RF Exposure Lab

802 N. Twin Oaks Valley Road, Suite 105 • San Marcos, CA 92069 • U.S.A.
TEL (760) 471-2100 • FAX (760) 471-2121
http://www.rfexposurelab.com

CERTIFICATE OF COMPLIANCE
SAR EVALUATION

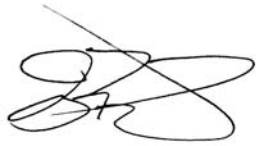
NAL Research Corporation		Dates of Test:	June 19, 2012
9300 West Courthouse Road, Suite 102		Test Report Number:	SAR.20120618
Manassas, VA 20110			

Contains FCC ID:	Q639602
Contains IC Certificate:	4629A-9602
Model(s):	SHOUT ts
Test Sample:	Engineering Unit Same as Production
Serial No.:	D03MP0
Equipment Type:	Wireless Satellite Tracker
Classification:	Portable Transmitter Next to Body
TX Frequency Range:	1616 – 1626 MHz
Frequency Tolerance:	± 2.5 ppm
Maximum RF Output:	25.69 dB Peak Conducted
Signal Modulation:	BPSK
Antenna Type (Length):	Decafilar or Quadrifilar Helical (37 mm)
Application Type:	Certification
FCC Rule Parts:	Part 2, 25
KDB Test Methodology:	KDB 447498
Industry Canada:	RSS-102, Safety Code 6
Maximum SAR Value:	1.592
Separation Distance:	0 mm

This wireless mobile and/or portable device has been shown to be compliant for localized specific absorption rate (SAR) for controlled environment limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in IEEE 1528-2003, OET Bulletin 65 Supp. C, KDB447498, RSS-102 and Safety Code 6 (See test report).

I attest to the accuracy of the data. All measurements were performed by myself or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RF Exposure Lab, LLC certifies that no party to this application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 853(a).



Jay M. Moulton
Vice President

ACCREDITED
Certificate # 2387.01

Table of Contents

1. Introduction

This measurement report shows compliance of the NAL Research Corporation Model SHOUT ts FCC ID: Q639602 with FCC Part 2, 1093, ET Docket 93-62 Rules for mobile and portable devices and IC Certificate: 4629A-9602 with RSS102 & Safety Code 6. The FCC have adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on August 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC regulated portable devices. [1], [6]

The test results recorded herein are based on a single type test of NAL Research Corporation Model SHOUT ts and therefore apply only to the tested sample.

The test procedures, as described in ANSI C95.1 – 1999 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [2], ANSI C95.3 – 2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields [3], FCC OET Bulletin 65 Supp. C – 2001 [4], IEEE Std.1528 – 2003 Recommended Practice [5], and Industry Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz were employed.

SAR Definition [5]

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

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

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

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

where:

σ = conductivity of the tissue (S/m)

ρ = mass density of the tissue (kg/m^3)

E = rms electric field strength (V/m)

2. SAR Measurement Setup

Robotic System

The measurements are conducted utilizing the ALSAS-10-U automated dosimetric assessment system. The ALSAS-10-U is designed and manufactured by Aprel Laboratories in Nepean, Ontario, Canada. The system utilizes a Robcomm 3 robot manufactured by ThermoCRS located in Michigan USA.

System Hardware

The system consists of a six axis articulated arm, controller for precise probe positioning (0.05 mm repeatability), a power supply, a teach pendent for teaching area scans, near field probe, an IBM Pentium 4™ 2.66 GHz PC with Windows XP Pro™, and custom software developed to enable communications between the robot controller software and the host operating system.

An amplifier is located on the articulated arm, which is isolated from the custom designed end effector and robot arm. The end effector provides the mechanical touch detection functionality and probe connection interface. The amplifier is functionally validated within the manufacturer's site and calibrated at NCL Calibration Laboratories. A Data Acquisition Card (DAC) is used to collect the signal as detected by the isotropic e-field probe. The DAC manufacturer calibrates the DAC to NIST standards. A formal validation is executed using all mechanical and electronic components to prove conformity of the measurement platform as a whole.

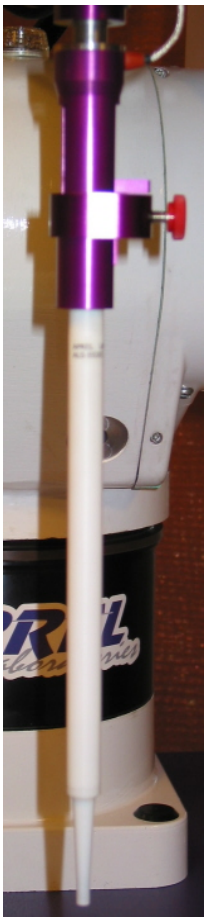
System Description

The ALSAS-10-U has been designed to measure devices within the compliance environment to meet all recognized standards. The system also conforms to standards, which are currently being developed by the scientific and manufacturing community.

The course scan resolution is defined by the operator and reflects the requirements of the standard to which the device is being tested. Precise measurements are made within the predefined course scan area and the values are logged.

The user predefines the sample rate for which the measurements are made so as to ensure that the full duty-cycle of a pulse modulation device is covered during the sample. The following algorithm is an example of the function used by the system for linearization of the output for the probe.

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



The Aprel E-Field probe is evaluated to establish the diode compression point.

A complex algorithm is then used to calculate the values within the measured points down to a resolution of 1mm. The data from this process is then used to provide the co-ordinates from which the cube scan is created for the determination of the 1 g and 10 g averages.

Cube scan averaging consists of a number of complex algorithms, which are used to calculate the one, and ten gram averages. The basis for the cube scan process is centered on the location where the maximum measured SAR value was found. When a secondary peak value is found which is within 60% of the initial peak value, the system will report this back to the operator who can then assess the need for further analysis of both the peak values prior to the one and ten-gram cube scan averaging process. The algorithm consists of 3D cubic Spline, and Lagrange extrapolation to the surface, which form the matrix for calculating the measurement output for the one and ten gram average values. The resolution for the physical scan integral is user defined with a final calculated resolution down to 1mm.

In-depth analysis for the differential of the physical scanning resolution for the cube scan analysis has been carried out, to identify the optimum setting for the probe positioning steps, and this has been determined at 8mm increments on the X, & Y planes. The reduction of the physical step increment increased the time taken for analysis but did not provide a better uncertainty or return on measured values.

The final output from the system provides data for the area scan measurements, physical and splined (1mm resolution) cube scan with physical and calculated values (1mm resolution).

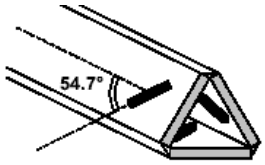
The overall uncertainty for the methodology and algorithms the ALSAS-10-U used during the SAR calculation was evaluated using the data from IEEE 1528 f3 algorithm:

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

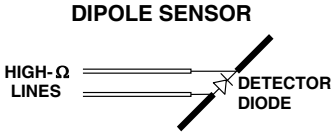
The probe used during the measurement process has been assessed to provide values for diode compression. These values are calculated during the probe calibration exercise and are used in the mathematical calculations for the assessment of SAR.

E-Field Probe

The E-field probe used by RF Exposure Lab, LLC, has been fully calibrated and assessed for isotropic, and boundary effect. The probe utilizes a triangular sensor arrangement as detailed in the diagram below right.



Δ-BEAM



The SAR is assessed with the probe which moves at a default height of 4mm from the center of the diode, which is mounted to the sensor, to the phantom surface (Z height). The diagram above right shows how the center of the sensor is defined with the location of the diode placed at the center of the dipole. The 4mm default in the Z axis is the optimum height for assessing SAR where the boundary effect is at its least, with the probe located closest to the phantom surface (boundary).

The manufacturer specified precision of the robot is ± 0.05 mm and the precision of the APREL bottom detection device is ± 0.1 mm. These precisions are calibrated and tested in the manufacturing process of the bottom detection device. A constant distance is maintained because the surface of the phantom is dynamically detected for each point. The surface detection algorithm corrects the position of the robot so that the probe rests on the surface of the phantom. The probe is then moved to the measurement location 2.44 mm above the phantom surface resulting in the probe center location to be at 4.0 mm above the phantom surface. Therefore, the probe sensor will be at 4.0 mm above the phantom surface ± 0.1 mm for each SAR location for frequencies below 3 GHz. The probe is moved to the measurement location 1.44 mm above the phantom surface resulting in the probe center location to be at 2.0 mm above the phantom surface. Therefore, the probe sensor will be at 2.0 mm above the phantom surface ± 0.1 mm for each SAR location for frequencies above 3 GHz.

The probe boundary effect compensation cannot be disabled in the ALSAS-10U testing system. The probe tip will always be at least half a probe tip diameter from the phantom surface. For frequencies up to 3 GHz, the probe diameter is 5 mm. With the sensor offset set at 1.54 mm (default setting), the sensor to phantom gap will be 4.0 mm which is greater than half the probe tip diameter. For frequencies greater than 3 GHz, the probe diameter is 3 mm. With the sensor offset set at 0.56 mm (default setting), the sensor to phantom gap will be 3.0 mm which is greater than half the probe tip diameter.

The separation of the first 2 measurement points in the zoom scan is specified in the test setup software. For frequencies below 3 GHz, the user must specify a zoom scan resolution of less than 6 mm in the z-axis to have the first two measurements within 1 cm of the surface. The z-axis is set to 4 mm as shown on each of the data sheets in Appendix B. For frequencies above 3 GHz, the user must specify a zoom scan resolution of less than 3 mm in the z-axis to have the first two measurements within 5 mm of the surface. The z-axis is set to 2 mm as shown on each of the data sheets in Appendix B.

The zoom scan volume for devices ≤3 GHz with a cube scan of 5x5x8 yields a volume of 32x32x28 mm^3. For devices >3 GHz and <4.5 GHz, the cube scan of 9x9x9 yields a volume of 32x32x24 mm^3. For devices ≥4.5 GHz, the cube scan of 7x7x12 yields a volume of 24x24x22 mm^3.

3. Robot Specifications

Specifications

Positioner:	ThermoCRS, Robot Model: Robocomm 3
Repeatability:	0.05 mm
No. of axis:	6

Data Acquisition Card (DAC) System

Cell Controller

Processor:	Pentium 4™
Clock Speed:	2.66 GHz
Operating System:	Windows XP Pro™

Data Converter

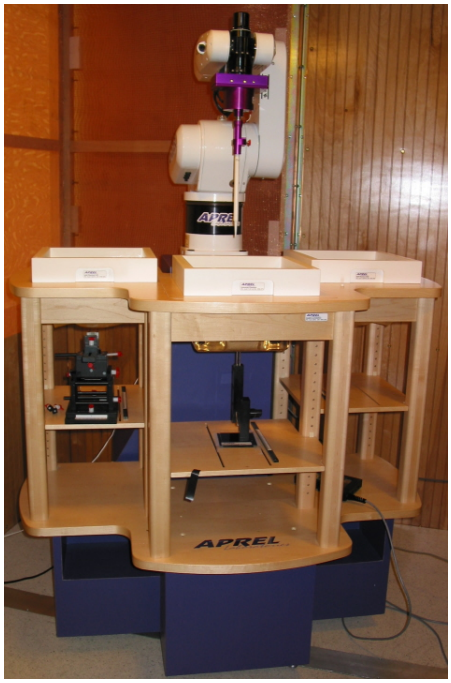
Features:	Signal Amplifier, End Effector, DAC
Software:	ALSAS 10-U Software

E-Field Probe

Model:	Various See Probe Calibration Sheet
Serial Number:	Various See Probe Calibration Sheet
Construction:	Triangular Core Touch Detection System
Frequency:	10MHz to 6GHz

Phantom

Phantom:	Uniphantom, Right Phantom, Left Phantom



4. Probe and Dipole Calibration

See Appendix D and E.

5. Phantom & Simulating Tissue Specifications

SAM Phantom

The Aprel system utilizes three separate phantoms. Each phantom for SAR assessment testing is a low loss dielectric shell, with shape and dimensions derived from the anthropomorphic data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM phantom shell is bisected along the mid sagittai plane into right and left halves. The perimeter sidewalls of each phantom half is extended to allow filling with liquid to a depth of 15 cm that is sufficient to minimize reflections from the upper surface [5]. The Uni-Phantom is used to conduct body measurements and held to face measurements. The depth of the phantom allows for 15 cm of tissue material to be filled within the phantom. See photos in Appendix C.

Head & Body Simulating Mixture Characterization

The head and body mixtures consist of the material based on the table listed below. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. Body tissue parameters that have not been specified in P1528 are derived from the issue dielectric parameters computed from the 4-Cole-Cole equations.

Table 5.1 Typical Composition of Ingredients for Tissue

Ingredients		Simulating Tissue
		1640 MHz Body
Mixing Percentage		
Water		54.47
Sugar		0.00
Salt		0.33
HEC		0.00
Bactericide		0.00
DGBE		45.22
Dielectric Constant	Target	53.72
Conductivity (S/m)	Target	1.42

Device Holder

In combination with the SAM phantom, the mounting device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can easily, accurately, and repeatably be positioned according to the FCC specifications. The device holder can be locked at different phantom locations (left head, right head, and uni-phantom).

Body Worn Configurations

Body-worn operating configurations are tested in a normal use configuration. Body dielectric parameters are used.

