

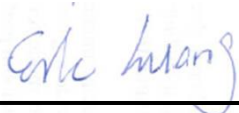
# FCC SAR Test Report

APPLICANT : Realtek Semiconductor Corp.  
EQUIPMENT : 802.11b/g/n RTL8192EE Combo module  
BRAND NAME : Realtek  
MODEL NAME : RTL8192EEBT  
FCC ID : TX2RTL8192EEBT  
STANDARD : FCC 47 CFR Part 2 (2.1093)  
ANSI/IEEE C95.1-1992  
IEEE 1528-2003

The product was installed into Notebook (Brand Name: Lenovo, Model Name: TP00066A) during test.

We, SPORTON INTERNATIONAL INC., 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.



Reviewed by: Eric Huang / Deputy Manager



Approved by: Jones Tsai / Manager



## SPORTON INTERNATIONAL INC.

No. 52, Hwa Ya 1<sup>st</sup> Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.



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### Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA421460-01	Rev. 01	Initial issue of report	Apr. 23, 2014



### 1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Realtek Semiconductor Corp., 802.11b/g/n RTL8192EE Combo module, RTL8192EEBT**, are as follows.

Equipment Class	Frequency Band	Operating Mode	Highest SAR Summary	
			Body 1g SAR (W/kg)	Simultaneous Transmission 1g SAR (W/kg)
DTS	WLAN 2.4GHz Band	Data	<b>0.47</b>	0.77
Date of Testing:		04/11/2014		

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 1528-2003.

### 2. Administration Data

Testing Laboratory	
Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1 <sup>st</sup> Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978

Applicant	
Company Name	Realtek Semiconductor Corp.
Address	No. 2, Innovation Road II, Hsinchu Science Park, Hsinchu 300 Taiwan (R.O.C.)

Manufacturer	
Company Name	Realtek Semiconductor Corp.
Address	No. 2, Innovation Road II, Hsinchu Science Park, Hsinchu 300 Taiwan (R.O.C.)

### 3. Guidance Standard

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 1528-2003
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- FCC KDB 865664 D02 SAR Reporting v01r01
- FCC KDB 447498 D01 General RF Exposure Guidance v05r02
- FCC KDB 248227 D01 SAR meas for 802 11abg v01r02
- FCC KDB 616217 D04 SAR for laptop and tablets v01r01

## 4. Equipment Under Test (EUT)

### 4.1 General Information

Product Feature & Specification	
Equipment Name	802.11b/g/n RTL8192EE Combo module
Brand Name	Realtek
Model Name	RTL8192EEBT
FCC ID	TX2RTL8192EEBT
S/N	1SLI5UXXXXXXLR0300EB
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	<ul style="list-style-type: none"> <li>• 802.11b/g/n HT20/HT40</li> <li>• Bluetooth v2.1+EDR · Bluetooth v4.0-LE</li> </ul>
EUT Stage	Production Unit
<b>Remark:</b>	
<ol style="list-style-type: none"> <li>1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.</li> <li>2. This host, the display screen can be rotated 360 degree and lay down on the back surface become a Tablet computer.</li> <li>3. This host has two kinds antenna manufacturer. RF exposure assessment was selected antenna1 as the main test; and antenna2 will be verified at the highest RF exposure position found in antenna1 SAR testing.</li> <li>4. The product has two kinds of battery option only different is manufacturer, therefore RF exposure evaluation was selected battery1 performed SAR testing more detail information which can be referred to External Photo.</li> </ol>	

Host Feature & Specification			
Host Name		Notebook	
Brand Name		Lenovo	
Model Name		TP00066A	
Antenna 1 (Tongda)	Manufacturer	Tongda	
	P/N	Main:DQ690210201	Aux:DQ690210200
	Antenna Type	Main: PIFA Antenna	Aux: PIFA Antenna
	Peak gain	Main Antenna : 2.4GHz: 0.79 dBi	Aux Antenna : 2.4GHz: -1.57 dBi
Antenna 2 (WNC)	Manufacturer	WNC	
	P/N	Main:DQ6G15G8100	Aux:DQ6G15G8000
	Antenna Type	Main: PIFA Antenna	Aux: PIFA Antenna
	Peak gain	Main Antenna : 2.4GHz: 0.12 dBi	Aux Antenna : 2.4GHz: -2.16 dBi



