

### Appendix C – SAR Test Setup Photos



**System Head Configuration**



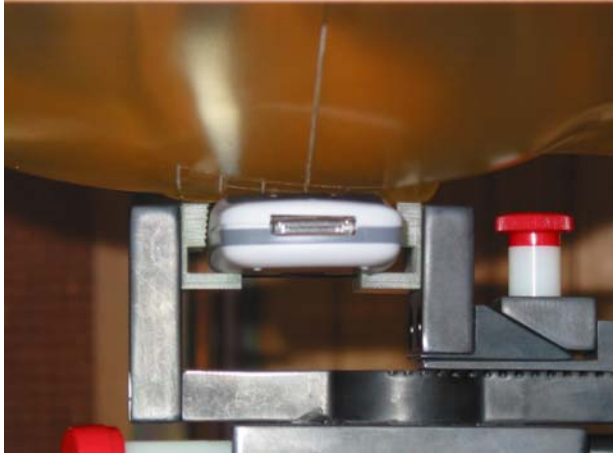
**Right Head Tissue Depth**



**Left Head Tissue Depth**



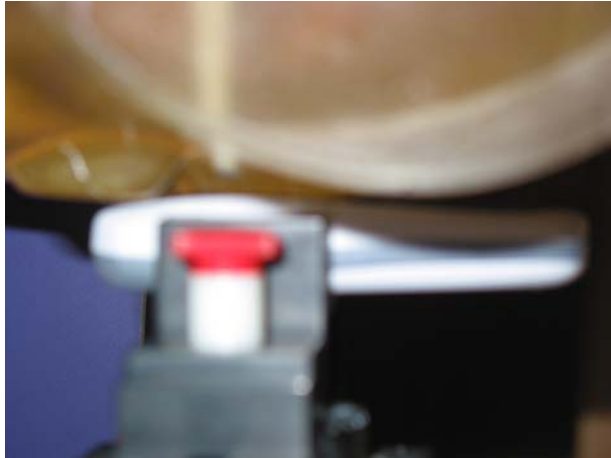
**Body Tissue Depth**



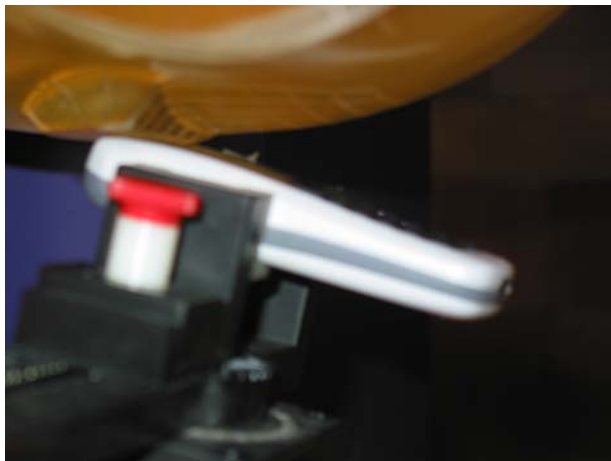
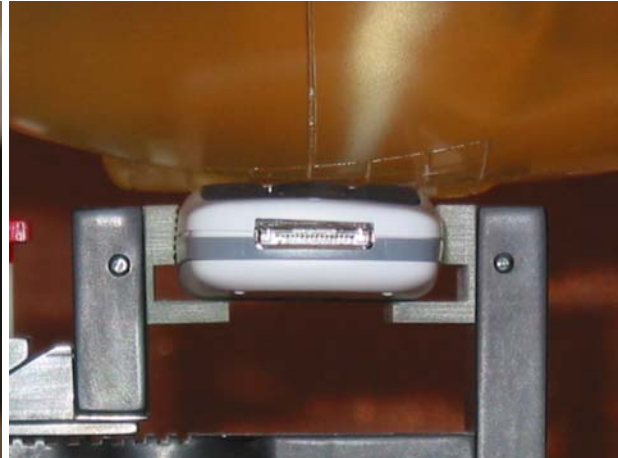
**Right Head Touch Position**



**Right Head Tilt Position**

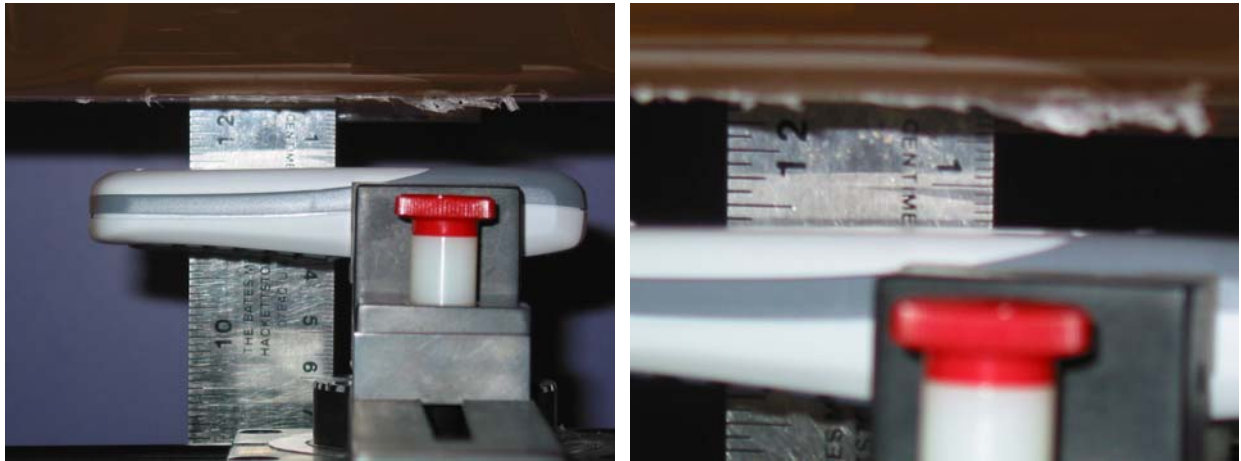


**Left Head Touch Position**



**Left Head Tilt Position**





**Body Position w/15 mm Separation**

## Appendix D – Probe Calibration Data Sheets

# NCL CALIBRATION LABORATORIES

Calibration File No.: CP-601

Client.: RFEL

## 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.

Equipment: Miniature Isotropic RF Probe 835 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 215

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2

Project No: RFEL-Probe-215-Calibration-5166

Calibrated: 10<sup>th</sup> June 2005  
Released on: 10<sup>th</sup> June 2005

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

Released By: \_\_\_\_\_ Signature On File

**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-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 215.

## **References**

SSI/DRB-TP-D01-032-E020-V2 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 215 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

**We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.**

---

**Stuart Nicol**  
**Director Product Development**

---

**Janusz Lokaj**  
**Member of Engineering Staff**  
**(Calibration Engineer)**

## Calibration Results Summary

<b>Probe Type:</b>	E-Field Probe E-020
<b>Serial Number:</b>	215
<b>Frequency:</b>	835 MHz
<b>Sensor Offset:</b>	1.56 mm
<b>Sensor Length:</b>	2.5 mm
<b>Tip Enclosure:</b>	Ertalyte*
<b>Tip Diameter:</b>	<5 mm
<b>Tip Length:</b>	60 mm
<b>Total Length:</b>	290 mm

\*Resistive to recommended tissue recipes per IEEE-1528

## Sensitivity in Air

<b>Channel X:</b>	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Channel Y:</b>	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Channel Z:</b>	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Diode Compression Point:</b>	95 mV



