

## **Appendix - Probe Calibration**

**Miniature Isotropic RF Probe**

**M/N: ALS-E-020**

**S/N: 264**

**1900MHz Head Calibration page 2~11**

**1900MHz Body Calibration page 12~21**

## NCL CALIBRATION LABORATORIES

Calibration File No.: CP-633

Client: QUIETEK

## 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 1900 MHz

Manufacturer: APREL Laboratories

Model No.: ALS-E-020

Serial No.: 264

HEAD Calibration

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

Project No: QUIB-Probe-Cal-5210

Calibrated: 21<sup>st</sup> March 2006

Released on: 21<sup>st</sup> March 2006

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

Released By: 

**NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2B 1E6

Division of APREL Lab.  
TEL: (613) 820-4948  
FAX: (613) 820-4161

**NCL Calibration Laboratories**  
Division of APREL Laboratories.

## 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-020 264.

## 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 264 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

Yi Pan

**NCL Calibration Laboratories**  
Division of APREL Laboratories.

## Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	264
Frequency:	1900 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:	1.2 $\mu$ V/(V/m) <sup>2</sup>
Channel Y:	1.2 $\mu$ V/(V/m) <sup>2</sup>
Channel Z:	1.2 $\mu$ V/(V/m) <sup>2</sup>
Diode Compression Point:	95 mV

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Division of APREL Laboratories.

### **Sensitivity in Head Tissue**

**Frequency:** 1900 MHz

**Epsilon:** 40.0 (+/-5%) **Sigma:** 1.40 S/m (+/-5%)

### **ConvF**

**Channel X:** 5.5

**Channel Y:** 5.5

**Channel Z:** 5.5

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

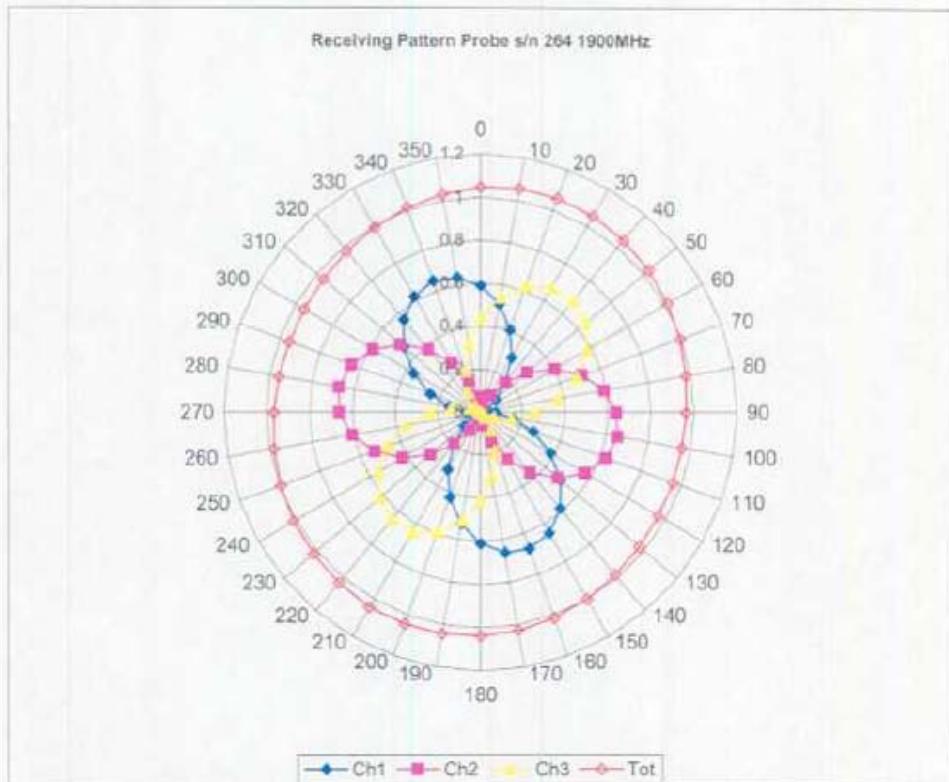
### **Boundary Effect:**

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.

