

## Appendix A SAR Plots



## SAR Data Report

Start : 31-Dec-2003 11:09:44 AM  
 End : 31-Dec-2003 11:16:34 AM  
 Scanning time : 410 secs

## Product Data

Device Name : DELL-DELL-P2-WNC  
 Device Serial No. : PN 5N793  
 Device Model : DELL-P2-WNC  
 Device Type : Other  
 Device Frequency : 2412.00 MHz  
 Max. Transmit Power : 0.045 W  
 Drift Time : 60 min(s)  
 Device Length : 0 mm  
 Device Width : 0 mm  
 Device Depth : 0 mm  
 Device Orientation : Touch  
 Antenna Type : Internal  
 Device Power at ERP-Start : 0.04  
 Device Power At ERP-Finish: 0.04  
 Device Drift : 0.00

## Measurement Data

Phantom Name : APREL-Uni  
 Phantom Type : Uni-Phantom  
 Phantom Size : 280 x 280 x 200  
 Phantom Serial No. : Default  
 Phantom Location : Center  
 Phantom Description : test  
 Tissue Type : Body  
 Tissue Serial No. : Lab1  
 Tissue Frequency : 2450.00 MHz  
 Tissue Calibration Date : 31-Dec-2003  
 Tissue Dielectric : 50.60 F/m  
 Tissue Conductivity : 2.03 S/m  
 Tissue Density : 1000.00 kg/cu. m  
 Crest Factor : 1.00

## Probe Data

Probe Name : APREL Lab Probe  
 Probe Model : E020  
 Probe Type : E-Field Triangle  
 Probe Serial No. : 209  
 Probe Frequency : 2450.00 MHz  
 Tissue Type : Body  
 Calibrated Dielectric : 50.60 F/m  
 Calibrated Conductivity : 2.03 S/m  
 Probe Offset : 2.44 mm  
 Conversion Factor : 4.60  
 Diode Compression Pt : 98.00 mV  
 Probe Sensitivity : 0.72 0.72 0.72  $\mu$ V/(V/sq. m)

Project number: ITLB-Dell-4091

FCC ID: ID:E2K24GBRL

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1 gram SAR Value

: X = 22.90 Y = -84.30 Z = 3.3 Value = 1.16 W/kg

10 gram SAR Value

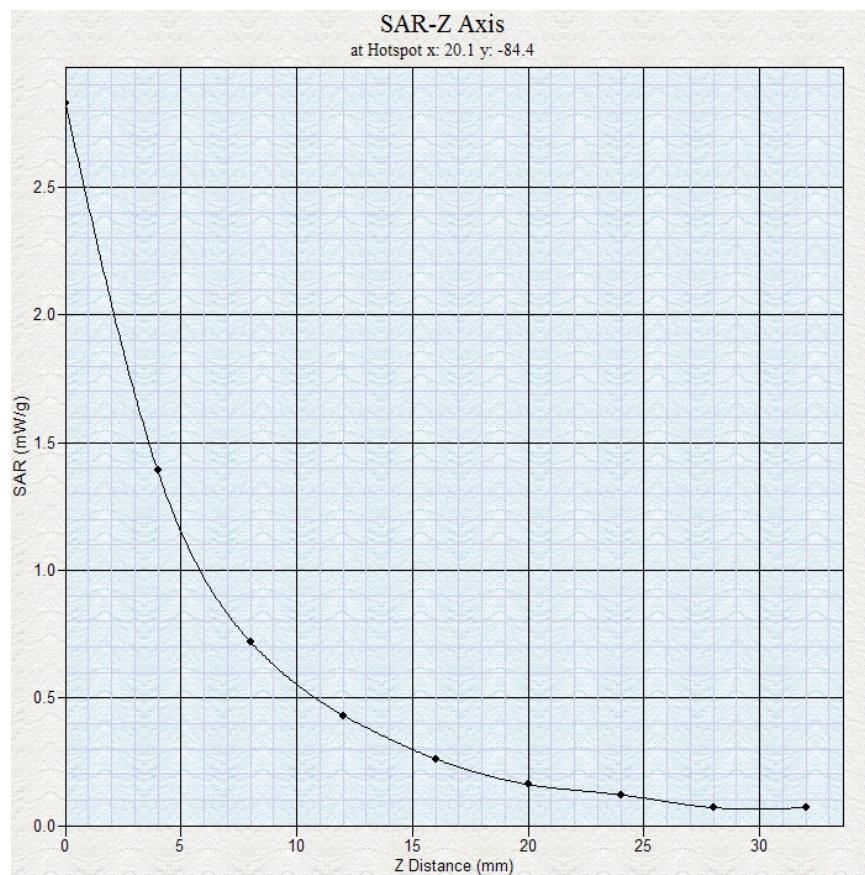
: X = 22.90 Y = -84.30 Z = 3.3 Value = 0.52 W/kg

Area Scan Peak SAR

: 1.21

Zoom Scan Peak SAR

: 2.83



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**SAR Data Report**

Start : 31-Dec-2003 11:20:24 AM  
 End : 31-Dec-2003 11:27:15 AM  
 Scanning time : 411 secs

**Product Data**

Device Name : DELL-DELL-P2-WNC  
 Device Serial No. : PN 5N793  
 Device Model : DELL-P2-WNC  
 Device Type : Other  
 Device Frequency : 2412.00 MHz  
 Max. Transmit Power : 0.045 W  
 Drift Time : 60 min(s)  
 Device Length : 0 mm  
 Device Width : 0 mm  
 Device Depth : 0 mm  
 Device Orientation : Touch  
 Antenna Type : Internal  
 Device Power at ERP-Start : 0.05  
 Device Power At ERP-Finish: 0.07  
 Device Drift : 0.02

