

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-557

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.: 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

51 SPECTRUM WAY
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CANADA K2R 1E6

Division of APREL Lab.
TEL: (615) 620-4988
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NCL Calibration Laboratories

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:	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

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Sensitivity in Head Tissue

Frequency: 2450 MHz

Epsilon: 39.2 (+/-5%)

Sigma: 1.80 S/m (+/-5%)

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.

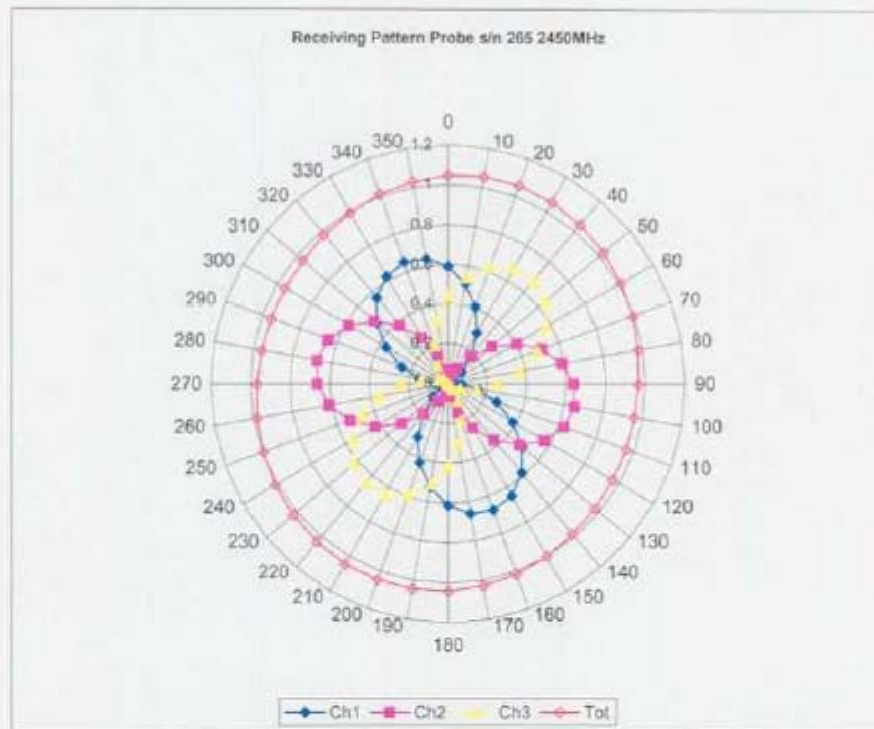
Boundary Effect:

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.

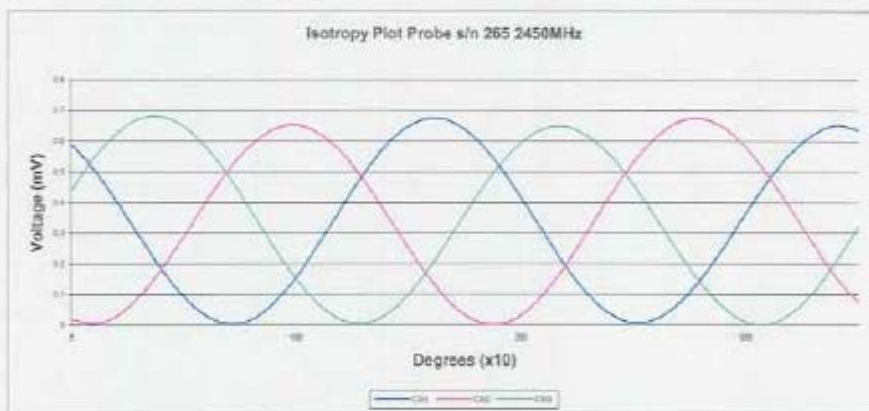
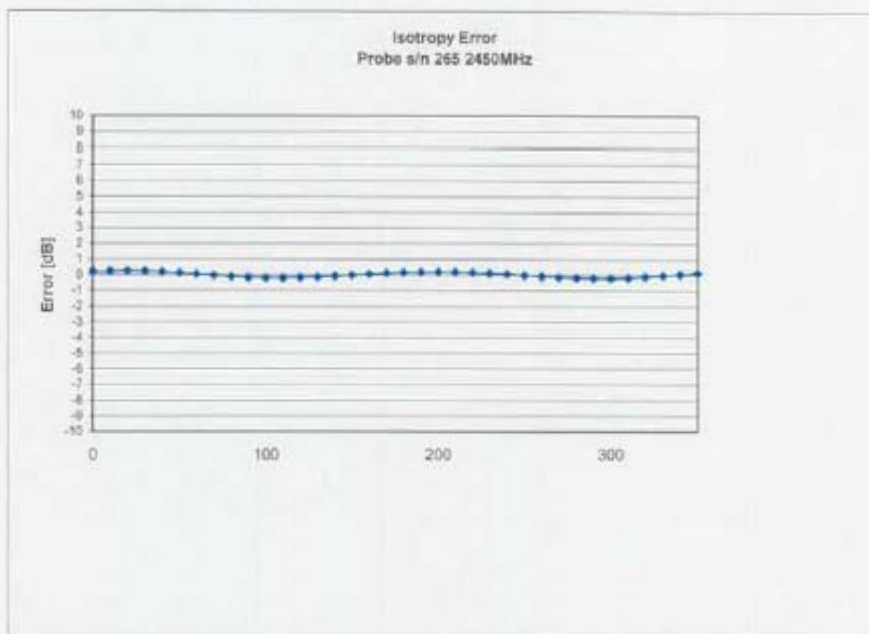
Spatial Resolution:

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)



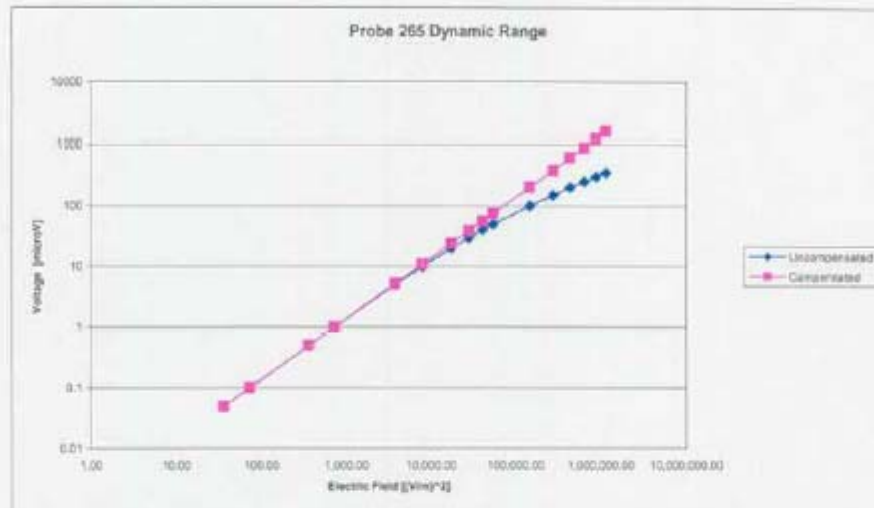
Isotropy Error 2450 MHz (Air)



Isotropicity in Tissue:

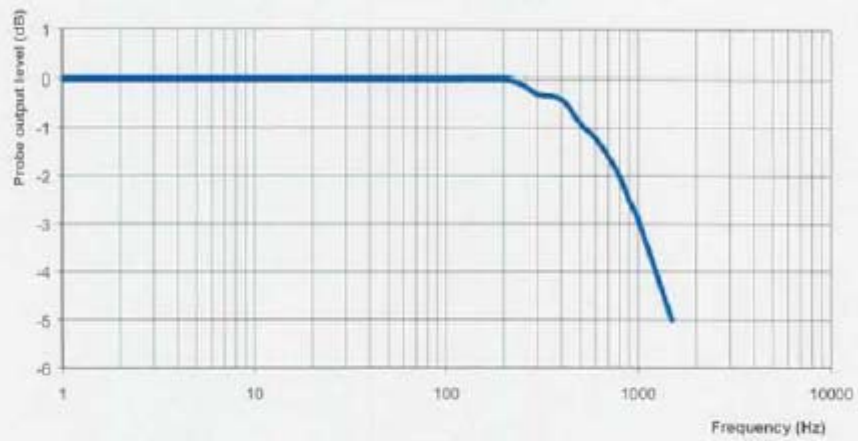
0.10 dB

Dynamic Range



Video Bandwidth

Probe Frequency Characteristics



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

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Conversion Factor Uncertainty Assessment

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

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%.

