TEST REPORT

1. Applicant

Name	:	Firefly Mobile, Inc.
Address	:	250 Parkway Drive, suite 220, Lincolnshire, IL, 60069, United states

2. Products

Name	:	Firefly Mobile, Inc.
Model	:	W100
Manufacturer	:	Firefly Mobile, Inc.

3. Test Standard/Method	:	250 Parkway Drive, suite 220, Lincolnshire, IL, 60069, United states
4. Test Results	:	Positive
5. Application Type	:	Certification
6. Date of Application	:	April 30, 2007
7. Date of Issue	:	July 24, 2007

Tested by	Approved by
Jong-Gon Ban	Seok-Jin Kim
Telecommunication Team Engineer	Telecommunication Team Manager

The test results contained apply only to the test sample(s) supplied by the applicant, and this test report shall not be reproduced in full or in part without approval of the KTL in advance.

Korea Testing Laboratory

TABLE OF CONTENTS

1. EQUIPMENT UNDER TEST

1.1 General Information :

1) **Test Sample :** Dual-Band GSM850/GSM1900 Phone

2) **Device Category :** Portable Device

3) **Model Number :** W100

4) **FCC ID :** R7C-W100

5) **Test Device :** Production Unit

6) **Applicant & Address :** Firefly Mobile, Inc.
250 Parkway Drive, suite 220, Lincolnshire, IL. 60069, United states

7) **Contact :** Mr. Shawn Novak (Phone : 847 3531984 , Fax : 847 3531820)

8) **Rule and Test Standard :** FCC 47 CFR § 2.1093; OET Bulletin 65, Supplement C(July 2001)

9) **FCC Clasification :** Licensed Portable Transmitter Held to Ear (PCE)

10) **RF exposure Category :** General Population/Uncontrolled

11) **Maximum SAR :** 1.26 W/kg GSM850 Head SAR / 0.700 W/kg GSM850 Body SAR
0.546 W/kg PCS1900 Head SAR / 0.326 W/kg GSM1900 Body SAR

1.2 Description of Device :

Operation Modes	GSM850/GPRS850 & GSM1900/GPRS1900
Conducted RF Power	32.4 dBm(GSM850) & 29.2 dBm(GSM1900)
Tx Frequency Range	824.2 ~ 848.8 MHz (GSM850) 1850.2 ~ 1909.8MHz (GSM1900)
GPRS Mode	GPRS CLASS 10
Duty Cycle	1: 8.3 (GSM850/1900) , 1: 4.15 (GPRS850/1900)
Device Dimensions (L x W x H)	104 x 44 x 16 mm
Antenna Type & Location	Internal Antenna Inside the back cover, near the top
Battery Type	Standard: 3.7V LI-ION Battery 800mAH

2. INTRODUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency(RF) radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emission due to FCC-regulated portable devices.[1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. (c) 1992 by the Institute of Electical and Electronics Engineers, Inc., New York, New York 10017.[2] The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromgnetic Fields – RF and Microwave[3] is used for guidance in measureing SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements(NCRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields "NCRP Report No. 86 (c) NCRP, 1986, Bethesda, MD 20814.[4] SAR is a measure of the rate of energy absorption due to exaposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

2.1 SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (*dU*) absorbed by (dissipated in) an incremental mass (*dm*) contained in a volume element (*dV*) of a given density(*p*). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body. (see Figure.1)

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{pdv}\right)$$

Figure 1. SAR Mathematical Equation

SAR is expressed in units of Watts per Kilogram (W/kg).

$$SAR = \sigma E^2 / p$$

Where :

σ = conductivity of the tissue-simulant material (S/m)

p = mass density of the tissue-simulant material (kg/m^3)

E = Total RMS electric field strength (V/m)

Note: The primary factors that control rate or energy absorption were found to be the wavelength of the incident field in realtions to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflectinf surfaces, and whether conductive contact is made by the organism with a ground plane.[4]

3. DESCRIPTION OF SAR MEASREMENT SYSTEM

3.1 SAR Measurement System

These measurements are performed using the DASY4 automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, measurement server, Measurement computer, near-field probe, probe alignment sensor, and the SAM twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig.2).

