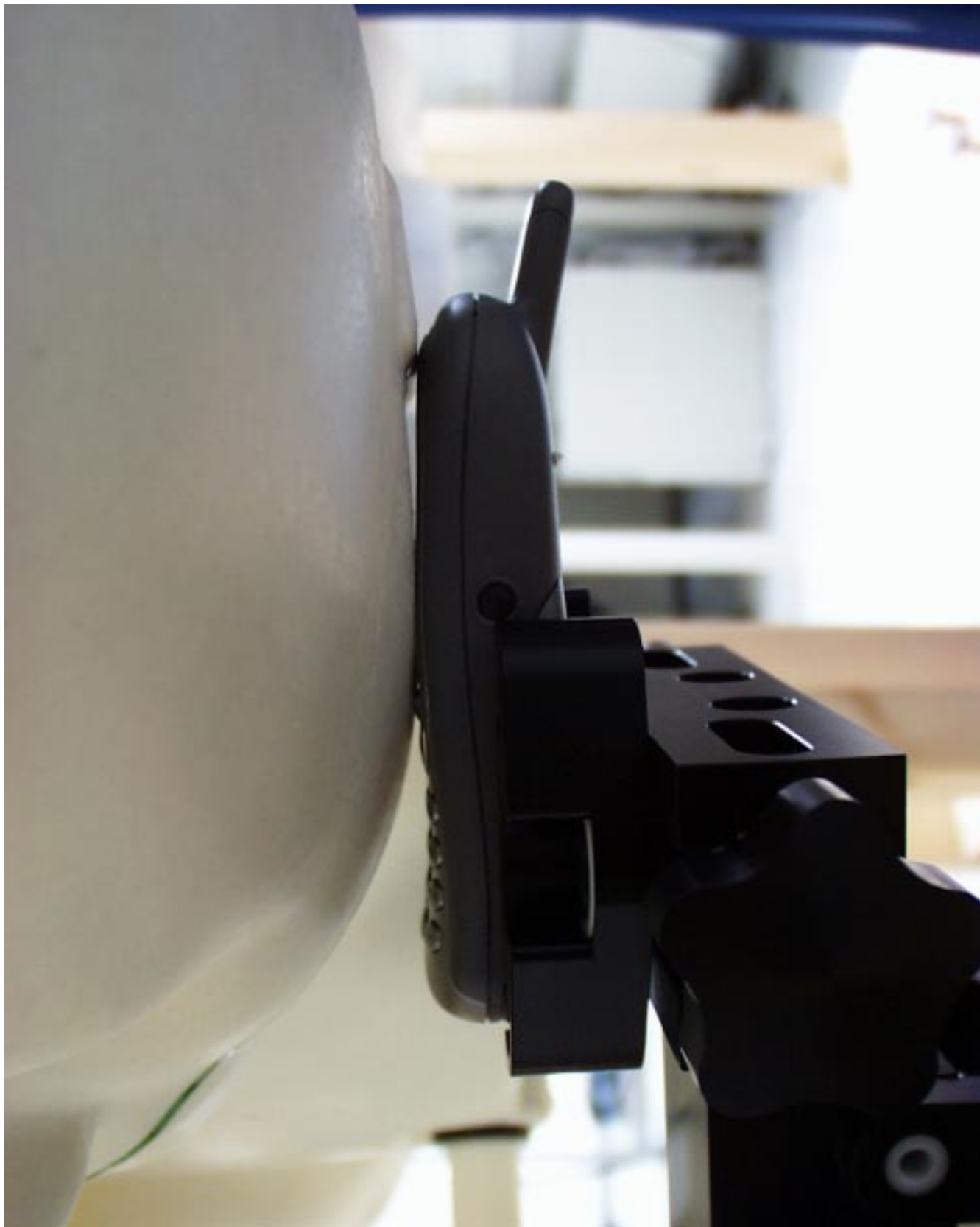


Fig. 21: Cheek position, left side.



Fig. 22: Tilted position, left side.



Fig. 23: Cheek position, right side.

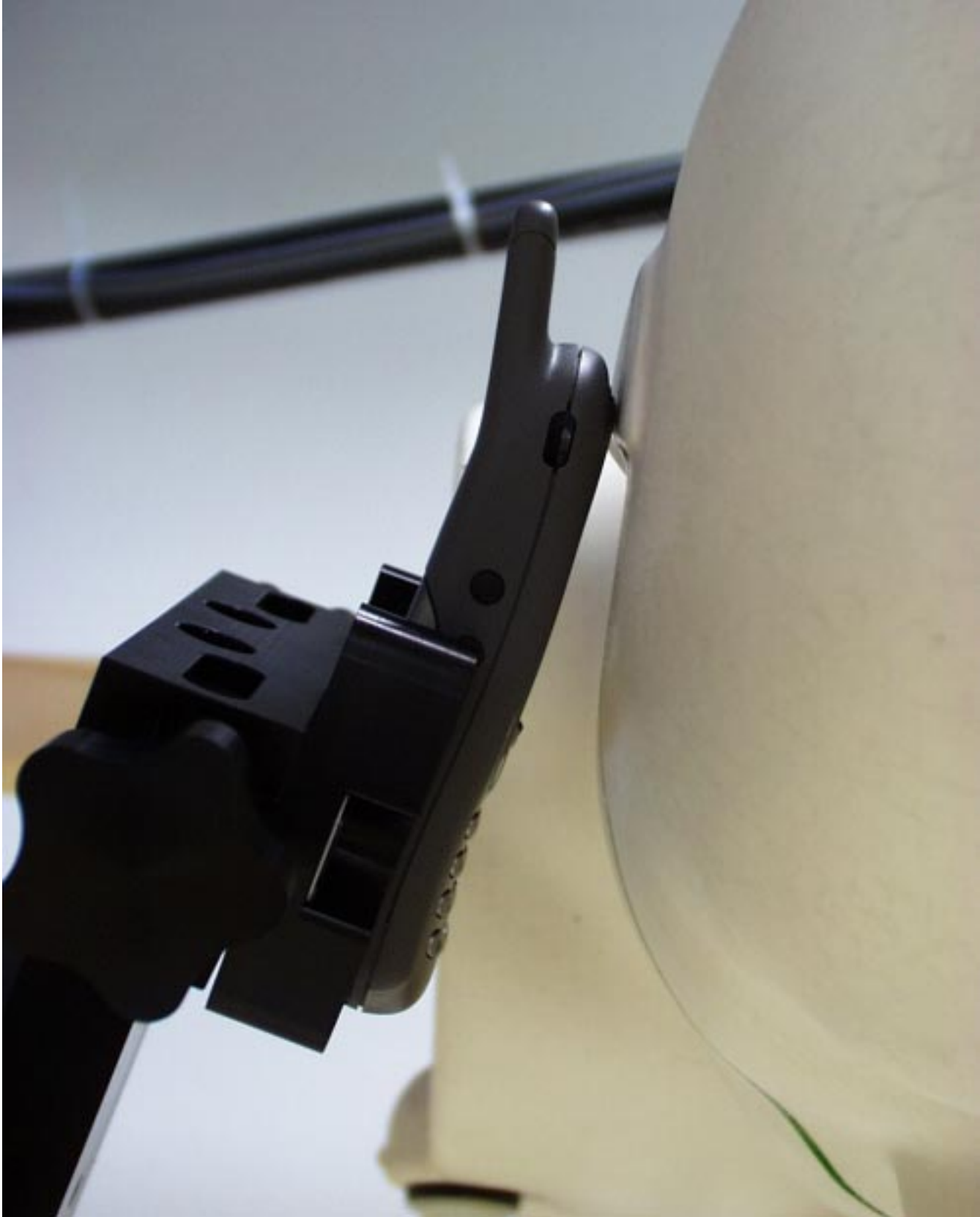


Fig. 24: Tilted position, right side.