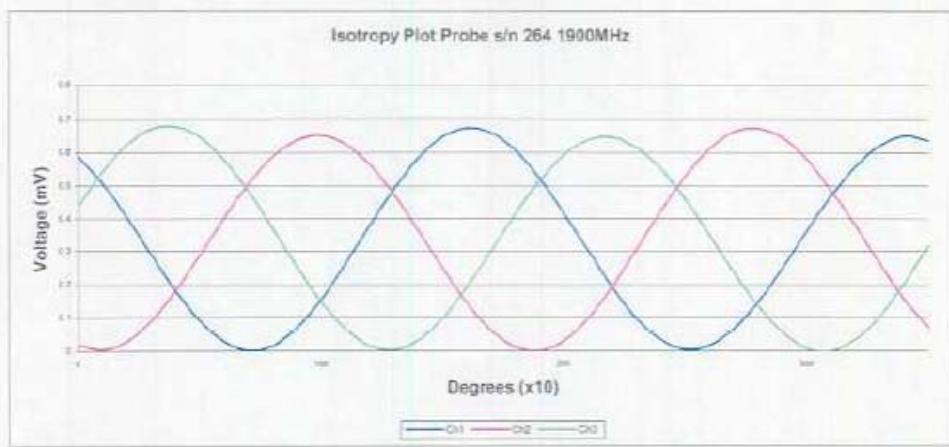
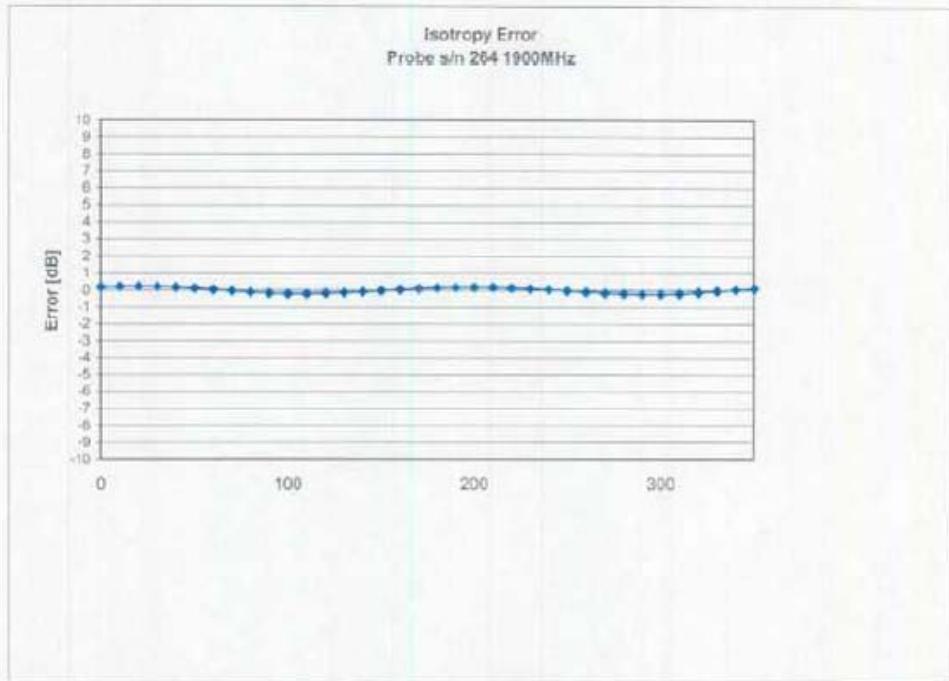
### **Spatial Resolution:**

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 1900 MHz (Air)



### Isotropy Error 1900 MHz (Air)



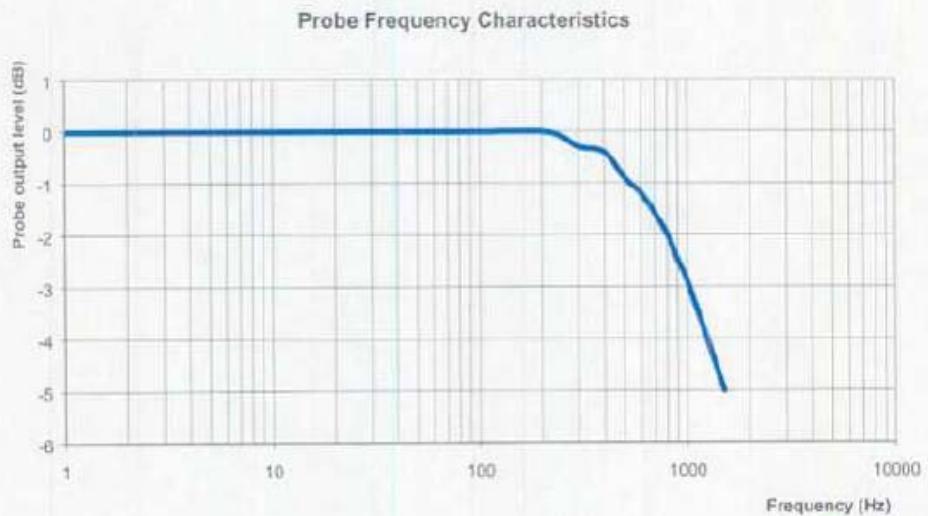
### Isotropy in Tissue:

0.10 dB

## Dynamic Range



## Video Bandwidth



Video Bandwidth at 500 Hz      1 dB  
Video Bandwidth at 1000 Hz      3 dB

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Division of APREL Laboratories.

## Conversion Factor Uncertainty Assessment

**Frequency:** 1900MHz

**Epsilon:** 40.0 (+/-5%) **Sigma:** 1.40 S/m (+/-5%)

**ConvF**

**Channel X:** 5.5 7%(K=2)

**Channel Y:** 5.5 7%(K=2)

**Channel Z:** 5.5 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%.

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## NCL Calibration Laboratories

Division of APREL Laboratories.

### 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

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Page 10 of 10

This page has been reviewed for content and attested to on Page 2 of this document.

## NCL CALIBRATION LABORATORIES

Calibration File No.: CP-640

Client: QUIETEK

## 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 1900 MHz

Manufacturer: APREL Laboratories

Model No.: ALS-E-020

Serial No.: 264

BODY Calibration

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

Project No: QUIB-Probe-Cal-5210

Calibrated: 21<sup>st</sup> March 2006

Released on: 21<sup>st</sup> March 2006

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

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

**NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2B 1E6

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



## NCL Calibration Laboratories

Division of APREL Laboratories

### 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-020 264.

### 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 264 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

Yi Pan

Page 2 of 10

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## **NCL Calibration Laboratories**

Division of APREL Laboratories.

### **Calibration Results Summary**

Probe Type:	E-Field Probe E-020
Serial Number:	264
Frequency:	1900 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:	1.2 $\mu$ V/(V/m) <sup>2</sup>
Channel Y:	1.2 $\mu$ V/(V/m) <sup>2</sup>
Channel Z:	1.2 $\mu$ V/(V/m) <sup>2</sup>
Diode Compression Point:	95 mV

## **NCL Calibration Laboratories**

Division of APREL Laboratories.

