FCC SAR Test Report

APPLICANT	:	Motion Computing Incorporated
EQUIPMENT	:	N6230 mini PCI-E WiFi a/b/g/n + BT module
BRAND NAME	:	Motion Computing Incorporated
MODEL NAME	:	62230ANHMW
FCC ID	:	Q3QIHW62230ANH
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 installed into Host (Brand Name: Motion Computing Incorporated, Model Name: CFT-003) during test.

The product was received on Nov. 22, 2011 and completely tested on Nov. 27, 2011. 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:

Jones Tsai

Jones Tsai / Manager

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.

Table of Contents

1. Statement of Compliance **4**
2. Administration Data **5**
2.1 Testing Laboratory 5
2.2 Applicant 5
2.3 Manufacturer 5
2.4 Factory 5
2.5 Application Details 5
3. General Information **6**
3.1 Description of Device Under Test (DUT) 6
3.2 Product Photos 7
3.3 Applied Standards 7
3.4 Device Category and SAR Limits 7
3.5 Test Conditions 7
4. Specific Absorption Rate (SAR) **8**
4.1 Introduction 8
4.2 SAR Definition 8
5. SAR Measurement System **9**
5.1 E-Field Probe 10
5.2 Data Acquisition Electronics (DAE) 11
5.3 Robot 11
5.4 Measurement Server 12
5.5 Phantom 12
5.6 Device Holder 13
5.7 Data Storage and Evaluation 15
5.8 Test Equipment List 17
6. Tissue Simulating Liquids **18**
7. Uncertainty Assessment **20**
8. SAR Measurement Evaluation **23**
8.1 Purpose of System Performance check 23
8.2 System Setup 23
8.3 Validation Results 25
9. DUT Testing Position **26**
10. Measurement Procedures **27**
10.1 Spatial Peak SAR Evaluation 27
10.2 Area & Zoom Scan Procedures 28
10.3 Volume Scan Procedures 28
10.4 SAR Averaged Methods 28
10.5 Power Drift Monitoring 28
11. SAR Test Configurations **29**
11.1 Exposure Positions Consideration 29
12. SAR Test Results **31**
12.1 Conducted Power (Unit: dBm) 31
12.2 Test Records for Body SAR Test 37
13. References **39**

Appendix A. Plots of System Performance Check
Appendix B. Plots of SAR Measurement
Appendix C. DASY Calibration Certificate
Appendix D. Product Photos
Appendix E. Test Setup Photos

Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA1N0901	Rev. 01	Initial issue of report	Jan. 20, 2012

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Motion Computing Incorporated , N6230 mini PCI-E WiFi a/b/g/n + BT module , Motion Computing Incorporated , 62230ANHMW** are as follows.

Band	Position	SAR_{1g} (W/kg)
WLAN 2.4G	**Body (0 cm Gap)**	**1.39**
WLAN 5G	**Body (0 cm Gap)**	**1.42**

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	Motion Computing Incorporated
Address	8601 Ranch Road 2222; Building #2 Austin, Texas 78730 USA

2.3 Manufacturer

Company Name	Motion Computing Incorporated
Address	8601 Ranch Road 2222; Building #2 Austin, Texas 78730 USA

2.4 Factory

Company Name	Pegatron Corporation
Address	5F. No. 76, Li-Gong St., Beitou District, Taipei City 112, Taiwan, R.O.C.

2.5 Application Details

Date of Receipt of Application	Nov. 22, 2011
Date of Start during the Test	Nov. 22, 2011
Date of End during the Test	Nov. 27, 2011

3. General Information

3.1 Description of Device Under Test (DUT)

Product Feature & Specification	
DUT Type	N6230 mini PCI-E WiFi a/b/g/n + BT module
Brand Name	Motion Computing Incorporated
Model Name	62230ANHMW
FCC ID	Q3QIHW62230ANH
Tx Frequency	802.11b/g/n: 2412 MHz ~ 2462 MHz 802.11a/n: 5180 MHz ~ 5320 MHz; 5500 MHz ~ 5700 MHz; 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz RFID:13.56MHz
Rx Frequency	802.11b/g/n: 2412 MHz ~ 2462 MHz 802.11a/n: 5180 MHz ~ 5320 MHz; 5500 MHz ~ 5700 MHz; 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz RFID:13.56MHz
Maximum Average Output Power to Antenna	802.11b: 16.78 dBm 802.11g: 16.60 dBm 802.11n (2.4GHz): 16.51 dBm (BW 20MHz) 802.11n (2.4GHz): 16.45 dBm (BW 40MHz) 802.11a: 16.70 dBm 802.11n (5GHz): 16.59 dBm (BW 20MHz) 802.11n (5GHz): 16.46 dBm (BW 40MHz) Bluetooth: 6.01 dBm RFID: EIRP -16.60 dbm
Antenna Type	WLAN: PIFA Antenna Bluetooth: PIFA Antenna RFID: Integrate Antenna
Type of Modulation	802.11b: DSSS (BPSK / QPSK / CCK) 802.11a/g/n: OFDM (BPSK / QPSK / 16QAM / 64QAM) Bluetooth (1Mbps): GFSK Bluetooth EDR (2Mbps): π/4-DQPSK Bluetooth EDR (3Mbps): 8-DPSK RFID: ASK
DUT Stage	Production Unit
Remark: The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.	

Host Information	
Brand Name	Motion Computing Incorporated
Model Name	CFT-003
FCC ID	Q3QTIRFID7960
Tx/Rx Frequency Range	13.56 MHz
Antenna Type	PCB Antenna
Type of Modulation	ASK

3.2 Product Photos

Please refer to Appendix D

3.3 Applied Standards

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

- FCC 47 CFR Part 2 (2.1093)
- IEEE C95.1-1991
- IEEE 1528-2003
- FCC OET Bulletin 65 Supplement C (Edition 01-01)
- FCC KDB 447498 D01 v04
- FCC KDB 616217 D03 v01
- 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 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