**Measurement Data**

Phantom Name : APREL-Uni  
 Phantom Type : Uni-Phantom  
 Phantom Size : 280 x 280 x 200  
 Phantom Serial No. : Default  
 Phantom Location : Center  
 Phantom Description : test  
 Tissue Type : Body  
 Tissue Serial No. : Lab1  
 Tissue Frequency : 2450.00 MHz  
 Tissue Calibration Date : 31-Dec-2003  
 Tissue Dielectric : 50.60 F/m  
 Tissue Conductivity : 2.03 S/m  
 Tissue Density : 1000.00 kg/cu. m  
 Crest Factor : 1.00

**Probe Data**

Probe Name : APREL Lab Probe  
 Probe Model : E020  
 Probe Type : E-Field Triangle  
 Probe Serial No. : 209  
 Probe Frequency : 2450.00 MHz  
 Tissue Type : Body  
 Calibrated Dielectric : 50.60 F/m  
 Calibrated Conductivity : 2.03 S/m  
 Probe Offset : 2.44 mm  
 Conversion Factor : 4.60  
 Diode Compression Pt : 98.00 mV  
 Probe Sensitivity : 0.72 0.72 0.72  $\mu$ V/(V/sq. m)

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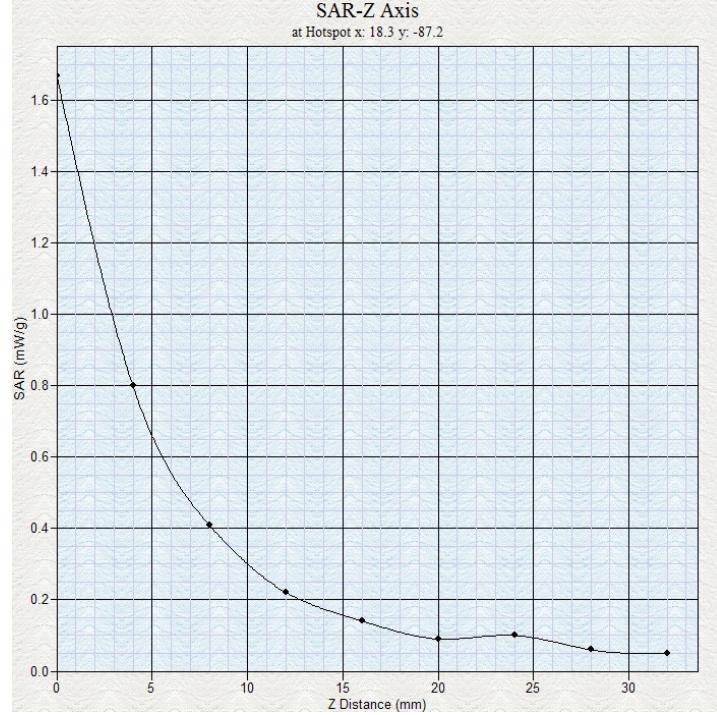
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1 gram SAR Value : X = 12.70 Y = -79.50 Z = 2.6 Value = 0.65 W/kg  
 10 gram SAR Value : X = 12.70 Y = -79.50 Z = 2.6 Value = 0.29 W/kg  
 Area Scan Peak SAR : 0.73  
 Zoom Scan Peak SAR : 1.67



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**SAR Data Report**

Start : 31-Dec-2003 09:34:10 AM  
 End : 31-Dec-2003 09:41:55 AM  
 Scanning time : 465 secs

**Product Data**

Device Name : DELL-DELL-P2-WNC  
 Device Serial No. : PN 5N793  
 Device Model : DELL-P2-WNC  
 Device Type : Other  
 Device Frequency : 2412.00 MHz  
 Max. Transmit Power : 0.045 W  
 Drift Time : 60 min(s)  
 Device Length : 0 mm  
 Device Width : 0 mm  
 Device Depth : 0 mm  
 Device Orientation : Touch  
 Antenna Type : Internal  
 Device Power at ERP-Start : 0.16  
 Device Power At ERP-Finish: 0.17  
 Device Drift : 0.01

**Measurement Data**

Phantom Name : APREL-Uni  
 Phantom Type : Uni-Phantom  
 Phantom Size : 280 x 280 x 200  
 Phantom Serial No. : Default  
 Phantom Location : Center  
 Phantom Description : test  
 Tissue Type : Body  
 Tissue Serial No. : Lab1  
 Tissue Frequency : 2450.00 MHz  
 Tissue Calibration Date : 31-Dec-2003  
 Tissue Dielectric : 50.60 F/m  
 Tissue Conductivity : 2.03 S/m  
 Tissue Density : 1000.00 kg/cu. m  
 Crest Factor : 1.00

**Probe Data**

Probe Name : APREL Lab Probe  
 Probe Model : E020  
 Probe Type : E-Field Triangle  
 Probe Serial No. : 209  
 Probe Frequency : 2450.00 MHz  
 Tissue Type : Body  
 Calibrated Dielectric : 50.60 F/m  
 Calibrated Conductivity : 2.03 S/m  
 Probe Offset : 2.44 mm  
 Conversion Factor : 4.60  
 Diode Compression Pt : 98.00 mV  
 Probe Sensitivity : 0.72 0.72 0.72  $\mu$ V/(V/sq. m)

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1 gram SAR Value

: X = 13.10 Y = -62.20 Z = 2.8 Value = 0.50 W/kg

10 gram SAR Value

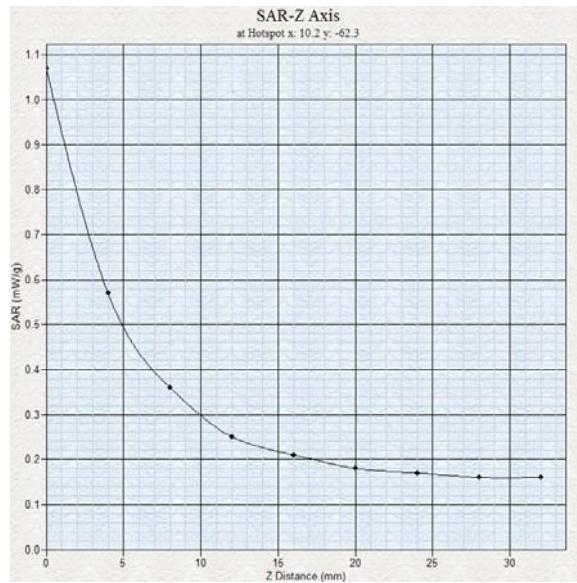
: X = 13.10 Y = -62.20 Z = 2.8 Value = 0.30 W/kg

