

**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-460

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.: E-020

Serial No.: 222

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

Project No: QTKB-ALSAS10U-505

Calibrated: 18<sup>th</sup> November 2004  
Released on: 18<sup>th</sup> November 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

## 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-020 222.

### 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

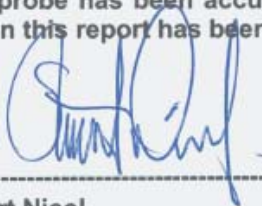
### Conditions

Probe 222 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



Y. Chen  
 Member of Engineering Staff  
 (Calibration Engineer)

## NCL Calibration Laboratories

Division of APREL Laboratories.

### Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	222
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:	$1.3 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Y:	$1.3 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Z:	$1.3 \mu\text{V}/(\text{V}/\text{m})^2$
Diode Compression Point:	95 mV

## NCL Calibration Laboratories

Division of APREL Laboratories.

### Sensitivity in Head Tissue

**Frequency:** 1900 MHz

**Epsilon:** 40.0 (+/-5%)

**Sigma:** 1.40 S/m (+/-10%)

### ConvF

**Channel X:** 6.0

**Channel Y:** 6.0

**Channel Z:** 6.0

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.

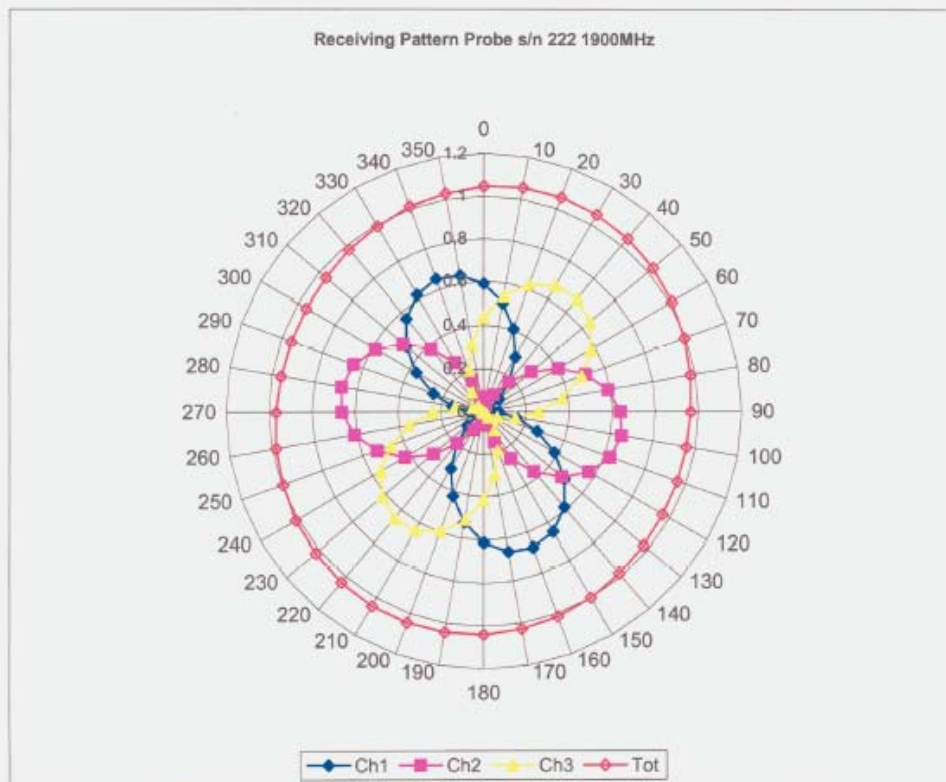
### Spatial Resolution:

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.

**NCL Calibration Laboratories**

Division of APREL Laboratories.

