3 The American 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 telecommunication devices, either by laboratory measurement techniques or by computational modeling, prior to equipment authorization or use. In 1997 the FCC has published additional information for evaluating compliance of mobile and portable devices with FCC limits for human exposure to radiofrequency emissions [FCC 1997]. This supplement is not intended, however, to establish mandatory procedures, and other methods and procedures may be acceptable if based on sound engineering practice.

Bluetooth devices are supposed to operate under 15.247 of FCC rules. The RF exposure requirement for Bluetooth or similar unlicensed spread spectrum devices are in 15.247(b)(4). Depending on whether the module operates in a final product that fits 2.1091 or 2.1093 requirements, compliance will need to be determined according to MPE or SAR requirements. Devices operating under 15.247 are categorically excluded from routine evaluation for demonstrating RF exposure compliance. The FCC generally looks for antenna gain, installation and operating instructions/requirements and exposure conditions for satisfying 15.247(b)(4) to ensure compliance and to determine if FCC needs to specifically request for RF exposure evaluation according to 1.1307(d). If the device has a high potential to exceed exposure limits the most convenient way is to perform RF exposure evaluation and include that in the filing to avoid delays before it is requested by the FCC.

3.1 Test Conditions

The device under test has to operate at maximum power level during the measurement. The measurement shall be made at the closest range to persons under normal operating conditions. In the dosimetric assessment of the Gigaset B420data a minimum distance of 0 cm (the Gigaset B420data touches the phantom) has been used to allow for *worst case* conditions. The setup is shown in Fig. 3 and 4. This measurement is performed for six possible orientations of the Gigaset B420data with respect to the flat part of the phantom. The definition of the orientations is given in Fig. 2.

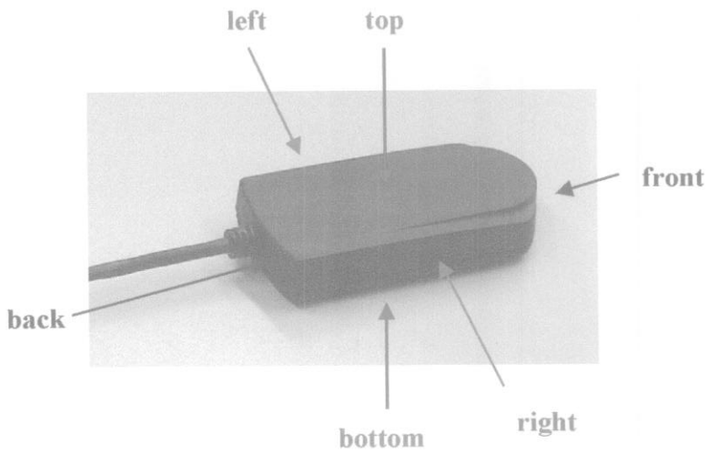

Fig. 2: Definition of the orientations of the Gigaset B420data with respect to the phantom.

