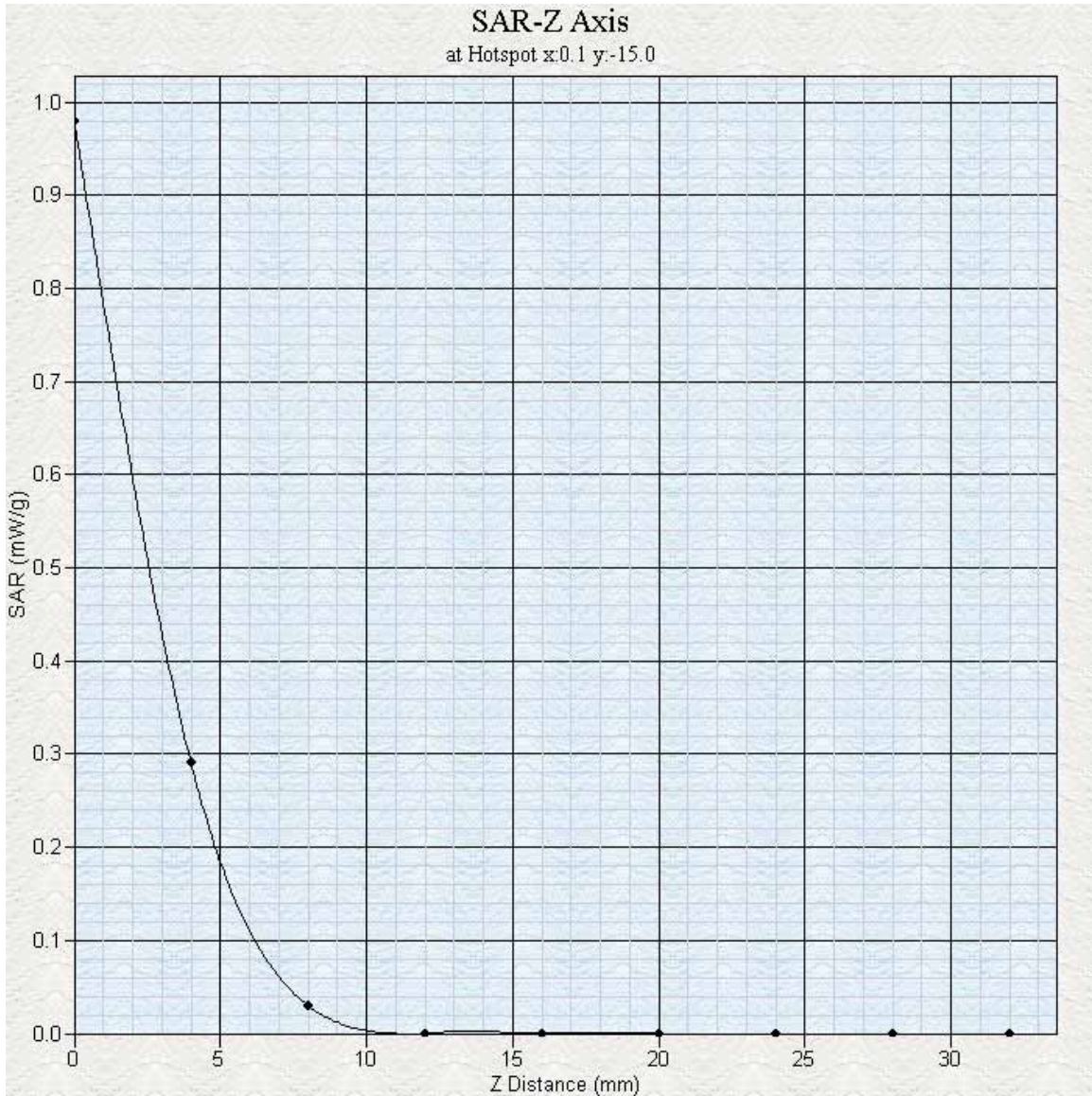


Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	$c_i^1$ (1-g)	$c_i^1$ (10-g)	Standard Uncertainty (1-g)	Standard Uncertainty (10-g)
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	0.0	rectangular	•3	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	0.6	rectangular	•3	0.7	0.5	0.2	0.2
Liquid Permittivity(target)	2.0	rectangular	•3	0.6	0.5	0.7	0.6
Liquid Permittivity(meas.)	2.6	rectangular	•3	0.6	0.5	0.9	0.8
Combined Uncertainty		RSS				9.1	9.0
Combined Uncertainty (coverage factor=2)		Normal (k=2)				18.3	18.0





Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 66 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

## SAR Test Report

Operator : Roman  
 Validation Date : 23-Sep-2004  
 Measurement Date : 23-Sep-2004  
 Starting Time : 23-Sep-2004 06:20:12 PM  
 End Time : 23-Sep-2004 06:36:23 PM  
 Scanning Time : 971 secs

Product Data  
 Device Name : Dell-Pebble  
 Serial No. : #5064  
 Type : Other  
 Model : D400  
 Frequency : 5800.00 MHz  
 Max. Transmit Pwr : 0.25 W  
 Drift Time : 0 min(s)  
 Length : 143  
 Width : 34  
 Depth : 0  
 Antenna Type : Internal  
 Power Drift-Start : 0.00  
 Power Drift-Finish : 0.00  
 Power Drift : 0.00

Phantom Data  
 Name : APREL-Uni  
 Type : Uni-Phantom  
 Size : 280 x 280 x 200  
 Serial No. : User Define  
 Location : Center  
 Description : Uni

Tissue Data  
 Type : Body  
 Serial No. : 5800  
 Frequency : 5800 MHz  
 Calibration Date : 23-Sep-2004  
 Temperature : 23 °C  
 Ambient Temp. : 23 °C  
 Humidity : 50 RH%  
 Epsilon : 41.0 F/m  
 Sigma : 6.5 S/m  
 Density : 1000 kg/cu. m

Probe Data  
 Name : APREL Probe 212  
 Model : E020  
 Type : E-Field Triangle  
 Serial No. : 212  
 Calibration Date : 04-Jun-2004  
 Frequency : 5800 MHz  
 Duty Cycle Factor : 1  
 Conversion Factor : 7.1  
 Probe Sensitivity : 0.61 0.61 0.61  $\mu\text{V}/(\text{V}/\text{sq. m})$   
 Compression Point : 95  
 Offset : 1.56

Measurement Data  
 Crest Factor : 1  
 Scan Type : Complete  
 Set-up Date : 23-Sep-2004  
 Set-up Time : 2:11:46 PM

Project number: ITLB-Dell-5064  
 FCC ID: ID:E2K5HCKT

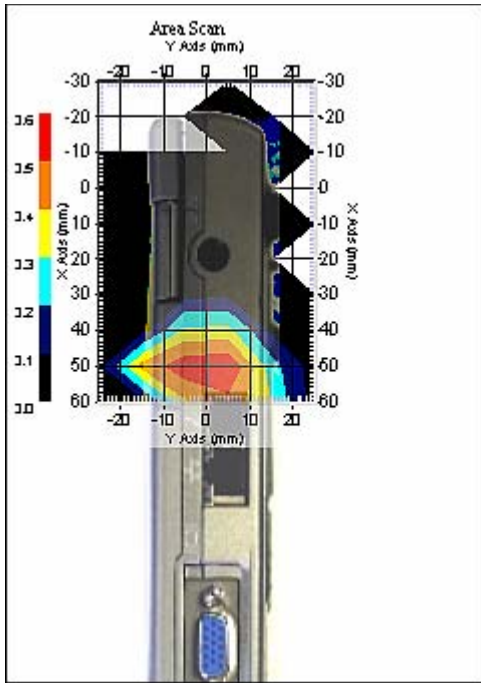
Page 67 of 80

51 Spectrum Way  
 Nepean, Ontario  
 Canada K2R 1E6  
 © 2004 APREL Laboratories



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

Other Data  
DUT Position : Separated  
Separation : 5 mm  
Channel : Low - 5745 MHz



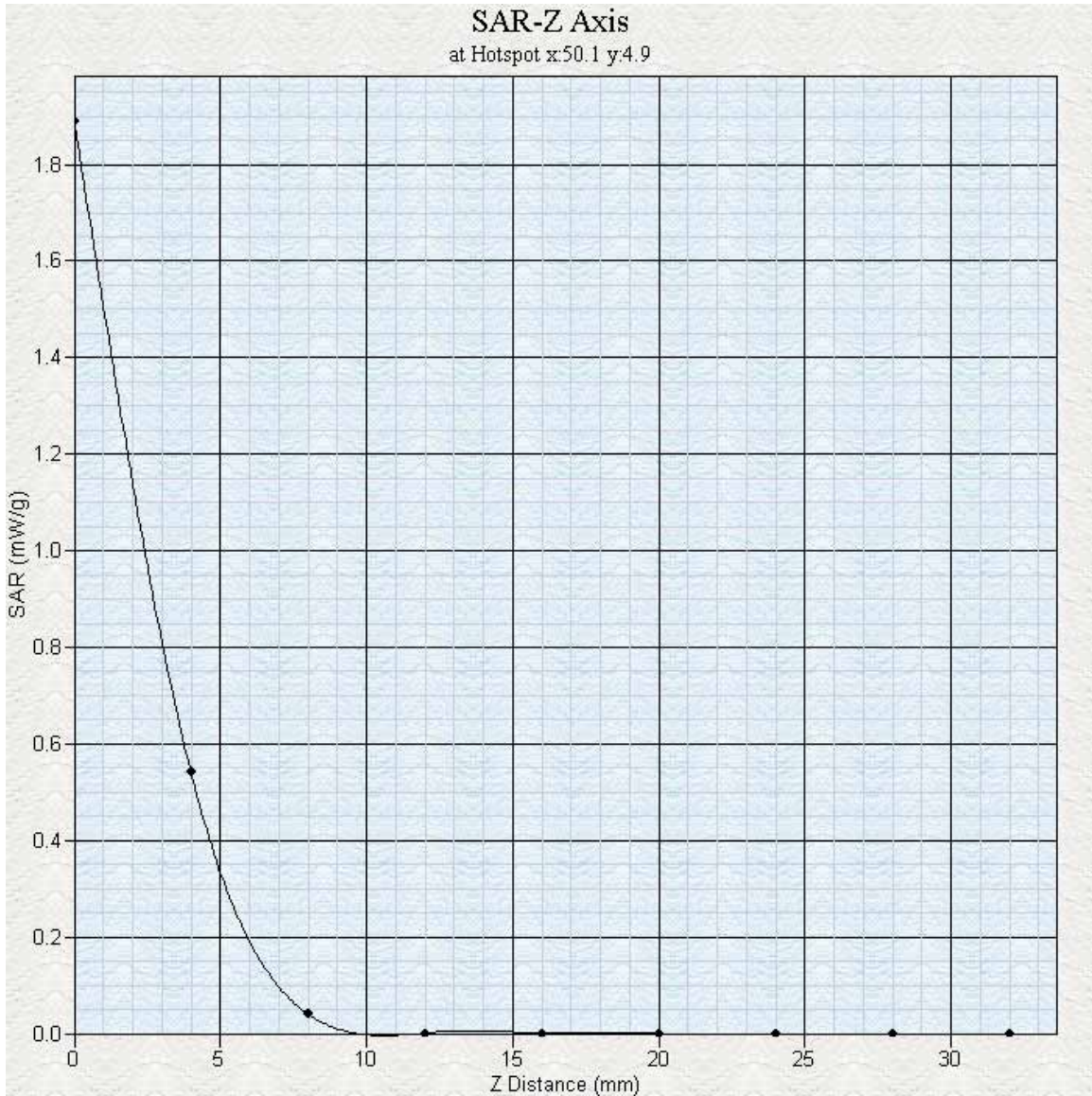
1 gram SAR value : 0.55 W/kg  
Zoom Scan Peak SAR : 1.89



Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	$c_i^1$ (1-g)	$c_i^1$ (10-g)	Standard Uncertainty (1-g)	Standard Uncertainty (10-g)
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	0.0	rectangular	•3	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty (shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity (target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity (meas.)	0.7	rectangular	•3	0.7	0.5	0.3	0.2
Liquid Permittivity (target)	2.0	rectangular	•3	0.6	0.5	0.7	0.6
Liquid Permittivity (meas.)	3.1	rectangular	•3	0.6	0.5	1.1	0.9
Combined Uncertainty		RSS				9.2	9.0
Combined Uncertainty (coverage factor=2)		Normal (k=2)				18.3	18.1





## SAR Test Report

Operator : Roman  
 Validation Date : 24-Sep-2004  
 Measurement Date : 24-Sep-2004  
 Starting Time : 24-Sep-2004 10:15:29 AM  
 End Time : 24-Sep-2004 10:31:44 AM  
 Scanning Time : 975 secs

Product Data  
 Device Name : Dell-Pebble  
 Serial No. : #5064  
 Type : Other  
 Model : D400  
 Frequency : 5800.00 MHz  
 Max. Transmit Pwr : 0.25 W  
 Drift Time : 0 min(s)  
 Length : 162  
 Width : 140  
 Depth : 0  
 Antenna Type : Internal  
 Power Drift-Start : 0.00  
 Power Drift-Finish : 0.00  
 Power Drift : 0.00

Phantom Data  
 Name : APREL-Uni  
 Type : Uni-Phantom  
 Size : 280 x 280 x 200  
 Serial No. : User Define  
 Location : Center  
 Description : Uni

Tissue Data  
 Type : Body  
 Serial No. : 5800  
 Frequency : 5800 MHz  
 Calibration Date : 24-Sep-2004  
 Temperature : 23 °C  
 Ambient Temp. : 23 °C  
 Humidity : 50 RH%  
 Epsilon : 41.0 F/m  
 Sigma : 6.5 S/m  
 Density : 1000 kg/cu. m

Probe Data  
 Name : APREL Probe 212  
 Model : E020  
 Type : E-Field Triangle  
 Serial No. : 212  
 Calibration Date : 04-Jun-2004  
 Frequency : 5800 MHz  
 Duty Cycle Factor : 1  
 Conversion Factor : 7.1  
 Probe Sensitivity : 0.61 0.61 0.61  $\mu\text{V}/(\text{V}/\text{sq. m})$   
 Compression Point : 95  
 Offset : 1.56

Measurement Data  
 Crest Factor : 1  
 Scan Type : Complete  
 Set-up Date : 24-Sep-2004  
 Set-up Time : 2:11:46 PM

Project number: ITLB-Dell-5064  
 FCC ID: ID:E2K5HCKT

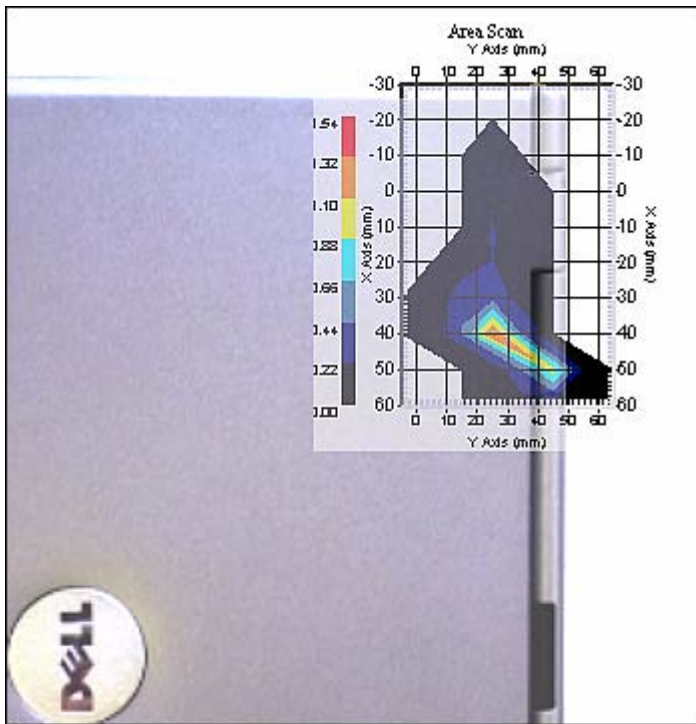
Page 71 of 80

51 Spectrum Way  
 Nepean, Ontario  
 Canada K2R 1E6  
 © 2004 APREL Laboratories



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

Other Data  
DUT Position : Touch  
Separation : 0  
Channel : Low - 5745 MHz



1 gram SAR value : 1.03 W/kg  
Zoom Scan Peak SAR : 4.45

Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



Page 72 of 80

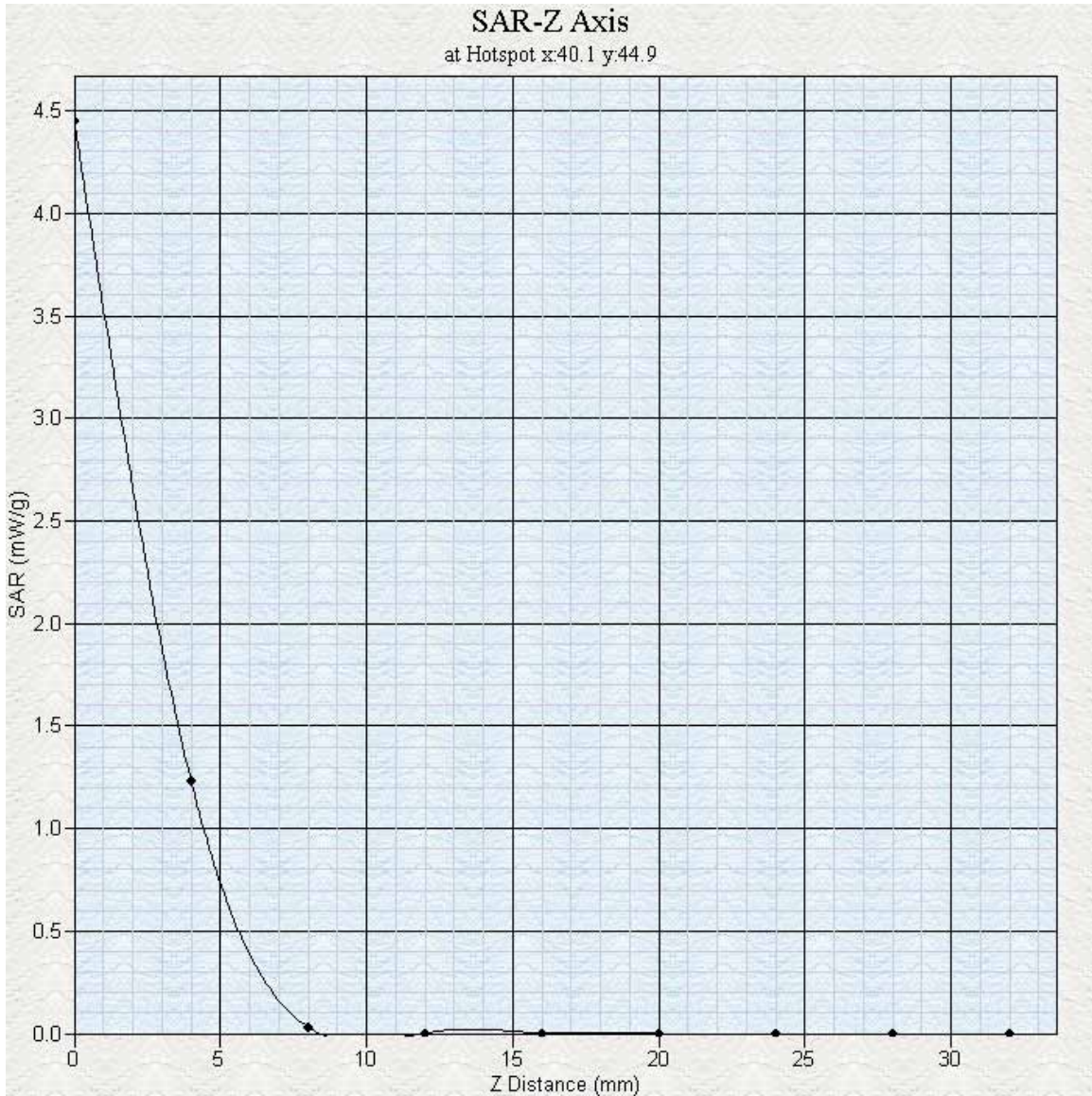
Tel: (613) 820-2730  
Fax: (613) 820-4161  
Info@aprel.com  
www.aprel.com



Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	$c_i^1$ (1-g)	$c_i^1$ (10-g)	Standard Uncertainty (1-g)	Standard Uncertainty (10-g)
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	0.0	rectangular	•3	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty (shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity (target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity (meas.)	0.7	rectangular	•3	0.7	0.5	0.3	0.2
Liquid Permittivity (target)	2.0	rectangular	•3	0.6	0.5	0.7	0.6
Liquid Permittivity (meas.)	3.1	rectangular	•3	0.6	0.5	1.1	0.9
Combined Uncertainty		RSS				9.2	9.0
Combined Uncertainty (coverage factor=2)		Normal (k=2)				18.3	18.1





Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

## SAR Test Report

Operator : Roman  
 Validation Date : 24-Sep-2004  
 Measurement Date : 24-Sep-2004  
 Starting Time : 24-Sep-2004 11:26:38 AM  
 End Time : 24-Sep-2004 11:44:29 AM  
 Scanning Time : 1071 secs

Product Data  
 Device Name : Dell-Pebble  
 Serial No. : #5064  
 Type : Other  
 Model : D400  
 Frequency : 5800.00 MHz  
 Max. Transmit Pwr : 0.25 W  
 Drift Time : 0 min(s)  
 Length : 115  
 Width : 157  
 Depth : 0  
 Antenna Type : Internal  
 Power Drift-Start : 0.81  
 Power Drift-Finish : 0.85  
 Power Drift : 0.04

Phantom Data  
 Name : APREL-Uni  
 Type : Uni-Phantom  
 Size : 280 x 280 x 200  
 Serial No. : User Define  
 Location : Center  
 Description : Uni

Tissue Data  
 Type : Body  
 Serial No. : 5800  
 Frequency : 5800 MHz  
 Calibration Date : 24-Sep-2004  
 Temperature : 23 °C  
 Ambient Temp. : 23 °C  
 Humidity : 50 RH%  
 Epsilon : 41.0 F/m  
 Sigma : 6.5 S/m  
 Density : 1000 kg/cu. m

Probe Data  
 Name : APREL Probe 212  
 Model : E020  
 Type : E-Field Triangle  
 Serial No. : 212  
 Calibration Date : 04-Jun-2004  
 Frequency : 5800 MHz  
 Duty Cycle Factor : 1  
 Conversion Factor : 5.1  
 Probe Sensitivity : 0.61 0.61 0.61  $\mu\text{V}/(\text{V}/\text{sq. m})$   
 Compression Point : 95  
 Offset : 1.56

Measurement Data  
 Crest Factor : 1  
 Scan Type : Complete  
 Set-up Date : 24-Sep-2004  
 Set-up Time : 2:11:46 PM

