

# SAR TEST REPORT

Test item : Pager  
Model No. : M1503  
Order No. : 1107-00915  
Date of receipt : 2011-07-01  
Test duration : 2011-07-04  
Date of issue : 2011-07-06  
Use of report : FCC Original Grant

Applicant : Hunetec Co., Ltd

RM612, Starwoodplaza, 5439-1 Sangdaewon-Dong, Jungwon-Gu,  
Sunghnam-City, Kyunggi-Do, Korea(ZIP CODE: 462 - 120)

Test laboratory : Digital EMC Co., Ltd.

683-3, Yubang-Dong, Cheoin-Gu, Yongin-Si, Kyunggi-Do, 449-080, Korea

Test specification : §2.1093, FCC/OET Bulletin 65 Supplement C[July 2001]

Test environment : See appended test report

Test result : ☒ Pass ☐ Fail

The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DIGITAL EMC CO., LTD.

Tested by:

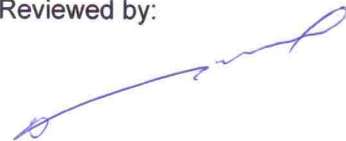


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## 1. DESCRIPTION OF DEVICE

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

### General Information

Equipment type	Pager
FCC ID:	RNGM1503RFX
Equipment model name	M1503
Equipment add model name	N/A
Equipment serial no.	Identical prototype
Mode(s) of Operation	4 Level FSK
TX Frequency Range	896 MHz ~902MHz
RX Frequency Range	929 MHz ~932MHz, 935 MHz ~942MHz
Max. SAR Measurement	<b>1.110</b> mW/g Body SAR
FCC Equipment Class	PCS Licensed Transmitter
Date(s) of Tests	2011-07-04
Antenna Type	Internal Type Antenna

## 2. INTROCUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency 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. 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 C95.1-2005 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave 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 Radio frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 20814. 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.

### SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (  $\rho$  ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 2.1)

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

**Figure 2.1 SAR Mathematical Equation**

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

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

Where:

$\sigma$  = conductivity of the tissue - simulating material (S/m)

$\rho$  = mass density of the tissue-simulating material (kg/m<sup>3</sup>)

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.

## **Automated TEST SYSTEM SPECIFICATIONS**

### **Positioner**

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

### **Data Acquisition Electronic (DAE) System Cell Controller**

**Processor:** Pentium 4 CPU  
**Clock Speed:** 3 GHz  
**Operating System:** Window 2000  
**Data Card:** DASY4 PC-Board

### **Data Converter**

**Features:** Signal, multiplexer, A/D converter. & control logic  
**Software:** DASY4  
**Connecting Lines:** Optical downlink for data and status info  
Optical uplink for commands and clock

### **PC Interface Card**

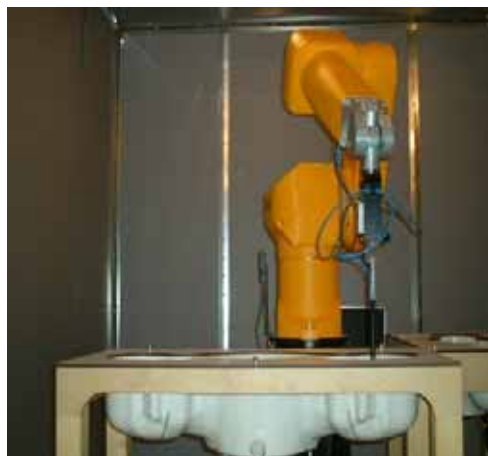
**Function:** 24 bit (64 MHz) DSP for real time processing  
Link to DAE 3  
16 bit A/D converter for surface detection system  
serial link to robot  
direct emergency stop output for robot

### **E-Field Probes**

**Model:** EX3DV4 S/N: 3643  
**Construction:** Triangular core fiber optic detection system  
**Frequency:** 10 MHz to 6 GHz  
**Linearity:**  $\pm 0.2\text{dB}$  (30MHz to 6GHz)

### **Phantom**

**Phantom:** SAM Twin Phantom (V4.0)  
**Shell Material:** Composite  
**Thickness:**  $2.0 \pm 0.2$  mm



**Figure 2.2 DASY4 Test System**

### 3. DESCRIPTION OF TEST EQUIPMENT

#### 3.1 SAR MEASUREMENT SETUP

##### Robotic System

These measurements are performed using the DASY4 automated dosimetric assessment system. The DASY4 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and 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 a remote control used to drive the robot motors. The PC consists of the Micron Pentium IV 500 MHz computer with Windows NT system and SAR Measurement Software DASY4, 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.

