FCC SAR Test Report

APPLICANT	:	**Qualcomm Atheros, Inc.**
EQUIPMENT	:	**PCIE 802.11a/b/g/n 2.4GHz/5GHz + USB BT 4.0 card**
BRAND NAME	:	**Atheros**
MODEL NAME	:	**AR5B22**
FCC ID	:	**PPD-AR5B22**
STANDARD	:	**FCC 47 CFR Part 2 (2.1093) ANSI/IEEE C95.1-1992 IEEE 1528-2003**

The product was installed into Tablet PC (Brand Name: Lenovo) during test.

The product was testing completed on Jan. 25, 2014. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and shown the compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

Reviewed by: Eric Huang / Deputy Manager

Approved by: Jones Tsai / Manager

ilac-MRA

TAF Testing Laboratory 1190

SPORTON INTERNATIONAL INC.

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

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA3D1404	Rev. 01	Initial issue of report	Feb. 11, 2014
FA3D1404	Rev. 02	Revise Applicant information.	Feb. 25, 2014

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Qualcomm Atheros, Inc. PCIE 802.11a/b/g/n 2.4GHz/5GHz + USB BT 4.0 card, AR5B22** are as follows.

<Highest SAR Summary>

Exposure Position	Frequency Band	Reported 1g-SAR (W/kg)	Equipment Class	Highest Reported 1g-SAR (W/kg)
Body (Separation 0cm)	WLAN 5.2GHz Band	0.86	NII	1.40
	WLAN 5.3GHz Band	1.16		
	WLAN 5.5GHz Band	1.40		
	WLAN 5.8GHz Band	1.26	DTS	1.37
	WLAN 2.4GHz Band	1.37		

<Highest Simultaneous transmission SAR>

Exposure Position	Frequency Band	Equipment Class	Highest Reported Simultaneous Transmission 1g-SAR (W/kg)
Body	WLAN 2.4GHz Band	DTS	1.46
	Bluetooth	DSS	

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

2. Administration Data

2.1 Testing Laboratory

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978

2.2 Applicant

Company Name	Qualcomm Atheros, Inc.
Address	1700 Technology Drive, San Jose, CA 95110

2.3 Manufacturer

Company Name	Qualcomm Atheros, Inc.
Address	1700 Technology Drive, San Jose, CA 95110

2.4 Application Details

Date of Start during the Test	Dec. 28, 2013
Date of End during the Test	Jan. 25, 2014

3. General Information

3.1 Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT	PCIE 802.11a/b/g/n 2.4GHz/5GHz + USB BT 4.0 card
Brand Name	Atheros
Model Name	AR5B22
FCC ID	PPD-AR5B22
S / N	WNC: 11S20200225ZZ1003811TN HT: 11S20200225ZZ1003811TA
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5700 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	‧802.11a/b/g/n HT20/HT40 ‧Bluetooth 2.1+EDR，Bluetooth 4.0+LE
EUT Stage	Production Unit

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. This host has a keyboard can be separated or combination with this host become a notebook computer.
3. This host has two kinds antenna manufacturer. RF exposure assessment was selected antenna1 as the main test; and antenna2 will be verified at the highest RF exposure position found in antenna1 SAR testing.

<table>
<tr><th colspan="4">Host Information</th></tr>
<tr><td rowspan="2">**Manufacturer**</td><td>**Company Name**</td><td colspan="2">Wistron Corporation</td></tr>
<tr><td>**Address**</td><td colspan="2">21F, No. 88, Sec. 1, Hsin Tai Wu Rd., Hsichih Dist, New Taipei City 221,Taiwan R.O.C.</td></tr>
<tr><td>**Host Name**</td><td colspan="3">Tablet PC</td></tr>
<tr><td>**Brand Name**</td><td colspan="3">Lenovo</td></tr>
<tr><td>**Marketing Name**</td><td colspan="3">Lenovo Miix 2 11</td></tr>
<tr><td rowspan="5">**Antenna 1**</td><td>Manufacturer</td><td colspan="2">WNC</td></tr>
<tr><td>P/N</td><td>Main: 025.9000X.0001</td><td>Aux:025.9000Y.0001</td></tr>
<tr><td>Antenna Type</td><td>Main: PIFA Antenna</td><td>Aux: PIFA Antenna</td></tr>
<tr><td>Antenna connector</td><td colspan="2">RF</td></tr>
<tr><td>Peak gain</td><td>Main Antenna :
2.4GHz: 1.87dBi
5GHz:
5150MHz ~ 5250MHz : -0.71dBi
5250MHz ~ 5350MHz : -0.71dBi
5470MHz ~ 5725MHz : -0.16dBi
5725MHz ~ 5850MHz : -3.71dBi</td><td>Aux Antenna :
2.4GHz: 0.69dBi
5GHz:
5150MHz ~ 5250MHz : 2.73dBi
5250MHz ~ 5350MHz : 2.73dBi
5470MHz ~ 5725MHz : 2.69dBi
5725MHz ~ 5850MHz : 2.67dBi</td></tr>
<tr><td rowspan="5">**Antenna 2**</td><td>Manufacturer</td><td colspan="2">HT</td></tr>
<tr><td>P/N</td><td>Main: 025.9000X.0011</td><td>Aux: 025.9000Y.0011</td></tr>
<tr><td>Antenna Type</td><td>Main: PIFA Antenna</td><td>Aux: PIFA Antenna</td></tr>
<tr><td>Antenna connector</td><td colspan="2">IPEX</td></tr>
<tr><td>Peak gain</td><td>Main Antenna :
2.4GHz: -1.63dBi
5GHz:
5150MHz ~ 5250MHz : -0.94dBi
5250MHz ~ 5350MHz : -0.94dBi
5470MHz ~ 5725MHz : 1.27dBi
5725MHz ~ 5850MHz : 1.84dBi</td><td>Aux Antenna :
2.4GHz: -0.35dBi
5GHz:
5150MHz ~ 5250MHz : 1.07dBi
5250MHz ~ 5350MHz : 1.07dBi
5470MHz ~ 5725MHz : -0.14dBi
5725MHz ~ 5850MHz : -1.91dBi</td></tr>
</table>

3.2 Maximum RF output power among production units

Band / Mode	Average Power (dBm)	
	v2.1+EDR	v4.0+LE
Bluetooth	5	5

Band / Frequency (MHz)		IEEE 802.11 Average Power (dBm)					
		Ant B		Ant A+B			
		11b	11g	11b	11g	HT20	HT40
2.4GHz Band	2412	18	14.5	21	17.5	17.5	
	2422						14
	2437	18.5	18.5	21.5	21.5	21.5	18
	2452						16
	2462	18	14	21	17	16.5	

Band / Frequency (MHz)		IEEE 802.11 Average Power (dBm)			
		Ant B	Ant A+B		
		11a	11a	HT20	HT40
5.2GHz Band	5180	13	16	16	
	5190				14
	5200	13	16	16	
	5220	13	16	16	
	5230				18.5
	5240	13	16	16	
5.3GHz Band	5260	16.5	19.5	19.5	
	5270				14
	5280	13	16	16	
	5300	13	16	16	
	5310				14
	5320	13	16	16	

Band / Frequency (MHz)		IEEE 802.11 Average Power (dBm)			
		Ant B	Ant A+B		
		11a	11a	HT20	HT40
5.5GHz Band	5500	13	16	17.5	
	5510				13.5
	5520	16	19	19	
	5540	16	19	19	
	5550				20
	5560	16	19	19	
	5580	16	19	19	
	5600	16	19	19	
	5620	16	19	19	
	5630				20
	5640	16	19	19	
	5660	15.5	18.5	18	
	5670				17.5
	5680	14.5	17.5	18	
	5700	12	15	17.5	
5.8GHz Band	5745	13	16	18	
	5755				19
	5765	13	16	18.5	
	5785	13	16	18.5	
	5795				18.5
	5805	13	16	18.5	
	5825	13	16	18.5	

3.3 Applied Standard

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

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2003
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r02
- FCC KDB 865664 D02 SAR Reporting v01r01
- FCC KDB 447498 D01 General RF Exposure Guidance v05r01
- FCC KDB 248227 D01 SAR meas for 802 11abg v01r02
- FCC KDB 616217 D04 SAR for laptop and tablets v01r01

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

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

Duty factor observed as below:

