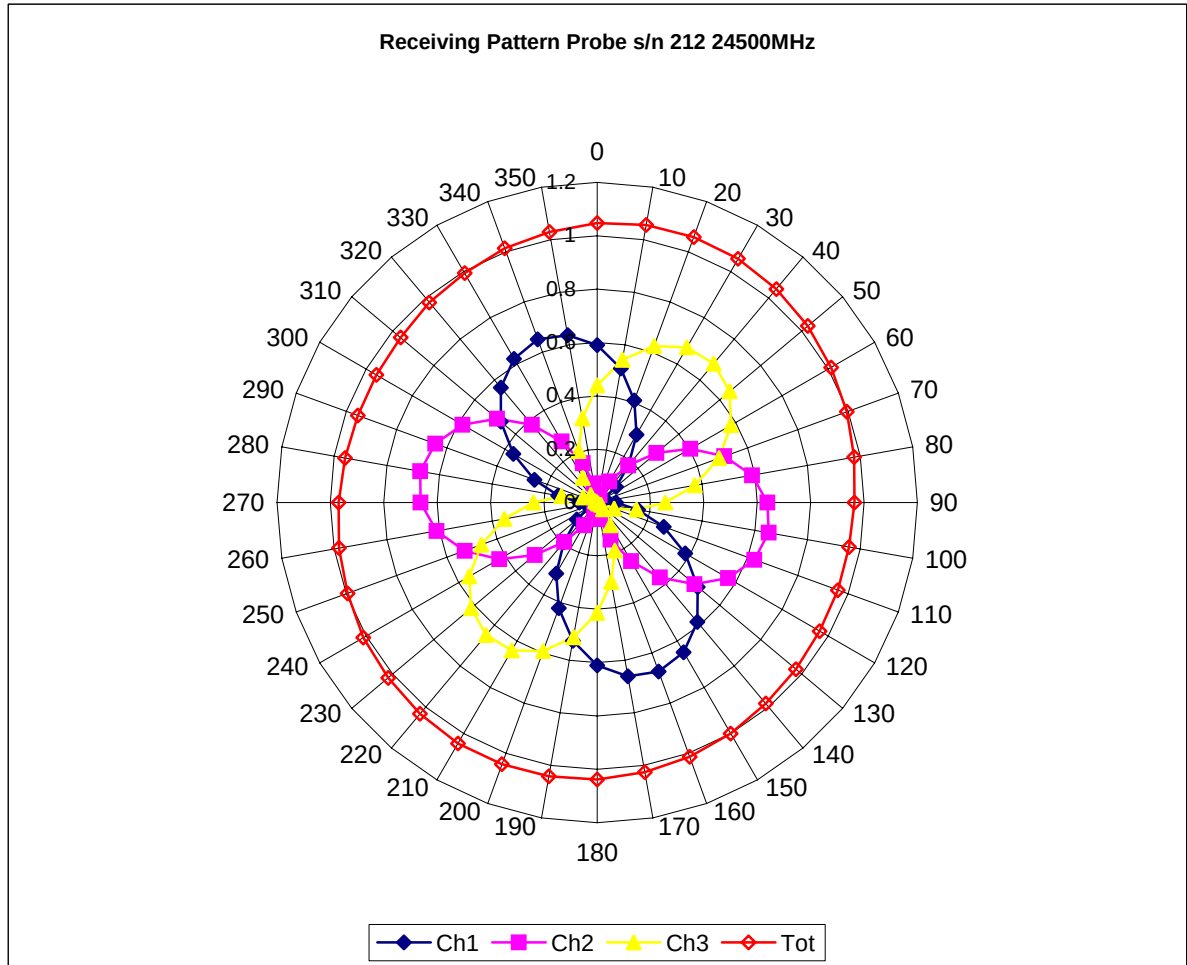
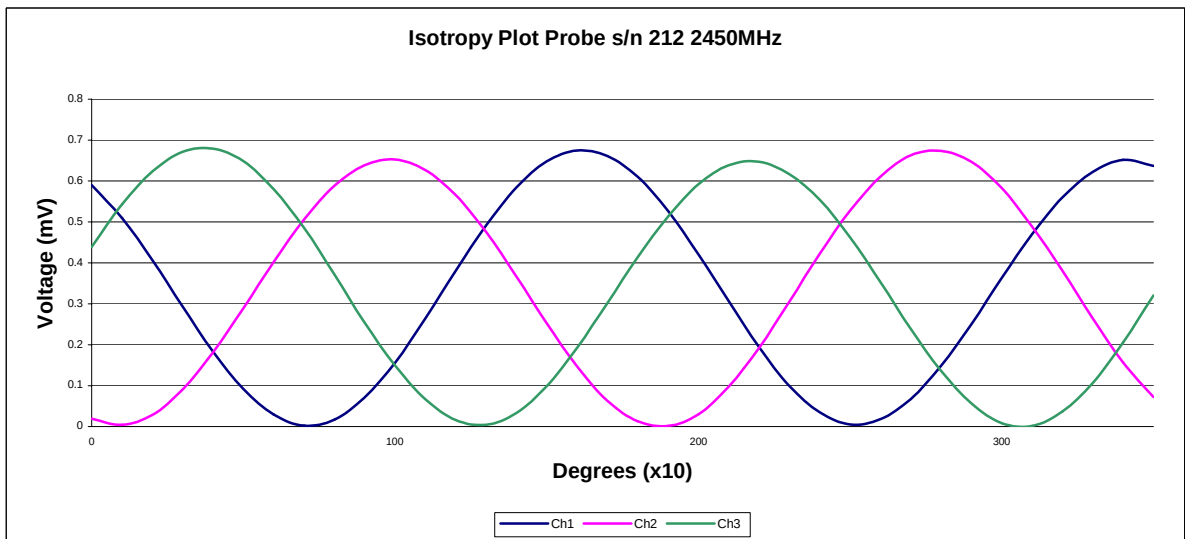
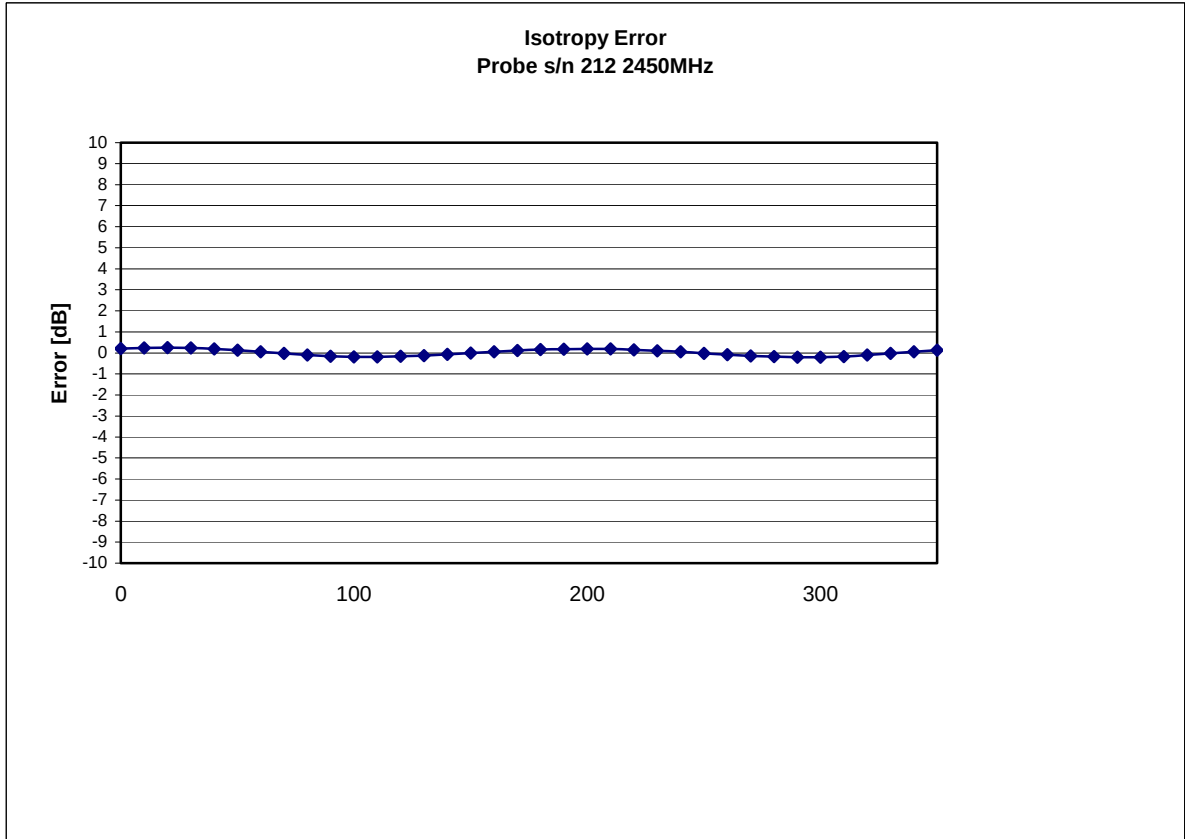


