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CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

APPLICANT NAME & ADDRESS:
SAMSUNG ELECTRONICS CO., LTD.
416 Maetan-3 Dong, Paldal-Ku
Suwon City Kyungki-Do 441-742, KOREA
Attn: Wallace Oh, Engineering Manager
Samsung Electronics America (QA Lab)

DATE & LOCATION OF TESTING:
Dates of Tests: Mar. 28-29 & Apr. 9-10, 2002
Test Report S/N: SAR.220327137.A3L
Test Site: PCTEST Lab, Columbia MD

FCC ID:	**A3LSPHA540**
APPLICANT:	**SAMSUNG ELECTRONICS CO., LTD.**

EUT Type:	**Tri-Mode Dual-Band Analog/PCS Phone (AMPS/CDMA)**
Tx Frequency:	**824.04 – 848.97 MHz (AMPS) / 824.70 – 848.31 MHz (CDMA)** **1851.25 – 1908.75 MHz (PCS CDMA)**
Rx Frequency:	**869.04 – 893.97 MHz (AMPS) / 869.70 – 893.31 MHz (CDMA)** **1931.25 – 1988.75 MHz (PCS CDMA)**
Max. RF Output Power:	**0.400 W ERP AMPS (26.023 dBm) / 26.0 dBm Conducted** **0.319 W ERP CDMA (25.033 dBm) / 25.0 dBm Conducted** **0.281 W EIRP PCS CDMA (24.481 dBm) / 24.5 dBm Conducted**
Max. SAR Measurement:	**1.48W/kg AMPS Head SAR; 1.39W/kg AMPS Body SAR;** **1.02W/kg CDMA Head SAR; 0.95W/kg CDMA Body SAR;** **1.31W/kg PCS CDMA Head SAR; 0.68W/kg PCS CDMA Body SAR**
Trade Name/Model(s):	***SPH-A540***
FCC Classification:	**Licensed Portable Transmitter Held to Ear (PCE)**
FCC Rule Part(s):	**§2.1093; FCC/OET Bulletin 65 Supplement C [July 2001]**
Application Type:	**Certification**
Test Device Serial No.:	***Identical* prototype**

This wireless portable device has been shown to be capable of 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 FCC/OET Bulletin 65 Supplement C (2001) and IEEE Std. 1528-200X (Draft 6.4, July 2001).

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.

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.

Alfred Cirwithian
Vice President Engineering

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1. INTRODUCTION / SAR DEFINITION

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] 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.

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 (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 1.1).

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

Figure 1.1
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]

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2. SAR MEASUREMENT SETUP

Robotic System

Measurements are performed using the ALIDX-500 automated dosimetric assessment system. The ALIDX-500 is made by IDX Robotics, Inc. (IDX) in the United States and consists of high precision robotics system (CRS), robot controller, Pentium 4 computer, near-field probe, probe alignment sensor, and the Left and Right SAM phantoms containing the head/brain equivalent tissue, and the flat phantoms for body/muscle equivalent. 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. 2.1).

System Hardware

The Robot table consists of the power supply, robot controller, safety computer, teach pendant (Joystick), six-axis robot arm, and the probe. The cell controller consists of DELL Dimension 4300 Pentium-4 1.6 GHz computer with Windows 2000 system and SAR Measurement software, National Instruments analog card, monitor, keyboard, and mouse. The robot controller is connected to the cell controller to communicate between the two computers. The probe data is connected to the cell controller via data acquisition cables.

System Electronics

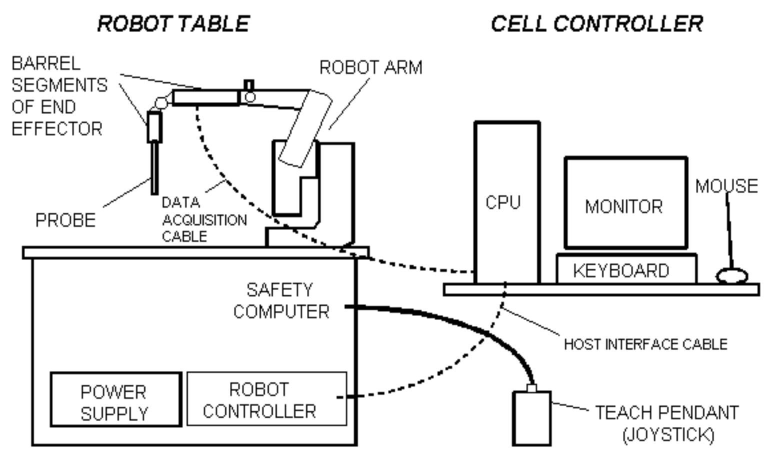

Figure 2.1
SAR Measurement System Setup

When the Robot is in the home position, the Y-axis of the coordinate system parallels the line of intersection between the tabletop and the long axis of the Robot's Large Shoulder. The Teach Pendant may be used to establish the X,Y coordinate directions by depressing the 0-X and 0-Y MOTOR/AXIS switches while in axis mode.

The robot is first taught to position the probe sensor following a specific pattern of points. In the first sweep the sensor enclosure touches the inside of the phantom head. The SAR is measured on a defined grid of points that are concentrated on the surface of the head closest to the antenna of the transmitting device (EUT).

3. ALIDX-500 E-FIELD PROBE SYSTEM

Probe Measurement System

Fig 3.1
IDX System

The near-field probe is an implantable isotropic E-field probe that measures the voltages proportional to the $|E|^2$ (electric) or $|H|^2$ (magnetic) fields. The probe is enclosed in a hollow glass protective cylinder 9-mm. outer diameter, 0.5 mm. thickness and 30 cm. in length. The E-probe contains three electrically small array of orthogonal dipoles strategically placed to provide greater accuracy and to compensate for near-field spatial gradients. The probe contains diodes that are placed over the gap of the dipoles to improve RF detection. The electrical signal detected by each diode is amplified by three DC amplifiers and are contained in a shielded container in the robot end effector so its performance is not affected by the presence of incident electromagnetic fields (see Fig. 3.1).

Probe Specifications

Frequency Range:	10 kHz – 3.0 GHz
Calibration:	In air from 10 MHz to 3.0 GHz
	In brain and muscle simulating tissue at Frequencies of 835 MHz, 1900MHz and 2450MHz
Sensitivity:	3.5 mV/mW/cm^2 (air – typical)
DC Resistance:	300 kohm
Isotropic Response:	0.25 dB
Dynamic Range:	10 mW/kg – 100 W/kg
Resistance to Pull:	25 N
Probe Length:	290 mm
Probe Tip Material:	Glass
Probe Tip Length:	40 mm
Probe Tip Diameter:	7 ± 0.2 mm
Application:	SAR Dosimetry Testing
	HAC (Hearing Aid Compatibility)
	Compliance tests of mobile phones

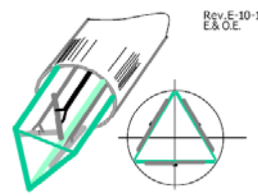

Figure 3.2
Triangular Probe Configuration

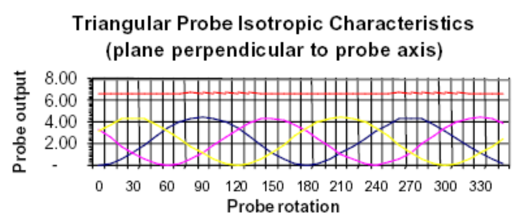

Figure 3.3
Probe Characteristics

4. Probe Calibration Process

Dosimetric Assessment Procedure

Each E-Probe/Probe amplifier combination has unique calibration parameters. A TEM calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the Probe to a known E-field density (1mW/cm^2) using an RF Signal generator, TEM cell, and RF Power Meter. The SAR measurement software is used for Probe calibration.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or some other methodologies above 1 GHz for free space. For the free space calibration, we place the probe in the volumetric center of the cavity and at the proper orientation with the field. We then rotate the probe 360 degrees until the three channels show the maximum reading. The power density readings equates to 1mW/cm^2.

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. 4.2).

