FCC SAR Test Report

APPLICANT	:	**EDIMAX TECHNOLOGY CO., LTD.**
EQUIPMENT	:	**Wireless 450N Dual Band USB Adapter**
BRAND NAME	:	**EDIMAX**
MODEL NAME	:	**EW-7733UND / GWU-H733Und / EW-7733UnD**
FCC ID	:	**NDD9577331111**
STANDARD	:	**FCC 47 CFR Part 2 (2.1093)** **IEEE C95.1-1991** **IEEE 1528-2003** **FCC OET Bulletin 65 Supplement C (Edition 01-01)**

The product was received on Sep. 01, 2011 and completely tested on Feb. 07, 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.

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ilac-MRA

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA181701	Rev. 01	Initial issue of report	Oct. 07, 2011
FA181701	Rev. 02	Update report of adding the description of Simulating Liquid for 5G and the description in section 9 and 11.1.	Nov. 02, 2011
FA181701	Rev. 03	1. Update report for adding test result of the 5G SAR. 2. Add test procedures in section 9, page 27.	Jan. 12, 2012
FA181701	Rev. 04	1. Retest SAR plot #60. 2. Add antenna configuration in section 3.1. 3. Add antenna location in section 9. 4. Add MIMO SAR testing configuration in section 11.3.	Feb. 10, 2012

1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **EDIMAX TECHNOLOGY CO., LTD. Wireless 450N Dual Band USB Adapter EDIMAX EW-7733UND / GWU-H733Und / EW-7733UnD** are as follows.

<Standalone SAR>

Band	Position	SAR_{1g} (W/kg)
802.11 b/g/n	Body (0.5 cm Gap)	0.304
802.11 a/n	Body (0.5 cm Gap)	0.819

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 C95.1-1991, 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 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	EDIMAX TECHNOLOGY CO., LTD.
Address	No.3, Wu Chuan 3rd Road, Wu-Ku Industrial Park, Taipei Hsien, Taiwan

2.3 Manufacturer

Company Name	EDIMAX TECHNOLOGY CO., LTD.
Address	No.3, Wu Chuan 3rd Road, Wu-Ku Industrial Park, Taipei Hsien, Taiwan

2.4 Application Details

Date of Receipt of Application	Sep. 01, 2011
Date of Start during the Test	Sep. 01, 2011
Date of End during the Test	Feb. 07, 2012

3 General Information

3.1 Description of Device Under Test (DUT)

Product Feature & Specification	
DUT Type	Wireless 450N Dual Band USB Adapter
Brand Name	EDIMAX
Model Name	EW-7733UND / GWU-H733Und / EW-7733UnD
FCC ID	NDD9577331111
Tx Frequency	802.11b/g/n : 2412 MHz ~ 2462 MHz 802.11a/n : 5180 MHz ~ 5240 MHz; 5745 MHz ~ 5825 MHz
Rx Frequency	802.11b/g/n : 2412 MHz ~ 2462 MHz 802.11a/n : 5180 MHz ~ 5240 MHz; 5745 MHz ~ 5825 MHz
Maximum Output Power to Antenna	802.11b : 14.26 dBm 802.11g : 9.52 dBm 802.11n (BW 20MHz) (2.4GHz) : 12.82 dBm 802.11n (BW 40MHz) (2.4GHz) : 13.07 dBm 802.11a : 11.81 dBm 802.11n (BW 20MHz) (5GHz) : 16.22 dBm 802.11n (BW 40MHz) (5GHz) : 15.91 dBm
Antenna Type	PIFA Antenna
Type of Modulation	802.11b : DSSS (BPSK / QPSK / CCK) 802.11a/g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM)
DUT Stage	Identical Prototype

Remark: The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

Antenna characteristics

Mode	Antenna 1	Antenna 2	Antenna 3
2.4GHz 802.11b		V	
2.4GHz 802.11n	V	V	V
5GHz 802.11a			V
5GHz 802.11n	V	V	V

Note:

1. The symbol "V" in the table representing the meaning of "transmitting" during the test, based on its operational configuration.
2. DUT has a swivel antenna and thus can be sorted into three configurations as shown in the following figure 3.1 (a) ~ (c).

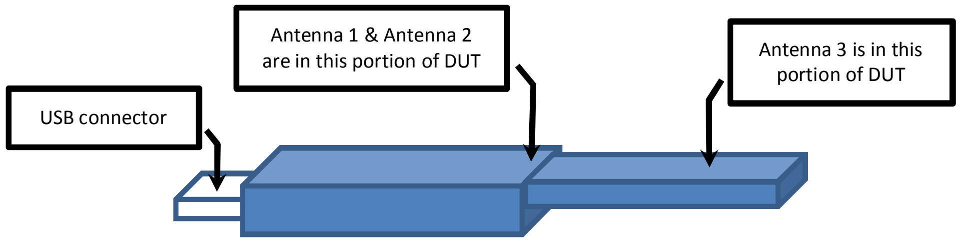


Figure 3.1(a): Antenna specifications with DUT flip 180 degree.

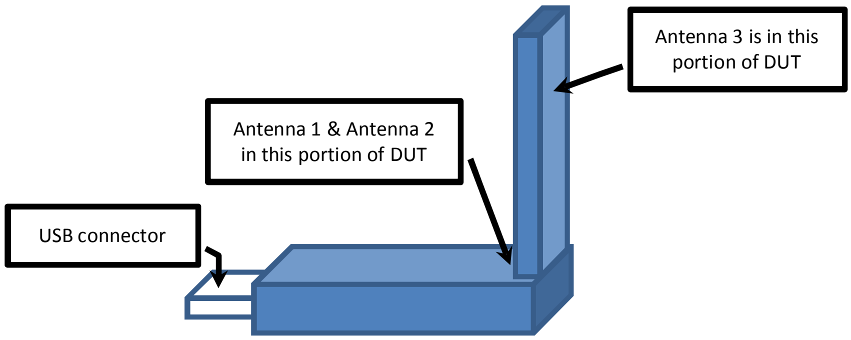


Figure 3.1(b): Antenna specifications with DUT flip 90 degree.

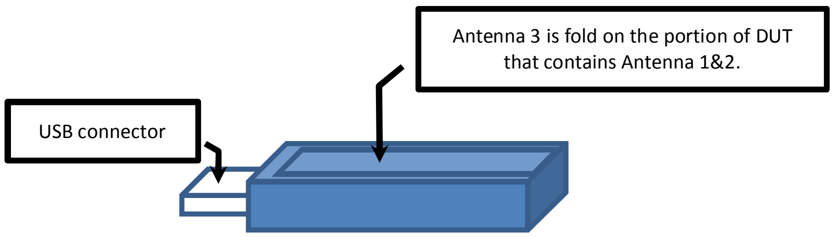


Figure 3.1(c): Antenna specifications with DUT flip closed.

