



# SAR EVALUATION REPORT

For

## X2 Computing Ltd.

Bond Industrial Estate, Wickhamford, EVESHAM, Worcestershire, WR11 7RL, UK

**FCC ID: RGCCARBONX2206300**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Tablet
<b>Test Engineer:</b> <u>Sandy Wang</u> 	
<b>Report Number:</b> <u>RSZ130621007-20</u>	
<b>Report Date:</b> <u>2013-08-27</u>	
<b>Reviewed By:</b> <u>RF Leader</u> 	
<b>Prepared By:</b> Bay Area Compliance Laboratories Corp. (Shenzhen) 6/F, the 3rd Phase of WanLi Industrial Building, ShiHua Road, FuTian Free Trade Zone Shenzhen, Guangdong, China Tel: +86-755-33320018 Fax: +86-755-33320008 <a href="http://www.baclcorp.com.cn">www.baclcorp.com.cn</a>	

**Note:** This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp.

Attestation of Test Results		
EUT Information	Company Name	X2 Computing Ltd.
	EUT Description	Tablet
	FCC ID	RGCCARBONX2206300
	Model Number	X220 Carbon
	Test Date	2013-07-09
Frequency	Max. SAR Level(s) Reported	Limit(W/Kg)
WiFi	0.902 W/kg 1g Body SAR	1.6
Applicable Standards	<b>ANSI / IEEE C95.1: 2005</b> IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fileds,3 kHz to 300 GHz.	
	<b>ANSI / IEEE C95.3 : 2002</b> IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to SuchFields,100 kHz—300 GHz.	
	<b>IEEE1528:2003</b> IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques	
	<b>PART 2.1093</b> Radiofrequency radiation exposure evaluation: portable devices	
	<b>KDB procedures</b> 447498 D01-Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies 248227 D01-SAR Measurement Procedures for 802.11a/b/g Transmitters	
<p><b>Note:</b> This wireless device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General Population/Uncontrolled Exposure limits specified in ANSI/IEEE Standards and has been tested in accordance with the measurement procedures specified in IEEE 1528-2003 and RF exposure KDB procedures.</p> <p><b>The results and statements contained in this report pertain only to the device(s) evaluated.</b></p>		

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**DOCUMENT REVISION HISTORY**

Revision Number	Report Number	Description of Revision	Date of Revision
0	RSZ130621007-20	Original Report	2013-08-27

## EUT DESCRIPTION

This report has been prepared on behalf of X2 Computing Ltd. and their product, FCC ID: RGCCARBONX2206300, Model: X220 Carbon or the EUT (Equipment under Test) as referred to in the rest of this report. The EUT is a Tablet.

*Note: the model X220 Carbon has different LCD screens, top covers, batteries capacity, pins, storages, halo LED, cameras and plastic & rubber I/O cover optional, the details information refer to the attached declaration letter which provided and guaranteed by the applicant.*

*Tested sample information: capacitive touch panel, black top cover, 8000mAh battery, 16pin, 32G storage, halo LED, camera and without plastic & rubber I/O cover*

## Technical Specification

<b>Product Type</b>	Portable
<b>Exposure Category:</b>	Population / Uncontrolled
<b>Antenna Type(s):</b>	Internal Antenna
<b>Body-Worn Accessories:</b>	None
<b>Face-Head Accessories:</b>	None
<b>Multi-slot Class:</b>	Not support
<b>Operation Mode :</b>	WiFi(802.11a/b/11g/n-20/n-40)
<b>Frequency Band:</b>	2412-2462MHz 5150-5250MHz
<b>Maximum Conducted RF Power:</b>	16.58 dBm
<b>Dimensions (L*W*H):</b>	324mm (L)× 196mm (W)× 28mm (H)
<b>Weight:</b>	550.7g
<b>Power Source:</b>	7.4VDC/8000mAh Rechargeable Battery
<b>Normal Operation:</b>	Body-support

## REFERENCE, STANDARDS, AND GUIDELINES

### FCC:

The Report and Order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g as recommended by the ANSI/IEEE standard C95.1-1992 [6] for an uncontrolled environment (Paragraph 65). According to the Supplement C of OET Bulletin 65 "Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under "worst-case" conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in North America is 1.6 mW/g average over 1 gram of tissue mass.

### CE:

The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 2 mW/g as recommended by EN62209-1 for an uncontrolled environment. According to the Standard, the device should be evaluated at maximum output power (radiated from the antenna) under "worst-case" conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in Europe is 2 mW/g average over 10 gram of tissue mass.

The test configurations were laid out on a specially designed test fixture to ensure the reproducibility of measurements. Each configuration was scanned for SAR. Analysis of each scan was carried out to characterize the above effects in the device.

## SAR Limits

### FCC Limit (1g Tissue)

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

### CE Limit (10g Tissue)

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 10 g of tissue)	2.0	10
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

General Population/Uncontrolled environments Spatial Peak limit 1.6W/kg (FCC) & 2 W/kg (CE) applied to the EUT.

## FACILITIES

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect data is located at 6/F, the 3rd Phase of WanLi Industrial Building, Shi Hua Road, Fu Tian Free Trade Zone, Shenzhen, Guangdong, P.R. of China.

## DESCRIPTION OF TEST SYSTEM

These measurements were performed with ALSAS 10 Universal Integrated SAR Measurement system from APREL Laboratories.

### ALSAS-10U System Description

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

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

### Applications

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

### Area Scans

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

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

### Zoom Scan (Cube Scan Averaging)

The averaging zoom scan volume utilized in the ALSAS-10U software is in the shape of a cube and the side dimension of a 1 g or 10 g mass is dependent on the density of the liquid representing the simulated tissue. A density of 1000 kg/m<sup>3</sup> is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21.5mm.

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

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



## ALSAS-10U Interpolation and Extrapolation Uncertainty

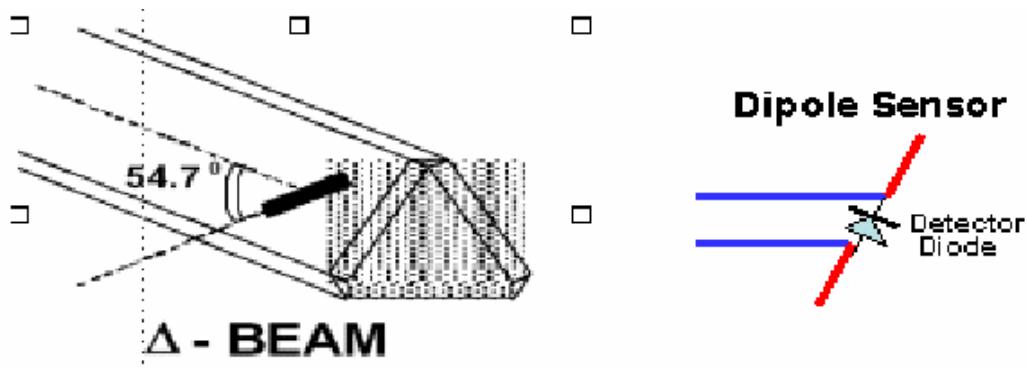
The overall uncertainty for the methodology and algorithms used during the SAR calculation was evaluated using the data from IEEE 1528 based on the example f3 algorithm:

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

## Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

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



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

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

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

## Isotropic E-Field Probe Specification

<b>Calibration Method</b>	Frequency Dependent Below 1 GHz Calibration in air performed in a TEM Cell Above 1 GHz Calibration in air performed in waveguide
<b>Sensitivity</b>	0.70 $\mu\text{V}/(\text{V}/\text{m})^2$ to 0.85 $\mu\text{V}/(\text{V}/\text{m})^2$
<b>Dynamic Range</b>	0.0005 W/kg to 100 W/kg
<b>Isotropic Response</b>	Better than 0.1 dB
<b>Diode Compression Point (DCP)</b>	Calibration for Specific Frequency
<b>Probe Tip Diameter</b>	< 2.9 mm
<b>Sensor Offset</b>	1.56 (+/- 0.02 mm)
<b>Probe Length</b>	289 mm
<b>Video Bandwidth</b>	@ 500 Hz: 1 dB @ 1.02 kHz: 3 dB
<b>Boundary Effect</b>	Less than 2.1% for distance greater than 0.58 mm
<b>Spatial Resolution</b>	The spatial resolution uncertainty is less than 1.5% for 4.9mm diameter probe. The spatial resolution uncertainty is less than 1.0% for 2.5mm diameter probe

## Boundary Detection Unit and Probe Mounting Device

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

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

## Daq-Paq (Analog to Digital Electronics)

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

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

## Axis Articulated Robot

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



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

## ALSAS Universal Workstation

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

## Universal Device Positioner

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

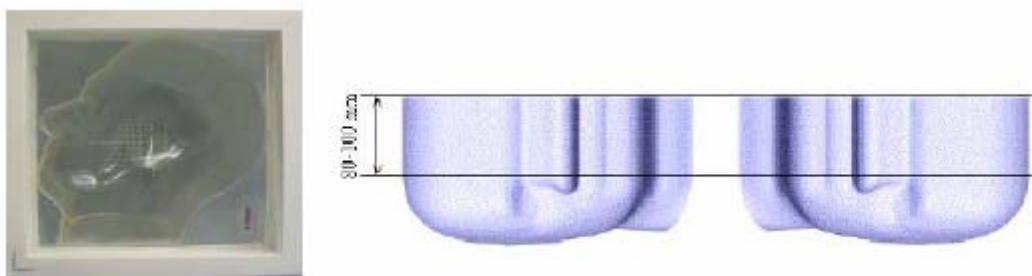


## Phantom Types

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

## APREL SAM Phantoms

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



## APREL Laboratories Universal Phantom

The Universal Phantom is used on the ALSAS-10U as a system validation phantom. The Universal Phantom has been fully validated both experimentally from 800MHz to 6GHz and numerically using XFDTD numerical software.

The shell thickness is 2mm overall, with a 4mm spacer located at the NF/MB intersection providing an overall thickness of 6mm in line with the requirements of IEEE-1528.

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



## Tissue Dielectric Parameters for Head and Body Phantoms

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

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton x-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (s/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

## Recommended Tissue Dielectric Parameters for Head and Body

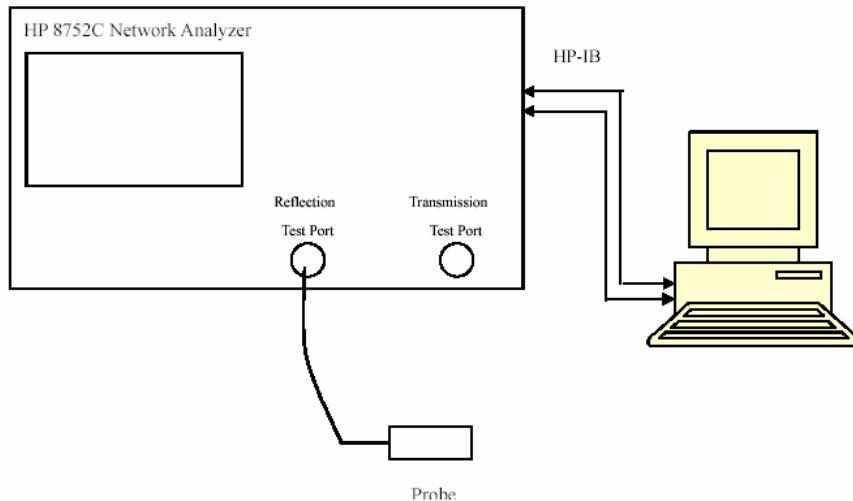
Frequency (MHz)	Head Tissue		Body Tissue	
	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000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

**EQUIPMENT LIST AND CALIBRATION****Equipments List & Calibration Information**

Equipment	Model	Calibration Date	S/N
CRS F3 robot	ALS-F3	N/A	RAF0805352
CRS F3 Software	ALS-F3-SW	N/A	N/A
CRS C500C controller	ALS-C500	N/A	RCF0805379
Probe mounting device & Boundary Detection Sensor System	ALS-PMDPS-3	N/A	120-00270
Universal Work Station	ALS-UWS	N/A	100-00157
Data Acquisition Package	ALS-DAQ-PAQ-3	2013-05-12	110-00212
Miniature E-Field Probe	ALS-E-020	2012-08-08	500-00283
Dipole,2450MHz	ALS-D-2450-S-2	2011-08-25	220-00758
Dipole Spacer	ALS-DS-U	N/A	250-00907
Device holder/Positioner	ALS-H-E-SET-2	N/A	170-00510
Left ear SAM phantom	ALS-P-SAM-L	N/A	130-00311
Right ear SAM phantom	ALS-P-SAM-R	N/A	140-00359
UniPhantom	ALS-P-UP-1	N/A	150-00413
Simulated Tissue 2450 MHz Body	ALS-TS-2450-B	Each Time	296-01002
Power Amplifier	5S1G4	N/A	71377
Synthesized Sweeper	HP 8341B	2013-05-16	2624A00116
EMI Test Receiver	ESCI	2012-08-08	101122

# SAR MEASUREMENT SYSTEM VERIFICATION

## Liquid Verification



Liquid Verification Setup Block Diagram

## Liquid Verification Results

Frequency	Liquid Type	Liquid Parameter		Target Value		Delta (%)		Tolerance (%)
		$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)	$\Delta \epsilon_r$	$\Delta \sigma$ (S/m)	
2412	Body	52.85	1.93	52.70	1.95	0.285	-1.259	$\pm 5$
2422	Body	52.76	1.94	52.70	1.95	0.114	-0.513	$\pm 5$
2437	Body	52.65	1.97	52.70	1.95	-0.095	0.994	$\pm 5$
2452	Body	52.55	1.99	52.70	1.95	-0.285	2.051	$\pm 5$
2462	Body	52.48	2.00	52.70	1.95	-0.417	2.788	$\pm 5$

\*Liquid Verification was performed on 2013-07-09.

