# ZEBRA TECHNOLOGIES CORP

## PRINTER WITH 802.11 A/B/G/N AND BT RADIO MODULE

**Model: QLn320 & QLn220**

**Nov 26th 2011**

**Report No.: SL11091402-ZBR-057A (FCC_SAR)_QLn320 & QLn220 Rev3.0**

(This report supersedes SL11091402-ZBR-057A (FCC_SAR)_QLn320 & QLn220 Rev2.0)

QLn320

QLn220

**Modifications made to the product : None**

| This Test Report is Issued Under the Authority of: | |
|---|---|
| David Zhang<br>Compliance Engineer | Leslie Bai<br>Director of Certification |

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Test result presented in this test report is applicable to the representative sample only.

SAR Test Report

To: C95.1 , IEEE 1528 , OET Bulletin 65 Suppl. C , RSS 102 and Safety Code 6, IEC 62209-2

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# 1 Executive Summary & EUT information

The purpose of this test programmed was to demonstrate compliance of the FCC certified Zebra Technologies Corp , N Radio Module with 802.11 a/b/g/n and BT, FCC ID: **I28MD-EXLAN11N** , Model: QLn320 & QLn220 after installing into the host printer QLn320 and QLn220, against the current Stipulated Standards. The whole system Printer with 802.11 a/b/g/n and BT radio module, Model: QLn320 & QLn220 have demonstrated compliance with the C95.1 , IEEE 1528, OET Bulletin 65 Supplement C , RSS-102 Issue 4 and Safety Code 6. The test has demonstrated that this unit complies with stipulated standards.

## EUT Information

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **EUT Description** | : | Printer with 802.11 a/b/g/n and BT radio module | | | | | |
| **Model No** | : | QLn320 & QLn220 | | | | | |
| **Serial No** | : | N/A | | | | | |
| **HW version** | : | N/A | | | | | |
| **IMEI** | : | N/A | | | | | |
| **Input Power** | : | 12VDC, 2.08A (25W) | | | | | |
| **Maximum Conducted Output Power to Antenna** | | WLAN (2.4GHz): 0.077W (18.87 dBm)<br>WLAN (5GHz): 0.053W (17.25dBm)<br>Bluetooth : 0.00597W (7.76dBm) | | | | | |
| **Classification Per Stipulated Test Standard** | : | Portable Device | | | | | |
| **Co-located TX** | : | N/A | | | | | |
| **Antenna Separation distances** | : | N/A | | | | | |
| **Measured Highest SAR** | : | Band: | 2.4GHz | Highest SAR Value: | 0.167 W/kg | (Qln320 Body SAR) | |
| | | | | | 0.223 W/kg | (Qln220 Body SAR) | |
| | | Band: | 5GHz | Highest SAR Value: | 0.179 W/kg | (Qln320 Body SAR) | |
| | | | | | 0.644 W/kg | (Qln220 Body SAR) | |
| **Antenna Gain description** | : | WLAN(2.4GHz)/Bluetooth: 3.81dBi; WLAN(5GHz): 3.19 dBi. | | | | | |

***Note: EUT supports both 802.11a/b/g/n and Bluetooth mode. Both 802.11 radio and Bluetooth radio shares same antenna. They don't transmit simultaneously.***

# 2 TECHNICAL DETAILS

| | |
|---|---|
| Purpose | Compliance testing of Printer with 802.11 a/b/g/n and BT radio module model QLn320 & QLn220 with stipulated standard |
| Applicant / Client | Zebra Technologies Corp |
| Manufacturer | Zebra Technologies Corp<br>333 Corporate Woods Parkway.<br>Vernon Hills, IL 60061 |
| Laboratory performing the tests | SIEMIC Laboratories |
| Test report reference number | SL11091402-ZBR-057A (FCC_SAR)_QLn320 & QLn220 Rev3.0 |
| Date EUT received | Oct 12th 2011 |
| Standard applied | See Page 9 |
| Dates of test (from – to) | Oct 25th 2011 |
| No of Units: | 1 |
| Equipment Category: | Portable Device |
| Trade Name: | Zebra Technologies Corp |
| Model Name: | QLn320 & QLn220 |
| RF Operating Frequency (ies) | 802.11a/b/g/n:2412MHz – 2462MHz;<br>802.11n: 5180MHz-5320MHz, 5500MHz-5700MHz, 5745MHz-5825MHz;<br>Bluetooth: 2402 – 2480MHz |
| Number of Channels: | N/A |
| Modulation: | WLAN: DSSS,OFDM<br>Bluetooth: GFSK ,$\pi$/4-DQPSK, 8-DPSK |
| FCC ID: | I28MD-EXLAN11N |
| IC ID: | 3798B-EXLAN11N |

# 3 INTRODUCTION

## Introduction

This measurement report shows compliance of the EUT with FCC OET Bulletin 65 Supplement C (Edition 01-01) & RSS 102 Issue 4.0.

The test procedures, as described in ANSI C95.1 – 1999 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [2], and ANSI C95.3 – 2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields [3], were employed.

## SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ).

$$SAR = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dV}\right)$$

SAR is expressed in units of watts per kilogram (W/kg). SAR can be related to the electric field at a point by

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

where:

σ = conductivity of the tissue (S/m)
ρ = mass density of the tissue (kg/m3)
E = rms electric field strength (V/m)

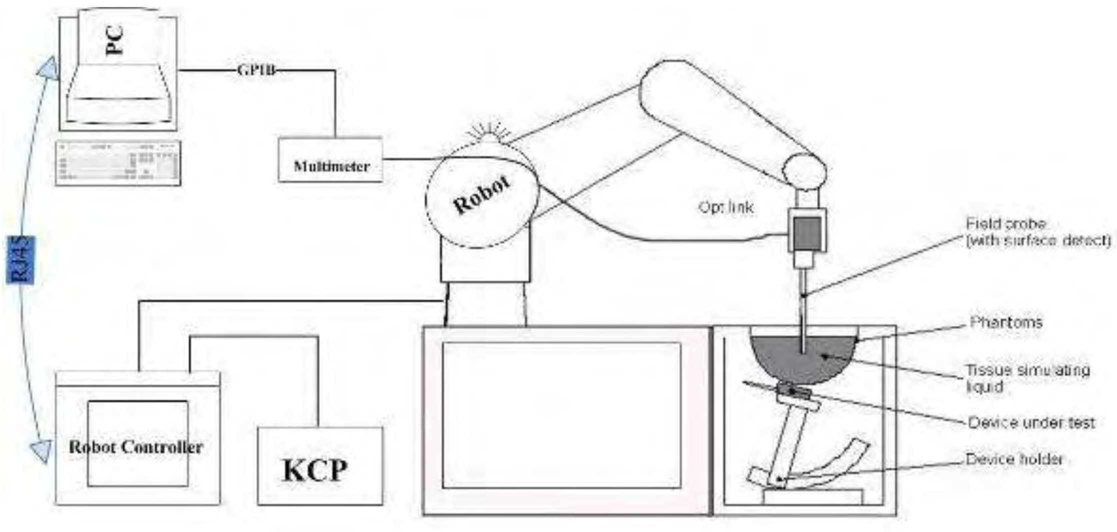
# 4 SAR Measurement Setup

## Dosimetric Assessment System

These measurements were performed with the automated near-field scanning system OPENSAR from SATIMO. The system is based on a high precision robot (working range: 850 mm), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in SAR standard with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure described in SAR starndard and found to be better than ±0.25 dB. The phantom used was the SAM Phantom as described in FCC supplement C, IEEE P1528 and CENELEC EN62209-1.

## Measurement System Diagram




**The OPENSAR system for performing compliance tests consist of the following items:**

1. A standard high precision 6-axis robot (KUKA) with controller and software.
2. KUKA Control Panel (KCP).
3. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
4. The functions of the PC plug-in card are to perform the time critical task such as signal filtering, surveillance of the robot operation fast movement interrupts.

5. A computer operating Windows XP.
6. OPENSAR software.
7. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
8. The SAM phantom enabling testing left-hand right-hand and body usage.
9. The Position device for handheld EUT.
10. Tissue simulating liquid mixed according to the given recipes (see Application Note).
11. System validation dipoles to validate the proper functioning of the system.

## EP100 Probe

Construction Symmetrical design with triangular Core. Built-in shielding against static charges Calibration in air from 100 MHz to 2.5 GHz. In brain and muscle simulating tissue at frequencies from 800 to 6000 MHz (accuracy of 8%) .

Frequency 100 MHz to 6 GHz;

Linearity ; 0.25 dB (100 MHz to 6 GHz) ,

Directivity : 0.25 dB in brain tissue (rotation around probe axis) 0.5 dB in brain tissue (rotation normal probe axis)

Dynamic : 0.001W/kg to > 100W/kg;

Range Linearity: 0.25 dB

Surface : 0.2 mm repeatability in air and liquids

Dimensions Overall length: 330 mm

Tip length: 16 mm

Body diameter: 8 mm

Tip diameter: 2.6 mm

Distance from probe tip to dipole centers: <1.5 mm

Application General dosimetric up to 6 GHz

Compliance tests of mobile phones

Fast automatic scanning in arbitrary phantoms

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique, with printed resistive lines on ceramic substrates.

It is connected to the KRC box on the robot arm and provides an automatic detection of the phantom surface. The 3D file of the phantom is include in OpenSAR software. The Video Positioning System allow the system to take the automatic reference and to move the probe safely and accurately on the phantom.

**E-Field Probe Calibration Process**

Each probe is calibrated according to a dosimetric assessment procedure described in SAR standard with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in SAR standard and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.
The free space E-field from probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 0.8 GHz, and in a waveguide above 0.8 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. E-field correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue.

## SAM Phantom

The SAM Phantom SAM29 is constructed of a fiberglass shell ntegrated in a wooden table. The shape of the shell is in compliance with the specification set in IEEE P1528 and CENELEC EN62209-1. The phantom enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region.
A cover prevents the evaporation of the liquid.
Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.
Shell Thickness: 2 ± 0.2 mm
Filling Volume: Approx. 25 liters
Dimensions (H x L x W): 810 x 1000 x 500 mm
Liquid is filled to at least 15mm from the bottom of Phantom.

## Device Holder

In combination with the Generic Twin Phantom V3.0, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

***Note:*** *A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations [10]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.*

## Data Evaluation

The OPENSAR software automatically executes the following procedure to calculate the field units from the microvolt readings at the probe connector. The parameters used in the valuation are stored in the configuration modules of the software:

| | | |
|---|---|---|
| Probe Parameters | - Sensitivity | $Norm_i$ |
| | - Conversion factor | ConvFi |
| | - Diode compression point Dcpi | |
| Device Parameter | - Frequency | f |
| | - Crest factor | cf |
| Media Parametrs | - Conductivity | σ |
| | - Density | ρ |

These parameters must be set correctly in the software. They can either be found in the component documents or be imported into the software from the configuration files issued for the OPENSAR components.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as

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

*Where $V_i$ = Compensated signal of channel i (i = x, y, z)*
*$U_i$ = Input signal of channel i (i = x, y, z)*
*cf = Crest factor of exciting field (DASY parameter)*
*$dcp_i$ = Diode compression point (DASY parameter)*

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes: $E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$

H-field probes: $H_i = \sqrt{Vi} \cdot \frac{a_{i10} + a_{i11} f + a_{i12} f^2}{f}$

Where $V_i$ = Compensated signal of channel i (i = x, y, z)
$Norm_i$ = Sensor sensitivity of channel i (i = x, y, z) $\mu V/(V/m)2$ for E0field Probes
ConvF = Sensitivity enhancement in solution
$a_{ij}$ = Sensor sensitivity factors for H-field probes

$f$ = Carrier frequency (GHz)
$E_i$ = Electric field strength of channel i in V/m
$H_i$ = Magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

where SAR = local specific absorption rate in mW/g
$E_{tot}$ = total field strength in V/m
$\sigma$ = conductivity in [mho/m] or [siemens/m]
$\rho$ = equivalent tissue density in g/cm3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

The power flow density is calculated assuming the excitation field as a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

where $P_{pwe}$ = Equivalent power density of a plane wave in mW/cm2
$E_{tot}$ = total electric field strength in V/m
$H_{tot}$ = total magnetic field strength in A/m

## SAR Evaluation – Peak Spatial - Average

The procedure for assessing the peak spatial-average SAR value consists of the following steps

- **Power Reference Measurement**

  The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- **Area Scan**

  The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in OPENSAR software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to 15 mm by 15 mm and can be edited by a user.

- **Zoom Scan**

  Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures 5 x 5 x 7 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more then one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

- **Power Drift measurement**

  The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have OPENSAR software stop the measurements if this limit is exceeded.

## SAR Evaluation – Peak SAR

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1 g and 10 g. The OPENSAR system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

**Extrapolation**

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation.
They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the fourth order least square polynomial method for extrapolation. For a grid using 5x5x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

## Definition of Reference Points

**Ear Reference Point**

Figure 6.2 shows the front, back and side views of the SAM Phantom. The point “M” is the reference point for the center of the mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERPs are 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 6.1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 6.1). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].

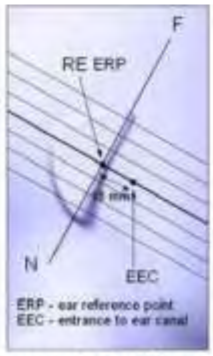


Figure 6.1 Close-up side view of ERP’s

Figure 6.2 Front, back and side view of SAM

## Device Reference Points

Two imaginary lines on the device need to be established: the vertical centerline and the horizontal line. The test device is placed in a normal operating position with the “test device reference point” located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (See Fig. 6.3). The “test device reference point” is than located at the same level as the center of the ear reference point. The test device is positioned so that the “vertical centerline” is bisecting the front surface of the device at it’s top and bottom edges, positioning the “ear reference point” on the outer surface of both the left and right head phantoms on the ear reference point [5].

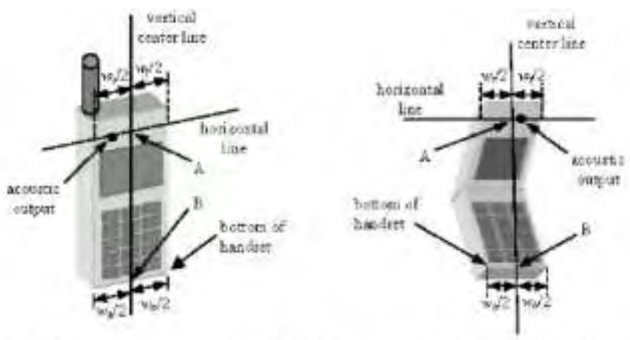


Figure 6.3 Handset Vertical Center & Horizontal Line Reference Points

# Test Configuration – Positioning for Cheek / Touch

1. Position the device 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 below), such that the plane defined by the vertical center line and the horizontal line of the device is approximately parallel to the sagittal plane of the phantom


**Figure 7.1 Front, Side and Top View of Cheek/Touch Position**

2. Translate the device towards the phantom along the line passing through RE and LE until the device touches the ear.

3. While maintaining the device 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).
4. Rotate the device around the vertical centerline until the device (horizontal line) is symmetrical with respect to the line NF.

5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE and maintaining the device contact with the ear, rotate the device about the line NF until any point on the device is in contact with a phantom point below the ear (cheek). See Figure below.

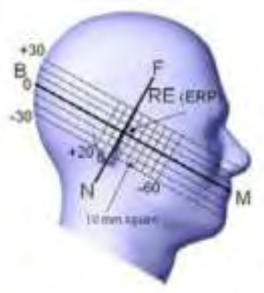



**Figure 7.2 Side view w/ relevant markings**

## Test Configuration – Positioning for Ear / 15° Tilt

With the test device aligned in the Cheek/Touch Position":

1. While maintaining the orientation of the device, retracted the device parallel to the reference plane far enough to enable a rotation of the device by 15 degrees.

2. Rotate the device around the horizontal line by 15 degrees.

3. While maintaining the orientation of the device, move the device parallel to the reference plane until any part of the device touches the head. (In this position, point A is located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact is at any location other than the pinna, the angle of the device shall be reduced. The tilted position is obtained when any part of the device is in contact with the ear as well as a second part of the device is in contact with the head (see Figure below).


Figure 7.3 Front, Side and Top View of Ear/15° Tilt Position

## Test Position – Body Worn Configurations

Body-worn operating configurations are tested with the accessories attached to the device and positioned against a flat phantom in a normal use configuration. A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then, when multiple accessories that contain metallic components are supplied with the device, the device is tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration where a separation distance between the back of the device and the flat phantom is used. All test position spacings are documented.

Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessory(ies), including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

In all cases SAR measurements are performed to investigate the worst-case positioning. Worst-case positioning is then documented and used to perform Body SAR testing.

# 5 ANSI/IEEE C95.1 – 1999 RF Exposure Limit

In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and cautions statements are included in the user's manual.

## Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

## Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Table 8.1 Human Exposure Limits**

| | UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g) | CONTROLLED ENVIROMENT Professional Population (W/kg) or (mW/g) |
|---|---|---|
| SPATIAL PEAK SAR[1] Brain | 1.60 | 8.00 |
| SPATIAL AVERAGE SAR[2] Whole Body | 0.08 | 0.40 |
| SPATIAL PEAK SAR[3] Hands, Feet, Ankles, Wrists | 4.00 | 20.00 |

[1] The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
[2] The Spatial Average value of the SAR averaged over the whole body.
[3] The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

# 6 SYSTEM AND LIQUID VALIDATION

## System Validation

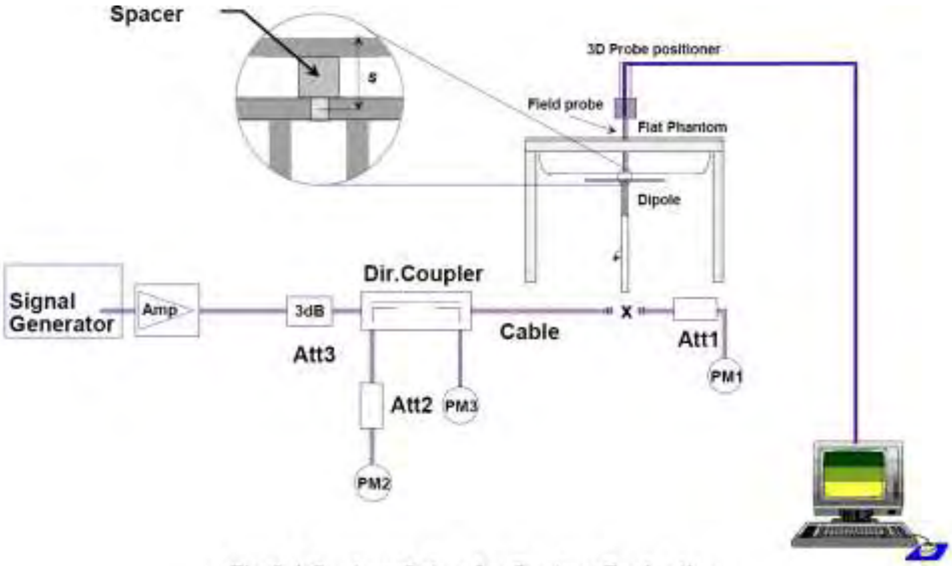



Fig 8.1 System Setup for System Evaluation

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:

1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. Calibrated Dipole

The output power on dipole port must be calibrated to 30 dBm (1000 mW) before dipole is connected.

## Numerical reference SAR values (W/kg) for reference dipole and flat phantom

| Frequency (MHz) | 1 g SAR | 10 g SAR | Local SAR at surface (above feed-point) | Local SAR at surface (y = 2 cm offset from feed-point)[a] |
|---|---|---|---|---|
| 300 | 3.0 | 2.0 | 4.4 | 2.1 |
| 450 | 4.9 | 3.3 | 7.2 | 3.2 |
| 835 | 9.5 | 6.2 | 4.1 | 4.9 |
| 900 | 10.8 | 6.9 | 16.4 | 5.4 |
| 1450 | 29.0 | 16.0 | 50.2 | 6.5 |
| 1800 | 38.1 | 19.8 | 69.5 | 6.8 |
| 1900 | 39.7 | 20.5 | 72.1 | 6.6 |
| 2000 | 41.1 | 21.1 | 74.6 | 6.5 |
| 2450 | 52.4 | 24.0 | 104.2 | 7.7 |
| 3000 | 63.8 | 25.7 | 140.2 | 9.5 |

**Target and measurement SAR after Normalized**

| Measurement Date | Frequency (MHz) | Configuration | Target SAR1g (W/kg) | Measured SAR1g (W/kg) | Deviation (%) |
|---|---|---|---|---|---|
| Oct 25th 2011 | 2450 | Body | 5.561 | 5.449 | -2.01 |
| Oct 25th 2011 | 5200 | Body | 14.412 | 14.282 | -0.90 |
| Oct 25th 2011 | 5500 | Body | 15.275 | 15.167 | -0.71 |
| Oct 25th 2011 | 5800 | Body | 16.352 | 16.197 | -0.95 |

## Liquid Validation

The dielectric parameters were checked prior to assessment using the HP85070C dielectric probe kit. The dielectric parameters measured are reported in each correspondent section.

### IEEE SCC-34/SC-2 P1528 recommended Tissue Dielectric Parameters

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 xpected 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 and extrapolated according to the head parameters specified in P1528

| Target Frequency | Head | | Body | |
|---|---|---|---|---|
| MHz | εr | σ (S/m) | εr | σ (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 |

***Note:*** *$\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 $kg/m^3$*

## Liquid Confirmation Result :

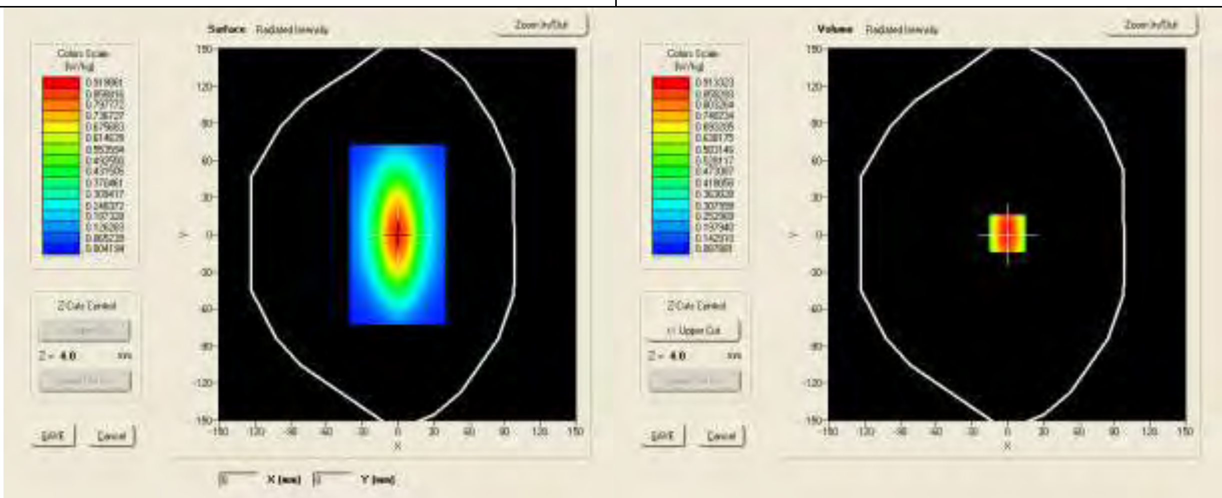
| Temperature: 21°C | | | Relative humidity: 58% | | | |
|---|---|---|---|---|---|---|
| Freq(MHz) | | | Target | Measured | Deviation (%) | Limit (%) |
| 2412 | Body | Permittivity | 52.649 | 52.875 | 0.43 | 5 |
| | | Conductivity | 1.711 | 1.702 | -0.51 | 5 |
| 2437 | Body | Permittivity | 52.683 | 52.910 | 0.43 | 5 |
| | | Conductivity | 1.754 | 1.745 | -0.51 | 5 |
| 2450 | Body | Permittivity | 52.700 | 52.863 | 0.31 | 5 |
| | | Conductivity | 1.776 | 1.782 | -0.34 | 5 |
| 2462 | Body | Permittivity | 52.716 | 52.943 | 0.43 | 5 |
| | | Conductivity | 1.797 | 1.788 | -0.51 | 5 |
| 5180 | Body | Permittivity | 47.359 | 47.563 | 0.43 | 5 |
| | | Conductivity | 5.276 | 5.249 | -0.51 | 5 |
| 5190 | Body | Permittivity | 47.372 | 47.779 | 0.86 | 5 |
| | | Conductivity | 5.288 | 5.273 | -0.28 | 5 |
| 5200 | Body | Permittivity | 47.372 | 47.779 | 0.86 | 5 |
| | | Conductivity | 5.288 | 5.273 | -0.28 | 5 |
| 5230 | Body | Permittivity | 47.426 | 47.834 | 0.86 | 5 |
| | | Conductivity | 5.334 | 5.319 | -0.28 | 5 |
| 5240 | Body | Permittivity | 47.440 | 47.848 | 0.86 | 5 |
| | | Conductivity | 5.346 | 5.331 | -0.28 | 5 |
| 5280 | Body | Permittivity | 47.494 | 47.902 | 0.86 | 5 |
| | | Conductivity | 5.393 | 5.378 | -0.28 | 5 |
| 5310 | Body | Permittivity | 47.535 | 47.944 | 0.86 | 5 |
| | | Conductivity | 5.428 | 5.413 | -0.28 | 5 |
| 5500 | Body | Permittivity | 47.793 | 48.978 | 2.48 | 5 |
| | | Conductivity | 5.650 | 5.577 | -1.29 | 5 |
| 5510 | Body | Permittivity | 47.793 | 48.978 | 2.48 | 5 |
| | | Conductivity | 5.650 | 5.577 | -1.29 | 5 |
| 5550 | Body | Permittivity | 47.901 | 49.089 | 2.48 | 5 |
| | | Conductivity | 5.743 | 5.669 | -1.29 | 5 |
| 5580 | Body | Permittivity | 47.901 | 49.089 | 2.48 | 5 |
| | | Conductivity | 5.743 | 5.669 | -1.29 | 5 |
| 5670 | Body | Permittivity | 48.024 | 49.215 | 2.48 | 5 |
| | | Conductivity | 5.848 | 5.773 | -1.29 | 5 |
| 5680 | Body | Permittivity | 48.037 | 48.359 | 0.67 | 5 |
| | | Conductivity | 5.860 | 5.830 | -0.52 | 5 |
| 5745 | Body | Permittivity | 48.125 | 48.447 | 0.67 | 5 |
| | | Conductivity | 5.936 | 5.905 | -0.52 | 5 |
| 5755 | Body | Permittivity | 48.139 | 48.462 | 0.67 | 5 |
| | | Conductivity | 5.947 | 5.916 | -0.52 | 5 |
| 5795 | Body | Permittivity | 48.193 | 48.516 | 0.67 | 5 |
| | | Conductivity | 5.994 | 5.963 | -0.52 | 5 |
| 5800 | Body | Permittivity | 48.193 | 48.516 | 0.67 | 5 |
| | | Conductivity | 5.994 | 5.963 | -0.52 | 5 |
| 5805 | Body | Permittivity | 48.207 | 48.530 | 0.67 | 5 |
| | | Conductivity | 6.006 | 5.975 | -0.52 | 5 |
| 5825 | Body | Permittivity | 48.234 | 48.557 | 0.67 | 5 |
| | | Conductivity | 6.029 | 5.998 | -0.52 | 5 |

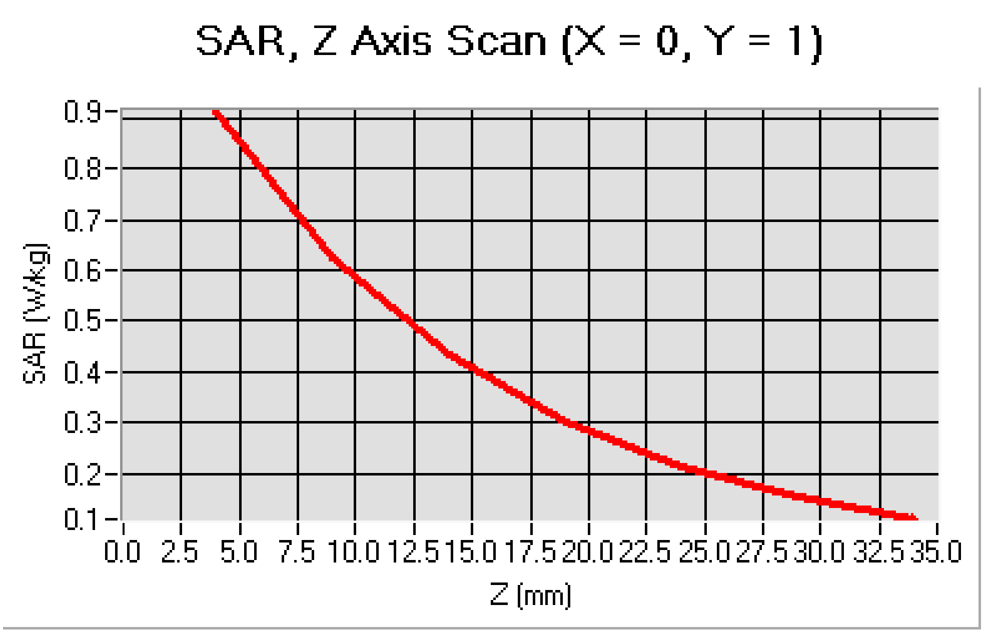
***Note:*** *Liquid Verification was performed on 2011-10-25*

## System Validation Plots

**Test Mode:** 2450MHz Validation (Body SAR)
**Position:** Flat Phantom
**Product Description:** N/A
**Model:** N/A **Test Date:** Oct 25th 2011

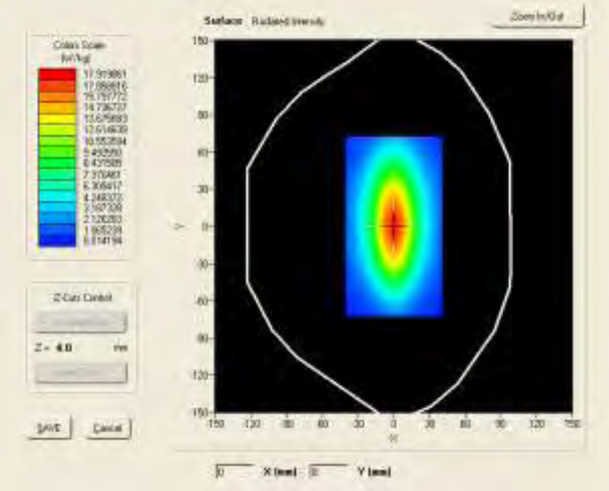
| Frequency (MHz) | 2450 (Body Liquid) |
|---|---|
| Relative permittivity (real part) | 52.863 |
| Relative permittivity (imaginary part) | 14.983 |
| Conductivity (S/m) | 1.782 |
| Variation (%) | -1.65 |
| SAR 1g (W/Kg) | 5.449 |
| **SURFACE SAR** | **VOLUME SAR** |

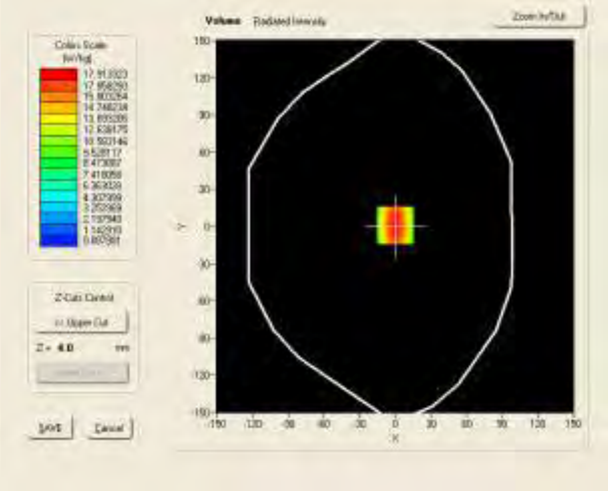


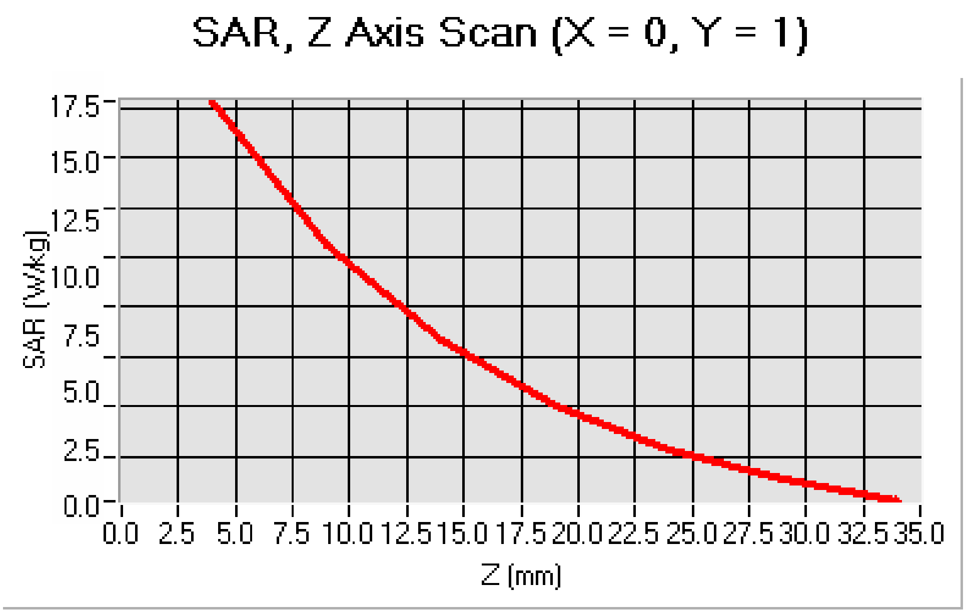


**Test Mode:** 5200MHz Validation (Body SAR)
**Position:** Flat Phantom
**Product Description:** N/A
**Model:** N/A **Test Date:** Oct 25th 2011

| Frequency (MHz) | 5200(Body Liquid) |
|---|---|
| Relative permitivity (real part) | 47.779 |
| Relative permitivity (imaginary part) | 15.031 |
| Conductivity (S/m) | 5.273 |
| Variation (%) | 0.12 |
| SAR 1g (W/Kg) | 14.282 |
| **SURFACE SAR** | **VOLUME SAR** |

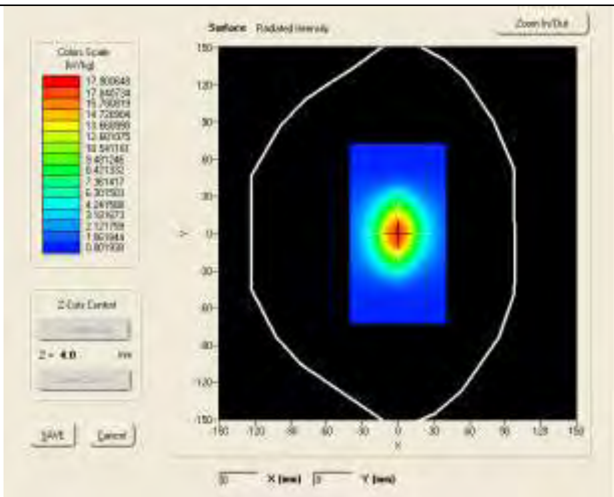
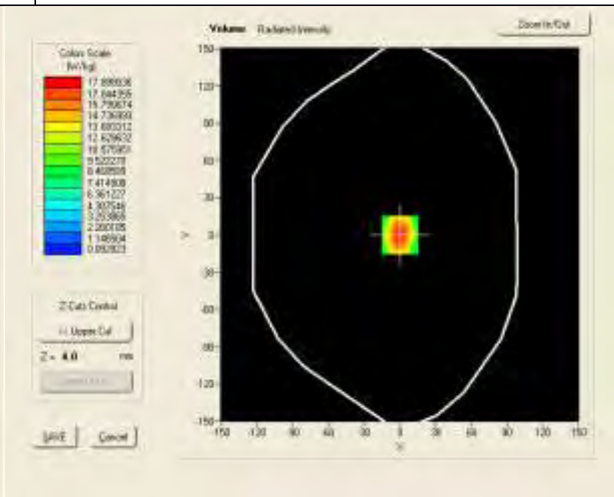


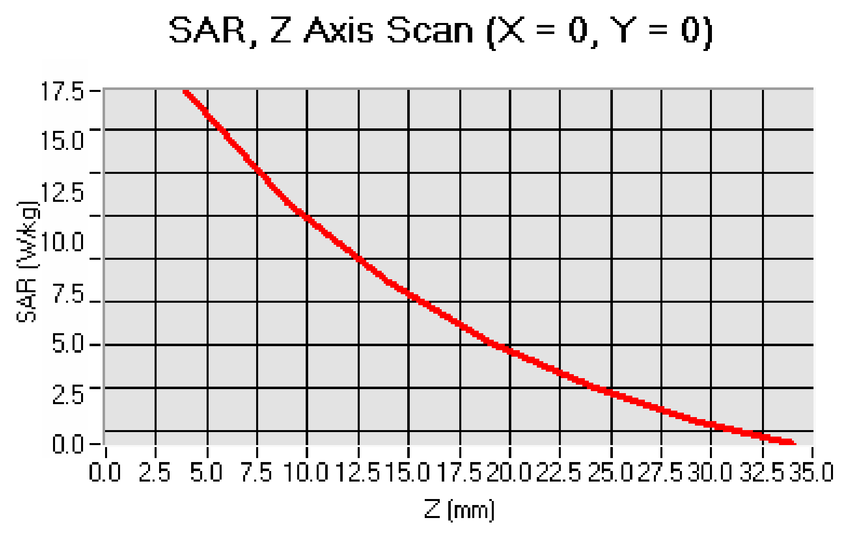




**Test Mode:** 5500MHz Validation (Body SAR)
**Position:** Flat Phantom
**Product Description:** N/A
**Model:** N/A **Test Date:** Oct 25th 2011

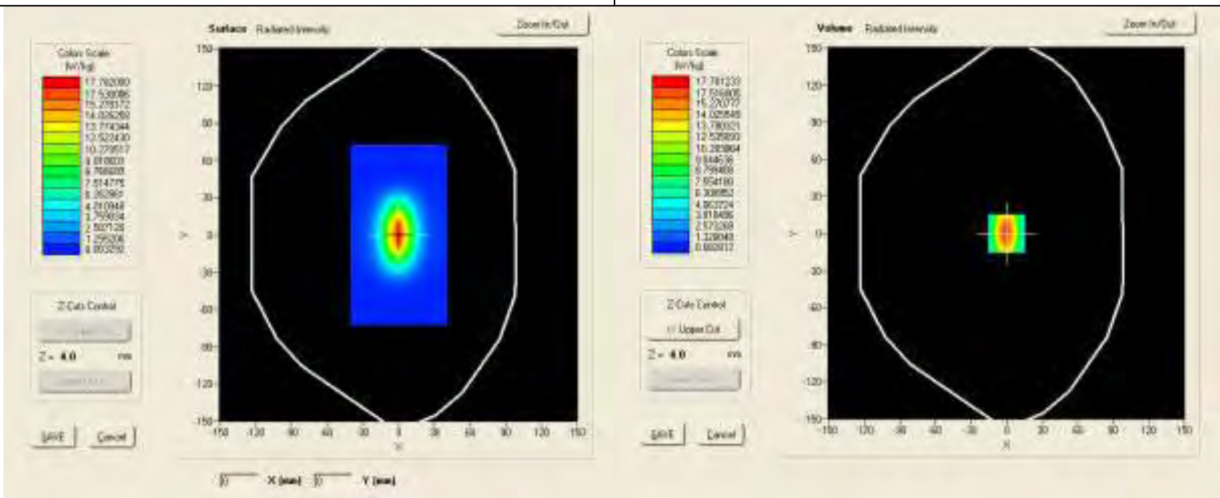
| Frequency (MHz) | 5500 (Body Liquid) |
|---|---|
| Relative permittivity (real part) | 48.978 |
| Relative permittivity (imaginary part) | 14.975 |
| Conductivity (S/m) | 5.577 |
| Variation (%) | -0.53 |
| SAR 1g (W/Kg) | 15.167 |
| **SURFACE SAR** | **VOLUME SAR** |

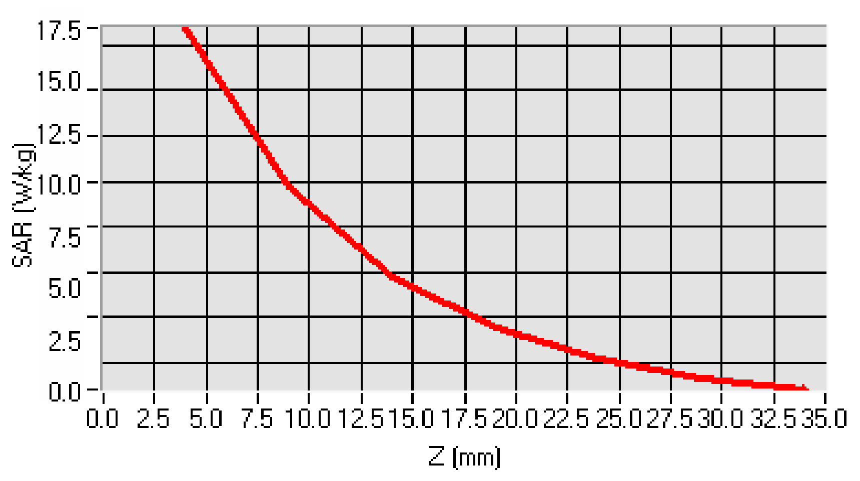


**Test Mode:** 5800MHz Validation (Body SAR)
**Position:** Flat Phantom
**Product Description:** N/A
**Model:** N/A **Test Date:** Oct 25th 2011

| Frequency (MHz) | 5800(Body Liquid) |
|---|---|
| Relative permitivity (real part) | 48.516 |
| Relative permitivity (imaginary part) | 15.146 |
| Conductivity (S/m) | 5.963 |
| Variation (%) | 0.06 |
| SAR 1g (W/Kg) | 16.197 |
| **SURFACE SAR** | **VOLUME SAR** |



SAR, Z Axis Scan (X = 0, Y = 0)



# 7 TYPE A MEASUREMENT UNCERTAINTY

*The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance*

*A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.*

*A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience and specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table below :*

| Uncertainty Distribution | Normal | Rectangle | Triangular | U Shape |
|---|---|---|---|---|
| Multi-plying Factor(a) | 1/k(b) | 1 / √3 | 1 / √6 | 1 / √2 |

*(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity*
*(b) κ is the coverage factor*

*Standard Uncertainty for Assumed Distribution*

*The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type -sum-by taking the positive square root of the estimated variances.*

*Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %.*

*The COMOSAR Uncertainty Budget is show in below table :*

## *Uncertainty Budget of COMOSAR for frequency range 300 MHz to 6 GHz*

| Uncertainty Component | Tolerances % | Probability Distribution | Divisor | Ci (1g) | Ci (10g) | Uncertainty 1g(%) | Uncertainty 10g(%) |
|---|---|---|---|---|---|---|---|
| **Measurement System Related** | | | | | | | |
| Probe Calibration | 6 | N | 1 | 1 | 1 | 6 | 6 |
| Axial Isotropy | 3 | R | √3 | √ (1-Cp) | √ (1-Cp) | 1.22474 | 1.22474 |
| Hemispherical Isotropy | 4 | R | √3 | √ Cp | √ Cp | 1.63299 | 1.63299 |
| Boundary Effect | 1 | R | √3 | 1 | 1 | 0.57735 | 0.57735 |
| Linearity | 5 | R | √3 | 1 | 1 | 2.88675 | 2.88675 |
| System Detection Limits | 1 | R | √3 | 1 | 1 | 0.57735 | 0.57735 |
| Readout Electronics | 0.5 | N | 1 | 1 | 1 | 0.5 | 0.5 |
| Response Time | 0.2 | R | √3 | 1 | 1 | 0.11547 | 0.11547 |
| Integration Time | 2 | R | √3 | 1 | 1 | 1.1547 | 1.1547 |
| RF Ambient Conditions | 3 | R | √3 | 1 | 1 | 1.73205 | 1.73205 |
| Probe Positioner Mechanical Tolerances | 2 | R | √3 | 1 | 1 | 1.1547 | 1.1547 |
| Probe Positioning with respect to Phantom Shell | 1 | R | √3 | 1 | 1 | 0.57735 | 0.57735 |
| Extrapolation, Interpolation and integration Algorithms for Max. SAR Evaluation. | 1.5 | R | √3 | 1 | 1 | 0.86603 | 0.86603 |
| **Test Sample Related** | | | | | | | |
| Test Sample Positioning | 1.5 | N | 1 | 1 | 1 | 1.5 | 1.5 |
| Device Holder Uncertainty | 5 | N | 1 | 1 | 1 | 5 | 5 |
| Output Power Variation – SAR Drift measurement | 3 | R | √3 | 1 | 1 | 1.73205 | 1.73205 |
| | | | | | | | |
| **Phantom and Tissue Parameters Related** | | | | | | | |
| Phantom Uncertainty (Shape and thickness Tolerances) | 4 | R | √3 | 1 | 1 | 2.3094 | 2.394 |
| Liquid Conductivity – deviation from target value | 5 | R | √3 | 0.64 | 0.43 | 1.84752 | 1.2413 |
| Liquid Conductivity – Measurement Uncertainty | 2.5 | N | 1 | 0.64 | 0.43 | 1.6 | 1.075 |
| Liquid Permittivity – deviation from target value | 3 | R | √3 | 0.6 | 0.49 | 1.03923 | 0.8487 |
| Liquid Permittivity – Measurement Uncertainty | 2.5 | N | 1 | 0.6 | 0.49 | 1.5 | 1.225 |
| | | | | | | | |
| Combined Standard Uncertainty | | | | | | 9.66051 % | 9.52428 % |
| Expanded Standard Uncertainty ( K=2 , confidence 95%) | | | | | | 18.9346 % | 18.6676 % |

# 8 OUTPUT POWER VERIFICATION

**Test Condition:**

1. Conducted Measurement
   EUT was set for low, mid, high channel with modulated mode and highest RF output power.
   The base station simulator was connected to the antenna terminal.
2. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.
3. Environmental Conditions

| | | |
|---|---|---|
| Environmental Conditions | Temperature | 23°C |
| | Relative Humidity | 50% |
| | Atmospheric Pressure | 1019mbar |

4. Test Date : Oct 25th 2011
   Tested By :David Zhang

## Test Procedures:

**Radio output power measurement**

1. The transmitter output port was connected to spectrum analyzer.
2. Setup EUT into continuous transmitting mode with 100% duty cycle.
3. Select lowest, middle, and highest channels for each band and different possible test mode.
4. Measure the conducted peak burst power and conducted average burst power from EUT antenna port.

