QuieTek

# Appendix D. Probe Calibration

**Miniature Isotropic RF Probe**
**M/N: ALS-E-020**
**S/N: 264**

**2450MHz Body Calibration**

## NCL CALIBRATION LABORATORIES

Calibration File No.: CP-832

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 2450 MHz

Manufacturer: APREL Laboratories
Model No.: ALS-E-020
Serial No.: 264

BODY Calibration

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2
Project No: QTKB-E-Probe-5305

Calibrated: 21st August 2007
Released on: 4th September 2007

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

Released By: _____

**NCL CALIBRATION LABORATORIES**

51 SPECTRUM WAY
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Division of APREL Lab.
TEL: (613) 820-4988
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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-020 264.

## References

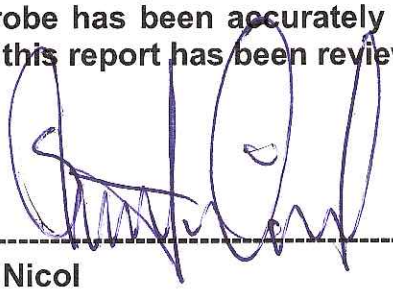
SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure
IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
SSI-TP-011 Tissue Calibration Procedure

## Conditions

Probe 264 was a re-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**

**J. Hones**

## Calibration Results Summary

| | |
|---|---|
| **Probe Type**: | E-Field Probe E-020 |
| **Serial Number:** | 264 |
| **Frequency:** | 2450 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 $\mu V/(V/m)^2$ |
| **Channel Y:** | 1.2 $\mu V/(V/m)^2$ |
| **Channel Z:** | 1.2 $\mu V/(V/m)^2$ |
| **Diode Compression Point:** | 95 mV |

## Sensitivity in Body Tissue

## Frequency: 2450 MHz

**Epsilon:** 52.7 (+/-5%) **Sigma:** 1.95 S/m (+/-5%)

**ConvF**

**Channel X:** 5.2

**Channel Y:** 5.2

**Channel Z:** 5.2

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

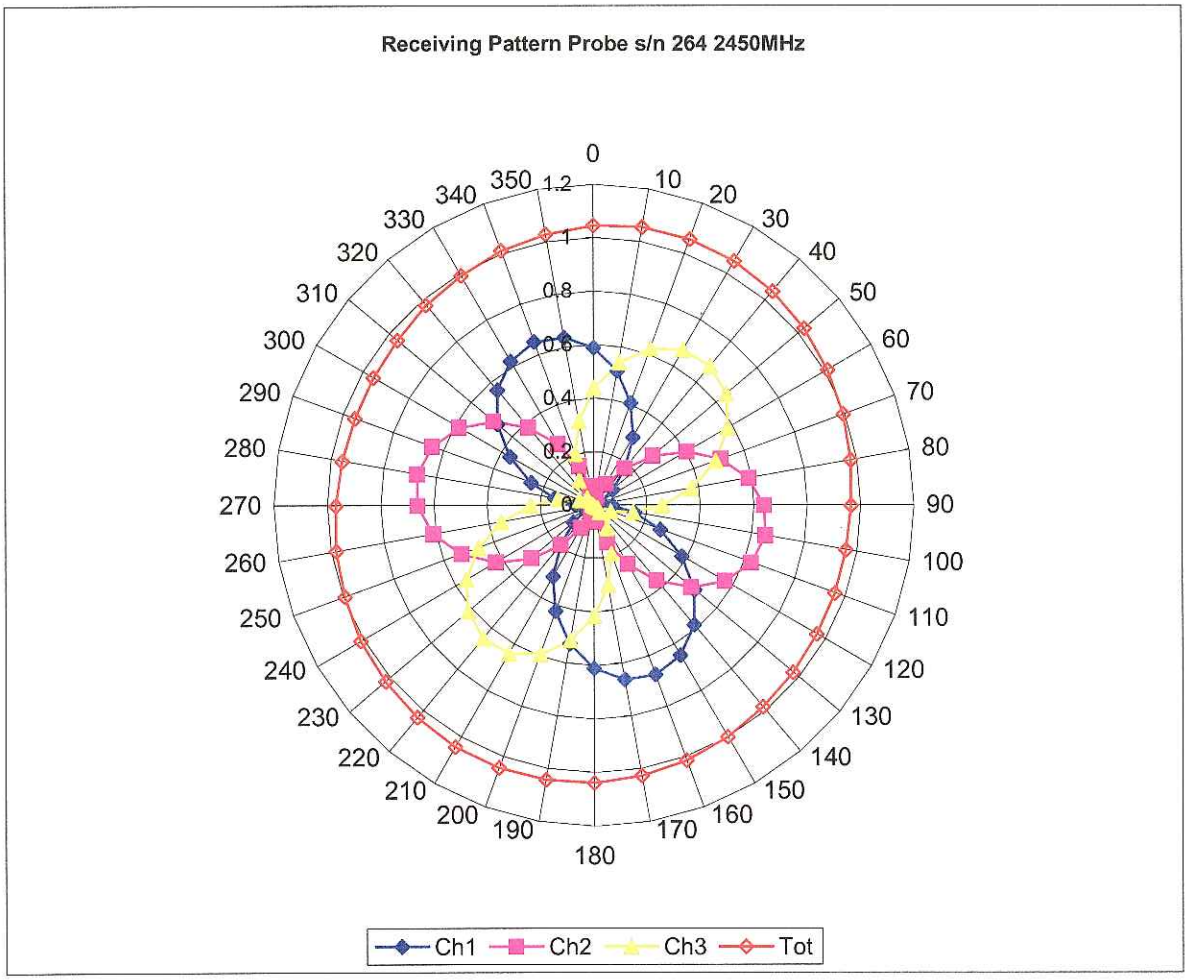
## Boundary Effect:

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 2450 MHz (Air)





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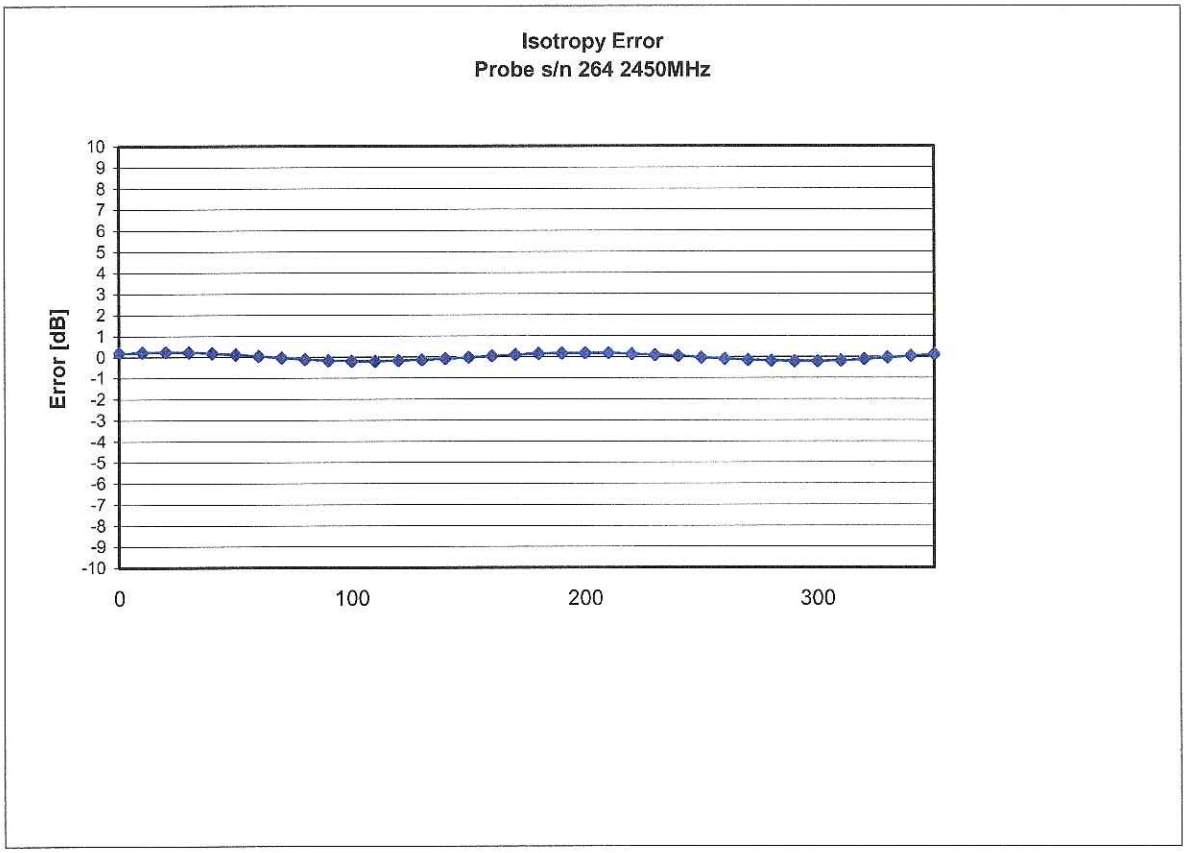
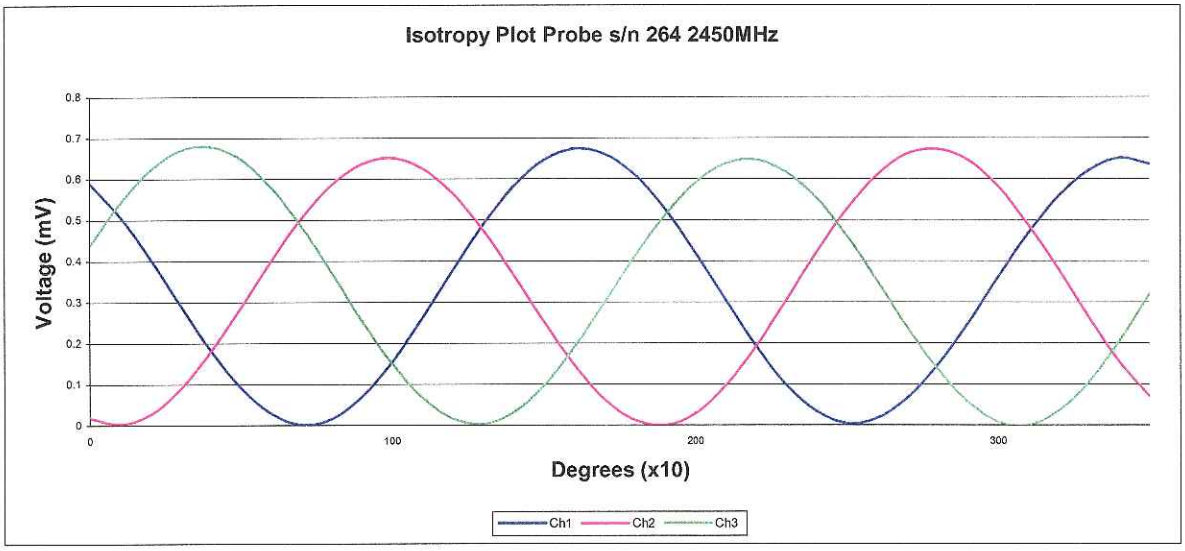
# Isotropy Error 2450 MHz (Air)




