ANSI/IEEE Std. C95.1-1992

in accordance with the requirements of
FCC Report and Order: ET Docket 93-62

FCC TEST REPORT

For

802.11 a/b/g/n 2.4GHz/5GHz + USB 4.0 card
(Tested inside of Notebook Computer, Non-Touch model 20267xxxxxx, 80B0xxxxxx, Lenovo IdeaPad U330pxxxxxx(x=0-9, A-Z or blank))

Trade Name: Qualcomm Atheros

Model: AR5B22

Issued to

Qualcomm Atheros, Inc.
1700 Technology Dr, San Jose,
CA, 95110

Issued by

Compliance Certification Services Inc.
No.11, Wugong 6th Rd., Wugu Dist.,
New Taipei City 24891,
Taiwan. (R.O.C.)
http://www.ccsrf.com
service@ccsrf.com

Testing Laboratory
1309

Issued Date: 2013/12/5

Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	2013/12/5	Initial Issue	ALL	Scott Hsu
01	2013/12/12	Add the test model notes of Product.	5	Scott Hsu

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1 Certificate of Compliance (SAR Evaluation)

Applicant: Qualcomm Atheros, Inc.
1700 Technology Dr, San Jose, CA, 95110

Equipment Under Test: 802.11 a/b/g/n 2.4GHz/5GHz + USB 4.0 card
(Tested inside of Notebook Computer, Non-Touch model 20267xxxxxx, 80B0xxxxxx, Lenovo IdeaPad U330pxxxxxx(x=0-9, A-Z or blank))

Trade Name: Qualcomm Atheros

Model Number: AR5B22

Date of Test: November 26 ~ December 05, 2013

Device Category: PORTABLE DEVICES

Exposure Category: GENERAL POPULATION/UNCONTROLLED EXPOSURE

Applicable Standards	
FCC	• IEEE 1528 2003 • KDB 447498 D01 General RF Exposure Guidance v05 • KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01 • KDB 248227 D01 SAR measurement for 802 11 a b g v01r02
Limit	
1.6 W/kg	
Test Result	
Pass	

The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Approved by:

Alex Wu
Section Manager
Compliance Certification Services Inc.

Tested by:

Scott Hsu
SAR Engineer
Compliance Certification Services Inc.

2 EUT Description

Product	802.11 a/b/g/n 2.4GHz/5GHz + USB 4.0 card (Tested inside of Notebook Computer, Non-Touch model 20267xxxxxx, 80B0xxxxxx, Lenovo IdeaPad U330pxxxxxx(x=0-9, A-Z or blank)) Note: The model of Lenovo IdeaPad U330p was be performed the SAR testing.		
Trade Name	Qualcomm Atheros		
Model Number	AR5B22		
Transmitters	Wi-Fi & BT		
WiFi+BT combo card	Atheros AR5B22		
Modulation Technique	802.11a: Orthogonal Frequency Division Multiplexing (OFDM)		
	802.11b: Direct Sequence Spread Spectrum(DSSS)		
	802.11g: Orthogonal Frequency Division Multiplexing (OFDM)		
	802.11n: Orthogonal Frequency Division Multiplexing (OFDM)		
Antenna Specification	WLAN	Brand name	Wistron Neweb Corporation
		Parts Number	Main:DQ6X15G3200
			Aux:DQ6X15G3300
		WLAN antenna: PIFA antenna	
FCC Rule Parts	Frequency Range	Highest Reported 1-g SAR	
15.247	2412 - 2462 MHz	0.617 W/kg (Bottom)	
	5725 - 5850 MHz	0.401 W/kg (Bottom)	
15.407	5150 - 5250 MHz	0.568 W/kg (Bottom)	
	5250 - 5350 MHz	0.827 W/kg (Bottom)	
	5500 - 5700 MHz	0.882 W/kg (Bottom)	
Rechargeable Li-polymer Battery–alternate	Brand: Simplo Model: L12M4P61 Rating: 7.4V, 45Wh, 4 cell Brand: LG Model: L12L4P61 Rating: 7.4V, 45Wh, 4 cell Note: The Simplo battery was used for SAR testing. The dimension is same as Sony battery. Therefore only Simplo battery was performed.		

Remark: *The sample selected for test was prototype that approximated to production product and was provided by manufacturer.*