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

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

6. ANSI/IEEE C95.1 – 1992 RF Exposure Limits [2]

Uncontrolled Environment

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

Controlled Environment

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

Table 6.1 Human Exposure Limits

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

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

7. Measurement Uncertainty

Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i^1 (1-g)	c_i^1 (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %	v_i
Measurement System								
Probe Calibration	3.5	normal	1	1	1	3.5	3.5	∞
Axial Isotropy	3.7	rectangular	√3	0.7	0.7	1.5	1.5	∞
Hemispherical Isotropy	10.9	rectangular	√3	0.7	0.7	4.4	4.4	∞
Boundary Effect	1.0	rectangular	√3	1	1	0.6	0.6	∞
Linearity	4.7	rectangular	√3	1	1	2.7	2.7	∞
Detection Limit	1.0	rectangular	√3	1	1	0.6	0.6	∞
Readout Electronics	1.0	normal	1	1	1	1.0	1.0	∞
Response Time	0.8	rectangular	√3	1	1	0.5	0.5	∞
Integration Time	1.7	rectangular	√3	1	1	1.0	1.0	∞
RF Ambient Condition	3.0	rectangular	√3	1	1	1.7	1.7	∞
Probe Positioner Mech. Restriction	0.4	rectangular	√3	1	1	0.2	0.2	∞
Probe Positioning with respect to Phantom Shell	2.9	rectangular	√3	1	1	1.7	1.7	∞
Extrapolation and Integration	3.7	rectangular	√3	1	1	2.1	2.1	∞
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0	7
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0	2
Drift of Output Power	4.2	rectangular	√3	1	1	2.4	2.4	∞
Phantom and Setup								
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	√3	1	1	2.0	2.0	∞
Algorithm for correcting SAR for deviations in permittivity and conductivity	1.2	Normal	1	1	0.84	1.2	0.97	∞
Liquid Conductivity(target)	5.0	rectangular	√3	0.7	0.5	2.0	1.4	∞
Liquid Conductivity(meas.)	0.5	normal	1	0.7	0.5	0.4	0.3	5
Liquid Permittivity(target)	5.0	rectangular	√3	0.6	0.5	1.7	1.4	∞
Liquid Permittivity(meas.)	1.0	normal	1	0.6	0.5	0.6	0.5	5
Combined Uncertainty		RSS				9.8	9.6	>500
Combined Uncertainty (coverage factor=2)		Normal(k=2)				19.4	19.1	>500

8. System Validation

Tissue Verification

Table 8.1 Measured Tissue Parameters

		1640 MHz Body	
Date(s)		Jun. 19, 2012	
Liquid Temperature (˚C)	20.0	Target	Measured
Dielectric Constant: ε		53.72	53.65
Conductivity: σ		1.42	1.43

See Appendix A for data printout.

Test System Verification

Prior to assessment, the system is verified to the ±10% of the specifications at the test frequency by using the system kit. Power is normalized to 1 watt. (Graphic Plots Attached)

Table 8.2 System Dipole Validation Target & Measured

	Test Frequency	Targeted SAR_{1g} (W/kg)	Measure SAR_{1g} (W/kg)	Tissue Used for Verification	Deviation (%)
19-Jun-2012	1640 MHz	34.201	34.99	Body	+ 2.31

See Appendix A for data plots.

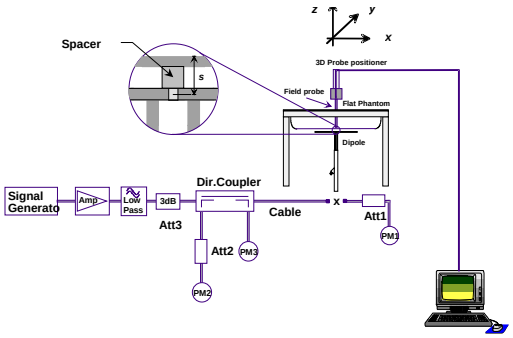


Figure 8.1 Dipole Validation Test Setup

Note: KDB 450824 D02 was applied for dipole calibrations.

SAR Correction Calculation per EN62209.

$\Delta SAR = c_\varepsilon \Delta\varepsilon_r + c_\sigma \Delta\sigma = (-0.23)(-0.13) + (0.64)(0.70) = +0.48$
$c_\varepsilon = -7.854\text{x}10^{-4}(1.640)^3 + 9.402\text{x}10^{-3}(1.640)^2 - 2.742\text{x}10^{-2}(1.640) - 0.2026 = -0.23$
$c\sigma = 9.804\text{x}10^{-3}(1.640)^3 - 8.661\text{x}10^{-2}(1.640)^2 + 2.981\text{x}10^{-2}(1.640) + 0.7829 = +0.64$

With a positive ΔSAR, the SAR results shall not be corrected per IC notice 2012-DRS0529.

9. SAR Test Data Summary

See Measurement Result Data Pages

See Appendix B for SAR Test Data Plots.
See Appendix C for SAR Test Setup Photos.

Procedures Used To Establish Test Signal

The device was either placed into simulated transmit mode using the manufacturer's test codes or the actual transmission is activated through a base station simulator or similar equipment. See data pages for actual procedure used in measurement.

Device Test Condition

Output power measurements were performed after the completion of all SAR measurements to insure the integrity of the unit. The power drift of each test is measured at the start of the test and again at the end of the test. The drift percentage is calculated by the formula ((end/start)-1)*100 and rounded to three decimal places. The drift percentage is calculated into the resultant SAR value on the data sheet for each test.

The testing was conducted on the front and back of the device. The device has a maximum of 10% duty cycle. The unit was tested with a 10 % duty cycle for all measurements. The device was tested at low mid and high channels for each configuration. All testing was conducted per KDB 447498.

Conducted Power (Peak)				
Freq	**Channel**	**Data Rate**	**Antenna**	**Power**
1616	1	N/A	Main	25.68
1621	120	N/A	Main	25.69
1626	240	N/A	Main	25.69

Maximum Power Measurements

SAR Data Summary – 1640 MHz Body Position

MEASUREMENT RESULTS							
Gap	Frequency		Position	Modulation	Battery	End Power	SAR (W/kg)
	MHz	Ch.				(dBm)	
0 mm	1616	1	Back	BPSK	Standard	25.68	1.499
	1621	120	Back	BPSK	Standard	25.69	1.582
	1626	240	Back	BPSK	Standard	25.69	1.084
	1616	1	Front	BPSK	Standard	25.68	1.111
	1621	120	Front	BPSK	Standard	25.69	1.592
	1626	240	Front	BPSK	Standard	25.69	1.050
				Body **1.6 W/kg (mW/g)** averaged over 1 gram			

1. Battery is fully charged for all tests.
   Power Measured ☒Conducted ☐ERP ☐EIRP
2. SAR Measurement
   Phantom Configuration ☐Left Head ☒Uniphantom ☐Right Head
   Tissue Configuration ☐Head ☒Body
3. Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Jay M. Moulton
Vice President

Note: SAR Tested on the Low, Mid and High channels. The testing was conducted the front and back of the device. All testing was conducted per KDB 447498 and OET Bulletin 65. See the photos in Appendix C for a pictorial of the setup and labeling of the test locations.

10. Test Equipment List

Table 10.1 Equipment Specifications

Type	Calibration Due Date	Calibration Done Date	Serial Number
ThermoCRS Robot	N/A	N/A	RAF0338198
ThermoCRS Controller	N/A	N/A	RCF0338224
ThermoCRS Teach Pendant (Joystick)	N/A	N/A	STP0334405
IBM Computer, 2.66 MHz P4	N/A	N/A	8189D8U KCPR08N
Aprel E-Field Probe ALS-E020	09/07/2012	09/07/2011	RFE-217
Aprel E-Field Probe ALS-E030	07/15/2012	07/15/2011	E030-001
Aprel Dummy Probe	N/A	N/A	023
Aprel Left Phantom	N/A	N/A	RFE-267
Aprel Right Phantom	N/A	N/A	RFE-268
Aprel UniPhantom	N/A	N/A	RFE-273
Aprel Validation Dipole ALS-D-450-S-2 Head	01/12/2013	01/12/2010	RFE-362
Aprel Validation Dipole ALS-D-450-S-2 Body	01/19/2013	01/19/2011	RFE-362
Aprel Validation Dipole ALS-D-750-S-2 Head	01/14/2013	01/14/2010	177-00501
Aprel Validation Dipole ALS-D-750-S-2 Body	11/15/2012	11/15/2010	177-00501
Aprel Validation Dipole ALS-D-835-S-2 Head	01/14/2013	01/14/2010	180-00561
Aprel Validation Dipole ALS-D-835-S-2 Body	11/16/2012	11/16/2010	180-00561
Aprel Validation Dipole ALS-D-900-S-2 Head	01/12/2013	01/12/2010	RFE-275
Aprel Validation Dipole ALS-D-900-S-2 Body	11/19/2012	11/19/2010	RFE-275
Aprel Validation Dipole ALS-D-1900-S-2 Head	01/15/2013	01/15/2010	210-00713
Aprel Validation Dipole ALS-D-1900-S-2 Body	11/16/2012	11/16/2010	210-00713
Aprel Validation Dipole ALS-D-2450-S-2 Head	01/12/2013	01/12/2010	RFE-278
Aprel Validation Dipole ALS-D-2450-S-2 Body	11/18/2012	11/18/2010	RFE-278
Aprel Validation Dipole RFE-D-2600-S-2 Body	01/18/2013	01/18/2010	RFE-121
Aprel Validation Dipole RFE-D-BB-S-2 Head	01/12/2013	01/12/2010	235-00801
Aprel Validation Dipole RFE-D-BB-S-2 Body	02/09/2013	02/09/2011	235-00801
Agilent N1911A Power Meter	03/29/2013	03/29/2012	GB45100254
Agilent N1922A Power Sensor	03/29/2013	03/29/2012	MY45240464
Advantest R3261A Spectrum Analyzer	03/29/2013	03/29/2012	31720068
Agilent (HP) 8350B Signal Generator	03/29/2013	03/29/2012	2749A10226
Agilent (HP) 83525A RF Plug-In	03/29/2013	03/29/2012	2647A01172
Agilent (HP) 8753C Vector Network Analyzer	03/29/2013	03/29/2012	3135A01724
Agilent (HP) 85047A S-Parameter Test Set	04/03/2013	04/03/2012	2904A00595
Agilent (HP) 8960 Base Station Sim.	04/05/2014	04/05/2012	MY48360364
Aprel Dielectric Probe Assembly	N/A	N/A	0011
Head Equivalent Matter (450 MHz)	N/A	N/A	N/A
Head Equivalent Matter (835/900 MHz)	N/A	N/A	N/A
Head Equivalent Matter (1900 MHz)	N/A	N/A	N/A
Head Equivalent Matter (2450 MHz)	N/A	N/A	N/A
Body Equivalent Matter (450 MHz)	N/A	N/A	N/A
Body Equivalent Matter (750 MHz)	N/A	N/A	N/A
Body Equivalent Matter (835/900 MHz)	N/A	N/A	N/A
Body Equivalent Matter (1900 MHz)	N/A	N/A	N/A
Body Equivalent Matter (2450 MHz)	N/A	N/A	N/A
Body Equivalent Matter (2600 MHz)	N/A	N/A	N/A
Body Equivalent Matter (5200 MHz)	N/A	N/A	N/A
Body Equivalent Matter (5800 MHz)	N/A	N/A	N/A

11. Conclusion

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters subject to the test. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body is a very complex phenomena that depends on the mass, shape, and size of the body; the orientation of the body with respect to the field vectors; and, the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

12. References

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio Frequency Radiation, August 1996

[2] ANSI/IEEE C95.1 – 1992, American National Standard Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300kHz to 100GHz, New York: IEEE, 1992.

[3] ANSI/IEEE C95.3 – 1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave, New York: IEEE, 1992.

[4] Federal Communications Commission, OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, June 2001.

[5] IEEE Standard 1528 – 2003, IEEE Recommended Practice for Determining the Peak-Spatial Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, October 2003.

[6] Industry Canada, RSS – 102e, Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), March 2010.

[7] Health Canada, Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz, 2009.