3.2 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)
- IEEE C95.1-1991
- IEEE 1528-2003
- FCC OET Bulletin 65 Supplement C (Edition 01-01)
- FCC KDB 447498 D01 v04
- FCC KDB 447498 D02 v02
- FCC KDB 248227 D01 v01r02

3.3 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.

3.4 Test Conditions

3.4.1 Ambient Condition

Ambient Temperature	20 to 24 ℃
Humidity	< 60 %

3.4.2 Test Configuration

For WLAN SAR testing, WLAN engineering testing software installed on the DUT can provide continuous transmitting RF signal. This RF signal utilized in SAR measurement has almost 100% duty cycle and its crest factor is 1.

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

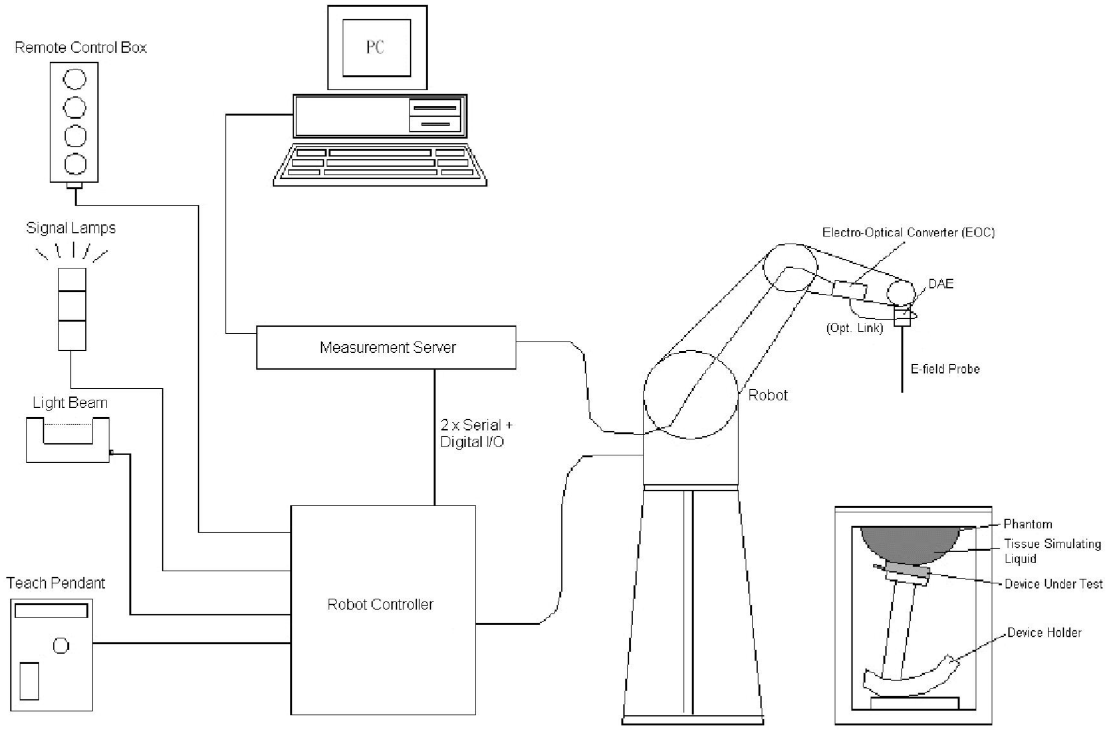


Fig 5.1 SPEAG DASY4 or DASY5 System Configurations

The DASY4 or DASY5 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 (ECO) 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
- DASY4 or DASY5 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

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

<ET3DV6 Probe >

Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Frequency	10 MHz to 3 GHz; Linearity: ± 0.2 dB
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic Range	5 μW/g to 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 6.8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm

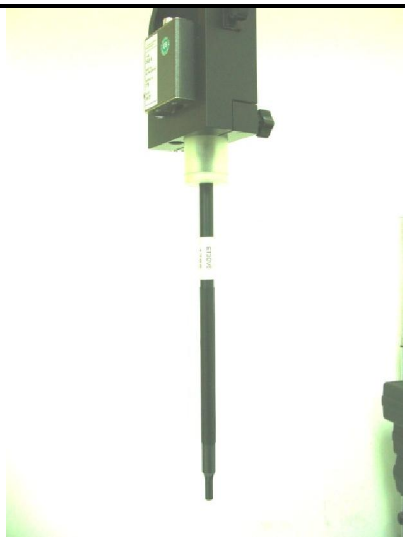


Fig 5.2 Photo of ET3DV6

<EX3DV4 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 5.3 Photo of EX3DV4

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 ± 0.25 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 5.4 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)

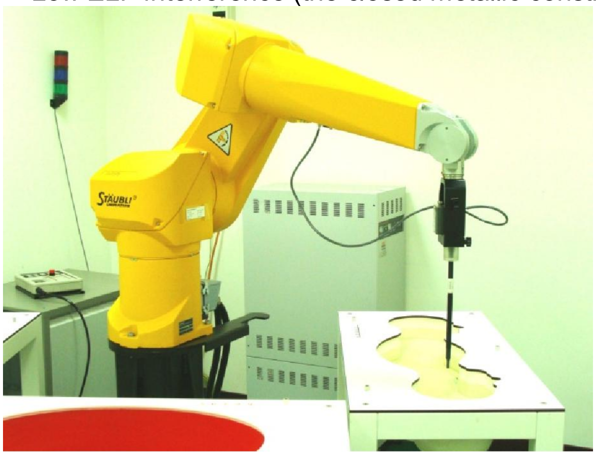


Fig 5.5 Photo of DASY4

Fig 5.6 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 5.7 Photo of Server for DASY4

Fig 5.8 Photo of Server for DASY5

5.5 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

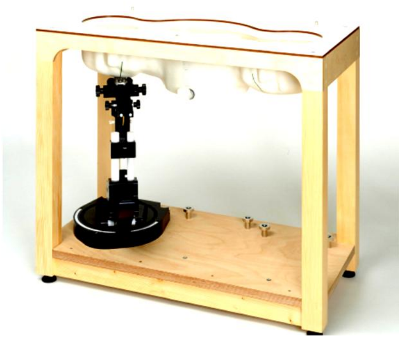


Fig 5.9 Photo of SAM Phantom

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

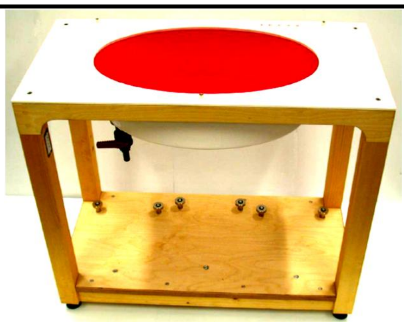


Fig 5.10 Photo of ELI4 Phantom

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.