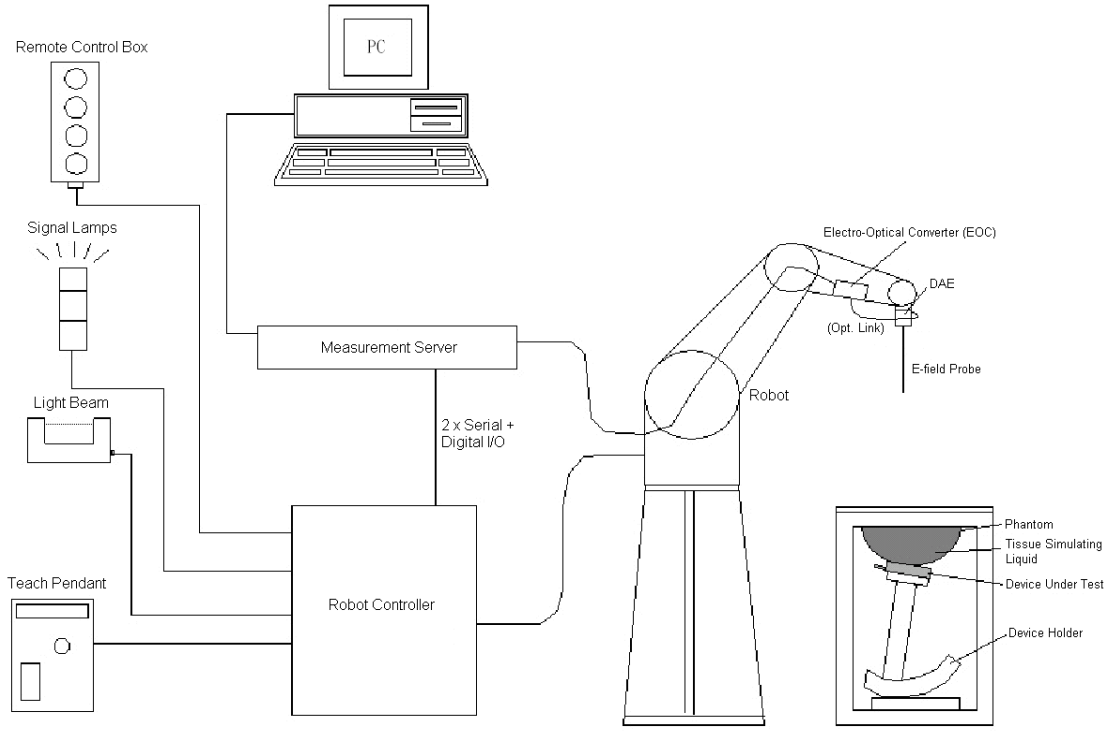


Fig 5.1 SPEAG DASY System Configurations

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 (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
- 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

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

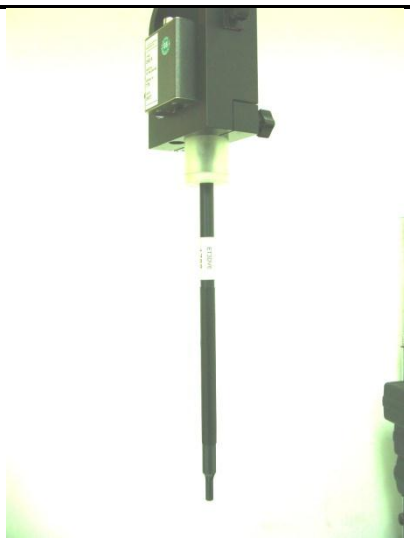


Fig 5.2 Photo of ET3DV6

<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)

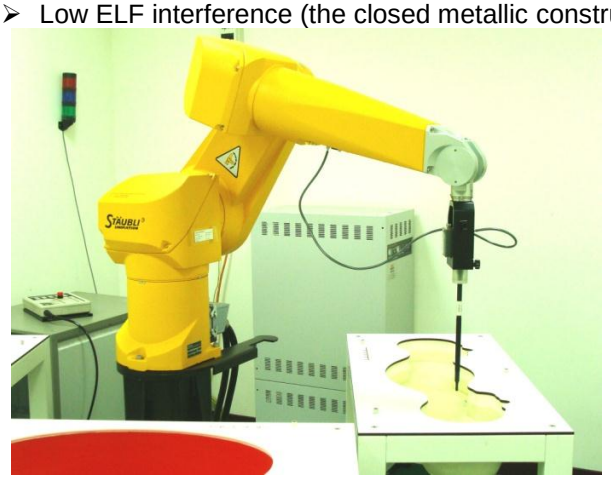


Fig 5.1 Photo of DASY4

Fig 5.2 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 5.1 Photo of Server for DASY4

Fig 5.2 Photo of Server for DASY5

5.5 Phantom

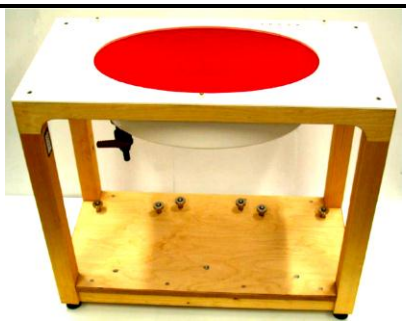
<SAM Twin Phantom>

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 5.3 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 5.4 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 $\varepsilon = 3$ and loss tangent $\delta = 0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

Fig 5.5 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.

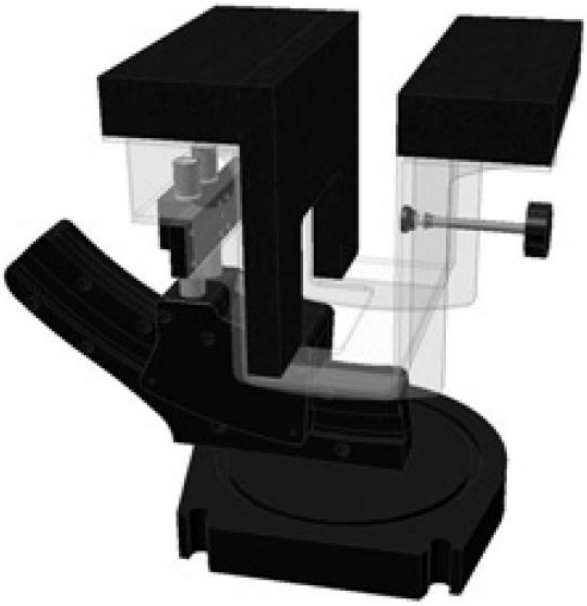


Fig 5.6 Laptop Extension Kit

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	ET3DV6	1788	Sep. 28, 2011	Sep. 27, 2012
SPEAG	Dosimetric E-Filed Probe	EX3DV4	3792	Jun. 20, 2011	Jun. 19, 2012
SPEAG	Dosimetric E-Filed Probe	ES3DV3	3270	Sep. 12, 2011	Sep. 11, 2012
SPEAG	2450MHz System Validation Kit	D2450V2	736	Jul. 25, 2011	Jul. 24, 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	1244	Jan. 07, 2011	Jan. 06, 2012
SPEAG	Data Acquisition Electronics	DAE4	1279	Jun. 17, 2011	Jun. 16, 2012
SPEAG	Device Holder	N/A	N/A	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1303	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1383	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1446	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1478	NCR	NCR
SPEAG	SAM Phantom	QD 000 P41 C	TP-1150	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 CD	TP-1644	NCR	NCR
SPEAG	SAM Phantom	SM 000 T01 DA	TP-1542	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 001 BB	1026	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 001 BA	1029	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 002 AA	TP-1127	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 002 AA	TP-1131	NCR	NCR
Agilent	ENA Series Network Analyzer	E5071C	MY46100746	Jun. 10, 2011	Jun. 09, 2012
Anritsu	Radio Communication Analyzer	MT8820C	6201026480	Aug. 12 ,2011	Aug. 11 ,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
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:

1. 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.

