

# NCL CALIBRATION LABORATORIES

Calibration File No: DC-513  
Project Number: WISB-ALSAS10U-5121

## 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.

WISB Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-2450-S-2

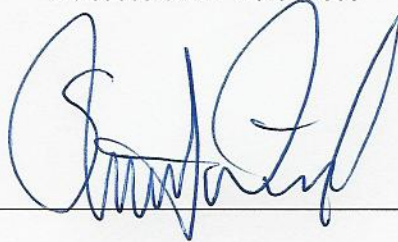
Frequency: 2450 MHz

Serial No: 2450-220-00753

Customer: WISB

Calibrated: 4<sup>th</sup> March 2005  
Released on: 4<sup>th</sup> March 2005

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



### **NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

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

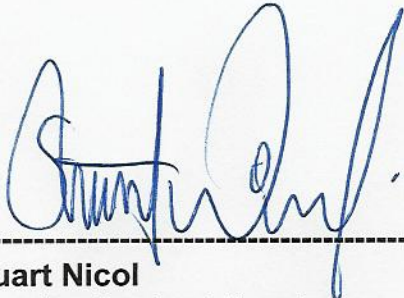
## Conditions

Dipole 2450-220-00753 was new and taken from stock prior to calibration.

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

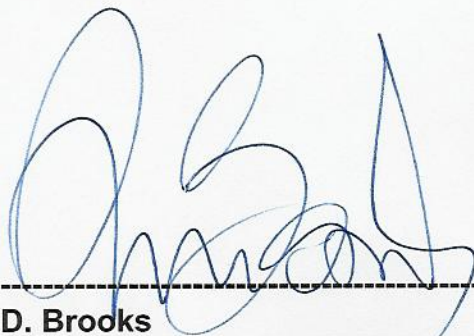
**Temperature of the Tissue:** 21 °C +/- 0.5°C

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



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



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**D. Brooks**  
**Member of Engineering Staff**  
**(Calibration Engineer)**

## Calibration Results Summary

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

### Mechanical Dimensions

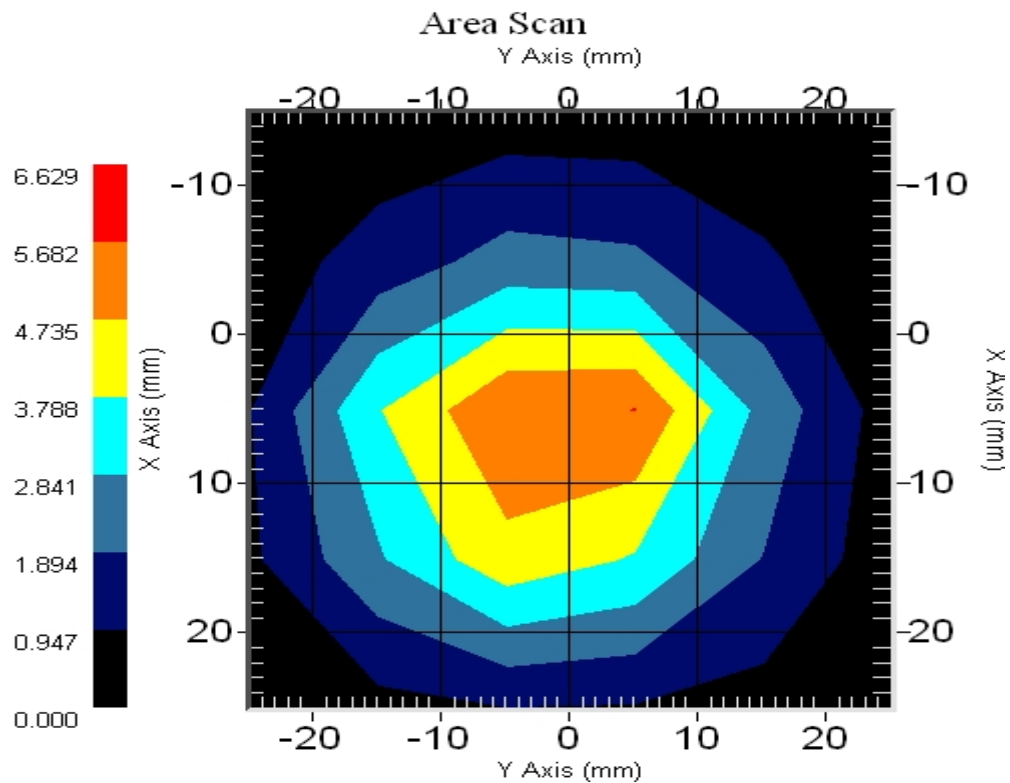
**Length:** 51.5 mm  
**Height:** 30.4 mm

