CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

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APPLICANT NAME & ADDRESS:
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Attn: Wallace Oh, Engineering Manager
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DATE & LOCATION OF TESTING:
Dates of Tests: January 23-25 & 28, 2002
Test Report S/N: SAR.220123041.A3L
Test Site: PCTEST Lab, Columbia, MD USA

FCC ID:	**A3LSTHA255**
APPLICANT:	**SAMSUNG ELECTRONICS CO., LTD.**

EUT Type:	**DualMode Analog/TDMA Phone (AMPS/TDMA)**
Tx Frequency:	**824.04 – 848.97 MHz (AMPS/TDMA)**
Rx Frequency:	**869.04 – 893.97 MHz (AMPS/TDMA)**
Max. RF Output Power:	**0.392 W ERP AMPS (25.933 dBm);** **0.440 W ERP Cellular TDMA (26.433 dBm)**
Max. SAR Measurement:	**1.390mW/g AMPS Head SAR; 1.270mW/g AMPS Body SAR;** **0.585mW/g Cell. TDMA Head SAR; 0.405mW/g Cell. TDMA Body**
SARTrade Name/Model(s):	***STH-A255***
FCC Classification:	**Non-Broadcast Transmitter Held to Ear (TNE)**
FCC Rule Part(s):	**§2.1093; FCC/OET Bulletin 65 Supplement C [July 2001]**
Application Type:	**Certification**
Test Device Serial No.:	***identical* prototype**
Antenna Manufacturer:	**ACE Technology Model: STHA255**
Antenna Dimensions:	**Length = 7.20 cm. [Helical / Whip]**

This wireless portable device has been shown to be capable of continued compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in ANSI/IEEE Std. C95.3-1992 and IEEE Std. 1528 (Draft Aug.2000).

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

NVLAP accreditation does not constitute any product endorsement by NVLAP or any agency of the United States Government.

PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.

Randy Ortanez
President

Lab Code 100431-0

1. INTRODUCTION

Scope

Environmental evaluation measurements of specific absorption rate[1] (SAR) distributions in simulated human head and body tissues exposed to radiofrequency (RF) radiation from wireless portable devices for compliance with the rules and regulations of the U.S. Federal Communications Commission (FCC).[2]

Evaluation Guidelines

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

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in *IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*. (c) 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017.[2] The measurement procedure described in *IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave* [3] and FCC OET Supplement C Edition 01-01 to OET Bulletin 65 Edition 97-01 *"Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields"* [4] is used for guidance in measuring SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,"* NCRP Report No. 86 (c) NCRP, 1986, Bethesda, MD 20814.[6] SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

The FCC guidelines differentiate between portable and mobile devices according to their proximity to exposed persons. For portable device (47 CFR §2.1093), RF evaluation must be based on specific absorption rate (SAR) limits. Mobile and portable transmitting devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services (PCS), the Satellite Communications Services, the General Wireless Communications Service, the Wireless Communications Service, the Maritime Services and Specialized Mobile Radio Service authorized, respectively, under Part 22 (Subpart H), Part 24, Part 25, Part 26, Part 27, Part 80 and Part 90 of the FCC rules are subject to routine environmental evaluation for RF exposure prior to equipment authorization or sue. Portable devices operating in the Wireless Medical Telemetry Service (WMTS) and the medical Implant Communications Service (MICS), authorized under Subparts H and I of Part 95 are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use. Unlicensed PCS, U-NII and millimeter wave devices authorized under Part 15 of the FCC rules are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use [4].

1 Specific Absorption Rate (SAR) is a measure of the rate of energy absorption due to exposure to an RF transmitting source (wireless portable device).

2 IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET Docket 93-62.

2. SAR DEFINITION

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 (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 2.1).

Overview

The Federal Communications Commissions (FCC) in the United States and regulatory bodied in other countries require the peak spatial-average SAR associated with certain wireless handset to be evaluated to ensure compliance with their rules and guidelines. One means to certify compliance with specific SAR requirements is by measurement of the electric field strength (E-field) in anthropomorphic models of the head. A typical model consists of a thin dielectric shell filled with a liquid material having dielectric properties equivalent to head and body tissues. The operating device under test is mounted at a defined location and orientation relative to the model phantom while the inside of the liquid-filled shell is scanned in a prescribed manner with a miniature E-field probe.

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

Figure 2.1 SAR Mathematical Equation

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

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

where:

σ	=	conductivity of the tissue-simulant material (S/m)
ρ	=	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 of 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.[6]

3. SAR MEASUREMENT SETUP

Robotic System

These measurements are performed using the DASY3 automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Staubli), robot controller, Pentium III computer, near-field probe, probe alignment sensor, and the generic 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).

