ANSI/IEEE Std. C95.1-1992

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

FCC TEST REPORT

For

IEEE 802.11 a/b/g/n Wireless LAN and Bluetooth Combo LGA Module

Trade Name: Lenovo

Model: AW-AM691NF

Issued to

AzureWave Technologies, Inc.
8F, No. 94, Baozhong Rd.,
Xindian, Taiwan 231

Issued by

Compliance Certification Services Inc.
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Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	2013/10/09	Initial Issue	ALL	Scott Hsu
01	2013/10/28	Revise Date of test, Measurement Uncertainty, Body Exposure Conditions for WiFi Main Antenna and Aux Antenna, the note(s) of under 2.4G output power table,5GHz Dipole of Equipment List, Add Simulating Liquids Parameter, System Performance Check Result, SAR Measurements of Edge2 position.	4,16,20,21,23,25, 27,33,34,35,36,39	Scott Hsu
02	2013/10/30	Add Bluetooth 4.0 Power Table	32	Scott Hsu
03	2013/10/31	Revise Applicant name	1,4	Scott Hsu

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1 Certificate of Compliance (SAR Evaluation)

Applicant	AzureWave Technologies, Inc.
	8F, No. 94, Baozhong Rd., Xindian, Taiwan 231
Equipment Under Test:	IEEE 802.11 a/b/g/n Wireless LAN and Bluetooth Combo LGA Module
Trade Name:	Lenovo
Model Number:	AW-AM691NF
Date of Test:	September 12 ~ October 28, 2013
Device Category:	PORTABLE DEVICES
Exposure Category:	GENERAL POPULATION/UNCONTROLLED EXPOSURE

Applicable Standards	
FCC	● IEEE 1528 2003 ● KDB 447498 D01 General RF Exposure Guidance v05r01 ● KDB 616217 D04 SAR for laptop and tablets v01r01 ● 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	IEEE 802.11 a/b/g/n Wireless LAN and Bluetooth Combo LGA Module		
Trade Name	Lenovo		
Model Number	AW-AM691NF		
Transmitters	Wi-Fi & BT		
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	Compal Electronics, INC.
		Parts Number	Main:SE-ECJH0-001
			Aux:SE-ECJH0-002
		WLAN antenna: PIFA Anntenna	
FCC Rule Parts	Frequency Range		Highest Reported 1-g SAR
15.247	2412 - 2462 MHz		0.842 W/kg (Rear)
	5725 - 5850 MHz		1.090 W/kg (Rear)
15.407	5150 - 5250 MHz		1.047 W/kg (Rear)
	5250 - 5350 MHz		1.020 W/kg (Rear)
	5500 - 5700 MHz		1.407 W/kg (Rear)
Rechargeable Li-polymer Battery–alternate	Brand: LG Model: L13L1P21 Rating: 3.7V, 17.5Wh, 4730mAh		
	Brand: SIMPLO Model: L13M1P21 Rating: 3.7V, 17.5Wh, 4730mAh		

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

3 Requirements for Compliance Testing Defined

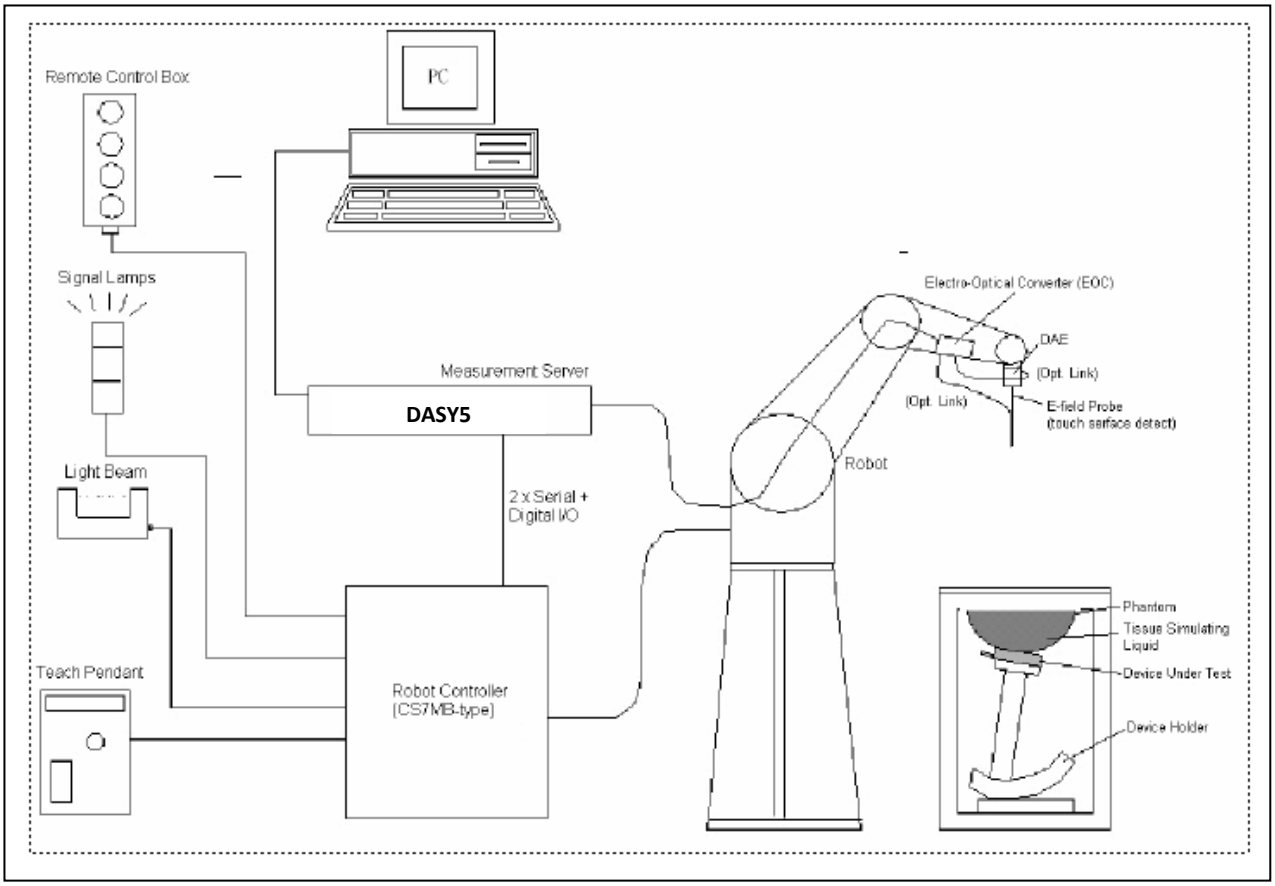
3.1 Requirements for Compliance Testing Defined by the FCC

