ENGINEERING TEST REPORT

NETPAD with TRX7431 Lucent 802.11 2.4GHz Radio
Model No.: NETPAD RLAN

Tested For

PSION TEKLOGIX Inc.
2100 Meadowvale Blvd.
Mississauga, ON
CanadaL5N 7J9

In Accordance With

SAR (Specific Absorption Rate) Requirements
using guidelines established in IEEE C95.1-1991,
FCC OET Bulletin 65 (Supplement C),
Industry Canada RSS-102(Issue 1) and
ACA Radiocommunications (Electromagnetic Radiation – Human Exposure)
Amendment Standard 2000 (No. 1)

UltraTech's File No.: TEK-369-SAR

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: June 27,2002	
Report Prepared by: Jaewook Choi Issued Date: June 27,2002	Tested by: Jaewook Choi Test Dates: June 26,2002

The results in this Test Report apply only to the sample(s) tested, which has been randomly selected.

UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Telephone (905) 829-1570 Facsimile (905) 829-8050
Website: www.ultratech-labs.com Email: vic@ultratech-labs.com

TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	SAR (Specific Absorption Rate) Requirements IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C) Industry Canada RSS-102 (Issue 1). ACA Radiocommunications (Electromagnetic Radiation – Human Exposure), Amendment Standard 2000 (No. 1)
Title	Safety Levels with respect to human exposure to Radio Frequency Electromagnetic Fields Guideline for Evaluating the Environmental Effects of Radio Frequency Radiation
Purpose of Test:	To verify compliance with Federal regulated SAR requirements in Canada and the US.
Method of Measurements:	IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C) and Industry Canada RSS-102 (Issue 1)
Exposure Category	General Population/Uncontrolled

1.2. REFERENCES

The methods and procedures used for the measurements contained in this report are details in the following reference standards:

Publications	Year	Title
IEEE Std. 1528-2001 Draft	2001	Draft Recommended practice for determining the Peak Spatial-Average Specific Absorption rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.
Industry Canada RSS102	1999	"Evaluation Procedure for Mobile and Portable Radio Transmitters with respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields"
ACA	2000	ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)
NCRP Report No.86	1986	"Biological Effects and Exposure Criteria for radio Frequency Electromagnetic Fields"
FCC OET Bulletin 65	1997	"Evaluating Compliance with FCC Guidelines for Human Exposure to radio Frequency Fields"
ANSI/IEEE C95.3	1992	"Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave"
ANSI/IEEE C95.1	1992	"Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz"
AS/NZS 2722.1	1998	Interim Australian/New Zealand Standard. "Radiofrequency fields, Part 1:Maximum exposure levels – 3kHz to 300GHz "

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT AND MANUFACTURER INFORMATION

APPLICANT:	
Name:	PSION TEKLOGIX Inc.
Address:	2100 Meadowvale Blvd. Mississauga, ON Canada, L5N 7J9
Contact Person:	Sada Dharwarkar Phone #: 1-905-812-6200 (Ext.3358) Fax #: 1-905-812-6301 Email Address: sdharwar@teklogix.com

MANUFACTURER:	
Name:	PSION TEKLOGIX Inc.
Address:	2100 Meadowvale Blvd. MississaugaON Canada, L5N 7J9
Contact Person:	Sada Dharwarkar Phone #: 1-905-812-6200 (Ext.3358) Fax #: 1-905-812-6301 Email Address: sdharwar@teklogix.com

2.2. DEVICE UNDER TEST (D.U.T.) DESCRIPTION

The following is the information provided by the applicant.

Trade Name	NETPAD with TRX7431 Lucent 802.11 2.4GHz Radio
Type/Model Number	NETPAD RLAN
Serial Number	Eng 001
Type of Equipment	Radio Equipment
Frequency of Operation	2412 ~ 2462 MHz
Rated RF Power	17.7 dBm conducted
Modulation Employed	DSSS
Antenna Type + Gain	Centurion Stubby + 2.6 dBi
External Power Supply	Rechargeable Lithium Ion battery (7.2V 1400mAh)
Primary User Functions of D.U.T.:	Data Radio Communication Through Air

2.3. LIST OF D.U.T.'S ACCESSORIES:

Rechargeable Lithium Ion battery (7.2V 1400mAh), Netpad portable battery charger (M/N:NP3001, 8.4VDC, 835mA), AC Power Adapter (M/N: TR36A15-OXF01, 15V, 1.3A)

2.4. SPECIAL CHANGES ON THE D.U.T.'S HARDWARE/SOFTWARE FOR TESTING PURPOSES

D.U.T. is limited to transmit a maximum duty cycle of 19 % on the network the radio modem is designed to be used in. But the exclusive controlling software, in order to make the D.U.T transmit continuously, was provided by the manufacturer for the SAR testing purpose only.

2.5. ANCILLARY EQUIPMENT

None

2.6. GENERAL TEST CONFIGURATIONS

2.6.1. Equipment Configuration

Power and signal distribution, grounding, interconnecting cabling and physical placement of equipment of a test system shall simulate the typical application and usage in so far as is practicable, and shall be in accordance with the relevant product specifications of the manufacturer.

The configuration that tends to maximize the D.U.T.'s emission or minimize its immunity is not usually intuitively obvious and in most instances selection will involve some trial and error testing. For example, interface cables may be moved or equipment re-orientated during initial stages of testing and the effects on the results observed.

Only configurations within the range of positions likely to occur in normal use need to be considered.

The configuration selected shall be fully detailed and documented in the test report, together with the justification for selecting that particular configuration.

2.6.2. Exercising Equipment

The exercising equipment and other auxiliary equipment shall be sufficiently decoupled from the D.U.T. so that the performance of such equipment does not significantly influence the test results.

2.7. SPECIFIC OPERATING CONDITIONS

D.U.T. was made transmit continuously, instead of with its actual duty cycle, using the exclusive controlling software for SAR test provided by the manufacturer.

2.8. BLOCK DIAGRAM OF TEST SETUP

The D.U.T. was configured as normal intended use. The following block diagram shows a representative equipment arrangement during tests:

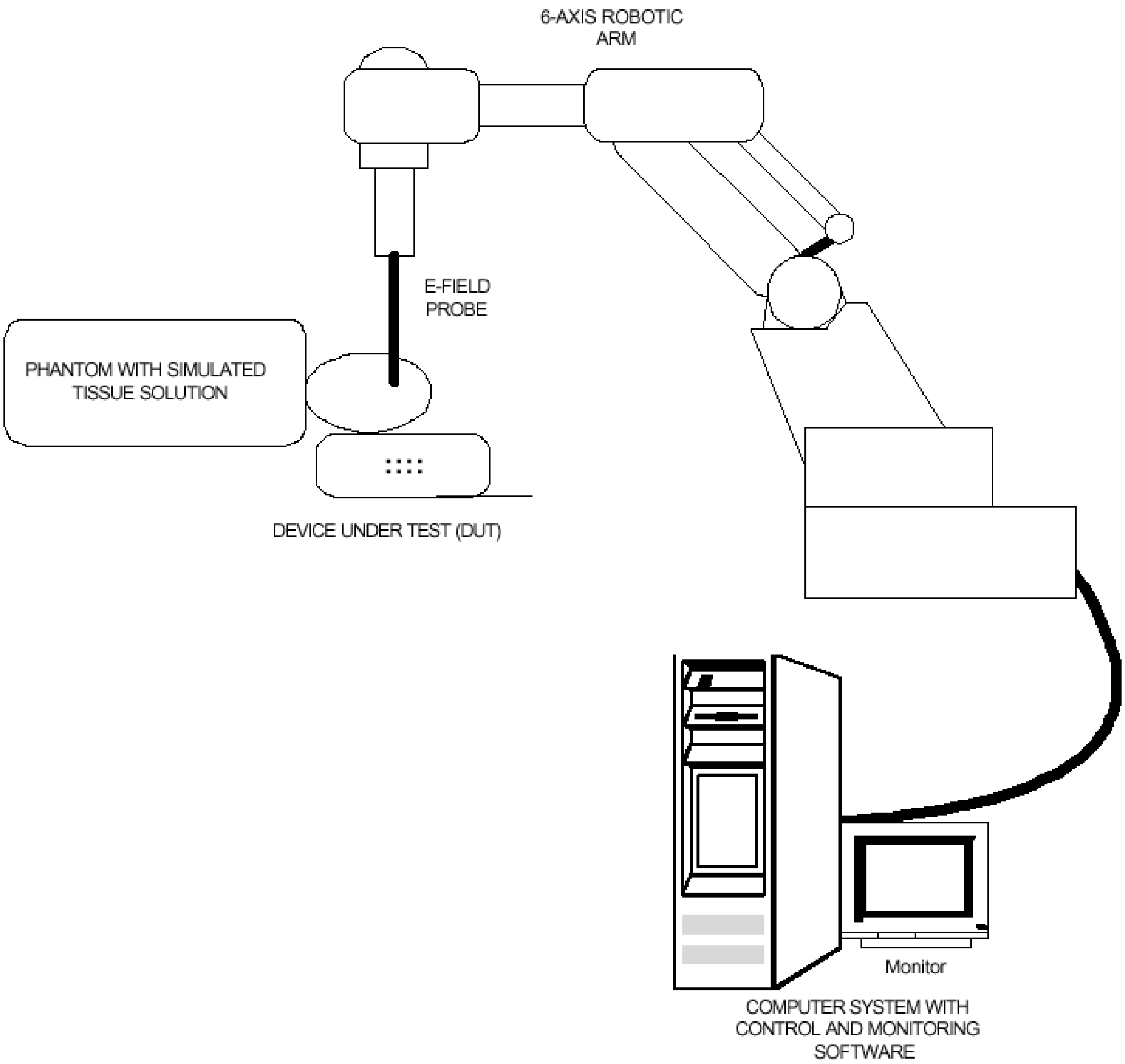


EXHIBIT 3. SUMMARY OF TEST RESULTS

3.1. LOCATION OF TESTS

All of the measurements described in this report were performed at UltraTech Group of Labs located at:

3000 Bristol Circle, in the city of Oakville, Province of Ontario, Canada.

All measurements were performed in UltraTech's shielded chamber, 24' x 16' x 8'.

3.2. APPLICABILITY & SUMMARY OF SAR RESULTS

The maximum peak spatial - average SAR measured was found to be 0.29 W/Kg with 19 % duty cycle (19 ms / 100 ms).

Exposure Category and SAR Limits	Test Requirements	Compliance (Yes/No)
General population/Uncontrolled exposure 0.08W/kg whole body average and spatial peak SAR of 1.6W/kg, averaged over 1gram of tissue Hands, wrist, feet and ankles have a peak SAR not to exceed 4 W/kg, averaged over 10 grams of tissue.	Requirements using guidelines established in IEEE C95.1-1991 FCC OET Bulletin 65 (Supplement C) Industry Canada RSS-102 (Issue 1). ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)	YES
Occupational/Controlled Exposure 0.4W/kg whole body average and spatial peak SAR of 8W/kg, averaged over 1gram of tissue Hands, wrist, feet and ankles have a peak SAR not to exceed 20 W/kg, averaged over 10 grams of tissue.	Requirements using guidelines established in IEEE C95.1-1991 FCC OET Bulletin 65 (Supplement C), Industry Canada RSS-102 (Issue 1) ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)	N/A

EXHIBIT 4. MEASUREMENTS, EXAMINATIONS & TEST DATA

4.1. TEST SETUP

D.U.T. Information		Condition	
Product Name	NETPAD with TRX7431 Lucent 802.11 2.4GHz Radio	**Robot Type**	6 Axis
Model Number	NETPAD RLAN	**Scan Type**	SAR - Area/Zoom/Attenuation Vs Depth
Serial Number	Eng 001	**Measured Field**	E
Frequency Band $_{[MHz]}$	2412 ~ 2462	**Phantom Type**	2_{mm} base Flat Phantom
Frequency Tested $_{[MHz]}$	2412, 2437, 2462	**Phantom Position**	Waist
Rated RF Output Power $_{[W]}$	17.7 dBm conducted	**Room Temperature** $_{[°C]}$	22.5 ± 1
Antenna Type	Centurion Stubby	**Room Humidity** $_{[\%]}$	35 ± 10
Modulation	DSSS	**Tissue Temperature** $_{[°C]}$	21.0 ± 1
Duty Cycle	100 %*		

Type of Tissue	Muscle
Target Frequency $_{[MHz]}$	2450
Target Dielectric Constant	52.7
Target Conductivity $_{[S/m]}$	1.95
Composition (by weight)	DI Water (76.19 %) DGBE (9.52 %) Triton X-100 (14.29 %)
Measured Dielectric Constant	54.33 (3.1 %)
Measured Conductivity $_{[S/m]}$	1.86 (-4.7 %)
Probe Model Number	E
Probe Orientation	Isotropic
Probe Offset $_{[mm]}$	2.24
Sensor Factor $_{[mV/(mW/cm^2)]}$	10.8
Conversion Factor $_{[mW/g/(mW/cm^2)]}$	2.6784
Calibration Date $_{[MM/DD/YY]}$	02/14/02

* D.U.T. was made transmit continuously, instead of its actual duty cycle, using the exclusive controlling software for SAR test provided by the manufacturer. (Refer to 2.4 & 2.7)

4.2. PHOTOGRAPH OF D.U.T. AND ALL ACCESORIES

< Front View >

< Rear View >

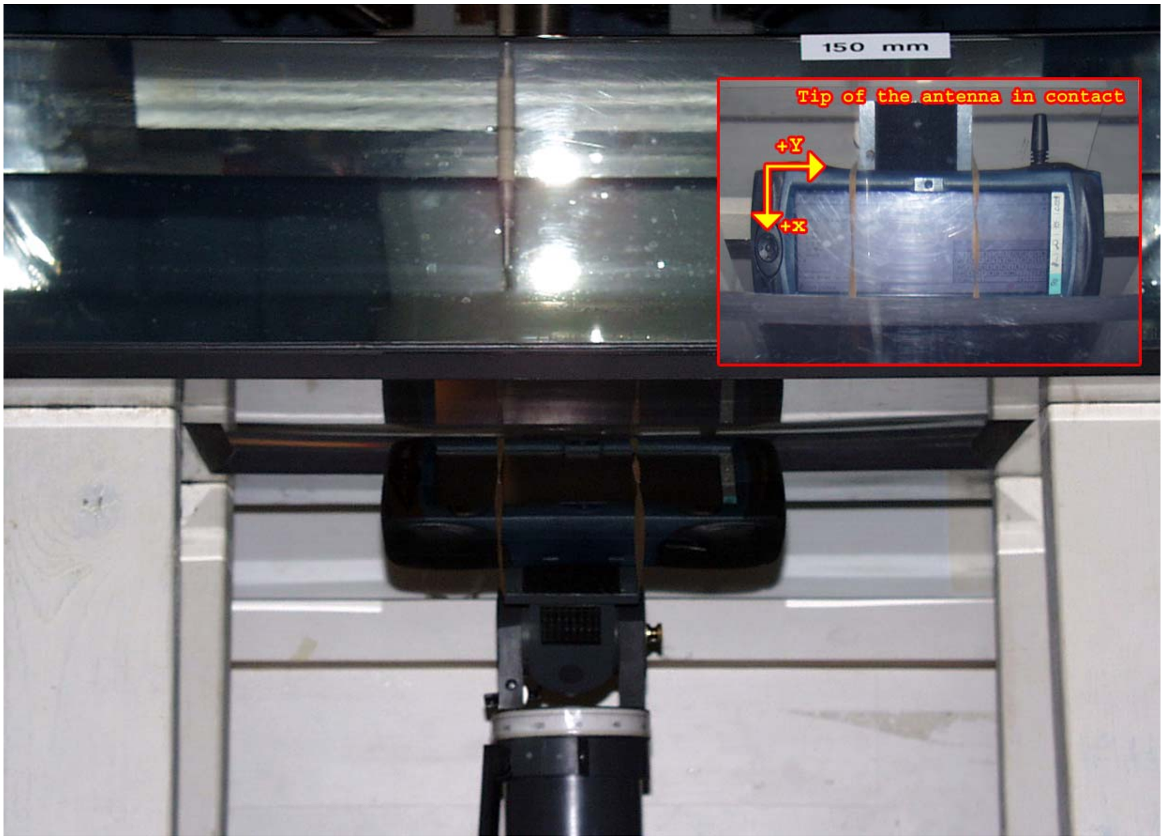
< Rechargeable Lithium Ion battery (7.2V, 1400mAh) >

< Portable Netpad portable battery charger (M/N:NP3001, 8.4VDC, 835mA), AC Power Adapter (M/N: TR36A15-OXF01, 15V, 1.3A) >

