

**ANSI/IEEE Std. C95.1-1992**

**In accordance with the requirements of SAR Report and Order:**

**ET Docket 93-62 ; FCC 47 CFR Part 2 ( 2.1093)**

**RSS102 issue 5**

## **SAR TEST REPORT**

**For**

**Product Name: 802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card**

**Brand Name: Qualcomm Atheros**

**Model No.: QCNFA344A**

**Series Model: N/A**

**FCCID: PPD-QCNFA344AH**

**IC: 4104A-QCNFA344A**

**Test Report Number:**

**C161111R03-C-SF**

**Issued for**

**Qualcomm Atheros, Inc.**

**1700 Technology Drive, San Jose, CA 95110**

**Issued by**

**Compliance Certification Services Inc.**

**Kun shan Laboratory**

**No.10 Weiye Rd., Innovation park, Eco&Tec,  
Development Zone, Kunshan City, Jiangsu, China**

**TEL: 86-512-57355888**

**FAX: 86-512-57370818**



**Note:** This report shall not be reproduced except in full, without the written approval of Compliance Certification Services Inc. This document may be altered or revised by Compliance Certification Services Inc. personnel only, and shall be noted in the revision section of the document. The client should not use it to claim product endorsement by A2LA or any government agencies. The test results in the report only apply to the tested sample.

## Revision History

Revision	REPORT NO.	Date	Page Revised	Contents
Original	C161111R03-C-SF	December 30, 2016	N/A	N/A
01	C161111R03-C-SF	January 13, 2017	All report	<ul style="list-style-type: none"><li>1、Update EUT DESCRIPTION on page 5.</li><li>2、Indicate the chain0 and chain1 antenna on page 37.</li><li>3、Update the title of section 10.10 and clarify the statement of simultaneous transmission on page 46.</li><li>4、Update INTERNAL PHOTOGRAPHS OF EUT.</li></ul>

## TABLE OF CONTENTS

<b>1. CERTIFICATE OF COMPLIANCE (SAR EVALUATION) .....</b>	<b>4</b>
<b>2. EUT DESCRIPTION.....</b>	<b>5</b>
2.1 MAXIMUM RF OUTPUT POWER WITH TEST CHANNEL.....	6
2.2 STATEMENT OF COMPLIANCE.....	7
<b>3. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC OR IC .....</b>	<b>8</b>
<b>4. TEST METHODOLOGY.....</b>	<b>8</b>
<b>5. TEST CONFIGURATION.....</b>	<b>8</b>
<b>6. DOSIMETRIC ASSESSMENT SETUP.....</b>	<b>9</b>
6.1 MEASUREMENT SYSTEM DIAGRAM.....	10
6.2 SYSTEM COMPONENTS.....	11
<b>7. EVALUATION PROCEDURES.....</b>	<b>14</b>
<b>8. MEASUREMENT UNCERTAINTY.....</b>	<b>18</b>
<b>9. EXPOSURE LIMIT .....</b>	<b>19</b>
<b>10. MEASUREMENT RESULTS.....</b>	<b>20</b>
10.1 TEST LIQUIDS CONFIRMATION .....	20
10.2 LIQUID MEASUREMENT RESULTS .....	21
10.3 SYSTEM PERFORMANCE CHECK .....	22
10.4 EUT TUNE-UP PROCEDURES AND TEST MODE .....	24
10.5 SAR TEST CONFIGURATIONS.....	34
10.6 ANTENNA LOCATION .....	35
10.7 BODY TEST EXCLUSION THRESHOLDS .....	38
10.7.1. EXCLUSION ANALYSIS FOR FCC (BT AND WLAN) .....	38
10.7.2. EXCLUSION ANALYSIS FOR ISED (BT AND WLAN) .....	40
10.8 SAR MEASUREMENT RESULTS .....	42
10.9 REPEATED SAR MEASUREMENT .....	45
10.10 SAR TABLET/CONVERTIBLE COMPUTER MULTI XMITER ASSESSMENT .....	46
<b>11. EQUIPMENT LIST &amp; CALIBRATION STATUS .....</b>	<b>49</b>
<b>12. FACILITIES.....</b>	<b>50</b>
<b>13. REFERENCES.....</b>	<b>50</b>
<b>Appendix A: DUT AND SAR SETUP Photo.....</b>	<b>51</b>
<b>Appendix B: Plots of Performance Check.....</b>	<b>51</b>
<b>Appendix C: DASY Calibration Certificate .....</b>	<b>58</b>
<b>Appendix D: Plots of SAR Test Result .....</b>	<b>58</b>

## 1. CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

<b>Product Name:</b>	802.11a/b/g/n/ac + BT 4.1 M.2230 Type Card
<b>Model Name.:</b>	QCNFA344A
<b>Series Model:</b>	N/A
<b>Device Category:</b>	PORTABLE DEVICES
<b>Exposure Category:</b>	GENERAL POPULATION/UNCONTROLLED EXPOSURE
<b>Date of Test:</b>	December 28, 2016 & December 29, 2016
<b>Applicant:</b>	<b>Qualcomm Atheros, Inc.</b> 1700 Technology Drive, San Jose, CA 95110
<b>Manufacturer:</b>	<b>Qualcomm Atheros, Inc.</b> 1700 Technology Drive, San Jose, CA 95110
<b>Application Type:</b>	Certification

### APPLICABLE STANDARDS AND TEST PROCEDURES

STANDARDS AND TEST PROCEDURES	TEST RESULT
FCC 47 CFR Part 2 ( 2.1093) IEEE 1528-2013 KDB 248227 KDB 865664 KDB 447498 KDB 616217 RSS102 issue 5 IEC 62209-2:2010	No non-compliance noted

### Deviation from Applicable Standard

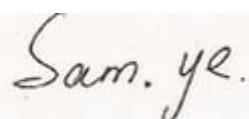
None

The device was tested by Compliance Certification Services Inc. in accordance with the measurement methods and procedures specified in KDB 865664. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Approved by:



Tested by:



Jeff.fang  
RF Manager  
Compliance Certification Services Inc.

Sam.ye  
Test Engineer  
Compliance Certification Services Inc.

## 2. EUT DESCRIPTION

<b>Product Name:</b>	802.11a/b/g/n/ac + BT 4.1 M.2230 Type Card
<b>Model Name.:</b>	QCNFA344A
<b>Series Model:</b>	N/A
<b>FCC ID:</b>	PPD-QCNFA344AH
<b>IC:</b>	4104A-QCNFA344A
<b>Power reduction:</b>	YES
<b>DTM Description:</b>	N/A
<b>Device Category:</b>	Production unit
<b>Frequency Range:</b>	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
<b>Modulation Technique:</b>	802.11a/b/g/n HT20/HT40/VHT20/VHT40/VHT80 Bluetooth:3.0 + EDR, 8-DPSK Bluetooth:4.0
<b>Operating Mode:</b>	Maximum continuous output

### Tested System Details

Product	Manufacturer	Model No.
Notebook / Tablet Computer	Lenovo	Model Name.: Lenovo ideapad MIIX 510-12IKB*****; 80XE***** (* can be 0-9,A-Z,a-z,- or blank)

Note:

Model discrepancy only for market segment

## 2.1 MAXIMUM RF OUTPUT POWER WITH TEST CHANNEL

Band / Mode	Target Power(dBm)		
	V3.0 + EDR, GFSK	V3.0 + EDR, π/4-DQPSK	V3.0 + EDR, 8-DPSK
Bluetooth	4.5	4.5	4.5

Band / Mode	Target Power(dBm)	
	BLE4.0, GFSK	
Bluetooth	1	

Band / Mode	Channel	SISO Target Power (dBm)	MIMO Target Power (dBm)
802.11b	1-11	13	16
802.11g	1-11	12	15
802.11n 20MHz	1-11	12	15
802.11n 40MHz	3-9	11	14
802.11 a U-NII-1	36-48	12	15
802.11 a U-NII-2A	52-64	12	15
802.11 a U-NII-2C	100-144	12	15
802.11 a U-NII-3	149-165	12	15
802.11 n20 U-NII-1	36-48	12	15
802.11 n20 U-NII-2A	52-64	12	15
802.11 n20 U-NII-2C	100-144	12	15
802.11 n20 U-NII-3	149-165	12	15
802.11 n40 U-NII-1	38-46	11.5	14.5
802.11 n40 U-NII-2A	54-62	11.5	14.5
802.11 n40 U-NII-2C	102-142	11.5	14.5
802.11 n40 U-NII-3	151-159	11.5	14.5
802.11 ac80 U-NII-1	42	11	14
802.11 ac80 U-NII-2A	58	11	14
802.11 ac80 U-NII-2C	106-138	11	14
802.11 ac80 U-NII-3	155	11	14

## 2.2 STATEMENT OF COMPLIANCE

The maximum results of Specific Absorption Rate (SAR) found during testing for **Qualcomm Atheros,, 802.11a/b/g/n/ac + BT 4.1 M.2230 Type Card**, are as follows.

Equipment Class	Frequency Band	Highest SAR Summary	
		Body 1g SAR (W/kg)	Simultaneous Transmission 1g SAR (W/kg)
DTS	2.4GHz WLAN	0.988	1.127
NII	5.2GHz WLAN	--	1.332
	5.3GHz WLAN	1.185	
	5.5GHz WLAN	1.193	
	5.8GHz WLAN	0.567	
DSSS(BT)	2.4GHz	0.139	1.332

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

### 3. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC OR IC

The US Federal Communications Commission has released the report and order "Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 W/Kg for an uncontrolled environment and 8.0 W/Kg for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992; ; RSS-102 issue 5: 2015.

### 4. TEST METHODOLOGY

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
- IEC 62209-2:2010
- IEEE 1528-2013
- RSS-102 issue 5: 2015
- KDB 447498 D01v06 General RF Exposure Guidance
- KDB 865664 D01v01r04 Measurement 100 MHz to 6 GHz
- KDB 865664 D02 v01r02 RF Exposure Reporting
- KDB 248227 D01v02r02 802.11 Wi-Fi SAR
- KDB 616217 D04v01r02 SAR for laptop and tablets

### 5. TEST CONFIGURATION

During WLAN SAR testing EUT is configured with the WLAN continuous TX tool, and the transmission duty factor was monitored on the spectrum analyzer with zero-span setting

For WLAN SAR testing, WLAN engineering test software installed on the EUT can provide continuous transmitting RF signal.

Duty cycle Form

Band	Mode	Duty cycle(100%)
2.4GHz	Bluetooth	77
	802.11b	100
	802.11g	95
	802.11n 20MHz	94
	802.11n 40MHz	88
5GHz	802.11a	95
	802.11 20MHz	95
	802.11 40MHz	89
	802.11 ac80	80

## 6. DOSIMETRIC ASSESSMENT SETUP

These measurements were performed with the automated near-field scanning system DASY 5 from ATTENNESSA. The system is based on a high precision robot (working range greater than 0.9 m), which positions the probes with a positional repeatability of better than  $\pm 0.02$  mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the E-field PROBE EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [7] with accuracy of better than  $\pm 10\%$ . The spherical isotropy was evaluated with the procedure described in [8] and found to be better than  $\pm 0.25$  dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEE P1528 and CENELEC EN 62209.