Project number: ITLB-Dell-5064  
 FCC ID: ID:E2K5HCKT

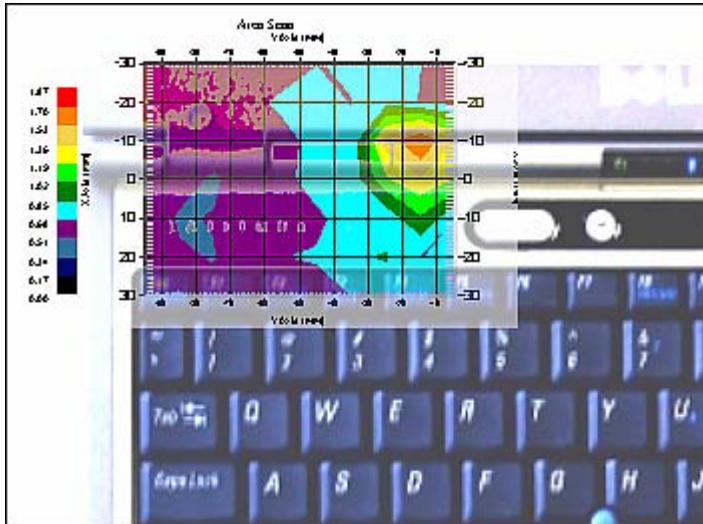
Page 75 of 80

51 Spectrum Way  
 Nepean, Ontario  
 Canada K2R 1E6  
 © 2004 APREL Laboratories



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

Other Data  
DUT Position : Touch  
Separation : 0  
Channel : Low - 5745 MHz



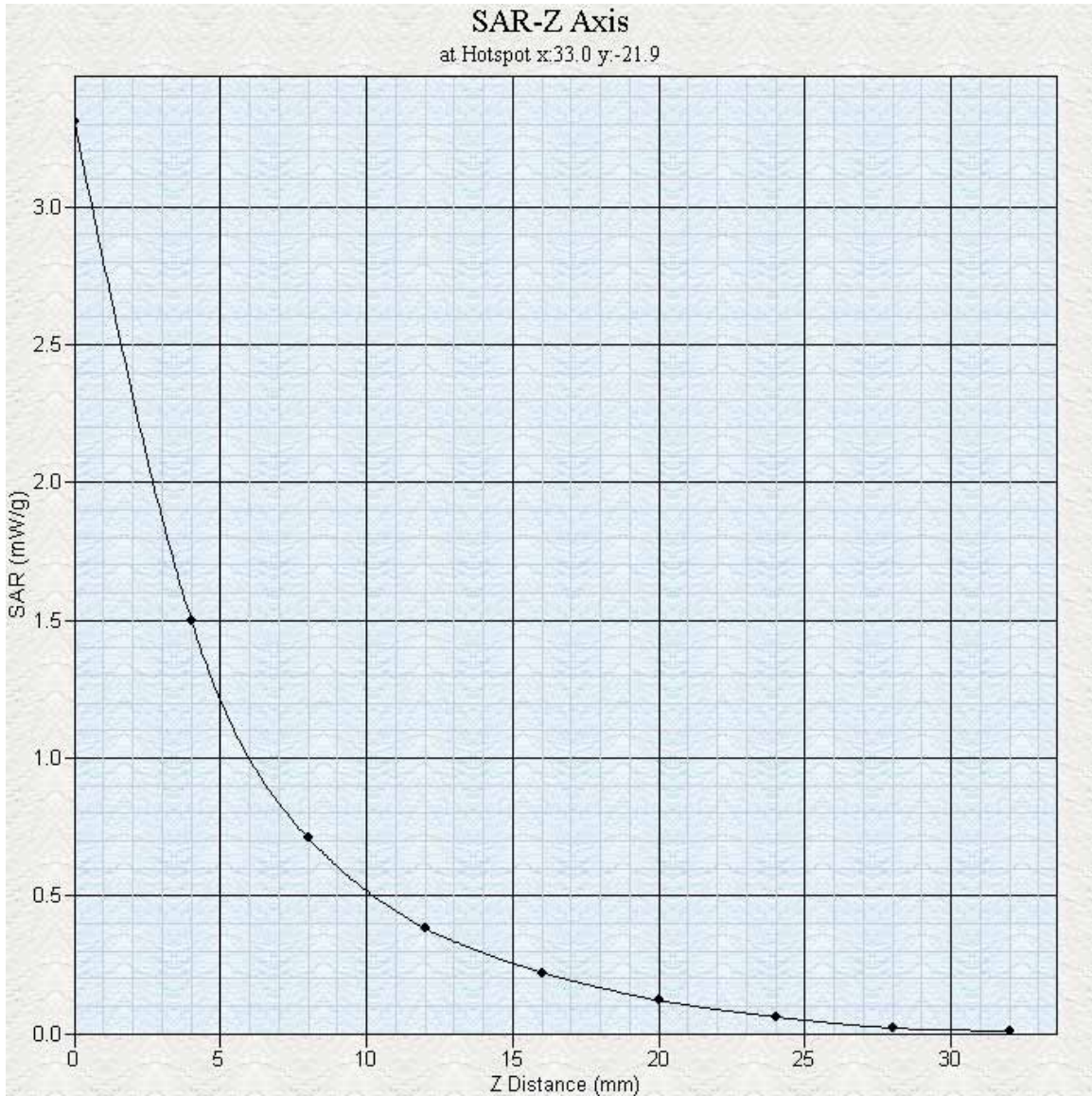
1 gram SAR value : 1.32 W/kg  
Zoom Scan Peak SAR : 3.32



Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	$c_i^1$ (1-g)	$c_i^1$ (10-g)	Standard Uncertainty (1-g)	Standard Uncertainty (10-g)
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	0.0	rectangular	•3	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty (shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity (target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity (meas.)	0.7	rectangular	•3	0.7	0.5	0.3	0.2
Liquid Permittivity (target)	2.0	rectangular	•3	0.6	0.5	0.7	0.6
Liquid Permittivity (meas.)	3.1	rectangular	•3	0.6	0.5	1.1	0.9
Combined Uncertainty		RSS				9.2	9.0
Combined Uncertainty (coverage factor=2)		Normal (k=2)				18.3	18.1





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

Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 79 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-339

Client.: APREL

**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 2450 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: 4<sup>th</sup> June 2004

Released on: 4<sup>th</sup> June 2004

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

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-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

<b>Probe Type:</b>	E-Field Probe E-020
<b>Serial Number:</b>	212
<b>Frequency:</b>	2450 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:** 2450 MHz

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

### ConvF

**Channel X:** 3.3

**Channel Y:** 3.3

**Channel Z:** 3.3

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

### Boundary Effect:

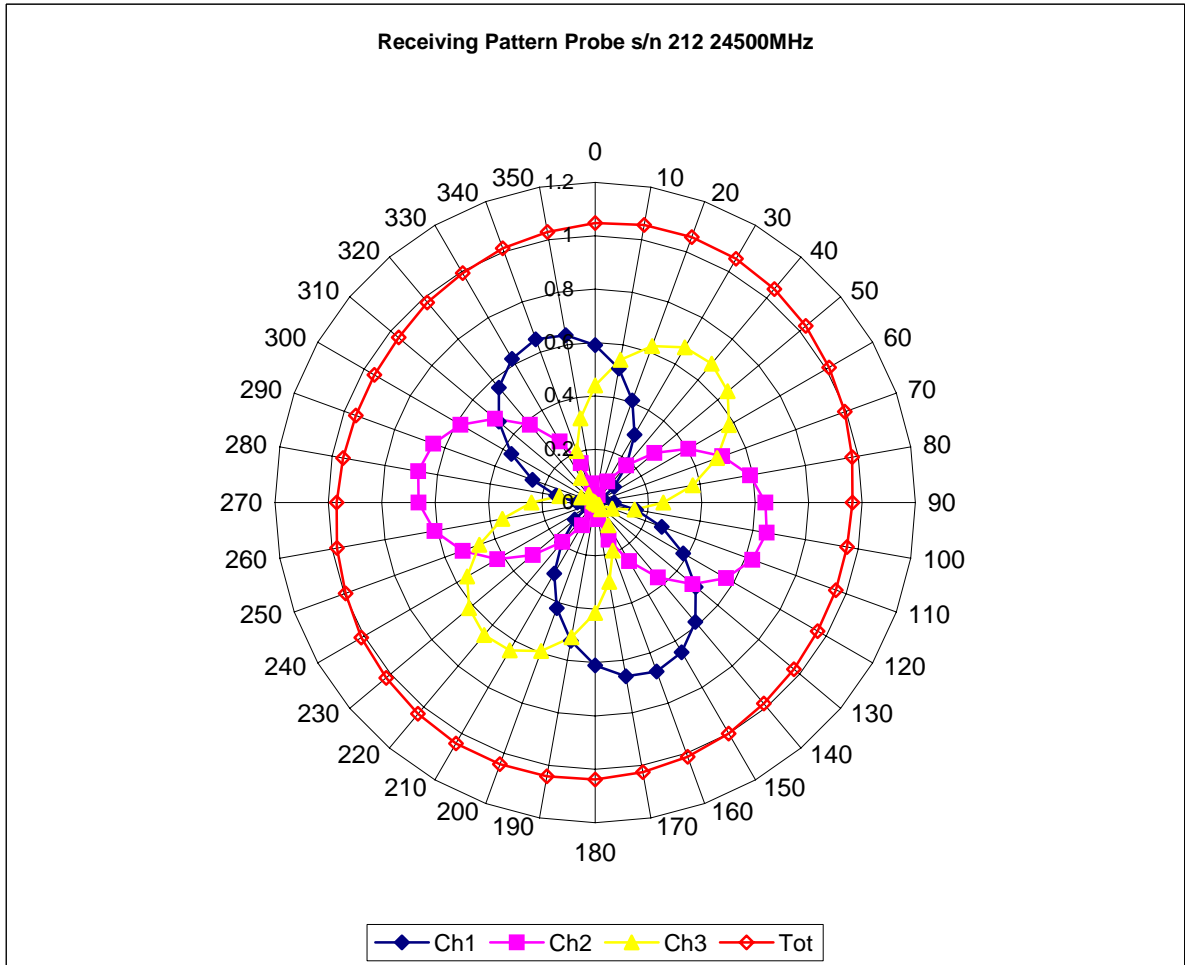
Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.4mm.

