

## **SAR Test Report**

Product Name : 802.11b wireless CF card

Model No. : WL0402

Applicant : BBWM CORP.

Address : 6F, No. 578, Rui Guang Road, Nei-Hu, Taipei,  
Taiwan, R.O.C.

Date of Receipt : 2004/09/27

Issued Date : 2004/09/30

Report No. : 04AL001SF

The test results relate only to the samples tested.

The test report shall not be reproduced except in full without the written approval of QuieTek Corporation.

# Test Report Certification

Issued Date: 2004/09/06

Report No.:04AL001SF



Product Name : 802.11b wireless CF card  
 Applicant : BBWM CORP.  
 Address : 6F, No. 578, Rui Guang Road, Nei-Hu, Taipei, Taiwan,  
 R.O.C.  
 Manufacturer : BBWM CORP.  
 Model No. : WL0402  
 Trade Name : BBWM  
 Measurement : FCC Oet65 Supplement C June 2001  
 Standard : FCC Oet65 Supplement C June 2001  
 Measurement Procedure : FCC Oet65 Supplement C June 2001  
 Test Result : Max. SAR Measurement (1g)  
 802.11b: 1.13 W/kg  
 Application Type : Certification

The test results relate only to the samples tested.

The test report shall not be reproduced except in full without the written approval of Quietek Corporation.

Documented By : Grace Lin  
 ( Grace Lin )

Tested By : Shine Hsu  
 ( Shine Hsu )

Approved By : Gene Chang  
 ( Gene Chang )

## TABLE OF CONTENTS

Description	Page
<b>1. General Information.....</b>	<b>5</b>
1.1 EUT Description .....	5
1.2 Test Environment .....	5
<b>2. SAR Measurement System .....</b>	<b>6</b>
2.1 ALSAS-10U System Description .....	6
2.1.1 Applications .....	6
2.1.2 Area Scans.....	6
2.1.3 Zoom Scan (Cube Scan Averaging).....	7
2.1.4 ALSAS-10U Interpolation and Extrapolation Uncertainty.....	7
2.2 Isotropic E-Field Probe .....	7
2.2.1 Isotropic E-Field Probe Specification .....	9
2.3 Boundary Detection Unit and Probe Mounting Device .....	9
2.4 Daq-Paq (Analog to Digital Electronics) .....	10
2.5 Axis Articulated Robot .....	10
2.6 ALSAS Universal Workstation.....	11
2.7 Universal Device Positioner.....	11
2.8 Phantom Types.....	11
2.8.1 APREL SAM Phantoms .....	12
2.8.2 APREL Laboratories Universal Phantom .....	12
<b>3. Tissue Simulating Liquid .....</b>	<b>13</b>
3.1 The composition of the tissue simulating liquid .....	13
3.2 Tissue Calibration Result .....	13
3.3 Tissue Dielectric Parameters for Head and Body Phantoms .....	14
<b>4. SAR Measurement Procedure .....</b>	<b>15</b>
4.1 SAR System Validation.....	15
4.1.1 Validation Dipoles.....	15
4.1.2 Validation Result .....	15
4.2 SAR Measurement Procedure .....	16
<b>5. SAR Exposure Limits .....</b>	<b>17</b>
<b>6. Test Equipment List.....</b>	<b>18</b>
<b>7. Measurement Uncertainty .....</b>	<b>19</b>
<b>8. Test Results.....</b>	<b>20</b>
8.1 SAR Test Results Summary .....	20
8.2 SAR System Validation Data .....	21
8.3 SAR Measurement Data.....	23

Test Setup Photographs .....	35
EUT Photographs .....	37
Dipole Calibration.....	39

## 1. General Information

### 1.1 EUT Description

Product Name	802.11b wireless CF card
Trade Name	BBWM
Model No.	WL0402
FCC ID	SKYBBWMWL0402
TX Frequency	2412MHz ~ 2462MHz
Number of Channel	11
Antenna Type	Internal
Device Category	Portable
RF Exposure Environment	Uncontrolled
Transfer Rate	802.11b: 11Mbps
Max. Output Power (Conducted)	802.11b: 16.98dBm

### 1.2 Test Environment

Ambient conditions in the laboratory:

Items	Required	Actual
Temperature (°C)	18-25	24
Humidity (%RH)	30-70	53

## 2. SAR Measurement System

### 2.1 ALSAS-10U System Description

**ALSAS-10-U** is fully compliant with the technical and scientific requirements of IEEE 1528, IEC 62209, CENELEC, ARIB, ACA, and the Federal Communications Commission. The system comprises of a six axes articulated robot which utilizes a dedicated controller.

ALSAS-10U uses the latest methodologies and FDTD modeling to provide a platform which is repeatable with minimum uncertainty.

#### 2.1.1 Applications

Predefined measurement procedures compliant with the guidelines of CENELEC, IEEE, IEC, FCC, etc are utilized during the assessment for the device. Automatic detection for all SAR maxima are embedded within the core architecture for the system, ensuring that peak locations used for centering the zoom scan are within a 1mm resolution and a 0.05mm repeatable position. System operation range currently available up-to 6 GHz in simulated tissue.

#### 2.1.2 Area Scans

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10mm<sup>2</sup> step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

Where the system identifies multiple SAR peaks (which are within 25% of peak value) the system will provide the user with the option of assessing each peak location individually for zoom scan averaging.



### 2.1.3 Zoom Scan (Cube Scan Averaging)

The averaging zoom scan volume utilized in the ALSAS-10U software is in the shape of a cube and the side dimension of a 1 g or 10 g mass is dependent on the density of the liquid representing the simulated tissue. A density of 1000 kg/m<sup>3</sup> is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21,5mm.

When the cube intersects with the surface of the phantom, it is oriented so that 3 vertices touch the surface of the shell or the center of a face is tangent to the surface. The face of the cube closest to the surface is modified in order to conform to the tangent surface.

The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications (including FCC) utilize a physical step of 5x5x8 (8mmx8mmx5mm) providing a volume of 32mm in the X & Y axis, and 35mm in the Z axis.

### 2.1.4 ALSAS-10U Interpolation and Extrapolation Uncertainty

The overall uncertainty for the methodology and algorithms the used during the SAR calculation was evaluated using the data from IEEE 1528 based on the example f3 algorithm:

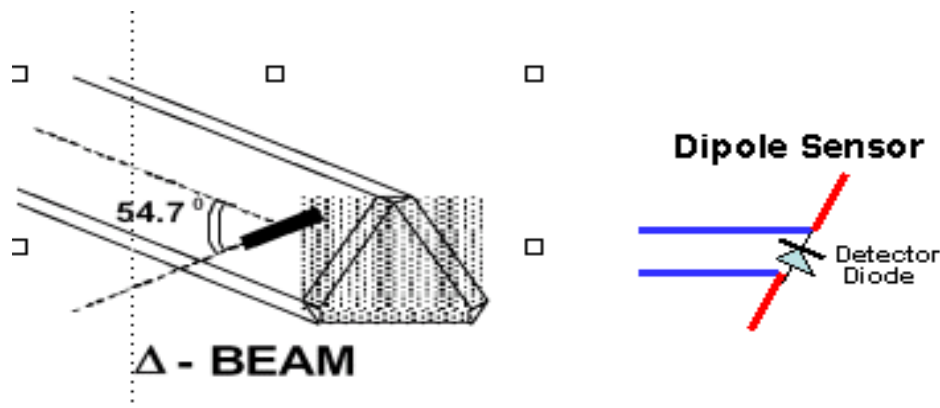
$$f_3(x, y, z) = A \frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2} \cdot \left( e^{-\frac{2z}{a}} + \frac{a^2}{2(a + 2z)^2} \right)$$

## 2.2 Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change. A number of methods is used for calibrating probes, and these are outlined in the table below:

Calibration Frequency	Air Calibration	Tissue Calibration
2450MHz	Waveguide	Temperature

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



SAR is assessed with a calibrated probe which moves at a default height of 5mm from the center of the diode, which is mounted to the sensor, to the phantom surface (in the Z Axis). The 5mm offset height has been selected so as to minimize any resultant boundary effect due to the probe being in close proximity to the phantom surface.

The following algorithm is an example of the function used by the system for linearization of the output from the probe when measuring complex modulation schemes.

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$



### 2.2.1 Isotropic E-Field Probe Specification

<b>Calibration in Air</b>	Frequency Dependent Below 2GHz Calibration in air performed in a TEM Cell Above 2GHz Calibration in air performed in waveguide
<b>Sensitivity</b>	0.70 $\mu\text{V}/(\text{V}/\text{m})^2$ to 0.85 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Dynamic Range</b>	0.0005 W/kg to 100W/kg
<b>Isotropic Response</b>	Better than 0.2dB
<b>Diode Compression point (DCP)</b>	Calibration for Specific Frequency
<b>Probe Tip Radius</b>	< 5mm
<b>Sensor Offset</b>	1.56 (+/- 0.02mm)
<b>Probe Length</b>	290mm
<b>Video Bandwidth</b>	@ 500 Hz: 1dB @1.02 KHz: 3dB
<b>Boundary Effect</b>	Less than 2% for distance greater than 2.4mm
<b>Spatial Resolution</b>	Diameter less than 5mm Compliant with Standards

### 2.3 Boundary Detection Unit and Probe Mounting Device

ALSAS-10U incorporates a boundary detection unit with a sensitivity of 0.05mm for detecting all types of surfaces. The robust design allows for detection during probe tilt (probe normalize) exercises, and utilizes a second stage emergency stop. The signal electronics are fed directly into the robot controller for high accuracy surface detection in lateral and axial detection modes (X, Y, & Z).

The probe is mounted directly onto the Boundary Detection unit for accurate tooling and displacement calculations controlled by the robot kinematics. The probe is connect to an isolated probe interconnect where the output stage of the probe is fed directly into the amplifier stage of the Daq-Paq

## 2.4 Daq-Paq (Analog to Digital Electronics)

ALSAS-10U incorporates a fully calibrated Daq-Paq (analog to digital conversion system) which has a 4 channel input stage, sent via a 2 stage auto-set amplifier module. The input signal is amplified accordingly so as to offer a dynamic range from 5 $\mu$ V to 800mV. Integration of the fields measured is carried out at board level utilizing a Co-Processor which then sends the measured fields down into the main computational module in digitized form via an RS232 communications port. Probe linearity and duty cycle compensation is carried out within the main Daq-Paq module.

