# SAR EVALUATION REPORT

For

# MAXWEST INTERNATIONAL LIMITED.

No.1,Longgang Road,Buji,Longgang,ShenzhenCity,Guangdong Province, P.R. China

**FCC ID:2AEN3GRAVITY55LTE**

| **Report Type:** | **Product Type:** |
|---|---|
| Original Report | Mobile Phone |

**Test Engineer:** Terry XiaHou

**Report Number:** RDG150901001-20A

**Report Date:** 2015-09-25

**Reviewed By:** Bell Hu
SAR Engineer

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

<table>
<tr><th colspan="3">Attestation of Test Results</th></tr>
<tr><td rowspan="6">EUT Information</td><td>Company Name</td><td>MAXWEST INTERNATIONAL LIMITED.</td></tr>
<tr><td>EUT Description</td><td>Mobile phone</td></tr>
<tr><td>Product name</td><td>Mobile Phone</td></tr>
<tr><td>FCC ID</td><td>2AEN3GRAVITY55LTE</td></tr>
<tr><td>Model Number</td><td>Gravity 5.5LTE</td></tr>
<tr><td>Test Date</td><td>2015-09-23</td></tr>
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<table>
<tr><th>Frequency</th><th>Max. SAR Level(s) Reported</th><th>Limit(W/Kg)</th></tr>
<tr><td>LTE Band 17</td><td>0.057 W/kg 1g Head SAR<br>0.374 W/kg 1g Body SAR</td><td rowspan="4">1.6</td></tr>
<tr><td rowspan="2">Simultaneous</td><td>0.736 W/kg 1g Head SAR</td></tr>
<tr><td>1.431 W/kg 1g Body SAR</td></tr>
<tr><td>Hotspot</td><td>1.431 W/kg 1g Body SAR</td></tr>
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<table>
<tr><td rowspan="4">Applicable Standards</td><td>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.</td></tr>
<tr><td>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.</td></tr>
<tr><td>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</td></tr>
<tr><td>KDB procedures<br>KDB 447498 D01 General RF Exposure Guidance v05r02.<br>KDB 648474 D04 Handset SAR v01r02.<br>KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03<br>KDB 865664 D02 RF Exposure Reporting v01r01<br>KDB 941225 D01 3G SAR Procedures v03<br>KDB 941225 D05 SAR for LTE Devices v02r03<br>KDB 941225 D06 Hotspot Mode v02</td></tr>
</table>

**Note:** This wireless device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General Population/Uncontrolled Exposure limits specified in ANSI/IEEE Standards and has been tested in accordance with the measurement procedures specified in IEEE 1528-2013 and RF exposure KDB procedures.

**The results and statements contained in this report pertain only to the device(s) evaluated.**

Note: For other radio band SAR and Simultaneous SAR , please refer to the SAR report: RDG150901001-20B, which was issued by Bay Area Compliance Laboratories Corp. (Dongguan)

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# DOCUMENT REVISION HISTORY

| Revision Number | Report Number | Description of Revision | Date of Revision |
|---|---|---|---|
| 0 | RDG150901001-20A | Original Report | 2015-06-24 |

**Note:**
For GSM 850,PCS 1900,WCDMA 850,WCDMA 1700,WCDMA 1900,LTE Band 2,LTE Band 4,LTE Band 7 SAR data, please refer to the report RDG150901001-20B.

# EUT DESCRIPTION

This report has been prepared on behalf of MAXWEST INTERNATIONAL LIMITED. and their product, FCC ID: 2AEN3GRAVITY55LTE, Model: Gravity 5.5LTE or the EUT (Equipment under Test) as referred to in the rest of this report.

## Technical Specification

| | |
|---|---|
| **Product Type** | Portable |
| **Exposure Category:** | Population / Uncontrolled |
| **Antenna Type(s):** | Internal Antenna |
| **Body-Worn Accessories:** | Headset |
| **Face-Head Accessories:** | None |
| **Multi-slot Class:** | Class12 |
| **Operation Mode :** | GSM Voice, EDGE/GPRS Data, WCDMA, LTE,Wi-Fi and Bluetooth |
| **Frequency Band:** | GSM 850 : 824-849 MHz(TX) ; 869-894 MHz(RX)<br>PCS 1900: 1850-1910 MHz(TX) ; 1930-1990 MHz(RX)<br>WCDMA 850: 824-849 MHz(TX) ; 869-894 MHz(RX)<br>WCDMA 1700: 1710-1755 MHz(TX) ; 2110-2155 MHz(RX)<br>WCDMA 1900: 1850-1910 MHz(TX) ; 1930-1990 MHz(RX)<br>LTE Band 2: 1850-1910MHz(TX) ; 1930-1990MHz(RX)<br>LTE Band 4: 1710-1755MHz(TX) ; 2110-2155MHz(RX)<br>LTE Band 7: 2500-2570MHz(TX) ; 2620-2690MHz(RX)<br>LTE Band 17: 704-716MHz(TX) ; 734-746MHz(RX)<br>WLAN: 2412MHz-2462 MHz<br>Bluetooth : 2402MHz-2480 MHz |
| **Conducted RF Power:** | GSM 850 : 32.97 dBm<br>PCS 1900: 29.55 dBm<br>WCDMA 850: 22.32 dBm<br>WCDMA 1700: 22.84 dBm<br>WCDMA 2100: 22.39 dBm<br>LTE Band 2:23.15 dBm<br>LTE Band 4:22.81 dBm<br>LTE Band 7:22.98 dBm<br>LTE Band 17:22.86 dBm<br>WLAN: 9.37 dBm<br>Bluetooth: 3.02 dBm<br>BLE:-3.28 dBm |
| **Dimensions (L*W*H):** | 156 mm (L) × 78.3 mm (W) × 7.8 mm (H) |
| **Power Source:** | 3.7 $V_{DC}$ Rechargeable Battery |
| **Normal Operation:** | Head and Body-worn |

# REFERENCE, STANDARDS, AND GUILDELINES

**FCC:**

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

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

**CE:**

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

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

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

## SAR Limits

FCC Limit (1g Tissue)

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

CE Limit (10g Tissue)

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

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

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

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

# FACILITIES

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

# DESCRIPTION OF TEST SYSTEM

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

### ALSAS-10U System Description

ALSAS-10-U is fully compliant with the technical and scientific requirements of IEEE 1528, IEC 62209, CENELEC, ARIB, ACA, and the Federal Communications Commission. The system comprises of a six axes articulated robot which utilizes a dedicated controller.
ALSAS-10U uses the latest methodologies. And FDTD modeling to provide a platform which is repeatable with minimum uncertainty.

### Applications

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

### Area Scans

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10mm2 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/m3 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**

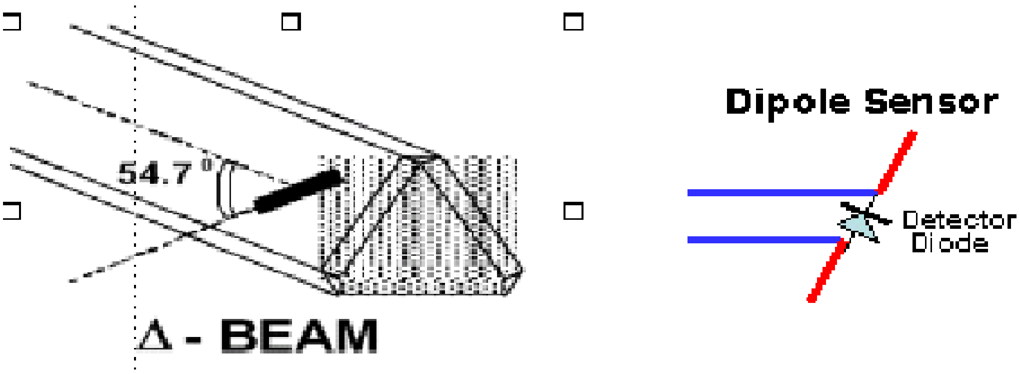
The overall uncertainty for the methodology and algorithms the used during the SAR calculation was evaluated using the data from IEEE 1528 based on the example f3 algorithm:

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

**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

| | |
|---|---|
| **Calibration Method** | Frequency Dependent<br>Below 1 GHz Calibration in air performed in a TEM Cell<br>Above 1 GHz Calibration in air performed in waveguide |
| **Sensitivity** | 0.70 $\mu V/(V/m)^2$ to 0.85 $\mu V/(V/m)^2$ |
| **Dynamic Range** | 0.0005 W/kg to 100 W/kg |
| **Isotropic Response** | Better than 0.1 dB |
| **Diode Compression Point (DCP)** | Calibration for Specific Frequency |
| **Probe Tip Diameter** | < 2.9 mm |
| **Sensor Offset** | 1.56 (+/- 0.02 mm) |
| **Probe Length** | 289 mm |
| **Video Bandwidth** | @ 500 Hz: 1 dB<br>@ 1.02 kHz: 3 dB |
| **Boundary Effect** | Less than 2.1% for distance greater than 0.58 mm |
| **Spatial Resolution** | 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 5µV 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.

| | |
|---|---|
| **ADC** | 12 Bit |
| **Amplifier Range** | 20 mV to 200 mV and 150 mV to 800 mV |
| **Field Integration** | Local Co-Processor utilizing proprietary integration algorithms |
| **Number of Input Channels** | 4 in total 3 dedicated and 1 spare |
| **Communication** | 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.


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

## ALSAS Universal Workstation

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

## Universal Device Positioner

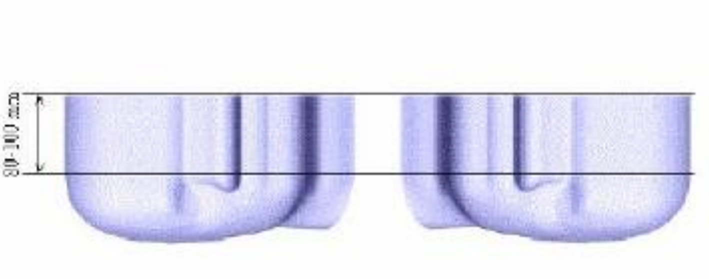
The universal device positioner allows complete freedom of movement of the EUT. Developed to hold a EUT in a free-space scenario any additional loading attributable to the material used in the construction of the positioner has been eliminated. Repeatability has been enhanced through the linear scales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

### Phantom Types

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

### APREL SAM Phantoms

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



## APREL Laboratories Universal Phantom

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

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

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

## Tissue Dielectric Parameters for Head and Body Phantoms

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

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

### Recommended Tissue Dielectric Parameters for Head and Body

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

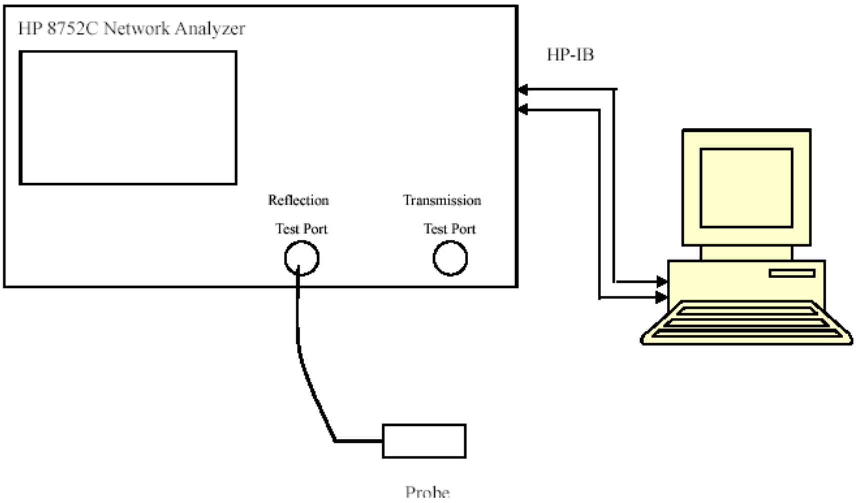
# EQUIPMENT LIST AND CALIBRATION

## Equipments List & Calibration Information

| Equipment | Model | Calibration Date | S/N |
|---|---|---|---|
| CRS F3 robot | ALS-F3 | N/A | RAF0805352 |
| CRS F3 Software | ALS-F3-SW | N/A | N/A |
| CRS C500C controller | ALS-C500 | N/A | RCF0805379 |
| Probe mounting device & Boundary | ALS-PMDPS-3 | N/A | 120-00270 |
| Universal Work Station | ALS-UWS | N/A | 100-00157 |
| Data Acquisition Package | ALS-DAQ-PAQ-3 | 2014-10-14 | 110-00212 |
| Miniature E-Field Probe | ALS-E-020 | 2014-10-14 | 500-00283 |
| Dipole, 750MHz | ALS-D-750-S-2 | 2013-10-08 | 177-00505 |
| Dipole Spacer | ALS-DS-U | N/A | 250-00907 |
| Device holder/Positioner | ALS-H-E-SET-2 | N/A | 170-00510 |
| Left ear SAM phantom | ALS-P-SAM-L | N/A | 130-00311 |
| Right ear SAM phantom | ALS-P-SAM-R | N/A | 140-00359 |
| UniPhantom | ALS-P-UP-1 | N/A | 150-00413 |
| Simulated Tissue 750 MHz Head | ALS-TS-750-H | Each Time | 269-01008 |
| Simulated Tissue 750 MHz Body | ALS-TS-750-B | Each Time | 269-02107 |
| Directional couple | DC6180A | N/A | 0325849 |
| Power Amplifier | 5S1G4 | N/A | 71377 |
| Dielectric probe kit | HP85070B | 2015-06-13 | US33020324 |
| Attenuator | 3dB | N/A | 5402 |
| Network analyzer | 8752C | 2015-06-03 | 3410A02356 |
| Synthesized Sweeper | HP 8341B | 2015-06-03 | 2624A00116 |
| WIDEBAND RADIO COMMUNICATION TESTER | CMW500 | 2015-04-18 | 114772 |
| EMI Test Receiver | ESCI | 2015-06-12 | 101746 |

