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# TEST REPORT ON SAR

Model Tested: SGH-C516  
FCC ID (Requested): A3LSGHC516  
Job No: FE-018  
Report No: FE-018-S1  
Date issued: Feb.28, 2007

- Abstract -

This document reports on SAR Tests carried out in accordance with FCC/OET Bulletin 65, Supplement C(July 2001).

Prepared By

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## 1. GENERAL INFORMATION

Test Sample : Dual-Band GSM850/1900 Phone  
Model Number : SGH-C516  
Serial Number : Identical prototype (S/N : # FE-018-D)

Manufacturer : SAMSUNG ELECTRONICS Co., Ltd.  
Contact : DH YOO

Phone : +82-31-301-0547  
Fax : +82-31-301-9201  
Test Standard : §2.1093; FCC/OET Bulletin 65, Supplement C(July 2001)  
FCC Classification : Licensed Portable Transmitter Held to Ear (PCE)  
Test Dates : Feb.22, 2007 ~ Feb.23, 2007  
Tested for : FCC/TCB Certification

## 2. DESCRIPTION OF DEVICE

Tx Freq. Range : 824.2 ~ 848.8 MHz (GSM850)  
1850.20 ~ 1909.80 MHz (GSM1900)

Rx Freq. Range : 869.2 ~ 893.8 MHz (GSM850)  
1930.20 ~ 1989.80 MHz (GSM1900)

Max. RF Output Power : 1.746 W ERP GSM850 (32.42 dBm)  
1.104 W EIRP GSM1900 (30.43 dBm)

Antenna Manufacturer : PATRON  
Model No.: SGH-C516

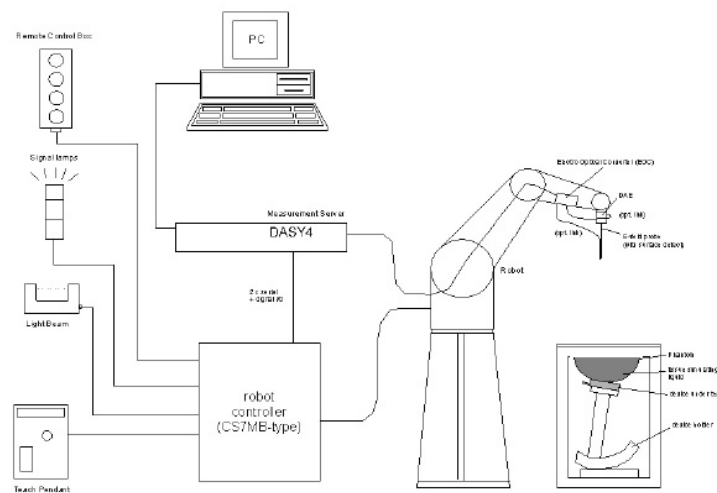
Antenna Dimensions : -

### 3. DESCRIPTION OF TEST EQUIPMENT

#### 3.1 SAR Measurement Setup

##### Robotic System

Measurements are performed using the DASY4 automated dosimetric assessment system. Which is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Stäubli), robot controller, measurement server, Samsung 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. 3.1).



**Figure 3.1 SAR Measurement System Setup**

##### System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control is used to drive the robot motors. The PC consists of the Samsung computer with Windows XP system and SAR Measurement Software DASY4, LCD monitor, mouse and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A



data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the measurement server

### **System Electronics**

The DAE4(or DAE3) 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 measurement server 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.

### 3.2 E-field Probe



The SAR measurement were conducted with the dosimetric probe ES3DV2, designed in the classical triangular configuration (see Fig.3.3) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. 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 approach and looks for the maximum using a 2<sup>nd</sup> order fitting (see Fig.3.2). The approach is stopped at reaching the maximum.

