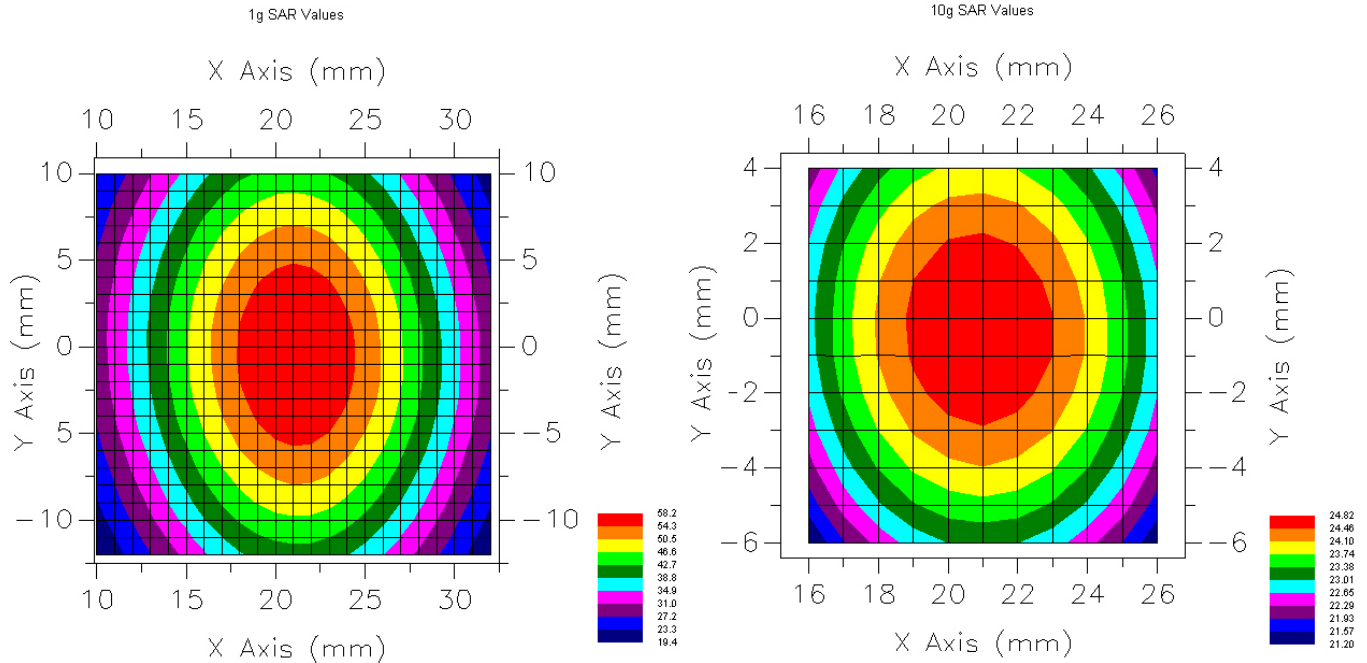


## Appendix C

# Validation Scan Results



## VALIDATION SCAN



Date: 11 September 2003  
 Frequency: 2450 MHz  
 Tissue Type: Muscle  
 Epsilon: 50.6  
 Sigma: 2.01  
 Tissue Calibration Date: 11 September 2003  
 Conversion Factor: 5.6  
 Input Power to Dipole: 1 W  
 Duty Cycle: 1  
 Distance from Dipole to Tissue: 10 mm  
 Tissue Temperature: 22°C  
 Tissue Depth: 15 cm

Measured 1 Gram SAR (W/Kg)	Target 1 Gram SAR (W/Kg)	Delta (%)
54.2	52.4	+3.4

Measured 10 Gram SAR (W/Kg)	Target 10 Gram SAR (W/Kg)	Delta (%)
24.8	24.0	+ 3.3

## Appendix d: Uncertainty Budget

Intel Mini PCI Type 3A 802.11b Wireless LAN Adapter model WM3A2100 located inside the Dell PP10L laptop.

