



# FCC SAR Test Report

**Equipment** : Broadcom 802.11a/b/g/n/ac WLAN + Bluetooth PCI-E  
NGFF 2230 Card

**Brand Name** : Broadcom

**Model No.** : BCM94356Z

**Part No.** : BCM94356Z, BCM94356ZAE

**FCC ID** : QDS-BRCM1085

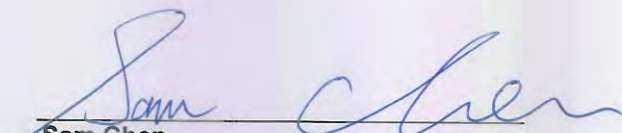
**Standard** : FCC 47 CFR Part 2 (2.1093)  
ANSI/IEEE C95.1-1992  
IEEE 1528-2013

**Applicant** : Broadcom Corporation  
190 Mathilda Place Sunnyvale CA 94086 U.S.A.

**Manufacturer** : Broadcom Corporation  
190 Mathilda Place Sunnyvale CA 94086 U.S.A.

The product sample received on Jul. 31, 2014 and completely tested on Aug. 28, 2014. We, SPORTON, would like to declare that the tested sample has been evaluated in accordance with the procedures and shown the compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

  
Sam Chen  
SPORTON INTERNATIONAL INC.



## TABLE OF CONTENTS

|                                                      |                                                  |           |
|------------------------------------------------------|--------------------------------------------------|-----------|
| <b>1</b>                                             | <b>GENERAL DESCRIPTION .....</b>                 | <b>5</b>  |
| 1.1                                                  | Information.....                                 | 5         |
| 1.2                                                  | Accessories .....                                | 9         |
| 1.3                                                  | Testing Applied Standards .....                  | 9         |
| 1.4                                                  | Device Category and SAR Limits .....             | 9         |
| 1.5                                                  | Testing Location .....                           | 10        |
| <b>2</b>                                             | <b>SPECIFIC ABSORPTION RATE (SAR) .....</b>      | <b>11</b> |
| 2.1                                                  | Introduction.....                                | 11        |
| 2.2                                                  | SAR Definition .....                             | 11        |
| <b>3</b>                                             | <b>SAR MEASUREMENT SYSTEM.....</b>               | <b>12</b> |
| 3.1                                                  | E-Field Probe .....                              | 13        |
| 3.2                                                  | Data Acquisition Electronics (DAE) .....         | 14        |
| 3.3                                                  | Robot .....                                      | 14        |
| 3.4                                                  | Measurement Server .....                         | 15        |
| 3.5                                                  | Phantom .....                                    | 15        |
| 3.6                                                  | Device Holder .....                              | 16        |
| 3.7                                                  | Data Storage and Evaluation .....                | 17        |
| <b>4</b>                                             | <b>TISSUE SIMULATING LIQUIDS .....</b>           | <b>19</b> |
| <b>5</b>                                             | <b>SAR SYSTEM VERIFICATION.....</b>              | <b>21</b> |
| 5.1                                                  | Purpose of System Performance check.....         | 21        |
| 5.2                                                  | System Setup .....                               | 21        |
| 5.3                                                  | SAR System Verification Results .....            | 23        |
| <b>6</b>                                             | <b>EUT TESTING POSITION .....</b>                | <b>24</b> |
| <b>7</b>                                             | <b>MEASUREMENT PROCEDURES.....</b>               | <b>25</b> |
| 7.1                                                  | Spatial Peak SAR Evaluation .....                | 25        |
| 7.2                                                  | Power Reference Measurement .....                | 26        |
| 7.3                                                  | Area & Zoom Scan Procedures .....                | 26        |
| 7.4                                                  | Volume Scan Procedures.....                      | 27        |
| 7.5                                                  | SAR Averaged Methods.....                        | 27        |
| 7.6                                                  | Power Drift Monitoring.....                      | 27        |
| <b>8</b>                                             | <b>CONDUCTED RF OUTPUT POWER .....</b>           | <b>28</b> |
| <b>9</b>                                             | <b>SAR TEST RESULTS.....</b>                     | <b>33</b> |
| 9.1                                                  | Test Records for Body SAR Test .....             | 33        |
| 9.2                                                  | Highest SAR Plot.....                            | 35        |
| 9.3                                                  | Enhanced Energy Coupling.....                    | 40        |
| <b>10</b>                                            | <b>SIMULTANEOUS TRANSMISSION ANALYSIS.....</b>   | <b>41</b> |
| 10.1                                                 | Body Exposure Conditions .....                   | 42        |
| <b>11</b>                                            | <b>TEST EQUIPMENT AND CALIBRATION DATA .....</b> | <b>43</b> |
| <b>12</b>                                            | <b>UNCERTAINTY ASSESSMENT.....</b>               | <b>44</b> |
| <b>13</b>                                            | <b>REFERENCES .....</b>                          | <b>47</b> |
| <b>APPENDIX A. TEST SETUP PHOTOS</b>                 |                                                  |           |
| <b>APPENDIX B. PLOTS OF SYSTEM PERFORMANCE CHECK</b> |                                                  |           |
| <b>APPENDIX C. PLOTS OF SAR MEASUREMENT</b>          |                                                  |           |
| <b>APPENDIX D. DASY CALIBRATION CERTIFICATE</b>      |                                                  |           |

## SUMMARY OF TEST RESULT

The maximum results of Specific Absorption Rate (SAR) found during testing as follows.

The SAR evaluation is for use in tablets and laptops only.

The distance between two antennas is 5cm.

### <Highest SAR Summary>

| Exposure Position        | Frequency Band    | Reported 1g-SAR (W/kg) | Highest Reported 1g-SAR (W/kg) |
|--------------------------|-------------------|------------------------|--------------------------------|
| Body<br>(Separation 5mm) | WLAN 5 GHz Band 1 | 0.759                  | 0.779                          |
|                          | WLAN 5 GHz Band 2 | 0.779                  |                                |
|                          | WLAN 5 GHz Band 3 | 0.767                  |                                |
|                          | WLAN 5 GHz Band 4 | 0.740                  |                                |
|                          | WLAN 2.4GHz Band  | 0.733                  | 0.733                          |

### < Highest Simultaneous transmission SAR >

| Frequency Band    | Exposure Position | Highest Reported Simultaneous Transmission 1g-SAR (W/kg) |
|-------------------|-------------------|----------------------------------------------------------|
| Bluetooth         | Body              | 0.832                                                    |
| WLAN 5 GHz Band 2 |                   |                                                          |

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR Part 2 (2.1093) and ANSI/IEEE C95.1-1992 and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.



SPORTON INTERNATIONAL INC.  
TEL : 886-3-327-3456  
FAX : 886-3-327-0973  
FCC ID: QDS-BRCM1085

# 1 General Description

## 1.1 Information

### 1.1.1 RF General Information

| Items           | Description                                                                                                                                                                                                                                      |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power Type      | From host system                                                                                                                                                                                                                                 |
| Product Type    | 802.11abgn/ac HT20/HT40/VHT20/VHT40/VHT80: WLAN (2TX, 2RX)<br>Bluetooth BR/EDR/LE                                                                                                                                                                |
| Frequency Range | WLAN 2.4 GHz Band: 2412 MHz ~ 2462 MHz<br>WLAN 5 GHz Band 1: 5180 MHz ~ 5240 MHz<br>WLAN 5 GHz Band 2: 5260 MHz ~ 5320 MHz<br>WLAN 5 GHz Band 3: 5500 MHz ~ 5720 MHz<br>WLAN 5 GHz Band 4: 5745 MHz ~ 5825 MHz<br>Bluetooth: 2402 MHz ~ 2480 MHz |
| EUT Stage       | Production Unit                                                                                                                                                                                                                                  |

**1.1.2 Antenna Information**

| Set | Ant. | Brand      | Part No.             | Antenna Type    | Connector | Gain (dBi)  |          |          |          |          |
|-----|------|------------|----------------------|-----------------|-----------|-------------|----------|----------|----------|----------|
|     |      |            |                      |                 |           | 2.4G/<br>BT | 5G<br>B1 | 5G<br>B2 | 5G<br>B3 | 5G<br>B4 |
| 1   | 1    | MAG.LAYERS | PCA-4077-25GC1-A1-RT | WLAN/BT antenna | I-PEX A13 | 3.33        | 5.85     | 5.85     | 6.21     | 6.21     |
|     | 2    | MAG.LAYERS | PCA-4077-25GC1-A1-RT | WLAN/BT antenna | I-PEX A13 | 3.33        | 5.85     | 5.85     | 6.21     | 6.21     |

Note: The EUT has one set of antenna, and each set contains two antennas.

Chain 1: Connect to Ant. 1, Chain 2: Connect to Ant. 2.

**For 2.4 GHz WLAN function (2TX/2RX):**

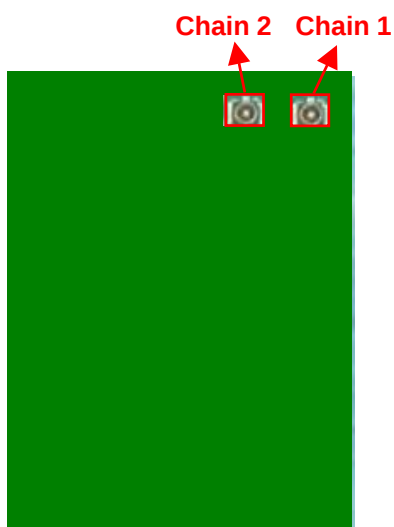
Chain 1 and Chain 2 could transmit/receive simultaneously.

**For Bluetooth function (1TX/1RX):**

Only Chain 1 could transmit/receive simultaneously.

**For 5 GHz WLAN function (2TX/2RX):**

Chain 1 and Chain 2 could transmit/receive simultaneously.





### 1.1.3 Maximum RF output power among production units

| WLAN Average Power (dBm) |                 |         |         |         |                |                |
|--------------------------|-----------------|---------|---------|---------|----------------|----------------|
| Mode                     | Frequency (MHz) | Channel | 802.11b | 802.11g | 802.11n (HT20) | 802.11n (HT40) |
| 2.4GHz                   | 2412            | CH1     | 17.5    | 17      | 17.5           |                |
|                          | 2422            | CH3     |         |         |                | 14             |
|                          | 2437            | CH6     | 17.5    | 17.5    | 17.5           | 16             |
|                          | 2452            | CH9     |         |         |                | 16             |
|                          | 2457            | CH10    |         |         |                | 14.5           |
|                          | 2462            | CH11    | 17.5    | 16.5    | 16.5           |                |
|                          | 2467            | CH12    | 17.5    | 16.5    | 14.5           |                |

| WLAN Average Power (dBm) |                 |         |         |                |                |                  |                  |                  |
|--------------------------|-----------------|---------|---------|----------------|----------------|------------------|------------------|------------------|
| Mode                     | Frequency (MHz) | Channel | 802.11a | 802.11n (HT20) | 802.11n (HT40) | 802.11ac (VHT20) | 802.11ac (VHT40) | 802.11ac (VHT80) |
| 5GHz Band1               | 5180            | CH36    | 17      | 17             |                | 17               |                  |                  |
|                          | 5190            | CH38    |         |                | 17             |                  | 17               |                  |
|                          | 5200            | CH40    | 17      | 17             |                | 17               |                  |                  |
|                          | 5210            | CH42    |         |                |                |                  |                  | 17               |
|                          | 5220            | CH44    | 17      | 17             |                | 17               |                  |                  |
|                          | 5230            | CH46    |         |                | 17             |                  | 17               |                  |
|                          | 5240            | CH48    | 17      | 17             |                | 17               |                  |                  |
| 5GHz Band2               | 5260            | CH52    | 17      | 17             |                | 17               |                  |                  |
|                          | 5270            | CH54    |         |                | 17             |                  | 17               |                  |
|                          | 5280            | CH56    | 17      | 17             |                | 17               |                  |                  |
|                          | 5290            | CH58    |         |                |                |                  |                  | 17               |
|                          | 5300            | CH60    | 17      | 17             |                | 17               |                  |                  |
|                          | 5310            | CH62    |         |                | 17             |                  | 17               |                  |
|                          | 5320            | CH64    | 17      | 17             |                | 17               |                  |                  |
| 5GHz Band3               | 5500            | CH100   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5510            | CH102   |         |                | 16.5           |                  | 16.5             |                  |
|                          | 5520            | CH104   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5530            | CH106   |         |                |                |                  |                  | 16.5             |
|                          | 5540            | CH108   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5550            | CH110   |         |                | 16.5           |                  | 16.5             |                  |
|                          | 5560            | CH112   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5580            | CH116   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5590            | CH118   |         |                | 16.5           |                  | 16.5             |                  |
|                          | 5600            | CH120   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5610            | CH122   |         |                |                |                  |                  | 16.5             |
|                          | 5620            | CH124   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5630            | CH126   |         |                | 16.5           |                  | 16.5             |                  |
|                          | 5640            | CH128   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5660            | CH132   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5670            | CH134   |         |                | 16.5           |                  | 16.5             |                  |
|                          | 5680            | CH136   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5690            | CH138   |         |                |                |                  |                  | 16.5             |
|                          | 5700            | CH140   | 16.5    | 16.5           |                | 16.5             |                  |                  |
|                          | 5710            | CH142   |         |                | 16.5           |                  | 16.5             |                  |
|                          | 5720            | CH144   | 16.5    | 16.5           |                | 16.5             |                  |                  |

|            |      |       |    |    |    |    |    |      |
|------------|------|-------|----|----|----|----|----|------|
| 5GHz Band4 | 5745 | CH149 | 17 | 17 |    | 17 |    |      |
|            | 5755 | CH151 |    |    | 17 |    | 16 |      |
|            | 5765 | CH153 | 17 | 17 |    | 17 |    |      |
|            | 5775 | CH155 |    |    |    |    |    | 16.5 |
|            | 5785 | CH157 | 17 | 17 |    | 17 |    |      |
|            | 5795 | CH159 |    |    | 17 |    | 17 |      |
|            | 5805 | CH161 | 17 | 17 |    | 17 |    |      |
|            | 5825 | CH165 | 17 | 17 |    | 17 |    |      |

| Bluetooth Average Power (dBm) |                 |                            |                   |                    |
|-------------------------------|-----------------|----------------------------|-------------------|--------------------|
| Mode                          | 1Mbps<br>(GFSK) | 2Mbps<br>( $\pi/4$ -DQPSK) | 3Mbps<br>(8-DPSK) | BT4.0-LE<br>(GFSK) |
| Bluetooth                     | 1               | 0                          | 0                 | -7                 |

#### 1.1.4 Table for Multiple Listing

The EUT has two part numbers which are identical to each other in all aspects except for the following table:

| Model No. | Part No.    | Description                                         |
|-----------|-------------|-----------------------------------------------------|
| BCM94356Z | BCM94356Z   | The base pin between these two models is different. |
|           | BCM94356ZAE |                                                     |

From the above models, part number: BCM94356Z was selected as representative model for the test and its data was recorded in this report.