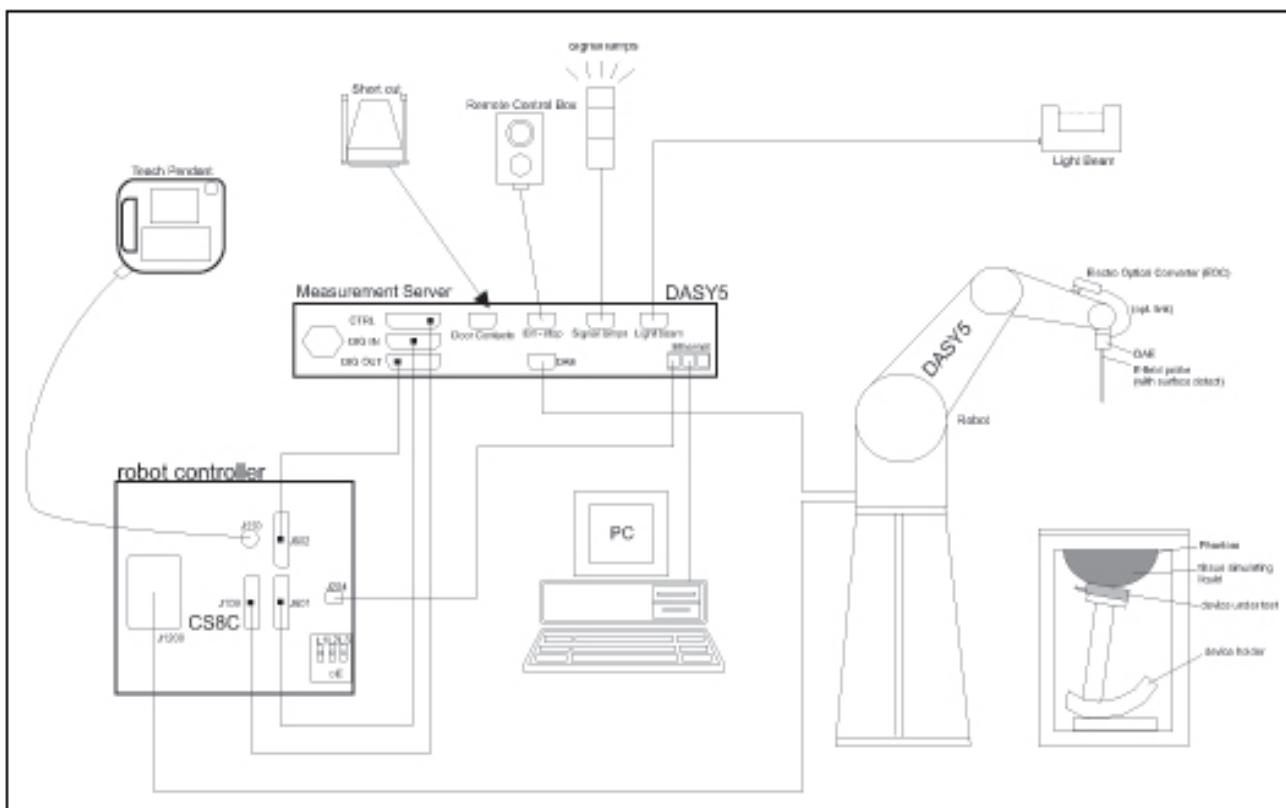
The following table gives the recipes for tissue simulating liquids.

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

### Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

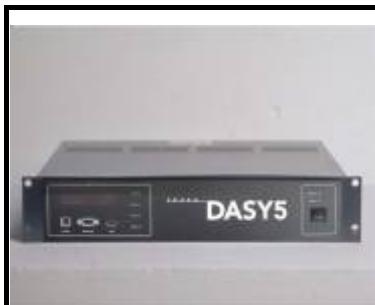
## 6.1 MEASUREMENT SYSTEM DIAGRAM



**The DASY5 system for performing compliance tests consists of the following items:**

- A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- 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 between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.

## 6.2 SYSTEM COMPONENTS



The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV celeron, 128MB chip-disk and 128 MB RAM. The necessary circuits for communication with either the DAE4 (or DAE3) electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.



The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

### Data Acquisition Electronics (DAE)



The data acquisition electronics (DAE4) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE4 box is 200MΩ; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

### EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements



**Construction:** Symmetrical design with triangular core  
Built-in shielding against static charges  
PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

**Calibration:** Basic Broad Band Calibration in air: 10-3000 MHz.  
Conversion Factors (CF) for HSL 900 and HSL 1800  
CF-Calibration for other liquids and frequencies upon request.

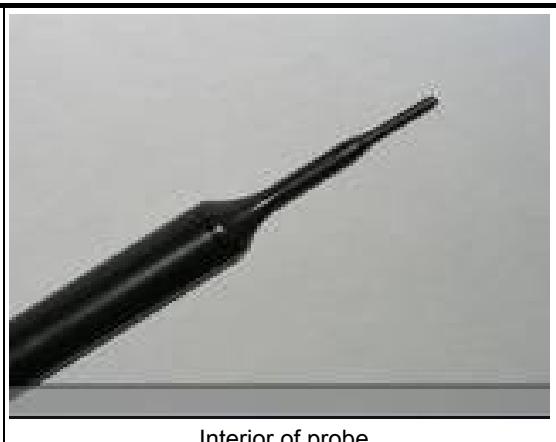
**Frequency:** 10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)

**Directivity:** ± 0.3 dB in HSL (rotation around probe axis)  
± 0.5 dB in HSL (rotation normal to probe axis)

**Dynamic Range:** 10 μW/g to > 100 mW/g; Linearity: ± 0.2 dB  
(noise: typically < 1 μW/g)

**Dimensions:** Overall length: 337 mm (Tip: 9 mm)  
Tip diameter: 2.5 mm (Body: 10 mm)  
Distance from probe tip to dipole centers: 1 mm

**Application:** High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



#### SAM Twin Phantom

##### Construction:

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50360 and IEC 62209. 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 manually teaching three points with the robot.



**Shell Thickness:** 2 ± 0.2 mm

**Filling Volume:** Approx. 25 liters

**Dimensions:** Height: 850mm; Length: 1000mm; Width: 750mm

#### SAM Phantom (ELI4 v4.0)

##### Description Construction:

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 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 supported by software version DASY4/DASY5.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles



**Shell Thickness:** 2.0 ± 0.2 mm (sagging: <1%)

**Filling Volume:** Approx. 25 liters

**Dimensions:** Major ellipse axis: 600 mm

**Minor axis:** 400 mm 500mm

**Device Holder for SAM Twin Phantom**

**Construction:** In combination with the Twin SAM Phantom, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, and flat phantom).

**System Validation Kits for SAM Twin Phantom**

**Construction:** Symmetrical dipole with I/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

**Frequency:** 900, 1800, 2450, 5800 MHz

**ReTune loss:** > 20 dB at specified validation position

**Power capability:** > 100 W (f < 1GHz); > 40 W (f > 1GHz)

**Dimensions:**

D835V2: dipole length: 161 mm; overall height: 340 mm

D1800V2: dipole length: 72.5 mm; overall height: 300 mm

D1900V2: dipole length: 67.7 mm; overall height: 300 mm

D2450V2: dipole length: 51.5 mm; overall height: 290 mm

D5GHzV2: dipole length: 20.6 mm; overall height: 300mm

**System Validation Kits for ELI4 phantom**

**Construction:** Symmetrical dipole with I/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

**Frequency:** 900, 1800, 2450, 5800 MHz

**ReTune loss:** > 20 dB at specified validation position

**Power capability:** > 100 W (f < 1GHz); > 40 W (f > 1GHz)

**Dimensions:**

D835V2: dipole length: 161 mm; overall height: 340 mm

D1800V2: dipole length: 72.5 mm; overall height: 300 mm

D1900V2: dipole length: 67.7 mm; overall height: 300 mm

D2450V2: dipole length: 51.5 mm; overall height: 290 mm

D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm



## 7. EVALUATION PROCEDURES

### DATA EVALUATION

The DASY 5 post processing software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i, a_{i0}, a_{i1}, a_{i2}$
	- Conversion factor	$ConvF_i$
	- Diode compression point	$dcp_i$
Device parameters:	- Frequency	$f$
	- Crest factor	$cf$
Media parameters:	- Conductivity	$\sigma$
	- Density	$\rho$

These parameters must be set correctly in the software. They can be found in the component documents or be imported into the software from the configuration files issued for the DASY 5 components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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

with	$V_i$	= Compensated signal of channel i (i = x, y, z)
	$U_i$	= Input signal of channel i (i = x, y, z)
	$cf$	= Crest factor of exciting field (DASY 5 parameter)
	$dcp_i$	= Diode compression point (DASY 5 parameter)

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

E-field probes: 
$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

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

with	$V_i$	= Compensated signal of channel i (i = x, y, z)
	$Norm_i$	= Sensor sensitivity of channel i (i = x, y, z) $\mu\text{V}/(\text{V}/\text{m})^2$ for E0field Probes
	$ConvF$	= Sensitivity enhancement in solution

$a_{ij}$  = Sensor sensitivity factors for H-field probes

$f$  = Carrier frequency (GHz)

$E_i$  = Electric field strength of channel i in V/m

$H_i$  = Magnetic field strength of channel i in A/m

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

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

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

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

with  $SAR$  = local specific absorption rate in mW/g

$E_{tot}$  = total field strength in V/m

$\sigma$  = conductivity in [mho/m] or [Siemens/m]

$\rho$  = equivalent tissue density in g/cm<sup>3</sup>

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

The power flow density is calculated assuming the excitation field as a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with  $P_{pwe}$  = Equivalent power density of a plane wave in mW/cm<sup>2</sup>

$E_{tot}$  = total electric field strength in V/m

$H_{tot}$  = total magnetic field strength in A/m

## **SAR EVALUATION PROCEDURES**

The procedure for assessing the peak spatial-average SAR value consists of the following steps:

- **Power Reference Measurement**

The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- **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 finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY 5 software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to 15 mm by 15 mm and can be edited by a user.

- **Zoom Scan**

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures 5 x 5 x 7 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more than one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

- **Power Drift measurement**

The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have DASY 5 software stop the measurements if this limit is exceeded.

- **Z-Scan**

The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.

## SPATIAL PEAK SAR EVALUATION

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1 g and 10 g.

The DASY 5 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

### Extrapolation

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. Several measurements at different distances are necessary for the extrapolation.

Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 5x5x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

### Boundary effect

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosimetric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx S_o + S_b \exp\left(-\frac{z}{a}\right) \cos\left(\frac{\pi z}{\lambda}\right)$$

Since the decay of the boundary effect dominates for small probes ( $a \ll \lambda$ ), the cos-term can be omitted. Factors  $S_b$  (parameter Alpha in the DASY 5 software) and  $a$  (parameter Delta in the DASY 5 software) are assessed during probe calibration and used for numerical compensation of the boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- the boundary curvature is small
- the probe axis is angled less than 30° to the boundary normal
- the distance between probe and boundary is larger than 25% of the probe diameter
- the probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY 5 system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.

## **8. MEASUREMENT UNCERTAINTY**

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2003 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

## 9. EXPOSURE LIMIT

(A). Limits for Occupational/Controlled Exposure (W/kg)

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

(B). Limits for General Population/Uncontrolled Exposure (W/kg)

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

**Note:** Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1 gram 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.

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

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

**NOTE**  
**GENERAL POPULATION/UNCONTROLLED EXPOSURE**  
**PARTIAL BODY LIMIT**  
**1.6 W/kg**

## 10. MEASUREMENT RESULTS

### 10.1 TEST LIQUIDS CONFIRMATION

#### SIMULATED TISSUE LIQUID PARAMETER CONFIRMATION

The dielectric parameters were checked prior to assessment using the SPEAG DAK3.5 dielectric probe kit. The dielectric parameters measured are reported in each correspondent section.

