

NCL Calibration Laboratories Division of APREL Laboratories, 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. Page 10 of 10. This page has been reviewed for content and attested to on Page 2 of this document.



NCL CALIBRATION LABORATORIES

Calibration File No.: CP-561

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.: 265

HEAD Calibration

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2 Project No: QTKB-ALS-E-020 Probe Cal-5091

> Calibrated: 23rd March 2005 Released on: 23rd March 2005

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

Released By:

NCL CALIBRATION LABORATORIES

ST SPECTRUM WAY NEPEAN, ONTARIO CANADA KOR 156 Division of APREL Lab. TEL: (613) 820-4988 FAX: (813) 820-4161



Division of APREL Laboratories

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-020 265.

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 265 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.

Ron Dulmage

Y. Chen

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



Calibration Results Summary

Probe Type:

E-Field Probe E-020

Serial Number:

265

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

Sensitivity in Air

Channel X: Channel Y: Channel Z:

1.2 μV/(V/m)² 1.2 μV/(V/m)² 1.2 µV/(V/m)²

Diode Compression Point:

95 mV

^{*}Resistive to recommended tissue recipes per IEEE-1528

Page 3 of 10. This page has been reviewed for content and attested to on Page 2 of this document.



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Sensitivity in Head Tissue

Frequency:

5800 MHz

Epsilon:

35.3 (+/-10%)

Sigma:

5.27 S/m (+/-5%)

ConvF

Channel X:

3.4

Channel Y:

3.4

Channel Z:

3.4

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:

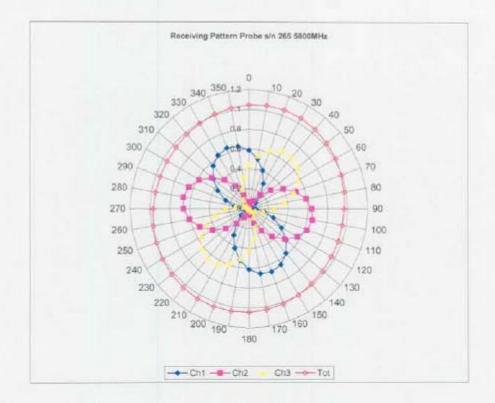
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

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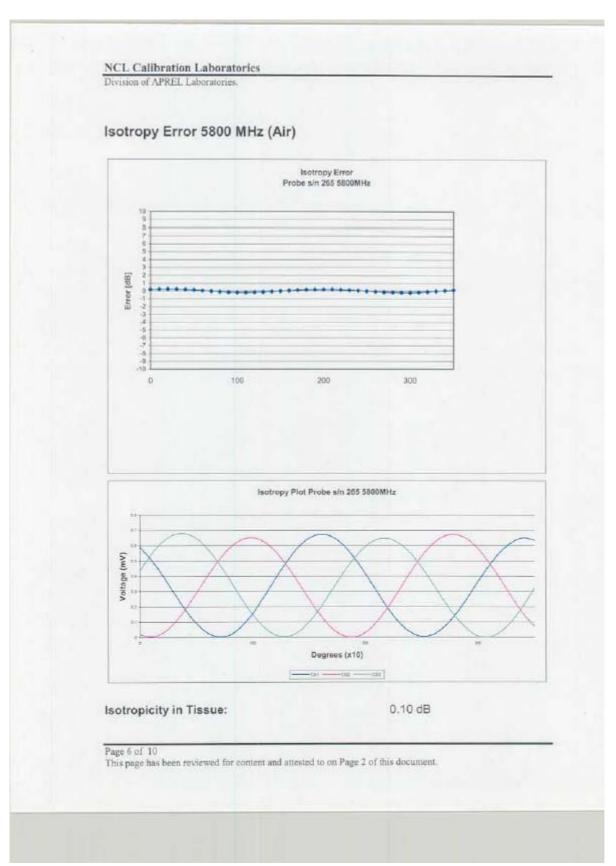
Receiving Pattern 5800 MHz (Air)



