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# TEST REPORT ON SAR

Model Tested: SGH-E640  
FCC ID (Requested): A3LSGHE640  
Job No: FC-050  
Report No: FC-050-S1  
Date issued: Apr. 27, 2005

- Abstract -

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

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## 1. GENERAL INFORMATION

Test Sample : Single-Band PCS GSM Phone with Bluetooth  
Model Number : SGH-E640  
Serial Number : Identical prototype (S/N : # FC-050-B )

Manufacturer : SAMSUNG ELECTRONICS Co., Ltd.  
Contact : JN CHEON, Engineer

Phone : +82-31-279-7444  
Fax : +82-31-279-6162  
Test Standard : §2.1093; FCC/OET Bulletin 65, Supplement C(July 2001)  
FCC Classification : Licensed Portable Transmitter Held to Ear (PCE)  
Test Dates : Apr. 22, 2005  
Tested for : FCC/TCB Certification

## 2. DESCRIPTION OF DEVICE

Tx Freq. Range : 1850.2 – 1909.8 MHz (GSM1900)  
2402 – 2480 MHz (Bluetooth)

Rx Freq. Range : 1930.2 – 1989.8 MHz (GSM1900)  
2402 – 2480 MHz (Bluetooth)

Max. RF Output Power : 1.567 W EIRP CDMA (31.95 dBm)

Antenna Manufacturer : Samsung Electro-Mechanics  
Model No.: IAPT0GDP3715HA

Antenna Dimensions : 36.94mm [Intenna]

### 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**

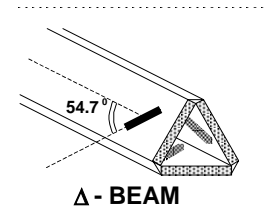
#### Probe Specifications

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
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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: $\pm 0.2\text{dB}$



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



**Figure 3.4 Probe Thick-Film Technique**

### 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)



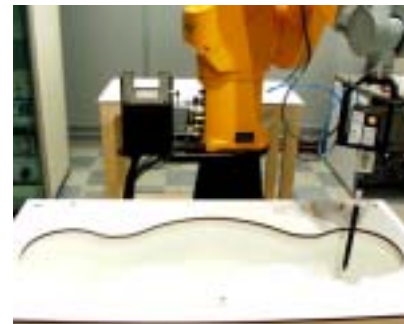
**Figure 3.5 SAM Twin Phantom**

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



**Figure 3.6 Simulated Tissue**

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

INGREDIENTS	1900MHz Brain	1900MHz Muscle
WATER	54.88%	69.91%
SUGAR	-	-
SALT	0.210%	0.130%
DGBE	44.91%	29.96%
BACTERIACIDE	-	-
HEC	-	-
Dielectric Constant Target	40.00	53.30
Conductivity Target (S/m)	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	1900 MHz
Return Loss	< -20 dB at specified validation position
Dimensions	D1900V2: dipole length: 68 mm; overall height: 300 mm



### 3.7 Equipment Calibration

**Table 3.1 Test Equipment Calibration**

Type	Calibration Due Date	Asset Number
Stäubli Robot RX90BL	Not Required	SWR-S001
SPEAG DAE3	2005-12-03	SWR-S048
SPEAG E-Field Probe ES3DV2	2005-09-24	SWR-S077
SPEAG SAM Twin Phantom V4.0	Not Required	SWR-S001-c
SPEAG Validation Dipole D1900V2	2007-02-18	SWR-S029
NRVD Power Meter	2006-02-17	SWR-S005
E4419B power Meter	2005-10-27	SWR-S037
8664A Signal Generator	2005-07-16	SWR-S035
BBS3Q7ELU Power Amp.	2005-10-27	SWR-S012
HP-8753ES Network Analyzer	2005-05-24	SWR-S006
HP85070C Dielectric Probe Kit	Not Required	SWR-S002
DASY4 S/W (ver 4.5)	Not Required	SWR-S001-a
NRV-Z53 Power Sensor	2006-02-22	SWR-S076
8481A Power Sensor	2005-10-28	SWR-S043
8481A Power Sensor	2004-10-28	SWR-S044

**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-axis. 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

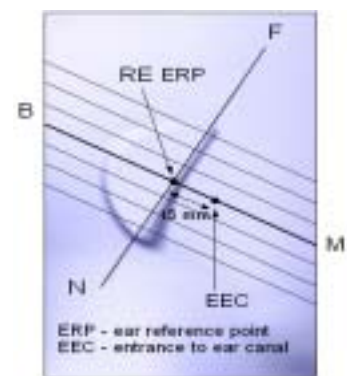
### 5.1 SAM Phantom Shape

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.