## Test Result:

### WLAN Mode

**802.11b/g/a/n mode (2.4GHz band)**

| Mode | Channel No. | Frequency (MHz) | Data Rate | Conducted Average Power(dBm) | Data Rate | Conducted Average Power(dBm) |
|---|---|---|---|---|---|---|
| 802.11b | 1 | 2412 | 1 Mbps | 14.95 | 11 Mbps | 17.89 |
| 802.11b | 7 | 2437 | 1 Mbps | 16.37 | 11 Mbps | 18.87 |
| 802.11b | 13 | 2462 | 1 Mbps | 14.99 | 11 Mbps | 17.73 |
| 802.11g | 1 | 2412 | 6Mbps | 8.57 | 54Mbps | 9.17 |
| 802.11g | 7 | 2437 | 6 Mbps | 9.97 | 54 Mbps | 10.47 |
| 802.11g | 13 | 2462 | 6 Mbps | 8.50 | 54 Mbps | 9.02 |
| 802.11a | 1 | 2412 | 6Mbps | 8.75 | 54Mbps | 9.28 |
| 802.11a | 7 | 2437 | 6 Mbps | 9.97 | 54 Mbps | 10.64 |
| 802.11a | 13 | 2462 | 6 Mbps | 8.53 | 54 Mbps | 9.23 |
| 802.11n-20MHz | 1 | 2412 | 7.2Mbps | 8.80 | 75.5Mbps | 8.85 |
| 802.11n-20MHz | 7 | 2437 | 7.2Mbps | 10.08 | 75.5Mbps | 10.14 |
| 802.11n-20MHz | 13 | 2462 | 72.2Mbps | 8.66 | 75.5Mbps | 8.70 |
| 802.11n-40MHz | 2 | 2422 | 72.2Mbps | 9.34 | 150Mbps | 9.40 |
| 802.11n-40MHz | 7 | 2437 | 72.2Mbps | 9.51 | 150Mbps | 9.61 |
| 802.11n-40MHz | 11 | 2452 | 72.2Mbps | 8.95 | 150Mbps | 9.00 |

802.11a (5GHz Band)

| Mode | Channel No. | Frequency (MHz) | Data Rate | Conducted Average Power(dBm) | Data Rate | Conducted Average Power(dBm) |
|---|---|---|---|---|---|---|
| 802.11a | 36 | 5180MHz | 6 Mbps | 16.64 | 54Mbps | 17.10 |
| 802.11a | 40 | 5200MHz | 6 Mbps | 16.34 | 54 Mbps | 16.86 |
| 802.11a | 44 | 5220MHz | 6 Mbps | 16.40 | 54 Mbps | 16.82 |
| 802.11a | 48 | 5240MHz | 6Mbps | 16.35 | 54Mbps | 16.82 |
| 802.11a | 52 | 5260MHz | 6 Mbps | 16.01 | 54 Mbps | 16.52 |
| 802.11a | 56 | 5280MHz | 6 Mbps | 16.00 | 54 Mbps | 16.52 |
| 802.11a | 60 | 5300MHz | 6Mbps | 15.88 | 54Mbps | 16.39 |
| 802.11a | 64 | 5320MHz | 6 Mbps | 16.49 | 54 Mbps | 16.78 |
| 802.11a | 100 | 5500MHz | 6 Mbps | 16.73 | 54 Mbps | 17.17 |
| 802.11a | 104 | 5520MHz | 6 Mbps | 16.66 | 54Mbps | 17.15 |
| 802.11a | 108 | 5540MHz | 6 Mbps | 16.06 | 54 Mbps | 16.67 |
| 802.11a | 112 | 5560MHz | 6 Mbps | 15.80 | 54 Mbps | 16.33 |
| 802.11a | 116 | 5580MHz | 6Mbps | 16.47 | 54Mbps | 16.91 |
| 802.11a | 132 | 5660MHz | 6 Mbps | 15.65 | 54 Mbps | 16.09 |
| 802.11a | 136 | 5680MHz | 6 Mbps | 14.78 | 54 Mbps | 15.29 |
| 802.11a | 140 | 5700MHz | 6 Mbps | 15.22 | 54Mbps | 15.58 |
| 802.11a | 149 | 5745MHz | 6 Mbps | 15.67 | 54 Mbps | 16.15 |
| 802.11a | 153 | 5765MHz | 6 Mbps | 15.24 | 54 Mbps | 15.68 |
| 802.11a | 157 | 5785MHz | 6Mbps | 15.11 | 54Mbps | 15.60 |
| 802.11a | 161 | 5805MHz | 6 Mbps | 15.43 | 54 Mbps | 15.94 |
| 802.11a | 165 | 5825MHz | 6 Mbps | 13.94 | 54 Mbps | 14.40 |

802.11n-20MHz (5GHz Band)

| Mode | Channel No. | Frequency (MHz) | Data Rate | Conducted Average Power(dBm) | Data Rate | Conducted Average Power(dBm) |
|---|---|---|---|---|---|---|
| 802.11n-20MHz | 36 | 5180MHz | 7.2Mbps | 17.25 | 75.5Mbps | 16.92 |
| 802.11n-20MHz | 40 | 5200MHz | 7.2Mbps | 17.04 | 75.5Mbps | 16.57 |
| 802.11n-20MHz | 44 | 5220MHz | 7.2Mbps | 16.86 | 75.5Mbps | 16.60 |
| 802.11n-20MHz | 48 | 5240MHz | 7.2Mbps | 17.06 | 75.5Mbps | 16.65 |
| 802.11n-20MHz | 52 | 5260MHz | 7.2Mbps | 16.45 | 75.5Mbps | 16.34 |
| 802.11n-20MHz | 56 | 5280MHz | 7.2Mbps | 16.74 | 75.5Mbps | 16.30 |
| 802.11n-20MHz | 60 | 5300MHz | 7.2Mbps | 16.51 | 75.5Mbps | 16.11 |
| 802.11n-20MHz | 64 | 5320MHz | 7.2Mbps | 16.29 | 75.5Mbps | 16.47 |
| 802.11n-20MHz | 100 | 5500MHz | 7.2Mbps | 17.05 | 75.5Mbps | 16.80 |
| 802.11n-20MHz | 104 | 5520MHz | 7.2Mbps | 16.96 | 75.5Mbps | 16.85 |
| 802.11n-20MHz | 108 | 5540MHz | 7.2Mbps | 16.39 | 75.5Mbps | 16.32 |
| 802.11n-20MHz | 112 | 5560MHz | 7.2Mbps | 16.00 | 75.5Mbps | 15.98 |
| 802.11n-20MHz | 116 | 5580MHz | 7.2Mbps | 16.56 | 75.5Mbps | 16.67 |
| 802.11n-20MHz | 132 | 5660MHz | 7.2Mbps | 15.91 | 75.5Mbps | 16.13 |
| 802.11n-20MHz | 136 | 5680MHz | 7.2Mbps | 15.18 | 75.5Mbps | 15.06 |
| 802.11n-20MHz | 140 | 5700MHz | 7.2Mbps | 15.46 | 75.5Mbps | 15.36 |
| 802.11n-20MHz | 149 | 5745MHz | 7.2Mbps | 15.96 | 75.5Mbps | 15.75 |
| 802.11n-20MHz | 153 | 5765MHz | 7.2Mbps | 15.57 | 75.5Mbps | 15.23 |
| 802.11n-20MHz | 157 | 5785MHz | 7.2Mbps | 15.34 | 75.5Mbps | 15.18 |
| 802.11n-20MHz | 161 | 5805MHz | 7.2Mbps | 15.55 | 75.5Mbps | 15.31 |
| 802.11n-20MHz | 165 | 5825MHz | 7.2Mbps | 14.09 | 75.5Mbps | 13.90 |

802.11n-40MHz (5GHz Band)

| Mode | Channel No. | Frequency (MHz) | Data Rate | Conducted Average Power(dBm) | Data Rate | Conducted Average Power(dBm) |
|---|---|---|---|---|---|---|
| 802.11n-40MHz | 40 | 5190MHz | 15Mbps | 16.65 | 150Mbps | 16.65 |
| 802.11n-40MHz | 48 | 5230MHz | 15Mbps | 16.52 | 150Mbps | 16.56 |
| 802.11n-40MHz | 56 | 5270MHz | 15Mbps | 16.53 | 150Mbps | 16.61 |
| 802.11n-40MHz | 64 | 5310MHz | 15Mbps | 16.34 | 150Mbps | 16.60 |
| 802.11n-40MHz | 104 | 5510MHz | 15Mbps | 16.21 | 150Mbps | 16.29 |
| 802.11n-40MHz | 112 | 5550MHz | 15Mbps | 16.23 | 150Mbps | 16.21 |
| 802.11n-40MHz | 136 | 5670MHz | 15Mbps | 16.57 | 150Mbps | 17.01 |
| 802.11n-40MHz | 153 | 5755MHz | 15Mbps | 15.44 | 150Mbps | 15.48 |
| 802.11n-40MHz | 161 | 5795MHz | 15Mbps | 15.74 | 150Mbps | 15.81 |

## Bluetooth Mode

### Bluetooth Measurement Result

| Mode | Channel No. | Frequency (MHz) | Data Rate | Conducted Average Power(dBm) |
|---|---|---|---|---|
| Basic Rate | 0 | 2402 | 1Mbps | 7.76 |
| Basic Rate | 0 | 2441 | 1Mbps | 7.20 |
| Basic Rate | 0 | 2480 | 1Mbps | 6.68 |
| EDR | 1 | 2412 | 3Mbps | 4.64 |
| EDR | 7 | 2442 | 3Mbps | 5.72 |
| EDR | 13 | 2480 | 3Mbps | 5.16 |

# 9 SAR TEST Summary

## Test Condition:

1. SAR Measurement

2 Measurement Uncertainty: See page 26 for detail

3 Environmental Conditions

| | |
|---|---|
| Temperature | 23°C |
| Relative Humidity | 50% |
| Atmospheric Pressure | 1019mbar |

4 Test Date : Oct 25th 2011
Tested By :David Zhang

## Test Procedures:

1. Establish communication link between EUT and base station emulation by air link.
2. Consider the SAR test reduction per FCC KDB guide line. Set EUT into highest output power channel with test mode which has the maximum average burst power listed in power table.
3. Place the EUT in the selected test position. (Cheek, tilt or flat)
4. Perform SAR testing at highest output power channel under the selected test mode. If the measured 1-g SAR is ≤ 0.8 W/kg, then testing for the other channel will not be performed.
4. Measure the conducted peak burst power and conducted average burst power from EUT antenna port.

SAR measurement system will proceed the following basic steps:

1. Initial power reference measurement
2. Area Scan
3. Zoom Scan
4. Power drift measurement

Area Scan and Zoom Scan Description:

The resolution for 2.4GHz band SAR measurement is at below,

| | |
|---|---|
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | dx=5mm dy=5mm dz=3mm |
| Zoom Scan Volume | 90mm x 60mm x 40mm |

The resolution for 5GHz band SAR measurement is at below,

| | |
|---|---|
| Area Scan | dx=8mm dy=8mm |
| Zoom Scan | dx=4mm dy=4mm dz=2.5mm |
| Zoom Scan Volume | 90mm x 60mm x 40mm |

**Test Configuration Summary:**

1. For 2.4GHz band, SAR testing was performed under 802.11b mode, with 11Mbps data rate, which had the highest average output power; and the 802.11n mode was also verified.
2. For 5GHz band, SAR testing was performed under 802.11n mode with both 20MHz bandwidth wide and 40MHz bandwidth setting. The recommended default channel per KDB Publication 248227 and the channel with highest output power were considered during selecting the channels for testing.
3. QLn320 and QLn220 are body worn products and manufacturer declares that they will be used only with the bottom touching human body. So only SAR testing with bottom side of EUT against phantom was performed.
4. Testing for BT mode was not performed due to the low output power.

## Test Result:

# WIFI Mode

**Body Worn SAR Test Result for QLn320 working at 2.4GHz band, High data rate (Separation distance: 0cm)**

| Test Configuration , **Body** | | | Crest Factor : 0 | | Date of Measured : Oct 25th, 2011 | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Freq Band | Mode | Channel | Position | SAR 1g(W/kg) | 1g SAR Limit (W/kg) | Variation (%) |
| 2412MHz | 802.11b | 1 | Bottom | 0.167 | 1.6 | -3.35 |
| 2437MHz | 802.11b | 7 | Bottom | 0.100 | 1.6 | -3.10 |
| 2462MHz | 802.11b | 13 | Bottom | 0.089 | 1.6 | -2.97 |
| 2412MHz | 802.11n | 1 | Bottom | 0.03 | 1.6 | -1.11 |
| 2437MHz | 802.11n | 7 | Bottom | 0.033 | 1.6 | -3.12 |
| 2462MHz | 802.11n | 13 | Bottom | 0.024 | 1.6 | -2.31 |

**Body Worn SAR Test Result for QLn320 working at 5GHz band (Separation distance: 0cm)**

| Test Configuration , **Body** | | | Crest Factor : 0 | | Date of Measured : Oct 25th, 2011 | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Freq Band | Mode | Channel | Position | SAR 1g(W/kg) | 1g SAR Limit (W/kg) | Variation (%) |
| 5180 | 802.11n-20MHz | 36 | Bottom | 0.168 | 1.6 | -0.02 |
| 5240 | 802.11n-20MHz | 48 | Bottom | 0.180 | 1.6 | 0.55 |
| 5280 | 802.11n-20MHz | 56 | Bottom | 0.179 | 1.6 | 0.66 |
| 5500 | 802.11n-20MHz | 100 | Bottom | 0.144 | 1.6 | 0.74 |
| 5580 | 802.11n-20MHz | 116 | Bottom | 0.120 | 1.6 | 1.28 |
| 5680 | 802.11n-20MHz | 136 | Bottom | 0.096 | 1.6 | -0.96 |
| 5745 | 802.11n-20MHz | 149 | Bottom | 0.096 | 1.6 | -3.84 |
| 5805 | 802.11n-20MHz | 161 | Bottom | 0.103 | 1.6 | -4.37 |
| 5825 | 802.11n-20MHz | 165 | Bottom | 0.104 | 1.6 | -4.50 |
| 5190 | 802.11n-40MHz | 40 | Bottom | 0.138 | 1.6 | 1.19 |
| 5230 | 802.11n-40MHz | 48 | Bottom | 0.152 | 1.6 | -3.94 |
| 5310 | 802.11n-40MHz | 64 | Bottom | 0.142 | 1.6 | 1.25 |
| 5510 | 802.11n-40MHz | 104 | Bottom | 0.116 | 1.6 | 1.47 |
| 5550 | 802.11n-40MHz | 112 | Bottom | 0.101 | 1.6 | -0.51 |
| 5670 | 802.11n-40MHz | 136 | Bottom | 0.077 | 1.6 | -3.73 |
| 5755 | 802.11n-40MHz | 153 | Bottom | 0.091 | 1.6 | -3.08 |
| 5795 | 802.11n-40MHz | 161 | Bottom | 0.096 | 1.6 | -1.81 |

Note: For 5GHz band, the SAR for 802.11n 20MHz Bandwidth was measured with low data rate, 7.2Mbps; the SAR for 802.11n 40MHz bandwidth was measured with high data rate, 150Mbps.

**Body Worn SAR Test Result for QLn220 working at 2.4GHz band (Separation distance: 0cm)**

| Test Configuration , **Body** | | | Crest Factor : 0 | | Date of Measured : Oct 25th, 2011 | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Freq Band | Mode | Channel | Position | SAR 1g(W/kg) | 1g SAR Limit (W/kg) | 1g SAR Limit (W/kg) |
| 2412MHz | 802.11b | 1 | Bottom | 0.223 | 1.6 | -4.28 |
| 2437MHz | 802.11b | 7 | Bottom | 0.175 | 1.6 | -3.91 |
| 2462MHz | 802.11b | 13 | Bottom | 0.156 | 1.6 | -1.74 |
| 2412MHz | 802.11n | 1 | Bottom | 0.034 | 1.6 | -1.20 |
| 2437MHz | 802.11n | 7 | Bottom | 0.028 | 1.6 | 3.55 |
| 2462MHz | 802.11n | 13 | Bottom | 0.034 | 1.6 | -3.95 |

**Body Worn SAR Test Result for Qln220 working at 5GHz band (Separation distance: 0cm)**

| Test Configuration , **Body** | | | Crest Factor : 0 | | Date of Measured : Oct 25th, 2011 | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Freq Band | Mode | Channel | Position | SAR 1g(W/kg) | 1g SAR Limit (W/kg) | 1g SAR Limit (W/kg) |
| 5180 | 802.11n-20MHz | 36 | Bottom | 0.538 | 1.6 | -2.03 |
| 5240 | 802.11n-20MHz | 48 | Bottom | 0.552 | 1.6 | -4.70 |
| 5280 | 802.11n-20MHz | 56 | Bottom | 0.514 | 1.6 | -4.18 |
| 5500 | 802.11n-20MHz | 100 | Bottom | 0.531 | 1.6 | -4.47 |
| 5580 | 802.11n-20MHz | 116 | Bottom | 0.488 | 1.6 | -4.48 |
| 5680 | 802.11n-20MHz | 136 | Bottom | 0.34 | 1.6 | -3.82 |
| 5745 | 802.11n-20MHz | 149 | Bottom | 0.271 | 1.6 | -3.54 |
| 5805 | 802.11n-20MHz | 161 | Bottom | 0.308 | 1.6 | -2.15 |
| 5825 | 802.11n-20MHz | 165 | Bottom | 0.286 | 1.6 | -3.45 |
| 5190 | 802.11n-40MHz | 40 | Bottom | 0.644 | 1.6 | -3.16 |
| 5230 | 802.11n-40MHz | 48 | Bottom | 0.563 | 1.6 | -3.26 |
| 5310 | 802.11n-40MHz | 64 | Bottom | 0.57 | 1.6 | -4.85 |
| 5510 | 802.11n-40MHz | 104 | Bottom | 0.54 | 1.6 | -4.38 |
| 5550 | 802.11n-40MHz | 112 | Bottom | 0.521 | 1.6 | -3.30 |
| 5670 | 802.11n-40MHz | 136 | Bottom | 0.293 | 1.6 | -4.16 |
| 5755 | 802.11n-40MHz | 153 | Bottom | 0.332 | 1.6 | -3.37 |
| 5795 | 802.11n-40MHz | 161 | Bottom | 0.292 | 1.6 | -4.54 |

## Bluetooth Mode

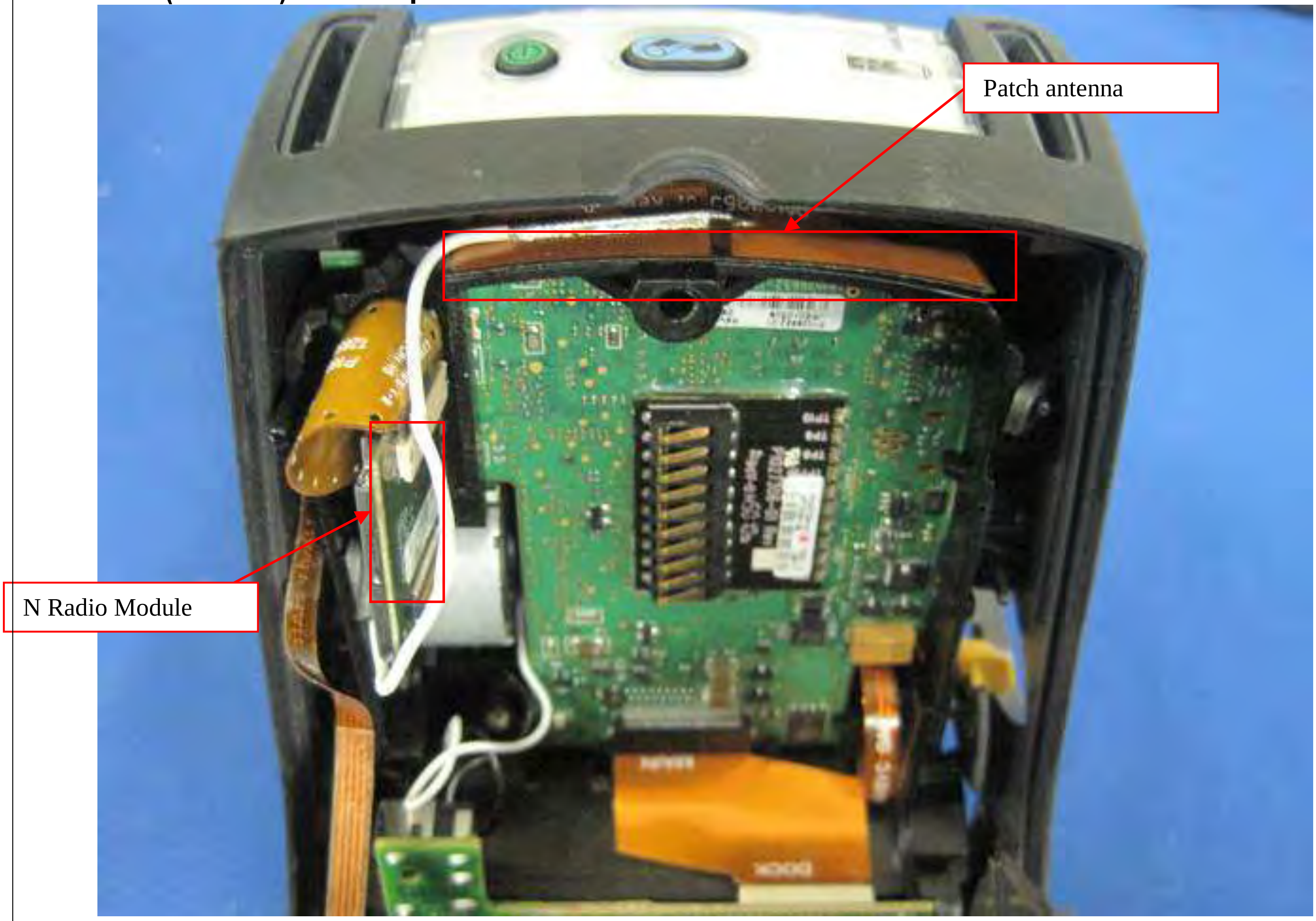
## N/A

Note: SAR for Bluetooth mode was not applicable because of the low output power.

## KDB & Simultaneous SAR Evaluation.

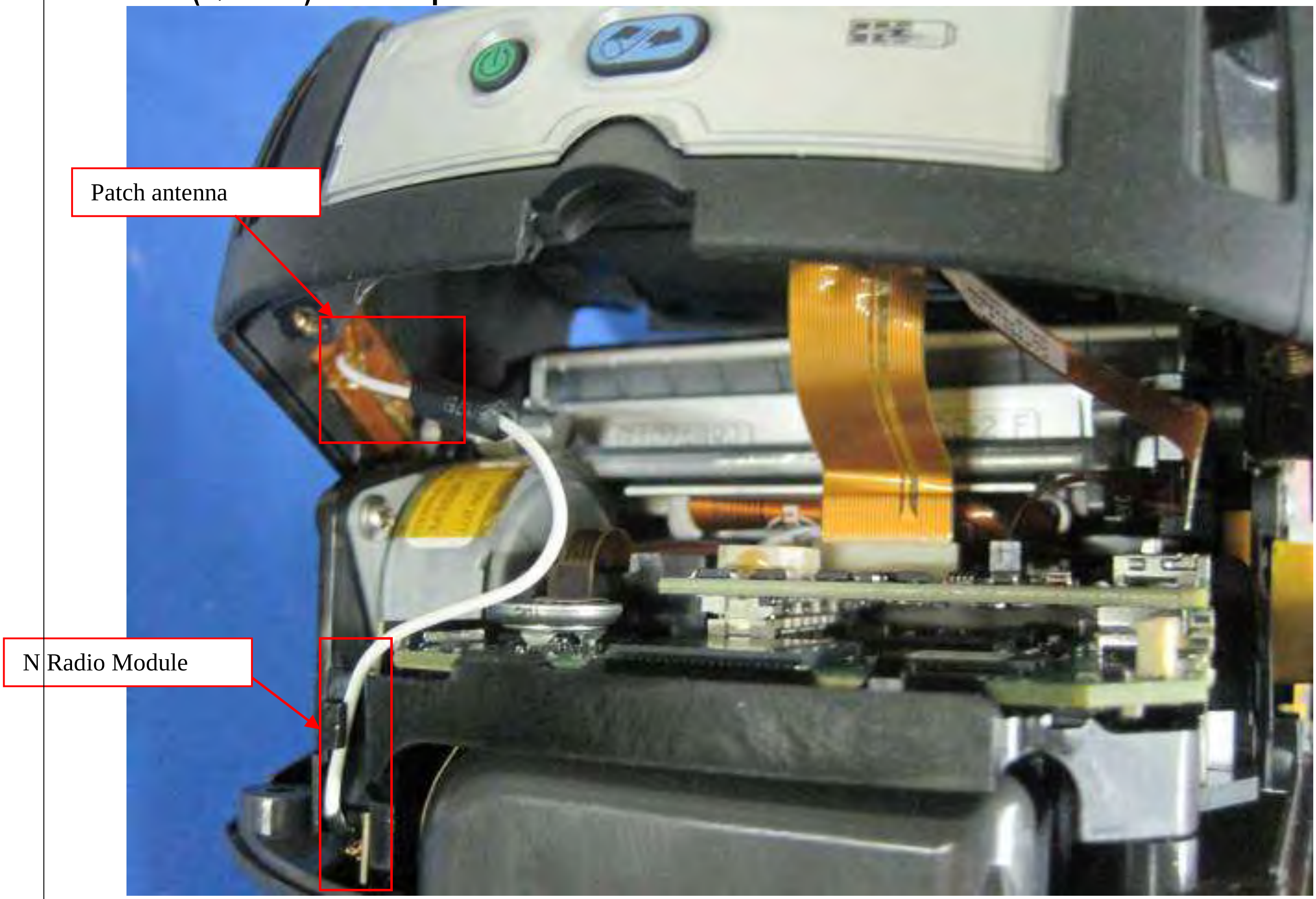
**N/A**

## EUT (QLn220) Internal picture:




QLn220 Internal View

## EUT (QLn320) Internal picture:

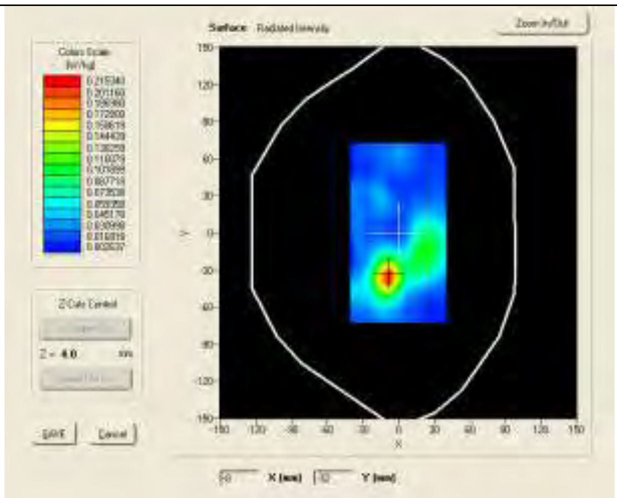


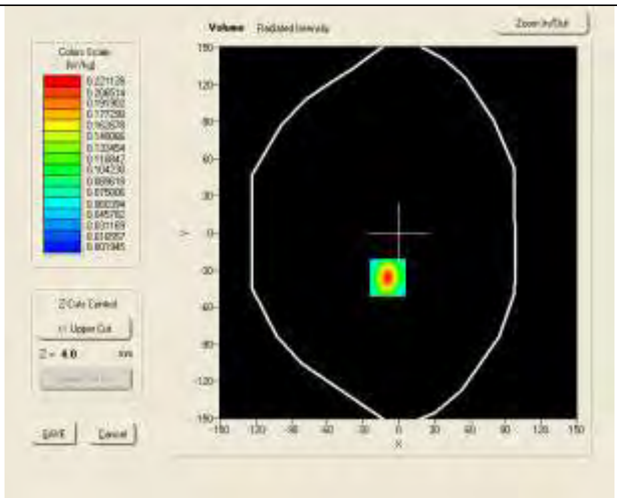

**QLn320 Internal View**

## SAR measurement Plots

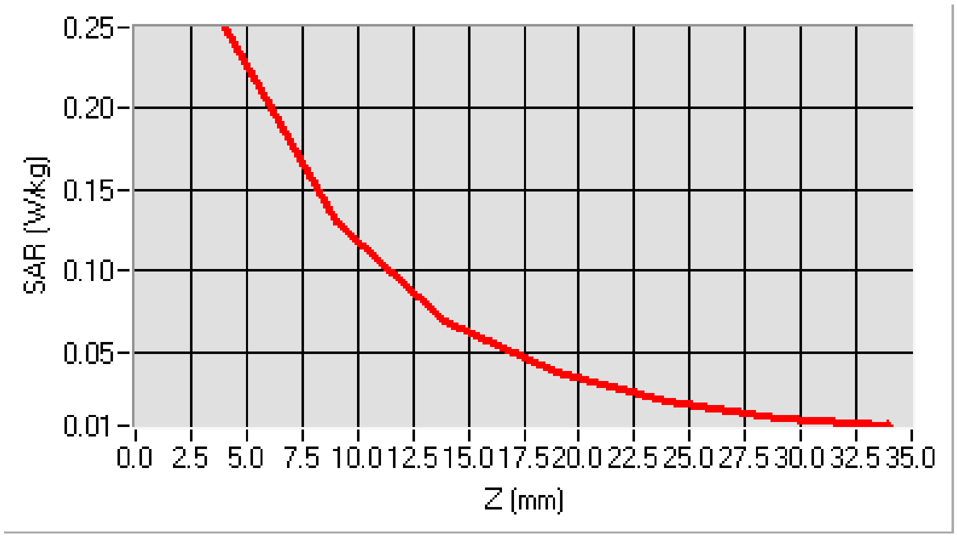
**Test Mode:** 802.11b low channel (11Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 2412.00 (Flat) |
| Relative permittivity (real part) | 52.875 |
| Relative permittivity (imaginary part) | 14.26 |
| Conductivity (S/m) | 1.702 |
| Variation (%) | -3.35 |
| SAR 10g (W/Kg) | 0.105 |
| SAR 1g (W/Kg) | 0.223 |
| **SURFACE SAR** | **VOLUME SAR** |



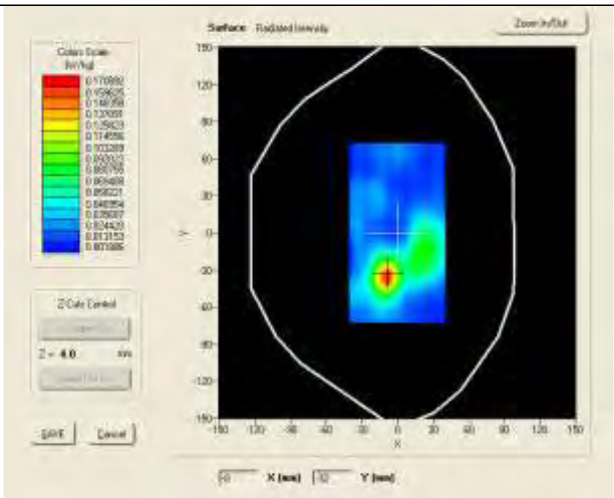
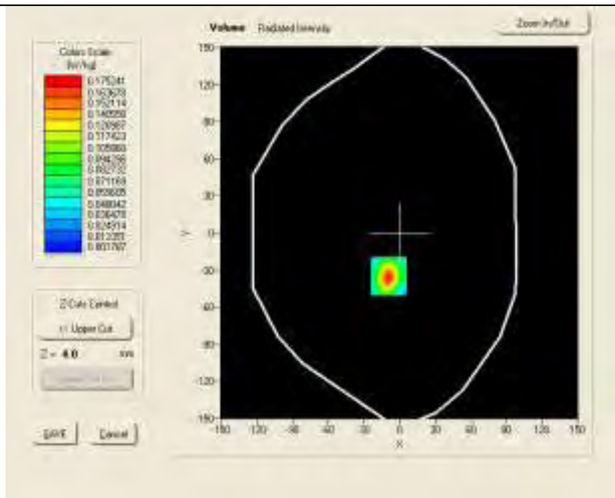


SAR, Z Axis Scan (X = -9, Y = -36)

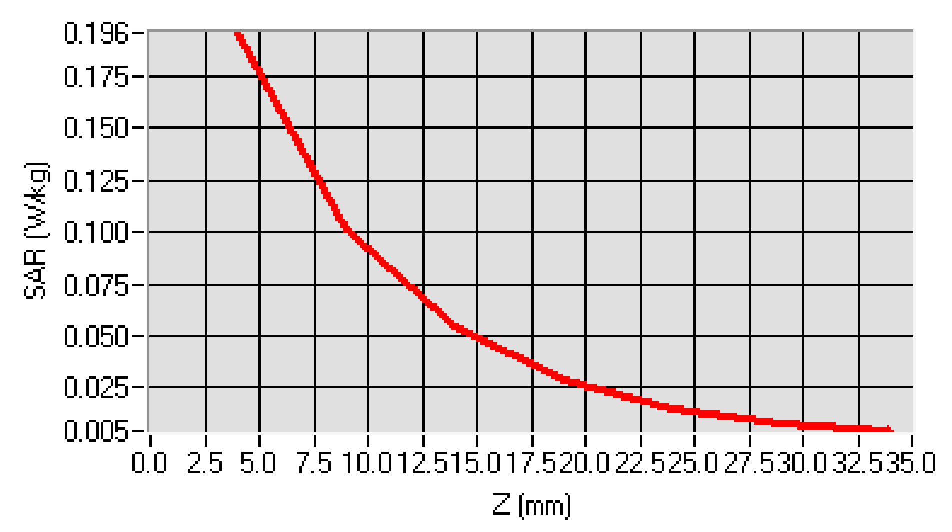


## SAR measurement Plots

**Test Mode:** 802.11b Mid channel (11Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

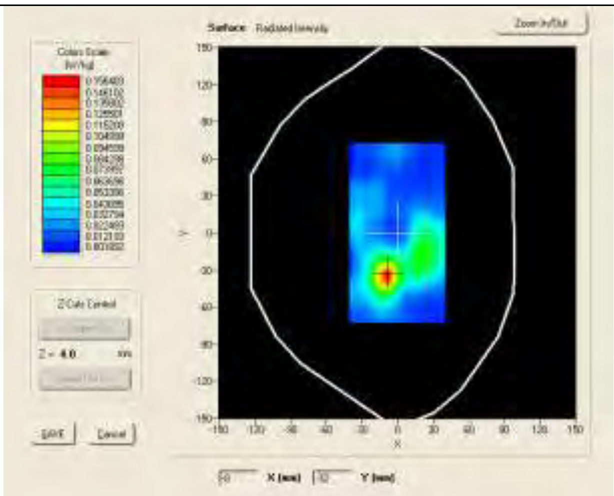
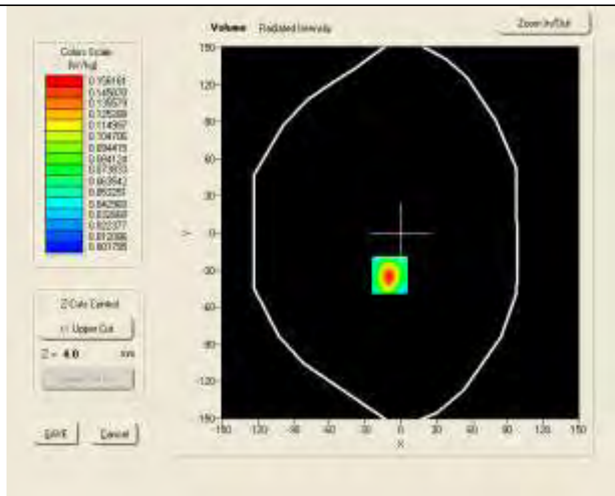
| | |
|---|---|
| Frequency (MHz) | 2437.00 (Flat) |
| Relative permittivity (real part) | 52.910 |
| Relative permittivity (imaginary part) | 14.31 |
| Conductivity (S/m) | 1.745 |
| Variation (%) | -3.10 |
| SAR 10g (W/Kg) | 0.082 |
| SAR 1g (W/Kg) | 0.175 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

