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**

The product was completely tested on Jul. 26, 2013. 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

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TAF
Testing Laboratory
1190

SPORTON INTERNATIONAL INC.
No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA2N0801-03	Rev. 01	Variant report to include enabled WLAN5GHz frequency 5260MHz~5320MHz and 5500MHz~5700MHz, other frequency band RF exposure evaluation please refer to original report (Sporton Report No. FA2N0801, FCC ID: Q87-WUSB6300).	Aug. 19, 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, Linksys, WUSB6300** are as follows.

<Highest SAR Summary>

Exposure Position	Frequency Band	Reported 1g-SAR (W/kg)	Equipment Class	Highest Reported 1g-SAR (W/kg)
Body (Separation 0.5cm)	WLAN 5.3GHz Band	1.09	NII	1.12
	WLAN 5.5GHz Band	1.12		

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2003.

2. Administration Data

2.1 Testing Laboratory

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st 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	Jul. 25, 2013
Date of End during the Test	Jul. 26, 2013

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
Wireless Technology and Frequency Range	WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5700 MHz
Mode	• 802.11a/b/g/n HT20/HT40/VHT20/VHT40/VHT80
Antenna Type	Printed Antenna
EUT Stage	Identical Prototype

Remark:
1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. WLAN5GHz operation in 5600 MHz ~ 5650 MHz is notched.

3.2 Maximum RF output power among production units

Mode / Band	Center Freq (MHz)	Channel	Average Power (dBm)					
			Ant B	Ant A+B				
			11a	HT20	HT40	VHT20	VTH40	VTH80
WLAN 5.3GHz Band	5260	CH 52	14	18		18		
	5270	CH 54			18		18	
	5280	CH 56	14	18		18		
	5290	CH 58						14.5
	5300	CH 60	14	18		18		
	5310	CH 62			17		17	
	5320	CH 64	14	18		18		
WLAN 5.5GHz Band	5500	CH 100	15	18		18		
	5510	CH 102			15		15	
	5520	CH 104	15	18		18		
	5530	CH 106						16
	5540	CH 108	15	18		18		
	5550	CH 110			18		18	
	5560	CH 112	16	18		18		
	5580	CH 116	16	18.5		18.5		
	5660	CH 132	16	18		18		
	5670	CH 134			18		18	
	5680	CH 136	16	18		18		
	5700	CH 140	16	18		18		

3.3 Applied Standard

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

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2003
- FCC KDB 447498 D01 v05r01
- FCC KDB 447498 D02 v02
- FCC KDB 644545 D01 v01r01
- FCC KDB 248227 D01 v01r02

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 ℃
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:

