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CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

APPLICANT NAME & ADDRESS:
Matsushita Electric Industrial Co., Ltd.
1006 Oaza Kadoma, Kadoma,
Osaka, 571 JAPAN
Attn: Rich Mullen (PSCD, MECA)
Yutaka Miyake (ITPD)

DATE & LOCATION OF TESTING:
Dates of Tests: July 17-18, 2003
Test Report S/N: SAR.230714339.ACJ
Test Site: PCTEST Lab, Columbia, MD USA
Project No: ITPD-03-F016A

FCC ID:	**ACJ9TGCF-291**
APPLICANT:	**MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**

EUT Type:	Panasonic TOUGHBOOK CF-29 w/ Intel WLAN Model: WM3B2100
Tx Frequency:	2412 – 2462 MHz (DTS)
Rx Frequency:	2412 – 2462 MHz (DTS)
Max. RF Output Power:	45 mW (16.5 dBm) Conducted; 0.052 W (17.2 dBm) EIRP
Max. SAR Measurement:	0.01W/kg DTS Body SAR (Lap Position)
	0.29 W/kg DTS Body SAR (Edge Position)
Trade Name/Model(s):	*PANASONIC CF-29*
FCC Classification:	FCC Part 15 Digital Transmission System (DTS)
FCC Rule Part(s):	§2.1093; FCC/OET Bulletin 65 Supplement C [July 2001]
Application Type:	Certification
Test Device Serial No.:	Identical Prototype [S/N: 28]

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 6.5, January 15, 2002).

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.

Grant Conditions: Output listed is conducted. This device is authorized to operate with the specific computer as described in this filing. The port replicator antenna must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-users must be provided with antenna installation and transmitter operating conditions for satisfying RF exposure compliance.

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

TABLE OF CONTENTS

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).

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

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]

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

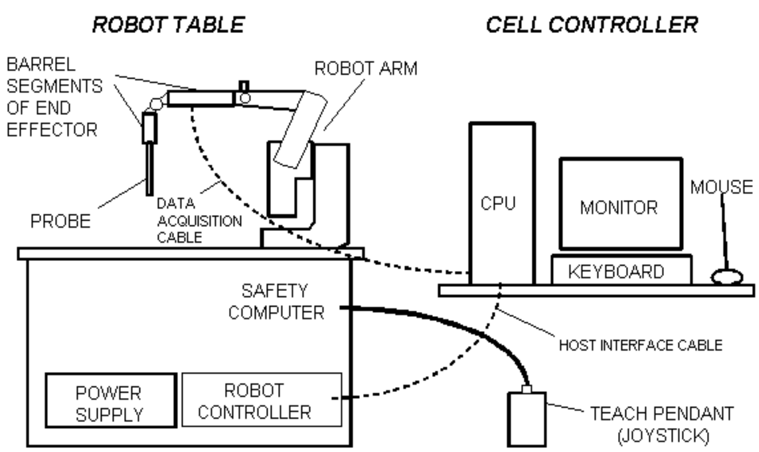


Figure 2.1
SAR Measurement System Setup

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 – 6.0 GHz
Calibration:	In air from 10 MHz to 6.0 GHz
	In brain and muscle simulating tissue at Frequencies from 835 up to 5800MHz
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

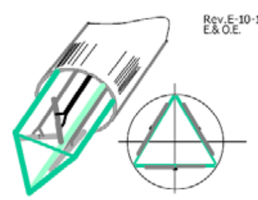


Figure 3.2
Triangular Probe Configuration

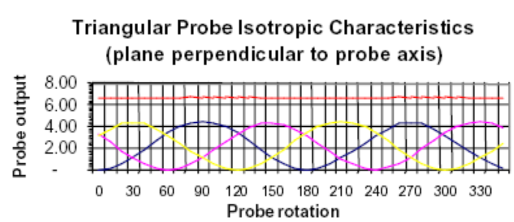


Figure 3.3
Probe Characteristics

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.

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

where:

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

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

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

where:

σ = simulated tissue conductivity,

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

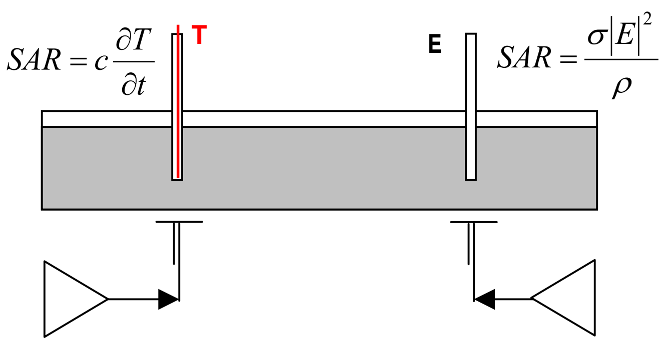


Figure 4.1 Temperature Assessment Test Configuration

5. PHANTOM & EQUIVALENT TISSUES

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 [7][8]. 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

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 bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been incorporated in 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 [9].(see Table 5.1)

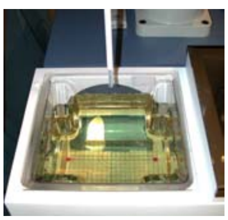


Figure 5.3
Body/Muscle Simulated Tissue

	Frequency (MHz)									
(% by weight)	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	58.55	73.2
Salt (NAC1)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.11	0.4
Sugar	56.32	46.78	56.0	45.0	56.0	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
Bacteride	0.19	0.05	0.1	0.1	0.27	0.0	0.1	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.38	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	6.96	26.7

Table 5.1
Composition of the Brain & Muscle Tissue Equivalent Matter

Figure 5.4
Device Positioner

Device Holder

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

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: PCT003
	Construction:	Triangular core absolute encoder system
	Frequency:	10 MHz to 6.0 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)

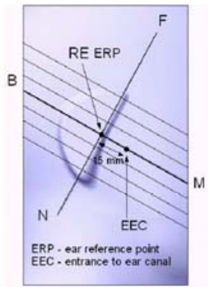


Figure 8.2 Close-up side view of ERPs

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 8.1 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.

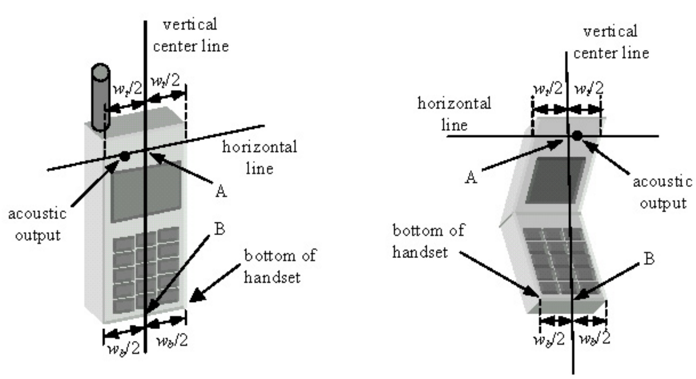


Figure 8.3 Handset Vertical Center & Horizontal Line Reference Points

9. TEST CONFIGURATION POSITION

Body Holster /Belt Clip Configurations

Body-held or Body-worn devices are tested with the EUT positioned against a flat phantom in a normal use configuration (see figure 9.1). SAR test for body-held devices are configured for lap-held, bystander, and/ or any other typical configurations. Other body-held or body-worn configurations are investigated and tested and the worst-case configurations are reported.

Figure 9.1 Body Held 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. A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.

Accessories for Body-held or 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.

Body-held or 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-held or body-worn operating requirements for meeting RF exposure compliance, operating instructions and cautions statements must be included in the user's manual.

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.

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	11.4	R	1.73	1	1	6.6	6.6	¸
Axial Isotropy	E1.2	3.4	R	1.73	0.7	0.7	1.4	1.4	¸
Hemishperical Isotropy	E1.2	5.2	R	1.73	1	1	3.0	3.0	¸
Boundary Effect	E1.3	4.7	R	1.73	1	1	2.7	2.7	¸
Linearity	E1.4	5.9	R	1.73	1	1	3.4	3.4	¸
System Detection Limits	E1.5	1.0	R	1.73	1	1	0.6	0.6	¸
Readout Electronics	E1.6	1.0	N	1	1	1	1.0	1.0	¸
Response Time	E1.7	0.8	R	1.73	1	1	0.5	0.5	¸
Integration Time	E1.8	1.7	R	1.73	1	1	1.0	1.0	¸
RF Ambient Conditions	E5.1	1.2	R	1.73	1	1	0.7	0.7	¸
Probe Positioner Mechanical Tolerance	E5.2	0.4	R	1.73	1	1	0.2	0.2	¸
Probe Positioning w/ respect to Phantom Shell	E5.3	2.9	R	1.73	1	1	1.7	1.7	¸
Extrapolation, Interpolation & Integration Algorithms for Max. SAR Evaluation	E4.2	3.9	R	1.73	1	1	2.3	2.3	¸
Test Sample Related									
Test Sample Positioning	E3.2.1	10.6	R	1.73	1	1	6.1	6.1	11
Device Holder Uncertainty	E3.1.1	8.7	R	1.73	1	1	5.0	5.0	8
Output Power Variation - SAR drift measurement	5.6.2	5.0	R	1.73	1	1	2.9	2.9	¸
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E2.1	4.0	R	1.73	1	1	2.3	2.3	¸
Liquid Conductivity - deviation from target values	E2.2	5.0	R	1.73	0.7	0.5	2.0	1.4	¸
Liquid Conductivity - measurement uncertainty	E2.2	5.0	R	1.73	0.7	0.5	2.0	1.4	¸
Liquid Permittivity - deviation from target values	E2.2	5.0	R	1.73	0.6	0.5	1.7	1.4	¸
Liquid Permittivity - measurement uncertainty	E2.2	5.0	R	1.73	0.6	0.5	1.7	1.4	¸
Combined Standard Uncertainty (k=1)			RSS				0.0	13.0	
Expanded Uncertainty (k=2) (95% CONFIDENCE LEVEL)							0.0	26.2	