## **1.2 Accessories**

N/A

## **1.3 Testing Applied Standards**

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

FCC 47 CFR Part 2 (2.1093)  
ANSI/IEEE C95.1-1992  
IEEE 1528-2013  
FCC KDB 248227 D01 v01r02  
FCC KDB 447498 D01 v05r02  
FCC KDB 644545 D03 v01  
FCC KDB 865664 D01 v01r03

## **1.4 Device Category and SAR Limits**

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user. Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

## 1.5 Testing Location

| Testing Location                    |        |                                                                                                                                    |                  |
|-------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------|------------------|
| <input type="checkbox"/>            | HWA YA | ADD : No. 52, Hwa Ya 1st Rd., Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.<br>TEL : 886-3-327-3456      FAX : 886-3-327-0973   |                  |
| <input checked="" type="checkbox"/> | JHUBEI | ADD : No.8, Lane 724, Bo-ai St., Jhubei City, HsinChu County 302, Taiwan, R.O.C.<br>TEL : 886-3-656-9065      FAX : 886-3-656-9085 |                  |
| Test Condition                      |        | Test Site No.                                                                                                                      | Test Environment |
| Radiated Emission                   |        | SAR01-CB                                                                                                                           | 22°C / 60%       |
|                                     |        |                                                                                                                                    | Test Engineer    |
|                                     |        |                                                                                                                                    | Jim Huang        |

## 2 Specific Absorption Rate (SAR)

### 2.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

### 2.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

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

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$\text{SAR} = C \left( \frac{\delta T}{\delta t} \right)$$

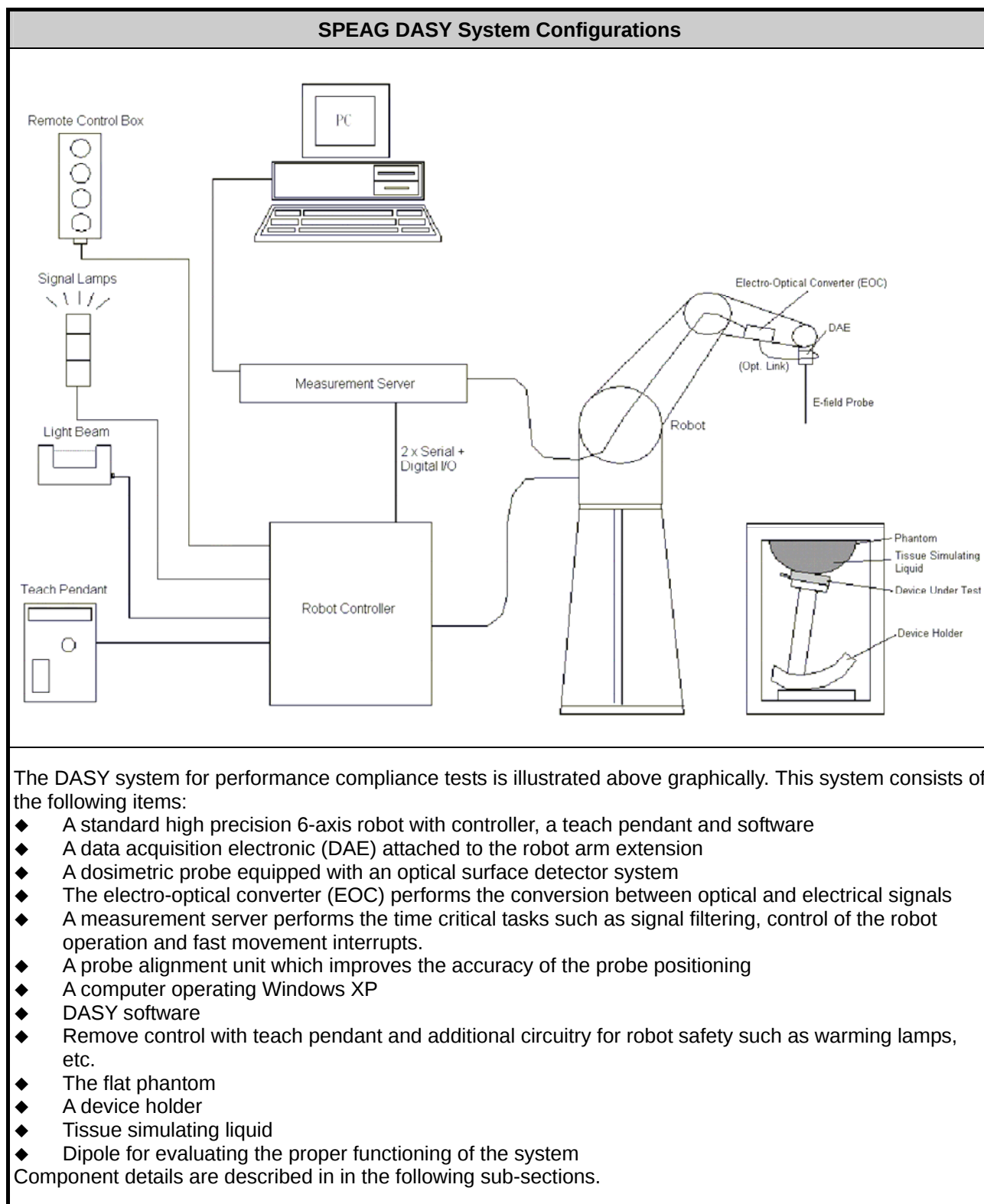
Where: C is the specific heat capacity,  $\delta T$  is the temperature rise and  $\delta t$  is the exposure duration, or related to the electrical field in the tissue by

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

Where:  $\sigma$  is the conductivity of the tissue,  $\rho$  is the mass density of the tissue and E is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

### 3 SAR Measurement System



### 3.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG). The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

#### 3.1.1 E-Field Probe Specification

| EX3DV4 Probe         |                                                                                                                                                             |                                                                                      |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Construction</b>  | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| <b>Frequency</b>     | 10 MHz to 6 GHz; Linearity: $\pm 0.2$ dB                                                                                                                    |                                                                                      |
| <b>Directivity</b>   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                         |                                                                                      |
| <b>Dynamic Range</b> | 10 $\mu$ W/g to 100 mW/g; Linearity: $\pm 0.2$ dB<br>(noise: typically $< 1$ $\mu$ W/g)                                                                     |                                                                                      |
| <b>Dimensions</b>    | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm                        |                                                                                      |
|                      |                                                                                                                                                             | <b>Photo of EX3DV4/ES3DV4</b>                                                        |

#### 3.1.2 E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than  $\pm 10\%$ . The spherical isotropy shall be evaluated and within  $\pm 0.25$ dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to appendix D of this report.

### 3.2 Data Acquisition Electronics (DAE)

#### Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

#### Photo of DAE



### 3.3 Robot

#### Robot

The SPEAG DASY system uses the high precision robots (DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- ◆ High precision (repeatability  $\pm 0.035$  mm)
- ◆ High reliability (industrial design)
- ◆ Jerk-free straight movements
- ◆ Low ELF interference (the closed metallic construction shields against motor control fields)

#### Photo of DASY5



### 3.4 Measurement Server

| Measurement Server                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5: 128 MB), RAM (DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.</p> <p>The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.</p> |
| Photo of Server for DASY5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

### 3.5 Phantom

| ELI4 Phantom                                                                                                                                                                                                                        |                                                  |                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Shell Thickness</b>                                                                                                                                                                                                              | 2 ± 0.2 mm (sagging: <1%)                        |  |
| <b>Filling Volume</b>                                                                                                                                                                                                               | Approx. 30 liters                                |                                                                                      |
| <b>Dimensions</b>                                                                                                                                                                                                                   | Major ellipse axis: 600 mm<br>Minor axis: 400 mm |                                                                                      |
|                                                                                                                                                                                                                                     |                                                  | <b>Photo of ELI4 Phantom</b>                                                         |
| <p>The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.</p> |                                                  |                                                                                      |

### 3.6 Device Holder

#### Device Holder for flat Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of  $\pm 0.5$  mm would produce a SAR uncertainty of  $\pm 20$  %. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon = 3$  and loss tangent  $\delta = 0.02$ . The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

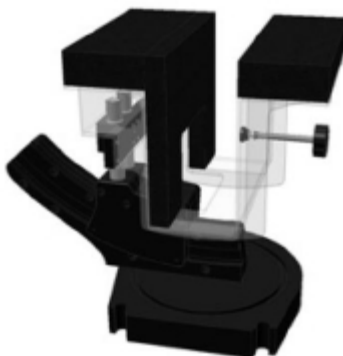
#### Photo of Device Holder



#### Laptop Extension Kit

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with ELI phantoms.

#### Photo of Laptop Extension Kit



## 3.7 Data Storage and Evaluation

### 3.7.1 Data Storage

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [A/m], [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a non-lose media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

### 3.7.2 Data Evaluation

The DASY post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software :

|                           |                           |                                         |
|---------------------------|---------------------------|-----------------------------------------|
| <b>Probe parameters:</b>  | - Sensitivity             | $\text{Norm}_i, a_{i0}, a_{i1}, a_{i2}$ |
|                           | - Conversion factor       | $\text{ConvF}_i$                        |
|                           | - Diode compression point | $\text{dcp}_i$                          |
| <b>Device parameters:</b> | - Frequency               | $f$                                     |
|                           | - Crest factor            | $cf$                                    |
| <b>Media parameters:</b>  | - Conductivity            | $\sigma$                                |
|                           | - Density                 | $\rho$                                  |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power.

The formula for each channel can be given as :

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

with  $V_i$  = compensated signal of channel i, (i = x, y, z)  
 $U_i$  = input signal of channel i, (i = x, y, z)  
 cf = crest factor of exciting field (DASY parameter)  
 dcp<sub>i</sub> = diode compression point (DASY parameter)

From the compensated input signals, the primary field data for each channel can be evaluated :

$$\text{E-field Probes: } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}}$$

$$\text{H-field Probes: } H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with  $V_i$  = compensated signal of channel i, (i = x, y, z)  
 $\text{Norm}_i$  = sensor sensitivity of channel i, (i = x, y, z),  $\mu\text{V}/(\text{V/m})^2$  for E-field Probes  
 ConvF = sensitivity enhancement in solution  
 $a_{ij}$  = sensor sensitivity factors for H-field probes  
 f = carrier frequency [GHz]  
 $E_i$  = electric field strength of channel i in V/m  
 $H_i$  = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude) :

$$E_{\text{tot}} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$\text{SAR} = E_{\text{tot}}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with SAR = local specific absorption rate in mW/g  
 $E_{\text{tot}}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

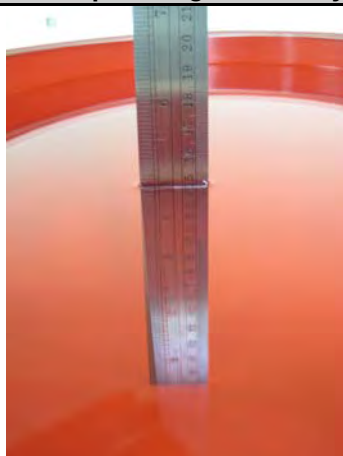
Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

## 4 Tissue Simulating Liquids

### Tissue Simulating Liquids

For the measurement of the field distribution inside the phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Photo of Liquid Height for Body SAR.