### **Sensitivity in Body Tissue**

**Frequency:** 1900 MHz

**Epsilon:** 53.3 (+/-5%) **Sigma:** 1.52 S/m (+/-5%)

**ConvF**

**Channel X:** 5.75

**Channel Y:** 5.75

**Channel Z:** 5.75

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

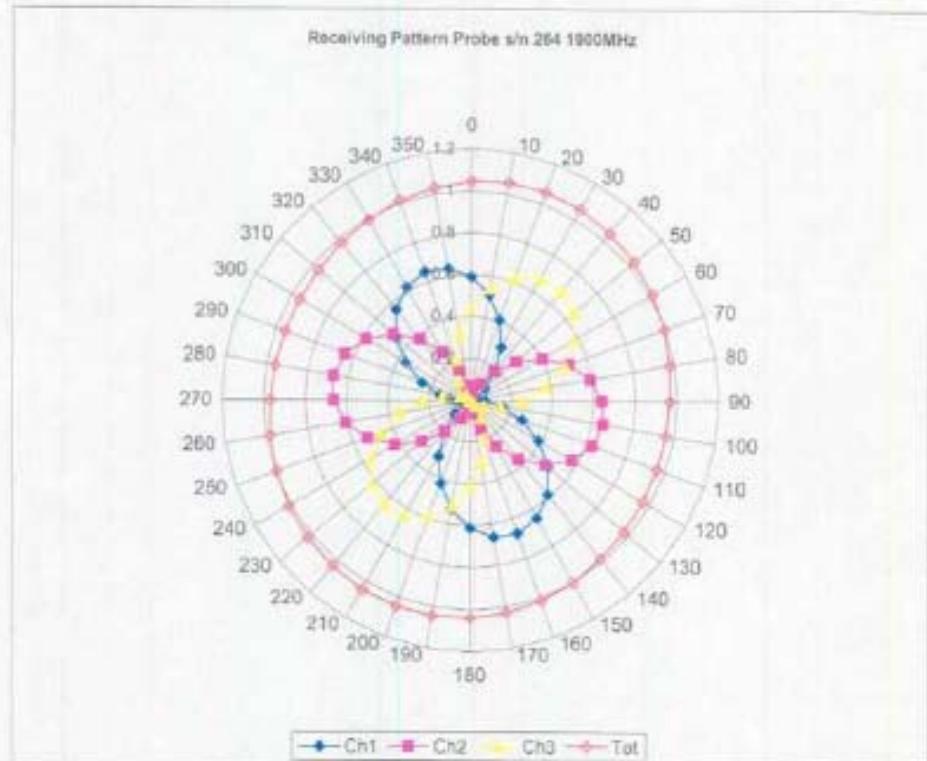
### **Boundary Effect:**

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.

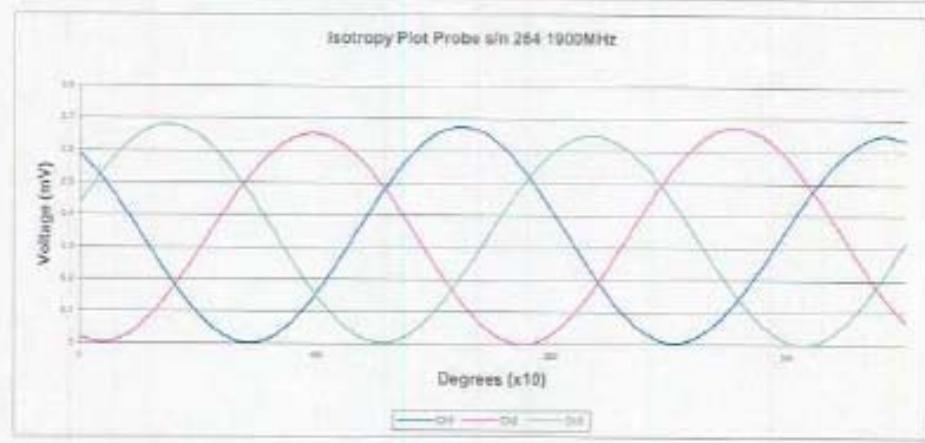
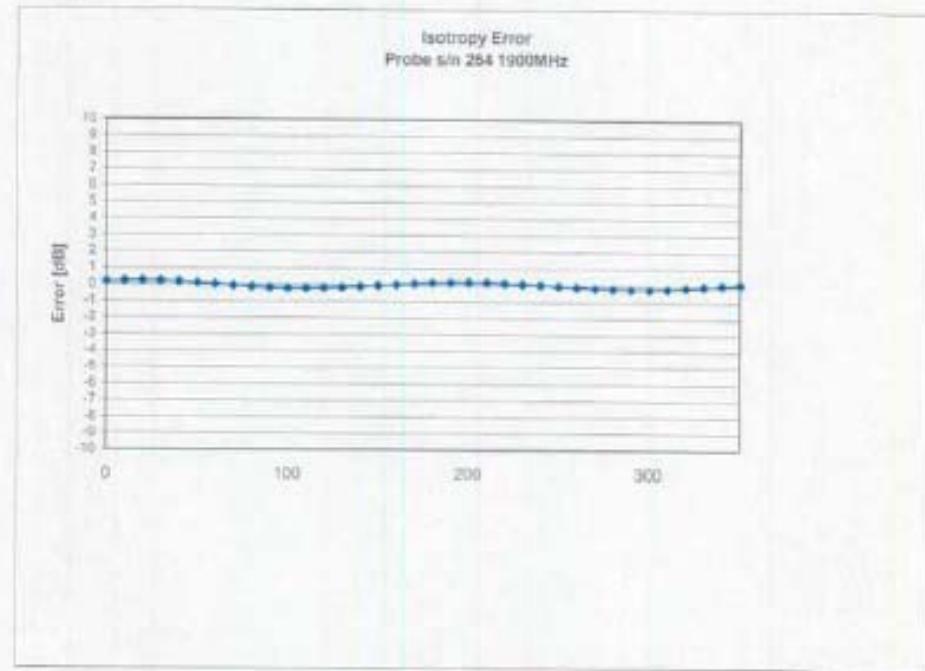
### **Spatial Resolution:**

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 1900 MHz (Air)

