

# SAR EVALUATION REPORT

For

## Hytera Communications Co.,Ltd.

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Park North,Nanshan District,Shenzhen,China

**FCC ID: YAMPD37XUB**

<b>Report Type:</b> Original report	<b>Product Type:</b> Digital Portable Radio
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<b>Report Number:</b> RSZ141231009-20C	
<b>Report Date:</b> 2015-01-20	
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**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	Hytera Communications Co.,Ltd.	
		EUT Description	Digital Portable Radio	
		FCC ID	YAMPD37XUB	
		Model Number	Test model: PD370 Ub Multiple model: PD372 Ub, PD375 Ub, PD376 Ub, PD378 Ub	
		Test Date	2015-01-15	
Frequency (MHz)	Mode	Max. SAR Level(s) Reported		Limit (W/Kg)
400-450	Digital	12.5kHz	Face up: 0.757 W/kg Body worn: 1.601 W/kg	8.0
	Analog	12.5kHz	Face up: 0.791 W/kg (Corrected by multiplying 50%) Body worn: 1.573 W/kg (Corrected by multiplying 50%)	
Applicable Standards		ANSI / IEEE C95.1: 2005 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fileds,3 kHz to 300 GHz.		
		ANSI / IEEE C95.3: 2002 IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to SuchFields,100 kHz—300 GHz.		
		IEEE1528:2013 IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques		
		KDB procedures KDB 447498 D01 v05r02: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies. KDB 865664 D01v01r03: SAR measurement 100 MHz to 6 GHz v01. KDB 643646D01 v01r01: SAR test Reduction Considerations for Occupational PTT Radios.		
<b>Note:</b> This wireless device has been shown to be capable of compliance for localized specific absorption rate (SAR) for Occupational /Controlled Exposure limits specified in ANSI/IEEE Standards and has been tested in accordance with the measurement procedures specified in IEEE 1528-2013 and RF exposure KDB procedures.				
<b>The results and statements contained in this report pertain only to the device(s) evaluated.</b>				

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	RSZ141231009-20C	Original Report	2015-01-22

## EUT DESCRIPTION

This report has been prepared on behalf of Hytera Communications Co.,Ltd. and their product and their product, FCC ID: YAMPD37XUB, Model: PD370 Ub or the EUT (Equipment Under Test) as referred to in the rest of this report.

**\*Note:**

This series products model: PD372 Ub, PD375 Ub, PD376 Ub, PD378 Ub and PD370 Ub, we select model: PD370 Ub to test, there is no electrical change has been made to the equipment, please refer to the product similarity letter.

## 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>	4FSK&FM
<b>Frequency Band:</b>	400MHz-450MHz
<b>Conducted RF Power:</b>	34.73dBm
<b>Dimensions (L*W*H):</b>	141mm (L)×57mm (W)×26mm (H)
<b>Power Source:</b>	4.2V Rechargeable Li-ION Battery
<b>Normal Operation:</b>	Face Up and Body-worn

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## REFERENCE, STANDARDS, AND GUIDELINES

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### **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)**

<b>EXPOSURE LIMITS</b>	<b>SAR (W/kg)</b>	
	(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)**

<b>EXPOSURE LIMITS</b>	<b>SAR (W/kg)</b>	
	(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.

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## FACILITIES

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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 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.

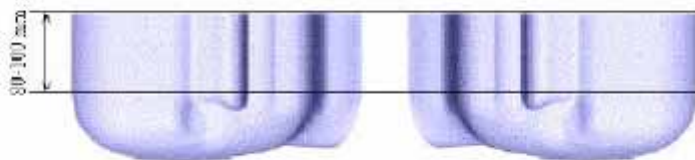


### Phantom Types

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 30MHz 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

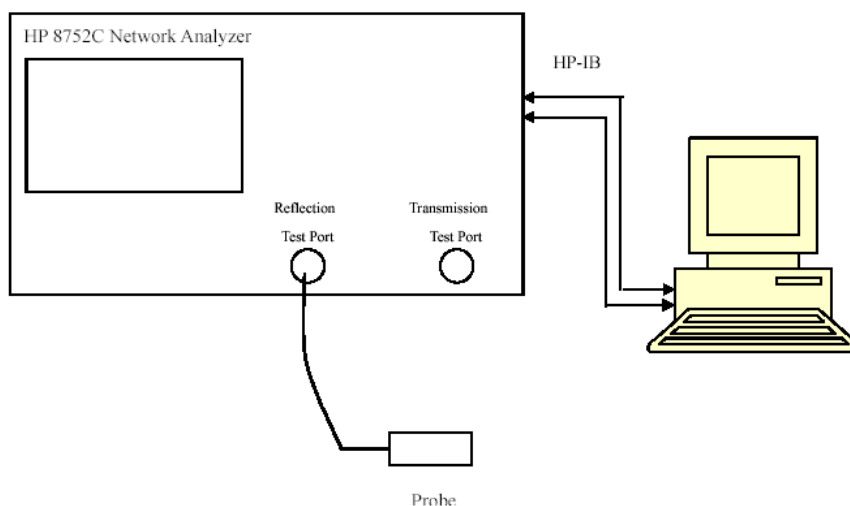
### Equipments List & Calibration Information

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	2014-10-14	110-00212
Miniature E-Field Probe	ALS-E-020	2014-10-14	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-UM-FLAT	N/A	153-00104
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
Attenuator	3dB	2014-05-08	5402
Network analyzer	8752C	2014-06-03	3410A02356
Dielectric probe kit	HP85070B	2014-06-13	N/A
Power Amplifier	5S1G4	N/A	71377
Directional couple	DC6180A	2014-06-13	0325849
Synthesized Sweeper	HP 8341B	2014-06-03	2624A00116
EMI Test Receiver	ESCI	2014-06-13	101746



## 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)	$\epsilon_r$	$\sigma$ (S/m)	
400.0125	Head	43.31	0.87	43.50	0.87	-0.437	0.000	$\pm 5$
	Body	55.58	0.94	56.70	0.94	-1.975	0.000	$\pm 5$
412.0125	Head	43.36	0.89	43.50	0.87	-0.322	2.299	$\pm 5$
	Body	52.92	0.94	56.70	0.94	-6.667	0.000	$\pm 5$
425.0125	Head	43.23	0.88	43.50	0.87	-0.621	1.149	$\pm 5$
	Body	54.21	0.96	56.70	0.94	-4.392	2.128	$\pm 5$
437.0125	Head	42.86	0.88	43.50	0.87	-1.471	1.149	$\pm 5$
	Body	54.02	0.95	56.70	0.94	-4.727	1.064	$\pm 5$
449.9875	Head	42.91	0.87	43.50	0.87	-1.356	0.000	$\pm 5$
	Body	54.43	0.96	56.70	0.94	-4.004	2.128	$\pm 5$

\*Liquid Verification was performed on 2015-01-15.

Please refer to the following tables.