## **Sensitivity in Head Tissue**

**Frequency:** 835 MHz

**Epsilon:** 41.5 (+/-5%)      **Sigma:** 0.90 S/m (+/-10%)

### **ConvF**

**Channel X:** 5.49

**Channel Y:** 5.49

**Channel Z:** 5.49

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

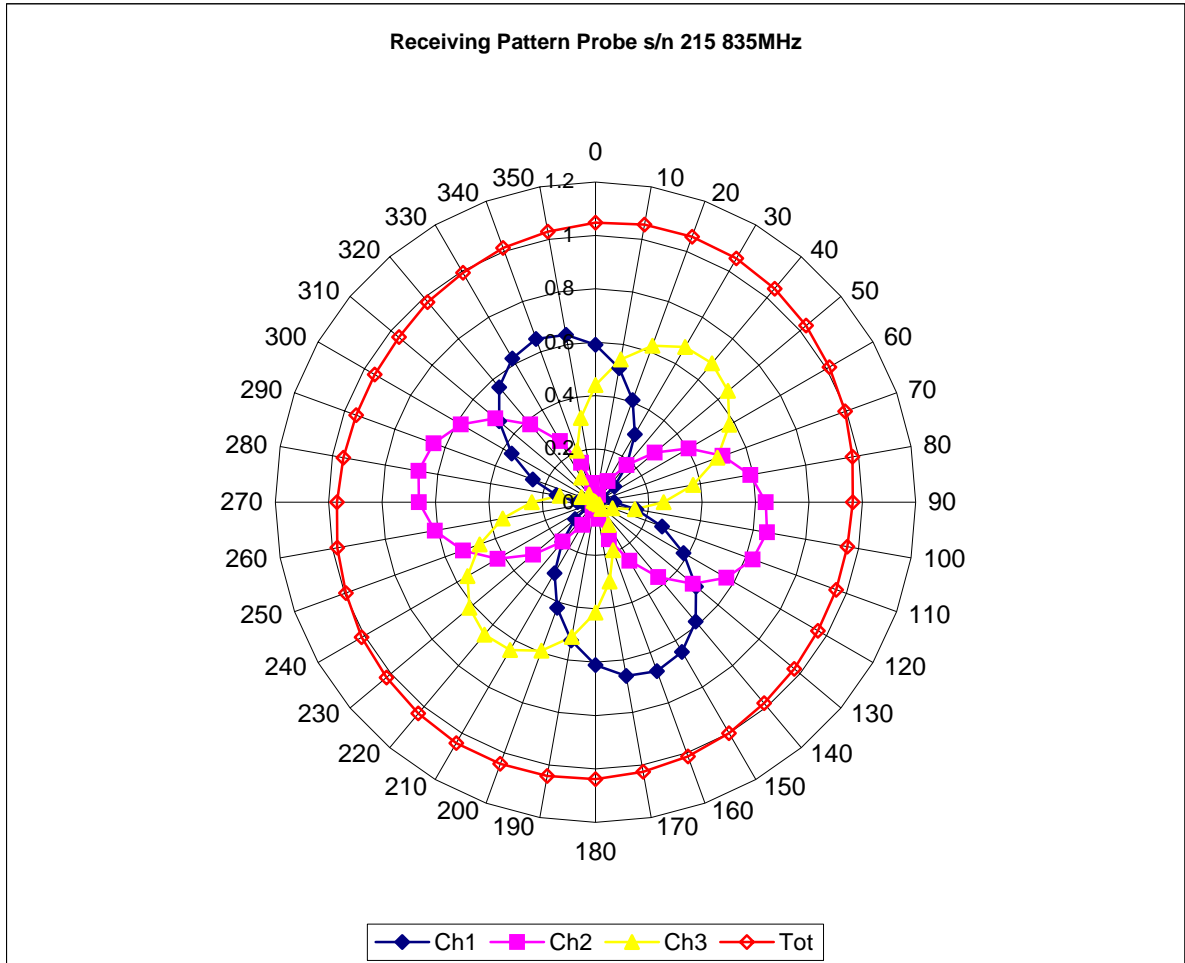
### **Boundary Effect:**

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 2.44mm.

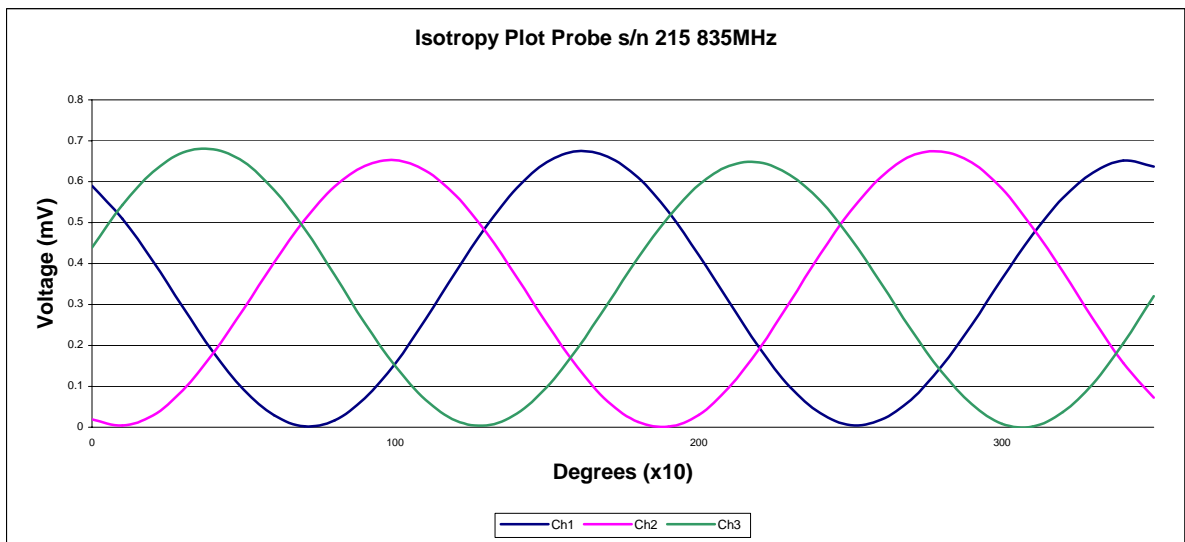
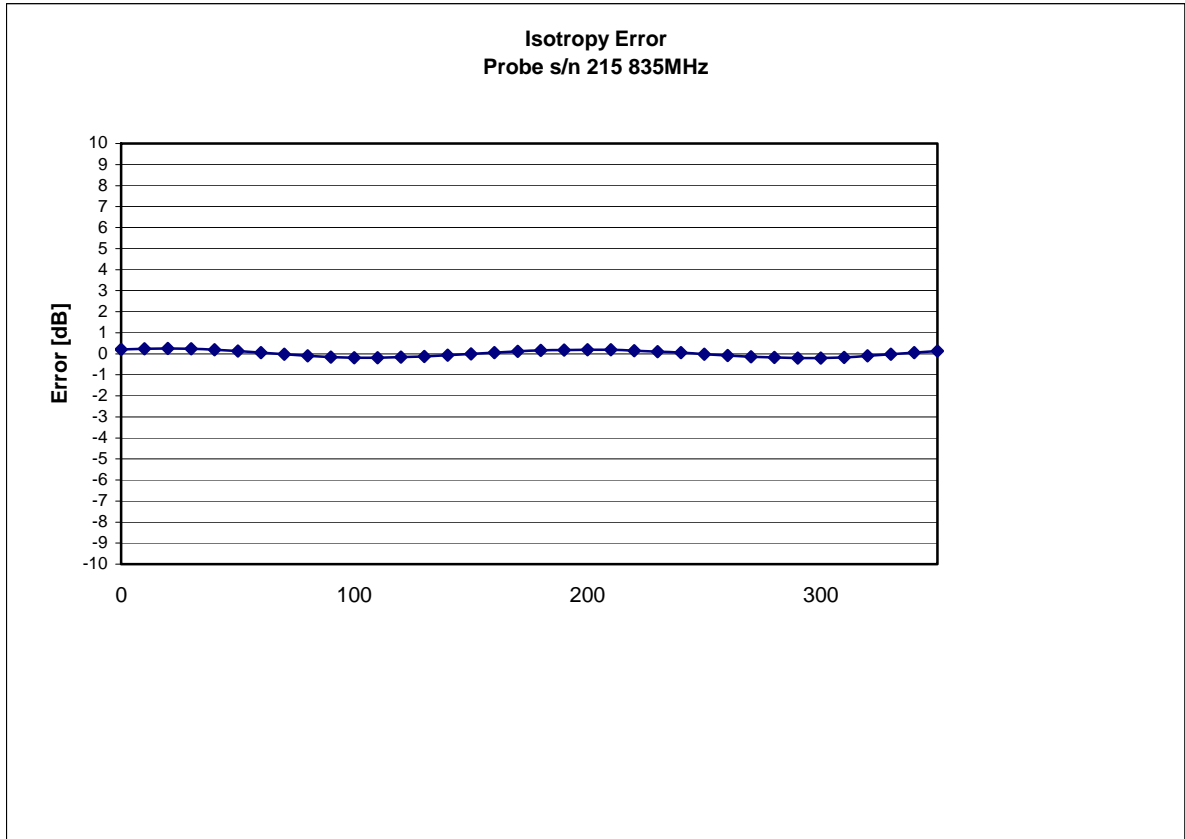
### **Spatial Resolution:**