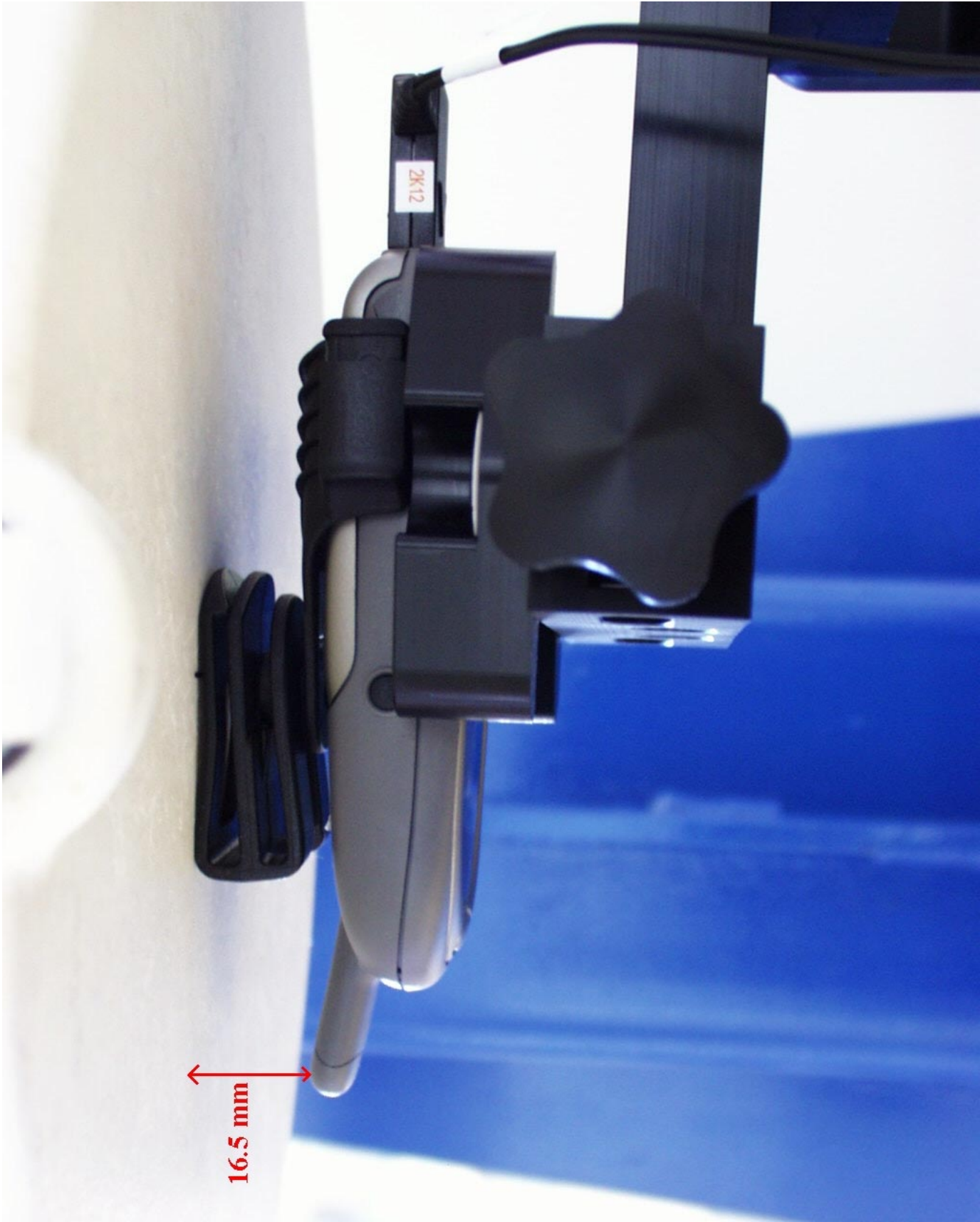


Fig. 25: Body worn configuration, Belt Clip with Headset.