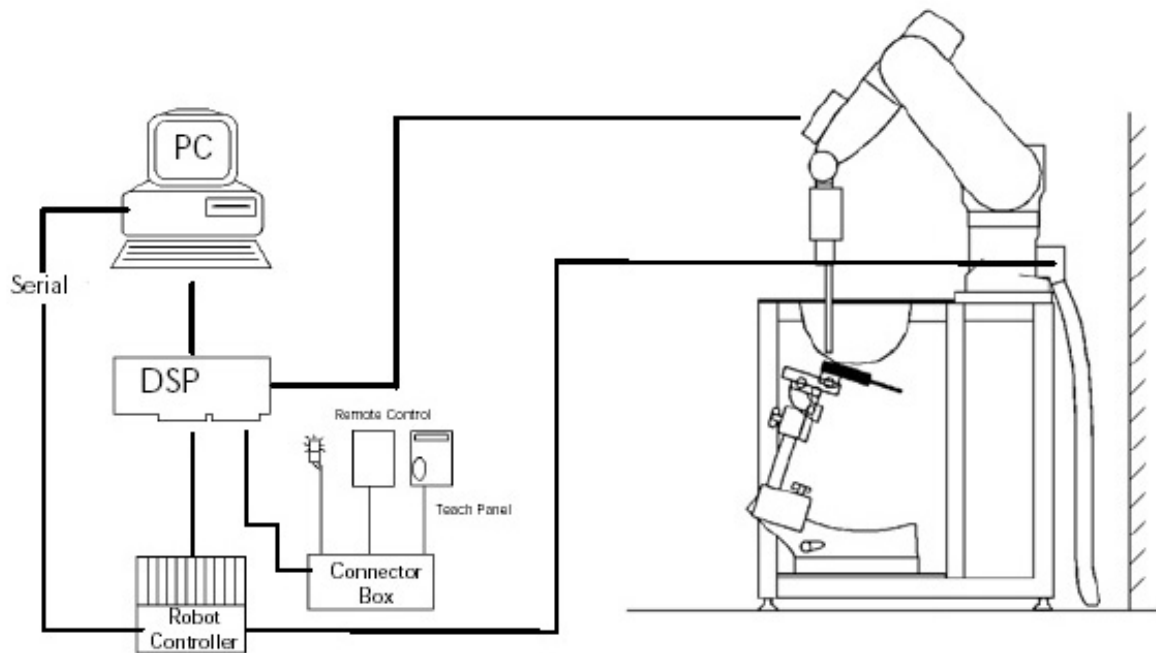


Figure 3.1 SAR Measurement System Setup

##### 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.

### 3.2 Probe Measurement System

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration (see Fig. 3.2) 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 multi fiber line ending at the front of the probe tip. (see Fig. 3.3) 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 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. The approach is stopped at reaching the maximum.



DAE System

#### Probe Specifications

**Calibration:** In air from 10 MHz to 6.0 GHz  
In brain and muscle simulating tissue at Frequencies of 450 MHz, 835 MHz, 1750 MHz, 1900 MHz, 2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5600 MHz, 5800 MHz

**Frequency:** 10 MHz to 6 GHz

**Linearity:**  $\pm 0.2\text{dB}$  (30 MHz to 6 GHz)

**Dynamic:** 10 mW/kg to 100 W/kg

**Range:** Linearity:  $\pm 0.2\text{dB}$

**Dimensions: Overall length:** 330 mm

**Tip length:** 20 mm

**Body diameter:** 12 mm

**Tip diameter:** 2.5 mm

**Distance from probe tip to sensor center:** 1 mm

**Application:** SAR Dosimetry Testing  
Compliance tests of mobile phones

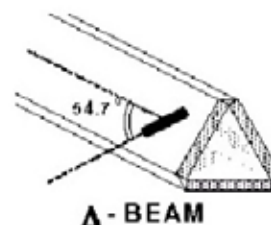


Figure 3.2 Triangular Probe Configurations



Figure 3.3 Probe Thick-Film Technique

### 3.3 Probe Calibration Process

#### Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in and found to be better than +/-0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe is tested.

#### Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm<sup>2</sup>.

#### 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 the rmistor based temperature probe is used in conjunction with the E-field probe

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

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

where:

where:

$\Delta t$  = exposure time (30 seconds),  
 C = heat capacity of tissue (brain or muscle),  
 $\Delta T$  = temperature increase due to RF exposure.

$\sigma$  = simulated tissue conductivity,

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

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;

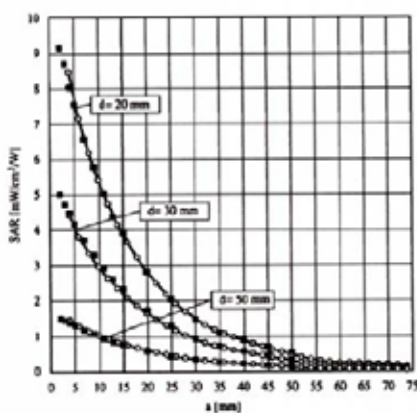


Figure 3.4 E-Field and Temperature Measurements at 900MHz

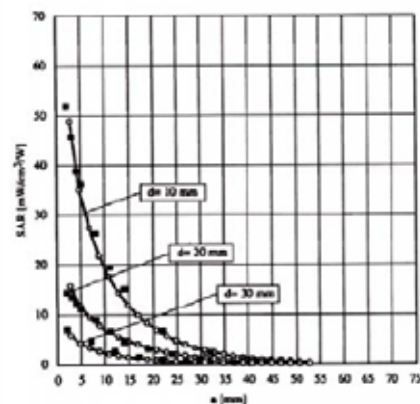


Figure 3.5 E-Field and Temperature Measurements at 1800MHz



**Data Extrapolation**

The DASY4 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with  $V_i$  = compensated signal of channel i (i=x,y,z)  
 $U_i$  = input signal of channel i (i=x,y,z)  
 $cf$  = crest factor of exciting field (DASY parameter)  
 $dcp_i$  = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with  $V_i$  = compensated signal of channel i (i = x,y,z)  
 $Norm_i$  = sensor sensitivity of channel i (i = x,y,z)  
 $\mu V/(V/m)^2$  for E-field probes  
 $ConvF$  = sensitivity of enhancement in solution  
 $E_i$  = electric field strength of channel i in V/m

The RSS value of the field components gives the total field strength (Hermetian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with  $SAR$  = local specific absorption rate in W/g  
 $E_{tot}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{free} = \frac{E_{tot}^2}{3770}$$

with  $P_{pwe}$  = equivalent power density of a plane wave in W/cm<sup>2</sup>  
 $E_{tot}$  = total electric field strength in V/m

### 3.4 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 Fig. 3.6)

#### Phantom Specification

<b>Phantom:</b>	SAM Twin Phantom (V4.0)
<b>Shell Material:</b>	Vivac Composite
<b>Thickness:</b>	2.0 ± 0.2 mm



**Figure 3.6 SAM Twin Phantom**

### 3.5 Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0 the Mounting Device (see Fig. 3.7), enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately, and repeat ably be positioned according to the FCC, CENELEC, IEC and IEEE specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



**Figure 3.7 Mounting Device**

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. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

### 3.6 Brain & Muscle Simulating Mixture Characterization



**Simulated Tissue**

The brain and muscle mixtures consist of a viscous gel using hydrox-ethyl cellulose (HEC) gelling agent and saline solution (see Table 3.1). 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 mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Harts grove.