3 Requirements for Compliance Testing Defined

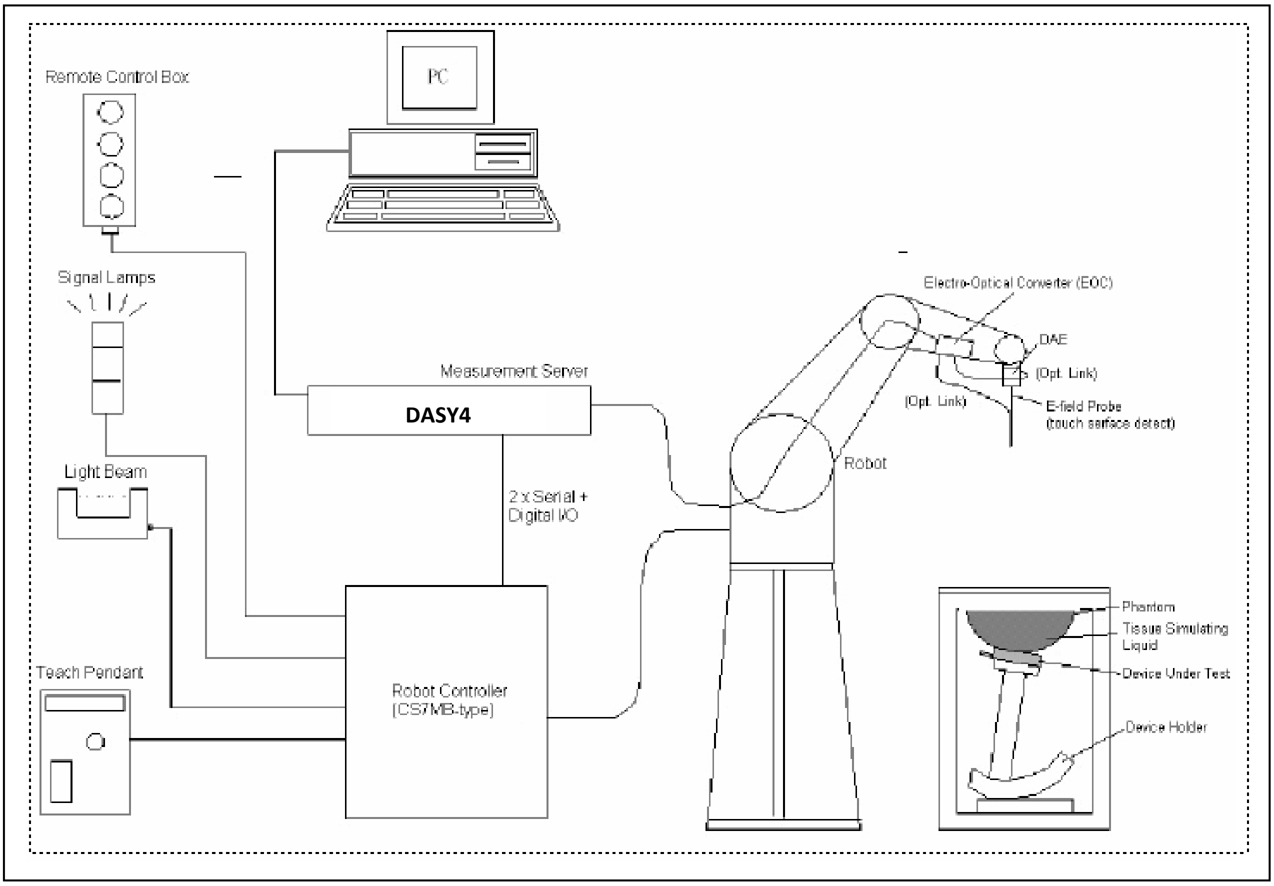
3.1 Requirements for Compliance Testing Defined by the FCC

The US Federal Communications Commission has released the report and order “Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996 [1]. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 W/kg for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992 [6].

4 Dosimetric Assessment System

These measurements were performed with the automated near-field scanning system DASY4/DAST5 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9 m) which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the dosimetric probe EX3DV4-SN: 3554 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure and found to be better than ±0.25 dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEEE 1528 2003.

4.1 Measurement System Diagram



The DASY4/DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (St¨aubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4/DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.

4.2 System Components

DASY4/DASY5 Measurement Server

The DASY4/DASY5 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4/DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

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

The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE4) 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 mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE4 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements

Construction: Symmetrical design with triangular core
Built-in shielding against static charges
PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

Calibration: Basic Broad Band Calibration in air: 10-3000 MHz.
Conversion Factors (CF) for HSL 900 and HSL 1800
CF-Calibration for other liquids and frequencies upon request.

Frequency: 10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Directivity: ± 0.3 dB in HSL (rotation around probe axis)
± 0.5 dB in HSL (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)
Distance from probe tip to dipole centers: 1 mm

Application: High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.

Interior of probe

SAM Phantom (V4.0)

Construction: The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-2003, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

Shell Thickness: 2 ±0.2 mm

Filling Volume: Approx. 25 liters

Dimensions: Height: 810mm; Length: 1000mm; Width: 500mm

SAM Phantom (ELI4)

Construction: Phantom 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 the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY4/DASY5 and higher and is compatible with all SPEAG dosimetric probes and dipoles

Shell Thickness: 2.0 ± 0.2 mm (sagging: <1%)

Filling Volume: Approx. 25 liters

Dimensions: Major ellipse axis: 600 mm

Minor axis: 400 mm 500mm

Device Holder for SAM Twin Phantom

Construction: In combination with the Twin SAM Phantom V4.0 or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, and flat phantom).

System Validation Kits for SAM Phantom (V4.0)

Construction: Symmetrical dipole with l/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 2450, 5200, 5300, 5600, 5800 MHz

Return loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions: D2450V2: dipole length: 51.5 mm; overall height: 290 mm
D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm

System Validation Kits for ELI4 phantom

Construction: Symmetrical dipole with l/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 2450, 5200, 5300, 5600, 5800 MHz

Return loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions: D2450V2: dipole length: 51.5 mm; overall height: 290 mm
D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm

5 Evaluation Procedures

Data Evaluation

The DASY4/DASY5 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 be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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

with	V_i	= Compensated signal of channel i	(i = x, y, z)
	U_i	= Input signal of channel i	(i = x, y, z)
	cf	= Crest factor of exciting field	(DASY parameter)
	dcp_i	= Diode compression point	(DASY parameter)