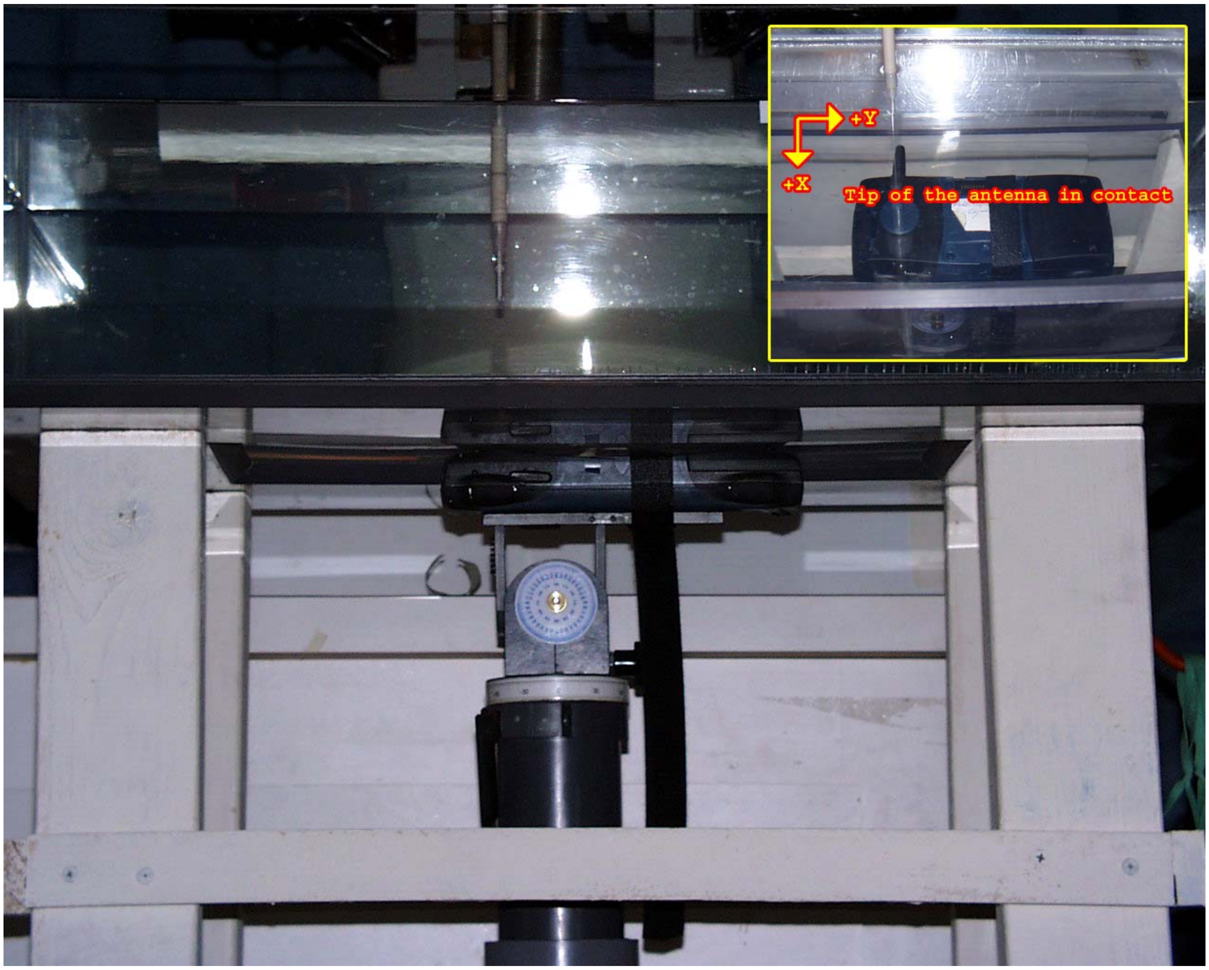
4.3. PHOTOGRAPHS OF D.U.T. POSITION

4.3.1. Body-Worn Configuration

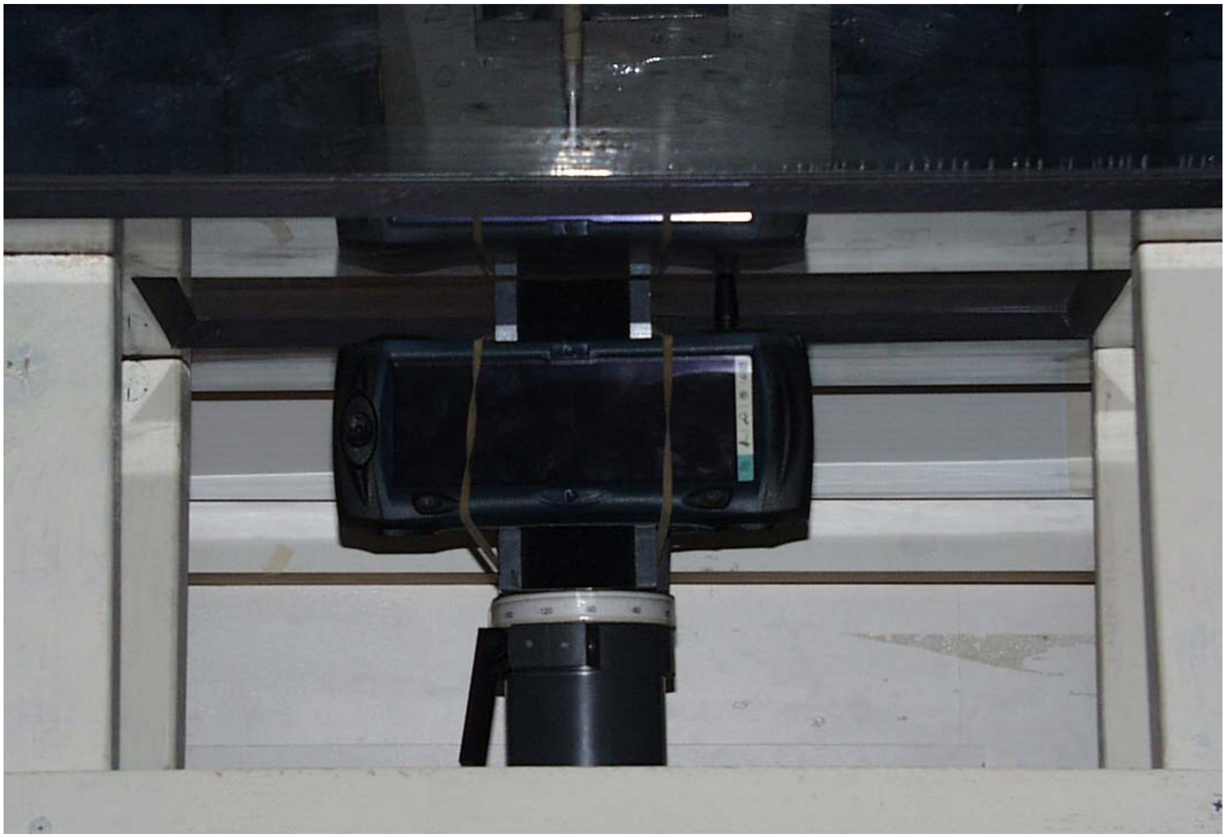
4.3.1.1. Front of the D.U.T. against the phantom and the tip of the antenna in contact



4.3.1.2. Rear of the D.U.T. against the phantom and the tip of the antenna in contact



4.3.1.3. Top of the D.U.T. against the phantom and the tip of the antenna in contact



4.4. MAXIMUM PEAK SPATIAL-AVERAGE SAR

4.4.1. Maximum Peak Spatial-average SAR Data

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	MAX. SAR* [W/Kg]
01	Rear of the D.U.T. against the phantom Tip of the antenna in contact 11MBps Data Rate 0 mm separation distance	Body-worn	Fixed	2412	CH01	0.29 *(1.51)

4.4.2. Maximum Peak Spatial-Average SAR LOCATION

Complete area Prescans was conducted to determine the location of the highest SAR and the device was repositioned to allow the identified hot-spots to be orientated with as large an area around the hot-spots to come into contact with the phantom surface. This procedure ensured that the maximum SAR readings would be obtained from the hot-spot areas identified.

Unless otherwise specified, the reference point (0, 0) in the plots was set to the point at the base of antenna in the projected image of D.U.T. to the phantom surface.

* The value in the parenthesis indicates the actual measured SAR value using the special software provided by manufacturer (for the SAR test purpose only) which make the D.U.T. transmit continuously (Refer to section 2.4 for duty cycle information). However the D.U.T. is limited to transmit a maximum duty cycle of 19 % on the network the radio modem is designed to be used in, therefore the factor of 0.19 was applied to compensate the duty cycle. (Refer to section 8.1)


Hot Spot
(-10, 0)
Y Axis (mm)
X Axis (mm)
Reference
Point (0, 0)

4.5. SAR MEASUREMENT DATA

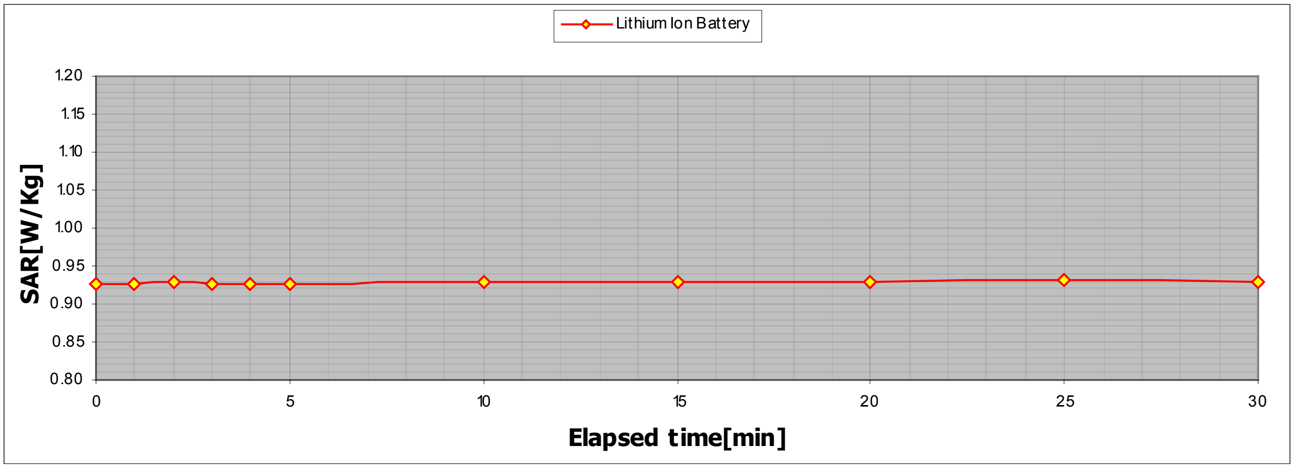
4.5.1. Body-Worn Configuration Result

4.5.1.1. Rear of the D.U.T. against the phantom and the tip of the antenna in contact

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	MAX. SAR* [W/Kg]
01	Rear of the D.U.T. against the phantom Tip of the antenna in contact 11 MBps Data Rate	0 mm separation	Fixed	2412	CH01	0.38 (1.51)*
02				2437	CH06	0.34 (1.36)*
03				2462	CH11	0.34 (1.36)*

4.5.2. Power Drift measurement

The local SAR was measured at a vicinity of mid-point of antenna in the muscle simulant tissue during the period of 30 minute for the fully charged Lithium Ion battery.



* The value in the parenthesis indicates the actual measured SAR value using the special software provided by manufacturer (for the SAR test purpose only) which make the D.U.T. transmit continuously (Refer to section 2.4 for duty cycle information). However the D.U.T. is limited to transmit a maximum duty cycle of 19 % on the network the radio modem is designed to be used in, therefore the factor of 0.19 was applied to compensate the duty cycle. (Refer to section 8.1)

EXHIBIT 5. SAR SYSTEM CONFIGURATION & TEST METHODOLOGY

5.1. MEASUREMENT SYSTEM SPECIFICATIONS

Positioning Equipment	Probe
Type : 3D Near Field Scanner Location Repeatability : 0.1mm Speed 180 °/sec AC motors	Sensor : E-Field Spatial Resolution : 0.1 cm^3 Isotropic Response : ± 0.25 dB Dynamic Range : 2 μW/g to 100 mW/g
Computer	**Phantom**
Type : Pentium III 500MHz Memory : 256 MB RAM Operating System : Windows 2000 Pro Monitor : 19" SVGA	Tissue : Simulated Tissue with electrical characteristics similar to those of the human at normal body temperature. Left/Right Head: IEEE P1528 Compliant SAM manufactured by Aprel Body/Frontal Head: IEEE Flat Phantom 2mm Base

5.2. TEST PROCEDURES

In the SAR measurement, the positioning of the probes must be performed with sufficient accuracy to obtain repeatable measurements in the presence of rapid spatial attenuation phenomena. The accurate positioning of the E-field probe is accomplished by using a high precision robot. The robot can be taught to position the probe sensor following a specific pattern of points. In a first sweep, the sensor is positioned as close as possible to the interface, with the sensor enclosure touching the inside of the fiberglass shell. The SAR is measured on a grid of points, which covers the curved surface of the phantom in an area larger than the size of the D.U.T. After the initial scan, a high- resolution grid is used to locate the absolute maximum measured energy point. At this location, attenuation versus depth scan will be accomplished by the measurement system to calculate the SAR value.

5.3. PHANTOM

For Head mounted devices placed next to the ear, the phantom used in the evaluation of the RF exposure of the user of the wireless device is a IEEE P1528 compliant SAM phantom, shaped like a human head and filled with a mixture simulating the dielectric characteristics of the brain. A left sided head and a right sided head are evaluated to determine the worst case orientation for SAR. For body mounted and frontal held push-to-talk devices, a flat phantom of dimensions 70x42x20cm with a base plate thickness of 2mm is used.

5.4. SIMULATED TISSUE

Simulated Tissue: Suggested in a paper by George Hartsgrove and colleagues in University of Ottawa Ref.: Bioelectromagnetics 8:29-36 (1987)

Ingredient	Quantity
Water	40.4 %
Sugar	56.0 %
Salt	2.5 %
HEC	1.0 %
Bactericide	0.1 %

Table. Example of composition of simulated tissue.

This simulated tissue is mainly composed of water, sugar and salt. At higher frequencies, in order to achieve the proper conductivity, the solution does not contain salt. Also, at these frequencies, D.I. water and alcohol is preferred.

Target Frequency	Head		Body	
(MHz)	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 Kg/m^{3}[*])

[*] Actual equivalent tissue's mass density is approximately 1250 Kg/m^3

5.4.1. Preparation

We determine the volume needs and carefully measure all components. A clean container is used where the ingredients will be mixed. A stirring paddle mounted to a drill press is used to stir the mixture. First we heat the DI water to about 40 ^{o}C to help the ingredients dissolve and then we pour the salt and the bactericide. We stir until all the ingredients are completely dissolved. We continue stirring slowly while adding the sugar. We avoid high RPM from the mixing device to prevent air bubbles in the mixture. Later on, we add the HEC to maintain the solution homogeneous. Mixing time is approximately 30 to 40 min.

5.5. MEASUREMENT OF ELECTRICAL CHARACTERISTICS OF SIMULATED TISSUE

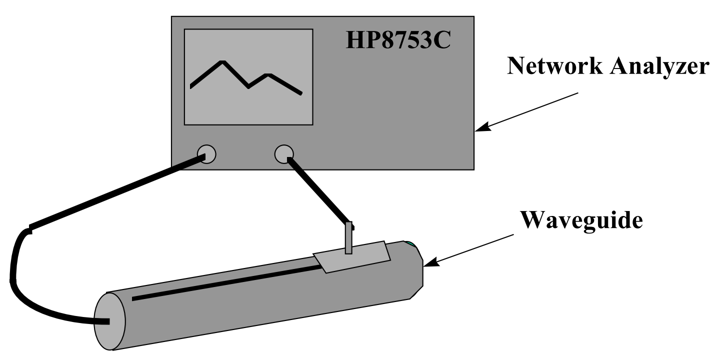
1) Network Analyzer HP8753C or others
2) Slotted Coaxial Waveguide
3) HP Dielectric Strength Probe System

5.5.1. Description of the slotted coaxial waveguide

The cylindrical waveguide is constructed with copper tube of about 30 to 40 cm in length, generally 12.5 mm diameter, with connectors at both ends. Inside of this tube, a conductive rod about 6.3 mm is coaxial supported by the two ends connectors (radiator). A slot 3 mm wide start at the beginning of the tube to approximately two thirds of the tube length. The outer edge of the slotted tube is marked in increments of 1 centimeter (10 to 12), and 0.5 centimeter for higher frequencies. A saddle piece containing the sampling probe is inserted in the slot so the tip of the probe is close but not in contact with the inner conductor (radiator).

To measure the electrical characteristics of the liquid simulated tissue, we fill the coaxial waveguide with the mixture, select CW frequency and measure amplitude and phase with the Network Analyzer for every point in the slot (typically 11). An effort is made to keep the resultant dielectric constant and conductivity within 5 % of published data.

Electrical Characteristics Measurement Setup



$$c = 3 \cdot 10^8 \ m/s$$

$$A = \frac{\Delta A}{20} \ln_{10} \frac{1}{m}$$

$$\theta = \frac{\Delta\theta \cdot 2\pi}{360}$$

$$\lambda = \frac{c}{f} \cdot \frac{100}{2.54} \text{inches}$$

$$\varepsilon_{re} = \frac{(A^2 + \theta^2) \cdot \lambda^2}{4\pi^2}$$

$$\theta' = \left| \frac{|A| \cdot \lambda}{4\pi\sqrt{\varepsilon_{re}}} \right|$$

$$S = \tan(2\theta')$$

$$\varepsilon_r = \frac{\varepsilon_{re}}{\sqrt{(1+S^2)}}$$

$$\sigma = S \cdot 2\pi \cdot f \cdot 8.854 \cdot 10^{12} \cdot \varepsilon_r \ (S/m)$$

where;

ΔA is the amplitude attenuation in dB

$\Delta\theta$ is the phase change in degrees for 5 cm of wave propagation in the slotted line

f is the frequency of interest in Hz.

5.6. SYSTEM CALIBRATION

The SAR measurement system has two main components:

a) the probe, which is connected to the inputs of
b) the instrumentation amplifier whose outputs are connected through the transmission line to
c) the computer.

The system is calibrated as one unit not as individual components. If any components is modified or replaced, the system must be re-calibrated.

The system calibration is performed by two steps:

1) determination of free space E-field from amplified probe outputs in a test RF field, and
2) correlation of the measured free space E-field and the measured E-field in the medium to temperature rise in a dielectric medium.

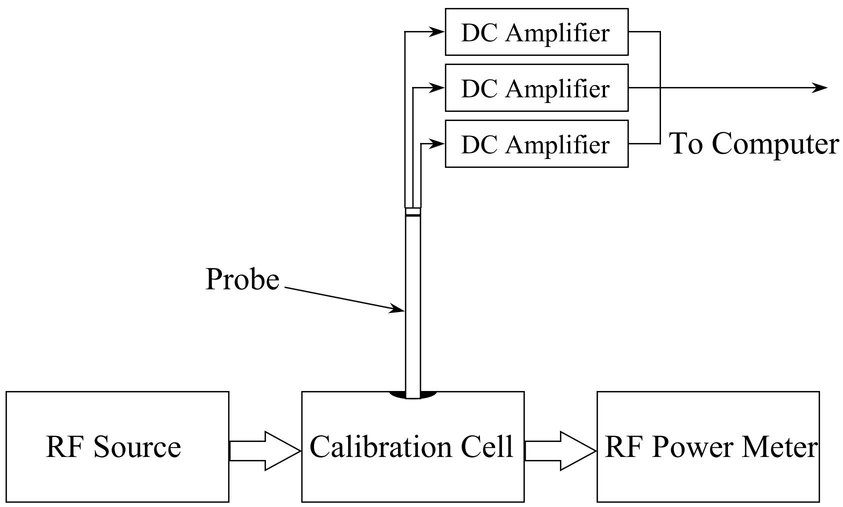
5.6.1. Determine E-Field from Amplified Probe Outputs

Note: Equipment must be regularly calibrated.

- RF Signal Generator - frequency range to at least 2 GHz,
- RF Amplifier - if needed to generate the required power density in the test cell,
- Test Cell - TEM (Crawford) cell, waveguide, or other device capable of maintaining a uniform field,
- RF Power Meter - capable of measuring at least 5 Watts (current calibration is mandatory!) if possible traceable to the National Institute of Standards and Technology (NIST).
- E-Field Probe (under Calibration)
- Probe Support Fixture
- Instrumentation Amplifier
- Transmission Line
- Computer Program with the Automated Calibration System Program

5.6.1.1. Method

Due to impedance variations in the diodes and the transmission line, and slight differences in gain between the channels of the instrumentation amplifier, a normalization method was designed. The calibration method actually used is to determine the factors necessary adjust each channel of the system so its indicated output can then be equated to the RF field. These factors are referred to as “Amplifier Settings”.



< Free Space Calibration Setup for Amplifier Setting >

5.6.1.2. Measurement

Free Space Calibration of E-field probes can be performed using a TEM cell manufactured by IFI (Instrumentation for Industry, Farmingdale, NY 11735) with operating frequency at or below 1 GHz.

- Connect the equipment as shown above;
- Adjust the RF generator output so that the power density inside the TEM cell is 1 mW/cm^2. (For the IFI model CC-110 cell, the correct power level is 271 mW);
- Mount the probe of the system to calibrate in the support fixture. Insert the probe through the aperture of the TEM cell. The probe handle should be at the geometric center of the aperture, i.e. midway between the septum and the upper surface, and orthogonal to the side of the cell. The sensing portion of the probe should be located at a point halfway across the depth of the cell (volumetric center).
- Once the prescribed position is obtained, it must be maintained during the rest of the measurement. The only movement of the probe allowed is rotation on its axis to position the dipole in the plane of the E-field and, for channel 3 only, parallel to the vertical uniform field (max./min. output).
- Verify that the RF power level remains constant throughout the measurement. While the probe is being rotated through 360 degrees, software indicators will show the maximum measured on each channel.