**Figure 3.2 DAE System**

#### Probe Specifications

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	Basic Broad Band Calibration in air: 10-3000 MHz Conversion Factors (CF) for HSL 900 and HSL 1800 Additional CF for other liquids and frequencies upon request
Frequency	10 MHz to > 6 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 3 GHz)
Directivity	$\pm 0.2$ dB in HSL (rotation around probe axis) $\pm 0.3$ dB in tissue material (rotation normal to probe axis)



Dynamic Range       $5\mu\text{W/g}$  to  $> 100\text{mW/g}$ ; Linearity:  $\pm 2\text{dB}$

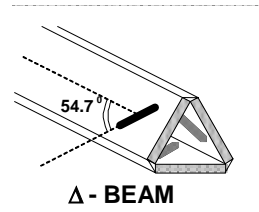


Figure 3.3 Triangular Probe Configuration

Dimensions      Overall length: 330 mm (Tip: 20 mm)  
Tip diameter: 3.9 mm (Body: 12 mm)  
Distance from probe tip to dipole centers:  
2.1 mm



Figure 3.4 Probe Thick-Film Technique

Application      General dosimetry up to 5 GHz  
Dosimetry in strong gradient fields  
Compliance tests of mobile phones

### 3.3 SAM Phantom

The SAM Twin Phantom V4.0 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. 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. (See Figure 3.5)



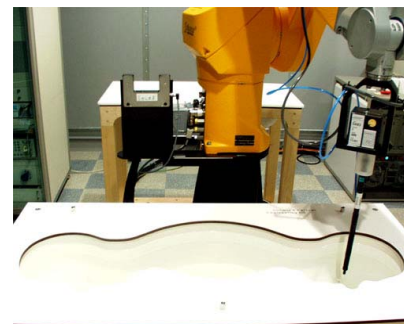
**Figure 3.5 SAM Twin Phantom**

#### Phantom Specification

Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-2003, CENELEC 50361 and IEC 62209. 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 evaporation of the liquid.
Shell Thickness	$2 \pm 0.2$ mm
Filling Volume	Approx. 25 liters
Dimensions	Height: 810 mm; Length: 1000 mm; Width: 500 mm

### 3.4 Brain & Muscle Simulating Mixture Characterization

The brain and muscle mixtures consist of a viscous gel using hydroxyethylcellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bactericide 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 head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been



**Figure 3.6 Simulated Tissue**

incorporated in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations.

**Table 3.1 Composition of the Brain & Muscle Tissue Equivalent Matter**

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%	-	-	-
Dielectric Constant Target	41.50	55.20	40.00	53.30
Conductivity Target (S/m)	0.900	0.970	1.400	1.520

### 3.5 Device Holder for Transmitters

In combination with the Twin SAM Phantom V4.0, the Mounting Device (see Fig. 3.7) 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 repeatedly be positioned according to the FCC 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 configuration. To produce worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

**Figure 3.7 Device Holder**

### 3.6 Validation Dipole

The reference dipole should have a return loss better than  $-20$  dB (measured in the setup) at the resonant frequency to reduce the uncertainty in the power measurement.

Frequency	835, 1900 MHz
Return Loss	< -20 dB at specified validation position
Dimensions	D835V2: dipole length: 161 mm; overall height: 330 mm D1900V2: dipole length: 68 mm; overall height: 300 mm



### 3.7 Equipment Calibration

**Table 3.2 Test Equipment Calibration**

Type	Calibration Due Date	Serial No.
SPEAG DAE4	Nov.16, 2007	533
E-Field Probe ES3DV2	Sep.20, 2007	3017
SPEAG Validation Dipole D835V2	Oct.17, 2007	451
SPEAG Validation Dipole D1900V2	Sep.13, 2007	548
Stäubli Robot RX90BL	Not Required	F01/5N19A1/A/01
SPEAG SAM Twin Phantom V4.0	Not Required	TP-1141
SPEAG SAM Twin Phantom V4.0	Not Required	TP-1143
8664A Signal Generator	Feb.05, 2008	MY45094010
BBS3Q7ELU Power Amp	Oct.23, 2007	1007D/C0035
E4419B Power Meter	Oct.24, 2007	GB41293847
HP-8753ES Network Analyzer	May.11, 2007	US39173712
HP85070C Dielectric Probe Kit	Not Required	US99360087
E4419B Power Meter	Jan.16, 2008	MY45101765
8481A Power Sensor	Oct.23, 2007	MY41092080
E9300B Power Sensor	Feb.05, 2008	MY41495894
8481A Power Sensor	Oct.23, 2007	MY41092090
DASY4 S/W (ver4.7)	Not Required	-
Directional Coupler	Jun.08, 2007	18862
Base Station Simulator	Jun.27, 2007	GB45360270

**NOTE:**

The E-field probe was calibrated by SPEAG, by temperature measurement procedure. Dipole Validation measurement is performed by Samsung Lab. before each test. (see § 7.2) The brain simulating material is calibrated by Samsung using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain-equivalent material. (see § 7.1)



## **4. SAR MEASUREMENT PROCEDURE**

The evaluation was performed using the following procedure.

