Product Compliance
SAR Test Report

Product : Cellular Phone
Model : MT261XF01A
FCC ID : 9GB MT261XF01A
Reference no.: 10019

3D-EMC Laboratory,Inc.
for NEAR FIELD MEASUREMENTS

TABLE OF CONTENT

SAR Test Report

To: MITSUBISHI

Date: 8/31/98

Re: 10019

Radio Information

Radio Type : Cell-phone
Model Number : MT261XF01A
Serial Number : PREP515
Frequency Band(MHz) 1900
Frequency Tested(MHz) 1850
Nominal Output Power:(W) 1 pk / av
Antenna Type : quarter wave
Antenna Position : out
Signal Type : GSM
Duty Cycle : 8/1

Simulated Tissue

Type of Tissue : BRAIN
Measured Dielectric Constant: 42.2
Measured Conductivity : 1.15

Conditions

Robot : 6 axis
Scan Type : SAR
Measured Field : E
Measured Power(W): 0.1
Phantom Type : Head
Phantom Position: RIGHT EAR
Room Temperature °C: 24.5
Distance Antenna-Shell: 26.5

Probe

Probe Name : E
Probe Orientation: –
Probe Offset(mm): 3
Sensor Factor : 10.8
Conversion Factor: 1.31
Calibration Date : 8/29/98

Results

Maximum Fields Location: X : 10.0 Y : -30.0
Peak Voltage (mv): 3.26
1cm Voltage (mv): 1.48
SAR (averaged over 1 gram of tissue) W/kg: 0.29

Product Compliance Test Report

Re: 10019

Manufacturer :	MITSUBISHI
Address :	JAPAN
Product Description:	Cellular Phone
Product Classification:	UNCONTROL

Based on the above information and the test results shown in attached test report, of the aforementioned product, the undersigned states that ;

> *Tests were performed to establish the maximum value of the* ***SAR*** *(Specific Absorption Rate) in a person holding the product as specified in the user's manual. The* ***D.U.T.*** *was found to be in compliance with the limits established in the* ***FCC 96-326*** *document.*

Name : OSCAR GARAY

Signed : [signature]

Date 8/31/98

2 Applicable Documents

2.1 Guidelines

The Guidelines of the following documents were considered in the performance of this test :

1) NCRP report 1986,
2) ANSI C95.1 - 1982,
3) IEEE C95.1 - 1991,
4) FCC rules 96 - 326
5) OET Bulletin 65

Location of test

All tests were performed at the **3 D-EMC Laboratory,Inc.** for Near Field Measurements located on 5450 NW, 33rd Avenue, Suite 100, Fort-Lauderdale, Florida, 33309.

2.2 Measurement System Specifications

Positionner	**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 : 166 MHz Pentium Memory : 32 Meg RAM Operating System : Windows NT Monitor : 17" SVGA	Tissue : Simulated Tissue with electrical characteristics similar to those of the human at normal body temperature. Shell : Fiberglass human shell shaped (1.5 mm thick)

2.3 Test Description

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 DUT. After the initial scan, a high resolution grid is used to locate the absolute maximum measured energy point. At this location, an attenuation versus depth scan will be accomplished by the measurement system to calculate the SAR value.

2.4 Phantom

The phantom used in the evaluation of the RF exposure of the user of the wireless device is a clear fiberglass enclosure 1.5 mm thick, shaped like a human head or body and filled with a mixture simulating the dielectric characteristics of the brain, muscle or other types of human tissue. The maximum width of the cranial model is 17 cm, the cephalic index is 0.7 and the crown circumference of the cranial model is 61 cm. The ear is 6 mm above the outer surface of the shell.

2.5 Simulated Tissue

1) 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 contains salt. Also, at these frequencies, D.I. water and alcohol is preferred.

2) Tissue Density : Approximately 1.25 g/cm^3

Preparation

We determine the volume needs and carefully measure all components. A clean container is used were the ingredients will be mixed. A stirring paddle and a hand drill is used to stir the mixture.First we heat the DI water to about 40 °C to help the ingredients to 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.