Appendix A – System Validation Plots and Data

```
************************************************************
Test Result for UIM Dielectric Parameter
Tue 19/Jun/2012 08:02:13
Freq  Frequency(GHz)
FCC_eH      FCC Bulletin 65 Supplement C ( June 2001) Limits for Head Epsilon
FCC_sH      FCC Bulletin 65 Supplement C (June 2001) Limits for Head Sigma
FCC_eB      FCC Limits for Body Epsilon
FCC_sB      FCC Limits for Body Sigma
Test_e      Epsilon  of  UIM
Test_s      Sigma of UIM
************************************************************
```

Freq	FCC_eB	FCC_sB	Test_e	Test_s
1.6100	53.80	1.40	53.73	1.40
1.6160	53.78	1.41	53.71	1.41*
1.6200	53.77	1.41	53.70	1.41
1.6210	53.77	1.41	53.70	1.41*
1.6260	53.76	1.41	53.68	1.42*
1.6300	53.75	1.41	53.67	1.42
1.6400	53.72	1.42	53.65	1.43
1.6500	53.69	1.43	53.62	1.44
1.6600	53.67	1.43	53.60	1.45
1.6700	53.64	1.44	53.56	1.46

* Values interpolated

SAR Test Report

By Operator : Jay
Measurement Date : 19-Jun-2012
Starting Time : 19-Jun-2012 08:07:44 AM
End Time : 19-Jun-2012 08:20:46 AM
Scanning Time : 782 secs

Product Data
Device Name : Validation
Serial No. : 1640
Type : Dipole
Model : ALS-D-1640-S-2
Frequency : 1640.00 MHz
Max. Transmit Pwr : 0.1 W
Drift Time : 0 min(s)
Length : 80.4 mm
Width : 3.6 mm
Depth : 45.7 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 4.383 W/kg
Power Drift-Finish: 4.402 W/kg
Power Drift (%) : 0.434

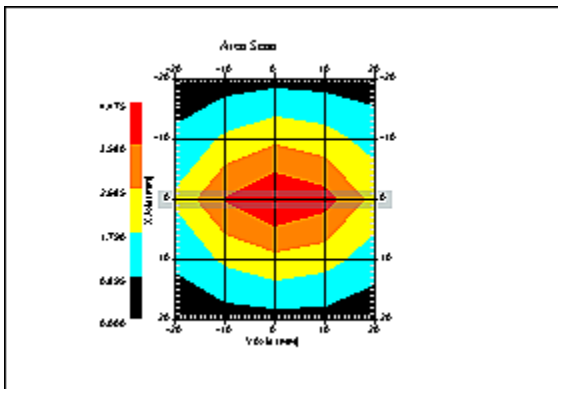
Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : System Default
Location : Center
Description : Uni-Phantom

Tissue Data
Type : BODY
Serial No. : 1640
Frequency : 1640.00 MHz
Last Calib. Date : 19-Jun-2012
Temperature : 20.00 °C
Ambient Temp. : 23.00 °C
Humidity : 49.00 RH%
Epsilon : 53.65 F/m
Sigma : 1.43 S/m
Density : 1000.00 kg/cu. m

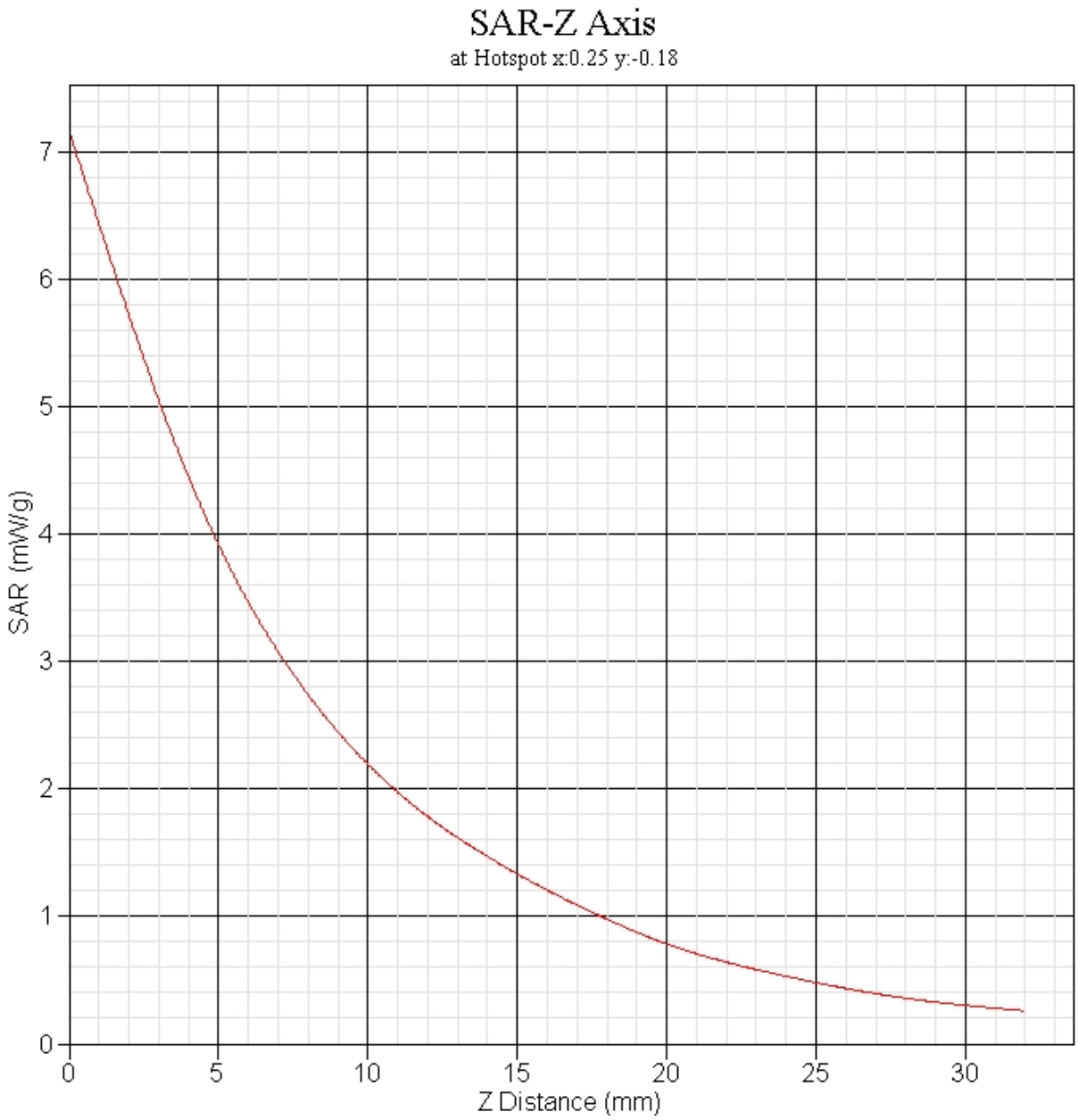
Probe Data
Name : Probe 217 - RFEL
Model : E020
Type : E-Field Triangle
Serial No. : 217
Last Calib. Date : 07-Sep-2011
Frequency : 1640.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 20.00 °C
Ambient Temp. : 23.00 °C
Set-up Date : 19-Jun-2012
Set-up Time : 7:04:12 AM
Area Scan : 5x5x1 : Measurement x=10mm, y=10mm, z=4mm
Zoom Scan : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position : Touch
Separation : 10 mm
Channel : Mid



1 gram SAR value : 3.499 W/kg
10 gram SAR value : 1.848 W/kg
Area Scan Peak SAR : 4.396 W/kg
Zoom Scan Peak SAR : 7.129 W/kg

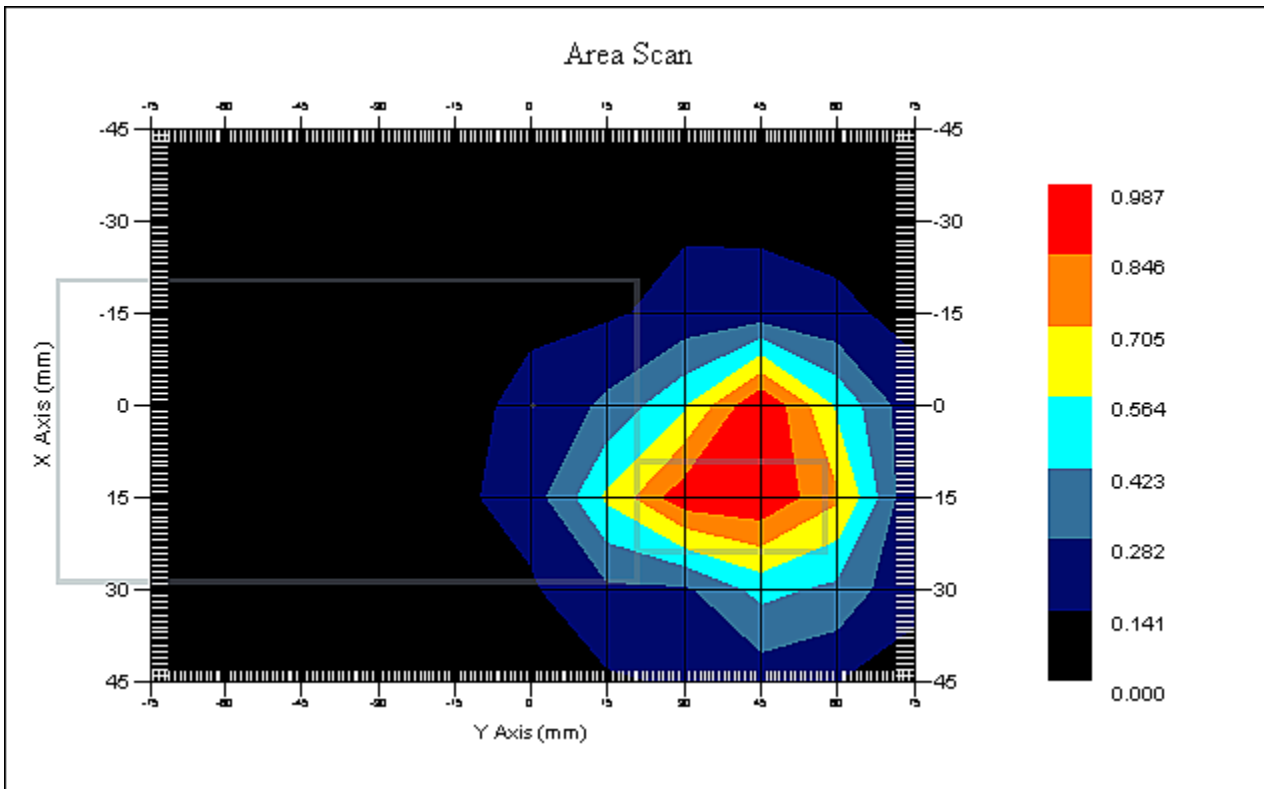


Appendix B – SAR Test Data Plots

SAR Test Report

```
By Operator       : Jay
Measurement Date  : 19-Jun-2012
Starting Time     : 19-Jun-2012  03:06:45 PM
End Time          : 19-Jun-2012  03:34:14 PM
Scanning Time     : 1649 secs

Product Data
Device Name       : NAL Research
Serial No.        : D03MP0
Mode              : BPSK
Model             : SHOUT ts
Frequency         : 1616.00 MHz
Max. Transmit Pwr : 0.370 W
Drift Time        : 0 min(s)
Length            : 112 mm
Width             : 60 mm
Depth             : 24 mm
Antenna Type      : Stub
Orientation       : Back
Power Drift-Start : 0.099 W/kg
Power Drift-Finish: 0.099 W/kg
Power Drift (%)   : 0.265

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

Tissue Data
Type              : BODY
Serial No.        : 1616
Frequency         : 1616.00 MHz
Last Calib. Date  : 19-Jun-2012
Temperature       : 20.00 °C
Ambient Temp.     : 23.00 °C
Humidity          : 45.00 RH%
Epsilon           : 53.71 F/m
Sigma             : 1.41 S/m
Density           : 1000.00 kg/cu. m

Probe Data
Name              : RFEL 217
Model             : E020
Type              : E-Field Triangle
Serial No.        : 217
Last Calib. Date  : 07-Sep-2011
Frequency         : 1640.00 MHz
Duty Cycle Factor: 10
Conversion Factor: 5
Probe Sensitivity: 1.20  1.20  1.20   µV/(V/m)^2
Compression Point: 95.00 mV
Offset            : 1.56 mm
```

```
Measurement Data
Crest Factor      : 10
Scan Type         : Complete
Tissue Temp.      : 20.00 °C
Ambient Temp.     : 23.00 °C
Set-up Date       : 19-Jun-2012
Set-up Time       : 8:52:32 AM
Area Scan         : 7x11x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan         : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position      : Back
Separation        : 0 mm
Channel           : Low
```




```
1 gram SAR value    : 1.499 W/kg
10 gram SAR value   : 0.730 W/kg
Area Scan Peak SAR  : 0.985 W/kg
Zoom Scan Peak SAR  : 3.122 W/kg
```

SAR Test Report

By Operator : Jay
Measurement Date : 19-Jun-2012
Starting Time : 19-Jun-2012 02:35:20 PM
End Time : 19-Jun-2012 03:02:51 PM
Scanning Time : 1651 secs

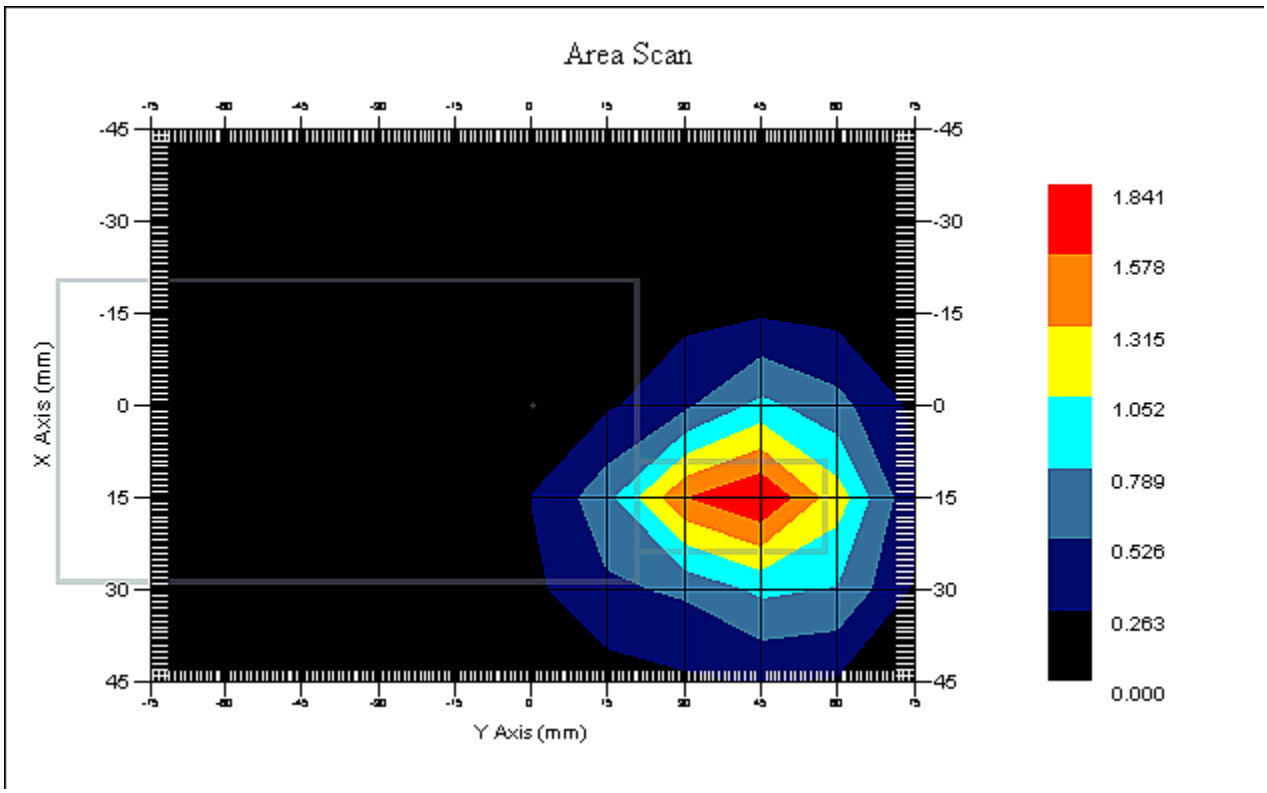
Product Data
Device Name : NAL Research
Serial No. : D03MP0
Mode : BPSK
Model : SHOUT ts
Frequency : 1621.00 MHz
Max. Transmit Pwr : 0.371 W
Drift Time : 0 min(s)
Length : 112 mm
Width : 60 mm
Depth : 24 mm
Antenna Type : Stub
Orientation : Back
Power Drift-Start : 0.116 W/kg
Power Drift-Finish: 0.115 W/kg
Power Drift (%) : -1.450