### Photo of Liquid Height for Body SAR



### Recipes of Tissue Simulating Liquid

| Frequency<br>(MHz) | Water<br>(%) | Sugar<br>(%) | Cellulose<br>(%) | Salt<br>(%) | Preventol<br>(%) | DGBE<br>(%) | Conductivity<br>( $\sigma$ ) | Permittivity<br>( $\epsilon_r$ ) |
|--------------------|--------------|--------------|------------------|-------------|------------------|-------------|------------------------------|----------------------------------|
| <b>For Body</b>    |              |              |                  |             |                  |             |                              |                                  |
| 2450               | 68.6         | 0            | 0                | 0           | 0                | 31.4        | 1.95                         | 52.7                             |

### Simulating Liquid for 5G, Manufactured by SPEAG

| Ingredients        | (% by weight) |
|--------------------|---------------|
| Water              | 64~78%        |
| Mineral oil        | 11~18%        |
| Emulsifiers        | 9~15%         |
| Additives and Salt | 2~3%          |

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an Agilent Network Analyzer.

| Measuring Results for Simulating Liquid |             |                   |                           |                               |                                  |                                      |                        |                            |           |           |
|-----------------------------------------|-------------|-------------------|---------------------------|-------------------------------|----------------------------------|--------------------------------------|------------------------|----------------------------|-----------|-----------|
| Frequency (MHz)                         | Liquid Type | Liquid Temp. (°C) | Conductivity ( $\sigma$ ) | Permittivity ( $\epsilon_r$ ) | Conductivity Target ( $\sigma$ ) | Permittivity Target ( $\epsilon_r$ ) | Delta ( $\sigma$ ) (%) | Delta ( $\epsilon_r$ ) (%) | Limit (%) | Cal. Date |
| 2450                                    | Body        | 22                | 1.95                      | 50.62                         | 1.95                             | 52.70                                | 0.15                   | -3.95                      | ±5        | 2014/8/18 |
| 5200                                    | Body        | 22                | 5.43                      | 46.90                         | 5.30                             | 49.00                                | 2.40                   | -4.29                      | ±5        | 2014/8/18 |
| 5300                                    | Body        | 22                | 5.55                      | 46.74                         | 5.42                             | 48.87                                | 2.42                   | -4.36                      | ±5        | 2014/8/18 |
| 5600                                    | Body        | 22                | 5.95                      | 46.26                         | 5.80                             | 48.50                                | 2.53                   | -4.62                      | ±5        | 2014/8/18 |
| 5800                                    | Body        | 22                | 6.23                      | 45.97                         | 6.00                             | 48.20                                | 3.88                   | -4.63                      | ±5        | 2014/8/18 |

| Measuring Results for Simulating Liquid |             |                   |                           |                               |                                  |                                      |                        |                            |           |           |
|-----------------------------------------|-------------|-------------------|---------------------------|-------------------------------|----------------------------------|--------------------------------------|------------------------|----------------------------|-----------|-----------|
| Frequency (MHz)                         | Liquid Type | Liquid Temp. (°C) | Conductivity ( $\sigma$ ) | Permittivity ( $\epsilon_r$ ) | Conductivity Target ( $\sigma$ ) | Permittivity Target ( $\epsilon_r$ ) | Delta ( $\sigma$ ) (%) | Delta ( $\epsilon_r$ ) (%) | Limit (%) | Cal. Date |
| 5200                                    | Body        | 22                | 5.40                      | 47.36                         | 5.30                             | 49.00                                | 1.91                   | -3.35                      | ±5        | 2014/8/21 |
| 5300                                    | Body        | 22                | 5.54                      | 47.23                         | 5.42                             | 48.87                                | 2.16                   | -3.36                      | ±5        | 2014/8/21 |
| 5600                                    | Body        | 22                | 5.95                      | 46.81                         | 5.80                             | 48.50                                | 2.55                   | -3.48                      | ±5        | 2014/8/21 |
| 5800                                    | Body        | 22                | 6.23                      | 46.49                         | 6.00                             | 48.20                                | 3.75                   | -3.55                      | ±5        | 2014/8/21 |

| Measuring Results for Simulating Liquid |             |                   |                           |                               |                                  |                                      |                        |                            |           |           |
|-----------------------------------------|-------------|-------------------|---------------------------|-------------------------------|----------------------------------|--------------------------------------|------------------------|----------------------------|-----------|-----------|
| Frequency (MHz)                         | Liquid Type | Liquid Temp. (°C) | Conductivity ( $\sigma$ ) | Permittivity ( $\epsilon_r$ ) | Conductivity Target ( $\sigma$ ) | Permittivity Target ( $\epsilon_r$ ) | Delta ( $\sigma$ ) (%) | Delta ( $\epsilon_r$ ) (%) | Limit (%) | Cal. Date |
| 5200                                    | Body        | 22                | 5.45                      | 47.39                         | 5.30                             | 49.00                                | 2.83                   | -3.29                      | ±5        | 2014/8/25 |
| 5300                                    | Body        | 22                | 5.57                      | 47.22                         | 5.42                             | 48.87                                | 2.68                   | -3.38                      | ±5        | 2014/8/25 |
| 5600                                    | Body        | 22                | 6.00                      | 46.75                         | 5.80                             | 48.50                                | 3.38                   | -3.61                      | ±5        | 2014/8/25 |
| 5800                                    | Body        | 22                | 6.29                      | 46.43                         | 6.00                             | 48.20                                | 4.78                   | -3.67                      | ±5        | 2014/8/25 |

| Measuring Results for Simulating Liquid |             |                   |                           |                               |                                  |                                      |                        |                            |           |           |
|-----------------------------------------|-------------|-------------------|---------------------------|-------------------------------|----------------------------------|--------------------------------------|------------------------|----------------------------|-----------|-----------|
| Frequency (MHz)                         | Liquid Type | Liquid Temp. (°C) | Conductivity ( $\sigma$ ) | Permittivity ( $\epsilon_r$ ) | Conductivity Target ( $\sigma$ ) | Permittivity Target ( $\epsilon_r$ ) | Delta ( $\sigma$ ) (%) | Delta ( $\epsilon_r$ ) (%) | Limit (%) | Cal. Date |
| 5200                                    | Body        | 22                | 5.46                      | 47.76                         | 5.30                             | 49.00                                | 2.92                   | -2.53                      | ±5        | 2014/8/28 |
| 5300                                    | Body        | 22                | 5.56                      | 47.59                         | 5.42                             | 48.87                                | 2.60                   | -2.62                      | ±5        | 2014/8/28 |
| 5600                                    | Body        | 22                | 5.99                      | 47.20                         | 5.80                             | 48.50                                | 3.33                   | -2.68                      | ±5        | 2014/8/28 |
| 5800                                    | Body        | 22                | 6.28                      | 46.85                         | 6.00                             | 48.20                                | 4.58                   | -2.80                      | ±5        | 2014/8/28 |

## 5 SAR System Verification

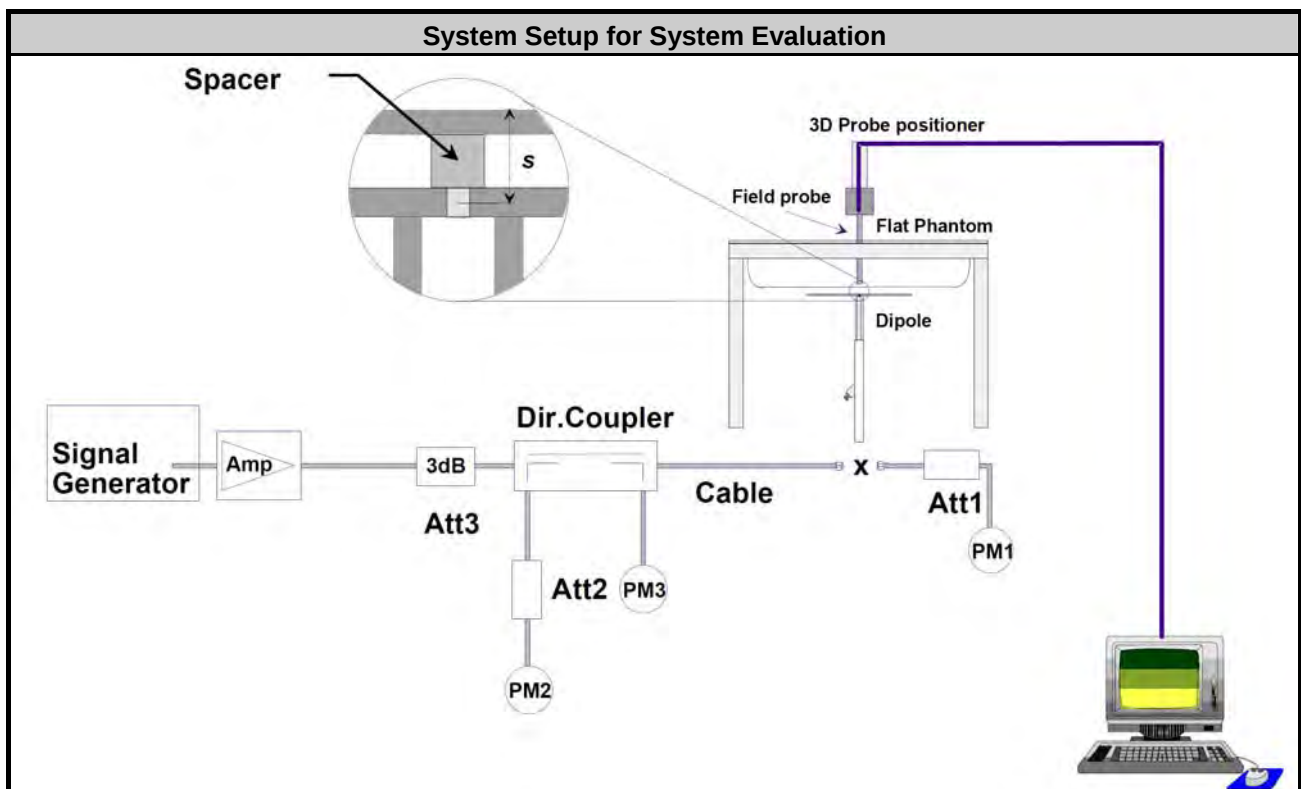
Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

### 5.1 Purpose of System Performance check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

### 5.2 System Setup

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



**Photo of Dipole Setup**



### 5.3 SAR System Verification Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. The table below shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix B of this report.

| Target and Measurement SAR after Normalized |             |                                      |                     |                     |                       |               |           |           |
|---------------------------------------------|-------------|--------------------------------------|---------------------|---------------------|-----------------------|---------------|-----------|-----------|
| Frequency (MHz)                             | Liquid Type | Power fed onto reference dipole (mW) | Targeted SAR (W/kg) | Measured SAR (W/kg) | Normalized SAR (W/kg) | Deviation (%) | Limit (%) | Date      |
| 2450                                        | Body        | 250                                  | 50.20               | 12.40               | 49.6                  | -1.20         | ±10       | 2014/8/18 |
| 5200                                        | Body        | 100                                  | 73.60               | 7.39                | 73.9                  | 0.41          | ±10       | 2014/8/18 |
| 5300                                        | Body        | 100                                  | 74.40               | 7.24                | 72.4                  | -2.69         | ±10       | 2014/8/18 |
| 5600                                        | Body        | 100                                  | 79.50               | 8.28                | 82.8                  | 4.15          | ±10       | 2014/8/18 |
| 5800                                        | Body        | 100                                  | 73.80               | 7.15                | 71.5                  | -3.12         | ±10       | 2014/8/18 |

| Target and Measurement SAR after Normalized |             |                                      |                     |                     |                       |               |           |           |
|---------------------------------------------|-------------|--------------------------------------|---------------------|---------------------|-----------------------|---------------|-----------|-----------|
| Frequency (MHz)                             | Liquid Type | Power fed onto reference dipole (mW) | Targeted SAR (W/kg) | Measured SAR (W/kg) | Normalized SAR (W/kg) | Deviation (%) | Limit (%) | Date      |
| 5200                                        | Body        | 100                                  | 73.60               | 7.15                | 71.5                  | -2.85         | ±10       | 2014/8/21 |
| 5300                                        | Body        | 100                                  | 74.40               | 7.55                | 75.5                  | 1.48          | ±10       | 2014/8/21 |
| 5600                                        | Body        | 100                                  | 79.50               | 8.09                | 80.9                  | 1.76          | ±10       | 2014/8/21 |
| 5800                                        | Body        | 100                                  | 73.80               | 7.49                | 74.9                  | 1.49          | ±10       | 2014/8/21 |

| Target and Measurement SAR after Normalized |             |                                      |                     |                     |                       |               |           |           |
|---------------------------------------------|-------------|--------------------------------------|---------------------|---------------------|-----------------------|---------------|-----------|-----------|
| Frequency (MHz)                             | Liquid Type | Power fed onto reference dipole (mW) | Targeted SAR (W/kg) | Measured SAR (W/kg) | Normalized SAR (W/kg) | Deviation (%) | Limit (%) | Date      |
| 5200                                        | Body        | 100                                  | 73.60               | 7.57                | 75.7                  | 2.85          | ±10       | 2014/8/25 |
| 5300                                        | Body        | 100                                  | 74.40               | 7.78                | 77.8                  | 4.57          | ±10       | 2014/8/25 |
| 5600                                        | Body        | 100                                  | 79.50               | 7.74                | 77.4                  | -2.64         | ±10       | 2014/8/25 |
| 5800                                        | Body        | 100                                  | 73.80               | 7.48                | 74.8                  | 1.36          | ±10       | 2014/8/25 |

| Target and Measurement SAR after Normalized |             |                                      |                     |                     |                       |               |           |           |
|---------------------------------------------|-------------|--------------------------------------|---------------------|---------------------|-----------------------|---------------|-----------|-----------|
| Frequency (MHz)                             | Liquid Type | Power fed onto reference dipole (mW) | Targeted SAR (W/kg) | Measured SAR (W/kg) | Normalized SAR (W/kg) | Deviation (%) | Limit (%) | Date      |
| 5200                                        | Body        | 100                                  | 73.60               | 7.39                | 73.9                  | 0.41          | ±10       | 2014/8/28 |
| 5300                                        | Body        | 100                                  | 74.40               | 7.49                | 74.9                  | 0.67          | ±10       | 2014/8/28 |
| 5600                                        | Body        | 100                                  | 79.50               | 7.94                | 79.4                  | -0.13         | ±10       | 2014/8/28 |
| 5800                                        | Body        | 100                                  | 73.80               | 7.65                | 76.5                  | 3.66          | ±10       | 2014/8/28 |



## **6 EUT Testing Position**

This EUT was tested in six different positions. They are Front/Back/Right Side/Left Side/Top Side/Bottom Side of the EUT with phantom 0.5cm gap. Please refer to Appendix A for the test setup photos.