## Receiving Pattern 2450 MHz (Air)



## Isotropy Error 2450 MHz (Air)



**Isotropy:**

**0.10 dB**

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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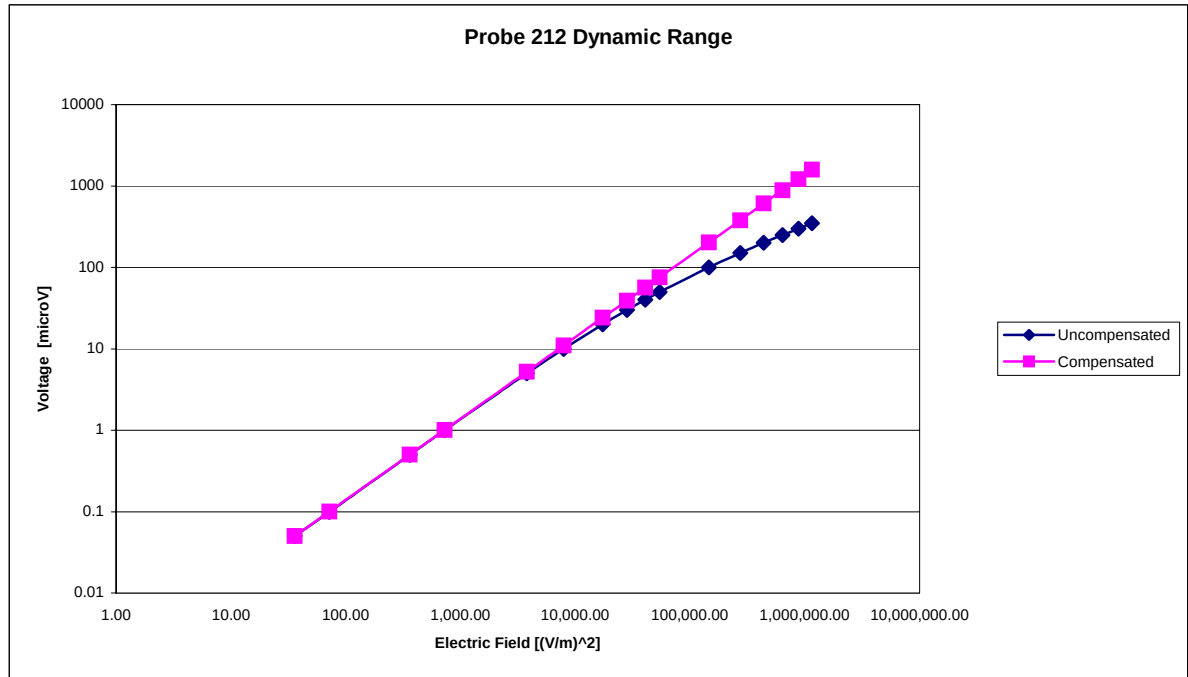


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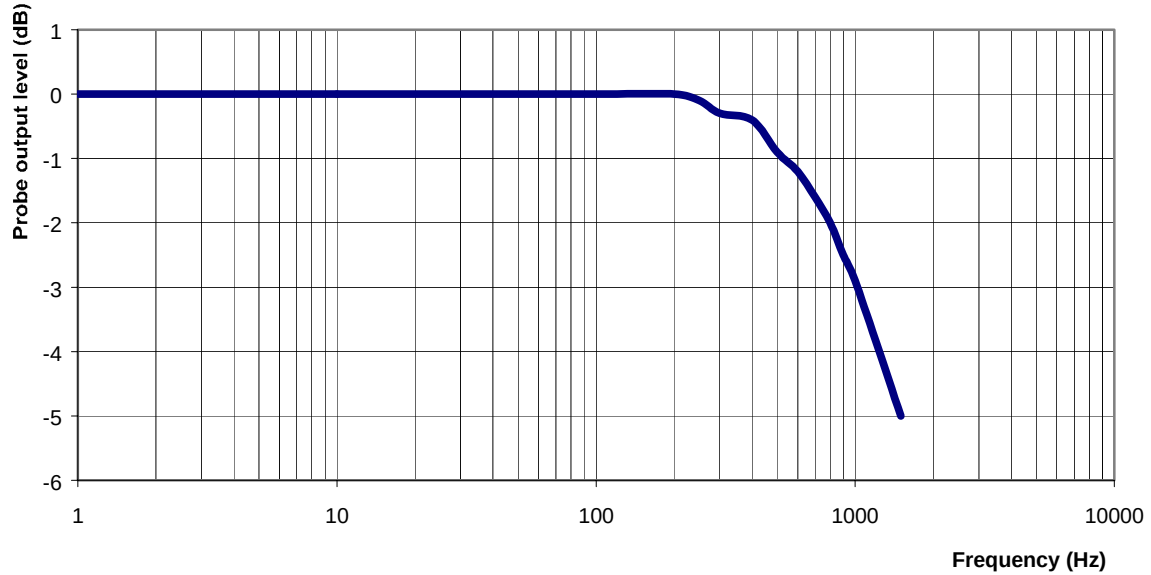
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## Dynamic Range



## 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:** 3.3 7% (K=2)**Channel Y:** 3.3 7% (K=2)**Channel Z:** 3.3 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 2.4mm 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 2004.

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-420

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 5200 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 212

BODY Calibration

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

Project No: Internal

Calibrated: 2<sup>nd</sup> March 2004

Released on: 2<sup>nd</sup> March 2004

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

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

**NCL CALIBRATION LABORATORIES**

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FAX: (613) 820-4161

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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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-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 212.

## 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 212 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:** 212  
**Frequency:** 5200 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:**  $0.61 \mu\text{V}/(\text{V}/\text{m})^2$   
**Channel Y:**  $0.61 \mu\text{V}/(\text{V}/\text{m})^2$   
**Channel Z:**  $0.61 \mu\text{V}/(\text{V}/\text{m})^2$   
**Diode Compression Point:** 95 mV

**Sensitivity in Body Tissue****Frequency:** 5200 MHz**Epsilon:** 36.0 (+/-5%)      **Sigma:** 4.7 S/m (+/-10%)**ConvF****Channel X:** 7.8**Channel Y:** 7.8**Channel Z:** 7.8