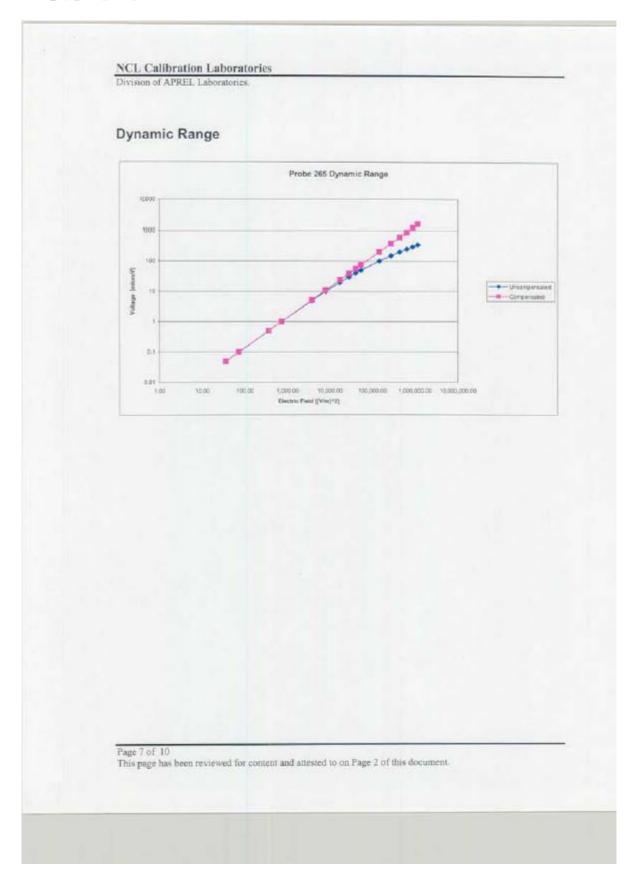
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This page has been reviewed for content and attested to on Page 2 of this document.

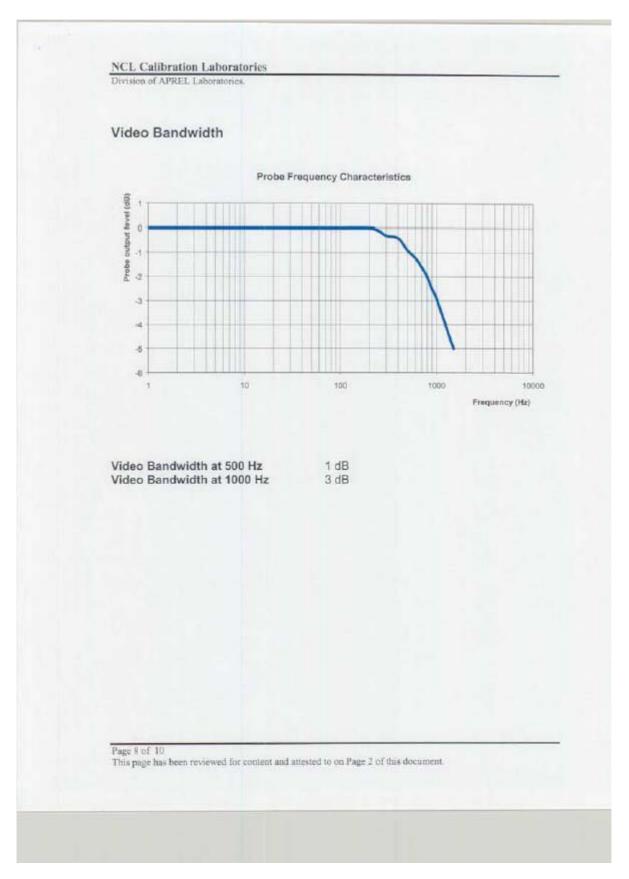














Conversion Factor Uncertainty Assessment

Frequency:

5800MHz

Epsilon:

35.3 (+/-10%)

Sigma: 5.27 S/m (+/-5%)

ConvF

Channel X: 3.4

7%(K=2)

Channel Y: 3.4

7%(K=2)

Channel Z: 3.4

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%.