450MHz Head				450MHz Body		
Frequency (MHz)	e'	e''		Frequency (MHz)	e'	e''
400.0	43.3141	39.2684		400.0	55.5792	42.4474
401.5	42.8704	39.0740		401.5	55.6200	42.3786
403.0	43.3697	39.2098		403.0	55.7750	42.2019
404.5	42.6172	39.1524		404.5	55.9610	42.2769
406.0	42.7213	38.8846		406.0	55.6565	42.2930
407.5	43.4771	38.8345		407.5	55.8727	42.3266
409.0	43.3840	38.9869		409.0	54.2785	41.1626
410.5	43.0478	38.8315		410.5	53.9090	41.0370
412.0	43.3610	38.6356		412.0	53.9228	41.2103
413.5	42.6919	38.5921		413.5	55.8362	41.0145
415.0	42.8608	38.5308		415.0	54.9168	41.3464
416.5	43.1062	38.4363		416.5	55.5988	41.3294
418.0	42.9721	38.3643		418.0	55.8001	40.2956
419.5	43.0021	37.2069		419.5	54.0340	40.2737
421.0	42.6976	37.1251		421.0	53.9581	40.2091
422.5	42.7669	37.0050		422.5	53.9535	40.0948
424.0	42.9991	37.1837		424.0	55.8132	40.2561
425.5	43.1746	37.0523		425.5	54.3195	40.0951
427.0	43.3763	36.9111		427.0	54.0269	40.2544
428.5	42.5690	36.8672		428.5	55.8468	40.1340
430.0	43.3489	37.0383		430.0	54.6810	39.8933
431.5	43.1127	36.7195		431.5	54.2262	39.9171
433.0	42.7982	36.5774		433.0	55.6747	39.1586
434.5	43.0799	35.6540		434.5	54.6247	39.4302
436.0	42.7169	36.2494		436.0	54.9895	39.0559
437.5	42.9694	36.1517		437.5	55.0404	39.2161
439.0	42.6421	36.2490		439.0	55.1899	39.4233
440.5	42.6170	36.1713		440.5	54.5952	39.0397
442.0	43.0515	36.1448		442.0	55.3218	39.2267
443.5	43.0655	35.7992		443.5	54.4867	39.2967
445.0	43.0183	35.9156		445.0	54.8172	39.1304
446.5	43.4075	35.9748		446.5	54.4317	39.0405
448.0	42.7014	35.6761		448.0	54.4119	38.2738
449.5	42.7440	34.6329		449.5	54.3646	38.4266
451.0	43.3412	34.3972		451.0	54.6144	38.2342
452.5	43.0302	34.3922		452.5	54.6797	38.1820
454.0	43.3654	34.2768		454.0	54.3765	38.3862
455.5	43.3992	34.4061		455.5	54.6859	38.1465
457.0	42.8549	34.2216		457.0	54.3732	38.2008
458.5	43.0276	34.1125		458.5	54.4736	38.0325
460.0	42.6265	34.0285		460.0	54.5823	38.0809
461.5	43.3729	32.8279		461.5	54.8949	38.0797
463.0	42.6448	33.2214		463.0	55.8836	38.1746
464.5	42.9857	32.8033		464.5	55.8887	38.1471
466.0	42.6325	33.0211		466.0	55.1023	37.9755
467.5	42.7093	32.9911		467.5	55.0549	36.9269
469.0	42.9892	32.8964		469.0	55.7295	36.9380
470.5	42.8969	33.5593		470.5	54.3356	36.8826
472.0	43.0222	33.5579		472.0	55.1678	36.8271
473.5	42.8658	33.9920		473.5	54.6453	35.8712
475.0	42.8551	34.0135		475.0	55.9123	35.8450
476.5	42.8680	33.7122		476.5	54.6588	35.8500
478.0	42.9083	33.5190		478.0	54.1231	35.8153
479.5	43.3953	33.7461		479.5	54.5994	35.8766
481.0	43.4389	33.7640		481.0	55.4993	35.9835

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.

The diagram illustrates the experimental setup for measuring the transmission coefficient of a flat phantom. The setup includes a Signal Generator, an Amplifier (Amp), a Low Pass Filter, a 3dB coupler, and three Attenuators (Att3, Att2, Att1). A 3D Probe positioner holds a Field probe and a Dipole antenna. A Flat Phantom is placed between them. A Spacer is used to adjust the distance  $s$  between the probe and the phantom. A Tuning element is also shown. The setup is connected to a computer for data acquisition. A coordinate system ( $x$ ,  $y$ ,  $z$ ) is shown in the top right corner.

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
APREL	Probe	ALS-E-020	500-00283	2014-10-14	2015-10-13
APREL	Dipole antenna(450MHz)	ALS-D-450-S-2	175-00503	2012-07-31	2015-07-30

Date	Frequency (MHz)	Liquid Type	Measured SAR (W/Kg)		Target Value (W/Kg)	Delta (%)	Tolerance (%)
2015-01-15	450	Head	1g	4.762	4.572	4.156	±10
		Body	1g	4.803	4.508	6.544	±10

## SAR Evaluation Report

**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 : 4.915 W/kg  
Power Drift-Finish : 4.970 W/kg  
Power Drift (%) : 1.174

**Phantom Data**

Name : APREL-Uni  
Type : Uni-Phantom  
Serial No. : System Default  
Location : Center  
Description : Default  
Phantom Data

**Tissue Data**

Type : Head  
Serial No. : 260-01106  
Frequency : 450.00MHz  
Last Calib. Date : 15-Jan-2015  
Temperature : 20.00 °C  
Ambient Temp. : 21.00 °C  
Humidity : 56.00 RH%  
Epsilon : 42.91 F/m  
Sigma : 0.87 S/m  
Density : 1000.00 kg/cu. m

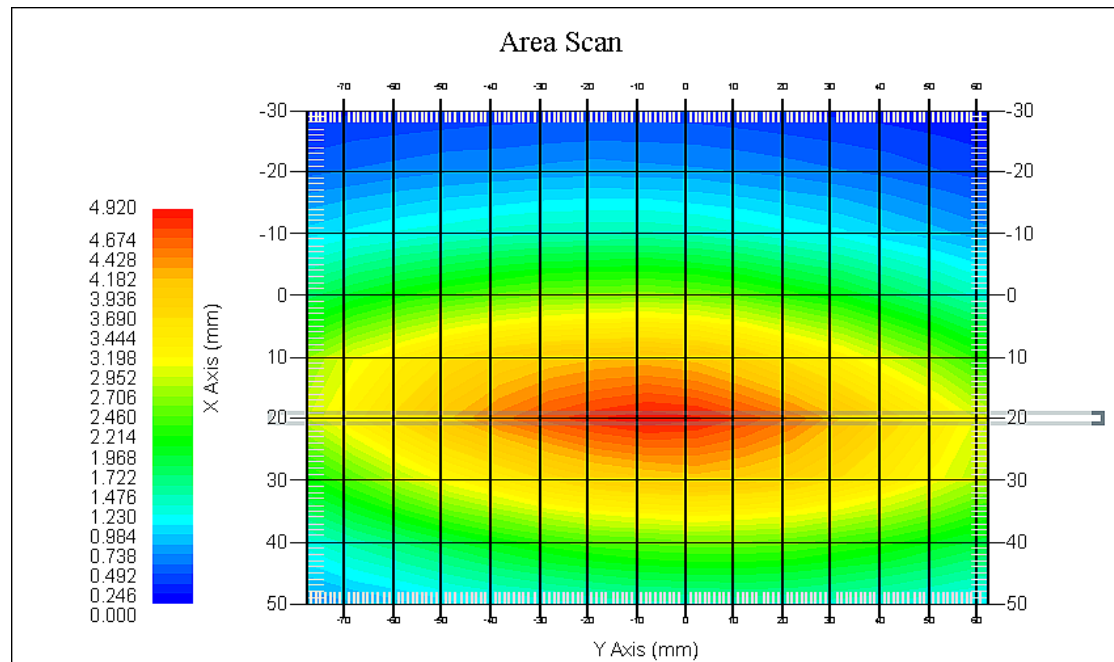
**Probe Data**

Name : E-Field  
Model : E-020  
Type : E-Field Triangle  
Serial No. : 500-00283  
Last Calib. Date : 14-Oct-2014  
Frequency Band : 450  
Duty Cycle Factor : 1  
Conversion Factor : 5.7  
Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V/m})^2$   
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 : 4.762 W/kg  
10 gram SAR value : 3.102 W/kg  
Area Scan Peak SAR : 4.917 W/kg  
Zoom Scan Peak SAR : 7.557 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 : 4.582 W/kg  
Power Drift-Finish : 4.503 W/kg  
Power Drift (%) : -1.639

## Phantom Data

Name : APREL-Uni  
Type : Uni-Phantom  
Serial No. : System Default  
Location : Center  
Description : Default  
Phantom Data

## Tissue Data

Type : Body  
Serial No. : 260-02108  
Frequency : 450.00MHz  
Last Calib. Date : 15-Jan-2015  
Temperature : 20.00 °C  
Ambient Temp. : 21.00 °C  
Humidity : 56.00 RH%  
Epsilon : 54.43 F/m  
Sigma : 0.96 S/m  
Density : 1000.00 kg/cu. m