# SAR MEASUREMENT SYSTEM VERIFICATION

## Liquid Verification




Liquid Verification Setup Block Diagram

### Liquid Verification Results

| Frequency | Liquid Type | Liquid Parameter | | Target Value | | Delta (%) | | Tolerance (%) |
|---|---|---|---|---|---|---|---|---|
| | | $\varepsilon_r$ | Ơ (S/m) | $\varepsilon_r$ | Ơ (S/m) | $\Delta\varepsilon_r$ | ΔƠ (S/m) | |
| 709.0 | Head | 42.31 | 0.89 | 41.95 | 0.89 | 0.858 | 0.000 | ±5 |
| | Body | 54.57 | 0.93 | 55.50 | 0.96 | -1.676 | -3.125 | ±5 |
| 710.0 | Head | 42.34 | 0.88 | 41.95 | 0.89 | 0.930 | -1.124 | ±5 |
| | Body | 54.64 | 0.94 | 55.50 | 0.96 | -1.550 | -2.083 | ±5 |
| 711.0 | Head | 41.89 | 0.88 | 41.95 | 0.89 | -0.143 | -1.124 | ±5 |
| | Body | 54.54 | 0.93 | 55.50 | 0.96 | -1.730 | -3.125 | ±5 |

**Liquid Verification was performed on 2015-09-23.*

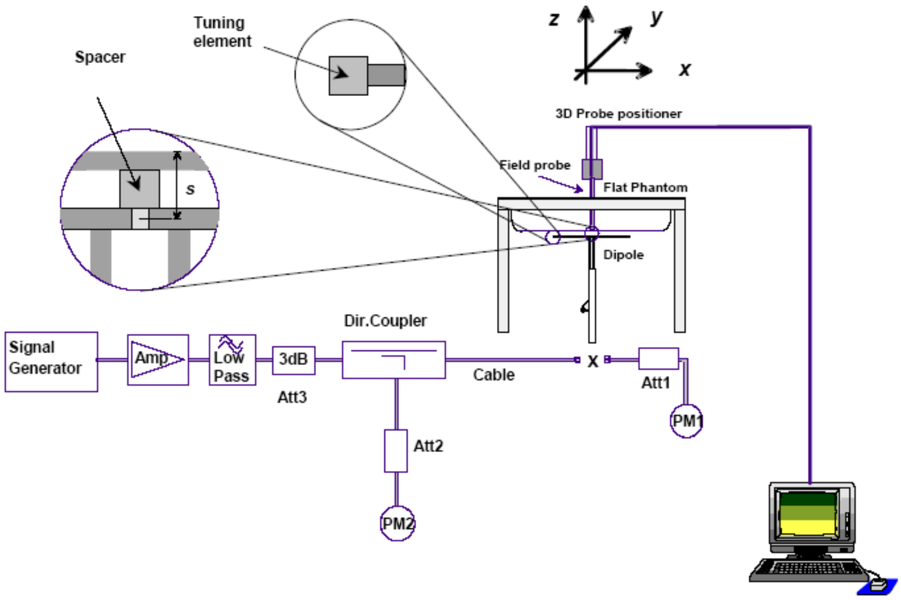
Please refer to the following tables.

| 750 MHz Head | | | | 750 MHz Body | | |
|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **e'** | **e''** | | **Frequency (MHz)** | **e'** | **e''** |
| 701.0 | 42.2392 | 22.5143 | | 701.0 | 54.6128 | 23.7548 |
| 702.0 | 41.7891 | 22.5592 | | 702.0 | 54.6091 | 23.6122 |
| 703.0 | 42.1033 | 22.5447 | | 703.0 | 54.6352 | 23.5697 |
| 704.0 | 42.1386 | 22.2873 | | 704.0 | 54.5996 | 23.7407 |
| 705.0 | 41.9077 | 22.1208 | | 705.0 | 54.5423 | 23.7663 |
| 706.0 | 42.0234 | 22.4911 | | 706.0 | 54.6425 | 23.7102 |
| 707.0 | 41.8384 | 22.4974 | | 707.0 | 54.6288 | 23.4516 |
| 708.0 | 42.0156 | 22.4865 | | 708.0 | 54.5425 | 23.5579 |
| 709.0 | 42.3107 | 22.4989 | | 709.0 | 54.5650 | 23.5251 |
| 710.0 | 42.3352 | 22.3114 | | 710.0 | 54.6358 | 23.6939 |
| 711.0 | 41.8892 | 22.2643 | | 711.0 | 54.5405 | 23.5709 |
| 712.0 | 41.9756 | 21.9685 | | 712.0 | 54.6323 | 23.4614 |
| 713.0 | 41.8840 | 22.2538 | | 713.0 | 54.5721 | 23.6221 |
| 714.0 | 42.0001 | 22.0362 | | 714.0 | 54.5568 | 23.7124 |
| 715.0 | 42.0429 | 22.4338 | | 715.0 | 54.5990 | 23.6162 |
| 716.0 | 42.2228 | 22.5163 | | 716.0 | 54.6392 | 23.4254 |
| 717.0 | 41.8738 | 22.1537 | | 717.0 | 54.5783 | 23.4217 |
| 718.0 | 41.8199 | 22.3412 | | 718.0 | 54.5674 | 23.6946 |
| 719.0 | 41.9414 | 22.4390 | | 719.0 | 54.6217 | 23.6823 |
| 720.0 | 42.2001 | 22.2399 | | 720.0 | 54.6054 | 23.7402 |
| 721.0 | 41.7726 | 22.1541 | | 721.0 | 54.5687 | 23.5348 |
| 722.0 | 42.0033 | 22.2166 | | 722.0 | 54.5845 | 23.6669 |
| 723.0 | 42.0908 | 22.3398 | | 723.0 | 54.6283 | 23.4655 |
| 724.0 | 42.1918 | 22.2645 | | 724.0 | 54.6199 | 23.7408 |
| 725.0 | 42.2151 | 22.2961 | | 725.0 | 54.5809 | 23.5450 |
| 726.0 | 42.0779 | 22.3105 | | 726.0 | 54.6153 | 23.7358 |
| 727.0 | 42.0134 | 22.1472 | | 727.0 | 54.5571 | 23.4771 |
| 728.0 | 41.7600 | 22.4832 | | 728.0 | 54.5494 | 23.6352 |
| 729.0 | 41.9560 | 22.5263 | | 729.0 | 54.6332 | 23.6529 |
| 730.0 | 41.8215 | 22.0584 | | 730.0 | 54.6467 | 23.4410 |
| 731.0 | 42.2403 | 22.0406 | | 731.0 | 54.6015 | 23.6875 |
| 732.0 | 41.7629 | 22.0527 | | 732.0 | 54.6466 | 23.5763 |
| 733.0 | 41.9359 | 21.9269 | | 733.0 | 54.6341 | 23.4779 |
| 734.0 | 42.1605 | 21.9773 | | 734.0 | 54.6332 | 23.6648 |
| 735.0 | 42.2228 | 21.7116 | | 735.0 | 54.6473 | 23.5992 |
| 736.0 | 42.3235 | 21.7863 | | 736.0 | 54.6284 | 23.5099 |
| 737.0 | 42.2066 | 22.3133 | | 737.0 | 54.6415 | 23.3971 |
| 738.0 | 41.9069 | 21.8764 | | 738.0 | 54.5744 | 23.7181 |
| 739.0 | 41.8541 | 21.8769 | | 739.0 | 54.6224 | 23.4345 |
| 740.0 | 42.2472 | 21.9014 | | 740.0 | 54.6499 | 23.5686 |
| 741.0 | 42.0611 | 22.2820 | | 741.0 | 54.5812 | 23.3884 |
| 742.0 | 42.0506 | 22.2759 | | 742.0 | 54.5923 | 23.3883 |
| 743.0 | 41.8962 | 21.7501 | | 743.0 | 54.5804 | 23.5889 |
| 744.0 | 42.2017 | 21.9942 | | 744.0 | 54.6224 | 23.4907 |
| 745.0 | 42.0653 | 21.7847 | | 745.0 | 54.5708 | 23.4539 |
| 746.0 | 42.0153 | 22.1215 | | 746.0 | 54.6160 | 23.5227 |
| 747.0 | 42.0779 | 22.0449 | | 747.0 | 54.6084 | 23.4900 |
| 748.0 | 42.0076 | 21.8783 | | 748.0 | 54.6032 | 23.6776 |
| 749.0 | 42.2241 | 21.8384 | | 749.0 | 54.5938 | 23.7543 |
| 750.0 | 41.9440 | 22.1024 | | 750.0 | 54.5931 | 23.5122 |
| 751.0 | 41.8467 | 21.6843 | | 751.0 | 54.5580 | 23.5751 |

## System Accuracy Verification

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

### System Verification Setup Block Diagram




### Probe and dipole antenna List and Detail

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| APREL | Probe | ALS-E-020 | 500-00283 | 2014-10-14 | 2015-10-13 |
| APREL | Dipole antenna(750MHz) | ALS-D-750-S-2 | 177-00505 | 2013-10-08 | 2016-10-07 |

### System Accuracy Check Results

| Date | Frequency Band | Liquid Type | Measured SAR (W/Kg) | | Target Value (W/Kg) | Delta (%) | Tolerance (%) |
|---|---|---|---|---|---|---|---|
| 2015-09-23 | 750 | Head | 1g | 8.635 | 8.500 | 1.588 | ±10 |
| | | Body | 1g | 8.596 | 8.540 | 0.656 | ±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 750 MHz Head Liquid**

**Dipole 750 MHz; Type: ALS-D-750-S-2; S/N: 177-00505**

| | |
|---|---|
| Product Data | |
| Device Name | : Dipole 750 MHz |
| Serial No. | : 177-00505 |
| Type | : Dipole |
| Model | : ALS-D-750-S-2 |
| Frequency Band | : 750 |
| Max. Transmit Pwr | : 1 W |
| Drift Time | : 3 min(s) |
| Power Drift-Start | : 8.102 W/kg |
| Power Drift-Finish | : 8.035 W/kg |
| Power Drift (%) | : -1.358 |

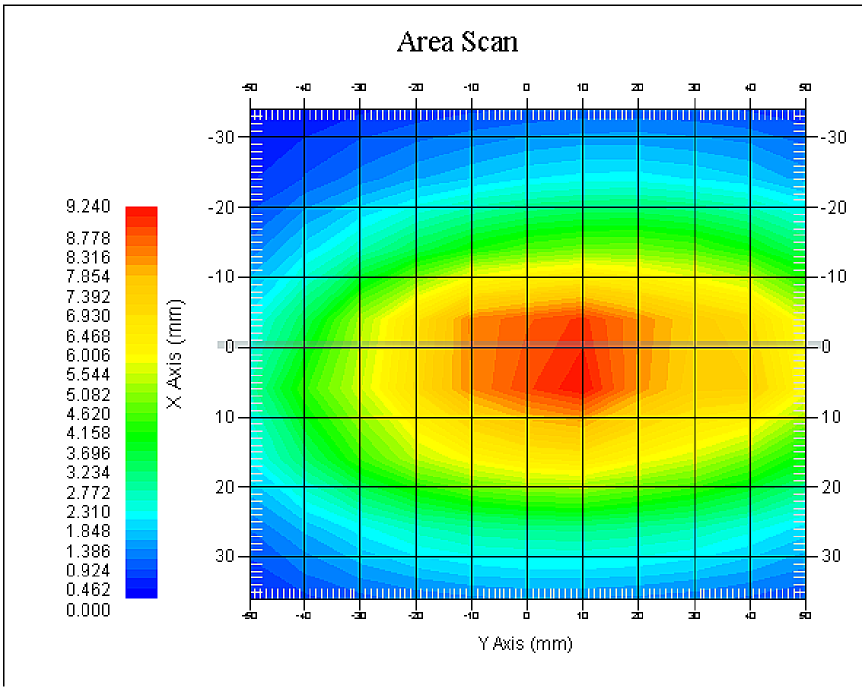
| | |
|---|---|
| Phantom Data | |
| Name | : APREL-Uni |
| Type | : Uni-Phantom |
| Serial No. | : System Default |
| Location | : Center |
| Description | : Default |
| Phantom Data | |

| | |
|---|---|
| Tissue Data | |
| Type | : Head |
| Serial No. | : 269-01008 |
| Frequency | : 750.0 MHz |
| Last Calib. Date | : 23-Sep-2015 |
| Temperature | : 20.00 ℃ |
| Ambient Temp. | : 21.00 ℃ |
| Humidity | : 56.00 RH% |
| Epsilon | : 41.94 F/m |
| Sigma | : 0.92 S/m |
| Density | : 1000.00 kg/cu. m |

| | |
|---|---|
| Probe Data | |
| Name | : E-Field |
| Model | : E-020 |
| Type | : E-Field Triangle |
| Serial No. | : 500-00283 |
| Last Calib. Date | : 14-Oct-2014 |
| Frequency Band | : 750 |
| Duty Cycle Factor | : 1 |
| Conversion Factor | : 6.0 |
| Probe Sensitivity | : 1.20 1.20 1.20 μV/(V/m)2 |
| Compression Point | : 95.00 mV |
| Offset | : 1.56 mm |

| | |
|---|---|
| Measurement Data | |
| Crest Factor | : 1 |
| Scan Type | : Complete |
| Tissue Temp. | : 21.00 ℃ |
| Ambient Temp. | : 21.00 ℃ |
| Area Scan | : 7x9x1 : Measurement x=10mm, y=10mm, z=4mm |
| Zoom Scan | : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm |

| | |
|---|---|
| 1 gram SAR value | : 8.635 W/kg |
| 10 gram SAR value | : 5.687 W/kg |
| Area Scan Peak SAR | : 9.236 W/kg |
| Zoom Scan Peak SAR | : 14.294 W/kg |