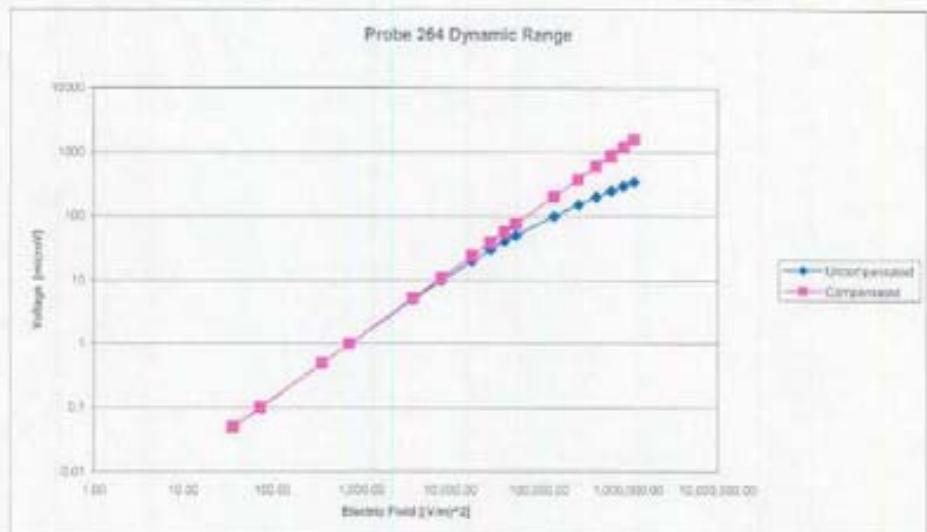


### Isotropy Error 1900 MHz (Air)

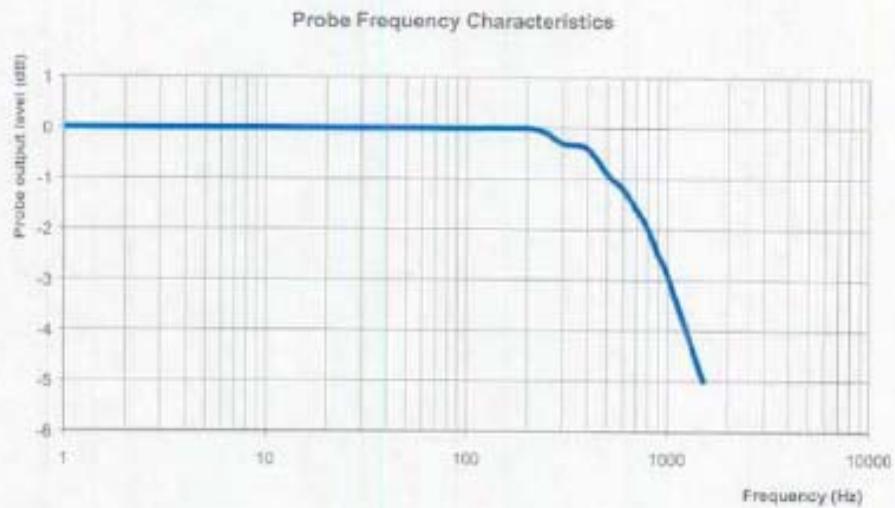


Isotropicity in Tissue: 0.10 dB

## Dynamic Range



## Video Bandwidth



Video Bandwidth at 500 Hz      1 dB  
Video Bandwidth at 1000 Hz      3 dB

## NCL Calibration Laboratories

Division of APREL Laboratories

### Conversion Factor Uncertainty Assessment

Frequency: 1900MHz

Epsilon: 53.3 (+/-5%) Sigma: 1.52 S/m (+/-5%)

ConvF

Channel X: 5.75 7%(K=2)

Channel Y: 5.75 7%(K=2)

Channel Z: 5.75 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%.

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Page 9 of 10

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## NCL Calibration Laboratories

Division of APREL Laboratories.