Source of Uncertainty	Description (Annex)	Tolerance Value	Probability Distribution	Divisor	$c_i^{-1} (1-g)$	$c_i^{-1} (10-g)$	Standard Uncertainty (1-g)	Standard Uncertainty (10-g)	$v_i^2$ or $v_{eff}$
<b>Measurement System</b>									
Probe Calibration	E1.1	3.5	normal	1	1	1	3.5	3.5	$\infty$
Axial Isotropy	E1.2	3.7	rectangular	$\sqrt{3}$	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5	$\infty$
Hemispherical Isotropy	E1.2	10.9	rectangular	$\sqrt{3}$	$\sqrt{cp}$	$\sqrt{cp}$	4.4	4.4	$\infty$
Boundary Effect	E1.3	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6	$\infty$
Linearity	E1.4	4.7	rectangular	$\sqrt{3}$	1	1	2.7	2.7	$\infty$
Detection Limit	E1.5	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6	$\infty$
Readout Electronics	E1.6	1.0	normal	1	1	1	1.0	1.0	$\infty$
Response Time	E1.7	0.8	rectangular	$\sqrt{3}$	1	1	0.5	0.5	$\infty$
Integration Time	E1.8	1.7	rectangular	$\sqrt{3}$	1	1	1.0	1.0	$\infty$
RF Ambient Condition	E5.1	3.0	rectangular	$\sqrt{3}$	1	1	1.7	1.7	$\infty$
Probe Positioner Mech. Restrictions	E5.2	0.4	rectangular	$\sqrt{3}$	1	1	0.2	0.2	$\infty$
Probe Positioning with respect to Phantom Shell	E5.3	2.9	rectangular	$\sqrt{3}$	1	1	1.7	1.7	$\infty$
Extrapolation and Integration	E4.2	3.7	rectangular	$\sqrt{3}$	1	1	2.1	2.1	$\infty$
Test Sample Positioning	E3.1.3	4.0	normal	1	1	1	4.0	4.0	11
Device Holder Uncertainty	E3.1.2	2.0	normal	1	1	1	2.0	2.0	8
Drift of Output Power	Section 5.6.2	0.0	rectangular	$\sqrt{3}$	1	1	0.0	0.0	$\infty$
<b>Phantom and Setup</b>									
Phantom Uncertainty (shape and thickness tolerance)	E2.1	3.4	rectangular	$\sqrt{3}$	1	1	2.0	2.0	$\infty$
Liquid Conductivity (target)	E2.2	3.1	rectangular	$\sqrt{3}$	0.7	0.5	1.3	0.9	$\infty$
Liquid Conductivity (meas.)	E2.2	2.0	rectangular	$\sqrt{3}$	0.7	0.5	0.8	0.6	$\infty$
Liquid Permittivity (target)	E2.2	4.0	rectangular	$\sqrt{3}$	0.6	0.5	1.4	1.2	$\infty$
Liquid Permittivity (meas.)	E2.2	2.0	rectangular	$\sqrt{3}$	0.6	0.5	0.7	0.6	$\infty$
<b>Combined Uncertainty</b>			RSS				9.0	8.9	$\infty$
<b>Combined Uncertainty (coverage factor = 2)</b>			Normal (k=2)				18.0	17.8	$\infty$

## Appendix E

# Probe Calibration Certificate



**NCL CALIBRATION LABORATORIES**

Calibration File No.: C-P-0265

**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 2.45 GHz

Manufacturer: APREL Laboratories

Model No.: E-010

Serial No.: 163

Calibration Procedure: SSI/DRB-TP-D01-032

Project No: Probe Cal Internal

Calibrated: November 5<sup>th</sup> 2002

Recalibration required: November 4<sup>th</sup> 2003

Released on: November 5<sup>th</sup> 2002

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

**NCL CALIBRATION LABORATORIES**

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Lab.  
TEL: (613) 820-4988  
FAX: (613) 820-4161



## INTRODUCTION

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-010 163.

## REFERENCES

SSI/DRB-TP-D01-032 E-Field Probe 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"

SSI-TP-014 Tissue Calibration Procedure

Conditions

Probe 163 is a working released probe.

**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-010

**Serial Number:** 163

**Frequency:** 2450 MHz

**Sensor Offset:** 2.4 mm

**Sensor Length:** 2.5 mm

**Tip Enclosure:** Glass\*

**Tip Diameter:** 7 mm

**Tip Length:** 40 mm

**Total Length:** 290 mm

\*Resistive to recommended tissue recipes per IEEE 1528

## SENSITIVITY IN AIR

**Channel X:**  $0.58 \mu\text{V}/(\text{V}/\text{m})^2$

**Channel Y:**  $0.58 \mu\text{V}/(\text{V}/\text{m})^2$

**Channel Z:**  $0.58 \mu\text{V}/(\text{V}/\text{m})^2$

**Diode Compression Point:** 76 mV



## SENSITIVITY IN BODY TISSUE

**Frequency:** 2450 MHz

**Epsilon:** 52.7(+/-5%) **Sigma:** 1.95 S/m (+/-10%)

### ConvF

**Channel X:** 5.6

**Channel Y:** 5.6

**Channel Z:** 5.6

Tissue sensitivity values were calculated using a load impedance of 5 MΩ.