<b>ADC</b>	12 Bit
Amplifier Range	20mV to 200mV and 150mV to 800mV
Field Integration	Local Co-Processor utilizing proprietary integration algorithms
Number of Input Channels	4 in total 3 dedicated and 1 spare
Communication	Packet data via RS232

## 2.5 Axis Articulated Robot



ALSAS-10U utilizes a six axis articulated robot, which is controlled using a Pentium based real-time movement controller. The movement kinematics engine utilizes proprietary (Thermo CRS) interpolation and extrapolation algorithms, which allow full freedom of movement for each of the six joints within the working envelope. Utilization of joint 6 allows for full probe rotation with a tolerance better than 0.05mm around the central axis.

<b>Robot/Controller Manufacturer</b>	Thermo CRS
<b>Number of Axis</b>	Six independently controlled axis
<b>Positioning Repeatability</b>	0.05mm
<b>Controller Type</b>	Single phase Pentium based C500C
<b>Robot Reach</b>	710mm
<b>Communication</b>	RS232 and LAN compatible

## 2.6 ALSAS Universal Workstation

ALSAS Universal workstation allows for repeatability and fast adaptability. It allows users to do calibration, testing and measurements using different types of phantoms with one set up, which significantly speeds up the measurement process.

## 2.7 Universal Device Positioner

The universal device positioner allow complete freedom of movement of the EUT. Developed to hold a EUT in a free-space scenario any additional loading attributable to the material used in the construction of the positioner has been eliminated. Repeatability has been enhanced through the linear scales which form the design used to indicate positioning for any given test scenario in all major axes. A 15° tilt indicator is included for the of aid cheek to tilt movements for head SAR analysis. Overall uncertainty for measurements have been reduced due to the design of the Universal device positioner, which allows positioning of a device in as near to a free-space scenario as possible, and by providing the means for complete repeatability.

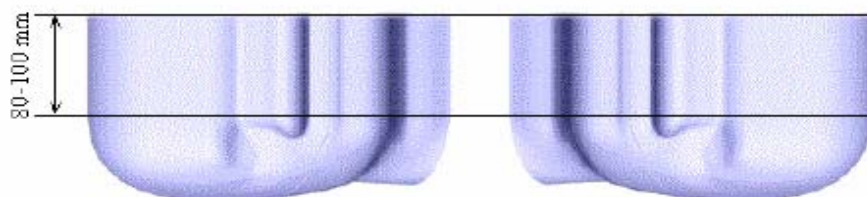


## 2.8 Phantom Types

The ALSAS-10U allows the integration of multiple phantom types. SAM Phantoms fully compliant with IEEE 1528, Universal Phantom, and Universal Flat.

### 2.8.1 APREL SAM Phantoms

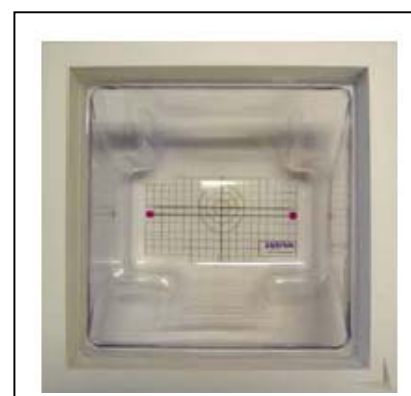
The SAM phantoms developed using the IEEE SAM CAD file. They are fully compliant with the requirements for both IEEE 1528 and FCC Supplement C. Both the left and right SAM phantoms are interchangeable, transparent and include the IEEE 1528 grid with visible NF and MB lines.



### 2.8.2 APREL Laboratories Universal Phantom

The Universal Phantom is used on the ALSAS-10U as a system validation phantom. The Universal Phantom has been fully validated both experimentally from 800MHz to 6GHz and numerically using XFDTD numerical software. The shell thickness is 2mm overall, with a 4mm spacer located at the NF/MB intersection providing an overall thickness of 6mm in line with the requirements of IEEE-1528.

The design allows for fast and accurate measurements, of handsets, by allowing the conservative SAR to be evaluated at on frequency for both left and right head experiments in one measurement.



### 3. Tissue Simulating Liquid

#### 3.1 The composition of the tissue simulating liquid

INGREDIENT (% Weight)	900MHz Head	1800MHz Head	2450MHz Head	2450MHz Body
<b>Water</b>	--	--	46.7	73.2
<b>Salt</b>	--	--	0.00	0.04
<b>Sugar</b>	--	--	0.00	0.00
<b>HEC</b>	--	--	0.00	0.00
<b>Preventol</b>	--	--	0.00	0.00
<b>DGBE</b>	--	--	53.3	26.7

#### 3.2 Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using APREL Dielectric Probe Kit and Anritsu MS4623B Vector Network Analyzer

Liquid	Frequency	Parameters	Target Value	Measured Value	Deviation [%]	Limit [%]
<b>Body</b>	2450MHz	$\epsilon_r$	52.7	52.1	-1.1	$\pm 5$
		$\sigma$	1.95	1.99	+2.1	$\pm 5$

### 3.3 Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

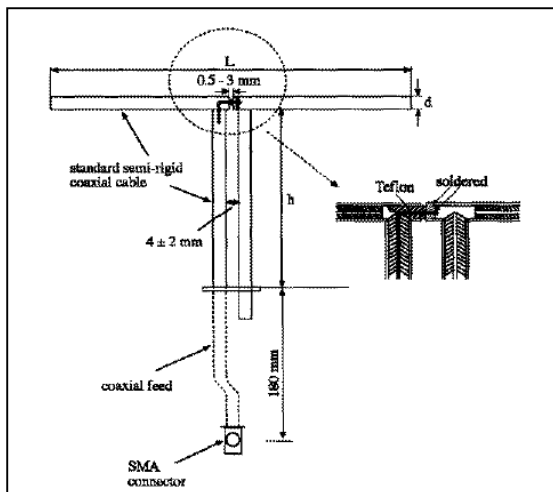
Target Frequency	Head		Body	
(MHz)	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000 \text{ kg/m}^3$ )

## 4. SAR Measurement Procedure

### 4.1 SAR System Validation

#### 4.1.1 Validation Dipoles



The dipoles used is based on the IEEE-1528 standard, and is complied with mechanical and electrical specifications in line with the requirements of both IEEE and FCC Supplement C. the table below provides details for the mechanical and electrical specifications for the dipoles.

Frequency	L (mm)	h (mm)	d (mm)
2450MHz	53.5	30.4	3.6

#### 4.1.2 Validation Result

Validation Kit: ASL-D-2450-S-2								
Frequency	Power	Measured Value [mW/g]		Target Value [mW/g]		Deviation [%]		Limit [%]
		1g	10g	1g	10g	1g	10g	
2450 MHz Head	1W	52.12	24.88	52.4	24.0	-0.5	+3.7	± 5

#### 4.2 SAR Measurement Procedure

The ALSAS-10U calculates SAR using the following equation,

$$SAR = \frac{\sigma |E|^2}{\rho}$$

$\sigma$ : represents the simulated tissue conductivity

$\rho$ : represents the tissue density

The EUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The EUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at  $1\text{mm}^2$ ) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at  $1\text{mm}^3$ ).



## 5. SAR Exposure Limits

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 “Uncontrolled Environments” limits. These limits apply to a location which is deemed as “Uncontrolled Environment” which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

**Limits for General Population/Uncontrolled Exposure (W/kg)**

<b>Type Exposure</b>	<b>Uncontrolled Environment Limit</b>
Spatial Peak SAR (1g cube tissue for brain or body)	<b>1.60 W/kg</b>
Spatial Average SAR (whole body)	<b>0.08 W/kg</b>
Spatial Peak SAR (10g for hands, feet, ankles and wrist)	<b>4.00 W/kg</b>

## 6. Test Equipment List

Instrument	Manufacturer	Model No.	Serial No.	Last Calibration
Data Acquisition Package	Aprel	ALS-DAQ-PAQ-1	QTK-313	Jun. 2004
Aprel Laboratories Probe	Aprel	ALS-E020	225	Jun. 2004
Aprel Laboratories Probe	Aprel	ALS-E020	226	Jun. 2004
Aprel Reference Dipole 2450MHz	Aprel	ALS-D-2450-S-2	QTK-319	Jun. 2004
Boundary Detection Sensor System	Aprel	ALS-PMDPS-1	QTK-314	N/A
Dielectric Probe Kit	Aprel	ALS-PR-DIEL	QTK-296	N/A
Universal Work Station	Aprel	ALS-UWS	QTK-326	N/A
Device Holder 2.0	Aprel	ALS-H-E-SET-2	QTK-294	N/A
Left Ear SAM Phantom	Aprel	ALS-P-SAM-L	QTK-292	N/A
Right Ear SAM Phantom	Aprel	ALS-P-SAM-R	QTK-288	N/A
Universal Phantom	Aprel	ALS-P-UP-1	QTK-246	N/A
Aprel Dipole Spacer	Aprel	ALS-DS-U	QTK-295	N/A
SAR Software	Aprel	ALSAS-10	Ver. 1.1.14	N/A
CRS C500C Controller	Thermo	ALS-C500	RCF0404433	N/A
CRF F3 Robot	Thermo	ALS-F3	RAF0412222	N/A
Power Amplifier	Mini-Circuit	ZHL-42	D051404-20	N/A
Directional Coupler	Agilent	87300C	3239A01864	N/A
Vector Network	Anritsu	MS4623B	992801	Mar 2004
Signal Generator	Anritsu	MG3692A	042319	Jun. 2004
Power Meter	Anritsu	ML2487A	6K00001447	Jan. 2004
Wide Bandwidth Sensor	Anritsu	MA2491	030677	Nov. 2003

Note: All equipment upon which need to be calibrated are with calibration period of 1 year.