#### IEEE SCC-34/SC-2 P1528 RECOMMENDED TISSUE DIELECTRIC PARAMETERS

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

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

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000 \text{ kg/m}^3$ )

## 10.2 LIQUID MEASUREMENT RESULTS

The following table show the measuring results for simulating liquid:

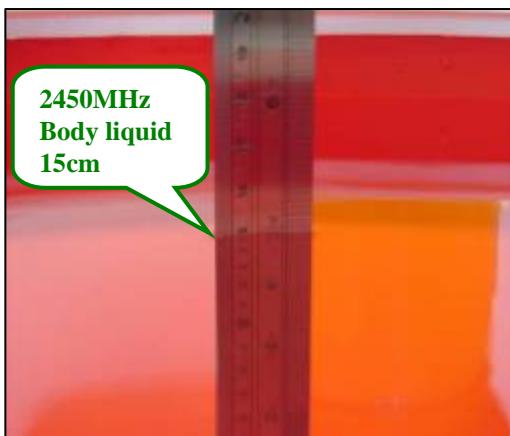
Liquid Type	Liquid Temp. (°C)	Parameters	Target	Measured	Deviation (%)	Limited (%)	Measured Date
Body2412	21.5	Permitivity(ε )	52.75	51.22	-2.89	± 5	2016-12-28
		Conductivity(σ)	1.90	1.93	1.38	± 5	
Body2437	21.5	Permitivity(ε )	52.70	51.14	-2.96	± 5	2016-12-28
		Conductivity(σ)	1.95	1.95	-0.05	± 5	
Body2462	21.5	Permitivity(ε )	52.68	51.02	-3.16	± 5	2016-12-28
		Conductivity(σ)	1.97	1.98	0.71	± 5	
Body2480	21.5	Permitivity(ε )	52.63	50.94	-3.22	± 5	2016-12-28
		Conductivity(σ)	1.99	2.01	1.02	± 5	
Body5260	21.5	Permitivity(ε )	48.95	47.90	-2.15	± 5	2016-12-29
		Conductivity(σ)	5.42	5.27	-2.71	± 5	
Body5280	21.5	Permitivity(ε )	48.92	47.83	-2.24	± 5	2016-12-29
		Conductivity(σ)	5.44	5.29	-2.73	± 5	
Body5320	21.5	Permitivity(ε )	48.87	47.68	-2.44	± 5	2016-12-29
		Conductivity(σ)	5.49	5.35	-2.47	± 5	
Body5500	21.5	Permitivity(ε )	48.62	47.33	-2.65	± 5	2016-12-29
		Conductivity(σ)	5.68	5.60	-1.52	± 5	
Body5560	21.5	Permitivity(ε )	48.54	47.16	-2.83	± 5	2016-12-29
		Conductivity(σ)	5.75	5.67	-1.26	± 5	
Body5640	21.5	Permitivity(ε )	48.42	47.01	-2.92	± 5	2016-12-29
		Conductivity(σ)	5.83	5.79	-0.73	± 5	
Body5745	21.5	Permitivity(ε )	48.28	46.76	-3.13	± 5	2016-12-29
		Conductivity(σ)	5.94	5.94	-0.13	± 5	
Body5785	21.5	Permitivity(ε )	48.22	46.68	-3.20	± 5	2016-12-29
		Conductivity(σ)	5.98	6.00	0.26	± 5	

### 10.3 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of  $\pm 10\%$ . The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

#### SYSTEM PERFORMANCE CHECK MEASUREMENT CONDITIONS

- The measurements were performed in the flat section of the SAM twin phantom filled with head and body simulating liquid of the following parameters.
- The DASY5 system with an E-field probe EX3DV4 SN: 3798 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm (below 1 GHz) and 10 mm (above 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration ( $dx = 5$  mm,  $dy = 5$  mm,  $dz = 5$  mm).
- Distance between probe sensors and phantom surface was set to 2 mm.
- The dipole less than 3G input power was 250mW $\pm 3\%$ .
- The dipole above than 3G input power was 100mW $\pm 3\%$ .
- The results are normalized to 1 W input power.



- Note: For SAR testing, less than 3G the liquid depth is 15cm shown above
- Note: For SAR testing, above than 3G the liquid depth is 10cm shown above

**SYSTEM PERFORMANCE CHECK RESULTS**

Liquid Type	Ambient Temp. (° C)	Liquid Temp. (°C)	Input Power (W)	Measured SAR <sub>1g</sub> (W/Kg)	1W Target SAR <sub>1g</sub> (W/Kg)	1W Normalized SAR <sub>1g</sub> (W/Kg)	Deviation (%)	Limited (%)	Date
Body2450	22	21.5	0.25	12.60	51.50	50.40	-2.14	± 10	2016-12-28
Body5200	22	21.5	0.1	7.49	74.50	74.9	0.54	± 10	2016-12-29
Body5300	22	21.5	0.1	7.85	77.20	78.5	1.68	± 10	2016-12-29
Body5500	22	21.5	0.1	7.91	81.10	79.1	-2.47	± 10	2016-12-29
Body5600	22	21.5	0.1	7.87	79.80	78.7	-1.38	± 10	2016-12-29
Body5800	22	21.5	0.1	7.61	77.20	76.1	-1.42	± 10	2016-12-29

## 10.4 EUT TUNE-UP PROCEDURES AND TEST MODE

### Conducted output power(dBm):

#### General Note:

- 1 Power must be measured at each transmit antenna port according to the DSSS and OFDM transmission configurations in each standalone and aggregated frequency band.
- 2 Power measurement is required for the transmission mode configuration with the highest maximum output power specified for production units.
  - 1) When the same highest maximum output power specification applies to multiple transmission modes, the largest channel bandwidth configuration with the lowest order modulation and lowest data rate is measured.
  - 2) When the same highest maximum output power is specified for multiple largest channel bandwidth configurations with the same lowest order modulation or lowest order modulation and lowest data rate, power measurement is required for all equivalent 802.11 configurations with the same maximum output power.
- 3 For each transmission mode configuration, power must be measured for the highest and lowest channels; and at the mid-band channel(s) when there are at least 3 channels. For configurations with multiple mid-band channels, due to an even number of channels, both channels should be measured.
- 4 Apply the default power measurement procedures to measure maximum output power for each standalone and aggregated frequency band.
  - a) When band gap channels between U-NII-2C band and U-NII-3 band or §15.247 5.8 GHz band are supported and the bands are aggregated for SAR testing according to KDB 248227D01 sections 2.3 and 3.3, apply the following to determine high, middle and low channels for power measurement and SAR test reduction.
    - i) channels in U-NII-2C band below 5.65 GHz are considered as one band
    - ii) channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
  - b) The maximum output power of band gap channels is limited to the lowest maximum output power certified for the adjacent bands regardless of whether band aggregation is applied for SAR testing.
  - c) The measured maximum output power results are used to reduce the number of channels that need testing.

### WLAN 2.4G Chain0

Mode	Channel	Frequency (MHz)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 b	1	2412	11.5	±1.5	13	12.68
	6	2437	11.5	±1.5	13	12.92
	11	2462	11.5	±1.5	13	12.69
802.11 g	1	2412	10.5	±1.5	12	Not required
	6	2437	10.5	±1.5	12	
	11	2462	10.5	±1.5	12	
802.11 n 20MHz	1	2412	10.5	±1.5	12	
	6	2437	10.5	±1.5	12	
	11	2462	10.5	±1.5	12	
802.11 n 40MHz	3	2422	9.5	±1.5	11	
	6	2437	9.5	±1.5	11	
	9	2452	9.5	±1.5	11	

## WLAN 2.4G Chain1

Mode	Channel	Frequency (MHz)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 b	1	2412	11.5	±1.5	13	12.82
	6	2437	11.5	±1.5	13	12.90
	11	2462	11.5	±1.5	13	12.78
802.11 g	1	2412	10.5	±1.5	12	Not required
	6	2437	10.5	±1.5	12	
	11	2462	10.5	±1.5	12	
802.11 n 20MHz	1	2412	10.5	±1.5	12	
	6	2437	10.5	±1.5	12	
	11	2462	10.5	±1.5	12	
802.11 n 40MHz	3	2422	9.5	±1.5	11	
	6	2437	9.5	±1.5	11	
	9	2452	9.5	±1.5	11	

## WLAN 2.4G Chain0+1

Mode	Channel	Frequency (MHz)	Chain0+1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 b	1	2412	14.5	±1.5	16	15.76
	6	2437	14.5	±1.5	16	15.92
	11	2462	14.5	±1.5	16	15.75
802.11 g	1	2412	13.5	±1.5	15	Not required
	6	2437	13.5	±1.5	15	
	11	2462	13.5	±1.5	15	
802.11 n 20MHz	1	2412	13.5	±1.5	15	
	6	2437	13.5	±1.5	15	
	11	2462	13.5	±1.5	15	
802.11 n 40MHz	3	2422	12.5	±1.5	14	
	6	2437	12.5	±1.5	14	
	9	2452	12.5	±1.5	14	

## WLAN Conducted output power(dBm):

## U-NII-1 Chain0

Mode	Channel	Frequency (MHz)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	36	5180	10	±2	12	11.95
	40	5200	10	±2	12	11.80
	44	5220	10	±2	12	11.96
	48	5240	10	±2	12	11.64
802.11 n 20MHz	36	5180	10	±2	12	Not required
	40	5200	10	±2	12	
	44	5220	10	±2	12	
	48	5240	10	±2	12	
802.11 n 40MHz	38	5190	9.5	±2	11.5	
	46	5230	9.5	±2	11.5	
802.11 ac80	42	5210	9	±2	11	

## U-NII-1 Chain1

Mode	Channel	Frequency (MHz)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	36	5180	10	±2	12	11.78
	40	5200	10	±2	12	11.67
	44	5220	10	±2	12	11.33
	48	5240	10	±2	12	11.71
802.11 n 20MHz	36	5180	10	±2	12	Not required
	40	5200	10	±2	12	
	44	5220	10	±2	12	
	48	5240	10	±2	12	
802.11 n 40MHz	38	5180	9.5	±2	11.5	
	46	5230	9.5	±2	11.5	
802.11 ac80	42	5210	9	±2	11	

## U-NII-1 Chain0+1

Mode	Channel	Frequency (MHZ)	Chain0+1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	36	5180	13	±2	15	14.88
	40	5200	13	±2	15	14.75
	44	5220	13	±2	15	14.67
	48	5240	13	±2	15	14.69
802.11 n 20MHz	36	5180	13	±2	15	Not required
	40	5200	13	±2	15	
	44	5220	13	±2	15	
	48	5240	13	±2	15	
802.11 n 40MHz	38	5180	12.5	±2	14.5	
	46	5230	12.5	±2	14.5	
802.11 ac80	42	5210	12	±2	14	

## U-NII-2A Chain0

Mode	Channel	Frequency (MHz)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	52	5260	10	±2	12	11.86
	56	5280	10	±2	12	11.91
	60	5300	10	±2	12	11.72
	64	5320	10	±2	12	11.86
802.11 n 20MHz	52	5260	10	±2	12	Not required
	56	5280	10	±2	12	
	60	5300	10	±2	12	
	64	5320	10	±2	12	
802.11 n 40MHz	54	5270	9.5	±2	11.5	
	62	5310	9.5	±2	11.5	
802.11 ac80	58	5290	9	±2	11	

