# SAR Test Report

| | | |
|---|---|---|
| **Report No.** | : | **SA190808C06B** |
| **Applicant** | : | **Qualcomm Atheros Inc.** |
| **Address** | : | **1700 Technology Drive,San Jose,CA 95110** |
| **Product** | : | **Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 Type Card** |
| **FCC ID** | : | **PPD-QCNFA435** |
| **Brand** | : | **Qualcomm Atheros** |
| **Model No.** | : | **QCNFA435** |
| **Standards** | : | **FCC 47 CFR Part 2 (2.1093), IEEE C95.1:1992, IEEE Std 1528:2013<br>KDB 865664 D01 v01r04, KDB 865664 D02 v01r02<br>KDB 248227 D01 v02r02, KDB 447498 D01 v06, KDB 616217 D04 v01r02** |
| **Sample Received Date** | : | **Jan. 09, 2020** |
| **Date of Testing** | : | **Jan. 14, 2020** |
| **Lab Address** | : | **No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan** |
| **Test Location** | : | **No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City, Taiwan** |

**CERTIFICATION:** The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch–Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

This report is issued as a supplementary report to BV CPS report no. SA190808C06. The difference compared with original report is using the Parts Number of new antenna.

**Prepared By :** Shelly Hsueh / Specialist

**Approved By :** Gordon Lin / Manager

Testing Laboratory 2021

**FCC Accredited No.: TW0003**

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# Release Control Record

| Report No. | Reason for Change | Date Issued |
|---|---|---|
| SA190808C06B | Initial release | Jan. 16, 2020 |
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# 1. Summary of Maximum SAR Value

| Equipment Class | Mode | Highest SAR-1g<br>Body<br>Tested at 0 mm<br>(W/kg) |
|---|---|---|
| DTS | 2.4G WLAN | 0.28 |
| NII | 5.3G WLAN | 0.10 |
| | 5.6G WLAN | 0.10 |
| | 5.8G WLAN | 0.07 |
| DSS | Bluetooth | N/A |

**Note:**

1. The SAR criteria **(Head & Body: SAR-1g1.6 W/kg, and Extremity: SAR-10g 4.0 W/kg)**for general population/uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.

## 2. Description of Equipment Under Test

| | |
|---|---|
| **EUT Type** | Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 Type Card |
| **FCC ID** | PPD-QCNFA435 |
| **Brand Name** | Qualcomm Atheros |
| **Model Name** | QCNFA435 |
| **Tx Frequency Bands (Unit: MHz)** | WLAN : 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5720, 5745 ~ 5825<br>Bluetooth : 2402 ~ 2480 |
| **Uplink Modulations** | 802.11b : DSSS<br>802.11a/g/n/ac : OFDM<br>Bluetooth : GFSK, π/4-DQPSK, 8-DPSK |
| **Maximum Tune-up Conducted Power (Unit: dBm)** | Please refer to section 4.6.1 of this report |
| **Antenna Type** | PIFA Antenna |
| **EUT Stage** | Engineering Sample |

**Note:**

1. This report is issued as a supplementary report to BV CPS report no. SA190808C06. The difference compared with original report is using the Parts Number of new antenna.
2. The EUT was installed in a specific End-product.

| Equipment Name | Brand Name | Model Name | Difference |
|---|---|---|---|
| Notebook Computer | Lenovo | Lenovo ThinkBook 14-IML | Test model |
| | | 20RV, Lenovo ThinkBook 14-I *******<br>("*"= 0-9, A-Z, "/", or blank for Marketing purpose only ) | Series model |
| All models are electrically identical, different models are for marketing purpose. | | | |

3. The antenna information is listed as below.

| Antenna Type | Manufacturer | Parts Number | Antenna Gain (dBi) | | | |
|---|---|---|---|---|---|---|
| | | | BT / WLAN 2.4 GHz | WLAN 5.15~5.35 GHz | WLAN 5.47~5.725 GHz | WLAN 5.725~5.85 GHz |
| PIFA | Wistron Neweb Corporation | Main/TX1 Antenna: DQ6615G4700 (81EAA615.G47)<br>Aux/TX2 Antenna: DQ6615G4700 (81EAA615.G47) | TX1: 0.93<br>TX2: 0.69 | TX1: 1.68<br>TX2: 1.52 | TX1: 1.33<br>TX2: 1.54 | TX1: 1.35<br>TX2: 1.86 |

4. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

# 3. SAR Measurement System

## 3.1 Definition of Specific Absorption Rate (SAR)

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.

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:

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

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

SAR measurement can be related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

## 3.2 SPEAG DASY6 System

DASY6 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY6 software defined. The DASY6 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

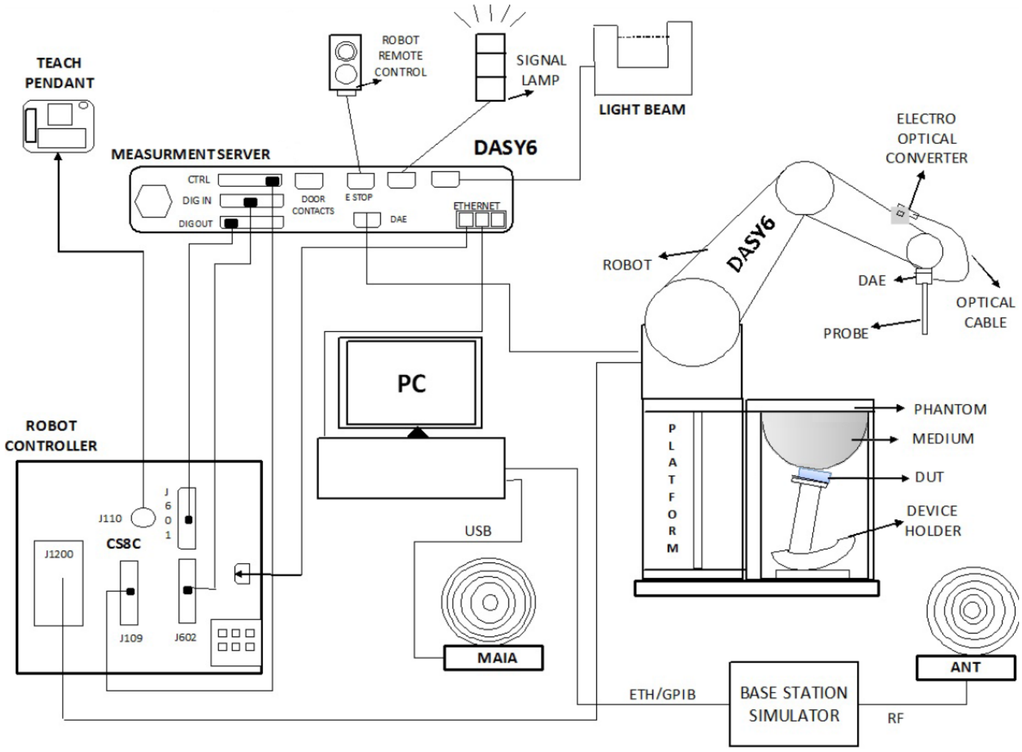



**Fig-3.1 SPEAG DASY6 System Setup**

### 3.2.1 Robot

The DASY6 systems use the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version of CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

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


**Fig-3.2 SPEAG DASY6 System**

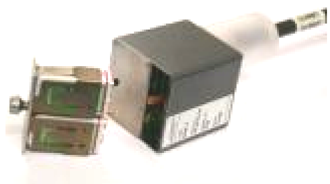
### 3.2.2 Probes

The SAR measurement is conducted with the dosimetric probe. 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.

| | |
|---|---|
| **Model** | EX3DV4 |
| **Construction** | Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). |
| **Frequency** | 4 MHz to 10 GHz<br>Linearity: ± 0.2 dB |
| **Directivity** | ± 0.1 dB in TSL (rotation around probe axis)<br>± 0.3 dB in TSL (rotation normal to probe axis) |
| **Dynamic Range** | 10 µW/g to 100 mW/g<br>Linearity: ± 0.2 dB (noise: typically < 1 µW/g) |
| **Dimensions** | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm |

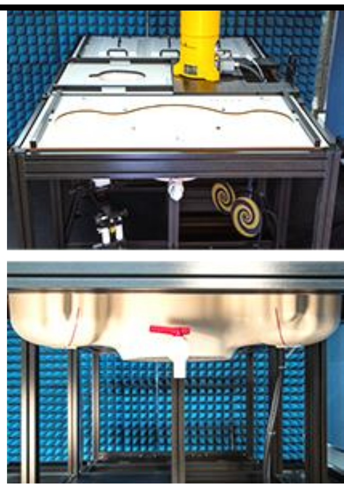
### 3.2.3 Data Acquisition Electronics (DAE)

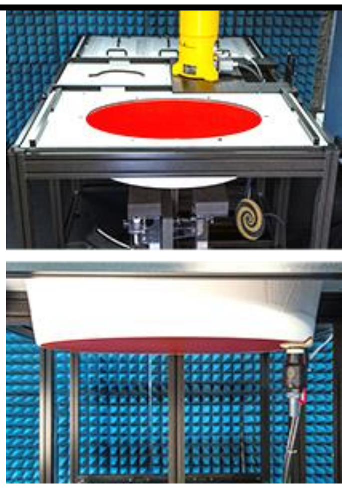
| | |
|---|---|
| **Model** | DAE3, DAE4 |
| **Construction** | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. |
| **Measurement Range** | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) |
| **Input Offset Voltage** | < 5µV (with auto zero) |
| **Input Bias Current** | < 50 fA |
| **Dimensions** | 60 x 60 x 68 mm |