System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC consists of the Micron Pentium III 500 MHz computer with Windows NT system and SAR Measurement Software DASY3, A/D interface card, monitor, mouse, and keyboard. The Staubli 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 PC plug-in card.

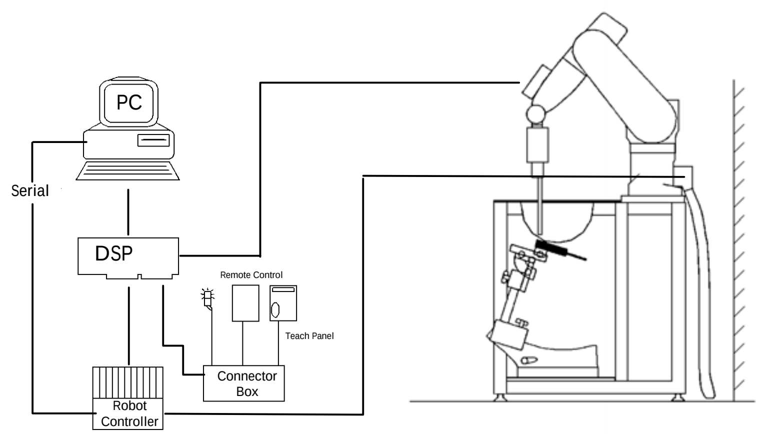

Figure 3.1 SAR Measurement System Setup

System Electronics

The 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 PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in [7].

4. DASY3 E-FIELD PROBE SYSTEM

Probe Measurement System

The SAR measurements were conducted with the dosimetric probe ET3DV6, designed in the classical triangular configuration [7] (see Fig. 4.1) 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. 4.2). 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 DASY3 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

Probe Specifications

Calibration:	In air from 10 MHz to 2.5 GHz
	In brain and muscle simulating tissue at
	Frequencies of 450 MHz, 835 MHz, 900 MHz
	1900MHz and 2450MHz
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 probe axis)
Dynamic:	5 : W/g to > 100 mW/g;
Range:	Linearity: ± 0.2 dB
Dimensions:	Overall length: 330 mm
	Tip length: 16 mm
	Body diameter: 12 mm
	Tip diameter: 6.8 mm
	Distance from probe tip to dipole centers: 2.7 mm
Application:	General dosimetry up to 3 GHz
	Compliance tests of mobile phones
	Fast automatic scanning in arbitrary phantoms

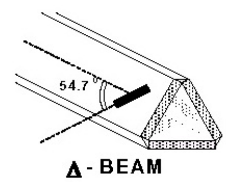

Figure 4.1 Triangular Probe Configuration

Figure 4.2 Probe Thick-Film Technique

5. Probe Calibration Process

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in [8] with an accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [9] 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 bellow 1 GHz (see Fig. 5.1), 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. 5.2).

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

where:

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

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

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

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

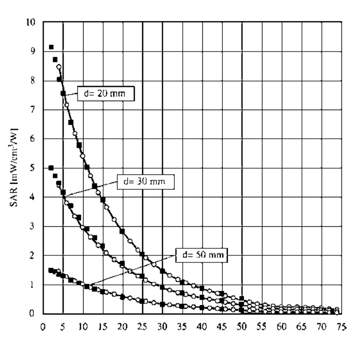

Figure 5.1 E-Field and Temperature measurements at 900MHz [7]

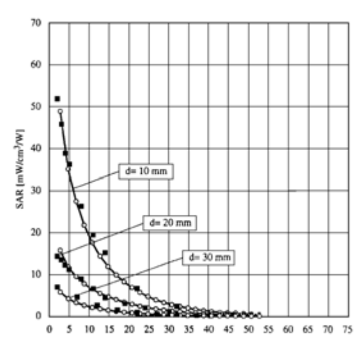

Figure 5.2 E-Field and temperature measurements at 1.9GHz [7]

6. PHANTOM & EQUIVALENT TISSUES

SAM Phantom

Figure 6.1 SAM Twin 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 [11][12]. 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 Fig. 6.1)

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 1). Preservation with a bacteriacide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been incorporated in the following table. Other head and body tissue parameters that have not bee specified in P1528 are derived from the issue dielectric parameters computed from the 4-Cole-Cole equations The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrove [13].