5.6 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 (EPR). 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 5.11 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.

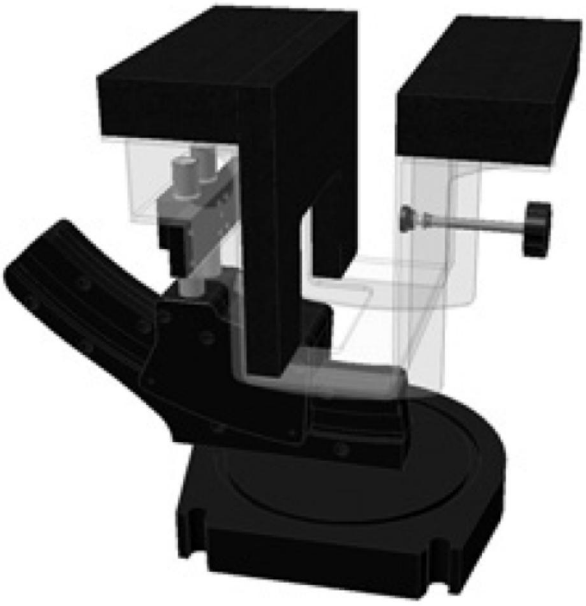


Fig 5.12 Laptop Extension Kit

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：

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

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), μV/(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.

5.8 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Dosimetric E-Field Probe	EX3DV4	3578	Jun. 21, 2011	Jun. 20, 2012
SPEAG	Dosimetric E-Field Probe	EX3DV3	3270	Sep. 12, 2011	Sep. 11, 2012
SPEAG	Dosimetric E-Filed Probe	EX3DV4	3792	Jun. 20, 2011	Jun. 19, 2012
SPEAG	2450MHz System Validation Kit	D2450V2	735	Jun. 22, 2011	Jun. 21, 2012
SPEAG	5GHz System Validation Kit	D5GHzV2	1040	Jun. 21, 2011	Jun. 20, 2012
SPEAG	Data Acquisition Electronics	DAE3	577	Jun. 20, 2011	Jun. 19, 2012
SPEAG	Data Acquisition Electronics	DAE4	778	Nov. 22, 2011	Nov. 21, 2012
SPEAG	Data Acquisition Electronics	DAE3	495	Apr. 28, 2011	Apr. 27, 2012
SPEAG	Data Acquisition Electronics	DAE4	1279	Jun. 17, 2011	Jun. 16, 2012
SPEAG	Device Holder	N/A	N/A	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 002 AA	TP-1127	NCR	NCR
Agilent	ENA Series Network Analyzer	E5071C	MY46100746	Jun. 10, 2011	Jun. 09, 2012
Agilent	Wireless Communication Test Set	E5515C	MY48360820	Jan. 12, 2010	Jan. 11, 2012
Agilent	Wireless Communication Test Set	E5515C	GB46311322	Mar. 23, 2011	Mar. 22, 2013
Agilent	Wireless Communication Test Set	E5515C	MY50264370	Apr. 19, 2011	Apr. 18, 2013
Agilent	RF Vector Network Analyzer	E8358A	US40260131	May. 17, 2011	May. 16, 2012
R&S	Universal Radio Communication Tester	CMU200	114256	Feb. 08, 2010	Feb. 07, 2012
Agilent	Dielectric Probe Kit	85070D	US01440205	NCR	NCR
Agilent	Dual Directional Coupler	778D	50422	NCR	NCR
AR	Power Amplifier	5S1G4M2	0328767	NCR	NCR
R&S	Spectrum Analyzer	FSP7	101131	Jul. 29, 2011	Jul. 28, 2012
R&S	Spectrum Analyzer	FSP30	101329	May. 03, 2011	May. 02, 2012

Table 5.1 Test Equipment List

Note: The calibration certificate of DASY can be referred to appendix C of this report.

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.

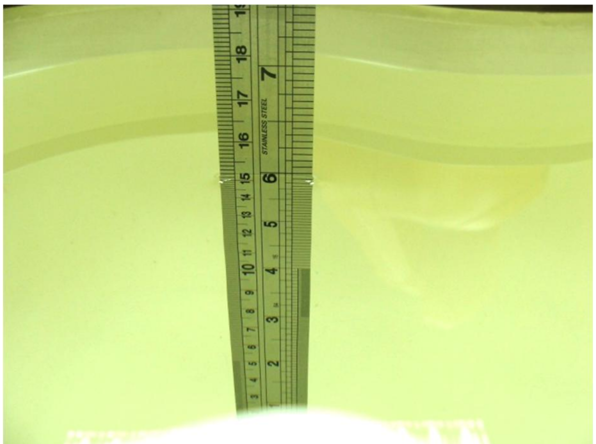


Fig 6.1 Photo of Liquid Height for Head SAR

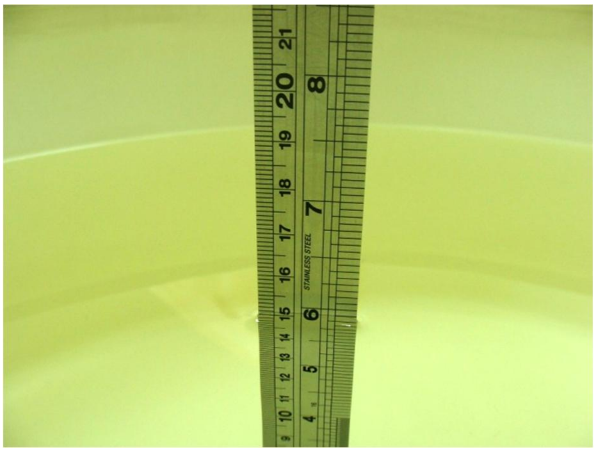


Fig 6.2 Photo of Liquid Height for Body SAR

The following table gives the recipes for tissue simulating liquid.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (ε_r)
For Body								
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 following table gives the targets for tissue simulating liquid.