## U-NII-2A Chain1

Mode	Channel	Frequency (MHz)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	52	5260	10	±2	12	11.92
	56	5280	10	±2	12	11.74
	60	5300	10	±2	12	11.76
	64	5320	10	±2	12	11.47
802.11 n 20MHz	52	5260	10	±2	12	Not required
	56	5280	10	±2	12	
	60	5300	10	±2	12	
	64	5320	10	±2	12	
802.11 n 40MHz	54	5270	9.5	±2	11.5	
	62	5310	9.5	±2	11.5	
802.11 ac80	58	5290	9	±2	11	

## U-NII-2A Chain0+1

Mode	Channel	Frequency (MHZ)	Chain0+1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	52	5260	13	±2	15	14.90
	56	5280	13	±2	15	14.84
	60	5300	13	±2	15	14.75
	64	5320	13	±2	15	14.68
802.11 n 20MHz	52	5260	13	±2	15	Not required
	56	5280	13	±2	15	
	60	5300	13	±2	15	
	64	5320	13	±2	15	
802.11 n 40MHz	54	5270	12.5	±2	14.5	
	62	5310	12.5	±2	14.5	
802.11 ac80	58	5290	12	±2	14	

## U-NII-2C Chain0

Mode	Channel	Frequency (MHz)	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	100	5500	10	±2	12	11.77
	112	5560	10	±2	12	11.95
	116	5580	10	±2	12	11.63
	128	5640	10	±2	12	11.96
	132	5660	10	±2	12	11.70
802.11 n 20MHz	100	5500	10	±2	12	
	112	5560	10	±2	12	
	116	5580	10	±2	12	
	128	5640	10	±2	12	
	132	5660	10	±2	12	
	142	5710	10	±2	12	
802.11 n 40MHz	102	5510	9.5	±2	11.5	Not required
	110	5550	9.5	±2	11.5	
	118	5590	9.5	±2	11.5	
	126	5630	9.5	±2	11.5	
	134	5670	9.5	±2	11.5	
802.11 ac80	106	5530	9	±2	11	
	122	5610	9	±2	11	
	138	5690	9	±2	11	

## U-NII-2C Chain1

Mode	Channel	Frequency (MHz)	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	100	5500	10	±2	12	11.77
	112	5560	10	±2	12	11.65
	116	5580	10	±2	12	11.69
	128	5640	10	±2	12	11.54
	132	5660	10	±2	12	11.49
802.11 n 20MHz	100	5500	10	±2	12	Not required
	112	5560	10	±2	12	
	116	5580	10	±2	12	
	128	5640	10	±2	12	
	132	5660	10	±2	12	
	142	5710	10	±2	12	
802.11 n 40MHz	102	5510	9.5	±2	11.5	
	110	5550	9.5	±2	11.5	
	118	5590	9.5	±2	11.5	
	126	5630	9.5	±2	11.5	
	134	5670	9.5	±2	11.5	
802.11 ac80	106	5530	9	±2	11	
	122	5610	9	±2	11	
	138	5690	9	±2	11	

## U-NII-2C Chain0+1

Mode	Channel	Frequency (MHz)	Chain0+1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average Power (dBm)
802.11 a	100	5500	13	±2	15	14.78
	112	5560	13	±2	15	14.81
	116	5580	13	±2	15	14.67
	128	5640	13	±2	15	14.77
	132	5660	13	±2	15	14.61
802.11 n 20MHz	100	5500	13	±2	15	
	112	5560	13	±2	15	
	116	5580	13	±2	15	
	128	5640	13	±2	15	
	132	5660	13	±2	15	
	142	5710	13	±2	15	
802.11 n 40MHz	102	5510	12.5	±2	14.5	Not required
	110	5550	12.5	±2	14.5	
	118	5590	12.5	±2	14.5	
	126	5630	12.5	±2	14.5	
	134	5670	12.5	±2	14.5	
802.11 ac80	106	5530	12	±2	14	
	122	5610	12	±2	14	
	138	5690	12	±2	14	

## U-NII-3 Chain0

Mode	Channel	Frequency	Chain0 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 a	149	5745	10	±2	12	11.91
	157	5785	10	±2	12	11.98
	165	5825	10	±2	12	11.97
802.11 n 20MHz	149	5745	10	±2	12	Not required
	157	5785	10	±2	12	
	165	5825	10	±2	12	
802.11 n 40MHz	151	5755	9.5	±2	11.5	Not required
	159	5795	9.5	±2	11.5	
802.11 ac80	155	5775	9	±2	11	

## U-NII-3 Chain1

Mode	Channel	Frequency	Chain1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 a	149	5745	10	±2	12	11.97
	157	5785	10	±2	12	11.91
	165	5825	10	±2	12	11.94
802.11 n 20MHz	149	5745	10	±2	12	Not required
	157	5785	10	±2	12	
	165	5825	10	±2	12	
802.11 n 40MHz	151	5755	9.5	±2	11.5	Not required
	159	5795	9.5	±2	11.5	
802.11 ac80	155	5775	9	±2	11	

## U-NII-3 Chain0+1

Mode	Channel	Frequency	Chain0+1 Target power(dBm)	Tune up tolerance (dBm)	Maximum Tune up power (dBm)	Average power (dBm)
802.11 a	149	5745	13	±2	15	14.95
	157	5785	13	±2	15	14.96
	165	5825	13	±2	15	14.97
802.11 n 20MHz	149	5745	13	±2	15	Not required
	157	5785	13	±2	15	
	165	5825	13	±2	15	
802.11 n 40MHz	151	5755	12.5	±2	14.5	Not required
	159	5795	12.5	±2	14.5	
802.11 ac80	155	5775	12	±2	14	

## Bluetooth

Band	Mode	Channel	Frequency	Averaged Power (dBm)
2.4 GHz	Bluetooth BR (GFSK)	0	2402	3.52
		39	2441	4.03
		78	2480	4.26
	Bluetooth EDR2 ( $\pi/4$ -DQPSK)	0	2402	3.21
		39	2441	3.84
		78	2480	4.01
	Bluetooth EDR3 (8-DPSK)	0	2402	2.90
		39	2441	3.42
		78	2480	3.62
	Bluetooth LE	0	2402	-0.13
		19	2440	0.19
		39	2480	0.25

## 10.5 SAR TEST CONFIGURATIONS

### <Tablet>

This EUT was tested in Two different positions. They are rear side of tablet, Edge 1. In these positions, the surface of EUT is touching with phantom 0cm.

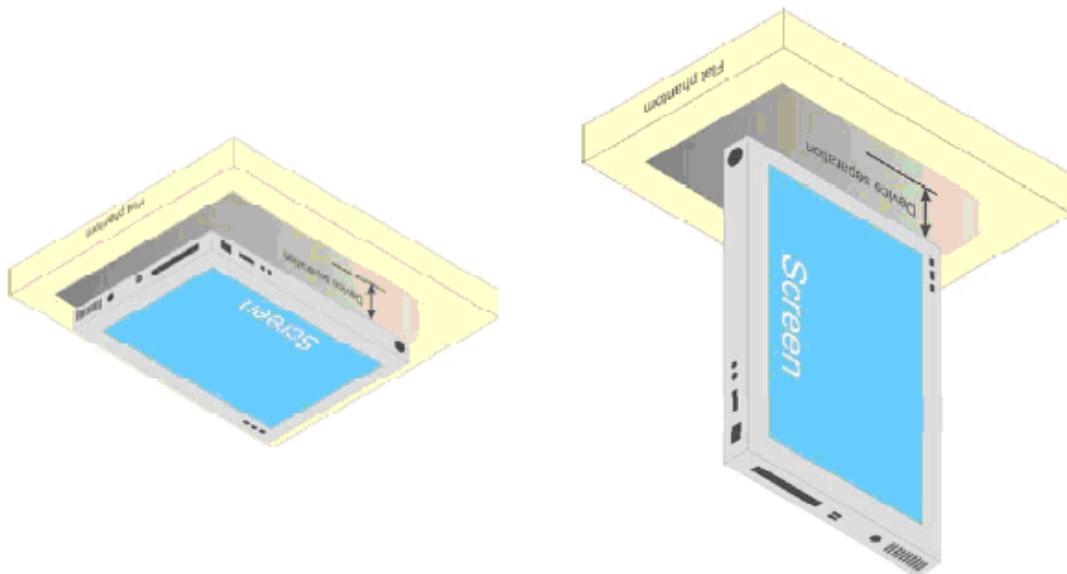
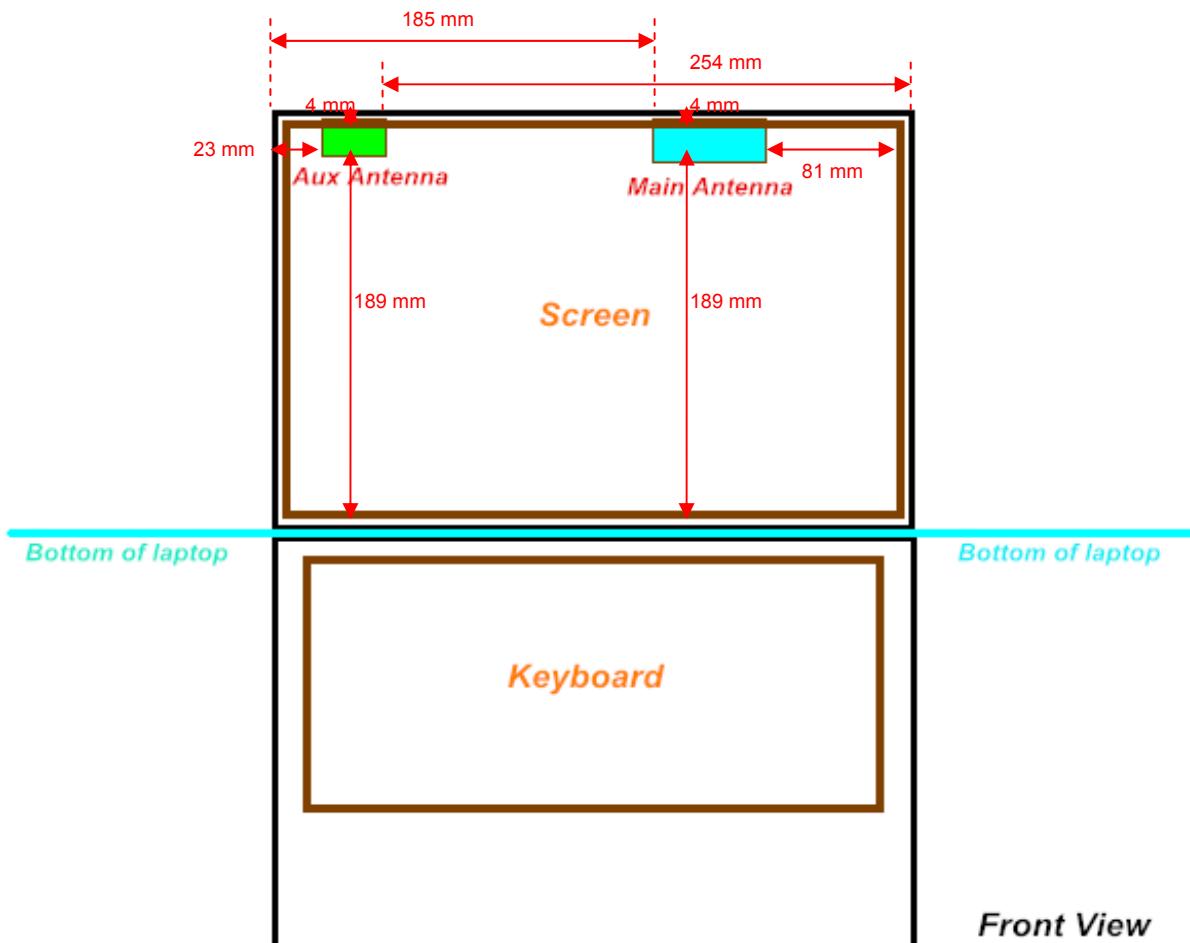


