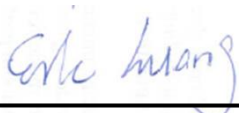


FCC SAR Test Report

APPLICANT : Linksys LLC
EQUIPMENT : Linksys Dual Band Wireless-AC USB Adapter
BRAND NAME : Linksys
MODEL NAME : WUSB6300
FCC ID : Q87-WUSB6300
STANDARD : FCC 47 CFR Part 2 (2.1093)
ANSI/IEEE C95.1-1992
IEEE 1528-2003
FCC OET Bulletin 65 Supplement C (Edition 01-01)

The product was completely tested on Dec. 06, 2012. 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 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.



Table of Contents

1. Statement of Compliance 4

2. Administration Data 5

 2.1 Testing Laboratory..... 5

 2.2 Applicant 5

 2.3 Manufacturer..... 5

 2.4 Application Details..... 5

3. General Information 6

 3.1 Description of Equipment Under Test (EUT) 6

 3.2 Maximum RF output power among production units 7

 3.3 Applied Standards..... 7

 3.4 Device Category and SAR Limits 7

 3.5 Test Conditions..... 7

4. Specific Absorption Rate (SAR)..... 8

 4.1 Introduction 8

 4.2 SAR Definition..... 8

5. SAR Measurement System 9

 5.1 E-Field Probe10

 5.2 Data Acquisition Electronics (DAE) 11

 5.3 Robot 11

 5.4 Measurement Server..... 11

 5.5 Phantom.....12

 5.6 Device Holder.....13

 5.7 Data Storage and Evaluation 14

 5.8 Test Equipment List.....16

6. Tissue Simulating Liquids17

7. SAR Measurement Evaluation19

 7.1 Purpose of System Performance check 19

 7.2 System Setup.....19

 7.3 SAR System Verification Results 20

8. EUT Testing Position21

9. Measurement Procedures22

 9.1 Spatial Peak SAR Evaluation 22

 9.2 Area & Zoom Scan Procedures..... 23

 9.3 Volume Scan Procedures..... 24

 9.4 SAR Averaged Methods 24

 9.5 Power Drift Monitoring..... 24

10. SAR Test Configurations25

 10.1 Exposure Positions Consideration 25

 10.2 Conducted RF Power (Unit: dBm)..... 26

11. SAR Test Results31

 11.1 Test Records for Body SAR Test 31

 11.2 Repeated SAR Measurement..... 33

 11.3 Highest SAR Plot..... 34

12. Uncertainty Assessment38

13. References41

- Appendix A. Plots of System Performance Check
- Appendix B. Plots of SAR Measurement
- Appendix C. DASy Calibration Certificate
- Appendix D. Test Setup Photos



Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA2N0801-01	Rev. 01	Initial issue of report	May 31, 2013



1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Linksys LLC Linksys Dual Band Wireless-AC USB Adapter WUSB6300** are as follows.

Exposure Position	Frequency Band	Reported 1g-SAR (W/kg)	Equipment Class	Highest Reported 1g-SAR (W/kg)
Body (0.5cm Gap)	WLAN, 2412 - 2462 MHz	1.17	DTS	1.17
	WLAN, 5745 - 5825 MHz	1.12		
	WLAN, 5180 - 5240 MHz	0.67	NII	0.67

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 and FCC OET Bulletin 65 Supplement C (Edition 01-01).



2. Administration Data

2.1 Testing Laboratory

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1 st 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

2.2 Applicant

Company Name	Linksys LLC
Address	131 Theory Drive, Irvine Ca., 92617

2.3 Manufacturer

Company Name	Linksys LLC
Address	131 Theory Drive, Irvine Ca., 92617

2.4 Application Details

Date of Start during the Test	Dec. 05, 2012
Date of End during the Test	Dec. 06, 2012



3. General Information

3.1 Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT	Linksys Dual Band Wireless-AC USB Adapter
Brand Name	Linksys
Model Name	WUSB6300
FCC ID	Q87-WUSB6300
Tx Frequency	WLAN2.4G: 2412 MHz ~ 2462 MHz WLAN5G: 5180 MHz ~ 5240 MHz; 5745 MHz ~ 5825 MHz
Antenna Type	Printed Antenna
Uplink Modulations	802.11b: DSSS (BPSK / QPSK / CCK) 802.11a/g/n/ac : OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM)
EUT Stage	Identical Prototype
Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.	



3.2 Maximum RF output power among production units

Max Target Average Power for Production Unit								
Mode / Band	IEEE 802.11							
	a	b	g	HT-20	HT-40	VHT-20	VHT-40	VHT-80
2.4 GHz WIFI (ANT 2)		17.5	17					
2.4 GHz WIFI (ANT 1+2)				19	18.5			
5 GHz Band 1 WIFI(ANT 2)	16							
5 GHz Band 4 WIFI(ANT 2)	16							
5 GHz Band 1 WIFI(ANT 1+2)				16	16	16	16	15
5 GHz Band 4 WIFI(ANT 1+2)				22	21.5	22	21.5	21.5

3.3 Applied Standards

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

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2003
- FCC OET Bulletin 65 Supplement C (Edition 01-01)
- FCC KDB 248227 D01 v01r02
- FCC KDB 447498 D01 v05
- FCC KDB 447498 D02 v02
- FCC KDB 644545 D01 v01

3.4 Device Category and SAR Limits

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

3.5 Test Conditions

3.5.1 Ambient Condition

Ambient Temperature	20 to 24 °C
Humidity	< 60 %

3.5.2 Test Configuration

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

4. Specific Absorption Rate (SAR)

4.1 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.

