NCL CALIBRATION LABORATORIES

Calibration File No.: CP-826

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 5200 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: 22nd 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
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-020 264.

References

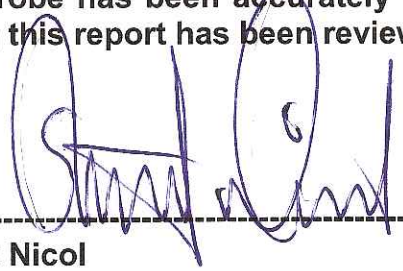
SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure
IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
SSI-TP-011 Tissue Calibration Procedure

Conditions

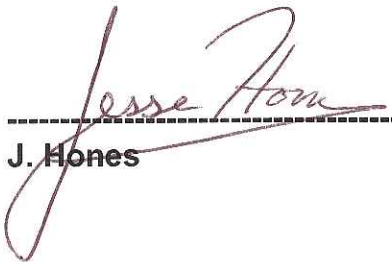
Probe 264 was a re-calibration.

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:	5200 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: 5200 MHz

Epsilon: 48.9 (+/-10%) **Sigma:** 5.35 S/m (+/-5%)

ConvF

Channel X: 4.5

Channel Y: 4.5

Channel Z: 4.5

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

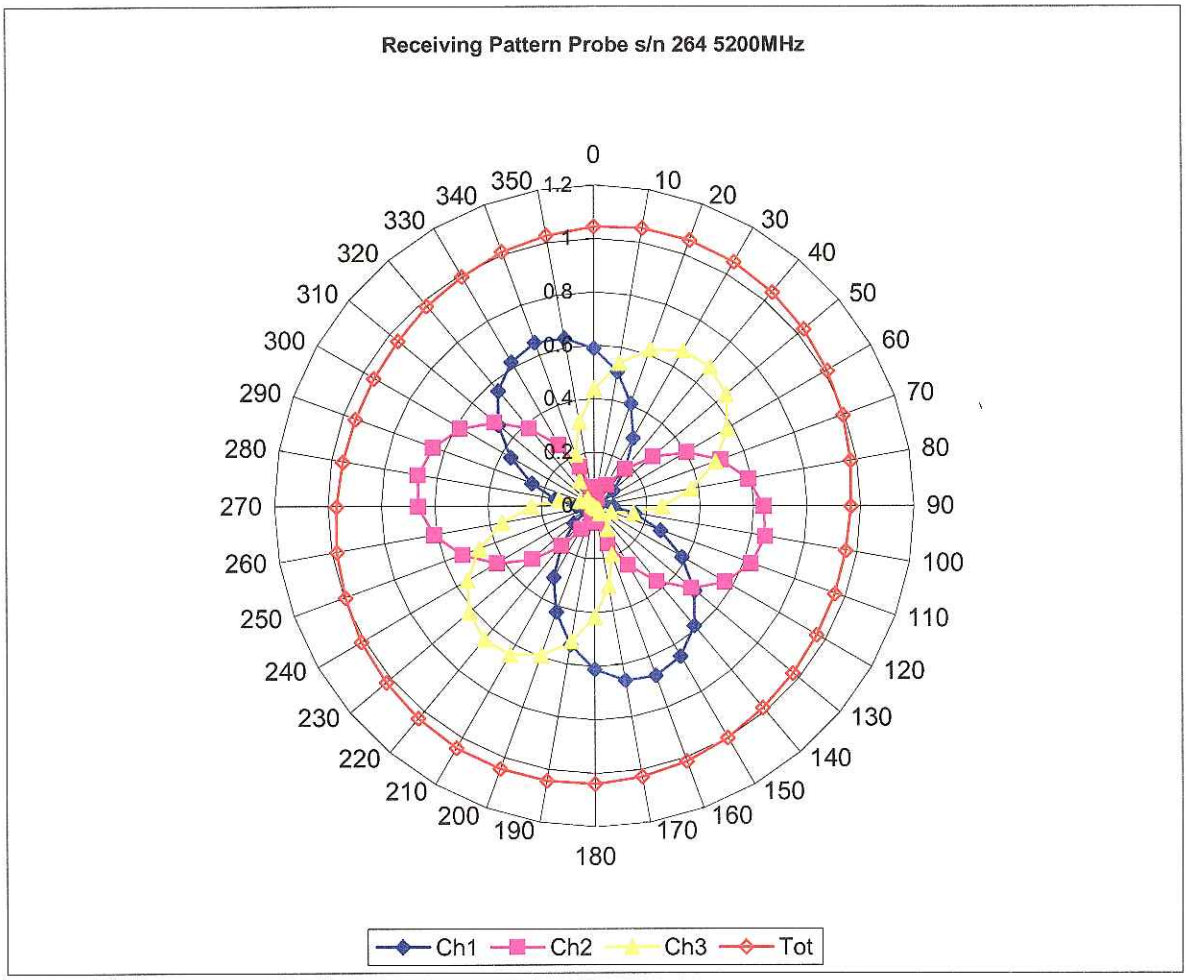
Boundary Effect:

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:

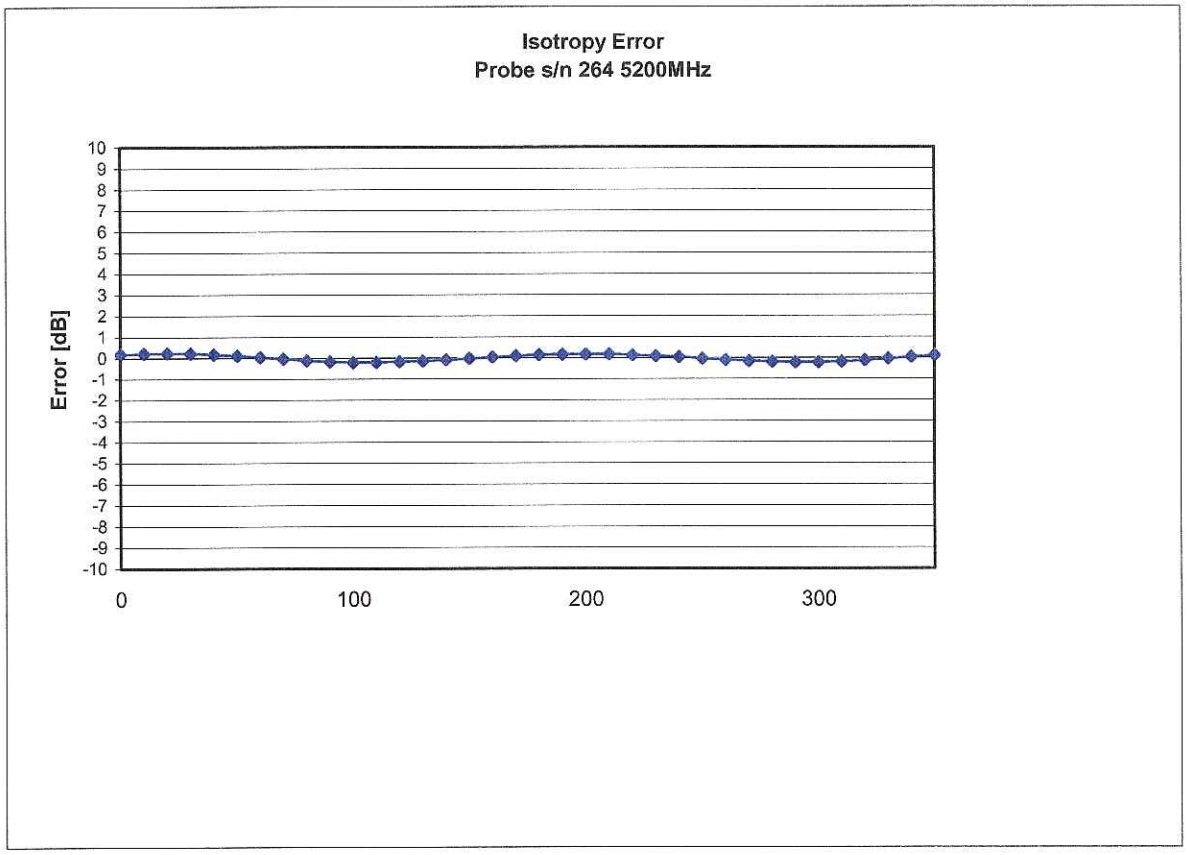
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

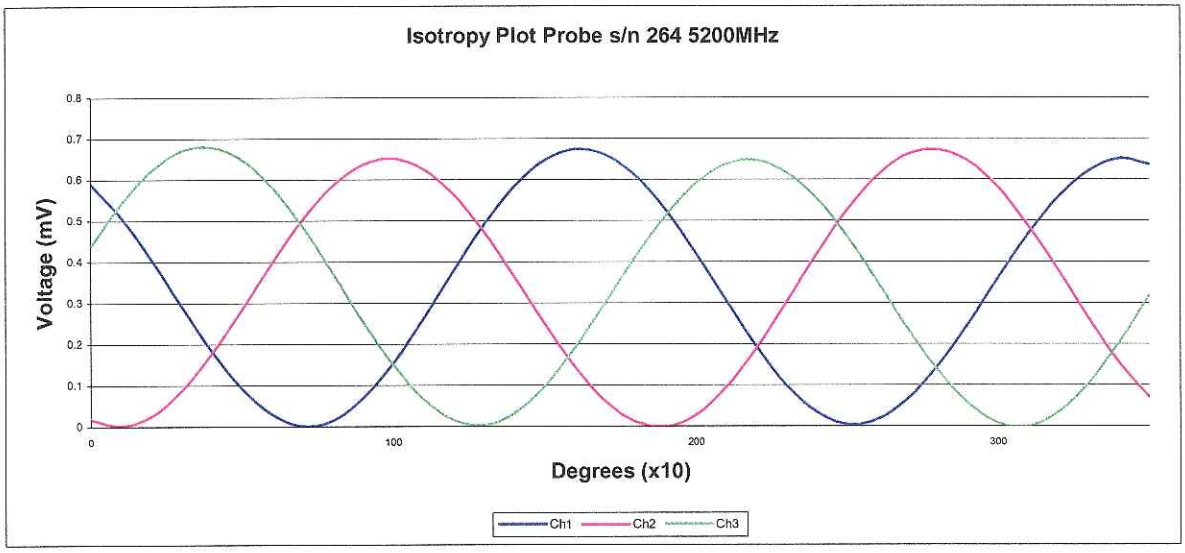
Receiving Pattern 5200 MHz (Air)



This page has been reviewed for content and attested to on Page 2 of this document.