**4.2 Maximum Tune-up Limit**

Band / Mode	Average Power (dBm)	
	v2.1+EDR	v4.0+LE
Bluetooth	4.0	4.0

Mode		Maximum Average Power (dBm)										
		Ant A				Ant B				Ant A+B		
Freq. (MHz)	Channel	11b	11g	HT20	HT40	11b	11g	HT20	HT40	11g	HT20	HT40
2412	CH 01	17.5	15.5	15.5		17.5	15.5	15.5		17.0	17.0	
2422	CH 03				14.5				14.5			16.0
2437	CH 06	18.5	18.5	18.5	18.0	18.5	18.5	18.5	18.0	21.5	21.5	19.5
2452	CH 09				15.0				15.0			16.0
2462	CH 11	17.5	15.5	15.5		17.5	15.5	15.5		18.5	18.5	



### 5. RF Exposure Limits

#### 5.1 Uncontrolled Environment

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

#### 5.2 Controlled Environment

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

**Limits for Occupational/Controlled Exposure (W/kg)**

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

**Limits for General Population/Uncontrolled Exposure (W/kg)**

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

## 6. Specific Absorption Rate (SAR)

### 6.1 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.

### 6.2 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 ( $\rho$ ). The equation description is as below:

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

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

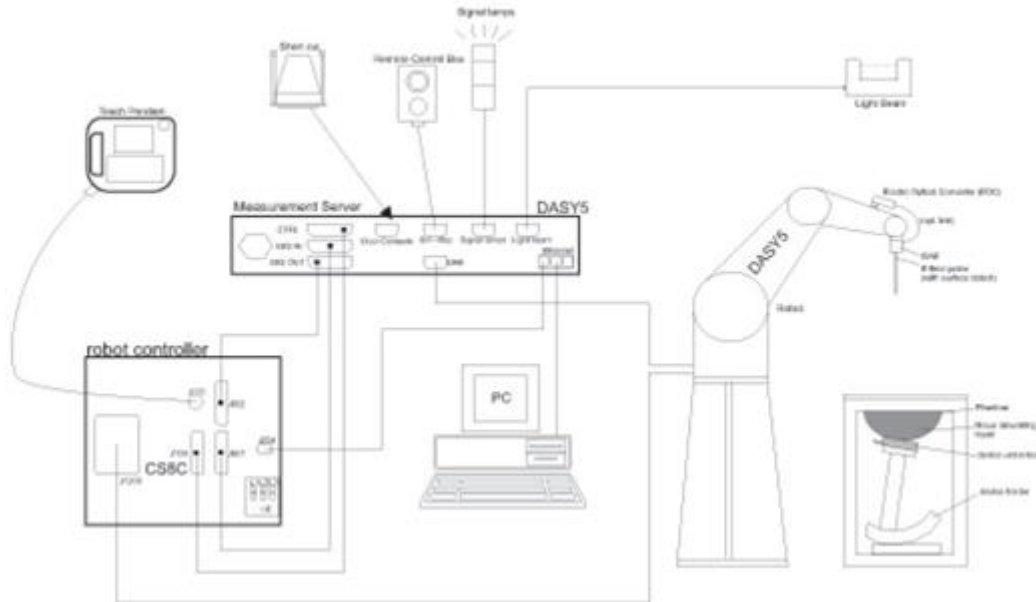
$$SAR = \frac{\sigma |E|^2}{\rho}$$

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



## 7. System Description and Setup

The DASY system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.