### Spatial Resolution:

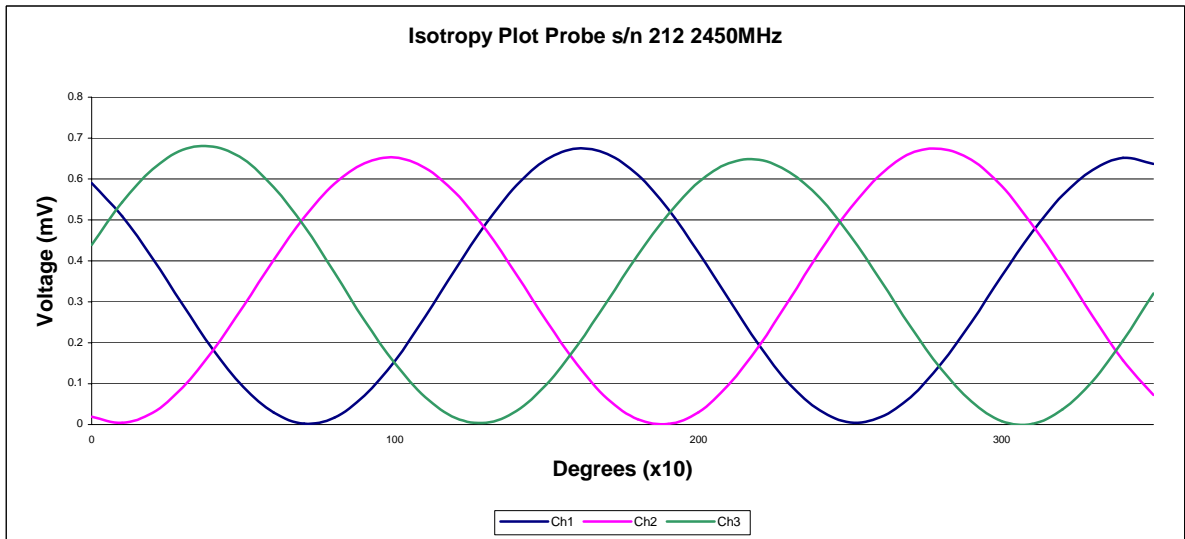
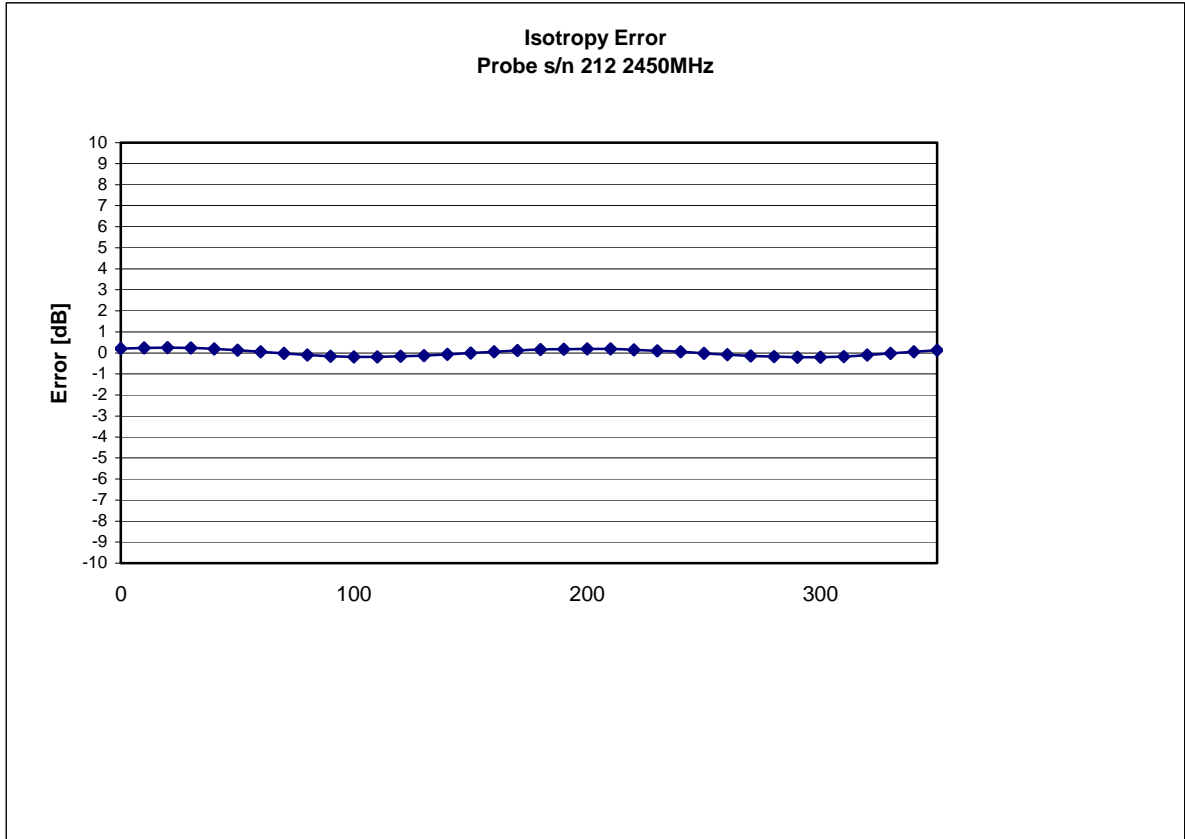
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.



## Receiving Pattern 2450 MHz (Air)



**Isotropy Error 2450 MHz (Air)**



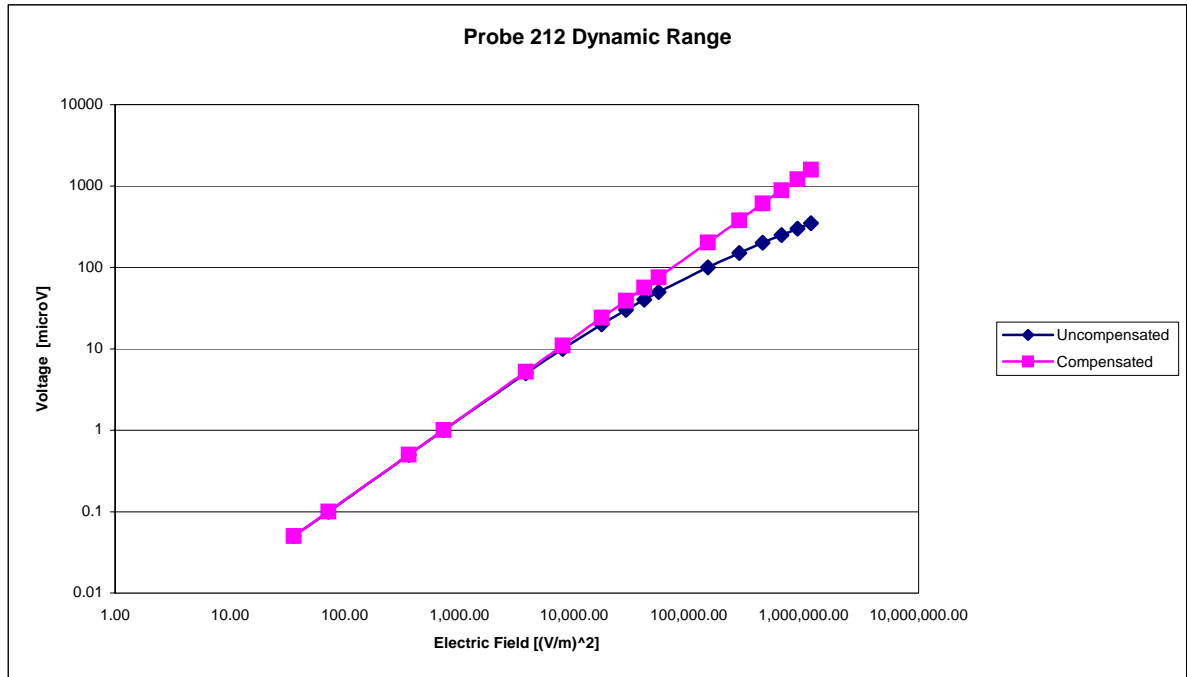
**Isotropicity:**

0.10 dB

Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

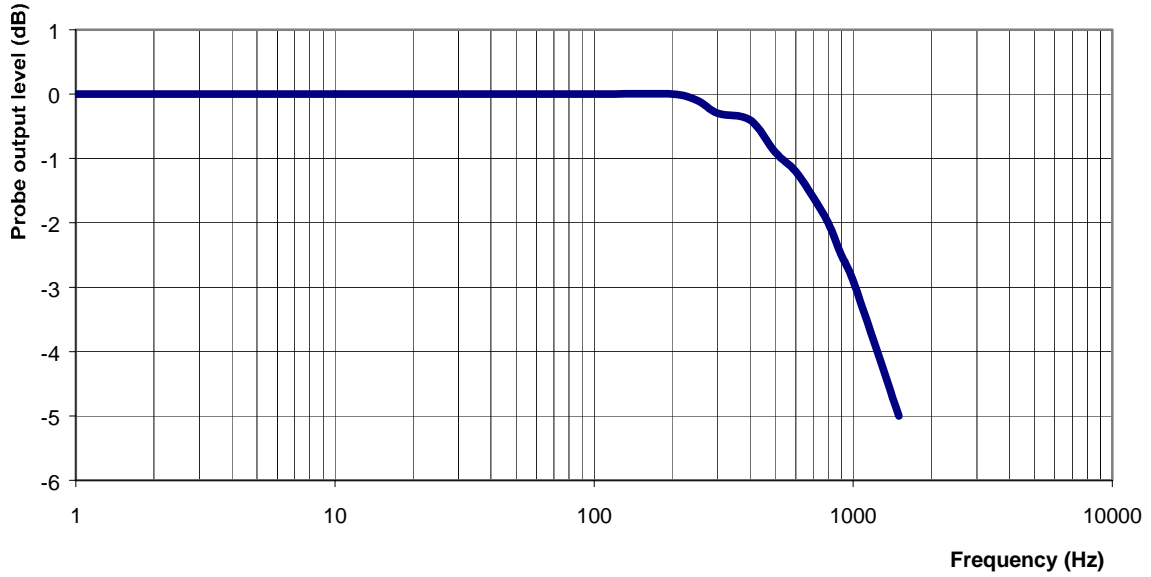


## Dynamic Range



## 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 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-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 89 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-420

Client.: APREL

**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 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**

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-020 212.

## 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:

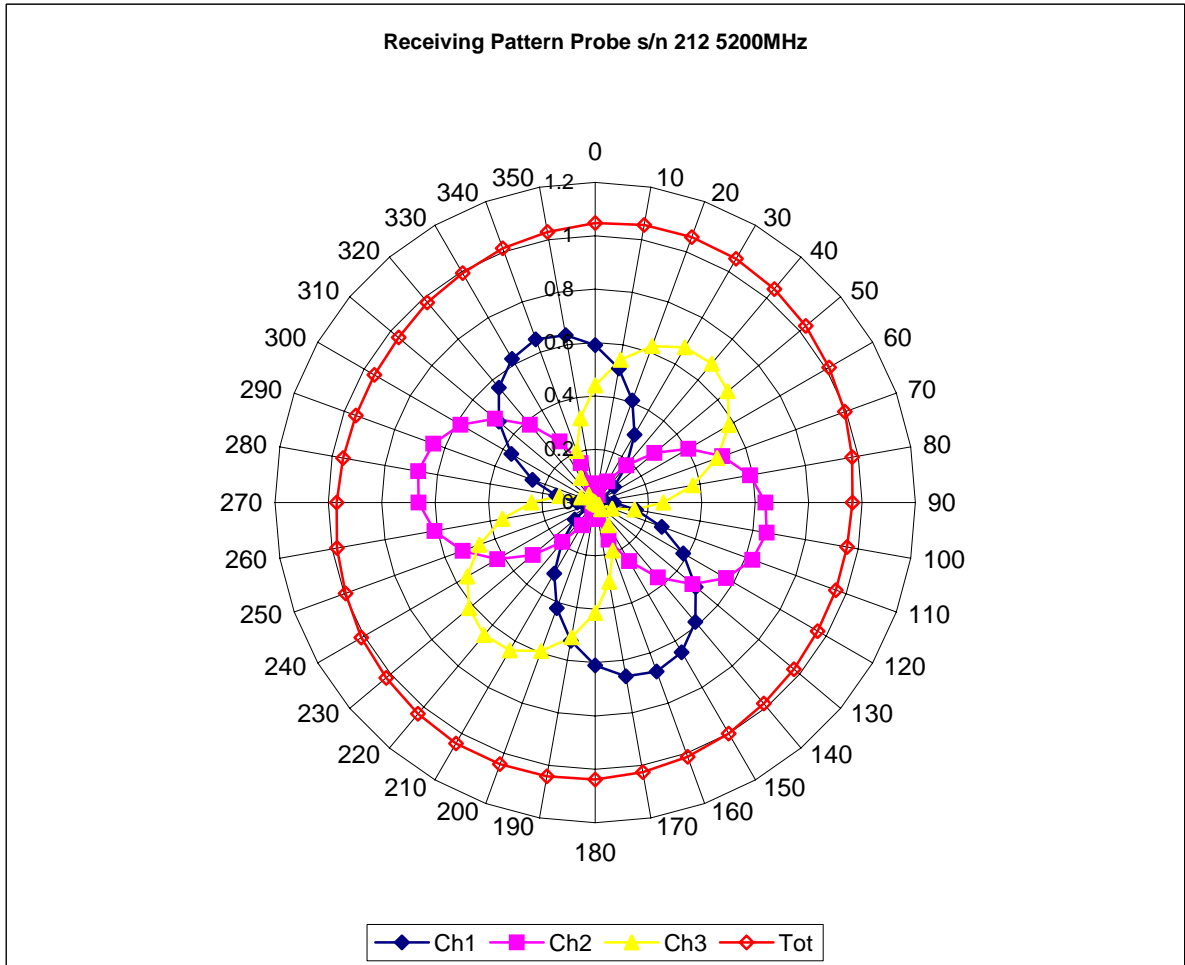
Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.4mm.