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

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

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

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

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

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

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

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

5. SAR Measurement System

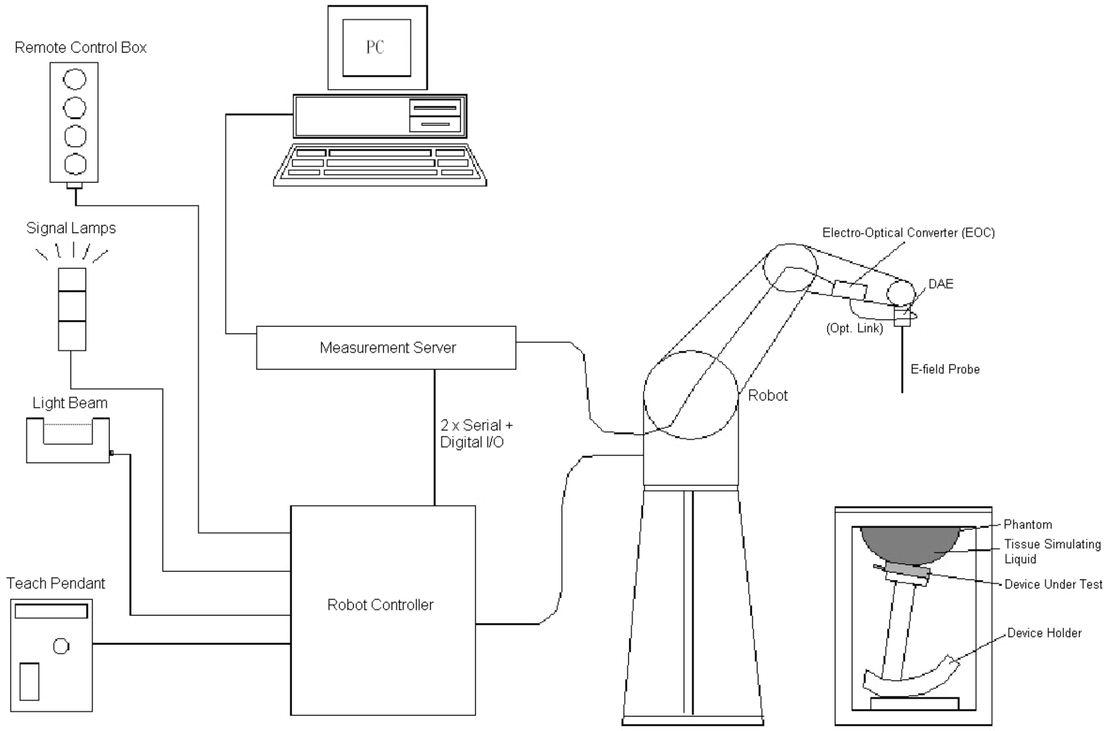


Fig 5.1 SPEAG DASY System Configurations

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
- Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
- The SAM twin phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system

Component details are described in 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)	
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 µW/g to 100 mW/g; Linearity: ± 0.2 dB (noise: typically < 1 µW/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	**Fig 5.2 Photo of EX3DV4/ES3DV4**

5.1.2 E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than ± 10%. The spherical isotropy shall be evaluated and within ± 0.25dB. 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

5.4 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)

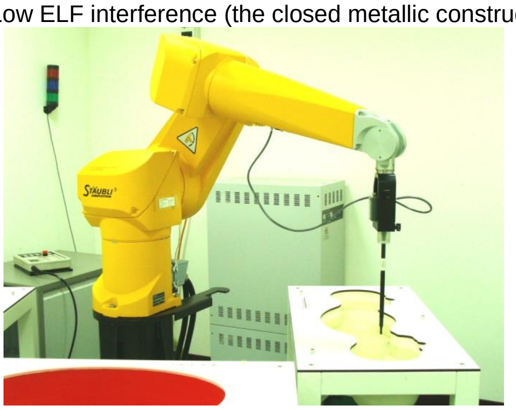


Fig 5.4 Photo of DASY4

Fig 5.5 Photo of DASY5

5.5 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

5.6 Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet
Measurement Areas	Left Hand, Right Hand, Flat Phantom

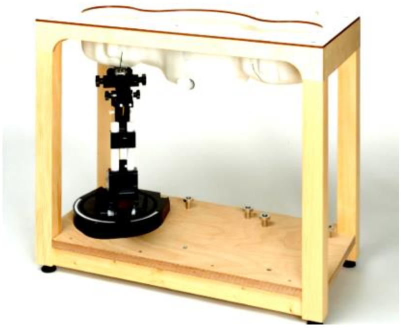


Fig 5.8 Photo of SAM Phantom

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%)
Filling Volume	Approx. 30 liters
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm

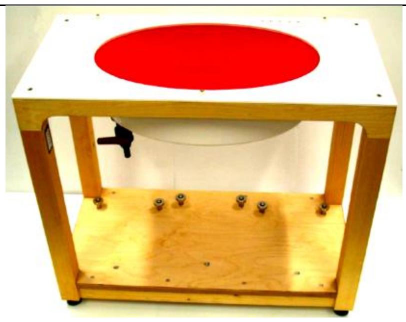


Fig 5.9 Photo of ELI4 Phantom

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.

5.7 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 ε = 3 and loss tangent δ = 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.

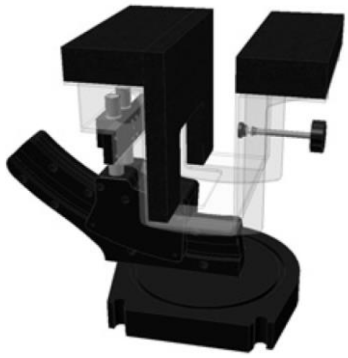


Fig 5.11 Laptop Extension Kit

5.8 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：

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

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：

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

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

with V_i = compensated signal of channel i, (i = x, y, z)
$Norm_i$ = sensor sensitivity of channel i, (i = x, y, z), $\mu V/(V/m)^2$ 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)：

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

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

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

with SAR = local specific absorption rate in mW/g
E_{tot} = total field strength in V/m
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.