### **STEP 1**

The SAR measurement was taken at a selected spatial reference point to monitor power variations during testing. This fixed location point was measured and used as a reference value.

### **STEP 2**

The SAR distribution at the exposed side of the head was measured at a distance of 3.9mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 20mm x 20mm. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation.

### **STEP 3**

Around this point, a volume of 32mm x 32mm x 34mm (fine resolution volume scan, zoom scan) was assessed by measuring 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

The data at the surface was extrapolated, since the center of the dipoles is 2.7mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. (This can be variable. Refer to the probe specification) The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were 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 directions). The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

### **STEP 4**

The SAR value at the same location as in step 1 was again measured. (If the value changed by more than 5%, the evaluation is repeated.)

## 5. DESCRIPTION OF TEST POSITION

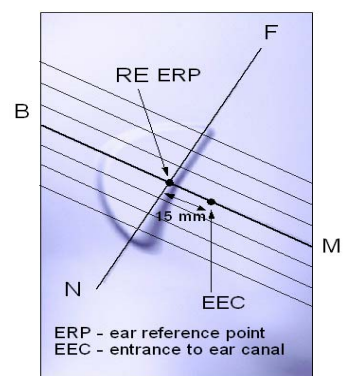
### 5.1 SAM Phantom Shape

Figure 5.1 shows the front, back and side views of SAM. The point “M” is the reference point for the center of mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERPs are 15 mm posterior to the entrance to ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 5.2.



**Figure 5.1 Front, back and side view of SAM**

The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 5.3). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines should be marked on the external phantom shell to facilitate handset positioning. Posterior to the N-F line, the thickness of the phantom shell with the shape of an ear is a flat surface 6 mm thick at the ERPs.

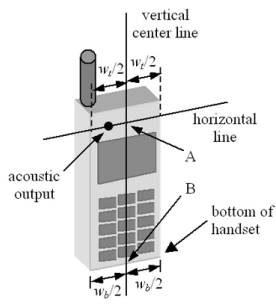


**Figure 5.2 Close up side view**

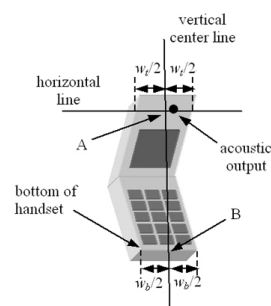
### 5.2 Cheek/Touch Position

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the “test device reference point” located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (see Fig. 5.4). The “test device reference point” was then located at the same level as the center of

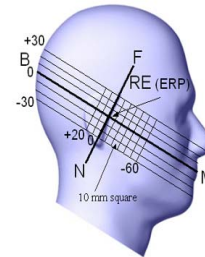
the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its tip and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point



**Figure 5.4 Handset vertical and horizontal reference lines**



**Figure 5.3 Side view of the phantom showing relevant markings**



### Step 1

The test device was positioned with 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 Figure 5.5), 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



**Figure 5.5 Front, Side and Top View of Cheek/Touch Position**

### Step 2

The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.

**Step 3**

While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).

**Step 4**

Rotate the handset around the vertical centerline until the phone (horizontal line) was symmetrical with respect to the line NF.

**Step 5**

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, the handset was rotated about the line NF until any point on the handset made contact with a phantom point below the ear (cheek). See Figure 5.2.

**5.3 EAR/Tilt 15° Position**

With the test device aligned in the “Cheek/Touch Position”:

**Step 1**

Repeat steps 1 to 5 of 5.2 to place the device in the “Cheek/Touch Position”



**Figure 5.6 Front, side and Top View of Ear/Tilt 15° Position**

**Step 2**

While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degree.

### Step 3

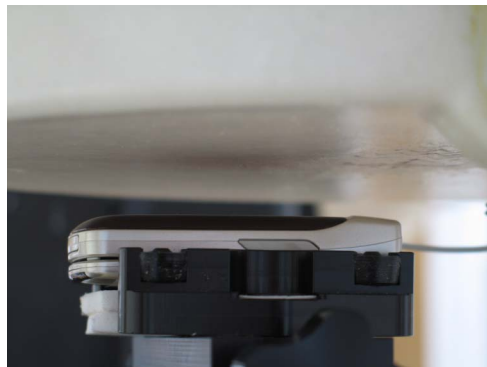
The phone was then rotated around the horizontal line by 15 degree.