### Spatial Resolution:

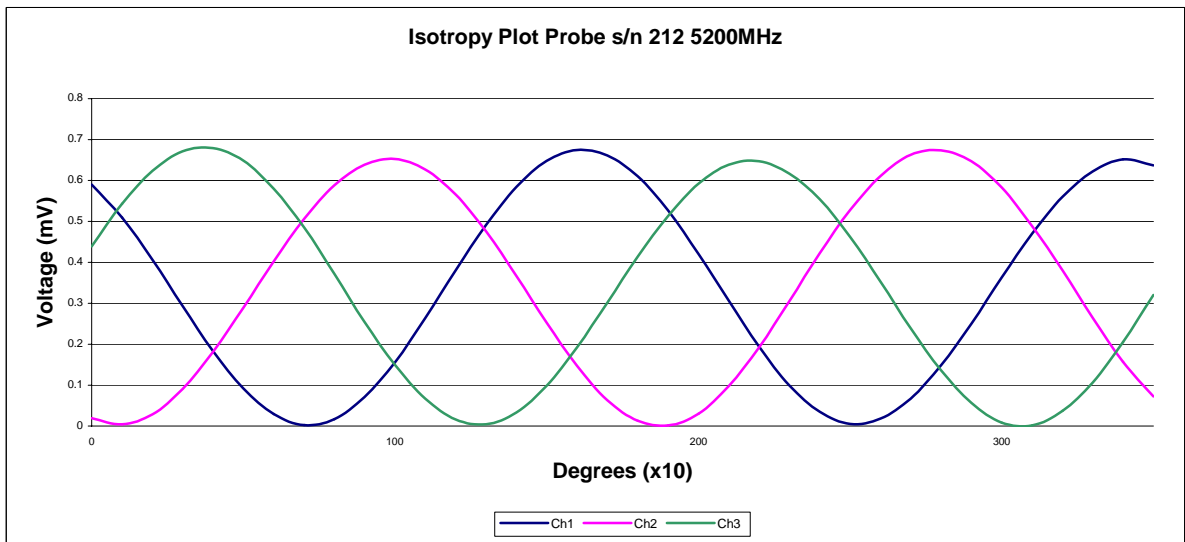
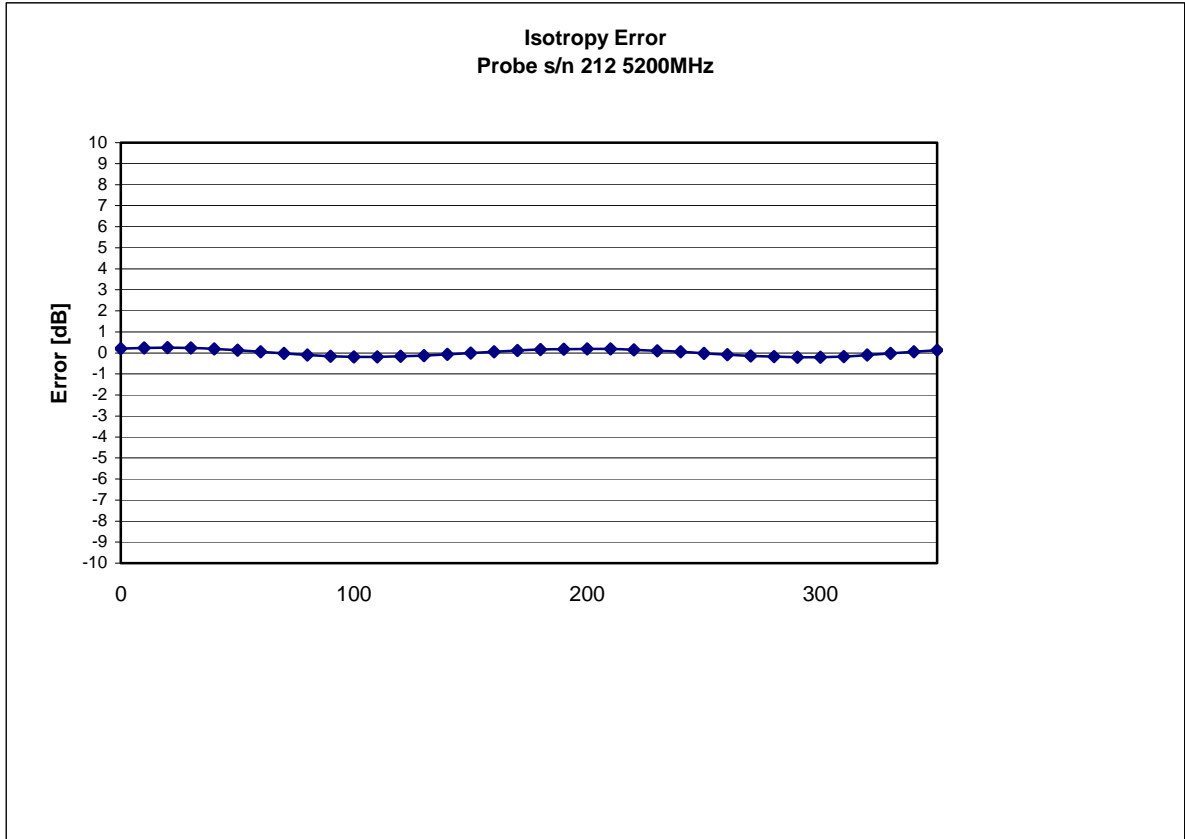
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.



## Receiving Pattern 5200 MHz (Air)



### Isotropy Error 5200 MHz (Air)



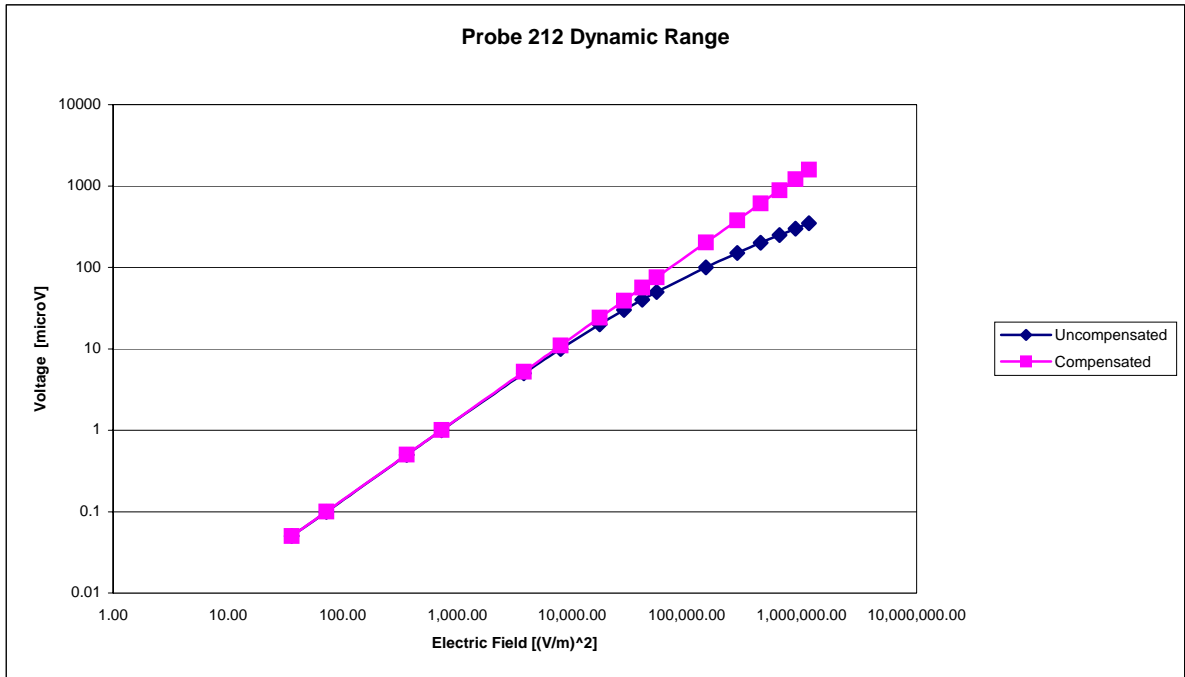
**Isotropy:**

0.10 dB

Project number: TLB-Dell-5064  
FCC ID: ID:E2K5HCKT



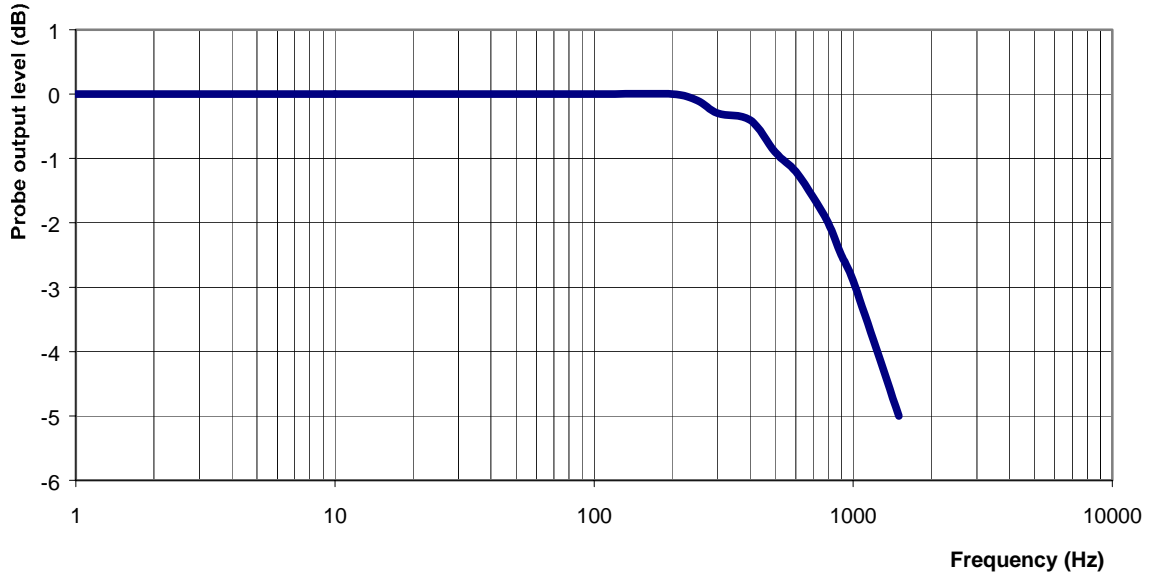
## Dynamic Range





## 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-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 99 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-421