Table 6.1 Composition of the Brain & Muscle Tissue Equivalent Matter

INGREDIENTS		SIMULATING TISSUE			
		835MHz Brain	835MHz Muscle	1900MHz Brain	1900MHz Muscle
Mixture Percentage					
WATER		41.45	52.50	54.90	40.40
DGBE		0.000	0.000	44.92	0.000
SUGAR		56.00	45.00	0.000	58.00
SALT		1.450	1.400	0.180	0.500
BACTERIACIDE		0.100	0.100	0.000	0.100
HEC		1.000	1.000	0.000	1.000
Dielectric Constant	Target	41.50	55.20	40.00	53.30
Conductivity (S/m)	Target	0.900	0.970	1.400	1.520

Device Holder for Transmitters

Figure 6.2 Mounting Device

In combination with the SAM Twin Phantom V4.0, the Mounting Device (see Fig. 6.2) 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 repeatably positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

* Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations [12]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

7. TEST SYSTEM SPECIFICATIONS

Automated Test System Specifications

Positioner

Robot:	Stäubli Unimation Corp. Robot Model: RX60L
Repeatability:	0.02 mm
No. of axis:	6

Figure 7.1 DASY3 Test System

Data Acquisition Electronic (DAE) System

Cell Controller

Processor:	Pentium III
Clock Speed:	450 MHz
Operating System:	Windows NT
Data Card:	DASY3 PC-Board

Data Converter

Features:	Signal Amplifier, multiplexer, A/D converter, & control logic
Software:	DASY3 software
Connecting Lines:	Optical downlink for data and status info. Optical uplink for commands and clock

PC Interface Card

Function:	24 bit (64 MHz) DSP for real time processing Link to DAE3 16 bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot

E-Field Probes

Model:	ET3DV6 S/N: 1560
Construction:	Triangular core fiber optic detection system
Frequency:	10 MHz to 6 GHz
Linearity:	± 0.2 dB (30 MHz to 3 GHz)

Phantom

Phantom:	SAM Twin Phantom (V4.0)
Shell Material:	Fiberglass
Thickness:	2.0 ± 0.2 mm

8. DOSIMETRIC ASSESSMENT & PHANTOM SPECS

Measurement Procedure

The evaluation was performed using the following procedure:

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.
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.
3. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation. 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:
   a. 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 [15]. 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.
   b. 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) [15][16]. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as procedure #1, was re-measured. If the value changed by more than 5%, the evaluation is repeated.

Anthropomorphic Phantom Specifications

The phantom for handset SAR assessment testing is a low-loss dielectric shell, with shape and dimensions derived from the anthropometric data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM Twin Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Fig. 8.1). The perimeter sidewalls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimized reflections from the upper surface. The liquid depth is maintained at a minimum depth of 15cm to minimize reflections from the upper surface.

Figure 8.1 SAM Twin Phantom shell

9. DEFINITION OF REFERENCE POINTS

EAR Reference Point

Figure 9.1 shows the front, back and side views of the SAM Twin Phantom. The point "M" is the reference point for the center of the mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERPs are 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 10.2. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 9.2). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].

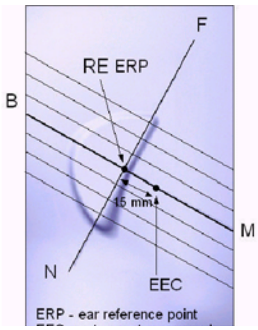

Figure 9.2 Close-up side view of ERPs

Figure 9.1 Front, back and side view of SAM Twin Phantom

Handset Reference Points

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. 9.3). The "test device reference point" was than 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 it's top 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.

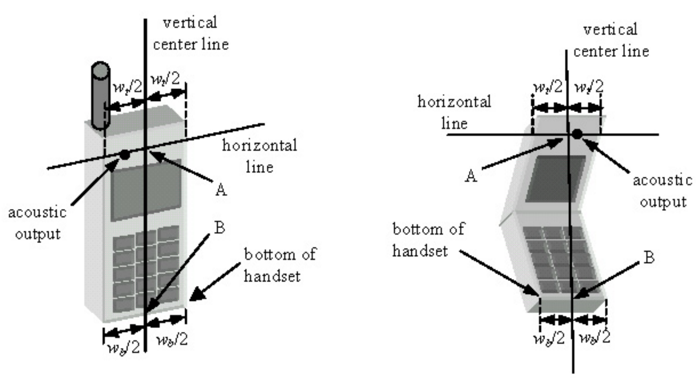

Figure 9.3 Handset Vertical Center & Horizontal Line Reference Points

10. TEST CONFIGURATION POSITIONS

Positioning for Cheek/Touch

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 10.1), 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.