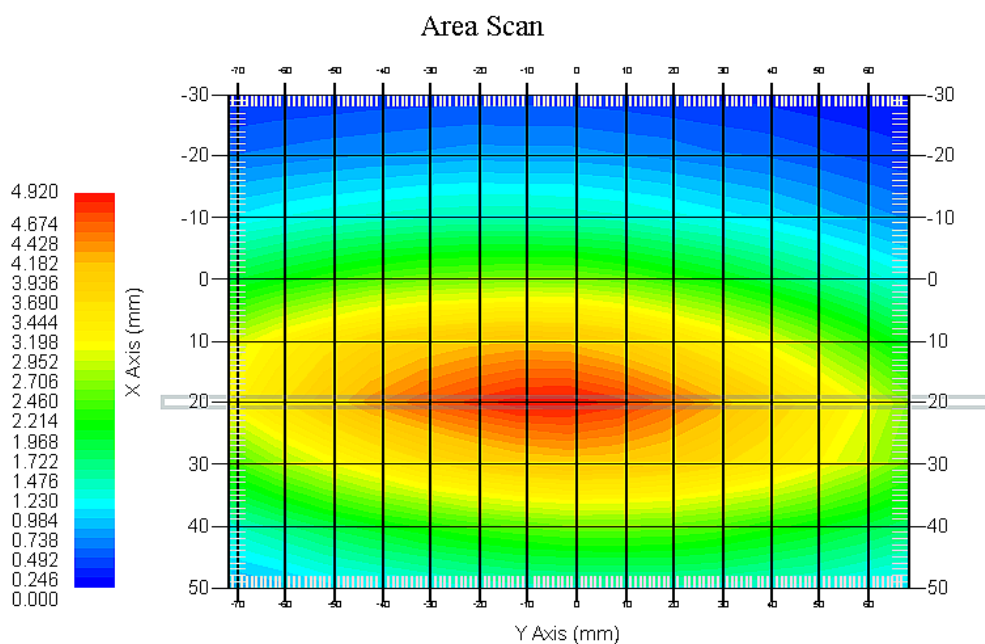
## Probe Data

Name : E-Field  
Model : E-020  
Type : E-Field Triangle  
Serial No. : 500-00283  
Last Calib. Date : 14-Oct-2014  
Frequency Band : 450  
Duty Cycle Factor : 1  
Conversion Factor : 5.8  
Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V/m})^2$   
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 : 4.803 W/kg  
10 gram SAR value : 3.115 W/kg  
Area Scan Peak SAR : 4.913 W/kg  
Zoom Scan Peak SAR : 7.639 W/kg



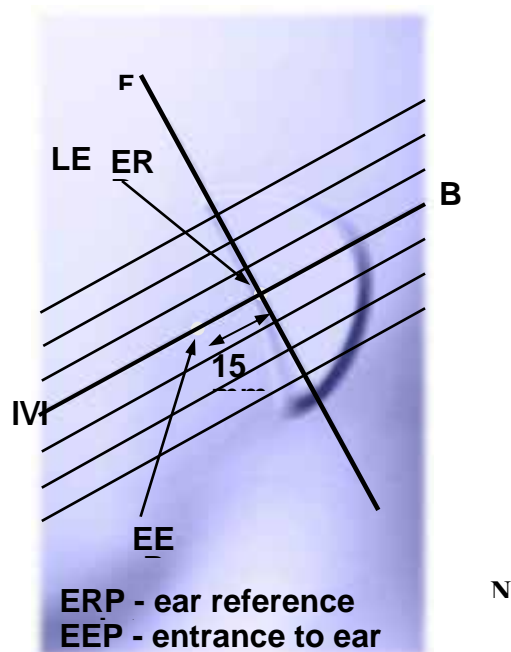
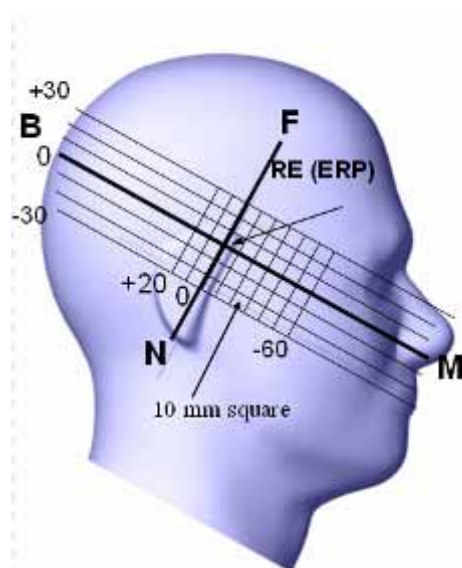
#### 450 MHz System Validation with Body Tissue

## 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  $\frac{1}{4}$  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

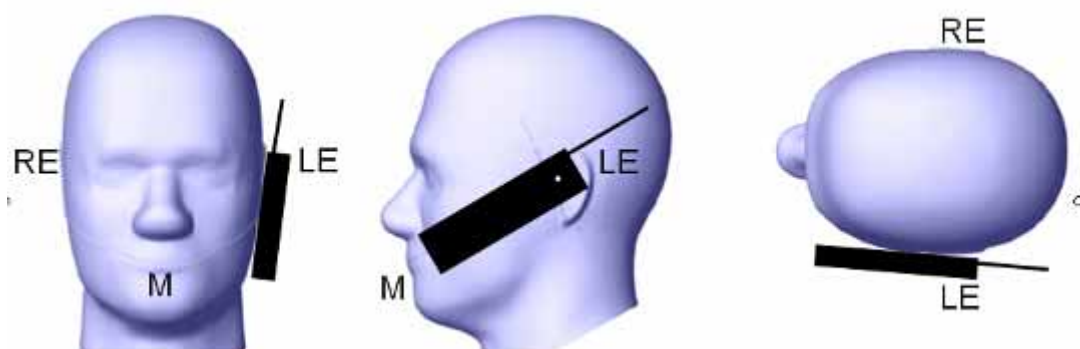
The device is brought toward the mouth of the head phantom by pivoting against the “ear reference point” or along the “N-F” line for the SCC-34/SC-2 head phantom.

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

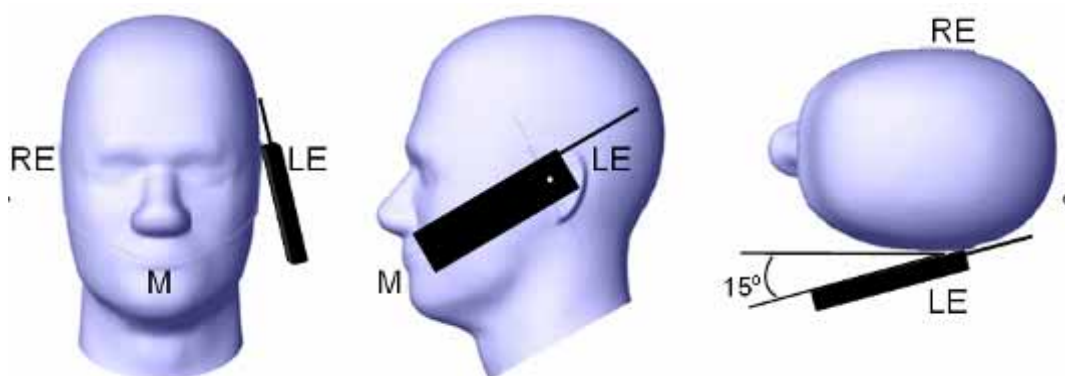
With the handset aligned in the “Cheek/Touch Position”:

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° to 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.

