



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

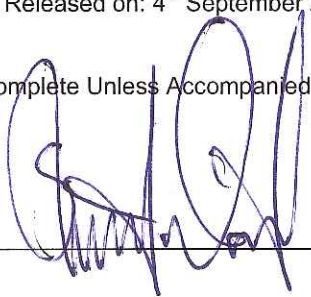
Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2

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: _____



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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

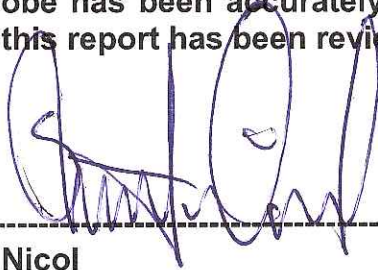
Conditions

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:	$1.2 \mu\text{V}/(\text{V}/\text{m})^2$
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: 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.

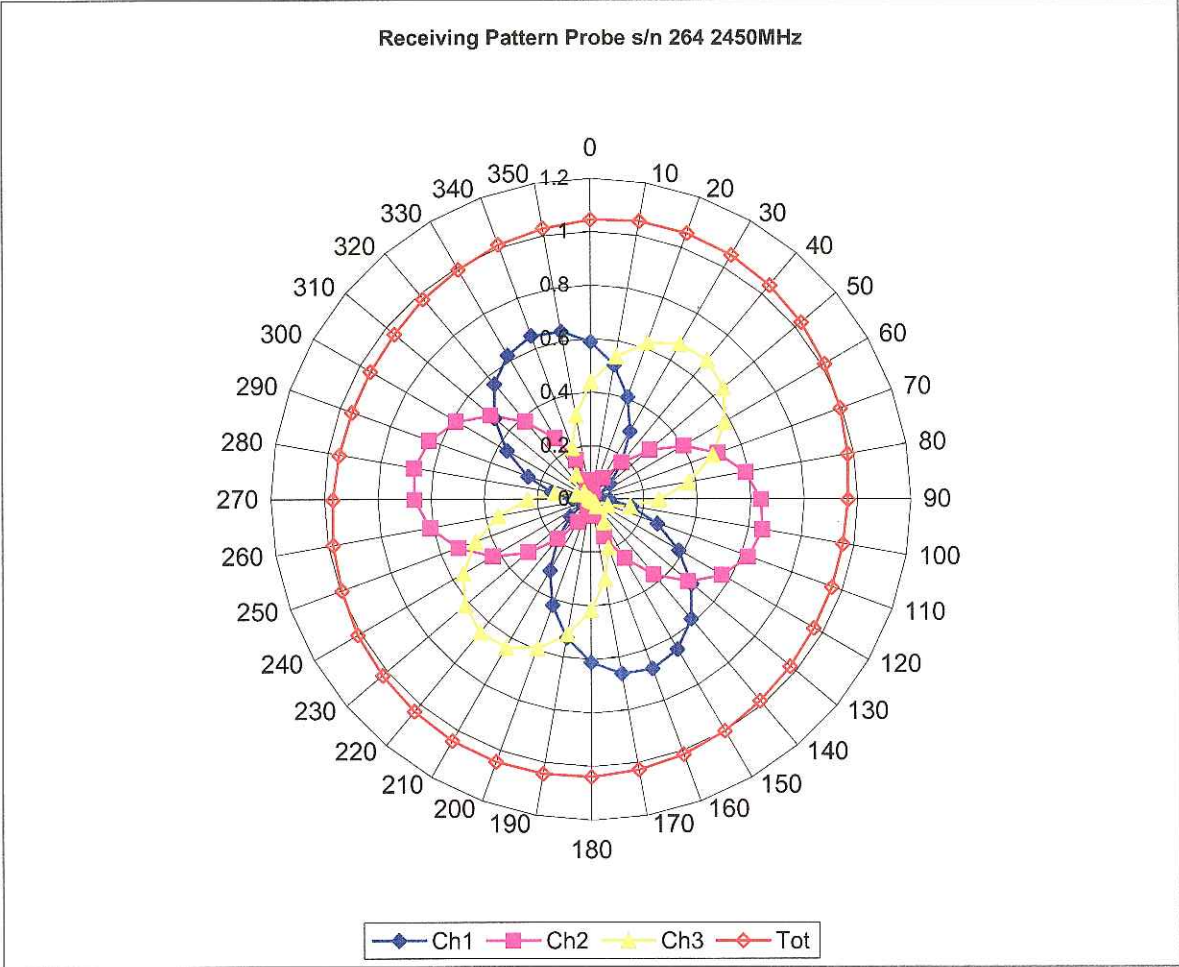
Boundary Effect:

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.

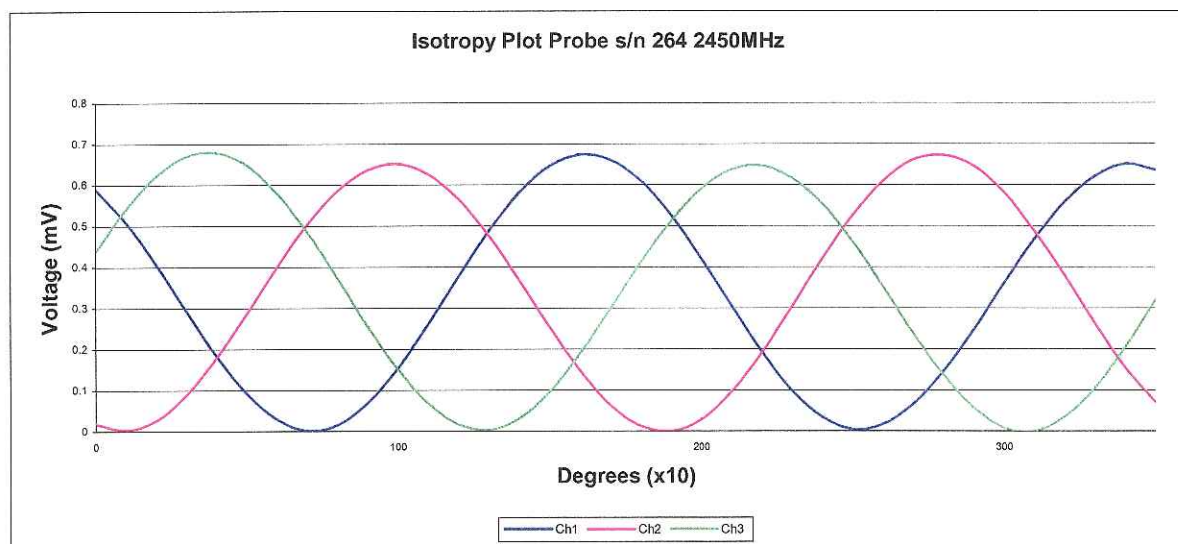
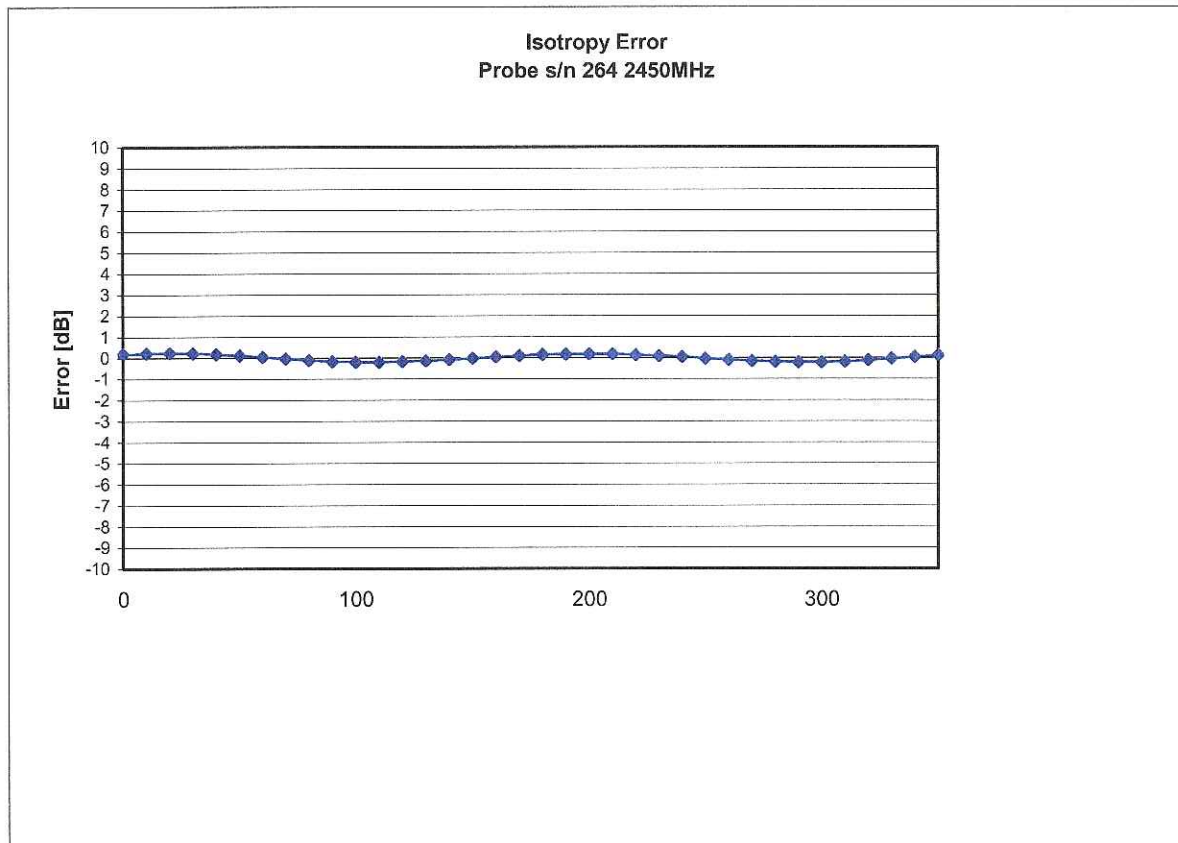
Spatial Resolution:

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)



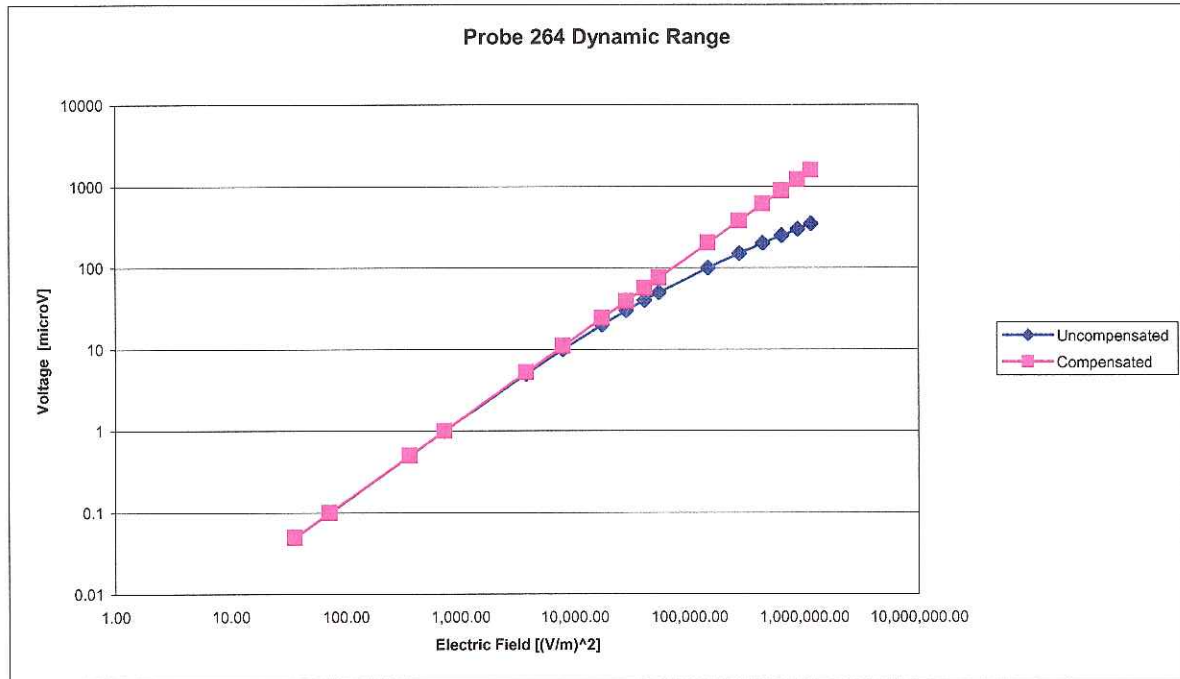
Isotropy Error 2450 MHz (Air)



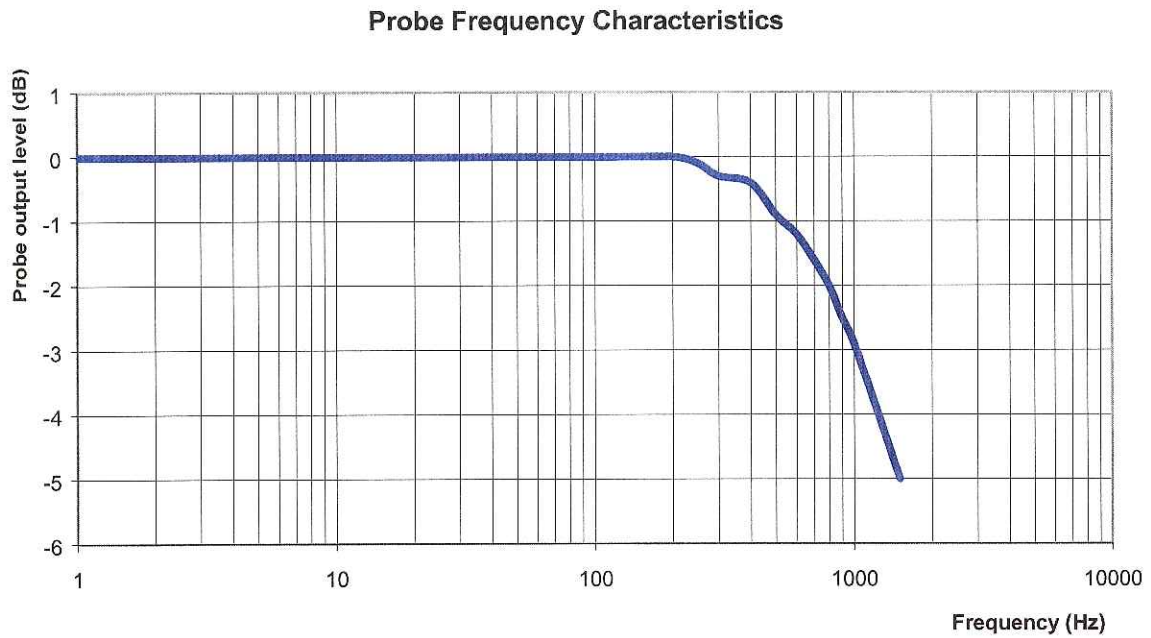
Isotropy in Tissue:

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: 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 835 MHz

M/N: ALS-D-835-S-2

S/N: QTK-315

NCL CALIBRATION LABORATORIES

Calibration File No: DC-887

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.

