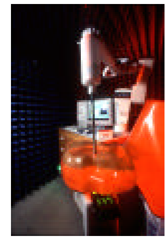
# PCTEST Engineering Laboratory, Inc.

*6660-B Dobbin Road • Columbia, MD 21045 • U.S.A.*
*TEL (410) 290-6652 • FAX (410) 290-6654*
*http://www.pctestlab.com*

## CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

**QUALCOMM INCORPORATED**
**6455 Lusk Boulevard**
**San Diego, CA 92121-2779**
**Attn: Mr. Jay Moulton – Director of Engineering Regulatory**

**Dates of Tests: August 19, 1998**
**Test Report S/N: SAR.980819572.J9C**
**Test Site: PCTEST Lab, Columbia MD**

| | |
|---|---|
| **FCC ID** | **J9CAEP15** |
| **APPLICANT** | **QUALCOMM INCORPORATED** |

| | |
|---|---|
| **EUT Type:** | **Single-Band PCS CDMA Phone** |
| **Tx Frequency:** | **1851.25 – 1908.75 MHz** |
| **Rx Frequency:** | **1931.25 – 1988.75 MHz** |
| **Max Output Power:** | **0.2 W** |
| **Trade Name/Model(s):** | ***QUALCOMM Q1900*** |
| **FCC Classification:** | **Licensed Portable Transmitter Held to Ear (PCE)** |
| **Application Type:** | **Type Acceptance (Class II Permissive Change)** |
| **Original Grant Date:** | **August 05, 1997** |
| **FCC Rule Part(s):** | **2.1093; ET Docket 96.326; 24(E)** |
| **Class II Change:** | **Alternate Antenna (Centarian 16.59cm Telescopic)** |

**This wireless portable device, with the Class II Permissive Change(s) described, has been shown to be capable of continued 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 ANSI/IEEE Std. C95.3-1992. (See Test Report).**
**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.**

*NVLAP accreditation does not constitute any product endorsement by NVLAP or any agency of the United States Government.*

*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. 853(a)*

Randy Ortanez
President & Chief Engineer

NVLAP®
LAB CODE 100431-0

**980819572.J9C**

# Table of Contents

# SAR MEASUREMENT REPORT

***Scope - Environmental evaluation measurements of specific absorption rate[1] (SAR) distributions in simulated human head tissues exposed to radiofrequency (RF) radiation from wireless portable devices for compliance with the rules and regulations of the U.S. Federal Communications Commission (FCC).[2]***

| | |
|---|---|
| **Company Name:** | **QUALCOMM INCORPORATED** |
| **ADDRESS :** | **6455 Lusk Boulevard** |
| | **San Diego, CA 92121-2779** |
| **Attention :** | **Jay Moulton – Director of Engineering Regulatory** |

- EUT Type: PCS CDMA Phone
- FCC IDENTIFIER: **J9CAEP15**
- Trade Name: ***QUALCOMM***
- Model: ***Q1900***
- S/N: Pre-production
- Tx Frequency Range: 1851.25 – 1908.75 MHz
- Rx Frequency Range: 1931.25 – 1988.75 MHz
- Application Type: Type Acceptance (Class II Permissive Change)
- FCC Classification: Licensed Portable Transmitter Held to Ear (PCE)
- FCC Rule Part(s): § 24(E); § 2.1093, Docket 96-326
- Original Grant Date: August 05, 1997
- Max. Output Power: 0.2 W
- Modulation : CDMA
- Antenna: Helical ($\lambda$/2)
- Antenna Dimensions: 16.59 cm. (Length)
- Dates of Test(s): August 19, 1998
- Place of Test(s): PCTEST Engineering Lab. Columbia, MD, U.S.A.
- Report Serial No.: SAR.980819572.J9C


Figure 1. SAR Test Set-up

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Lab Code 100431-0

[1] *Specific Absorption Rate (SAR) is a measure of the rate of energy absorption due to exposure to an RF transmitting source (wireless portable device).*
[2] *IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET-Docket 93-62.*

# 1.1 INTRODUCTION

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.[4] 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.

## 1.2 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 ($r$). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 2).

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

**Figure 2. SAR Mathematical Equation**

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

$$SAR = s E^2 / r$$

where:

$s$ = conductivity of the tissue-simulant material (S/m)
$r$ = 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.[4]

## 2.1 SAR MEASUREMENT SET-UP

PCTEST Lab SAR measurement system consists of completely automated robotics system, cell controller (Pentium Pro 200 computer), E-field probe, and phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 3).

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 PCTEST Pentium-Pro 200 MHz computer with Windows NT system and SAR Measurement software, National Instruments analog card, NEC 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 high-impedance carbon-fiber cable to avoid field distortions and minimize external noise from interfering with the data.

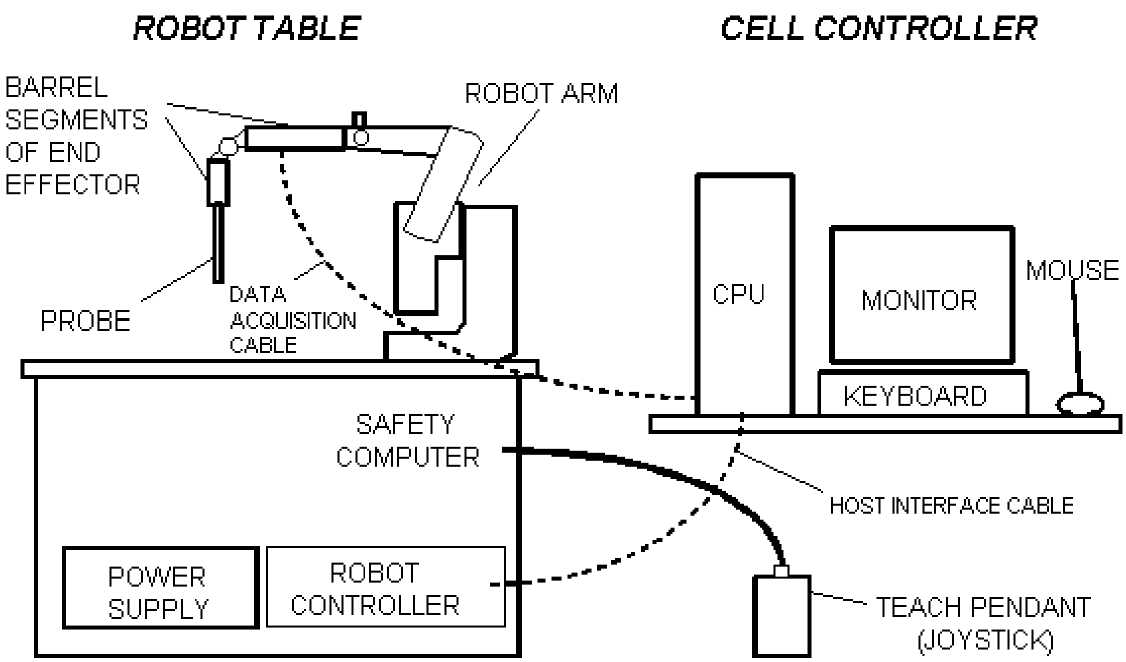



**Figure 3. PCTEST Robotics SAR Test Measurement Set-up**

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 which are concentrated on the surface of the head closest to the antenna of the transmitting device (EUT).

# 3.1 ISOTROPIC E-FIELD PROBE SYSTEM

## 3.2 E-Field Probe

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 plastic protective cylinder 9 mm. outer diameter, 0.5 mm. thickness and 30 cm. in length. This SAR measurement system and the probe are similar to the one developed by Motorola.[8] 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 which 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 an shielded container in the robot end effector so its performance is not affected by the presence of incident electromagnetic fields (see Fig. 4).


**Figure 4. Isotropic E-field Probe**

**Figure 5. Photograph of the Probe and the Phantom**

*(See Section 6.2 for E-Probes Specifications)*

# 4.1 E-FIELD PROBE CALIBRATION PROCESS

## 4.2 E-Probe Calibration

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 (see Fig. 6).

Calibration is performed in two steps:

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 $1mW/cm^2$ .

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. The location of the maximum E-field close to the phantom's bottom is determined as a function of power into the RF source; in this case, a dipole. 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 power levels used for the E-field measurement are recorded. The following equation related SAR to initial temperature slope :

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

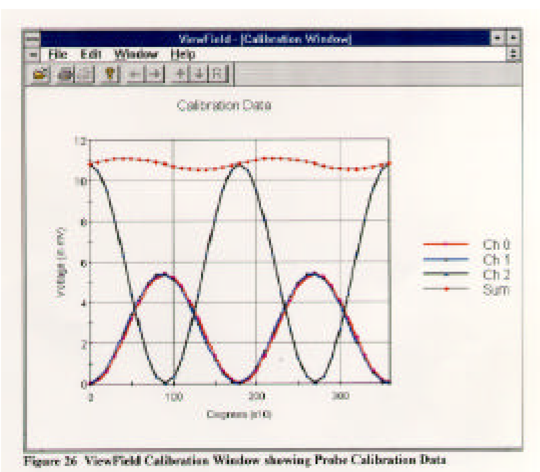



Figure 26 ViewField Calibration Window showing Probe Calibration Data

**Figure 6. Probe Calibration Data in**

$\Delta t$ = exposure time (30 seconds),

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

$\Delta T$ = 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;

$$\text{SAR} = \frac{|E|^2 \cdot s}{P} \qquad \text{where:}$$

$\sigma$ = simulated tissue conductivity,

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

## 4.3 Data Extrapolation

The probe offset is determined by measuring the distance between the center of the sensor to the end of the protective tube. The data is collected when the probe outer surface make contact with the surface of the phantom and measures the corresponding field in the simulated tissue near the shell surface. An average slope is obtained from these data points nearest the surface and is used to define an exponential decay of the energy density with the depth.

The field attenuation versus depth is recorded and extrapolated to obtain the $|E|^2$ value at the surface of the phantom where the maximum SAR is located.

$$Slope = \frac{\frac{Etotal \cdot Z1}{Etotal \cdot Z2} + \frac{Etotal \cdot Z2}{Etotal \cdot Z3}}{2}$$

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

$$Etotal \cdot Z0 = Etotal \cdot Z1 \cdot e^{\exp}$$

## 4.4 Interpolation and Gram Averaging

The 1 cm. voltage ($E_{total}$ 1 cm) above the phantom's surface is needed to calculate the exposure of one gram of tissue. The SAR value (mW/g) estimates the average over a one gram cube obtained from the extrapolated value ($E_{total}$ $Z_0$) and interpolated value ($E_{total}$ 1cm) obtained by interpolation as shown below.

$$SAR(mW/g) = \frac{Etotal \cdot Z0 + Etotal 1cm}{2} \cdot \frac{CF}{SensorFactor}$$

$$SensorFactor = \frac{10.8\,mV}{mW/cm^2} = \frac{0.0108\,V}{mW/cm^2}$$

*Conversion Factor (CF) =* *intermediate scaling constant for a particular probe which produced an output of 10.8 mV in the TEM cell when the flux density is 1 mW/cm*$^2$

# 5.1 PHANTOM AND THE BRAIN EQUIVALENT TISSUE

## 5.2 Phantom

The phantom is an anatomically-shaped homogeneous torso model filled with a liquid simulating brain tissue. The phantom is placed at 0 degrees (horizontal position) with the left/right ear placed on the EUT (see Fig. 5). The phantom is made of a shell of fiberglass 1.5mm. thick (giving the worst case SAR value absorbed by brain tissue and the skull bones) and the EUT supported by a non-metallic (delrin) material*. Similar phantoms have been used to simulate human head modelling studies[6][7].

## 5.3 Brain Simulating Mixture Characterization

The brain mixture consist of a viscous gel using hydroxethylcellullose (HEC) gelling agent and saline solution (see Table 1). Preservation with a bacteriacide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the brain. The mixture characterizations used for the brain tissue simulating liquid are according to the data by C. Gabriel and G. Hartsgrove [9].

| BRAIN MIXTURE % | FREQUENCY 800 - 850 MHz | FREQUENCY 1850 -1910 MHz |
|---|---|---|
| WATER | 40.4 | 45.0 |
| SUGAR | 56.0 | 53.9 |
| SALT | 2.5 | 0.0 |
| BACTERIACIDE | 0.1 | 0.1 |
| HEC | 1.0 | 1.0 |

**Table 1. Composition of the Brain Tissue Equivalent Matter**

* Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations [8]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

# 6.1 SYSTEM SPECIFICATIONS

## 6.2 Robotic System Specifications

**Specifications**

| | |
|---|---|
| **POSITIONER:** | IDX Robot with 6 axis |
| **Repeatability:** | 0.002 in. |
| **Accuracy:** | 0.004 in. |

**Data Acquisition**

| | |
|---|---|
| **Processor:** | Pentium PRO CPU |
| **Clock Speed:** | 200 MHz |
| **Operating System:** | Windows NT |
| **Data Card:** | National Instruments Analog Card |
| **Software:** | IDX Flexware |
| **AMPLIFIER GAIN:** | Adjustable 20 - 40, high isolation between channels |
| **Connecting Lines:** | High Impedance 4.5 kohm/foot |
| **Sample Rate:** | 6000 |

| **E-Field Probe** | **E-Probe #1** | **E-Probe #2** |
|---|---|---|
| **Probe Offset:** | 2.5 mm | 2.5 mm |
| **Frequency Band:** | 150 - 2200 MHz | 150 - 2200 MHz |
| **Conversion Factor:** | 0.601 (800-880MHz) | 0.79 (800-880MHz) |
| **Conversion Factor:** | 1.20 (1850-1910MHz) | 1.20 (1850-1910MHz) |
| **Dynamic Response:** | 2 μW/g - 10 mW/g | 2 μW/g - 10 mW/g |
| **Input:** | 2.2 meg | 2.2 meg |
| **Isotropicity:** | ± 0.5 dB | ± 0.5 dB |
| **Resolution:** | 0.1 $cm^3$ | 0.1 $cm^3$ |

| **Phantom** | **Phantom #1 (Left)** | **Phantom #2 (Right)** |
|---|---|---|
| **Phantoms:** | Homogenous | Homogenous |
| **Shell Material:** | Fiberglass | Fiberglass |
| **Thickness:** | 1 - 1.5 mm | 1 - 1.5 mm |
| **Head:** | with Left ear | with Right ear |

| **Brain Tissue Equivalent** | **800-850 MHz** | **1850-1910 MHz** |
|---|---|---|
| **Dielectric Constant:** $\varepsilon$ | 43.4 | 42.9 |
| **Conductivity:** $\sigma$ | 0.90 | 1.65 |

# 7.1 MEASUREMENT PROCESS

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

## 7.2 Area & Zoom Scan Grids

The SAR Measurement System measures field strength by employing three different types of systematic measurement scans; an Area scan, a Zoom scan, and an SAR scan. Area and Zoom 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 an Area scan is completed, a Zoom scan is conducted at the peak field strength value (hot spots) that was measured in the Area scan. The Zoom scan usually has a greater resolution (smaller grid squares) than the Area scan, and covers only a fraction of the measurement area in the Area scan (see Fig. 7).

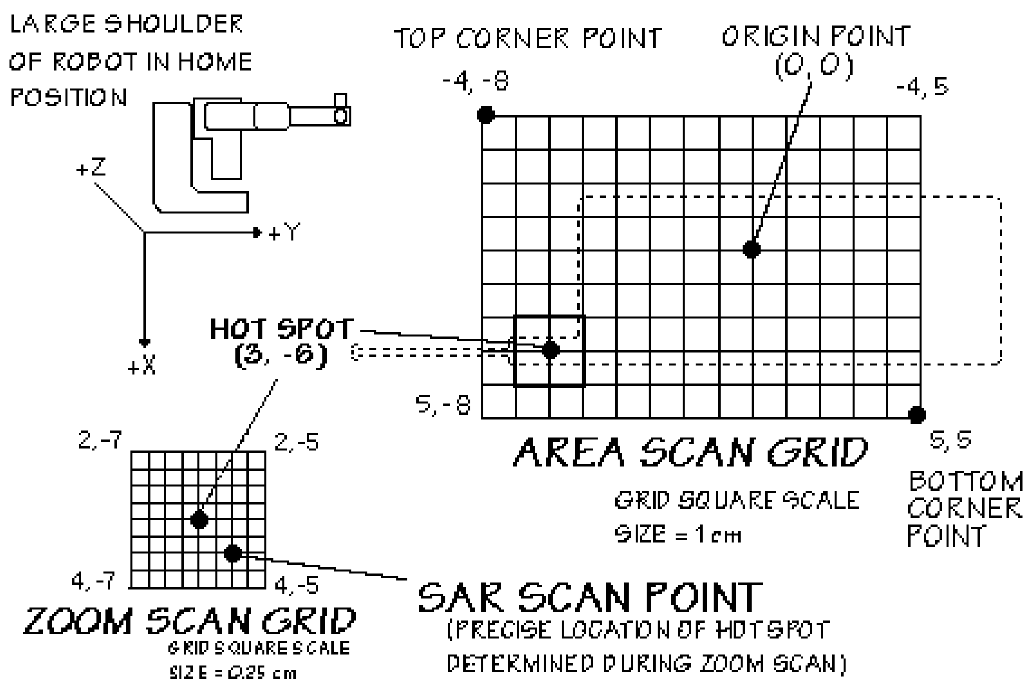



**Figure 7. SAR Measurement Points in Area Scan and Zoom Scan Grids Showing the Typical Hot Spot with respect to the Phone**

# 8.1 TEST POSITION OF THE PHONE

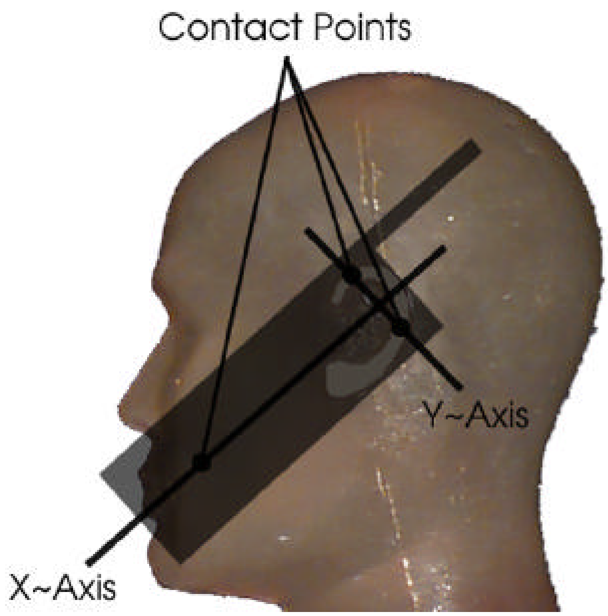



**Figure 8. Diagram showing Typical Alignment & Contact Points**

## 8.2 HANDSET TEST POSITION

The device was placed in a normal operating position with the center of its ear-piece aligned with the location of the ear canal on the phantom (See Fig. 9). With the ear-piece pressed against the head, the vertical center line of the body of the handset was aligned with an imaginary plane consisting of the three lines joining both ears and the tip of the mouth. While maintaining these alignments, the body of the handset was gradually moved towards the cheek until any point on the mouth-piece or keypad contacted the cheek (See Fig 8).

