

Dipole calibration report

**NCL CALIBRATION LABORATORIES**

Calibration File No: DC-608  
Project Number: INKB—D2450-cal-5449

**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.

Inventec Validation Dipole

Manufacturer: APREL Laboratories

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

Frequency: 2450 MHz

Serial No: 2450-220-00755

Customer: IAC

Calibrated: May 28 2009

Released on: May 28 2009

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

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

**NCL** CALIBRATION LABORATORIES

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Division of APREL Laboratories.

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**Conditions**

Dipole 2450-220-00755 client 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**



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**C. Teodorian**

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## 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 2450-220-00755. 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 2450-220-00755 was client's.

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

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**Dipole Calibration Results**

**Mechanical Verification**

APREL Length	APREL Height	Measured Length	Measured Height
51.5 mm	30.4 mm	52.7mm	31.2 mm

**Tissue Validation**

Head Tissue 2450 MHz	Measured
Dielectric constant, $\epsilon_r$	39.2
Conductivity, $\sigma$ [S/m]	1.80

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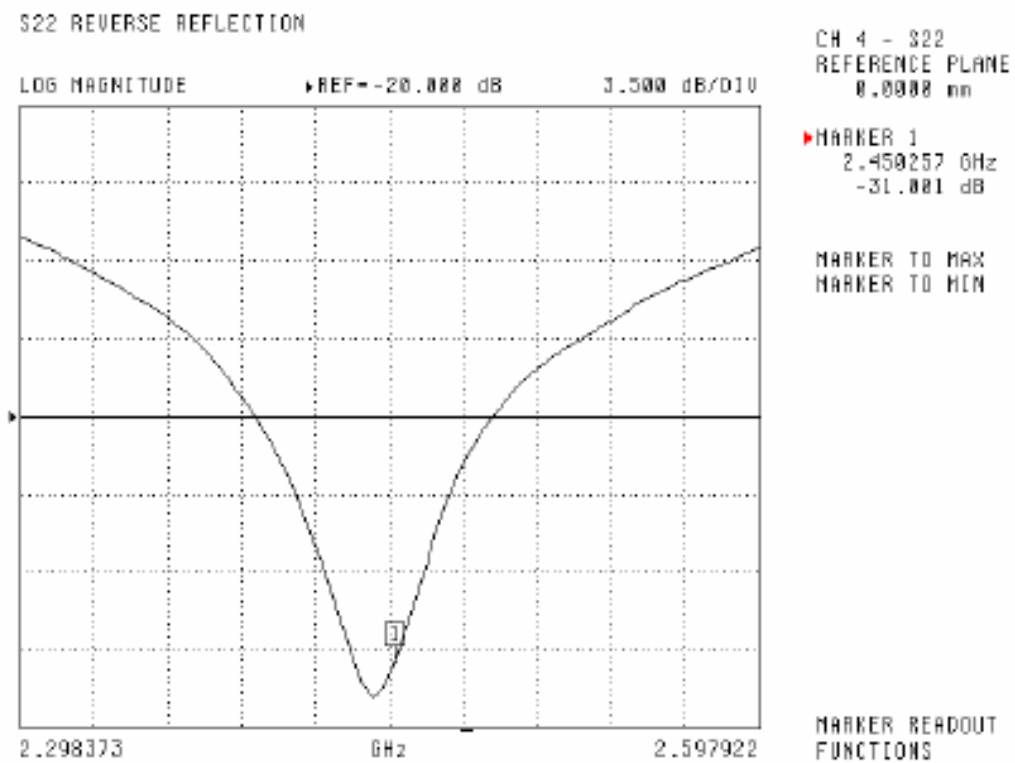
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**Electrical Calibration**