Client.: APREL

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

**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-020 212.

## 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:

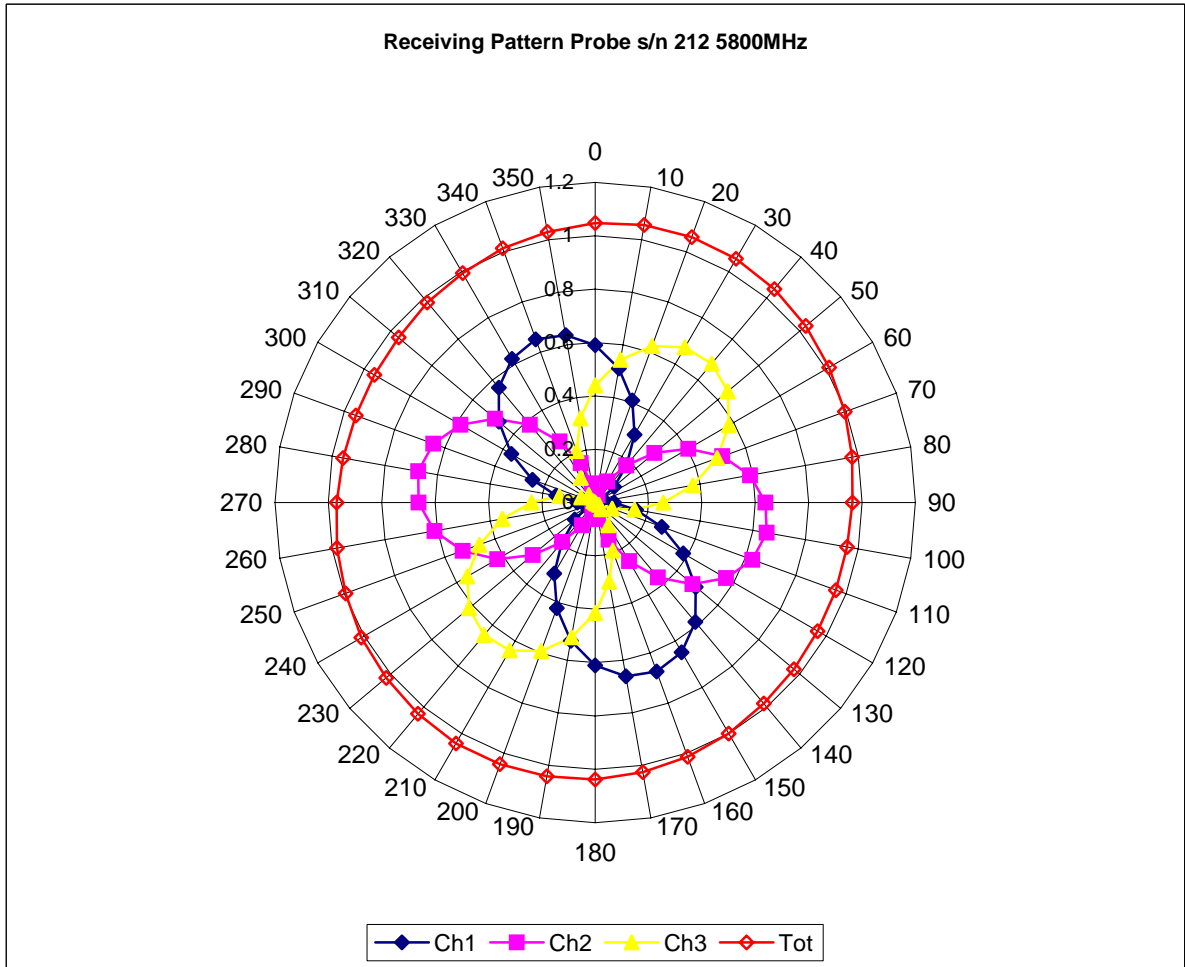
Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.4mm.

### 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.

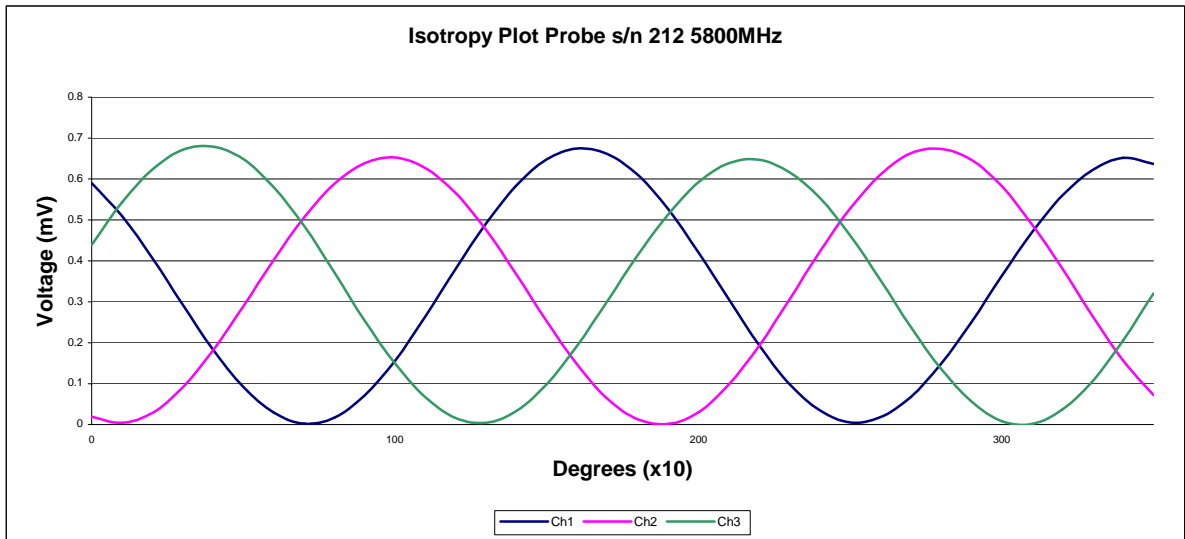
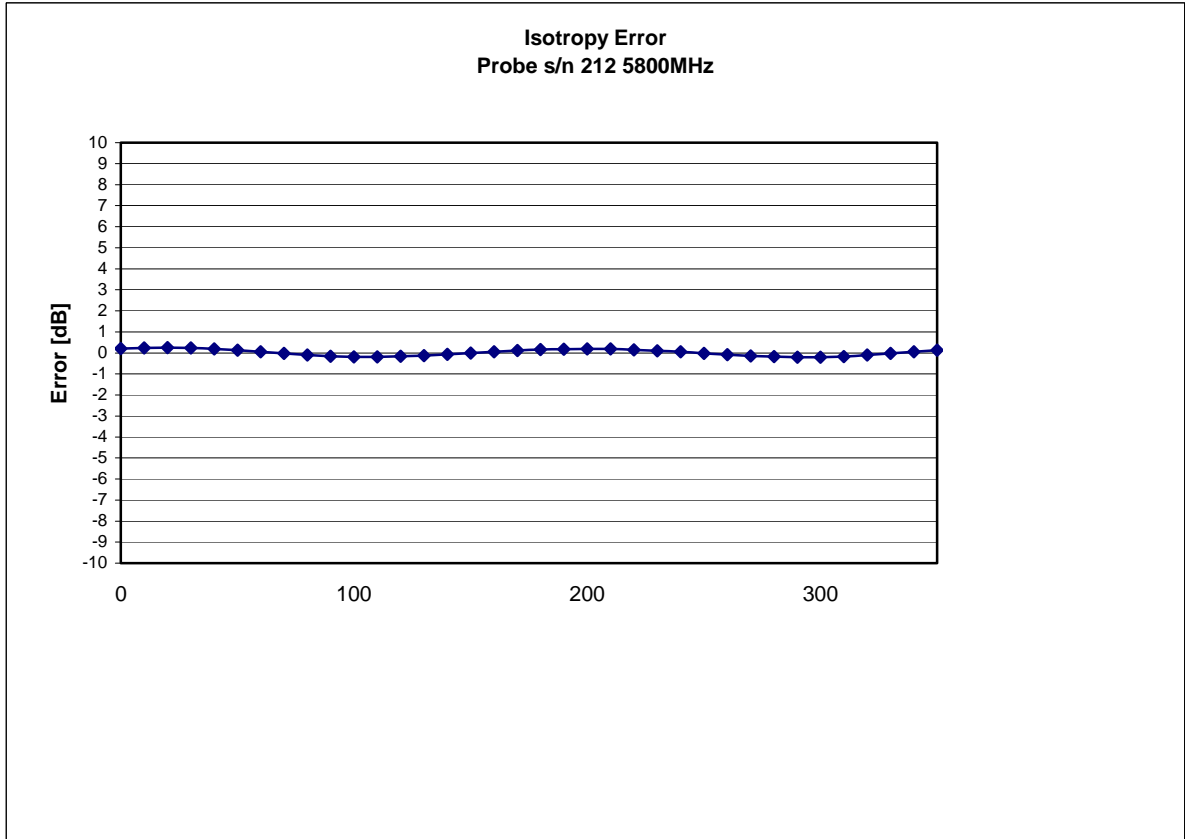


**Receiving Pattern 5800 MHz (Air)**





### Isotropy Error 5800 MHz (Air)

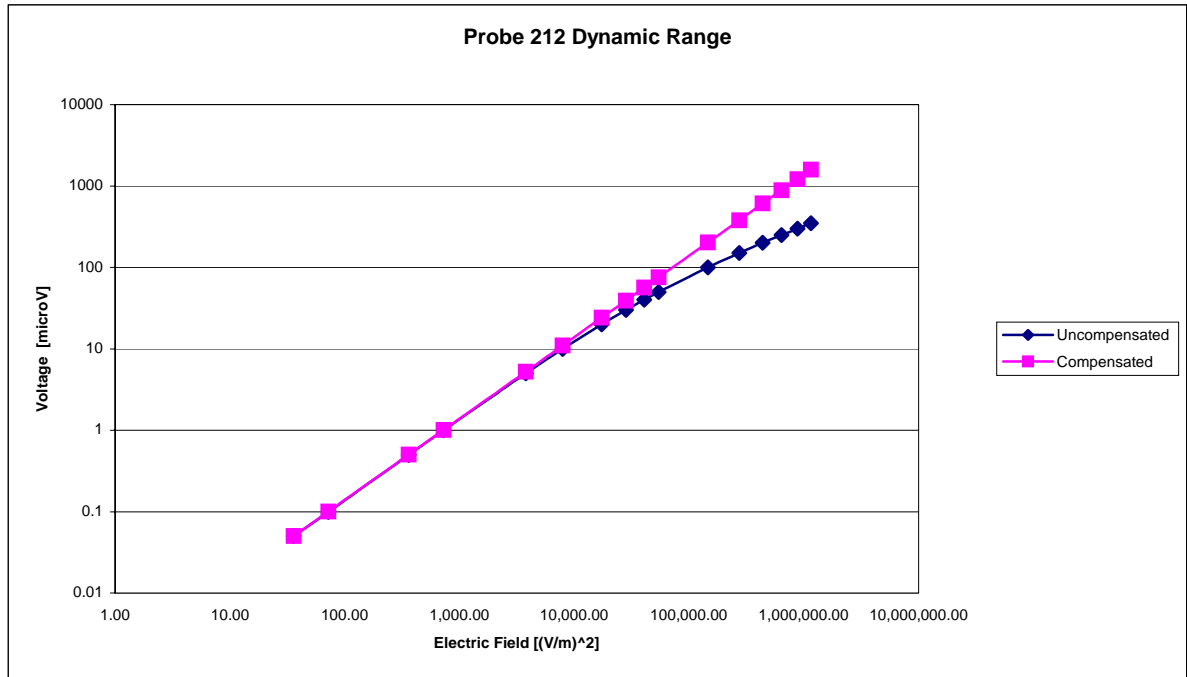


**Isotropicity:** 0.10 dB

Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

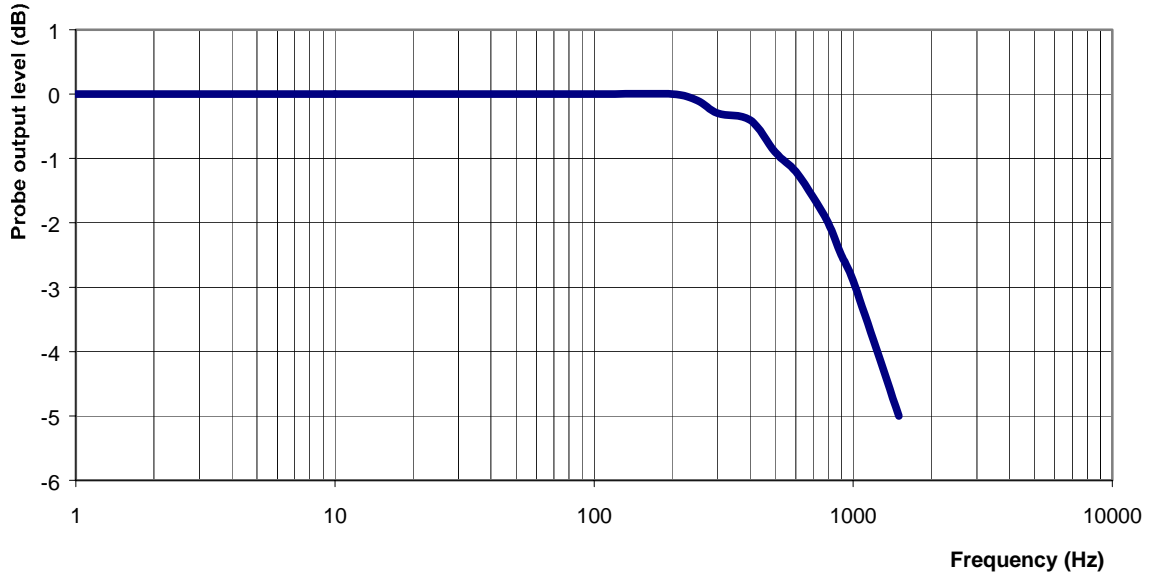


## Dynamic Range



## 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-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 109 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

