# SAR Test Report

Product Name ： Wi-Fi Phone

Model No. ： FX28, SS28, SS58

Applicant ： Fi Win, Inc

Address ： 8F, NO.10,Prosperity Rd.1, Science Park, HsinChu, Taiwan 300

Date of Receipt ： 2006/03/30

Issued Date ： 2006/04/13

Report No. ： 064L030-HP-US-P09V01

The test results relate only to the samples tested.
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SAR test report is for production unit.

# Test Report Certification

Issued Date: 2006/04/13
Report No. :064L030-HP-US-P09V01

QuieTek

| | | |
|---|---|---|
| Product Name | : | Wi-Fi Phone |
| Applicant | : | Fi Win, Inc |
| Address | : | 8F, NO.10,Prosperity Rd.1, Science Park, HsinChu, Taiwan 300 |
| Manufacturer | : | Fi Win, Inc |
| Model No. | : | FX28, SS28, SS58 |
| Applicable Standard | : | FCC Oet65 Supplement C June 2001 |
| | | IEEE Std. 1528-2003 |
| | | 47CFR § 2.1093 |
| | | RSS-102 Issue 2 |
| Test Result | : | Max. SAR Measurement (1g) |
| | | Head 802.11b: **0.272** W/kg Body 802.11b: **0.141** W/kg |
| Application Type | | Certification |

The test results relate only to the samples tested.
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# 1. General Information

## 1.1 EUT Description

| | |
|---|---|
| Product Name | Wi-Fi Phone |
| Model No. | FX28, SS28, SS58 |
| FCC ID | Q5S-SS28 |
| TX Frequency | 2412MHz ~2462MHz |
| Type of Modulation | DSSS |
| Antenna Type | Internal |
| Device Category | Portable |
| RF Exposure Environment | Uncontrolled |
| Transfer Rate | 802.11b: 11Mbps |
| Max. Output Power (Conducted) | 802.11b: 21.83dBm |

## 1.2 Test Environment

Ambient conditions in the laboratory:

| **Items** | **Required** | **Actual** |
|---|---|---|
| Temperature (°C) | 18-25 | 21.5 |
| Humidity (%RH) | 30-70 | 55 |

# 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 odeling to provide aplatform 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 $10mm^2$ 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$^3$ 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:

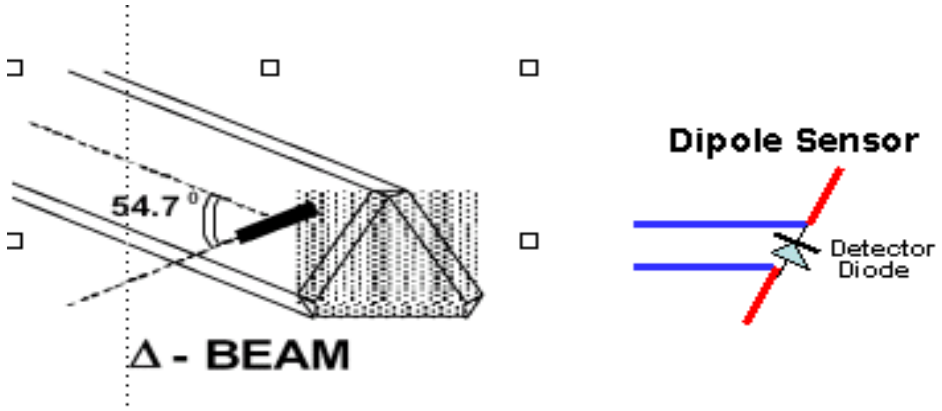
$$f_3(x,y,z) = A\frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2}\cdot\left(e^{-\frac{2z}{a}} + \frac{a^2}{2(a+2z)^2}\right)$$

### 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

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

| | |
|---|---|
| **ADC** | 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.

| | |
|---|---|
| **Robot/Controller Manufacturer** | Thermo CRS |
| **Number of Axis** | Six independently controlled axis |
| **Positioning Repeatability** | 0.05mm |
| **Controller Type** | Single phase Pentium based C500C |
| **Robot Reach** | 710mm |
| **Communication** | 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

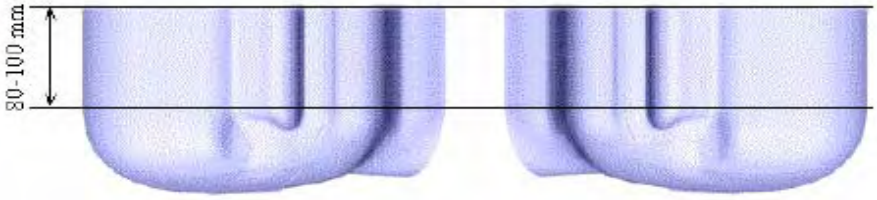
The universal device positioner allow complete freedom of movement of the EUT. Developed to hold a EUT in a free-space scenario any additional loading attributable to the material used in the construction of the positioner has been eliminated. Repeatability has been enhanced through the linear scales 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) | 2450MHz Head | 2450MHz Body | - | - |
|---|---|---|---|---|
| **Water** | 46.7 | 73.2 | - | - |
| **Salt** | 0.00 | 0.04 | - | - |
| **Sugar** | 0.00 | 0.00 | - | - |
| **HEC** | 0.00 | 0.00 | - | - |
| **Preventol** | 0.00 | 0.00 | - | - |
| **DGBE** | 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

| **Head Tissue Simulant Measurement** | | | | |
|---|---|---|---|---|
| Frequency [MHz] | Description | Dielectric Parameters | | Tissue Temp. [°C] |
| | | $\varepsilon_r$ | $\sigma$ [s/m] | |
| 2450MHz | Reference result ± 5% window | 39.2 37.24 to 41.16 | 1.8 1.71 to 1.89 | N/A |
| | 12-Apr-06 | 38.16 | 1.847 | 21.1 |
| 2412 MHz | Low channel | 38.50 | 1.863 | 21.1 |
| 2437 MHz | Mid channel | 38.27 | 1.853 | 21.1 |
| 2462 MHz | High channel | 38.06 | 1.842 | 21.1 |
| | | | | |

| **Body Tissue Simulant Measurement** | | | | |
|---|---|---|---|---|
| Frequency [MHz] | Description | Dielectric Parameters | | Tissue Temp. [°C] |
| | | $\varepsilon_r$ | $\sigma$ [s/m] | |
| 2450MHz | Reference result ± 5% window | 52.7 50.065 to 55.335 | 1.95 1.8525 to 2.0475 | N/A |
| | 12-Apr-06 | 51.28 | 1.988 | 21.1 |
| 2412 MHz | Low channel | 51.59 | 2.016 | 21.1 |
| 2437 MHz | Mid channel | 51.39 | 1.997 | 21.1 |
| 2462 MHz | High channel | 51.17 | 1.980 | 21.1 |
| | | | | |

### 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.

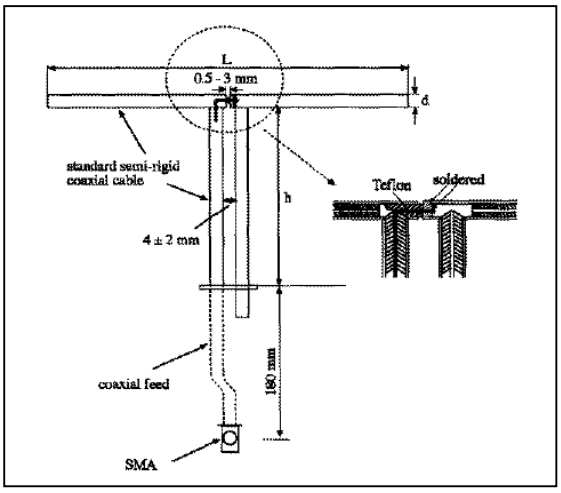
| Target Frequency | Head | | Body | |
|---|---|---|---|---|
| (MHz) | $\varepsilon_r$ | $\sigma$ (S/m) | $\varepsilon_r$ | $\sigma$ (S/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 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 |

($\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 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

**System Performance Check at 2450MHz**

**Validation Kit: ASL-D-2450-S-2**

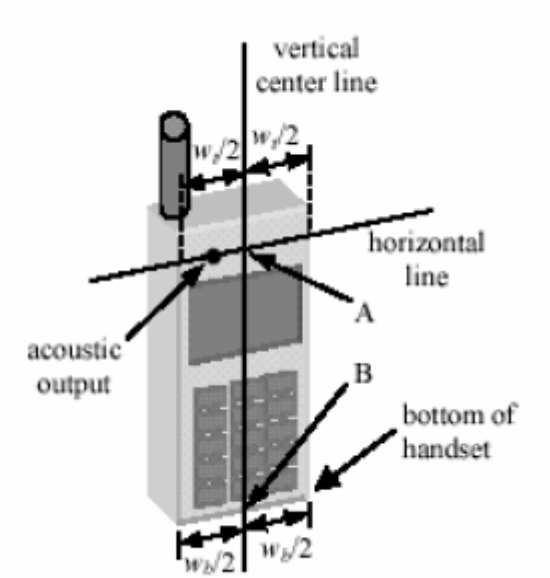
| Frequency [MHz] | Description | SAR [w/kg] 1g | SAR [w/kg] 10g | Tissue Temp. [°C] |
|---|---|---|---|---|
| 2450 MHz | Reference result ± 5% window | 52.4 49.78 to 55.02 | 24 22.8 to 25.2 | N/A |
| | 12-Apr-06 | 52.628 | 23.868 | 21.1 |

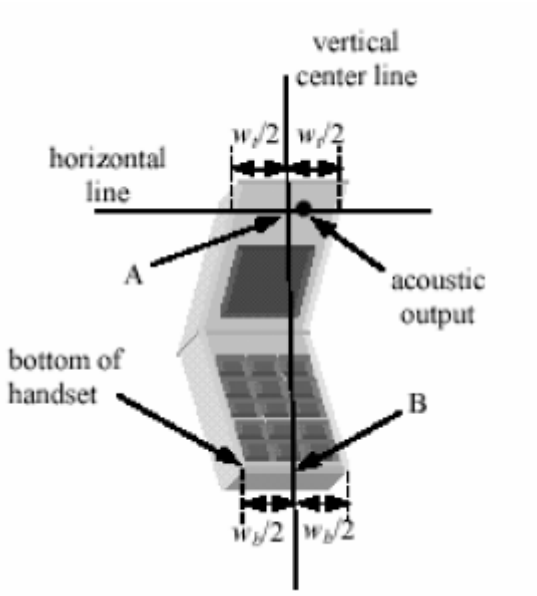
Note: All SAR values are normalized to 1W forward power.

## 4.2 Arrangement Assessment Setup

4.2.1 Test Positions of Device Relative to Head

This specifies exactly two test positions for the handset against the head phantom, the “cheek” position and the “tilted” position. The handset should be tested in both positions on the left and right sides of the SAM phantom. If the handset construction is such that it cannot be positioned using the handset positioning procedures described in 4.2.2.1 and 4.2.2.2 to represent normal use conditions (e.g., asymmetric handset), alternative alignment procedures should be considered with details provided in the test




report.

Figure 4.1a Fixed Case

Figure4.1b Clam Shell

#### 4.2.1.1 Definition of the “Cheek” Position

The “cheek” position is defined as follows:

a. Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece, open the cover. (If the handset can also be used with the cover closed both configurations must be tested.)

b. Define two imaginary lines on the handset: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width *wt* of the handset at the level of the acoustic output (point A on Figures 4.1a and 4.1b), and the midpoint of the width *wb* of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 4.1a). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 4.1b), especially for clamshell handsets, handsets with flip pieces, and other irregularly-shaped handsets.

c. Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 4.2), such that the plane defined by the vertical center line and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.

d. Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the pinna.

e. While maintaining the handset in this plane, rotate it around the LE-RE line until the

vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane).

f. Rotate the handset around the vertical centerline until the handset (horizontal line) is symmetrical with respect to the line NF.

g. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE and maintaining the handset contact with the pinna, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the pinna (cheek). See Figure 4.2 the physical angles of rotation should be noted.

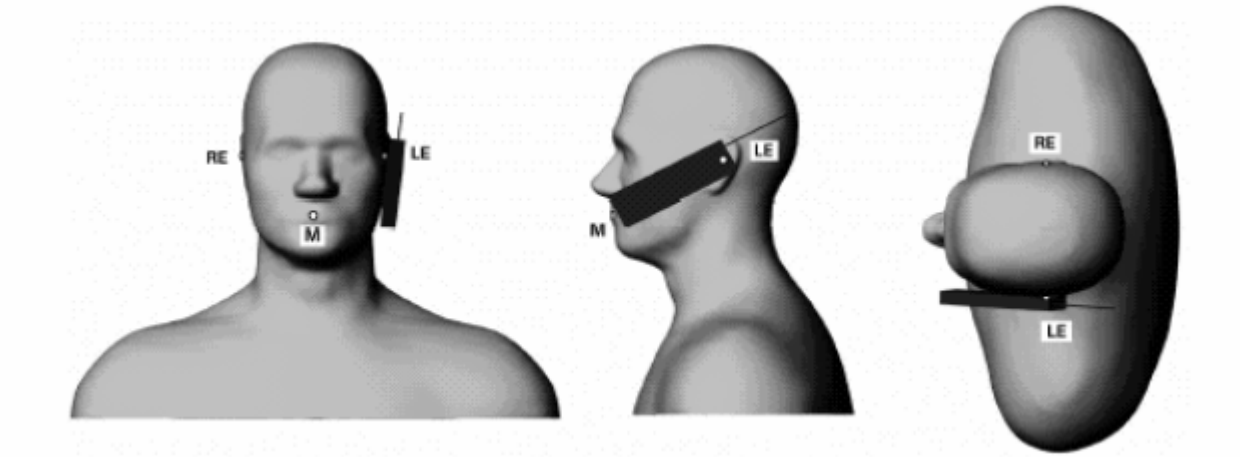



Figure 4.2 – Phone position 1, “cheek” or “touch” position.

**4.2.1.2 Definition of the “Tilted” Position**

The “tilted” position is defined as follows:

a. Repeat steps (a) – (g) of 4.2.1.1 to place the device in the “cheek position.”

b. While maintaining the orientation of the handset move the handset away from the pinna along the line passing through RE and LE in order to enable a rotation of the handset by 15 degrees.

c. Rotate the handset around the horizontal line by 15 degrees.

d. While maintaining the orientation of the handset, move the handset towards the phantom on a line passing through RE and LE until any part of the handset touches the ear. The tilted position is obtained when the contact is on the pinna. If the contact is at any location other than the pinna (e.g., the antenna with the back of the phantom head), the angle of the handset should be reduced. In this case, the tilted position is obtained if any part of the handset is in contact with the pinna as well as a second part of the handset is contact with the phantom (e.g., the antenna with the back of the head).

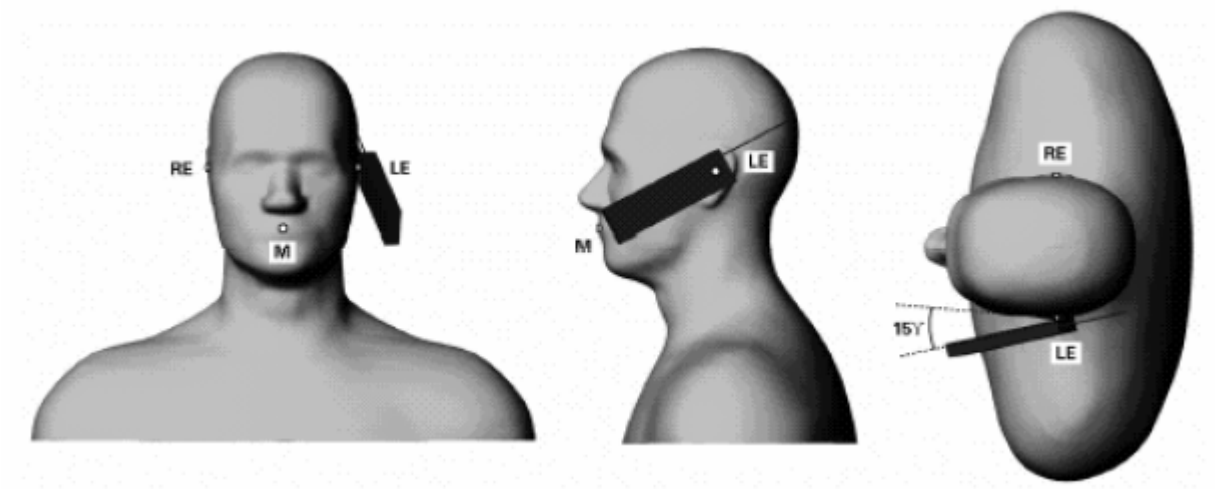



Figure 4.3 – Phone position 2, “tilted” position.

### 4.2.2 Test Positions for body-worn

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distance may be use, but not exceed 2.5 cm.

### 4.3 SAR Measurement Procedure

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

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

σ: represents the simulated tissue conductivity
ρ: 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 $1mm^2$ )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 $1mm^3$ ).

## 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)**

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

## 6. Test Equipment List

| Instrument | Manufacturer | Model No. | Serial No. | Last Calibration |
|---|---|---|---|---|
| Data Acquisition Package | Aprel | ALS-DAQ-PAQ-2 | QTK-337 | Mar. 2006 |
| Aprel Laboratories Probe | Aprel | ALS-E020 | 264 | Mar. 2006 |
| Aprel Reference Dipole 2450Mhz | Aprel | ALS-D-2450-S-2 | QTK-319 | Jun. 2004 |
| Boundary Detection Sensor System | Aprel | ALS-PMDPS-2 | QTK-336 | 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. 2.2.0 | 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 | 778D-012 | 50550 | N/A |
| Universal Radio Communication Tester | Rohde & Schwarz | CMU 200 | 104846 | Mar. 2006 |
| Radio Communication Analyzer | Anritsu | MT8820A | 6200323183 | Jun. 2005 |
| Vector Network | Anritsu | MS4623B | 992801 | Mar 2006 |
| Signal Generator | Anritsu | MG3692A | 042319 | Jun. 2005 |
| Power Meter | Anritsu | ML2487A | 6K00001447 | Jan. 2006 |
| Wide Bandwidth Sensor | Anritsu | MA2491 | 030677 | Jan. 2006 |

# 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 | $\sqrt{3}$ | $(1-cp)^{1/2}$ | $(1-cp)^{1/2}$ | 1.5 | 1.5 |
| Hemispherical Isotropy | 10.9 | rectangular | $\sqrt{3}$ | $\sqrt{cp}$ | $\sqrt{cp}$ | 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 | 4.7 | rectangular | $\sqrt{3}$ | 1 | 1 | 2.7 | 2.7 |
| | | | | | | | |
| 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.) | 0.1 | normal | 1 | 0.7 | 0.5 | 0.1 | 0.0 |
| Liquid Permittivity(target) | 2.0 | rectangular | $\sqrt{3}$ | 0.6 | 0.5 | 0.7 | 0.6 |
| Liquid Permittivity(meas.) | 2.6 | normal | 1 | 0.6 | 0.5 | 1.6 | 1.3 |
| Combined Uncertainty | | RSS | | | | 9.6 | 9.5 |
| Combined Uncertainty (coverage factor=2) | | Normal(k=2) | | | | 19.3 | 18.9 |

# 8. Test Results

## 8.1 SAR Test Results Summary

| | | | | | | |
|---|---|---|---|---|---|---|
| SAR MEASUREMENT | | | | | | |
| Ambient Temperature (°C) : 21.5 ±2 | | | | Relative Humidity (%): 55 | | |
| Liquid Temperature (°C) : 20.1 ±2 | | | | Depth of Liquid (cm):>15 | | |
| Product: Wi-Fi Phone | | | | | | |
| Test Mode: 802.11b | | | | | | |
| Test Position Head | Antenna Position | Frequency | | Conducted Power (dBm) | **SAR** 1g (W/kg) | Limit (W/kg) |
| | | Channel | MHz | | | |
| Right-Cheek | Internal | 1 | 2412 | 21.82 | 0.199 | 1.6 |
| Right-Cheek | Internal | 6 | 2437 | 21.83 | 0.172 | 1.6 |
| Right-Cheek | Internal | 11 | 2462 | 20.28 | 0.14 | 1.6 |
| Left-Cheek | Internal | 1 | 2412 | 21.82 | **0.272** | 1.6 |
| Left-Cheek | Internal | 6 | 2412 | 21.83 | 0.221 | 1.6 |
| Left-Cheek | Internal | 11 | 2462 | 20.28 | 0.17 | 1.6 |
| Right-Tilted | Internal | 1 | 2412 | 21.82 | 0.204 | 1.6 |
| Right-Tilted | Internal | 6 | 2437 | 21.83 | 0.153 | 1.6 |
| Right-Tilted | Internal | 11 | 2462 | 20.28 | 0.129 | 1.6 |
| Left-Tilted | Internal | 1 | 2412 | 21.82 | 0.319 | 1.6 |
| Left-Tilted | Internal | 6 | 2437 | 21.83 | 0.166 | 1.6 |
| Left-Tilted | Internal | 11 | 2462 | 20.28 | 0.134 | 1.6 |
| Note: The EUT test position is touch & tilted 15 degrees.<br>The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at the high and low channels is option. | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| SAR MEASUREMENT | | | | | | |
| Ambient Temperature (°C) :21.5 ±2 | | | | Relative Humidity (%): 55 | | |
| Liquid Temperature (°C) : 20.1 ±2 | | | | Depth of Liquid (cm):>15 | | |
| Product: Wi-Fi Phone | | | | | | |
| Test Mode: 802.11b EUT Front | | | | | | |
| Test Position Body | Antenna Position | Frequency | | Conducted Power (dBm) | **SAR** 1g (W/kg) | Limit (W/kg) |
| | | Channel | MHz | | | |
| Body-wore | Internal | 1 | 2412 | 21.82 | 0.087 | 1.6 |
| Body-wore | Internal | 6 | 2437 | 21.83 | 0.078 | 1.6 |
| Body-wore | Internal | 11 | 2462 | 20.28 | 0.072 | 1.6 |
| Test Mode: 802.11b EUT Back | | | | | | |
| Body-wore | Internal | 6 | 2437 | 21.83 | 0.072 | 1.6 |
| Note: A separation distance of 1.5cm between the back of the device and a flat phantom for test.<br>The SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at the high and low channels is option. | | | | | | |