Area Scan Peak SAR

: 0.73

Zoom Scan Peak SAR

: 1.07



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**SAR Data Report**

Start : 30-Dec-2003 11:28:51 PM  
 End : 30-Dec-2003 11:36:38 PM  
 Scanning time : 467 secs

**Product Data**

Device Name : DELL-P2\_WNC  
 Device Serial No. :  
 Device Model : DELL-P2-WNC  
 Device Type : Other  
 Device Frequency : 2412.00 MHz  
 Max. Transmit Power : 0.045 W  
 Drift Time : 60 min(s)  
 Device Length : 0 mm  
 Device Width : 0 mm  
 Device Depth : 0 mm  
 Device Orientation : Touch  
 Antenna Type : Internal  
 Device Power at ERP-Start : 0.20  
 Device Power At ERP-Finish: 0.18  
 Device Drift : 0.02

**Measurement Data**

Phantom Name : APREL-Uni  
 Phantom Type : Uni-Phantom  
 Phantom Size : 280 x 280 x 200  
 Phantom Serial No. : Default  
 Phantom Location : Center  
 Phantom Description : test  
 Tissue Type : Body  
 Tissue Serial No. : Lab1  
 Tissue Frequency : 2450.00 MHz  
 Tissue Calibration Date : 31-Dec-2003  
 Tissue Dielectric : 50.60 F/m  
 Tissue Conductivity : 2.03 S/m  
 Tissue Density : 1000.00 kg/cu. m  
 Crest Factor : 1.00

**Probe Data**

Probe Name : APREL Lab Probe  
 Probe Model : E020  
 Probe Type : E-Field Triangle  
 Probe Serial No. : 209  
 Probe Frequency : 2450.00 MHz  
 Tissue Type : Body  
 Calibrated Dielectric : 50.60 F/m  
 Calibrated Conductivity : 2.03 S/m  
 Probe Offset : 2.44 mm  
 Conversion Factor : 4.60  
 Diode Compression Pt : 98.00 mV  
 Probe Sensitivity : 0.72 0.72 0.72  $\mu$ V/(V/sq. m)

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1 gram SAR Value

: X = 2.60 Y = -59.60 Z = 2.4 Value = 0.30 W/kg

10 gram SAR Value

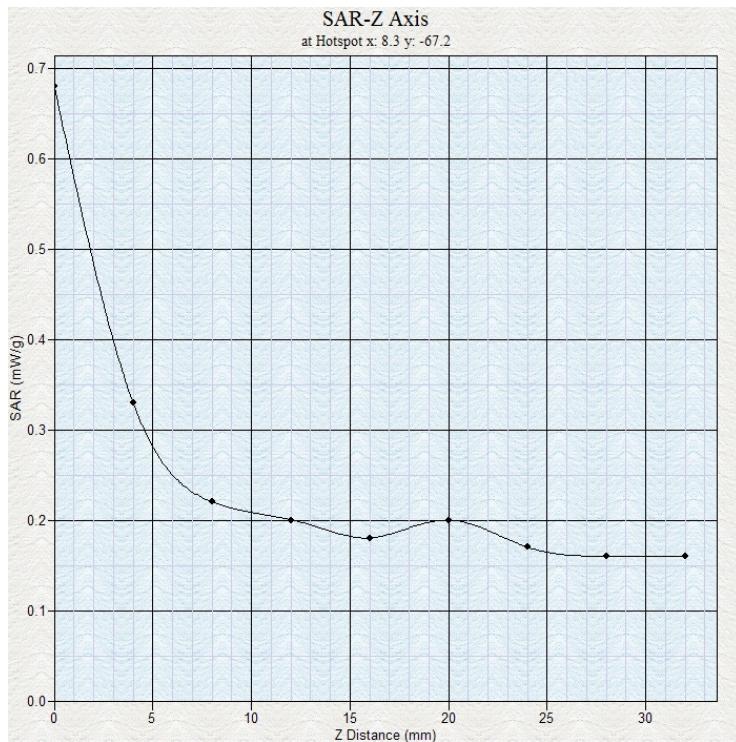
: X = 2.60 Y = -59.60 Z = 2.4 Value = 0.21 W/kg

Area Scan Peak SAR

: 0.28

Zoom Scan Peak SAR

: 0.68



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**Appendix B**  
**Probe Calibration Certificate**



**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-339

Client.: APREL

**C E R T I F I C A T E   O F   C A L I B R A T I O N**

It is certified that the equipment identified below has been calibrated in the  
**NCL CALIBRATION LABORATORIES** by qualified personnel following recognized  
procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe 2450 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 209

**BODY Calibration**

Calibration Procedure: SSI/DRB-TP-D01-032-E020  
Project No: Internal

Calibrated: 3<sup>rd</sup> November 2003

Released on: 4<sup>th</sup> November 2003

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration  
Results Summary

Released By: \_\_\_\_\_

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## Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 209.

## References

SSI/DRB-TP-D01-032-E020 E-Field Probe Calibration Procedure

IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"

SSI-TP-011 Tissue Calibration Procedure

## Conditions

Probe 209 was a new probe taken from stock prior to calibration.