### Step 4

While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the phone touches the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head.

## 5.4 Body Holster/Belt Clip Configurations

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 (see Figure 5.7). A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.



**Figure 5.7 Body Belt Clip and Holster Configurations**

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that 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 supplied with the device, the device is tested with each accessory that contains unique metallic component. If multiple accessory 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 intended to be authorized for body-worn use. In this case, a test configuration where a separation distance between the back of the device and the flat phantom is used.

Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessory(ies), 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 order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and cautions statements must be included in the user's manual.



## 6. MEASUREMENT UNCERTAINTY

**Table 6.1 Uncertainty Budget (835MHz)**

Error Description	Uncertainty Value( $\pm\%$ )	Probability Distribution	Divisor	$C_i$	Standard uncertainty	$v_i^2$ or $v_{eff}$
<b>Measurement System</b>						
Probe Calibration	11.90	Normal	2.000	1	5.90	
Axial Isotropy	4.70	rectangular	1.732	0.7	1.90	
Hemispherical Isotropy	9.60	rectangular	1.732	0.7	3.88	
Linearity	4.70	rectangular	1.732	1	2.71	
System Detection Limits	0.25	rectangular	1.732	1	0.14	
Boundary effects	1.00	rectangular	1.732	1	0.58	
Readout electronics	1.00	Normal	1.000	1	0.30	
Response time	0.80	rectangular	1.732	1	0.46	
RF ambient conditions	3.00	rectangular	1.732	1	1.73	
Integration time	0.00	rectangular	1.732	1	0.00	
Mechanical constrains of robot	1.43	rectangular	1.732	1	0.87	
Probe positioning	2.86	rectangular	1.732	1	1.67	
Extrapolation and integration	1.00	rectangular	1.732	1	0.58	
<b>Test Sample Related</b>						
Test Sample positioning	0.82	Normal	1.000	1	0.24	14
Device holded uncertainty	2.78	Normal	1.000	1	1.67	
Power Drift	5.00	Rectangular	1.732	1	2.89	
<b>Phantom and Setup</b>						
Phantom uncertainty	4.00	Rectangular	1.732	1	2.31	
Liquid conductivity (deviation from target)	5.00	Rectangular	1.732	0.64	1.85	
Liquid conductivity (measurement error)	5.50	Normal	1.000	0.64	3.76	
Liquid permittivity (deviation from target)	5.00	Rectangular	1.732	0.6	1.73	
Liquid permittivity (measurement error)	5.55	Normal	1000	0.6	3.26	
Combined Standard Uncertainty		Normal	-	-	<b>10.77</b>	<b>56811967</b>
<b>Extended Standard Uncertainty(K=2.00)</b>					<b>21.54</b>	<b>56811967</b>



**Table 6.2 Uncertainty Budget (1900MHz)**

Error Description	Uncertainty Value(±%)	Probability Distribution	Divisor	c <sub>i</sub>	Standard uncertainty	v <sub>i</sub> <sup>2</sup> or v <sub>eff</sub>
<b>Measurement System</b>						
Probe Calibration	11.90	Normal	2.000	1	5.90	
Axial Isotropy	4.70	rectangular	1.732	0.7	1.90	
Hemispherical Isotropy	9.60	rectangular	1.732	0.7	3.88	
Linearity	4.70	rectangular	1.732	1	2.71	
System Detection Limits	0.25	rectangular	1.732	1	0.14	
Boundary effects	1.00	rectangular	1.732	1	0.58	
Readout electronics	1.00	Normal	1.000	1	0.30	
Response time	0.80	rectangular	1.732	1	0.46	
RF ambient conditions	3.00	rectangular	1.732	1	1.73	
Integration time	0.00	rectangular	1.732	1	0.00	
Mechanical constrains of robot	1.43	rectangular	1.732	1	0.87	
Probe positioning	2.86	rectangular	1.732	1	1.67	
Extrapolation and integration	1.00	rectangular	1.732	1	0.58	
<b>Test Sample Related</b>						
Test Sample positioning	0.82	Normal	1.000	1	0.24	14
Device holded uncertainty	2.78	Normal	1.000	1	1.67	
Power Drift	5.00	Rectangular	1.732	1	2.89	
<b>Phantom and Setup</b>						
Phantom uncertainty	4.00	Rectangular	1.732	1	2.31	
Liquid conductivity (deviation from target)	5.00	Rectangular	1.732	0.64	1.85	
Liquid conductivity (measurement error)	4.96	Normal	1.000	0.64	3.33	
Liquid permittivity (deviation from target)	5.00	Rectangular	1.732	0.6	1.73	
Liquid permittivity (measurement error)	4.83	Normal	1000	0.6	2.81	
Combined Standard Uncertainty		Normal	-	-	<b>10.50</b>	<b>51355040</b>
<b>Extended Standard Uncertainty(K=2.00)</b>					<b>21.01</b>	<b>51355040</b>