### **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.

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Page 10 of 10

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## NCL CALIBRATION LABORATORIES

Calibration File No: DC-408-1  
Project Number: QTKB-Dipole Cal-5230

## 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.

Quietek Validation Dipole

Manufacturer: APREL Laboratories  
Part number: ALS-D-1900-S-2  
Frequency: 1.9 GHz  
Serial No: QTK-318

Customer: Quietek

Calibrated: 15 June 2006  
Released on: 15 June 2006

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

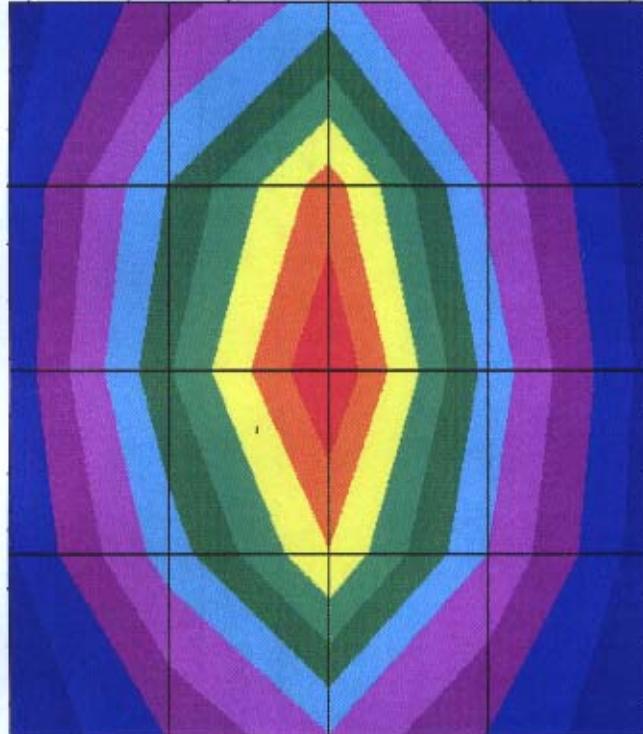
**Length:** 70.0 mm  
**Height:** 39.5 mm

### Electrical Specification

**SWR:** 1.1 U  
**Return Loss:** -25.7 dB  
**Impedance:** 46.8  $\Omega$

### System Validation Results

Frequency	1 Gram	10 Gram	Peak
1.9 GHz	36.0	20.78	67.7



## 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 QTK-318. 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 QTK E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

## 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 QTK-318 was received for calibration.

**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
68.0 mm	39.5 mm	70.0 mm	39.5 mm

**Tissue Validation**

Head Tissue 1900 MHz	Measured
Dielectric constant, $\epsilon_r$	39.9
Conductivity, $\sigma$ [S/m]	1.42