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 835 MHz (Air)



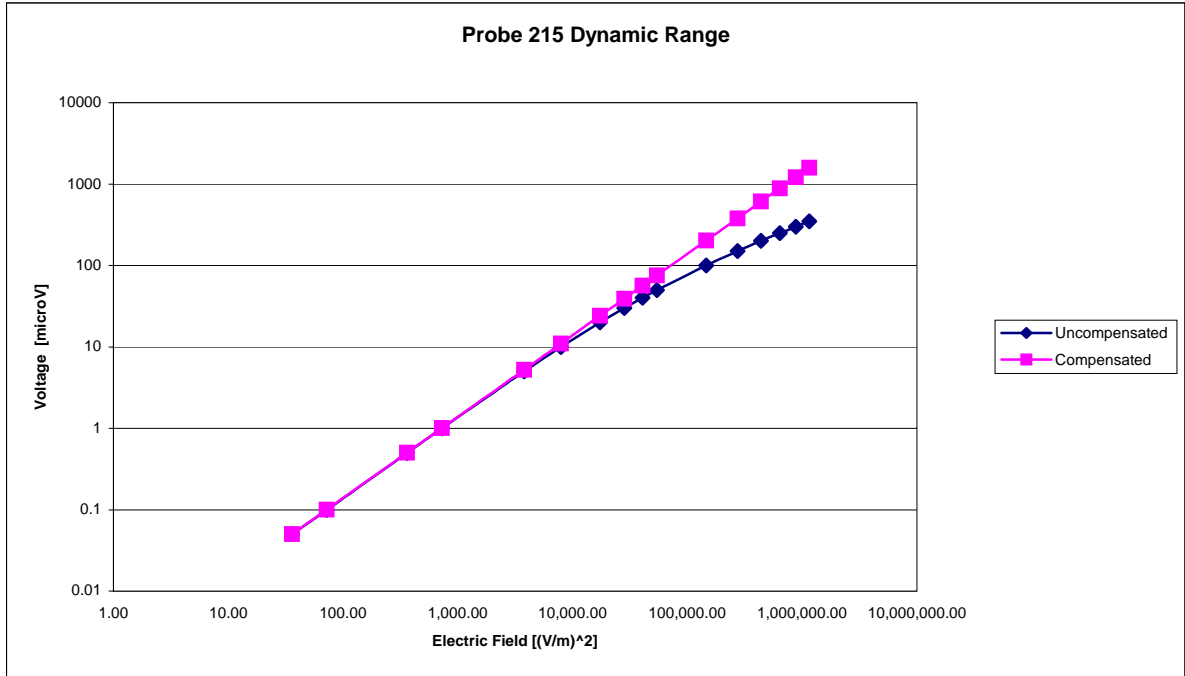
### Isotropy Error 835 MHz (Air)



Isotropicity Tissue:

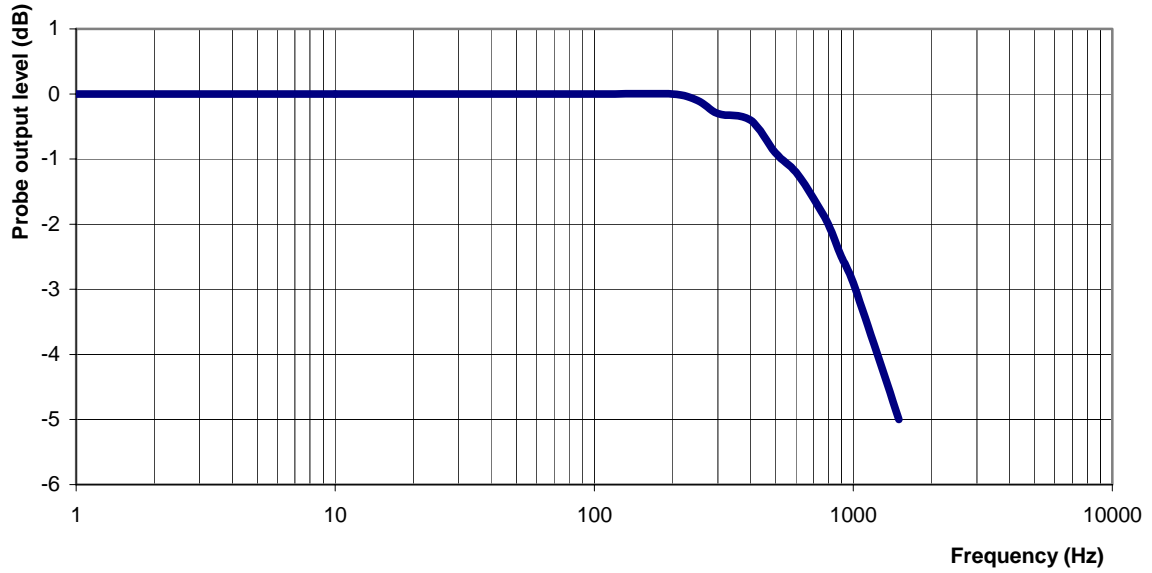
0.10 dB

## 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:** 835MHz  
**Epsilon:** 41.5 (+/-5%)      **Sigma:** 0.90 S/m (+/-10%)

### **ConvF**

**Channel X:** 5.49      7%(K=2)  
**Channel Y:** 5.49      7%(K=2)  
**Channel Z:** 5.49      7%(K=2)

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 M $\Omega$ .

### **Boundary Effect:**

For a distance of 2.5mm 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 2005.

# NCL CALIBRATION LABORATORIES

Calibration File No.: CP-604

Client.: RFEL

## 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.

Equipment: Miniature Isotropic RF Probe 835 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 215

BODY Calibration

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2

Project No: RFEL-Probe-215-Calibration-5166

Calibrated: 10<sup>th</sup> June 2005  
Released on: 10<sup>th</sup> June 2005

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

Released By: \_\_\_\_\_ Signature On File

**NCL CALIBRATION LABORATORIES**

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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-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 215.