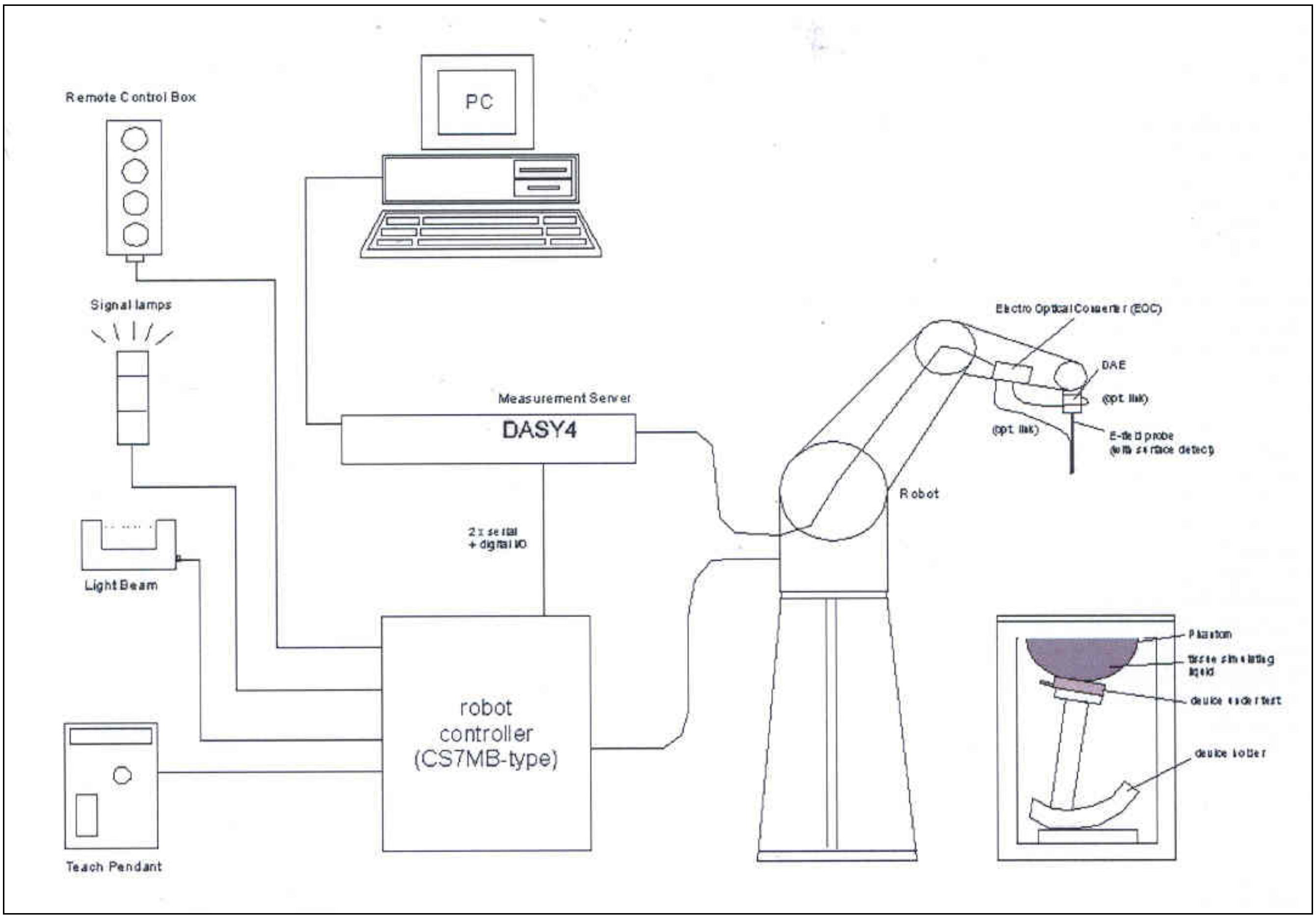

Figure 2. SAR Measurement System

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in [5].

3.2 E-Field Probe Type and Performance

The SAR measurements were conducted with the dosimetric probe ET3DV6, (see Fifure.4) designed in the classical triangular configuration [5] and optimised for dosimetric evaluation. The probe has been constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical mortifier line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches a maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approace and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

Figure 3. Probe and DAE

Probe Specifications

Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection System Built-in shielding against static charges
Calibration	In air from 10 MHz to 2.5 GHz In brain and muscle simulating tissue at Frequencies of 450 MHz, 900 MHz and 1.8 GHz (accuracy ± 8%)
Frequency	10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity	± 0.2 dB in brain tissue (rotation around probe axis) ± 0.4 dB in brain tissue (rotation normal probe axis)
Dynamic Range Linearity Surface Detection	5 uW/g to > 100 mW/g; 0.2 dB 0.2 mm repeatability in air and clear liquids Over diffuse reflecting surfaces.
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	General dissymmetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

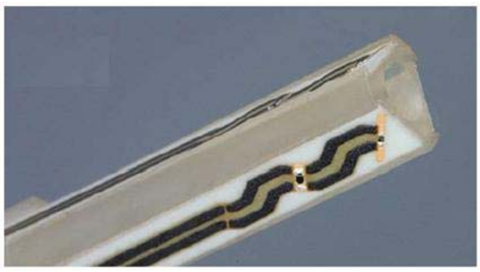

Figure 4. ET3DV6 E-Field Probe

3.3 Probe Calibration Process

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described [6] with an accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/- 0.25dB. The sensitivity parameters (NornX, NornY, NornZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe is tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a waveguide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

where:

Δt = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

ΔT = temperature increase due to RF exposure.

SAR is proportional to $\Delta T / \Delta t$, the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm³ for brain tissue)

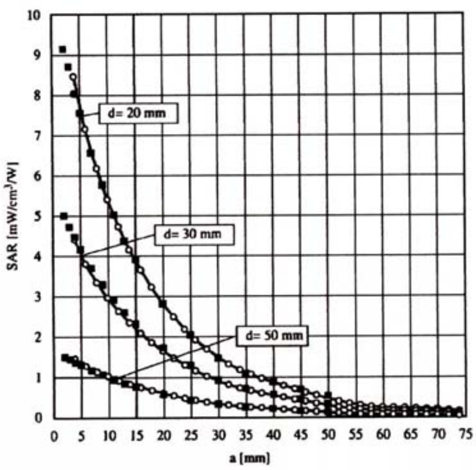

Figure B.1. E-Field and Temperature measurements at 900MHz[5]

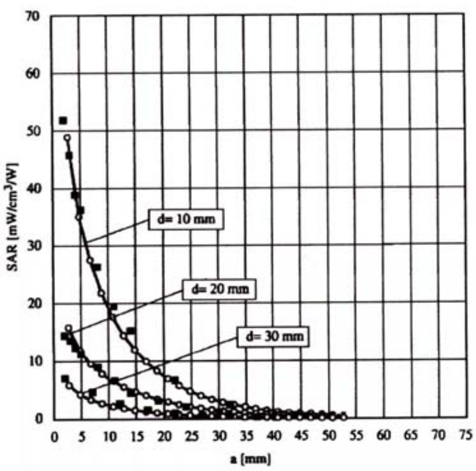

Figure B.2. E -field and temperature measurements at 1.8GHz[5]