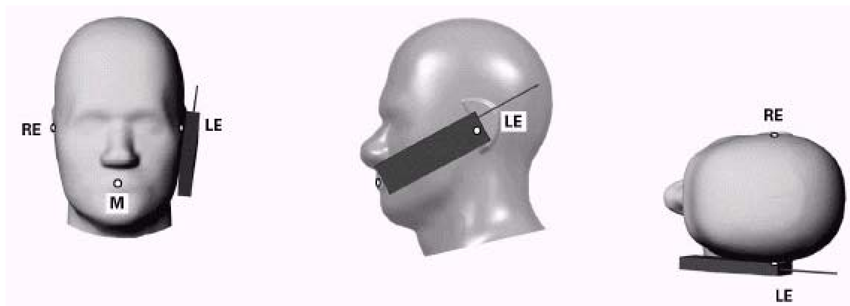

Figure 10.1 Front, Side and Top View of Cheek/Touch Position

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.
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).
4. The phone was hen rotated around the vertical centerline until the phone (horizontal line) was symmetrical was respect to the line NF.
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 10.2)

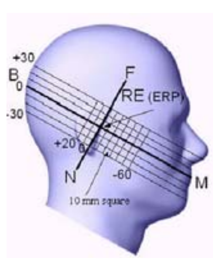

Figure 10.2 Side view w/ relevant markings

10. TEST CONFIGURATION POSITIONS (Continued)

Ear / 15° Tilt Position

With the test device aligned in the "Cheek/Touch Position":

1. 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 15degree.
2. The phone was then rotated around the horizontal line by 15 degree.
3. 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 (see Figure 10.3).

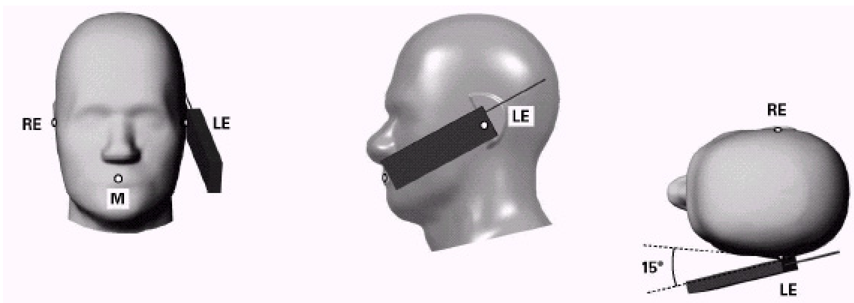

Figure 10.3 Front, Side and Top View of Ear/15° Tilt Position

Body Holster /Belt Clip Configuration

The body holster configuration is used for body-worn devices that have a body holster / beltclip accessory and/or that have an ear-microphone jack. Typically, a holster (carrying case) or beltclip is provided or available as an accessory item for supporting headset and body-worn operations. SAR may vary depending on the body separation distance provided by the type of holster/beltclip and batteries supplied for a phone. In some cases, the antenna may become closer to the user's body than next to the head. The design of the holster/beltclip permits the phone to be positioned only with the keypad facing away from the phantom. Proper use of the holster/beltclip restricts the antenna to a specified distance away from the surface of the body. For this test the EUT is placed into the holster/beltclip and the holster/beltclip is positioned against the torso of the flat phantom in a normal operating position. The headphone wire is then connected to the phone to simulate hands-free operation in a body holster/beltclip configuration (see Figure 10.4). SAR measurements are then performed to investigate the worst-case positioning.

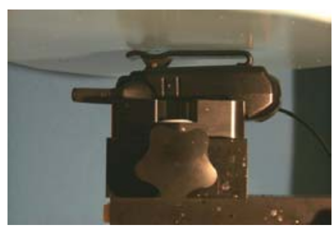

Figure 10.4
BeltClip Configuration

11. 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 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 11.1. Safety Limits for Partial Body Exposure [2]

	HUMAN EXPOSURE LIMITS	
As per ANSI/IEEE C95.1 – 1992 RF Exposure Limits		
	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)
SPATIAL PEAK SAR [1] Brain	1.60	8.00
SPATIAL AVERAGE SAR [2] Whole Body	0.08	0.40
SPATIAL PEAK SAR [3] Hands, Feet, Ankles, Wrists	4.00	20.00

1 The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2 The Spatial Average value of the SAR averaged over the whole body.
3 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.