Frequency (MHz)	Liquid Type	Conductivity (σ)	±5% Range	Permittivity (ε_r)	±5% Range
2450	Body	1.95	1.85 ~ 2.05	52.7	50.1 ~ 55.3
5200	Body	5.30	5.04 ~ 5.57	49.0	46.6 ~ 51.5
5800	Body	6.00	5.70 ~ 6.30	48.2	45.8 ~ 50.6

Table 6.2 Targets of Tissue Simulating Liquid

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. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target(ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
2450	Body	21.6	2.02	50.71	1.95	52.7	3.59	-3.78	±5	Sep. 01, 2011
2450	Body	21.5	1.968	53.802	1.95	52.7	0.92	2.09	±5	Sep. 08, 2011
2450	Body	21.5	1.97	54.2	1.95	52.7	1.03	2.85	±5	Jan. 02, 2012
5200	Body	21.3	5.325	48.639	5.3	49	0.47	-0.74	±5	Sep. 01, 2011
5200	Body	21.4	5.425	48.739	5.3	49	2.36	-0.53	±5	Sep. 06, 2011
5200	Body	21.5	5.287	48.755	5.3	49	-0.25	-0.50	±5	Sep. 08, 2011
5200	Body	21.5	5.28	47.6	5.3	49	-0.38	-2.86	±5	Dec. 22, 2011
5200	Body	21.4	5.37	48.5	5.3	49	1.32	-1.02	±5	Jan. 12, 2012
5200	Body	21.6	5.28	48.5	5.3	49	-0.38	-1.02	±5	Feb. 07, 2012
5800	Body	21.4	6.106	47.392	6	48.2	1.77	-1.68	±5	Sep. 06, 2011
5800	Body	21.5	6.12	47.381	6	48.2	2.00	-1.70	±5	Sep. 08, 2011
5800	Body	21.5	5.98	47.2	6	48.2	-0.33	-2.07	±5	Dec. 22, 2011
5800	Body	21.3	6.14	46.5	6	48.2	2.33	-3.53	±5	Jan. 01, 2012
5800	Body	21.4	6.22	47.1	6	48.2	3.67	-2.28	±5	Jan. 12, 2012

Table 6.3 Measuring Results for Simulating Liquid

7 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 7.1

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor[(a)]	1/k[(b)]	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

(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 7.1 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 showed in Table 7.2.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Standard Uncertainty (1g)
Measurement System					
Probe Calibration	6.0	Normal	1	1	± 6.0 %
Axial Isotropy	4.7	Rectangular	√3	0.7	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	± 3.9 %
Boundary Effects	1.0	Rectangular	√3	1	± 0.6 %
Linearity	4.7	Rectangular	√3	1	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	± 0.6 %
Readout Electronics	0.3	Normal	1	1	± 0.3 %
Response Time	0.8	Rectangular	√3	1	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	± 1.7 %
Probe Positioner	0.4	Rectangular	√3	1	± 0.2 %
Probe Positioning	2.9	Rectangular	√3	1	± 1.7 %
Max. SAR Eval.	1.0	Rectangular	√3	1	± 0.6 %
Test Sample Related					
Device Positioning	2.9	Normal	1	1	± 2.9 %
Device Holder	3.6	Normal	1	1	± 3.6 %
Power Drift	5.0	Rectangular	√3	1	± 2.9 %
Phantom and Setup					
Phantom Uncertainty	4.0	Rectangular	√3	1	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	± 1.8 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	± 1.6 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	± 1.7 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	± 1.5 %
Combined Standard Uncertainty					± 11.0 %
Coverage Factor for 95 %					K = 2
Expanded Uncertainty					**± 22.0 %**

Table 7.2 Uncertainty Budget of DASY for frequency range 300 MHz to 3 GHz

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Standard Uncertainty (1g)
Measurement System					
Probe Calibration	6.55	Normal	1	1	± 6.55 %
Axial Isotropy	4.7	Rectangular	√3	0.7	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	± 3.9 %
Boundary Effects	2.0	Rectangular	√3	1	± 1.2 %
Linearity	4.7	Rectangular	√3	1	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	± 0.6 %
Readout Electronics	0.3	Normal	1	1	± 0.3 %
Response Time	0.8	Rectangular	√3	1	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	± 1.7 %
Probe Positioner	0.8	Rectangular	√3	1	± 0.5 %
Probe Positioning	9.9	Rectangular	√3	1	± 5.7 %
Max. SAR Eval.	4.0	Rectangular	√3	1	± 2.3 %
Test Sample Related					
Device Positioning	2.9	Normal	1	1	± 2.9 %
Device Holder	3.6	Normal	1	1	± 3.6 %
Power Drift	5.0	Rectangular	√3	1	± 2.9 %
Phantom and Setup					
Phantom Uncertainty	4.0	Rectangular	√3	1	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	± 1.8 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	± 1.6 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	± 1.7 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	± 1.5 %
Combined Standard Uncertainty					± 12.8 %
Coverage Factor for 95 %					K = 2
Expanded Uncertainty					**± 25.6 %**

Table 7.3 Uncertainty Budget of DASY for frequency range 3 GHz to 6 GHz

8 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.

8.1 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.

8.2 System Setup

In the simplified setup for system evaluation, the DUT 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 SAR 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:

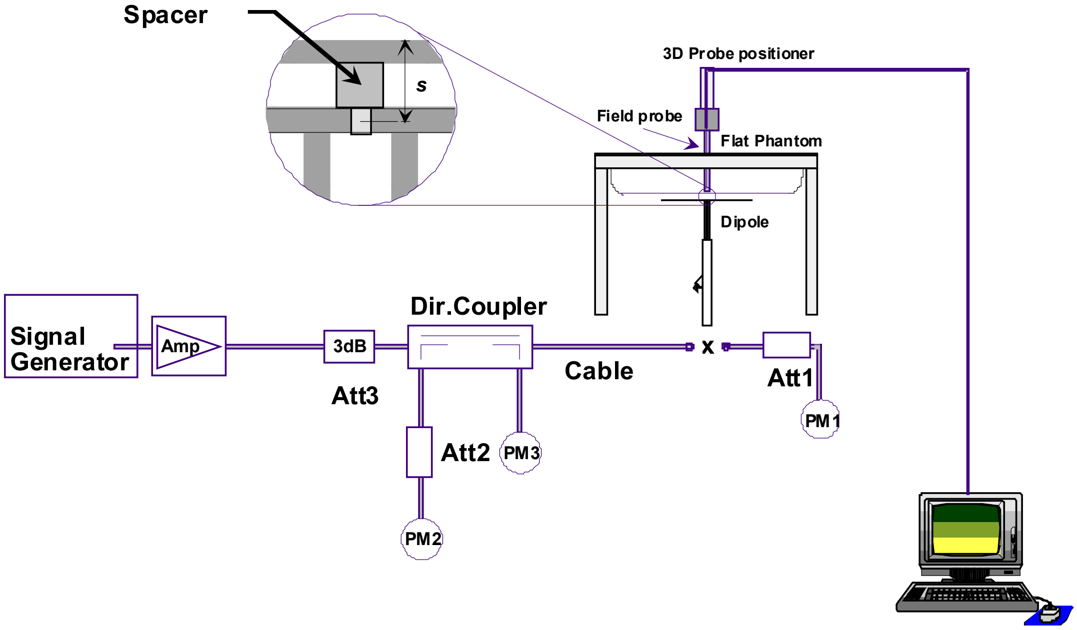


Fig 8.1 System Setup for System Evaluation

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

The output power on dipole port must be calibrated to 24 dBm (250 mW) before dipole is connected.