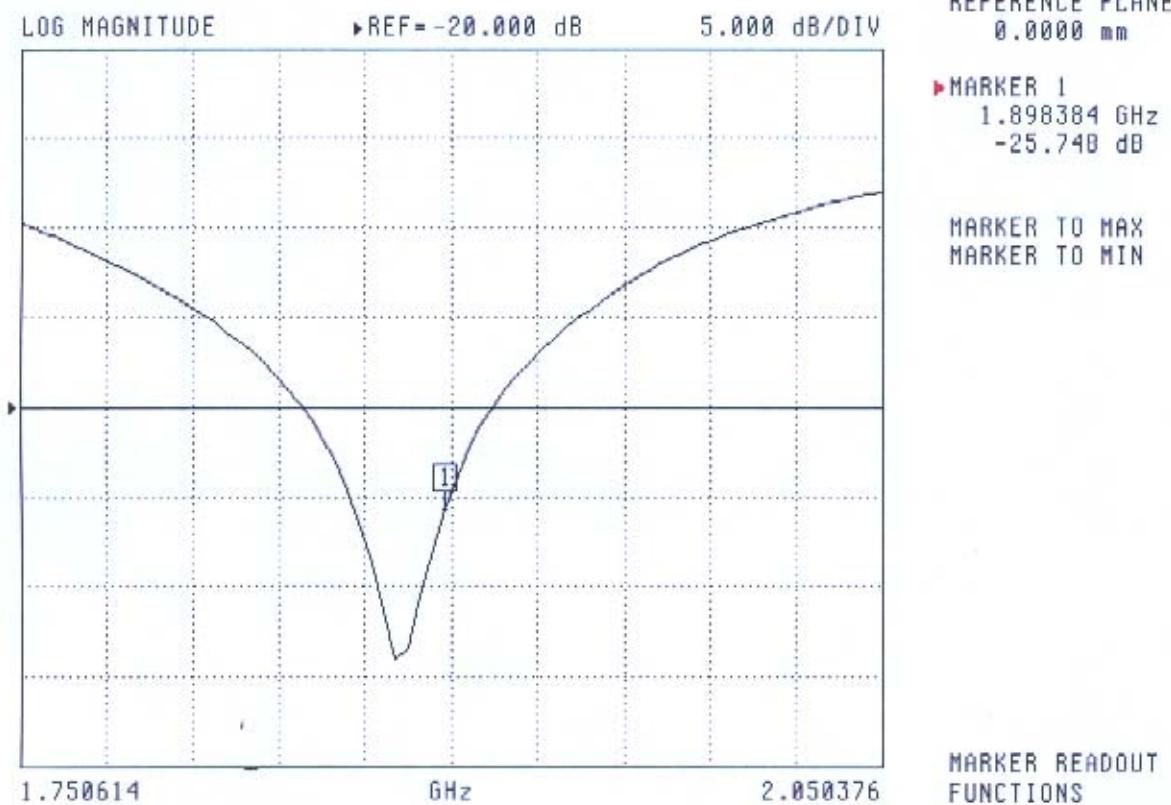
**Electrical Calibration**

Test	Result
S11 R/L	-25.7 dB
SWR	1.1 U
Impedance	46.8 $\Omega$

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

**S11 Parameter Return Loss**

S22 REVERSE REFLECTION



# NCL Calibration Laboratories

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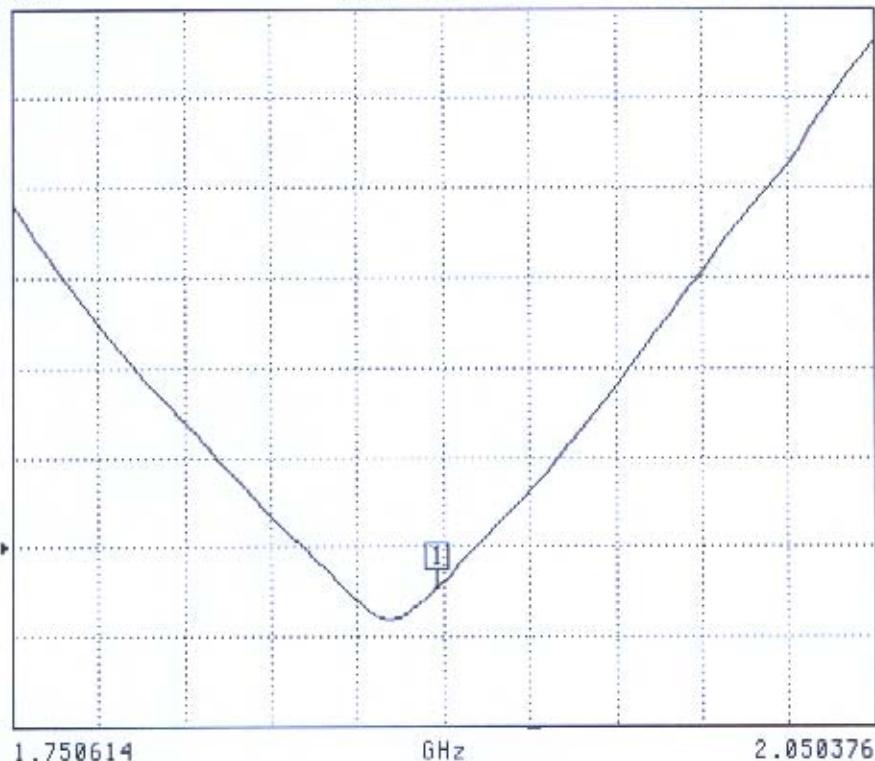
## SWR