Quietek Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-835-S-2

Frequency: 835 MHz

Serial No: QTK-315

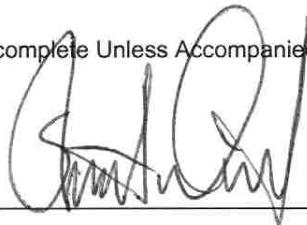
Customer: Quietek

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: _____



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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

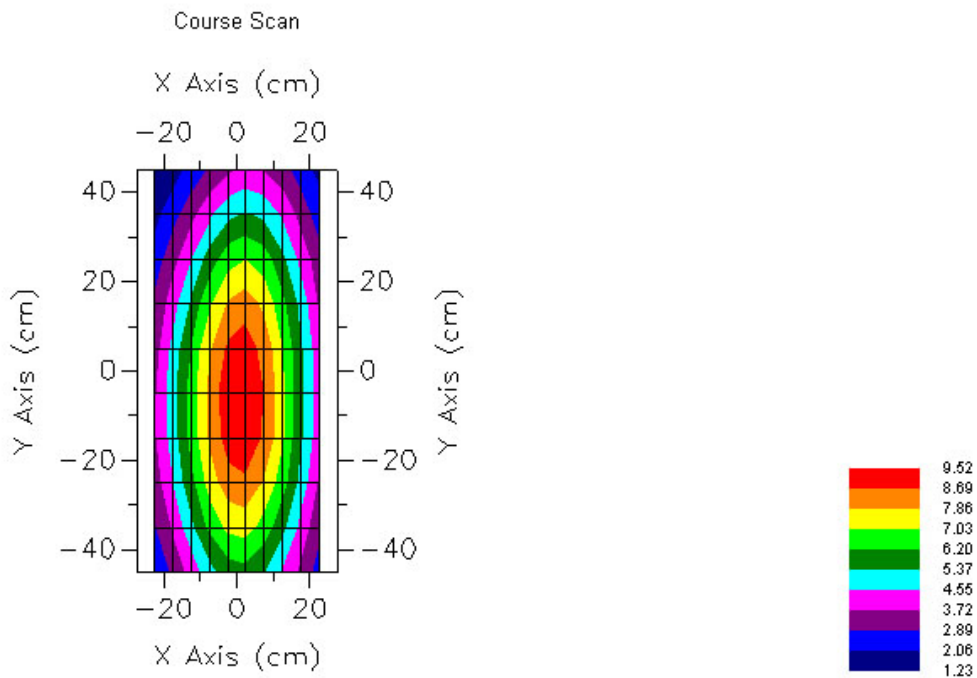
Length: 165.0 mm
Height: 90.0 mm

Electrical Specification

SWR: 1.04 U
Return Loss: -32.9 dB
Impedance: 51.1 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
835 MHz	9.33	6.42	15.0



Conditions

Dipole 315 is a recalibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

References

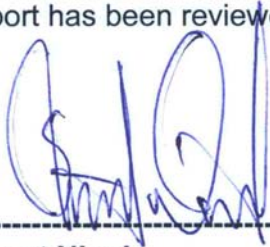
SSI-TP-018-ALSAS Dipole Calibration Procedure

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"

IEC 62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures –Part 1 & Part 2: Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

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
161.0 mm	89.8 mm	165.0 mm	90.0 mm

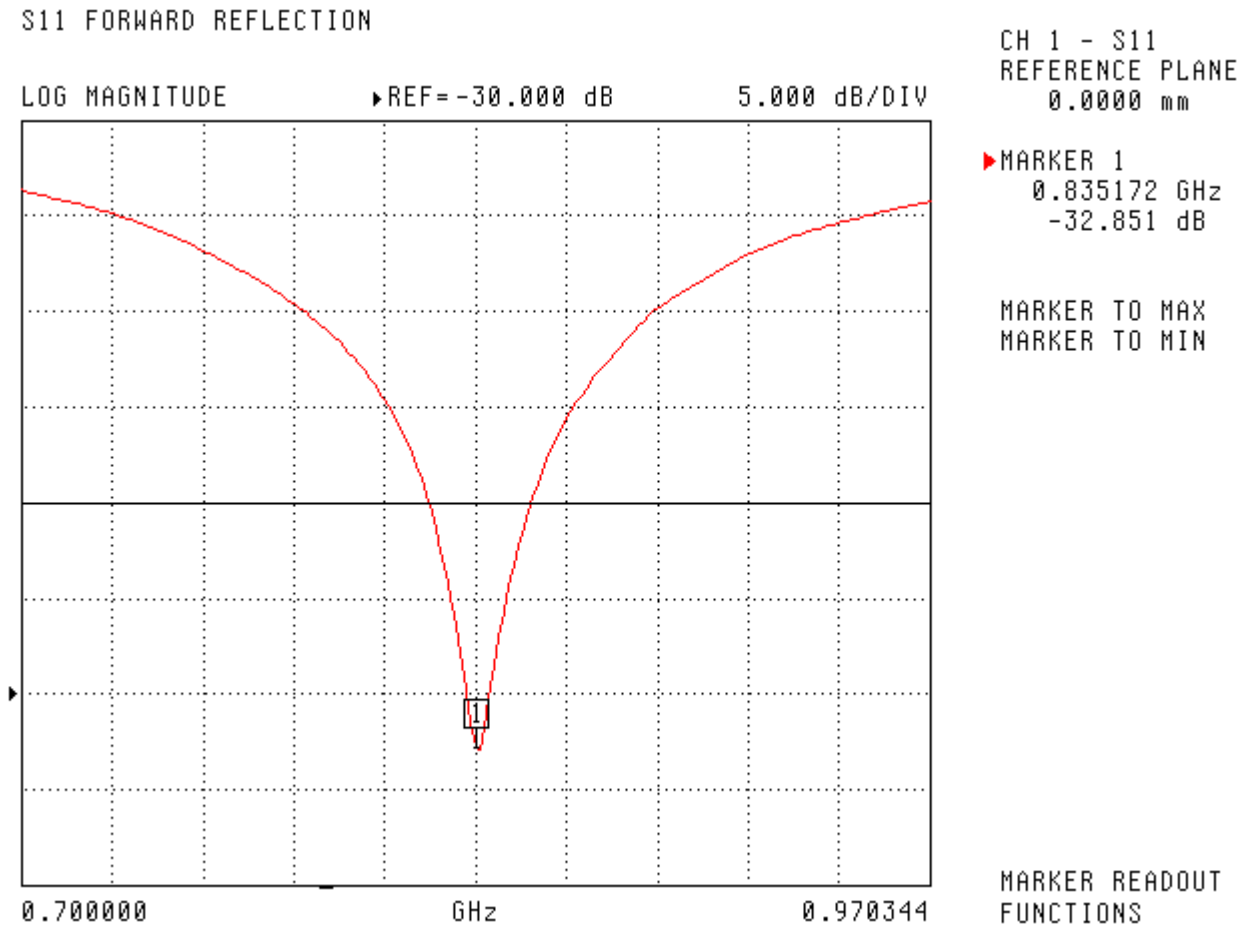
Tissue Validation

Head Tissue 835 MHz	Measured
Dielectric constant, ϵ_r	42.54
Conductivity, σ [S/m]	0.91