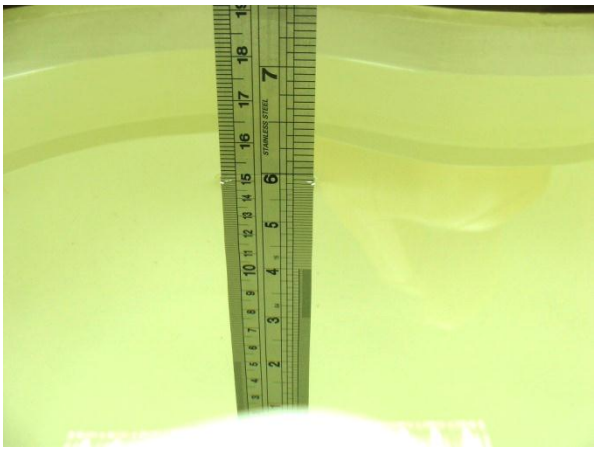


Fig 6.1 Photo of Liquid Height for Head SAR

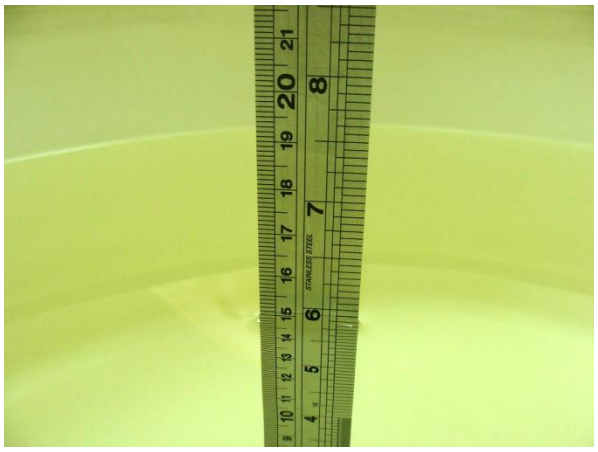


Fig 6.2 Photo of Liquid Height for Body SAR

The following table gives the recipes for tissue simulating liquid.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (ε_r)
For Head								
2450	55.0	0	0	0	0	45.0	1.80	39.2
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 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	21.4	1.973	52.342	1.95	52.7	1.18	-0.68	±5	Nov. 22, 2011
2450	Body	21.3	1.97	52.8	1.95	52.7	1.03	0.19	±5	Nov. 26, 2011
5200	Body	21.3	5.325	48.639	5.3	49	0.47	-0.74	±5	Nov. 23, 2011
5200	Body	21.2	5.32	47.5	5.3	49	0.38	-3.06	±5	Nov. 26, 2011
5200	Body	21.4	5.14	47.5	5.3	49	-3.02	-3.06	±5	Nov. 27, 2011
5500	Body	21.2	5.71	47	5.65	48.6	1.06	-3.29	±5	Nov. 26, 2011
5500	Body	21.4	5.52	47	5.65	48.6	-2.30	-3.29	±5	Nov. 27, 2011
5800	Body	21.2	6.22	46.4	6	48.2	3.67	-3.73	±5	Nov. 26, 2011
5800	Body	21.4	5.99	46.5	6	48.2	-0.17	-3.53	±5	Nov. 27, 2011

Table 6.2 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 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:

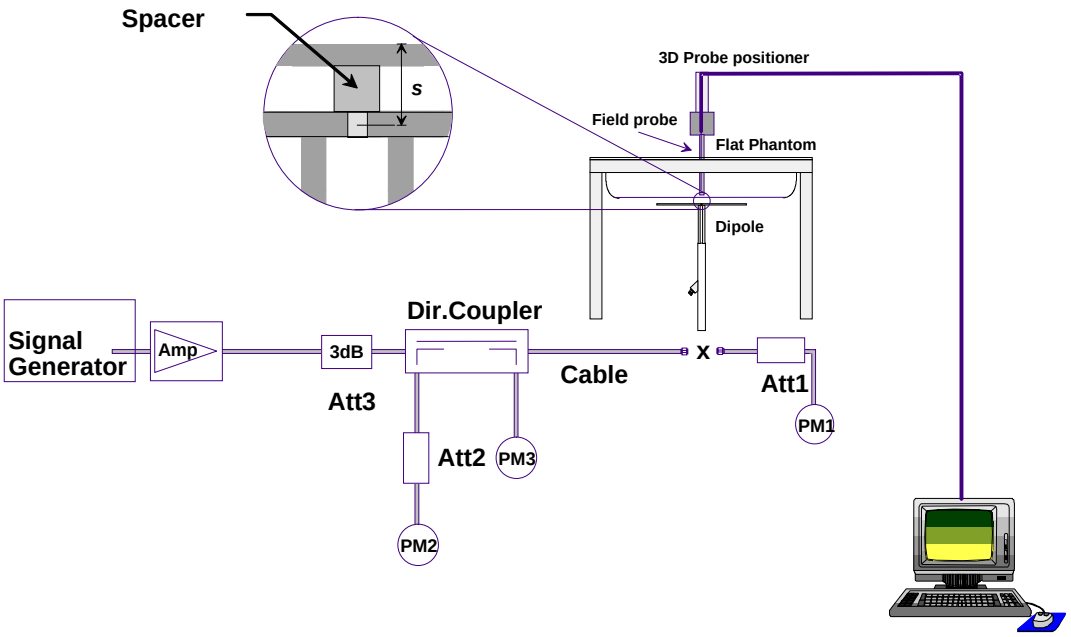


Fig 8.1 System Setup for System Evaluation

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.