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

**Boundary Effect:**

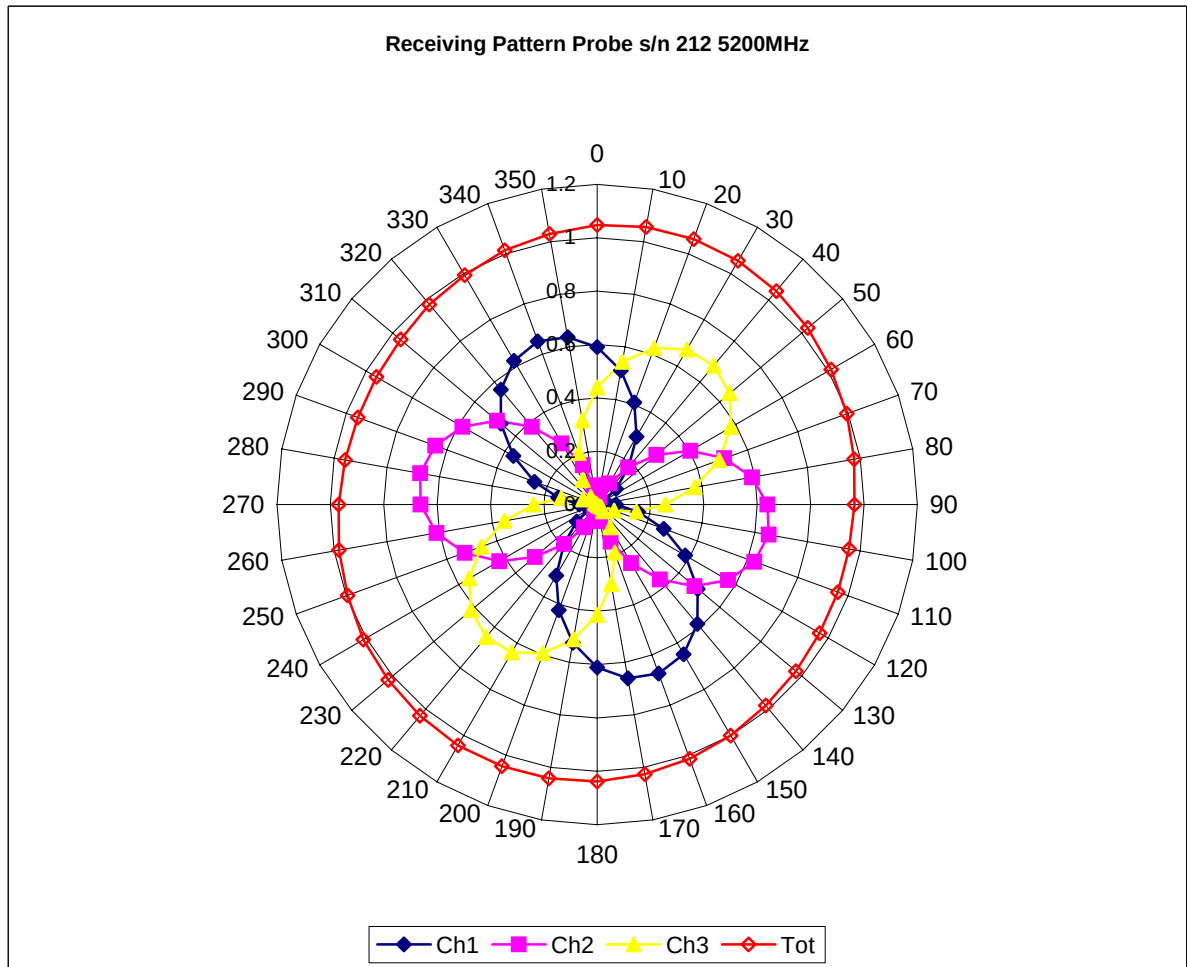
Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.4mm.

**Spatial Resolution:**

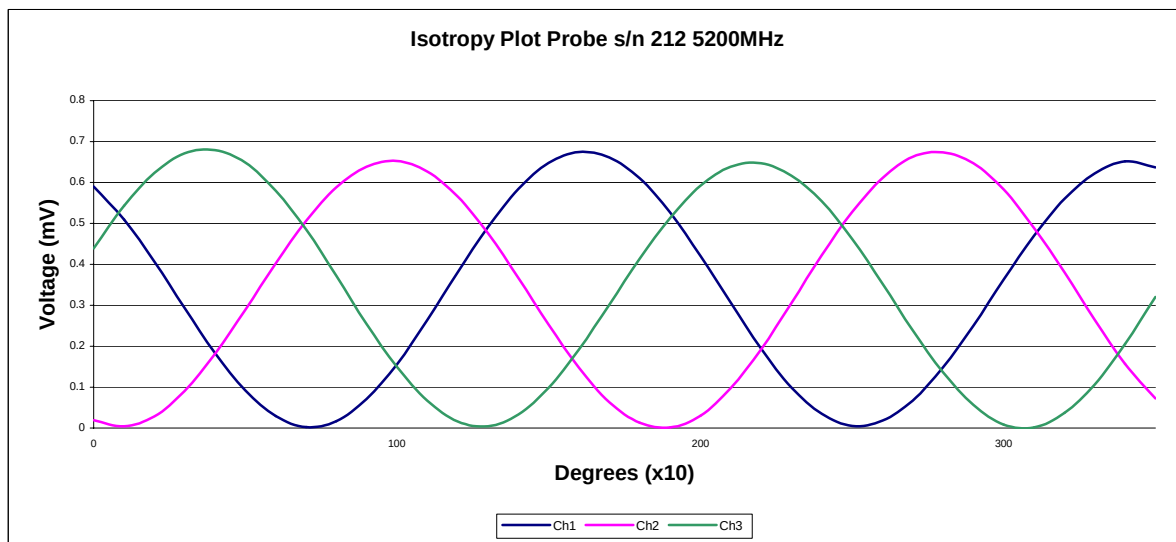
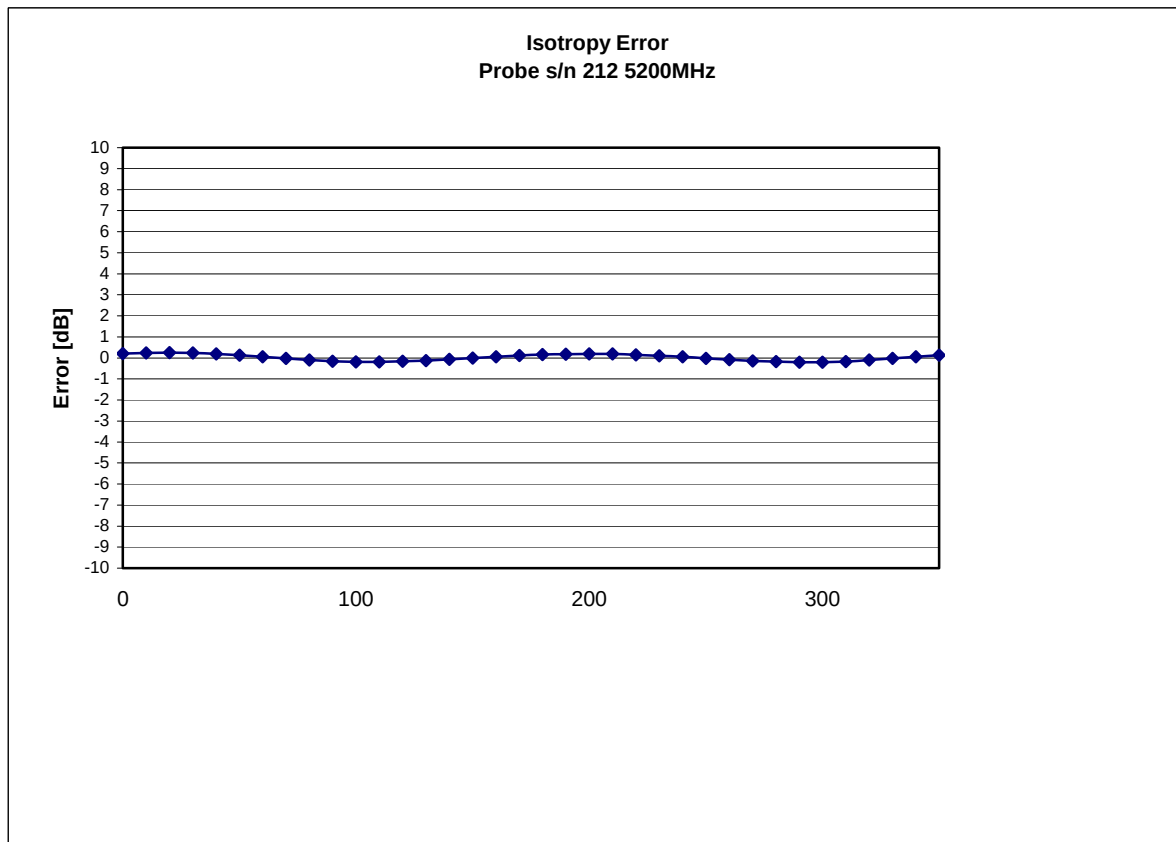
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.