**Isotropicity in Tissue:** 0.10 dB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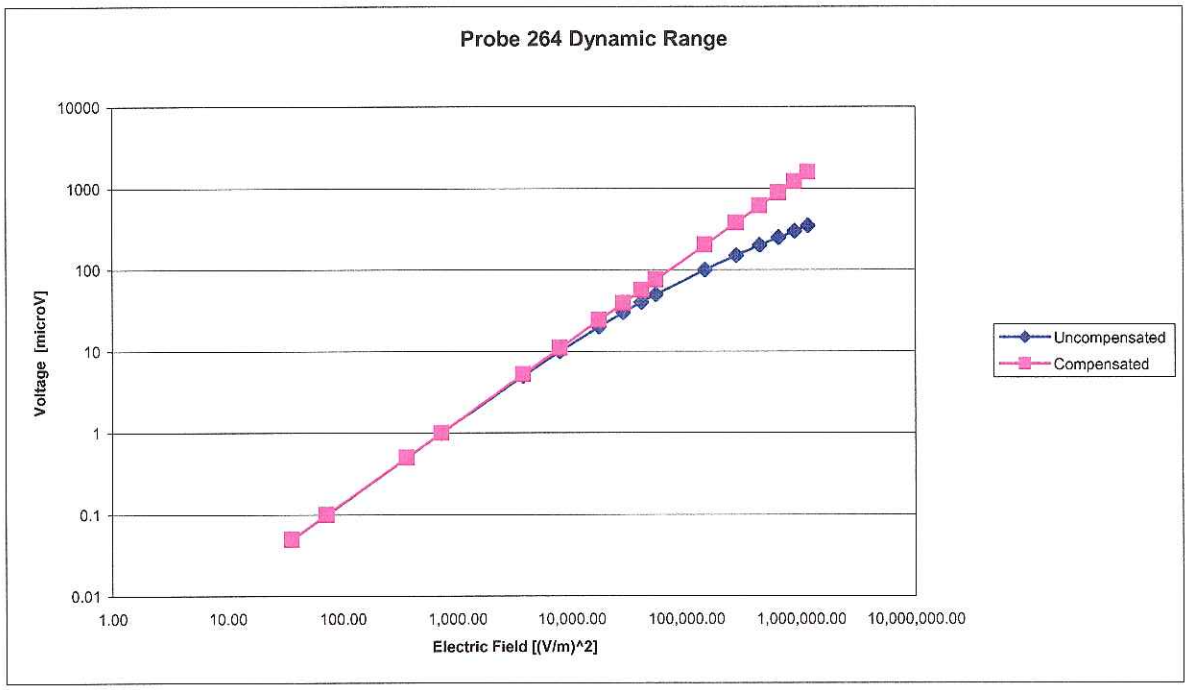
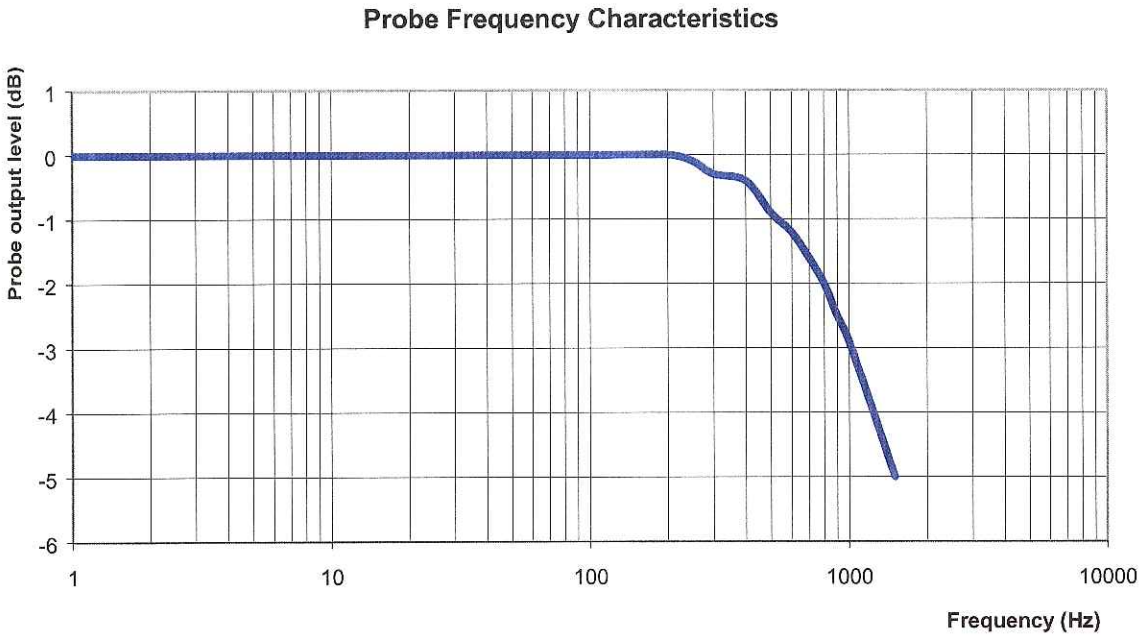
# Dynamic Range