### Electrical Specification

**SWR:** 1.01 U  
**Return Loss:** -45.3 dB  
**Impedance:** 50.6  $\Omega$

### System Validation Results

Frequency	1 Gram	10 Gram	Peak
2450 MHz	53.09	24.44	101.85



## **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 2450-220-00753. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the 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 APREL 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 2450-220-00753 was new taken from stock.

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

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

## Dipole Calibration Results

### Mechanical Verification

<b>APREL Length</b>	<b>APREL Height</b>	<b>Measured Length</b>	<b>Measured Height</b>
51.5 mm	30.4 mm	52.1 mm	31.0 mm

### Tissue Validation

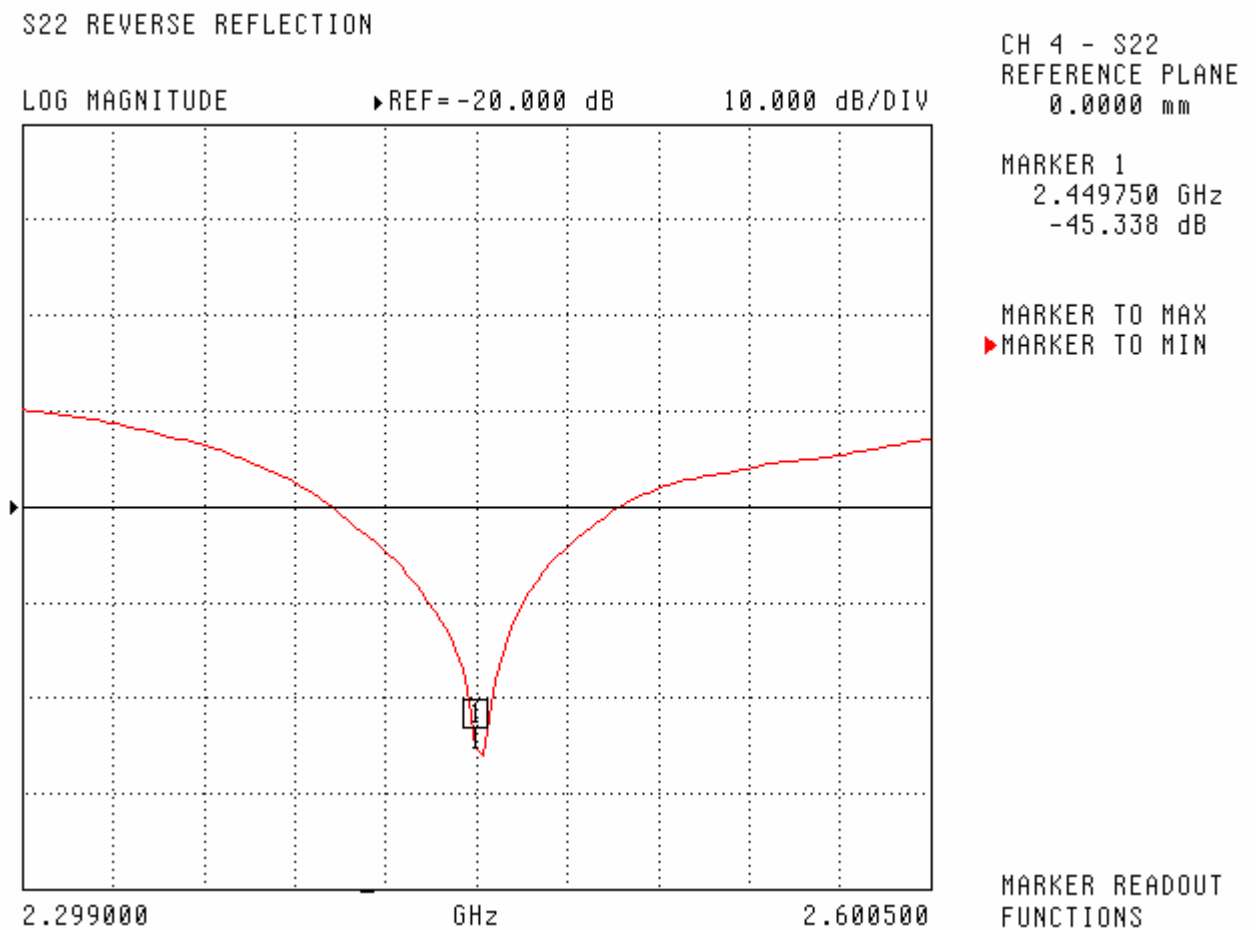
<b>Head Tissue 2450 MHz</b>	<b>Measured</b>
<b>Dielectric constant, <math>\epsilon_r</math></b>	39.2
<b>Conductivity, <math>\sigma</math> [S/m]</b>	1.80