## Receiving Pattern 5200 MHz (Air)



## Isotropy Error 5200 MHz (Air)



### Isotropy:

Project number: TLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

0.10 dB

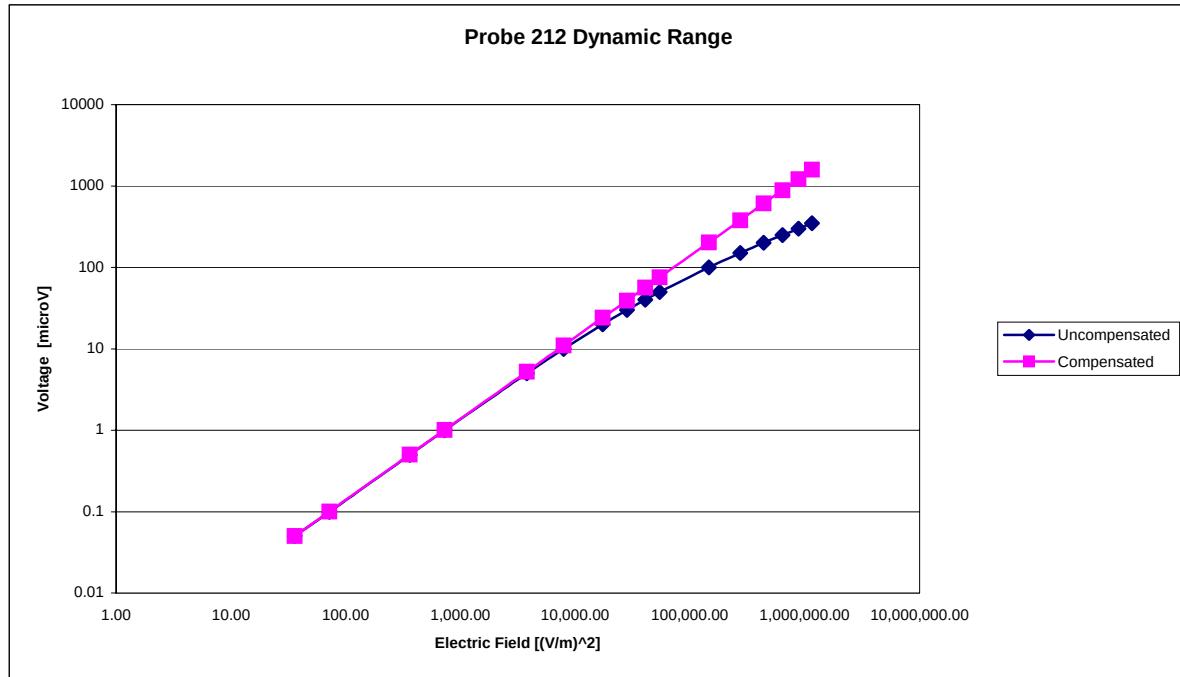
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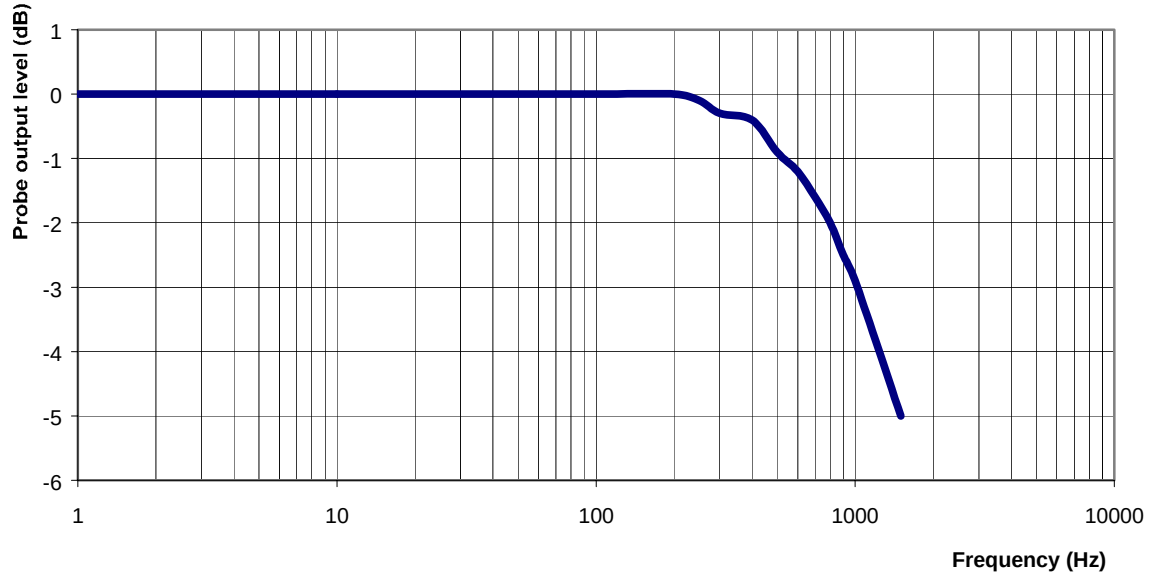
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## Dynamic Range



## 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:** 5200MHz**Epsilon:** 36.0 (+/-5%)**Sigma:** 4.7 S/m (+/-10%)**ConvF****Channel X:** 7.8 7%(K=2)**Channel Y:** 7.8 7%(K=2)**Channel Z:** 7.8 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 2004.

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-421

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 5800 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 212

BODY Calibration

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

Project No: Internal

Calibrated: 2<sup>nd</sup> March 2004

Released on: 2<sup>nd</sup> March 2004

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

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

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Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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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-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 212.

## 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 212 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:** 212

**Frequency:** 5800 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:**  $0.61 \mu\text{V}/(\text{V}/\text{m})^2$

**Channel Y:**  $0.61 \mu\text{V}/(\text{V}/\text{m})^2$

**Channel Z:**  $0.61 \mu\text{V}/(\text{V}/\text{m})^2$

**Diode Compression Point:** 95 mV

**Sensitivity in Body Tissue****Frequency:** 5800 MHz**Epsilon:** 35.15 (+/-5%) **Sigma:** 6.4 S/m (+/-10%)**ConvF****Channel X:** 7.1**Channel Y:** 7.1**Channel Z:** 7.1

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

**Boundary Effect:**

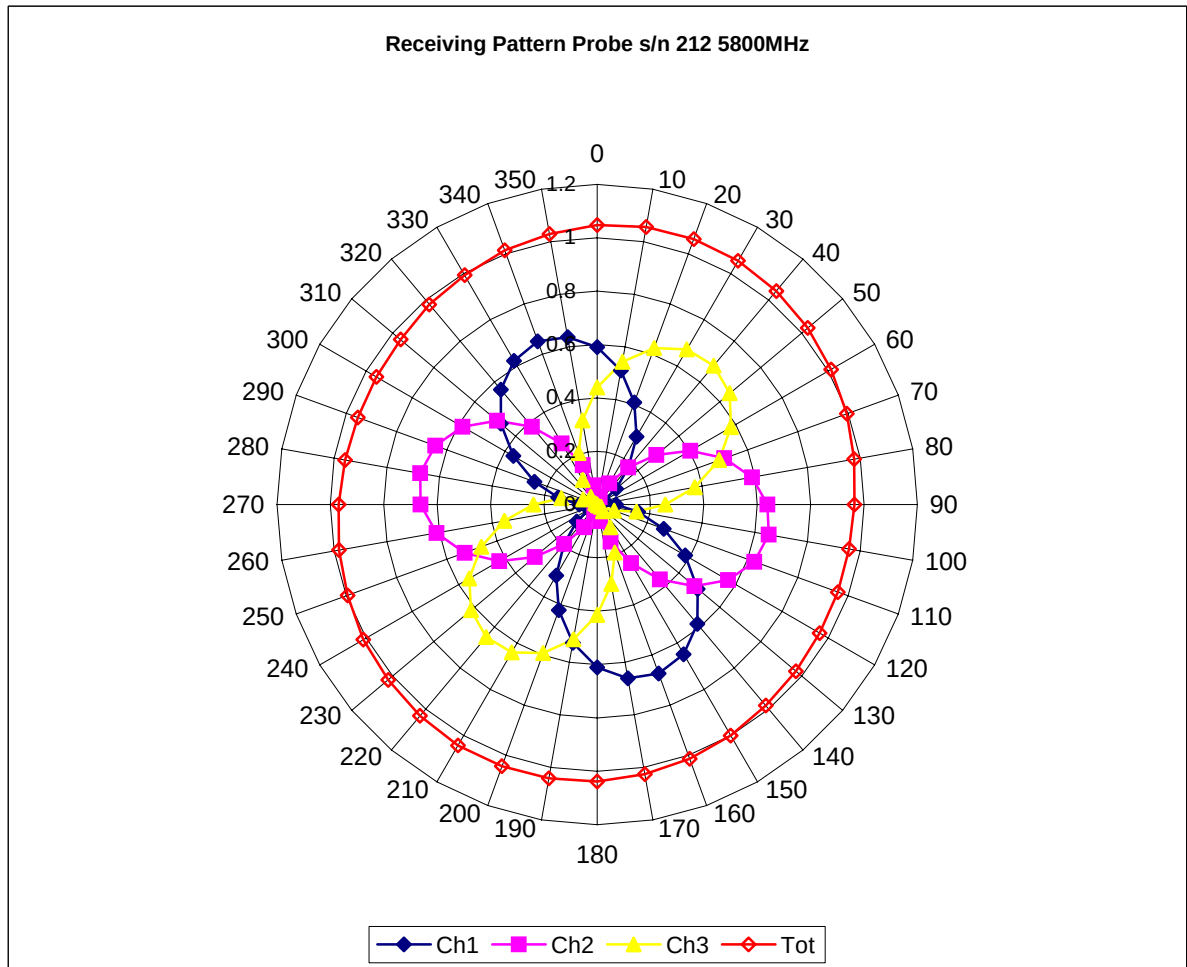
Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.4mm.