Thus, the amplifier settings for each channel are as follows:

$$AS_i = \frac{Sensor\_Factor}{V_{\max_i} - DC_i} \times \cos^2 \theta_i$$

Where:

As_i : Amplifier Setting for channel i
Sensor Factor : an arbitrary value 10.8 [mV/(mW/cm$^{2)}$]
$Vmax_i$: Maximum voltage recorded for channel i by rotation about the probe axis with the probe in a TEM cell
DC_i : DC offset of channel i (the voltage out of the transmission line with the instrumentation amplifier on and RF power off, recorded at the beginning of the probe calibration)
θ_i : Angles between the probe axis and the dipole sensor axis of channel i ($\theta_1 = \theta_2 = 45°$, $\theta_3 = 0°$ for I-beam probe, and $\theta_1 = \theta_2 = \theta_3 = 90° – 54.7° = 35.3°$ for triangular probe when the probe axis is assumed to be perpendicular to the plane of the septum inside TEM cell)

5.6.2. SAR from Temperature Measurement and Correlation to E-Field Probe

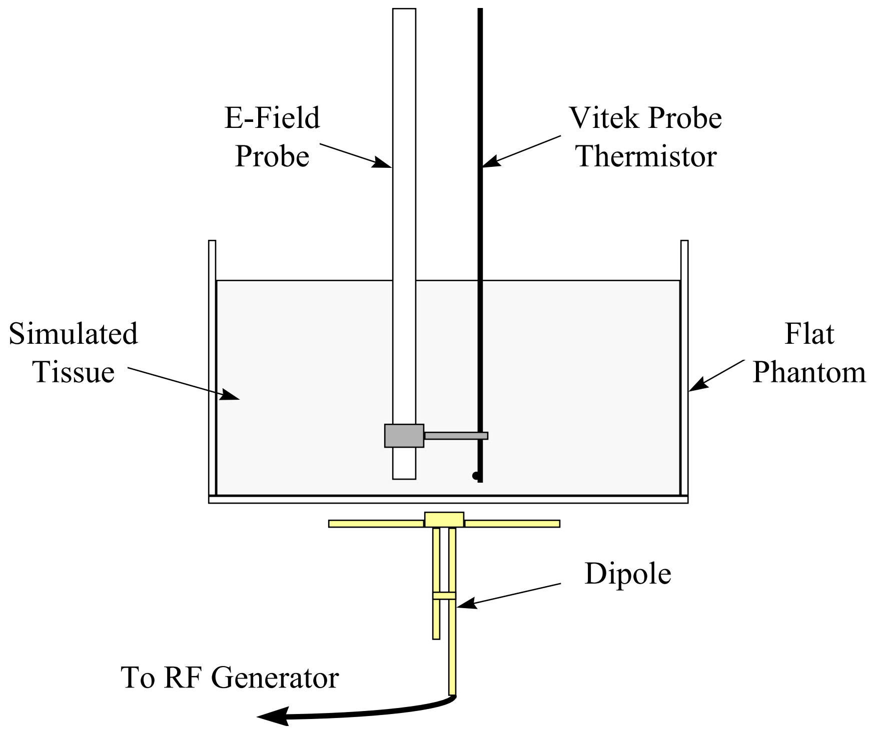
5.6.2.1. Measurement

A RF transparent thermistor based temperature probe and a isotropic E-field probe are placed side-by-side in a planar phantom while both are exposed to RF energy from a half wave dipole antenna located below the phantom The E-field probe and amplifiers were previously calibrated.

First, the location of the maximum E-field close to the phantom’s bottom is determined as a function of power into the dipole

Then, the E-field probe is moved sideways so that the temperature probe, while affixed to the E-field probe is placed at the previous location of the E-field probe.

Finally, temperature changes for a certain amount of time (generally 30 seconds) exposures at the same RF power levels used for the E-field are recorded. Care is taken to allow cooling down to the original temperature and temperature stabilization between tests.



Flat Phantom, Thermistor and E-Field Probe

The following simple equation relates SAR to the initial temperature slope:

$$SAR \cdot \Delta t = c \cdot \Delta T \qquad \text{(eq.1)}$$

In (eq.1) Δt is the exposure time (30 sec), c is the specific heat capacity of the simulated brain tissue (approximately c = 2.7 joules/g/^{o}C for simulated brain tissue) and ΔT is the temperature increase due to the RF exposure. SAR is proportional to ΔT/Δt, the initial rate of tissue heating, before thermal diffusion takes place.

From (eq.1) it is possible to quantify the electric field in the simulated tissue by equating the thermally-derived SAR to the E-field:

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho} \quad \text{(eq.2)}$$

where σ is the simulated tissue conductivity and ρ its density; typically ρ = 1.25 g/cm^3 for simulated brain tissue.

Since, even at the closest practical position, the E-field sensors are at a distance (≈ 3 mm) from the surface of the phantom shell, the field in the simulated tissue near the shell surface must be calculated. To do so, data are obtained as the probe is moved vertically, from the surface of the planar phantom.

The field attenuation is recorded and extrapolated to obtain the $|E|^2$ value at the surface of the phantom, where the maximum SAR is located. This method has given highly repeatable results. (the method is described in the next section).

5.6.2.2. *Determination of SAR Conversion Factor (CF)*

The conversion factor scales the E-field in terms of the thermally-derived SAR. It is the quotient of SAR_t, the SAR determined from temperature measurements in the flat phantom, and ΔV_t, the E-field prove output voltage obtained at the same location in the phantom

$$CF_{\left[mW/g/(mW/cm^2)\right]} = \frac{SAR_t}{\Delta V_t} \times 0.0108 \qquad (\Delta V_t \text{ in volts})$$

$$CF_{\left[mW/g/(mW/cm^2)\right]} = \frac{SAR_t}{\Delta V_t} \times 10.8 \qquad (\Delta V_t \text{ in mV})$$

For historical reasons, CF is scaled by the factor 10.8 [mV/(mw/cm^2)]. (see discussion to sensor factor in Appendix B) Note, as a result of the scaling constant (10.8 [mV/(mw/cm^2)]) the dimensions of CF are [mW/g/(mw/cm^2)].

The temperature E-field correlation is illustrated below (for simulated brain tissue) for an example in which the thermal quantities were,

RF power input = 0.5 W
$\Delta T = 0.0163^oC$ (from thermistor base temperature probe)
c = 2.7 J/g/^{o}C (simulated brain tissue) 3.0 (simulated muscle tissue)
Δt = 30 sec.

The resulting SAR_t was (eq.1)

SAR_t = (2.7 x 0.0163) / 30 = 1.47 mW/g

In this case the output of the E-field probe when at the same position as the thermistor probe was

ΔV_t = 28.5 mV (from the software acquisition screen)

The calculation of CF follows:

CF = (1.47[mW/g] / 28.5[mV]) x 10.8 [mV/(mw/cm^2)] = 0.56 [mW/g/(mw/cm^2)]

5.6.3. Data Acquisition Methodology

5.6.3.1. E-Field Measurement

The probe calibration must be current before starting measurements. Instrumentation amplifier batteries must be charged. This can be monitored by observing DC offset voltages. A daily log of the DC offset voltages should be kept for this purpose.

Measurements in the phantom are automatically calculated for each location by summation of the three dipole outputs. Because each dipole produces an output voltage proportional to the square of the electric field component along the dipole, the sum of dipole voltages represents the RMS values for the total electric field. Thus, taking into consideration the amplifier settings and the DC offset voltages, the total electric field strength at a measurement location is as follows. See Appendix C. Pd_{tot} is labeled by the software as measure of values (volts). The SAR for calculations that are derived from the measure of values are discussed below.

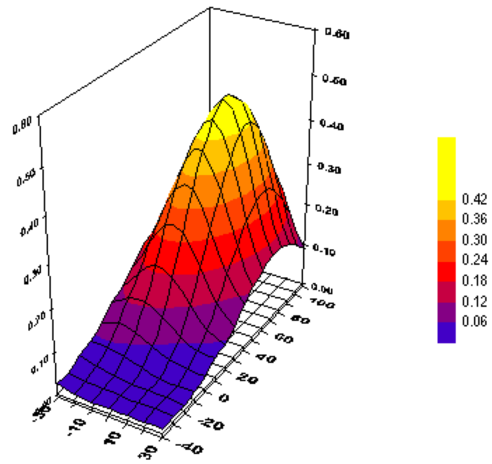
At each measurement point, the program records the output of the three channels:

$E_1 = V_1 - DC_1$
$E_2 = V_2 - DC_2$
$E_3 = V_3 - DC_3$
$Pd_{tot} = (E_1 \times AS_1) + (E_2 \times AS_2) + (E_3 \times AS_3)$

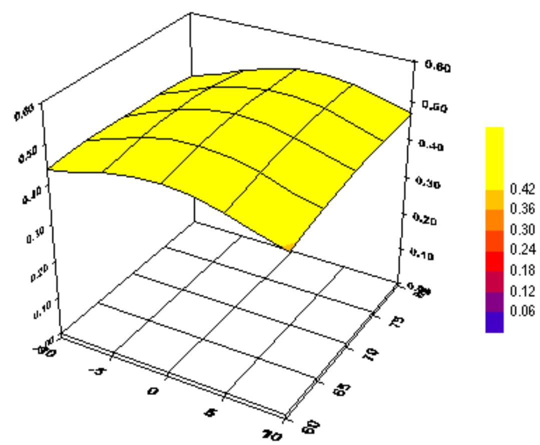
V_n = Voltmeter reading of channel n at one measurement point
E_n = Actual voltage of channel n at one measurement point
AS_n = amplifier setting of channel n
Pd_{tot} = Total probe output at one measurement point (see Appendix C)

5.6.3.2. SAR Measurement

The goals of the measurement process are to scan the phantom over a selected area in order to find the region of highest levels of RF energy and then to obtain a single value for the peak spatial average of SAR over a volume that would contain one gram (in the shape of a cube) of biological tissue (brain or muscle). The test procedure, of course, measures SAR in the simulated tissue.



The software request the user to move the probe to locations at two extreme corners of a rectangle that encloses the area to be scanned. An arbitrary origin and the spatial resolution for the scan are also specified. Under program control, the scan is performed automatically by the robot-guided probe.



Next, using a higher spatial resolution, the robot guides the probe through locations with the highest SAR. Finally, the SAR is averaged over the cubic volume surrounding the peak localized SAR. This spatially-averaged SAR is reported as SAR (W/kg).

5.6.3.3. Data Extrapolation

The distance from the center of the sensor (diode) to the end of the protective tube is called the 'probe offset'. To compensate we use an exponential curve fitting method to obtain the peak surface value from the voltages measured at the distance from the inner surface of the phantom. At the point where the highest voltage was recorded, the field is measured as close as possible to the phantom's surface and every 1mm along the ` Z ` axis for a distance of 50 mm. The appropriate exponential curve is obtained from all the points measured and used to define an exponential decay of the energy density versus depth.

$$E(z) = E_0 \cdot e^{-2\cdot z/\delta} \text{ (mV)}$$

5.6.3.4. Data Interpolation and Gram Averaging

The voltage, (1 cm) above the phantoms surface (E_{tot} 1 cm), is needed to calculate the exposure over one gram of tissue. This SAR value that estimates the average over 1 gram of tissue, is obtained by taking the integral over 1 cm^2 surface of the measured field along the exponential decay curve of the energy density with depth.

$$SAR(mW/g) = \int_{v=1g} SAR(\bullet)dv = \int_{s=1cm^2} \int_0^{1cm} E(z) \cdot \frac{CF}{SensorFactor} dzds$$

5.6.4. Determining the Heat Capacity of Simulated Tissue

5.6.4.1. Instruments and Materials

- Calibrated differential thermometer (Vitek or BAT-8 or equivalent)
- Two identical 500 ml containers
- A thermally insulated vessel (thick styrofoam, with a form fitting hole for one container)
- Hot and cold tap water
- Solution under test
- Hot plate
- Temperature vs. time (chart recorder, or data loger)

5.6.4.2. Method

Heat can be propagated by conduction, convection and radiation. In the case of liquids heated from below, gravity convection is the main and predominant heating mechanism of the fluid mass.

Obtain two containers that can be rapidly heated (e.g. glass or suitable plastic). Fill one container with 250 ml of water, the other with the same mass of simulated tissue. The initial temperature of the water should be the same as that of the simulated tissue ($\pm$1°C). Since we are dealing with heating by electromagnetic sources at ambient temperature, it is essential that we eliminate the chance of any direct infrared heating of the temperature sensor. To ensure this, position the tip of the sensor 2 mm from the bottom of the center of the container. Turn on the heat source and wait at least 5 minutes for its temperature to stabilize. Record the initial temperature of the water. Place the container of water 5 mm above the center of the hot plate and monitor the temperature increase.

After 30 seconds of heating, the water temperature should have increased by at least 5°C. Record the time and temperature. Remove the container from the heat source and place it in the thermally insulated vessel. Stir the liquid thoroughly and record the steady state temperature 1-2 minutes after stirring.

Repeat the above procedure using the container of simulated tissue. Ensure that the container is placed on the same area of the hot plate, is heated for the identical length of time, and the steady state temperature is recorded after the identical time interval.

Since the heat capacity of water is C_w = 1 cal/°C/g with excellent approximation (~1%) in the temperature range of interest, the heat capacity (C_s) of the solution is given by:

$$C_s = C_w \cdot \frac{\Delta T_w}{\Delta T_s}$$

where ΔT_w is the temperature increase of water and ΔT_s the temperature increase of the solution. The ration of the values, $\Delta T_w / \Delta T_s$, should be the same (within the sensivity of the thermometer) at the end of the heating and stirring. This ensures that the liquids have been uniformly heated.

5.6.4.3. Rationale

$$C \cdot \Delta T = Heat\_Flow \cdot Time = Total\_Heating\_Energy$$

If the heat flow, sample mass, and absorption (heat transfer) are the same for both liquids, then:

$$C_w \cdot \Delta T_w = C_s \cdot \Delta T_s$$

The heat flow and total heating are kept constant by using the same source for the same amount of time. If the heat transfer mechanisms for the woe liquids are about the same, with insignificant differences in convective and conductive characteristics, then any differences in temperature increase are a direct measure of the specific heat capacity, C.

5.6.5. Definition of Amplifier Setting and Other Terms

5.6.5.1. Related to Sensor Calibration

The initial sequence of probe calibrations steps performed with SAR determinations produces the factors used in scaling probe output voltage to RF power density. For historical reasons all probes factors are compared to a factor 10.8 mV per mW/cm^2 that was typical of a prototype probe, but is in fact an arbitrary ure. The factor of 10.8 mV/ mW/cm^2 is known as the sensor factor, but does not change. To calibrate a probe, each channel is assigned an amplifier setting.

This factor is obtained from the maximum probe output voltage measured during probe calibration. This probe output voltage is corrected for any DC offset of the instrumentation amplifier, usually a very small amount.

During calibration, for probe with I-beam cross-section, the channel 3 is aligned parallel to the E-field, but each of the channel 1 and 2 dipoles are at 45° to the direction of the field, resulting in outputs one half as large. Thus, the amplifier settings for each channel are as follows:

$$AS_i = \frac{Sensor\_Factor}{V_{\max_i} - DC_i} \times \cos^2 \theta_i$$

Where:

As_i : Amplifier Setting for channel i
Sensor_Factor : an arbitrary value 10.8 [mV/(mW/cm$^{2)}$]
$Vmax_i$: Maximum voltage recorded for channel i by rotation about the probe axis with the probe in a TEM cell
DC_i : DC offset of channel i (the voltage out of the transmission line with the instrumentation amplifier on and RF power off, recorded at the beginning of the probe calibration)
θ_i : Angles between the probe axis and the dipole sensor axis of channel i ($\theta_1 = \theta_2 = 45°$, $\theta_3 = 0°$ for I-beam probe, and $\theta_1 = \theta_2 = \theta_3 = 90° – 54.7° = 35.3°$ for triangular probe when the probe axis is assumed to be perpendicular to the plane of the septum inside TEM cell)

5.6.5.2. Note on Units and Various Calibration Factors

Three calibration factors, already defined, are used in the process of obtaining electric field strengths and SARs. This note shows how the units applicable to each are consistent and produce suitable units for the final quantities. The units Pd_{tot} are also discussed.

<u>Sensor Factor</u> is a numerical constant fixed by the properties of a particular probe used in the past. It represents the voltage output from a probe placed in a flux density of 1 mW/cm^2.

$$Sensor\_Factor = 10.8\left(mV/(mW/cm^2)\right)$$

$$Sensor\_Factor = 0.0108\left(V/(mW/cm^2)\right)$$

<u>Amplifier Setting</u> (AS) is a calibration factor that reflects the probe and amplifier properties. The values of AS for each channel are computed by the software. The data for the values of each AS are obtained when the E-field probe is rotated for maximum output from the probe channels while in a TEM cell with a field strength of 1 [mW/cm^2]. The AS values are shown on screen and in the output as Amplifier Channel Settings.

For a simple example, assume only channel 3 of the probe had a non-zero output. If CF = 0.56 (mW/g/V), $AS_3 = 0.375$ and $E_3 = 350$ mV, the SAR at this location is:

$$SAR = E_3 \cdot AS_3 \cdot \frac{CF}{Sensor\_Factor}$$

$$SAR = 0.350 \cdot 0.375 \cdot \frac{0.56}{0.0108} = 6.81\,[mW/g]$$

The appearance of the Sensor Factor in the denominator for the SAR calculation effectively cancels the introduction of the same scaling constant (10.8) used in making the calculation of CF. See above for discussion of the units for AS and Sensor Factor.

The numerical scaling for CF is based on the TEM cell measurement where a test flux density of 1 mW/cm^2 was used. This flux density corresponds to an electric field strength in the TEM cell of 0.614 V/cm, or the squared value of 0.377 V^2/cm^2 (E^2). For historical reasons, CF is defined in terms on an intermediate scaling constant for a particular probe which produced an output of 10.8 mV in the TEM cell when the field strength was 0.614 V/cm.