### 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 2.6mm.

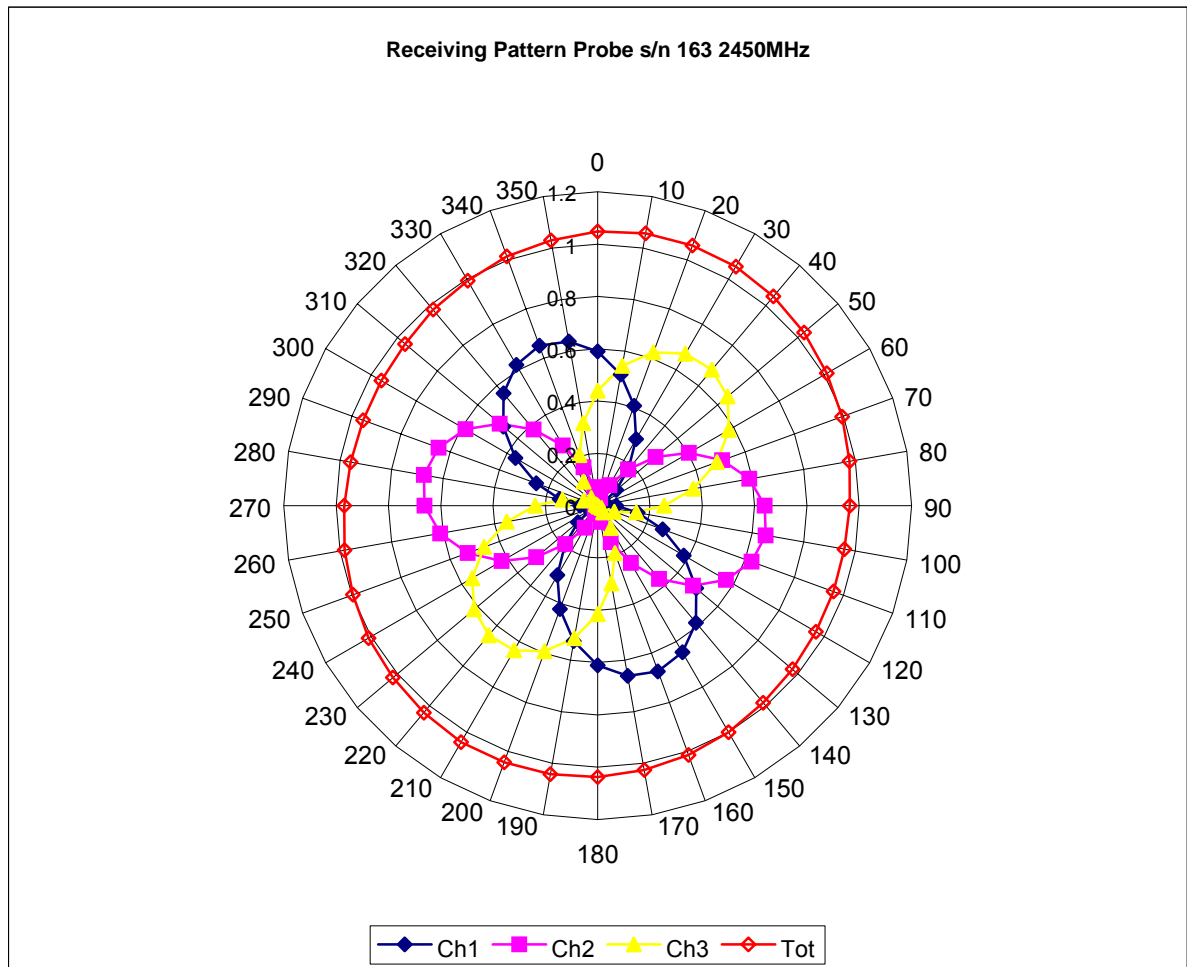
### Spatial Resolution:

The measured probe tip diameter is 7 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