An upper right-hand corner antenna requires the left-hand phantom while handsets with an upper left antenna requires the right-hand phantom. The handset was tested both with its antenna extended (out) and retracted (in). A sample diagram of a typical handset shows the earpiece at the center of the X and Y axis, placed at the center of the ear canal of the phantom (see Fig. 10).

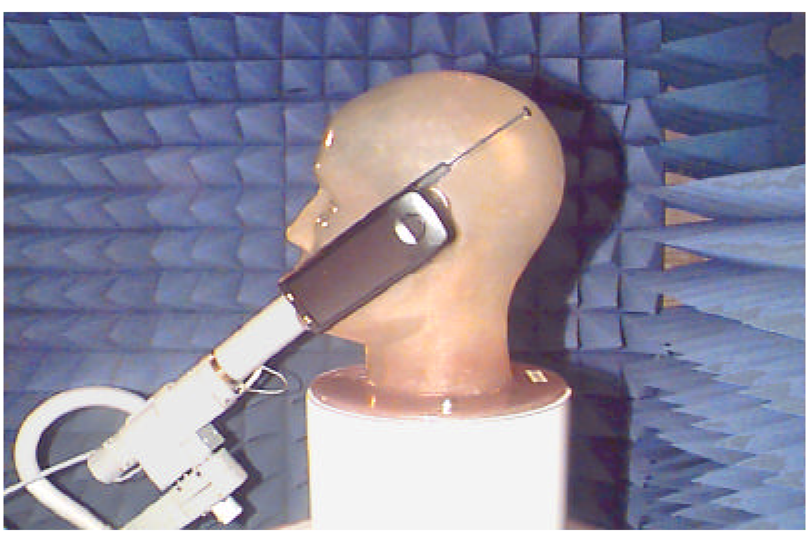


**Figure 9. Sample of Handset alignment with the Ear Canal of the Phantom**

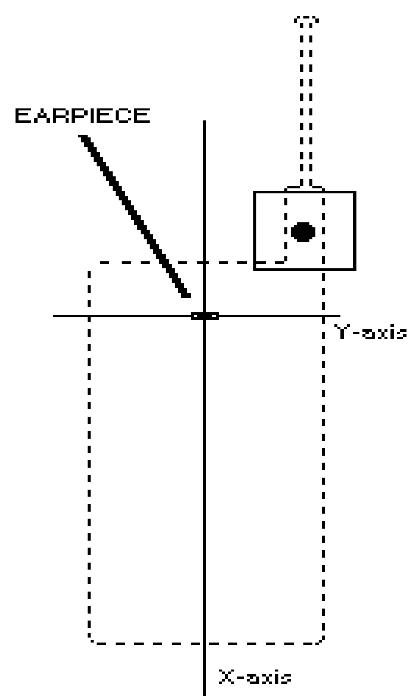



**Figure 10. Origin of Axis at Earpiece Position**

## 9.1 ANSI/IEEE C95.1 - 1992 RF EXPOSURE LIMITS

| HUMAN EXPOSURE | UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g) | CONTROLLED ENVIRONMENT Occupational (W/kg) or (mW/g) |
|---|---|---|
| **SPATIAL PEAK SAR *** (Brain) | 1.60 | 8.00 |
| **SPATIAL AVERAGE SAR **** (Whole Body) | 0.08 | 0.40 |
| **SPATIAL PEAK SAR ***** (Hands / Feet / Ankle / Wrist) | 4.00 | 20.00 |

**Table 2. Safety Limits for Partial Body Exposure [2]**

***NOTES:***

* 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.

** The Spatial Average value of the SAR averaged over the whole-body.

*** 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.

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

**Controlled Environments** are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

## 10.1 MEASUREMENT UNCERTAINTIES

Measurement uncertainties in SAR measurements are difficult to quantify due to several variables including biological, physiological, and environmental. However, we estimate the measurement uncertainties in SAR to be less than 15-25 %.

According to ANSI/IEEE C95.3, the overall uncertainty are difficult to assess and will vary with the type of meter and usage situation. However, accuracies of ± 1 to 3 dB can be expected in practice, with greater uncertainties in near-field situations and at higher frequencies (shorter wavelengths), or areas where large reflecting objects are present. Under optimum measurement conditions, SAR measurement uncertainties of at least ± 2dB can be expected.[3]

According to CENELEC [5], typical worst-case uncertainty of field measurements is ± 5 dB. For well defined modulation characteristics the uncertainty can be reduced to ± 3 dB.

| Estimated Errors | Percent |
|---|---|
| Measurement of the Conductivity/Dielectric Constant of the Tissue Simulant | ± 5 % |
| Temperature Rise Calibration of Probe | ± 5 % |
| Measurement of Thermal Capacity of Tissue Simulant | ± 5 % |
| Accuracy of a Repeatable Phone Position | ± 10 % |
| Probe Isotropic Response | ± 12 % |
| Total Root-Sum Square Calculation | ± 17.9 % |

**Table 3. Breakdown of Individual Errors**

# 11.1 TEST DATA SUMMARY

Ambient TEMPERATURE (°C) 23.0
Relative HUMIDITY (%) 55.5
Atmospheric PRESSURE (kPa) 96.2

**Mixture Type:** Brain

**Dielectric Constant:** 42.9

**Conductivity:** 1.65 S/m

**Closest Distance (between E-Probe & Phone Antenna):** 2.6 cm

## Measurement Results

| FREQUENCY MHz | FREQUENCY Ch. | Modulation | POWER (W) | EAR Position | Antenna Position | SAR (W/kg) |
|---|---|---|---|---|---|---|
| 1851.25 | 25 | CDMA | 0.2 | Left | IN | 0.8050 |
| 1851.25 | 25 | CDMA | 0.2 | Left | OUT | 0.5778 |
| 1880.00 | 600 | CDMA | 0.2 | Left | IN | 0.8132 |
| 1880.00 | 600 | CDMA | 0.2 | Left | OUT | 0.8085 |
| 1908.75 | 1175 | CDMA | 0.2 | Left | IN | 0.6902 |
| 1908.75 | 1175 | CDMA | 0.2 | Left | OUT | 0.5996 |
| **ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak (Brain) Uncontrolled Exposure/General Population** | | | | **1.6 W/kg (mW/g)** | | |

NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. All modes of operation were investigated and the worst-case are reported.
2. Battery condition is fully charged for all readings.
3. Power measured: ☒ Conducted ☐ EIRP ☐ ERP

Randy Ortanez
President & Chief Engineer

**PCTEST SEAL**

**DATE: 08-19-98**

## 12.1 SAR TEST EQUIPMENT

| Type / Model | Calib. Date | S/N: |
|---|---|---|
| PCTEST Robot Arm | Jan. 98 | PCT482 |
| PCTEST Computer<br>200 MHz Pentium Pro<br>Windows NT | Jan. 98 | PCT480 |
| Robot Controller | Jan. 98 | PCT464 |
| Teach Pendant (Joystick) | Jan. 98 | PCT467 |
| Phantom Head Model (Right) | Jan. 98 | PCT484 |
| Phantom Head Model (Left) | Apr. 98 | PCT497 |
| Brain Equivalent Matter (800MHz) | Aug. 98 | PCTBEM10 |
| Brain Equivalent Matter (1800MHz) | Aug. 98 | PCTBEM11 |
| E-Field Probe | Feb. 98 | PCT486A |
| E-Field Probe | May 98 | PCT486B |
| HP Spectrum Analyzer | Dec. 97 | PCT200 |
| IFT TEM Cell Model: CC110EXX<br>(DC - 2000MHz) | Jan. 98 | A427-0697 |
| Microwave Amp. Model: 5S1G4<br>(800MHz - 4.2GHz, 5 Watts) | Jan. 98 | 22332 |
| Non-metallic Handset Tripod | | PCT487 |

NOTE:
The E-field probe was calibrated by IDX Systems, Inc. The SAR calibration of the E-field probe is performed by temperature measurement procedure. A TEM cell is used for the free space calibration of the probe. 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.

The following list of equipment was used to calibrate the system (from IDX):

| | |
|---|---|
| Power Meter | HP-437B |
| RF Generator | HP-8657B |
| Power Amp | Power System Technology (Amplifier Research) |
| TEM cell | IFI CC-110 |
| Network Analyzer | HP-8753C |

## 13.1 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.

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]

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] 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.

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

[6] 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.

[7] 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.

[8] 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.

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

## ATTACHMENT A – TEST PLOT(S)

File : c:/idx3/SYSTEM/SARMEAS3/data/Normal/98081910_ZOOM.VLT
Start : 19-Aug-98 11:31:27 am  End : 19-Aug-98 11:38:00 am

Radio Type : QUALCOMM
Model Number : Q 1900
Serial Number : 745
Frequency : 1851.25 MHz
Peak Trans. Pwr : 0.200 W
Start Trans. Pwr: 0.200 W
Antenna Type : Helical
Antenna Posn. : In
Phantom Type : Head
Phantom Posn. : Left Ear
Scan Type : ZOOM/SAR
Probe Name : PCTEST
Field Type : E Field
Orientation : 0 Degrees

Mixture Type = Brain
Mixture Dielectric Constant = 42.900
Mixture Conductivity = 1.650

Comment :
CHAN 0025 CDMA MODE
PCS PHONE
PCTEST ENGINEERING LABORATORY

Robot : PCTEST

Probe Offset = 0.25 cm
Sensor Factor = 0.0108
Conversion Factor = 1.200

PCTEST Amplifier Channel Settings : 0.250 0.233 0.225

Diode Coefficients:

| | | | | | | |
|---|---|---|---|---|---|---|
| Channel 1 | An=-52.065 | Bn=113.200 | Cn=39.840 | Dn=0.001 | Mn=0.024 | Yn=0.000 |
| Channel 2 | An=0.000 | Bn=0.000 | Cn=0.000 | Dn=0.000 | Mn=0.000 | Yn=0.000 |
| Channel 3 | An=0.000 | Bn=0.000 | Cn=0.000 | Dn=0.000 | Mn=0.000 | Yn=0.000 |

Max Location : X = 9.000, Y = -1.000, Z = 0.000 (cm) Value = 7.990

Measured Values (volts) =
7.384E-003 5.914E-003 3.162E-003 1.539E-003 5.703E-004 1.743E-004
2.973E-004 1.085E-004 1.073E-004 2.012E-004 2.748E-004 2.400E-005
2.400E-005

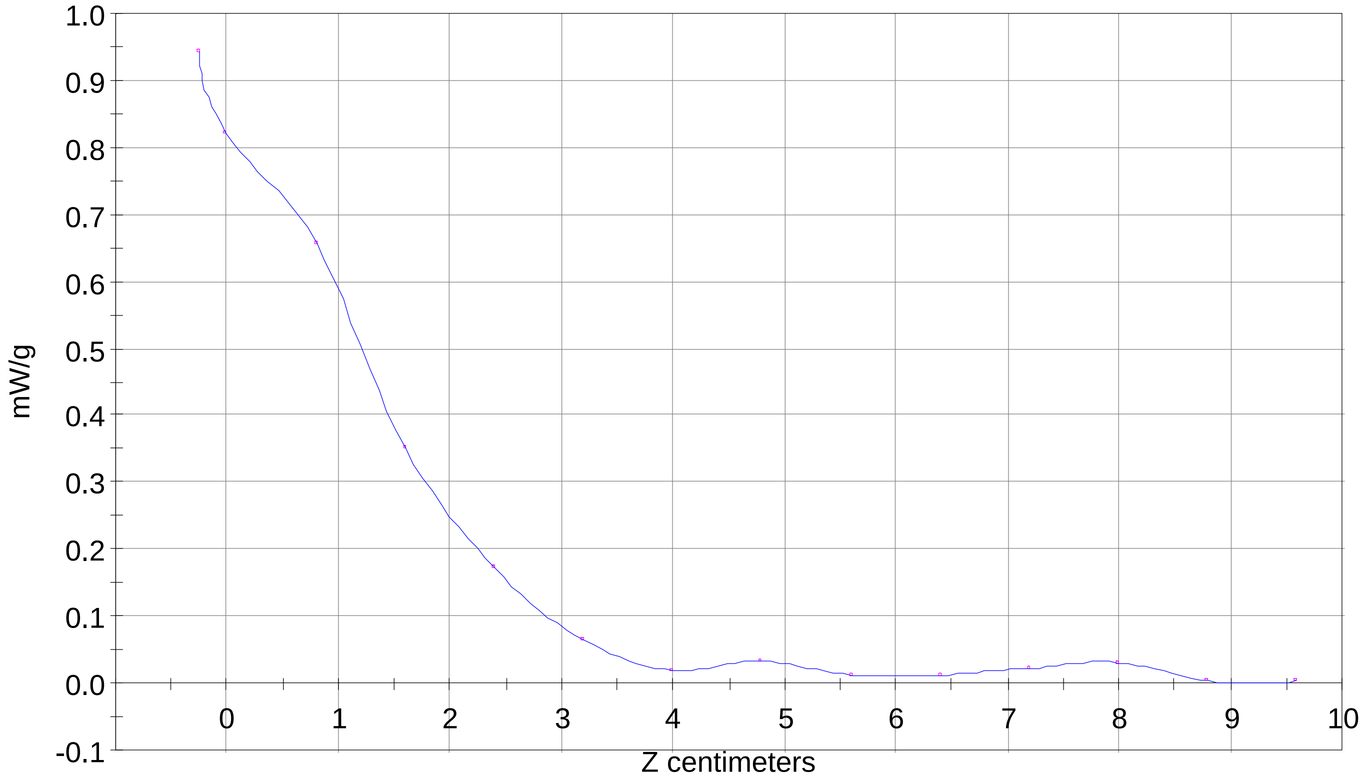
Calc. Voltage @ Surface (Vs) = 0.0085

Voltage @ 1.00 cm (Vt) = 0.0060

Ave. Voltage (Vs+Vt)/2 = 0.0072

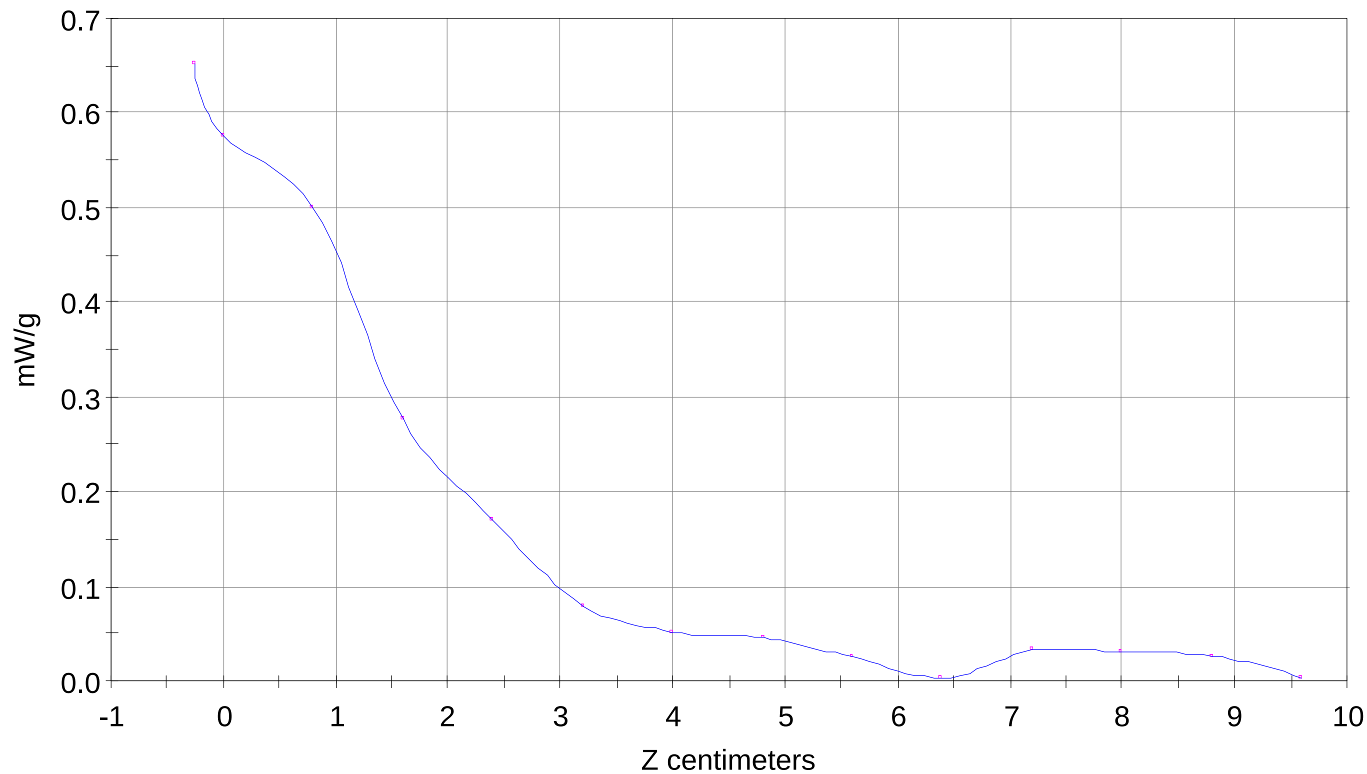
Ave. SAR over 1 g (mW/g) = 0.8050

SAR Scan
File : 98081910_ZOOM
Start : 19-Aug-98 11:31:27 am  End : 19-Aug-98 11:38:00 am
QUALCOMM/Q 1900/745;1851.25MHz;W;Helical/In;
Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650