4.2 SAR Definition

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

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

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

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

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

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

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

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

5. SAR Measurement System

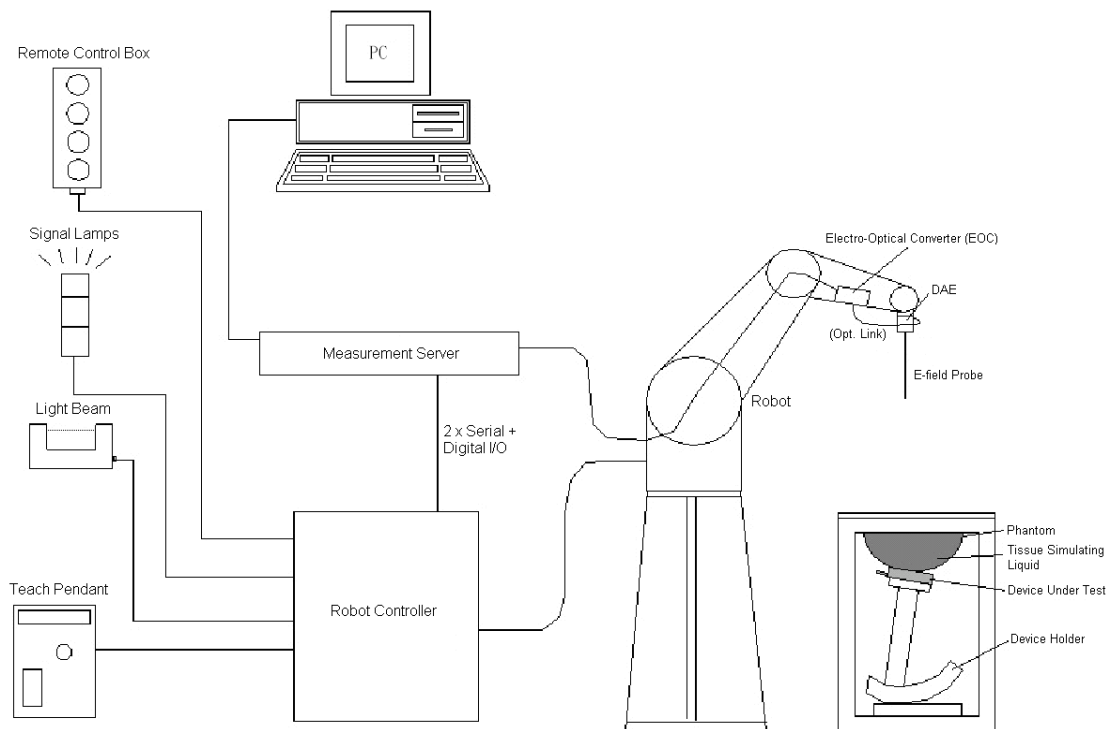


Fig 5.1 SPEAG DASY System Configurations

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY software
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system


Some of the components are described in details in the following sub-sections.

5.1 E-Field Probe

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

5.1.1 E-Field Probe Specification

<EX3DV4 / ES3DV4 Probe>

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	 <p>Fig 5.2 Photo of EX3DV4/ES3DV4</p>
Frequency	10 MHz to 6 GHz; Linearity: ± 0.2 dB	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 μ W/g to 100 mW/g; Linearity: ± 0.2 dB (noise: typically $< 1 \mu$ W/g)	
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

5.1.2 E-Field Probe Calibration

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

5.2 Data Acquisition Electronics (DAE)

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

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



Fig 5.3 Photo of DAE

5.3 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90BL; DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

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



Fig 5.4 Photo of DASY4



Fig 5.5 Photo of DASY5

5.4 Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 128 MB), RAM (DASY4: 64 MB, DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

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




Fig 5.6 Photo of Server for DASY4



Fig 5.7 Photo of Server for DASY5


5.5 Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm	 <p>Fig 5.8 Photo of SAM Phantom</p>
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Hand, Right Hand, Flat Phantom	

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

<ELI4 Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%)	 <p>Fig 5.9 Photo of ELI4 Phantom</p>
Filling Volume	Approx. 30 liters	
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm	

The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

5.6 Device Holder

<Device Holder for SAM Twin Phantom>

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

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

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



Fig 5.10 Device Holder

<Laptop Extension Kit>

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

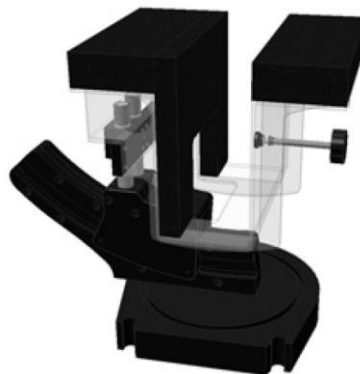


Fig 5.11 Laptop Extension Kit



5.7 Data Storage and Evaluation

5.7.1 Data Storage

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

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

5.7.2 Data Evaluation

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

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	σ
	- Density	ρ

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

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

The formula for each channel can be given as :

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

with V_i = compensated signal of channel i, (i = x, y, z)
 U_i = input signal of channel i, (i = x, y, z)
 cf = crest factor of exciting field (DASY parameter)
 dcp_i = diode compression point (DASY parameter)

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

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

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

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

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

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

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

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

with SAR = local specific absorption rate in mW/g
 E_{tot} = total field strength in V/m
 σ = conductivity in [mho/m] or [Siemens/m]
 ρ = equivalent tissue density in g/cm^3

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



5.8 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	736	Jul. 25, 2011	Jul. 24, 2013
SPEAG	5GHz System Validation Kit	D5GHzV2	1006	Jan. 18, 2012	Jan. 17, 2013
SPEAG	Data Acquisition Electronics	DAE4	1338	Jun. 12, 2012	Jun. 11, 2013
SPEAG	Dosimetric E-Field Probe	EX3DV4	3792	Jun. 21, 2012	Jun. 20, 2013
SPEAG	Device Holder	N/A	N/A	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 001 BB	1026	NCR	NCR
Agilent	Network Analyzer	E5071C	MY46101588	May. 11, 2012	May. 10, 2013
Agilent	ESG Vector Series Signal Generator	E4438C	MY49070755	Oct. 02, 2012	Oct. 01, 2013
Anritsu	Power Meter	ML2495A	1132003	Aug. 14, 2012	Aug. 13, 2013
Agilent	Dual Directional Coupler	778D	50422	Note 4	
Woken	Attenuator 1	WK0602-XX	N/A	Note 4	
PE	Attenuator 2	PE7005-10	N/A	Note 4	
PE	Attenuator 3	PE7005- 3	N/A	Note 4	
Agilent	Dielectric Probe Kit	85070D	US01440205	Note 5	
AR	Power Amplifier	5S1G4M2	328767	Note 6	
R&S	Spectrum Analyzer	FSP	101131	Jul. 23, 2012	Jul. 22, 2013

Table 5.1 Test Equipment List

Note:

1. The calibration certificate of DASY can be referred to appendix C of this report.
2. The dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
3. The justification data of dipole D2450V2, SN: 736, can be found in appendix C. The return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration.
4. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
5. The dielectric probe kit was calibrated via the network analyzer, with the specified procedure (calibrated in pure water) and calibration kit (standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Agilent.
6. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized to 1W input power according to the ratio of 1W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical and we do have calibration for it
7. Attenuator 1 insertion loss is calibrated by the network Analyzer, which the calibration is valid, before system check.

6. Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 6.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 6.2.