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

Tissue Data
Type : BODY
Serial No. : 1621
Frequency : 1621.00 MHz
Last Calib. Date : 19-Jun-2012
Temperature : 20.00 °C
Ambient Temp. : 23.00 °C
Humidity : 45.00 RH%
Epsilon : 53.70 F/m
Sigma : 1.41 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : RFEL 217
Model : E020
Type : E-Field Triangle
Serial No. : 217
Last Calib. Date : 07-Sep-2011
Frequency : 1640.00 MHz
Duty Cycle Factor: 10
Conversion Factor: 5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

```
Measurement Data
Crest Factor      : 10
Scan Type         : Complete
Tissue Temp.      : 20.00 °C
Ambient Temp.     : 23.00 °C
Set-up Date       : 19-Jun-2012
Set-up Time       : 8:52:32 AM
Area Scan         : 7x11x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan         : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position      : Back
Separation        : 0 mm
Channel           : Mid
```

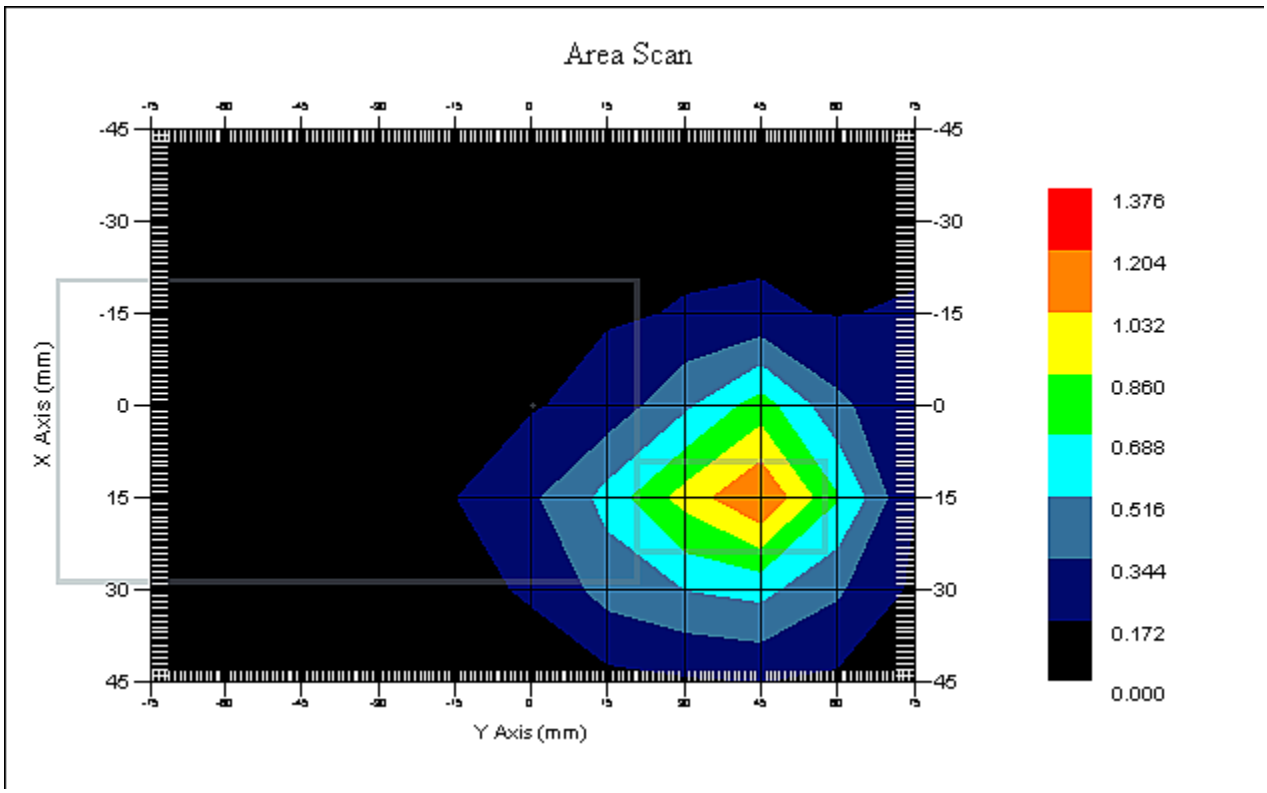



```
1 gram SAR value    : 1.582 W/kg
10 gram SAR value   : 0.928 W/kg
Area Scan Peak SAR  : 1.839 W/kg
Zoom Scan Peak SAR  : 3.002 W/kg
```

SAR Test Report

```
By Operator       : Jay
Measurement Date  : 19-Jun-2012
Starting Time     : 19-Jun-2012  03:37:37 PM
End Time          : 19-Jun-2012  04:05:33 PM
Scanning Time     : 1676 secs

Product Data
Device Name       : NAL Research
Serial No.        : D03MP0
Mode              : BPSK
Model             : SHOUT ts
Frequency         : 1626.00 MHz
Max. Transmit Pwr : 0.371 W
Drift Time        : 0 min(s)
Length            : 112 mm
Width             : 60 mm
Depth             : 24 mm
Antenna Type      : Stub
Orientation       : Back
Power Drift-Start : 0.113 W/kg
Power Drift-Finish: 0.111 W/kg
Power Drift (%)   : -1.770

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

Tissue Data
Type              : BODY
Serial No.        : 1626
Frequency         : 1626.00 MHz
Last Calib. Date  : 19-Jun-2012
Temperature       : 20.00 °C
Ambient Temp.     : 23.00 °C
Humidity          : 45.00 RH%
Epsilon           : 53.68 F/m
Sigma             : 1.42 S/m
Density           : 1000.00 kg/cu. m

Probe Data
Name              : RFEL 217
Model             : E020
Type              : E-Field Triangle
Serial No.        : 217
Last Calib. Date  : 07-Sep-2011
Frequency         : 1640.00 MHz
Duty Cycle Factor: 10
Conversion Factor: 5
Probe Sensitivity: 1.20  1.20  1.20   µV/(V/m)^2
Compression Point: 95.00 mV
Offset            : 1.56 mm
```

```
Measurement Data
Crest Factor      : 10
Scan Type         : Complete
Tissue Temp.      : 20.00 °C
Ambient Temp.     : 23.00 °C
Set-up Date       : 19-Jun-2012
Set-up Time       : 8:52:32 AM
Area Scan         : 7x11x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan         : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position      : Back
Separation        : 0 mm
Channel           : High
```




```
1 gram SAR value    : 1.084 W/kg
10 gram SAR value   : 0.577 W/kg
Area Scan Peak SAR  : 1.205 W/kg
Zoom Scan Peak SAR  : 2.392 W/kg
```

SAR Test Report

By Operator : Jay
Measurement Date : 19-Jun-2012
Starting Time : 19-Jun-2012 07:13:00 PM
End Time : 19-Jun-2012 07:40:46 PM
Scanning Time : 1666 secs

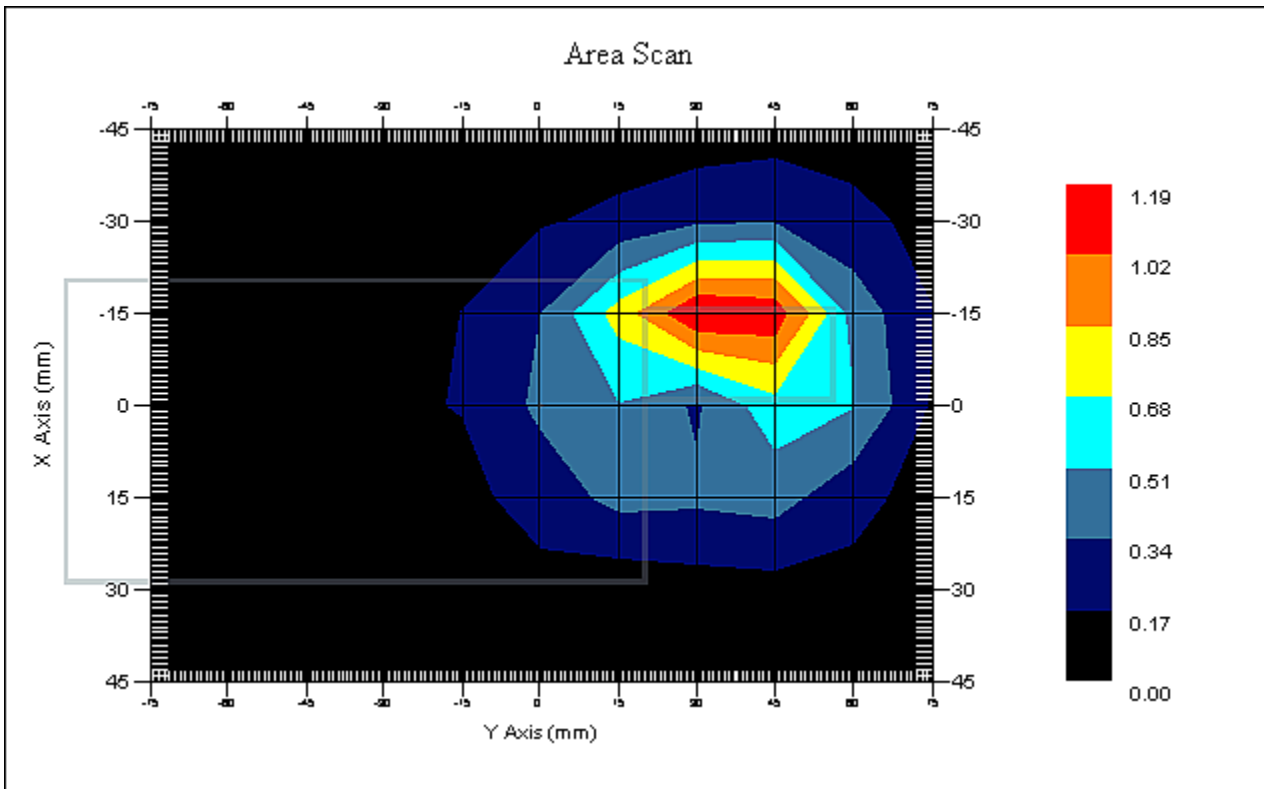
Product Data
Device Name : NAL Research
Serial No. : D03MP0
Mode : BPSK
Model : SHOUT ts
Frequency : 1616.00 MHz
Max. Transmit Pwr : 0.371 W
Drift Time : 0 min(s)
Length : 112 mm
Width : 60 mm
Depth : 24 mm
Antenna Type : Stub
Orientation : Front
Power Drift-Start : 0.378 W/kg
Power Drift-Finish: 0.370 W/kg
Power Drift (%) : -2.114

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

Tissue Data
Type : BODY
Serial No. : 1616
Frequency : 1616.00 MHz
Last Calib. Date : 19-Jun-2012
Temperature : 20.00 °C
Ambient Temp. : 23.00 °C
Humidity : 45.00 RH%
Epsilon : 53.71 F/m
Sigma : 1.41 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : RFEL 217
Model : E020
Type : E-Field Triangle
Serial No. : 217
Last Calib. Date : 07-Sep-2011
Frequency : 1640.00 MHz
Duty Cycle Factor: 10
Conversion Factor: 5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

```
Measurement Data
Crest Factor      : 10
Scan Type         : Complete
Tissue Temp.      : 20.00 °C
Ambient Temp.     : 23.00 °C
Set-up Date       : 19-Jun-2012
Set-up Time       : 8:52:32 AM
Area Scan         : 7x11x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan         : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position      : Front
Separation        : 0 mm
Channel           : Low
```




```
1 gram SAR value    : 1.111 W/kg
10 gram SAR value   : 0.604 W/kg
Area Scan Peak SAR  : 1.190 W/kg
Zoom Scan Peak SAR  : 1.991 W/kg
```

SAR Test Report

By Operator : Jay
Measurement Date : 19-Jun-2012
Starting Time : 19-Jun-2012 04:38:43 PM
End Time : 19-Jun-2012 05:06:33 PM
Scanning Time : 1670 secs