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

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;

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

where:

σ = simulated tissue conductivity,

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

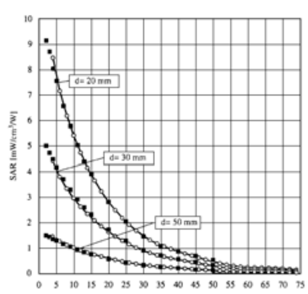

Figure 4.1 E-Field and Temperature measurements at 900MHz [7]

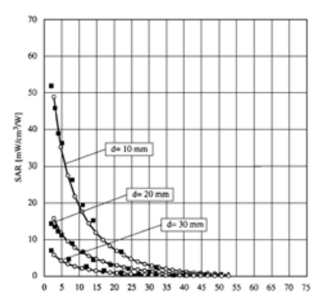

Figure 4.2 E-Field and temperature measurements at 1.9GHz [7]

5. PHANTOM & EQUIVALENT TISSUES

SAM Phantom

Figure 5.1
SAM Phantoms

The Left and Right SAM Phantoms are constructed of a vivac composite integrated in a corian stand. 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. 5.1)

Brain & Muscle Simulating Mixture Characterization

Figure 5.2
Head Simulated Tissue

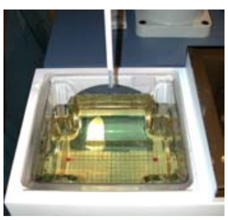

Figure 5.3
Body/Muscle Simulated Tissue

The brain and muscle mixtures consist of a viscous gel using hydroxethylcellullose (HEC) gelling agent and saline solution (see Table 6.1). 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 been 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].(see Table 5.1)

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7

Salt: 99⁺% Pure Sodium Chloride — Sugar: 98⁺% Pure Sucrose
Water: De-ionized, 16 MΩ⁺ 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] ether

Table 5.1
Composition of the Brain & Muscle Tissue Equivalent Matter

Device Holder

Figure 5.4
Device Positioner

In combination with the SAM Phantom, the EUT Holder (see Fig. 6.2) enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. Device positioning is accurate and repeatable 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.

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6. TEST SYSTEM SPECIFICATIONS

Automated Test System Specifications

Positioner

Robot:	CRS Robotics, Inc. Robot Model: F3
Repeatability:	± 0.05 mm (0.002 in.)
No. Of axes:	6

Data Acquisition Electronic (DAE) System

Cell Controller

Processor:	Pentium 4
Clock Speed:	1.6 GHz
Operating System:	Windows 2000™ Professional
Data Card:	NI DAQ Card (in CPU)

Data Converter

Software:	IDX Flexware
Connecting Lines:	Data Acquisition Cable RS-232 Host Interface Cable
Sampling Rate:	6000 samples/sec

Figure 6.1
ALIDX-500 Test System

E-Field Probes

Model:	E-010 S/N: PCT001 & PCT002
Construction:	Triangular core absolute encoder system
Frequency:	10 MHz to 3.0 GHz

Phantom

Phantom:	SAM Phantoms (Left & Right)
Shell Material:	Vivac Composite
Thickness:	2.0 ± 0.2 mm

7. DOSIMETRIC ASSESSMENT & PHANTOM SPECS

Measurement Procedure

The measurement procedure consists of the process parameters, probe parameters, EUT product data, and measurement scans (teach points). The measurement procedure is a set of predefined points to be scanned and measured by the probe, DC amplified and processed by the cell controller. The corresponding voltages determined by the electric and magnetic fields are extrapolated to determine peak SAR value.

The SAR Measurement System measures field strength by employing two different types of systematic measurement scans; a coarse scan and a fine scan. Coarse and fine scans measure field strength in a rectangular area within the XY plane (a plane parallel to the top of the Robot Table). The measurement area is divided into a grid of small squares defined by equally spaced grid lines. During an actual measurement process, the probe moves along grid lines systematically recording the field strength at grid line intersections. Typically, after a coarse scan is completed, a fine scan is conducted at the peak field strength value (hot spot) that was measured in the coarse scan. The fine scan has a greater resolution (smaller grid squares) than the coarse scan, and covers only a fraction of the measurement area in the coarse 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 Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Fig. 7.1). 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. The SAM shell thickness is 2.0 $\pm$ 0.2 mm.

Figure 7.1
Left and Right SAM Phantom shells

8. DEFINITION OF REFERENCE POINTS

EAR Reference Point (ERP)

Figure 8.1 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 9.2. 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 8.2). 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].

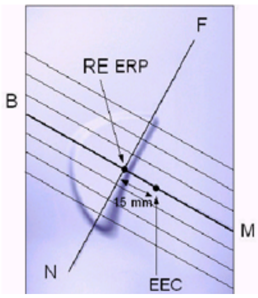

Figure 8.2 Close-up side view of ERPs

Figure 8.1 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. 8.3). 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.

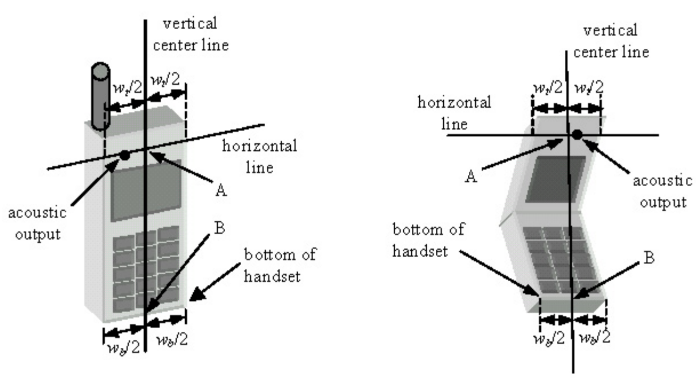

Figure 8.3 Handset Vertical Center & Horizontal Line Reference Points

9. 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 9.1), 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.

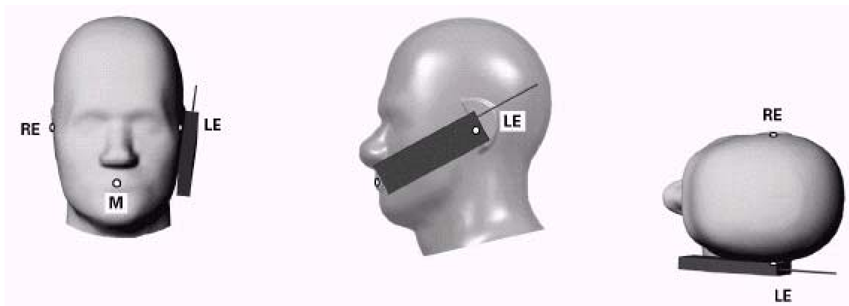

Figure 9.1 Front, Side and Top View of Cheek/Touch Position

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 9.2)

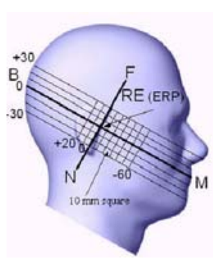

Figure 9.2 Side view w/ relevant markings

9. TEST CONFIGURATION POSITIONS (Continued)

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 were 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 9.3).

Figure 9.3 Front, Side and Top View of Ear/15° Tilt Position

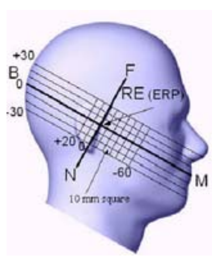

Figure 9.4 Side view w/ relevant markings

9. TEST CONFIGURATION POSITIONS (Continued)

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 9.5). A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do 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.