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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.

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

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-558

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.: 205

BODY Calibration

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

Project No: QTKB-ALS-E-020 Probe Cal-6001

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

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NCL Calibration Laboratories

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

NCL Calibration Laboratories

Division of APREL Laboratories.

Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	265
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

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

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Sensitivity in Body Tissue

Frequency: 2450 MHz

Epsilon: 52.7 (+/-5%) **Sigma:** 1.95 S/m (+/-5%)

ConvF

Channel X: 4.7

Channel Y: 4.7

Channel Z: 4.7

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

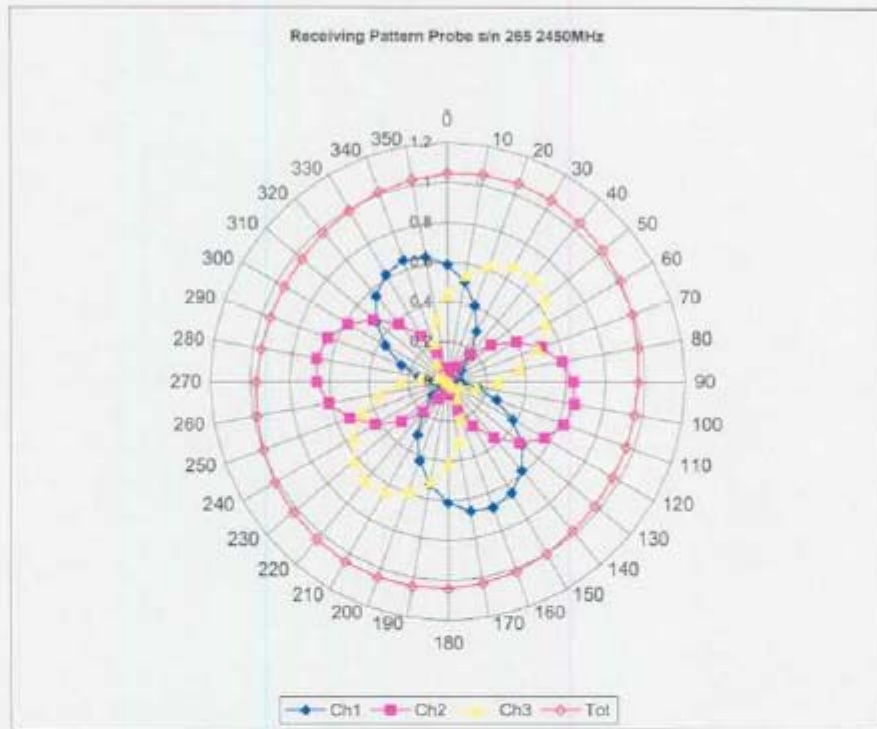
Boundary Effect:

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.

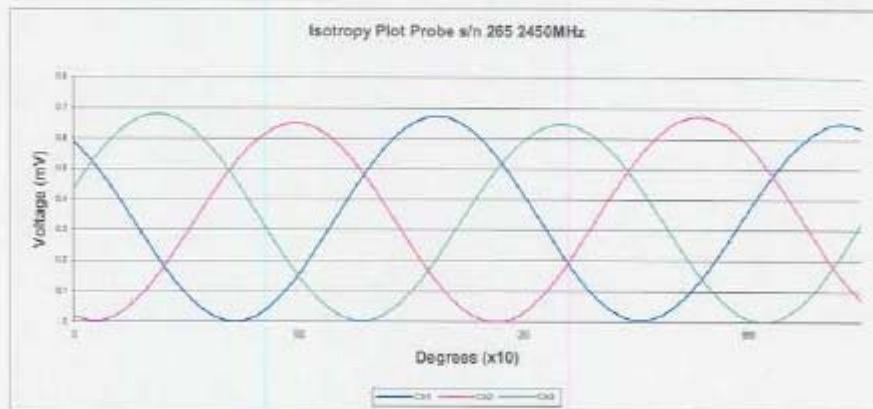
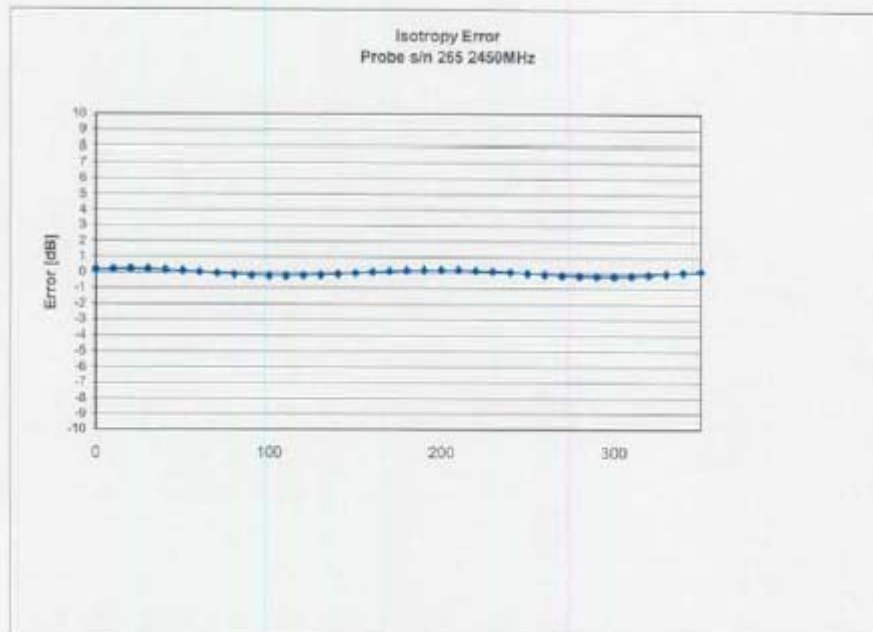
Receiving Pattern 2450 MHz (Air)



