

# SAR EVALUATION REPORT

For

## Hytera Communications Co., Ltd.

HYT Tower, Hi-Tech Industrial Park North, Nanshan District, Shenzhen China

**FCC ID: YAMX1PU2**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Digital Portable Radio
<b>Test Engineer:</b> Sandy Wang	<i>Sandy Wang</i>
<b>Report Number:</b> RSZ130508003-20A	
<b>Report Date:</b> 2013-08-05	
<b>Reviewed By:</b> Alvin Huang RF Leader	<i>Alvin Huang</i>
<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				
<b>EUT Information</b>		<b>Company Name</b>	Hytera Communications Co., Ltd.	
		<b>EUT Description</b>	Digital Portable Radio	
		<b>FCC ID</b>	YAMX1PU2	
		<b>Model Number</b>	X1p U(2)	
		<b>Test Date</b>	2013-07-10 to 2013-07-12	
<b>Mode</b>	<b>Frequency (MHz)</b>	<b>Max. SAR Level(s) Reported</b>		<b>Limit (W/Kg)</b>
Digital	450-520	12.5k	Face up: 1.376 W/kg Body-Back: 1.404 W/kg	8
Analog	450-520	12.5k	Face up: 1.362 W/kg (50% duty cycle) Body-Back: 1.341 W/kg (50% duty cycle)	
Simultaneous		PTT+BT	Face up: 1.387 W/kg (50% duty cycle) Body-Back: 1.457 W/kg (50% duty cycle)	
<b>Applicable Standards</b>		<b>ANSI / IEEE C95.1 : 2005</b> IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 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 Such Fields, 100 kHz—300 GHz.		
		<b>OET BULLETIN 65 SUPPLEMENT C</b> Evaluating Compliance with FCC Guidelines for Human Exposure To Radiofrequency Electromagnetic Fields		
		<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		
<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 FCC OET 65 Supplement C, IEEE 1528-2003 and KDB643646.</p> <p><b>The results and statements contained in this report pertain only to the device(s) evaluated.</b></p>				

## TABLE OF CONTENTS

<b>DOCUMENT REVISION HISTORY .....</b>	<b>5</b>
<b>EUT DESCRIPTION .....</b>	<b>6</b>
TECHNICAL SPECIFICATION .....	6
<b>REFERENCE, STANDARDS, AND GUIDELINES .....</b>	<b>7</b>
SAR LIMITS .....	8
<b>FACILITIES .....</b>	<b>9</b>
<b>DESCRIPTION OF TEST SYSTEM .....</b>	<b>10</b>
<b>EQUIPMENT LIST AND CALIBRATION .....</b>	<b>17</b>
EQUIPMENTS LIST & CALIBRATION INFORMATION .....	17
<b>SAR MEASUREMENT SYSTEM VERIFICATION .....</b>	<b>18</b>
LIQUID VERIFICATION .....	18
SYSTEM ACCURACY VERIFICATION .....	20
SAR SYSTEM VALIDATION DATA .....	21
<b>EUT TEST STRATEGY AND METHODOLOGY .....</b>	<b>25</b>
TEST POSITIONS FOR DEVICE OPERATING NEXT TO A PERSON’S EAR .....	25
CHEEK/TOUCH POSITION .....	26
EAR/TILT POSITION .....	26
TEST POSITIONS FOR BODY-WORN AND OTHER CONFIGURATIONS .....	27
SAR EVALUATION PROCEDURE .....	28
<b>CONDUCTED OUTPUT POWER MEASUREMENT .....</b>	<b>29</b>
PROVISION APPLICABLE .....	29
TEST PROCEDURE .....	29
MAXIMUM OUTPUT POWER AMONG PRODUCTION UNITS .....	29
TEST RESULTS: .....	29
<b>SAR MEASUREMENT RESULTS .....</b>	<b>31</b>
SAR TEST DATA .....	31
TEST RESULT: .....	32
<b>SAR SIMULTANEOUS TRANSMISSION DESCRIPTION .....</b>	<b>34</b>
EUT SCAN RESULTS .....	36
<b>APPENDIX A – MEASUREMENT UNCERTAINTY .....</b>	<b>48</b>
<b>APPENDIX B – PROBE CALIBRATION CERTIFICATES .....</b>	<b>49</b>
<b>APPENDIX C – DIPOLE CALIBRATION CERTIFICATES .....</b>	<b>59</b>
<b>APPENDIX D – EUT TEST POSITION PHOTOS .....</b>	<b>68</b>
LIQUID DEPTH ≥ 15CM .....	68
FACE-UP 2.5 CM SEPARATION TO FLAT PHANTOM SETUP PHOTO .....	68
BODY-BACK 0.0 CM SEPARATION TO FLAT PHANTOM SETUP PHOTO (PCN005) .....	69
BODY-BACK 0.0 CM SEPARATION TO FLAT PHANTOM SETUP PHOTO (CH04L01) .....	69
<b>APPENDIX E – EUT PHOTOS .....</b>	<b>70</b>
EUT – FRONT VIEW .....	70
EUT – BACK VIEW .....	70
EUT – LEFT VIEW .....	71
EUT – RIGHT VIEW .....	71
EUT – TOP VIEW .....	72
EUT – BOTTOM VIEW .....	72

EUT – UNCOVERED VIEW .....73

EUT–BATTERY: BL1103 1100MAH .....73

EUT–BATTERY: BL1809 1800MAH .....74

EUT–HEADSET: EWN07 .....74

EUT–HEADSET: EWN08 .....75

EUT – HEADSET: EAN19 .....75

EUT – HEADSET: EAN21 .....76

EUT – HEADSET: ACN-02 .....76

EUT – HEADSET: EH-01 .....77

EUT – HEADSET: EH-02 .....77

EUT – HEADSET: ES-01 .....78

EUT – HEADSET: ES-02 .....78

EUT –BODY-WORN ACCESSORIES VIEW: PCN005 .....79

EUT –BODY-WORN ACCESSORIES VIEW: CH04L01 .....79

**APPENDIX F – ACCESSORIES LIST .....80**

**APPENDIX G – INFORMATIVE REFERENCES .....81**

---

## DOCUMENT REVISION HISTORY

---

Revision Number	Report Number	Description of Revision	Date of Revision
0	RSZ130508003-20A	Original Report	2013-08-05

## EUT DESCRIPTION

---

This report has been prepared on behalf of Hytera Communications Co., Ltd. and their product, FCC ID: YAMX1PU2, Model: X1p U(2) or the EUT(Equipment Under Test) as referred to in the rest of this report. The EUT is a Digital Portable Radio.

### Technical Specification

<b>Product Type</b>	Portable
<b>Exposure Category:</b>	Occupational/Controlled Exposure
<b>Antenna Type(s):</b>	External Antenna
<b>Body-Worn Accessories:</b>	Belt Clip and Headset Cable
<b>Face-Head Accessories:</b>	None
<b>Modulation Type:</b>	FM and 4FSK
<b>Frequency Band:</b>	450-520 MHz
<b>Conducted RF Power:</b>	PTT: 36.76 dBm Bluetooth: 0.58 dBm
<b>Dimensions (L*W*H):</b>	210mm (L)×60mm (W)×27mm (H)
<b>Weight:</b>	289.4g
<b>Power Source:</b>	Rechargeable Li-ION Battery
<b>Normal Operation:</b>	Face Up and Body-worn

---

## 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).

Occupational/Controlled environments Spatial Peak limit 8.0W/kg (FCC/IC) & 10 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<sup>3</sup> in the X & Y axis, and 35mm in the Z axis.



### ALSAS-10U Interpolation and Extrapolation Uncertainty

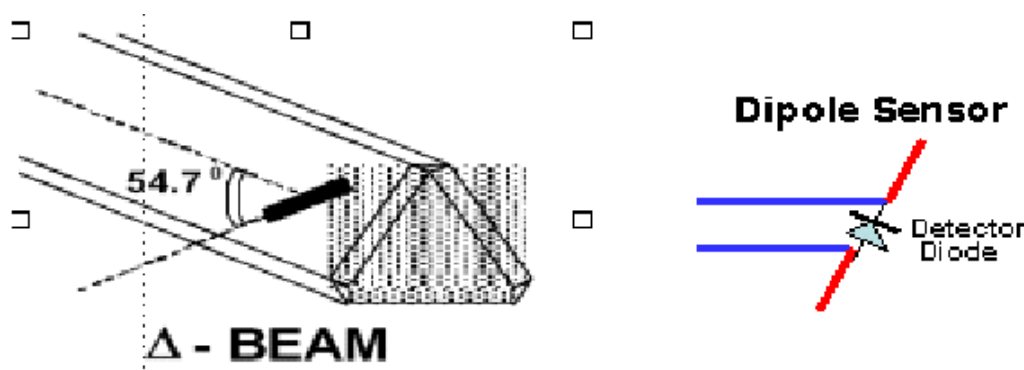
The overall uncertainty for the methodology and algorithms the used during the SAR calculation was evaluated using the data from IEEE 1528 based on the example f3 algorithm:

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

### 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 of aid cheek to tilt movements for head SAR analysis. Overall uncertainty for measurements have been reduced due to the design of the Universal device positioner, which allows positioning of a device in as near to a free-space scenario as possible, and by providing the means for complete repeatability.

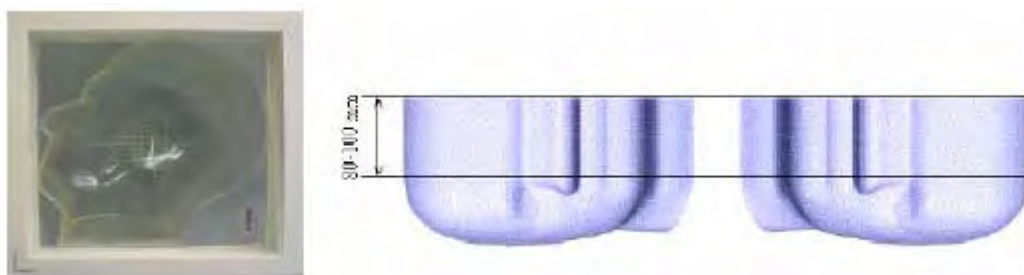


**Phantom Types**

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 on 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



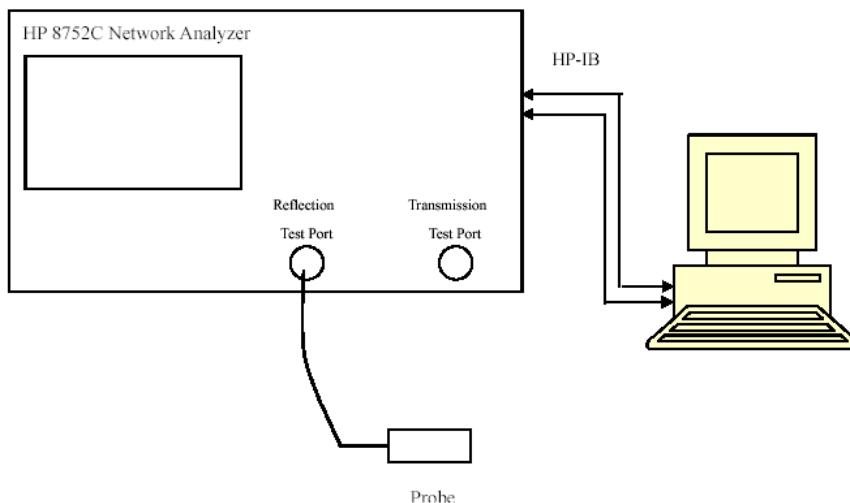
## EQUIPMENT LIST AND CALIBRATION

### 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	E-020	2012-08-09	500-00283
Dipole, 450 MHz	ALS-D-450-S-2	2012-07-31	175-00503
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 450 MHz Head	ALS-TS-450-H	Each Time	260-01106
Simulated Tissue 450 MHz Body	ALS-TS-450-B	Each Time	260-02108
Power Amplifier	5S1G4	N/A	71377
Synthesized Sweeper	HP 8341B	2013-05-16	2624A00116
Signal Analyzer	FSIQ26	2012-08-08	8386001028

# SAR MEASUREMENT SYSTEM VERIFICATION

## Liquid Verification



Liquid Verification Setup Block Diagram

## Liquid Verification Results

Frequency (MHz)	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)	
450.0125	Head	43.10	0.86	43.50	0.87	-0.920	-1.149	$\pm 5$
	Body	55.48	0.94	56.70	0.94	-2.152	0.000	$\pm 5$
469.9875	Head	43.04	0.87	43.50	0.87	-1.057	0.000	$\pm 5$
	Body	55.52	0.93	56.70	0.94	-2.081	-1.064	$\pm 5$
485.0125	Head	43.06	0.86	43.50	0.87	-1.011	-1.149	$\pm 5$
	Body	55.55	0.96	56.70	0.94	-2.028	2.128	$\pm 5$
500.0125	Head	43.00	0.86	43.50	0.87	-1.149	-1.149	$\pm 5$
	Body	55.58	0.91	56.70	0.94	-1.975	-3.191	$\pm 5$
519.9875	Head	42.89	0.87	43.50	0.87	-1.402	0.000	$\pm 5$
	Body	55.63	0.95	56.70	0.94	-1.887	1.064	$\pm 5$

\*Liquid Verification was performed on 2013-07-10.