3.4 Data Acquisition Electronics

The data acquisition electronics (DAE4) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. The input impedance of the DAE4 box is 200 Mohm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.Transmission to the PC-card is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.
The mechanical probe-mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

3.5 Phantom Properties

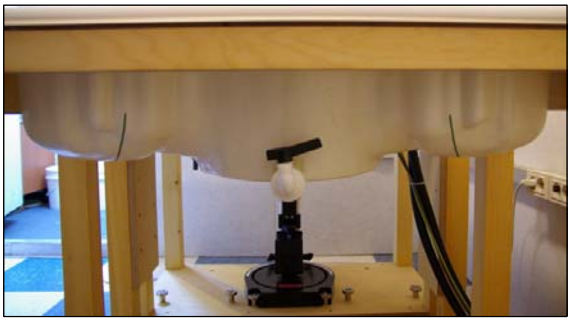

Figure 5. SAM twin phantom

The SAM Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users [9][10]. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

Phantom Properties	Requirement for specific EUT	Measured
Depth of Phantom	> 150 mm	200 mm
Width of flat section	> 10 cm (Twice EUT Width)	20 cm
Length of flat section	> 26 cm (Twice EUT Length)	30 cm
Thickness of fla section	2 mm ± 0.2 mm	2.08 ~ 2.20 mm

Table 1. Flat Section Properties of SAM Twin Phantom

3.6 Device Holder for DASY4

In combination with the SAM Phantom V4.0, the Mounting Device(POM) enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatable positioned according to the FCC CENELEC specifications. The device holder can be locked at different phantom locations(left head, right head, flat phantom).

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations [10]. To produce the Worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

Figure 4. Device Holder

3.7 Brain & Muscle Simulating Mixture Characteristic

The brain and muscle mixtures consist of a viscous gel using hydroxethylcellulose (HEC) gelling agent and saline solution (see Table 2). Preservation with bacteriacide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrove [11].

Ingredients	835MHz Brain	835MHz Muscle	1900MHz Brain	1900MHz Muscle
Water	40.29%	50.75%	55.24%	70.23%
Sugar	57.90%	48.21%	-	-
Salt	1.38%	0.94%	0.31%	0.29%
DGBE	-	-	44.45%	29.47%
Bacteriacide	0.18%	0.10%	-	-
HEC	0.24%	-	-	-

Table 2 : Composition of Tissue Equivalent Matter

4. System Verification

4.1 Tissue Verification

The dielectric parameters of the brain and muscle simulating liquid were measured prior to SAR assessment using the HP85070D dielectric probe kit and Agilent 8753D Network Analyzer. The actual dielectric parameters are shown in the following table.

Freq. [MHz]	Liquid	Date	Liquid Temp [°C]	parameters	Target Value	Measured Value	Deviation (%)	Limit (%)
835	Head	July 20th, 2007	22.5	εr	41.5	41.9	+0.9%	±5%
835	Head	July 20th, 2007	22.5	σ	0.90	0.897	-0.4%	±5%
835	Body	July 20th, 2007	22.0	εr	55.2	53.0	-4.0%	±5%
835	Body	July 20th, 2007	22.0	σ	0.97	0.957	-1.4%	±5%
1900	Head	July 23th, 2007	22.5	εr	40.0	39.5	-1.3%	±5%
1900	Head	July 23th, 2007	22.5	σ	1.40	1.396	-0.3%	±5%
1900	Body	July 23th, 2007	22.0	εr	53.3	51.6	-3.2%	±5%
1900	Body	July 23th, 2007	22.0	σ	1.52	1.526	+0.3%	±5%

Table 3 : Measured Simulating Liquid Dielectric Values

The humidity and dielectric/ambient temperatures are recorded during the assessment of the tissue material dielectric parameters. The difference between the ambient temperature of the liquid during the dielectric measurement and the temperature during tests was less than |2|°C.

4.2 System Validation

Figure 5. Validation setup

Prior to the SAR assessment, the system validation kit was used to verify that the DASY4 was operating within its specifications. The validation dipoles are highly symmetric and matched at the centre frequency for the specified liquid and distance to the phantom. The accurate distance between the liquid surface and the dipole centre is achieved with a distance holder that snaps onto the dipole.
System validation is performed by feeding a known power level into a reference dipole, set at a know distance from the phantom. The measured SAR is compared to the theoretically derived level.

The reference SAR values are derived using a reference dipole and flat phantom suitable. The forward power into the reference dipole for each SAR validation was adjusted to 250 mW.

These reference SAR values are obtained from the IEEE Std 1528 and are normalized to 1 W. The measured 1g(10g) SAR should be within 10 % of the expected target reference values shown in table 4 below.

System Validation Kit	Date	Tissue	Liquid Temp.(˚C)	Ambient Temp.(˚C)	Targeted SAR1g (mW/g)	Measured SAR 1 g (mW/g)	Deviation (%)
D835V2 S/N:481	20th July 2007	835MHz Brain	22.5	21.0	9.5	9.4	-1.1%
D1900V2 S/N:5d032	23th July 2007	1900MHz Brain	22.5	21.5	39.7	38.1	-4.1%

Table 4 : Deviation from Reference Validation Values

During the SAR measurement process the liquid depth was maintained to a level of a least 15 tolerance of ± 0.2cm.
The following photo shows the depth of the liquid depth of the liquid maintained during the testing.