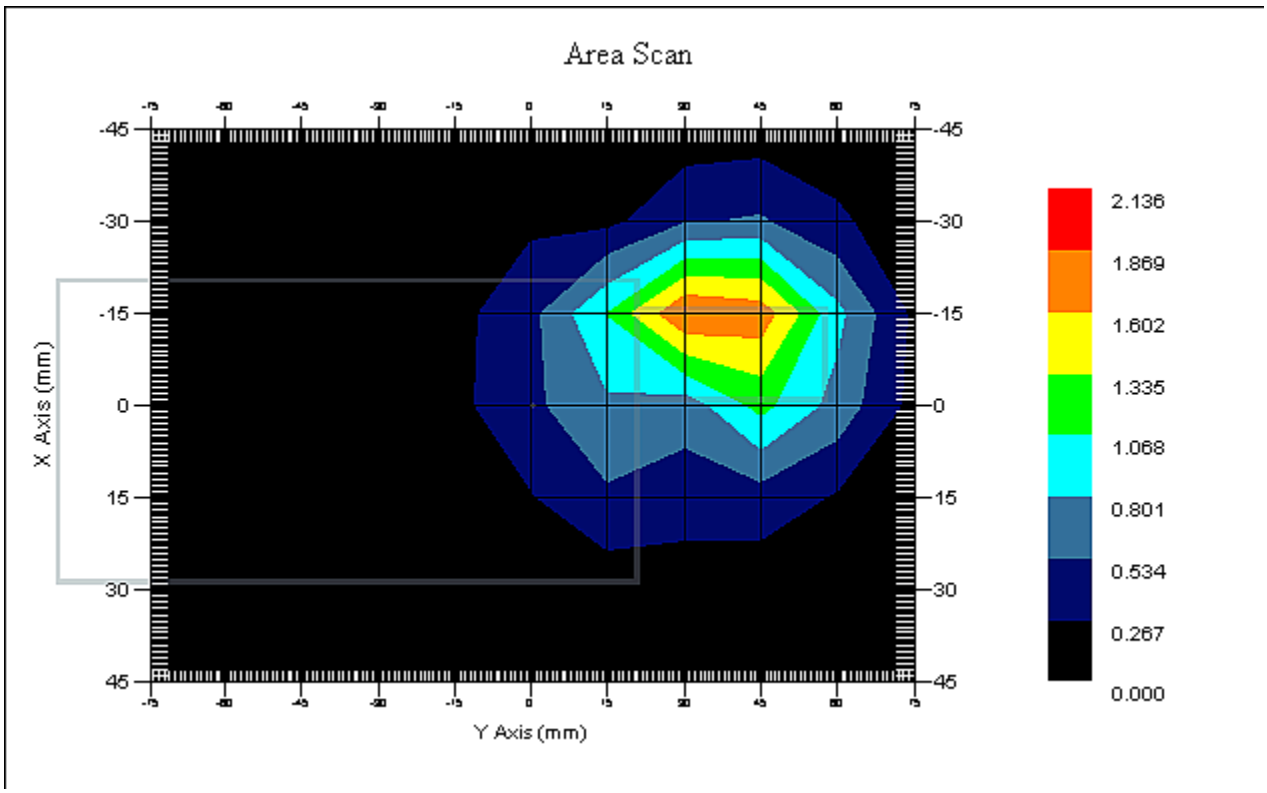
Product Data
Device Name : NAL Research
Serial No. : D03MP0
Mode : BPSK
Model : SHOUT ts
Frequency : 1621.00 MHz
Max. Transmit Pwr : 0.370 W
Drift Time : 0 min(s)
Length : 112 mm
Width : 60 mm
Depth : 24 mm
Antenna Type : Stub
Orientation : Front
Power Drift-Start : 0.396 W/kg
Power Drift-Finish: 0.408 W/kg
Power Drift (%) : 3.039

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

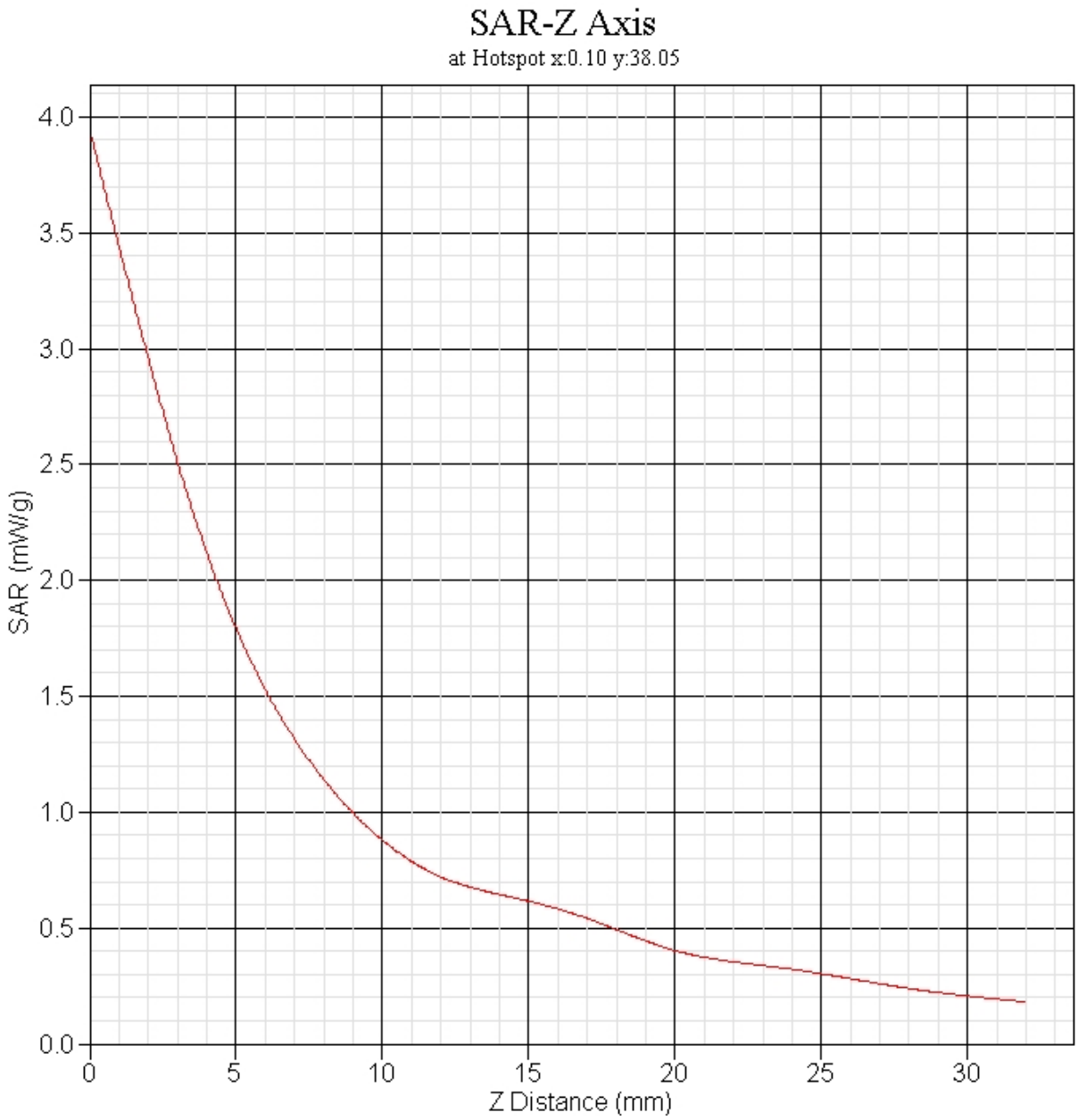
Tissue Data
Type : BODY
Serial No. : 1621
Frequency : 1621.00 MHz
Last Calib. Date : 19-Jun-2012
Temperature : 20.00 °C
Ambient Temp. : 23.00 °C
Humidity : 45.00 RH%
Epsilon : 53.70 F/m
Sigma : 1.41 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : RFEL 217
Model : E020
Type : E-Field Triangle
Serial No. : 217
Last Calib. Date : 07-Sep-2011
Frequency : 1640.00 MHz
Duty Cycle Factor: 10
Conversion Factor: 5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

```
Measurement Data
Crest Factor      : 10
Scan Type         : Complete
Tissue Temp.      : 20.00 °C
Ambient Temp.     : 23.00 °C
Set-up Date       : 19-Jun-2012
Set-up Time       : 8:52:32 AM
Area Scan         : 7x11x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan         : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position      : Front
Separation        : 0 mm
Channel           : Mid
```




```
1 gram SAR value    : 1.592 W/kg
10 gram SAR value   : 0.831 W/kg
Area Scan Peak SAR  : 1.870 W/kg
Zoom Scan Peak SAR  : 3.943 W/kg
```



SAR Test Report

By Operator : Jay
Measurement Date : 19-Jun-2012
Starting Time : 19-Jun-2012 04:07:27 PM
End Time : 19-Jun-2012 04:35:01 PM
Scanning Time : 1654 secs

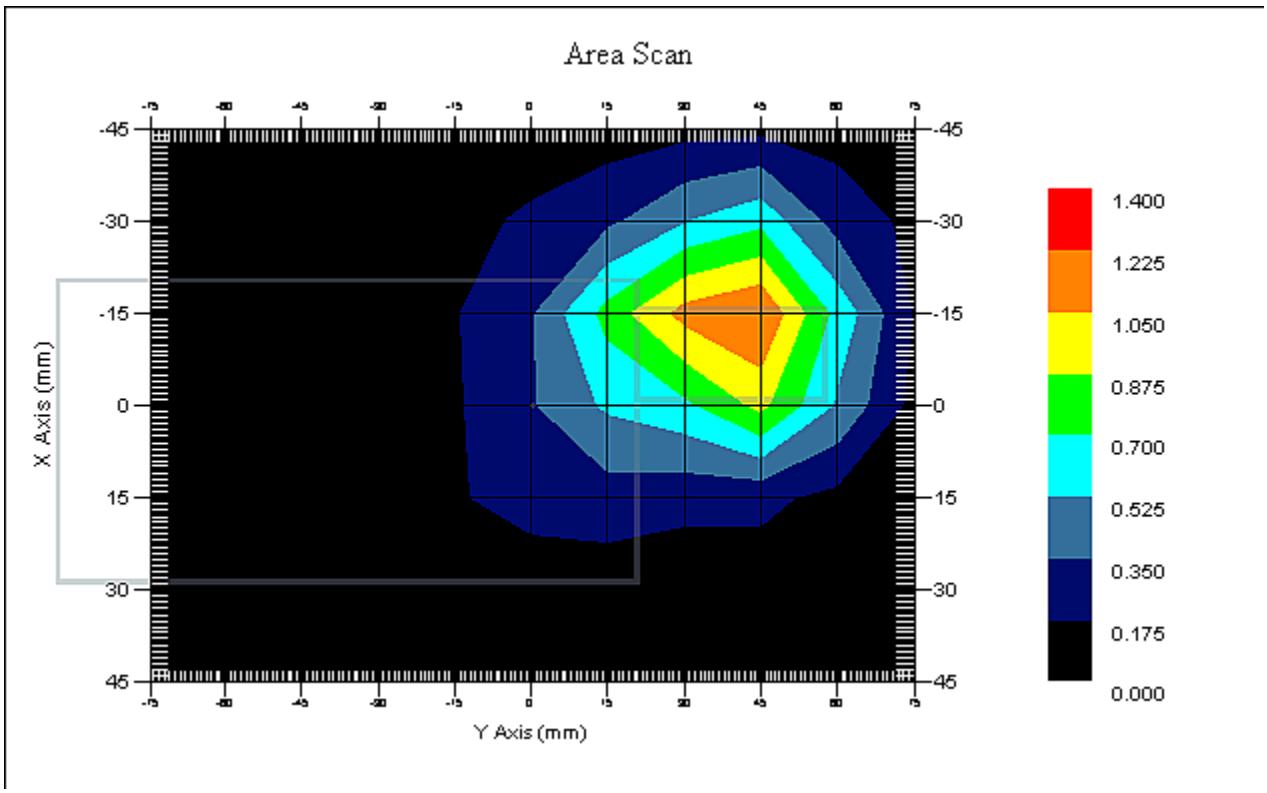
Product Data
Device Name : NAL Research
Serial No. : D03MP0
Mode : BPSK
Model : SHOUT ts
Frequency : 1626.00 MHz
Max. Transmit Pwr : 0.371 W
Drift Time : 0 min(s)
Length : 112 mm
Width : 60 mm
Depth : 24 mm
Antenna Type : Stub
Orientation : Front
Power Drift-Start : 0.319 W/kg
Power Drift-Finish: 0.330 W/kg
Power Drift (%) : 3.568

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

Tissue Data
Type : BODY
Serial No. : 1626
Frequency : 1626.00 MHz
Last Calib. Date : 19-Jun-2012
Temperature : 20.00 °C
Ambient Temp. : 23.00 °C
Humidity : 45.00 RH%
Epsilon : 53.68 F/m
Sigma : 1.42 S/m
Density : 1000.00 kg/cu. m