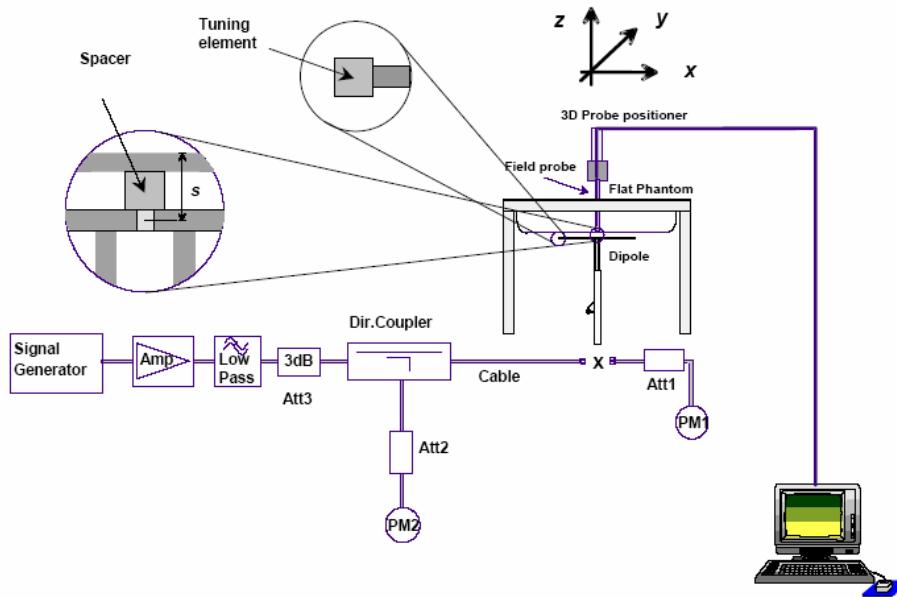
Please refer to the following tables.

2450 MHz Body		
Frequency (MHz)	e'	e''
2410	52.86370645	14.34553335
2411	52.85467645	14.35253035
2412	52.84566445	14.35753235
2413	52.83665545	14.36252935
2414	52.82764445	14.36753235
2415	52.81864145	14.37253735
2416	52.80963245	14.37753235
2417	52.80061745	14.38253235
2418	52.79160945	14.38753135
2419	52.78260045	14.39252935
2420	52.77360545	14.39753635
2421	52.76457445	14.42253235
2422	52.75756545	14.42953535
2423	52.75055745	14.43653235
2424	52.74354945	14.44353135
2425	52.73654245	14.45053235
2426	52.72953445	14.45753135
2427	52.72252645	14.46453035
2428	52.71551845	14.47153735
2429	52.70851145	14.47853235
2430	52.70150745	14.48552935
2431	52.69449545	14.49252935
2432	52.68748745	14.49953135
2433	52.68047945	14.50653635
2434	52.67347245	14.51353135
2435	52.66646445	14.52053135
2436	52.65945645	14.52753635
2437	52.65244845	14.53453535
2438	52.64544045	14.54153535
2440	52.63843845	14.54853135
2441	52.63142545	14.55553035
2442	52.62441745	14.56252935
2443	52.61740945	14.56652835
2444	52.61040245	14.57053135
2445	52.60339445	14.57453435
2446	52.59638645	14.57853335
2447	52.58937845	14.58253235
2448	52.58237045	14.58653035
2449	52.57536745	14.59053035
2450	52.56835545	14.59453135
2451	52.56134745	14.59853035
2452	52.55433945	14.60252935
2453	52.54733145	14.60653035
2454	52.54032445	14.61053435
2455	52.53331645	14.61453035
2456	52.52630845	14.61853035
2457	52.51930045	14.62253735
2458	52.51229445	14.62653035
2459	52.50528545	14.63053535
2460	52.49827745	14.63453035
2461	52.49126945	14.63853335
2462	52.48426145	14.64252835

## System Accuracy Verification

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of  $\pm 10\%$ . The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

### System Verification Setup Block Diagram



### Probe and dipole antenna List and Detail

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
APREL	Probe	ALS-E-020	500-00283	2012-08-09	2013-08-08
APREL	Dipole antenna(2450MHz)	ALS-D-2450-S-2	220-00758	2011-08-25	2014-08-24

### System Accuracy Check Results

Date	Frequency Band	Liquid Type	Measured SAR (W/Kg)		Target Value (W/Kg)	Delta (%)	Tolerance (%)
2013-07-09	2450	Body	1g	53.816	52.561	2.388	$\pm 10$

\*All SAR values are normalized to 1 Watt forward power.

**SAR SYSTEM VALIDATION DATA****Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****System Performance Check 2450 MHz Body Liquid****Dipole 2450 MHz; Type: ALS-D-2450-S-2; S/N: 220-00758****Product Data**

Device Name : Dipole 2450MHz  
Serial No. : 220-00758  
Type : Dipole  
Model : ALS-D-2450-S-2  
Frequency Band : 2450 MHz  
Max. Transmit Pwr : 1 W  
Drift Time : 3 min(s)  
Power Drift-Start : 50.102 W/kg  
Power Drift-Finish : 50.479W/kg  
Power Drift (%) : 0.752

**Phantom Data**

Name : APREL-Uni  
Type : Uni-Phantom  
Size (mm) : 280 x 280 x 200  
Serial No. : System Default  
Location : Center  
Description : Default

**Tissue Data**

Type : BODY  
Serial No. : 296-01002  
Frequency : 2450.0 MHz  
Last Calib. Date : 09-Jul-2013  
Temperature : 20.00 °C  
Ambient Temp. : 21.00 °C  
Humidity : 50.00 RH%  
Epsilon : 52.57 F/m  
Sigma : 1.98 S/m  
Density : 1000.00 kg/cu. M

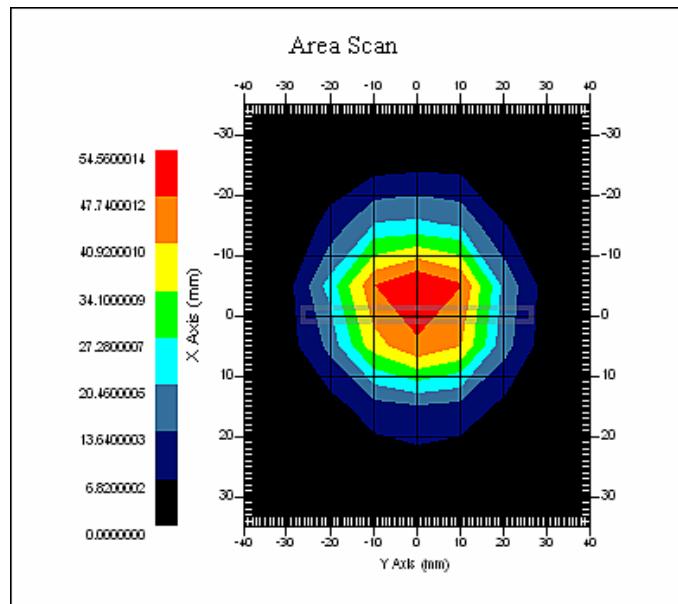
**Probe Data**

Name : E-Field  
Model : E-020  
Type : E-Field Triangle  
Serial No. : 500-00283  
Last Calib. Date : 09-Aug-2012  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20 µV/(V/m)<sup>2</sup>  
Compression Point : 95.00 mV  
Offset : 1.56 mm

**Measurement Data**

Crest Factor : 1  
Scan Type : Complete  
Tissue Temp. : 20.00 °C  
Ambient Temp. : 20.00 °C  
Area Scan : 8x9x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

1 gram SAR value : 53.816 W/kg  
10 gram SAR value : 24.921 W/kg  
Area Scan Peak SAR : 54.561 W/kg  
Zoom Scan Peak SAR : 93.846 W/kg



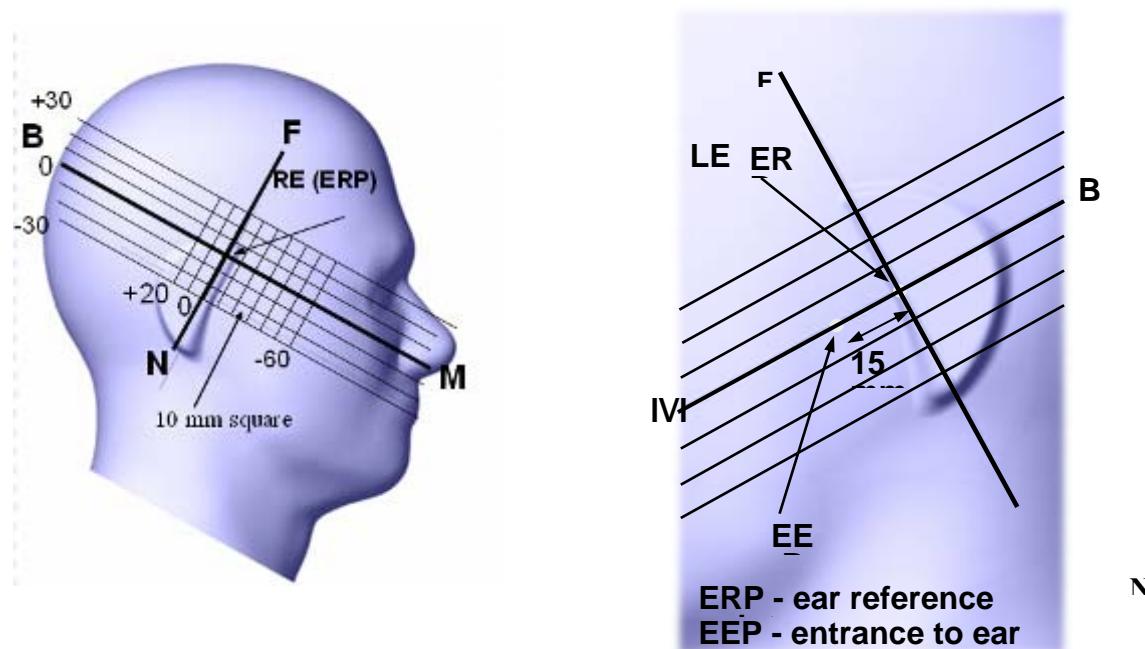
### 2450 MHz System Validation

## EUT TEST STRATEGY AND METHODOLOGY

### Test Positions for Device Operating Next to a Person's Ear

This category includes most wireless handsets with fixed, retractable or internal antennas located toward the top half of the device, with or without a foldout, sliding or similar keypad cover. The handset should have its earpiece located within the upper  $\frac{1}{4}$  of the device, either along the centerline or off-centered, as perceived by its users. This type of handset should be positioned 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”. The “test device reference point” should be located at the same level as the center of the earpiece region. The “vertical centerline” should bisect the front surface of the handset at its top and bottom edges. A “ear reference point” is located on the outer surface of the head phantom on each ear spacer. It is located 1.5 cm above the center of the ear canal entrance in the “phantom reference plane” defined by the three lines joining the center of each “ear reference point” (left and right) and the tip of the mouth.