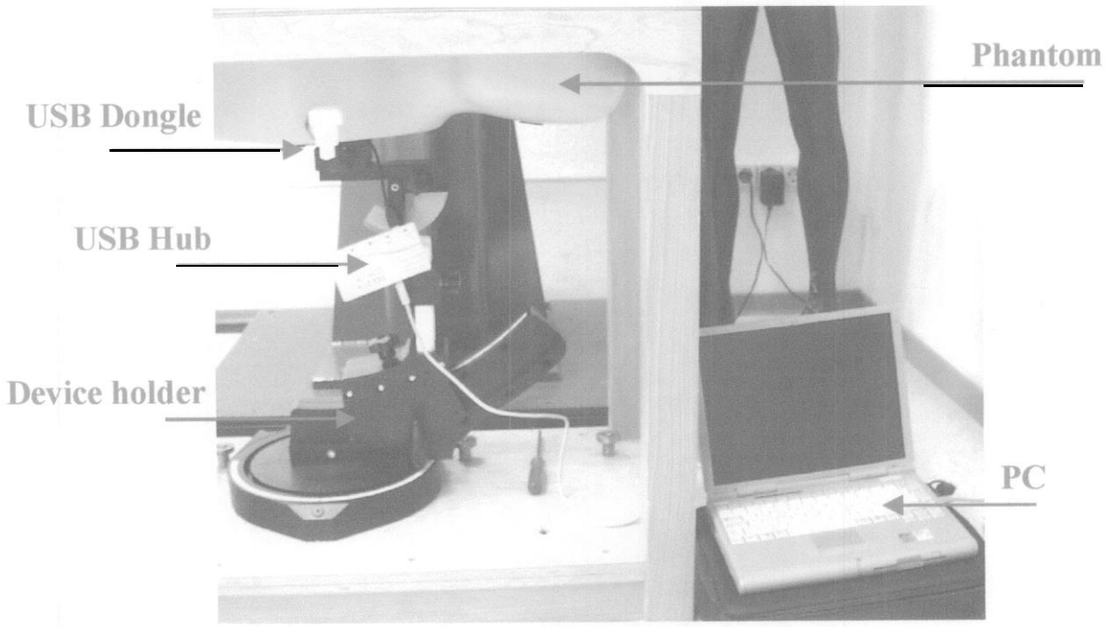

Fig. 3: Test setup including Laptop, Gigaset B420data, and Device holder.

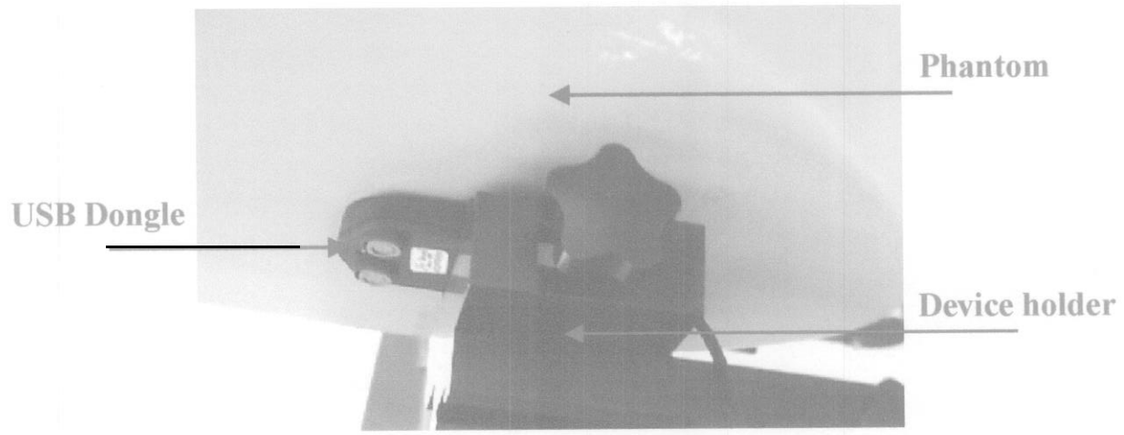

Fig. 4: Test setup including Gigaset B420data, and Device holder (detail).

4 The Measurement System

DASY is an abbreviation of „Dosimetric Assessment System" and describes a system which 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. 5 shows the equipment, similar to the installations in other laboratories [DASY 1995].

A mobile phone operating at the maximum power level is placed by a non metallic device holder

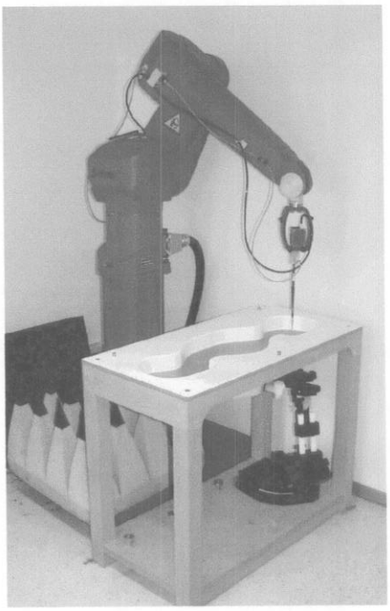

Fig. 5: The measurement setup with a phantom containing tissue simulating liquid and a device under test.

in a well-defined position 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 miniaturized 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.