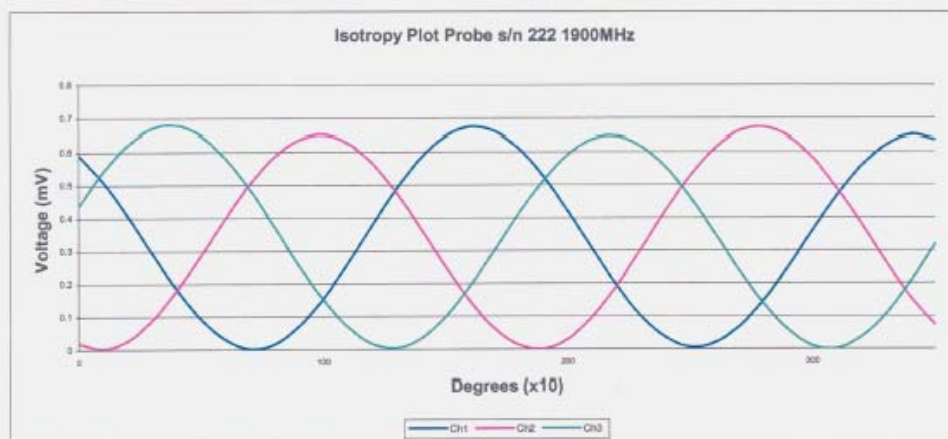
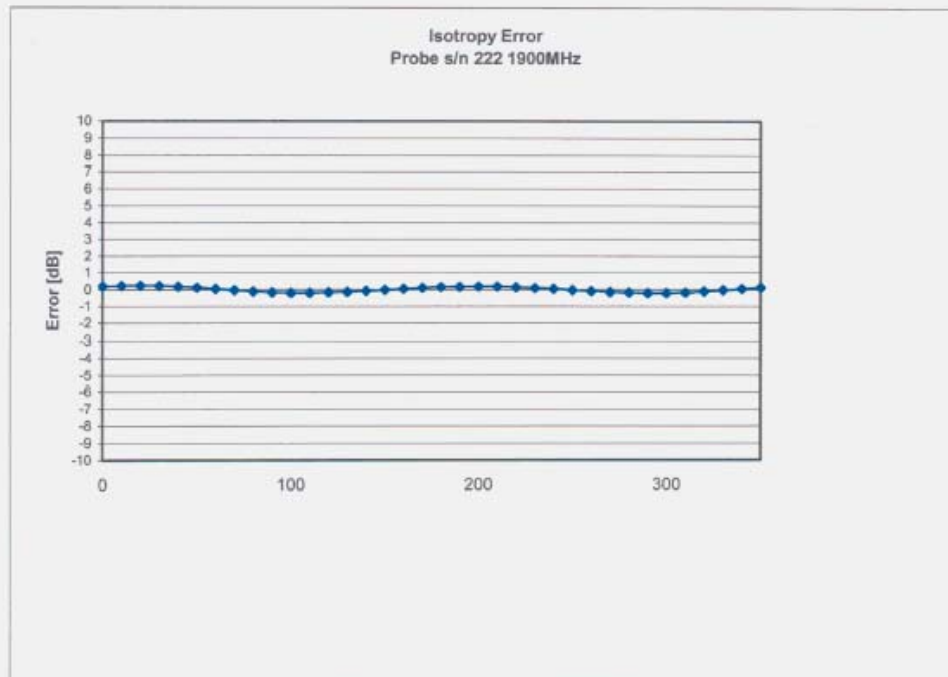
**Receiving Pattern 1900 MHz (Air)**