Isotropy Error 5200 MHz (Air)

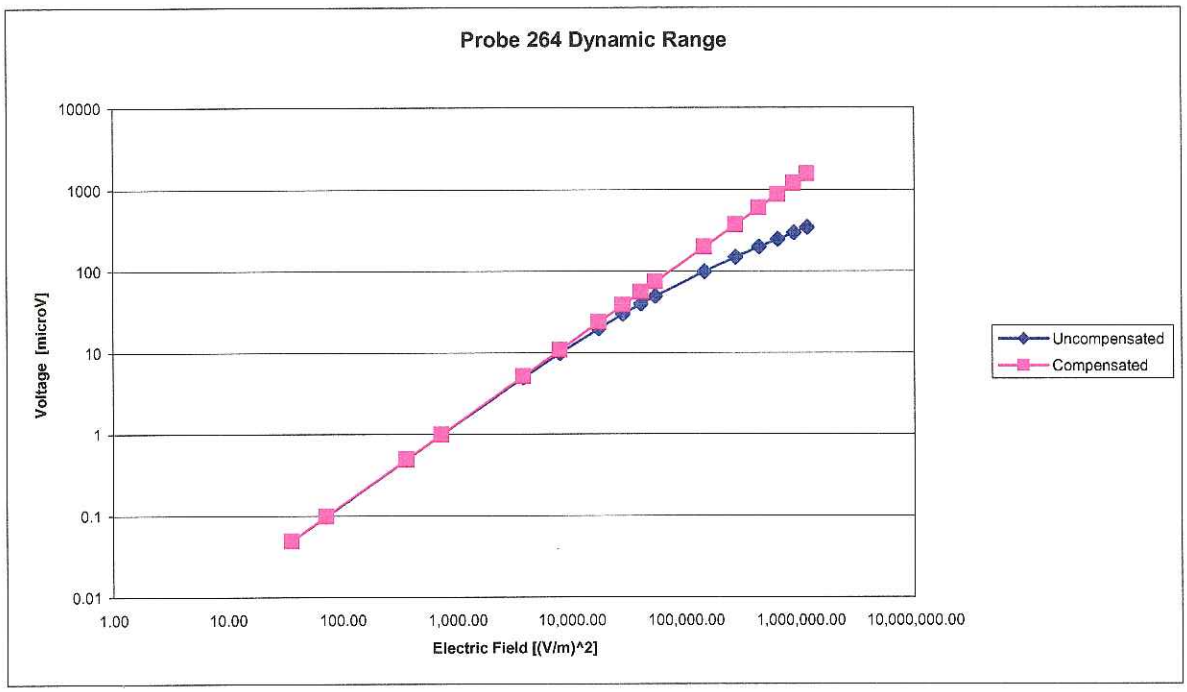




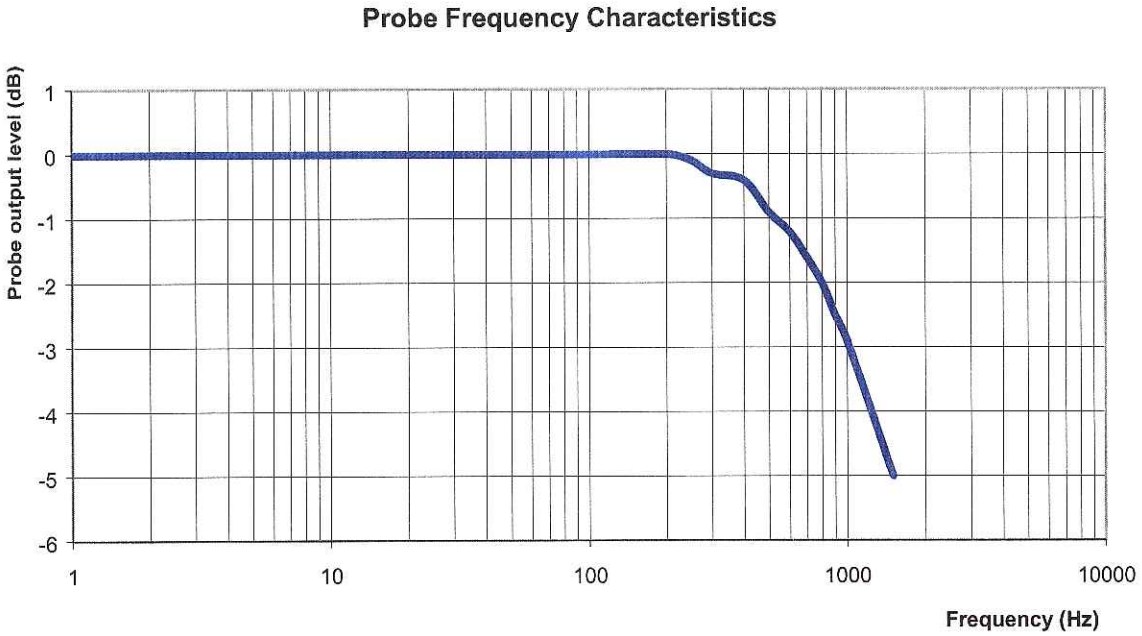
Isotropicity in Tissue: 0.10 dB

This page has been reviewed for content and attested to on Page 2 of this document.

Dynamic Range



Video Bandwidth



Video Bandwidth at 500 Hz	1 dB
Video Bandwidth at 1000 Hz	3 dB

Conversion Factor Uncertainty Assessment

Frequency:		5200MHz	
Epsilon:	48.9 (+/-10%)	**Sigma:**	5.35 S/m (+/-5%)
ConvF			
Channel X:	4.5	7%(K=2)	
Channel Y:	4.5	7%(K=2)	
Channel Z:	4.5	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.

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-827

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 5800 MHz

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

HEAD Calibration

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

Calibrated: 23rd 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
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-020 264.

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:	5800 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 Head Tissue

Frequency: 5800 MHz

Epsilon: 35.3 (+/-10%) **Sigma:** 5.27 S/m (+/-5%)

ConvF

Channel X: 3.3

Channel Y: 3.3

Channel Z: 3.3

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

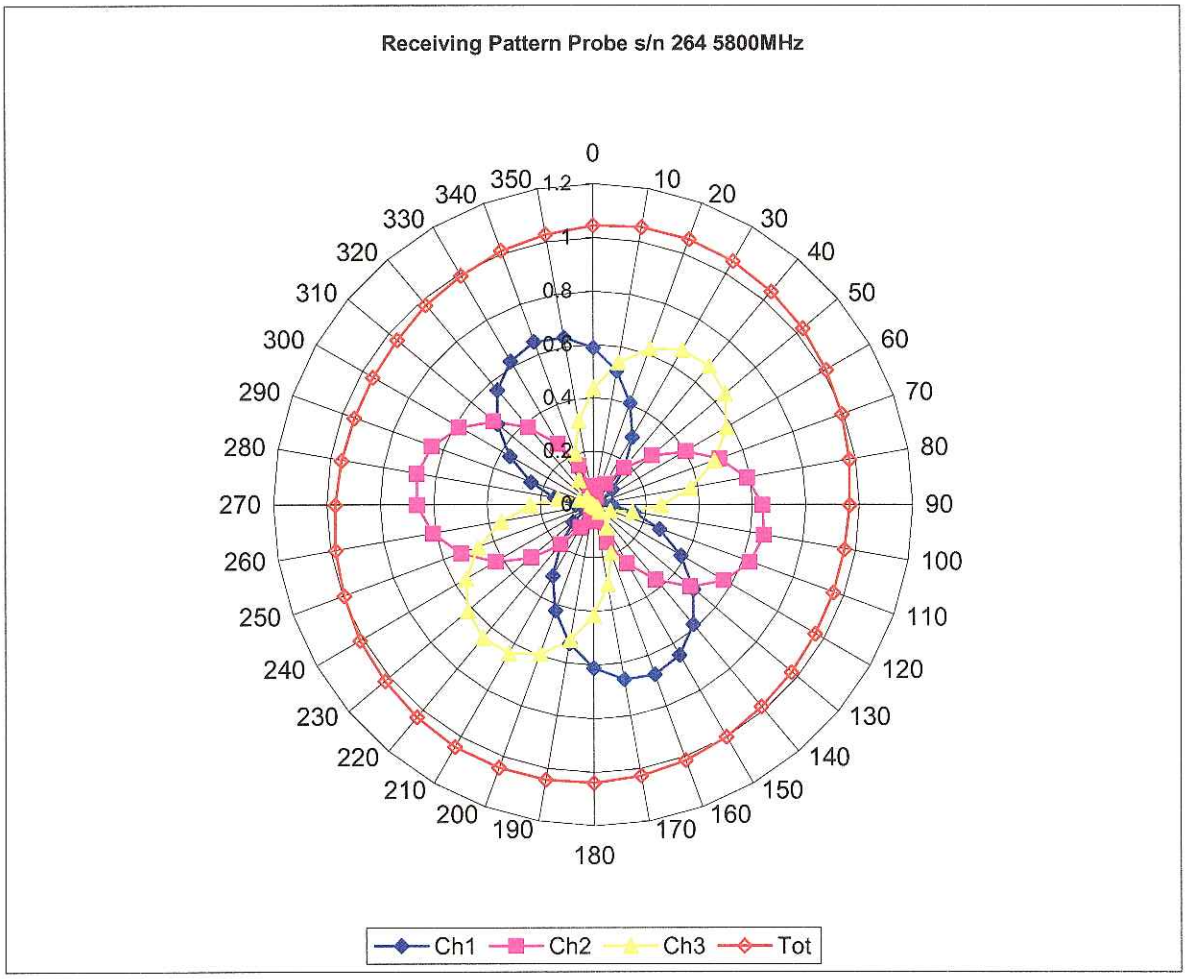
Boundary Effect:

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:

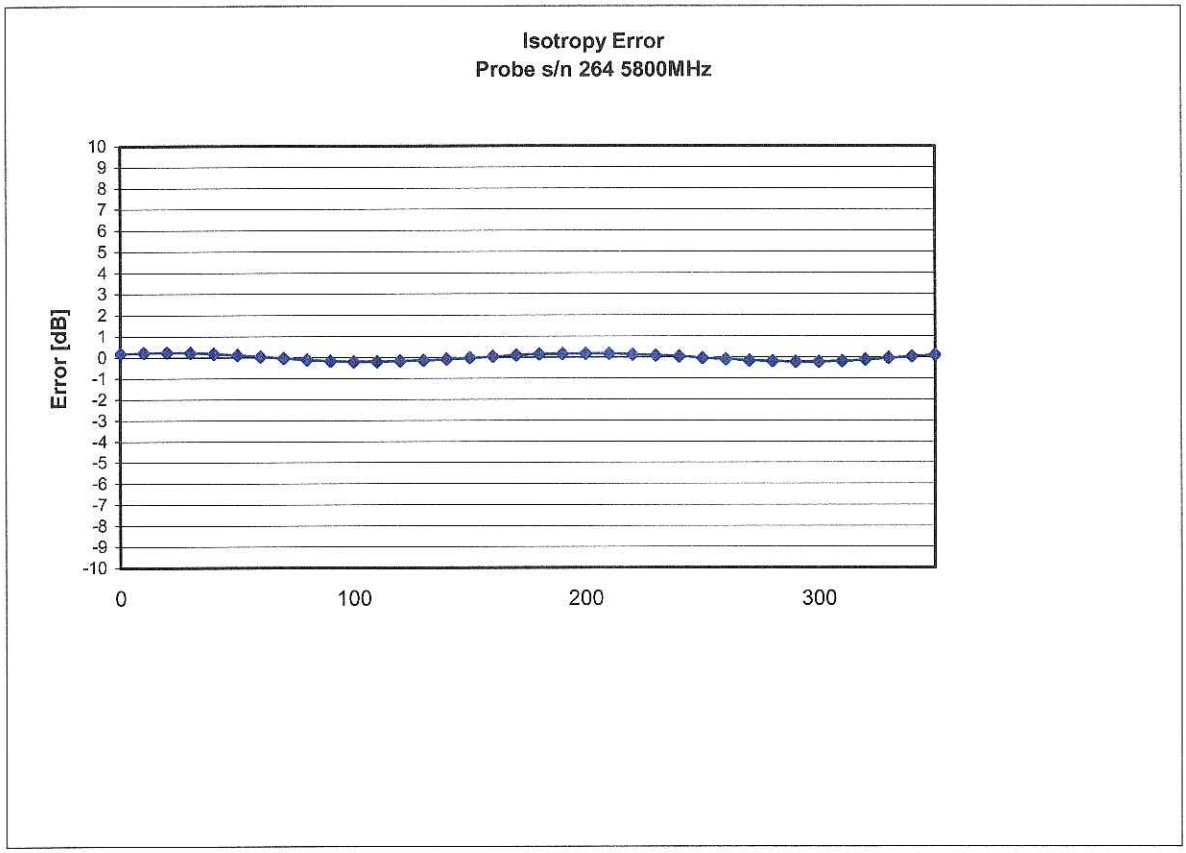
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