2.6 Measurement of Electrical Characteristics of Simulated Tissue

1) Network Analyzer HP8753C or others

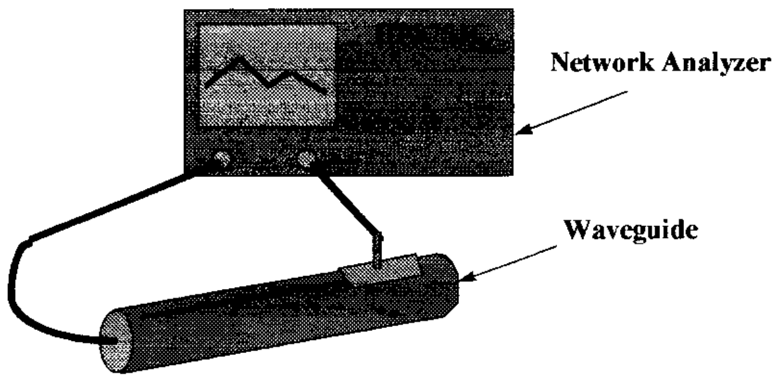
2) Slotted Coaxial Waveguide

Description of the slotted coaxial waveguide

The cylindrical waveguide is constructed with copper tube of about 30 to 40 cm of 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 almost the two third of the tube length. The outer edge of the slotted tube is marked in centimeters (10 to 12) every 1 centimeter, 0.5 if 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, 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 results dielectric constant and conductivity within 5 % of published data.

Electrical Characteristics
Measurement Setup



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

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

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

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

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

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

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

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

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

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

2.7 System Description

The measurement system consists of an E-field probe, instrumentation amplifiers, RF transparent cable connecting the amplifiers to the computer, the robotics arm with its extension and proximity sensors, a phantom with simulated tissue and a radio holder to support the device under test. The E-field probe is a three channel device used to measure RF electric fields in the near vicinity of the source. The three sensors are mutually orthogonal positioned dipoles, and are constructed over a quartz substrate. Located in the center of the dipole is a Schottky diode. High impedance lines are connecting the sensor to the amplifier and then optically linked to the computer. The probe has an isotropic response and is transparent to the RF fields.

Calibration is performed by two steps :

1) Determination of free space E-field from amplified probe outputs in a test RF field. This calibration is performed in a TEM cell when the frequency is below 1 GHz and in a waveguide or some other methodologies above 1 GHz. For the free space calibration, we place the probe in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. This reading equate to $1mW/cm^2$ if that power density is available in the correspondent cavity.

2) Correlation of the measured free space E-field, to temperature rise in a dielectric medium. E-field temperature correlation calibration is performed in a planar phantom filled with the appropriate simulated tissue.

For temperature correlation calibration, a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe. First, the location of the maximum E-field close to the phantom's inner surface is determined as a function of power into the RF source; in this case, a 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 30 seconds exposure at the same RF power levels used for the E-field measurement are recorded. The following equation relates SAR to initial temperature slope :

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

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

The heat capacity used for brain simulated tissue is 2.7 joules/^{0}C/g and 3.0 joules/^{0}C/g for muscle.

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

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

σ = simulated tissue conductivity,

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

2.8 Data Extrapolation

There is a distance from the center of the sensor (diode) to the end of the protective tube called 'probe offset'. To compensate we use an extrapolation method to obtain the peak surface SAR from the SAR 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 5 mm. along the ` Z ` axis for a distance of 50 mm. An average slope is obtained from the three data points nearest the surface and used to define an exponential decay of the energy density with depth using the following relations

$$Slope = \frac{\frac{E_{tot\_Z1}}{E_{tot\_Z2}} + \frac{E_{tot\_Z2}}{E_{tot\_Z3}}}{2}$$

$$\exp = \ln(slope) \cdot \frac{offset}{spacing}$$

$$E_{tot\_Z0} = E_{tot\_Z1} \cdot e^{\exp}$$

2.9 Interpolation and Gram Averaging

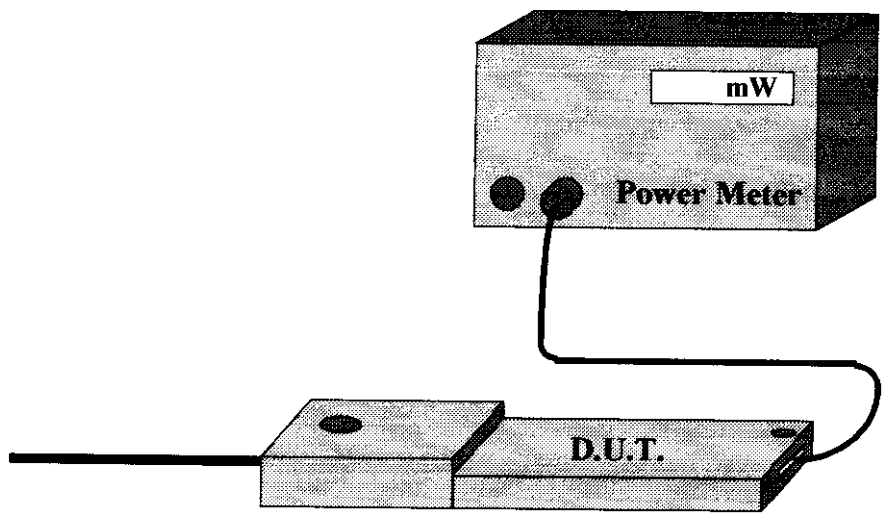
The voltage, 1 cm above the phantoms surface (E_{tot} 1 cm), is needed to calculate the exposure of one gram of tissue. The SAR value that estimates the average over 1 gram cubes is obtained from the extrapolated value. $E_{tot}Z_0$ and interpolated value, E_{tot} 1 cm, is obtained by interpolation;