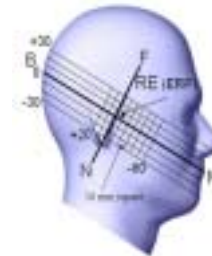


**Figure 5.2 Close up side view**

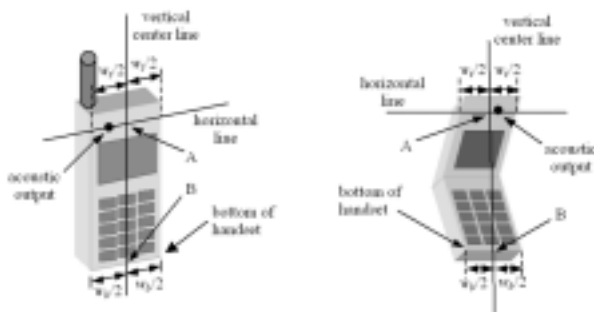
### 5.2 Cheek/Touch Position

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 5.3 Side view of the phantom showing relevant markings**



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

**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 was 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 (1900MHz)

Error Description	Uncertainty Value( $\pm\%$ )	Probability Distribution	Divisor	$C_i$	Standard uncertainty	$v_i^2$ or $v_{eff}$
<b>Measurement System</b>						
Probe Calibration	4.85	Normal	1.000	1	4.85	
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	1.00	
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	0.83	
Probe positioning	2.86	rectangular	1.732	1	1.65	
Extrapolation and integration	1.00	rectangular	1.732	1	0.58	
<b>Test Sample Related</b>						
Test Sample positioning	1.21	Normal	1.000	1	1.21	11
Device holded uncertainty	3.33	Normal	1.000	1	3.33	
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)	2.50	Normal	1.000	0.64	1.60	
Liquid permittivity (deviation from target)	5.00	Rectangular	1.732	0.6	1.73	
Liquid permittivity (measurement error)	2.42	Normal	1000	0.6	1.45	
Combined Standard Uncertainty		Normal			9.75	13474
<b>Extended Standard Uncertainty(K=2.00)</b>					<b>19.51</b>	13474

## 7. SYSTEM VERIFICATION

### 7.1 Tissue Verification

**Table 7.1 MEASURED TISSUE PARAMETERS**

	1900MHz Brain		1900MHz Muscle	
	Target	Measured	Target	Measured
Date	-	Apr. 22, 2005	-	Apr. 22, 2005
Liquid Temperature(°C)	-	21.0	-	21.5
Dielectric Constant:	40.0	39.6	53.3	51.7
Conductivity:	1.40	1.42	1.52	1.52

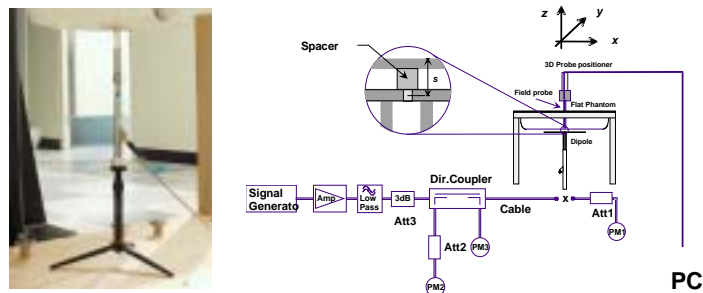
The measured value must be within  $\pm 5\%$  of the target value.