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

E-field probes:
$$E_i = \sqrt{\frac{V_i}{Norm_i \bullet ConvF}}$$

H-field probes:
$$H_i = \sqrt{Vi} \cdot \frac{a_{i10} + a_{i11} f + a_{i12} f^2}{f}$$

with	V_i	= Compensated signal of channel i	(i = x, y, z)
	$Norm_i$	= Sensor sensitivity of channel i µV/(V/m)^2 for E0field Probes	(i = x, y, z)
	$ConvF$	= Sensitivity enhancement in solution	
	aij	= Sensor sensitivity factors for H-field probes	
	f	= Carrier frequency (GHz)	
	Ei	= Electric field strength of channel i in V/m	
	Hi	= Magnetic field strength of channel i in A/m	

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

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

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

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

with SAR = local specific absorption rate in W/kg

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 normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

The power flow density is calculated assuming the excitation field as a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{377} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with P_{pwe} = Equivalent power density of a plane wave in mW/cm^2

E_{tot} = total electric field strength in V/m

H_{tot} = total magnetic field strength in A/m

SAR Measurement Procedures

The procedure for assessing the peak spatial-average SAR value consists of the following steps:

- **Power Reference Measurement**

  The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- **Area Scan**

  The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4/DASY5 software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, the grid resolution has to less than 15 mm by 15 mm at frequency ≤2GHz; the grid resolution has to less than 12mm by 12 mm at frequency between 2GHz to 4GHz; grid resolution has to less than 10 mm by 10 mm at frequency between 4GHz to 6GHz. According to KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01)

- **Zoom Scan**

  Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures points in accordance with the frequency can be divided into three parts. (1)The zoom scan volume was set to 5x5x7 points at frequency ≤ 2GHz. (2) The zoom scan volume was set to 7x7x7 points at frequency between 2GHz to 4GHz (3) The zoom scan volume was set to 7x7x12 points at frequency between 4GHz to 6GHz. The measures points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more then one maximum, the number of Zoom Scans has to be enlarged accordingly.

- **Power Drift Measurement**

  The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have DASY4/DASY5 software stop the measurements if this limit is exceeded.

- **Z-Scan**

  The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.

Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1528 2003 standard. It can be conducted for 1 g and 10 g.

The DASY4/DASY5 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation

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. Several measurements at different distances are necessary for the extrapolation.

Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation.

Boundary Effect

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosimetric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx S_o + S_b \exp(-\frac{z}{a}) \cos(\pi \frac{z}{\lambda})$$

Since the decay of the boundary effect dominates for small probes ($a \ll \lambda$), the cos-term can be omitted. Factors S_b (parameter Alpha in the DASY4/DASY5 software) and a (parameter Delta in the DASY4/DASY5 software) are assessed during probe calibration and used for numerical compensation of the boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- the boundary curvature is small
- the probe axis is angled less than 30_ to the boundary normal
- the distance between probe and boundary is larger than 25% of the probe diameter
- the probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY4/DASY5 system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.

6 Measurement Uncertainty

Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram

Uncertainty Component	Uncertainty	Prob.	Div.	$c_{i\,(1g)}$	Std. Unc.(1-g)	v_i or v_{eff}
Measurement System						
Probe Calibration (*k*=1)	5.90	Normal	1	1	5.9	∞
Axial Isotropy	4.70	Rectangular	√3	1	2.7	∞
HemisphericalIsotropy	9.60	Rectangular	√3	0	0.0	∞
Boundary Effect	1.00	Rectangular	√3	1	0.6	∞
Linearity	4.70	Rectangular	√3	1	2.7	∞
System Detection Limit	1.00	Rectangular	√3	1	0.6	∞
Readout Electronics	0.30	Normal	1	1	0.3	∞
Response Time	0.00	Rectangular	√3	1	0.0	∞
Integration Time	0.00	Rectangular	√3	1	0.0	∞
RFAmbientNoise	3.00	Rectangular	√3	1	1.7	∞
RF Ambient Reflections	3.00	Rectangular	√3	1	1.7	∞
Probe Positioner	0.40	Rectangular	√3	1	0.2	∞
Probe Positioning	2.90	Rectangular	√3	1	1.7	∞
Algorithms for Max. SAR Evaluation	1.00	Rectangular	√3	1	0.6	∞
Diople						
DipoleAxistoLiquidDistance	2.00	Normal	√3	1	1.2	∞
InputpowerandSARdriftmeas.	4.70	Normal	√3	1	2.7	∞
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	4.00	Rectangular	√3	1	2.3	∞
Liquid Conductivity - deviation from target values	5.00	Rectangular	√3	0.64	1.8	∞
Liquid Conductivity - measurement uncertainty	-2.21	Normal	1	0.64	-1.4	∞
Liquid Permittivity - deviation from target values	5.00	Rectangular	√3	0.6	1.7	∞
Liquid Permittivity - measurement uncertainty	0.53	Normal	1	0.6	0.3	∞
Temp. Unc. - Conductivity	1.70	Rectangular	√3	0.78	0.77	∞
Temp. Unc. - Permittivity	0.30	Rectangular	√3	0.23	0.04	∞
CombinedStdandardUncertainty					9.09	611
CoverageFactorfor95%		*kp*=2			18.18%	
Expanded Uncertainty		*k*=2			1.45dB	

Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram

Uncertainty Component	Uncertainty	Prob.	Div.	$c_{i\,(1g)}$	Std. Unc.(1-g)	v_i or v_{eff}
Measurement System						
Probe Calibration (*k*=1)	5.90	Normal	1	1	5.9	∞
Axial Isotropy	4.70	Rectangular	√3	1	2.7	∞
HemisphericalIsotropy	9.60	Rectangular	√3	0	0.0	∞
Boundary Effect	0.90	Rectangular	√3	1	0.5	∞
Linearity	3.45	Rectangular	√3	1	2.0	∞
System Detection Limit	1.00	Rectangular	√3	1	0.6	∞
Readout Electronics	1.00	Normal	√3	1	1.0	∞
Response Time	0.80	Rectangular	√3	1	0.5	∞
Integration Time	2.60	Rectangular	√3	1	1.5	∞
RFAmbientNoise	3.00	Rectangular	√3	1	1.7	∞
RF Ambient Reflections	3.00	Rectangular	√3	1	1.7	∞
Probe Positioner	0.40	Rectangular	√3	1	0.2	∞
Probe Positioning	2.90	Rectangular	√3	1	1.7	∞
Algorithms for Max. SAR Evaluation	3.90	Rectangular	√3	1	2.3	∞
Diople						
DipoleAxistoLiquidDistance	2.00	Normal	√3	1	1.2	∞
InputpowerandSARdriftmeas.	4.70	Normal	√3	1	2.7	∞
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	4.00	Rectangular	√3	1	2.3	∞
Liquid Conductivity - deviation from target values	5.00	Rectangular	√3	0.64	1.8	∞
Liquid Conductivity - measurement uncertainty	-3.99	Normal	1	0.64	-2.6	∞
Liquid Permittivity - deviation from target values	5.00	Rectangular	√3	0.6	1.7	∞
Liquid Permittivity - measurement uncertainty	-3.58	Normal	1	0.6	-2.1	∞
Temp. Unc. - Conductivity	1.70	Rectangular	√3	0.78	0.77	∞
Temp. Unc. - Permittivity	0.30	Rectangular	√3	0.23	0.04	∞
CombinedStdandardUncertainty					9.81	611
CoverageFactorfor95%		*kp*=2			19.63%	
Expanded Uncertainty		*k*=2			1.56dB	

7 Exposure Limit

(A). Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	2.0

(B). Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

NOTE: **Whole-Body SAR** is averaged over the entire body, **partial-body SAR** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. **SAR for hands, wrists, feet and ankles** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

Population/Uncontrolled Environments:

are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

Occupational/Controlled Environments:

are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

NOTE
GENERAL POPULATION/UNCONTROLLED EXPOSURE
PARTIAL BODY LIMIT
1.6 W/kg

8 Tissue Dielectric Properties

8.1 Test Liquid Confirmation

Simulating Liquids Parameter Check

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values

The relative permittivity and conductivity of the tissue material should be within ± 5% of the values given in the table below 5% may not be easily achieved at certain frequencies.

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in IEEE 1528 2003 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in IEEE 1528 2003 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE 1528 2003

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

8.2 Typical Composition of Ingredients for Liquid Tissue Phantoms

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

alt: 99^{+}% Pure Sodium Chloride
Sugar: 98^{+}% Pure Sucrose
Water: De-ionized, 16 $M\Omega^{+}$ resistivity
HEC: Hydroxy thyl Cellulose
DGBE: 99^{+}% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra-pure): Polyethylene glycol mono [4-(1, 1, 3, 3-tetramethylbutyl)phenyl]ether

Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

8.3 Simulating Liquids Parameter Check Results

Date	Band	Freq(MHz)	Measured			Standard		Δ		Limit
			e' (εr)	e''	σ	e' (εr)	σ	e' (εr)	σ	±5
2013/11/29	Body 5000	5180	47.98	18.29	5.26	49.02	5.28	-2.12%	-0.22%	±5
		5200	47.90	18.32	5.29	49.00	5.30	-2.24%	-0.16%	±5
		5300	47.79	18.38	5.41	48.90	5.42	-2.27%	-0.15%	±5
		5500	47.53	18.64	5.69	48.60	5.65	-2.19%	0.78%	±5
		5600	47.33	18.73	5.83	48.50	5.77	-2.41%	1.01%	±5
		5700	47.11	18.79	5.95	48.30	5.88	-2.46%	1.19%	±5
		5800	46.95	18.82	6.06	48.20	6.00	-2.60%	1.07%	±5
		5825	46.93	18.88	6.11	48.15	6.03	-2.54%	1.34%	±5
2013/12/2	Body 5000	5180	48.67	18.29	5.26	49.02	5.28	-0.72%	-0.26%	±5
		5200	48.62	18.30	5.29	49.00	5.30	-0.78%	-0.24%	±5
		5300	48.46	18.37	5.41	48.90	5.42	-0.90%	-0.18%	±5
		5500	48.14	18.55	5.67	48.60	5.65	-0.95%	0.34%	±5
		5600	47.96	18.64	5.80	48.50	5.77	-1.10%	0.52%	±5
		5700	47.80	18.73	5.93	48.30	5.88	-1.04%	0.85%	±5
		5800	47.63	18.80	6.06	48.20	6.00	-1.17%	0.96%	±5
		5825	47.62	18.83	6.09	48.15	6.03	-1.11%	1.03%	±5
2013/12/3	Body 5000	5180	48.06	17.86	5.14	49.02	5.28	-1.95%	-2.58%	±5
		5200	48.03	17.85	5.16	49.00	5.30	-1.99%	-2.71%	±5
		5300	47.90	17.93	5.28	48.90	5.42	-2.05%	-2.60%	±5
		5500	47.60	18.14	5.54	48.60	5.65	-2.06%	-1.87%	±5
		5600	47.42	18.22	5.67	48.50	5.77	-2.23%	-1.78%	±5
		5700	47.22	18.26	5.78	48.30	5.88	-2.23%	-1.64%	±5
		5800	47.07	18.27	5.89	48.20	6.00	-2.34%	-1.87%	±5
		5825	47.08	18.40	5.95	48.15	6.03	-2.22%	-1.24%	±5
2013/12/4	Body 5000	5180	47.43	17.63	5.07	49.02	5.28	-3.24%	-3.86%	±5
		5200	47.37	17.61	5.09	49.00	5.30	-3.32%	-3.99%	±5
		5300	47.27	17.68	5.21	48.90	5.42	-3.34%	-3.93%	±5
		5500	46.99	17.90	5.47	48.60	5.65	-3.31%	-3.18%	±5
		5600	46.80	17.97	5.59	48.50	5.77	-3.50%	-3.09%	±5
		5700	46.61	18.01	5.70	48.30	5.88	-3.50%	-3.00%	±5
		5800	46.48	18.02	5.81	48.20	6.00	-3.58%	-3.24%	±5
		5825	46.47	18.14	5.87	48.15	6.03	-3.49%	-2.66%	±5
2013/12/5	Body 2450	2412	53.03	13.97	1.87	52.75	1.91	0.53%	-2.21%	±5
		2437	52.99	14.05	1.90	52.72	1.94	0.52%	-1.80%	±5
		2442	52.99	14.07	1.91	52.71	1.94	0.52%	-1.74%	±5
		2462	52.92	14.18	1.94	52.68	1.97	0.45%	-1.41%	±5
		2472	52.88	14.23	1.95	52.67	1.98	0.39%	-1.39%	±5