## 7 Measurement Procedures

| Measurement Procedures                                                                                                                      |                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conducted power measurement                                                                                                                 |                                                                                                                                                                                         |
| (a)                                                                                                                                         | For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band |
| (b)                                                                                                                                         | Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power                                                                                               |
| SAR measurement                                                                                                                             |                                                                                                                                                                                         |
| (a)                                                                                                                                         | Use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.                                                         |
| (b)                                                                                                                                         | Place the EUT in the positions as Appendix A demonstrates.                                                                                                                              |
| (c)                                                                                                                                         | Set scan area, grid size and other setting on the DASY software.                                                                                                                        |
| (d)                                                                                                                                         | Measure SAR results for the highest power channel on each testing position.                                                                                                             |
| (e)                                                                                                                                         | Find out the largest SAR result on these testing positions of each band                                                                                                                 |
| (f)                                                                                                                                         | Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg                                               |
| Peak spatial-average SAR value                                                                                                              |                                                                                                                                                                                         |
| According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps: |                                                                                                                                                                                         |
| (a)                                                                                                                                         | Power reference measurement                                                                                                                                                             |
| (b)                                                                                                                                         | Area scan                                                                                                                                                                               |
| (c)                                                                                                                                         | Zoom scan                                                                                                                                                                               |
| (d)                                                                                                                                         | Power drift measurement                                                                                                                                                                 |

### 7.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- Extraction of the measured data (grid and values) from the Zoom Scan
- Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- Generation of a high-resolution mesh within the measured volume
- Interpolation of all measured values from the measurement grid to the high-resolution grid
- Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- Calculation of the averaged SAR within masses of 1g and 10g

## 7.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

## 7.3 Area & Zoom Scan Procedures

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows FCC KDB 865664 D01 v01r03 quoted below.

For any secondary peaks found in the area scan which are within 2 dB of the maximum peak and are not within this zoom scan, the zoom scan should be repeated

|                                                                                                                                                                                                                                                                                                             |                                    |                                                                                      | $\leq 3$ GHz                                                                                                                                                                                                                                                           | $> 3$ GHz                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface                                                                                                                                                                                                      |                                    |                                                                                      | $5 \pm 1$ mm                                                                                                                                                                                                                                                           | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm                            |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location                                                                                                                                                                                                                   |                                    |                                                                                      | $30^{\circ} \pm 1^{\circ}$                                                                                                                                                                                                                                             | $20^{\circ} \pm 1^{\circ}$                                                    |
| Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$                                                                                                                                                                                                                                 |                                    |                                                                                      | $\leq 2$ GHz: $\leq 15$ mm<br>2 – 3 GHz: $\leq 12$ mm                                                                                                                                                                                                                  | 3 – 4 GHz: $\leq 12$ mm<br>4 – 6 GHz: $\leq 10$ mm                            |
|                                                                                                                                                                                                                                                                                                             |                                    |                                                                                      | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                                                               |
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$                                                                                                                                                                                                                                 |                                    |                                                                                      | $\leq 2$ GHz: $\leq 8$ mm<br>2 – 3 GHz: $\leq 5$ mm*                                                                                                                                                                                                                   | 3 – 4 GHz: $\leq 5$ mm*<br>4 – 6 GHz: $\leq 4$ mm*                            |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                                                             | uniform grid: $\Delta z_{Zoom}(n)$ |                                                                                      | $\leq 5$ mm                                                                                                                                                                                                                                                            | 3 – 4 GHz: $\leq 4$ mm<br>4 – 5 GHz: $\leq 3$ mm<br>5 – 6 GHz: $\leq 2$ mm    |
|                                                                                                                                                                                                                                                                                                             | graded grid                        | $\Delta z_{Zoom}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface | $\leq 4$ mm                                                                                                                                                                                                                                                            | 3 – 4 GHz: $\leq 3$ mm<br>4 – 5 GHz: $\leq 2.5$ mm<br>5 – 6 GHz: $\leq 2$ mm  |
|                                                                                                                                                                                                                                                                                                             |                                    | $\Delta z_{Zoom}(n>1)$ : between subsequent points                                   | $\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$                                                                                                                                                                                                                                  |                                                                               |
| Minimum zoom scan volume                                                                                                                                                                                                                                                                                    | x, y, z                            |                                                                                      | $\geq 30$ mm                                                                                                                                                                                                                                                           | 3 – 4 GHz: $\geq 28$ mm<br>4 – 5 GHz: $\geq 25$ mm<br>5 – 6 GHz: $\geq 22$ mm |
| Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.                                                                                                                                                           |                                    |                                                                                      |                                                                                                                                                                                                                                                                        |                                                                               |
| * When zoom scan is required and the <u>reported</u> SAR from the <u>area scan based 1-g SAR estimation</u> procedures of KDB 447498 is $\leq 1.4$ W/kg, $\leq 8$ mm, $\leq 7$ mm and $\leq 5$ mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. |                                    |                                                                                      |                                                                                                                                                                                                                                                                        |                                                                               |



## **7.4 Volume Scan Procedures**

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

## **7.5 SAR Averaged Methods**

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

## **7.6 Power Drift Monitoring**

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

## 8 Conducted RF Output Power

| Band             | Mode           | Channel | Frequency (MHz) | Data Rate (Mbps) | Chain | Average Power (dBm) |
|------------------|----------------|---------|-----------------|------------------|-------|---------------------|
| WLAN 2.4GHz Band | 802.11b        | CH 1    | 2412            | 1                | 1+2   | 17.17               |
|                  |                | CH 6    | 2437            |                  |       | 17.20               |
|                  |                | CH 11   | 2462            |                  |       | 17.19               |
|                  |                | CH 12   | 2467            |                  |       | 17.18               |
|                  | 802.11g        | CH 1    | 2412            | 6                | 1+2   | 16.83               |
|                  |                | CH 6    | 2437            |                  |       | 17.22               |
|                  |                | CH 11   | 2462            |                  |       | 16.42               |
|                  |                | CH 12   | 2467            |                  |       | 16.25               |
|                  | 802.11n (HT20) | CH 1    | 2412            | MCS0             | 1+2   | 17.18               |
|                  |                | CH 6    | 2437            |                  |       | 17.24               |
|                  |                | CH 11   | 2462            |                  |       | 16.20               |
|                  |                | CH 12   | 2467            |                  |       | 14.30               |
|                  | 802.11n (HT40) | CH 3    | 2422            | MCS0             | 1+2   | 13.75               |
|                  |                | CH 6    | 2437            |                  |       | 15.91               |
|                  |                | CH 9    | 2452            |                  |       | 15.66               |
|                  |                | CH 10   | 2457            |                  |       | 14.39               |

Note:

1. Per FCC KDB 248227 D01 v01r02, choose the highest output power channel to test SAR and determine further SAR exclusion
2. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at the lowest data rate
3. Per FCC KDB 248227 D01 v01r02, 11g, 11n-HT20 and 11n-HT40 output power is less than 1/4dB higher than 11b mode, thus the SAR can be excluded.



| Band              | Mode             | Channel | Frequency (MHz) | Data Rate (Mbps) | Chain | Average Power (dBm) |
|-------------------|------------------|---------|-----------------|------------------|-------|---------------------|
| WLAN 5 GHz Band 1 | 802.11a          | CH36    | 5180            | 6                | 1+2   | 16.89               |
|                   |                  | CH40    | 5200            |                  |       | 16.91               |
|                   |                  | CH44    | 5220            |                  |       | 16.73               |
|                   |                  | CH48    | 5240            |                  |       | 16.90               |
|                   | 802.11n (HT20)   | CH36    | 5180            | MCS0             | 1+2   | 16.78               |
|                   |                  | CH40    | 5200            |                  |       | 16.81               |
|                   |                  | CH44    | 5220            |                  |       | 16.92               |
|                   |                  | CH48    | 5240            |                  |       | 16.87               |
|                   | 802.11n (HT40)   | CH38    | 5190            | MCS0             | 1+2   | 16.78               |
|                   |                  | CH46    | 5230            |                  |       | 16.76               |
|                   | 802.11ac (VHT20) | CH36    | 5180            | MCS0/Nss1        | 1+2   | 16.90               |
|                   |                  | CH40    | 5200            |                  |       | 16.89               |
|                   |                  | CH44    | 5220            |                  |       | 16.96               |
|                   |                  | CH48    | 5240            |                  |       | 16.95               |
|                   | 802.11ac (VHT40) | CH38    | 5190            | MCS0/Nss1        | 1+2   | 16.89               |
|                   |                  | CH46    | 5230            |                  |       | 16.91               |
|                   | 802.11ac (VHT80) | CH42    | 5210            | MCS0/Nss1        | 1+2   | 16.94               |

| Band              | Mode             | Channel | Frequency (MHz) | Data Rate (Mbps) | Chain | Average Power (dBm) |
|-------------------|------------------|---------|-----------------|------------------|-------|---------------------|
| WLAN 5 GHz Band 2 | 802.11a          | CH52    | 5260            | 6                | 1+2   | 16.87               |
|                   |                  | CH56    | 5280            |                  |       | 16.89               |
|                   |                  | CH60    | 5300            |                  |       | 16.91               |
|                   |                  | CH64    | 5320            |                  |       | 16.82               |
|                   | 802.11n (HT20)   | CH52    | 5260            | MCS0             | 1+2   | 16.80               |
|                   |                  | CH56    | 5280            |                  |       | 16.89               |
|                   |                  | CH60    | 5300            |                  |       | 16.81               |
|                   |                  | CH64    | 5320            |                  |       | 16.93               |
|                   | 802.11n (HT40)   | CH54    | 5270            | MCS0             | 1+2   | 16.75               |
|                   |                  | CH62    | 5310            |                  |       | 16.85               |
|                   | 802.11ac (VHT20) | CH52    | 5260            | MCS0/Nss1        | 1+2   | 16.95               |
|                   |                  | CH56    | 5280            |                  |       | 16.93               |
|                   |                  | CH60    | 5300            |                  |       | 16.89               |
|                   |                  | CH64    | 5320            |                  |       | 16.93               |
|                   | 802.11ac (VHT40) | CH54    | 5270            | MCS0/Nss1        | 1+2   | 16.83               |
|                   |                  | CH62    | 5310            |                  |       | 16.91               |
|                   | 802.11ac (VHT80) | CH58    | 5290            | MCS0/Nss1        | 1+2   | 16.94               |