A handset should be initially positioned with the earpiece region pressed against the ear spacer of a head phantom. For the SCC-34/SC-2 head phantom, the device should be positioned parallel to the “N-F” line defined along the base of the ear spacer that contains the “ear reference point”. For interim head phantoms, the device should be positioned parallel to the cheek for maximum RF energy coupling. The “test device reference point” is aligned to the “ear reference point” on the head phantom and the “vertical centerline” is aligned to the “phantom reference plane”. This is called the “initial ear position”. While maintaining these three alignments, the body of the handset is gradually adjusted to each of the following positions for evaluating SAR:



## Cheek/Touch Position

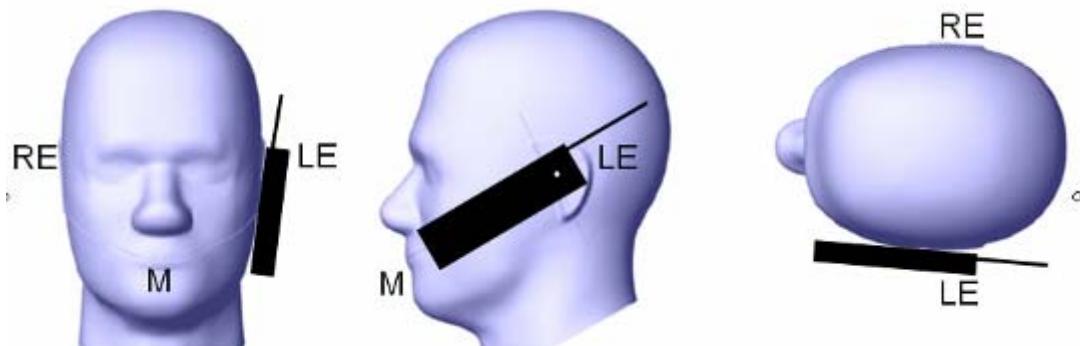
The device is brought toward the mouth of the head phantom by pivoting against the “ear reference point” or along the “N-F” line for the SCC-34/SC-2 head phantom.

This test position is established:

- When any point on the display, keypad or mouthpiece portions of the handset is in contact with the phantom.
- (or) When any portion of a foldout, sliding or similar keypad cover opened to its intended self-adjusting normal use position is in contact with the cheek or mouth of the phantom.

For existing head phantoms – when the handset loses contact with the phantom at the pivoting point, rotation should continue until the device touches the cheek of the phantom or breaks its last contact from the ear spacer.

### Cheek /Touch Position



## Ear/Tilt Position

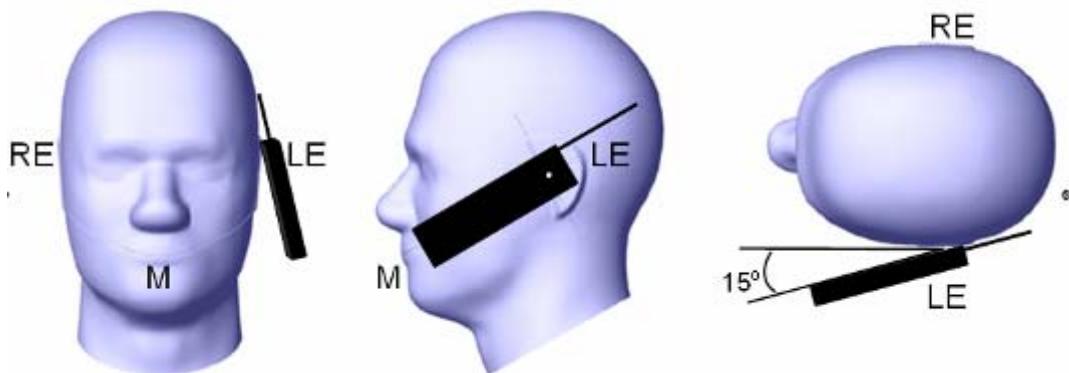
With the handset aligned in the “Cheek/Touch Position”:

1) If the earpiece of the handset is not in full contact with the phantom’s ear spacer (in the “Cheek/Touch position”) and the peak SAR location for the “Cheek/Touch” position is located at the ear spacer region or corresponds to the earpiece region of the handset, the device should be returned to the “initial ear position” by rotating it away from the mouth until the earpiece is in full contact with the ear spacer.

2) (otherwise) The handset should be moved (translated) away from the cheek perpendicular to the line passes through both “ear reference points” (note: one of these ear reference points may not physically exist on a split head model) for approximate 2-3 cm. While it is in this position, the device handset is tilted away from the mouth with respect to the “test device reference point” until the inside angle between the vertical centerline on the front surface of the phone and the horizontal line passing through the ear reference point is by 15°. After the tilt, it is then moved (translated) back toward the head perpendicular to the line passes through both “ear reference points” until the device touches the phantom or the ear spacer. If the antenna touches the head first, the positioning process should be repeated with a tilt angle less than 15° so that the device and its antenna would touch the phantom simultaneously. This test position may require a device holder or positioner to achieve the translation and tilting with acceptable positioning repeatability.

If a device is also designed to transmit with its keypad cover closed for operating in the head position, such positions should also be considered in the SAR evaluation. The device should be tested on the left and right side of the head phantom in the “Cheek/Touch” and “Ear/Tilt” positions. When applicable, each configuration should be tested with the antenna in its fully extended and fully retracted positions. These test configurations should be tested at the high, middle and low frequency channels of each operating mode; for example, AMPS, CDMA, and TDMA. If the SAR measured at the middle channel for each test configuration (left, right, Cheek/Touch, Ear, extended and retracted) is at least 2.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s). If the transmission band of the test device is less than 10 MHz, testing at the high and low frequency channels is optional.

#### Ear /Tilt 15° Position



#### **Test positions for body-worn and other configurations**

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device. When multiple accessories that do not contain metallic components are supplied with the device, the device may be tested with only the accessory that dictates the closest spacing to the body. When multiple accessories that contain metallic components are supplied with the device, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (e.g., 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 must be tested.

Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.

## SAR Evaluation Procedure

The evaluation was performed with the following procedure:

Step 1: Measurement of the SAR value at a fixed location above the ear point or central position was used as a reference value for assessing the power drop. The SAR at this point is measured at the start of the test and then again at the end of the testing.

Step 2: The SAR distribution at the exposed side of the head was measured at a distance of 4 mm from the inner surface of the shell. The area covered the entire dimension of the head or EUT and the horizontal grid spacing was 10 mm x 10 mm. Based on these data, the area of the maximum absorption was determined by spline interpolation. The first Area Scan covers the entire dimension of the EUT to ensure that the hotspot was correctly identified.

Step 3: Around this point, a volume of 35 mm x 35 mm x 35 mm was assessed by measuring 7x 7 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

- 1) The data at the surface were extrapolated, since the center of the dipoles is 1.2 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
- 2) The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one dimensional splines with the "Not a knot"-condition (in x, y and z-directions). The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the averages.

All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.

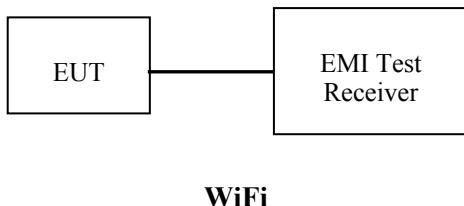
## CONDUCTED OUTPUT POWER MEASUREMENT

### Provision Applicable

The measured peak output power should be greater and within 5% than EMI measurement.

### Test Procedure

The RF output of the transmitter was connected to the input of the EMI Test Receiver through sufficient attenuation.



### Maximum Output Power among production units

Max Target Power for Production Unit (dBm)-SISO				
Mode/Band	Antenna Type	Frequency		
		Low	Middle	High
802.11b	A	17.0	17.0	17.0
	B	17.0	17.0	17.0
	C	17.0	17.0	17.0
802.11g	A	16.0	17.0	15.0
	B	15.0	17.0	15.0
	C	16.0	17.0	15.0
802.11n-20	A	15.0	17.0	15.0
	B	15.0	17.0	15.0
	C	16.0	17.0	16.0
802.11n-40	A	12.5	17.0	12.5
	B	12.5	17.0	12.5
	C	12.5	17.0	12.5

Max Target Power for Production Unit (dBm)-MIMO				
Mode/Band	Antenna Type	Frequency		
		Low	Middle	High
802.11n-20	ABC	15.0	17.0	15.0
802.11n-40	ABC	13.0	17.0	13.0

**Test Results:**

Maximum Average Power for Production Unit (dBm)-Single Port(SISO)				
Mode/Band	Antenna Type	Frequency		
		Low	Middle	High
802.11b	A	16.66	16.53	16.45
	B	16.67	16.52	16.49
	C	16.60	16.49	16.40
802.11g	A	15.52	16.53	14.54
	B	14.51	16.46	14.57
	C	15.46	16.55	14.49
802.11n-20	A	14.37	16.45	14.40
	B	14.45	16.41	14.46
	C	15.42	16.26	15.41
802.11n-40	A	12.11	16.52	12.13
	B	12.08	16.46	12.27
	C	12.12	16.52	12.16

Max Target Power for Production Unit (dBm)-MIMO				
Mode/Band	Antenna Type	Frequency		
		Low	Middle	High
802.11n-20	ABC	14.67	16.61	14.48
802.11n-40	ABC	12.43	16.48	12.56

**Note:**

1. The data rates used for all test were the lowest data rates for each mode- 1 Mbps for 802.11b, 6 Mbps for 802.11g, 6.5 Mbps for 802.11n-20, and 13 Mbps for 802.11n-40.
2. Legacy modes (SISO-only) were evaluated on each chain individually. The 802.11n modes were evaluated operating on each chain separately (SISO) and on both chains simultaneously (MIMO).
3. All the output power data of this device is refer to the module report INTEL-090615F.
4. **KDB248227-SAR** is not required for 802.11g/n channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels.

## SAR MEASUREMENT RESULTS

This page summarizes the results of the performed dosimetric evaluation.

### SAR Test Data

#### Environmental Conditions

Temperature:	21° C
Relative Humidity:	56%
ATM Pressure:	1002 mbar

\* Testing was performed by Sandy Wang on 2013-07-09

#### Test result:

#### SISO Mode:

#### 802.11b

EUT Position	Antenna Type	Frequency (MHz)		Test Mode	Power Drift (%)	Meas. Power (dBm)	Max. Rated Power (dBm)	FCC 1g SAR (W/Kg)		
		Channel	MHz					Scaled Factor	Meas. SAR	Scaled SAR
Body-Back	SISO-A	1	2412.0	802.11b	-0.561	16.66	17.0	1.081	0.012	0.013
		6	2437.0	802.11b	/	/	/	/	/	/
		11	2462.0	802.11b	/	/	/	/	/	/
	SISO-B	1	2412.0	802.11b	-0.649	16.67	17.0	1.079	0.051	0.055
		6	2437.0	802.11b	/	/	/	/	/	/
		11	2462.0	802.11b	/	/	/	/	/	/
	SISO-C	1	2412.0	802.11b	-0.381	16.60	17.0	1.096	0.034	0.037
		6	2437.0	802.11b	/	/	/	/	/	/
		11	2462.0	802.11b	/	/	/	/	/	/
Body-Top	SISO-A	1	2412.0	802.11b	-1.406	16.66	17.0	1.081	0.834	0.902
		6	2437.0	802.11b	-1.658	16.53	17.0	1.114	0.782	0.871
		11	2462.0	802.11b	-1.086	16.45	17.0	1.132	0.754	0.854
Body-Bottom	SISO-B	1	2412.0	802.11b	-1.042	16.67	17.0	1.079	0.209	0.226
		6	2437.0	802.11b	/	/	/	/	/	/
		11	2462.0	802.11b	/	/	/	/	/	/

#### Note:

1. When the 1-g SAR is  $\leq 0.8\text{W/Kg}$ , testing for other channel is optional.
2. The output power was tested under data rate 1Mbps for 1Mbps for 802.11b.
3. When SAR or MPE is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance.
4. **KDB248227-SAR** is not required for 802.11g/n channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels.
5. All testing was base on the worst case and worst channel selected base on the orientation and antenna location of the device.(SISO worst than MIMO mode)
6. The SAR value for 5GHz band, please refer to the report R1307022-FCC-SAR.