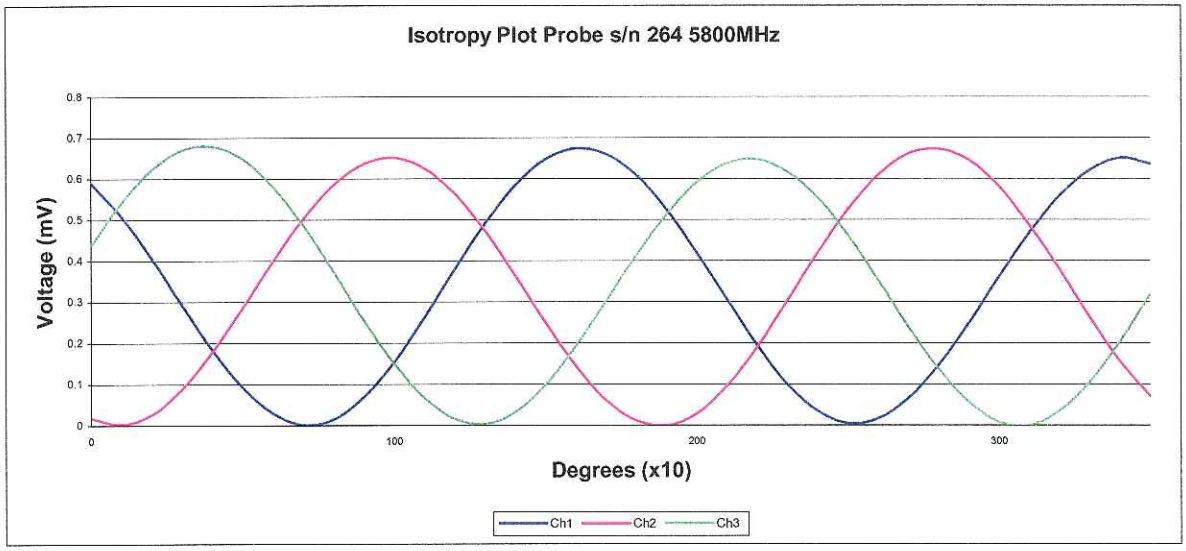
Receiving Pattern 5800 MHz (Air)



This page has been reviewed for content and attested to on Page 2 of this document.

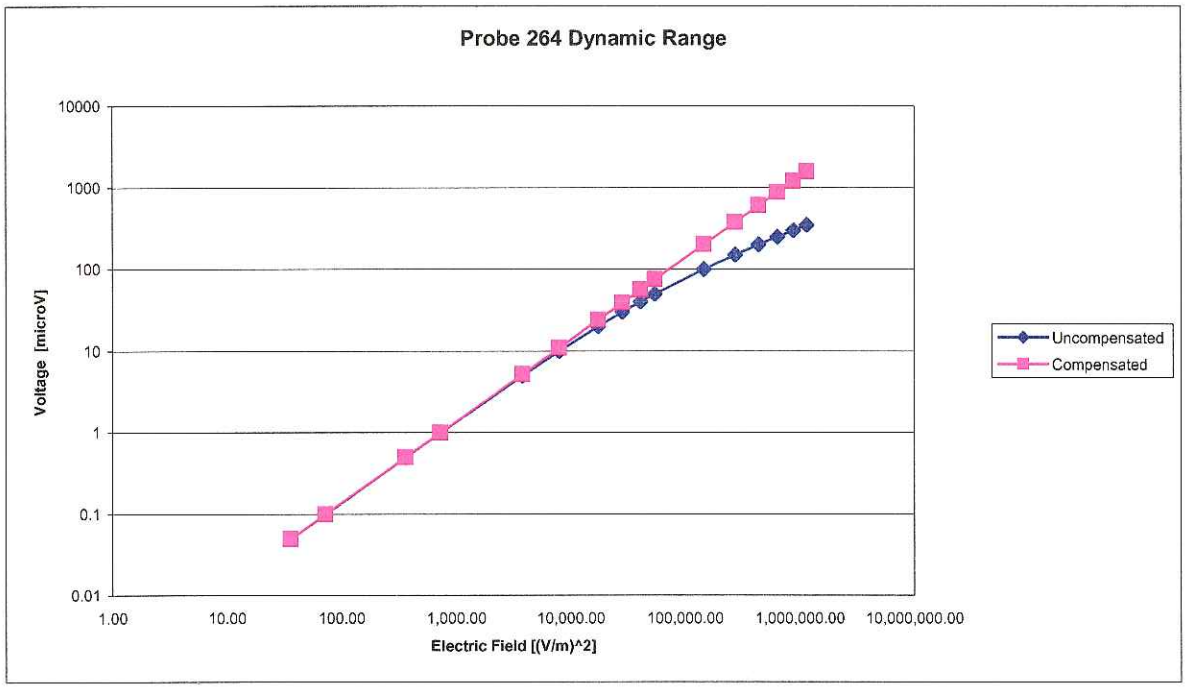
Isotropy Error 5800 MHz (Air)



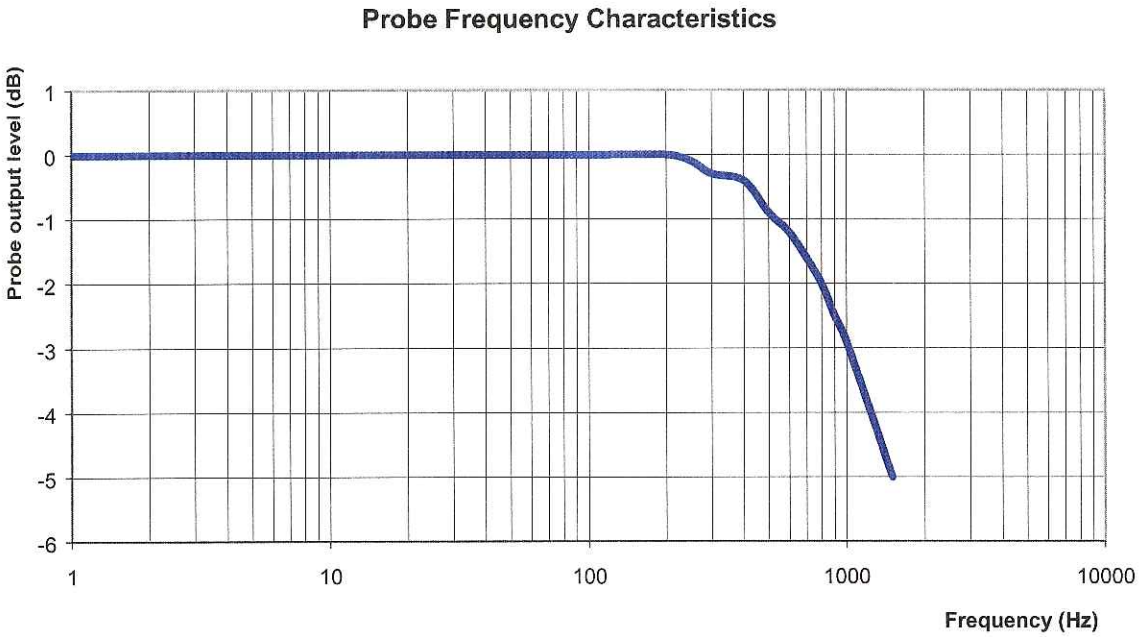


Isotropicity in Tissue: 0.10 dB

Dynamic Range



Video Bandwidth



Video Bandwidth at 500 Hz	1 dB
Video Bandwidth at 1000 Hz	3 dB

Conversion Factor Uncertainty Assessment

Frequency:		5800MHz
Epsilon:	35.3 (+/-10%)	**Sigma:** 5.27 S/m (+/-5%)
ConvF		
Channel X:	3.3	7%(K=2)
Channel Y:	3.3	7%(K=2)
Channel Z:	3.3	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.

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-834

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 5800 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: QTK-EProbe-5305

Calibrated: 23rd 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
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-020 264.

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:	5800 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: 5800 MHz

Epsilon: 48.2 (+/-10%) **Sigma:** 6.0 S/m (+/-5%)

ConvF

Channel X: 4.3

Channel Y: 4.3

Channel Z: 4.3

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

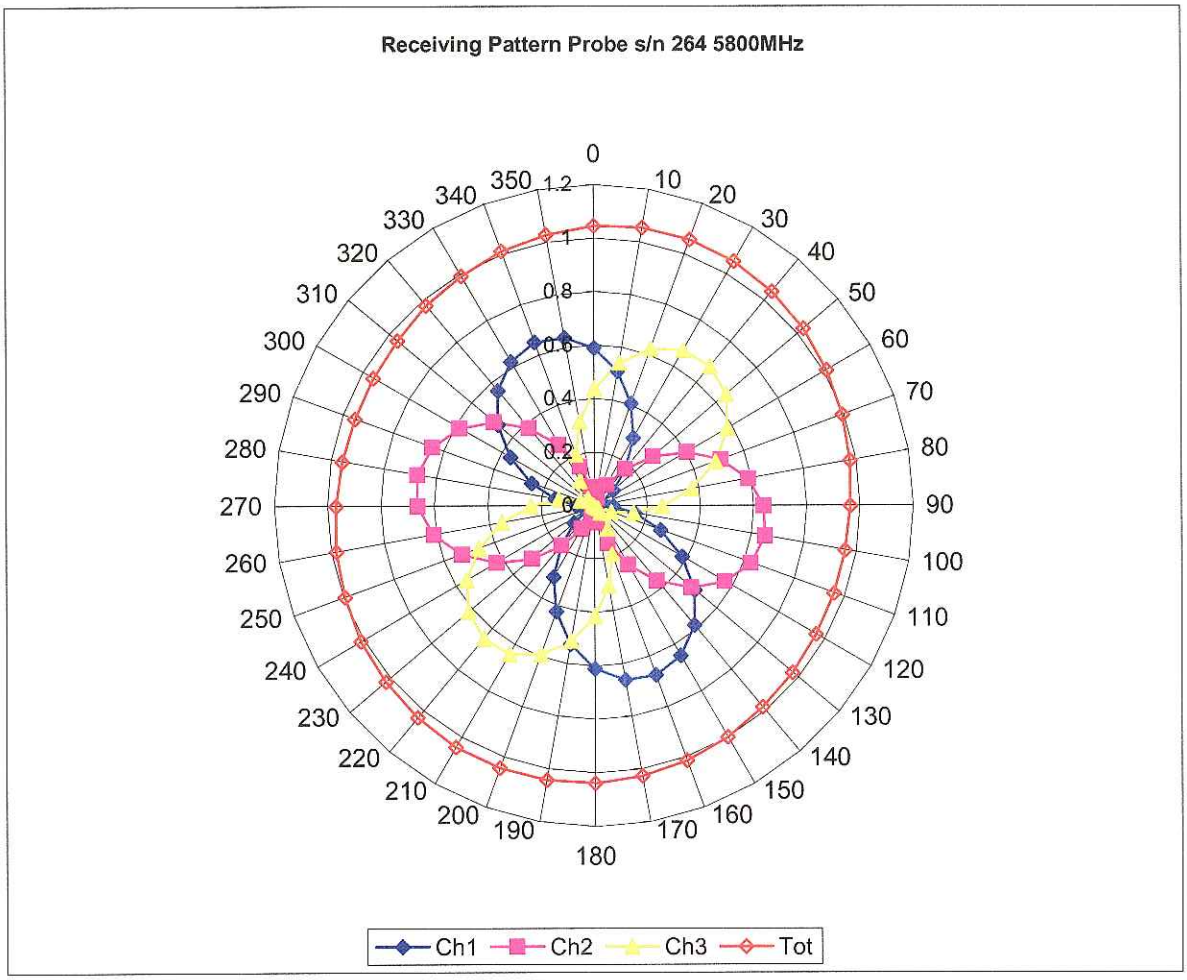
Boundary Effect:

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:

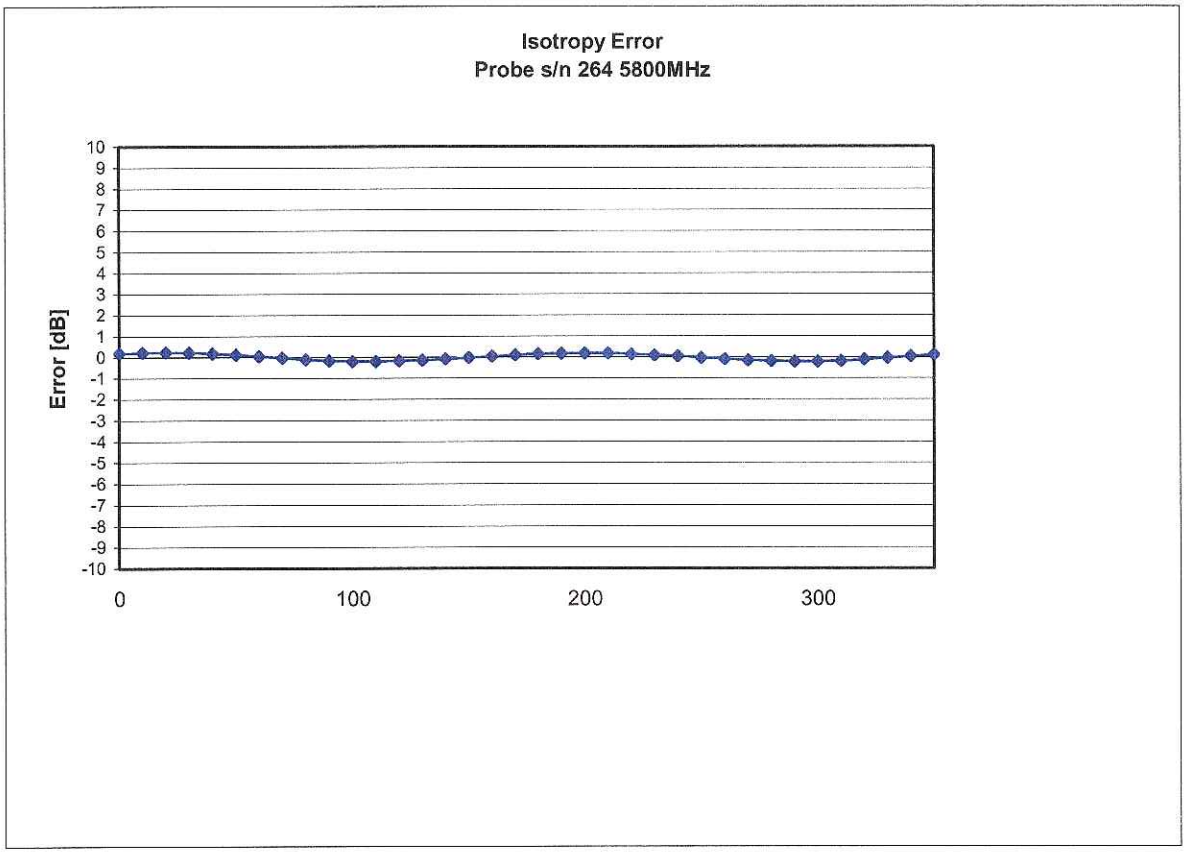
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

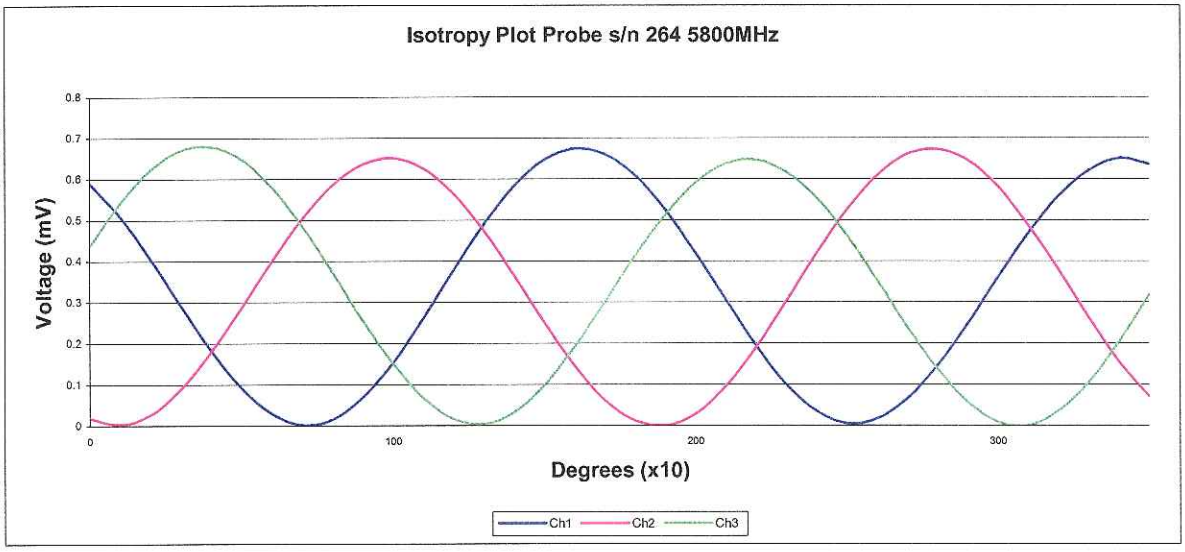
Receiving Pattern 5800 MHz (Air)



This page has been reviewed for content and attested to on Page 2 of this document.

Isotropy Error 5800 MHz (Air)

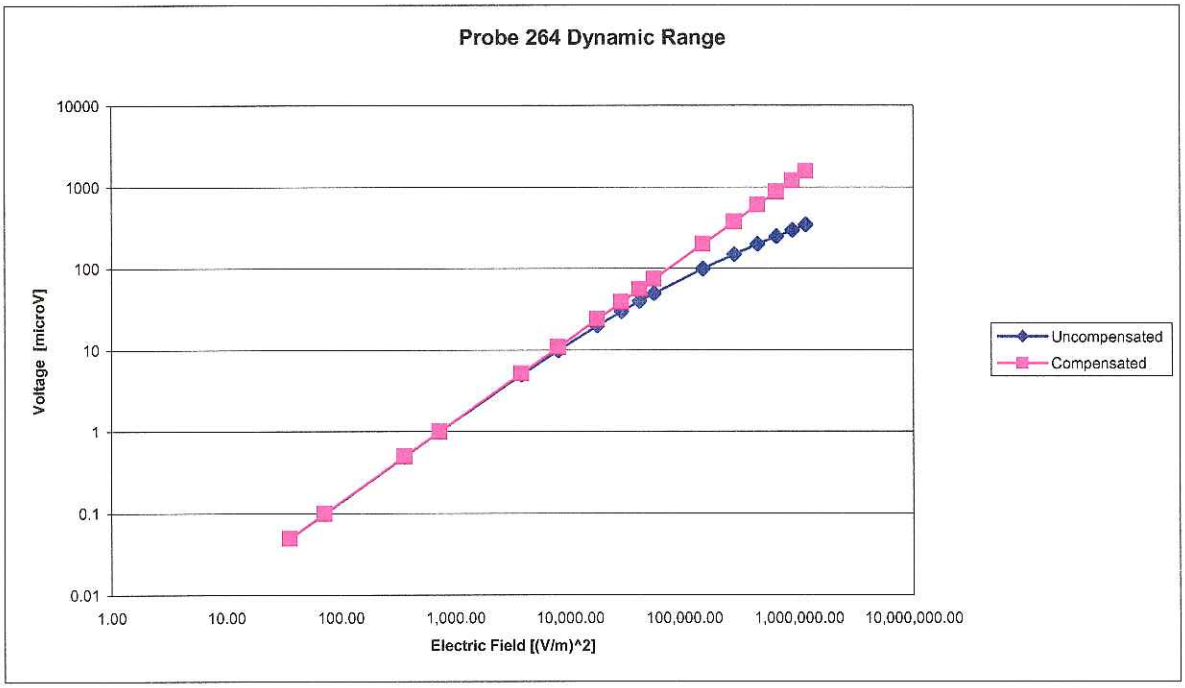




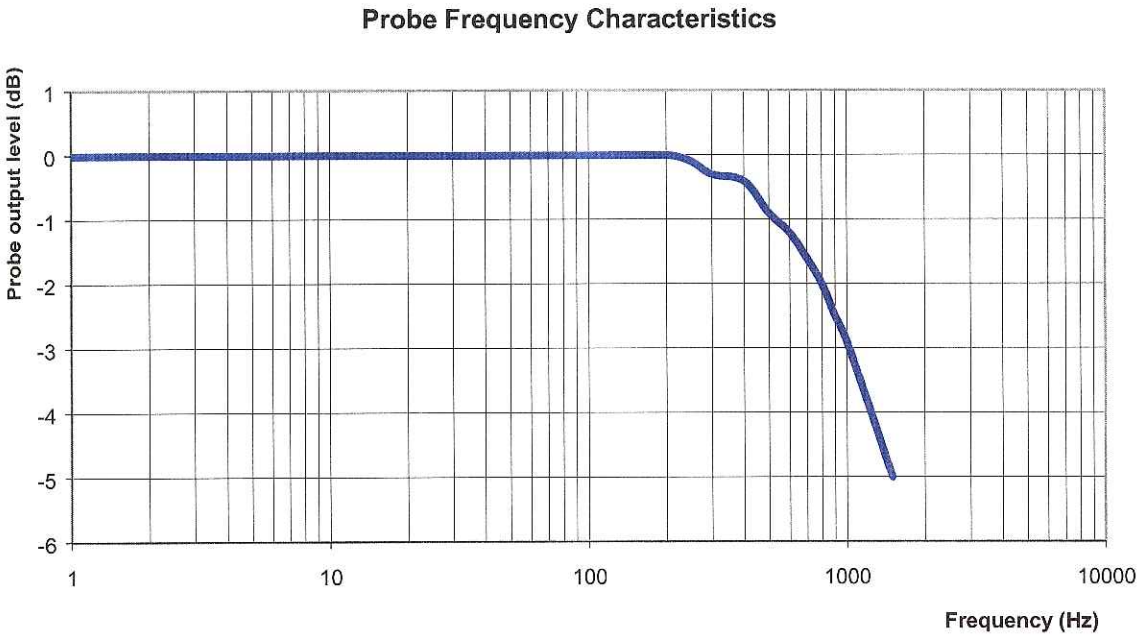
Isotropicity in Tissue: 0.10 dB

This page has been reviewed for content and attested to on Page 2 of this document.