## 7. SYSTEM VERIFICATION

### 7.1 Tissue Verification

**Table 7.1 MEASURED TISSUE PARAMETERS**

	835MHz Brain		835MHz Muscle		1900MHz Brain		1900MHz Muscle	
	Target	Measured	Target	Measured	Target	Measured	Target	Measured
Date	-	Feb22, 2007	-	Feb22, 2007	-	Feb23, 2007	-	Feb23, 2007
Liquid Temperature(°C)	-	21.0	-	21.0	-	21.7	-	21.6
Dielectric Constant: $\epsilon'$	41.5	41.2	55.2	53.0	40.0	39.9	53.3	52.2
Conductivity: $\sigma$	0.90	0.91	0.97	0.98	1.40	1.41	1.52	1.50

The measured value must be within  $\pm 5\%$  of the target value.

### 7.2 Test System Validation

Prior to assessment, the system is verified to the  $\pm 10\%$  of the specification at 835MHz and 1900MHz by using the system validation kit(s). (see Appendix E, Graphic Plot Attached)

**Table 7.2 System Validation Results**

System Validation Kit	Tissue	Targeted SAR <sub>1g</sub> (mW/g)	Measured SAR <sub>1g</sub> (mW/g)	Deviation (%)	Date	Liquid Temperature(°C)	Ambient Temperature(°C)
D835V2	835MHz Brain	2.375	2.43	2.32	Feb.22, 2007	21.3	21.7
D1900V2	1900MHz Brain	9.925	10.1	1.76	Feb.23, 2007	21.6	21.9

\*Validation was measured with input power 250 mW.

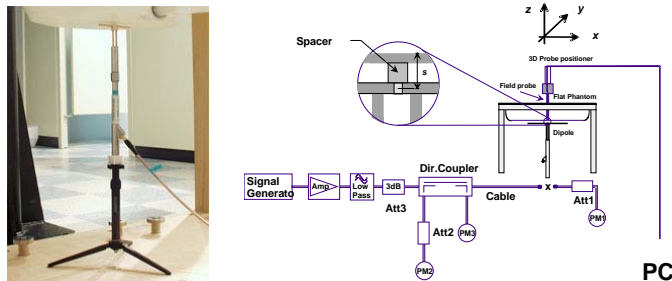


Figure 7.1 Dipole Validation Test Setup



## **8. SAR MEASUREMENT RESULTS**

### **Procedures Used To Establish Test Signal**

The handset was placed into simulated call mode using manufacturers test codes. Such test signals offer a consistent means for testing SAR and are recommended for evaluating SAR. When test modes are not available or inappropriate for testing a handset, the actual transmission is activated through a base station simulator or similar equipment. See data pages for actual procedure used in measurement.

### **Device Test Conditions**

The handset is battery operated. Each SAR measurement was taken with a fully charged battery. In order to verify that the device was tested at full power, conducted output power measurements were performed before and after each SAR measurement to confirm the output power. If a conducted power deviation of more than 5% occurred, the test was repeated.



