



SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

Appendix B Probe Calibration Certificate





SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-469

Client.: APREL

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 5800 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 212

Body Calibration

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

Project No: Internal

Calibrated: 27th December 2004
Released on: 27th December 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



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-020 212.

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 212 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

Calibration Results Summary



SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

Probe Type: E-Field Probe E-020

Serial Number: 212

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: 50.6 (+/-5%) **Sigma:** 1.98 S/m (+/-10%)

ConvF

Channel X: 5.0

Channel Y: 5.0

Channel Z: 5.0

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 2.4mm.

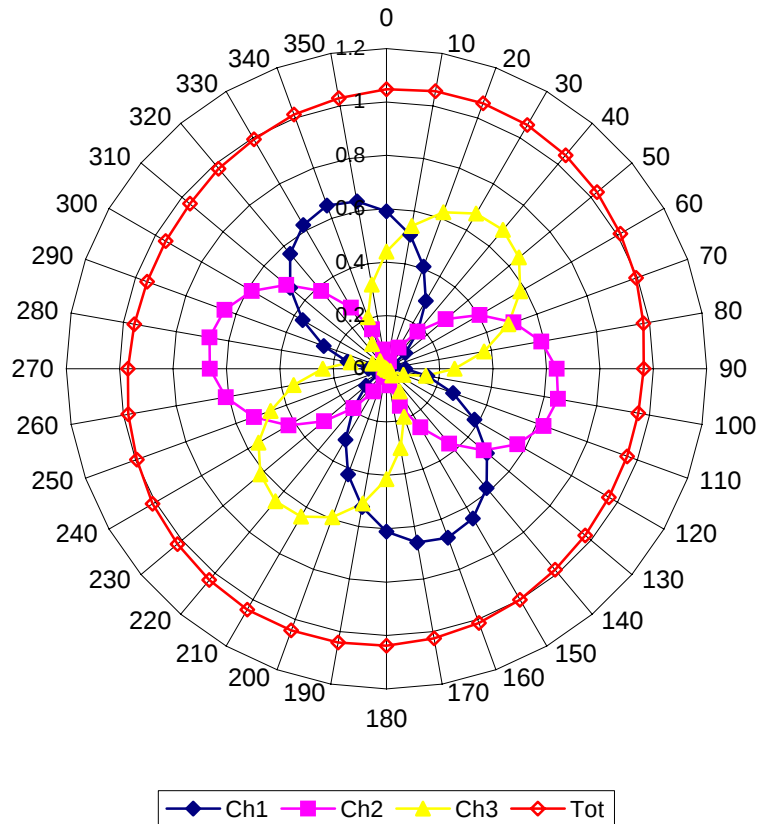
Spatial Resolution:

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.