12. MEASUREMENT UNCERTAINTIES

SAR Measurement Uncertainties

Measurement uncertainties in SAR measurements are difficult to quantify due to several variables including biological, physiological, and environmental. However, we estimate the measurement uncertainties in SAR to be less than 15-25 % [18].

According to ANSI/IEEE C95.3, the overall uncertainties are difficult to assess and will vary with the type of meter and usage situation. However, accuracy's of ± 1 to 3 dB can be expected in practice, with greater uncertainties in near-field situations and at higher frequencies (shorter wavelengths), or areas where large reflecting objects are present. Under optimum measurement conditions, SAR measurement uncertainties of at least ± 2dB can be expected.[3]

According to CENELEC [19], typical worst-case uncertainty of field measurements is ± 5 dB. For well-defined modulation characteristics the uncertainty can be reduced to ± 3 dB.

Figure 12.1. Breakdown of Errors [20]

	SAR MEASUREMENT UNCERTAINTIES				
As per IEEE/SCC-34 1528 Draft, July 2001					
	Error	Distribution	Weight	Standard Deviation	Offset
Probe Uncertainty					
Axial isotropy	±0.2 dB	U-Shaped	0.5	±2.4 %	
Spherical isotropy	±0.4 dB	U-Shaped	0.5	±4.8 %	
Isotropy from gradient	±0.5 dB	U-Shaped	0.0	±	
Spatial resolution	±0.5 %	Normal	1.0	±0.5 %	
Linearity error	±0.2 dB	Rectangle	1.0	±2.7 %	
Calibration error	±3.3 %	Normal	1.0	±3.3 %	
SAR Evaluation Uncertainty					
Data acquisition error	±1.00 %	Rectangle	1.0	±0.6 %	
ELF and RF disturbances	±0.25 %	Normal	1.0	±0.25 %	
Conductivity assessment	±10.0 %	Rectangle	1.0	±5.8 %	
Spatial Peak SAR Evaluation Uncertainty					
Extrapolated boundary effect	±3.00 %	Normal	1.0	±3 %	±5 %
Probe positioning error	±0.1 mm	Normal	1.0	±1 %	
Integrated and cube orientation	±3.00 %	Normal	1.0	±3 %	
Cube Shape inaccuracies	±2.00 %	Rectangle	1.0	±1.2 %	
Device positioning	±6.00 %	Normal	1.0	±6 %	
Combined Uncertainties				±11.7 %	±5 %

13. SYSTEM VERIFICATION

Tissue Verification

Table 13.1 Simulated Tissue Verification

	MEASURED TISSUE PARAMETERS							
	835MHz Brain		835MHz Muscle		1900MHz Brain		1900MHz Muscle	
	Target	Measured	Target	Measured	Target	Measured	Target	Measured
As per IEEE/SCC-34 1528 Draft, July 2001								
Dielectric Constant: ε	41.50	41.50	55.20	54.90	40.00	40.00	53.30	53.30
Conductivity: σ	0.900	0.900	0.970	0.960	1.400	1.400	1.520	1.520

Test System Verification

Prior to assessment, the system is verified to the ±10% of the specifications at 835MHz and 1900MHz by using the system validation kit(s). (Graphic Plots Attached)

Table 13.2 System Verification

	SYSTEM DIPOLE VERIFICATION TARGET & MEASURED		
As per IEEE/SCC-34 1528 Draft, July 2001			
System Validation Kit: D835V2, S/N: 406	835MHz Brain	Targeted SAR_{1g} (mW/g) 2.375	Measured SAR_{1g} (mW/g) **2.43 / 2.31**
System Validation Kit: D835V2, S/N: 406	835MHz Muscle	Targeted SAR_{1g} (mW/g) 2.375	Measured SAR_{1g} (mW/g) **2.35**
Validation Kit D1900V2, S/N: 502	1900MHz Brain	Targeted SAR_{1g} (mW/g) 9.925	Measured SAR_{1g} (mW/g) n/a
Validation Kit D1900V2, S/N: 502	1900MHz Muscle	Targeted SAR_{1g} (mW/g) 9.925	Measured SAR_{1g} (mW/g) **n/a**

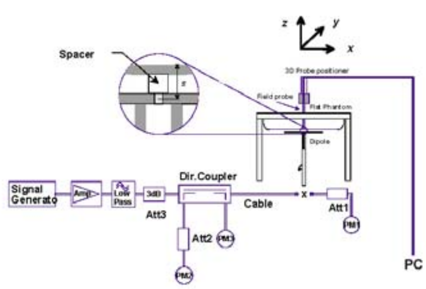

Figure 13.1 Dipole Validation Test Setup

14. SAR TEST DATA SUMMARY

SEE MEASUREMENT RESULT DATA PAGES

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 [4]. 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 14.1 Handset Reference Points