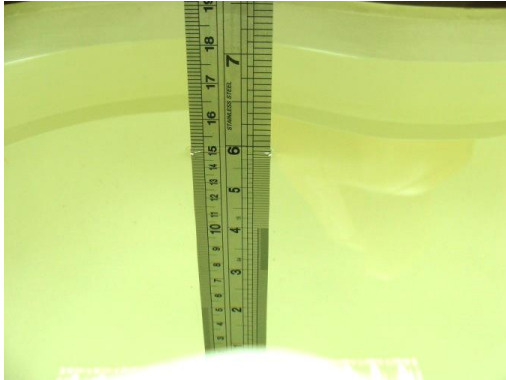


Fig 6.1 Photo of Liquid Height for Head SAR

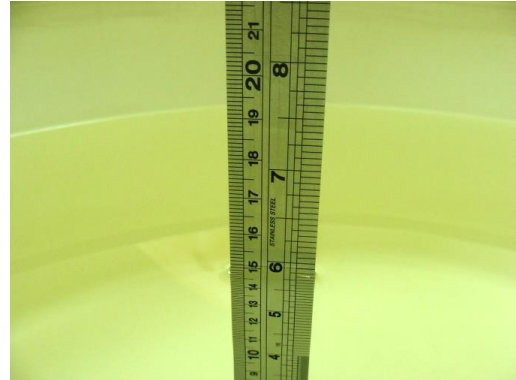


Fig 6.2 Photo of Liquid Height for Body SAR

The following table gives the recipes for tissue simulating liquid.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (ϵ_r)
2450	68.6	0	0	0	0	31.4	1.95	52.7

Table 6.1 Recipes of Tissue Simulating Liquid

Simulating Liquid for 5G, Manufactured by SPEAG

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



The dielectric parameters of the liquids were verified prior to the SAR evaluation using an Agilent 85070D Dielectric Probe Kit and an Agilent Network Analyzer.

The following table shows the measuring results for simulating liquid.

Freq. (MHz)	Liquid Type	Temp. (°C)	Conductivity (σ)	Permittivity (ϵ_r)	Conductivity Target (σ)	Permittivity Target (ϵ_r)	Delta (σ) (%)	Delta (ϵ_r) (%)	Limit (%)	Date
2450	Body	21.5	2.015	53.858	1.95	52.7	3.33	2.20	±5	Dec. 06, 2012
5200	Body	21.7	5.336	47.488	5.30	49.0	0.68	-3.09	±5	Dec. 05, 2012
5800	Body	21.6	6.243	46.387	6.00	48.2	4.05	-3.76	±5	Dec. 05, 2012

Table 6.2 Measuring Results for Simulating Liquid

7. SAR Measurement Evaluation

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

7.1 Purpose of System Performance check

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

7.2 System Setup

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

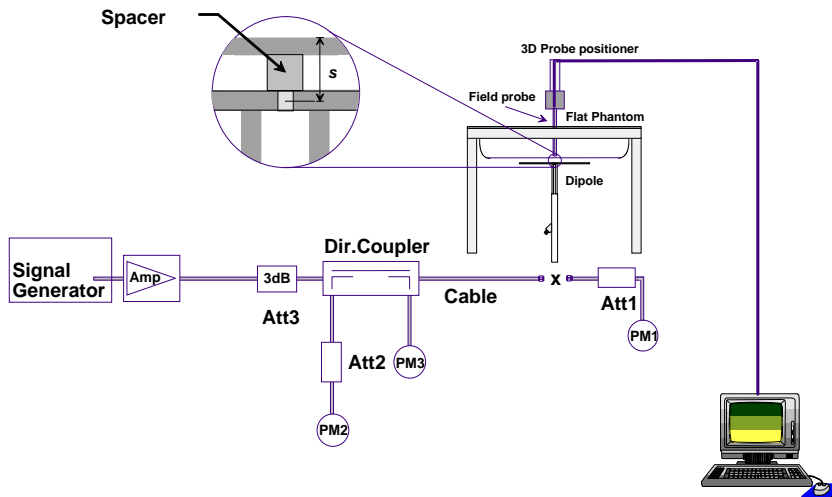


Fig 7.1 System Setup for System Evaluation

1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. Calibrated Dipole



Fig 7.2 Photo of Dipole Setup



7.3 SAR System Verification Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Table 7.1 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.

Measurement Date	Frequency (MHz)	Liquid Type	Input power fed to dipole (mW)	Targeted SAR _{1g} (W/kg)	Measured SAR _{1g} (W/kg)	Normalized SAR _{1g} (W/kg)	Deviation (%)
Dec. 06, 2012	2450	Body	250	52.3	12.4	49.60	-5.16
Dec. 05, 2012	5200	Body	100	72.60	7.36	73.60	1.38
Dec. 05, 2012	5800	Body	100	73.10	7.32	73.20	0.14

Table 7.1 Target and Measurement SAR after Normalized

8. EUT Testing Position

This EUT was tested in four different USB configurations. They are “direct laptop plug-in for configuration 1 and 3”, “USB cable plug-in for configuration 2 and 4”, and “USB cable plug-in for Tip Mode (the tip of the EUT)” shown as below. Both direct laptop plug-in and USB cable plug-in test configurations are tested with 5 cm separation between the particular dongle orientation and the flat phantom. Please refer to Appendix D for the test setup photos.





			
<p>Configuration 1 (Horizontal Up)</p>	<p>Configuration 2 (Horizontal Down)</p>	<p>Configuration 3 (Vertical Front)</p>	<p>Configuration 4 (Vertical Back)</p>

Fig 8.1 Illustration for USB Connector Orientations



9. 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

9.1 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

9.2 Area & Zoom Scan Procedures

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

Area scan and zoom scan resolution setting follows KDB 865664 D01v01 quoted below.

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



9.3 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.

9.4 SAR Averaged Methods

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

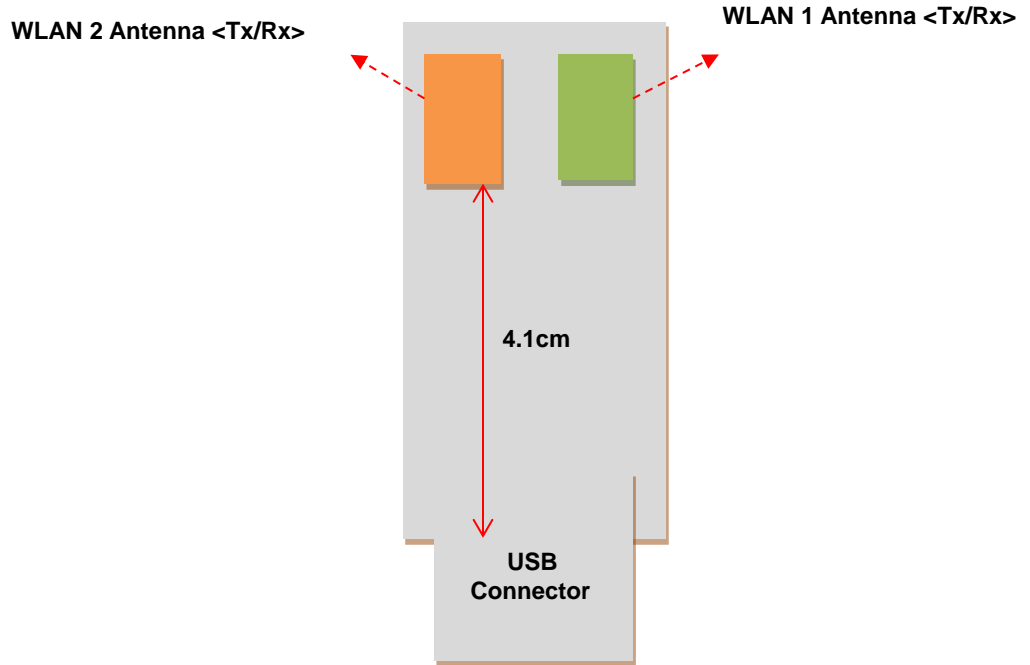
Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty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