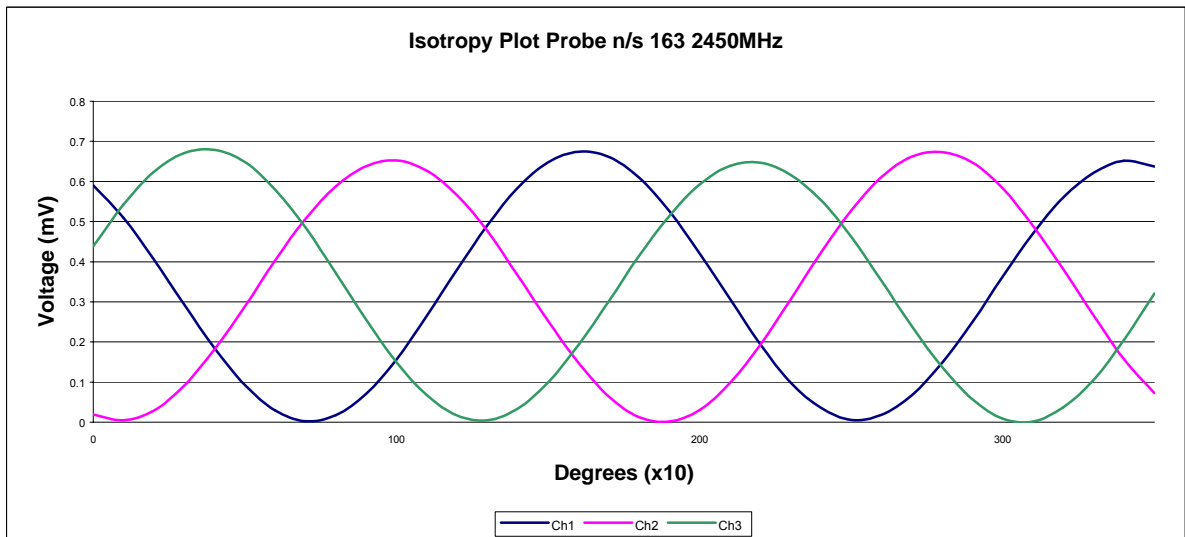
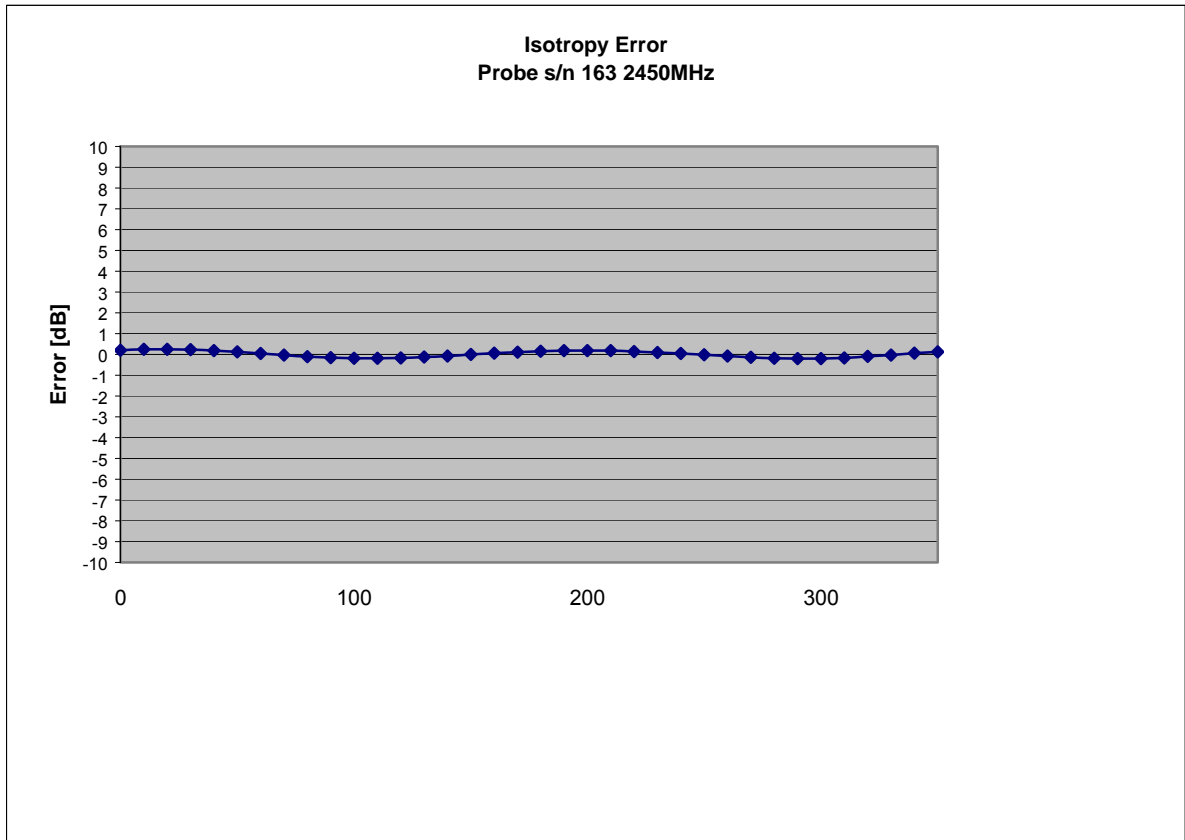