### 3.2.4 Phantoms

| | |
|---|---|
| **Model** | SAM-Twin Phantom |
| **Construction** | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE Std 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body-mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. |
| **Material** | Vinylester, fiberglass reinforced (VE-GF) |
| **Shell Thickness** | 2 ± 0.2 mm (6 ± 0.2 mm at ear point) |
| **Dimensions** | Length: 1000 mm<br>Width: 500 mm<br>Height: adjustable feet |
| **Filling Volume** | approx. 25 liters |



<table>
<tr><td>Model</td><td>ELI</td><td rowspan="6"></td></tr>
<tr><td>Construction</td><td>The ELI phantom is used for compliance testing of handheld and body-mounted wireless devices. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.</td></tr>
<tr><td>Material</td><td>Vinylester, fiberglass reinforced (VE-GF)</td></tr>
<tr><td>Shell Thickness</td><td>2.0 ± 0.2 mm (bottom plate)</td></tr>
<tr><td>Dimensions</td><td>Major axis: 600 mm<br>Minor axis: 400 mm</td></tr>
<tr><td>Filling Volume</td><td>approx. 30 liters</td></tr>
</table>

### 3.2.5 Device Holder

<table>
<tr><td>Model</td><td>MD4HHTV5 - Mounting Device for Hand-Held Transmitters</td><td rowspan="3"></td></tr>
<tr><td>Construction</td><td>In combination with the Twin SAM or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).</td></tr>
<tr><td>Material</td><td>Polyoxymethylene (POM)</td></tr>
</table>

<table>
<tr><td>Model</td><td>MDA4WTV5 - Mounting Device Adaptor for Ultra Wide Transmitters</td><td rowspan="3"></td></tr>
<tr><td>Construction</td><td>An upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.</td></tr>
<tr><td>Material</td><td>Polyoxymethylene (POM)</td></tr>
</table>

<table>
<tr><td>Model</td><td>MDA4SPV6 - Mounting Device Adaptor for Smart Phones</td><td rowspan="3"></td></tr>
<tr><td>Construction</td><td>The solid low-density MDA4SPV6 adaptor assuring no impact on the DUT radiation performance and is conform with any DUT design and shape.</td></tr>
<tr><td>Material</td><td>ROHACELL</td></tr>
</table>

| | | |
|---|---|---|
| **Model** | MD4LAPV5 - Mounting Device for Laptops and other Body-Worn Transmitters |  |
| **Construction** | In combination with the Twin SAM or ELI phantoms, the Mounting Device (Body-Worn) enables testing of transmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at a flat phantom section. | |
| **Material** | Polyoxymethylene (POM), PET-G, Foam | |

### 3.2.6 System Validation Dipoles

| | | |
|---|---|---|
| **Model** | D-Serial |  |
| **Construction** | Symmetrical dipole with l/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions. | |
| **Frequency** | 750 MHz to 5800 MHz | |
| **Return Loss** | > 20 dB | |
| **Power Capability** | > 100 W (f < 1GHz), > 40 W (f > 1GHz) | |

### 3.2.7 Power Source

| | | |
|---|---|---|
| **Model** | Powersource1 |  |
| **Signal Type** | Continuous Wave | |
| **Operating Frequencies** | 600 MHz to 5850 MHz | |
| **Output Power** | -5.0 dBm to +17.0 dBm | |
| **Power Supply** | 5V DC, via USB jack | |
| **Power Consumption** | <3 W | |
| **Applications** | System performance check and validation with a CW signal. | |

### 3.2.8 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 10 % are listed in Table-3.1.

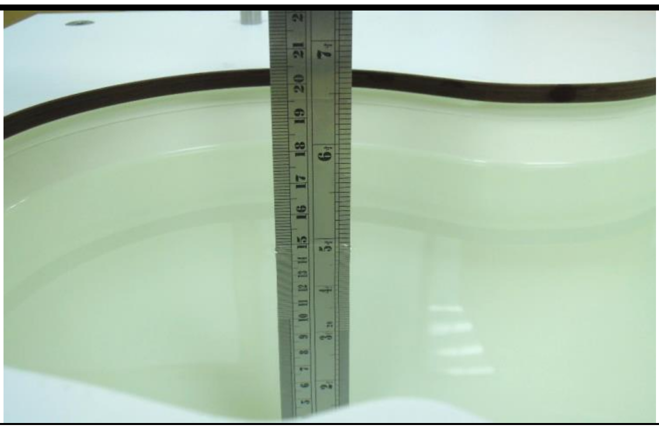


**Photo of Liquid Height for Head Position**

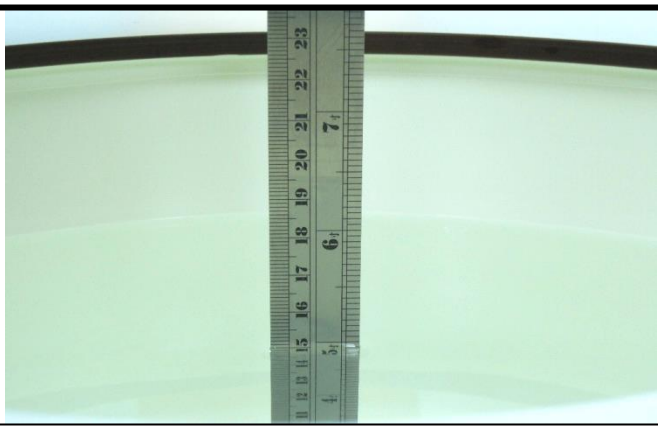


**Photo of Liquid Height for Body Position**

**Table-3.1 Targets of Tissue Simulating Liquid**

| Frequency (MHz) | Target Permittivity | Range of ±10 % | Target Conductivity | Range of ±10 % |
|---|---|---|---|---|
| 450 | 43.5 | 39.2 ~ 47.9 | 0.87 | 0.78 ~ 0.96 |
| 750 | 41.9 | 37.7 ~ 46.1 | 0.89 | 0.80 ~ 0.98 |
| 835 | 41.5 | 37.4 ~ 45.7 | 0.90 | 0.81 ~ 0.99 |
| 900 | 41.5 | 37.4 ~ 45.7 | 0.97 | 0.87 ~ 1.07 |
| 1450 | 40.5 | 36.5 ~ 44.6 | 1.20 | 1.08 ~ 1.32 |
| 1500 | 40.4 | 36.4 ~ 44.4 | 1.23 | 1.11 ~ 1.35 |
| 1640 | 40.2 | 36.2 ~ 44.2 | 1.31 | 1.18 ~ 1.44 |
| 1750 | 40.1 | 36.1 ~ 44.1 | 1.37 | 1.23 ~ 1.51 |
| 1800 | 40.0 | 36.0 ~ 44.0 | 1.40 | 1.26 ~ 1.54 |
| 1900 | 40.0 | 36.0 ~ 44.0 | 1.40 | 1.26 ~ 1.54 |
| 2000 | 40.0 | 36.0 ~ 44.0 | 1.40 | 1.26 ~ 1.54 |
| 2100 | 39.8 | 35.8 ~ 43.8 | 1.49 | 1.34 ~ 1.64 |
| 2300 | 39.5 | 35.6 ~ 43.5 | 1.67 | 1.50 ~ 1.84 |
| 2450 | 39.2 | 35.3 ~ 43.1 | 1.80 | 1.62 ~ 1.98 |
| 2600 | 39.0 | 35.1 ~ 42.9 | 1.96 | 1.76 ~ 2.16 |
| 3000 | 38.5 | 34.7 ~ 42.4 | 2.40 | 2.16 ~ 2.64 |
| 3500 | 37.9 | 34.1 ~ 41.7 | 2.91 | 2.62 ~ 3.20 |
| 4000 | 37.4 | 33.7 ~ 41.1 | 3.43 | 3.09 ~ 3.77 |
| 4500 | 36.8 | 33.1 ~ 40.5 | 3.94 | 3.55 ~ 4.33 |
| 5000 | 36.2 | 32.6 ~ 39.8 | 4.45 | 4.01 ~ 4.90 |
| 5200 | 36.0 | 32.4 ~ 39.6 | 4.66 | 4.19 ~ 5.13 |
| 5400 | 35.8 | 32.2 ~ 39.4 | 4.86 | 4.37 ~ 5.35 |
| 5600 | 35.5 | 32.0 ~ 39.1 | 5.07 | 4.56 ~ 5.58 |
| 5800 | 35.3 | 31.8 ~ 38.8 | 5.27 | 4.74 ~ 5.80 |
| 6000 | 35.1 | 31.6 ~ 38.6 | 5.48 | 4.93 ~ 6.03 |

The dielectric properties of the tissue simulating liquids are defined in IEC 62209-1 and IEC 62209-2. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

Since the range of ±10 % of the required target values is used to measure relative permittivity and conductivity, the SAR correction procedure is applied to correct measured SAR for the deviations in permittivity and conductivity. Only positive correction has been used to scale up the measured SAR, and SAR result would not be corrected if the correction △SAR has a negative sign.

