

## SAR EVALUATION REPORT

For

### Northfield Telecommunications, Inc. d/b/a Advanced Wireless Communications

20809 Kensington Blvd, Lakeville, Minnesota, 55044, USA

**FCC ID: Q9SAWR8000**

|                                                                                                                                                                                                                                                                                                                  |                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>Report Type:</b><br>Original report                                                                                                                                                                                                                                                                           | <b>Product Type:</b><br>Two-way radio |
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| <b>Report Number:</b> <u>RDG160815001-20A</u>                                                                                                                                                                                                                                                                    |                                       |
| <b>Report Date:</b> <u>2016-09-10</u>                                                                                                                                                                                                                                                                            |                                       |
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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                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                | Northfield Telecommunications, Inc. d/b/a Advanced Wireless Communications |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            | EUT Description                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                | Two-way radio                                                              |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            | FCC ID                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                | Q9SAWR8000                                                                 |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            | Model Number                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                | Tested Model:AWR8000<br>Multiple Models: AWR8002                           |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            | Test Date                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                | 2016-08-26                                                                 |     |
| Frequency (MHz)                                                                                                                                                                                                                                                                                                                                                                                                                                        | Modulation | Max. SAR Level(s) Reported (1g)                                                                                                                                                                                                                                                                                                                             |                                                                                                                                | Limit (W/Kg)                                                               |     |
| 450-470                                                                                                                                                                                                                                                                                                                                                                                                                                                | Analog     | 6.25kHz                                                                                                                                                                                                                                                                                                                                                     | Face up: 0.508 W/kg(corrected by Multiplying 50%.)<br>Body-Back: 0.896 W/kg(corrected by Multiplying 50%.)                     |                                                                            | 8.0 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Analog     | 12.5kHz                                                                                                                                                                                                                                                                                                                                                     | Face up: 2.545 W/kg ( <i>corrected by Multiplying 50%.</i> )<br>Body-Back: 4.125 W/kg ( <i>corrected by Multiplying 50%.</i> ) |                                                                            |     |
| Simultaneous                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                                                                                                                                                                                                                                                                                                                                                             | Face up: 2.576 W/kg<br>Body-Back: 4.281 W/kg                                                                                   |                                                                            |     |
| Applicable Standards                                                                                                                                                                                                                                                                                                                                                                                                                                   |            | ANSI / IEEE C95.1: 2005<br>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<br>IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to   SuchFields,100 kHz—300 GHz.                                                                                                                                                            |                                                                                                                                |                                                                            |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            | IEC62209-2:2010<br>Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body.                                |                                                                                                                                |                                                                            |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            | IEEE1528:2013<br>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<br>KDB 447498 D01 v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.<br>KDB 865664 D01v01r04: SAR measurement 100 MHz to 6 GHz v01.<br>KDB 643646D01 v01r03: SAR test Reduction Considerations for Occupational PTT Radios.<br>KDB Inquiry: Tracking Number 316436 for SAR VHF system validation. |                                                                                                                                |                                                                            |     |
| <b>Note:</b> This wireless device has been shown to be capable of compliance for localized specific absorption rate SAR for Occupational /Controlled Exposure Environment 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.<br><b>The results and statements contained in this report pertain only to the device(s) evaluated.</b> |            |                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                |                                                                            |     |

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**DOCUMENT REVISION HISTORY**

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| Revision Number | Report Number    | Description of Revision | Date of Revision |
|-----------------|------------------|-------------------------|------------------|
| 0               | RDG160815001-20A | Original Report         | 2016-09-10       |

## EUT DESCRIPTION

This report has been prepared on behalf of Northfield Telecommunications, Inc. d/b/a Advanced Wireless Communications and their product and their product, FCC ID: Q9SAWR8000, Model: AWR8000 or the EUT (Equipment Under Test) as referred to in the rest of this report. The EUT is a Two-way radio.

Note:

1. This series products model: AWR8002 and AWR8000, we select model: AWR8000 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>       | FM                               |
| <b>Frequency Band:</b>        | FM :450MHz-470MHz                |
| <b>Conducted RF Power:</b>    | FM :36.18 dBm                    |
| <b>Dimensions (L*W*H):</b>    | 132mm (L)×58mm (W)×39mm (H)      |
| <b>Power Source:</b>          | 7.4V 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 /<br>Uncontrolled Exposure<br>Environment) | (Occupational /<br>Controlled Exposure<br>Environment) |
| Spatial Average<br>(averaged over the whole body)                | 0.08                                                           | 0.4                                                    |
| Spatial Peak<br>(averaged over any 1 g of tissue)                | 1.60                                                           | 8.0                                                    |
| Spatial Peak<br>(hands/wrists/feet/ankles<br>averaged over 10 g) | 4.0                                                            | 20.0                                                   |

**CE Limit (10g Tissue)**

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

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

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

Occupational/Controlled environments Spatial Peak limit 8.0W/kg (FCC/IC) & 10 W/kg (CE) applied to the EUT.

## **FACILITIES**

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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

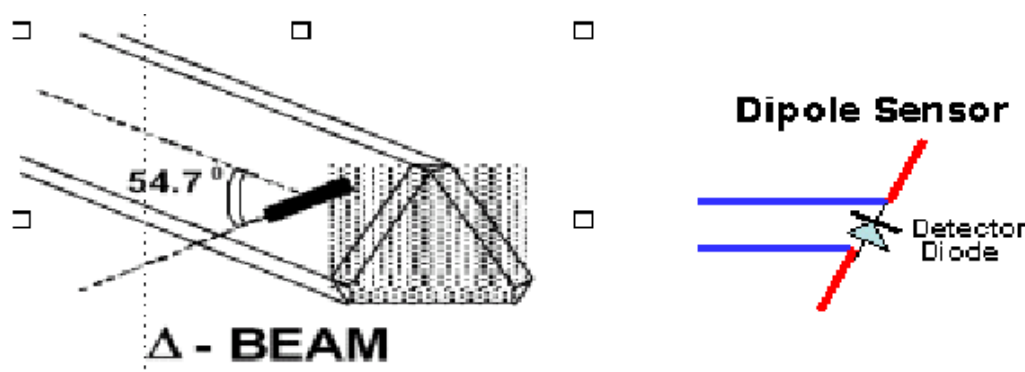
The overall uncertainty for the methodology and algorithms the used during the SAR calculation was evaluated using the data from IEEE 1528 based on the example f3 algorithm:

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

## 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<br>Below 1 GHz Calibration in air performed in a TEM Cell<br>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<br>@ 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.<br>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.

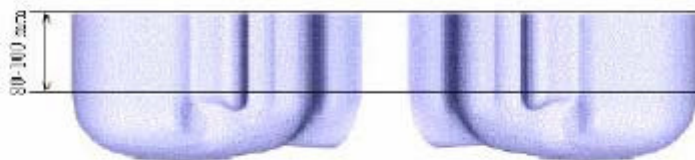


### Phantom Types

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<br>(% 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<br>(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           |

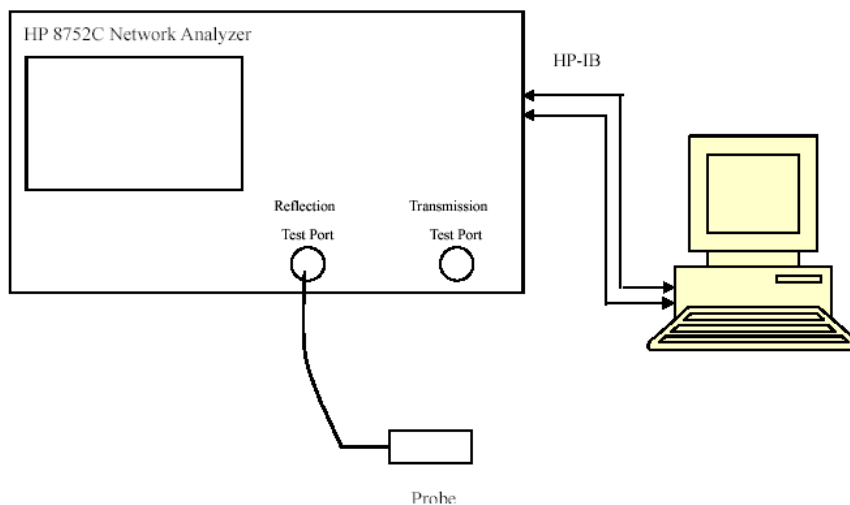
## EQUIPMENT LIST AND CALIBRATION

### Equipments List & Calibration Information

| Equipment                                                | Model         | Calibration Date | Calibration Due Date | S/N        |
|----------------------------------------------------------|---------------|------------------|----------------------|------------|
| CRS F3 robot                                             | ALS-F3        | N/A              | N/A                  | RAF0805352 |
| CRS F3 Software                                          | ALS-F3-SW     | N/A              | N/A                  | N/A        |
| CRS C500C controller                                     | ALS-C500      | N/A              | N/A                  | RCF0805379 |
| Probe mounting device & Boundary Detection Sensor System | ALS-PMDPS-3   | N/A              | N/A                  | 120-00270  |
| Universal Work Station                                   | ALS-UWS       | N/A              | N/A                  | 100-00157  |
| Data Acquisition Package                                 | ALS-DAQ-PAQ-3 | 2015-12-14       | 2016-12-14           | 110-00212  |
| Miniature E-Field Probe                                  | ALS-E-020     | 2015-12-14       | 2016-12-14           | 500-00283  |
| Dipole, 450 MHz                                          | ALS-D-450-S-2 | 2013-10-08       | 2016-10-08           | 175-00503  |
| Device holder/Positioner                                 | ALS-H-E-SET-2 | N/A              | N/A                  | 170-00510  |
| Left ear SAM phantom                                     | ALS-P-SAM-L   | N/A              | N/A                  | 130-00311  |
| Right ear SAM phantom                                    | ALS-P-SAM-R   | N/A              | N/A                  | 140-00359  |
| UniPhantom                                               | ALS-UM-FLAT   | N/A              | N/A                  | 153-00104  |
| Simulated Tissue 450 MHz Head                            | ALS-TS-450-H  | Each Time        | Each Time            | 260-01106  |
| Simulated Tissue 450 MHz Body                            | ALS-TS-450-B  | Each Time        | Each Time            | 260-02108  |
| Power Amplifier                                          | 5S1G4         | N/A              | N/A                  | 71377      |
| Attenuator                                               | 3dB           | N/A              | N/A                  | 5402       |
| Dielectric probe kit                                     | HP85070B      | 2016-06-13       | 2017-06-13           | US33020324 |
| Network analyzer                                         | 8752C         | 2016-06-03       | 2017-06-03           | 3410A02356 |
| Synthesized Sweeper                                      | HP 8341B      | 2016-06-03       | 2017-06-03           | 2624A00116 |
| Directional couple                                       | DC6180A       | 2016-06-13       | 2017-06-13           | 0325849    |
| EMI Test Receiver                                        | ESCI          | 2016-06-13       | 2017-06-13           | 101746     |