## 7. Measurement Uncertainty

### Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	$c_i^{-1}$ (1-g)	$c_i^{-1}$ (10-g)	Standard Uncertainty (1-g)	Standard Uncertainty (10-g)
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	$\sqrt{3}$	$(1-\text{cp})^{1/2}$	$(1-\text{cp})^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	$\sqrt{3}$	$\sqrt{\text{cp}}$	$\sqrt{\text{cp}}$	4.4	4.4
Boundary Effect	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Linearity	4.7	rectangular	$\sqrt{3}$	1	1	2.7	2.7
Detection Limit	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	$\sqrt{3}$	1	1	0.5	0.5
Integration Time	1.7	rectangular	$\sqrt{3}$	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	$\sqrt{3}$	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	$\sqrt{3}$	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	0.4	rectangular	$\sqrt{3}$	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	$\sqrt{3}$	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	$\sqrt{3}$	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	0.2	rectangular	$\sqrt{3}$	0.7	0.5	0.1	0.1
Liquid Permittivity(target)	2.0	rectangular	$\sqrt{3}$	0.6	0.5	0.7	0.6
Liquid Permittivity(meas.)	5.3	rectangular	$\sqrt{3}$	0.6	0.5	1.8	1.5
Combined Uncertainty		RSS				9.3	9.1
Combined Uncertainty (coverage factor=2)		Normal (k=2)				18.6	18.2

## 8. Test Results

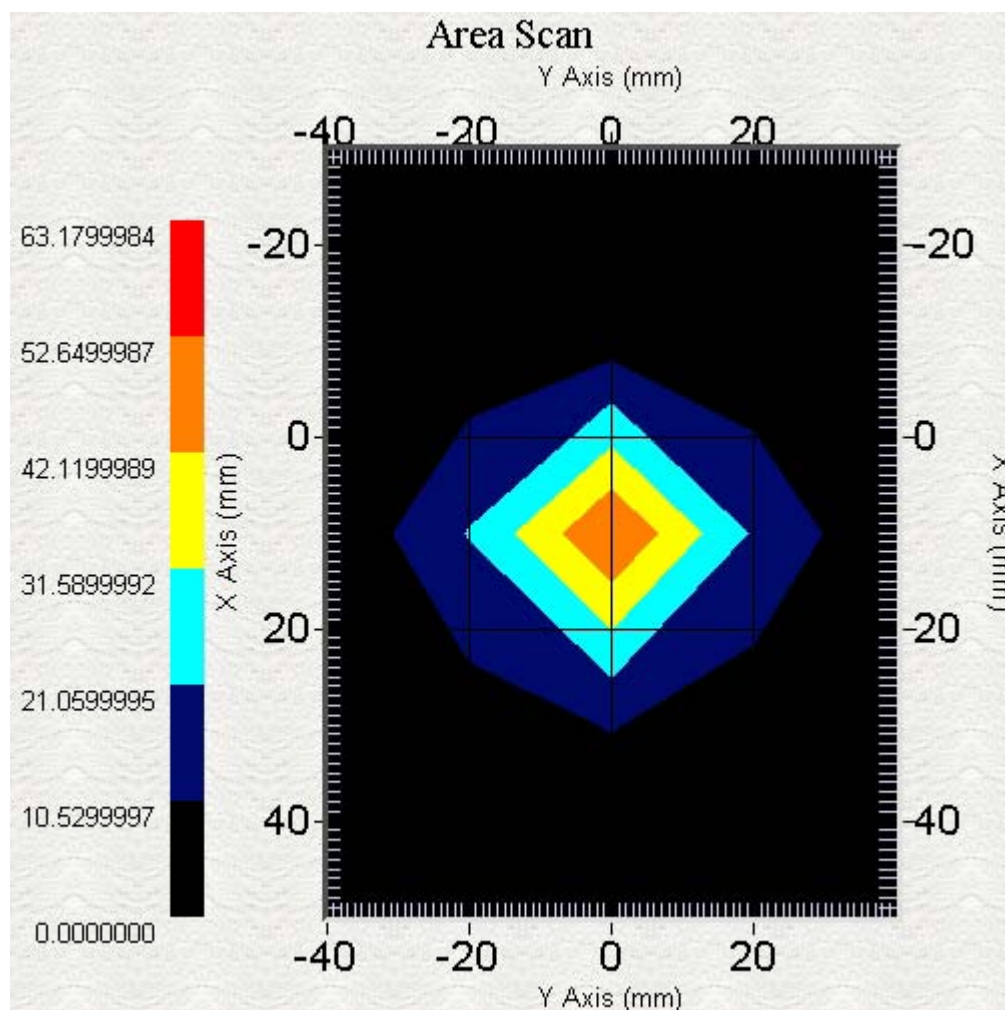
### 8.1 SAR Test Results Summary

SAR MEASUREMENT						
Ambient Temperature (°C) : 24 ± 2				Relative Humidity (%): 53		
Liquid Temperature (°C) : 23.5 ± 2				Depth of Liquid (cm):>15		
Product: 802.11b wireless CF card						
Test Mode: 802.11b						
Test Position Head	Antenna Position	Frequency		Conducted Power (dBm)	SAR 1g (W/kg)	Limit (W/kg)
		Channel	MHz			
Rear side	Internal	1	2412	16.89	0.75	1.6
Rear side	Internal	6	2437	16.90	0.79	1.6
Rear side	Internal	11	2462	16.98	0.93	1.6
Bottom	Internal	1	2412	16.89	1.03	1.6
Bottom	Internal	6	2437	16.90	1.07	1.6
Bottom	Internal	11	2462	16.98	0.95	1.6
Top	Internal	1	2412	16.89	0.99	1.6
Top	Internal	6	2437	16.90	1.13	1.6
Top	Internal	11	2462	16.98	1.10	1.6

## 8.2 SAR System Validation Data

## SAR Test Report

Name : APREL-Uni  
 Channel : Dipole – 2450  
 Tissue Temperature :  $23.50 \pm 2$   
 Tissue Ambient Temp. :  $24.00 \pm 2$   
 Crest Factor : 1.00  
 Conversion Factor : 3.00



1 gram SAR value : 52.12 W/kg  
 10 gram SAR value : 24.88 W/kg  
 Area Scan Peak SAR : 52.66  
 Zoom Scan Peak SAR : 113.00

### 8.3 SAR Measurement Data

#### Product Data

Device Name : Wireless CF Card  
 Device Serial No. : WL0402  
 Device Model : Standard  
 Device Type : Other  
 Device Frequency : 2450.00 MHz  
 Max. Transmit Power : 1 W  
 Drift Time : 0 min(s)  
 Device Length : 298 mm  
 Device Width : 242 mm  
 Device Depth : 18.8 mm  
 Device Orientation : Touch  
 Antenna Type : Internal  
 Device Power at ERP-Start : 0.78  
 Device Power At ERP-Finish: 0.89  
 Device Drift : 0.11

#### Measurement Data

Phantom Name : APREL-Uni  
 Phantom Type : Uni-Phantom  
 Phantom Size : 280 x 280 x 200  
 Phantom Serial No. : System Default  
 Phantom Location : Center  
 Phantom Description : Q\_Center  
 Tissue Type : Body  
 Tissue Serial No. : 325-B  
 Tissue Frequency : 2450.00 MHz  
 Tissue Calibration Date : 29-Sep-2004  
 Tissue Temperature : 23.50  
 Tissue Ambient Temp. : 24.00

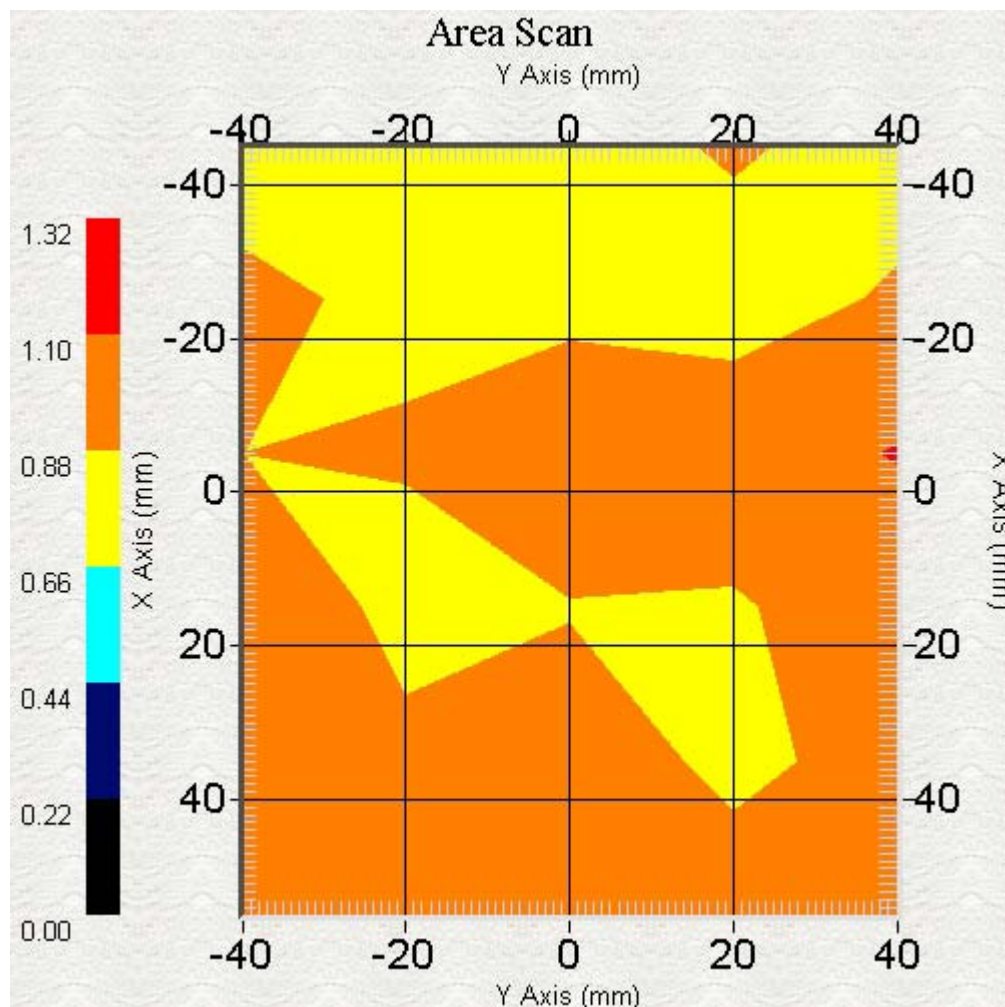
Humidity : 53.00 RH%  
 Tissue Dielectric : 52.10 F/m  
 Tissue Conductivity : 1.99 S/m  
 Tissue Density : 1000.00 kg/cu. m  
 Crest Factor : 1.00