| Band              | Mode             | Channel | Frequency (MHz) | Data Rate (Mbps) | Chain | Average Power (dBm) |
|-------------------|------------------|---------|-----------------|------------------|-------|---------------------|
| WLAN 5 GHz Band 3 | 802.11a          | CH100   | 5500            | 6                | 1+2   | 16.12               |
|                   |                  | CH104   | 5520            |                  |       | 16.11               |
|                   |                  | CH108   | 5540            |                  |       | 16.09               |
|                   |                  | CH112   | 5560            |                  |       | 16.11               |
|                   |                  | CH116   | 5580            |                  |       | 16.24               |
|                   |                  | CH120   | 5600            |                  |       | 16.09               |
|                   |                  | CH124   | 5620            |                  |       | 16.11               |
|                   |                  | CH128   | 5640            |                  |       | 16.13               |
|                   |                  | CH132   | 5660            |                  |       | 16.11               |
|                   |                  | CH136   | 5680            |                  |       | 16.13               |
|                   |                  | CH140   | 5700            |                  |       | 16.20               |
|                   |                  | CH144   | 5720            |                  |       | 16.12               |
|                   | 802.11n (HT20)   | CH100   | 5500            | MCS0             | 1+2   | 16.26               |
|                   |                  | CH104   | 5520            |                  |       | 16.25               |
|                   |                  | CH108   | 5540            |                  |       | 16.29               |
|                   |                  | CH112   | 5560            |                  |       | 16.27               |
|                   |                  | CH116   | 5580            |                  |       | 16.31               |
|                   |                  | CH120   | 5600            |                  |       | 16.40               |
|                   |                  | CH124   | 5620            |                  |       | 16.27               |
|                   |                  | CH128   | 5640            |                  |       | 16.24               |
|                   |                  | CH132   | 5660            |                  |       | 16.23               |
|                   |                  | CH136   | 5680            |                  |       | 16.30               |
|                   |                  | CH140   | 5700            |                  |       | 16.23               |
|                   |                  | CH144   | 5720            |                  |       | 16.32               |
|                   | 802.11n (HT40)   | CH102   | 5510            | MCS0             | 1+2   | 16.33               |
|                   |                  | CH110   | 5550            |                  |       | 16.43               |
|                   |                  | CH118   | 5590            |                  |       | 16.36               |
|                   |                  | CH126   | 5630            |                  |       | 16.38               |
|                   |                  | CH134   | 5670            |                  |       | 16.36               |
|                   |                  | CH142   | 5710            |                  |       | 16.28               |
|                   | 802.11ac (VHT20) | CH100   | 5500            | MCS0/Nss1        | 1+2   | 16.31               |
|                   |                  | CH104   | 5520            |                  |       | 16.25               |
|                   |                  | CH108   | 5540            |                  |       | 16.35               |
|                   |                  | CH112   | 5560            |                  |       | 16.31               |
|                   |                  | CH116   | 5580            |                  |       | 16.36               |
|                   |                  | CH120   | 5600            |                  |       | 16.30               |
|                   |                  | CH124   | 5620            |                  |       | 16.44               |
|                   |                  | CH128   | 5640            |                  |       | 16.30               |
|                   |                  | CH132   | 5660            |                  |       | 16.42               |
|                   |                  | CH136   | 5680            |                  |       | 16.35               |
|                   |                  | CH140   | 5700            |                  |       | 16.42               |
|                   |                  | CH144   | 5720            |                  |       | 16.33               |
|                   | 802.11ac (VHT40) | CH102   | 5510            | MCS0/Nss1        | 1+2   | 16.25               |
|                   |                  | CH110   | 5550            |                  |       | 16.25               |
|                   |                  | CH118   | 5590            |                  |       | 16.36               |
|                   |                  | CH126   | 5630            |                  |       | 16.30               |
|                   |                  | CH134   | 5670            |                  |       | 16.33               |
|                   |                  | CH142   | 5710            |                  |       | 16.30               |
|                   | 802.11ac (VHT80) | CH106   | 5530            | MCS0/Nss1        | 1+2   | 16.41               |
|                   |                  | CH122   | 5610            |                  |       | 16.35               |
|                   |                  | CH138   | 5690            |                  |       | 16.32               |

| Band                 | Mode                | Channel | Frequency (MHz) | Data Rate (Mbps) | Chain | Average Power (dBm) |
|----------------------|---------------------|---------|-----------------|------------------|-------|---------------------|
| WLAN 5 GHz<br>Band 4 | 802.11a             | CH149   | 5745            | 6                | 1+2   | 16.88               |
|                      |                     | CH153   | 5765            |                  |       | 16.89               |
|                      |                     | CH157   | 5785            |                  |       | 16.92               |
|                      |                     | CH161   | 5805            |                  |       | 16.80               |
|                      |                     | CH165   | 5825            |                  |       | 16.90               |
|                      |                     |         |                 |                  |       |                     |
|                      | 802.11n<br>(HT20)   | CH149   | 5745            | MCS0             | 1+2   | 16.88               |
|                      |                     | CH153   | 5765            |                  |       | 16.81               |
|                      |                     | CH157   | 5785            |                  |       | 16.79               |
|                      |                     | CH161   | 5805            |                  |       | 16.71               |
|                      |                     | CH165   | 5825            |                  |       | 16.84               |
|                      |                     |         |                 |                  |       |                     |
|                      | 802.11n<br>(HT40)   | CH151   | 5755            | MCS0             | 1+2   | 16.73               |
|                      |                     | CH159   | 5795            |                  |       | 16.85               |
|                      | 802.11ac<br>(VHT20) | CH149   | 5745            | MCS0/Nss1        | 1+2   | 16.95               |
|                      |                     | CH153   | 5765            |                  |       | 16.97               |
|                      |                     | CH157   | 5785            |                  |       | 16.90               |
|                      |                     | CH161   | 5805            |                  |       | 16.92               |
|                      |                     | CH165   | 5825            |                  |       | 16.89               |
|                      |                     |         |                 |                  |       |                     |
|                      | 802.11ac<br>(VHT40) | CH151   | 5755            | MCS0/Nss1        | 1+2   | 15.75               |
|                      |                     | CH159   | 5795            |                  |       | 16.95               |
|                      | 802.11ac<br>(VHT80) | CH155   | 5775            | MCS0/Nss1        | 1+2   | 16.39               |

Note:

1. Per FCC KDB 248227 D01 v01r02, choose the highest output power channel to test SAR and determine further SAR exclusion
2. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at the lowest data rate.
3. Per FCC KDB 248227 D01 v01r02, 11n/ac-HT20/HT40/VHT20/VHT40 output power is less than 1/4dB higher than 11a mode, thus the SAR can be excluded.
4. For 802.11ac SAR evaluation for each frequency band, 802.11ac VHT80 will be verified at the worst case found in 802.11a SAR testing.

| Bluetooth – Burst Average Power (dBm) |                 |      |                |        |
|---------------------------------------|-----------------|------|----------------|--------|
| Channel                               | Frequency (MHz) | Mode |                |        |
|                                       |                 | GFSK | $\pi$ /4-DQPSK | 8-DPSK |
| CH 0                                  | 2402            | 0.72 | -0.58          | -0.67  |
| CH 39                                 | 2441            | 0.51 | -0.67          | -0.57  |
| CH 78                                 | 2480            | 0.11 | -1.13          | -1.08  |

| Bluetooth – Source-base time-Average Power (dBm) |                 |       |                |        |
|--------------------------------------------------|-----------------|-------|----------------|--------|
| Channel                                          | Frequency (MHz) | Mode  |                |        |
|                                                  |                 | GFSK  | $\pi$ /4-DQPSK | 8-DPSK |
| CH 0                                             | 2402            | -0.07 | -1.37          | -1.46  |
| CH 39                                            | 2441            | -0.28 | -1.46          | -1.36  |
| CH 78                                            | 2480            | -0.68 | -1.92          | -1.87  |

| Bluetooth Average Power (dBm) |                 |                  |  |  |
|-------------------------------|-----------------|------------------|--|--|
| Channel                       | Frequency (MHz) | Mode             |  |  |
|                               |                 | BT v4.0 LE, GFSK |  |  |
| CH 0                          | 2402            | -8.12            |  |  |
| CH 19                         | 2440            | -7.65            |  |  |
| CH 39                         | 2480            | -7.94            |  |  |

Note:

- The data above is the average power level during the “ON” burst of Bluetooth transmitter
- The duty factor of DH5/2DH5/3DH5 is applied to determine source-base time-average power and time-average power = burst average power \* duty factor.
- Duty factor used for DH5/2DH5/3DH5 is the theoretical maximum of 83.3%.
- Per FCC KDB 447498 D01 v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:  

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f_{(\text{GHz})}}] \leq 3.0$$
for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR
  - $f_{(\text{GHz})}$  is the RF channel transmit frequency in GHz
  - Power and distance are rounded to the nearest mW and mm before calculation
  - The result is rounded to one decimal place for comparison

| Bluetooth Max Power (dBm) | mW  | Test Distance (mm) | Frequency (GHz) | Exclusion Thresholds |
|---------------------------|-----|--------------------|-----------------|----------------------|
| -0.07                     | 1.0 | 5                  | 2.48            | 0.31                 |

- Per FCC KDB 447498 D01 v05r02 exclusion thresholds is  $0.31 < 3$ , RF exposure evaluation is not required.

## 9 SAR Test Results

- Per FCC KDB 447498 D01 v05r02, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
  - Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
  - For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)".
  - For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)\* Duty Cycle scaling factor \* Tune-up scaling factor.
- Per FCC KDB 447498 D01 v05r02, for each exposure position, if the highest output channel reported SAR  $\leq 0.8$ W/kg, other channels SAR testing is not necessary.

### 9.1 Test Records for Body SAR Test

| WLAN SAR DTS |            |               |               |          |     |             |       |                     |                     |                        |                |                           |                  |                        |                      |
|--------------|------------|---------------|---------------|----------|-----|-------------|-------|---------------------|---------------------|------------------------|----------------|---------------------------|------------------|------------------------|----------------------|
| Plot No.     | Band (GHz) | Mode          | Test Position | Gap (cm) | Ch. | Freq. (MHz) | Chain | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle (%) | Duty Cycle Scaling Factor | Power Drift (dB) | Measured SAR 1g (W/kg) | Scaled SAR 1g (W/kg) |
| 1            | 2.4        | 802.11b 1Mbps | Front         | 0.5      | 6   | 2437        | 1+2   | 17.20               | 17.50               | 1.072                  | 95.40          | 1.048                     | -0.10            | 0.653                  | 0.733                |
| 2            | 2.4        | 802.11b 1Mbps | Back          | 0.5      | 6   | 2437        | 1+2   | 17.20               | 17.50               | 1.072                  | 95.40          | 1.048                     | -0.18            | 0.622                  | 0.699                |
| 3            | 2.4        | 802.11b 1Mbps | Left Site     | 0.5      | 6   | 2437        | 1+2   | 17.20               | 17.50               | 1.072                  | 95.40          | 1.048                     | -0.02            | 0.059                  | 0.067                |
| 4            | 2.4        | 802.11b 1Mbps | Right Site    | 0.5      | 6   | 2437        | 1+2   | 17.20               | 17.50               | 1.072                  | 95.40          | 1.048                     | -0.07            | 0.146                  | 0.164                |
| 5            | 2.4        | 802.11b 1Mbps | Top Site      | 0.5      | 6   | 2437        | 1+2   | 17.20               | 17.50               | 1.072                  | 95.40          | 1.048                     | 0.14             | 0.010                  | 0.011                |
| 6            | 2.4        | 802.11b 1Mbps | Bottom Site   | 0.5      | 6   | 2437        | 1+2   | 17.20               | 17.50               | 1.072                  | 95.40          | 1.048                     | 0.13             | 0.455                  | 0.511                |



