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TEST REPORT ON SAR

Model Tested:	SGH-E316
FCC ID (Requested):	A3LSGHE316
Job No:	FB-004
Report No:	FB-004-S1
Date issued:	Feb. 03, 2004

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

Prepared By	MH PARK – Test Engineer	**Date**	2004.02.05
Checked By	JH CHOI - Manager	**Date**	2004.02.05
Authorized By	JK CHOI – Senior Manager	**Date**	2004.02.05

Contents

1. GENERAL INFORMATION

Test Sample :	Dual-Mode GSM850/GSM1900 Phone
Model Number :	SGH-E316
Serial Number :	Identical prototype (S/N : FB-004-A)
Manufacturer :	SAMSUNG ELECTRONICS Co., Ltd.
Contact :	HK KIM, Engineer
Phone :	+82-54-479-7623
Fax :	+82-54-479-5921
Test Standard :	§2.1093; FCC/OET Bulletin 65, Supplement C(July 2001)
FCC Classification :	Licensed Portable Transmitter Held to Ear (PCE)
Test Dates :	Jan. 26, 2004 ~ Jan. 28, 2004
Tested for :	FCC/TCB Certification

2. DESCRIPTION OF DEVICE

Tx Freq. Range :	824.2 – 848.8 MHz (GSM 850)
	1850.00 – 1910.00 MHz (PCS GSM)
Rx Freq. Range :	869.2 – 893.8 MHz (GSM 850)
	1930.00 – 1990.00 MHz (PCS GSM)
Max. RF Output Power :	3.475 W ERP GSM 850 (35.41dBm)
	1.600 W EIRP PCS GSM (32.04dBm)
Antenna Manufacturer :	E.M.W
	Model No. : SGH-E316
Antenna Dimensions :	18.5mm [Fixed]

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).

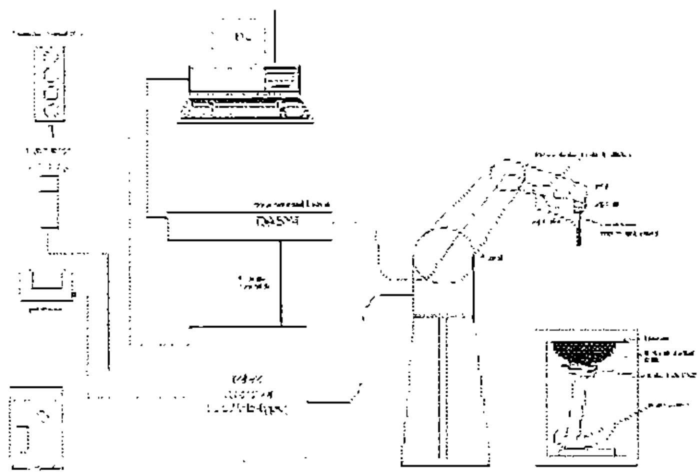


Figure 3.1 SAR Measurement System Setup

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

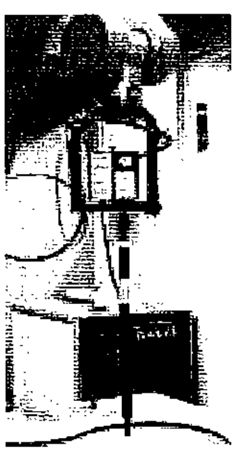


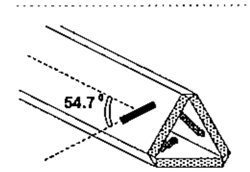
Figure 3.2 DAE System

The SAR measurement were conducted with the dosimetric probe ET3DV6, 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. The probe is equipped with an optical multifiber line ending at the front of the probe tip (see Fig.3.4). 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 approach and looks for the maximum using a 2nd order fitting (see Fig.3.2). The approach is stopped at reaching the maximum.

Probe Specifications

Construction	Symmetrical design with triangular core
	Built-in optical fiber for surface detection system
	Built-in shielding against static charges
	PEEK enclosure material (resistant to organic solvents, e.g., glycolether)

Calibration	In air from 10 MHz to 2.5 GHz In brain and muscle simulating liquid at 835, 1900 MHz (accuracy ± 9.5%; k=2)
Frequency	10 MHz to 3 GHz; Linearity :±0.2 dB (30 MHz to 3 GHz)
Directivity	±0.2 dB in HSL (rotation around probe axis) ±0.4 dB in HSL (rotation normal to probe axis)
Dynamic Range	5μW/g to > 100mW/g; Linearity: ±0.2dB
Dimensions	Overall length: 330mm Tip length: 16mm Body diameter: 12mm Tip diameter: 6.8mm Distance from probe tip to dipole centers: 2.7mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms
Optical Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces



Δ - BEAM

Figure 3.3 Triangular Probe Configuration

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 1528-200X, 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 ± 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 hydroxethylcellullose (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	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).