**750 MHz System Validation with Head Tissue**

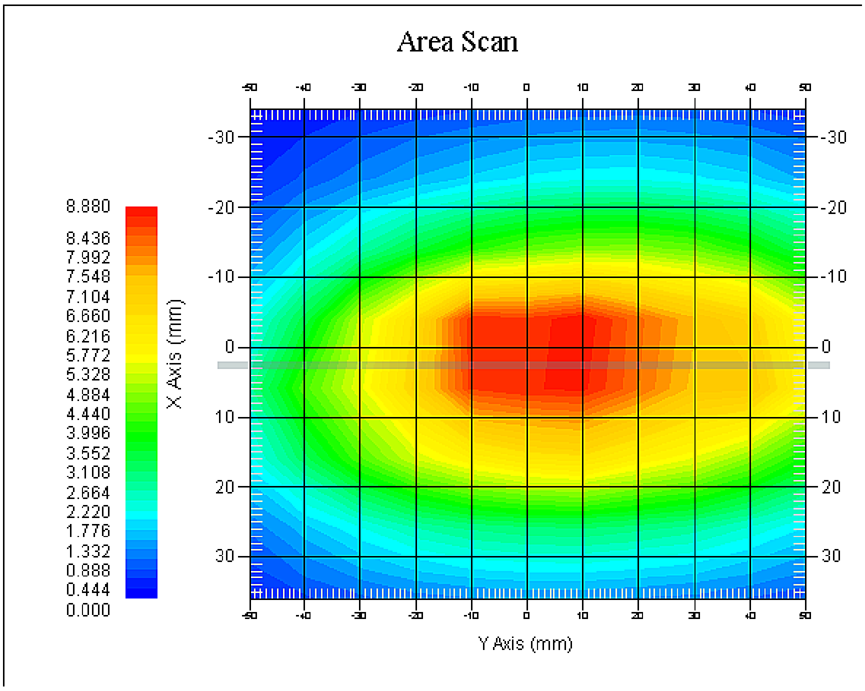
**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)**

**System Performance Check 750 MHz Body Liquid**

**Dipole 750 MHz; Type: ALS-D-750-S-2; S/N: 177-00505**

| | |
|---|---|
| Product Data | |
| Device Name | : Dipole 750 MHz |
| Serial No. | : 177-00505 |
| Type | : Dipole |
| Model | : ALS-D-750-S-2 |
| Frequency Band | : 750 |
| Max. Transmit Pwr | : 1 W |
| Drift Time | : 3 min(s) |
| Power Drift-Start | : 8.203 W/kg |
| Power Drift-Finish | : 8.269 W/kg |
| Power Drift (%) | : 0.794 |
| | |
| Phantom Data | |
| Name | : APREL-Uni |
| Type | : Uni-Phantom |
| Serial No. | : System Default |
| Location | : Center |
| Description | : Default |
| Phantom Data | |
| | |
| Tissue Data | |
| Type | : Body |
| Serial No. | : 269-02107 |
| Frequency | : 750.0 MHz |
| Last Calib. Date | : 23-Sep-2015 |
| Temperature | : 20.00 ℃ |
| Ambient Temp. | : 21.00 ℃ |
| Humidity | : 56.00 RH% |
| Epsilon | : 54.59 F/m |
| Sigma | : 0.98 S/m |
| Density | : 1000.00 kg/cu. m |
| | |
| Probe Data | |
| Name | : E-Field |
| Model | : E-020 |
| Type | : E-Field Triangle |
| Serial No. | : 500-00283 |
| Last Calib. Date | : 14-Oct-2014 |
| Frequency Band | : 750 |
| Duty Cycle Factor | : 1 |
| Conversion Factor | : 5.5 |
| Probe Sensitivity | : 1.20 1.20 1.20 µV/(V/m)2 |
| Compression Point | : 95.00 mV |
| Offset | : 1.56 mm |
| | |
| Measurement Data | |
| Crest Factor | : 1 |
| Scan Type | : Complete |
| Tissue Temp. | : 21.00 ℃ |
| Ambient Temp. | : 21.00 ℃ |
| Area Scan | : 7x9x1 : Measurement x=10mm, y=10mm, z=4mm |
| Zoom Scan | : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm |

| | |
|---|---|
| 1 gram SAR value | : 8.596 W/kg |
| 10 gram SAR value | : 5.998 W/kg |
| Area Scan Peak SAR | : 8.877 W/kg |
| Zoom Scan Peak SAR | : 13.884 W/kg |



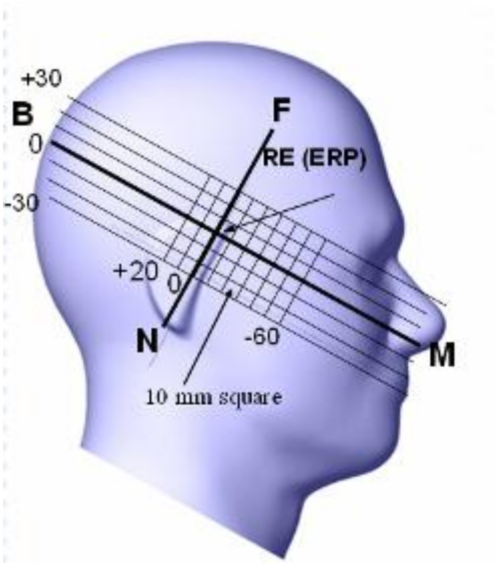

**750 MHz System Validation with Body Tissue**

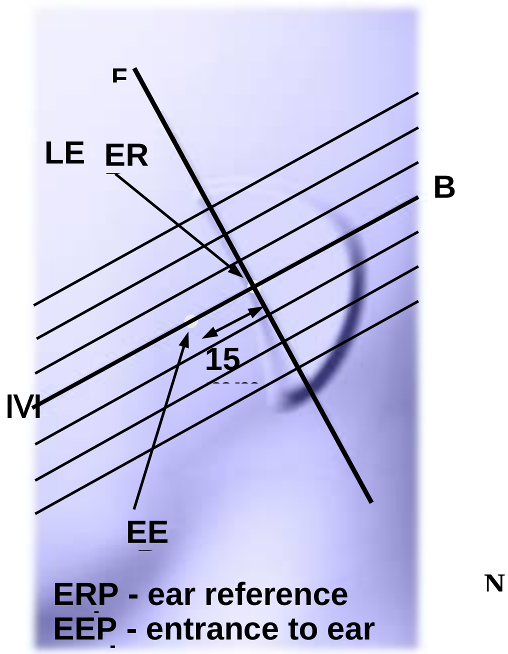
# EUT TEST STRATEGY AND METHODOLOGY

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

This category includes most wireless handsets with fixed, retractable or internal antennas located toward the top half of the device, with or without a foldout, sliding or similar keypad cover. The handset should have its earpiece located within the upper ¼ of the device, either along the centerline or off-centered, as perceived by its users. This type of handset should be positioned in a normal operating position with the "test device reference point" located along the "vertical centerline" on the front of the device aligned to the "ear reference point". The "test device reference point" should be located at the same level as the center of the earpiece region. The "vertical centerline" should bisect the front surface of the handset at its top and bottom edges. A "ear reference point" is located on the outer surface of the head phantom on each ear spacer. It is located 1.5 cm above the center of the ear canal entrance in the "phantom reference plane" defined by the three lines joining the center of each "ear reference point" (left and right) and the tip of the mouth.

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



## Cheek/Touch Position

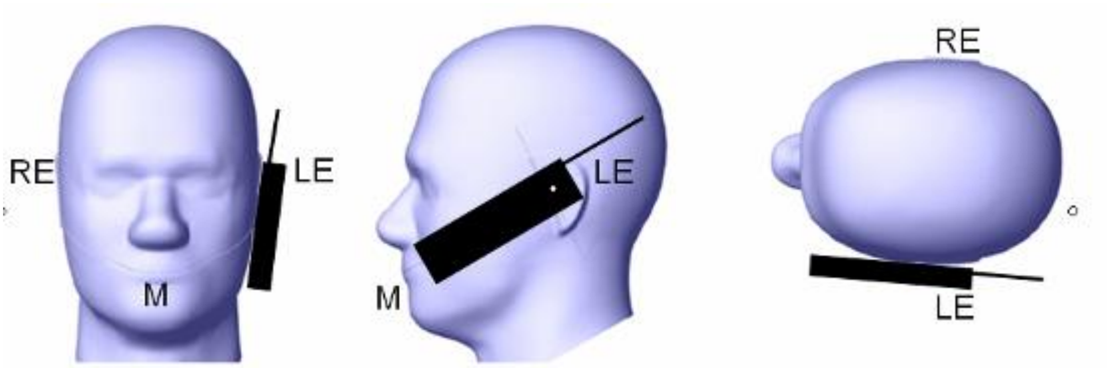
The device is brought toward the mouth of the head phantom by pivoting against the "ear reference point" or along the "N-F" line for the SCC-34/SC-2 head phantom.

This test position is established:

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

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

**Cheek /Touch Position**




## Ear/Tilt Position

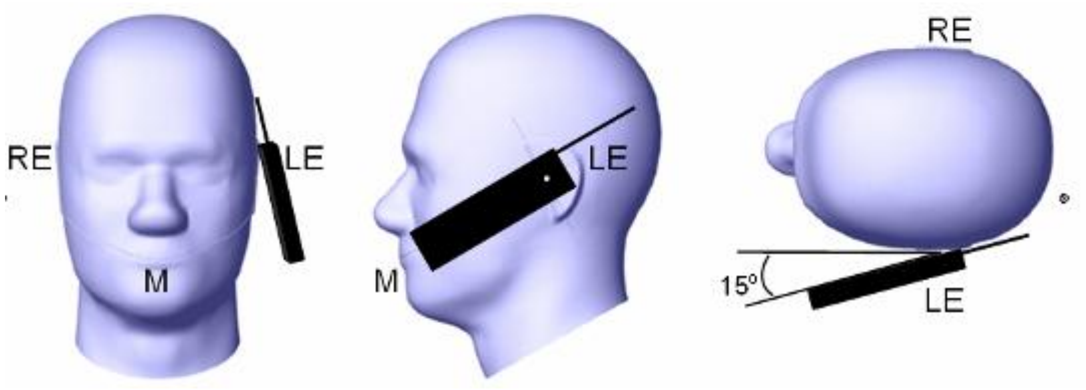
With the handset aligned in the "Cheek/Touch Position":

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

2) (otherwise) The handset should be moved (translated) away from the cheek perpendicular to the line passes through both "ear reference points" (note: one of these ear reference points may not physically exist on a split head model) for approximate 2-3 cm. While it is in this position, the device handset is tilted away from the mouth with respect to the "test device reference point" until the inside angle between the vertical centerline on the front surface of the phone and the horizontal line passing through the ear reference point isby 15 80°. After the tilt, it is then moved (translated) back toward the head perpendicular to the line passes through both "ear reference points" until the device touches the phantom or the ear spacer. If the antenna touches the head first, the positioning process should be repeated with a tilt angle less than 15° so that the device and its antenna would touch the phantom simultaneously. This test position may require a device holder or positioner to achieve the translation and tilting with acceptable positioning repeatability.

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

**Ear /Tilt 15° Position**




## Test positions for body-worn and other configurations

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device. When multiple accessories that do not contain metallic components are supplied with the device, the device may be tested with only the accessory that dictates the closest spacing to the body. When multiple accessories that contain metallic components are supplied with the device, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (e.g., the same metallic belt-clip used with different holsters with no other metallic components), only the accessory that dictates the closest spacing to the body must be tested.

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

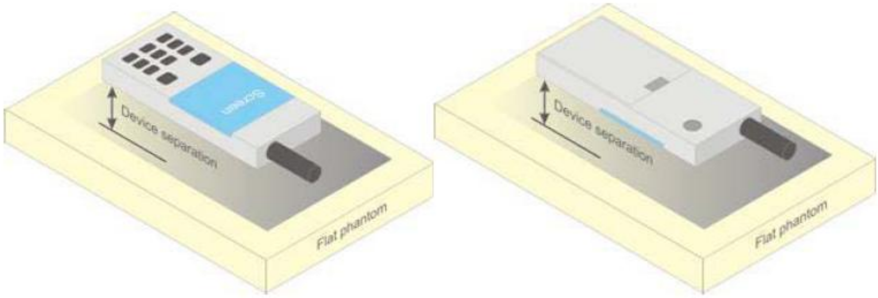



**Figure 5 – Test positions for body-worn devices**

## SAR Evaluation Procedure

The evaluation was performed with the following procedure:

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

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

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

1) The data at the surface were extrapolated, since the center of the dipoles is 1.2 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

2) The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one dimensional splines with the "Not a knot"-condition (in x, y and z-directions). The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the averages.