15.1 MEASUREMENT RESULTS (AMPS Right Head SAR – Touch)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.04	0991	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.390**
824.04	0991	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**1.190**
836.49	0383	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.270**
836.49	0383	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**1.180**
848.97	0799	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.150**
848.97	0799	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**1.090**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure/General Population**						**Brain** **1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.4
Conductivity	0.90	Relative HUMIDITY (%)	60.0
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.5
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.2

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☒ Right Head	☐ Flat Phantom	☐ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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Figure 15.1 Right Head SAR Test Setup
-- Cheek / Touch Position --

15.2 MEASUREMENT RESULTS (AMPS Right Head SAR – Tilt)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.04	0991	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	In	**0.405**
824.04	0991	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	Out	**0.351**
836.49	0383	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	In	**0.357**
836.49	0383	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	Out	**0.338**
848.97	0799	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	In	**0.340**
848.97	0799	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	Out	**0.326**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.4
Conductivity	0.90	Relative HUMIDITY (%)	60.0
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.5
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.2

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☒ Right Head	☐ Flat Phantom	☐ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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Figure 15.2 Right Head SAR Test Setup
-- Ear / 15° Tilt Position --

15.3 MEASUREMENT RESULTS (AMPS Left Head SAR - Touch)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.04	0991	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.300**
824.04	0991	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**1.110**
836.49	0383	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.180**
836.49	0383	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**1.090**
848.97	0799	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.160**
848.97	0799	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**1.060**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.2
Conductivity	0.90	Relative HUMIDITY (%)	60.0
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.5
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.2

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☐ Right Head	☐ Flat Phantom	☒ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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Figure 15.3 Left Head SAR Test Setup
-- Cheek / Touch Position --

15.4 MEASUREMENT RESULTS (AMPS Left Head SAR – Tilt)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.04	0991	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	In	**0.412**
824.04	0991	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	Out	**0.359**
836.49	0383	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	In	**0.346**
836.49	0383	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	Out	**0.337**
848.97	0799	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	In	**0.333**
848.97	0799	AMPS	26.0	26.0	Standard	Ear / 15° Tilt	Out	**0.321**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.4
Conductivity	0.90	Relative HUMIDITY (%)	60.0
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.5
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.2

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☐ Right Head	☐ Flat Phantom	☒ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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Figure 15.4 Left Head SAR Test Setup
-- Ear / 15° Tilt Position –

15.5 MEASUREMENT RESULTS (CELLULAR TDMA Right Head SAR – Touch)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.70	1013	CDMA	26.5	26.5	Standard	Cheek / Touch	In	**0.585**
824.70	1013	CDMA	26.5	26.5	Standard	Cheek / Touch	Out	**0.527**
836.49	0383	CDMA	26.5	26.5	Standard	Cheek / Touch	In	**0.511**
836.49	0383	CDMA	26.5	26.5	Standard	Cheek / Touch	Out	**0.519**
848.31	0777	CDMA	26.5	26.5	Standard	Cheek / Touch	In	**0.489**
848.31	0777	CDMA	26.5	26.5	Standard	Cheek / Touch	Out	**0.529**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure/General Population**						**Brain** **1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.5
Conductivity	0.90	Relative HUMIDITY (%)	60.3
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.8
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.3

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☒ Right Head	☐ Flat Phantom	☐ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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Figure 15.5 Right Head SAR Test Setup
-- Cheek / Touch Position --

15.5 MEASUREMENT RESULTS (CELLULAR TDMA Right Head SAR – Tilt)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.70	1013	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	In	**0.232**
824.70	1013	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	Out	**0.205**
836.49	0383	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	In	**0.193**
836.49	0383	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	Out	**0.191**
848.31	0777	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	In	**0.177**
848.31	0777	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	Out	**0.186**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.5
Conductivity	0.90	Relative HUMIDITY (%)	60.3
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.8
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.3

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☒ Right Head	☐ Flat Phantom	☐ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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Figure 15.5 Right Head SAR Test Setup
-- Ear / 15° Tilt Position --