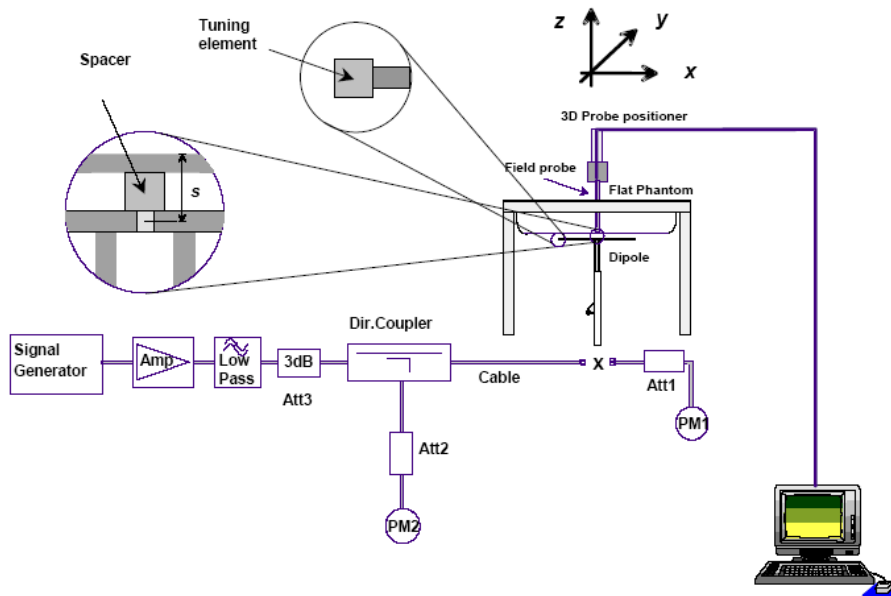
Please refer to the following tables.

450 Head				450 Body		
Frequency (MHz)	e'	e''		Frequency (MHz)	e'	e''
450.0	43.104070	34.265426		450.0	55.480685	37.600716
451.5	43.073041	34.189960		451.5	55.483823	37.500227
453.0	43.056381	34.114499		453.0	55.486956	37.512745
454.5	42.951241	34.039031		454.5	55.490099	37.525179
456.0	42.969599	33.963560		456.0	55.493237	37.660241
457.5	42.991492	33.888087		457.5	55.496375	37.723972
459.0	42.967979	33.812620		459.0	55.499513	37.638471
460.5	43.015300	33.737150		460.5	55.502651	37.516607
462.0	43.034906	33.661677		462.0	55.505789	37.551169
463.5	43.041332	33.586218		463.5	55.508927	37.508592
465.0	43.092263	33.510751		465.0	55.512065	37.612747
466.5	43.040756	33.435280		466.5	55.515203	37.555576
468.0	43.077124	33.359809		468.0	55.518341	35.433473
469.5	43.037153	33.284338		469.5	55.521479	35.497861
471.0	43.010151	33.208869		471.0	55.524617	35.483036
472.5	43.029706	33.133407		472.5	55.527755	35.690460
474.0	42.991524	33.057940		474.0	55.530892	35.668124
475.5	42.966348	32.982470		475.5	55.534030	35.444823
477.0	43.006884	32.906997		477.0	55.537168	35.378187
478.5	43.038303	32.831527		478.5	55.540306	35.489654
480.0	43.035728	32.756057		480.0	55.543444	35.641511
481.5	43.034308	32.680599		481.5	55.546582	35.534473
483.0	43.059137	31.850820		483.0	55.549720	35.477932
484.5	43.060137	31.775347		484.5	55.552858	35.725639
486.0	43.063737	31.699877		486.0	55.555996	35.732562
487.5	43.048769	31.624410		487.5	55.559134	35.590369
489.0	43.035566	31.548939		489.0	55.562272	35.417452
490.5	43.029773	31.473470		490.5	55.565410	34.453718
492.0	43.052946	31.398005		492.0	55.568548	34.738001
493.5	43.011476	31.322536		493.5	55.571686	34.753205
495.0	43.001407	31.247065		495.0	55.574824	32.675217
496.5	43.003877	31.171595		496.5	55.577962	32.610175
498.0	43.014944	31.096128		498.0	55.581100	32.677318
499.5	43.004306	31.020655		499.5	55.584238	32.722682
501.0	42.987578	30.945200		501.0	55.587376	32.677810
502.5	43.017020	30.869726		502.5	55.590514	32.614547
504.0	43.018722	30.794256		504.0	55.593652	32.790387
505.5	43.022418	30.718787		505.5	55.596790	32.758900
507.0	43.016513	30.643314		507.0	55.599928	32.719298
508.5	42.940216	30.567846		508.5	55.603066	32.674809
510.0	43.016468	30.492378		510.0	55.606204	32.692467
511.5	42.970759	30.416917		511.5	55.609342	32.718374
513.0	42.896777	30.341446		513.0	55.612480	32.627792
514.5	42.912079	30.265979		514.5	55.615618	32.574178
516.0	42.866662	30.190505		516.0	55.618756	32.747179
517.5	42.907601	30.115035		517.5	55.621894	32.808583
519.0	42.887870	30.039566		519.0	55.625032	32.757442
520.5	42.891054	29.964105		520.5	55.628170	32.677743
522.0	42.864656	29.888635		522.0	55.631307	32.767900
523.5	42.869251	29.813169		523.5	55.634445	32.845984
525.0	42.829519	29.737699		525.0	55.637583	32.846166

### 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	2012-08-08	2013-08-07
APREL	Dipole antenna(450MHz)	ALS-D-450-S-2	175-00503	2011-08-25	2014-08-24

### System Accuracy Check Results

Date	Frequency (MHz)	Liquid Type	Measured SAR (W/Kg)		Target Value (W/Kg)	Delta (%)	Tolerance (%)
2013-07-10	450	Head	1g	4.623	4.572	1.103	$\pm 10$
		Body	1g	4.574	4.508	1.443	$\pm 10$

\*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 450 MHz Head Liquid****Dipole 450 MHz; Type: ALS-D-450-S-2; S/N: 175-00503**

## Product Data

Device Name : Dipole 450 MHz  
Serial No. : 175-00503  
Type : Dipole  
Model : ALS-D-450-S-2  
Frequency Band : 450  
Max. Transmit Pwr : 1 W  
Drift Time : 3 min(s)  
Power Drift-Start : 4.628 W/kg  
Power Drift-Finish : 4.617 W/kg  
Power Drift (%) : -0.216

## Phantom Data

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

## Tissue Data

Type : Head  
Serial No. : 260-01106  
Frequency : 450.00MHz  
Last Calib. Date : 10-Jul-2013  
Temperature : 20.00 °C  
Ambient Temp. : 21.00 °C  
Humidity : 56.00 RH%  
Epsilon : 43.10 F/m  
Sigma : 0.86 S/m  
Density : 1000.00 kg/cu. m

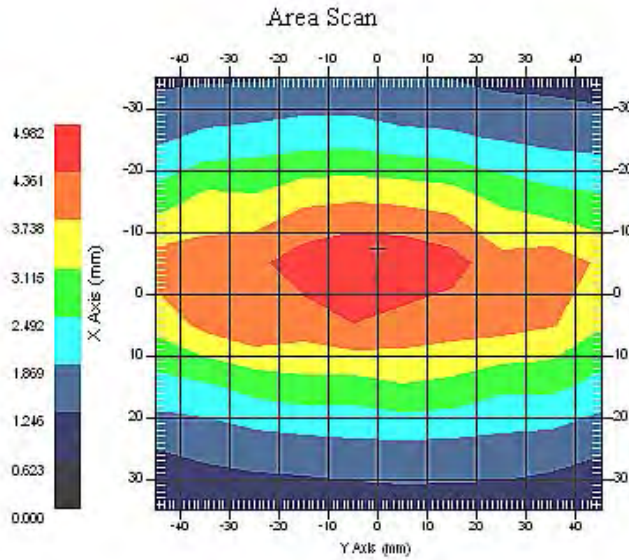
## Probe Data

Name : E-Field  
Model : E-020  
Type : E-Field Triangle  
Serial No. : 500-00283  
Last Calib. Date : 09-Aug-2012  
Frequency Band : 450  
Duty Cycle Factor : 1  
Conversion Factor : 6.0  
Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
Compression Point : 95.00 mV  
Offset : 1.56 mm

## Measurement Data

Crest Factor : 1  
Scan Type : Complete  
Tissue Temp. : 21.00 °C  
Ambient Temp. : 21.00 °C  
Area Scan : 8x10x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

1 gram SAR value : 4.623 W/kg  
 10 gram SAR value : 3.195 W/kg  
 Area Scan Peak SAR : 4.975 W/kg  
 Zoom Scan Peak SAR : 7.016 W/kg



**450 MHz System Validation with Head Tissue**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****System Performance Check 450 MHz Body Liquid****Dipole 450 MHz; Type: ALS-D-450 -S-2; S/N: 175-00503**

## Product Data

Device Name : Dipole 450 MHz  
Serial No. : 175-00503  
Type : Dipole  
Model : ALS-D-450-S-2  
Frequency Band : 450  
Max. Transmit Pwr : 1 W  
Drift Time : 3 min(s)  
Power Drift-Start : 4.630 W/kg  
Power Drift-Finish : 4.621 W/kg  
Power Drift (%) : -0.432

## Phantom Data

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

## Tissue Data

Type : Body  
Serial No. : 260-02108  
Frequency : 450.00MHz  
Last Calib. Date : 10-Jul-2013  
Temperature : 20.00 °C  
Ambient Temp. : 21.00 °C  
Humidity : 56.00 RH%  
Epsilon : 55.48 F/m  
Sigma : 0.94 S/m  
Density : 1000.00 kg/cu. m

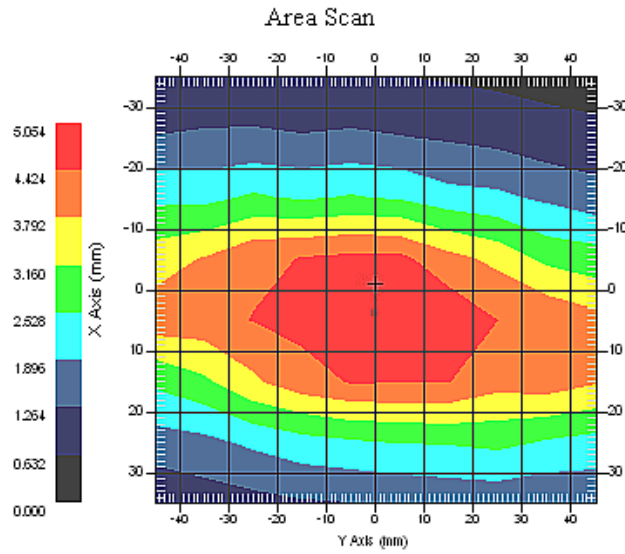
## Probe Data

Name : E-Field  
Model : E-020  
Type : E-Field Triangle  
Serial No. : 500-00283  
Last Calib. Date : 09-Aug-2012  
Frequency Band : 450  
Duty Cycle Factor : 1  
Conversion Factor : 6.0  
Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
Compression Point : 95.00 mV  
Offset : 1.56 mm

## Measurement Data

Crest Factor : 1  
Scan Type : Complete  
Tissue Temp. : 21.00 °C  
Ambient Temp. : 21.00 °C  
Area Scan : 8x10x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

1 gram SAR value : 4.574 W/kg  
 10 gram SAR value : 3.135 W/kg  
 Area Scan Peak SAR : 5.054 W/kg  
 Zoom Scan Peak SAR : 7.790 W/kg