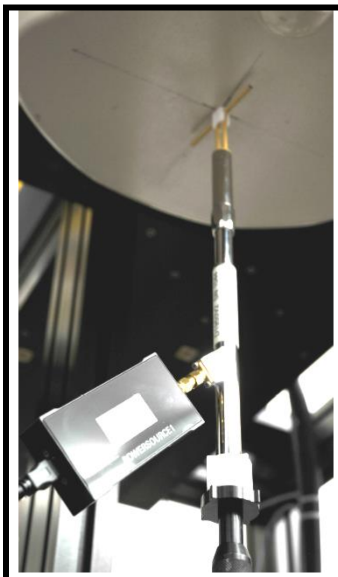
The following table gives the recipes for tissue simulating liquids.

**Table-3.2 Recipes of Tissue Simulating Liquid**

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|---|---|---|---|---|---|---|---|---|
| H750 | 0.2 | - | 0.2 | 1.5 | 56.0 | - | 42.1 | - |
| H835 | 0.2 | - | 0.2 | 1.5 | 57.0 | - | 41.1 | - |
| H900 | 0.2 | - | 0.2 | 1.4 | 58.0 | - | 40.2 | - |
| H1450 | - | 43.3 | - | 0.6 | - | - | 56.1 | - |
| H1640 | - | 45.8 | - | 0.5 | - | - | 53.7 | - |
| H1750 | - | 47.0 | - | 0.4 | - | - | 52.6 | - |
| H1800 | - | 44.5 | - | 0.3 | - | - | 55.2 | - |
| H1900 | - | 44.5 | - | 0.2 | - | - | 55.3 | - |
| H2000 | - | 44.5 | - | 0.1 | - | - | 55.4 | - |
| H2300 | - | 44.9 | - | 0.1 | - | - | 55.0 | - |
| H2450 | - | 45.0 | - | 0.1 | - | - | 54.9 | - |
| H2600 | - | 45.1 | - | 0.1 | - | - | 54.8 | - |
| H3500 | - | 8.0 | - | 0.2 | - | 20.0 | 71.8 | - |
| H5G | - | - | - | - | - | 17.2 | 65.5 | 17.3 |

## 3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.



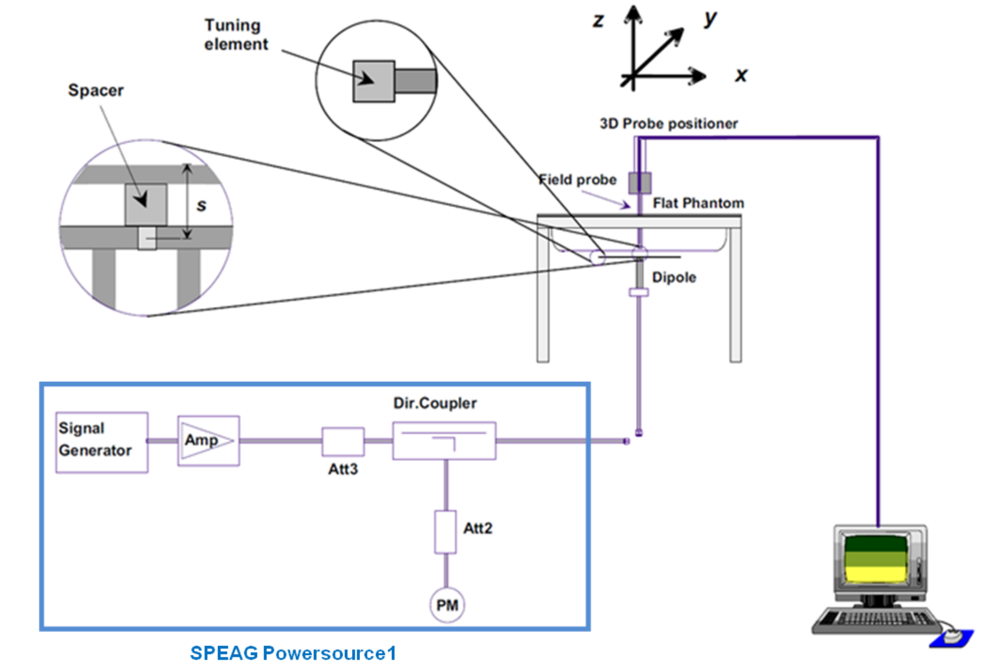



**Fig-3.3 System Verification Setup**

The SPEAG Powersource1 is a portable and very stable RF source providing a continuous wave (CW) signal. It is designed for conducting SAR system checks and SAR system validation of DASY and is compatible with IEC 62209-1, IEC 62209-2 and IEEE Std 1528 standards. The Powersource1 has been calibrated by SPEAG's ISO/IEC 17025-accredited calibration center. When using Powersource1, the setup can be simplified, as shown in Fig-3.3. The signal purity is warranted by design. Since the Powersource1 is calibrated, no additional equipment is needed and the Powersource1 can directly be connected to the SMA connector of the dipole without a cable as all separate components (signal generator, amplifier, coupler and power meter) are built into the unit.

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The Powersource1 is adjusted for the desired forward power of 17 dBm at the dipole connector and the RF output power would be turned on. After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

## 3.4 SAR Measurement Procedure

According to the SAR 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

The SAR measurement procedures for each of test conditions are as follows:

(a) Make EUT to transmit maximum output power
(b) Measure conducted output power through RF cable
(c) Place the EUT in the specific position of phantom
(d) Perform SAR testing steps on the DASY system
(e) Record the SAR value

### 3.4.1 Area Scan and Zoom Scan Procedure

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.

Measure the local SAR at a test point at 1.4 mm of the inner surface of the phantom recommended by SEPAG. The area scan (two-dimensional SAR distribution) is performed cover at least an area larger than the projection of the EUT or antenna. The measurement resolution and spatial resolution for interpolation shall be chosen to allow identification of the local peak locations to within one-half of the linear dimension of the corresponding side of the zoom scan volume. Following table provides the measurement parameters required for the area scan.

| Parameter | $f \leqq$ 3 GHz | 3 GHz < $f \leqq$ 6 GHz |
|---|---|---|
| Maximum distance from closest measurement point to phantom surface | 5 ± 1 | $\delta$ ln(2)/2 ±0.5 |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | 30° ±1° | 20° ±1° |
| Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$ | ≦2 GHz: ≦15 mm<br>2 – 3 GHz: ≦12 mm | 3 – 4 GHz: ≦12 mm<br>4 – 6 GHz: ≦10 mm |

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks. Additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g. 1 W/kg for 1.6 W/kg, 1 g limit; or 1.26 W/kg for 2 W/kg, 10 g limit).

The zoom scan (three-dimensional SAR distribution) is performed at the local maxima locations identified in previous area scan procedure. The zoom scan volume must be larger than the required minimum dimensions. When graded grids are used, which only applies in the direction normal to the phantom surface, the initial grid separation closest to the phantom surface and subsequent graded grid increment ratios must satisfy the required protocols. The 1-g SAR averaging volume must be fully contained within the zoom scan measurement volume boundaries; otherwise, the measurement must be repeated by shifting or expanding the zoom scan volume. The similar requirements also apply to 10-g SAR measurements. Following table provides the measurement parameters required for the zoom scan.

| Parameter | | *f* ≦ 3 GHz | 3 GHz < *f* ≦ 6 GHz |
|---|---|---|---|
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | ≦2 GHz: ≦8 mm<br>2 – 3 GHz: ≦5 mm | 3 – 4 GHz: ≦5 mm<br>4 – 6 GHz: ≦4 mm |
| Maximum zoom scan spatial resolution, normal to phantom surface | *uniform grid:* $\Delta z_{Zoom}(n)$ | ≦5 mm | 3 – 4 GHz: ≦4 mm<br>4 – 5 GHz: ≦3 mm<br>5 – 6 GHz: ≦2 mm |
| | *graded grids:* $\Delta z_{Zoom}(1)$ | ≦4 mm | 3 – 4 GHz: ≦3.0 mm<br>4 – 5 GHz: ≦2.5 mm<br>5 – 6 GHz: ≦2.0 mm |
| | $\Delta z_{Zoom}(n>1)$ | ≦1.5·$\Delta z_{Zoom}(n-1)$ mm | |
| Minimum zoom scan volume (x, y, z) | | ≥30 mm | 3 – 4 GHz: ≥28 mm<br>4 – 5 GHz: ≥25 mm<br>5 – 6 GHz: ≥22 mm |

Per IEC 62209-2 AMD1, the successively higher resolution zoom scan is required if the zoom scan measured as defined above complies with both of the following criteria, or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed:

(1) The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal grid steps in both x and y directions (Δx, Δy). This shall be checked for the measured zoom scan plane conformal to the phantom at the distance zM1.

(2) The ratio of the SAR at the second measured point (M2) to the SAR at the closest measured point (M1) at the x-y location of the measured maximum SAR value shall be at least 30 %.

If one or both of the above criteria are not met, the zoom scan measurement shall be repeated using a finer resolution. New horizontal and vertical grid steps shall be determined from the measured SAR distribution so that the above criteria are met. Compliance with the above two criteria shall be demonstrated for the new measured zoom scan.

### 3.4.2 Volume Scan Procedure

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.