The phantom (generic twin phantom) is a fiberglass shell integrated in a wooden table. The thickness of the phantom amounts to 2 mm ± 0.1 mm. It enables the dosimetric evaluation of left and right hand phone usage. The phantom setup includes a coverage (polyethylene) which prevents the evaporation of the liquid. The ear is simulated by ensuring a space of 4 mm thickness between the tissue simulating liquid and the speaker of the phone.

4.1 Technical Parameters of the Measurement System

Parameter	DASY
Spatial resolution	5 mm
Repeatability of probe position	± 0.1 mm
Dynamic range	5 mW/kg - 100 W/kg

Table 2: DASY system specification.

Parameter	Accuracy
Frequency linearity	± 0.2 dB
Deviation from isotropy (in air)	± 0.8 dB
Surface detection	± 0.2 mm

Table 3: Probe specification.

Parameter	Noise floor
SAR values	< 0.005 W/kg
Electric field strength *E*	< 1 V/m

Table 4: Sensitivity of DASY.

Accuracy influencing conditions	Accuracy of SAR values
Isotropy, calibration, noise floor	< 13 % @ 1 W/kg
Extrapolation of SAR values	< 7 %
Dielectric parameters	< 5 %

Table 5: Accuracy of the SAR values determined by measurements [Kuster 1997].

5 SAR Results

The Table below contains the measured SAR values averaged over a mass of 1 g.

Position	Remark	SAR(1g) W/kg	File
top	2402 MHz (ch. 0x)	0.521 ± 0.133	bludhl_1.da3
top	2441 MHz (ch. 27x)	0.492 ± 0.126	bludhm_1.da3
top	2480 MHz (ch. 4Ex)	0.468 ± 0.120	bludhh_1.da3
bottom	2441 MHz (ch. 27x)	0.261 ± 0.069	bludhm_2.da3
left	2441 MHz (ch. 27x)	0.258 ± 0.068	bludhm_3.da3
right	2441 MHz (ch. 27x)	0.376 ± 0.097	bludhm_4.da3
front	2441 MHz (ch. 27x)	0.261 ± 0.069	bludhm_5.da3
back	2441 MHz (ch. 27x)	0.087 ± 0.026	bludhm_6.da3

Table 6: Measurement results for the Siemens Gigaset B420data in a distance of 0 cm from the phantom for six orientations.

6 Evaluation

In Fig. 6 the SAR results given in Tables 6 are summarized and compared to the limit.

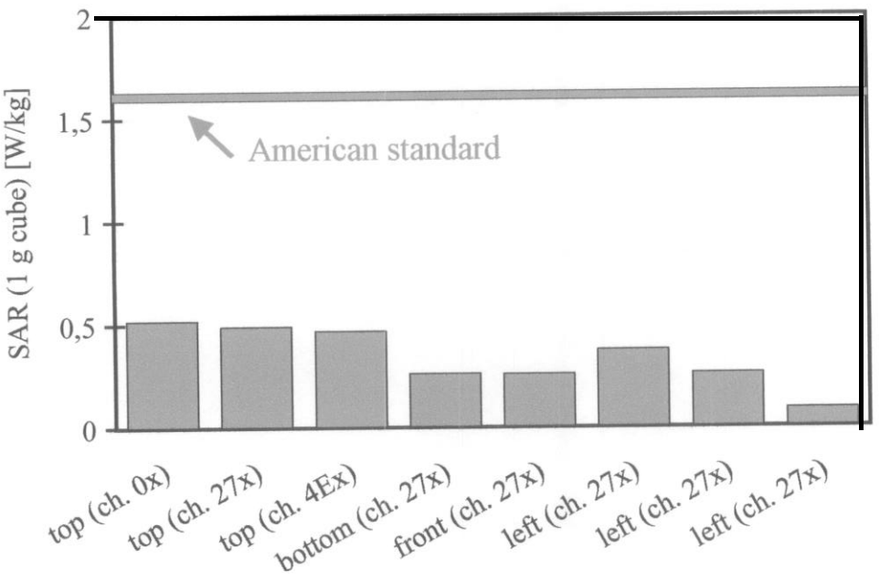

Fig. 6: The measured SAR values for the Siemens Gigaset B420data in comparison to the American standard.

Fig. 7 shows the SAR distribution plot with the maximum local SAR for the touch position.