9.5 Power Drift Monitoring

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

10. SAR Test Configurations

10.1 Exposure Positions Consideration



Band \ Antenna	Ant. 1	Ant. 2	Ant.1+2
2.4GHz 802.11b/g	No	Yes	No
2.4GHz 802.11n	No	No	Yes
5GHz 802.11a	No	Yes	No
5GHz 802.11n	No	No	Yes
5GHz 802.11ac	No	No	Yes



10.2 Conducted RF Power (Unit: dBm)

<WLAN 2.4GHz>

Ant .2

WLAN 2.4G 802.11b Average Power (dBm)							
Power vs. Channel				Power vs. Data Rate			
Channel	Frequency (MHz)	Chain	Data Rate (bps)	Channel	Data Rate (bps)		
			1M		2M	5.5M	11M
CH 01	2412	2	16.70	CH11	17.21	17.10	17.00
CH 06	2437	2	17.00				
CH 11	2462	2	17.30				

WLAN 2.4G 802.11g Average Power (dBm)											
Power vs. Channel				Power vs. Data Rate							
Channel	Frequency (MHz)	Chain	Data Rate (bps)	Channel	Data Rate (bps)						
			6M		9M	12M	18M	24M	36M	48M	54M
CH 01	2412	2	15.72	CH11	16.55	16.50	16.45	16.41	16.38	16.29	16.20
CH 06	2437	2	16.00								
CH 11	2462	2	16.60								

Note:

1. Per KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. Per KDB 248227, 11g average output power is less than 0.25dB higher than 11b mode, thus the SAR can be excluded.

For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 0.25dB higher than those measured at the lowest data rate.



Ant .1+2

WLAN 2.4G 802.11n (BW 20MHz) Average Power (dBm)											
Power vs. Channel				Power(Chain1+2) vs. Data Rate							
Channel	Frequency (MHz)	Chain	MCS Index	Channel	MCS Index						
			MCS8		MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
CH 01	2412	2	15.36	CH06	18.80	18.75	18.71	18.67	18.52	18.60	17.90
		1	15.47								
		1+2	18.43								
CH 06	2437	2	16.03								
		1	15.67								
		1+2	18.86								
CH 11	2462	2	15.71								
		1	15.73								
		1+2	18.73								

WLAN 2.4G 802.11n (BW 40MHz) Average Power (dBm)											
Power vs. Channel				Power(Chain1+2) vs. Data Rate							
Channel	Frequency (MHz)	Chain	MCS Index	Channel	MCS Index						
			MCS8		MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
CH 03	2422	2	15.16	CH09	18.20	18.10	18.07	18.00	17.92	17.85	17.80
		1	14.67								
		1+2	17.93								
CH 06	2437	2	15.18								
		1	14.63								
		1+2	17.92								
CH 09	2452	2	15.61								
		1	15.12								
		1+2	18.38								

Note:

1. Per KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. Per KDB 248227, 11n-HT40 average output power is less than 0.25dB higher than 11b mode, thus the SAR can be excluded.
3. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4 dB higher than those measured at the lowest data rate.



<WLAN 5GHz>

Ant. 2

WLAN 5G 802.11a Average Power (dBm)											
Power vs. Channel				Power vs. Data Rate							
Channel	Frequency (MHz)	Chain	Data Rate (bps)	Channel	Data Rate (bps)						
			6M		9M	12M	18M	24M	36M	48M	54M
CH 36	5180	2	15.92	CH48	15.90	15.85	15.81	15.75	15.70	15.65	15.62
CH 40	5200	2	15.85								
CH 44	5220	2	15.94								
CH 48	5240	2	15.97								
CH 149	5745	2	15.56	CH157	15.70	15.64	15.66	15.74	15.69	15.50	15.43
CH 153	5765	2	15.72								
CH 157	5785	2	15.79								
CH 161	5805	2	15.78								
CH 165	5825	2	15.65								
		2									

Ant. 1+2

WLAN 5G 802.11n (BW 20M) Average Power (dBm)																			
Power vs. Channel				Power(Chain1+2) vs. Data Rate															
Channel	Frequency (MHz)	Chain	MCS Index	Channel	MCS Index														
			MCS8		MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15								
CH 36	5180	2	12.87	CH 40	15.90	15.87	15.84	15.83	15.79	15.72	15.68								
		1	12.92																
		1+2	15.91																
CH 40	5200	2	12.85																
		1	13.08																
		1+2	15.98																
CH 44	5220	2	12.81																
		1	12.64																
		1+2	15.74																
CH 48	5240	2	12.65																
		1	12.66																
		1+2	15.67																
CH 149	5745	2	19.47									CH 149	21.90	21.88	21.81	21.75	21.70	21.68	21.63
		1	18.34																
		1+2	21.95																
CH 153	5765	2	19.47																
		1	18.22																
		1+2	21.90																
CH 157	5785	2	19.35																
		1	18.21																
		1+2	21.83																
CH 161	5805	2	19.27																
		1	18.38																
		1+2	21.86																
CH 165	5825	2	19.33																
		1	18.27																
		1+2	21.84																



WLAN 5G 802.11n (BW 40M) Average Power (dBm)																			
Power vs. Channel				Power(Chain1+2) vs. Data Rate															
Channel	Frequency (MHz)	Chain	MCS Index	Channel	MCS Index														
			MCS8		MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15								
CH 38	5190	2	12.18	CH 46	15.61	15.54	15.51	15.45	15.38	15.32	15.34								
		1	12.84																
		1+2	15.53																
CH 46	5230	2	12.7																
		1	12.57																
		1+2	15.65																
CH 151	5755	2	18.75									CH 159	21.28	21.25	21.20	21.15	21.10	21.05	21.00
		1	17.56																
		1+2	21.21																
CH 159	5795	2	18.79																
		1	17.78																
		1+2	21.32																