**Appendix A. SAR System Validation Data**

**Appendix B. SAR measurement Data**

**Appendix C. Test Setup Photographs & EUT Photographs**

**Appendix D. Probe Calibration Data**

**Appendix E. Dipole Calibration Data**

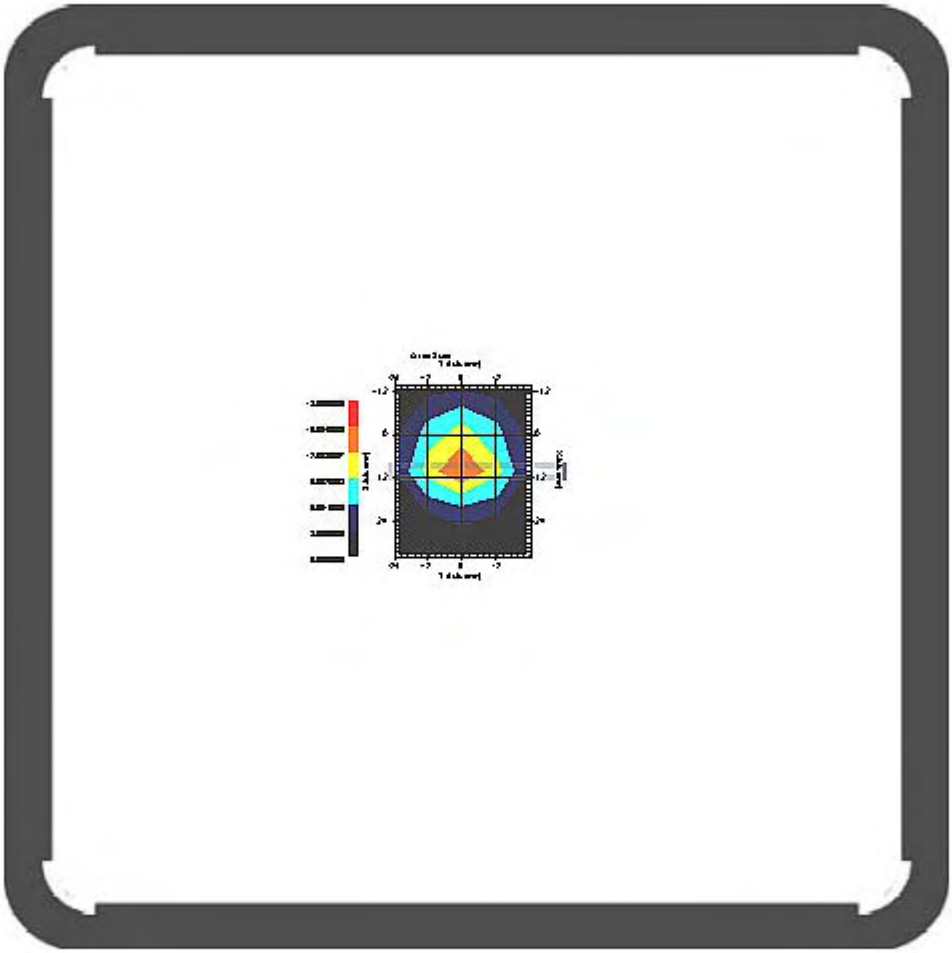
## SAR System Validation Data

ALSAS-10U VER 2.3.0APREL Laboratories

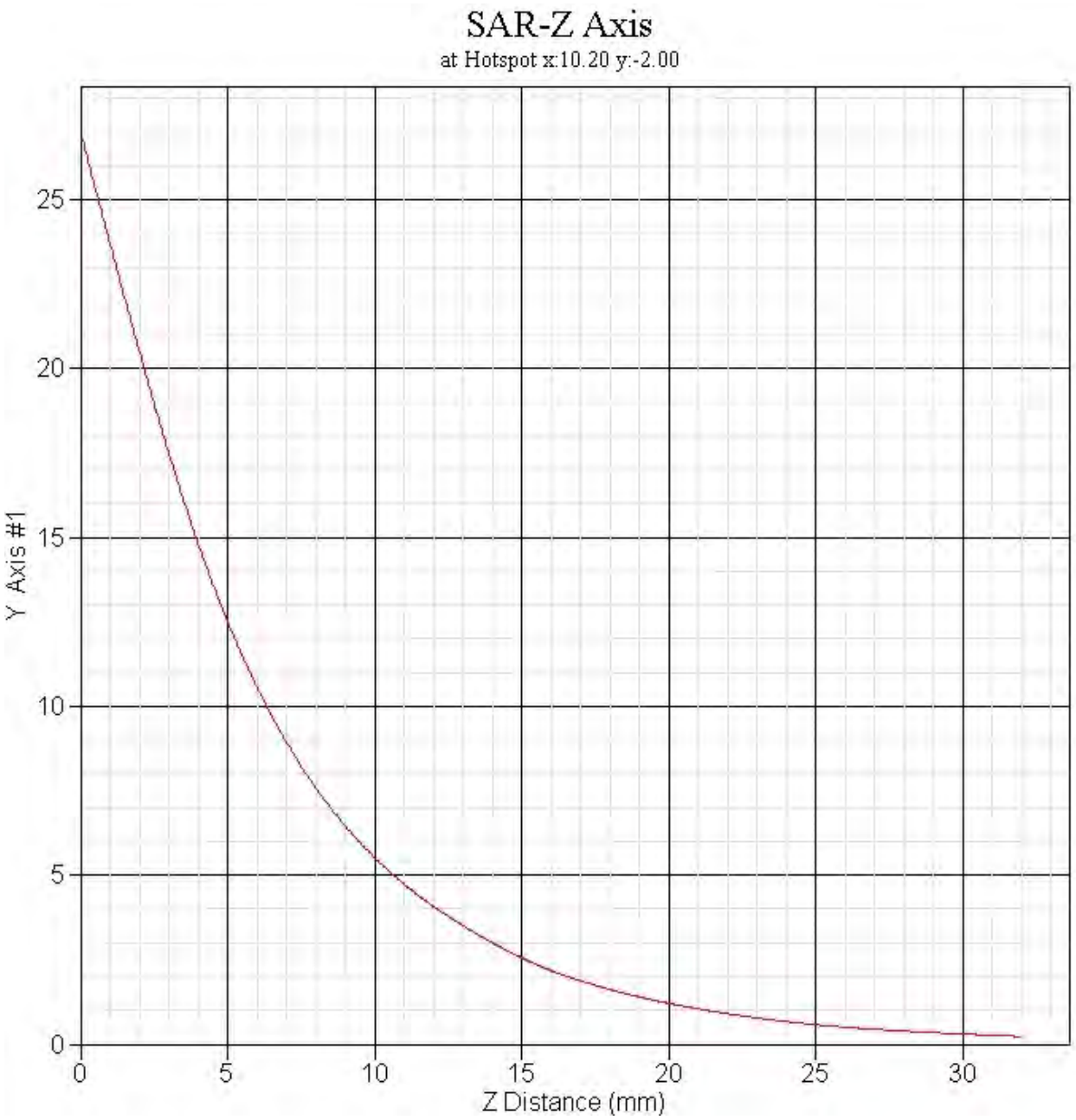
SAR Test Report

```
Validation Date  : 12-Apr-2006
Measurement Date  : 12-Apr-2006

Product Data
Device Name      : Dipole-2450
Type            : Dipole
Frequency        : 2450.00 MHz
Max. Transmit Pwr : 0.25 W
Drift Time       : 0 min(s)
Length          : 51.5 mm
Width           : 3.6 mm
Depth           : 30.4 mm
Power Drift-Start : 11.196 W/kg
Power Drift-Finish: 11.430 W/kg
Power Drift (%)   : 2.094

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

Tissue Data
Type           : HEAD
Serial No.      : 325-H
Frequency       : 2450.00 MHz
Last Calib. Date : 12-Apr-2006
Temperature     : 21.10 °C
Ambient Temp.    : 21.50 °C
Humidity        : 55.00 RH%
Epsilon         : 38.16 F/m
Sigma           : 1.847 S/m
Density         : 1000.00 kg/cu. m

Probe Data
Name           : Probe 264
Model          : E020
Type           : E-Field Triangle
Serial No.      : 264
Last Calib. Date : 21-Mar-2006
Frequency       : 2450.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset         : 1.56 mm
```

Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 5x5x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Frequency : 2450



1 gram SAR value : 13.157 W/kg
10 gram SAR value : 5.967 W/kg
Area Scan Peak SAR : 15.007 W/kg
Zoom Scan Peak SAR : 27.023 W/kg


SAR-Z Axis
at Hotspot x:10.20 y:-2.00
Y Axis #1
0
5
10
15
20
25
0
5
10
15
20
25
30
Z Distance (mm)

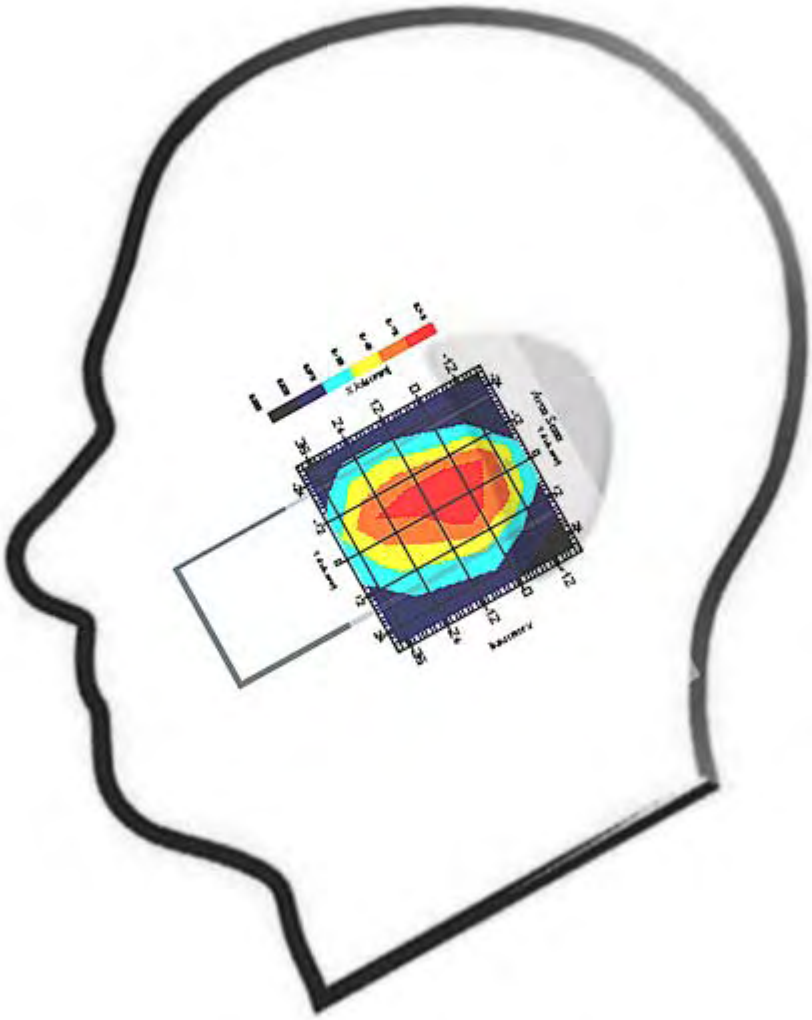
## SAR 2.45GHz Measurement Data

ALSAS-10U VER 2.3.0APREL Laboratories

**SAR Test Report**

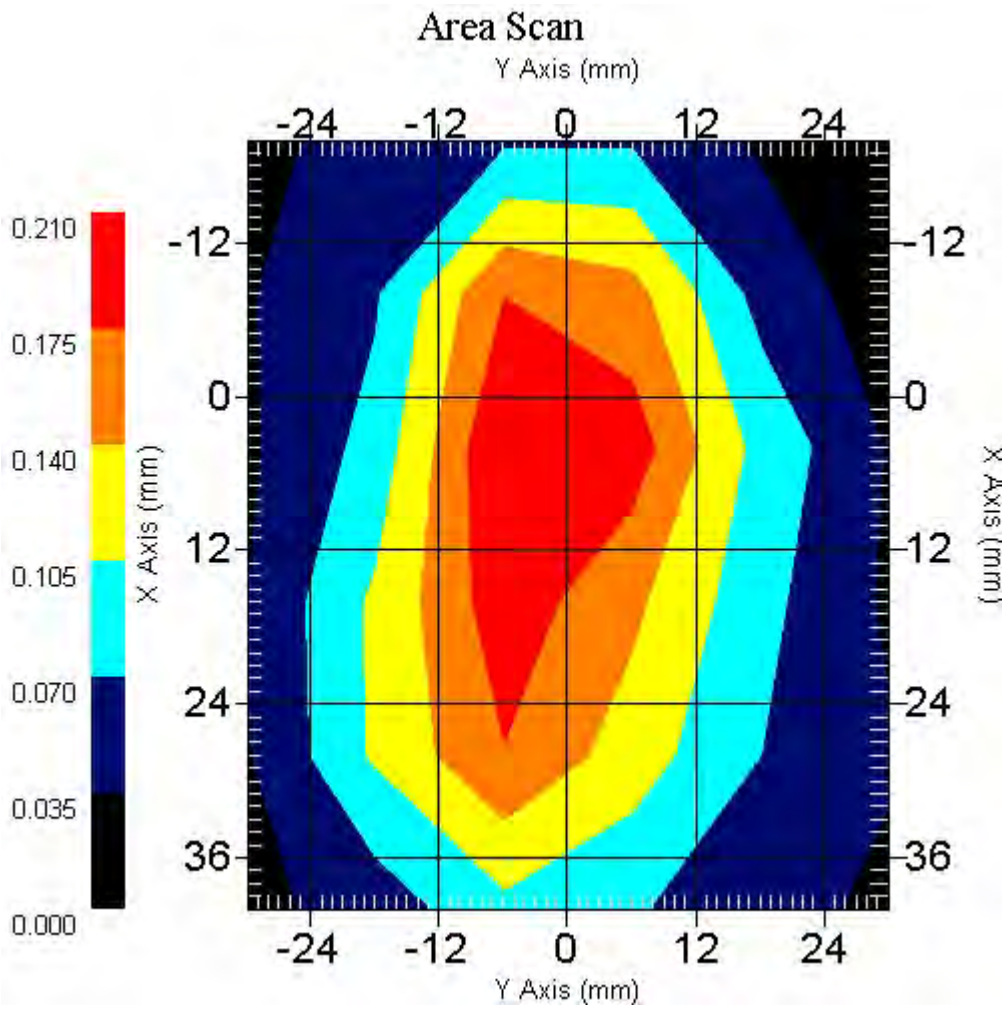
```
Vaildation Date  : 12-Apr-2006
Measurement Date  : 12-Apr-2006

Product Data
Device Name       : Fi Win
Type             : Std Form Cell Phone
Model            : FX28,SS28,SS58
Frequency         : 2450.00 MHz
Drift Time        : 0 min(s)
Length           : 108 mm
Width            : 42 mm
Depth            : 18.7 mm
Antenna Type      : Internal

Phantom Data
Type            : SAM-Right
Size (mm)        : 280 x 280 x 280
Location         : Right

Tissue Data
Type            : HEAD
Serial No.       : 325-H
Frequency        : 2450.00 MHz
Last Calib. Date : 12-Apr-2006
Temperature      : 21.10 °C
Ambient Temp.     : 21.50 °C
Humidity         : 55.00 RH%
Epsilon          : 38.16 F/m
Sigma            : 1.847 S/m
Density          : 1000.00 kg/cu. m

Probe Data
Name            : Probe 264
Model           : E020
Type            : E-Field Triangle
Serial No.       : 264
Last Calib. Date : 21-Mar-2006
Frequency        : 2450.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5
Probe Sensitivity: 1.20  1.20  1.20   μV/(V/m)²
Compression Point: 95.00 mV
Offset          : 1.56 mm
```

Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.230 W/kg
Power Drift-Finish: 0.232 W/kg
Power Drift (%) : 0.967
Channel : 1 (Cheek)



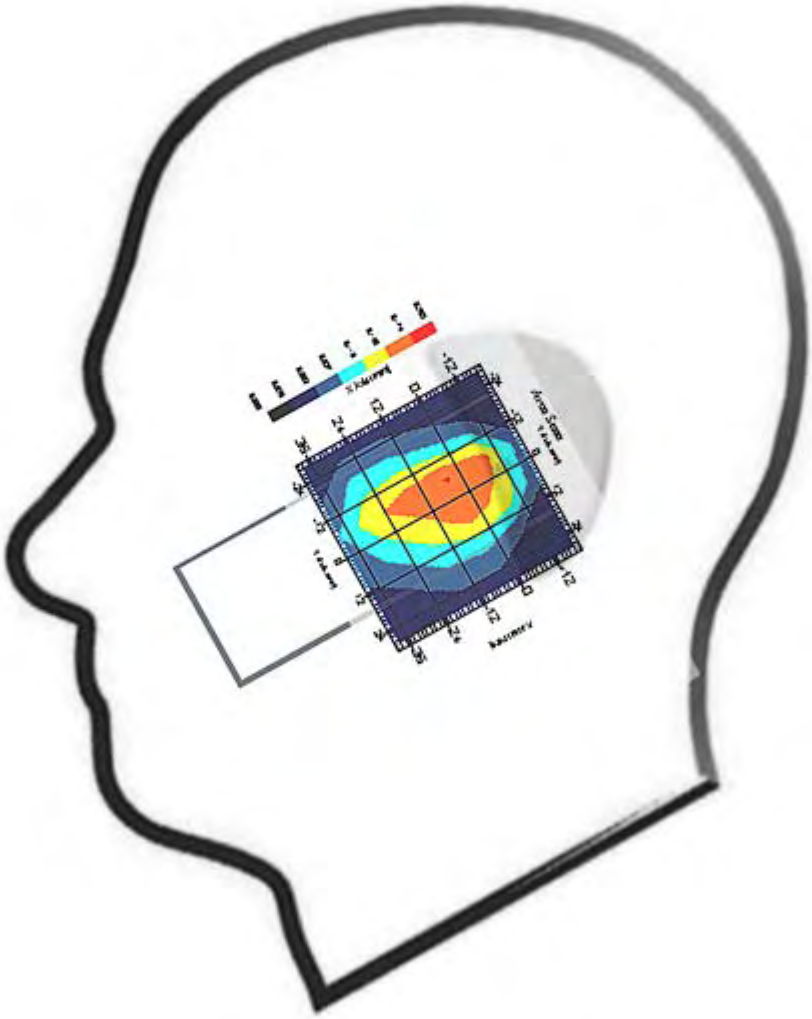
1 gram SAR value : 0.199 W/kg
10 gram SAR value : 0.104 W/kg
Area Scan Peak SAR : 0.210 W/kg
Zoom Scan Peak SAR : 0.400 W/kg

This is previous page plot (zoom in)



Measurement Data

Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.206 W/kg
Power Drift-Finish: 0.201 W/kg
Power Drift (%) : -2.178
Channel : 6 (Cheek)



1 gram SAR value : 0.172 W/kg

10 gram SAR value : 0.091 W/kg

Area Scan Peak SAR : 0.175 W/kg

Zoom Scan Peak SAR : 0.340 W/kg

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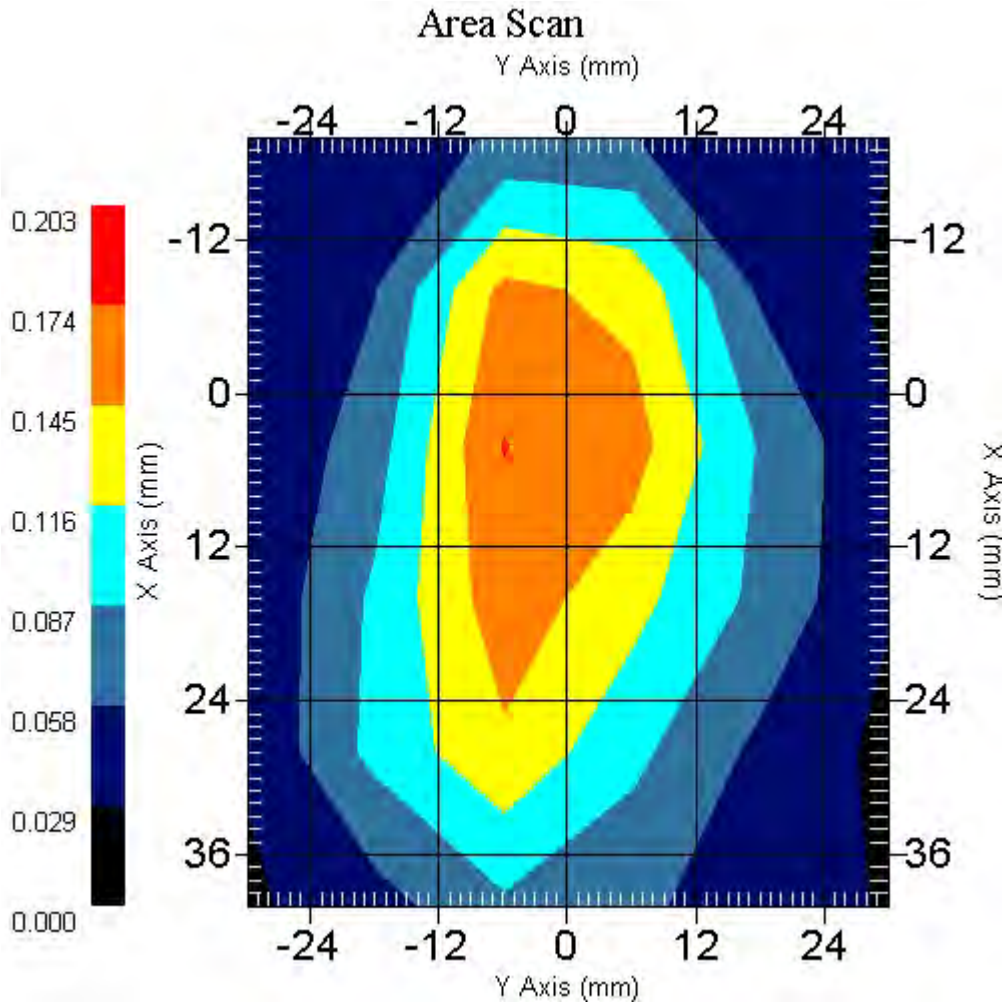
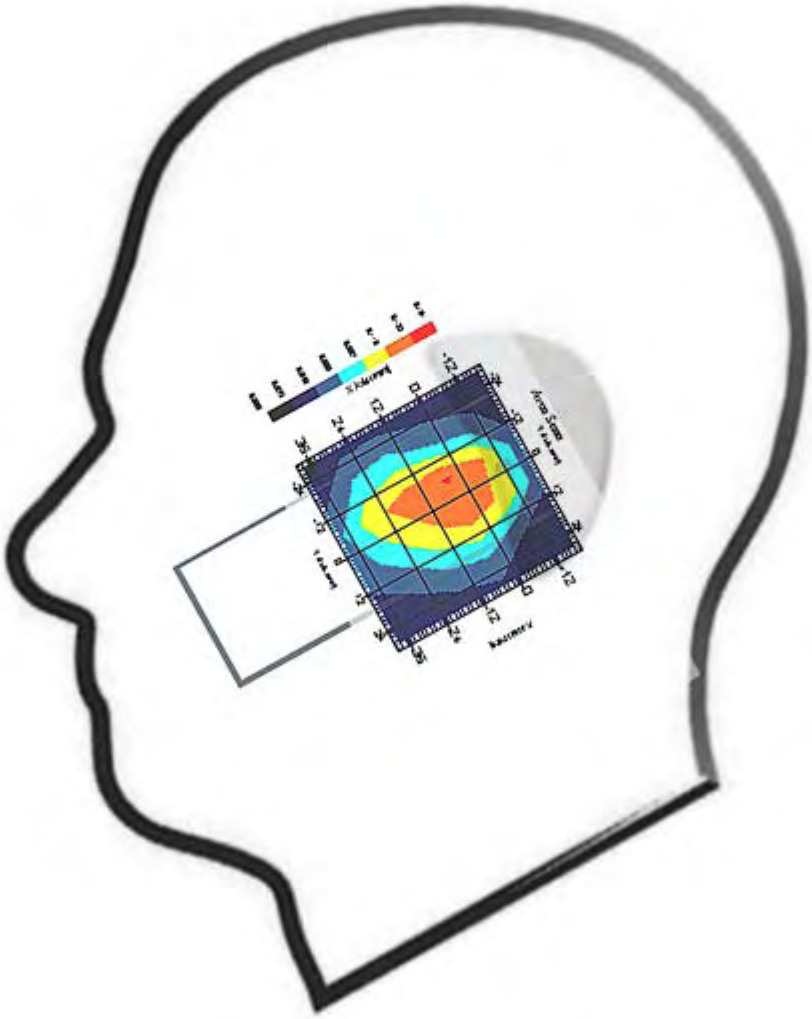