$$SAR(mW \cdot g) = \frac{E_{tot\_Z0} + E_{tot\_1cm}}{2} \cdot \frac{CF}{SensorFactor}$$

2.10 Power Measurement

When ever 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 circuits 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 for the time of test. A difference in output power would determinate a need for battery replacement and repetition the SAR test.



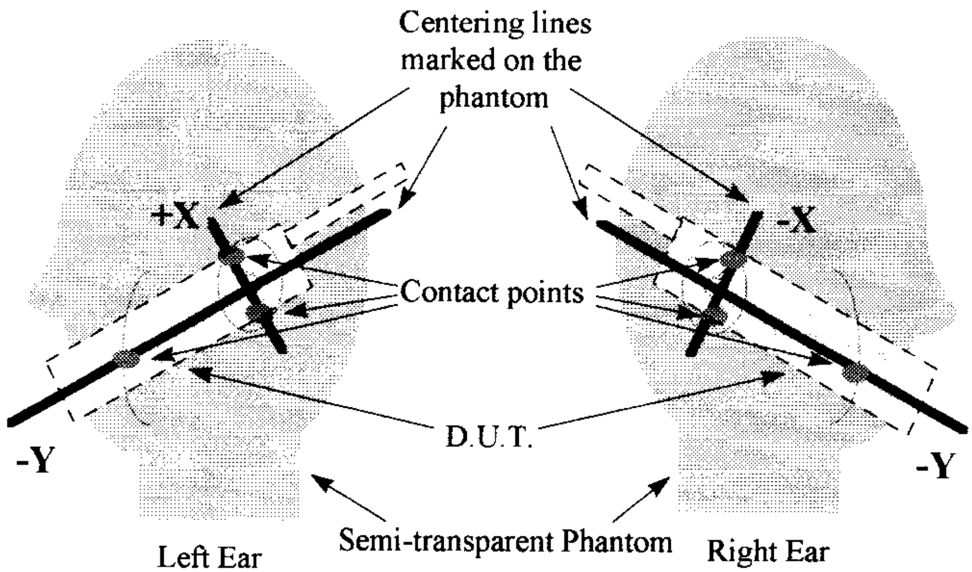
Measured Power ≈ Measured Power + Cable and Switching Mechanism Loss

2.11 Positioning of D.U.T.

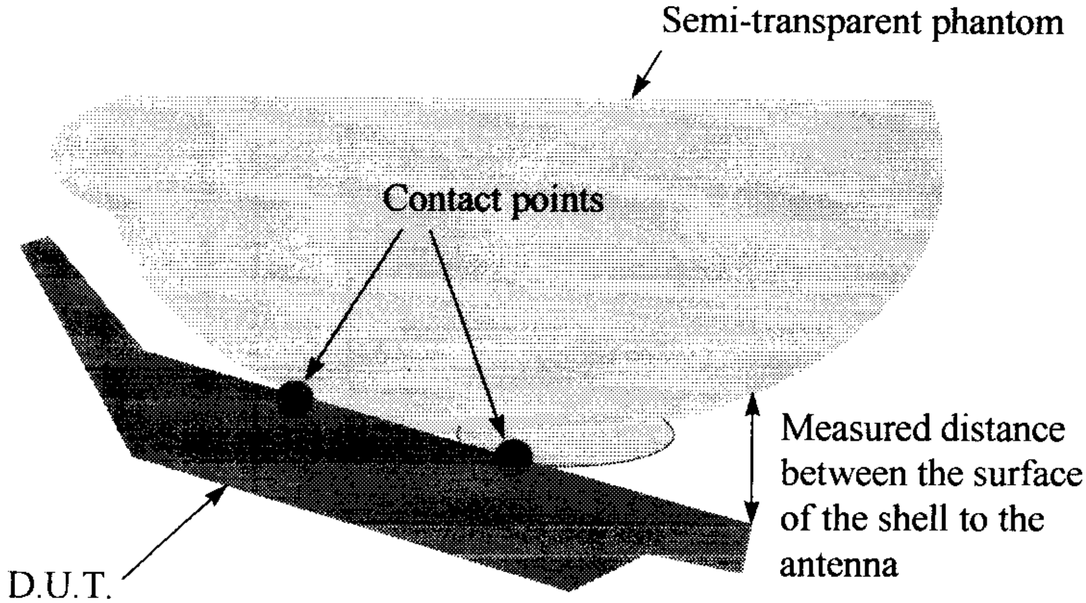
The clear fiberglass phantom shell have been previously marked with a highly visible line, so can easily be seen through the liquid simulated tissue. In the case of testing a cellular phone, this line is connecting the ear channel with the corner of the lips. The D.U.T. is then placed by centering the speaker with the ear channel and the center of the radio width with the corner of the mouth. At the same time the surface of the D.U.T. is always in contact with the phantoms shell. Three points contact; two in the ear region and one on the chin in addition to the previously describe alignment will assure repeatability of the test.