WLAN 5G 802.11ac (BW 20M) Average Power (dBm)																							
Power vs. Channel				Power(Chain1+2) vs. Data Rate																			
Channel	Frequency (MHz)	Chain	MCS Index	Channel	MCS Index																		
			MCS8		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS9										
CH 36	5180	2	12.91	CH 36	15.90	15.94	15.90	15.95	15.88	15.85	15.91	15.92	15.96										
		1	13																				
		1+2	15.97																				
CH 40	5200	2	12.55																				
		1	12.72																				
		1+2	15.65																				
CH 44	5220	2	12.69																				
		1	12.78																				
		1+2	15.75																				
CH 48	5240	2	12.58																				
		1	12.77																				
		1+2	15.69																				
CH 149	5745	2	19.32											CH 165	21.80	21.85	21.81	21.84	21.78	21.76	21.81	21.82	21.75
		1	18.20																				
		1+2	21.81																				
CH 153	5765	2	19.41																				
		1	18.17																				
		1+2	21.84																				
CH 157	5785	2	19.28																				
		1	18.14																				
		1+2	21.76																				
CH 161	5805	2	19.16																				
		1	18.13																				
		1+2	21.69																				
CH 165	5825	2	19.35																				
		1	18.30																				
		1+2	21.87																				



WLAN 5G 802.11 ac (BW 40M) Average Power (dBm)																							
Power vs. Channel				Power(Chain1+2) vs. Data Rate																			
Channel	Frequency (MHz)	Chain	MCS Index	Channel	MCS Index																		
			MCS8		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS9										
CH 38	5190	2	12.68	CH 46	15.61	15.59	15.63	15.60	15.66	15.62	15.64	15.62	15.58										
		1	12.51																				
		1+2	15.61																				
CH 46	5230	2	12.88																				
		1	12.45																				
		1+2	15.68																				
CH 151	5755	2	18.79											CH 151	21.13	21.05	21.06	21.08	21.13	21.09	21.10	21.11	21.09
		1	17.34																				
		1+2	21.14																				
CH 159	5795	2	18.55																				
		1	17.61																				
		1+2	21.12																				

WLAN 5G 802.11ac (BW 80M) Average Power (dBm)																							
Power vs. Channel				Power(Chain1+2) vs. Data Rate																			
Channel	Frequency (MHz)	Chain	MCS Index	Channel	MCS Index																		
			MCS8		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS9										
CH 42	5210	2	11.55	CH 42	14.48	14.44	14.46	14.48	14.44	14.41	14.47	14.44	14.39										
		1	11.42																				
		1+2	14.50																				
CH 155	5775	2	18.74											CH 155	21.25	21.27	21.26	21.24	21.18	21.26	21.23	21.25	21.16
		1	17.77																				
		1+2	21.29																				

Note:

1. The conducted power is the summation of the power of each chain
2. Per KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion.
3. Per KDB 248227, choose the lowest order modulation mode to test SAR; therefore 11a was chosen for SAR testing.
4. For 5180MHz~5240MHz, 11n-HT20, the highest output power is more than 0.25 dB higher than 11a, thus 11n-HT20 SAR was additionally verified in the worst case found in 11a SAR testing;
5. For 5745MHz~5825MHz, 11n-HT20, the highest output power is more than 0.25 dB higher than 11a, thus 11n-HT20 SAR was additionally verified in the worst case found in 11a SAR testing;
6. For 11ac-VHT80, SAR is verified in both 5180MHz~5240MHz and 5745MHz~5825MHz due to conservative consideration for a wider bandwidth.
7. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4 dB higher than those measured at the lowest data rate.



11. SAR Test Results

11.1 Test Records for Body SAR Test

<General Note>

- Per KDB 447498 D01v05, for each exposure position, if the highest output channel reported SAR <0.8 other channels SAR testing are not necessary.
- Per KDB 447498 D01v05, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
 $Scaling\ Factor = \frac{tune-up\ limit\ power\ (mW)}{EUT\ RF\ power\ (mW)}$, where tune-up limit is the maximum rated power among all production units.
 $Reported\ SAR(W/kg) = Measured\ SAR(W/kg) * Scaling\ Factor$

<WLAN DTS>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ant.	Ch	Data Rate	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	SAR _{1g} (W/kg)	Scale d SAR _{1g} (W/kg)
32	WLAN2.4G	802.11b	Horizontal Up	0.5cm	Ant 2	11	1Mbps	2462	17.30	17.5	1.047	0.02	1.03	1.079
33	WLAN2.4G	802.11b	Horizontal Down	0.5cm	Ant 2	11	1Mbps	2462	17.30	17.5	1.047	-0.06	0.979	1.025
34	WLAN2.4G	802.11b	Vertical Front	0.5cm	Ant 2	11	1Mbps	2462	17.30	17.5	1.047	-0.1	0.144	0.151
35	WLAN2.4G	802.11b	Vertical Back	0.5cm	Ant 2	11	1Mbps	2462	17.30	17.5	1.047	-0.03	0.756	0.792
36	WLAN2.4G	802.11b	Tip Mode	0.5cm	Ant 2	11	1Mbps	2462	17.30	17.5	1.047	-0.03	0.12	0.126
37	WLAN2.4G	802.11b	Horizontal Up	0.5cm	Ant 2	1	1Mbps	2412	16.70	17.5	1.202	0.01	0.726	0.873
38	WLAN2.4G	802.11b	Horizontal Up	0.5cm	Ant 2	6	1Mbps	2437	17.00	17.5	1.122	0.02	0.833	0.935
39	WLAN2.4G	802.11b	Horizontal Down	0.5cm	Ant 2	1	1Mbps	2412	16.70	17.5	1.202	0.11	0.753	0.905
40	WLAN2.4G	802.11b	Horizontal Down	0.5cm	Ant 2	6	1Mbps	2437	17.00	17.5	1.122	0.02	0.824	0.925
41	WLAN2.4G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	6	MCS8	2437	18.86	19	1.032	-0.12	0.915	0.944
42	WLAN2.4G	802.11n-HT20	Horizontal Down	0.5cm	Ant 1+2	6	MCS8	2437	18.86	19	1.032	-0.12	0.906	0.935
43	WLAN2.4G	802.11n-HT20	Vertical Front	0.5cm	Ant 1+2	6	MCS8	2437	18.86	19	1.032	-0.034	0.388	0.400
44	WLAN2.4G	802.11n-HT20	Vertical Back	0.5cm	Ant 1+2	6	MCS8	2437	18.86	19	1.032	-0.1	0.396	0.409
45	WLAN2.4G	802.11n-HT20	Tip Mode	0.5cm	Ant 1+2	6	MCS8	2437	18.86	19	1.032	-0.06	0.205	0.212
46	WLAN2.4G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	1	MCS8	2412	18.43	19	1.141	-0.04	0.934	1.066
47	WLAN2.4G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	11	Mcs8	2462	18.73	19	1.064	-0.19	1.1	1.170
48	WLAN2.4G	802.11n-HT20	Horizontal Down	0.5cm	Ant 1+2	1	MCS8	2412	18.43	19	1.141	-0.08	0.811	0.926
49	WLAN2.4G	802.11n-HT20	Horizontal Down	0.5cm	Ant 1+2	11	MCS8	2462	18.73	19	1.064	-0.09	0.916	0.975



