

Appendix D – Probe Calibration Data Sheets

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-606

Client.: RFEL

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.: 215

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

Project No: RFEL-Probe-215-Calibration-5166

BODY Calibration

Calibrated: 10th June 2005
Released on: 10th June 2005

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

Released By: _____ Signature On File

NCL CALIBRATION LABORATORIES

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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-020 215.

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 215 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

Janusz Lokaj
Member of Engineering Staff
(Calibration Engineer)

Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	215
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 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Y:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Z:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Diode Compression Point:	95 mV

Sensitivity in Body Tissue

Frequency: 2450 MHz

Epsilon: 39.2 (+/-5%) **Sigma:** 1.80 S/m (+/-10%)

ConvF

Channel X: 4.6

Channel Y: 4.6

Channel Z: 4.6

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

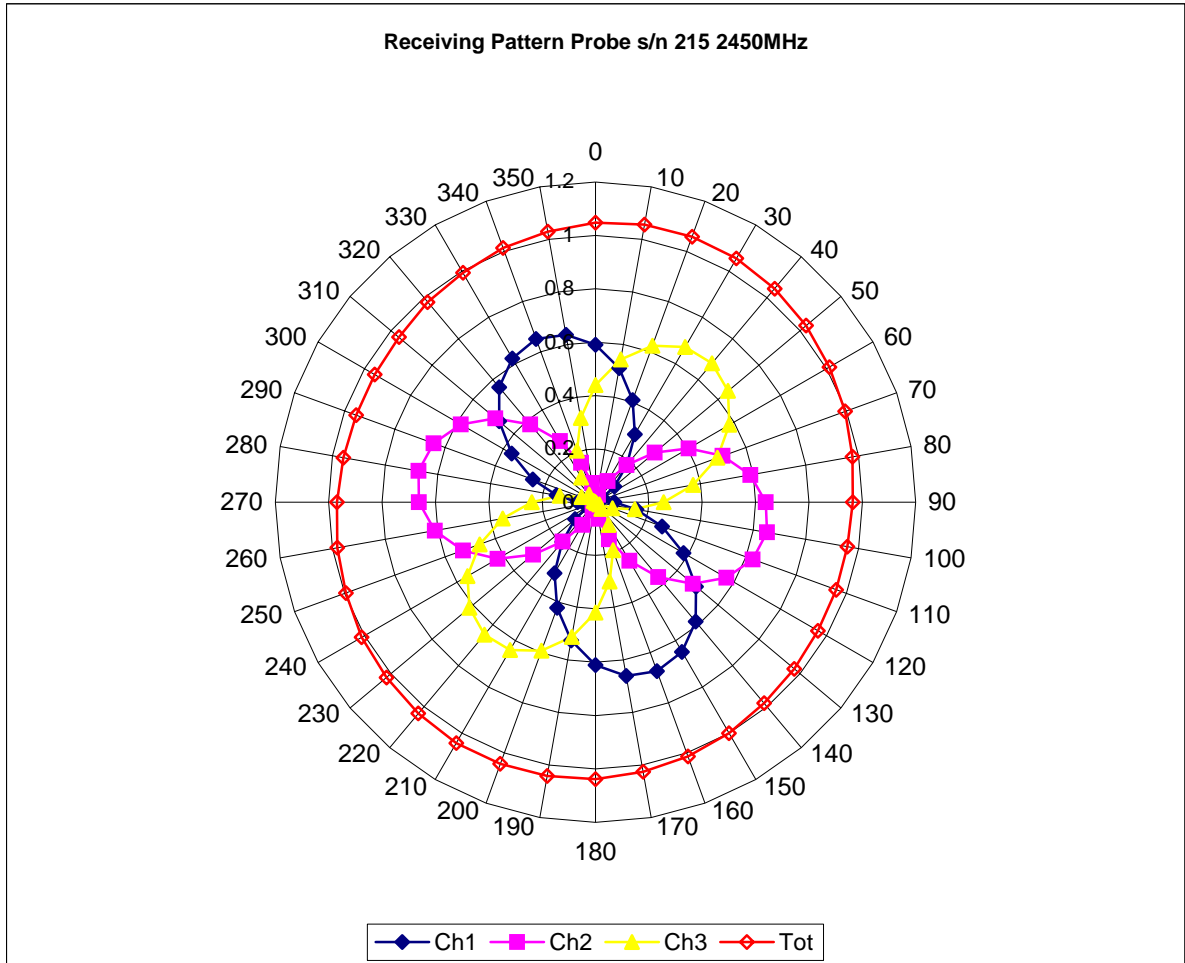
Boundary Effect:

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.