**Ambient Temperature of the Laboratory:** 22 °C +/- 0.5°C  
**Temperature of the Tissue:** 21 °C +/- 0.5°C



**Calibration Results Summary**

**Probe Type:** E-Field Probe E-020  
**Serial Number:** 209  
**Frequency:** 2450 MHz  
**Sensor Offset:** 1.56 mm  
**Sensor Length:** 2.5 mm  
**Tip Enclosure:** Ertalyte\*  
**Tip Diameter:** 5 mm  
**Tip Length:** 60 mm  
**Total Length:** 290 mm

\*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

**Channel X:** 0.72  $\mu$ V/(V/m)<sup>2</sup>  
**Channel Y:** 0.72  $\mu$ V/(V/m)<sup>2</sup>  
**Channel Z:** 0.72  $\mu$ V/(V/m)<sup>2</sup>  
**Diode Compression Point:** 98 mV

## Sensitivity in Body Tissue

**Frequency:** 2450 MHz

**Epsilon:** 50.6 (+/-5%)      **Sigma:** 1.98 S/m (+/-10%)

### ConvF

**Channel X:** 4.60

**Channel Y:** 4.60

**Channel Z:** 4.60

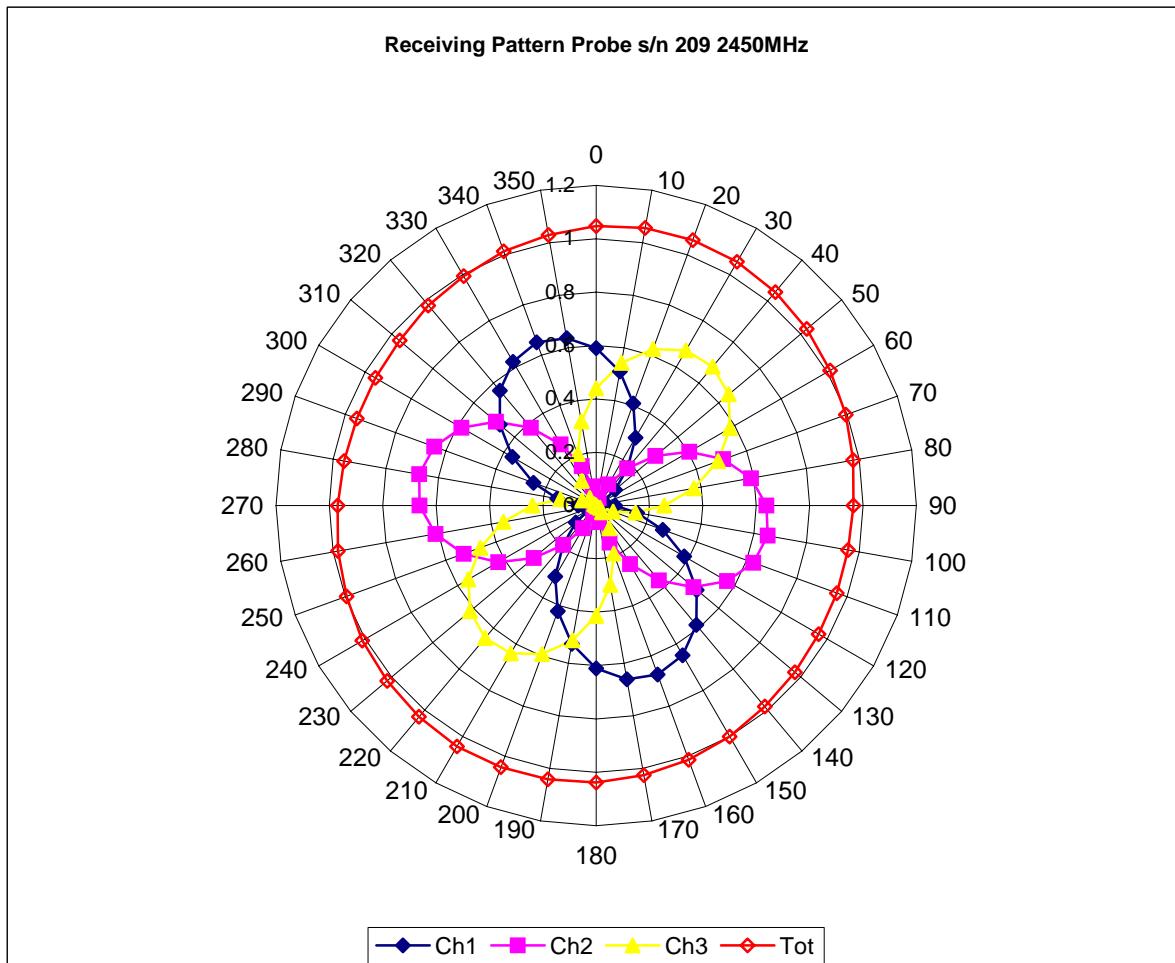
Tissue sensitivity values were calculated using the load impedance of the APREL Laboratories Daq-Paq.