**450 MHz System Validation with Body Tissue**

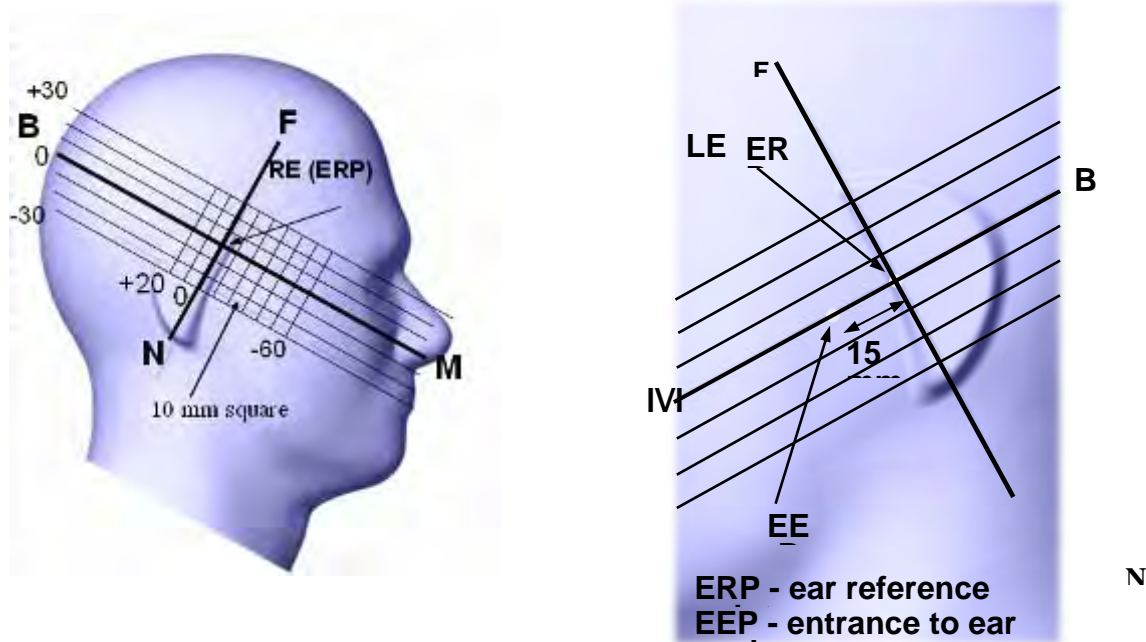


## EUT TEST STRATEGY AND METHODOLOGY

### 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 ¼ 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

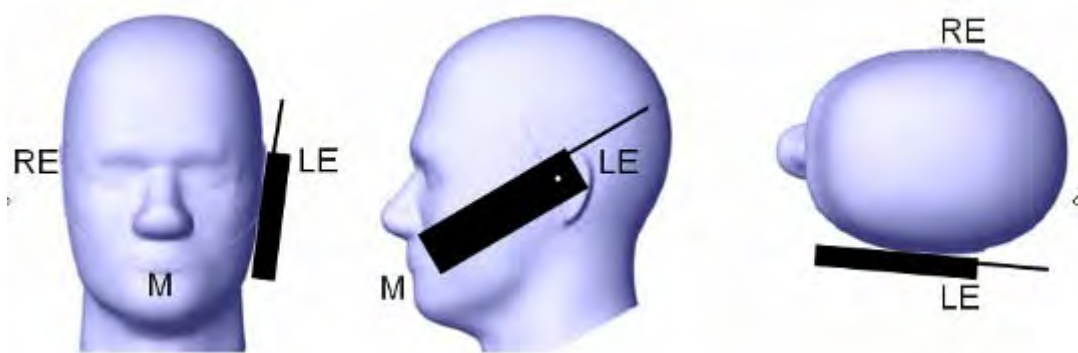
The device is brought toward the mouth of the head phantom by pivoting against the “ear reference point” or along the “N-F” line for the SCC-34/SC-2 head phantom.

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

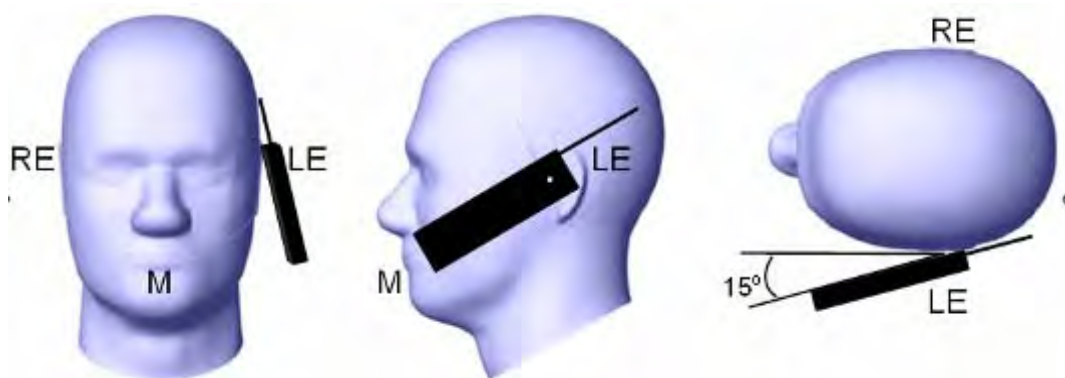
With the handset aligned in the “Cheek/Touch Position”:

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 80°. 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, Tile/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.

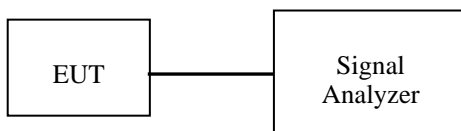
## CONDUCTED OUTPUT POWER MEASUREMENT

### 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 Signal Analyzer through sufficient attenuation.



### Maximum Output Power among production units

Max Target Power for Production Unit (dBm)					
PTT/Mode	Frequency				
	450.0125	469.9875	485.0125	500.0125	519.9875
Digital-12.5K	36.80	36.80	36.80	36.80	36.80
Analog-12.5K	36.80	36.80	36.80	36.80	36.80
Bluetooth/Mode	Low		Middle		High
4-BDR	1.0		1.0		1.0
8-EDR	1.0		1.0		1.0
EDR	1.0		1.0		1.0

### Test Results:

PTT

Mode	Frequency Spacing (kHz)	Frequency (MHz)	Output(dBm)	Output Power(W)	Power level
Digital	12.5	450.0125	36.73	4.710	High
		469.9875	36.73	4.710	High
		485.0125	36.72	4.699	High
		500.0125	36.84	4.831	High
		519.9875	<b>36.76</b>	<b>4.742</b>	High
Analog	12.5	450.0125	36.66	4.634	High
		469.9875	36.72	4.699	High
		485.0125	36.73	4.710	High
		500.0125	36.75	4.732	High
		519.9875	<b>36.76</b>	<b>4.742</b>	High

Bluetooth

Mode	Channel	Frequency (MHz)	Reading power (dBm)	Power output (mw)
<b>4-BDR</b>	Low	2402	-0.82	0.828
	Middle	2441	-0.31	0.931
	High	2480	0.26	1.062
<b>8-BDR</b>	Low	2402	-0.57	0.877
	Middle	2441	-0.03	0.993
	High	2480	<b>0.58</b>	1.143
<b>EDR</b>	Low	2402	-0.55	0.881
	Middle	2441	0.04	1.009
	High	2480	0.54	1.132

## SAR MEASUREMENT RESULTS

This page summarizes the results of the performed dosimetric evaluation.

### SAR Test Data

#### Environmental Conditions

<b>Temperature:</b>	21 °C
<b>Relative Humidity:</b>	50%
<b>ATM Pressure:</b>	1002 mbar

\* Testing was performed by Sandy Wang on 2013-07-10 and 2013-07-12

Associated Accessories List		
<b>Antenna</b>	1	<b>AN0485H04</b>
<b>Battery</b>	1	BL1103 1100mAh
	2	<b>BL1809 1800mAh</b>
<b>Body-worn Accessories</b>	1	<b>PCN005</b>
	2	CH04L01
<b>Audio Accessories</b>	1	EWN07
	2	EWN08
	3	EAN19
	4	EAN21
	5	<b>ACN-02+(EH-01/EH-02/ES-01/ES-02)</b>

1. When multiple default body-worn accessories are supplied with a radio, the standard body-worn accessory expected to result in the highest SAR based on its construction and exposure conditions is considered the default body-worn accessory for making body-worn SAR measurements.
2. When multiple standard batteries are supplied with a radio, the battery with the highest capacity is considered the default battery for making head SAR measurements.
3. Testing a PTT radio with the thinnest battery and a standard (default) body-worn accessory that are both supplied with the radio and, if applicable, a default audio accessory, to measure the body SAR. But, during the test, the body-worn accessory provided a same separation whether the battery you used. So we select the battery with the highest capacity for making body SAR measurement as the default battery.
4. For audio accessories with similar construction and operating requirements, test only the audio accessory within the group that is expected to result in the highest SAR, with respect to changes in RF characteristics and exposure conditions for the combination.
5. The highlight accessories combination is regard as a default one for different construction and operating requirements accessories.

**Test Result:****Digital (Modulation 4FSK; Channel Spacing 12.5 kHz):**

EUT Position	Frequency (MHz)	Body-Worn Accessory	Battery	Power Drift (%)	Max. Meas. Power (dBm)	Max. Rated Power (dBm)	1 g SAR Value(W/Kg)		
							Scaled Factor	Meas. SAR	Scaled SAR
Face up (2.5cm)	519.9875	/	BL1809	1.289	36.76	36.80	1.009	1.254	1.265
	519.9875	/	BL1103	-0.620	36.76	36.80	1.009	1.364	<b>1.376</b>
Body-Back (0.0cm)	519.9875	PCN005	BL1809	-0.085	36.76	36.80	1.009	1.280	1.292
	519.9875	CH04L01	BL1809	0.999	36.76	36.80	1.009	0.640	0.646
	519.9875	PCN005	BL1103	-0.995	36.76	36.80	1.009	1.391	<b>1.404</b>
	519.9875	CH04L01	BL1103	1.558	36.76	36.80	1.009	0.744	0.751

**Note:**

1. When the 1-g SAR tested using the default battery and default accessories is  $\leq 3.5W/Kg$ , testing for other channels are optional.
2. When 1-g SAR tested using the default battery and default accessories is  $\leq 4.0W/Kg$ , the test using additional batteries is only required for the configuration that resulted in the highest SAR among previous test. We used BL1809 (1800mAh) for SAR measurements as the default battery.
3. When the 1-g SAR is  $> 6.0 W/kg$ , test additional battery and antenna combination with the default body-worn and audio accessory on all required channels.
4. Passive body-worn and audio accessories generally do not apply to the head SAR of PTT radios.
5. The audio accessory ACN-02+EH-01 will result higher SAR value than other audio accessory. So all test of the body-back are testing with the audio accessory ACN-02+EH-01.