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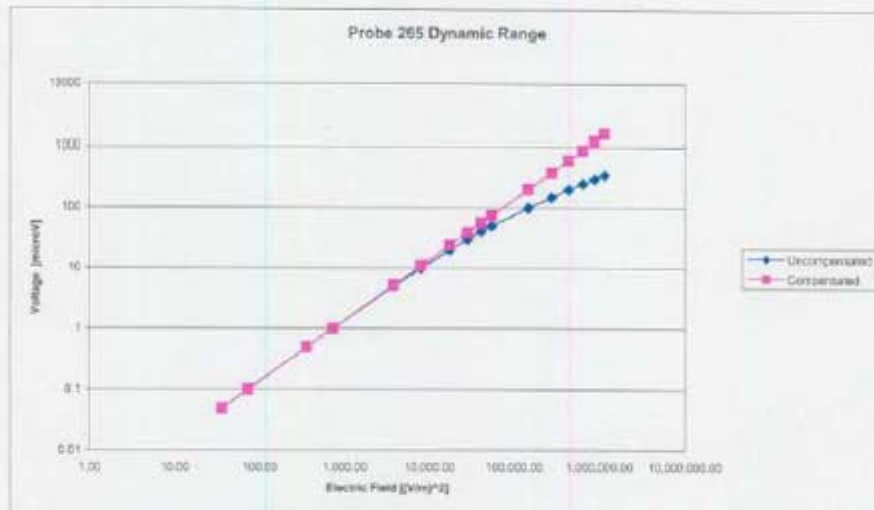
Isotropy Error 2450 MHz (Air)



Isotropicity in Tissue:

0.10 dB

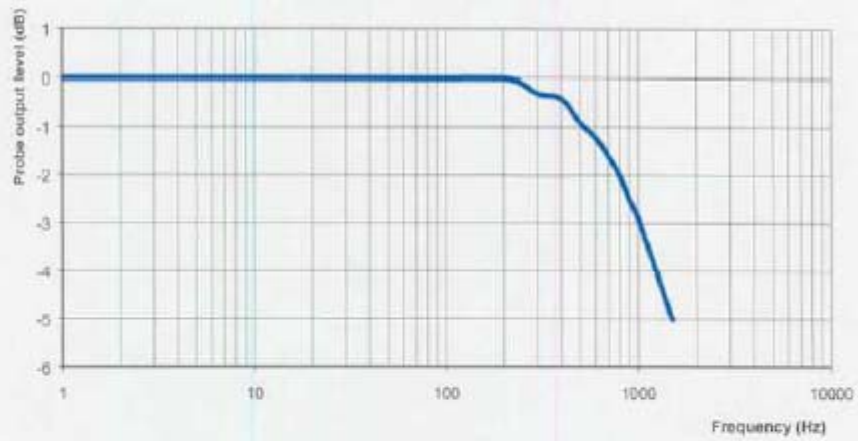
Dynamic Range



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Division of APREL Laboratories.

Video Bandwidth

Probe Frequency Characteristics



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

NCL Calibration Laboratories

Division of APREL Laboratories.

Conversion Factor Uncertainty Assessment

Frequency:		2450MHz	
Epsilon:	52.7 (+/-5%)	Sigma:	1.95 S/m (+/-5%)
ConvF			
Channel X:	4.7		7%(K=2)
Channel Y:	4.7		7%(K=2)
Channel Z:	4.7		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%.

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.

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Appendix - Dipole Calibration

Validation Dipole 2450MHz

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

S/N: QTK-319

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.

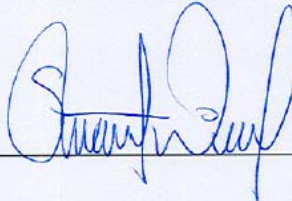
Quietek Validation Dipole

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: _____



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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

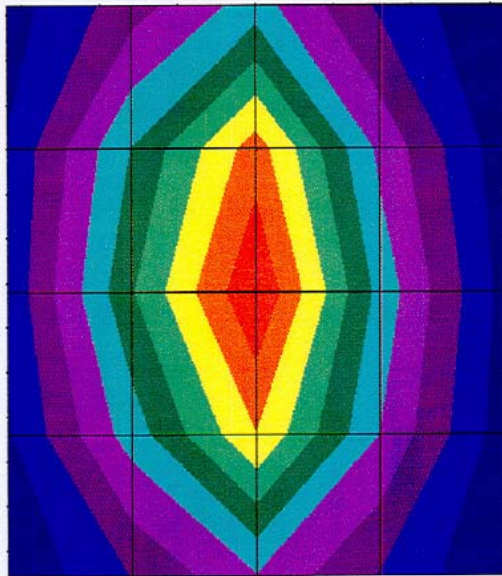
Length: 53.5 mm
Height: 30.4 mm

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



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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 °C +/- 0.5°C
Temperature of the Tissue: 20 °C +/- 0.5°C

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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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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.

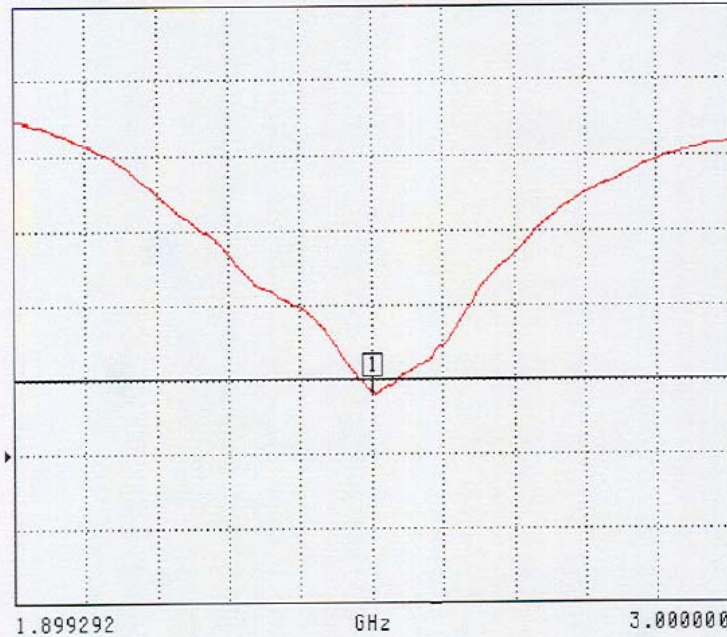
S11 Parameter Return Loss

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

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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

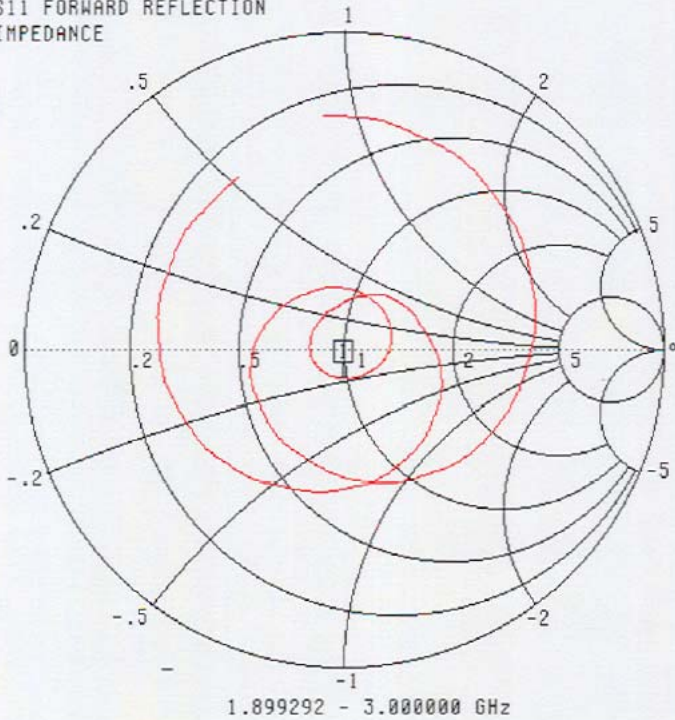
MARKER READOUT
FUNCTIONS

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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 $j\Omega$