## SAR MEASUREMENT SYSTEM VERIFICATION

### Liquid Verification



Liquid Verification Setup Block Diagram

### Liquid Verification Results

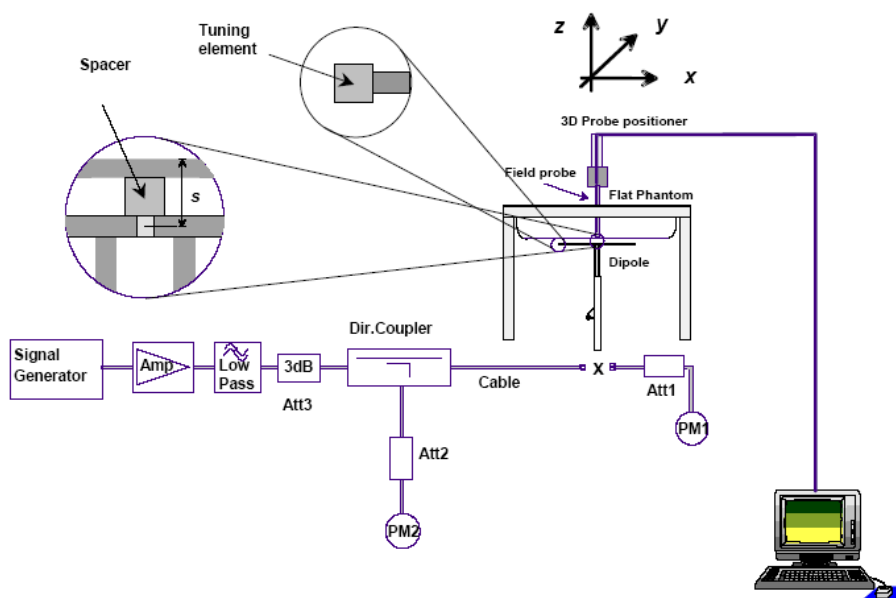
| Frequency (MHz) | Liquid Type | Liquid Parameter |                | Target Value |                | Delta (%)          |                      | Tolerance (%) |
|-----------------|-------------|------------------|----------------|--------------|----------------|--------------------|----------------------|---------------|
|                 |             | $\epsilon_r$     | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) | $\Delta\epsilon_r$ | $\Delta\sigma$ (S/m) |               |
| 450.0125        | Head        | 42.73            | 0.89           | 43.50        | 0.87           | -1.770             | 2.299                | $\pm 5$       |
|                 | Body        | 56.93            | 0.95           | 56.70        | 0.94           | 0.406              | 1.064                | $\pm 5$       |
| 460.0125        | Head        | 42.34            | 0.88           | 43.50        | 0.87           | -2.667             | 1.149                | $\pm 5$       |
|                 | Body        | 56.27            | 0.95           | 56.70        | 0.94           | -0.758             | 1.064                | $\pm 5$       |
| 469.9875        | Head        | 42.86            | 0.90           | 43.50        | 0.87           | -1.471             | 3.448                | $\pm 5$       |
|                 | Body        | 55.76            | 0.97           | 56.70        | 0.94           | -1.658             | 3.191                | $\pm 5$       |

\*Liquid Verification was performed on 2016-08-26

## System Accuracy Verification

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

### System Verification Setup Block Diagram



### System Accuracy Check Results

| Date       | Frequency (MHz) | Liquid Type | Measured SAR (W/Kg) |       | Target Value (W/Kg) | Delta (%) | Tolerance (%) |
|------------|-----------------|-------------|---------------------|-------|---------------------|-----------|---------------|
| 2016-08-26 | 450             | Head        | 1g                  | 4.652 | 4.572               | 0.974     | $\pm 10$      |
|            |                 | Body        | 1g                  | 4.716 | 4.508               | 3.049     | $\pm 10$      |

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

**SAR SYSTEM VALIDATION DATA****Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****System Performance Check 450 MHz 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 : 4.315 W/kg  
Power Drift-Finish : 4.353 W/kg  
Power Drift (%) : 0.892

**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 : 26-Aug-2016  
Temperature : 20.00 °C  
Ambient Temp. : 21.00 °C  
Humidity : 56.00 RH%  
Epsilon : 42.73 F/m  
Sigma : 0.89 S/m  
Density : 1000.00 kg/cu. m

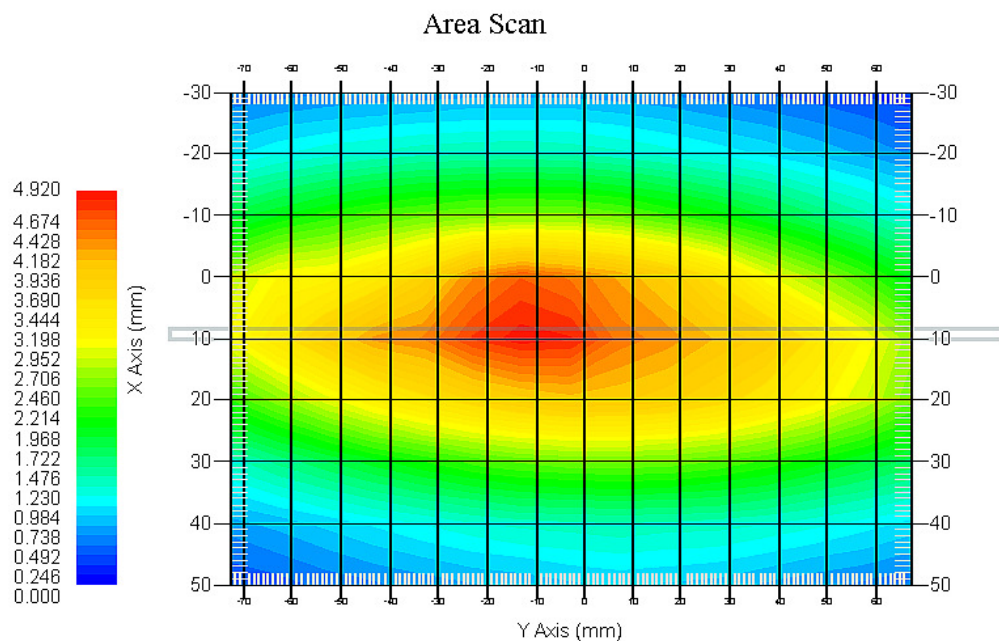
**Probe Data**

Name : E-Field  
Model : E-020  
Type : E-Field Triangle  
Serial No. : 500-00283  
Last Calib. Date : 14-Dec-2015  
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 : 9x15x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

1 gram SAR value : 4.652 W/kg  
10 gram SAR value : 2.817 W/kg  
Area Scan Peak SAR : 4.905 W/kg  
Zoom Scan Peak SAR : 6.833 W/kg



**450 MHz System Verification with Head Tissue**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****System Performance Check 450 MHz 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 : 3.552 W/kg  
Power Drift-Finish : 3.597 W/kg  
Power Drift (%) : 1.236

## 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 : 26-Aug-2016  
Temperature : 20.00 °C  
Ambient Temp. : 21.00 °C  
Humidity : 56.00 RH%  
Epsilon : 56.93 F/m  
Sigma : 0.95 S/m  
Density : 1000.00 kg/cu. m

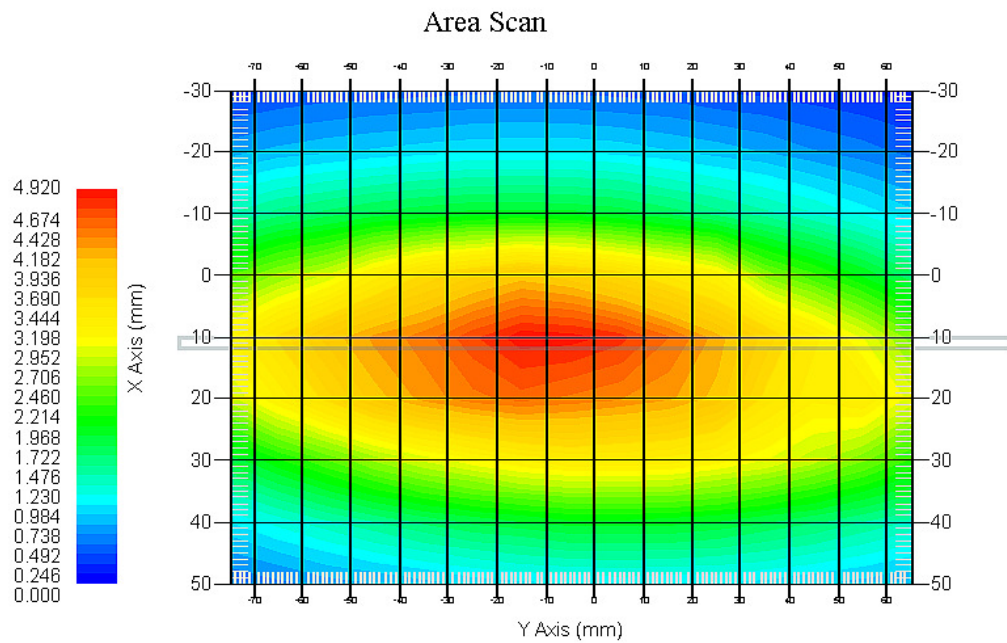
## Probe Data

Name : E-Field  
Model : E-020  
Type : E-Field Triangle  
Serial No. : 500-00283  
Last Calib. Date : 14-Dec-2015  
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 : 9x15x1 : Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm

1 gram SAR value : 4.716 W/kg  
10 gram SAR value : 2.772 W/kg  
Area Scan Peak SAR : 4.911 W/kg  
Zoom Scan Peak SAR : 7.025 W/kg

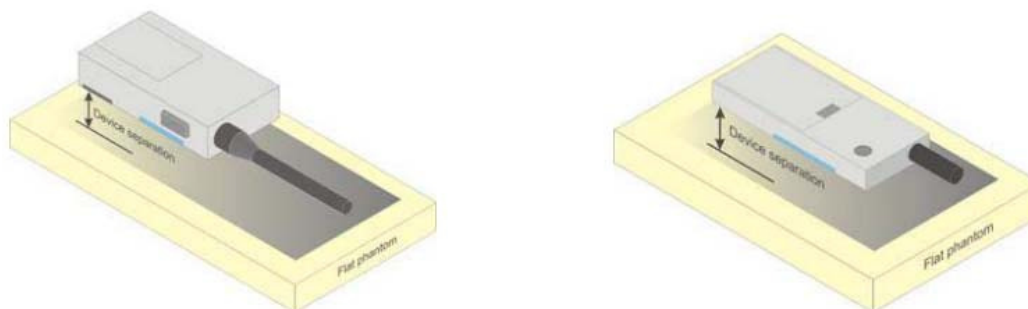


#### 450 MHz System Verification with Body Tissue

## EUT TEST STRATEGY AND METHODOLOGY

### Test Positions for front-of-face configurations

A typical example of a front-of-face device is a two-way radio that is held at a distance from the face of the user when transmitting. In these cases the device under test shall be positioned at the distance to the phantom surface that corresponds to the intended use as specified by the manufacturer in the user instructions. If the intended use is not specified, a separation distance of 25 mm<sup>5</sup> between the phantom surface and the device shall be used.