# Video Bandwidth




| | |
|---|---|
| **Video Bandwidth at 500 Hz** | 1 dB |
| **Video Bandwidth at 1000 Hz** | 3 dB |

## Conversion Factor Uncertainty Assessment

| | | | |
|---|---|---|---|
| **Frequency:** | | 2450MHz | |
| **Epsilon:** | 52.7 (+/-5%) | **Sigma:** | 1.95 S/m (+/-5%) |
| **ConvF** | | | |
| **Channel X:** | 5.2 | 7%(K=2) | |
| **Channel Y:** | 5.2 | 7%(K=2) | |
| **Channel Z:** | 5.2 | 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 2007.

# Appendix E. Dipole Calibration

**Validation Dipole 2450 MHz**
**M/N: ALS-D-2450-S-2**
**S/N: QTK-319**

## NCL CALIBRATION LABORATORIES

Calibration File No: DC-891

# C E R T I F I C A T E  OF  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.

Quietek Validation Dipole

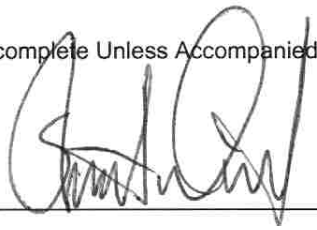
Manufacturer: APREL Laboratories
Part number: ALS-D-2450-S-2
Frequency: 2.45 GHz
Serial No: QTK-319

Customer: Quietek

Project Number: QTKB-Dipole-CAL-5336

Calibrated: 9th May 2008
Released on: 9th May 2008

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

## Calibration Results Summary

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

### Mechanical Dimensions

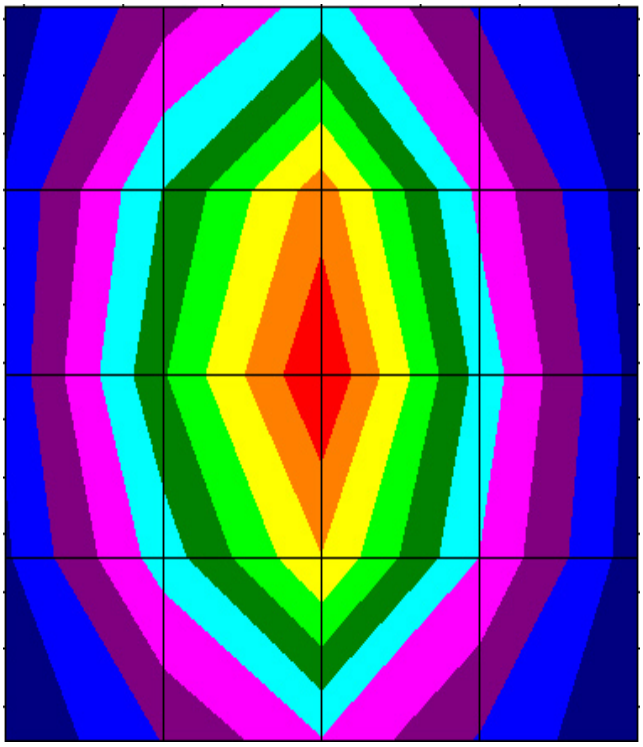
**Length:** 53.5 mm
**Height:** 30.4 mm

### Electrical Specification

**SWR:** 1.19 U
**Return Loss:** -20.8 dB
**Impedance:** 49.4 Ω

### System Validation Results

| Frequency | 1 Gram | 10 Gram | Peak |
|---|---|---|---|
| 2.45 GHz | 48.07 | 25.65 | 95.6 |



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## Conditions

Dipole 319 is a recalibration.

**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**

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**C. Teodorian**

# Dipole Calibration Results

## Mechanical Verification

| IEEE Length | IEEE Height | Measured Length | Measured Height |
|---|---|---|---|
| 51.5 mm | 30.4 mm | 53.5 mm | 30.4 mm |