**Analog (Modulation FM; Channel Spacing 12.5 kHz):**

EUT Position	Frequency (MHz)	Body-Worn Accessory	Battery	Power Drift (%)	Max. Meas. Power (dBm)	Max. Rated Power (dBm)	1 g SAR Value (W/Kg)			
							Scaled Factor	Meas. SAR	Scaled SAR	50% Duty Cycle
Face up (2.5cm)	519.9875	/	BL1809	-0.492	36.76	36.80	1.009	2.223	2.243	1.122
	519.9875	/	BL1103	0.843	36.76	36.80	1.009	2.699	2.723	<b>1.362</b>
Body-Back (0.0cm)	519.9875	PCN005	BL1809	0.320	36.76	36.80	1.009	2.576	2.599	1.300
	519.9875	CH04L01	BL1809	0.672	36.76	36.80	1.009	1.396	1.409	0.705
	519.9875	PCN005	BL1103	1.249	36.76	36.80	1.009	2.657	2.681	<b>1.341</b>
	519.9875	CH04L01	BL1103	0.769	36.76	36.80	1.009	1.441	1.454	0.727

**Note:**

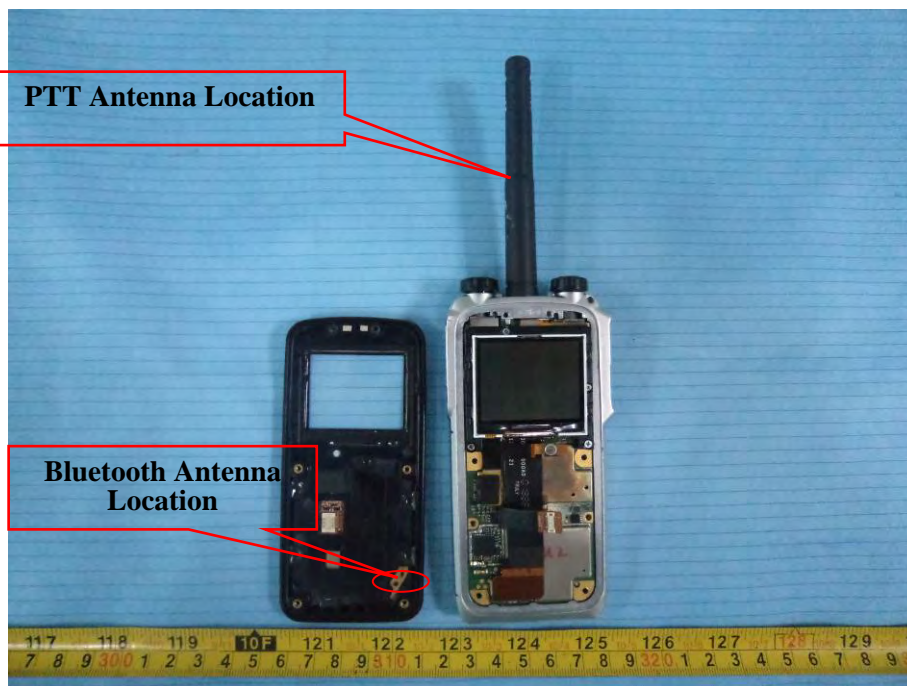
1. When the 1-g SAR (50% duty cycle) tested using the default battery and default accessories is  $\leq 3.5$ W/Kg, testing for other channels are optional.
2. When 1-g SAR (50% duty cycle) tested using the default battery and default accessories is  $\leq 4.0$ W/Kg, the test using additional batteries is only required for the configuration that resulted in the highest SAR among previous test. We used BL1809 (1800mAh) for SAR measurements as the default battery.
3. When the 1-g SAR (50% duty cycle) is  $> 6.0$  W/kg, test additional battery and antenna combination with the default body-worn and audio accessory on all required channels.
4. Passive body-worn and audio accessories generally do not apply to the head SAR of PTT radios.
5. The audio accessory ACN-02+EH-01 will result higher SAR value than other audio accessory. So all test of the body-back are testing with the audio accessory ACN-02+EH-01.
6. 50% duty cycle applies to FM Modulation.

## SAR SIMULTANEOUS TRANSMISSION DESCRIPTION

### KDB 447498D01 General RF Exposure Guidance v05

Stand-alone and simultaneous SAR evaluation for a PTT with multiple transmitters is base on the antennas distance of each radio.

#### BT and PTT Antenna Location:



#### Antenna Information:

Description of Simultaneous Transmit Capabilities		Antennas Distance (mm)
Transmitter Combination	Simultaneous?	
PTT + Bluetooth	√	105

#### Standalone SAR test exclusion considerations

Head:

Mode	Frequency (MHz)	P <sub>avg</sub> (dBm)	P <sub>avg</sub> (mW)	Distance (mm)	Calculated value	Threshold (1-g)	SAR Test Exclusion
PTT	450	36.76	4742	25	127.2	3.0	No
Bluetooth	2450	0.58	1.143	25	0.07	3.0	Yes

Body:

Mode	Frequency (MHz)	P <sub>avg</sub> (dBm)	P <sub>avg</sub> (mW)	Distance (mm)	Calculated value	Threshold (1-g)	SAR Test Exclusion
PTT	450	36.76	4742	0	636.2	3.0	No
Bluetooth	2450	0.58	1.143	0	0.36	3.0	Yes

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

**Simultaneous SAR test exclusion considerations:**

Position	Reported SAR (W/kg)		ΣSAR (W/kg)
	PTT	BT	
Face Up	1.376	0.011	1.387
Body-Back	1.404	0.053	1.457

Mode	Frequency (GHz)	Distance (mm)	P <sub>avg</sub> (dBm)	P <sub>avg</sub> (mW)	Estimated 1-g (W/kg)
Bluetooth Face Up	2.45	25	1.0	1.259	0.011
Bluetooth Body-Back	2.45	0	1.0	1.259	0.053

**Note:**

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}/x]$$

W/kg for *test separation distances* ≤ 50 mm;

where *x* = 7.5 for 1-g SAR.

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion

**Conclusion:**

ΣSAR < 8.0 W/kg therefore simultaneous transmission SAR with Volume Scans is **not** required.

### EUT SCAN RESULTS

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

**Face-Up 2.5cm (Digital 12.5k-519.9875 MHz)**

**Battery: BL1809**

**Measurement Data**

Modulation mode : 4FSK  
 Crest Factor : 2  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 1.164 W/kg  
 Power Drift-Finish : 1.179W/kg  
 Power Drift (%) : 1.298

**Tissue Data**

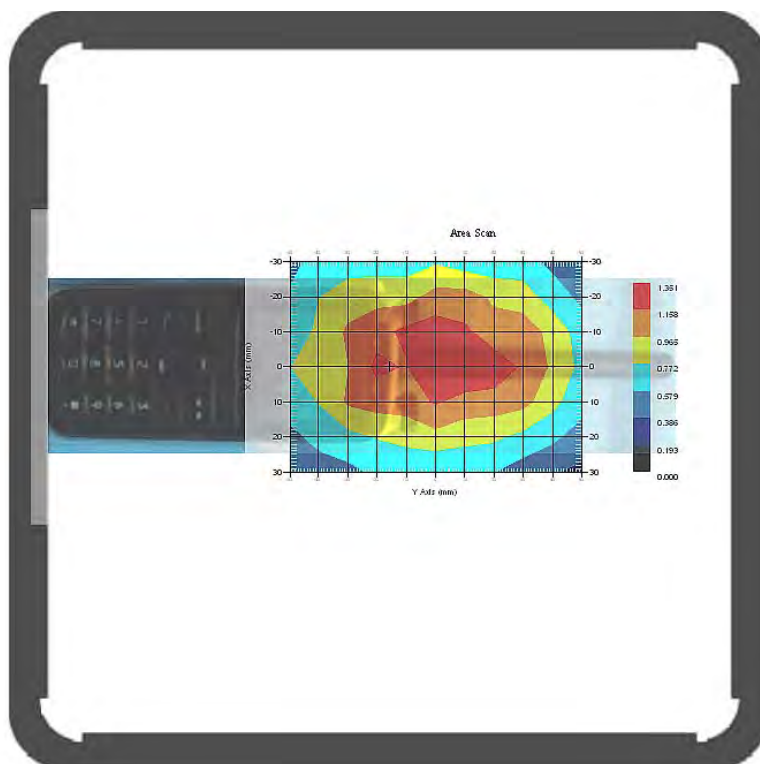
Type : Head  
 Frequency : 519.9875 MHz  
 Epsilon : 42.89 F/m  
 Sigma : 0.87 S/m  
 Density : 1000.00 kg/cu. m

**Probe Data**

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 2  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 1.254 W/kg  
 10 gram SAR value : 0.876 W/kg  
 Area Scan Peak SAR : 1.349 W/kg  
 Zoom Scan Peak SAR : 1.671 W/kg

**Plot 1#**



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

**Face-Up 2.5cm (Digital 12.5k-519.9875 MHz)  
Battery: BL1103**

Measurement Data

Modulation mode : 4FSK  
 Crest Factor : 2  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 1.290 W/kg  
 Power Drift-Finish : 1.282 W/kg  
 Power Drift (%) : -0.620

Tissue Data

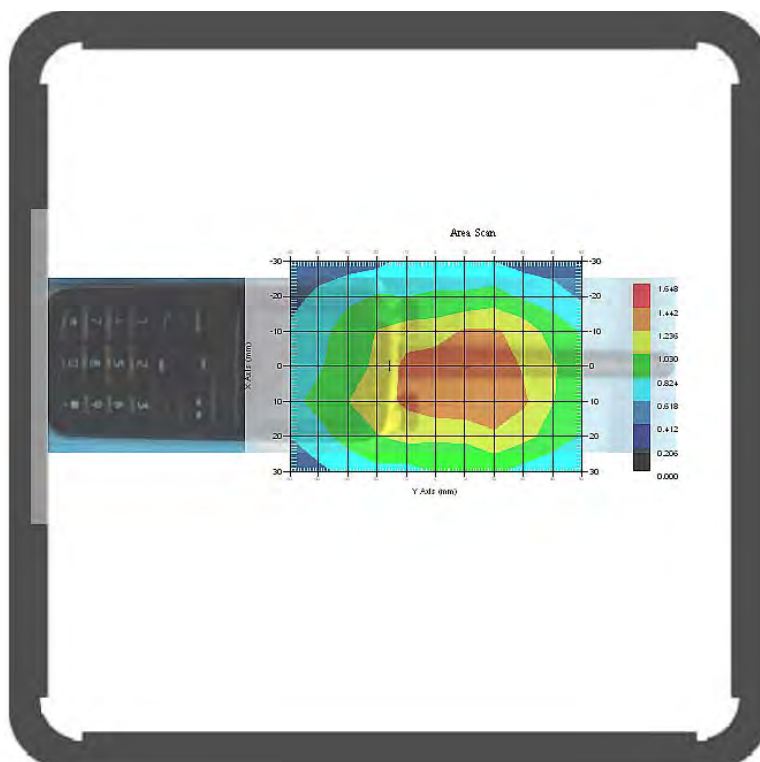
Type : Head  
 Frequency : 519.9875 MHz  
 Epsilon : 42.89 F/m  
 Sigma : 0.87 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 2  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 1.364 W/kg  
 10 gram SAR value : 1.100 W/kg  
 Area Scan Peak SAR : 1.445 W/kg  
 Zoom Scan Peak SAR : 2.292 W/kg

**Plot 2#**



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

**Body-Back 0.0cm (Digital 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: PCN005; Battery: BL1809**

Measurement Data

Modulation mode : 4FSK  
 Crest Factor : 2  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 1.176 W/kg  
 Power Drift-Finish : 1.181 W/kg  
 Power Drift (%) : -0.085

Tissue Data

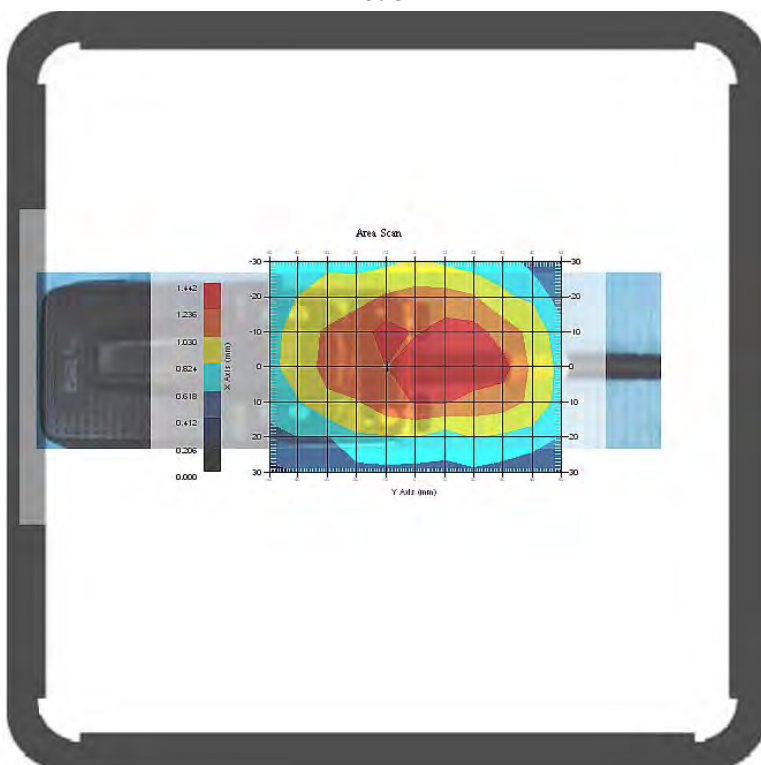
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 2  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 1.280 W/kg  
 10 gram SAR value : 0.932 W/kg  
 Area Scan Peak SAR : 1.440 W/kg  
 Zoom Scan Peak SAR : 2.031 W/kg

**Plot 3#**



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

**Body-Back 0.0cm (Digital 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: CH04L01; Battery: BL1809**

Measurement Data

Modulation mode : 4FSK  
 Crest Factor : 2  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 0.601 W/kg  
 Power Drift-Finish : 0.607 W/kg  
 Power Drift (%) : 0.999