**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 5800 MHz (Air)



Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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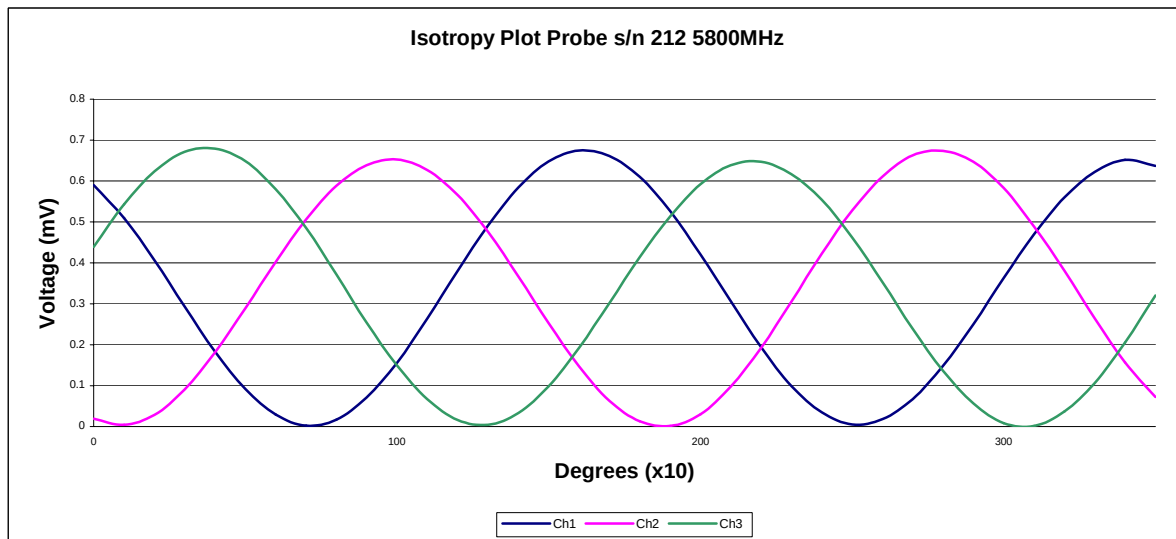
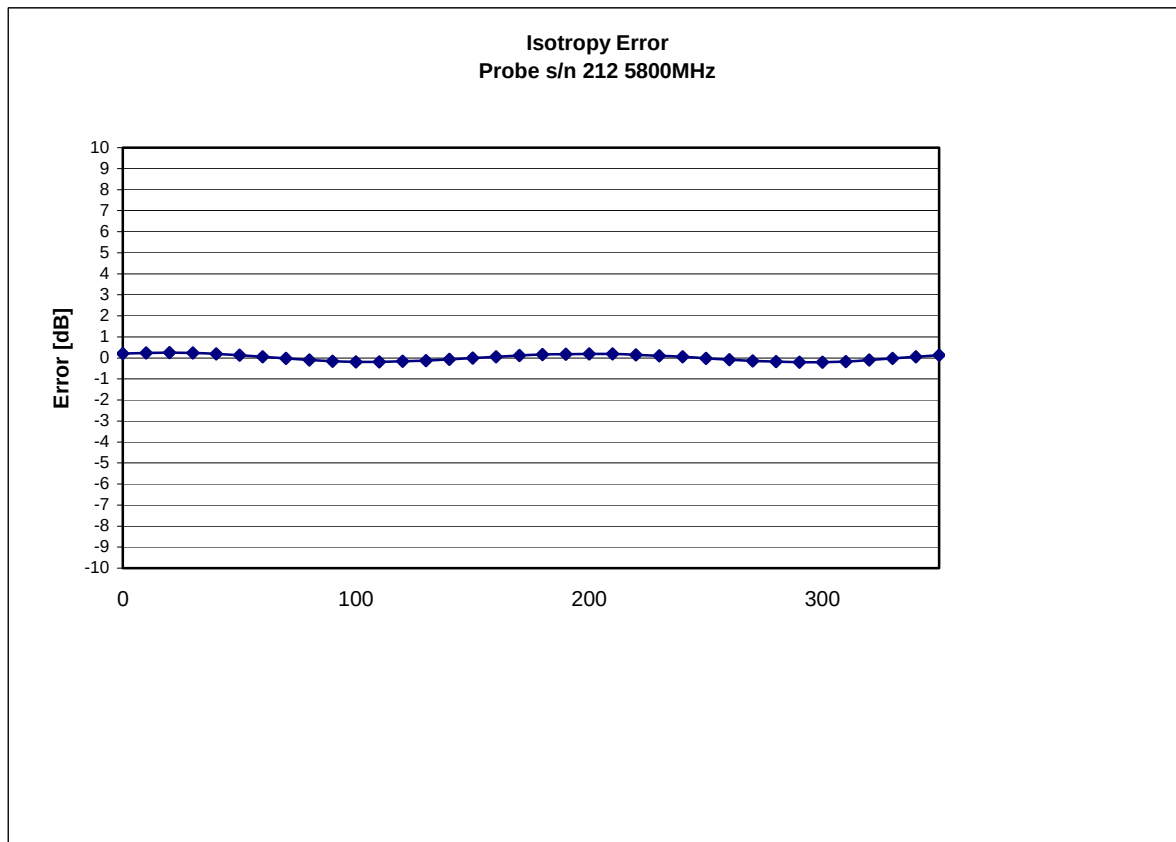


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## Isotropy Error 5800 MHz (Air)



**Isotropy:**

0.10 dB

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

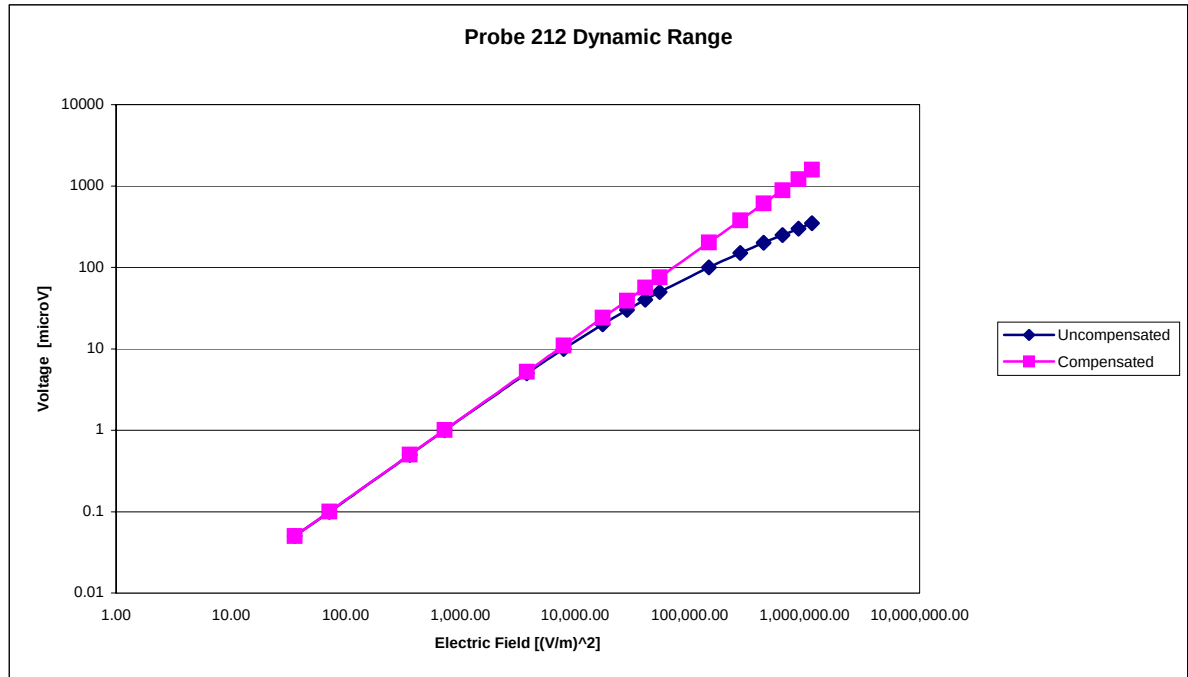
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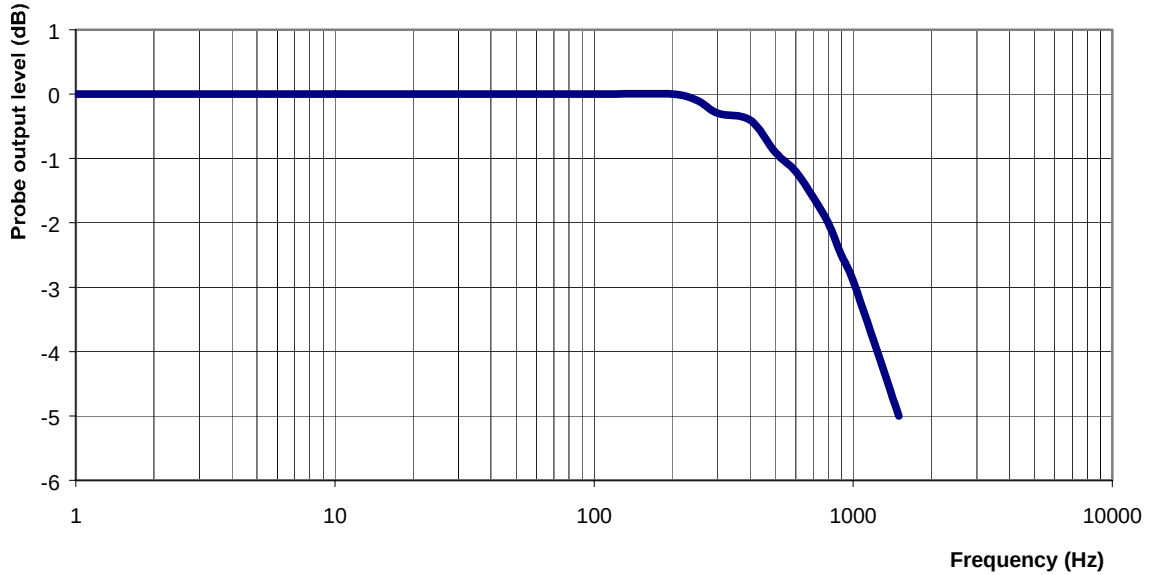
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## Dynamic Range