## 8.1 Measurement Results(GSM850 Right Head SAR - Touch)

Mixture Type : 835 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	32.18	32.16	Standard	Cheek/Touch	Intenna	0.981
836.6	190	GSM 850	32.12	32.02	Standard	Cheek/Touch	Intenna	1.09
848.8	251	GSM 850	31.83	31.85	Standard	Cheek/Touch	Intenna	<b>1.16</b>
<b>ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population</b>						<b>1.6W/kg (mW/g) averaged over 1 gram</b>		

### NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
  2. All modes of operation were investigated, and the worst-case results are reported.
  3. Tissue parameters and temperatures are listed on the SAR plot.
  4. Liquid tissue depth is 15.2 ± 0.2cm
  5. Battery is fully charged for all readings.
- \*Power Measured  Conducted
6. Battery Option  Standard  Extended  Slim
7. Phantom Configuration  Left Head  Flat Phantom  Right Head
8. SAR Configuration  Head  Body  Hand
9. Test Signal Call Mode  Manu. Test Codes  Base Station Simulator



## 8.2 Measurement Results(GSM850 Right Head SAR - Tilt)

Mixture Type : 835 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
836.6	190	GSM 850	32.09	32.14	Standard	Ear/Tilt 15°	Intenna	<b>0.337</b>
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						1.6W/kg (mW/g) averaged over 1 gram		

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
  - All modes of operation were investigated, and the worst-case results are reported.
  - Tissue parameters and temperatures are listed on the SAR plot.
  - Liquid tissue depth is 15.2 ± 0.2cm
  - Battery is fully charged for all readings.
- \*Power Measured                       Conducted
- Battery Option                       Standard                       Extended                       Slim
  - Phantom Configuration             Left Head                       Flat Phantom                       Right Head
  - SAR Configuration                       Head                       Body                       Hand
  - Test Signal Call Mode                       Manu. Test Codes                       Base Station Simulator
- Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



### 8.3 Measurement Results(GSM850 Left Head SAR - Touch)

Mixture Type : 835 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	32.17	32.15	Standard	Cheek/Touch	Intenna	0.916
836.6	190	GSM 850	32.03	32.12	Standard	Cheek/Touch	Intenna	1.04
848.8	251	GSM 850	31.89	31.90	Standard	Cheek/Touch	Intenna	<b>1.08</b>
<b>ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population</b>						<b>1.6W/kg (mW/g) averaged over 1 gram</b>		

#### NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
  2. All modes of operation were investigated, and the worst-case results are reported.
  3. Tissue parameters and temperatures are listed on the SAR plot.
  4. Liquid tissue depth is 15.2 ± 0.2cm
  5. Battery is fully charged for all readings.
- \*Power Measured                       Conducted
6. Battery Option                         Standard             Extended             Slim
7. Phantom Configuration             Left Head             Flat Phantom         Right Head
8. SAR Configuration                  Head                  Body                  Hand
9. Test Signal Call Mode               Manu. Test Codes     Base Station Simulator



## 8.4 Measurement Results(GSM850 Left Head SAR - Tilt)

Mixture Type : 835 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
836.6	190	GSM 850	32.05	32.14	Standard	Ear/Tilt 15°	Intenna	<b>0.300</b>
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						1.6W/kg (mW/g) averaged over 1 gram		

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
  - All modes of operation were investigated, and the worst-case results are reported.
  - Tissue parameters and temperatures are listed on the SAR plot.
  - Liquid tissue depth is 15.2 ± 0.2cm
  - Battery is fully charged for all readings.
- \*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
  - Phantom Configuration  Left Head  Flat Phantom  Right Head
  - SAR Configuration  Head  Body  Hand
  - Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
  - Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



## 8.5 Measurement Results(GPRS850 Body SAR without Holster)

Mixture Type : 835 MHz Muscle

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	32.26	32.26	Standard	1.5 cm [w/o Holster]	Intenna	<b>0.303</b>
836.6	190	GSM 850	32.10	32.03	Standard	1.5 cm [w/o Holster]	Intenna	0.302
848.8	251	GSM 850	31.85	31.90	Standard	1.5 cm [w/o Holster]	Intenna	0.302
<b>ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population</b>						<b>1.6W/kg (mW/g) averaged over 1 gram</b>		

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
- All modes of operation were investigated, and the worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plot.
- Liquid tissue depth is  $15.2 \pm 0.2$ cm
- Battery is fully charged for all readings.
- \*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Test Configuration  With Holster  Without Holster
- Justification for reduced test configurations: This model supports GPRS CLASS "10" (2Tx). So the burst power and timing period is more than 2dB higher in GPRS mode than in GSM850 mode. Hence, the GSM850 mode was not measured.