## **References**

SSI/DRB-TP-D01-032-E020-V2 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 215 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

**We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.**

-----  
**Stuart Nicol**  
**Director Product Development**

-----  
**Janusz Lokaj**  
**Member of Engineering Staff**  
**(Calibration Engineer)**

## Calibration Results Summary

<b>Probe Type:</b>	E-Field Probe E-020
<b>Serial Number:</b>	215
<b>Frequency:</b>	835 MHz
<b>Sensor Offset:</b>	1.56 mm
<b>Sensor Length:</b>	2.5 mm
<b>Tip Enclosure:</b>	Ertalyte*
<b>Tip Diameter:</b>	<5 mm
<b>Tip Length:</b>	60 mm
<b>Total Length:</b>	290 mm

\*Resistive to recommended tissue recipes per IEEE-1528

## Sensitivity in Air

<b>Channel X:</b>	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Channel Y:</b>	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Channel Z:</b>	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Diode Compression Point:</b>	95 mV

## **Sensitivity in Body Tissue**

**Frequency:** 835 MHz

**Epsilon:** 56.1 (+/-5%)      **Sigma:** 0.95 S/m (+/-10%)

### **ConvF**

**Channel X:** 6.07

**Channel Y:** 6.07

**Channel Z:** 6.07

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

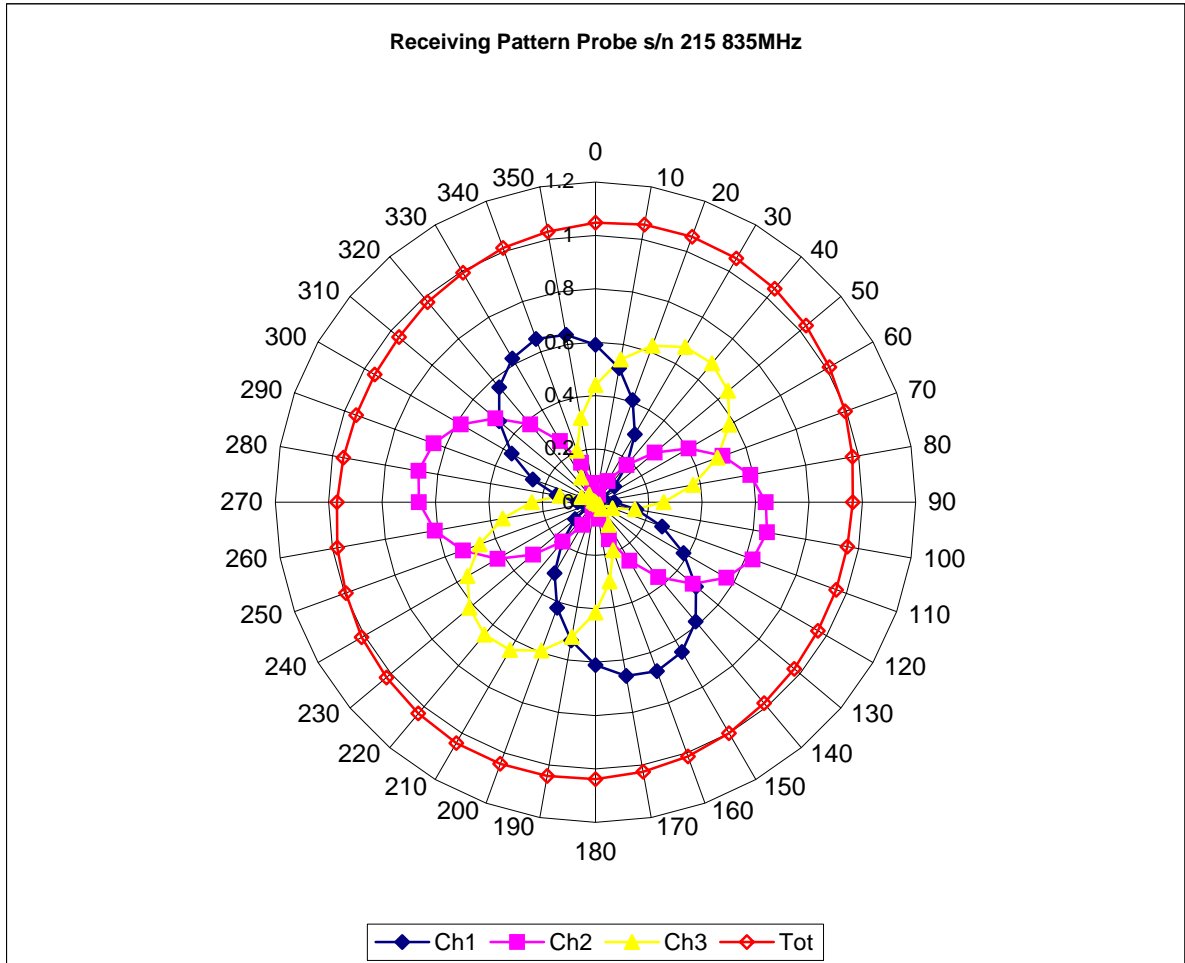
### **Boundary Effect:**

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 2.44mm.

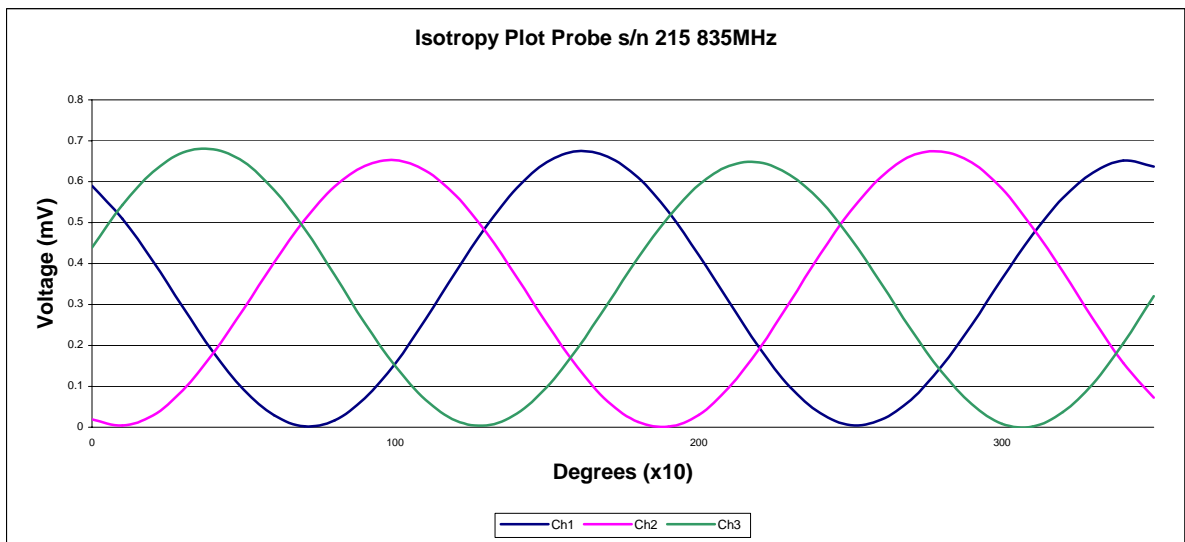
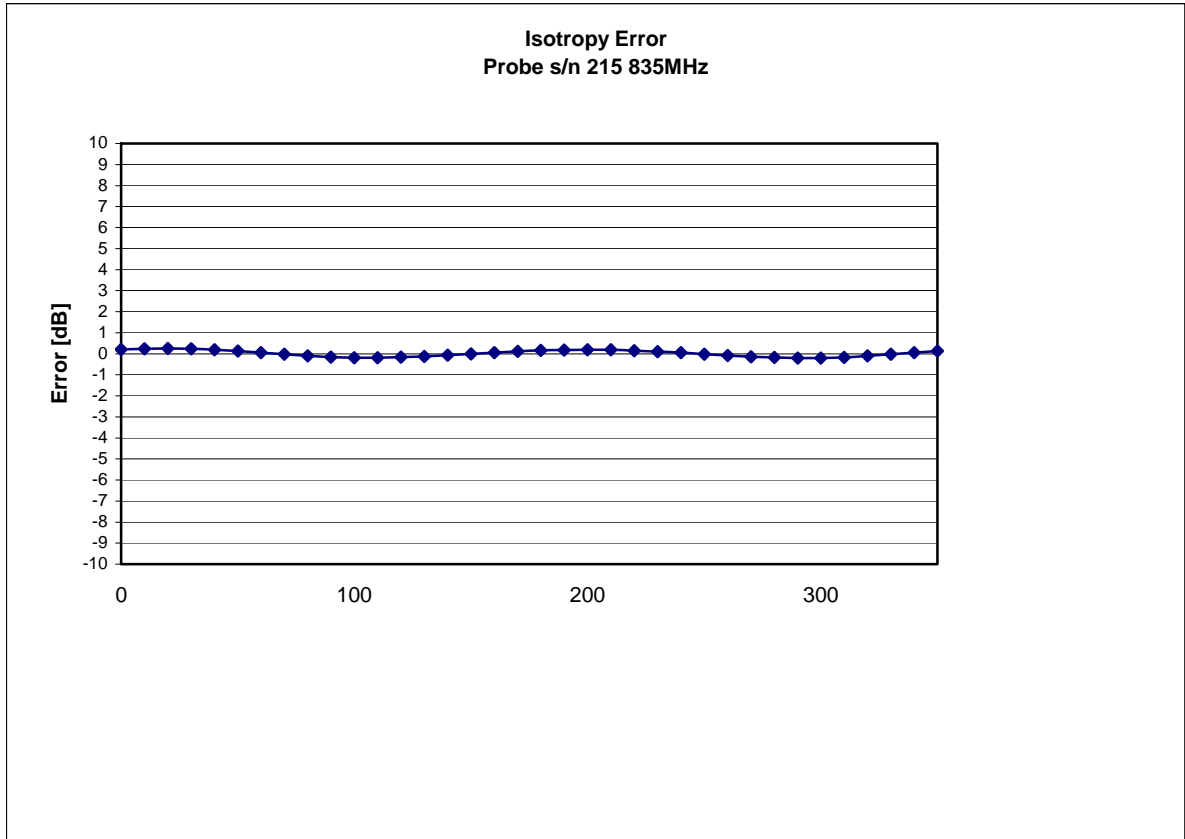
### **Spatial Resolution:**