Tissue Data

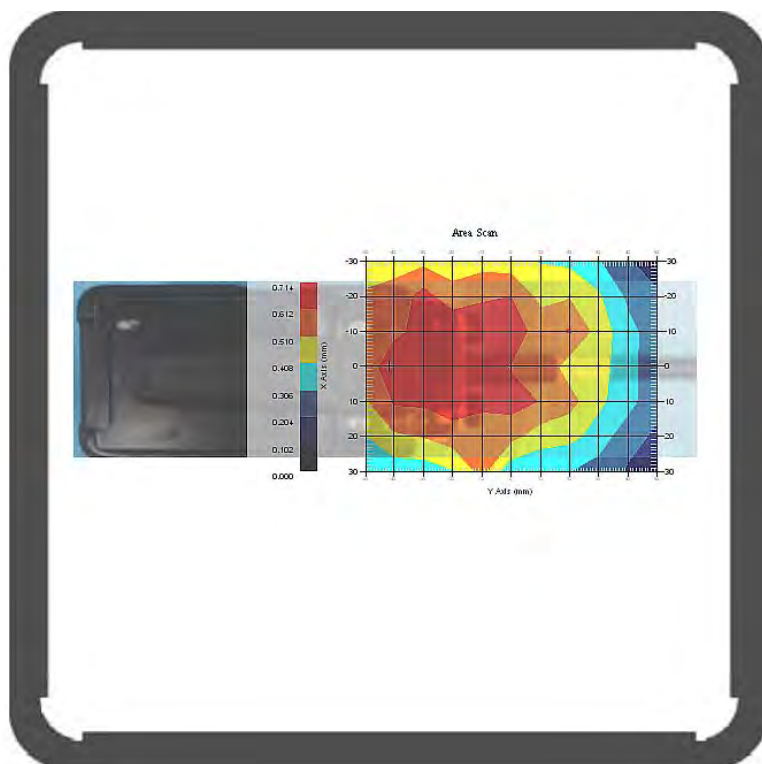
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 2  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 0.640 W/kg  
 10 gram SAR value : 0.476 W/kg  
 Area Scan Peak SAR : 0.712 W/kg  
 Zoom Scan Peak SAR : 1.451 W/kg

**Plot 4#**



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

**Body-Back 0.0cm (Digital 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: PCN005; Battery: BL1103**

Measurement Data

Modulation mode : 4FSK  
 Crest Factor : 2  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 1.274 W/kg  
 Power Drift-Finish : 1.262W/kg  
 Power Drift (%) : -0.995

Tissue Data

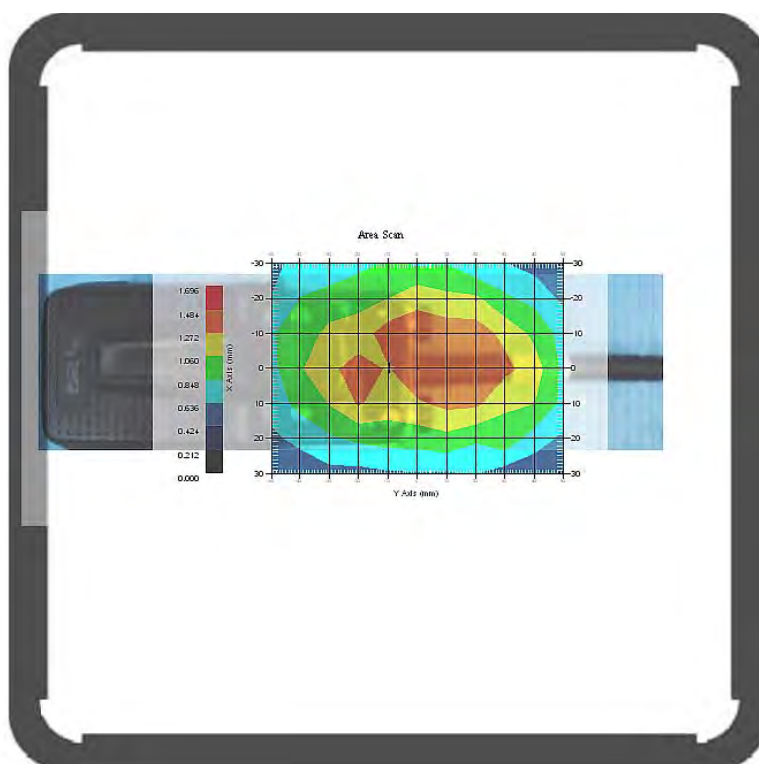
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 2  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 1.391 W/kg  
 10 gram SAR value : 0.970 W/kg  
 Area Scan Peak SAR : 1.485 W/kg  
 Zoom Scan Peak SAR : 2.061 W/kg

**Plot 5#**





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

**Body-Back 0.0cm (Digital 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: CH04L01; Battery: BL1103**

Measurement Data

Modulation mode : 4FSK  
 Crest Factor : 2  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 0.770 W/kg  
 Power Drift-Finish : 0.782 W/kg  
 Power Drift (%) : 1.558

Tissue Data

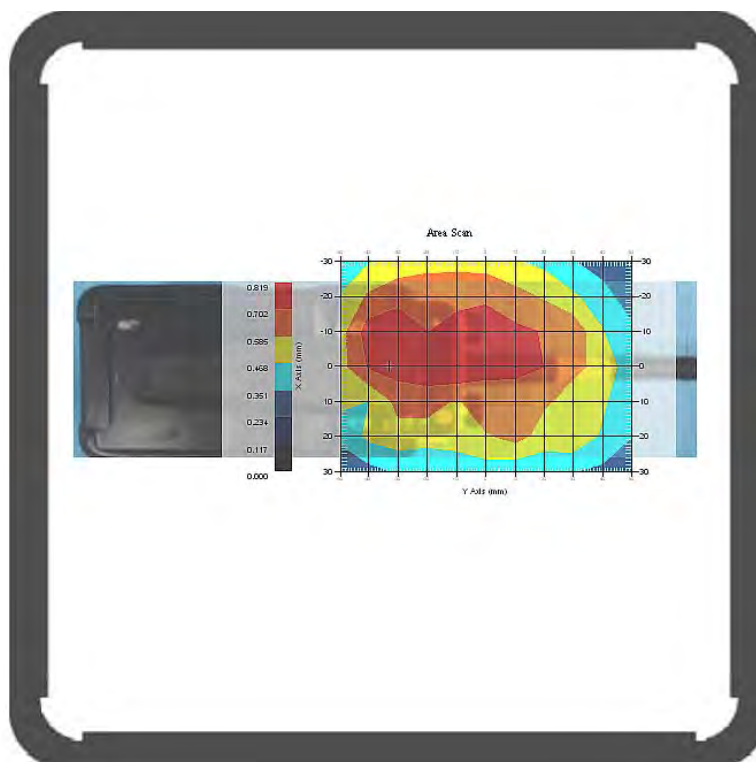
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 2  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 0.744 W/kg  
 10 gram SAR value : 0.556 W/kg  
 Area Scan Peak SAR : 0.819 W/kg  
 Zoom Scan Peak SAR : 1.171 W/kg

**Plot 6#**



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

**Face-Up 2.5cm (Analog 12.5k-519.9875 MHz)  
Battery: BL1809**

Measurement Data

Modulation mode : FM  
 Crest Factor : 1  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 2.235 W/kg  
 Power Drift-Finish : 2.224 W/kg  
 Power Drift (%) : -0.492

Tissue Data

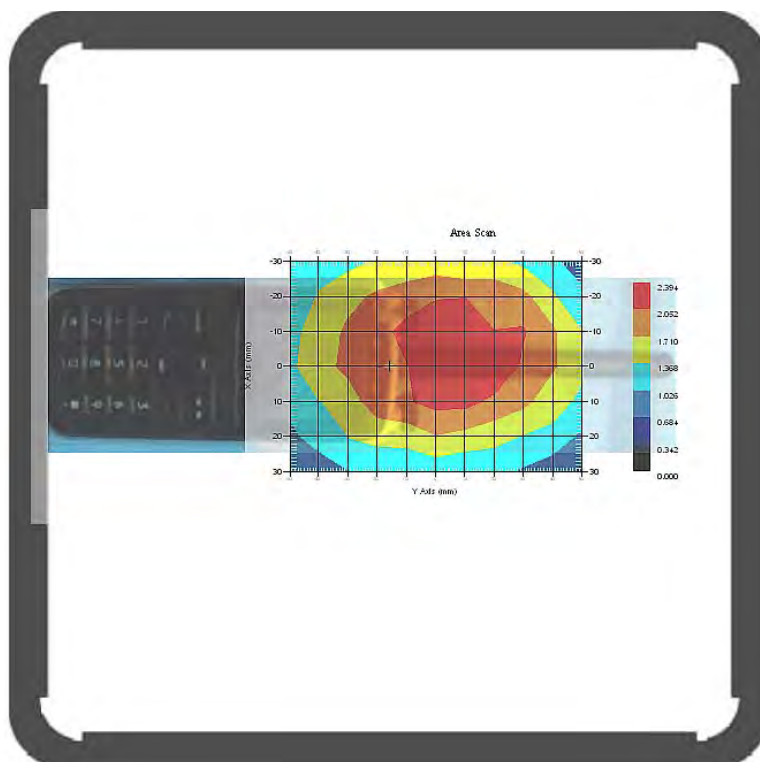
Type : Head  
 Frequency : 519.9875 MHz  
 Epsilon : 42.89 F/m  
 Sigma : 0.87 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 1  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 2.223 W/kg  
 10 gram SAR value : 1.490 W/kg  
 Area Scan Peak SAR : 2.391 W/kg  
 Zoom Scan Peak SAR : 3.182 W/kg

**Plot 7#**



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

**Face-Up 2.5cm (Analog 12.5k-519.9875 MHz)  
Battery: BL1103**

Measurement Data

Modulation mode : FM  
 Crest Factor : 1  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 2.610 W/kg  
 Power Drift-Finish : 2.632 W/kg  
 Power Drift (%) : 0.843

Tissue Data

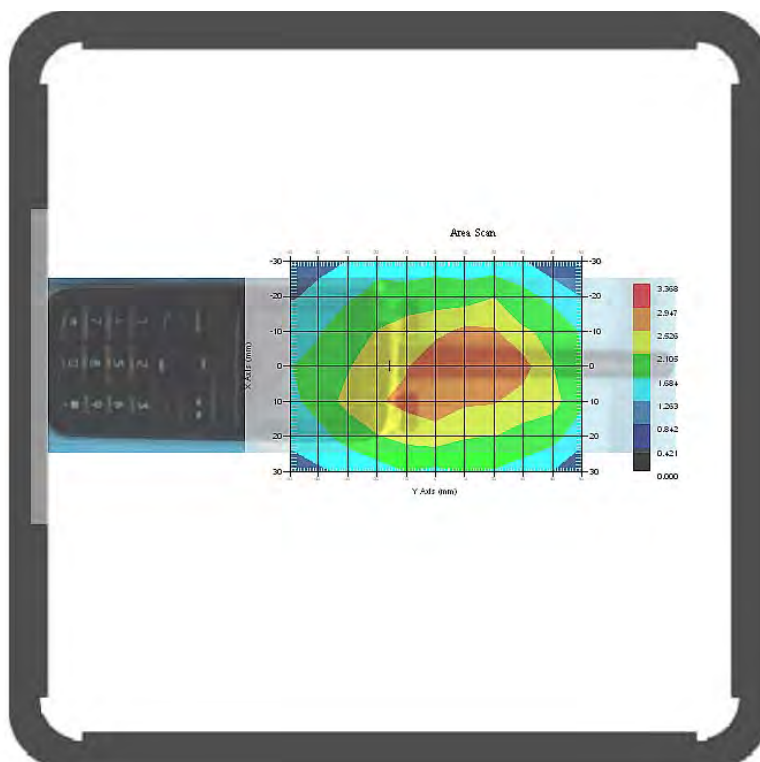
Type : Head  
 Frequency : 519.9875 MHz  
 Epsilon : 42.89 F/m  
 Sigma : 0.87 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 1  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 2.699 W/kg  
 10 gram SAR value : 1.856 W/kg  
 Area Scan Peak SAR : 2.950 W/kg  
 Zoom Scan Peak SAR : 3.873 W/kg