The units of the total output of the probe, Pd_{tot} are mV. In physical terms, the probe voltages are developed in diodes and represents an electric field squared (V^2/m^2) and equivalently a power density (W/kg). Therefore, Pd_{tot} is physically appropriate for measurement of SAR. To obtain the power density corresponding to Pd_{tot} perform the following calculation:

$$SAR = Pd_{tot} \times \frac{CF}{Sensor\_Factor}$$

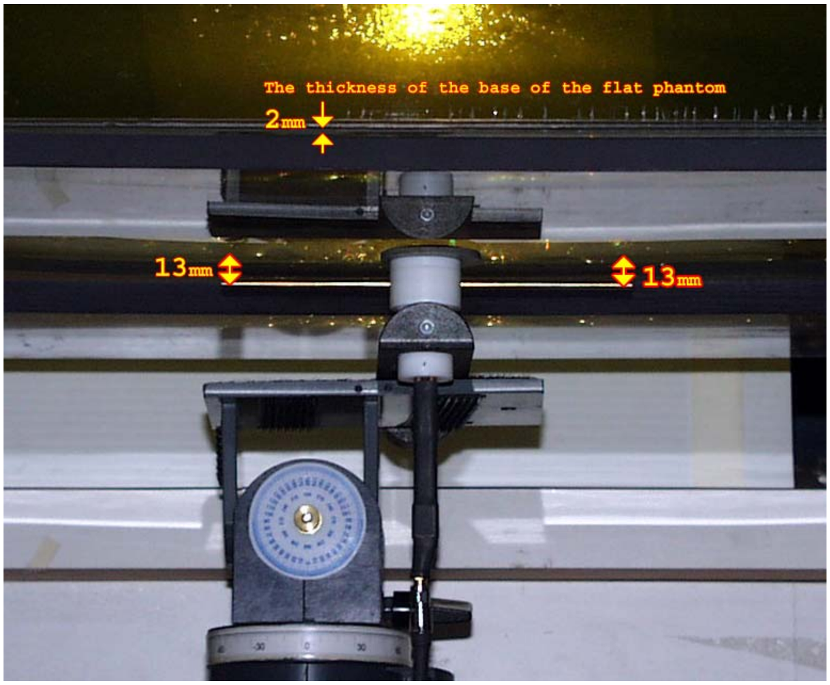
,or to show the units explicitly,

$$SAR(mW/g) = Pd_{tot}(mV) \times \frac{CF\left(mW/g/(mW/cm^2)\right)}{Sensor\_Factor\left(mV/(mW/cm^2)\right)}$$

5.7. SAR MEASUREMENT SYSTEM VALIDATION

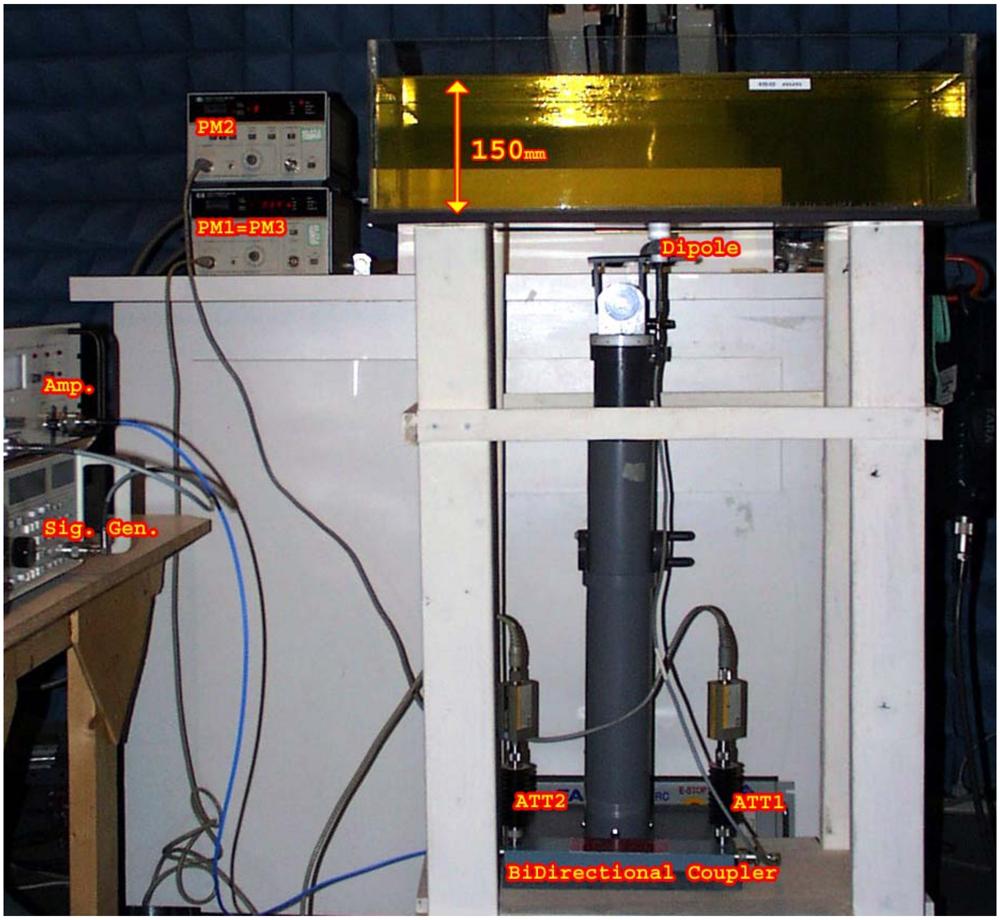
5.7.1. Standard Source

A half-wave dipole is 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 center of the dipole axis, *s*, is chosen as specified IEEE 1528 at the specific test frequency (i.e. 15 mm at 835 MHz). A low loss and low dielectric constant spacer is used to establish the correct distance between the top surface of the dipole and the bottom surface of the phantom.



5.7.2. Standard Source Input Power Measurement

The system validation is performed as shown below or in Figure 7.1 in IEEE 1528.



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 0.01dB steps, the remaining difference at PM2 must be taken into consideration. PM3 records the reflected power from the dipole to ensure that the value is not changed from the previous value. The reflected power was verified to be at least 20dB below the forward power.

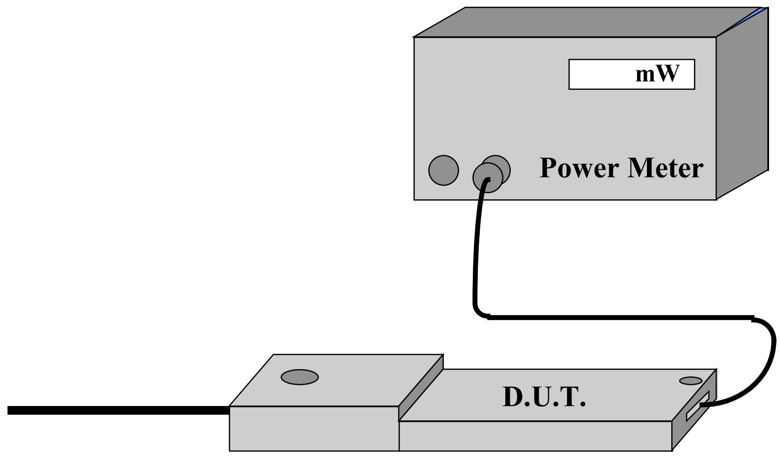
5.7.3. System Validation Procedure

A complete 1g-averaged SAR measurement is performed. The measured 1g-averaged SAR value is normalized to a forward power of 1W to a half-wave dipole and compared with the reference SAR value for the reference dipole and flat phantom shown in columns 2 and 3 of Table 7.1 in IEEE 1528.

5.8. POWER MEASUREMENT

Whenever possible, a conducted power measurement is performed. To accomplish this, we utilize a fully charged battery, a calibrated power meter and a cable adapter provided by the manufacturer. The data of the cable and related circuit losses are also provided by the manufacturer. The power measurement is then performed across the operational band and the channel with the highest output power is recorded.

Power measurement is performed before and after the SAR to verify if the battery was delivering full power at the time of testing. A difference in output power would determine a need for battery replacement and to repeat the SAR test.



Measured Power + Cable and Switching Mechanism Loss

5.9. POSITIONING OF D.U.T.

The clear SAM phantom shell have been previously marked with a highly visible grid with a defined centre line, so it can easily be seen through the liquid simulated tissue. In the case of testing a cellular phone, this line is connecting the ear channel with the corner of the lips. The D.U.T. is then placed by centering the speaker with the ear channel and the center of the radio width with the corner of the mouth.

For HAND HELD devices (push-to-talk), or any other type of wireless transmitters postioned in front of the face, the D.U.T. will be positioned 2.5cm distance from a flat phantom to simulate the frontal facial position in use. All body-worn operating configurations are tested using a flat phantom. The length and width of the phantom is at least twice the corresponding dimensions of the test device, including its antenna.

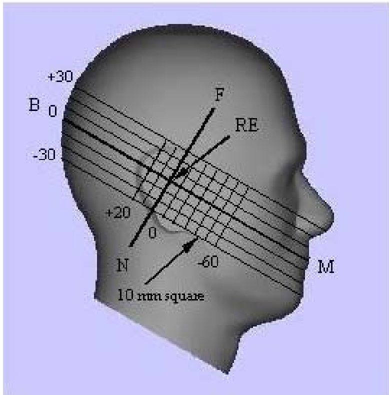


Figure 5.1 – Side view of the phantom showing relevant marking

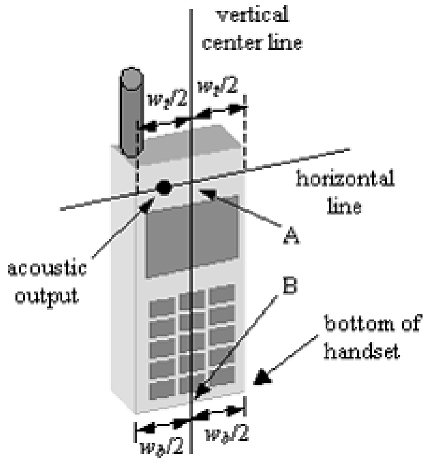


Figure 5.2a – Handset vertical and horizontal reference lines – fixed case

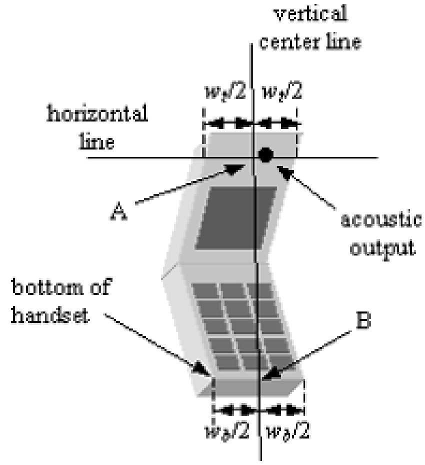


Figure 5.2b – Handset vertical and horizontal reference lines – "clam-shell"

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

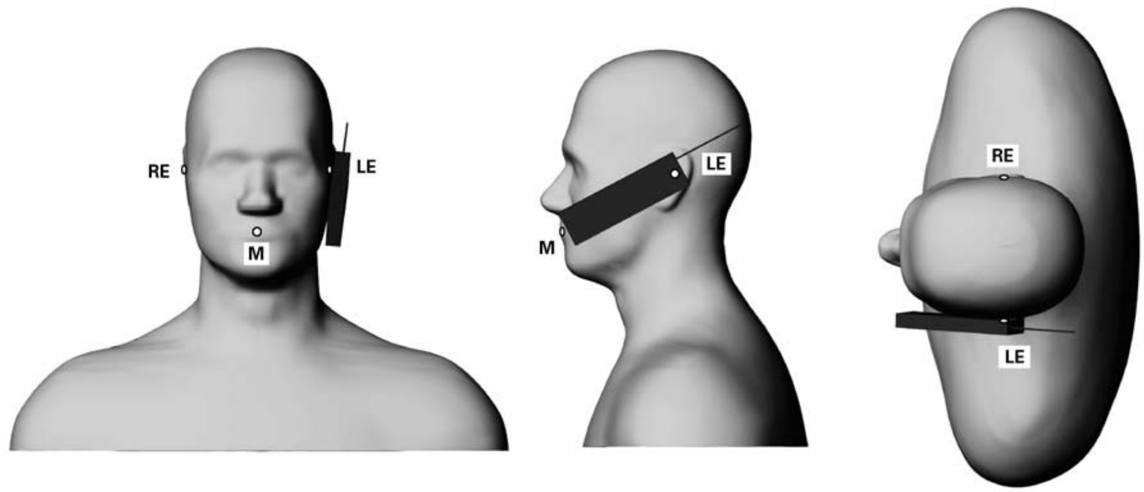


Figure 5.3 – Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

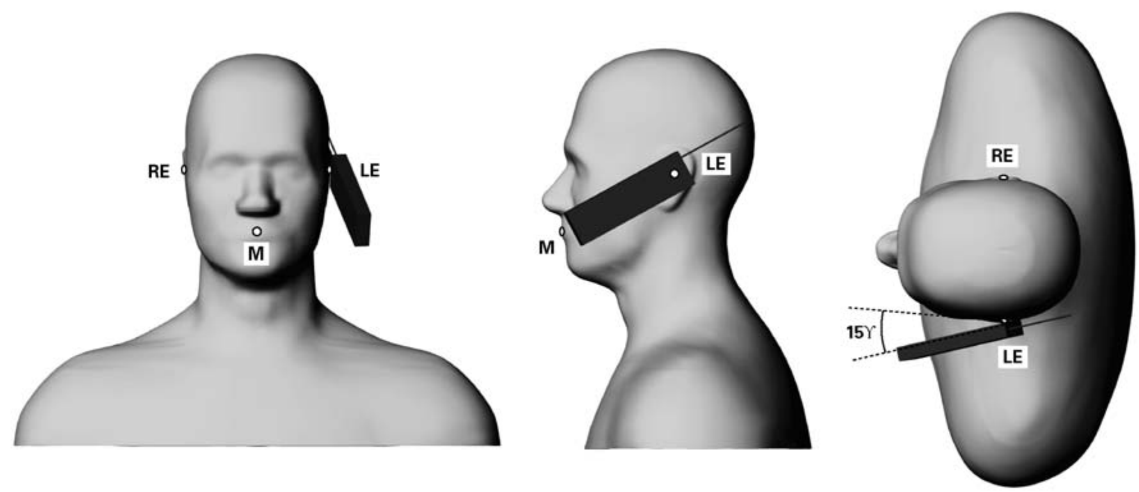


Figure 5.4 – Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

5.10. SAR MEASUREMENT UNCERTAINTY

This uncertainty analysis covers the 3D-EMC Laboratory test procedure for Specific Absorption Rate (SAR) associated with wireless telephones and similar devices.

Standards Covered Are:

WGMTE 96/4 - Secretary SC211/B

FCC 96-326, ET Docket No. 93-62

Industry Canada RSS 102

ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)

The laboratory test procedure, and this uncertainty analysis, may be used to cover all standards above. It is based on test equipment and procedures specified by 3D-EMC Laboratories, Inc. located in Ft. Lauderdale, Florida.

5.10.1. Measurement Uncertainty

5.10.1.1. Measurement Uncertainty evaluation for handset SAR test

a	*b*	*c*	*d*	*e = f(d,k)*	*F*	*g*	*h = c x f / e*	*i = c x g / 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	3.0	N	1	1	1	3.0	3.0	∞
Axial Isotropy	E1.2	5.0	R	√3	0.7	0.7	2.0	2.0	∞
Hemispherical Isotropy	E1.2	8.0	R	√3	1	1	4.6	4.6	∞
Boundary Effect	E1.3	10.0	R	√3	1	1	5.8	5.8	∞
Linearity	E1.4	4.2	R	√3	1	1	2.4	2.4	∞
System Detection Limits	E1.5	2.0	R	√3	1	1	1.2	1.2	∞
Readout Electronics	E1.6	1.0	N	1	1	1	1.0	1.0	∞
Response Time	E1.7	1.5	R	√3	1	1	0.9	0.9	∞
Integration Time	E1.8	2.0	R	√3	1	1	1.2	1.2	∞
RF Ambient Conditions	E5.1	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E5.2	1.0	R	√3	1	1	0.6	0.6	∞
Probe Positioning with respect to Phantom Shell	E5.3	3.0	R	√3	1	1	1.7	1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E4.2	3.5	R	√3	1	1	2.0	2.0	∞
Test sample Related									
Test Sample Positioning	E3.2.1	7.5	N	1	1	1	7.5	7.5	*11*
Device Holder Uncertainty	E3.1.1	6.5	N	1	1	1	6.5	6.5	*8*
Output Power Variation - SAR drift measurement	5.6.2	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	E2.1	4.0	R	√3	1	1	2.3	2.3	∞
Liquid Conductivity Target - tolerance	E2.2	5.0	R	√3	0.7	0.5	2.0	1.4	∞
Liquid Conductivity - measurement uncertainty	E2.2	4.0	R	√3	0.7	0.5	1.6	1.2	∞
Liquid Permittivity Target tolerance	E2.2	5.0	R	√3	0.6	0.5	1.7	1.4	∞
Liquid Permittivity - measurement uncertainty	E2.2	4.0	R	√3	0.6	0.5	1.4	1.2	∞
Combined Standard Uncertainty			RSS				14.3	14.2	
Expanded Uncertainty (95% confidence interval)							**28.5**	**28.3**	

5.10.1.2. *Measurement Uncertainty for System Performance Check*

a	*b*	*c*	*d*	*e = f(d,k)*	*f*	*g*	*h = c x f / e*	*i = c x g / 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 **or** v_{eff}
Measurement System									
Probe Calibration	E1.1	3.0	N	1	1	1	3.0	3.0	∞
Axial Isotropy	E1.2	5.0	R	√3	0.7	0.7	2.0	2.0	∞
Hemispherical Isotropy	E1.2	8.0	R	√3	1	1	4.6	4.6	∞
Boundary Effect	E1.3	10.0	R	√3	1	1	5.8	5.8	∞
Linearity	E1.4	4.2	R	√3	1	1	2.4	2.4	∞
System Detection Limits	E1.5	2.0	R	√3	1	1	1.2	1.2	∞
Readout Electronics	E1.6	1.0	N	1	1	1	1.0	1.0	∞
Response Time	E1.7	1.5	R	√3	1	1	0.9	0.9	∞
Integration Time	E1.8	2.0	R	√3	1	1	1.2	1.2	∞
RF Ambient Conditions	E5.1	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E5.2	0.4	R	√3	1	1	0.2	0.2	∞
Probe Positioning with respect to Phantom Shell	E5.3	3.0	R	√3	1	1	1.7	1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E4.2	3.5	R	√3	1	1	2.0	2.0	∞
Dipole									
Dipole Axis to Liquid Distance	7, X3.2	2.0	R	√3	1	1	1.2	1.2	∞
Input Power and SAR Drift Measurement	7, 5.6.2	3.0	R	√3	1	1	1.7	1.7	∞
Phantom and Tissue Parameters									
Phantom Uncertainty - shell thickness tolerance	E2.1	4.0	R	√3	1	1	2.3	2.3	∞
Liquid Conductivity – deviation from target values	E2.2	5.0	R	√3	0.7	0.5	2.0	1.4	∞
Liquid Conductivity - measurement uncertainty	E2.2	4.0	R	√3	0.7	0.5	1.6	1.2	∞
Liquid Permittivity – deviation from target values	E2.2	5.0	R	√3	0.6	0.5	1.7	1.4	∞
Liquid Permittivity - measurement uncertainty	E2.2	4.0	R	√3	0.6	0.5	1.4	1.2	∞
Combined Standard Uncertainty			RSS				10.0	9.9	
Expanded Uncertainty (95% confidence interval)							**20.1**	**19.8**	

EXHIBIT 6. SAR PRESCANS

6.1.1. Body-Worn Configuration

6.1.1.1. Test configurations used

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device. The D.U.T. was placed against the phantom and tested in its appropriate holster as would normally be used by the end user. If the SAR measured at the middle channel for each test is at least 32.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).

If the transmission band of the test device is less than 10 MHz, testing at the high and low frequency channels is optional.

When multiple accessories that do not contain metallic components are supplied with the device, the device may be tested with only the accessory that dictates the closest spacing to the body. When multiple accessories that contain metallic components are supplied with the device, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (e.g., 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 must be tested.

Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components..

6.1.1.2. Equipment permutation investigated for each orientation

Three configurations, the front of the D.U.T. against the phantom with the tip of the antenna in contact, the rear of the D.U.T. against the phantom with the tip of the antenna in contact and the top of the D.U.T. against the phantom with the tip of the antenna in contact, were investigated in order to find the worst case exposure.

6.1.1.3. Comments on non-tested configurations

Through the prescan that covers the entire D.U.T., it was evident that the measurable power density is distributed along the antenna only. Thus some insignificant configurations such as the right of the D.U.T. against the phantom, the left of the D.U.T. against the phantom and the bottom of the D.U.T. against phantom, were not investigated.

6.2. RECOMMENDED CAUTION STATEMENTS TO BE INCLUDED IN USERS MANUAL

In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and caution statements should be included in the manual. The information should allow users to make informed decisions on the type of body-worn accessories and operating configurations that are appropriate for the device. The following are *examples* of typical statements that provide end-users with the necessary information about body-worn accessories:

Example 1. For a product that has the potential to be used in a body worn configuration and has been tested and certified with a specific accessory device(s):

"For body worn operation, this phone has been tested and meets the FCC RF exposure guidelines when used with the (*manufacturer name*) accessories supplied or designated for this product. Use of other accessories may not ensure compliance with FCC RF exposure guidelines. "

Example 2. For a product that has the potential to be used in a body worn configuration and has not been certified with a specific accessory device(s):

"For body worn operation, this phone has been tested and meets FCC RF exposure guidelines when used with an accessory that contains no metal and that positions the handset a minimum of (specified distance) from the body. Use of other accessories may not ensure compliance with FCC RF exposure guidelines."

Example 3. For a product that has the potential to be used in a body worn configuration with future manufacturer designed accessories:

"For body worn operation, this phone has been tested and meets the FCC RF exposure guidelines when used with a (*manufacturer name*) accessory designated for this product or when used with an accessory that contains no metal and that positions the handset a minimum of (specified distance) from the body."