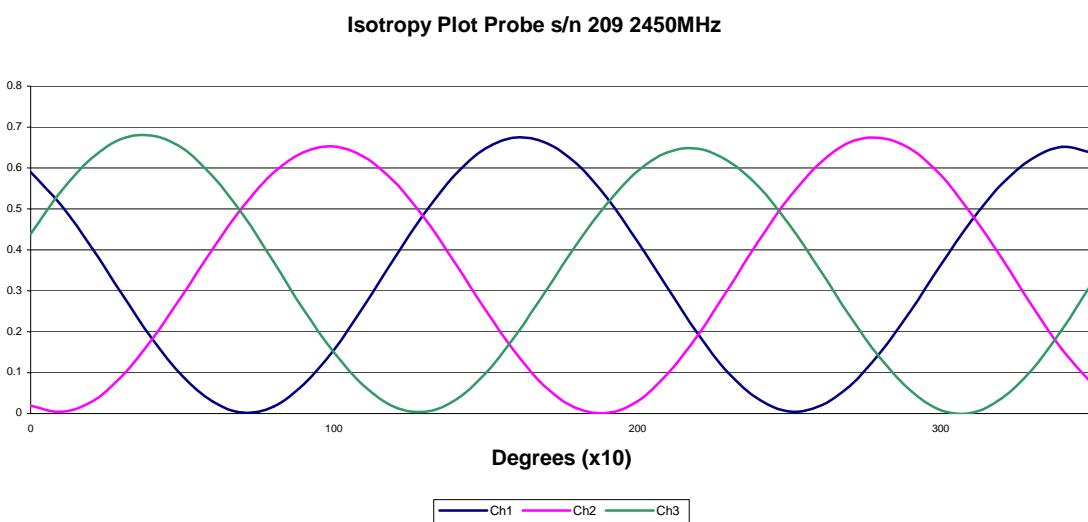
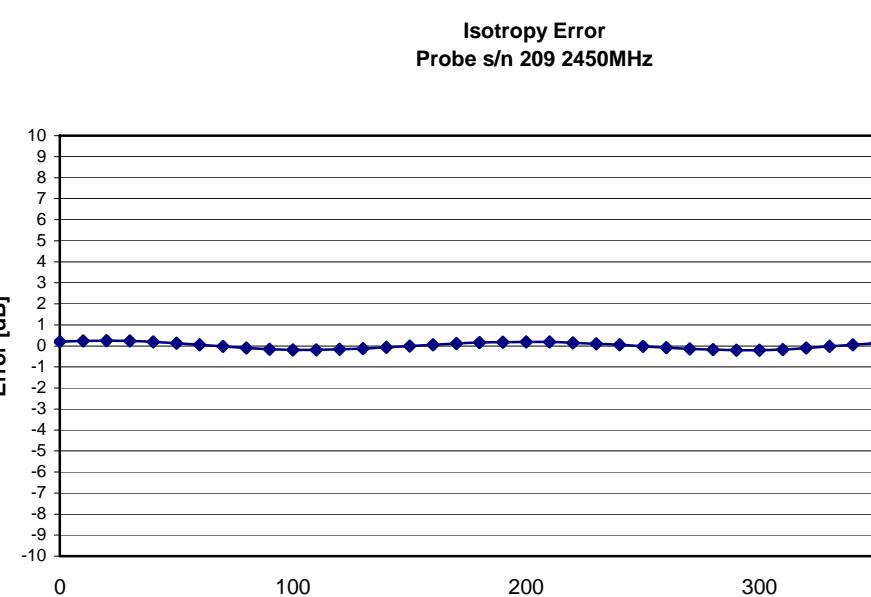
### Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.4mm.

### Spatial Resolution:

The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

**Receiving Pattern 2450 MHz (Air)**

**Isotropy Error 2450 MHz (Air)****Isotropicity:**

0.10 dB

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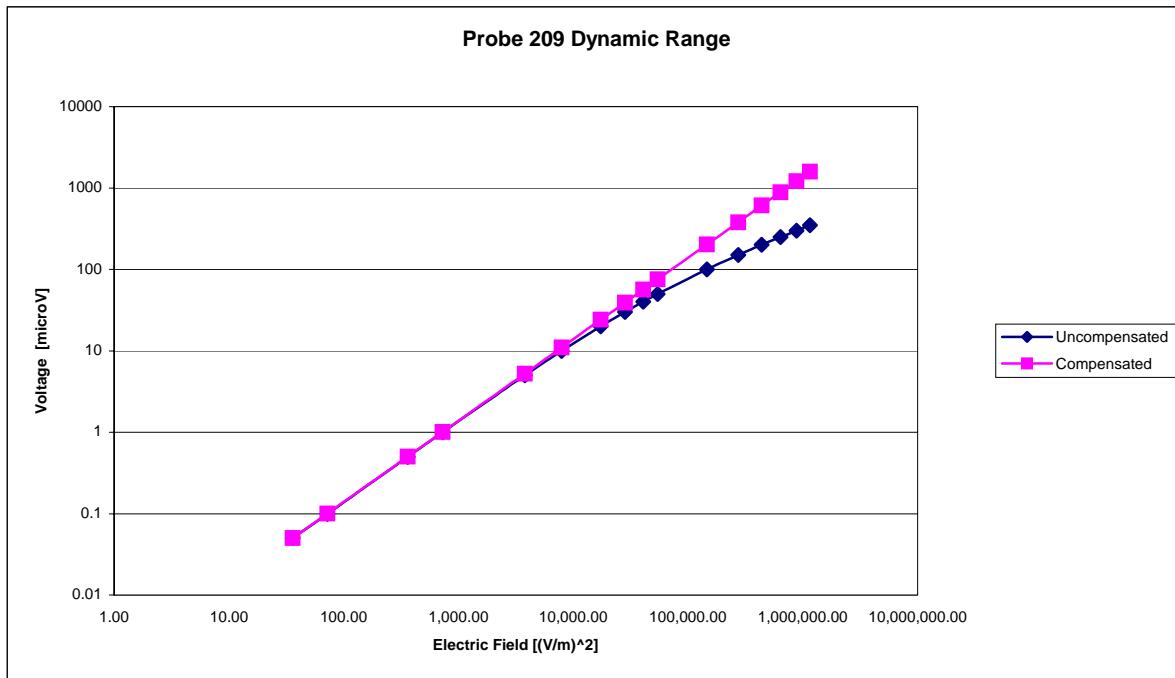
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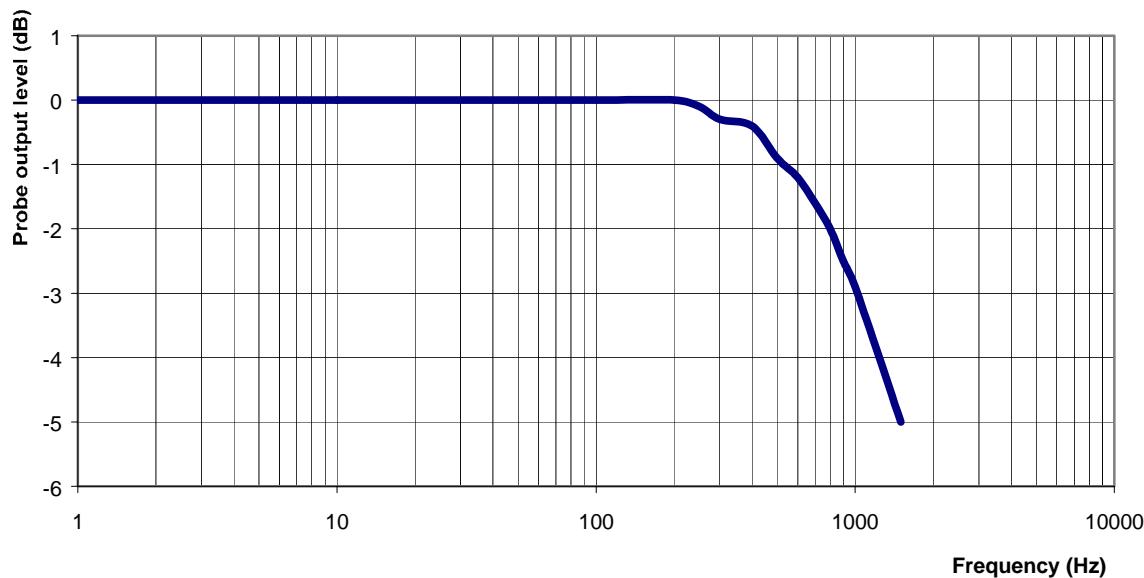
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## Dynamic Range