**Table 3.1 Composition of the Tissue Equivalent Matter**

INGREDIENTS		SIMULATING TISSUE					
		900 MHz Brain	900 MHz Muscle	1800 MHz Brain	1800 MHz Muscle	2450MHz Brain	2450MHz Muscle
Mixture Percentage							
WATER		41.45	52.50	54.90	40.40	62.70	73.20
DGBE		0.000	0.000	44.92	58.00	0.000	26.70
SUGAR		56.00	45.00	0.000	0.000	0.000	0.000
SALT		1.450	1.400	0.180	0.500	0.500	0.040
BACTERICIDE		0.100	0.100	0.000	0.100	36.80	0.000
HEC		1.000	1.000	0.000	1.000	0.000	0.000
Dielectric Constant	Target	<b>41.50</b>	<b>55.00</b>	<b>40.00</b>	<b>53.30</b>	<b>39.2</b>	<b>52.7</b>
Conductivity (S/m)	Target	<b>0.970</b>	<b>1.050</b>	<b>1.400</b>	<b>1.520</b>	<b>1.80</b>	<b>1.95</b>

Salt: 99 % Pure Sodium Chloride Sugar: 98 % Pure Sucrose

Water: De-ionized, 16M resistivity HEC: Hydroxyethyl Cellulose

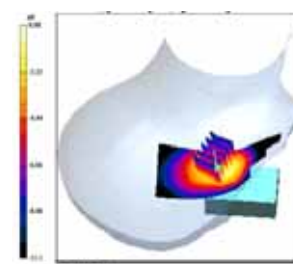
DGBE: 99 % Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy) ethanol]

Triton X-100(ultra pure): Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]

## 4. SAR 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 15 mm x 15 mm.
3. Based on the area scan data, the area of the maximum absorption was determined by sp line interpolation. Around this point, a volume of 32 mm x32 mm x 30 mm (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 (see Sample Sar Area Scan):
  - a. The data at the surface was extrapolated, since the center of the dipoles is 2.5 mm 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 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 sp lines 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 10x 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 step 1, was re-measured. If the value changed by more than 5%, the evaluation is repeated.



**Sample SAR Area Scan**

### Specific Anthropomorphic Mannequin (SAM) 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. 4.1). The perimeter side walls 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 4.1 Sam Twin Phantom shell**

## 5. DEFINITION OF REFERENCE POINTS

### EAR Reference Point

Figure 5.1 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 5.5. 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 5.2). 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.



Figure 5.1 Front, back and side view of SAM Twin Phantom

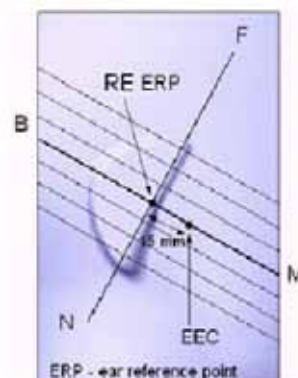


Figure 5.2 Close-up side view of ERPs

### 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. 5.3). The “test device reference point” was then located at the same level as the center of the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its 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.