The above measurement uncertainties are according to IEEE Std. 1528-200X (January, 2002)

12. SYSTEM VERIFICATION

Tissue Verification

Table 12.1 Simulated Tissue Verification

MEASURED TISSUE PARAMETERS					
Date(s)	07-18-03	2450MHz Brain		2450MHz Muscle	
Liquid Temperature (°C)	23.1	Target	Measured	Target	Measured
Dielectric Constant: ε		39.20	40.03	52.70	52.50
Conductivity: σ		1.800	1.88	1.950	1.94

Test System Verification

Prior to assessment, the system is verified to the ±10% of the specifications at 2450 MHz by using the system validation kits. (Graphic Plots Attached)

Table 12.2 System Verification

System Validation TARGET & MEASURED							
Date:	Amb. Temp (°C)	Liquid Temp(°C)	Input Power (W)	Tissue	Targeted SAR_{1g} (mW/g)	Measured SAR_{1g} (mW/g)	Deviation (%)
7/18/03	22.3	21.1	0.100	2450MHz Brain	5.24	5.34	1.82 %

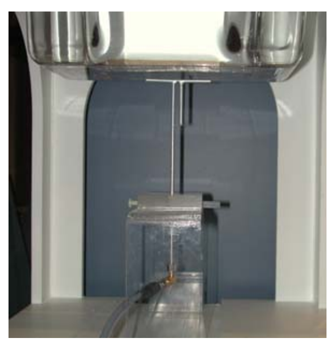


Figure 12.1 Dipole Validation Test Setup

13. SAR TEST DATA SUMMARY

See Measurement Result Data Pages

Procedures Used To Establish Test Signal

The EUT was placed into continuous transmit mode using the manufacturer's software. Such test signals offer a consistent means for testing SAR and are recommended for evaluating SAR [4].

Device Test Conditions

The EUT is powered through the internal 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 maximum output power. If a power deviation of more than 5% occurred, the test was repeated.

14. SAR DATA SUMMARY

Mixture Type: 2450MHz Muscle

14.1 MEASUREMENT RESULTS (DTS Body SAR – Lap Position)

FREQUENCY		Modulation	Begin / End POWER‡		Test Position	Data Rate (MBps)	Separation Distance (cm)	SAR (W/kg)
MHz	Ch.		dBm					
2412	01	DTS	17.11	17.06	Lap	11	TOUCH	**0.01**
2437	06	DTS	17.20	17.18	Lap	11	TOUCH	**0.01**
2462	11	DTS	16.97	16.98	Lap	11	TOUCH	**0.01**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population					**Muscle 1.6 W/kg (mW/g)** averaged over 1 gram			

NOTES:

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

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

7. Tissue parameters and temperatures are listed on the SAR plots.
8. Liquid tissue depth is 15 cm. ± 0.1

Alfred Cirwithian
Vice President Engineering

Figure 14.1 Body SAR Lap Position Test Setup

14. SAR DATA SUMMARY

Mixture Type: **2450MHz Muscle**

14.2 MEASUREMENT RESULTS (DTS Body SAR – Edge Position)

FREQUENCY		Modulation	Begin / End POWER‡		Test Position	Data Rate (MBps)	Separation Distance (cm)	SAR (W/kg)
MHz	Ch.		dBm					
2412	01	DTS	16.90	16.77	Edge	11	Touch	**0.26**
2437	06	DTS	16.87	16.75	Edge	11	Touch	**0.22**
2462	11	DTS	17.11	17.10	Edge	11	Touch	**0.29**
2462	11	DTS	17.08	17.10	Edge	5.5	Touch	**0.28**
2462	11	DTS	17.08	17.06	Edge	2	Touch	**0.27**
2462	11	DTS	17.09	17.07	Edge	1	Touch	**0.27**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Muscle 1.6 W/kg (mW/g)** averaged over 1 gram		

NOTES:

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

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

7. Tissue parameters and temperatures are listed on the SAR plots.
8. Liquid tissue depth is 15 cm. ± 0.1

Alfred Cirwithian
Vice President Engineering

Figure 14.2
Body SAR
Edge Position Test Setup

15. SAR TEST EQUIPMENT

Equipment Calibration

Table 15.1 Test Equipment Calibration

EQUIPMENT SPECIFICATIONS			
Type		**Calibration Date**	**Serial Number**
CRS Robot F3		February 2003	RAF0134133
CRS C500C Motion Controller		February 2003	RCB0003303
CRS Teach Pendant (Joystick)		February 2003	STP0132231
DELL Computer, Pentium 4 1.6 GHz, Windows 2000™		February 2003	4PJZ111
E-Field Probe E-010		January 2003	PCT003
Right Ear SAM Phantom (P-SAM-R)		February 2003	94X-113
Left Ear SAM Phantom (P-SAM-L)		February 2003	94X-019
Flat SAM Phantom (P-SAM-FLAT)		February 2003	94X-097
IDX Robot End Effector (EE-103-C)		February 2003	07111223
IDX Probe Amplifier		February 2003	07111113
Validation Dipole D-835S		February 2003	PCT640
Validation Dipole D-1900S		February 2003	PCT641
Brain Equivalent Matter (835MHz)		July 2003	PCTBEM101
Brain Equivalent Matter (1900MHz)		July 2003	PCTBEM301
Brain Equivalent Matter (2450MHz)		July 2003	PCTBEM501
Muscle Equivalent Matter (835MHz)		July 2003	PCTMEM201
Muscle Equivalent Matter (1900MHz)		July 2003	PCTMEM401
Muscle Equivalent Matter (2450MHz)		July 2003	PCTMEM601
Microwave Amp. Model: 5S1G4, (800MHz - 4.2GHz)		January 2003	22332
Gigatronics 8651A Power Meter		January 2003	1835299
HP-8648D (9kHz ~ 4GHz) Signal Generator		January 2003	PCT530
Amplifier Research 5S1G4 Power Amp		January 2003	PCT540
HP-8753E (30kHz ~ 3GHz) Network Analyzer		January 2003	PCT552
HP85070B Dielectric Probe Kit		January 2003	PCT501
Ambient Noise/Reflection, etc.	January 2003	January 2003	Anechoic Room PCT01

NOTE:
Dipole Validation measurement was 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

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

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

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

[4] Federal Communications Commission, OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01), *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, July 2001.

[5] IEEE Standards Coordinating Committee 34 – IEEE Std. 1528-200X (Draft 6.5 – January 2002), *Draft Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.*

[6] NCRP, National Council on Radiation Protection and Measurements, *Biological Effects and Exposure Criteria for RadioFrequency Electromagnetic Fields*, NCRP Report No. 86, 1986. Reprinted Feb. 1995.

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

[8] N. Kuster and Q. Balzano, *Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz*, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

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

[10] Q. Balzano, O. Garay, T. Manning Jr., *Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones*, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.

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

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

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

APPENDIX A: SAR TEST DATA

SAR Data Report 03071808

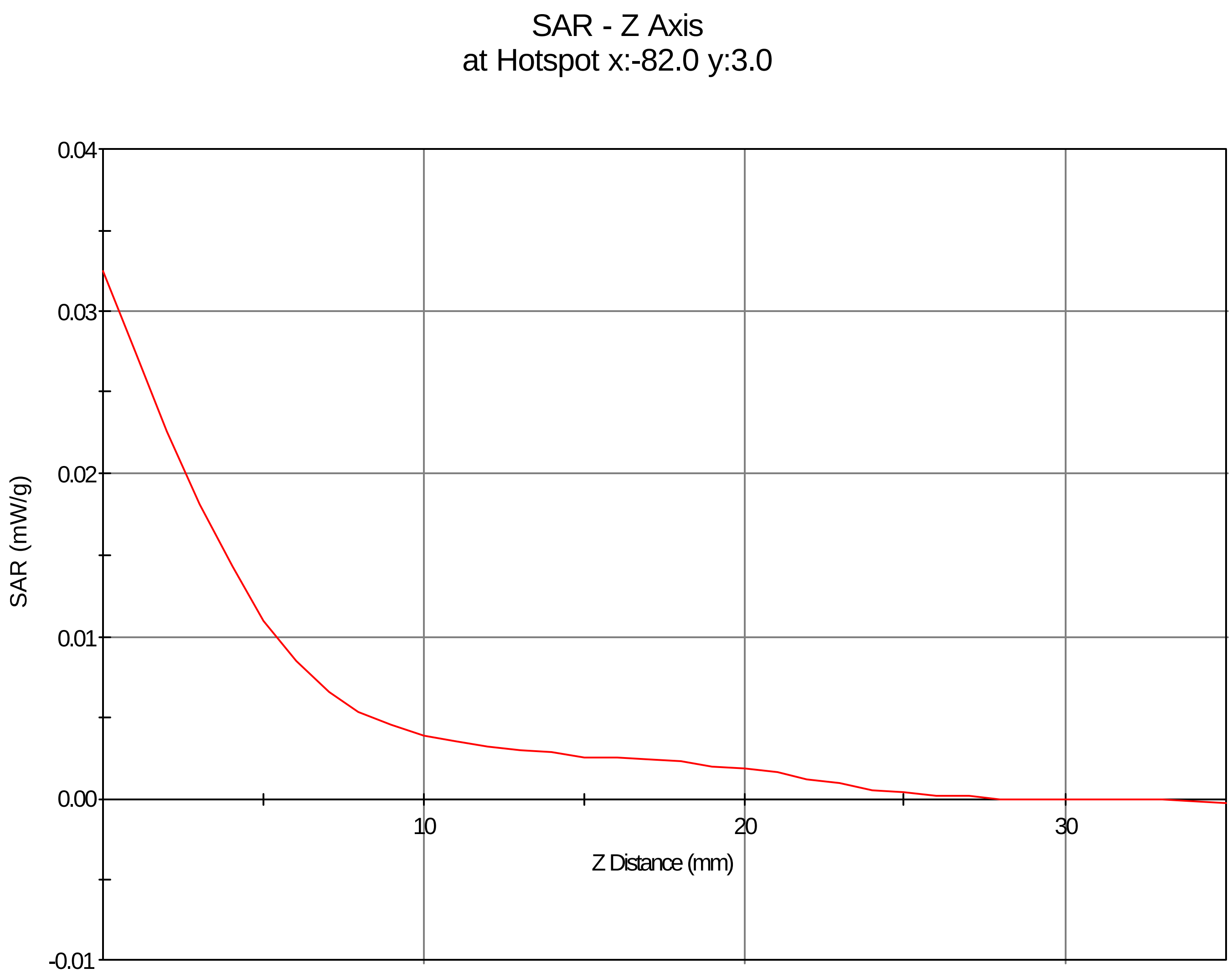
```
  Start        : 18-Jul-03 02:35:38 pm
  End          : 18-Jul-03 02:42:37 pm
  Code Version : 4.08
  Robot Version: 4.08

Product Data:
  Type             : PANASONIC
  Model Number     : CF-29
  Serial Number    : 28
  Frequency        : 2437 MHz
  Transmit Pwr     : 0.045 W
  Antenna Type     : Helical
  Antenna Posn.    : Fixed

Measurement Data:
  Phantom Name        : SAM-FLAT-B
  Phantom Type        : Uniphantom
  Tissue Type         : Muscle
  Tissue Dielectric   : 52.800
  Tissue Conductivity : 1.960
  Tissue Density      : 1.000
  Robot Name          : CRS

Probe Data:
  Probe Name               : PCT003
  Probe Type               : E Fld Triangle
  Frequency                : 2450 MHz
  Tissue Type              : Muscle
  Calibrated Dielectric    : 52.300
  Calibrated Conductivity  :  1.990
  Calibrated Density       :  1.000
  Probe Offset             :  2.400 mm
  Conversion Factor        :  9.900
  Probe Sensitivity :  2.075   2.820   2.456   mV/(mW/cm^2)
  Amplifier Gains   :  20.00   20.00   20.00

Sample:
  Rate:         6000 Samples/Sec
  Count:        1000 Samples
  NIDAQ Gain:   5

Comments:
  DSS Mode CH-6
  Body
  CF=1; Amb. Temp= 22.5 'C; Liq. Temp=21.1 'C
```