## Tissue Validation

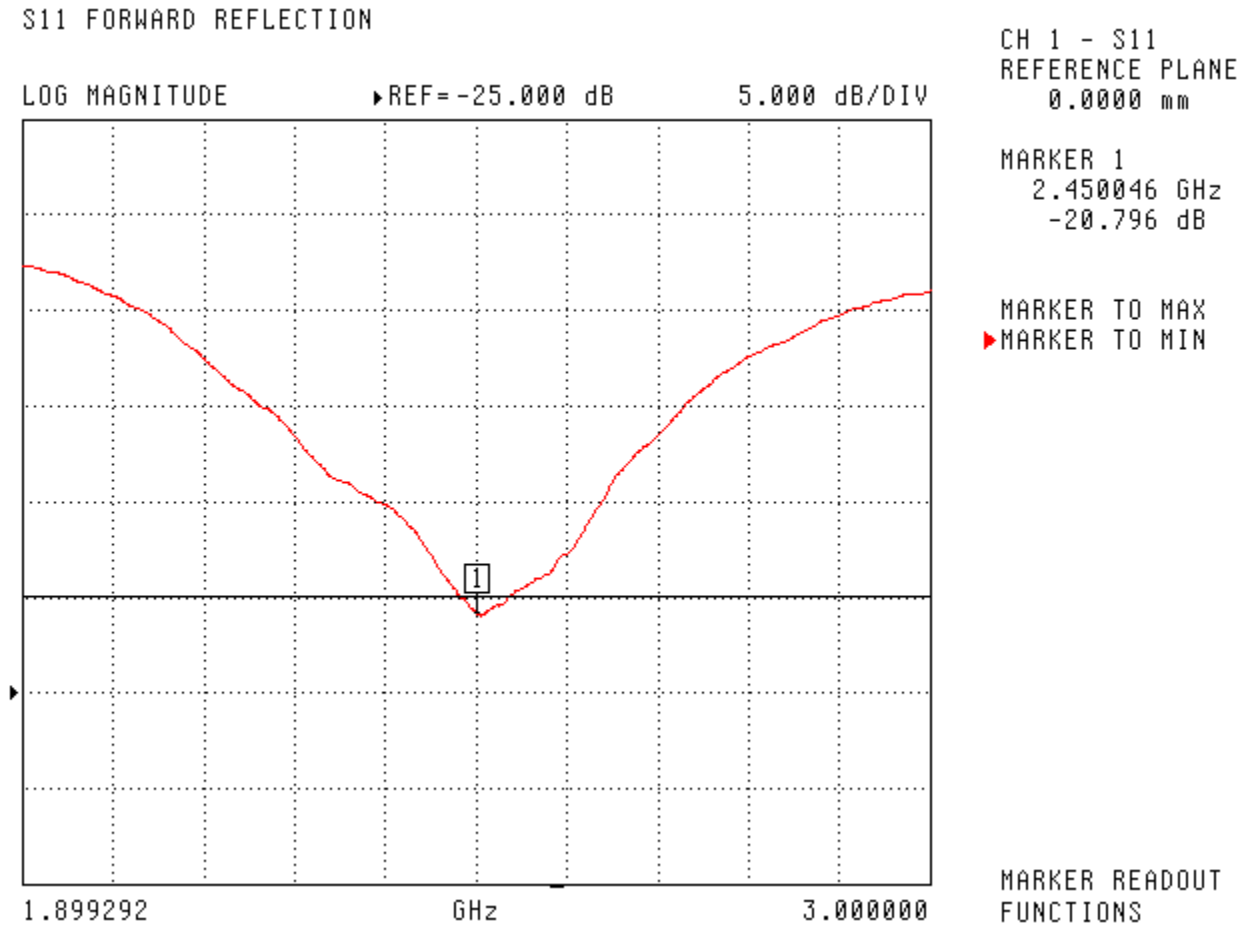
| Body Tissue 2450 MHz | Measured |
|---|---|
| **Dielectric constant, $\varepsilon_r$** | 52.5 |
| **Conductivity, $\sigma$ [S/m]** | 1.78 |

## Electrical Calibration

| Test | Result |
|---|---|
| S11 R/L | -20.8 dB |
| SWR | 1.2 U |
| Impedance | 49.4 Ω |