## Probe Data

Probe Name : Probe 226  
 Probe Model : E020  
 Probe Type : E-Field Triangle  
 Probe Serial No. : 225  
 Probe Calibration Date : 28-Jun-2004  
 Probe Frequency : 2450.00 MHz  
 Calibrated Dielectric : 52.70 F/m  
 Calibrated Conductivity : 1.95 S/m  
 Probe Offset : 2.44 mm  
 Conversion Factor : 3.00  
 Diode Compression Pt : 95.00 mV  
 Probe Sensitivity : 1.20 1.20 1.20 (V/sq. m)

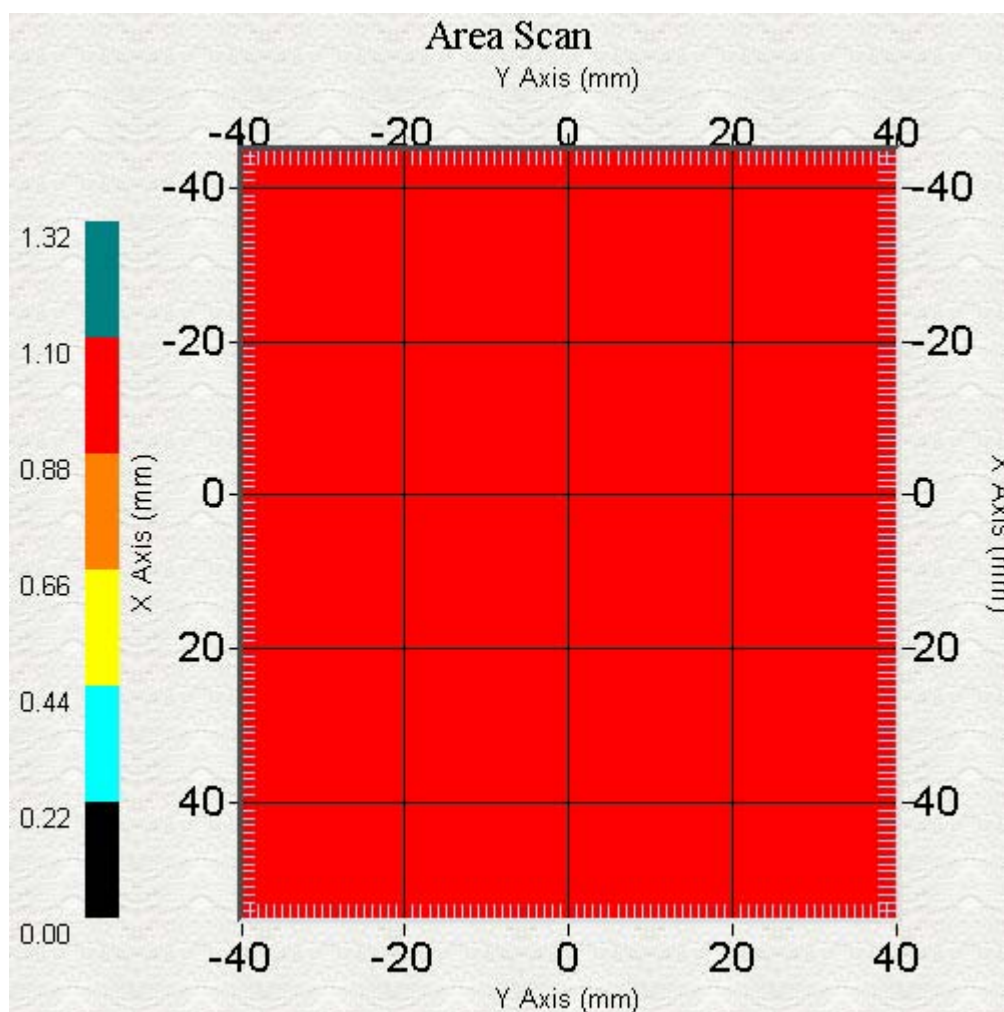


Name : APREL-Uni  
 DUT Position : Touch(Bottom)  
 Channel : Low - 1  
 Tissue Temperature :  $23.50 \pm 2$   
 Tissue Ambient Temp. :  $24.00 \pm 2$   
 Crest Factor : 1.00  
 Conversion Factor : 3.00



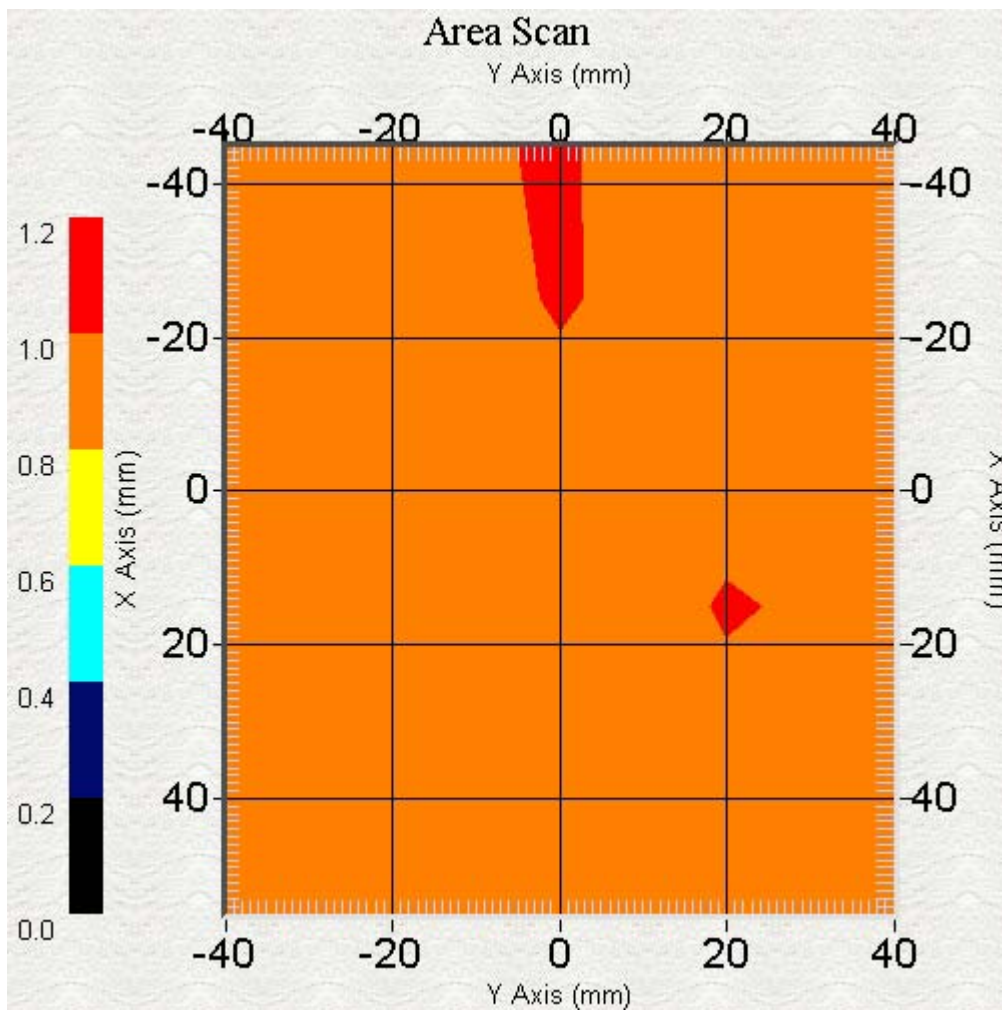
1 gram SAR value : 1.03 W/kg  
 10 gram SAR value : 0.98 W/kg  
 Area Scan Peak SAR : 1.11  
 Zoom Scan Peak SAR : 1.47

Name : APREL-Uni  
 DUT Position : Touch(Bottom)  
 Channel : Mid - 6  
 Tissue Temperature :  $23.50 \pm 2$   
 Tissue Ambient Temp. :  $24.00 \pm 2$   
 Crest Factor : 1.00  
 Conversion Factor : 3.00



1 gram SAR value : 1.07 W/kg  
 10 gram SAR value : 1.03 W/kg  
 Area Scan Peak SAR : 1.10  
 Zoom Scan Peak SAR : 1.54

Name : APREL-Uni  
DUT Position : Touch(Bottom)  
Channel : High - 11  
Tissue Temperature :  $23.50 \pm 2$   
Tissue Ambient Temp. :  $24.00 \pm 2$   
Crest Factor : 1.00  
Conversion Factor : 3.00



1 gram SAR value : 0.95 W/kg  
10 gram SAR value : 0.92 W/kg  
Area Scan Peak SAR : 1.01  
Zoom Scan Peak SAR : 1.36

Name : APREL-Uni

DUT Position : Touch(TOP)