### 3.4.3 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 drift more than 5%, the SAR will be retested.

### 3.4.4 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:

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

### 3.4.5 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.

# 4. SAR Measurement Evaluation

## 4.1 EUT Configuration and Setting

**<Considerations Related to WLAN for Setup and Testing>**

In general, various vendor specific external test software and chipset based internal test modes are typically used for SAR measurement. These chipset based test mode utilities are generally hardware and manufacturer dependent, and often include substantial flexibility to reconfigure or reprogram a device. A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

According to KDB 248227 D01,this device has installed WLAN engineering testing software which can provide continuous transmitting RF signal. During WLAN SAR testing, this device was operated to transmit continuously at the maximum transmission duty with specified transmission mode, operating frequency, lowest data rate, and maximum output power.

**Initial Test Configuration**

An initial test configuration is determined for OFDM transmission modes in 2.4 GHz and 5 GHz bands according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

**Subsequent Test Configuration**

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units. Additional power measurements may be required to determine if SAR measurements are required for subsequent highest output power channels in a subsequent test configuration. When the highest reported SAR for the initial test configuration according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

### SAR Test Configuration and Channel Selection

When multiple channel bandwidth configurations in a frequency band have the same specified maximum output power, the initial test configuration is using largest channel bandwidth, lowest order modulation, lowest data rate, and lowest order 802.11 mode (i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is chosen over 802.11n).After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following.

1) The channel closest to mid-band frequency is selected for SAR measurement.

2) For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.

### Test Reduction for U-NII-1 (5.2 GHz) and U-NII-2A (5.3 GHz) Bands

For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following.

1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition).

2) When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration.

## 4.2 EUT Testing Position

This variant report is made for verification. All the worst SAR configurations specified in the original SAR report was repeated and verified to ensure the device remains compliant.

### 4.2.1 Body Exposure Conditions

For laptop PC, according to KDB 616217 D04, SAR evaluation is required for the bottom surface of the keyboard. This EUT was tested in the base of EUT directly against the flat phantom. The required minimum test separation distance for incorporating transmitters and antennas into laptop computer display is determined with the display screen opened at an angle of 90° to the keyboard compartment.

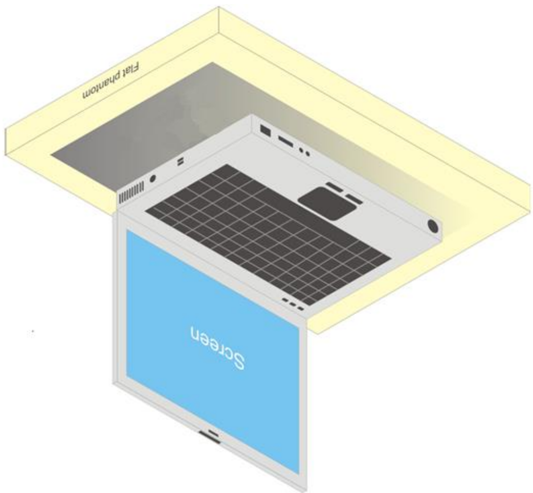



**Fig-4.1 Illustration for Laptop Setup**

### 4.2.2 SAR Test Exclusion Evaluations

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The SAR exclusion threshold is determined by the following formula.

1. For the test separation distance <= 50 mm

$$\frac{\textbf{Max. Tune up Power}_{(mW)}}{\textbf{Min. Test Separation Distance}_{(mm)}} \times \sqrt{f_{(GHz)}} \leq 3.0 \text{ for SAR-1g}, \leq 7.5 \text{ for SAR-10g}$$

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

2. For the test separation distance > 50 mm, and the frequency at 100 MHz to 1500 MHz

$$\left[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50\text{ mm}) \times \left(\frac{f_{(MHz)}}{150}\right)\right]_{(mW)}$$

3. For the test separation distance > 50 mm, and the frequency at > 1500 MHz to 6 GHz

$$[(\text{Threshold at 50 mm in Step 1}) + (\text{Test Separation Distance} - 50\text{ mm}) \times 10]_{(mW)}$$

| Mode | Max. Tune-up Power (dBm) | Max. Tune-up Power (mW) | Bottom Side | | |
|---|---|---|---|---|---|
| | | | Ant. to Surface (mm) | Calculated Result | Require SAR Testing? |
| BT | 4 | 3 | 9.6 | 0.49 | No |

**Note:**

1. When separation distance <= 50 mm and the calculated result shown in above table is <= 3.0 for SAR-1g exposure condition, or <= 7.5 for SAR-10g exposure condition, the SAR testing exclusion is applied.
2. When separation distance > 50 mm and the device output power is less than the calculated result (power threshold, mW) shown in above table, the SAR testing exclusion is applied.

## 4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

| Test Date | Frequency (MHz) | Liquid Temp. (℃) | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Target Conductivity (σ) | Target Permittivity ($\varepsilon_r$) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---|---|---|---|---|---|---|---|---|
| Jan. 14, 2020 | 2450 | 23.4 | 1.876 | 38.408 | 1.8 | 39.2 | 4.22 | -2.02 |
| Jan. 14, 2020 | 5250 | 23.4 | 4.715 | 34.907 | 4.71 | 35.9 | 0.11 | -2.77 |
| Jan. 14, 2020 | 5600 | 23.4 | 5.03 | 34.394 | 5.07 | 35.5 | -0.79 | -3.12 |
| Jan. 14, 2020 | 5750 | 23.4 | 5.175 | 34.165 | 5.22 | 35.4 | -0.86 | -3.49 |

**Note:**

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within ±5% of the target values. Liquid temperature during the SAR testing must be within ±2 ℃.

## 4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

| Test Date | Probe S/N | Calibration Point | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Validation for CW | | | Validation for Modulation | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type | Duty Factor | PAR |
| Jan. 14, 2020 | 3898 | 2450 | 1.876 | 38.408 | Pass | Pass | Pass | OFDM | N/A | Pass |
| Jan. 14, 2020 | 3898 | 5250 | 4.715 | 34.907 | Pass | Pass | Pass | OFDM | N/A | Pass |
| Jan. 14, 2020 | 3898 | 5600 | 5.03 | 34.394 | Pass | Pass | Pass | OFDM | N/A | Pass |
| Jan. 14, 2020 | 3898 | 5750 | 5.175 | 34.165 | Pass | Pass | Pass | OFDM | N/A | Pass |

## 4.5 System Verification

The measuring result for system verification is tabulated as below.

| Test Date | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N | DAE S/N |
|---|---|---|---|---|---|---|---|---|
| Jan. 14, 2020 | 2450 | 53.10 | 2.5 | 50.00 | -5.84 | 835 | 3898 | 914 |
| Jan. 14, 2020 | 5250 | 80.70 | 4.07 | 81.40 | 0.87 | 1019 | 3898 | 914 |
| Jan. 14, 2020 | 5600 | 85.80 | 4.29 | 85.80 | 0.00 | 1019 | 3898 | 914 |
| Jan. 14, 2020 | 5750 | 81.50 | 3.99 | 79.80 | -2.09 | 1019 | 3898 | 914 |

**Note:**

Comparing to the reference SAR value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

## 4.6 Maximum Output Power

### 4.6.1 Maximum Target Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

**<WLAN 2.4G>**

| Mode | Channel | Frequency (MHz) | Tune-up Power |
|---|---|---|---|
| 802.11b | 1 | 2412 | 19.0 |
| | 6 | 2437 | 19.0 |
| | 11 | 2462 | 19.0 |
| 802.11g | 1 | 2412 | 16.5 |
| | 6 | 2437 | 18.0 |
| | 11 | 2462 | 16.5 |
| 802.11n (HT20) | 1 | 2412 | 15.5 |
| | 6 | 2437 | 18.0 |
| | 11 | 2462 | 14.5 |
| 802.11n (HT40) | 3 | 2422 | 11.5 |
| | 6 | 2437 | 17.0 |
| | 9 | 2452 | 9.5 |
| 802.11ac (VHT20) | 1 | 2412 | 15.5 |
| | 6 | 2437 | 18.0 |
| | 11 | 2462 | 14.5 |
| 802.11ac (VHT40) | 3 | 2422 | 11.5 |
| | 6 | 2437 | 17.0 |
| | 9 | 2452 | 9.5 |

**<WLAN 5.2G>**

| Mode | Channel | Frequency (MHz) | Tune-up Power |
|---|---|---|---|
| 802.11a | 36 | 5180 | 13.0 |
| | 40 | 5200 | 13.0 |
| | 44 | 5220 | 13.0 |
| | 48 | 5240 | 13.0 |
| 802.11n (HT20) | 36 | 5180 | 13.0 |
| | 40 | 5200 | 13.0 |
| | 44 | 5220 | 13.0 |
| | 48 | 5240 | 13.0 |
| 802.11n (HT40) | 38 | 5190 | 9.5 |
| | 46 | 5230 | 12.5 |
| 802.11ac (VHT20) | 36 | 5180 | 13.0 |
| | 40 | 5200 | 13.0 |
| | 44 | 5220 | 13.0 |
| | 48 | 5240 | 13.0 |
| 802.11ac (VHT40) | 38 | 5190 | 9.5 |
| | 46 | 5230 | 12.5 |
| 802.11ac (VHT80) | 42 | 5210 | 8.5 |