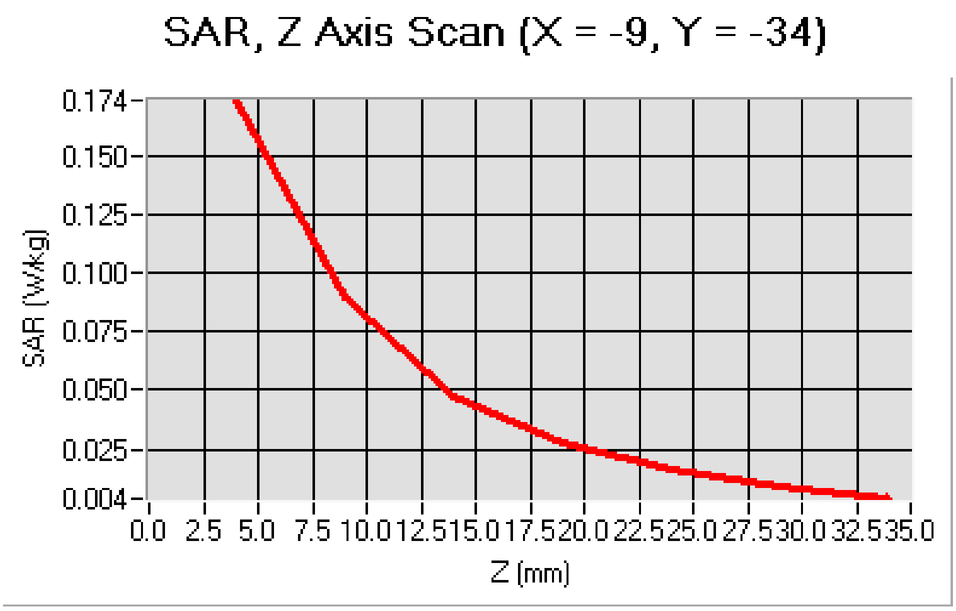
SAR, Z Axis Scan (X = -9, Y = -35)



## SAR measurement Plots

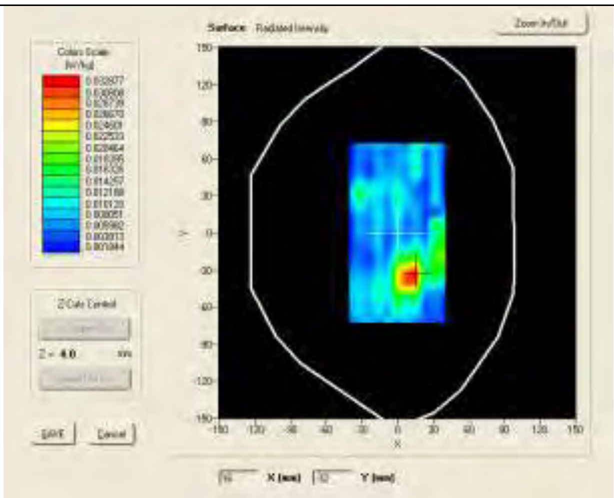
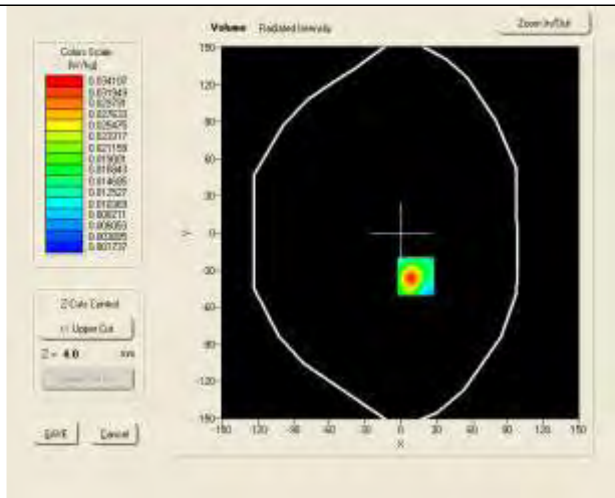
**Test Mode:** 802.11b High channel (11Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

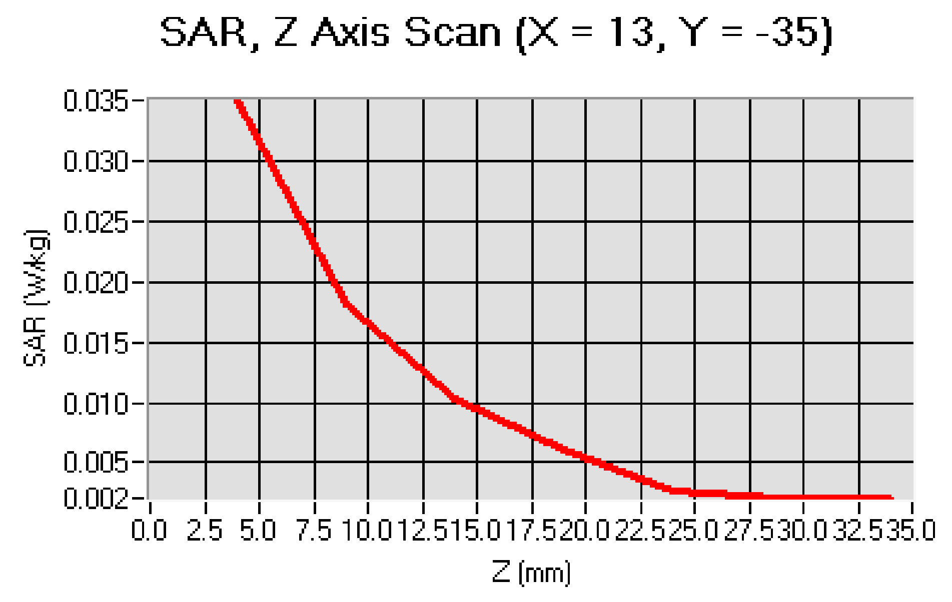
| | |
|---|---|
| Frequency (MHz) | 2462.00 (Flat) |
| Relative permittivity (real part) | 52.943 |
| Relative permittivity (imaginary part) | 14.31 |
| Conductivity (S/m) | 1.788 |
| Variation (%) | -2.97 |
| SAR 10g (W/Kg) | 0.073 |
| SAR 1g (W/Kg) | 0.156 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

**Test Mode:** 802.11n low channel (54Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

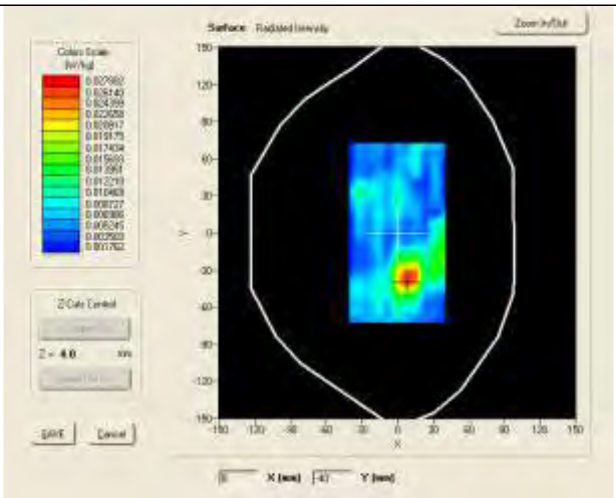
| | |
|---|---|
| Frequency (MHz) | 2412.00 (Flat) |
| Relative permittivity (real part) | 52.875 |
| Relative permittivity (imaginary part) | 14.26 |
| Conductivity (S/m) | 1.702 |
| Variation (%) | -1.11 |
| SAR 10g (W/Kg) | 0.016 |
| SAR 1g (W/Kg) | 0.034 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

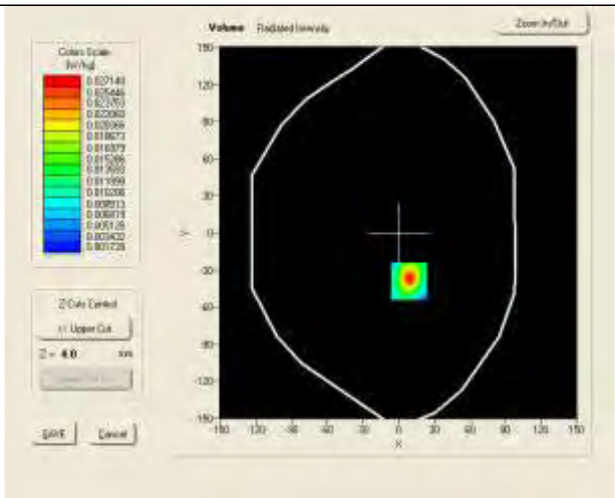


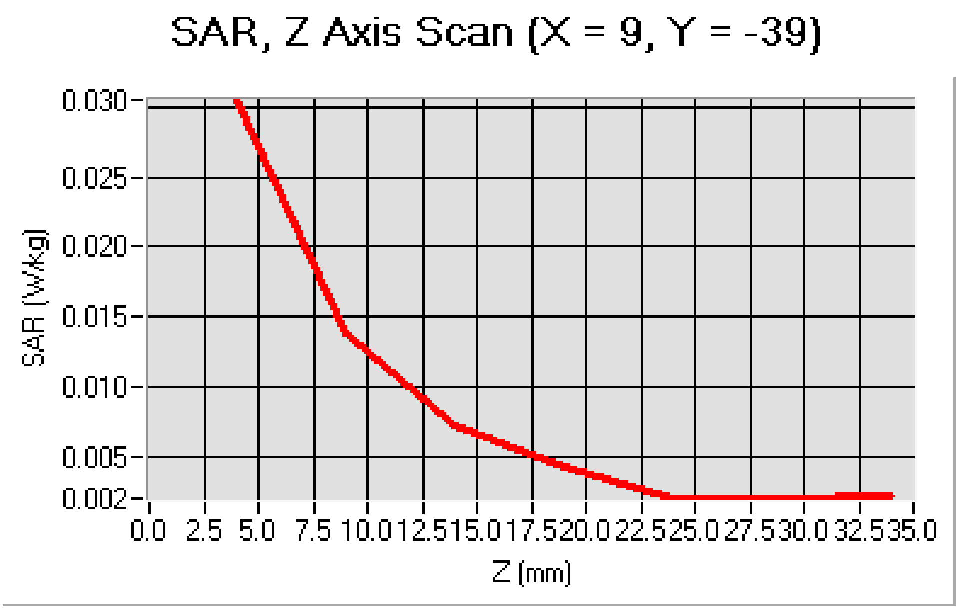
## SAR measurement Plots

**Test Mode:** 802.11n Mid channel (54Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 2437.00 (Flat) |
| Relative permittivity (real part) | 52.910 |
| Relative permittivity (imaginary part) | 14.31 |
| Conductivity (S/m) | 1.745 |
| Variation (%) | -3.12 |
| SAR 10g (W/Kg) | 0.012 |
| SAR 1g (W/Kg) | 0.028 |
| **SURFACE SAR** | **VOLUME SAR** |



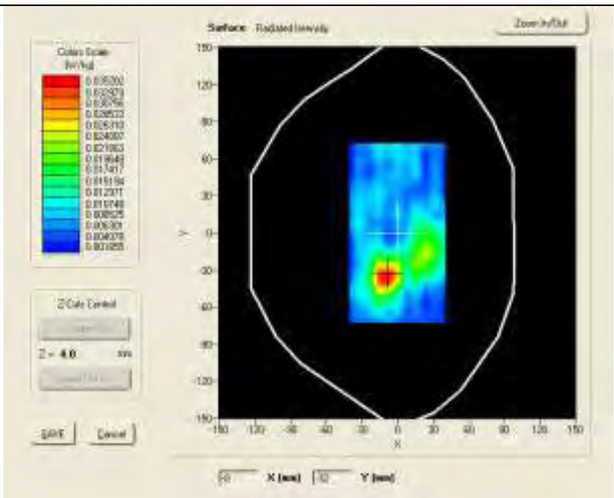


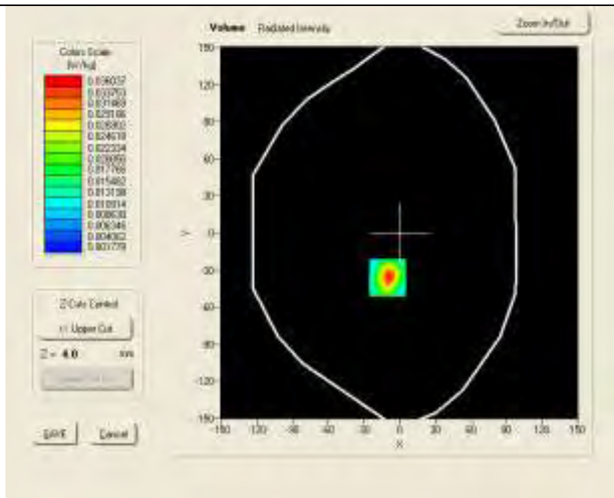


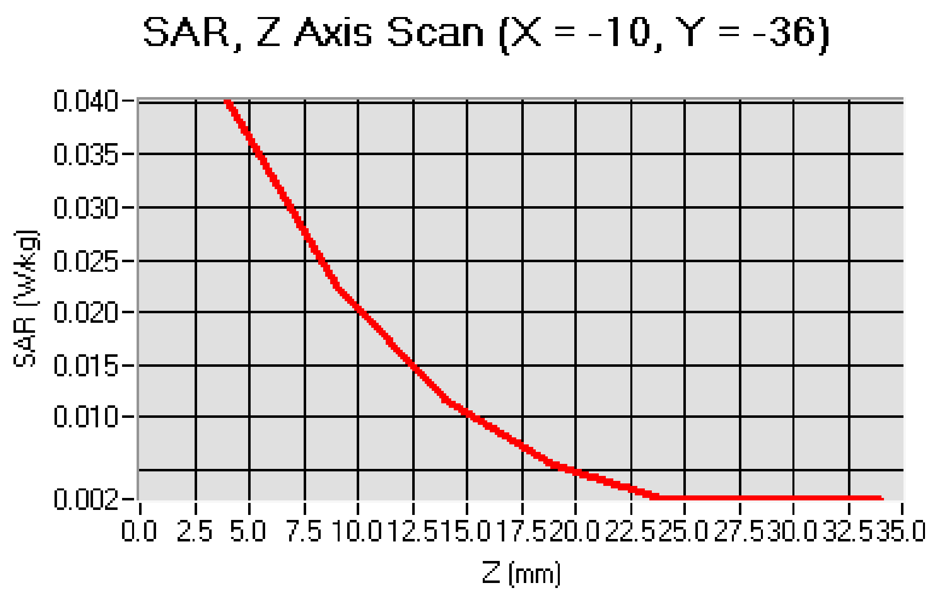
## SAR measurement Plots

**Test Mode:** 802.11n High channel (54Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 2462.00 (Flat) |
| Relative permittivity (real part) | 52.943 |
| Relative permittivity (imaginary part) | 14.31 |
| Conductivity (S/m) | 1.788 |
| Variation (%) | -2.31 |
| SAR 10g (W/Kg) | 0.017 |
| SAR 1g (W/Kg) | 0.034 |
| **SURFACE SAR** | **VOLUME SAR** |

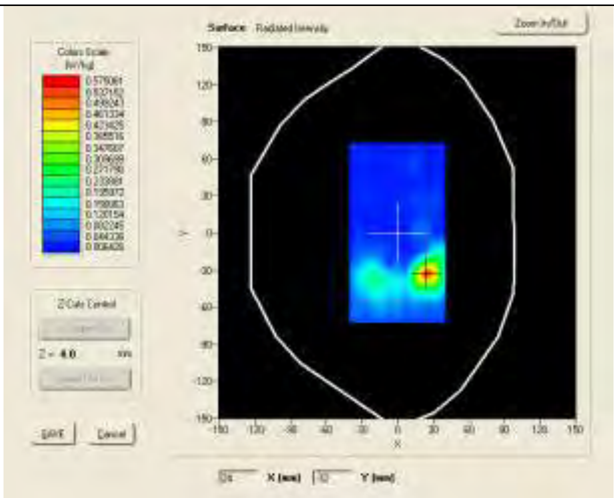
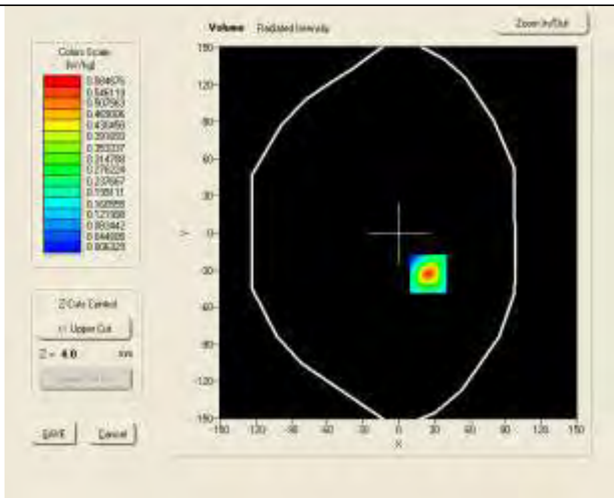


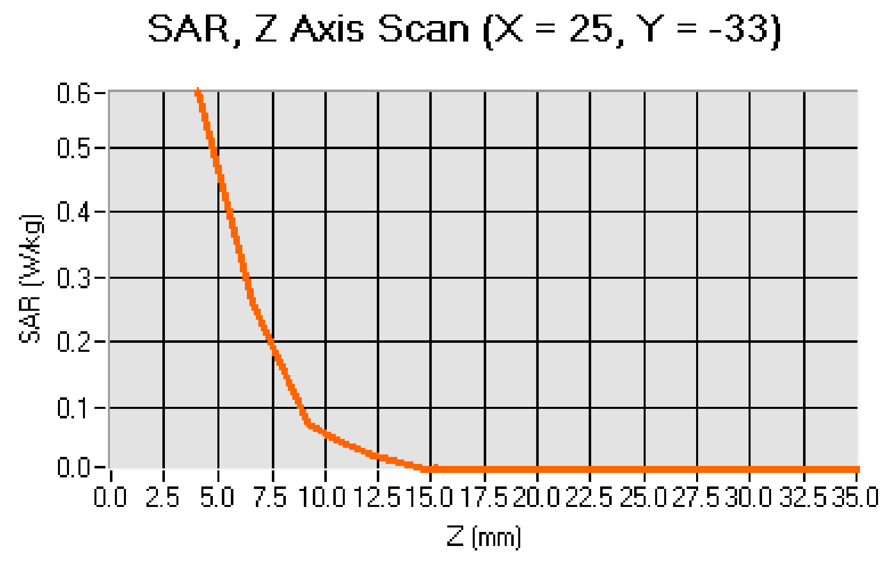




## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 36 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

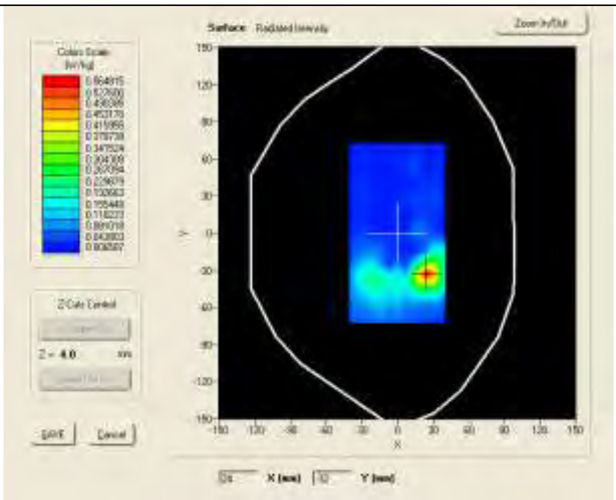
| | |
|---|---|
| Frequency (MHz) | 5180.00 (Flat) |
| Relative permittivity (real part) | 47.563 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.249 |
| Variation (%) | -0.02 |
| SAR 10g (W/Kg) | 0.188 |
| SAR 1g (W/Kg) | 0.538 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

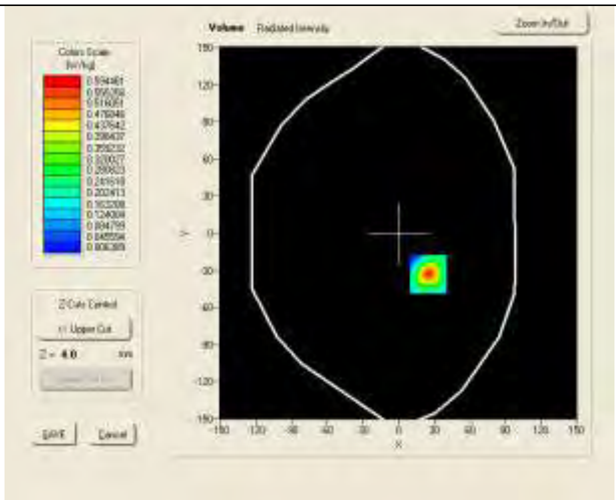


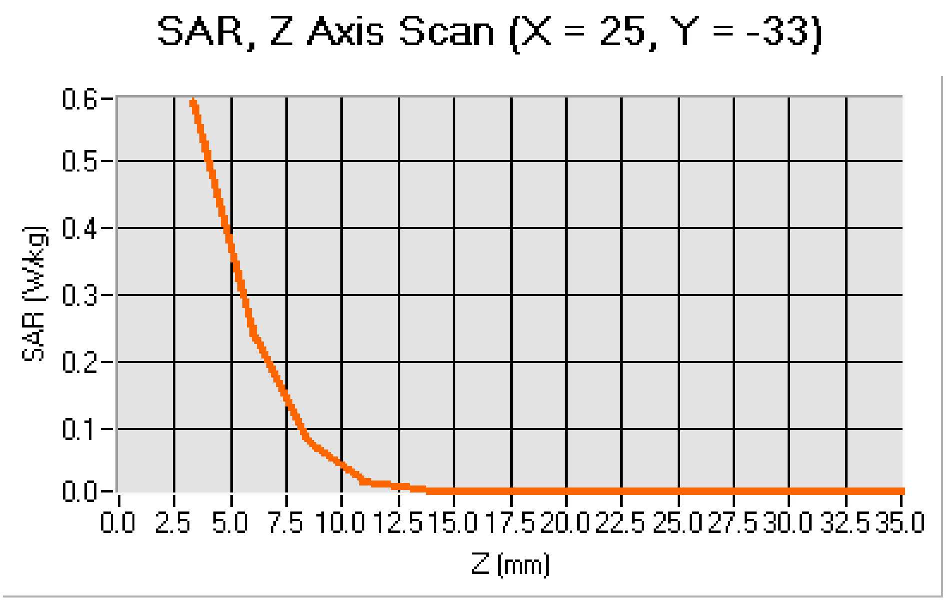
## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 48 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| Frequency (MHz) | 5240.00 (Flat) |
|---|---|
| Relative permittivity (real part) | 47.848 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.331 |
| Variation (%) | 0.55 |
| SAR 10g (W/Kg) | 0.192 |
| SAR 1g (W/Kg) | 0.552 |
| **SURFACE SAR** | **VOLUME SAR** |



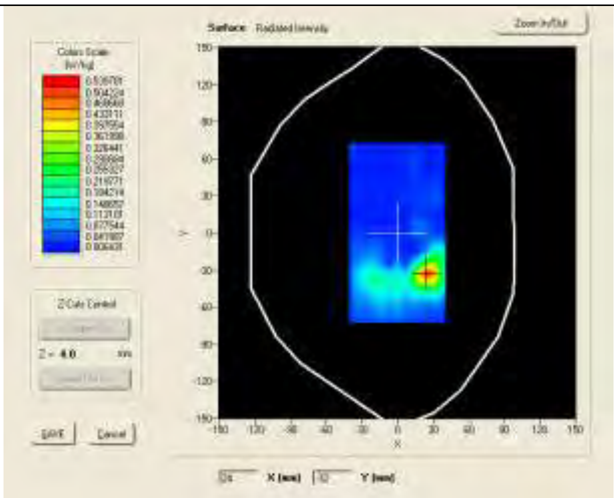


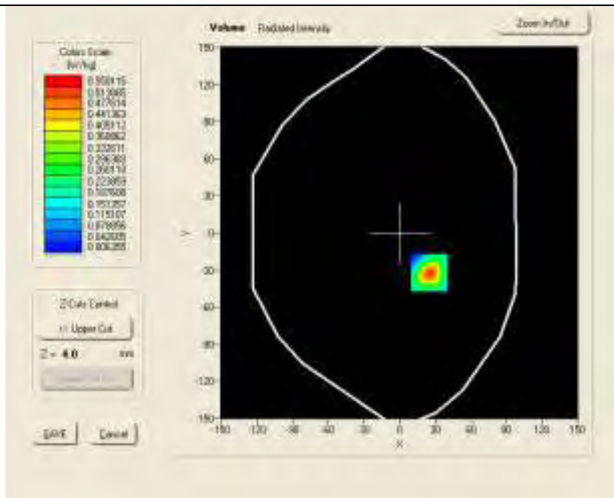


## SAR measurement Plots

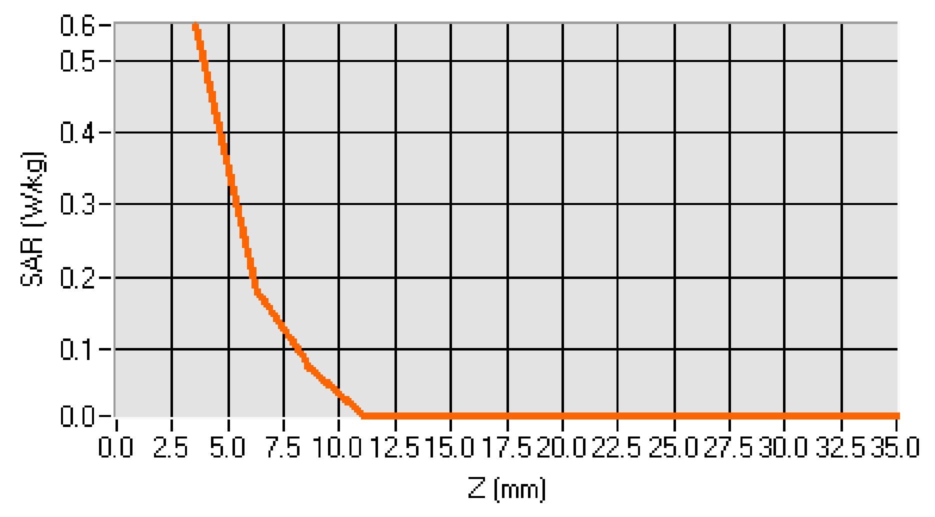
**Test Mode:** 802.11n-20MHz 56 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5280.00 (Flat) |
| Relative permittivity (real part) | 47.902 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.378 |
| Variation (%) | 0.66 |
| SAR 10g (W/Kg) | 0.180 |
| SAR 1g (W/Kg) | 0.514 |
| **SURFACE SAR** | **VOLUME SAR** |





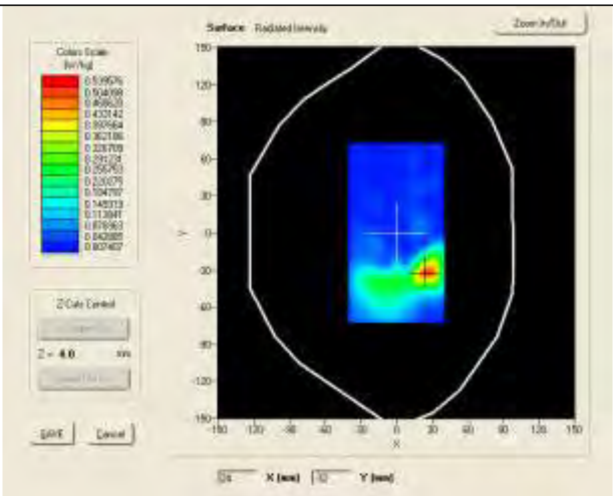
SAR, Z Axis Scan (X = 25, Y = -32)

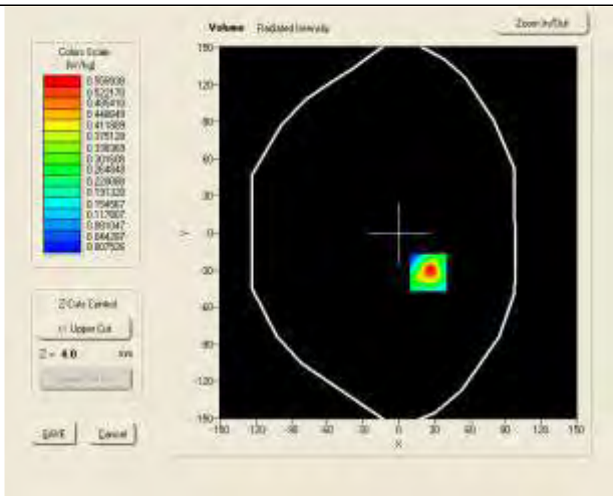


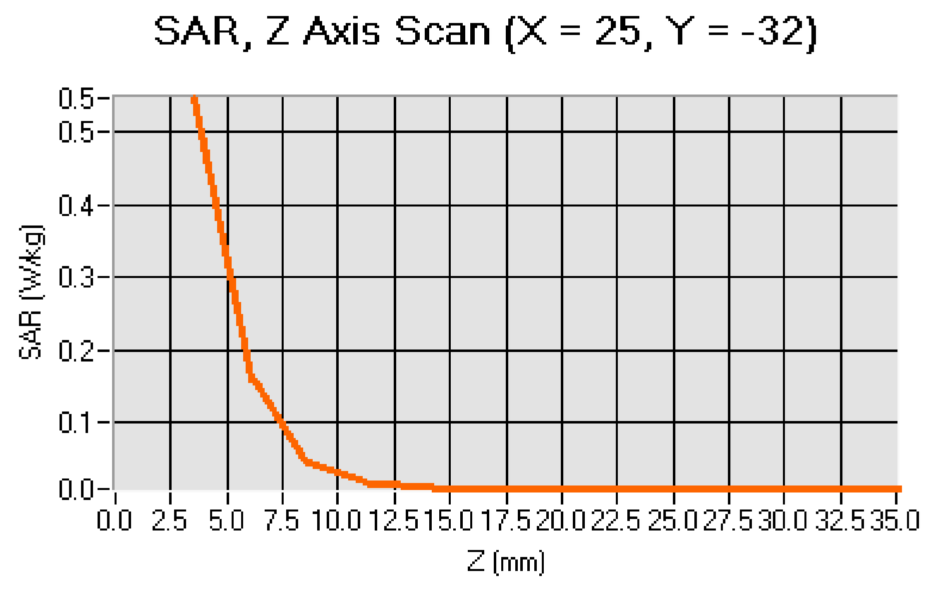
## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 100 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5500.00 (Flat) |
| Relative permittivity (real part) | 48.978 |
| Relative permittivity (imaginary part) | 16.19 |
| Conductivity (S/m) | 5.577 |
| Variation (%) | 0.74 |
| SAR 10g (W/Kg) | 0.185 |
| SAR 1g (W/Kg) | 0.531 |
| **SURFACE SAR** | **VOLUME SAR** |



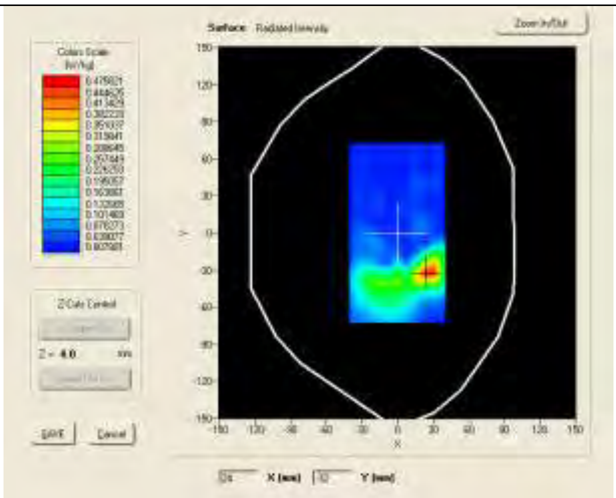


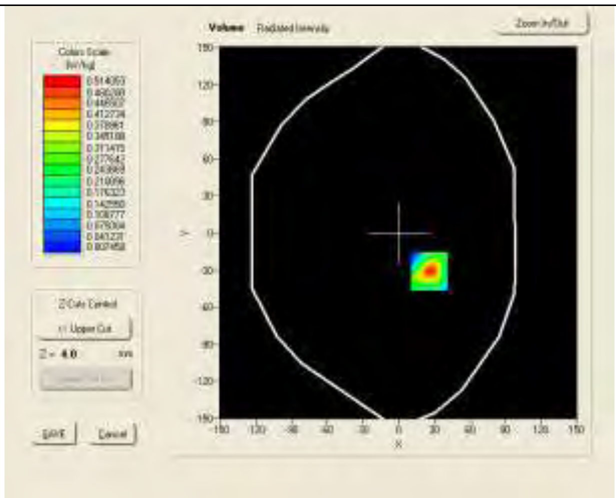


## SAR measurement Plots

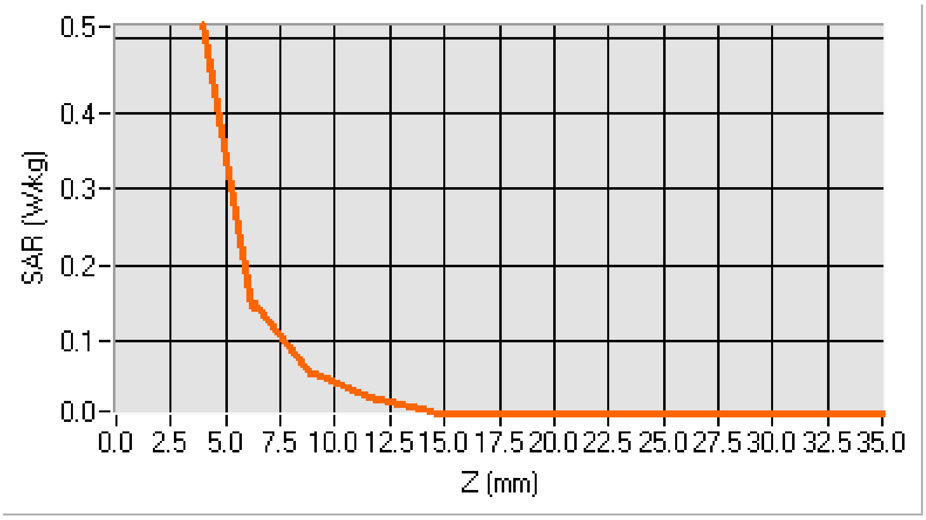
**Test Mode:** 802.11n-20MHz 116 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5580.00 (Flat) |
| Relative permittivity (real part) | 49.089 |
| Relative permittivity (imaginary part) | 16.19 |
| Conductivity (S/m) | 5.669 |
| Variation (%) | 1.28 |
| SAR 10g (W/Kg) | 0.178 |
| SAR 1g (W/Kg) | 0.488 |
| **SURFACE SAR** | **VOLUME SAR** |





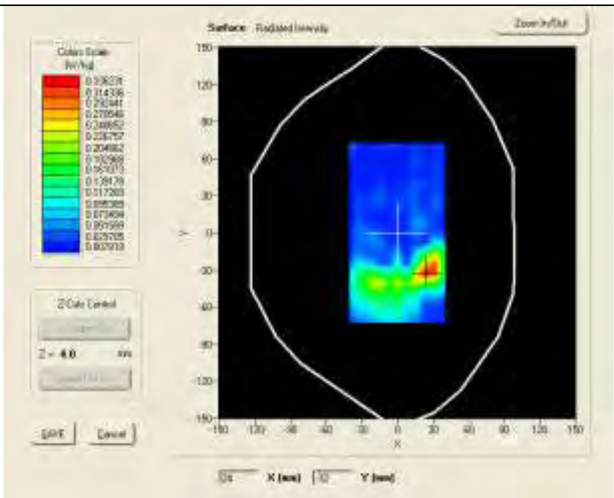
SAR, Z Axis Scan (X = 26, Y = -31)

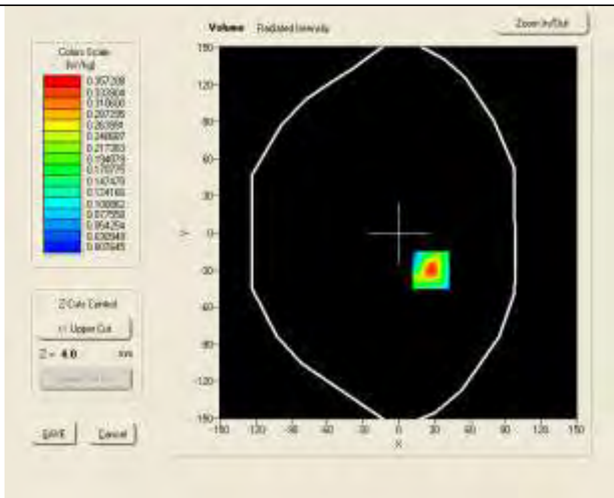


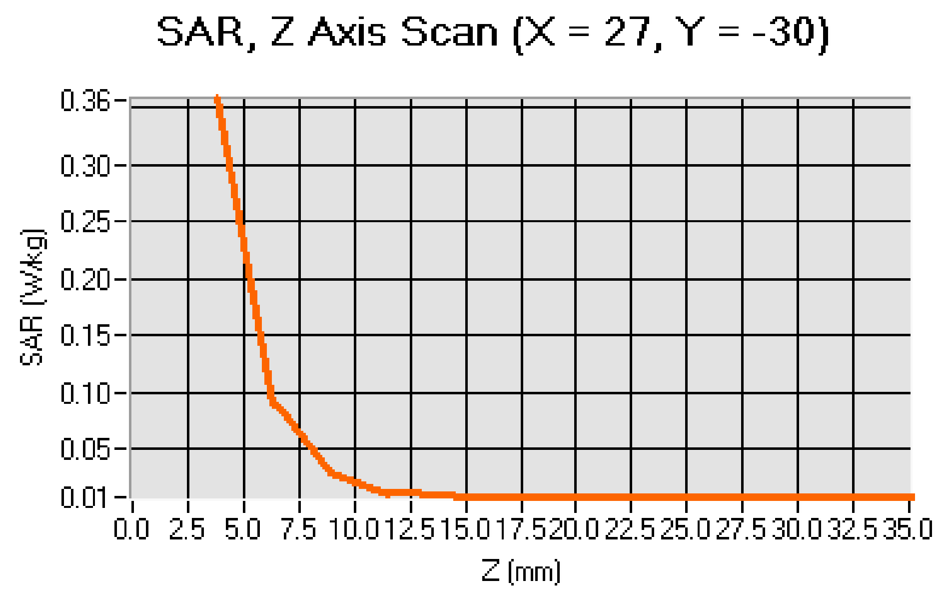
## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 136 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5680.00 (Flat) |
| Relative permittivity (real part) | 48.359 |
| Relative permittivity (imaginary part) | 16.19 |
| Conductivity (S/m) | 5.830 |
| Variation (%) | -0.96 |
| SAR 10g (W/Kg) | 0.125 |
| SAR 1g (W/Kg) | 0.340 |
| **SURFACE SAR** | **VOLUME SAR** |