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 835 MHz (Air)



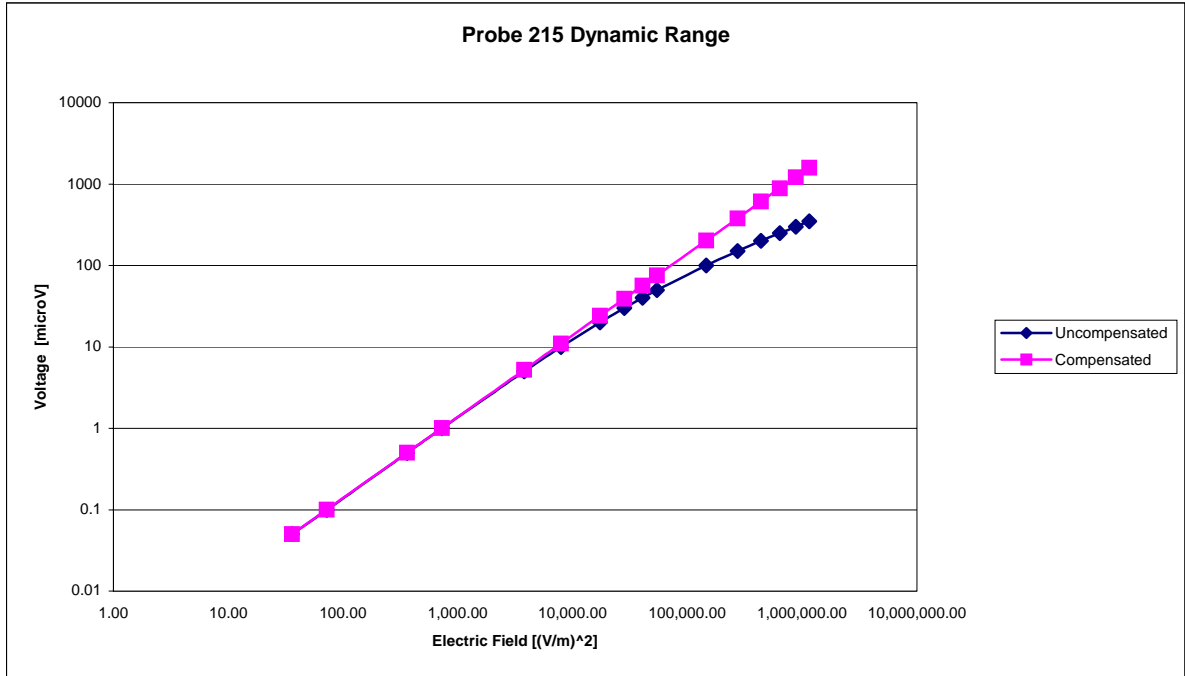
### Isotropy Error 835 MHz (Air)



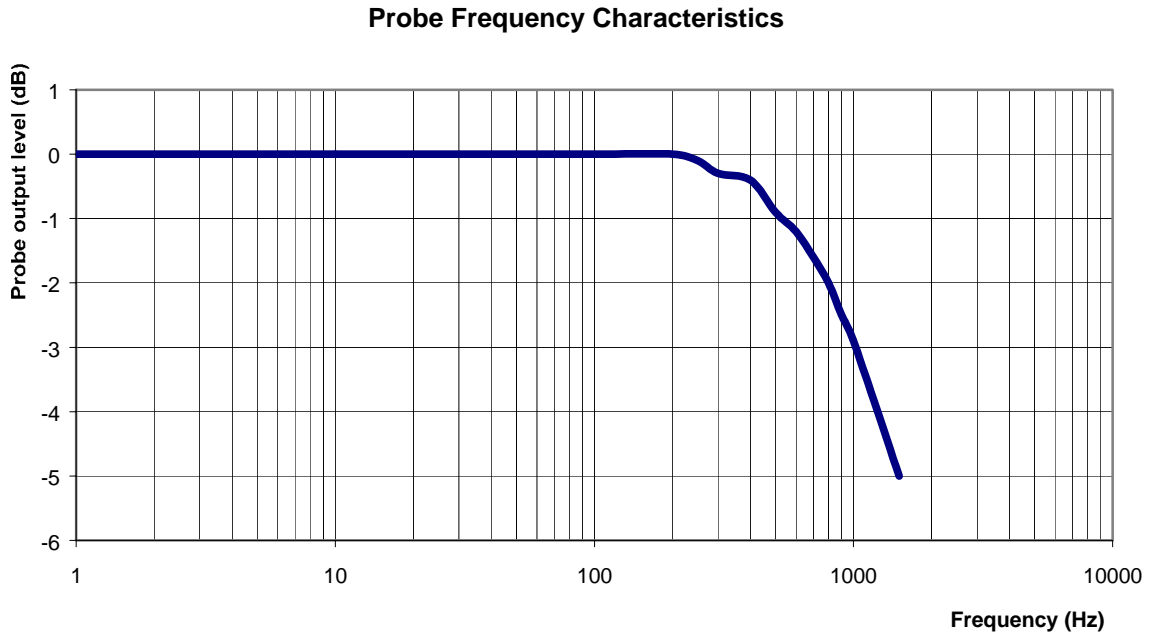
Isotropicity in Tissue:

0.10 dB

## Dynamic Range



## Video Bandwidth



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

## **Conversion Factor Uncertainty Assessment**

**Frequency:** 835MHz  
**Epsilon:** 56.1 (+/-5%)      **Sigma:** 0.95 S/m (+/-10%)

### **ConvF**

**Channel X:** 6.07      7%(K=2)

**Channel Y:** 6.07      7%(K=2)

**Channel Z:** 6.07      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 2005.

## Appendix E – Dipole Calibration Data Sheets

# NCL CALIBRATION LABORATORIES

Calibration File No: CD-339  
Project Number: RFEB-ALSAS-10U-4087

## 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.

RFE Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-835-S-2

Frequency: 835 MHz

Serial No: RFE-274

Customer: RFE

Calibrated: 20 February 2004  
Released on: 20 February 2004

Released By: 