MARKER TO MAX
▶ MARKER TO MIN

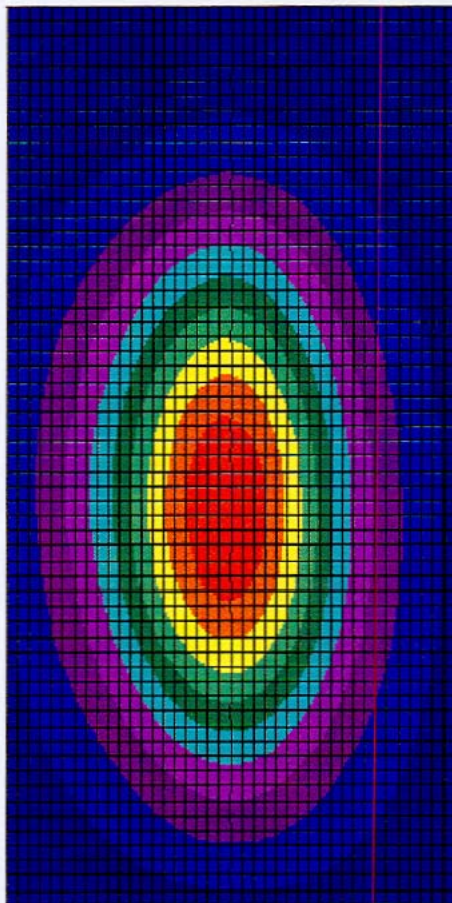
MARKER READOUT
FUNCTIONS

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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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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

SAR System Validation Data

ALSAS-10U VER 2.1.0APREL Laboratories

SAR Test Report

Product Data

Device Name : Dipole-2450
Type : Dipole
Frequency : 2450.00 MHz
Max. Transmit Pwr : 1 W
Drift Time : 0 min(s)
Length : 51.5 mm
Width : 3.6 mm
Depth : 30.4 mm
Power Drift-Start : 34.846 W/kg
Power Drift-Finish: 35.771 W/kg
Power Drift (%) : 2.655

Phantom Data

Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Location : Center

Tissue Data

Type : HEAD
Serial No. : 325-H
Frequency : 2450 MHz
Last Calib. Date : 11-Jul-2005
Temperature : 22.9 °C
Ambient Temp. : 23.4 °C
Humidity : 52 RH%
Epsilon : 38.9 F/m
Sigma : 1.82 S/m
Density : 1000 kg/cu. m

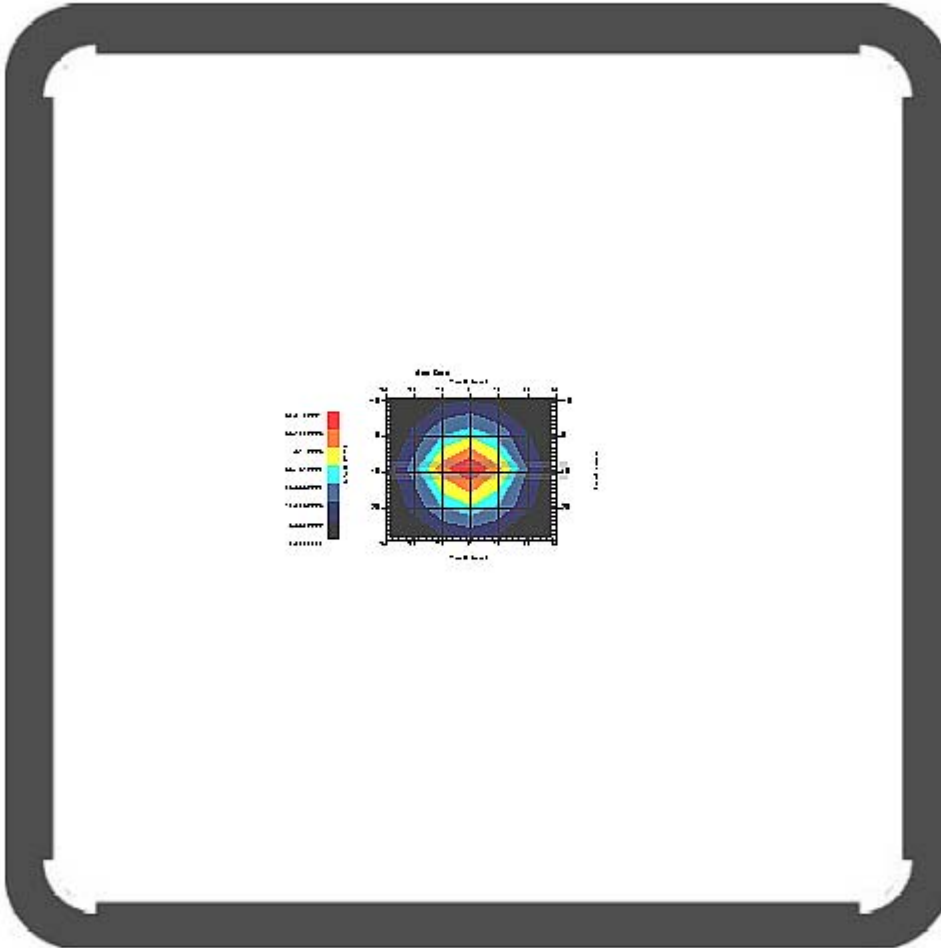
Probe Data

Name : Probe 265
Model : E020
Type : E-Field Triangle
Serial No. : 265
Last Calib. Date : 23-Mar-2005
Frequency : 2450 MHz
Duty Cycle Factor: 1
Conversion Factor: 4.6
Probe Sensitivity: 1.20 1.20 1.20 $\mu\text{V}/(\text{V}/\text{m})^2$
Compression Point: 95 mV
Offset : 1.56 mm

Measurement Data

Crest Factor : 1
Tissue Temp. : 22.9°C
Ambient Temp. : 23.4°C
Area Scan : 5x7x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