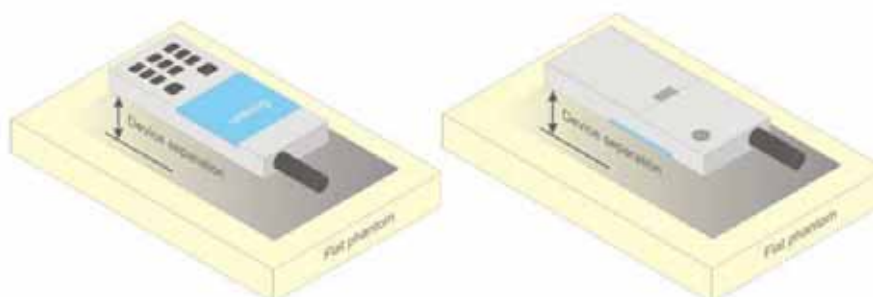
### **Ear /Tilt 15° Position**



### **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.



**Figure 5 – Test positions for body-worn devices**

## 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.

## Test methodology

IEEE1528:2013  
KDB 447498 D01 v05r02  
KDB 865664 D01 v01r03  
KDB 643646 D01 v01r01

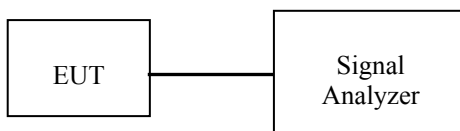
## CONDUCTED OUTPUT POWER MEASUREMENT

### 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(400-450MHz)
Digital-12.5K	34.80
Analog-12.5K	34.80

### Test Results:

Mode	Frequency Spacing (kHz)	Frequency (MHz)	Output(dBm)	Output Power(W)	Power level
Digital	12.5	400.0125	<b>34.73</b>	2.972	High
		412.0125	34.65	2.917	High
		425.0125	34.61	2.891	High
		437.0125	34.54	2.844	High
		449.9875	34.40	2.754	High
Analog	12.5	400.0125	<b>34.70</b>	2.951	High
		412.0125	34.62	2.897	High
		425.0125	34.54	2.844	High
		437.0125	34.49	2.812	High
		449.9875	34.35	2.723	High

## SAR MEASUREMENT RESULTS

This page summarizes the results of the performed dosimetric evaluation.

### SAR Test Data

#### Environmental Conditions

Temperature:	21 °C
Relative Humidity:	50%
ATM Pressure:	1002 mbar

\* Testing was performed by Wilson Chen on 2015-01-15

### Test Result:

#### Digital (Modulation 4FSK; Channel Spacing 12.5 kHz):

Frequency (MHz)	Power Drift (%)	Max. Meas. Power (dBm)	Max. Rated Power (dBm)	1 g SAR Value (W/Kg)			
				Scaled Factor	Meas. SAR	Scaled SAR	Plot
Face Up (2.5cm)							
400.0125	2.941	34.73	34.80	1.016	0.745	<b>0.757</b>	<b>1#</b>
Body-Back With Belt Clip(0.0cm)							
400.0125	-2.506	34.73	34.80	1.016	1.576	<b>1.601</b>	<b>2#</b>

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

Frequency (MHz)	Power Drift (%)	Max. Meas. Power (dBm)	Max. Rated Power (dBm)	1 g SAR Value (W/Kg)				
				Scaled Factor	Meas. SAR	Scaled SAR	50%	Plot
Face Up (2.5cm)								
400.0125	-1.132	34.70	34.80	1.023	1.547	1.583	<b>0.791</b>	<b>3#</b>
Body-Back With Belt Clip(0.0cm)								
400.0125	1.642	34.70	34.80	1.023	3.076	3.147	<b>1.573</b>	<b>4#</b>

### Note:

1. When the 1-g SAR tested using the default battery and default accessories is  $\leq 3.5W/Kg$  (corrected by Multiplying 50% for FM mode), testing for other channels are optional.
2. For a analog PTT, only simplex communication technology was supported, so the SAR value need to be corrected by Multiplying 50%.
3. Passive body-worn and audio accessories generally do not apply to the head SAR of PTT radios.
4. The whole antenna and radiating structures that may contribute to the measured SAR or influence the SAR distribution has been included in the area scan.

**SAR Plots (Summary of the Highest SAR Values)****Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Face-Up 2.5cm (Digital 12.5k-400.0125 MHz)****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 : 0.595 W/kg  
Power Drift-Finish : 0.612 W/kg  
Power Drift (%) : 2.941

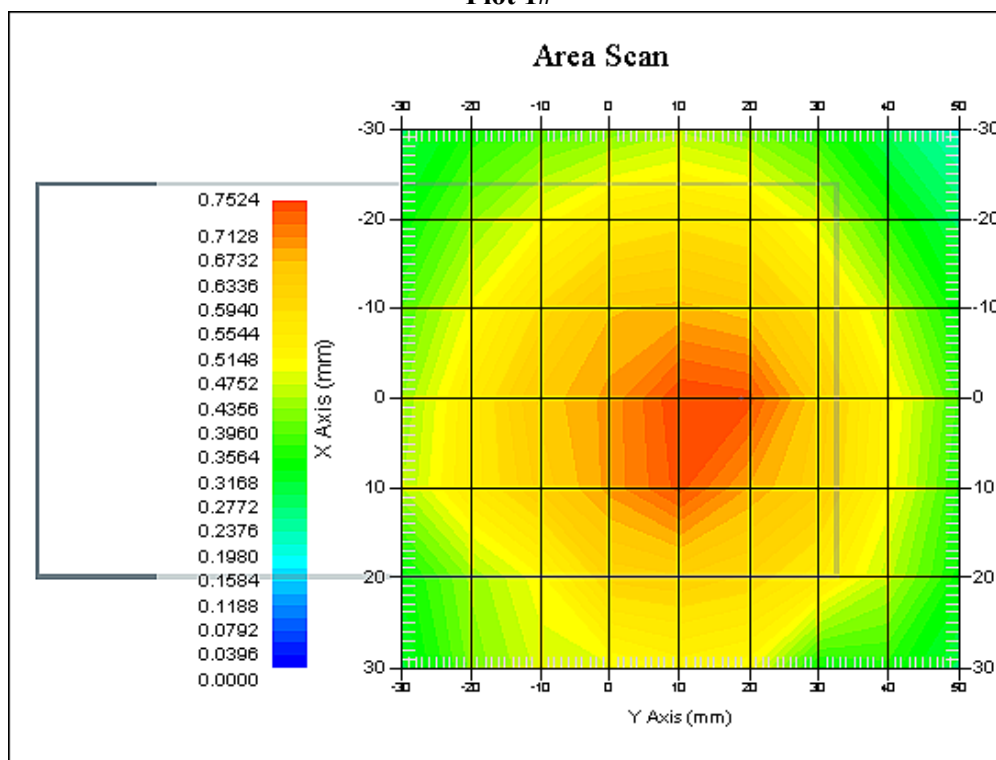
**Tissue Data**

Type : Head  
Frequency : 400.0125 MHz  
Epsilon : 43.31 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 : 5.7  
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 : 0.745 W/kg  
10 gram SAR value : 0.624 W/kg  
Area Scan Peak SAR : 0.752 W/kg  
Zoom Scan Peak SAR : 1.174 W/kg

**Plot 1#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Back-Worn 0.0cm (Digital 12.5k-400.0125 MHz)**

## Measurement Data

Modulation mode : 4FSK  
Crest Factor : 2  
Scan Type : Complete  
Area Scan : 8x16x1: Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 1.336 W/kg  
Power Drift-Finish : 1.302 W/kg  
Power Drift (%) : -2.506