**Plot 8#**



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

**Body-Back 0.0cm (Analog 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: PCN005; Battery: BL1809**

Measurement Data

Modulation mode : FM  
 Crest Factor : 1  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 2.498 W/kg  
 Power Drift-Finish : 2.506 W/kg  
 Power Drift (%) : 0.320

Tissue Data

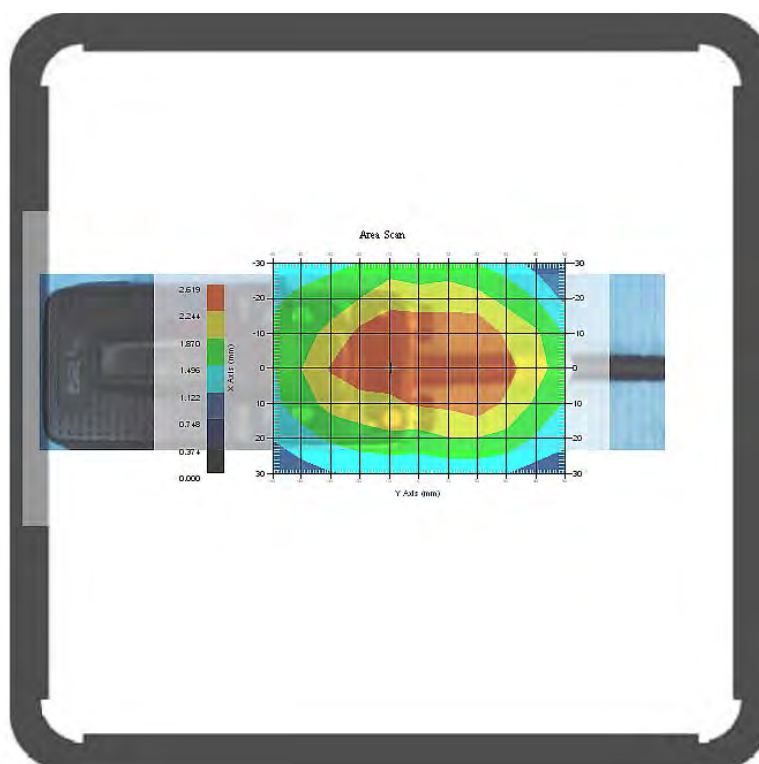
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 1  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 2.576 W/kg  
 10 gram SAR value : 1.885 W/kg  
 Area Scan Peak SAR : 2.619 W/kg  
 Zoom Scan Peak SAR : 3.453 W/kg

**Plot 9#**



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

**Body-Back 0.0cm (Analog 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: CH04L01; Battery: BL1809**

Measurement Data

Modulation mode : FM  
 Crest Factor : 1  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 1.341 W/kg  
 Power Drift-Finish : 1.350 W/kg  
 Power Drift (%) : 0.672

Tissue Data

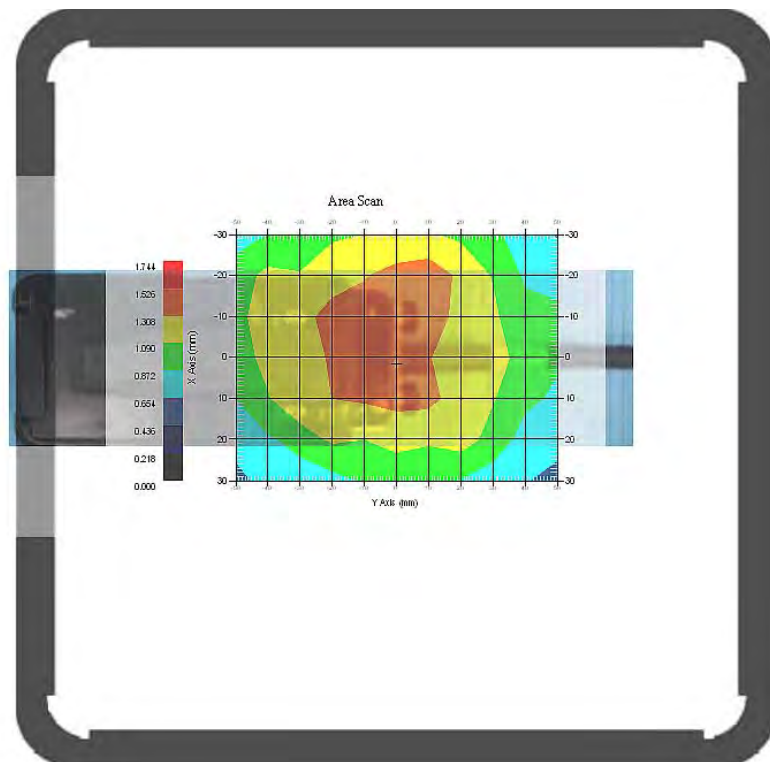
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 1  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 1.396 W/kg  
 10 gram SAR value : 0.980 W/kg  
 Area Scan Peak SAR : 1.530 W/kg  
 Zoom Scan Peak SAR : 1.940 W/kg

**Plot 10#**



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

**Body-Back 0.0cm (Analog 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: PCN005; Battery: BL1103**

Measurement Data

Modulation mode : FM  
 Crest Factor : 1  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 2.402 W/kg  
 Power Drift-Finish : 2.431 W/kg  
 Power Drift (%) : 1.249

Tissue Data

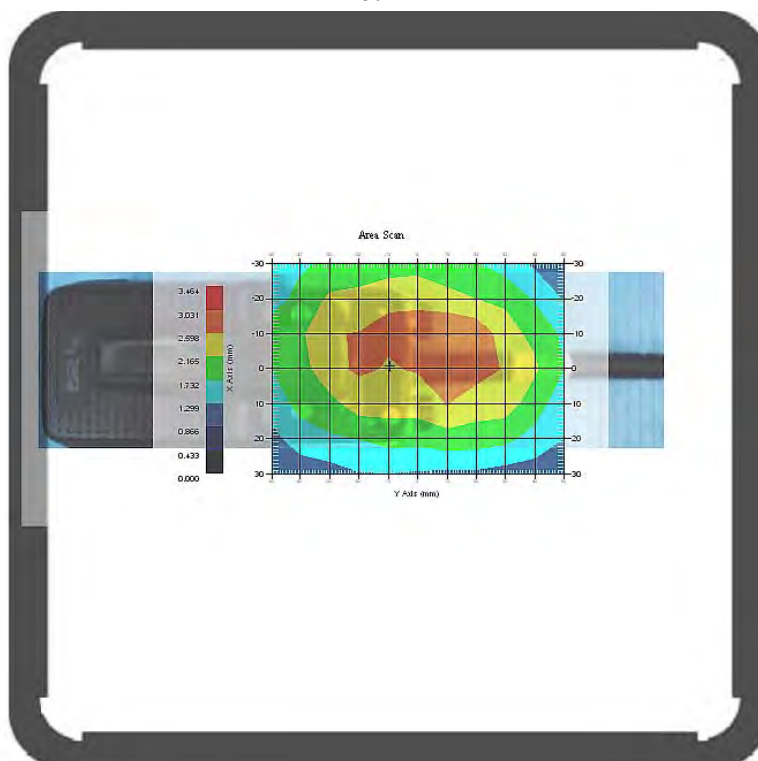
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 1  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 2.657 W/kg  
 10 gram SAR value : 1.614 W/kg  
 Area Scan Peak SAR : 3.034 W/kg  
 Zoom Scan Peak SAR : 3.563 W/kg

**Plot 11#**



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

**Body-Back 0.0cm (Analog 12.5k-519.9875 MHz);  
Headset: ACN-02+EH-01; Body-worn accessory: CH04L01; Battery: BL1103**

Measurement Data

Modulation mode : FM  
 Crest Factor : 1  
 Scan Type : Complete  
 Area Scan : 11x8x1: Measurement x=10mm, y=10mm, z=4mm  
 Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
 Power Drift-Start : 1.392 W/kg  
 Power Drift-Finish : 1.403 W/kg  
 Power Drift (%) : 0.790

Tissue Data

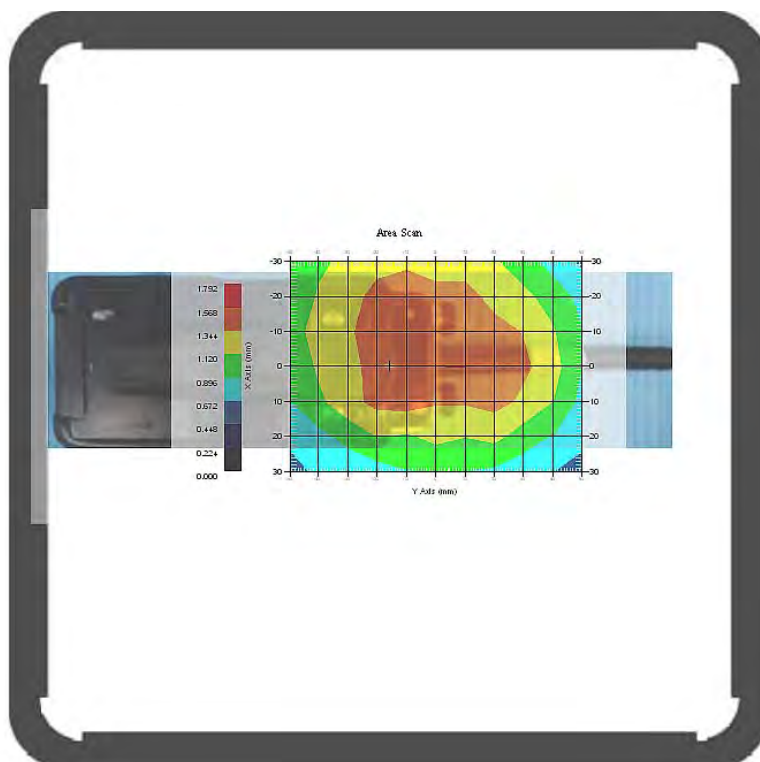
Type : Body  
 Frequency : 519.9875 MHz  
 Epsilon : 55.63 F/m  
 Sigma : 0.95 S/m  
 Density : 1000.00 kg/cu. m

Probe Data

Serial No. : 500-00283  
 Frequency Band : 450  
 Duty Cycle Factor : 1  
 Conversion Factor : 6.0  
 Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V}/\text{m})^2$   
 Compression Point : 95.00 mV  
 Offset : 1.56 mm

1 gram SAR value : 1.441 W/kg  
 10 gram SAR value : 1.070 W/kg  
 Area Scan Peak SAR : 1.570 W/kg  
 Zoom Scan Peak SAR : 1.941 W/kg

**Plot 12#**



## 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	$\sqrt{3}$	$(1-cp)^{1/2}$	$(\frac{1-cp}{2})^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	$\sqrt{3}$	$\sqrt{cp}$	$\sqrt{cp}$	4.4	4.4
Boundary Effect	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Linearity	4.7	rectangular	$\sqrt{3}$	1	1	2.7	2.7
Detection Limit	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	$\sqrt{3}$	1	1	0.5	0.5
Integration Time	1.7	rectangular	$\sqrt{3}$	1	1	1.0	1.0
RF Ambient Condition -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

## CERTIFICATE OF CALIBRATION

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

Equipment: Miniature Isotropic RF Probe

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 3J1

Division 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 meteorological 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

---

Page 2 of 10

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

**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**

Instrument	Serial Number	Cal due date
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

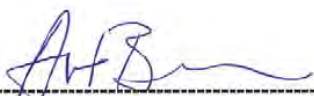
**Secondary Measurement Standards**


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**

Page 3 of 10  
 This page has been reviewed for content and attested to on Page 2 of this document.

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

**NCL Calibration Laboratories**

Division of APREL Inc.

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

**NCL Calibration Laboratories**

---

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 MΩ.