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

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

## Test methodology

KDB 447498 D01 General RF Exposure Guidance v05r02.
KDB 648474 D04 Handset SAR v01r02.
KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03
KDB 865664 D02 RF Exposure Reporting v01r01
KDB 941225 D01 3G SAR Procedures v03
KDB 941225 D05 SAR for LTE Devices v02r03
KDB 941225 D06 Hotspot Mode v02

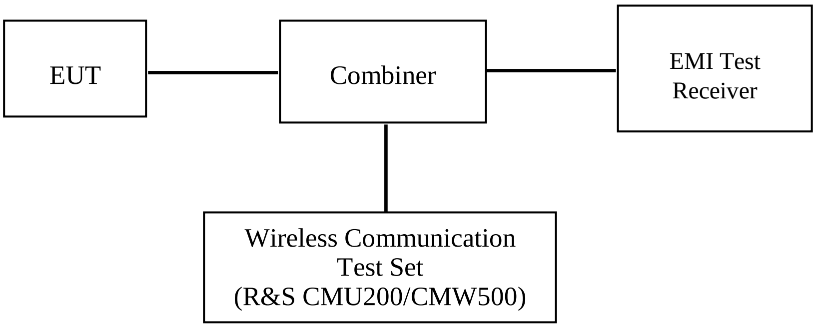
# CONDUCTED OUTPUT POWER MEASUREMENT

## Provision Applicable

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

## Test Procedure

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




**GSM&3G&LTE**

## Maximum Output Power among production units

| Max Target Power for Production Unit (dBm) | | | |
|---|---|---|---|
| Mode/Band | Channel | | |
| | Low | Middle | High |
| LTE Band 17 | 23 | 23 | 23 |

**Note:**

For GSM 850,PCS 1900,WCDMA 850,WCDMA 1700,WCDMA 1900,LTE Band 2,LTE Band 4,LTE Band 7 ,Bluetooth and Wi-Fi conducted power data, please refer to the report RDG150901001-20B .

# LTE

The following tests were conducted according to the test requirements outlined in section 6.2 of the 3GPP TS36.101 specification.

UE Power Class: 3 (23 +/- 2dBm). The allowed Maximum Power Reduction (MPR) for the maximum output power due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3-1 of the 3GPP TS36.101.

**Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3**

| Modulation | Channel bandwidth / Transmission bandwidth (RB) | | | | | | MPR (dB) |
|---|---|---|---|---|---|---|---|
| | 1.4 MHz | 3.0 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | |
| QPSK | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | ≤ 1 |
| 16 QAM | ≤ 5 | ≤ 4 | ≤ 8 | ≤ 12 | ≤ 16 | ≤ 18 | ≤ 1 |
| 16 QAM | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | ≤ 2 |

The allowed A-MPR values specified below in Table 6.2.4.-1 of 3GPP TS36.101 are in addition to the allowed MPR requirements. All the measurements below were performed with A-MPR disabled, by using Network Signaling Value of "NS_01".

**Table 6.2.4-1: Additional Maximum Power Reduction (A-MPR)**

| Network Signalling value | Requirements (sub-clause) | E-UTRA Band | Channel bandwidth (MHz) | Resources Blocks ($N_{RB}$) | A-MPR (dB) |
|---|---|---|---|---|---|
| NS_01 | 6.6.2.1.1 | Table 5.5-1 | 1.4, 3, 5, 10, 15, 20 | Table 5.6-1 | NA |
| NS_03 | 6.6.2.2.1 | 2, 4,10, 23, 25, 35, 36 | 3 | >5 | ≤ 1 |
| | | | 5 | >6 | ≤ 1 |
| | | | 10 | >6 | ≤ 1 |
| | | | 15 | >8 | ≤ 1 |
| | | | 20 | >10 | ≤ 1 |
| NS_04 | 6.6.2.2.2 | 41 | 5 | >6 | ≤ 1 |
| | | | 10, 15, 20 | See Table 6.2.4-4 | |
| NS_05 | 6.6.3.3.1 | 1 | 10,15,20 | ≥ 50 | ≤ 1 |
| NS_06 | 6.6.2.2.3 | 12, 13, 14, 17 | 1.4, 3, 5, 10 | Table 5.6-1 | n/a |
| NS_07 | 6.6.2.2.3<br>6.6.3.3.2 | 13 | 10 | Table 6.2.4-2 | Table 6.2.4-2 |
| NS_08 | 6.6.3.3.3 | 19 | 10, 15 | > 44 | ≤ 3 |
| NS_09 | 6.6.3.3.4 | 21 | 10, 15 | > 40 | ≤ 1 |
| | | | | > 55 | ≤ 2 |
| NS_10 | | 20 | 15, 20 | Table 6.2.4-3 | Table 6.2.4-3 |
| NS_11 | 6.6.2.2.1 | 23[1] | 1.4, 3, 5, 10 | Table 6.2.4-5 | Table 6.2.4-5 |
| .. | | | | | |
| NS_32 | - | - | - | - | - |
| Note 1: Applies to the lower block of Band 23, i.e. a carrier placed in the 2000-2010 MHz region. | | | | | |

**LTE Band 17:**

| Test Bandwidth | Test Modulation | Resource Block & RB offset | Target MPR | Meas. MPR | Ave Tx Power (dBm) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Low Channel | Mid Channel | High Channel |
| 5M | QPSK | 1#0 | 0 | 0 | 22.49 | 22.78 | 22.29 |
| | | 1#12 | 0 | 0 | 22.58 | 22.68 | 22.38 |
| | | 1#24 | 0 | 0 | 22.67 | 22.79 | 22.45 |
| | | 12#0 | 1 | 1 | 21.92 | 22.21 | 21.98 |
| | | 12#6 | 1 | 1 | 21.90 | 22.21 | 21.91 |
| | | 12#11 | 1 | 1 | 21.93 | 22.05 | 21.83 |
| | | 25#0 | 1 | 1 | 21.32 | 21.68 | 21.33 |
| | 16QAM | 1#0 | 1 | 1 | 21.64 | 21.80 | 21.46 |
| | | 1#12 | 1 | 1 | 21.46 | 21.73 | 21.38 |
| | | 1#24 | 1 | 1 | 21.47 | 21.71 | 21.49 |
| | | 12#0 | 2 | 2 | 20.75 | 21.14 | 20.89 |
| | | 12#6 | 2 | 2 | 20.91 | 21.15 | 20.77 |
| | | 12#11 | 2 | 2 | 20.81 | 20.93 | 20.81 |
| | | 25#0 | 2 | 2 | 20.52 | 20.80 | 20.59 |
| 10M | QPSK | 1#0 | 0 | 0 | 22.55 | **22.84** | 22.50 |
| | | 1#24 | 0 | 0 | 22.54 | 22.76 | 22.52 |
| | | 1#49 | 0 | 0 | 22.73 | 22.86 | 22.55 |
| | | 25#0 | 1 | 1 | 21.82 | 21.98 | 21.69 |
| | | 25#12 | 1 | 1 | 22.04 | 22.08 | 21.80 |
| | | 25#24 | 1 | 1 | 21.83 | 22.00 | 21.80 |
| | | 50#0 | 1 | 1 | 21.50 | 21.74 | 21.49 |
| | 16QAM | 1#0 | 1 | 1 | 21.77 | 22.12 | 21.74 |
| | | 1#24 | 1 | 1 | 21.72 | 21.92 | 21.65 |
| | | 1#49 | 1 | 1 | 21.82 | 21.98 | 21.57 |
| | | 25#0 | 2 | 2 | 21.26 | 21.54 | 21.28 |
| | | 25#12 | 2 | 2 | 21.44 | 21.58 | 21.25 |
| | | 25#24 | 2 | 2 | 21.18 | 21.45 | 21.11 |
| | | 50#0 | 2 | 2 | 20.77 | 21.00 | 20.54 |

**Note:**

1. SAR for LTE band exposure configurations is measured according to the procedures of KDB 941225 D05 SAR for LTE Devices v02.
2. The CMW500 Wideband Radio Communication tester is used for LTE output power measurements and SAR testing. Closed loop power control is used to keep the radio transmitters the max output power during the test.
3. KDB941225D05v02- SAR for higher order modulation is required only when the highest maximum output power for the configuration in the higher order modulation is > ½ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg

# SAR MEASUREMENT RESULTS

This page summarizes the results of the performed dosimetric evaluation.

## SAR Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 21-24 ℃ |
| **Relative Humidity:** | 50-53 % |
| **ATM Pressure:** | 1001-1002 mbar |

*Testing was performed by Terry XiaHou on 2015-09-23*

## LTE Band 17:

| EUT Position | Frequency (MHz) | Test Mode | Power Drift (%) | Max. Meas. Power (dBm) | Max. Rated Power (dBm) | 1g SAR (W/Kg) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Scaled Factor | Meas. SAR | Scaled SAR | Plot |
| Left Head Cheek | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | 2.981 | 22.84 | 23.00 | 1.038 | 0.055 | **0.057** | **1#** |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=0 | 1.238 | 22.05 | 23.00 | 1.245 | 0.042 | 0.052 | / |
| Left Head Tilt | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | -3.526 | 22.84 | 23.00 | 1.038 | 0.029 | 0.030 | / |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=0 | 1.588 | 22.05 | 23.00 | 1.245 | 0.023 | 0.029 | |
| Right Head Cheek | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | -2.176 | 22.84 | 23.00 | 1.038 | 0.052 | 0.054 | / |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=0 | -1.587 | 22.05 | 23.00 | 1.245 | 0.042 | 0.052 | |
| Right Head Tilt | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | -2.413 | 22.84 | 23.00 | 1.038 | 0.026 | 0.027 | / |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=0 | 0.894 | 22.05 | 23.00 | 1.245 | 0.025 | 0.031 | |

**Note**:

1. When the 1-g SAR is ≤ 0.8W/Kg, testing for other channels are optional.
2. SAR for LTE band exposure configurations is measured according to the procedures of KDB 941225 D05 SAR for LTE Devices v02.
3. KDB941225D05- SAR for higher order modulation is required only when the highest maximum output power for the configuration in the higher order modulation is > ½ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg
4. KDB941225D05- For QPSK with 100% RB allocation, when the reported SAR measured for the Highest output power channel is <1.45 W/kg, tests for the remaining required test channels are optional.

5.KDB941225D05- For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg.
6. KDB941225D05- Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offset the upper edge, middle and lower edge of each required test channel.
7. Worst case SAR for 50% RB allocation is selected to be tested.

**Mobile Hot-Spot Test Result**

The DUT is capable of functioning as a Wi-Fi to Cellular Mobile hotspot. Additional SAR testing was performed according to KDB 941225 D06. Testing was performed with a separation of 1cm between the DUT and the flat phantom. The DUT was positioned for SAR tests with the front and back surfaces facing the phantom, and also with the edges facing the phantom in which the transmitting antenna is <2.5 cm from the edge. Each transmit band was utilized for SAR testing. The tested mode has been selected within each band that exhibits the highest time average output power.

**LTE Band 17:**

| EUT Position | Frequency (MHz) | Test Mode | Power Drift (%) | Max. Meas. Power (dBm) | Max. Rated Power (dBm) | 1g SAR (W/Kg) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Scaled Factor | Meas. SAR | Scaled SAR | Plot |
| Body-Back (10mm) | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | 1.314 | 22.84 | 23.00 | 1.038 | 0.360 | **0.374** | **2#** |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=12 | -2.512 | 22.05 | 23.00 | 1.245 | 0.279 | 0.347 | / |
| Body-Left (10mm) | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | 1.793 | 22.84 | 23.00 | 1.038 | 0.126 | 0.131 | / |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=12 | 2.662 | 22.05 | 23.00 | 1.245 | 0.103 | 0.128 | |
| Body- Right (10mm) | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | 2.676 | 22.84 | 23.00 | 1.038 | 0.179 | 0.186 | / |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=12 | 1.128 | 22.05 | 23.00 | 1.245 | 0.097 | 0.121 | |
| Body-Bottom (10mm) | 709 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 1RB,0ffset=0 | -1.511 | 22.84 | 23.00 | 1.038 | 0.152 | 0.158 | / |
| | 711 | 1RB,0ffset=0 | / | / | / | / | / | / | / |
| | 710 | 50% RB,offset=12 | -3.151 | 22.05 | 23.00 | 1.245 | 0.106 | 0.132 | |

**Note**:

1. When the 1-g SAR is ≤ 0.8W/Kg, testing for other channels are optional.
2. SAR for LTE band exposure configurations is measured according to the procedures of KDB 941225 D05 SAR for LTE Devices v02.
3. KDB941225D05- SAR for higher order modulation is required only when the highest maximum output power for the configuration in the higher order modulation is > ½ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg
4. KDB941225D05- For QPSK with 100% RB allocation, when the reported SAR measured for the Highest output power channel is <1.45 W/kg, tests for the remaining required test channels are optional.
5.KDB941225D05- For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg.
6. KDB941225D05- Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offset the upper edge, middle and lower edge of each required test channel.
7. Worst case SAR for 50% RB allocation is selected to be tested.