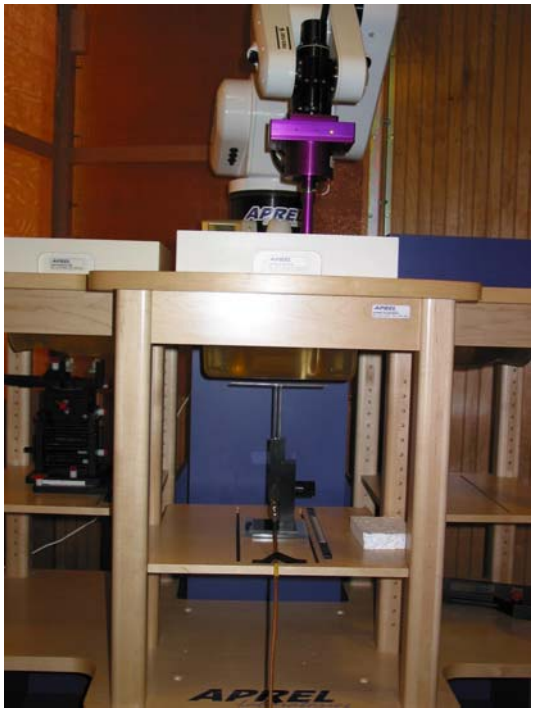
Probe Data
Name : RFEL 217
Model : E020
Type : E-Field Triangle
Serial No. : 217
Last Calib. Date : 07-Sep-2011
Frequency : 1640.00 MHz
Duty Cycle Factor: 10
Conversion Factor: 5
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

```
Measurement Data
Crest Factor      : 10
Scan Type         : Complete
Tissue Temp.      : 20.00 °C
Ambient Temp.     : 23.00 °C
Set-up Date       : 19-Jun-2012
Set-up Time       : 8:52:32 AM
Area Scan         : 7x11x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan         : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position      : Front
Separation        : 0 mm
Channel           : High
```

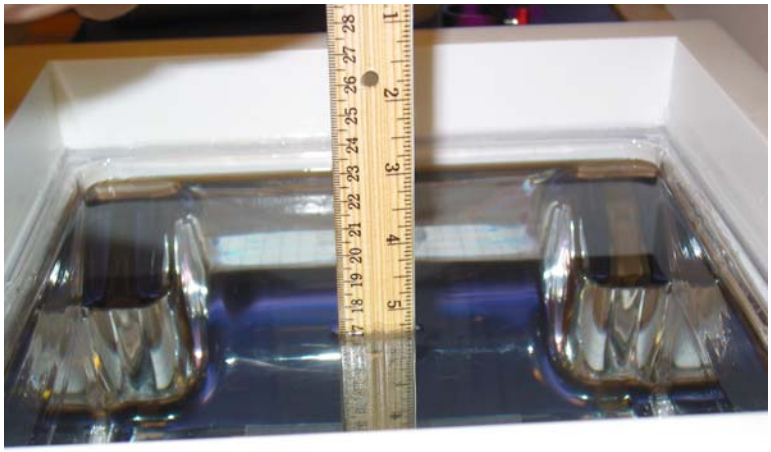



```
1 gram SAR value    : 1.050 W/kg
10 gram SAR value   : 0.620 W/kg
Area Scan Peak SAR  : 1.226 W/kg
Zoom Scan Peak SAR  : 1.791 W/kg
```

Appendix C – SAR Test Setup Photos

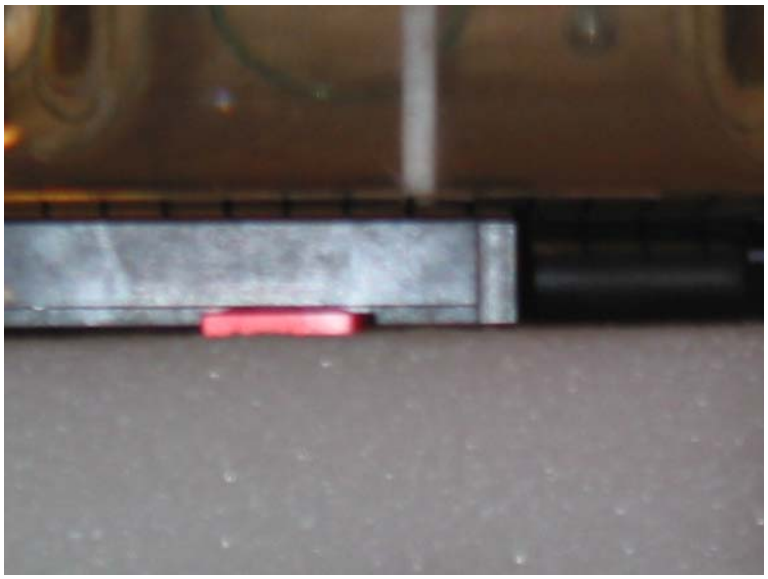


System Body Configuration



Body Tissue Depth

Back Test Position 0 mm Gap



Front Test Position 0 mm Gap

Front of Device

Back of Device

Appendix D – Probe Calibration Data Sheets

NCL CALIBRATION LABORATORIES

Calibration File No.: PC1333-1350

Client.: RFEL

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

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

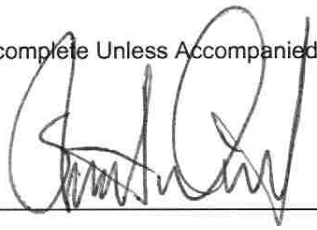
Equipment: Miniature Isotropic RF Probe
Record of Calibration
Head and Body
Manufacturer: APREL Laboratories
Model No.: E-020
Serial No.: 217

Calibration Procedure: D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole
Project No: RFEL-PC-5620

Calibrated: 7th September 2011
Released on: 7th September 2011

Approved By: Stuart Nicol

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

Released By: 

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

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 meteorgical 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

Conditions

Probe 217 was a re-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 date**
Power meter Anritsu MA2408A	90025437	Nov.4, 2010
Power Sensor Anritsu MA2481D	103555	Nov 4, 2010
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2010
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2011

Secondary Measurement Standards

Signal Generator Agilent E4438C -506	MY55182336	June 7, 2011

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 probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

Jesse Hones

Probe Summary

Probe Type:	E-Field Probe E020
Serial Number:	217
Frequency:	750MHz
Sensor Offset:	1.56
Sensor Length:	2.5
Tip Enclosure:	Composite*
Tip Diameter:	< 2.9 mm
Tip Length:	55 mm
Total Length:	289 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X:	1.2 μV/(V/m)^2
Channel Y:	1.2 μV/(V/m)^2
Channel Z:	1.2 μV/(V/m)^2
Diode Compression Point:	95 mV

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**	**45.31**	**0.91**	**4.1**	**3.6**	**5.8**
450 B	**Body**	**56.77**	**0.99**	**4.1**	**3.6**	**6.0**
650 B	**Body**	**57.42**	**0.91**	**3.96**	**3.5**	**6.2**
750 H	**Head**	**42.16**	**0.87**	**3.94**	**3.5**	**6.2**
750 B	**Body**	**55.54**	**0.94**	**3.94**	**3.4**	**6.3**
835 H	**Head**	**42.5**	**0.93**	**3.5**	**3.4**	**6.4**
835 B	**Body**	**56.37**	**0.954**	**3.5**	**3.4**	**6.4**
900 H	**Head**	**41.89**	**1.0**	**3.5**	**3.4**	**6.1**
900 B	**Body**	**53.68**	**1.05**	**3.5**	**3.4**	**6.1**
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**	**39.0**	**1.25**	**3.5**	**2.7**	**5.2**
1640 B	**Body**	**52.03**	**1.39**	**3.5**	**2.7**	**5.0**
1735 H	Head	X	X	X	X	X
1735 B	**Body**	**51.68**	**1.5**	**3.5**	**2.7**	**5.2**
1800 H	**Head**	**38.38**	**1.39**	**3.5**	**2.7**	**4.9**
1800 B	**Body**	**51.54**	**1.56**	**3.5**	**2.7**	**5.1**
1900 H	**Head**	**38.4**	**1.43**	**3.5**	**2.7**	**4.9**
1900 B	**Body**	**52.08**	**1.59**	**3.5**	**2.7**	**4.8**
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**	**38.2**	**1.82**	**3.5**	**3.5**	**3.91**
2450B	**Body**	**51.74**	**1.96**	**3.5**	**3.5**	**3.94**
2600 H	Head	X	X	X	X	X
2600 B	**Body**	**51.18**	**2.16**	**3.5**	**3.5**	**4.0**
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

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%.

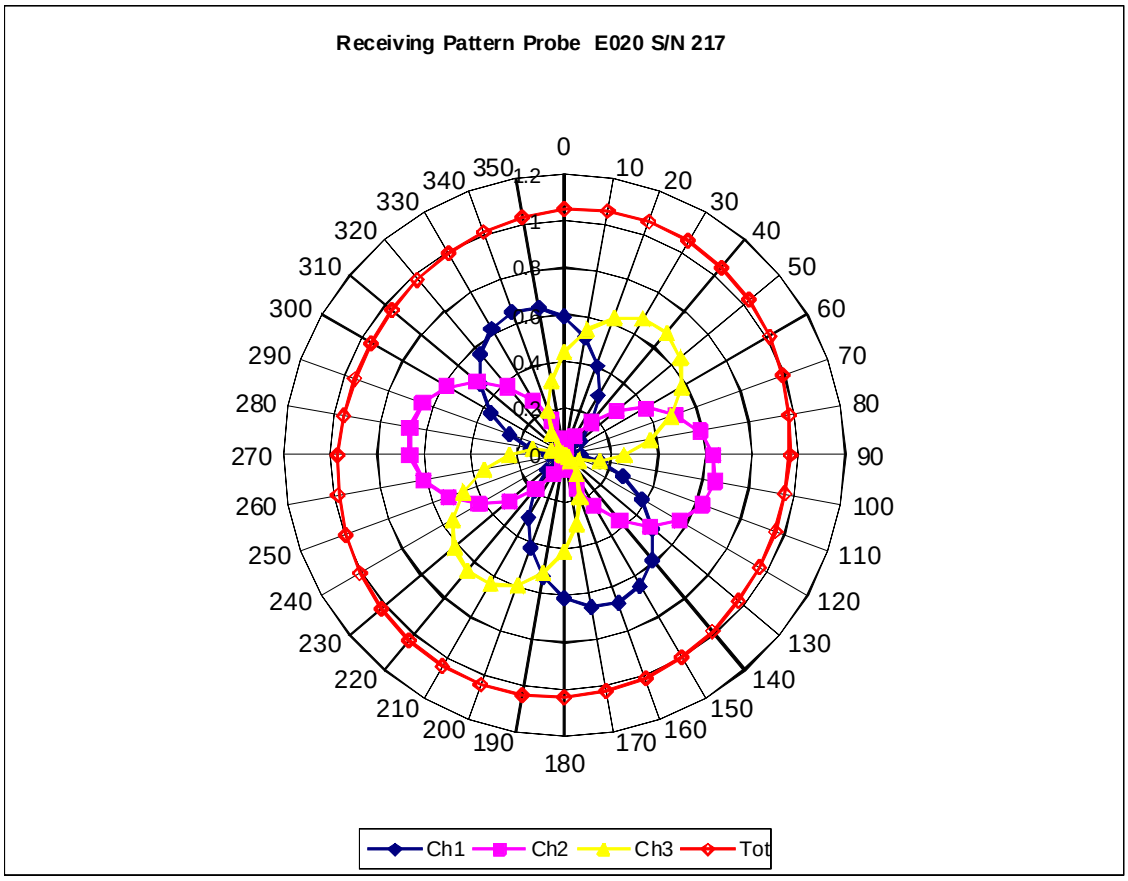
NOTES:

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

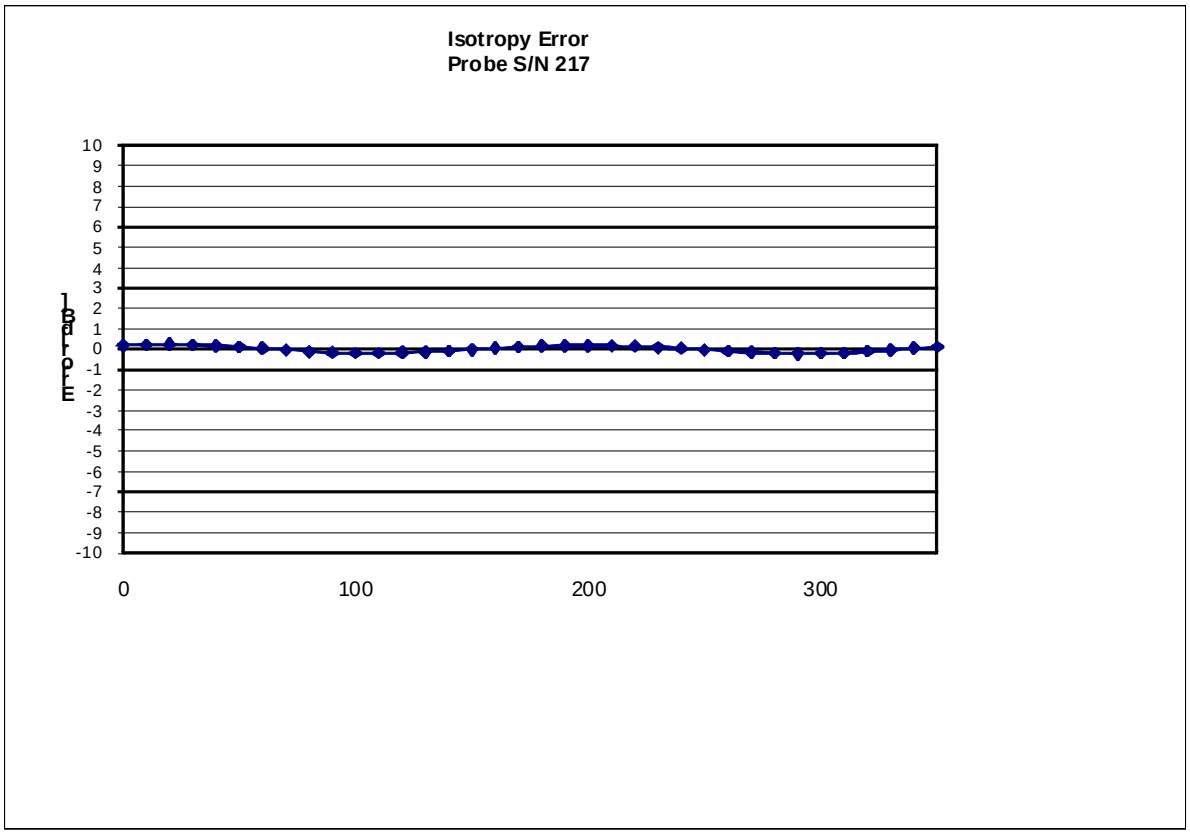
The probe was received in good condition.