## 8. Measurement Procedures

The measurement procedures are as follows:

### <Conducted power measurement>

- (a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- (b) Read the WWAN RF power level from the base station simulator.
- (c) 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
- (d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

### <SAR measurement>

- (a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and 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 D 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

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

### 8.1 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:

- (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 from 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



**8.2 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.

**8.3 Area Scan**

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 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° ± 1°	20° ± 1°
Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 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 ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

### 8.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz.

		≤ 3 GHz	> 3 GHz	
Maximum zoom scan spatial resolution: $\Delta x_{Zoom}, \Delta y_{Zoom}$		$\leq 2$ GHz: $\leq 8$ mm 2 – 3 GHz: $\leq 5$ mm*	3 – 4 GHz: $\leq 5$ mm* 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 4 – 5 GHz: $\leq 3$ mm 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 4 – 5 GHz: $\leq 2.5$ mm 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 4 – 5 GHz: $\geq 25$ mm 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 <i>reported</i> SAR from the <i>area scan based 1-g SAR estimation</i> 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.				

### 8.5 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.

### 8.6 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.



**9. Test Equipment List**

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	924	Nov. 13, 2013	Nov. 12, 2014
SPEAG	Data Acquisition Electronics	DAE4	1279	Jan. 30, 2014	Jan. 29, 2015
SPEAG	Dosimetric E-Field Probe	EX3DV4	3954	Nov. 04, 2013	Nov. 03, 2014
Wisewind	Thermometer	ETP-101	TM560	Oct. 22, 2013	Oct. 21, 2014
SPEAG	Device Holder	N/A	N/A	NCR	NCR
Agilent	Signal Generator	E4438C	MY49070755	Oct. 08, 2013	Oct. 07, 2014
SPEAG	Dielectric Probe Kit	DAK-3.5	1126	Jul. 23, 2013	Jul. 22, 2014
Agilent	ENA Network Analyzer	E5071C	MY46316648	Feb. 07, 2014	Feb. 06, 2015
Anritsu	Power Meter	ML2495A	1349001	Dec. 04, 2013	Dec. 03, 2014
Anritsu	Power Sensor	MA2411B	1306099	Dec. 03, 2013	Dec. 02, 2014
R&S	Spectrum Analyzer	FSP 7	101131	Jul. 09, 2013	Jul. 08, 2014
Agilent	Dual Directional Coupler	778D	50422	*CBT	
Woken	Attenuator	WK0602-XX	N/A	*CBT	
PE	Attenuator	PE7005-10	N/A	*CBT	
PE	Attenuator	PE7005- 3	N/A	*CBT	
AR	Power Amplifier	5S1G4M2	0328767	*CBT	
Mini-Circuits	Power Amplifier	ZVE-3W	162601250	*CBT	
Mini-Circuits	Power Amplifier	ZHL-42W+	13440021344	*CBT	

**General Note:**

1. The calibration certificate of DASY can be referred to appendix C of this report.
2. \*CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing an amplifier, coupler and attenuator were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurement.



## 10. System Verification

### 10.1 Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity ( $\sigma$ )	Permittivity ( $\epsilon_r$ )
For Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
900	40.3	57.9	0.2	1.4	0.2	0	0.97	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0
For Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7
2600	68.1	0	0	0.1	0	31.8	2.16	52.5

Simulating Liquid for 5GHz, Manufactured by SPEAG

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

#### <Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (°C)	Conductivity ( $\sigma$ )	Permittivity ( $\epsilon_r$ )	Conductivity Target ( $\sigma$ )	Permittivity Target ( $\epsilon_r$ )	Delta ( $\sigma$ ) (%)	Delta ( $\epsilon_r$ ) (%)	Limit (%)	Date
2450	Body	22.3	1.904	51.836	1.95	52.70	-2.36	-1.64	±5	2014/4/11

### 10.2 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Table 8.3.1 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 A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured SAR (W/kg)	Targeted SAR (W/kg)	Normalized SAR (W/kg)	Deviation (%)
2014/4/11	2450	Body	250	D2450V2-924	3954	1279	11.80	50.20	47.2	-5.98