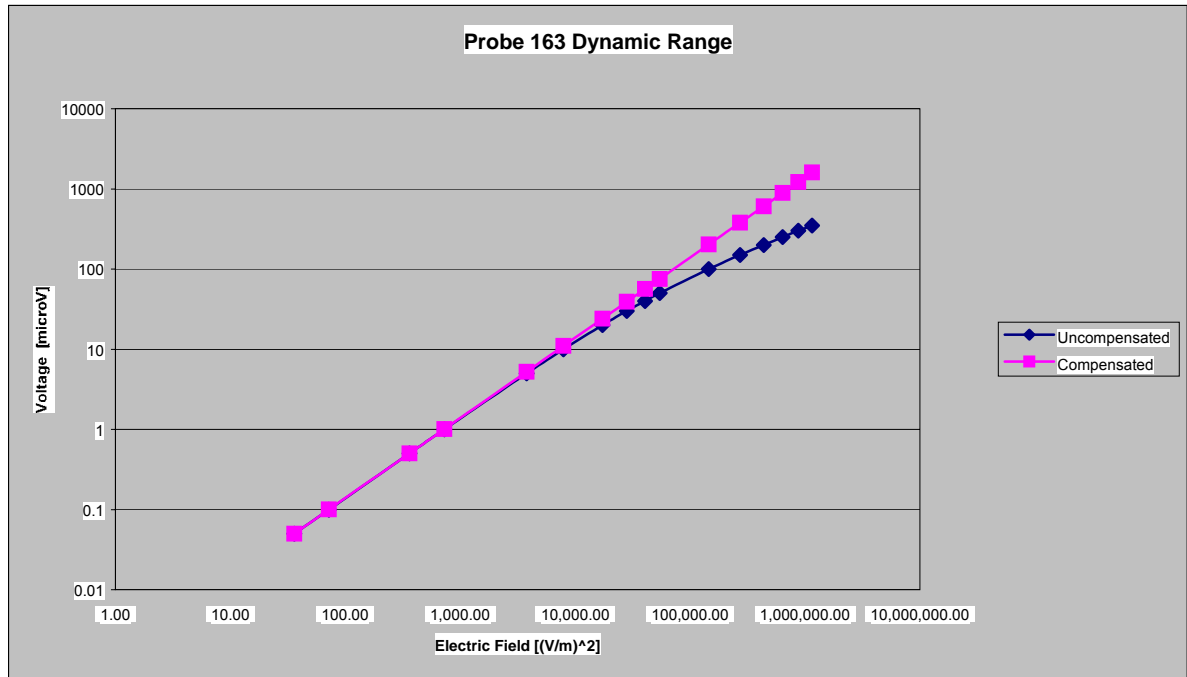
## RECEIVING PATTERN 2450 MHZ (AIR)