Figure 3.7 Device Holder

*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.

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, 1900MHz
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	Asset Number
Stäubli Robot RX90BL	Not Required	SWR-S045
SPEAG DAE3	2004-11-21	SWR-S025
SPEAG E-Field Probe ET3DV6	2004-08-28	SWR-S023
SPEAG SAM Twin Phantom V4.0	Not Required	SWR-S045-b
SPEAG SAM Twin Phantom V4.0	Not Required	SWR-S045-c
SPEAG Validation Dipole D835V2	2005-11-18	SWR-S026
SPEAG Validation Dipole D1900V2	2005-11-13	SWR-S029
EPM-441A Power Meter	2004-08-22	SWR-S036
E4419B Power Meter	2004-11-13	SWR-S037
HP-8664A Signal Generator	2004-08-25	SWR-S038
BBS3Q7ELU Power Amp.	2004-11-19	SWR-S012
HP-8753ES Network Analyzer	2004-05-26	SWR-S006
HP85070C Dielectric Probe Kit	Not Required	SWR-S002
DASY4 S/W (ver 4.1)	Not Required	SWR-S045-a
8481A Power Sensor	2004-12-30	SWR-S042
8481A Power Sensor	2004-12-30	SWR-S043
8481A Power Sensor	2004-12-30	SWR-S044
E5515C Call Box	2004-12-30	SWR-S062

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 15mm x 15mm. 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. 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 evaluated 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.

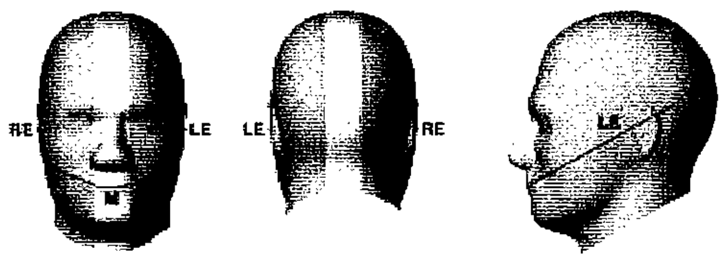


Figure 5.1 Front, back and side view of SAM

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.

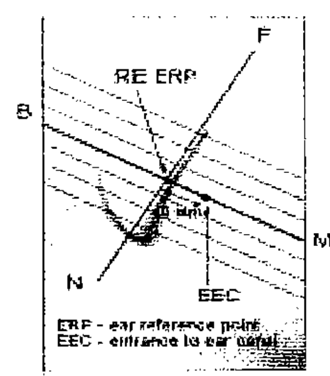


Figure 5.2 Close up side view

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 than located at the same level as the center of the eat reference point. The test device was positioned so that the "vertical centerline" was bisecting the front surface of the handset at it's 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

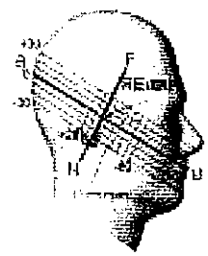


Figure 5.3 Side view of the phantom showing relevant markings

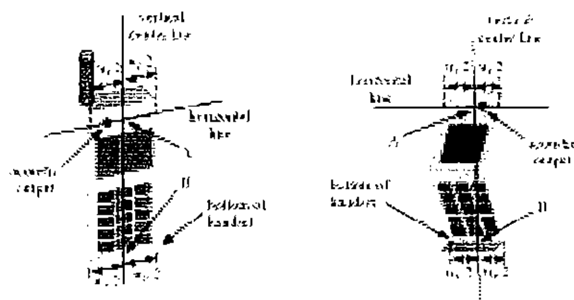


Figure 5.4 Handset vertical and horizontal reference lines

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

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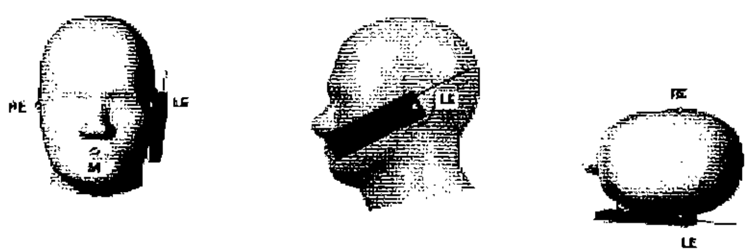