**<WLAN 5.3G>**

| Mode | Channel | Frequency (MHz) | Tune-up Power |
|---|---|---|---|
| 802.11a | 52 | 5260 | 13.0 |
| | 56 | 5280 | 13.0 |
| | 60 | 5300 | 13.0 |
| | 64 | 5320 | 13.0 |
| 802.11n (HT20) | 52 | 5260 | 13.0 |
| | 56 | 5280 | 13.0 |
| | 60 | 5300 | 13.0 |
| | 64 | 5320 | 13.0 |
| 802.11n (HT40) | 54 | 5270 | 12.5 |
| | 62 | 5310 | 12.0 |
| 802.11ac (VHT20) | 52 | 5260 | 13.0 |
| | 56 | 5280 | 13.0 |
| | 60 | 5300 | 13.0 |
| | 64 | 5320 | 13.0 |
| 802.11ac (VHT40) | 54 | 5270 | 12.5 |
| | 62 | 5310 | 12.0 |
| 802.11ac (VHT80) | 58 | 5290 | 10.0 |

<WLAN 5.6G>

| Mode | Channel | Frequency (MHz) | Tune-up Power |
|---|---|---|---|
| 802.11a | 100 | 5500 | 13.0 |
| | 116 | 5580 | 13.0 |
| | 120 | 5600 | 13.0 |
| | 124 | 5620 | 13.0 |
| | 132 | 5660 | 13.0 |
| | 140 | 5700 | 13.0 |
| | 144 | 5720 | 13.0 |
| 802.11n (HT20) | 100 | 5500 | 13.0 |
| | 116 | 5580 | 13.0 |
| | 120 | 5600 | 13.0 |
| | 124 | 5620 | 13.0 |
| | 132 | 5660 | 13.0 |
| | 140 | 5700 | 13.0 |
| | 144 | 5720 | 13.0 |
| 802.11n (HT40) | 102 | 5510 | 9.5 |
| | 110 | 5550 | 12.5 |
| | 118 | 5590 | 12.5 |
| | 126 | 5630 | 12.5 |
| | 134 | 5670 | 12.5 |
| | 142 | 5710 | 12.5 |
| 802.11ac (VHT20) | 100 | 5500 | 13.0 |
| | 116 | 5580 | 13.0 |
| | 120 | 5600 | 13.0 |
| | 124 | 5620 | 13.0 |
| | 132 | 5660 | 13.0 |
| | 140 | 5700 | 13.0 |
| | 144 | 5720 | 13.0 |
| 802.11ac (VHT40) | 102 | 5510 | 9.5 |
| | 110 | 5550 | 12.5 |
| | 118 | 5590 | 12.5 |
| | 126 | 5630 | 12.5 |
| | 134 | 5670 | 12.5 |
| | 142 | 5710 | 12.5 |
| 802.11ac (VHT80) | 106 | 5530 | 10.0 |
| | 122 | 5610 | 12.5 |
| | 138 | 5690 | 12.5 |

<WLAN 5.8G>

| Mode | Channel | Frequency (MHz) | Tune-up Power |
|---|---|---|---|
| 802.11a | 149 | 5745 | 13.0 |
| | 153 | 5765 | 13.0 |
| | 157 | 5785 | 13.0 |
| | 161 | 5805 | 13.0 |
| | 165 | 5825 | 13.0 |
| 802.11n (HT20) | 149 | 5745 | 13.0 |
| | 153 | 5765 | 13.0 |
| | 157 | 5785 | 13.0 |
| | 161 | 5805 | 13.0 |
| | 165 | 5825 | 13.0 |
| 802.11n (HT40) | 151 | 5755 | 10.0 |
| | 159 | 5795 | 12.5 |
| 802.11ac (VHT20) | 149 | 5745 | 13.0 |
| | 153 | 5765 | 13.0 |
| | 157 | 5785 | 13.0 |
| | 161 | 5805 | 13.0 |
| | 165 | 5825 | 13.0 |
| 802.11ac (VHT40) | 151 | 5755 | 10.0 |
| | 159 | 5795 | 12.5 |
| 802.11ac (VHT80) | 155 | 5775 | 8.0 |

<Bluetooth>

| Mode | Channel | Frequency (MHz) | Tune-up Power |
|---|---|---|---|
| Bluetooth EDR | 0 | 2402 | 4.0 |
| | 39 | 2441 | 4.0 |
| | 78 | 2480 | 4.0 |
| Bluetooth LE | 0 | 2402 | -3.0 |
| | 19 | 2440 | -3.0 |
| | 39 | 2480 | -3.0 |

### 4.6.2 Measured Conducted Power Result

The measuring conducted average power (Unit: dBm) is shown as below.

<WLAN 2.4G>

| Mode | Channel | Frequency (MHz) | Average Power |
|---|---|---|---|
| 802.11b | 1 | 2412 | 18.93 |
| | 6 | 2437 | 18.95 |
| | 11 | 2462 | 18.97 |

<WLAN 5.3G>

| Mode | Channel | Frequency (MHz) | Average Power |
|---|---|---|---|
| 802.11a | 52 | 5260 | 12.95 |
| | 56 | 5280 | 12.85 |
| | 60 | 5300 | 12.94 |
| | 64 | 5320 | 12.93 |

<WLAN 5.6G>

| Mode | Channel | Frequency (MHz) | Average Power |
|---|---|---|---|
| 802.11a | 100 | 5500 | 12.91 |
| | 116 | 5580 | 12.93 |
| | 120 | 5600 | 12.86 |
| | 124 | 5620 | 12.84 |
| | 132 | 5660 | 12.83 |
| | 140 | 5700 | 12.95 |
| | 144 | 5720 | 12.82 |

<WLAN 5.8G>

| Mode | Channel | Frequency (MHz) | Average Power |
|---|---|---|---|
| 802.11a | 149 | 5745 | 12.93 |
| | 153 | 5765 | 12.85 |
| | 157 | 5785 | 12.94 |
| | 161 | 5805 | 12.84 |
| | 165 | 5825 | 12.96 |

<Bluetooth>

| Mode | Channel | Frequency (MHz) | Average Power |
|---|---|---|---|
| Bluetooth EDR | 0 | 2402 | 3.01 |
| | 39 | 2441 | 3.12 |
| | 78 | 2480 | 3.15 |
| Bluetooth LE | 0 | 2402 | -3.75 |
| | 19 | 2440 | -3.71 |
| | 39 | 2480 | -3.77 |

## 4.7 SAR Testing Results

### 4.7.1 SAR Test Reduction Considerations

**<KDB 447498 D01, General RF Exposure Guidance>**

Testing of other required channels within the operating mode of a frequency band is not required when the reported SAR for the mid-band or highest output power channel is:

(1) ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz

(2) ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz

(3) ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

When SAR is not measured at the maximum power level allowed for production units, the measured SAR will be scaled to the maximum tune-up tolerance limit to determine compliance. The scaling factor for the tune-up power is defined as maximum tune-up limit (mW) / measured conducted power (mW). The reported SAR would be calculated by measured SAR x tune-up power scaling factor.

The SAR has been measured with highest transmission duty factor supported by the test mode tools for WLAN and/or Bluetooth. When the transmission duty factor could not achieve 100%, the reported SAR will be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up power. The scaling factor for the duty factor is defined as 100% / transmission duty cycle (%). The reported SAR would be calculated by measured SAR x tune-up power scaling factor x duty cycle scaling factor.

**<KDB 248227 D01, SAR Guidance for Wi-Fi Transmitters>**

(1) For handsets operating next to ear, hotspot mode or mini-tablet configurations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When the reported SAR of initial test position is <= 0.4 W/kg, SAR testing for remaining test positions is not required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is <= 0.8 W/kg or all test positions are measured.

(2) For WLAN 2.4 GHz, the highest measured maximum output power channel for DSSS was selected for SAR measurement. When the reported SAR is <= 0.8 W/kg, no further SAR testing is required. Otherwise, SAR is evaluated at the next highest measured output power channel. When any reported SAR is >1.2 W/kg, SAR is required for the third channel. For OFDM modes (802.11g/n),SAR is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and it is <= 1.2 W/kg.

(3) For WLAN 5GHz, the initial test configuration was selected according to the transmission mode with the highest maximum output power. When the reported SAR of initial test configuration is > 0.8 W/kg, SAR is required for the subsequent highest measured output power channel until the reported SAR result is <=1.2 W/kg or all required channels are measured. For other transmission modes, SAR is not required when the highest reported SAR for initial test configuration is adjusted by the ratio of subsequent test configuration to initial test configuration specified maximum output power and it is <= 1.2 W/kg.

### 4.7.2 SAR Results for Body Exposure Condition (Test Separation Distance is 0 mm)

| Plot No. | Band | Mode | Test Position | Ch. | Duty Cycle | Crest Factor | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | WLAN2.4G | 802.11b | Bottom | 1 | 99.00 | 1.01 | 20.00 | 18.93 | 1.28 | -0.08 | 0.216 | **0.28** |
| 02 | WLAN5.3G | 802.11a | Bottom | 64 | 95.00 | 1.05 | 13.00 | 12.93 | 1.02 | -0.09 | 0.089 | **0.10** |
| 03 | WLAN5.6G | 802.11a | Bottom | 132 | 95.00 | 1.05 | 13.00 | 12.83 | 1.04 | -0.08 | 0.092 | **0.10** |
| 04 | WLAN5.8G | 802.11a | Bottom | 149 | 95.00 | 1.05 | 13.00 | 12.93 | 1.02 | 0.07 | 0.063 | **0.07** |

### 4.7.3 Simultaneous Multi-band Transmission Evaluation

There is no simultaneous transmission configuration in this device.