6.3. PRESCAN DATA FOR WORST CONFIGURATION OF RF EXPSOSURE

6.3.1. Body-Worn Configuration

Configuration // Modification	Antenna Position	SAR (W/kg)
Front of D.U.T. against the phantom and the tip of the antenna in contact, 100% duty cycle, 11 Mbps // No Modification	Fixed	0.10
Rear of D.U.T. against the phantom and the tip of the antenna in contact, 100% duty cycle, 11 Mbps // No Modification	Fixed	1.36
Top of D.U.T. against the phantom and the tip of the antenna in contact, 100% duty cycle, 11 Mbps // No Modification	Fixed	0.00
Rear of D.U.T. against the phantom and the tip of the antenna in contact, 100% duty cycle, 1 Mbps // No Modification	Fixed	1.27
Rear of D.U.T. against the phantom and the tip of the antenna in contact, 100% duty cycle, 11 Mbps // No Modification	Fixed	1.36

Prescans for the feasible configurations had been performed in order to determine the worst case under the specific configurations as described in the table. Through these prescans, the hot spot was found to be located at the vicinity of the mid-point of the antenna.

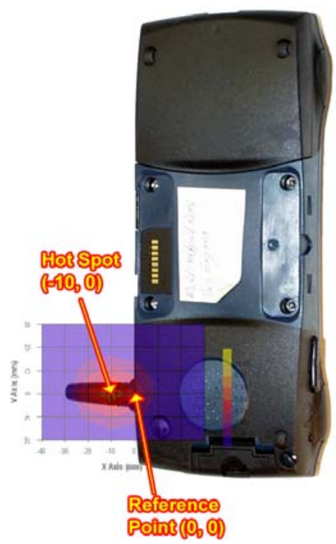
EXHIBIT 7. SAR MEASUREMENT

7.1. BODY-WORN CONFIGURATION

7.1.1. Rear of the D.U.T. against the phantom and the tip of the antenna in contact

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	MAX. SAR* [W/Kg]
01	Rear of the D.U.T. faced toward the phantom Tip of the antenna in contact 11 Mbps Data Rate	0 mm separation	Fixed	2412	CH01	0.29 (1.51)*
02				2437	CH06	0.26 (1.36)*
03				2462	CH11	0.26 (1.36)*

Unless otherwise specified, the reference point (0, 0) in the plots was set to the point at the base of antenna in the projected image of D.U.T. to the phantom surface.



* The value in the parenthesis indicates the actual measured SAR value using the special software provided by manufacturer (for the SAR test purpose only) which make the D.U.T. transmit continuously (Refer to section 2.4 for duty cycle information). However the D.U.T. is limited to transmit a maximum duty cycle of 19 % on the network the radio modem is designed to be used in, therefore the factor of 0.19 was applied to compensate the duty cycle. (Refer to section 8.1)

Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2412 MHz

Test Information

Date : 06/26/2002
Time : 3:20:15 PM

Product	: NETPAD with TRX7431	**Test**	: SAR
Manufacturer	: PSION TEKLOGIX INC.	**Frequency (MHz)**	: 2412
Model Number	: NETPAD RLAN	**Nominal Output Power (dBm)**	: 17.7
Serial Number	: Eng 001	**Antenna Type**	: Stubby
FCC ID Number	: GM3WLPC24H	**Signal**	: DSSS

Phantom	: Waist	**Dielectric Constant**	: 54.33
Simulated Tissue	: Muscle	**Conductivity**	: 1.86

Probe	: UT-ETR-0200-1	**Antenna Position**	: Fixed
Probe Offset (mm)	: 2.250	**Measured Power (dBm) (conducted)**	: 17.7
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 2.678		
Calibrated Date	: 2/14/2002		

Amplifier Setting :

Channel 1 : 0.0047 Channel 2 : 0.0046 Channel 3 : 0.0061

Location of Maximum Field :

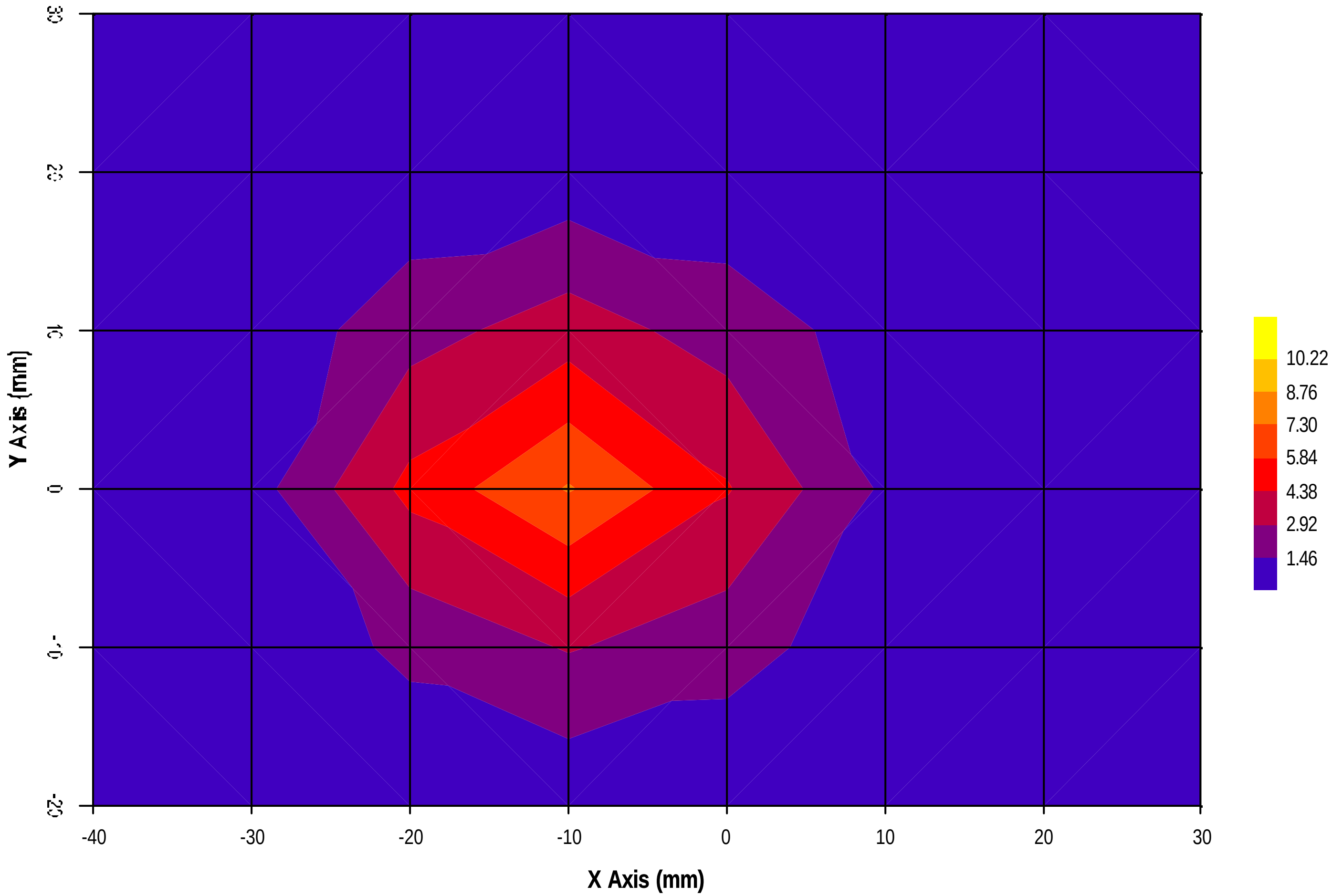
X = -10 Y = 0

Measured Values (mV) :

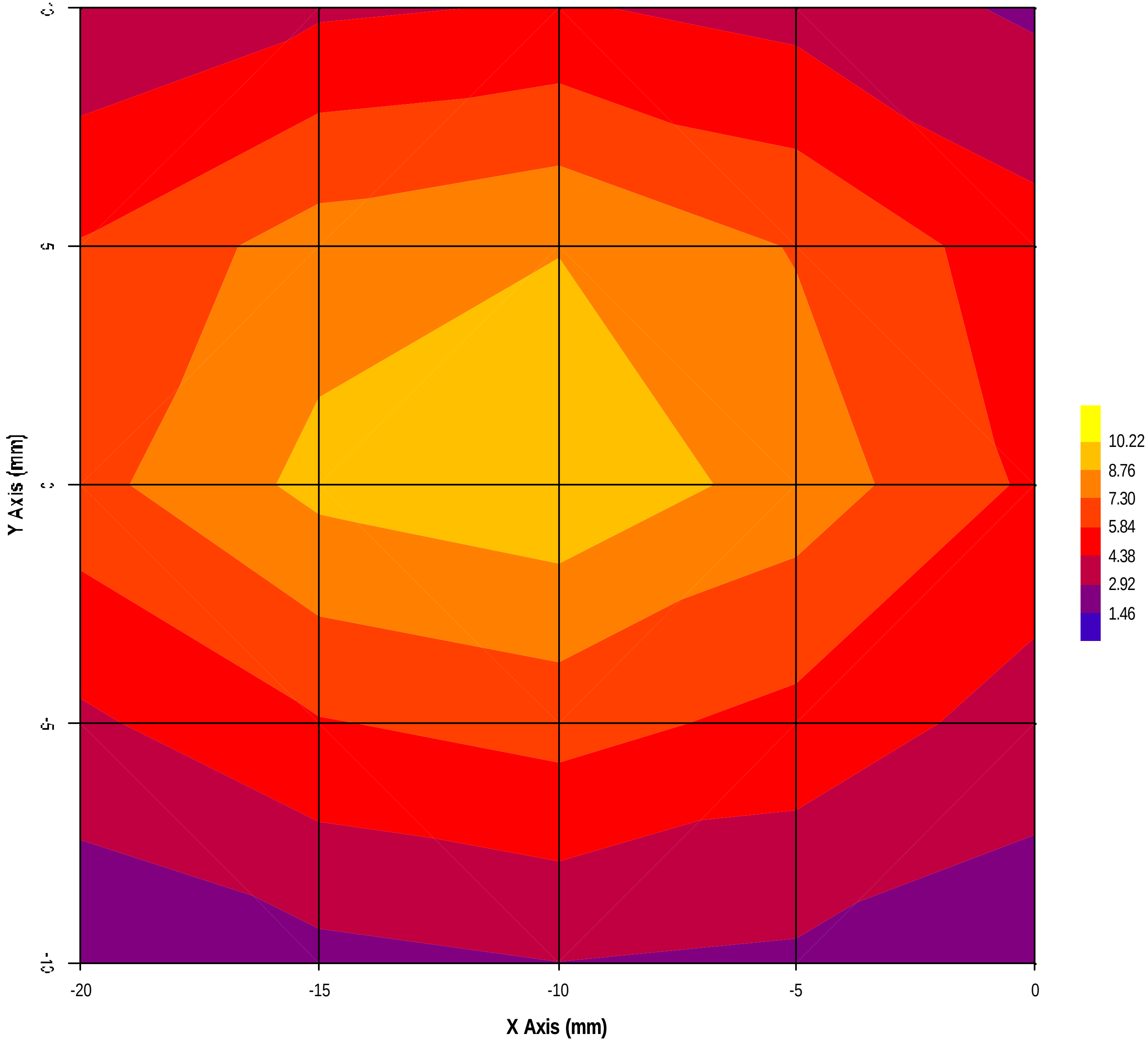
11.585	9.505	8.221	7.038	6.109	5.286
4.673	4.083	3.596	3.137	2.731	

Peak Voltage (mV) : 16.457 **1 Cm Voltage (mV)** : 3.537 **SAR (W/Kg)** : 1.506

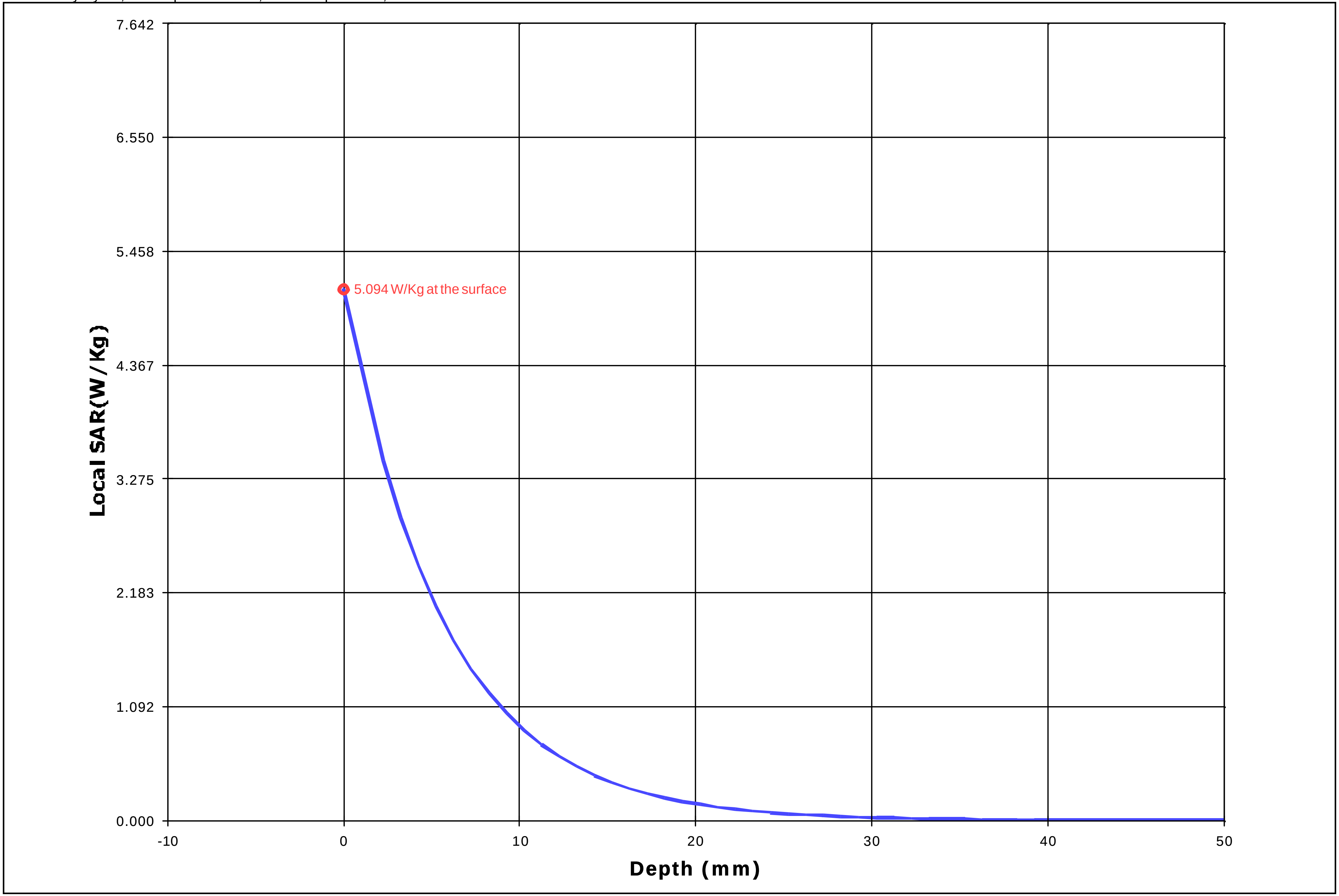
Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2412 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2412 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2412 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2437 MHz

Test Information

Date : 06/26/2002
Time : 11:41:08 AM

Product	: NETPAD with TRX7431	**Test**	: SAR
Manufacturer	: PSION TEKLOGIX INC.	**Frequency (MHz)**	: 2437
Model Number	: NETPAD RLAN	**Nominal Output Power (dBm)**	: 17.7
Serial Number	: Eng 001	**Antenna Type**	: Stubby
FCC ID Number	: GM3WLPC24H	**Signal**	: DSSS

Phantom	: Waist	**Dielectric Constant**	: 54.33
Simulated Tissue	: Muscle	**Conductivity**	: 1.86

Probe	: UT-ETR-0200-1	**Antenna Position**	: Fixed
Probe Offset (mm)	: 2.250	**Measured Power (dBm) (conducted)**	: 17.7
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 2.678		
Calibrated Date	: 2/14/2002		

Amplifier Setting :

Channel 1 : 0.0047 Channel 2 : 0.0046 Channel 3 : 0.0061

Location of Maximum Field :

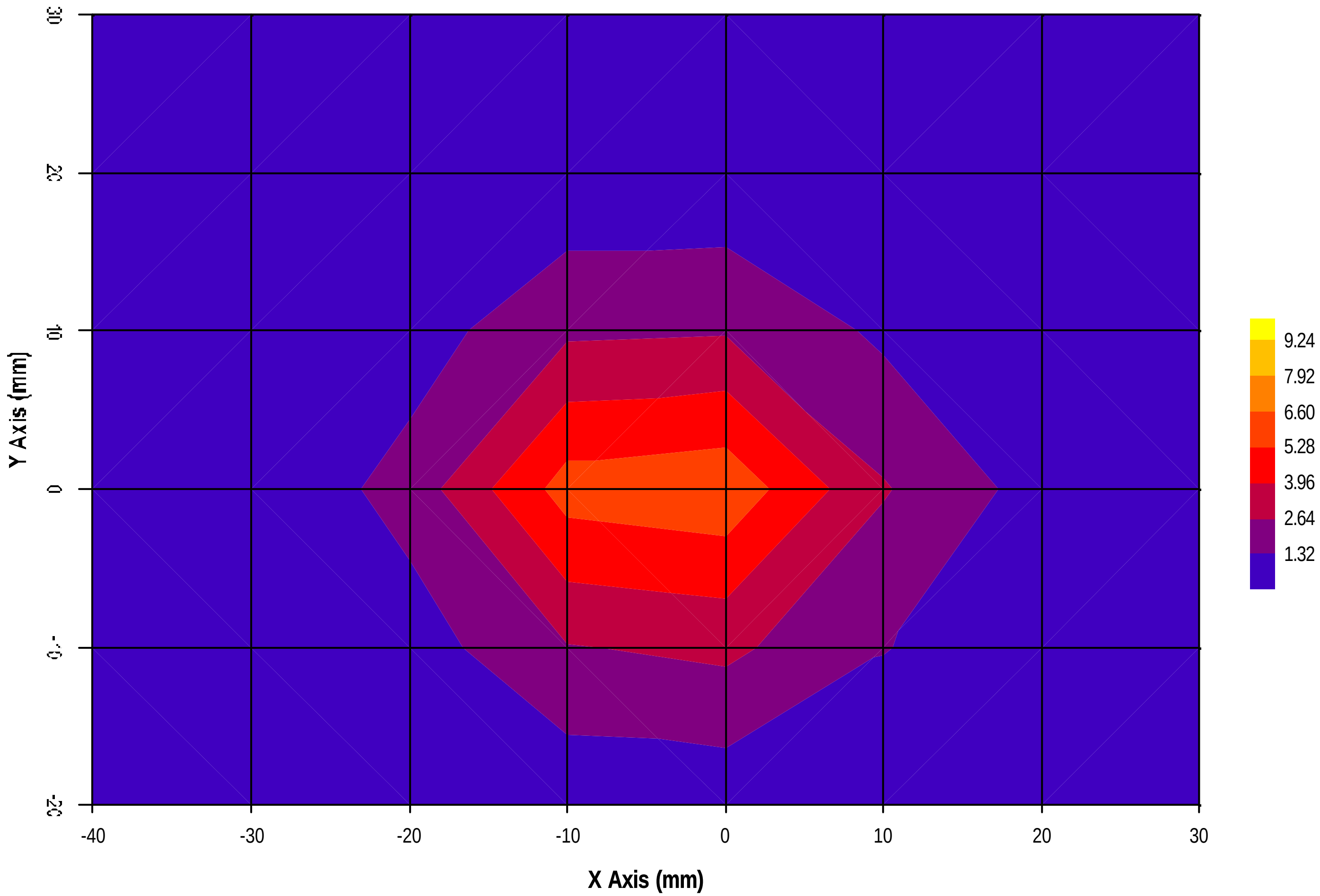
X = -5 Y = 0

Measured Values (mV) :