Figure 5.5 Front, Side and Top View of Cheek/Touch Position

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"

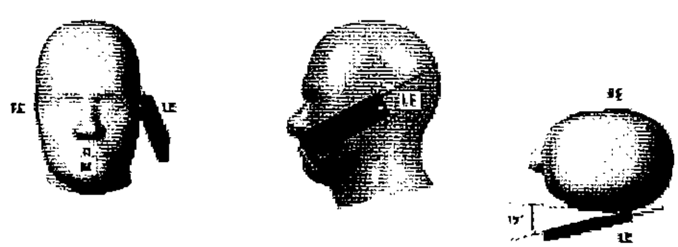

Figure 5.6 Front, side and Top View of Ear/Tilt 15° Position

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 (835MHz)

Error Description	Uncertainty Value(±%)	Probability Distribution	Divisor	c_i	Standard uncertainty	v_i^2 or v_{eff}
Measurement System						
Probe Calibration	4.75	Normal 1	1.000	1	4.75	∞
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	∞
Test Sample Related						
Test Sample positioning	1.21	Normal 1	1.000	1	1.21	11
Device holded uncertainty	3.33	Normal 1	1.000	1	3.33	∞
Power Drift	5.00	Rectangular	1.732	1	2.89	∞
Phantom and Setup						
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)	5.40	Normal 1	1.000	0.64	3.46	∞
Liquid permittivity (deviation from target)	5.00	Rectangular	1.732	0.6	1.73	∞
Liquid permittivity (measurement error)	5.38	Normal 1	1.000	0.6	3.23	∞
Combined Standard Uncertainty		Normal			10.58	65306
Extended Standard Uncertainty(K=1.96)					**20.73**	65306

Table 6.2 Uncertainty Budget (1900MHz)

Error Description	Uncertainty Value(±%)	Probability Distribution	Divisor	c_i	Standard uncertainty	v_i^2 or v_{eff}
Measurement System						
Probe Calibration	4.75	Normal 1	1.000	1	4.75	∞
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	∞
Test Sample Related						
Test Sample positioning	1.21	Normal 1	1.000	1	1.21	11
Device holded uncertainty	3.33	Normal 1	1.000	1	3.33	∞
Power Drift	5.00	Rectangular	1.732	1	2.89	∞
Phantom and Setup						
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)	4.90	Normal 1	1.000	0.64	3.14	∞
Liquid permittivity (deviation from target)	5.00	Rectangular	1.732	0.6	1.73	∞
Liquid permittivity (measurement error)	4.70	Normal 1	1.000	0.6	2.28	∞
Combined Standard Uncertainty		Normal			10.36	13474
Extended Standard Uncertainty(K=1.96)					**20.30**	13474

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	-	Jan. 27,2004	-	Jan. 27,2004	-	Jan. 26,2004	-	Jan. 28,2004
Liquid Temperature(°C)	-	21.0	-	21.3	-	21.8	-	21.1
Dielectric Constant: ε'	41.5	41.5	55.2	53.0	40.0	40.1	53.3	51.2
Conductivity: σ	0.90	0.89	0.97	0.93	1.40	1.42	1.52	1.56

The measured value must be within ±5% of the target value.

7.2 Test System Validation

Prior to assessment, the system is verified to the ±10% of the specification at 835MHz and 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$_{1g}$ (mW/g)	Measured SAR$_{1g}$ (mW/g)	Deviation (%)	Date	Liquid Temperature(°C)
D-835V2 S/N: 451	835MHz Brain	2.375	2.34	-1.47	Jan. 27,2004	20.6
D-1900V2 S/N: 548	1900MHz Brain	9.925	9.7	-2.27	Jan. 26,2004	21.5