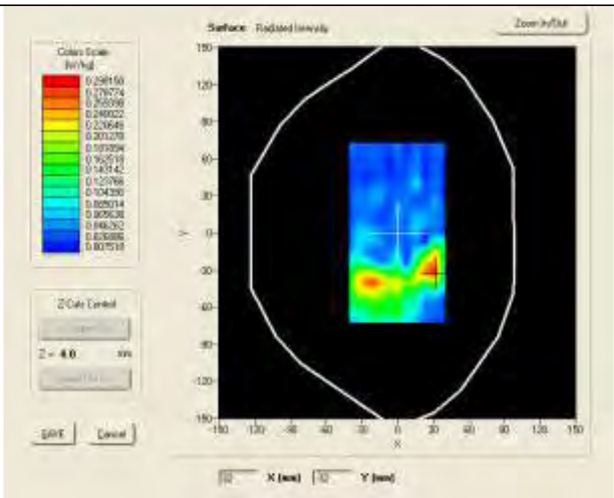


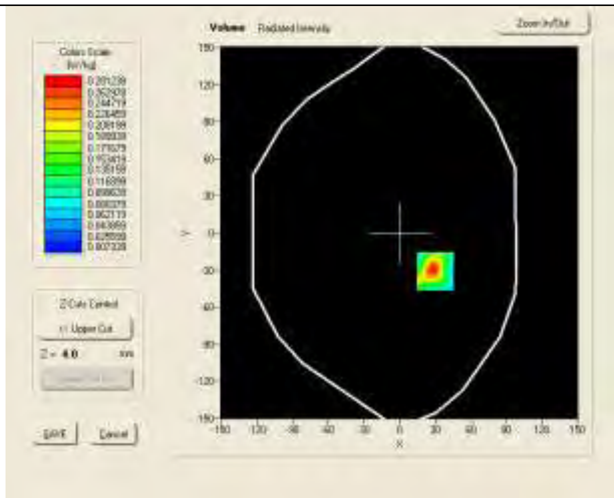


# SAR measurement Plots

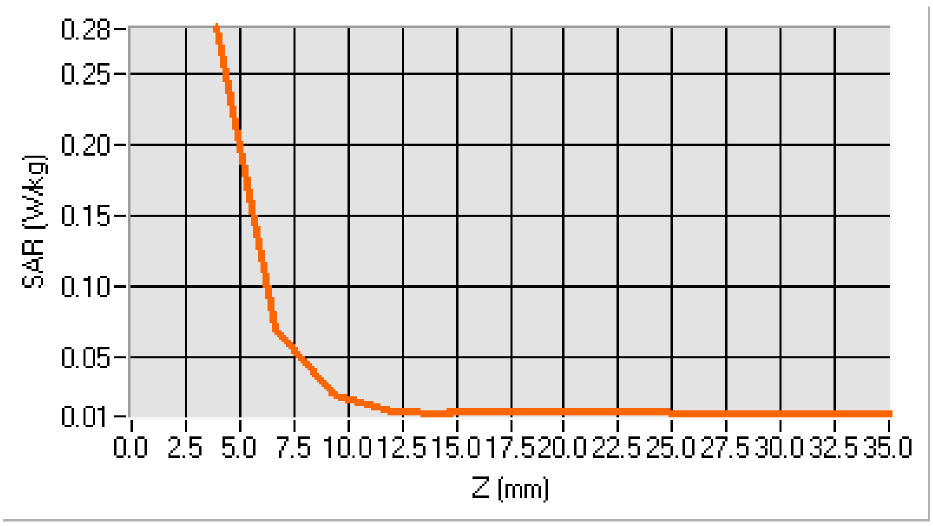
**Test Mode:** 802.11n-20MHz 149 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5745.00 (Flat) |
| Relative permittivity (real part) | 48.447 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.905 |
| Variation (%) | -3.84 |
| SAR 10g (W/Kg) | 0.104 |
| SAR 1g (W/Kg) | 0.271 |
| **SURFACE SAR** | **VOLUME SAR** |



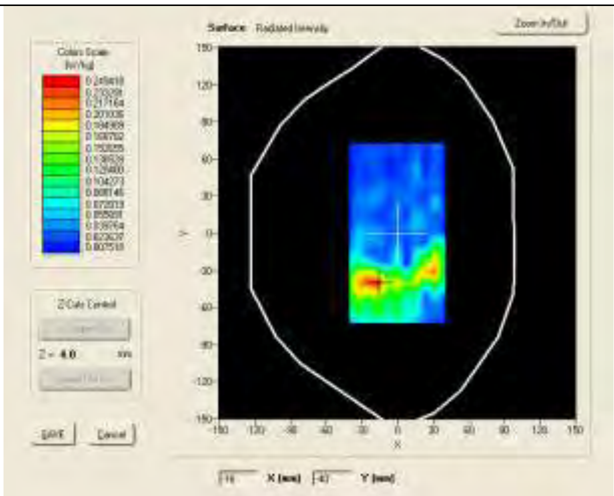
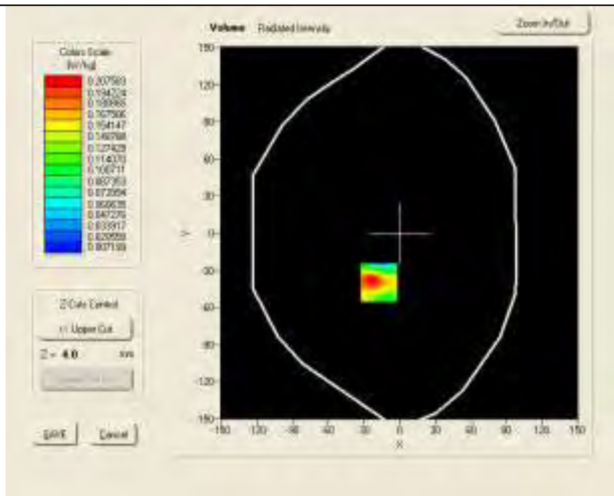


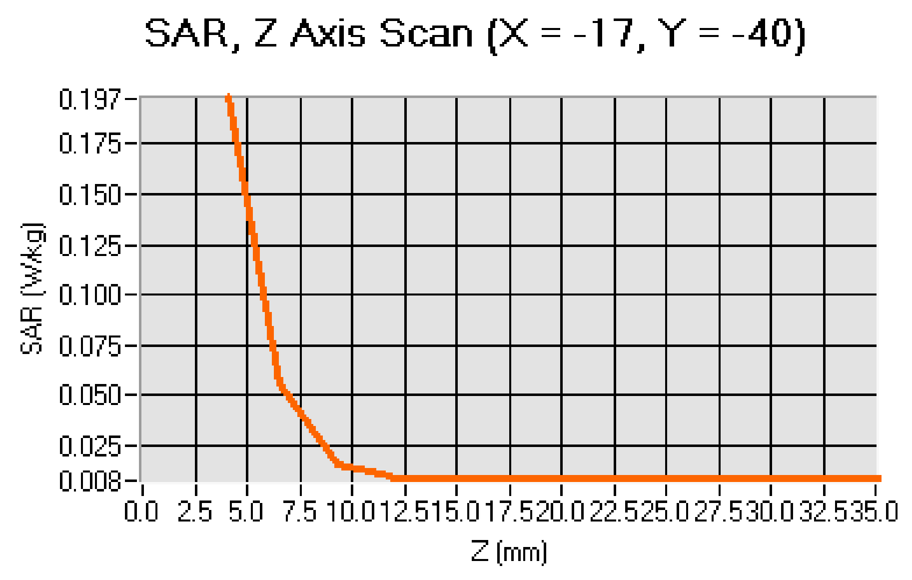
SAR, Z Axis Scan (X = 30, Y = -31)



## SAR measurement Plots

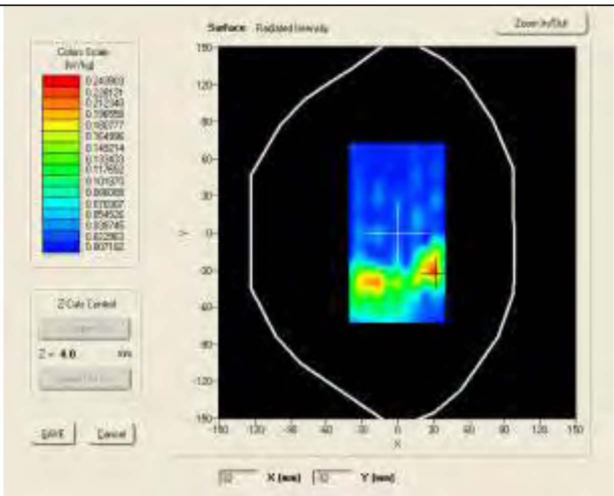
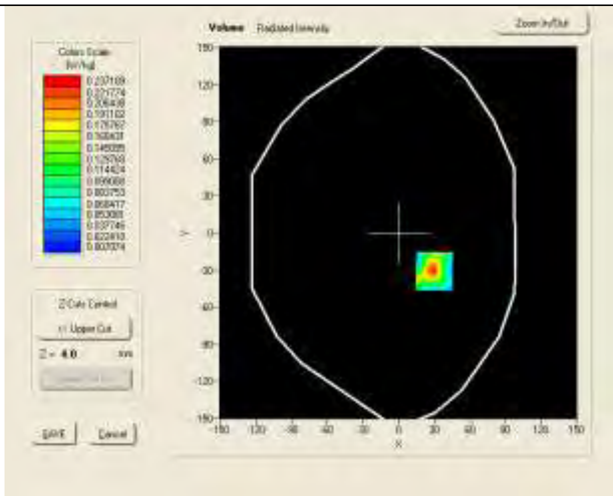
**Test Mode:** 802.11n-20MHz 161 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

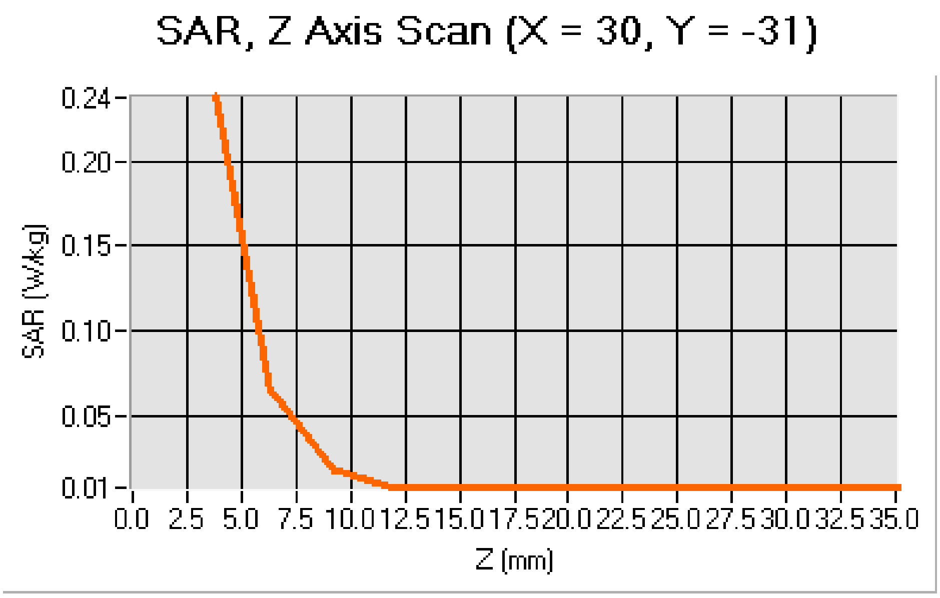
| | |
|---|---|
| Frequency (MHz) | 5805.00 (Flat) |
| Relative permittivity (real part) | 48.530 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.975 |
| Variation (%) | -4.37 |
| SAR 10g (W/Kg) | 0.183 |
| SAR 1g (W/Kg) | 0.308 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

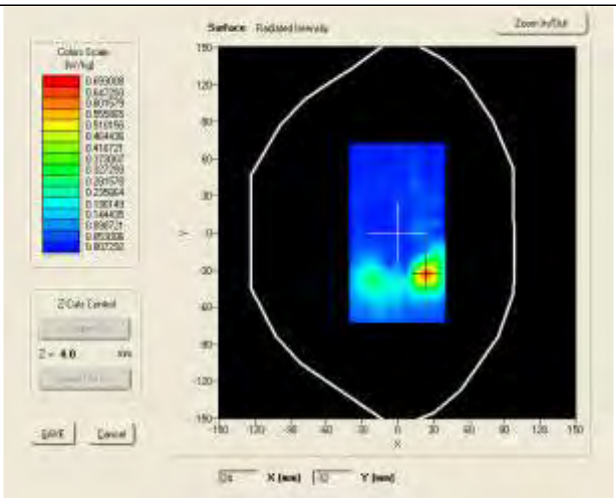
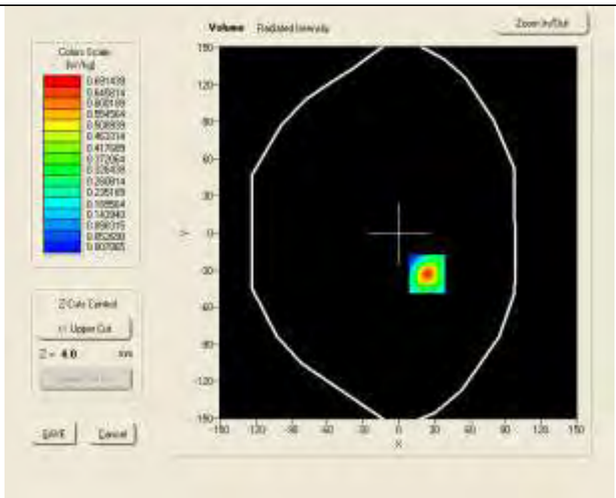
**Test Mode:** 802.11n-20MHz 165 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

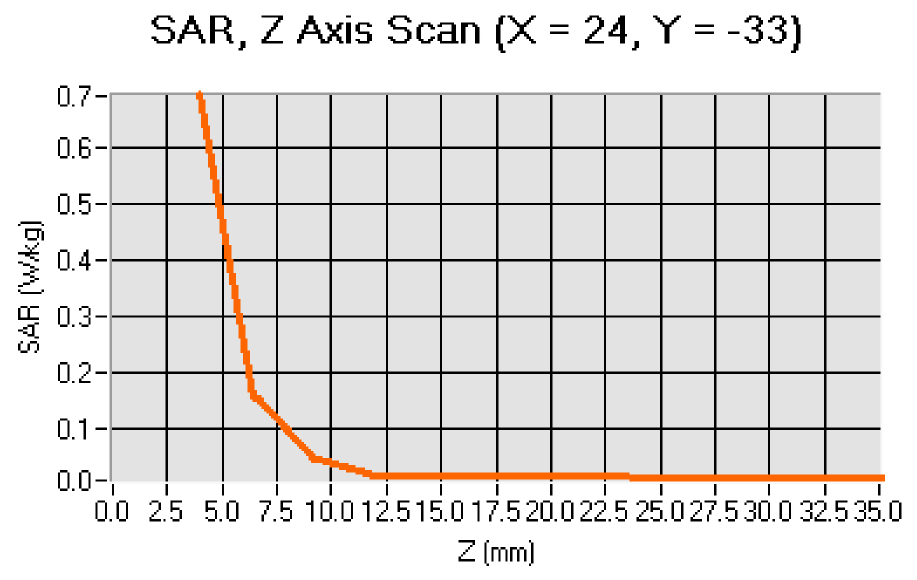
| | |
|---|---|
| Frequency (MHz) | 5825.00 (Flat) |
| Relative permittivity (real part) | 48.557 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.998 |
| Variation (%) | -4.50 |
| SAR 10g (W/Kg) | 0.108 |
| SAR 1g (W/Kg) | 0.286 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

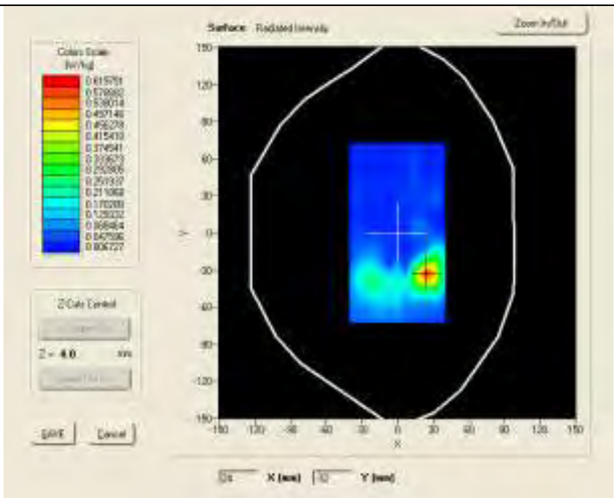
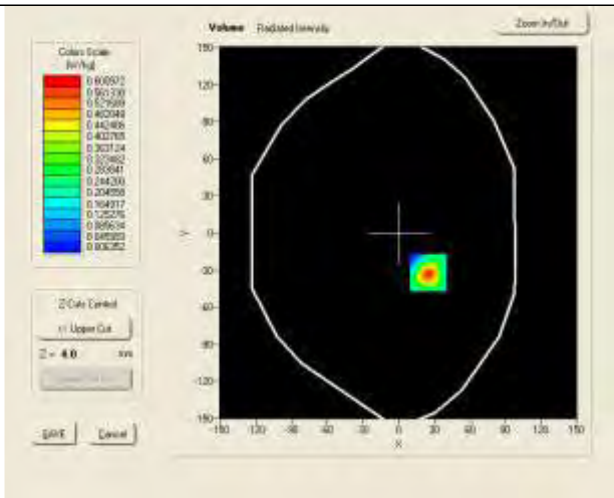
**Test Mode:** 802.11n-40MHz 40 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

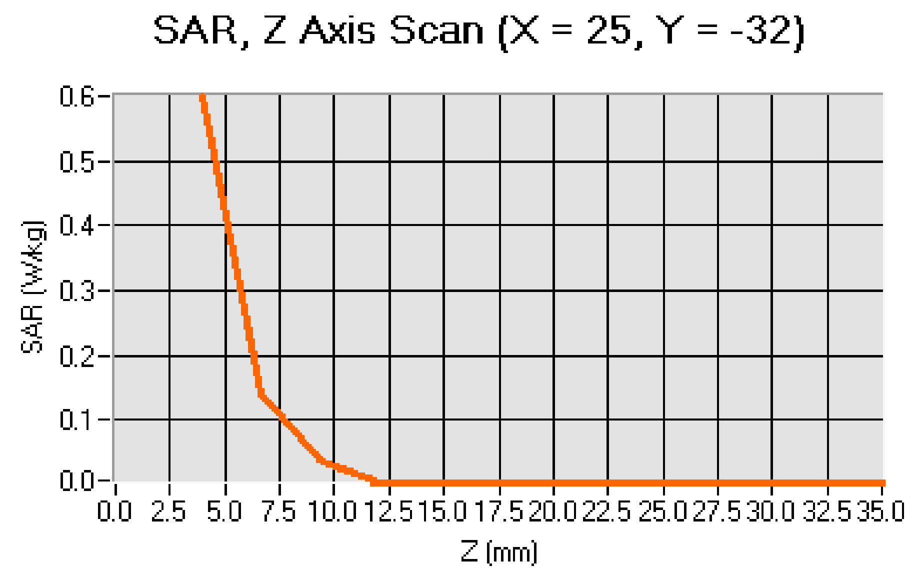
| | |
|---|---|
| Frequency (MHz) | 5190.00 (Flat) |
| Relative permittivity (real part) | 47.779 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.273 |
| Variation (%) | 1.19 |
| SAR 10g (W/Kg) | 0.228 |
| SAR 1g (W/Kg) | 0.644 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 48 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

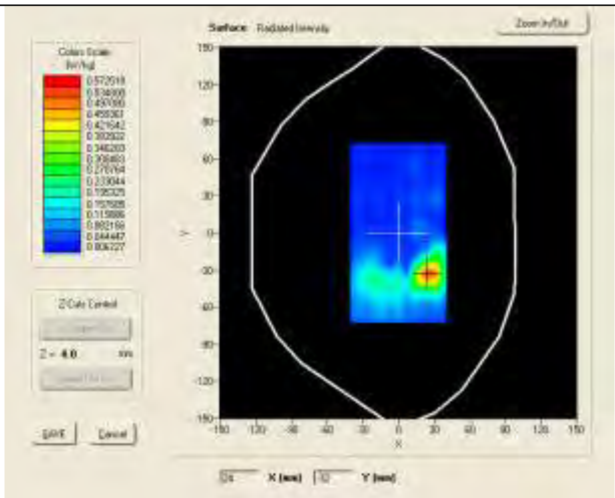
| | |
|---|---|
| Frequency (MHz) | 5230.00 (Flat) |
| Relative permittivity (real part) | 47.834 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.319 |
| Variation (%) | -3.94 |
| SAR 10g (W/Kg) | 0.198 |
| SAR 1g (W/Kg) | 0.563 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

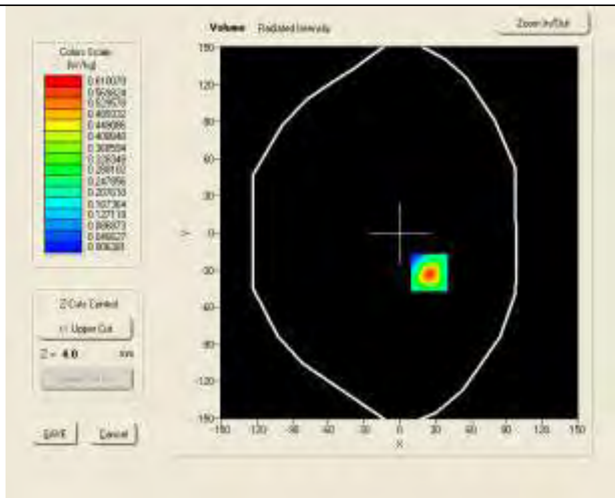


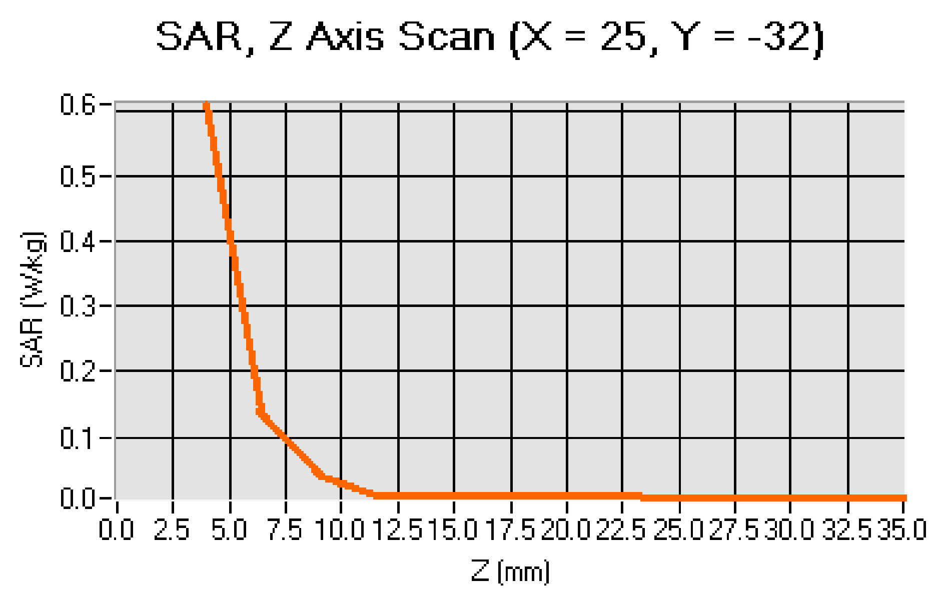
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 64 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5310.00 (Flat) |
| Relative permittivity (real part) | 47.944 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.413 |
| Variation (%) | 1.25 |
| SAR 10g (W/Kg) | 0.200 |
| SAR 1g (W/Kg) | 0.570 |
| **SURFACE SAR** | **VOLUME SAR** |



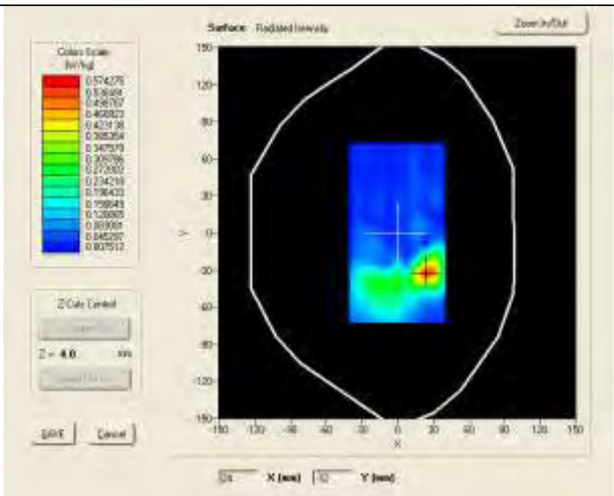



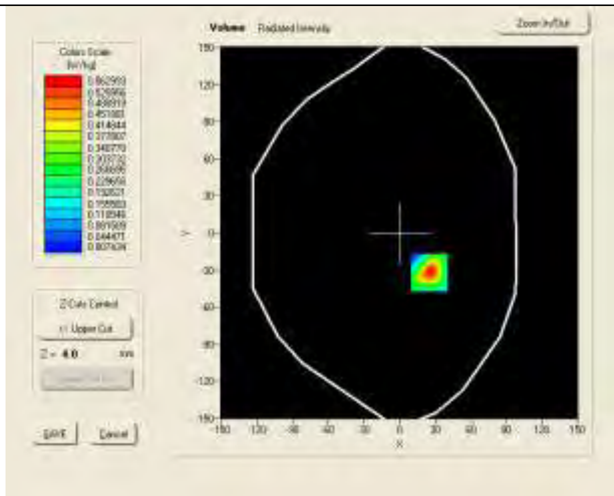



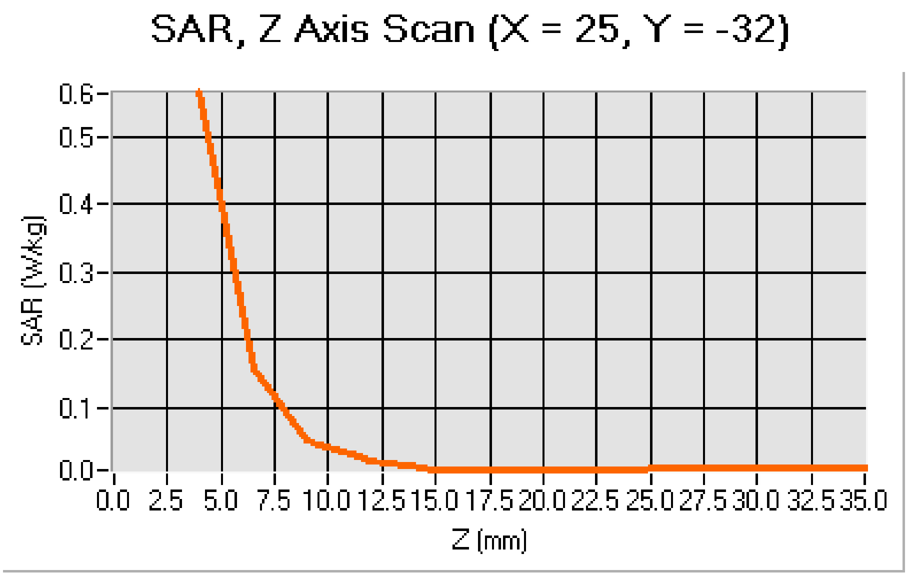
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 104 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5510.00 (Flat) |
| Relative permittivity (real part) | 48.978 |
| Relative permittivity (imaginary part) | 16.19 |
| Conductivity (S/m) | 5.577 |
| Variation (%) | 1.47 |
| SAR 10g (W/Kg) | 0.197 |
| SAR 1g (W/Kg) | 0.540 |
| **SURFACE SAR** | **VOLUME SAR** |

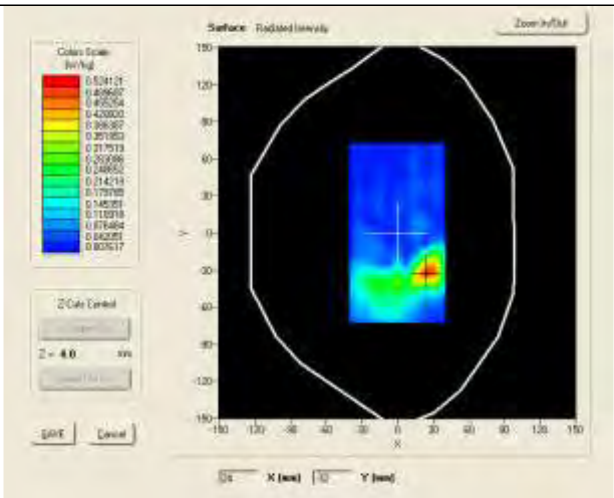
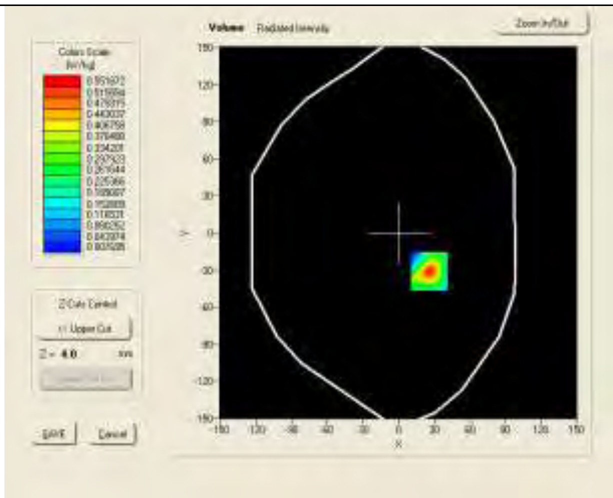




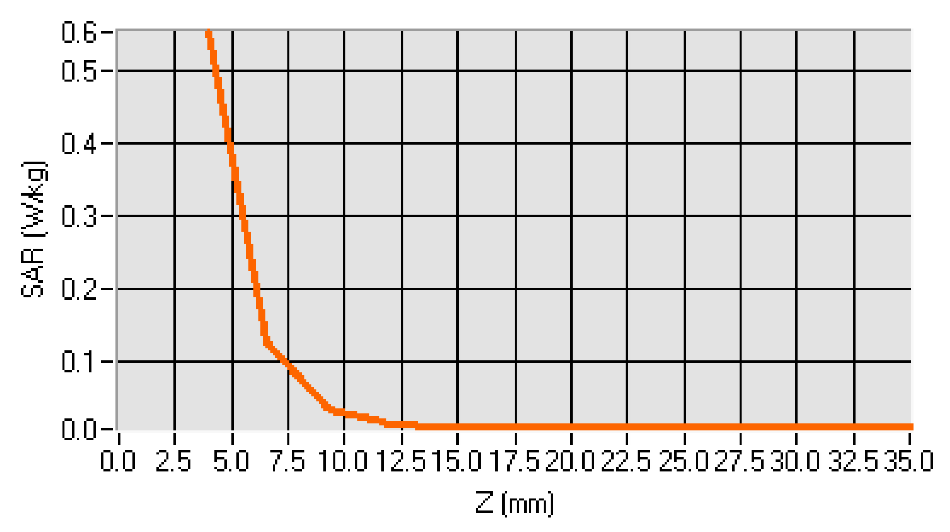


## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 112 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5550.00 (Flat) |
| Relative permittivity (real part) | 49.089 |
| Relative permittivity (imaginary part) | 16.19 |
| Conductivity (S/m) | 5.669 |
| Variation (%) | -0.51 |
| SAR 10g (W/Kg) | 0.190 |
| SAR 1g (W/Kg) | 0.521 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

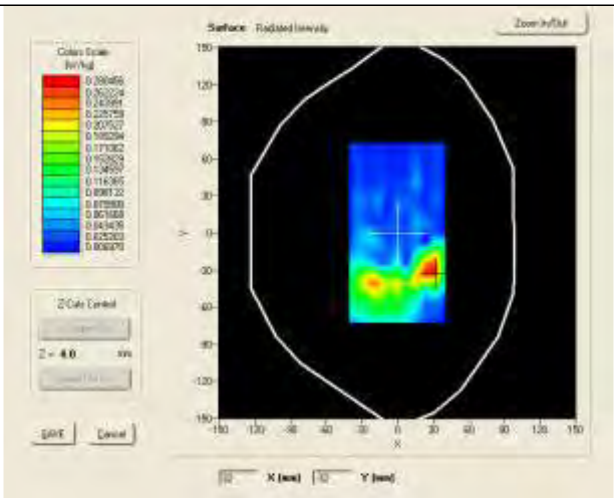
SAR, Z Axis Scan (X = 26, Y = -31)

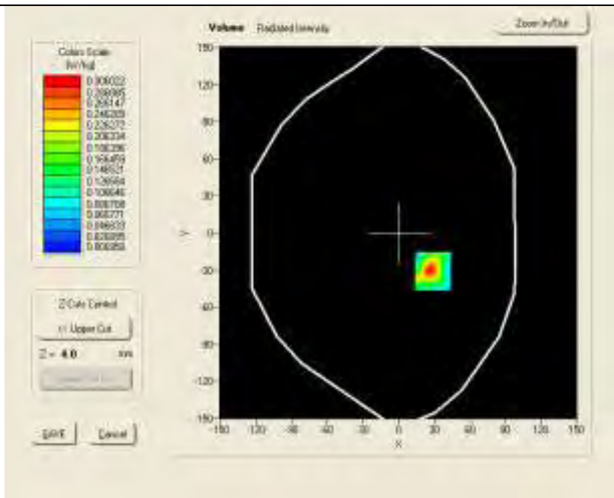


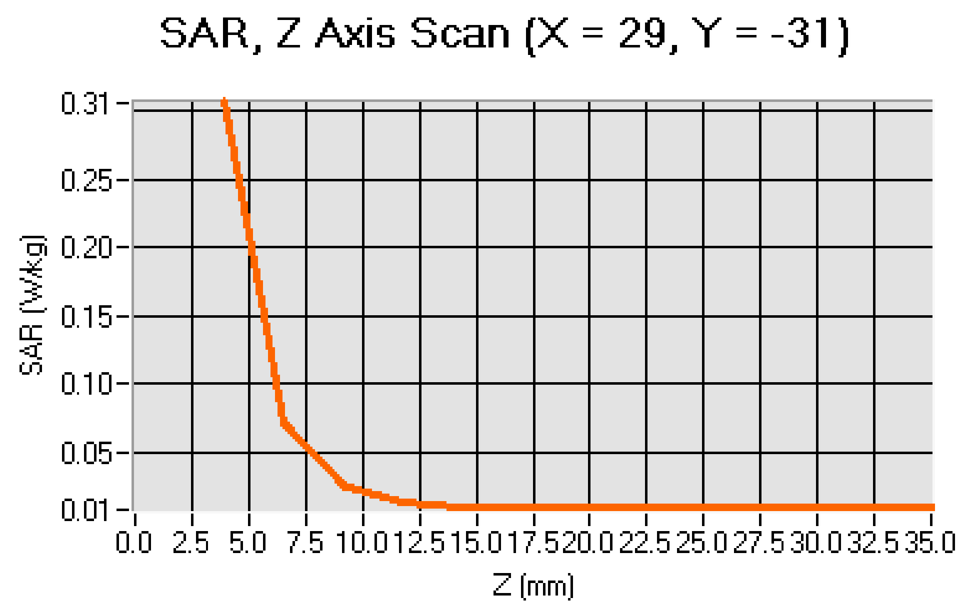
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 136 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5670.00 (Flat) |
| Relative permittivity (real part) | 49.215 |
| Relative permittivity (imaginary part) | 16.24 |
| Conductivity (S/m) | 5.773 |
| Variation (%) | -3.73 |
| SAR 10g (W/Kg) | 0.108 |
| SAR 1g (W/Kg) | 0.293 |
| **SURFACE SAR** | **VOLUME SAR** |



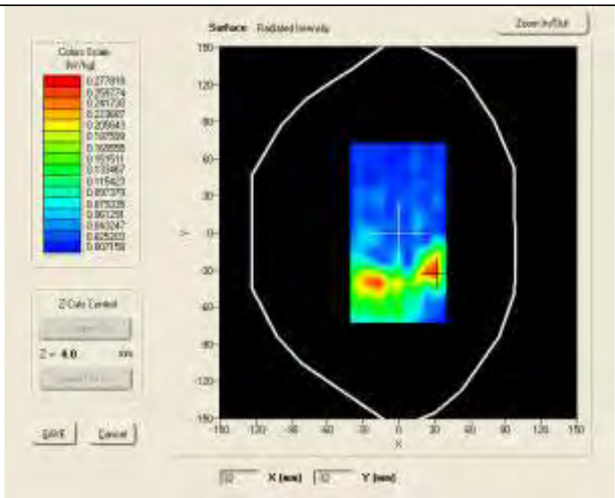


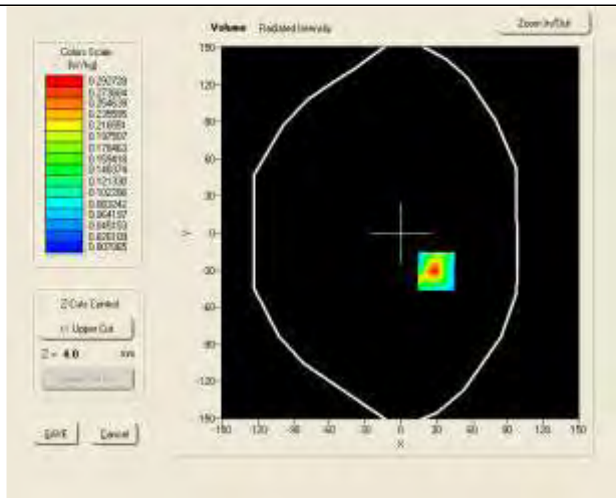


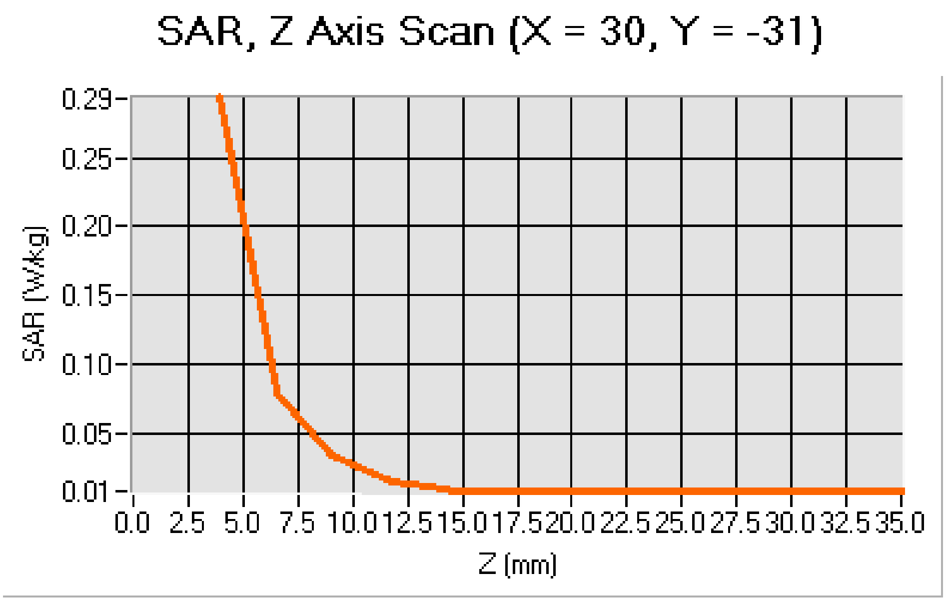
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 153 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5755.00 (Flat) |
| Relative permittivity (real part) | 48.462 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.916 |
| Variation (%) | -3.08 |
| SAR 10g (W/Kg) | 0.139 |
| SAR 1g (W/Kg) | 0.332 |
| **SURFACE SAR** | **VOLUME SAR** |