Measurement Data

Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.148 W/kg
Power Drift-Finish: 0.152 W/kg
Power Drift (%) : 2.755
Channel : 11(Cheek)



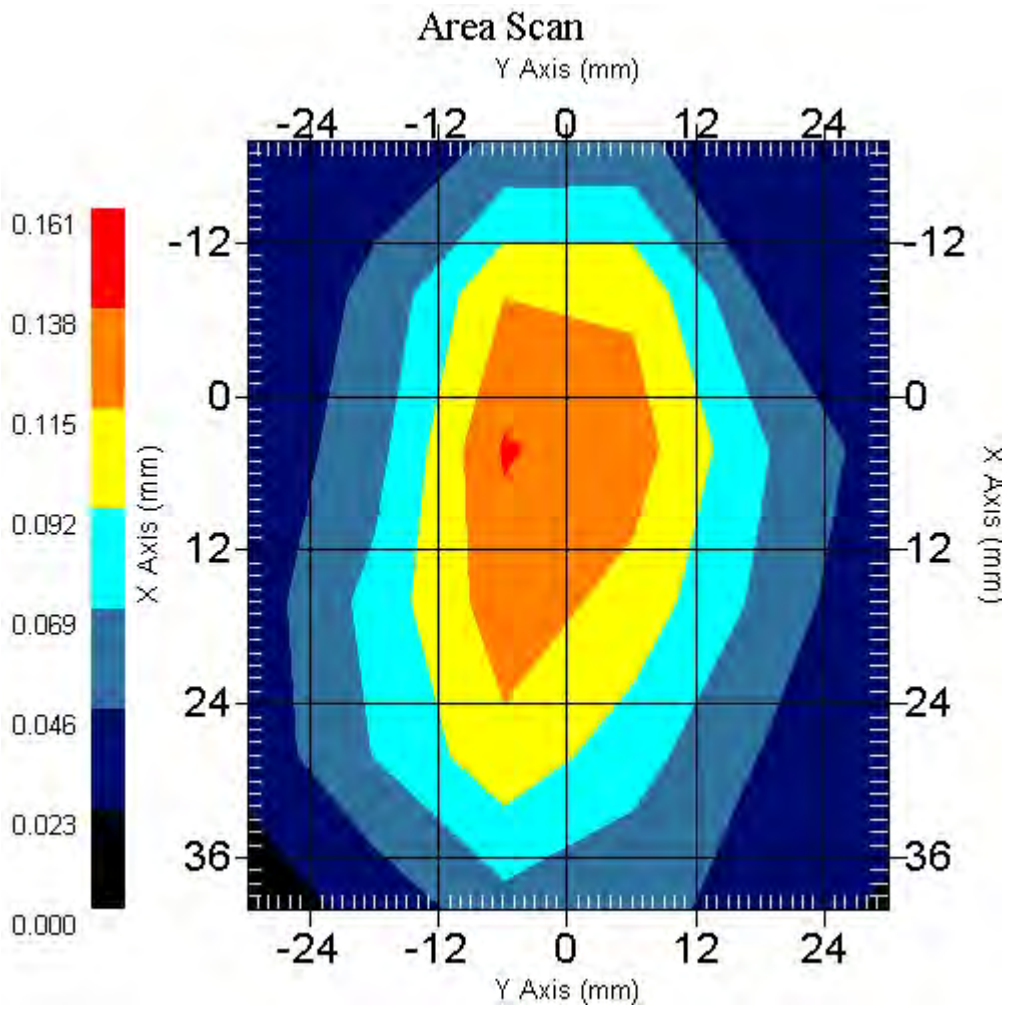
1 gram SAR value : 0.140 W/kg

10 gram SAR value : 0.076 W/kg

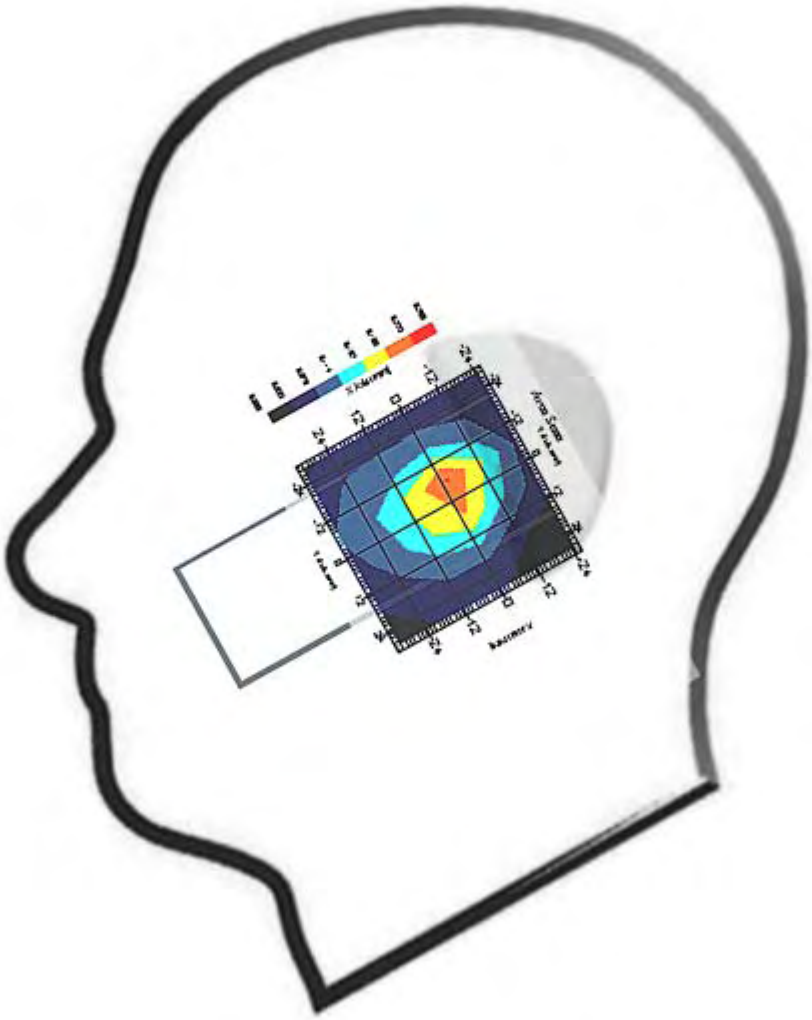
Area Scan Peak SAR : 0.140 W/kg

Zoom Scan Peak SAR : 0.280 W/kg

This is previous page plot (zoom in)



Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.220 W/kg
Power Drift-Finish: 0.217 W/kg
Power Drift (%) : -1.284
Channel : 1 (Tilted)



1 gram SAR value : 0.204 W/kg
10 gram SAR value : 0.107 W/kg
Area Scan Peak SAR : 0.230 W/kg
Zoom Scan Peak SAR : 0.410 W/kg

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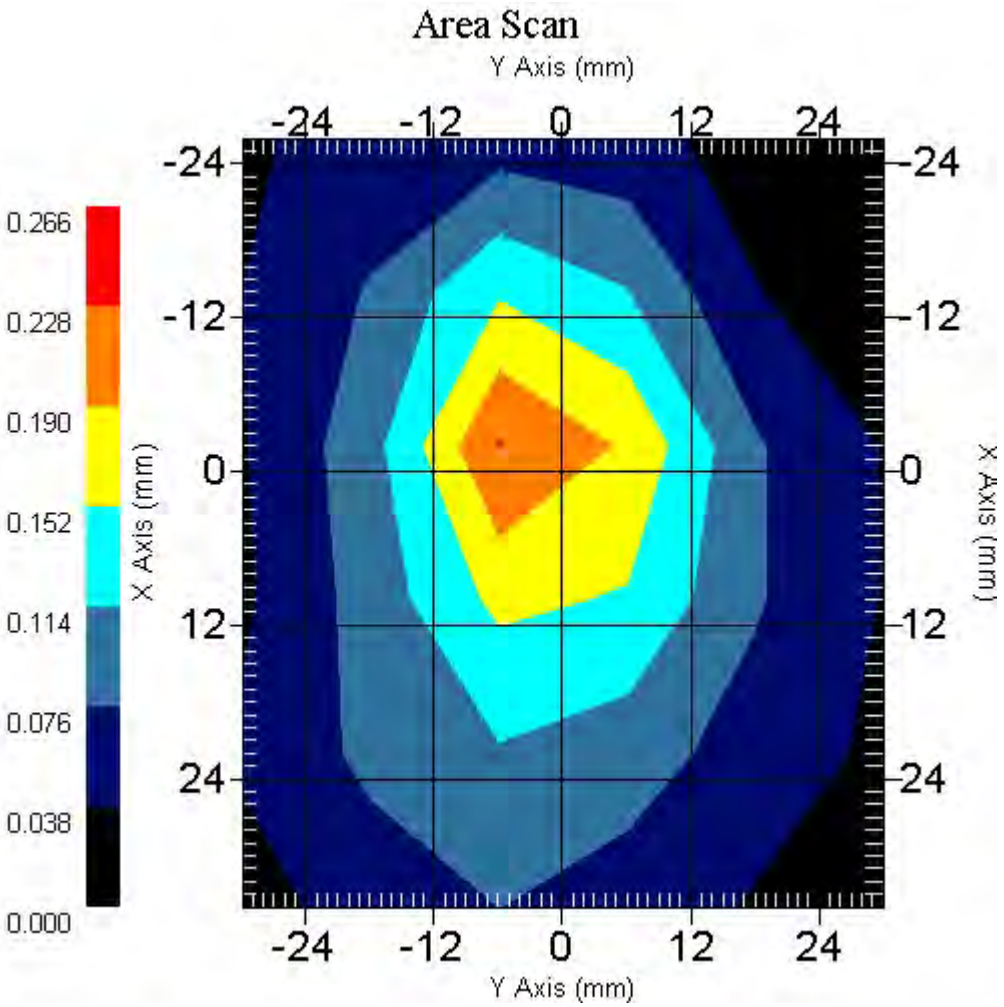
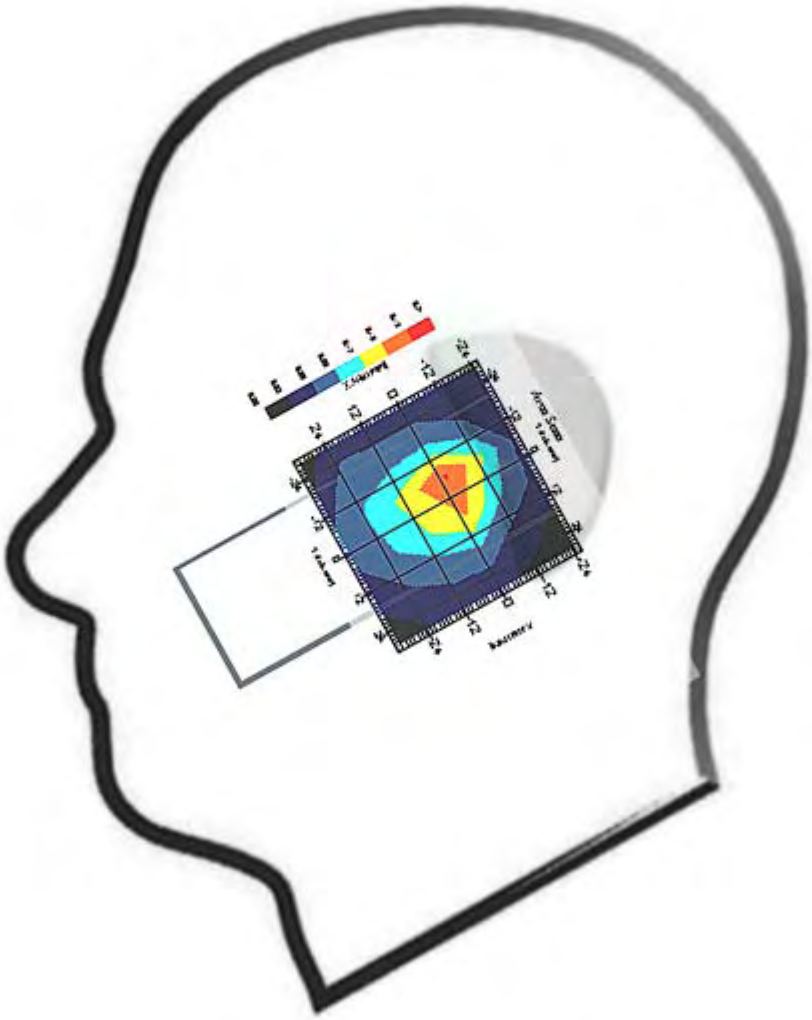


Measurement Data

Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.173 W/kg
Power Drift-Finish: 0.174 W/kg
Power Drift (%) : 1.043
Channel : 6 (Tilted)



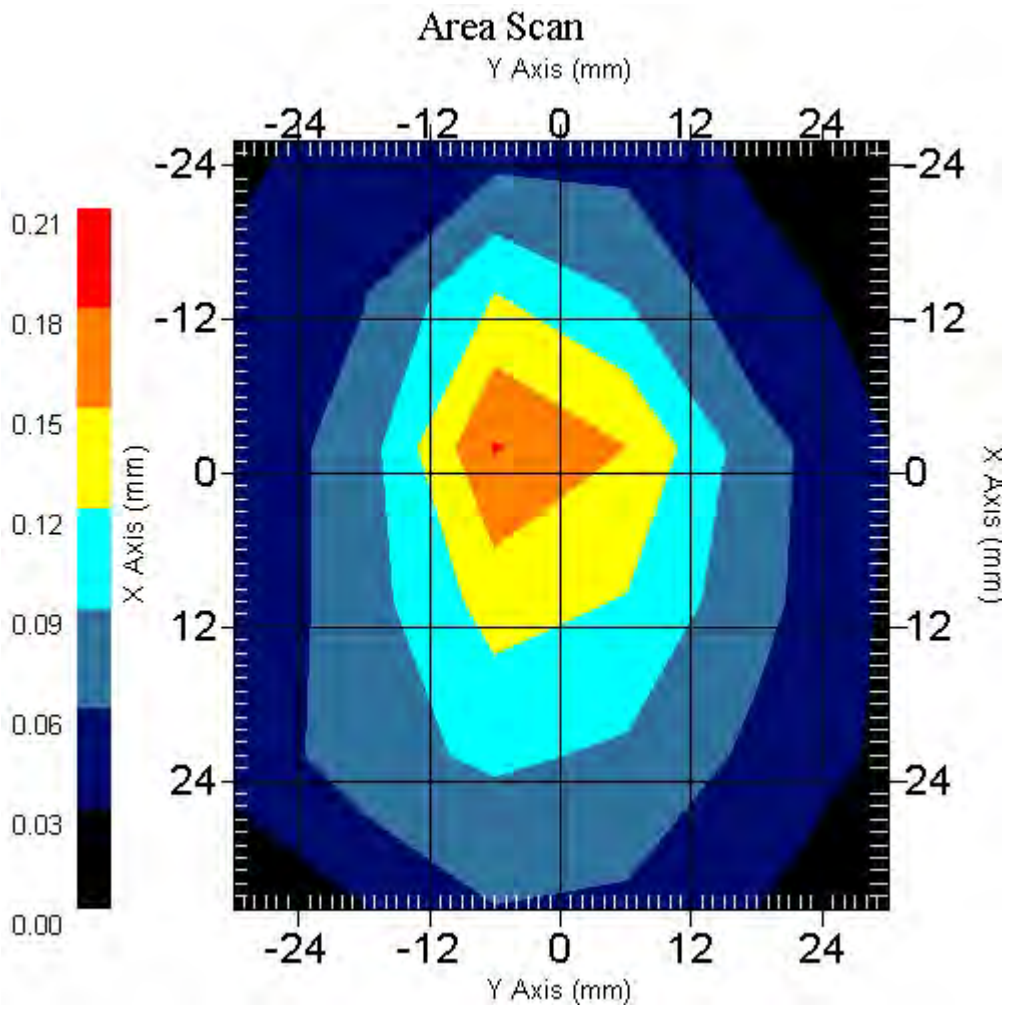
1 gram SAR value : 0.153 W/kg

10 gram SAR value : 0.086 W/kg

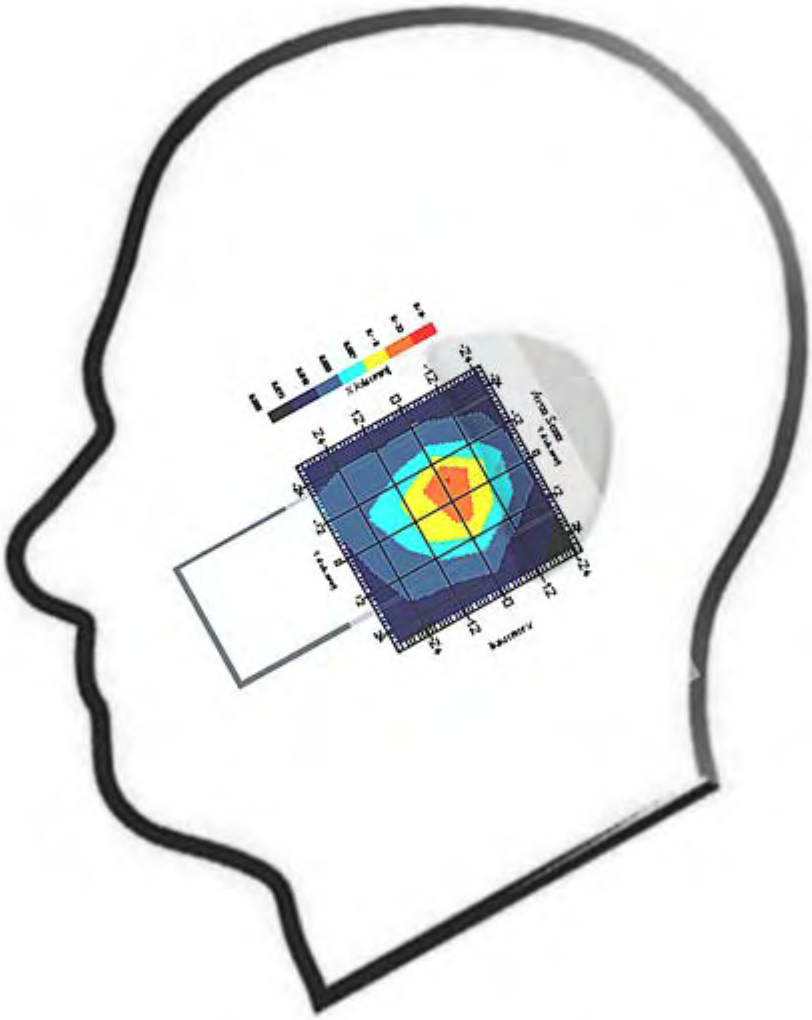
Area Scan Peak SAR : 0.182 W/kg

Zoom Scan Peak SAR : 0.280 W/kg

This is previous page plot (zoom in)