Figure 9.5 Body Belt Clip & Holster Configurations

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 spacings are 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 accessory(ies), including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

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

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

11. MEASUREMENT UNCERTAINTIES

a	b	c	d	e= f(d,k)	f	g	h = cxf/e	i = cxg/e	k
Uncertainty Component	**Sec.**	**Tol. (± %)**	**Prob. Dist.**	**Div.**	**c_i (1 - g)**	**c_i (10 - g)**	**1 - g u_i (± %)**	**10 - g u_i (± %)**	**v_i**
Measurement System									
Probe Calibration	E1.1	6.0	N	1	1	1	6.0	6.0	∞
Axial Isotropy	E1.2	4.88	R	$\sqrt{3}$	0.5	0.5	1.4	1.4	∞
Hemishperical Isotropy	E1.2	9.6	R	$\sqrt{3}$	0.5	0.5	2.8	2.8	∞
Boundary Effect	E1.3	11.0	R	$\sqrt{3}$	1	1	6.4	6.4	∞
Linearity	E1.4	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
System Detection Limits	E1.5	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
Readout Electronics	E1.6	1.0	R	1	1	1	1.0	1.0	∞
Response Time	E1.7	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
Integration Time	E1.8	1.7	R	$\sqrt{3}$	1	1	1.0	1.0	∞
RF Ambient Conditions	E5.1	1.2	R	$\sqrt{3}$	1	1	0.7	0.7	∞
Probe Positioner Mechanical Tolerance	E5.2	0.4	R	$\sqrt{3}$	1	1	0.2	0.2	∞
Probe Positioning w/ respect to Phantom Shell	E5.3	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
Extrapolation, Interpolation & Integration Algorithms for Max. SAR Evaluation	E4.2	3.9	R	$\sqrt{3}$	1	1	2.3	2.3	∞
Test Sample Related									
Test Sample Positioning	E3.2.1	10.6	R	$\sqrt{3}$	1	1	6.1	6.1	11
Device Holder Uncertainty	E3.1.1	8.7	R	$\sqrt{3}$	1	1	5.0	5.0	8
Output Power Variation - SAR drift measurement	5.6.2	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E2.1	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
Liquid Conductivity - deviation from target values	E2.2	5.0	R	$\sqrt{3}$	0.7	0.5	2.0	1.4	∞
Liquid Conductivity - measurement uncertainty	E2.2	10.0	R	$\sqrt{3}$	0.7	0.5	4.0	2.9	∞
Liquid Permittivity - deviation from target values	E2.2	5.0	R	$\sqrt{3}$	0.6	0.5	1.7	1.4	∞
Liquid Permittivity - measurement uncertainty	E2.2	5.0	R	$\sqrt{3}$	0.6	0.5	1.7	1.4	∞
Combined Standard Uncertainty (k=1)			RSS				14.4	14.0	
Expanded Uncertainty (k=2) (95% CONFIDENCE LEVEL)							28.8	28.0	

The above measurement uncertainties are according to IEEE Std. 1528-200x (July, 2001)

10. 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 10.1. Safety Limits for Partial Body Exposure [2]

	HUMAN 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.

15. SAR TEST EQUIPMENT

Equipment Calibration

Table 15.1 Test Equipment Calibration

EQUIPMENT SPECIFICATIONS		
Type	**Calibration Date**	**Serial Number**
CRS Robot F3	February 2002	RAF0134133
CRS C500C Motion Controller	February 2002	RCB0003303
CRS Teach Pendant (Joystick)	February 2002	STP0132231
DELL Computer, Pentium 4 1.6 GHz, Windows 2000™	February 2002	
E-Field Probe E-010	February 2002	PCT002
Right Ear SAM Phantom (P-SAM-R)	February 2002	
Left Ear SAM Phantom (P-SAM-L)	February 2002	
IDX Robot End Effector (EE-103-C)	February 2002	07111223
IDX Probe Amplifier	February 2002	07111113
Validation Dipole D-835S	February 2002	PCT640
Validation Dipole D-1900S	February 2002	PCT639
Brain Equivalent Matter (835MHz)	April 2002	PCTBEM101
Brain Equivalent Matter (1900MHz)	April 2002	PCTBEM301
Muscle Equivalent Matter (835MHz)	April 2002	PCTMEM201
Muscle Equivalent Matter (1900MHz)	April 2002	PCTMEM401
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

NOTE:

The E-field probe was calibrated by IDX, 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.

16. 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. 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 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]

17. REFERENCES

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Probe E-010

SN: PCT002

Manufactured:	October 19, 2001
Calibrated:	February 4, 2002

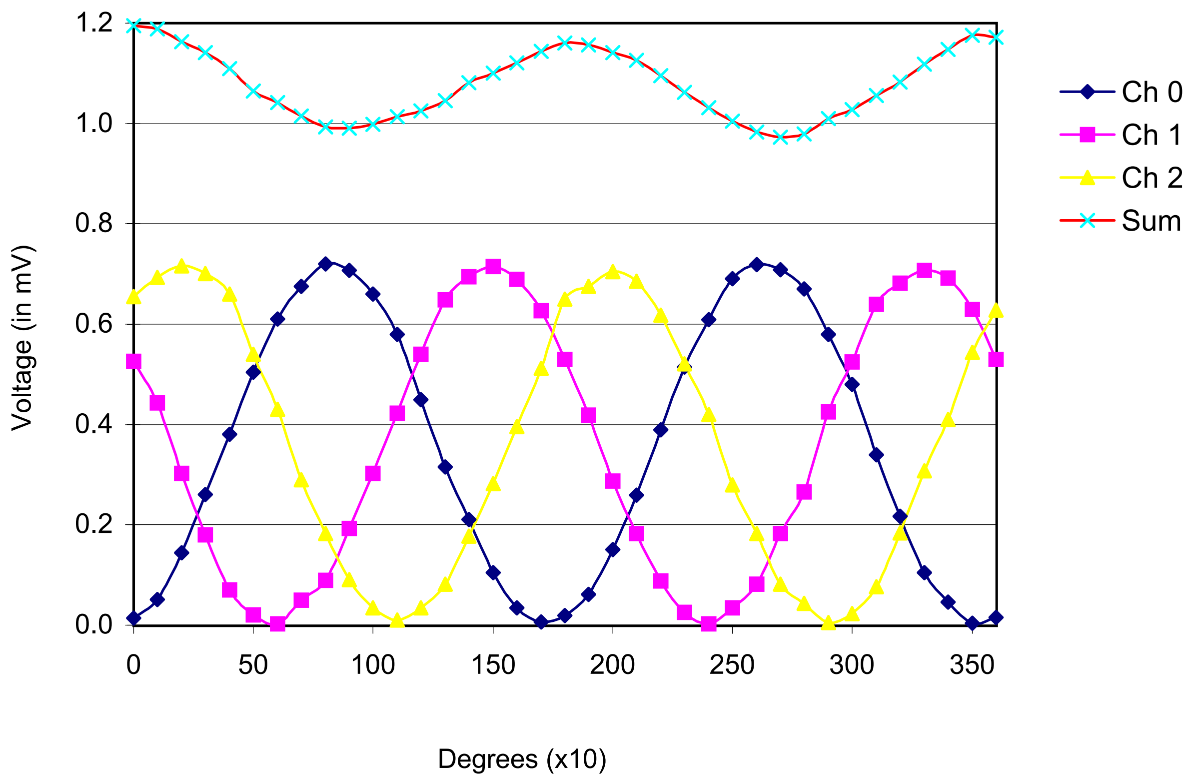
Calibrated for the IDX System

PCTEST Calibration Laboratory

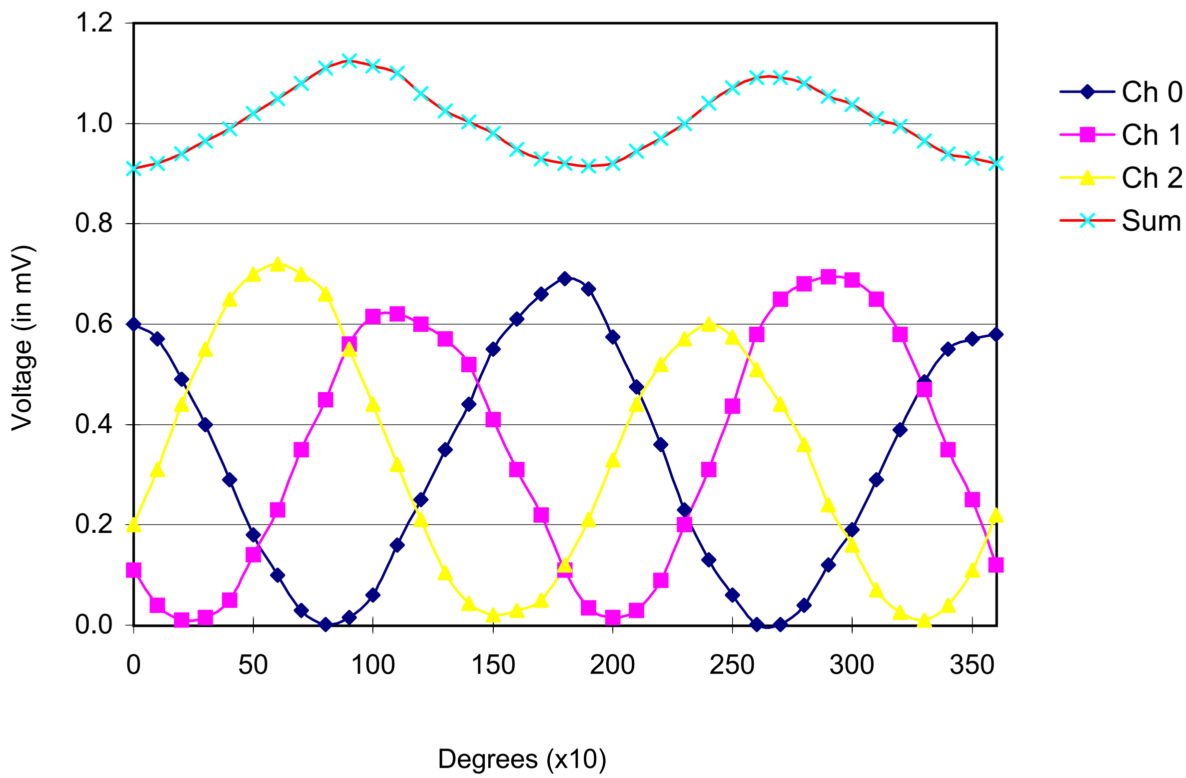
Approved By:

Alfred Cirwithian
Vice President Engineering

File:	02-04-2002.cal
Date:	04-Feb-02 01:20:16 pm
Probe Name:	PCT002
Frequency:	835 MHz
Comment:	PCTEST TEM CAL
Amp 1 Setting:	20.000
Amp 2 Setting:	20.000
Amp 3 Setting:	20.000



File:	02-04-2002.cal2
Date:	04-Feb-02 03:18:09 pm
Probe Name:	PCT002
Frequency:	1900 MHz
Comment:	PCTEST TEM CAL
Amp 1 Setting:	20.000
Amp 2 Setting:	20.000
Amp 3 Setting:	20.000



Calibration Data

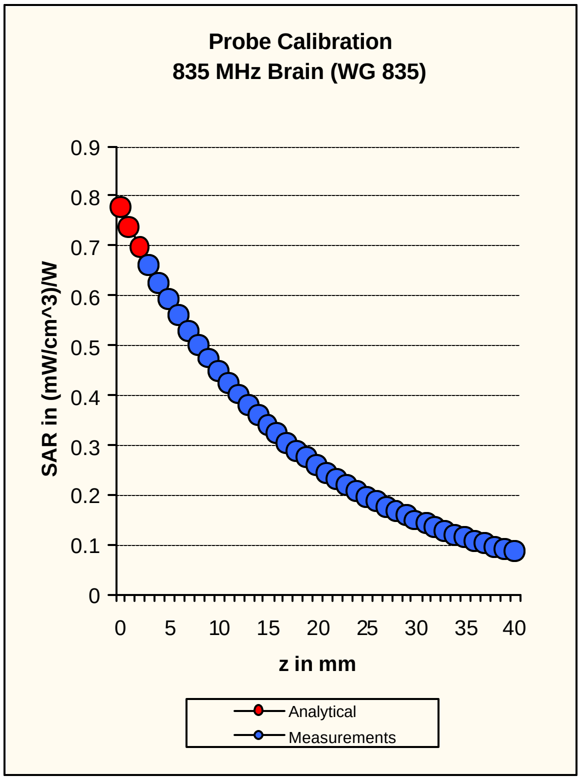
Probe: PCT002

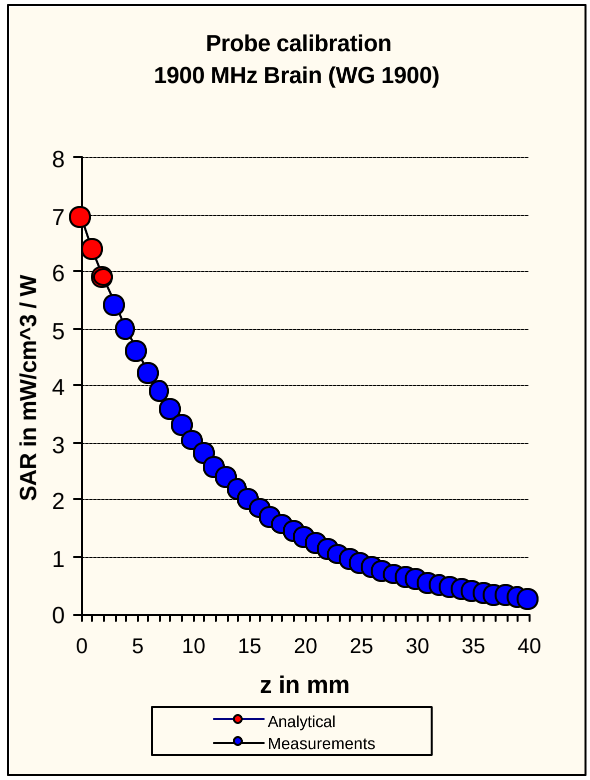
OFFSET (cm)	ANGLE (deg)
0.24	54.73

Tissue Type	Freq. (MHz)	Dielectric Constant	Conductivity (S/m)	Conversion Factor
Brain	835	40.7	0.89	5.8
Brain	1900	40.2	1.41	4.7
Muscle	835	55.7	0.99	4.9
Muscle	1900	53.9	1.48	4.5

Frequency	Isotropicity	
	%	dB
835	4.06	0.173
1900	5.05	0.148

Calibrated by: SL Date: 02/04/2002





Conversion Factor Assessment for *IDX* SAR Measurement System

S/N: PCT002

835 MHz Brain

$\varepsilon_r = 40.7 \pm 5\%$ $\sigma = 0.89 \pm 5\%$ mho/m

Conversion Factor = **5.8** $\pm$ 7% (k=2)

1900 MHz Brain

$\varepsilon_r = 40.2 \pm 5\%$ $\sigma = 1.41 \pm 5\%$ mho/m

Conversion Factor = **4.7** $\pm$ 7% (k=2)

1. SAR Measurement System Validation

7.1 Introduction

This section provides procedures for the following three levels of SAR measurement
System verification:

a) System performance checking

b) System validation

c) Interlaboratory comparison

The objectives and applications of these different levels of verification procedures are as follows:

System performance checking (*system check*) provides a simple, fast, and reliable test method that can be performed daily or before every SAR measurement. The objective here is to ascertain that the system components are still within laboratory calibration limits, including drift effects. This test requires a flat phantom and a Standard Source, e.g., a half-wave dipole.

System validation[1] provides means of system-level validation. The test system utilizes a flat phantom and a reference dipole (see Annex F). Thus, *system validation* verifies the system accuracy against its phantoms nor does it include the uncertainty due to the use of anthropomorphic phantoms nor does it include the uncertainty due to handset positioning variability. This test is performed annually (e.g., after probe calibration), before measurements related to interlaboratory comparison, and every time modifications have been made to the system, such as a new software release, different readout electronics or different types of probes.

Interlaboratory comparisons provide laboratories with a reference handset and a standard anthropomorphic phantom to quantify the global measurement uncertainty. This allows the data scatter due to the human-like phantom and due to handset positioning effects to be evaluated. This test is used to compare the accuracy and precision performance of various laboratories.

7.2 System performance Check

7.2.1 Purpose

The purpose of the system performance check (*system check*) is to verify that the system operates within its specifications. The *system check* is a simple check of repeatability to make sure that the system works correctly at the time of the compliance test. It is not a verification of the system with respect to external standards. The *system check* should detect possible short time drift and errors in the system, such as:

a) Changes in the liquid parameters (e.g. due to water evaporation or temperature change

b) Component failures

c) Component drift

1 In the international standards (e.g., CENELEC, IEC), the term System Validation may e used to refer to tests using reference handsets with the standard anthropomorphic phantom.

d) Operator errors in the setup or software parameters

e) Adverse conditions in system configuration

The *system check* is a complete 1 g or 10 g averaged SAR measurement in a simplified test system with a standard source (see 7.2.3). The instrumentation and procedures in the *system check* are the same as those used for the compliance tests. The *system check* must be performed using the same liquid as in the compliance test and at a chosen fixed frequency that is within ± 10% of the compliance test mid-band frequency. The *system check* is performed prior to compliance tests and the result must always be within ± 10% of the target value corresponding to the test frequency, liquid and the source used. The target values are 1 g or 10 g averaged SARs measured by any system on which *system validation* has been performed using the *system check* test system in figure 7.1 These target values should be determined using a controlled standard source.