**Electrical Calibration**

Test	Result
S11 R/L	-45.3 dB
SWR	1.01 U
Impedance	50.6 $\Omega$

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

**S11 Parameter Return Loss**



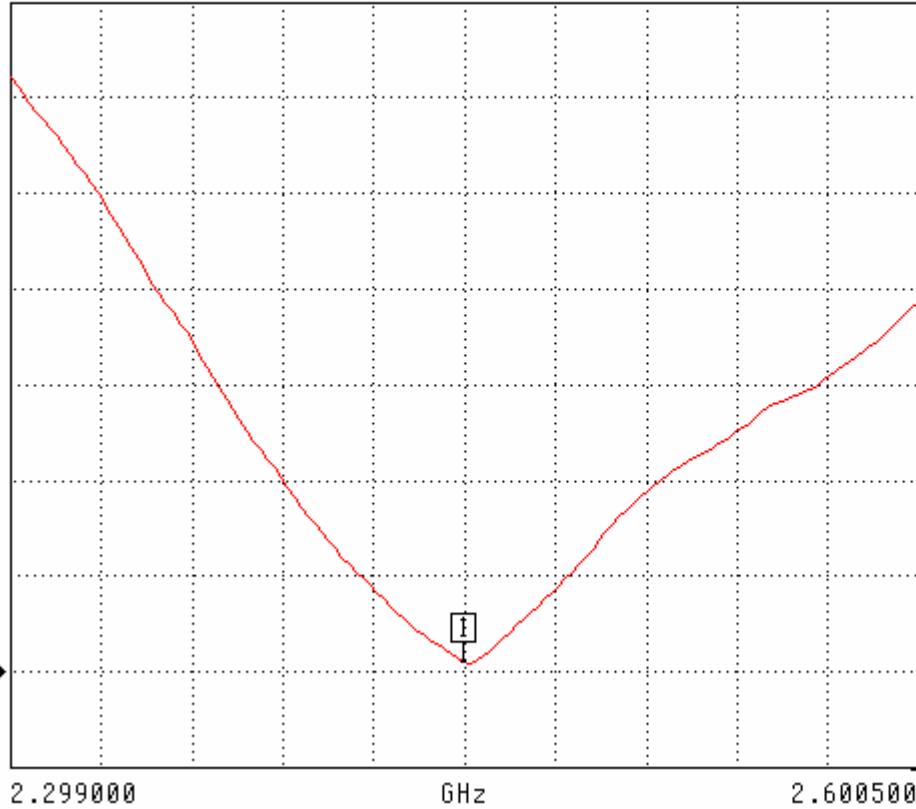
SWR

S22 REVERSE REFLECTION

SWR

REF=1.000 U

150.000 mU/DIV



CH 4 - S22  
REFERENCE PLANE  
0.0000 mm

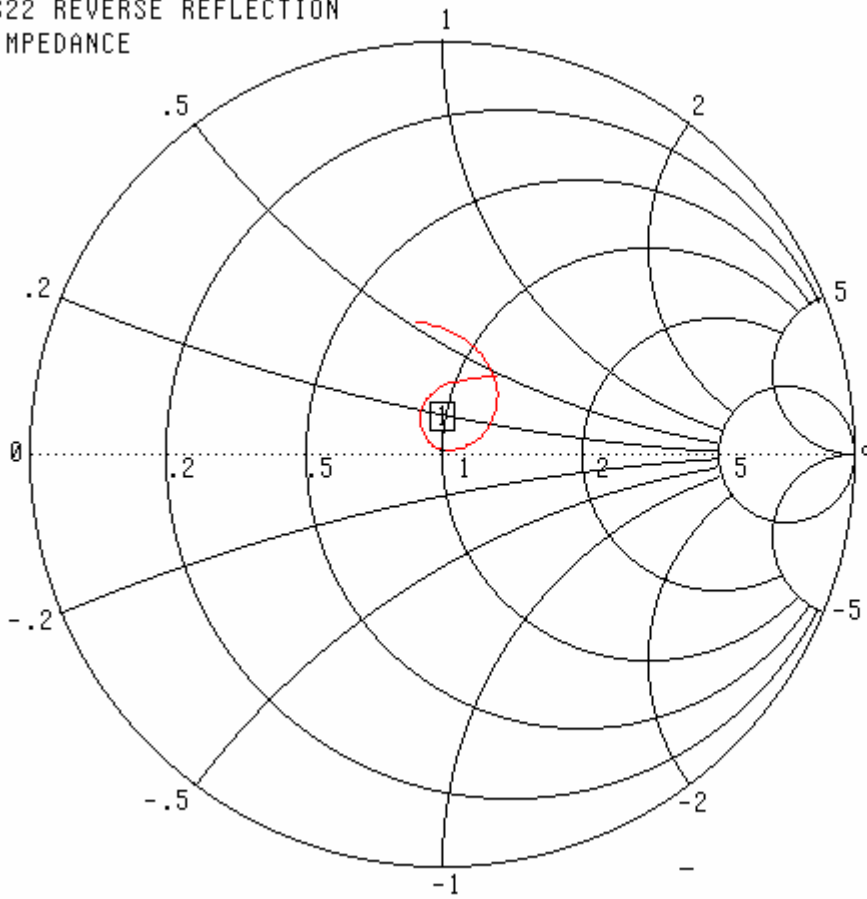
MARKER 1  
2.449750 GHz  
1.014 U

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  
2.449750 GHz  
50.609  $\Omega$   
602.944  $j\Omega$