5.9 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	5GHz System Validation Kit	D5GHzV2	1006	Dec. 11, 2012	Dec. 10, 2013
SPEAG	Data Acquisition Electronics	DAE3	495	May. 08, 2013	May. 07, 2014
SPEAG	Data Acquisition Electronics	DAE4	1303	Nov. 22, 2012	Nov. 21, 2013
SPEAG	Dosimetric E-Field Probe	EX3DV4	3925	Jun. 12, 2013	Jun. 11, 2014
SPEAG	Dosimetric E-Field Probe	EX3DV4	3819	Nov. 26, 2012	Nov. 25, 2013
Wisewind	Thermometer	ETP-101	TM560	Nov. 13, 2012	Nov. 12, 2013
Wisewind	Thermometer	ETP-101	TM685	Nov. 13, 2012	Nov. 12, 2013
Agilent	Wireless Communication Test Set	E5515C	MY48360820	Jan. 05, 2012	Jan. 04, 2014
Agilent	ESG Vector Series Signal Generator	E4438C	MY49070755	Oct. 02, 2012	Oct. 01, 2013
Agilent	ENA Network Analyzer	E5071C	MY46316648	Feb. 07, 2013	Feb. 06, 2014
Anritsu	Power Meter	ML2495A	1132003	Aug. 14, 2012	Aug. 13, 2013
Anritsu	Power Sensor	MA2411B	1126017	Aug. 14, 2012	Aug. 13, 2013
Agilent	Dual Directional Coupler	778D	50422	Note 3	
Woken	Attenuator 1	WK0602-XX	N/A	Note 3	
PE	Attenuator 2	PE7005-10	N/A	Note 3	
PE	Attenuator 3	PE7005- 3	N/A	Note 3	
AR	Power Amplifier	5S1G4M2	328767	Note 4	
R&S	Spectrum Analyzer	FSP 7	101131	Jul. 09, 2013	Jul. 08, 2014

Table 5.1 Test Equipment List

Note:
1. The calibration certificate of DASY can be referred to appendix C of this report.
2. Referring to KDB 865664 D01v01r01, 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 Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
4. 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
5. 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.

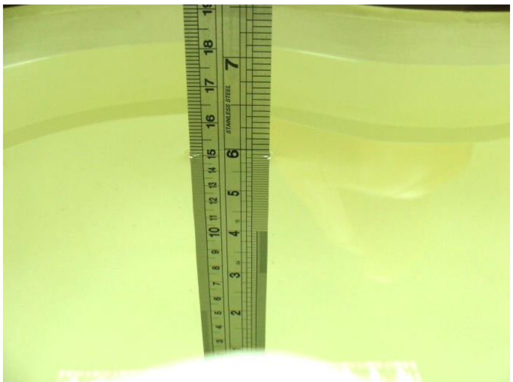


Fig 6.1 Photo of Liquid Height for Head SAR

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)
For Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
900	40.3	57.9	0.2	1.4	0.2	0	0.97	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
For Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7

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.

Frequency (MHz)	Liquid Type	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target (ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
5300	Body	22.5	5.615	48.275	5.42	48.88	3.60	-1.24	±5	Jul. 25, 2013
5300	Body	22.5	5.615	48.275	5.42	48.88	3.60	-1.24	±5	Jul. 25, 2013
5600	Body	22.5	6.005	47.866	5.77	48.47	4.07	-1.25	±5	Jul. 26, 2013
5600	Body	22.5	6.005	47.866	5.77	48.47	4.07	-1.25	±5	Jul. 26, 2013

Table 6.2 Measuring Results for Simulating Liquid

7. System Verification Procedures

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:

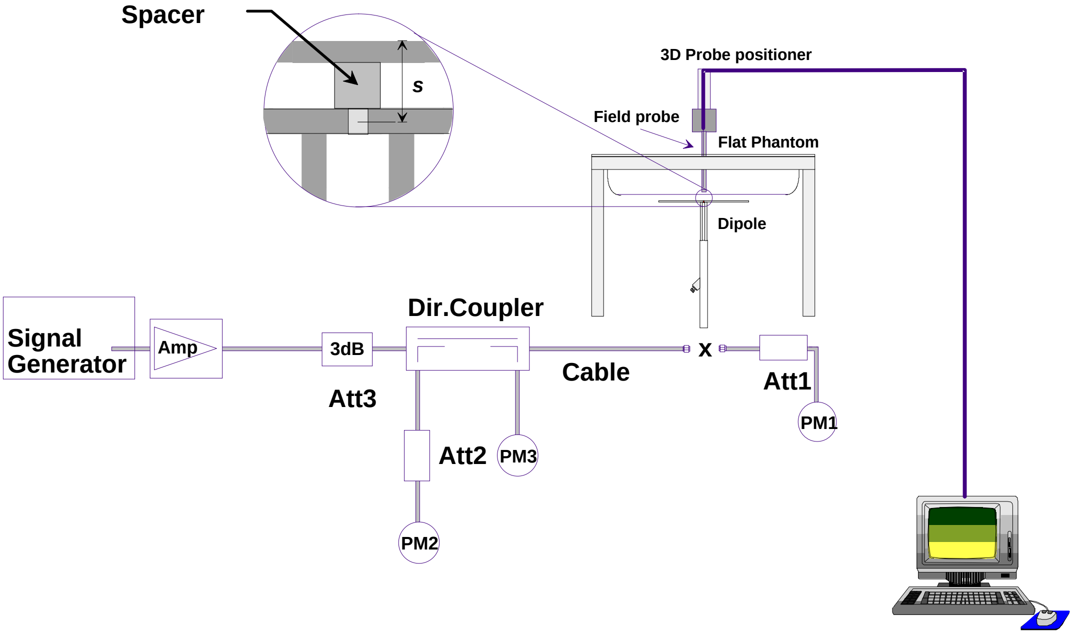


Fig 7.1 System Setup for System Evaluation

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

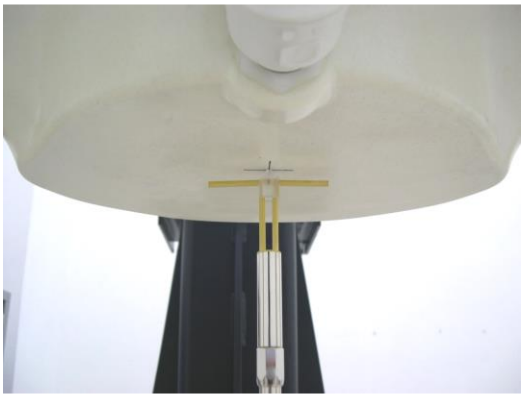


Fig 7.2 Photo of Dipole Setup

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.

Date	Frequency (MHz)2	Liquid Type	Power fed onto reference dipole (mW)	Targeted SAR (W/kg)	Measured SAR (W/kg)	Normalized SAR (W/kg)	Deviation (%)
Jul. 25, 2013	5300	Body	100	73.5	6.95	69.5	-5.44
Jul. 25, 2013	5300	Body	100	73.5	7.38	73.8	0.41
Jul. 26, 2013	5600	Body	100	76.8	7.48	74.8	-2.60
Jul. 26, 2013	5600	Body	100	76.8	8.07	80.7	5.08

Table 7.1 Target and Measurement SAR after Normalized

8. EUT Testing Position

1. 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 E for the test setup photos.

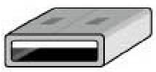
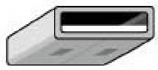
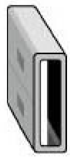
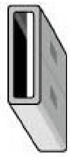
			
Configuration 1 (Horizontal Up)	Configuration 2 (Horizontal Down)	Configuration 3 (Vertical Front)	Configuration 4 (Vertical Back)

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 E 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 form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

9.2 Power Reference Measurement

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

9.3 Area & Zoom Scan Procedures

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows KDB 865664 D01v01 quoted below.

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

<table>
<tr><td colspan="3"></td><td>$\leq$ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>$\leq$ 2 GHz: $\leq$ 15 mm
2 – 3 GHz: $\leq$ 12 mm</td><td>3 – 4 GHz: $\leq$ 12 mm
4 – 6 GHz: $\leq$ 10 mm</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>$\leq$ 2 GHz: $\leq$ 8 mm
2 – 3 GHz: $\leq$ 5 mm*</td><td>3 – 4 GHz: $\leq$ 5 mm*
4 – 6 GHz: $\leq$ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>$\leq$ 5 mm</td><td>3 – 4 GHz: $\leq$ 4 mm
4 – 5 GHz: $\leq$ 3 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>$\leq$ 4 mm</td><td>3 – 4 GHz: $\leq$ 3 mm
4 – 5 GHz: $\leq$ 2.5 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>$\geq$ 30 mm</td><td>3 – 4 GHz: $\geq$ 28 mm
4 – 5 GHz: $\geq$ 25 mm
5 – 6 GHz: $\geq$ 22 mm</td></tr>
<tr><td colspan="5">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.
* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is $\leq$ 1.4 W/kg, $\leq$ 8 mm, $\leq$ 7 mm and $\leq$ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