Figure 6. Liquid Depth

5. SAR MEASUREMENT PROCEDURE USING DASY4

The SAR evaluation was performed with the SPEAG DASY4 system. A summary of the procedure follows ;

a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the EUT. The SAR at this point is measured at the start of the test and then again at the end of the test.

b) The SAR distribution at the exposed side of the phantom is measured at a distance of 3.9 mm from the inner surface of the shell. The area covers the entire dimension of the EUT and the horizontal grid spacing is 15 mm x 15 mm(or 20mm x 20mm). The actual Area Scan has dimensions surrounding the test device. Based on this data, the area of the maximum absorption is determined by Spline interpolation.

c) Around this point, a volume is assessed by measuring 5 x 5 x 7 (7 x 7 x 7) points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure ;

(i) The data at the surface are extrapolated, since the centre of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation is based on a least square algorithm[13]. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.

(ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot”- condition (in x, y and z-direction)[13][14]. The volume is integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.

(iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

(iv) The SAR value at the same location as in Step (a) is again measured (If the value changed by more than 5%, the evaluation is repeatd.)

6. MEASUREMENT UNCERTAINTY

The uncertainty analysis is based on the template listed in the IEEE Std 1528-2003 for both EUT SAR tests and Validation uncertainty. The measurement uncertainty of a specific device is evaluated independently and the total uncertainty for both evaluations (95 % confidence level) must be less than 25 %.

a	b	c	d	e= f(d,k)	f	g	h=cxf/e	i=cxg/e	k
Uncertainty Component	Sec.	Tol. (%)	Prob. Dist.	Div.	Ci (1 g)	Ci (10 g)	1 g Ui (± %)	10 g Ui (± %)	vi
Measurement System									
Probe Calibration (k=1)	E.2.1	5.9	N	1	1	1	5.9	5.9	∞
Axial Isotropy	E.2.2	4.7	R	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	E.2.2	9.6	R	√3	0.7	0.7	3.9	3.9	∞
Boundary Effect	E.2.3	1.0	R	√3	1	1	0.6	0.6	∞
Linearity	E.2.4	4.7	R	√3	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1.0	R	√3	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	0.3	N	1	1	1	0.3	0.3	∞
Response Time	E.2.7	0.8	R	√3	1	1	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	√3	1	1	1.5	1.5	∞
RF Ambient Noise	E.6.1	3.0	R	√3	1	1	1.7	1.7	∞
RF Ambient Refections	E.6.1	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner	E.6.2	0.4	R	√3	1	1	0.2	0.2	∞
Probe Positioning with respect to Phantom Shell	E.6.3	2.9	R	√3	1	1	1.7	1.7	∞
Algorithms for Max. SAR Evaluation	E.5	1.0	R	√3	1	1	0.6	0.6	∞
Test Sample Related									
Test Sample Positioning	E.4.2	2.9	N	1	1	1	2.9	2.9	145
Device Holder Uncertainty	E.4.1	3.6	N	1	1	1	3.6	3.6	5
Output Power Variation — SAR Drift Measurement	6.6.2	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	E.3.1	4.0	R	√3	1	1	2.3	2.3	∞
Liquid Conductivity — Deviation from target values	E.3.2	5.0	R	√3	0.64	0.43	1.8	1.2	∞
Liquid Conductivity — Measurement uncertainty	E.3.3	2.5	N	1	0.64	0.43	1.6	1.1	∞
Liquid Permititivity — Deviation from target values	E.3.2	5.0	R	√3	0.6	0.49	1.7	1.4	∞
Liquid Pemiittivity — Measurement uncertainty	E.3.3	2.5	N	1	0.6	0.49	1.5	1.2	∞
Cornbined standard Uncertainty			RSS				± 10.9	± 10.7	387
Expanded Uncertainty (95% CONFIDENCE LEVEL)			K=2				± 21.9	± 21.4	

Table 5. EUT SAR Test - Uncertainty Budget for DASY4 Version V4.6 Build 19

Estimated total measurement uncertainity for the DASY4 measurement system was ± 10.9 %.
The extended uncertainity (K=2) was assessed to be ± 21.9 % based on 95 % confidence level.
The uncertainity is not added to the measurement result.