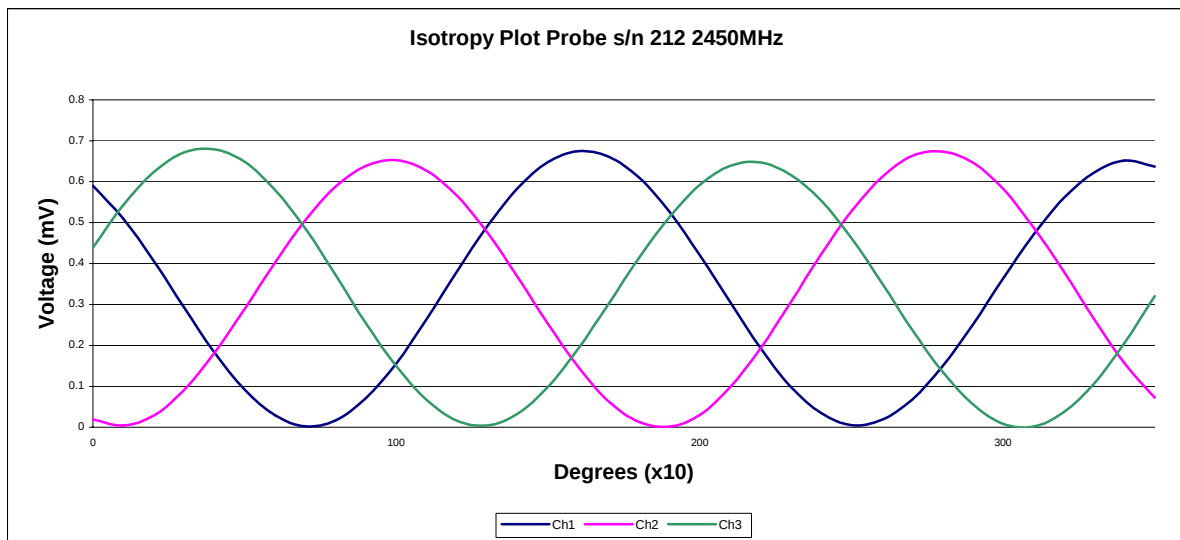
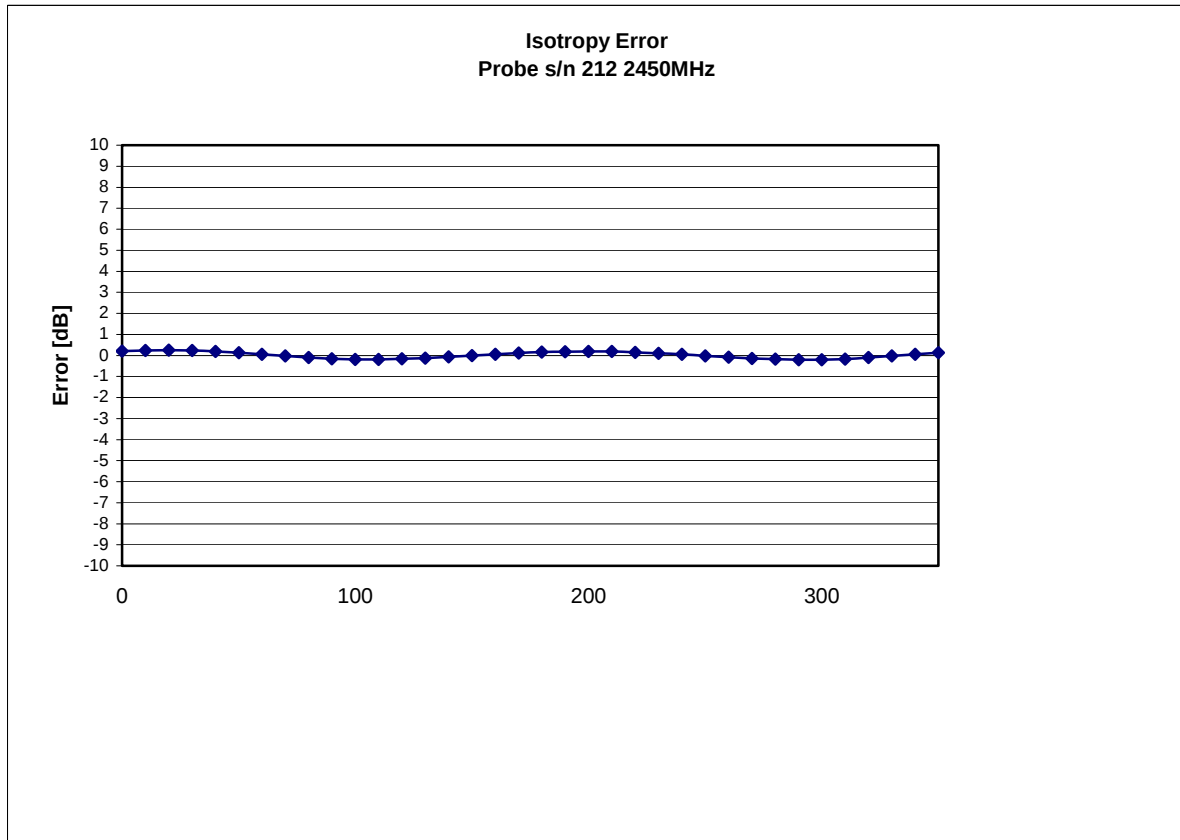
Receiving Pattern 2450 MHz (Air)