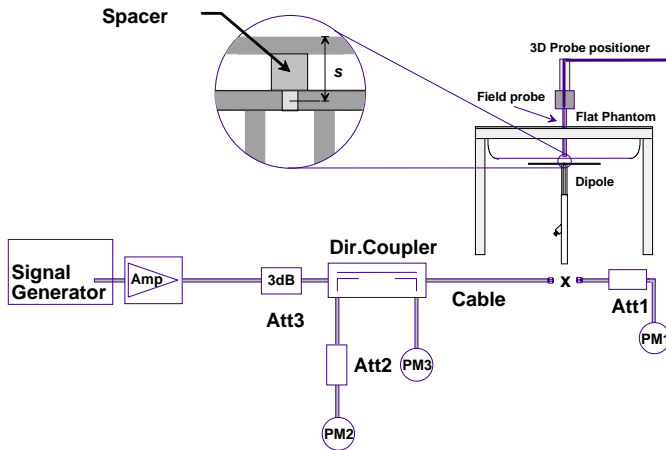


Fig 8.3.1 System Performance Check Setup



Fig 8.3.2 Setup Photo

## 11. RF Exposure Positions

### 11.1 SAR Testing for Tablet

This device can be used also in full sized tablet exposure conditions, due to its size. Per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR exclusion threshold in KDB 447498 D01v05r02 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.



## 12. Conducted RF Output Power (Unit: dBm)

### <WLAN Conducted Power>

**General Note:**

- For SAR testing was performed on single antenna RF power in SISO mode is larger or equal to the single antenna RF power in MIMO mode, and for RF exposure assessment of MIMO mode simultaneous transmission exclusion analysis was performed with SAR test results of each antenna in SISO mode.
- For 2.4GHz WLAN SAR testing, highest average RF output power channel for the lowest data rate for 802.11b were selected for SAR evaluation. 802.11g/n HT20/HT40 were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of 802.11b mode.

### <2.4GHz WLAN Antenna A>

WLAN 2.4GHz 802.11b Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	Data Rate
		1Mbps
CH 1	2412	17.49
CH 6	2437	18.48
CH 11	2462	17.44

WLAN 2.4GHz 802.11g Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	Data Rate
		6Mbps
CH 1	2412	15.44
CH 6	2437	18.47
CH 11	2462	15.08

WLAN 2.4GHz 802.11n-HT20 Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	Data Rate
		MCS0
CH 1	2412	15.46
CH 6	2437	18.45
CH 11	2462	15.19

WLAN 2.4GHz 802.11n-HT40 Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	Data Rate
		MCS0
CH 3	2422	14.17
CH 6	2437	17.48
CH 9	2452	14.66





<2.4GHz WLAN Antenna B>

WLAN 2.4GHz 802.11b Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	Data Rate
		1Mbps
CH 1	2412	17.40
CH 6	2437	18.47
CH 11	2462	17.35

WLAN 2.4GHz 802.11g Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	Data Rate
		6Mbps
CH 1	2412	15.35
CH 6	2437	18.45
CH 11	2462	14.99

WLAN 2.4GHz 802.11n-HT20 Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	MCS Index
		MCS0
CH 1	2412	15.45
CH 6	2437	18.44
CH 11	2462	15.13

WLAN 2.4GHz 802.11n-HT40 Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	MCS Index
		MCS0
CH 3	2422	14.11
CH 6	2437	17.42
CH 9	2452	14.60



<2.4GHz WLAN Antenna A+B>

WLAN 2.4GHz 802.11g Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	Data Rate
		6Mbps
CH 1	2412	16.76
CH 6	2437	21.29
CH 11	2462	18.40

WLAN 2.4GHz 802.11n-HT20 Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	MCS Index
		MCS0
CH 1	2412	16.96
CH 6	2437	21.36
CH 11	2462	18.44

WLAN 2.4GHz 802.11n-HT40 Average Power (dBm)		
Power vs. Channel		
Channel	Frequency (MHz)	MCS Index
		MCS0
CH 3	2422	15.85
CH 6	2437	19.14
CH 9	2452	15.94

**13. Bluetooth Exclusions Applied**

Mode Band	Average power(dBm)	
	Bluetooth v2.1+EDR	Bluetooth v4.0+LE
2.4GHz Bluetooth	4.0	4.0

**General Note:**

1. Per KDB 447498 D01v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for}$$

1-g SAR and ≤ 7.5 for 10-g extremity SAR

- f(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)	Separation Distance (mm)	Frequency (GHz)	exclusion thresholds
4	5	2.48	0.94

**Note:**

Per KDB 447498 D01v05r02, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 0.94 which is ≤ 3, SAR testing is not required.