a	b	c	d	e= f(d,k)	f	g	h=cxf/e	i=cxg/e	k
Uncertainty Component	Sec.	Tol. **(%)**	Prob. Dist.	Div.	Ci (1 g)	Ci (10 g)	1 g Ui (± %)	10 g Ui (± %)	vi
Measurement System									
Probe Calibration (k=1)	E.2.1	5.9	N	1	1	1	5.9	5.9	∞
Axial Isotropy	E.2.2	4.7	R	√ 3	1	1	2.7	2.7	∞
Hemispherical Isotropy	E.2.2	9.6	R	√ 3	0	0	0	0	∞
Boundary Effect	E.2.3	1.0	R	√ 3	1	1	0.6	0.6	∞
Linearity	E.2.4	4.7	R	√ 3	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1.0	R	√ 3	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	0.3	N	1	1	1	0.3	0.3	∞
Response Time	E.2.7	0	R	√ 3	1	1	0	0	∞
Integration Time	E.2.8	0	R	√ 3	1	1	0	0	∞
RF Ambient Noise	E.6.1	3.0	R	√ 3	1	1	1.7	1.7	∞
RF Ambient Refections	E.6.1	3.0	R	√ 3	1	1	1.7	1.7	∞
Probe Positioner	E.6.2	0.4	R	√ 3	1	1	0.2	0.2	∞
Probe Positioning with respect to Phantom Shell	E.6.3	2.9	R	√ 3	1	1	1.7	1.7	∞
Algorithms for Max. SAR Evaluation	E.5.2	1.0	R	√ 3	1	1	0.6	0.6	∞
Dipole									
Dipole Axis to Liquid Distance	8, E.4.2	2.0	R	√ 3	1	1	1.2	1.2	∞
Input Power and SAR Drift Measurement	8, 6.6.2	4.7	R	√ 3	1	1	2.7	2.7	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	E.3.1	4.0	R	√ 3	1	1	2.3	2.3	∞
Liquid Conductivity — Deviation from target values	E.3.2	5.0	R	√ 3	0.64	0.43	1.8	1.2	∞
Liquid Conductivity — Measurement uncertainty	E.3.3	2.5	N	1	0.64	0.43	1.6	1.1	∞
Liquid Permititivity — Deviation from target values	E.3.2	5.0	R	√ 3	0.6	0.49	1.7	1.4	∞
Uquid Pemiittivity — Measurement unceilainty	E.3.3	2.5	N	1	0.6	0.49	1.5	1.2	∞
Cornbined standard Uncertainty			RSS				± 9.2	± 8.9	∞
Expanded Uncertainty (95% CONFIDENCE LEVEL)			K=2				± 18.4	± 17.8	

Table 6. Validation - Uncertainty Budget for DASY4 Version V4.6 Build 19

Estimated total measurement uncertainty for the DASY4 measurement system was ± 9.2 %.
The extended uncertainty (K = 2) was assessed to be ± 18.4 % based on 95 % confidence level.
The uncertainty is not added to the validation measurement result.

7. Description of Test Position

SAR measurements were performed in the "cheek" and "tilted" positions on left and right sides of the phantom. Both were measured in the head section of the SAM Twin Phantom . For the "Belt " position , it was measured in the flat section of the SAM Twin Phantom .

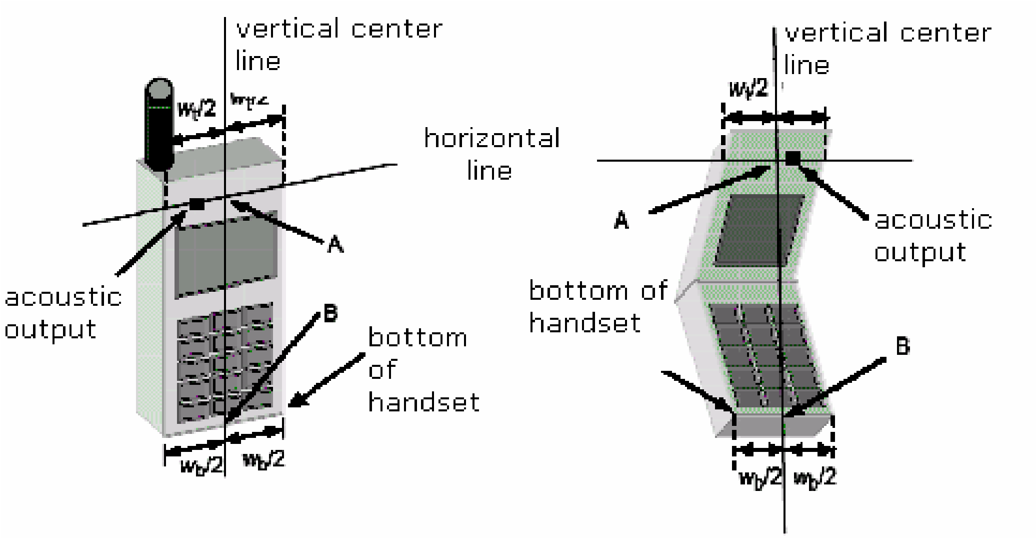

Figure 7. Handset vertical and horizontal reference line

7.1 Cheek Position

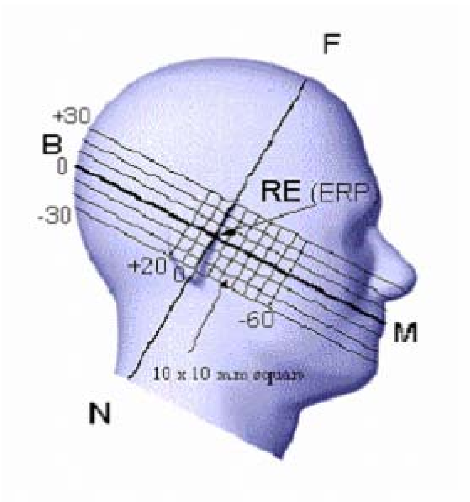

Figure 8. Side view of SAM phantom

The device was positioned with the vertical center line of the body of the device and the horizontal line crossing the center (see Figure 7) of the ear piece in a plane parallel to the sagittal plane of the phantom(see Figure 8). While maintaining the device in this plane, it was aligned the vertical center line with the reference plane containing the three ear and mouth reference points(M, RE and LE) and aligned the center of the ear piece with the line RE-LE. Then device was translated towards the phantom with the ear piece aligned with the line LE-RE until it touched the ear. While maintaining the device in the reference plane and maintaining the device contact with the ear, the bottom of the device was moved until any point on the front side is in contact with the cheek of the phantom.(see Figure 9)