Receiving Pattern Probe s/n 212 24500MHz

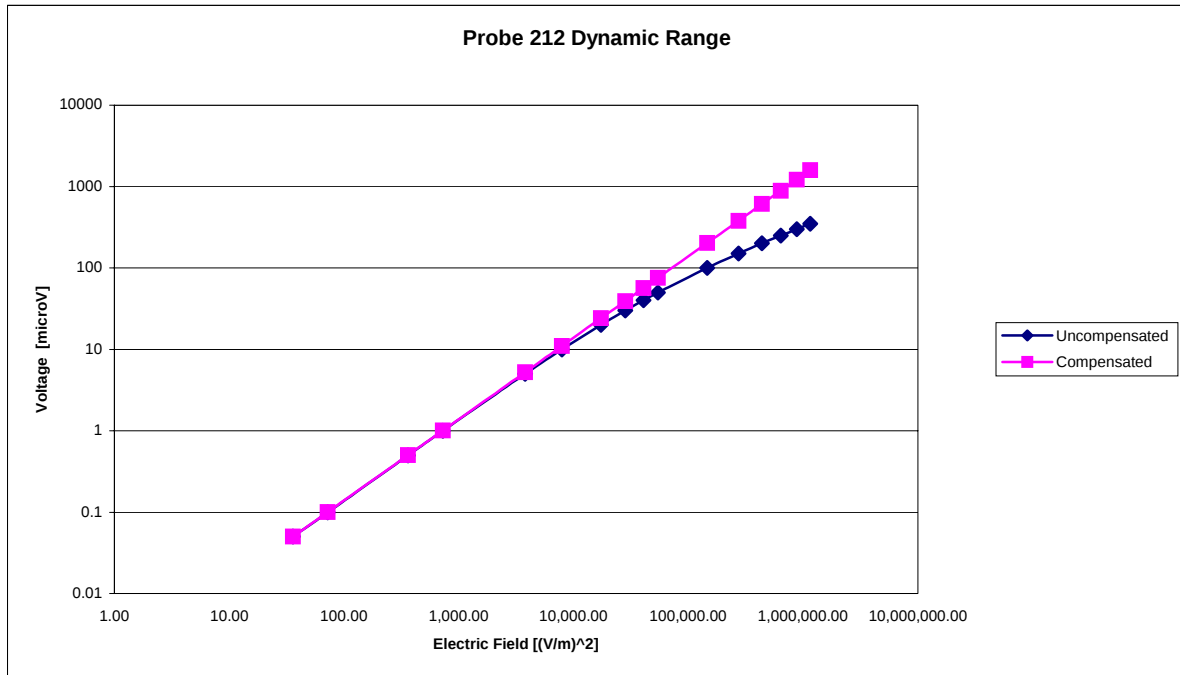


Isotropy Error 2450 MHz (Air)



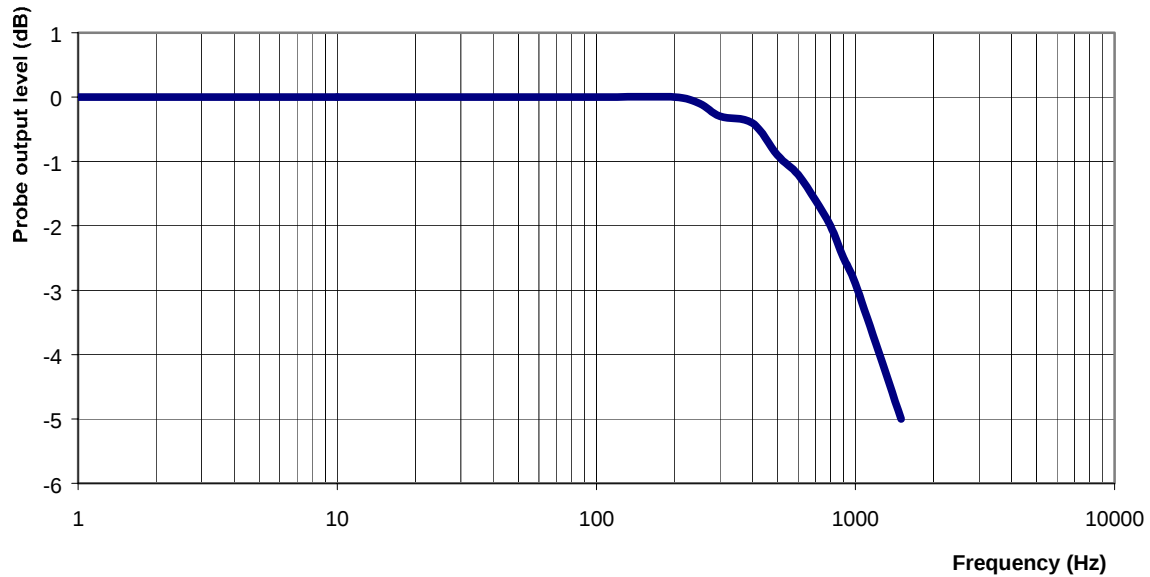
Isotropy: 0.10 dB

Dynamic Range



Video Bandwidth

Probe Frequency Characteristics



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

Conversion Factor Uncertainty Assessment

Frequency: 2450MHz

Epsilon: 50.6 (+/-5%)

Sigma: 1.98 S/m (+/-10%)

ConvF

Channel X: 5.0 7% (K=2)

Channel Y: 5.0 7% (K=2)

Channel Z: 5.0 7% (K=2)

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

Boundary Effect:

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





SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

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.





SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

Appendix C Dipole Calibration Certificate





SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

NCL CALIBRATION LABORATORIES

Calibration File No: DC-0265
Project Number: Internal

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.

APREL Validation Dipole

Manufacturer: APREL Laboratories
Part number: D-2450-S-1
Frequency: 2.45 GHz
Serial No: ALCD-10

Customer: APREL

Calibrated: 14 November 2003
Released on: 15 November 2003

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



Calibration Results Summary

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

Mechanical Dimensions

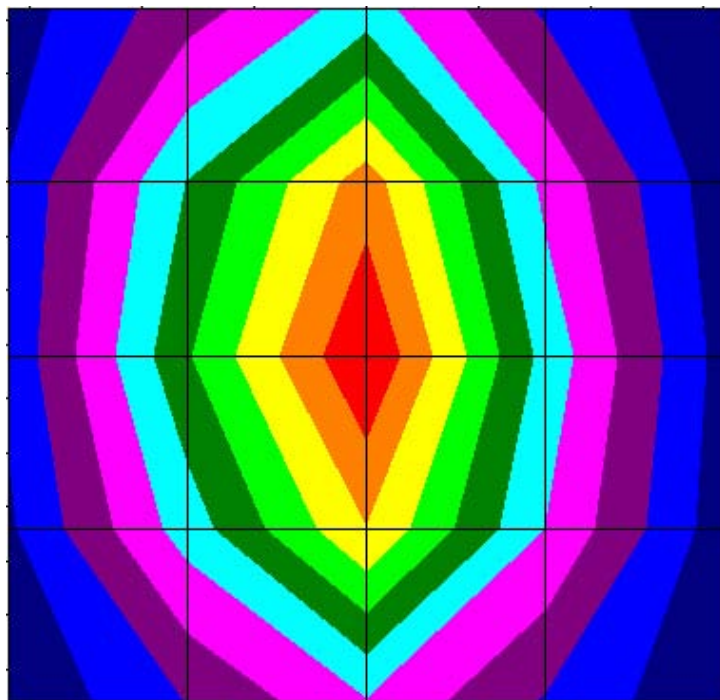
Length: 51.7 mm
Height: 30.8 mm

Electrical Specification

SWR: 1.181U
Return Loss: -21.4 dB
Impedance: 46.175

System Validation Results

Frequency	1 Gram	10 Gram	Peak
2.45 GHz	52.45	22.91	102.91



Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018. The results contained within this report are for Validation Dipole ALCD-10 at 2.45 GHz. 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 mechanical specification. 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 ALIDX-500, along with the APREL Reference E-010 130 MHz to 26 GHz E-Field Probe Serial Number 163.

References

SSI-TP-018 Dipole Calibration Procedure
 SSI-TP-016 Tissue Calibration Procedure
 IEEE 1528 *DRAFT* "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 ALCD-10 was a new Dipole taken from stock prior to calibration.

Ambient Temperature of the Laboratory:	24 °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	51.7 mm	30.8 mm

Tissue Validation

Head Tissue 2450 MHz	Measured
Dielectric constant, ϵ_r	39.2
Conductivity, σ [S/m]	1.82
Tissue Conversion Factor,	4.61