Test	Result
S11 R/L	-31.2 dB
SWR	1.06 U
Impedance	47.9 $\Omega$

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

**S11 Parameter Return Loss**

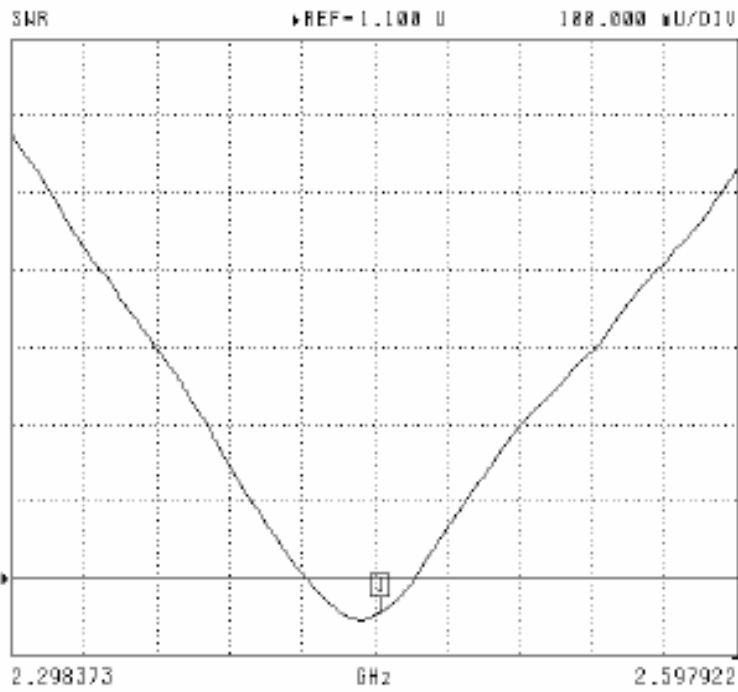


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**SWR**

522 REVERSE REFLECTION



CH 4 - 522  
REFERENCE PLANE  
0.0000 mm

MARKER 1  
2.450257 GHz  
1.055 U

MARKER TO MAX  
MARKER TO MIN

MARKER READOUT  
FUNCTIONS

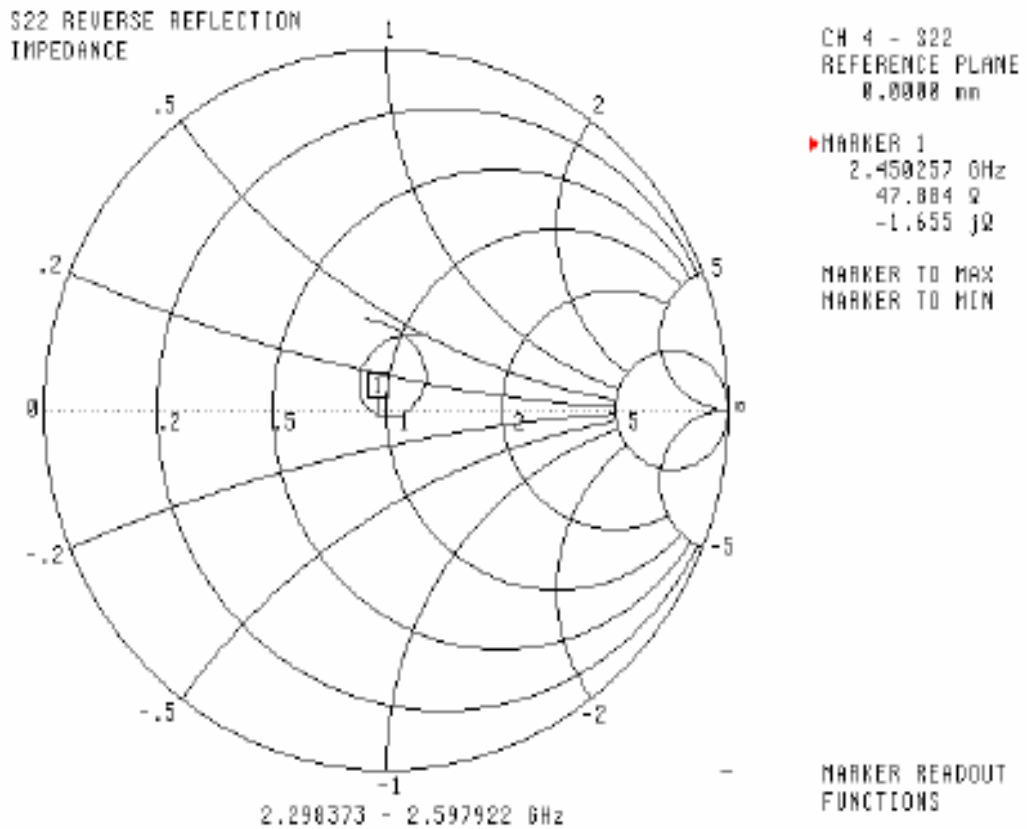
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**Smith Chart Dipole Impedance**