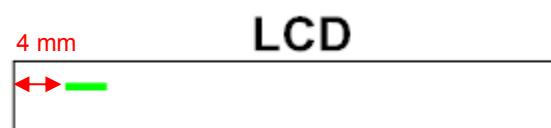
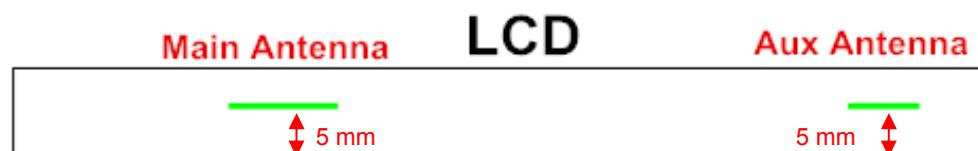
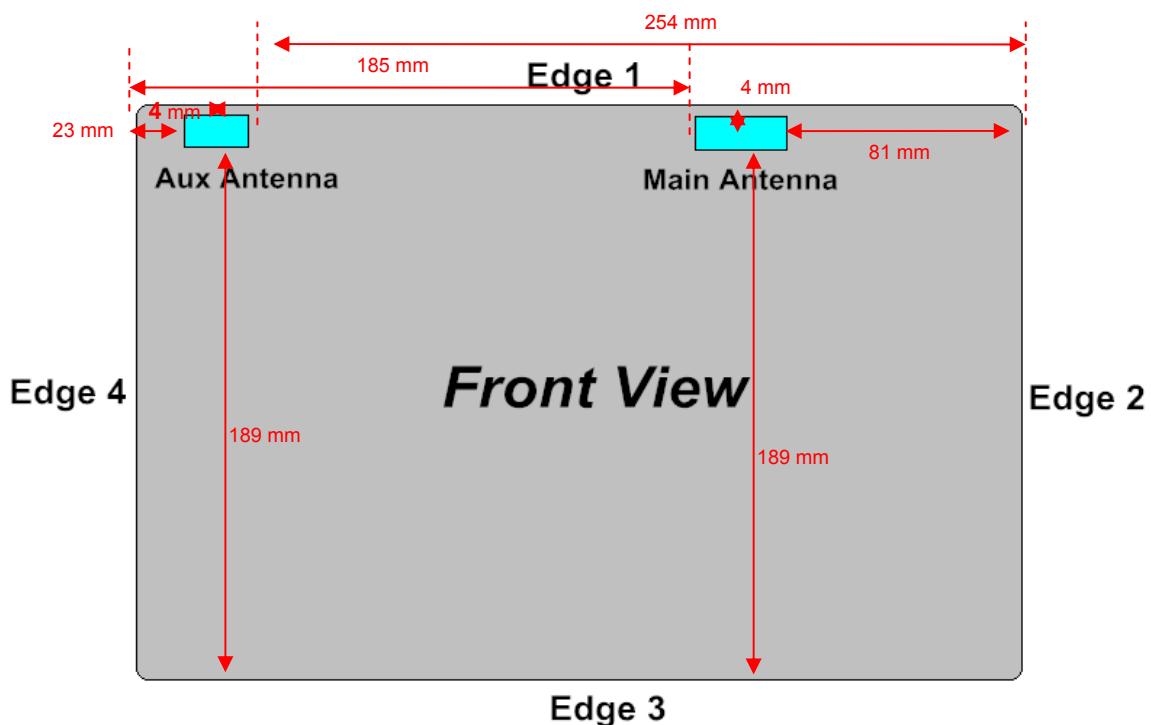
Fig Illustration for Lap-touching Position

## 10.6 ANTENNA LOCATION

<Notebook>



&lt;Tablet&gt;



Device dimensions for Tablet mode (H x W): 300 x 205 mm

Antennas	Wireless Interface
Bluetooth & WLAN Antenna	WLAN 2.4GHz WLAN 5.2GHz WLAN 5.3GHz WLAN 5.5GHz WLAN 5.8GHz Bluetooth
Main Antenna	WLAN TX/RX 2.4GHz/5GHz
Aux Antenna	WLAN TX/RX 2.4GHz/5GHz+ Bluetooth

**Test Mode**

IEEE 802.11	Data transmission mode(802.11a;802.11b; Bluetooth GFSK)
-------------	---

**Note:**

Chain0 is Main Antenna

Chain1 is Aux Antenna.

## 10.7 BODY TEST EXCLUSION THRESHOLDS

### 10.7.1. Exclusion analysis for FCC (BT and WLAN)

According to KDB447498 D01: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances*  $\leq$  50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f_{(\text{GHz})}}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR,<sup>24</sup> where

- $f_{(\text{GHz})}$  is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation<sup>25</sup>
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below
- If the test separation distance (antenna-user) is  $< 5\text{mm}$ , 5mm is used for excluded SAR calculation

	Wireless Interface	Bluetooth
Tune-up Maximum power (dBm)		4.5
Tune-up Maximum rated power (mW)		2.818
Body	Antenna to user (mm)	5
	Frequency(GHz)	2480
	SAR exclusion threshold	0.888

Per KDB 447498 D01 exclusion thresholds is  $0.888 < 3$ , Bluetooth RF exposure evaluation is not required.

The following SAR test exclusion Thresholds based on KDB 447498 D01 General RF Exposure Guidance v06 4.3.1

Exposure Position	Wireless Interface	WLAN	WLAN	WLAN	WLAN	Bluetooth
		802.11 b Main	802.11 a Main	802.11 b Aux	802.11 a Aux	GFSK Aux
	Maximum power	13	12	13	12	4.5
	Maximum rated power(mW)	19.95	15.85	19.95	15.85	2.82
Rear view	Antenna to user (mm)	5	5	5	5	5
	SAR exclusion threshold	9.58	6.23	9.58	6.23	9.58
	SAR testing required?	Yes	Yes	Yes	Yes	No
Edge1	Antenna to user (mm)	4	4	4	4	4
	SAR exclusion threshold	7.67	4.98	7.67	4.98	7.67
	SAR testing required?	Yes	Yes	Yes	Yes	No
Edge2	Antenna to user (mm)	81	81	254	254	254
	SAR exclusion threshold	406	372.28	2136	2012.28	2136
	SAR testing required?	No	No	No	No	No
Edge3	Antenna to user (mm)	189	189	189	189	189
	SAR exclusion threshold	1486	1452.28	1486	1452.28	1486
	SAR testing required?	No	No	No	No	No
Edge4	Antenna to user (mm)	185	185	23	23	23
	SAR exclusion threshold	1446	1412.28	44.08	28.65	44.08
	SAR testing required?	No	No	No	No	No

**Note:**

1. Maximum power is the source-based time-average power and represents the maximum RF output power among production units
2. Per KDB 447498 D01v06, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
3. Per KDB 447498 D01v06, standalone SAR test exclusion threshold is applied; If the distance of the antenna to the user is < 5mm, 5mm is used to determine SAR exclusion threshold
4. Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances*  $\leq$  50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot \sqrt{f(\text{GHz})} \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR

$f(\text{GHz})$  is the RF channel transmit frequency in GHz

Power and distance are rounded to the nearest mW and mm before calculation

The result is rounded to one decimal place for comparison

For  $< 50$  mm distance, we just calculate mW of the exclusion threshold value (3.0) to do compare.

This formula is  $[3.0] / [\sqrt{f(\text{GHz})}] \cdot [(\text{min. test separation distance, mm})] = \text{exclusion threshold of mW.}$

5. Per KDB 447498 D01v06, at 100 MHz to 6 GHz and for *test separation distances*  $> 50$  mm, the SAR test exclusion threshold is determined according to the following

- a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)  $\cdot$  (f(MHz)/150)] mW, at 100 MHz to 1500 MHz
- b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)  $\cdot$  10] mW at  $> 1500$  MHz and  $\leq 6$  GHz

6. When the minimum *test separation distance* is  $< 5$  mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

### 10.7.2. Exclusion analysis for ISED (BT and WLAN)

According to RSS102-2015 :

SAR evaluation for this device was performed with a separation distance of 5 mm. Observing the SAR evaluation exemption limit table (Table 1, see below) found in § 2.5.1 of RSS102:2015 , it was determined that the SAR exemption limit for this device is 4 mW for 2.4GHz transmission. No Wi-Fi mode qualified for test exemption as all power levels were above the stated thresholds. On the contrary, Bluetooth, with a frequency of 2480 MHz and a maximum output power of 6.714 mW (8.27 dBm, tune-up tolerance accounted for), is High than the exemption threshold and therefore exempt from SAR evaluation for either the intended user or bystanders. So Bluetooth RF exposure evaluation is required

**Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance**

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

The following SAR test exclusion Thresholds based on RSS102 issue5 2.5.1

Exposure Position	Wireless Interface	WLAN	WLAN	WLAN	WLAN	Bluetooth
		802.11 b Main	802.11 a Main	802.11 b Aux	802.11 a Aux	GFSK Aux
		Maximum power	13	12	13	4.5
Rear view	Maximum rated power(mW)	19.95	15.85	19.95	15.85	2.82
	Antenna to user (mm)	5	5	5	5	5
	SAR exclusion threshold	4	1	4	1	4
Edge1	SAR testing required?	Yes	Yes	Yes	Yes	No
	Antenna to user (mm)	4	4	4	4	4
	SAR exclusion threshold	4	1	4	1	4
Edge2	SAR testing required?	Yes	Yes	Yes	Yes	No
	Antenna to user (mm)	81	81	254	254	254
	SAR exclusion threshold	309	106	106	106	309
Edge3	SAR testing required?	No	No	No	No	No
	Antenna to user (mm)	189	189	189	189	189
	SAR exclusion threshold	309	106	106	106	309
Edge4	SAR testing required?	No	No	No	No	No
	Antenna to user (mm)	185	185	23	23	23
	SAR exclusion threshold	309	106	52	41	52

Note:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

## 10.8 SAR MEASUREMENT RESULTS

### Note:

1. Per KDB 447498 D01, 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)\* Duty Cycle scaling factor \* Tune-up scaling factor
2. Per KDB 447498 D01, for each exposure position, if the highest output channel reported SAR  $\leq 0.8\text{W/kg}$ , other channels SAR testing is not necessary.
3. Per KDB 447498 D01, 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:
  - $\leq 0.8\text{ W/kg}$  or  $2.0\text{ W/kg}$ , for 1-g or 10-g respectively, when the transmission band is  $\leq 100\text{ MHz}$
  - $\leq 0.6\text{ W/kg}$  or  $1.5\text{ W/kg}$ , for 1-g or 10-g respectively, when the transmission band is between  $100\text{ MHz}$  and  $200\text{ MHz}$
  - $\leq 0.4\text{ W/kg}$  or  $1.0\text{ W/kg}$ , for 1-g or 10-g respectively, when the transmission band is  $\geq 200\text{ MHz}$

### 2.4GHz SAR Results for Test Records

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHz)	Ant	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)
WLAN 2.4Ghz	802.11b	TB	Rear	0	2412	Main	12.68	13	1.076	0.02	1	0.864	0.930
		TB	Rear	0	2437	Main	12.92	13	1.019	0.03	1	0.808	0.823
		TB	Rear	0	2462	Main	12.69	13	1.074	0.16	1	0.620	0.666
		TB	Edge 1	0	2437	Main	12.92	13	1.019	0.07	1	0.186	0.189
		TB	Rear	0	2437	Aux	12.90	13	1.023	-0.13	1	0.494	0.506
		TB	Edge 1	0	2437	Aux	12.90	13	1.023	0.07	1	0.095	0.097
2.4Ghz	BT GFSK	TB	Rear	0	2480	Aux	4.26	4.5	1.057	-0.03	1.30	0.101	0.139
		TB	Edge 1	0	2480	Aux	4.26	4.5	1.057	0.04	1.30	0.016	0.022

Remark: SAR is not required for the following 2.4 GHz OFDM conditions.