## EUT SCAN RESULTS

### Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)

#### 802.11b; Body-Back (2412MHz Channel 1); SISO-A

##### Measurement Data

Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.007 W/kg  
Power Drift-Finish : 0.007 W/kg  
Power Drift (%) : -0.561

##### T Tissue Data

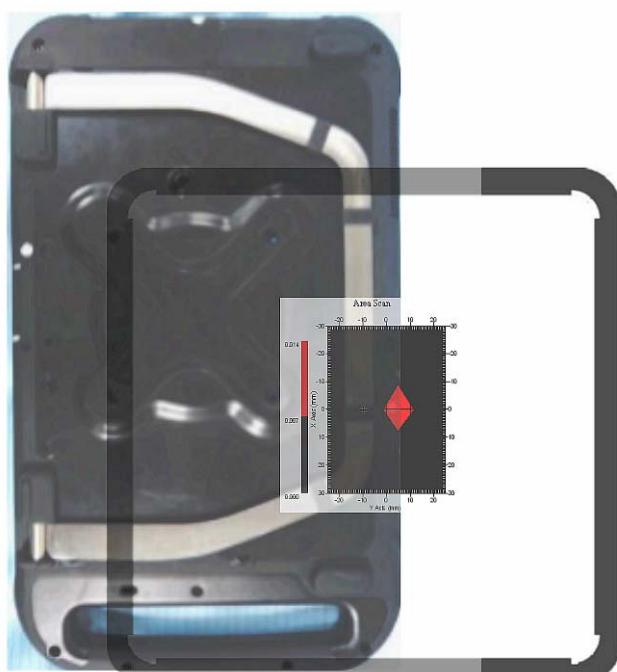
Type : Body  
Frequency : 2412.0 MHz  
Epsilon : 52.85 F/m  
Sigma : 1.93 S/m  
Density : 1000.00 kg/cu. m

##### Probe Data

Serial No. : 500-00283  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20  $\mu$ V/(V/m)2  
Compression Point : 95.00 mV  
Offset : 1.56 mm

1 gram SAR value : 0.012 W/kg  
10 gram SAR value : 0.007 W/kg  
Area Scan Peak SAR : 0.014 W/kg  
Zoom Scan Peak SAR : 0.021 W/kg

#### Plot 1#



**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****802.11b; Body-Back (2412MHz Channel 1); SISO-B**

## Measurement Data

Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.025 W/kg  
Power Drift-Finish : 0.025 W/kg  
Power Drift (%) : -0.649

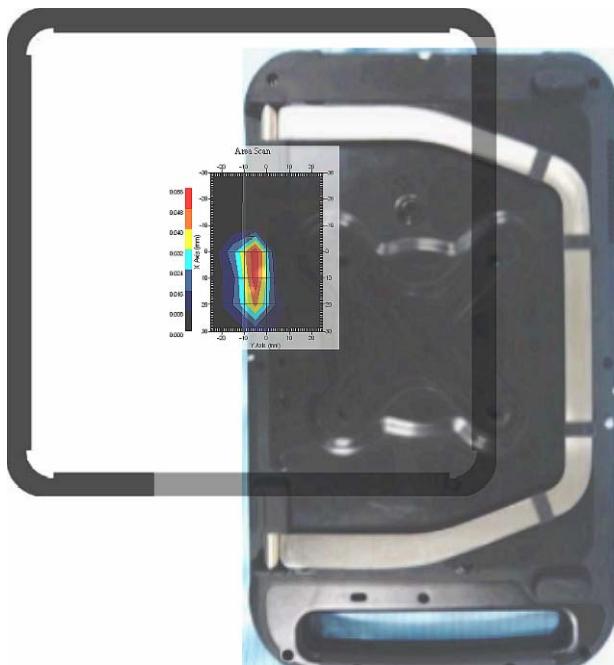
## T Tissue Data

Type : Body  
Frequency : 2412.0 MHz  
Epsilon : 52.85 F/m  
Sigma : 1.93 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20  $\mu$ V/(V/m)2  
Compression Point : 95.00 mV  
Offset : 1.56 mm

1 gram SAR value : 0.051 W/kg  
10 gram SAR value : 0.028 W/kg  
Area Scan Peak SAR : 0.055 W/kg  
Zoom Scan Peak SAR : 0.108 W/kg

**Plot 2#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****802.11b; Body-Back (2412MHz Channel 1); SISO-C**

## Measurement Data

Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.006 W/kg  
Power Drift-Finish : 0.006 W/kg  
Power Drift (%) : -0.381

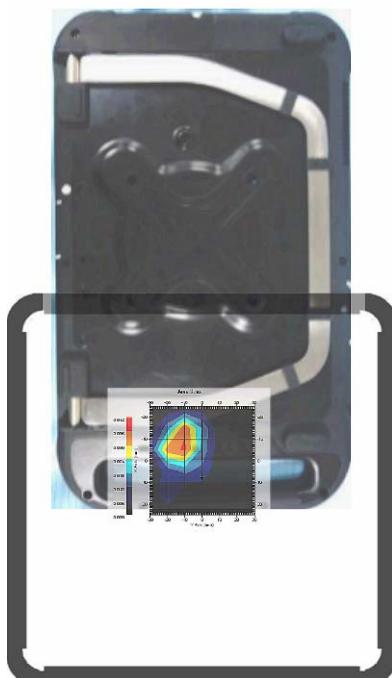
## Tissue Data

Type : Body  
Frequency : 2412.0 MHz  
Epsilon : 52.85 F/m  
Sigma : 1.93 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20  $\mu$ V/(V/m)2  
Compression Point : 95.00 mV  
Offset : 1.56 mm

1 gram SAR value : 0.034 W/kg  
10 gram SAR value : 0.012 W/kg  
Area Scan Peak SAR : 0.039 W/kg  
Zoom Scan Peak SAR : 0.056 W/kg

**Plot 3#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****802.11b; Body-Top (2412MHz Channel 1); SISO-A**

## Measurement Data

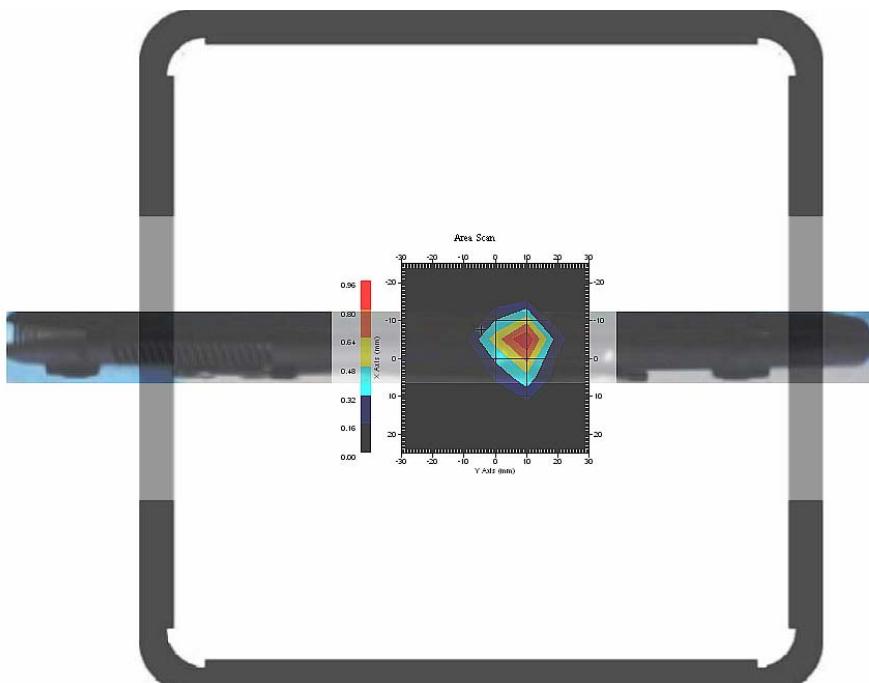
Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.498 W/kg  
Power Drift-Finish : 0.491 W/kg  
Power Drift (%) : -1.406

## Tissue Data

Type : Body  
Frequency : 2412.0 MHz  
Epsilon : 52.85F/m  
Sigma : 1.93 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20  $\mu$ V/(V/m)2  
Compression Point : 95.00 mV  
Offset : 1.56 mm  
  
1 gram SAR value : 0.834 W/kg  
10 gram SAR value : 0.337 W/kg  
Area Scan Peak SAR : 0.912 W/kg  
Zoom Scan Peak SAR : 1.681 W/kg

**Plot 4#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****802.11b; Body-Top (2437MHz Channel 6); SISO-A**

## Measurement Data

Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.369 W/kg  
Power Drift-Finish : 0.363 W/kg  
Power Drift (%) : -1.658

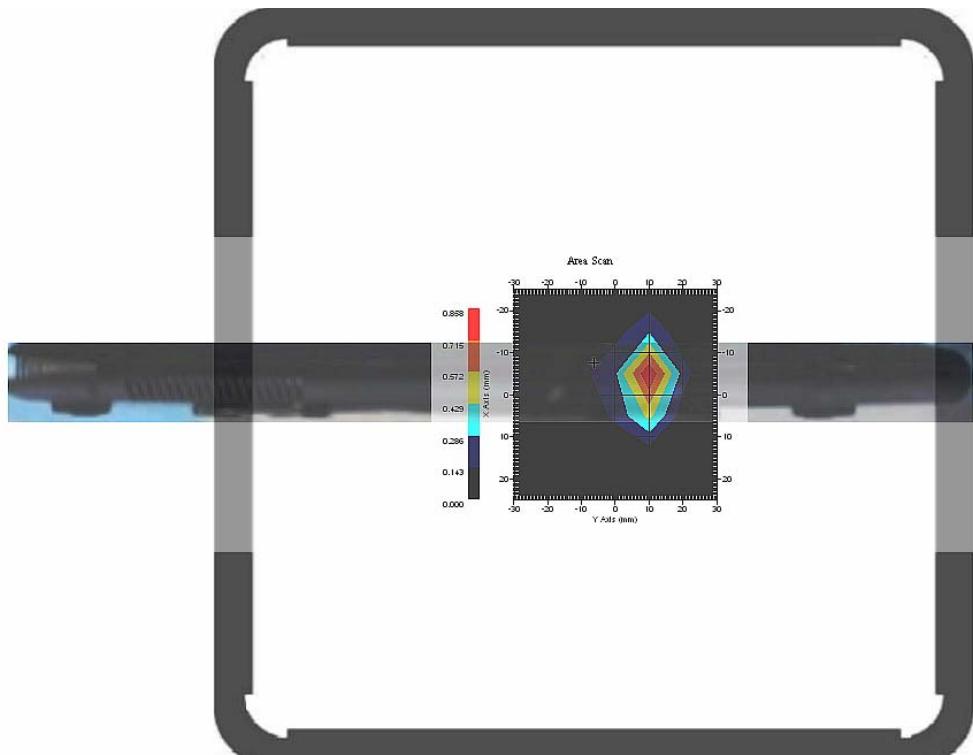
## Tissue Data

Type : Body  
Frequency : 2437.0 MHz  
Epsilon : 52.65F/m  
Sigma : 1.97 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20  $\mu$ V/(V/m)2  
Compression Point : 95.00 mV  
Offset : 1.56 mm

1 gram SAR value : 0.782 W/kg  
10 gram SAR value : 0.307 W/kg  
Area Scan Peak SAR : 0.812 W/kg  
Zoom Scan Peak SAR : 1.419 W/kg

**Plot 5#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****802.11b; Body-Top (2462MHz Channel 11); SISO-A**

## Measurement Data

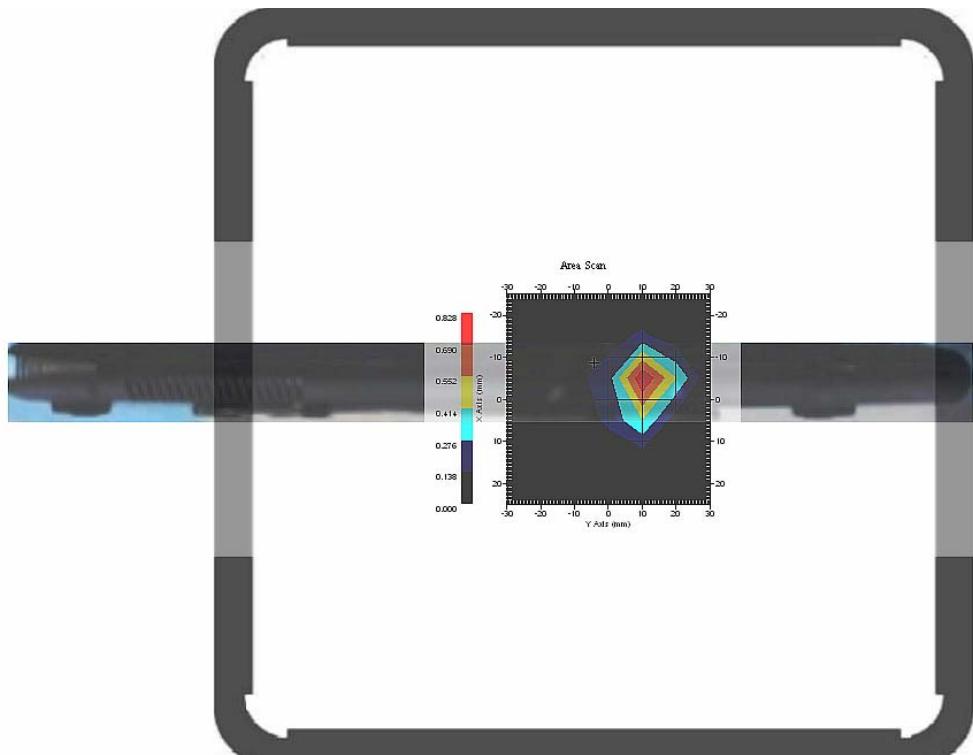
Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.297 W/kg  
Power Drift-Finish : 0.294W/kg  
Power Drift (%) : -1.086