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: 3665 (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)

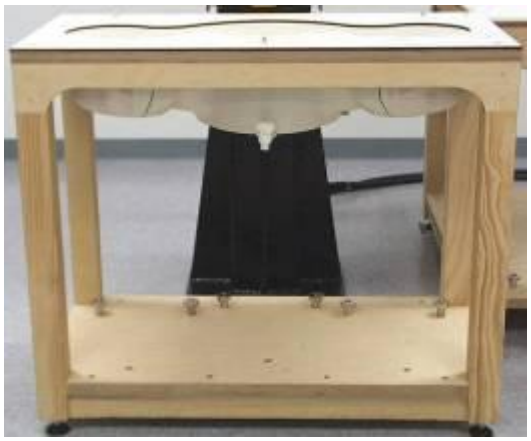
Dimensions: Overall length: 330 mm (Tip: 20 mm)
Tip diameter: 2.5 mm (Body: 12 mm)
Distance from probe tip to dipole centers: 1 mm

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 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, 5500,5800 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, 5500,5800 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 (i = x, y, z)
$\mu V/(V/m)^2$ for E0field Probes
$ConvF$ = 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 ($a<<\lambda$), 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.	$c_{i\ (10g)}$	Std. Unc.(1-g)	$v_{i\ or\ Veff}$
Measurement System						
Probe Calibration (k=1)	6.00	Normal	1	1	6.00	∞
Probe Isotropy	7.60	Rectangular	$\sqrt{3}$	0.7	3.07	∞
Boundary Effect	0.65	Rectangular	$\sqrt{3}$	1	0.38	∞
Linearity	4.70	Rectangular	$\sqrt{3}$	1	2.71	∞
System Detection Limit	1.00	Rectangular	$\sqrt{3}$	1	0.58	∞
Readout Electronics	0.30	Normal	1	1	0.30	∞
Response Time	0.80	Rectangular	$\sqrt{3}$	1	0.46	∞
Integration Time	2.60	Rectangular	$\sqrt{3}$	1	1.50	∞
RF Ambient Conditions	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
RF Ambient Reflections	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
Probe Positioner Mechanical Tolerance	0.40	Rectangular	$\sqrt{3}$	1	0.23	∞
Probe Positioning with respect to Phantom Shell	2.90	Rectangular	$\sqrt{3}$	1	1.67	∞
Extrapolation, interpolation and integration Algorithms for Max. SAR Evaluation	2.00	Rectangular	$\sqrt{3}$	1	1.15	∞
Test sample Related						
Test sample Positioning	3.70	Normal	1	1	3.7	89
Device Holder Uncertainty	3.40	Normal	1	1	3.4	5
Output Power Variation - SAR drift measurement	5.00	Rectangular	$\sqrt{3}$	1	2.89	∞
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	7.50	Rectangular	$\sqrt{3}$	1	4.33	∞
Liquid Conductivity - deviation from target values	4.14	Rectangular	$\sqrt{3}$	0.64	1.53	∞
Liquid Conductivity - measurement uncertainty	-2.32	Normal	1	0.64	-1.48	39
Liquid Permittivity - deviation from target values	3.92	Rectangular	$\sqrt{3}$	0.6	1.36	∞
Liquid Permittivity - measurement uncertainty	2.39	Normal	1	0.6	1.43	39
Temp. Unc. - Conductivity	1.70	Rectangular	$\sqrt{3}$	0.78	0.77	∞
Temp. Unc. - Permittivity	0.30	Rectangular	$\sqrt{3}$	0.23	0.04	∞
		RSS			11.29	611
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =		k=2			22.57%	
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =		k=2			1.77dB	

Measurement uncertainty for 3 to 6 GHz averaged over 1 gram

Uncertainty Component	Uncertainty	Prob.	Div.	$c_{i\ (10g)}$	Std. Unc.(1-g)	$v_{i\ or\ Veff}$
Measurement System						
Probe Calibration (k=1)	6.55	Normal	1	1	6.55	∞
Probe Isotropy	7.60	Rectangular	$\sqrt{3}$	0.7	3.07	∞
Boundary Effect	2.00	Rectangular	$\sqrt{3}$	1	1.15	∞
Linearity	4.70	Rectangular	$\sqrt{3}$	1	2.71	∞
System Detection Limit	1.00	Rectangular	$\sqrt{3}$	1	0.58	∞
Readout Electronics	0.30	Normal	1	1	0.30	∞
Response Time	0.80	Rectangular	$\sqrt{3}$	1	0.46	∞
Integration Time	2.60	Rectangular	$\sqrt{3}$	1	1.50	∞
RF Ambient Conditions	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
RF Ambient Reflections	3.00	Rectangular	$\sqrt{3}$	1	1.73	∞
Probe Positioner Mechanical Tolerance	0.80	Rectangular	$\sqrt{3}$	1	0.46	∞
Probe Positioning with respect to Phantom Shell	6.70	Rectangular	$\sqrt{3}$	1	3.87	∞
Extrapolation, interpolation and integration Algorithms for Max. SAR Evaluation	4.00	Rectangular	$\sqrt{3}$	1	2.31	∞
Test sample Related						
Test sample Positioning	3.70	Normal	1	1	3.7	89
Device Holder Uncertainty	3.40	Normal	1	1	3.4	5
Output Power Variation - SAR drift measurement	5.00	Rectangular	$\sqrt{3}$	1	2.89	∞
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	7.90	Rectangular	$\sqrt{3}$	1	4.56	∞
Liquid Conductivity - deviation from target values	5.00	Rectangular	$\sqrt{3}$	0.64	1.85	∞
Liquid Conductivity - measurement uncertainty	-3.88	Normal	1	0.64	-2.48	39
Liquid Permittivity - deviation from target values	5.00	Rectangular	$\sqrt{3}$	0.6	1.73	∞
Liquid Permittivity - measurement uncertainty	-2.48	Normal	1	0.6	-1.49	39
Temp. Unc. - Conductivity	1.70	Rectangular	$\sqrt{3}$	0.78	0.77	∞
Temp. Unc. - Permittivity	0.30	Rectangular	$\sqrt{3}$	0.23	0.04	∞
		RSS			12.66	611
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =		k=2			25.31%	
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =		k=2			1.96dB	