9.4 Volume Scan Procedures

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

9.5 SAR Averaged Methods

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

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

9.6 Power Drift Monitoring

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

10. Conducted RF Output Power (Unit: dBm)

<WLAN 5GHz SISO mode Conducted Power>

<Antenna B>

WLAN 5GHz 802.11a Average Power (dBm)											Tune up Limit (dBm)
Power vs. Channel			Power vs. Data Rate								
Channel	Frequency (MHz)	Data Rate 6Mbps	Channel	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps	
CH 52	5260	13.63	CH 64	13.55	13.48	13.62	13.56	13.42	13.53	13.34	14
CH 56	5280	13.68									14
CH 60	5300	13.61									14
CH 64	5320	13.72									14
CH 100	5500	14.59	CH 116	15.75	15.77	15.63	15.71	15.49	15.61	15.52	15
CH 104	5520	14.83									15
CH 108	5540	14.68									15
CH 112	5560	15.35									16
CH 116	5580	15.83									16
CH 132	5660	15.77									16
CH 136	5680	15.48									16
CH 140	5700	15.55									16

Note:

1. Per KDB 248227 D01 v01r02, choose the highest output power channel to test SAR and determine further SAR exclusion
2. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at the lowest data rate.

<WLAN 5GHz MIMO Mode Conducted Power>
<Antenna A + B>

WLAN 5GHz 802.11n-HT20 Average Power (dBm)											Tune up Limit (dBm)
Power vs. Channel			Power vs. MCS Index								
Channel	Frequency (MHz)	MCS Index MCS8	Channel	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15	
CH 52	5260	17.84	CH 52	17.8	17.65	17.58	17.69	17.57	17.68	17.62	18
CH 56	5280	17.41									18
CH 60	5300	17.35									18
CH 64	5320	17.65									18
CH 100	5500	17.55	CH 116	18.01	17.95	17.86	17.85	17.93	17.75	17.66	18
CH 104	5520	17.62									18
CH 108	5540	17.48									18
CH 112	5560	17.65									18
CH 116	5580	18.09									18.5
CH 132	5660	17.74									18
CH 136	5680	17.55									18
CH 140	5700	17.70									18

WLAN 5GHz 802.11n-HT40 Average Power (dBm)											Tune up Limit (dBm)
Power vs. Channel			Power vs. MCS Index								
Channel	Frequency (MHz)	MCS Index MCS8	Channel	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15	
CH 54	5270	17.85	CH 54	17.74	17.65	17.71	17.81	17.63	17.59	17.54	18
CH 62	5310	16.12									17
CH 102	5510	14.93	CH 134	17.66	17.57	17.53	17.59	17.74	17.71	17.63	15
CH 110	5550	17.77									18
CH 134	5670	17.81									18

WLAN 5GHz 802.11ac-VHT20 Average Power (dBm)												Tune up Limit (dBm)
Power vs. Channel			Power vs. MCS Index									
Channel	Frequency (MHz)	MCS Index MCS 10	Channel	MCS 11	MCS 12	MCS 13	MCS 14	MCS 15	MCS 16	MCS 17	MCS 18	
CH 52	5260	17.52	CH 52	17.36	17.28	17.5	17.26	17.15	17.23	17.31	17.4	18
CH 56	5280	17.33										18
CH 60	5300	17.24										18
CH 64	5320	17.18										18
CH 100	5500	17.61	CH 116	17.74	17.69	17.59	17.82	17.66	17.69	17.51	17.77	18
CH 104	5520	17.52										18
CH 108	5540	17.39										18
CH 112	5560	17.48										18
CH 116	5580	17.92										18.5
CH 132	5660	17.66										18
CH 136	5680	17.58										18
CH 140	5700	17.42										18