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NCL Calibration Laboratories Division of APREL Laboratories. 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. Page 10 of 10 This page has been reviewed for content and attested to on Page 2 of this document.



NCL CALIBRATION LABORATORIES

Calibration File No.: CP-562

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.: 265

BODY Calibration

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2 Project No: QTKB-ALS-E-020 Probe Cal-5091

> Calibrated: 23rd March 2005 Released on: 23rd March 2005

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



Division of APREL Laboratories.

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-020 265.

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 265 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.

Bon Dulmage

Y. Chen

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Division of APREL Laboratories.

Calibration Results Summary

Probe Type:

E-Field Probe E-020

Serial Number:

265

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

Sensitivity in Air

Channel X: Channel Y: Channel Z: 1.2 µV/(V/m)² 1.2 µV/(V/m)² 1.2 µV/(V/m)²

Diode Compression Point:

95 mV

^{*}Resistive to recommended tissue recipes per IEEE-1528

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Sensitivity in Body Tissue

Frequency:

5800 MHz

Epsilon:

48.2 (+/-10%)

Sigma:

6.0 S/m (+/-5%)

ConvF

Channel X:

3.9

Channel Y:

3.9

Channel Z:

3.9

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:

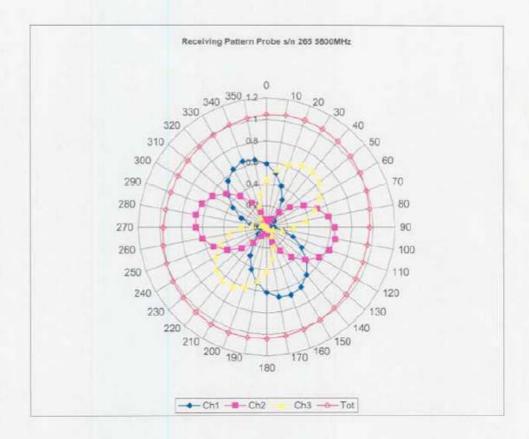
The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

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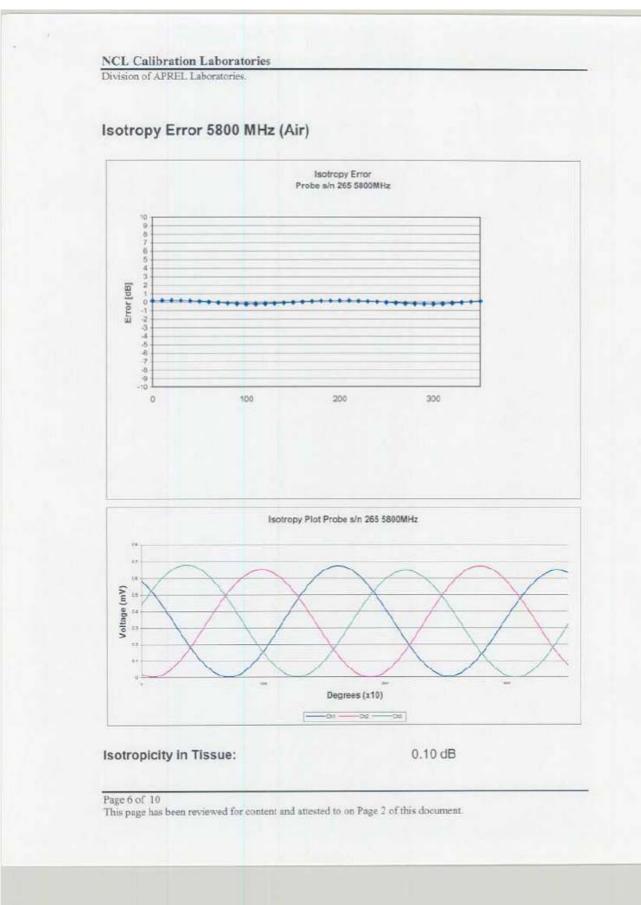
Division of APREL Laboratories

Receiving Pattern 5800 MHz (Air)