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 MΩ^{+} 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
2013/9/12	Body 5000	5180	48.82	17.87	5.14	49.07	5.25	-0.50%	-2.13%	±5
		5200	48.80	17.88	5.17	49.04	5.28	-0.49%	-2.11%	±5
		5300	48.67	17.97	5.29	48.88	5.41	-0.44%	-2.18%	±5
		5500	48.27	18.09	5.53	48.64	5.62	-0.76%	-1.74%	±5
		5600	48.17	18.15	5.65	48.47	5.76	-0.62%	-1.98%	±5
		5700	48.09	18.22	5.77	48.33	5.88	-0.49%	-1.87%	±5
		5800	47.88	18.34	5.91	48.23	5.97	-0.74%	-1.03%	±5
		5825	47.85	18.33	5.93	48.20	6.00	-0.73%	-1.16%	±5
2013/9/13	Body 5000	5180	48.84	18.25	5.25	49.07	5.25	-0.46%	-0.01%	±5
		5200	48.75	18.30	5.29	49.04	5.28	-0.59%	0.20%	±5
		5300	48.64	18.39	5.41	48.88	5.41	-0.49%	0.07%	±5
		5500	48.34	18.59	5.68	48.64	5.62	-0.61%	1.01%	±5
		5600	48.15	18.72	5.82	48.47	5.76	-0.65%	1.11%	±5
		5700	47.98	18.81	5.96	48.33	5.88	-0.73%	1.28%	±5
		5800	47.80	18.94	6.10	48.23	5.97	-0.90%	2.19%	±5
		5825	47.76	18.92	6.12	48.20	6.00	-0.92%	2.05%	±5
2013/9/15	Body 5000	5180	48.49	17.59	5.06	49.07	5.25	-1.19%	-3.65%	±5
		5200	48.43	17.58	5.08	49.04	5.28	-1.25%	-3.77%	±5
		5300	48.33	17.66	5.20	48.88	5.41	-1.12%	-3.88%	±5
		5500	48.10	17.91	5.47	48.64	5.62	-1.11%	-2.70%	±5
		5600	47.88	17.98	5.59	48.47	5.76	-1.22%	-2.90%	±5
		5700	47.71	18.03	5.71	48.33	5.88	-1.29%	-2.92%	±5
		5800	47.59	18.08	5.82	48.23	5.97	-1.34%	-2.45%	±5
		5825	47.56	18.10	5.86	48.20	6.00	-1.32%	-2.40%	±5
2013/9/16	Body 5000	5180	48.11	18.57	5.34	49.07	5.25	-1.95%	1.71%	±5
		5200	48.11	18.59	5.37	49.04	5.28	-1.90%	1.78%	±5
		5300	47.94	18.63	5.48	48.88	5.41	-1.92%	1.38%	±5
		5500	47.55	18.81	5.75	48.64	5.62	-2.23%	2.21%	±5
		5600	47.46	18.91	5.88	48.47	5.76	-2.09%	2.16%	±5
		5700	47.21	19.06	6.04	48.33	5.88	-2.32%	2.67%	±5
		5800	47.04	19.16	6.17	48.23	5.97	-2.48%	3.41%	±5
		5825	47.05	19.12	6.19	48.20	6.00	-2.39%	3.12%	±5
2013/10/8	Body 2450	2412	54.01	13.95	1.87	52.75	1.91	2.39%	-2.32%	±5
		2437	53.93	14.06	1.90	52.72	1.94	2.31%	-1.75%	±5
		2442	53.93	14.08	1.91	52.71	1.94	2.31%	-1.69%	±5
		2462	53.88	14.16	1.94	52.68	1.97	2.26%	-1.51%	±5
		2472	53.85	14.20	1.95	52.67	1.98	2.24%	-1.55%	±5
2013/10/28	Body 5000	5180	49.24	18.29	5.26	49.07	5.25	0.36%	0.17%	±5
		5200	49.30	18.27	5.28	49.04	5.28	0.53%	0.03%	±5
		5300	49.09	18.36	5.41	48.88	5.41	0.43%	-0.09%	±5
		5500	48.76	18.48	5.65	48.64	5.62	0.26%	0.42%	±5
		5600	48.63	18.55	5.77	48.47	5.76	0.33%	0.22%	±5
		5700	48.51	18.67	5.91	48.33	5.88	0.36%	0.54%	±5
		5800	48.37	18.76	6.04	48.23	5.97	0.28%	1.21%	±5
		5825	48.36	18.76	6.07	48.20	6.00	0.34%	1.20%	±5