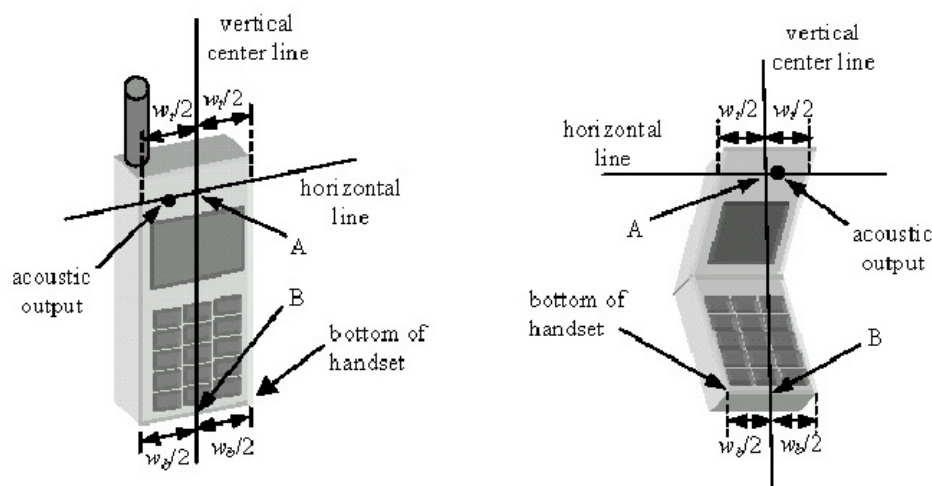


Figure 5.3 Handset Vertical Center & Horizontal Line Reference Points

## 5.1 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 5.4), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.



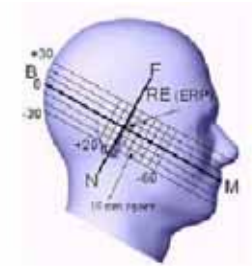
**Figure 5.4 Front, Side and Top View of Cheek/Touch Position**

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 then rotated around the vertical centerline until the phone (horizontal line) was symmetrical with 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 5.5)



**Figure 5.5 Side view w/ relevant markings**

### Positioning for Ear / 15° Tilt

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 15 degree.

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 5.6).



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



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

Body-worn accessories may not always be supplied or available as options for some Devices 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. All test position spacing is documented.

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 accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

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

In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and cautions statements are included in the user's manual.

## 6. ANSI / IEEE C95.1-2005 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 employment, which 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 6.1.SAR Human Exposure Specified in ANSI/IEEE C95.1-2005**

	HUMAN EXPOSURE LIMITS	
	General Public Exposure (W/kg) or (mW/g)	Occupational Exposure (W/kg) or (mW/g)
Whole-Body average SAR (W/kg)	0.08	0.40
Localized SAR (head and trunk) (W/kg)	1.60	8.00
Localized SAR (limbs) (W/kg)	4.00	20.0

**NOTES:**

- \* The Spatial Peak value of the SAR averaged over any 1 g of tissue  
(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
- \*\* The Spatial Average value of the SAR averaged over the whole-body.
- \*\*\* The Spatial Peak value of the SAR averaged over any 10 g of tissue  
(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

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).



## 7. IEEE P1528 –MEASUREMENT UNCERTAINTIES

Error Description	Uncertain value $\pm\%$	Probability Distribution	Divisor	(Ci) 1g	Standard (1g)	vi 2 or Veff
<b>Measurement System</b>						
Probe calibration	$\pm 4.8$	Normal	1	1	$\pm 4.8 \%$	$\infty$
Axial isotropy	$\pm 4.7$	Rectangular	$\sqrt{3}$	0.7	$\pm 1.9 \%$	$\infty$
Hemispherical isotropy	$\pm 9.6$	Rectangular	$\sqrt{3}$	0.7	$\pm 3.9 \%$	$\infty$
Boundary Effects	$\pm 1.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	$\infty$
Probe Linearity	$\pm 4.7$	Rectangular	$\sqrt{3}$	1	$\pm 2.7 \%$	$\infty$
Detection limits	$\pm 1.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	$\infty$
Readout Electronics	$\pm 1.0$	Normal	1	1	$\pm 1.0 \%$	$\infty$
Response time	$\pm 0.8$	Rectangular	$\sqrt{3}$	1	$\pm 0.5 \%$	$\infty$
Integration time	$\pm 2.6$	Rectangular	$\sqrt{3}$	1	$\pm 1.5 \%$	$\infty$
RF Ambient Conditions	$\pm 3.0$	Rectangular	$\sqrt{3}$	1	$\pm 1.7 \%$	$\infty$
Probe Positioner	$\pm 0.4$	Rectangular	$\sqrt{3}$	1	$\pm 0.2 \%$	$\infty$
Probe Positioning	$\pm 2.9$	Rectangular	$\sqrt{3}$	1	$\pm 1.7 \%$	$\infty$
Algorithms for Max. SAR Eval.	$\pm 1.0$	Rectangular	$\sqrt{3}$	1	$\pm 0.6 \%$	$\infty$
<b>Test Sample Related</b>						
Device Positioning	$\pm 2.9$	Normal	1	1	$\pm 2.9 \%$	145
Device Holder	$\pm 3.6$	Normal	1	1	$\pm 3.6 \%$	5
Power Drift	$\pm 5.0$	Rectangular	$\sqrt{3}$	1	$\pm 2.9 \%$	$\infty$
<b>Physical Parameters</b>						
Phantom Shell	$\pm 4.0$	Rectangular	$\sqrt{3}$	1	$\pm 2.3 \%$	$\infty$
Liquid conductivity (Target)	$\pm 5.0$	Rectangular	$\sqrt{3}$	0.64	$\pm 1.8 \%$	$\infty$
Liquid conductivity (Meas.)	$\pm 2.5$	Normal	1	0.64	$\pm 1.6 \%$	$\infty$
Liquid permittivity (Target)	$\pm 5.0$	Rectangular	$\sqrt{3}$	0.6	$\pm 1.7 \%$	$\infty$
Liquid permittivity (Meas.)	$\pm 2.5$	Normal	1	0.6	$\pm 1.5 \%$	$\infty$
<b>Combined Standard Uncertainty</b>					<b><math>\pm 10.3 \%</math></b>	330
<b>Expanded Uncertainty (k=2)</b>					<b><math>\pm 20.6 \%</math></b>	