## ISOTROPY ERROR 2450 MHZ (AIR)

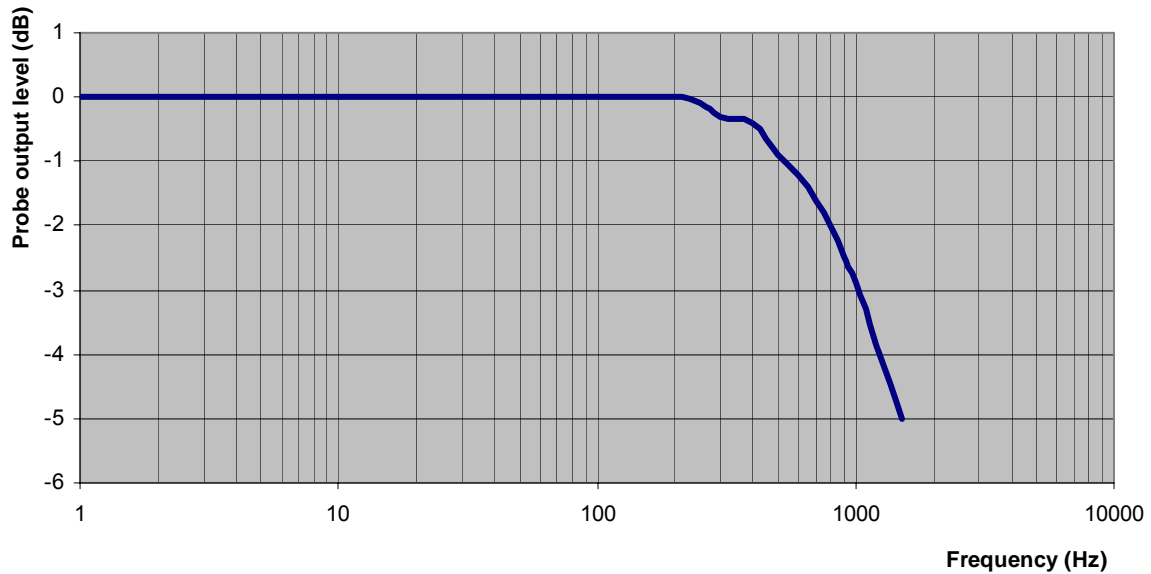


## DYNAMIC RANGE



## 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:** 2450 MHz

**Epsilon:** 52.7 (+/-5%) **Sigma:** 1.95 S/m (+/-10%)

**ConvF**

**Channel X:** 5.6 7%(K=2)

**Channel Y:** 5.6 7%(K=2)

**Channel Z:** 5.6 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 2.6MM 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 2002



## Appendix F

# Dipole Calibration Certificate



## NCL CALIBRATION LABORATORIES

Calibration File No: DC-0265

Project Number: Internal

# CERTIFICATE OF CALIBRATION

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: 15 November 2002  
Released on: 14 November 2003

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

## **NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Lab.  
TEL: (613) 820-4988  
FAX: (613) 820-4161





## 7.0 CALIBRATION RESULTS SUMMARY

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

### *Mechanical Dimensions*

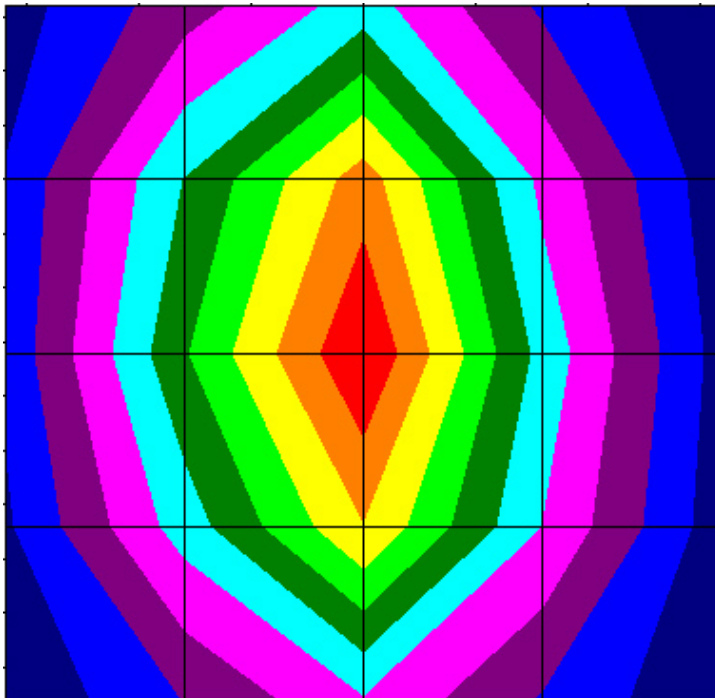
**Length:** 51.7 mm  
**Height:** 30.8 mm