## 14. Exposure Position Conditions

### <SAR test exclusion table>

#### General Note:

- Above the table, when the distance is < 50 mm exclusion threshold is "Ratio", when the distance is > 50 mm exclusion threshold is "mW".
- Maximum power is the source-based time-average power and represents the maximum RF output power among production units.
- Per KDB 447498 D01v05r02, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
- Per KDB 447498 D01v05r02, standalone SAR test exclusion threshold is applied; If the test separation distance is < 5mm, 5mm is used to determine SAR exclusion threshold.
- Per KDB 447498 D01v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 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 ≤ 7.5 for 10-g extremity SAR
  - f(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
  - For < 50 mm distance, we just calculate mW of the exclusion threshold value (3.0) to do compare. This formula is  $[3.0] / [\sqrt{f(\text{GHz})}] \cdot (\text{min. test separation distance, mm}) = \text{exclusion threshold of mW}$ .
- Per KDB 447498 D01v05r02, at 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following.
  - [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · (f(MHz)/150)] mW, at 100 MHz to 1500 MHz
  - [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · 10] mW at > 1500 MHz and ≤ 6 GHz
- Detail antenna location please refers to the appendix D setup photo.

Exposure Position	Wireless Interface	WLAN2.4GHz Ant A	WLAN2.4GHz Ant B
	Calculated Frequency	2462MHz	2462MHz
	Maximum power (dBm)	18.5	18.5
	Maximum rated power(mW)	71	71
Bottom Face	Separation distance(mm)	5	5
	exclusion threshold	22	22
	Testing required?	Yes	Yes
Edge 1	Separation distance(mm)	5.00	5.00
	exclusion threshold	22	22
	Testing required?	Yes	Yes
Edge 2	Separation distance(mm)	235.44	32.00
	exclusion threshold	1950	3
	Testing required?	No	No
Edge 3	Separation distance(mm)	186.99	186.99
	exclusion threshold	1465	1465
	Testing required?	No	No
Edge 4	Separation distance(mm)	29.00	233.23
	exclusion threshold	4	1928
	Testing required?	Yes	No
Bottom of Laptop	Separation distance(mm)	210.00	210.00
	exclusion threshold	1696	1696
	Testing required?	No	No



## 15. SAR Test Results

### General Note:

1. Per KDB 447498 D01v05r02, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
  - a. 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.
  - b. For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)\* Tune-up scaling factor
2. Per KDB 447498 D01v05r02, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
  - $\leq 0.8$  W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$  MHz
  - $\leq 0.6$  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
  - $\leq 0.4$  W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\geq 200$  MHz
3. This device supports SISO mode and MIMO mode configuration, when the single antenna RF power in SISO mode is larger or equal to the single antenna RF power in MIMO mode, and for RF exposure assessment of MIMO mode simultaneous transmission exclusion analysis was performed with SAR test results of each antenna in SISO mode
4. Per KDB 865664 D01v01r03, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8$ W/kg.
5. When the WLAN transmission was verified using a spectrum analyzer.

### 15.1 Body SAR

#### <DTS WLAN SAR>

Plot No.	Band	Mode	Test Position	Configuration	Gap (cm)	Antenna	Antenna Vendor	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	Tablet Mode	0cm	Ant A	Tongda	6	2437	18.48	18.5	-0.19	0.102	0.102
01	WLAN2.4GHz	802.11b 1Mbps	Edge 1	Tablet Mode	0cm	Ant A	Tongda	6	2437	18.48	18.5	0.06	0.470	0.472
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	Tablet Mode	0cm	Ant A	WNC	6	2437	18.48	18.5	0.07	0.467	0.469
	WLAN2.4GHz	802.11b 1Mbps	Edge 4	Tablet Mode	0cm	Ant A	Tongda	6	2437	18.48	18.5	0.13	0.221	0.222
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	Tablet Mode	0cm	Ant B	Tongda	6	2437	18.47	18.5	0.12	0.141	0.142
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	Tablet Mode	0cm	Ant B	Tongda	6	2437	18.47	18.5	-0.01	0.294	0.296
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	Tablet Mode	0cm	Ant B	WNC	6	2437	18.47	18.5	-0.01	0.28	0.282