**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.

---

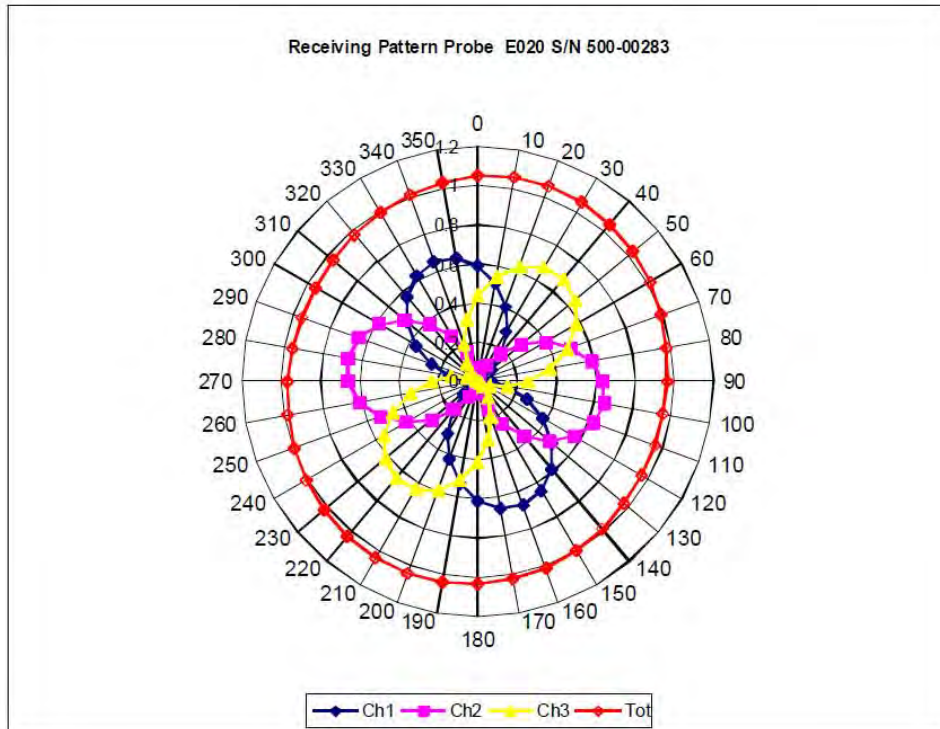
Page 6 of 10

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

**NCL Calibration Laboratories**

Division of APREL Inc.

**Receiving Pattern Air**



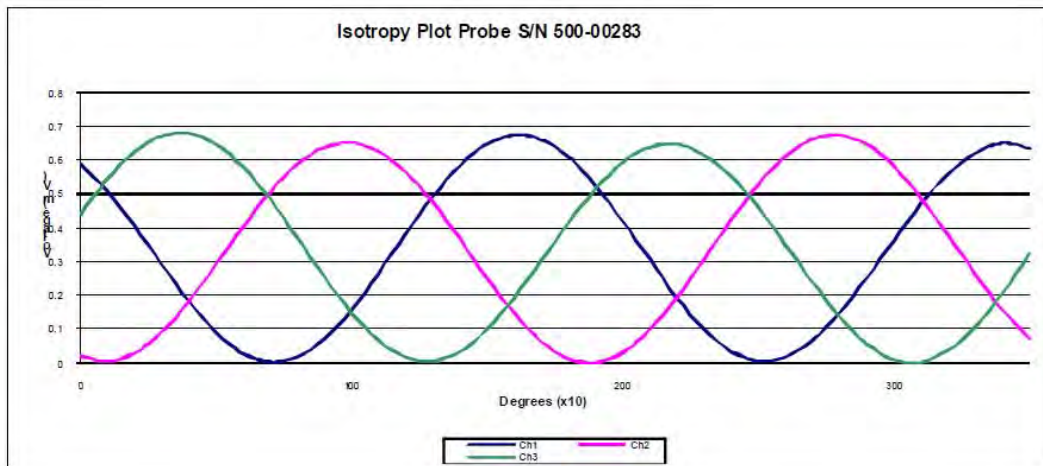
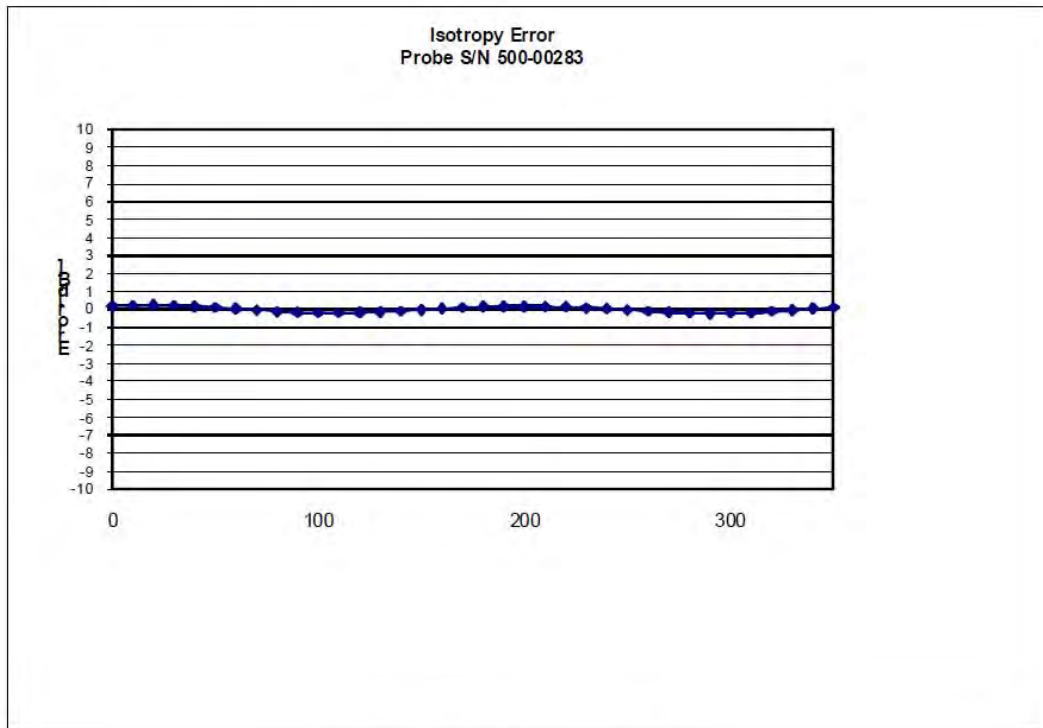
Page 7 of 10

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

**NCL Calibration Laboratories**

Division of APREL Inc.

**Isotropy Error Air**



**Isotropy Tissue:**

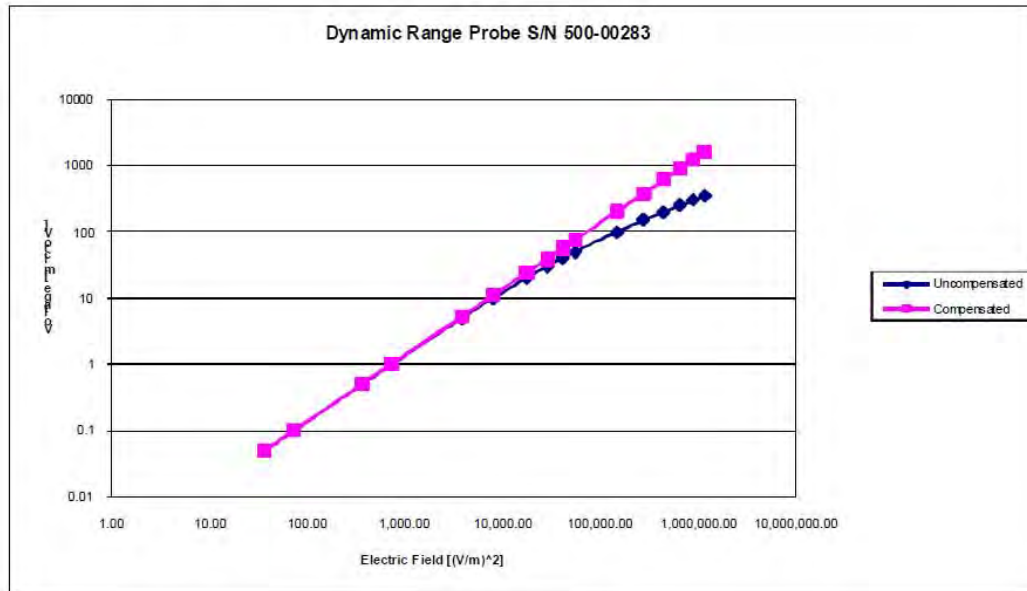
0.10 dB



**NCL Calibration Laboratories**

Division of APREL Inc.

**Dynamic Range**

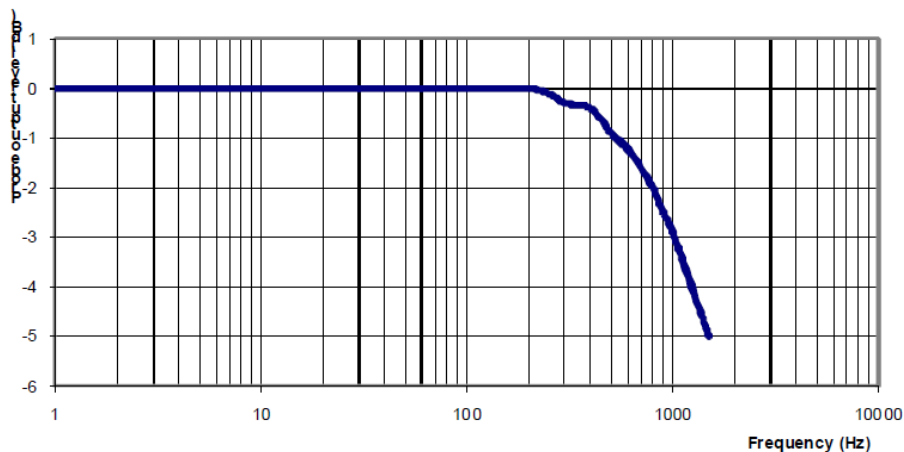


**NCL Calibration Laboratories**

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.

---

Page 10 of 10  
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-1426  
Project Number: BACL-5672

## CERTIFICATE OF CALIBRATION

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

Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-450-S-2

Frequency: 450 MHz

Serial No: **175-00503**

Customer: Bay Area Compliance

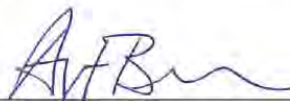
Head and Body Calibration

Calibrated: 31st July 2012

Released on: 2<sup>nd</sup> August 2012

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

Released By:



Art Brennan, Quality Manager

### **NCL** CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102  
Kanata, Ontario  
CANADA K2K 3J1

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

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Conditions**

Dipole 175-00503 was taken from stock for an original 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 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

**Calibration Results Summary**

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

**Mechanical Dimensions**

**Length:** 270.0 mm

**Height:** 166.7 mm

**Electrical Specification**

	Head	Body
Return Loss	-30.726 dB	-33.258 dB
SWR	1.061 U	1.049 U
Impedance	50.600 Ω	48.155 Ω

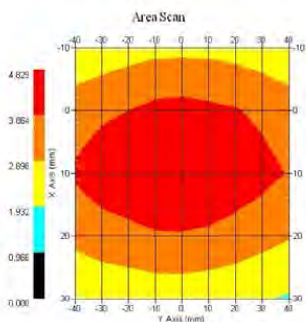
This page has been reviewed for content and attested to by signature within this document.

**NCL Calibration Laboratories**

Division of APREL Laboratories.

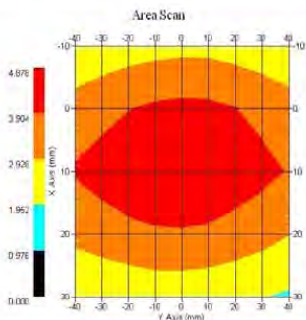
**System Validation Results Head**

Frequency	1 Gram	10 Gram	Peak
450 MHz	4.572	2.952	6.746



**System Validation Results Body**

Frequency	1 Gram	10 Gram	Peak
450 MHz	4.508	2.959	6.656



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

**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 RFE-362. 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"

**Conditions**

Original calibration.

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

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

4

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Dipole Calibration Results**

**Mechanical Verification**

APREL Length	APREL Height	Measured Length	Measured Height
280.0 mm	166.7 mm	280.0 mm	166.0 mm

**Tissue Validation**

Body Tissue 450MHz	Measured Head	Measured Body
Dielectric constant, $\epsilon_r$	<b>43.98</b>	<b>57.07</b>
Conductivity, $\sigma$ [S/m]	<b>0.9</b>	<b>0.92</b>

**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>

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

**NCL Calibration Laboratories**

Division of APREL Laboratories.