7.2.2 Phantom

The test system uses a flat phantom as specified in 4.5.3.

7.2.3 Standard Source

The phantoms should be irradiated using a standard source for the required frequency (e.g., a half-wave dipole or patch antenna). The reference dipoles used for *system validation* (see Annex F) can also be used for the *system check*, but are not required. To ensure good SAR measurement repeatability, standard sources should be selected with good positioning repeatability, mechanical and electrical stability, and impedance matching. The standard source should have a return loss better than –20 dB (measured in the test system) at the test frequency to reduce the uncertainty in the power measurement. In the following positioning instructions, a half-wave dipole is used as an example of a standard source.

A half-wave dipole should be positioned below the bottom of the phantom and centered with its axis parallel to the longest side of the phantom. The distance between the liquid filled phantom bottom surface and the dipole center, *s*, (see Fig. 7.1) should be specified for each test frequency. A low loss and low dielectric constant spacer should be used to establish the correct distance between the top surface of the dipole and the bottom surface of the phantom. For other standard sources, the distance *s* should be defined according to the source structure. To ensure good repeatability, the same dipoles (or other controlled sources) and spacers shall always be used for *system check*. The acceptable tolerance of distance *s* should be within + 0.2 mm.

7.2.4 Standard Source Input Power Measurement

The uncertainty of the power to the source must be as small as possible. This requires the use of a test system with directional couplers and power meters during the *system check*. The recommended test system is shown Figure 7.1 (which uses a half-wave dipole as an example of a standard source).

Figure 7.1 – Test system for the system performance check

First the power meter PM1 (including attenuator Att1) is connected to the cable to measure the forward power at the location of the dipole connector (X). The signal generator is adjusted for the desired forward power at the dipole connector (taking into account the attenuation of Att1) as read by power meter PM2. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2. If the signal generator does not allow adjustment in 0.01 dB steps, the remaining difference at PM2 must be taken into consideration (e.g., by scaling the measured SAR values versus the forward power difference). PM3 records the reflected power from the dipole to ensure that the reflected power is at least 20dB below the forward power.

The component and instrumentation requirements are as follows:

a) The signal generator and amplifier should be stable to within 2 %(short term stability after warm-up). The forward power to the dipole to the dipole should be high enough to produce SAR exceeding the lower detection limit of the probe system (see Annex A4). The recommended 1 g averaged SAR range is 0.4-8 W/kg. If the signal generator can deliver 15 dBm or more, and amplifier is generally not necessary. Some high power amplifiers should not be operated at a level far below their maximum output can be quite noisy. An attenuator between the signal generator and amplifier is recommended to protect the amplifier is recommended to protect the amplifier input.

b) The pass filter inserted after the amplifier reduces the effect of harmonics and noise from the amplifier. For most amplifiers in normal operation the filter is not necessary.

c) The attenuator after the amplifier improves the source matching and the accuracy of the power sensor. (Consult the power meter manual.)

d) The directional coupler (recommended –20 dB coupling coefficient) is used to monitor the forward power and adjust the signal generator output for constant forward power. A medium-quality coupler is sufficient because the loads (dipole and power head) are both well-matched.

e) The power meters PM2 and PM3 should have low drift and a resolution of 0.01 dBm, but otherwise the accuracy has negligible impact on the power setting. (Absolute calibration is not required.)

f) The power meter PM1 and attenuator Attl must be high-quality components. These should be calibrated, preferably together. The attenuator (-10 dB) improves the accuracy of the power reading. (Some high-power heads come with a built-in calibrated attenuator.) The exact attenuation of the attenuator at the test frequency must be known; many attenuators vary up to 0.2 dB from the specified value.

g) Use the same power level for PM1 test as used for the actual measurement to avoid linearity and range switching errors in the power meters PM2 and PM3. If the power level is changed, the power level setting procedure should be repeated.

h) The dipole must be connected directly to the cable at location "X". If the power meter has different connector system, use high-quality adapters.

7.2.5 System Check Procedure

The *system check* is a complete **1** g or 10 g averaged ***S A R*** measurement. The measured **1** g (or 10 g) averaged SAR value is normalized to the target input power of the standard source and compared with the previously recorded target **1** g (or 10g) value corresponding to the measurement frequency, the Standard Source and specific phantom. The acceptable tolerance must be determined for each *system check* and should be within ± 10% of previously recorded *system check* target values.

7.3 System Validation

7.3.1 Purpose

The *system validation* procedure tests the system against reference SAR values, and the performance of probe, readout electronics and software. The test system utilizes a flat phantom and a reference dipole. Thus, the *system validation* process does not include data scatter due to the use of anthropomorphicphantoms, or uncertainty due to handset positioning variability.

System validation is performed before each test, or when a new system is put into operation, or whenever modifications have been made to the system, such as a new software release, different readout electronics or different types of probes. *System validation* should be done after the probe calibration has taken place.

The objective of this clause is to provide a methodology for SAR measurement verification. Since ***S A R*** measurement equipment and calibration technique scan vary widely between various laboratories, a validation methodology is needed to verify the system accuracy against its specifications. Numerically calculated reference SAR values are listed in Table 7.1.

7.3.2 Phantom

The flat phantom described for the system performance check (see Figure 7.1) is also used for the *system validation* tests. The *system validation* must be performed using head tissue equivalent liquids having dielectric properties as defined in Table 4.1.

7.3.3 Reference Dipole Source

The phantom should be irradiated using a reference dipole specified in Annex F for the required frequency. The reference dipoles are defined for the specific phantom shell dielectric parameters and thickness indicated in Table 7.2. The reference dipole should be positioned below the bottom of the phantom and centered with its axis parallel to the longest side of the phantom. A low loss and low dielectric constant spacer can be used to establish the correct distance between the top surface of the reference dipole and the bottom surface of the phantom. The spacer should not change the measured **1** g and 10 g averaged SAR values more than 1 %. The distance between the liquid filled phantom bottom surface and the reference dipole center (designated *s*) is specified within 1.2 mm for each test frequency. The reference dipole should have a return loss better than –20 dB (measured in the test system) at the test frequency to reduce the uncertainty in the power measurement.

For the reference dipoles described in Annex F, the spacing distance *s* is given by:

a) s = 15mm + 0.2 mm for 300 MHz ≤ f ≤ 1000 MHz:

b) s = 10mm + 0.2 mm for 1000 MHz < f ≤ 3000 MHz

The reference dipole arms shall be parallel to the flat surface of the phantom within a tolerance of + 2 degrees or less (see Figure 7.1). This can be assured by carefully positioning the empty phantom and the reference dipole to horizontal level using a waterpas.

7.3.4 Reference Dipole Input Power Measurement

The input power measurement test system described for the system performance check (7.2.4) is also used for *system validation* tests.