Area Scan - Max Peak SAR Value at x=-66.0 y=3.0 = 0.01 W/kg

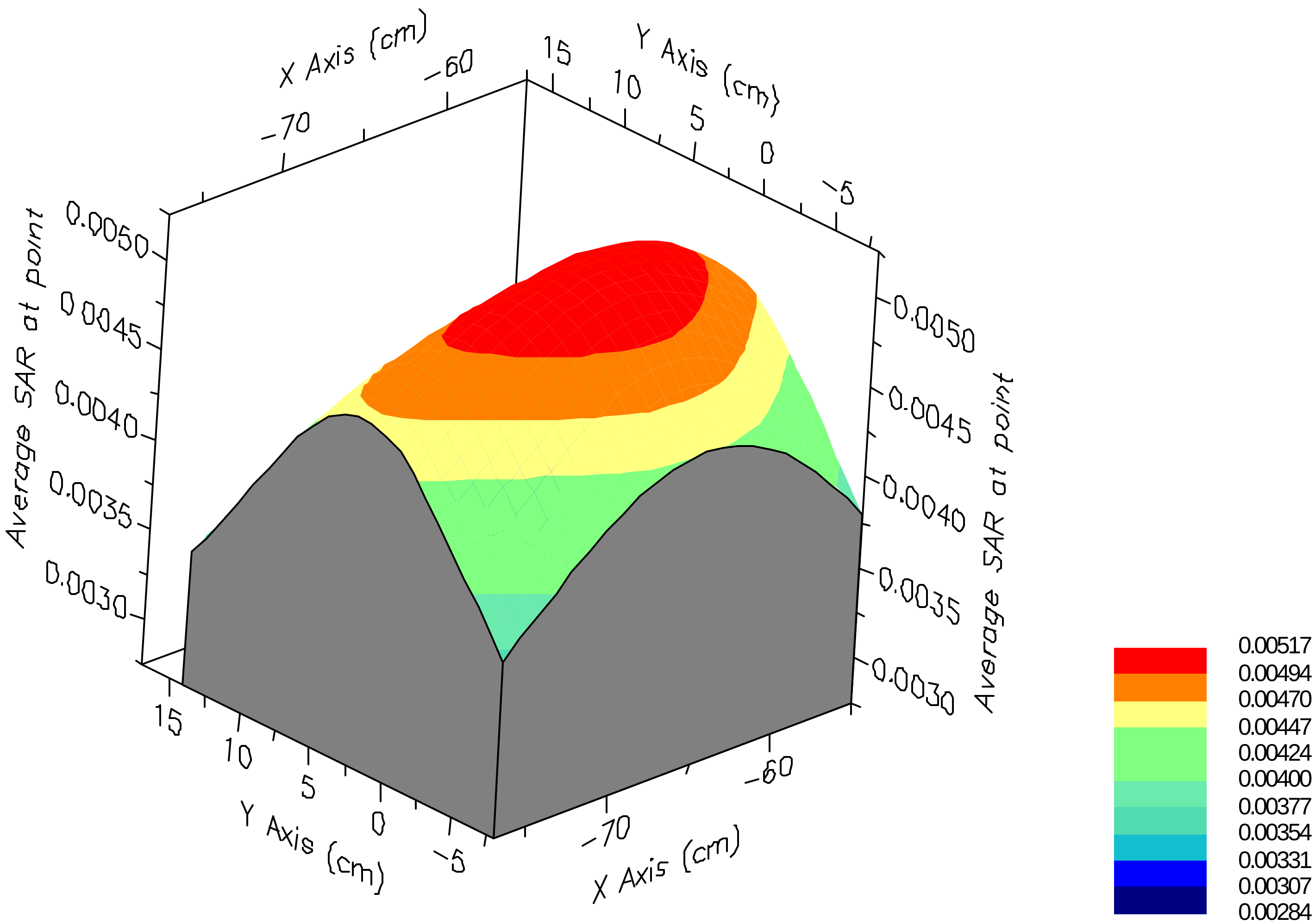
Zoom Scan - Max Peak SAR Value at x=-82.0 y=3.0 z=0.0 = 0.03 W/kg

Max 1g SAR at x=-77.0 y=4.0 z=0.0 = 0.01 W/kg

Max 10g SAR at x=-71.0 y=2.0 z=0.0 = 0.01 W/kg


SAR - Z Axis
at Hotspot x:-82.0 y:3.0
SAR (mW/g)
0.04
0.03
0.02
0.01
0.00
-0.01
10
20
30
Z Distance (mm)

1g SAR Values




Panasonic
◄MP RELEASE

SAR Data Report 03071803

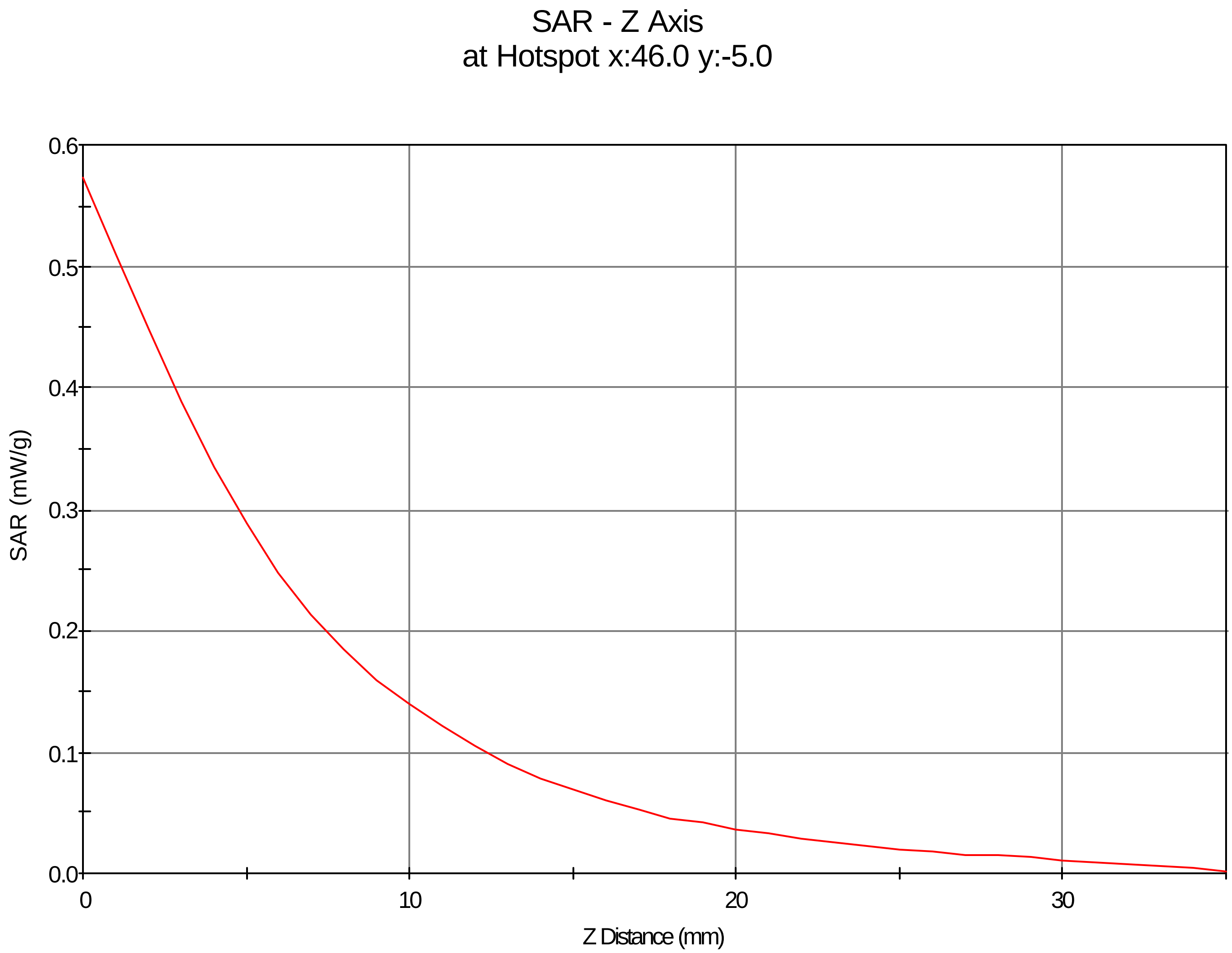
```
  Start        : 18-Jul-03 01:46:47 pm
  End          : 18-Jul-03 01:52:50 pm
  Code Version : 4.08
  Robot Version: 4.08

Product Data:
  Type             : PANASONIC
  Model Number     : CF-29
  Serial Number    : 28
  Frequency        : 2462 MHz
  Transmit Pwr     : 0.045 W
  Antenna Type     : Helical
  Antenna Posn.    : Fixed

Measurement Data:
  Phantom Name        : SAM-FLAT-B
  Phantom Type        : Uniphantom
  Tissue Type         : Muscle
  Tissue Dielectric   : 52.800
  Tissue Conductivity : 1.960
  Tissue Density      : 1.000
  Robot Name          : CRS

Probe Data:
  Probe Name               : PCT003
  Probe Type               : E Fld Triangle
  Frequency                : 2450 MHz
  Tissue Type              : Muscle
  Calibrated Dielectric    : 52.300
  Calibrated Conductivity  :  1.990
  Calibrated Density       :  1.000
  Probe Offset             :  2.400 mm
  Conversion Factor        :  9.900
  Probe Sensitivity :  2.075   2.820   2.456   mV/(mW/cm^2)
  Amplifier Gains   :  20.00   20.00   20.00

Sample:
  Rate:         6000 Samples/Sec
  Count:        1000 Samples
  NIDAQ Gain:   5

Comments:
  DSS Mode CH-11
  Body
  CF=1; Amb. Temp= 22.5 'C; Liq. Temp=21.1 'C
```