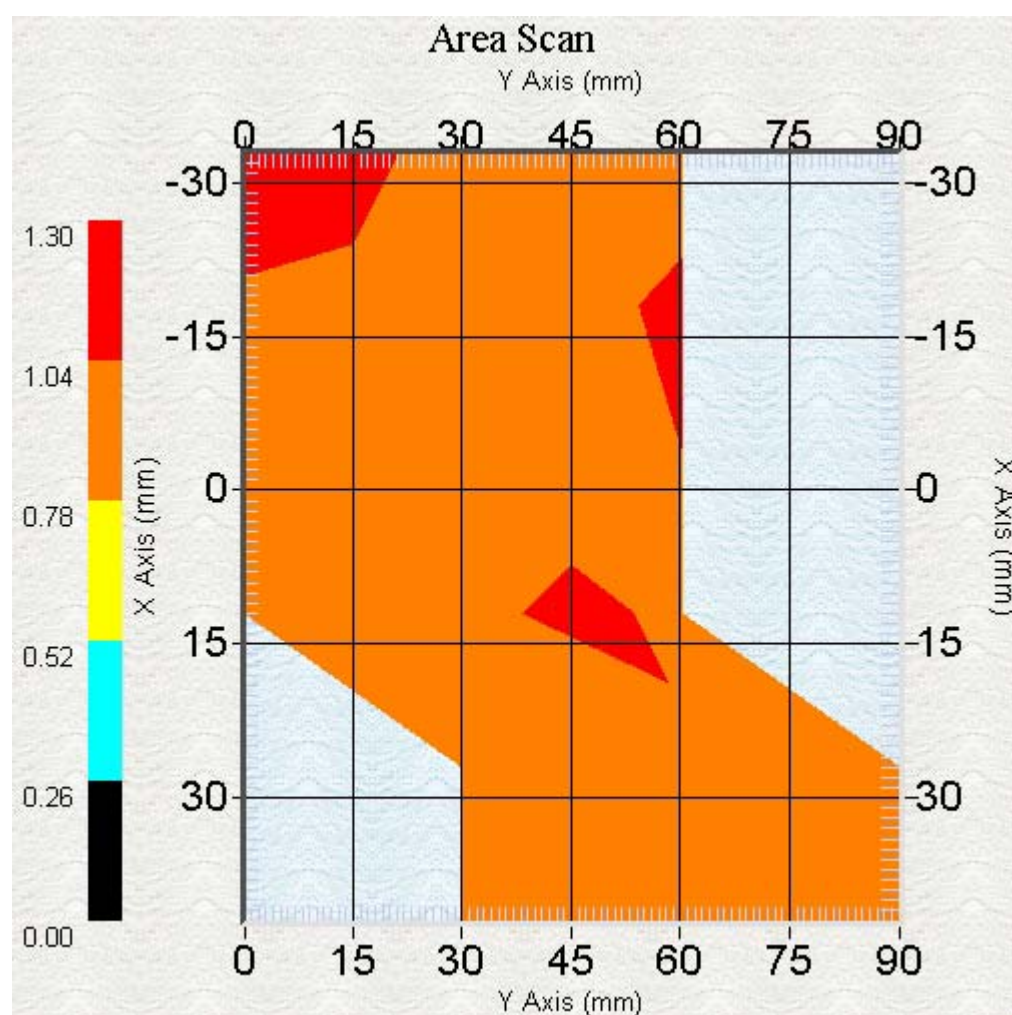
Channel : Low - 1

Tissue Temperature :  $23.50 \pm 2$

Tissue Ambient Temp. :  $24.00 \pm 2$

Crest Factor : 1.00

Conversion Factor : 3.00



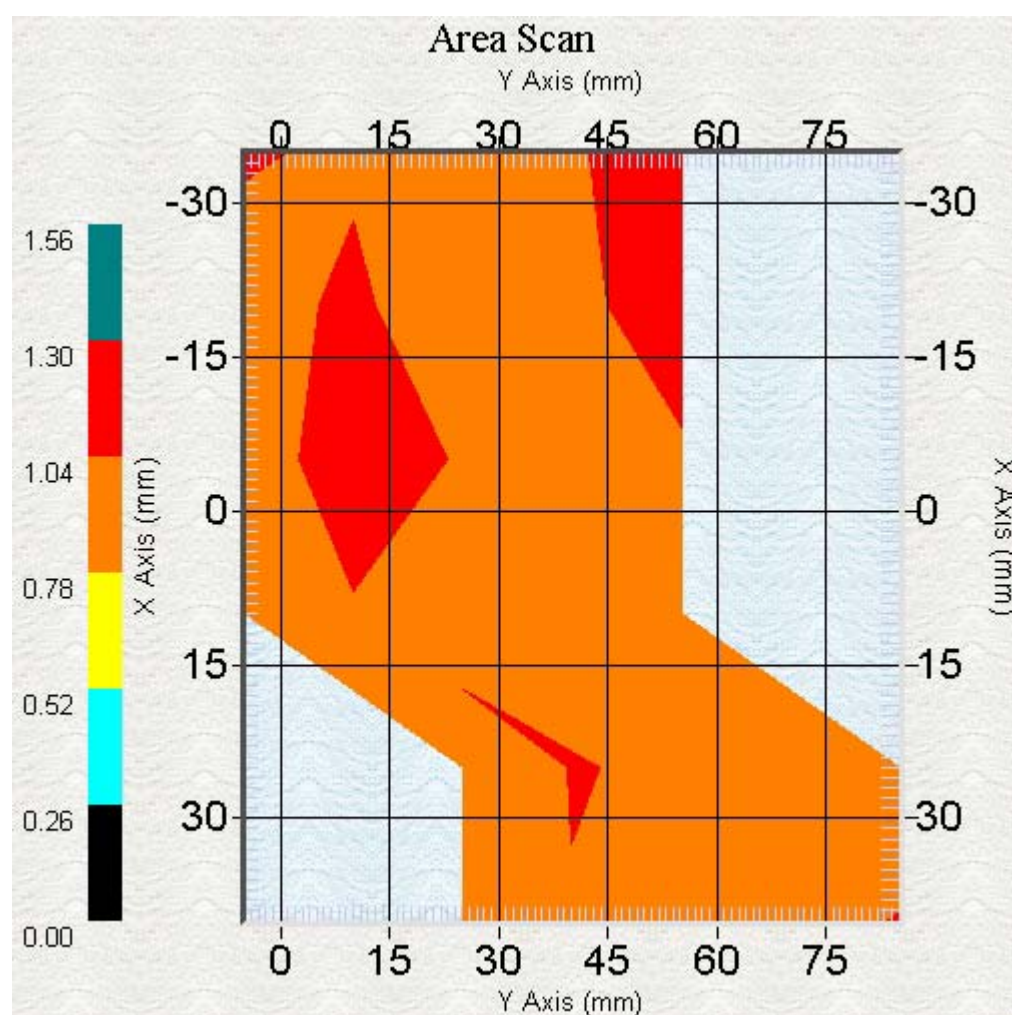
1 gram SAR value : 0.99 W/kg

10 gram SAR value : 0.80 W/kg

Area Scan Peak SAR : 1.28

Zoom Scan Peak SAR : 2.24

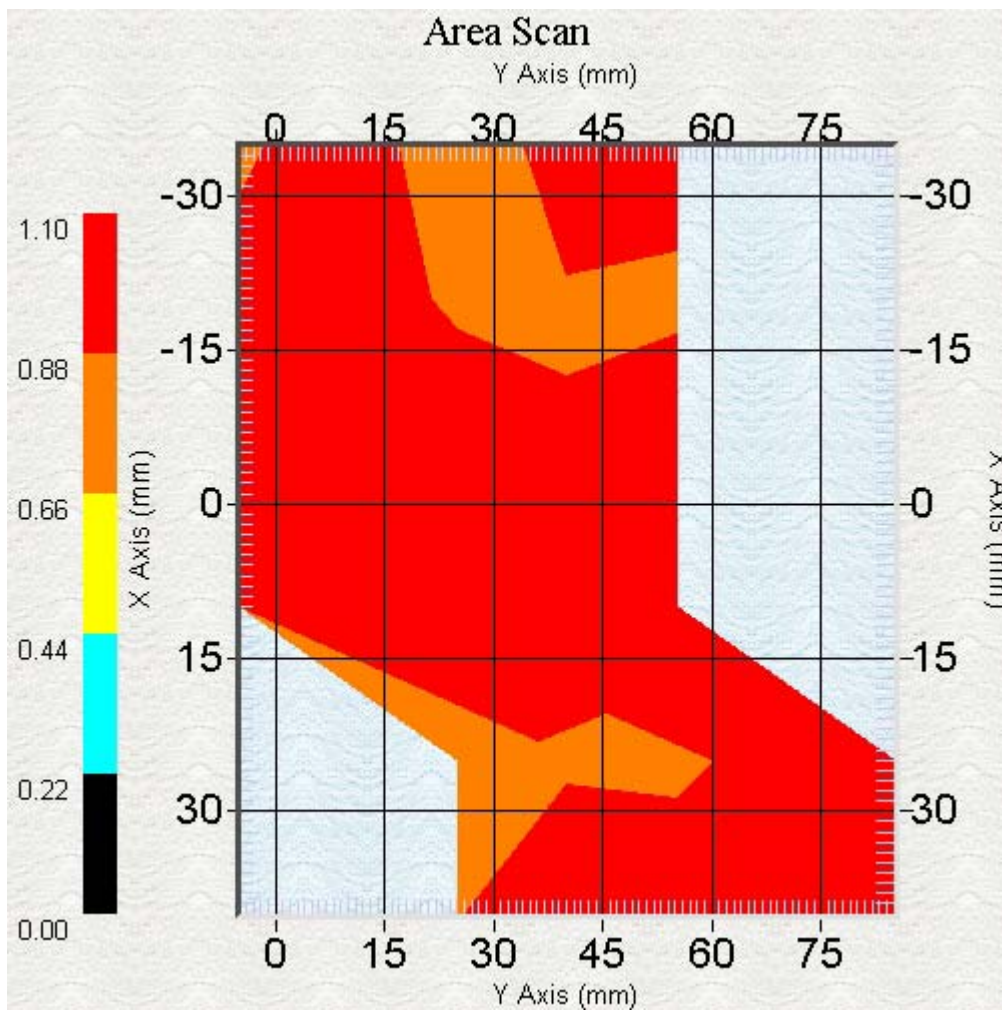
Name : APREL-Uni  
DUT Position : Touch(TOP)  
Channel : Mid - 6  
Tissue Temperature :  $23.50 \pm 2$   
Tissue Ambient Temp. :  $24.00 \pm 2$   
Crest Factor : 1.00  
Conversion Factor : 3.00



1 gram SAR value : 1.13 W/kg  
10 gram SAR value : 1.02 W/kg  
Area Scan Peak SAR : 1.30  
Zoom Scan Peak SAR : 1.86