802.11b, 1Mbps: 100%

802.11a, 6Mbps: 99.12%

802.11n-HT40 MCS0: 97.62%

802.11n-HT20, MCS0,: 98.44%

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

4. Specific Absorption Rate (SAR)

4.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

4.2 SAR Definition

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

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

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

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

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

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

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

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

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

5. SAR Measurement System

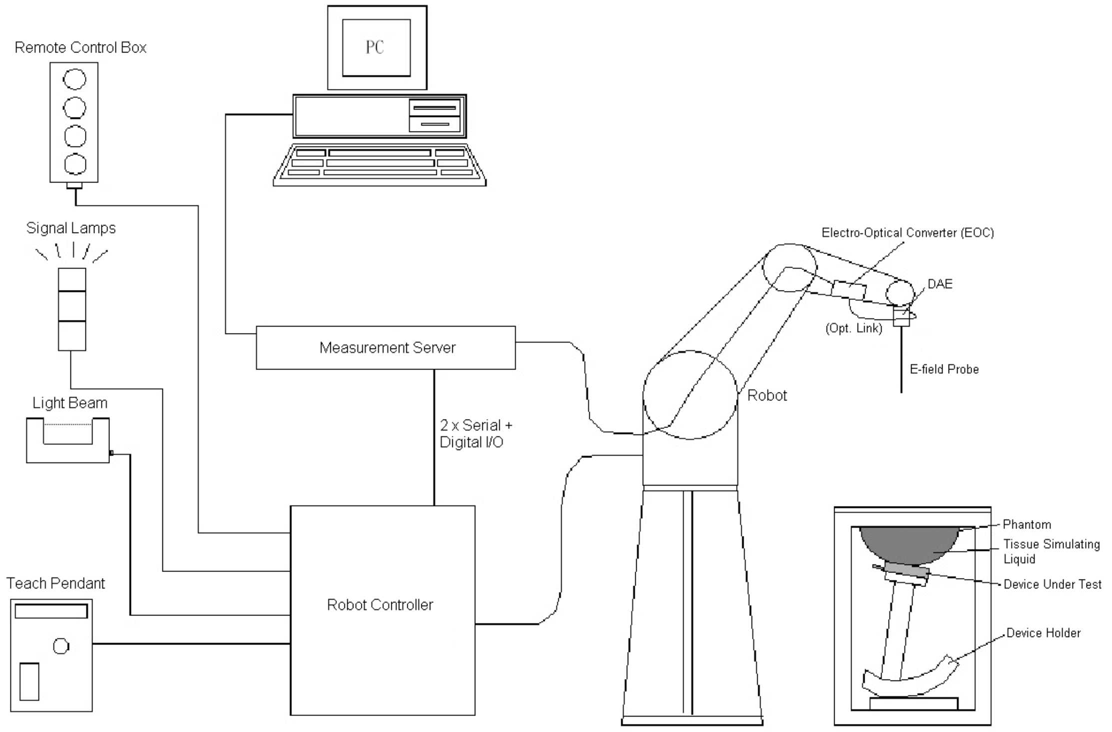


Fig 5.1 SPEAG DASY System Configurations

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

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

Component details are described in in the following sub-sections.

5.1 E-Field Probe

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

5.1.1 E-Field Probe Specification

<ES3DV3 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: 337 mm (Tip: 10 mm) Tip diameter: 4 mm (Body: 10 mm) Distance from probe tip to dipole centers: 3 mm

Fig 5.2 Photo of ES3DV3

<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/ES3DV4

5.1.2 E-Field Probe Calibration

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

5.2 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.
The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Fig 5.4 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)

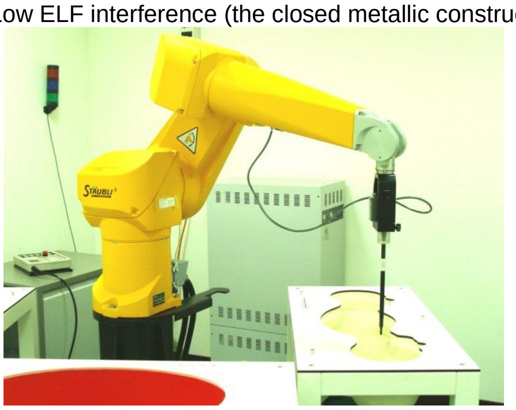


Fig 5.5 Photo of DASY4

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

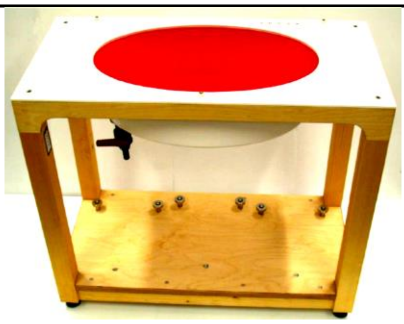


Fig 5.10 Photo of ELI4 Phantom

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 (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity $\varepsilon = 3$ 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 5.11 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.

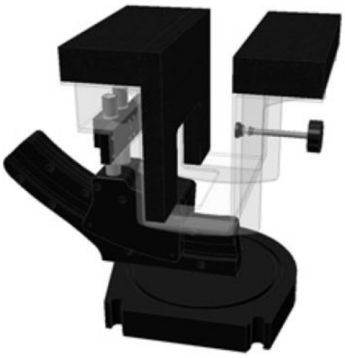


Fig 5.12 Laptop Extension Kit

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	2450MHz System Validation Kit	D2450V2	924	Nov. 13, 2013	Nov. 12, 2014
SPEAG	5GHz System Validation Kit	D5GHzV2	1128	Jul. 24, 2013	Jul. 23, 2014
SPEAG	Data Acquisition Electronics	DAE4	778	Aug. 21, 2013	Aug. 20, 2014
SPEAG	Data Acquisition Electronics	DAE4	1338	Nov. 05, 2013	Nov. 04, 2014
SPEAG	Data Acquisition Electronics	DAE3	577	May. 08, 2013	May. 07, 2014
SPEAG	Data Acquisition Electronics	DAE4	1279	Jan. 28, 2013	Jan. 27, 2014
SPEAG	Data Acquisition Electronics	DAE4	914	Dec. 18, 2013	Dec. 17, 2014
SPEAG	Dosimetric E-Field Probe	ES3DV3	3270	Sep. 24, 2013	Sep. 23, 2014
SPEAG	Dosimetric E-Field Probe	EX3DV4	3954	Nov. 04, 2013	Nov. 03, 2014
SPEAG	Dosimetric E-Field Probe	EX3DV4	3955	Nov. 12, 2013	Nov. 11, 2014
SPEAG	Dosimetric E-Field Probe	EX3DV4	3661	Jan. 15, 2013	Jan. 14, 2014
Wisewind	Thermometer	ETP-101	TM685	Oct. 22, 2013	Oct. 21, 2014
Wisewind	Thermometer	HTC-1	TM281	Oct. 22, 2013	Oct. 21, 2014
WonDer	Thermometer	WD-5015	TM225	Dec. 02, 2013	Dec. 01, 2014
SPEAG	Device Holder	N/A	N/A	NCR	NCR
R&S	Signal Generator	SMF 100A	101107	May. 27, 2013	May. 26, 2014
SPEAG	Dielectric Probe Kit	DAK-3.5	1126	Jul. 23, 2013	Jul. 22, 2014
Agilent	ENA Network Analyzer	E5071C	MY46316648	Feb. 07, 2013	Feb. 06, 2014
Anritsu	Power Meter	ML2495A	1132003	Aug. 28, 2013	Aug. 27, 2014
Anritsu	Power Sensor	MA2411B	1126017	Aug. 27, 2013	Aug. 26, 2014
Agilent	Dual Directional Coupler	778D	50422	Note 2	
Woken	Attenuator 1	WK0602-XX	N/A	Note 2	
PE	Attenuator 2	PE7005-10	N/A	Note 2	
PE	Attenuator 3	PE7005- 3	N/A	Note 2	
AR	Power Amplifier	5S1G4M2	328767	Note 3	
R&S	Spectrum Analyzer	FSP 7	101131	Jul. 09, 2013	Jul. 08, 2014

Table 5.1 Test Equipment List

Note:

1. The calibration certificate of DASY can be referred to appendix C of this report.
2. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
3. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized to 1W input power according to the ratio of 1W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical and we do have calibration for it
4. Attenuator 1 insertion loss is calibrated by the network Analyzer, which the calibration is valid, before system check.