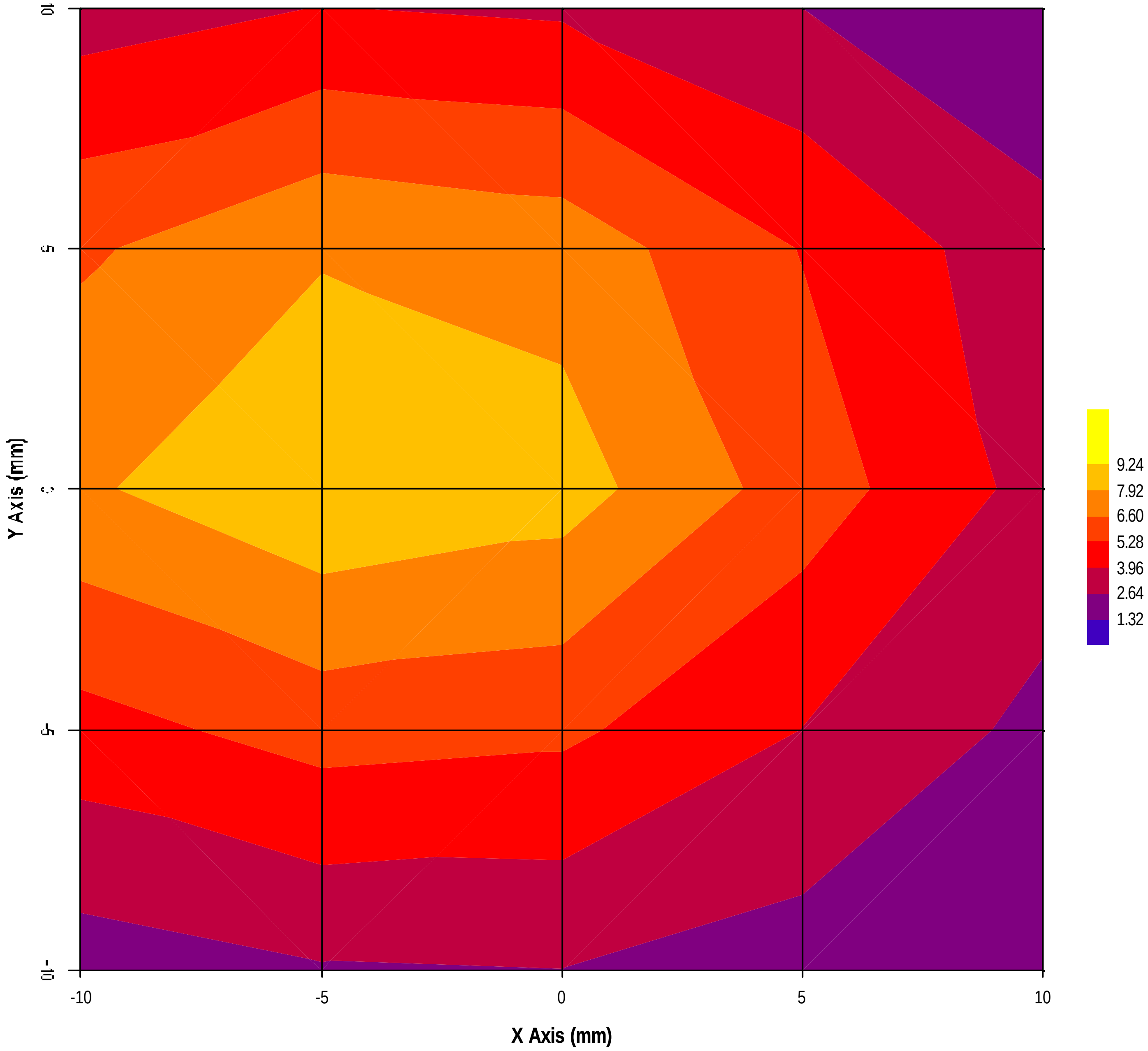
10.572	8.673	7.340	6.384	5.485	4.709
4.063	3.541	3.116	2.690	2.327	

Peak Voltage (mV) : 15.174 **1 Cm Voltage (mV)** : 3.078 **SAR (W/Kg)** : 1.363

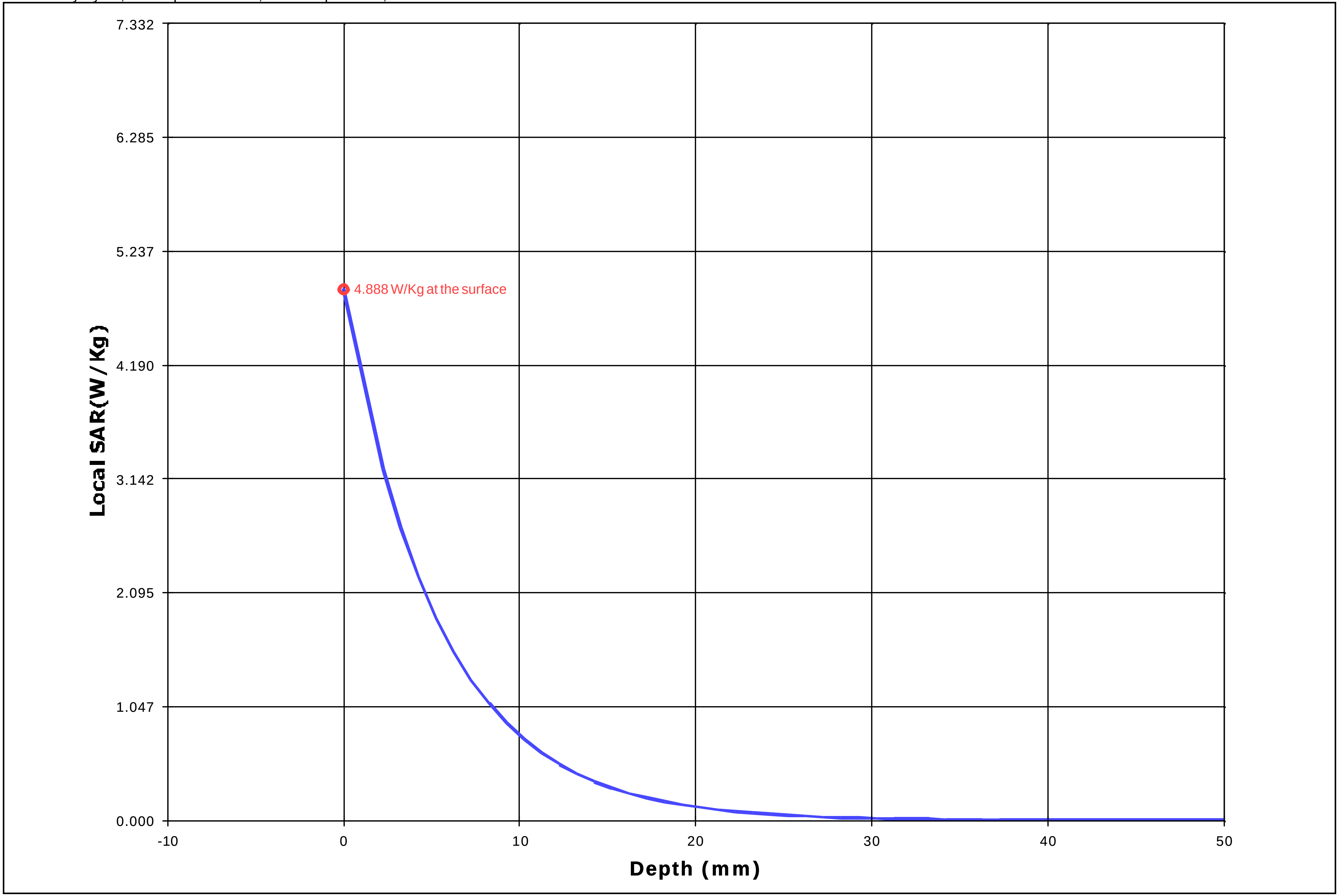
Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2437 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2437 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2437 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2462 MHz

Test Information

Date : 06/26/2002
Time : 2:52:58 PM

Product	: NETPAD with TRX7431	**Test**	: SAR
Manufacturer	: PSION TEKLOGIX INC.	**Frequency (MHz)**	: 2462
Model Number	: NETPAD RLAN	**Nominal Output Power (dBm)**	: 17.7
Serial Number	: Eng 001	**Antenna Type**	: Stubby
FCC ID Number	: GM3WLPC24H	**Signal**	: DSSS

Phantom	: Waist	**Dielectric Constant**	: 54.33
Simulated Tissue	: Muscle	**Conductivity**	: 1.86

Probe	: UT-ETR-0200-1	**Antenna Position**	: Fixed
Probe Offset (mm)	: 2.250	**Measured Power (dBm) (conducted)**	: 17.7
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 2.678		
Calibrated Date	: 2/14/2002		

Amplifier Setting :

Channel 1 : 0.0047 Channel 2 : 0.0046 Channel 3 : 0.0061

Location of Maximum Field :

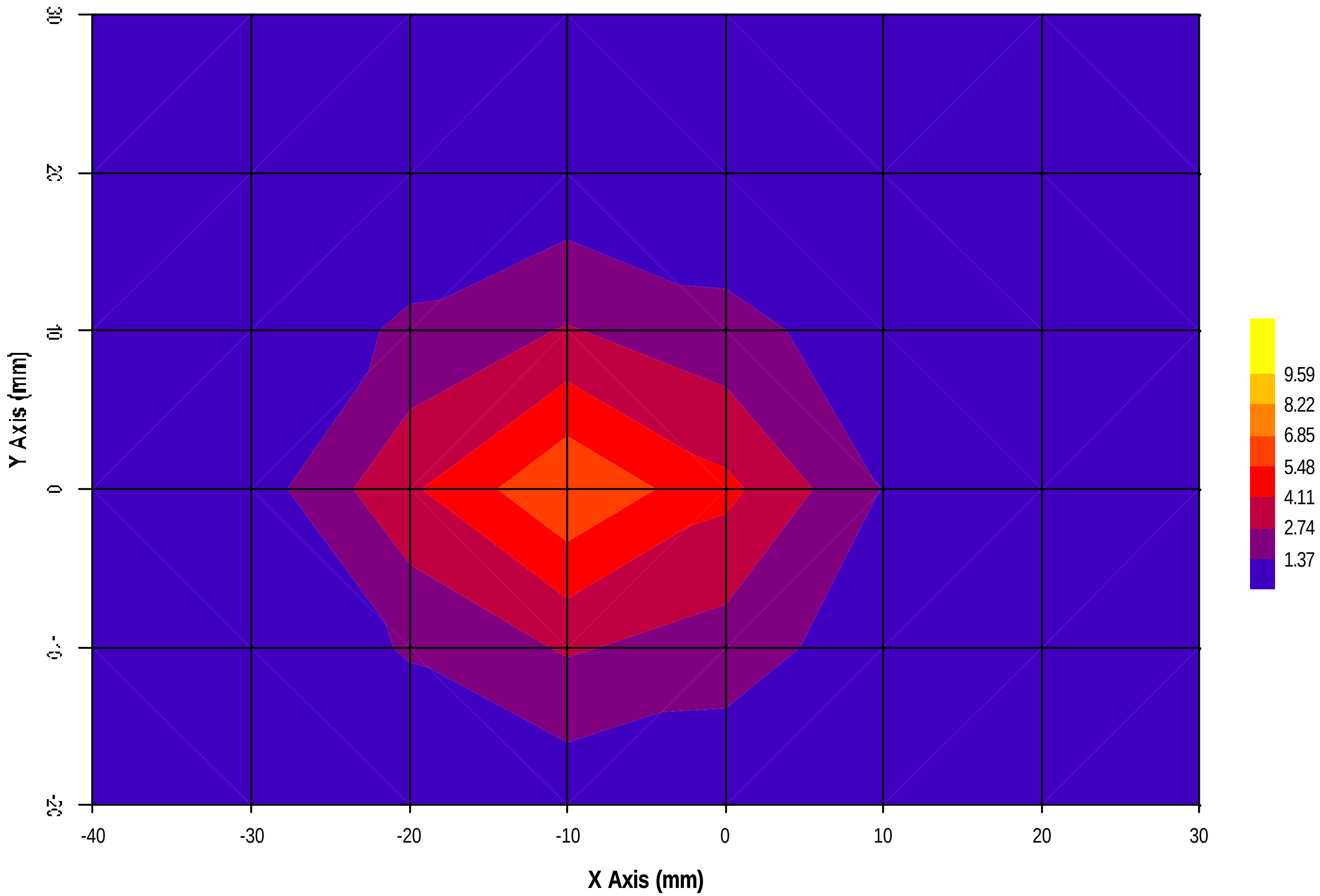
X = -10 Y = 0

Measured Values (mV) :

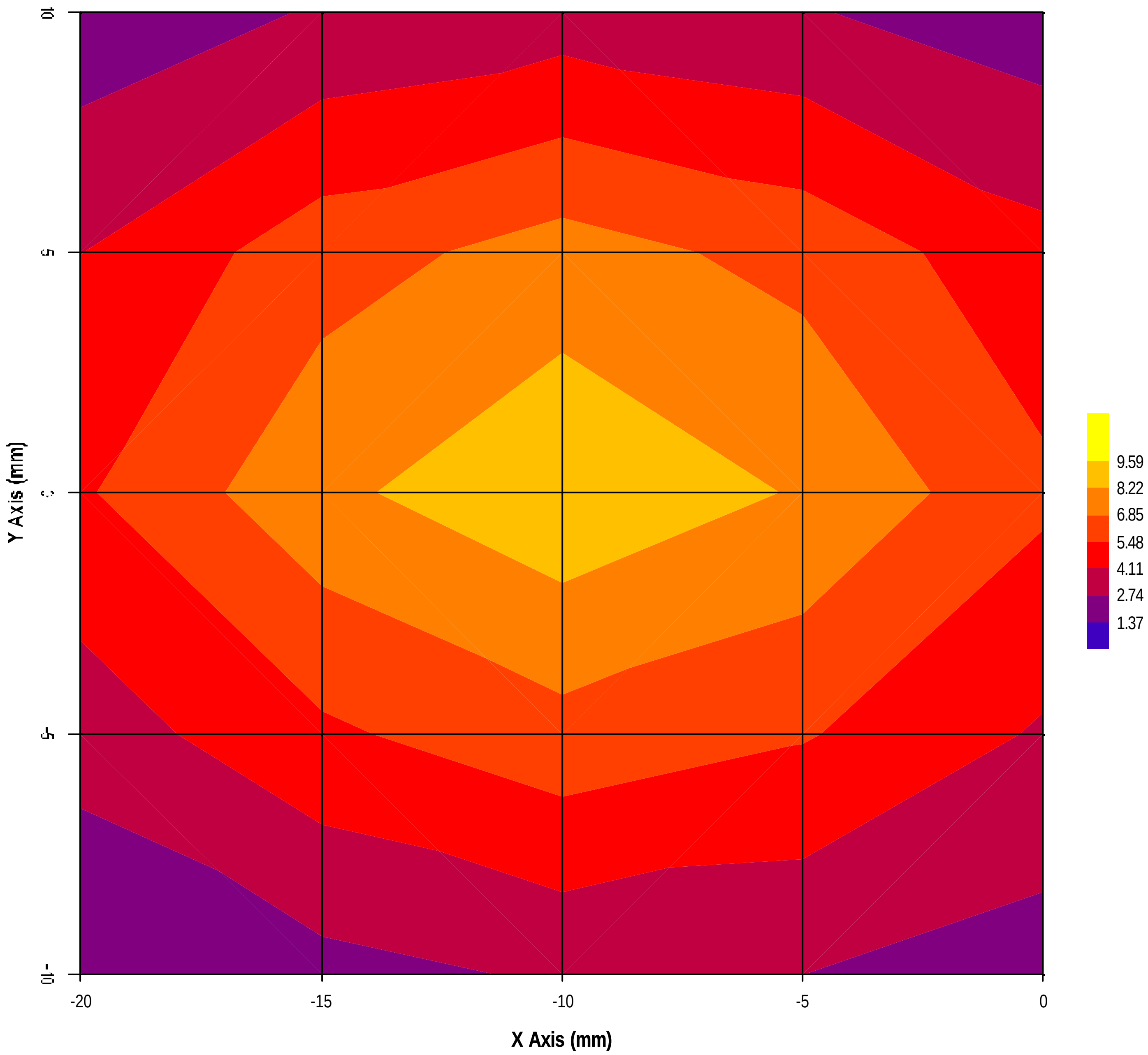
11.069	9.075	7.666	6.591	5.609	4.840
4.228	3.663	3.239	2.815	2.374	

Peak Voltage (mV) : 16.069 **1 Cm Voltage (mV)** : 3.162 **SAR (W/Kg)** : 1.362

Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2462 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2462 MHz



Rear of the D.U.T. against the phantom with the tip of the antenna in contact
100% duty cycle, 11 Mbps data rate,0 mm separation, 2462 MHz

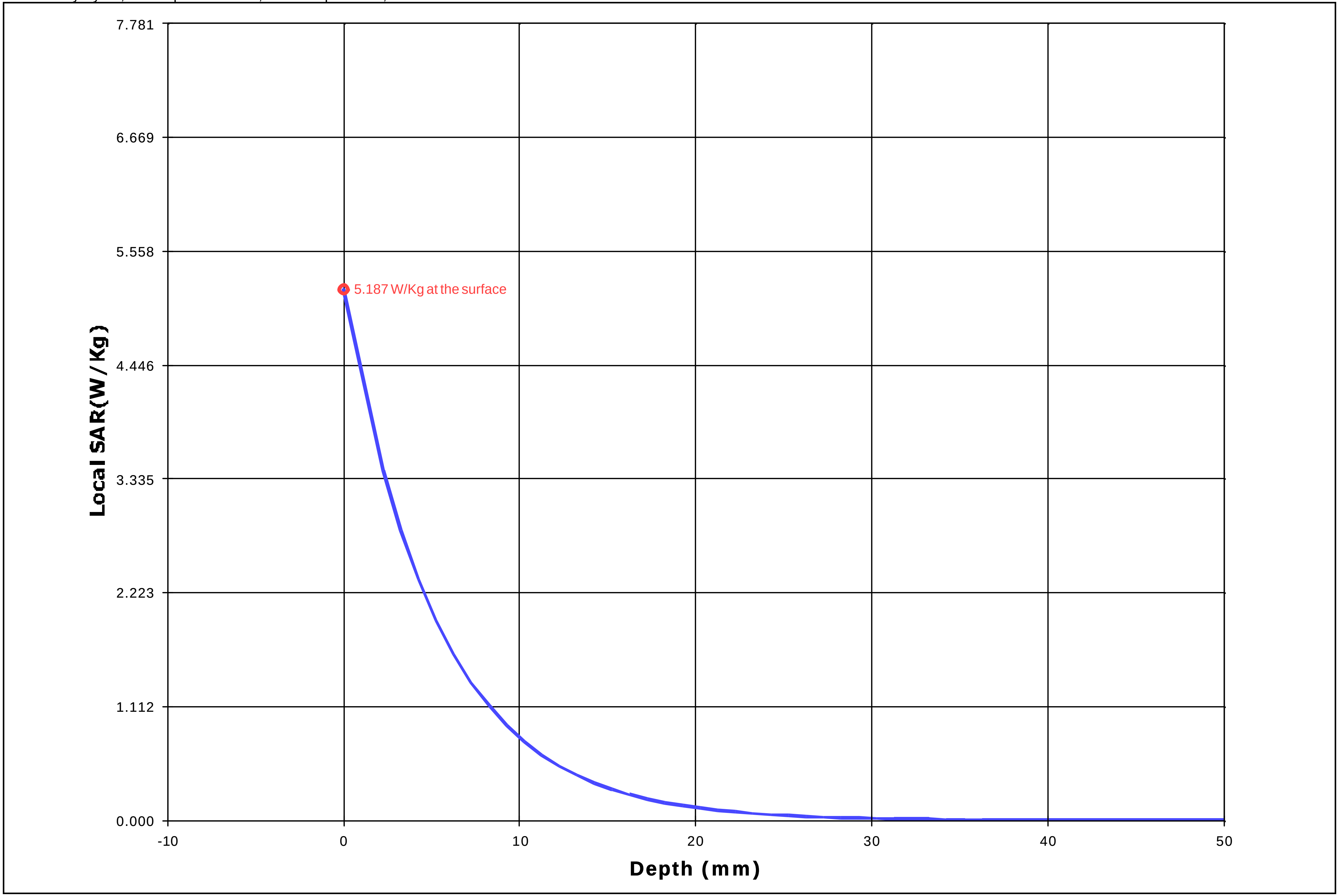


EXHIBIT 8. DUTY CYCLE

8.1. DUTY CYCLE LIMITATION

The manufacturer provides the description of duty cycle limitation as shown below.