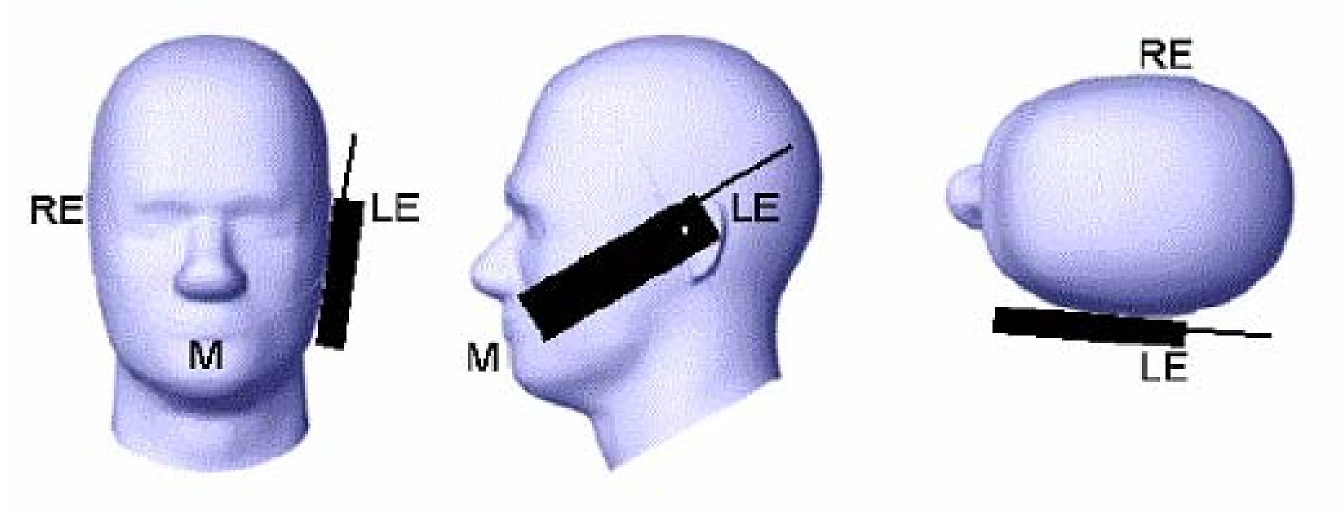

Figure 9. Cheek/Touch Position

2)

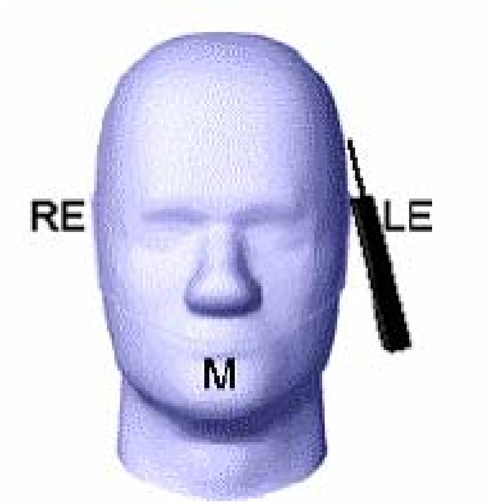

Figure 10. Ear /Tilt Position

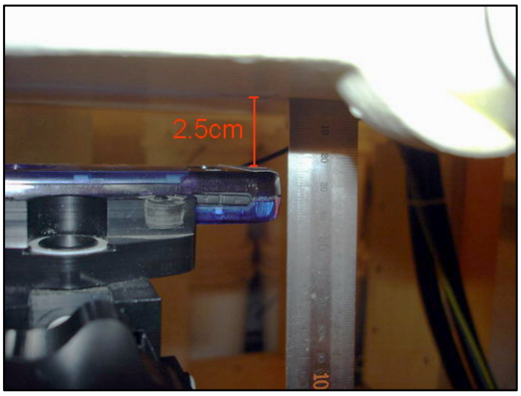

Figure 11. Belt Position set up with holster

7.2 Tilt Position

The device was positioned in the “Cheek” position. While maintaining the device in the reference plane described above cheek position and pivoting against the ear, device was moved outward away from the mouth by an angle of 15 degrees. (see Figure 10)

7.3 Body Holster/Belt-Clip Position

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration .A device with a headset output is tested with a headset connectd to the device.
Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested

with the device with each accessory. If multiple accessories share an identical metallic component(i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intented to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented.
Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are test for SAR compliance with the front of the device positioned to face the flat phantom in brain fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

In all cases SAR measurements are performed to investigate the worst-case positioning. Worst-case positioning is then documented and used to perform Body SAR testing.

In this test case, a belt position maintained a distance of approximately 2.5 cm between the back of the device and the flat phantom(see Figure 11). The device was placed under the flat section of the phantom and suspended. The device is not provided with belt- clip.

8. FCC RF Exposure Limits

HUMAN EXPOSURE	UNCONTROLLED ENVIRONMENT General Population (W/Kg) or (mW/g)	CONTROLLED ENVIRONMENT Occupational (W/Kg) or (mW/g)
SPATIAL PEAK SAR (Brain)	1.60	8.00
SPATIAL AVERAGE SAR (Whole Body)	0.08	0.40
SPATIAL PEAK SAR (Hand / Feet / Ankle / Wrist)	4.00	20.00

Table. 8 Safety Limits for Partial Body Exposure

NOTE 1 : **Whole-Body SAR** is averaged over the entire body, **partial-body SAR** is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. **SAR for hands, wrists, feet and ankles** is averaged ower any 10 grams of tissue defined as a tissue volume in the shape of cube

NOTE 2 : At frequencies above 6.0 GHz, SAR limits ajre not applicable and MPE limits for power density should be appoied at 5 cm or more from the transmitting device.