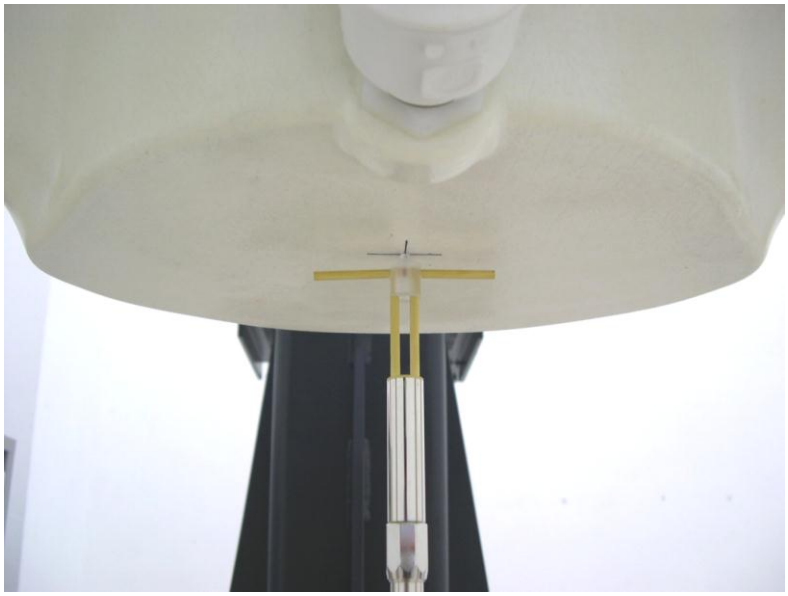


Fig 8.2 Photo of Dipole Setup

8.3 Validation Results

Comparing to the original SAR value provided by SPEAG, the validation 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	Frequency (MHz)	Liquid Type	Targeted SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	Normalized SAR_{1g} (W/kg)	Deviation (%)
Nov. 22, 2011	2450	Body	52.3	13.7	54.80	4.78
Nov. 26, 2011	2450	Body	52.3	13.3	53.20	1.72
Nov. 23, 2011	5200	Body	76	19.5	78.00	2.63
Nov. 26, 2011	5200	Body	76	18.6	74.40	-2.11
Nov. 27, 2011	5200	Body	76	18	72.00	-5.26
Nov. 26, 2011	5500	Body	81.7	19.5	78.00	-4.53
Nov. 27, 2011	5500	Body	81.7	18.8	75.20	-7.96
Nov. 26, 2011	5800	Body	75.4	17.8	71.20	-5.57
Nov. 27, 2011	5800	Body	75.4	17.2	68.80	-8.75

Table 8.1 Target and Measurement SAR after Normalized

9. DUT Testing Position

This DUT was tested in three different positions. They are bottom face of tablet PC, Secondary Landscape, and Secondary Portrait. In these positions, the surface of DUT is touching with phantom 0 cm gap. Please refer to Appendix E for the test setup photos.

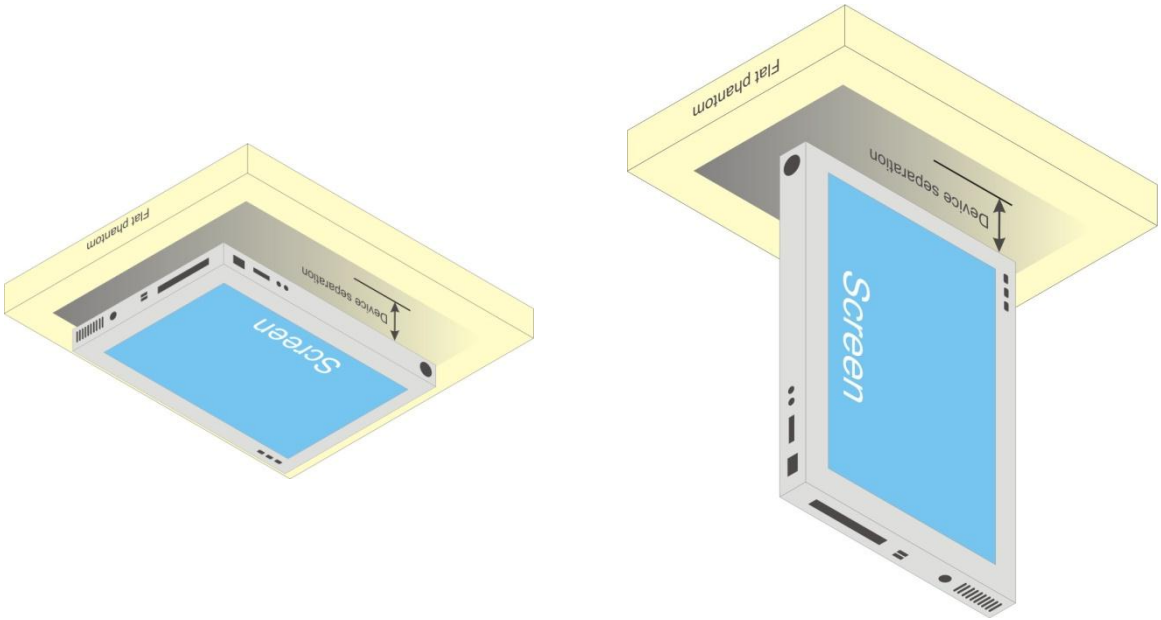


Fig 9.1 Illustration for Lap-touching Position

10. Measurement Procedures

The measurement procedures are as follows:

(a) Use engineering software to transmit RF power continuously (continuous Tx) in the highest power channel.
(b) Keep DUT to radiate 100% duty factor.
(c) Measure output power through RF cable and power meter.
(d) Place the DUT in the positions as Appendix E demonstrates.
(e) Set scan area, grid size and other setting on the DASY software.
(f) Measure SAR results for the highest power channel on each testing position.
(g) Find out the largest SAR result on these testing positions of each band
(h) 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.