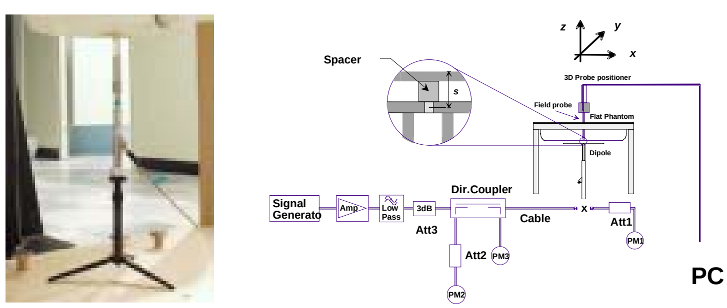

Figure 7.1 Dipole Validation Test Setup

8. SAR MEASUREMENT RESULTS

Procedures Used To Establish Test Signal

The handset was placed into simulated call mode (GSM850 & GSM1900) 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

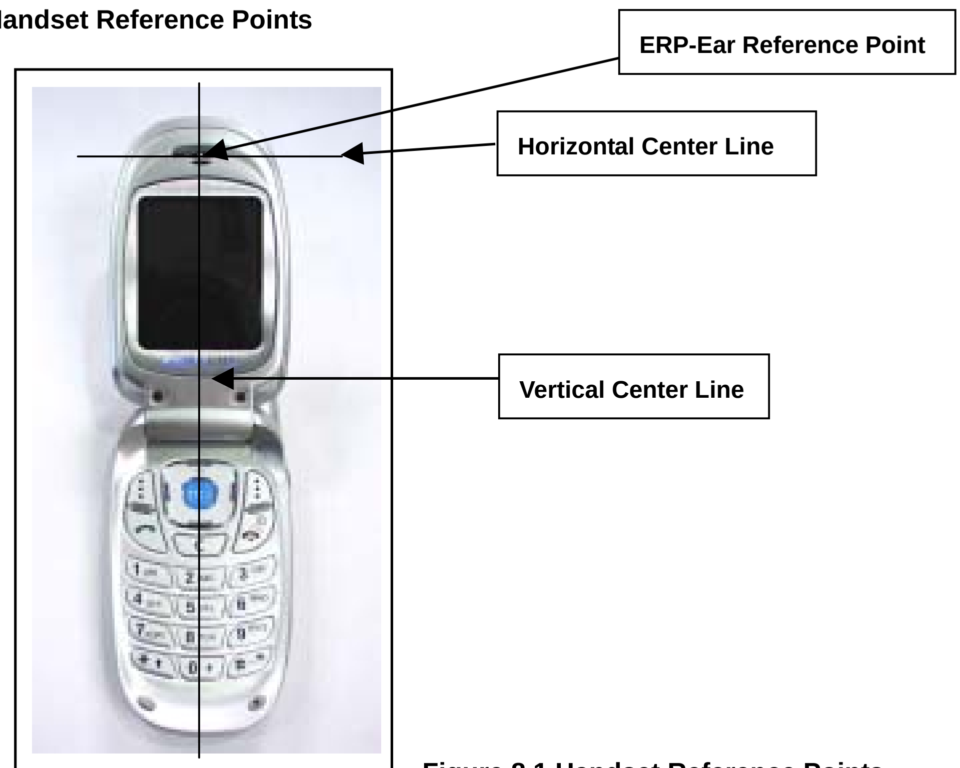

Figure 8.1 Handset Reference Points

8.1 MEASUREMENT RESULTS (GSM 850 Right Head SAR – Touch)

Date of Test :	Jan. 27, 2003		
Mixture Type:	835MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	41.5	Liquid Tissue Temp.:	21.0
Conductivity:	0.89	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	33	33.07	Standard	Cheek / Touch	Fixed	1.21
836.6	190	GSM 850	33	32.994	Standard	Cheek / Touch	Fixed	1.37
848.8	251	GSM 850	33	32.90	Standard	Cheek / Touch	Fixed	1.44
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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 8.2 Right Head SAR Test Setup

-- Cheek / Touch Position--

8.2 MEASUREMENT RESULTS (GSM 850 Right Head SAR – Tilt)

Date of Test :	Jan. 27, 2003		
Mixture Type:	835MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	41.5	Liquid Tissue Temp.:	21.0
Conductivity:	0.89	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	33	32.92	Standard	Ear/Tilt 15°	Fixed	0.376
836.6	190	GSM 850	33	32.95	Standard	Ear/Tilt 15°	Fixed	0.391
848.8	251	GSM 850	33	32.90	Standard	Ear/Tilt 15°	Fixed	0.399
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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 8.3 Right Head SAR Test Setup