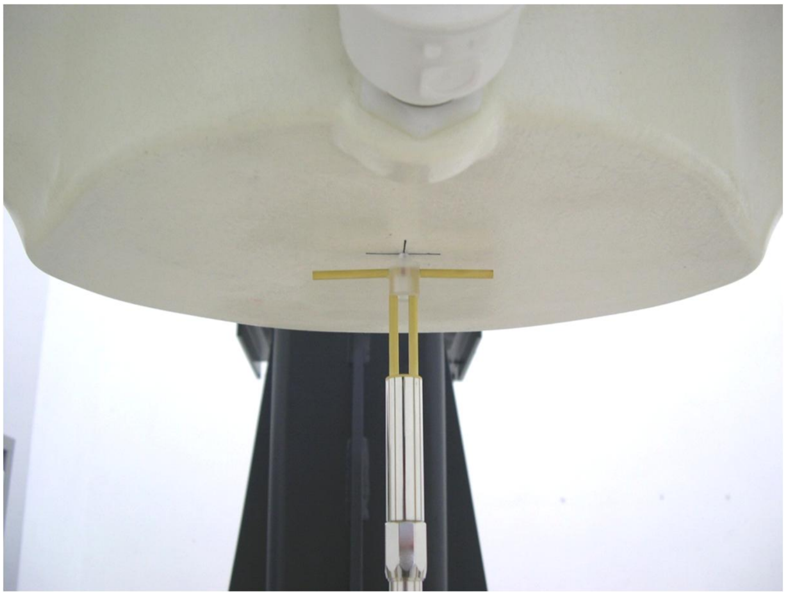


Fig 8.2 Photo of Dipole Setup

8.3 System Verification Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Table 8.1 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	Probe S/N	Frequency (MHz)	Targeted SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	Normalized SAR_{1g} (W/kg)	Deviation (%)
Sep. 01, 2011	SN3792	2450	51.200	13.500	54.00	5.47
Sep. 08, 2011	SN3792	2450	51.200	13.500	54.00	5.47
Jan. 02, 2012	SN3270	2450	51.200	13.700	54.80	7.03
Sep. 01, 2011	SN3578	5200	76.000	20.000	80.00	5.26
Sep. 06, 2011	SN3578	5200	76.000	20.500	82.00	7.89
Sep. 08, 2011	SN3792	5200	76.000	17.900	71.60	-5.79
Dec. 22, 2011	SN3792	5200	76.000	19.900	79.60	4.74
Jan. 12, 2012	SN3792	5200	76.000	20.200	80.80	6.32
Feb. 07, 2012	SN3792	5200	76.000	19.900	79.60	4.74
Sep. 06, 2011	SN3578	5800	75.400	19.900	79.60	5.57
Sep. 08, 2011	SN3792	5800	75.400	17.500	70.00	-7.16
Dec. 22, 2011	SN3792	5800	75.400	18.900	75.60	0.27
Jan. 01, 2012	SN3792	5800	75.400	19.500	78.00	3.45
Jan. 12, 2012	SN3792	5800	75.400	19.700	78.80	4.51

Table 8.1 Target and Measurement SAR after Normalized

9 DUT Testing Position

This DUT was tested in four different USB configurations. They are “direct laptop plug-in for configuration 1 and 4”, “USB cable plug-in for configuration 2 and 3”, and “direct laptop plug-in for Tip Mode (the tip of the DUT)” shown as below. Both direct laptop plug-in and USB cable plug-in test configurations are tested with 0.5 cm separation between the particular dongle orientation and the flat phantom. Please refer to Appendix D for the test setup photos.

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

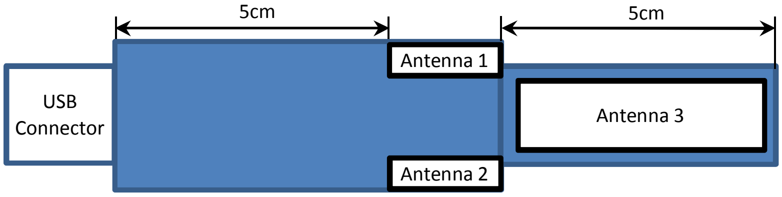
Fig 9.1 Illustration for USB Connector Orientations

<DUT Setup Photos and all test configurations>

Test positions follow the guidance in KDB inquiry.

1. 2.4GHz 802.11b
   - Flip Close: Follow KDB 447498 D02
   - Flip 180-degree open: Follow KDB 447498 D02, Tip-mode is excluded since 2.4GHz antenna is > 1cm from the Tip.
2. 5GHz 802.11a
   - Flip Close: Follow KDB 447498 D02
   - Flip 180-degree open: Follow KDB 447498 D02
   - Flip 90-degree open:
     - i. Test Horizontal-Up, Vertical-Front, Vertical-Back.
     - ii. Horizontal-Down, position the Flip-Front, Flip-Back 1cm to the flat phantom
3. 2.4GHz and 5GHz 802.11n
   - Flip Close: All antennas transmitting at the same time, and follow KDB 447498 D02 for test positions.
   - Flip 180-degree open: All antennas transmitting at the same time, and follow KDB 447498 D02 for test positions.
   - Flip 90-degree open:
     - i. Vertical-Front, Vertical-Back: All antennas transmitting at the same time
     - ii. Horizontal-Up, Horizontal-Down:
       - (a) Test antenna 1, antenna 2 SAR, separately.
       - (b) Test antenna 3, Flip-Front and Flip-Back to the flat phantom
       - (c) Use the results in (a) (b), to determine simultaneous transmission SAR

Antenna location diagram



Mode	Antenna 1	Antenna 2	Antenna 3
2.4GHz 802.11b		V	
2.4GHz 802.11n	V	V	V
5GHz 802.11a			V
5GHz 802.11n	V	V	V