7.3.5 System Validation Procedure

System validation is used for verifying the accuracy of the probe and readout electronics, and performance of the software. Device positioning and head phantom shape errors are not considered. The *system validation* procedure consists of six steps. Step (a) is the most important part of the *system validation* procedure and shall be done every time. Steps (b)-(f) (recommended) offer a means for quick and simple validation of probe, readout electronics, and software performance. These additional tests should be done any time system components have been modified (e.g., new software release, new readout electronics, new probe type, etc.). The *system validation* procedure is as follows:

a) **SAR evaluation:** A complete 1 g or 10 g averaged SAR measurement is performed. The reference dipole input power is adjusted to produce a 1 g averaged SAR value falling in the range of 0.4 W/kg to 8 W/kg. The 1 g or 10 g averaged SAR is measured at frequencies in Table 7.1 within the range to be used in compliance tests. The results are normalized to 1 W forward input power and compared with the reference SAR value for the reference dipole and flat phantom shown in columns 2 and 3 Table 7.1. The difference from the reference value given in Table 7.1 should be less than the standard uncertainty determined in Clause 6 (Table 6.2).

b) **Extrapolation routine:** Local SAR values are measured along a vertical axis directly above the Reference Dipole feed point using the same point spacing as used for the evaluation of the peak spatial average SAR. This measurement is repeated along another vertical axis with a 2 cm horizontal offset (y direction – see Fig. 7.1) along the dipole from the reference dipole feed point. SAR values at the phantom surface are extrapolated and compared with the numerical values given in columns 4 and 5 Table 7.1. The difference from the reference values given in Table 7.1 should be less than the difference from the reference values given in Table 7.1 should be less than the extrapolation standard uncertainty item in Table 6.2.

c) **Probe linearity:** The measurements in step (a) are repeated using different reference dipole input power levels. The power levels are selected for each frequency are selected to produce 1 g averaged SAR values of approximately 8 W/kg, and 0.4 W/kg. The measured SAR values are normalized to 1 W forward input power and compared with the 1 W normalized values from step (a). The difference between these values should be less than the probe linearity standard uncertainty item in Table 6.2.

d) **Modulation response:** The measurements in step (a) are repeated with pulse-modulated signals having a duty factor of 0.1 and pulse repetition rate of 10 Hz. The power is adjusted to produce a 1 g-averaged SAR of approximately 8 W/kg with a CW signal. The measured SAR values are normalized to 1 W forward input power and duty factor of 1, and compared with the 1 W normalized values from step (a). The difference between these values should be less than the linearity standard uncertainty item in Table 6.2.

e) **System offset:** The measurements I (a) are repeated with a reference dipole input forward power that produces a 1 g averaged SAR of approximately 0.05 W/kg. The measured SAR values are normalized to 1 W forward input power and compared with the 1 W normalized values from step (a). The difference between these values should be less than the probe linearity standard uncertainty item in Table 6.2.

f) **Probe axial isotropy:** The probe is placed directly above the reference dipole center at a measurement distance of approximately 5 mm from the phantom inner surface. The probe (or reference dipole) is rotated around its axis at least 180^0 in steps no larger than 15^0. The maximum and minimum SAR readings are recorded. The difference between these values should be less than the probe axial isotropy standard uncertainty item in Table 6.2.

NOTE: The *system validation* is neither an alternative procedure to the probe calibration nor to the uncertainty assessment of Clause 6. The probe and the readout electronics shall be calibrated regularly according to the procedures given in clause 3 and Annex A. Probe hemispherical isotropy is not considered in the test system for *system validation*.

7.3.6 Reference SAR Values

In the *system validation* test, the reference dipole constructed for the frequency f_i (described in Annex F) should produce the numerical reference peak spatial-average SAR values shown in columns 2 and 3 of Table 7.1, within the uncertainty of the system. Columns 4 and 5 Table 7.1 are used to validate the system extrapolation routines, as described in 7.3.5. The reference SAR values have been calculated using the finite-difference time-domain method [Yee, 1966]. The values in columns 4 and 5 for frequencies between 835 and 3000 MHz have been experimentally verified by using 4th–order polynomial extrapolation [to be determined]. The values for frequencies between 300 and 450 MHz will be experimentally verified in the next revision of the standard. The parameters for the lossless phantom shell used in the simulations (dimensions, shell thickness and permittivity), and the distance *s* between the reference dipole and liquid are giving in Table 7.2. The dielectric properties used for the liquid are defined in Table 4.1 and the dimensions of the reference dipoles are shown in Table F1.

Table 7.1 – Numerical reference SAR values for reference dipole and flat Phantom. All values are normalized to a forward power of 1 W.

Frequency (MHz)	1 g SAR	10 g SAR	Local SAR at surface (above feedpoint)	Local SAR at surface (y=2cm offset from feedpoint)
300	3.0	2.0	4.4	2.1
450	4.9	3.3	7.2	3.2
835	9.5	6.2	14.1	4.9
900	10.8	6.9	16.4	5.4
1450	29.0	16.0	50.2	6.5
1800	38.1	19.8	69.5	6.8
1900	39.7	20.5	72.1	6.6
2000	41.1	21.1	74.6	6.5
2450	52.4	24.0	104.2	7.7
3000	63.8	25.7	140.2	9.5

Table 7.2 – Parameters used for calculation of reference SAR values in Table 7.1

Frequency (MHz)	Phantom Shell Thisckness (mm)	Phantom Shell Permittivity	Phantom Dimensions (mm) x, y, z	Reference dipole distance *s* (mm) from the liquid
300	6.3	3.7	1000, 8000, 170	15
450	6.3	3.7	700, 600, 170	15
835	2.0	3.7	360 ,300, 150	15
900	2.0	3.7	360, 300, 150	15
1450	2.0	3.7	240, 200, 150	10
1800	2.0	3.7	220, 160, 150	10

SAR Data Report 02031507

```
  Start        : 15-Mar-02 12:01:50 pm
  End          : 15-Mar-02 12:13:28 pm
  Code Version : 4.08
  Robot Version: 4.08

Product Data:
  Type            : Validation
  Frequency       : 835 MHz
  Transmit Pwr    : 0.250 W
  Antenna Type    : Dipole

Measurement Data:
  Phantom Name        : SAM-FLAT
  Phantom Type        : Uniphantom
  Tissue Type         : Brain
  Tissue Dielectric   : 43.440
  Tissue Conductivity : 0.870
  Tissue Density      : 1.000
  Robot Name          : CRS

Probe Data:
  Probe Name              : PCT002
  Probe Type              : E Fld Triangle
  Frequency               : 835 MHz
  Tissue Type             : Brain
  Calibrated Dielectric   : 40.700
  Calibrated Conductivity :  0.890
  Calibrated Density      :  1.000
  Probe Offset            :  2.400 mm
  Conversion Factor       :  5.800
  Probe Sensitivity :  3.597   3.474   3.049   mV/(mW/cm^2)
  Amplifier Gains   :  20.00   20.00   20.00

Sample:
  Rate:         6000 Samples/Sec
  Count:        100 Samples
  NIDAQ Gain:   5

Comments:
  835 MHz Validation

  CF=1; Amb. Temp= 22.3 'C; Liq. Temp=21.8 'C
```

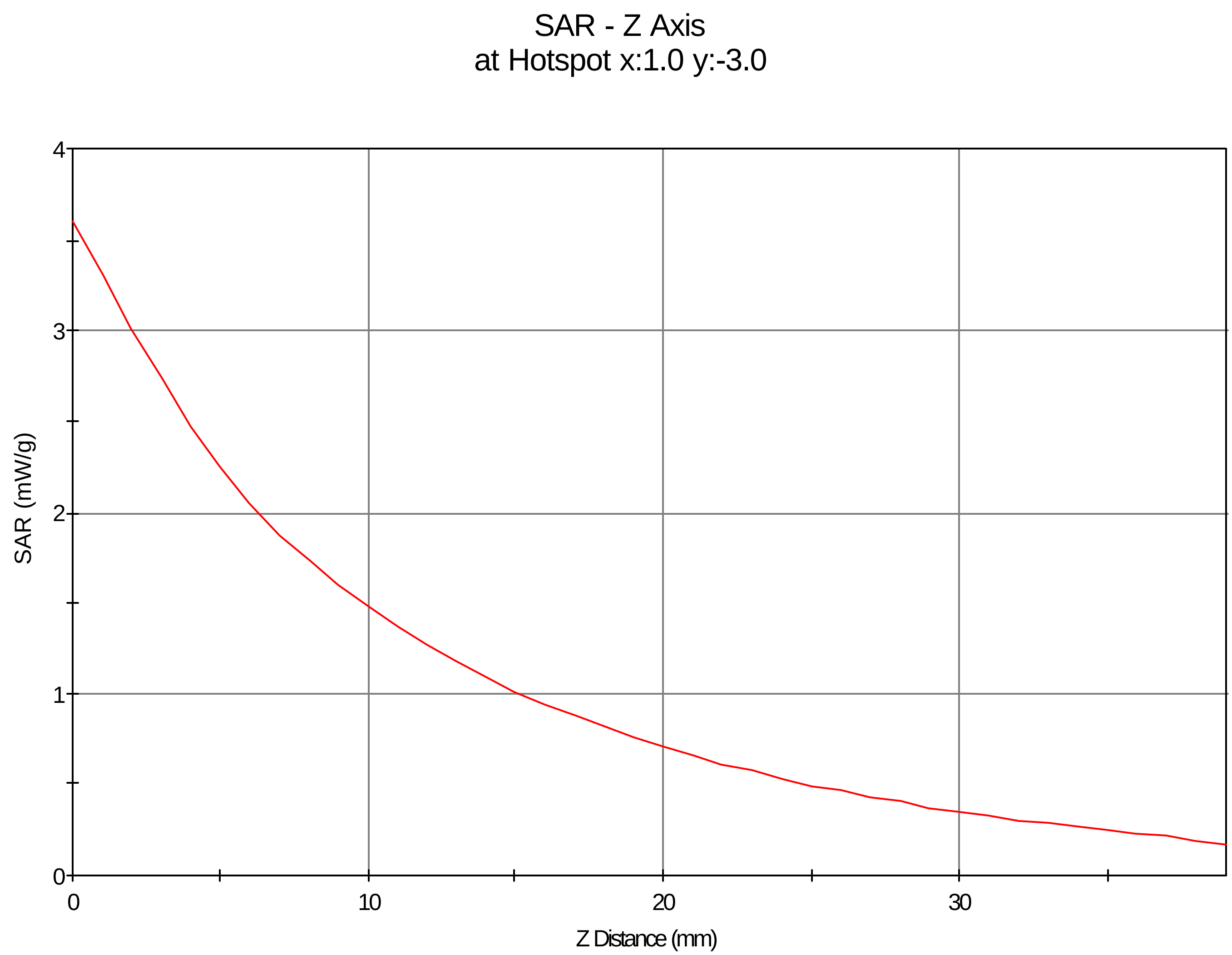
Area Scan - Max Peak SAR Value at x=1.0 y=-2.0 = 2.26 W/kg