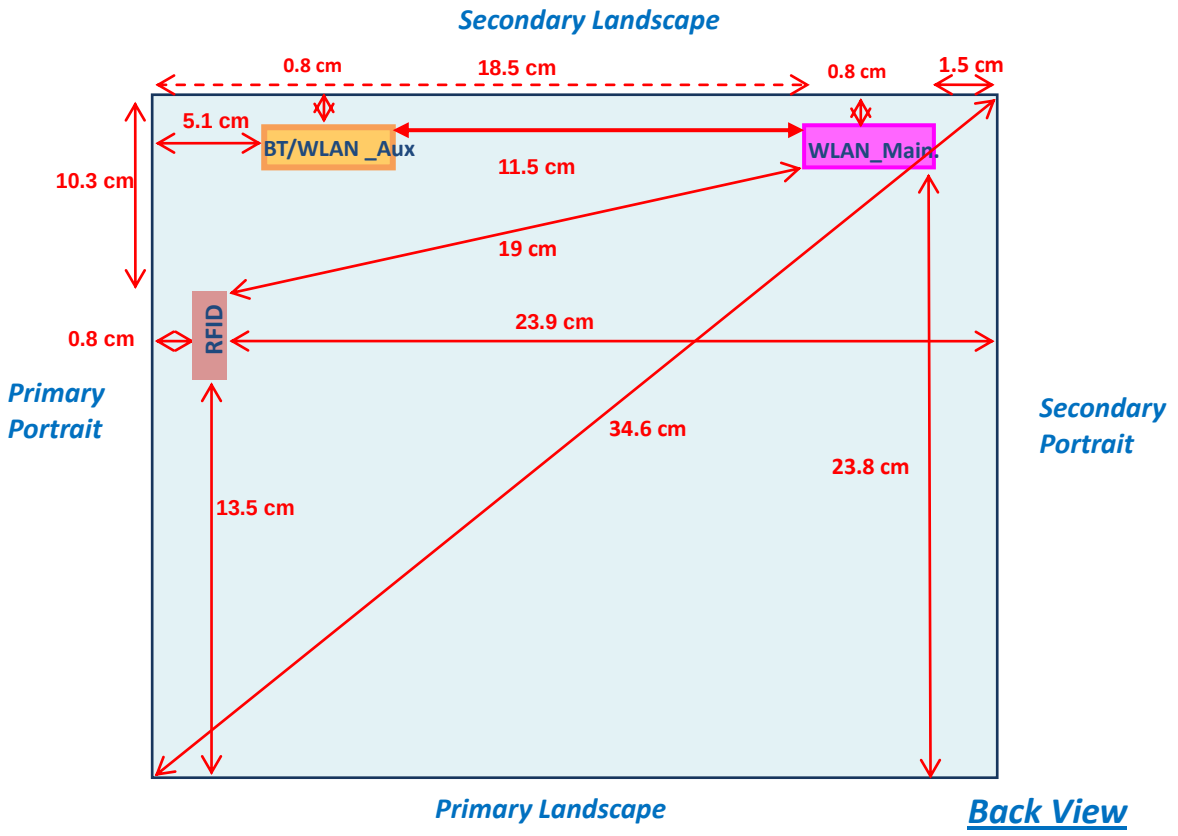
Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty 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 Configurations

11.1 Exposure Positions Consideration



Antenna	Mode
WLAN_Main (TX/Rx)	802.11 b/g/n 802.11 a/n
Bluetooth/WLAN_Aux (TX/RX)	Bluetooth 802.11 b/g/n 802.11 a/n
RFID (Tx/RX)	RFID

Antenna	Length	Width
WLAN_Main (TX/Rx)	3cm	0.8cm
Bluetooth/WLAN_Aux (TX/RX)	3cm	0.8cm
RFID (Tx/RX)	2.6cm	1cm

Note:
1. WLAN_Main antenna hereinafter refers to as Ant. A.
2. Bluetooth/WLAN_Aux antenna hereinafter refers to as Ant. B.

Sides for SAR tests; Tablet mode						
Antenna Mode	**Bottom Face**	**Front Face**	**Secondary Landscape**	**Primary Landscape**	**Secondary Portrait**	**Primary Portrait**
Ant. A	✓(0 mm)	x	✓(0 mm)	x	✓(0 mm)	x
Ant. B	✓(0 mm)	x	✓(0 mm)	x	x	x
Ant. A + B	✓(0 mm)	x	✓(0 mm)	x	✓(0 mm)	x

Note:

1. The DUT diagonal dimension is 34.6 cm; per KDB 941225 D07, the DUT diagonal > 20 cm and Mini-Tablet procedure is not applied. Therefore, SAR tests follow the Tablet Mode in KDB447498.
2. There is no screen orientation limitation in DUT; that is 4 orientations are supported. The power reduction for SAR compliance is not triggered by the screen orientation.
3. As in (1), the test distance is 0 mm to the flat phantom; SAR evaluation is required for Bottom Face and each applicable Edge with the antenna within 5 cm to the user.
4. Per KDB 447498 D01, the distance from WLAN_Main antenna (Ant. A) to the Primary-Portrait / Primary-Landscape edge > 5 cm, therefore the stand-alone in these configurations SAR are not required.
5. Per KDB 447498 D01, the distance from Bluetooth/WLAN_Aux antenna (Ant. B) to the Primary-Portrait / Primary-Landscape /Secondary-Portrait edge > 5 cm, therefore the stand-alone SAR in these configurations are not required.
6. Per KDB 447498 D01, Bluetooth and RFID output power ≤ 60/f thus stand-alone SAR is not required.
7. WLAN and Bluetooth share the same antenna and cannot transmit simultaneously.
8. 5 GHz and 2.4 GHz share the same antenna, and will not transmit simultaneously (the transmitting overlapping period will not exceed 30 seconds during AP searching/registration).
9. 802.11n can simultaneously transmit via antenna A and antenna B, hereinafter refer to as "Ant. A + B" mode. In this mode, SAR evaluation is required for the union of Ant. A and Ant. B; that is Bottom Face, Secondary-Landscape, and Secondary-Portrait here.

12. SAR Test Results

12.1 Conducted Power (Unit: dBm)

Mode	Channel	Frequency (MHz)	Average power (dBm)			
			Ant A			
			Data Rate (bps)			
			1M	2M	5.5M	11M
802.11b	CH 01	2412 MHz	16.62	-	-	-
	CH 06	2437 MHz	16.68	-	-	-
	CH 11	2462 MHz	**16.78**	16.63	16.6	16.72

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant A							
			Data Rate (bps)							
			6M	9M	12M	18M	24M	36M	48M	54M
802.11g	CH 01	2412 MHz	14.08	-	-	-	-	-	-	-
	CH 06	2437 MHz	**16.60**	16.37	16.54	16.59	16.38	16.40	16.09	16.00
	CH 11	2462 MHz	14.02	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant A							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 20M	CH 01	2412 MHz	12.97	-	-	-	-	-	-	-
	CH 06	2437 MHz	**16.37**	16.15	16.09	16.13	16.18	16.05	15.98	15.87
	CH 11	2462 MHz	12.23	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant A							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 40M	CH 03	2422 MHz	10.52	-	-	-	-	-	-	-
	CH 06	2437 MHz	**16.45**	16.34	16.07	15.84	15.53	15.28	15.64	15.53
	CH 09	2452 MHz	10.01	-	-	-	-	-	-	-

Note:

1. Per 2010/10 TCB workshop and KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. Per KDB 248227, 11g and 11n output power is less than 1/4 dB higher than 11b mode, thus the SAR can be excluded.