**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Isotropy Error 1900 MHz (Air)**

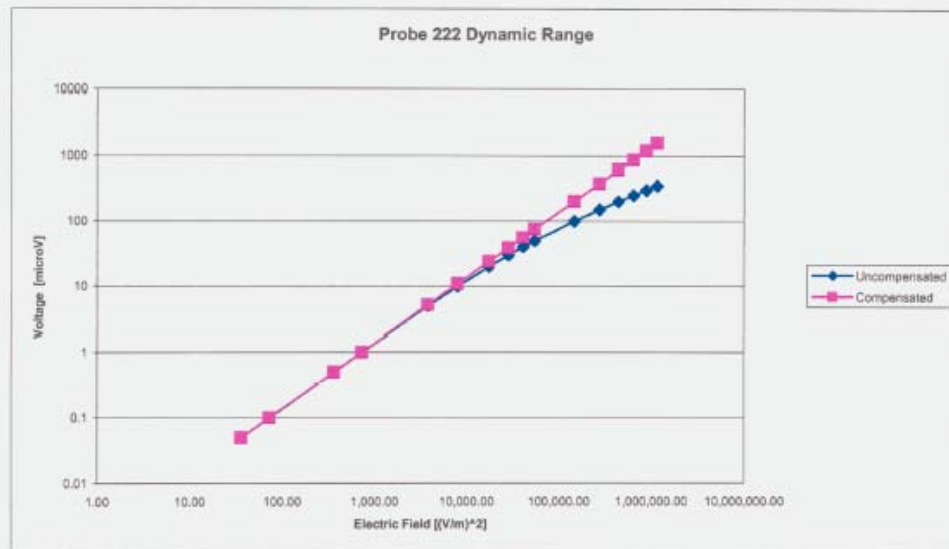


**Isotropy:** 0.10 dB

NCL Calibration Laboratories

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Dynamic Range

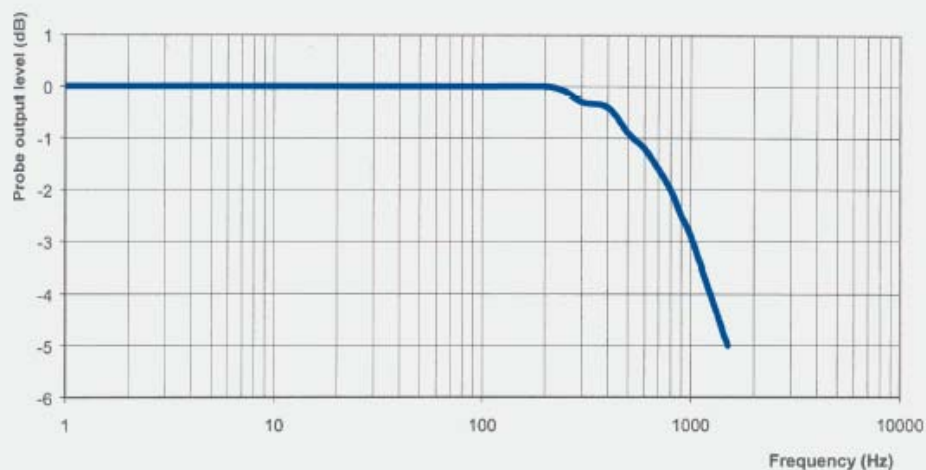


## NCL Calibration Laboratories

Division of APREL Laboratories.

### Video Bandwidth

Probe Frequency Characteristics



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



**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Conversion Factor Uncertainty Assessment**

**Frequency:** 1900MHz

**Epsilon:** 40.0 (+/-5%)

**Sigma:** 1.40 S/m (+/-10%)

**ConvF**

**Channel X:** 6.0 7%(K=2)

**Channel Y:** 6.0 7%(K=2)

**Channel Z:** 6.0 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%.

## **NCL Calibration Laboratories**

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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 May 2004.

**NCL CALIBRATION LABORATORIES**

Calibration File No.: CP-464

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.: E-020

Serial No.: 222

BODY Calibration

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

Project No: QTKB-ALSAS10U-505

Calibrated: 18<sup>th</sup> November 2004  
Released on: 18<sup>th</sup> November 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

## 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-020 222.

## References

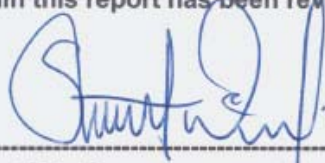
SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure  
 IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"  
 SSI-TP-011 Tissue Calibration Procedure

## Conditions

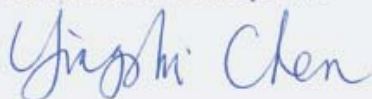
Probe 222 was a new probe taken from stock prior to calibration.

**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



Y. Chen  
 Member of Engineering Staff  
 (Calibration Engineer)

## NCL Calibration Laboratories

Division of APREL Laboratories.

### Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	222
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:	$1.3 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Y:	$1.3 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Z:	$1.3 \mu\text{V}/(\text{V}/\text{m})^2$
Diode Compression Point:	95 mV

## NCL Calibration Laboratories

Division of APREL Laboratories.

### Sensitivity in Body Tissue

**Frequency:**

1900 MHz

**Epsilon:** 54.0 (+/-5%)

**Sigma:** 1.45 S/m (+/-10%)

### ConvF

**Channel X:** 6.1

**Channel Y:** 6.1

**Channel Z:** 6.1

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

### Boundary Effect:

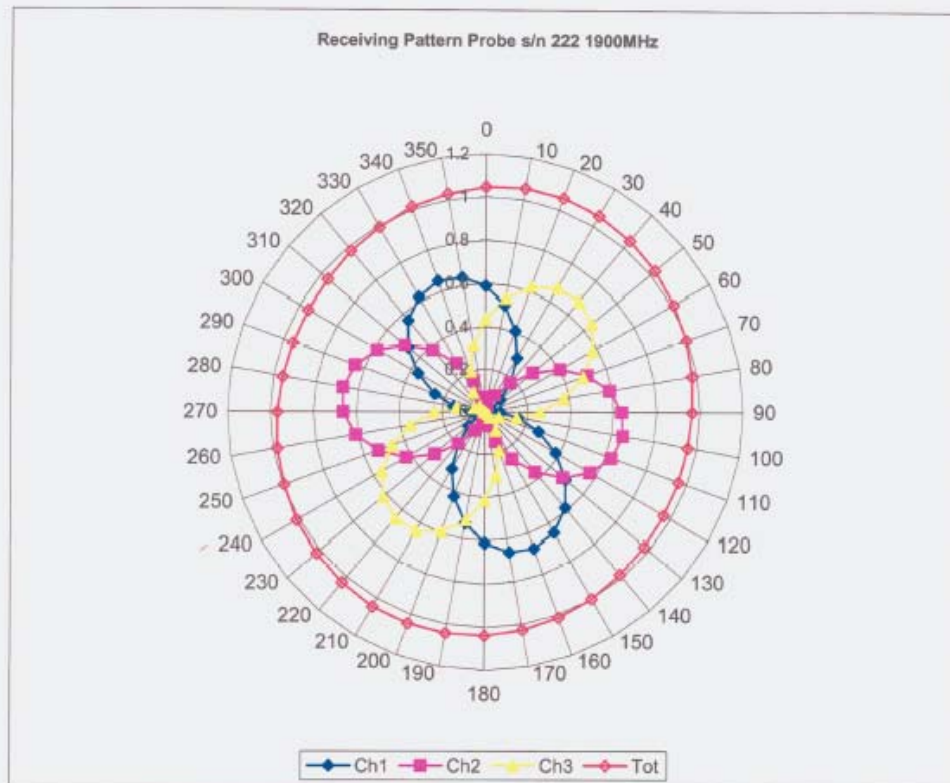
Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.44mm.

### 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.

NCL Calibration Laboratories  
Division of APREL Laboratories.