Zoom Scan - Max Peak SAR Value at x=1.0 y=-3.0 z=0.0 = 3.60 W/kg

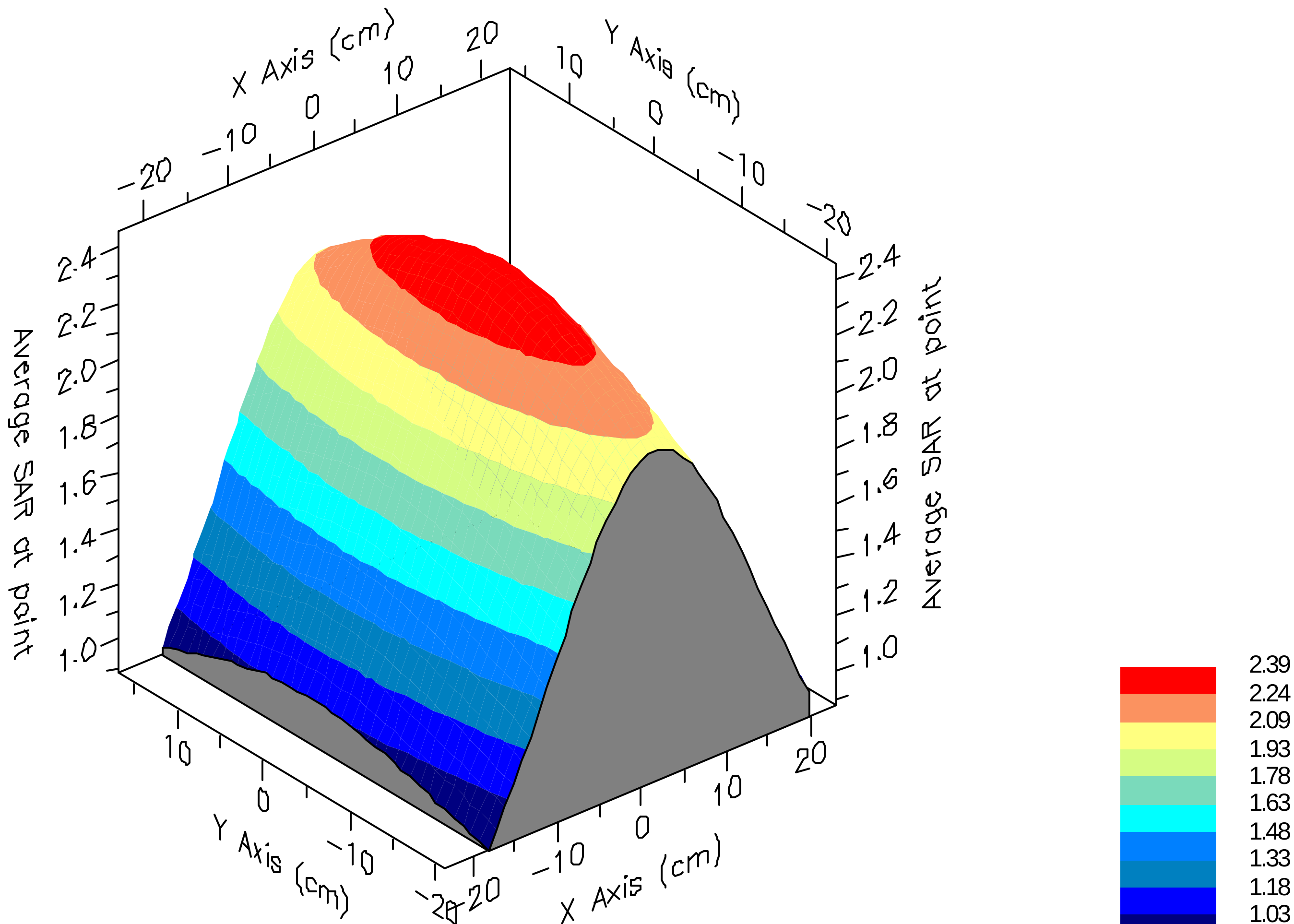
Max 1g SAR at x=1.0 y=-2.0 z=0.0 = 2.39 W/kg

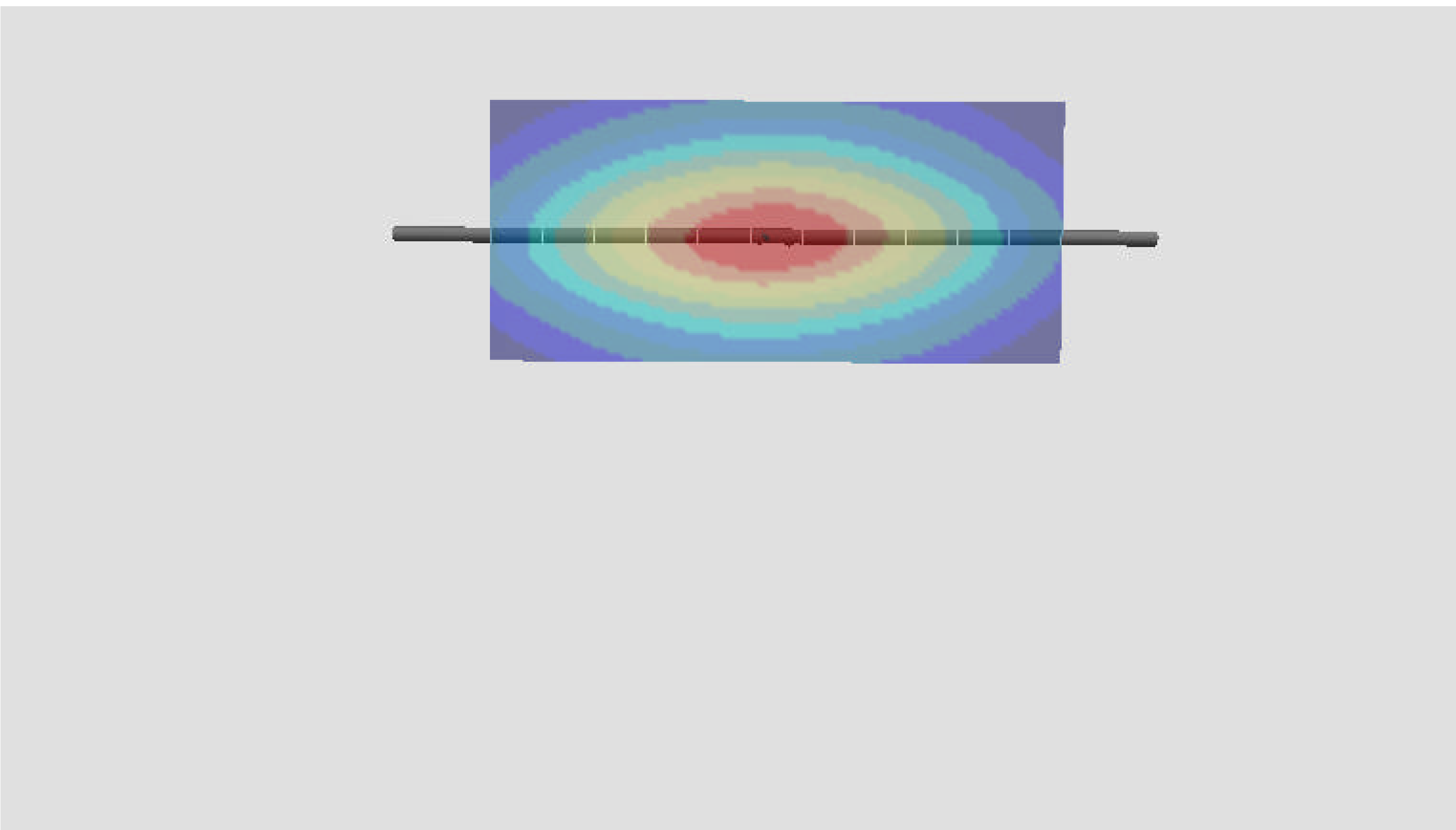
Max 10g SAR at x=1.0 y=-1.0 z=0.0 = 1.49 W/kg

```
Validation Results at 0.25 W:
Peak Nominal = 3.5, Error:  2.97 %
1g Nominal   = 2.4, Error:  0.53 %
10g Nominal  = 1.6, Error:  -3.78 %
```