Duty Cycle calculation for PSION Teklogix equipment

"The access point sends out a beacon every 100ms. A client terminal can only transmit once (if at all) during each of these intervals. The maximum fragmentation limit of a client terminal is 2,312 bytes. This translate to 18,496 bits. There is a 192 bit preample for each packet sent. Thus a client terminal can transmit a maximum of ~19kbits/100ms. At 1Mbps data rate, this will take 19ms every 100ms, translating to a max duty cycle of 19%. Duty cycle will be reduced when a higher data rate is used or when there are less data being transmitted."

EXHIBIT 9. TISSUE DIELECTRIC PARAMETER CALIBRATION

The tissue conductivity was calibrated in accordance with IEEE Std 1528-200X, Draft 6.1 November 14, 2000, Sponsor IEEE SCC 34

1. The solutions were **INITIALLY** mixed then calibrated using the slotted coaxial waveguide on 04/23/2002 for muscle tissue as shown on next pages.

2. The dielectric parameters of the solutions were verified **AGAIN** using HP 85070C dielectric probe kit on 06/26/2002 as shown below.

Calibration Kit	**Tissue Type**	**Calibrated Date** [MM/DD/YYYY]	**Tissue Temp.** [°C]	**Freq.** [MHz]	ε′	ε″	σ [S/m]
HP 85070C Dielectric Probe Kit	Muscle	06/26/2002	22.0 ± 1	2450	54.33	13.63	1.86

UltraTech Group of Labs.
3000 Bristol Circle, Oakville, Ontario, Canada. L6H 6G4 Phone:(905) 829-1570 Fax:(905)829-8050

Tester's Name: *Wayne*

Calibration Date: *04/23/2002*

Cal. Frequency [MHz]: *2450.0*
Mixture Type: *Muscle Tissue*
Room Temp. ±1 [°C]: *20*

Comment:

# of Effective Point: *11*
Point Distance [mm]: *5*

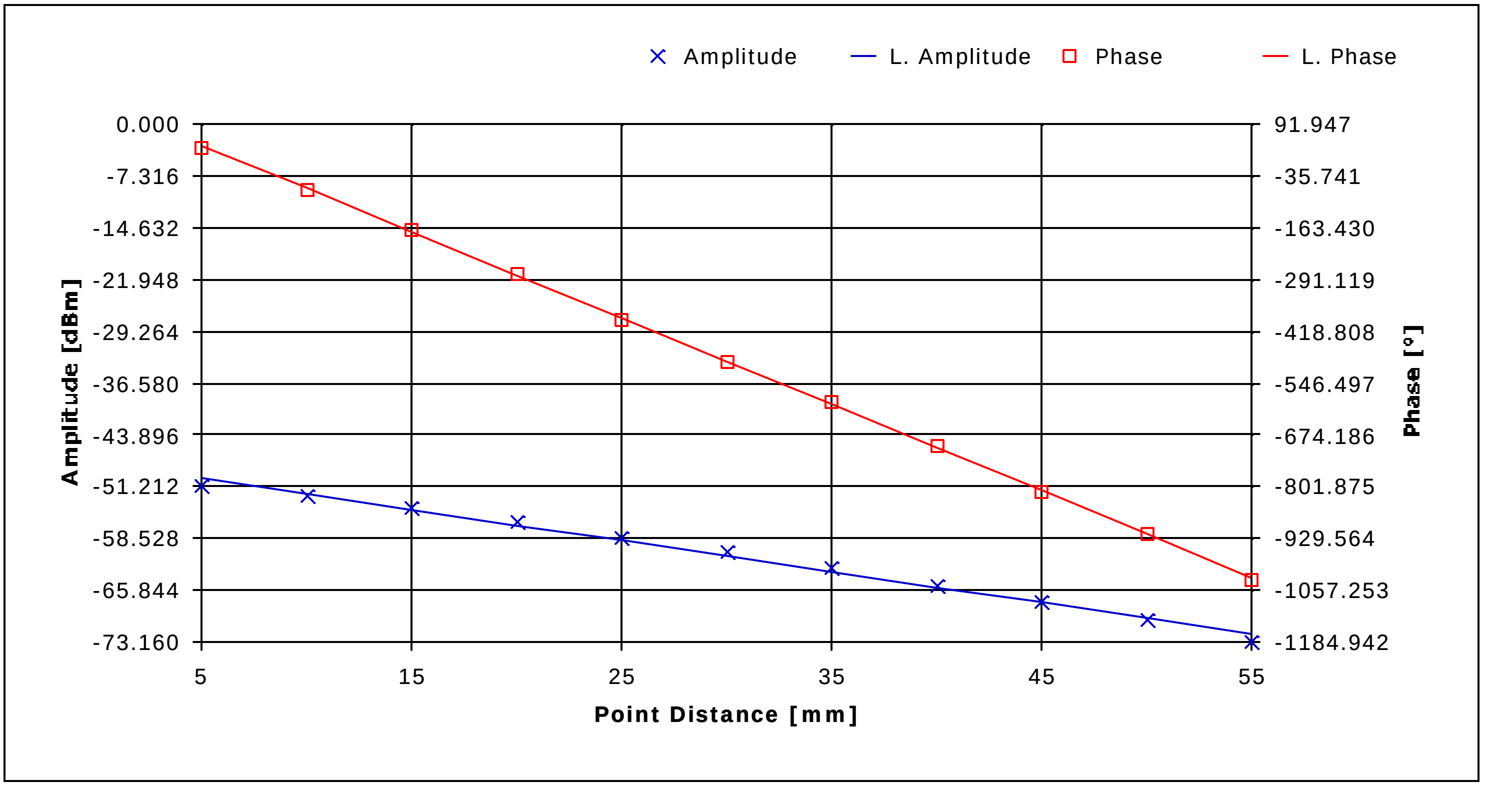
Composition:	Weight [g]	[%]
DI Water	45714.0	76.19
Sugar	0.0	0.00
DGBE	5712.0	9.52
Salt	0.0	0.00
HEC	0.0	0.00
Bactericide	0.0	0.00
Triton X-100	8574.0	14.29
1,2-propanediol	0.0	0.00
	0.0	0.00
	0.0	0.00
TOTAL:	60000.0	100.00

Point	Amplitude [dB]	Phase [°]
1	-51.139	32.639
2	-52.570	-68.681
3	-54.254	-170.589
4	-56.193	83.513
5	-58.358	-29.461
6	-60.462	-134.356
7	-62.779	125.125
8	-65.132	20.430
9	-67.404	-93.655
10	-70.174	159.590
11	-73.128	49.215

Mass Density [Kg/m³]: *1.004*
Specific Heat Capacity [J/g/°C]: *3.979*

Skin Depth [mm]: *19.731*
(Plane wave incident)

Results:		Target	Low limit	High limit	% off target
D. Const.	53.5	52.7	50.1	55.3	1.5
Conductivity	1.99	1.95	1.85	2.05	1.89



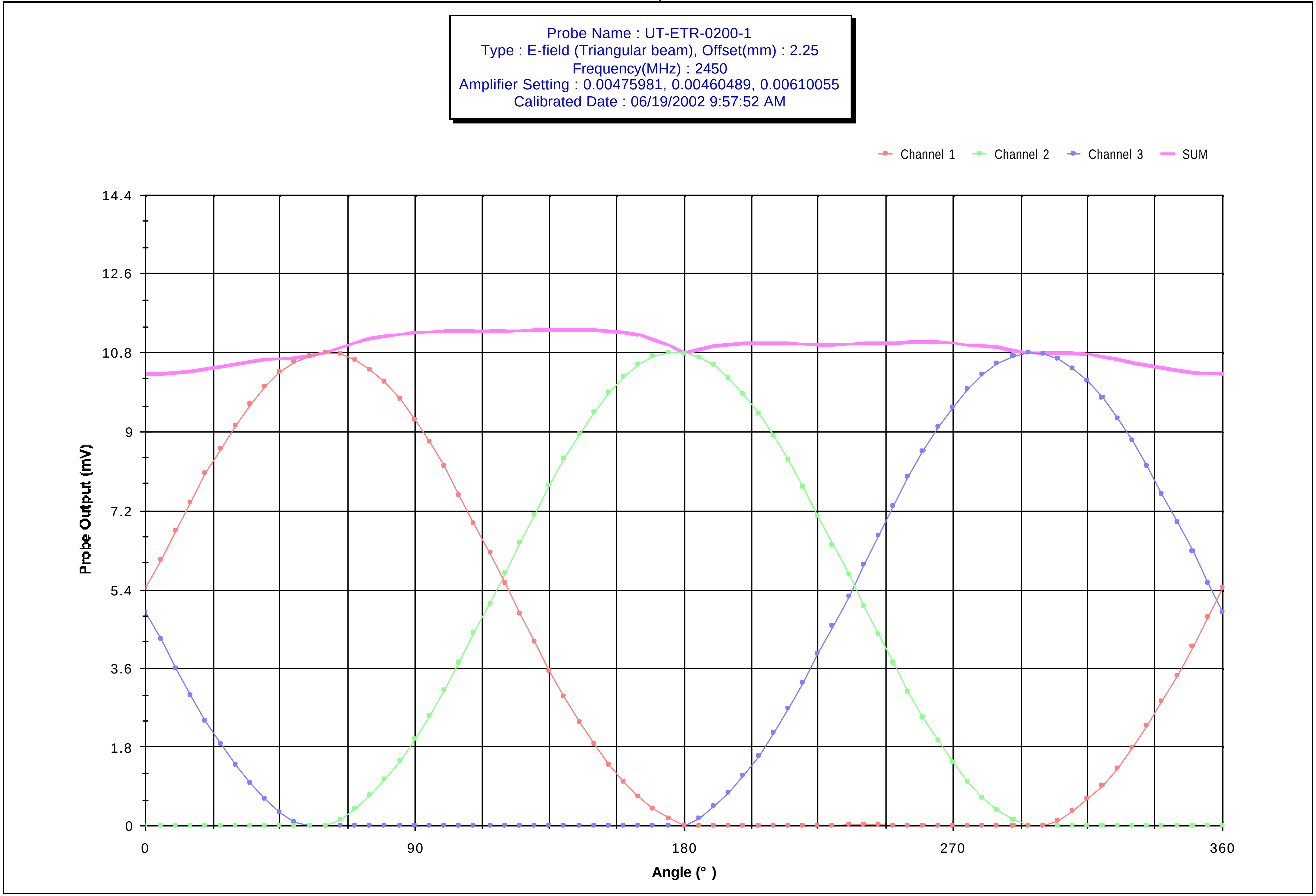
Annex - Simulated Tissue Calibration

EXHIBIT 10. SAR SYSTEM CALIBRATION

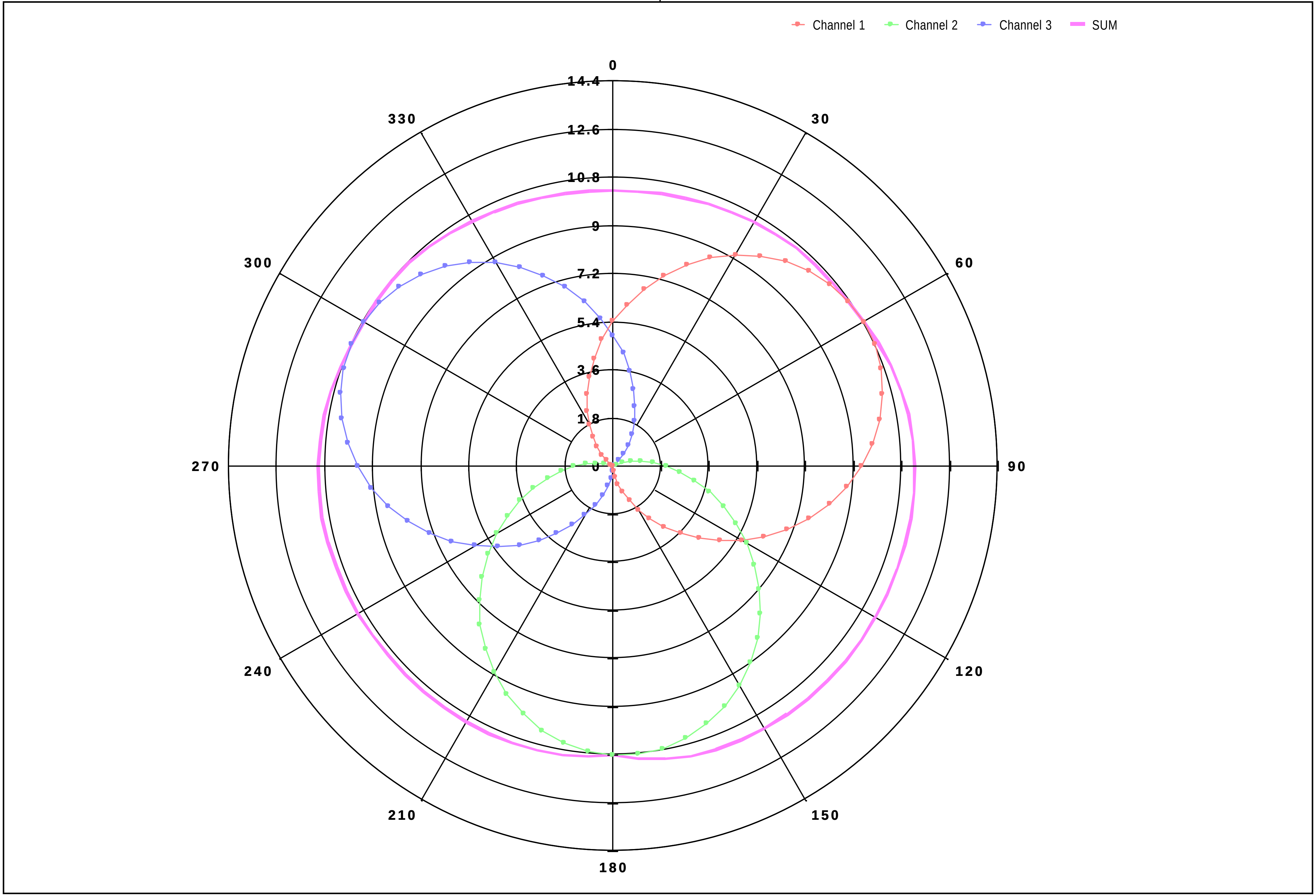
10.1. PROBE FREE SPACE CALIBRATION

Probe Type	E-Field Triangle
Model Number	UT-ETR
Serial Number	0200-01
Manufacturer	3D-EMC Laboratory Inc.
Manufactured Date	February 2000
Length	270 [mm]
Internal sensor offset	2.25 [mm]
Tip diameter	4.0 [mm]
Sensor Factor	10.8 [mV/(mW/cm^2)] or 2.864 [uV/(V/m)^2]