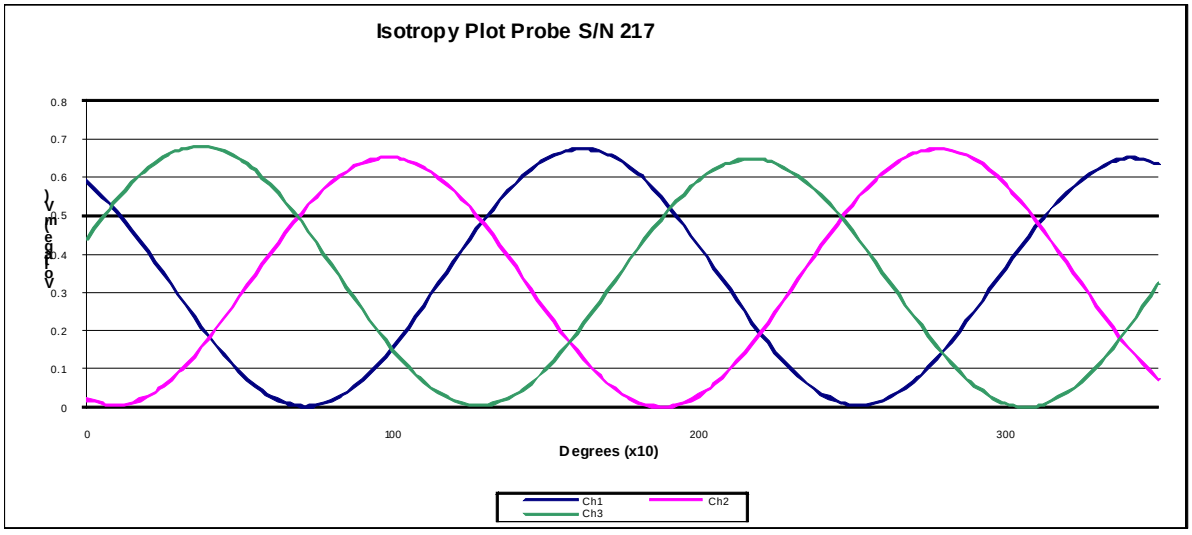
Probe was calibrated on new DAC-PAQ.

Receiving Pattern Air



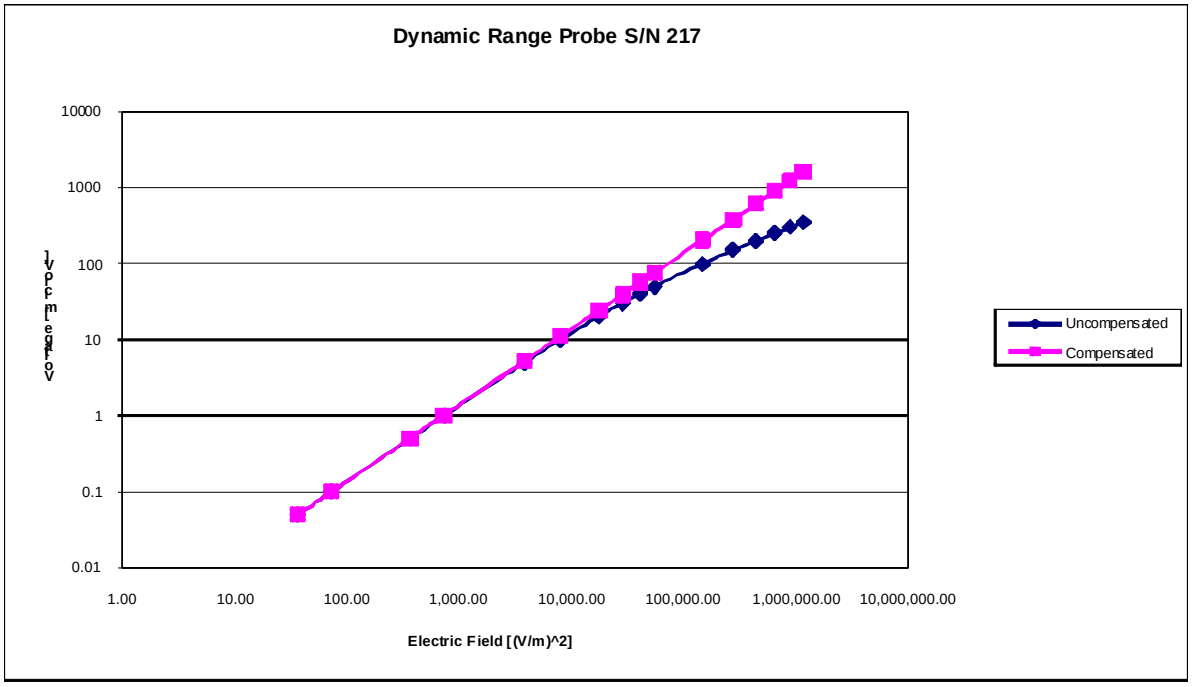
Isotropy Error



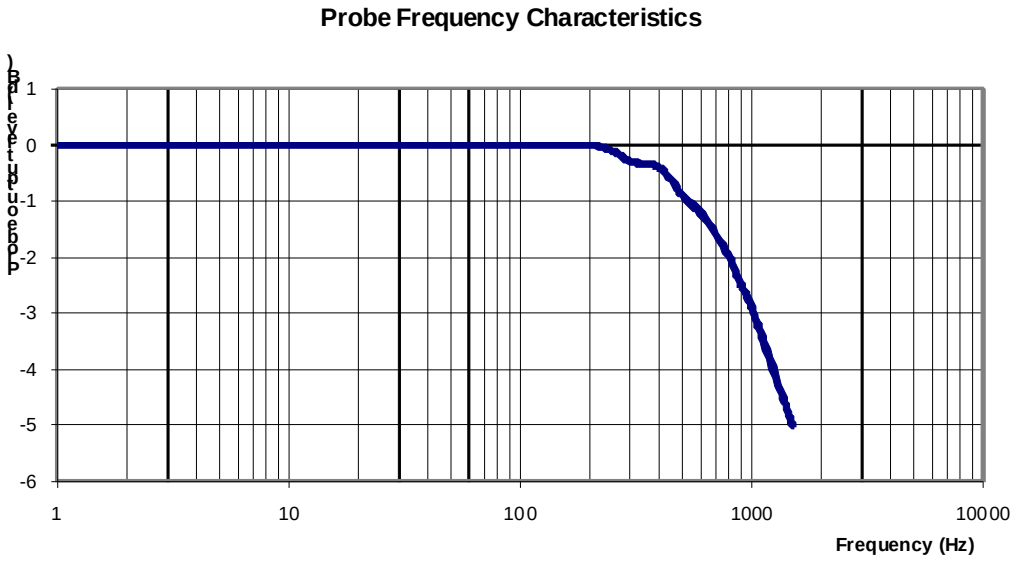


Isotropicity Tissue: 0.12 dB

Dynamic Range



Video Bandwidth



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 2011.

Appendix E – Dipole Calibration Data Sheets

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1121
Project Number: RFEB-5500

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

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

Validation Dipole

Manufacturer: APREL Laboratories
Part number: ALS-D-1640-S-2
Frequency: 1640 MHz Body
Serial No: 207-001-01

Customer: RFEL

Calibrated: 23rd February 2010
Released on: 23rd February 2010

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

Released By: _____

NCL CALIBRATION LABORATORIES
51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6
Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4162

Conditions

Dipole 207-001-01 was a new calibration.

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

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

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

Stuart Nicol

C. Teodorian

Calibration Results Summary

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

Mechanical Dimensions

Length: 80.4 mm
Height: 45.7 mm

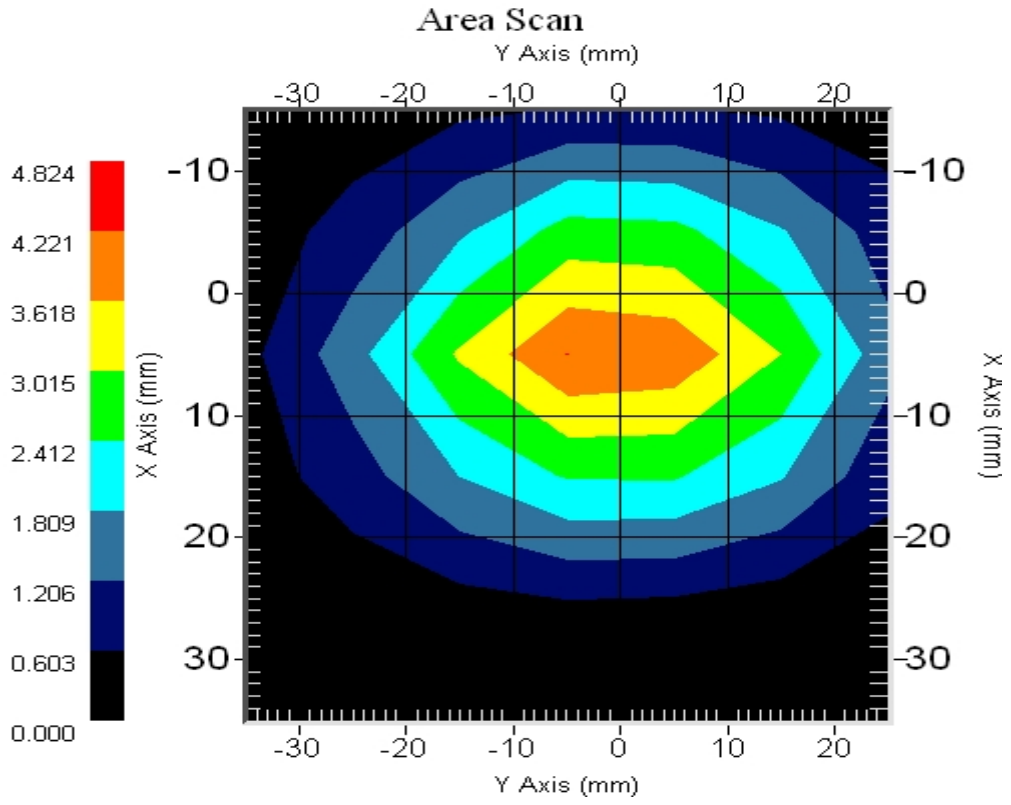
Electrical Specification

SWR: 1.087 U
Return Loss: -27.568 dB
Impedance: 49.426 Ω

System Validation Results @ 1W

Measured Values

Frequency	1 Gram	10 Gram	Peak
1640 MHz	34.201	18.144	61.76



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

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 207-001-01. 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 215.

References

SSI-TP-018-ALSAS Dipole Calibration Procedure
SSI-TP-016 Tissue Calibration Procedure
IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”

Conditions

Dipole 207-001-01 was a re-calibration.