**Test Engineer：** Willy Chang

# 5. Calibration of Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|
| System Validation Dipole | SPEAG | D2450V2 | 835 | Jun. 27, 2019 | 1 Year |
| System Validation Dipole | SPEAG | D5GHzV2 | 1019 | Mar. 21, 2019 | 1 Year |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3898 | Jun. 27, 2019 | 1 Year |
| Data Acquisition Electronics | SPEAG | DAE4 | 914 | Jun. 20, 2019 | 1 Year |
| Spectrum Analyzer | R&S | FSL6 | 102006 | Mar. 26, 2019 | 1 Year |
| Dielectric Assessment Kit | SPEAG | DAKS_VNA R140 | 0010917 | May. 08, 2019 | 1 Year |
| Powersource1 | SPEAG | SE_UMS_160 BA | 4010 | Aug. 21, 2019 | 1 Year |
| Thermometer | YFE | YF-160A | 130504591 | Mar. 22, 2019 | 1 Year |

# 6. Measurement Uncertainty

According to KDB 865664 D01, SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR, and ≥ 3.75 W/kg for 10-g SAR. The procedures described in IEEE Std 1528-2013should be applied. The expanded SAR measurement uncertainty must be ≤ 30%,for a confidence interval of k = 2. When the highest measured SAR within a frequency band is < 1.5 W/kg for 1-g and < 3.75 W/kg for 10-g, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. Hence, the measurement uncertainty analysis is not required in this SAR report because the test result met the condition.

# 7. Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

**Taiwan Huaya Lab:**
Add: No. 19, Huaya 2nd Rd., Guishan Dist., Taoyuan City 333, Taiwan
Tel: +886-(0)3-318-3232
Fax: +886-(0)3-211-5834

**Taiwan Linkou Lab:**
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**Taiwan Hsinchu Lab1:**
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Fax: +886-(0)2-8914-5840

**Email:** service.adt@tw.bureauveritas.com
**Web Site:** https://ee.bureauveritas.com.tw/BVInternet/Default

The road map of all our labs can be found in our web site also.

**---END---**

# Appendix A. SAR Plots of System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2020/01/14

## System Check_H2450_200114

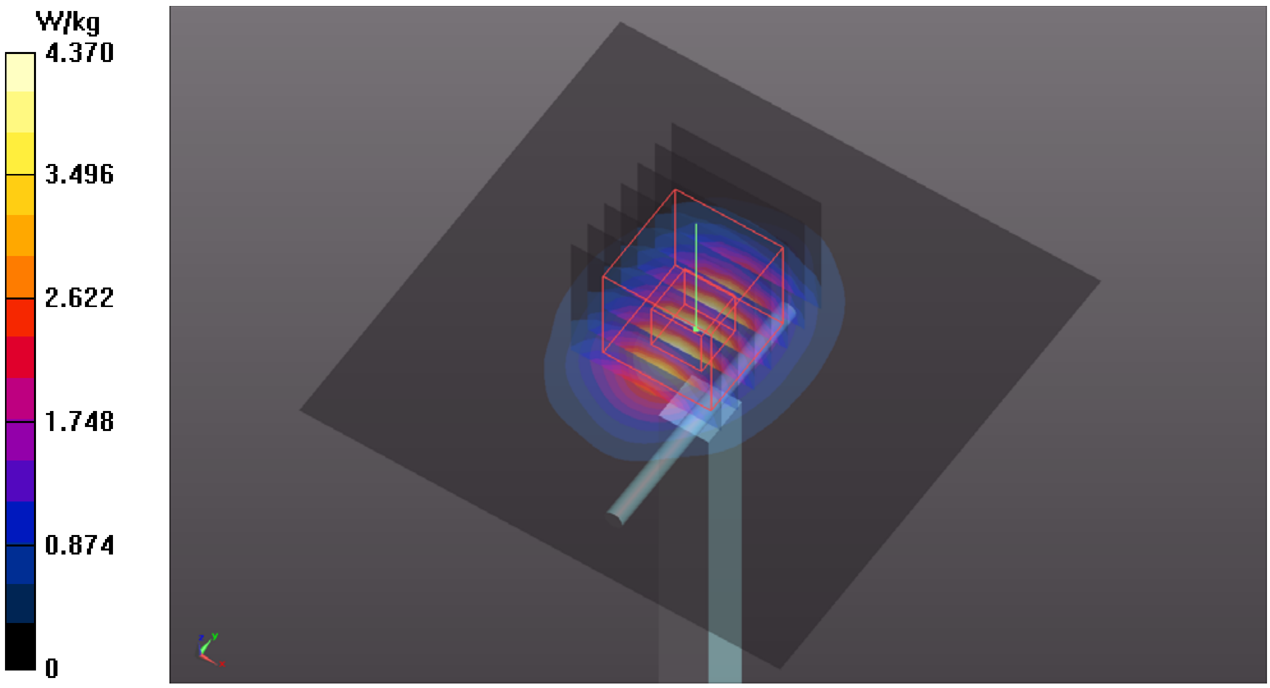
### DUT: Dipole 2450 MHz; Type: D2450V2; SN: 835

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: H19T27N2_0114 Medium parameters used: f = 2450 MHz; $\sigma$ = 1.876 S/m; $\varepsilon_r$ = 38.408; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(7.56, 7.56, 7.56); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**Pin=50mW/Area Scan (81x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 4.37 W/kg

**Pin=50mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 48.19 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 5.69 W/kg
**SAR(1 g) = 2.5 W/kg; SAR(10 g) = 1.14 W/kg** (SAR corrected for target medium)
Maximum value of SAR (measured) = 4.46 W/kg



## System Check_H5250_200114

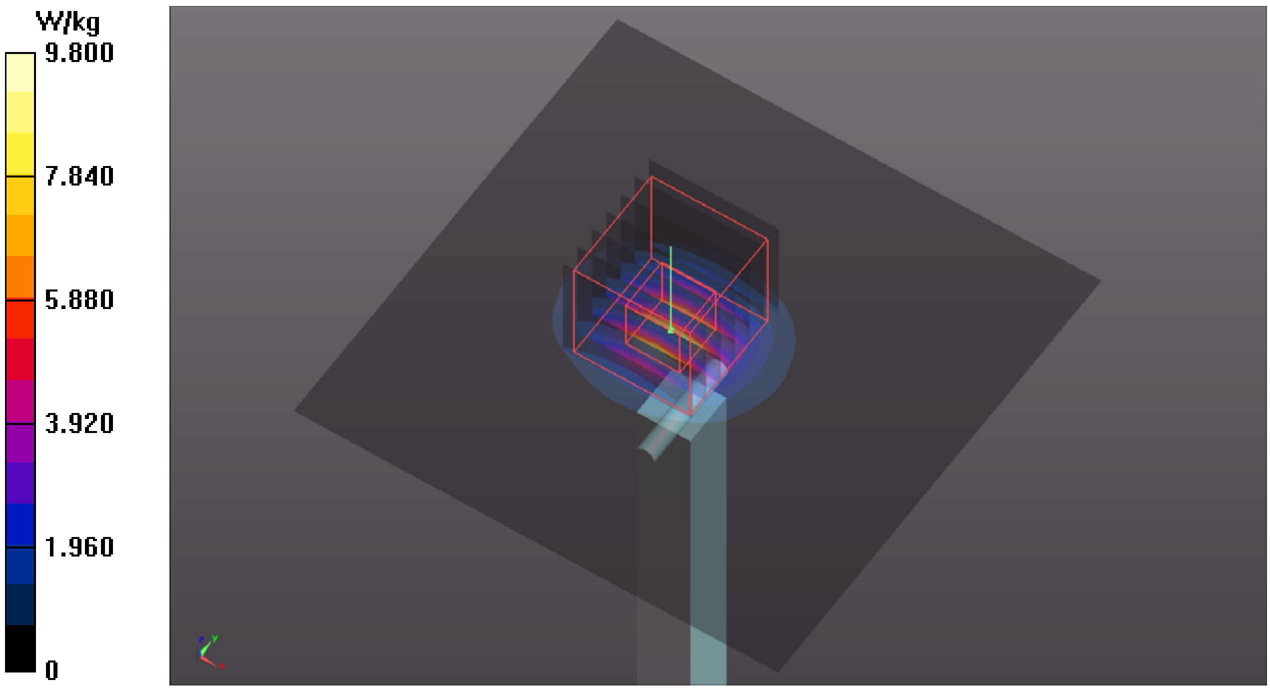
### DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5250 MHz;Duty Cycle: 1:1
Medium: H34T60N3_0114 Medium parameters used: f = 5250 MHz; $\sigma$ = 4.715 S/m; $\varepsilon_r$ = 34.907; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(5.33, 5.33, 5.33); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**Pin=50mW/Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 9.80 W/kg

**Pin=50mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 44.44 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 15.8 W/kg
**SAR(1 g) = 4.07 W/kg; SAR(10 g) = 1.19 W/kg** (SAR corrected for target medium)
Maximum value of SAR (measured) = 10.2 W/kg