## Video Bandwidth

Probe Frequency Characteristics



**Video Bandwidth at 500 Hz** 1 dB  
**Video Bandwidth at 1.02 KHz:** 3 dB

## Conversion Factor Uncertainty Assessment

**Frequency:** 2450MHz

**Epsilon:** 50.6 (+/-5%)      **Sigma:** 1.98 S/m (+/-10%)

### ConvF

**Channel X:** 4.60 7%(K=2)

**Channel Y:** 4.60 7%(K=2)

**Channel Z:** 4.60 7%(K=2)

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

### Boundary Effect:

For a distance of 2.4mm the evaluated uncertainty (increase in the probe sensitivity) is less than 2%.

## Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2003.



**Appendix C**  
**Dipole Calibration Certificate**



**NCL CALIBRATION LABORATORIES**

Calibration File No: DC-0265  
Project Number: Internal

**C E R T I F I C A T E   O F   C A L I B R A T I O N**

It is certified that the equipment identified below has been calibrated in the  
**NCL CALIBRATION LABORATORIES** by qualified personnel following recognized  
procedures and using transfer standards traceable to NRC/NIST.

APREL Validation Dipole

Manufacturer: APREL Laboratories  
Part number: D-2450-S-1  
Frequency: 2.45 GHz  
Serial No: ALCD-10

Customer: APREL

Calibrated: 14 November 2003  
Released on: 15 November 2003

Released By: \_\_\_\_\_

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## Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

### Mechanical Dimensions

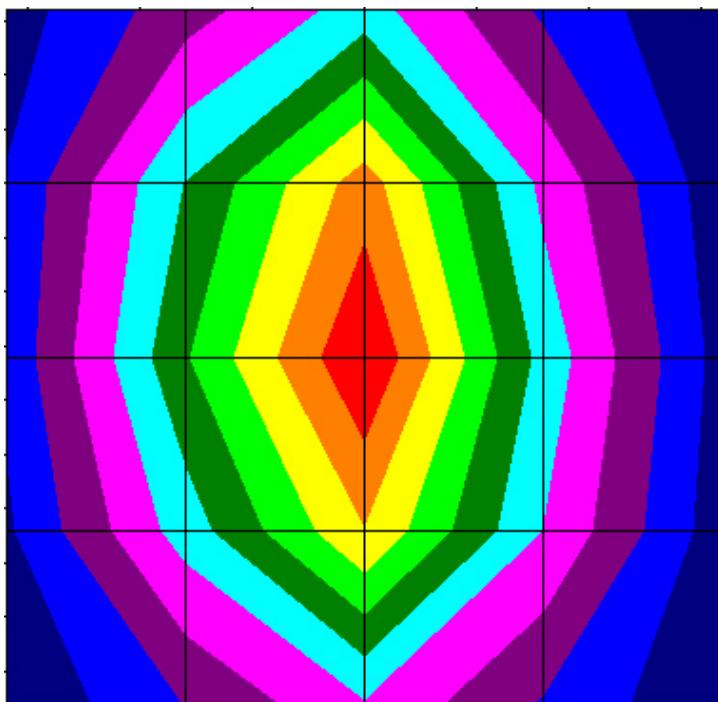
**Length:** 51.7 mm  
**Height:** 30.8 mm

### Electrical Specification

**SWR:** 1.181U  
**Return Loss:** -21.4 dB  
**Impedance:** 46.175

### System Validation Results

Frequency	1 Gram	10 Gram	Peak
2.45 GHz	52.45	22.91	102.91



## Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018. The results contained within this report are for Validation Dipole ALCD-10 at 2.45 GHz. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the IEEE mechanical specification. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALIDX-500, along with the APREL Reference E-010 130 MHz to 26 GHz E-Field Probe Serial Number 163.

## References

SSI-TP-018 Dipole Calibration Procedure

SSI-TP-016 Tissue Calibration Procedure

IEEE 1528 *DRAFT* "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"

## Conditions

Dipole ALCD-10 was a new Dipole taken from stock prior to calibration.