Date	Band	Freq(MHz)	Measured			Standard		Δ		Limit
			e' (εr)	e''	σ	e' (εr)	σ	e' (εr)	σ	±5
2013/10/28	Body 2450	2412	53.60	14.31	1.92	52.75	1.91	1.60%	0.17%	±5
		2437	53.52	14.41	1.95	52.72	1.94	1.52%	0.71%	±5
		2442	53.51	14.43	1.96	52.71	1.94	1.51%	0.77%	±5
		2462	53.45	14.51	1.99	52.68	1.97	1.46%	0.92%	±5
		2472	53.42	14.55	2.00	52.67	1.98	1.42%	0.89%	±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-field probe EX3DV4 SN:3665 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	05/02/2012	2450	1g	53.5	51.1
				10g	25.0	23.9
D5GHzV2	1004	11/16/2012	5200	1g	77.8	71.8
				10g	22.1	20.1
D5GHzV2	1004	11/16/2012	5300	1g	83.9	75.4
				10g	24.0	21.2
D5GHzV2	1004	11/16/2012	5600	1g	83.3	78.8
				10g	23.6	21.8
D5GHzV2	1004	11/16/2012	5800	1g	79.8	73.5
				10g	22.7	20.4

9.1 System Performance Check Results

Date	System Dipole			Parameters	Target	Measured	Deviation[%]	Limited[%]
	Type	Serial No.	Liquid					
2013/9/12	D5GHzV2 (5.2GHz)	1004	Body	1g SAR:	71.80	72.80	1.39	± 5
				10g SAR:	20.10	20.70	2.99	± 5
2013/9/13	D5GHzV2 (5.3GHz)	1004	Body	1g SAR:	75.40	77.40	2.65	± 5
				10g SAR:	21.20	21.90	3.30	± 5
2013/9/13	D5GHzV2 (5.6GHz)	1004	Body	1g SAR:	78.80	81.60	3.55	± 5
				10g SAR:	21.80	22.70	4.13	± 5
2013/9/15	D5GHzV2 (5.6GHz)	1004	Body	1g SAR:	78.80	78.30	-0.63	± 5
				10g SAR:	21.80	21.80	0.00	± 5
2013/9/15	D5GHzV2 (5.8GHz)	1004	Body	1g SAR:	73.50	73.80	0.41	± 5
				10g SAR:	20.40	20.90	2.45	± 5
2013/9/16	D5GHzV2 (5.8GHz)	1004	Body	1g SAR:	73.50	70.90	-3.54	± 5
				10g SAR:	20.40	20.50	0.49	± 5
2013/10/8	D2450V2	728	Body	1g SAR:	51.30	51.20	-0.19	± 5
				10g SAR:	24.00	24.30	1.25	± 5
2013/10/28	D5GHzV2 (5.2GHz)	1004	Body	1g SAR:	71.80	74.40	3.62	± 5
				10g SAR:	20.10	21.10	4.98	± 5
2013/10/28	D5GHzV2 (5.3GHz)	1004	Body	1g SAR:	75.40	77.20	2.39	± 5
				10g SAR:	21.20	21.90	3.30	± 5
2013/10/28	D5GHzV2 (5.6GHz)	1004	Body	1g SAR:	78.80	80.80	2.54	± 5
				10g SAR:	21.80	22.50	3.21	± 5
2013/10/28	D5GHzV2 (5.8GHz)	1004	Body	1g SAR:	73.50	70.40	-4.22	± 5
				10g SAR:	20.40	20.30	-0.49	± 5
2013/10/28	D2450V2	728	Body	1g SAR:	51.30	52.40	2.14	± 5
				10g SAR:	24.00	24.90	3.75	± 5

10 Summary of Test Configurations

10.1 Body Test Exclusion Thresholds

Main Ant.

The following SAR test exclusion Thresholds based on KDB 447498 D01 General RF Exposure Guidance v05) 4.3.1)

Band	Test Configurations	Antenna-to-edge/surface	Power Target (dBm)	Power Tolerance (dBm)	Calculate Power (mW)	Test Exclusion Power Threshold(mW)	SAR Required
WiFi 2.4GHz	Rear	3.4 mm	12	1	19.9	7	Yes
WiFi 5GHz	Rear	3.4 mm	9	1.5	11.2	5	Yes

Aux. Ant

The following SAR test exclusion Thresholds based on KDB 447498 D01 General RF Exposure Guidance v05) 4.3.1)

Band	Test Configurations	Antenna-to-edge/surface	Power Target (dBm)	Power Tolerance (dBm)	Calculate Power (mW)	Test Exclusion Power Threshold(mW)	SAR Required
WiFi 2.4GHz	Edge 1	2.5 mm	12	1	19.9	5	Yes
WiFi 5GHz	Edge 1	2.5 mm	9	1.5	11.2	3	Yes

10.2 Body Exposure Conditions for Wi-Fi for Main Antenna

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Front	4.4mm	No	SAR is not Required
Rear	3.4mm	Yes	This is most conservative antenna-to-user distance at edge mode
Edge 1	201.3mm	No	This is not the most conservative antenna-to-user distance at edge mode
Edge 2	3.6mm	Yes	This is most conservative antenna-to-user distance at edge mode
Edge 3	4mm	Yes	This is most conservative antenna-to-user distance at edge mode
Edge 4	110.5mm	No	This is not the most conservative antenna-to-user distance at edge mode

10.3 Body Exposure Conditions for Wi-Fi for Aux Antenna

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Front	2.05mm	No	SAR is not Required
Rear	5.75mm	Yes	This is most conservative antenna-to-user distance at edge mode
Edge 1	2.5mm	Yes	This is most conservative antenna-to-user distance at edge mode
Edge 2	75.6mm	No	This is not the most conservative antenna-to-user distance at edge mode
Edge 3	201.1mm	No	This is not the most conservative antenna-to-user distance at edge mode
Edge 4	34mm	No	This is not the most conservative antenna-to-user distance at edge mode

11 Device Under Test

11.1 Simultaneous Transmission

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

Note(s):