For HAND HELD devices (push-to-talk), or any other type of wireless transmiters, the D.U.T. will be positioned as suggested by manufacturer operational manuals.

Positioning of the D.U.T.



Side View



Test Information

Date : 8/31/98
Time : 12:02:00 PM

Ref. : 10019

Product	: Cellular phone	**Test**	: SAR
Manufacturer	: Mitsubishi	**Frequency (MHz)**	: 1850
Model Number	: MT261XF01A	**Nominal Output Power (W)**	: 1
Serial Number	: PREP515	**Antenna Type**	: 1/4 wave
FCC ID Number	: BGBMT261XF01A	**Signal**	: GSM

Phantom	: Head - Right Ear	**Dielectric Constant**	: 42.2
Simulated Tissue	: Brain	**Conductivity**	: 1.15

Probe	: E	**Antenna Position**	: out
Probe Offset (mm)	: 3.0	**Measured Power (W) (conducted)**	: 0.1
Sensor Factor (mV)	: 10.8		
Conversion Factor	: 1.31		
Calibrated Date	: 8/29/98		

Amplifier Setting :

Channel 1 : 0.0035 Channel 2 : 0.0032 Channel 3 : 0.0036

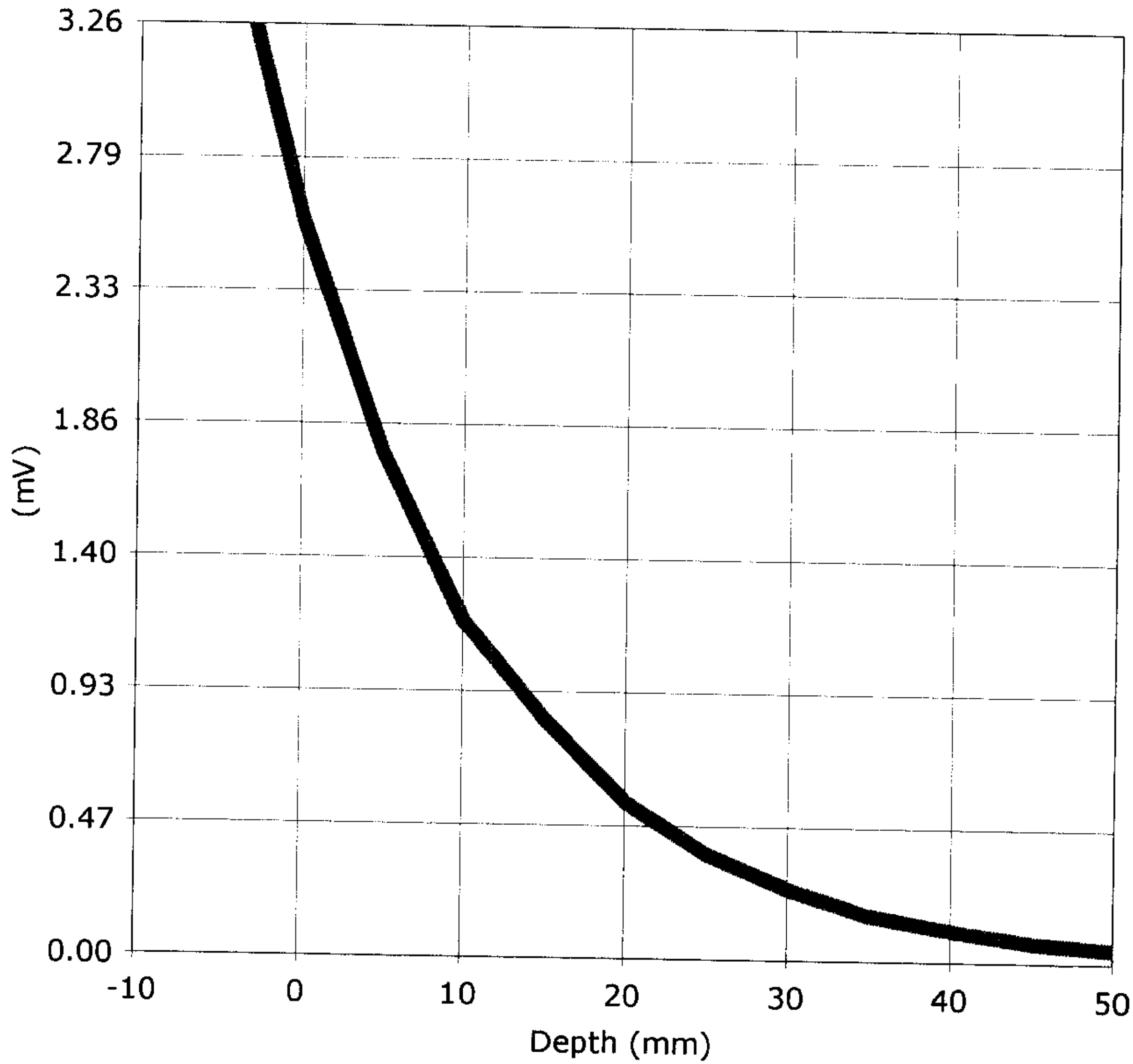
Location of Maximum Field :