2450 MHz Freespace Calibration

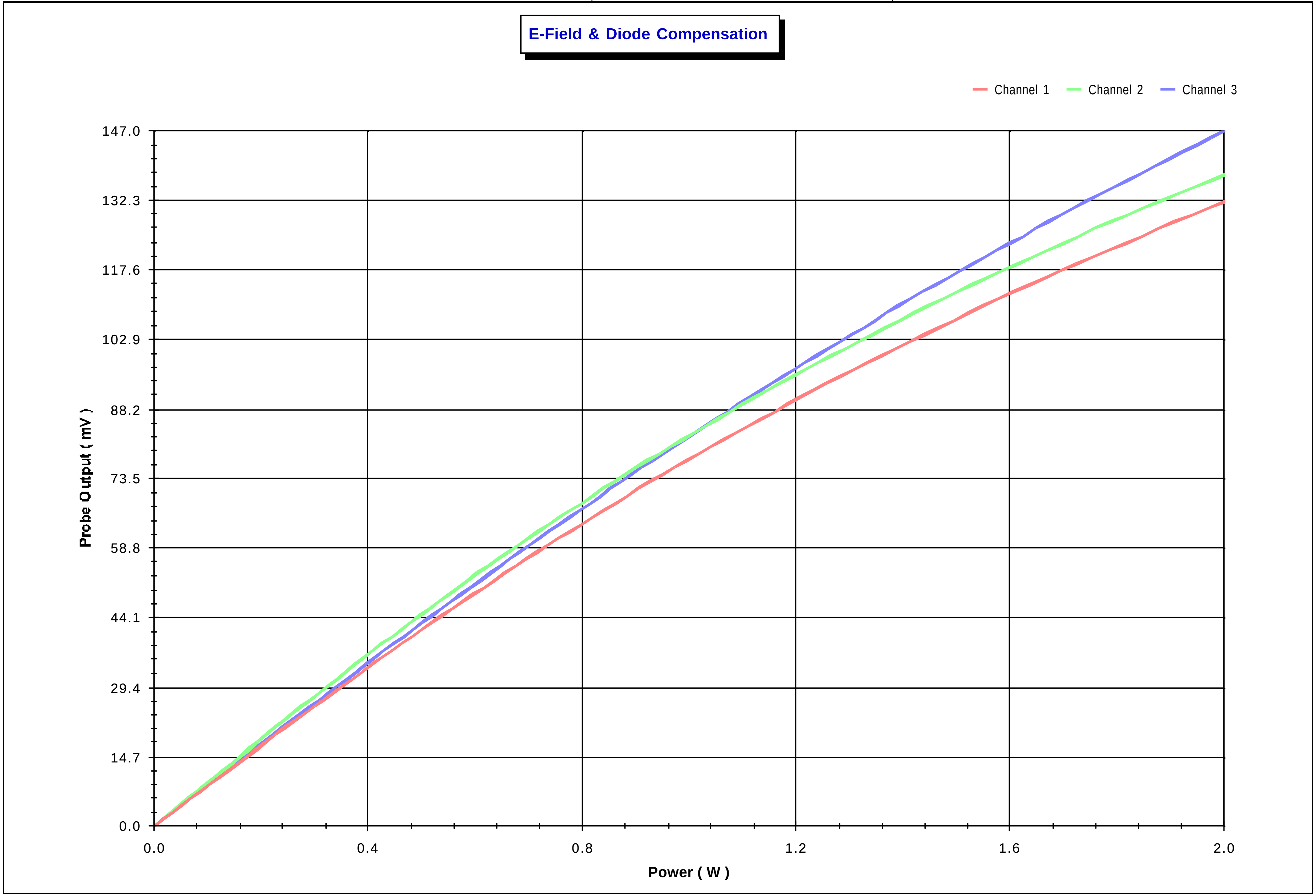


2450 MHz Freespace Calibration



10.2. PROBE THERMAL TRANSFER CALIBRATION

2450 MHz Muscle simulant tissue, Thermal Transfer Calibration - Diode Compensation



2450 MHz Muscle simulant tissue, Thermal Transfer Calibration

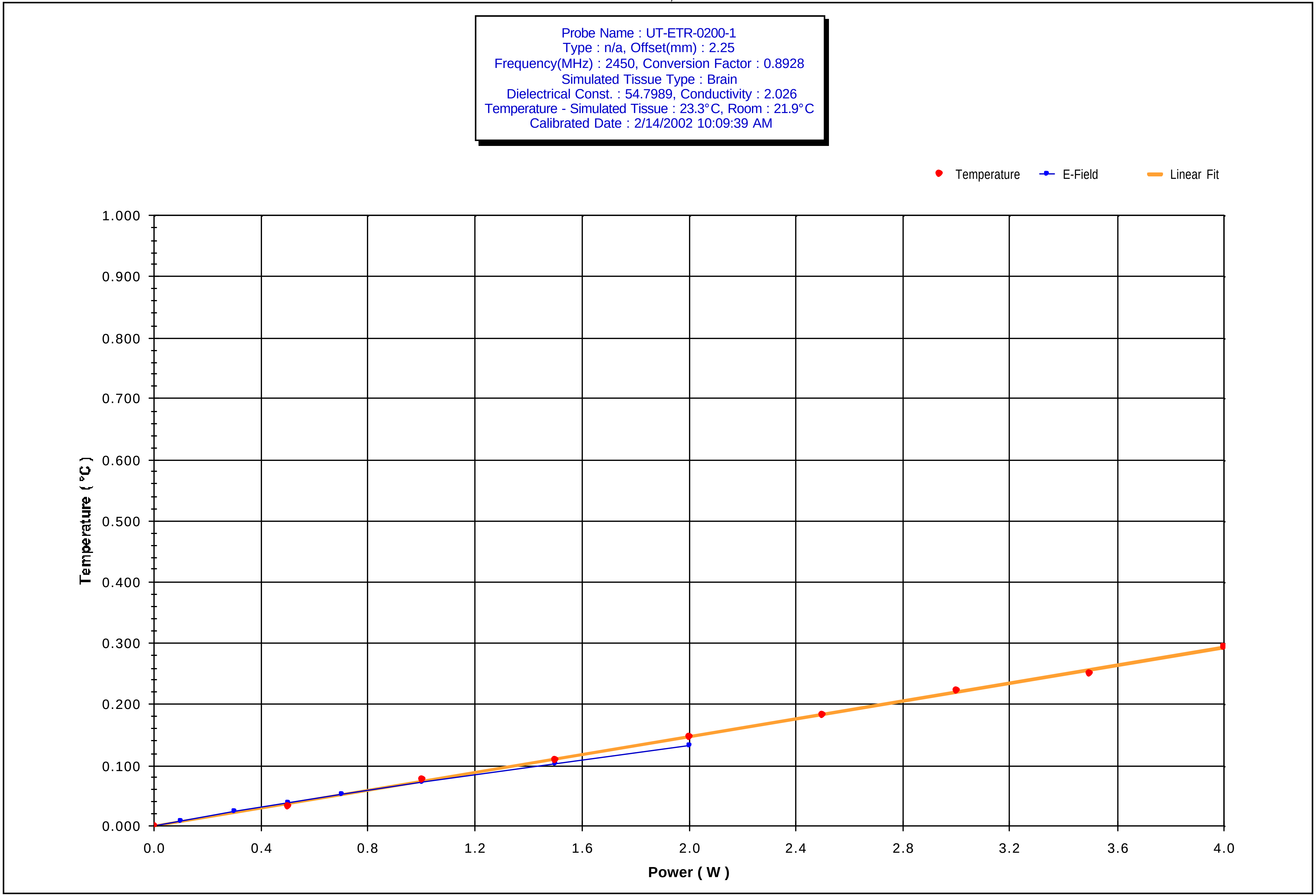
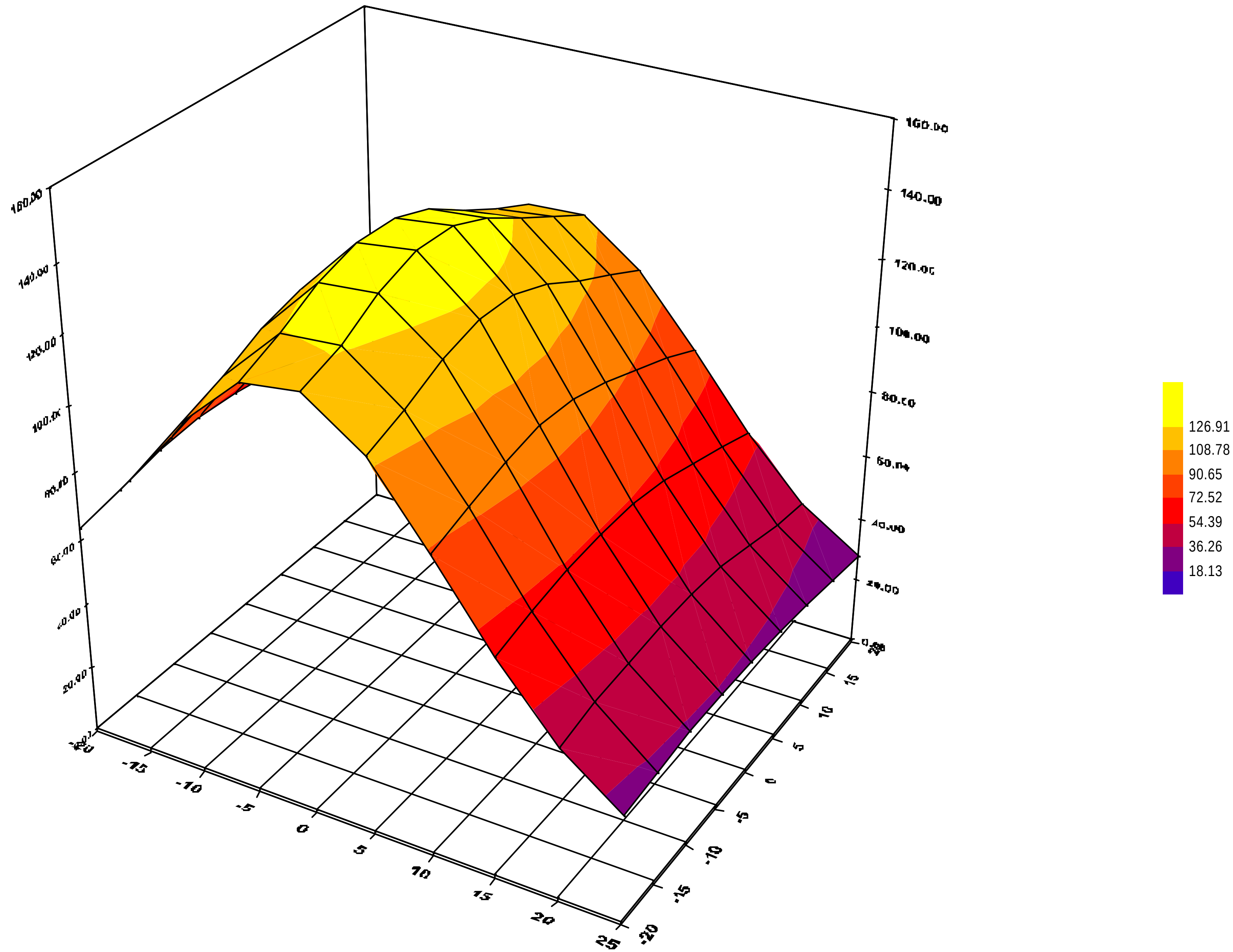
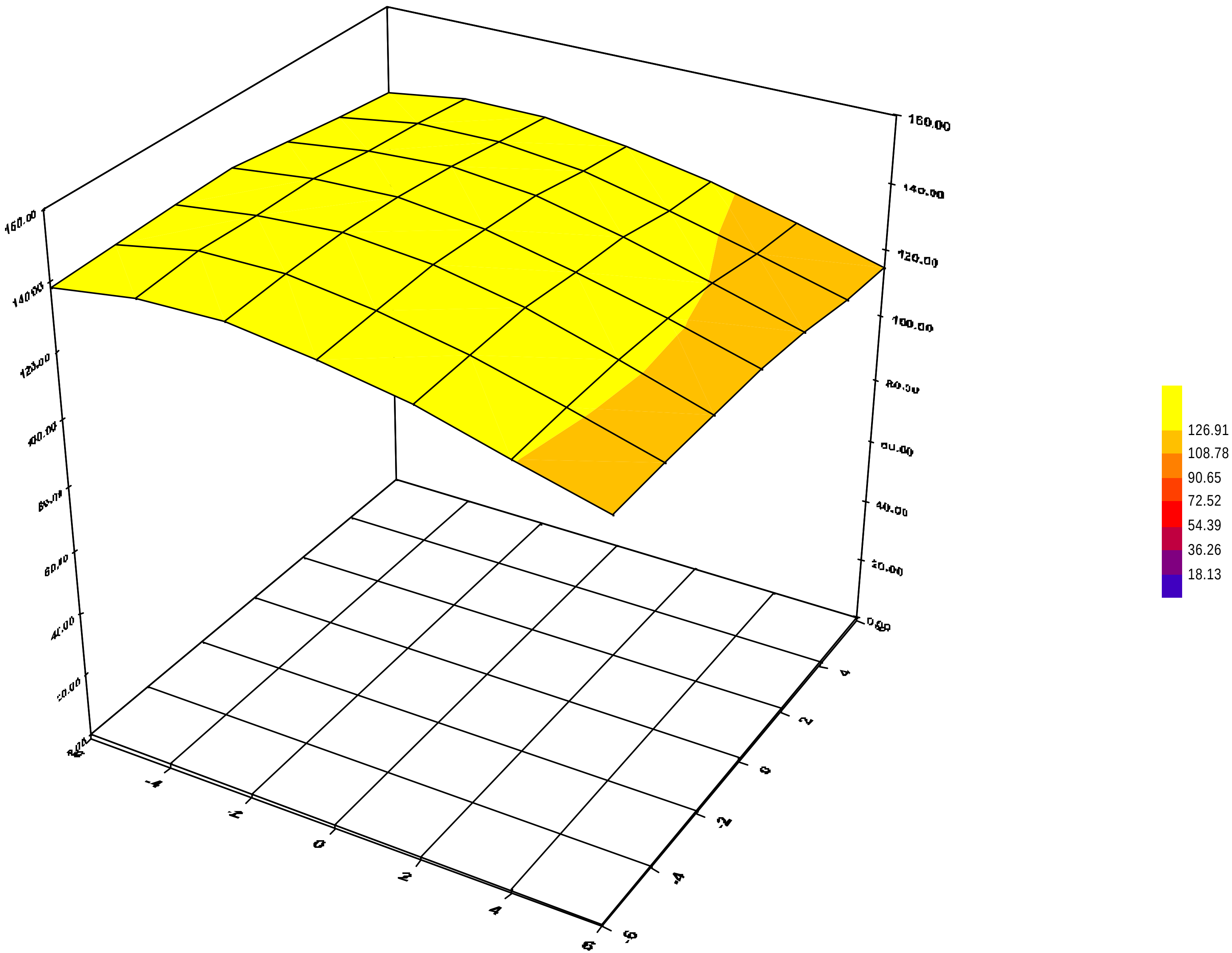


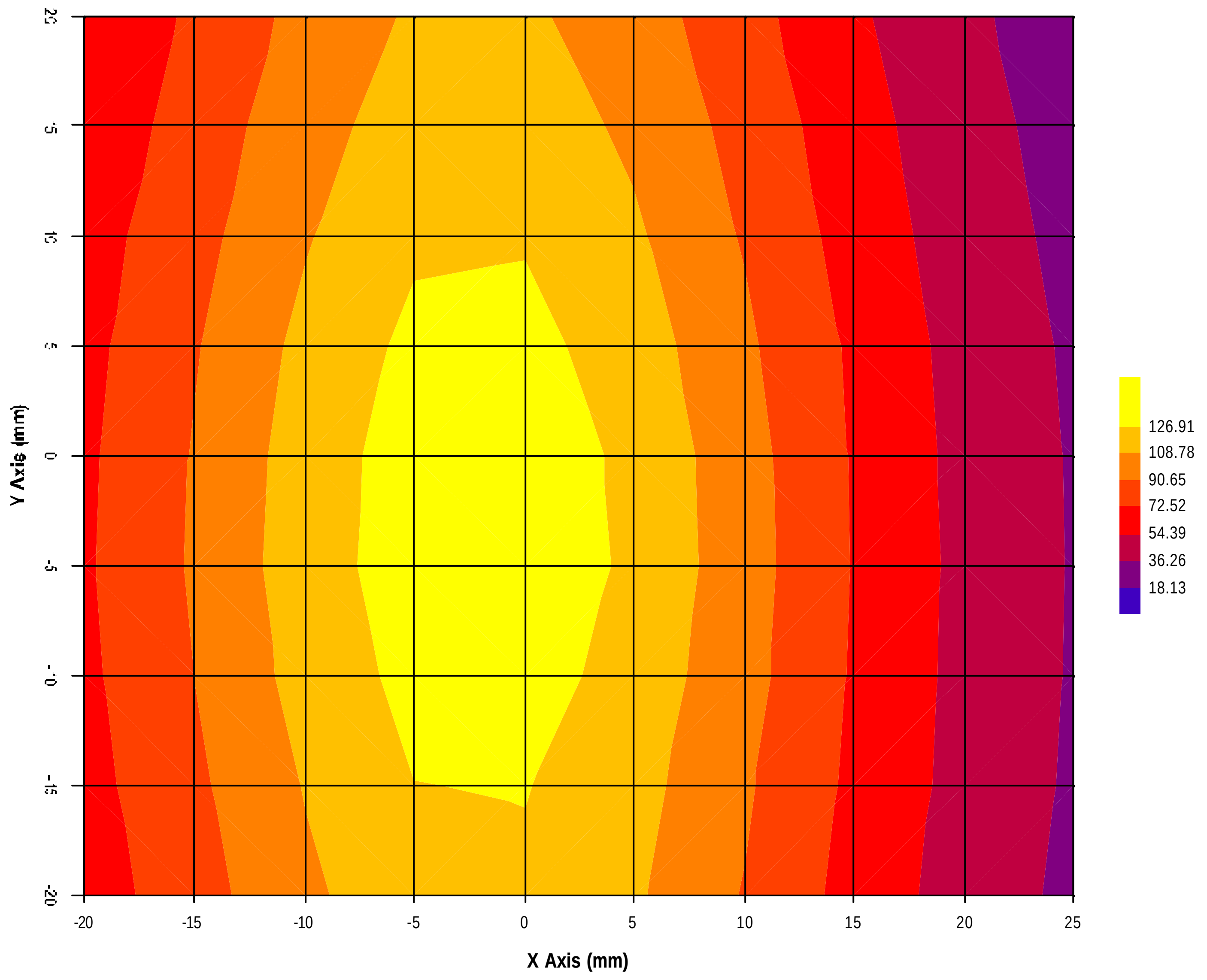
EXHIBIT 11. SAR SYSTEM VERIFICATION USING DIPOLE REFERENCE

The system was verified in the flat phantom (2.0mm ± 0.2mm base thickness) using 835 MHz dipole validation kit (M/N: 3125-870 S/N: 1011) manufactured by EMCO. A forward power of 1.0 W was fed to the dipole and the distance between the dipole axis and the liquid were 15mm as specified in IEEE Standards 1528.

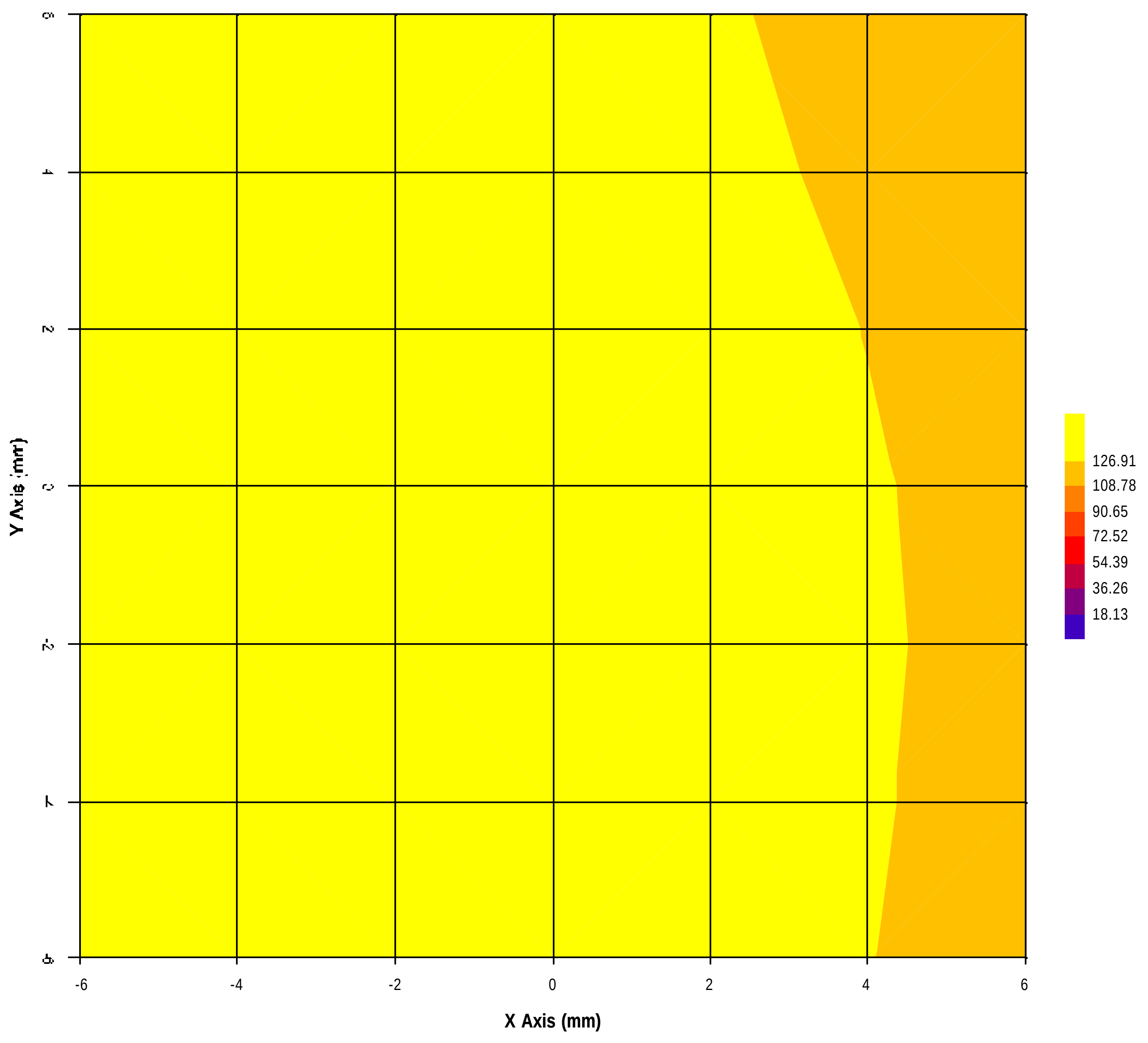
Validation Kit	Target SAR (W/Kg) over 1g volume	SAR (W/Kg) over 1g volume
EMCO M/N:3125-870	9.5	9.93


160.00
140.00
120.00
-15
-10
-5
0
5
10
15
20
25
15
10
5
0
-5
-10
-15
-20
126.91
108.78
90.65
72.52
54.39
36.26
18.13


160.00
140.00
120.00
100.00
60.00
40.00
20.00
0.00
-4
-2
0
2
4
6
-6
126.91
108.78
90.65
72.52
54.39
36.26
18.13



Y Axis (mm)
20
15
10
5
0
-5
-10
-15
-20
-20
-15
-10
-5
0
5
10
15
20
25
X Axis (mm)
126.91
108.78
90.65
72.52
54.39
36.26
18.13



126.91
108.78
90.65
72.52
54.39
36.26
18.13
-6
-4
-2
0
2
4
6
X Axis (mm)
Y Axis (mm)