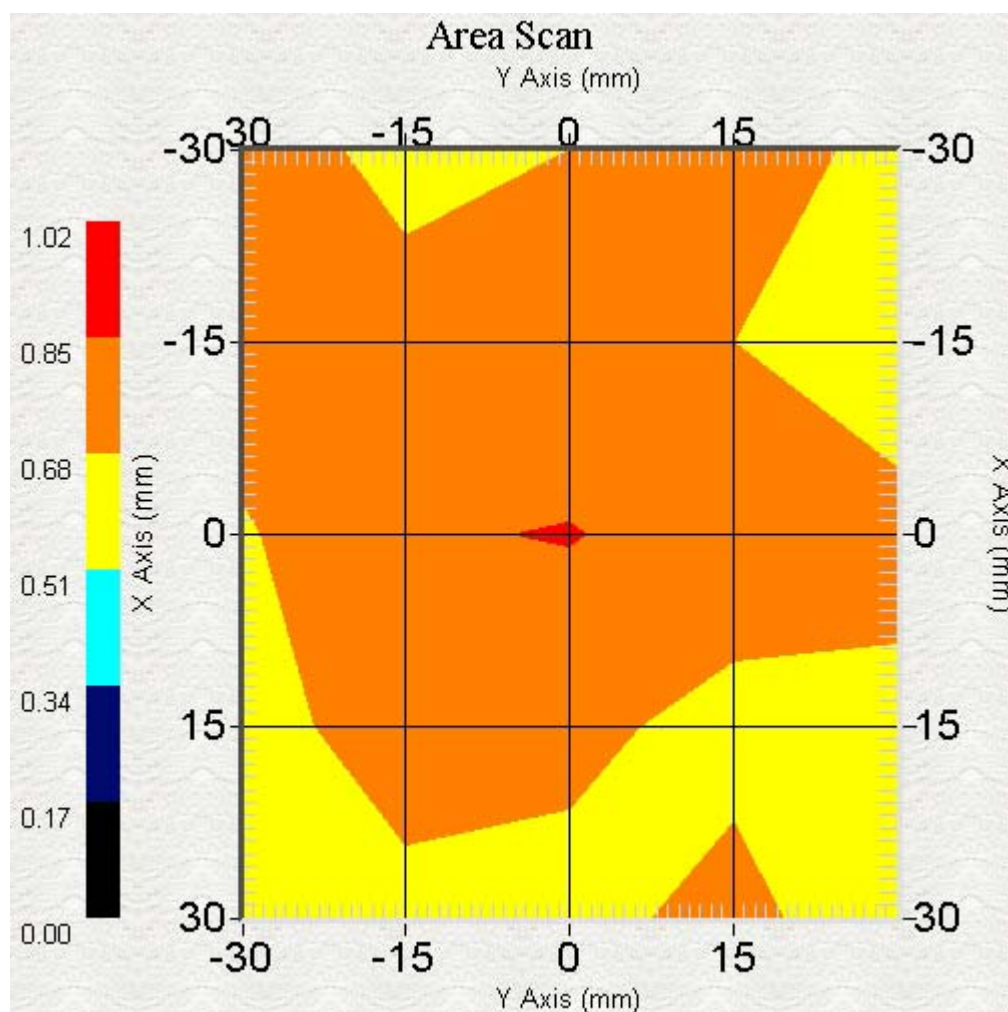


Name : APREL-Uni  
 DUT Position : Touch(TOP)  
 Channel : High - 11  
 Tissue Temperature :  $23.50 \pm 2$   
 Tissue Ambient Temp. :  $24.00 \pm 2$   
 Crest Factor : 1.00  
 Conversion Factor : 3.00



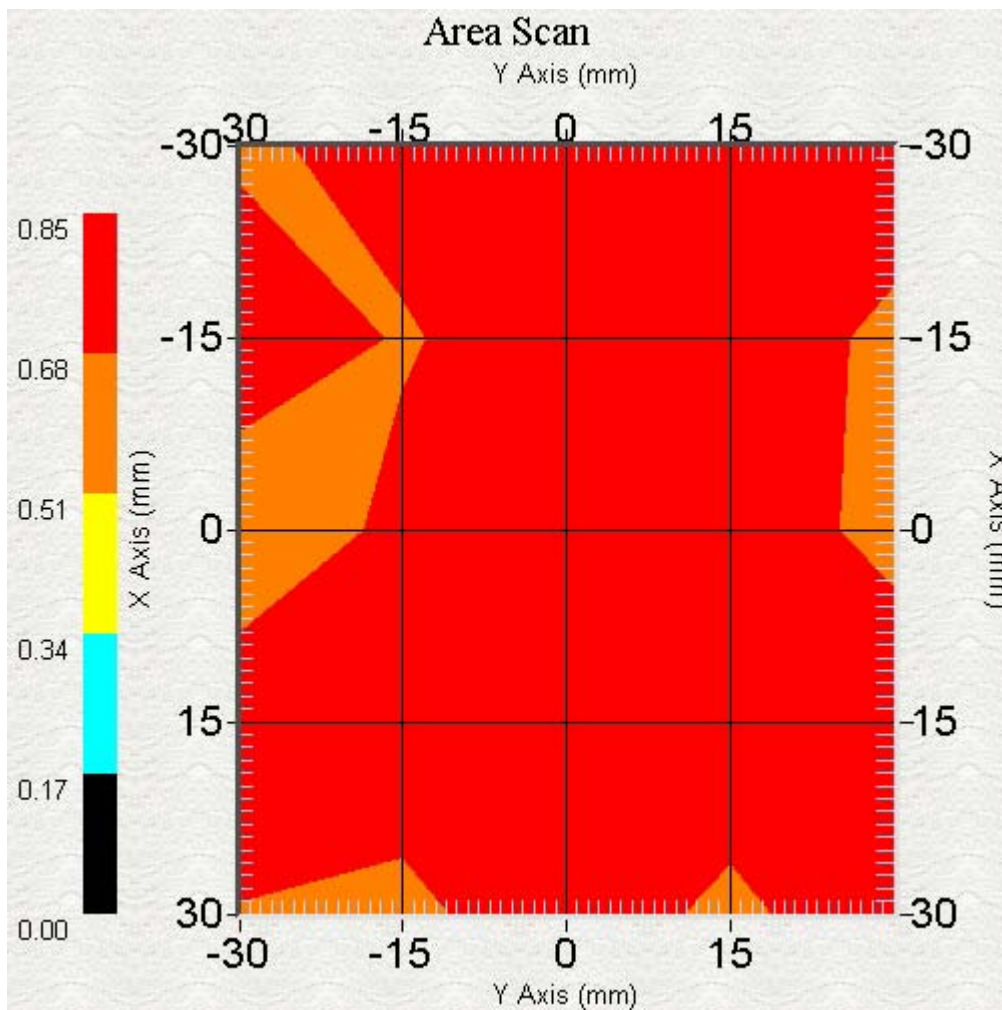
1 gram SAR value : 1.10 W/kg  
 10 gram SAR value : 0.97 W/kg  
 Area Scan Peak SAR : 1.09  
 Zoom Scan Peak SAR : 2.03

Name : APREL-Uni  
DUT Position : Touch(Rear)  
Channel : Low - 1  
Tissue Temperature :  $23.50 \pm 2$   
Tissue Ambient Temp. :  $24.00 \pm 2$   
Crest Factor : 1.00  
Conversion Factor : 3.00



1 gram SAR value : 0.75 W/kg  
10 gram SAR value : 0.71 W/kg  
Area Scan Peak SAR : 0.86  
Zoom Scan Peak SAR : 1.26

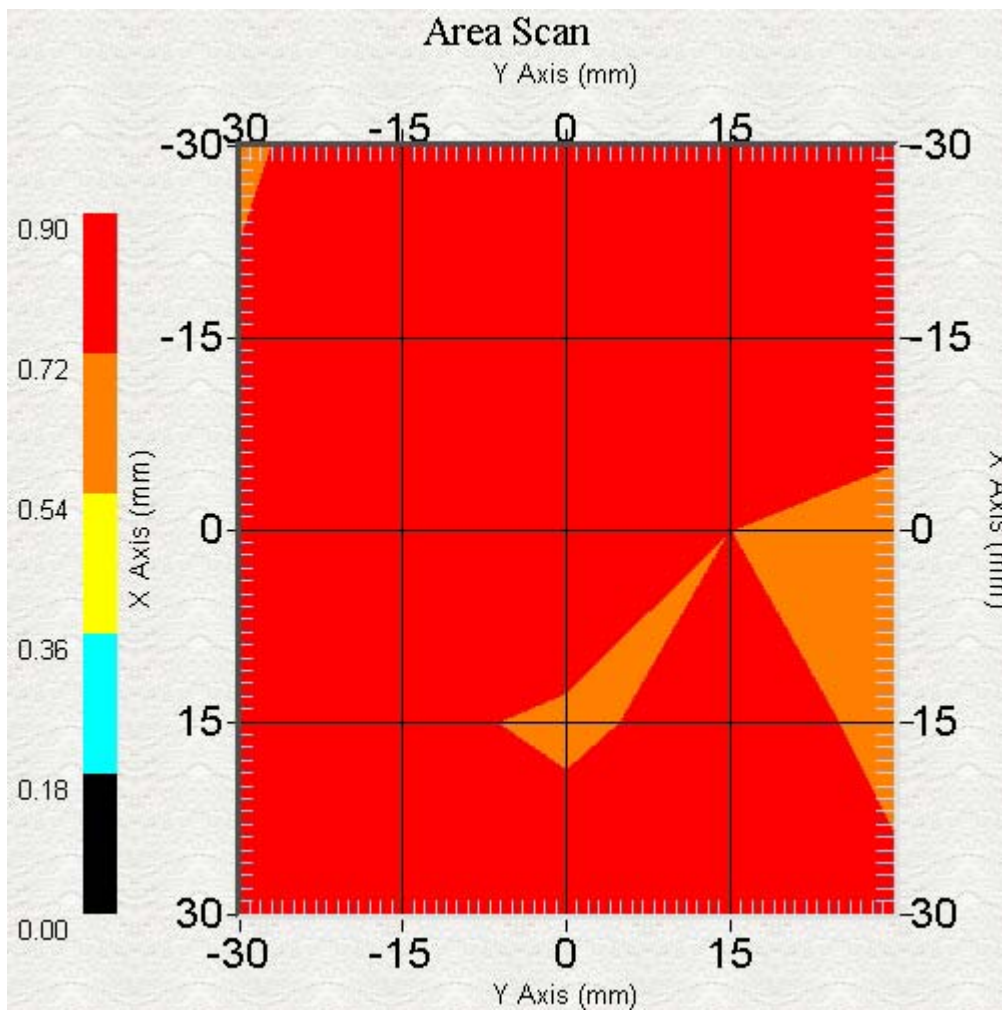
Name : APREL-Uni  
 DUT Position : Touch(Rear)  
 Channel : Mid - 6  
 Tissue Temperature :  $23.50 \pm 2$   
 Tissue Ambient Temp. :  $24.00 \pm 2$   
 Crest Factor : 1.00  
 Conversion Factor : 3.00