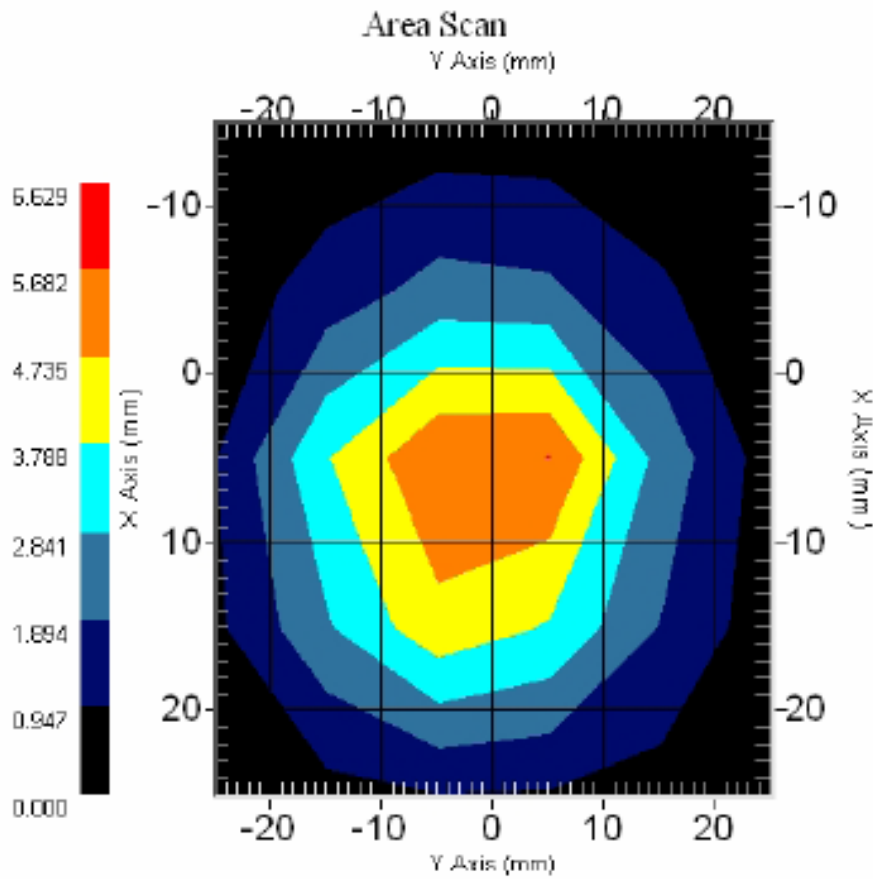
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**System Validation Results Using the Electrically Calibrated Dipole**

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
2450 MHz	5.31	2.44	10.18



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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

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## Probe calibration report

### NCL CALIBRATION LABORATORIES

Calibration File No.: CP-1152

Client.: IAC

## 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.: 273-B

Body Calibration

Calibration Procedure: SSIDRB-TP-D01-032-E020-V2

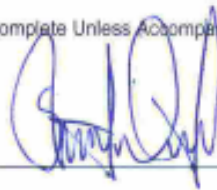
Project No: SGLB-IAC rep-E020-5538

Calibrated: 13 September 2010

Released on: 17 September 2010

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

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



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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-020 278.

## 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
- IEC 62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures –Part 1 & 2: Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)"
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

## Conditions

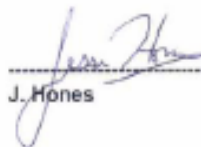
Probe 273-B was a new-calibration.