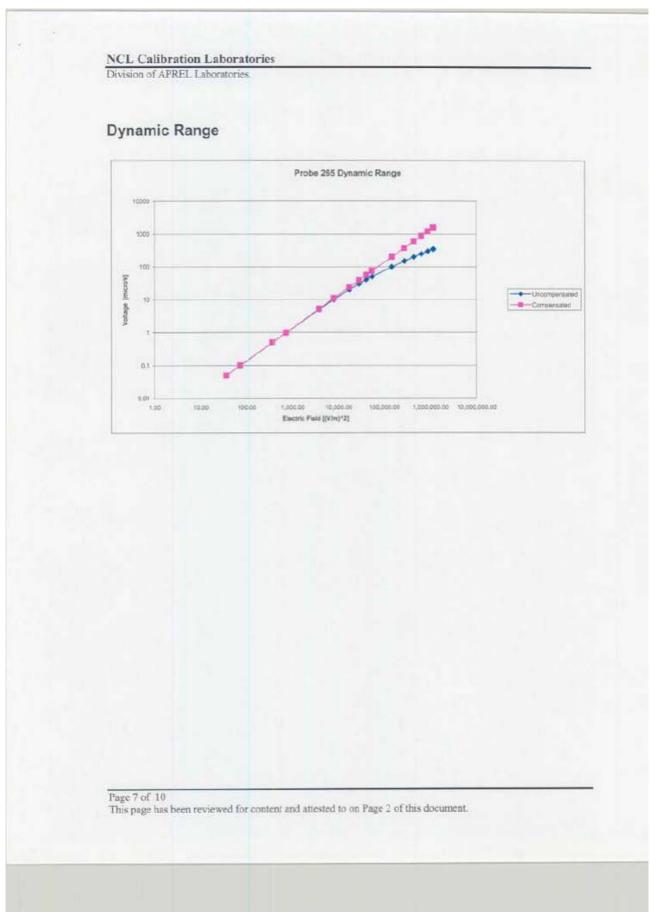


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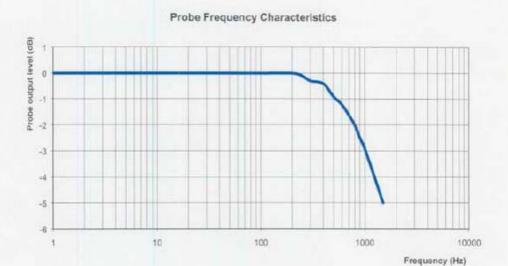








Video Bandwidth



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

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Conversion Factor Uncertainty Assessment

Frequency:

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

ConvF

Channel X: 3.9 7%(K=2)

Channel Y: 3.9 7%(K=2)

Channel Z: 3.9 7%(K=2)

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

5800MHz

Boundary Effect:

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



NCL Calibration Laboratories Division of APREL Laboratories. **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. Page 10 of 10 This page has been reviewed for content and attested to on Page 2 of this document.

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QuieTek

Appendix - Dipole Calibration

Validation Dipole 2450MHz

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

S/N: QTK-319

Validation Dipole 5200MHz

P/N: ALS-D-5200-S-2

S/N: QTK-320

Validation Dipole 5800MHz

P/N: ALS-D-5800-S-2

S/N: QTK-321



NCL CALIBRATION LABORATORIES

Calibration File No: DC-409 Project Number: QTKB-ALSAS-10U-5050

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

Calibrated: 23 June 2004 Released on: 23 June 2004

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



Division of APREL Laboratories.

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

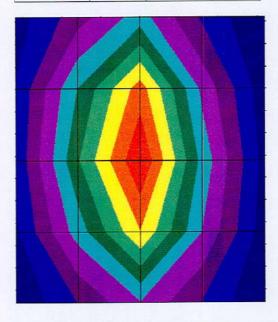
Electrical Specification

1.19 U

Return Loss: -20.8 dB Impedance: 49.4Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
2.45 GHz	48.07	25.65	95.6



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Calibrated by

Approved by:



Division of APREL Laboratories.

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 QTK-319. 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 QTK 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 QTK-319 was new taken from stock.