Plot No.	Band	Mode	Test Position	Gap (cm)	Ant.	Ch.	Data Rate	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	SAR _{1g} (W/kg)	Scaled SAR _{1g} (W/kg)
6	WLAN5G	802.11a	Horizontal Up	0.5cm	Ant 2	157	6Mbps	5785	15.79	16	1.050	0.03	0.63	0.661
7	WLAN5G	802.11a	Horizontal Down	0.5cm	Ant2	157	6Mbps	5785	15.79	16	1.050	-0.05	0.55	0.577
8	WLAN5G	802.11a	Vertical Front	0.5cm	Ant 2	157	6Mbps	5785	15.79	16	1.050	0.04	0.022	0.023
9	WLAN5G	802.11a	Vertical Back	0.5cm	Ant 2	157	6Mbps	5785	15.79	16	1.050	0.06	1.07	1.123
10	WLAN5G	802.11a	Tip Mode	0.5cm	Ant 2	157	6Mbps	5785	15.79	16	1.050	-0.01	0.259	0.272
11	WLAN5G	802.11a	Vertical Back	0.5cm	Ant 2	153	6Mbps	5765	15.72	16	1.067	-0.06	0.981	1.046
12	WLAN5G	802.11a	Vertical Back	0.5cm	Ant 2	161	6Mbps	5805	15.78	16	1.052	0.01	0.914	0.961
18	WLAN5G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	149	MCS8	5745	21.95	22	1.011	0.19	0.847	0.856
19	WLAN5G	802.11n-HT20	Horizontal Down	0.5cm	Ant 1+2	149	MCS8	5745	21.95	22	1.011	-0.09	0.843	0.852
20	WLAN5G	802.11n-HT20	Vertical Front	0.5cm	Ant 1+2	149	MCS8	5745	21.95	22	1.011	0.02	0.865	0.875
21	WLAN5G	802.11n-HT20	Vertical Back	0.5cm	Ant 1+2	149	MCS8	5745	21.95	22	1.011	-0.04	0.986	0.997
22	WLAN5G	802.11n-HT20	Tip Mode	0.5cm	Ant 1+2	149	MCS8	5745	21.95	22	1.011	-0.07	0.414	0.419
30	WLAN5G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	157	MCS8	5785	21.83	22	1.040	0.1	0.84	0.874
31	WLAN5G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	161	MCS8	5805	21.86	22	1.033	0.05	0.805	0.832
28	WLAN5G	802.11n-HT20	Horizontal Down	0.5cm	Ant 1+2	157	MCS8	5785	21.83	22	1.040	-0.14	0.787	0.819
29	WLAN5G	802.11n-HT20	Horizontal Down	0.5cm	Ant 1+2	161	MCS8	5805	21.86	22	1.033	-0.17	0.757	0.782
26	WLAN5G	802.11n-HT20	Vertical Front	0.5cm	Ant 1+2	157	MCS8	5785	21.83	22	1.040	0	0.821	0.854
27	WLAN5G	802.11n-HT20	Vertical Front	0.5cm	Ant 1+2	161	MCS8	5805	21.86	22	1.033	0	0.799	0.826
23	WLAN5G	802.11n-HT20	Vertical Back	0.5cm	Ant 1+2	157	MCS8	5785	21.83	22	1.040	-0.04	0.885	0.921
24	WLAN5G	802.11n-HT20	Vertical Back	0.5cm	Ant 1+2	161	MCS8	5805	21.86	22	1.033	-0.03	0.85	0.878
25	WLAN5G	802.11ac-VHT80	Vertical Back	0.5cm	Ant 1+2	155	MCS0	5775	21.29	21.5	1.049	-0.02	0.81	0.850

<WLAN NII>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ant.	Ch.	Data Rate	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	SAR _{1g} (W/kg)	Scaled SAR _{1g} (W/kg)
1	WLAN5G	802.11a	Horizontal Up	0.5cm	Ant 2	48	6Mbps	5240	15.97	16	1.007	-0.17	0.416	0.419
2	WLAN5G	802.11a	Horizontal Down	0.5cm	Ant 2	48	6Mbps	5240	15.97	16	1.007	-0.14	0.4	0.403
3	WLAN5G	802.11a	Vertical Front	0.5cm	Ant 2	48	6Mbps	5240	15.97	16	1.007	-0.026	0.034	0.034
4	WLAN5G	802.11a	Vertical Back	0.5cm	Ant 2	48	6Mbps	5240	15.97	16	1.007	-0.05	0.669	0.674
5	WLAN5G	802.11a	Tip Mode	0.5cm	Ant 2	48	6Mbps	5240	15.97	16	1.007	-0.06	0.122	0.123
13	WLAN5G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	40	MCS8	5200	15.98	16	1.005	0.07	0.229	0.230
14	WLAN5G	802.11n-HT20	Horizontal Down	0.5cm	Ant 1+2	40	MCS8	5200	15.98	16	1.005	-0.15	0.16	0.161
15	WLAN5G	802.11n-HT20	Vertical Front	0.5cm	Ant 1+2	40	MCS8	5200	15.98	16	1.005	-0.01	0.284	0.286
16	WLAN5G	802.11n-HT20	Vertical Back	0.5cm	Ant 1+2	40	MCS8	5200	15.98	16	1.005	-0.07	0.326	0.328
17	WLAN5G	802.11n-HT20	Tip Mode	0.5cm	Ant 1+2	40	MCS8	5200	15.98	16	1.005	-0.05	0.071	0.071
50	WLAN5G	802.11ac-VHT80	Vertical Back	0.5cm	Ant 1+2	42	MCS0	5210	14.50	15	1.123	-0.155	0.188	0.211



11.2 Repeated SAR Measurement

Plot No.	Band	Mode	Test Position	Gap (cm)	Ant.	Ch.	Data Rate	Freq. (MHz)	Average Power (dBm)	Tune-up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	SAR _{1g} (W/kg)	Ratio	Scaled SAR _{1g} (W/kg)
32	WLAN2.4G	802.11b	Horizontal Up	0.5cm	Ant 2	11	1Mbps	2462	17.30	17.5	1.047	0.02	1.03	1	1.079
51	WLAN2.4G	802.11b	Horizontal Up	0.5cm	Ant 2	11	1Mbps	2462	17.30	17.5	1.047	0.056	1.02	1.01	1.068
47	WLAN2.4G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	11	MCS8	2462	18.73	19	1.064	-0.19	1.1	1	1.170
52	WLAN2.4G	802.11n-HT20	Horizontal Up	0.5cm	Ant 1+2	11	MCS8	2462	18.73	19	1.064	-0.01	1.06	1.04	1.128
9	WLAN5G	802.11a	Vertical Back	0.5cm	Ant 2	157	6Mbps	5785	15.79	16	1.050	0.06	1.07	1	1.123
53	WLAN5G	802.11a	Vertical Back	0.5cm	Ant 2	157	6Mbps	5785	15.79	16	1.050	0.069	0.953	1.13	1.000
21	WLAN5G	802.11n-HT20	Vertical Back	0.5cm	Ant 1+2	149	MCS8	5745	21.95	22	1.011	-0.04	0.986	1	0.997
54	WLAN5G	802.11n-HT20	Vertical Back	0.5cm	Ant 1+2	149	MCS8	5745	21.95	22	1.011	-0.14	0.971	1.02	0.982

Note:

1. Per KDB 865664 D01v01, for each frequency band, repeated SAR measurement is required only when the measured SAR is $\geq 0.8W/kg$
2. Per KDB 865664 D01v01, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR $< 1.45W/kg$, only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated measured SAR.
4. All measured SAR result is scaled-up to account for tune-up tolerance and is compliant.