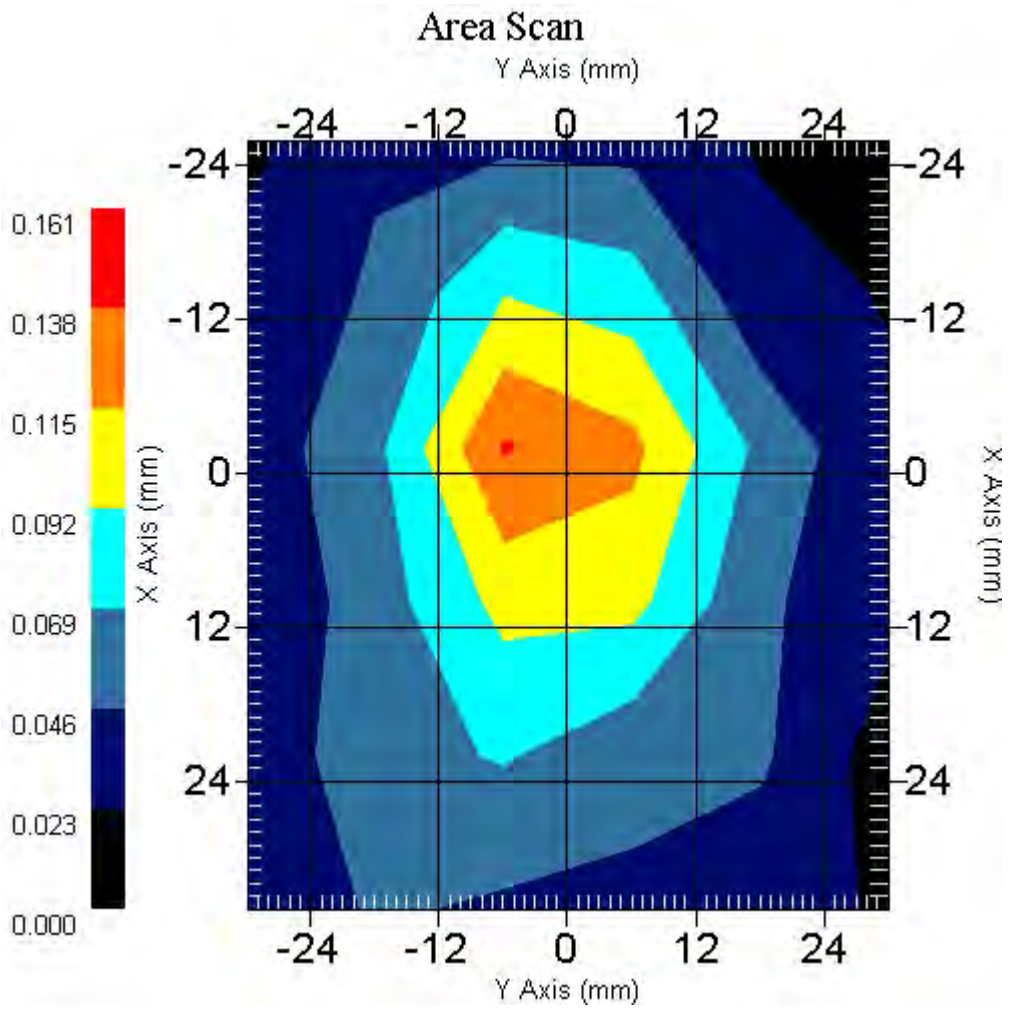


Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.140 W/kg
Power Drift-Finish: 0.144 W/kg
Power Drift (%) : 2.571
Channel : 11 (Tilted)



1 gram SAR value : 0.129 W/kg
10 gram SAR value : 0.073 W/kg
Area Scan Peak SAR : 0.140 W/kg
Zoom Scan Peak SAR : 0.220 W/kg

This is previous page plot (zoom in)



ALSAS-10U VER 2.3.0 APREL Laboratories

SAR Test Report

Validation Date : 12-Apr-2006
Measurement Date : 12-Apr-2006

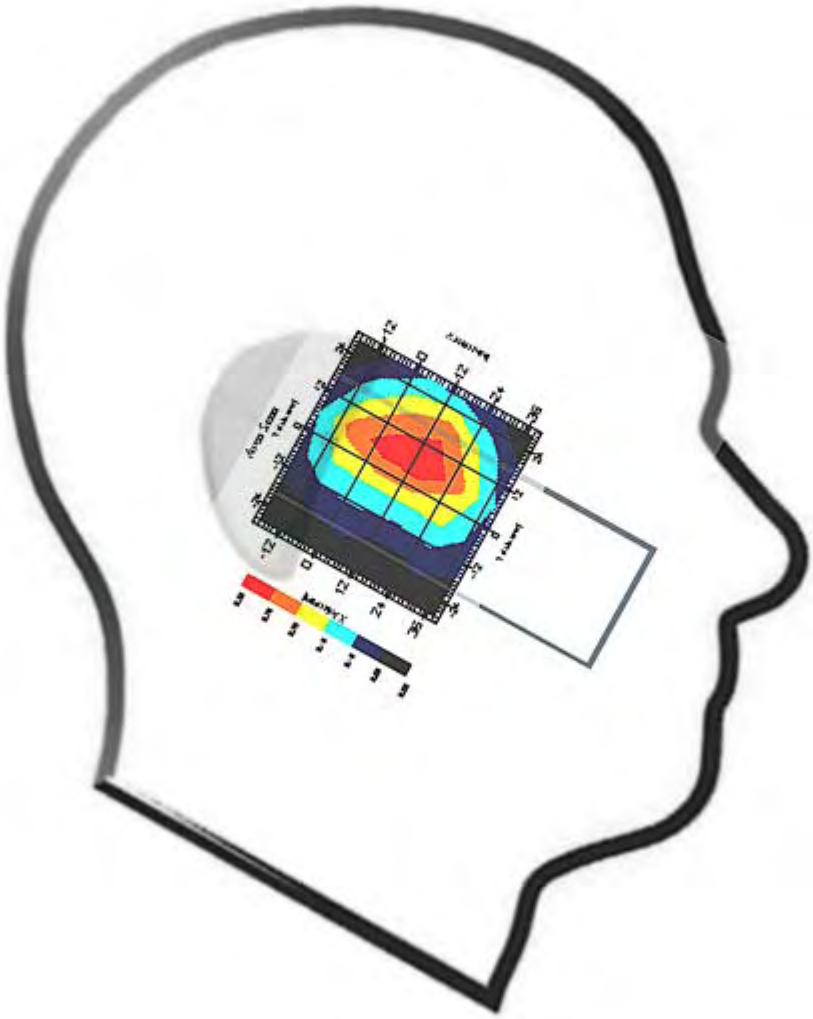
Product Data
Device Name : Fi Win
Type : Std Form Cell Phone
Model : FX28, SS28,SS58
Frequency : 2450.00 MHz
Max. Transmit Pwr : 1 W
Drift Time : 0 min(s)
Length : 108 mm
Width : 42 mm
Depth : 18.7 mm
Antenna Type : Internal

Phantom Data
Type : SAM-Left
Size (mm) : 280 x 280 x 280
Location : Left

Tissue Data
Type : HEAD
Serial No. : 325-H
Frequency : 2450.00 MHz
Last Calib. Date : 12-Apr-2006
Temperature : 21.10 °C
Ambient Temp. : 21.50 °C
Humidity : 55.00 RH%
Epsilon : 38.16 F/m
Sigma : 1.847 S/m
Density : 1000.00 kg/cu. m

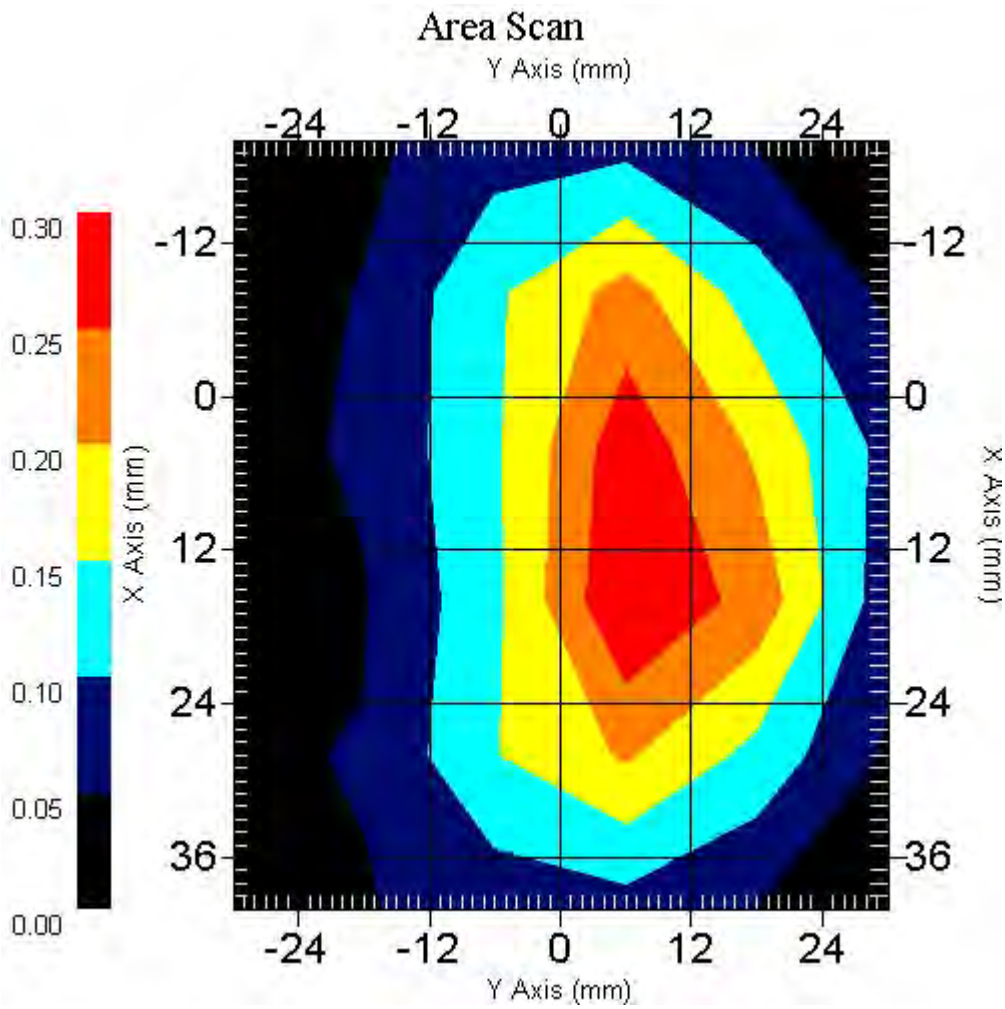
Probe Data
Name : Probe 264
Model : E020
Type : E-Field Triangle
Serial No. : 264
Last Calib. Date : 21-Mar-2006
Frequency : 2450.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.204 W/kg
Power Drift-Finish: 0.210 W/kg
Power Drift (%) : 2.882
Channel : 1 (Cheek)

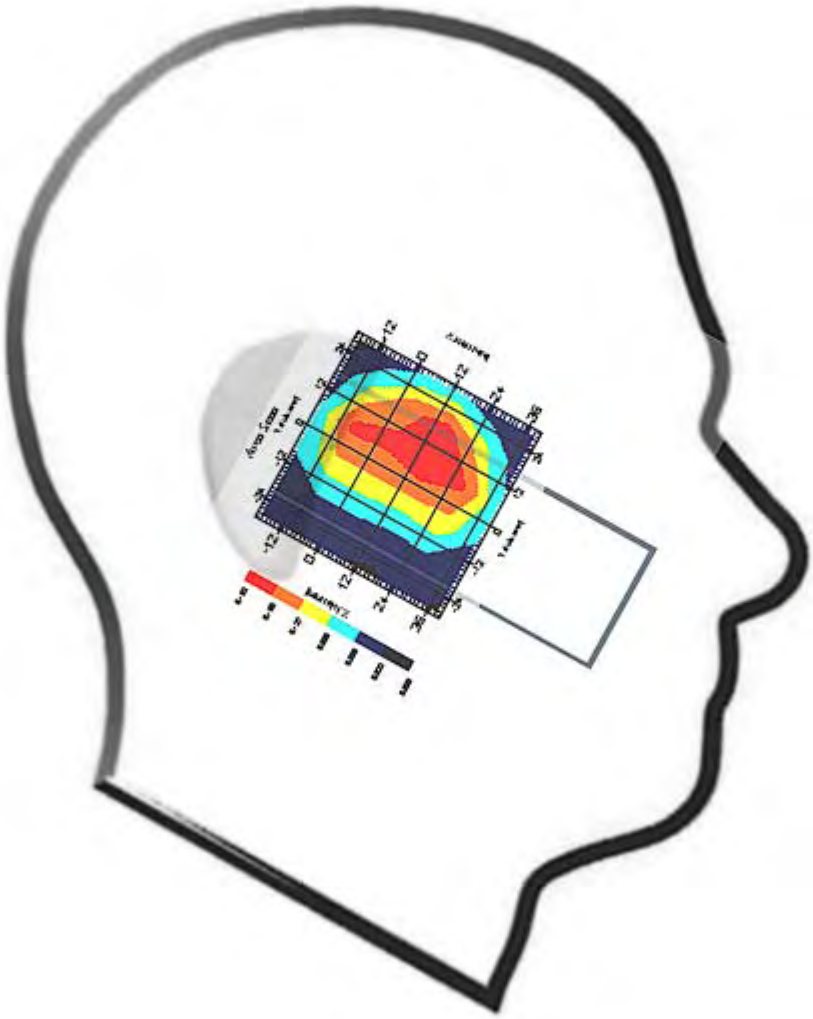


1 gram SAR value : 0.272 W/kg
10 gram SAR value : 0.141 W/kg
Area Scan Peak SAR : 0.298 W/kg
Zoom Scan Peak SAR : 0.540 W/kg

This is previous page plot (zoom in)

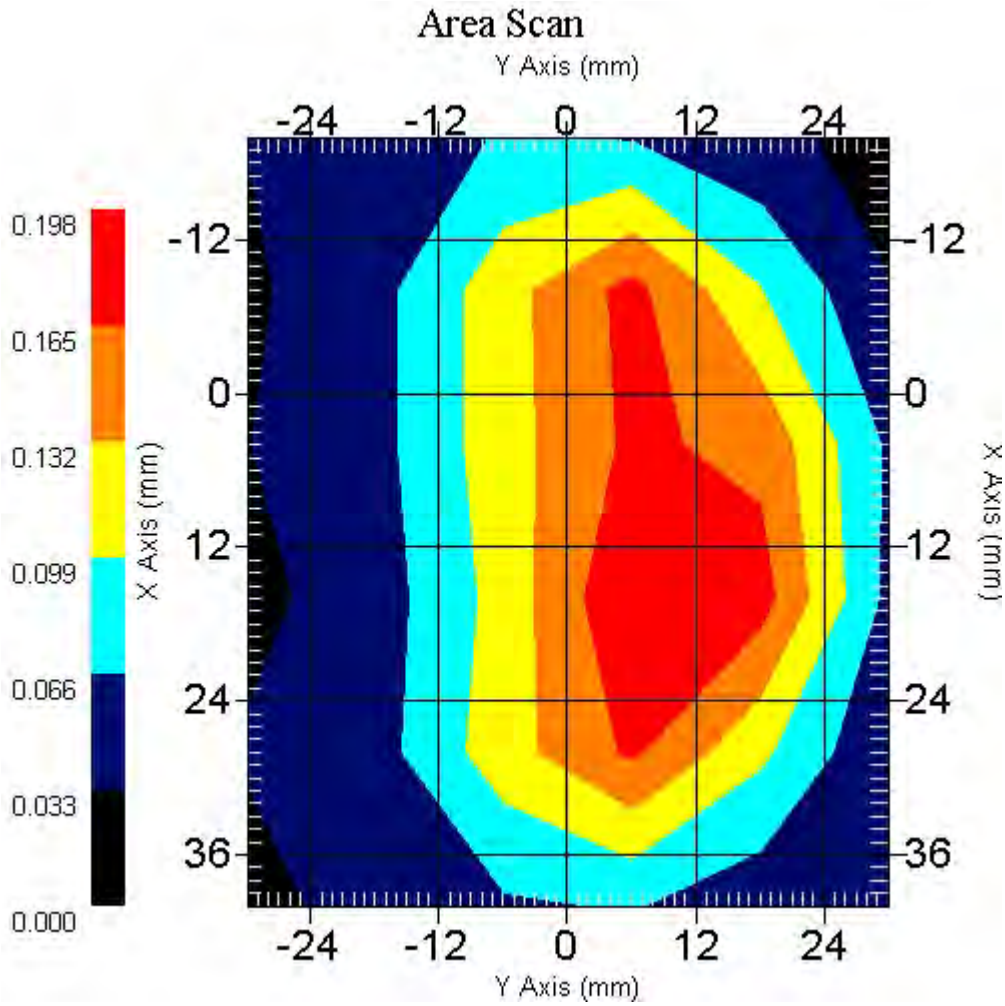


Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.172 W/kg
Power Drift-Finish: 0.177 W/kg
Power Drift (%) : 3.094
Channel : 6(Cheek)

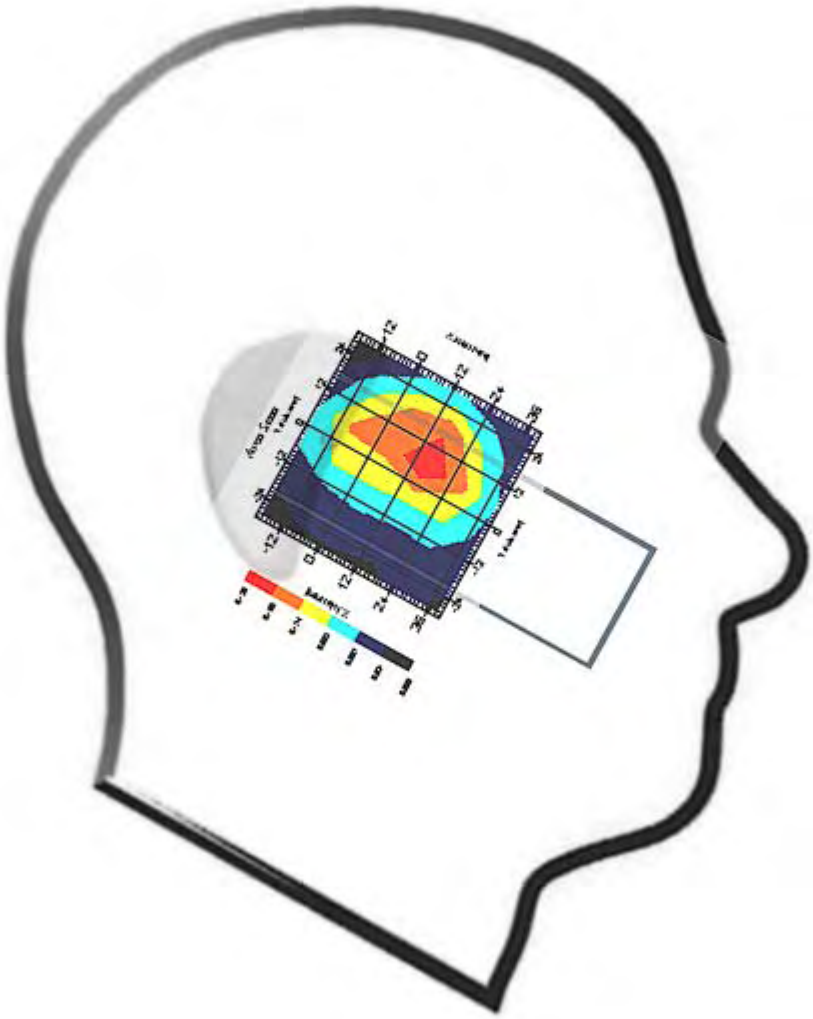


1 gram SAR value : 0.221 W/kg
10 gram SAR value : 0.116 W/kg
Area Scan Peak SAR : 0.196 W/kg
Zoom Scan Peak SAR : 0.430 W/kg

This is previous page plot (zoom in)

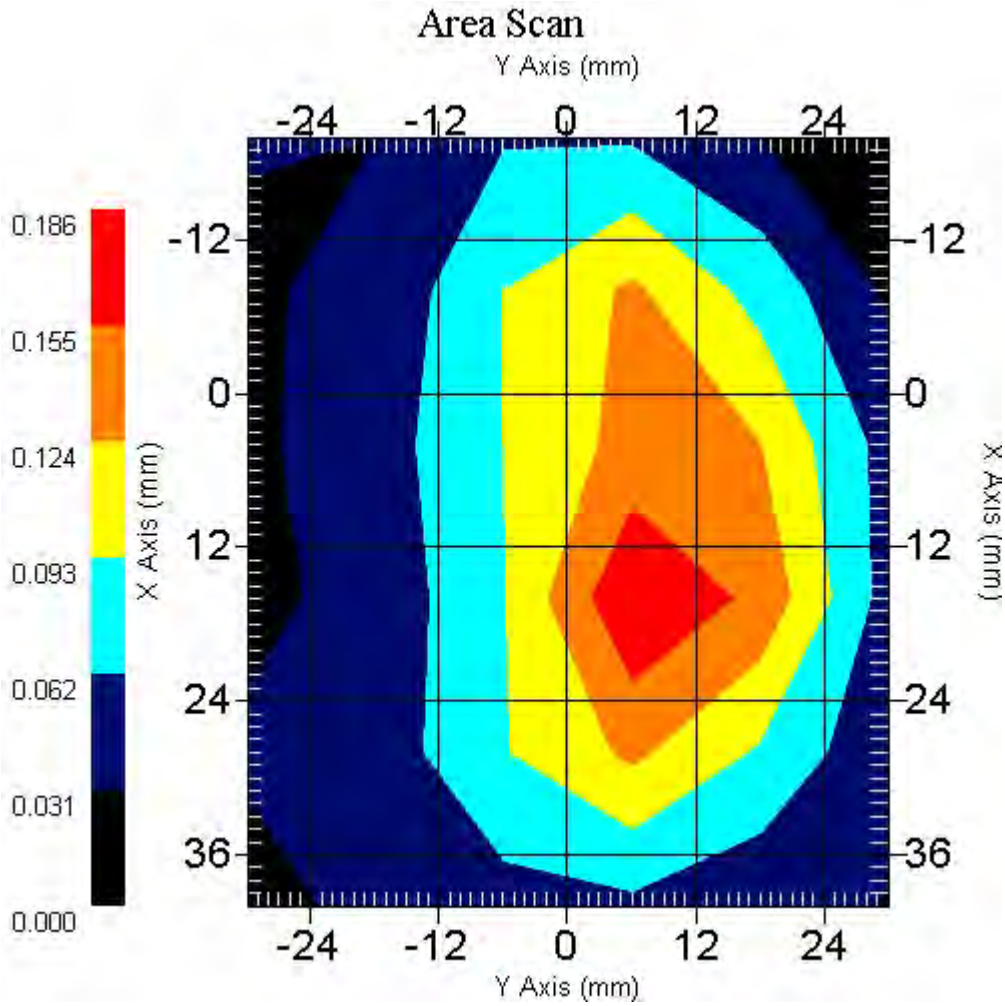


Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.130 W/kg
Power Drift-Finish: 0.131 W/kg
Power Drift (%) : 0.743
Channel : 11 (Cheek)