## 8.6 Measurement Results(GSM1900 Right Head SAR - Touch)

Mixture Type : 1900 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1880.0	661	PCS GSM	29.27	29.18	Standard	Cheek/Touch	Intenna	<b>0.562</b>
<b>ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population</b>						<b>1.6W/kg (mW/g) averaged over 1 gram</b>		

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
- All modes of operation were investigated, and the worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plot.
- Liquid tissue depth is  $15.2 \pm 0.2$ cm
- Battery is fully charged for all readings.  
\*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



## 8.7 Measurement Results(GSM1900 Right Head SAR - Tilt)

Mixture Type : 1900 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1880.0	661	PCS GSM	29.26	29.16	Standard	Ear/Tilt 15°	Intenna	<b>0.104</b>
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						1.6W/kg (mW/g) averaged over 1 gram		

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
- All modes of operation were investigated, and the worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plot.
- Liquid tissue depth is 15.2 ± 0.2cm
- Battery is fully charged for all readings.  
\*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



## 8.8 Measurement Results(GSM1900 Left Head SAR - Touch)

Mixture Type : 1900 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	PCS GSM	29.44	29.47	Standard	Cheek/Touch	Intenna	<b>0.599</b>
1880.0	661	PCS GSM	29.28	29.22	Standard	Cheek/Touch	Intenna	0.579
1909.8	810	PCS GSM	28.97	29.03	Standard	Cheek/Touch	Intenna	0.568
<b>ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population</b>						<b>1.6W/kg (mW/g) averaged over 1 gram</b>		

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
  - All modes of operation were investigated, and the worst-case results are reported.
  - Tissue parameters and temperatures are listed on the SAR plot.
  - Liquid tissue depth is  $15.2 \pm 0.2$ cm
  - Battery is fully charged for all readings.
- \*Power Measured  Conducted
6. Battery Option  Standard  Extended  Slim
7. Phantom Configuration  Left Head  Flat Phantom  Right Head
8. SAR Configuration  Head  Body  Hand
9. Test Signal Call Mode  Manu. Test Codes  Base Station Simulator



### 8.9 Measurement Results(GSM1900 Left Head SAR - Tilt)

Mixture Type : 1900 MHz Brain

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1880.0	661	PCS GSM	29.32	29.23	Standard	Ear/Tilt 15°	Intenna	<b>0.116</b>
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						1.6W/kg (mW/g) averaged over 1 gram		

**NOTES:**

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
2. All modes of operation were investigated, and the worst-case results are reported.
3. Tissue parameters and temperatures are listed on the SAR plot.
4. Liquid tissue depth is 15.2 ± 0.2cm
5. Battery is fully charged for all readings.  
\*Power Measured  Conducted
6. Battery Option  Standard  Extended  Slim
7. Phantom Configuration  Left Head  Flat Phantom  Right Head
8. SAR Configuration  Head  Body  Hand
9. Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
10. Justification for reduced test configurations: Per FCC/OET Bulletin 65 Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (left, right, cheek/touch, tilt/ear, extended and retracted) is least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).



## 8.10 Measurement Results(GPRS1900 Body SAR without Holster)

Mixture Type : 1900 MHz Muscle

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	PCS GSM	29.40	29.37	Standard	1.5 cm [w/o Holster]	Intenna	0.156
1880.0	661	PCS GSM	29.32	29.41	Standard	1.5 cm [w/o Holster]	Intenna	<b>0.164</b>
1909.8	810	PCS GSM	29.07	29.08	Standard	1.5 cm [w/o Holster]	Intenna	0.157
<b>ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population</b>						<b>1.6W/kg (mW/g) averaged over 1 gram</b>		

### NOTES:

- The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
- All modes of operation were investigated, and the worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plot.
- Liquid tissue depth is  $15.2 \pm 0.2$ cm
- Battery is fully charged for all readings.
- \*Power Measured  Conducted
- Battery Option  Standard  Extended  Slim
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Test Configuration  With Holster  Without Holster
- Justification for reduced test configurations: This model supports GPRS CLASS "10" (2Tx). So the burst power and timing period is more than 2dB higher in GPRS mode than in GSM1900 mode. Hence, the GSM1900 mode was not measured.