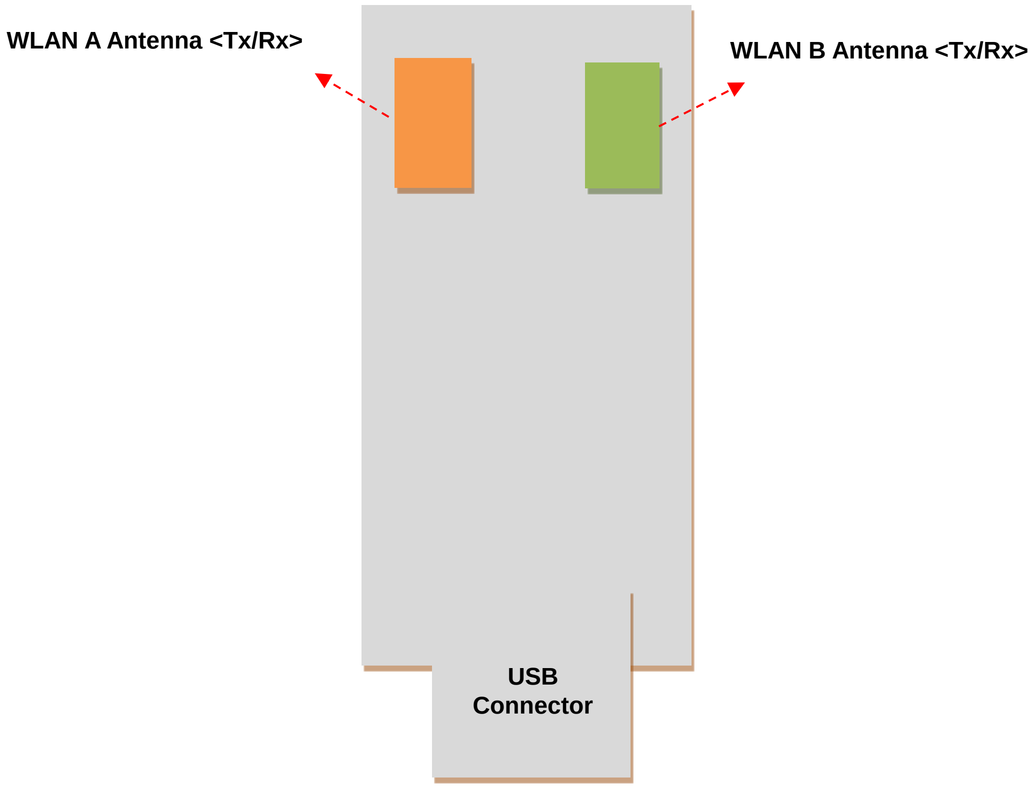
WLAN 5GHz 802.11ac-VHT40 Average Power (dBm)													Tune up Limit (dBm)
Power vs. Channel			Power vs. MCS Index										
Channel	Frequency (MHz)	MCS Index MCS10	Channel	MCS11	MCS12	MCS13	MCS14	MCS15	MCS16	MCS17	MCS18	MCS19	
CH 54	5270	17.55	CH 54	17.41	17.35	17.43	17.22	17.26	17.38	17.37	17.31	17.44	18
CH 62	5310	16.03											17
CH 102	5510	14.63	CH 110	17.52	17.41	17.33	17.4	17.33	17.29	17.31	17.26	17.43	15
CH 110	5550	17.55											18
CH 134	5670	17.37											18

WLAN 5GHz 802.11ac-VHT80 Average Power (dBm)													Tune up Limit (dBm)
Power vs. Channel			Power vs. MCS Index										
Channel	Frequency (MHz)	MCS Index MCS10	Channel	MCS11	MCS12	MCS13	MCS14	MCS15	MCS16	MCS17	MCS18	MCS19	
CH 58	5290	14.41	CH 58	14.22	14.18	14.09	14.28	14.01	13.98	14.06	14.17	14.33	14.5
CH 106	5530	15.86	CH 106	15.74	15.77	15.68	15.62	15.66	15.71	15.6	15.55	15.57	16

Note:

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

11. Exposure Positions Consideration



12. SAR Test Results

Note:

1. Per KDB 447498 D01v05r01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   Scaling Factor = 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*
2. Per KDB 447498 D01v05r01, for each exposure position, if the highest output channel reported SAR ≤0.8W/kg, other channels SAR testing is not necessary.