### **NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Lab.  
TEL: (613) 820-4988  
FAX: (613) 820-4162

## Calibration Results Summary

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

### Mechanical Dimensions

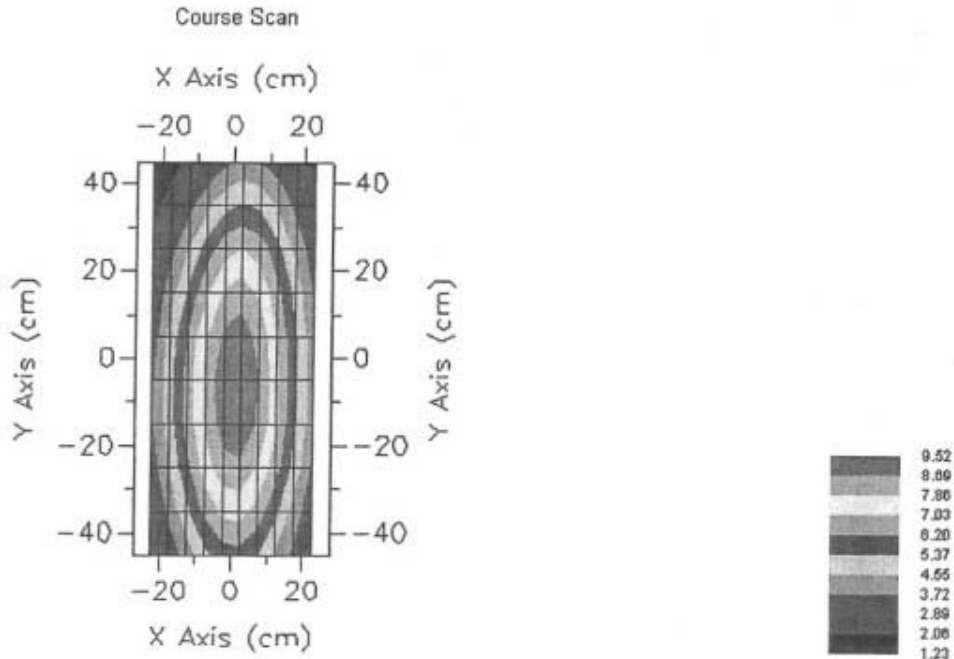
**Length:** 161.8 mm  
**Height:** 91.1 mm

### Electrical Specification

**SWR:** 1.11 U  
**Return Loss:** -26.20 dB  
**Impedance:** 52.40  $\Omega$

### System Validation Results

Frequency	1 Gram	10 Gram	Peak
835 MHz	9.33	6.42	15.0



## Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole RFE-274. 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/APREL mechanical specifications. 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 ALSAS-10U, along with RFE E-020 130 MHz to 26 GHz E-Field Probe Serial Number 213.

## References

SSI-TP-018-ALSAS Dipole Calibration Procedure  
SSI-TP-016 Tissue 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"

## Conditions

Dipole RFE-274 was new taken from stock.

**Ambient Temperature of the Laboratory:** 22 °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
162.0 mm	91.0 mm	161.8 mm	91.1 mm

### Tissue Validation

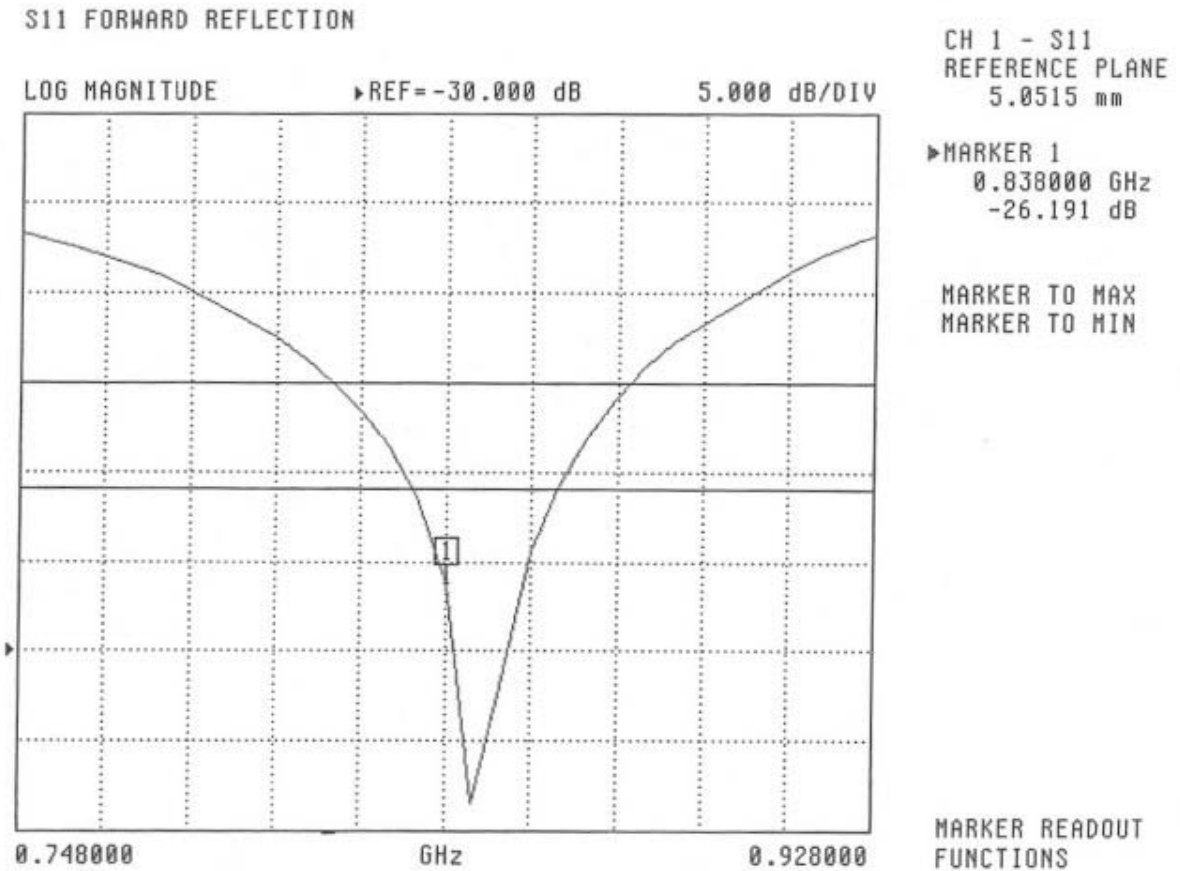
Head Tissue 835 MHz	Measured
Dielectric constant, $\epsilon_r$	42.54
Conductivity, $\sigma$ [S/m]	0.91