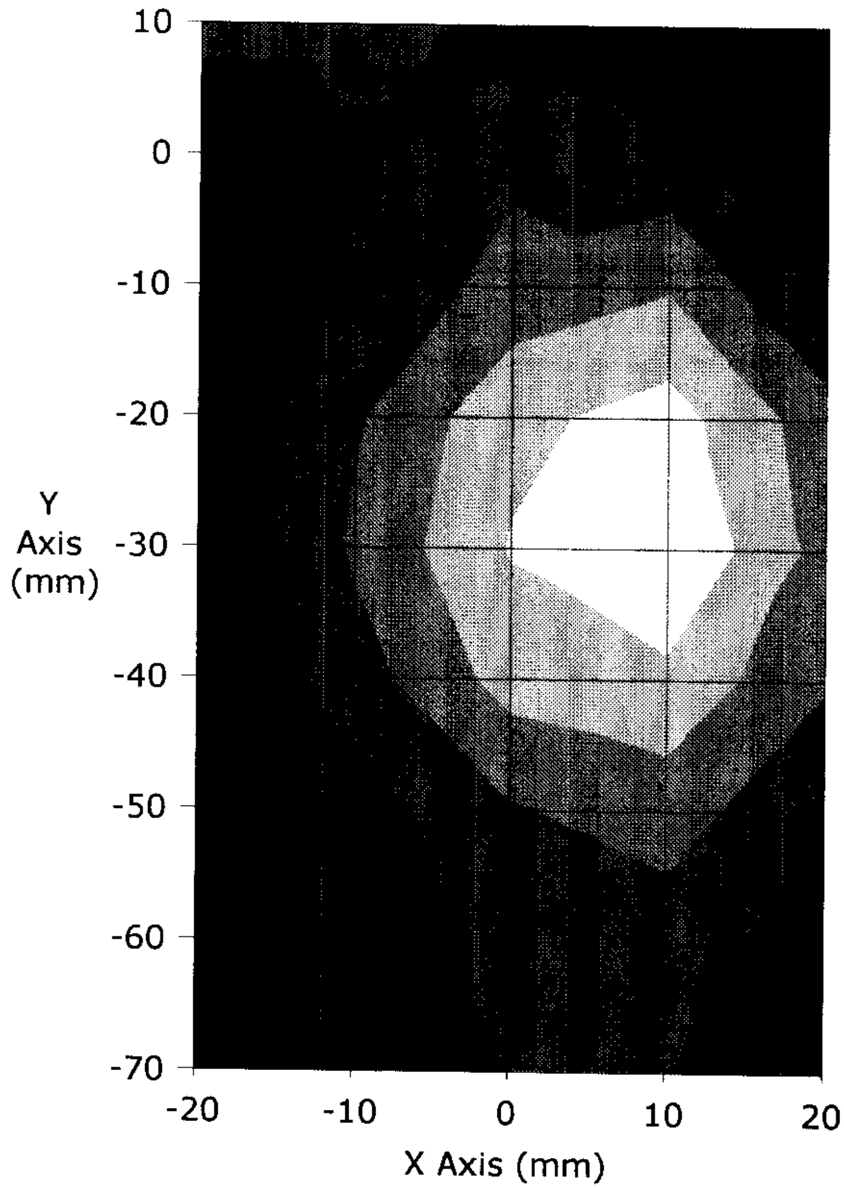
X = 10 Y = -30