6. Tissue Simulating Liquids

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

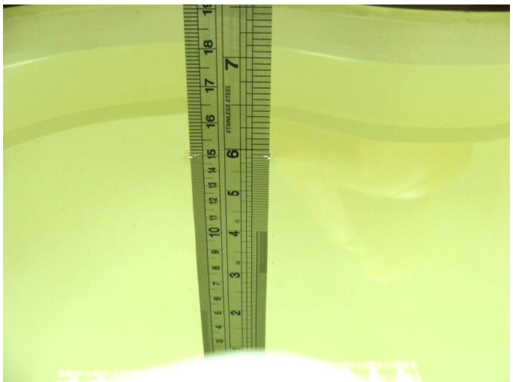


Fig 6.1 Photo of Liquid Height for Head SAR

Fig 6.2 Photo of Liquid Height for Body SAR

The following table gives the recipes for tissue simulating liquid.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (ε_r)
For Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
900	40.3	57.9	0.2	1.4	0.2	0	0.97	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0
For Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7
2600	68.1	0	0	0.1	0	31.8	2.16	52.5

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 SPEAG DAK-3.5 Dielectric Probe Kit and an Agilent Network Analyzer.

The following table shows the measuring results for simulating liquid.

Frequency (MHz)	Tissue Type	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target (ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
2450	Body	22.5	1.985	52.646	1.95	52.70	1.79	-0.10	±5	2013/12/28
2450	Body	22.7	2.020	53.849	1.95	52.70	3.59	2.18	±5	2014/1/24
5200	Body	22.4	5.366	47.608	5.30	49.00	1.25	-2.84	±5	2013/12/29
5200	Body	22.3	5.325	47.518	5.30	49.00	0.47	-3.02	±5	2014/1/3
5200	Body	22.4	5.446	47.803	5.30	49.00	2.75	-2.44	±5	2014/1/22
5300	Body	22.4	5.506	47.344	5.42	48.88	1.59	-3.14	±5	2013/12/29
5300	Body	22.3	5.466	47.251	5.42	48.88	0.85	-3.33	±5	2014/1/3
5300	Body	22.4	5.593	47.668	5.42	48.88	3.19	-2.48	±5	2014/1/22
5600	Body	22.6	5.648	47.036	5.77	48.47	-2.11	-2.96	±5	2013/12/30
5600	Body	22.3	5.868	46.726	5.77	48.47	1.70	-3.60	±5	2014/1/3
5600	Body	22.4	6.004	47.055	5.77	48.47	4.06	-2.92	±5	2014/1/22
5600	Body	22.3	5.817	46.837	5.77	48.47	0.81	-3.37	±5	2014/1/25
5800	Body	22.5	6.017	47.213	6.00	48.20	0.28	-2.05	±5	2013/12/31
5800	Body	22.3	6.229	46.417	6.00	48.20	3.82	-3.70	±5	2014/1/3
5800	Body	22.4	6.231	46.738	6.00	48.20	3.85	-3.03	±5	2014/1/22

Table 6.2 Measuring Results for Simulating Liquid

7. System Verification Procedures

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

7.1 Purpose of System Performance check

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

7.2 System Setup

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

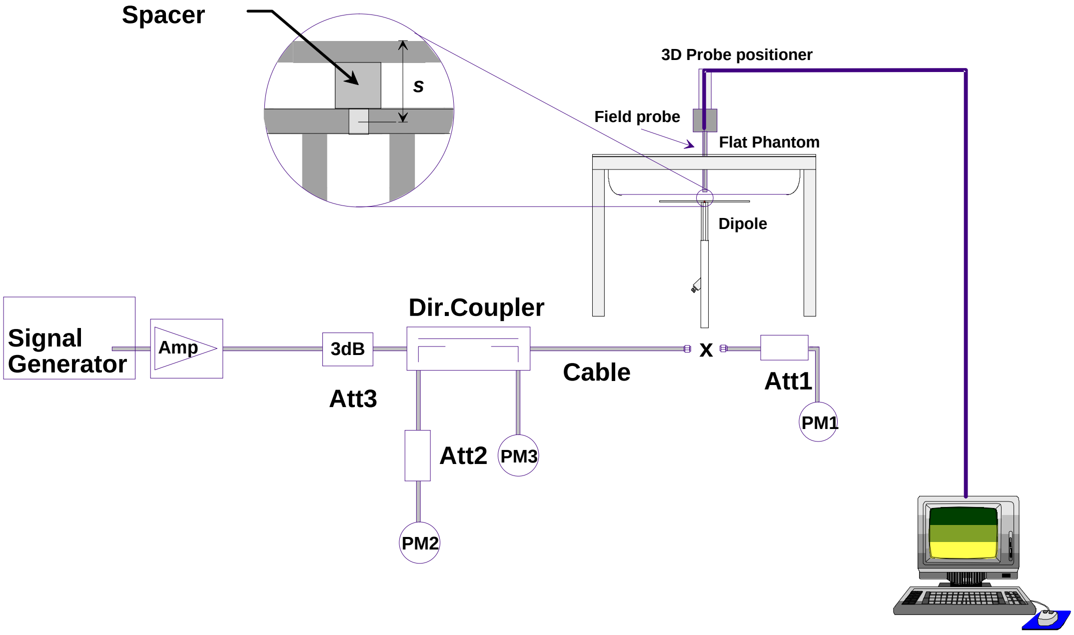


Fig 7.1 System Setup for System Evaluation

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

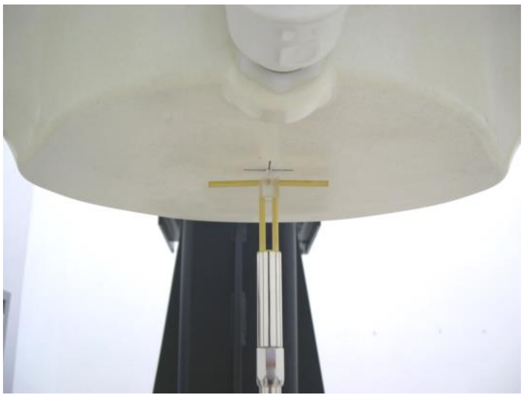


Fig 7.2 Photo of Dipole Setup

7.3 SAR System Verification Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Table 7.1 shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured SAR (W/kg)	Targeted SAR (W/kg)	Normalized SAR (W/kg)	Deviation (%)
2013/12/28	2450	Body	250	D2450V2-924	3270	778	13.10	50.20	52.4	4.38
2014/1/24	2450	Body	250	D2450V2-924	3954	1338	11.90	50.20	47.6	-5.18
2013/12/29	5200	Body	100	D5GHzV2-1128	3954	1279	7.73	73.40	77.3	5.31
2014/1/3	5200	Body	100	D5GHzV2-1128	3661	577	7.13	73.40	71.3	-2.86
2014/1/22	5200	Body	100	D5GHzV2-1128	3955	914	7.77	73.40	77.7	5.86
2013/12/29	5300	Body	100	D5GHzV2-1128	3954	1279	7.92	74.30	79.2	6.59
2014/1/3	5300	Body	100	D5GHzV2-1128	3661	577	7.17	74.30	71.7	-3.50
2014/1/22	5300	Body	100	D5GHzV2-1128	3955	914	7.10	74.30	71	-4.44
2013/12/30	5600	Body	100	D5GHzV2-1128	3954	1279	7.46	77.80	74.6	-4.11
2014/1/3	5600	Body	100	D5GHzV2-1128	3661	577	8.02	77.80	80.2	3.08
2014/1/22	5600	Body	100	D5GHzV2-1128	3954	1338	8.01	77.80	80.1	2.96
2014/1/25	5600	Body	100	D5GHzV2-1128	3954	1338	7.76	77.80	77.6	-0.26
2013/12/31	5800	Body	100	D5GHzV2-1128	3954	1279	7.79	72.20	77.9	7.89
2014/1/3	5800	Body	100	D5GHzV2-1128	3661	577	7.31	72.20	73.1	1.25
2014/1/22	5800	Body	100	D5GHzV2-1128	3954	1338	7.79	72.20	77.9	7.89

Table 7.1 Target and Measurement SAR after Normalized

8. EUT Testing Position

Please refer to Appendix D for the test setup photos.

9. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

(a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
(b) Read the WWAN RF power level from the base station simulator.
(c) For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band
(d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

<SAR measurement>

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
(b) Place the EUT in the positions as Appendix D demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band
(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

9.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

(a) Extraction of the measured data (grid and values) from the Zoom Scan
(b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
(c) Generation of a high-resolution mesh within the measured volume
(d) Interpolation of all measured values form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

9.2 Power Reference Measurement

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

9.3 Area & Zoom Scan Procedures

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows KDB 865664 D01v01r02 quoted below.

When the 1-g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR.