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2020/01/14

## System Check_H5600_200114

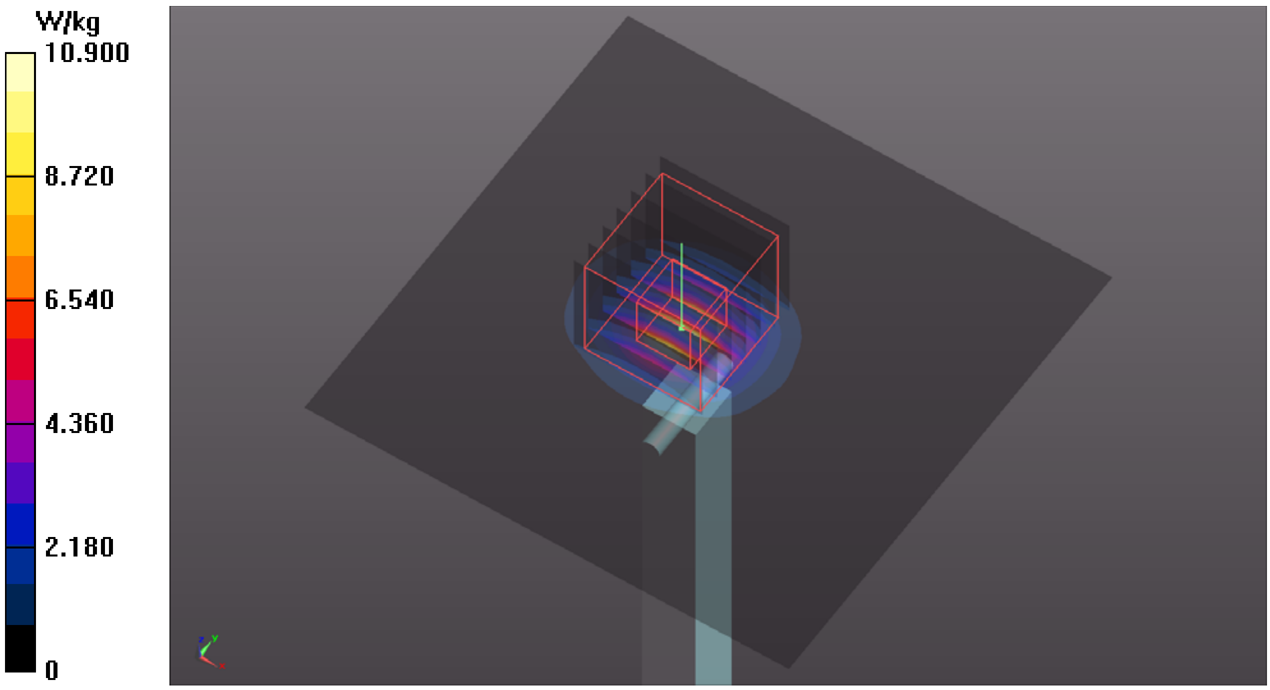
### DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019

Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1
Medium: H34T60N3_0114 Medium parameters used: f = 5600 MHz; $\sigma$ = 5.03 S/m; $\varepsilon_r$ = 34.394; $\rho$ = 1000 kg/$m^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(4.85, 4.85, 4.85); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**Pin=50mW/Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 10.9 W/kg

**Pin=50mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 45.55 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 18.3 W/kg
**SAR(1 g) = 4.29 W/kg; SAR(10 g) = 1.23 W/kg** (SAR corrected for target medium)
Maximum value of SAR (measured) = 11.1 W/kg



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2020/01/14

# System Check_H5750_200114

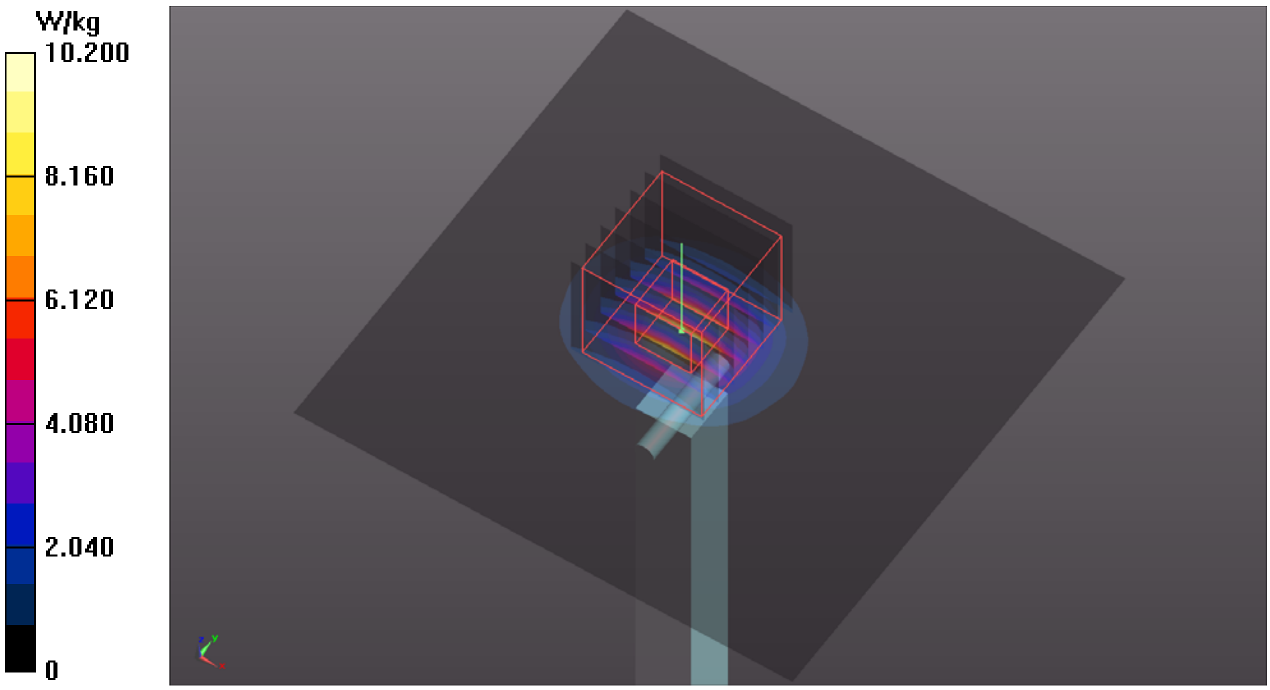
**DUT: Dipole 5 GHz; Type: D5GHzV2; SN: 1019**

Communication System: CW; Frequency: 5750 MHz;Duty Cycle: 1:1
Medium: H34T60N3_0114 Medium parameters used: f = 5750 MHz; $\sigma$ = 5.175 S/m; $\varepsilon_r$ = 34.165; $\rho$ = 1000 kg/$m^3$
Ambient Temperature：23.6 ℃；Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(4.95, 4.95, 4.95); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**Pin=50mW/Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 10.2 W/kg

**Pin=50mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 43.60 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 17.9 W/kg
**SAR(1 g) = 3.99 W/kg; SAR(10 g) = 1.15 W/kg** (SAR corrected for target medium)
Maximum value of SAR (measured) = 10.5 W/kg



# Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

## P01 WLAN2.4G_802.11b_Bottom_0mm_Ch1_Ant TX1

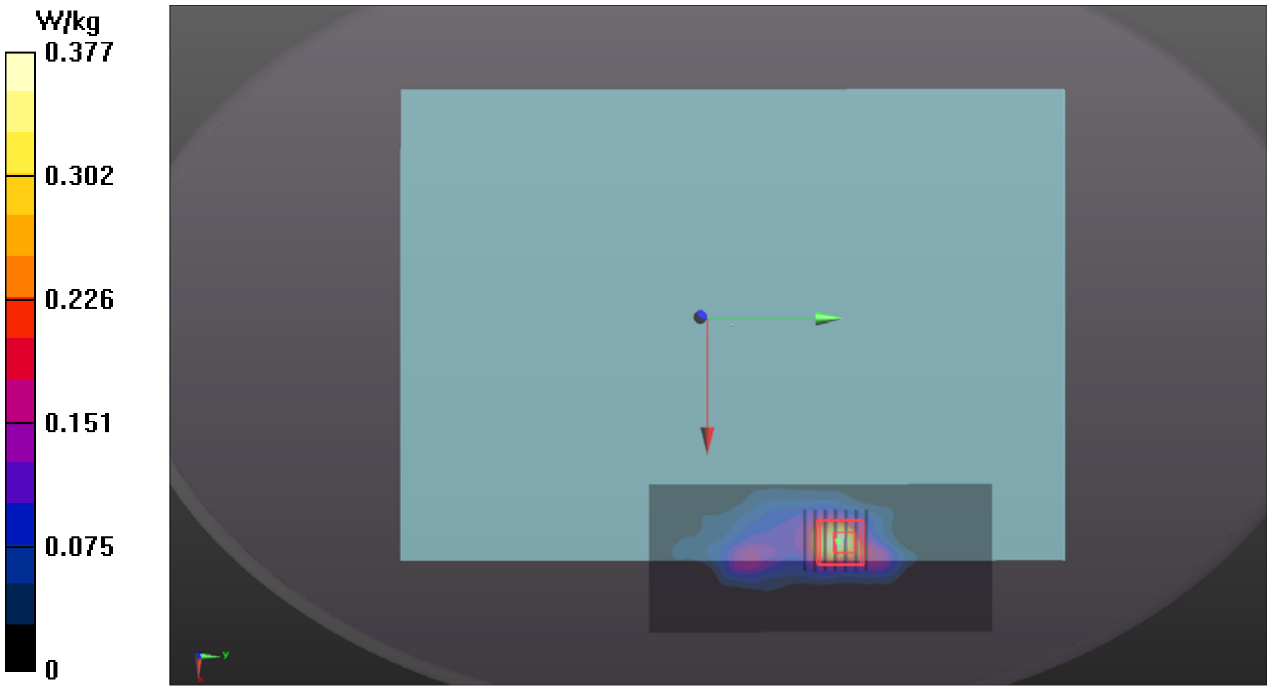
**DUT: 200109C15**

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle);
Frequency: 2412 MHz;Duty Cycle: 1:1.01
Medium: H19T27N2_0114 Medium parameters used: f = 2412 MHz; $\sigma$ = 1.839 S/m; $\varepsilon_r$ = 38.586; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(7.56, 7.56, 7.56); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**- Area Scan (61x141x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.377 W/kg

**- Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 13.80 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 0.531 W/kg
**SAR(1 g) = 0.216 W/kg; SAR(10 g) = 0.099 W/kg** (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 8.9 mm
Ratio of SAR at M2 to SAR at M1 = 40.1%
Maximum value of SAR (measured) = 0.395 W/kg



## P02 WLAN5.3G_802.11a_Bottom_0mm_Ch64_Ant TX1

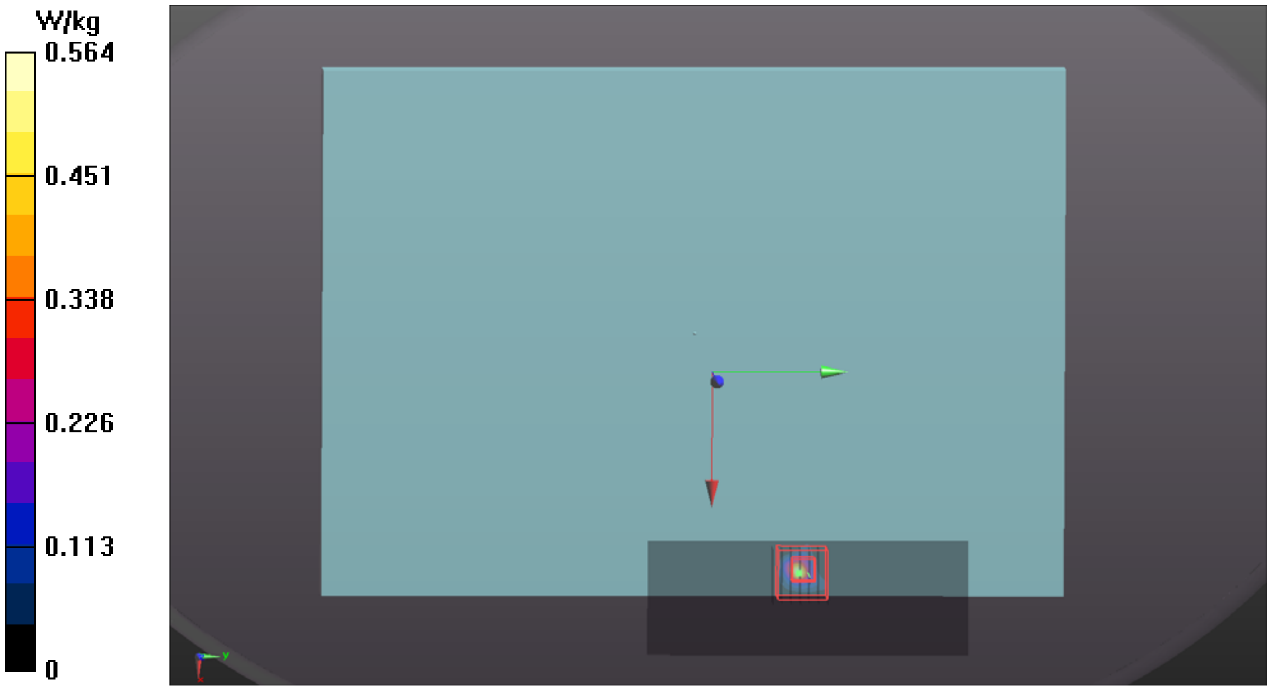
**DUT: 200109C15**

Communication System: IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle); Frequency: 5320 MHz;Duty Cycle: 1:1.05
Medium: H34T60N3_0114 Medium parameters used: f = 5320 MHz; $\sigma$ = 4.782 S/m; $\varepsilon_r$ = 34.798; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(5.33, 5.33, 5.33); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**- Area Scan (51x141x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.564 W/kg

**- Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 7.030 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.375 W/kg
**SAR(1 g) = 0.089 W/kg; SAR(10 g) = 0.029 W/kg** (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 5.4 mm
Ratio of SAR at M2 to SAR at M1 = 61.8%
Maximum value of SAR (measured) = 0.225 W/kg



# P03 WLAN5.6G_802.11a_Bottom_0mm_Ch132_Ant TX1

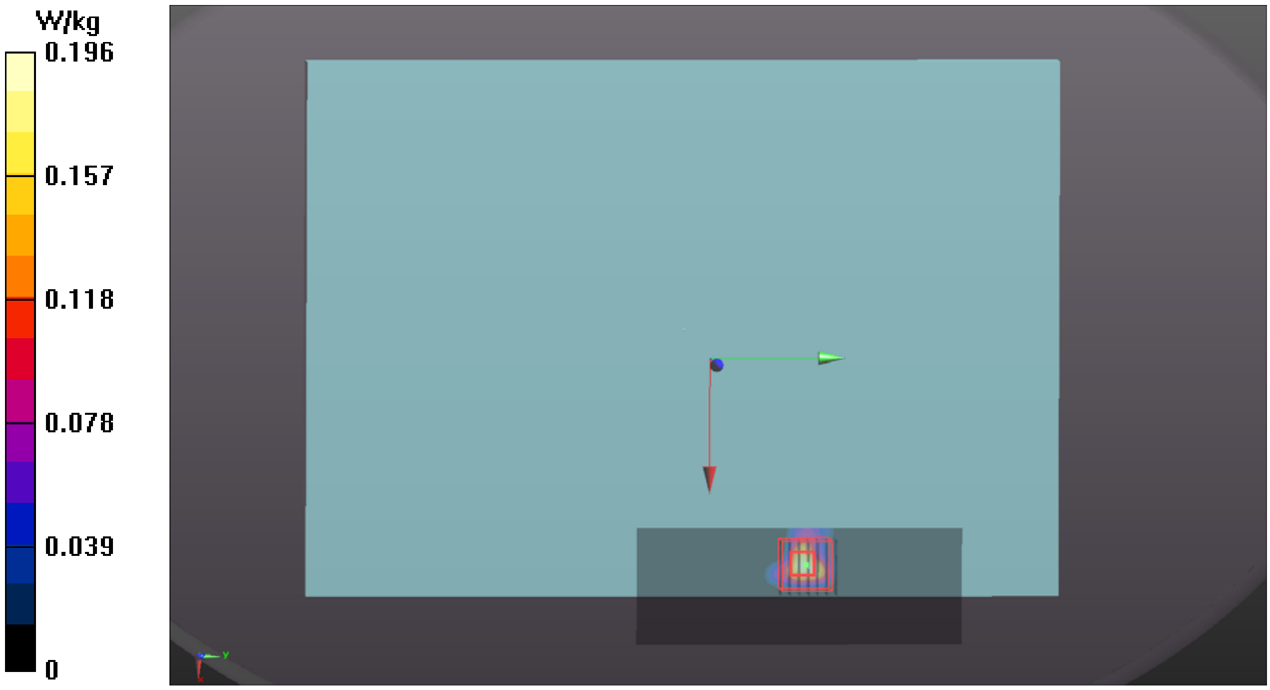
**DUT: 200109C15**

Communication System: IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle); Frequency: 5660 MHz;Duty Cycle: 1:1.05
Medium: H34T60N3_0114 Medium parameters used: f = 5660 MHz; $\sigma$ = 5.088 S/m; $\varepsilon_r$ = 34.299; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(4.85, 4.85, 4.85); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**- Area Scan (51x141x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.196 W/kg

**- Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 6.139 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 0.400 W/kg
**SAR(1 g) = 0.092 W/kg; SAR(10 g) = 0.032 W/kg** (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 5.8 mm
Ratio of SAR at M2 to SAR at M1 = 58.7%
Maximum value of SAR (measured) = 0.240 W/kg



# P04 WLAN5.8G_802.11a_Bottom_0mm_Ch149_Ant TX1

**DUT: 200109C15**

Communication System: IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle); Frequency: 5745 MHz;Duty Cycle: 1:1.05
Medium: H34T60N3_0114 Medium parameters used: f = 5745 MHz; $\sigma$ = 5.169 S/m; $\varepsilon_r$ = 34.171; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3898; ConvF(4.95, 4.95, 4.95); Calibrated: 2019/06/27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn914; Calibrated: 2019/06/20
- Phantom: ELI Phantom_1204; Type: QDOVA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**- Area Scan (51x141x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.242 W/kg

**- Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 5.888 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 0.297 W/kg
**SAR(1 g) = 0.063 W/kg; SAR(10 g) = 0.023 W/kg** (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 5.1 mm
Ratio of SAR at M2 to SAR at M1 = 58.8%
Maximum value of SAR (measured) = 0.166 W/kg