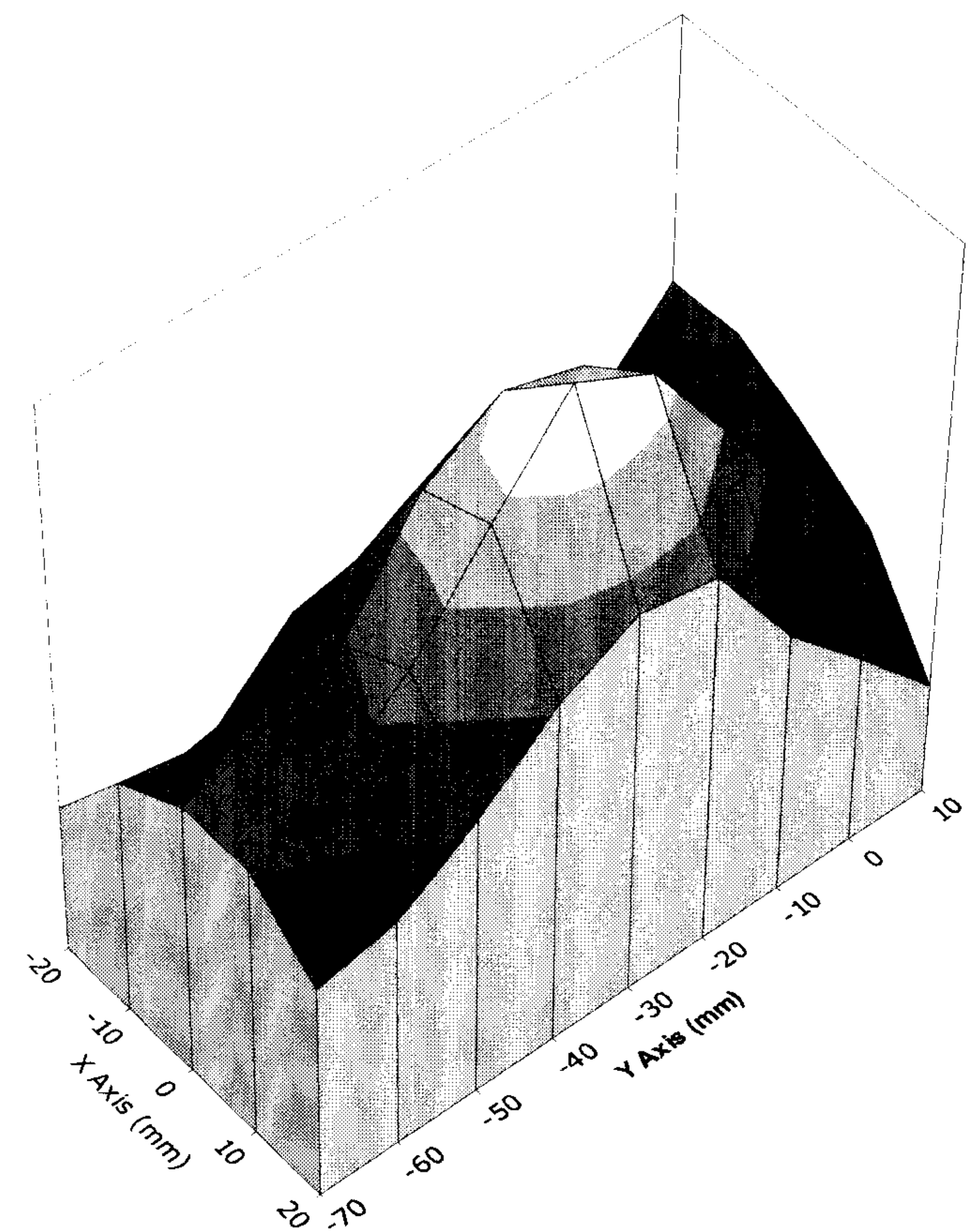
Measured Values (mV) :