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

Dipole Calibration uncertainty

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

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

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
80.4 mm	45.7 mm	80.4 mm	45.6 mm

Tissue Validation

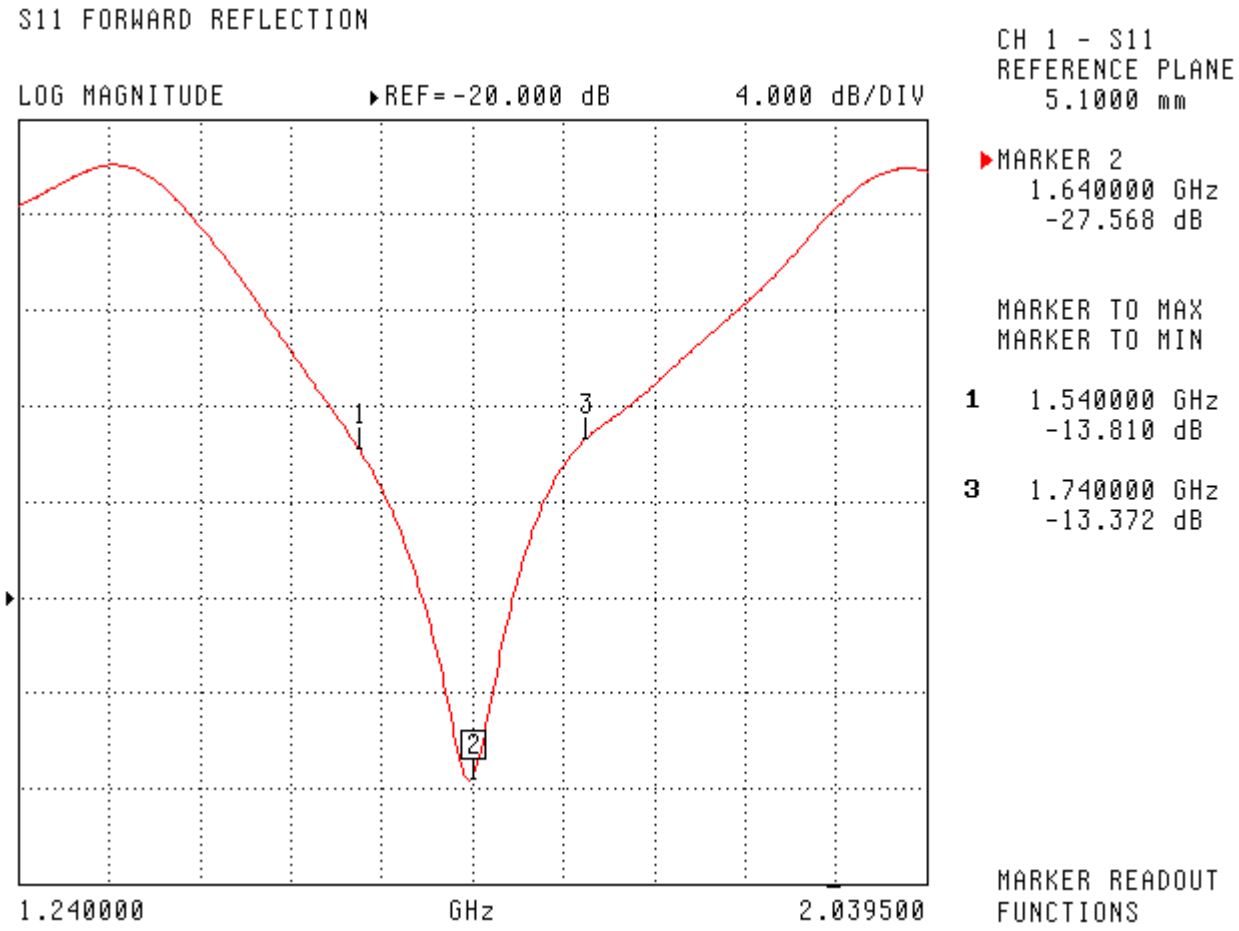
Body Tissue 1640 MHz	Measured
Dielectric constant, ε_r	53.4
Conductivity, σ [S/m]	1.41

Electrical Calibration

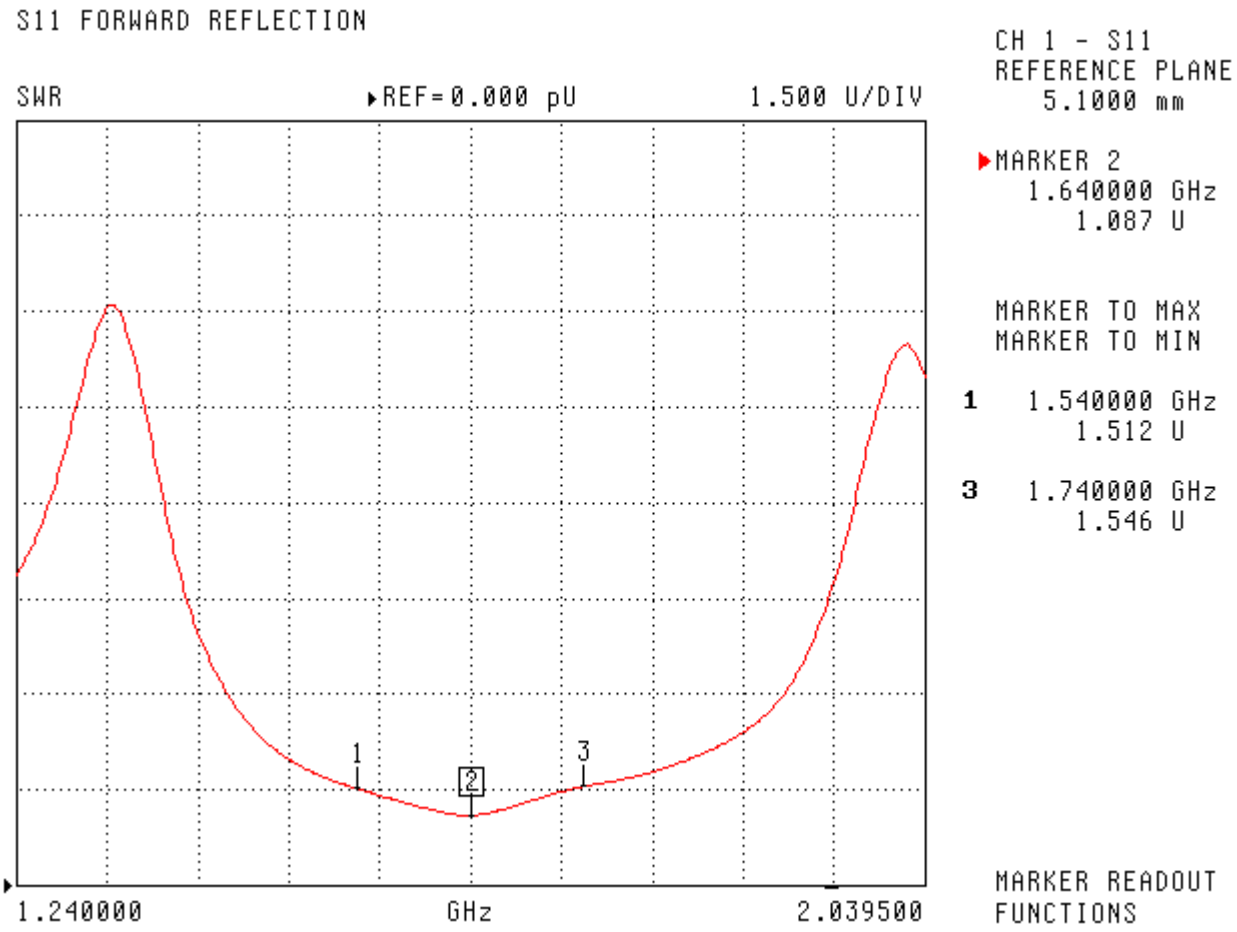
Test	Result
S11 R/L	-27.568dB
SWR	1.087U
Impedance	49.426 Ω

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

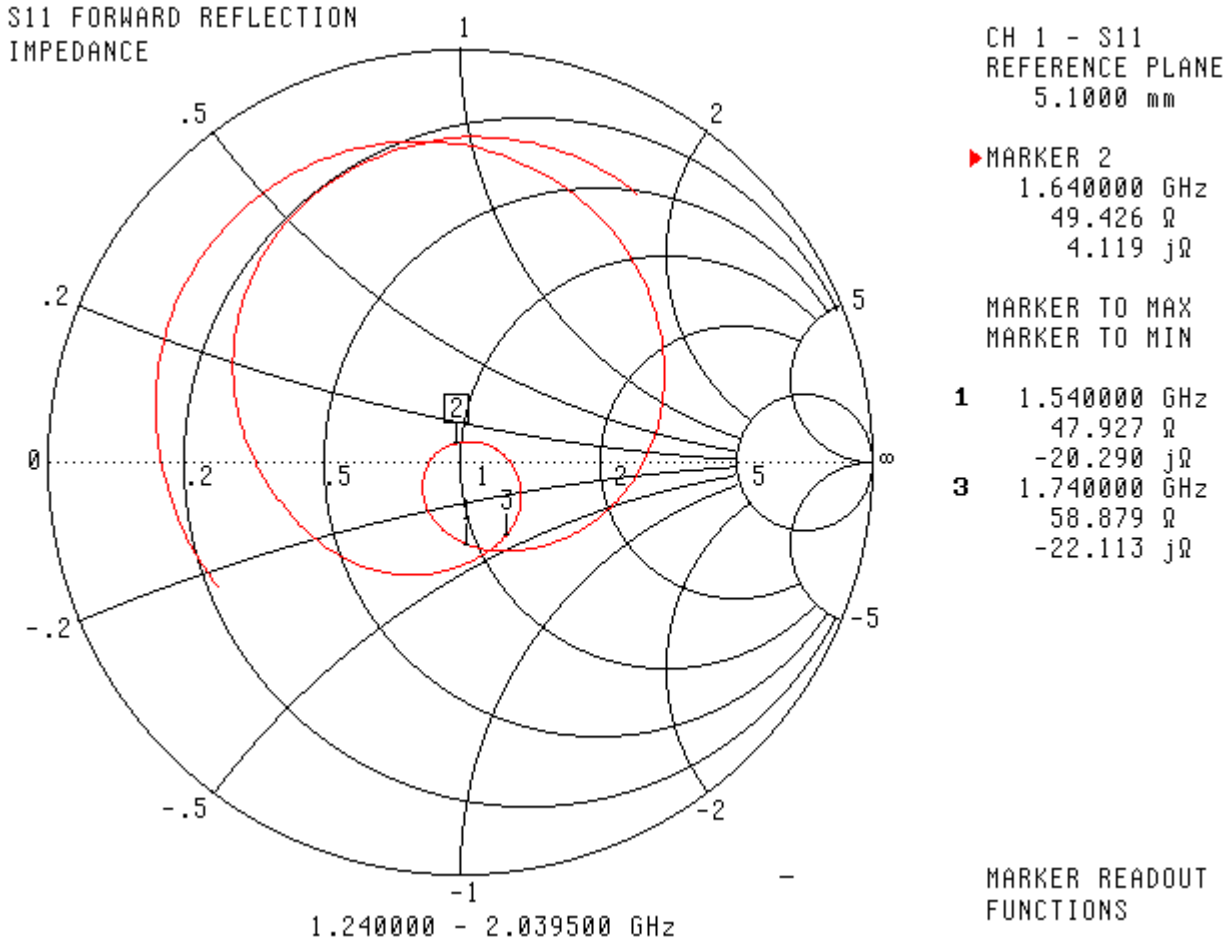
S11 Parameter Return Loss



SWR



Smith Chart Dipole Impedance



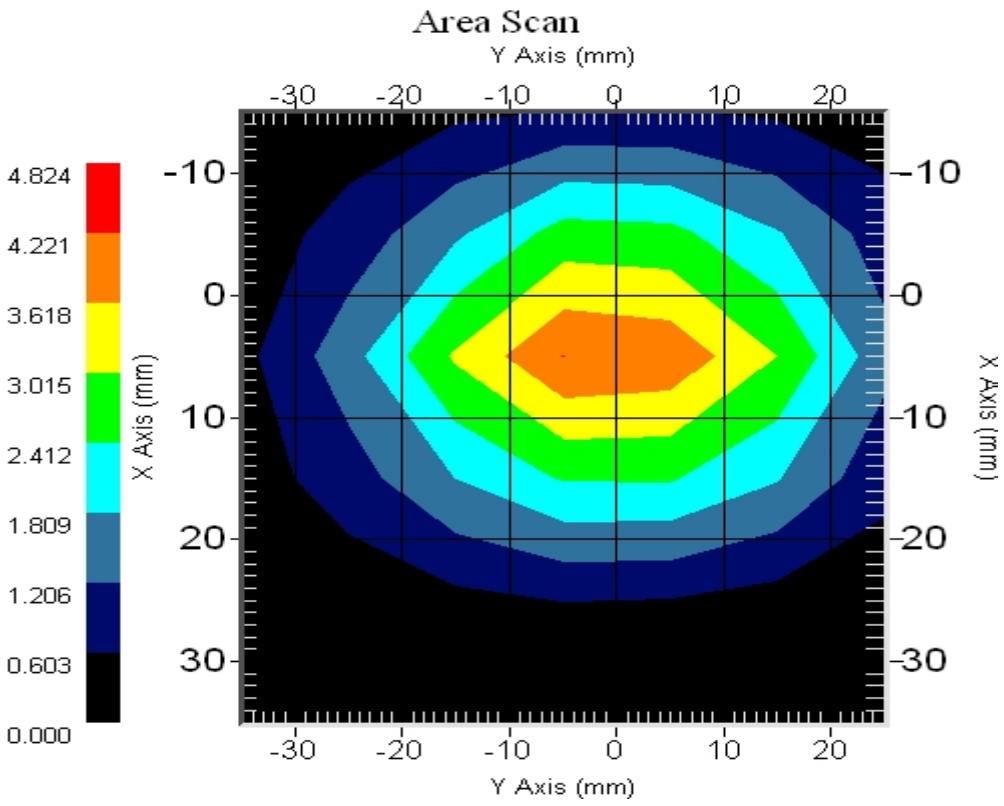
This page has been reviewed for content and attested to by signature within this document.

System Validation Results Using the Electrically Calibrated Dipole

Results @ 1W

Measured Results

Body Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
1640 MHz	34.201	18.14	61.76



NOTE: Target values based on interpolated vales presented in FCC Supplement C.

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 2009.

Extended Calibration

Usage of SAR dipoles calibrated less than 2 years ago but more than 1 year ago were confirmed in maintaining return loss (< -20 dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB Publication 450824:

ALS-D-1640-S-2 SN: 207-001-01				
Date of Measurement	Return Loss (dB)	Δ%	Impedance (Ω)	Δ%
2/23/2010	-27.568		49.426	
1/12/2011	-26.384	-4.3	48.291	-2.3
1/12/2012	-26.945	-2.3	49.023	-0.8

Appendix F – Phantom Calibration Data Sheets

NCL CALIBRATION LABORATORIES

Calibration File No.: RFE-273

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 National Standards.

Thickness of the UniPhantom is 2 mm ± 10%
Pinna thickness is 6 mm ± 10%

Resolution:	0.01 mm	Calibrated to:	0.0 mm
Stability:	OK	Accuracy:	< 0.1 mm

Calibrated By: Karen K. Feb 17/04.

NCL CALIBRATION LABORATORIES
51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161