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# SAR EVALUATION REPORT

**Applicant Name:**
Samsung Electronics, Co. Ltd.
416, Maetan 3-dong, Yeongtong-gu, Suwon-si
Gyeonggi-do, 443-742
Republic of Korea

**Date of Testing:**
03/28/12
**Test Site/Location:**
PCTEST Lab, Columbia, MD, USA
**Document Serial No.:**
0Y1203280348.A3L

**FCC ID:** **A3LGTN8013A**

**APPLICANT:** **SAMSUNG ELECTRONICS, CO. LTD.**

| | |
|---|---|
| **DUT Type:** | Portable Tablet Computer |
| **Application Type:** | Certification |
| **FCC Rule Part(s):** | CFR §2.1093 |
| **Model(s):** | GT-N8013 |
| **Test Device Serial No.:** | Pre-Production [S/N: FCC RAD SAMPLE #2] |

| Band & Mode | Tx Frequency | Conducted Power [dBm] | SAR 1 gm Body (W/kg) |
|---|---|---|---|
| 2.4 GHz WLAN | 2412 - 2462 MHz | 12.67 | 0.67 |
| 5.8 GHz WLAN | 5745 - 5825 MHz | 9.67 | |
| 5.2 GHz WLAN | 5180 - 5240 MHz | 9.86 | |
| 5.3 GHz WLAN | 5260 - 5320 MHz | 9.92 | |
| 5.5 GHz WLAN | 5500 - 5700 MHz | 10.10 | |
| Bluetooth | 2402 - 2480 MHz | 10.61 | N/A |

Note: Powers in the above table represent output powers for the SAR test configurations and may not represent the highest output powers for all configurations for each mode.

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001), IEEE 1528-2003 and in applicable Industry Canada Radio Standards Specifications (RSS); for North American frequency bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

*PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.*

Randy Ortanez
President

ACCREDITED
TESTING LABORATORY
CERTIFICATE #2041.01

# TABLE OF CONTENTS

# 1 DEVICE UNDER TEST

## 1.1 Device Overview

| Band & Mode | Tx Frequency |
|---|---|
| 2.4 GHz WLAN | 2412 - 2462 MHz |
| 5.8 GHz WLAN | 5745 - 5825 MHz |
| 5.2 GHz WLAN | 5180 - 5240 MHz |
| 5.3 GHz WLAN | 5260 - 5320 MHz |
| 5.5 GHz WLAN | 5500 - 5700 MHz |
| Bluetooth | 2402 - 2480 MHz |