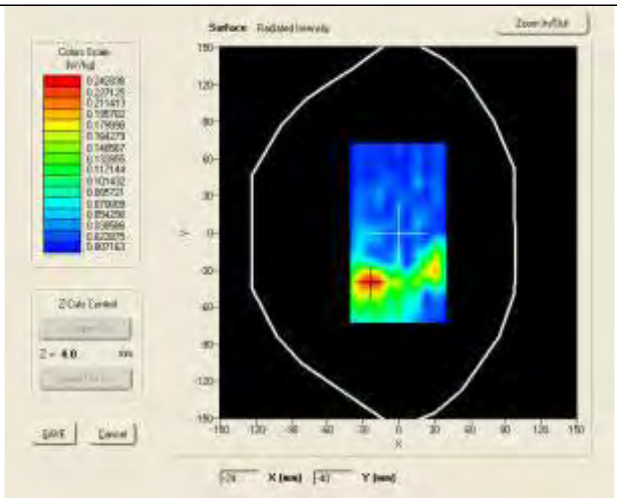


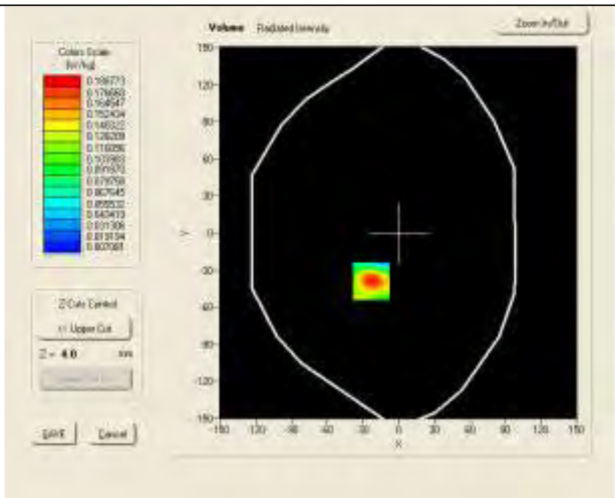


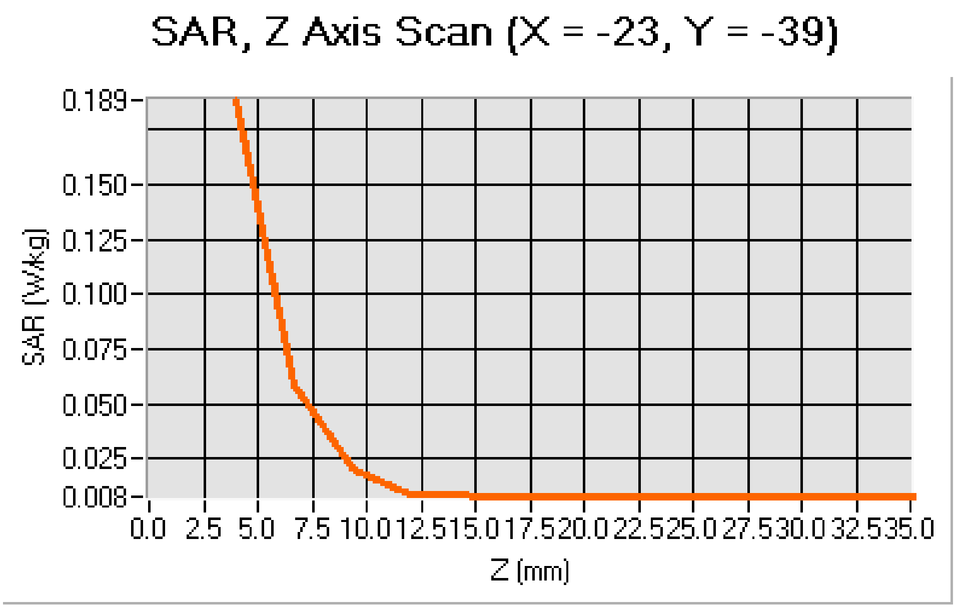
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 161 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln220 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5795.00 (Flat) |
| Relative permittivity (real part) | 48.516 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.963 |
| Variation (%) | -1.81 |
| SAR 10g (W/Kg) | 0.074 |
| SAR 1g (W/Kg) | 0.186 |
| **SURFACE SAR** | **VOLUME SAR** |

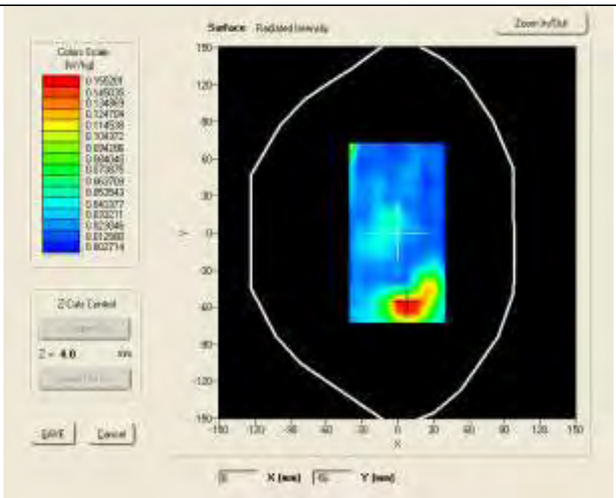
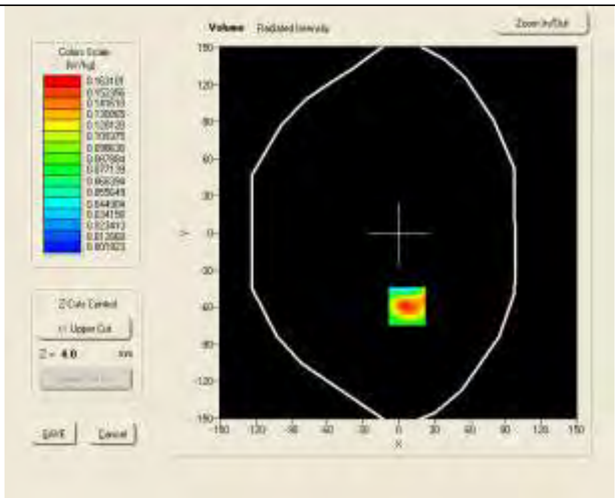


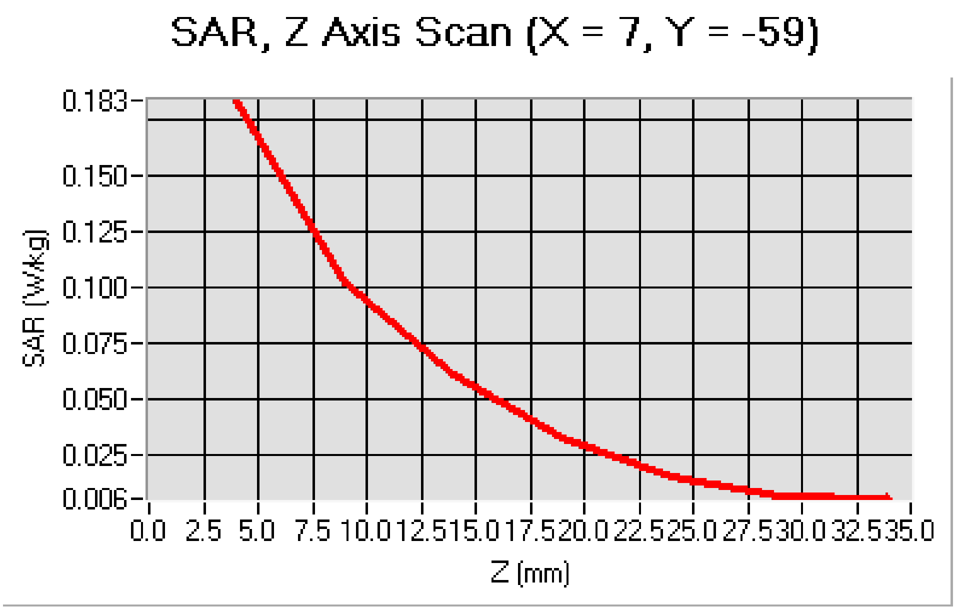



## SAR measurement Plots

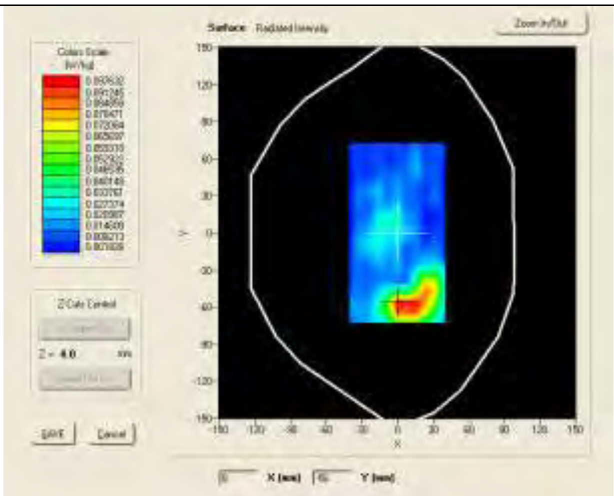
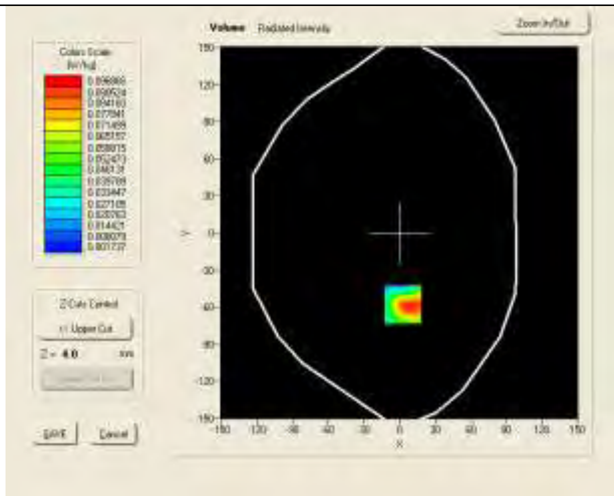
**Test Mode:** 802.11b low channel (11Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

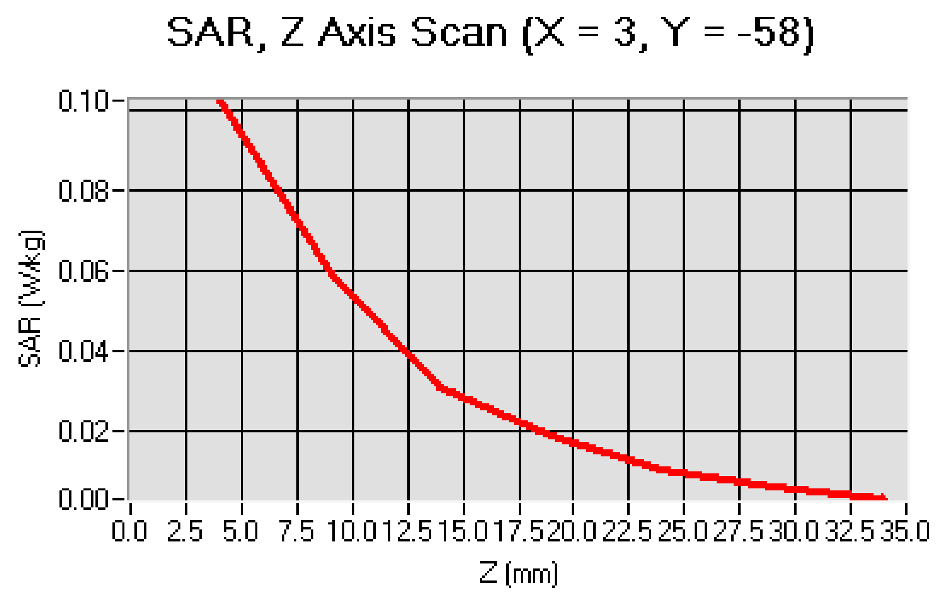
| | |
|---|---|
| Frequency (MHz) | 2412.00 (Flat) |
| Relative permittivity (real part) | 52.875 |
| Relative permittivity (imaginary part) | 14.26 |
| Conductivity (S/m) | 1.702 |
| Variation (%) | -4.28 |
| SAR 10g (W/Kg) | 0.088 |
| SAR 1g (W/Kg) | 0.167 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

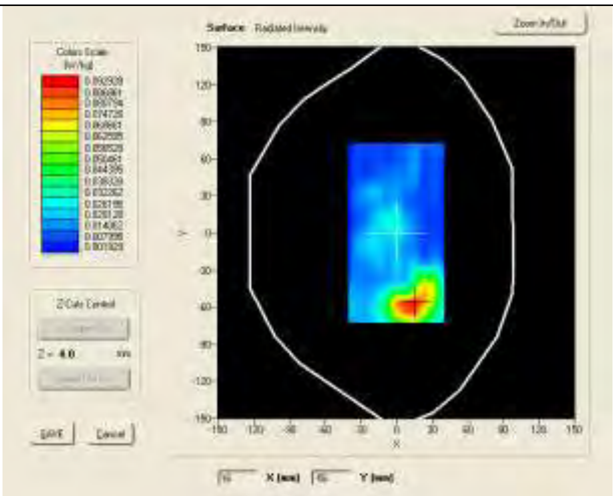
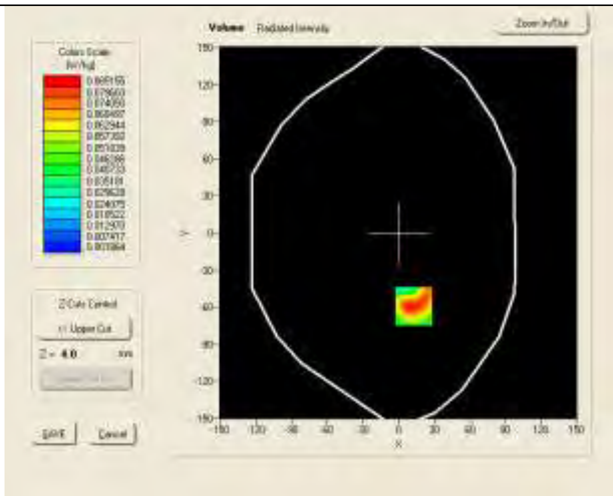
**Test Mode:** 802.11b Mid channel (11Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

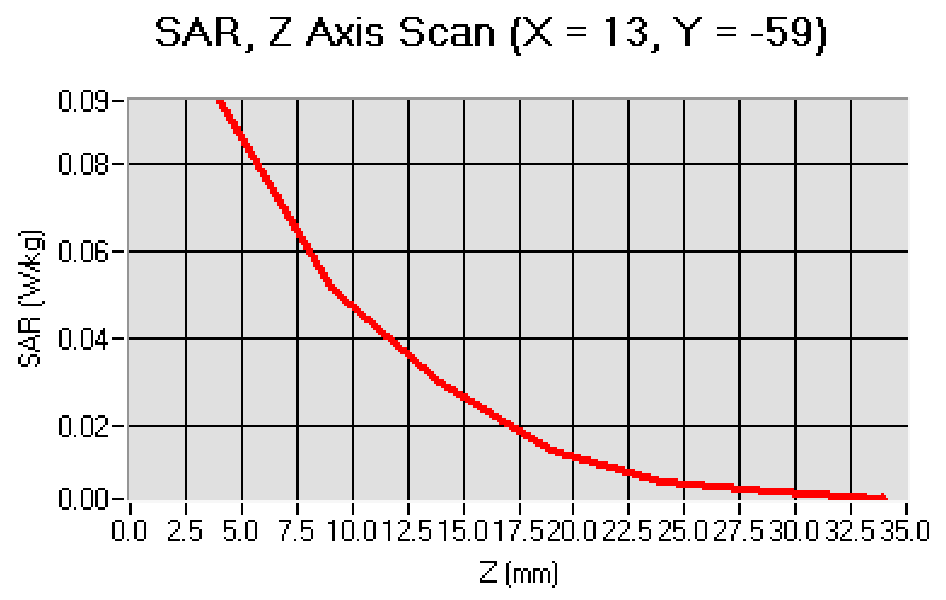
| | |
|---|---|
| Frequency (MHz) | 2437.00 (Flat) |
| Relative permittivity (real part) | 52.910 |
| Relative permittivity (imaginary part) | 14.26 |
| Conductivity (S/m) | 1.745 |
| Variation (%) | -3.91 |
| SAR 10g (W/Kg) | 0.052 |
| SAR 1g (W/Kg) | 0.100 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

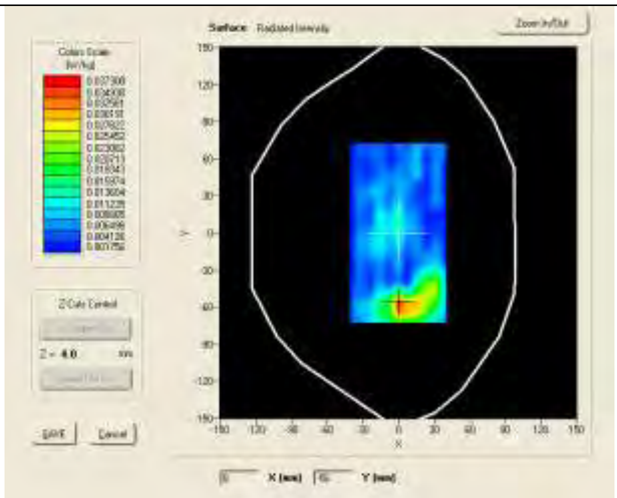
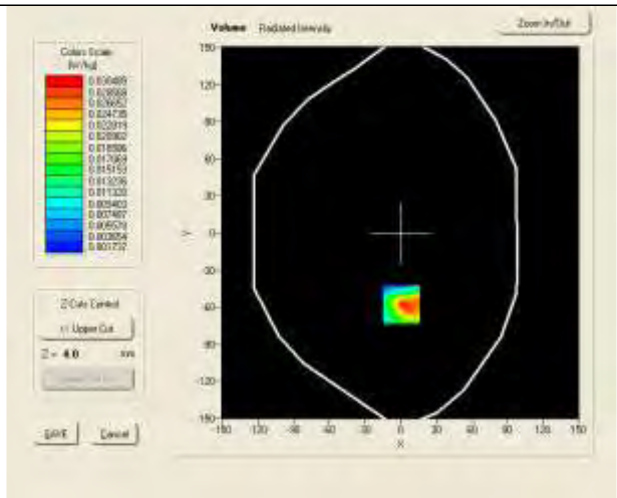
**Test Mode:** 802.11b High channel (11Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 2462.00 (Flat) |
| Relative permittivity (real part) | 52.943 |
| Relative permittivity (imaginary part) | 14.44 |
| Conductivity (S/m) | 1.788 |
| Variation (%) | -1.74 |
| SAR 10g (W/Kg) | 0.047 |
| SAR 1g (W/Kg) | 0.089 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

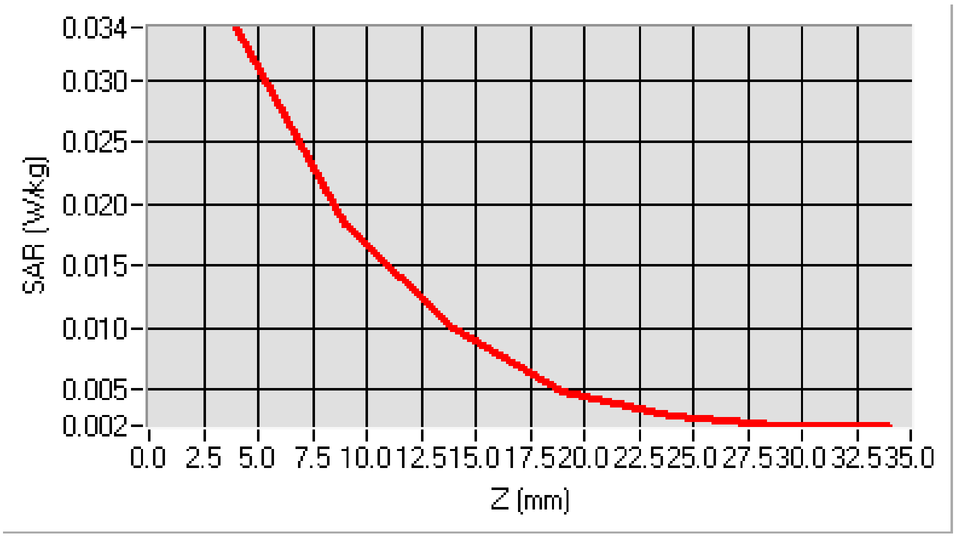


## SAR measurement Plots

**Test Mode:** 802.11n low channel (54Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

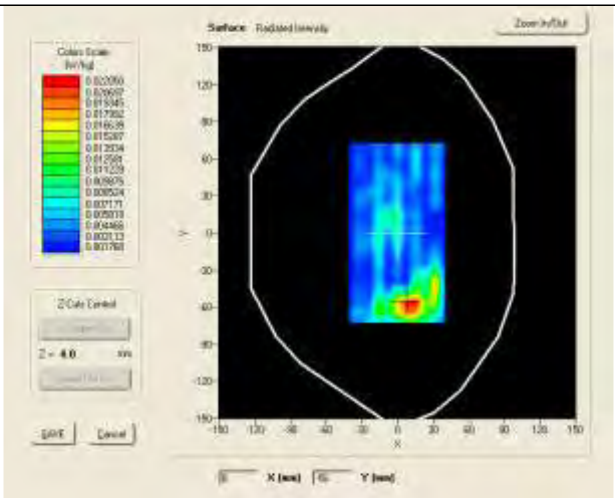
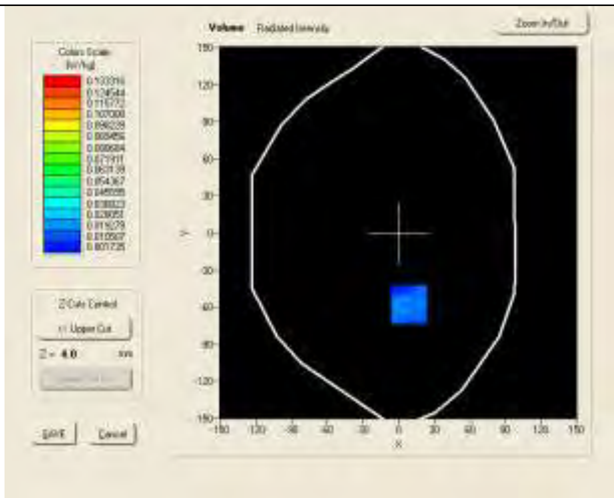
| | |
|---|---|
| Frequency (MHz) | 2412.00 (Flat) |
| Relative permittivity (real part) | 52.875 |
| Relative permittivity (imaginary part) | 14.26 |
| Conductivity (S/m) | 1.702 |
| Variation (%) | -1.20 |
| SAR 10g (W/Kg) | 0.015 |
| SAR 1g (W/Kg) | 0.030 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

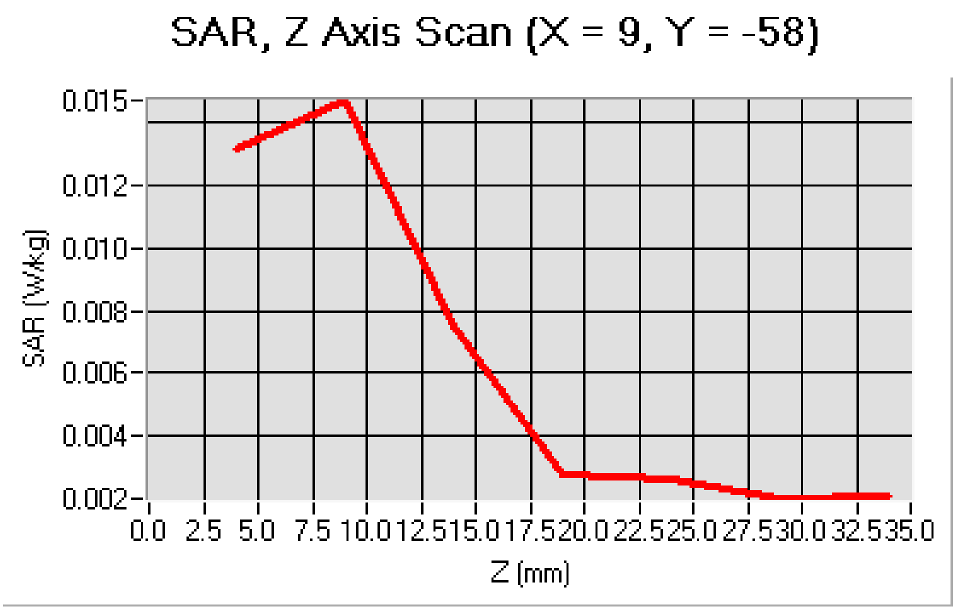
SAR, Z Axis Scan (X = 1, Y = -58)



## SAR measurement Plots

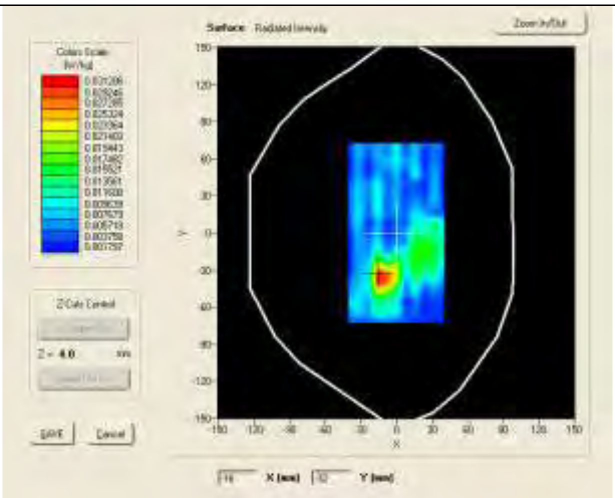
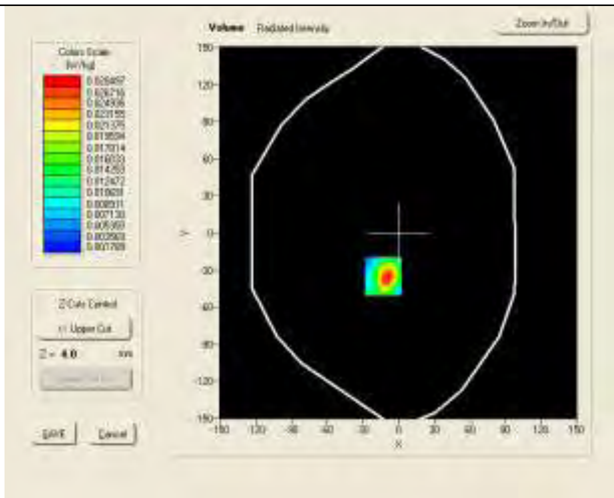
**Test Mode:** 802.11n Mid channel (54Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

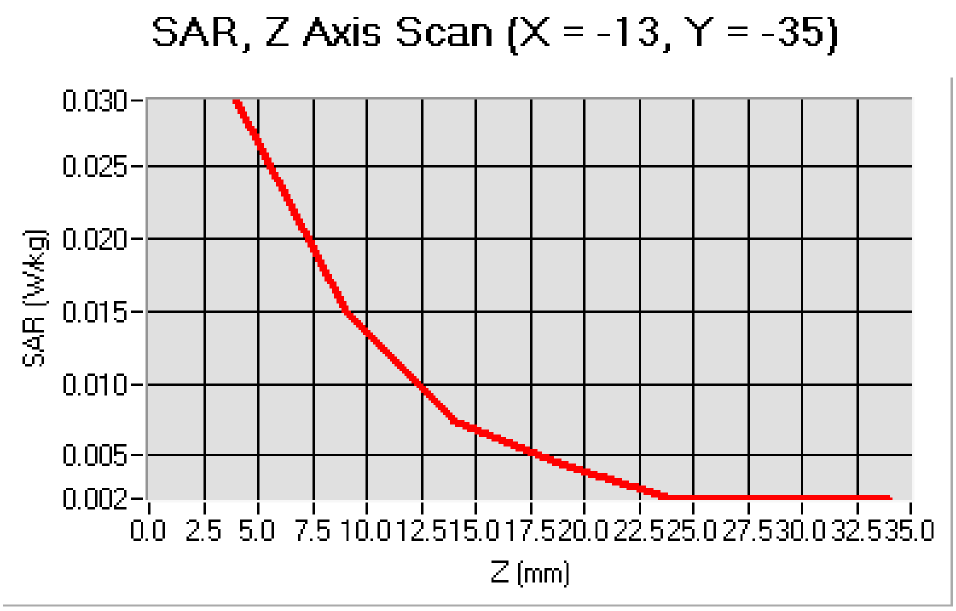
| | |
|---|---|
| Frequency (MHz) | 2437.00 (Flat) |
| Relative permittivity (real part) | 52.910 |
| Relative permittivity (imaginary part) | 14.26 |
| Conductivity (S/m) | 1.745 |
| Variation (%) | 3.55 |
| SAR 10g (W/Kg) | 0.012 |
| SAR 1g (W/Kg) | 0.033 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

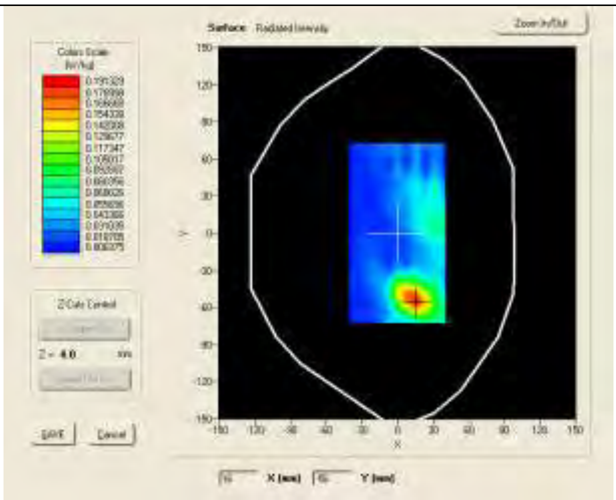
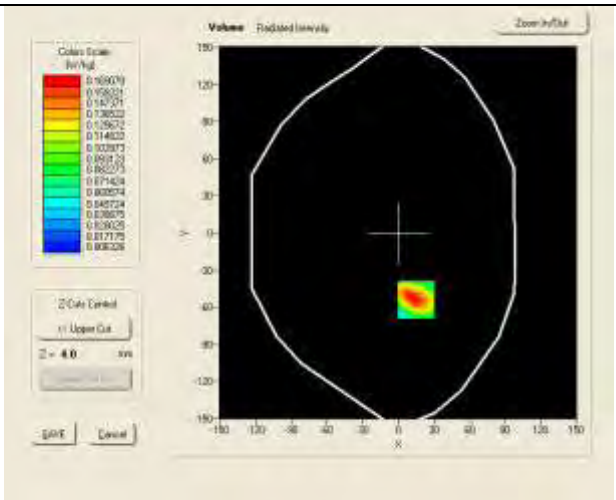
**Test Mode:** 802.11n High channel (54Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

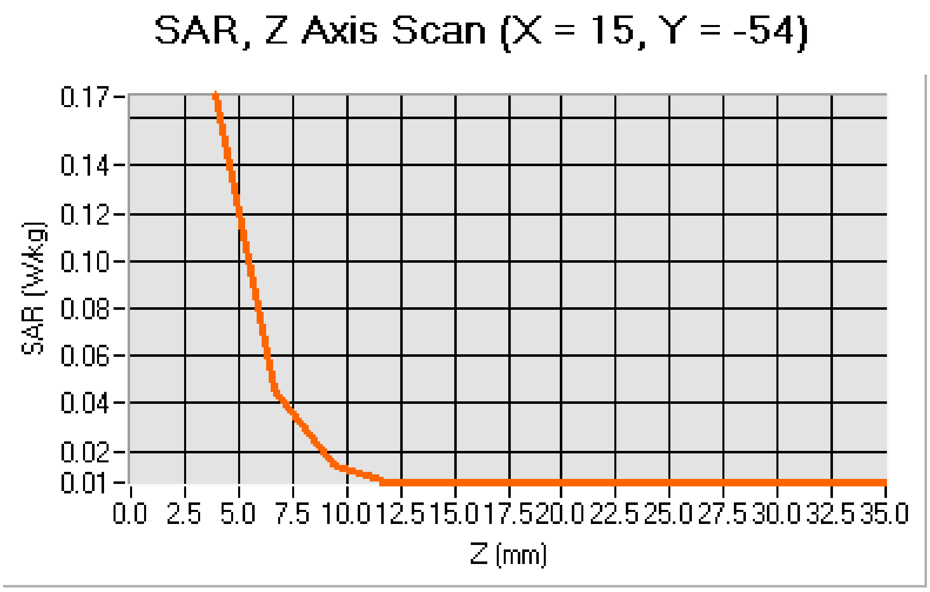
| | |
|---|---|
| Frequency (MHz) | 2462.00 (Flat) |
| Relative permittivity (real part) | 52.943 |
| Relative permittivity (imaginary part) | 14.31 |
| Conductivity (S/m) | 1.788 |
| Variation (%) | -3.95 |
| SAR 10g (W/Kg) | 0.013 |
| SAR 1g (W/Kg) | 0.024 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

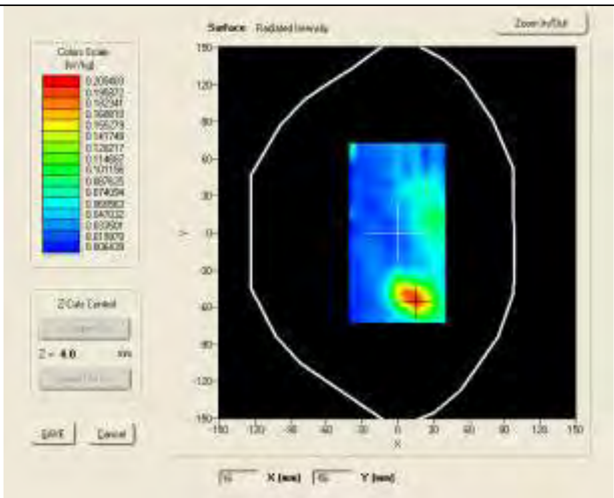
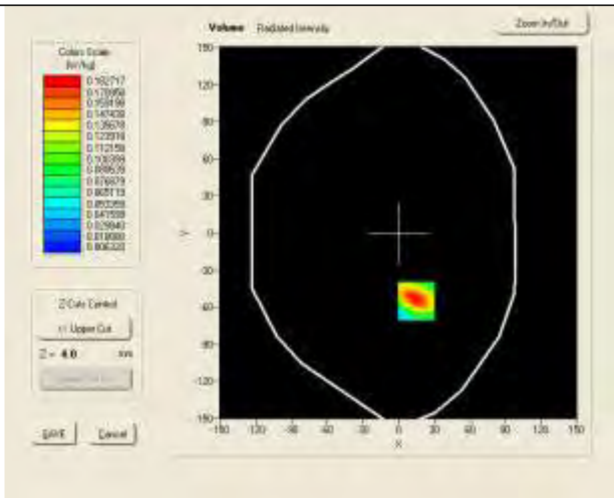
**Test Mode:** 802.11n-20MHz 36 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

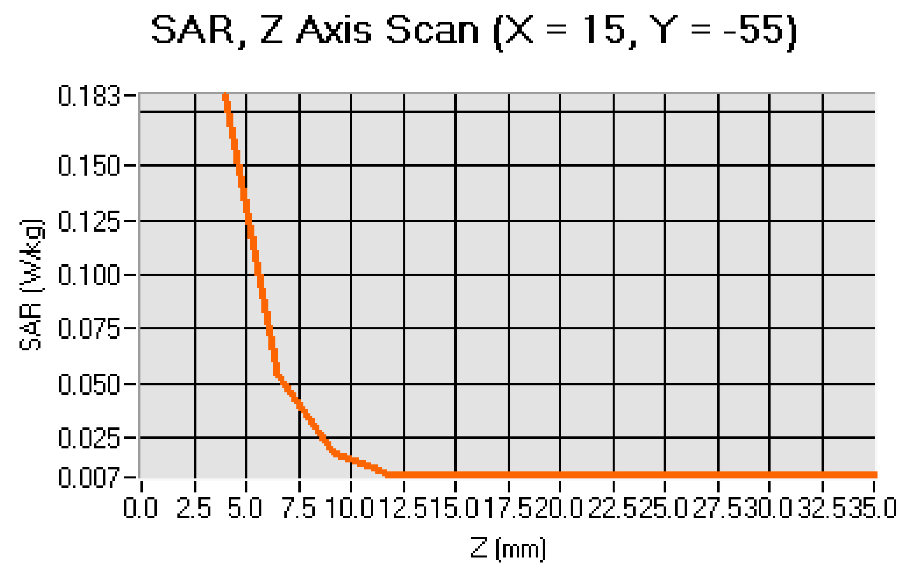
| | |
|---|---|
| Frequency (MHz) | 5180.00 (Flat) |
| Relative permittivity (real part) | 47.563 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.249 |
| Variation (%) | -2.03 |
| SAR 10g (W/Kg) | 0.071 |
| SAR 1g (W/Kg) | 0.168 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

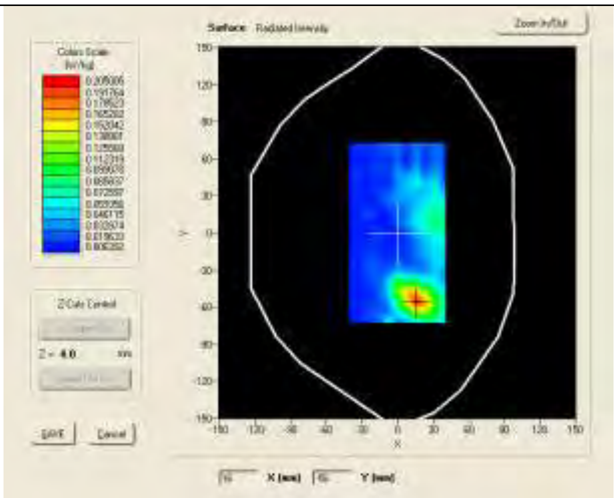
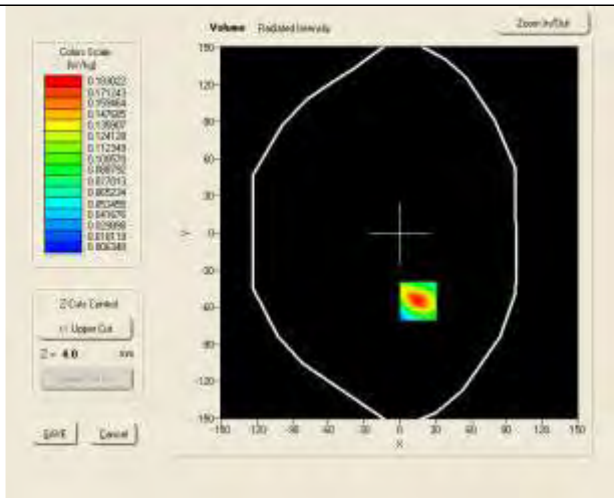
**Test Mode:** 802.11n-20MHz 48 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

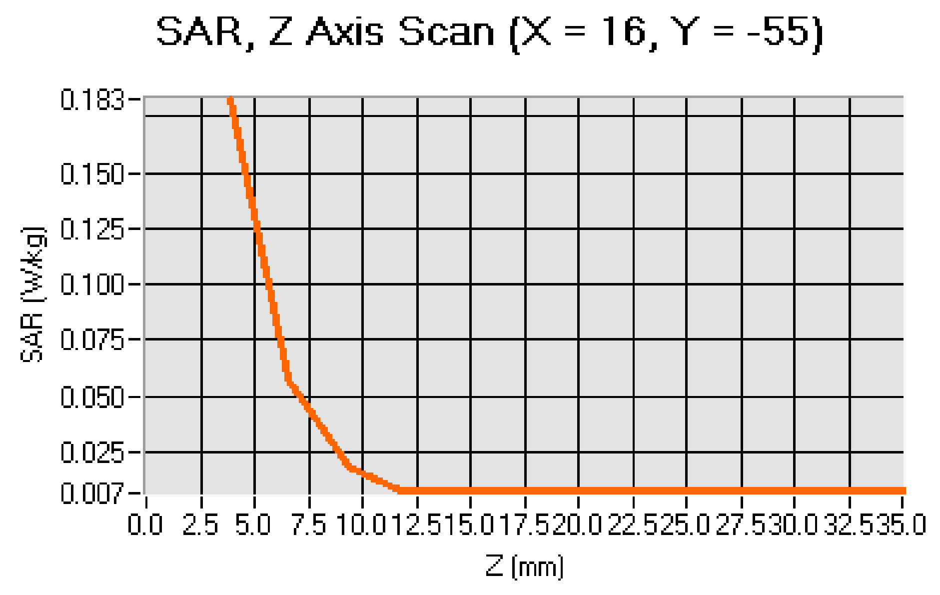
| | |
|---|---|
| Frequency (MHz) | 5240.00 (Flat) |
| Relative permittivity (real part) | 47.848 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.331 |
| Variation (%) | -4.70 |
| SAR 10g (W/Kg) | 0.077 |
| SAR 1g (W/Kg) | 0.180 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |



## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 56 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

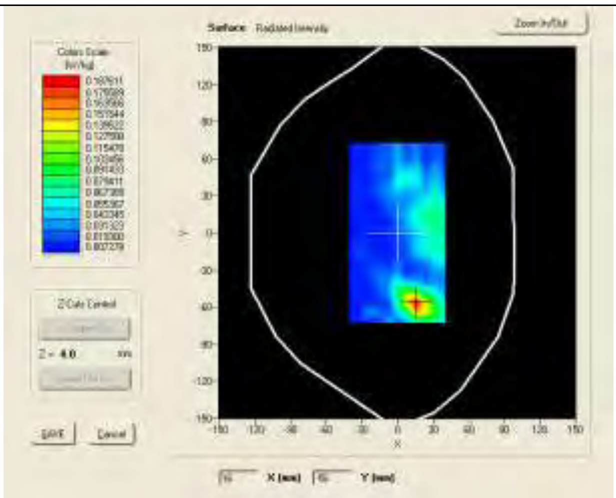
| | |
|---|---|
| Frequency (MHz) | 5280.00 (Flat) |
| Relative permittivity (real part) | 47.902 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.378 |
| Variation (%) | -4.18 |
| SAR 10g (W/Kg) | 0.072 |
| SAR 1g (W/Kg) | 0.179 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