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

### S11 Parameter Return Loss

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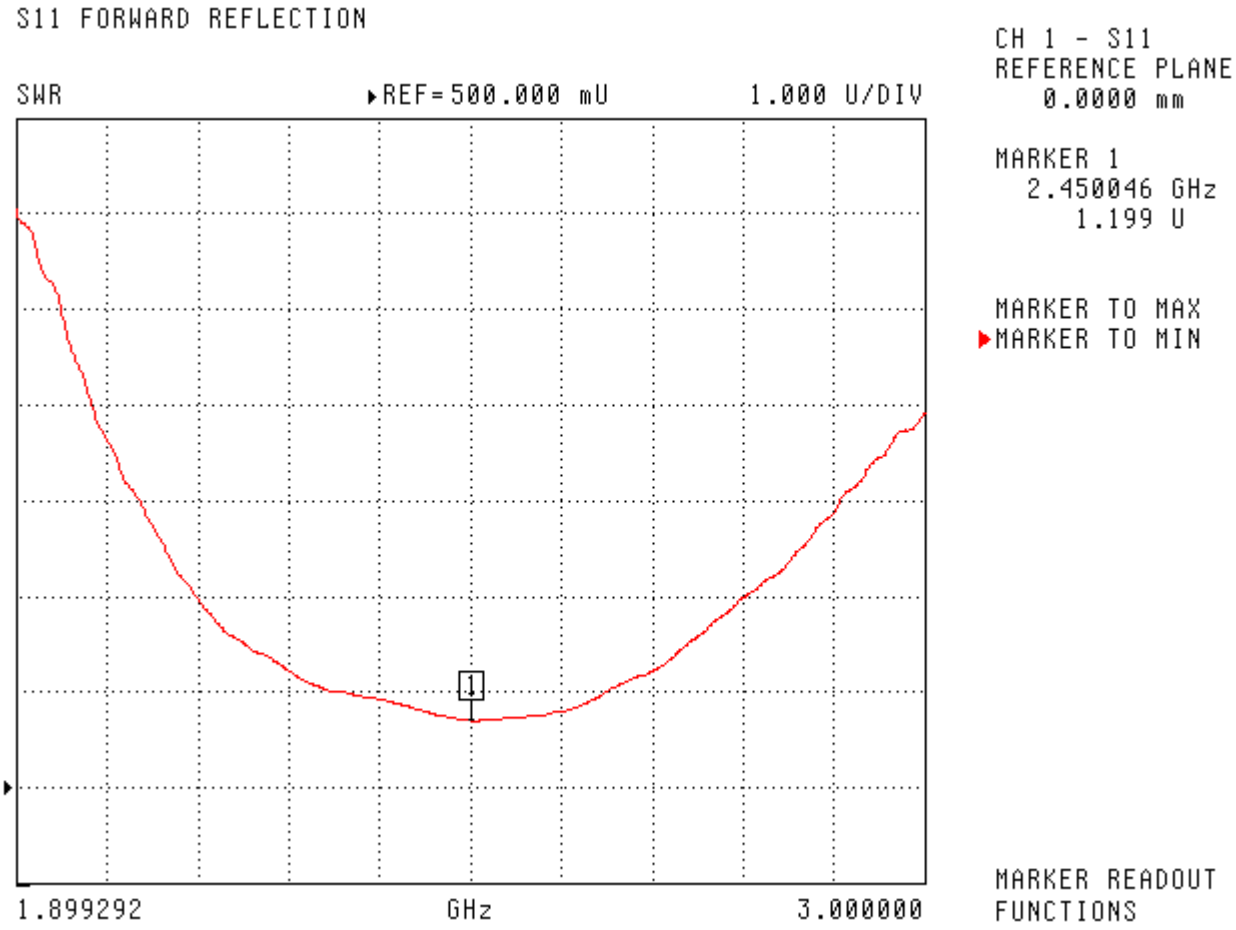
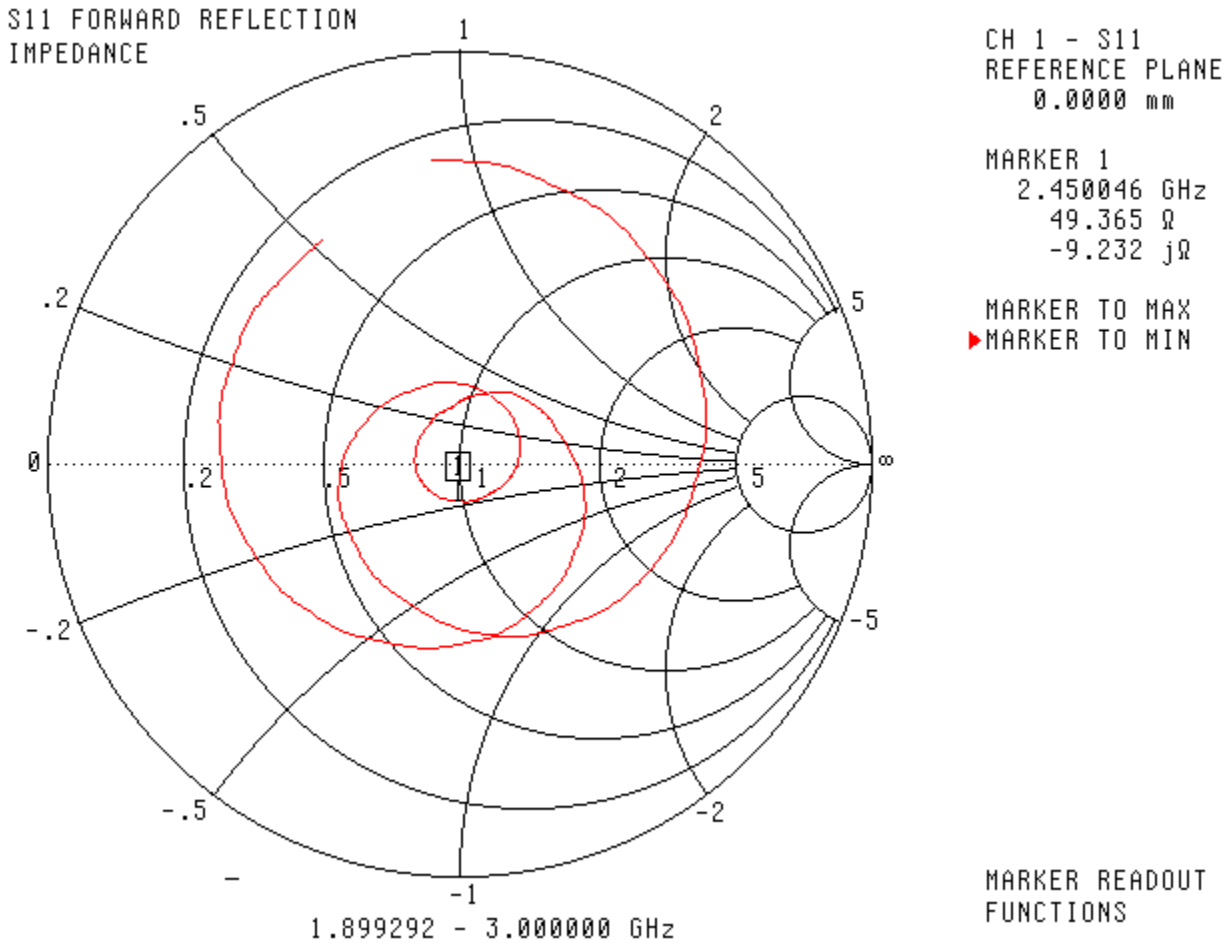
## SWR