## 1.2 DUT Antenna Locations

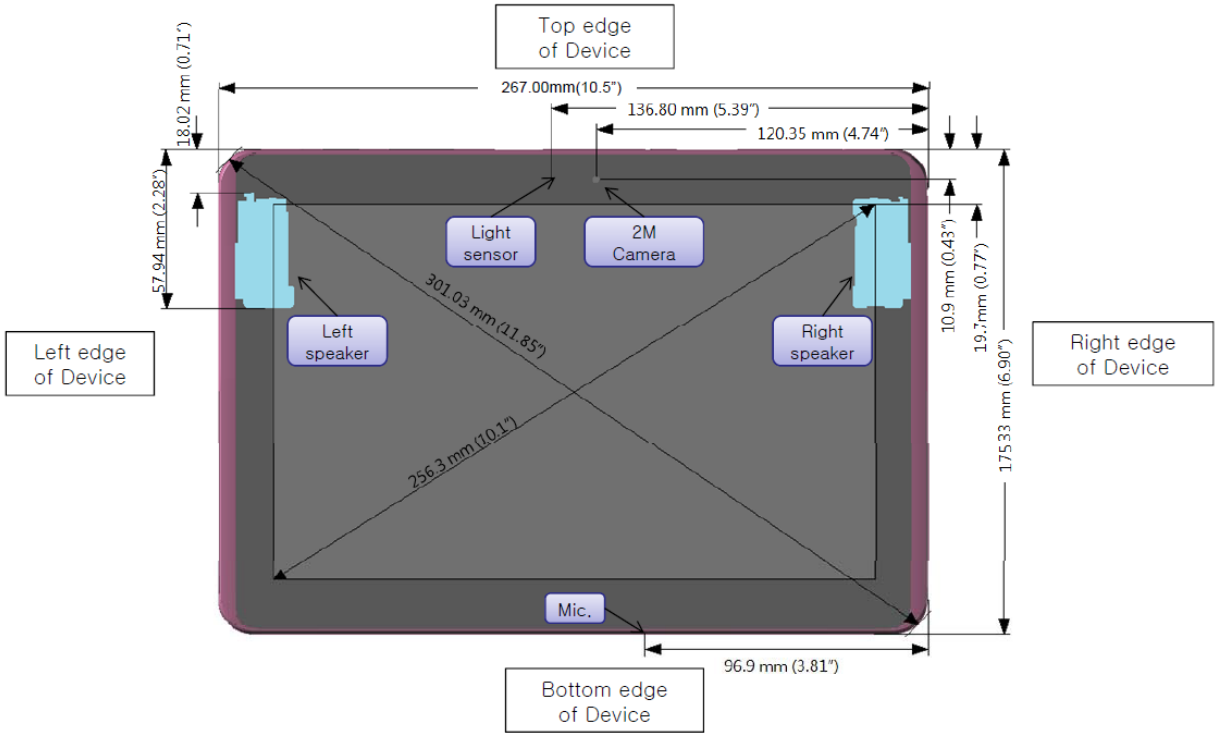


**Figure 1-1**
**Front View of Device**

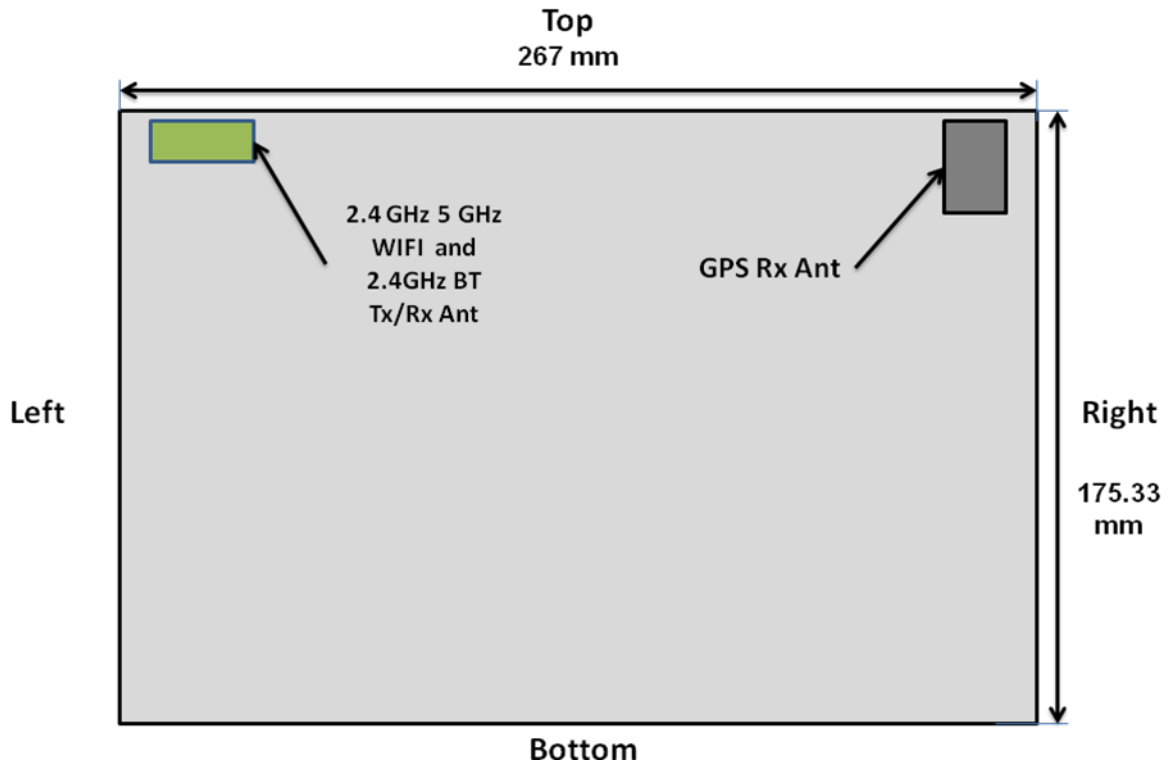


**Figure 1-2**
**Front View of Device**

## 1.3 SAR Test Exclusions Applied

Per KDB Publication 447498 4) b), SAR is not required when the maximum average output power rounded to the nearest mW is less than 60/f(GHz). Therefore, Bluetooth SAR was not required since the maximum conducted power of Bluetooth Tx is 11.508 mW (please refer to the DSS EMC report filed for this EUT for a complete set of Bluetooth powers). WLAN SAR was additionally not required since the maximum 2.4GHz WIFI conducted power is 19.543 mW, and 5GHz WIFI conducted power is 10.233 mW. 2.4GHz WIFI SAR was tested per manufacturer's request.

## 1.4 Power Reduction for SAR

There is no power reduction for any band/mode implemented in this device for SAR purposes.

## 1.5 FCC Guidance Applied

- FCC KDB 248227 (802.11)
- FCC KDB 447498 Section 4 (Tablet SAR Considerations)

# 2 INTRODUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [24]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

## 2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density ($\rho$). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1).