### *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



## 8.0 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.

## 9.0 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

## 10.0 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 $\Omega$	

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

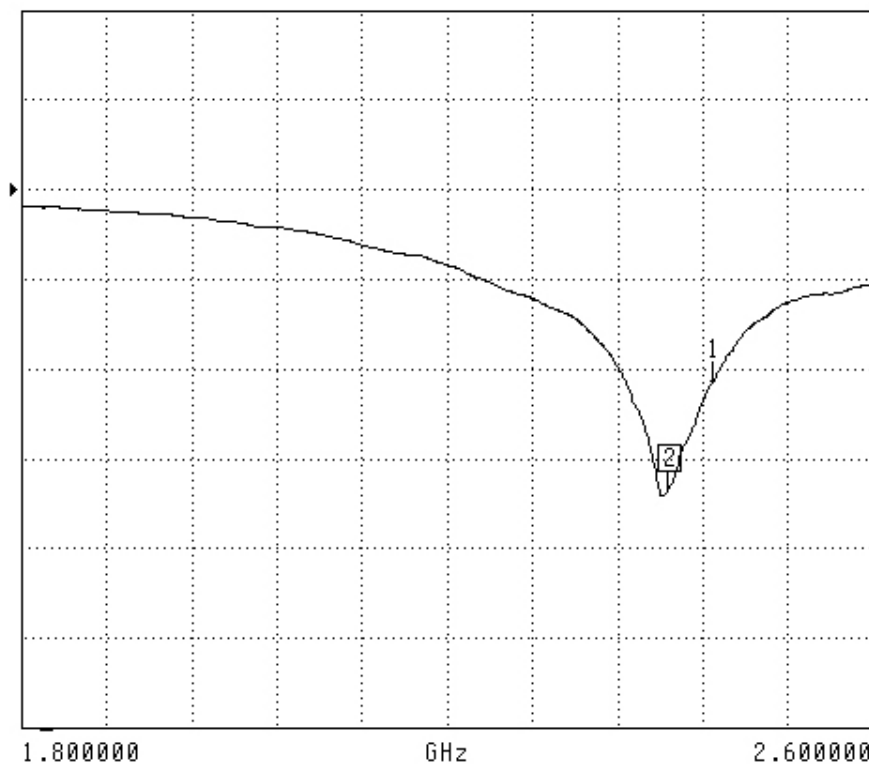
### S11 Parameter Return Loss

S11 FORWARD REFLECTION

LOG MAGNITUDE

REF=0.000 dB

10.000 dB/DIV



CH 1 - S11  
REFERENCE PLANE  
5.1160 mm

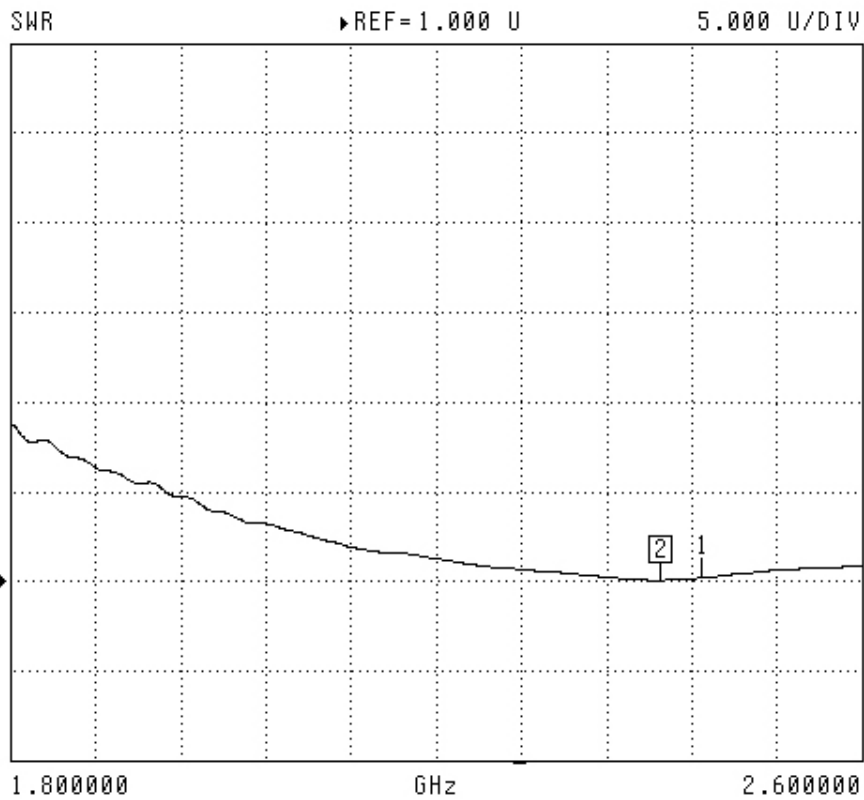
MARKER 2  
2.408000 GHz  
-33.566 dB

MARKER TO MAX  
MARKER TO MIN  
**1** 2.450000 GHz  
-21.377 dB

MARKER READOUT  
FUNCTIONS