### 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.

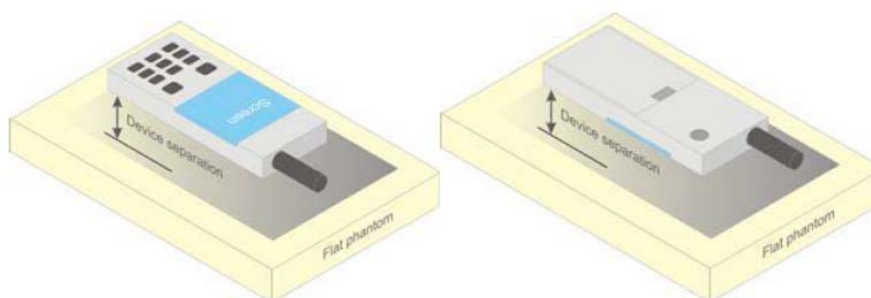


Figure 5 – Test positions for body-worn devices

## For EUT Positioning Procedures

The EUT is a portable device operational at the body and face. The intended operating positions are "at the face" with the EUT at least 2.5cm from the mouth, and "at the body" by means of the offered body worn accessories. Body worn audio and PTT operation is accomplished by means of optional remote accessories that are connected to the radio.

### Body

The EUT was positioned in normal use configuration against the phantom with the offered body worn accessory with the offered audio accessories as applicable

### Head

Not applicable

### Face

The EUT was positioned with its' front side separated 2.5cm from the phantom

## 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 30 mm x 30 mm x 30 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

IEC62209-2:2010  
IEEE1528:2013  
KDB 447498 D01 v06  
KDB 865664 D01 v01r04  
KDB 643646 D01 v01r03

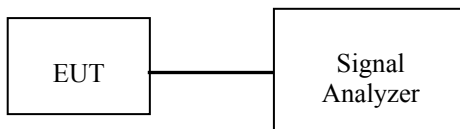
## CONDUCTED OUTPUT POWER MEASUREMENT

### 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. tune-up tolerance power limit for Production Unit (dBm) |                       |        |      |
|--------------------------------------------------------------|-----------------------|--------|------|
| PTT/Mode                                                     | Frequency(450-470MHz) |        |      |
| Analog-6.25K                                                 | 30.10                 |        |      |
| Analog-12.5K                                                 | 36.20                 |        |      |
| Mode/Band                                                    | Channel               |        |      |
|                                                              | Low                   | Middle | High |
| Bluetooth3.0                                                 | 5.70                  |        |      |

### Test Results:

| Mode   | Frequency Spacing (kHz) | Frequency (MHz) | Output(dBm)  | Output Power(W) | Power level |
|--------|-------------------------|-----------------|--------------|-----------------|-------------|
| Analog | 6.25                    | 450.0125        | /            | /               | High        |
|        |                         | 460.0125        | /            | /               | High        |
|        |                         | 469.9875        | /            | /               | High        |
|        |                         | 450.0125        | 30.00        | 1.00            | Low         |
|        |                         | 460.0125        | 30.04        | 1.01            | Low         |
|        |                         | 469.9875        | 29.91        | 0.98            | Low         |
|        | 12.5                    | 450.0125        | 36.09        | 4.06            | High        |
|        |                         | 460.0125        | <b>36.18</b> | 4.15            | High        |
|        |                         | 469.9875        | 36.05        | 4.03            | High        |
|        |                         | 450.0125        | 30.04        | 1.01            | Low         |
|        |                         | 460.0125        | 30.09        | 1.02            | Low         |
|        |                         | 469.9875        | 30.00        | 1.00            | Low         |

Note : The measurement was made in the room temperature.

**Bluetooth:**

| Mode                 | Channel No. | Channel frequency (MHz) | Conducted Output Power |       |
|----------------------|-------------|-------------------------|------------------------|-------|
|                      |             |                         | (dBm)                  | (mW)  |
| BDR(GFSK)            | 0           | 2402                    | 5.41                   | 3.475 |
|                      | 39          | 2441                    | 5.59                   | 3.622 |
|                      | 78          | 2480                    | <b>5.66</b>            | 3.681 |
| EDR( $\pi/4$ -DQPSK) | 0           | 2402                    | 3.70                   | 2.344 |
|                      | 39          | 2441                    | 3.82                   | 2.410 |
|                      | 78          | 2480                    | 3.82                   | 2.410 |
| EDR(8DPSK)           | 0           | 2402                    | 4.13                   | 2.588 |
|                      | 39          | 2441                    | 4.25                   | 2.661 |
|                      | 78          | 2480                    | 4.28                   | 2.679 |

## 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 Hans.Zhao on 2016-08-26.

### Test Result:

#### Analog (Modulation FM; Channel Spacing 6.25 kHz):

| Frequency<br>(MHz)               | Power<br>Drift<br>(%) | Max.<br>Meas.<br>Power<br>(dBm) | Max.<br>Rated<br>Power<br>(dBm) | 1 g SAR Value (W/Kg) |           |            |              |           |
|----------------------------------|-----------------------|---------------------------------|---------------------------------|----------------------|-----------|------------|--------------|-----------|
|                                  |                       |                                 |                                 | Scaled<br>Factor     | Meas. SAR | Scaled SAR | 50%          | Plot      |
| Face up (2.5cm)                  |                       |                                 |                                 |                      |           |            |              |           |
| 450.0125                         | -1.440                | 30.00                           | 30.10                           | 1.023                | 0.993     | 1.016      | <b>0.508</b> | <b>1#</b> |
| 460.0125                         | 2.999                 | 30.04                           | 30.10                           | 1.014                | 0.915     | 0.928      | 0.464        | /         |
| 469.9875                         | -1.441                | 29.91                           | 30.10                           | 1.045                | 0.862     | 0.901      | 0.451        | /         |
| Body-Back with Belt Clip (0.0cm) |                       |                                 |                                 |                      |           |            |              |           |
| 450.0125                         | -0.889                | 30.00                           | 30.10                           | 1.023                | 1.751     | 1.792      | <b>0.896</b> | <b>2#</b> |
| 460.0125                         | -3.273                | 30.04                           | 30.10                           | 1.014                | 1.586     | 1.608      | 0.804        | /         |
| 469.9875                         | 1.949                 | 29.91                           | 30.10                           | 1.045                | 1.577     | 1.648      | 0.824        | /         |

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

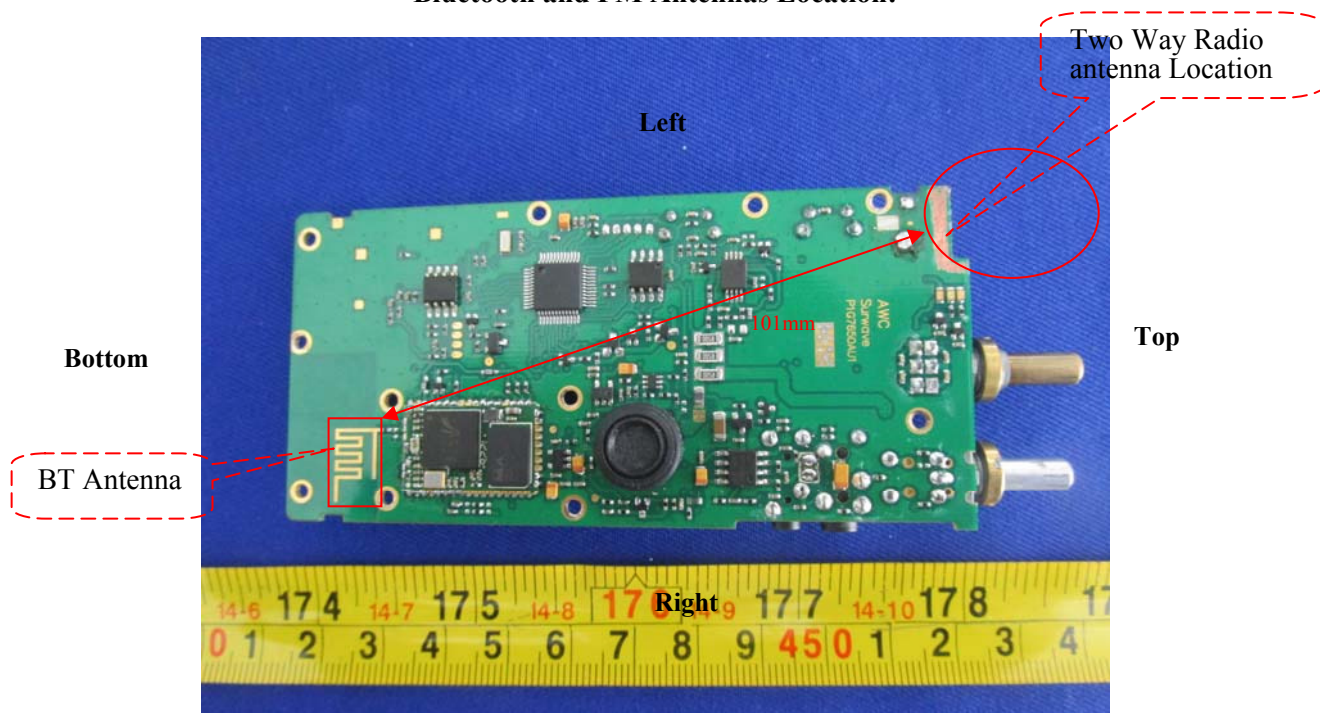
| Frequency<br>(MHz)               | Power<br>Drift<br>(%) | Max.<br>Meas.<br>Power<br>(dBm) | Max.<br>Rated<br>Power<br>(dBm) | 1 g SAR Value (W/Kg) |           |            |              |           |
|----------------------------------|-----------------------|---------------------------------|---------------------------------|----------------------|-----------|------------|--------------|-----------|
|                                  |                       |                                 |                                 | Scaled<br>Factor     | Meas. SAR | Scaled SAR | 50%          | Plot      |
| Face up (2.5cm)                  |                       |                                 |                                 |                      |           |            |              |           |
| 450.0125                         | -1.352                | 36.09                           | 36.20                           | 1.026                | 4.962     | 5.089      | <b>2.545</b> | <b>3#</b> |
| 460.0125                         | 2.443                 | 36.18                           | 36.20                           | 1.005                | 4.436     | 4.456      | 2.228        | /         |
| 469.9875                         | 1.702                 | 36.05                           | 36.20                           | 1.035                | 4.152     | 4.298      | 2.149        | /         |
| Body-Back with Belt Clip (0.0cm) |                       |                                 |                                 |                      |           |            |              |           |
| 450.0125                         | -0.762                | 36.09                           | 36.20                           | 1.026                | 8.043     | 8.249      | <b>4.125</b> | <b>4#</b> |
| 460.0125                         | -4.157                | 36.18                           | 36.20                           | 1.005                | 7.658     | 7.693      | 3.847        | /         |
| 469.9875                         | 0.561                 | 36.05                           | 36.20                           | 1.035                | 7.220     | 7.474      | 3.737        | /         |