- 1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
- 2) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2\text{ W/kg}$ .

The highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2\text{ W/kg}$ . So 2.4 GHz OFDM mode is not required.

### Repeated SAR Test Records for 2.4GHz

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHz)	Chain	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)
WLAN 2.4Ghz	802.11b	TB	Rear	0	2412	Main	12.68	13	1.076	-0.03	1	0.918	0.988

## 5GHz SAR Results for Test Records

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHz)	Chain	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)
U-NII-2A	802.11a	TB	Rear	0	5280	Main	11.91	12	1.021	0.17	1.05	0.553	0.594
U-NII-2C		TB	Rear	0	5640	Main	11.96	12	1.009	0.10	1.05	0.719	0.764
U-NII-3		TB	Rear	0	5785	Main	11.98	12	1.005	0.12	1.05	0.262	0.277
U-NII-2A		TB	Rear	0	5260	Aux	11.92	12	1.019	-0.09	1.05	0.547	0.586
U-NII-2C		TB	Rear	0	5500	Aux	11.77	12	1.054	0.15	1.05	0.713	0.791
U-NII-3		TB	Rear	0	5745	Aux	11.97	12	1.007	0.06	1.05	0.535	0.567
U-NII-2A	802.11a	TB	Edge1	0	5280	Main	11.91	12	1.021	0.07	1.05	1.07	1.150
U-NII-2A		TB	Edge1	0	5320	Main	11.86	12	1.033	0.11	1.05	1.09	1.185
U-NII-2C		TB	Edge1	0	5560	Main	11.95	12	1.012	-0.19	1.05	1.12	1.193
U-NII-2C		TB	Edge1	0	5640	Main	11.96	12	1.009	0.12	1.05	0.926	0.984
U-NII-3		TB	Edge1	0	5785	Main	11.98	12	1.005	-0.10	1.05	0.483	0.511
U-NII-2A		TB	Edge1	0	5260	Aux	11.92	12	1.019	-0.08	1.05	0.597	0.640
U-NII-2C		TB	Edge1	0	5500	Aux	11.77	12	1.054	0.07	1.05	0.539	0.598
U-NII-3		TB	Edge1	0	5745	Aux	11.97	12	1.007	0.09	1.05	0.200	0.212

Remark: For devices that operate in both U-NII-1 and U-NII-2A 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  $\leq 1.2$  W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, each band is tested independently for SAR.

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  $\leq 1.2$  W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, each band is tested independently for SAR.

The highest reported SAR for Main Antenna is adjusted by the ratio of U-NII-1 to U-NII-2A specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg. So Main Antenna U-NII-1 mode is not required.

## Repeated SAR Test Records for 5GHz

Band	Mode	Configure	Test Position	Dist. (mm)	Freq. (MHZ)	Chain	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Duty Cycle Factor	SAR1g (mW/g)	Scaled SAR1g (mW/g)
U-NII-2A	802.11a	TB	Edge1	0	5320	Main	11.86	12	1.033	0.10	1.05	1.09	1.185
U-NII-2C		TB	Edge1	0	5560	Main	11.95	12	1.012	0.14	1.05	1.11	1.182

## 10.9 REPEATED SAR MEASUREMENT

**Note:**

1. Per KDB 865664 D01v01, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8\text{W/Kg}$
2. Per KDB 865664 D01v01, if the ratio of largest to smallest SAR for the original and first repeated measurement is  $\leq 1.2$  and the measured SAR  $< 1.45\text{W/Kg}$ , only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated measured SAR.

Band	Mode	Test Position			Freq (MHZ)	Original Measured SAR1g (mW/g)	1st Repeated SAR1g (mW/g)	Ratio	Original Measured SAR1g (mW/g)	2nd Repeated SAR1g (mW/g)	Ratio
WLAN 2.4Ghz	802.11b	TB	Rear	Main	2412	0.864	0.918	1.063	--	--	--
U-NII-2A	802.11a	TB	Edge1	Main	5320	1.09	1.09	1			
U-NII-2C	802.11a	TB	Edge1	Main	5560	1.12	1.11	1.009			

## 10.10 SAR TABLET/CONVERTIBLE COMPUTER MULTI XMITER ASSESSMENT

	Position	Applicable Combination
Simultaneous Transmission	Body	Main Antenna + Aux Antenna/BT

**Note:**

1. Aux Antenna 2.4GHz WLAN and BT share the same antenna, and cannot transmit simultaneously.
2. The DUT support chain0 and chain1 WLAN simultaneous transmission
3. The reported SAR summation is calculated based on the same configuration and test position.
4. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
  - 1) Scalar SAR summation < 1.6W/kg.
  - 2) SPLSR =  $(\text{SAR}_1 + \text{SAR}_2)1.5 / (\text{min. separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$ , where  $(x_1, y_1, z_1)$  and  $(x_2, y_2, z_2)$  are the coordinates of the extrapolated peak SAR locations in the zoom scan
  - If  $\text{SPLSR} \leq 0.04$ , simultaneously transmission SAR is compliant
  - 3) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg
5. According to KDB 447498 D01 simultaneous SAR testing can be excluded under the following conditions:  
The sum of the SAR for all simultaneously transmitting antennas is within the SAR limit.

If the sum of the SAR for all simultaneously transmitting antennas exceeds the SAR limit testing can still be excluded if the SAR to Peak Location Ratio (SPLSR) between any pair of simultaneously transmitting antennas is  $\leq 0.04$

$$\text{SPLSR} = (\text{SAR}_1 + \text{SAR}_2)1.5 / \text{R}_i$$

Where:

$\text{SAR}_1$  is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

$\text{SAR}_2$  is the highest measured or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

$\text{R}_i$  is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of  $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

**Sum of SAR for worst case standalone measurements (Wi-Fi 2.4 GHz)**

SUM $\sum \text{SAR}_{1g}$ 2.4G								
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]			
		Main WLAN 2.4G①	Aux WLAN 2.4G②	Bluetooth ③	①+②	SPLSR (Yes/No)	①+③	SPLSR (Yes/No)
Rear	0	0.988	0.506	0.139	1.494	No	1.127	No
Edge1	0	0.189	0.097	0.022	0.286	No	0.211	No

**Conclusion:**

When the  $\sum$  1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

## standalone measurements (Wi-Fi U-NII-2A)

SUM $\Sigma$ SAR1g 5G								
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]			
		Main U-NII-2A①	Aux U-NII-2A②	Bluetooth ③	①+②	SPLSR (Yes/No)	①+③	SPLSR (Yes/No)
Rear	0	0.594	0.586	0.139	1.180	No	0.733	No
Edge1	0	1.185	0.640	0.022	1.825	Yes	1.207	No

**Conclusion:**

When the  $\Sigma$  1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

When the  $\Sigma$  1-g SAR is greater than 1.6 W/kg SPLSR evaluation is required

## SAR to Peak Location Separation Ratio (SPLSR)

Position	Worst-case combination		SUM SAR(1g) [W/kg]	Calculated distance	SPLSR	Simultaneous SAR	
	①	②					
Rear	1.185	0.640	1.825	162.98	0.015	No	
SAR peak location(m)							
X,Y,Z	-0.04,0,-0.048,-0.179	8.74e-011,0.11,-0.179					

**Conclusion:**

SPLSR is  $\leq 0.04$  therefore simultaneous transmission testing is not required

## Sum of SAR for worst case standalone measurements (Wi-Fi U-NII-2C)

SUM $\Sigma$ SAR1g 5G								
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]			
		Main U-NII-2A①	Aux U-NII-2A②	Bluetooth ③	①+②	SPLSR (Yes/No)	①+③	SPLSR (Yes/No)
Rear	0	0.764	0.791	0.139	1.555	No	0.903	No
Edge1	0	1.193	0.598	0.022	1.791	Yes	1.215	No

**Conclusion:**

When the  $\Sigma$  1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

When the  $\Sigma$  1-g SAR is greater than 1.6 W/kg SPLSR evaluation is required

## SAR to Peak Location Separation Ratio (SPLSR)

Position	Worst-case combination		SUM SAR(1g) [W/kg]	Calculated distance	SPLSR	Simultaneous SAR	
	①	③					
Rear	1.193	0.598	1.791	155.21	0.015	No	
SAR peak location(m)							
X,Y,Z	8.74e-011,-0.049,-0.179	-0.008,0.106,-0.179					

**Conclusion:**

SPLSR is  $\leq 0.04$  therefore simultaneous transmission testing is not required

## Sum of SAR for worst case standalone measurements (Wi-Fi U-NII-3)

SUM $\Sigma$ SAR1g 5G									
Position	Distance [mm]	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]				
		Main U-NII-3①	Aux U-NII-3②	Bluetooth ③	①+②	SPLSR (Yes/No)	①+③	SPLSR (Yes/No)	
Rear	0	0.277	0.567	0.139	0.844	No	0.416	No	
Edge1	0	0.511	0.212	0.022	0.723	No	0.533	No	

**Conclusion:**

When the  $\Sigma$  1-g SAR is less than 1.6 W/kg simultaneous transmission testing is not required

## 11. EQUIPMENT LIST & CALIBRATION STATUS

Name of Equipment	Manufacturer	Type/Model	Serial Number	Last Calibration	Calibration Due
P C	HP	Core(rm)3.16G	CZCO48171H	N/A	N/A
Signal Generator	Agilent	E8257C	US37101915	11/01/2016	10/31/2017
S-Parameter Network Analyzer	Agilent	E5071B	MY42301382	03/02/2016	03/01/2017
Power meter	Anritsu	ML2495A	1445010	03/02/2016	03/01/2017
Power sensor	Anritsu	MA2411B	1339220	03/02/2016	03/01/2017
E-field PROBE	SPEAG	EX3DV4	3798	07/27/2016	07/26/2017
DAE	SPEAG	DEA4	1245	07/26/2016	07/25/2017
DIPOLE 2450MHZ ANTENNA	SPEAG	D2450V2	817	05/31/2016	05/28/2019
DIPOLE 5GHZ ANTENNA	SPEAG	D5GHzV2	1095	05/25/2016	05/22/2019
DUMMY PROBE	SPEAG	DP_2	SPDP2001AA	N/A	N/A
SAM PHANTOM (ELI4 v4.0)	SPEAG	QDOVA001BB	1102	N/A	N/A
Twin SAM Phantom	SPEAG	QD000P40CD	1609	N/A	N/A
ROBOT	SPEAG	TX60	F10/5E6AA1/A101	N/A	N/A
ROBOT KRC	SPEAG	CS8C	F10/5E6AA1/C101	N/A	N/A
LIQUID CALIBRATION KIT	ANTENNESSA	41/05 OCP9	00425167	N/A	N/A

## 12. FACILITIES

All measurement facilities used to collect the measurement data are located at

No.10, Weiye Rd., Innovation Park, Eco & Tec. Development Part, Kunshan City, Jiangsu Province, China.