			$\leq$ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	$\frac{1}{2}\cdot\delta\cdot\ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			$\leq$ 2 GHz: $\leq$ 15 mm 2 – 3 GHz: $\leq$ 12 mm	3 – 4 GHz: $\leq$ 12 mm 4 – 6 GHz: $\leq$ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			$\leq$ 2 GHz: $\leq$ 8 mm 2 – 3 GHz: $\leq$ 5 mm*	3 – 4 GHz: $\leq$ 5 mm* 4 – 6 GHz: $\leq$ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		$\leq$ 5 mm	3 – 4 GHz: $\leq$ 4 mm 4 – 5 GHz: $\leq$ 3 mm 5 – 6 GHz: $\leq$ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	$\leq$ 4 mm	3 – 4 GHz: $\leq$ 3 mm 4 – 5 GHz: $\leq$ 2.5 mm 5 – 6 GHz: $\leq$ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5\cdot\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		$\geq$ 30 mm	3 – 4 GHz: $\geq$ 28 mm 4 – 5 GHz: $\geq$ 25 mm 5 – 6 GHz: $\geq$ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is $\leq$ 1.4 W/kg, $\leq$ 8 mm, $\leq$ 7 mm and $\leq$ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

9.4 Volume Scan Procedures

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

9.5 SAR Averaged Methods

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

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

9.6 Power Drift Monitoring

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

10. Bluetooth Exclusions Applied

Mode Band	Average power(dBm)	
	Bluetooth v2.1+EDR	Bluetooth v4.0+LE
2.4GHz Bluetooth	5.0	5.0

Note:

1. Per KDB 447498 D01v05r01, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:
   [(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)] ·[$\sqrt{f(GHz)}$] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   - f(GHz) is the RF channel transmit frequency in GHz
   - Power and distance are rounded to the nearest mW and mm before calculation
   - The result is rounded to one decimal place for comparison

Bluetooth Max Power (dBm)	Test Distance (mm)	Frequency (GHz)	exclusion thresholds
5	5	2.48	0.126

2. Per KDB 447498 D01v05r01 exclusion thresholds is 0.126 < 3, RF exposure evaluation is not required.

11. Conducted RF Output Power (Unit: dBm)

<WLAN 2.4GHz Conducted Power>

<Antenna B>

WLAN 2.4GHz 802.11b Average Power (dBm)			Tune up Limite (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	Data Rate	
		1Mbps	
CH 1	2412	16.34	18.0
CH 6	2437	17.00	18.5
CH 11	2462	16.35	18.0

WLAN 2.4GHz 802.11g Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	Data Rate	
		6Mbps	
CH 1	2412	13.41	14.5
CH 6	2437	17.19	18.5
CH 11	2462	12.25	14.0

<Antenna A+B>

Note:

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

WLAN 2.4GHz 802.11b Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	Data Rate	
		1Mbps	
CH 1	2412	19.39	21.0
CH 6	2437	19.87	21.5
CH 11	2462	19.33	21.0

WLAN 2.4GHz 802.11g Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	Data Rate	
		6Mbps	
CH 1	2412	15.89	17.5
CH 6	2437	19.94	21.5
CH 11	2462	15.47	17.0

WLAN 2.4GHz 802.11n-HT20 Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	MCS Index	
		MCS0	
CH 1	2412	16.10	17.5
CH 6	2437	19.72	21.5
CH 11	2462	14.78	16.5

WLAN 2.4GHz 802.11n-HT40 Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	MCS Index	
		MCS0	
CH 3	2422	12.46	14.0
CH 6	2437	16.34	18.0
CH 9	2452	14.89	16.0

<WLAN 5GHz Conducted Power>

<Antenna B>

WLAN 5GHz 802.11a Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	Data Rate	
		6Mbps	
CH 36	5180	11.45	13.0
CH 40	5200	11.51	13.0
CH 44	5220	11.36	13.0
CH 48	5240	11.53	13.0
CH 52	5260	14.98	16.5
CH 56	5280	11.42	13.0
CH 60	5300	11.66	13.0
CH 64	5320	11.29	13.0
CH 100	5500	11.20	13.0
CH 104	5520	14.25	16.0
CH 108	5540	14.51	16.0
CH 112	5560	14.51	16.0
CH 116	5580	14.26	16.0
CH 120	5600	14.37	16.0
CH 124	5620	14.33	16.0
CH 128	5640	14.35	16.0
CH 132	5660	13.83	15.5
CH 136	5680	13.22	14.5
CH 140	5700	10.09	12.0
CH 149	5745	11.76	13.0
CH 153	5765	11.74	13.0
CH 157	5785	11.69	13.0
CH 161	5805	11.68	13.0
CH 165	5825	11.42	13.0

<Antenna A+B>

Note:

1. Per KDB 248227 D01 v01r02, choose the highest output power channel to test SAR and determine further SAR exclusion
2. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at the lowest data rate.
3. Per KDB 248227 D01 v01r02, for 5180MHz~5240MHz 11n-HT40 average output power is higher than 1/4dB higher than 802.11a mode, these modes SAR will be verified at the highest RF exposure position found in 802.11a SAR testing.
4. Per KDB 248227 D01 v01r02, for 5260MHz~5320MHz 11n-HT20 average output power is higher than 1/4dB higher than 802.11a mode, these modes SAR will be verified at the highest RF exposure position found in 802.11a SAR testing.
5. Per KDB 248227 D01 v01r02, for 5500MHz~5700MHz 11n-HT20 and 11n-HT40 average output power is higher than 1/4dB higher than 802.11a mode, these modes SAR will be verified at the highest RF exposure position found in 802.11a SAR testing.
6. Per KDB 248227 D01 v01r02, for 5740MHz~5825MHz 11n-HT20 and 11n-HT40 average output power is higher than 1/4dB higher than 802.11a mode, these modes SAR will be verified at the highest RF exposure position found in 802.11a SAR testing.

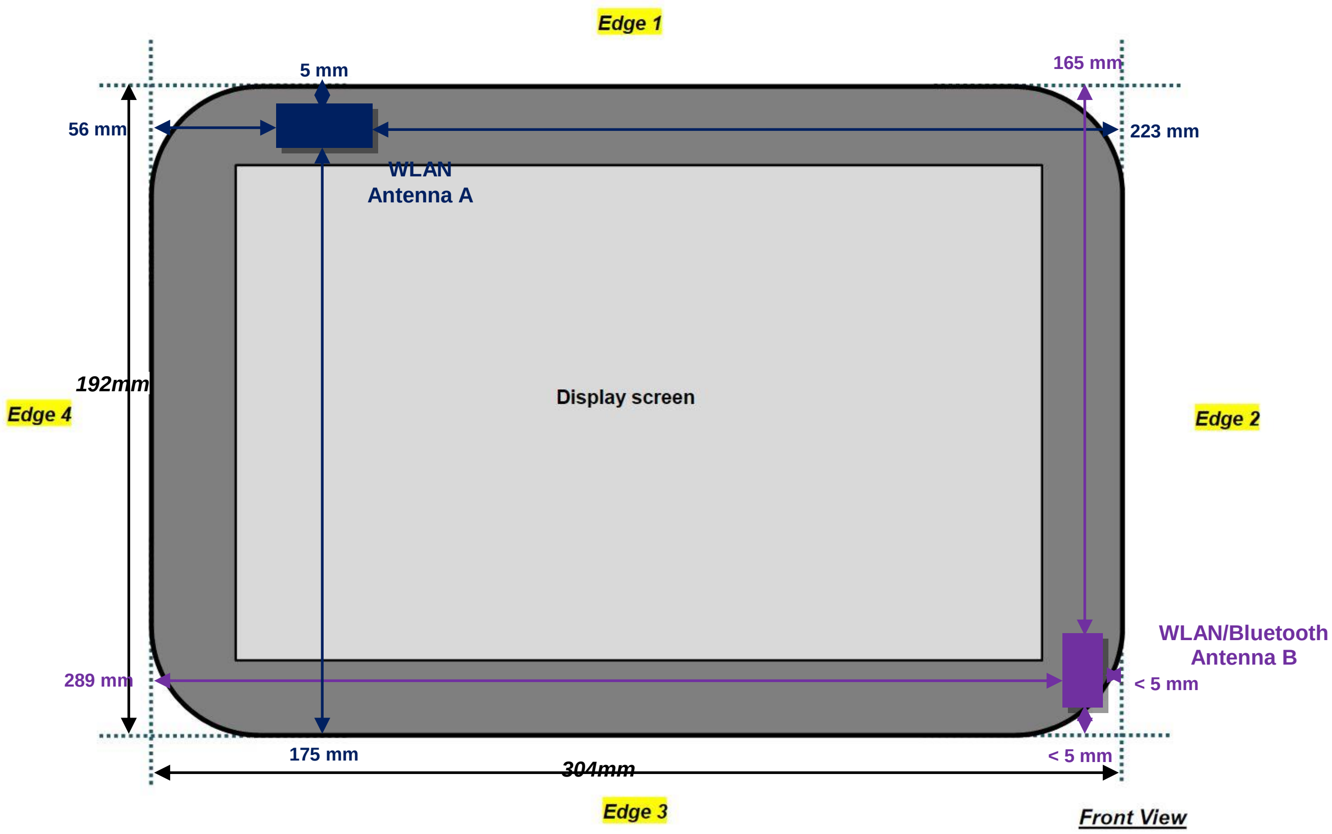
WLAN 5GHz 802.11a Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	Data Rate	
		6Mbps	
CH 36	5180	14.33	16.0
CH 40	5200	14.30	16.0
CH 44	5220	14.46	16.0
CH 48	5240	14.35	16.0
CH 52	5260	17.43	19.5
CH 56	5280	14.30	16.0
CH 60	5300	14.38	16.0
CH 64	5320	14.36	16.0
CH 100	5500	14.30	16.0
CH 104	5520	17.21	19.0
CH 108	5540	17.23	19.0
CH 112	5560	17.25	19.0
CH 116	5580	17.30	19.0
CH 120	5600	17.27	19.0
CH 124	5620	17.23	19.0
CH 128	5640	17.23	19.0
CH 132	5660	16.75	18.0
CH 136	5680	16.56	17.5
CH 140	5700	13.43	15.0
CH 149	5745	14.43	16.0
CH 153	5765	14.41	16.0
CH 157	5785	14.49	16.0
CH 161	5805	14.44	16.0
CH 165	5825	14.42	16.0