The above measurement uncertainties are according to IEEE P1528 (2003)

## 8. SYSTEM VERIFICATION

### Tissue Verification

**Table 8.1 Simulated Tissue Verification**

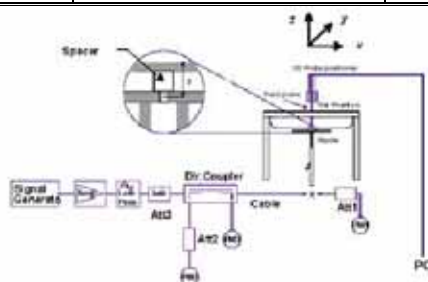
MEASURED TISSUE PARAMETERS							
Date(s)	Target Frequency	Dielectric constant: $\epsilon$			Conductivity: $\sigma$		
		Target	Measured	Deviation (%)	Target	Measured	Deviation (%)
July 04, 2011	900 MHz Muscle	55.0	54.7	-0.55	1.050	1.010	-3.81

### Test System Validation

Prior to assessment, the system is verified to the  $\pm 10\%$  of the specifications at 900 MHz by using the system validation kit(s). (Graphic Plots Attached)

**Table 8.2 System Validation**

SYSTEM DIPOLE VALIDATION TARGET & MEASURED (900 MHz values are normalized to a forward power of 1/4 W)					
Date(s)	System Validation Kit:	Target Frequency	Targeted SAR <sub>1g</sub> (mW/g)	Measured SAR <sub>1g</sub> (mW/g)	Deviation (%)
July 04, 2011	D-835V2, S/N: 464	900 MHz Muscle	2.700	2.870	6.30



**Figure 8.1 Dipole Validation Test Setup**

### Justification for Extended SAR Dipole Calibrations

#### **About KDB Publication 450824-2**

The following are the recommended FCC procedures for SAR dipole calibration.

- 1) The phantom configuration, tissue dielectric parameters, dipole positioning requirements, dielectric spacer and other electrical and mechanical details should be clearly specified in the dipole calibration report. Dipoles must be recalibrated at least once every three years; however, immediate re-calibration is required for the following conditions. The test laboratory must ensure that the required supporting information and documentation have been included in the SAR report to qualify for the extended 3-year calibration interval; otherwise, the IEEE Standard 1528-2003 recommended annual calibration is expected.
- When the most recent return-loss, measured at least annually, deviates by more than 20% from the previous measurement (i.e. 0.2 of the dB value) or not meeting the required -20 dB return-loss specification

### **Antenna Parameters**

Date(s)	Frequency	Return loss (Head)	Impedance ( )	Return loss (Body)	Impedance ( )
March 21.2011	835MHz	-30.5 dB	49.9	-25.1 dB	49.3

## 9. SAR TEST DATA SUMMARY AND POWER TABLE

### See Measurement Result Data Pages

#### Procedures Used To Establish Test Signal

The EUT was placed into simulated call mode (FSK) using manufacturers test codes. This EUT was tested FSK test program to control DUT. The channel was selected at Low, Middle, and High channel. The modulation was set to 6400 using the test program.