## 13. REFERENCES

- [1] Federal Communications Commission, \Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.
- [2] David L. Means Kwok Chan, Robert F. Cleveland, \Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commision, O\_ce of Engineering & Technology, Washington, DC, 1997.
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E\_eld scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.
- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, \Dosimetric evaluation of mobile communications equipment with known precision", IEICE Transactions on Communications, vol. E80-B, no. 5, pp. 645{652, May 1997.
- [5] CENELEC, \Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz – 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.
- [6] ANSI, ANSI/IEEE C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E\_eld probes in tissue simulating liquids at mobile communications frequencies", in ICECOM \_97, Dubrovnik, October 15{17, 1997, pp. 120{124.
- [8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E\_eld probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172{175.
- [9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard K. uhn, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions onMicrowave Theory and Techniques, vol. 44, no. 10, pp. 1865{1873, Oct. 1996.
- [10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.
- [11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992..Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, \The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, \Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10

**APPENDIX A: DUT AND SAR SETUP PHOTO****APPENDIX B: PLOTS OF PERFORMANCE CHECK**

**The plots are showing as followings.**

Test Laboratory: Compliance Certification Services Inc.

Date: 12/28/2016

**System Performance Check - Body D2450**

**DUT: Dipole 2450 MHz; Type: D24500V2; Serial: 817**

Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.964$  S/m;  $\epsilon_r = 51.081$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(7.07, 7.07, 7.07); Calibrated: 7/27/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/26/2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (9x10x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 17.0 W/kg

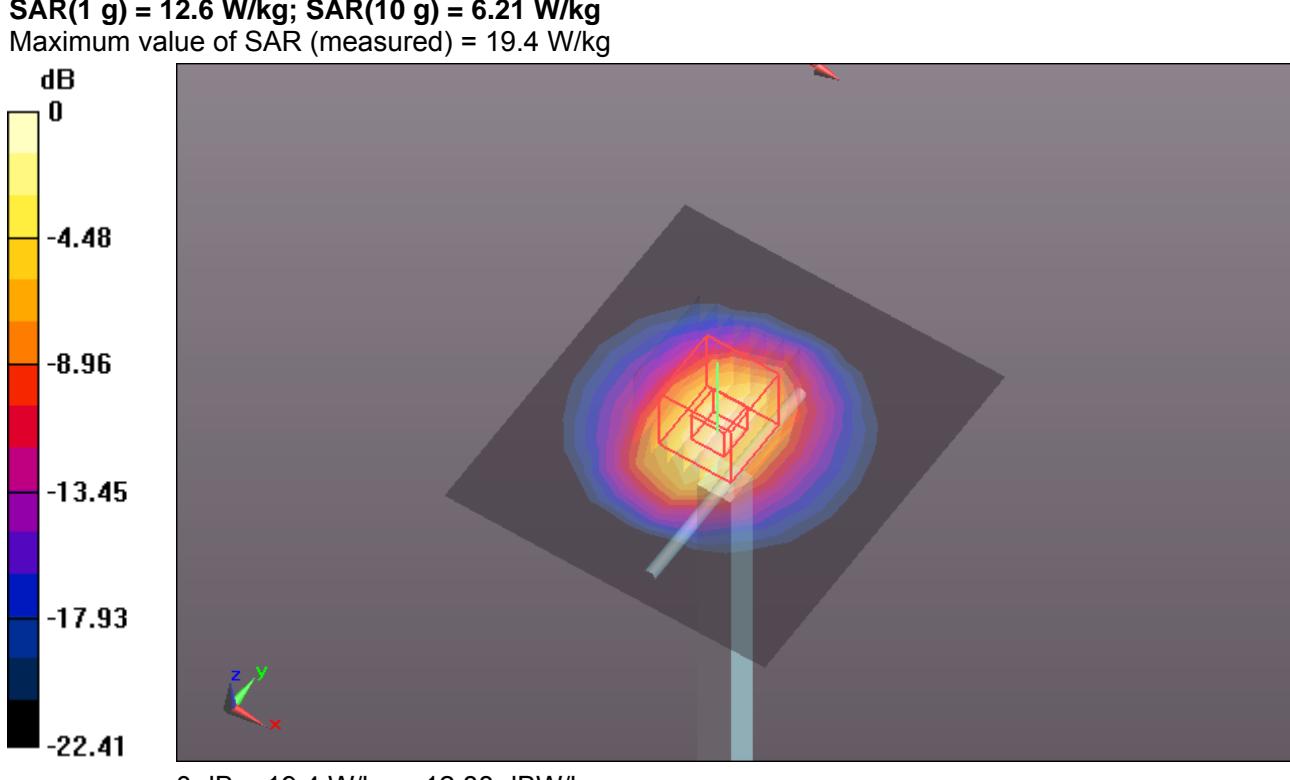
**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.29 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 26.0 W/kg

**SAR(1 g) = 12.6 W/kg; SAR(10 g) = 6.21 W/kg**

Maximum value of SAR (measured) = 19.4 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/29/2016

**System Performance Check-D5200**

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095**

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5200 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.193$  S/m;  $\epsilon_r = 47.959$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.77, 4.77, 4.77); Calibrated: 7/27/2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/26/2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200**

**MHz/Area Scan (10x10x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 13.1 W/kg

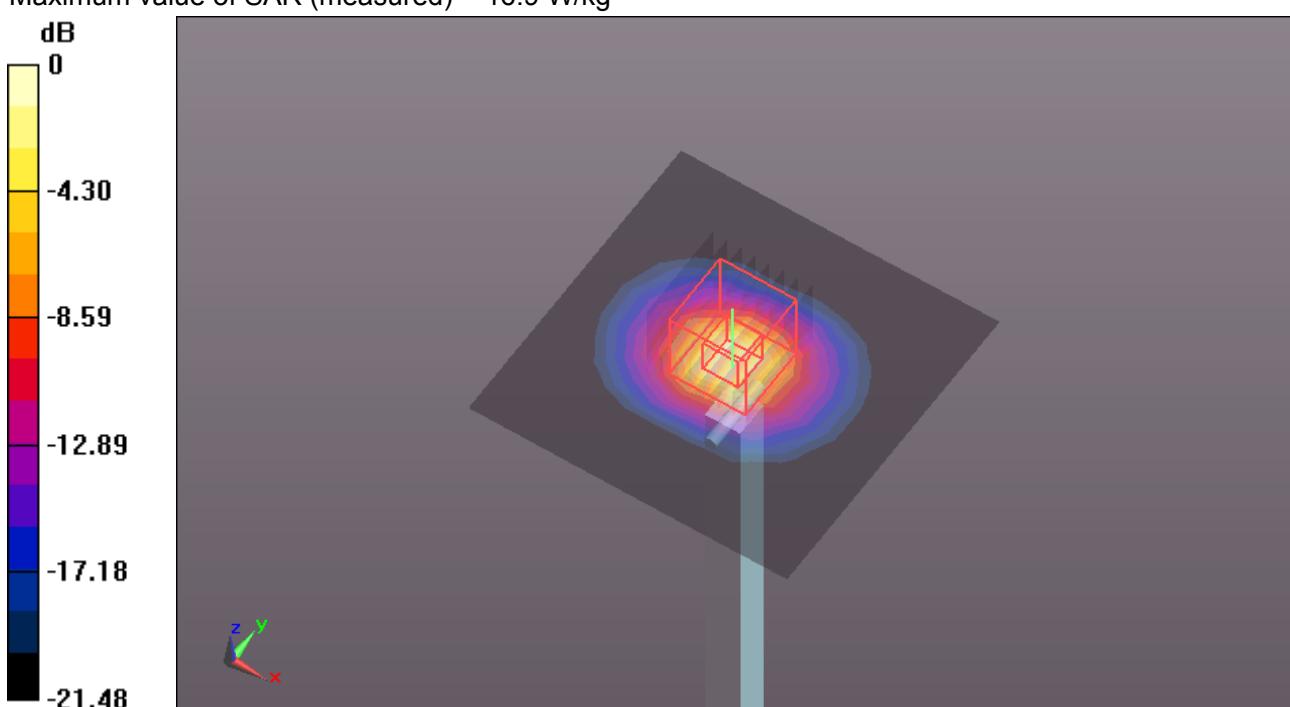
**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200**  
**MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 67.98 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 28.4 W/kg

**SAR(1 g) = 7.49 W/kg; SAR(10 g) = 2.19 W/kg**

Maximum value of SAR (measured) = 16.9 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/29/2016

**SystemPerformanceCheck-D5300**

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095**

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5300 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5300$  MHz;  $\sigma = 5.319$  S/m;  $\epsilon_r = 47.742$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.6, 4.6, 4.6); Calibrated: 7/27/2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/26/2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300**

**MHz/Area Scan (9x10x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 14.2 W/kg

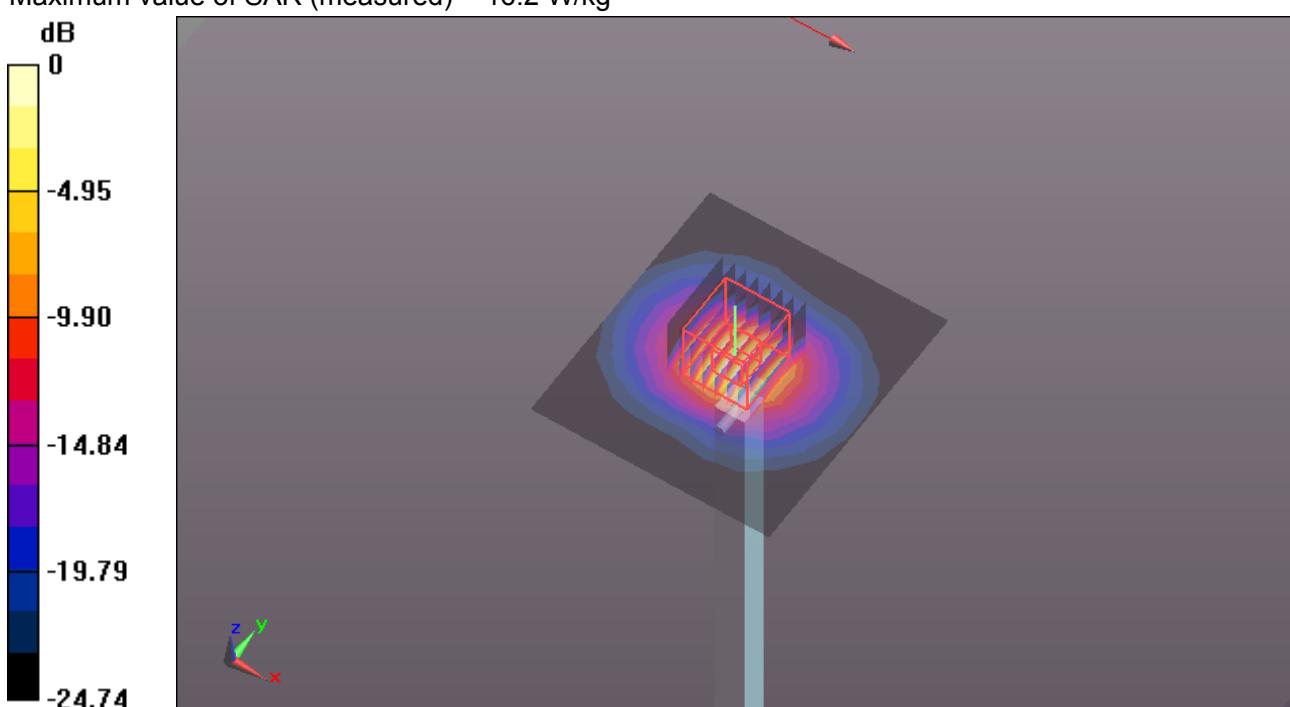
**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300**  
**MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.78 V/m; Power Drift = -0.12 dB