**Ambient Temperature of the Laboratory:** 24 °C +/- 0.5°C

**Temperature of the Tissue:** 20 °C +/- 0.5°C



## Dipole Calibration Results

### Mechanical Verification

IEEE Length	IEEE Height	Measured Length	Measured Height
51.5 mm	30.4 mm	51.7 mm	30.8 mm

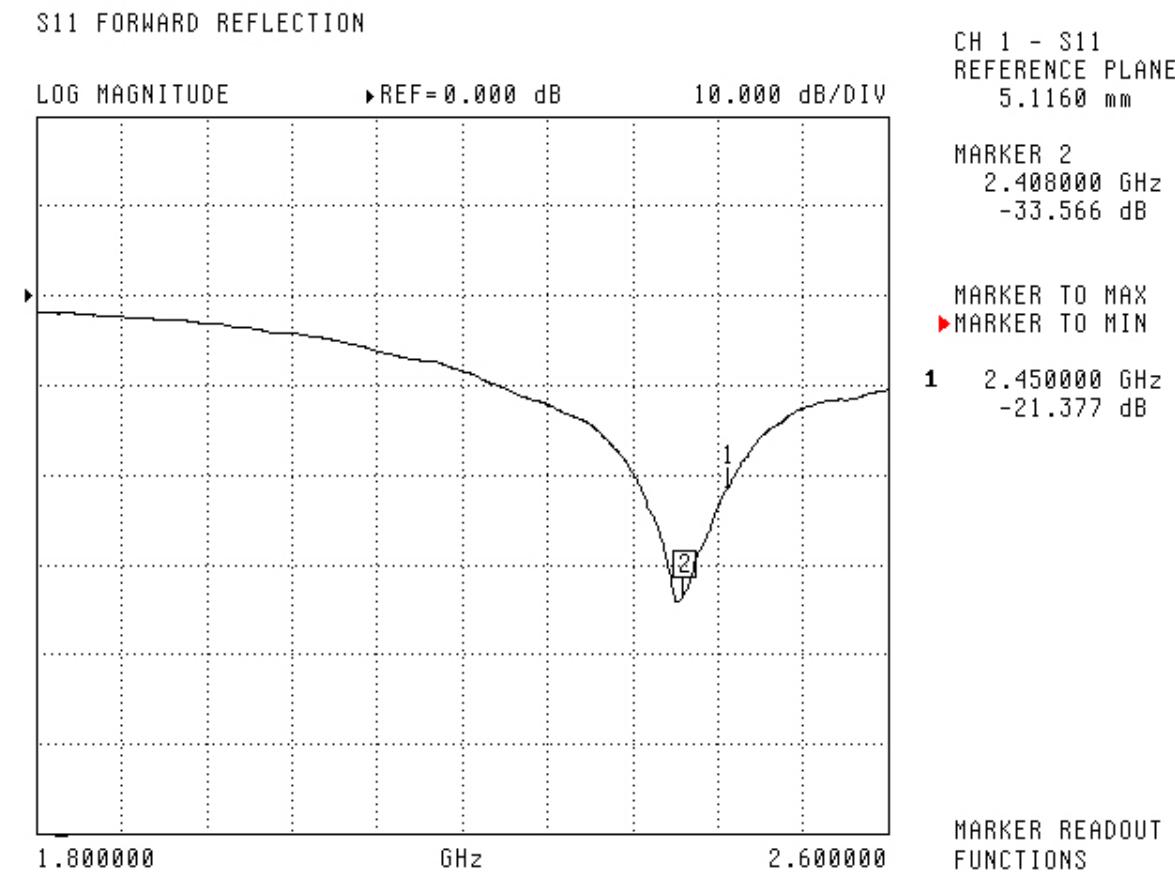
### Tissue Validation

Head Tissue 2450 MHz	Measured
Dielectric constant, $\epsilon_r$	39.2
Conductivity, $\sigma$ [S/m]	1.82
Tissue Conversion Factor,	4.61

**Electrical Calibration**

Test	Result	IEEE Value
S11 R/L	-21.4	-21 dB
SWR	1.181U	-
Impedance	46.175 Ω	

The Following Graphs are the results as displayed on the Vector Network Analyzer.