15.5 MEASUREMENT RESULTS (CELLULAR TDMA Left Head SAR – Touch)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.70	1013	CDMA	26.5	26.5	Standard	Cheek / Touch	In	**0.487**
824.70	1013	CDMA	26.5	26.5	Standard	Cheek / Touch	Out	**0.437**
836.49	0383	CDMA	26.5	26.5	Standard	Cheek / Touch	In	**0.439**
836.49	0383	CDMA	26.5	26.5	Standard	Cheek / Touch	Out	**0.400**
848.31	0777	CDMA	26.5	26.5	Standard	Cheek / Touch	In	**0.410**
848.31	0777	CDMA	26.5	26.5	Standard	Cheek / Touch	Out	**0.389**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure/General Population**						**Brain** **1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.5
Conductivity	0.90	Relative HUMIDITY (%)	60.3
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.8
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.3

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☐ Right Head	☐ Flat Phantom	☒ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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President

Figure 15.5 Left Head SAR Test Setup
-- Cheek / Touch Position –

15.5 MEASUREMENT RESULTS (CELLULAR CDMA Left Head SAR – Tilt)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.70	1013	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	In	**0.206**
824.70	1013	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	Out	**0.232**
836.49	0383	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	In	**0.228**
836.49	0383	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	Out	**0.221**
848.31	0777	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	In	**0.218**
848.31	0777	CDMA	26.5	26.5	Standard	Ear / 15° Tilt	Out	**0.231**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Brain	Ambient TEMPERATURE (°C)	22.5
Conductivity	0.90	Relative HUMIDITY (%)	60.3
Permittivity	41.5	Atmospheric PRESSURE (kPa)	99.8
Measured Depth of Simulating Tissue	15.0 cm	Measured Tissue TEMPERATURE (°C)	22.3

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 worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☐ Right Head	☐ Flat Phantom	☒ Left Head
5.	SAR Configuration	☒ Head	☐ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	

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Figure 15.5 Left Head SAR Test Setup
-- Ear / 15° Tilt Position –

15.10 MEASUREMENT RESULTS (AMPS Body SAR w/o Holster)

FREQUENCY		Modulation	Begin / End POWER‡			Separation Distance (cm) ‡‡	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.04	0991	AMPS	26.0	26.0	Standard	1.5 [w/o Holster]	In	**1.270**
824.04	0991	AMPS	26.0	26.0	Standard	1.5 [w/o Holster]	Out	**1.210**
836.49	0383	AMPS	26.0	26.0	Standard	1.5 [w/o Holster]	In	**1.080**
836.49	0383	AMPS	26.0	26.0	Standard	1.5 [w/o Holster]	Out	**1.160**
848.97	0799	AMPS	26.0	26.0	Standard	1.5 [w/o Holster]	In	**0.973**
848.97	0799	AMPS	26.0	26.0	Standard	1.5 [w/o Holster]	Out	**1.120**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT **Spatial Peak** **Uncontrolled Exposure/General Population**						**Muscle** **1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Muscle	Ambient TEMPERATURE (°C)	22.4
Conductivity	0.960	Relative HUMIDITY (%)	60.1
Permittivity	54.90	Atmospheric PRESSURE (kPa)	99.6
Measured Depth of Simulating Tissue	15.5 cm	Measured Tissue TEMPERATURE (°C)	22.2

NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in atypical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
2. All modes of operation were investigated, and worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

	‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP
4.	SAR Measurement System	☒ DASY3	☐ IDX	☐
	Phantom Configuration	☐ Right Head	☒ Flat Phantom	☐ Left Head
5.	SAR Configuration	☐ Head	☒ Body	☐ Hand
6.	Test Signal Call Mode	☐ Manu. Test Codes	☒ Base Station Simulator	
7.	‡‡Test Configuration	☐ With Holster	☒ Without Holster	

Spacing = 2.0cm from flat phantom to the back top & base of phone, 1.7cm from flat phantom to retracted antenna, & 1.0cm from flat phantom to extended antenna. *The worst-case spacing of 2.0cm is noted and specified in the User's Manual on the RF Exposure Warning page.*

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President

Figure 15.10 Body SAR Test Setup
-- w/o Holster --

15.11 MEASUREMENT RESULTS (CELLULAR CDMA Body SAR w/o Holster)

FREQUENCY		Modulation	Begin / End POWER‡			Separation Distance (cm) ‡‡	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.70	1013	CDMA	26.5	26.5	Standard	1.5 [w/o Holster]	In	**0.405**
824.70	1013	CDMA	26.5	26.5	Standard	1.5 [w/o Holster]	Out	**0.392**
836.49	0383	CDMA	26.5	26.5	Standard	1.5 [w/o Holster]	In	**0.346**
836.49	0383	CDMA	26.5	26.5	Standard	1.5 [w/o Holster]	Out	**0.369**
848.31	0777	CDMA	26.5	26.5	Standard	1.5 [w/o Holster]	In	**0.323**
848.31	0777	CDMA	26.5	26.5	Standard	1.5 [w/o Holster]	Out	**0.370**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Muscle 1.6 W/kg (mW/g)** averaged over 1 gram		