Ambient Temperature of the Laboratory: $22 \,^{\circ}\text{C} \, +/- \, 0.5 \,^{\circ}\text{C}$ Temperature of the Tissue: $20 \,^{\circ}\text{C} \, +/- \, 0.5 \,^{\circ}\text{C}$

Calibrated by

Approved by:

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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	

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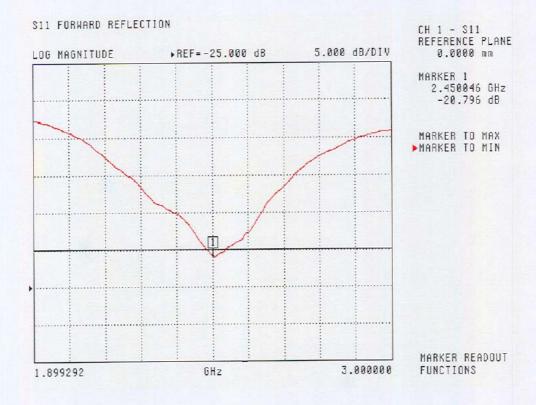
Division of APREL Laboratories.

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

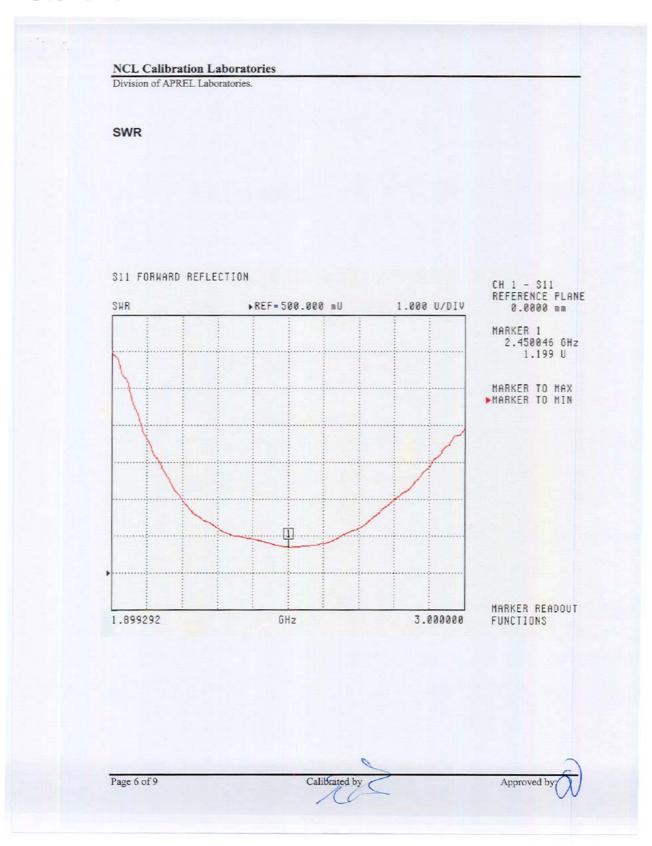


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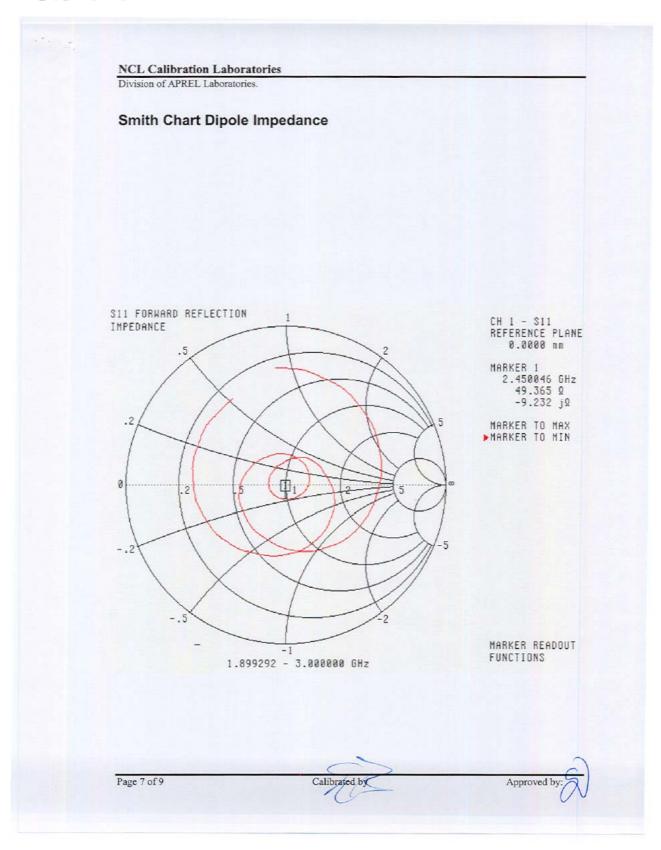
Calibrated by