MARKER TO MAX  
▶ MARKER TO MIN

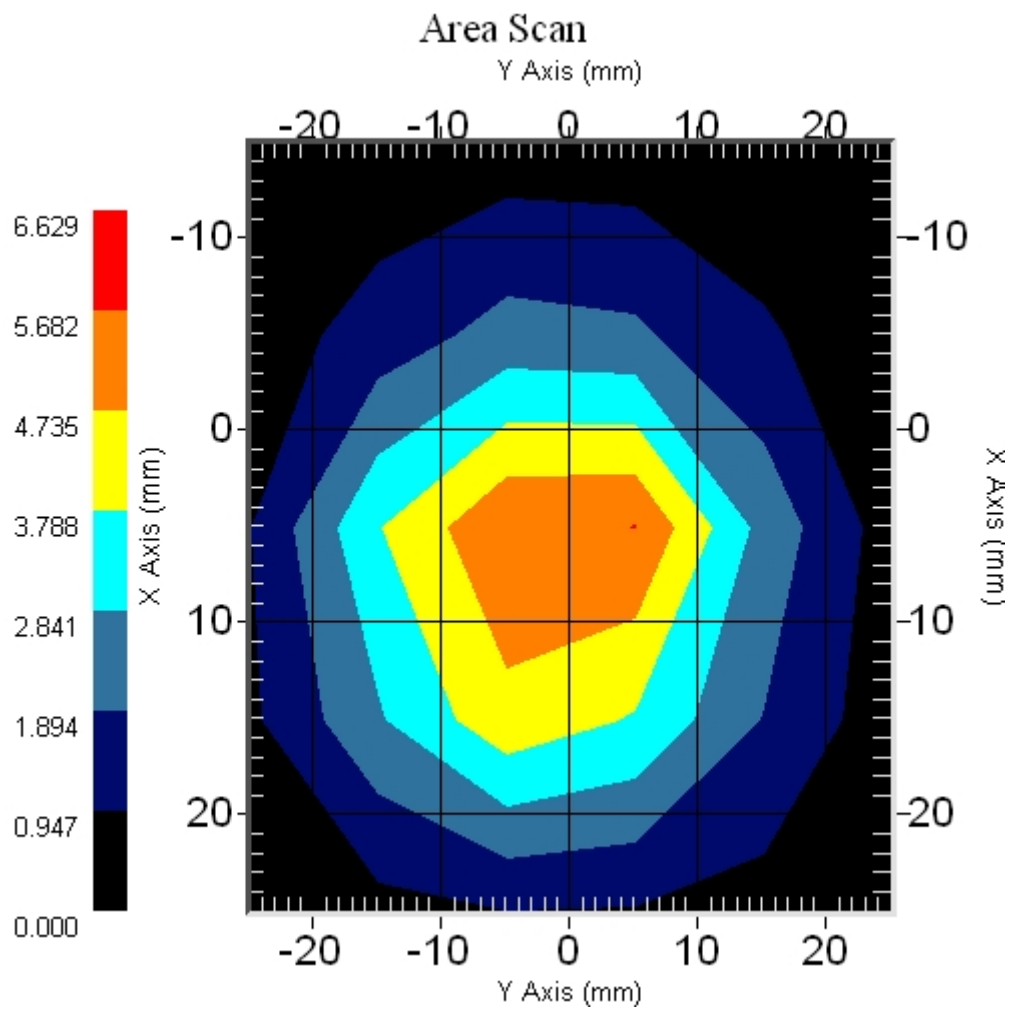
MARKER READOUT  
FUNCTIONS

2.299000 - 2.600500 GHz



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

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
2450 MHz	53.09	24.44	101.85



## **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: DC-514  
Project Number: WISB-ALSAS10U-5121

## 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.

WISB Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-5200-S-2

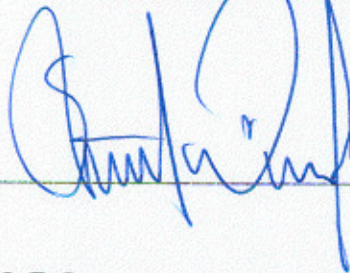
Frequency: 5200 MHz

Serial No: 5200-230-00802

Customer: WISB

Calibrated: 4<sup>th</sup> March 2005  
Released on: 4<sup>th</sup> March 2005

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



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**NCL Calibration Laboratories**

Division of APREL Laboratories.

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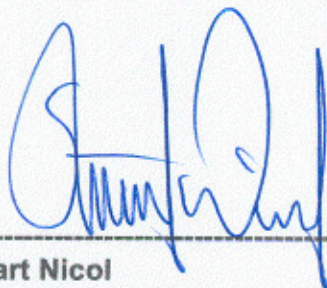
**Conditions**

Dipole 5200-230-00802 was new and 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 device has been accurately conducted and that all information contained within this report has been reviewed for accuracy.**



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



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**D. Brooks**  
**Member of Engineering Staff**  
**(Calibration Engineer)**

This page has been reviewed for content and attested to by signature within this document.