## Tissue Data

Type : Body  
Frequency : 2462.0 MHz  
Epsilon : 52.48F/m  
Sigma : 2.00 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20  $\mu$ V/(V/m)2  
Compression Point : 95.00 mV  
Offset : 1.56 mm  
  
1 gram SAR value : 0.754 W/kg  
10 gram SAR value : 0.294 W/kg  
Area Scan Peak SAR : 0.826 W/kg  
Zoom Scan Peak SAR : 1.507 W/kg

**Plot 6#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****802.11b; Body-Bottom (2412MHz Channel 1); SISO-B**

## Measurement Data

Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.096 W/kg  
Power Drift-Finish : 0.095 W/kg  
Power Drift (%) : -1.042

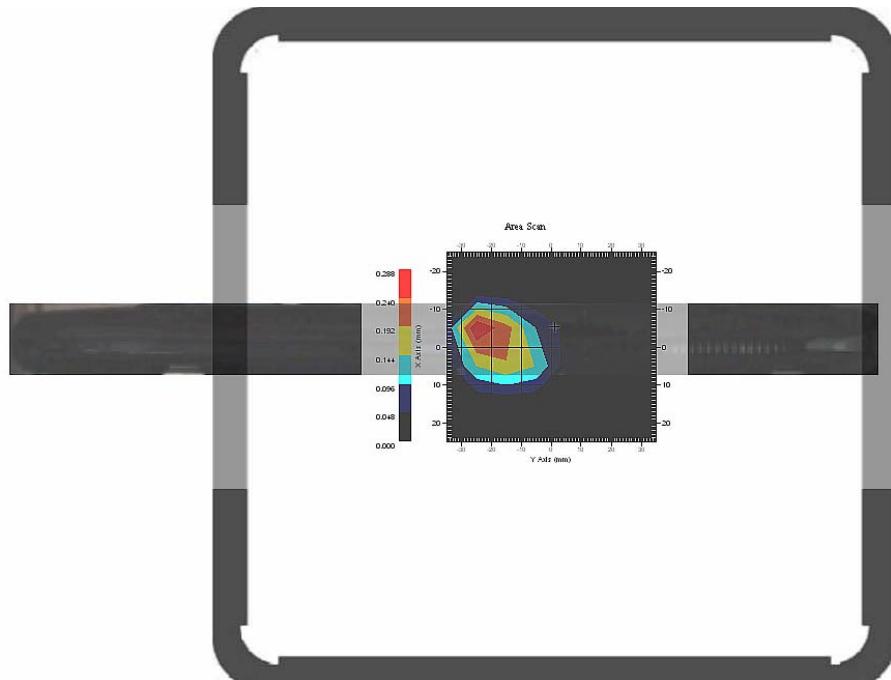
## Tissue Data

Type : Body  
Frequency : 2412.0 MHz  
Epsilon : 52.85 F/m  
Sigma : 1.93 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 2450 MHz  
Duty Cycle Factor : 1  
Conversion Factor : 4.3  
Probe Sensitivity : 1.20 1.20 1.20  $\mu$ V/(V/m)2  
Compression Point : 95.00 mV  
Offset : 1.56 mm

1 gram SAR value : 0.209 W/kg  
10 gram SAR value : 0.103 W/kg  
Area Scan Peak SAR : 0.231 W/kg  
Zoom Scan Peak SAR : 0.800 W/kg

**Plot 7#**

## APPENDIX A – MEASUREMENT UNCERTAINTY

The uncertainty budget has been determined for the measurement system and is given in the following Table.

### Measurement Uncertainty for 300MHz to 3GHz

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	$c_i^1 (1-g)$	$c_i^1 (10-g)$	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %
<b>Measurement System</b>							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	$\sqrt{3}$	$(1-cp)^{1/2}$	$\frac{(1-cp)^1}{\sqrt{2}}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	$\sqrt{3}$	$\sqrt{cp}$	$\sqrt{cp}$	4.4	4.4
Boundary Effect	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Linearity	4.7	rectangular	$\sqrt{3}$	1	1	2.7	2.7
Detection Limit	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	$\sqrt{3}$	1	1	0.5	0.5
Integration Time	1.7	rectangular	$\sqrt{3}$	1	1	1.0	1.0
RF Ambient Condition -Noise	0.006	rectangular	$\sqrt{3}$	1	1	0.003	0.003
RF Ambient Condition - Reflections	3.0	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Probe Positioner Mech. Restrictions	0.4	rectangular	$\sqrt{3}$	1	1	0.2	0.2
<b>Restriction</b>							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	$\sqrt{3}$	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	$\sqrt{3}$	1	1	2.1	2.1
Test Sample Positioning	0.023	normal	1	1	1	0.023	0.023
Device Holder Uncertainty	6.215	normal	1	1	1	6.215	6.215
Drift of Output Power	4.627	rectangular	$\sqrt{3}$	1	1	2.67	2.67
<b>Phantom and Setup</b>							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	$\sqrt{3}$	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	$\sqrt{3}$	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	1.938	normal	1	0.7	0.5	1.36	0.97
Liquid Permittivity(target)	5.0	rectangular	$\sqrt{3}$	0.6	0.5	1.7	1.4
Liquid Permittivity(meas.)	3.093	normal	1	0.6	0.5	1.86	1.55
Combined Uncertainty		RSS				10.78	10.55
Expanded uncertainty (coverage factor=2)		Normal(k=2)				21.56	21.10

**APPENDIX B – PROBE CALIBRATION CERTIFICATES****NCL CALIBRATION LABORATORIES****Calibration File No.: 1427-1430****Client.: BACL Lab****C E R T I F I C A T E   O F   C A L I B R A T I O N**

It is certified that the equipment identified below has been calibrated in the  
**NCL CALIBRATION LABORATORIES** by qualified personnel following recognized  
procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe

Record of Calibration

Head and Body

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 500-00283

**Calibration Procedure:** D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole  
**Project No:** BACL-5673**Calibrated:** 8<sup>th</sup> August 2012  
**Released on:** 9<sup>th</sup> August 2012

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

Released By:



Art Brennan, Quality Manager

***NCL* CALIBRATION LABORATORIES**Suite 102, 303 Terry Fox Dr.  
OTTAWA, ONTARIO  
CANADA K2K 3J1Division of APREL Lab.  
TEL: (613) 435-8300  
FAX: (613) 435-8306

**NCL Calibration Laboratories**

Division of APREL Inc.

**Introduction**

This Calibration Report reproduces the results of the calibration performed in line with the references listed below. Calibration is performed using accepted methodologies as per the references listed below. Probes are calibrated for air, and tissue and the values reported are the results from the physical quantification of the probe through metrological practices.

**Calibration Method**

Probes are calibrated using the following methods.

<1000MHz

TEM Cell for sensitivity in air

Standard phantom using temperature transfer method for sensitivity in tissue

>1000MHz

Waveguide\* method to determine sensitivity in air and tissue

\*Waveguide is numerically (simulation) assessed to determine the field distribution and power

The boundary effect for the probe is assessed using a standard flat phantom where the probe output is compared against a numerically simulated series of data points

**References**

- IEEE Standard 1528 (2003) including Amendment 1  
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1 (2006)  
Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures-Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2 Ed. 1.0 (2010-03)  
Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- TP-D01-032-E020-V2 E-Field probe calibration procedure
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

**NCL Calibration Laboratories**

Division of APREL Inc.

**Conditions**

Probe 500-00283 was a recalibration with the exception frequency of 450 MHz .which was a new calibration

**Ambient Temperature of the Laboratory:** 22 °C +/- 1.5°C  
**Temperature of the Tissue:** 21 °C +/- 1.5°C  
**Relative Humidity:** < 60%

**Primary Measurement Standards**

<b>Instrument</b>	<b>Serial Number</b>	<b>Cal due date</b>
Power meter Anritsu MA2408A	90025437	Nov.4, 2012
Power Sensor Anritsu MA2481D	103555	Nov 4, 2012
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2012
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2013

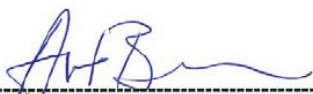
**Secondary Measurement Standards**

Signal Generator Agilent E4438C -506 MY55182336 June 7, 2013

**Attestation**

The below named signatories have conducted the calibration and review of the data which is presented in this calibration report.

**We the undersigned attest that to the best of our knowledge the calibration of this subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.**

  
-----  
Art Brennan, Quality Manager  
-----  
Dan Brooks, Test Engineer

**NCL Calibration Laboratories**

Division of APREL Inc.

**Probe Summary**

<b>Probe Type:</b>	E-Field Probe E020
<b>Serial Number:</b>	500-00283
<b>Frequency:</b>	As presented on page 5
<b>Sensor Offset:</b>	1.56
<b>Sensor Length:</b>	2.5
<b>Tip Enclosure:</b>	Composite*
<b>Tip Diameter:</b>	< 2.9 mm
<b>Tip Length:</b>	55 mm
<b>Total Length:</b>	289 mm

\*Resistive to recommended tissue recipes per IEEE-1528

**Sensitivity in Air**

<b>Channel X:</b>	1.2 $\mu$ V/(V/m) <sup>2</sup>
<b>Channel Y:</b>	1.2 $\mu$ V/(V/m) <sup>2</sup>
<b>Channel Z:</b>	1.2 $\mu$ V/(V/m) <sup>2</sup>

<b>Diode Compression Point:</b>	95 mV
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This page has been reviewed for content and attested to on Page 2 of this document.

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**Calibration for Tissue (Head H, Body B)**

Frequency	Tissue Type	Measured Epsilon	Measured Sigma	Calibration Uncertainty	Tolerance Uncertainty for 5%*	Conversion Factor
450 H	Head	43.98	0.9	3.5	3.4	6
450 B	Body	57.07	0.92	3.5	3.4	6
750 H	Head	X	X	X	X	X
750 B	Body	X	X	X	X	X
835 H	Head	42.35	0.938	3.5	3.4	6.6
835 B	Body	56.65	1.018	3.5	3.4	6.6
900 H	Head	41.35	0.98	3.5	3.4	6
900 B	Body	56.08	1.05	3.5	3.4	6
1450 H	Head	X	X	X	X	X
1450 B	Body	X	X	X	X	X
1500 H	Head	X	X	X	X	X
1500 B	Body	X	X	X	X	X
1640 H	Head	X	X	X	X	X
1640 B	Body	X	X	X	X	X
1750 H	Head	X	X	X	X	X
1750 B	Body	X	X	X	X	X
1800 H	Head	X	X	X	X	X
1800 B	Body	X	X	X	X	X
1900 H	Head	38.72	1.35	3.5	2.7	5.2
1900 B	Body	51.62	1.48	3.5	2.7	5
2000 H	Head	X	X	X	X	X
2000 B	Body	X	X	X	X	X
2100 H	Head	X	X	X	X	X
2100 B	Body	X	X	X	X	X
2300 H	Head	X	X	X	X	X
2300 B	Body	X	X	X	X	X
2450 H	Head	38.06	1.87	3.5	3.5	4.9
2450 B	Body	50.22	2.03	3.5	3.5	4.3
2600 H	Head	X	X	X	X	X
2600 B	Body	X	X	X	X	X
3000 H	Head	X	X	X	X	X
3000 B	Body	X	X	X	X	X
3600 H	Head	X	X	X	X	X
3600 B	Body	X	X	X	X	X
5200 H	Head	X	X	X	X	X
5200 B	Body	X	X	X	X	X
5600 H	Head	X	X	X	X	X
5600 B	Body	X	X	X	X	X
5800 H	Head	X	X	X	X	X
5800 B	Body	X	X	X	X	X

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Division of APREL Inc.

**Boundary Effect:**

Uncertainty resulting from the boundary effect is less than 2.1% for the distance between the tip of the probe and the tissue boundary, when less than 0.58mm.