S11 FORWARD REFLECTION
SWR
REF=500.000 mU
1.000 U/DIV
1.899292
GHz
3.000000
CH 1 - S11
REFERENCE PLANE
0.0000 mm
MARKER 1
2.450046 GHz
1.199 U
MARKER TO MAX
MARKER TO MIN
MARKER READOUT
FUNCTIONS

# Smith Chart Dipole Impedance

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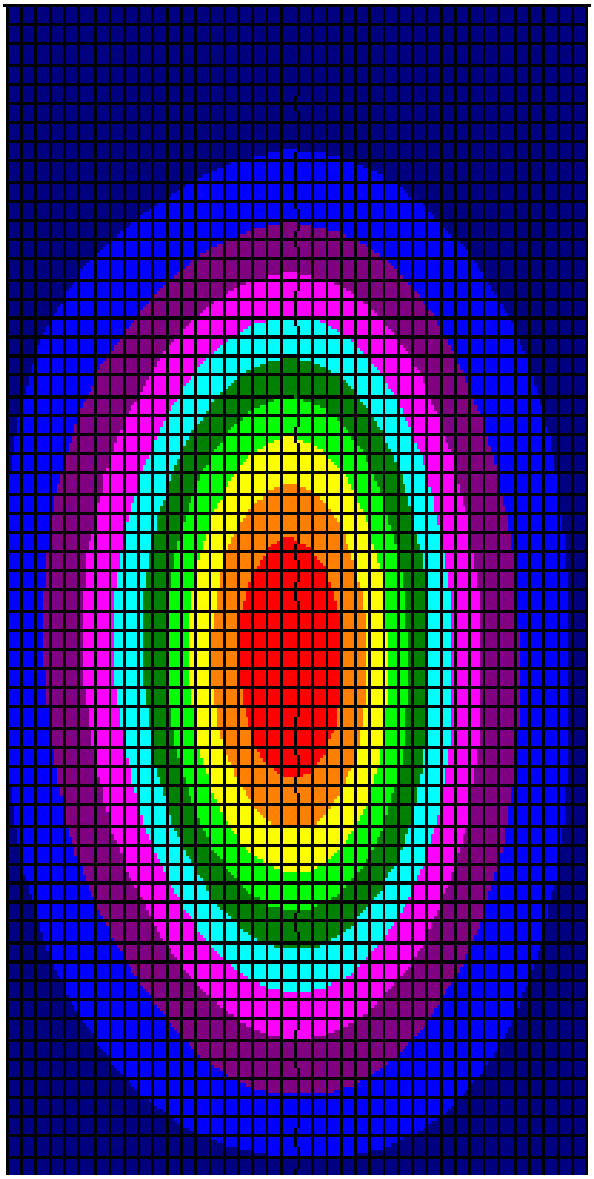
## System Validation Results Using the Electrically Calibrated Dipole

| Frequency | 1 Gram | 10 Gram | Peak Above Feed Point |
|---|---|---|---|
| 2.45 GHz | 48.07 | 25.65 | 95.6 |



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## Test Equipment

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