Electrical Calibration

Test	Result	IEEE Value
S11 R/L	-21.4	-21 dB
SWR	1.181U	-
Impedance	46.175 Ω	

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

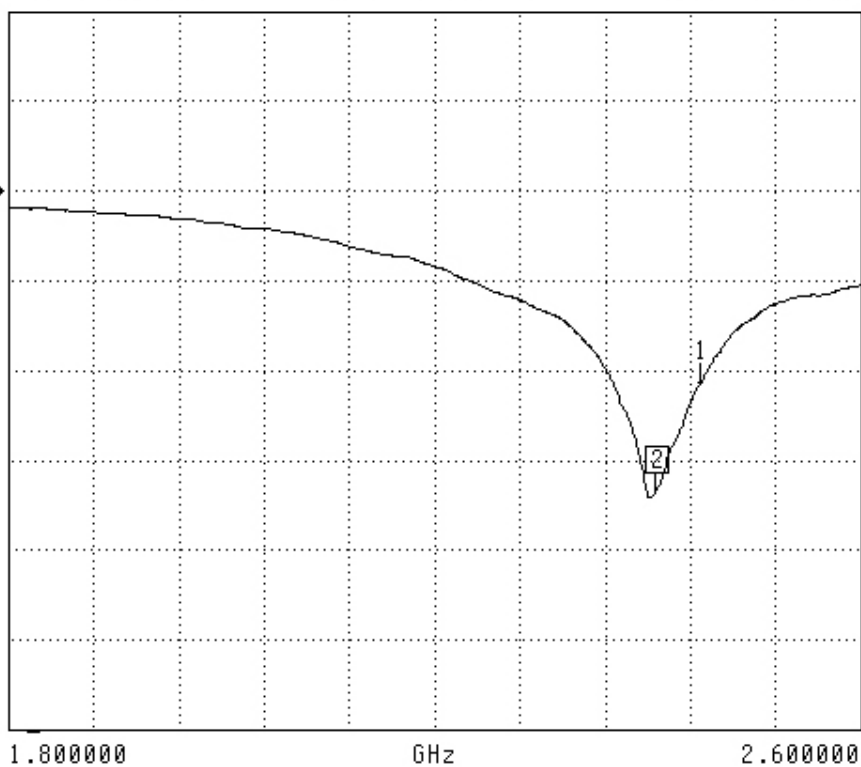
S11 Parameter Return Loss

S11 FORWARD REFLECTION

LOG MAGNITUDE

REF=0.000 dB

10.000 dB/DIV



CH 1 - S11
REFERENCE PLANE
5.1160 mm

MARKER 2
2.408000 GHz
-33.566 dB

MARKER TO MAX
▶ MARKER TO MIN
1 2.450000 GHz
-21.377 dB

MARKER READOUT
FUNCTIONS



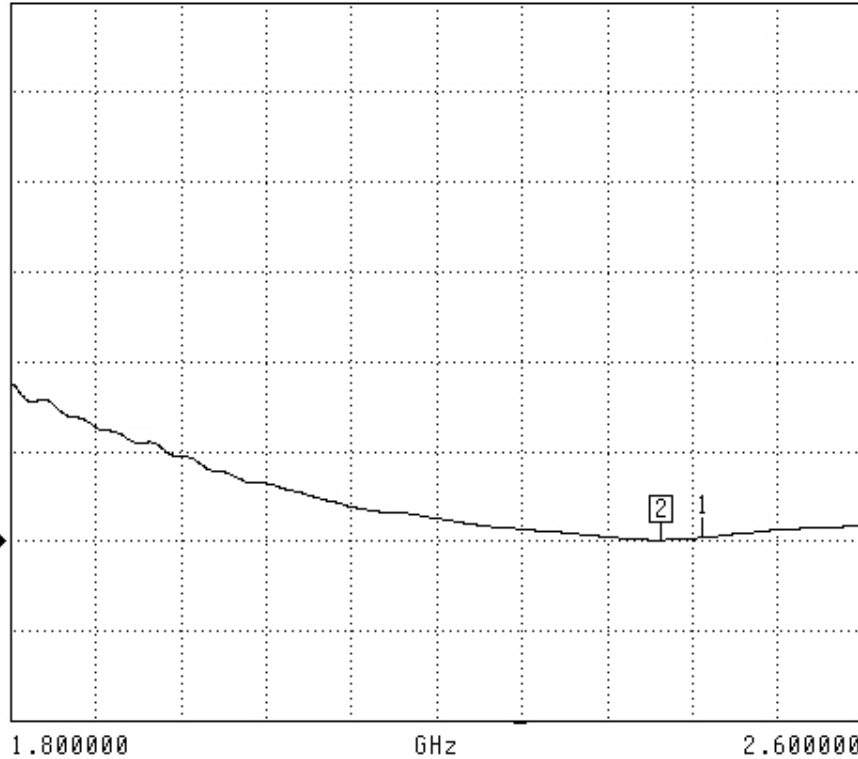
SWR

S11 FORWARD REFLECTION

SWR

REF=1.000 U

5.000 U/DIV



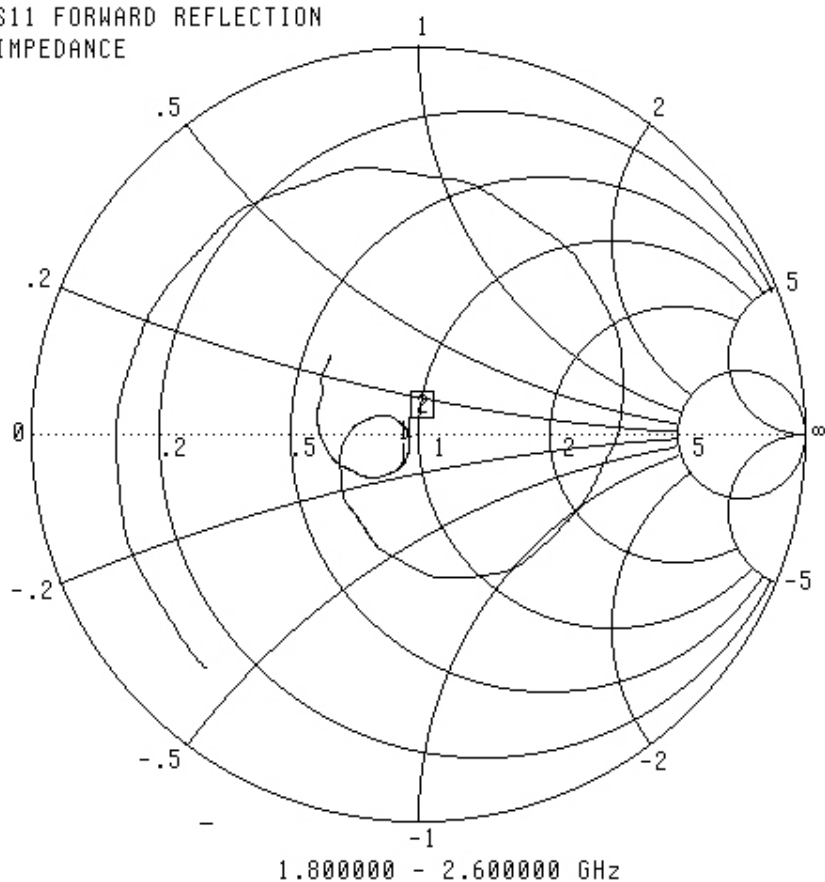
CH 1 - S11
REFERENCE PLANE
5.1160 mm

MARKER 2