| WLAN SAR NII |            |                            |               |          |        |             |       |                     |                     |                        |                |                           |                  |                        |                      |
|--------------|------------|----------------------------|---------------|----------|--------|-------------|-------|---------------------|---------------------|------------------------|----------------|---------------------------|------------------|------------------------|----------------------|
| Plot No.     | Band (GHz) | Mode                       | Test Position | Gap (cm) | Ch.    | Freq. (MHz) | Chain | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle (%) | Duty Cycle Scaling Factor | Power Drift (dB) | Measured SAR 1g (W/kg) | Scaled SAR 1g (W/kg) |
| 11           | 5          | 802.11a 6Mbps              | Front         | 0.5      | 40     | 5200        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | 0.02             | 0.712                  | 0.759                |
| 12           | 5          | 802.11a 6Mbps              | Back          | 0.5      | 40     | 5200        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.03            | 0.605                  | 0.645                |
| 37           | 5          | 802.11a 6Mbps              | Left Site     | 0.5      | 40     | 5200        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.13            | 0.132                  | 0.141                |
| 41           | 5          | 802.11a 6Mbps              | Right Site    | 0.5      | 40     | 5200        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.08            | 0.220                  | 0.234                |
| 45           | 5          | 802.11a 6Mbps              | Top Site      | 0.5      | 40     | 5200        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.20            | 0.080                  | 0.085                |
| 49           | 5          | 802.11a 6Mbps              | Bottom Site   | 0.5      | 40     | 5200        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.14            | 0.436                  | 0.464                |
| 26           | 5          | 802.11ac (VHT80) MCS0/Nss1 | Front         | 0.5      | 42     | 5210        | 1+2   | 16.94               | 17.00               | 1.014                  | 95.10          | 1.052                     | -0.05            | 0.696                  | 0.742                |
| 13           | 5          | 802.11a 6Mbps              | Front         | 0.5      | 60     | 5300        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.19            | 0.691                  | 0.736                |
| 16           | 5          | 802.11a 6Mbps              | Back          | 0.5      | 60     | 5300        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.05            | 0.641                  | 0.683                |
| 38           | 5          | 802.11a 6Mbps              | Left Site     | 0.5      | 60     | 5300        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.07            | 0.151                  | 0.161                |
| 42           | 5          | 802.11a 6Mbps              | Right Site    | 0.5      | 60     | 5300        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.18            | 0.208                  | 0.222                |
| 46           | 5          | 802.11a 6Mbps              | Top Site      | 0.5      | 60     | 5300        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.14            | 0.109                  | 0.116                |
| 50           | 5          | 802.11a 6Mbps              | Bottom Site   | 0.5      | 60     | 5300        | 1+2   | 16.91               | 17.00               | 1.021                  | 95.83          | 1.044                     | -0.18            | 0.529                  | 0.564                |
| 30           | 5          | 802.11ac (VHT80) MCS0/Nss1 | Front         | 0.5      | 58     | 5290        | 1+2   | 16.94               | 17.00               | 1.014                  | 95.10          | 1.052                     | 0.06             | 0.731                  | 0.779                |
| 14           | 5          | 802.11a 6Mbps              | Front         | 0.5      | 116    | 5580        | 1+2   | 16.24               | 16.50               | 1.062                  | 95.83          | 1.044                     | -0.16            | 0.692                  | 0.767                |
| 17           | 5          | 802.11a 6Mbps              | Back          | 0.5      | 116    | 5580        | 1+2   | 16.24               | 16.50               | 1.062                  | 95.83          | 1.044                     | -0.17            | 0.597                  | 0.661                |
| 39           | 5          | 802.11a 6Mbps              | Left Site     | 0.5      | 116    | 5580        | 1+2   | 16.24               | 16.50               | 1.062                  | 95.83          | 1.044                     | 0.13             | 0.113                  | 0.125                |
| 43           | 5          | 802.11a 6Mbps              | Right Site    | 0.5      | 116    | 5580        | 1+2   | 16.24               | 16.50               | 1.062                  | 95.83          | 1.044                     | -0.14            | 0.196                  | 0.217                |
| 47           | 5          | 802.11a 6Mbps              | Top Site      | 0.5      | 116    | 5580        | 1+2   | 16.24               | 16.50               | 1.062                  | 95.83          | 1.044                     | 0.04             | 0.084                  | 0.093                |
| 51           | 5          | 802.11a 6Mbps              | Bottom Site   | 0.5      | 116    | 5580        | 1+2   | 16.24               | 16.50               | 1.062                  | 95.83          | 1.044                     | -0.10            | 0.323                  | 0.358                |
| 31           | 5          | 802.11a 6Mbps              | Front         | 0.5      | 104    | 5520        | 1+2   | 16.11               | 16.50               | 1.094                  | 95.83          | 1.044                     | -0.06            | 0.632                  | 0.721                |
| 32           | 5          | 802.11a 6Mbps              | Front         | 0.5      | 124    | 5620        | 1+2   | 16.11               | 16.50               | 1.094                  | 95.83          | 1.044                     | -0.13            | 0.617                  | 0.704                |
| 33           | 5          | 802.11a 6Mbps              | Front         | 0.5      | 136    | 5680        | 1+2   | 16.13               | 16.50               | 1.089                  | 95.83          | 1.044                     | -0.17            | 0.639                  | 0.726                |
| 35           | 5          | 802.11ac (VHT80) MCS0/Nss1 | Front         | 0.5      | 106    | 5530        | 1+2   | 16.41               | 16.50               | 1.021                  | 95.10          | 1.052                     | -0.15            | 0.646                  | 0.694                |
| 15           | 5          | 802.11a 6Mbps              | Front         | 0.5      | 157    | 5785        | 1+2   | 16.92               | 17.00               | 1.019                  | 95.83          | 1.044                     | -0.14            | 0.696                  | 0.740                |
| 18           | 5          | 802.11a 6Mbps              | Back          | 0.5      | 157    | 5785        | 1+2   | 16.92               | 17.00               | 1.019                  | 95.83          | 1.044                     | -0.05            | 0.668                  | 0.710                |
| 36           | 5          | 802.11a 6Mbps              | Left Site     | 0.5      | 157    | 5785        | 1+2   | 16.92               | 17.00               | 1.019                  | 95.83          | 1.044                     | 0.11             | 0.136                  | 0.145                |
| 40           | 5          | 802.11a 6Mbps              | Right Site    | 0.5      | CH1 57 | 5785        | 1+2   | 16.92               | 17.00               | 1.019                  | 95.83          | 1.044                     | -0.12            | 0.178                  | 0.189                |
| 44           | 5          | 802.11a 6Mbps              | Top Site      | 0.5      | 157    | 5785        | 1+2   | 16.92               | 17.00               | 1.019                  | 95.83          | 1.044                     | -0.06            | 0.116                  | 0.123                |
| 48           | 5          | 802.11a 6Mbps              | Bottom Site   | 0.5      | 157    | 5785        | 1+2   | 16.92               | 17.00               | 1.019                  | 95.83          | 1.044                     | -0.01            | 0.292                  | 0.310                |
| 22           | 5          | 802.11ac VHT80 MCS0 Nss1   | Front         | 0.5      | 155    | 5775        | 1+2   | 16.39               | 16.50               | 1.026                  | 95.10          | 1.052                     | -0.05            | 0.671                  | 0.724                |

## 9.2 Highest SAR Plot

### WLAN 2.4GHz

Test Laboratory: Sporton International Inc SAR Testing Lab

Date: 2014/08/19

**P01 802.11b\_Front\_0.5cm\_CH6**

**DUT: 473142**

Communication System: WLAN 2.4GHz ; Frequency: 2437 MHz; Duty Cycle: 1:1  
Medium: B2450\_140818 Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.935$  S/m;  $\epsilon_r = 50.666$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
**Ambient Temperature:** 21.9 °C ; **Liquid Temperature:** 22.1 °C

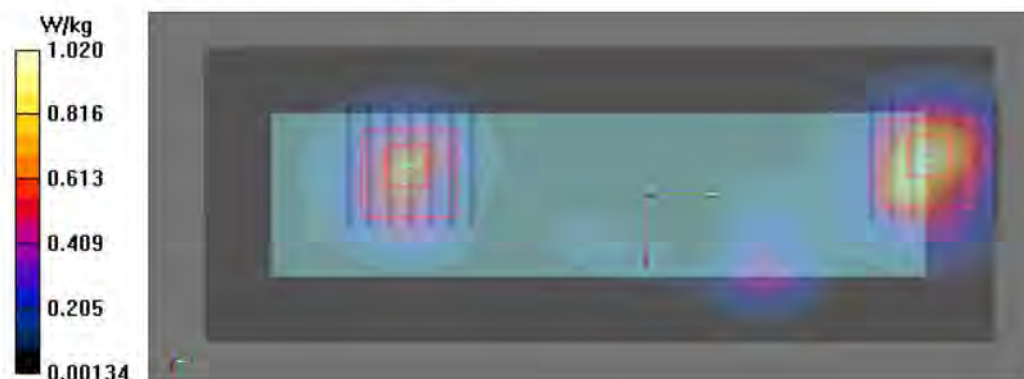
DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(7.6, 7.6, 7.6); Calibrated: 2013/12/09;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1386; Calibrated: 2013/12/02
- Phantom: ELI v4.0 right; Type: QDOVA001BB; Serial: TP:1232
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/CH6/Area Scan (61x161x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm  
Maximum value of SAR (interpolated) = 1.02 W/kg

**Configuration/CH6/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 22.58 V/m; Power Drift = -0.10 dB  
Peak SAR (extrapolated) = 1.26 W/kg  
**SAR(1 g) = 0.653 W/kg; SAR(10 g) = 0.319 W/kg**  
Maximum value of SAR (measured) = 0.966 W/kg

**Configuration/CH6/Zoom Scan (7x7x7)/Cube 1:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 22.58 V/m; Power Drift = -0.10 dB  
Peak SAR (extrapolated) = 0.832 W/kg  
**SAR(1 g) = 0.431 W/kg; SAR(10 g) = 0.215 W/kg**  
Maximum value of SAR (measured) = 0.625 W/kg



**WLAN 5GHz Band1**

Test Laboratory: Sporton International Inc SAR Testing Lab

Date: 2014/08/20

**P11 802.11a\_Front\_0.5cm\_CH40**

**DUT: 473142**

Communication System: WLAN 5GHz ; Frequency: 5200 MHz; Duty Cycle: 1:1  
Medium: B5G\_140818 Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.427$  S/m;  $\epsilon_r = 46.895$ ;  $\rho = 1000$  kg/m<sup>3</sup>

**Ambient Temperature:** 21.9 °C ; **Liquid Temperature:** 22.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.55, 4.55, 4.55); Calibrated: 2013/12/09;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1386; Calibrated: 2013/12/02
- Phantom: ELI v4.0 front; Type: QDOVA001BB; Serial: TP:1233
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/CH40/Area Scan (61x201x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.64 W/kg

**Configuration/CH40/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 18.91 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 2.50 W/kg

**SAR(1 g) = 0.712 W/kg; SAR(10 g) = 0.237 W/kg**

Maximum value of SAR (measured) = 1.64 W/kg



## WLAN 5GHz Band2

Test Laboratory: Sporton International Inc SAR Testing Lab

Date: 2014/08/26

**P30 802.11ac\_VHT80\_MCS0\_Front\_0.5cm\_CH58**

**DUT: 473142**

Communication System: WLAN 5GHz ; Frequency: 5290 MHz; Duty Cycle: 1:1  
Medium: B5G\_140825 Medium parameters used:  $f = 5290$  MHz;  $\sigma = 5.565$  S/m;  $\epsilon_r = 47.259$ ;  $\rho = 1000$  kg/m<sup>3</sup>

**Ambient Temperature: 22.2 °C ; Liquid Temperature: 22.1 °C**

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.55, 4.55, 4.55); Calibrated: 2013/12/09;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1386; Calibrated: 2013/12/02
- Phantom: ELI v4.0 front; Type: QDOVA001BB; Serial: TP:1233
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/CH58/Area Scan (61x201x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.66 W/kg

**Configuration/CH58/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 19.06 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 2.62 W/kg

**SAR(1 g) = 0.731 W/kg; SAR(10 g) = 0.236 W/kg**

Maximum value of SAR (measured) = 1.70 W/kg

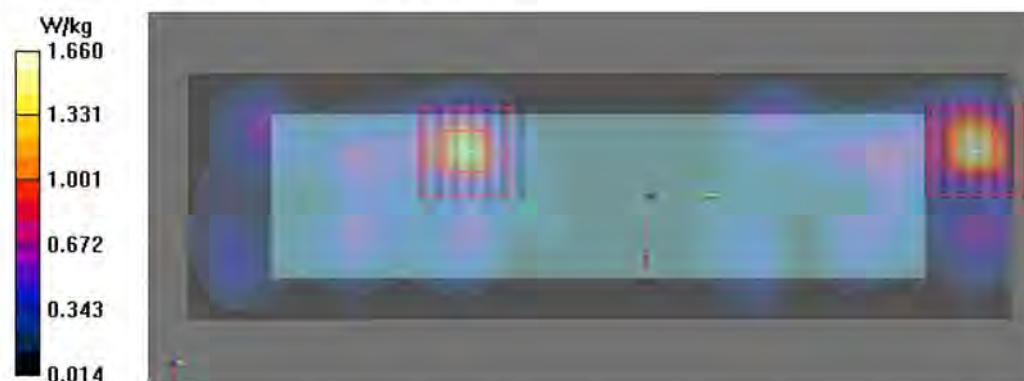
**Configuration/CH58/Zoom Scan (7x7x7)/Cube 1:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 19.06 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 2.42 W/kg

**SAR(1 g) = 0.657 W/kg; SAR(10 g) = 0.215 W/kg**

Maximum value of SAR (measured) = 1.53 W/kg



**WLAN 5GHz Band3**

Test Laboratory: Sporton International Inc SAR Testing Lab

Date: 2014/08/22

**P14 802.11a\_Front\_0.5cm\_CH116**

**DUT: 473142**

Communication System: WLAN 5GHz ; Frequency: 5580 MHz; Duty Cycle: 1:1  
 Medium: B5G\_140821 Medium parameters used:  $f = 5580 \text{ MHz}$ ;  $\sigma = 5.919 \text{ S/m}$ ;  $\epsilon_r = 46.844$ ;  $\rho = 1000 \text{ kg/m}^3$   
**Ambient Temperature: 22.1 °C ; Liquid Temperature: 22.3 °C**

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(3.91, 3.91, 3.91); Calibrated: 2013/12/09;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1386; Calibrated: 2013/12/02
- Phantom: ELI v4.0 front; Type: QDOVA001BB; Serial: TP:1233
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/CH116/Area Scan (61x201x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 1.70 W/kg

**Configuration/CH116/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 18.48 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 2.78 W/kg

**SAR(1 g) = 0.692 W/kg; SAR(10 g) = 0.220 W/kg**

Maximum value of SAR (measured) = 1.67 W/kg

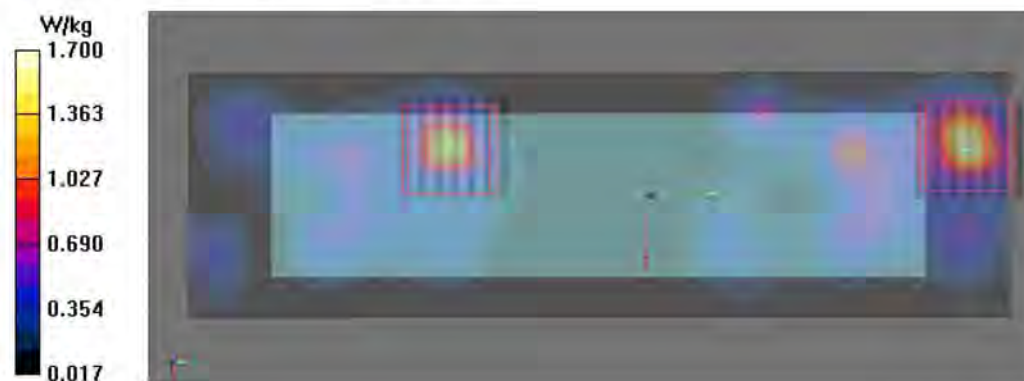
**Configuration/CH116/Zoom Scan (7x7x7)/Cube 1:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 18.48 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 2.19 W/kg