1. WiFi and BT can't simultaneous transmit.

12 RF Output Power Measurement

12.1 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)	Target Pwr (dBm)			Tune-up Tolerance (dBm)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
					Main	Aux	Total			Main	Aux	Total
2.4	802.11b	1	1	2412	12.0			±1.0	13.0	12.9		
			6	2437	12.0			±1.0	13.0	12.4		
			11	2462	12.0			±1.0	13.0	12.6		
	802.11b	1	1	2412		12.0		±1.0	13.0		12.4	
			6	2437		12.0		±1.0	13.0		12.6	
			11	2462		12.0		±1.0	13.0		12.8	
	802.11g	6	1	2412	12.0			±1.0	13.0	12.9		
			6	2437	12.0			±1.0	13.0	12.3		
			11	2462	12.0			±1.0	13.0	12.5		
	802.11g	6	1	2412		12.0		±1.0	13.0		12.2	
			6	2437		12.0		±1.0	13.0		12.5	
			11	2462		12.0		±1.0	13.0		12.7	
	802.11n HT20	MCS8	1	2412	10.0	10.0	13.0	±1.0	14.0	10.0	10.1	13.1
			6	2437	10.0	10.0	13.0	±1.0	14.0	10.1	10.3	13.2
			11	2462	10.0	10.0	13.0	±1.0	14.0	10.4	10.9	13.6
	802.11n HT40	MCS8	3	2422	8.0	8.0	11.0	±1.0	12.0	8.4	9.2	11.8
			6	2437	8.0	8.0	11.0	±1.0	12.0	8.7	9.1	11.9
			9	2452	8.0	8.0	11.0	±1.0	12.0	8.7	9.1	11.9

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

12.2 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.

Wi-Fi 5.2GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Target Pwr (dBm)			Tune-up Tolerance (dBm)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
					Main	Aux	Total			Main	Aux	Total
5.2	802.11a	6	36	5180	10.0			± 1.5	11.5	11.3		
			40	5200	10.0			± 1.5	11.5	11.4		
			44	5220	10.0			± 1.5	11.5	11.3		
			48	5240	10.0			± 1.5	11.5	11.2		
	802.11a	6	36	5180		10.0		± 1.5	11.5		11.5	
			40	5200		10.0		± 1.5	11.5		11.4	
			44	5220		10.0		± 1.5	11.5		11.4	
			48	5240		10.0		± 1.5	11.5		11.2	
	802.11n (HT20)	MCS8	36	5180	6.0	6.0	9.0	± 1.5	10.5	6.2	8.2	10.3
			40	5200	6.0	6.0	9.0	± 1.5	10.5	6.4	8.3	10.5
			44	5220	6.0	6.0	9.0	± 1.5	10.5	6.3	8.1	10.3
			48	5240	6.0	6.0	9.0	± 1.5	10.5	6.1	8.0	10.2
	802.11n (HT40)	MCS8	38	5190	6.0	6.0	9.0	± 1.5	10.5	6.4	8.4	10.5
			46	5230	6.0	6.0	9.0	± 1.5	10.5	6.2	8.3	10.4

Note(s):

SAR is not required for 802.11 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.

Wi-Fi 5.3GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Target Pwr (dBm)			Tune-up Tolerance (dBm)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
					Main	Aux	Total			Main	Aux	Total
5.3	802.11a	6	52	5260	10.0			± 1.5	11.5	11.5		
			56	5280	10.0			± 1.5	11.5	11.4		
			60	5300	10.0			± 1.5	11.5	11.4		
			64	5320	10.0			± 1.5	11.5	11.5		
	802.11a	6	52	5260		10.0		± 1.5	11.5		11.3	
			56	5280		10.0		± 1.5	11.5		11.3	
			60	5300		10.0		± 1.5	11.5		11.3	
			64	5320		10.0		± 1.5	11.5		11.2	
	802.11n (HT20)	MCS8	52	5260	6.0	6.0	9.0	± 1.5	10.5	6.5	8.2	10.4
			56	5280	6.0	6.0	9.0	± 1.5	10.5	6.5	8.3	10.5
			60	5300	6.0	6.0	9.0	± 1.5	10.5	6.4	8.2	10.4
			64	5320	6.0	6.0	9.0	± 1.5	10.5	6.5	8.1	10.4
	802.11n (HT40)	MCS8	54	5270	6.0	6.0	9.0	± 1.5	10.5	6.5	8.2	10.4
			62	5310	6.0	6.0	9.0	± 1.5	10.5	6.4	8.0	10.3

Note(s):

SAR is not required for 802.11 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.

Wi-Fi 5.5GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Target Pwr (dBm)			Tune-up Tolerance (dBm)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
					Main	Aux	Total			Main	Aux	Total
5.5	802.11a	6	100	5500	10.0			± 1.5	11.5	10.7		
			104	5520	10.0			± 1.5	11.5	10.6		
			108	5540	10.0			± 1.5	11.5	10.6		
			112	5560	10.0			± 1.5	11.5	11.4		
			116	5580	10.0			± 1.5	11.5	11.3		
			120	5600	10.0			± 1.5	11.5	11.5		
			124	5620	10.0			± 1.5	11.5	11.4		
			128	5640	10.0			± 1.5	11.5	11.3		
			132	5660	10.0			± 1.5	11.5	11.4		
			136	5680	10.0			± 1.5	11.5	11.5		
			140	5700	10.0			± 1.5	11.5	11.4		
	802.11a	6	100	5500		10.0		± 1.5	11.5		11.3	
			104	5520		10.0		± 1.5	11.5		11.3	
			108	5540		10.0		± 1.5	11.5		11.2	
			112	5560		10.0		± 1.5	11.5		11.2	
			116	5580		10.0		± 1.5	11.5		11.1	
			120	5600		10.0		± 1.5	11.5		11.1	
			124	5620		10.0		± 1.5	11.5		11.2	
			128	5640		10.0		± 1.5	11.5		11.1	
			132	5660		10.0		± 1.5	11.5		11.3	
			136	5680		10.0		± 1.5	11.5		11.1	
			140	5700		10.0		± 1.5	11.5		11.1	
	802.11n (HT20)	MCS8	100	5500	6.0	6.0	9.0	± 1.5	10.5	5.5	8.0	9.9
			104	5520	6.0	6.0	9.0	± 1.5	10.5	5.4	8.1	9.9
			108	5540	6.0	6.0	9.0	± 1.5	10.5	5.1	7.8	9.6
			112	5560	6.0	6.0	9.0	± 1.5	10.5	4.8	8.0	9.7
			116	5580	6.0	6.0	9.0	± 1.5	10.5	4.7	7.6	9.4
			120	5600	6.0	6.0	9.0	± 1.5	10.5	5.0	7.5	9.4
			124	5620	6.0	6.0	9.0	± 1.5	10.5	5.0	7.3	9.3
			128	5640	6.0	6.0	9.0	± 1.5	10.5	5.0	7.4	9.4
			132	5660	6.0	6.0	9.0	± 1.5	10.5	5.0	7.5	9.4
			136	5680	6.0	6.0	9.0	± 1.5	10.5	5.1	7.4	9.4
			140	5700	6.0	6.0	9.0	± 1.5	10.5	5.7	7.3	9.6
	802.11n (HT40)	MCS8	102	5510	6.0	6.0	9.0	± 1.5	10.5	6.3	8.3	10.4
			118	5550	6.0	6.0	9.0	± 1.5	10.5	6.8	7.9	10.4
			134	5670	6.0	6.0	9.0	± 1.5	10.5	6.6	7.8	10.3