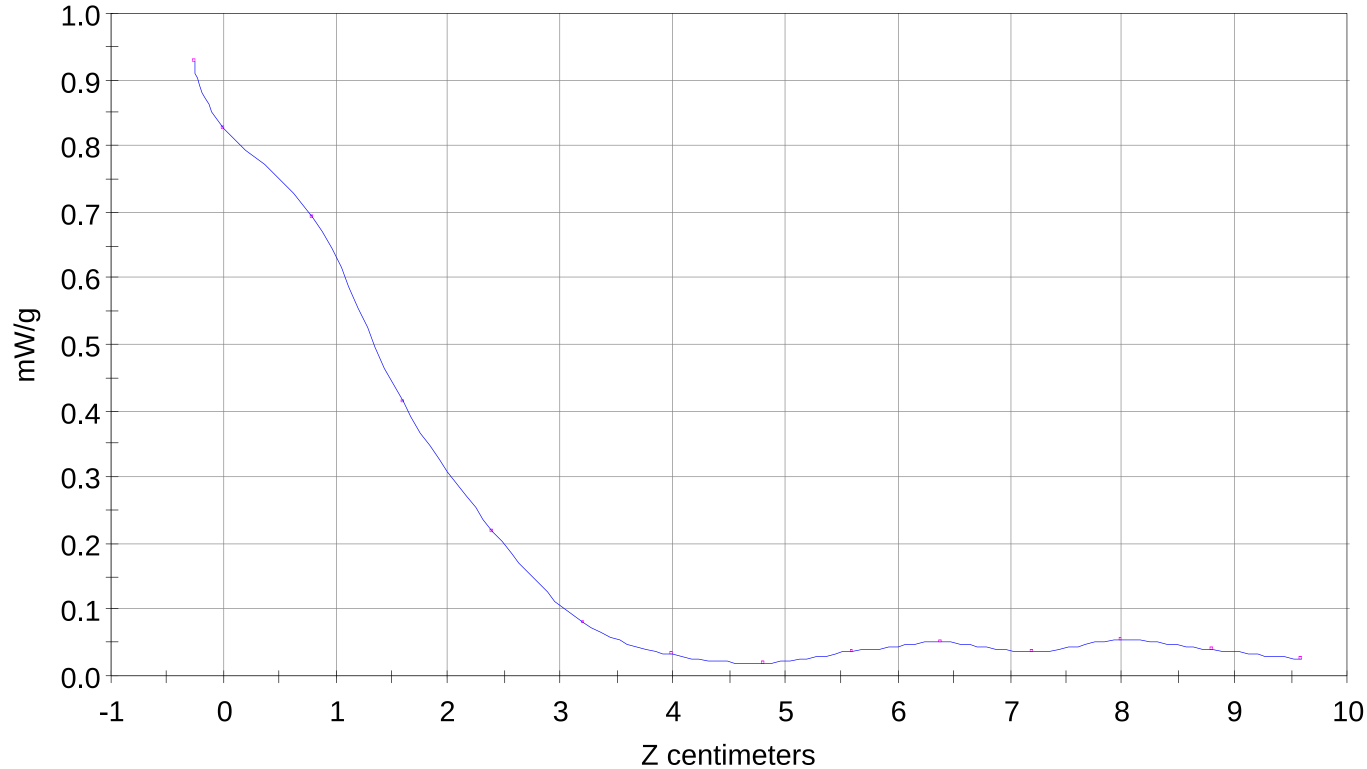
```
File : c:/idx3/SYSTEM/SARMEAS3/data/Normal/98081911_ZOOM.VLT
Start : 19-Aug-98 11:39:01 am  End : 19-Aug-98 11:45:44 am

Radio Type       : QUALCOMM
Model Number     : Q 1900
Serial Number    : 745
Frequency        : 1851.25 MHz
Peak Trans. Pwr  : 0.200 W
Start Trans. Pwr: 0.200 W
Antenna Type     : Helical
Antenna Posn.    : Out
Phantom Type     : Head
Phantom Posn.    : Left Ear
Scan Type        : ZOOM/SAR
Probe Name       : PCTEST
Field Type       : E Field
Orientation      : 0 Degrees

Mixture Type                 = Brain
Mixture Dielectric Constant = 42.900
Mixture Conductivity         =  1.650


Comment :
    CHAN 0025 CDMA MODE
      PCS PHONE
    PCTEST ENGINEERING LABORATORY


Robot   : PCTEST


Probe Offset         = 0.25 cm
Sensor Factor        = 0.0108
Conversion Factor    =  1.200


PCTEST   Amplifier Channel Settings :  0.250   0.233   0.225

Diode Coefficients:
    Channel 1 An=-52.065 Bn=113.200 Cn=39.840  Dn=0.001   Mn=0.024   Yn=0.000
    Channel 2 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000
    Channel 3 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000

Max Location : X =   9.000,  Y =  -1.250,  Z =   0.000   (cm)  Value =   5.038


Measured Values (volts) =
  5.179E-003  4.503E-003  2.484E-003  1.526E-003  7.161E-004  4.624E-004
  4.083E-004  2.237E-004  2.400E-005  2.862E-004  2.728E-004  2.377E-004
  2.400E-005


Calc. Voltage @ Surface (Vs) = 0.0059


Voltage @ 1.00 cm (Vt)       = 0.0045


Ave. Voltage (Vs+Vt)/2       = 0.0052


Ave. SAR over 1 g (mW/g)    = 0.5778
```

SAR Scan
File : 98081911_ZOOM
Start : 19-Aug-98 11:39:01 am  End : 19-Aug-98 11:45:44 am
QUALCOMM/Q 1900/745;1851.25MHz;W;Helical/Out;
Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650

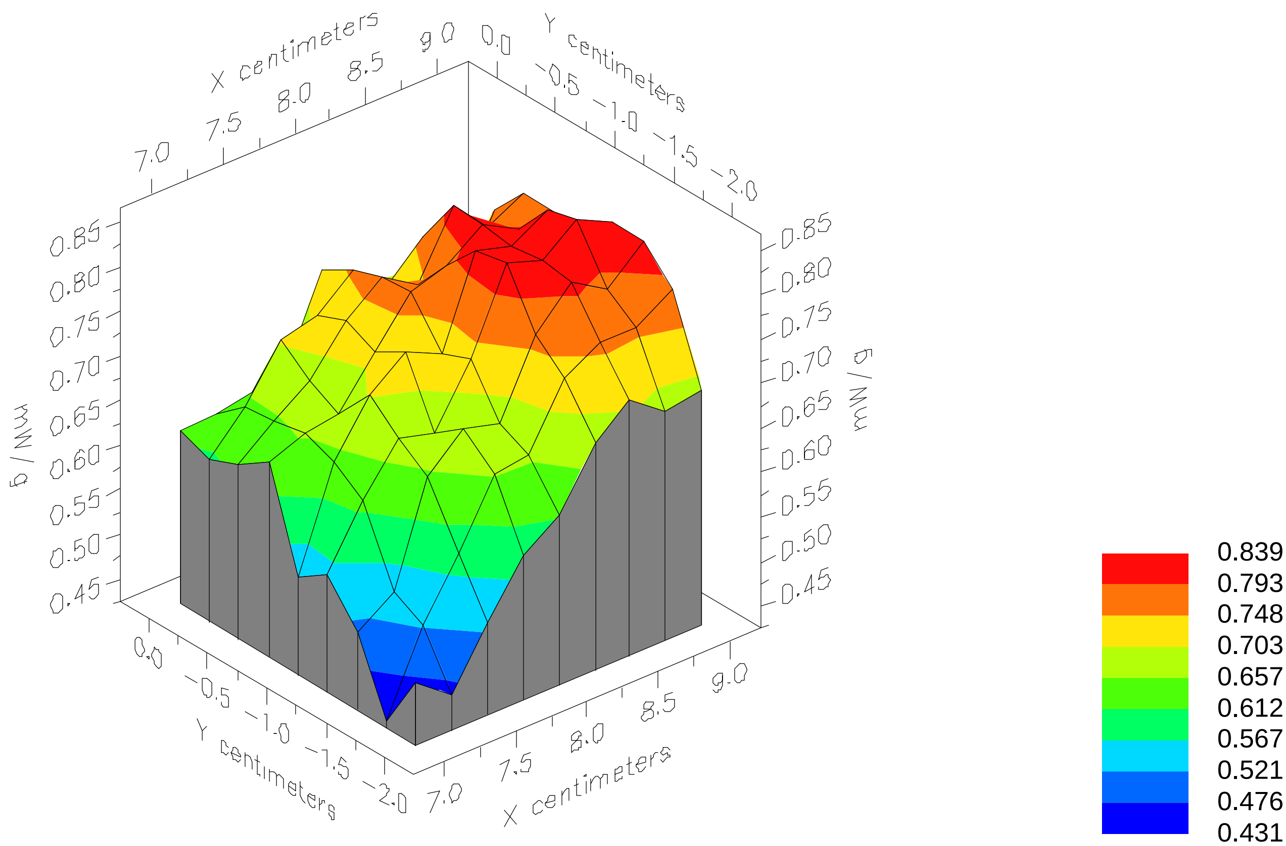


```
File : c:/idx3/SYSTEM/SARMEAS3/data/Normal/98081907_ZOOM.VLT
Start : 19-Aug-98 10:48:24 am  End : 19-Aug-98 11:00:36 am

Radio Type       : QUALCOMM
Model Number     : Q 1900
Serial Number    : 745
Frequency        : 1880 MHz
Peak Trans. Pwr  : 0.200 W
Start Trans. Pwr : 0.200 W
Antenna Type     : Helical
Antenna Posn.    : In
Phantom Type     : Head
Phantom Posn.    : Left Ear
Scan Type        : ZOOM/SAR
Probe Name       : PCTEST
Field Type       : E Field
Orientation      : 0 Degrees

Mixture Type                 = Brain
Mixture Dielectric Constant = 42.900
Mixture Conductivity         =  1.650


Comment :
    CHAN 0600 CDMA MODE
      PCS PHONE
    PCTEST ENGINEERING LABORATORY


Robot   : PCTEST


Probe Offset         = 0.25 cm
Sensor Factor        = 0.0108
Conversion Factor    =  1.200


PCTEST   Amplifier Channel Settings :  0.250   0.233   0.225

Diode Coefficients:
    Channel 1 An=-52.065 Bn=113.200 Cn=39.840  Dn=0.001   Mn=0.024   Yn=0.000
    Channel 2 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000
    Channel 3 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000

Max Location : X =   8.750,  Y =  -1.250,  Z =   0.000   (cm)  Value =   7.547


Measured Values (volts) =
  7.448E-003  6.222E-003  3.715E-003  1.968E-003  7.277E-004  2.785E-004
  1.729E-004  3.280E-004  4.490E-004  3.228E-004  4.868E-004  3.508E-004
  2.260E-004


Calc. Voltage @ Surface (Vs) = 0.0083


Voltage @ 1.00 cm (Vt)       = 0.0063


Ave. Voltage (Vs+Vt)/2       = 0.0073


Ave. SAR over 1 g (mW/g)    = 0.8132
```

SAR Scan
File : 98081907_ZOOM
Start : 19-Aug-98 10:48:24 am  End : 19-Aug-98 11:00:36 am
QUALCOMM/Q 1900/745;1880MHz;W;Helical/In;
Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650



File : 98081907_ZOOM
Start : 19-Aug-98 10:48:24 am  End : 19-Aug-98 11:00:36 am
QUALCOMM/Q 1900/745;1880MHz;W;Helical/In;
Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650

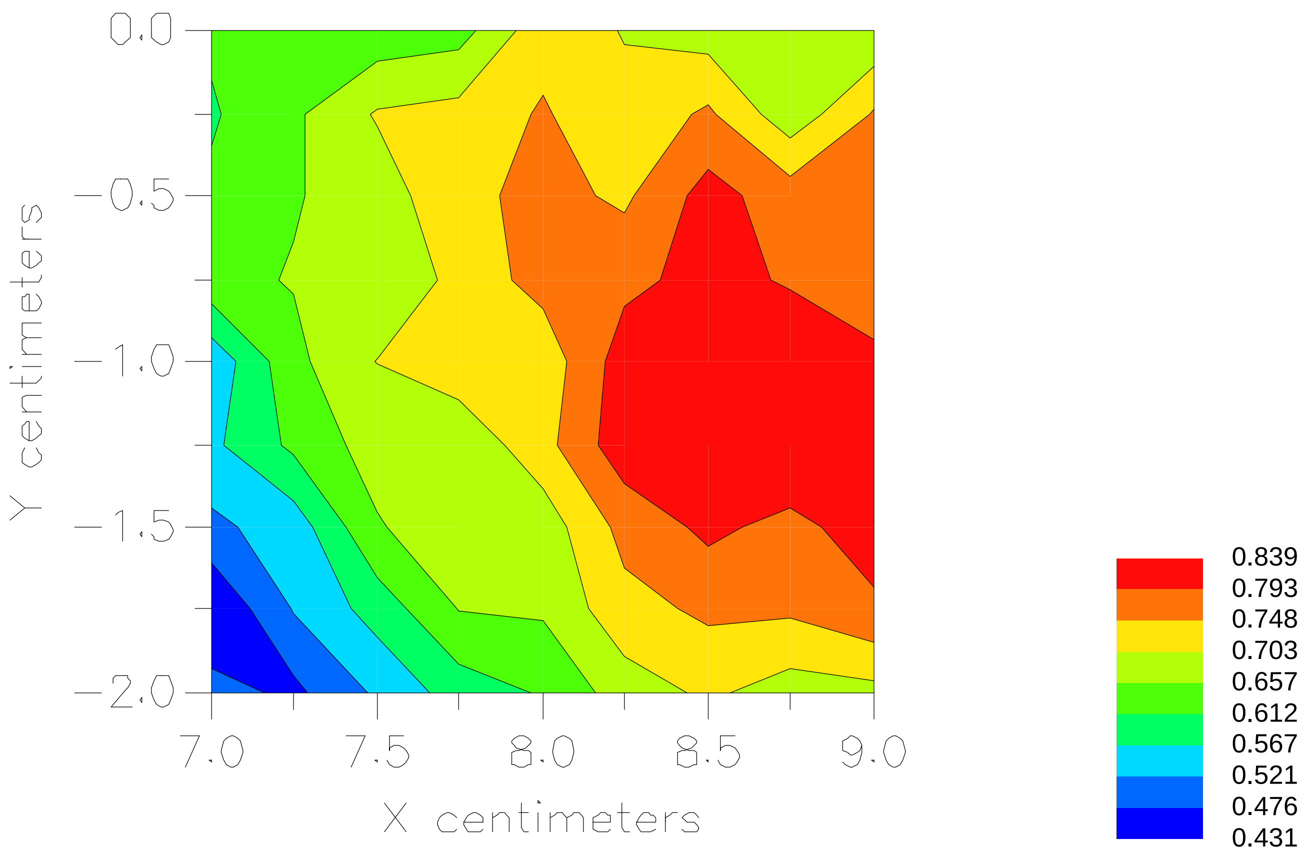


File : 98081907_ZOOM

Start : 19-Aug-98 10:48:24 am End : 19-Aug-98 11:00:36 am

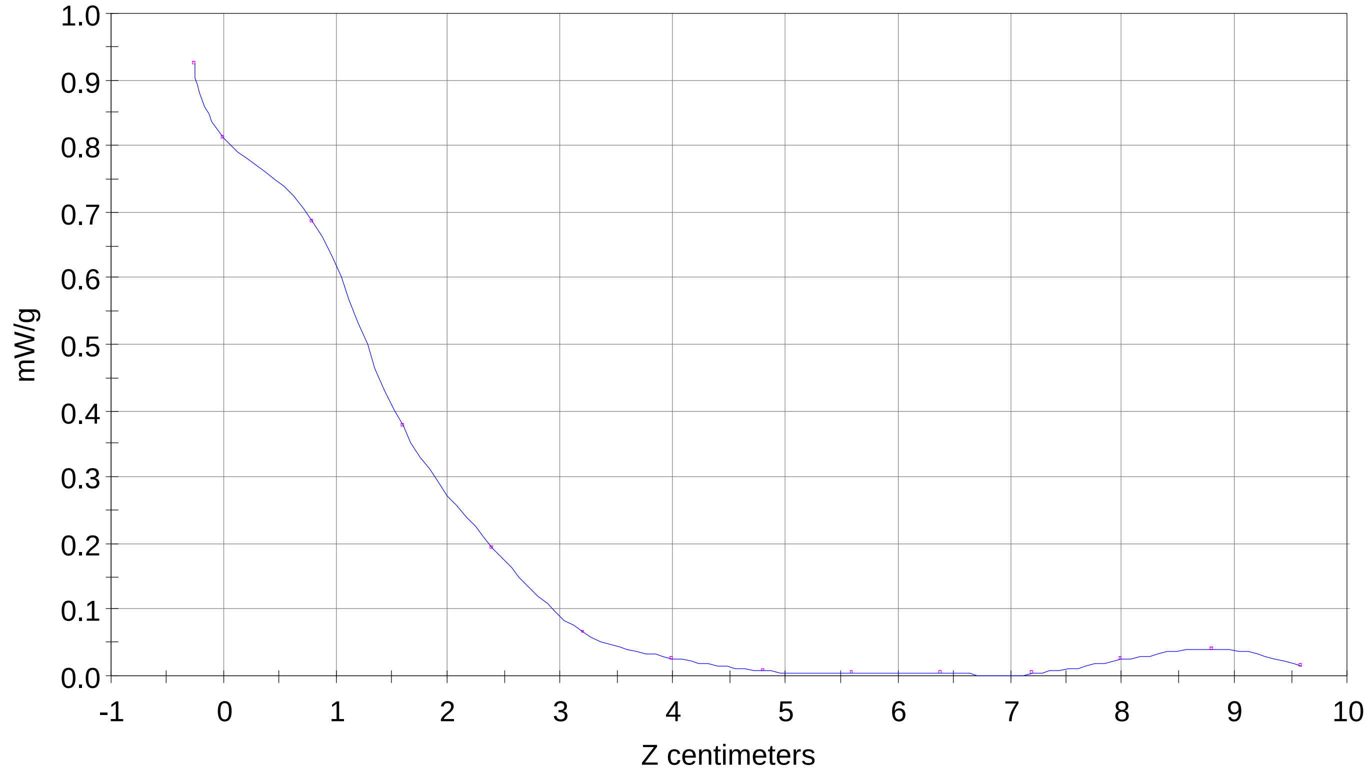
QUALCOMM/Q 1900/745;1880MHz;W;Helical/In;

Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650



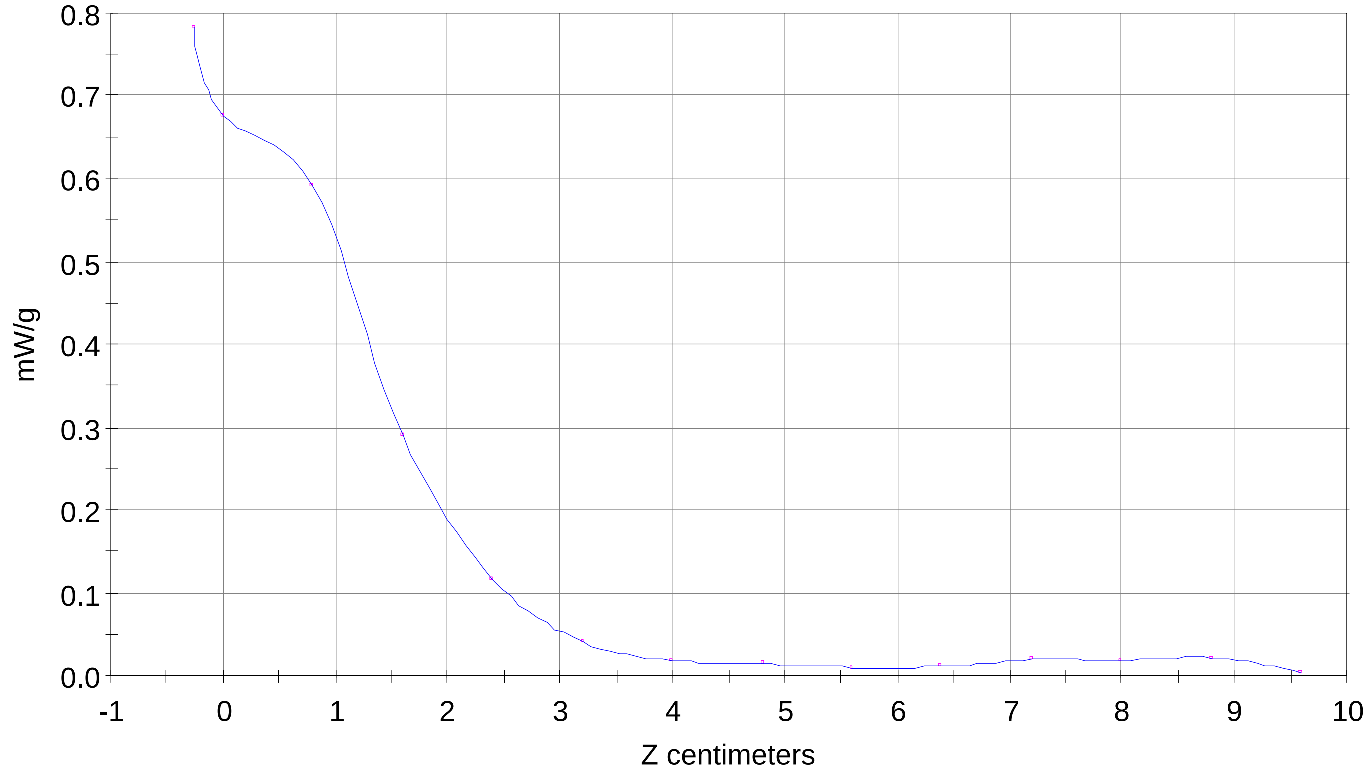
```
File : c:/idx3/SYSTEM/SARMEAS3/data/Normal/98081908_ZOOM.VLT
Start : 19-Aug-98 11:12:20 am  End : 19-Aug-98 11:23:25 am

Radio Type      : QUALCOMM
Model Number    : Q 1900
Serial Number   : 745
Frequency       : 1880 MHz
Peak Trans. Pwr : 0.200 W
Start Trans. Pwr: 0.200 W
Antenna Type    : Helical
Antenna Posn.   : Out
Phantom Type    : Head
Phantom Posn.   : Left Ear
Scan Type       : ZOOM/SAR
Probe Name      : PCTEST
Field Type      : E Field
Orientation     : 0 Degrees

Mixture Type                = Brain
Mixture Dielectric Constant = 42.900
Mixture Conductivity        =  1.650


Comment :
    CHAN 0600 CDMA MODE
      PCS PHONE
    PCTEST ENGINEERING LABORATORY


Robot   : PCTEST


Probe Offset        = 0.25 cm
Sensor Factor       = 0.0108
Conversion Factor   =  1.200


PCTEST   Amplifier Channel Settings :  0.250   0.233   0.225

Diode Coefficients:
    Channel 1 An=-52.065 Bn=113.200 Cn=39.840  Dn=0.001   Mn=0.024   Yn=0.000
    Channel 2 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000
    Channel 3 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000

Max Location : X =   9.000,  Y =  -1.250,  Z =   0.000   (cm)  Value =   7.229


Measured Values (volts) =
  7.315E-003  6.171E-003  3.384E-003  1.744E-003  5.931E-004  2.407E-004
  6.646E-005  2.400E-005  2.400E-005  2.400E-005  2.160E-004  3.627E-004
  1.250E-004


Calc. Voltage @ Surface (Vs) = 0.0083


Voltage @ 1.00 cm (Vt)       = 0.0062


Ave. Voltage (Vs+Vt)/2       = 0.0073


Ave. SAR over 1 g (mW/g)    = 0.8085
```

SAR Scan
File : 98081908_ZOOM
Start : 19-Aug-98 11:12:20 am  End : 19-Aug-98 11:23:25 am
QUALCOMM/Q 1900/745;1880MHz;W;Helical/Out;
Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650



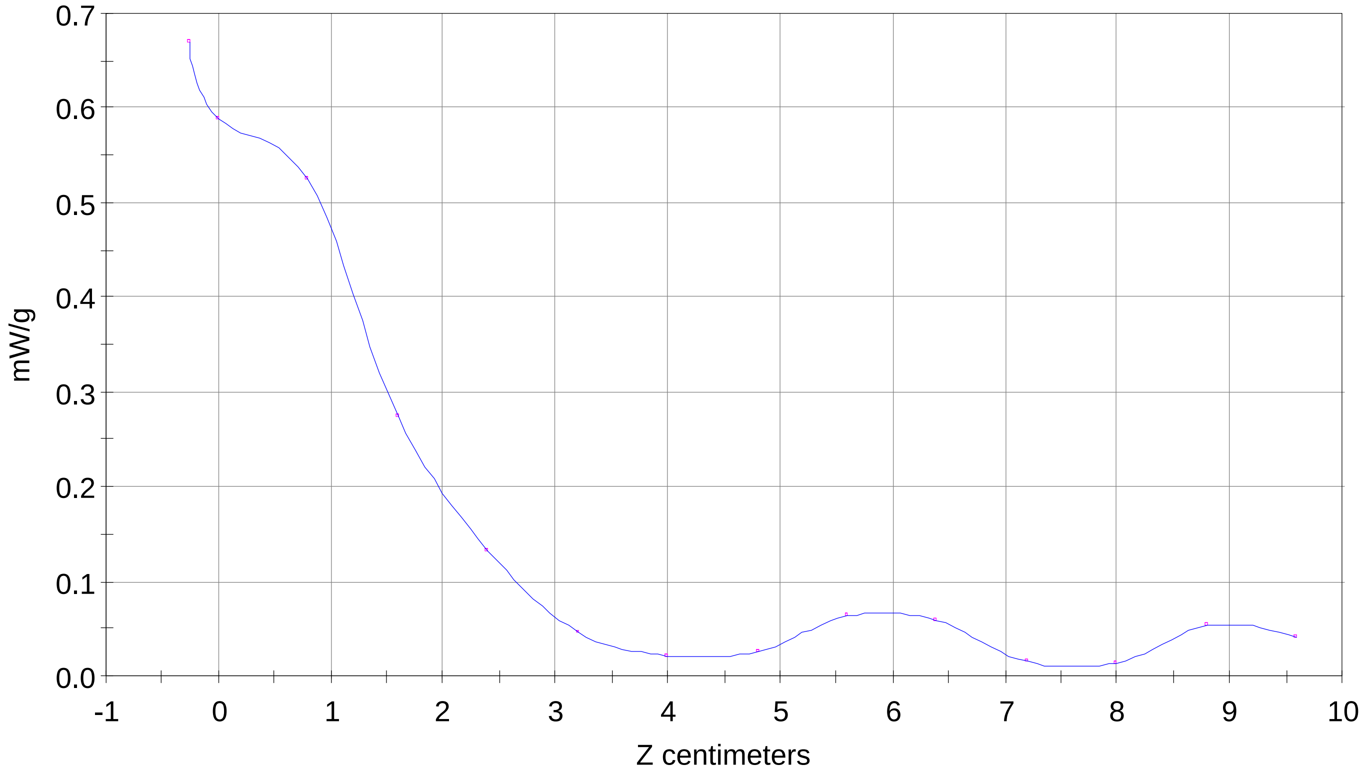
```
File : c:/idx3/SYSTEM/SARMEAS3/data/Normal/98081912_ZOOM.VLT
Start : 19-Aug-98 11:57:41 am  End : 19-Aug-98 12:07:37 pm

Radio Type      : QUALCOMM
Model Number    : Q 1900
Serial Number   : 745
Frequency       : 1908.75 MHz
Peak Trans. Pwr : 0.200 W
Start Trans. Pwr: 0.200 W
Antenna Type    : Helical
Antenna Posn.   : In
Phantom Type    : Head
Phantom Posn.   : Left Ear
Scan Type       : ZOOM/SAR
Probe Name      : PCTEST
Field Type      : E Field
Orientation     : 0 Degrees

Mixture Type                 = Brain
Mixture Dielectric Constant = 42.900
Mixture Conductivity        =  1.650


Comment :
    CHAN 1175 CDMA MODE
      PCS PHONE
    PCTEST ENGINEERING LABORATORY


Robot   : PCTEST


Probe Offset        = 0.25 cm
Sensor Factor       = 0.0108
Conversion Factor   =  1.200


PCTEST   Amplifier Channel Settings :  0.250   0.233   0.225

Diode Coefficients:
    Channel 1 An=-52.065 Bn=113.200 Cn=39.840  Dn=0.001   Mn=0.024   Yn=0.000
    Channel 2 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000
    Channel 3 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000

Max Location : X =   9.000,  Y =  -1.000,  Z =   0.000   (cm)  Value =   6.561


Measured Values (volts) =
  6.091E-003  5.332E-003  2.608E-003  1.054E-003  3.638E-004  1.625E-004
  1.229E-004  9.069E-005  9.755E-005  1.700E-004  1.665E-004  1.923E-004
  2.400E-005


Calc. Voltage @ Surface (Vs) = 0.0070


Voltage @ 1.00 cm (Vt)       = 0.0054


Ave. Voltage (Vs+Vt)/2       = 0.0062


Ave. SAR over 1 g (mW/g)    = 0.6902
```

SAR Scan
File : 98081912_ZOOM
Start : 19-Aug-98 11:57:41 am  End : 19-Aug-98 12:07:37 pm
QUALCOMM/Q 1900/745;1908.75MHz;W;Helical/In;
Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650



```
File : c:/idx3/SYSTEM/SARMEAS3/data/Normal/98081913_ZOOM.VLT
Start : 19-Aug-98 12:08:59 pm  End : 19-Aug-98 12:15:17 pm

Radio Type       : QUALCOMM
Model Number     : Q 1900
Serial Number    : 745
Frequency        : 1908.75 MHz
Peak Trans. Pwr  : 0.200 W
Start Trans. Pwr: 0.200 W
Antenna Type     : Helical
Antenna Posn.    : Out
Phantom Type     : Head
Phantom Posn.    : Left Ear
Scan Type        : ZOOM/SAR
Probe Name       : PCTEST
Field Type       : E Field
Orientation      : 0 Degrees

Mixture Type                 = Brain
Mixture Dielectric Constant = 42.900
Mixture Conductivity         =  1.650


Comment :
    CHAN 1175 CDMA MODE
      PCS PHONE
    PCTEST ENGINEERING LABORATORY


Robot   : PCTEST


Probe Offset         = 0.25 cm
Sensor Factor        = 0.0108
Conversion Factor    =  1.200


PCTEST   Amplifier Channel Settings :  0.250   0.233   0.225

Diode Coefficients:
    Channel 1 An=-52.065 Bn=113.200 Cn=39.840  Dn=0.001   Mn=0.024   Yn=0.000
    Channel 2 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000
    Channel 3 An=0.000   Bn=0.000   Cn=0.000   Dn=0.000   Mn=0.000   Yn=0.000

Max Location : X =   9.000,  Y =  -1.250,  Z =   0.000   (cm)  Value =   5.431


Measured Values (volts) =
  5.298E-003  4.721E-003  2.467E-003  1.193E-003  4.149E-004  1.932E-004
  2.260E-004  5.678E-004  5.253E-004  1.310E-004  1.234E-004  4.707E-004
  3.631E-004


Calc. Voltage @ Surface (Vs) = 0.0060


Voltage @ 1.00 cm (Vt)       = 0.0048


Ave. Voltage (Vs+Vt)/2       = 0.0054


Ave. SAR over 1 g (mW/g)    = 0.599
```

SAR Scan
File : 98081913_ZOOM
Start : 19-Aug-98 12:08:59 pm  End : 19-Aug-98 12:15:17 pm
QUALCOMM/Q 1900/745;1908.75MHz;W;Helical/Out;
Head/Left Ear;ZOOM/SAR;PCTEST/E Field/0 DegreesBrain/42.900/1.650

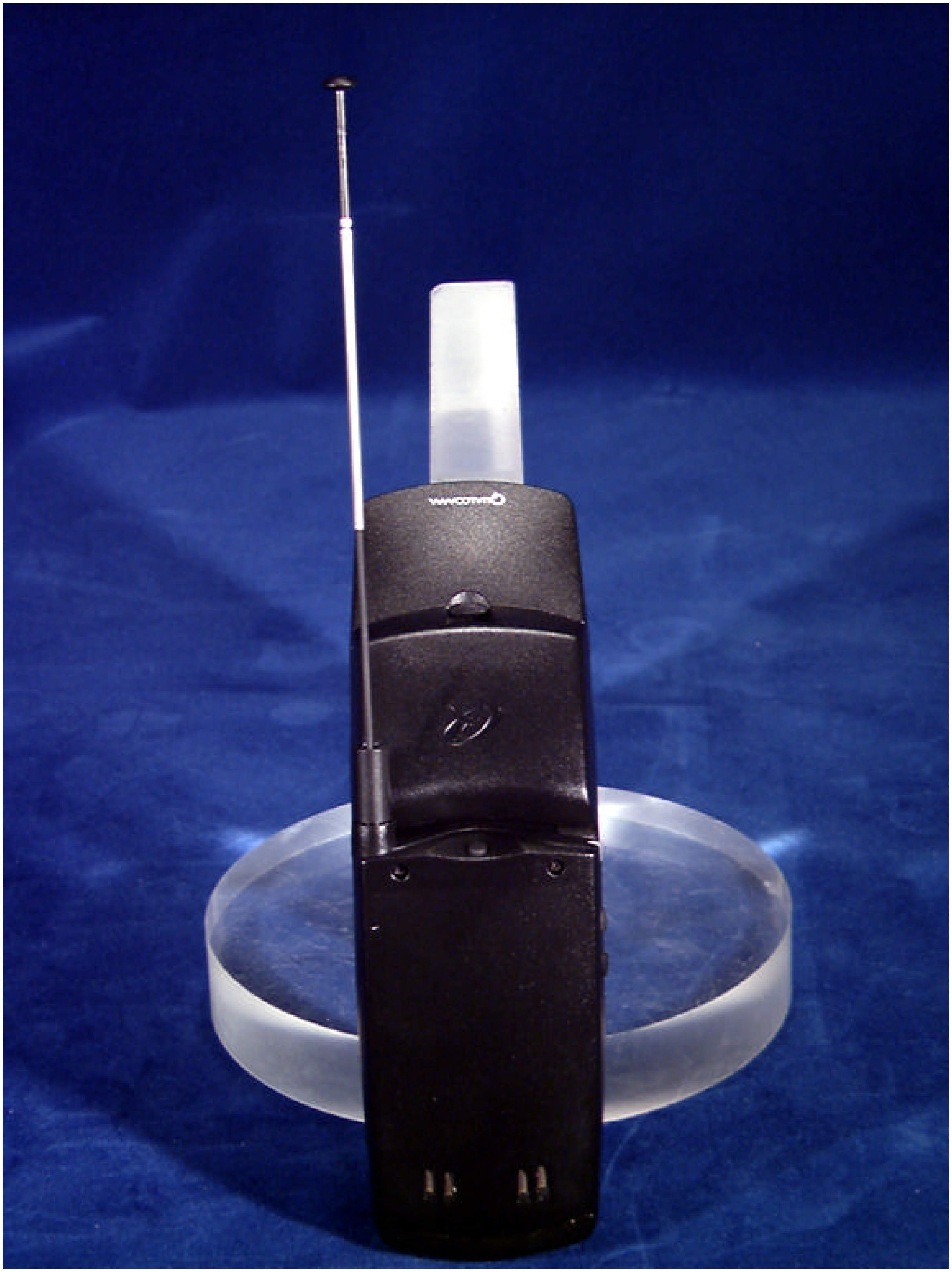


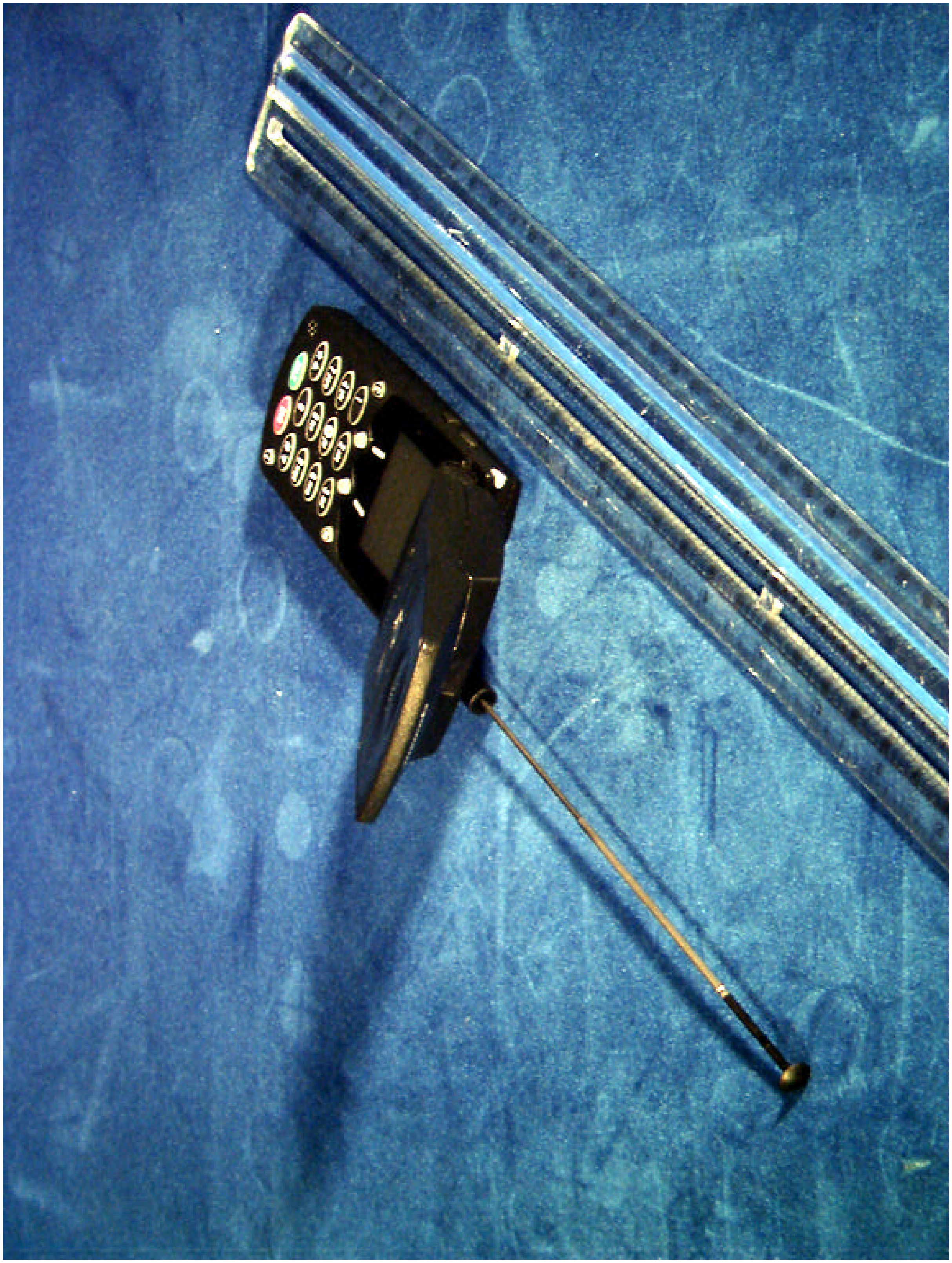
## ATTACHMENT B – PHOTOGRAPHS

[1]