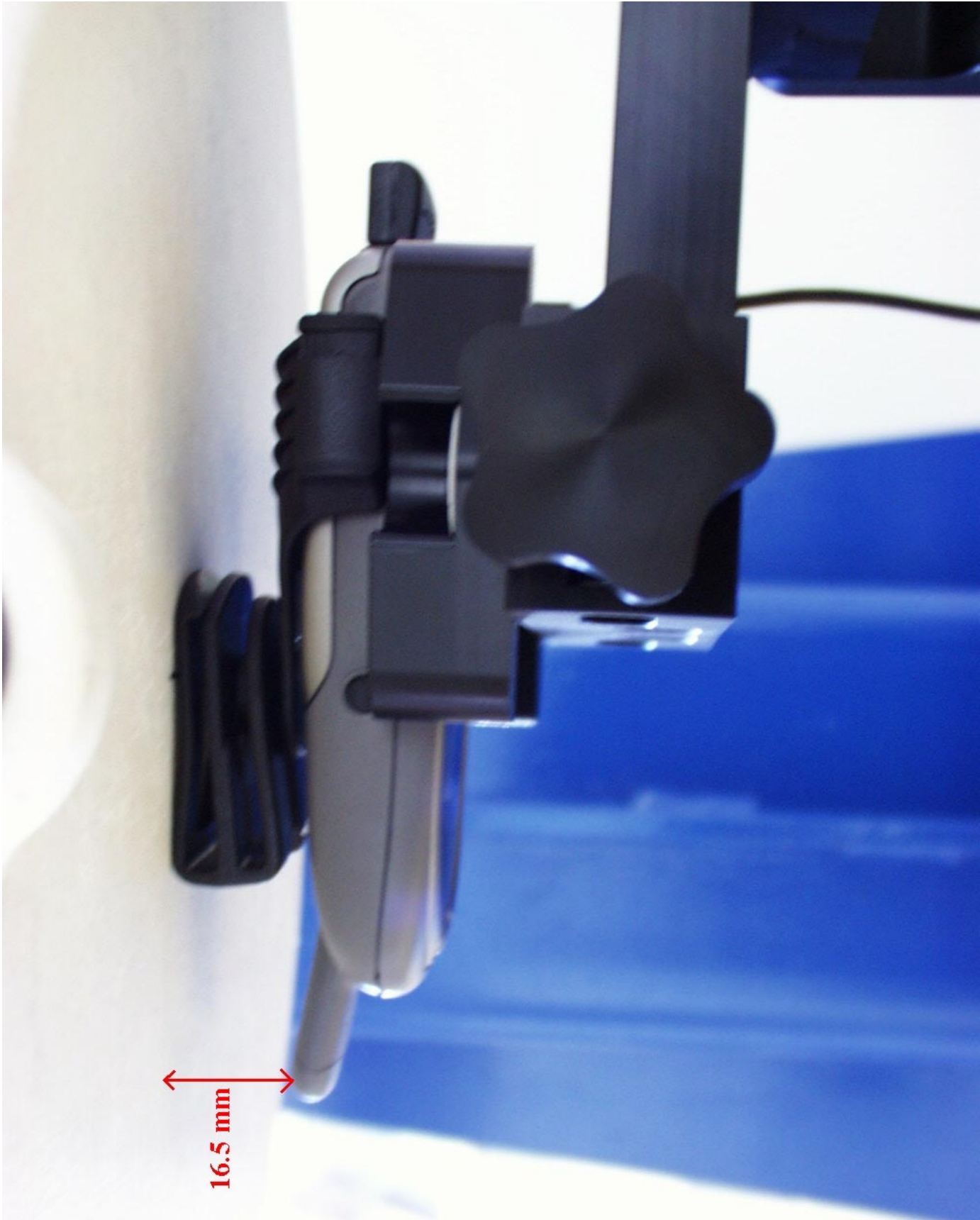


Fig. 26: Body worn configuration, Belt Clip with MP3 Player USB.

8 References

- [DASY 1995] Referenzliste des Herstellers, der Fa. Schmid & Partner Engineering AG, über installierte DASY-Systeme mit RX90 Robotern: Deutsche Telekom, Forschungs- und Technologiezentrum; Motorola Cellular - MRO; Motorola; Ericsson Mobile Communications AB; Nokia Mobile Phones LTD; IMST GmbH, 1995.
- [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 200x] IEEE Std 1528-200x: DRAFT Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques. Draft 6.2, Inst. of Electrical and Electronics Engineers, Inc., 2000.
- [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.



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Appendix for the Report

Dosimetric Assessment of the
Siemens S-46 (FCC ID: PWX-S46)
According to the FCC Requirements

Body worn configuration:
Measurements with “Leather Case”

November 05, 2001
IMST GmbH
Carl-Friedrich-Gauß-Str. 2
D-47475 Kamp-Lintfort

Customer
Siemens Information and Communication Mobile LLC
16745 West Bernardo Drive Suite 400
San Diego-CA 92127

The test results only relate to the items tested.
This report shall not be reproduced except in full without the written
approval of the testing laboratory.

Executive Summary

The S-46 is a new mobile phone from Siemens operating in the 800 MHz, 900 MHz and 1900 MHz frequency range. The device has a helix antenna. The system concepts used are the TDMA 800, TDMA 1900, GSM 900 and PCS 1900 standards.

The objective of the measurements done by IMST was the dosimetric assessment of one device in the TDMA 800, TDMA 1900 and PCS 1900 standards. The examinations have been carried out with the dosimetric assessment system „DASY3“.

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.

The Siemens S-46 mobile phone (FCC ID: PWX-S46) is in compliance with the Federal Communications Commission (FCC) Guidelines [FCC 2001] for uncontrolled exposure. The phone was tested in the Body Worn configuration with the following accessory: “Leather Case“.

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1 SAR Results

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

| Accessory | SAR _{1g} [W/kg] (Drift[dB]) | | |
|---|---------------------------------------|---------------------------------------|---------------------------------------|
| | Channel 991 824.04 MHz 25.7 dBm | Channel 383 836.49 MHz 25.8 dBm | Channel 799 848.97 MHz 25.9 dBm |
| S-46 with leather case, display towards the ground | 0.405 (-0.01) | 0.376 (-0.11) | 0.352 (-0.02) |
| S-46 with leather case, display towards the phantom | 0.289 (-0.11) | 0.280 (-0.05) | 0.267 (0.05) |

Table 1: Measurement results in body-worn configuration for TDMA 800 for the Siemens S-46 .

| Accessory | SAR _{1g} [W/kg] (Drift[dB]) | | |
|---|---|---|---|
| | Channel 0002 1850.04 MHz 26.0 dBm | Channel 1000 1879.98 MHz 26.0 dBm | Channel 1998 1909.92 MHz 26.0 dBm |
| S-46 with leather case, display towards the ground | 0.297* (-0.13) | 0.284* (-0.08) | 0.286* (0.02) |
| S-46 with leather case, display towards the phantom | 0.268* (-0.11) | 0.286* (0.01) | 0.307* (-0.01) |

Table 2: Measurement results in body-worn configuration for TDMA 1900 for the Siemens S-46 (* Cube 1).

| Accessory | SAR _{1g} [W/kg] (Drift[dB]) | | |
|---|--|--|--|
| | Channel 512 1850.20 MHz 29.3 dBm | Channel 661 1880.00 MHz 29.3 dBm | Channel 810 1909.80 MHz 29.0 dBm |
| S-46 with leather case, display towards the ground | 0.210* (-0.05) | 0.210* (0.01) | 0.202* (0.0) |
| S-46 with leather case, display towards the phantom | 0.221* (0.03) | 0.236* (-0.03) | 0.240* (0.04) |

Table 3: Measurement results in body-worn configuration for PCS 1900 for the Siemens S-46 (* Cube 1).

The above mentioned power values are conducted measured values. The power output was measured by the FCC accredited test lab TÜV Product Service, San Diego. The same unit was used for the SAR measurements.

Before the measurements the test side ambient conditions were checked performing SAR measurements with the phone powered off. The results were shown in the Appendix SAR Plots.

Since the measurements were done with two phantoms, different designations in the SAR distribution plots were used. The phantom used for the 800 MHz measurements is marked as SAM, the phantom used for the 1900 MHz measurements (TDMA 1900 and PCS 1900) is marked as GSM1800.

2 Evaluation

In Fig. 1 - 3 the SAR results in body-worn configuration for TDMA 800, TDMA 1900 and PCS 1900 given in Table 1 - 3 are summarized and compared to the limit.