Area Scan - Max Peak SAR Value at x=41.0 y=-5.0 = 0.31 W/kg

Zoom Scan - Max Peak SAR Value at x=46.0 y=-5.0 z=0.0 = 0.57 W/kg

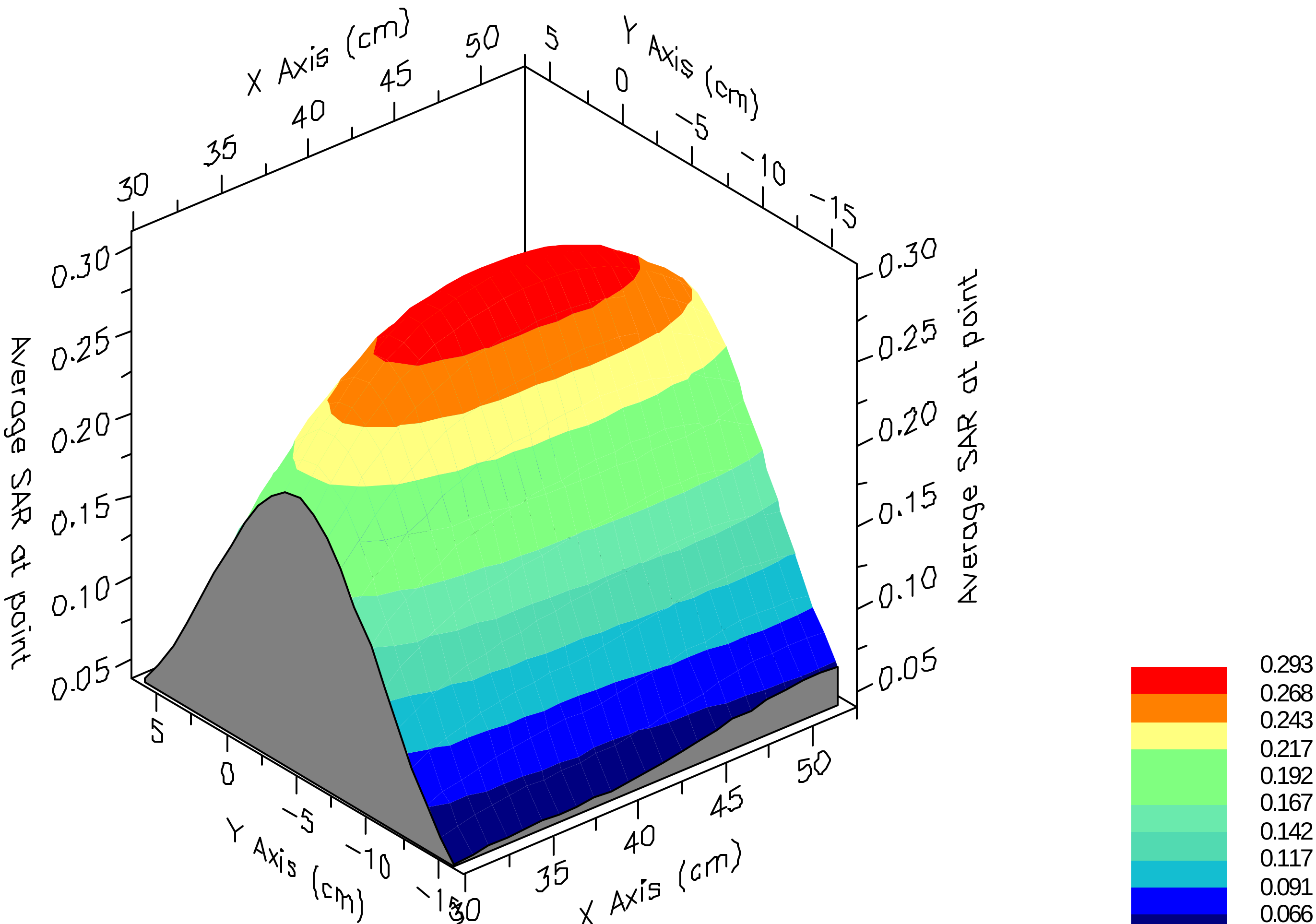
Max 1g SAR at x=42.0 y=-5.0 z=0.0 = 0.29 W/kg

Max 10g SAR at x=42.0 y=-5.0 z=0.0 = 0.11 W/kg



SAR - Z Axis
at Hotspot x:46.0 y:-5.0
0.6
0.5
0.4
0.3
0.2
0.1
0.0
SAR (mW/g)
0
10
20
30
Z Distance (mm)

1g SAR Values



APPENDIX B: DIPOLE VALIDATION

SAR Data Report 03071804

```
  Start        : 18-Jul-03 9:32:33 am
  End          : 18-Jul-03 9:36:45 am
  Code Version : 4.08
  Robot Version: 4.08
```

Product Data:

```
  Type             : Verification
  Model Number     : E-010
  Serial Number    : PCT003
  Frequency        : 2450 MHz
  Transmit Pwr     : 0.100 W
  Antenna Type     : Dipole
  Antenna Posn.    : Validation
```

Measurement Data:

```
  Phantom Name        : SAM-FLAT-B
  Phantom Type        : Uniphantom
  Tissue Type         : Brain
  Tissue Dielectric   : 40.030
  Tissue Conductivity : 1.880
  Tissue Density      : 1.000
  Robot Name          : CRS
```

Probe Data:

```
  Probe Name               : PCT003
  Probe Type               : E Fld Triangle
  Frequency                : 2450 MHz
  Tissue Type              : Brain
  Calibrated Dielectric    : 39.340
  Calibrated Conductivity  :  1.770
  Calibrated Density       :  1.300
  Probe Offset             :  2.400 mm
  Conversion Factor        :  8.000
  Probe Sensitivity :  2.075   2.820   2.456   mV/(mW/cm^2)
  Amplifier Gains   :  20.00   20.00   20.00
```

Sample:

```
  Rate:         6000 Samples/Sec
  Count:        1000 Samples
  NIDAQ Gain:   5
```

Comments:

Verification

CF=1; Amb. Temp= 22.3 'C; Liq. Temp=21.1 'C

Area Scan - Max Peak SAR Value at x=1.0 y=-1.0 = 4.69 W/kg

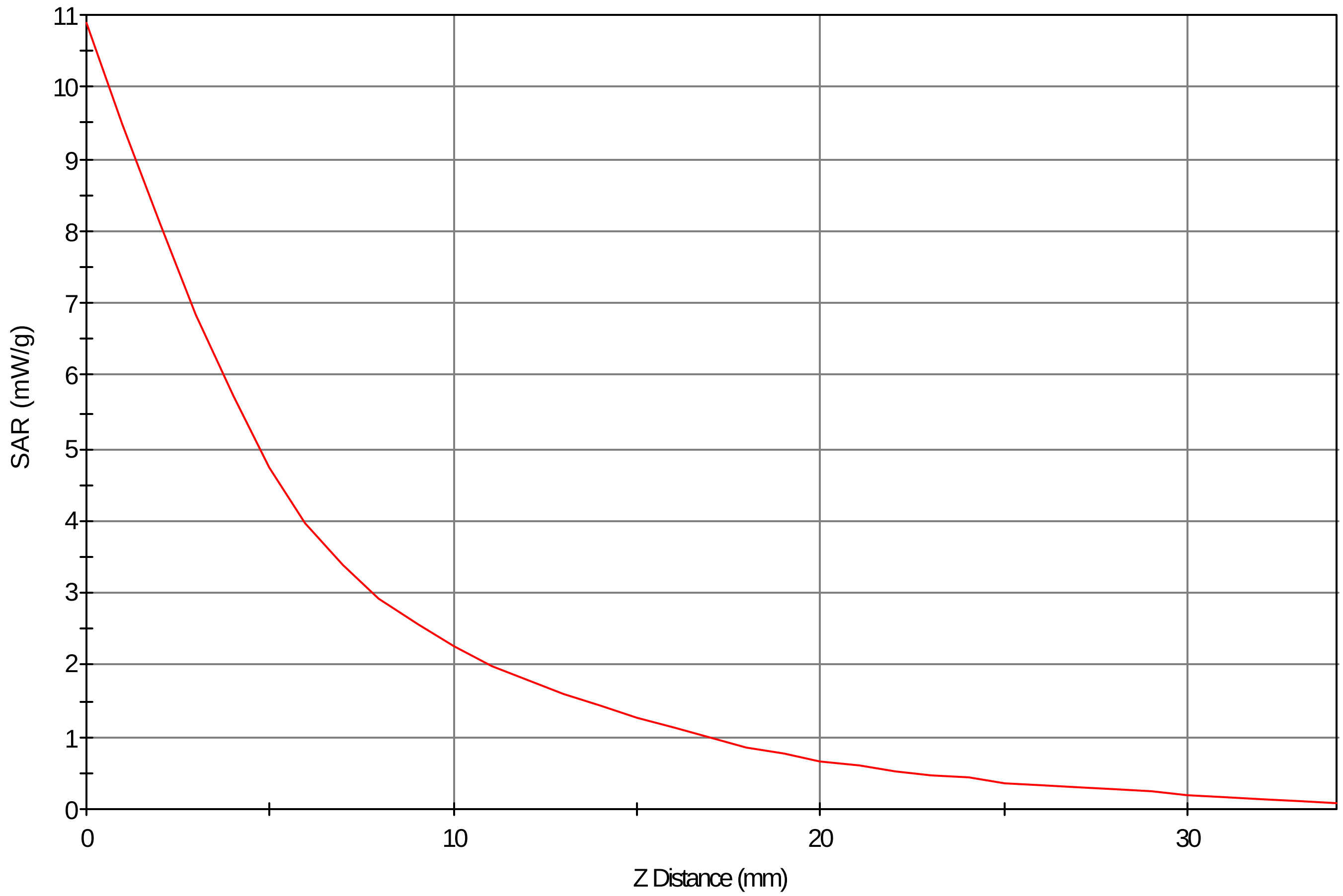
Zoom Scan - Max Peak SAR Value at x=0.0 y=-1.0 z=0.0 = 10.89 W/kg

Max 1g SAR at x=1.0 y=-1.0 z=0.0 = 5.34 W/kg

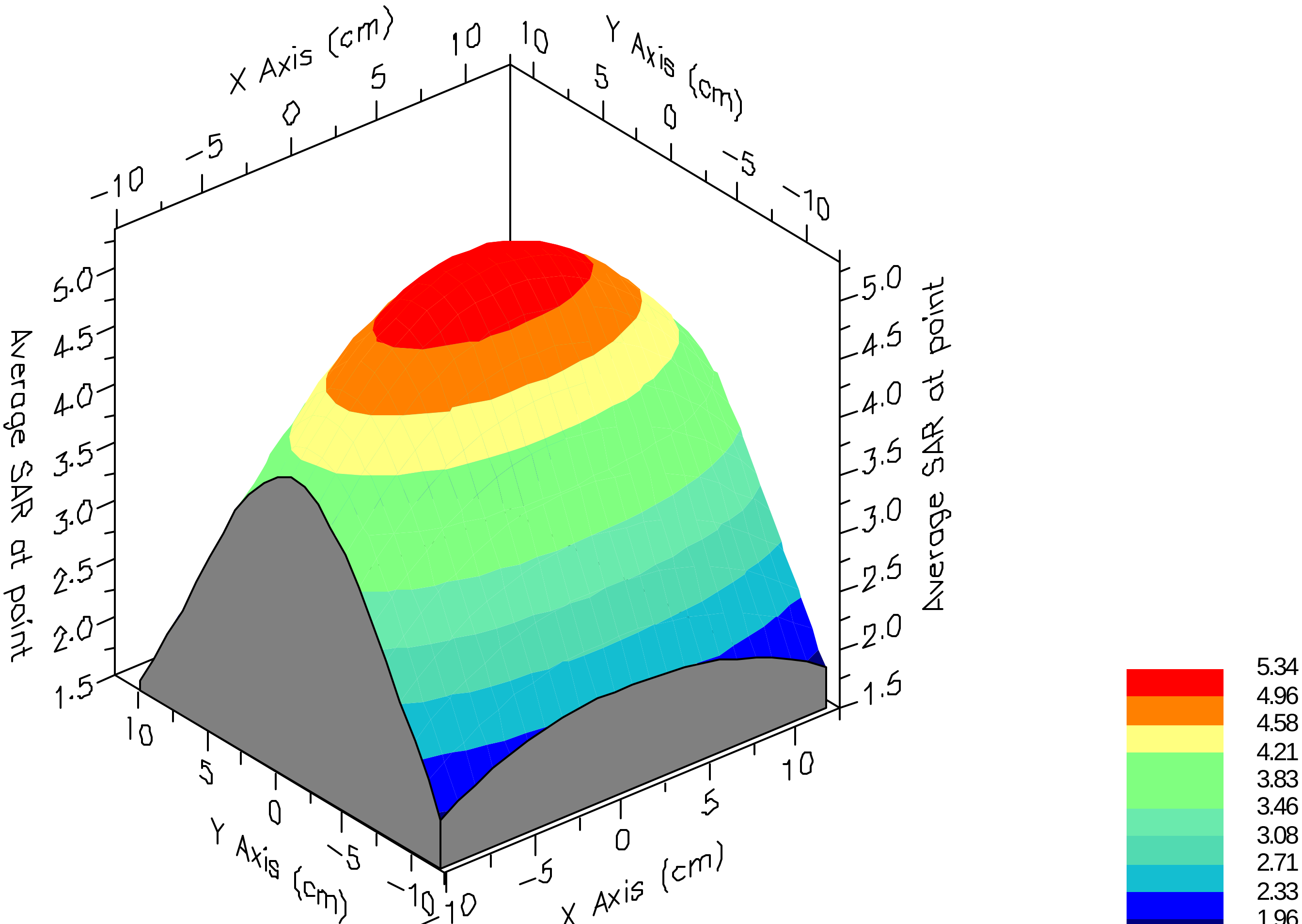
Max 10g SAR at x=1.0 y=-1.0 z=0.0 = 2.33 W/kg

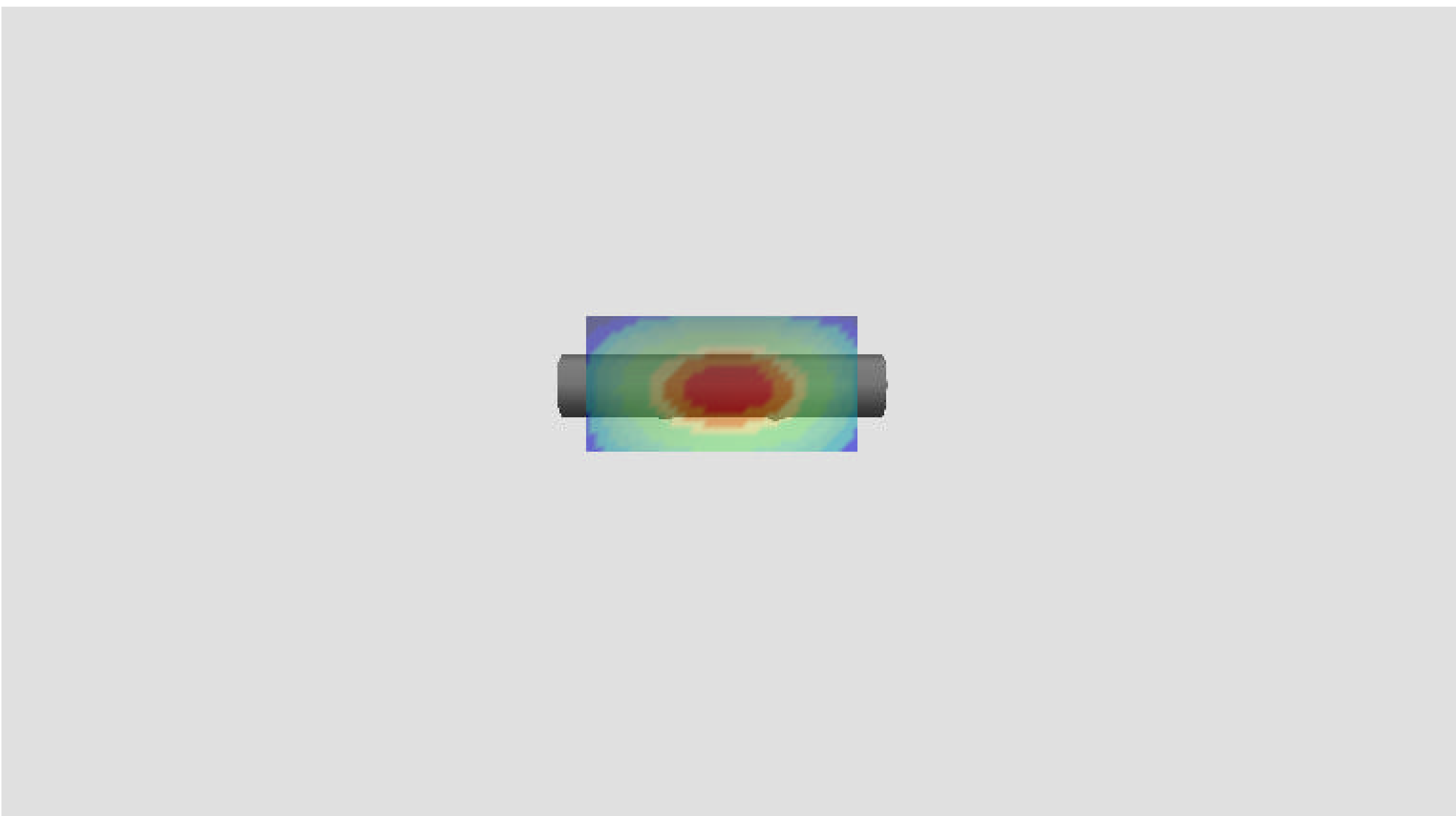
Validation Results at 0.10 W:
Peak Nominal = 10.4, Error: 4.50 %
1g Nominal   = 5.2, Error: 1.82 %
10g Nominal = 2.4, Error: -2.80 %

SAR - Z Axis
at Hotspot x:0.0 y:-1.0



1g SAR Values





APPENDIX C: PROBE CALIBRATION

Probe E-010

SN: PCT003

Manufactured:	November 4, 2002
Calibrated:	January 3, 2003

Calibrated for the IDX System

PCTEST Calibration Laboratory

Approved By:

Alfred Cirwithian
Vice President Engineering

Calibration is performed according to IEEE Std. P1528-200X, Sec. 7 Draft 6.5 (2001) and all test equipment used are traceable to U.S. NIST.