## SWR

S11 FORWARD REFLECTION



CH 1 - S11  
REFERENCE PLANE  
5.1160 mm

MARKER 2  
2.411000 GHz  
1.049 U

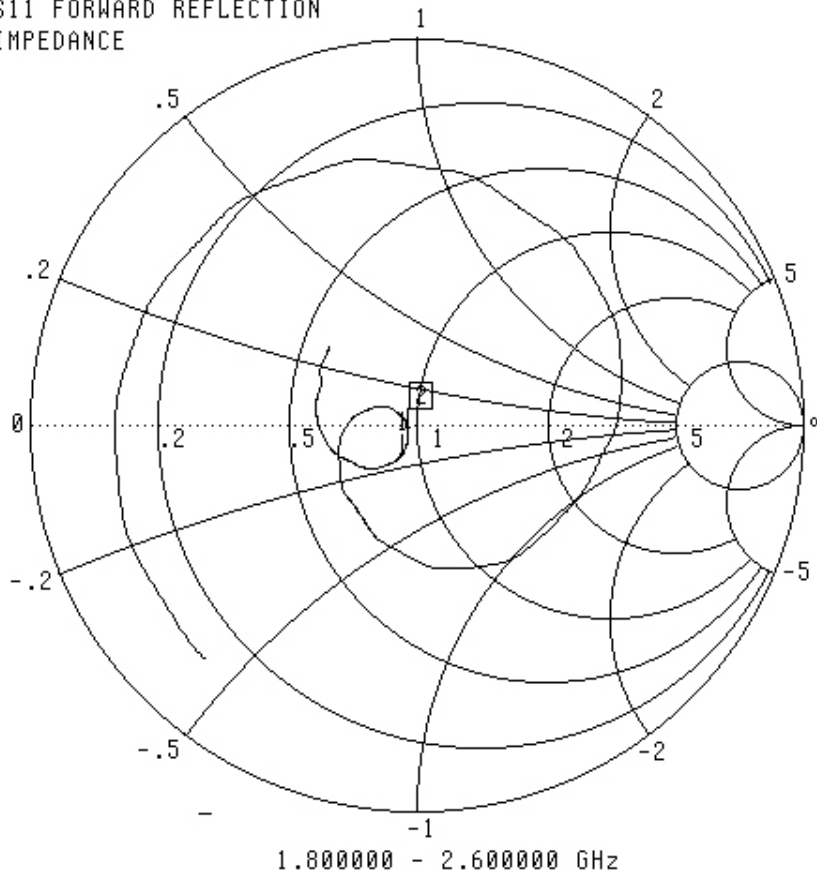
MARKER TO MAX  
▶ MARKER TO MIN

1 2.450000 GHz  
1.181 U

MARKER READOUT  
FUNCTIONS

## Smith Chart Dipole Impedance

S11 FORWARD REFLECTION  
IMPEDANCE



CH 1 - S11  
REFERENCE PLANE  
5.1160 mm

MARKER 2  
2.411000 GHz  
48.080  $\Omega$   
-1.171 j $\Omega$

MARKER TO MAX  
▶ MARKER TO MIN

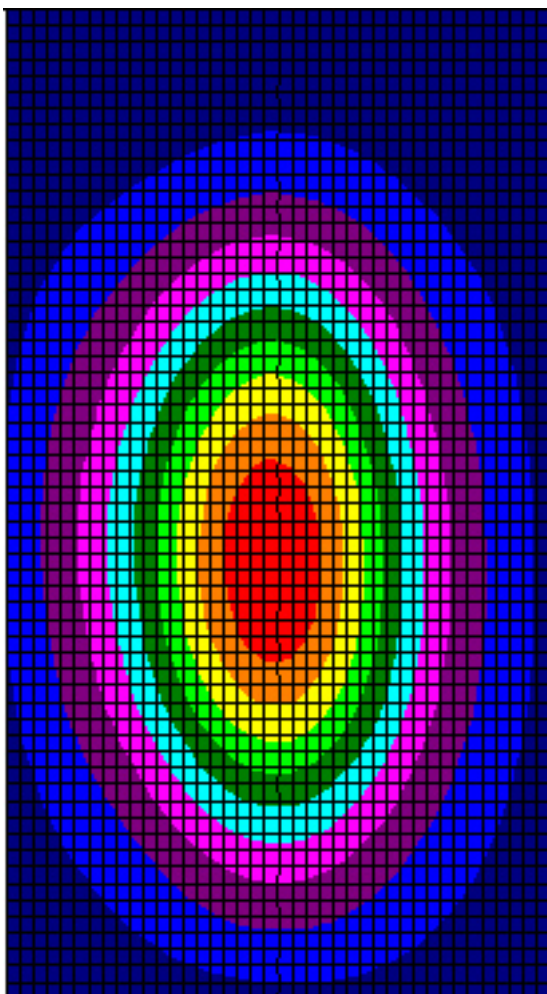
**1** 2.450000 GHz  
46.175  $\Omega$   
-7.199 j $\Omega$

MARKER READOUT  
FUNCTIONS

**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.



## 11.0 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 2002