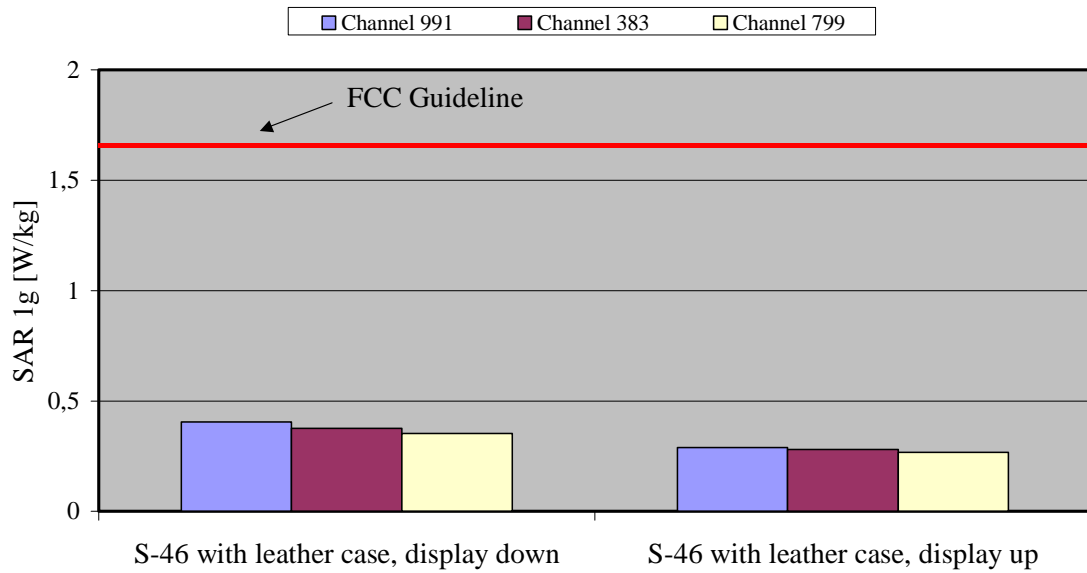


Fig. 1: The measured SAR values in body-worn configuration for the Siemens S-46 for TDMA 800 in comparison to the FCC exposure limit.

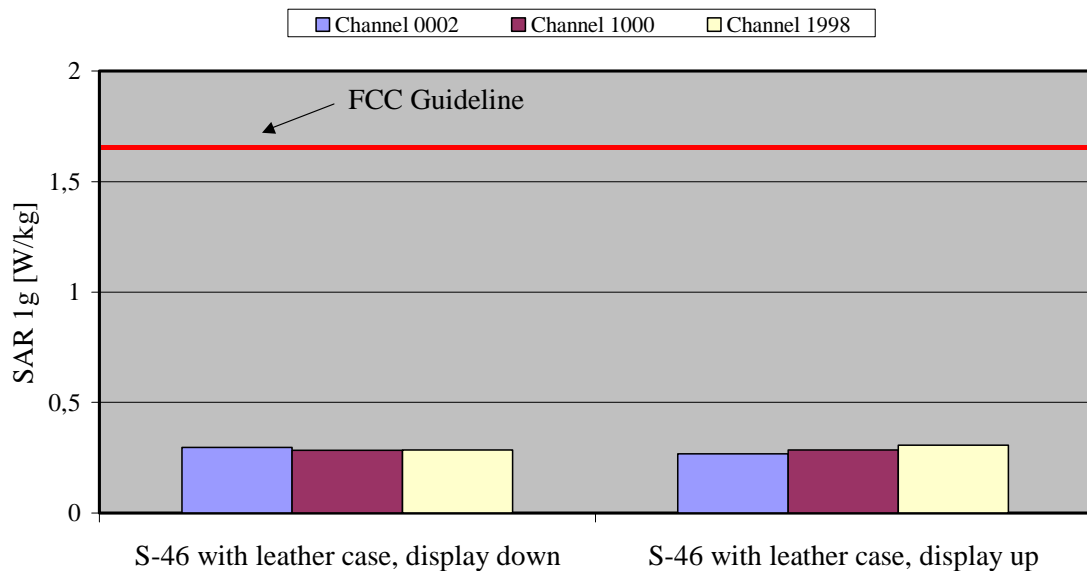


Fig. 2: The measured SAR values in body-worn configuration for the Siemens S-46 for TDMA 1900 in comparison to the FCC exposure limit.

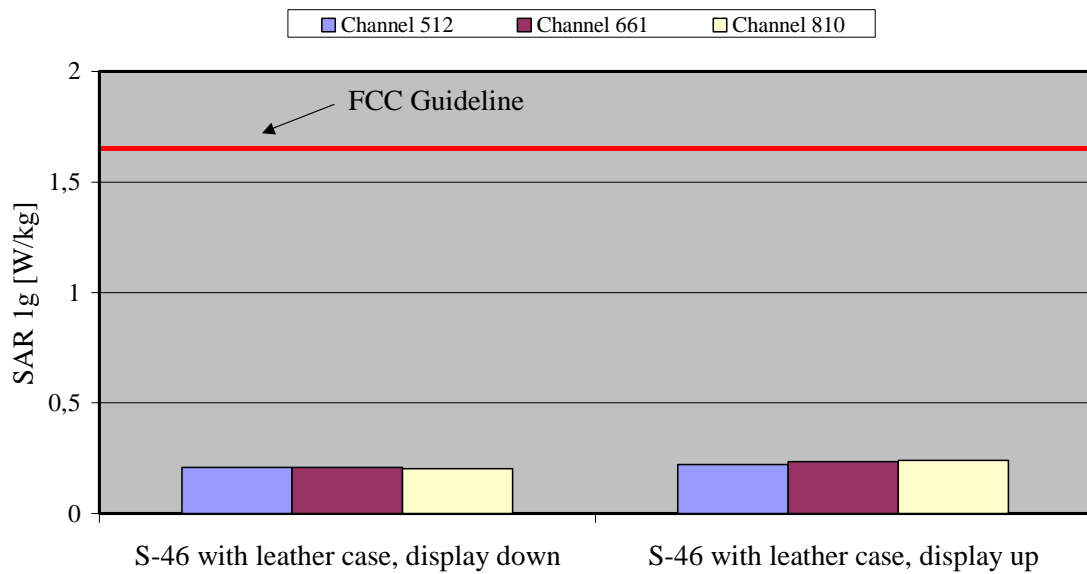


Fig. 3: The measured SAR values in body-worn configuration for the Siemens S-46 for PCS 1900 in comparison to the FCC exposure limit.

The Siemens S-46 mobile phone (FCC ID: PWX-S46) is in compliance with the Federal Communications Commission (FCC) Guidelines [FCC 2001] for uncontrolled exposure. The phone was tested in the Body Worn configuration with the following accessory: “Leather Case“.

2.1 Pictures of the device under test

Fig. 4 – 5 show the device under test and the used accessories.

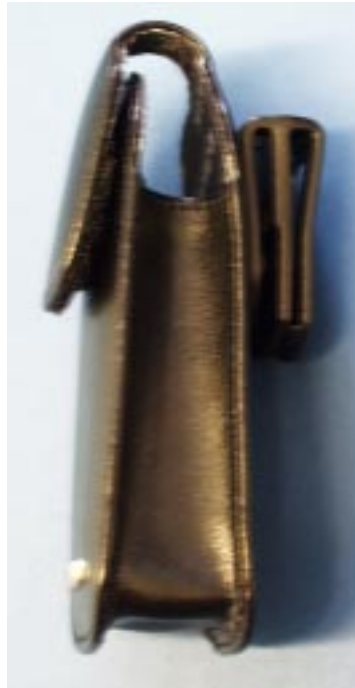


Fig. 4: leather case



Fig. 5: Phone with leather case in the configuration: Display towards the ground (left) and Display towards the phantom (right).