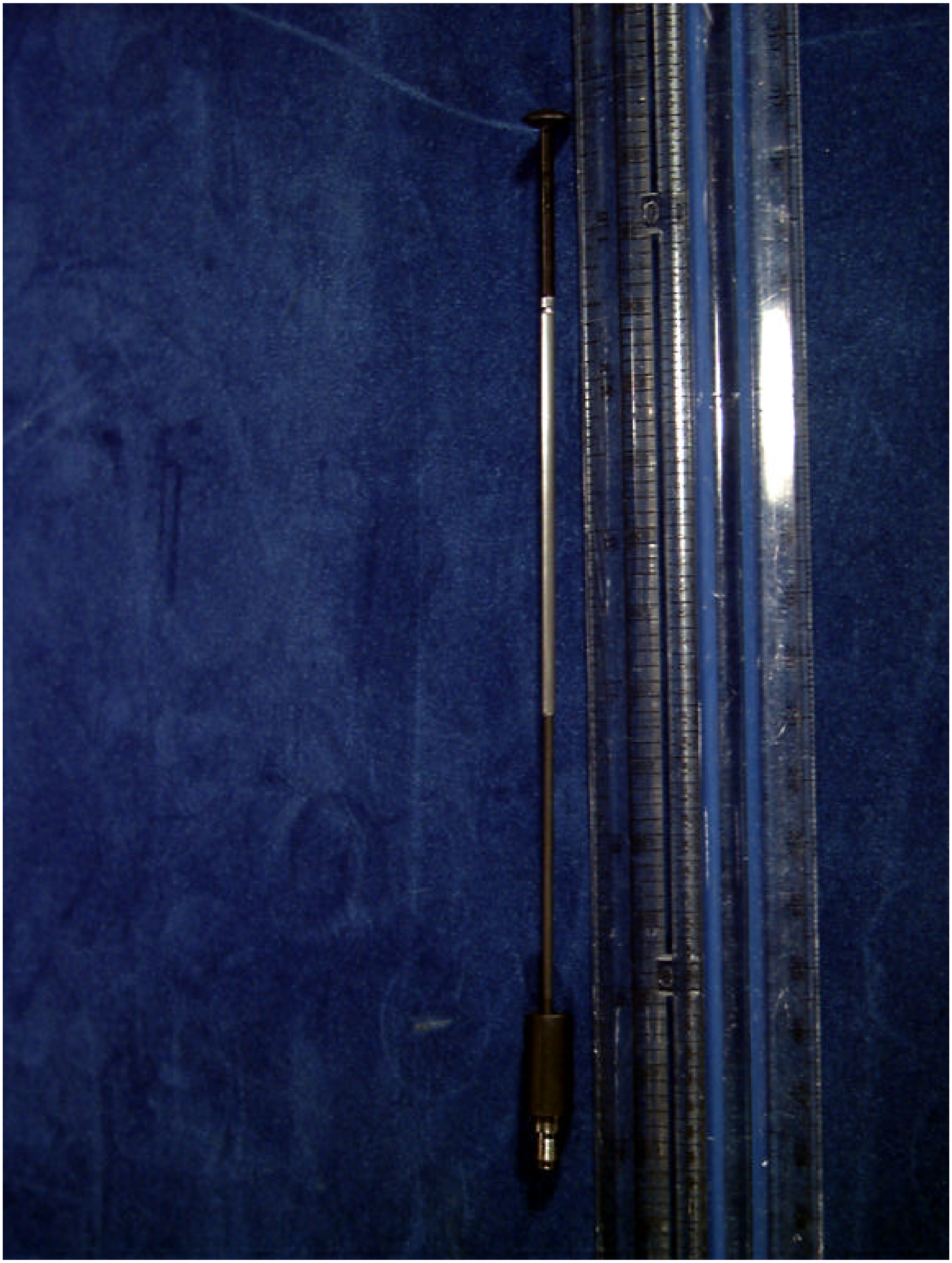

[1] Peak SAR Value at the surface of the phantom @ Z=0 (not averaged over 1-gram of tissue). This is a computer simulation of the hot spot(s) of the phone.