## 16. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations	Supported
1.	WLAN Antenna A + Bluetooth Antenna B	Yes
2.	WLAN Antenna A + WLAN Antenna B	Yes

**General Note:**

- WLAN RF exposure assessment of MIMO mode simultaneous transmission exclusion analysis was performed with SAR test results of each antenna in SISO mode. Therefore SPLSR calculation was choose worst case with SAR test results of each antenna in SISO mode perform evaluation.
- The Scaled SAR summation is calculated based on the same configuration and test position.
- Per KDB 447498 D01v05r02, simultaneous transmission SAR is compliant if,
  - Scalar SAR summation < 1.6W/kg.
  - $SPLSR = (SAR1 + SAR2)1.5 / (\text{min. separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$ , where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan.
  - If  $SPLSR \leq 0.04$ , simultaneously transmission SAR measurement is not necessary.
  - Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg.
- For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01v05r02 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.
  - When the minimum separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
  - 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.
  - Bluetooth estimated SAR is conservatively determined by 5mm separation, for all applicable exposure positions.

Bluetooth Max Power	Exposure Position	All Positions
4.0 dBm	Estimated SAR (W/kg)	0.126 W/kg

### 16.1 Body Exposure Conditions

<WWAN + WLAN2.4GHz>

Exposure Position	Antenna A	Antenna B	Summed SAR (W/kg)
	SAR (W/kg)	SAR (W/kg)	
Bottom Face at 0cm	0.102	0.142	<b>0.24</b>
Edge1 at 0cm	0.472	0.296	<b>0.77</b>
Edge4 at 0cm	0.222		<b>0.22</b>

Exposure Position	Antenna A	Bluetooth DSS	Summed SAR (W/kg)
	SAR (W/kg)	Estimated SAR (W/kg)	
Bottom Face at 0cm	0.102	0.126	<b>0.23</b>
Edge1 at 0cm	0.472	0.126	<b>0.60</b>
Edge4 at 0cm	0.222	0.126	<b>0.35</b>

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## 17. 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 Table 16.1

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor <sup>(a)</sup>	1/k <sup>(b)</sup>	1/√3	1/√6	1/√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

**Table 17.1. Standard Uncertainty for Assumed Distribution**

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.



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	√3	0.7	0.7	± 1.9 %	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %
Boundary Effects	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Linearity	4.7	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %
Response Time	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	1	± 1.5 %	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Probe Positioner	0.4	Rectangular	√3	1	1	± 0.2 %	± 0.2 %
Probe Positioning	2.9	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Max. SAR Eval.	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
<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	√3	1	1	± 2.9 %	± 2.9 %
<b>Phantom and Setup</b>							
Phantom Uncertainty	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	0.43	± 1.6 %	± 1.1 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	0.49	± 1.5 %	± 1.2 %
<b>Combined Standard Uncertainty</b>						± 11.0 %	± 10.8 %
<b>Coverage Factor for 95 %</b>						K=2	
<b>Expanded Uncertainty</b>						± 22.0 %	± 21.5 %

Table 17.2. Uncertainty Budget for frequency range 300 MHz to 3 GHz



## **18. 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 Device RF Exposure Procedures and Equipment Authorization Policies", Feb 2014
- [7] FCC KDB 616217 D04 v01r01, "SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers", May 2013
- [8] FCC KDB 865664 D01 v01r03, "SAR Measurement Requirements for 100 MHz to 6 GHz", Feb 2014.
- [9] FCC KDB 865664 D02 v01r01, "RF Exposure Compliance Reporting and Documentation Considerations" May 2013.