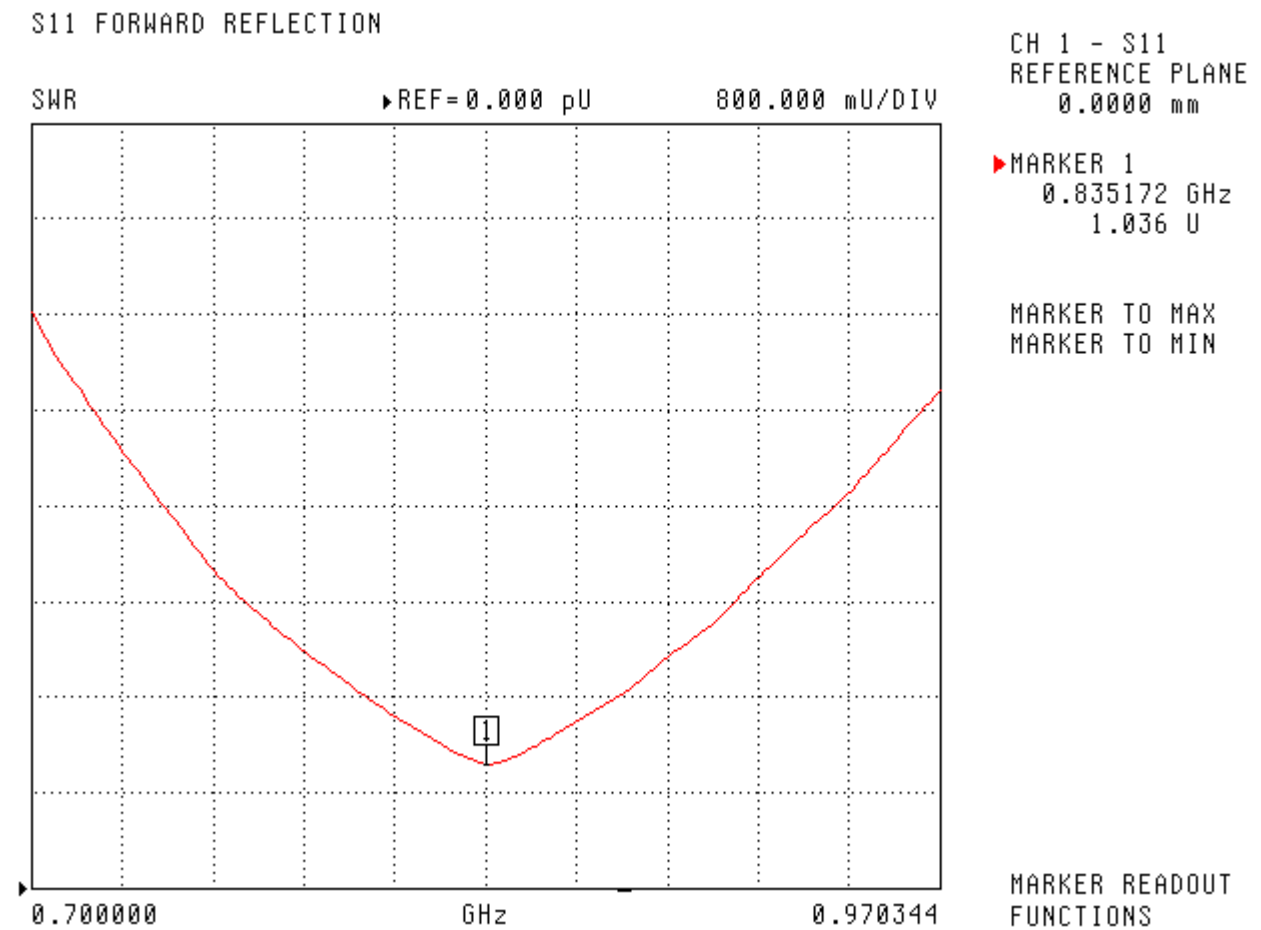
Electrical Calibration

Test	Result
S11 R/L	-32.9 dB
SWR	1.04 U
Impedance	51.1 Ω

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

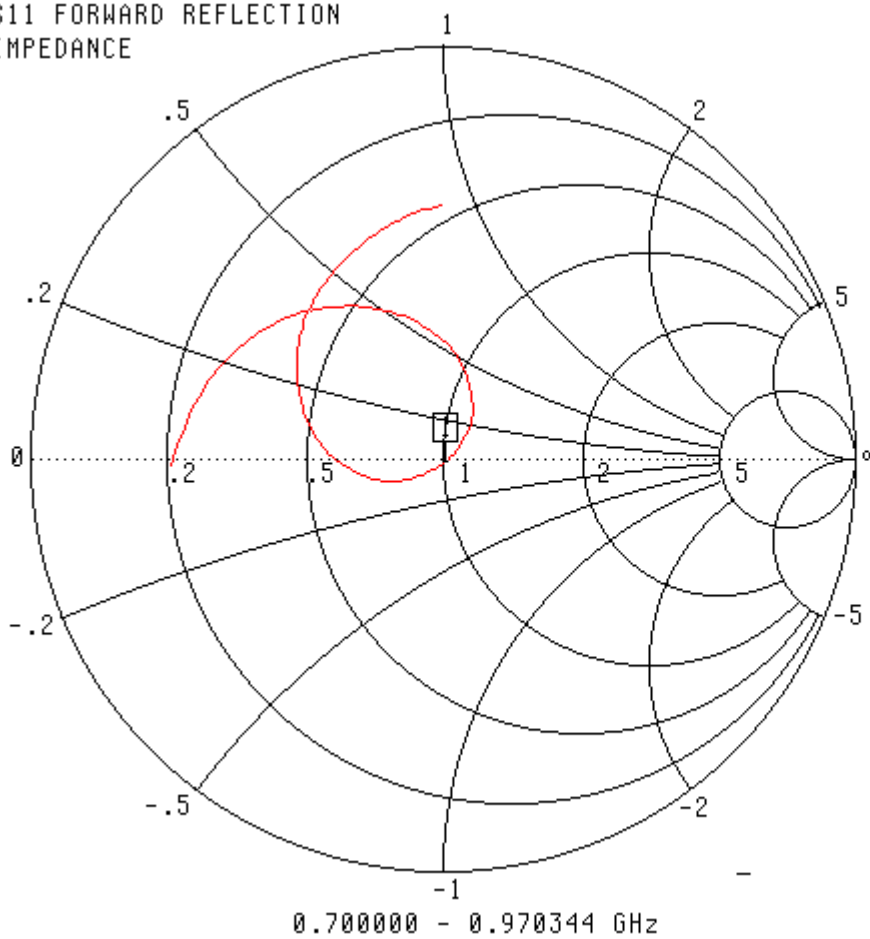
S11 Parameter Return Loss

SWR



Smith Chart Dipole Impedance

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
REFERENCE PLANE
0.0000 mm

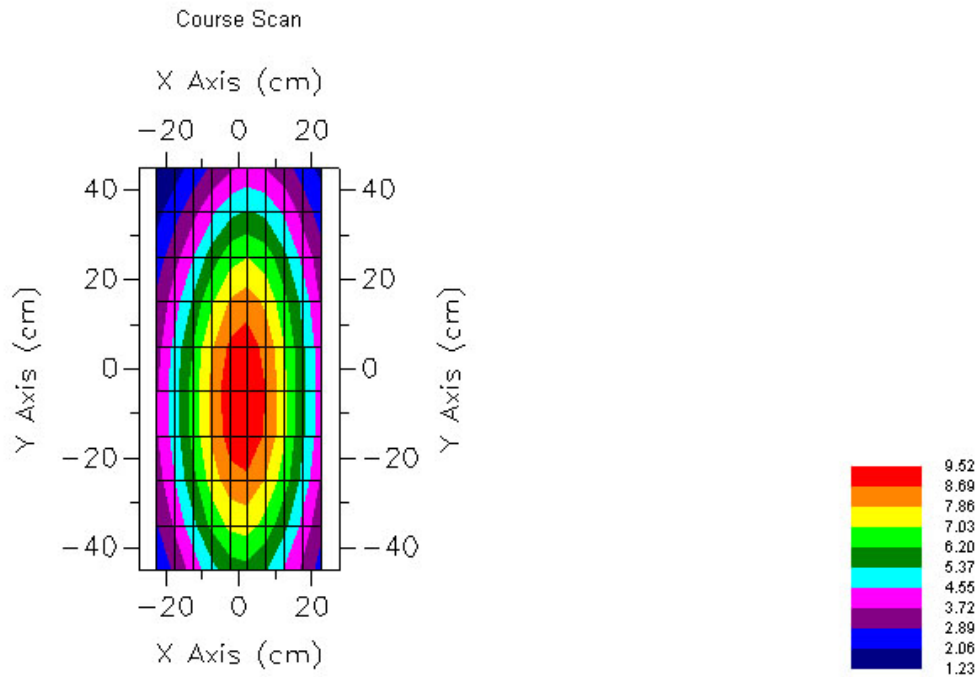
▶ MARKER 1
0.835172 GHz
51.124 Ω
-920.979 $j\Omega$

MARKER TO MAX
MARKER TO MIN

MARKER READOUT
FUNCTIONS

System Validation Results Using the Electrically Calibrated Dipole

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
835 MHz	9.33	6.42	15.0



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 1900 MHz

M/N: ALS-D-1900-S-2

S/N: QTK-318

NCL CALIBRATION LABORATORIES

Calibration File No: DC-890

C E R T I F I C A T E O F 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-1900-S-2

Frequency: 1.9 GHz

Serial No: QTK-318

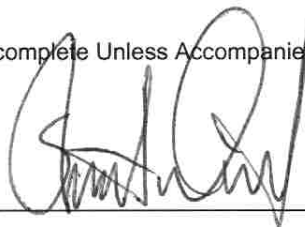
Customer: Quietek