Note(s):

SAR is not required for 802.11 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.

Wi-Fi 5.8GHz Band:

Band (GHz)	Mode	Data rate (Mbps)	Ch #	Freq. (MHz)	Target Pwr (dBm)			Tune-up Tolerance (dBm)	Maximum Tune-up Pwr (dBm)	Avg. Pwr (dBm)		
					Main	Aux	Total			Main	Aux	Total
5.8	802.11a	6	149	5745	10.0			± 1.5	11.5	11.5		
			153	5765	10.0			± 1.5	11.5	11.4		
			157	5785	10.0			± 1.5	11.5	11.4		
			161	5805	10.0			± 1.5	11.5	11.5		
			165	5825	10.0			± 1.5	11.5	11.5		
	802.11a	6	149	5745		10.0		± 1.5	11.5		11.4	
			153	5765		10.0		± 1.5	11.5		11.3	
			157	5785		10.0		± 1.5	11.5		11.3	
			161	5805		10.0		± 1.5	11.5		11.4	
			165	5825		10.0		± 1.5	11.5		11.4	
	802.11n (HT20)	MCS8	149	5745	6.0	6.0	9.0	± 1.5	10.5	6.4	8.2	10.4
			153	5765	6.0	6.0	9.0	± 1.5	10.5	6.4	8.1	10.4
			157	5785	6.0	6.0	9.0	± 1.5	10.5	6.4	8.0	10.3
			161	5805	6.0	6.0	9.0	± 1.5	10.5	6.5	8.1	10.4
			165	5825	6.0	6.0	9.0	± 1.5	10.5	6.4	8.3	10.5
	802.11n (HT40)	MCS8	151	5755	6.0	6.0	9.0	± 1.5	10.5	7.2	7.8	10.5
			159	5795	6.0	6.0	9.0	± 1.5	10.5	6.8	7.9	10.4

Note(s):

SAR is not required for 802.11 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.

12.3 Bluetooth

Target Power: 7.5 dBm

Tune-up Tolerance: 2 dBm

Output power table

Band	Mode	Ch #	Freq. (MHz)	Avg pwr (dBm)
Bluetooth	GFSK	0	2402	7.8
		39	2441	8.0
		78	2480	8.3

Target Power: 4.5 dBm

Tune-up Tolerance: 2 dBm

Output power table

Band	Mode	Ch #	Freq. (MHz)	Avg pwr (dBm)
Bluetooth	8DPSK	0	2402	5.2
		39	2441	5.0
		78	2480	4.8

Target Power: 7.5 dBm

Tune-up Tolerance: 2 dBm

Output power table

Band	Mode	Ch #	Freq. (MHz)	Avg pwr (dBm)
Bluetooth	BLE	0	2402	7.3
		19	2440	7.8
		39	2480	8.1

13 SAR Measurements Results

Wi-Fi (2.4GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Chain	Dist. (mm)	Power (dBm)		Measured 1g SAR (W/kg)	Reported SAR(W/kg)	Note
							Tune up limit	Measured			
2.4GHz	802.11b	Edge 3	1	2437	0	0	13.0	12.9	0.118	0.121	
		Edge 2	1	2437	0	0	13.0	12.9	0.464	0.475	
		Edge 1	11	2437	1	0	13.0	12.8	0.162	0.170	
		Rear	1	2412	0	0	13.0	12.9	0.823	0.842	
			6	2437	0	0	13.0	12.4	0.723	0.830	1
			11	2462	0	0	13.0	12.6	0.721	0.791	1
			11	2437	1	0	13.0	12.8	0.027	0.028	
			1	2412	0	0	13.0	12.9	0.819	0.838	2
	802.11n HT20	Edge 3	11	2462	0+1	0	14.0	13.6	0.077	0.084	
		Edge 1	11	2462	0+1	0	14.0	13.6	0.133	0.146	
		Rear	11	2462	0+1	0	14.0	13.6	0.559	0.613	

Note(s):

1. Testing of other required channels within the operating mode of a frequency band is 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)
2. 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)
   - 2.1 Original SAR = 0.823 W/kg, therefore two times repeat SAR is required.
   - 2.2 Repeat SAR = 0.819W/kg < 1.45W/kg
   - 2.3 SAR variation= 0.4% < 20%