**Equation 2-1**
**SAR Mathematical Equation**

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{\rho dv}\right)$$

**SAR is expressed in units of Watts per Kilogram (W/kg).**

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

where:

$\sigma$ = conductivity of the tissue-simulating material (S/m)
$\rho$ = mass density of the tissue-simulating material (kg/m$^3$)
E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

# 3 SAR MEASUREMENT SETUP

## 3.1 Automated SAR Measurement System

Measurements are performed using the DASY automated dosimetric SAR assessment system. The DASY is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of a high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the SAM phantom containing the head or body equivalent material. The robot is a six-axis industrial robot, performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF). See www.speag.com for more information about the specification of the SAR assessment system.

**Figure 3-1**
**SAR Measurement System**

**Figure 3-2**
**Near-Field Probe**

**Table 3-1**
**Composition of the Tissue Equivalent Matter**

| Frequency (MHz) | 2450 |
|---|---|
| Tissue | Body |
| Ingredients (% by weight) | |
| DGBE | 26.7 |
| NaCl | 0.1 |
| Water | 73.2 |

# 4 DOSIMETRIC ASSESSMENT

## 4.1 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head interface and the horizontal grid resolution was 15mm and 15mm for frequencies < 3 GHz in the x and y directions respectively. When applicable, for frequencies above 3 GHz, a 10 mm by 10 mm resolution was used.
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1 gram cube evaluation. SAR at this fixed point was measured and used as a reference value.

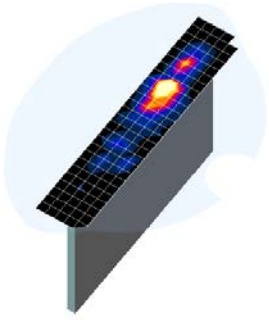

**Figure 4-1**
**Sample SAR Area Scan**

3. Based on the area scan data, the peak area of the maximum absorption was determined by spline interpolation. Around this point, a volume of 32mm x 32mm x 30mm (fine resolution volume scan, zoom scan) was assessed by measuring at least 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

   a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the dipoles 2.7mm away from the tip of the probe housing plus the 1.2 mm distance between the surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).

   b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 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 then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.

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

4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.
5. For testing 5 GHz devices, finer resolution zoom scans were performed as specified by FCC SAR Measurement Requirements for 3 – 6 GHz, KDB 865664 publication. The 5 GHz zoom scan requires a minimum volume of 24mm x 24mm x 20mm and 7 x 7 x 11 points.

# 5 FCC RF EXPOSURE LIMITS

## 5.1 Uncontrolled Environment

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

## 5.2 Controlled Environment

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

**Table 5-1**
**SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6**

| HUMAN EXPOSURE LIMITS | | |
|---|---|---|
| | UNCONTROLLED ENVIRONMENT *General Population* (W/kg) or (mW/g) | CONTROLLED ENVIRONMENT *Occupational* (W/kg) or (mW/g) |
| SPATIAL PEAK SAR Brain | 1.6 | 8.0 |
| SPATIAL AVERAGE SAR Whole Body | 0.08 | 0.4 |
| SPATIAL PEAK SAR Hands, Feet, Ankles, Wrists | 4.0 | 20 |

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

# 6 SAR TABLET TESTING

## 6.1 SAR Testing for Tablet per KDB Publication 447498 Section 4

Lap-touching devices that have transmitting antennas located less than 20 cm from the body of the user require routine SAR evaluation. Such devices are considered portable, and are capable of being held to the body. Devices are to be setup according to KDB publication 447498 requirements and are configured with maximum output power during SAR assessment for a worst-case SAR evaluation.

Per KDB 447498 4) b) i), the bottom face (back of the device) is required to be tested touching the flat phantom.

Per KDB Publication 447498 4) b) ii) (2), SAR testing applies for the tablet edges with antennas located within 5 cm of each tablet edge closest to the user. According to KDB Publication 447498 4) b) ii) (2), for each antenna, SAR is only required for the edge with the most conservative exposure condition. Since the diagonal dimension of the device is more than 20 cm (30.1 cm), this device is a tablet.

## 6.2 Display Orientation Capabilities

This device is capable of multiple display orientations supporting both portrait and landscape positions. Therefore per KDB 447498 4) b) ii) (2), SAR testing applies for the tablet edges with antennas located within 5 cm of each tablet edge closest to the user. According to KDB 447498 4) b) ii) (2), for each antenna, SAR is only required for the edge with the most conservative exposure condition.

# 7 FCC MEASUREMENT PROCEDURES

## 7.1 SAR Testing with 802.11 Transmitters

Normal network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g/n transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 for more details.

### 7.1.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

### 7.1.2 Frequency Channel Configurations [27]

For 2.4 GHz, the highest average RF output power channel between the low, mid and high channel at the lowest data rate was selected for SAR evaluation in 802.11b mode. 802.11g/n modes and higher data rates for 802.11b were additionally evaluated for SAR if the output power of the respective mode was 0.25 dB or higher than the powers of the SAR configurations tested in the 802.11b mode.