11.3 Highest SAR Plot

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab

Date: 2012/12/6

#32_WLAN2.4G_802.11b_Horizontal Up_0.5cm_Ch11;Ant 2

DUT: 2N0801-01

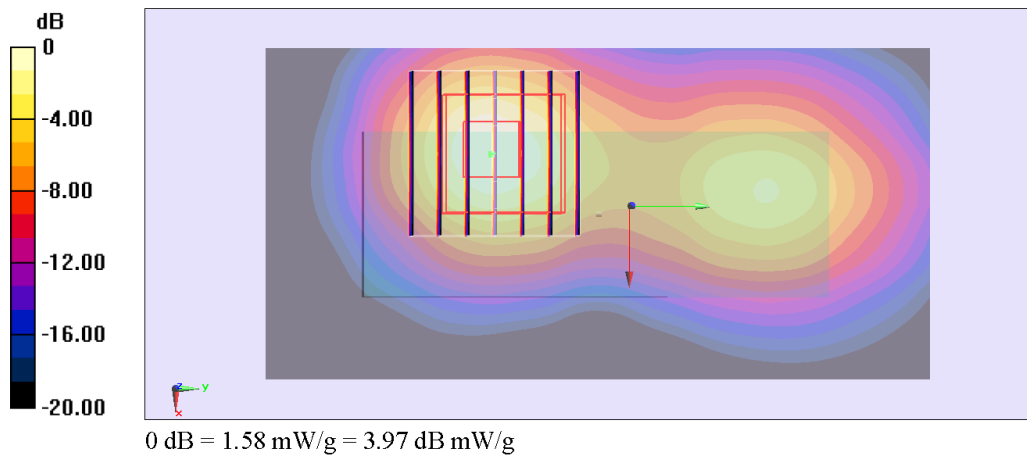
Communication System: 802.11b; Frequency: 2462 MHz; Duty Cycle: 1:1
 Medium: MSL_2450_121206 Medium parameters used: $f = 2462$ MHz; $\sigma = 2.032$ mho/m; $\epsilon_r = 53.846$; $\rho = 1000$ kg/m³
 Ambient Temperature : 22.5 °C; Liquid Temperature : 21.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3792; ConvF(7.1, 7.1, 7.1); Calibrated: 2012/6/21;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1338; Calibrated: 2012/6/12
- Phantom: ELI 4.0 Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.5 (6469)

Configuration/Ch11/Area Scan (51x101x1): Measurement grid: dx=12mm, dy=12mm
 Maximum value of SAR (interpolated) = 1.68 mW/g

Configuration/Ch11/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Reference Value = 28.156 V/m; Power Drift = 0.02 dB
 Peak SAR (extrapolated) = 2.169 mW/g
SAR(1 g) = 1.03 mW/g; SAR(10 g) = 0.467 mW/g
 Maximum value of SAR (measured) = 1.58 mW/g



Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab

Date: 2012/12/6

#47_WLAN2.4G_802.11n-HT20_Horizontal Up_0.5cm_Ch11;Ant 1+2

DUT: 2N0801-01

Communication System: 802.11n; Frequency: 2462 MHz; Duty Cycle: 1:1

Medium: MSL_2450_121206 Medium parameters used: $f = 2462$ MHz; $\sigma = 2.032$ mho/m; $\epsilon_r = 53.846$; $\rho = 1000$ kg/m³

Ambient Temperature : 22.5 °C ; Liquid Temperature : 21.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3792; ConvF(7.1, 7.1, 7.1); Calibrated: 2012/6/21;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1338; Calibrated: 2012/6/12
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.5 (6469)

Configuration/Ch11/Area Scan (51x101x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 1.81 mW/g

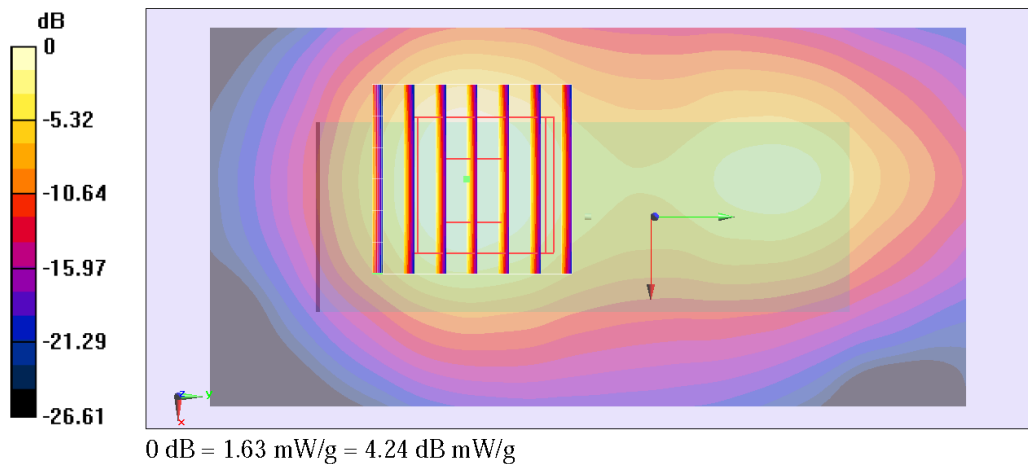
Configuration/Ch11/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 28.927 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 2.268 mW/g

SAR(1 g) = 1.1 mW/g; SAR(10 g) = 0.524 mW/g

Maximum value of SAR (measured) = 1.63 mW/g



Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab

Date: 2012/12/5

#09_WLAN5G_802.11a_Vertical Back_0.5cm_Ch157;Ant 2

DUT: 2N0801-01

Communication System: 802.11a; Frequency: 5785 MHz; Duty Cycle: 1:1

Medium: MSL_5G_121205 Medium parameters used: $f = 5785$ MHz; $\sigma = 6.23$ mho/m; $\epsilon_r = 46.452$; $\rho =$

1000 kg/m³

Ambient Temperature : 22.6 °C ; Liquid Temperature : 21.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3792; ConvF(3.89, 3.89, 3.89); Calibrated: 2012/6/21;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1338; Calibrated: 2012/6/12
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY52, Version 52.8 (3); SEMCAD X Version 14.6.5 (6469)