**Note:**

1. When the 1-g SAR tested using the default battery and default accessories is  $\leq 3.5\text{W/Kg}$  (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 SIMULTANEOUS TRANSMISSION DESCRIPTION

### Bluetooth and FM Antennas Location:



### Simultaneous Transmission:

| Description of Simultaneous Transmit Capabilities |               |          | Antennas Distance (mm) |
|---------------------------------------------------|---------------|----------|------------------------|
| Transmitter Combination                           | Simultaneous? | Hotspot? |                        |
| FM + Bluetooth                                    | √             | ×        | 101                    |

### Standalone SAR test exclusion considerations

| Mode      | Frequency (GHz) | Test Position | P <sub>avg</sub> (dBm) | P <sub>avg</sub> (mW) | Distance (mm) | Calculated value | Threshold (1-g) | SAR Test Exclusion |
|-----------|-----------------|---------------|------------------------|-----------------------|---------------|------------------|-----------------|--------------------|
| Bluetooth | 2.480           | Face up       | 5.70                   | 3.715                 | 25            | 0.2              | 3.0             | Yes                |
| Bluetooth | 2.480           | Body-Back     | 5.70                   | 3.715                 | 0             | 1.2              | 3.0             | Yes                |

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

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

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

**Standalone SAR estimation:**

| Mode                | Frequency (GHz) | Distance (mm) | P <sub>avg</sub> (dBm) | P <sub>avg</sub> (mW) | Estimated 1-g (W/kg) |
|---------------------|-----------------|---------------|------------------------|-----------------------|----------------------|
| Bluetooth Face up   | 2.480           | 25            | 5.70                   | 3.715                 | 0.031                |
| Bluetooth Body-Back | 2.480           | 0             | 5.70                   | 3.715                 | 0.156                |

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

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}/x] \text{ W/kg}$  for test separation distances  $\leq 50 \text{ mm}$ ;

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

When the minimum test separation distance is  $< 5 \text{ mm}$ , a distance of  $5 \text{ mm}$  is applied to determine SAR test Exclusion

**Simultaneous SAR test exclusion considerations:****FM with BT:**

| Mode | Position                        | Reported SAR (W/kg) |       | $\Sigma$ SAR         |
|------|---------------------------------|---------------------|-------|----------------------|
|      |                                 | FM                  | BT    | $< 8.0 \text{ W/kg}$ |
| FM   | Face up (2.5cm)                 | 2.545               | 0.031 | 2.576                |
|      | Body-Back with Belt Clip(0.0cm) | 4.125               | 0.156 | 4.281                |

**Conclusion:**

$\Sigma$ SAR  $< 8.0 \text{ W/kg}$  therefore simultaneous transmission SAR with Volume Scans is **not** required.

**SAR Plots (Summary of the Highest SAR Values)****Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Face-Up 2.5cm (Analog 6.25k-450.0125 MHz)****Measurement Data**

Modulation mode : FM  
Crest Factor : 1  
Scan Type : Complete  
Area Scan : 10x13x1: Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 0.985 W/kg  
Power Drift-Finish : 0.971 W/kg  
Power Drift (%) : -1.440

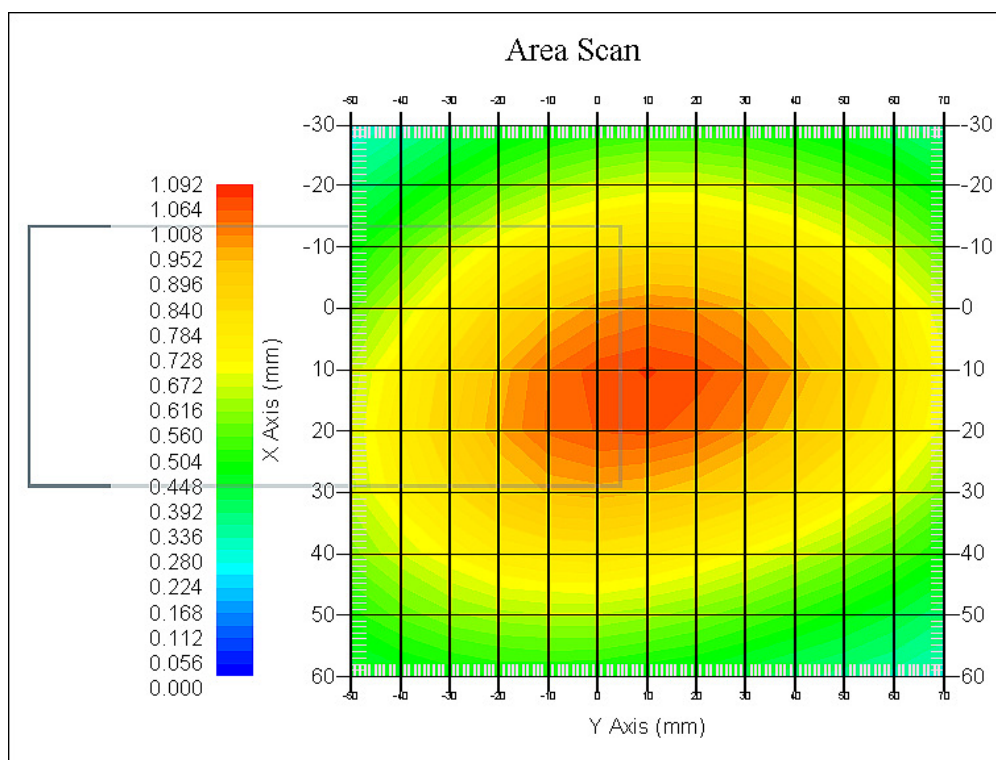
**Tissue Data**

Type : Head  
Frequency : 450.0125 MHz  
Epsilon : 42.73 F/m  
Sigma : 0.89 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 : 0.993 W/kg  
10 gram SAR value : 0.712 W/kg  
Area Scan Peak SAR : 1.087 W/kg  
Zoom Scan Peak SAR : 1.675 W/kg

**Plot 1#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Back-Worn 0.0cm (Analog 6.25k-450.0125 MHz)**

## Measurement Data

Modulation mode : FM  
Crest Factor : 1  
Scan Type : Complete  
Area Scan : 10x13x1: Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 1.557 W/kg  
Power Drift-Finish : 1.543 W/kg  
Power Drift (%) : -0.889

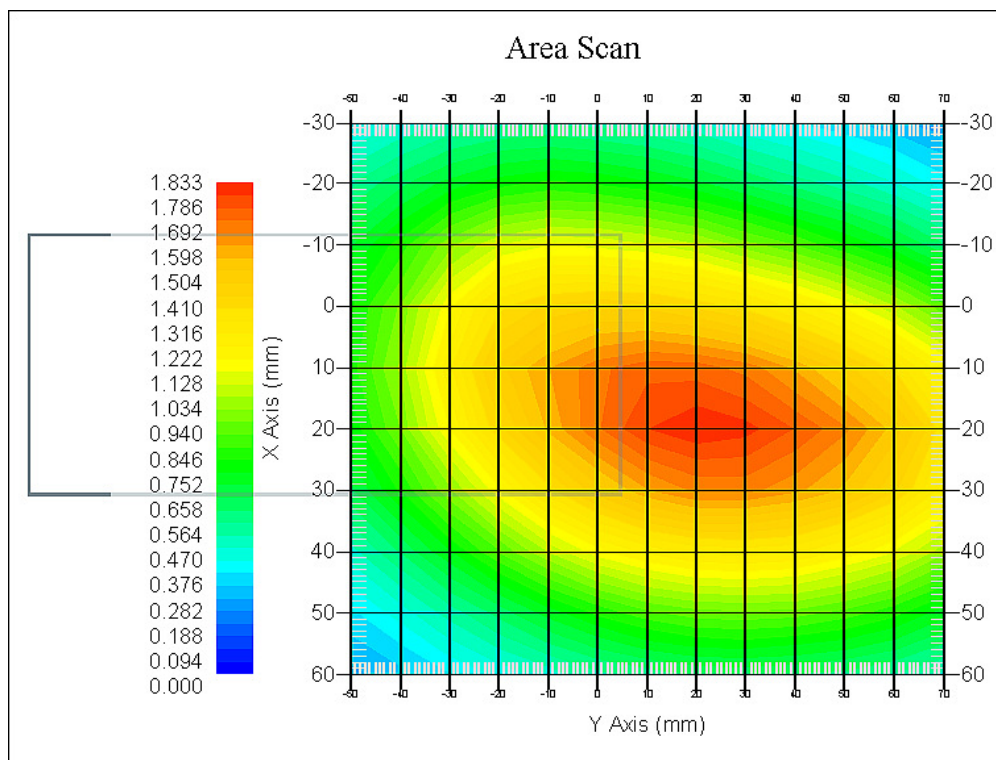
## Tissue Data

Type : Body  
Frequency : 450.0125 MHz  
Epsilon : 56.93 F/m  
Sigma : 0.95 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 450  
Duty Cycle Factor : 1  
Conversion Factor : 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 : 1.751 W/kg  
10 gram SAR value : 1.242 W/kg  
Area Scan Peak SAR : 1.828 W/kg  
Zoom Scan Peak SAR : 2.865 W/kg