WLAN 5GHz 802.11n-HT20 Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	MCS Index	
		MCS0	
CH 36	5180	14.63	16.0
CH 40	5200	14.52	16.0
CH 44	5220	14.45	16.0
CH 48	5240	14.42	16.0
CH 52	5260	18.41	19.5
CH 56	5280	14.32	16.0
CH 60	5300	14.42	16.0
CH 64	5320	14.24	16.0
CH 100	5500	15.98	17.5
CH 104	5520	17.09	19.0
CH 108	5540	17.19	19.0
CH 112	5560	17.36	19.0
CH 116	5580	17.67	19.0
CH 120	5600	17.39	19.0
CH 124	5620	17.28	19.0
CH 128	5640	17.34	19.0
CH 132	5660	17.19	18.0
CH 136	5680	17.08	18.0
CH 140	5700	16.06	17.5
CH 149	5745	16.90	18.0
CH 153	5765	16.84	18.5
CH 157	5785	17.33	18.5
CH 161	5805	17.31	18.5
CH 165	5825	17.31	18.5

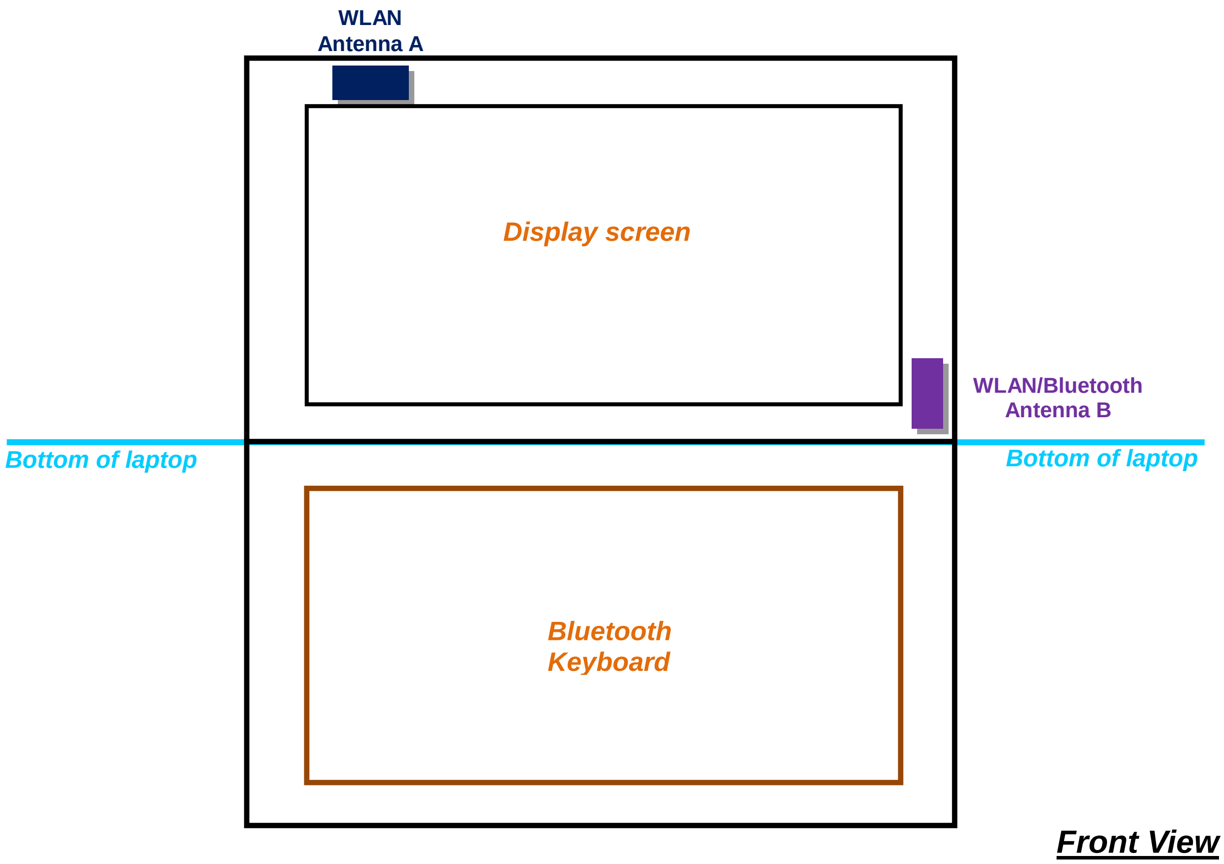
WLAN 5GHz 802.11n-HT40 Average Power (dBm)			Tune up Limit (dBm)
Power vs. Channel			
Channel	Frequency (MHz)	MCS Index	
		MCS0	
CH 38	5190	12.65	14.0
CH 46	5230	17.11	18.5
CH 54	5270	12.59	14.0
CH 62	5310	12.22	14.0
CH 102	5510	12.20	13.5
CH 110	5550	18.76	20.0
CH 126	5630	18.37	20.0
CH 134	5670	16.19	17.5
CH 151	5755	17.26	19.0
CH 159	5795	17.03	18.5

12. Antenna Location

<Tablet PC >



<Laptop Mode>


WLAN
Antenna A
Display screen
WLAN/Bluetooth
Antenna B
Bottom of laptop
Bottom of laptop
Bluetooth
Keyboard
Front View

< SAR test exclusion table>

Exposure Position	Wireless Interface	**WLAN2.4GHz Ant B**	**WLAN2.4GHz Ant A+B**	**WLAN5GHz Ant B**	**WLAN5GHz Ant A+B**
	Calculated Frequency	2462MHz	2462MHz	5825MHz	5825MHz
	Maximum power (dBm)	18.5	21.5	16.5	20
	Maximum rated power(mW)	71	141	45	100
Bottom Face	Test Separation distance(mm)	5	5	5	5
	exclusion threshold	22	44	22	27
	Testing required?	**Yes**	**Yes**	**Yes**	**Yes**
Edge 1	Test Separation distance(mm)	160.90	5.00	160.90	5.00
	exclusion threshold	1205	44	1171	27
	Testing required?	**No**	**Yes**	**No**	**Yes**
Edge 2	Test Separation distance(mm)	5.00	5.00	5.00	5.00
	exclusion threshold	22	44	22	27
	Testing required?	**Yes**	**Yes**	**Yes**	**Yes**
Edge 3	Test Separation distance(mm)	5.00	5.00	5.00	5.00
	exclusion threshold	22	44	22	27
	Testing required?	**Yes**	**Yes**	**Yes**	**Yes**
Edge 4	Test Separation distance(mm)	286.60	56.00	286.60	56.00
	exclusion threshold	2462	156	2428	122
	Testing required?	**No**	**No**	**No**	**No**

Note:

1. Above the table, when the distance is < 50 mm exclusion threshold is "Ratio", when the distance is > 50 mm exclusion threshold is "mW"
2. Maximum power is the source-based time-average power and represents the maximum RF output power among production units
3. Per KDB 447498 D01v05r01, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
4. Per KDB 447498 D01v05r01, standalone SAR test exclusion threshold is applied; If the test separation distance is < 5mm, 5mm is used to determine SAR exclusion threshold.
5. Per KDB 447498 D01v05r01, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:
   [(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)] ·[$\sqrt{f(GHz)}$] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   - f(GHz) is the RF channel transmit frequency in GHz
   - Power and distance are rounded to the nearest mW and mm before calculation
   - The result is rounded to one decimal place for comparison
6. Per KDB 447498 D01v05r01, at 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following
   a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz
   b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

13. SAR Test Results

Note:

1. Per KDB 447498 D01v05r01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)*Tune-up Scaling Factor
2. Per KDB 447498 D01v05r01, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
   - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
   - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
   - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 616217 D04v01r01, the additional separation introduced by the contour against a flat phantom is < 5 mm and reported SAR is > 1.2 W/kg, a slant of edge SAR is required, more detail information please refer to the setup photo.
4. For SAR testing of the curved region of the device, the device was placed directly against the phantom at the point where the distance between the antenna and device exterior is a minimum.