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.



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Stuart Nicol



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J. Hones

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**Calibration Results Summary**

<b>Probe Type:</b>	E-Field Probe E-020
<b>Serial Number:</b>	273-B
<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

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**Sensitivity in Body Tissue Measured**

**Frequency:** 2450 MHz

**Epsilon:** 50.89 (+/-5%)      **Sigma:** 1.94 S/m (+/-5%)

**ConvF**

**Channel X:** 3.6

**Channel Y:** 3.6

**Channel Z:** 3.6

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

**Boundary Effect:**

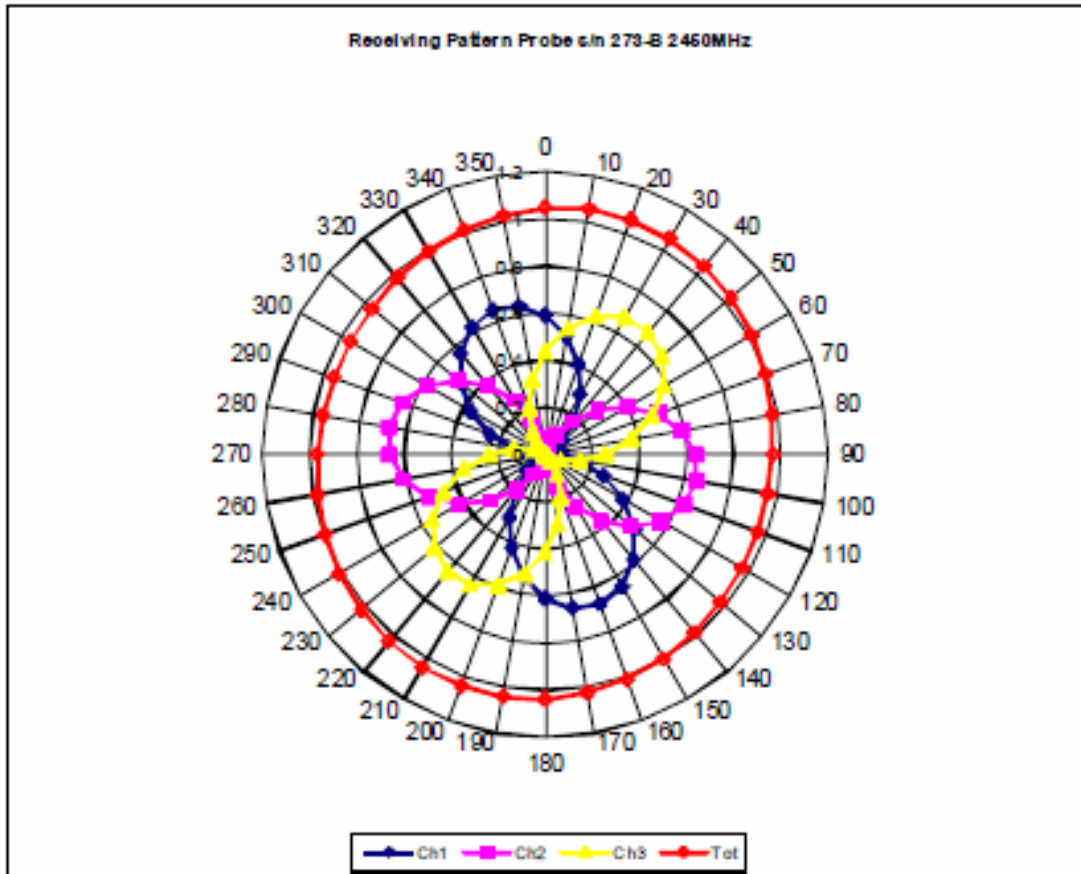
Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.44mm.