Dynamic Range



Video Bandwidth



Video Bandwidth at 500 Hz	1 dB
Video Bandwidth at 1000 Hz	3 dB

Conversion Factor Uncertainty Assessment

Frequency:		5800MHz
Epsilon:	48.2 (+/-10%)	**Sigma:** 6.0 S/m (+/-5%)
ConvF		
Channel X:	4.3	7%(K=2)
Channel Y:	4.3	7%(K=2)
Channel Z:	4.3	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

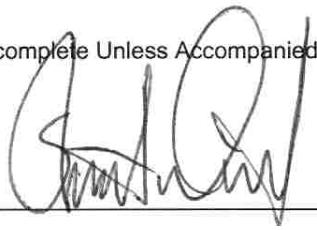
Manufacturer: APREL Laboratories
Part number: ALS-D-2450-S-2
Frequency: 2.45 GHz
Serial No: QTK-319

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

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

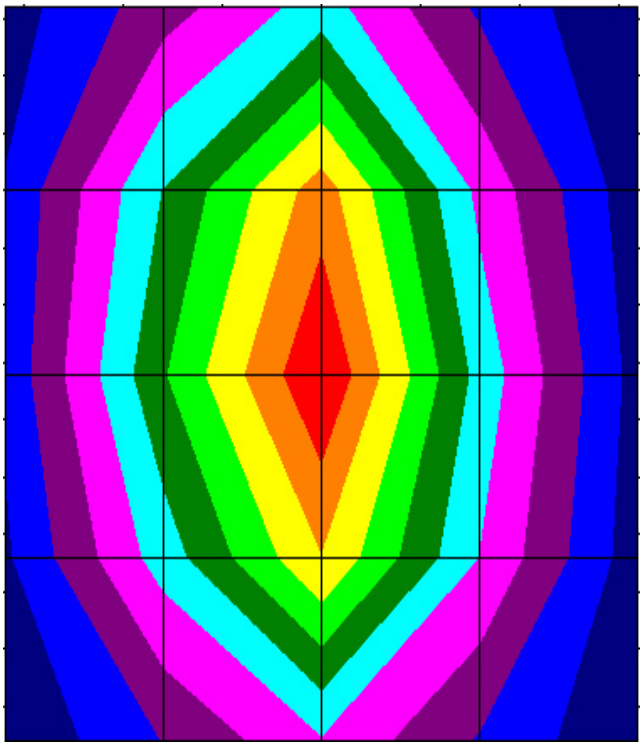
Length: 53.5 mm
Height: 30.4 mm

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



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

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.

Stuart Nicol

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

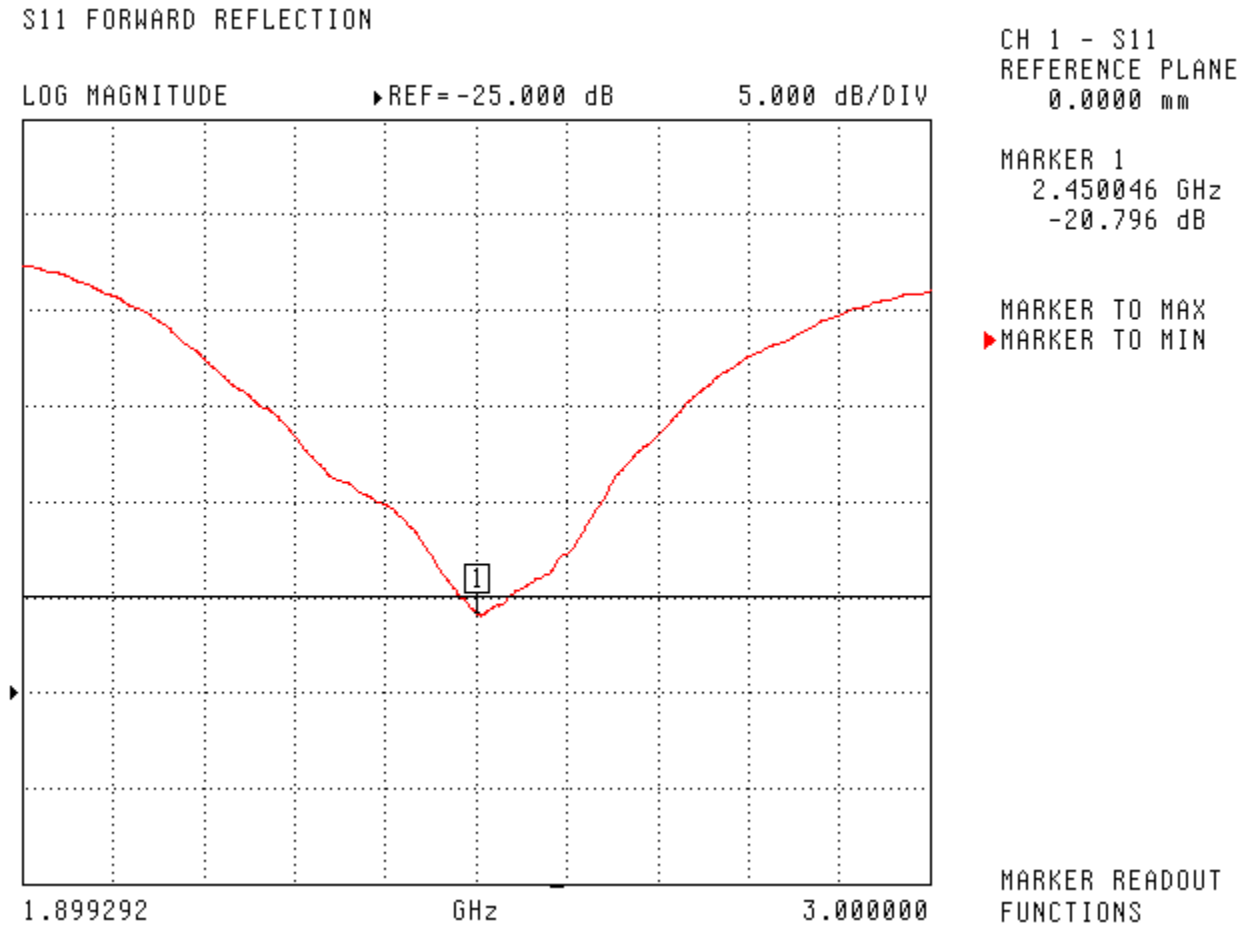
Body Tissue 2450 MHz	Measured
Dielectric constant, ε_r	52.5
Conductivity, σ [S/m]	1.78

Electrical Calibration

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

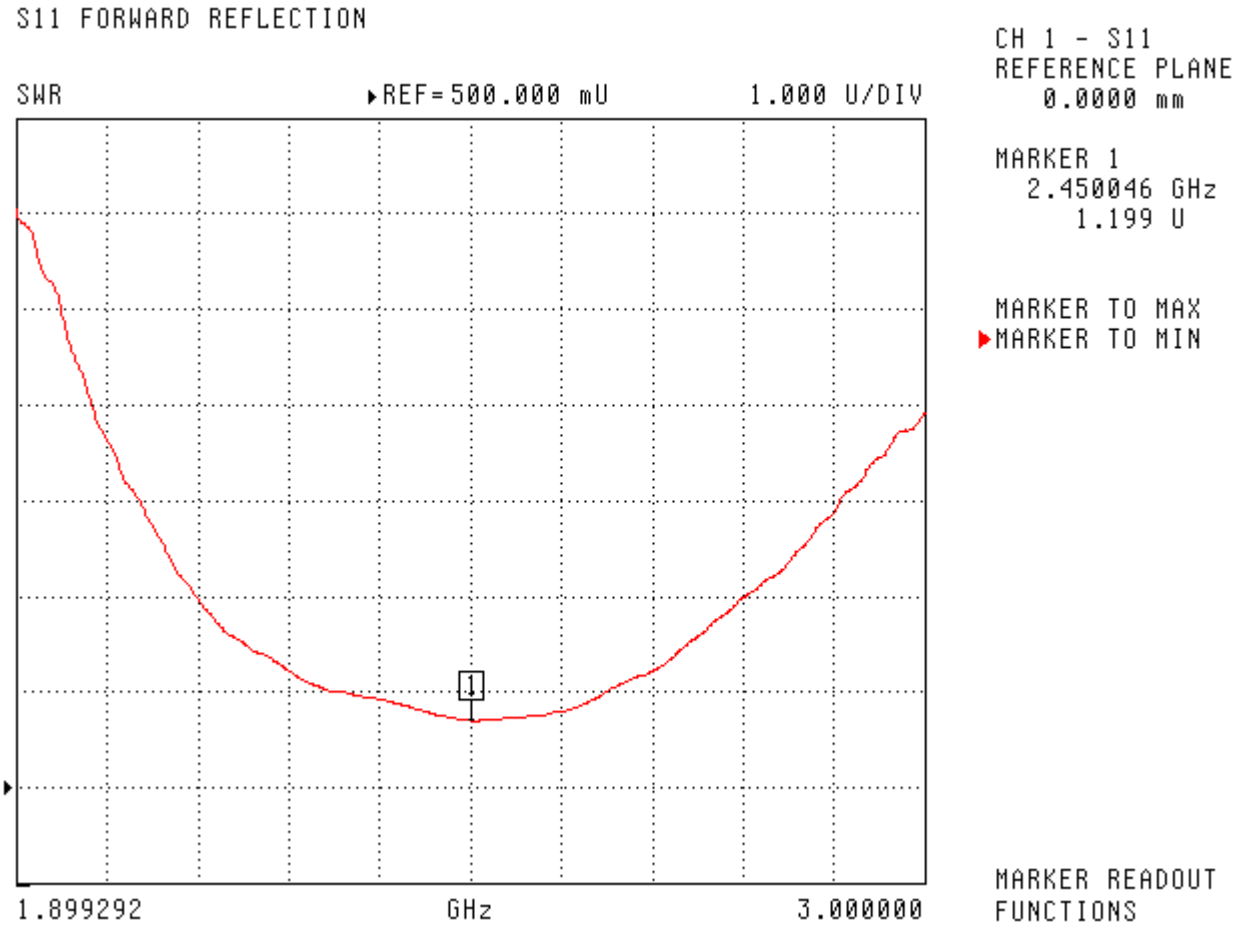
The Following Graphs are the results as displayed on the Vector Network Analyzer.