If the maximum extrapolated peak SAR of the zoom scan for the highest output channel was less than 1.6 W/kg or if the 1g averaged SAR was less than 0.8 W/kg, SAR testing was not required for the other test channels in the band.

# 8 RF CONDUCTED POWERS

**Table 8-1**
**IEEE 802.11b Average RF Power**

| Mode | Freq | Channel | Conducted Power [dBm] | | | |
|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | |
| | [MHz] | | 1 | 2 | 5.5 | 11 |
| 802.11b | 2412 | 1 | 12.28 | 12.35 | 12.36 | 12.45 |
| 802.11b | 2437 | 6 | 12.53 | 12.54 | 12.62 | 12.57 |
| 802.11b | 2462 | 11 | **12.67** | 12.81 | 12.79 | 12.80 |

**Table 8-2**
**IEEE 802.11g Average RF Power**

| Mode | Freq | Channel | Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11g | 2412 | 1 | 12.52 | 12.54 | 12.56 | 12.51 | 12.54 | 12.44 | 12.47 | 12.48 |
| 802.11g | 2437 | 6 | 12.73 | 12.74 | 12.74 | 12.69 | 12.81 | 12.76 | 12.72 | 12.77 |
| 802.11g | 2462 | 11 | 12.91 | 12.87 | 12.89 | 12.91 | 12.87 | 12.86 | 12.90 | 12.86 |

**Table 8-3**
**IEEE 802.11n Average RF Power**

| Mode | Freq | Channel | Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6.5 | 13 | 20 | 26 | 39 | 52 | 58 | 65 |
| 802.11n | 2412 | 1 | 11.49 | 11.40 | 11.38 | 11.45 | 11.47 | 11.41 | 11.43 | 11.41 |
| 802.11n | 2437 | 6 | 11.65 | 11.73 | 11.70 | 11.64 | 11.69 | 11.65 | 11.63 | 11.67 |
| 802.11n | 2462 | 11 | 11.86 | 11.92 | 11.87 | 11.86 | 11.86 | 11.86 | 11.86 | 11.87 |

**Table 8-4**
**IEEE 802.11a Average RF Power**

| Mode | Freq | Channel | Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11a | **5180** | **36*** | 9.61 | 9.75 | 9.85 | 9.83 | 9.84 | 9.78 | 9.84 | 9.86 |
| 802.11a | 5200 | 40 | 9.59 | 9.69 | 9.61 | 9.60 | 9.60 | 9.72 | 9.64 | 9.62 |
| 802.11a | 5220 | 44 | 9.34 | 9.36 | 9.29 | 9.35 | 9.26 | 9.32 | 9.25 | 9.33 |
| 802.11a | **5240** | **48*** | 9.03 | 9.17 | 9.18 | 9.24 | 9.06 | 9.10 | 9.04 | 9.14 |
| 802.11a | **5260** | **52*** | 9.92 | 9.84 | 9.83 | 9.90 | 9.91 | 9.91 | 9.87 | 9.84 |
| 802.11a | 5280 | 56 | 9.74 | 9.65 | 9.72 | 9.74 | 9.73 | 9.76 | 9.77 | 9.75 |
| 802.11a | 5300 | 60 | 9.61 | 9.54 | 9.57 | 9.58 | 9.54 | 9.65 | 9.63 | 9.49 |
| 802.11a | **5320** | **64*** | 9.49 | 9.47 | 9.54 | 9.41 | 9.46 | 9.40 | 9.51 | 9.51 |
| 802.11a | 5500 | 100 | 9.62 | 9.65 | 9.62 | 9.59 | 9.61 | 9.63 | 9.60 | 9.61 |
| 802.11a | **5520** | **104*** | 9.59 | 9.59 | 9.57 | 9.58 | 9.56 | 9.56 | 9.63 | 9.55 |
| 802.11a | 5540 | 108 | 9.46 | 9.50 | 9.47 | 9.50 | 9.39 | 9.53 | 9.56 | 9.45 |
| 802.11a | 5560 | 112 | 9.31 | 9.45 | 9.40 | 9.43 | 9.38 | 9.45 | 9.41 | 9.45 |
| 802.11a | **5580** | **116*** | 9.32 | 9.38 | 9.35 | 9.32 | 9.33 | 9.36 | 9.33 | 9.36 |
| 802.11a | 5600 | 120 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5620 | 124* | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5640 | 128 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5660 | 132 | 9.17 | 9.17 | 9.21 | 9.23 | 9.18 | 9.21 | 9.21 | 9.20 |
| 802.11a | **5680** | **136*** | 9.15 | 9.17 | 9.15 | 9.21 | 9.19 | 9.17 | 9.23 | 9.19 |
| 802.11a | 5700 | 140 | 9.15 | 9.10 | 9.11 | 9.09 | 9.09 | 9.17 | 9.19 | 9.11 |
| 802.11a | **5745** | **149*** | 9.50 | 9.53 | 9.52 | 9.49 | 9.56 | 9.58 | 9.64 | 9.66 |
| 802.11a | 5765 | 153 | 9.55 | 9.51 | 9.52 | 9.51 | 9.45 | 9.59 | 9.49 | 9.52 |
| 802.11a | **5785** | **157*** | 9.48 | 9.61 | 9.47 | 9.57 | 9.59 | 9.62 | 9.60 | 9.50 |
| 802.11a | **5805** | **161*** | 9.48 | 9.54 | 9.53 | 9.57 | 9.59 | 9.66 | 9.60 | 9.59 |
| 802.11a | 5825 | 165 | 9.56 | 9.55 | 9.61 | 9.57 | 9.47 | 9.58 | 9.67 | 9.64 |