-- Ear/Tilt 15° Position--

8.3 MEASUREMENT RESULTS (GSM 850 Left Head SAR – Touch)

Date of Test :	Jan. 27, 2003		
Mixture Type:	835MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	41.5	Liquid Tissue Temp.:	21.0
Conductivity:	0.89	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	33	33.10	Standard	Cheek / Touch	Fixed	1.14
836.6	190	GSM 850	33	32.97	Standard	Cheek / Touch	Fixed	1.29
848.8	251	GSM 850	33	33.04	Standard	Cheek / Touch	Fixed	1.26
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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

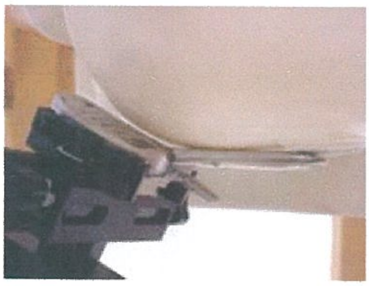

Figure 8.4 Left Head SAR Test Setup
-- Cheek / Touch Position--

8.4 MEASUREMENT RESULTS (GSM 850 Left Head SAR – Tilt)

Date of Test :	Jan. 27, 2003		
Mixture Type:	835MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	41.5	Liquid Tissue Temp.:	21.0
Conductivity:	0.89	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	33	33.01	Standard	Ear/Tilt 15°	Fixed	0.331
836.6	190	GSM 850	33	33.02	Standard	Ear/Tilt 15°	Fixed	0.378
848.8	251	GSM 850	33	32.95	Standard	Ear/Tilt 15°	Fixed	0.365
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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 8.5 Left Head SAR Test Setup

-- Ear/Tilt 15° Position--

8.5 MEASUREMENT RESULTS (PCS GSM Right Head SAR – Touch)

Date of Test :	Jan. 26, 2003		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	40.1	Liquid Tissue Temp.:	21.5
Conductivity:	1.42	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	PCS GSM	30	30.10	Standard	Cheek / Touch	Fixed	0.663
1880.0	661	PCS GSM	30	29.90	Standard	Cheek / Touch	Fixed	0.566
1909.8	810	PCS GSM	30	30.07	Standard	Cheek / Touch	Fixed	0.452
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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 8.6 Right Head SAR Test Setup
-- Cheek / Touch Position--

8.6 MEASUREMENT RESULTS (PCS GSM Right Head SAR – Tilt)

Date of Test :	Jan. 26, 2003		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	40.1	Liquid Tissue Temp.:	21.5
Conductivity:	1.42	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	PCS GSM	30	30.09	Standard	Ear/Tilt 15°	Fixed	0.0985
1880.0	661	PCS GSM	30	30.05	Standard	Ear/Tilt 15°	Fixed	0.0932
1909.8	810	PCS GSM	30	29.91	Standard	Ear/Tilt 15°	Fixed	0.0632
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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 8.7 Right Head SAR Test Setup

-- Ear/Tilt 15° Position--

8.7 MEASUREMENT RESULTS (PCS GSM Left Head SAR – Touch)

Date of Test :	Jan. 26, 2003		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	40.1	Liquid Tissue Temp.:	21.5
Conductivity:	1.42	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	PCS GSM	30	29.97	Standard	Cheek / Touch	Fixed	0.413
1880.0	661	PCS GSM	30	30.09	Standard	Cheek / Touch	Fixed	0.364
1909.8	810	PCS GSM	30	30.07	Standard	Cheek / Touch	Fixed	0.291
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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 8.8 Left Head SAR Test Setup
-- Cheek / Touch Position--

8.8 MEASUREMENT RESULTS (PCS GSM Left Head SAR – Tilt)

Date of Test :	Jan. 26, 2003		
Mixture Type:	1900MHz Brain	Tissue Depth:	15.0 cm
Dielectric Constant:	40.1	Liquid Tissue Temp.:	21.5
Conductivity:	1.42	Ambient Temp:	21.8

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	PCS GSM	30	30.005	Standard	Ear/Tilt 15°	Fixed	0.118
1880.0	661	PCS GSM	30	30.02	Standard	Ear/Tilt 15°	Fixed	0.0886
1909.8	810	PCS GSM	30	29.99	Standard	Ear/Tilt 15°	Fixed	0.0674
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population						Brain 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. 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 8.9 Left Head SAR Test Setup
-- Ear/Tilt 15° Position--