Wi-Fi (5.2GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Chain	Dist. (mm)	Power (dBm)		Measured 1g SAR (W/kg)	Reported SAR(W/kg)	Note
							Tune up limit	Measured			
5.2GHz	802.11a	Edge 3	40	5200	0	0	11.5	11.4	0.530	0.542	
			44	5220	0	0	11.5	11.3	0.516	0.540	
		Edge 1	36	5180	1	0	11.5	11.5	0.386	0.386	
			44	5220	1	0	11.5	11.4	0.442	0.452	
		Rear	40	5200	0	0	11.5	11.4	0.900	0.921	
			44	5220	0	0	11.5	11.3	1.000	1.047	
			36	5180	1	0	11.5	11.5	0.038	0.038	
			44	5220	1	0	11.5	11.4	0.040	0.041	
			44	5220	0	0	11.5	11.3	0.862	0.903	1
		Edge 2	40	5200	0	0	11.5	11.4	0.323	0.331	
			44	5220	0	0	11.5	11.3	0.348	0.364	

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 = 1.00 W/kg, therefore two times repeat SAR is required.
   1.2 Repeat SAR = 0.862 W/kg < 1.45W/kg
   1.3 SAR variation= 16% < 20%

Wi-Fi (5.3GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Chain	Dist. (mm)	Power (dBm)		Measured 1g SAR (W/kg)	Reported SAR(W/kg)	Note
							Tune up limit	Measured			
5.3GHz	802.11a	Edge 3	52	5260	0	0	11.5	11.5	0.507	0.507	
			64	5320	0	0	11.5	11.5	0.577	0.577	
		Edge 1	52	5260	1	0	11.5	11.3	0.634	0.664	
			60	5300	1	0	11.5	11.3	0.493	0.516	
		Rear	52	5260	0	0	11.5	11.5	0.878	0.878	
			64	5320	0	0	11.5	11.5	0.834	0.834	
			52	5260	1	0	11.5	11.3	0.103	0.108	
			60	5300	1	0	11.5	11.3	0.114	0.119	
			52	5260	0	0	11.5	11.5	1.020	1.020	1
		Edge 2	52	5260	0	0	11.5	11.5	0.308	0.308	
			64	5320	0	0	11.5	11.5	0.243	0.243	

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 = 0.878W/kg, therefore two times repeat SAR is required.
   1.2 Repeat SAR = 1.02 W/kg < 1.45W/kg
   1.3 SAR variation= 13.9% < 20%

Wi-Fi (5.5GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Chain	Dist. (mm)	Power (dBm)		Measured 1g SAR (W/kg)	Reported SAR(W/kg)	Note
							Tune up limit	Measured			
5.5GHz	802.11a	Edge 3	100	5500	0	0	11.5	10.7	0.641	0.771	
			120	5600	0	0	11.5	11.5	0.543	0.543	
			124	5620	0	0	11.5	11.4	0.499	0.511	
			136	5680	0	0	11.5	11.5	0.435	0.435	
		Edge 1	100	5500	1	0	11.5	11.3	0.341	0.357	
			112	5560	1	0	11.5	11.2	0.377	0.404	
			124	5620	1	0	11.5	11.2	0.369	0.395	
			132	5660	1	0	11.5	11.3	0.500	0.524	
		Rear	100	5500	0	0	11.5	10.7	1.170	1.407	
			120	5600	0	0	11.5	11.5	1.050	1.050	
			124	5620	0	0	11.5	11.4	0.918	0.939	
			136	5680	0	0	11.5	11.5	0.741	0.741	
			100	5500	1	0	11.5	11.3	0.047	0.049	
			112	5560	1	0	11.5	11.2	0.076	0.081	
			124	5620	1	0	11.5	11.2	0.094	0.101	
			132	5660	1	0	11.5	11.3	0.065	0.068	
			100	5500	0	0	11.5	10.7	1.090	1.310	1
		Edge 2	100	5500	0	0	11.5	10.7	0.396	0.476	
			120	5600	0	0	11.5	11.5	0.277	0.277	
			124	5620	0	0	11.5	11.4	0.244	0.250	
			136	5680	0	0	11.5	11.5	0.297	0.297	

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 = 1.170W/kg, therefore two times repeat SAR is required.
   1.2 Repeat SAR = 1.09 W/kg < 1.45W/kg
   1.3 SAR variation= 7.3% < 20%

Wi-Fi (5.5GHz Band):

Band	Mode	Test Position	Channel	Freq. (MHz)	Chain	Dist. (mm)	Power (dBm)		Measured 1g SAR (W/kg)	Reported SAR(W/kg)	Note
							Tune up limit	Measured			
5.8GHz	802.11a	Edge 3	149	5745	0	0	11.5	11.5	0.398	0.398	
			161	5805	0	0	11.5	11.5	0.464	0.464	
			165	5825	0	0	11.5	11.5	0.641	0.641	
		Edge 1	149	5745	1	0	11.5	11.4	0.227	0.232	
			161	5805	1	0	11.5	11.4	0.167	0.171	
			165	5825	1	0	11.5	11.4	0.176	0.180	
		Rear	149	5745	0	0	11.5	11.5	0.607	0.607	
			161	5805	0	0	11.5	11.5	1.090	1.090	
			165	5825	0	0	11.5	11.5	0.927	0.927	
			149	5745	1	0	11.5	11.4	0.464	0.475	
			161	5805	1	0	11.5	11.4	0.488	0.499	
			165	5825	1	0	11.5	11.4	0.490	0.501	
			161	5805	0	0	11.5	11.5	1.060	1.060	1
		Edge 2	149	5745	0	0	11.5	11.5	0.211	0.211	
			161	5805	0	0	11.5	11.5	0.255	0.255	
			165	5825	0	0	11.5	11.5	0.265	0.265	

Note(s):