NOTE 3 : The time averaging criteria for field strength and power density do not apply to general population SAR limit of 47 CFR § 2.1093.

9. SAR MEASUREMENT RESULTS

1) GSM850 Head SAR Measurement Result

Date of Test : 20th July 2007
Mixture Type : 835MHz Brain
Ambient Temperature (C) : 21.0
Dielectric Constant : 41.9

Liquid Temperature (C) : 22.5
Humidity (%) : 46
Conductivuty : 0.897

Frequency		Band	Power (dBm)		Head Position	Device Position	Antenna Position	SAR 1g (W/Kg)
MHz	CH		Begin	End				
824.2	128	GSM850	32.4	32.3	Left	Cheek /Touch	Internal Ant.	0.831
836.6	190		32.4	32.3		Cheek /Touch	Internal Ant.	1.08
848.8	251		32.3	32.3		Cheek /Touch	Internal Ant.	1.24
824.2	128	GSM850	32.4	32.4		Ear/Tilt	Internal Ant.	0.493
836.6	190		32.4	32.4		Ear/Tilt	Internal Ant.	0.593
848.8	251		32.3	32.3		Ear/Tilt	Internal Ant.	0.770
824.2	128	GSM850	32.4	32.3	Right	Cheek /Touch	Internal Ant.	0.854
836.6	190		32.4	32.4		Cheek /Touch	Internal Ant.	1.10
848.8	251		32.3	32.3		Cheek /Touch	Internal Ant.	**1.26**
824.2	128	GSM850	32.4	32.4		Ear/Tilt	Internal Ant.	0.505
836.6	190		32.4	32.4		Ear/Tilt	Internal Ant.	0.625
848.8	251		32.3	32.3		Ear/Tilt	Internal Ant.	0.747

NOTES:
1.The test data reported are the worst-case SAR value with the antenna –head position set in a typical configuration
2.All modes of operation were investigated and the worst-case are reported.
3.Battery : Standard Batteries are used and fully charged for all readings
4.Power Measured : Conducted
5.SAR Configuration : Head
6.Test Signal Call mode : Base Station Simulator
7.Duty Cycle : 1: 8.3
8.SAR Measurement System : SPEAG-DASY4

2) GSM850 Body SAR Measurement Result

Date of Test : 20th July 2007
Mixture Type : 835MHz Muscle
Ambient Temperature (C) : 21.0
Dielectric Constant : 53.0

Liquid Temperature (C) : 22.0
Humidity (%) : 46
Conductivuty : 0.957

Frequency		Band	Power (dBm)		EUT Position	Device Position	Antenna Position	SAR 1g (W/Kg)
MHz	CH		Begin	End				
824.2	128	GSM850	32.4	32.3	Body (rear facing Phanstom)	Belt without Holster	Internal Ant.	0.367
836.6	190		32.4	32.3		Belt without Holster	Internal Ant.	0.336
848.8	251		32.3	32.3		Belt without Holster	Internal Ant.	0.290
824.2	128	GPRS850	32.4	32.4	Body (rear facing Phanstom)	Belt without Holster	Internal Ant.	**0.700**
836.6	190		32.4	32.4		Belt without Holster	Internal Ant.	0.636
848.8	251		32.3	32.3		Belt without Holster	Internal Ant.	0.550
824.2	128	GPRS850	32.4	32.4	Body (front facing Phantom)	Belt without Holster	Internal Ant.	0.574

NOTES:
1.The test data reported are the worst-case SAR value with the antenna –head position set in a typical configuration
2.All modes of operation were investigated and the worst-case are reported.
3.Battery : Standard Batteries are used and fully charged for all readings.
4.Power Measured : Conducted
5.SAR Configuration : Body (worst case found in rear facing phantom for GSM850)
6.Test Signal Call mode : Base Station Simulator
7.Duty Cycle : 1: 8.3(GSM850) , 1:4.15(GPRS850)
8.SAR Measurement System : SPEAG-DASY4

3) PCS1900 Head SAR Measurement Result

Date of Test : 23th July 2007
Mixture Type : 1900MHz Brain
Ambient Temperature (C) : 21.5
Dielectric Constant : 39.5

Liquid Temperature (C) : 22.5
Humidity (%) : 47
Conductivuty : 1.396

Frequency		Band	Power (dBm)		Head Position	Device Position	Antenna Position	SAR 1g (W/Kg)
MHz	CH		Begin	End				
1850.2	512	PCS1900	29.1	29.1	Left	Cheek /Touch	Internal Ant.	0.355
1880.0	661		29.2	29.2		Cheek /Touch	Internal Ant.	0.344
1909.8	810		29.2	29.1		Cheek /Touch	Internal Ant.	0.388
1850.2	512	PCS1900	29.1	29.1	Left	Ear/Tilt	Internal Ant.	0.272
1880.0	661		29.2	29.2		Ear/Tilt	Internal Ant.	0.314
1909.8	810		29.2	29.2		Ear/Tilt	Internal Ant.	0.343
1850.2	512	PCS1900	29.1	29.1	Right	Cheek /Touch	Internal Ant.	0.415
1880.0	661		29.2	29.1		Cheek /Touch	Internal Ant.	**0.546**
1909.8	810		29.2	29.2		Cheek /Touch	Internal Ant.	0.478
1850.2	512	PCS1900	29.1	29.1	Right	Ear/Tilt	Internal Ant.	0.366
1880.0	661		29.2	29.2		Ear/Tilt	Internal Ant.	0.474
1909.8	810		29.2	29.1		Ear/Tilt	Internal Ant.	0.393