2.411000 GHz
1.049 U

MARKER TO MAX
▶ MARKER TO MIN
1 2.450000 GHz
1.181 U

MARKER READOUT
FUNCTIONS





```

MARKER TO MAX
▶ MARKER TO MIN
1  2.450000 GHz
    46.175 Ω
    -7.199 jΩ

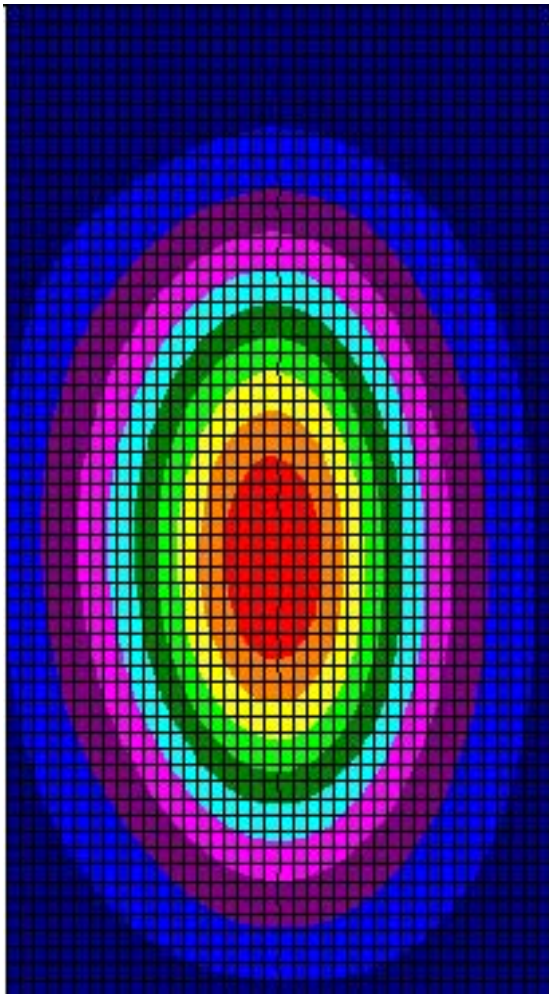
```

MARKER READOUT FUNCTIONS

System Validation Results Using the Electrically Calibrated Dipole

Frequency	1 Gram	10 Gram	Peak Above Feed Point
2.45 GHz	52.45	22.91	102.91

The following Graphic Plot is the splined measurement result for the course scan.





SAR & HAC Instruments for Wireless • Consulting • Research • Standards • Compliance • Training

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.