2.2 Test Positions for the Device under Test

Fig. 6 – Fig. 7 shown the test positions for the SAR measurements.



Fig. 6: Body worn configuration with leather case, display towards the ground.



Fig. 7: Body worn configuration with leather case, display towards the phantom.

2.3 SAR distribution plots

Since the SAR distribution is similar for the different channels, only the worst case plots were shown in Fig. 8 – Fig. 13.

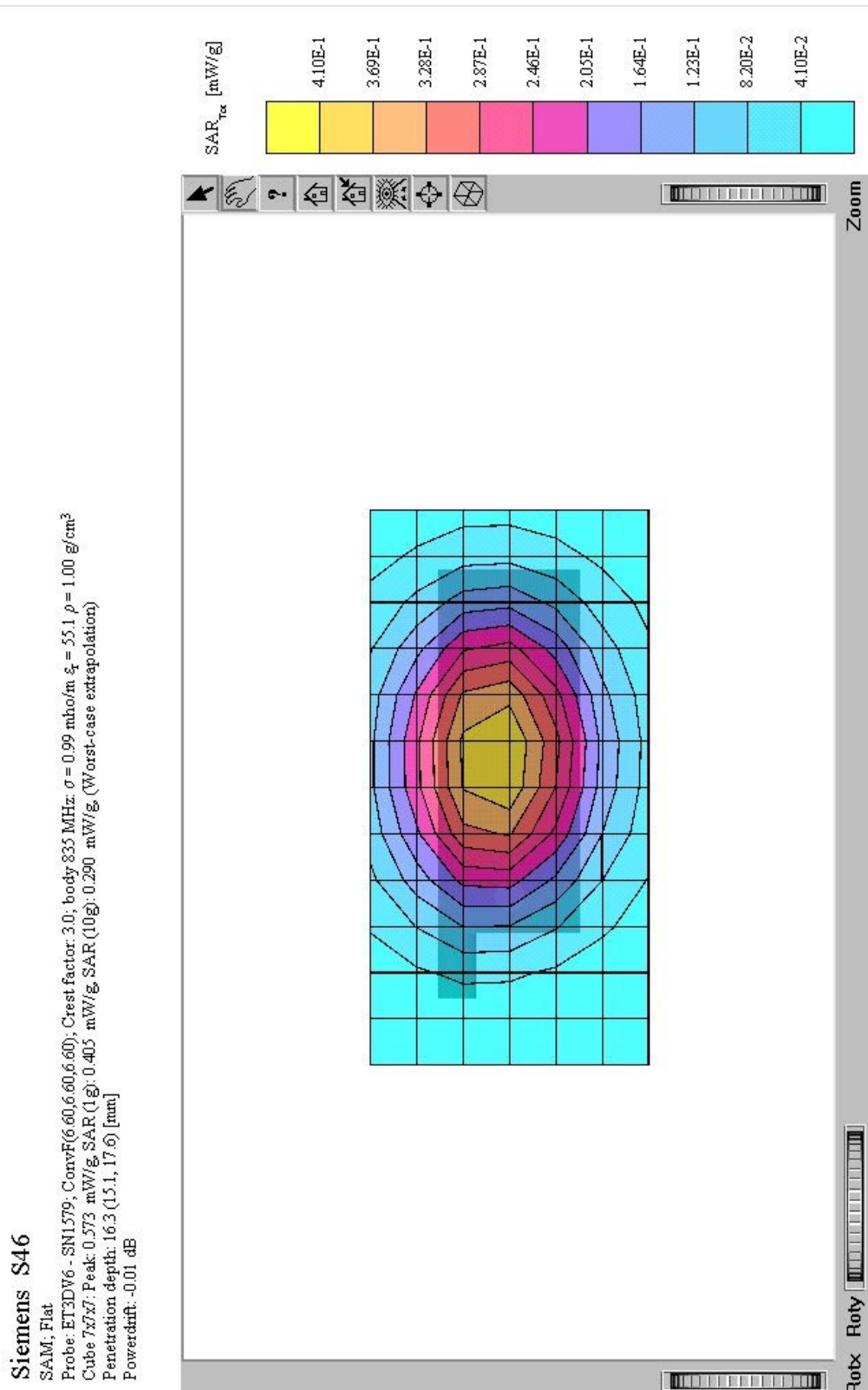


Fig. 8: Worst Case SAR distribution, TDMA 800, channel 991, display towards the ground.

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Siemens-S46

SAM; Flat

Probe: ET3DV6 - SN1579; ConvF(6.60,6.60,6.60); Crest factor: 3.0; body 835 MHz; $\sigma = 0.99$ mho/m $\epsilon_r = 55.1$ $\rho = 1.00$ g/cm³

Cube 7x7x7; Peak: 0.413 mW/g, SAR (1g): 0.289 mW/g, SAR (10g): 0.206 mW/g, SAR (Worst-case extrapolation)

Penetration depth: 16.3 (14.5, 18.2) [mm]