## SAR Plots (Summary of the Highest SAR Values)

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

### LTE FDD Band17; Left-Head-Cheek (710 MHz Middle Channel);

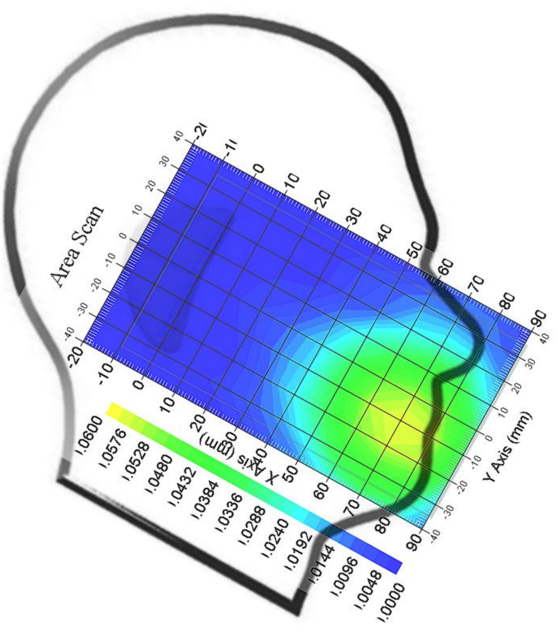
| | |
|---|---|
| Measurement Data | |
| Test mode | : RB1 |
| Crest Factor | : 1 |
| Scan Type： | : Complete |
| Area Scan | : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm |
| Zoom Scan | : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm |
| Power Drift-Start | : 0.002 W/kg |
| Power Drift-Finish | : 0.002 W/kg |
| Power Drift (%) | : 2.981 |

| | |
|---|---|
| Tissue Data | |
| Type | : Head |
| Frequency | : 710 MHz |
| Epsilon | : 42.34 F/m |
| Sigma | : 0.88 S/m |
| Density | : 1000.00 kg/cu. m |

| | |
|---|---|
| Probe Data | |
| Serial No. | : 500-00283 |
| Frequency Band | : 750 |
| Duty Cycle Factor | : 1 |
| Conversion Factor | : 6.0 |
| Probe Sensitivity | : 1.20 1.20 1.20 μV/(V/m)2 |
| Compression Point | : 95.00 mV |
| Offset | : 1.56 mm |

| | |
|---|---|
| 1 gram SAR value | : 0.055 W/kg |
| 10 gram SAR value | : 0.037 W/kg |
| Area Scan Peak SAR | : 0.060 W/kg |
| Zoom Scan Peak SAR | : 0.087 W/kg |

**Plot 1#**

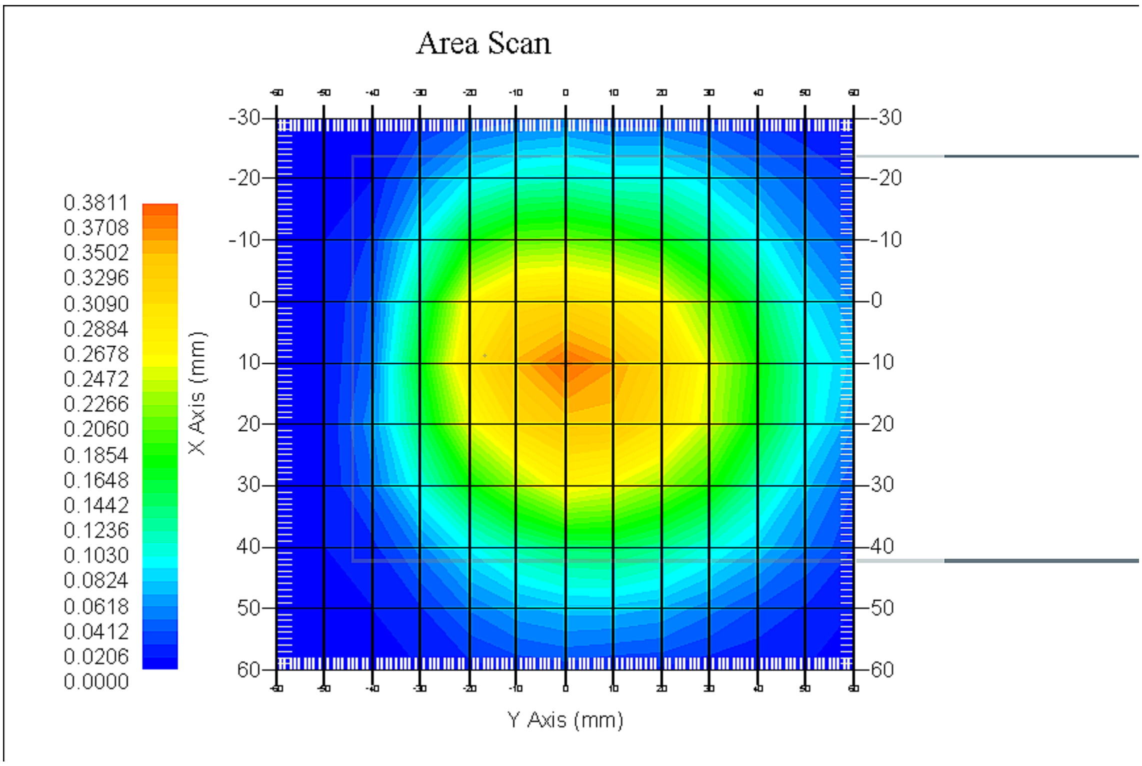


**Test Laboratory: Bay Area Compliance Lab Corp. (Shenzhen)**

**LTE FDD Band17; Body-Worn-Back (710 MHz Middle Channel);**

| | |
|---|---|
| Measurement Data | |
| Test mode | : 1RB |
| Crest Factor | : 1 |
| Scan Type : | : Complete |
| Area Scan | : 8x11x1 : Measurement x=10mm, y=10mm, z=4mm |
| Zoom Scan | : 7x7x7 : Measurement x=5mm, y=5mm, z=5mm |
| Power Drift-Start | : 0.303 W/kg |
| Power Drift-Finish | : 0.307 W/kg |
| Power Drift (%) | : 1.314 |
| Tissue Data | |
| Type | : Body |
| Frequency | : 710 MHz |
| Epsilon | : 54.64 F/m |
| Sigma | : 0.94 S/m |
| Density | : 1000.00 kg/cu. m |
| Probe Data | |
| Serial No. | : 500-00283 |
| Frequency Band | : 750 |
| Duty Cycle Factor | : 1 |
| Conversion Factor | : 5.5 |
| Probe Sensitivity | : 1.20 1.20 1.20 µV/(V/m)2 |
| Compression Point | : 95.00 mV |
| Offset | : 1.56 mm |
| 1 gram SAR value | : 0.360 W/kg |
| 10 gram SAR value | : 0.265 W/kg |
| Area Scan Peak SAR | : 0.373 W/kg |
| Zoom Scan Peak SAR | : 0.520 W/kg |

**Plot 2#**



# 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 | $c_i^1$ (1-g) | $c_i^1$ (10-g) | Standard Uncertainty (1-g) % | Standard Uncertainty (10-g) % |
|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | |
| Probe Calibration | 3.5 | normal | 1 | 1 | 1 | 3.5 | 3.5 |
| Axial Isotropy | 3.7 | rectangular | $\sqrt{3}$ | $(1-cp)^{1/2}$ | $(1-cp)^{1/2}$ | 1.5 | 1.5 |
| Hemispherical Isotropy | 10.9 | rectangular | $\sqrt{3}$ | √cp | √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 |
| **Test sample related** | | | | | | | |
| 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 |
| **Phantom and Setup** | | | | | | | |
| 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 | $c_i^1$ (1-g) | $c_i^1$ (10-g) | Standard Uncertainty (1-g) % | Standard Uncertainty (10-g) % |
|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | |
| 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 |
| **Test sample related** | | | | | | | |
| 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 |
| **Phantom and Setup** | | | | | | | |
| 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-1598

**Task No: BACL-5778**

## CERTIFICATE OF CALIBRATION

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

Equipment: Miniature Isotropic RF Probe
Record of Calibration
Head and Body
Manufacturer: APREL Laboratories
**Model No.:** E-020
**Serial No.:** 500-00283

**Calibration Procedure:** D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole
**Project No:** BACL-5745

**Calibrated:** 14th October 2014
**Released on:** 14th October 2014

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

Released By: ______________________

Art Brennan, Quality Manager

NCL CALIBRATION LABORATORIES

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

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

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

### Introduction

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

### Calibration Method

Probes are calibrated using the following methods.

<1000MHz
TEM Cell for sensitivity in air
Standard phantom using temperature transfer method for sensitivity in tissue

>1000MHz
Waveguide* method to determine sensitivity in air and tissue
*Waveguide is numerically (simulation) assessed to determine the field distribution and power

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

### References

- IEEE Standard 1528
  IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1
  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
  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

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**Conditions**

Probe 500-00283 was a recalibration.

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

**Primary Measurement Standards**

| Instrument | Serial Number | Cal due date |
|---|---|---|
| Tektronix USB Power Meter | 11C940 | May 14, 2015 |
| Signal Generator HP 83640B | 3844A00689 | Feb 12, 2015 |

**Secondary Measurement Standards**

| | | |
|---|---|---|
| Network Analyzer Anritsu 37347C | 002106 | Feb. 20, 2015 |

**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**

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

**Probe Summary**

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

*Resistive to recommended tissue recipes per IEEE-1528

**Sensitivity in Air**

| | |
|---|---|
| **Channel X:** | 1.2 $\mu V/(V/m)^2$ |
| **Channel Y:** | 1.2 $\mu V/(V/m)^2$ |
| **Channel Z:** | 1.2 $\mu V/(V/m)^2$ |

| | |
|---|---|
| **Diode Compression Point:** | 95 mV |

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Calibration for Tissue (Head H, Body B)

| Frequency | Tissue Type | Measured Epsilon | Measured Sigma | Standard Uncertainty (%) | Calibration Frequency Range (MHz) | Conversion Factor |
|---|---|---|---|---|---|---|
| 450 H | Head | 43.59 | 0.86 | 3.5 | ±50 | 5.7 |
| 450 B | Body | 56.74 | 0.94 | 3.5 | ±50 | 5.8 |
| 750 H | Head | 42.98 | 0.92 | 3.5 | ±50 | 6.0 |
| 750 B | Body | 43.05 | 0.93 | 3.5 | ±50 | 5.5 |
| 835 H | Head | 43.42 | 0.94 | 3.5 | ±50 | 5.9 |
| 835 B | Body | 55.77 | 1.01 | 3.5 | ±50 | 5.9 |
| 900 H | Head | 41.87 | 1.06 | 3.5 | ±50 | 6.0 |
| 900 B | Body | 55.62 | 1.05 | 3.5 | ±50 | 5.9 |
| 1450 H | Head | X | X | X | X | X |
| 1450 B | Body | X | X | X | X | X |
| 1500 H | Head | X | X | X | X | X |
| 1500 B | Body | X | X | X | X | X |
| 1640 H | Head | X | X | X | X | X |
| 1640 B | Body | X | X | X | X | X |
| 1750 H | Head | 38.23 | 1.38 | 3.5 | ±75 | 5.4 |
| 1750 B | Body | 52.86 | 1.54 | 3.5 | ±75 | 5.3 |
| 1800 H | Head | X | X | X | X | X |
| 1800 B | Body | X | X | X | X | X |
| 1900 H | Head | 40.20 | 1.38 | 3.5 | ±75 | 4.8 |
| 1900 B | Body | 52.63 | 1.46 | 3.5 | ±75 | 4.5 |
| 2000 H | Head | X | X | X | X | X |
| 2000 B | Body | X | X | X | X | X |
| 2100 H | Head | X | X | X | X | X |
| 2100 B | Body | X | X | X | X | X |
| 2300 H | Head | X | X | X | X | X |
| 2300 B | Body | X | X | X | X | X |
| 2450 H | Head | 37.26 | 1.84 | 3.5 | ±75 | 4.9 |
| 2450B | Body | 53.61 | 1.9 | 3.5 | ±75 | 4.3 |
| 3000 H | Head | X | X | X | X | X |
| 3000 B | Body | X | X | X | X | X |
| 3600 H | Head | 37.49 | 3.16 | 3.5 | ±100 | 4.5 |
| 3600 B | Body | 49.94 | 3.86 | 3.5 | ±100 | 4.0 |
| 5250 H | Head | 35.51 | 4.78 | 3.5 | ±100 | 3.0 |
| 5250 B | Body | 47.54 | 5.11 | 3.5 | ±100 | 2.8 |
| 5600 H | Head | 36.05 | 5.15 | 3.5 | ±100 | 2.8 |
| 5600 B | Body | 46.49 | 5.72 | 3.5 | ±100 | 2.2 |
| 5800 H | Head | 45.99 | 6.01 | 3.5 | ±100 | 3.2 |
| 5800 B | Body | 35.6 | 5.37 | 3.5 | ±100 | 2.5 |