**Plot 2#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Face-Up 2.5cm (Analog 12.5k-450.0125 MHz)**

## Measurement Data

Modulation mode : FM  
Crest Factor : 1  
Scan Type : Complete  
Area Scan : 10x13x1: Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 4.630 W/kg  
Power Drift-Finish : 4.567 W/kg  
Power Drift (%) : -1.352

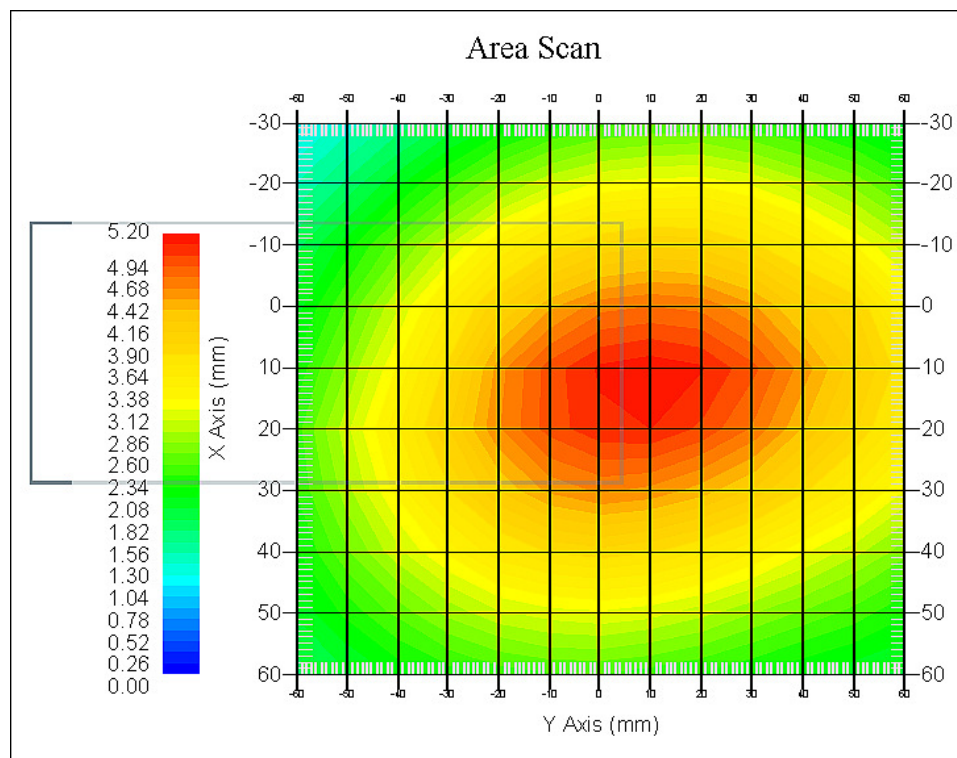
## Tissue Data

Type : Head  
Frequency : 450.0125 MHz  
Epsilon : 42.73 F/m  
Sigma : 0.89 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 : 4.962 W/kg  
10 gram SAR value : 3.437 W/kg  
Area Scan Peak SAR : 5.097 W/kg  
Zoom Scan Peak SAR : 8.602 W/kg

**Plot 3#**

**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)****Back-Worn 0.0cm (Analog 12.5k-450.0125 MHz)**

## Measurement Data

Modulation mode : FM  
Crest Factor : 1  
Scan Type : Complete  
Area Scan : 10x13x1: Measurement x=10mm, y=10mm, z=4mm  
Zoom Scan : 7x7x7: Measurement x=5mm, y=5mm, z=5mm  
Power Drift-Start : 6.335 W/kg  
Power Drift-Finish : 6.287 W/kg  
Power Drift (%) : -0.762

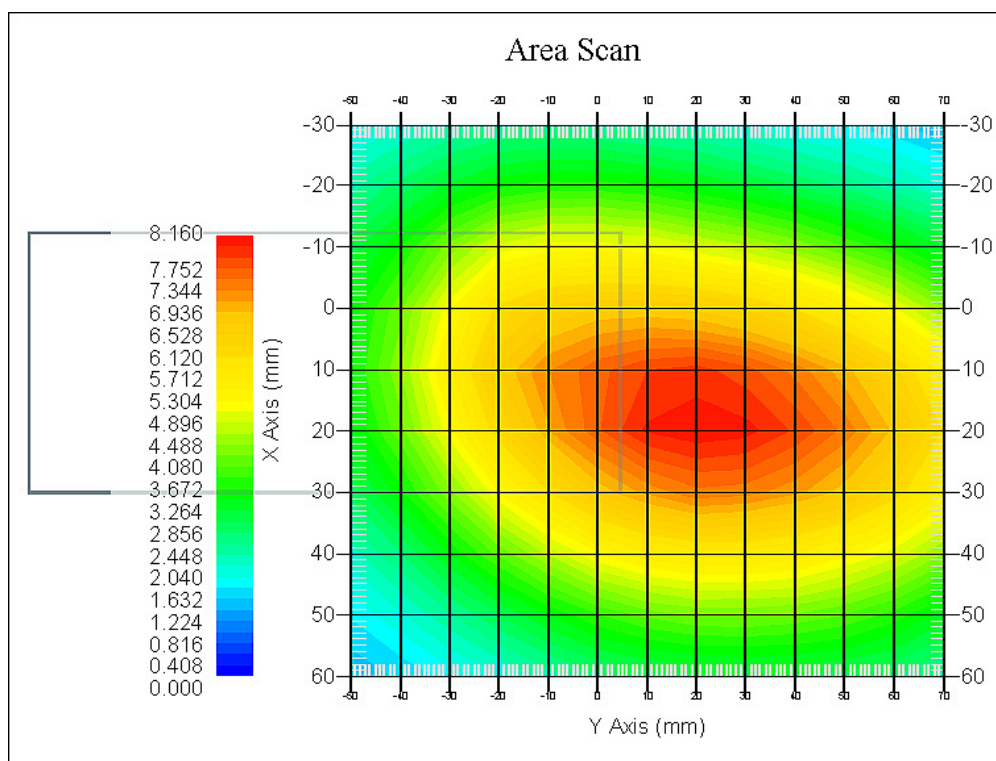
## Tissue Data

Type : Body  
Frequency : 450.0125 MHz  
Epsilon : 56.93F/m  
Sigma : 0.95 S/m  
Density : 1000.00 kg/cu. m

## Probe Data

Serial No. : 500-00283  
Frequency Band : 450  
Duty Cycle Factor : 1  
Conversion Factor : 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 : 8.043 W/kg  
10 gram SAR value : 5.443 W/kg  
Area Scan Peak SAR : 8.127 W/kg  
Zoom Scan Peak SAR : 13.532 W/kg

**Plot 4#**

## APPENDIX A – MEASUREMENT UNCERTAINTY

According to **IEEE1528:2013**, the uncertainty budget has been determined for the Head SAR measurement system and is given in the following Table.

| Source of Uncertainty                           | Tolerance Value | Probability Distribution | Divisor    | $c_i^1$<br>(1-g) | $c_i^1$<br>(10-g)        | Standard Uncertainty<br>(1-g) % | Standard Uncertainty<br>(10-g) % |
|-------------------------------------------------|-----------------|--------------------------|------------|------------------|--------------------------|---------------------------------|----------------------------------|
| <b>Measurement System</b>                       |                 |                          |            |                  |                          |                                 |                                  |
| Probe Calibration                               | 3.5             | normal                   | 1          | 1                | 1                        | 3.5                             | 3.5                              |
| Axial Isotropy                                  | 3.7             | rectangular              | $\sqrt{3}$ | $(1-cp)^{1/2}$   | $(\frac{1-cp}{2})^{1/2}$ | 1.5                             | 1.5                              |
| Hemispherical Isotropy                          | 10.9            | rectangular              | $\sqrt{3}$ | $\sqrt{cp}$      | $\sqrt{cp}$              | 4.4                             | 4.4                              |
| Boundary Effect                                 | 1.0             | rectangular              | $\sqrt{3}$ | 1                | 1                        | 0.6                             | 0.6                              |
| Linearity                                       | 4.7             | rectangular              | $\sqrt{3}$ | 1                | 1                        | 2.7                             | 2.7                              |
| Detection Limit                                 | 1.0             | rectangular              | $\sqrt{3}$ | 1                | 1                        | 0.6                             | 0.6                              |
| Readout Electronics                             | 1.0             | normal                   | 1          | 1                | 1                        | 1.0                             | 1.0                              |
| Response Time                                   | 0.8             | rectangular              | $\sqrt{3}$ | 1                | 1                        | 0.5                             | 0.5                              |
| Integration Time                                | 1.7             | rectangular              | $\sqrt{3}$ | 1                | 1                        | 1.0                             | 1.0                              |
| RF Ambient Condition -Noise                     | 0.6             | 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                              |
| 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                              |
| <b>Test sample related</b>                      |                 |                          |            |                  |                          |                                 |                                  |
| Test sample positioning                         | 2.0             | normal                   | 1          | 1                | 1                        | 2.0                             | 2.0                              |
| Device Holder Uncertainty                       | 4.0             | normal                   | 1          | 1                | 1                        | 6.215                           | 6.215                            |
| Drift of Output Power                           | 5.0             | rectangular              | $\sqrt{3}$ | 1                | 1                        | 2.67                            | 2.67                             |
| <b>Phantom and Setup</b>                        |                 |                          |            |                  |                          |                                 |                                  |
| Phantom Uncertainty                             | 3.4             | rectangular              | $\sqrt{3}$ | 1                | 1                        | 2.0                             | 2.0                              |
| SAR correction in permittivity and conductivity | 1.2             | normal                   | 1          | 1                | 0.85                     | 1.2                             | 1.0                              |
| Liquid conductivity measurement                 | 5.0             | normal                   | 1          | 0.78             | 0.71                     | 3.9                             | 3.6                              |
| Liquid permittivity measurement                 | 5.0             | normal                   | 1          | 0.25             | 0.29                     | 1.3                             | 1.5                              |
| conductivity—temperature                        | 1.1             | rectangular              | $\sqrt{3}$ | 0.78             | 0.71                     | 0.5                             | 0.5                              |
| permittivity—temperature                        | 1.3             | rectangular              | $\sqrt{3}$ | 0.23             | 0.23                     | 0.2                             | 0.2                              |
| Combined Uncertainty                            |                 | RSS                      |            |                  |                          | 10.78                           | 10.55                            |
| Expanded uncertainty (coverage factor=2)        |                 | Normal(k=2)              |            |                  |                          | 21.56                           | 21.10                            |

According to **IEC62209-2:2010**, the uncertainty budget has been determined for the Body SAR measurement system and is given in the following Table.