NOTES:
1.The test data reported are the worst-case SAR value with the antenna –head position set in a typical configuration
2.All modes of operation were investigated and the worst-case are reported.
3.Battery : Standard Batteries are used and fully charged for all readings.
4.Power Measured : Conducted
5.SAR Configuration : Head
6.Test Signal Call mode : Base Station Simulator
7.Duty Cycle : 1:8.3
8.SAR Measurement System : SPEAG-DASY4

4) PCS1900 Body SAR Measurement Result

Date of Test : 23th July 2007
Mixture Type : 1900MHz Muscle
Ambient Temperature (C) : 21.5
Dielectric Constant : 51.6

Liquid Temperature (C) : 22.0
Humidity (%) : 47
Conductivuty : 1.526

Frequency		Band	Power (dBm)		DUT Position	Device Position	Antenna Position	SAR 1g (W/Kg)
MHz	CH		Begin	End				
1850.2	512	PCS1900	29.1	29.1	Body (back facing Phanstom)	Belt without Holster	Internal Ant.	0.097
1880.0	661		29.2	29.2		Belt without Holster	Internal Ant.	0.138
1909.8	810		29.2	29.1		Belt without Holster	Internal Ant.	0.094
1850.2	512	GPRS1900	29.0	29.0	Body (back facing Phanstom)	Belt without Holster	Internal Ant.	0.216
1880.0	661		29.1	29.1		Belt without Holster	Internal Ant.	0.262
1909.8	810		29.1	29.1		Belt without Holster	Internal Ant.	**0.326**
1909.8	810	GPRS1900	29.1	29.1	Body (front facing Phantom)	Belt without Holster	Internal Ant.	0.261

NOTES:
1.The test data reported are the worst-case SAR value with the antenna –head position set in a typical configuration
2.All modes of operation were investigated and the worst-case are reported.
3.Battery : Standard Batteries are used and fully charged for all readings.
4. Power Measured : Conducted
5.SAR Configuration : Body (worst case found in rear facing phantom for PCS1900)
6.Test Signal Call mode : Base Station Simulator
7.Duty Cycle : 1:8.3 (PCS1900) , 1:4.15 (GPRS1900)
8.SAR Measurement System : SPEAG-DASY4

10. CONCLUSION

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the ANSI/IEEE C95.1 1992**.** These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

11. EQUIPMENT LIST AND CALIBRATION DETAILS

Equipment Type	Manufacturer	Model Number	Serial Number	Calibration Due	Used For this Test?
Robot - Six Axes	Staubli	RX60	N/A	N/A	Yes
Robot Remote Control	SPEAG	CS7MB	F03/5U96A1 /C/01	N/A	Yes
SAM Twin Phantom	SPEAG	TP1276	QD000P40CA	N/A	Yes
Flat Phantom V4.4	SPEAG	QD000P44BA, BB	1001, higher	N/A	No
Data Acquisition Electronics	SPEAG	DAE4	559	2008.04.17	Yes
Probe E-Field	SPEAG	ET3DV6	1773	2008.05.31	Yes
Antenna Dipole 835 MHz	SPEAG	D835V2	481	2008.05.24	Yes
Antenna Dipole 900 MHz	SPEAG	D900V2	194	2007.11.21	No
Antenna Dipole 1800 MHz	SPEAG	D1800V2	2d066	2008.05.23	No
Antenna Dipole 1900 MHz	SPEAG	D1900V2	5d032	2008.02.20	Yes
Antenna Dipole 1950 MHz	SPEAG	D1950V2	1027	2008.03.14	No
Antenna Dipole 2450 MHz	SPEAG	D2450V2	746	2008.02.20	No
High power RF Amplifier	EMPOWER	2057-BBS3Q5KCK	1002D/C0321	2007.10.13	Yes
Universal Radio Communication Tester	R&S	CMU200	110019	2007.08.29	Yes
Signal Generator	Hewlett Packard	8648C	3629U00868	2008.05.20	Yes
RF Power Meter Dual	Hewlett Packard	E4419A	GB37170495	2008.04.24	Yes
RF Power Sensor 0.01 - 18 GHz	Hewlett Packard	8481A	US37299851	2008.01.12	Yes
RF Power Sensor 0.01 - 18 GHz	Hewlett Packard	8481A	3318A92872	2008.01.12	Yes
S-Parameter Network Analyzer	Agilent	8753D	3410A07251	2008.04.06	Yes
Dual Directional Coupler	Hewlett Packard	778D	1144AO4576	2007.10.13	Yes
Directional Coupler	Agilent	773D	MY28390213	2007.10.13	No

12. REFERENCES

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio frequency Radiation, Aug. 1996.

[2] ANSI/IEEE C95.1 - 1991, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300kHz to 100GHz, New York: IEEE, Aug. 1992

[3] ANSI/IEEE C95.3 - 1991, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, 1992.

[4] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radio Frequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.

[5] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.

[6] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. 120-124.

[7]K. Pokoviº, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.

[8] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.

[9] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Head Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct.1996, pp. 1865-1873.

[10] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[11] G. Hartsgrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectro magnetics, Canada: 1987, pp. 29-36.

[12] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.

[13] W. Gander, Computer mathematick, Birkhaeuser, Basel, 1992.

[14] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.

[15] Federal Communications Commission, OET Bulletin 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields. Supplement C, Dec. 1997.

[16] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

[17] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Field High-frequency: 10kHz-300GHz, Jan. 1995.

[18] Prof. Dr. Niels Kuster, ETH, EidgenØssische Technische Hoschschule Zòrich, Dosimetric Evaluation of the Cellular Phone.