S11 Parameter Return Loss

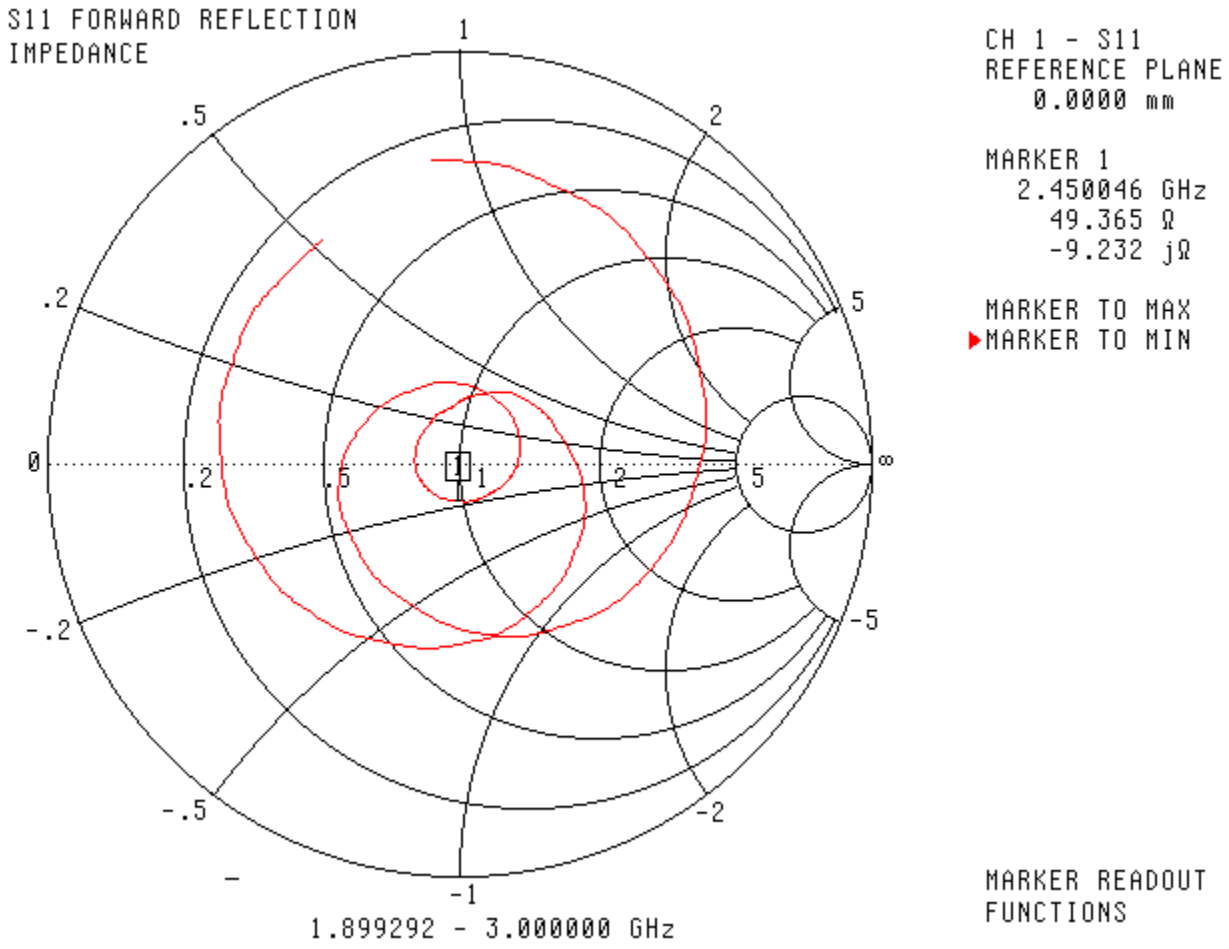


This page has been reviewed for content and attested to by signature within this document.

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

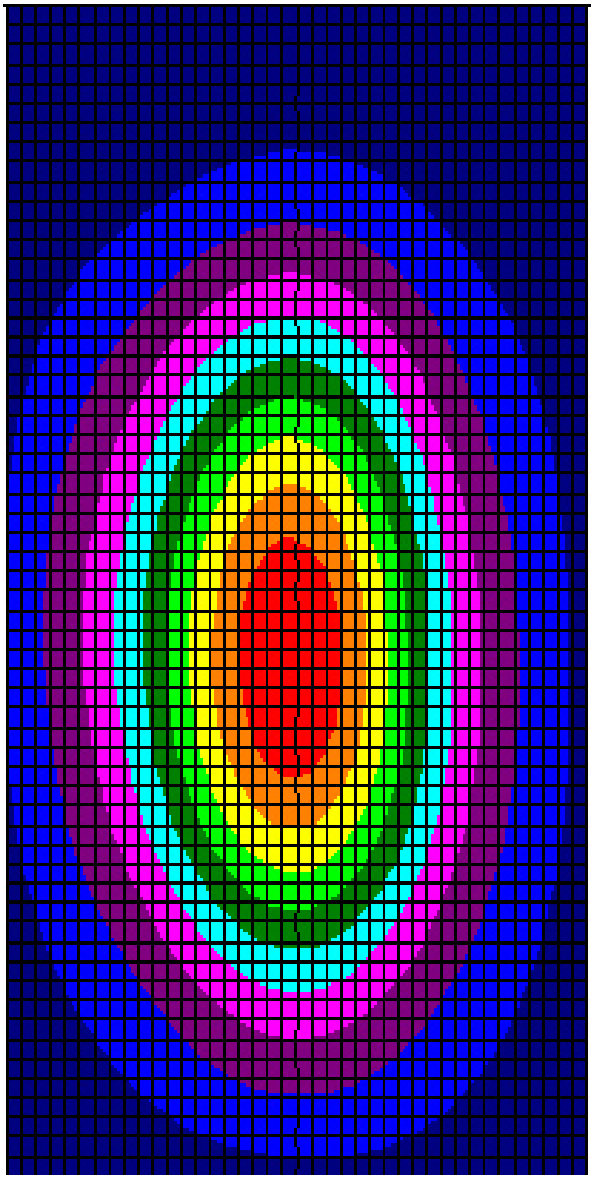
Smith Chart Dipole Impedance



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

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



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

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 2008.

Appendix E. Dipole Calibration

Validation Dipole 5200 MHz
M/N: ALS-D-5200-S-2
S/N: QTK-320

NCL CALIBRATION LABORATORIES

Calibration File No: DC-892

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

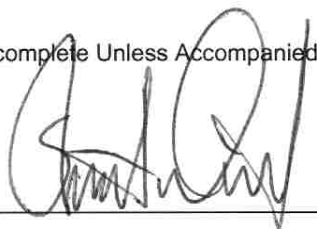
Manufacturer: APREL Laboratories
Part number: ALS-D-5200-S-2
Frequency: 5.2 GHz
Serial No: QTK-320

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

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

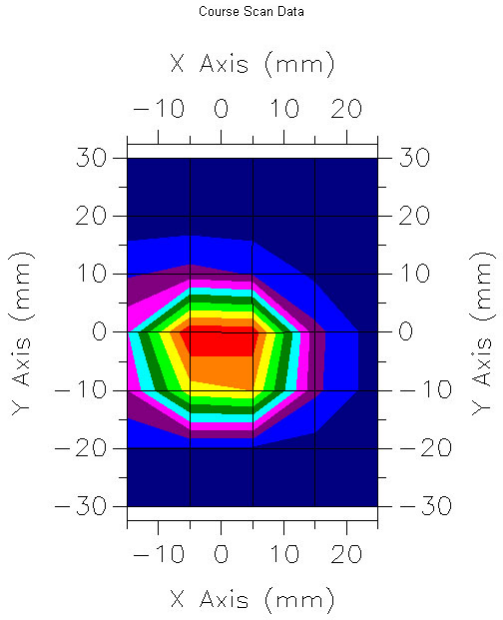
Length: 23.6 mm
Height: 14.0 mm

Electrical Specification

SWR: 1.57 U
Return Loss: -13.15 dB
Impedance: 78.2 Ω

System Validation Results

Frequency	1 Gram
5200 GHz	58.8



Conditions

Dipole 320 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.

Stuart Nicol

C. Teodorian

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
23.6 mm	14.0 mm	23.1 mm	14.2 mm

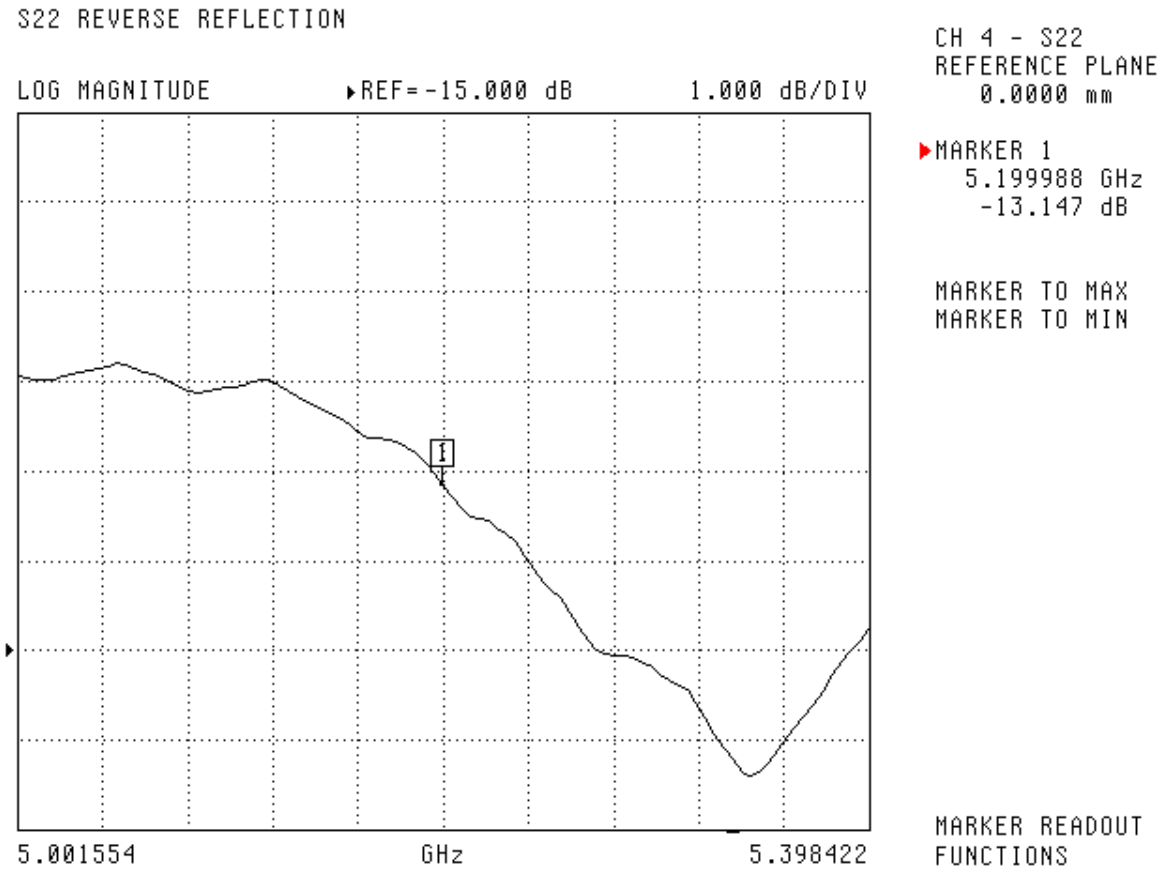
Tissue Validation

Head Tissue 5200 MHz	Measured
Dielectric constant, ε_r	39.94
Conductivity, σ [S/m]	5.24