PCTEST

Calibration Laboratory

6660-B Dobbin Road
Columbia, Maryland 21045 USA

Calibration Summary

Model: E-010
S/N: PCT003

OFFSET (cm)	ANGLE (deg)
0.24	54.73

Tissue Type	Frequency (MHz)	Dielectric Constant e_r	Conductivity (S/m) s	Conversion Factor g_x, g_y, g_z
Brain	835	40.00	0.91	7.20
Brain	1880	40.20	1.41	4.05
Brain	2440	39.34	1.77	8.80
Brain	5300	37.10	4.84	3.20
Brain	5800	36.00	5.28	2.30
Muscle	835	55.70	0.98	7.70
Muscle	1900	53.90	1.48	4.40
Muscle	2440	52.30	1.99	9.90
Muscle	5300	48.80	5.43	3.45
Muscle	5800	48.50	6.05	2.50

Frequency (MHz)	Isotropy	
	%	dB
835	3.49	0.15
1880	5.35	0.23
2440	4.02	0.17
5300	4.85	0.21
5800	4.93	0.21

Boundary Effect < 2%, 2.6 mm from probe tip to phantom

Diode Compression Point: 76 mV

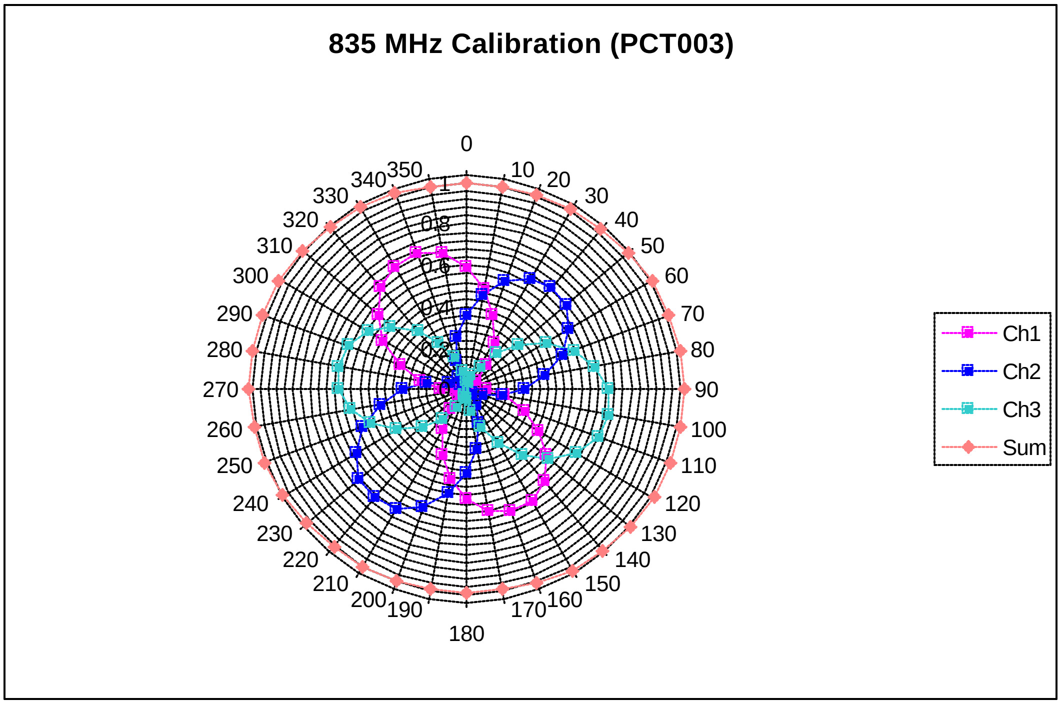
Environmental Conditons:

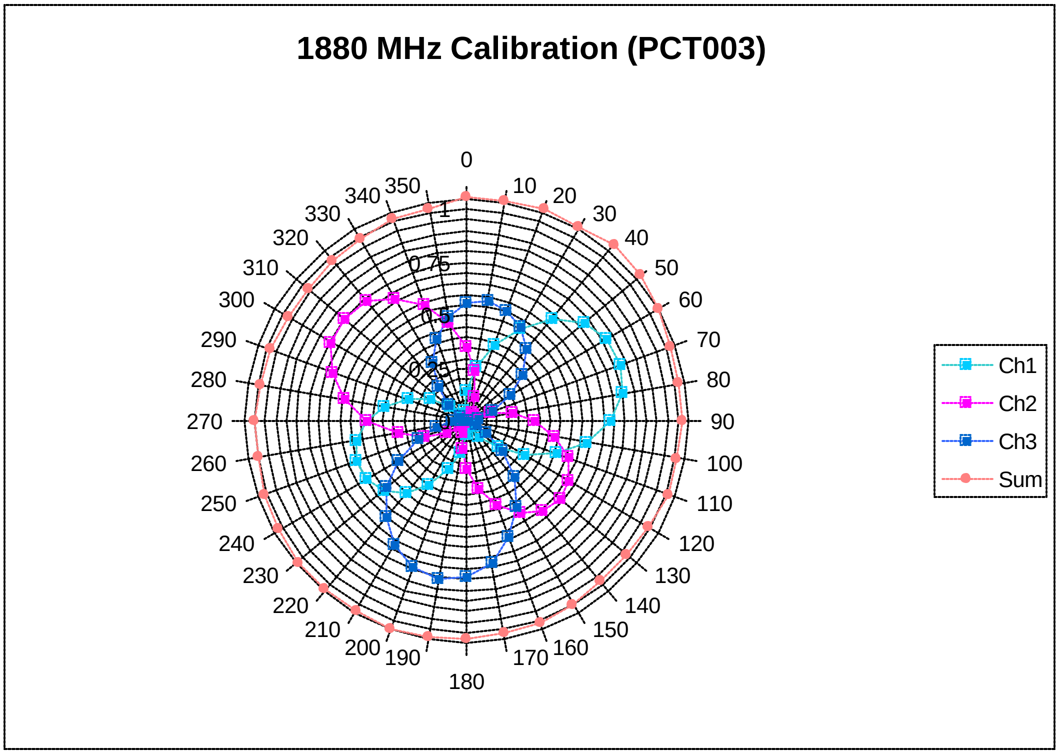
Temperature: 23.34 °C
Relative Humidity: 34%
Barometer: 100.1 kPa

This probe was calibrated under the IEEE Std 1309-1966, *IEEE Standard for Calibration of Electromagnetic Field Sensors and Probes, Exluding Antennas, from 9 kHz to 40 GHz*.