S22 REVERSE REFLECTION

SWR

►REF=1.200 U

200.000 mU/DIV



CH 4 - S22  
REFERENCE PLANE  
0.0000 mm

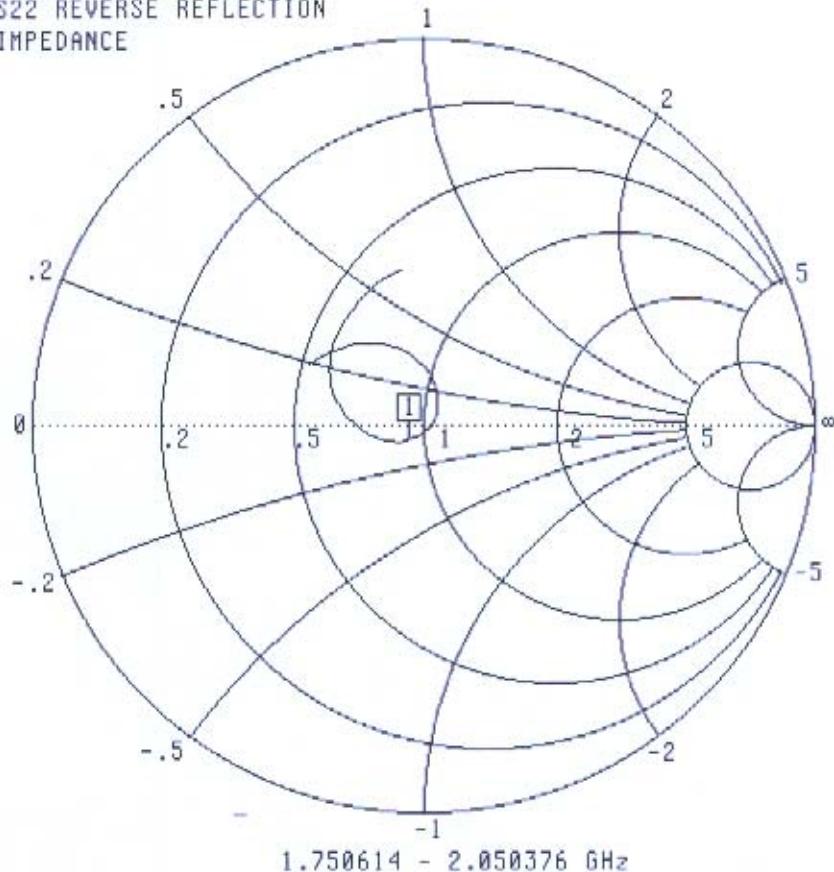
►MARKER 1  
1.898384 GHz  
1.106 U

MARKER TO MAX  
MARKER TO MIN

MARKER READOUT  
FUNCTIONS

## Smith Chart Dipole Impedance

S22 REVERSE REFLECTION  
IMPEDANCE



CH 4 - S22  
REFERENCE PLANE  
0.0000 mm

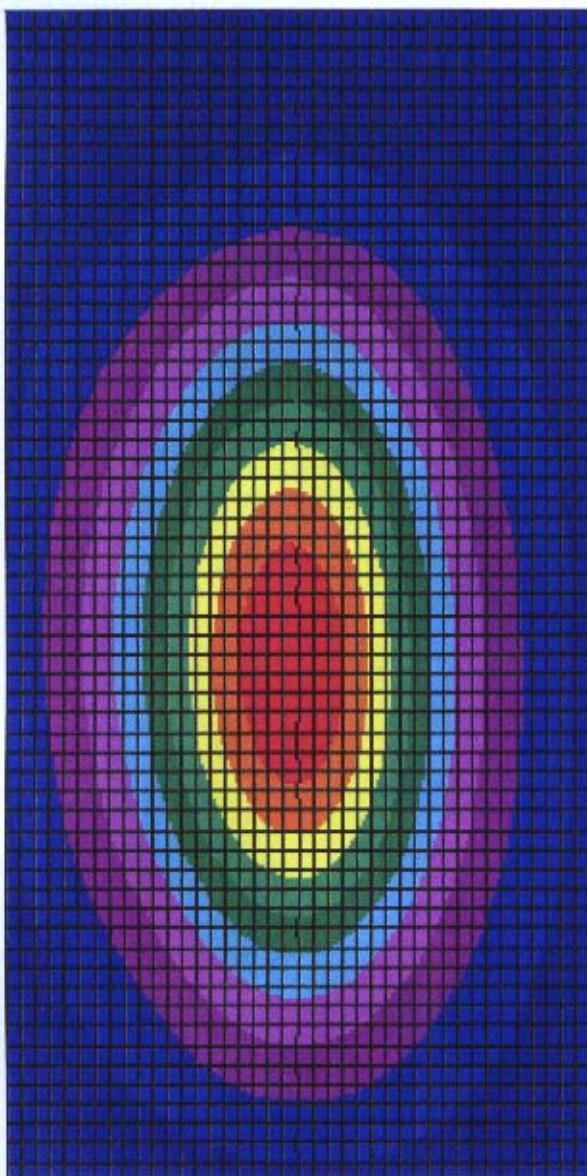
► MARKER 1  
1.898384 GHz  
46.767 Ω  
-3.770 jΩ

MARKER TO MAX  
MARKER TO MIN

MARKER READOUT  
FUNCTIONS

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

Frequency	1 Gram	10 Gram	Peak Above Feed Point
1.9 GHz	36.0	20.78	67.7



## **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