12.1 Test Records for Body SAR Test

<WLAN NII>

Plot No.	Band	Mode	Test Position	Gap (cm)	Antenna	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured SAR 1g (W/kg)	Scaled SAR 1g (W/kg)
1	WLAN5GHz	802.11a 6Mbps	Horizontal Up	0.5cm	Ant B	64	5280	13.72	14	1.067	0.14	0.661	0.705
2	WLAN5GHz	802.11a 6Mbps	Horizontal Down	0.5cm	Ant B	64	5280	13.72	14	1.067	0.19	0.516	0.550
3	WLAN5GHz	802.11a 6Mbps	Vertical Front	0.5cm	Ant B	64	5280	13.72	14	1.067	0.11	0.047	0.050
4	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	64	5280	13.72	14	1.067	-0.12	0.988	1.054
5	WLAN5GHz	802.11a 6Mbps	Tip Mode	0.5cm	Ant B	64	5280	13.72	14	1.067	0.16	0.128	0.137
34	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	56	5320	13.68	14	1.076	-0.05	1.01	**1.087**
7	WLAN5GHz	802.11a 6Mbps	Horizontal Up	0.5cm	Ant B	116	5580	15.83	16	1.040	0.15	0.714	0.743
8	WLAN5GHz	802.11a 6Mbps	Horizontal Down	0.5cm	Ant B	116	5580	15.83	16	1.040	0.01	0.657	0.683
9	WLAN5GHz	802.11a 6Mbps	Vertical Front	0.5cm	Ant B	116	5580	15.83	16	1.040	-0.01	0.067	0.070
33	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	116	5580	15.83	16	1.040	0.1	1.08	**1.123**
11	WLAN5GHz	802.11a 6Mbps	Tip Mode	0.5cm	Ant B	116	5580	15.83	16	1.040	-0.05	0.201	0.209
12	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	104	5520	14.83	15	1.040	-0.09	0.922	0.959
14	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	132	5660	15.77	16	1.054	-0.09	0.986	1.040
16	WLAN5GHz	802.11n-HT20 MCS8	Horizontal Up	0.5cm	Ant A+B	52	5280	17.84	18	1.038	-0.09	0.584	0.606
17	WLAN5GHz	802.11n-HT20 MCS8	Horizontal Down	0.5cm	Ant A+B	52	5280	17.84	18	1.038	-0.03	0.557	0.578
31	WLAN5GHz	802.11n-HT20 MCS8	Vertical Front	0.5cm	Ant A+B	52	5280	17.84	18	1.038	0.06	0.996	**1.033**
19	WLAN5GHz	802.11n-HT20 MCS8	Vertical Back	0.5cm	Ant A+B	52	5280	17.84	18	1.038	-0.06	0.244	0.253
20	WLAN5GHz	802.11n-HT20 MCS8	Tip Mode	0.5cm	Ant A+B	52	5280	17.84	18	1.038	-0.01	0.213	0.221
32	WLAN5GHz	802.11n-HT20 MCS8	Vertical Front	0.5cm	Ant A+B	64	5320	17.65	18	1.084	-0.11	0.926	1.004
29	WLAN5GHz	802.11n-VHT80 MCS10	Vertical Front	0.5cm	Ant A+B	58	5290	14.41	14.5	1.021	0.04	0.468	0.478
21	WLAN5GHz	802.11n-HT20 MCS8	Horizontal Up	0.5cm	Ant A+B	116	5580	18.09	18.5	1.099	-0.06	0.555	0.610
22	WLAN5GHz	802.11n-HT20 MCS8	Horizontal Down	0.5cm	Ant A+B	116	5580	18.09	18.5	1.099	-0.03	0.544	0.598
32	WLAN5GHz	802.11n-HT20 MCS8	Vertical Front	0.5cm	Ant A+B	116	5580	18.09	18.5	1.099	0.04	0.951	**1.045**
24	WLAN5GHz	802.11n-HT20 MCS8	Vertical Back	0.5cm	Ant A+B	116	5580	18.09	18.5	1.099	0.09	0.194	0.213
25	WLAN5GHz	802.11n-HT20 MCS8	Tip Mode	0.5cm	Ant A+B	116	5580	18.09	18.5	1.099	-0.08	0.172	0.189
26	WLAN5GHz	802.11n-HT20 MCS8	Vertical Front	0.5cm	Ant A+B	104	5520	17.62	18	1.091	-0.02	0.884	0.965
28	WLAN5GHz	802.11n-HT20 MCS8	Vertical Front	0.5cm	Ant A+B	132	5660	17.74	18	1.062	-0.03	0.826	0.877
30	WLAN5GHz	802.11n-VHT80 MCS10	Vertical Front	0.5cm	Ant A+B	106	5530	15.86	16	1.033	-0.02	0.61	0.630