Approved by:

QuieTek



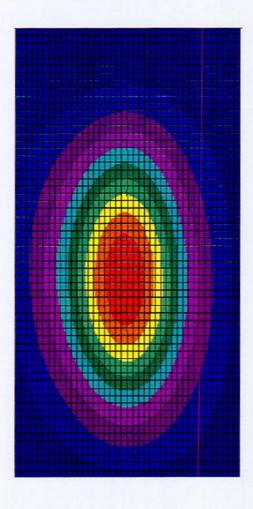






System Validation Results Using the Electrically Calibrated Dipole

Frequency	1 Gram	10 Gram	Peak Above Feed Point
2.45 GHz	48.07	25.65	95.6



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Approved by:



NCL Calibration Laboratories Division of APREL Laboratories. **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 Calibrated by Page 9 of 9 Approved by

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NCL CALIBRATION LABORATORIES

Calibration File No: DC-410 Project Number: QTKB-ALSAS-10U-5050

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the NGL 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

Calibrated: 23 June 2004 Released on: 23 June 2004

Released By:

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY NEPEAN, ONTARIO CANADA K2R 166 Division of APREL Lab. TEL: (613) 820-4988 FAX: (613) 820-4161



NCL CALIBRATION LABORATORIES

Calibration File No: DC-410 Project Number: QTKB-ALSAS-10U-5050

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the NGL 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

Calibrated: 23 June 2004 Released on: 23 June 2004

Released By:

NCL CALIBRATION LABORATORIES

NEPEAN, ONTARIO CANADA K2R 1E6 Division of APREL Lab. TEL: (613) 820-4988 FAX: (613) 820-4161



Division of APREL Laboratories.

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 QTK-320 at 5.2 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 ALSAS-10U, along with QTK E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

SSI-TP-018 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 QTK-320 was a new Dipole 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

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Dipole Calibration Results

Mechanical Verification

APREL	APREL	Measured	Measured
Length	Height	Length	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, o [S/m]	5.24	