9 System Performance Check

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications. The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY4/DASY5 system with an E-fileld probe EX3DV4 SN: 3554 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm (below 1 GHz) and 10 mm (above 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration (dx=dy= 5 mm, dz= 5 mm).
- Distance between probe sensors and phantom surface was set to 3.0 mm.
- The dipole input power (forward power) was 100 mW±3%.
- The results are normalized to 1 W input power.

Reference SAR Values for System Performance Check

The reference SAR values can be obtained from the calibration certificate of system validation dipoles

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	Target SAR Values (W/kg)		
				1g/10g	Head	Body
D2450V2	728	2013/5/2	2450	1g	53.5	51.1
				10g	25.0	23.9
D5GHzV2	1040	2013/7/2	5200	1g	78.5	74.8
				10g	22.4	21.0
D5GHzV2	1040	2013/7/2	5300	1g	82.0	76.6
				10g	23.5	21.5
D5GHzV2	1040	2013/7/2	5600	1g	81.7	81.2
				10g	23.3	22.4
D5GHzV2	1040	2013/7/2	5800	1g	77.7	74.8
				10g	22.1	20.6

9.1 System Performance Check Results

Date	System Dipole			Parameters	Target	Measured	Deviation[%]	Limited[%]
	Type	Serial No.	Liquid					
11/29/2013	D5GHzV2 (5.2GHz)	1040	Body	1g SAR:	74.80	73.10	-2.27	± 5
				10g SAR:	21.00	20.50	-2.38	± 5
12/2/2013	D5GHzV2 (5.3GHz)	1040	Body	1g SAR:	76.60	76.00	-0.78	± 5
				10g SAR:	21.50	22.00	2.33	± 5
12/3/2013	D5GHzV2 (5.6GHz)	1040	Body	1g SAR:	81.20	80.10	-1.35	± 5
				10g SAR:	22.40	22.70	1.34	± 5
12/4/2013	D5GHzV2 (5.8GHz)	1040	Body	1g SAR:	74.80	74.80	0.00	± 5
				10g SAR:	20.60	21.40	3.88	± 5
12/5/2013	D2450V2 (2.4GHz)	728	Body	1g SAR:	51.10	51.70	1.17	± 5
				10g SAR:	23.90	24.60	2.93	± 5

10 Device Under Test

10.1 Simultaneous Transmission

No.	Conditions	Head	Body	Hotspot
1	WiFi + BT	☐	☐	☐

Note(s):

1. WiFi 2.4GHz band and BT can't simultaneous transmit.

11 RF Output Power Measurement

11.1 WiFi (2.4 GHz Band)

Required Test Channels per KDB 248227 D01

Mode	Band (GHz)	Freq. (MHz)	Ch #	Default Test Channels	
				802.11b	802.11g
802.11 b/g	2.4	2412	1#	✓	∇
		2437	6	✓	∇
		2462	11#	✓	∇

Notes
✓ = "default test channels"
∇ = possible 802.11g channels with maximum average output ¼ dB the "default test channels"
= when output power is reduced for channel 1 and /or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested.

The indicated Wi-Fi target powers in the following table are absolute maximums.

Output power table

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
						Main	Aux	Total
2.4	802.11b	1	1	2412	16.5		15.7	
			6	2437	17.0		16.5	
			11	2462	16.5		16.0	
	802.11g	6	1	2412	13.0		12.1	
			6	2437	17.0		16.7	
			11	2462	12.5		11.8	
	802.11b 2TX	2	1	2412	19.5	16.9	16.0	19.5
			6	2437	20.0	16.3	16.5	19.4
			11	2462	19.5	16.9	16.0	19.5
	802.11g 2TX	12	1	2412	16.0	13.0	12.2	15.6
			6	2437	20.0	16.3	16.4	19.4
			11	2462	15.5	12.3	12.2	15.3
	802.11n HT20	MCS8	1	2412	16.0	12.8	12.5	15.7
			6	2437	20.0	17.0	16.2	19.6
			11	2462	15.0	11.8	11.3	14.6
	802.11n HT40	MCS8	3	2412	12.5	9.4	8.9	12.2
			6	2437	17.5	14.3	13.6	17.0
			9	2462	14.5	11.3	10.5	13.9

Note(s):
SAR is not required for 802.11g/HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a channels per KDB 248227 D01.