#### Device Test Conditions

The EUT 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.

#### Max. Power Output Table for M1503

Mode	Frequency (MHz)	Test Result(dBm)
4 Level FSK	896	28.41
	899	28.22
	902	28.41

## 10. SAR TEST DATA SUMMARY

### 10.1 Measurement Results (FSK Body SAR)

FREQUENCY MHz	Begin Power (dBm)	Drift Power (dB)	Mode	Device Test Position	Antenna Position	SAR (W/kg)
896	28.41	-0.127	FSK	10 mm [With Holster]	Internal	1.110
899	28.22	-0.148	FSK	10 mm [With Holster]	Internal	1.100
902	28.41	-0.164	FSK	10 mm [With Holster]	Internal	1.090
896	28.41	-0.283	FSK	10 mm [Without Holster]	Internal	0.966
899	28.22	0.161	FSK	10 mm [Without Holster]	Internal	1.040
902	28.41	0.046	FSK	10 mm [Without Holster]	Internal	0.943
ANSI / IEEE C95.1 2005 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure/ General Population Exposure					Body 1.6 W/kg (mW/g) averaged over 1 gram	

#### NOTE:

1. The test data reported are the worst-case SAR value with the antenna-body 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. Prior to testing the conducted output power was measured.
4. The EUT is tested 2<sup>nd</sup> hot-spot peak, if it is less than 2dB below the highest peak.
5. Battery is fully charged for all readings.
6. Test Signal Call Mode                      Continuous Tx On                      ☐Manu.Test Codes                      ☐Base Station Simulator
7. Tissue parameters and temperatures are listed on the SAR plots.
8. Liquid tissue depth is 15.0cm.±0.1
9. Justification for reduced test configurations: per FCC/OET Supplement C (July, 2001), if the SAR measured at the middle channel for each test configuration (Left, right, cheek/touch, tilt/ear, extended and retracted) is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).