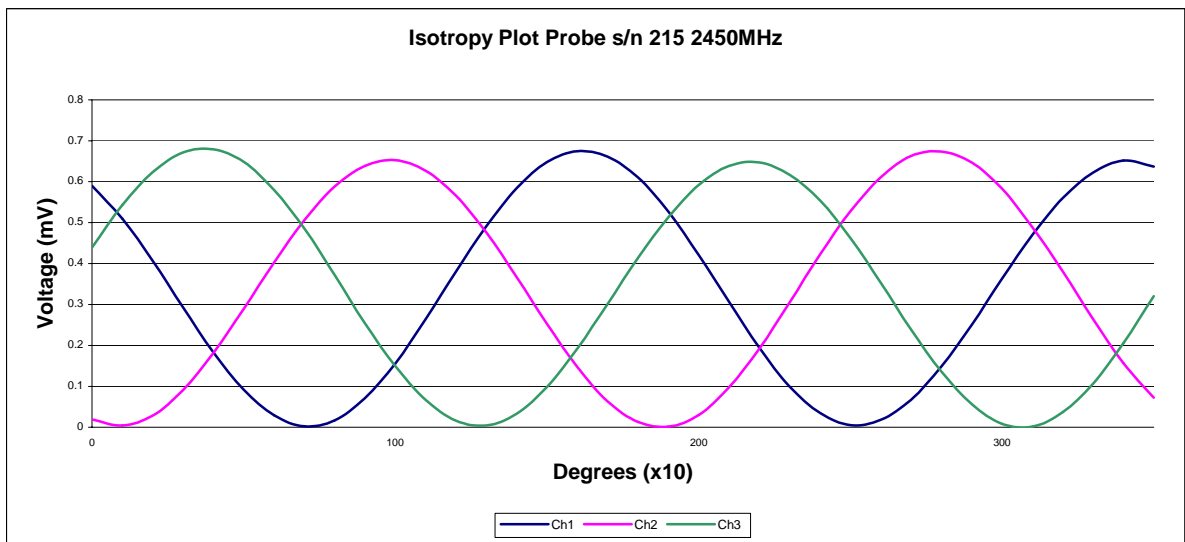
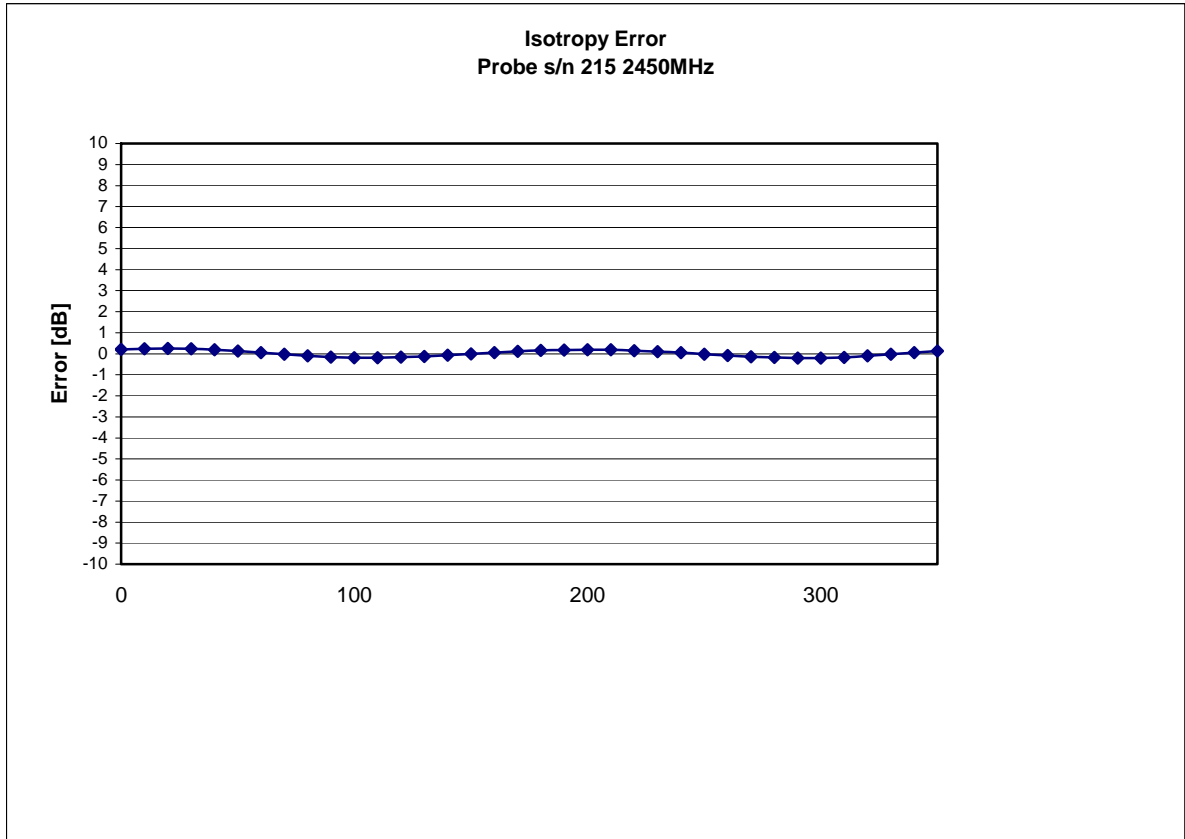
Spatial Resolution:

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.

Receiving Pattern 2450 MHz (Air)



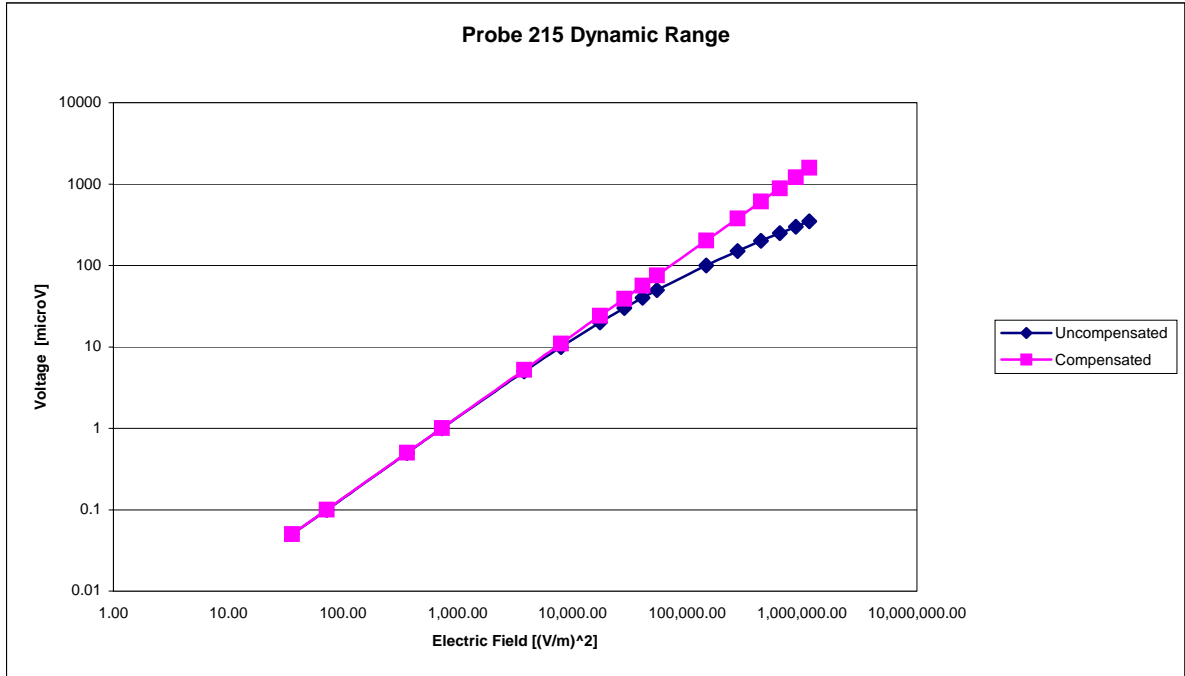
Isotropy Error 2450 MHz (Air)