## Receiving Pattern 1900 MHz (Air)

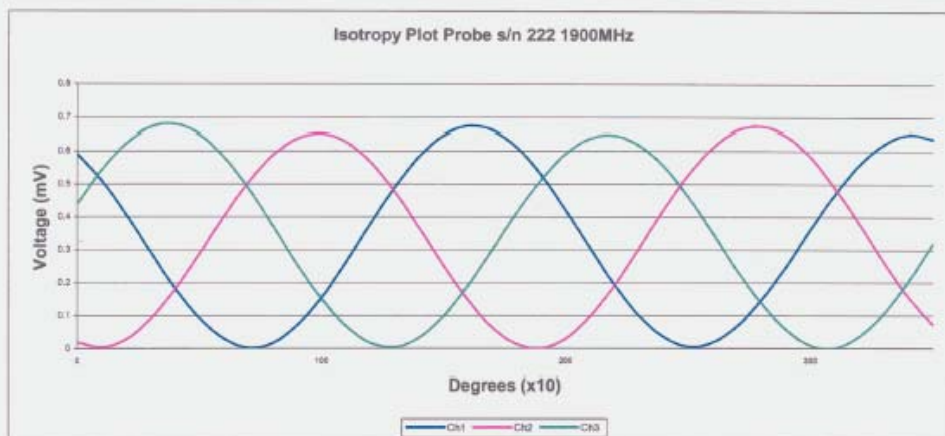
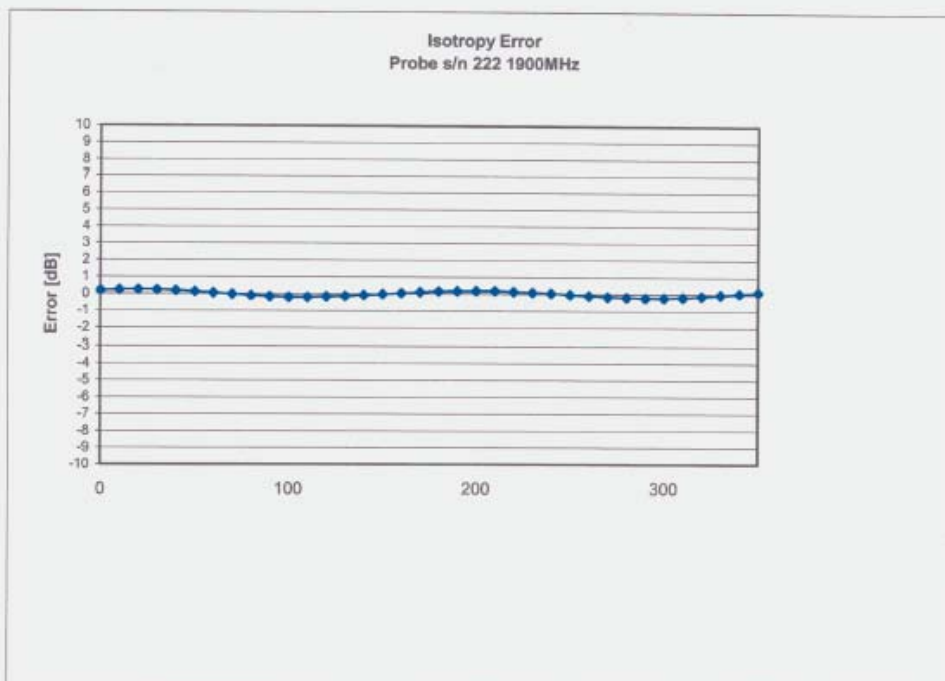




NCL Calibration Laboratories

Division of APREL Laboratories,

Isotropy Error 1900 MHz (Air)



Isotropy:

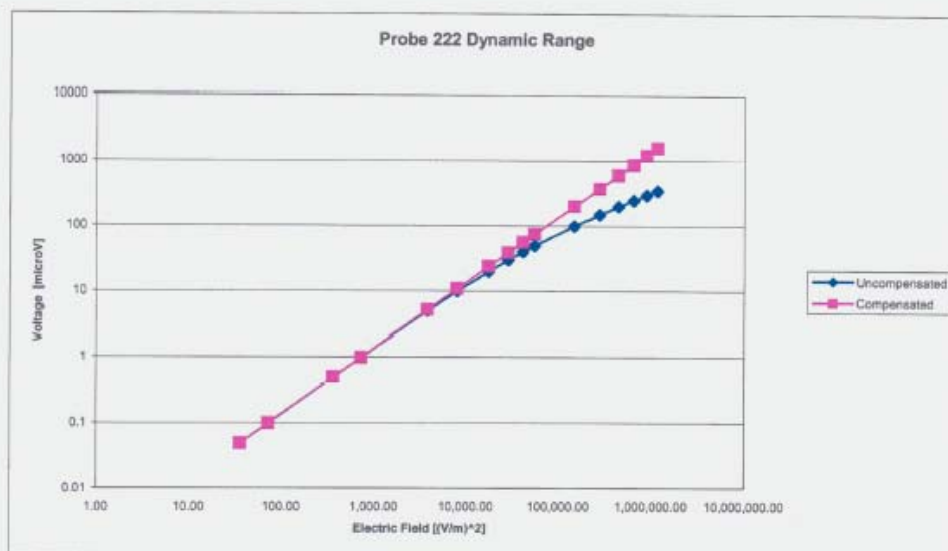
0.10 dB



NCL Calibration Laboratories

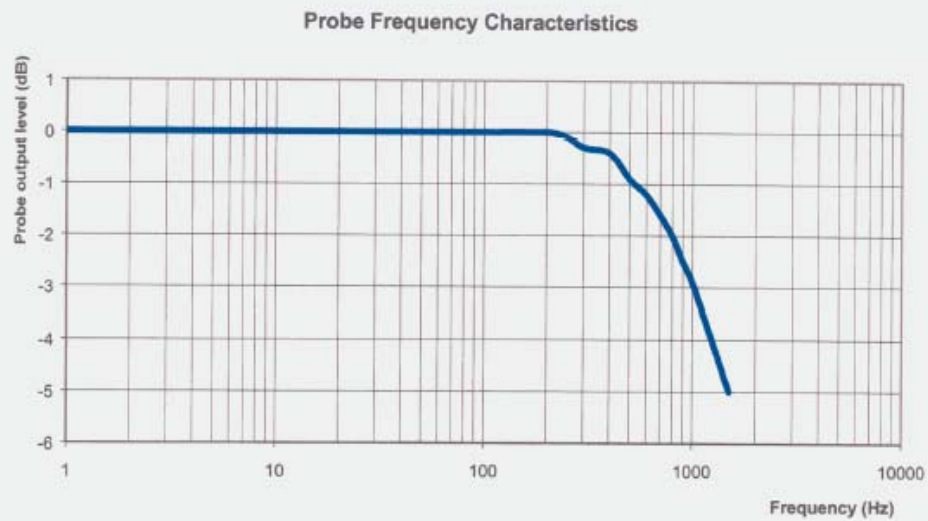
Division of APREL Laboratories,

Dynamic Range



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

## Video Bandwidth



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

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Conversion Factor Uncertainty Assessment**

**Frequency:** 1900MHz

**Epsilon:** 54.0 (+/-5%)

**Sigma:** 1.45 S/m (+/-10%)

**ConvF**

**Channel X:** 6.1 7%(K=2)

**Channel Y:** 6.1 7%(K=2)

**Channel Z:** 6.1 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%.

**NCL Calibration Laboratories**

Division of APREL Laboratories.

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**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.

## Dipole Calibration

**NCL CALIBRATION LABORATORIES**

Calibration File No: DC-408  
Project Number: QTKB-ALSAS-10U-5050

**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

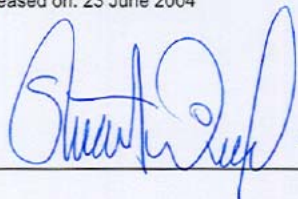
Frequency: 1.9 GHz

Serial No: QTK-318

Customer: Quietek

Calibrated: 23 June 2004  
Released on: 23 June 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

## NCL Calibration Laboratories

Division of APREL Laboratories.

### Calibration Results Summary

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

#### Mechanical Dimensions

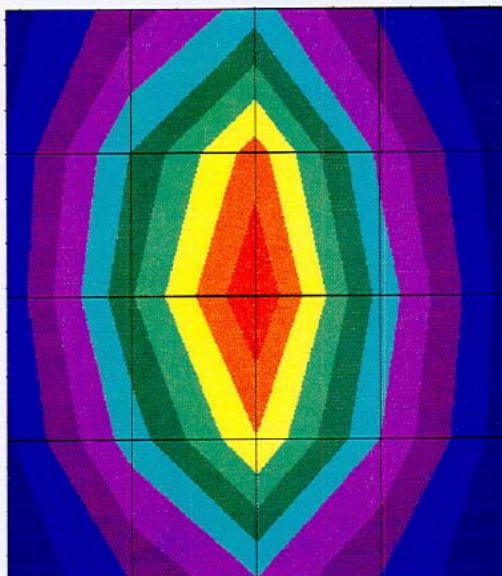
Length: 70.0 mm  
Height: 39.5 mm

#### Electrical Specification

SWR: 1.1 U  
Return Loss: -25.8 dB  
Impedance: 47.8  $\Omega$

#### System Validation Results

Frequency	1 Gram	10 Gram	Peak
1.9 GHz	36.0	20.78	67.7





## NCL Calibration Laboratories

Division of APREL Laboratories.