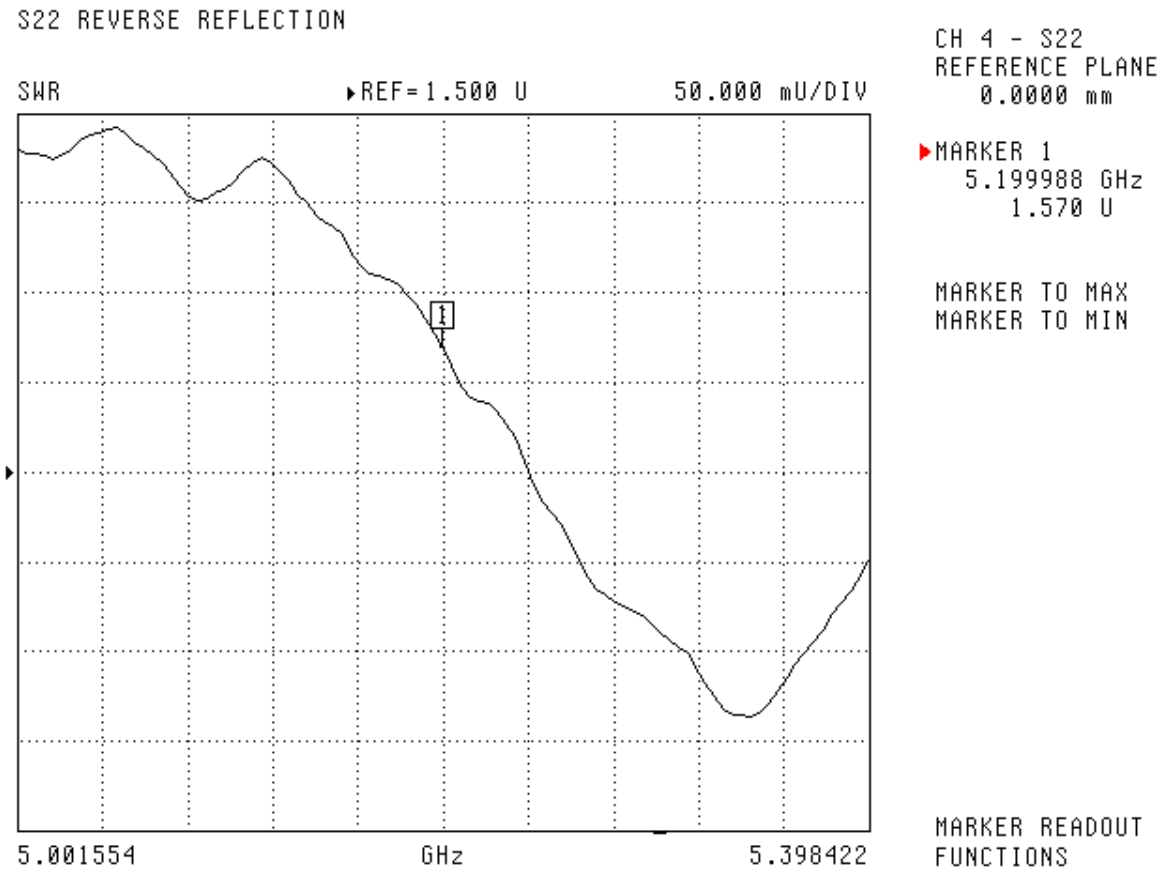
Electrical Calibration

Test	Result
S11 R/L	-13.15 dB
SWR	1.57 U
Impedance	78.2 Ω

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

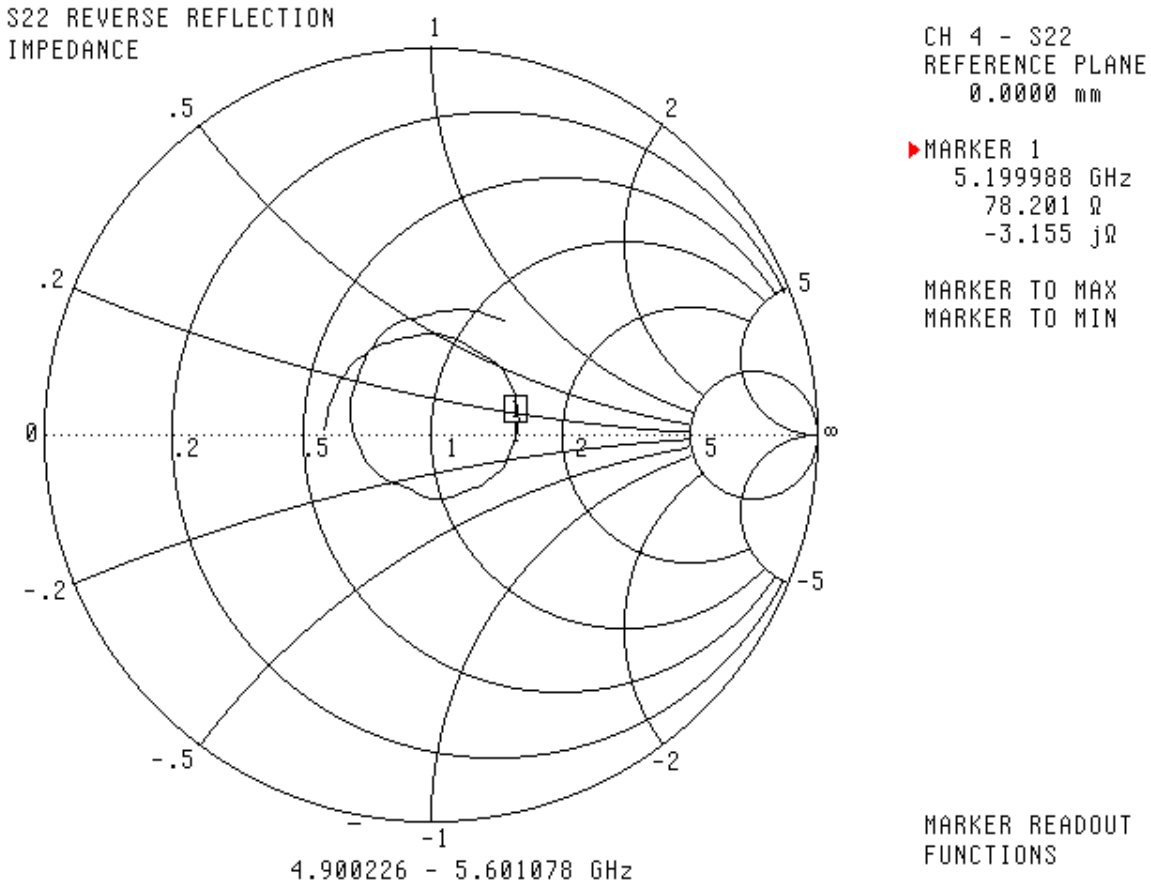


S11 Parameter Return Loss


S22 REVERSE REFLECTION
SWR
▸REF=1.500 U
50.000 mU/DIV
CH 4 - S22
REFERENCE PLANE
0.0000 mm
▸MARKER 1
5.199988 GHz
1.570 U
MARKER TO MAX
MARKER TO MIN
5.001554
GHz
5.398422
MARKER READOUT
FUNCTIONS

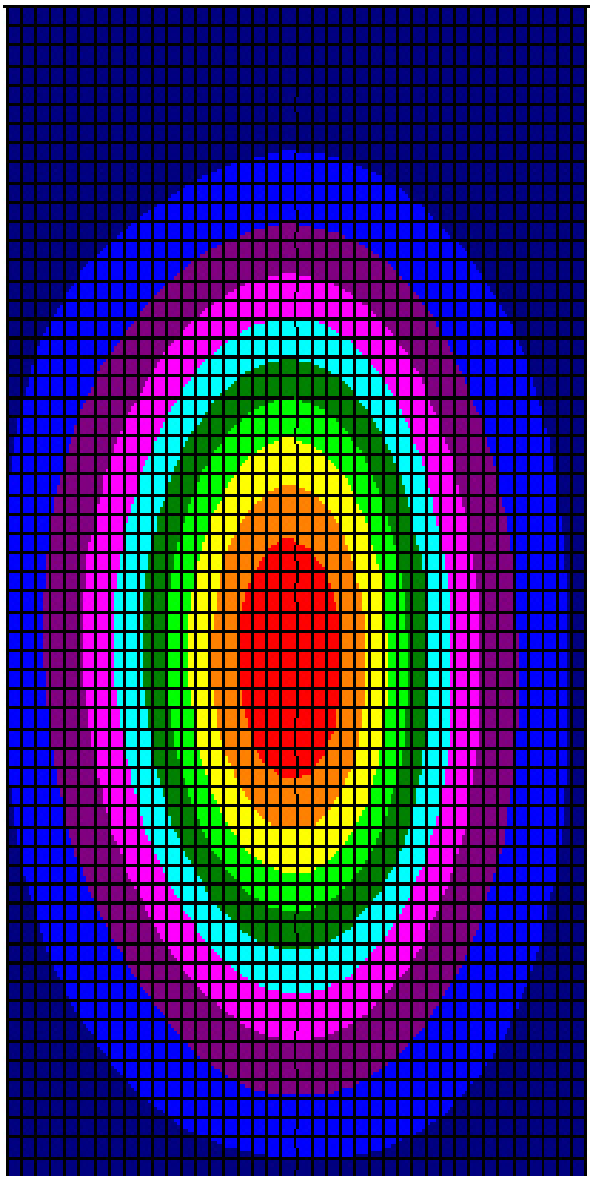
SWR

Smith Chart Dipole Impedance



System Validation Results Using a Complex Dipole Model (FDTD calculations)

Frequency	1 Gram
5.2 GHz	58.8



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 List May 2008.

Appendix E. Dipole Calibration

Validation Dipole 5800 MHz
M/N: ALS-D-5800-S-2
S/N: QTK-321

NCL CALIBRATION LABORATORIES

Calibration File No: DC-893

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

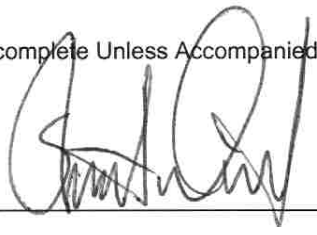
Manufacturer: APREL Laboratories
Part number: ALS-D-5800-S-2
Frequency: 5.8 GHz
Serial No: QTK-321

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

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

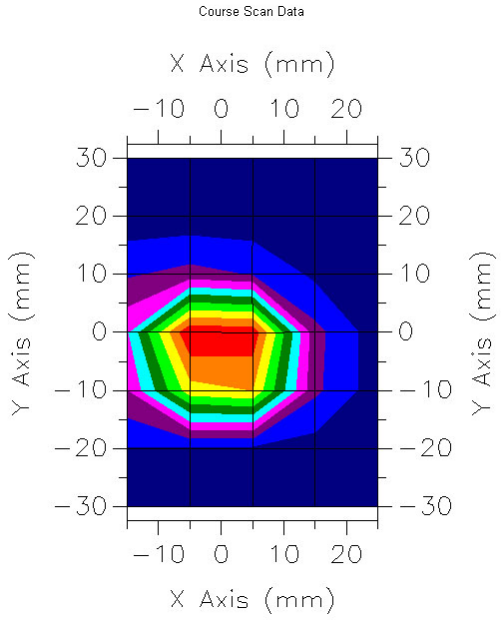
Length: 21.6 mm
Height: 12.6 mm

Electrical Specification

SWR: 1.74 U
Return Loss: -11.5 dB
Impedance: 68.3 Ω

System Validation Results

Frequency	1 Gram
5800 GHz	57.9



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

Conditions

Dipole 321 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.