## 11. SAR TEST EQUIPMENT

Table 11.1 Test Equipment Calibration

	Type	Manufacturer	Model	Cal.Date (dd/mm/yy)	Next.Cal.Date (dd/mm/yy)	S/N
<input checked="" type="checkbox"/>	SEMITEC Engineering	SEMITEC	N/A	N/A	N/A	Shield Room
<input checked="" type="checkbox"/>	Robot	SCHMID	RX90BL	N/A	N/A	F02/5Q85A1/A/01
<input checked="" type="checkbox"/>	Robot Controller	SCHMID	CS7MB	N/A	N/A	F02/5Q85A1/C/01
<input checked="" type="checkbox"/>	Joystick	SCHMID	N/A	N/A	N/A	D221340031
<input checked="" type="checkbox"/>	Hicron Computer Pentium Celeron 1.1GHz Window2000	N/A	N/A	N/A	N/A	N/A
<input checked="" type="checkbox"/>	Probe Alignment Unit LB	N/A	N/A	N/A	N/A	321
<input checked="" type="checkbox"/>	Mounting Device	SCHMID	Holder	N/A	N/A	N/A
<input checked="" type="checkbox"/>	Sam Phantom	SCHMID	TP1223	N/A	N/A	N/A
<input type="checkbox"/>	Sam Phantom	SCHMID	TP1224	N/A	N/A	N/A
<input type="checkbox"/>	Head/Body Equivalent Matter(450MHz)	N/A	N/A	01/01/11	01/01/12	N/A
<input checked="" type="checkbox"/>	Head/Body Equivalent Matter(900MHz)	N/A	N/A	01/01/11	01/01/12	N/A
<input type="checkbox"/>	Head/Body Equivalent Matter(1800MHz)	N/A	N/A	01/01/11	01/01/12	N/A
<input type="checkbox"/>	Head/Body Equivalent Matter(1900MHz)	N/A	N/A	01/01/11	01/01/12	N/A
<input type="checkbox"/>	Head/Body Equivalent Matter(2450MHz)	N/A	N/A	01/01/11	01/01/12	N/A
<input checked="" type="checkbox"/>	Data Acquisition Electronics	SCHMID	DAE3V1	28/01/11	28/01/12	519
<input type="checkbox"/>	Data Acquisition Electronics	SCHMID	DAE3V1	23/11/10	23/11/11	520
<input checked="" type="checkbox"/>	Dosimetric E-Field Probe	SCHMID	EX3DV4	24/01/11	24/01/12	3643
<input type="checkbox"/>	Dosimetric E-Field Probe	SCHMID	ET3DV6	06/07/10	06/07/11	1703
<input type="checkbox"/>	Dummy Probe	N/A	N/A	N/A	N/A	N/A
<input type="checkbox"/>	450MHz System Validation Dipole	SCHMID	D450V2	24/01/11	24/01/13	1011
<input checked="" type="checkbox"/>	835MHz System Validation Dipole	SCHMID	D835V2	22/03/10	22/03/12	464
<input type="checkbox"/>	1800MHz System Validation Dipole	SCHMID	D1800V2	16/07/10	16/07/12	2d047
<input type="checkbox"/>	1900MHz System Validation Dipole	SCHMID	D1900V2	23/03/10	23/03/12	5d029
<input type="checkbox"/>	2450MHz System Validation Dipole	SCHMID	D2450V2	18/03/10	18/03/12	726
<input type="checkbox"/>	2600MHz System Validation Dipole	SCHMID	D2600V2	27/05/10	27/05/12	1016
<input type="checkbox"/>	3500MHz System Validation Dipole	SCHMID	D3500V2	27/05/10	27/05/12	1018
<input checked="" type="checkbox"/>	Network Analyzer	HP	8753D	08/03/11	08/03/12	3410J01204
<input checked="" type="checkbox"/>	Signal Generator	HP	ESG-3000A	01/07/11	01/07/12	US37230529
<input checked="" type="checkbox"/>	Amplifier	EMPOWER	BBS3Q7ELU	04/10/10	04/10/11	1020
<input checked="" type="checkbox"/>	Power Meter	HP	EPM-442A	07/03/11	07/03/12	GB37170267
<input checked="" type="checkbox"/>	Power Sensor	HP	8481A	07/03/11	07/03/12	3318A96566
<input checked="" type="checkbox"/>	Power Sensor	HP	8481A	07/03/11	07/03/12	3318A90918
<input checked="" type="checkbox"/>	Dual Directional Coupler	Agilent	778D-012	11/01/11	11/01/12	50228
<input type="checkbox"/>	Directional Coupler	HP	773D	01/07/11	01/07/12	2389A00640
<input checked="" type="checkbox"/>	Low Pass Filter 1.5GHz	Micro LAB	LA-15N	11/01/11	11/01/12	N/A
<input type="checkbox"/>	Low Pass Filter 3.0GHz	Micro LAB	LA-30N	04/10/10	04/10/11	N/A
<input checked="" type="checkbox"/>	Attenuators(3dB)	Agilent	8491B	02/07/11	02/07/12	MY39260700
<input checked="" type="checkbox"/>	Attenuators(10dB)	WEINSCHEL	23-10-34	11/01/11	11/01/12	BP4387
<input type="checkbox"/>	Step Attenuator	HP	8494A	04/10/10	04/10/11	3308A33341
<input checked="" type="checkbox"/>	Dielectric Probe kit	Agilent	85070D	N/A	N/A	US01440118
<input type="checkbox"/>	8960 Series 10 Wireless Comms. Test Set	Agilent	E5515C	07/03/11	07/03/12	GB43461134
<input type="checkbox"/>	Bluetooth Tester	TESCOM	TC-3000B	01/07/11	01/07/12	3000B640046

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

## 12. 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 the worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters subject to the test. 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 impossible 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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