**Spatial Resolution:**

The spatial resolution uncertainty is less than 1.5% for 4.9mm diameter probe.  
The spatial resolution uncertainty is less than 1.0% for 2.5mm diameter probe.

**DAQ-PAQ Contribution**

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

**Boundary Effect:**

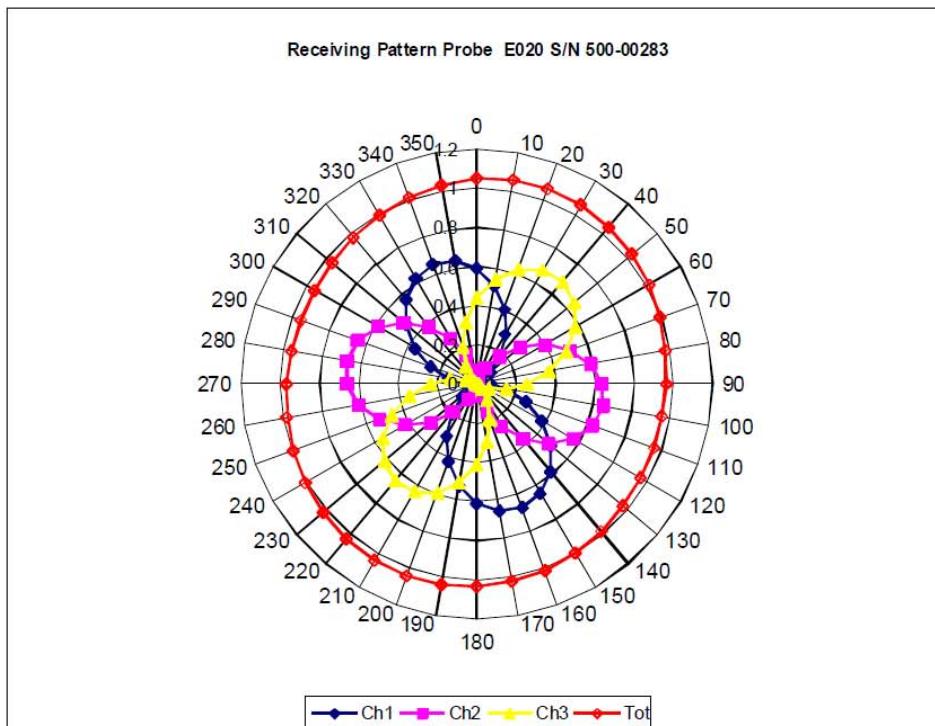
For a distance of 0.58mm the worst case evaluated uncertainty (increase in the probe sensitivity) is less than 2.1%.

**NOTES:**

\*The maximum deviation from the centre frequency when comparing the lower to upper range is listed.

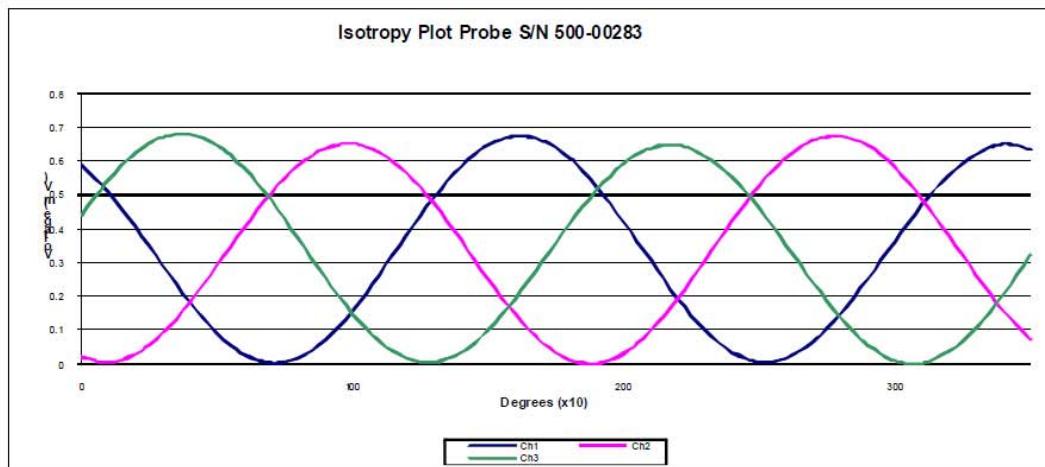
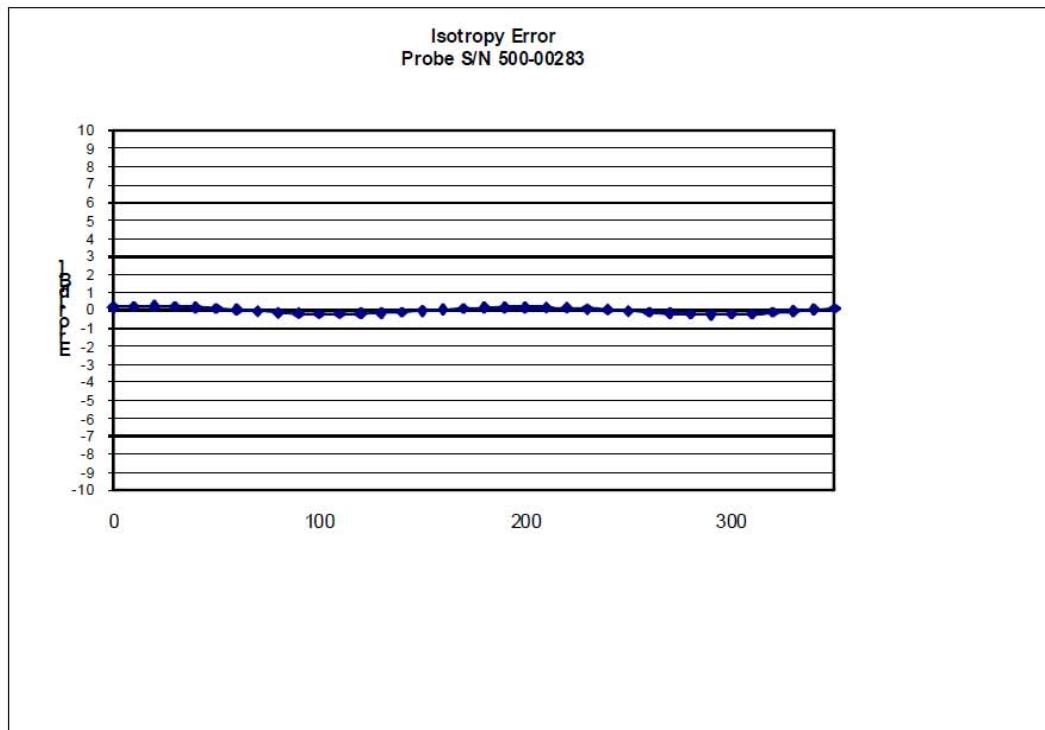
**NCL Calibration Laboratories**

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**Receiving Pattern Air**

**NCL Calibration Laboratories**

Division of APREL Inc.

**Isotropy Error Air****Isotropicity Tissue:**

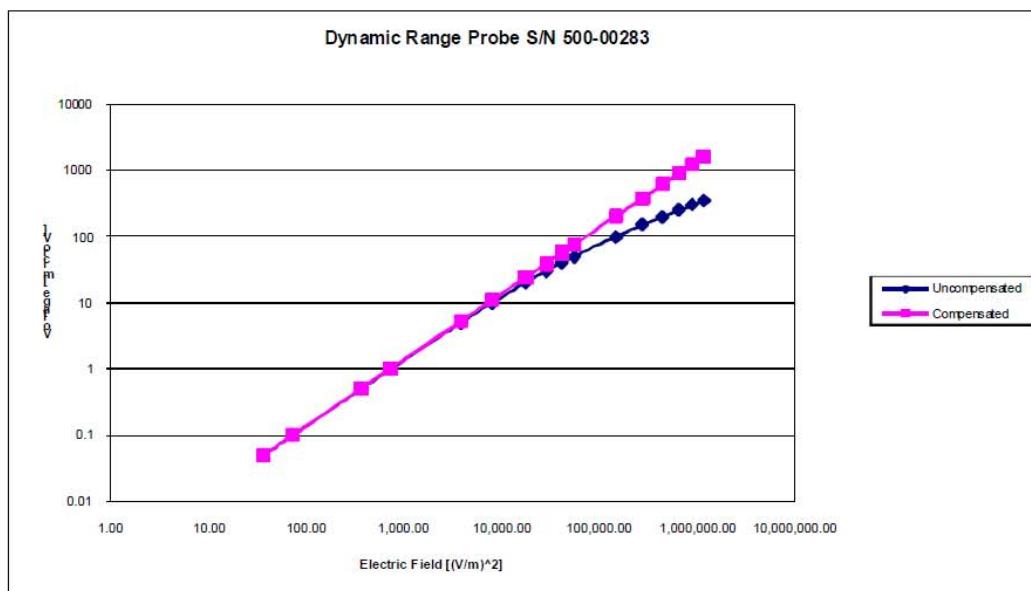
0.10 dB

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

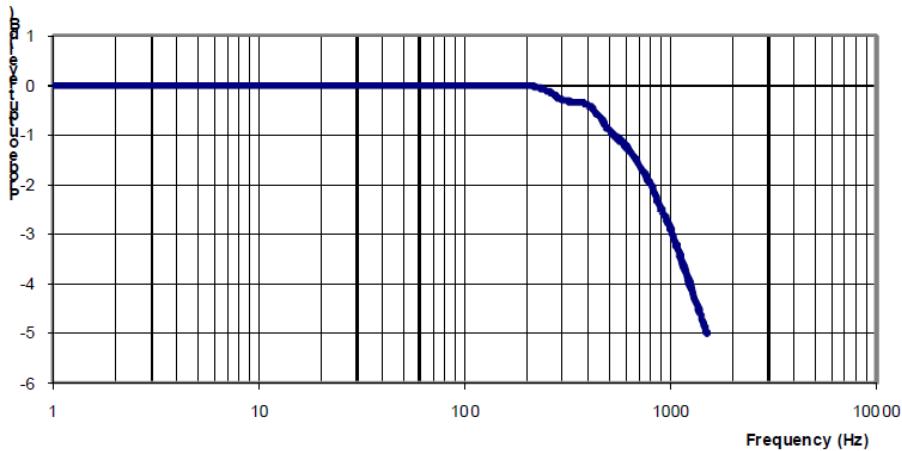
**NCL Calibration Laboratories**

Division of APREL Inc.

**Dynamic Range**

**NCL Calibration Laboratories**

Division of APREL Inc.

**Video Bandwidth****Probe Frequency Characteristics****Video Bandwidth at 500 Hz**

1 dB

**Video Bandwidth at 1.02 KHz:**

3 dB

**Test Equipment**

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2012.

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

**APPENDIX C – DIPOLE CALIBRATION CERTIFICATES****NCL CALIBRATION LABORATORIES**

Calibration File No: DC-1330  
Project Number: BAC-dipole-cal-5619

**C E R T I F I C A T E   O F   C A L I B R A T I O N**

It is certified that the equipment identified below has been calibrated in the  
**NCL CALIBRATION LABORATORIES** by qualified personnel following recognized  
procedures and using transfer standards traceable to NRC/NIST.

Validation Dipole (Head & Body)

Manufacturer: APREL Laboratories

Part number: ALS-D-2450-S-2

Frequency: 2450 MHz

Serial No: 220-00758

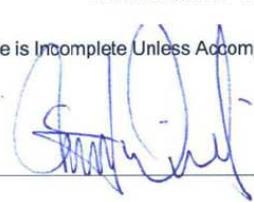
Customer: Bay Area Compliance Laboratory

Calibrated: 25<sup>th</sup> August, 2011

Released on: 25<sup>th</sup> August, 2011

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

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

**NCL CALIBRATION LABORATORIES**

Suite 102, 303 Terry Fox Dr.  
Kanata, ONTARIO  
CANADA K2K 3J1

Division of APREL Lab.  
TEL: (613) 435-8300  
FAX: (613)435-8306

**NCL Calibration Laboratories**

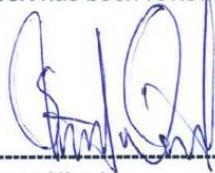
Division of APREL Laboratories.

**Conditions**

Dipole 220-00758 was received in good condition and was a re-calibration.

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

We the undersigned attest that to the best of our knowledge the calibration of this device has been accurately conducted and that all information contained within this report has been reviewed for accuracy.