### 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 new taken from stock.

**Ambient Temperature of the Laboratory:** 22 °C +/- 0.5°C

**Temperature of the Tissue:** 20 °C +/- 0.5°C



**NCL Calibration Laboratories**

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**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

## NCL Calibration Laboratories

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### Electrical Calibration

Test	Result
S11 R/L	-25.8 dB
SWR	1.1 U
Impedance	47.8 $\Omega$

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

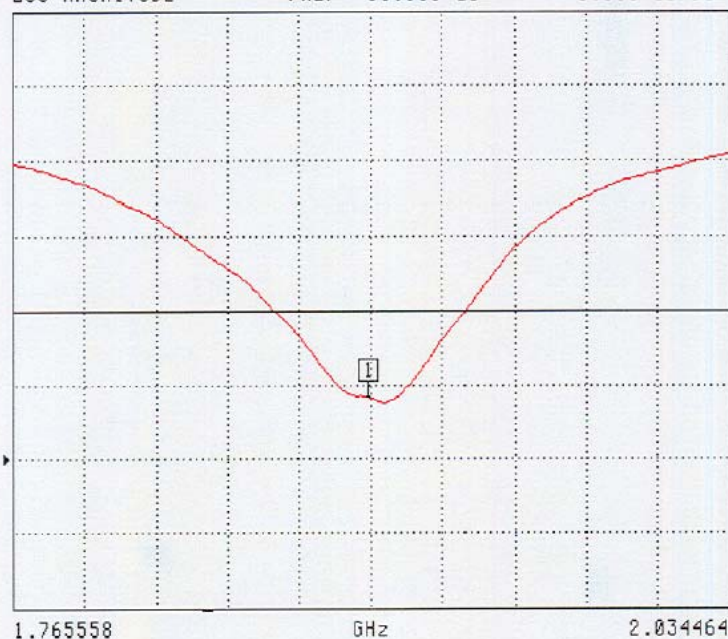
### S11 Parameter Return Loss

S11 FORWARD REFLECTION

LOG MAGNITUDE

REF = -30.000 dB

5.000 dB/DIV



CH 1 - S11  
REFERENCE PLANE  
0.0000 mm

MARKER 1  
1.899292 GHz  
-25.041 dB

MARKER TO MAX  
MARKER TO MIN

MARKER READOUT  
FUNCTIONS

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Calibrated by:

Approved by:

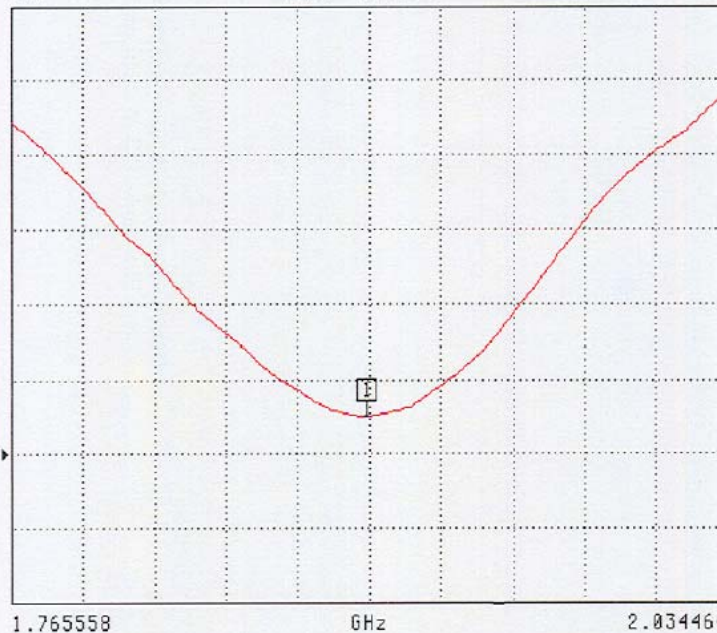
## NCL Calibration Laboratories

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### SWR

S11 FORWARD REFLECTION

SWR REF=1.000 U 200.000 mU/DIV



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Calibrated by

Approved by:

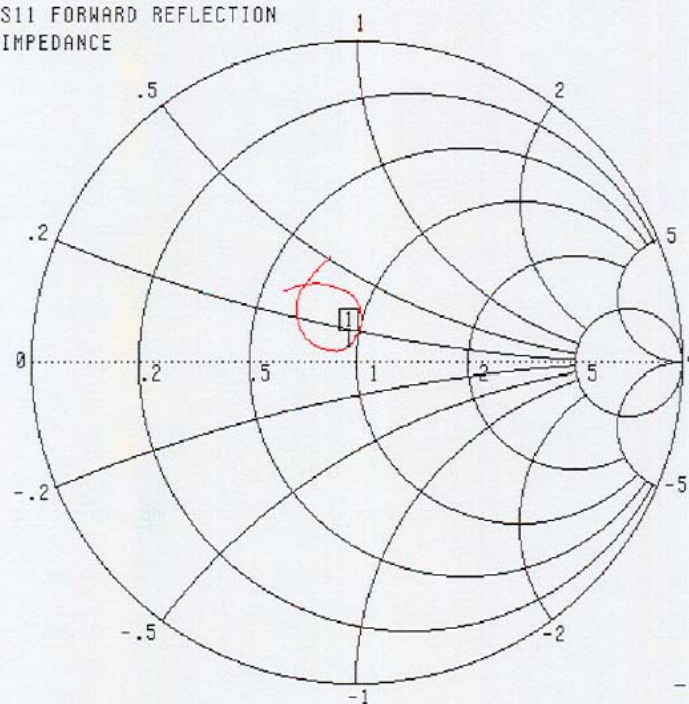


## NCL Calibration Laboratories

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### Smith Chart Dipole Impedance

S11 FORWARD REFLECTION  
IMPEDANCE



CH 1 - S11  
REFERENCE PLANE  
0.0000 mm

MARKER 1  
1.899292 GHz  
47.748  $\Omega$   
4.401 j $\Omega$

▶ MARKER TO MAX  
MARKER TO MIN

MARKER READOUT  
FUNCTIONS

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Calibrated by:

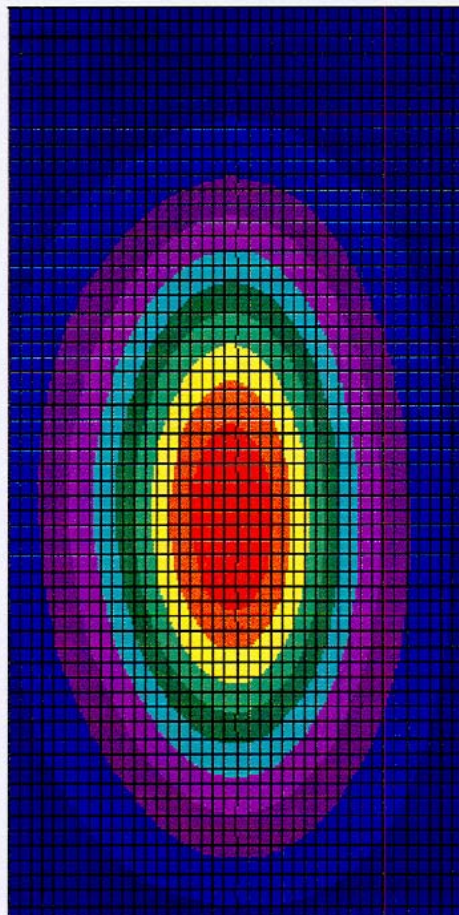
Approved by:

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**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



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Calibrated by:

Approved by:

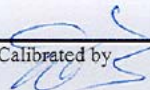
**NCL Calibration Laboratories**

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 May 2003

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Calibrated by 

Approved by 