Stuart Nicol

C. Teodorian

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
21.6 mm	12.6 mm	21.2 mm	13.1 mm

Tissue Validation

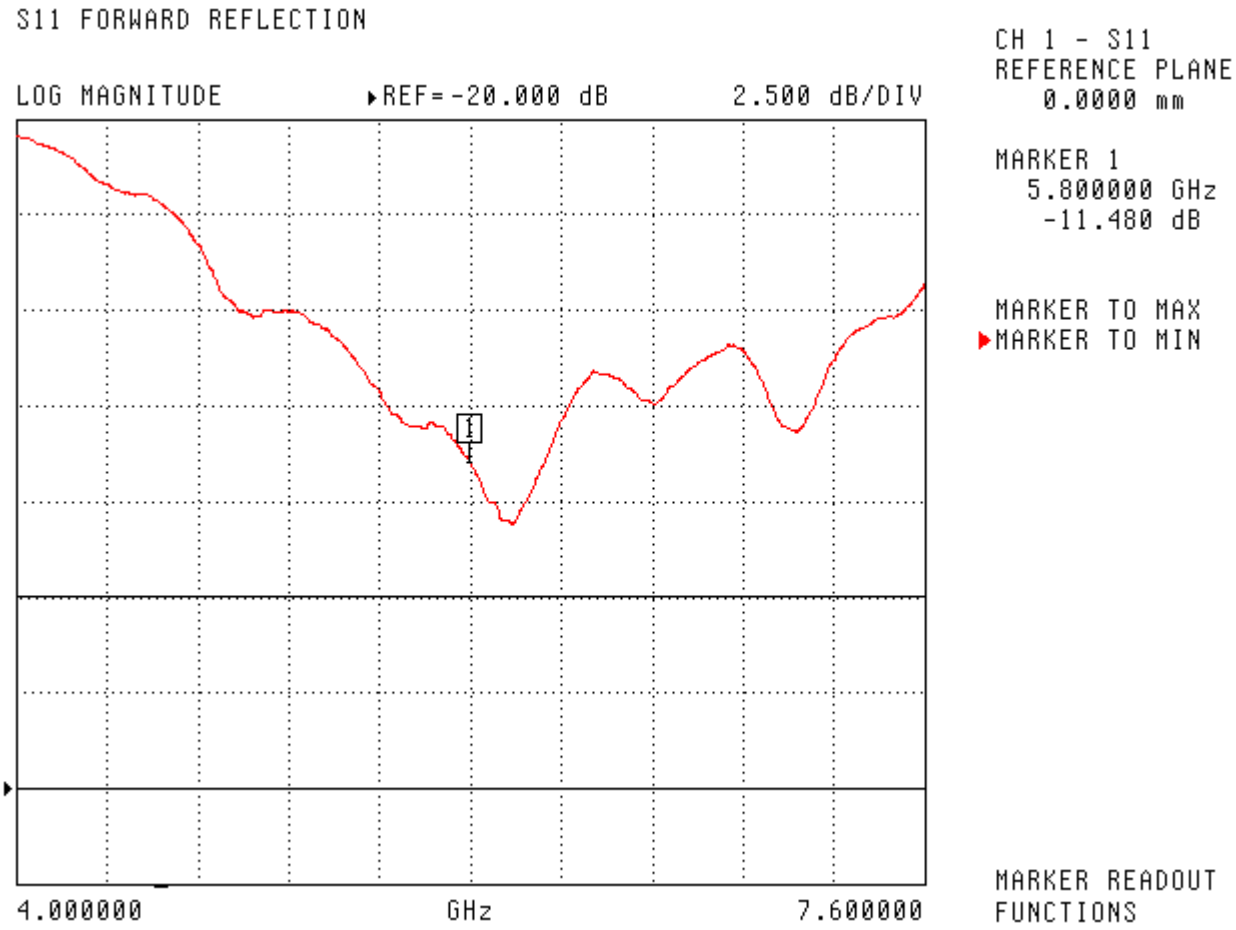
Head Tissue 5800 MHz	Measured
Dielectric constant, ε_r	35.15
Conductivity, σ [S/m]	6.4

Electrical Calibration

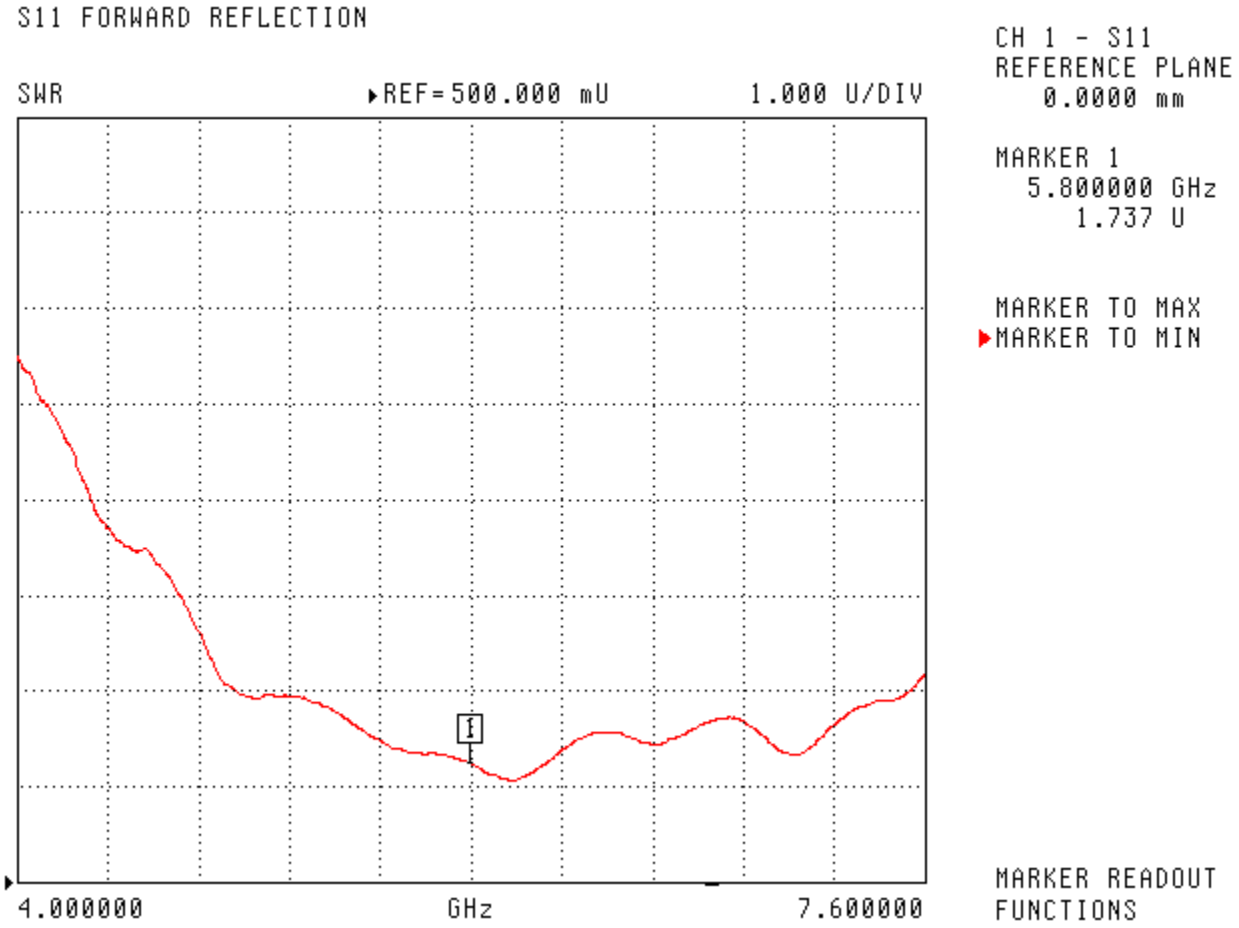
Test	Result
S11 R/L	-11.5 dB
SWR	1.74 U
Impedance	68.3 Ω

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

S11 Parameter Return Loss

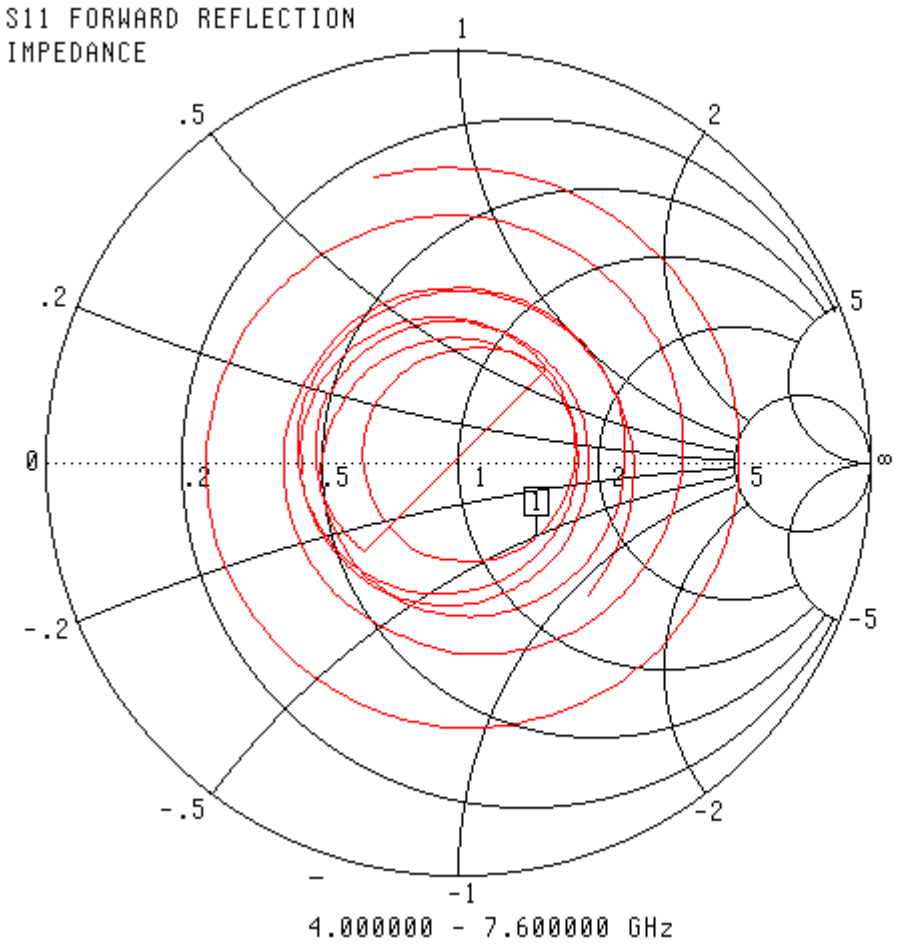


SWR



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

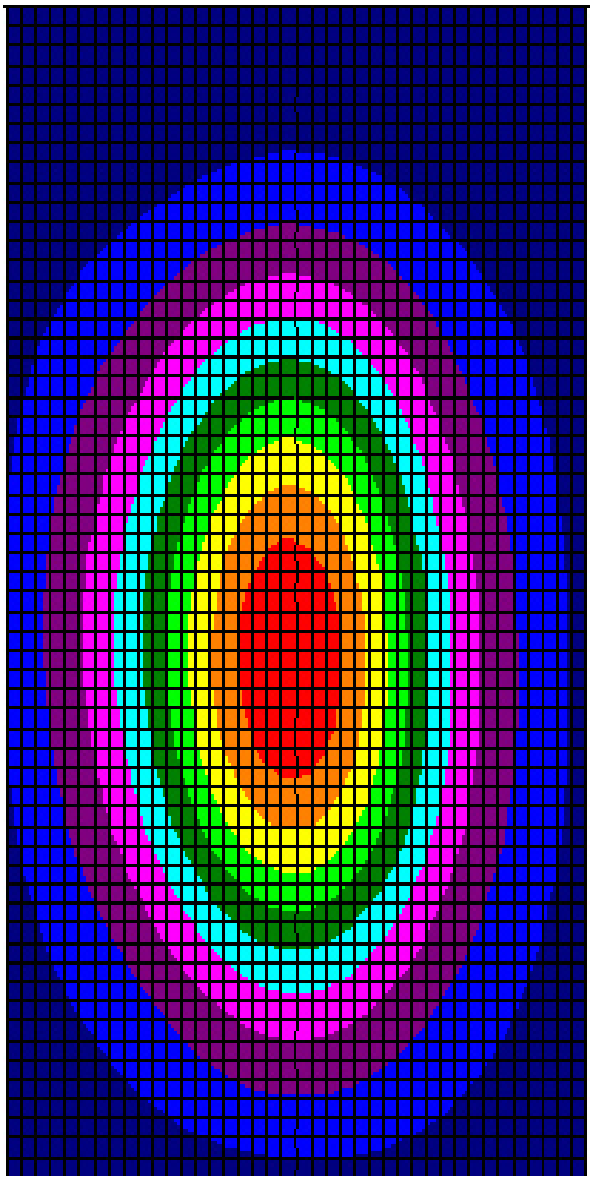
Smith Chart Dipole Impedance



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

System Validation Results Using a Complex Dipole Model (FDTD calculations)

Frequency	1 Gram
5.8 GHz	57.9



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 List May 2008.