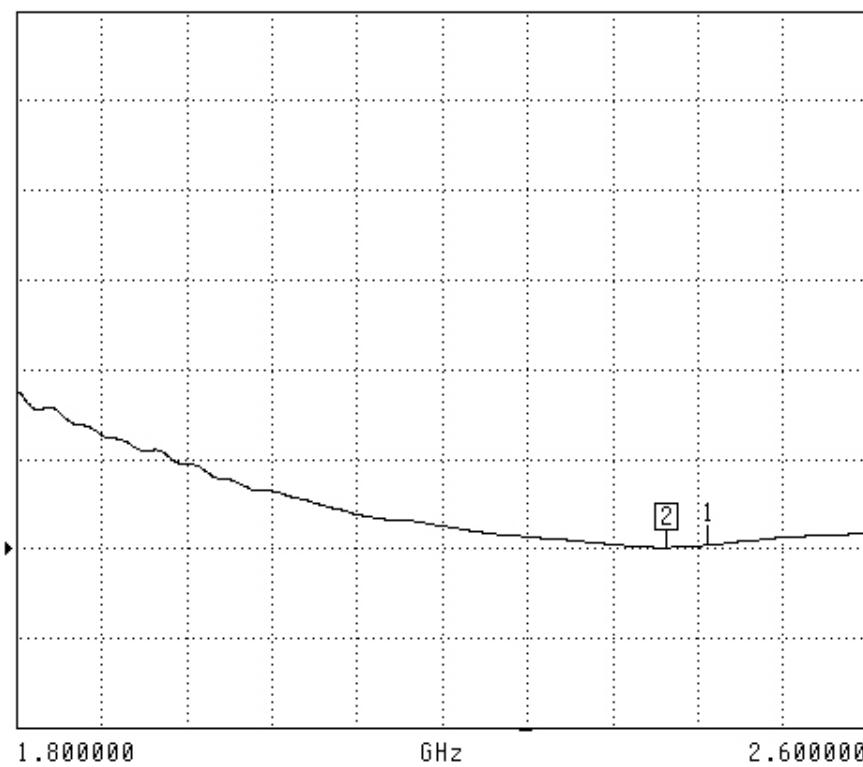
**S11 Parameter Return Loss**

**SWR****S11 FORWARD REFLECTION**

SWR

►REF=1.000 U

5.000 U/DIV



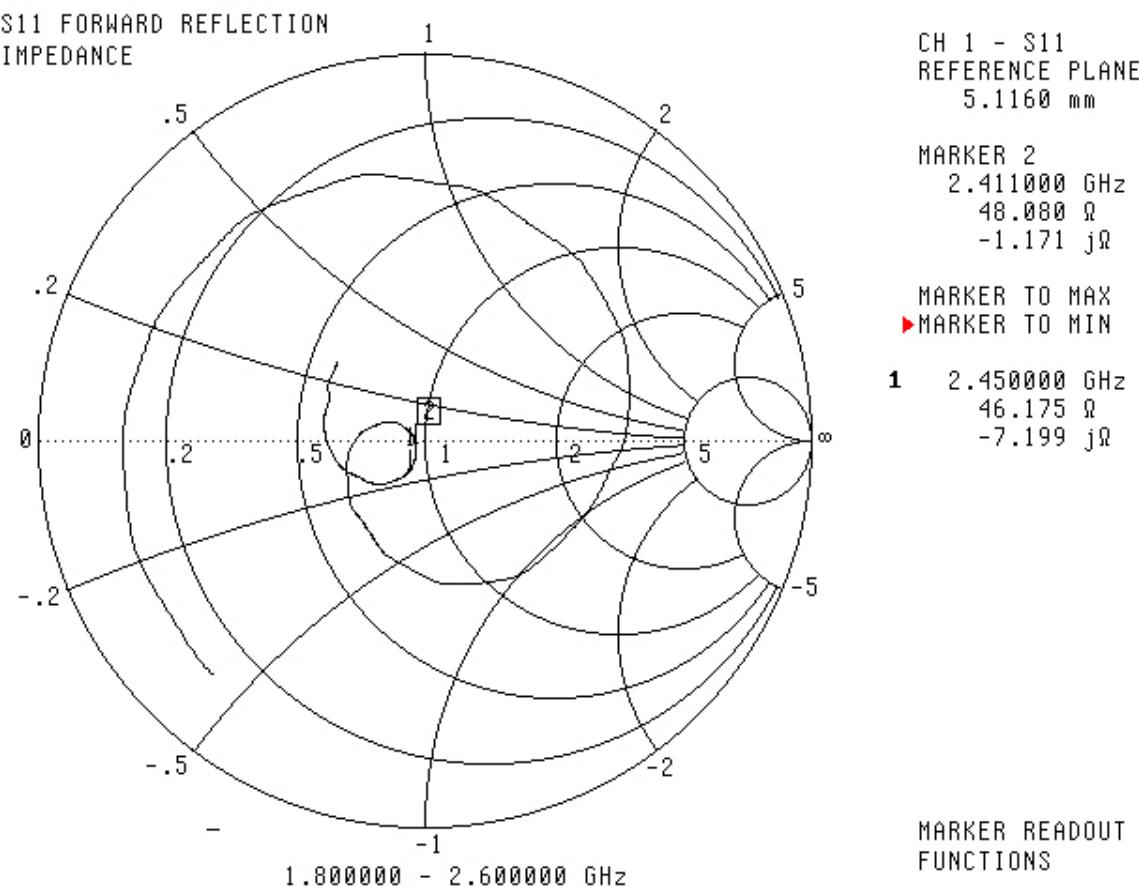
CH 1 - S11  
REFERENCE PLANE  
5.1160 mm

MARKER 2  
2.411000 GHz  
1.049 U

► MARKER TO MAX  
► MARKER TO MIN

1 2.450000 GHz  
1.181 U

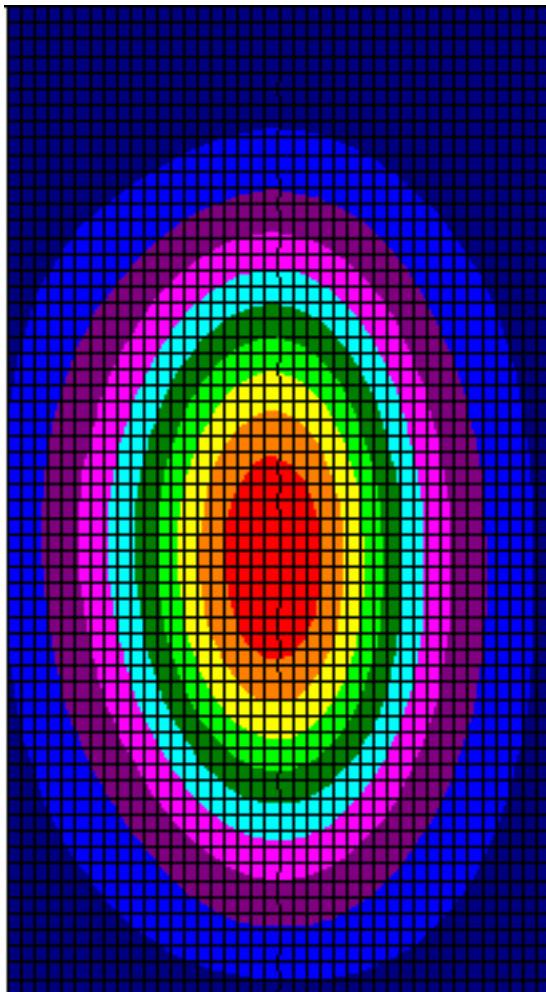
► MARKER READOUT  
FUNCTIONS

**Smith Chart Dipole Impedance**

**System Validation Results Using the Electrically Calibrated Dipole**

Frequency	1 Gram	10 Gram	Peak Above Feed Point
2.45 GHz	52.45	22.91	102.91

The following Graphic Plot is the splined measurement result for the course scan.



## Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2003