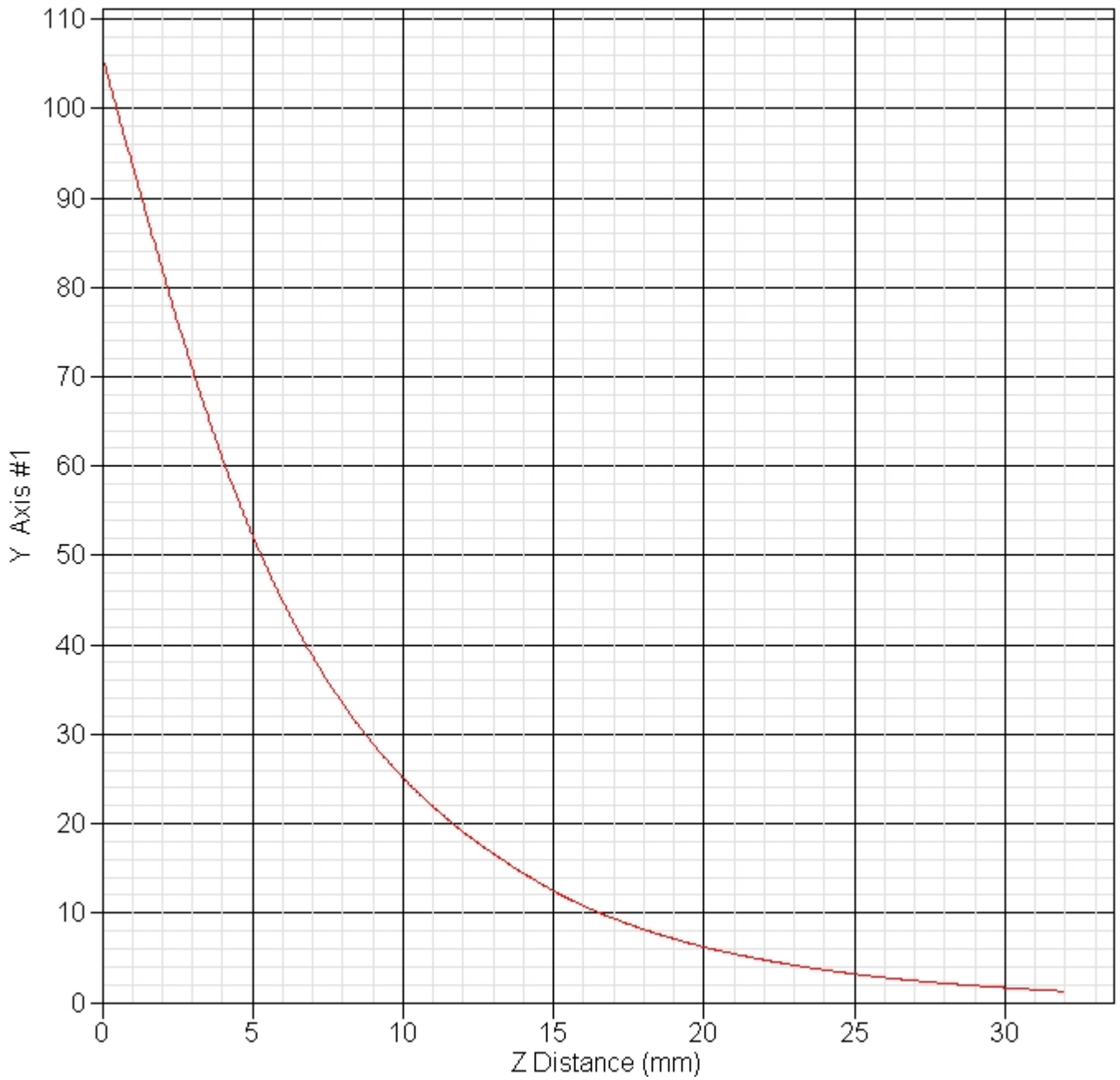
Frequency : 2450MHz



1 gram SAR value : 53.006 W/kg
10 gram SAR value : 24.532 W/kg
Area Scan Peak SAR : 62.034 W/kg
Zoom Scan Peak SAR : 105.920 W/kg

SAR-Z Axis

at Hotspot x:9.00 y:-2.00



SAR 2.45GHz Measurement Data

ALSAS-10U VER 2.1.0APREL Laboratories

SAR Test Report

Product Data

Device Name : ASUS_W1
Serial No. : Z61A Z61Ae
Frequency : 2450.00 MHz
Drift Time : 0 min(s)
Length : 249 mm
Width : 222 mm
Depth : 25 mm
Antenna Type : Internal

Phantom Data

Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Location : Center

Tissue Data

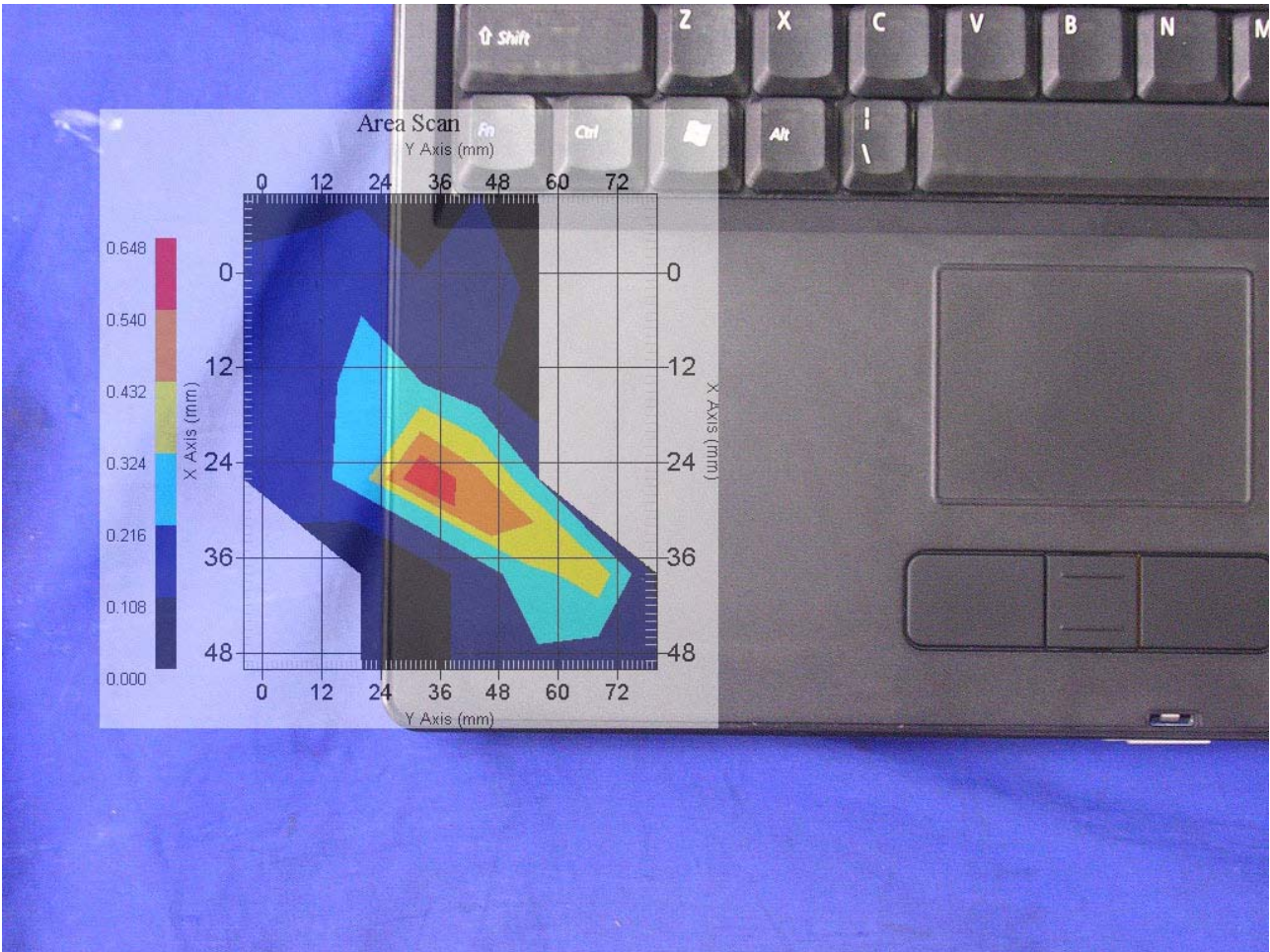
Type : BODY
Serial No. : 325-B
Frequency : 2450 MHz
Last Calib. Date : 11-Jul-2005
Temperature : 22.3 °C
Ambient Temp. : 23.4 °C
Humidity : 52 RH%
Epsilon : 53.85 F/m
Sigma : 1.96 S/m
Density : 1000 kg/cu. m

Probe Data

Name : Probe 265
Model : E020
Type : E-Field Triangle
Serial No. : 265
Last Calib. Date : 23-Mar-2005
Frequency : 2450 MHz
Duty Cycle Factor: 1
Conversion Factor: 4.7
Probe Sensitivity: 1.20 1.20 1.20 $\mu\text{V}/(\text{V}/\text{m})^2$
Compression Point: 95 mV
Offset : 1.56 mm