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: _____



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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

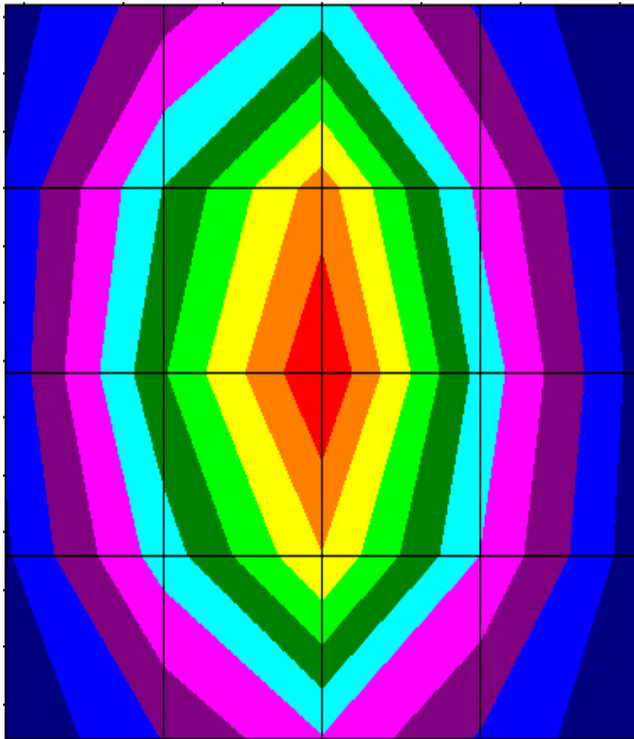
Length: 70.0 mm
Height: 39.5 mm

Electrical Specification

SWR: 1.1 U
Return Loss: -25.8 dB
Impedance: 47.8 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
1.9 GHz	36.0	20.78	67.7



Conditions

Dipole 318 is a recalibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

References

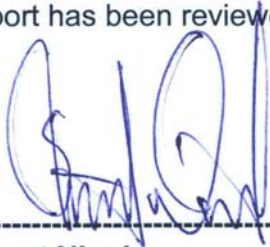
SSI-TP-018-ALSAS Dipole Calibration Procedure

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"

IEC 62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures –Part 1 & Part 2: Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

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

20 °C +/- 0.5°C

NCL Calibration Laboratories

Division of APREL Laboratories.

Dipole Calibration Results

Mechanical Verification

IEEE Length	IEEE Height	Measured Length	Measured Height
68.0 mm	39.5 mm	70.0 mm	39.5 mm