Powerdrift: -0.11 dB

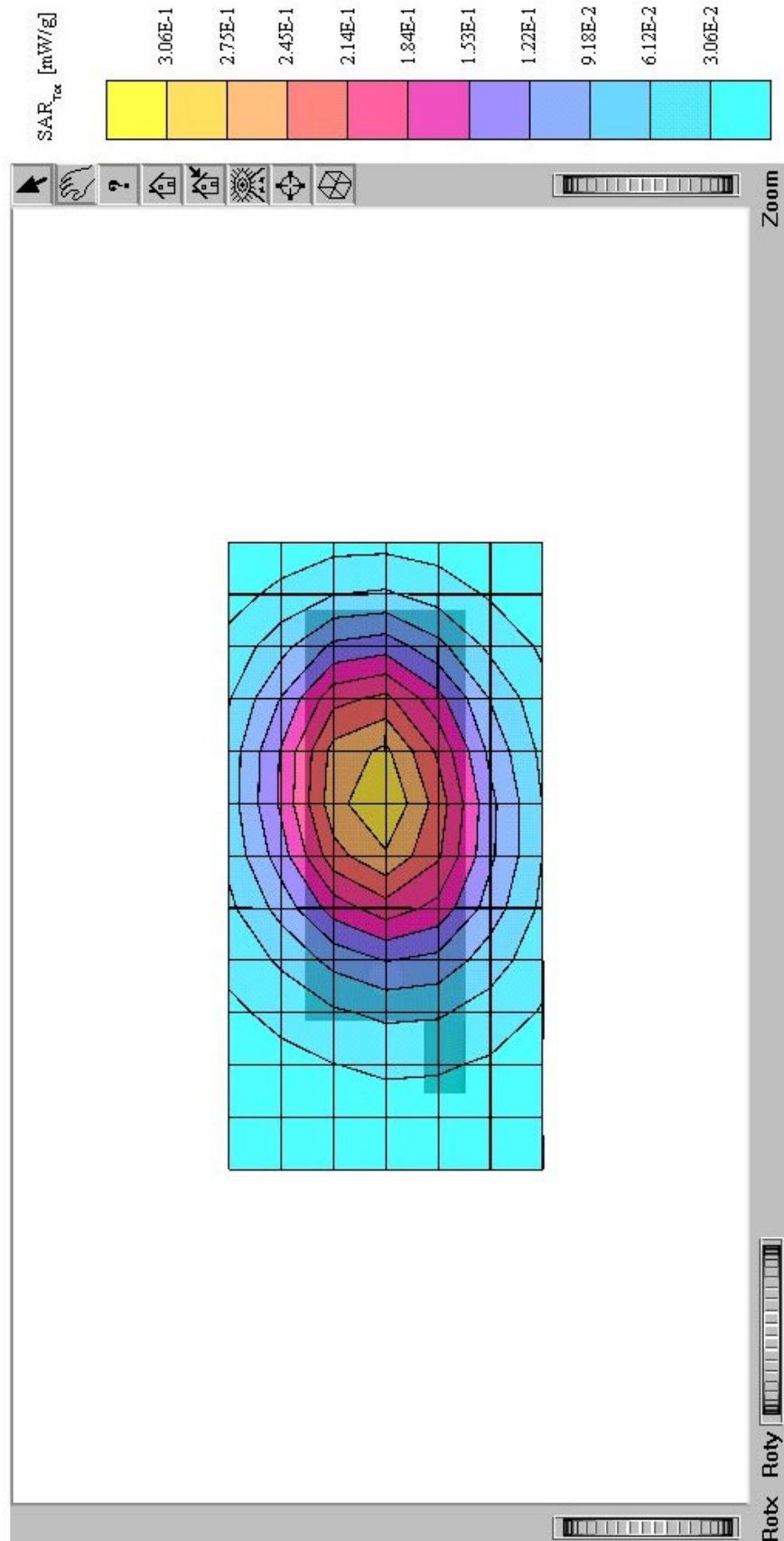


Fig. 9: Worst Case SAR distribution, TDMA 800, channel 991, display towards the phantom.

dasy_report_fcc_supplement_c_2.0.doc/25.09.2001/CH

Siemens S46

GSM1800; Flat
 Probe: ET3DV6 - SN1579; ConvF(4.90,4.90,4.90); Crest factor: 3.0; body: 1900 MHz; $\sigma = 1.57$ mho/m $\epsilon_r = 33.1$ $\rho = 1.00$ g/cm³
 Cube 7x7x7: Peak: 0.490 mW/g; SAR (1g): 0.297 mW/g; SAR (10g): 0.185 mW/g; (Worst-case extrapolation)
 Penetration depth: 10.9 (9.7, 12.5) [mm]
 Powerdirt: -0.13 dB

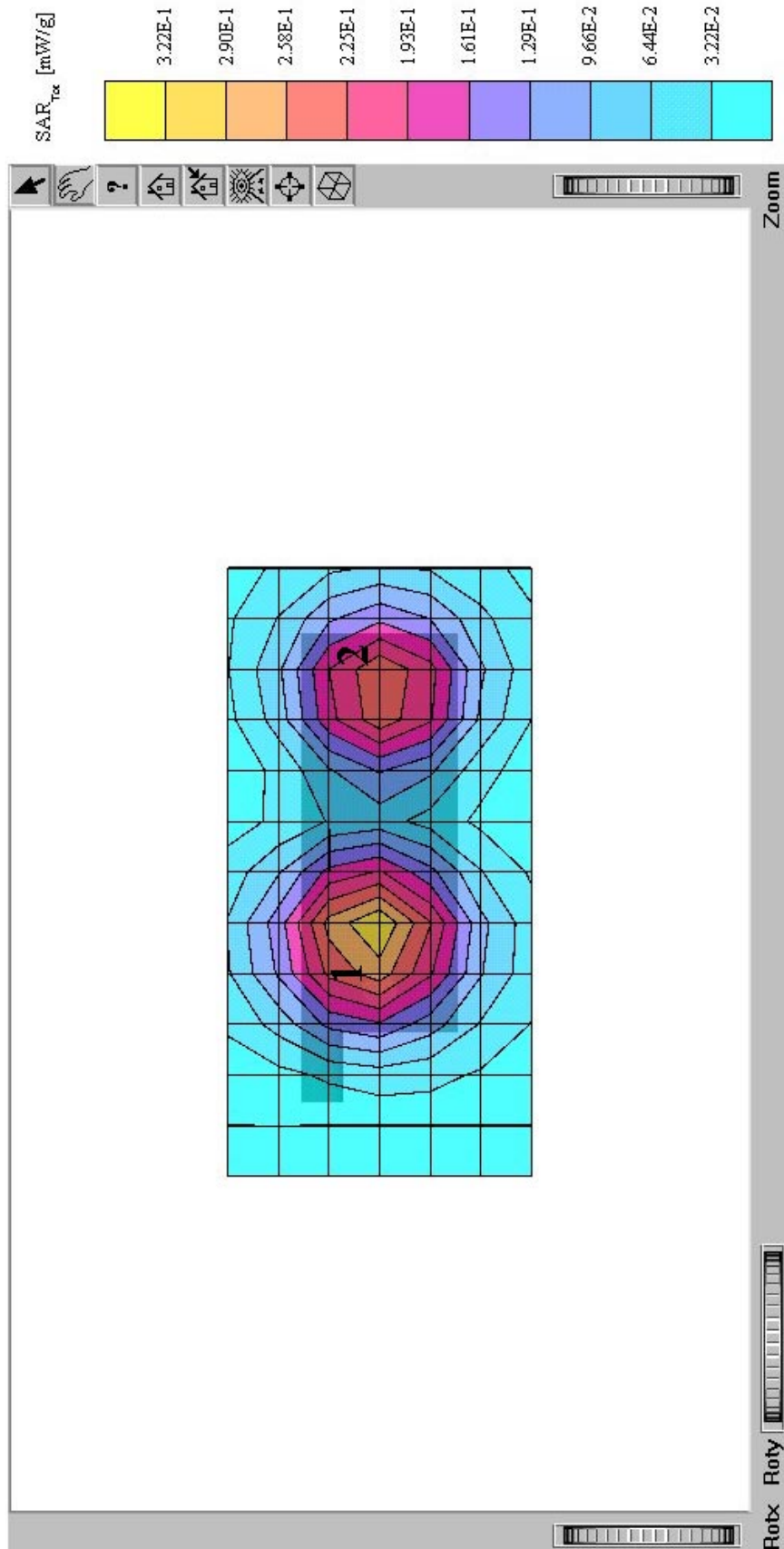


Fig. 10: Worst Case SAR distribution, TDMA 1900, channel 0002, display towards the ground, Cube 2: 0.245 W/kg.