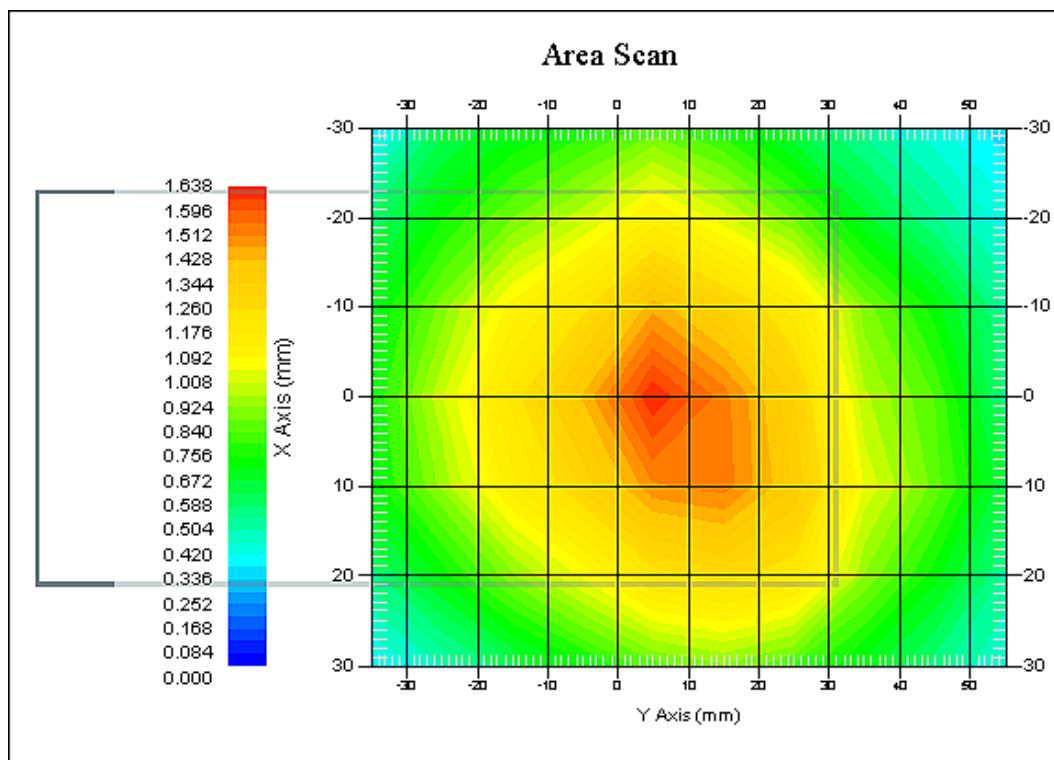
## Tissue Data

Type : Body  
Frequency : 400.0125 MHz  
Epsilon : 55.58 F/m  
Sigma : 0.94 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 450  
Duty Cycle Factor : 2  
Conversion Factor : 5.8  
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 : 1.576 W/kg  
10 gram SAR value : 1.298 W/kg  
Area Scan Peak SAR : 1.631 W/kg  
Zoom Scan Peak SAR : 2.885 W/kg

**Plot 2#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Face-Up 2.5cm (Analog 12.5k-400.0125 MHz)**

## 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 : 1.285 W/kg  
Power Drift-Finish : 1.270 W/kg  
Power Drift (%) : -1.132

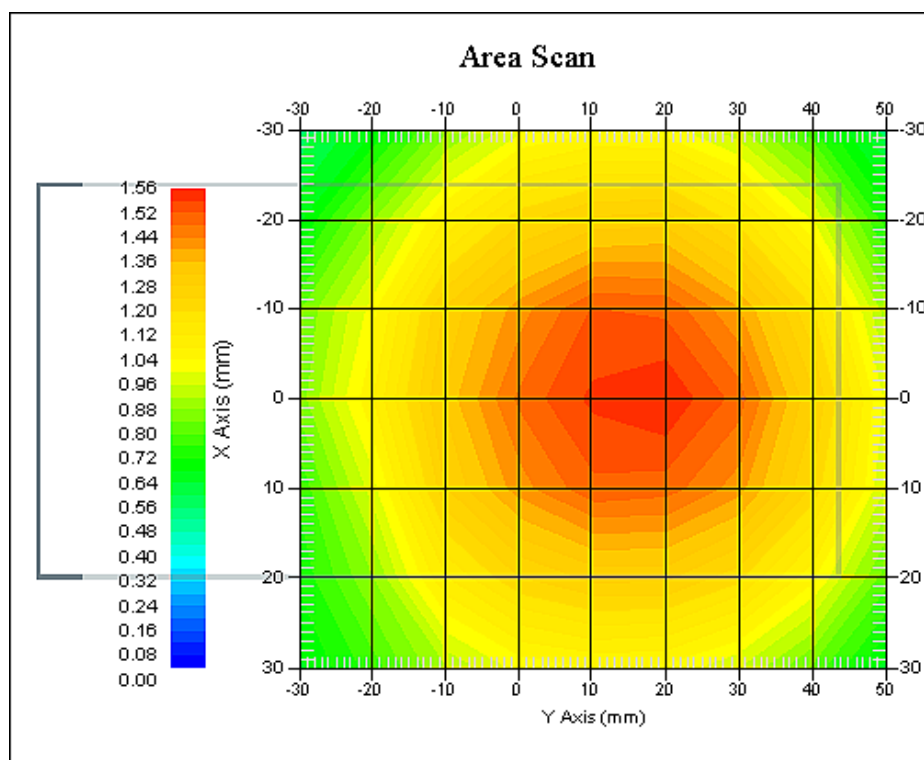
## Tissue Data

Type : Head  
Frequency : 400.0125 MHz  
Epsilon : 43.31 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 : 5.7  
Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V/m})^2$   
Compression Point : 95.00 mV  
Offset : 1.56 mm

1 gram SAR value : 1.547 W/kg  
10 gram SAR value : 1.352 W/kg  
Area Scan Peak SAR : 1.549 W/kg  
Zoom Scan Peak SAR : 2.795 W/kg

**Plot 3#**



**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Back-Worn 0.0cm (Analog 12.5k-400.0125 MHz)**

## Measurement Data

Modulation mode : FM  
Crest Factor : 1  
Scan Type : Complete  
Area Scan : 8x16x1: Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 2.105 W/kg  
Power Drift-Finish : 2.139 W/kg  
Power Drift (%) : 1.642

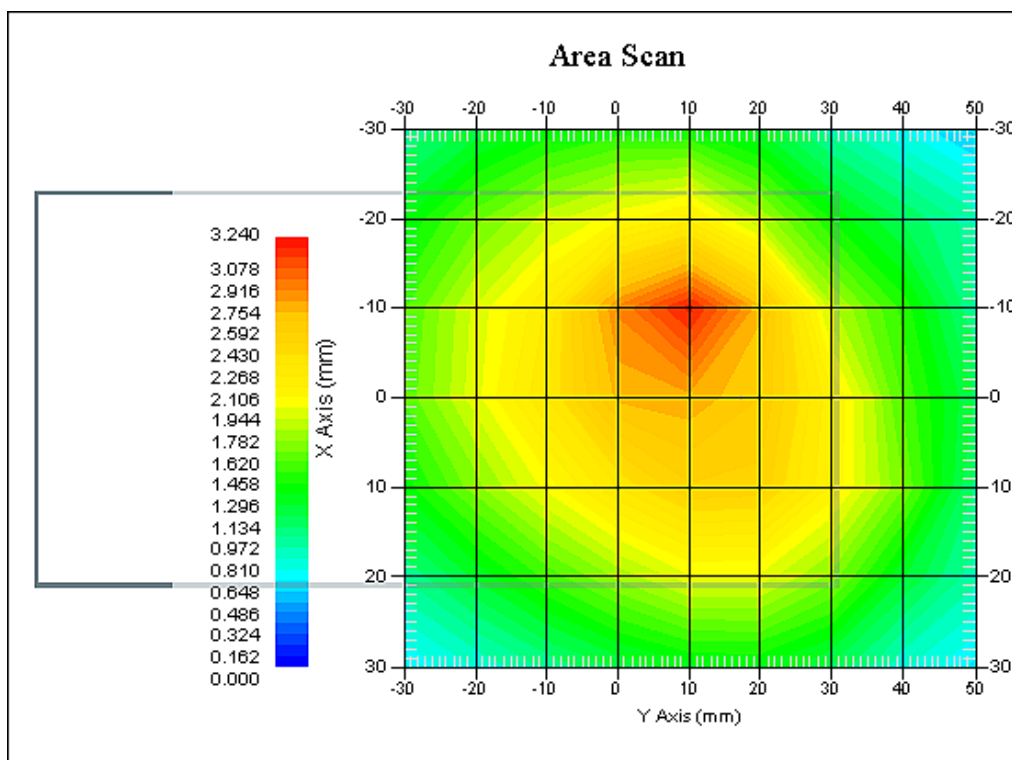
## Tissue Data

Type : Body  
Frequency : 400.0125 MHz  
Epsilon : 55.58 F/m  
Sigma : 0.94 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 450  
Duty Cycle Factor : 1  
Conversion Factor : 5.8  
Probe Sensitivity : 1.20 1.20 1.20  $\mu\text{V}/(\text{V/m})^2$   
Compression Point : 95.00 mV  
Offset : 1.56 mm

1 gram SAR value : 3.076 W/kg  
10 gram SAR value : 2.479 W/kg  
Area Scan Peak SAR : 3.237 W/kg  
Zoom Scan Peak SAR : 4.998 W/kg

**Plot 4#**

## 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 6GHz

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	$\sqrt{3}$	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	$\sqrt{3}$	$\sqrt{cp}$	$\sqrt{cp}$	4.4	4.4
Boundary Effect	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Linearity	4.7	rectangular	$\sqrt{3}$	1	1	2.7	2.7
Detection Limit	1.0	rectangular	$\sqrt{3}$	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	$\sqrt{3}$	1	1	0.5	0.5
Integration Time	1.7	rectangular	$\sqrt{3}$	1	1	1.0	1.0
RF Ambient Condition -Noise	0.6	rectangular	$\sqrt{3}$	1	1	0.3	0.3
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	2.3	normal	1	1	1	2.3	2.3
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.: PC-1598

Task No: BACL-5778

## 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-5745

Calibrated: 14<sup>th</sup> October 2014

Released on: 14<sup>th</sup> October 2014

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

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**NCL Calibration Laboratories**

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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.