Stuart Nicol



C. Teodorian

**Primary Measurement Standards****Instrument**

Power meter Anritsu MA2408A	Serial Number	Cal due date
Power Sensor Anritsu MA2481D	245025437	Nov.4, 2011
Attenuator HP 8495A (70dB) 1	103555	Nov 4, 2011
Network Analyzer Agilent E5071C	944A10711	Aug.8, 2012
	1334746J	Feb. 8, 2012

**Secondary Measurement Standards**

Signal Generator Agilent E4438C	-506 MY55182336	June 7, 2012
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**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Calibration Results Summary**

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

**Mechanical Dimensions**

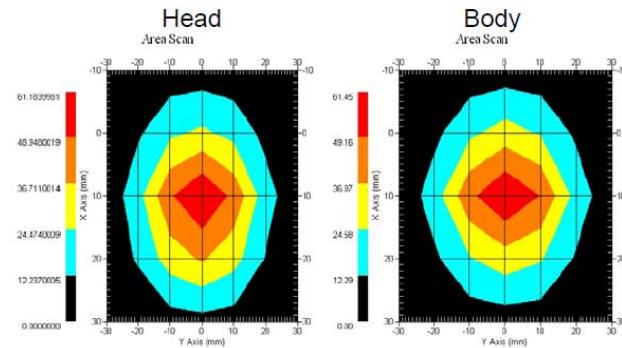
**Length:** 52.4 mm  
**Height:** 30.3 mm

**Electrical Specification**

Tissue	Frequency	SWR:	Return Loss	Impedance
Head	2450 MHz	1.0459 U	-33.024 dB	48.533 $\Omega$
Body	2450 MHz	1.1159 U	-25.235 dB	46.676 $\Omega$

**System Validation Results**

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	2450 MHz	52.667	24.518	105.920
Body	2450 MHz	52.561	24.104	108.940



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**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Introduction**

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole 220-00758. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

**References**

SSI-TP-018-ALSAS Dipole Calibration Procedure  
SSI-TP-016 Tissue Calibration Procedure  
IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"  
IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"  
Part 1: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)"  
IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"  
Part 2 *Draft*: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 6 GHz)"

**Conditions**

Dipole 220-00758 was a re-calibration.

**Ambient Temperature of the Laboratory:** 22 °C +/- 0.5°C  
**Temperature of the Tissue:** 20 °C +/- 0.5°C

**Dipole Calibration uncertainty**

The calibration uncertainty for the dipole is made up of various parameters presented below.

<b>Mechanical</b>	1%
<b>Positioning Error</b>	1.22%
<b>Electrical</b>	1.7%
<b>Tissue</b>	2.2%
<b>Dipole Validation</b>	2.2%
<b>TOTAL</b>	<b>8.32% (16.64% K=2)</b>

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**NCL Calibration Laboratories**

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**Dipole Calibration Results****Mechanical Verification**

APREL Length	APREL Height	Measured Length	Measured Height
51.5 mm	30.4 mm	52.4 mm	30.3 mm

**Electrical Calibration**

Tissue Type	Return Loss:	SWR:	Impedance:
Head	-33.024 dB	1.0459 U	48.533 Ω
Body	-25.235 dB	1.1159 U	46.676 Ω

**Tissue Validation**

	Dielectric constant, $\epsilon_r$	Conductivity, $\sigma$ [S/m]
Head Tissue 2450MHz	38.2	1.82
Body Tissue 2450MHz	51.74	1.96

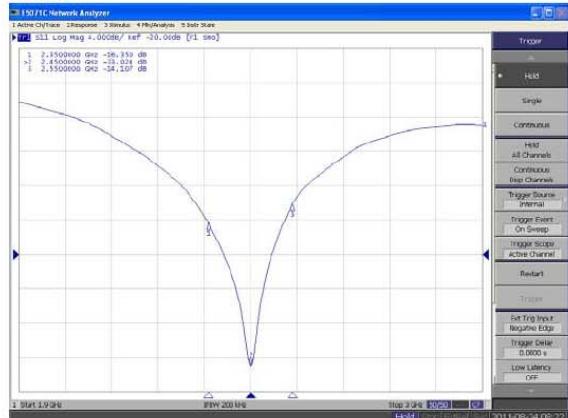
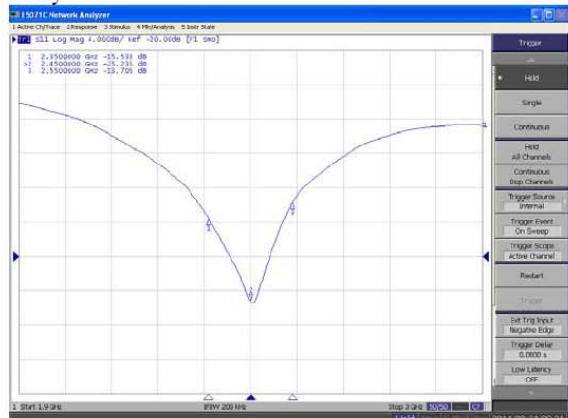
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5

**NCL Calibration Laboratories**

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

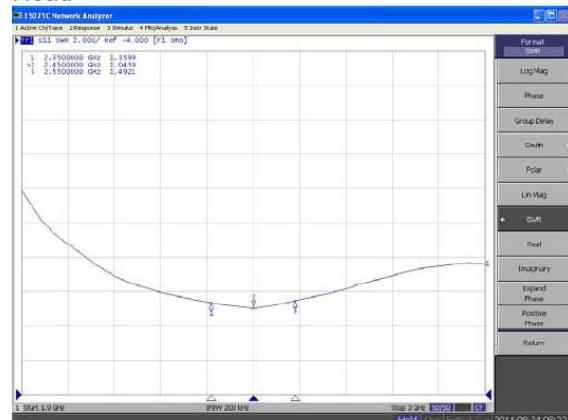
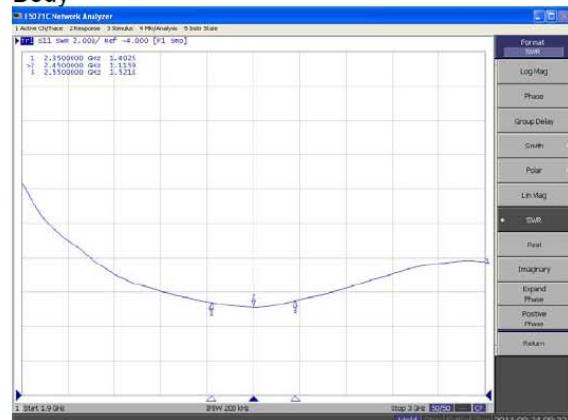
**S11 Parameter Return Loss****Head****Body**

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6

**NCL Calibration Laboratories**

Division of APREL Laboratories.

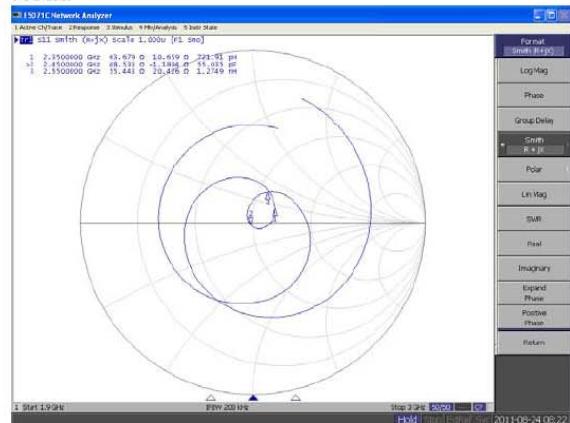
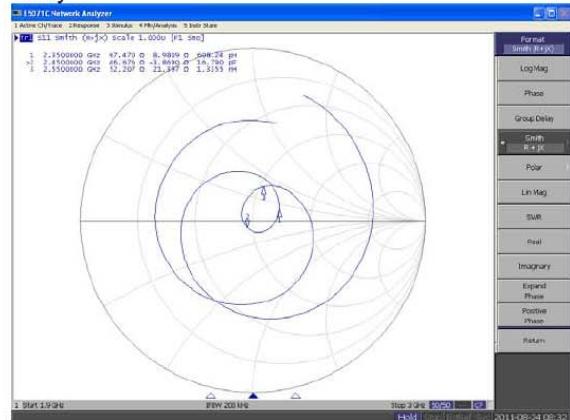
**SWR****Head****Body**

This page has been reviewed for content and attested to by signature within this document.

7

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Smith Chart Dipole Impedance****Head****Body**

This page has been reviewed for content and attested to by signature within this document.

8

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

## **Test Equipment**

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2011.

This page has been reviewed for content and attested to by signature within this document.

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## 2450MHz Dipole Calibration By BACL at 2012-12-12

### Mechanical Verification

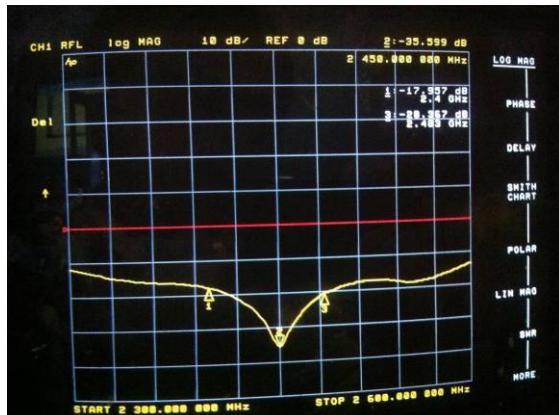
APREL Length	APREL Height	Measured Length	Measured Height
51.5mm	30.4 mm	51.6 mm	30.2 mm

Tissue Type	Measured Return Loss	Measured Impedance
Head	-35.559 dB	49.627 $\Omega$
Body	-27.477 dB	48.238 $\Omega$

### Test Graphs:

Head Tissue

Return Loss :

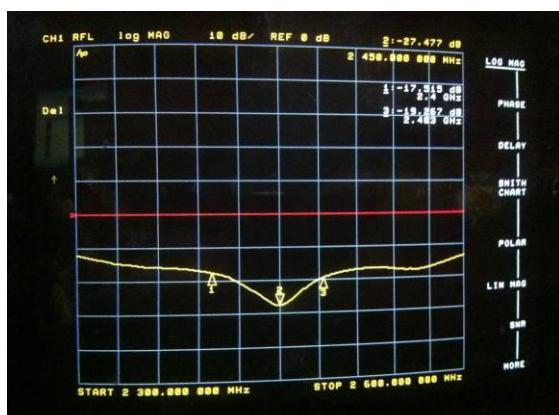


Impedance :



Body Tissue

Return Loss :

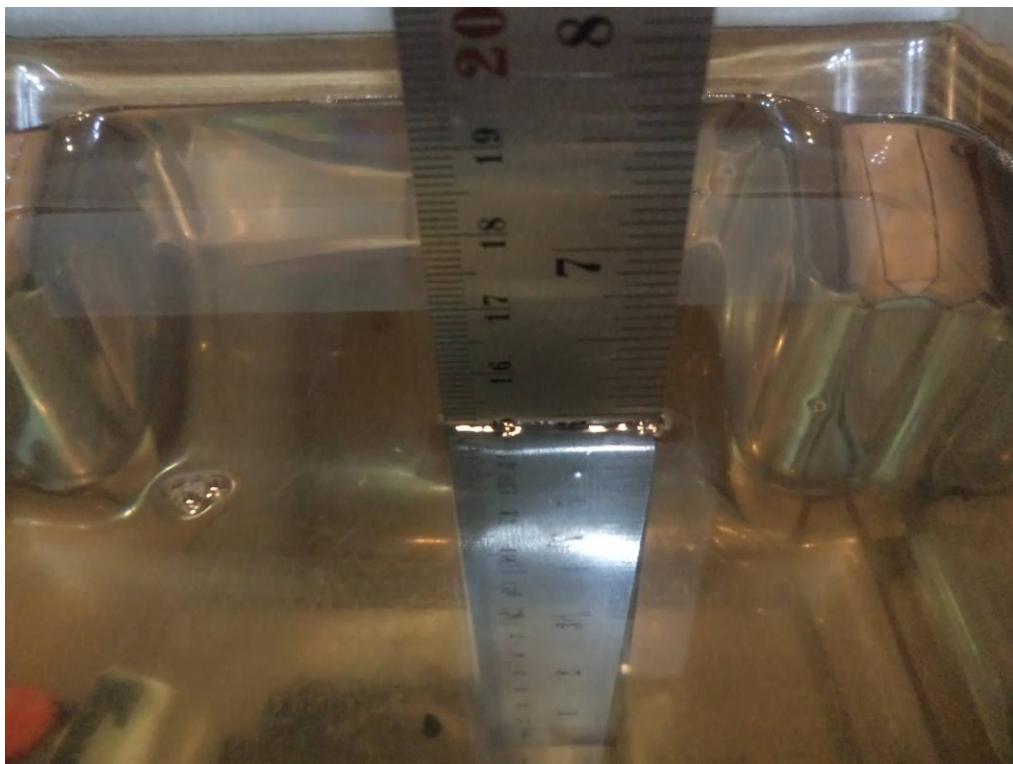


Impedance :