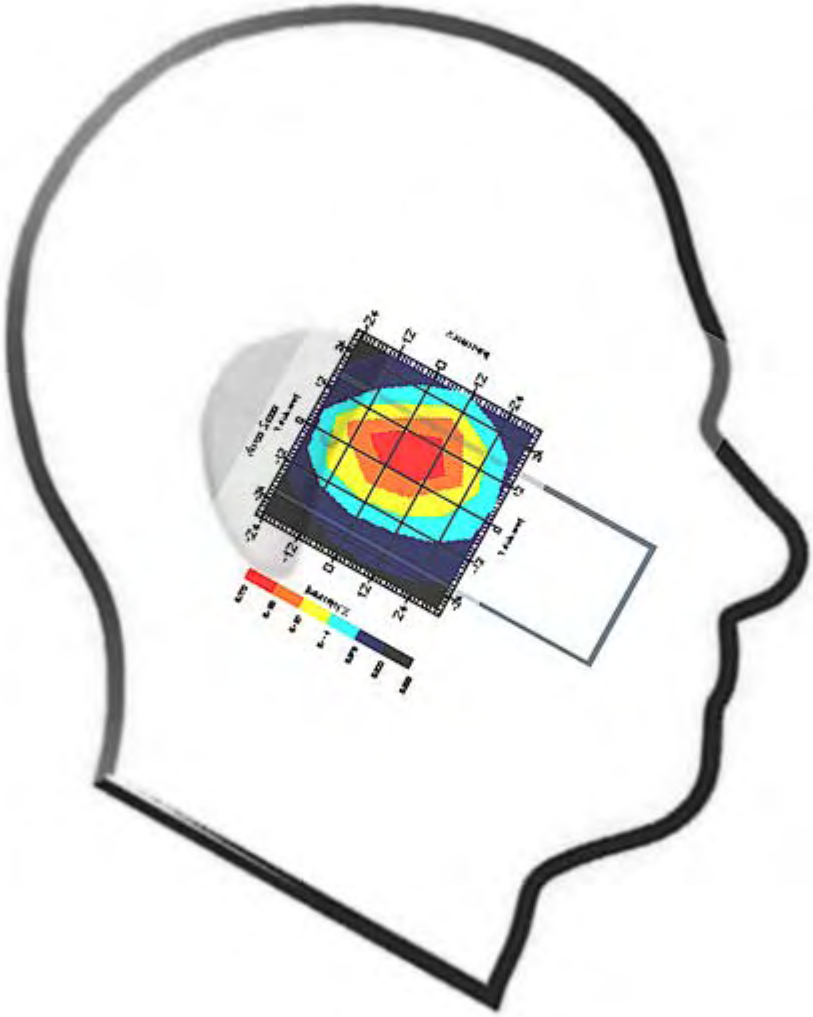


1 gram SAR value : 0.170 W/kg
10 gram SAR value : 0.094 W/kg
Area Scan Peak SAR : 0.184 W/kg
Zoom Scan Peak SAR : 0.320 W/kg

This is previous page plot (zoom in)

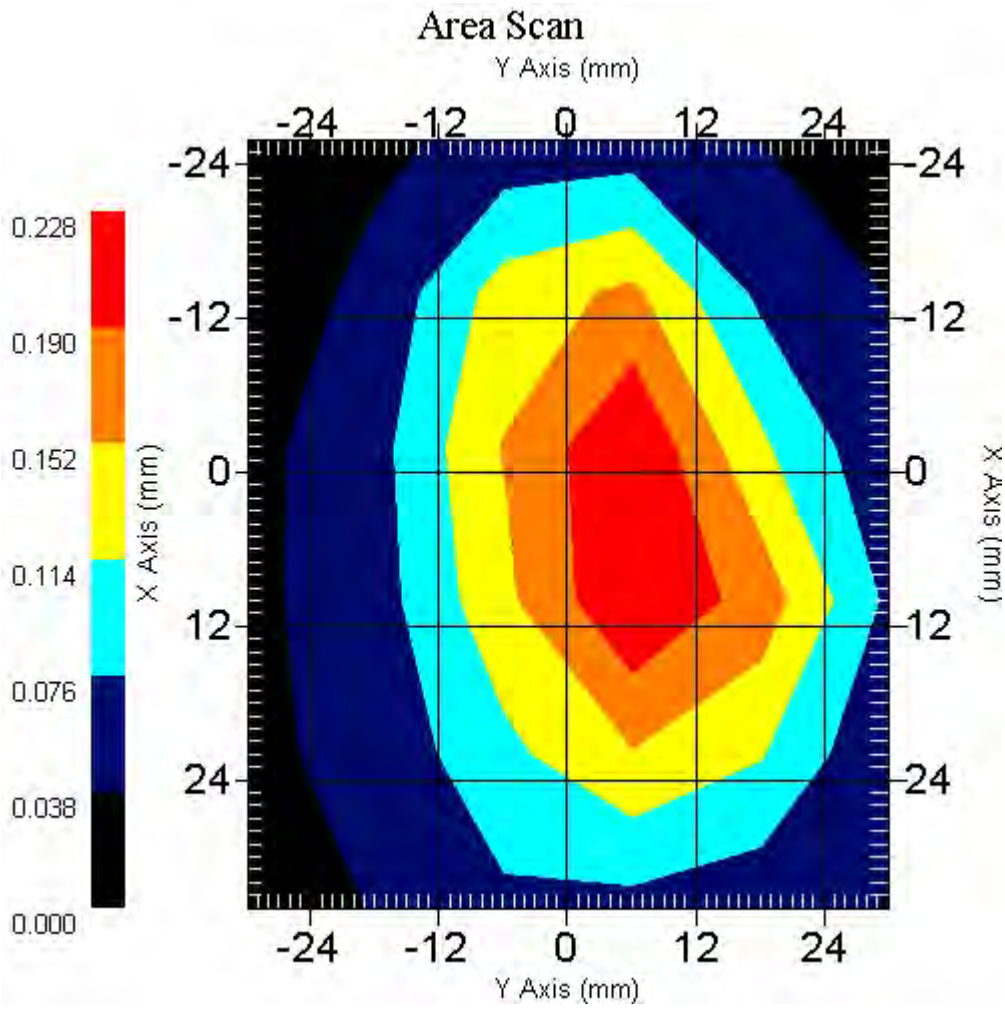


Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.196 W/kg
Power Drift-Finish: 0.205 W/kg
Power Drift (%) : 4.308
Channel : 1 (Tilted)

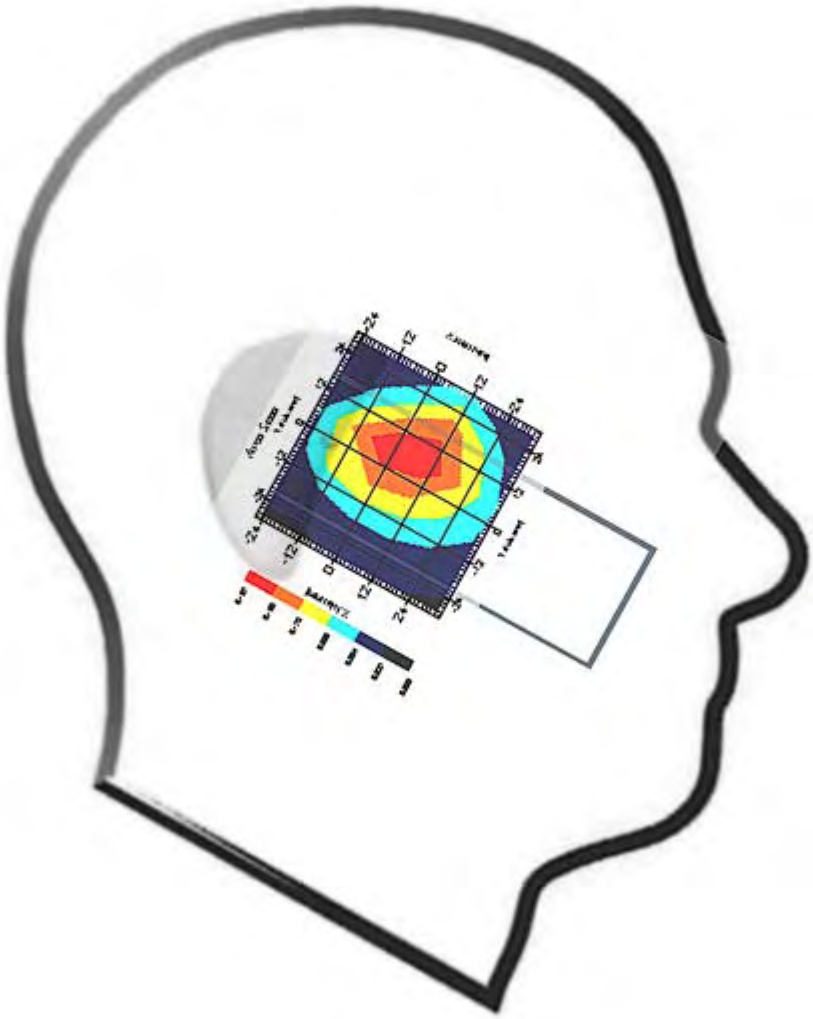


1 gram SAR value : 0.219 W/kg
10 gram SAR value : 0.122 W/kg
Area Scan Peak SAR : 0.227 W/kg
Zoom Scan Peak SAR : 0.400 W/kg

This is previous page plot (zoom in)

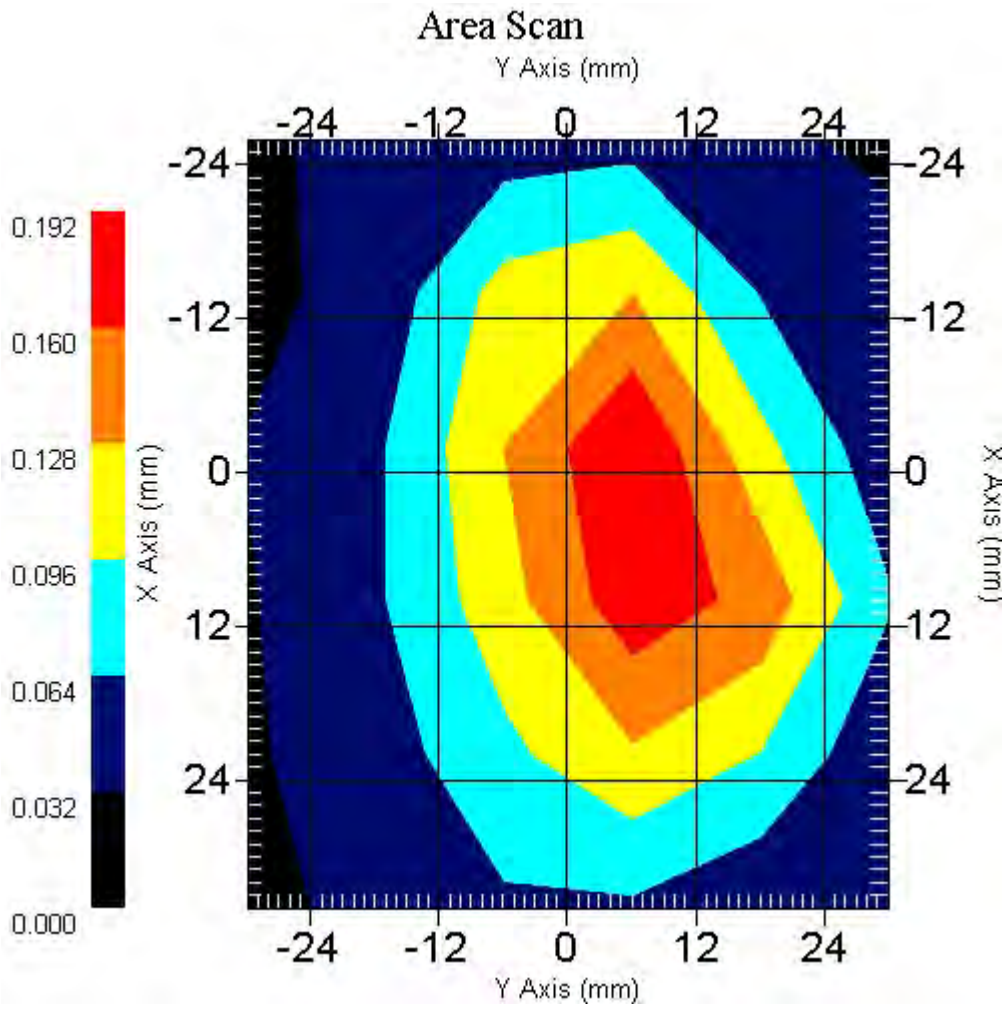


Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.151 W/kg
Power Drift-Finish: 0.156 W/kg
Power Drift (%) : 3.784
Channel : 6 (Tilted)

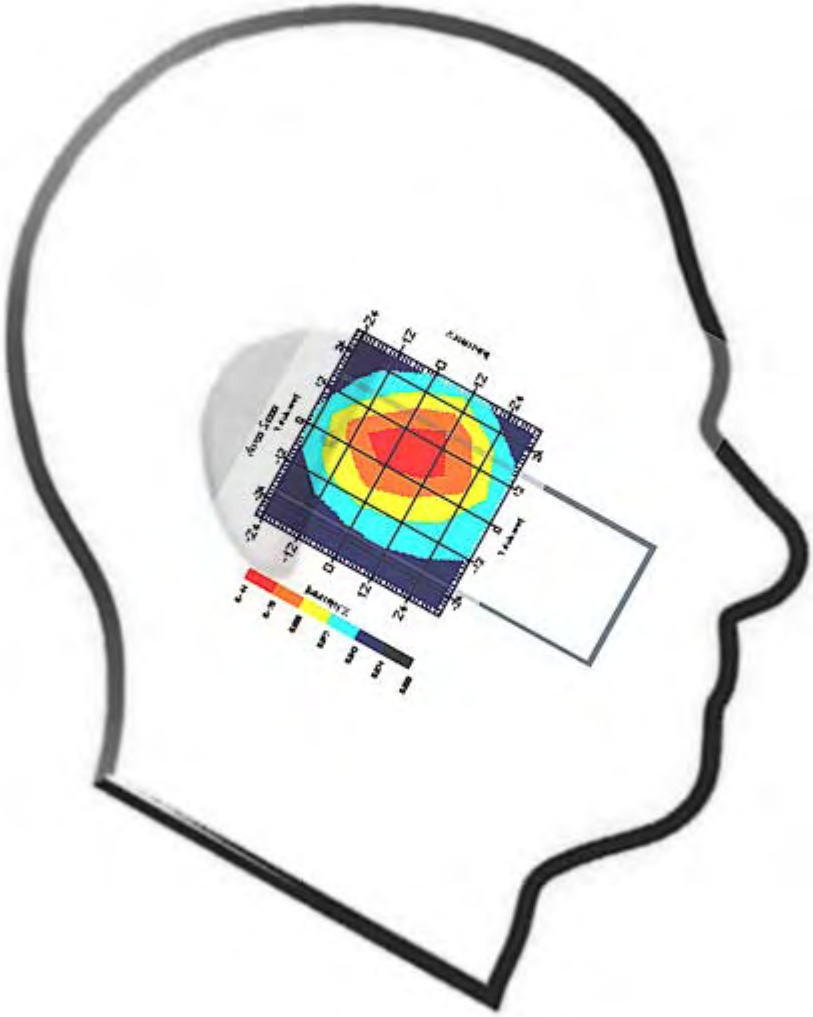


1 gram SAR value : 0.166 W/kg
10 gram SAR value : 0.095 W/kg
Area Scan Peak SAR : 0.192 W/kg
Zoom Scan Peak SAR : 0.290 W/kg

This is previous page plot (zoom in)

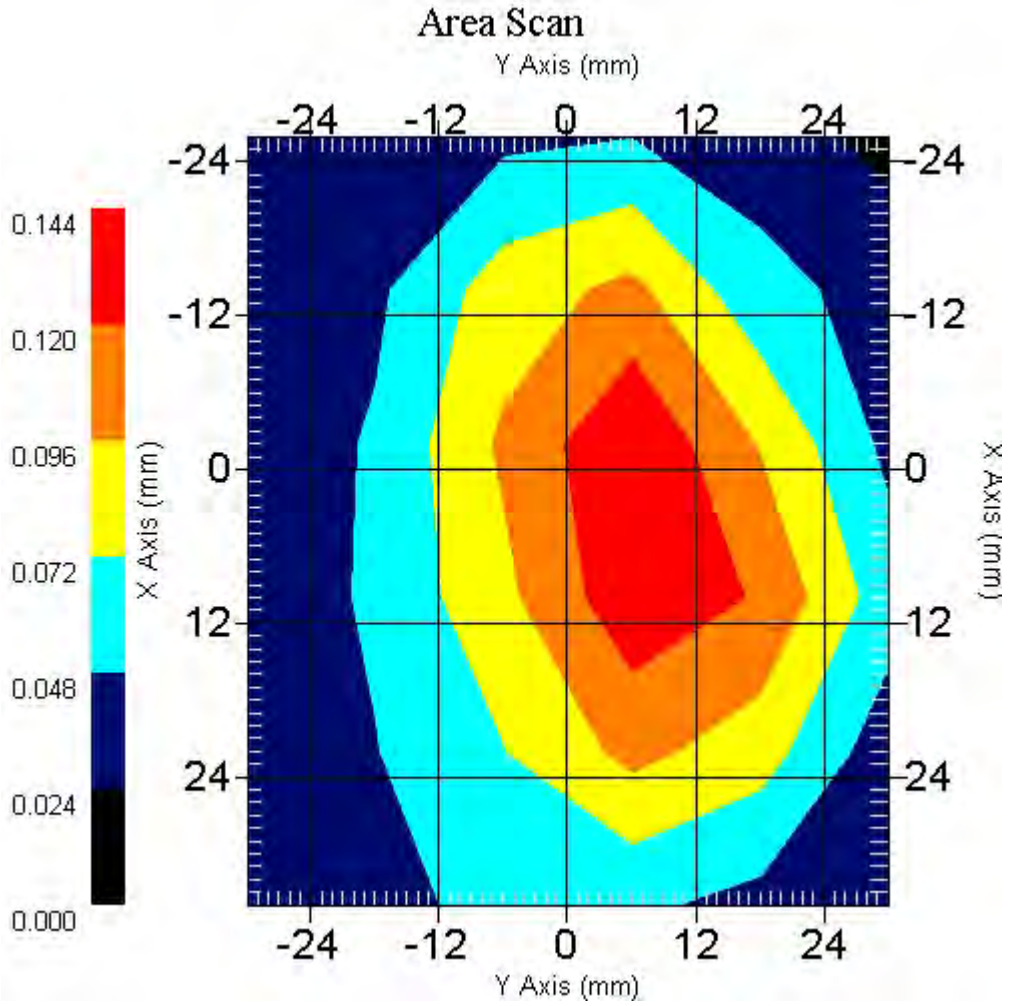


Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.118 W/kg
Power Drift-Finish: 0.122 W/kg
Power Drift (%) : 3.428
Channel : 11 (Tilted)



1 gram SAR value : 0.134 W/kg
10 gram SAR value : 0.077 W/kg
Area Scan Peak SAR : 0.142 W/kg
Zoom Scan Peak SAR : 0.240 W/kg

This is previous page plot (zoom in)



ALSAS-10U VER 2.3.0APREL Laboratories

SAR Test Report

Validation Date : 12-Apr-2006
Measurement Date : 12-Apr-2006

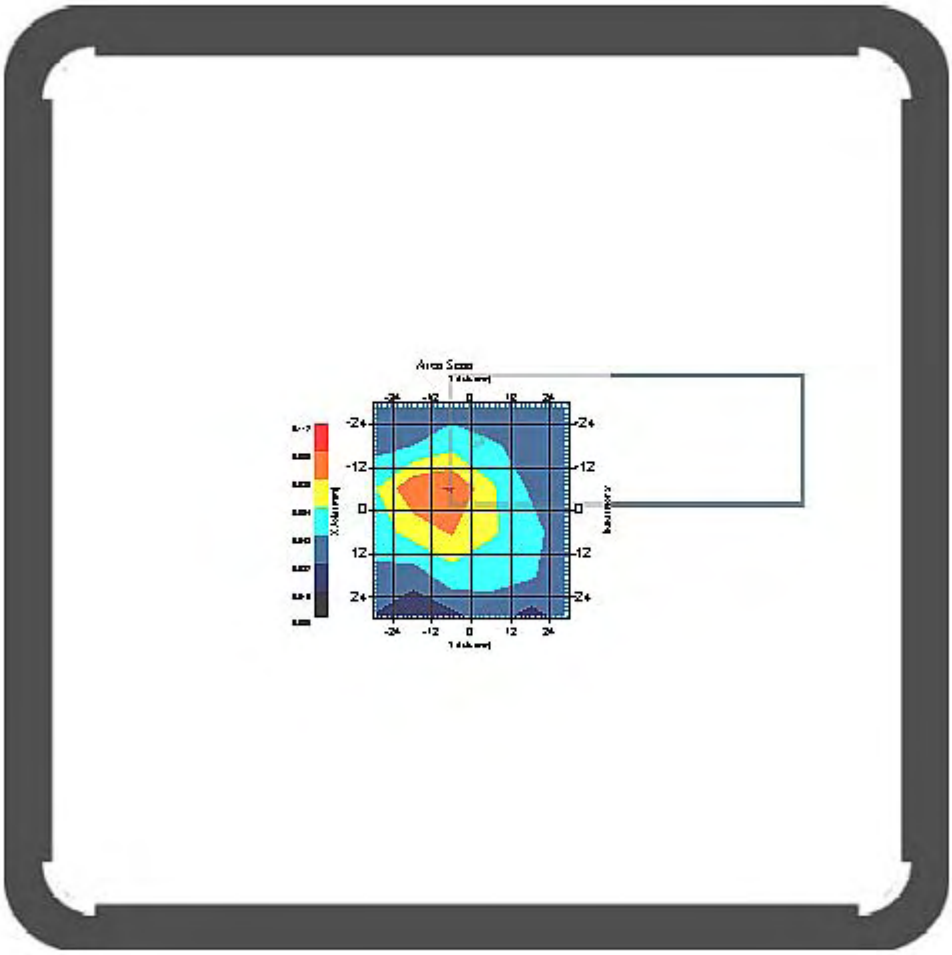
Product Data
Device Name : Fi Win
Type : Std Form Cell Phone
Model : FX28, SS28,SS58
Frequency : 2450.00 MHz
Max. Transmit Pwr : 1 W
Drift Time : 0 min(s)
Length : 108 mm
Width : 42 mm
Depth : 18.7 mm
Antenna Type : Internal