| Source of Uncertainty                           | Tolerance Value | Probability Distribution | Divisor    | $c_i^1$<br>(1-g) | $c_i^1$<br>(10-g) | Standard Uncertainty<br>(1-g) % | Standard Uncertainty<br>(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                | 1                 | 1.5                             | 1.5                              |
| 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                              |
| 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                              |
| <b>Test sample related</b>                      |                 |                          |            |                  |                   |                                 |                                  |
| Test sample positioning                         | 2.0             | normal                   | 1          | 1                | 1                 | 2.0                             | 2.0                              |
| Device Holder Uncertainty                       | 4.0             | normal                   | 1          | 1                | 1                 | 6.215                           | 6.215                            |
| Drift of Output Power                           | 5.0             | rectangular              | $\sqrt{3}$ | 1                | 1                 | 2.67                            | 2.67                             |
| <b>Phantom and Setup</b>                        |                 |                          |            |                  |                   |                                 |                                  |
| Phantom Uncertainty                             | 3.4             | rectangular              | $\sqrt{3}$ | 1                | 1                 | 2.0                             | 2.0                              |
| SAR correction in permittivity and conductivity | 1.2             | normal                   | 1          | 1                | 0.84              | 1.2                             | 1.0                              |
| Liquid conductivity measurement                 | 5.0             | normal                   | 1          | 0.78             | 0.71              | 3.9                             | 3.6                              |
| Liquid permittivity measurement                 | 5.0             | normal                   | 1          | 0.23             | 0.26              | 1.3                             | 1.5                              |
| conductivity—temperature                        | 1.1             | rectangular              | $\sqrt{3}$ | 0.78             | 0.71              | 0.5                             | 0.5                              |
| permittivity—temperature                        | 1.3             | rectangular              | $\sqrt{3}$ | 0.23             | 0.26              | 0.2                             | 0.2                              |
| Combined Uncertainty                            |                 | RSS                      |            |                  |                   | 9.58                            | 9.49                             |
| Expanded uncertainty (coverage factor=2)        |                 | Normal(k=2)              |            |                  |                   | 19.16                           | 18.98                            |

## APPENDIX B – PROBE CALIBRATION CERTIFICATES

### NCL CALIBRATION LABORATORIES

Calibration File No.: PC-1654

Task No: BACL-5805

## 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 Inc.

Model No.: ALS-E020

Serial No.: 500-00283

Calibration Procedure: D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole  
Project No: BACL-5805

Calibrated: 12<sup>th</sup> December 2015  
Released on: 14<sup>th</sup> December 2015

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

Released By:



Art Brennan, Quality Manager

### **NCL** CALIBRATION LABORATORIES

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

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

**NCL Calibration Laboratories**

Division of APREL, Inc.

**Introduction**

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

**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**

- 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
- IEC 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 62209-2:2010  
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)
- 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 Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

**NCL Calibration Laboratories**

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**Conditions**

Probe 500-00283 was a recalibration.

**Ambient Temperature of the Laboratory:** 20 °C +/- 1.5°C  
**Temperature of the Tissue:** 21 °C +/- 1.5°C  
**Relative Humidity:** < 60%

**Primary Measurement Standards**

| Instrument                      | Serial Number | Cal due date |
|---------------------------------|---------------|--------------|
| Power Meter Tektronix USB       | 11C940        | Apr 2, 2017  |
| Signal Generator Agilent E4438C | MY45094463    | Dec 11, 2017 |

**Secondary Measurement Standards**

|                                 |        |              |
|---------------------------------|--------|--------------|
| Network Analyzer Anritsu 37347C | 002106 | Feb. 4, 2017 |
|---------------------------------|--------|--------------|

**Attestation**

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

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



Art Brennan, Quality Manager



Dan Brooks, Test Engineer

**NCL Calibration Laboratories**

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**Probe Summary**

|                                 |                        |
|---------------------------------|------------------------|
| <b>Probe Type:</b>              | E-Field Probe E-020    |
| <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                 |
| <b>Diode Compression Point:</b> | 95 mV                  |

**Sensitivity in Air**

| Frequency Range                | Channel X,<br>$\mu\text{V}/(\text{V}/\text{m})^2$ | Channel Y,<br>$\mu\text{V}/(\text{V}/\text{m})^2$ | Channel Z,<br>$\mu\text{V}/(\text{V}/\text{m})^2$ | Tolerance,<br>$\mu\text{V}/(\text{V}/\text{m})^2$ |
|--------------------------------|---------------------------------------------------|---------------------------------------------------|---------------------------------------------------|---------------------------------------------------|
| 450 MHz                        | 1.212                                             | 1.205                                             | 1.199                                             | $\pm 0.004$                                       |
| 750 MHz,<br>835 MHz<br>900 MHz | 1.212                                             | 1.21                                              | 1.209                                             | $\pm 0.004$                                       |
| 1 GHz – 4 GHz                  | 1.21                                              | 1.21                                              | 1.207                                             | $\pm 0.004$                                       |
| 5 GHz – 6 GHz                  | 1.2                                               | 1.192                                             | 1.19                                              | $\pm 0.005$                                       |

\*Resistive to recommended tissue recipes per IEEE-1528

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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        | 43.5             | 0.84           | 3.5                      | ±50                               | 5.7               |
| 450 B     | Body        | 56.77            | 0.93           | 3.5                      | ±50                               | 5.8               |
| 750 H     | Head        | 42.92            | 0.92           | 3.5                      | ±50                               | 6.0               |
| 750 B     | Body        | 55.57            | 0.93           | 3.5                      | ±50                               | 5.9               |
| 835 H     | Head        | 43.44            | 0.94           | 3.5                      | ±50                               | 5.9               |
| 835 B     | Body        | 54.91            | 1.00           | 3.5                      | ±50                               | 5.9               |
| 900 H     | Head        | 41.05            | 1.01           | 3.5                      | ±50                               | 6.0               |
| 900 B     | Body        | 54.86            | 1.04           | 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        | 38.58            | 1.36           | 3.5                      | ±75                               | 5.4               |
| 1750 B    | Body        | 51.5             | 1.52           | 3.5                      | ±75                               | 5.3               |
| 1800 H    | Head        | X                | X              | X                        | X                                 | X                 |
| 1800 B    | Body        | X                | X              | X                        | X                                 | X                 |
| 1900 H    | Head        | 40.72            | 1.37           | 3.5                      | ±75                               | 4.8               |
| 1900 B    | Body        | 52.29            | 1.58           | 3.5                      | ±75                               | 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        | 37.35            | 1.85           | 3.5                      | ±75                               | 4.8               |
| 2450 B    | Body        | 53.26            | 1.96           | 3.5                      | ±75                               | 4.3               |
| 3000 H    | Head        | X                | X              | X                        | X                                 | X                 |
| 3000 B    | Body        | X                | X              | X                        | X                                 | X                 |
| 3600 H    | Head        | 37.24            | 3.14           | 3.5                      | ±100                              | 4.4               |
| 3600 B    | Body        | 50.23            | 3.81           | 3.5                      | ±100                              | 4.1               |
| 5250 H    | Head        | 35.05            | 4.65           | 3.5                      | ±100                              | 3.1               |
| 5250 B    | Body        | 46.24            | 5.11           | 3.5                      | ±100                              | 2.9               |
| 5600 H    | Head        | 34.95            | 5.06           | 3.5                      | ±100                              | 3.0               |
| 5600 B    | Body        | 45.95            | 5.73           | 3.5                      | ±100                              | 2.4               |
| 5800 H    | Head        | 34.57            | 5.27           | 3.5                      | ±100                              | 3.1               |
| 5800 B    | Body        | 46.01            | 6.10           | 3.5                      | ±100                              | 2.6               |

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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 $\Omega$ .

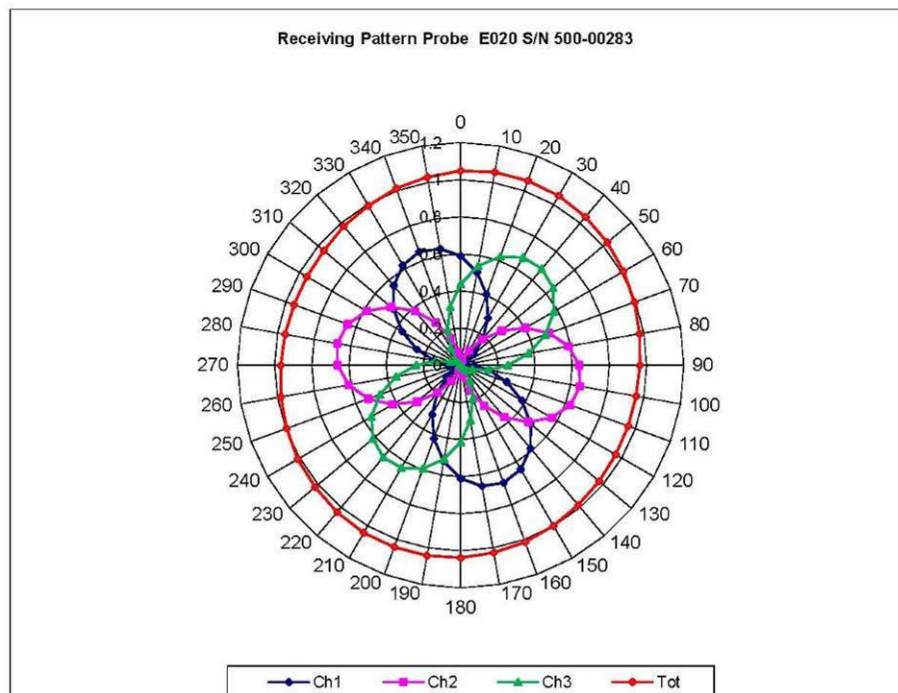
**Probe Calibration Uncertainty**

| Uncertainty component                | Tolerance<br>( $\pm$ %) | Probability distribution | Divisor    | Standard<br>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> |                         | RSS                      |            | <b>3.50</b>                        |