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

**Boundary Effect:**

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

**Spatial Resolution:**

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

**DAQ-PAQ Contribution**

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

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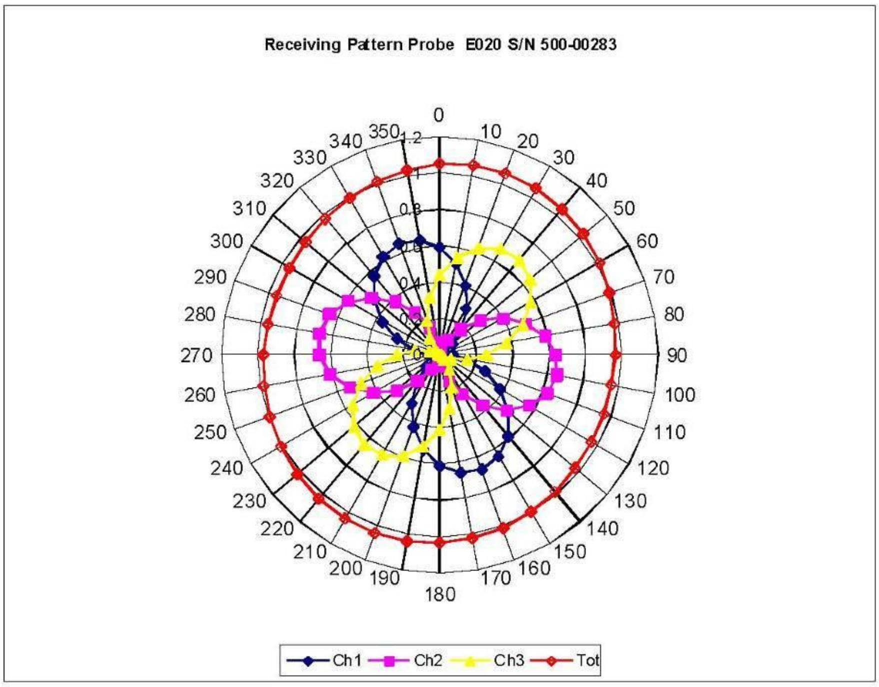
## Receiving Pattern Air

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

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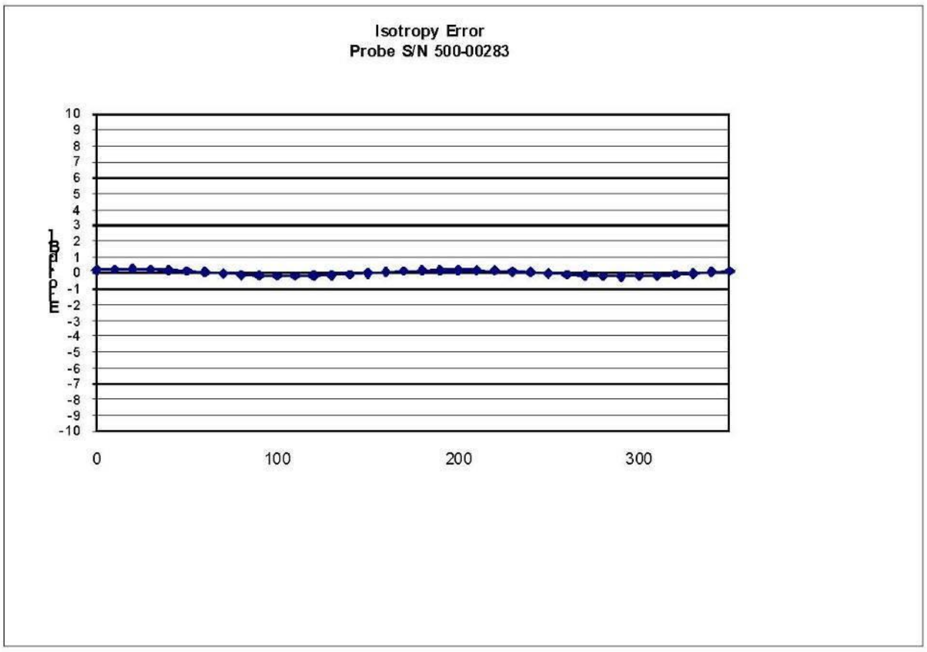
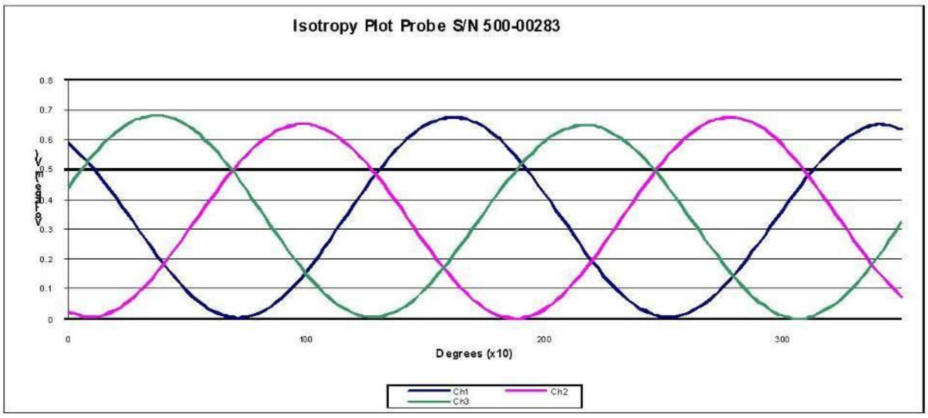
## Isotropy Error Air




**Isotropicity Tissue:** 0.10 dB

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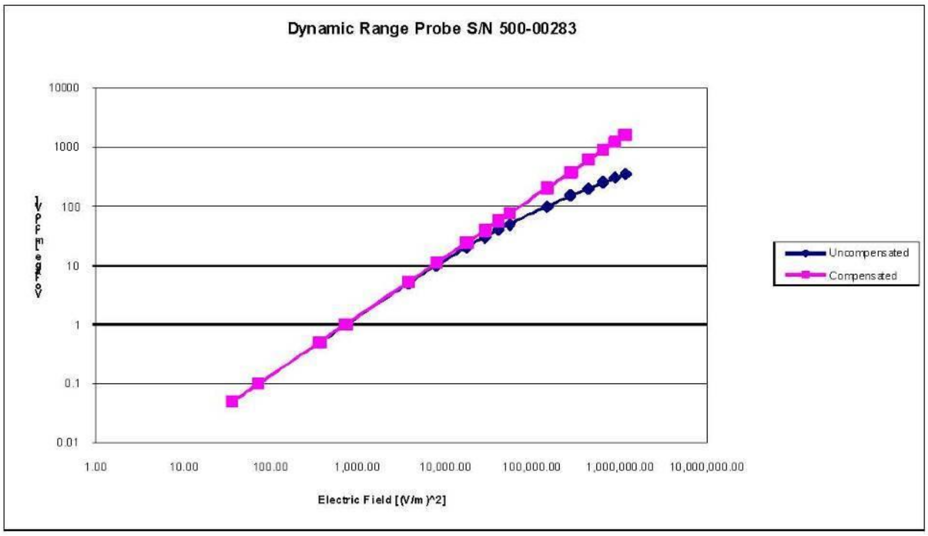
## Dynamic Range

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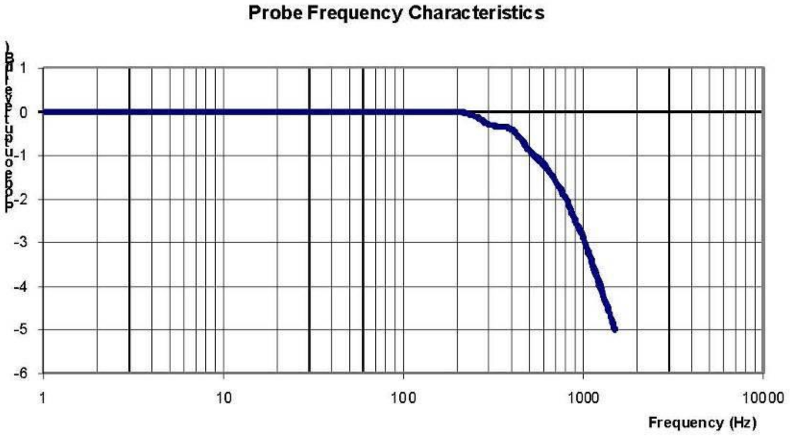
## Video Bandwidth




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

**Test Equipment**

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2014.

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# APPENDIX C DIPOLE CALIBRATION CERTIFICATES

**NCL CALIBRATION LABORATORIES**

Calibration File No: DC-1532
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-750-S-2
Frequency: 750 MHz
Serial No: 177-00505

Customer: BACL

Calibrated: 8th of October 2013
Released on: 8th of 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 177-00505 was a new calibration, removed from stock.

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

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

**We the undersigned attest that to the best of our knowledge the calibration of this 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**

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

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

## Calibration Results Summary

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

### Mechanical Dimensions

**Length:** 180.2 mm
**Height:** 97.0 mm

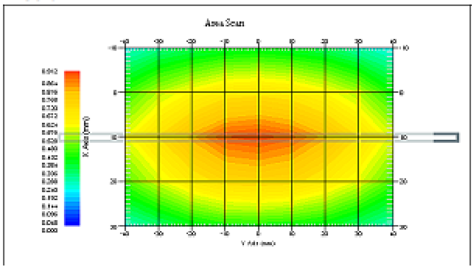
### Electrical Calibration

| Test | Result Head | Result Body |
|---|---|---|
| S11 R/L | -27.621 dB | -21.672 dB |
| SWR | 1.106 U | 1.201 U |
| Impedance | 52.505 Ω | 55.933 Ω |

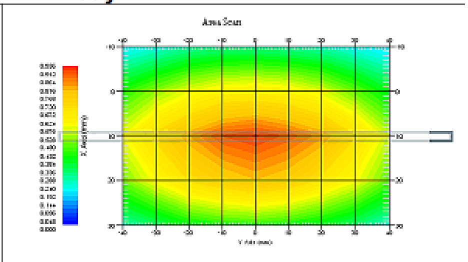
### System Validation Results

| Frequency 750 MHz | 1 Gram | 10 Gram |
|---|---|---|
| Head | 8.5 | 54.0 |
| Body | 8.54 | 5.42 |

**Head**



**Body**



3
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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 177-00505. 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 2225.

## References

- SSI-TP-018-ALSAS Dipole Calibration Procedure
- SSI-TP-016 Tissue Calibration Procedure
- IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
- IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
- Part 1: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)"
- IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
- Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 6 GHz)"
- TP-D01-032-E020-V2 E-Field probe calibration procedure
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

## Conditions

Dipole 177-00505 was a new 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 |
|---|---|---|---|
| 180.0 mm | 97.8 mm | 180.2 mm | 97.0 mm |

### Tissue Validation

| Tissue 750MHz | Measured Head | Measured Body |
|---|---|---|
| Dielectric constant, $\varepsilon_r$ | 42.7 | 56.6 |
| Conductivity, $\sigma$ [S/m] | 0.85 | 0.94 |

### Dipole Calibration uncertainty

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

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

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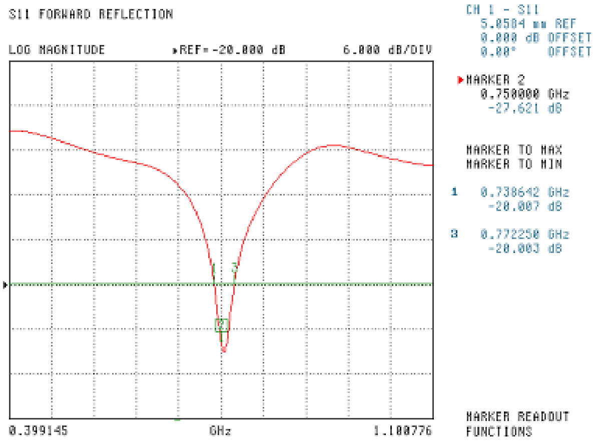
### Electrical Calibration

| Test | Result Head | Result Body |
|---|---|---|
| S11 R/L | -27.621 dB | -21.672 dB |
| SWR | 1.106 U | 1.201 U |
| Impedance | 52.505 Ω | 55.933 Ω |