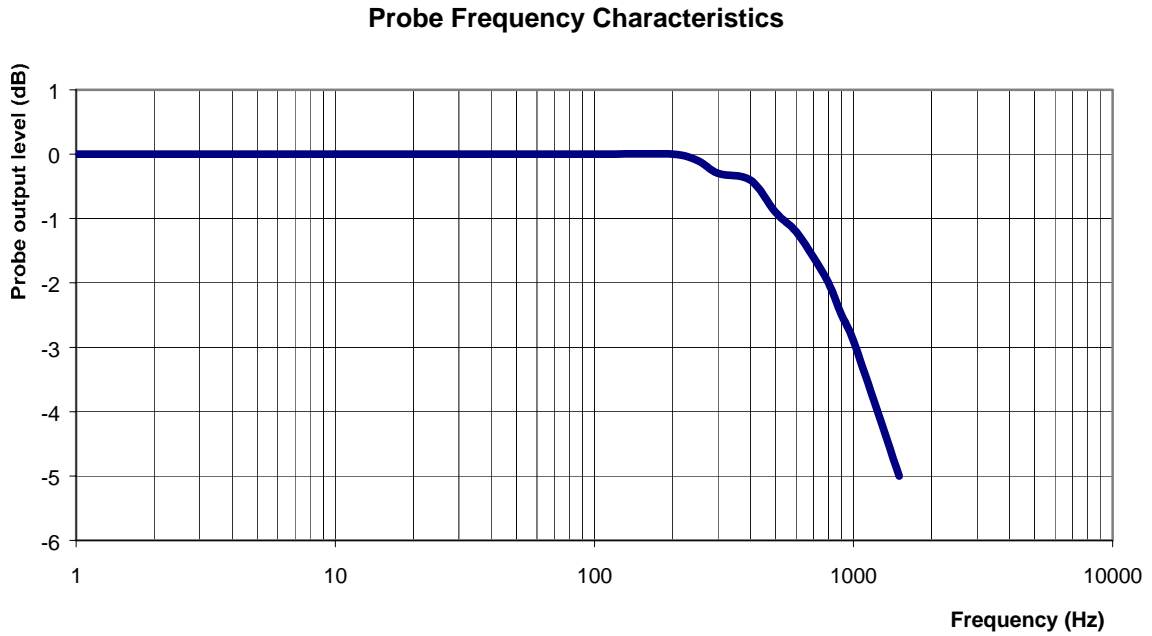
Isotropicity in Tissue:

0.10 dB

Dynamic Range



Video Bandwidth



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

Conversion Factor Uncertainty Assessment

Frequency: 2450MHz
Epsilon: 39.2 (+/-5%) **Sigma:** 1.80 S/m (+/-10%)

ConvF

Channel X: 4.6 7%(K=2)
Channel Y: 4.6 7%(K=2)
Channel Z: 4.6 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 2005.

Appendix E – Dipole Calibration Data Sheets

NCL CALIBRATION LABORATORIES

Calibration File No: CD-342
Project Number: RFEB-ALSAS-10U-4087

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.

RFE Validation Dipole

Manufacturer: APREL Laboratories

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

Frequency: 2.45 GHz

Serial No: RFE-278

Customer: RFE

Calibrated: 20 February 2004
Released on: 20 February 2004

Released By:



W. Frank for S. Nicol

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Calibration Results Summary

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

Mechanical Dimensions

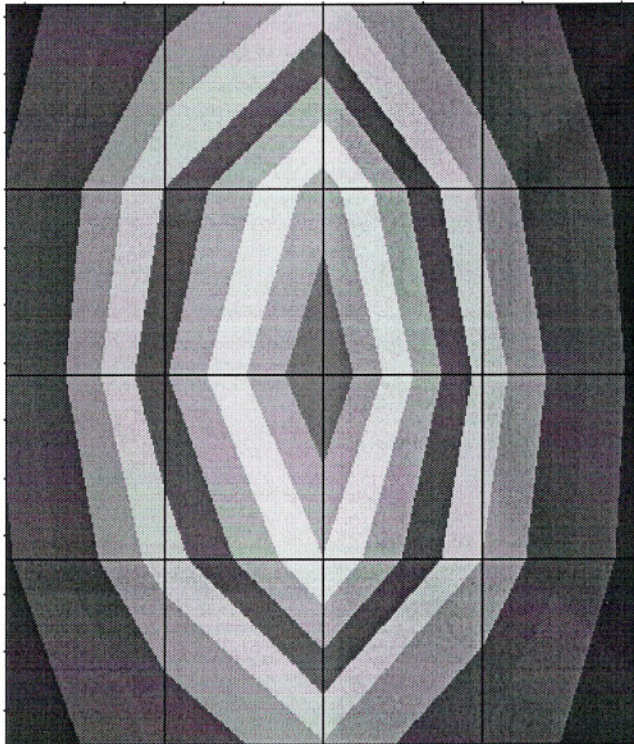
Length: 51.5 mm
Height: 30.5 mm

Electrical Specification

SWR: 1.09 U
Return Loss: -26.8 dB
Impedance: 49.0 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
2.45 GHz	48.07	25.65	95.6



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 RFE-278. 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 Panasonic E-020 130 MHz to 26 GHz E-Field Probe Serial Number 213.

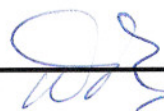
References

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 RFE-278 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

IEEE Length	IEEE Height	Measured Length	Measured Height
51.5 mm	30.4 mm	51.5 mm	30.5 mm

Tissue Validation

Body Tissue 2450 MHz	Measured
Dielectric constant, ϵ_r	52.5
Conductivity, σ [S/m]	1.78