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

Tissue Data
Type : BODY
Serial No. : 325-B
Frequency : 2450.00 MHz
Last Calib. Date : 12-Apr-2006
Temperature : 21.10 °C
Ambient Temp. : 21.50 °C
Humidity : 55.00 RH%
Epsilon : 51.28 F/m
Sigma : 1.988 S/m
Density : 1000.00 kg/cu. m

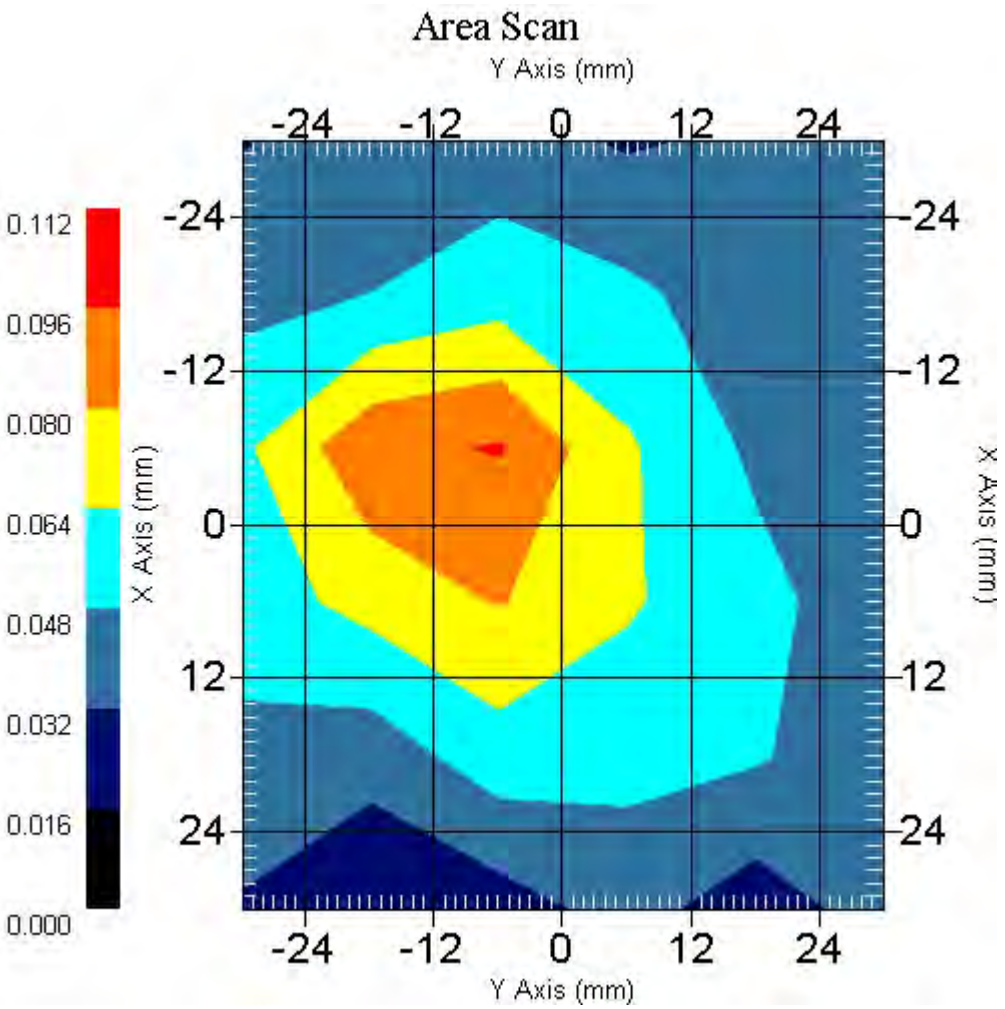
Probe Data
Name : Probe 264
Model : E020
Type : E-Field Triangle
Serial No. : 264
Last Calib. Date : 21-Mar-2006
Frequency : 2450.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.2
Probe Sensitivity: 1.20 1.20 1.20 μV/(V/m)$^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.082 W/kg
Power Drift-Finish: 0.084 W/kg
Power Drift (%) : 2.481
Channel : 1 (Front)



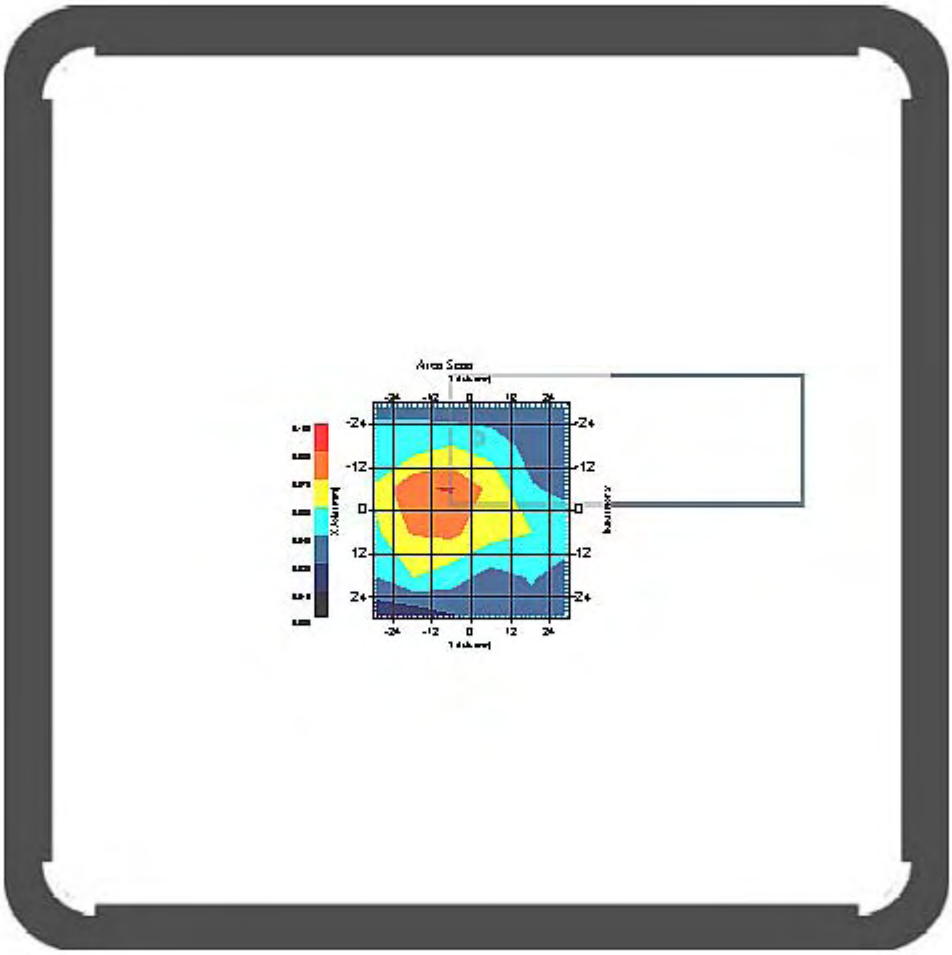
1 gram SAR value : 0.087 W/kg
10 gram SAR value : 0.057 W/kg
Area Scan Peak SAR : 0.097 W/kg
Zoom Scan Peak SAR : 0.140 W/kg

This is previous page plot (zoom in)



Measurement Data

Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.078 W/kg
Power Drift-Finish: 0.076 W/kg
Power Drift (%) : -2.573
Channel : 6 (Front)



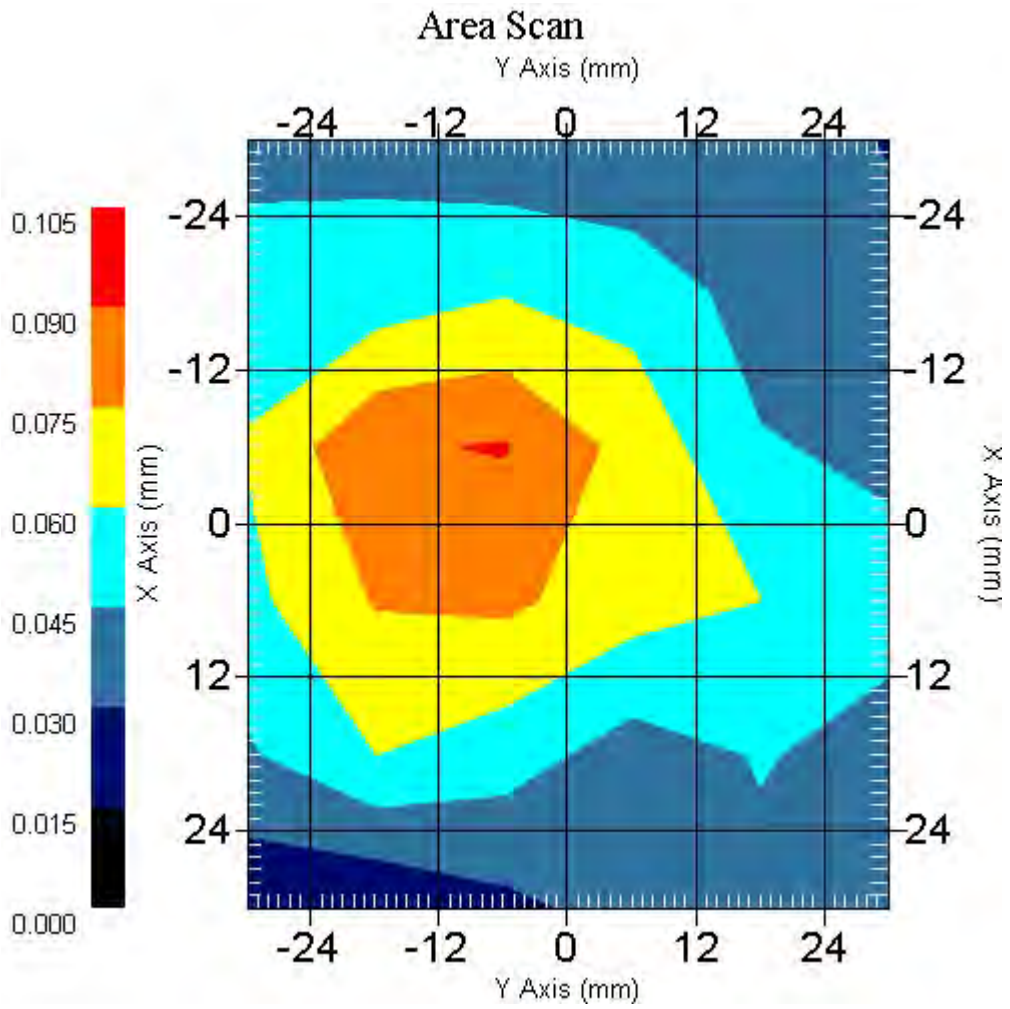
1 gram SAR value : 0.078 W/kg

10 gram SAR value : 0.052 W/kg

Area Scan Peak SAR : 0.091 W/kg

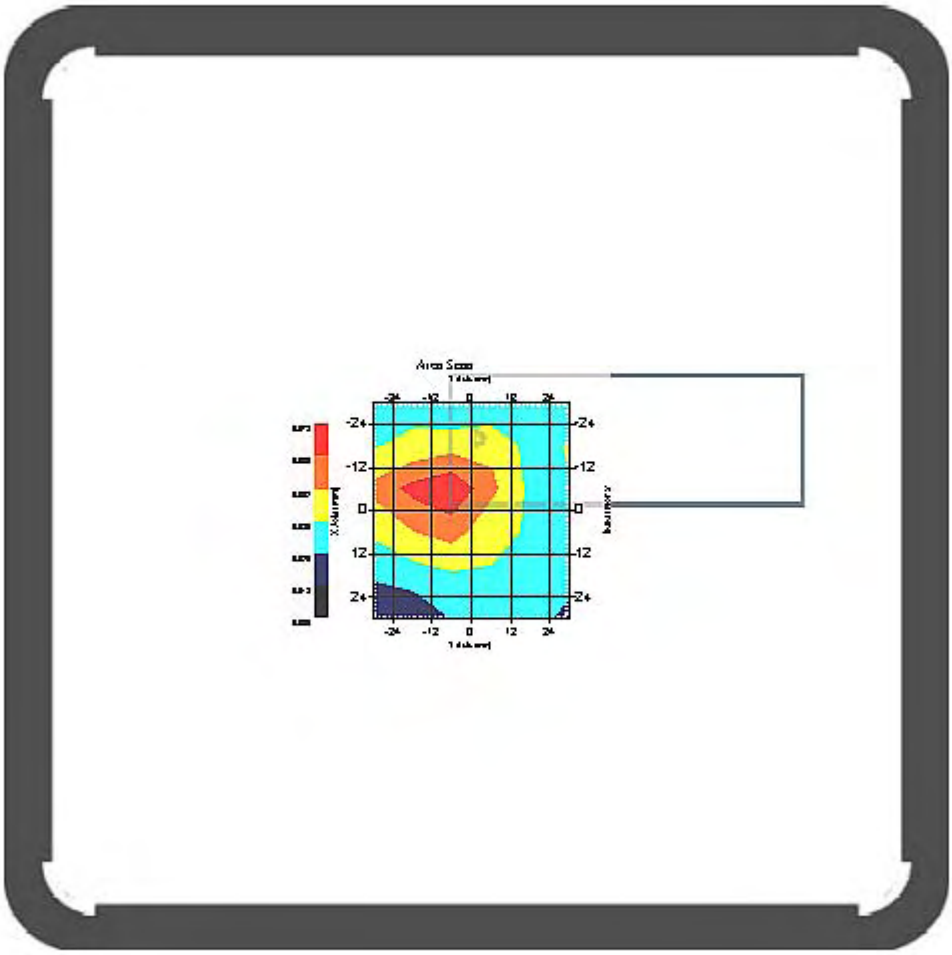
Zoom Scan Peak SAR : 0.120 W/kg

This is previous page plot (zoom in)



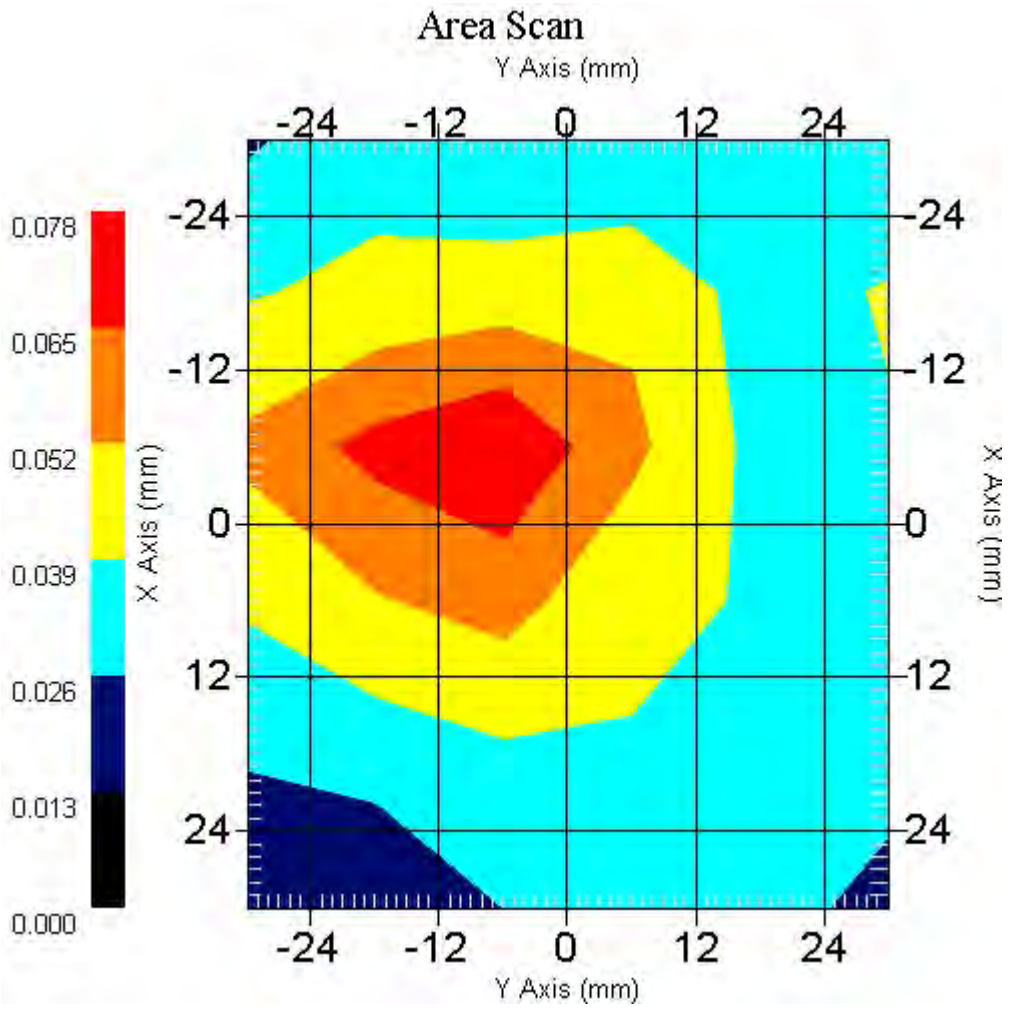
Measurement Data

Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.060 W/kg
Power Drift-Finish: 0.060 W/kg
Power Drift (%) : -1.209
Channel : 11 (Front)



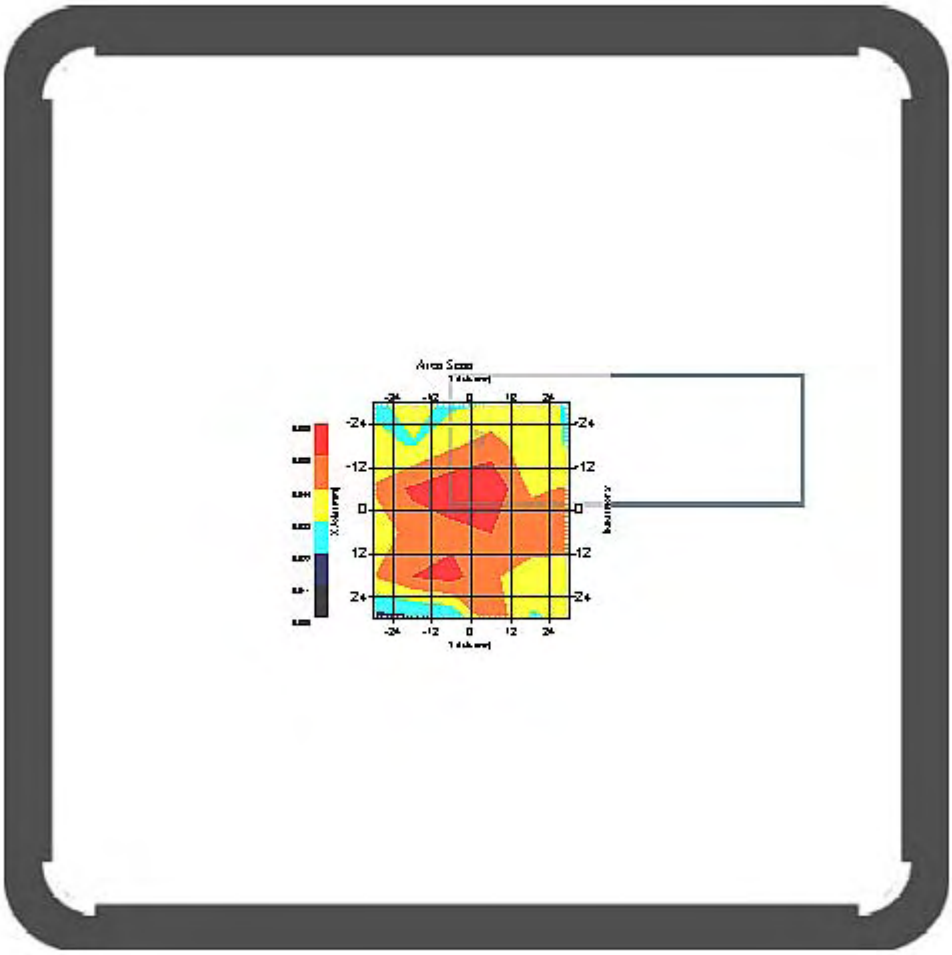
1 gram SAR value : 0.072 W/kg
10 gram SAR value : 0.048 W/kg
Area Scan Peak SAR : 0.077 W/kg
Zoom Scan Peak SAR : 0.090 W/kg

This is previous page plot (zoom in)



Measurement Data

Crest Factor : 1
Tissue Temp. : 21.10 °C
Ambient Temp. : 21.50 °C
Area Scan : 6x6x1 : Measurement x=12mm, y=12mm, z=4mm
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm
Power Drift-Start : 0.061 W/kg
Power Drift-Finish: 0.061 W/kg
Power Drift (%) : -1.273
Channel : 6 (Back)