CALIBRATED BY: [signature] DATE: 01/15/03

Calibration Laboratory
6660-B Dobbin Road
Columbia, Maryland 21045 USA

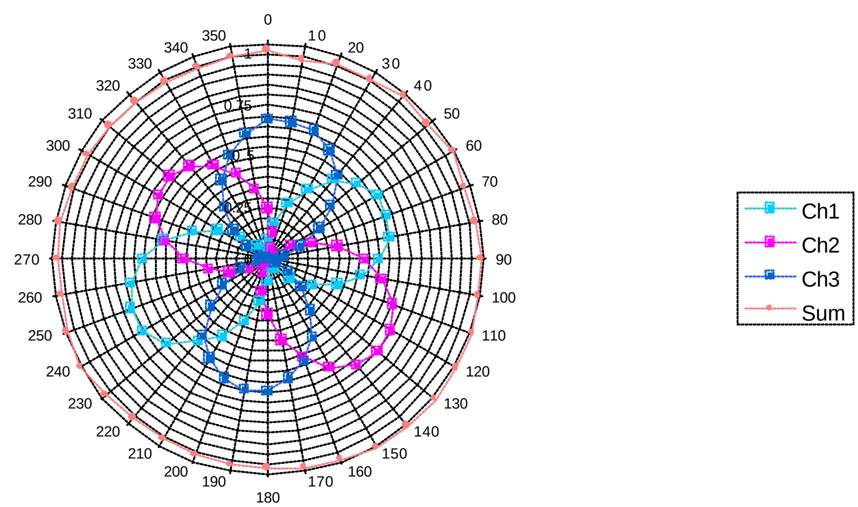




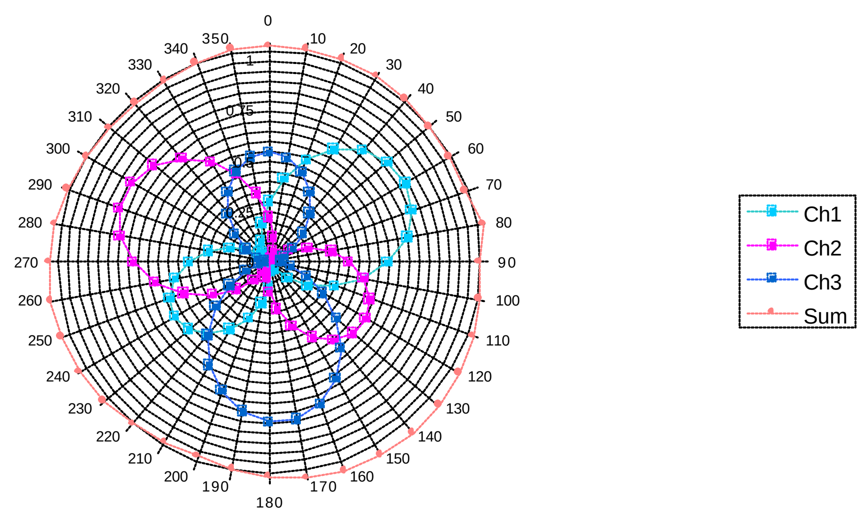
CALIBRATED BY: ________ DATE: 01/15/03

Calibration Laboratory
6660-B Dobbin Road
Columbia, Maryland 21045 USA

2440 MHz Calibration (PCT003)



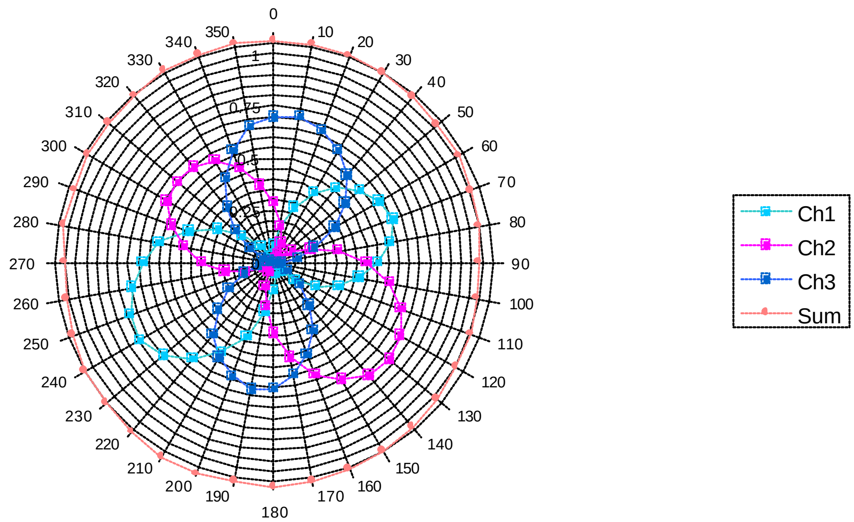
5300 MHz Calibration (PCT003)



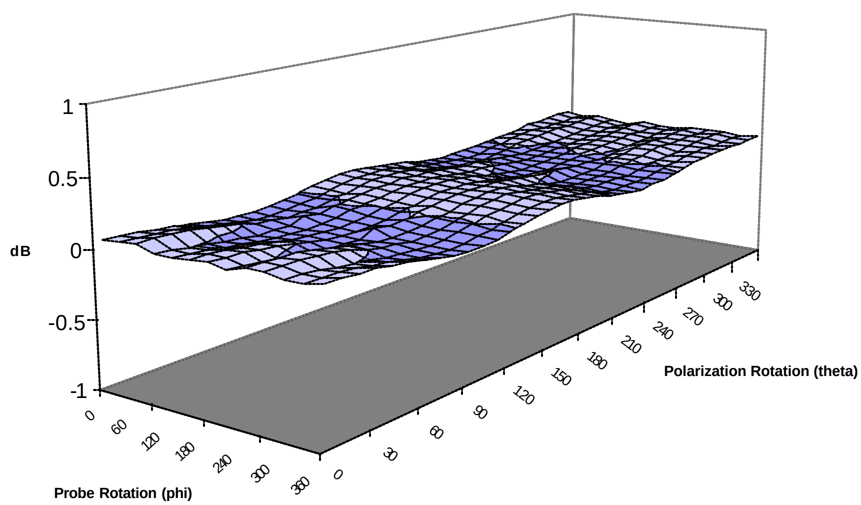
CALIBRATED BY: ____________ DATE: 01/15/03

Calibration Laboratory
6660-B Dobbin Road
Columbia, Maryland 21045 USA

5800 MHz Calibration (PCT003)

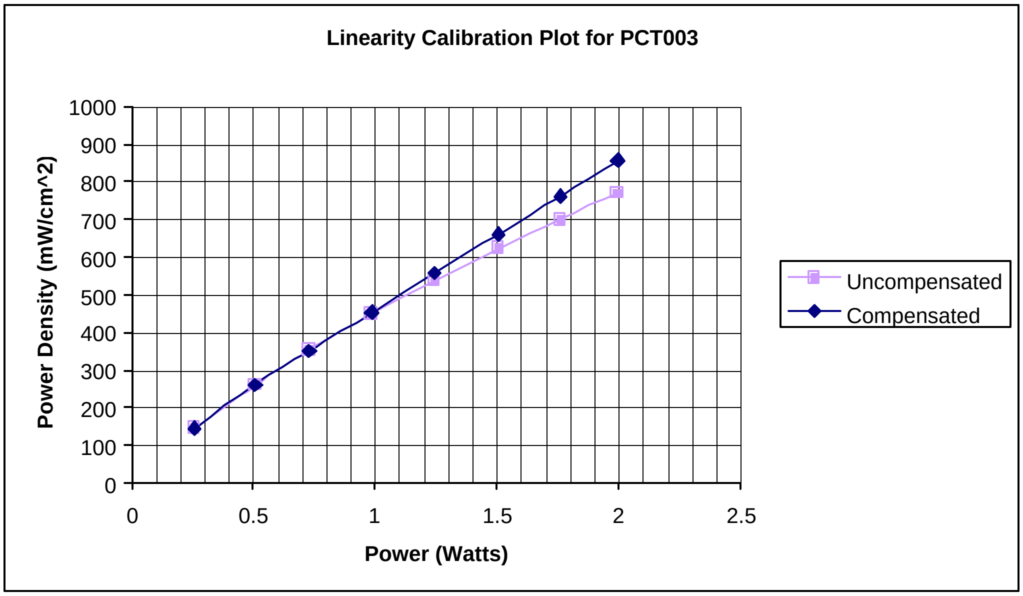


Verification of Isotropy for PCT003



CALIBRATED BY: ________ DATE: 01/15/03

PCTEST
Calibration Laboratory
6660-B Dobbin Road
Columbia, Maryland 21045 USA



Probe Physical Characteristics

Serial Number:	PCT003
Sensor Offset:	2.4 mm
Sensor Length:	2.5 mm
Tip Enclosure:	Glass
Tip Diameter:	7 mm
Tip Length:	40 mm
Total Length:	290 mm

CALIBRATED BY: ________ DATE: 01/15/03

Calibration Laboratory
6660-B Dobbin Road
Columbia, Maryland 21045 USA

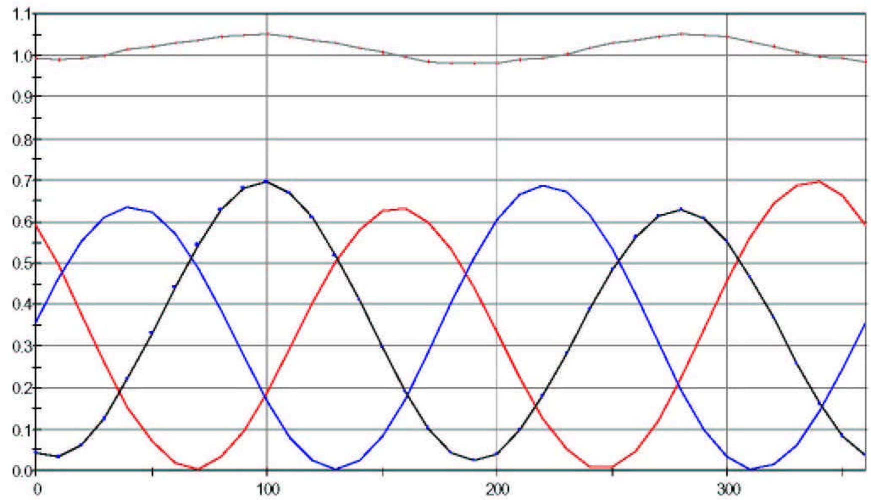
Test Equipment

The test equipment used during the probe calibration are listed as follows:

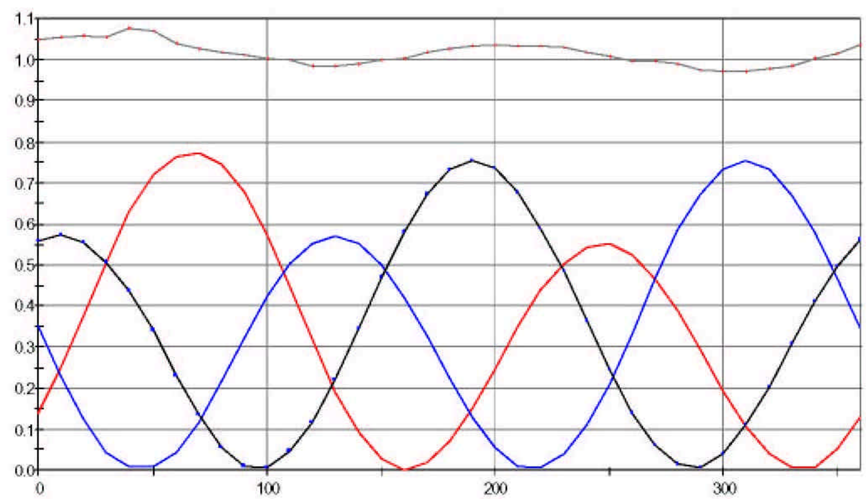
EQUIPMENT SPECIFICATIONS		
Type	Calibration Date	Asset Number/ Serial Number
CRS Robot F3	February 2002	RAF0134133
CRS C500C Motion Controller	February 2002	RCB0003303
CRS Teach Pendant (Joystick)	February 2002	STP0132231
DELL Computer, Pentium 4 1.6 GHz, Windows 2000™	February 2002	4PJZ111
E-Field Probe E-010	January 2003	PCT003
Flat SAM Phantom (P-SAM-FLAT)	February 2002	94X-097
IDX Robot End Effector (EE-103-C)	February 2002	07111223
IDX Probe Amplifier	February 2002	07111113
Validation Dipole D-835S	October 2002	PCT441
Validation Dipole D-1900S	October 2002	PCT541
Validation Dipole D-2450S	October 2002	PCT641
Validation Dipole D-5000S	November 2002	PCT741
HP-778D Dual-Directional Coupler (0.1 ~ 2.0 GHz)	November 2002	PCT664
MicroCircuits Directional Coupler (4.0 ~ 8.0 GHz)	November 2002	PE2204-6
Amplifier Research 5S1G4 Power Amp	January 2003	PCT540
IFI T184-10 Power Amplifier (4.0 ~ 18.0 GHz)	December 2002	5957
Agilent E8241A (250kHz ~ 20GHz) Signal Generator	November 2002	US42110432
HP-8648D (9kHz ~ 4 GHz) Signal Generator	January 2003	PCT526
HP-8753E (30kHz ~ 6GHz) Network Analyzer	January 2003	PCT552
HP85070B Dielectric Probe Kit	January 2003	PCT501
IFI CC110EXX TEM Cell (DC to 2000 MHz)	January 2003	PCT498
EMCO 3115 Horn Antenna (2.0 ~ 18.0 GHz)	August 2002	PCT496
Guidline 5150 Precision Dual-Thermometer	November 2002	66145