11.2 WiFi (5 GHz Band)

Required Test Channels per KDB 248227 D01

Mode	Band (GHz)	Freq. (MHz)	Ch #	Default Test Channels			
				§15.247		UNII	
802.11a	UNII	5180	36			✓	
		5200	40				*
		5220	44				*
		5240	48			✓	
		5260	52			✓	
		5280	56				*
		5300	60				*
		5320	64			✓	
		5500	100				*
		5520	104			✓	
		5540	108				*
		5560	112				*
		5580	116			✓	
		5600	120				*
		5620	124			✓	
		5640	128				*
		5660	132				*
		5680	136			✓	
		5700	140				*
	UNII or §15.247	5745	149	✓		✓	
		5765	153		*		*
		5785	157	✓			*
		5805	161		*	✓	
	§15.247	5825	165	✓			

Notes

✓ = "default test channels"

* = possible 802.11a channels with maximum average output > the "default test channels"

The indicated Wi-Fi target powers in the following table are absolute maximums.

WiFi 5.2GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
						Main	Aux	Total
5.2	802.11a	6	36	5180	11.5		10.9	
			40	5200	11.5		11.3	
			44	5220	11.5		11.3	
			48	5240	11.5		11.2	
	802.11a (2TX)	12	36	5180	14.5	11.4	11.4	14.4
			40	5200	14.5	11.4	11.3	14.4
			44	5220	14.5	11.6	11.2	14.4
			48	5240	14.5	11.6	11.3	14.5
	802.11n (HT20)	MCS8	36	5180	14.5	11.2	11.0	14.1
			40	5200	14.5	11.2	11.0	14.1
			44	5220	14.5	11.2	11.0	14.1
			48	5240	14.5	10.9	10.9	13.9
	802.11n (HT40)	MCS8	38	5190	12.5	9.5	9.2	12.4
			46	5230	17.0	13.4	13.4	16.4

Note(s):

The tune up power is based on manufactory shipping power level.

WiFi 5.3GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
						Main	Aux	Total
5.3	802.11a	6	52	5260	16.5		16.1	
			56	5280	11.5		16.2	
			60	5300	11.5		11.5	
			64	5320	11.5		11.2	
	802.11a 2TX	12	52	5260	19.5	16.4	16.5	19.5
			56	5280	14.5	11.2	11.4	14.3
			60	5300	14.5	11.5	11.4	14.5
			64	5320	14.5	11.2	11.3	14.3
	802.11n (HT20)	MCS8	52	5260	18.0	14.2	14.3	17.3
			56	5280	14.5	11.3	11.4	14.4
			60	5300	14.5	11.3	11.4	14.4
			64	5320	14.5	11.3	11.4	14.4
	802.11n (HT40)	MCS8	54	5270	12.5	9.4	9.4	12.4
			62	5310	12.5	9.4	9.3	12.4

Note(s):

The tune up power is based on manufactory shipping power level.

WiFi 5.5GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
						Main	Aux	Total
5.5	802.11a	6	100	5500	11.5		11.4	
			104	5520	14.5		14.5	
			108	5540	14.5		14.2	
			112	5560	14.5		14.2	
			116	5580	14.5		14.5	
			132	5660	14.5		14.3	
			136	5680	14.0		14.3	
			140	5700	10.5		10.3	
	802.11a 2TX	12	100	5500	14.5	11.0	11.7	14.4
			104	5520	17.5	14.2	14.3	17.3
			108	5540	17.5	14.1	14.3	17.2
			112	5560	17.5	14.0	14.2	17.1
			116	5580	17.5	14.3	14.3	17.3
			132	5660	17.5	14.0	14.1	17.1
			136	5680	17.0	13.7	14.0	16.9
			140	5700	13.5	10.1	10.4	13.3
	802.11n (HT20)	MCS8	100	5500	16.0	12.1	13.1	15.6
			104	5520	17.5	14.0	14.3	17.2
			108	5540	17.5	14.0	14.3	17.2
			112	5560	17.5	14.1	14.2	17.2
			116	5580	17.5	14.3	14.5	17.4
			132	5660	17.5	14.2	14.3	17.3
			136	5680	17.5	14.1	14.2	17.2
			140	5700	16.0	12.2	12.6	15.4
	802.11n (HT40)	MCS8	102	5510	12.0	8.5	8.8	11.7
			118	5590	18.5	14.8	15.0	17.9
			134	5670	16.0	12.3	12.6	15.5

Note(s):
The tune up power is based on manufactory shipping power level.

WiFi 5.8GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
						Main	Aux	Total
5.8	802.11a	6	149	5745	11.5		11.4	
			153	5765	11.5		11.2	
			157	5785	11.5		11.5	
			161	5805	11.5		11.2	
			165	5825	11.5		11.2	
	802.11n 2TX	12	149	5745	14.5	11.0	11.5	14.3
			153	5765	14.5	11.0	11.3	14.2
			157	5785	14.5	11.0	11.6	14.3
			161	5805	14.5	11.0	11.3	14.2
			165	5825	14.5	11.1	11.8	14.5
	802.11n (HT20)	MCS8	149	5745	16.5	13.1	13.6	16.4
			153	5765	17.0	13.1	13.5	16.3
			157	5785	17.0	13.6	13.9	16.8
			161	5805	17.0	13.6	13.8	16.7
			165	5825	17.0	14.0	13.7	16.9
	802.11n (HT40)	MCS8	151	5755	17.5	14.6	14.3	17.5
			159	5795	17.0	13.8	14.1	17.0

Note(s):
The tune up power is based on manufactory shipping power level.