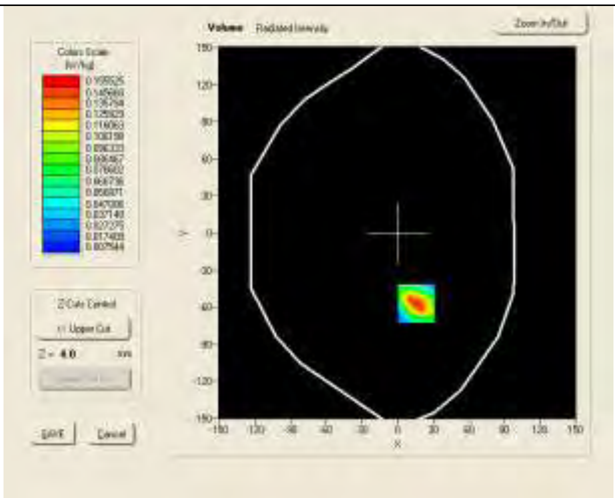


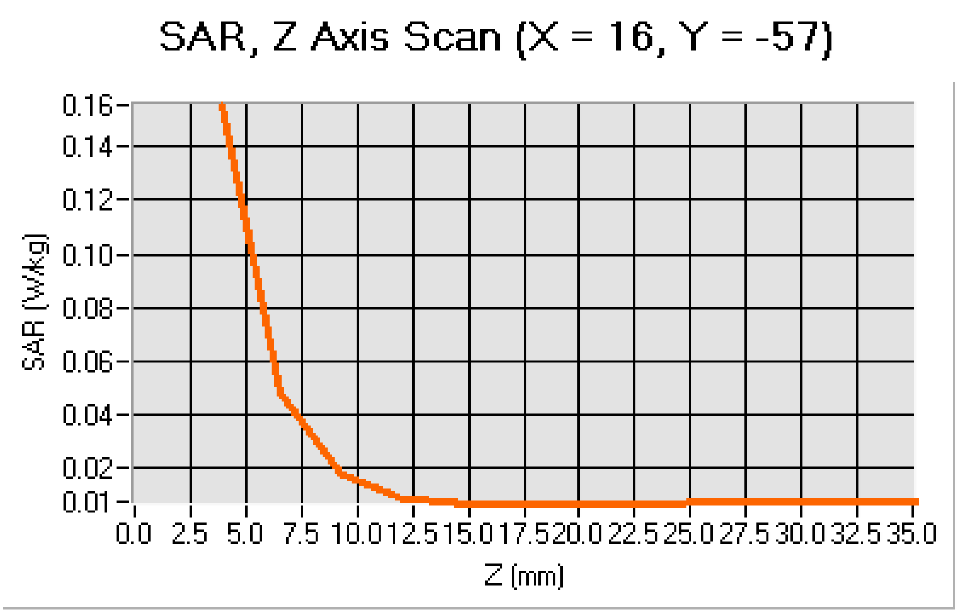
## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 100 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5500.00 (Flat) |
| Relative permittivity (real part) | 48.978 |
| Relative permittivity (imaginary part) | 16.17 |
| Conductivity (S/m) | 5.577 |
| Variation (%) | -4.47 |
| SAR 10g (W/Kg) | 0.056 |
| SAR 1g (W/Kg) | 0.144 |
| **SURFACE SAR** | **VOLUME SAR** |



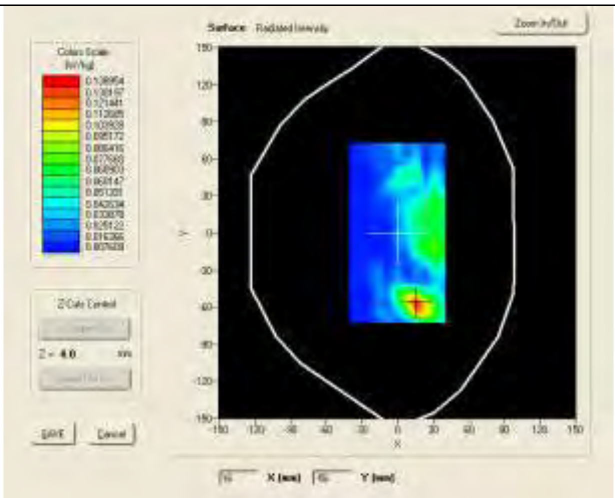


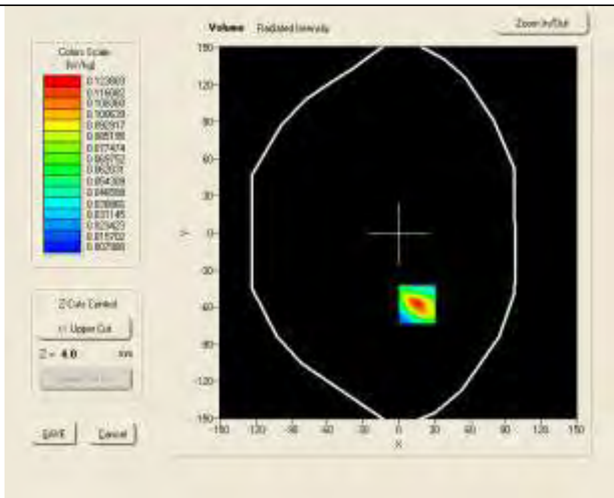


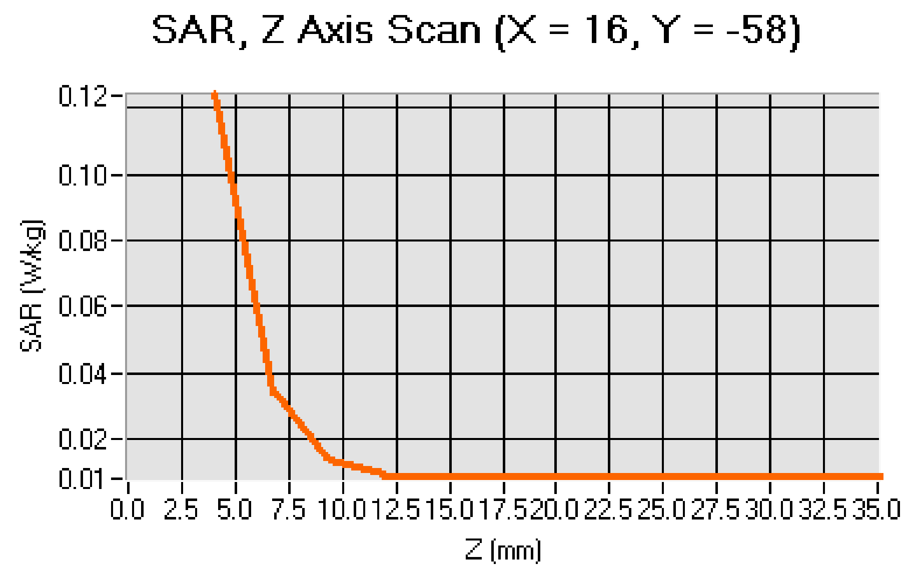
## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 116 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5580.00 (Flat) |
| Relative permittivity (real part) | 49.089 |
| Relative permittivity (imaginary part) | 16.30 |
| Conductivity (S/m) | 5.669 |
| Variation (%) | -4.48 |
| SAR 10g (W/Kg) | 0.048 |
| SAR 1g (W/Kg) | 0.120 |
| **SURFACE SAR** | **VOLUME SAR** |

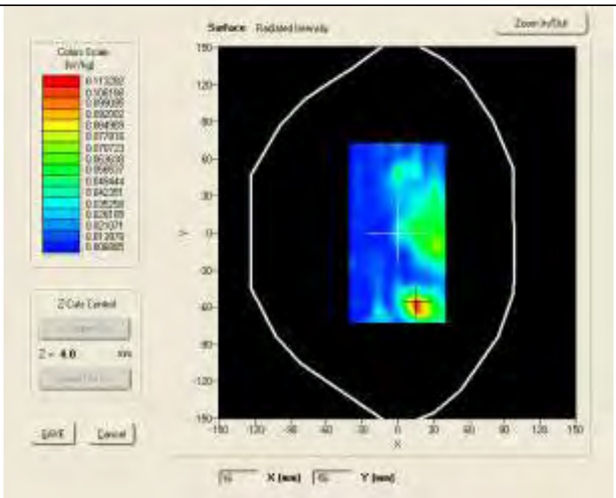
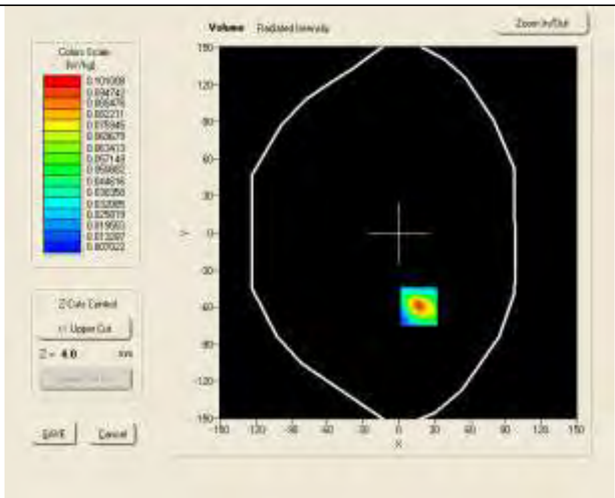


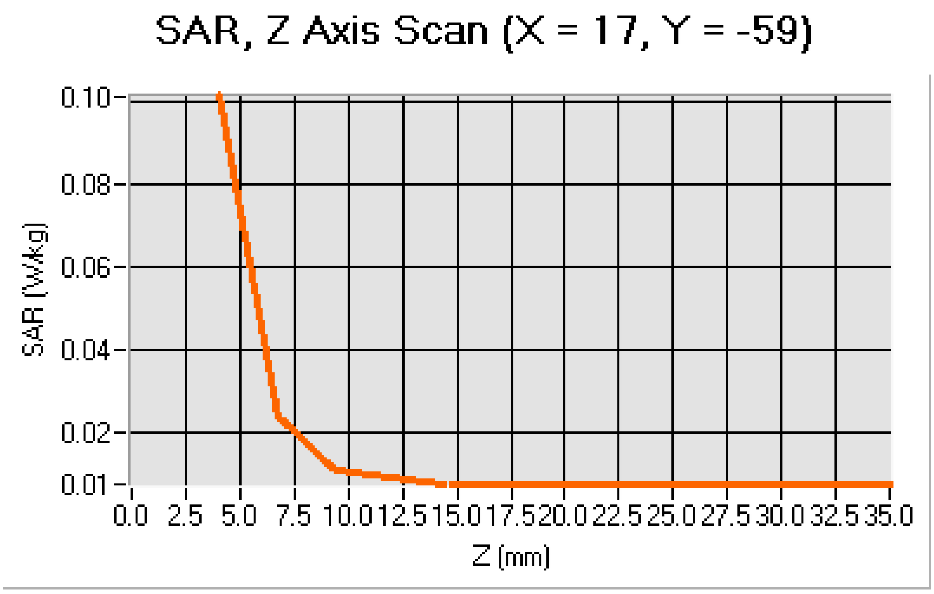




# SAR measurement Plots

**Test Mode:** 802.11n-20MHz 136 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

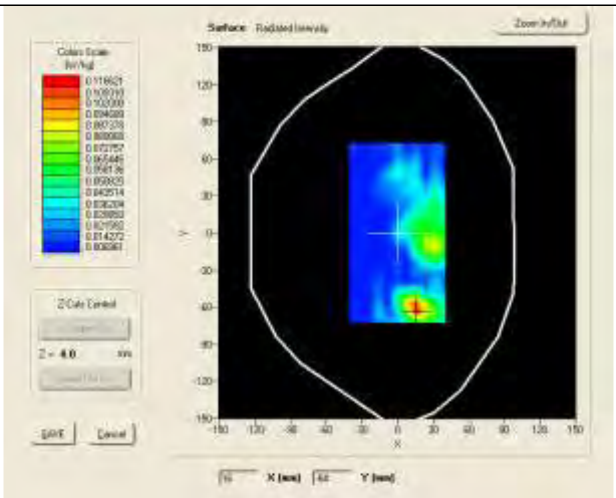
| Frequency (MHz) | 5680.00 (Flat) |
|---|---|
| Relative permittivity (real part) | 48.359 |
| Relative permittivity (imaginary part) | 16.24 |
| Conductivity (S/m) | 5.830 |
| Variation (%) | -3.82 |
| SAR 10g (W/Kg) | 0.037 |
| SAR 1g (W/Kg) | 0.096 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

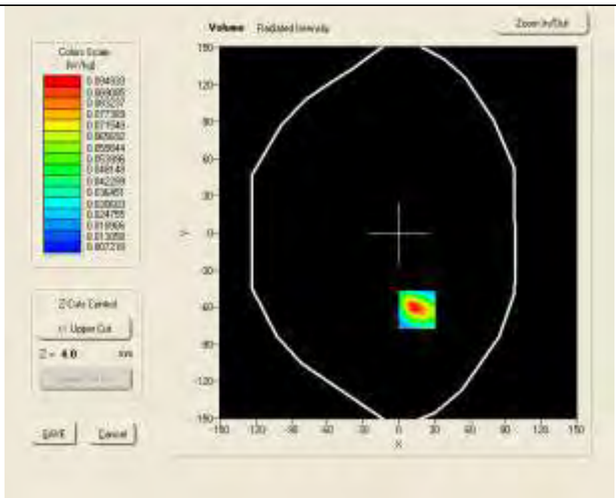


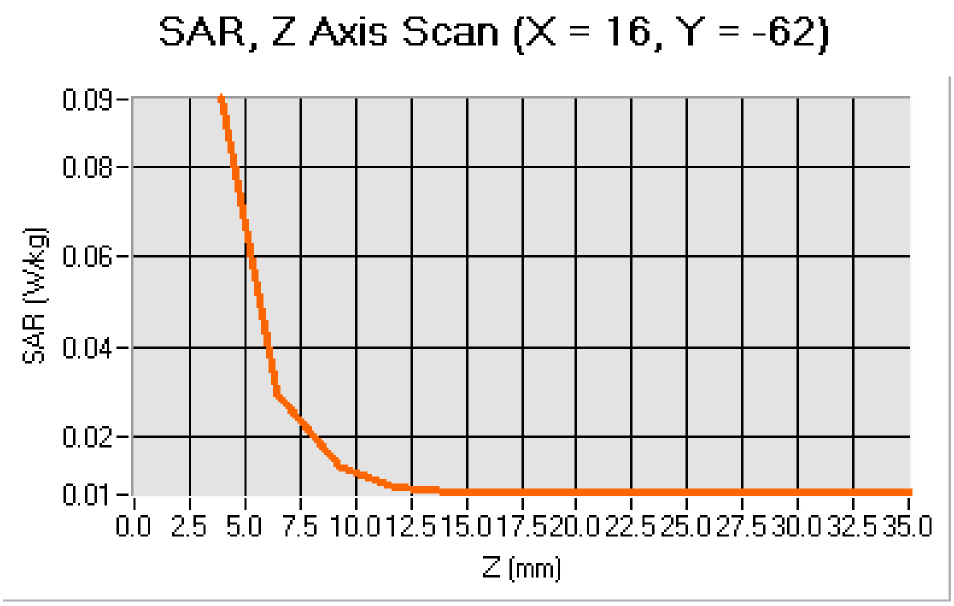
## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 149 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5745.00 (Flat) |
| Relative permittivity (real part) | 48.447 |
| Relative permittivity (imaginary part) | 16.24 |
| Conductivity (S/m) | 5.905 |
| Variation (%) | -3.54 |
| SAR 10g (W/Kg) | 0.037 |
| SAR 1g (W/Kg) | 0.096 |
| **SURFACE SAR** | **VOLUME SAR** |



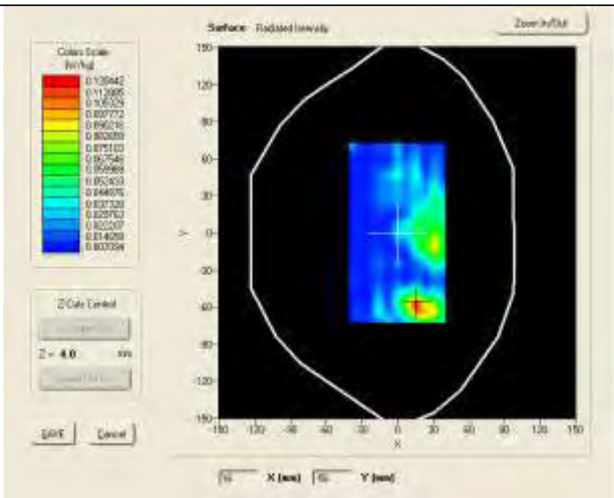


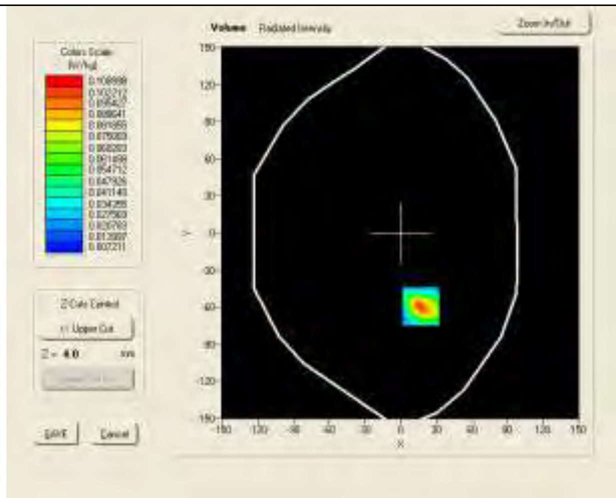


## SAR measurement Plots

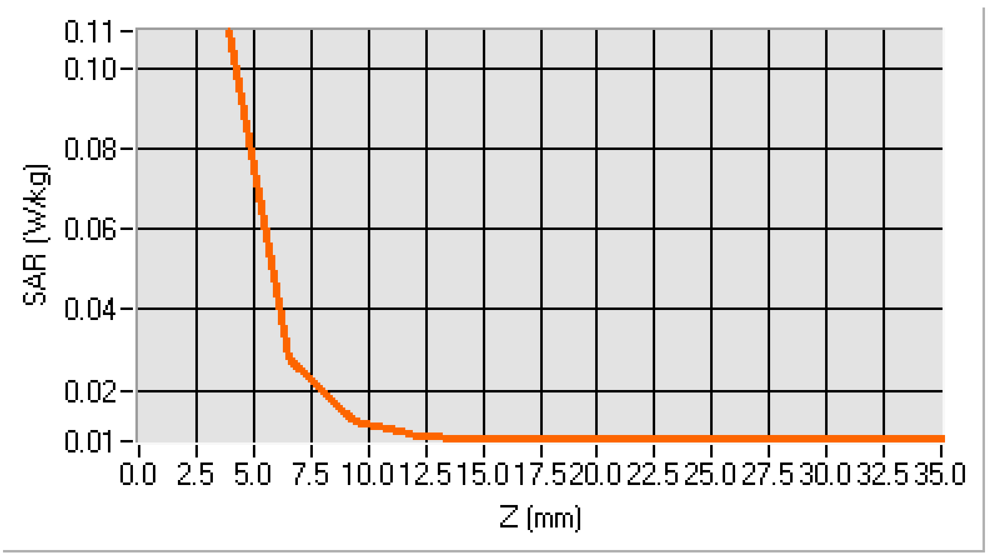
**Test Mode:** 802.11n-20MHz 161 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5805.00 (Flat) |
| Relative permittivity (real part) | 48.530 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.975 |
| Variation (%) | -2.15 |
| SAR 10g (W/Kg) | 0.040 |
| SAR 1g (W/Kg) | 0.103 |
| **SURFACE SAR** | **VOLUME SAR** |



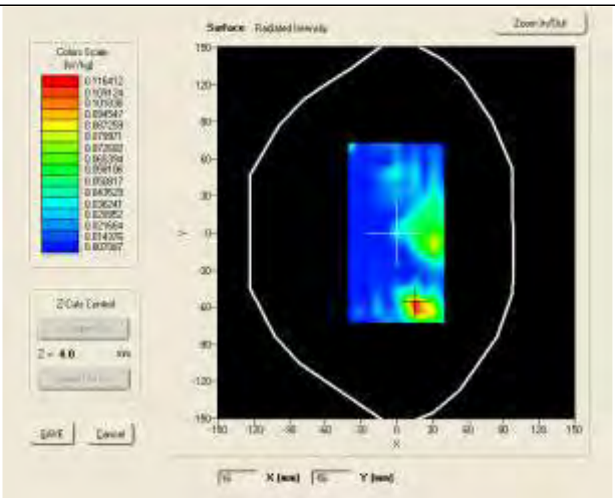
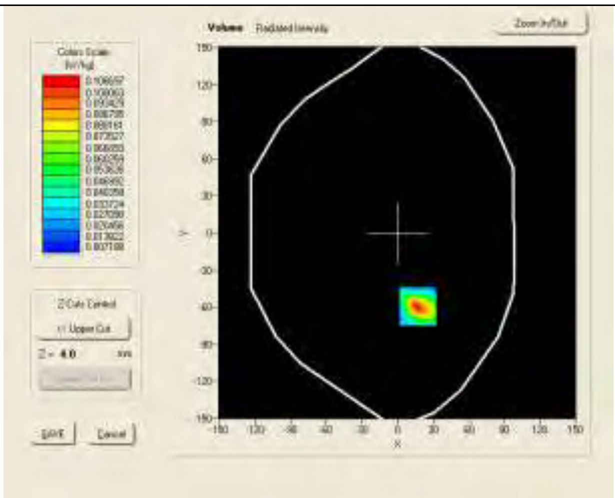




SAR, Z Axis Scan (X = 17, Y = -59)

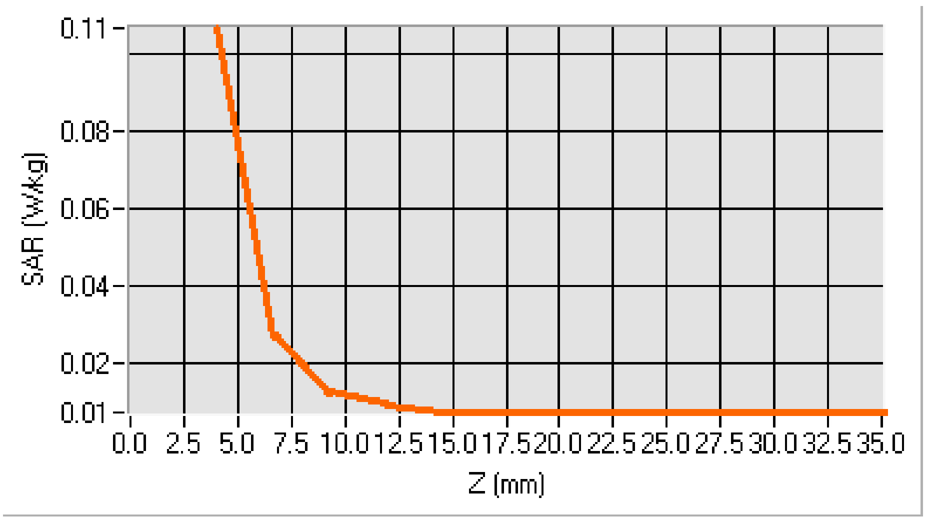


## SAR measurement Plots

**Test Mode:** 802.11n-20MHz 165 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

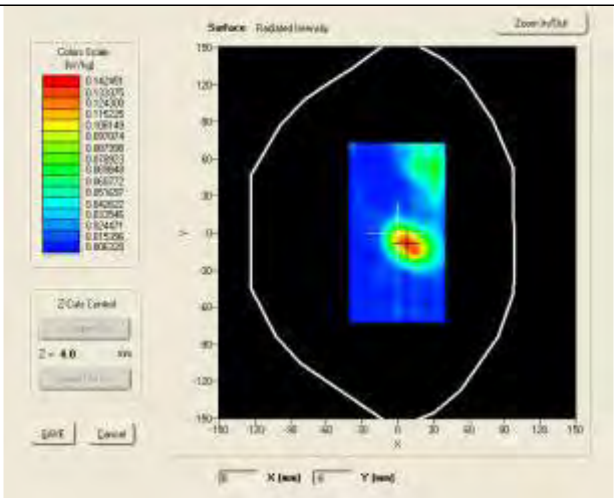
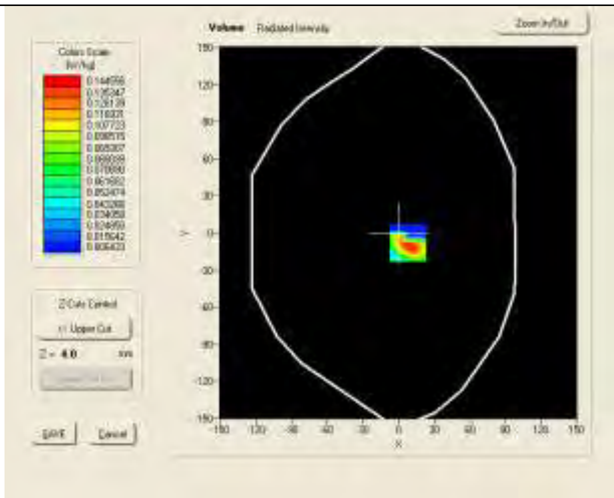
| | |
|---|---|
| Frequency (MHz) | 5825.00 (Flat) |
| Relative permittivity (real part) | 48.557 |
| Relative permittivity (imaginary part) | 16.35 |
| Conductivity (S/m) | 5.998 |
| Variation (%) | -3.45 |
| SAR 10g (W/Kg) | 0.040 |
| SAR 1g (W/Kg) | 0.104 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

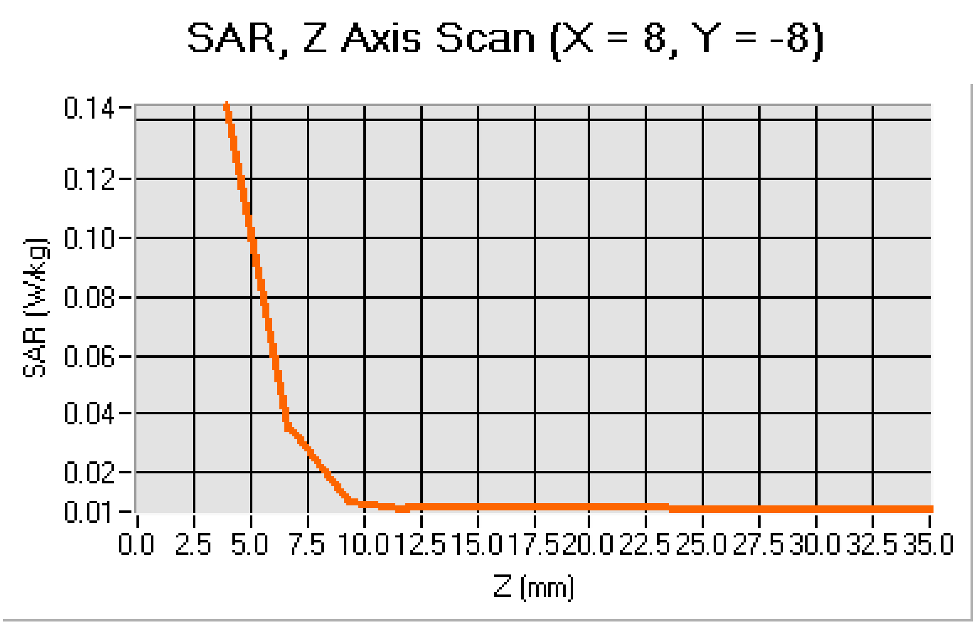
SAR, Z Axis Scan (X = 17, Y = -59)



## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 40 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

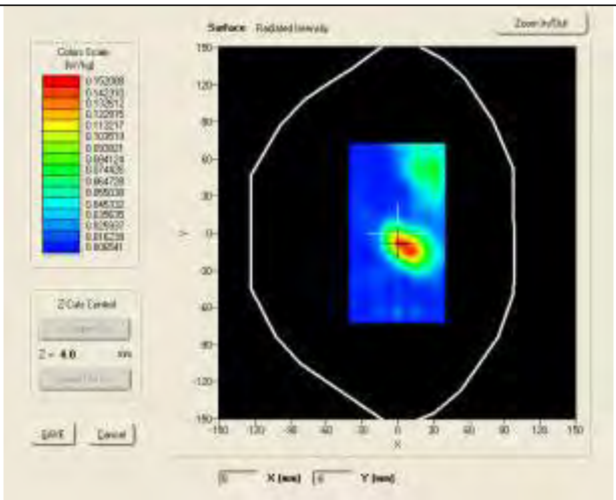
| | |
|---|---|
| Frequency (MHz) | 5190.00 (Flat) |
| Relative permittivity (real part) | 47.779 |
| Relative permittivity (imaginary part) | 15.92 |
| Conductivity (S/m) | 5.273 |
| Variation (%) | -3.16 |
| SAR 10g (W/Kg) | 0.049 |
| SAR 1g (W/Kg) | 0.138 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

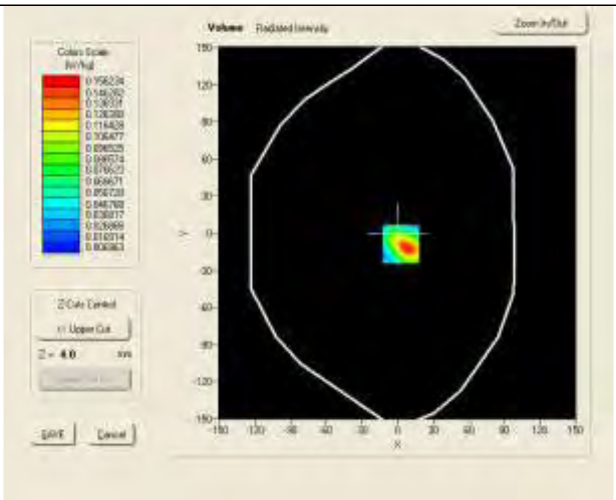


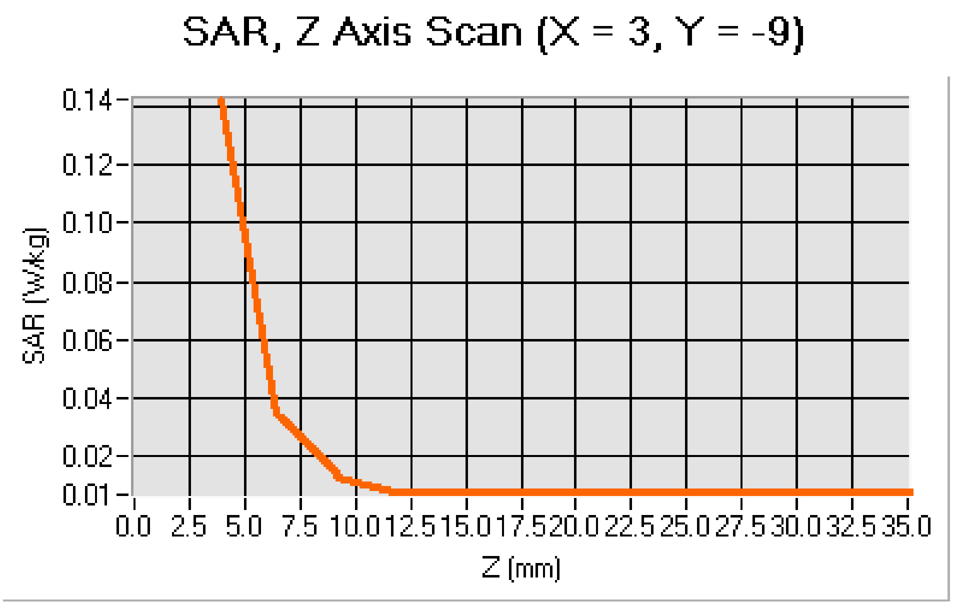
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 48 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5230.00 (Flat) |
| Relative permittivity (real part) | 47.834 |
| Relative permittivity (imaginary part) | 16.17 |
| Conductivity (S/m) | 5.319 |
| Variation (%) | -3.26 |
| SAR 10g (W/Kg) | 0.059 |
| SAR 1g (W/Kg) | 0.152 |
| **SURFACE SAR** | **VOLUME SAR** |

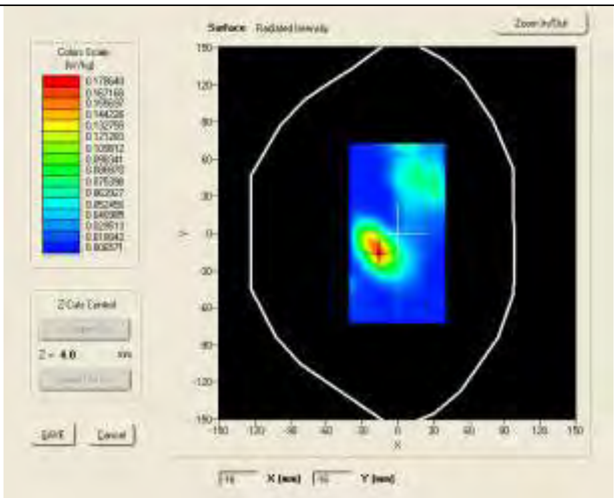
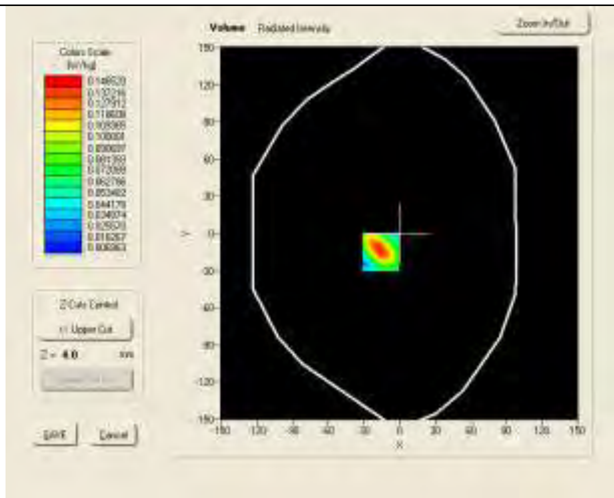


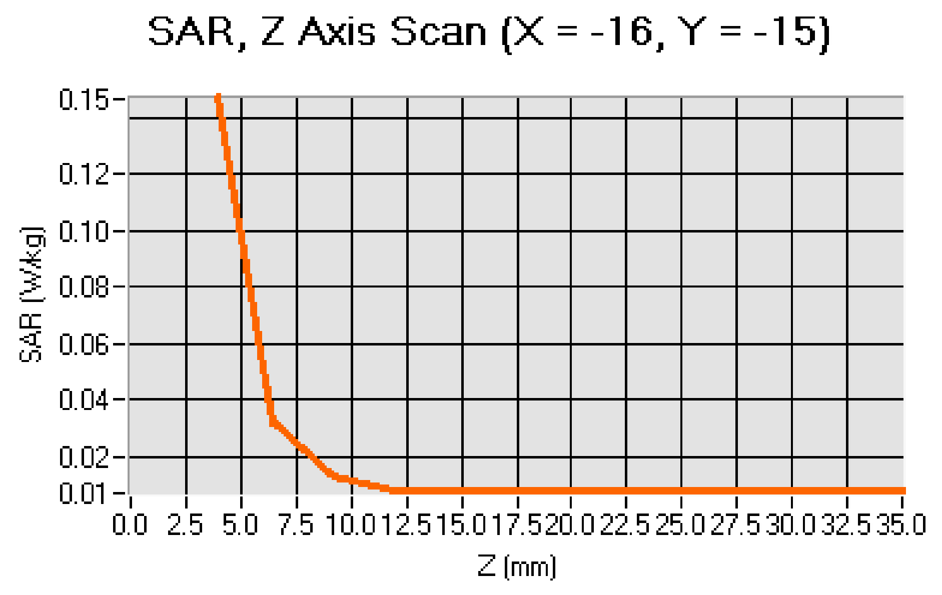



## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 64 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

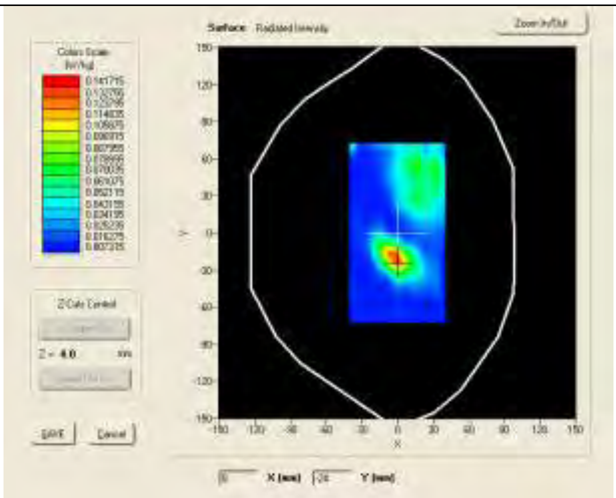
| | |
|---|---|
| Frequency (MHz) | 5310.00 (Flat) |
| Relative permittivity (real part) | 47.944 |
| Relative permittivity (imaginary part) | 16.17 |
| Conductivity (S/m) | 5.413 |
| Variation (%) | -4.85 |
| SAR 10g (W/Kg) | 0.057 |
| SAR 1g (W/Kg) | 0.142 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

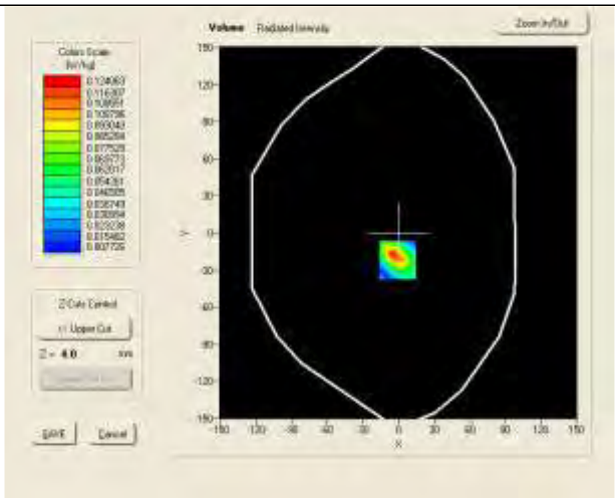


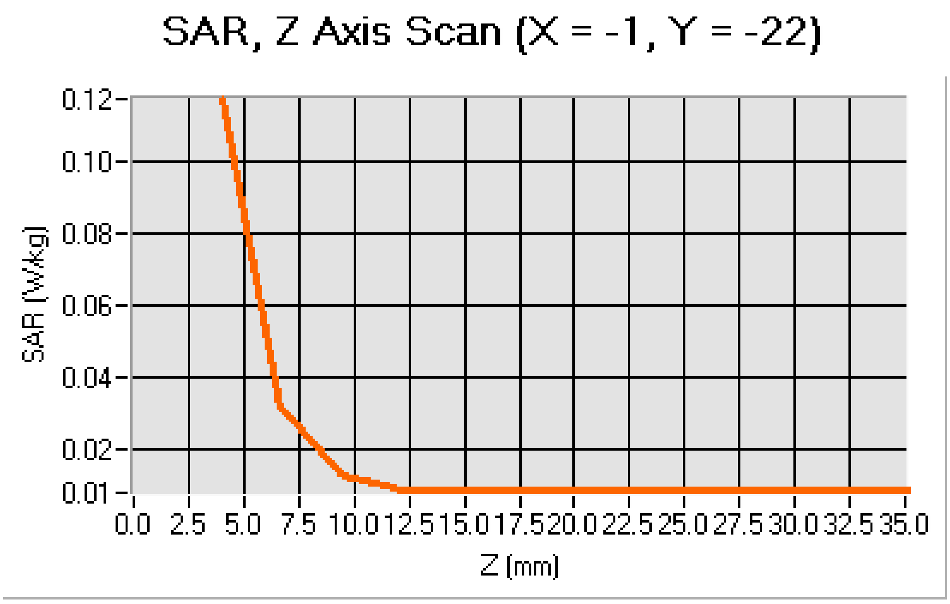
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 104 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5510.00 (Flat) |
| Relative permittivity (real part) | 48.978 |
| Relative permittivity (imaginary part) | 16.17 |
| Conductivity (S/m) | 5.577 |
| Variation (%) | -4.38 |
| SAR 10g (W/Kg) | 0.044 |
| SAR 1g (W/Kg) | 0.116 |
| **SURFACE SAR** | **VOLUME SAR** |