### Calibration Results Summary

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

#### Mechanical Dimensions

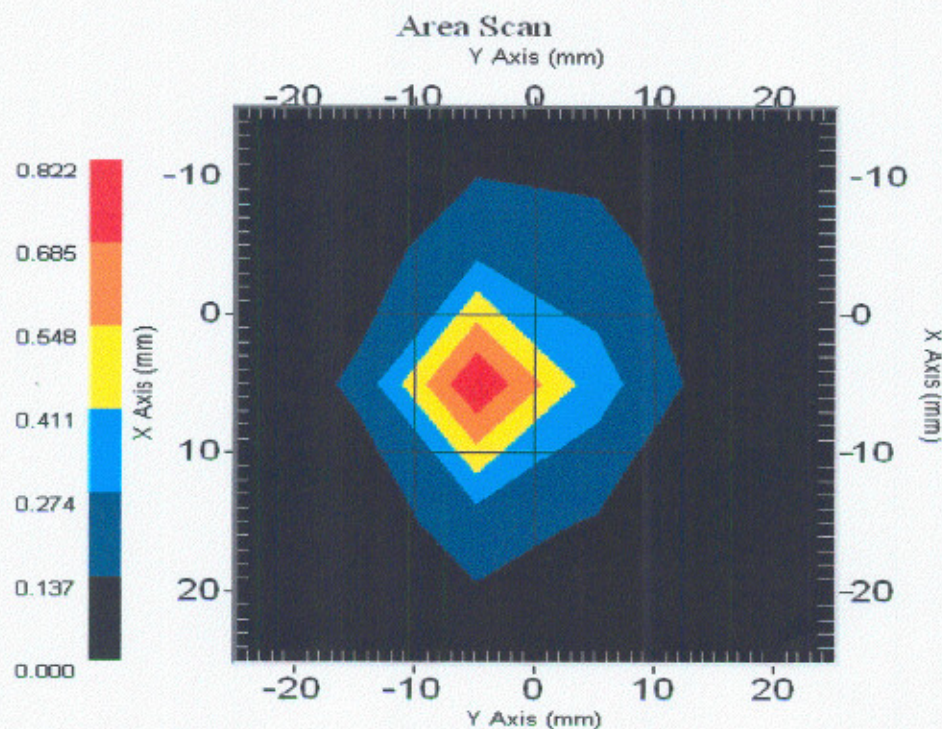
**Length:** 23.6 mm  
**Height:** 14.0 mm

#### Electrical Specification

**SWR:** 1.16 U  
**Return Loss:** -22.2 dB  
**Impedance:** 58.0  $\Omega$

#### System Validation Results

Frequency	1 Gram	10 Gram	Peak
5200 MHz	62.9	17.9	223.1



## **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 5200-230-00802. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the 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 APREL 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 5200-230-00802 was new taken from stock.

**Ambient Temperature of the Laboratory:** 22 °C +/- 0.5°C  
**Temperature of the Tissue:** 20 °C +/- 0.5°C

## Dipole Calibration Results

### Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
23.6 mm	14.0 mm	23.4 mm	15.4 mm

### Tissue Validation

Head Tissue 5200 MHz	Measured
Dielectric constant, $\epsilon_r$	35.3
Conductivity, $\sigma$ [S/m]	5.30