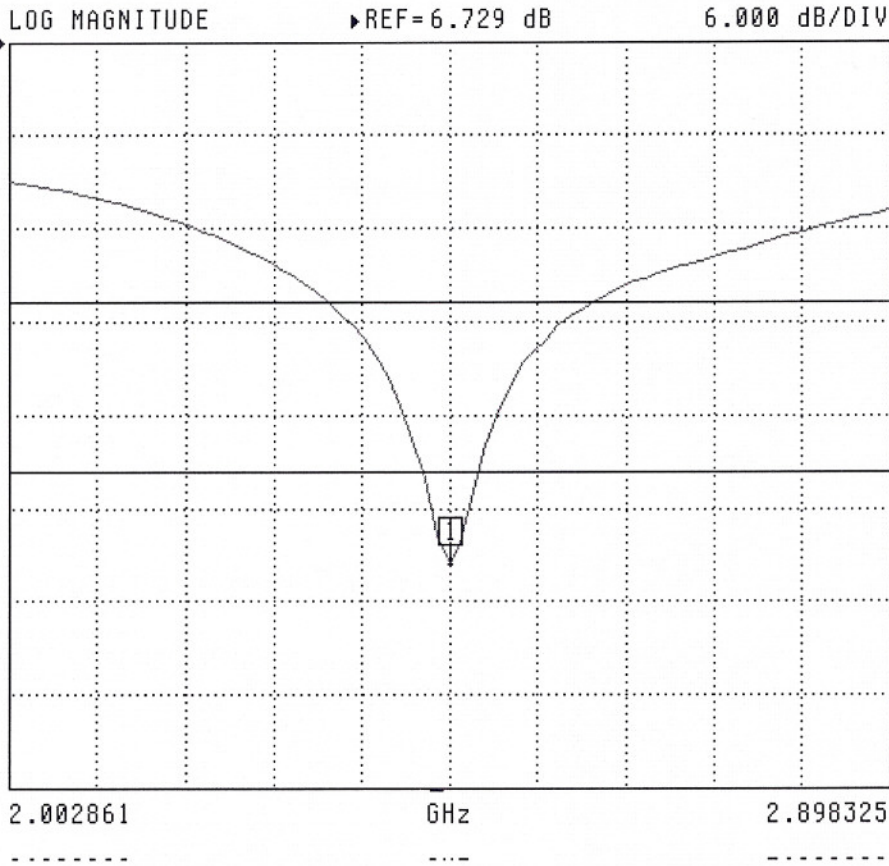
Electrical Calibration

Test	Result
S11 R/L	-26.8 dB
SWR	1.098 U
Impedance	49.0 Ω

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

S11 Parameter Return Loss

S11 FORWARD REFLECTION



CH 1 - S11
REFERENCE PLANE
6.9844 mm

▶ MARKER 1
2.450593 GHz
-26.830 dB

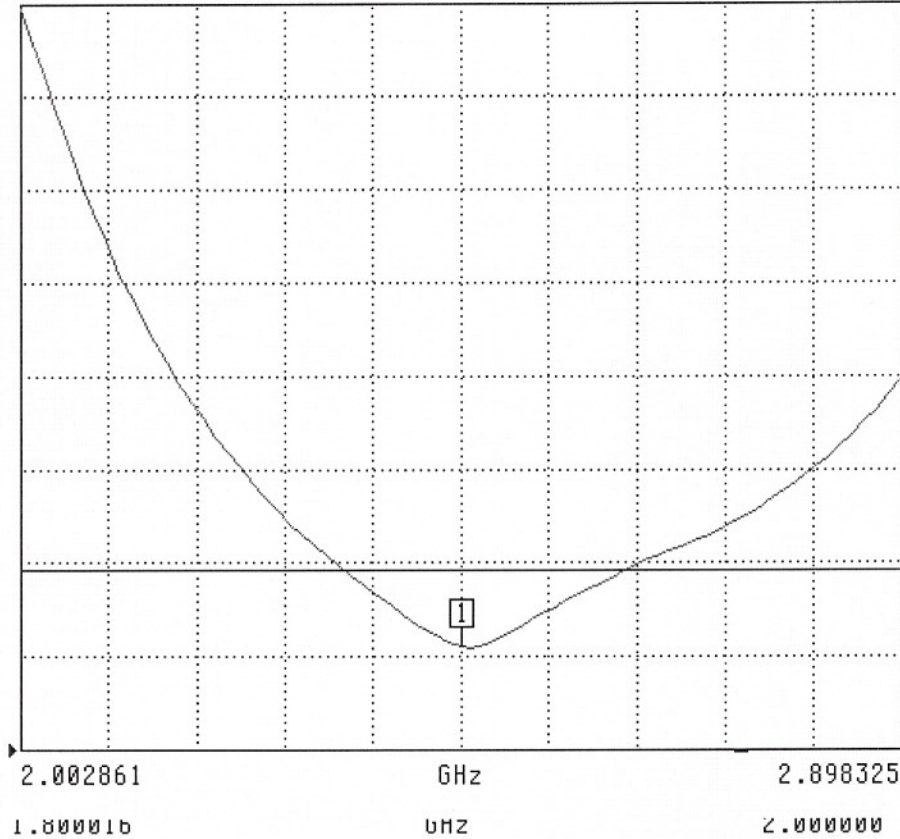
MARKER TO MAX
MARKER TO MIN

MARKER READOUT
FUNCTIONS

SWR

S11 FORWARD REFLECTION

SWR ▶ REF=0.000 pU 1.000 U/DIV



CH 1 - S11
REFERENCE PLANE
6.9844 mm

▶ MARKER 1
2.450593 GHz
1.098 U

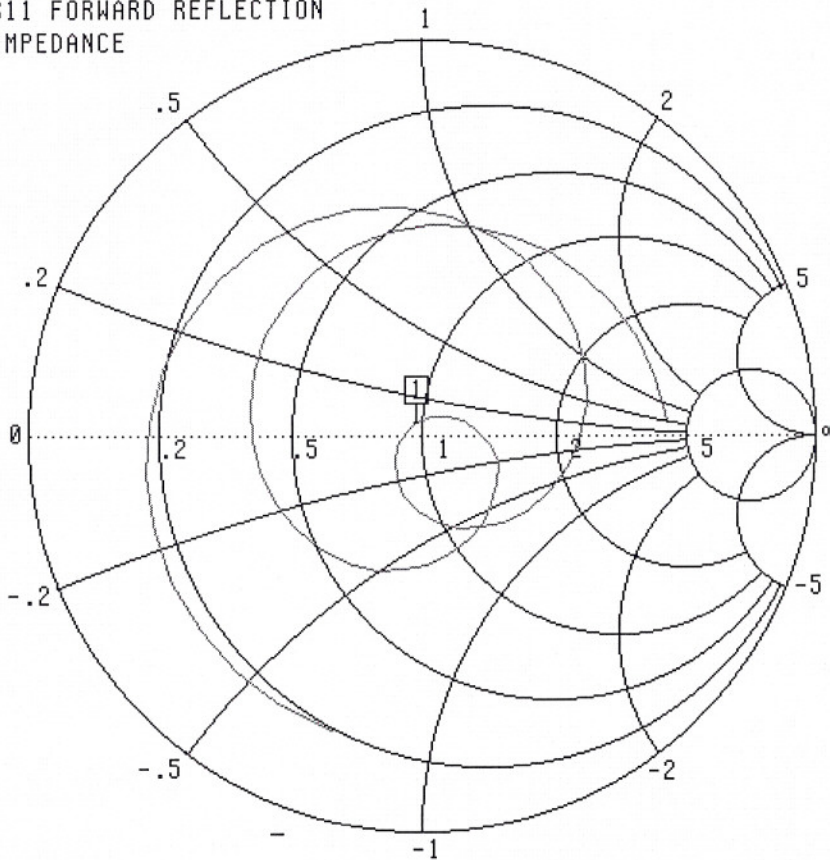
MARKER TO MAX
MARKER TO MIN

MARKER READOUT
FUNCTIONS

FUNCTIONS

Smith Chart Dipole Impedance

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
REFERENCE PLANE
6.9844 mm

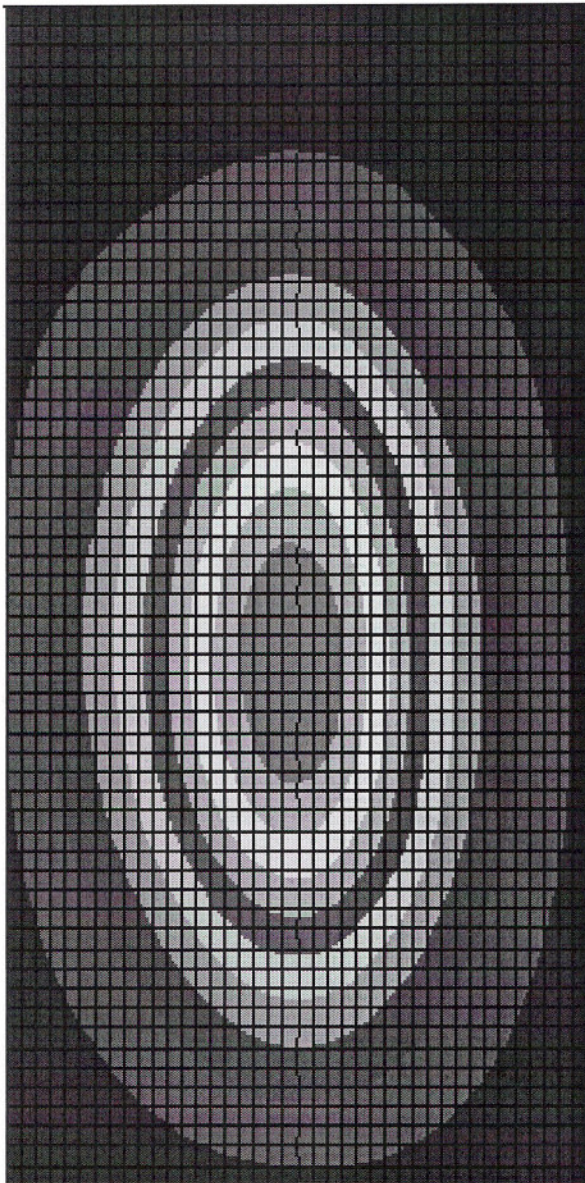
▶ MARKER 1
2.450593 GHz
49.037 Ω
2.877 $j\Omega$

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
2.45 GHz	48.07	25.65	95.6

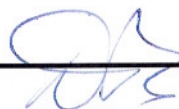


A handwritten signature in blue ink, located below the 'Calibrated by' text.

A handwritten signature in blue ink, located below the 'Approved by:' text.

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



Appendix F – Phantom Calibration Data Sheets

NCL CALIBRATION LABORATORIES

Calibration File No.: RFE-273

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 National Standards.

Thickness of the UniPhantom is 2 mm \pm 10%
Pinna thickness is 6 mm \pm 10%

Resolution:	0.01 mm	Calibrated to:	0.0 mm
Stability:	OK	Accuracy:	< 0.1 mm

Calibrated By: Karen K. Feb 17/04.

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