### 7.2 Test System Validation

Prior to assessment, the system is verified to the  $\pm 10\%$  of the specification at 1900MHz by using the system validation kit(s). (see Appendix F, 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)
D-1900V2 S/N: 5D023	1900MHz Brain	9.925	10.1	1.76	Apr.22, 2005	21.3



**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 (PCS GSM) 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.

### EUT Handset Reference Points

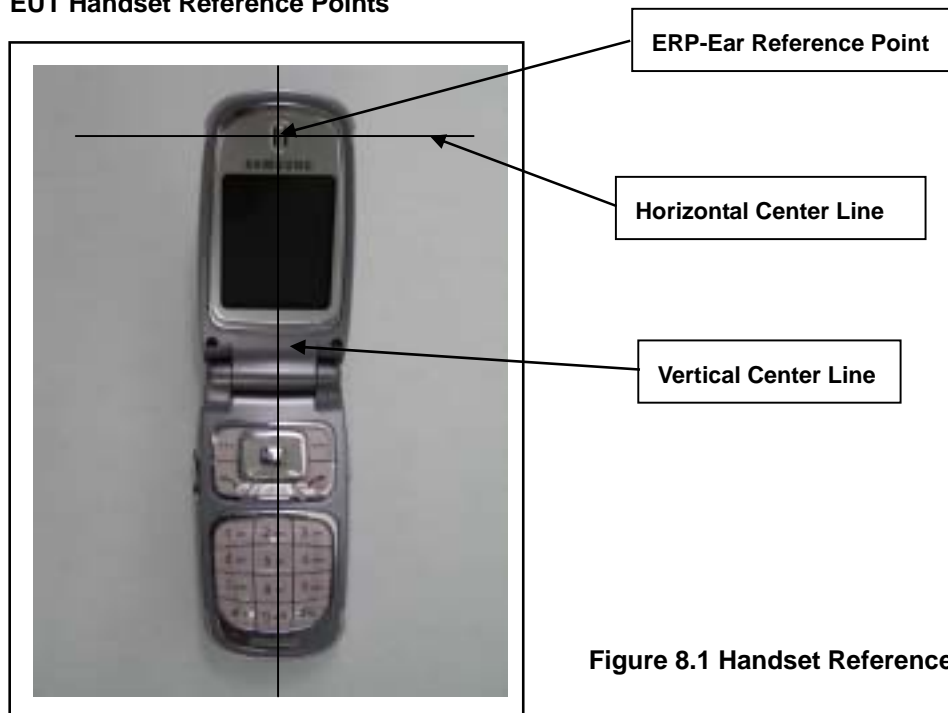


Figure 8.1 Handset Reference Points



## 8.1 MEASUREMENT RESULTS (GSM1900 Right Head SAR – Touch)

Date of Test :	Apr. 22, 2005		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.4 cm
Dielectric Constant:	39.6	Liquid Tissue Temp.:	21.3
Conductivity:	1.42	Ambient Temp:	22.7

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		PCL(dBm)		Battery			
1850.2	512	PCS GSM	0	30	Standard	Cheek / Touch	Intenna	1.29
1880.0	661	PCS GSM	0	30	Standard	Cheek / Touch	Intenna	1.3
1909.8	810	PCS GSM	0	30	Standard	Cheek / Touch	Intenna	1.09
1880.0	661	PCS GSM	0	30	Standard	Cheek / Touch	Intenna	**1.3
<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.
- Battery is fully charged for all readings.
  - \*Power Measured  Conducted
- SAR Measurement System  DASY4
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Battery Option  Standard  Extended  Slim
- \*\* Highest SAR value measurement in this band repeated with Bluetooth active.



**Figure 8.2 Right Head SAR Test Setup  
-- Cheek / Touch Position--**



## 8.2 MEASUREMENT RESULTS (GSM1900 Right Head SAR – Tilt)

Date of Test :	Apr. 22, 2005		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.4 cm
Dielectric Constant:	39.6	Liquid Tissue Temp.:	21.3
Conductivity:	1.42	Ambient Temp:	22.7

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		PCL (dBm)		Battery			
1880.0	661	PCS GSM	0	30	Standard	Ear/Tilt 15°	Intenna	0.072
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.
- Battery is fully charged for all readings.
  - \*Power Measured  Conducted
- SAR Measurement System  DASY4
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Battery Option  Standard  Extended  Slim
- 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).