SAR - Z Axis
at Hotspot x:1.0 y:-3.0
SAR (mW/g)
Z Distance (mm)
0
1
2
3
4
0
10
20
30

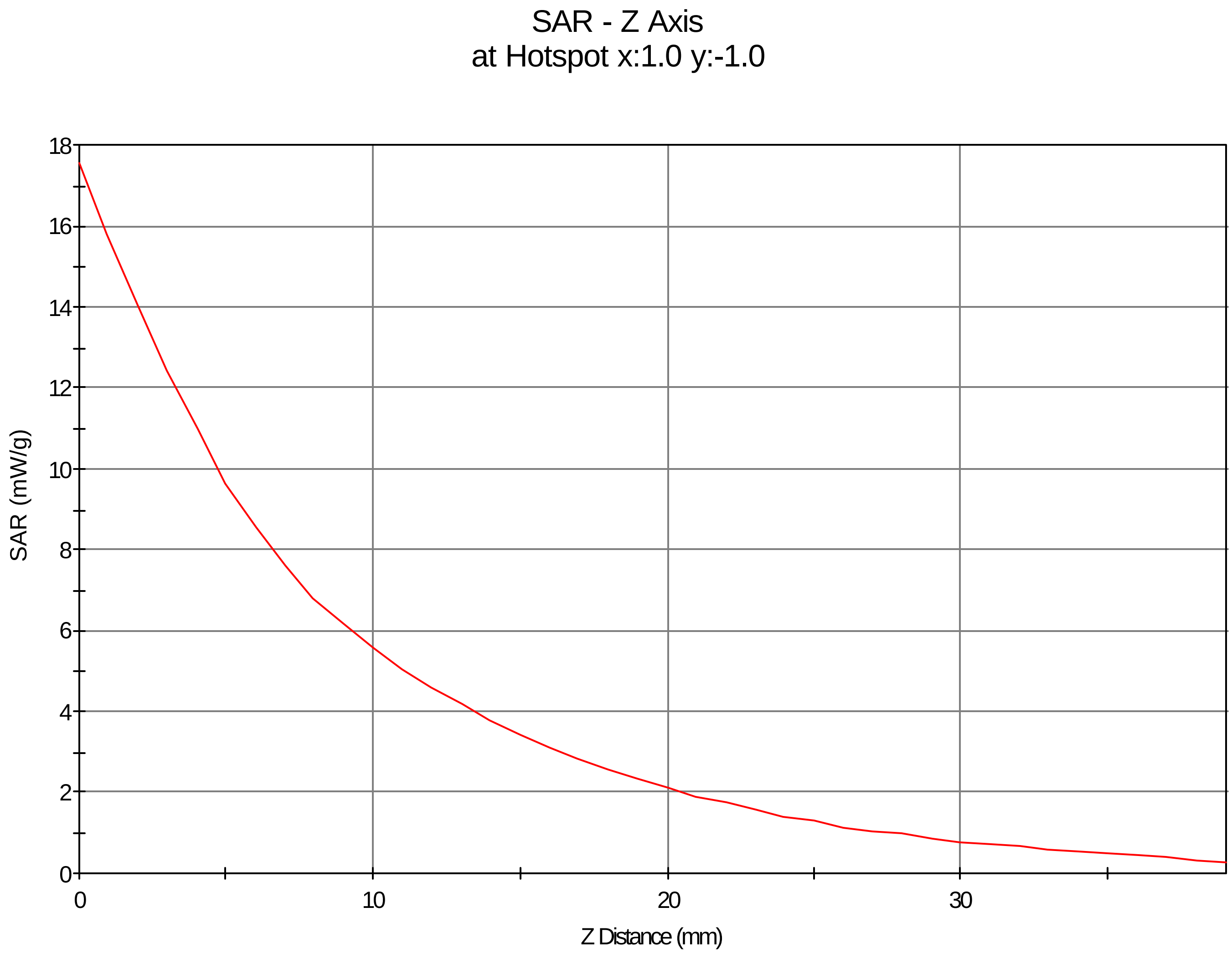
1g SAR Values





SAR Data Report 02031514

```
  Start        : 15-Mar-02 04:16:07 pm
  End          : 15-Mar-02 04:27:46 pm
  Code Version : 4.08
  Robot Version: 4.08

Product Data:
  Type             : Validation
  Frequency        : 1900 MHz
  Transmit Pwr     : 0.250 W
  Antenna Type     : Dipole

Measurement Data:
  Phantom Name        : SAM-FLAT
  Phantom Type        : Uniphantom
  Tissue Type         : Brain
  Tissue Dielectric   : 40.290
  Tissue Conductivity : 1.440
  Tissue Density      : 1.000
  Robot Name          : CRS

Probe Data:
  Probe Name              : PCT002
  Probe Type              : E Fld Triangle
  Frequency               : 1900 MHz
  Tissue Type             : Brain
  Calibrated Dielectric   : 40.200
  Calibrated Conductivity :  1.410
  Calibrated Density      :  1.000
  Probe Offset            :  2.400 mm
  Conversion Factor       :  4.700
  Probe Sensitivity :  3.000   2.995   2.653   mV/(mW/cm^2)
  Amplifier Gains   :  20.00   20.00   20.00

Sample:
  Rate:         6000 Samples/Sec
  Count:        100 Samples
  NIDAQ Gain:   5

Comments:
  1900 MHz Validation

  CF=1; Amb. Temp= 22.5 'C; Liq. Temp=21.4 'C



Area Scan - Max Peak SAR Value at x=1.0 y=-1.0 = 9.61 W/kg

Zoom Scan - Max Peak SAR Value at x=1.0 y=-1.0 z=0.0 = 17.55 W/kg

Max 1g SAR at x=1.0 y=0.0 z=0.0 = 10.31 W/kg

Max 10g SAR at x=1.0 y=0.0 z=0.0 = 5.39 W/kg

Validation Results at 0.25 W:
Peak Nominal = 18.0, Error:  -2.63 %
1g Nominal   = 9.9, Error:  3.90 %
10g Nominal  = 5.1, Error:  5.11 %
```



SAR - Z Axis
at Hotspot x:1.0 y:-1.0
18
16
14
12
10
8
6
4
2
0
SAR (mW/g)
0
10
20
30
Z Distance (mm)

1g SAR Values