**SAR(1 g) = 0.553 W/kg; SAR(10 g) = 0.180 W/kg**

Maximum value of SAR (measured) = 1.33 W/kg



WLAN 5GHz Band4

Test Laboratory: Sporton International Inc SAR Testing Lab

Date: 2014/08/22

**P15 802.11a\_Front\_0.5cm\_CH157**

**DUT: 473142**

Communication System: WLAN 5GHz ; Frequency: 5785 MHz; Duty Cycle: 1:1

Medium: B5G\_140821 Medium parameters used:  $f = 5785$  MHz;  $\sigma = 6.201$  S/m;  $\epsilon_r = 46.531$ ;  $\rho = 1000$  kg/m<sup>3</sup>

**Ambient Temperature:** 22.1 °C ; **Liquid Temperature:** 22.3 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.15, 4.15, 4.15); Calibrated: 2013/12/09;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1386; Calibrated: 2013/12/02
- Phantom: ELI v4.0 front; Type: QDOVA001BB; Serial: TP:1233
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/CH157/Area Scan (61x201x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.64 W/kg

**Configuration/CH157/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 18.56 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 2.75 W/kg

**SAR(1 g) = 0.696 W/kg; SAR(10 g) = 0.220 W/kg**

Maximum value of SAR (measured) = 1.64 W/kg

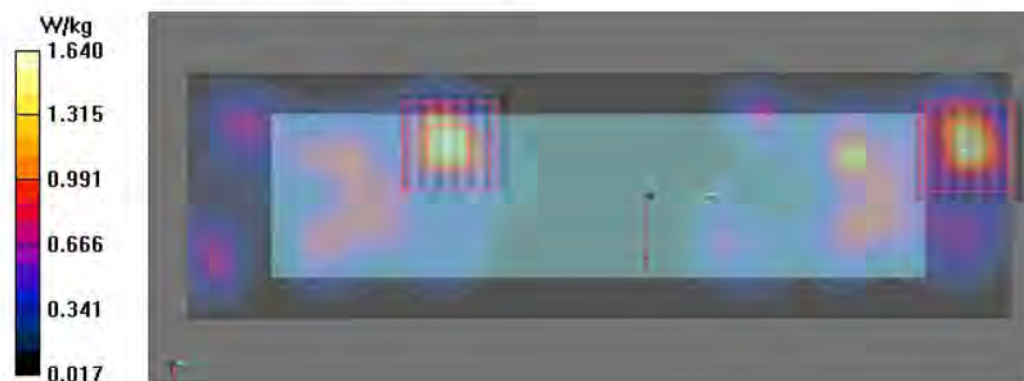
**Configuration/CH157/Zoom Scan (7x7x7)/Cube 1:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 18.56 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 2.72 W/kg

**SAR(1 g) = 0.702 W/kg; SAR(10 g) = 0.223 W/kg**

Maximum value of SAR (measured) = 1.67 W/kg





### 9.3 Enhanced Energy Coupling

| Enhanced Energy Coupling |             |                   |    |                     |                     |                        |                             |                          |                |
|--------------------------|-------------|-------------------|----|---------------------|---------------------|------------------------|-----------------------------|--------------------------|----------------|
| Exposure Position        | Band        | Antenna-to-person |    | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Measured Peak SAR 1g (W/kg) | Peak Reported SAR (W/kg) | Percent Change |
|                          |             | Distance (mm)     |    |                     |                     |                        |                             |                          |                |
| Front                    | WLAN 2.4GHz | Initial           | 5  | 17.2                | 17.5                | 1.072                  | 0.774                       | 0.829                    | -              |
|                          |             | Step 1            | 10 | 17.2                | 17.5                | 1.072                  | 0.352                       | 0.377                    | -54.52         |
| Back                     | WLAN 2.4GHz | Initial           | 5  | 17.2                | 17.5                | 1.072                  | 0.751                       | 0.805                    | -              |
|                          |             | Step 1            | 10 | 17.2                | 17.5                | 1.072                  | 0.363                       | 0.389                    | -51.66         |
| Left Side                | WLAN 2.4GHz | Initial           | 5  | 17.2                | 17.5                | 1.072                  | 0.062                       | 0.066                    | -              |
|                          |             | Step 1            | 10 | 17.2                | 17.5                | 1.072                  | 0.019                       | 0.020                    | -69.35         |
| Right Side               | WLAN 2.4GHz | Initial           | 5  | 17.2                | 17.5                | 1.072                  | 0.227                       | 0.243                    | -              |
|                          |             | Step 1            | 10 | 17.2                | 17.5                | 1.072                  | 0.163                       | 0.175                    | -28.19         |
|                          |             | Step 2            | 15 | 17.2                | 17.5                | 1.072                  | 0.095                       | 0.102                    | -58.15         |
| Top Side                 | WLAN 2.4GHz | Initial           | 5  | 17.2                | 17.5                | 1.072                  | 0.158                       | 0.169                    | -              |
|                          |             | Step 1            | 10 | 17.2                | 17.5                | 1.072                  | 0.054                       | 0.058                    | -65.82         |
| Bottom Side              | WLAN 2.4GHz | Initial           | 5  | 17.2                | 17.5                | 1.072                  | 0.604                       | 0.647                    | -              |
|                          |             | Step 1            | 10 | 17.2                | 17.5                | 1.072                  | 0.291                       | 0.312                    | -51.82         |

| Enhanced Energy Coupling |                  |                   |    |                     |                     |                        |                             |                          |                |
|--------------------------|------------------|-------------------|----|---------------------|---------------------|------------------------|-----------------------------|--------------------------|----------------|
| Exposure Position        | Band             | Antenna-to-person |    | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Measured Peak SAR 1g (W/kg) | Peak Reported SAR (W/kg) | Percent Change |
|                          |                  | Distance (mm)     |    |                     |                     |                        |                             |                          |                |
| Front                    | WLAN 5GHz Band 2 | Initial           | 5  | 16.94               | 17                  | 1.014                  | 0.822                       | 0.833                    | -              |
|                          |                  | Step 1            | 10 | 16.94               | 17                  | 1.014                  | 0.391                       | 0.396                    | -52.43         |
| Back                     | WLAN 5GHz Band 2 | Initial           | 5  | 16.91               | 17                  | 1.014                  | 0.764                       | 0.775                    | -              |
|                          |                  | Step 1            | 10 | 16.91               | 17                  | 1.014                  | 0.366                       | 0.371                    | -52.09         |
| Left Side                | WLAN 5GHz Band 2 | Initial           | 5  | 16.91               | 17                  | 1.014                  | 0.287                       | 0.291                    | -              |
|                          |                  | Step 1            | 10 | 16.91               | 17                  | 1.014                  | 0.119                       | 0.121                    | -58.54         |
| Right Side               | WLAN 5GHz Band 2 | Initial           | 5  | 16.91               | 17                  | 1.014                  | 0.383                       | 0.388                    | -              |
|                          |                  | Step 1            | 10 | 16.91               | 17                  | 1.014                  | 0.168                       | 0.170                    | -56.14         |
| Top Side                 | WLAN 5GHz Band 2 | Initial           | 5  | 16.91               | 17                  | 1.014                  | 0.281                       | 0.285                    | -              |
|                          |                  | Step 1            | 10 | 16.91               | 17                  | 1.014                  | 0.108                       | 0.110                    | -61.57         |
| Bottom Side              | WLAN 5GHz Band 2 | Initial           | 5  | 16.91               | 17                  | 1.014                  | 0.637                       | 0.646                    | -              |
|                          |                  | Step 1            | 10 | 16.91               | 17                  | 1.014                  | 0.285                       | 0.289                    | -55.26         |

Note:

1. Pre FCC KDB 447498 D01 v05r02, The probe tip distance to the phantom should be positioned at a distance of half the probe tip diameter, rounded to the nearest mm.
2. Percent Change = [Measured Peak Reported SAR - Initial Peak Reported SAR] / Initial Peak Reported SAR \*100%
3. Pre FCC KDB 447498 D01 v05r02, when there is more than 15% variation in the single-point measurements at each position, more measurements are required to ensure a representative high range value is recorded. The highest of the single-point SAR values, adjusted for tune-up tolerance, should be reported for each position. When the highest measured single point SAR among all positions is 25% greater than that measured with the device positioned at Initial from the phantom, a complete 1-g SAR evaluation is required for that test configuration at the device position producing the highest single-point SAR.

## 10 Simultaneous Transmission Analysis

| No. | Simultaneous Transmission Configurations | Body |
|-----|------------------------------------------|------|
| 1   | Bluetooth+ WLAN 2.4GHz                   | Yes  |
| 2   | Bluetooth+ WLAN 5GHz                     | Yes  |

Note:

- The Scaled SAR summation is calculated based on the same configuration and test position.
- Per FCC KDB 447498 D01 v05r02, simultaneous transmission SAR is compliant if,
  - Scalar SAR summation  $< 1.6 \text{ W/kg}$ .
  - $\text{SPLSR} = (\text{SAR}_1 + \text{SAR}_2)^{1.5} / (\text{min. separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$ , where  $(x_1, y_1, z_1)$  and  $(x_2, y_2, z_2)$  are the coordinates of the extrapolated peak SAR locations in the zoom scan. If  $\text{SPLSR} \leq 0.04$ , simultaneously transmission SAR measurement is not necessary.
  - Simultaneously transmission SAR measurement, and the reported multi-band SAR  $< 1.6 \text{ W/kg}$ .
- For simultaneous transmission analysis, Bluetooth SAR is estimated per FCC KDB 447498 D01 v05r02 based on the formula below.
  - $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})/x}] \text{ W/kg}$  for test separation distances  $\leq 50 \text{ mm}$ ; where  $x = 7.5$  for 1-g SAR, and  $x = 18.75$  for 10-g SAR.
  - $0.4 \text{ W/kg}$  for 1-g SAR and  $1.0 \text{ W/kg}$  for 10-g SAR, when the test separation distances is  $> 50 \text{ mm}$ .

| Max Power (dBm) | Exposure Position Test Separation | Body 5 mm  |
|-----------------|-----------------------------------|------------|
| -0.07           | Antenna to user distance          | 5 mm       |
|                 | Estimated SAR (W/kg)              | 0.053 W/kg |

## 10.1 Body Exposure Conditions

| Body Exposure Conditions |                   |         |            |                      |                   |
|--------------------------|-------------------|---------|------------|----------------------|-------------------|
| Position                 | WLAN              |         |            | Bluetooth            | Summed SAR (W/kg) |
|                          | Band              | Plot No | SAR (W/kg) | Estimated SAR (W/kg) |                   |
| Front                    | WLAN 2.4 GHz      | 1       | 0.733      | 0.053                | <b>0.786</b>      |
|                          | WLAN 5 GHz Band 1 | 11      | 0.759      | 0.053                | <b>0.812</b>      |
|                          | WLAN 5 GHz Band 2 | 30      | 0.779      | 0.053                | <b>0.832</b>      |
|                          | WLAN 5 GHz Band 3 | 14      | 0.767      | 0.053                | <b>0.820</b>      |
|                          | WLAN 5 GHz Band 4 | 15      | 0.740      | 0.053                | <b>0.793</b>      |
| Back                     | WLAN 2.4 GHz      | 2       | 0.699      | 0.053                | <b>0.752</b>      |
|                          | WLAN 5 GHz Band 1 | 12      | 0.645      | 0.053                | <b>0.698</b>      |
|                          | WLAN 5 GHz Band 2 | 16      | 0.683      | 0.053                | <b>0.736</b>      |
|                          | WLAN 5 GHz Band 3 | 17      | 0.661      | 0.053                | <b>0.714</b>      |
|                          | WLAN 5 GHz Band 4 | 18      | 0.710      | 0.053                | <b>0.763</b>      |
| Left Side                | WLAN 2.4 GHz      | 3       | 0.067      | 0.053                | <b>0.120</b>      |
|                          | WLAN 5 GHz Band 1 | 37      | 0.141      | 0.053                | <b>0.194</b>      |
|                          | WLAN 5 GHz Band 2 | 38      | 0.161      | 0.053                | <b>0.214</b>      |
|                          | WLAN 5 GHz Band 3 | 39      | 0.125      | 0.053                | <b>0.178</b>      |
|                          | WLAN 5 GHz Band 4 | 36      | 0.145      | 0.053                | <b>0.198</b>      |
| Right Side               | WLAN 2.4 GHz      | 4       | 0.164      | 0.053                | <b>0.217</b>      |
|                          | WLAN 5 GHz Band 1 | 41      | 0.234      | 0.053                | <b>0.287</b>      |
|                          | WLAN 5 GHz Band 2 | 42      | 0.222      | 0.053                | <b>0.275</b>      |
|                          | WLAN 5 GHz Band 3 | 43      | 0.217      | 0.053                | <b>0.270</b>      |
|                          | WLAN 5 GHz Band 4 | 40      | 0.189      | 0.053                | <b>0.242</b>      |
| Top Side                 | WLAN 2.4 GHz      | 5       | 0.011      | 0.053                | <b>0.064</b>      |
|                          | WLAN 5 GHz Band 1 | 45      | 0.085      | 0.053                | <b>0.138</b>      |
|                          | WLAN 5 GHz Band 2 | 46      | 0.116      | 0.053                | <b>0.169</b>      |
|                          | WLAN 5 GHz Band 3 | 47      | 0.093      | 0.053                | <b>0.146</b>      |
|                          | WLAN 5 GHz Band 4 | 44      | 0.123      | 0.053                | <b>0.176</b>      |
| Bottom Side              | WLAN 2.4 GHz      | 6       | 0.511      | 0.053                | <b>0.564</b>      |
|                          | WLAN 5 GHz Band 1 | 49      | 0.464      | 0.053                | <b>0.517</b>      |
|                          | WLAN 5 GHz Band 2 | 50      | 0.564      | 0.053                | <b>0.617</b>      |
|                          | WLAN 5 GHz Band 3 | 51      | 0.358      | 0.053                | <b>0.411</b>      |
|                          | WLAN 5 GHz Band 4 | 48      | 0.310      | 0.053                | <b>0.363</b>      |