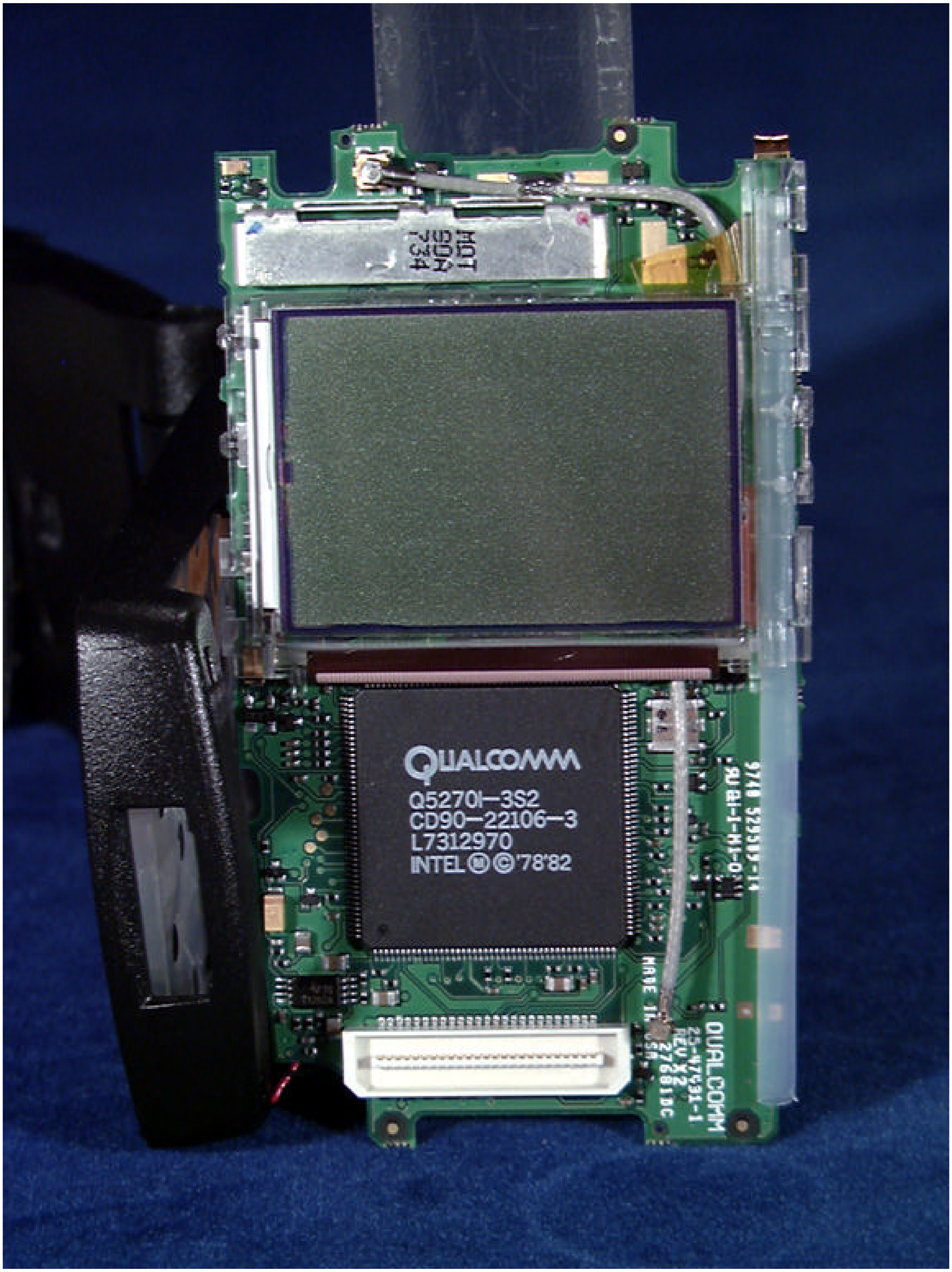

QUALCOMM
TALK
END

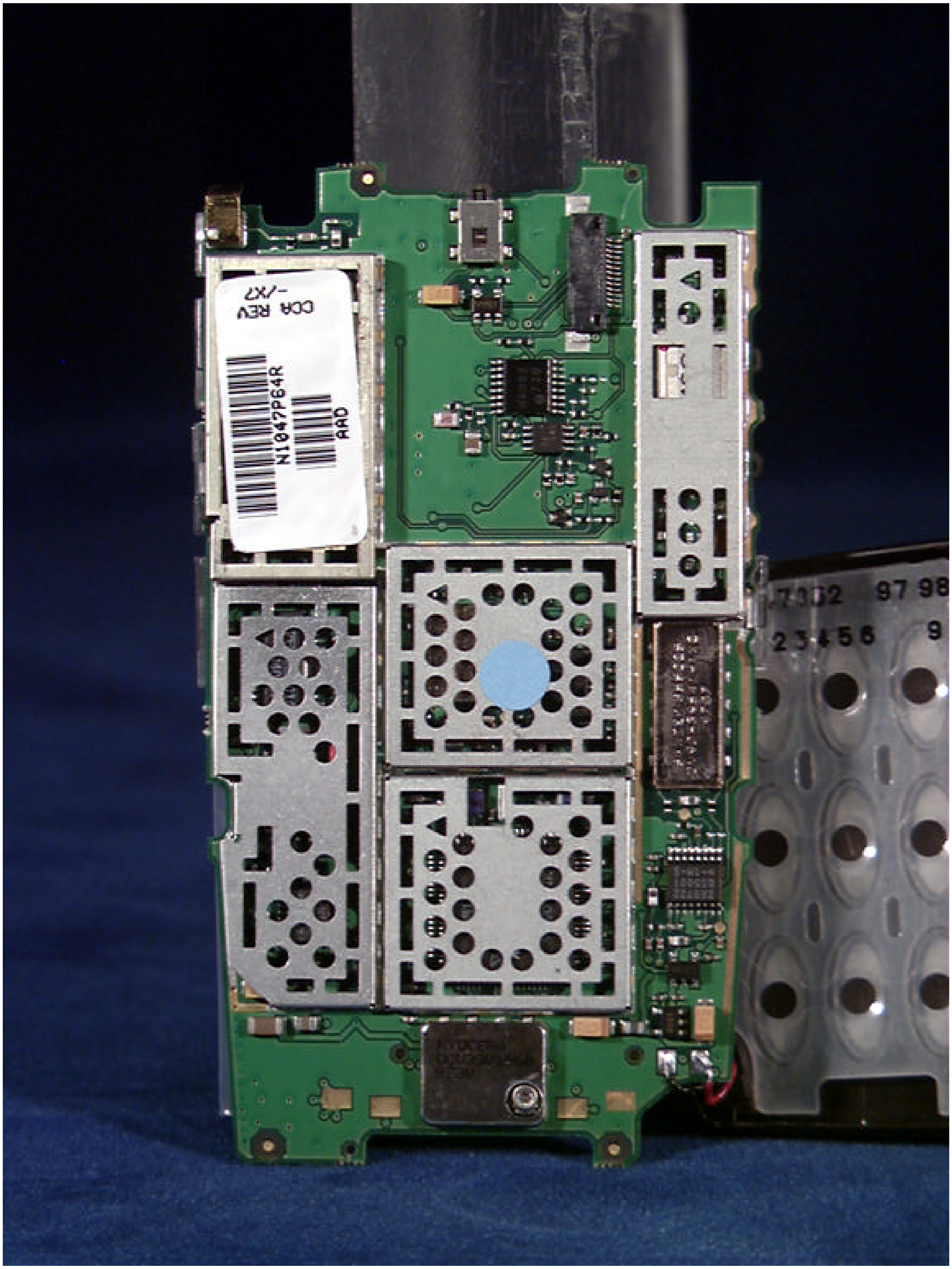


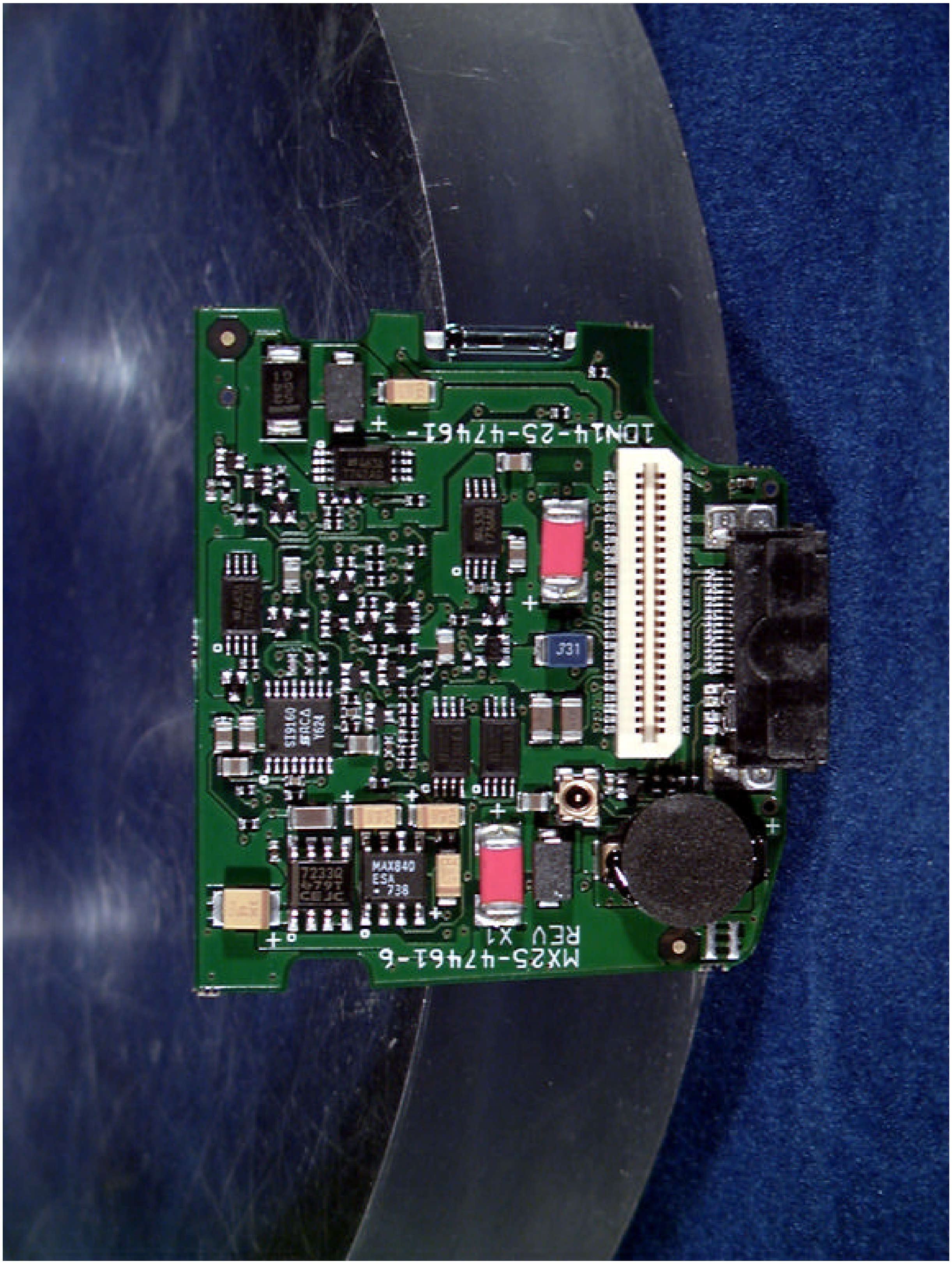


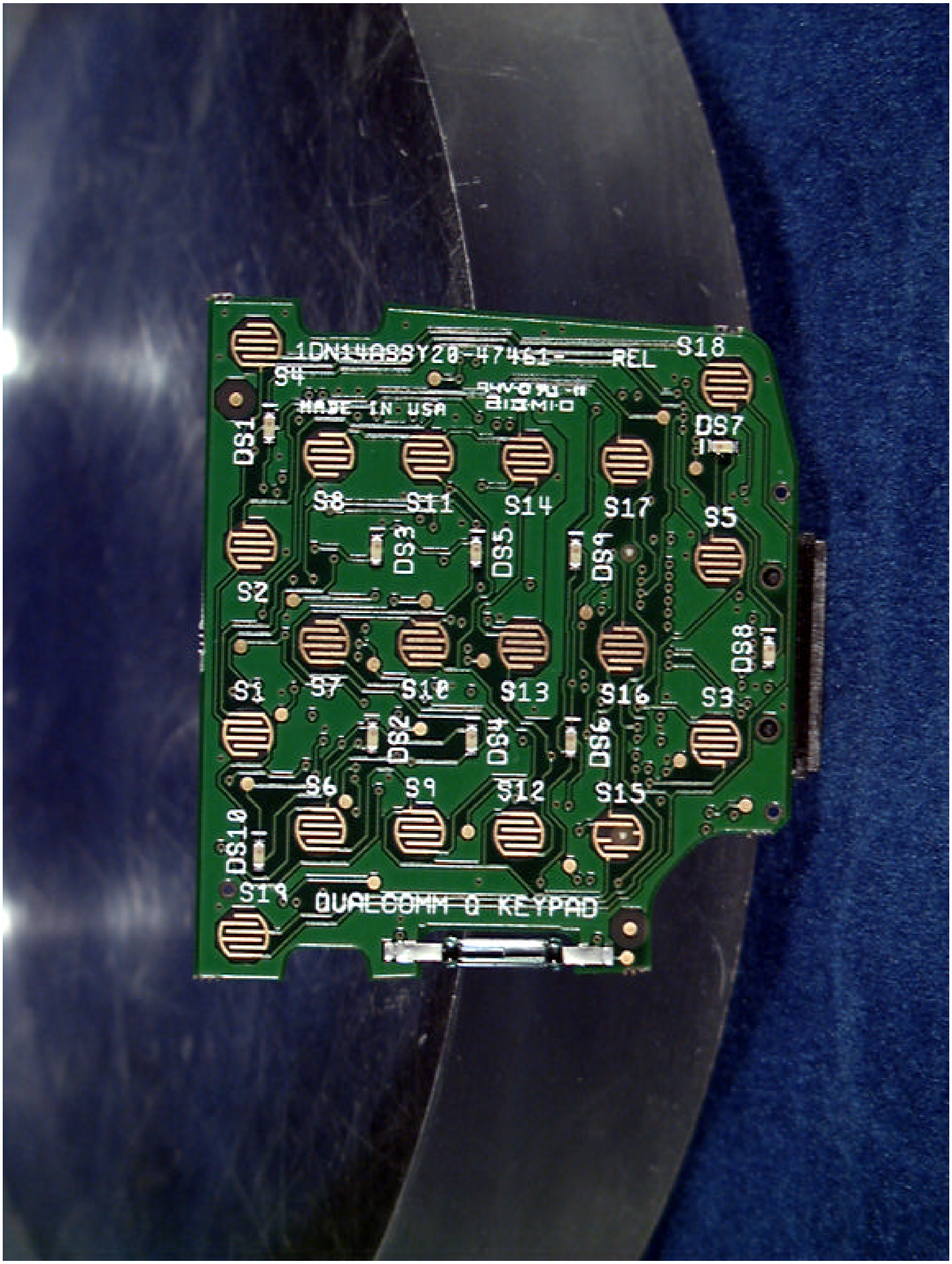

QUALCOMM
QUALCOMM

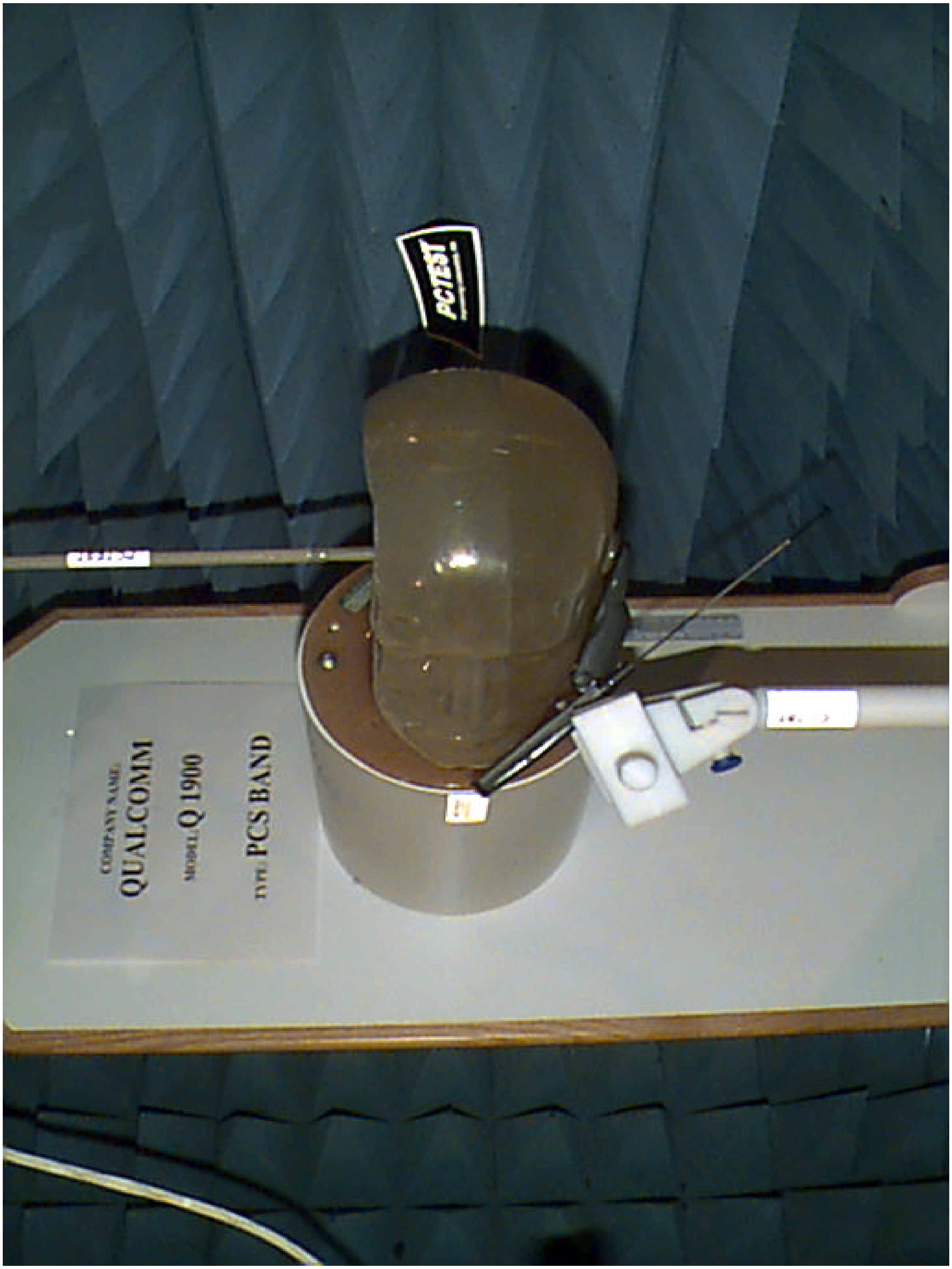


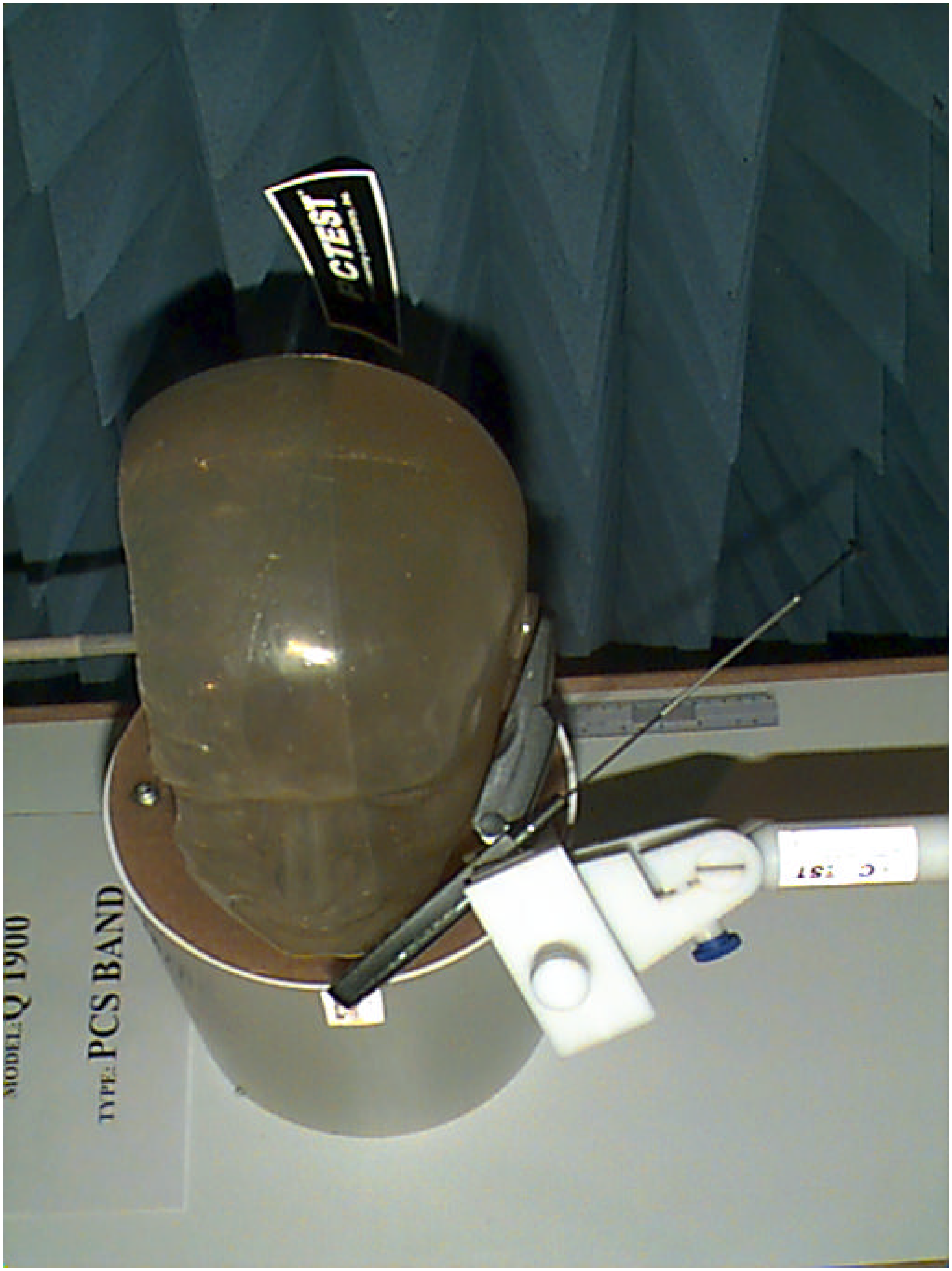

QUALCOMM
Q5270I–3S2
CD90–22106–3
L7312970
INTEL ©'78'82

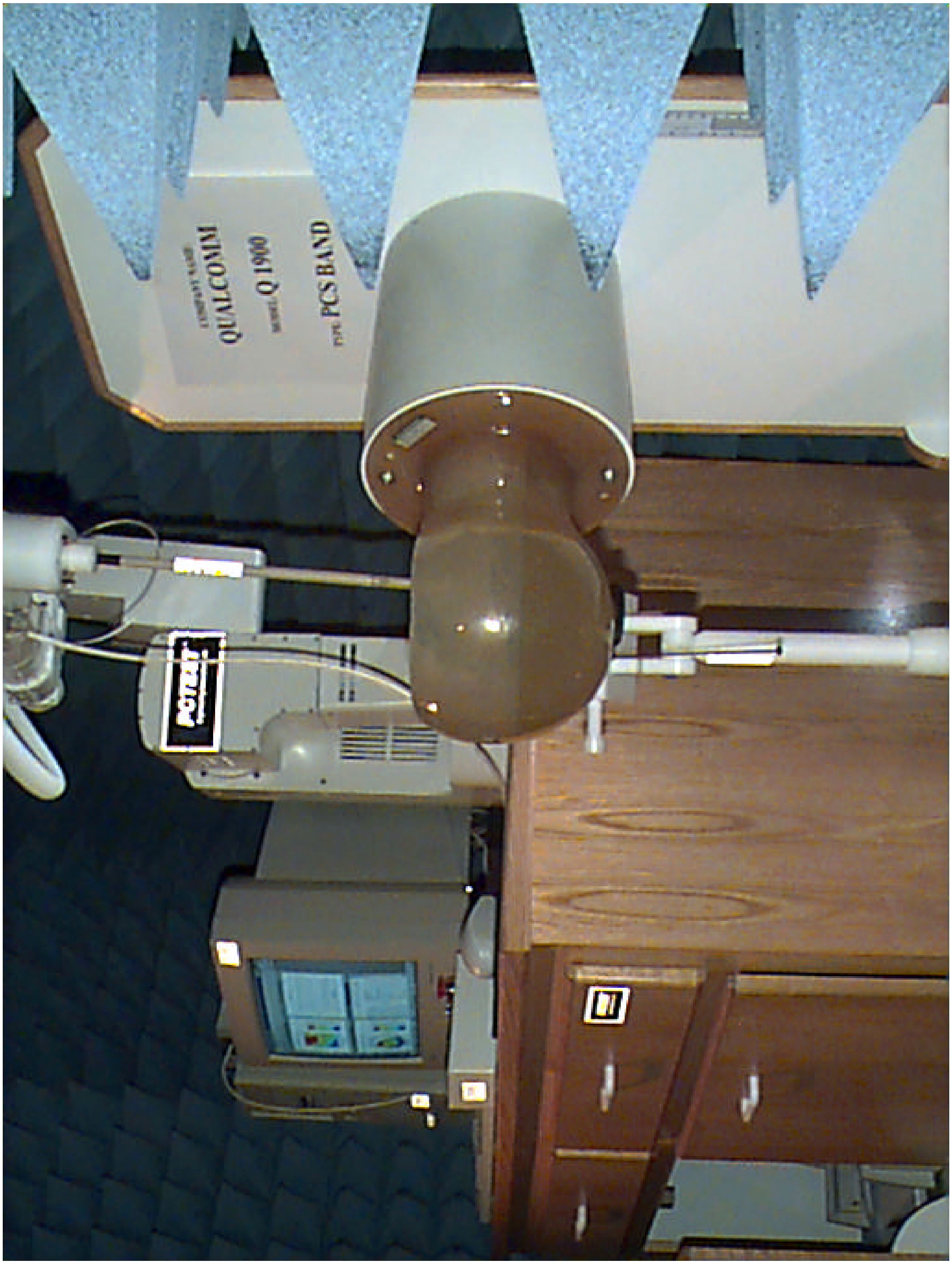

CCA REV
-/X7
N1047P64R
AAD




MADE IN USA
QUALCOMM Q KEYPAD

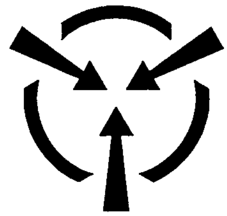

PCTEST
COMPANY NAME:
QUALCOMM
MODEL: Q 1900
TYPE: PCS BAND


PCTEST
MODEL: Q 1900
TYPE: PCS BAND


QUALCOMM
Q 1900
PCS BAND

## ATTACHMENT C – ANTENNA SPECIFICATIONS

| APPLICATIONS | | REVISIONS | | | |
|---|---|---|---|---|---|
| NEXT ASSY | USED ON | REV | DESCRIPTION | DATE | APPROVED |
| —— | —— | X1 | Preliminary - See DCR 18674 | —— | —— |



**CAUTION**

This Part is Electrostatic Discharge Sensitive (ESDS) and may be damaged by improper handling or Packaging.

RELEASED

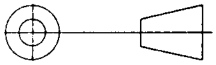
**QUALCOMM PROPRIETARY**

Export of this technology may be controlled by the United States Government. Diversion contrary to U.S. law prohibited.



The dimensions shown in this document are in inches only, metric only, or both (dual dimensions). For dual dimensions metric is the controlling dimension and shown above the inch dimension which is for reference only. The dimension style indicator shown above the QUALCOMM logo on the "D" size sheets indicate the dimension style for that sheet.

THIRD ANGLE PROJECTION



**"D" SIZE SHEET AVAILABLE**

QUALCOMM®

Source Control Drawing

6455 LUSK BLVD
SAN DIEGO, CA 92121-2779

UNLESS OTHERWISE SPECIFIED

DIMENSION UNITS ARE AS NOTED ABOVE OR ON DRAWING SHEETS, AND APPLY AFTER SURFACE TREATMENT

TOLERANCES

| LINEAR MM | LINEAR INCHES | ANGULAR EXCL OF SHEET METAL FLANGES |
|---|---|---|
| X ± 2.5<br>.X ± 0.76<br>.XX ± 0.25 | .X ± .1<br>.XX ± .030<br>.XXX ± .010 | ± 0° 30' |

| HOLE DIAMETER MM | HOLE DIAMETER INCHES | TOLERANCES MM | TOLERANCES INCHES |
|---|---|---|---|
| 0.34 - 6.35 | .0135 - .250 | + 0.13<br>- 0.03 | + .005<br>- .001 |
| 6.37 - 12.7 | .251 - .500 | + 0.15<br>- 0.03 | + .006<br>- .001 |
| 12.7 - 25.4 | .501 - 1.000 | + 0.25<br>- 0.03 | + .010<br>- .001 |

| | |
|---|---|
| CONTRACT NO. | |
| DRAWN BY: P. Giovannoni | DATE: 06/22/98 |
| ENGINEERING: [illegible] | [illegible] |
| ENGINEERING: [illegible] | 6/24/98 |
| QUALITY ASSURANCE | |
| CONFIGURATION: [illegible] | 6/24/98 |
| PROJECT ENGINEER: [illegible] | [illegible] |

TITLE

**ANTENNA, TELESCOPIC, 1.9GHz, Q-1900**

| SIZE | CAGE CODE | DWG NO. |
|---|---|---|
| A | 1DN14 | CV90-48628 |

| SCALE | RELEASE DATE | SHEET |
|---|---|---|
| None | JUN 24 1998 | 1 of 20 |

Form 76-33319-1 Rev -

## 1.0 **SCOPE**

1.1 This control drawing defines the requirements for a 1.85-1.91 GHz and 1.93-1.99 GHz Antenna, hereinafter referred to as the "Device".

1.2 Definitions.

1.2.1 Revision Changes. Bars appearing to the left of paragraphs shall indicate changes made to this document since the previous revision issue.

## 2.0 **APPLICABLE DOCUMENTS**

2.1 The following documents of the issue in effect on the release date of this drawing (unless an exact issue is shown) form a part of this drawing to the extent specified herein. In the event of conflict between this control drawing, the procurement document and applicable document, the order of precedence shall be the procurement document, this control drawing, and the applicable documents. For reference only unless identified elsewhere in this document.