13.1 Body SAR

<WLAN SAR DTS>

Plot No.	Band	Mode	Test Position	Gap (cm)	Antenna	Antenna Vender	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant B	WNC	6	2437	17	18.5	1.413	100	1.000	0.07	0.855	1.208
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant B	WNC	1	2412	16.34	18	1.466	100	1.000	-0.03	0.858	1.257
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant B	WNC	11	2462	16.35	18	1.462	100	1.000	0	0.585	0.855
	WLAN2.4GHz	802.11b 1Mbps	Edge 2	0cm	Ant B	WNC	6	2437	17	18.5	1.413	100	1.000	-0.05	0.193	0.273
	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0cm	Ant B	WNC	6	2437	17	18.5	1.413	100	1.000	0.14	0.234	0.331
	WLAN2.4GHz	802.11b 1Mbps	Slant of Edge3	0cm	Ant B	WNC	6	2437	17	18.5	1.413	100	1.000	0.17	0.377	0.533
	WLAN2.4GHz	802.11b 1Mbps	Bottom	0cm	Ant B	WNC	6	2437	17	18.5	1.413	100	1.000	-0.03	0.086	0.121
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant B	HT	1	2412	16.34	18	1.466	100	1.000	0.03	0.798	1.170
01	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant B	HT	6	2437	17	18.5	1.413	100	1.000	0.01	0.947	1.338
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant B	HT	11	2462	16.35	18	1.462	100	1.000	-0.05	0.736	1.076
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	WNC	6	2437	19.87	21.5	1.455	100	1.000	-0.01	0.846	1.231
02	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	WNC	1	2412	19.39	21	1.449	100	1.000	-0.01	0.947	1.372
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	WNC	1	2412	19.39	21	1.449	100	1.000	-0.1	0.892	1.292
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	WNC	11	2462	19.33	21	1.469	100	1.000	-0.1	0.649	0.953
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0cm	Ant A+B	WNC	6	2437	19.87	21.5	1.455	100	1.000	0.06	0.542	0.789
	WLAN2.4GHz	802.11b 1Mbps	Edge 2	0cm	Ant A+B	WNC	6	2437	19.87	21.5	1.455	100	1.000	-0.03	0.130	0.189
	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0cm	Ant A+B	WNC	6	2437	19.87	21.5	1.455	100	1.000	-0.15	0.175	0.255
	WLAN2.4GHz	802.11b 1Mbps	Curved surface of Edge1	0cm	Ant A+B	WNC	6	2437	19.87	21.5	1.455	100	1.000	-0.03	0.697	1.014
	WLAN2.4GHz	802.11b 1Mbps	Curved surface of Edge1	0cm	Ant A+B	WNC	1	2437	19.39	21	1.449	100	1.000	-0.17	0.666	0.965
	WLAN2.4GHz	802.11b 1Mbps	Curved surface of Edge1	0cm	Ant A+B	WNC	11	2462	19.33	21	1.469	100	1.000	0.01	0.415	0.610
	WLAN2.4GHz	802.11b 1Mbps	Slant of Edge3	0cm	Ant A+B	WNC	6	2437	19.87	21.5	1.455	100	1.000	0.1	0.215	0.313
	WLAN2.4GHz	802.11b 1Mbps	Bottom	0cm	Ant A+B	WNC	6	2437	19.87	21.5	1.455	100	1.000	0.12	0.048	0.070
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	HT	1	2412	19.39	21	1.449	100	1.000	0.07	0.756	1.095
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	HT	6	2437	19.87	21.5	1.455	100	1.000	0.04	0.923	1.343
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	HT	11	2462	19.33	21	1.469	100	1.000	0.06	0.685	1.006

Plot No.	Band	Mode	Test Position	Gap (cm)	Antenna	Antenna Vender	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant B	WNC	149	5745	11.76	13	1.330	99.12	1.009	-0.1	0.217	0.291
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant B	WNC	149	5745	11.76	13	1.330	99.12	1.009	-0.1	0.265	0.356
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant B	WNC	149	5745	11.76	13	1.330	99.12	1.009	-0.12	0.316	0.424
03	WLAN5GHz	802.11a 6Mbps	Slant of Edge 3	0cm	Ant B	WNC	149	5745	11.76	13	1.330	99.12	1.009	-0.01	0.408	0.548
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant B	WNC	149	5745	11.76	13	1.330	99.12	1.009	-0.15	0.094	0.126
	WLAN5GHz	802.11a 6Mbps	Slant of Edge 3	0cm	Ant B	WNC	157	5785	11.69	13	1.352	99.12	1.009	-0.17	0.323	0.441
	WLAN5GHz	802.11a 6Mbps	Slant of Edge 3	0cm	Ant B	WNC	165	5825	11.42	13	1.439	99.12	1.009	-0.1	0.270	0.392
	WLAN5GHz	802.11a 6Mbps	Slant of Edge 3	0cm	Ant B	HT	149	5745	11.76	13	1.330	99.12	1.009	-0.17	0.073	0.098
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	157	5785	14.49	16	1.414	99.12	1.009	-0.03	0.315	0.450
	WLAN5GHz	802.11a 6Mbps	Edge 1	0cm	Ant A+B	WNC	157	5785	14.49	16	1.414	99.12	1.009	0.12	0.145	0.207
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant A+B	WNC	157	5785	14.49	16	1.414	99.12	1.009	0.01	0.342	0.488
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	157	5785	14.49	16	1.414	99.12	1.009	0.17	0.383	0.547
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	157	5785	14.49	16	1.414	99.12	1.009	-0.15	0.429	0.612
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	149	5745	14.43	16	1.434	99.12	1.009	-0.11	0.353	0.511
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant A+B	WNC	157	5785	14.49	16	1.414	99.12	1.009	-0.19	0.142	0.203
	WLAN5GHz	802.11n-HT20 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	157	5785	17.33	18.5	1.309	98.44	1.016	-0.17	0.847	1.127
	WLAN5GHz	802.11n-HT20 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	149	5745	16.9	18	1.288	98.44	1.016	-0.09	0.926	1.212
	WLAN5GHz	802.11n-HT20 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	149	5745	16.9	18	1.288	98.44	1.016	-0.09	0.864	1.131
	WLAN5GHz	802.11n-HT20 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	161	5805	17.31	18.5	1.315	98.44	1.016	-0.12	0.825	1.102
04	WLAN5GHz	802.11n-HT40 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	151	5755	17.26	19	1.493	97.62	1.024	-0.19	0.826	1.263
	WLAN5GHz	802.11n-HT40 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	159	5795	17.03	18.5	1.403	97.62	1.024	-0.15	0.684	0.983
	WLAN5GHz	802.11n-HT40 MCS0	Slant of Edge3	0cm	Ant A+B	HT	151	5755	17.26	19	1.493	97.62	1.024	0.14	0.141	0.216