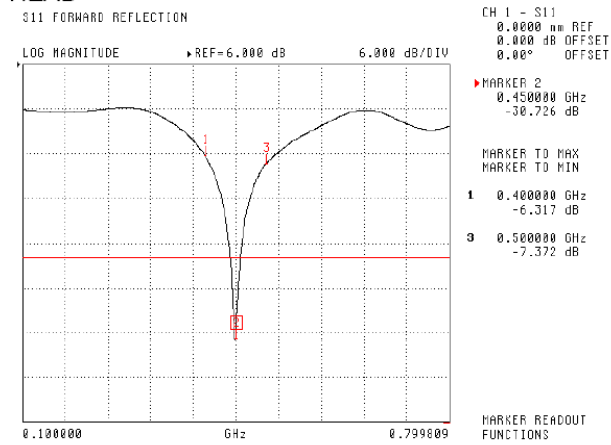
**Electrical Calibration**

Test	Result Head	Result Body
S11 R/L	-30.726 dB	-33.258 dB
SWR	1.061 U	1.049 U
Impedance	50.600 Ω	48.155 Ω

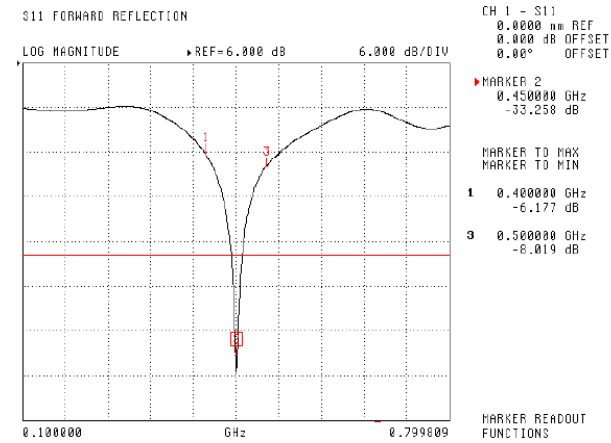
The Following Graphs are the results as displayed on the Vector Network Analyzer.

**S11 Parameter Return Loss**

**HEAD**



**BODY**



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



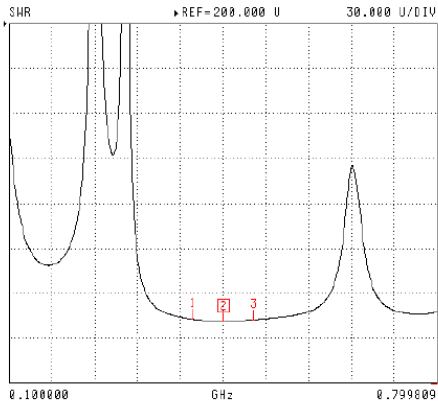
**NCL Calibration Laboratories**

Division of APREL Laboratories.

**SWR**

**HEAD**

S11 FORWARD REFLECTION



CH 1 - S11  
0.0000 nm REF  
0.000 dB OFFSET  
0.00° OFFSET

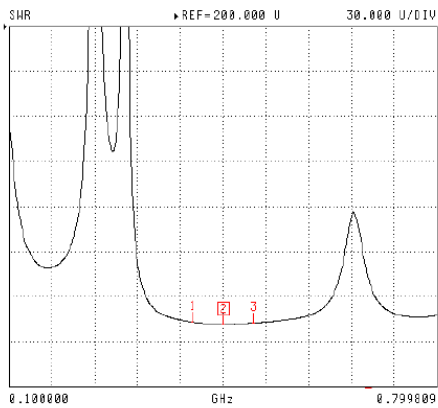
MARKER 2  
0.450000 GHz  
1.051 U

MARKER TO MAX  
MARKER TO MIN  
1 0.400000 GHz  
2.872 U  
3 0.500000 GHz  
2.497 U

MARKER READOUT  
FUNCTIONS

**BODY**

S11 FORWARD REFLECTION



CH 1 - S11  
0.0000 nm REF  
0.000 dB OFFSET  
0.00° OFFSET

MARKER 2  
0.450000 GHz  
1.049 U

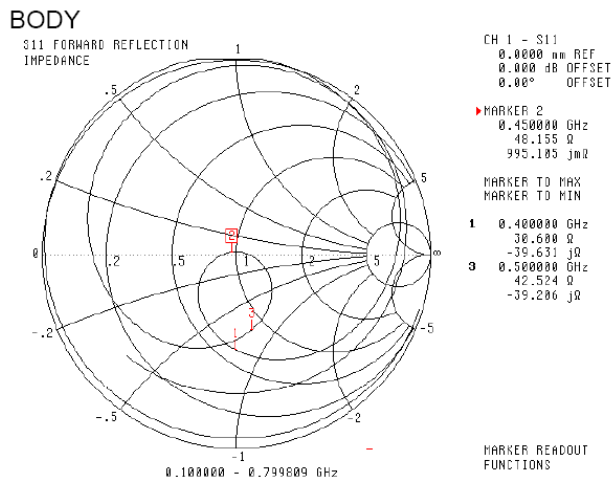
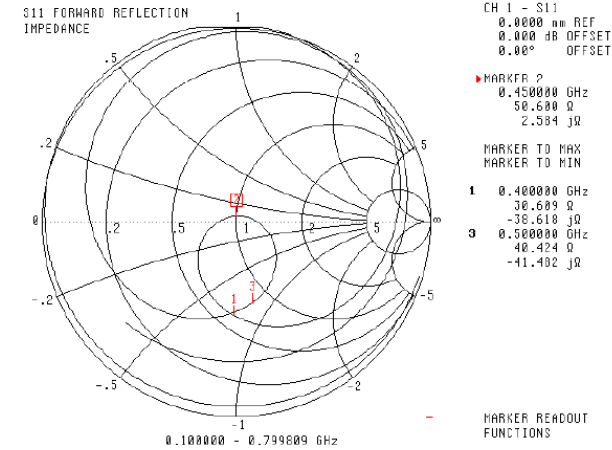
MARKER TO MAX  
MARKER TO MIN  
1 0.400000 GHz  
2.931 U  
3 0.500000 GHz  
2.319 U

MARKER READOUT  
FUNCTIONS

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

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

**Smith Chart Dipole Impedance**  
**HEAD**



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

**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 2012.

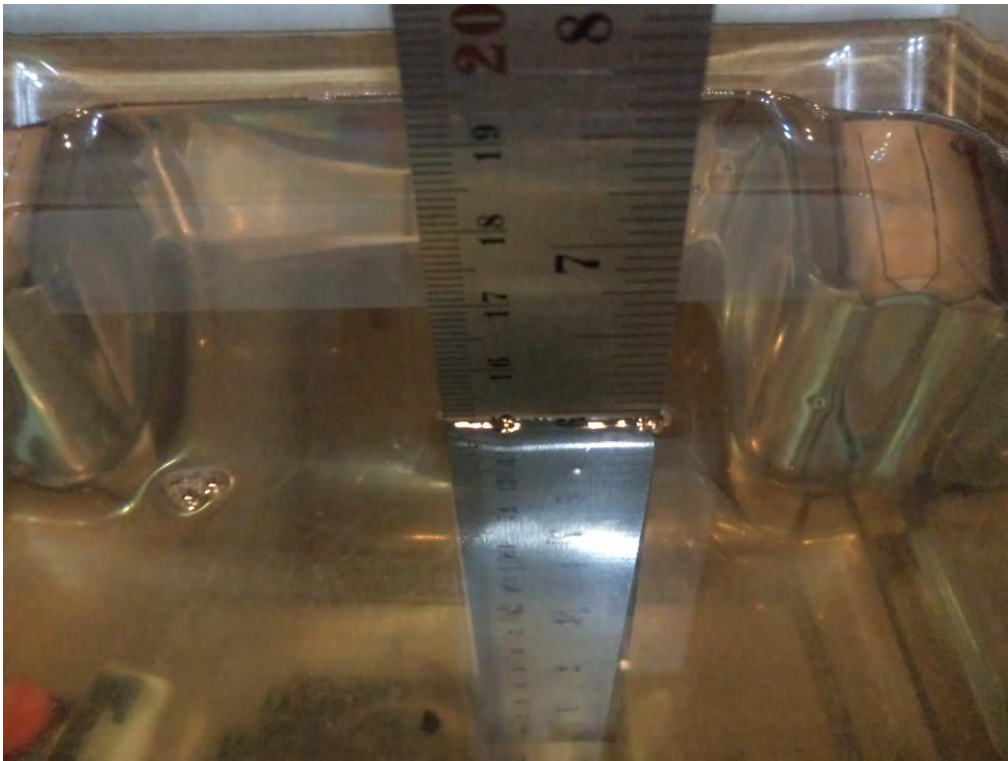
This page has been reviewed for content and attested to by signature within this document.

9

## APPENDIX D – EUT TEST POSITION PHOTOS

---

Liquid depth  $\geq 15$ cm



Face-Up 2.5 cm Separation to Flat Phantom Setup Photo



**Body-Back 0.0 cm Separation to Flat Phantom Setup Photo (PCN005)**



**Body-Back 0.0 cm Separation to Flat Phantom Setup Photo (CH04L01)**



## APPENDIX E – EUT PHOTOS

**EUT – Front View**



**EUT – Back View**



**EUT – Left View**



**EUT – Right View**



**EUT – Top View**



**EUT – Bottom View**





**EUT – Uncovered View**



**EUT–Battery: BL1103 1100mAh**



**EUT–Battery: BL1809 1800mAh**



**EUT–Headset: EWN07**



**EUT-Headset: EWN08**



**EUT - Headset: EAN19**



**EUT – Headset: EAN21**



**EUT – Headset: ACN-02**



**EUT – Headset: EH-01**



**EUT – Headset: EH-02**



**EUT – Headset: ES-01**



**EUT – Headset: ES-02**



**EUT –Body-Worn Accessories View: PCN005**



**EUT –Body-Worn Accessories View: CH04L01**



**APPENDIX F – ACCESSORIES LIST**

Accessory Name	Model		Description
<b>Antenna</b>	AN0485H04	450-520MHz	/
<b>Battery</b>	Thicker Battery	BL1809	Battery, Li-Lon 1800MAH
	Thinner Battery	BL1103	Battery, Li-Lon 1100 MAH
<b>Body Worn</b>	Belt Clip	PCN005	/
	Portable Charger	CH04L01	/
<b>Audio Accessories</b>	Earphone 1	EWN07	Digital Wireless Covert Earpiece With in-Line Controller (Neckloop Sensor)
	Earphone 2	EWN08	Digital Wireless Covert Earpiece (Flatpack Sensor)
	Earphone 3	EAN19	3-wire Surveillance Earpiece with Transparent Acoustic Tube (Beige)
	Earphone 4	EAN21	3-wire Surveillance Earpiece with Transparent Acoustic Tube(Beige)
	Earphone 5	ESN14	Detachable Earpiece with Transparent Acoustic Tube,contains two parts, one is ACN-02, the other is ES-01
	Earphone 6	EAN22	Detachable Earpiece with Transparent Acoustic Tube, contains two parts, one is ACN-02,the other is ES-02
	Earphone 7	EHN20	Remote Swivel Earset,contains two parts,one is ACN-02, the other is EH-02
	Earphone 8	EHN21	Remote C-Earset,contains two parts,one is ACN-02, the other is EH-01
	Earphone 9	ACN-02	PTT&MIC cable(for use with Receive-Only Earpiece)
	Earphone 10	EH-01	Receive – Only C Style Earloop(for use with PTT&MIC cable)
	Earphone 11	EH-02	Receive – Only Ajustable Earhook with Swivel Speaker(for use with PTT&MIC cable)
	Earphone 12	ES-02	Receive-Only Earpiece with Transparent Acoustic Tube
	Earphone 13	ES-01	Receive – Only Earpiece(for use with PTT&MIC cable)

**Note:** The manufacturer is Hytera Communications Co., Ltd.



---

## APPENDIX G – INFORMATIVE REFERENCES

---

- [1] Federal Communications Commission, "Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.
- [2] David L. Means Kwok Chan, Robert F. Cleveland, "Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, Office of Engineering & Technology, Washington, DC, 1997.
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, "Automated E-field scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105-113, Jan. 1996.
- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetric evaluation of mobile communications equipment with known precision", IEEE Transactions on Communications, vol. E80-B, no. 5, pp. 645-652, May 1997.
- [5] CENELEC, "Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.
- [6] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [7] Katja Pokovic, Thomas Schmid, and Niels Kuster, "Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM '97, Dubrovnik, October 15-17, 1997, pp. 120-24.
- [8] Katja Pokovic, Thomas Schmid, and Niels Kuster, "E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23-25 June, 1996, pp. 172-175.
- [9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard Kuhn, and Niels Kuster, "The dependence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 10, pp. 1865-1873, Oct. 1996.
- [10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, "The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.
- [11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992. Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10.
- [15] FCC OET KDB643646 SAR Test Reduction Considerations for Occupational PTT Radios.

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