Per FCC KDB Publication 443999 and RSS-210 A9.2(3), transmission on channels which overlap the 5600-5650 MHz is prohibited as a client. This device does not transmit any beacons or initiate any transmissions in 5.3 and 5.5 GHz Band. (*) – indicates default channels per KDB Publication 248227. When the adjacent channels are higher in power then the default channels, these “required channels” are considered instead of the default channels for SAR testing.

**Table 8-5**
**IEEE 802.11n Average RF Power**

| Mode | Freq | Channel | Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6.5 | 13 | 20 | 26 | 39 | 52 | 58 | 65 |
| 802.11n | **5180** | **36*** | 8.75 | 8.80 | 8.80 | 8.68 | 8.82 | 8.77 | 8.78 | 8.86 |
| 802.11n | 5200 | 40 | 8.70 | 8.71 | 8.78 | 8.85 | 8.81 | 8.83 | 8.86 | 8.81 |
| 802.11n | 5220 | 44 | 8.64 | 8.72 | 8.56 | 8.67 | 8.76 | 8.70 | 8.68 | 8.71 |
| 802.11n | **5240** | **48*** | 8.65 | 8.61 | 8.63 | 8.68 | 8.60 | 8.69 | 8.62 | 8.61 |
| 802.11n | **5260** | **52*** | 9.21 | 9.12 | 9.20 | 9.15 | 9.07 | 9.06 | 9.16 | 9.20 |
| 802.11n | 5280 | 56 | 9.02 | 9.12 | 9.20 | 9.09 | 9.18 | 9.25 | 9.19 | 9.13 |
| 802.11n | 5300 | 60 | 9.62 | 9.60 | 9.68 | 9.69 | 9.70 | 9.69 | 9.77 | 9.71 |
| 802.11n | **5320** | **64*** | 9.65 | 9.69 | 9.63 | 9.65 | 9.53 | 9.63 | 9.70 | 9.65 |
| 802.11n | 5500 | 100 | 8.98 | 8.94 | 8.99 | 8.93 | 9.00 | 8.99 | 9.03 | 9.12 |
| 802.11n | **5520** | **104*** | 9.30 | 9.26 | 9.18 | 9.11 | 9.24 | 9.21 | 9.25 | 9.25 |
| 802.11n | 5540 | 108 | 9.28 | 9.31 | 9.26 | 9.18 | 9.30 | 9.40 | 9.33 | 9.25 |
| 802.11n | 5560 | 112 | 9.48 | 9.38 | 9.42 | 9.38 | 9.35 | 9.35 | 9.38 | 9.26 |
| 802.11n | **5580** | **116*** | 9.46 | 9.64 | 9.51 | 9.42 | 9.52 | 9.59 | 9.54 | 9.57 |
| 802.11n | 5600 | 120 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5620 | 124* | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5640 | 128 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5660 | 132 | 9.85 | 9.96 | 9.96 | 9.83 | 9.88 | 9.92 | 9.88 | 9.89 |
| 802.11n | **5680** | **136*** | 9.92 | 9.94 | 9.86 | 10.01 | 10.07 | 10.00 | 10.06 | 10.06 |
| 802.11n | 5700 | 140 | 10.02 | 10.04 | 10.02 | 10.02 | 10.10 | 10.07 | 10.06 | 10.07 |
| 802.11n | **5745** | **149*** | 9.04 | 9.06 | 9.09 | 9.10 | 9.17 | 9.19 | 9.26 | 9.16 |
| 802.11n | 5765 | 153 | 9.16 | 9.16 | 9.14 | 9.15 | 9.20 | 9.20 | 9.18 | 9.17 |
| 802.11n | **5785** | **157*** | 9.13 | 9.22 | 9.21 | 9.34 | 9.24 | 9.24 | 9.23 | 9.20 |
| 802.11n | **5805** | **161*** | 9.23 | 9.26 | 9.26 | 9.21 | 9.40 | 9.28 | 9.25 | 9.31 |
| 802.11n | 5825 | 165 | 9.18 | 9.28 | 9.19 | 9.33 | 9.33 | 9.30 | 9.27 | 9.24 |

Per FCC KDB Publication 443999 and RSS-210 A9.2(3), transmission on channels which overlap the 5600-5650 MHz is prohibited as a client. This device does not transmit any beacons or initiate any transmissions in 5.3 and 5.5 GHz Bands. (*) – indicates default channels per KDB Publication 248227. When the adjacent channels are higher in power then the default channels, these “required channels” are considered instead of the default channels for SAR testing.