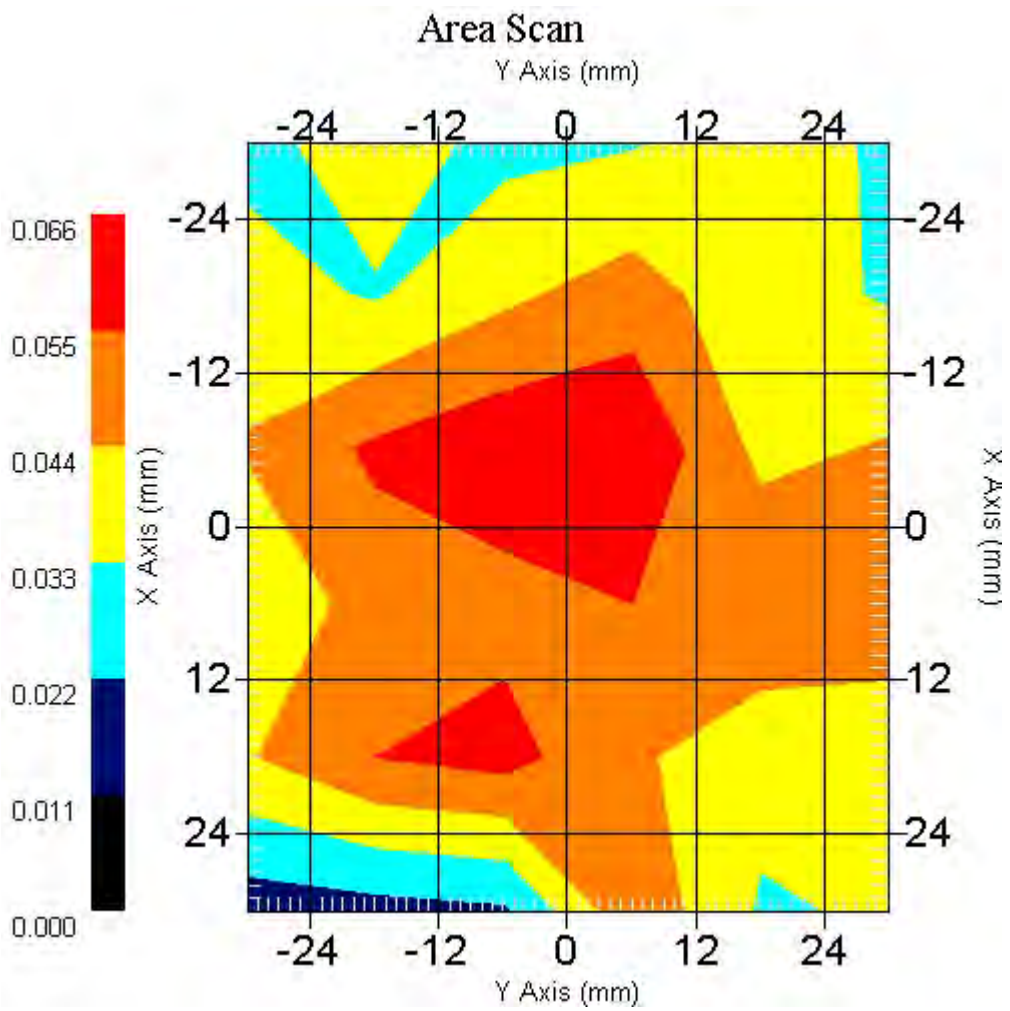
1 gram SAR value : 0.042 W/kg

10 gram SAR value : 0.042 W/kg

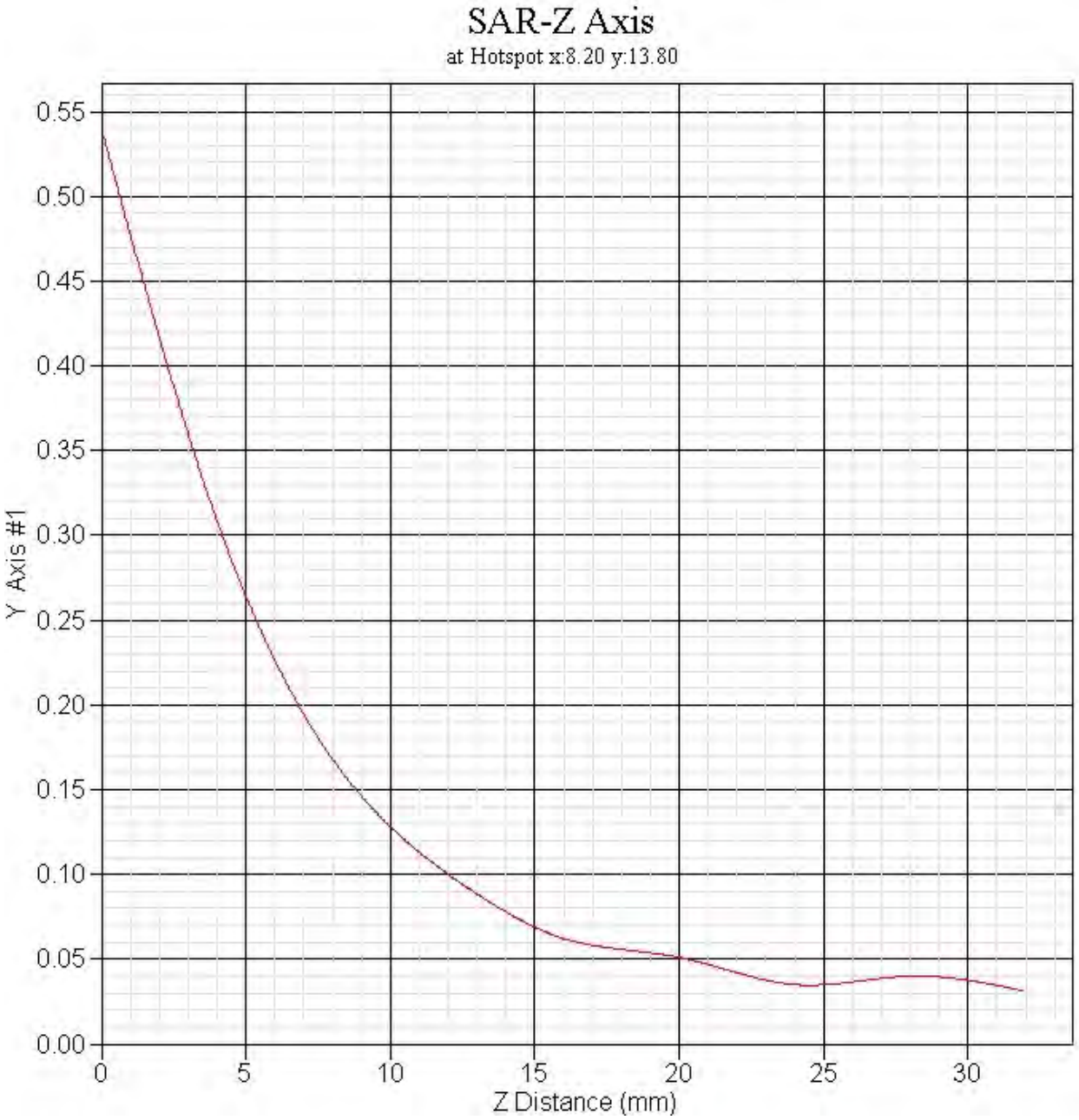
Area Scan Peak SAR : 0.065 W/kg

Zoom Scan Peak SAR : 0.060 W/kg

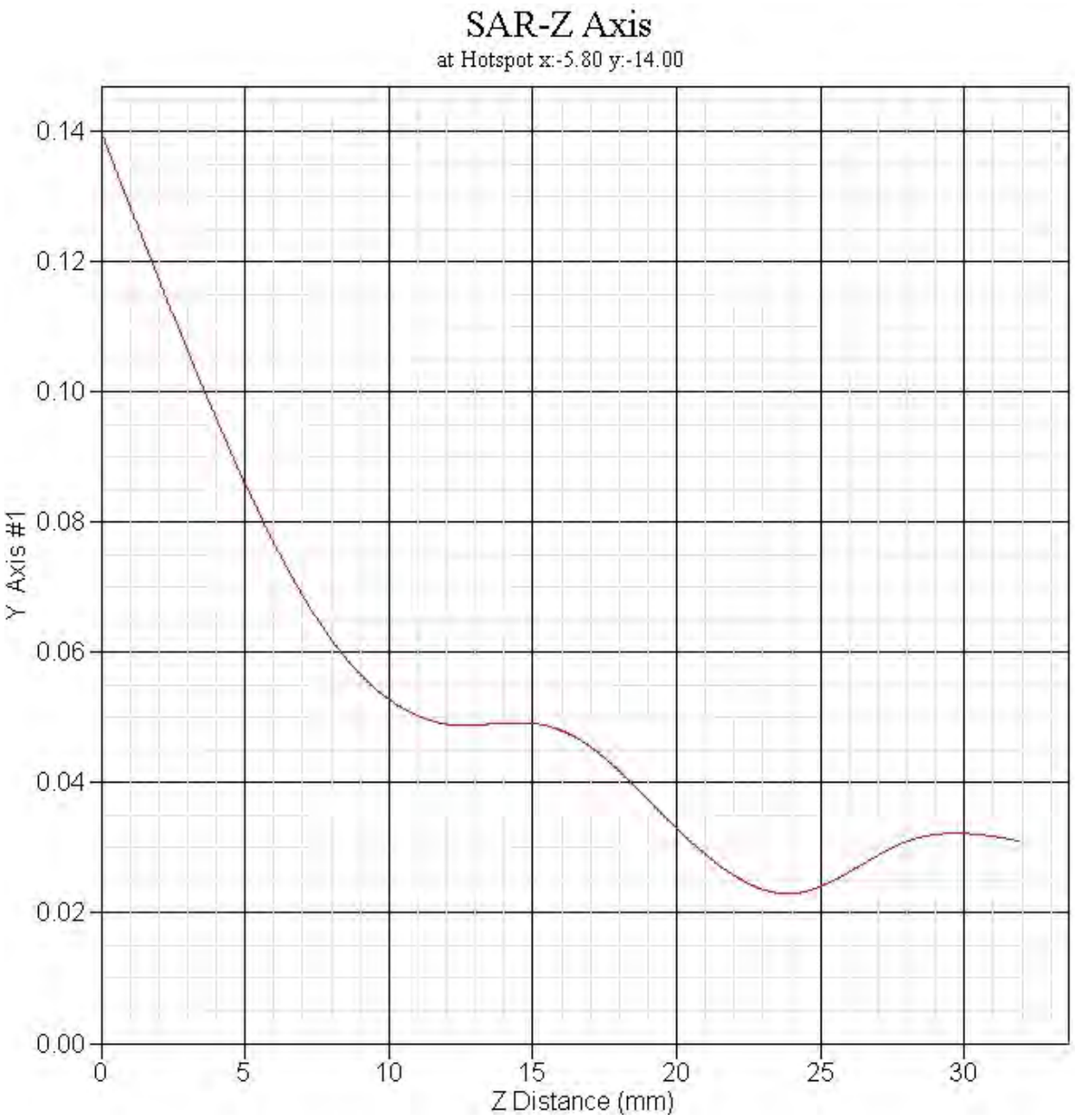
This is previous page plot (zoom in)



# EUT 802.11b SAR test Z-Axis plot (Left Head, Cheek, Channel 1)



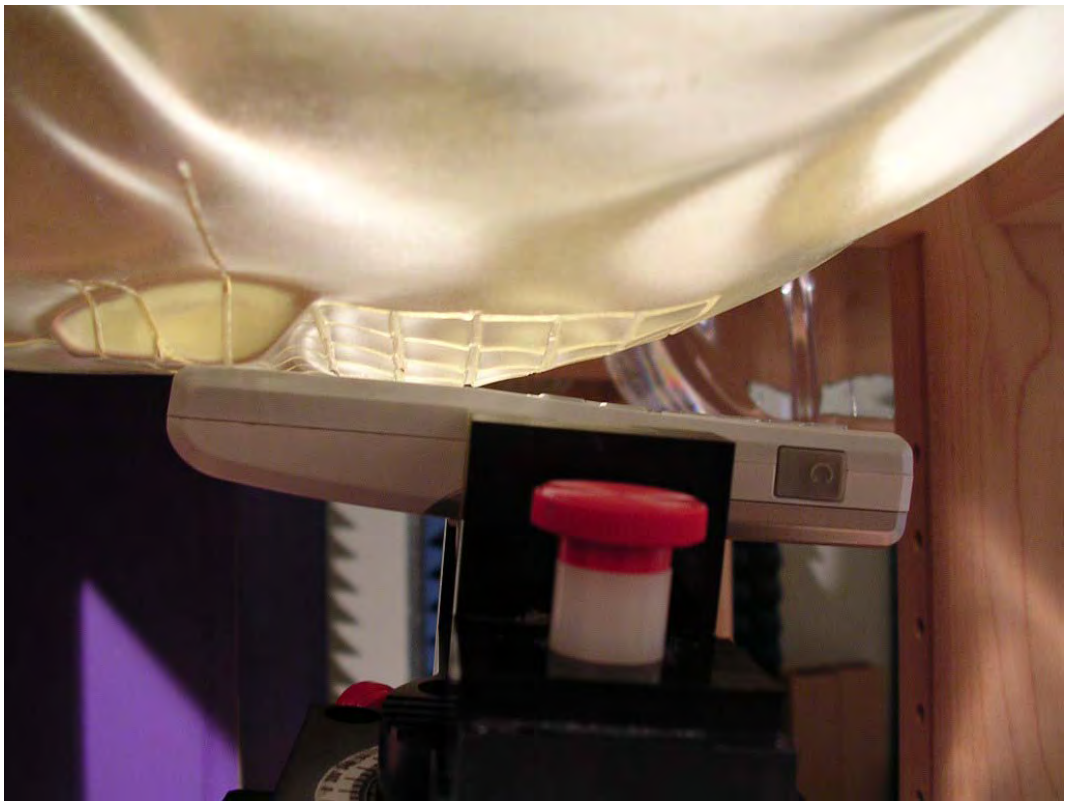
# EUT 802.11b SAR test Z-Axis plot (Body, Channel 11)



## Test Setup Photographs

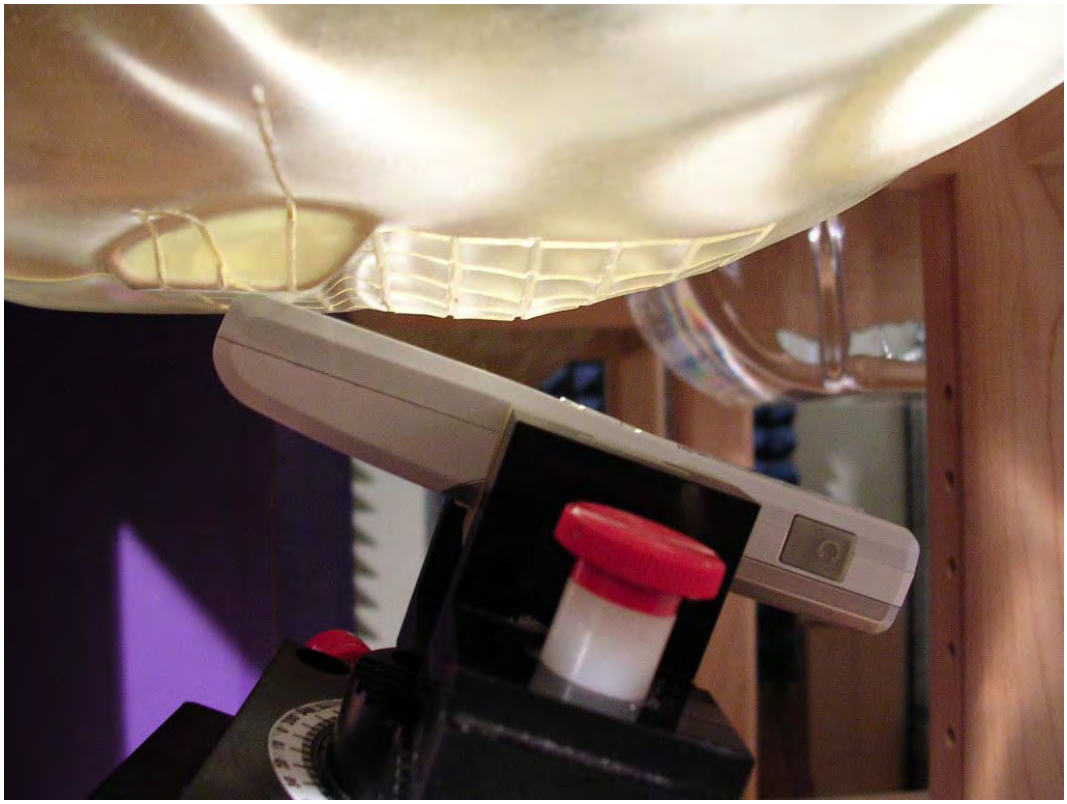
### Right Head (EUT Cheek)

### Left Head (EUT Cheek)

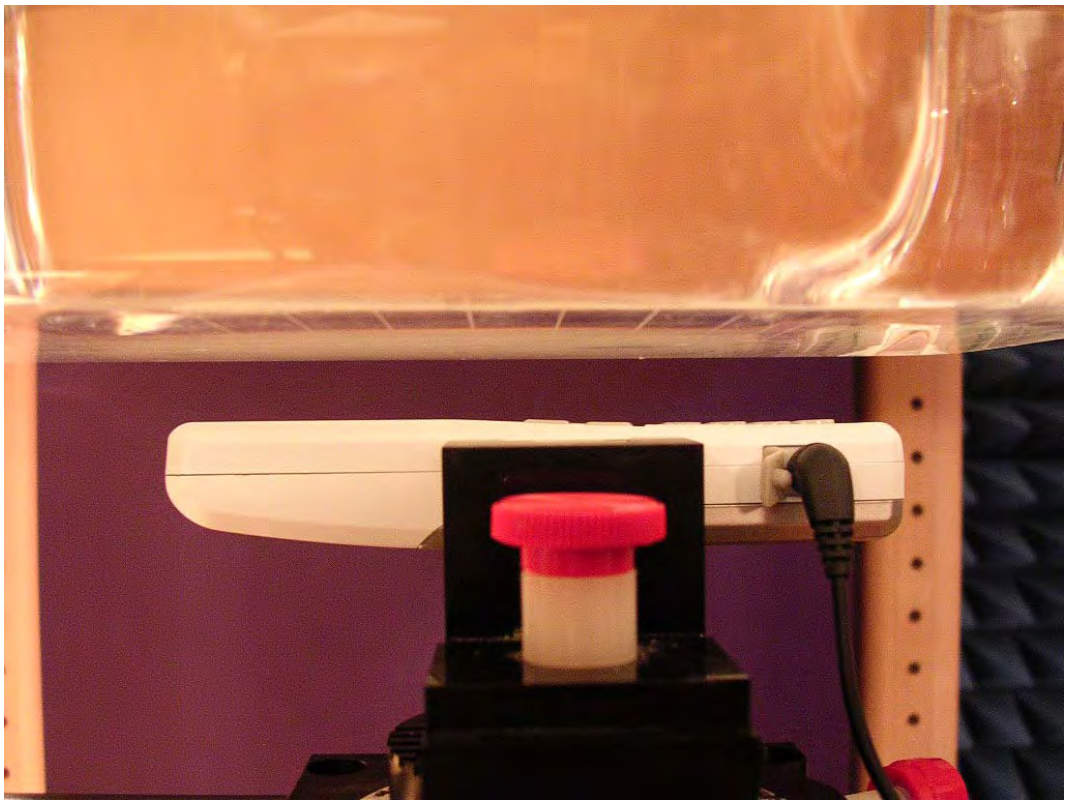


**Right Head (EUT Tilted)**

**Left Head (EUT Tilted)**



**Body worn bottom (EUT Front) distance 15mm**



Note: The positions used in the measurements were according to IEEE 1528-2003.

## EUT Photographs

QuieTek

# Appendix - Probe Calibration

**Miniature Isotropic RF Probe**
**M/N: ALS-E-020**
**S/N: 264**

**2450MHz Head Calibration page 2~11**
**2450MHz Body Calibration page 12~21**

## NCL CALIBRATION LABORATORIES

Calibration File No.: CP-634

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

HEAD Calibration

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2
Project No: QUIB-Probe-Cal-5210

Calibrated: 21st March 2006
Released on: 21st March 2006

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

**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**

## 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 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.**

---
**Stuart Nicol**

---
**Yi Pan**

## 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 $\mu V/(V/m)^2$ |
| **Channel Y:** | 1.2 $\mu V/(V/m)^2$ |
| **Channel Z:** | 1.2 $\mu V/(V/m)^2$ |
| **Diode Compression Point:** | 95 mV |


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

## Sensitivity in Head Tissue

**Frequency:** 2450 MHz

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

**ConvF**

**Channel X:** 5.0

**Channel Y:** 5.0

**Channel Z:** 5.0

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

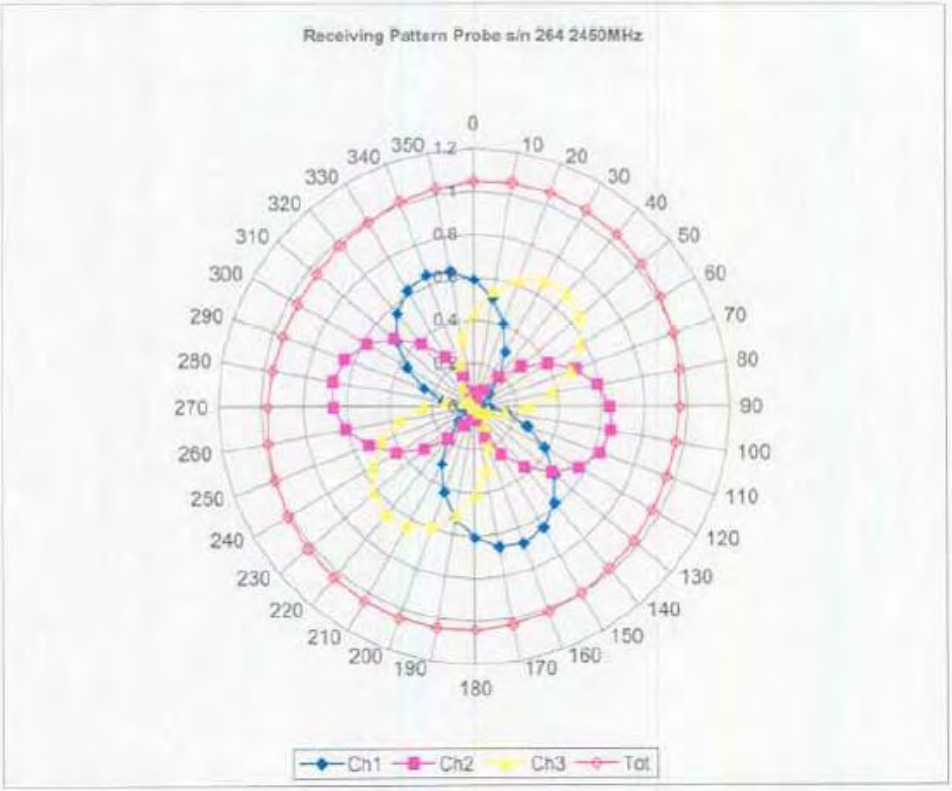
## Boundary Effect:

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.