## 3.0 REQUIREMENTS

3.1 General. The Device shall conform to accepted engineering practices consistent with the requirements in this control drawing. Details of design, construction, materials, and finishes not specified herein shall be such that the Device shall meet all the requirements of this control drawing. Acceptance or approval of any such details shall not be construed as a guarantee of acceptance.

3.1.1 Environment For Electrical Tests. Electrical test platform is QUALCOMM phone, MCN# TBD and applicable dash number. QUALCOMM designates the phone. Input port to antenna system replaces duplexer port output.

3.2. Electrical Requirements. The following summarizes the performance requirements of the Device. All measurements are required to be made utilizing the test circuit indicated in Figure 1 and paragraph 3.2.3.2.

3.2.1 Frequency Bands.

3.2.1.1 Transmit Band (Tx). 1.85-1.91 GHz

3.2.1.2 Receive Band (Rx). 1.93-1.99 GHz

3.2.2 Impedance. 50 Ω (Nominal Value)

3.2.3 VSWR

3.2.3.1 Matching Section. The Matching section in the designated handset shall be according to Figure 1.

3.2.3.2 Method of Measuring VSWR. VSWR shall be referenced to 50 Ω at the feed point shown in Figure 1. Furthermore, VSWR in extended and retracted condition shall be measured in free space (provided that matching circuit shall be optimized with phone/antenna system held next to the head).

3.2.3.3 Maximum values of VSWR in Frequency Band.

| | Tx | Rx |
|---|---|---|
| extended | 2.3 | 2.3 |
| retracted | 3.0 | 3.0 |

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3.2.4 Gain

3.2.4.1 Items Measured Regarding Gain. Gain in extended and retracted condition shall be measured in free space.

3.2.4.2 Minimum Values of Gain in Frequency Band (measured in all planes).

At Peak Direction

| | Tx | Rx |
|---|---|---|
| extended | -1.0 dBd | -2.0 dBd |
| retracted | -4.0 dBd | -4.0 dBd |

3.2.5 Power Rating.

3.2.5.1 Method of Measuring Power Rating. 2W CW is applied for 10 minutes at +20 ± 3°C through 50 Ω feed point shown in Figure 1.

3.2.5.2 Demand After the Test. No visual deterioration shall occur after the test. The Device shall satisfy the electrical demand according to sections 3.2.3 and 3.2.4 after the test.

3.3 Mechanical Characteristics. The Device can be identified to have three different positions as shown in Figure 2b.

1) Device fully extended
2) Device partially extended
3) Device fully retracted

Due to the design of this Device, at two locations (location #1 and location #2 as shown in Figure 2b) two pieces of the Device move in relation to another piece.

Location #1 is internal to the helix
Location #2 is internal to the stainless steel tube

3.3.1 Retraction Force From Extended Position.

3.3.1.1 Method of Measuring Retracted Force at Location #1. The Device is pushed down at location #1 from its extended position with a speed 2mm/s. The maximum force before the Device is released is registered.

3.3.1.2 Demand After the Test at Location #1. The mean value from 5 measurements shall be within 1.0 to 3.0N as retracted force. No visual deterioration shall occur during the test. The Device shall satisfy the electrical demand, according to paragraphs 3.2.3.3 and 3.2.4.2.

3.3.1.3 Method of Measuring Retracted Force at Location #2. The Device is pushed down at location #2 from its extended position with a speed 2mm/s. The maximum force before the Device is released is registered.

3.3.1.4 Demand After The Test at Location #2. The mean value from 5 measurements shall be within 1.0 to 3.0N as retracted force. No visual deterioration shall occur during the test. The Device shall satisfy the electrical demand, according to paragraphs 3.2.3.3 and 3.2.4.2.

3.3.2 Extension Force From Retracted Position.

3.3.2.1 Method of Measuring Extension Force at Location #1. The Device is pulled up at location #1 from its retracted position with a speed 2mm/s. The maximum force before the Device is released is registered.

3.3.2.2 Demand After The Test at Location #1. The mean value from 5 measurements shall be within 0.5 to 6.0N as extension force. No visual deterioration shall occur during the test. The Device shall satisfy the electrical demand, according to paragraphs 3.2.3.3 and 3.2.4.2.

3.3.2.3 Method of Measuring Extension Force at Location #2. The Device is pulled up at location #2 from its retracted position with a speed 2mm/s. The maximum force before the Device is released is registered.

3.3.2.4 Demand After The Test at Location #2. The mean value from 5 measurements shall be within 0.5 to 6.0N as extension force. No visual deterioration shall occur during the test. The Device shall satisfy the electrical demand, according to paragraphs 3.2.3.3 and 3.2.4.2.

3.3.3 Consistency of Retraction Force.

3.3.3.1 Method of Measuring Consistency at Location #1. The Device is fully extended/retracted (1 cycle) with random rotation with a speed of 30 cycles/min. The retraction force is measured every 5,000 cycles. These extension/retraction cycles are totally repeated during 10,000 cycles.

3.3.3.2 Demand During the Test at Location #1. No visual deterioration shall occur, and the retraction force must not differ from the specified values, according to paragraph 3.3.1.2, during 10,000 extension/retraction cycles. The Device shall satisfy the electrical demands, according to paragraph 3.2.3.3, after the test.

3.3.3.3 Method Of Measuring Consistency at Location #2. The Device is fully extended/retracted (1 cycle) with random rotation with a speed of 30 cycles/min. The retraction force is measured every 5,000 cycles. These extension/retraction cycles are totally repeated during 10,000 cycles.

3.3.3.4 Demand During The Test at Location #2. No visual deterioration shall occur, and the retraction force must not differ from the specified values, according to paragraph 3.3.1.2, during 10,000 extension/retraction cycles. The Device shall satisfy the electrical demands, according to paragraph 3.2.3.3, after the test.

3.3.4 Consistency of Extension Force.

3.3.4.1 Method of Measuring Consistency at Location #1. The Device is fully extended/retracted (1 cycle) with random rotation with a speed of 30 cycles/min. The extension force is measured every 5000 cycles. These extension/retraction cycles are totally repeated during 10,000 cycles.

3.3.4.2 Demand During The Test at Location #1. No visual deterioration shall occur, and the extension force must not differ from the specified values, according to paragraph 3.3.2.2, during 10,000 extension/retraction cycles. The Device shall satisfy the electrical demands, according to paragraph 3.2.3.3, after the test.

3.3.4.3 Method of Measuring Consistency at Location #2. The Device is fully extended/retracted (1 cycle) with random rotation with a speed of 30 cycles/min. The extension force is measured every 5,000 cycles. These extension/retraction cycles are totally repeated during 10,000 cycles.

3.3.4.4 Demand During The Test at Location #2. No visual deterioration shall occur, and the extension force must not differ from the specified values, according to paragraph 3.3.2.2, during 10,000 extension/retraction cycles. The Device shall satisfy the electrical demands, according to paragraph 3.2.3.3, after the test.

3.3.5. Pull Test.

3.3.5.1 Method of Pull Test. The Device is assembled to the test equipment. A static load of 50 N is applied to the knob of the Device for 1 minute, according to Figure 4a.

3.3.5.2 Demand After the Test. No visual deterioration shall occur, and the knob and wire shall remain mechanically bonded, after the test. The Device shall satisfy the electrical demands, according to paragraph 3.2.3.3, after the test.

3.3.6 Torque Test.

3.3.6.1 Method of Torque Test. The Device is assembled to the test equipment. A torque instrument is attached to the helical antenna. The Device is exposed to a torque of 20 Ncm between fitting and plastic in clockwise direction according to Figure 4b.

3.3.6.2 Demand After the Test. No visual deterioration shall occur, and the fitting and plastic shall occur, and the fitting and plastic shall remain mechanically bonded, after the test. The Device shall satisfy the electrical demands according to paragraph 3.2.3.3 after the test.

3.3.7 Deformation Test. TBD

3.3.8 Bending Endurance.

3.3.8.1 Method of Measuring Bending Endurance. The Device is assembled to the test equipment in vertical extended position, according to Figure 4d. The Device is bent 90° left and 90° right (1 cycle) with a speed of 20 cycle/min. for 2,000 cycles.

3.3.8.2 Demand After the Test. No visual deterioration shall occur after the test. The Device shall satisfy the electrical demands according to paragraph 3.2.3.3 after the test.

3.3.9 Vibration Test.

3.3.9.1 Method of Vibration Test. The vibration is done in extended and retracted position each as follows, according to Figure 4e.

- A rate of frequency sweep (1 cycle): 5-150-5Hz/10min.
- Displacement: 13mm (5-9Hz)
- Acceleration: 2.1G (9-150Hz)
- Duration of the Test: 2 hours regarding X and Z direction each

3.3.9.2 Demand After the Test. No visual deterioration shall occur after the test. The extended Device shall remain extended, and retracted Device shall remain retracted during this test. The Device shall satisfy the electrical demands according to paragraph 3.2.3.3 after the test.

3.3.10 Drop Test.

3.3.10.1 Method of Drop Test. The Device is attached to the phone and shall be dropped six times, from 1.5 meters off the ground, onto concrete covered with 1/8" thick vinyl tile. The phone is to be dropped with the extended battery pack (weight = ~180g total). The sequence of the six drops is to be:

1) Device fully extended - vertical
2) Device partially extended - vertical
3) Device fully retracted - vertical
4) Device fully extended - 30 degrees off vertical (antenna side)
5) Device partially extended - 30 degrees off vertical (antenna side)
6) Device fully retracted - 30 degrees off vertical (antenna side)

3.3.10.2 Demand After the Test. The Device shall satisfy the electrical demands according to paragraph 3.2.3.3 after the test. The original shape shall be possible to restore.

3.4 Physical.

3.4.1 Dimensions. The preferred Device dimensions and positions of interface connections conform to Figure 2a.

3.4.2 Part Number Identification.

**Table 1**

| Part Number | Tool Used to Create Device | Color Marking* |
|---|---|---|
| CV90-48628 | TBD | TBD |
| * Note the color marking will place on the bottom whip stopper. | | |

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3.5 Environmental. The Device shall meet all specified electrical requirements under the following conditions in any combination.

3.5.1 Operational Temperatures Test.

3.5.1.1 Method of Operational Temperature Test. The Device is placed in an environment chamber at -40°C for 48 hours. The Device is taken out from chamber, and VSWR is immediately measured after the Device is placed at room temperature and humidity for 1 hour. The Device is placed in an environment chamber at 85°C for 96 hours. The Device is taken out from chamber, and VSWR is immediately measured after the Device is placed at room temperature and humidity for 1 hour.

3.5.1.2 Demand After the Test. No visual deterioration shall occur after the test. The Device shall satisfy the electrical demands according to paragraph 3.2.3.3 after the test.

3.5.2 Humidity Test.

3.5.2.1 Method of Humidity Test. The Device is placed in an environment chamber with a temperature of 40°C and a humidity of 90-95% RH for 96 hours. The Device is taken out from chamber, and VSWR is immediately measured after the Device is placed at room temperature and humidity for 1 hour.

3.5.2.2 Demand After the Test. No visual deterioration shall occur after the test. The Device shall satisfy the electrical demands according to paragraph 3.2.3.3 after the test.

3.5.3 Temperature Test.

3.5.3.1 Method of Temperature Test. The Device is placed in a temperature cycling chamber at -40°C for 1 hour. The temperature is increased to +85°C during 1 hour and kept constantly at +85°C for 1 hour. The temperature is then decreased to -40°C for 1 hour and kept constantly at -40°C for 1 hour. This procedure is repeated 10 times, according to Figure 3 ending at room temperature.

3.5.3.2 Demand After the Test. The Device shall satisfy the electrical demands according to paragraph 3.2.3.3, the mechanical appearance according to Figure 2a, and the mechanical demand according to paragraphs 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8, 3.3.9 and 3.3.10.

3.6 Marking. The Shipping Packaging shall be marked with the following as a minimum:

- Applicable QUALCOMM part number (CV90-48628) and applicable dash number and revision level
- Manufacturer's name, symbol, or code identification
- Manufacture's date code

If the Device cannot be marked with QUALCOMM part number then the shipping package shall contain the identification. Other markings that do not obscure the above are permissible. The markings shall be permanent and inert to all commonly used industrial cleaning solvents.

## 4.0 QUALITY ASSURANCE PROVISIONS

4.1 General.

4.1.1 Quality and Reliability Assurance Program. A Quality and Reliability assurance program with on-going monitoring shall be established and maintained by the Supplier.

4.1.2 Responsibility for Inspections. Unless otherwise specified, the Supplier shall be responsible for in-process controls and all inspections. QUALCOMM reserves the right to perform any of the inspections deemed necessary to ensure that the Device conforms to the prescribed requirements. Inspection records shall be kept complete and made available to QUALCOMM upon request.

4.1.3 Change Notification and Approval. Suppliers to this drawing shall not ship Devices incorporating changes that will affect the form, fit, or function of the Device without receiving written approval, in advance, from QUALCOMM.

4.1.4 Workmanship. The Device shall be fabricated and finished in such a manner that criteria for appearance, fit, and adherence to specific tolerances shall be observed. The Device shall be uniform in quality and shall be free from defects that will affect life or serviceability.

4.2 Quality Control.

4.2.1 Quality Control Program. The Supplier shall establish a program to demonstrate that each unit has been produced in accordance with approved drawings, fully documented manufacturing procedures and practices, and quality standards, and operates and performs in accordance with the requirements of this drawing.

4.2.2 Certificate of Conformance. Each shipment shall be accompanied by a certificate of conformance signed by a responsible company official certifying that all shipped Devices conform to the requirements of this drawing. The certificate of conformance will contain a positive statement that each Device was tested to the QUALCOMM approved test program and the test results are on file at the Supplier's facility.

4.2.3 Failure Analysis. Devices rejected as defective or non-conforming shall be returned to the Supplier for failure analysis. The Supplier shall deliver to QUALCOMM a written report specifying in reasonable detail the analysis conducted by the Supplier, the cause of the defect or non-conformity, and its recommendations how to correct such defect or non-conformity.

4.2.4 Test Equipment and Inspection Facilities. The Supplier may use their own or any other facilities suitable for the performance of the inspection requirements. Test and measuring equipment shall have sufficient accuracy to permit performance of the required inspection. The Supplier shall ensure that a calibration system is utilized and maintained to control the accuracy of the measuring and test equipment (the extent of which shall be determined by the Supplier and submitted to QUALCOMM for acceptance).

4.3 Device Inspections.

4.3.1 Test Conditions. All tests shall be performed in accordance with the conditions specified in this control drawing.

4.3.2 Inspections. The following inspections, tests and examinations shall be performed. The Supplier may elect not to perform all tests as indicated, but must guarantee requirements will be met. Demonstration of adequate characterization of the Device is required where 100% testing is not performed to guarantee Devices meet specification.

a. First Article Qualification
b. Product for Delivery (Production Units)
c. Production Lot Inspection

4.3.2.1 Inspection of Product for Delivery. This inspection shall consist of examinations and tests specified in the following paragraphs and shall be performed on all deliverable units:

a. VSWR per Paragraph 3.2.3.3

4.3.2.2 Physical Inspection. The following shall be verified by visual/mechanical inspection:

a. Physical configuration per Figure 2a.
b. Marking per paragraph 3.6
c. Workmanship per paragraph 4.1.4

4.4 Device Qualification.

4.4.1 First Article Qualification. Qualification testing and examination shall be performed as required by this specification and the procurement document. A minimum of five First Article Devices shall be subjected to qualification testing and examination prior to approval of the manufacturer's design to meet the requirements of this drawing. Test Procedures and Test Data will be submitted to QUALCOMM for approval. Qualification testing of five units shall be repeated any time a Device design change is implemented. The Supplier shall maintain complete records of the First Article Qualification and shall make the records available upon request.

4.4.1.1 Visual/Mechanical Inspections. The following requirements shall be verified by visual/mechanical inspection:

a. Physical configuration per Figure 2a.
b. Marking per paragraph 3.6
c. Workmanship per paragraph 4.1.4

4.4.1.2 Electrical Tests. Each performance criteria specified in this drawing shall be verified by 100% electrical test. Test data shall be provided for the five First Article Qualification Devices.

4.4.1.3 Environmental Tests. The First Article Qualification units will be subjected to the environmental tests outlined in section 3.5. Performance tests shall be performed over the operating temperature conditions specified. Test data shall also be recorded after the units have been subjected to the specified non-operating conditions. Test data shall be sufficient to indicate mechanical/electrical parameter change or drift.

4.5 Useful Life. The Device shall have a useful life of at least 10 years when operated within the limits specified within this document. Useful life is defined as the period of service when the instantaneous failure rate is less than that specified in paragraph 4.5.1.

4.5.1 Reliability Demonstration. The Supplier's reliability qualification shall include Accelerated Life Testing to demonstrate with a 60% confidence level:

- a 100 FIT maximum steady state failure rate
- the establishment of production burnin conditions to eliminate early life failures
- a Device useful life per paragraph 4.5

4.5.2 On-going Reliability Monitoring Program. The Supplier is required to meet the minimum requirements set forth in section 4.2, or an approved equivalent.

## 5.0 **PREPARATION FOR DELIVERY**

5.1 Preparation for Delivery. Items shall be packaged in a manner that will afford adequate protection against contamination, corrosion, deterioration, and physical damage.

5.2 Shipping Shock. The unit shall be designed to withstand a flat drop from a height of 457.2 mm (18") onto a concrete (or equivalent) floor in it's packaged-for-shipment configuration.

## 6.0 **NOTES**

6.1 Approved Source(s) of Supply. Only the item(s) described on this drawing are approved for use in the applications where specified. A substitute item shall not be used without prior approval by QUALCOMM Incorporated.

| Vendor | QUALCOMM Part Number |
|---|---|
| TBD | CV90-48628-1 |

6.2 Availability of Source(s) of Supply. Identification of the Approved Item(s) hereon is not to be construed as a guarantee of present or continued availability.