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes:

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- For 5 GHz WIFI, per KDB Publication 447498 4) b), when the maximum average output power is less than 60/f(GHz), testing is not required.
- The bolded data rate and channel above were tested for SAR.


**Figure 8-1**
**Power Measurement Setup**

# 9 SYSTEM VERIFICATION

## 9.1 Tissue Verification

**Table 9-1**
**Measured Tissue Properties**

| Calibrated for Tests Performed on: | Tissue Type | Tissue Temp During Calibration (C°) | Measured Frequency (MHz) | Measured Conductivity, σ (S/m) | Measured Dielectric Constant, ε | TARGET Conductivity, σ (S/m) | TARGET Dielectric Constant, ε | %dev σ | %dev ε |
|---|---|---|---|---|---|---|---|---|---|
| 3/28/2012 | 2450B | 22.8 | 2401 | 1.983 | 50.35 | 1.903 | 52.765 | *4.20%* | *-4.58%* |
| | | | 2450 | 2.047 | 50.19 | 1.950 | 52.700 | *4.97%* | *-4.76%* |
| | | | 2499 | 2.118 | 50.05 | 2.019 | 52.638 | *4.90%* | *-4.92%* |

Note: KDB Publication 450824 was ensured to be applied for probe calibration frequencies greater than or equal to 50 MHz of the DUT frequencies.

The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies (per IEEE 1528 6.6.1.2). The SAR test plots may slightly differ from the table above since the DASY software rounds to three significant digits.

## 9.2 Measurement Procedure for Tissue verification

1) The network analyzer and probe system was configured and calibrated.

2) The probe was immersed in the sample which was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.

3) The complex admittance with respect to the probe aperture was measured

4) The complex relative permittivity , for example from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\varepsilon_r\varepsilon_0}{\left[\ln(b/a)\right]^2}\int_a^b\int_a^b\int_0^\pi \cos\phi' \frac{\exp\left[-j\omega r(\mu_0\varepsilon_r^{'}\varepsilon_0)^{1/2}\right]}{r} d\phi' d\rho' d\rho$$

where *Y* is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$ , $\omega$ is the angular frequency, and $j = \sqrt{-1}$ .

## 9.3 Test System Verification

Prior to assessment, the system is verified to ±10% of the manufacturer SAR measurement on the reference dipole at the time of calibration.

**Table 9-2**
**System Verification Results**

| System Verification<br>TARGET & MEASURED | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tissue Frequency (MHz) | Tissue Type | Date: | Amb. Temp (°C) | Liquid Temp (°C) | Input Power (W) | Dipole SN | Probe SN | Measured $SAR_{1g}$ (W/kg) | 1 W Target $SAR_{1g}$ (W/kg) | 1 W Normalized $SAR_{1g}$ (W/kg) | Deviation (%) |
| 2450 | Body | 03/28/2012 | 22.9 | 22.8 | 0.040 | 719 | 3022 | 2.19 | 51.300 | 54.750 | 6.73% |

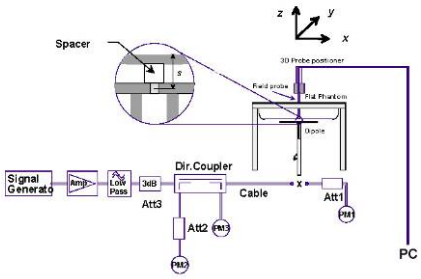


**Figure 9-1**
**System Verification Setup Diagram**

**Figure 9-2**
**System Verification Setup Photo**

# 10 SAR DATA SUMMARY

**Table 10-1**
**WLAN SAR Data**

| MEASUREMENT RESULTS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY | | Mode | Service | Conducted Power [dBm] | Power Drift [dB] | Spacing | Data Rate (Mbps) | Side | SAR (1g) |
| MHz | Ch. | | | | | | | | (W/kg) |
| 2412 | 1 | IEEE 802.11b | DSSS | 12.28 | 0.00 | 0.0 cm | 1 | back | 0.574 |
| 2437 | 6 | IEEE 802.11b | DSSS | 12.53 | 0.00 | 0.0 cm | 1 | back | 0.592 |
| 2462 | 11 | IEEE 802.11b | DSSS | 12.67 | 0.02 | 0.0 cm | 1 | back | **0.673** |
| 2462 | 11 | IEEE 802.11b | DSSS | 12.67 | 0.03 | 0.0 cm | 1 | top | 0.076 |
| 2462 | 11 | IEEE 802.11b | DSSS | 12.67 | -0.21 | 0.0 cm | 1 | left | 0.088 |
| **ANSI / IEEE C95.1 1992 - SAFETY LIMIT**<br>**Spatial Peak**<br>**Uncontrolled Exposure/General Population** | | | | | | **Body**<br>**1.6 W/kg (mW/g)**<br>averaged over 1 gram | | | |