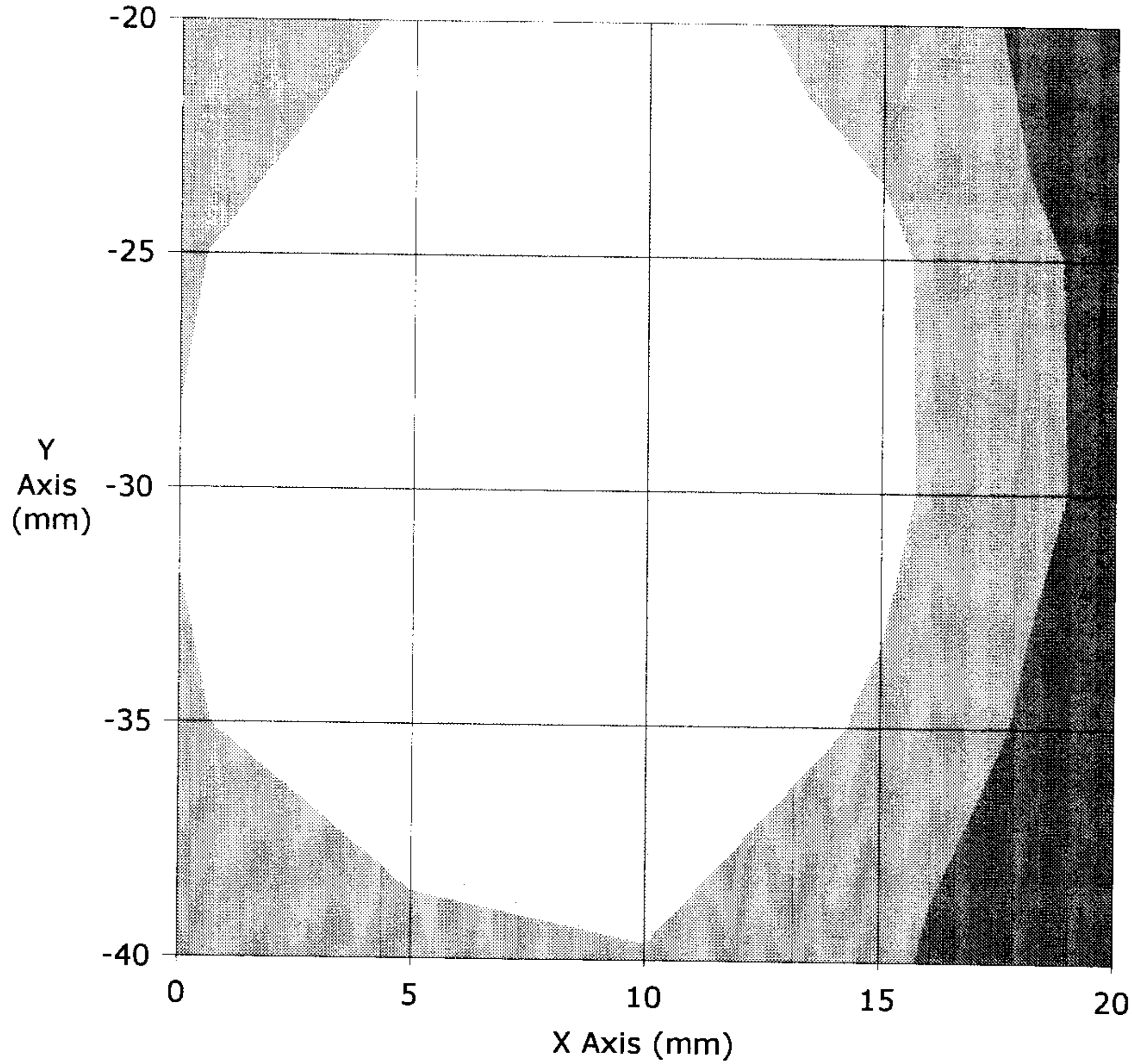
2.58	1.77	1.18	0.84	0.55	0.37
0.25	0.16	0.11	0.07	0.05	