11.3 Bluetooth

Output power table

Band	Mode	Ch #	Freq. (MHz)	Avg pwr (dBm)
Bluetooth	DH5	0	2402	3.0
		39	2441	3.6
		78	2480	4.1

Band	Mode	Ch #	Freq. (MHz)	Avg pwr (dBm)
Bluetooth	3DH5	0	2402	3.2
		39	2441	3.9
		78	2480	4.4

Band	Mode	Ch #	Freq. (MHz)	Avg pwr (dBm)
Bluetooth	BLE	0	2402	2.9
		19	2440	3.6
		38	2480	4.1

12 SAR Measurements Results

Wi-Fi (2.4GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Dist. (mm)	Power (dBm)		Measured1g SAR (W/kg)	Reported SAR(W/kg)	Note
						Tune up limit	Measured			
2.4GHz	802.11b	Bottom	1	2412	0					1
			6	2437	0	17.0	16.5	0.343	0.385	
			11	2462	0					1
	802.11b 2TX	Bottom	1	2412	0					1
			6	2437	0	20.0	19.4	0.537	0.617	Plot 1
			11	2462	0					1

Note(s):

1. Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g SAR for the mid-band or highest output power channel. ≤ 0.8 W/kg and transmission band ≤ 100 MHz (Per KDB 447498 D01 v05 section 4.3.3)

Wi-Fi (5.2GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Dist. (mm)	Power (dBm)		Measured1g SAR (W/kg)	Reported SAR(W/kg)	Note
						Tune up limit	Measured			
5.2GHz	802.11a	Bottom	36	5180	0	11.5	10.9	0.281	0.323	
			48	5240	0	11.5	11.2	0.317	0.340	
	802.11n HT40	Bottom	46	5230	0	17.0	16.4	0.495	0.568	plot 2

Wi-Fi (5.3GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Dist. (mm)	Power (dBm)		Measured 1g SAR (W/kg)	Reported SAR(W/kg)	Note
						Tune up limit	Measured			
5.3GHz	802.11a	Bottom	52	5260	0	16.5	16.1	0.721	0.791	
			60	5300	0	11.5	11.5	0.157	0.157	
	802.11a 2TX	Bottom	52	5260	0	19.5	19.5	0.821	0.821	Plot 3
			60	5300	0	14.5	14.5	0.287	0.287	
			52	5260	0	19.5	19.5	0.827	0.827	1

Note(s):

1. Repeated measurements are required only when the measured SAR is ≥0.80 W/kg. If the measured SAR values are < 1.45 W/kg with ≤20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. (Per KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01)
   1.1 Original SAR = 0.821W/kg, therefore two times repeat SAR is required.
   1.2 Repeat SAR = 0.827 W/kg < 1.45W/kg
   1.3 SAR variation= 0.7% < 20%

Wi-Fi (5.5GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Dist. (mm)	Power (dBm)		Measure d1g SAR (W/kg)	Reported SAR(W/kg)	Note
						Tune up limit	Measured			
5.5GHz	802.11a	Bottom	104	5520	0	14.5	14.5	0.292	0.292	
			116	5580	0	14.5	14.5	0.561	0.561	
			132	5660	0	14.5	14.3	0.604	0.632	
	802.11n HT40	Bottom	118	5590	0	18.5	17.9	0.768	0.882	Plot 4

Wi-Fi (5.8GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Dist. (mm)	Power (dBm)		Measure d1g SAR (W/kg)	Reported SAR(W/kg)	Note
						Tune up limit	Measured			
5.8GHz	802.11a	Bottom	149	5745	0	11.5	11.4	0.243	0.249	
			157	5785	0	11.5	11.5	0.172	0.172	
			165	5825	0	11.5	11.2	0.287	0.308	
	802.11n HT40	Bottom	151	5755	0	17.5	17.5	0.401	0.401	Plot5

Bluetooth:

Band	Mode	Freq. (MHz)	Power (dBm)		Estimated 1g SAR (W/kg)	Note
			Tune up limit	Measured		
Bluetooth	3DH5	2402				
		2440				
		2480	4.5	4.4	0.126	

Note(s):

2. 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)] [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR,
   Where:
   - 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.
   For the Bluetooth operations the frequency is 2.480 GHz, the maximum power is 4.5dBm (2.8mW, so 3mW will be used in the calculation) and the distance from enclosure to persons is 1mm:
   [(max. power of channel)/(min. test separation distance)] ·[√f] = 3 / 5 x √2.480 = 0.9.
   As this is ≤ 3.0, Bluetooth operations are exempt from stand-alone SAR measurements
3. When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following KDB 447498 D01 v05 section 4.3.2.
   - Maximum power of channel, including tune-up tolerance (mW)=3mW
   - Minimum test separation distance (mm) = 5 mm