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

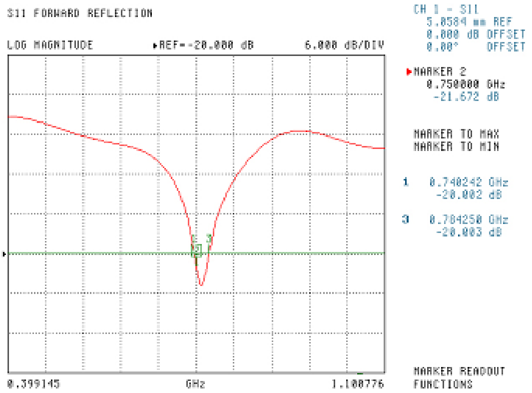
### S11 Parameter Return Loss

**HEAD**




Frequency Range 738 MHz to 772 MHz

**BODY**




Frequency Range 740 MHz to 784 MHz

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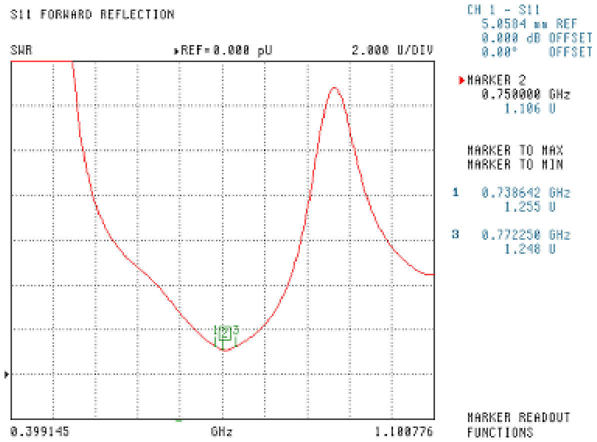
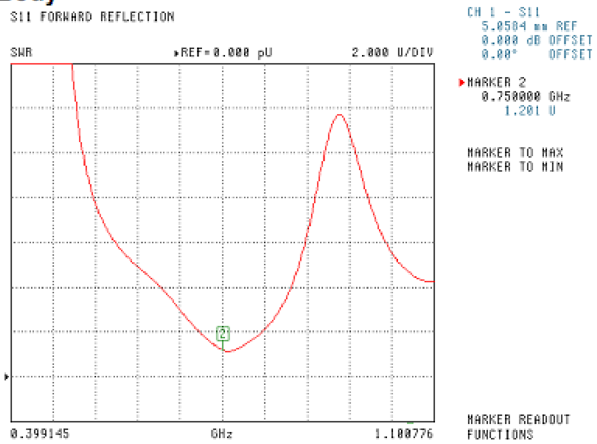
## SWR

### Head




### Body

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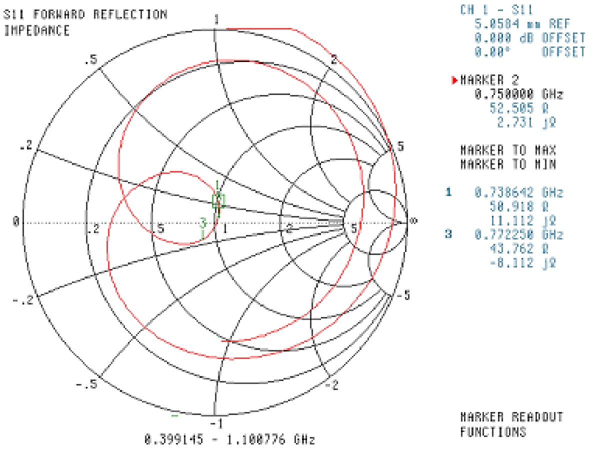
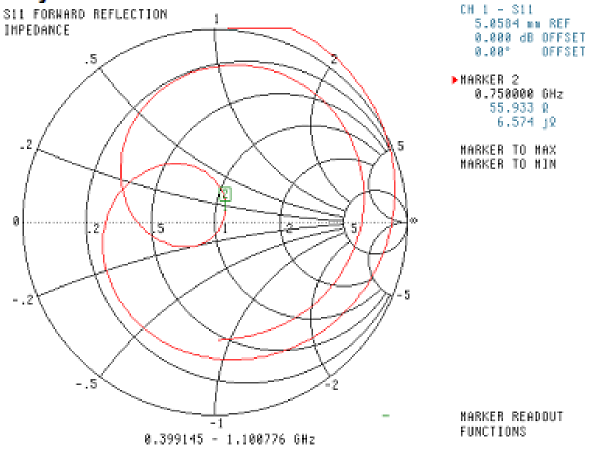
## Smith Chart Dipole Impedance

### Head




### Body

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Division of APREL Laboratories.

## Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2013.



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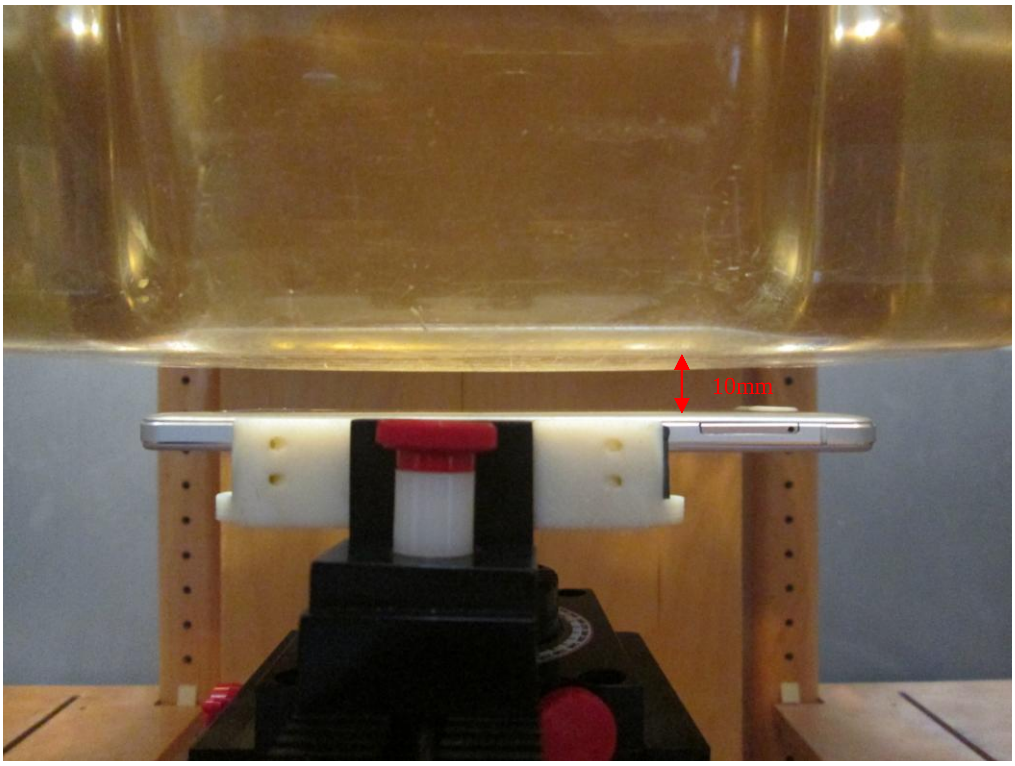
# APPENDIX D EUT TEST POSITION PHOTOS