**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.

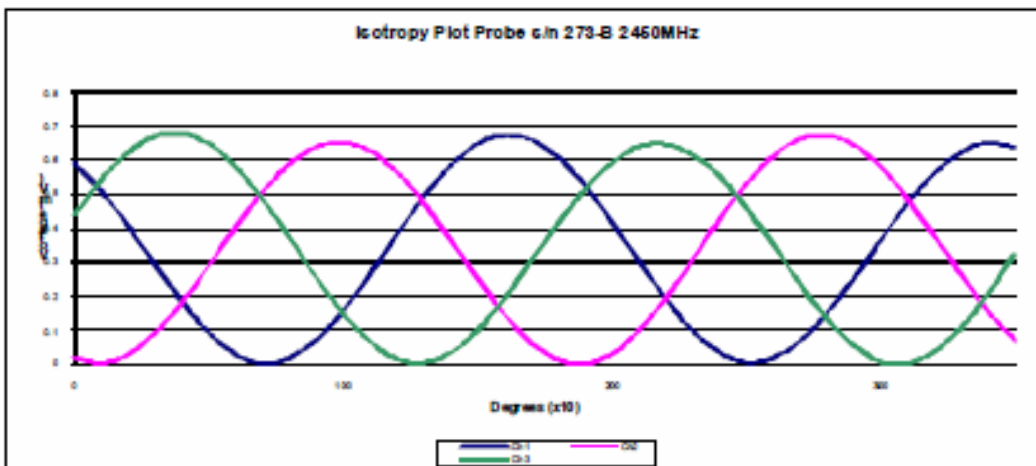
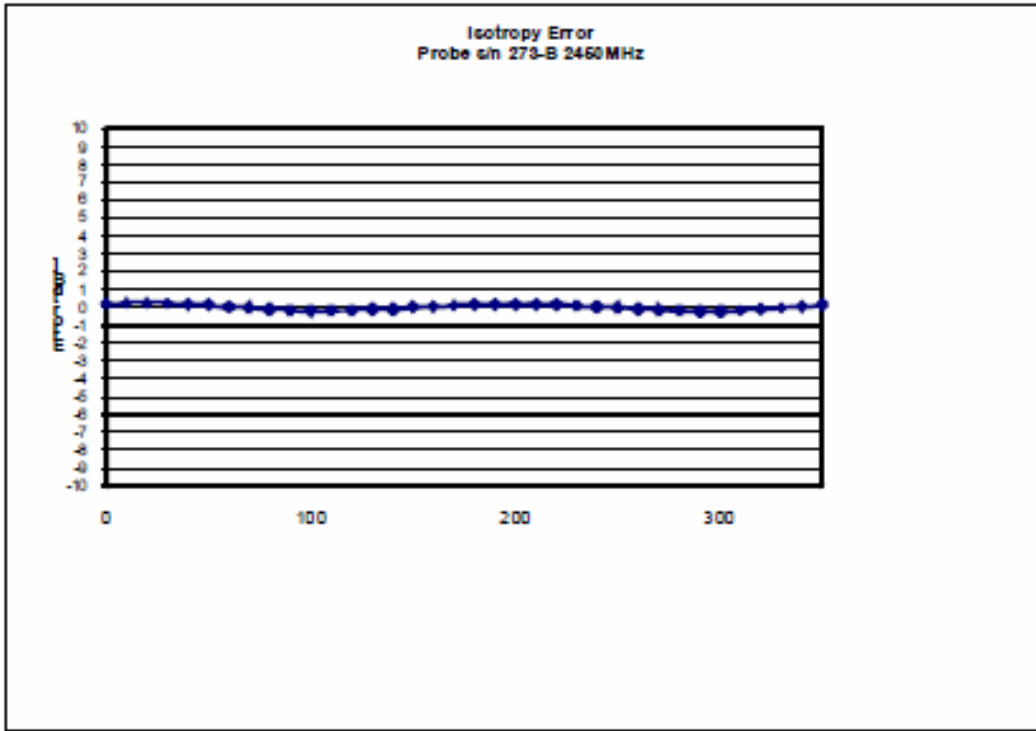
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### Receiving Pattern 2450 MHz (Air)



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### Isotropy Error 2450 MHz (Air)



Isotropicity in Tissue:

0.10 dB

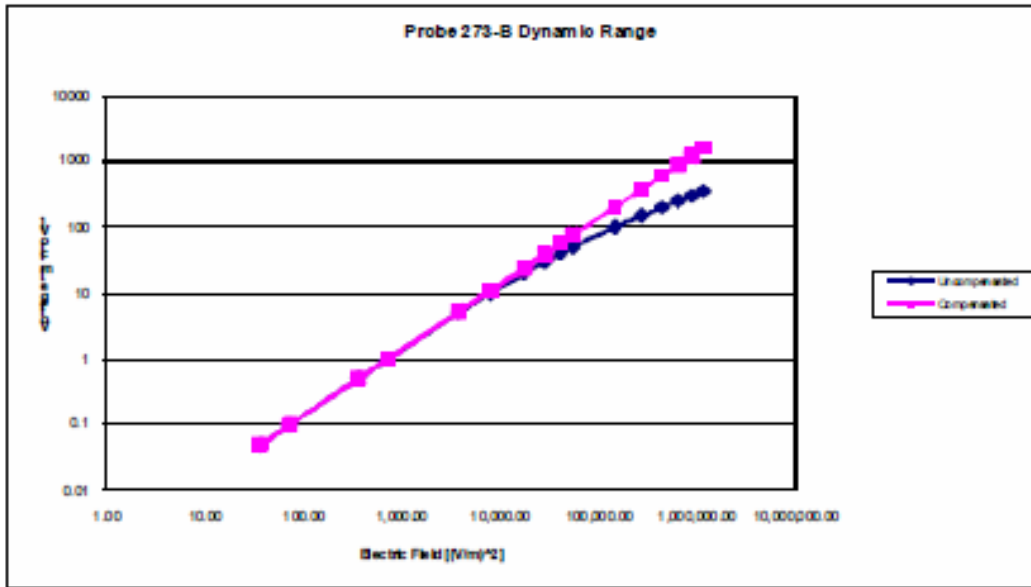


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## Dynamic Range



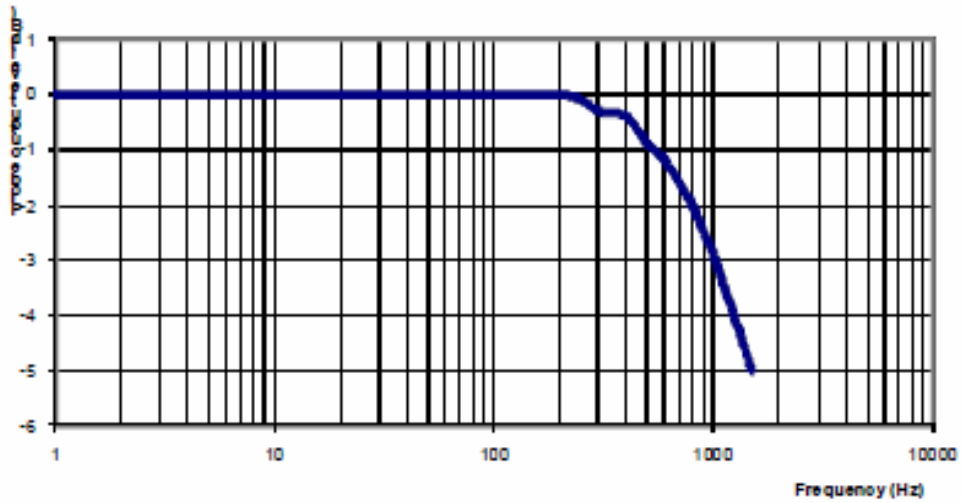
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## Video Bandwidth

Probe Frequency Characteristics



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

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**Conversion Factor Uncertainty Assessment**

**Frequency:** 2450MHz  
**Epsilon:** 50.89 (+/-5%)      **Sigma:** 1.94 S/m (+/-5%)

**ConvF**

**Channel X:** 3.6      7%(K=2)  
**Channel Y:** 3.6      7%(K=2)  
**Channel Z:** 3.6      7%(K=2)

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 M $\Omega$ .

**Boundary Effect:**

For a distance of 2.4mm the evaluated uncertainty (increase in the probe sensitivity) is less than 2%.

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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 2010.

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