**Electrical Calibration**

Test	Result
S11 R/L	-26.2 dB
SWR	1.11 U
Impedance	52.4 $\Omega$

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

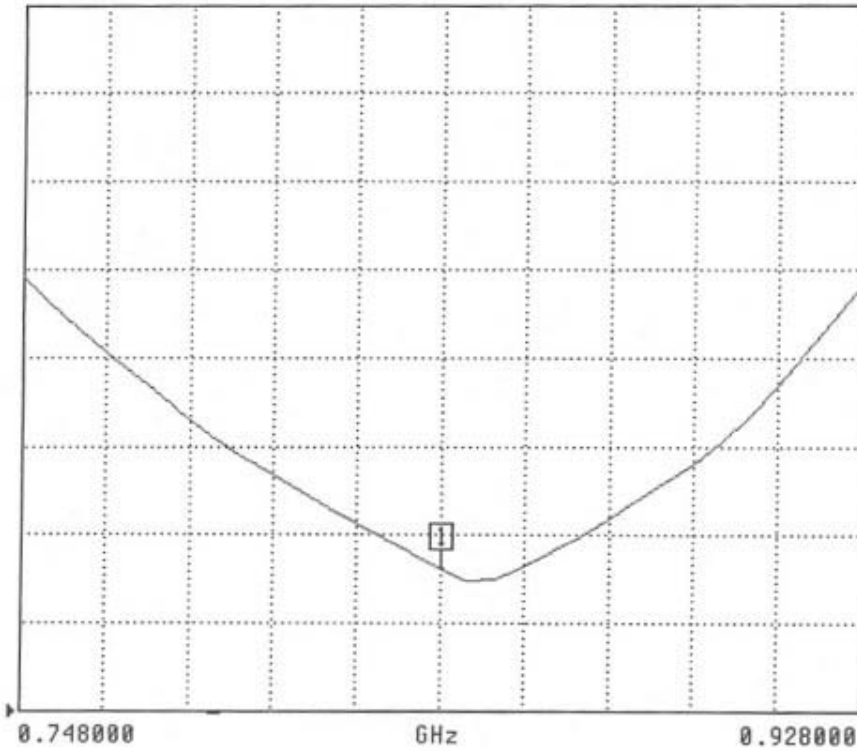
**S11 Parameter Return Loss**



SWR

S11 FORWARD REFLECTION

SWR REF=294.938 mU 500.000 mU/DIV



CH 1 - S11  
REFERENCE PLANE  
5.0515 mm

▶ MARKER 1  
0.838000 GHz  
1.108 U

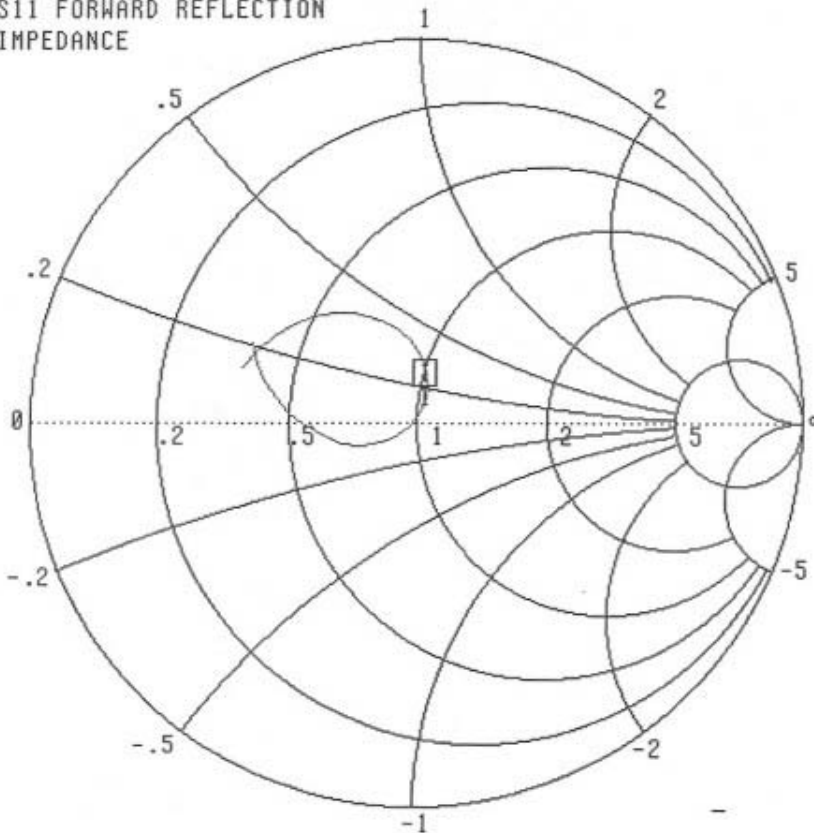
MARKER TO MAX  
MARKER TO MIN

MARKER READOUT  
FUNCTIONS



### Smith Chart Dipole Impedance

S11 FORWARD REFLECTION  
IMPEDANCE



CH 1 - S11  
REFERENCE PLANE  
5.0515 mm

▶ MARKER 1  
0.838000 GHz  
52.440  $\Omega$   
4.834  $j\Omega$

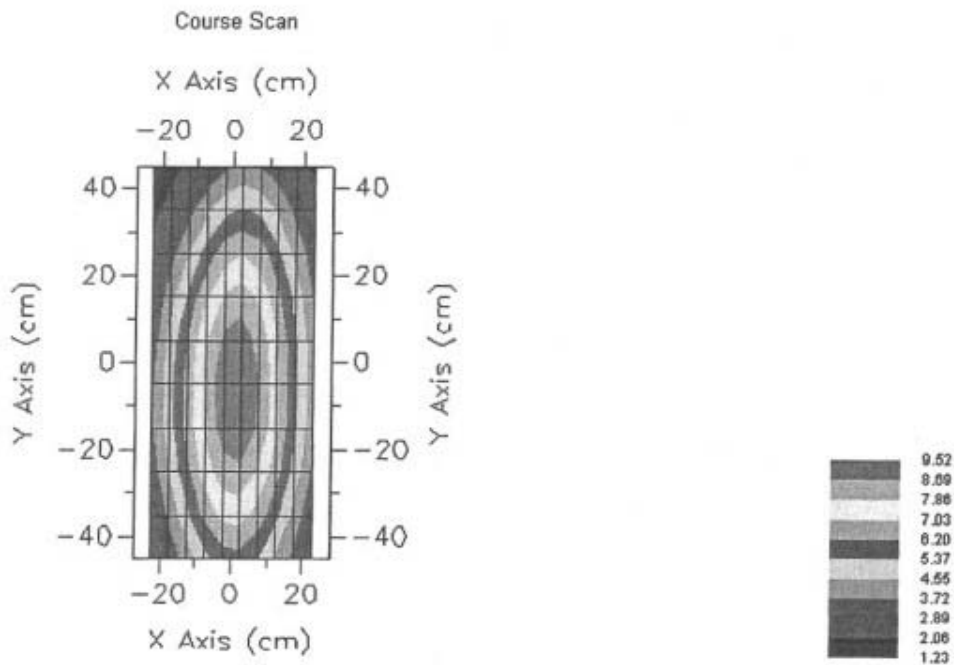
MARKER TO MAX  
MARKER TO MIN

MARKER READOUT  
FUNCTIONS

0.748000 - 0.928000 GHz

System Validation Results Using the Electrically Calibrated Dipole

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
835 MHz	9.33	6.42	15.0



## 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 2003

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*[Handwritten signature]*

## Appendix F – Phantom Calibration Data Sheets

# NCL CALIBRATION LABORATORIES

Calibration File No.: RFE-268

## 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 National Standards.

Unit serial number: RFE-268

### MEASUREMENTS OF THE PINNA

#### Right SAM Head

MB0	NF6	1.96
MB0	NF8	1.99
MB -30	NF6	1.98
MB +30	NF6	2.00
MB0	NF0	5.80
MB +30	NF0	4.46
MB -30	NF0	11.56
MB0	NF -2	5.6

NOTE: Lowest value was recorded.