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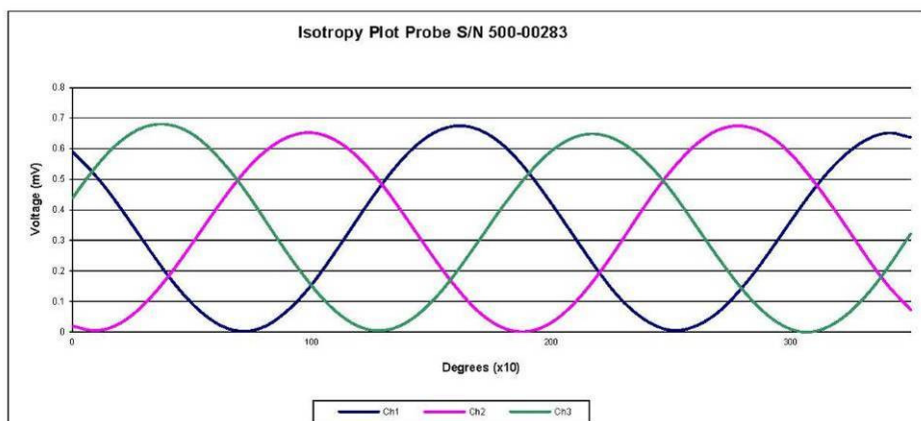
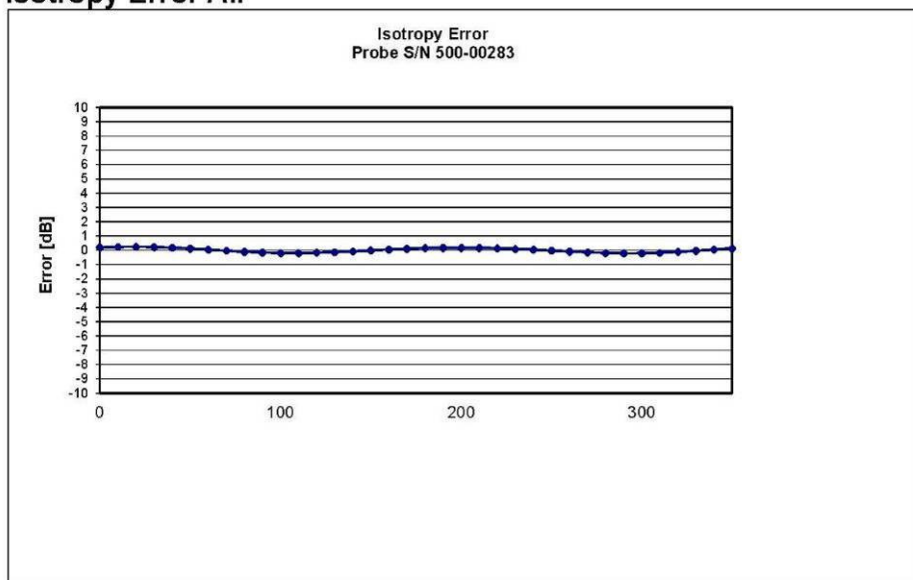
**Receiving Pattern Air**



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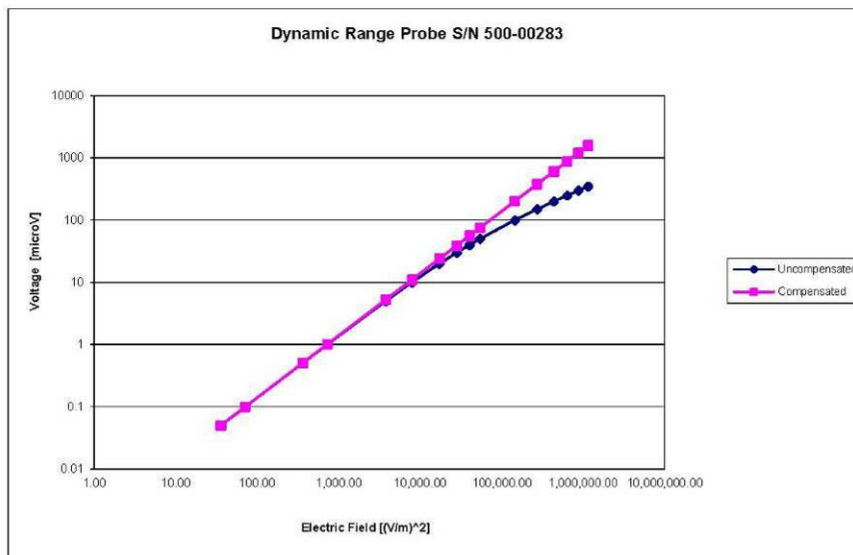
## **Isotropy Error Air**



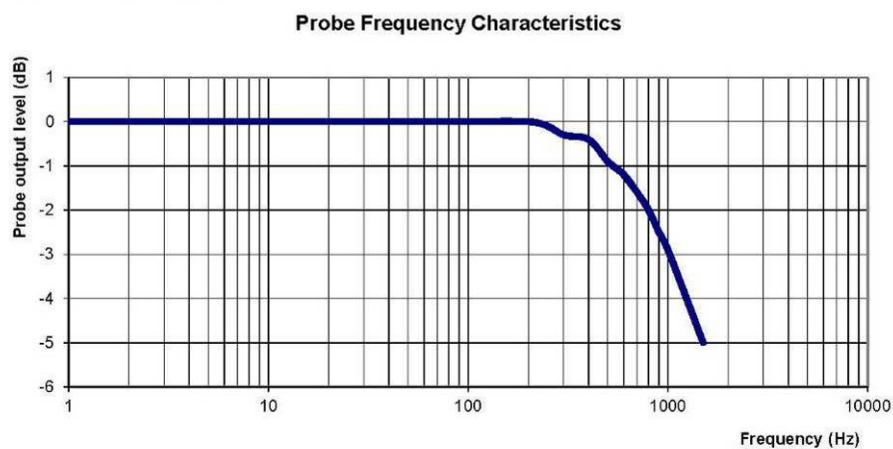
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## Dynamic Range



## Video Bandwidth



Video Bandwidth at 500 Hz 1 dB  
Video Bandwidth at 1.02 KHz: 3 dB

**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                      |         | 3.50                       |

## APPENDIX C – DIPOLE CALIBRATION CERTIFICATES

### NCL CALIBRATION LABORATORIES

Calibration File No: DC-1534  
Project Number: BACL-5745

## 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: 8th October 2013  
Released on: 8th October 2013

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

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



Art Brennan, Quality Manager

### **NCL** CALIBRATION LABORATORIES

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

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

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Conditions**

Dipole 175-00503 was taken from stock for an original calibration..

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

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

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



Art Brennan, Quality Manager



Dan Brooks, Test Engineer

**Calibration Results Summary**

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

**Mechanical Dimensions**

**Length:** 270.0 mm

**Height:** 166.7 mm

**Electrical Specification**

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

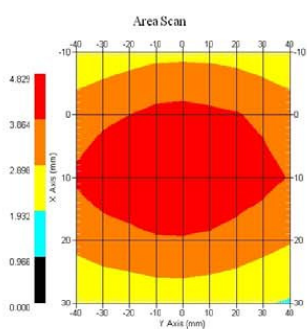
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### NCL Calibration Laboratories

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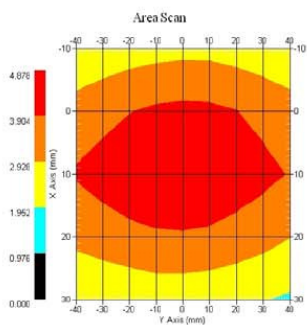
### System Validation Results Head

| 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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**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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**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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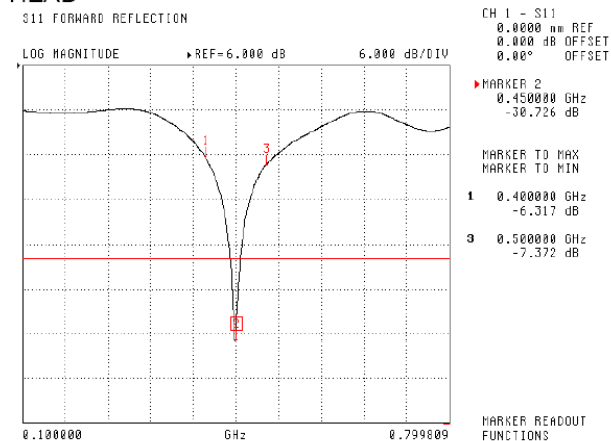
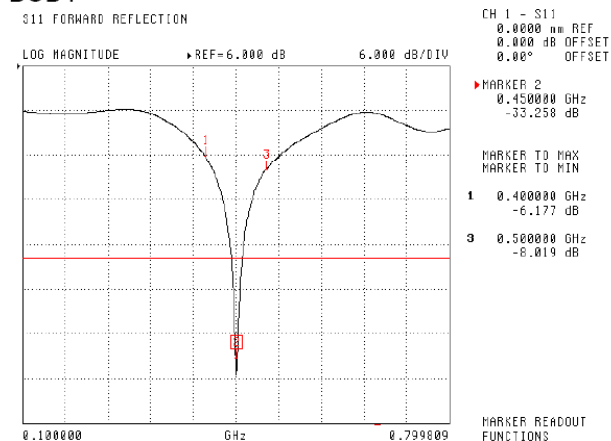
**NCL Calibration Laboratories**

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**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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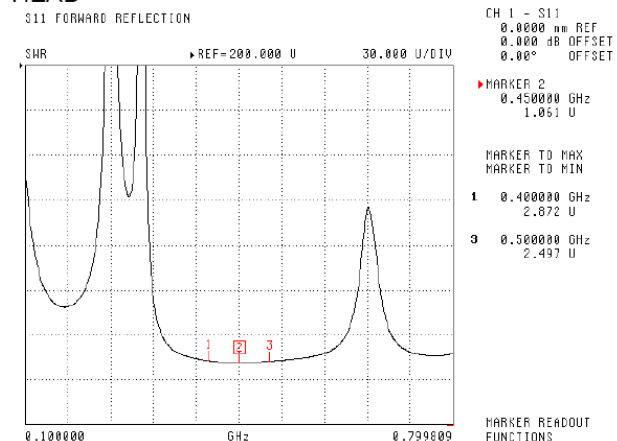
6

## NCL Calibration Laboratories

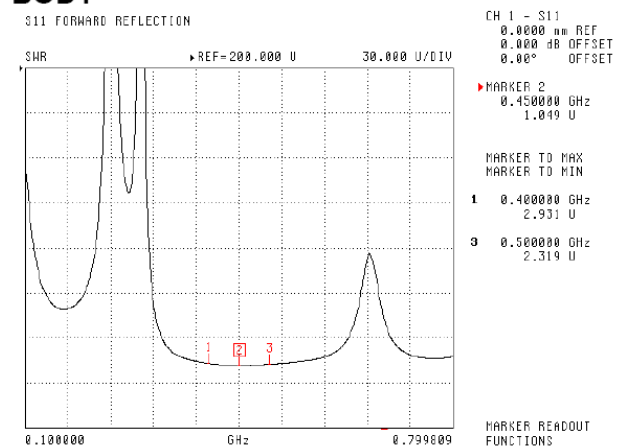
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### SWR