Measurement Data

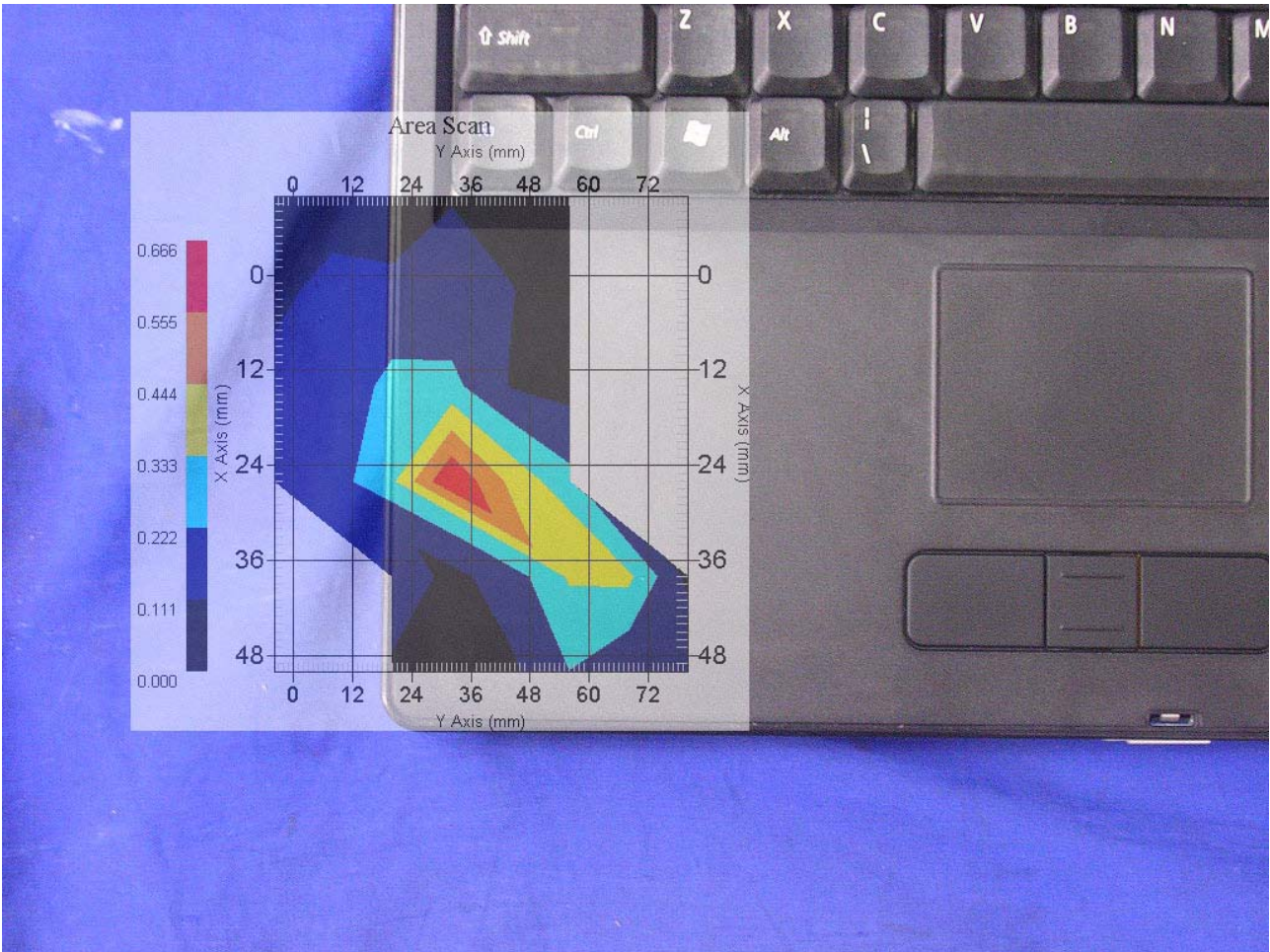
Crest Factor : 1
Tissue Temp. : 22.3°C
Ambient Temp. : 23.4°C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.137 W/kg
Power Drift-Finish: 0.135 W/kg
Power Drift (%) : -1.459
DUT Position : Touch EUT Left Front(Main Antenna)
Frequency : 802.11b 2412MHz



1 gram SAR value : 0.506 W/kg
10 gram SAR value : 0.297 W/kg
Area Scan Peak SAR : 0.642 W/kg
Zoom Scan Peak SAR : 1.030 W/kg

Measurement Data

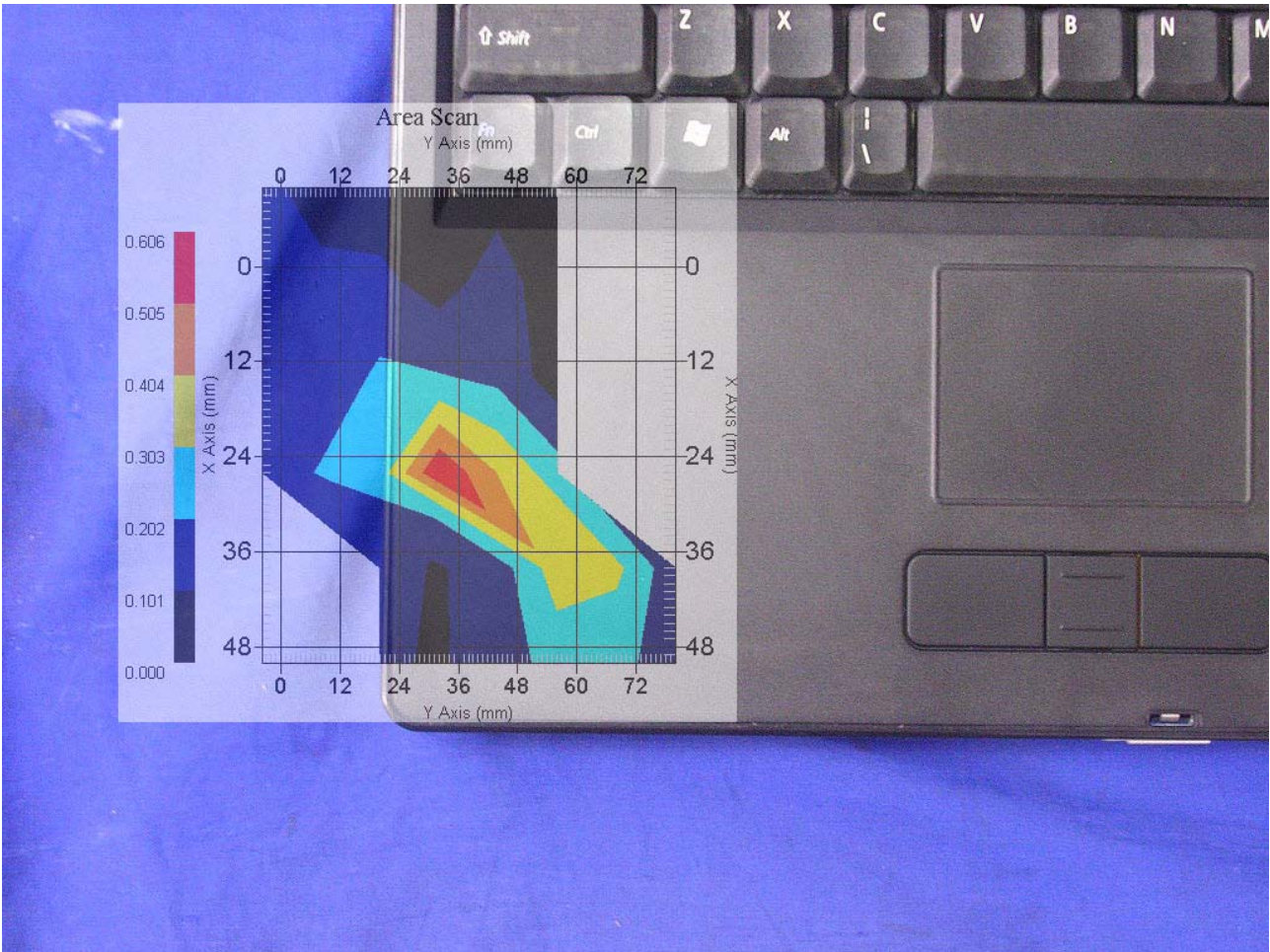
Crest Factor : 1
Tissue Temp. : 22.3°C
Ambient Temp. : 23.4°C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.115 W/kg
Power Drift-Finish: 0.112 W/kg
Power Drift (%) : -2.608
DUT Position : Touch EUT Left Front(Main Antenna)
Frequency : 802.11b 2437MHz