Configuration/Ch157/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 2.55 mW/g

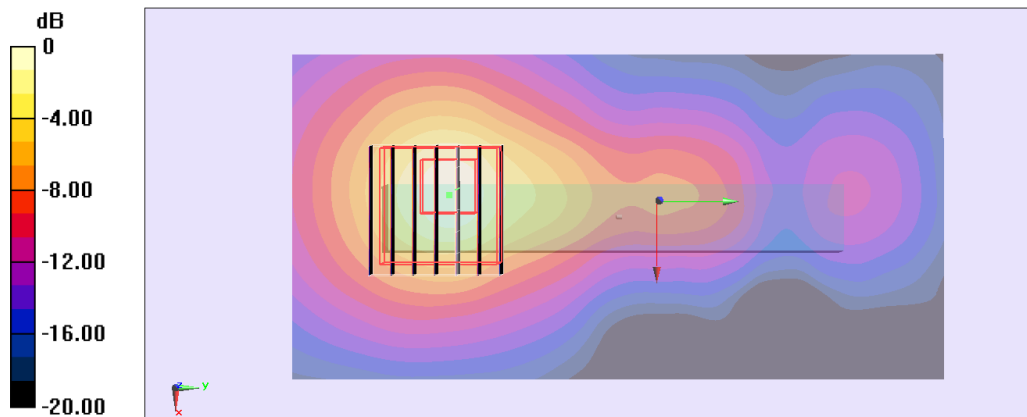
Configuration/Ch157/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 24.398 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 4.577 mW/g

SAR(1 g) = 1.07 mW/g; SAR(10 g) = 0.340 mW/g

Maximum value of SAR (measured) = 2.64 mW/g



0 dB = 2.64 mW/g = 8.43 dB mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab

Date: 2012/12/5

#21_WLAN5G_802.11n-HT20_Veritical Back_0.5cm_Ch149;Ant 1+2

DUT: 2N0801-01

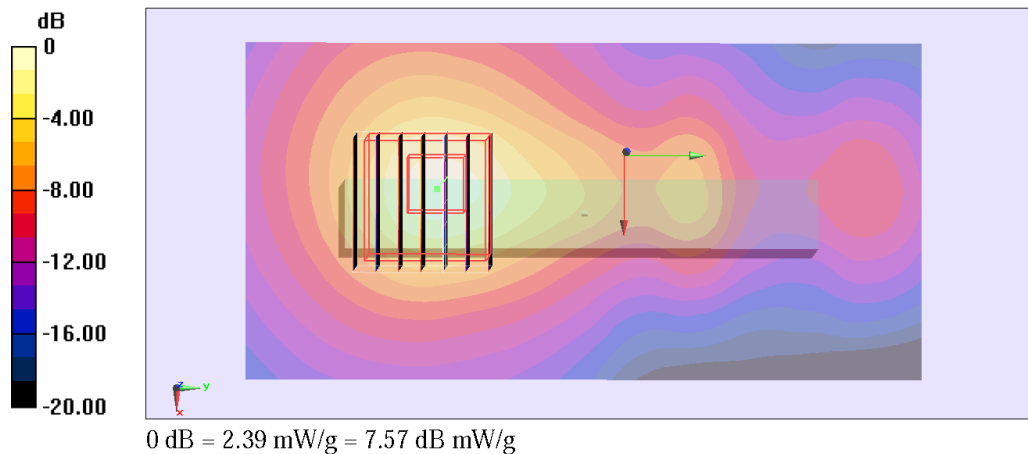
Communication System: 802.11n; Frequency: 5745 MHz; Duty Cycle: 1:1
 Medium: MSL_5G_121205 Medium parameters used: $f = 5745 \text{ MHz}$; $\sigma = 6.184 \text{ mho/m}$; $\epsilon_r = 46.6$; $\rho = 1000 \text{ kg/m}^3$
 Ambient Temperature : 22.6 °C ; Liquid Temperature : 21.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3792; ConvF(3.89, 3.89, 3.89); Calibrated: 2012/6/21;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1338; Calibrated: 2012/6/12
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY52, Version 52.8 (3);SEMCAD X Version 14.6.5 (6469)

Configuration/Ch149/Area Scan (61x121x1): Measurement grid: dx=10mm, dy=10mm
 Maximum value of SAR (interpolated) = 2.18 mW/g

Configuration/Ch149/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
 Reference Value = 23.388 V/m; Power Drift = -0.04 dB
 Peak SAR (extrapolated) = 4.067 mW/g
SAR(1 g) = 0.986 mW/g; SAR(10 g) = 0.325 mW/g
 Maximum value of SAR (measured) = 2.39 mW/g



Test Engineer : Cona Huang and Ted Sun

12. Uncertainty Assessment

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

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

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture’s specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table 12.1

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor ^(a)	1/k ^(b)	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) κ is the coverage factor

Table 12.1 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 following tables.



Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)
Measurement System							
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 %
Test Sample Related							
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 %
Phantom and Setup							
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 %
Combined Standard Uncertainty						± 11.0 %	± 10.8 %
Coverage Factor for 95 %						K=2	
Expanded Uncertainty						± 22.0 %	± 21.5 %

Table 12.2 Uncertainty Budget of DASY for frequency range 300 MHz to 3 GHz



Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)
Measurement System							
Probe Calibration	6.55	Normal	1	1	1	± 6.55 %	± 6.55 %
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	2.0	Rectangular	√3	1	1	± 1.2 %	± 1.2 %
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	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Probe Positioning	9.9	Rectangular	√3	1	1	± 5.7 %	± 5.7 %
Max. SAR Eval.	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Test Sample Related							
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 %
Phantom and Setup							
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 %
Combined Standard Uncertainty						± 12.8 %	± 12.6 %
Coverage Factor for 95 %						K=2	
Expanded Uncertainty						± 25.6 %	± 25.2 %

Table 12.3 Uncertainty Budget of DASY for frequency range 3 GHz to 6 GHz



13. References

- [1] FCC 47 CFR Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"
- [2] ANSI/IEEE Std. C95.1-1992, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", September 1992
- [3] IEEE Std. 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- [4] FCC OET Bulletin 65 (Edition 97-01) Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", June 2001
- [5] SPEAG DASY System Handbook
- [6] FCC KDB 248227 D01 v01r02, "SAR Measurement Procedures for 802.11 a/b/g Transmitters", May 2007
- [7] FCC KDB 447498 D01 v05, "Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies", November 2009
- [8] FCC KDB 447498 D02 v02, "SAR Measurement Procedures for USB Dongle Transmitters", November 2009
- [9] FCC KDB 644545 D01 v01, "Guidance for IEEE 802.11ac and Pre-ac Device Emission Testing", June 2012