dasy_report_fcc_supplement_c_2.0.doc/25.09.2001/CH

Siemens-S46

GSM1800; Flat
 Probe: ET3DV6 - SN1579; ConvF(490,490,490); Crest factor: 3.0; body: 1900 MHz: $\sigma = 1.57$ mho/m $\epsilon_r = 53.1$ $\rho = 1.00$ g/cm³
 Cube 7x7x7: Peak: 0.522 mW/g SAR (1g): 0.307 mW/g SAR (10g): 0.187 mW/g. (Worst-case extrapolation)
 Penetration depth: 10.6 (9.2, 12.5) [mm]
 Powerdrift: -0.01 dB

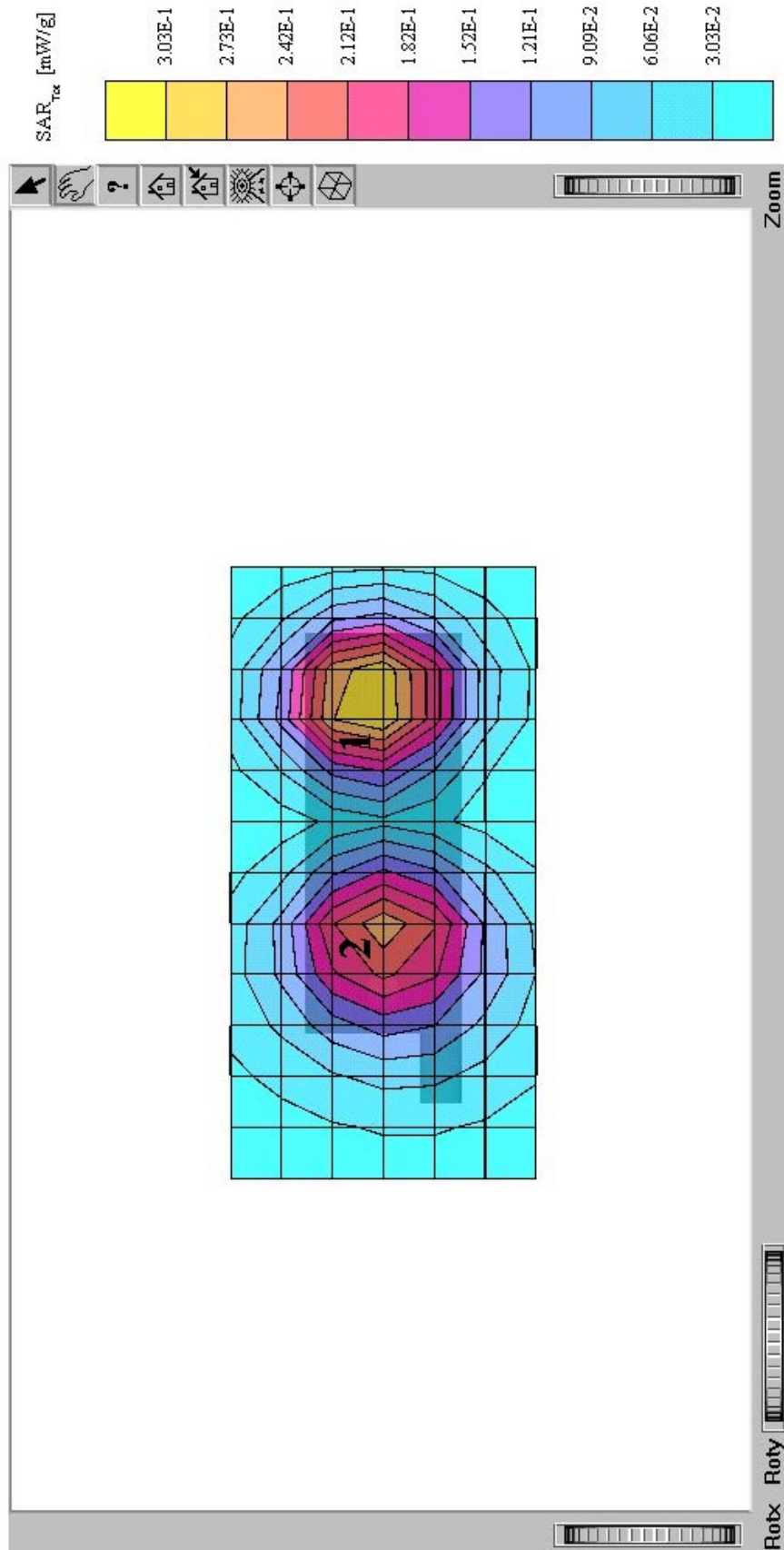


Fig. 11: Worst Case SAR distribution, TDMA 1900, channel 1998, display towards the phantom, Cube 2: 0.245 W/kg.

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Siemens S46

GSM1800; Flat
 Probe: ET3DV6 - SN1579; ConvF(4,90,4,90); Crest factor: 8.0; body: 1900 MHz: $\sigma = 1.57$ mho/m $\epsilon_r = 53.1$ $\rho = 1.00$ g/cm³
 Cube 7x7x7: Peak: 0.354 mW/g SAR(1g): 0.210 mW/g SAR(10g): 0.129 mW/g (Worst-case extrapolation)
 Penetration depth: 10.6 (9.4, 12.1) [mm]
 Powerdrift: 0.01 dB