<800 MHz

TEM Cell for sensitivity in air

Standard phantom using temperature transfer method for sensitivity in tissue

>800 MHz

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**

- o IEEE Standard 1528:2013  
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- o 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
- o IEC 62209-2:2010  
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)
- o TP-D01-032-E020-V2 E-Field probe calibration procedure
- o D22-012-Tissue dielectric tissue calibration procedure
- o D28-002-Dipole procedure for validation of SAR system using a dipole
- o IEEE 1309 Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

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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.

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
Tektronix USB Power Meter	11C940	May 14, 2015
Signal Generator HP 83640B	3844A00689	Feb 12, 2015

**Secondary Measurement Standards**

Network Analyzer Anritsu 37347C	002106	Feb. 20, 2015
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**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**

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**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

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

Frequency	Tissue Type	Measured Epsilon	Measured Sigma	Standard Uncertainty (%)	Calibration Frequency Range (MHz)	Conversion Factor
450 H	Head	43.59	0.86	3.5	±50	5.7
450 B	Body	56.74	0.94	3.5	±50	5.8
750 H	Head	42.98	0.92	3.5	±50	6.0
750 B	Body	43.05	0.93	3.5	±50	5.5
835 H	Head	43.42	0.94	3.5	±50	5.9
835 B	Body	55.77	1.01	3.5	±50	5.9
900 H	Head	41.87	1.06	3.5	±50	6.0
900 B	Body	55.62	1.05	3.5	±50	5.9
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	38.23	1.38	3.5	±75	5.4
1750 B	Body	52.86	1.54	3.5	±75	5.3
1800 H	Head	X	X	X	X	X
1800 B	Body	X	X	X	X	X
1900 H	Head	40.20	1.38	3.5	±75	4.8
1900 B	Body	52.63	1.46	3.5	±75	4.5
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	37.26	1.84	3.5	±75	4.9
2450 B	Body	53.61	1.9	3.5	±75	4.3
3000 H	Head	X	X	X	X	X
3000 B	Body	X	X	X	X	X
3600 H	Head	37.49	3.16	3.5	±100	4.5
3600 B	Body	49.94	3.86	3.5	±100	4.0
5250 H	Head	35.51	4.78	3.5	±100	3.0
5250 B	Body	47.54	5.11	3.5	±100	2.8
5600 H	Head	36.05	5.15	3.5	±100	2.8
5600 B	Body	46.49	5.72	3.5	±100	2.2
5800 H	Head	45.99	6.01	3.5	±100	3.2
5800 B	Body	35.6	5.37	3.5	±100	2.5

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**NCL Calibration Laboratories**

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**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 M $\Omega$ .

**Probe Calibration Uncertainty**

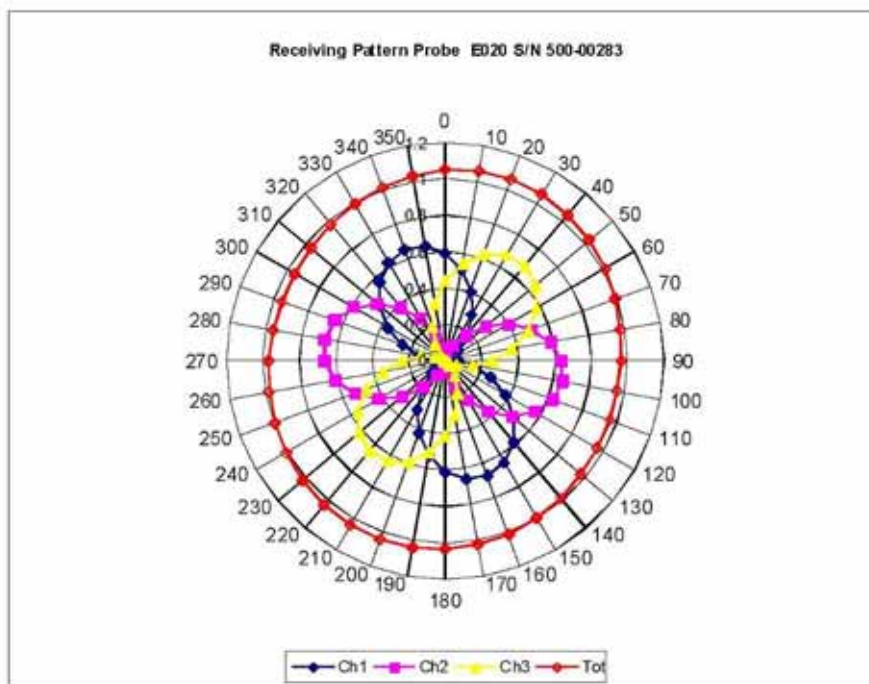
Uncertainty component	Tolerance ( $\pm$ %)	Probability distribution	Divisor	Standard uncertainty ( $\pm$ %)
Incident or forward power	2.5	R	$\sqrt{3}$	1.44
Reflected power	2	R	$\sqrt{3}$	1.15
Liquid conductivity measurement	1	R	$\sqrt{3}$	0.58
Liquid permittivity measurement	1	R	$\sqrt{3}$	0.58
Liquid conductivity deviation	1.5	R	$\sqrt{3}$	0.87
Liquid permittivity deviation	1.5	R	$\sqrt{3}$	0.87
Frequency deviation	2.25	R	$\sqrt{3}$	1.30
Field homogeneity	2.5	R	$\sqrt{3}$	1.44
Field-probe positioning	2.5	R	$\sqrt{3}$	1.44
Field-probe linearity	1.55	R	$\sqrt{3}$	0.89
<b>Combined standard uncertainty</b>		<b>RSS</b>		<b>3.50</b>