Calibrated by Approved by Page 4 of 9

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Electrical Calibration

Test	t Result	
S11 R/L	-13.4 dB	
SWR	1.59 U	
Impedance	32.9 Ω	

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

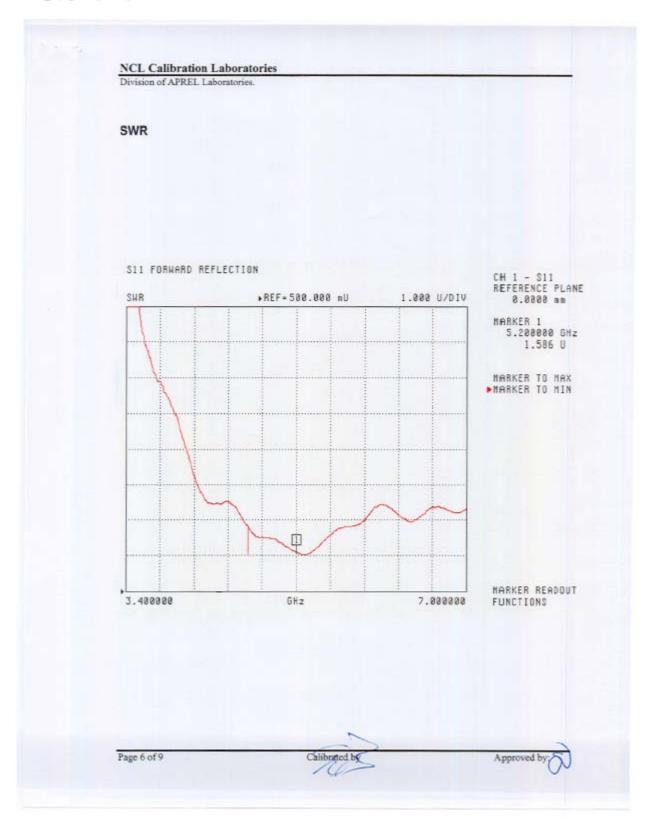
S11 Parameter Return Loss





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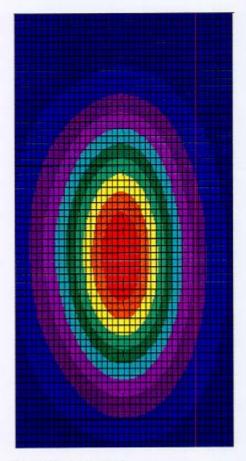


NCL Calibration Laboratories Division of APREL Laboratories. Smith Chart Dipole Impedance S11 FORWARD REFLECTION CH 1 - S11 REFERENCE PLANE 0.0000 mm IMPEDANCE MARKER 1 5.200000 GHz 32.855 Q 8.046 jQ MARKER TO MAX ►MARKER TO MIN 1 MARKER READOUT FUNCTIONS 3.400000 - 7.000000 GHz Approved by Page 7 of 9 Calibrated by



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

Frequency	1 Gram
5.2 GHz	58.8



Test Equipment

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NCL Calibration Laboratories Division of APREL Laboratories. 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 Page 9 of 9 Calibrated by Approved by:



NCL CALIBRATION LABORATORIES

Calibration File No: DC-411 Project Number: QTKB-ALSAS-10U-5050

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-5800-S-2
Froquency: 5.8 GHz
Serial No: QTK-321

Customer: Quietek

Calibrated: 23 June 2004 Released on: 23 June 2004

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



NCL Calibration Laboratories

Division of APREL Laboratories.

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

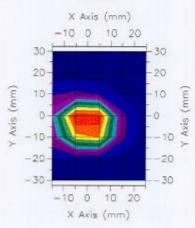
 Return Loss:
 -11.5 dB

 Impedance:
 68.3 Ω

System Validation Results

Frequency	1 Gram
5800 GHz	57.9

Course Scan Data



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NCL Calibration Laboratories

Division of APREL Laboratories.

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 QTK-321 at 5.8 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 ALSAS-10U, along with QTK E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

SSI-TP-018 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 QTK-321 was a new Dipole 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

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Dipole Calibration Results

Mechanical Verification

APREL	APREL	Measured	Measured
Length	Height	Length	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, o [S/m]	6.4	

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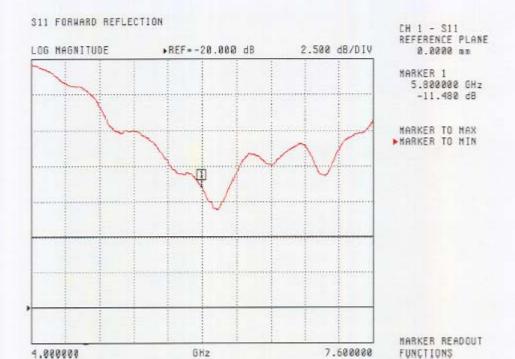