<WLAN SAR NII>

Plot No.	Band	Mode	Test Position	Gap (cm)	Antenna	Antenna Vender	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
05	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant B	WNC	48	5240	11.53	13	1.403	99.12	1.009	-0.14	0.290	0.411
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant B	WNC	48	5240	11.53	13	1.403	99.12	1.009	0.04	0.181	0.256
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant B	WNC	48	5240	11.53	13	1.403	99.12	1.009	-0.1	0.226	0.320
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	WNC	48	5240	11.53	13	1.403	99.12	1.009	0.13	0.269	0.381
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant B	WNC	48	5240	11.53	13	1.403	99.12	1.009	-0.06	0.107	0.152
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant B	WNC	48	5240	11.53	13	1.403	99.12	1.009	0.02	0.240	0.340
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant B	WNC	52	5260	14.98	16.5	1.419	99.12	1.009	-0.19	0.440	0.630
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant B	WNC	52	5260	14.98	16.5	1.419	99.12	1.009	-0.1	0.317	0.454
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant B	WNC	52	5260	14.98	16.5	1.419	99.12	1.009	-0.03	0.486	0.696
06	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	WNC	52	5260	14.98	16.5	1.419	99.12	1.009	-0.09	0.636	0.911
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	WNC	60	5300	11.66	13	1.362	99.12	1.009	-0.14	0.460	0.632
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant B	WNC	52	5260	14.98	16.5	1.419	99.12	1.009	-0.1	0.168	0.241
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	HT	52	5260	14.98	16.5	1.419	99.12	1.009	-0.04	0.175	0.251
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant B	WNC	112	5560	14.51	16	1.409	99.12	1.009	-0.06	0.228	0.324
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant B	WNC	112	5560	14.51	16	1.409	99.12	1.009	-0.11	0.262	0.373
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant B	WNC	112	5560	14.51	16	1.409	99.12	1.009	-0.17	0.263	0.374
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	WNC	112	5560	14.51	16	1.409	99.12	1.009	-0.1	0.422	0.600
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	WNC	108	5540	14.51	16	1.409	99.12	1.009	-0.11	0.387	0.550
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	WNC	120	5600	14.37	16	1.455	99.12	1.009	-0.11	0.497	0.730
07	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	WNC	132	5660	13.83	15.5	1.469	99.12	1.009	-0.18	0.857	1.270
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant B	WNC	112	5560	14.51	16	1.409	99.12	1.009	0.12	0.083	0.118
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant B	HT	132	5660	13.83	15.5	1.469	99.12	1.009	-0.15	0.124	0.184

Plot No.	Band	Mode	Test Position	Gap (cm)	Antenna	Antenna Vender	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	44	5220	14.46	16	1.425	99.12	1.009	0.08	0.213	0.306
	WLAN5GHz	802.11a 6Mbps	Edge 1	0cm	Ant A+B	WNC	44	5220	14.46	16	1.425	99.12	1.009	0.1	0.171	0.246
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant A+B	WNC	44	5220	14.46	16	1.425	99.12	1.009	-0.09	0.173	0.249
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	44	5220	14.46	16	1.425	99.12	1.009	0.1	0.232	0.334
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	44	5220	14.46	16	1.425	99.12	1.009	-0.11	0.251	0.361
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant A+B	WNC	44	5220	14.46	16	1.425	99.12	1.009	-0.1	0.070	0.101
08	WLAN5GHz	802.11n-HT40 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	46	5230	17.109	18.5	1.378	97.62	1.024	0.05	0.607	0.856
	WLAN5GHz	802.11n-HT40 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	38	5190	12.65	14	1.365	97.62	1.024	-0.05	0.161	0.225
	WLAN5GHz	802.11n-HT40 MCS0	Slant of Edge3	0cm	Ant A+B	HT	46	5230	17.109	18.5	1.378	97.62	1.024	-0.01	0.105	0.148
09	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	52	5260	17.43	19.5	1.611	99.12	1.009	-0.08	0.715	1.162
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	60	5300	14.38	16	1.452	99.12	1.009	0	0.334	0.489
	WLAN5GHz	802.11a 6Mbps	Edge 1	0cm	Ant A+B	WNC	52	5260	17.43	19.5	1.611	99.12	1.009	0.14	0.452	0.735
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant A+B	WNC	52	5260	17.43	19.5	1.611	99.12	1.009	-0.01	0.462	0.751
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	52	5260	17.43	19.5	1.611	99.12	1.009	-0.08	0.689	1.120
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	60	5300	14.38	16	1.452	99.12	1.009	0.17	0.370	0.542
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	52	5260	17.43	19.5	1.611	99.12	1.009	-0.08	0.632	1.027
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	60	5300	14.38	16	1.452	99.12	1.009	-0.15	0.430	0.630
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant A+B	WNC	52	5260	17.43	19.5	1.611	99.12	1.009	-0.17	0.198	0.322
	WLAN5GHz	802.11n-HT20 MCS0	Bottom Face	0cm	Ant A+B	WNC	52	5260	18.41	19.5	1.284	98.44	1.016	0.11	0.771	1.006
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	HT	52	5260	17.43	19.5	1.611	99.12	1.009	-0.04	0.424	0.689
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	116	5580	17.30	19	1.478	99.12	1.009	-0.16	0.582	0.868
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	108	5540	17.23	19	1.503	99.12	1.009	-0.09	0.481	0.730
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	120	5600	17.27	19	1.489	99.12	1.009	-0.14	0.561	0.843
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0cm	Ant A+B	WNC	136	5680	16.56	17.5	1.242	99.12	1.009	0.11	0.684	0.857
	WLAN5GHz	802.11a 6Mbps	Edge 1	0cm	Ant A+B	WNC	116	5580	17.30	19	1.478	99.12	1.009	-0.12	0.316	0.471
	WLAN5GHz	802.11a 6Mbps	Edge 1	0cm	Ant A+B	WNC	108	5540	17.23	19	1.503	99.12	1.009	0.09	0.234	0.355
	WLAN5GHz	802.11a 6Mbps	Edge 1	0cm	Ant A+B	WNC	120	5600	17.27	19	1.489	99.12	1.009	-0.14	0.266	0.400
	WLAN5GHz	802.11a 6Mbps	Edge 1	0cm	Ant A+B	WNC	136	5680	16.56	17.5	1.242	99.12	1.009	-0.03	0.322	0.403
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant A+B	WNC	116	5580	17.30	19	1.478	99.12	1.009	-0.11	0.434	0.647
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant A+B	WNC	108	5540	17.23	19	1.503	99.12	1.009	-0.16	0.347	0.526
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant A+B	WNC	120	5600	17.27	19	1.489	99.12	1.009	-0.09	0.535	0.804
	WLAN5GHz	802.11a 6Mbps	Edge 2	0cm	Ant A+B	WNC	136	5680	16.56	17.5	1.242	99.12	1.009	-0.12	0.570	0.714
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	116	5580	17.30	19	1.478	99.12	1.009	0.16	0.409	0.610
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	108	5540	17.23	19	1.503	99.12	1.009	0.13	0.450	0.683
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	120	5600	17.27	19	1.489	99.12	1.009	0.07	0.653	0.981
	WLAN5GHz	802.11a 6Mbps	Edge 3	0cm	Ant A+B	WNC	136	5680	16.56	17.5	1.242	99.12	1.009	-0.14	0.890	1.115
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	116	5580	17.30	19	1.478	99.12	1.009	-0.07	0.504	0.752
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	108	5540	17.23	19	1.503	99.12	1.009	-0.11	0.460	0.698
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	120	5600	17.27	19	1.489	99.12	1.009	-0.19	0.680	1.022
	WLAN5GHz	802.11a 6Mbps	Slant of Edge3	0cm	Ant A+B	WNC	136	5680	16.56	17.5	1.242	99.12	1.009	-0.16	0.942	1.180
	WLAN5GHz	802.11a 6Mbps	Bottom	0cm	Ant A+B	WNC	116	5580	17.30	19	1.478	99.12	1.009	-0.08	0.178	0.265
	WLAN5GHz	802.11n-HT20 MCS0	Edge 3	0cm	Ant A+B	WNC	132	5660	17.19	18	1.205	98.44	1.016	-0.08	1.010	1.237
	WLAN5GHz	802.11n-HT20 MCS0	Edge 3	0cm	Ant A+B	WNC	132	5660	17.19	18	1.205	98.44	1.016	-0.16	0.920	1.126
	WLAN5GHz	802.11n-HT20 MCS0	Edge 3	0cm	Ant A+B	WNC	108	5540	17.19	19	1.517	98.44	1.016	0.15	0.508	0.783
	WLAN5GHz	802.11n-HT20 MCS0	Edge 3	0cm	Ant A+B	WNC	116	5580	17.67	19	1.360	98.44	1.016	0.11	0.608	0.840
	WLAN5GHz	802.11n-HT20 MCS0	Edge 3	0cm	Ant A+B	WNC	120	5600	17.39	19	1.449	98.44	1.016	0.16	0.708	1.042
	WLAN5GHz	802.11n-HT40 MCS0	Edge 3	0cm	Ant A+B	WNC	110	5550	18.76	20	1.332	97.62	1.024	0.13	0.671	0.915
10	WLAN5GHz	802.11n-HT40 MCS0	Edge 3	0cm	Ant A+B	WNC	126	5630	18.37	20	1.455	97.62	1.024	0.01	0.942	1.404
	WLAN5GHz	802.11n-HT40 MCS0	Edge 3	0cm	Ant A+B	HT	126	5630	18.37	20	1.455	97.62	1.024	0.06	0.178	0.265