Mode	Channel	Frequency (MHz)	Average power (dBm)			
			Ant B			
			Data Rate (bps)			
			1M	2M	5.5M	11M
802.11b	CH 01	2412 MHz	16.40	16.23	16.21	16.31
	CH 06	2437 MHz	**14.63**	-	-	-
	CH 11	2462 MHz	16.00	-	-	-

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant B							
			Data Rate (bps)							
			6M	9M	12M	18M	24M	36M	48M	54M
802.11g	CH 01	2412 MHz	13.89	-	-	-	-	-	-	-
	CH 06	2437 MHz	**16.37**	16.34	16.36	16.3	16.26	16.03	16.07	16.09
	CH 11	2462 MHz	13.01	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 20M	CH 01	2412 MHz	12.29	-	-	-	-	-	-	-
	CH 06	2437 MHz	**16.51**	16.50	16.36	16.50	16.48	16.17	16.22	16.43
	CH 11	2462 MHz	13.13	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 40M	CH 03	2422 MHz	8.73	-	-	-	-	-	-	-
	CH 06	2437 MHz	**12.52**	12.39	12.46	12.35	12.19	12.18	12.25	12.13
	CH 09	2452 MHz	9.43	-	-	-	-	-	-	-

Note:

1. Per 2010/10 TCB workshop and KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. Per KDB 248227, 11g and 11n output power is less than 1/4 dB higher than 11b mode, thus the SAR can be excluded.

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant A+B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 20M	CH 01	2412 MHz	14.32	-	-	-	-	-	-	-
	CH 06	2437 MHz	**16.13**	16.07	15.82	15.63	15.49	11.14	15.52	15.61
	CH 11	2462 MHz	13.59	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average power (dBm)							
			Ant A+B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 40M	CH 03	2422 MHz	9.86	-	-	-	-	-	-	-
	CH 06	2437 MHz	**15.17**	15.13	15.03	15.06	14.51	14.49	14.42	14.41
	CH 09	2452 MHz	9.17	-	-	-	-	-	-	-

Note:

1. Per 2010/10 TCB workshop and KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. 802.11n can simultaneously transmit via antenna A and antenna B in this mode.

Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant A							
			Data Rate (bps)							
			6M	9M	12M	18M	24M	36M	48M	54M
802.11a	CH 036	5180 MHz	16.18	-	-	-	-	-	-	-
	CH 040	5200 MHZ	16.17	-	-	-	-	-	-	-
	CH 044	5220 MHz	16.13	-	-	-	-	-	-	-
	CH 048	5240 MHz	15.64	-	-	-	-	-	-	-
	CH 052	5260 MHz	15.58	-	-	-	-	-	-	-
	CH 056	5280 MHz	16.25	-	-	-	-	-	-	-
	CH 060	5300 MHz	16.14	-	-	-	-	-	-	-
	CH 064	5320 MHz	16.27	15.75	15.53	15.99	15.80	15.87	16.12	15.84
	CH 100	5500 MHz	16.17	-	-	-	-	-	-	-
	CH 104	5520 MHz	16.32	-	-	-	-	-	-	-
	CH 108	5540 MHz	16.23	-	-	-	-	-	-	-
	CH 112	5560 MHz	16.31	-	-	-	-	-	-	-
	CH 116	5580 MHz	16.36	16.20	15.93	15.98	15.94	15.90	16.09	15.88
	CH 120	5600 MHz	16.07	-	-	-	-	-	-	-
	CH 124	5620 MHz	16.22	-	-	-	-	-	-	-
	CH 128	5640 MHz	16.29	-	-	-	-	-	-	-
	CH 132	5660 MHz	16.26	-	-	-	-	-	-	-
	CH 136	5680 MHz	16.34	-	-	-	-	-	-	-
	CH 140	5700 MHz	16.30	-	-	-	-	-	-	-
	CH 149	5745 MHz	**16.50**	16.41	16.48	16.46	16.47	16.49	16.47	16.43
	CH 153	5765 MHz	16.25	-	-	-	-	-	-	-
	CH 157	5785 MHz	16.35	-	-	-	-	-	-	-
	CH 161	5805 MHz	16.43	-	-	-	-	-	-	-
	CH 165	5825 MHz	16.43	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant A							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 20M	CH 036	5180 MHz	15.87	-	-	-	-	-	-	-
	CH 040	5200 MHZ	14.93	-	-	-	-	-	-	-
	CH 044	5220 MHz	16.05	-	-	-	-	-	-	-
	CH 048	5240 MHz	15.54	-	-	-	-	-	-	-
	CH 052	5260 MHz	15.64	-	-	-	-	-	-	-
	CH 056	5280 MHz	14.30	-	-	-	-	-	-	-
	CH 060	5300 MHz	16.18	-	-	-	-	-	-	-
	CH 064	5320 MHz	16.20	15.98	16.14	16.11	16.18	16.19	16.10	16.14
	CH 100	5500 MHz	16.18	-	-	-	-	-	-	-
	CH 104	5520 MHz	13.41	-	-	-	-	-	-	-
	CH 108	5540 MHz	14.17	-	-	-	-	-	-	-
	CH 112	5560 MHz	14.51	-	-	-	-	-	-	-
	CH 116	5580 MHz	16.32	15.98	16.11	16.24	16.22	16.24	16.26	16.23
	CH 120	5600 MHz	14.07	-	-	-	-	-	-	-
	CH 124	5620 MHz	14.65	-	-	-	-	-	-	-
	CH 128	5640 MHz	15.24	-	-	-	-	-	-	-
	CH 132	5660 MHz	14.28	-	-	-	-	-	-	-
	CH 136	5680 MHz	13.82	-	-	-	-	-	-	-
	CH 140	5700 MHz	16.19	-	-	-	-	-	-	-
	CH 149	5745 MHz	**16.59**	16.43	16.40	16.27	16.38	16.29	16.31	16.23
	CH 153	5765 MHz	15.72	-	-	-	-	-	-	-
	CH 157	5785 MHz	16.37	-	-	-	-	-	-	-
	CH 161	5805 MHz	15.86	-	-	-	-	-	-	-
	CH 165	5825 MHz	16.39	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant A							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 40M	CH 038	5190 MHz	12.80	-	-	-	-	-	-	-
	CH 046	5230 MHZ	16.13	16.06	16.07	15.90	16.00	16.00	16.00	16.06
	CH 054	5270 MHz	15.99	-	-	-	-	-	-	-
	CH 062	5310 MHz	11.30	-	-	-	-	-	-	-
	CH 102	5510 MHz	15.44	-	-	-	-	-	-	-
	CH 118	5590 MHz	13.72	-	-	-	-	-	-	-
	CH 134	5670 MHz	16.25	-	-	-	-	-	-	-
	CH 151	5755 MHz	**16.35**	16.20	16.08	15.86	16.03	15.98	15.82	15.58
	CH 159	5795 MHz	16.33	-	-	-	-	-	-	-

Note:

1. Per 2010/10 TCB workshop and KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. Per KDB 248227, 11g and 11n output power is less than 1/4 dB higher than 11b mode, thus the SAR can be excluded.

Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant B							
			Data Rate (bps)							
			6M	9M	12M	18M	24M	36M	48M	54M
802.11a	CH 036	5180 MHz	15.88	15.72	15.61	15.68	15.62	15.75	15.69	15.70
	CH 040	5200 MHZ	14.09	-	-	-	-	-	-	-
	CH 044	5220 MHz	15.62	-	-	-	-	-	-	-
	CH 048	5240 MHz	15.51	-	-	-	-	-	-	-
	CH 052	5260 MHz	15.19	-	-	-	-	-	-	-
	CH 056	5280 MHz	15.40	-	-	-	-	-	-	-
	CH 060	5300 MHz	15.28	-	-	-	-	-	-	-
	CH 064	5320 MHz	15.61	-	-	-	-	-	-	-
	CH 100	5500 MHz	15.50	-	-	-	-	-	-	-
	CH 104	5520 MHz	15.53	-	-	-	-	-	-	-
	CH 108	5540 MHz	15.48	-	-	-	-	-	-	-
	CH 112	5560 MHz	15.47	-	-	-	-	-	-	-
	CH 116	5580 MHz	15.57	15.45	15.37	15.46	15.29	15.31	15.54	15.51
	CH 120	5600 MHz	15.55	-	-	-	-	-	-	-
	CH 124	5620 MHz	15.44	-	-	-	-	-	-	-
	CH 128	5640 MHz	15.31	-	-	-	-	-	-	-
	CH 132	5660 MHz	15.47	-	-	-	-	-	-	-
	CH 136	5680 MHz	15.45	-	-	-	-	-	-	-
	CH 140	5700 MHz	15.24	-	-	-	-	-	-	-
	CH 149	5745 MHz	**16.70**	16.63	16.55	16.51	16.65	16.62	16.61	16.68
	CH 153	5765 MHz	16.22	-	-	-	-	-	-	-
	CH 157	5785 MHz	16.68	-	-	-	-	-	-	-
	CH 161	5805 MHz	16.15	-	-	-	-	-	-	-
	CH 165	5825 MHz	16.45	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 20M	CH 036	5180 MHz	15.83	15.70	15.73	15.80	15.76	15.74	15.82	15.82
	CH 040	5200 MHZ	14.44	-	-	-	-	-	-	-
	CH 044	5220 MHz	15.74	-	-	-	-	-	-	-
	CH 048	5240 MHz	15.63	-	-	-	-	-	-	-
	CH 052	5260 MHz	15.27	-	-	-	-	-	-	-
	CH 056	5280 MHz	15.52	-	-	-	-	-	-	-
	CH 060	5300 MHz	15.17	-	-	-	-	-	-	-
	CH 064	5320 MHz	15.54	-	-	-	-	-	-	-
	CH 100	5500 MHz	15.27	-	-	-	-	-	-	-
	CH 104	5520 MHz	15.56	-	-	-	-	-	-	-
	CH 108	5540 MHz	15.47	-	-	-	-	-	-	-
	CH 112	5560 MHz	15.56	-	-	-	-	-	-	-
	CH 116	5580 MHz	15.56	15.49	15.37	15.38	15.49	15.55	15.51	15.52
	CH 120	5600 MHz	15.56	-	-	-	-	-	-	-
	CH 124	5620 MHz	15.52	-	-	-	-	-	-	-
	CH 128	5640 MHz	15.53	-	-	-	-	-	-	-
	CH 132	5660 MHz	15.55	-	-	-	-	-	-	-
	CH 136	5680 MHz	15.44	-	-	-	-	-	-	-
	CH 140	5700 MHz	15.48	-	-	-	-	-	-	-
	CH 149	5745 MHz	**16.68**	16.55	16.57	16.41	16.53	16.44	16.41	16.36
	CH 153	5765 MHz	16.08	-	-	-	-	-	-	-
	CH 157	5785 MHz	16.58	-	-	-	-	-	-	-
	CH 161	5805 MHz	15.24	-	-	-	-	-	-	-
	CH 165	5825 MHz	16.52	-	-	-	-	-	-	-

Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 40M	CH 038	5190 MHz	12.63	-	-	-	-	-	-	-
	CH 046	5230 MHZ	15.78	15.69	15.64	15.61	15.73	15.70	15.66	15.74
	CH 054	5270 MHz	14.99	-	-	-	-	-	-	-
	CH 062	5310 MHz	12.35	-	-	-	-	-	-	-
	CH 102	5510 MHz	14.76	-	-	-	-	-	-	-
	CH 118	5590 MHz	15.55	-	-	-	-	-	-	-
	CH 134	5670 MHz	15.54	-	-	-	-	-	-	-
	CH 151	5755 MHz	**16.46**	16.32	16.31	16.03	15.89	15.94	16.01	15.45
	CH 159	5795 MHz	16.35	-	-	-	-	-	-	-

Note:

1. Per 2010/10 TCB workshop and KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. Per KDB 248227, 11g and 11n output power is less than 1/4 dB higher than 11b mode, thus the SAR can be excluded.

Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant A+B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 20M	CH 036	5180 MHz	**16.23**	16.20	16.17	16.21	16.19	16.18	16.20	16.13
	CH 040	5200 MHZ	15.75	-	-	-	-	-	-	-
	CH 044	5220 MHz	16.13	-	-	-	-	-	-	-
	CH 048	5240 MHz	15.92	-	-	-	-	-	-	-
	CH 052	5260 MHz	15.53	-	-	-	-	-	-	-
	CH 056	5280 MHz	15.86	-	-	-	-	-	-	-
	CH 060	5300 MHz	15.89	-	-	-	-	-	-	-
	CH 064	5320 MHz	15.92	-	-	-	-	-	-	-
	CH 100	5500 MHz	15.78	-	-	-	-	-	-	-
	CH 104	5520 MHz	15.85	-	-	-	-	-	-	-
	CH 108	5540 MHz	15.74	-	-	-	-	-	-	-
	CH 112	5560 MHz	15.84	-	-	-	-	-	-	-
	CH 116	5580 MHz	15.88	15.71	15.76	15.84	15.71	15.87	15.86	15.77
	CH 120	5600 MHz	15.64	-	-	-	-	-	-	-
	CH 124	5620 MHz	15.82	-	-	-	-	-	-	-
	CH 128	5640 MHz	15.86	-	-	-	-	-	-	-
	CH 132	5660 MHz	15.78	-	-	-	-	-	-	-
	CH 136	5680 MHz	15.80	-	-	-	-	-	-	-
	CH 140	5700 MHz	15.21	-	-	-	-	-	-	-
	CH 149	5745 MHz	13.19	12.78	12.61	12.32	12.25	12.10	12.20	12.12
	CH 153	5765 MHz	12.85	-	-	-	-	-	-	-
	CH 157	5785 MHz	12.90	-	-	-	-	-	-	-
	CH 161	5805 MHz	12.41	-	-	-	-	-	-	-
	CH 165	5825 MHz	13.00	-	-	-	-	-	-	-
Mode	Channel	Frequency (MHz)	Average Power (dBm)							
			Ant A+B							
			Data Rate (bps)							
			MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n 40M	CH 038	5190 MHz	13.26	-	-	-	-	-	-	-
	CH 046	5230 MHZ	**16.20**	16.17	16.17	16.15	16.06	16.11	16.19	16.16
	CH 054	5270 MHz	15.52	-	-	-	-	-	-	-
	CH 062	5310 MHz	15.06	-	-	-	-	-	-	-
	CH 102	5510 MHz	15.82	-	-	-	-	-	-	-
	CH 118	5590 MHz	15.66	-	-	-	-	-	-	-
	CH 134	5670 MHz	15.51	-	-	-	-	-	-	-
	CH 151	5755 MHz	13.31	12.70	12.56	12.23	12.06	12.17	12.22	11.99
	CH 159	5795 MHz	12.93	-	-	-	-	-	-	-