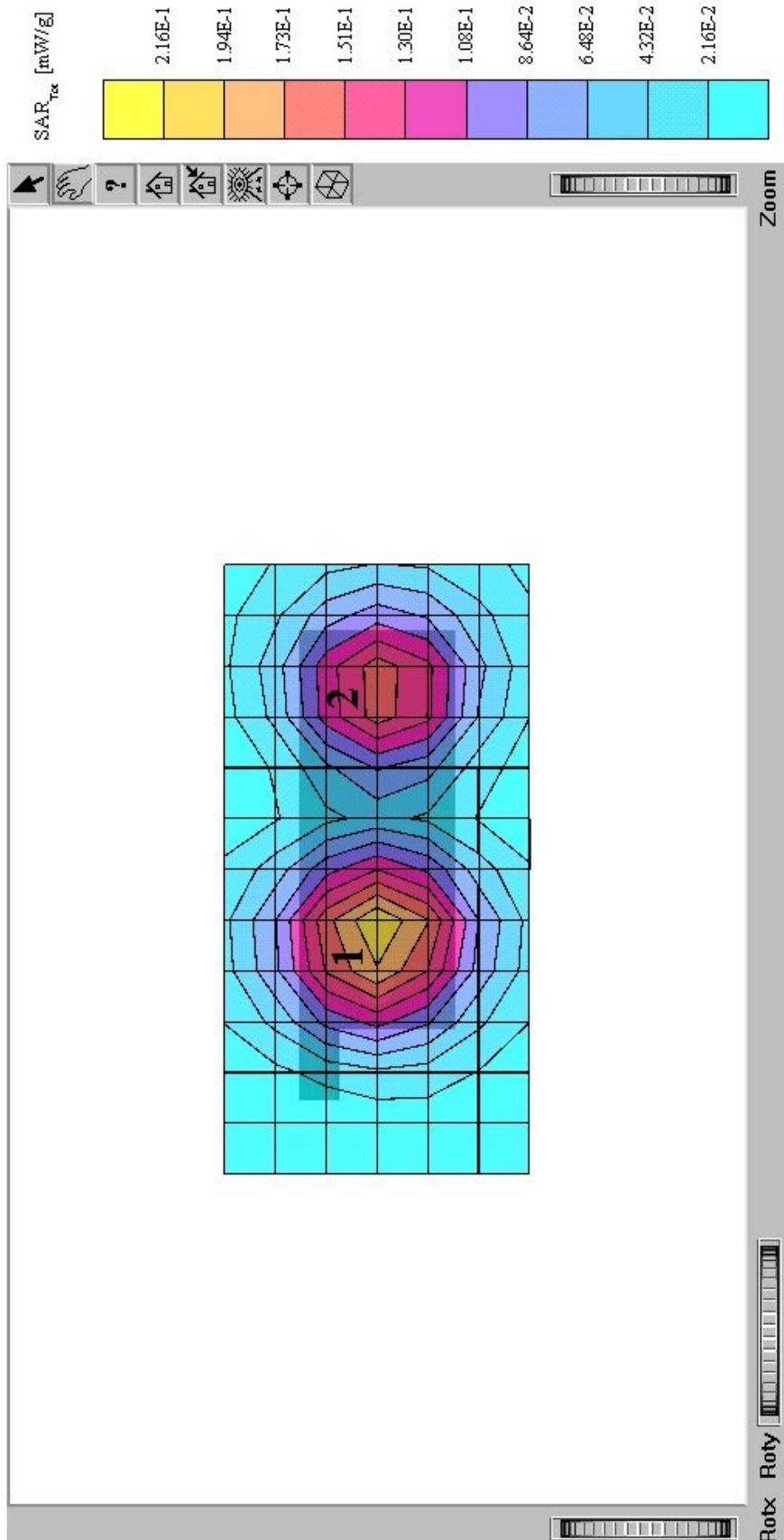


Fig. 12: Worst Case SAR distribution, PCS 1900, channel 661, display towards the ground, Cube 2: 0.162 W/kg.

dasy_report_fcc_supplement_e_2.0.doc/25.09.2001/CH

Siemens-S46

GSM1800; Flat

Probe: ET3DV6 - SNI1579; ConvF(490,490,490); Crest factor: 8.0; body 1900 MHz: $\sigma = 1.57 \text{ mho/m}$, $\epsilon_r = 53.1$, $\rho = 1.00 \text{ g/cm}^3$

Cube 7x7x7: Peak: 0.405 mW/g, SAR (1g): 0.240 mW/g, SAR (10g): 0.145 mW/g. (Worst-case extrapolation)

Penetration depth: 10.5 (9.3, 12.2) [mm]

Powerdrift: 0.04 dB

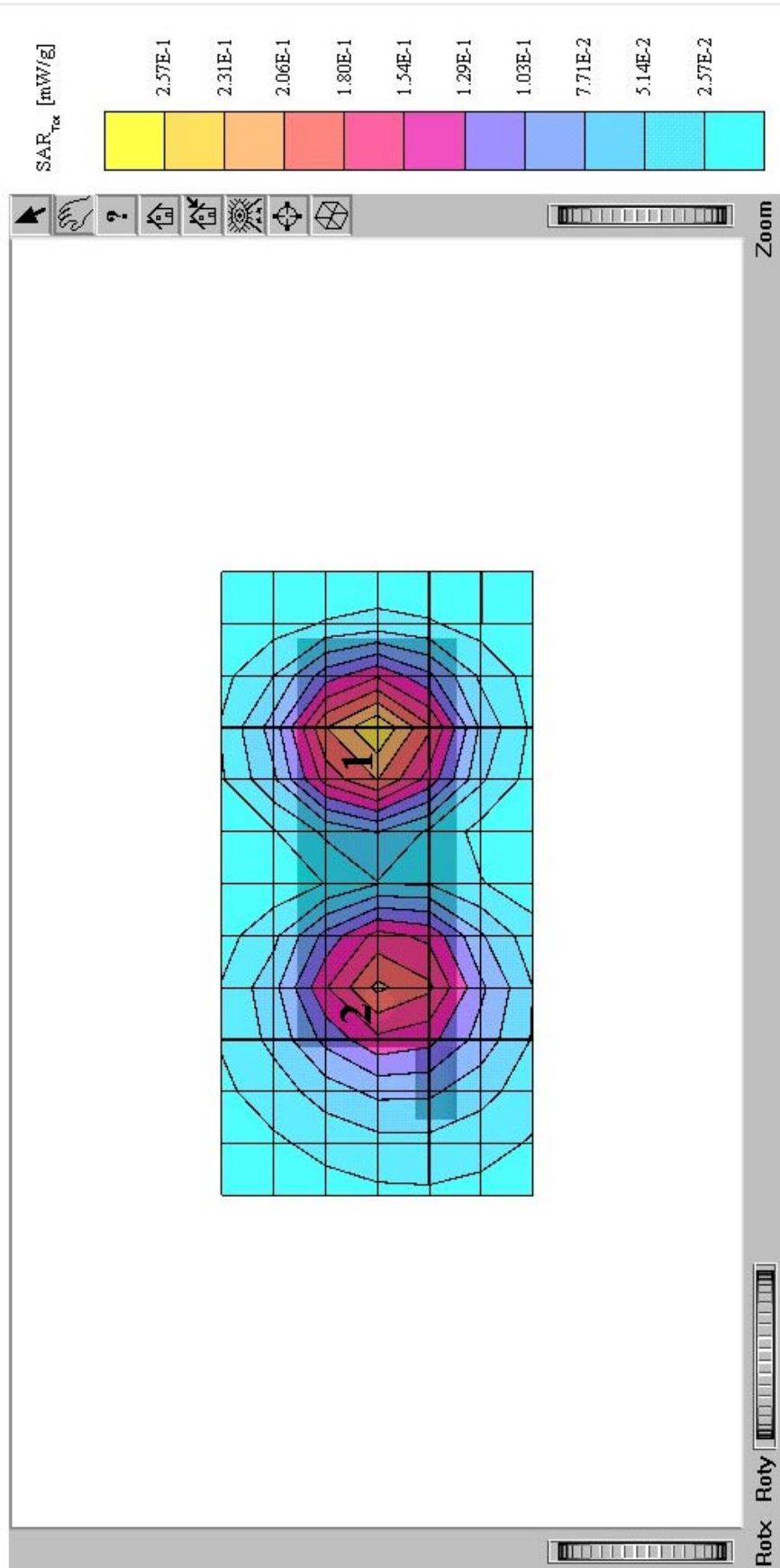


Fig. 13: Worst Case SAR distribution, PCS 1900, channel 810, display towards the phantom, Cube 2: 0.198 W/kg.

3 References

- [DASY 1995] Referenzliste des Herstellers, der Fa. Schmid & Partner Engineering AG, über installierte DASY-Systeme mit RX90 Robotern: Deutsche Telekom, Forschungs- und Technologiezentrum; Motorola Cellular - MRO; Motorola; Ericsson Mobile Communications AB; Nokia Mobile Phones LTD; IMST GmbH, 1995.
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