Calibrated By: Parvati K

Date: Feb 17/04

### **NCL** CALIBRATION LABORATORIES

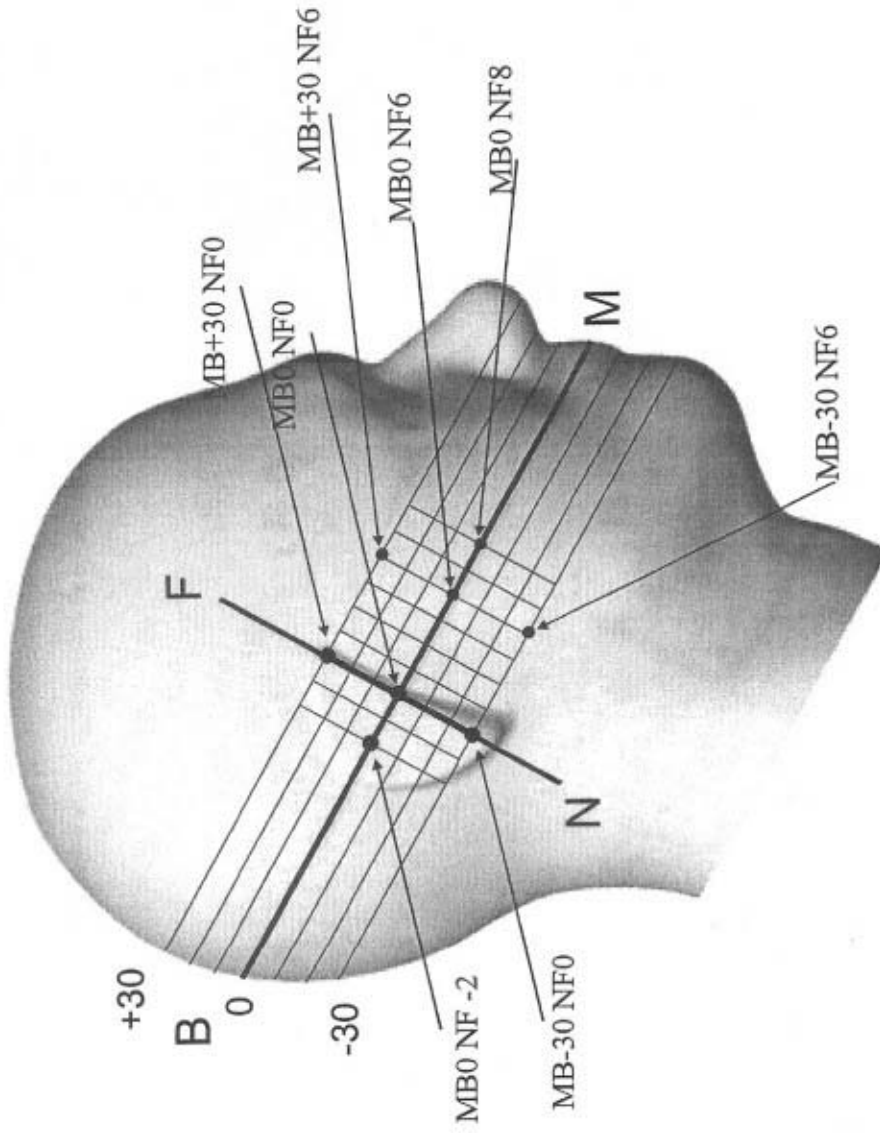
51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Laboratories,  
TEL: (613) 820-4988  
FAX: (613) 820-4161

# NCL CALIBRATION LABORATORIES

Calibration File No.: RFE-268

## CERTIFICATE OF CALIBRATION



### **NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA, K2R 1E6

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

# NCL CALIBRATION LABORATORIES

Calibration File No.: RFE-267

## 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 National Standards.

Unit serial number: RFE-267

### MEASUREMENTS OF THE PINNA

#### Left SAM Head

MB0	NF6	2.00
MB0	NF8	2.01
MB -30	NF6	2.00
MB +30	NF6	1.98
MB0	NF0	5.68
MB +30	NF0	4.68
MB -30	NF0	1.52
MB0	NF -2	5.61

NOTE: Lowest value was recorded.

Calibrated By:

*Karen K*

Date:

*Feb 17/04*

### **NCL** CALIBRATION LABORATORIES

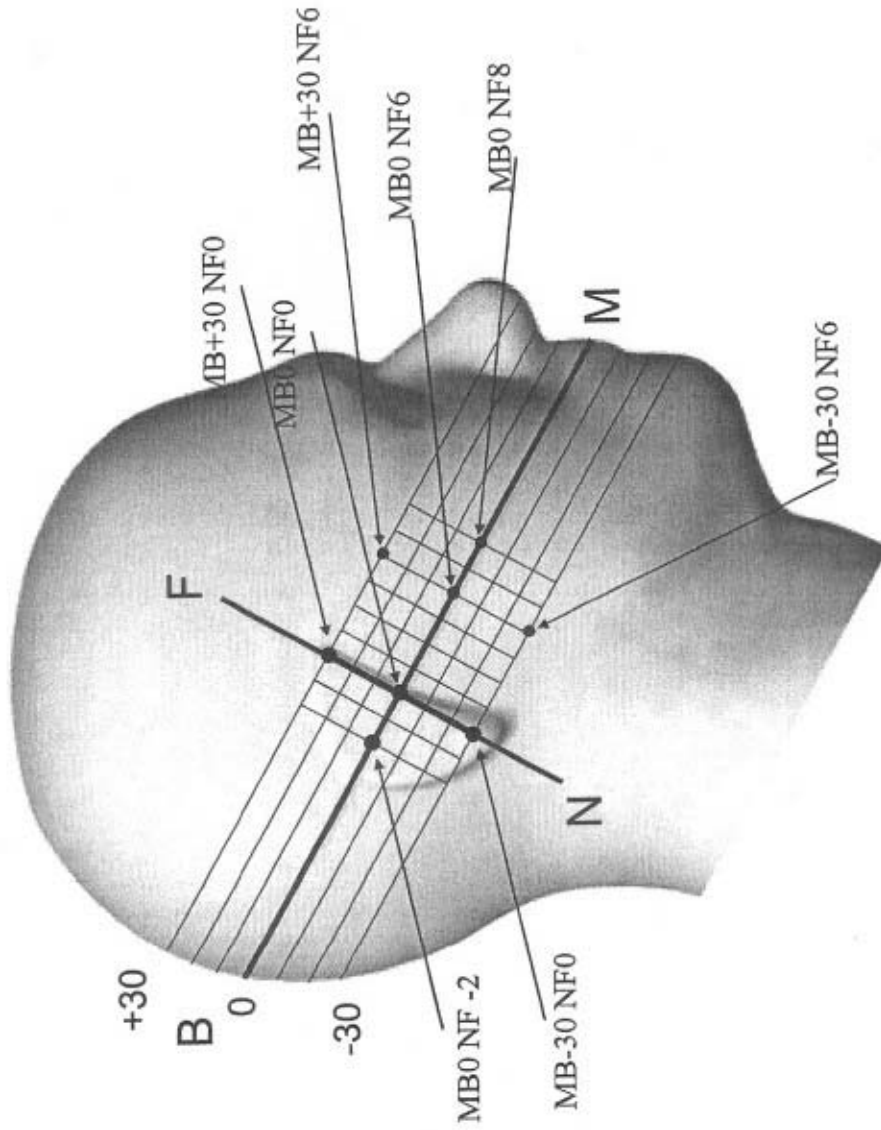
51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Laboratories,  
TEL: (613) 820-4988  
FAX: (613) 820-4161

# NCL CALIBRATION LABORATORIES

Calibration File No.: RFE-267

## CERTIFICATE OF CALIBRATION



### **NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Lab.  
TEL: (613) 820-4988  
FAX: (613) 820-4151



## NCL CALIBRATION LABORATORIES

Calibration File No.: RFE-273

# 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 National Standards.

Thickness of the UniPhantom is 2 mm  $\pm$  10%  
Pinna thickness is 6 mm  $\pm$  10%

Resolution:	0.01 mm	Calibrated to:	0.0 mm
Stability:	OK	Accuracy:	< 0.1 mm

Calibrated By: Karen K. Feb 17/04.

### **NCL** CALIBRATION LABORATORIES

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NEPEAN, ONTARIO  
CANADA K2R 1E6

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