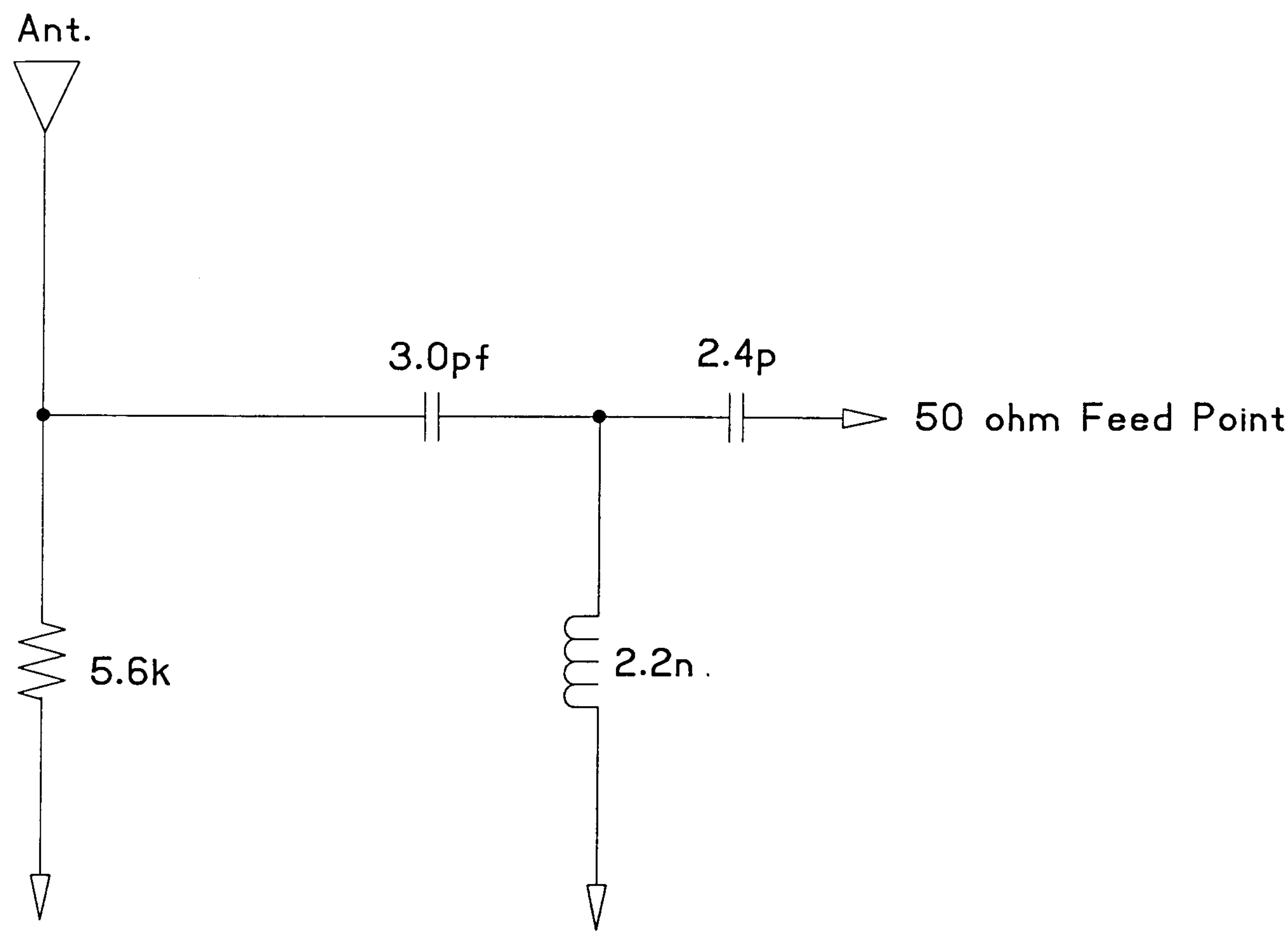


**Figure 1. Antenna Matching Circuit**



| QUALCOMM Incorporated<br>6455 LUSK BLVD.<br>SAN DIEGO, CA 92121-2779 | SIZE<br>A | CAGE CODE<br>1DN14 | DWG NO.<br>CV90-48628 |
|---|---|---|---|
| | SCALE None | REV X1 | SHEET 13 of 20 |

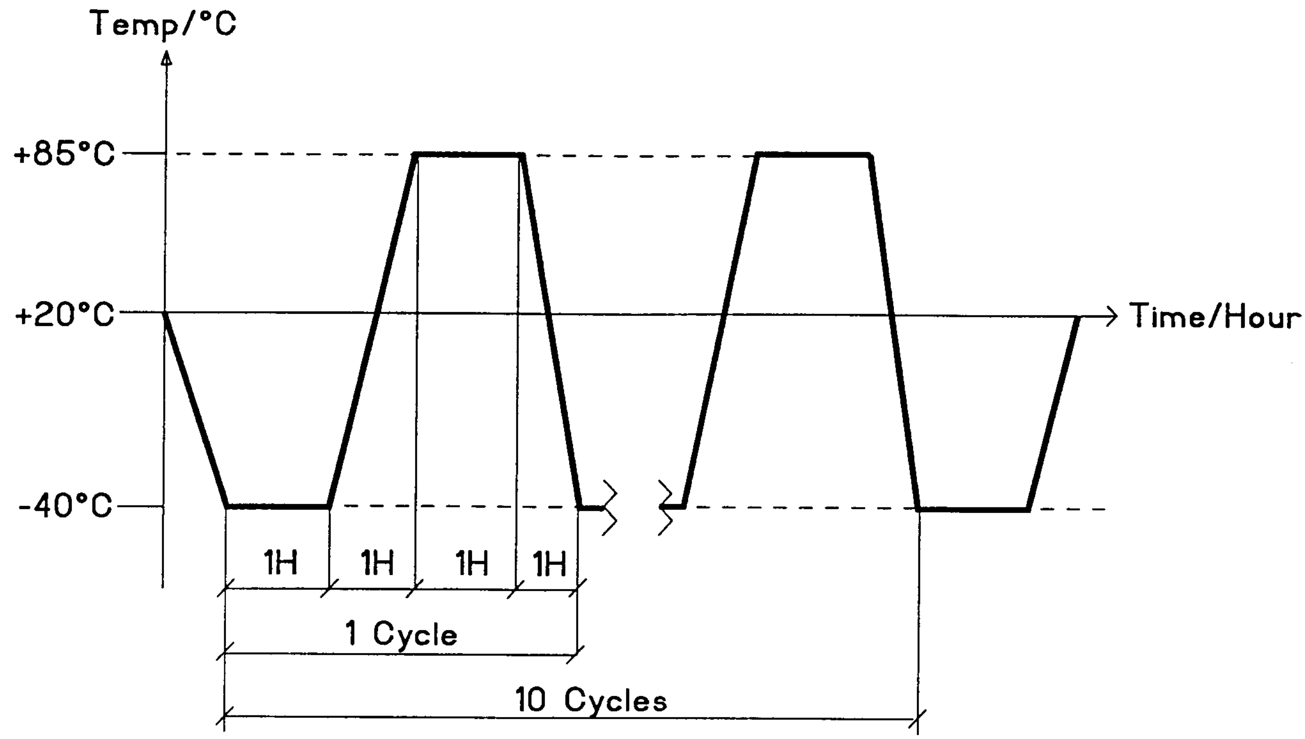


**Figure 3. Temperature Test Cycle**

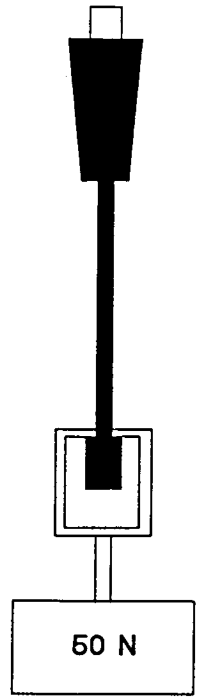


**Figure 4a. Pull Test**

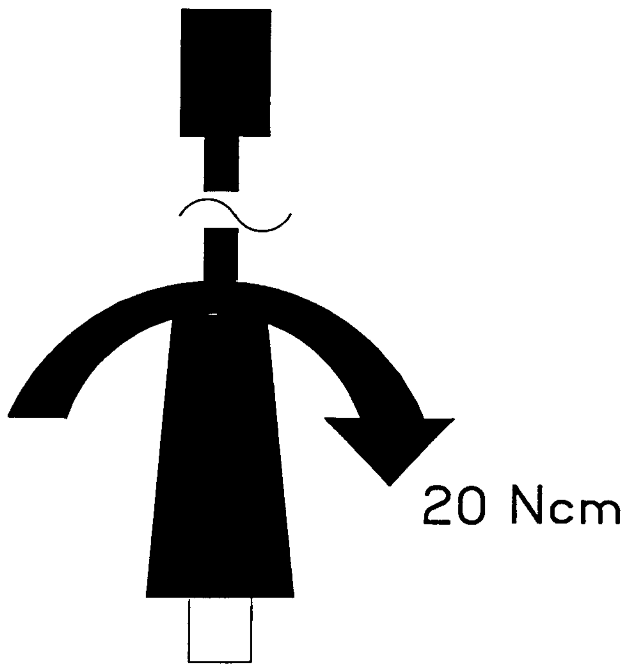


**Figure 4b. Torque Test**

| DWG NO. | SH | REV |
|---|---|---|
| CV90-48628 | 16 | X1 |

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| X1 | SEE SHEET 1 | —— | —— |

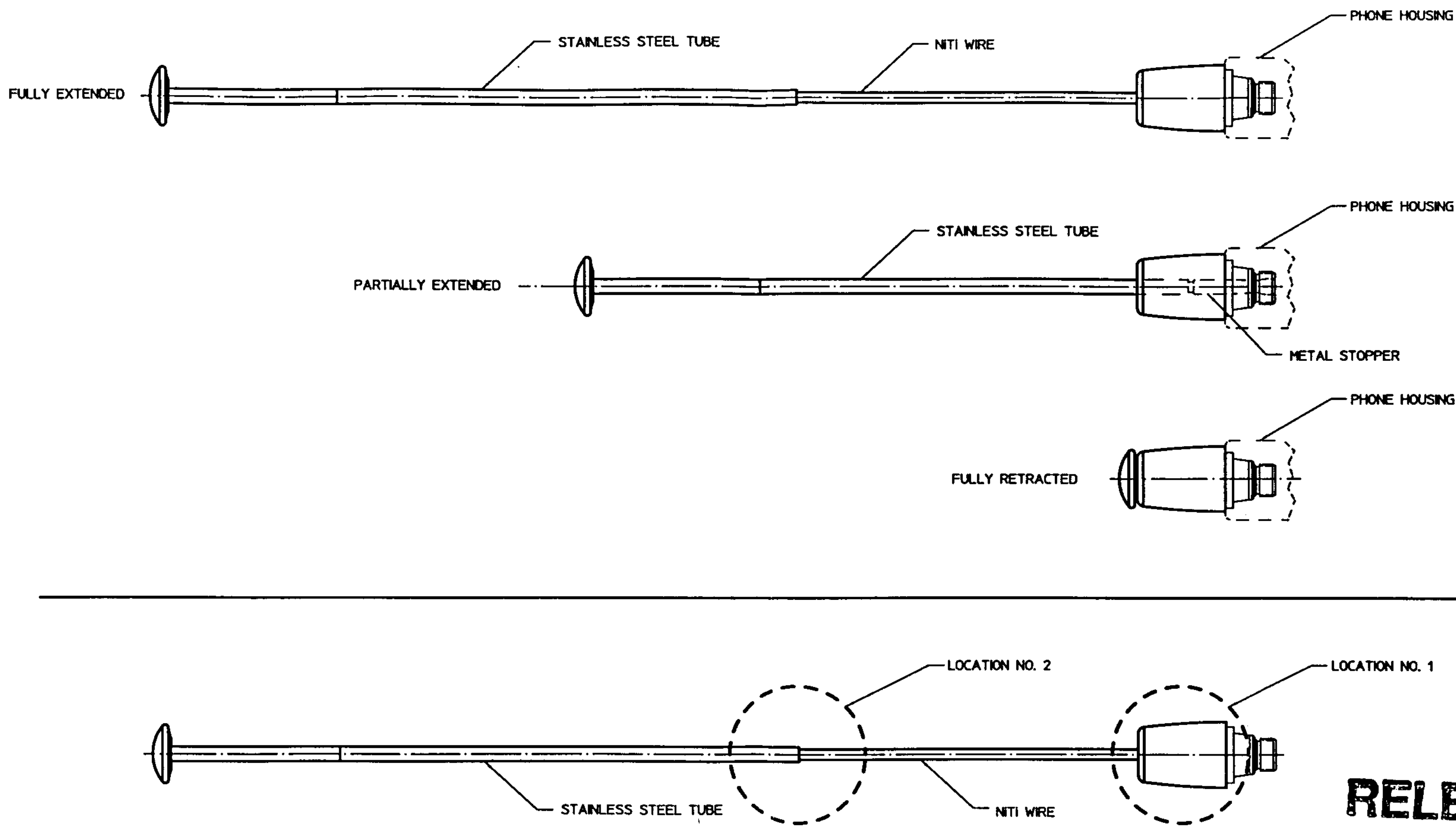


FIGURE 2b

RELEASED

D/SIZE DRAWING AVAILABLE

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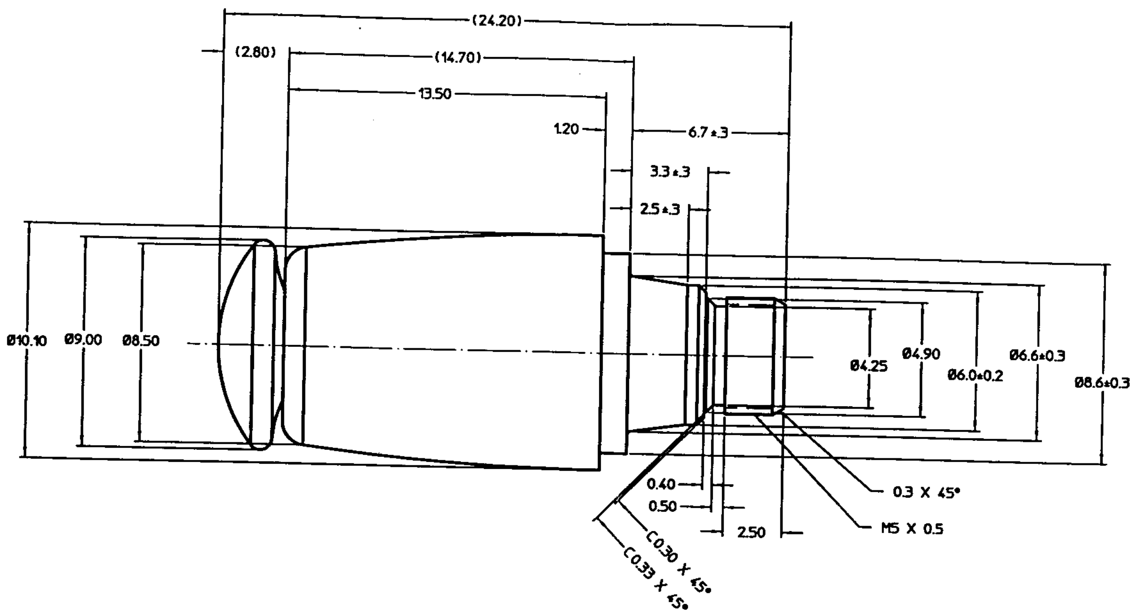
6455 LUSK BOULEVARD SAN DIEGO, CA 92121-2779

| SIZE | CAGE CODE | DRAWING NO. | REV |
|---|---|---|---|
| D | 1DN14 | CV90-48628 | X1 |
| SCALE 3/1 | | SHEET 16 | |

| DWG NO. | SH | REV |
|---|---|---|
| CV90-48628 | 15 | X1 |

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| X1 | SEE SHEET 1 | — | — |




VIEW A
SCALE 10/1

RELEASED

D/SIZE DRAWING
AVAILABLE

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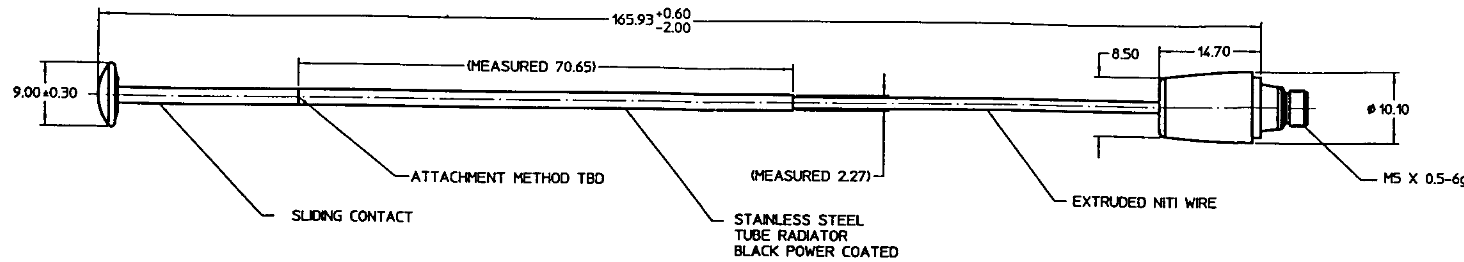
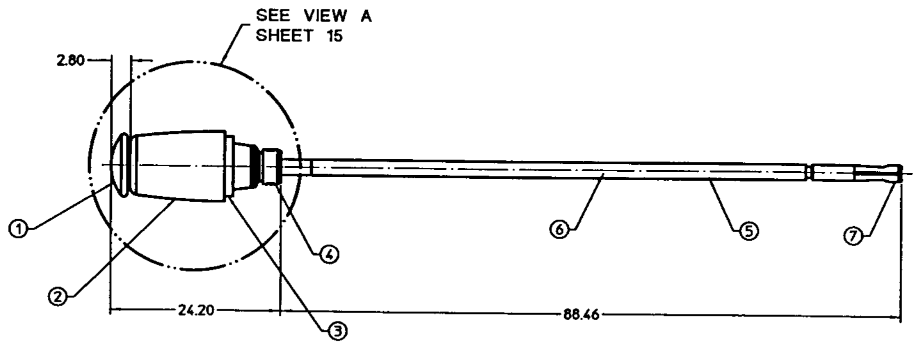
| SIZE | CAGE CODE | DRAWING NO. | REV |
|---|---|---|---|
| D | 1DN14 | CV90-48628 | X1 |
| SCALE NONE | | SHEET 15 | |

| DWG NO. | SH | REV |
|---|---|---|
| CV90-48628 | 14 | X1 |

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| X1 | SEE SHEET 1 | — | — |

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(ANTENNA ELEMENT COSMETIC)

RELEASED

| ITEM NO. | MATERIAL | SURFACE TREATMENT |
|---|---|---|
| 1 | TBD | TBD |
| 2 | TBD | TBD |
| 3 | TBD | TBD |
| 4 | TBD | TBD |
| 5 | TBD | TBD |
| 6 | TBD | TBD |
| 7 | TBD | TBD |

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| D | 1DN14 | CV90-48628 | X1 |
| SCALE 3/1 | | SHEET 14 | |