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

Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 110 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

**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**

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

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

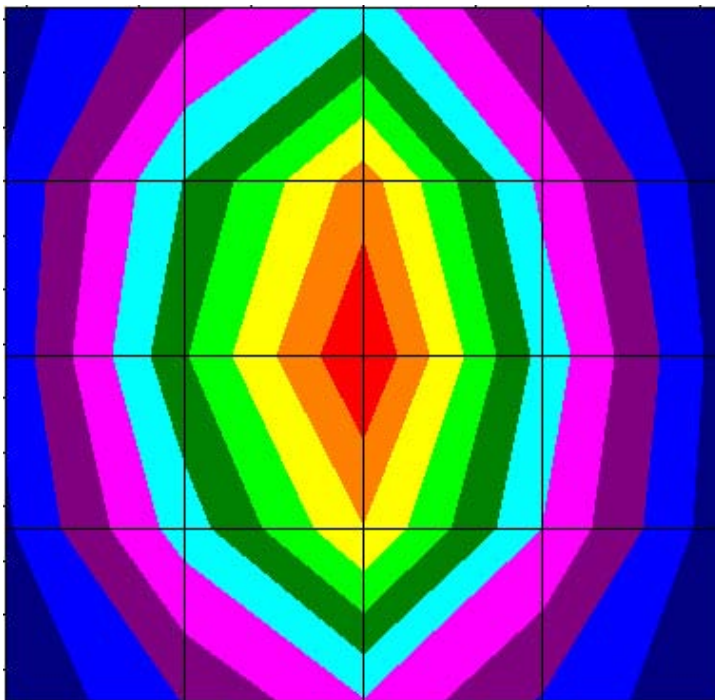
**Length:** 51.7 mm  
**Height:** 30.8 mm

### 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

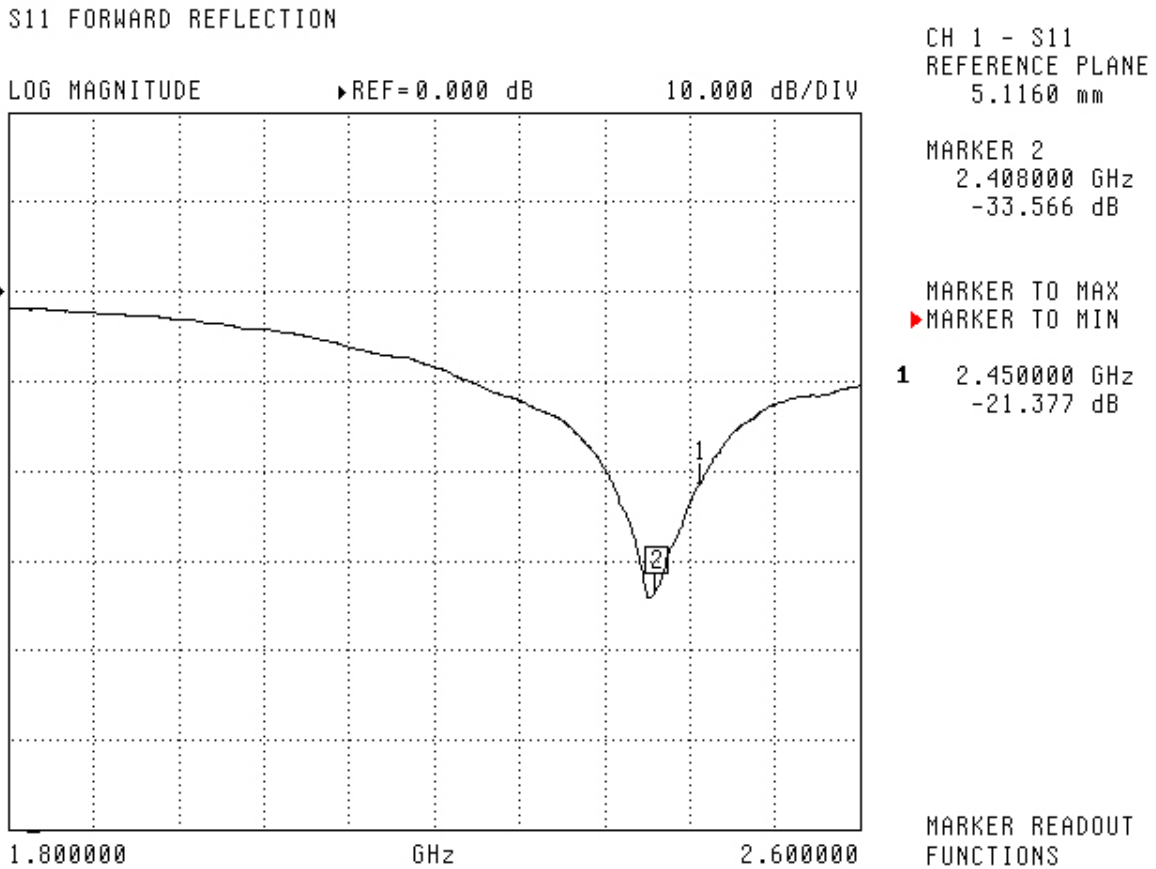


## Electrical Calibration

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

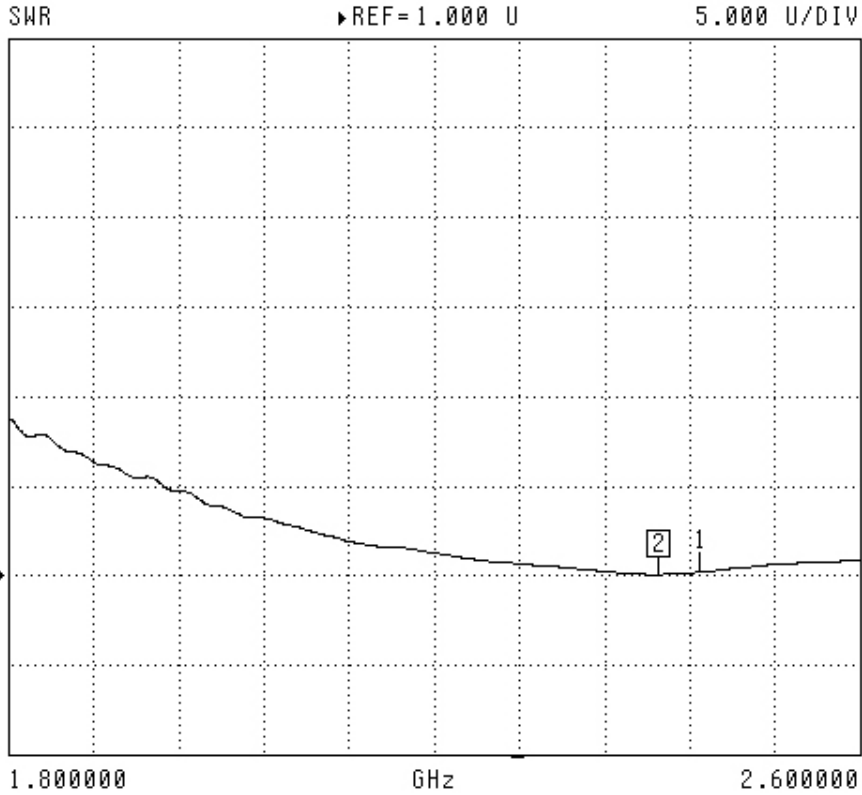
The Following Graphs are the results as displayed on the Vector Network Analyzer.

### S11 Parameter Return Loss



## SWR

S11 FORWARD REFLECTION



CH 1 - S11  
REFERENCE PLANE  
5.1160 mm

MARKER 2  
2.411000 GHz  
1.049 U

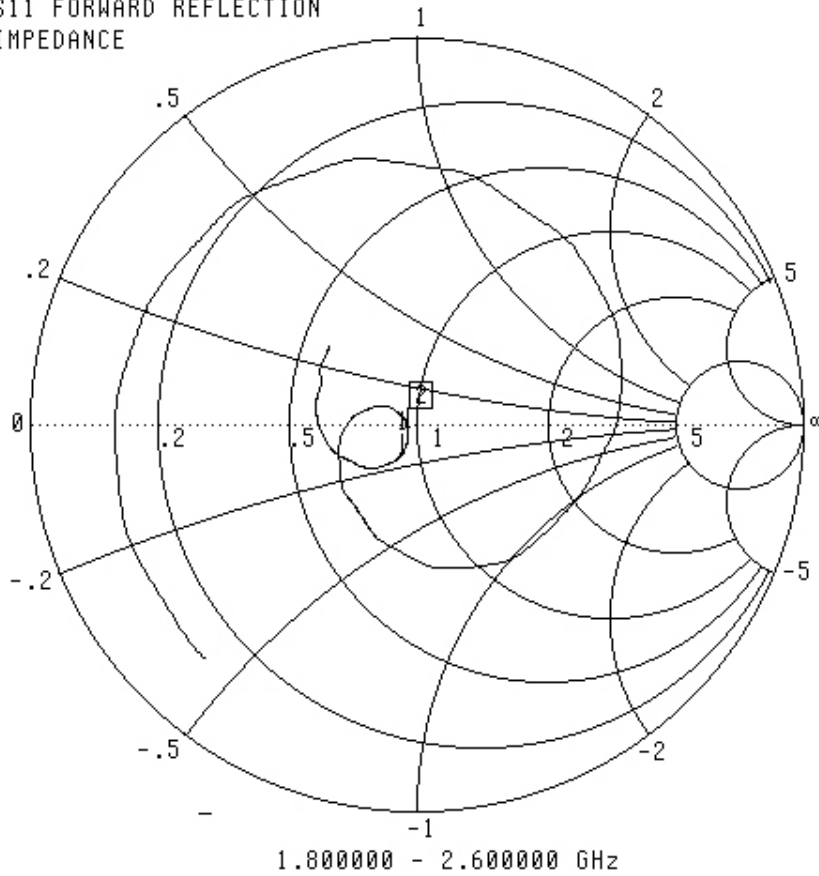
MARKER TO MAX  
▶ MARKER TO MIN  
**1** 2.450000 GHz  
1.181 U