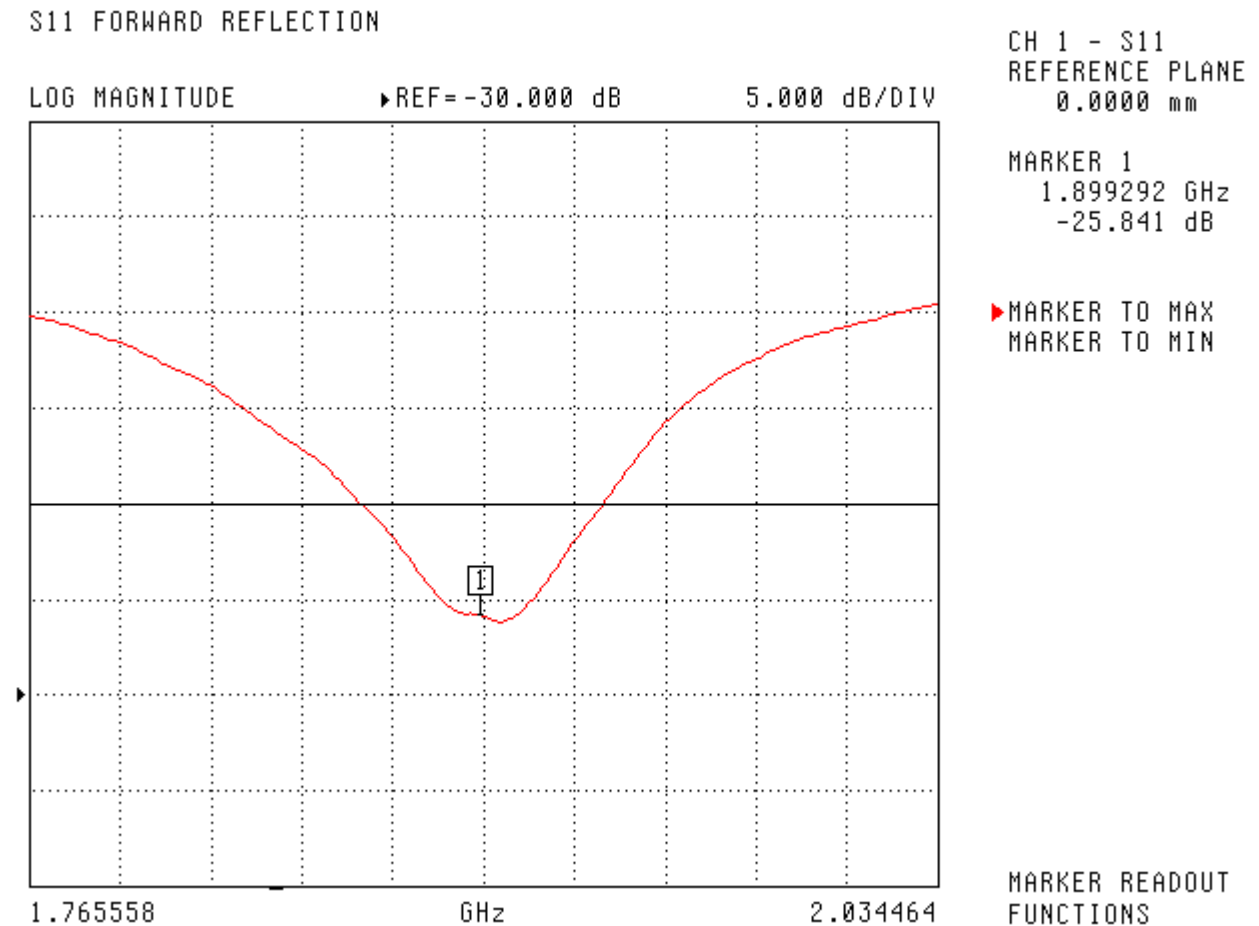
Tissue Validation

Head Tissue 1900 MHz	Measured
Dielectric constant, ϵ_r	39.9
Conductivity, σ [S/m]	1.42