13.2 Repeated SAR Measurement

Plot No.	Band	Mode	Test Position	Gap (cm)	Antenna	Antenna Vender	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Ratio	Reported 1g SAR (W/kg)
1st	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	WNC	1	2412	19.39	21	1.449	100	1.000	-0.01	0.947	-	1.372
2ed	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0cm	Ant A+B	WNC	1	2412	19.39	21	1.449	100	1.000	-0.1	0.892	1.06	1.292
1st	WLAN5GHz	802.11n-HT20 MCS0	Edge 3	0cm	Ant A+B	WNC	132	5660	17.19	18	1.205	98.44	1.016	-0.08	1.010	-	1.237
2ed	WLAN5GHz	802.11n-HT20 MCS0	Edge 3	0cm	Ant A+B	WNC	132	5660	17.19	18	1.205	98.44	1.016	-0.16	0.920	1.10	1.126
1st	WLAN5GHz	802.11n-HT20 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	149	5745	16.9	18	1.288	98.44	1.016	-0.09	0.926	-	1.212
2ed	WLAN5GHz	802.11n-HT20 MCS0	Slant of Edge3	0cm	Ant A+B	WNC	149	5745	16.9	18	1.288	98.44	1.016	-0.09	0.864	1.07	1.131

Note:

1. Per KDB 865664 D01v01r02, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg
2. Per KDB 865664 D01v01r02, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR <1.45W/kg, only one repeated measurement is required.
3. The ratio is the largest SAR to the smallest SAR among original and repeated measurement.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

14. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations	Supported
1.	WLAN Antenna B + Bluetooth	Yes

Note:

1. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, 2.4GHz WLAN and 5GHz WLAN will not operate simultaneously at any moment.
2. The Scaled SAR summation is calculated based on the same configuration and test position.
3. Per KDB 447498 D01v05r01, simultaneous transmission SAR is compliant if,
   i) Scalar SAR summation < 1.6W/kg.
   ii) SPLSR = $(SAR_1 + SAR_2)^{1.5}$ / (*min. separation distance, mm*), and the peak separation distance is determined from the square root of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$, where (x_1, y_1, z_1) and (x_2, y_2, z_2) are the coordinates of the extrapolated peak SAR locations in the zoom scan
   If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary
   iii) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg
4. For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01v05r01 based on the formula below.
   i) (*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]·[$\sqrt{f(GHz)}/x$] W/kg for *test separation distances* ≤ 50 mm; where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
   ii) When the minimum test separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
   iii) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the *test separation distances* is > 50 mm.
   iv) Bluetooth estimated SAR is conservatively determined by 5mm separation, for all applicable exposure positions.

Max Power	Exposure Position	Bottom Face	Edge 1	Edge 2	Edge 3	Edge 4
	Test separation	0 mm	0 mm	0 mm	0 mm	0 mm
5 dBm	Antenna to user distance	5 mm	5 mm	226.2 mm	171.6 mm	56 mm
	Estimated SAR (W/kg)	0.126 W/kg	0.126 W/kg	0.4 W/kg	0.4 W/kg	0.4 W/kg

14.1 Body Exposure Conditions

<WLAN Antenna B + Bluetooth>

Position	Band	WLAN Ant B SAR (W/kg)	Bluetooth Estimated SAR (W/kg)	**Summed SAR (W/kg)**
Bottom Face At 0cm	WLAN 2.4GHz	1.338	0.126	**1.46**
	WLAN 5.2GHz	0.411	0.126	**0.54**
	WLAN 5.3GHz	0.630	0.126	**0.76**
	WLAN 5.5GHz	0.324	0.126	**0.45**
	WLAN 5.8GHz	0.291	0.126	**0.42**
Edge2 At 0cm	WLAN 2.4GHz	0.273	0.400	**0.67**
	WLAN 5.2GHz	0.256	0.400	**0.66**
	WLAN 5.3GHz	0.454	0.400	**0.85**
	WLAN 5.5GHz	0.373	0.400	**0.77**
	WLAN 5.8GHz	0.356	0.400	**0.76**
Edge3 At 0cm	WLAN 2.4GHz	0.331	0.400	**0.73**
	WLAN 5.2GHz	0.320	0.400	**0.72**
	WLAN 5.3GHz	0.696	0.400	**1.10**
	WLAN 5.5GHz	0.374	0.400	**0.77**
	WLAN 5.8GHz	0.424	0.400	**0.82**
Slant of Edge3 At 0cm	WLAN 2.4GHz	0.533	0.126	**0.66**
	WLAN 5.2GHz	0.381	0.126	**0.51**
	WLAN 5.3GHz	0.911	0.126	**1.04**
	WLAN 5.5GHz	1.270	0.126	**1.40**
	WLAN 5.8GHz	0.548	0.126	**0.67**
Bottom At 0cm	WLAN 2.4GHz	0.121	0.400	**0.52**
	WLAN 5.2GHz	0.152	0.400	**0.55**
	WLAN 5.3GHz	0.241	0.400	**0.64**
	WLAN 5.5GHz	0.118	0.400	**0.52**
	WLAN 5.8GHz	0.126	0.400	**0.53**

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15. 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 14.1

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 15.1. Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)
Measurement System							
Probe Calibration	6.0	Normal	1	1	1	± 6.0 %	± 6.0 %
Axial Isotropy	4.7	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %
Boundary Effects	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Linearity	4.7	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %
Response Time	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	1	± 1.5 %	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Probe Positioner	0.4	Rectangular	√3	1	1	± 0.2 %	± 0.2 %
Probe Positioning	2.9	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Max. SAR Eval.	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Test Sample Related							
Device Positioning	2.9	Normal	1	1	1	± 2.9 %	± 2.9 %
Device Holder	3.6	Normal	1	1	1	± 3.6 %	± 3.6 %
Power Drift	5.0	Rectangular	√3	1	1	± 2.9 %	± 2.9 %
Phantom and Setup							
Phantom Uncertainty	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	0.43	± 1.6 %	± 1.1 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	0.49	± 1.5 %	± 1.2 %
Combined Standard Uncertainty						± 11.0 %	± 10.8 %
Coverage Factor for 95 %						K=2	
Expanded Uncertainty						**± 22.0 %**	**± 21.5 %**

Table 15.2. Uncertainty Budget for frequency range 300 MHz to 3 GHz

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)
Measurement System							
Probe Calibration	6.55	Normal	1	1	1	± 6.55 %	± 6.55 %
Axial Isotropy	4.7	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %
Boundary Effects	2.0	Rectangular	√3	1	1	± 1.2 %	± 1.2 %
Linearity	4.7	Rectangular	√3	1	1	± 2.7 %	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %
Response Time	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	1	± 1.5 %	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	1	± 1.7 %	± 1.7 %
Probe Positioner	0.8	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Probe Positioning	9.9	Rectangular	√3	1	1	± 5.7 %	± 5.7 %
Max. SAR Eval.	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Test Sample Related							
Device Positioning	2.9	Normal	1	1	1	± 2.9 %	± 2.9 %
Device Holder	3.6	Normal	1	1	1	± 3.6 %	± 3.6 %
Power Drift	5.0	Rectangular	√3	1	1	± 2.9 %	± 2.9 %
Phantom and Setup							
Phantom Uncertainty	4.0	Rectangular	√3	1	1	± 2.3 %	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	0.43	± 1.6 %	± 1.1 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	0.49	± 1.5 %	± 1.2 %
Combined Standard Uncertainty						± 12.8 %	± 12.6 %
Coverage Factor for 95 %						K=2	
Expanded Uncertainty						**± 25.6 %**	**± 25.2 %**

Table 15.3. Uncertainty Budget for frequency range 3 GHz to 6 GHz

16. References

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

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

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

[4] SPEAG DASY System Handbook

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

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

[7] FCC KDB 616217 D04 v01r01, “SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers”, May 2013

[8] FCC KDB 865664 D01 v01r02, "SAR Measurement Requirements for 100 MHz to 6 GHz", Dec 2013.