1 gram SAR value : 0.519 W/kg
10 gram SAR value : 0.278 W/kg
Area Scan Peak SAR : 0.661 W/kg
Zoom Scan Peak SAR : 0.953 W/kg

Measurement Data

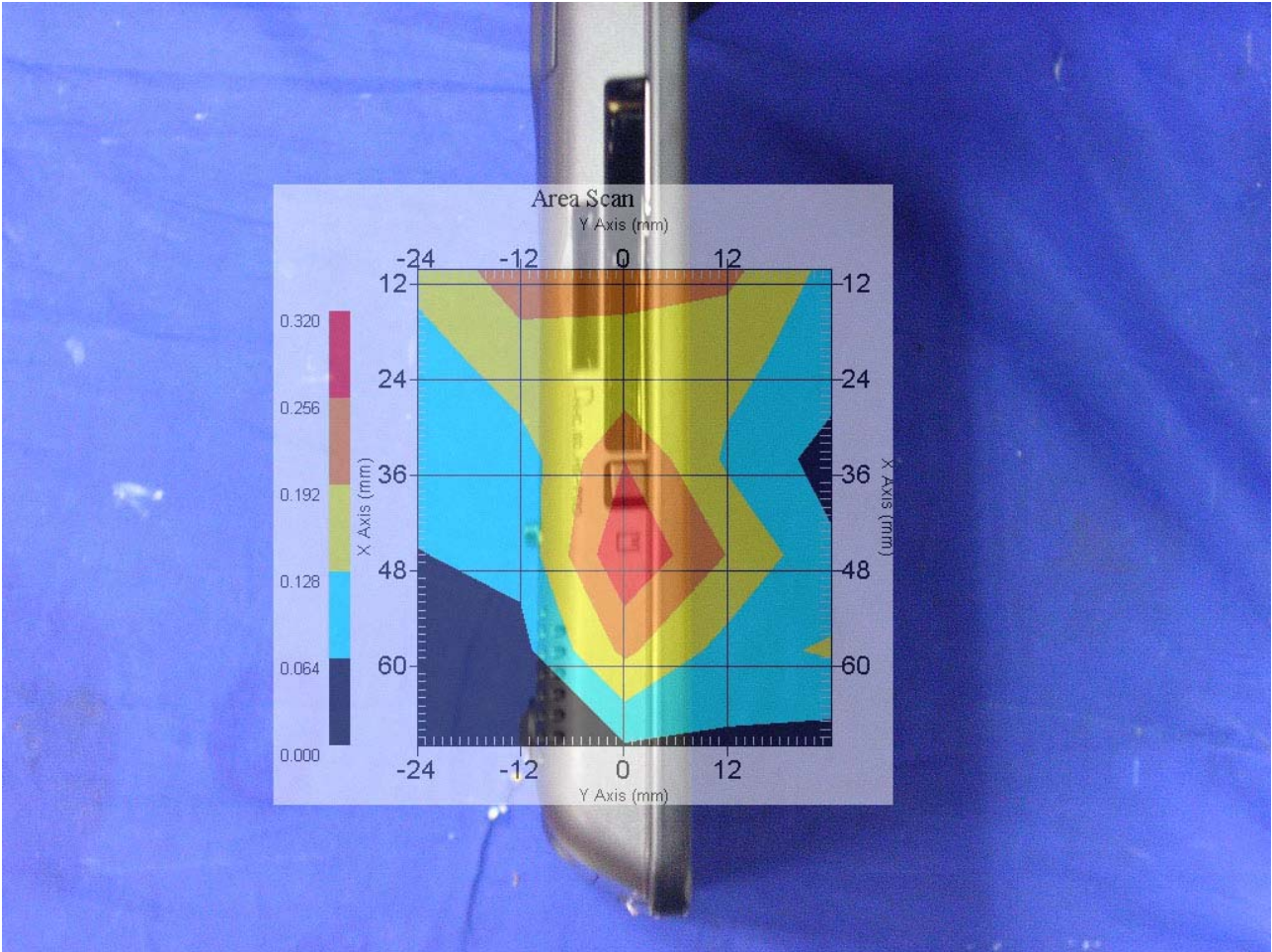
Crest Factor : 1
Tissue Temp. : 22.3°C
Ambient Temp. : 23.4°C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.109 W/kg
Power Drift-Finish: 0.106 W/kg
Power Drift (%) : -2.752
DUT Position : Touch EUT Left Front(Main Antenna)
Frequency : 802.11b 2462MHz



1 gram SAR value : 0.444 W/kg
10 gram SAR value : 0.227 W/kg
Area Scan Peak SAR : 0.600 W/kg
Zoom Scan Peak SAR : 1.080 W/kg