## 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:** 5800MHz

**Epsilon:** 35.15 (+/-5%)

**Sigma:** 6.4 S/m (+/-10%)

### ConvF

**Channel X:** 7.1 7%(K=2)

**Channel Y:** 7.1 7%(K=2)

**Channel Z:** 7.1 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 2004.

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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**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: \_\_\_\_\_

**NCL CALIBRATION LABORATORIES**

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CANADA K2R 1E6

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FAX: (613) 820-4161



### Calibration Results Summary

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

### Mechanical Dimensions

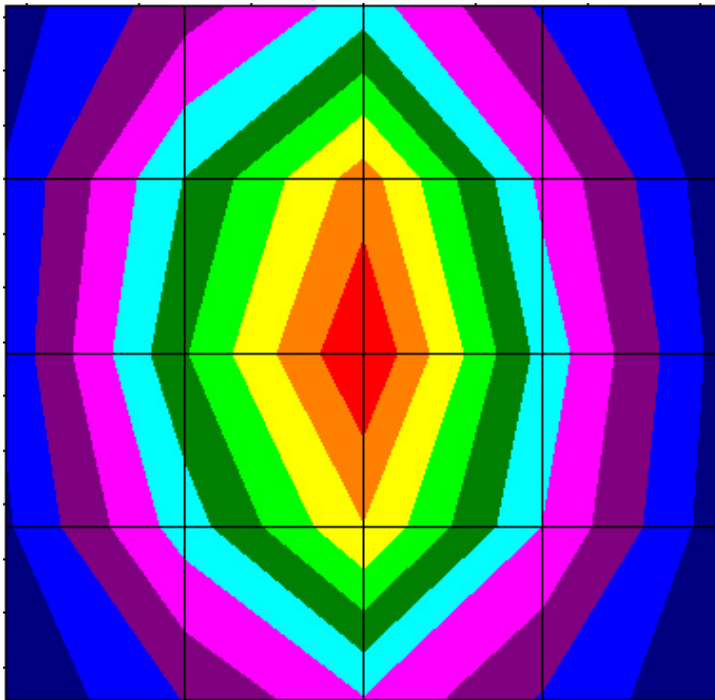
**Length:** 51.7 mm  
**Height:** 30.8 mm

### 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     |

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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## Electrical Calibration

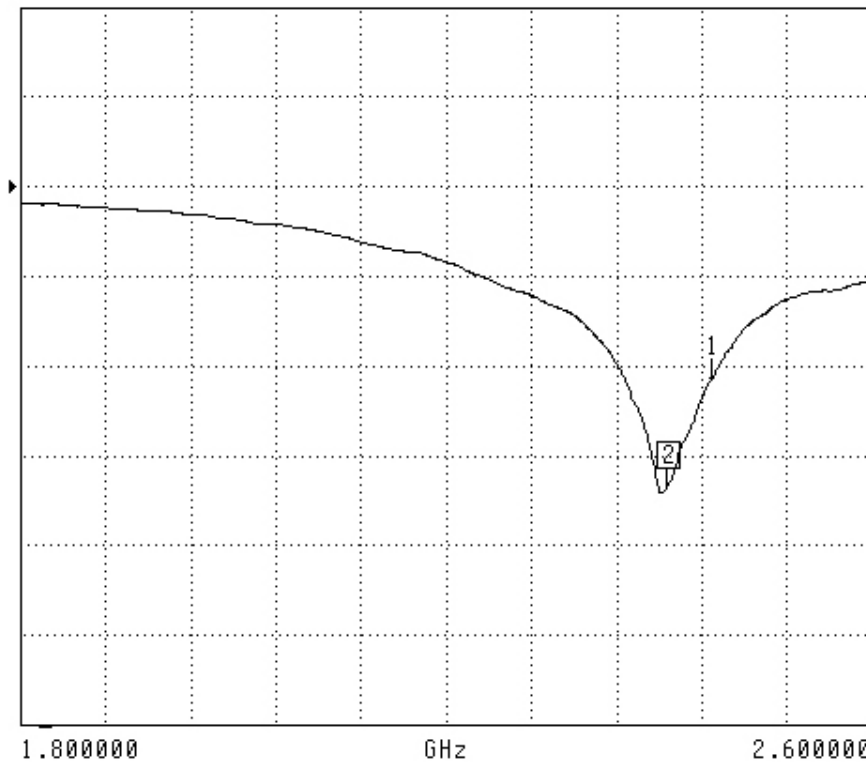
| Test      | Result          | IEEE Value |
|-----------|-----------------|------------|
| S11 R/L   | -21.4           | -21 dB     |
| SWR       | 1.181U          | -          |
| Impedance | 46.175 $\Omega$ |            |