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 Ω  
-1.171 jΩ

MARKER TO MAX  
▶ MARKER TO MIN

**1** 2.450000 GHz  
46.175 Ω  
-7.199 jΩ

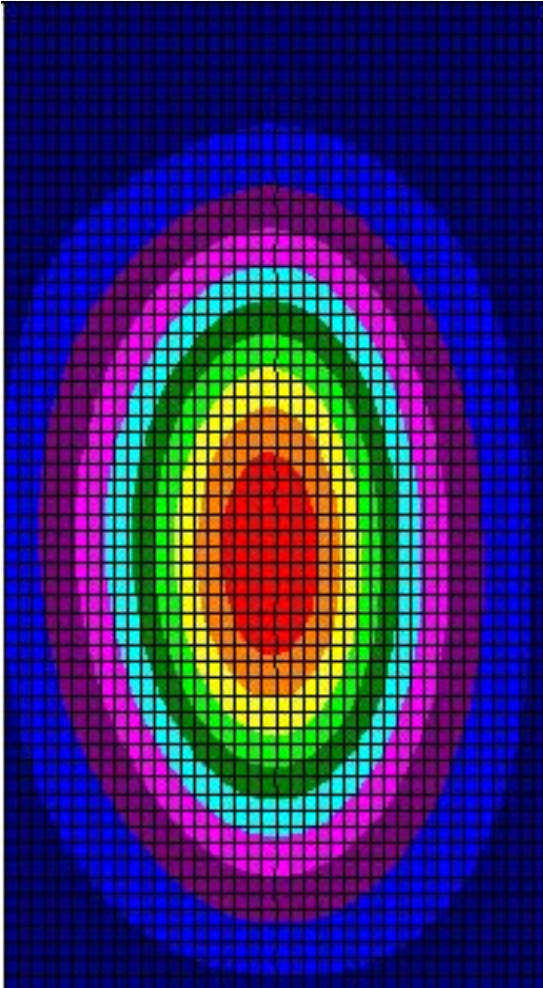
MARKER READOUT  
FUNCTIONS



### 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-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 119 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

**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**

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

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

Project number: ITLB-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 120 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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



## Calibration Results Summary

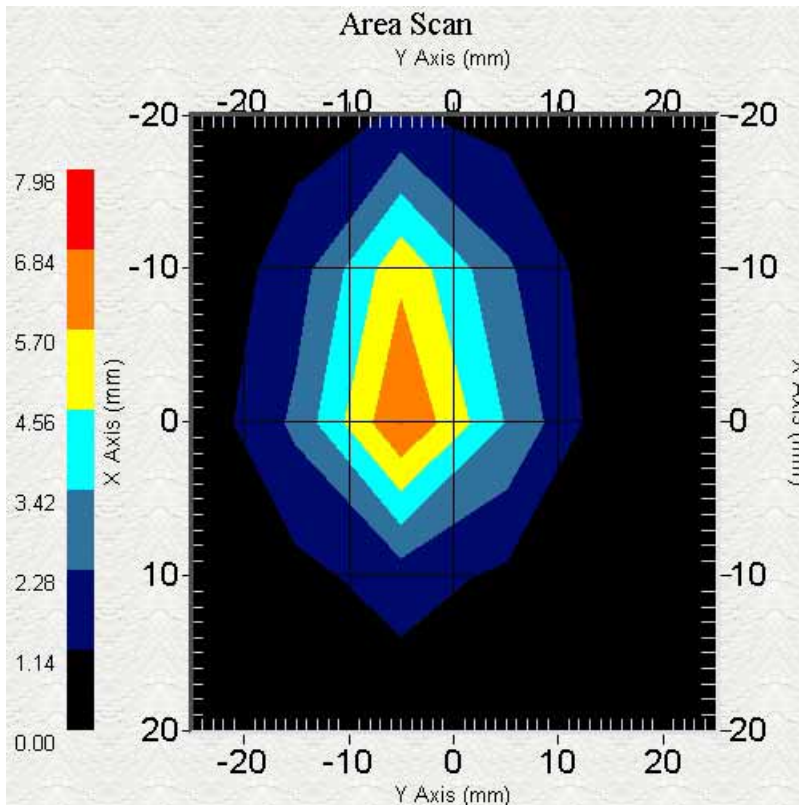
The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

## Electrical Specification

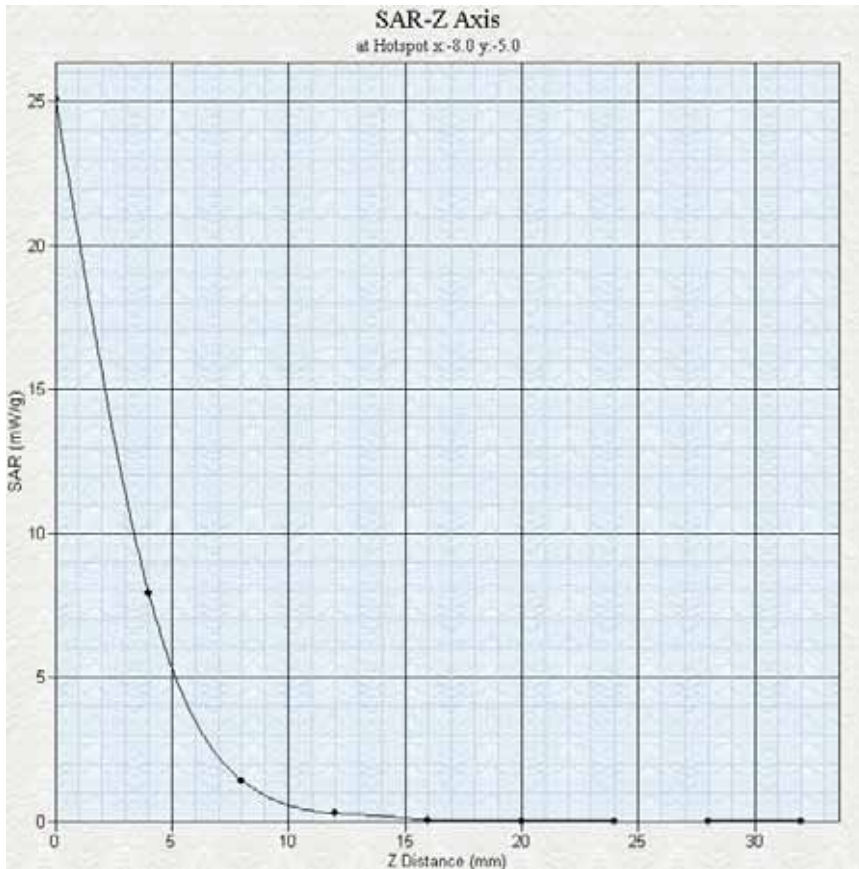
**SWR:** 1.21U  
**Return Loss:** -17.9 dB  
**Impedance:** 45.175

## 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-Dell-5064  
FCC ID: ID:E2K5HCKT

Page 124 of 80

51 Spectrum Way  
Nepean, Ontario  
Canada K2R 1E6  
© 2004 APREL Laboratories



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

### Calibration Results Summary

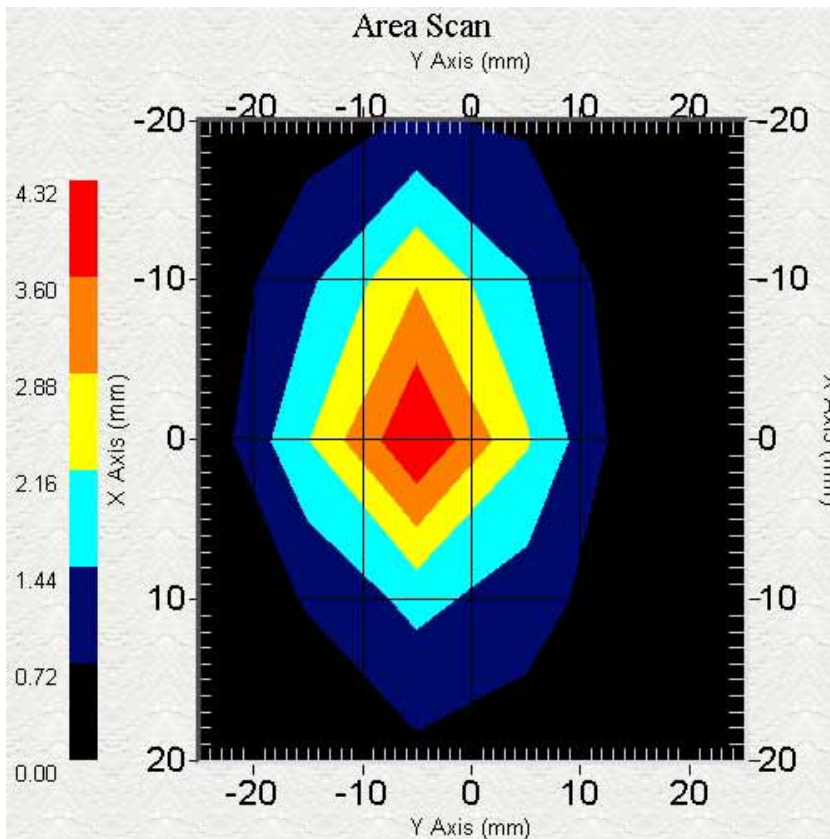
The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

### Electrical Specification

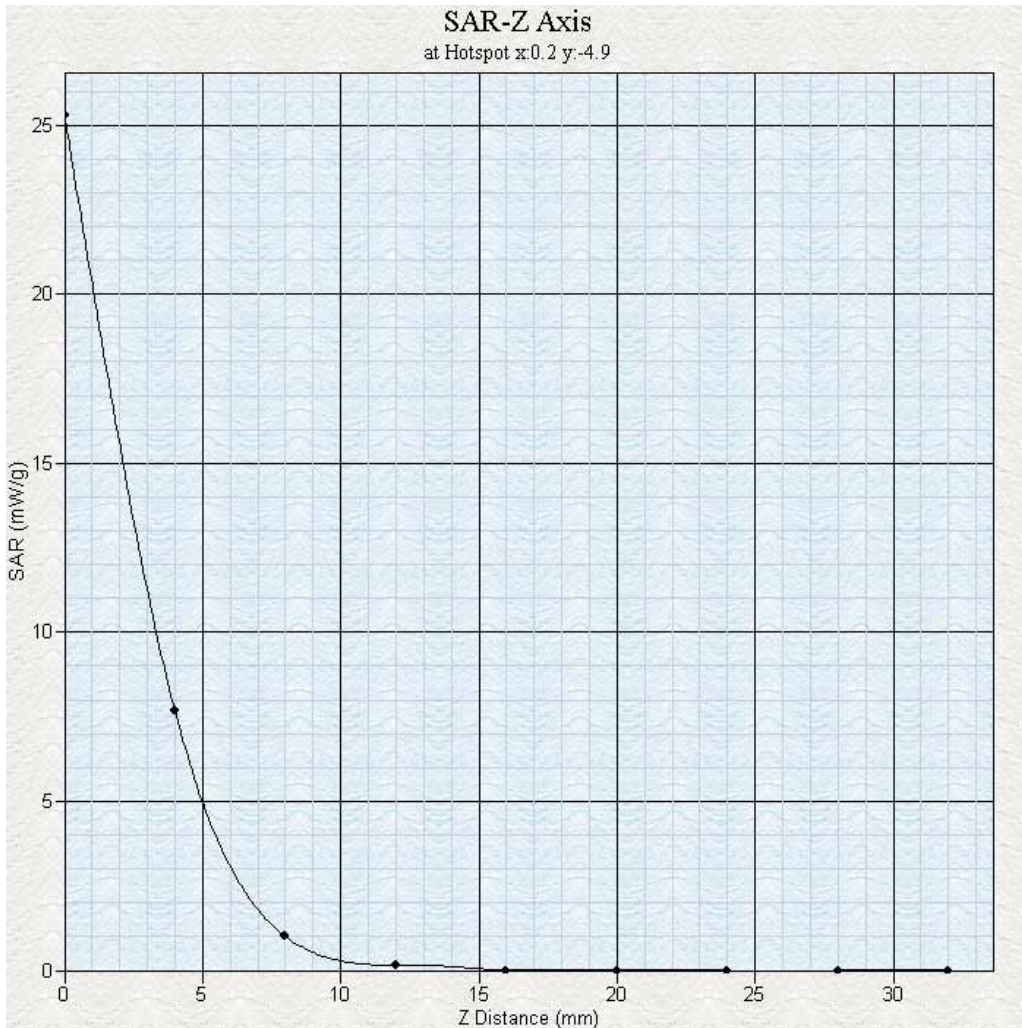
**SWR:** 1.26U  
**Return Loss:** -16.3 dB  
**Impedance:** 44.175

### System Validation Results

Frequency	1 Gram
5800 GHz	57.9



## 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 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