## 11 Test Equipment and Calibration Data

| Instrument                       | Manufacturer                      | Model No.           | Serial No. | Characteristics | Calibration Date | Remark   |
|----------------------------------|-----------------------------------|---------------------|------------|-----------------|------------------|----------|
| 2450MHz System<br>Validation Kit | SPEAG                             | D2450V2             | 926        | 300MHz~3GHz     | Dec. 3, 2013     | SAR01-CB |
| 5GHz System<br>Validation Kit    | SPEAG                             | D5GHzV2             | 1167       | 3GHz~6GHz       | Dec. 11, 2013    | SAR01-CB |
| Data Acquisition<br>Electronics  | SPEAG                             | DAE4                | 1386       | -               | Dec. 2, 2013     | SAR01-CB |
| Dosimetric<br>E-Field Probe      | SPEAG                             | EX3DV4              | 3958       | 30MHz~6GHz      | Dec. 9, 2013     | SAR01-CB |
| Device Holder                    | SPEAG                             | N/A                 | N/A        | N/A             | N.C.R.           | SAR01-CB |
| Dielectric Probe<br>Kit          | SPEAG                             | DAK-3.5             | 1144       | 200MHz~20GHz    | Dec. 3, 2013     | SAR01-CB |
| Network<br>Analyzers             | Agilent                           | E5071C              | MY46418863 | 9kHz~6GHz       | Oct. 30, 2013    | SAR01-CB |
| Power Meter                      | Agilent                           | E4416A              | GB41991199 | 50MHz~18GHz     | Dec. 02, 2013    | SAR01-CB |
| Power Sensor                     | Agilent                           | E9327A              | US40442088 | 50MHz~18GHz     | Dec. 02, 2013    | SAR01-CB |
| Thermometer                      | HTC-1                             | HTC-1               | TM-1       | -50°C~70°C      | Jan. 16, 2014    | SAR01-CB |
| Mini-Circuits                    | Power Amplifier                   | ZVE-8G              | N/A        | 2GHz~8GHz       | Dec. 02, 2013    | SAR01-CB |
| LKM                              | Electronic Digital<br>Thermometer | DTM3000-<br>special | 3241       | -20°C..110°C    | Apr. 15, 2014    | SAR01-CB |

**Note:**

1. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
2. The calibration certificate of DASY can be referred to appendix D of this report.
3. Referring to FCC KDB 865664 D01 v01r03, the dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
4. The justification data of dipole D2450V2, SN: 926 can be found in appendix D. The return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration.
5. The dielectric probe kit was calibrated via the network analyzer, with the specified procedure (calibrated in pure water) and calibration kit (standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Agilent.
6. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized to 1W input power according to the ratio of 1W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical and we do have calibration for it
7. Calibration Interval of instruments listed above is one year.
8. NCR means Non-Calibration required.

## 12 Uncertainty Assessment

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in below table.

| Standard Uncertainty for Assumed Distribution |                            |               |               |               |
|-----------------------------------------------|----------------------------|---------------|---------------|---------------|
| Uncertainty Distributions                     | Normal                     | Rectangular   | Triangular    | U-Shape       |
| Multi-plying Factor <sup>(a)</sup>            | 1/ $\kappa$ <sup>(b)</sup> | 1/ $\sqrt{3}$ | 1/ $\sqrt{6}$ | 1/ $\sqrt{2}$ |

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity

(b)  $\kappa$  is the coverage factor

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.



| Uncertainty Budget for frequency range 0.3 MHz to 3 GHz |                        |                          |            |         |          |                           |                            |
|---------------------------------------------------------|------------------------|--------------------------|------------|---------|----------|---------------------------|----------------------------|
| Error Description                                       | Uncertainty Value (±%) | Probability Distribution | Divisor    | Ci (1g) | Ci (10g) | Standard Uncertainty (1g) | Standard Uncertainty (10g) |
| <b>Measurement System</b>                               |                        |                          |            |         |          |                           |                            |
| Probe Calibration                                       | 6.0                    | Normal                   | 1          | 1       | 1        | ± 6.0 %                   | ± 6.0 %                    |
| Axial Isotropy                                          | 4.7                    | Rectangular              | $\sqrt{3}$ | 0.7     | 0.7      | ± 1.9 %                   | ± 1.9 %                    |
| Hemispherical Isotropy                                  | 9.6                    | Rectangular              | $\sqrt{3}$ | 0.7     | 0.7      | ± 3.9 %                   | ± 3.9 %                    |
| Boundary Effects                                        | 1.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.6 %                   | ± 0.6 %                    |
| Linearity                                               | 4.7                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 2.7 %                   | ± 2.7 %                    |
| System Detection Limits                                 | 1.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.6 %                   | ± 0.6 %                    |
| Modulation Response                                     | 2.4                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.4 %                   | ± 1.4 %                    |
| Readout Electronics                                     | 0.3                    | Normal                   | 1          | 1       | 1        | ± 0.3 %                   | ± 0.3 %                    |
| Response Time                                           | 0.8                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.5 %                   | ± 0.5 %                    |
| Integration Time                                        | 2.6                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.5 %                   | ± 1.5 %                    |
| RF Ambient Noise                                        | 3.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.7 %                   | ± 1.7 %                    |
| RF Ambient Reflections                                  | 3.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.7 %                   | ± 1.7 %                    |
| Probe Positioner                                        | 0.4                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.2 %                   | ± 0.2 %                    |
| Probe Positioning                                       | 2.9                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.7 %                   | ± 1.7 %                    |
| Max. SAR Eval.                                          | 2.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.2 %                   | ± 1.2 %                    |
| <b>Test Sample Related</b>                              |                        |                          |            |         |          |                           |                            |
| Device Positioning                                      | 2.9                    | Normal                   | 1          | 1       | 1        | ± 2.9 %                   | ± 2.9 %                    |
| Device Holder                                           | 3.6                    | Normal                   | 1          | 1       | 1        | ± 3.6 %                   | ± 3.6 %                    |
| Power Drift                                             | 5.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 2.9 %                   | ± 2.9 %                    |
| Power Scaling                                           | 0                      | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.0 %                   | ± 0.0 %                    |
| <b>Phantom and Setup</b>                                |                        |                          |            |         |          |                           |                            |
| Phantom Uncertainty                                     | 6.1                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 3.5 %                   | ± 3.5 %                    |
| SAR correction                                          | 1.9                    | Rectangular              | $\sqrt{3}$ | 1       | 0.84     | ± 1.1 %                   | ± 0.9 %                    |
| Liquid Conductivity (Mea.)                              | 2.5                    | Rectangular              | $\sqrt{3}$ | 0.78    | 0.71     | ± 1.1 %                   | ± 1.0 %                    |
| Liquid Permittivity (Mea.)                              | 2.5                    | Rectangular              | $\sqrt{3}$ | 0.26    | 0.26     | ± 0.3 %                   | ± 0.4 %                    |
| Temp. unc. – Conductivity                               | 3.4                    | Rectangular              | $\sqrt{3}$ | 0.78    | 0.71     | ± 1.5 %                   | ± 1.4 %                    |
| Temp. unc. – Permittivity                               | 0.4                    | Rectangular              | $\sqrt{3}$ | 0.23    | 0.26     | ± 0.1 %                   | ± 0.1 %                    |
| <b>Combined Standard Uncertainty</b>                    |                        |                          |            |         |          | ± 11.2 %                  | ± 11.1 %                   |
| <b>Coverage Factor for 95 %</b>                         |                        |                          |            |         |          | K=2                       |                            |
| <b>Expanded Uncertainty</b>                             |                        |                          |            |         |          | ± 22.3 %                  | ± 22.2 %                   |



| Uncertainty Budget for frequency range 3 GHz to 6 GHz |                        |                          |            |         |          |                           |                            |
|-------------------------------------------------------|------------------------|--------------------------|------------|---------|----------|---------------------------|----------------------------|
| Error Description                                     | Uncertainty Value (±%) | Probability Distribution | Divisor    | Ci (1g) | Ci (10g) | Standard Uncertainty (1g) | Standard Uncertainty (10g) |
| <b>Measurement System</b>                             |                        |                          |            |         |          |                           |                            |
| Probe Calibration                                     | 6.55                   | Normal                   | 1          | 1       | 1        | ± 6.55 %                  | ± 6.55 %                   |
| Axial Isotropy                                        | 4.7                    | Rectangular              | $\sqrt{3}$ | 0.7     | 0.7      | ± 1.9 %                   | ± 1.9 %                    |
| Hemispherical Isotropy                                | 9.6                    | Rectangular              | $\sqrt{3}$ | 0.7     | 0.7      | ± 3.9 %                   | ± 3.9 %                    |
| Boundary Effects                                      | 2.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.2 %                   | ± 1.2 %                    |
| Linearity                                             | 4.7                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 2.7 %                   | ± 2.7 %                    |
| System Detection Limits                               | 1.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.6 %                   | ± 0.6 %                    |
| Modulation Response                                   | 2.4                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.4 %                   | ± 1.4 %                    |
| Readout Electronics                                   | 0.3                    | Normal                   | 1          | 1       | 1        | ± 0.3 %                   | ± 0.3 %                    |
| Response Time                                         | 0.8                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.5 %                   | ± 0.5 %                    |
| Integration Time                                      | 2.6                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.5 %                   | ± 1.5 %                    |
| RF Ambient Noise                                      | 3.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.7 %                   | ± 1.7 %                    |
| RF Ambient Reflections                                | 3.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 1.7 %                   | ± 1.7 %                    |
| Probe Positioner                                      | 0.8                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.5 %                   | ± 0.5 %                    |
| Probe Positioning                                     | 6.7                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 3.9 %                   | ± 3.9 %                    |
| Max. SAR Eval.                                        | 4.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 2.3 %                   | ± 2.3 %                    |
| <b>Test Sample Related</b>                            |                        |                          |            |         |          |                           |                            |
| Device Positioning                                    | 2.9                    | Normal                   | 1          | 1       | 1        | ± 2.9 %                   | ± 2.9 %                    |
| Device Holder                                         | 3.6                    | Normal                   | 1          | 1       | 1        | ± 3.6 %                   | ± 3.6 %                    |
| Power Drift                                           | 5.0                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 2.9 %                   | ± 2.9 %                    |
| Power Scaling                                         | 0                      | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 0.0 %                   | ± 0.0 %                    |
| <b>Phantom and Setup</b>                              |                        |                          |            |         |          |                           |                            |
| Phantom Uncertainty                                   | 6.6                    | Rectangular              | $\sqrt{3}$ | 1       | 1        | ± 3.8 %                   | ± 3.8 %                    |
| SAR correction                                        | 1.9                    | Rectangular              | $\sqrt{3}$ | 1       | 0.84     | ± 1.1 %                   | ± 0.9 %                    |
| Liquid Conductivity (Mea.)                            | 2.5                    | Rectangular              | $\sqrt{3}$ | 0.78    | 0.71     | ± 1.1 %                   | ± 1.0 %                    |
| Liquid Permittivity (Mea.)                            | 2.5                    | Rectangular              | $\sqrt{3}$ | 0.26    | 0.26     | ± 0.3 %                   | ± 0.4 %                    |
| Temp. unc. – Conductivity                             | 3.4                    | Rectangular              | $\sqrt{3}$ | 0.78    | 0.71     | ± 1.5 %                   | ± 1.4 %                    |
| Temp. unc. – Permittivity                             | 0.4                    | Rectangular              | $\sqrt{3}$ | 0.23    | 0.26     | ± 0.1 %                   | ± 0.1 %                    |
| <b>Combined Standard Uncertainty</b>                  |                        |                          |            |         |          | ± 12.3 %                  | ± 12.2 %                   |
| <b>Coverage Factor for 95 %</b>                       |                        |                          |            |         |          | K=2                       |                            |
| <b>Expanded Uncertainty</b>                           |                        |                          |            |         |          | ± 24.6 %                  | ± 24.5 %                   |



## **13 References**

- [1] FCC 47 CFR Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"
- [2] ANSI/IEEE Std. C95.1-1992, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", September 1992
- [3] IEEE Std. 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- [4] SPEAG DASY System Handbook
- [5] FCC KDB 248227 D01 v01r02, "SAR Measurement Procedures for 802.11 a/b/g Transmitters", May 2007.
- [6] FCC KDB 447498 D01 v05r02, "Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies", Feb. 2014.
- [7] FCC KDB 644545 D03 v01, "GUIDANCE FOR IEEE Std 802.11ac<sup>TM</sup> DEVICES EMISSION TESTING ", Aug. 2014.