**Figure 8.3 Right Head SAR Test Setup**  
-- Ear/Tilt 15° Position --



### 8.3 MEASUREMENT RESULTS (GSM1900 Left Head SAR – Touch)

Date of Test :	Apr. 22, 2005		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.4 cm
Dielectric Constant:	39.6	Liquid Tissue Temp.:	21.3
Conductivity:	1.42	Ambient Temp:	22.7

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		PCL (dBm)		Battery			
1850.2	512	PCS GSM	0	30	Standard	Cheek / Touch	Intenna	1.3
1880.0	661	PCS GSM	0	30	Standard	Cheek / Touch	Intenna	1.18
1909.8	810	PCS GSM	0	30	Standard	Cheek / Touch	Intenna	0.959
<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. Battery is fully charged for all readings.
- \*Power Measured                     Conducted
4. SAR Measurement System             DASY4
  5. Phantom Configuration             Left Head             Flat Phantom             Right Head
  6. SAR Configuration                 Head                 Body                 Hand
  7. Test Signal Call Mode             Manu. Test Codes             Base Station Simulator
  8. Battery Option                       Standard             Extended             Slim



**Figure 8.4 Left Head SAR Test Setup  
-- Cheek / Touch Position--**



## 8.4 MEASUREMENT RESULTS (GSM1900 Left Head SAR – Tilt)

Date of Test :	Apr. 22, 2005		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.4 cm
Dielectric Constant:	39.6	Liquid Tissue Temp.:	21.3
Conductivity:	1.42	Ambient Temp:	22.7

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		PCL (dBm)		Battery			
1880.0	661	PCS GSM	0	30	Standard	Ear/Tilt 15°	Intenna	0.055
<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.
- Battery is fully charged for all readings.
  - \*Power Measured  Conducted
- SAR Measurement System  DASY4
- Phantom Configuration  Left Head  Flat Phantom  Right Head
- SAR Configuration  Head  Body  Hand
- Test Signal Call Mode  Manu. Test Codes  Base Station Simulator
- Battery Option  Standard  Extended  Slim
- 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).



**Figure 8.5 Left Head SAR Test Setup  
-- Ear/Tilt 15° Position--**



## 8.5 MEASUREMENT RESULTS (GSM1900 Body SAR w/o Holster)

Date of Test :	Apr. 22, 2005		
Mixture Type:	1900MHz Muscle	Tissue Depth:	15.4 cm
Dielectric Constant:	51.7	Liquid Tissue Temp.:	21.6
Conductivity:	1.52	Ambient Temp:	22.7

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		PCL (dBm)		Battery			
1850.2	512	PCS GSM	0	30	Standard	1.5cm [w/o holster]	Fixed	0.324
1880.0	661	PCS GSM	0	30	Standard	1.5cm [w/o holster]	Fixed	0.373
1909.8	810	PCS GSM	0	30	Standard	1.5cm [w/o holster]	Fixed	0.338
1880.0	661	PCS GSM	0	30	Standard	1.5cm [w/o holster]	Fixed	**0.366
<b>ANSI / IEEE C95.1 1992 – SAFETY LIMIT</b> Spatial Peak Uncontrolled Exposure / General Population						<b>1.6W/kg (mW/g)</b> 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.
  - Battery is fully charged for all readings.
- \*Power Measured  Conducted
- SAR Measurement System  DASY4
  - 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
  - Battery Option  Standard  Extended  Slim
- \*\* Highest SAR value measurement in this band repeated with Bluetooth active.
  - Justification for reduced test configurations: The SGH-E640 supports GPRS CLASS "10" (2Tx). So the burst power and timing period is more than 2dB higher in GPRS mode than in PCS GSM mode. Hence, the PCS GSM mode was not measured.



Figure 8.6 Body SAR Test Setup  
-- w/o Holster--



## 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.



## 10. REFERENCES

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## 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 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).

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

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

where:

**t** = exposure time (30 seconds)

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

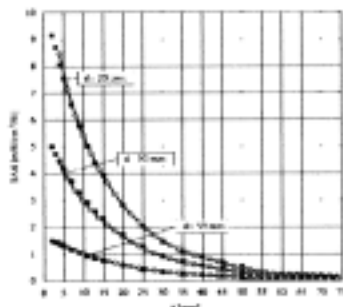
**T** = temperature increase due to RF exposure.

SAR is proportional to  $\frac{\Delta T}{\Delta t}$ , 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;

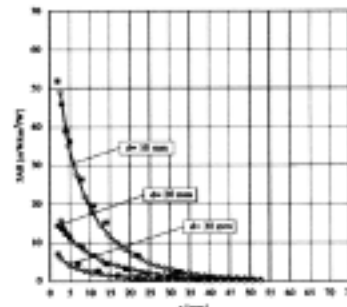
where:

= 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.