#### HEAD



#### BODY

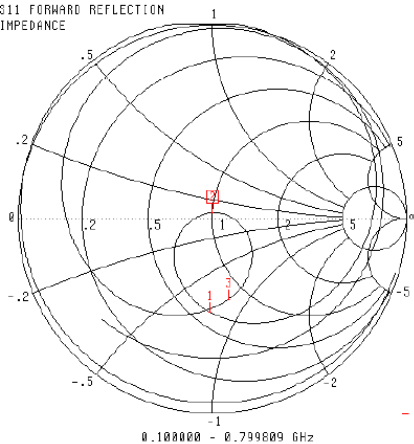


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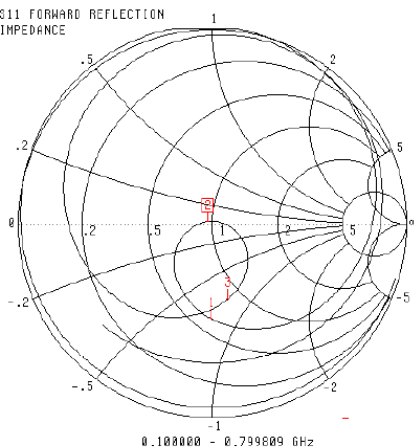
7

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**Smith Chart Dipole Impedance**  
**HEAD**S11 FORWARD REFLECTION  
IMPEDANCECH 1 - S11  
0.0000 nm REF  
0.000 dB OFFSET  
0.00° OFFSET▶ MARKER 2  
0.450000 GHz  
50.600 Ω  
2.584 jΩMARKER TO MAX  
MARKER TO MIN

|   |              |
|---|--------------|
| 1 | 0.400000 GHz |
|   | 30.600 Ω     |
|   | -38.618 jΩ   |
| 3 | 0.500000 GHz |
|   | 40.424 Ω     |
|   | -41.402 jΩ   |

MARKER READOUT  
FUNCTIONS**BODY**S11 FORWARD REFLECTION  
IMPEDANCECH 1 - S11  
0.0000 nm REF  
0.000 dB OFFSET  
0.00° OFFSET▶ MARKER 2  
0.450000 GHz  
48.155 Ω  
990.105 jΩMARKER TO MAX  
MARKER TO MIN

|   |              |
|---|--------------|
| 1 | 0.400000 GHz |
|   | 30.600 Ω     |
|   | -39.631 jΩ   |
| 3 | 0.500000 GHz |
|   | 42.524 Ω     |
|   | -39.206 jΩ   |

MARKER READOUT  
FUNCTIONS

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### **NCL Calibration Laboratories**

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### **Test Equipment**

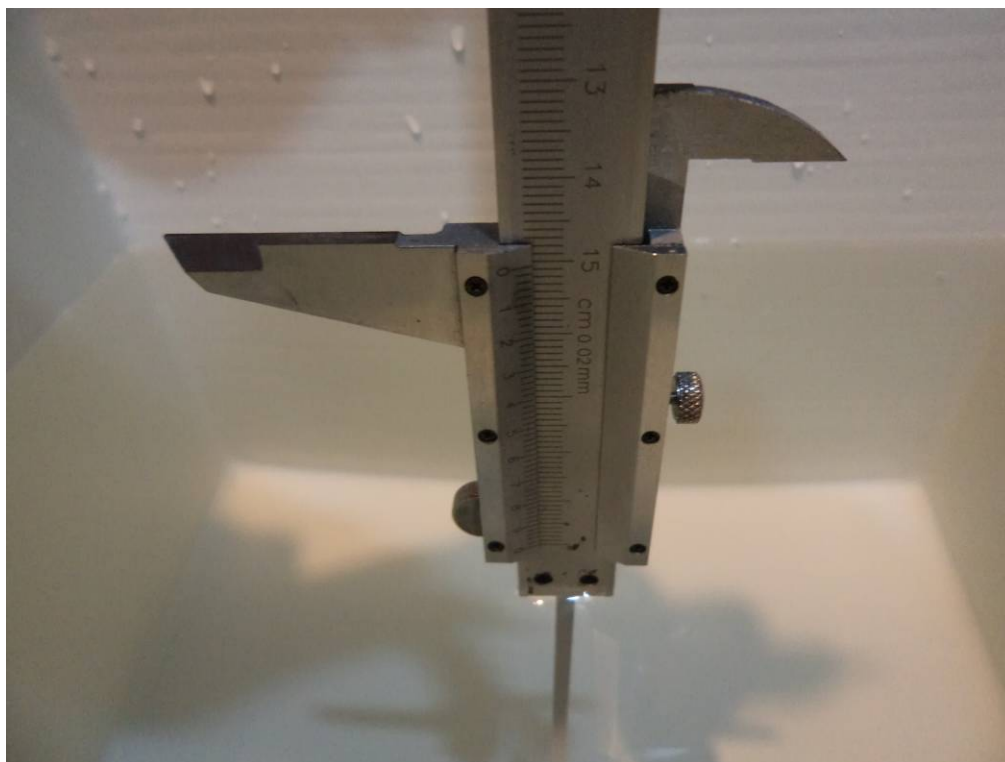
The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2012.

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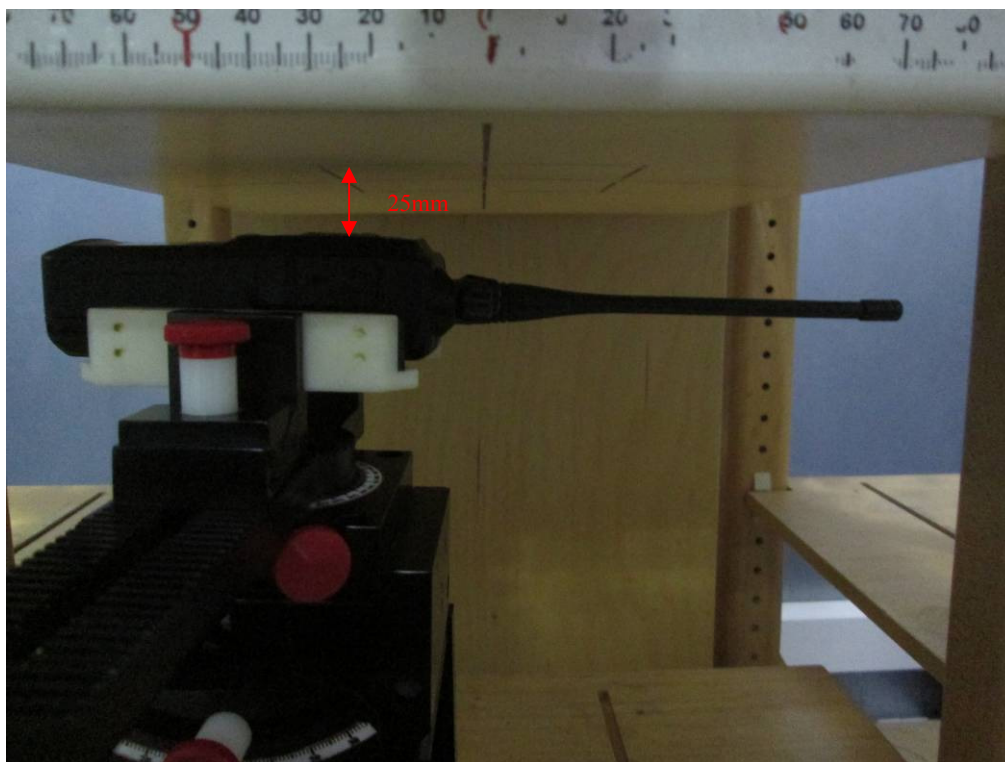
9

## APPENDIX D – EUT TEST POSITION PHOTOS

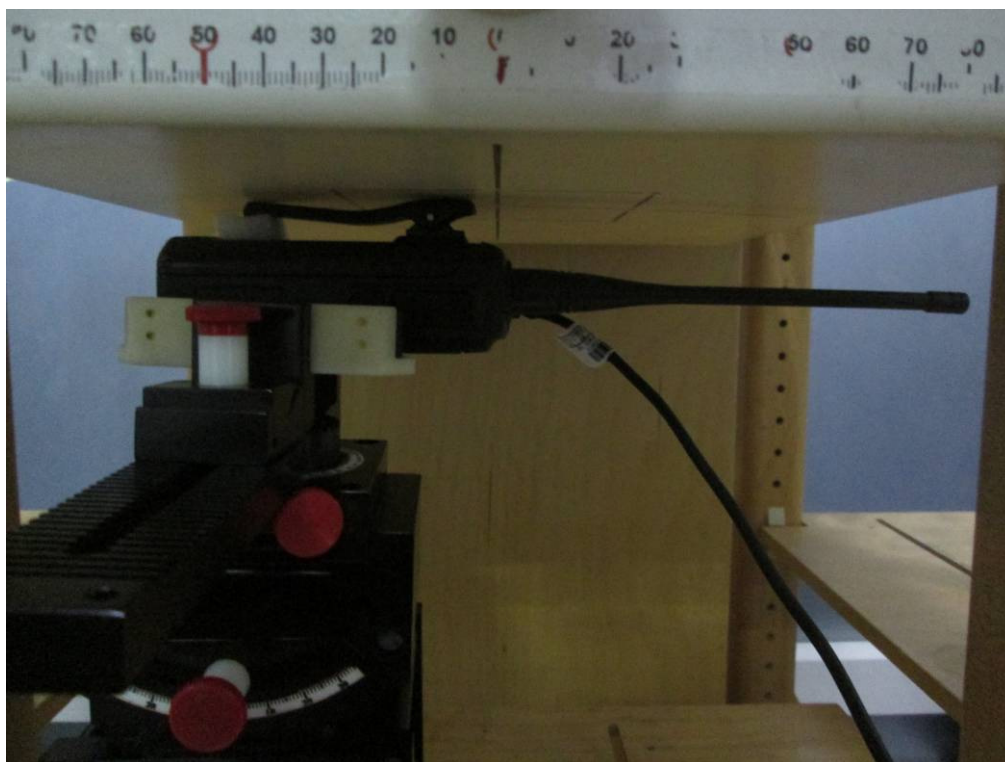
**Liquid depth  $\geq 15\text{cm}$**



**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-Side View**



**EUT-Right View**



### EUT-Uncover View



### EUT-Antenna View



### EUT-Battery View



### EUT-Belt-clip View



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## APPENDIX F – INFORMATIVE REFERENCES

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- [2] David L. Means Kwok Chan, Robert F. Cleveland, "Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, Office of Engineering & Technology, Washington, DC, 1997.
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- [13] NIS81 NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
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\*\*\*\*\* END OF REPORT \*\*\*\*\*