ENVIRONMENTAL AND TISSUE CONDITIONS			
Mixture Type	835MHz Muscle	Ambient TEMPERATURE (°C)	22.4
Conductivity	0.960	Relative HUMIDITY (%)	60.1
Permittivity	54.90	Atmospheric PRESSURE (kPa)	99.6
Measured Depth of Simulating Tissue	15.5 cm	Measured Tissue TEMPERATURE (°C)	22.2

NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in atypical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
2. All modes of operation were investigated, and worst case results are reported.
3. Battery is fully charged for all readings. *Standard Battery is the Only Battery option.*

   ‡Power Measured ☒ Conducted ☐ ERP ☐ EIRP
4. SAR Measurement System ☒ DASY3 ☐ IDX ☐

   Phantom Configuration ☐ Right Head ☒ Flat Phantom ☐ Left Head
5. SAR Configuration ☐ Head ☒ Body ☐ Hand
6. Test Signal Call Mode ☐ Manu. Test Codes ☒ Base Station Simulator
7. ‡‡Test Configuration ☐ With Holster ☒ Without Holster

   Spacing = 2.0cm from flat phantom to the back top & base of phone, 1.7cm from flat phantom to retracted antenna, & 1.0cm from flat phantom to extended antenna. *The worst-case spacing of 2.0cm is noted and specified in the User's Manual on the RF Exposure Warning page.*

Randy Ortanez
President

Figure 15.11 Body SAR Test Setup
-- w/o Holster --

16. SAR TEST EQUIPMENT

Equipment Calibration

Table 16.1 Test Equipment Calibration

EQUIPMENT SPECIFICATIONS			
Type		**Calibration Date**	**Serial Number**
Stäubli Robot RX60L		February 2001	599131-01
Stäubli Robot Controller		February 2001	PCT592
Stäubli Teach Pendant (Joystick)		February 2001	3323-00161
Micron Computer, 450 MHz Pentium III, Windows NT		February 2001	PCT577
SPEAG EDC3		February 2001	321
SPEAG DAE3		February 2001	330
SPEAG E-Field Probe ET3DV6		February 2001	1560
SPEAG Dummy Probe		February 2001	PCT583
SPEAG SAM Twin Phantom V4.0		February 2001	PCT666
SPEAG Light Alignment Sensor		February 2001	205
SPEAG Validation Dipole D1900V2		February 2001	PCT613
Brain Equivalent Matter (835MHz)		January 2002	PCTBEM101
Brain Equivalent Matter (1900MHz)		January 2002	PCTBEM301
Muscle Equivalent Matter (835MHz)		January 2002	PCTMEM201
Muscle Equivalent Matter (1900MHz)		January 2002	PCTMEM401
Robot Table			PCT668
Phone Holder			PCT586
A/B Power Indicator			PCT589
Remote Power Switch			PCT590
Phantom Cover			PCT667
HP Spectrum Analyzer			PCT200
IFI TEM Cell Model: CC110EXX (DC - 2000 MHz)			A427-0697
Microwave Amp. Model: 5S1G4, (800MHz - 4.2GHz)		January 2002	22332
Gigatronics 8651A Power Meter		January 2002	1835299
HP-8648D (9kHz ~ 4GHz) Signal Generator		January 2002	PCT530
Amplifier Research 5S1G4 Power Amp		January 2002	PCT540
HP-8753E (30kHz ~ 3GHz) Network Analyzer		January 2002	PCT552
HP85070B Dielectric Probe Kit		January 2002	PCT501
Ambient Noise/Reflection, etc.	<12mW/kg/<3%of SAR	January 2002	Anechoic Room PCT01

NOTE:

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

17. CONCLUSION

Measurement 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.

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.[3]

18. REFERENCES

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

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

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

[4] 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.

[5] IEEE Standards Coordinating Committee 34 – IEEE Std. 1528-200X (Draft 6.1 – July 2001), *Draft Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.*

[6] 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.

[7] 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.

[8] 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.

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

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

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

[12] 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.

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

[14] 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.

[15] W. Gander, *Computermathematick*, Birkhaeuser, Basel, 1992.

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

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

[18] 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.

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

[20] Prof. Dr. Niels Kuster, ETH, Eidgenössische Technische Hoschschule Zürich, Dosimetric Evaluation of the Cellular Phone.