Electrical Calibration

Test	Result
S11 R/L	-22.2 dB
SWR	1.16 U
Impedance	58.0 $\Omega$

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

S11 Parameter Return Loss

S22 REVERSE REFLECTION

LOG MAGNITUDE

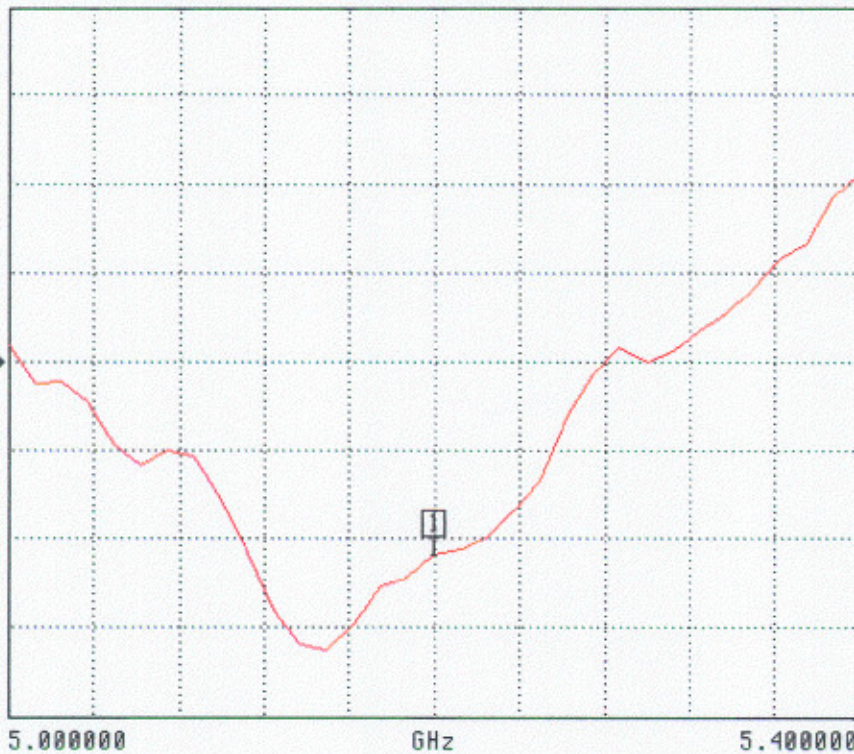
REF=-20.000 dB

1.000 dB/DIV

CH 4 - S22  
REFERENCE PLANE  
0.0000 mm

MARKER 1  
5.200000 GHz  
-22.181 dB