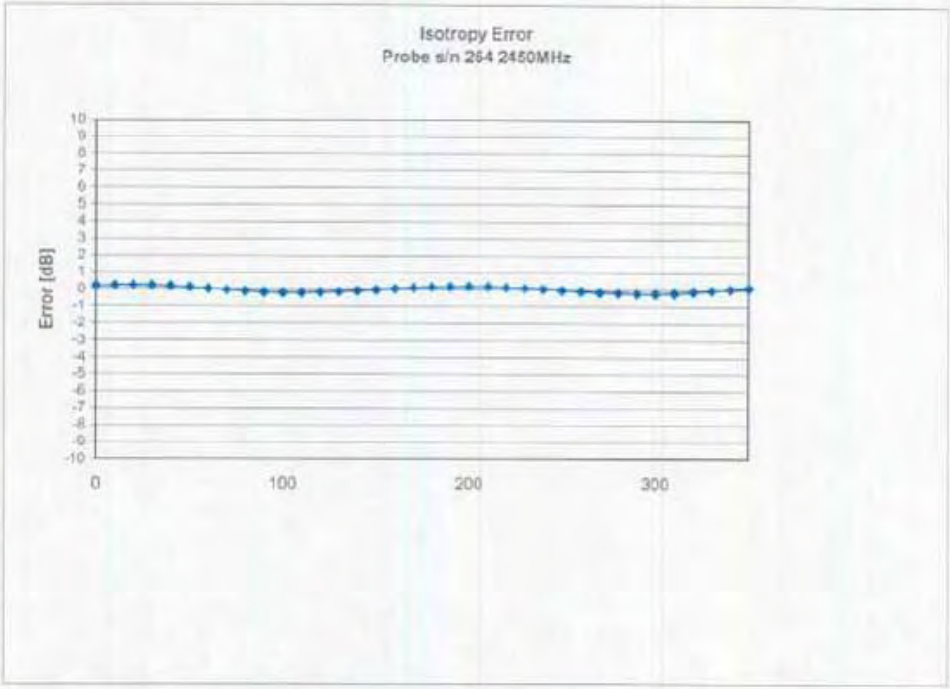
## Spatial Resolution:

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)



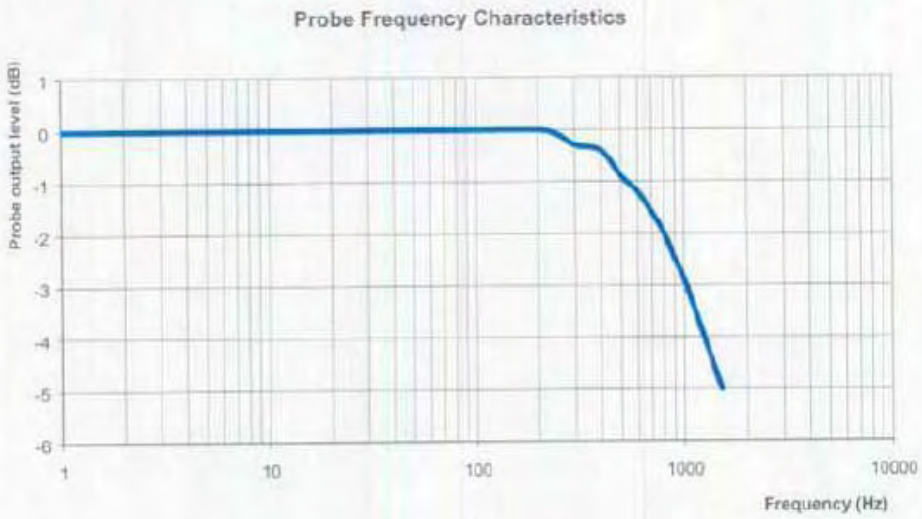
**Isotropicity in Tissue:** 0.10 dB

QuieTek



## 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:** | 39.2 (+/-5%) | **Sigma:** | 1.80 S/m (+/-5%) |
| **ConvF** | | | |
| **Channel X:** | 5.0 | 7%(K=2) | |
| **Channel Y:** | 5.0 | 7%(K=2) | |
| **Channel Z:** | 5.0 | 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.

## NCL CALIBRATION LABORATORIES

Calibration File No.: CP-641

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: QUIB-Probe-Cal-5210

Calibrated: 21st March 2006
Released on: 21st March 2006

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

Released By: _____

**NCL** CALIBRATION LABORATORIES
51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6
Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161

## Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 264.

## References

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

## Conditions

Probe 264 was a 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.**

---
**Stuart Nicol**

---
**Yi Pan**

## 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 $\mu V/(V/m)^2$ |
| **Channel Y:** | 1.2 $\mu V/(V/m)^2$ |
| **Channel Z:** | 1.2 $\mu V/(V/m)^2$ |
| **Diode Compression Point:** | 95 mV |


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

## 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.

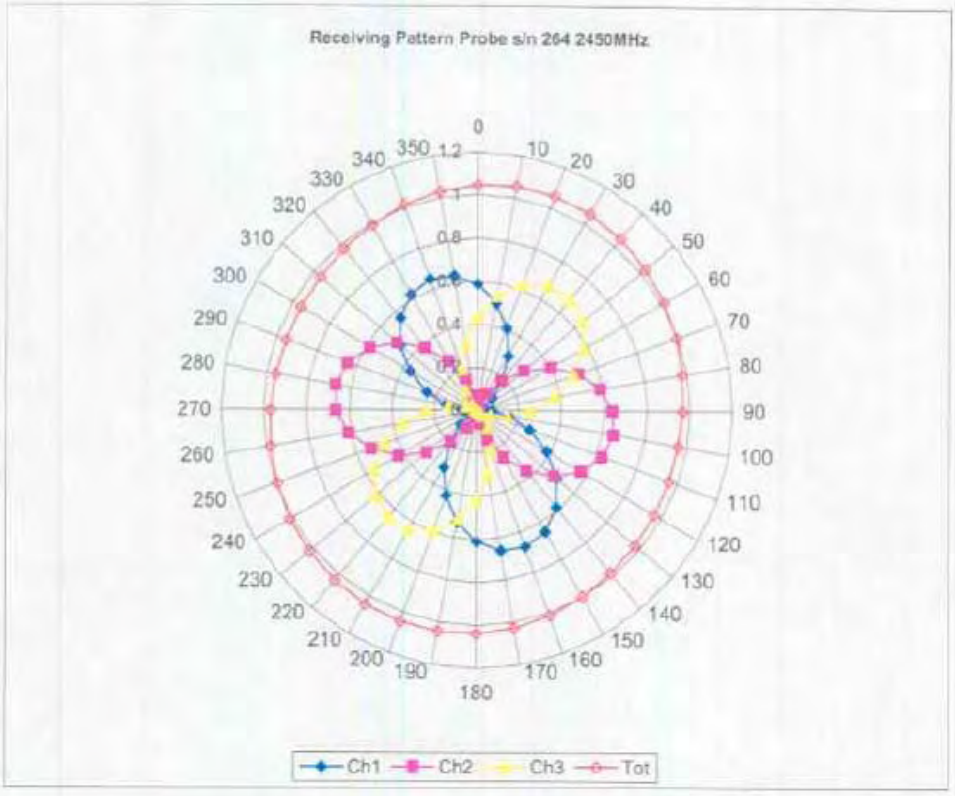
## Spatial Resolution:

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.

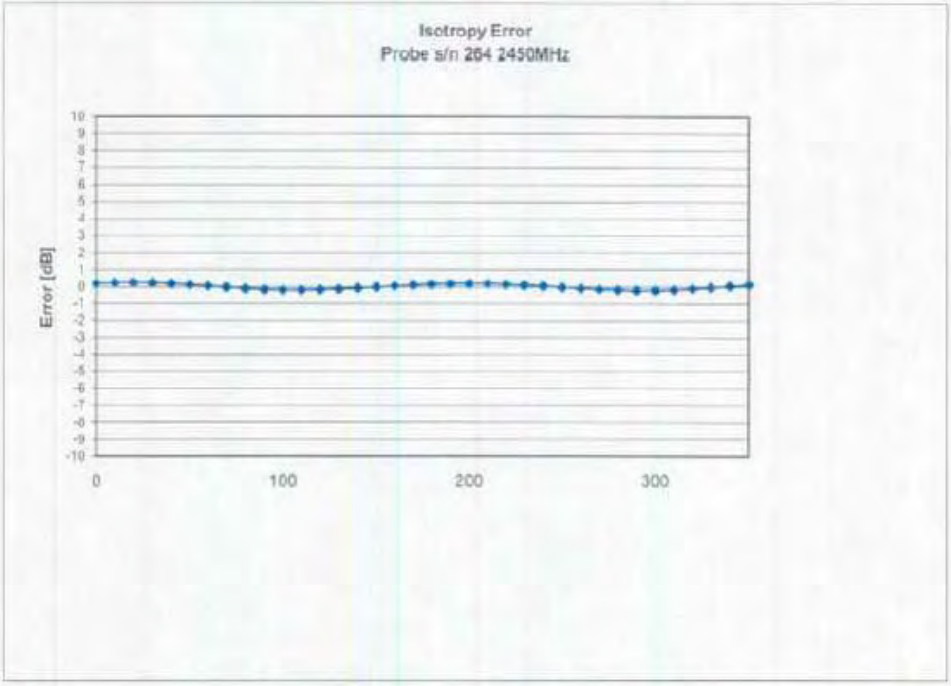
QuieTek

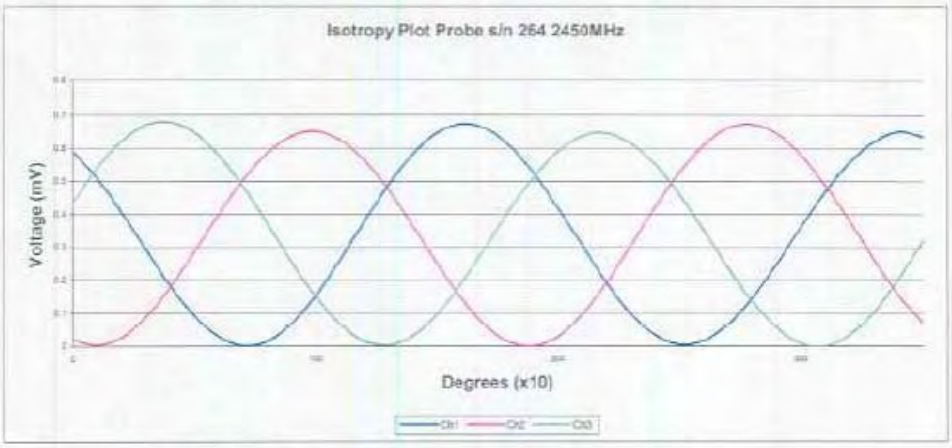


## Receiving Pattern 2450 MHz (Air)



## Isotropy Error 2450 MHz (Air)




**Isotropicity in Tissue:** 0.10 dB

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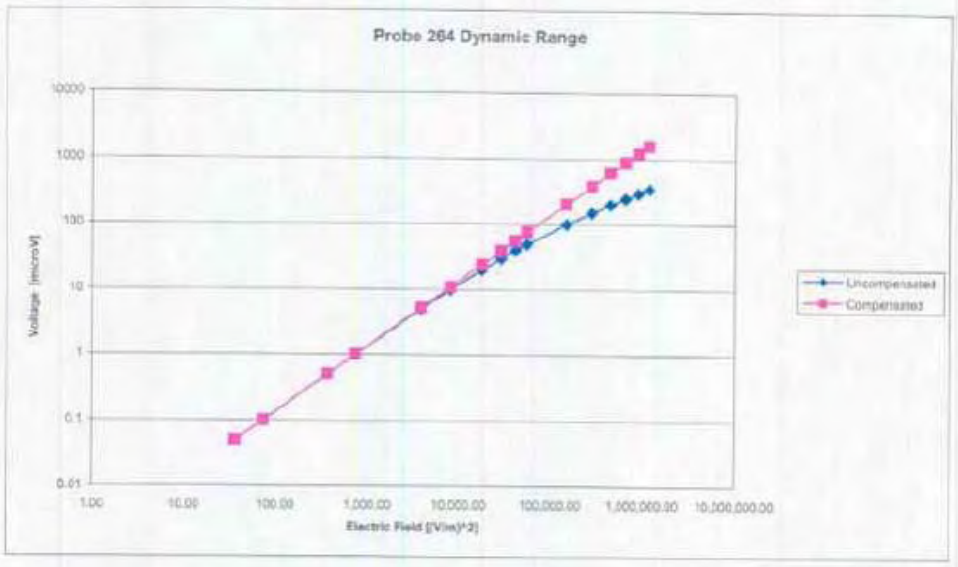
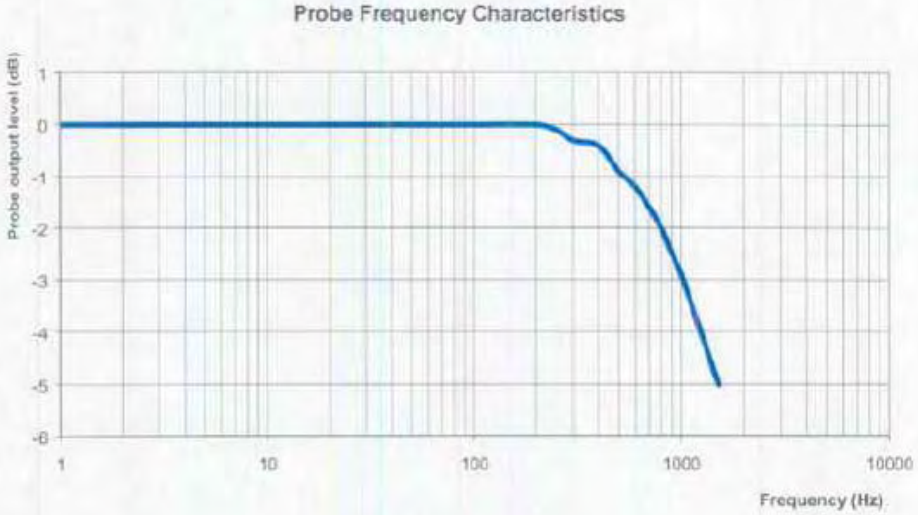
## Dynamic Range



## 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.

# Appendix - Dipole Calibration

## Validation Dipole 2450MHz
## P/N: ALS-D-2450-S-2
## S/N: QTK-319

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## 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

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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

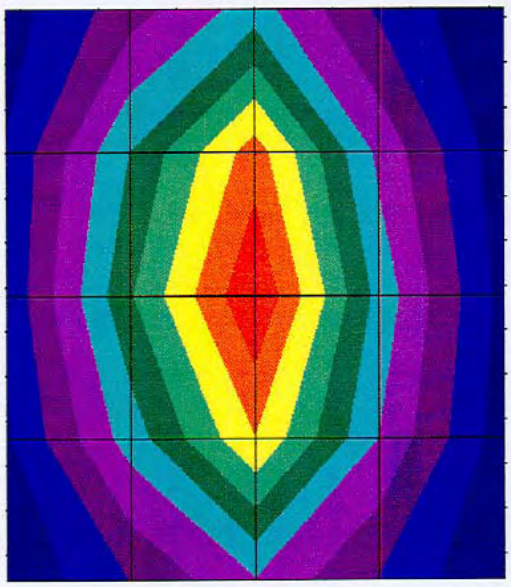
**Length:** 53.5 mm
**Height:** 30.4 mm

### 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 |





Calibrated by:

Approved by:

## 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 |

## 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

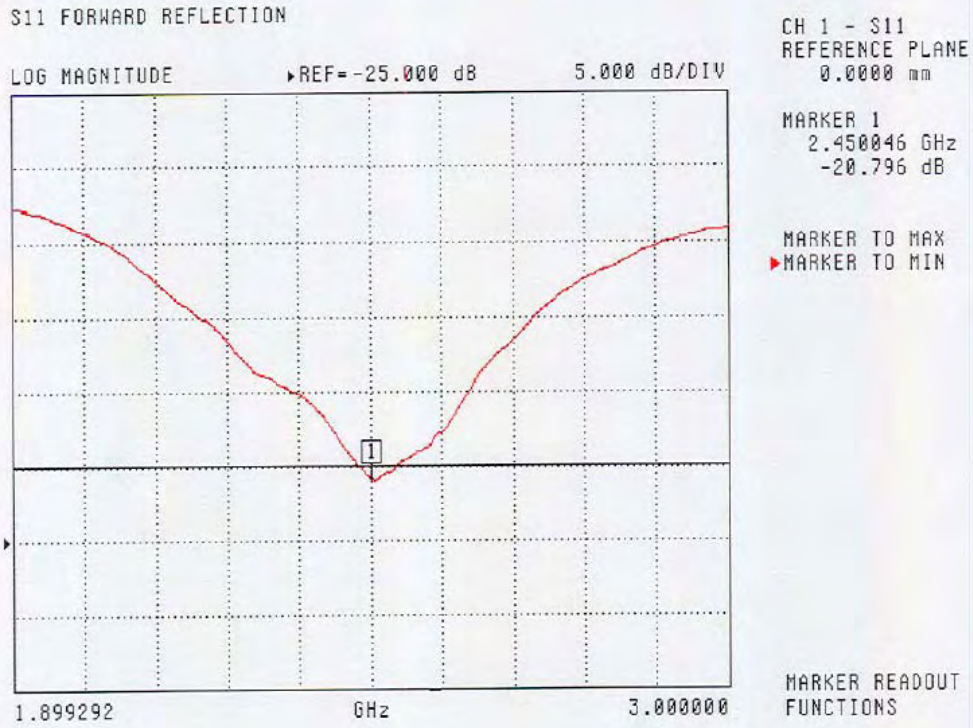
| Body Tissue 2450 MHz | Measured |
|---|---|
| Dielectric constant, $\varepsilon_r$ | 52.5 |
| Conductivity, $\sigma$ [S/m] | 1.78 |

### 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



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**NCL Calibration Laboratories**
Division of APREL Laboratories.

**SWR**

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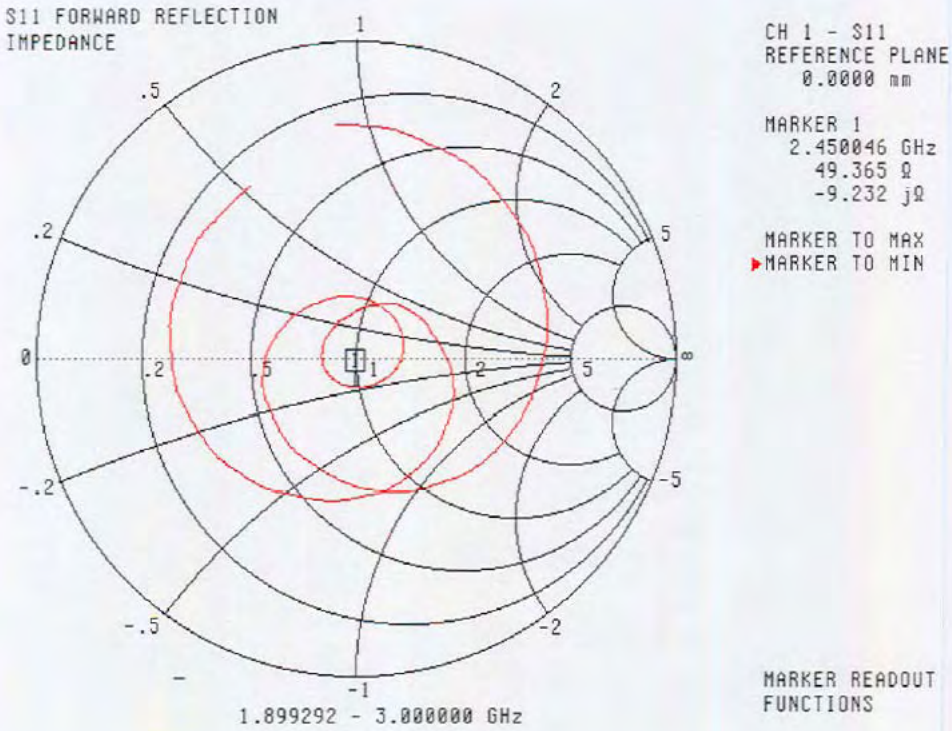
## Smith Chart Dipole Impedance






Calibrated by:

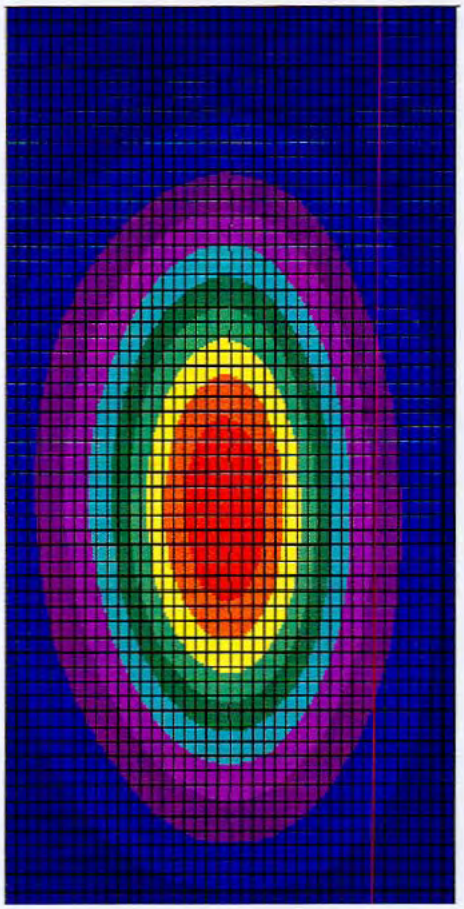
Approved by:

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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## Test Equipment

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