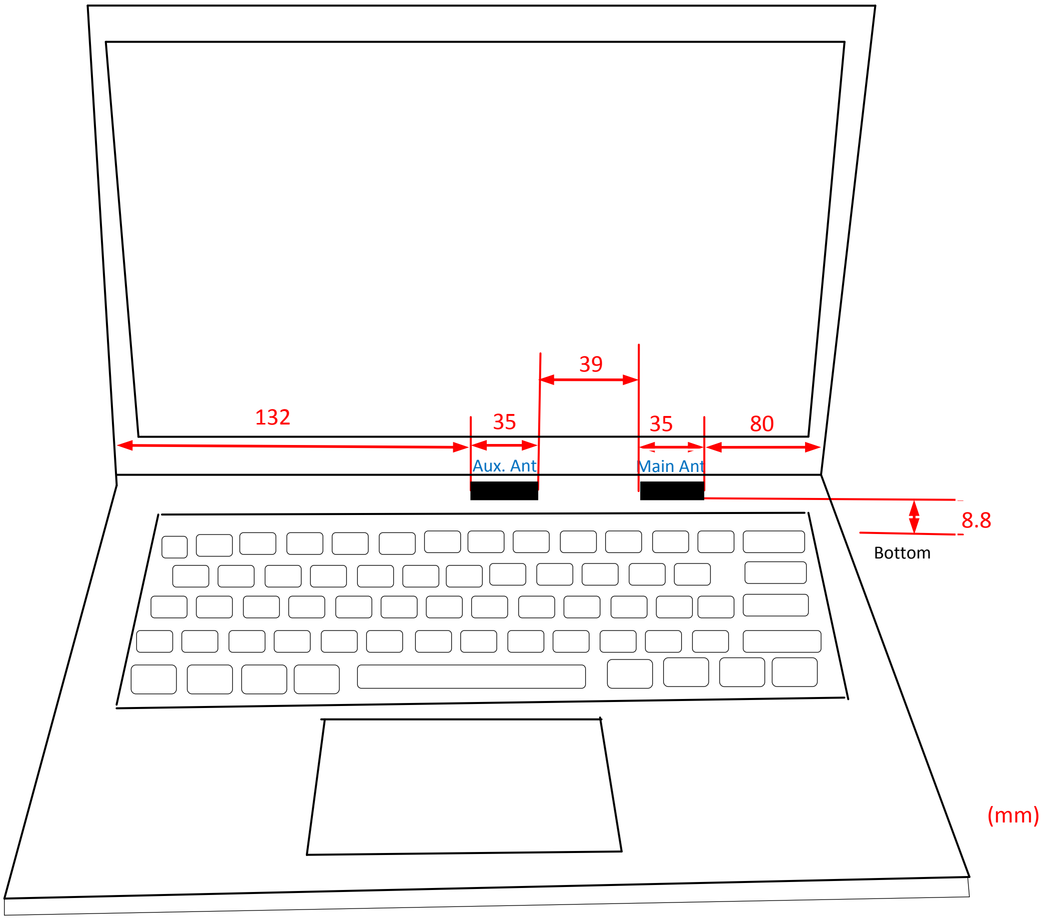
Estimated SAR= (3mW/5mm)[(2.480GHz^0.5)/7.5)]=0.126W/kg

12.1 SUMMARY OF HIGHEST SAR VALUES

Results for highest reported SAR values for each frequency band and mode

Technology/Band	Test configuration	Mode	Highest Reported 1g-SAR (W/kg)
WiFi 2.4 GHz	Bottom	802.11b	0.617
WiFi 5.2 GHz	Bottom	802.11a	0.568
WiFi 5.3 GHz	Bottom	802.11a	0.827
WiFi 5.5 GHz	Bottom	802.11n HT40	0.882
WiFi 5.8 GHz	Bottom	802.11n HT40	0.401

13 Antenna Locations & Separation Distances



14 Equipment List & Calibration Status

Name of Equipment	Manufacturer	Type/Model	Serial Number	Calibration Cycle(year)	Calibration Due
S-Parameter Network Analyzer	Agilent	E5071C	MY46213916	1	2014/6/3
Electronic Probe kit	Hewlett Packard	85070D	N/A	N/A	N/A
Power Meter	Agilent	E4416	GB41291611	1	2014/9/10
Power Sensor	Agilent	8481H	MY41091956	1	2014/9/10
Spectrum Analyzer	Agilent	E4446A	US42510252	1	2013/12/9
Data Acquisition Electronics (DAE)	SPEAG	DAE4	558	1	2014/7/24
Dosimetric E-Field Probe	SPEAG	EX3DV4	3554	1	2014/9/25
2450 MHz System Validation Dipole	SPEAG	D2450V2	728	1	2014/5/1
5GHz System Validation Dipole	SPEAG	D5GHzV2	1040	1	2014/7/1
Robot	Staubli	RX60L	F02/5T69A1/A/01	N/A	N/A
Amplifier	Mini-Circuit	ZVE-8G	665500309	N/A	N/A
Amplifier	Mini-Circuit	ZHL-1724HLN	D072602#2	N/A	N/A
DC Power generator	ABM	8301HD	N/A	N/A	N/A
Probe Alignment Unit	SPEAG	LB (V2)	348	N/A	N/A
SAM Twin Phantom V4.0	SPEAG	N/A	N/A	N/A	N/A
Devices Holder	SPEAG	N/A	N/A	N/A	N/A

15 Facilities

All measurement facilities used to collect the measurement data are located at

☐ No. 81-1, Lane 210, Bade Rd. 2, Luchu Hsiang, Taoyuan Hsien, Taiwan, R.O.C.

☒ No.11, Wugong 6th Rd., Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.)

☐ No. 199, Chunghsen Road, Hsintien City, Taipei Hsien, Taiwan, R.O.C.

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17 Attachments

Exhibit	Content
1	System performance check plots
2	SAR test plots for WiFi
3	SAR_DAE4_sn558
4	SAR_Probe_EX3DV4_sn3554
5	SAR_Dipole_D2450v2_sn728
6	SAR_Dipole_D5GHzv2_sn1040
7	T131126L01-SF PHOTOs

END OF REPORT