Measurement Data

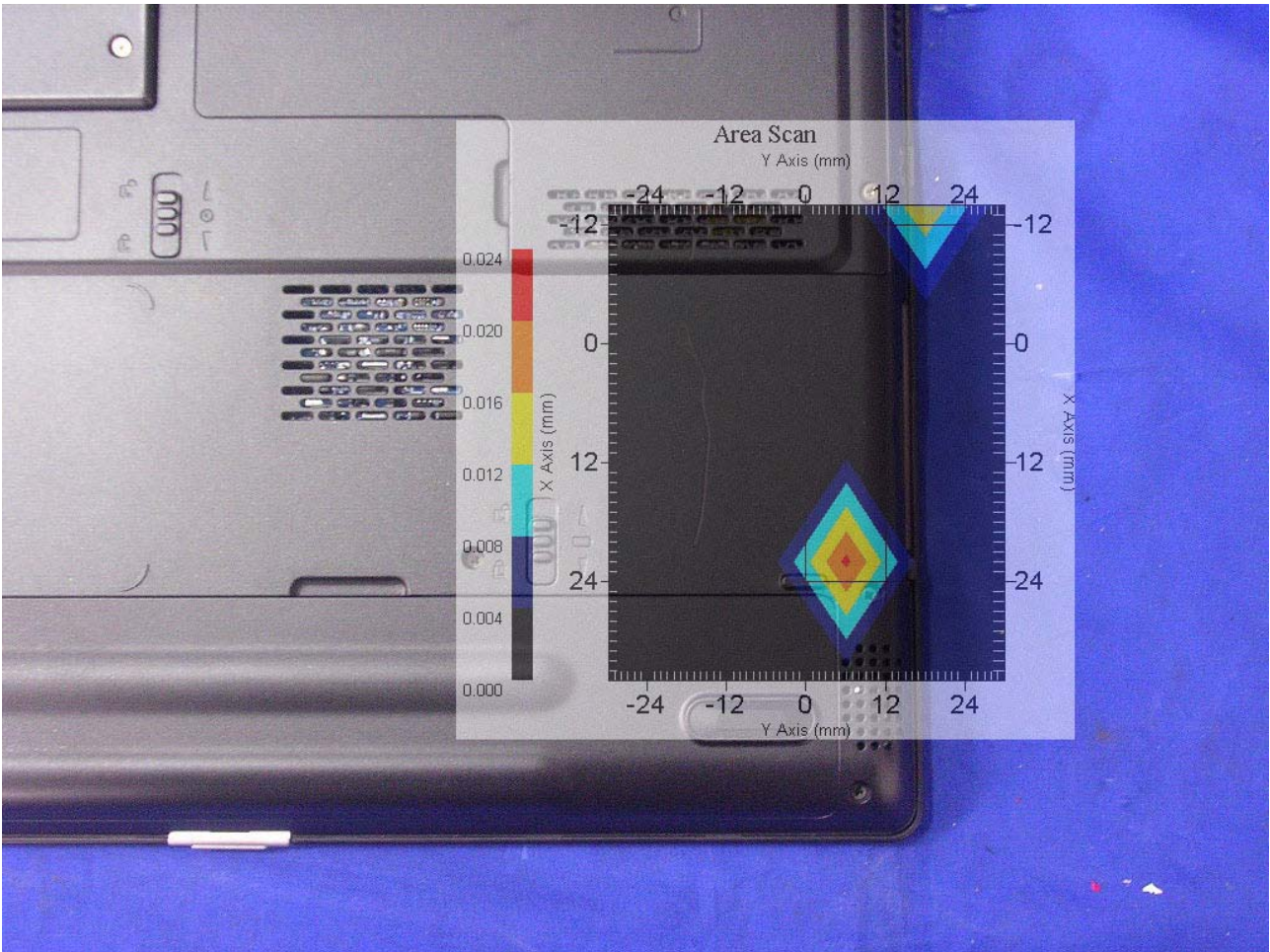
Crest Factor : 1
 Tissue Temp. : 22.3°C
 Ambient Temp. : 23.4°C
 Area Scan : 6x5x1 : Measurement x=12mm, y=12mm, z=4mm
 Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
 Power Drift-Start : 0.134 W/kg
 Power Drift-Finish: 0.140 W/kg
 Power Drift (%) : 4.477
 DUT Position : Touch EUT Left Side(Main Antenna)
 Frequency : 802.11b 2437MHz



1 gram SAR value : 0.298 W/kg
 10 gram SAR value : 0.164 W/kg
 Area Scan Peak SAR : 0.315 W/kg
 Zoom Scan Peak SAR : 0.650 W/kg

Measurement Data

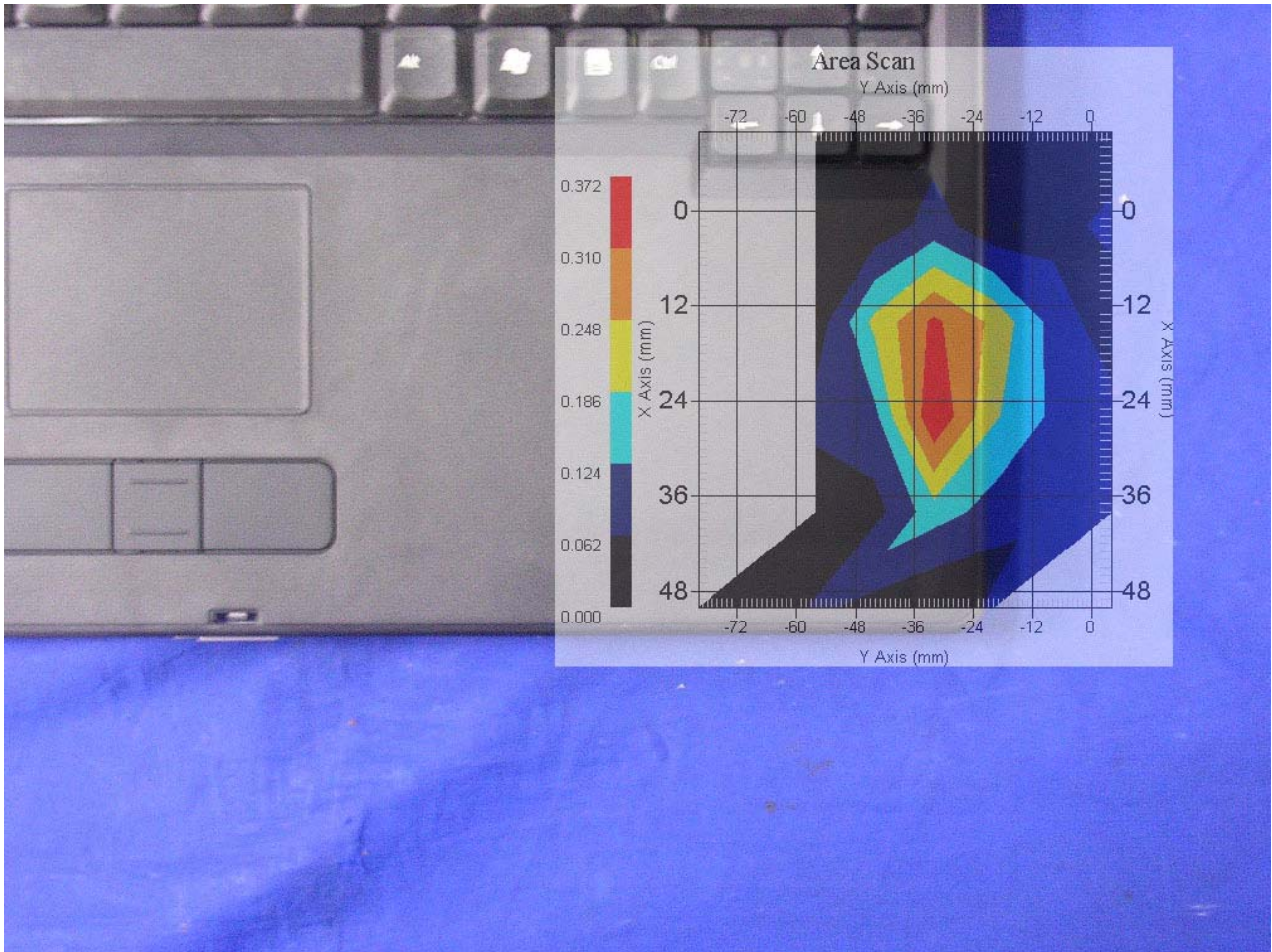
Crest Factor : 1
Tissue Temp. : 22.3°C
Ambient Temp. : 23.4°C
Area Scan : 5x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.010 W/kg
Power Drift-Finish: 0.010 W/kg
Power Drift (%) : 0.000
DUT Position : Touch EUT Back(Main Antenna)
Frequency : 802.11b 2437MHz



1 gram SAR value : 0.024 W/kg
10 gram SAR value : 0.008 W/kg
Area Scan Peak SAR : 0.021 W/kg
Zoom Scan Peak SAR : 0.075 W/kg

Measurement Data

Crest Factor : 1
Tissue Temp. : 22.3°C
Ambient Temp. : 23.4°C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.059 W/kg
Power Drift-Finish: 0.058 W/kg
Power Drift (%) : -1.694
DUT Position : Touch EUT Right Front(Aux. Antenna)
Frequency : 802.11b 2437MHz



1 gram SAR value : 0.326 W/kg
10 gram SAR value : 0.172 W/kg
Area Scan Peak SAR : 0.369 W/kg
Zoom Scan Peak SAR : 0.580 W/kg