MARKER TO MAX  
▶ MARKER TO MIN



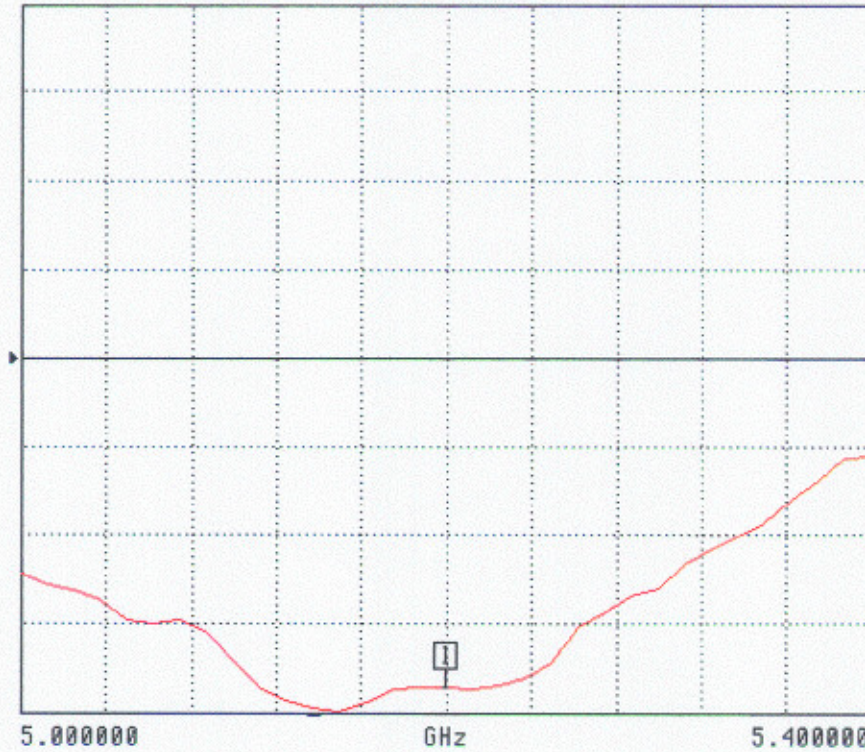
MARKER READOUT  
FUNCTIONS



SWR

S22 REVERSE REFLECTION

SWR REF=1.350 U 50.000 mU/DIV



CH 4 - S22  
REFERENCE PLANE  
0.0000 mm

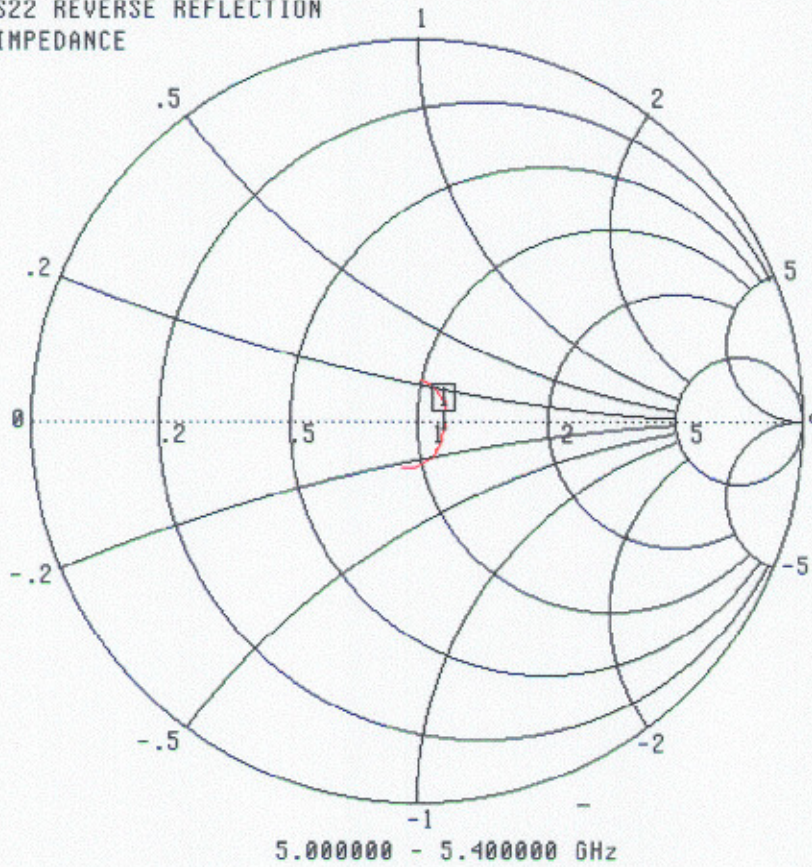
MARKER 1  
5.200000 GHz  
1.164 U

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