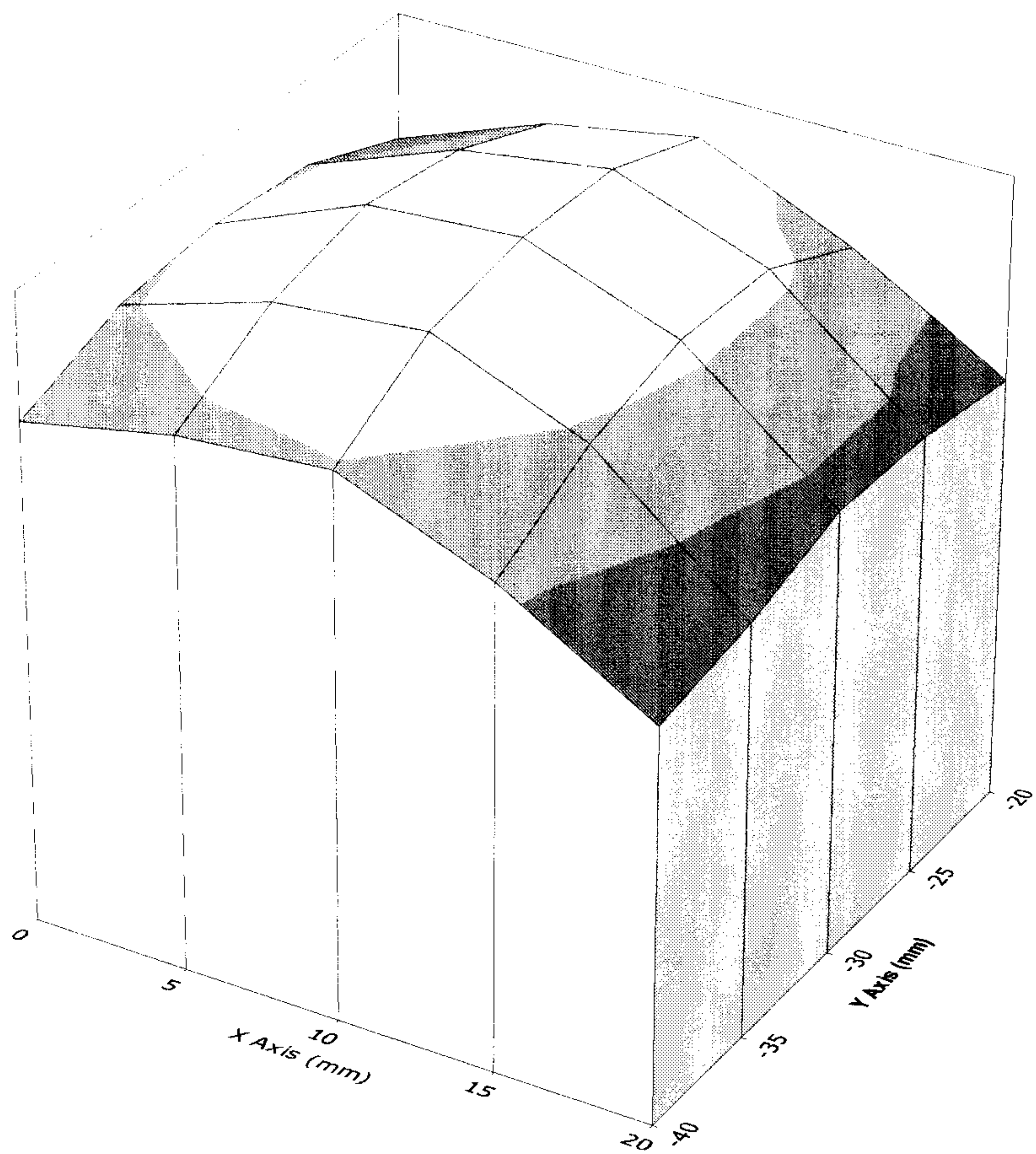
Peak Voltage (mV) : 3.26 **1 Cm Voltage (mV)** : 1.48 **SAR (W/Kg)** : 0.29


3.26
2.79
2.33
1.86
1.40
0.93
0.47
0.00
(mV)
-10
0
10
20
30
40
50
Depth (mm)


10
0
-10
-20
-30
-40
-50
-60
-70
Y
Axis
(mm)
-20
-10
0
10
20
X Axis (mm)


-20
-10
0
10
20
X Axis (mm)
-70
-60
-50
-40
-30
-20
-10
0
10
Y Axis (mm)


-20
-25
-30
-35
-40
Y
Axis
(mm)
0
5
10
15
20
X Axis (mm)


0
5
10
15
20
X Axis (mm)
-40
-35
-30
-25
-20
Y Axis (mm)

3D-EMC Laboratory Inc.

5450 NW 33 Ave. Suite 100
Fort-Lauderdale, FL, 33309

Date: 8/31/98, 10:44

Frequency: 1900 MHz

Comments:

Mixture: Brain ('Brain' or 'Muscle')

# of Points: 11

Point Dist: 0.5 cm.

Point	Amplitude	Phase
1	-41.90	-38.20
2	-42.60	-119.20
3	-40.90	153.40
4	-42.30	78.80
5	-44.00	11.70
6	-45.80	-62.30
7	-47.70	-131.70
8	-49.80	151.70
9	-51.60	78.30
10	-53.40	0.00
11	-54.70	-76.80

Least Sqrs:	
ma=	-2.872727273
ba=	-38.17272727
mp=	-149.4381818
bp=	27.01454545

Omega:	11938052084	rad/sec
Epsilon 0:	8.85E-14	F/m
mu:	1.26E-08	H/m
alpha avg:	-0.33073495	Np/cm
beta avg:	-2.608188301	rad/cm

Results:		Target	Low Limit	High Limit	% Off Target
D. Const:	**42.2**	42.0	39.9	44.1	0.50
Cond:	**1.15**	1.20	1.14	1.26	-4.25