## 10.1 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR value with the position of the device configured for SAR testing according to KDB 447498 Section 4.
2. Batteries are fully charged for all readings.
3. Tissue parameters and temperatures are listed on the SAR plots.
4. Liquid tissue depth was at least 15.0 cm. To confirm the proper SAR liquid depth, the z-axis plots from the system verifications were included since the system verifications were performed using the same liquid, probe and DAE as the SAR tests in the same time period.
5. Per KDB Publication 447498 4) b) i) the back side is required to be tested touching the flat phantom for regular large sized tablet devices.
6. This device is capable of multiple display orientations supporting both portrait and landscape positions. Therefore per KDB 447498 4) b) ii) (2), SAR testing applies for the tablet edges with antennas located within 5 cm of each tablet edge closest to the user. According to KDB 447498 4) b) ii) (2), for each antenna, SAR is required for the edge with the most conservative exposure condition.

WLAN Notes:

1. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes for 2.4 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11b. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
2. WLAN transmission was verified using an uncalibrated spectrum analyzer.
3. When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.

# 11 EQUIPMENT LIST

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | 8594A | (9kHz-2.9GHz) Spectrum Analyzer | N/A | N/A | N/A | 3051A00187 |
| Agilent | 8648D | Signal Generator | 4/5/2011 | Annual | 4/5/2012 | 3629U00687 |
| Agilent | 8648D | (9kHz-4GHz) Signal Generator | 10/10/2011 | Annual | 10/10/2012 | 3613A00315 |
| Agilent | 8753E | (30kHz-6GHz) Network Analyzer | 4/21/2011 | Annual | 4/21/2012 | JP38020182 |
| Agilent | E8257D | (250kHz-20GHz) Signal Generator | 4/8/2011 | Annual | 4/8/2012 | MY45470194 |
| Amplifier Research | 5S1G4 | 5W, 800MHz-4.2GHz | N/A | N/A | N/A | 21910 |
| Anritsu | MA2411B | Pulse Sensor | 10/13/2011 | Annual | 10/13/2012 | 1027293 |
| Anritsu | MA2481A | Power Sensor | 2/14/2012 | Annual | 2/14/2013 | 5318 |
| Anritsu | MA2481A | Power Sensor | 2/14/2012 | Annual | 2/14/2013 | 5442 |
| Anritsu | MA2481A | Power Sensor | 2/14/2012 | Annual | 2/14/2013 | 5821 |
| Anritsu | MA2481A | Power Sensor | 2/14/2012 | Annual | 2/14/2013 | 8013 |
| Anritsu | MA2481A | Power Sensor | 2/14/2012 | Annual | 2/14/2013 | 2400 |
| Anritsu | ML2438A | Power Meter | 10/13/2011 | Annual | 10/13/2012 | 1070030 |
| Anritsu | ML2438A | Power Meter | 2/14/2012 | Annual | 2/14/2013 | 1190013 |
| Anritsu | ML2438A | Power Meter | 2/14/2012 | Annual | 2/14/2013 | 98150041 |
| Anritsu | ML2495A | Power Meter | 10/13/2011 | Annual | 10/13/2012 | 1039008 |
| Anritsu | MT8820C | Radio Communication Tester | 11/11/2011 | Annual | 11/11/2012 | 6200901190 |
| Control Company | 61220-416 | Long-Stem Thermometer | 7/1/2011 | Biennial | 7/1/2013 | 111642834 |
| Control Company | 61220-416 | Long-Stem Thermometer | 7/1/2011 | Biennial | 7/1/2013 | 111642916 |
| Control Company | 61220-416 | Long-Stem Thermometer | 7/1/2011 | Biennial | 7/1/2013 | 111642941 |
| Gigatronics | 80701A | (0.05-18GHz) Power Sensor | 10/12/2011 | Annual | 10/12/2012 | 1833460 |
| Gigatronics | 8651A | Universal Power Meter | 10/12/2011 | Annual | 10/12/2012 | 8650319 |
| Index SAR | IXTL-010 | Dielectric Measurement Kit | N/A | N/A | N/A | N/A |
| Index SAR | IXTL-030 | 30MM TEM line for 6 GHz | N/A | N/A | N/A | N/A |
| Intelligent Weigh | PD-3000 | Electronic Balance | 3/27/2012 | Annual | 3/27/2013 | 11081534 |
| MCL | BW-N6W5+ | 6dB Attenuator | CBT | N/A | CBT | 1139 |
| MiniCircuits | SLP-2400+ | Low Pass Filter | CBT | N/A | CBT | R8979500903 |
| MiniCircuits | VLF-6000+ | Low Pass Filter | CBT | N/A | CBT | N/A |
| MiniCircuits | VLF-6000+ | Low Pass Filter | CBT | N/A | CBT | N/A |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-1200+ | Low Pass Filter DC to 1000 MHz | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Narda | 4014C-6 | 4 - 8 GHz SMA 6 dB Directional Coupler | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Narda | BW-S3W2 | Attenuator (3dB) | CBT | N/A | CBT | 120 |
| Pasternack | PE2208-6 | Bidirectional Coupler | 6/3/2011 | Annual | 6/3/2012 | N/A |
| Pasternack | PE2209-10 | Bidirectional Coupler | 6/3/2011 | Annual | 6/3/2012 | N/A |
| Rohde & Schwarz | NRVD | Dual Channel Power Meter | 4/8/2011 | Biennial | 4/8/2013 | 101695 |
| Rohde & Schwarz | SMIQ03B | Signal Generator | 4/6/2011 | Annual | 4/6/2012 | DE27259 |
| Seekonk | NC-100 | Torque Wrench (8" lb) | 11/29/2011 | Triennial | 11/29/2014 | 21053 |
| SPEAG | D2450V2 | 2450 MHz SAR Dipole | 8/19/2011 | Annual | 8/19/2012 | 719 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 5/19/2011 | Annual | 5/19/2012 | 859 |
| Speag | DAK-3.5 | Dielectric Assessment Kit | 12/1/2011 | Annual | 12/1/2012 | 1031 |
| SPEAG | ES3DV2 | SAR Probe | 8/25/2011 | Annual | 8/25/2012 | 3022 |
| Tektronix | RSA-6114A | Real Time Spectrum Analyzer | 4/7/2011 | Annual | 4/7/2012 | B010177 |
| VWR | 36934-158 | Wall-Mounted Thermometer | 1/21/2011 | Biennial | 1/21/2013 | 111286460 |
| VWR | 36934-158 | Wall-Mounted Thermometer | 1/21/2011 | Biennial | 1/21/2013 | 111286454 |
| VWR | 36934-158 | Wall-Mounted Thermometer | 9/30/2011 | Biennial | 9/30/2013 | 111859323 |
| VWR | 36934-158 | Wall-Mounted Thermometer | 9/30/2011 | Biennial | 9/30/2013 | 111859332 |