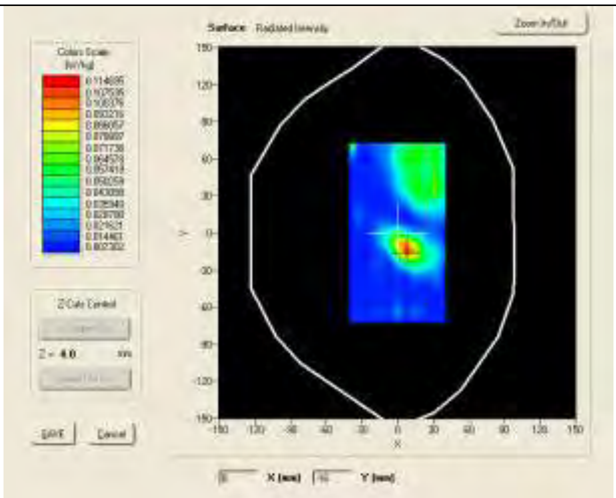
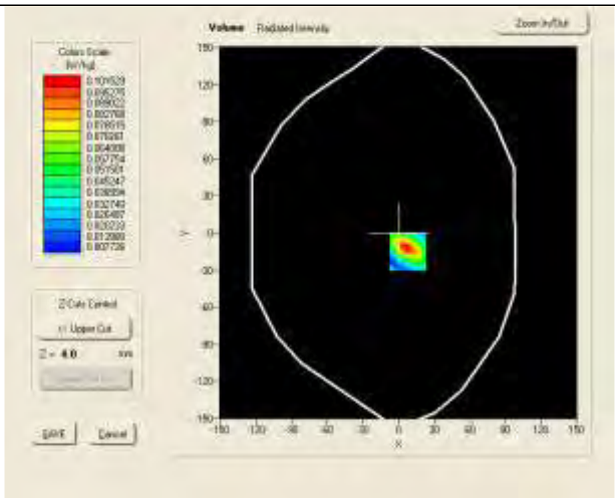


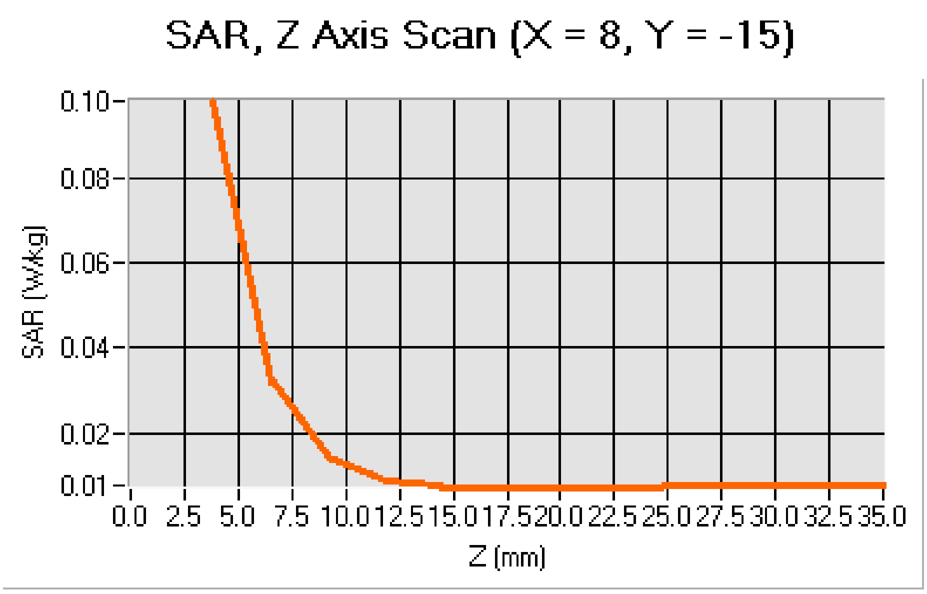




## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 112 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

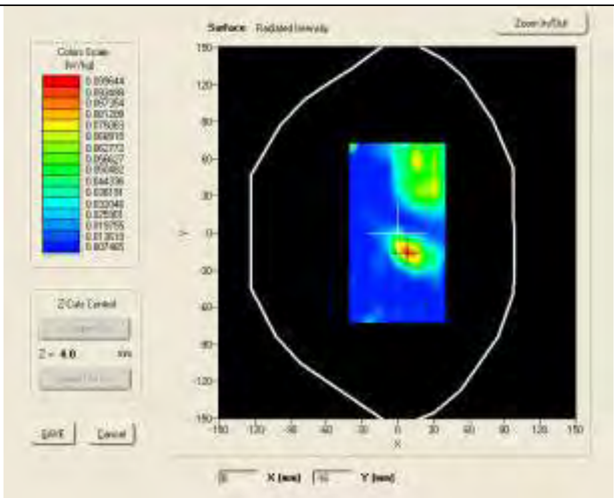
| | |
|---|---|
| Frequency (MHz) | 5550.00 (Flat) |
| Relative permittivity (real part) | 49.089 |
| Relative permittivity (imaginary part) | 16.17 |
| Conductivity (S/m) | 5.669 |
| Variation (%) | -3.30 |
| SAR 10g (W/Kg) | 0.039 |
| SAR 1g (W/Kg) | 0.101 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

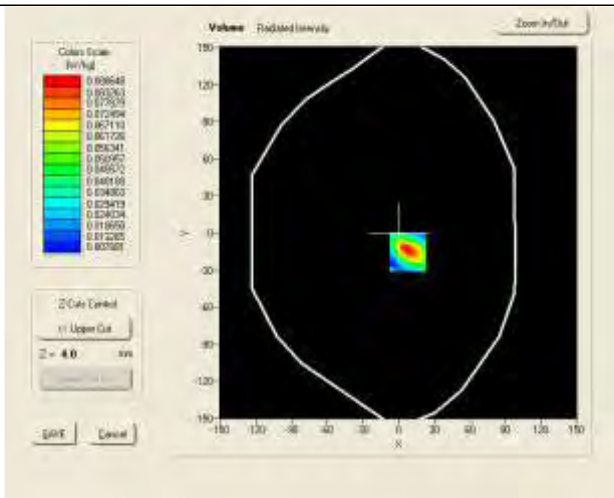


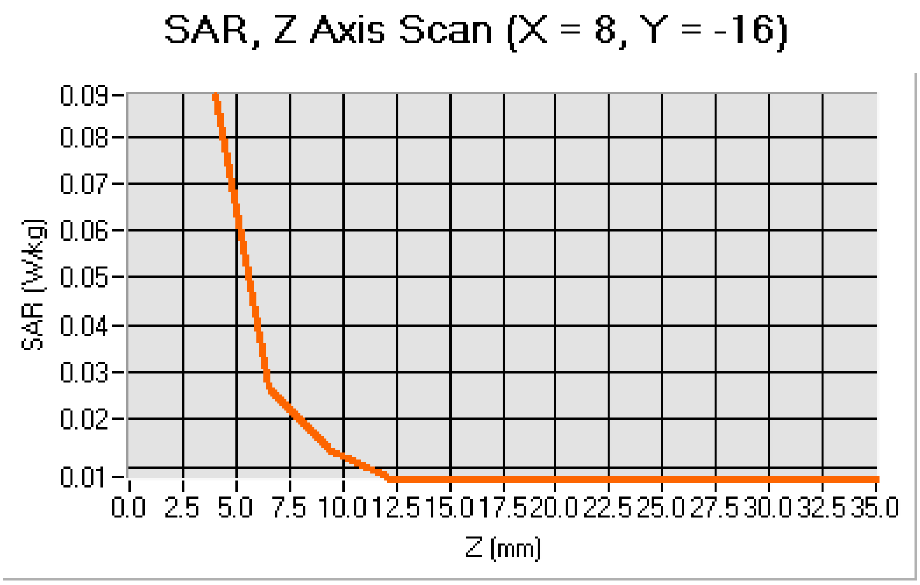
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 120 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5590.00 (Flat) |
| Relative permittivity (real part) | 49.103 |
| Relative permittivity (imaginary part) | 16.19 |
| Conductivity (S/m) | 5.681 |
| Variation (%) | -5.11 |
| SAR 10g (W/Kg) | 0.035 |
| SAR 1g (W/Kg) | 0.090 |
| **SURFACE SAR** | **VOLUME SAR** |

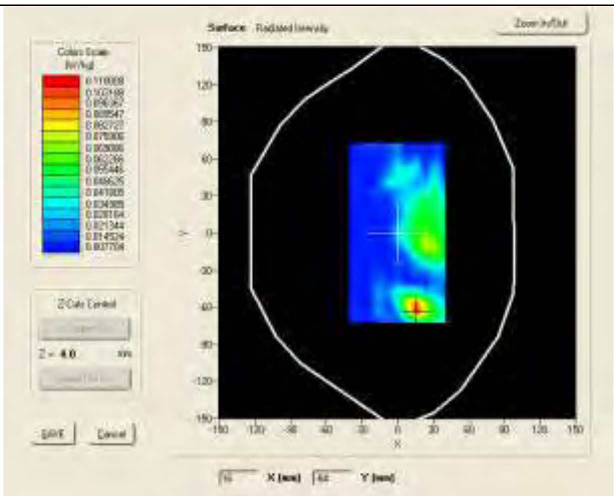
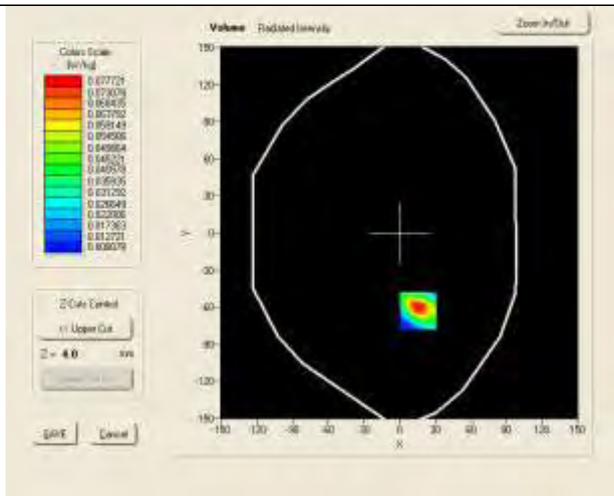


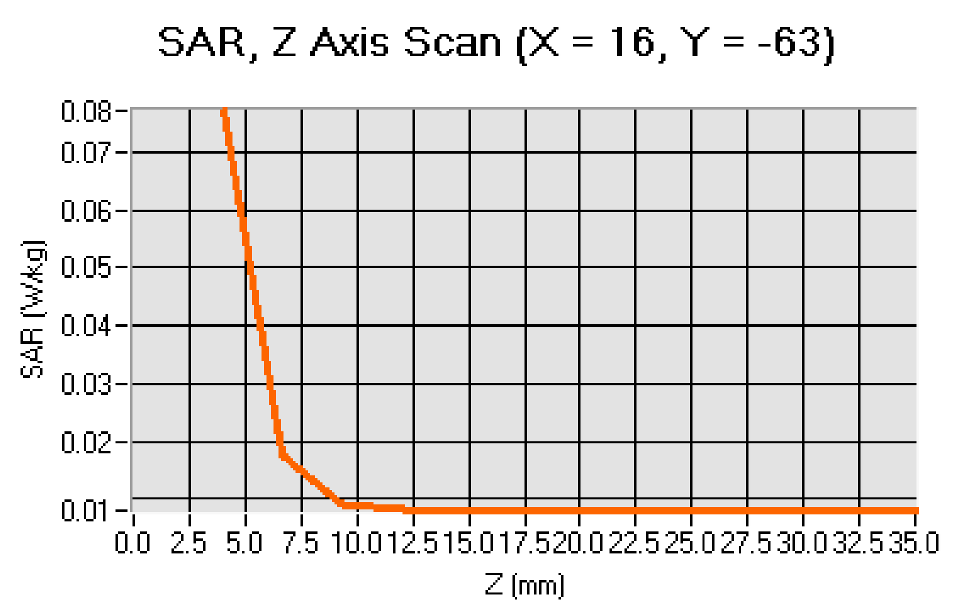




## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 128 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

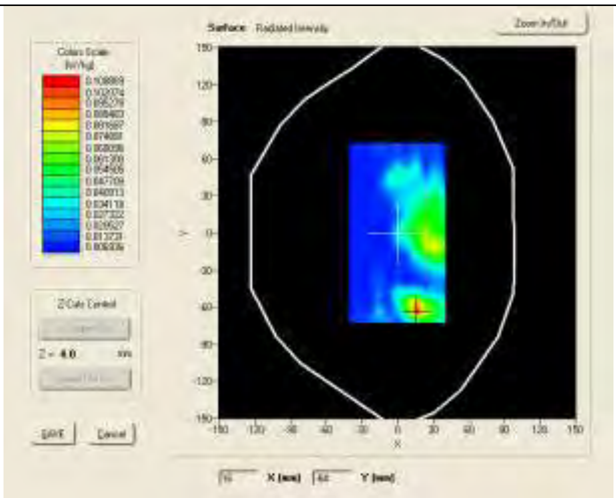
| | |
|---|---|
| Frequency (MHz) | 5630.00 (Flat) |
| Relative permittivity (real part) | 49.159 |
| Relative permittivity (imaginary part) | 16.30 |
| Conductivity (S/m) | 5.726 |
| Variation (%) | -2.30 |
| SAR 10g (W/Kg) | 0.032 |
| SAR 1g (W/Kg) | 0.079 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

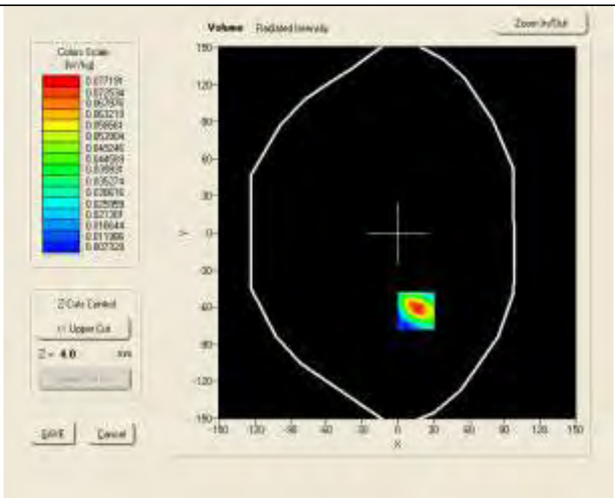


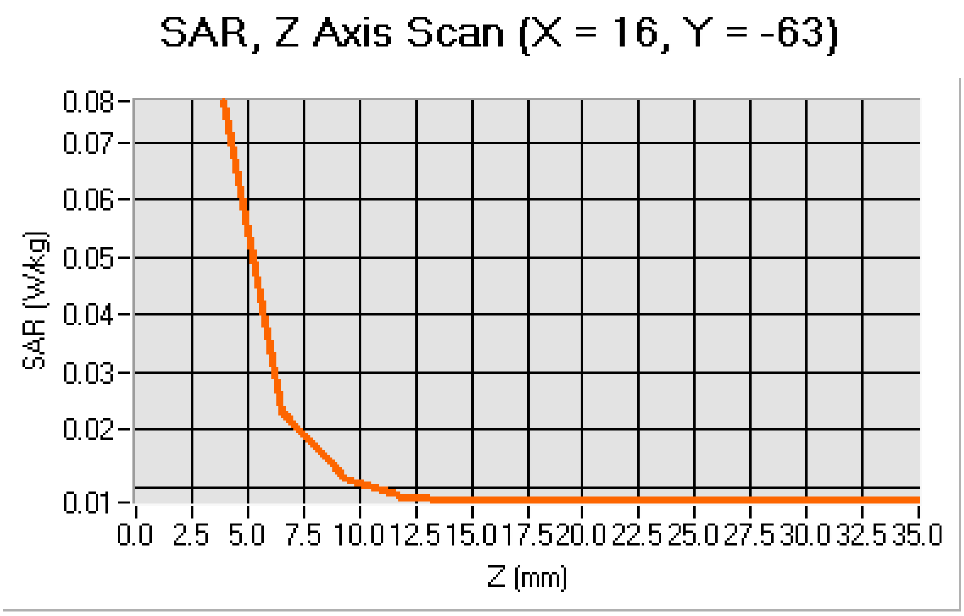
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 136 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5670.00 (Flat) |
| Relative permittivity (real part) | 49.215 |
| Relative permittivity (imaginary part) | 16.24 |
| Conductivity (S/m) | 5.773 |
| Variation (%) | -4.16 |
| SAR 10g (W/Kg) | 0.031 |
| SAR 1g (W/Kg) | 0.077 |
| **SURFACE SAR** | **VOLUME SAR** |



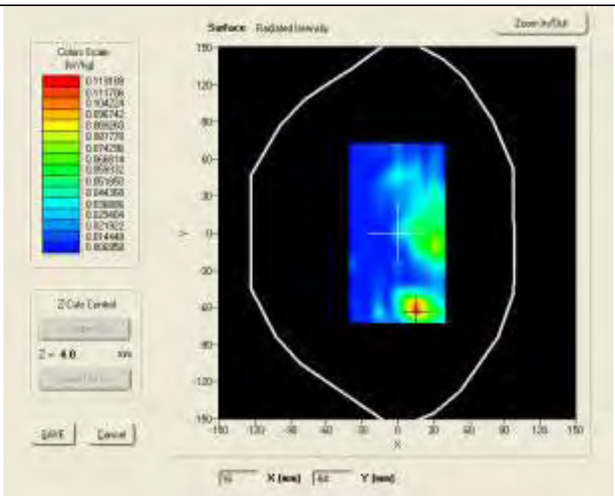


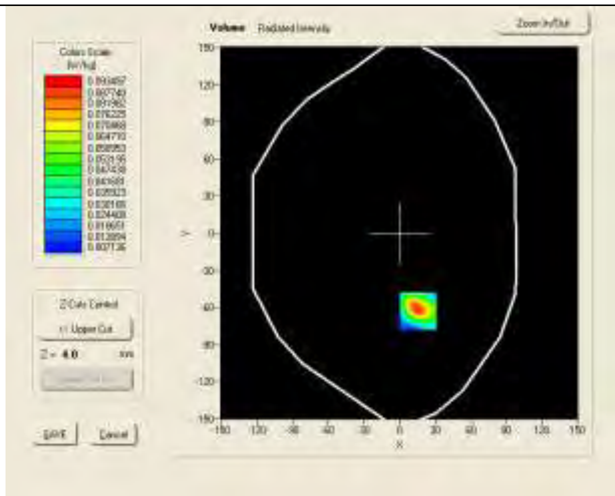


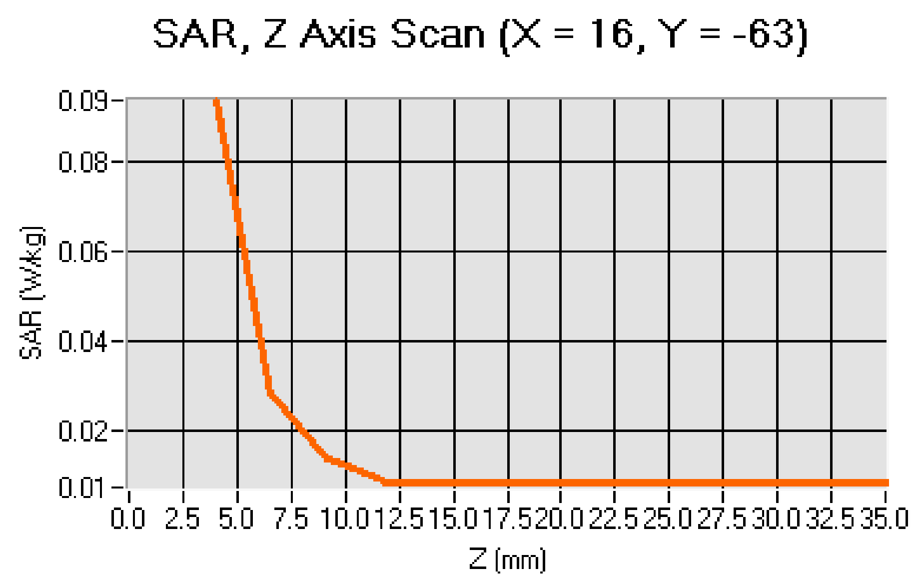
## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 153 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5755.00 (Flat) |
| Relative permittivity (real part) | 48.462 |
| Relative permittivity (imaginary part) | 16.24 |
| Conductivity (S/m) | 5.916 |
| Variation (%) | -3.37 |
| SAR 10g (W/Kg) | 0.036 |
| SAR 1g (W/Kg) | 0.091 |
| **SURFACE SAR** | **VOLUME SAR** |

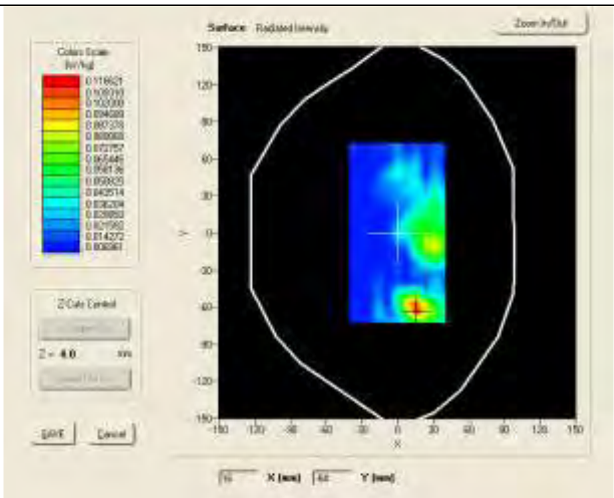
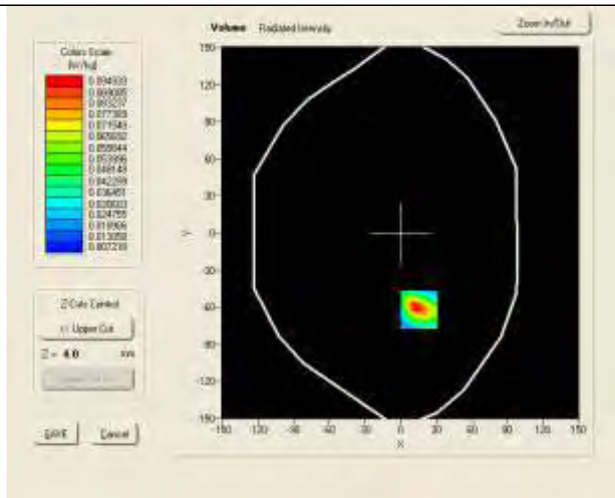




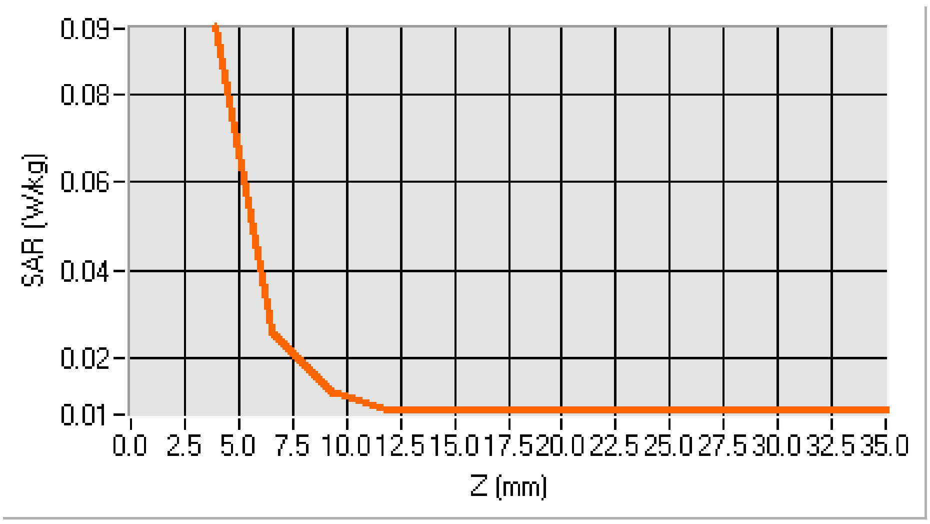


## SAR measurement Plots

**Test Mode:** 802.11n-40MHz 161 channel (150Mbps)
**Position:** Bottom
**Product Description:** Portable Printer
**Model:** Qln320 Test Date: Oct 25th, 2011

| | |
|---|---|
| Frequency (MHz) | 5795.00 (Flat) |
| Relative permittivity (real part) | 48.516 |
| Relative permittivity (imaginary part) | 16.24 |
| Conductivity (S/m) | 5.963 |
| Variation (%) | -4.54 |
| SAR 10g (W/Kg) | 0.037 |
| SAR 1g (W/Kg) | 0.096 |
| **SURFACE SAR** | **VOLUME SAR** |
|  |  |

SAR, Z Axis Scan (X = 16, Y = -62)



# Annex A. TEST INSTRUMENT & METHOD

## Annex A.i. TEST INSTRUMENTATION & GENERAL PROCEDURES

| Name of Equipment | Manufacturer | Type/Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| P C | Compaq | PV 3.06GHz | 375052-AA1 | N/A | N/A |
| Signal Generator | Agilent | 8665B-008 | 3744A01304 | 5/17/2011 | 5/17/2012 |
| MultiMeter | Keithley | MiltiMeter 2000 | 1259033 | 08/13/2011 | 08/13/2012 |
| S-Parameter Network Analyzer | Agilent | 8753ES | US38161019 | 08/04/2011 | 08/04/2012 |
| Wireless Communication Test Set | R & S | CMU200 | 111078 | 2/22/2011 | 2/22/2012 |
| Power Meter | HP | 437B | 3038A03648 | 5/17/2011 | 5/17/2012 |
| E-field PROBE | SATIMO | EPG129 | SN 26/11 EPG129 | 10/03/2011 | 10/03/2012 |
| DIPOLE 835 | SATIMO | DIPOLE 835MHz | SN 18/11 DIPC 150 | 06/01/2011 | 06/01/2012 |
| DIPOLE 900 | SATIMO | DIPOLE 900MHz | SN 18/11 DIPC 151 | 06/01/2011 | 06/01/2012 |
| DIPOLE 1800 | SATIMO | DIPOLE 1800MHz | SN 18/11 DIPC 152 | 06/01/2011 | 06/01/2012 |
| DIPOLE 1900 | SATIMO | DIPOLE 1900MHz | SN 18/11 DIPC 153 | 06/01/2011 | 06/01/2012 |
| DIPOLE 2000 | SATIMO | DIPOLE 2000MHz | SN 18/11 DIPC 154 | 06/01/2011 | 06/01/2012 |
| DIPOLE 2450 | SATIMO | DIPOLE 2450MHz | SN 18/11 DIPC 155 | 06/01/2011 | 06/01/2012 |
| DIPOLE 3500 | SATIMO | DIPOLE 3500MHz | SN 18/11 DIPC 156 | 06/01/2011 | 06/01/2012 |
| WaveGuide 5/6 GHz | SATIMO | Wave Guide 5/6GHz | SN 31/10 DIPWGA13 | 06/01/2011 | 06/01/2012 |
| COMOHAC E-Field Probe | SATIMO | EPH30 | SN 24/11 EPH30 | 06/01/2011 | 06/01/2012 |
| COMOHAC H-Field Probe | SATIMO | HPH42 | SN 43/10 HPH42 | 06/01/2011 | 06/01/2012 |
| COMOSAR Open Coaxial Probe | SATIMO | OCP43 | SN 24/11 OCPG43 | 06/01/2011 | 06/01/2012 |
| T-Coil Probe | SATIMO | TCP21 | SN 24/11 TCP21 | 06/01/2011 | 06/01/2012 |
| Communication Antenna | SATIMO | ANTA3 | SN 20/11 ANTA 3 | 06/20/2011 | 06/20/2012 |
| Laptop POSITIONING DEVICE | SATIMO | LSH15 | SN 24/11 LSH15 | N/A | N/A |
| Mobile Phone POSITIONING DEVICE | SATIMO | MSH73 | SN 24/11 MSH73 | N/A | N/A |
| COMOHAC Broadband Dipole 800-950 | SATIMO | COMOHAC Broadband Dipole 800-950MHz | SN 24/11 DHA31 | 06/01/2011 | 06/01/2012 |
| COMOHAC Broadband Dipole 1700-2000 | SATIMO | COMOHAC Broadband Dipole 1700-2000MHz | SN 24/11 DHB32 | 06/01/2011 | 06/01/2012 |
| COMOHAC TELEPHONE MAGNETIC FIELD SIMULATOR | SATIMO | TMFS12 | SN 24/11 TMFS12 | 06/01/2011 | 06/01/2012 |
| DUMMY PROBE | ANTENNESSA | DP41 | SN 24/11DP41 | N/A | N/A |
| Hygro Hermograph | Sekonic | ST-50 | HE01-000092 | 06/04/2011 | 06/04/2012 |

| | | | | | |
|---|---|---|---|---|---|
| SAM PHANTOM | SATIMO | SAM77 | SN 31/10 SAM77 | N/A | N/A |
| Elliptic Phantom | SATIMO | ELLI17 | SN 31-10 ELLI17 | N/A | N/A |
| PHANTOM TABLE | SATIMO | N/A | N/A | N/A | N/A |
| 6 AXIS ROBOT | KUKA | KR5 | 949319 | N/A | N/A |
| High Power Solid State Amplifier (80MHz~1000MHz) | Instruments for Industry | CMC150 | M631-0408 | N/A | N/A |
| Medium Power Solid State Amplifier (0.8~4.2GHz) | Instruments for Industry | S41-25 | M629-0408 | N/A | N/A |
| Wave Tube Amplifier 4-8 GHz at 20Watt | Hughes Aircraft Company | 1277H02F000 | 81 | N/A | N/A |

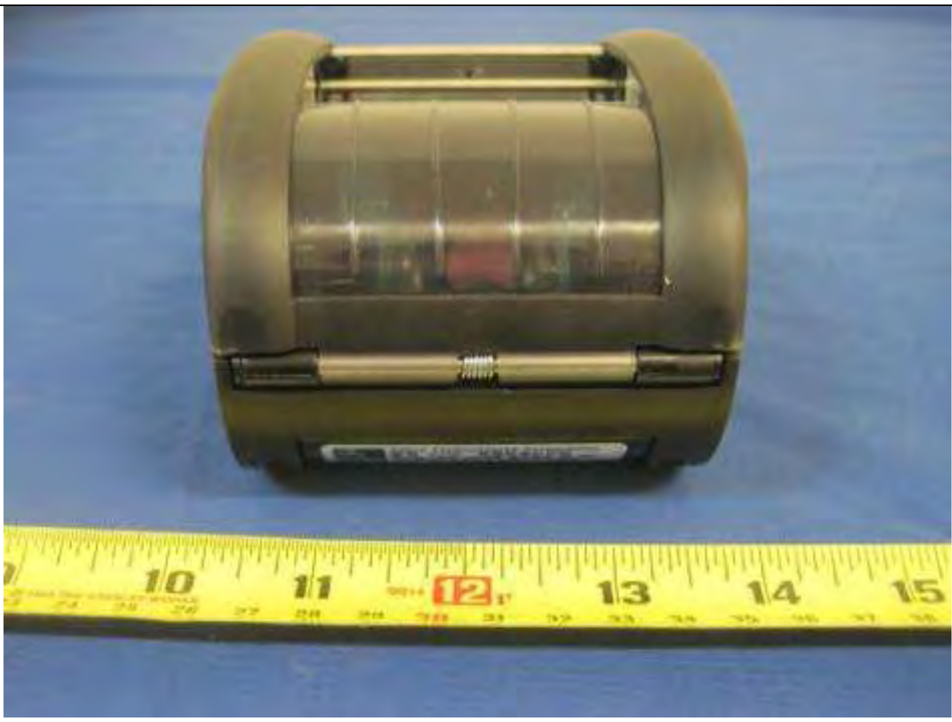
# Annex B EUT AND TEST SETUP PHOTOGRAPHS

## Annex B.i. EUT Pictures


QLn220 Top View


QLn220 Bottom View

QLn220 Front View



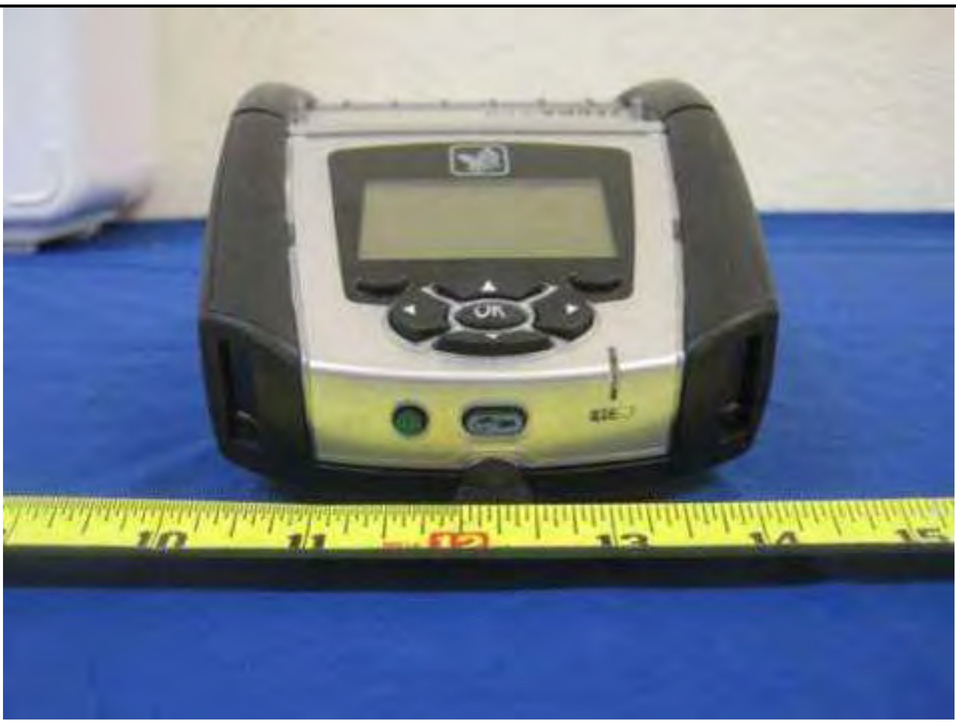
QLn220 Rear View

QLn220 Right View

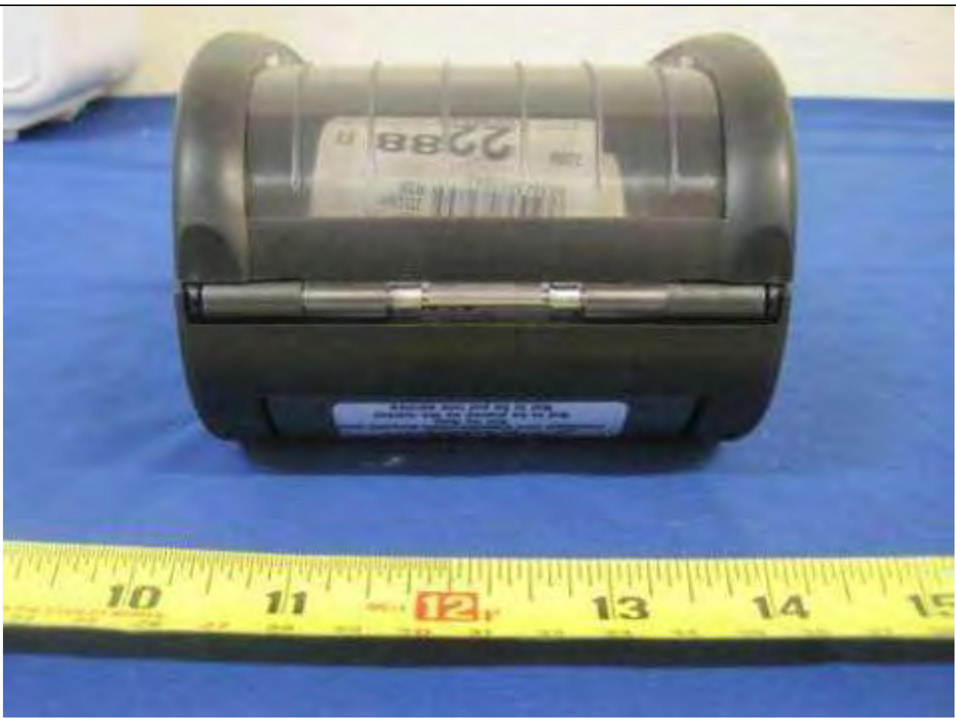
QLn220 Left View


QLn320 Top View


QLn320 Bottom View



QLn320 Front View

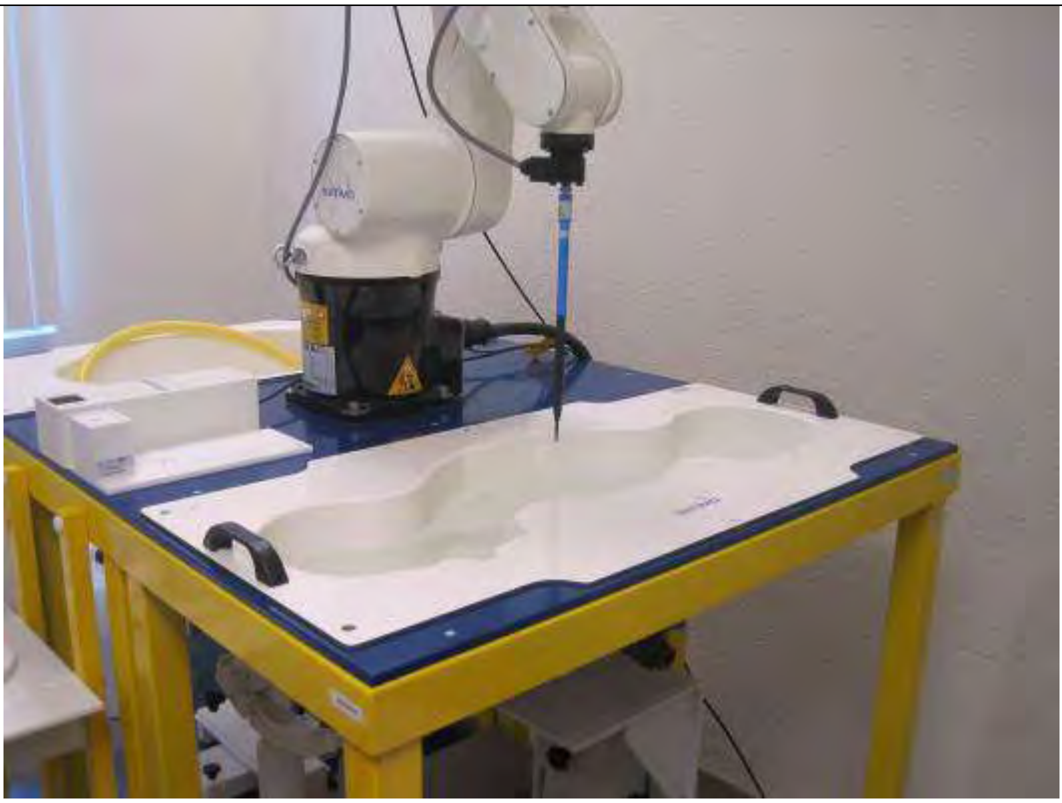


QLn320 Rear View

QLn320 Right View

QLn320 Left View

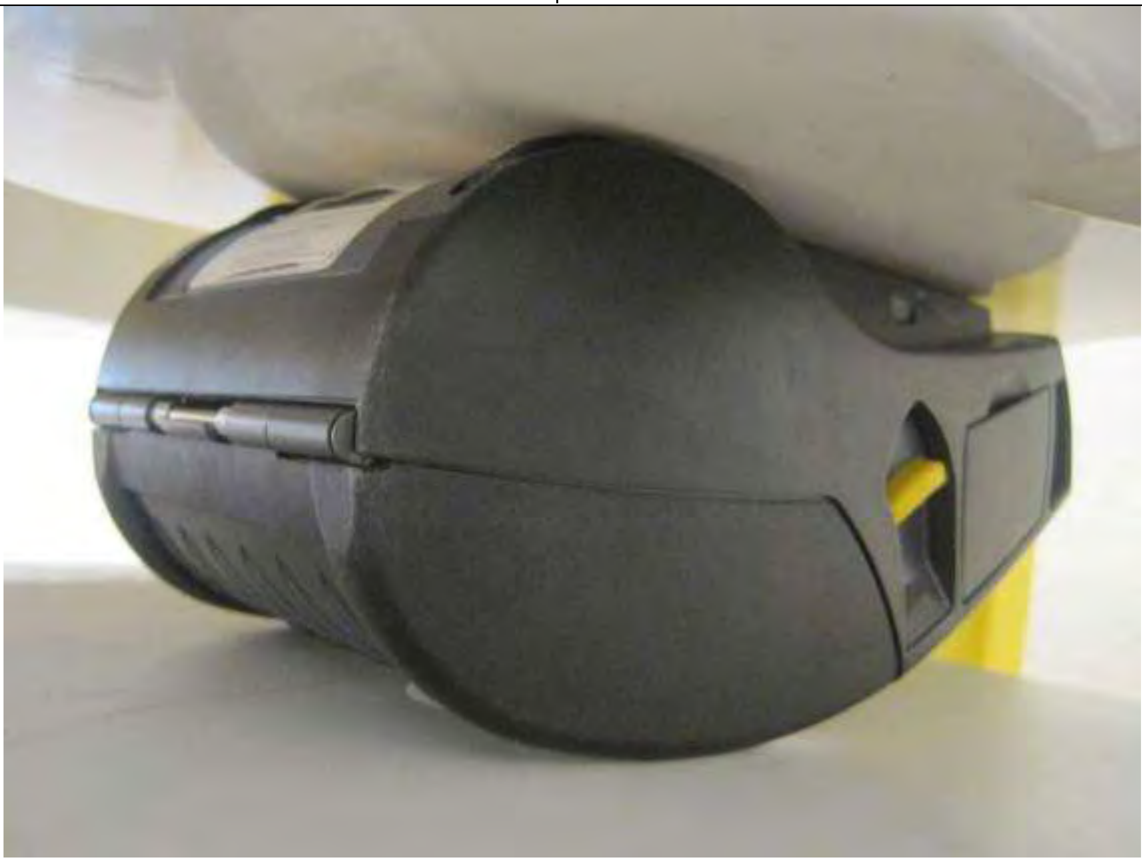
## Annex B.ii Test System and Setup Pictures



SAR test system picture

Liquid depth ≥ 15cm


Test Setup for QLn220


Test Setup for QLn320

# Annex C CALIBRATION REPORTS

SATIMO
The microwave vision company

## COMOSAR E-Field Probe Calibration Report

Ref : ACR.277.1.11.SATU.B

**SIEMIC TESTING AND CERTIFICATION SERVICES**
**SUITE 311, BUILDING 1, SECTION 30 ,NO.2 KEFA ROAD, SCIENCE AND TECHNOLOGY PARK**
**NAN SHAN DISTRICT, SHENZHEN 518057 , GUANGDONG ,P.R.C.**
**SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE**
**SERIAL NO.: SN 26/11 EPG129**

**Calibrated at SATIMO US**
**2105 Barrett Park Dr. - Kennesaw, GA 30144**

ACCREDITED
Calibration CERT #2246.02

**10/03/2011**

*Summary:*

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed in SATIMO USA using the CALISAR / CALIBAIR test bench, for use with a SATIMO COMOSAR system only. All calibration results are traceable to national metrology institutions.