2.4GHz 802.11b (Ant. 2) SAR tests configurations					
Flip status	Horizontal Up	Horizontal Down	Tip Mode	Vertical Front	Vertical Back
Flip Closed	Standalone	Standalone	Standalone	Standalone	Standalone
Flip 90 degree	Not required	Not required	Not required	Not required	Not required
Flip 180 degree	Standalone	Standalone	Not required	Standalone	Standalone
5 GHz 802.11a (Ant. 3) SAR tests configurations					
Antennas	Horizontal Up	Horizontal Down	Tip Mode	Vertical Front	Vertical Back
Flip Closed	Standalone	Standalone	Standalone	Standalone	Standalone
Flip 90 degree	Standalone	Horizontal Down (Flip Back)	Horizontal Down (Flip Front)	Standalone	Standalone
Flip 180 degree	Standalone	Standalone	Standalone	Standalone	Standalone
2.4GHz and 5GHz 802.11n (Ant. 1/2/3) SAR tests configurations					
Antennas	Horizontal Up	Horizontal Down	Tip Mode	Vertical Front	Vertical Back
Flip Closed	MIMO	MIMO	MIMO	MIMO	MIMO
Flip 90 degree	Refer to Table 9.3	Refer to Table 9.3	Refer to Table 9.3	MIMO	MIMO
Flip 180 degree	MIMO	MIMO	MIMO	MIMO	MIMO

Note:

1. DUT support 2.4GHz and 5GHz 802.11n in MIMO mode, hence antenna 1, antenna 2, and antenna 3 will transmit simultaneously in this mode. Per KDB 248227, SAR test under MIMO configuration can be measured directly under all antennas transmit simultaneously.
2. Per KDB 447498 D02, SAR at Tip-mode (Flip 180 degree) position is not required since the distance between Ant.2 and flat phantom > 1 cm. Standalone SAR for Ant.2 under Flip-90-degree status are also not required per FCC KDB inquiry guideline.

<Table 9.3>

Flip 90 degree for 802.11n SAR tests configurations				
Antennas	Combination #1	Combination #2	Combination #3	Combination #4
Ant. 1	Horizontal Up	Horizontal Up	Horizontal Down	Horizontal Down
Ant. 2	Horizontal Up	Horizontal Up	Horizontal Down	Horizontal Down
Ant. 3	Horizontal Down (Flip Front)	Horizontal Down (Flip Back)	Horizontal Down (Flip Front)	Horizontal Down (Flip Back)

Note:

1. During the tests of DUT Flip-90-degree horizontal up/down configuration, DUT MIMO SAR cannot be assessed under the flat phantom, with 3 antennas transmitting simultaneously. Therefore, antenna 1 and 2 are tested separately with its highest power setting in MIMO mode. Antenna 3 is tested separately with its highest power setting in MIMO mode, while at revised Flip-Front and Flip-Back in Horizontal-Down position. An engineering tool was used to set each antenna individually.
2. In Horizontal-down antenna 1/2 SAR testing, the dongle is placed under the phantom while the flip is 90-degree open and flip out of phantom. The 1g SAR summation of antenna 1/2/3 is for evaluation of composite zone between flip (90-degree open) and the dongle (upper face).

10 Measurement Procedures

The measurement procedures are as follows:

(a) For WWAN function, link DUT with base station emulator in highest power channel
(b) Set base station emulator to allow DUT to radiate maximum output power
(c) For WLAN function, using engineering software to transmit RF power continuously (continuous Tx) in the middle channel
(d) Measure output power through RF cable and power meter
(e) Place the DUT in the positions described in the last section
(f) Set scan area, grid size and other setting on the DASY software
(g) Taking data for the middle channel on each testing position
(h) Find out the largest SAR result on these testing positions of each band
(i) Measure SAR results for other channels in worst SAR testing position if the 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

10.1 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

10.2 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 measures 5x5x7 points with step size 8, 8 and 5 mm for 300 MHz to 3 GHz, and 8x8x8 points with step size 4, 4 and 2.5 mm for 3 GHz to 6 GHz. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g.

10.3 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 DUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing (step-size is 4, 4 and 2.5 mm). When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

10.4 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.

10.5 Power Drift Monitoring

All SAR testing is under the DUT 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 DUT 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.

11 SAR Test Results

11.1 Conducted Power (Unit: dBm)

Band	802.11b			802.11g		
Channel	1	6	11	1	6	11
Frequency (MHz)	2412	2437	2462	2412	2437	2462
ANT. 2 Avg. Power	14.26	13.74	13.79	9.52	8.27	7.09

Band	802.11n (BW 20MHz)			802.11n (BW 40MHz)		
Channel	1	6	11	3	6	9
Frequency (MHz)	2412	2437	2462	2422	2437	2452
ANT. 1 Avg. Power	8.25	6.98	5.83	7.95	7.68	8.28
ANT. 2 Avg. Power	9.63	8.32	7.01	8.88	8.06	6.79
ANT. 3 Avg. Power	5.14	5.47	6.08	8.01	8.08	7.96
Total Avg. Power	12.82	11.85	11.11	13.07	12.72	12.49

Band	802.11a								
Channel	36	40	44	48	149	153	157	161	165
Frequency (MHz)	5180	5200	5220	5240	5745	5765	5785	5805	5825
ANT. 3 Avg. Power	11.57	11.76	11.81	11.75	6.22	6.05	5.86	6.09	5.67

Band	802.11n (BW 20MHz)			
Channel	36	40	44	48
Frequency (MHz)	5180	5200	5220	5240
ANT. 1 Avg. Power	11.12	10.78	11.58	10.74
ANT. 2 Avg. Power	10.97	11.58	11.53	11.47
ANT. 3 Avg. Power	10.79	10.89	11.23	10.45
Total Avg. Power	15.73	15.86	16.22	15.59

Band	802.11n (BW 20MHz)				
Channel	149	153	157	161	165
Frequency (MHz)	5745	5765	5785	5805	5825
ANT. 1 Avg. Power	7.12	6.51	5.97	5.46	4.91
ANT. 2 Avg. Power	3.69	3.15	3.73	3.66	3.57
ANT. 3 Avg. Power	4.83	4.59	5.45	5.23	5.29
Total Avg. Power	10.22	9.74	9.92	9.62	9.42

Band	802.11n (BW 40MHz)				
Channel	38	46	151	159	
Frequency (MHz)	5190	5230	5755	5795	
ANT. 1 Avg. Power	10.54	10.39	6.26	5.55	
ANT. 2 Avg. Power	11.24	11.36	3.94	4.11	
ANT. 3 Avg. Power	11.44	11.59	5.53	5.11	
Total Avg. Power	15.86	15.91	10.11	9.73	

Note:

1. 802.11b/g transmits via antenna 2 only; 802.11a transmits via antenna 3 only; 802.11n transmits via antenna 1/antenna 2/antenna 3 at the same time.
2. WLAN2.4G 11g standalone SAR is not required because WLAN2.4G 11g highest average power (9.52 dBm) is less than 60/f(GHz) mW.
3. WLAN2.4G 11n standalone SAR is not required because WLAN2.4G 11n highest average power, 3 antennas summed power, (12.82 dBm) is less than 60/f(GHz) mW.
4. 11a 5745 MHz ~ 5825 MHz standalone SAR is not required because 11a 5745 MHz ~ 5825 MHz highest average power (6.22 dBm) is less than 60/f(GHz) mW.
5. Per 2010/4 TCB workshop, choose the highest output power channel to test SAR and determine further SAR exclusion, and 11b CH1, 11a CH44, 11n(20M) CH44 for 5180MHz ~ 5240MHz, 11n(20M) CH149 for 5745MHz ~ 5825MHz, are chosen here.
6. Per KDB 248227, 11n(40M) 5190 MHz ~ 5230MHz output power is less than 1/4 dB higher than 11n(20M) 5180 MHz ~ 5240 MHz, thus the SAR can be excluded.

11.2 Test Records for Body SAR Test

Plot No.	Band	Mode	Position	Flip Status	Gap (cm)	Ch.	Ant 1	Ant 2	Ant 3	Note	SAR_{1g} (W/kg)
12	**802.11b**	**-**	**Horizontal Up**	**flip closed**	**0.5**	**1**		**v**		**NB**	**0.304**
46	802.11b	-	Horizontal Down	flip closed	0.5	1		v		-	0.134
16	802.11b	-	Vertical Back	flip closed	0.5	1		v		NB	0.098
18	802.11b	-	Vertical Front	flip closed	0.5	1		v		-	0.148
20	802.11b	-	Tip Mode	flip closed	0.5	1		v		-	0.144
15	802.11b	-	Horizontal Up	180 degree	0.5	1		v		NB	0.288
79	802.11b	-	Horizontal Down	180 degree	0.5	1		v		-	0.138
47	802.11b	-	Vertical Back	180 degree	0.5	1		v		-	0.081
19	802.11b	-	Vertical Front	180 degree	0.5	1		v		-	0.21
1	802.11a	-	Horizontal Up	flip closed	0.5	44			v	NB	0.012
49	802.11a	-	Horizontal Down	flip closed	0.5	44			v	-	0.128
4	802.11a	-	Vertical Back	flip closed	0.5	44			v	NB	0.134
51	802.11a	-	Vertical Front	flip closed	0.5	44			v	-	0.033
7	802.11a	-	Tip Mode	flip closed	0.5	44			v	-	0.023
56	802.11a	-	Horizontal Up	180 degree	0.5	44			v	NB	0.04
10	**802.11a**	**-**	**Horizontal Down**	**180 degree**	**0.5**	**44**			**v**		**0.386**
59	802.11a	-	Vertical Back	180 degree	0.5	44			v	NB	0.086
58	802.11a	-	Vertical Front	180 degree	0.5	44			v	-	0.074
9	802.11a	-	Tip Mode	180 degree	0.5	44			v	-	0.035
57	802.11a	-	Horizontal Up	90 degree	0.5	44			v	NB	0.00873
5	802.11a		Vertical Back	90 degree	0.5	44			v		0.218
6	802.11a		Vertical Front	90 degree	0.5	44			v		0.11
8	802.11a	-	Horizontal Down	90 degree flip front	0.5	44			v	-	0.157
60	802.11a	-	Horizontal Down	90 degree flip front	1	44			v	-	0.066
61	802.11a	-	Horizontal Down	90 degree flip back	1	44			v	-	0.12
23	**802.11n**	**20M**	**Horizontal Up**	flip closed	**0.5**	**44**	**v**	**v**	**v**	**NB**	**0.819**
24	802.11n	20M	Horizontal Up	flip closed	0.5	36	v	v	v	NB	0.626
26	802.11n	20M	Horizontal Down	flip closed	0.5	44	v	v	v	-	0.234
28	802.11n	20M	Vertical Back	flip closed	0.5	44	v	v	v	NB	0.401
30	802.11n	20M	Vertical Front	flip closed	0.5	44	v	v	v	-	0.505
32	802.11n	20M	Tip Mode	flip closed	0.5	44	v	v	v	-	0.213
27	802.11n	20M	Horizontal Up	180 degree	0.5	44	v	v	v	NB	0.702
54	802.11n	20M	Horizontal Down	180 degree	0.5	44	v	v	v		0.329
53	802.11n	20M	Vertical Back	180 degree	0.5	44	v	v	v	NB	0.12
31	802.11n	20M	Vertical Front	180 degree	0.5	44	v	v	v	-	0.444
80	802.11n	20M	Tip Mode	180 degree	0.5	44	v	v	v		0.074
62	802.11n	20M	Horizontal Up	90 degree	0.5	44	v			NB	0.578
63	802.11n	20M	Horizontal Up	90 degree	0.5	44		v		NB	0.539
67	802.11n	20M	Horizontal Down	90 degree	0.5	44	v			-	0.144
68	802.11n	20M	Horizontal Down	90 degree	0.5	44		v		-	0.264
29	802.11n	20M	Vertical Back	90 degree	0.5	44	v	v	v	NB	0.233
55	802.11n	20M	Vertical Front	90 degree	0.5	44	v	v	v	-	0.456
33	802.11n	20M	Horizontal Down	90 degree flip front	0.5	44			v	-	0.203
66	802.11n	20M	Horizontal Down	90 degree flip back	0.5	44			v	-	0.274

35	802.11n	20M	Horizontal Up	flip closed	0.5	149	v	v	v	NB	0.094
50	802.11n	20M	Horizontal Down	flip closed	0.5	149	v	v	v	-	0.033
39	802.11n	20M	Vertical Back	flip closed	0.5	149	v	v	v	NB	0.042
52	802.11n	20M	Vertical Front	flip closed	0.5	149	v	v	v	-	0.014
43	802.11n	20M	Tip Mode	flip closed	0.5	149	v	v	v	-	0.093
75	802.11n	20M	Horizontal Up	180 degree	0.5	149	v	v	v	-	0.094
78	802.11n	20M	Horizontal Down	180 degree	0.5	149	v	v	v		0.04
76	802.11n	20M	Vertical Back	180 degree	0.5	149	v	v	v	-	0.013
77	802.11n	20M	Vertical Front	180 degree	0.5	149	v	v	v	-	0.019
81	802.11n	20M	Tip Mode	180 degree	0.5	149	v	v	v		0.000354
64	802.11n	20M	Horizontal Up	90 degree	0.5	149	v			NB	0.107
65	802.11n	20M	Horizontal Up	90 degree	0.5	149		v		-	0.088
73	802.11n	20M	Vertical Back	90 degree	0.5	149	v	v	v	NB	0.01
74	802.11n	20M	Vertical Front	90 degree	0.5	149	v	v	v	-	0.03
44	802.11n	20M	Horizontal Down	90 degree flip front	0.5	149			v	NB	0.104
70	802.11n	20M	Horizontal Down	90 degree flip back	0.5	149			v	NB	0.091
71	802.11n	20M	Horizontal Down	90 degree	0.5	149	v			-	0.056
72	802.11n	20M	Horizontal Down	90 degree	0.5	149		v		NB	0.106