12.2 Repeated SAR Measurement

Plot No.	Band	Mode	Test Position	Gap (cm)	Antenna	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Power Drift (dB)	Measured SAR 1g (W/kg)	Ratio	Scaled SAR 1g (W/kg)
34	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	56	5320	13.68	14	1.076	-0.05	1.01	1	**1.087**
101	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	56	5320	13.68	14	1.076	-0.18	0.956	1.056	1.029
33	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	116	5580	15.83	16	1.040	0.1	1.08	1	**1.123**
15	WLAN5GHz	802.11a 6Mbps	Vertical Back	0.5cm	Ant B	116	5580	15.83	16	1.040	0.1	1.040	1.038	1.082

Note:

1. Per KDB 865664 D01v01, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥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 measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

12.3 Highest SAR Plot

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2013/7/26

#33_WLAN5GHz_802.11a 6Mbps_Vertical Back_0.5cm_Ch116;Ant B

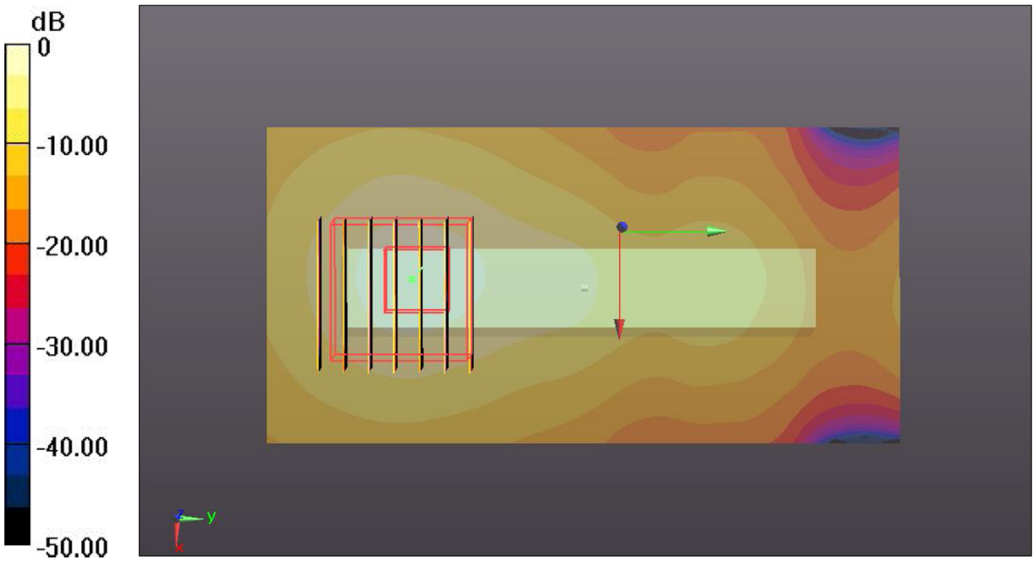
DUT: 2N0801-03

Communication System: WIFI; Frequency: 5580 MHz;Duty Cycle: 1:1
Medium: MSL_5G_130726 Medium parameters used: f = 5580 MHz; σ = 5.978 mho/m; ε_r = 47.893; ρ = 1000 kg/m^3
Ambient Temperature：23.5 ℃; Liquid Temperature：22.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3925; ConvF(3.78, 3.78, 3.78); Calibrated: 2013/6/12;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn495; Calibrated: 2013/5/8
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1029
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Ch116/Area Scan (51x101x1): Interpolated grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 2.51 W/kg

Ch116/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 21.845 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 4.555 mW/g
SAR(1 g) = 1.08 mW/g; SAR(10 g) = 0.352 mW/g
Maximum value of SAR (measured) = 2.29 W/kg



0 dB = 2.29 W/kg

13. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations
1.	None

Test Engineer： Frank Wu

14. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An 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 the following tables.

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 from IEEE Std 1528™-2003

15. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] IEEE Std. 1528-2003, “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, December 2003

[4] SPEAG DASY System Handbook

[5] FCC KDB 248227 D01 v01r02, “SAR Measurement Procedures for 802.11 a/b/g Transmitters”, May 2007

[6] FCC KDB 644545 D01 v01r01, "Guidance for IEEE 802.11ac and Pre-ac Device Emission Testing", Apr 2013

[7] FCC KDB 447498 D01 v05r01, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, May 2013

[8] FCC KDB 447498 D02 v02, "SAR Measurement Procedures for USB Dongle Transmitters", November 2009