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme LUC | Product Manager | 10/4/2011 | |
| *Checked by :* | Jérôme LUC | Product Manager | 10/4/2011 | |
| *Approved by :* | Kim RUTKOWSKI | Quality Manager | 10/4/2011 | |

| | *Customer Name* |
|---|---|
| *Distribution :* | SIEMIC Testing and Certification Services |

| *Issue* | *Date* | *Modifications* |
|---|---|---|
| A | 10/4/2011 | Initial release |
| B | 11/30/2011 | Add detail about the calibration method |
| | | |
| | | |

# TABLE OF CONTENTS

## 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | Satimo |
| Model | SSE2 |
| Serial Number | SN 26/11 EPG129 |
| Product Condition (new / used) | new |
| Frequency Range of Probe | 0.7 GHz-6GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.153 MΩ<br>Dipole 2: R2=0.215 MΩ<br>Dipole 3: R3=0.192 MΩ |

A yearly calibration interval is recommended.

## 2 PRODUCT DESCRIPTION

### 2.1 GENERAL INFORMATION

Satimo's COMOSAR E field Probes are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards.

**Figure 1** – *Satimo COMOSAR Dosimetric E field Dipole*

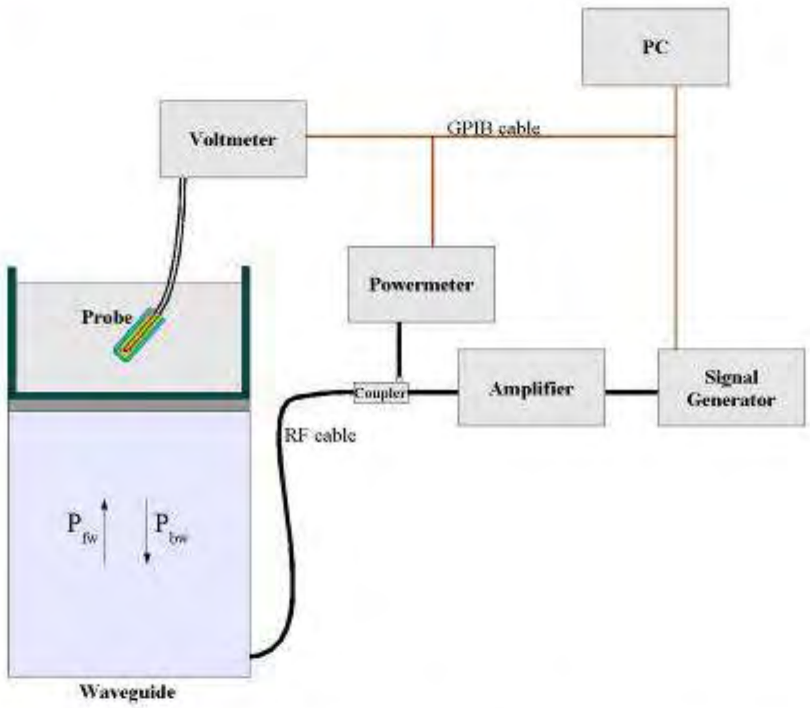
| | |
|---|---|
| Probe Length | 330 mm |
| Length of Individual Dipoles | 2 mm |
| Maximum external diameter | 8 mm |
| Probe Tip External Diameter | 2.5 mm |
| Distance between dipoles / probe extremity | 1 mm |

## 3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

### 3.1 METHOD

Probe calibration is realized, in compliance with CENELEC EN 50361; CEI/IEC 62209 and IEEE 1528 std, with CALISAR, SATIMO proprietary calibration system. The calibration is performed with the technique using reference waveguide.




$$SAR = \frac{4\left(P_{fw} - P_{bw}\right)}{ab\delta}\cos^2\left(\pi\frac{y}{a}\right)e^{-(2z/\delta)}$$

Where :

$P_{fw}$ = Forward Power
$P_{bw}$ = Backward Power
a and b = Waveguide dimensions
$\delta$ = Skin depth

*Keithley configuration:*

Rate = Medium; Filter =ON; RDGS=10; FILTER TYPE =MOVING AVERAGE; RANGE AUTO

*After each calibration, a SAR measurement is performed on a validation dipole and compared with a NPL calibrated probe, to verify it.*

### 3.2 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

### 3.3 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

### 3.4 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

### 3.5 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

### 3.6 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

## 4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

| Uncertainty analysis of the probe calibration in waveguide | | | | | |
|---|---|---|---|---|---|
| ERROR SOURCES | Uncertainty value (%) | Probability Distribution | Divisor | ci | Standard Uncertainty (%) |
| Incident or forward power | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |
| Reflected power | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |
| Liquid conductivity | 5.00% | Rectangular | $\sqrt{3}$ | 1 | 2.887% |
| Liquid permittivity | 4.00% | Rectangular | $\sqrt{3}$ | 1 | 2.309% |
| Field homogeneity | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |
| Field probe positioning | 5.00% | Rectangular | $\sqrt{3}$ | 1 | 2.887% |
| Field probe linearity | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |

| | | | | | |
|---|---|---|---|---|---|
| **Combined standard uncertainty** | | | | | 5.831% |
| **Expanded uncertainty** 95 % confidence level k = 2 | | | | | 11.662% |

## 5 CALIBRATION MEASUREMENT RESULTS

| Calibration Parameters | |
|---|---|
| Liquid Temperature | 21 °C |
| Lab Temperature | 21 °C |
| Lab Humidity | 45 % |

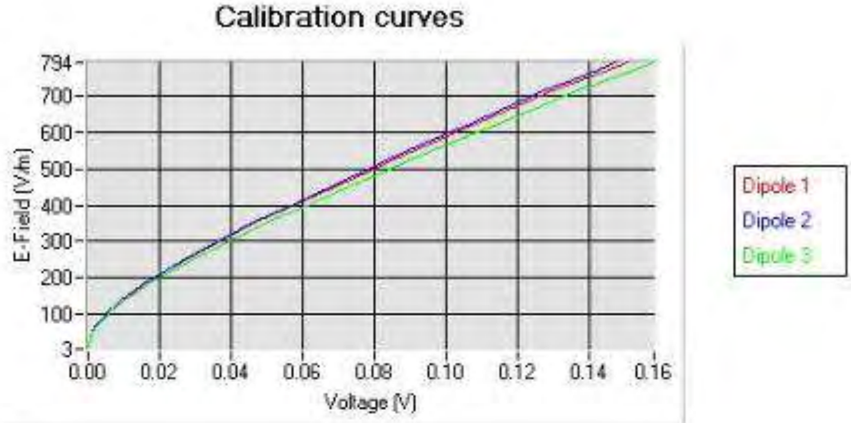
### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 ($\mu V/(V/m)^2$) | Normy dipole 2 ($\mu V/(V/m)^2$) | Normz dipole 3 ($\mu V/(V/m)^2$) |
|---|---|---|
| 0.53 | 0.53 | 0.58 |

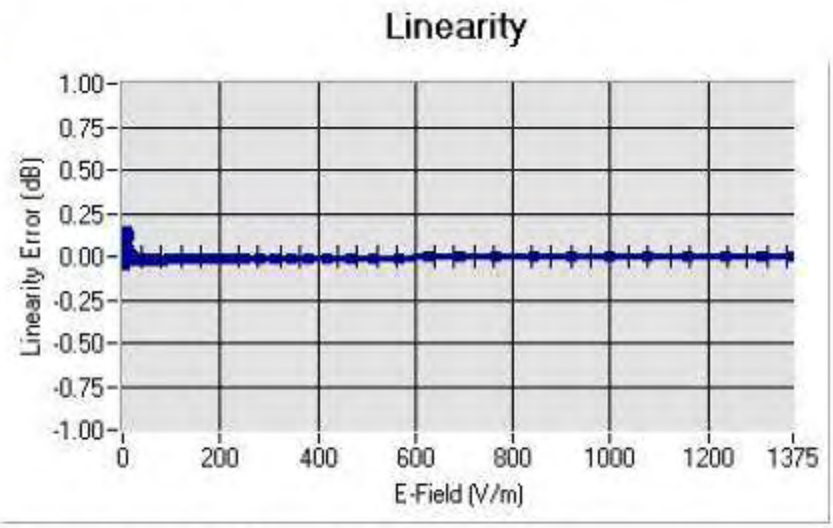
| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 120 | 118 | 123 |

Calibration curves ei=f(V) (i=1,2,3) allow to obtain H-field value using the formula:

$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$



## 5.2 LINEARITY




Linearity:+/-3.51% (+/-0.16dB)

## 5.3 SENSITIVITY IN LIQUID

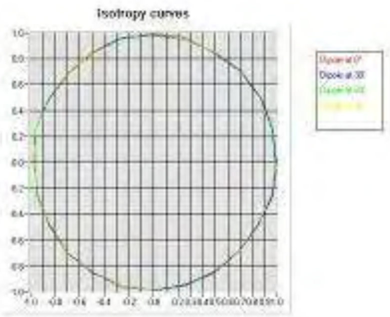
| Liquid | Frequency (MHz +/- 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|---|---|---|---|---|
| HL850 | 835 | 42.56 | 0.88 | 8.78 |
| BL850 | 835 | 55.23 | 0.98 | 9.07 |
| HL900 | 900 | 42.02 | 0.96 | 8.74 |
| BL900 | 900 | 55.02 | 1.03 | 9.03 |
| HL1800 | 1750 | 39.03 | 1.39 | 8.60 |
| BL1800 | 1750 | 53.78 | 1.50 | 8.83 |
| HL1900 | 1880 | 39.43 | 1.42 | 9.09 |
| BL1900 | 1880 | 53.99 | 1.52 | 9.32 |
| HL2000 | 1950 | 39.43 | 1.44 | 8.54 |
| BL2000 | 1950 | 54.76 | 1.54 | 8.82 |
| HL2450 | 2450 | 40.32 | 1.82 | 9.02 |
| BL2450 | 2450 | 53.67 | 1.96 | 9.28 |
| HL3500 | 3500 | 36.43 | 2.86 | 7.99 |
| BL3500 | 3500 | 52.75 | 3.43 | 8.31 |
| HL5200 | 5200 | 34.57 | 4.41 | 6.30 |
| BL5200 | 5200 | 48.32 | 5.01 | 6.43 |
| HL5500 | 5500 | 34.93 | 4.96 | 7.27 |
| BL5500 | 5500 | 48.99 | 5.77 | 7.55 |
| HL5800 | 5800 | 33.69 | 5.42 | 7.52 |
| BL5800 | 5800 | 49.56 | 6.11 | 7.79 |

LOWER DETECTION LIMIT: 7mW/kg

### 5.4 ISOTROPY

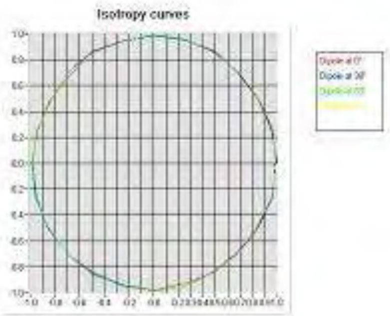
**HL900 MHz**

- Axial isotropy: 0.08 dB
- Hemispherical isotropy: 0.04 dB



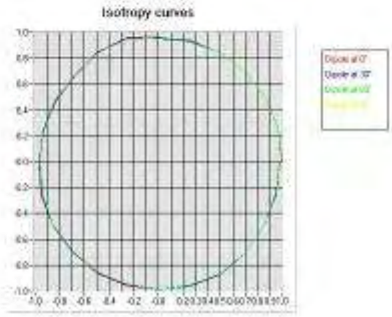

**HL1800 MHz**

- Axial isotropy: 0.09 dB
- Hemispherical isotropy: 0.07 dB



**HL5500 MHz**

- Axial isotropy: 0.14 dB
- Hemispherical isotropy: 0.08 dB



## 6 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| Flat Phantom | Satimo | SN-20/09-SAM71 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rhode & Schwarz ZVA | SN100132 | 02/2010 | 02/2013 |
| Reference Probe | Satimo | EP 94 SN 37/08 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Multimeter | Keithley 2000 | 1188656 | 11/2010 | 11/2013 |
| Signal Generator | Agilent E4438C | MY49070581 | 12/2010 | 12/2013 |
| Amplifier | Aethercomm | SN 046 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | HP E4418A | US38261498 | 11/2010 | 11/2013 |
| Power Sensor | HP ECP-E26A | US37181460 | 11/2010 | 11/2013 |
| Directional Coupler | Narda 4216-20 | 01386 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide | Mega Industries | 069Y7-158-13-712 | Validated. No cal required. | Validated. No cal required. |
| Waveguide Transition | Mega Industries | 069Y7-158-13-701 | Validated. No cal required. | Validated. No cal required. |
| Waveguide Termination | Mega Industries | 069Y7-158-13-701 | Validated. No cal required. | Validated. No cal required. |
| Temperature / Humidity Sensor | Control Company | 11-661-9 | 3/2010 | 3/2012 |

SATIMO
The microwave vision company

# SAR Reference Dipole Calibration Report

Ref : ACR.158.9.11.SATU.A

## SIEMIC TESTING AND CERTIFICATION SERVICES

### SUITE 311, BUILDING 1, SECTION 30 ,NO.2 KEFA ROAD, SCIENCE AND TECHNOLOGY PARK
### NAN SHAN DISTRICT, SHENZHEN 518057 , GUANGDONG ,P.R.C.

## SATIMO COMOSAR REFERENCE DIPOLE

**Calibrated at SATIMO US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**

ACCREDITED
Calibration CERT #2246.02

**06/01/2011**

*Summary:*

This document presents the method and results from an accredited SAR reference dipole calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme LUC | Product Manager | 6/7/2011 | |
| *Checked by :* | Jérôme LUC | Product Manager | 6/7/2011 | |
| *Approved by :* | Kim RUTKOWSKI | Quality Manager | 6/7/2011 | |

| | *Customer Name* |
|---|---|
| *Distribution :* | SIEMIC Testing and Certification Services |

| *Issue* | *Date* | *Modifications* |
|---|---|---|
| A | 6/7/2011 | Initial release |
| | | |
| | | |
| | | |

# TABLE OF CONTENTS

# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 2450 MHz REFERENCE DIPOLE |
| Manufacturer | Satimo |
| Model | SID2450 |
| Serial Number | SN 18/11 DIPJ155 |
| Product Condition (new / used) | new |

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

**Figure 1 –** *Satimo COMOSAR Validation Dipole*

## 4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

### 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constucted as outlined in the fore mentioned standards.

### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

## 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

| Frequency band | Expanded Uncertainty on Return Loss |
|---|---|
| 400-6000MHz | 0.1 dB |

### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|---|---|
| 3 - 300 | 0.05 mm |

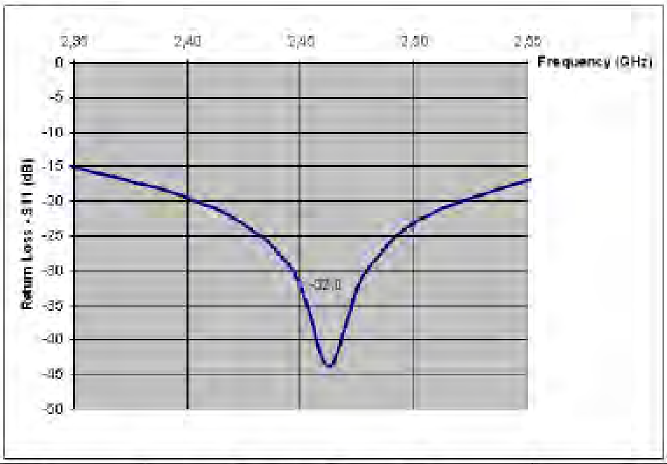
### 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

| Scan Volume | Expanded Uncertainty |
|---|---|
| 1 g | 16.19 % |
| 10 g | 15.86 % |

# 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) |
|---|---|---|
| 2450 | -32.00 | -20 |

## 6.2 MECHANICAL DIMENSIONS

| Frequency MHz | L mm | | h mm | | d mm | |
|---|---|---|---|---|---|---|
| | required | measured | required | measured | required | measured |
| 300 | 420.0 ±1 %. | | 250.0 ±1 %. | | 6.35 ±1 %. | |
| 450 | 290.0 ±1 %. | | 166.7 ±1 %. | | 6.35 ±1 %. | |
| 750 | 176.0 ±1 %. | | 100.0 ±1 %. | | 6.35 ±1 %. | |
| 835 | 161.0 ±1 %. | | 89.8 ±1 %. | | 3.6 ±1 %. | |
| 900 | 149.0 ±1 %. | | 83.3 ±1 %. | | 3.6 ±1 %. | |
| 1450 | 89.1 ±1 %. | | 51.7 ±1 %. | | 3.6 ±1 %. | |
| 1500 | 80.5 ±1 %. | | 50.0 ±1 %. | | 3.6 ±1 %. | |
| 1640 | 79.0 ±1 %. | | 45.7 ±1 %. | | 3.6 ±1 %. | |
| 1750 | 75.2 ±1 %. | | 42.9 ±1 %. | | 3.6 ±1 %. | |
| 1800 | 72.0 ±1 %. | | 41.7 ±1 %. | | 3.6 ±1 %. | |
| 1900 | 68.0 ±1 %. | | 39.5 ±1 %. | | 3.6 ±1 %. | |
| 1950 | 66.3 ±1 %. | | 38.5 ±1 %. | | 3.6 ±1 %. | |
| 2000 | 64.5 ±1 %. | | 37.5 ±1 %. | | 3.6 ±1 %. | |
| 2100 | 61.0 ±1 %. | | 35.7 ±1 %. | | 3.6 ±1 %. | |
| 2300 | 55.5 ±1 %. | | 32.6 ±1 %. | | 3.6 ±1 %. | |
| 2450 | 51.5 ±1 %. | PASS | 30.4 ±1 %. | PASS | 3.6 ±1 %. | PASS |
| 2600 | 48.5 ±1 %. | | 28.8 ±1 %. | | 3.6 ±1 %. | |
| 3000 | 41.5 ±1 %. | | 25.0 ±1 %. | | 3.6 ±1 %. | |
| 3500 | 37.0±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |
| 3700 | 34.7±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |

# 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, OET 65 Bulletin C and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

## 7.1 MEASUREMENT CONDITION

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Head Liquid Values: eps' : 38.8 sigma : 1.88 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/dz=5mm |
| Frequency | 2450 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 21 °C |
| Lab Temperature | 21 °C |
| Lab Humidity | 45 % |

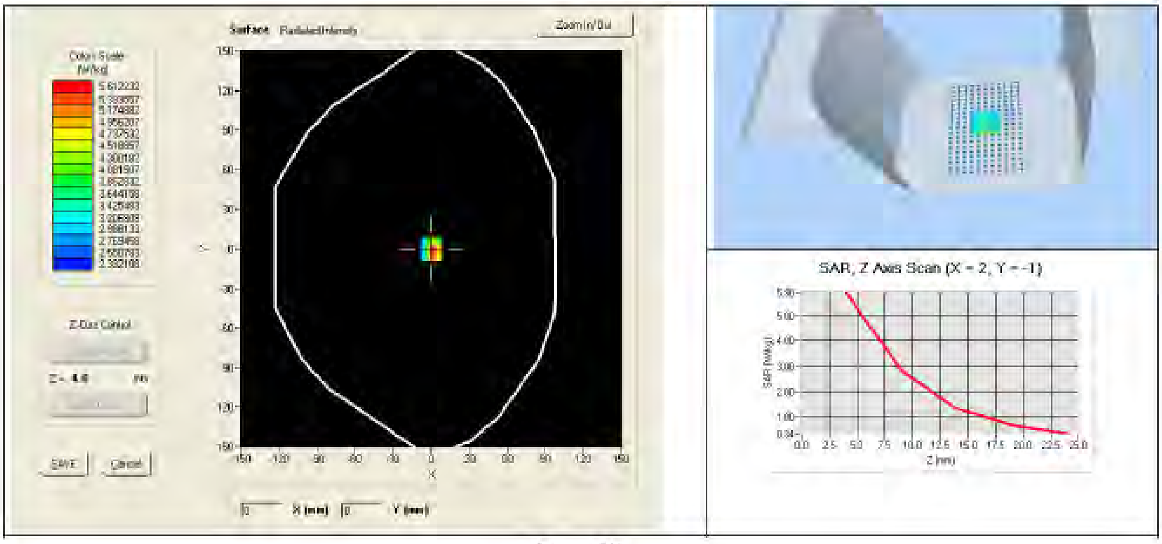
## 7.2 HEAD LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity ($\varepsilon_r'$) | | Conductivity ($\sigma$) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 45.3 ±5 % | | 0.87 ±5 % | |
| 450 | 43.5 ±5 % | | 0.87 ±5 % | |
| 750 | 41.9 ±5 % | | 0.89 ±5 % | |
| 835 | 41.5 ±5 % | | 0.90 ±5 % | |
| 900 | 41.5 ±5 % | | 0.97 ±5 % | |
| 1450 | 40.5 ±5 % | | 1.20 ±5 % | |
| 1500 | 40.4 ±5 % | | 1.23 ±5 % | |
| 1640 | 40.2 ±5 % | | 1.31 ±5 % | |
| 1750 | 40.1 ±5 % | | 1.37 ±5 % | |
| 1800 | 40.0 ±5 % | | 1.40 ±5 % | |
| 1900 | 40.0 ±5 % | | 1.40 ±5 % | |
| 1950 | 40.0 ±5 % | | 1.40 ±5 % | |
| 2000 | 40.0 ±5 % | | 1.40 ±5 % | |
| 2100 | 39.8 ±5 % | | 1.49 ±5 % | |
| 2300 | 39.5 ±5 % | | 1.67 ±5 % | |
| 2450 | 39.2 ±5 % | PASS | 1.80 ±5 % | PASS |
| 2600 | 39.0 ±5 % | | 1.96 ±5 % | |
| 3000 | 38.5 ±5 % | | 2.40 ±5 % | |
| 3500 | 37.9 ±5 % | | 2.91 ±5 % | |

## 7.3 MEASUREMENT RESULT

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

| Frequency MHz | 1 g SAR (W/kg/W) | | 10 g SAR (W/kg/W) | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 2.85 | | 1.94 | |
| 450 | 4.58 | | 3.06 | |
| 750 | 8.49 | | 5.55 | |
| 835 | 9.56 | | 6.22 | |
| 900 | 10.9 | | 6.99 | |
| 1450 | 29 | | 16 | |
| 1500 | 30.5 | | 16.8 | |
| 1640 | 34.2 | | 18.4 | |
| 1750 | 36.4 | | 19.3 | |
| 1800 | 38.4 | | 20.1 | |
| 1900 | 39.7 | | 20.5 | |
| 1950 | 40.5 | | 20.9 | |
| 2000 | 41.1 | | 21.1 | |
| 2100 | 43.6 | | 21.9 | |
| 2300 | 48.7 | | 23.3 | |
| 2450 | 52.4 | 53.82 (5.38) | 24 | 24.12 (2.41) |
| 2600 | 55.3 | | 24.6 | |
| 3000 | 63.8 | | 25.7 | |
| 3500 | 67.1 | | 25 | |



## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| Equipment Description | Manufacturer / Model | Identification No. | Current Calibration Date | Next Calibration Date |
| Flat Phantom | Satimo | SN-20/09-SAM71 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rhode & Schwarz ZVA | SN100132 | 02/2010 | 02/2013 |
| Calipers | Carrera | CALIPER-01 | 12/2010 | 12/2013 |
| Reference Probe | Satimo | EPG122 SN 18/11 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Multimeter | Keithley 2000 | 1188656 | 11/2010 | 11/2013 |
| Signal Generator | Agilent E4438C | MY49070581 | 12/2010 | 12/2013 |
| Amplifier | Aethercomm | SN 046 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | HP E4418A | US38261498 | 11/2010 | 11/2013 |
| Power Sensor | HP ECP-E26A | US37181460 | 11/2010 | 11/2013 |
| Directional Coupler | Narda 4216-20 | 01386 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor | Control Company | 11-661-9 | 3/2010 | 3/2012 |

SATIMO
The microwave vision company

# SAR Reference Waveguide Calibration Report

Ref : ACR.158.11.11.SATU.A

**SIEMIC TESTING AND CERTIFICATION SERVICES**

**SUITE 311, BUILDING 1, SECTION 30 ,NO.2 KEFA ROAD, SCIENCE AND TECHNOLOGY PARK**

**NAN SHAN DISTRICT, SHENZHEN 518057 , GUANGDONG ,P.R.C.**

**SATIMO COMOSAR REFERENCE WAVEGUIDE**

**Calibrated at SATIMO US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**

ACCREDITED
Calibration CERT #2246.02

**06/01/2011**

*Summary:*

This document presents the method and results from an accredited SAR reference waveguide calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme LUC | Product Manager | 6/7/2011 | [signature] |
| *Checked by :* | Jérôme LUC | Product Manager | 6/7/2011 | [signature] |
| *Approved by :* | Kim RUTKOWSKI | Quality Manager | 6/7/2011 | [signature] |

| | *Customer Name* |
|---|---|
| *Distribution :* | SIEMIC Testing and Certification Services |

| *Issue* | *Date* | *Modifications* |
|---|---|---|
| A | 6/7/2011 | Initial release |
| | | |
| | | |
| | | |

## TABLE OF CONTENTS

## 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528 and CEI/IEC 62209 standards for reference waveguides used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

## 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 5000-6000 MHz REFERENCE WAVEGUIDE |
| Manufacturer | Satimo |
| Model | SWG5500 |
| Serial Number | SN 24/11 WGA16 |
| Product Condition (new / used) | new |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Waveguides are built in accordance to the IEEE 1528 and CEI/IEC 62209 standards.

## 4 MEASUREMENT METHOD

The IEEE 1528 and CEI/IEC 62209 standards provide requirements for reference waveguides used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

### 4.1 RETURN LOSS REQUIREMENTS

The waveguide used for SAR system validation measurements and checks must have a return loss of -8 dB or better. The return loss measurement shall be performed with matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell as outlined in the fore mentioned standards.

### 4.2 MECHANICAL REQUIREMENTS

The IEEE 1528 and CEI/IEC 62209 standards specify the mechanical dimensions of the validation waveguide, the specified dimensions are as shown in Section 6.2. Figure 1 shows how the dimensions relate to the physical construction of the waveguide.

## 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

| Frequency band | Expanded Uncertainty on Return Loss |
|---|---|
| 400-6000MHz | 0.1 dB |

### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|---|---|
| 3 - 300 | 0.05 mm |

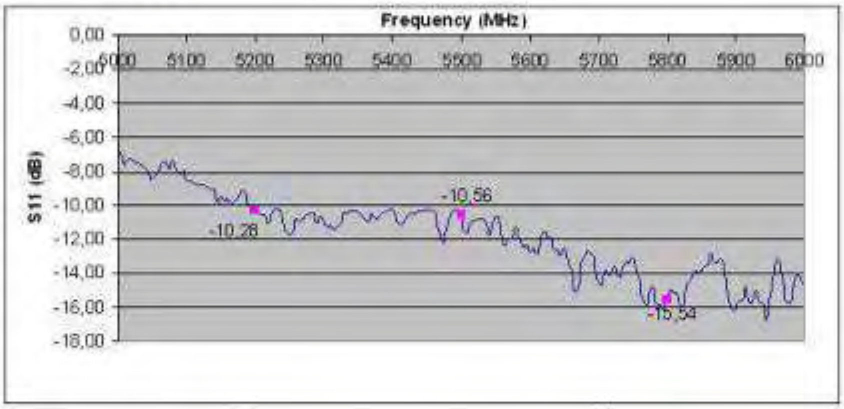
### 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

| Scan Volume | Expanded Uncertainty |
|---|---|
| 1 g | 16.19 % |
| 10 g | 15.86 % |

## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) |
|---|---|---|
| 5000-6000 | < -20.00 | -8 |

## 6.2 MECHANICAL DIMENSIONS

| Frequency (MHz) | L (mm) | | W (mm) | | $L_f$ (mm) | | $W_f$ (mm) | | T (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Required | Measured | Required | Measured | Required | Measured | Required | Measured | Required | Measured |
| 5200 | 40.39 ± 0.13 | PASS | 20.19 ± 0.13 | PASS | 81.03 ± 0.13 | PASS | 61.98 ± 0.13 | PASS | 5.3* | PASS |
| 5800 | 40.39 ± 0.13 | PASS | 20.19 ± 0.13 | PASS | 81.03 ± 0.13 | PASS | 61.98 ± 0.13 | PASS | 4.3* | PASS |

* The tolerance for the matching layer is included in the return loss measurement.

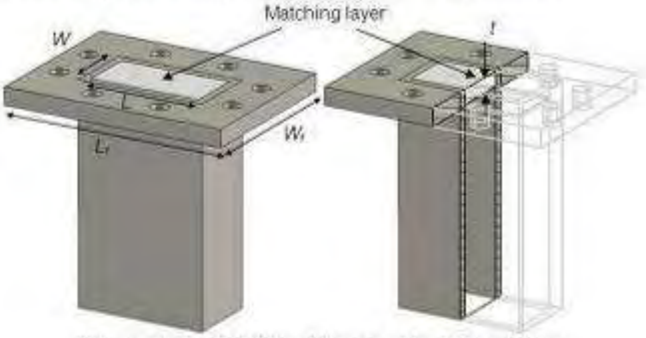



**Figure 1: Validation Waveguide Dimensions**

## 7 VALIDATION MEASUREMENT

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference waveguide meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed with the matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell.

Measurement Condition

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Head Liquid Values 5200 MHz: eps' :36.80 sigma : 4.87<br>Head Liquid Values 5500 MHz: eps' :35.83 sigma : 5.35<br>Head Liquid Values 5800 MHz: eps' :34.75 sigma : 5.77 |
| Distance between dipole waveguide and liquid | 0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=4mm/dy=4m/dz=2mm |
| Frequency | 5200 MHz<br>5500 MHz<br>5800 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 21 °C |
| Lab Temperature | 21 °C |
| Lab Humidity | 45 % |

## 7.1 HEAD LIQUID MEASUREMENT

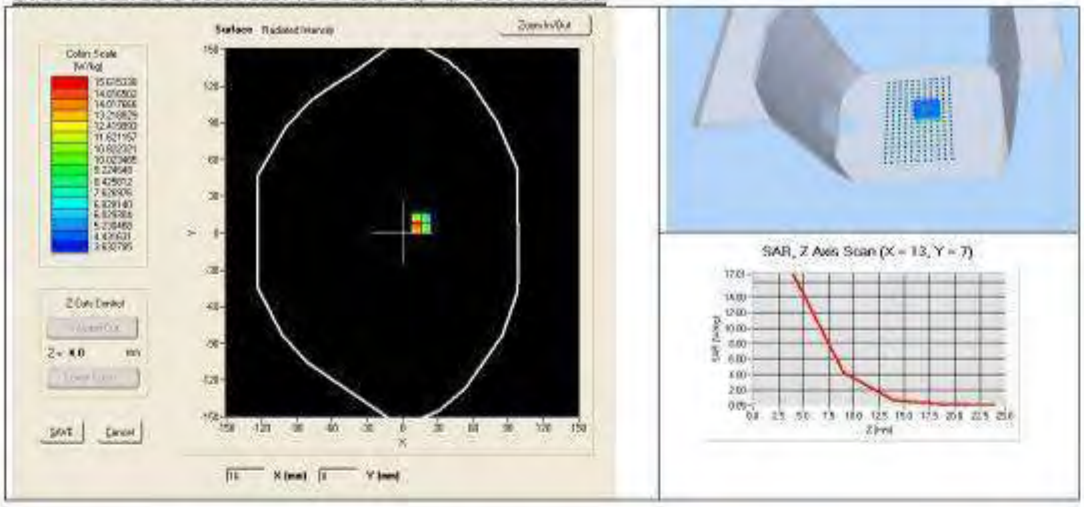
| Frequency MHz | Relative permittivity (ε,') | | Conductivity (σ) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 5000 | 36.2 ±10 % | | 4.45 ±10 % | |
| 5100 | 36.1 ±10 % | | 4.56 ±10 % | |
| 5200 | 36.0 ±10 % | PASS | 4.66 ±10 % | PASS |
| 5300 | 35.9 ±10 % | | 4.76 ±10 % | |
| 5400 | 35.8 ±10 % | | 4.86 ±10 % | |
| 5500 | 35.6 ±10 % | PASS | 4.97 ±10 % | PASS |
| 5600 | 35.5 ±10 % | | 5.07 ±10 % | |
| 5700 | 35.4 ±10 % | | 5.17 ±10 % | |
| 5800 | 35.3 ±10 % | PASS | 5.27 ±10 % | PASS |
| 5900 | 35.2 ±10 % | | 5.38 ±10 % | |
| 6000 | 35.1 ±10 % | | 5.48 ±10 % | |

## 7.2 MEASUREMENT RESULT

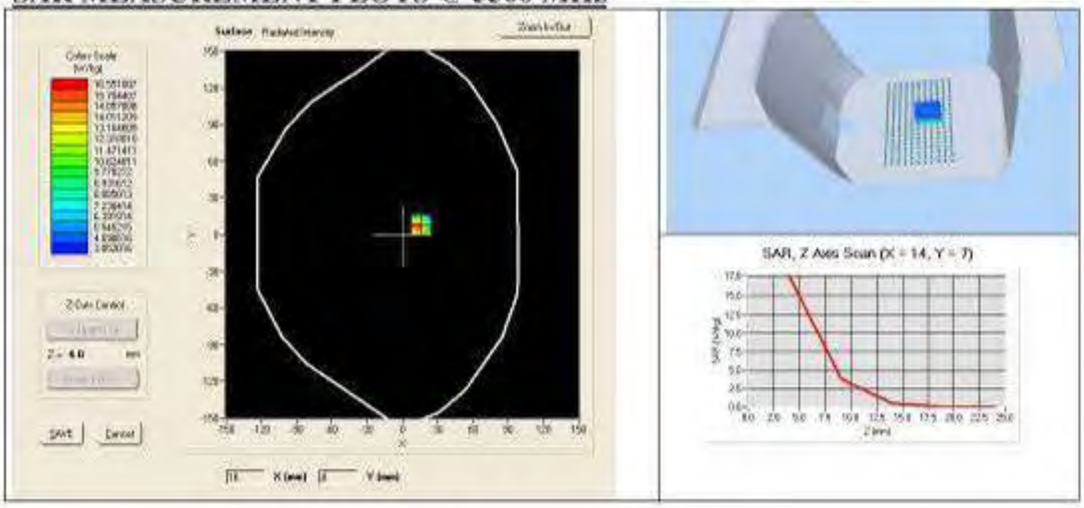
At those frequencies, the target SAR value can not be generic. Hereunder is the target SAR value defined by Satimo, within the uncertainty for the system validation. All SAR values are normalized to 1 W net power. In bracket, the measured SAR is given with the used input power.

| Frequency (MHz) | 1 g SAR (W/kg) | | 10 g SAR (W/kg) | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 5200 | 159.00 | 157.69 (15.77) | 56.90 | 54.61 (5.46) |
| 5500 | 170.10 | 167.81 (16.78) | 59.20 | 57.03 (5.70) |
| 5800 | 181.20 | 173.59 (17.36) | 61.50 | 58.41 (5.84) |

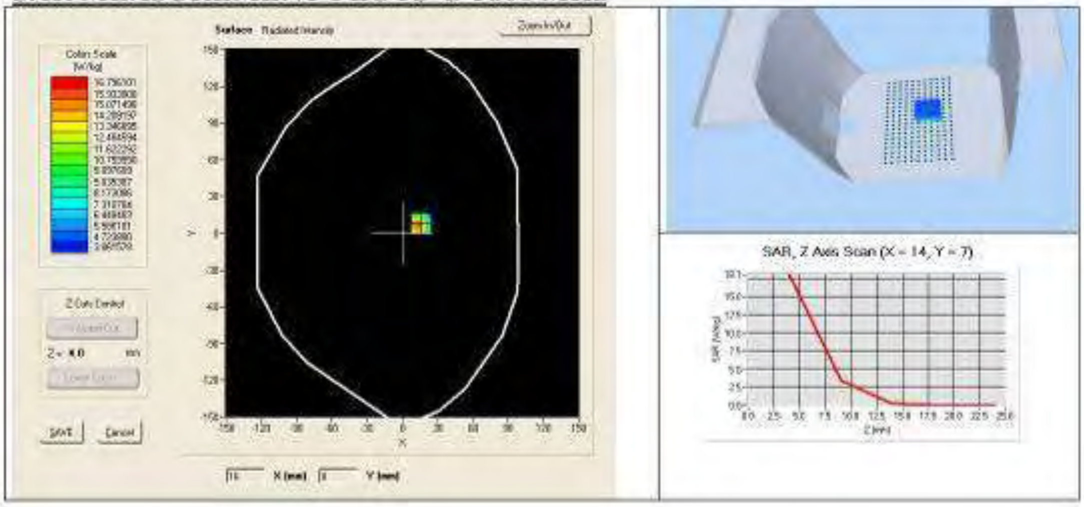
## SAR MEASUREMENT PLOTS @ 5200 MHz




## SAR MEASUREMENT PLOTS @ 5500 MHz



## SAR MEASUREMENT PLOTS @ 5800 MHz



## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| Equipment Description | Manufacturer / Model | Identification No. | Current Calibration Date | Next Calibration Date |
| Flat Phantom | Satimo | SN-20/09-SAM71 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rhode & Schwarz ZVA | SN100132 | 02/2010 | 02/2013 |
| Calipers | Carrera | CALIPER-01 | 12/2010 | 12/2013 |
| Reference Probe | Satimo | EPG122 SN 18/11 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Multimeter | Keithley 2000 | 1188656 | 11/2010 | 11/2013 |
| Signal Generator | Agilent E4438C | MY49070581 | 12/2010 | 12/2013 |
| Amplifier | Aethercomm | SN 046 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | HP E4418A | US38261498 | 11/2010 | 11/2013 |
| Power Sensor | HP ECP-E26A | US37181460 | 11/2010 | 11/2013 |
| Directional Coupler | Narda 4216-20 | 01386 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor | Control Company | 11-661-9 | 3/2010 | 3/2012 |