## 9. CONCLUSION

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

The highest reported SAR values are as follows:

GSM850: Head: 1.16 W/Kg : Body-worn: 0.303 W/Kg

GSM1900: Head: 0.599 W/Kg : Body-worn: 0.164 W/Kg



## 10. REFERENCES

- [1] IEEE Standards Coordinating Committee 34 – IEEE Std. 1528-2003 (Draft 6.1 – July 2001), *IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques..*
- [2] Federal Communications Commission, OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01), *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, July 2001.
- [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] Federal Communications Commission, OET Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields. Supplement C*, Dec. 1997.
- [5] 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.
- [6] Federal Communications Commission, ET Docket 93-62, *Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation*, Aug. 1996.
- [7] NCRP, National Council on Radiation Protection and Measurements, *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields*, NCRP Report No. 86, 1986. Reprinted Feb. 1995.
- [8] 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.
- [9] 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.
- [10] G.Hartsgrove, A. raszewski, A. Surowiec, *Simulated Biological Materials for Electromagnetic Radiation Absorption Studies*, University of Ottawa, Bioelectromagnetics, Canada: 1987, pp. 29-36
- [11] 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.
- [12] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, *Numerical Recipes in C, The Art of Scientific Computing*, Second edition, Cambridge University Press, 1992.
- [13] K. Pokovic, T.Schmid, N. Kuster, *E-field Probe with improved isotropy in brain simulating liquids*, Proceedings of the ELMAR, Zadar, June 23-25, 1996, pp. 172-175.
- [14] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.
- [15] V. Hombach, K.Meier, M. Burkhardt, E. Kuhn, N. Kuster, *The Dependence of EM Energy Absorption upon Human Head Modeling at 900MHz*, IEEE Transaction on Microwave Theory and Techniques, vol 44 no. 10, Oct. 1996, pp. 1865-1873.
- [16] 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.
- [17] 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.

## APPENDIX A

### 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 ( $\rho$ ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. A.1).

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

Figure A.1 SAR Mathematical Equation

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

$$SAR = \frac{E^2}{\rho}$$

Where :

- $\sigma$  = conductivity of the tissue-simulant material (S/m)
- $\rho$  = mass density of the tissue-simulant material (kg/m<sup>3</sup>)
- $E$  = 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 relations 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 reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.

## APPENDIX B

### Probe Calibration Process

#### Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in **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*** with an accuracy better than +/-10%. The spherical isotropy was evaluated with the procedure described in **K. Pokovic, T.Schmid, N. Kuster, *E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, June 23-25, 1996, pp. 172-175*** and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe is tested.

#### Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz (see Fig. B.1), 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.

#### Temperature Assessment

E-field temperature correlation calibration is performed in a flat phantom 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 (see Fig. B.2).

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

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

where:

t = exposure time (30 seconds)

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

T = temperature increase due to RF exposure.

SAR is proportional to T/ 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;

where:

= simulated tissue conductivity

p = Tissue density (1.25 g/cm<sup>3</sup> for brain tissue)

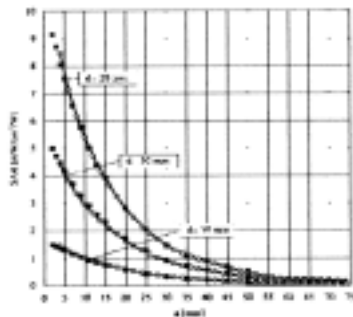


Figure B.1. E-Field and Temperature measurements at 900MHz

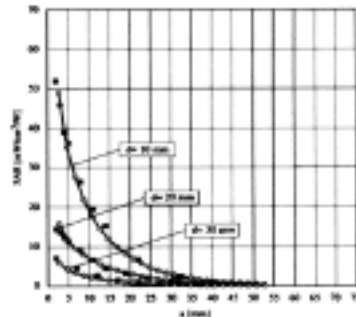


Figure B.2. E-Field and temperature measurements at 1.9GHz

## APPENDIX C

### ANSI/IEEE C95.1 – 1992 RF EXPOSURE LIMITS

#### Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

#### Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is the exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Table C.1 Safety Limits for Partial Body Exposure**

	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)
SPATIAL PEAK SAR <sup>1</sup> Brain	1.60	8.00
SPATIAL PEAK SAR <sup>2</sup> Whole Body	0.08	0.40
SPATIAL PEAK SAR <sup>3</sup> Hands, Feet, Ankles, Wrists	4.00	20.00

<sup>1</sup> The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as tissue volume in the shape of a cube) and over the appropriate averaging time.

<sup>2</sup> The Spatial Average value of the SAR averaged over the whole body.

<sup>3</sup> The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.