Note:

1. Per 2010/10 TCB workshop and KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. 802.11n can simultaneously transmit via antenna A and antenna B in this mode.

Mode	Channel	Frequency (MHz)	Average power (dBm)
			Data Rate (bps)
			DH5
Bluetooth	CH 00	2402 MHz	5.99
	CH 39	2441 MHz	6.01
	CH 78	2480 MHz	5.77

Note: Bluetooth standalone SAR is not required because the Bluetooth highest average power (6.01 dBm) is less than 60/f.

12.2 Test Records for Body SAR Test

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Ant. mode	SAR_{1g} (W/kg)
1	802.11b	-	Bottom Face	0	11	A	0.1
2	802.11b	-	Secondary Landscape	0	11	A	0.543
9	802.11b	-	Secondary Portrait	0	11	A	0.044
3	802.11b	-	Bottom Face	0	1	B	0.213
4	802.11b	-	Secondary Landscape	0	1	B	1.16
5	802.11b	-	Secondary Landscape	0	6	B	0.829
6	**802.11b**	**-**	**Secondary Landscape**	**0**	**11**	**B**	**1.39**
19	802.11n	20M	Bottom Face	0	6	A+B	0.137
20	802.11n	20M	Secondary Landscape	0	6	A+B	0.844
21	802.11n	20M	Secondary Portrait	0	6	A+B	0.034
22	802.11n	20M	Secondary Landscape	0	1	A+B	0.324
23	802.11n	20M	Secondary Landscape	0	11	A+B	0.613
10	802.11a	-	Bottom Face	0	36	A	0.098
11	802.11a	-	Secondary Landscape	0	36	A	0.95
12	802.11a	-	Secondary Portrait	0	36	A	0.026
14	802.11a	-	Secondary Landscape	0	48	A	1.02
40	802.11a	-	Bottom Face	0	36	B	0.313
41	802.11a	-	Secondary Landscape	0	36	B	0.812
42	802.11a	-	Secondary Landscape	0	48	B	0.884
52	802.11n	20M	Bottom Face	0	36	A+B	0.194
53	802.11n	20M	Secondary Landscape	0	36	A+B	0.476
54	802.11n	20M	Secondary Portrait	0	36	A+B	0.012
24	802.11a	-	Bottom Face	0	64	A	0.194
25	802.11a	-	Secondary Landscape	0	64	A	1.4
26	802.11a	-	Secondary Portrait	0	64	A	0.03
27	802.11a	-	Secondary Landscape	0	52	A	1.1
43	802.11a	-	Bottom Face	0	64	B	0.273
44	802.11a	-	Secondary Landscape	0	64	B	0.776
55	802.11n	20M	Bottom Face	0	64	A+B	0.141
56	802.11n	20M	Secondary Landscape	0	64	A+B	0.525
57	802.11n	20M	Secondary Portrait	0	64	A+B	0.015
28	802.11a	-	Bottom Face	0	116	A	0.21
29	802.11a	-	Secondary Landscape	0	116	A	1.38
30	802.11a	-	Secondary Portrait	0	116	A	0.042
31	**802.11a**	**-**	**Secondary Landscape**	**0**	**104**	**A**	**1.42**
32	802.11a	-	Secondary Landscape	0	124	A	1.4
33	802.11a	-	Secondary Landscape	0	136	A	1.34
45	802.11a	-	Bottom Face	0	116	B	0.354
46	802.11a	-	Secondary Landscape	0	116	B	0.891
47	802.11a	-	Secondary Landscape	0	104	B	0.861
48	802.11a	-	Secondary Landscape	0	124	B	0.903
49	802.11a	-	Secondary Landscape	0	136	B	0.819
58	802.11n	20M	Bottom Face	0	116	A+B	0.159
59	802.11n	20M	Secondary Landscape	0	116	A+B	0.661

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Ant.	SAR_{1g} (W/kg)
60	802.11n	20M	Secondary Portrait	0	116	A+B	0.014
34	802.11a	-	Bottom Face	0	149	A	0.155
35	802.11a	-	Secondary Landscape	0	149	A	0.831
36	802.11a	-	Secondary Portrait	0	149	A	0.024
37	802.11a	-	Secondary Landscape	0	157	A	0.809
38	802.11a	-	Secondary Landscape	0	161	A	0.801
39	802.11a	-	Secondary Landscape	0	165	A	0.818
50	802.11a	-	Bottom Face	0	149	B	0.284
51	802.11a	-	Secondary Landscape	0	149	B	0.426
61	802.11n	20M	Bottom Face	0	149	A+B	0.036
62	802.11n	20M	Secondary Landscape	0	149	A+B	0.138
63	802.11n	20M	Secondary Portrait	0	149	A+B	0.00976

Note:

1. Per KDB447498, if the highest output channel SAR for each exposure position ≤ 0.8 W/kg other channels SAR tests are not necessary.

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13. 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 616217 D03 v01, “SAR Evaluation Considerations for Laptop/Notebook/Netbook and Tablet Computers”, November 2009

[9] FCC KDB 941225 D03 v01, “Recommended SAR Test Reduction Procedures for GSM / GPRS / EDGE”, December 2008

[10] FCC KDB 941225 D07 01, "SAR Evaluation Procedure for UMPC Mini-Tablet Devices", April 2011

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.