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

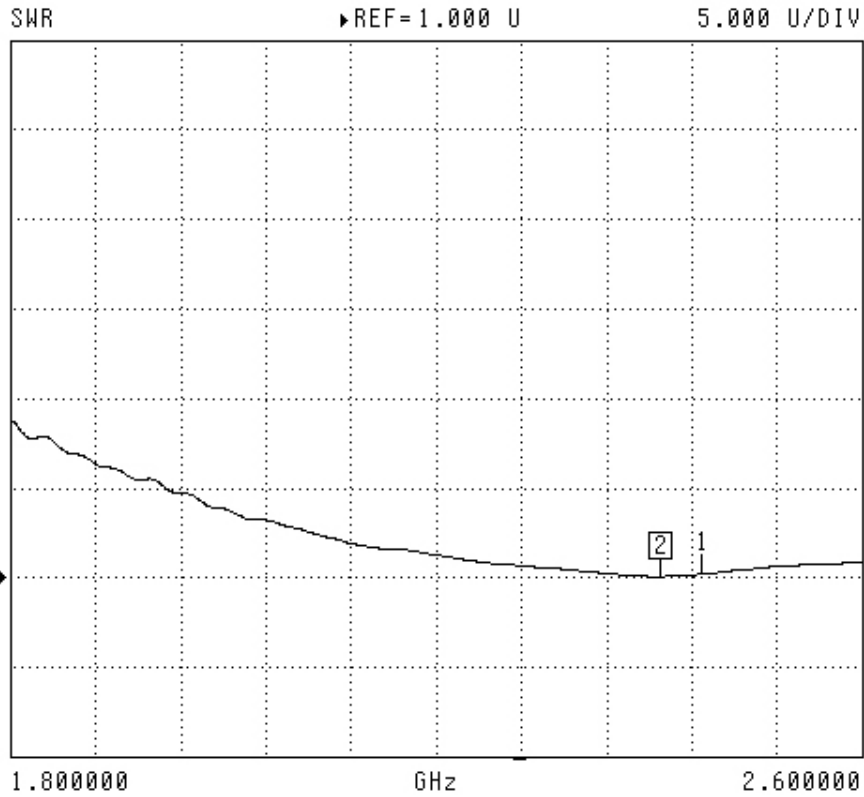
MARKER TO MAX  
▶ MARKER TO MIN

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

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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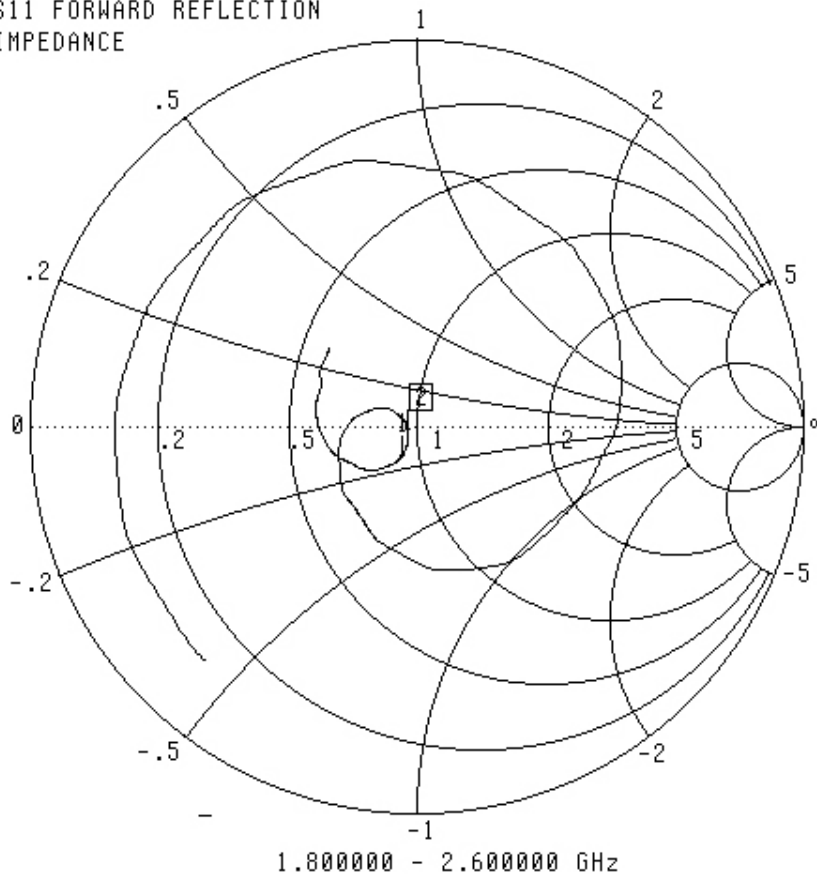
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## Smith Chart Dipole Impedance

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

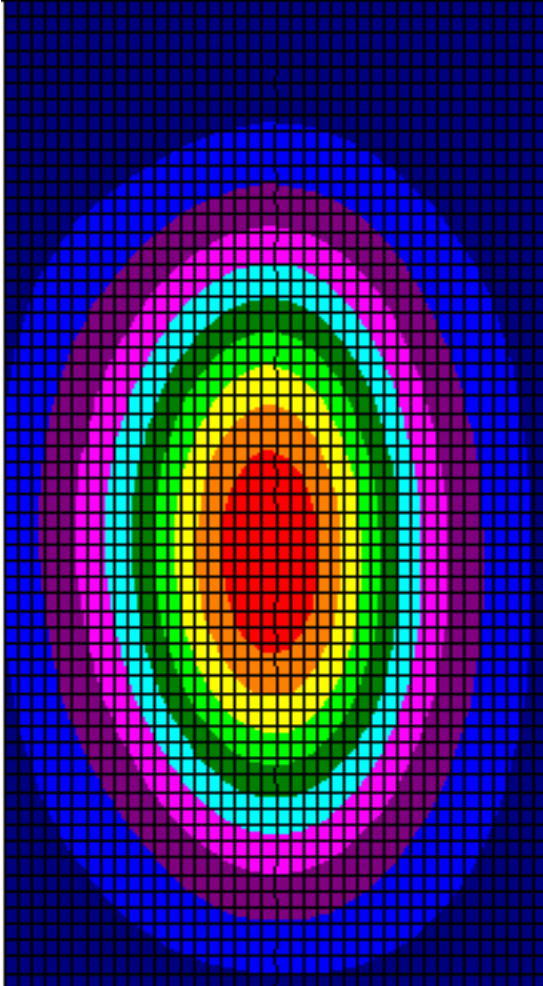
**1** 2.450000 GHz  
46.175  $\Omega$   
-7.199 j $\Omega$

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.



## 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 2004.

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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## NCL CALIBRATION LABORATORIES

Calibration File No: DC-0254

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-5240-S-2

Frequency: 5.24 GHz

Serial No: 301460

Customer: APREL

Calibrated: 1 March 2004  
Released on: 1 March 2004

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

## **NCL** CALIBRATION LABORATORIES

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Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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## Calibration Results Summary

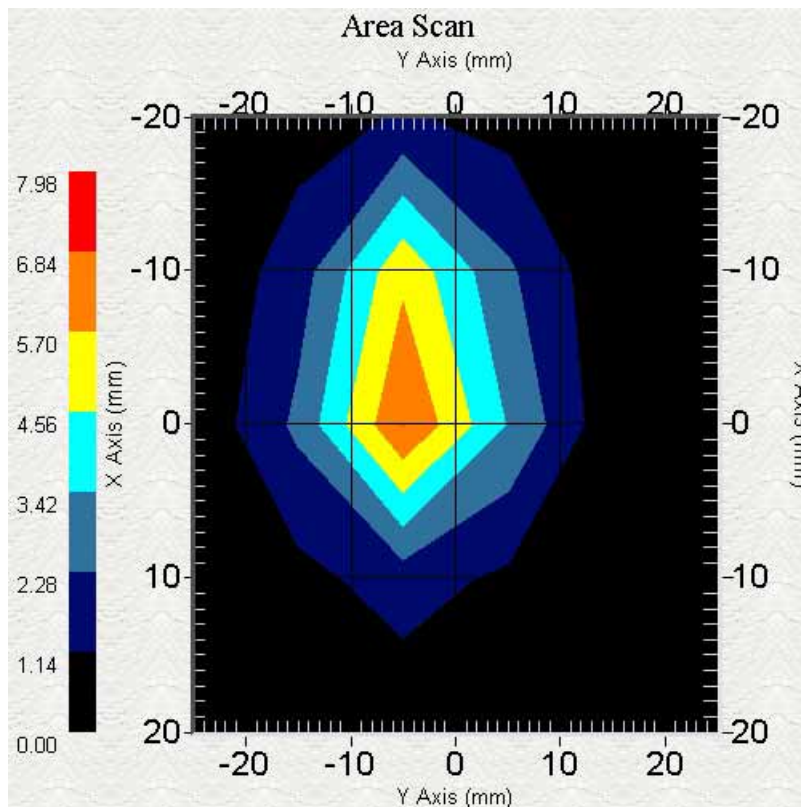
The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