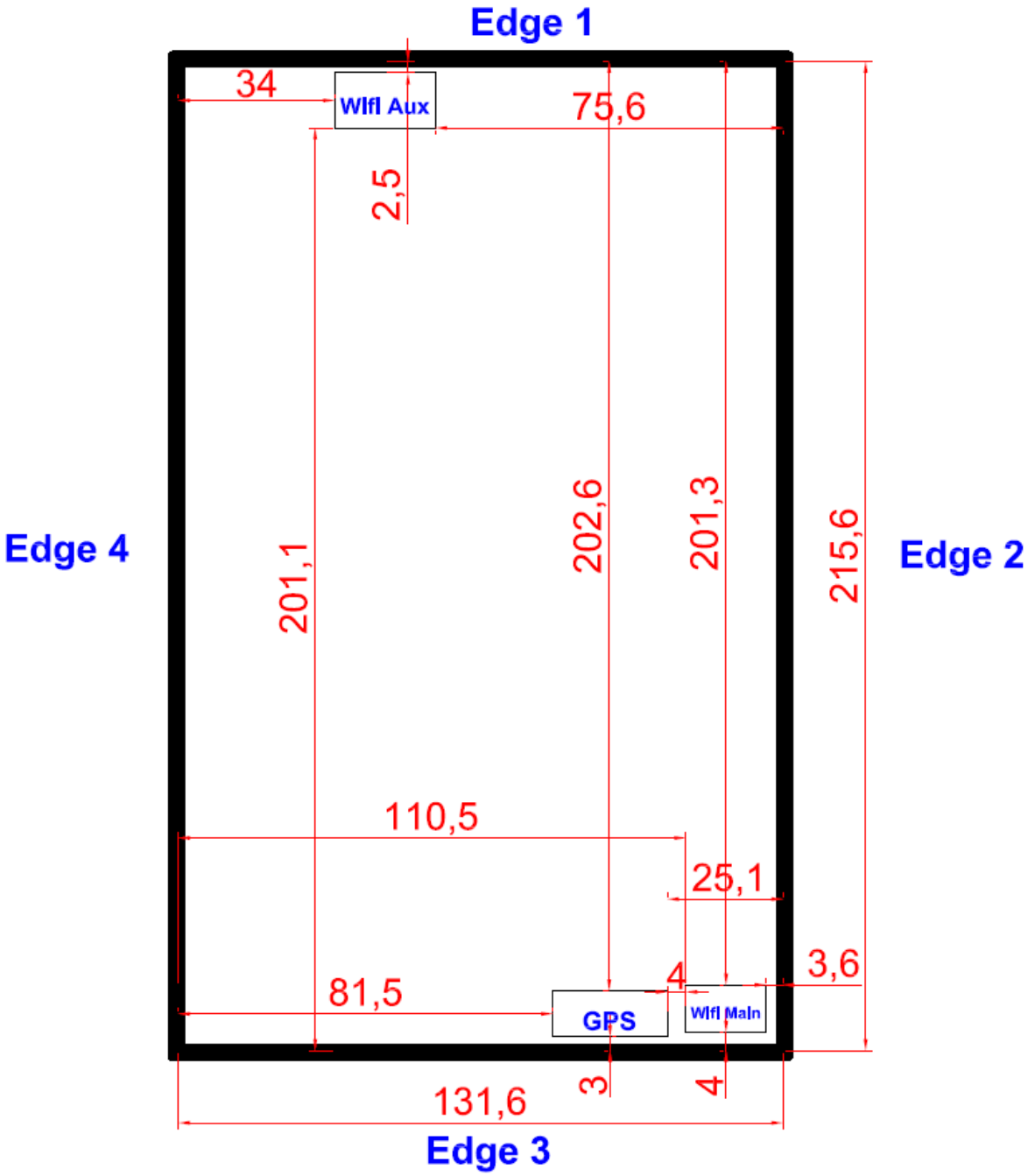
1. Repeated measurements are required only when the measured SAR is ≥0.80 W/kg. If the measured SAR values are < 1.45 W/kg with ≤20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. (Per KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01)
   1.1 Original SAR = 1.09W/kg, therefore two times repeat SAR is required.
   1.2 Repeat SAR = 1.06 W/kg < 1.45W/kg
   1.3 SAR variation= 2.8% < 20%

13.1 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	Rear	802.11b	0.842
WiFi 5.2 GHz	Rear	802.11a	1.047
WiFi 5.3 GHz	Rear	802.11a	1.02
WiFi 5.5 GHz	Rear	802.11a	1.407
WiFi 5.8 GHz	Rear	802.11a	1.090

14 Antenna Locations & Separation Distances



15 Equipment List & Calibration Status

Name of Equipment	Manufacturer	Type/Model	Serial Number	Calibration Cycle(year)	Calibration Due
S-Parameter Network Analyzer	Agilent	E8358A	US40260243	1	06/03/2014
Electronic Probe kit	Hewlett Packard	85070D	N/A	N/A	N/A
Power Meter	Agilent	E4416A	GB41291611	1	09/11/2014
Power Sensor	Agilent	8481H	MY41091956	1	09/11/2014
Spectrum Analyzer	Agilent	E4446A	US42510252	1	12/09/2013
Data Acquisition Electronics (DAE)	SPEAG	DAE4	877	1	03/11/2014
Dosimetric E-Field Probe	SPEAG	EX3DV4	3665	1	05/06/2014
2450 MHz System Validation Dipole	SPEAG	D2450V2	728	1	05/01/2014
5 GHz System Validation Dipole	SPEAG	D5GHzV2	1004	1	11/15/2013
Robot	Staubli	RX60L	F02/5T69A1/A/01	N/A	N/A
Amplifier	Mini-Circuit	ZVE-8G	665500309	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

16 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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18 Attachments

Exhibit	Content
1	System Performance Check Plots
2	SAR test plots for 2.4GHz Band
3	SAR test plots for 5.2GHz Band
4	SAR test plots for 5.3GHz Band
5	SAR test plots for 5.5GHz Band
6	SAR test plots for 5.8GHz Band
7	SAR_Probe_EX3DV4_sn3665
8	SAR_DAE4_sn877
9	SAR_Dipole_D2450v2_sn728
10	SAR_Dipole_D5GHzv2_sn1004
11	T130828W01-SF PHOTOs

END OF REPORT