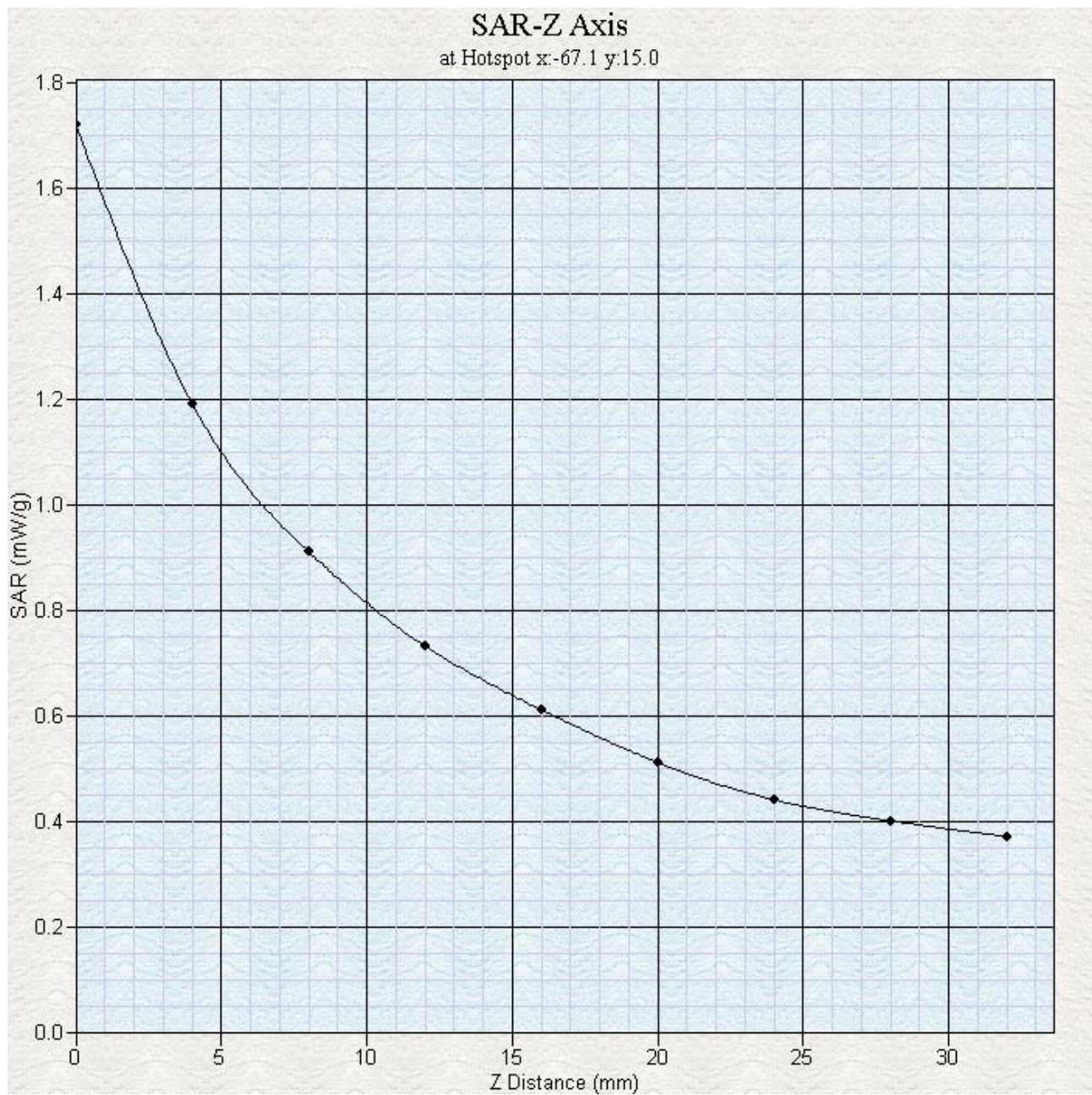
1 gram SAR value : 0.79 W/kg  
 10 gram SAR value : 0.71 W/kg  
 Area Scan Peak SAR : 0.84  
 Zoom Scan Peak SAR : 1.74



Name : APREL-Uni  
DUT Position : Touch(Rear)  
Channel : High - 11  
Tissue Temperature :  $23.50 \pm 2$   
Tissue Ambient Temp. :  $24.00 \pm 2$   
Crest Factor : 1.00  
Conversion Factor : 3.00



1 gram SAR value : 0.93 W/kg  
10 gram SAR value : 0.77 W/kg  
Area Scan Peak SAR : 0.90  
Zoom Scan Peak SAR : 2.17



**Test Setup Photographs****Top panel (Touch)****Bottom face (Touch)**



**Rear side (Touch)**

**EUT Photographs**



## Probe calibration

## NCL CALIBRATION LABORATORIES

Calibration File No.: CP-413

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 BODY

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 225

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

Project No: QTKB-ALSAS10U-505

Calibrated: 23<sup>rd</sup> June 2004  
Released on: 23<sup>rd</sup> June 2004

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

Released By: \_\_\_\_\_

**NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Lab.  
TEL: (613) 820-4988  
FAX: (613) 820-4161



## **Introduction**

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 225.

## **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 225 was a new probe taken from stock prior to calibration.

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

**Calibration Results Summary**

<b>Probe Type:</b>	E-Field Probe E-020
<b>Serial Number:</b>	225
<b>Frequency:</b>	2450 MHz
<b>Sensor Offset:</b>	1.56 mm
<b>Sensor Length:</b>	2.5 mm
<b>Tip Enclosure:</b>	Ertalyte*
<b>Tip Diameter:</b>	<5 mm
<b>Tip Length:</b>	60 mm
<b>Total Length:</b>	290 mm

\*Resistive to recommended tissue recipes per IEEE-1528

**Sensitivity in Air**

<b>Channel X:</b>	$1.2 \mu\text{V}/(\text{V}/\text{m})^2$
<b>Channel Y:</b>	$1.2 \mu\text{V}/(\text{V}/\text{m})^2$
<b>Channel Z:</b>	$1.2 \mu\text{V}/(\text{V}/\text{m})^2$
<b>Diode Compression Point:</b>	95 mV

## **Sensitivity in Body Tissue**

**Frequency:** 2450 MHz

**Epsilon:** 52.7 (+/-5%)      **Sigma:** 1.95 (+/-10%)

### **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.

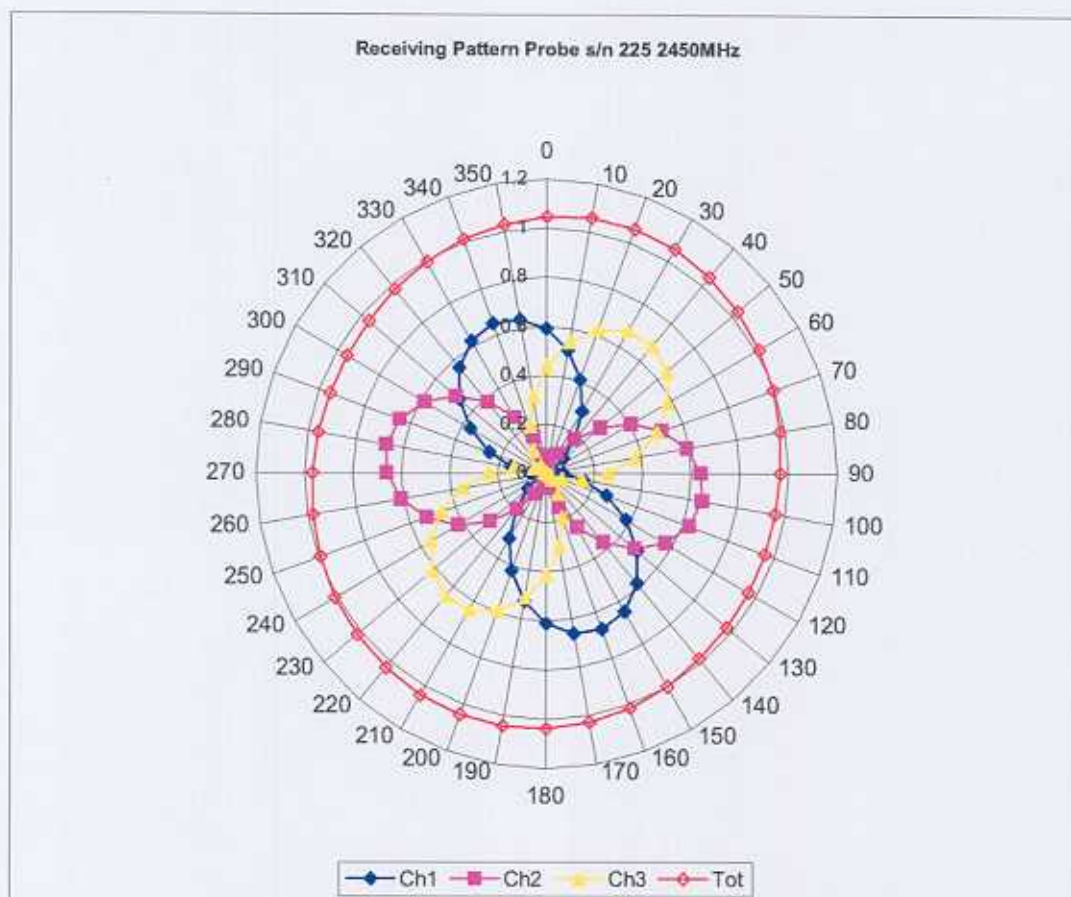
## **Boundary Effect:**

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 2.54mm.