## Electrical Specification

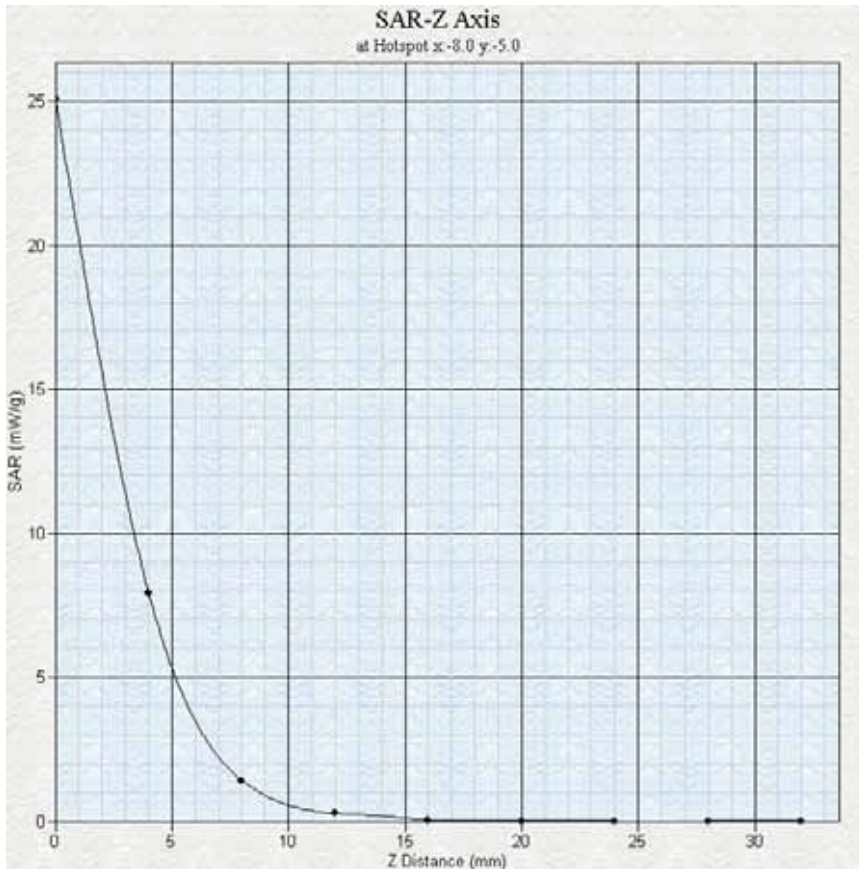
**SWR:** 1.21U  
**Return Loss:** -17.9 dB  
**Impedance:** 45.175

## System Validation Results

| Frequency | 1 Gram |
|-----------|--------|
| 5240 GHz  | 61.8   |



## Z-Axis Results



## 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 301532 at 5.8 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 P-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 301532 was a new Dipole 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





## NCL CALIBRATION LABORATORIES

Calibration File No: Not Applicable  
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-5800-S-2

Frequency: 5.80 GHz

Serial No: PT-015-a

Customer: APREL

Calibrated: 1 March 2004  
Released on: 1 March 2004

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

## **NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

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

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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Canada K2R 1E6  
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Tel: (613) 820-2730  
Fax: (613) 820-4161  
Info@aprel.com  
www.aprel.com

## Calibration Results Summary

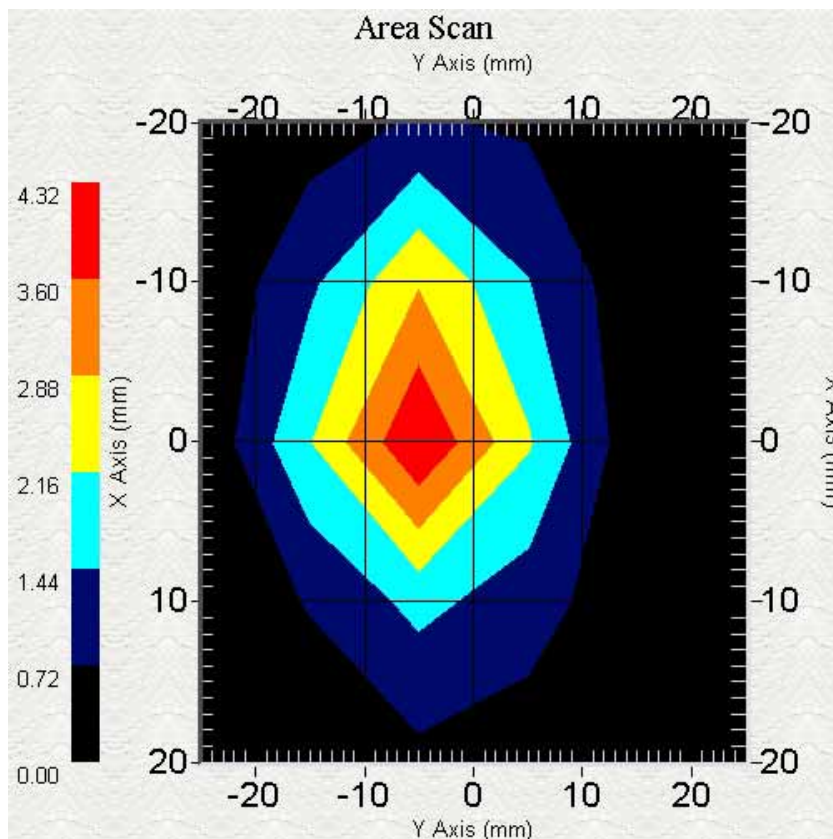
The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

## Electrical Specification

**SWR:** 1.26U  
**Return Loss:** -16.3 dB  
**Impedance:** 44.175

## System Validation Results

| Frequency | 1 Gram |
|-----------|--------|
| 5800 GHz  | 57.9   |



Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

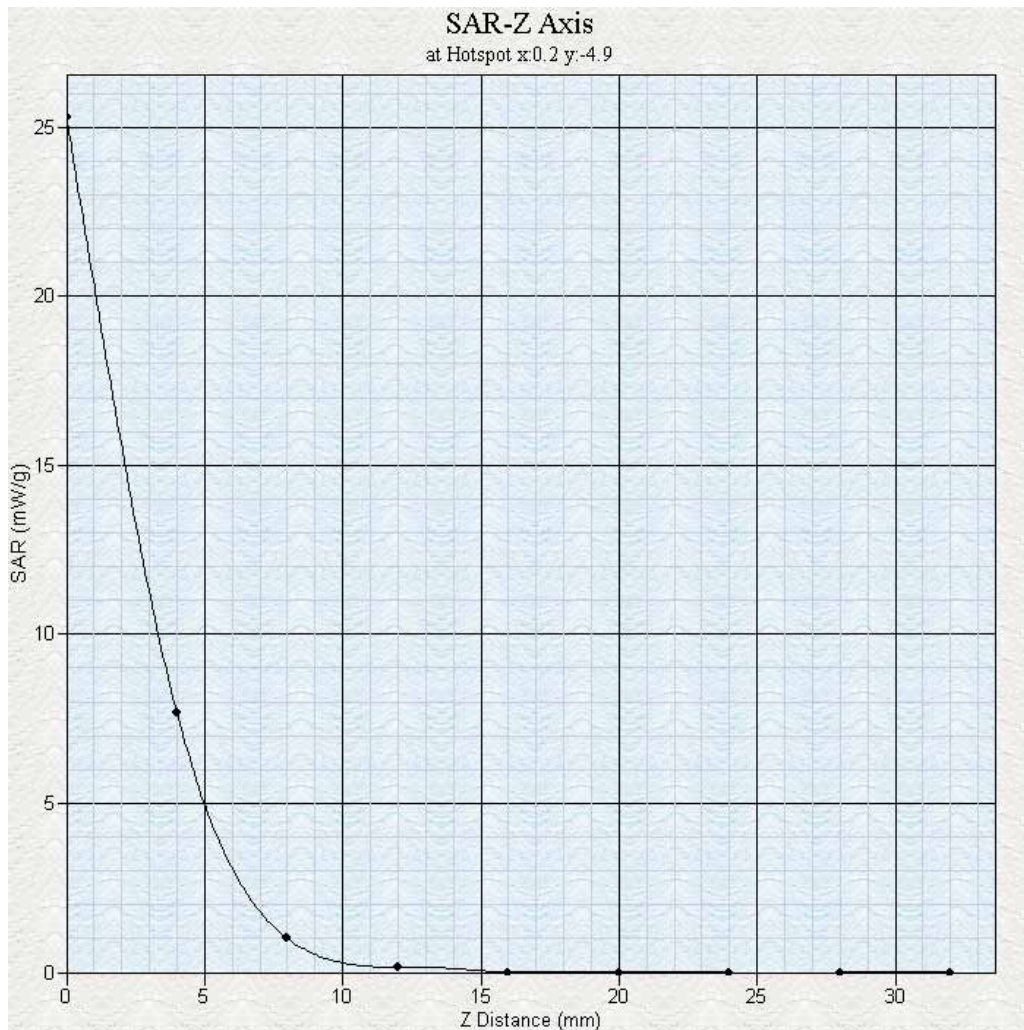
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## Z-Axis Results



## 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 301532 at 5.8 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.

Project number: ITLB-HP-5044  
FCC ID: ID: CNTWM3B2915ABG

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## References

SSI-TP-018 Dipole Calibration Procedure

SSI-TP-016 Tissue Calibration Procedure

IEEE P-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 PT-015-a was a new Dipole 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