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

# 12 MEASUREMENT UNCERTAINTIES

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | **IEEE 1528 Sec.** | **Tol. (± %)** | **Prob. Dist.** | **Div.** | **$c_i$ 1gm** | **$c_i$ 10 gms** | **1gm $u_i$ (± %)** | **10gms $u_i$ (± %)** | **$v_i$** |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | ∞ |
| Axial Isotropy | E.2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E.2.2 | 1.3 | N | 1 | 1.0 | 1.0 | 1.3 | 1.3 | ∞ |
| Boundary Effect | E.2.3 | 0.4 | N | 1 | 1.0 | 1.0 | 0.4 | 0.4 | ∞ |
| Linearity | E.2.4 | 0.3 | N | 1 | 1.0 | 1.0 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E.2.5 | 5.1 | N | 1 | 1.0 | 1.0 | 5.1 | 5.1 | ∞ |
| Readout Electronics | E.2.6 | 1.0 | N | 1 | 1.0 | 1.0 | 1.0 | 1.0 | ∞ |
| Response Time | E.2.7 | 0.8 | R | 1.73 | 1.0 | 1.0 | 0.5 | 0.5 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1.0 | 1.0 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions | E.6.1 | 3.0 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.4 | R | 1.73 | 1.0 | 1.0 | 0.2 | 0.2 | ∞ |
| Probe Positioning w/ respect to Phantom | E.6.3 | 2.9 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5 | 1.0 | R | 1.73 | 1.0 | 1.0 | 0.6 | 0.6 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | 287 |
| Device Holder Uncertainty | E.4.1 | 3.32 | R | 1.73 | 1.0 | 1.0 | 1.9 | 1.9 | ∞ |
| Output Power Variation - SAR drift measurement | 6.6.2 | 5.0 | R | 1.73 | 1.0 | 1.0 | 2.9 | 2.9 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E.3.1 | 4.0 | R | 1.73 | 1.0 | 1.0 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity - measurement uncertainty | E.3.3 | 3.8 | N | 1 | 0.64 | 0.43 | 2.4 | 1.6 | 6 |
| Liquid Permittivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity - measurement uncertainty | E.3.3 | 4.5 | N | 1 | 0.60 | 0.49 | 2.7 | 2.2 | 6 |
| **Combined Standard Uncertainty (k=1)** | | | RSS | | | | 12.1 | 11.7 | 299 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | k=2 | | | | 24.2 | 23.5 | |

The above measurement uncertainties are according to IEEE Std. 1528-2003

# 13 CONCLUSION

## 13.1 Measurement Conclusion

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

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

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