Peak SAR (extrapolated) = 28.7 W/kg

**SAR(1 g) = 7.85 W/kg; SAR(10 g) = 2.39 W/kg**

Maximum value of SAR (measured) = 16.2 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/29/2016

**System Performance Check-D5500**

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095**

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5500 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.596$  S/m;  $\epsilon_r = 47.329$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.23, 4.23, 4.23); Calibrated: 7/27/2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/26/2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500**

**MHz/Area Scan (9x10x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 15.3 W/kg

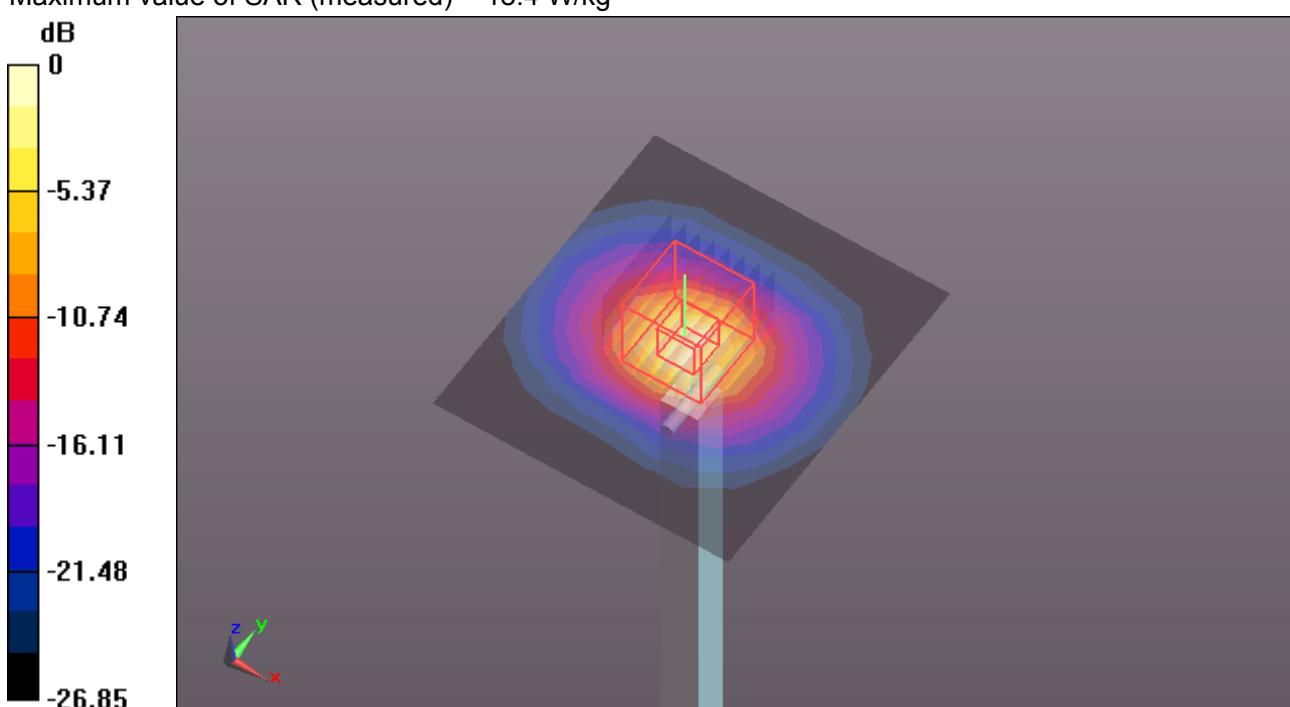
**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500**  
**MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.25 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 33.5 W/kg

**SAR(1 g) = 7.91 W/kg; SAR(10 g) = 2.48 W/kg**

Maximum value of SAR (measured) = 18.4 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/29/2016

**System Performance Check-D5600**

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095**

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.731$  S/m;  $\epsilon_r = 47.057$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.18, 4.18, 4.18); Calibrated: 7/27/2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/26/2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600**

**MHz/Area Scan (9x10x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 15.6 W/kg

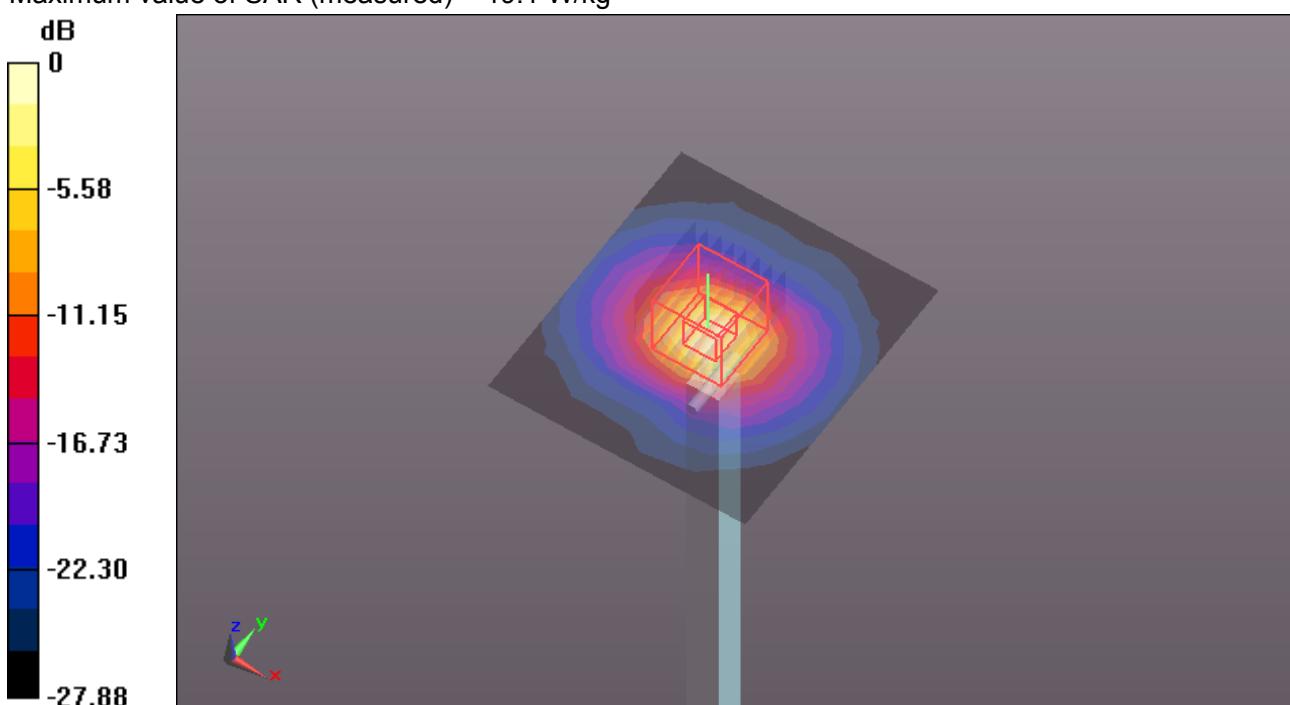
**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600**  
**MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.80 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 35.0 W/kg

**SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.52 W/kg**

Maximum value of SAR (measured) = 19.1 W/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/29/2016

**System Performance Check-D5800**

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095**

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5800 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.024$  S/m;  $\epsilon_r = 46.651$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.34, 4.34, 4.34); Calibrated: 7/27/2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/26/2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5800**

**MHz/Area Scan (9x10x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 15.1 W/kg

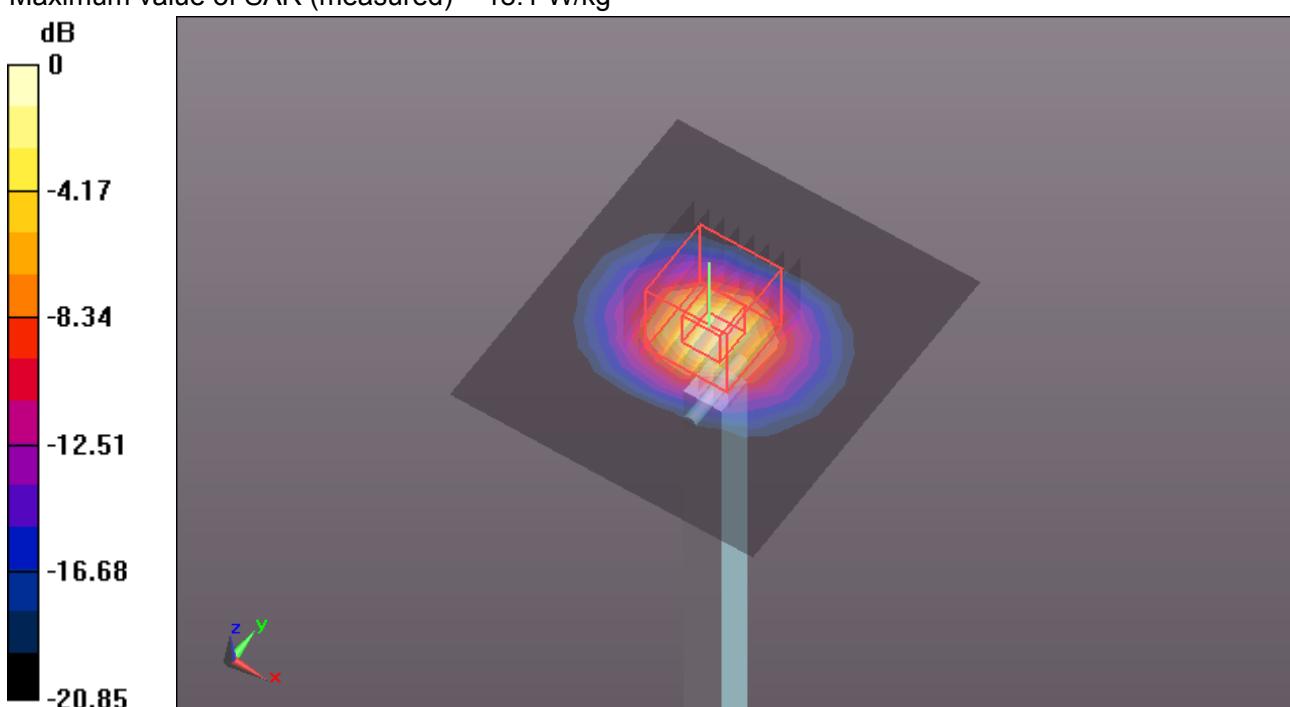
**System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5800**  
**MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.10 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 33.7 W/kg

**SAR(1 g) = 7.61 W/kg; SAR(10 g) = 2.33 W/kg**

Maximum value of SAR (measured) = 18.1 W/kg



**APPENDIX C: DASY CALIBRATION CERTIFICATE**

**The DASY Calibration Certificates are showing in the file named Appendix C DASY Calibration Certificate .**

**APPENDIX D: PLOTS OF SAR TEST RESULT**

**The plots are showing in the file named Appendix D Plots of Highest SAR Test Result**

**END REPORT**