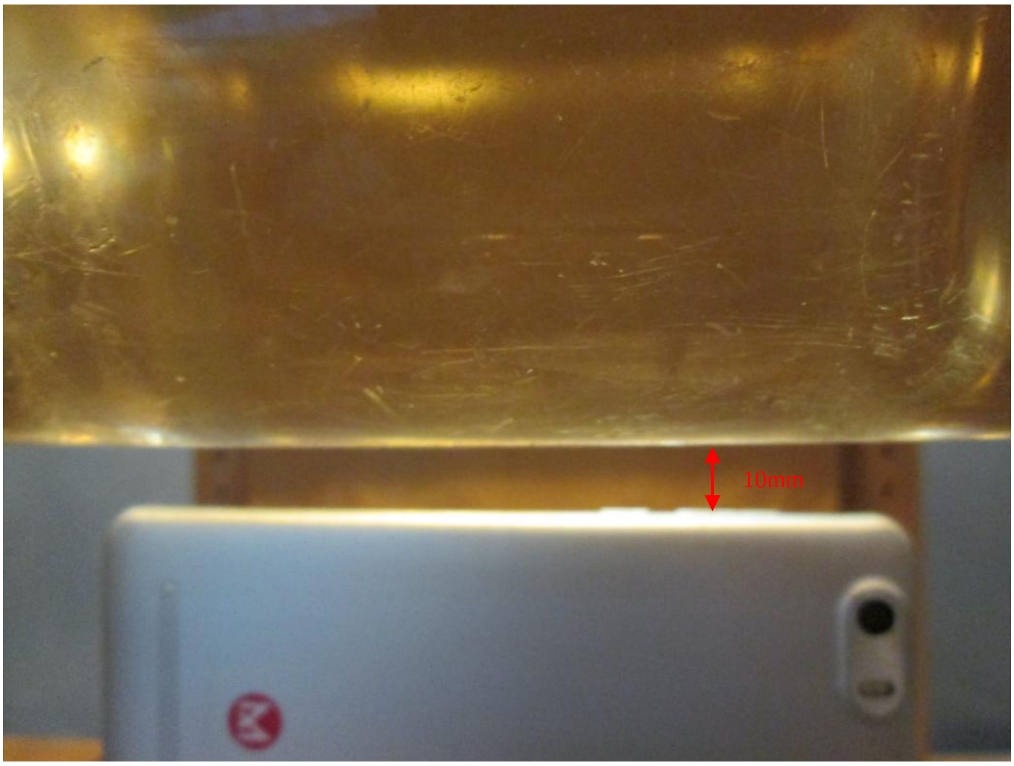
**Liquid depth ≥ 15cm**

**Body-worn Back Setup Photo (10mm)**

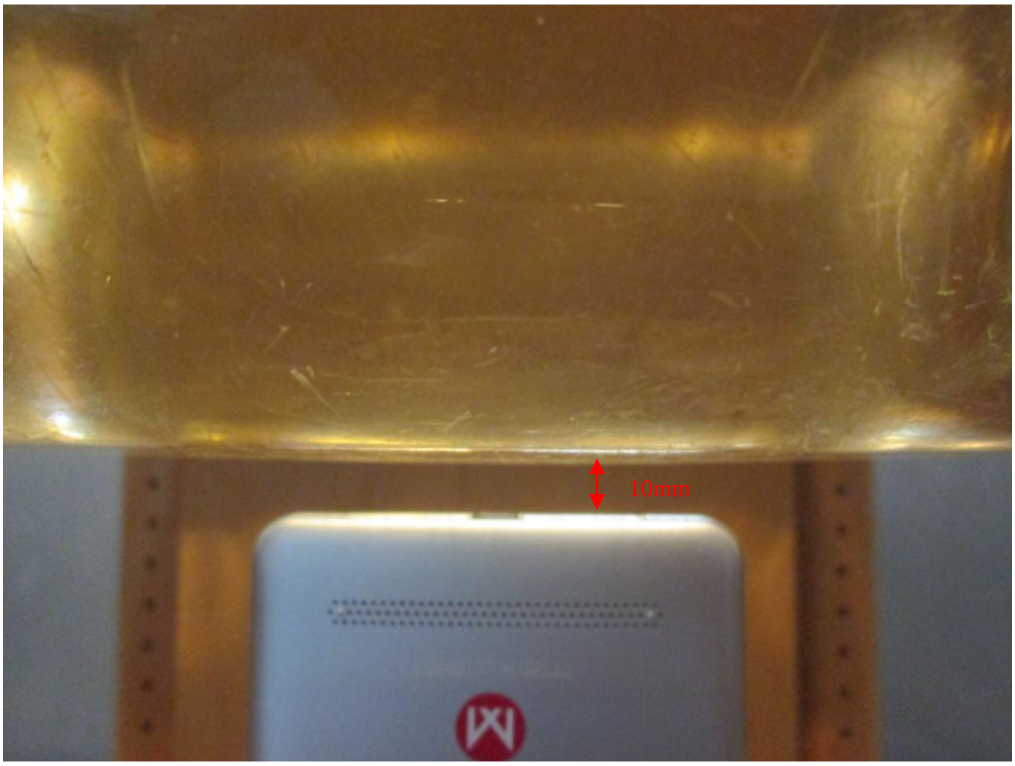


**Body-worn Left Setup Photo (10mm)**

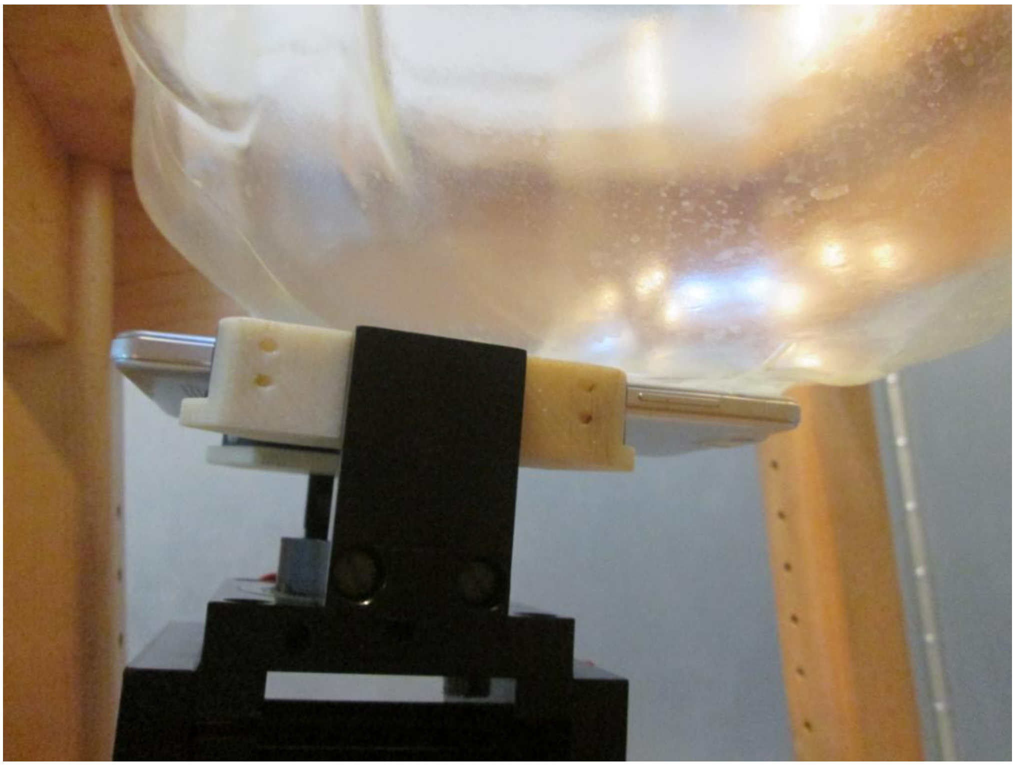

**Body-worn Right Setup Photo (10mm)**



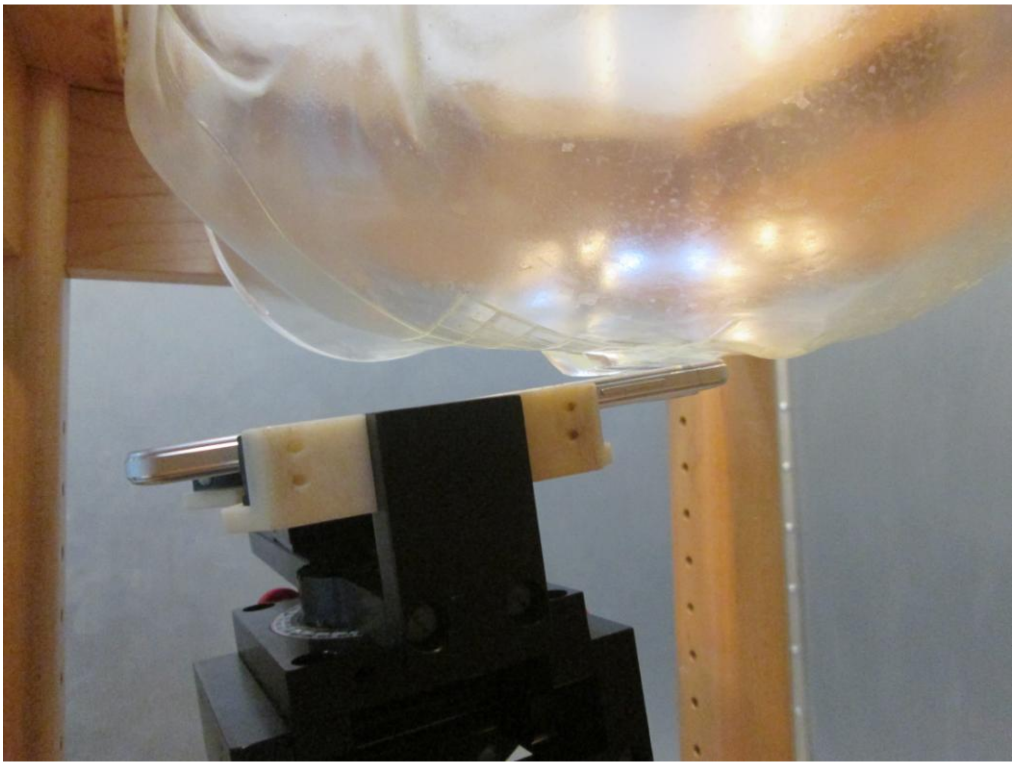
**Body-worn Bottom Setup Photo (10mm)**



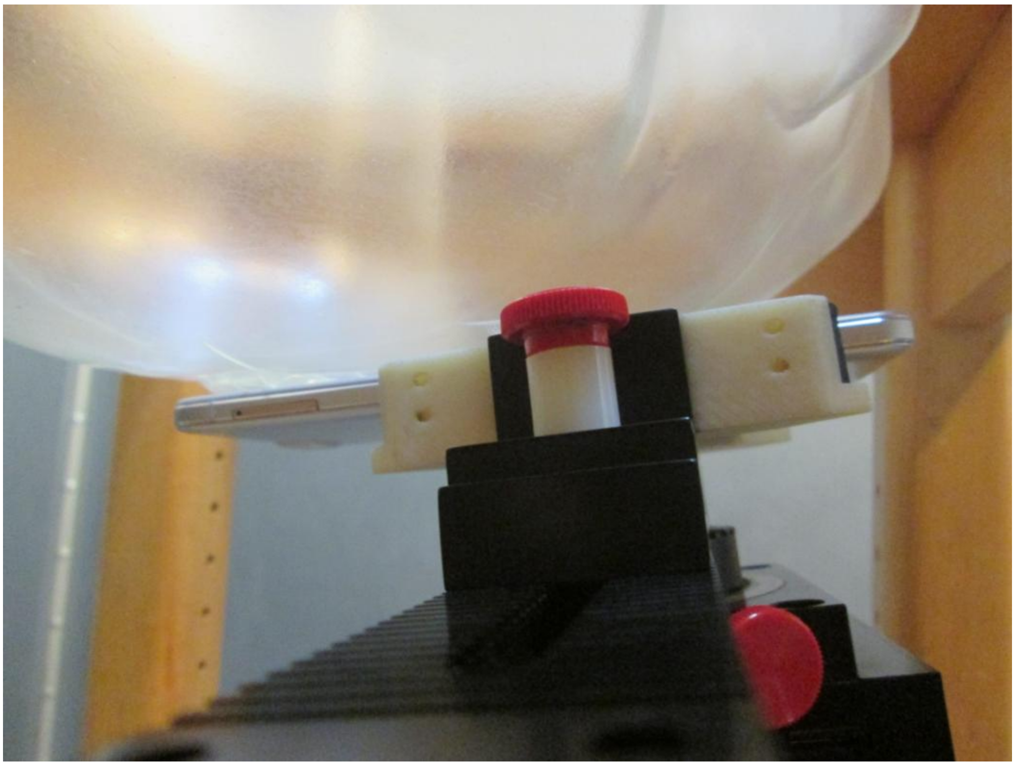

**Left Head Touch Setup Photo**



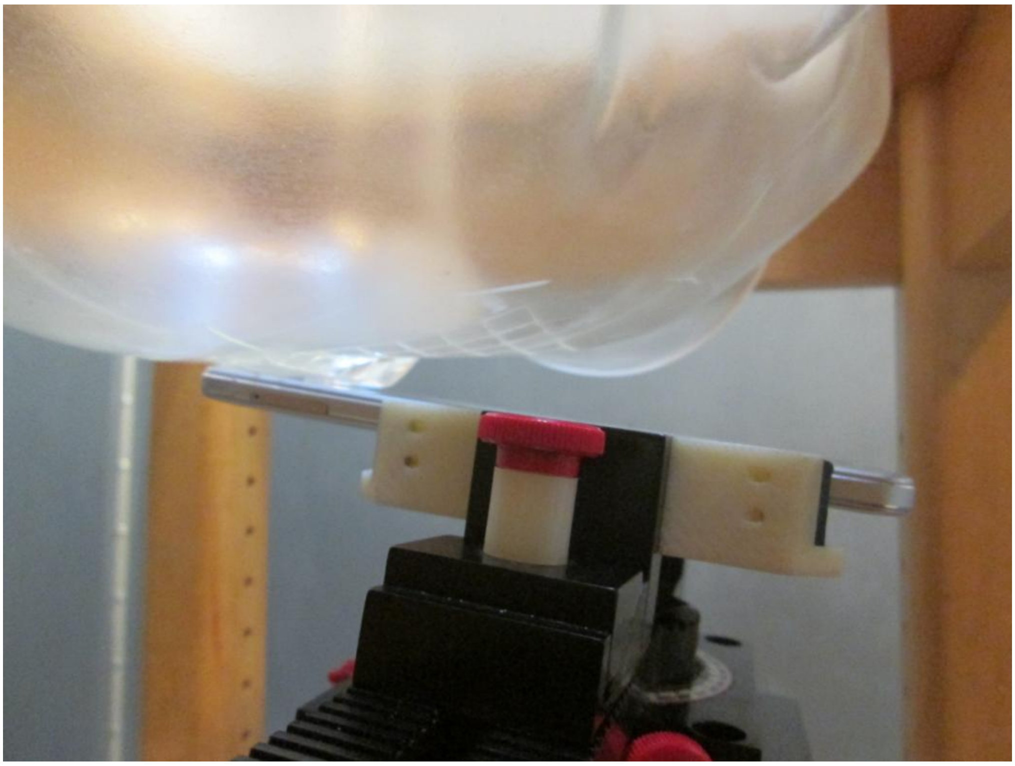
**Left Head Tilt Setup Photo**



**Right Head Touch Setup Photo**

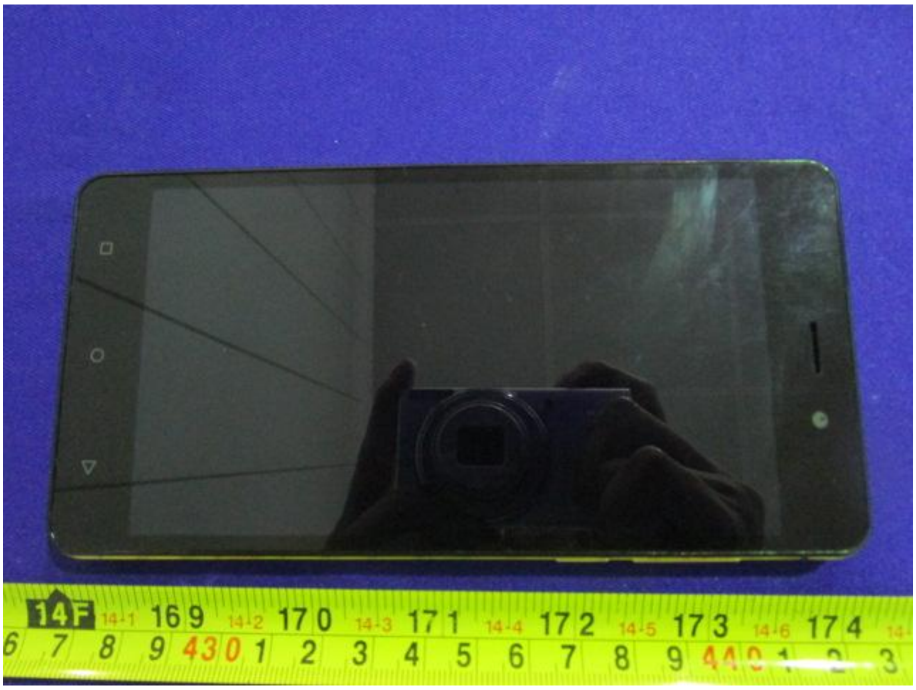


**Right Head Tilt Setup Photo**



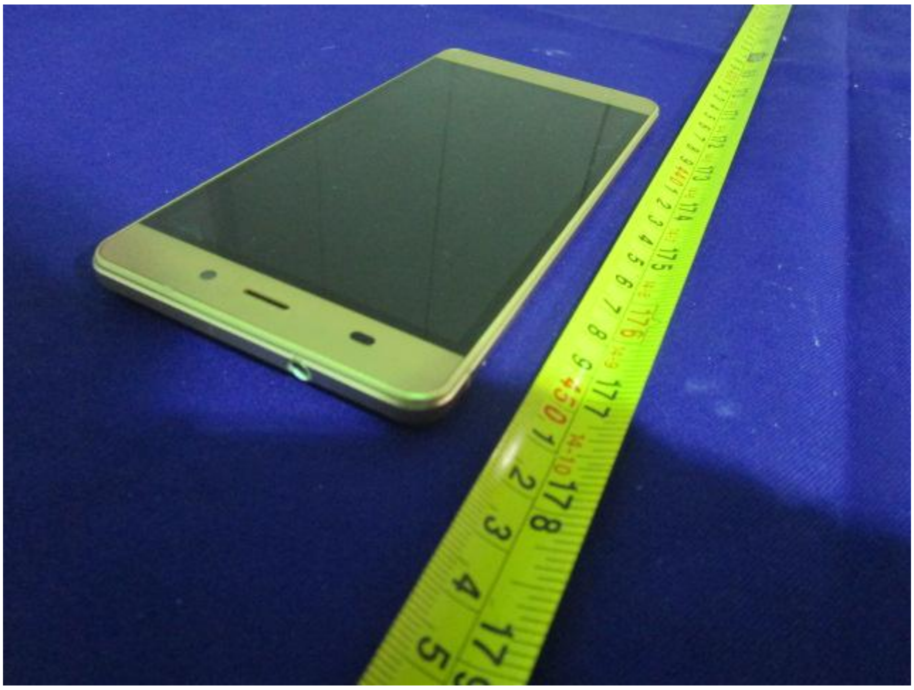
# APPENDIX E EUT PHOTOS

**EUT – Front View**



**EUT – Back View**

**EUT – Side View-1**



**EUT – Side View-2**

## EUT – Uncover View

# 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, O_ce of Engineering & Technology, Washington, DC, 1997.

[3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-_eld scanning system for dosimetricPage 64 of 64
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[6] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.

[7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM _ 97, Dubrovnik, October 15{17, 1997, pp. 120-24.

[8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172-175.

[9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard K. uhn, and Niels Kuster, \The depen-dence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 10, pp. 1865-1873, Oct. 1996.

[10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.

[11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.

[12] W. H. Press, S. A. Teukolsky,W. T. Vetterling, and B. P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992.Dosimetric Evaluation of Sample device, month 1998 9

[13] NIS81 NAMAS, \The treatment of uncertainity in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.

[14] Barry N. Taylor and Christ E. Kuyatt, \Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10.

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