Electrical Calibration

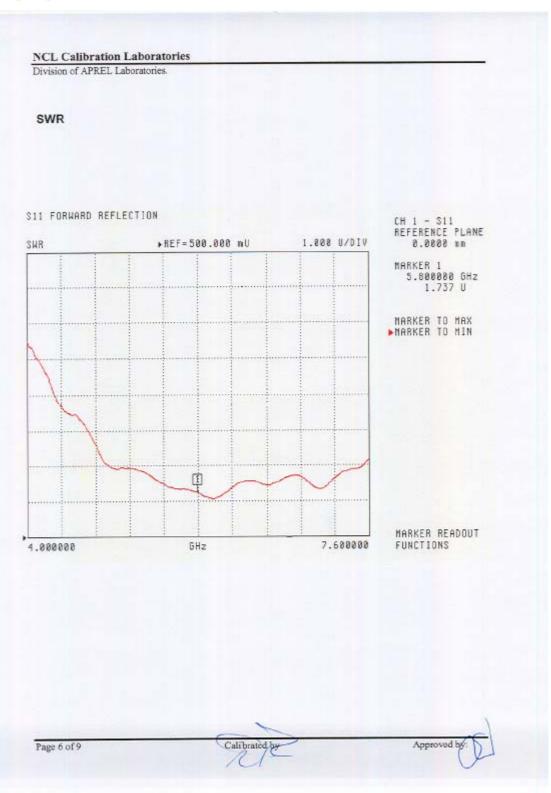
Test	Result	
S11 R/L	-11.5 dB	
SWR	1.74 U	
Impedance	68.3 Ω	

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

S11 Parameter Return Loss



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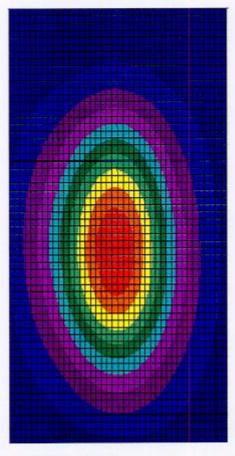


NCL Calibration Laboratories Division of APREL Laboratories. Smith Chart Dipole Impedance S11 FORWARD REFLECTION CH 1 - S11 REFERENCE PLANE 8.8000 mm IMPEDANCE MARKER 1 5.880000 GHz 68.290 N -26.643 JR .2 MARKER TO MAX MARKER TO MIN 8 MARKER READOUT FUNCTIONS 4.000000 - 7.600000 GHz Calibrated by Page 7 of 9 Approved by



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

Frequency	1 Gram
5.8 GHz	57.9

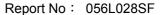


Test Equipment

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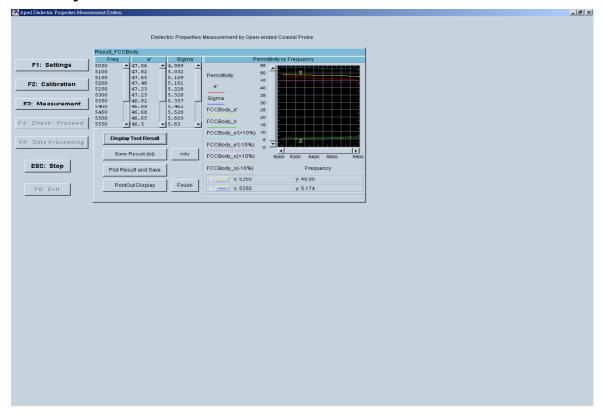


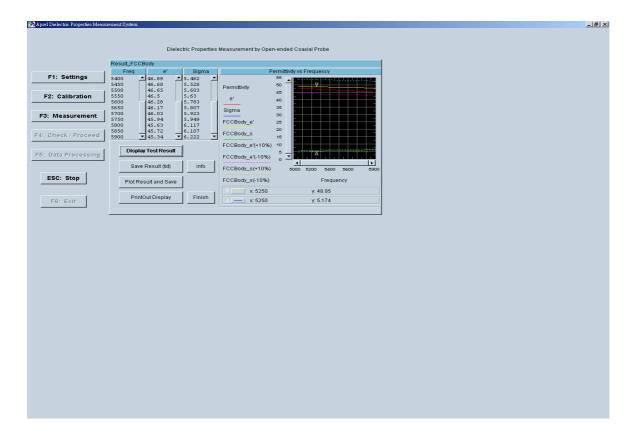
NCL Calibration Laboratories Division of APREL Laboratories. The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Calibrated by Page 9 of 9





5GHz Body Tissue Calibration results





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