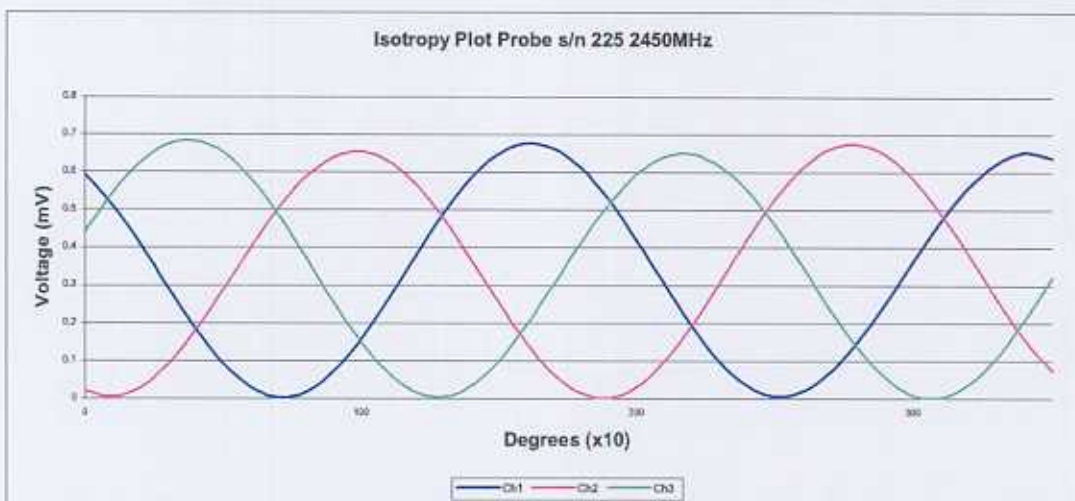
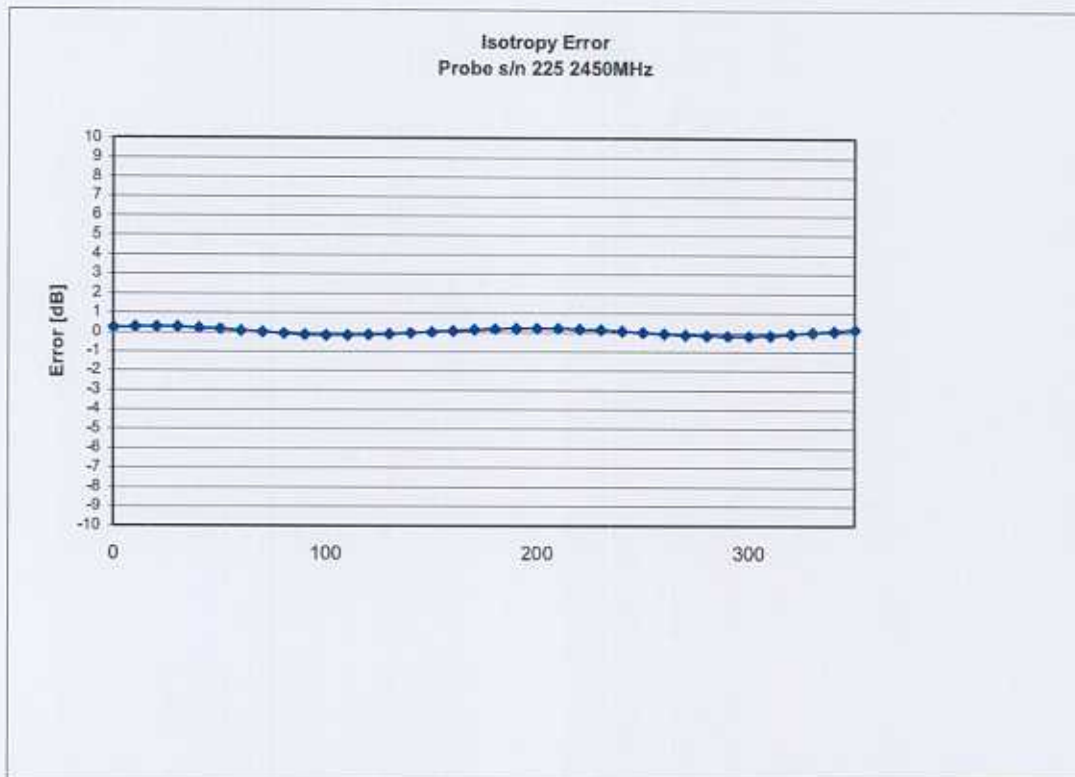
## **Spatial Resolution:**

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)



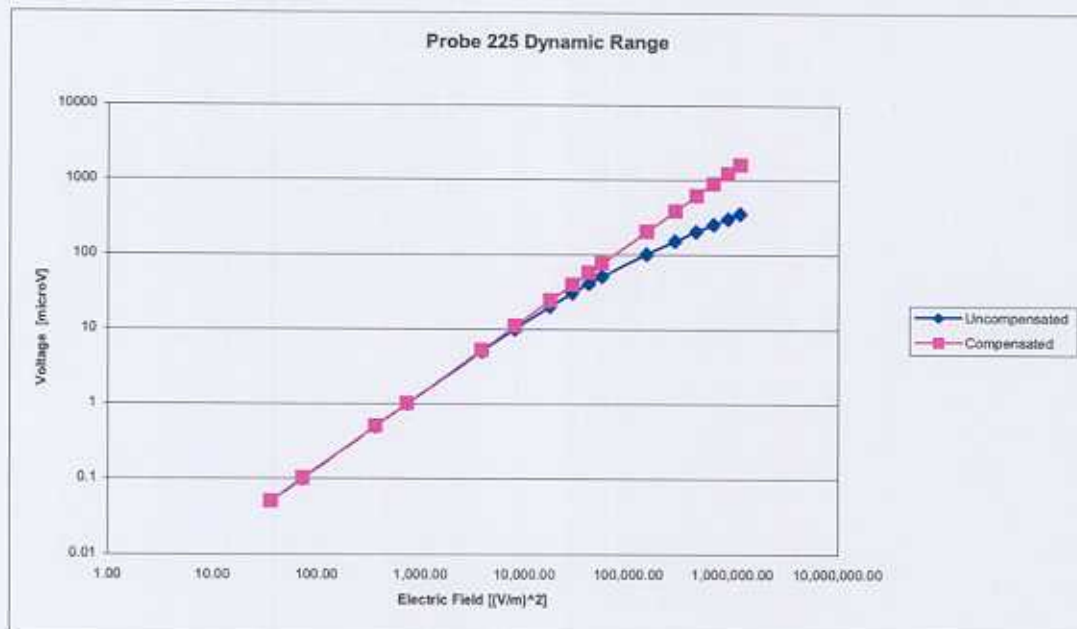
## Isotropy Error 2450 MHz (Air)



Isotropy:

0.10 dB

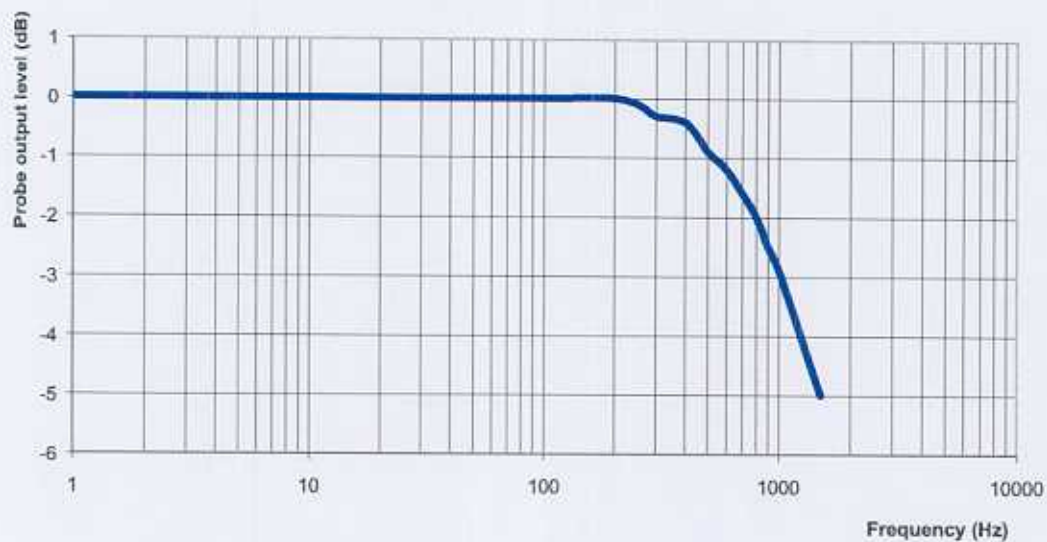
## Dynamic Range





## Video Bandwidth

Probe Frequency Characteristics



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

**Conversion Factor Uncertainty Assessment**

<b>Frequency:</b>	2450MHz		
<b>Epsilon:</b>	52.7 (+/-5%)	<b>Sigma:</b>	1.95 S/m (+/-10%)
<b>ConvF</b>			
<b>Channel X:</b>	3.3		7%(K=2)
<b>Channel Y:</b>	3.3		7%(K=2)
<b>Channel Z:</b>	3.3		7%(K=2)

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

**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 2004.

## Dipole Calibration



# 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

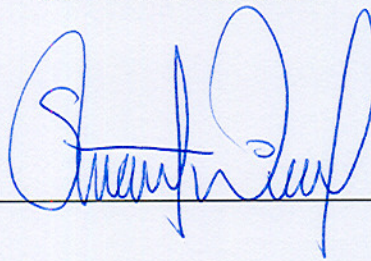
Frequency: 2.45 GHz

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



## 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  $\Omega$

### System Validation Results

Frequency	1 Gram	10 Gram	Peak
2.45 GHz	48.07	25.65	95.6