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**Receiving Pattern Air**



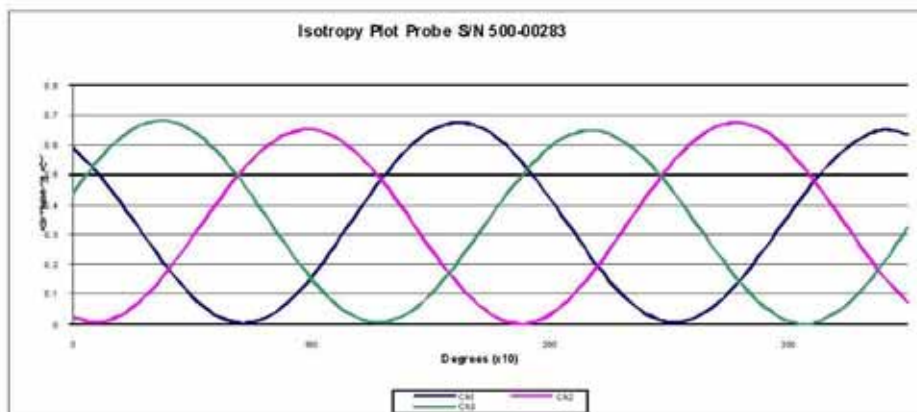
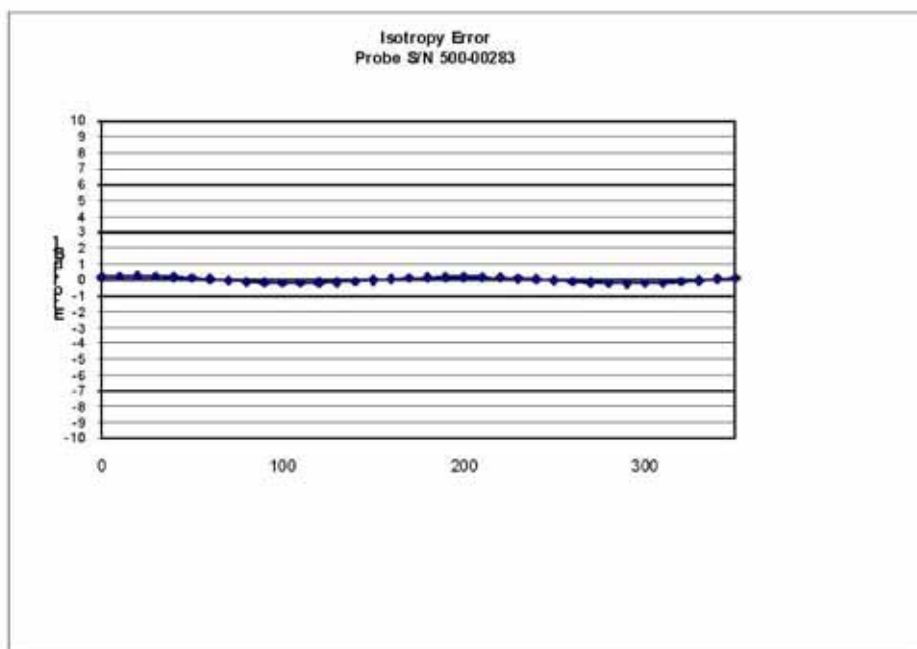
Page 7 of 10

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**Isotropy Error Air**



**Isotropy Tissue:**

**0.10 dB**

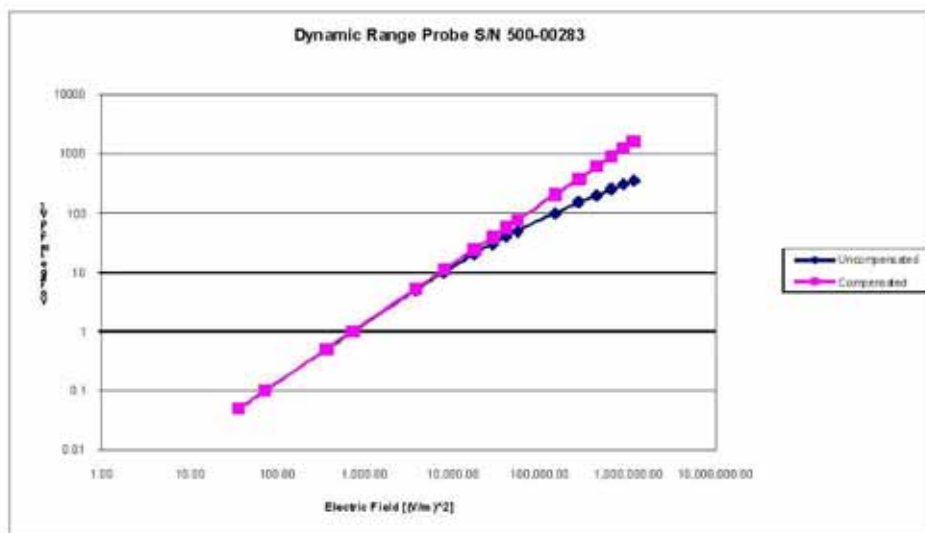
Page 8 of 10

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# **NCL Calibration Laboratories**

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## **Dynamic Range**

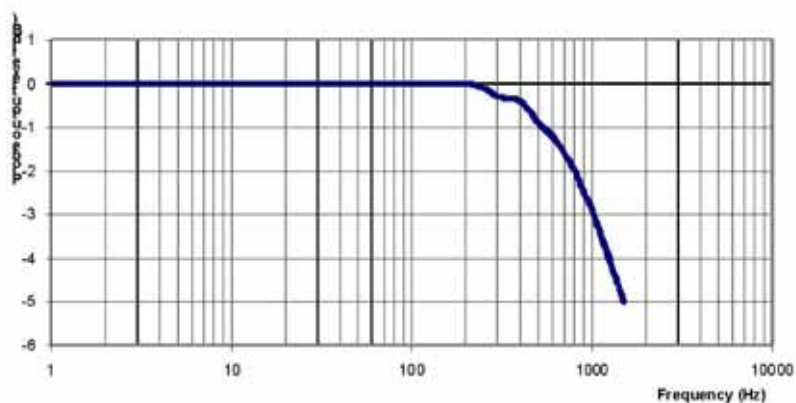


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**NCL Calibration Laboratories**

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 2014.

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Page 10 of 10

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

**ANNEX****PROBE ALS-E020 S/N 500-00283 CALIBRATION****Conditions**

Ambient Temperature of the laboratory: 20 °C +/- 1.5°C  
 Temperature of the Tissue: 21 °C +/- 1.5°C  
 Relative Humidity: < 55%

Frequency	Tissue Type	Measured Epsilon	Measured Sigma	Standard Uncertainty (%)	Calibration Frequency Range (MHz)	Conversion Factor
150 H	Head	50.6	0.78	3.5	±50	6.0
150 B	Body	60.8	0.82	3.5	±50	6.0

**Probe Calibration Uncertainty**

Uncertainty component	Tolerance (± %)	Probability distribution	Divisor	Standard uncertainty (± %)
Incident or forward power	2.5	R	√3	1.44
Reflected power	2	R	√3	1.15
Liquid conductivity measurement	1	R	√3	0.58
Liquid permittivity measurement	1	R	√3	0.58
Liquid conductivity deviation	1.5	R	√3	0.87
Liquid permittivity deviation	1.5	R	√3	0.87
Frequency deviation	2.25	R	√3	1.30
Field homogeneity	2.5	R	√3	1.44
Field-probe positioning	2.5	R	√3	1.44
Field-probe linearity	1.55	R	√3	0.89
<b>Combined standard uncertainty</b>		RSS		<b>3.50</b>

## 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 $\Omega$	48.155 $\Omega$

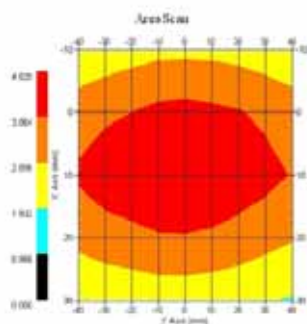
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# **NCL Calibration Laboratories**

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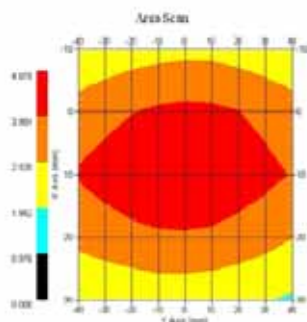
## **System Validation Results Head**

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



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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 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

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**NCL Calibration Laboratories**

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**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>

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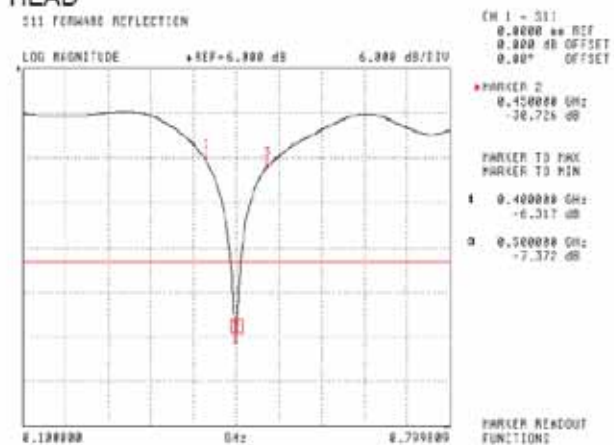
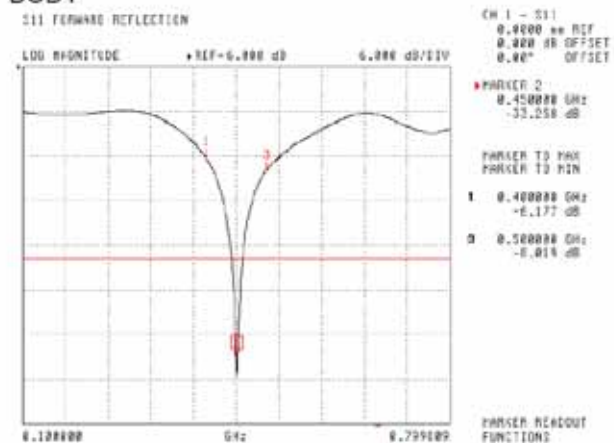
**NCL Calibration Laboratories**