8.9 MEASUREMENT RESULTS (GSM 850 Body SAR w/o Holster)

Date of Test :	Jan. 27, 2003			
Mixture Type:	835MHz Muscle		Tissue Depth:	15.0 cm
Dielectric Constant:	53.0		Liquid Tissue Temp.:	21.5
Conductivity:	0.93		Ambient Temp:	22.1

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GSM 850	33	33.06	Standard	1.5cm[W/o Holster]	Fixed	0.542
836.6	190	GSM 850	33	32.94	Standard	1.5cm[W/o Holster]	Fixed	0.678
848.8	251	GSM 850	33	32.97	Standard	1.5cm[W/o Holster]	Fixed	0.719
ANSI / IEEE C95.1 1992 – SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure / General Population**						**Muscle** **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. 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 8.10 Body SAR Test Setup

-- w/o Holster--

8.10 MEASUREMENT RESULTS (GPRS[GSM 850] Body SAR w/o Holster)

Date of Test :	Jan. 27, 2003		
Mixture Type:	835MHz Muscle	Tissue Depth:	15.0 cm
Dielectric Constant:	53.0	Liquid Tissue Temp.:	21.5
Conductivity:	0.93	Ambient Temp:	22.1

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.2	128	GPRS[GSM 850]	33	32.9998	Standard	1.5cm[W/o Holster]	Fixed	1.00
836.6	190	GPRS[GSM 850]	33	33.008	Standard	1.5cm[W/o Holster]	Fixed	1.25
848.8	251	GPRS[GSM 850]	33	32.95	Standard	1.5cm[W/o Holster]	Fixed	1.30
ANSI / IEEE C95.1 1992 – SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure / General Population**						**Muscle** **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. 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

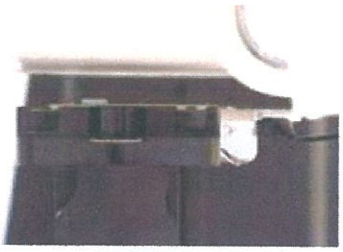

Figure 8.10 Body SAR Test Setup

-- w/o Holster--

8.11 MEASUREMENT RESULTS (PCS GSM Body SAR w/o Holster)

Date of Test :	Jan. 28, 2003		
Mixture Type:	1900MHz Muscle	Tissue Depth:	15.2cm
Dielectric Constant:	51.2	Liquid Tissue Temp.:	20.9
Conductivity:	1.56	Ambient Temp:	22.4

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	PCS GSM	30	29.80	Standard	1.5cm[W/o Holster]	Fixed	0.244
1880.0	661	PCS GSM	30	30.04	Standard	1.5cm[W/o Holster]	Fixed	0.201
1909.8	810	PCS GSM	30	29.90	Standard	1.5cm[W/o Holster]	Fixed	0.145
ANSI / IEEE C95.1 1992 – SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure / General Population**						**Muscle** **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. 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 8.11 Body SAR Test Setup

-- w/o Holster--

8.12 MEASUREMENT RESULTS (GPRS[PCS GSM] Body SAR w/o Holster)

Date of Test :	Jan. 28, 2003		
Mixture Type:	1900MHz Muscle	Tissue Depth:	15.2cm
Dielectric Constant:	51.2	Liquid Tissue Temp.:	20.9
Conductivity:	1.56	Ambient Temp:	22.4

FREQUENCY		Modulation	Begin/End POWER*			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1850.2	512	GPRS[PCS GSM]	30	29.90	Standard	1.5cm[W/o Holster]	Fixed	0.449
1880.0	661	GPRS[PCS GSM]	30	29.97	Standard	1.5cm[W/o Holster]	Fixed	0.372
1909.8	810	GPRS[PCS GSM]	30	29.99	Standard	1.5cm[W/o Holster]	Fixed	0.276
ANSI / IEEE C95.1 1992 – SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure / General Population**						**Muscle** **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. 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

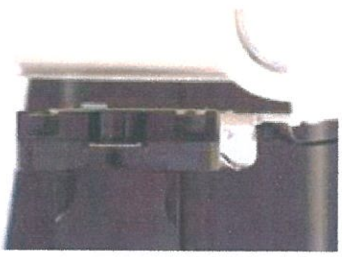

Figure 8.11 Body SAR Test Setup
-- w/o Holster--

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.

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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 (*p*). It is also defined as the rate of RF energy absorption pet unit mass at a point in an absorbing body (see Fig. A.1).

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

Figure A.1 SAR Mathematical Equation

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

$$\text{SAR} = \sigma E^2 / p$$

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 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.