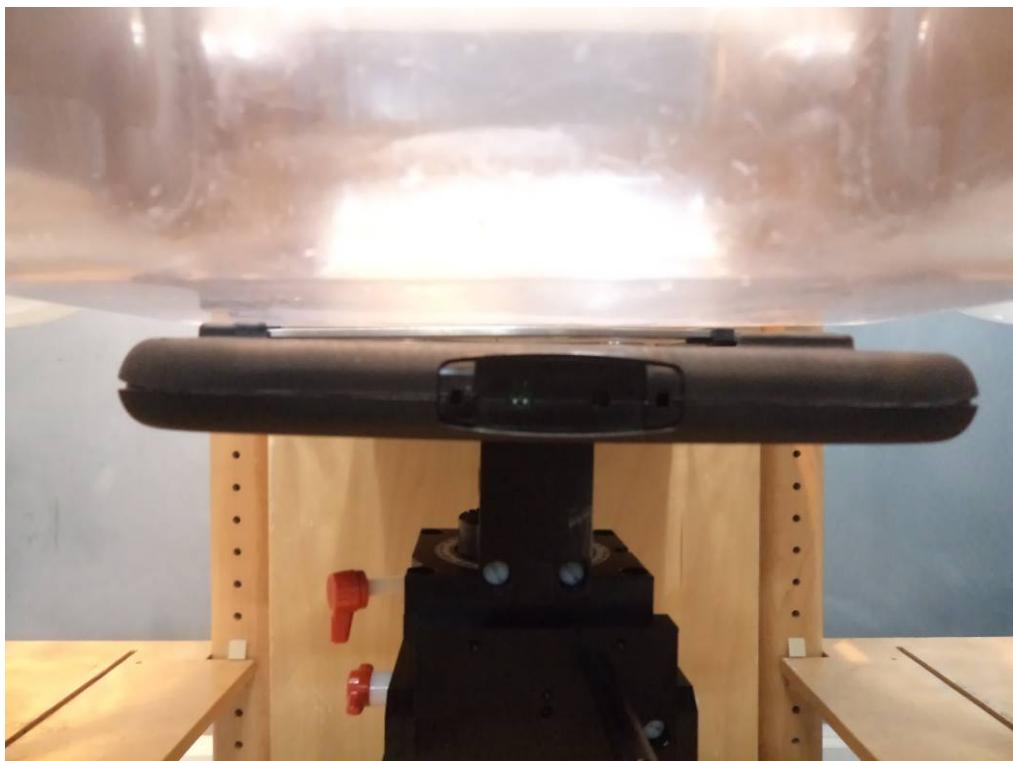


## APPENDIX D – EUT TEST POSITION PHOTOS

**Liquid depth  $\geq$  15cm**



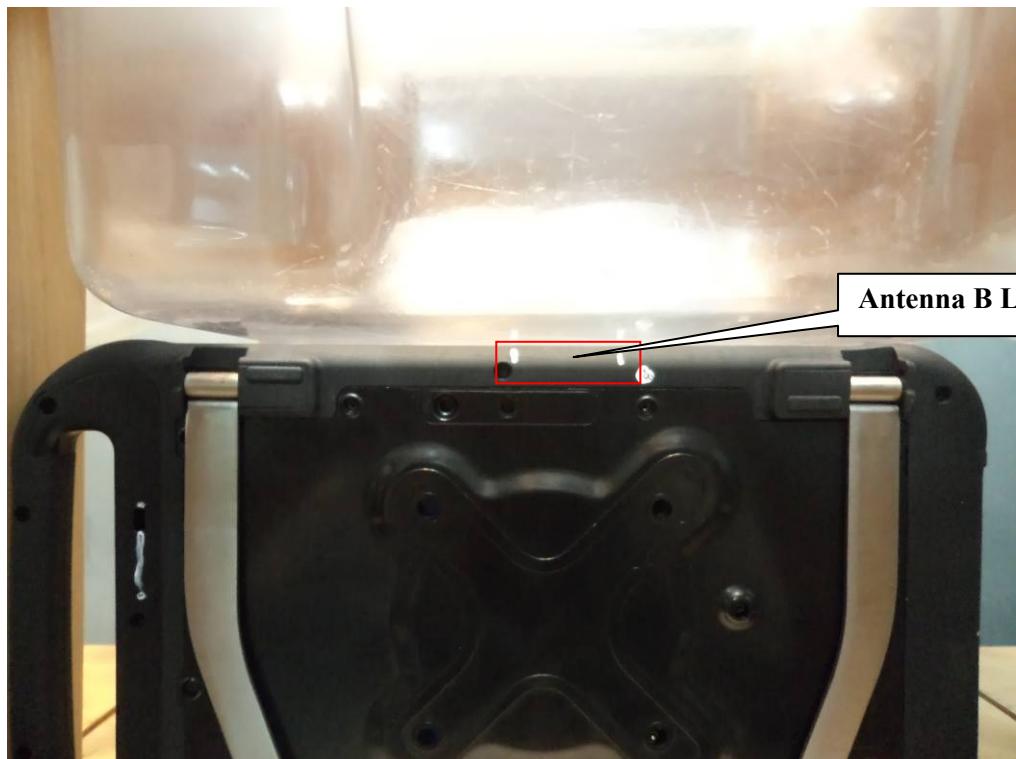
**Body-Back Setup Photo**



**Body-Top Setup Photo**



**Body-Bottom Setup Photo**

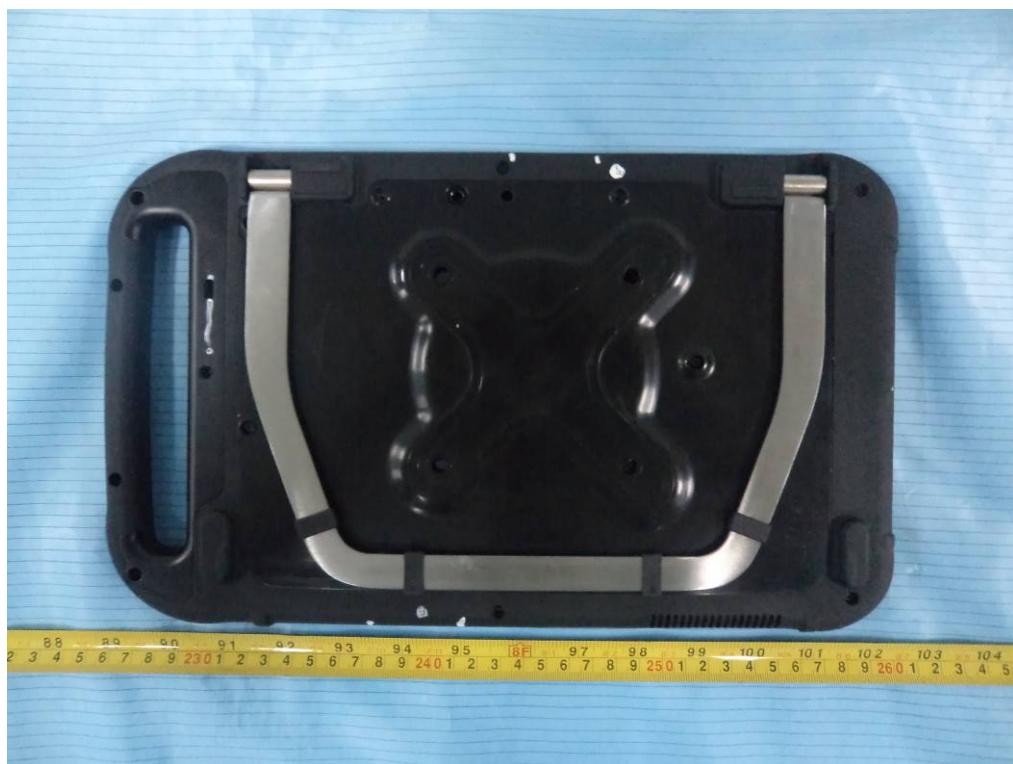


## APPENDIX E EUT PHOTOS

### EUT – Front Side View



### EUT – Back Side View



**EUT – Left Side View**



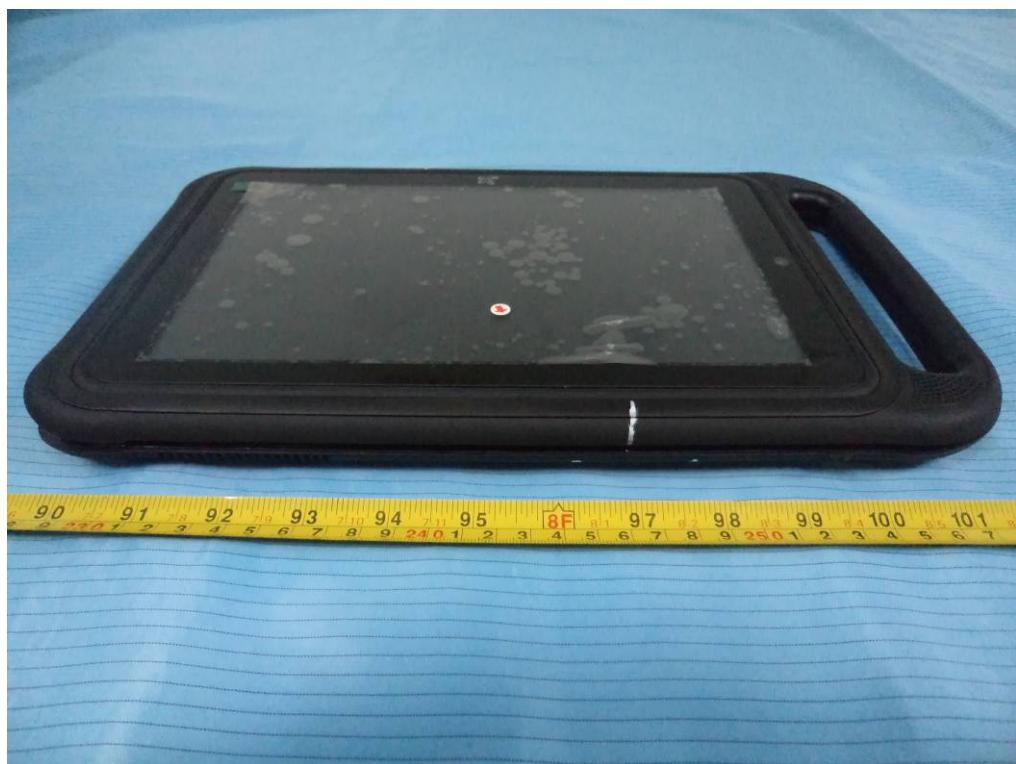
**EUT – Right Side View**



**EUT – Top Side View**



**EUT – Bottom Side View**



**EUT – Uncovered View****EUT – Antenna View**

## APPENDIX F – INFORMATIVE REFERENCES

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**DECLARATION LETTER****X2 Computing Ltd.**

Bond Industrial Estate, Wickhamford, EVESHAM, Worcestershire, WR11 7RL, UK  
Tel: +44 (0)1386 830082      Fax: +44 (0)1386 830032

**Attestation Letter**

August 1, 2013

To:

Bay Area Compliance Laboratories Corp.  
1274 Anvilwood Avenue  
Sunnyvale, CA 94089

Dear Sir or Madam:

We, X2 Computing Ltd. hereby declare that our Tablet, Model Number: X220 Carbon, FCC ID: RGCCARBONX2206300, with AUO & Chimei LCD screens; different top cover for Capacitive & Resistive touch panels; different battery cover each of 8000mAh and 16000mAh batteries; the PCBA with same PCB but with 8pin and 12pin pogo connector alternative; with 32G and 16G storage, different color for led lamp each of Halo LED or not; front camera and rear camera both are the optional part; Plastic and Rubber I/O cover is also optional on product.

Best Regards,

Signature  
A handwritten signature in black ink, appearing to read 'Robin Daunter', is placed over a stylized blue ink signature line. The line has a wavy, organic shape with loops and curves.

Robin Daunter  
Technical Director

\*\*\*\*\* END OF REPORT \*\*\*\*\*