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 $\Omega$	48.155 $\Omega$

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

**S11 Parameter Return Loss****HEAD****BODY**

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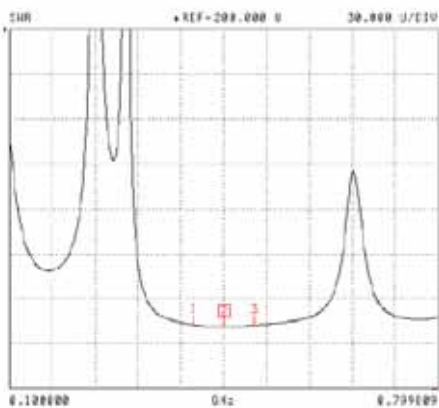
# NCL Calibration Laboratories

Division of APREL Laboratories.

## SWR

### HEAD

S11 FORWARD REFLECTION



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

PARSER 2  
0.450000 GHz  
1.051 U

PARSER TO MAX  
PARSER TO MIN

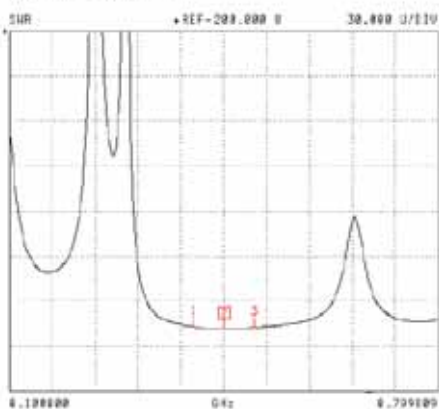
1 0.400000 GHz  
2.072 U

0 0.500000 GHz  
2.497 U

PARSER READOUT  
FUNCTIONS

### BODY

S11 FORWARD REFLECTION



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

PARSER 2  
0.450000 GHz  
1.049 U

PARSER TO MAX  
PARSER TO MIN

1 0.400000 GHz  
2.931 U

0 0.500000 GHz  
2.319 U

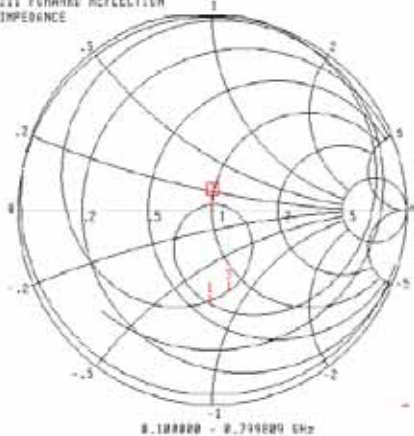
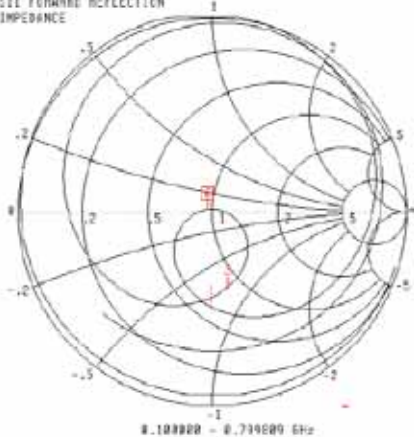
PARSER READOUT  
FUNCTIONS

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**NCL Calibration Laboratories**

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**Smith Chart Dipole Impedance**  
**HEAD**S11 FORWARD REFLECTION  
IMPEDANCECH 1 - S11  
0.0000 dB REF  
0.000 dB OFFSET  
0.00° OFFSETMARKER 2  
0.400000 GHz  
30.680 Ω  
-30.631 jΩMARKER TO MAX  
MARKER TO MIN1 0.400000 GHz  
30.680 Ω  
-30.631 jΩ  
3 0.500000 GHz  
40.474 Ω  
-41.432 jΩMARKER READOUT  
FUNCTIONS**BODY**S11 FORWARD REFLECTION  
IMPEDANCECH 1 - S11  
0.0000 dB REF  
0.000 dB OFFSET  
0.00° OFFSETMARKER 2  
0.400000 GHz  
40.155 Ω  
-39.286 jΩMARKER TO MAX  
MARKER TO MIN1 0.400000 GHz  
30.680 Ω  
-30.631 jΩ  
3 0.500000 GHz  
40.574 Ω  
-39.286 jΩMARKER READOUT  
FUNCTIONS

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**NCL Calibration Laboratories**

Division of APREL Laboratories.

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**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.

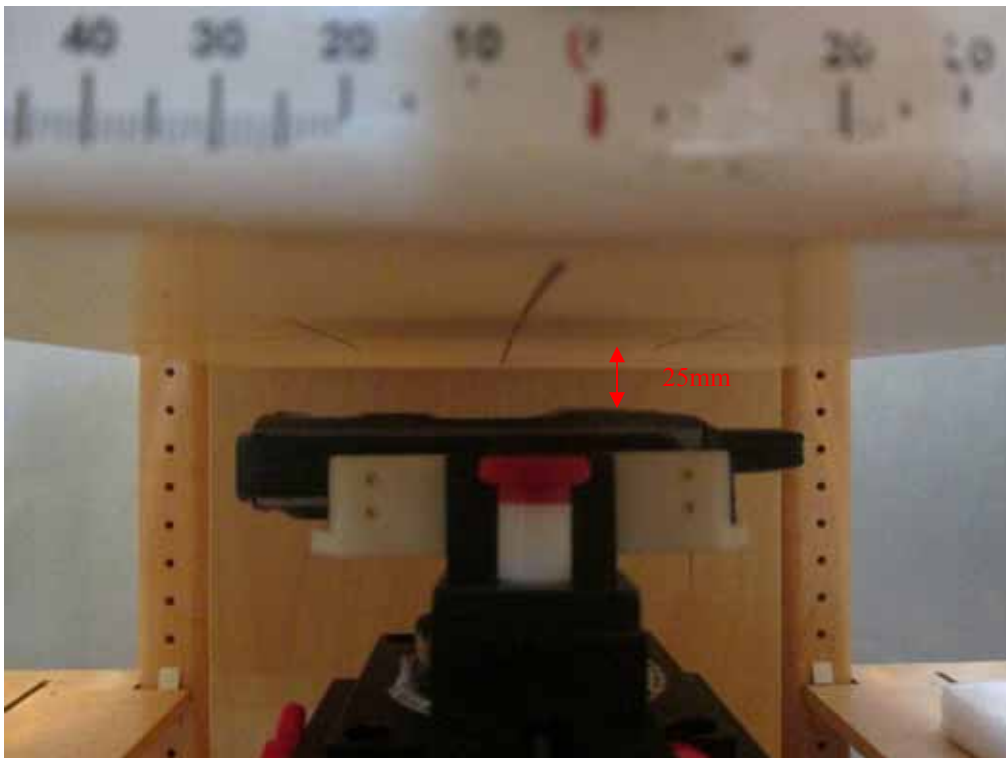
9

## APPENDIX D – EUT TEST POSITION PHOTOS

**Liquid depth  $\geq 15\text{cm}$**



**Face-Up 2.5 cm Separation to Flat Phantom**



**Body-Back 0.0 cm Separation to Flat Phantom**





## APPENDIX E – EUT PHOTOS

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**EUT – Front View**



**EUT – Back View**



**EUT-Left View**



**EUT-Right View**



**EUT-Top View**



**EUT-Bottom View**



### EUT-Uncover View



### Battery View (2000mAh)





**EUT – Belt Clip**



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## APPENDIX G – INFORMATIVE REFERENCES

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