CALIBRATED BY: [signature] DATE: 01/15/03

TEM Calibration Plot
Date: 3-Jan-03 05:19:17 pm
Probe Name: PCT003
Frequency: 835
Sensitivity: Ch1: 2.439 Ch2: 2.706 Ch3: 2.822 mV/(mW/cm^2)
Isotropicity: 3.49% 0.15 db Min=0.981 Max=1.051



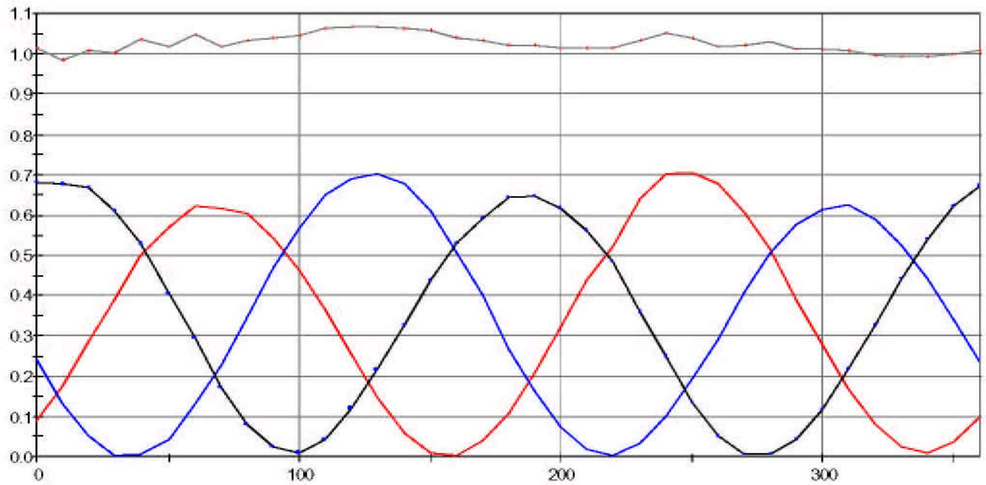
TEM Calibration Plot
Date: 3-Jan-03 05:52:39 pm
Probe Name: PCT003
Frequency: 1880
Sensitivity: Ch1: 4.794 Ch2: 5.895 Ch3: 5.327 mV/(mW/cm^2)
Isotropicity: 5.35% 0.23 db Min=0.971 Max=1.078



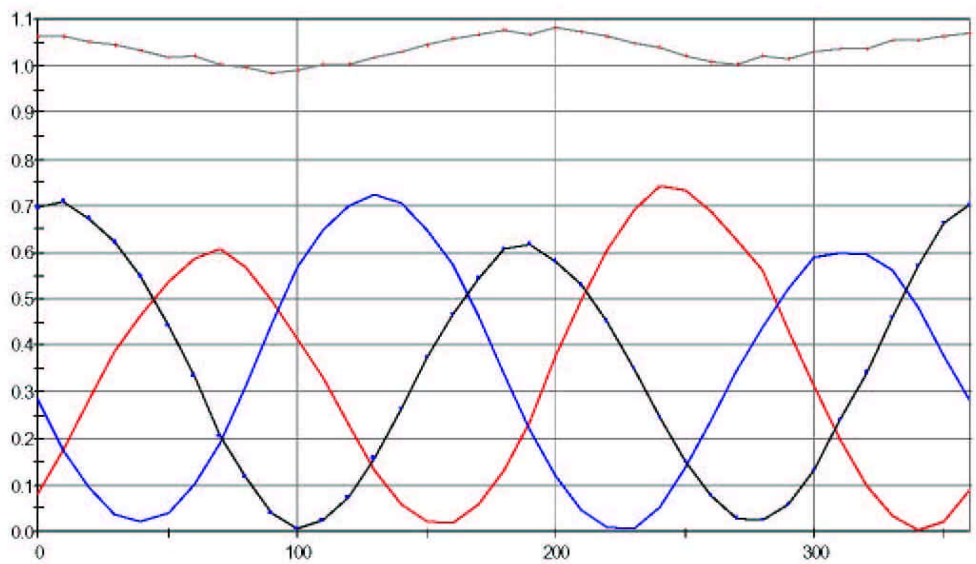
CALIBRATED BY: ____________ **DATE:** 01/15/03

Calibration Laboratory
6660-B Dobbin Road
Columbia, Maryland 21045 USA

TEM Calibration Plot
Date: 3-Jan-03 10:10:11 am
Probe Name: PCT003
Frequency: 2440
Sensitivity: Ch1: 2.075 Ch2: 2.820 Ch3: 2.456 mV/(mW/cm^2)
Isotropicity: 4.02% 0.17 db Min=0.985 Max=1.066



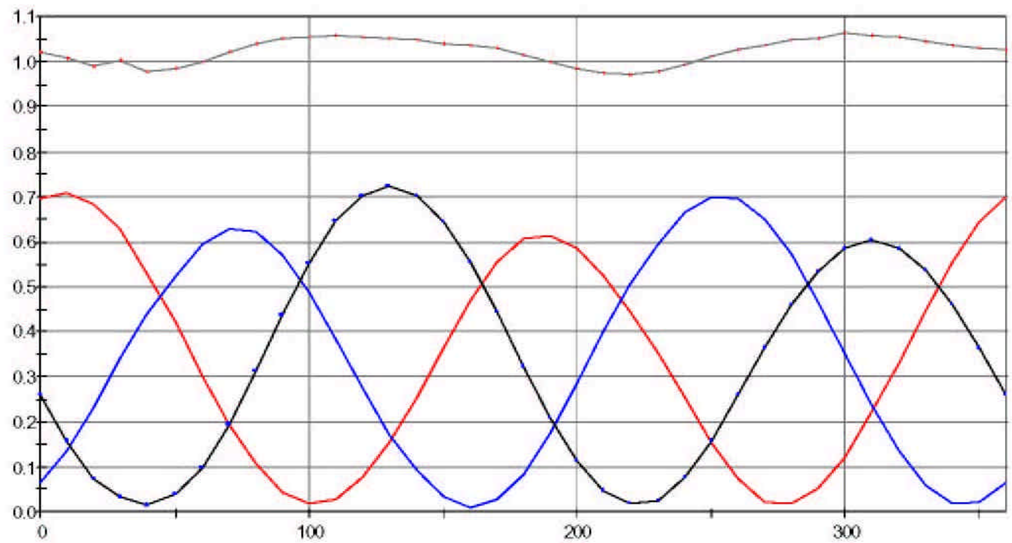
TEM Calibration Plot
Date: 3-Jan-03 10:31:24 am
Probe Name: PCT003
Frequency: 5300
Sensitivity: Ch1: 1.939 Ch2: 2.177 Ch3: 2.062 mV/(mW/cm^2)
Isotropicity: 4.85% 0.21 db Min=0.984 Max=1.081



CALIBRATED BY: ________ **DATE:** 01/15/03

PCTEST
Calibration Laboratory
6660-B Dobbin Road
Columbia, Maryland 21045 USA

TEM Calibration Plot
Date: 3-Jan-02 12:06:18 pm
Probe Name: PCT003
Frequency: 5800
Sensitivity: Ch1: 0.6759 Ch2: 0.8082 Ch3: 0.7596 mV/(mW/cm^2)
Isotropicity: 4.93% 0.21 db Min=0.973 Max=1.082



CALIBRATED BY: ________ DATE: 01/15/03

APPENDIX D: MPE Report

RF Exposure Evaluation - Maximum Permissible Exposure (MPE)

1. Introduction

2.4 GHz frequency band is regarded specially as a dangerous band for its heating harmfulness to the human body. That's why microwave oven is operating in this frequency band. The manufacturer whose product is working in this frequency band is obligatory to prove the harmfulness of this product.
In this document, we try to prove the safety of radiation harmfulness to the human body. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1210 is followed. The Gain of the antenna used in this product is measured by power meter. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

2. RF Exposure Limit

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures				
300-1500	…	…	F/300	6
1500-100,000	…	…	5	6
(B) Limits For General Population / Uncontrolled Exposure				
300-1500	…	…	F/1500	6
1500-100,000	…	…	1.0	30

F = Frequency in MHz

3. Friis Formula

Friis transmission formula: $Pd = (Pout*G) / (4\pi r^2)$

Where
Pd = power density in mW/cm^2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi = 3.1416$
R = distance between observation point and center of the radiator in cm
Pd is the limit of MPE, 1 mW/cm2. If we know the maximum Gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

Ref.: David K. Cheng, Field and Wave Electromagnetics, Second Edition, Page 640, Eq. (11.133)

4. EUT Operating Condition

Software provided by the client enabled the EUT to transmit and receive data at lowest, middle, and highest channel individually.

5. Climate Condition

The temperature and related humidity: 22˚C and 78% RH

6. Test Results (Antenna Configuration)

6.1 Output Power into Antenna & RF Exposure Distance:

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)
06	2437	45	0.1785

7. Conclusion

The device meets the mobile 20cm. separation distance as specified in Section 2.1091 of the FCC Rules and an appropriate RF exposure compliance statement will be placed in the users manual.