Note:

1. Test positions follow the guidance from KDB inquiry.
2. For test case #66, #33, #44, #70, the test separation is 0.5cm and the SAR will be more conservative than test separation 1cm.
3. The symbol "V" in table representing the meaning of "transmitting" in this report.
4. NB mode means dongle directly plugged in the NB to test SAR, Other Test mode means dongle connected 12 inches USB cable to test SAR

11.3 Simultaneous Transmission SAR Analysis and Measurements

Evaluate directly with MIMO configuration

DUT Flip closed SAR tests configurations					
Antenna	Horizontal Up	Horizontal Down	Tip Mode	Vertical Front	Vertical Back
MIMO(1&2&3)	Yes	Yes	Yes	Yes	Yes
DUT Flip 180 degree SAR tests configurations					
Antenna	Horizontal Up	Horizontal Down	Tip Mode	Vertical Front	Vertical Back
MIMO(1&2&3)	Yes	Yes	Yes	Yes	Yes

DUT Flip 90 degree SAR tests configurations		
Antennas	Vertical Front	Vertical Back
MIMO(1&2&3)	Yes	Yes

Evaluate separately with individual antenna transmission

Revised Horizontal Down for 2.4GHz and 5GHz 802.11n Flip 90 degree SAR tests configurations				
Antennas	Combination #1	Combination #2	Combination #3	Combination #4
Ant. 1	Horizontal Up	Horizontal Up	Horizontal Down	Horizontal Down
Ant. 2	Horizontal Up	Horizontal Up	Horizontal Down	Horizontal Down
Ant. 3	Horizontal Down (Flip Front)	Horizontal Down (Flip Back)	Horizontal Down (Flip Front)	Horizontal Down (Flip Back)

Note:

1. For tests under Flip-Closed, Flip-180-degree positions, Flip-90 degree of Vertical Front, and Flip-90 degree of Vertical Back positions, simultaneous transmission SAR are assessed under MIMO configuration directly according to KDB 248227.
2. During the tests of DUT flip 90 degree configuration, DUT MIMO SAR cannot be assessed under the flat phantom, with 3 antennas transmitting simultaneously. Therefore, antenna 1 and 2 are tested separately with its highest power setting in MIMO mode. Antenna 3 is tested separately with its highest power setting in MIMO mode, while at revised Flip-Front and Flip-Back in Horizontal-Down position.
3. As in (2), for test under revised Horizontal Down Flip 90 degree position, sum up each SAR results for simultaneous transmission assessment. The sums of SAR from individual Ant.1/2 and Ant.3 transmission in MIMO mode under revised Horizontal Down Flip 90 degree positions summary in the following tables are less than 1.6W/kg, therefore the simultaneous SAR evaluation for these positions is not required.

Combination #1

Mode	Channel	Ant 1	Ant 2	Ant 3	Max. SAR Summation	Simultaneous SAR
802.11n	44	0.578	0.539	0.203	**1.32**	**Not required**
	149	0.107	0.088	0.104	**0.299**	

Note:
1. Antenna 1, antenna 2 SAR in Horizontal-Up position with flip 90-degree open.
2. Antenna 3 SAR in Horizontal-Down position, flip-front to the phantom, with flip 90-degree open
3. If 1g-SAR scalar summation < 1.6W/kg, simultaneous SAR measurement is not necessary.

Combination #2

Mode	Channel	Ant 1	Ant 2	Ant 3	Max. SAR Summation	Simultaneous SAR
802.11n	44	0.578	0.539	0.274	**1.39**	**Not required**
	149	0.107	0.088	0.091	**0.286**	

Note:
1. Antenna 1, antenna 2 SAR in Horizontal-Up position with flip 90-degree open.
2. Antenna 3 SAR in Horizontal-Down position, flip-back to the phantom, with flip 90-degree open
3. If 1g-SAR scalar summation < 1.6W/kg, simultaneous SAR measurement is not necessary.

Combination #3

Mode	Channel	Ant 1	Ant 2	Ant 3	Max. SAR Summation	Simultaneous SAR
802.11n	44	0.144	0.264	0.203	**0.611**	**Not required**
	149	0.056	0.106	0.104	**0.266**	

Note:
1. Antenna 1, antenna 2 SAR in Horizontal-Down position with flip 90-degree open.
2. Antenna 3 SAR in Horizontal-Down position, flip-front to the phantom, with flip 90-degree open
3. If 1g-SAR scalar summation < 1.6W/kg, simultaneous SAR measurement is not necessary.

Combination #4

Mode	Channel	Ant 1	Ant 2	Ant 3	Max. SAR Summation	Simultaneous SAR
802.11n	44	0.144	0.264	0.274	**0.682**	**Not required**
	149	0.056	0.106	0.091	**0.253**	

Note:
1. Antenna 1, antenna 2 SAR in Horizontal-Down position with flip 90-degree open.
2. Antenna 3 SAR in Horizontal-Down position, flip-back to the phantom, with flip 90-degree open
3. If 1g-SAR scalar summation < 1.6W/kg, simultaneous SAR measurement is not necessary.

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12 References

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

[2] IEEE Std. C95.1-1991, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, 1991

[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 v04, “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 616217 D01 v01r01, “SAR Evaluation Considerations for Laptop Computers with Antennas Built-in on Display Screens”, November 2009

[10] FCC KDB 616217 D03 v01, “SAR Evaluation Considerations for Laptop/Notebook/Netbook and Tablet Computers”, November 2009

[11] FCC KDB 648474 D01 v01r05, “SAR Evaluation Considerations for Handsets with Multiple Transmitters and Antennas”, September 2008

[12] FCC KDB 941225 D01 v02, “SAR Measurement Procedures for 3G Devices – CDMA 2000 / Ev-Do / WCDMA / HSDPA / HSPA”, October 2007

Appendix A. Plots of System Performance Check

The plots are shown as follows.

Appendix B. Plots of SAR Measurement

The plots are shown as follows.

Appendix C. DASY Calibration Certificate

The DASY calibration certificates are shown as follows.