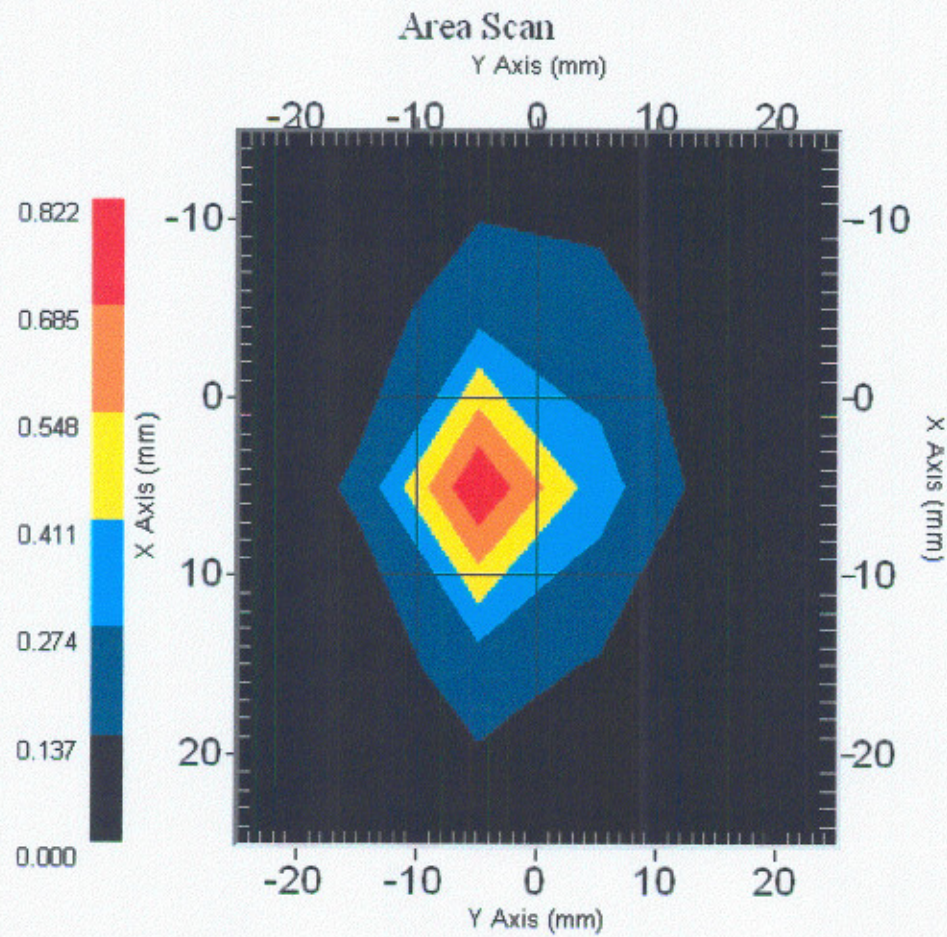
MARKER 1  
5.200000 GHz  
58.013  $\Omega$   
-3.067  $j\Omega$

MARKER TO MAX  
▶ MARKER TO MIN

MARKER READOUT  
FUNCTIONS

### System Validation Results Using the Electrically Calibrated Dipole

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
5200 MHz	62.9	17.9	223.1



## **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