Electrical Calibration

Test	Result
S11 R/L	-25.8 dB
SWR	1.1 U
Impedance	47.8 Ω

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

S11 Parameter Return Loss

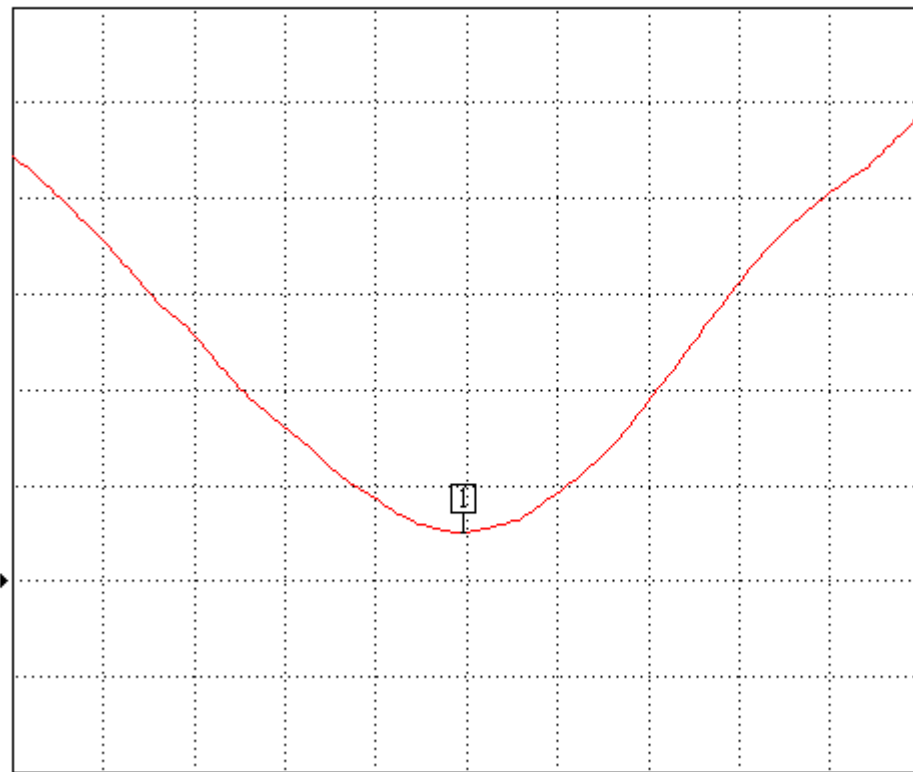
SWR

S11 FORWARD REFLECTION

SWR

REF=1.000 U

200.000 mU/DIV



1.76558

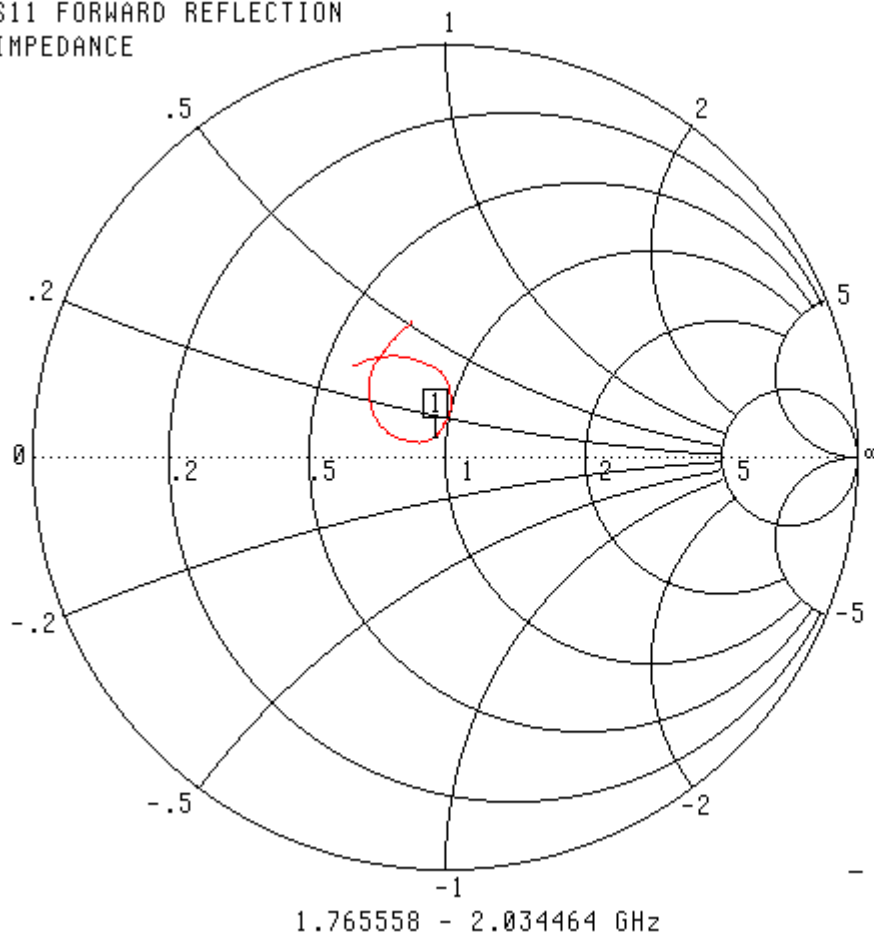
GHz

2.034464

MARKER READOUT
FUNCTIONS

Smith Chart Dipole Impedance

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
REFERENCE PLANE
0.0000 mm

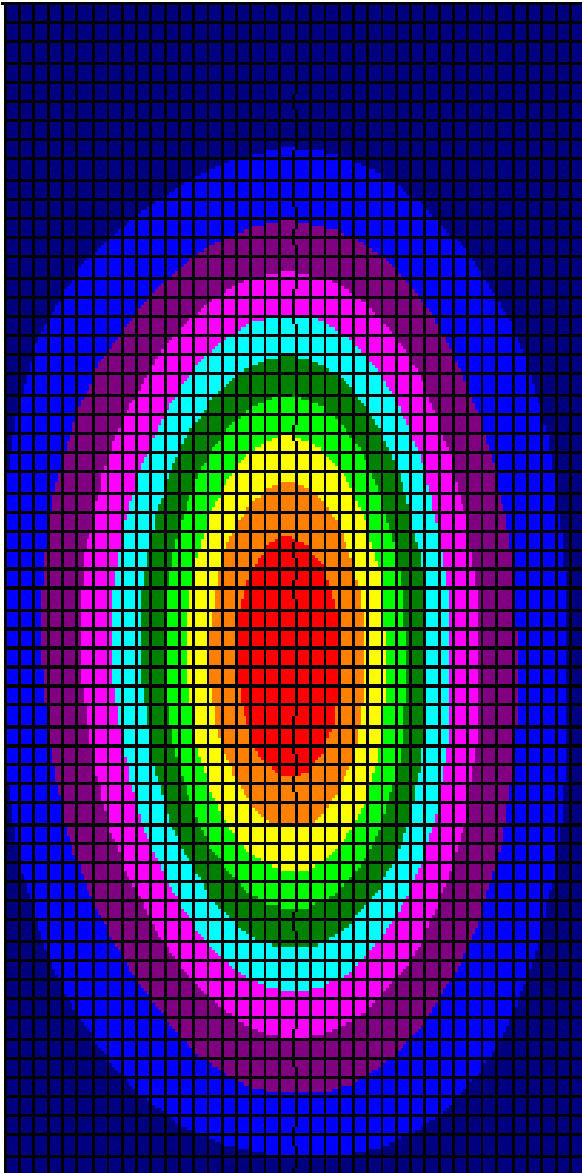
MARKER 1
1.899292 GHz
47.748 Ω
4.401 $j\Omega$

▶ 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
1.9 GHz	36.0	20.78	67.7



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 2450 MHz

M/N: ALS-D-2450-S-2

S/N: QTK-319

NCL CALIBRATION LABORATORIES

Calibration File No: DC-891

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.

Quietek Validation Dipole

Manufacturer: APREL Laboratories

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

Frequency: 2.45 GHz

Serial No: QTK-319

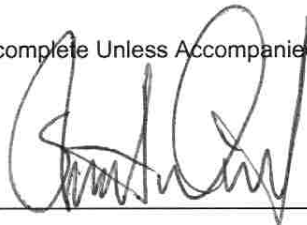
Customer: Quietek

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: _____



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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

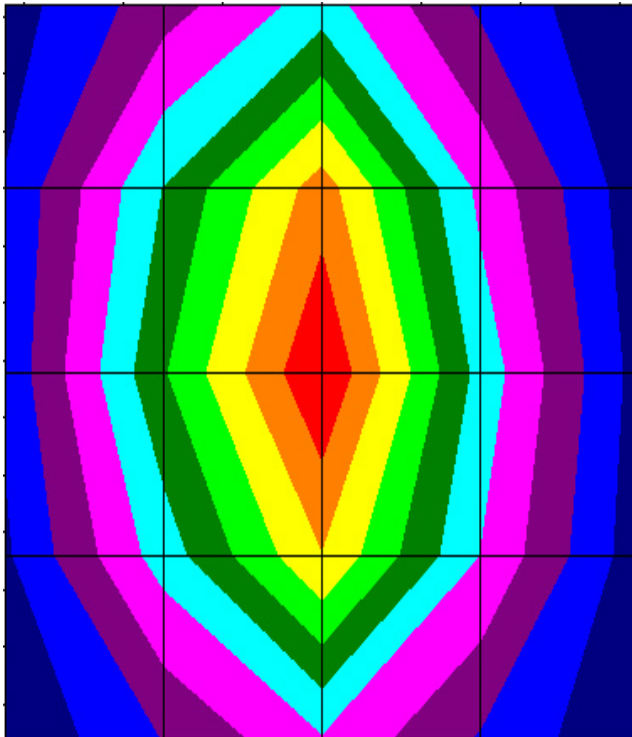
Length: 53.5 mm
Height: 30.4 mm

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



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

References

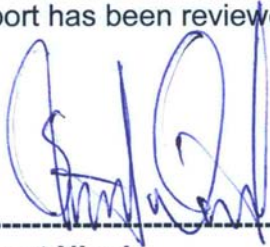
SSI-TP-018-ALSAS Dipole Calibration Procedure

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"

IEC 62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures –Part 1 & Part 2: Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

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

S11 FORWARD REFLECTION

LOG MAGNITUDE

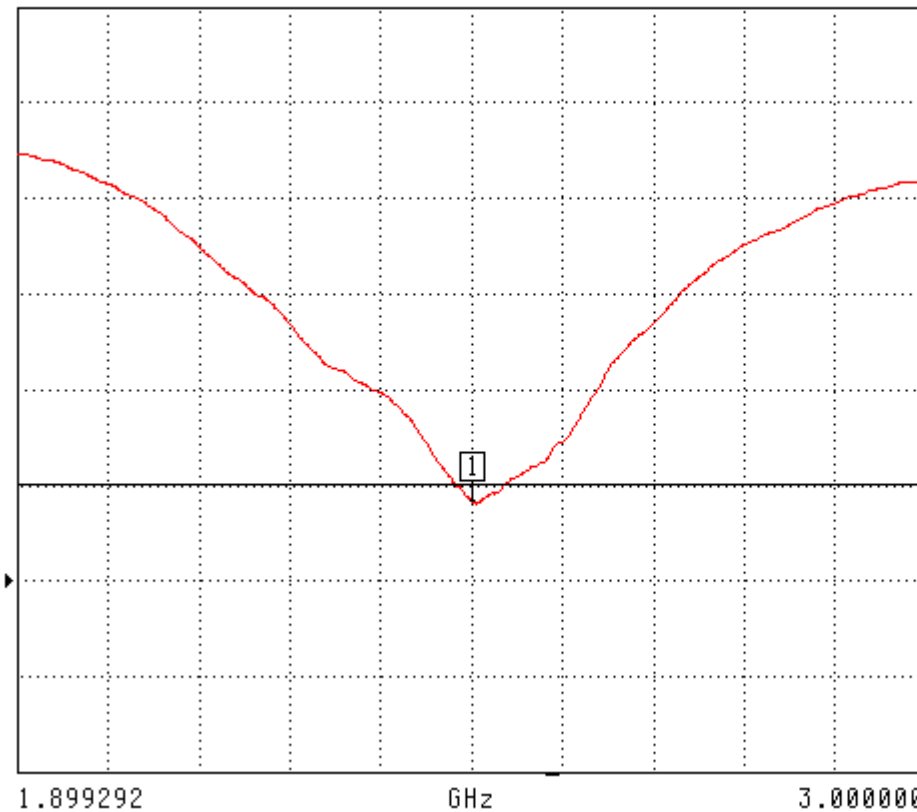
REF = -25.000 dB

5.000 dB/DIV

CH 1 - S11
REFERENCE PLANE
0.0000 mm

MARKER 1
2.450046 GHz
-20.796 dB

MARKER TO MAX
▶ MARKER TO MIN



MARKER READOUT
FUNCTIONS

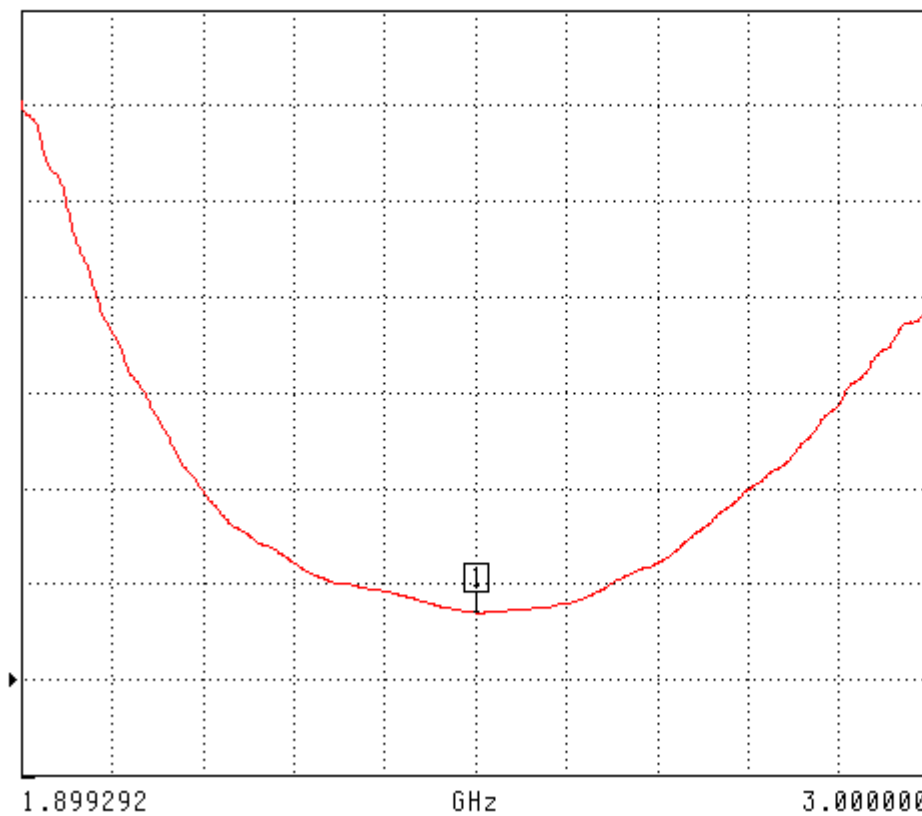
SWR

S11 FORWARD REFLECTION

SWR

REF=500.000 mU

1.000 U/DIV



CH 1 - S11
REFERENCE PLANE
0.0000 mm

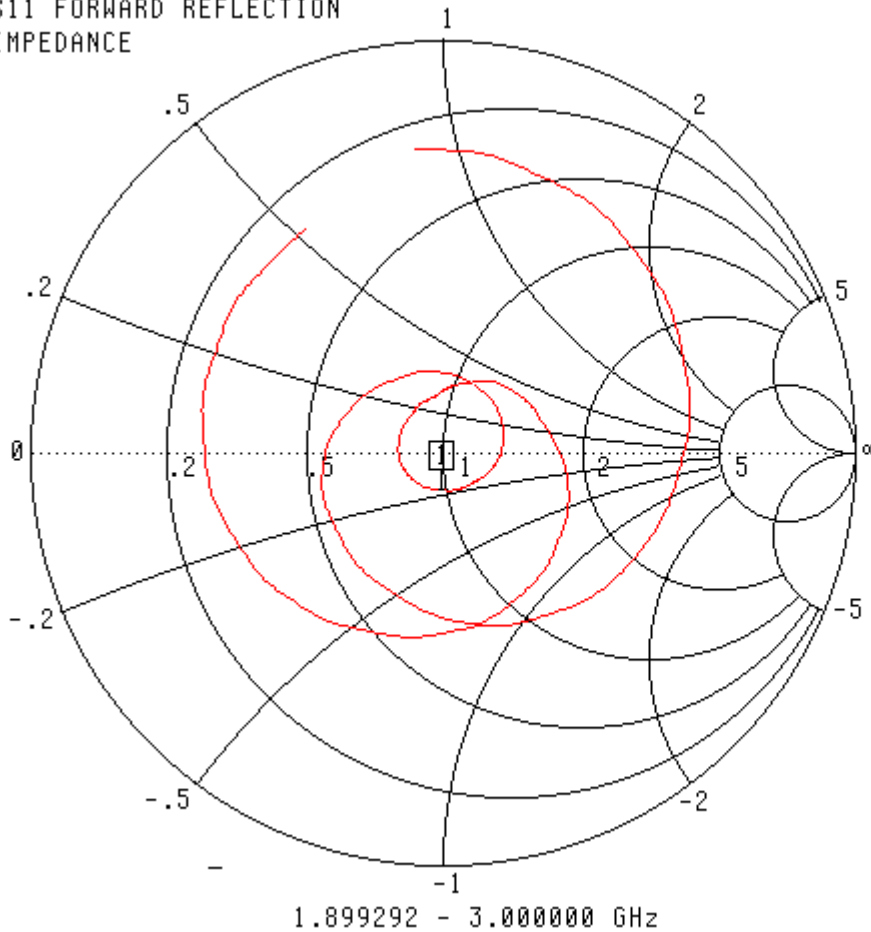
MARKER 1
2.450046 GHz
1.199 U

MARKER TO MAX
▶ MARKER TO MIN

MARKER READOUT
FUNCTIONS

Smith Chart Dipole Impedance

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
REFERENCE PLANE
0.0000 mm

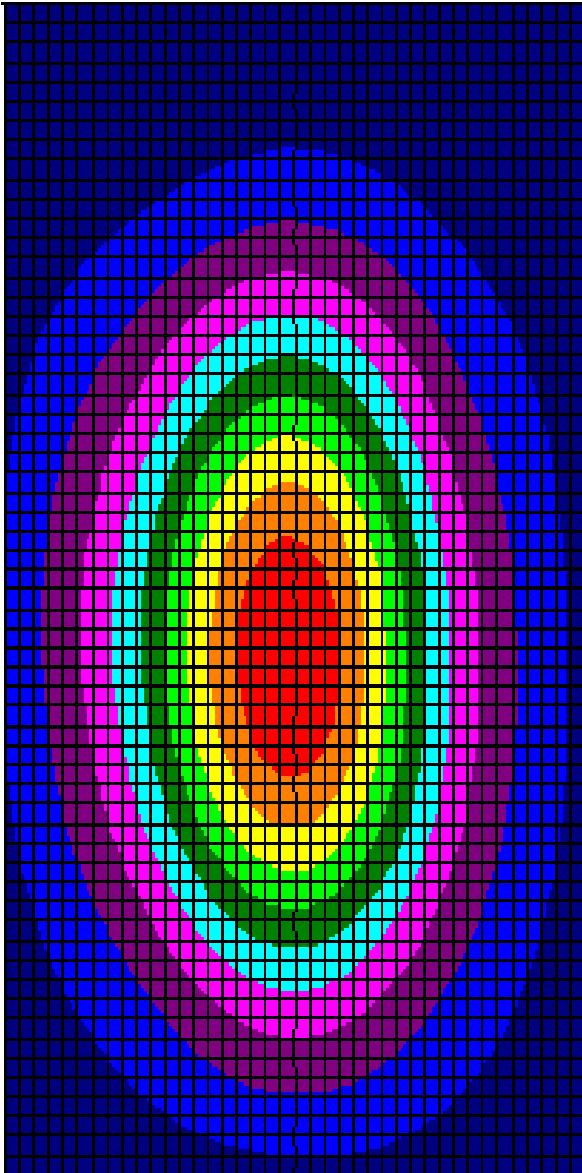
MARKER 1
2.450046 GHz
49.365 Ω
-9.232 j Ω

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



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.