



ANSI/IEEE Std. C95.1-1992

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



FCC TEST REPORT

For

802.11abgn WLAN + Bluetooth Card

Trade Name: Broadcom

Model: BCM94330LGA

Issued to

Broadcom Corporation
190 Mathilda Place, Sunnyvale,
CA 94086, United States

Issued by

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Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	2013/12/18	Initial Issue	ALL	Scott Hsu
01	2014/03/20	Revise Model Name	1,4,5	Scott Hsu



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1 Certificate of Compliance (SAR Evaluation)

Applicant Broadcom Corporation
 190 Mathilda Place, Sunnyvale, CA 94086, United States

Equipment Under Test: 802.11abgn WLAN + Bluetooth Card

Trade Name: Broadcom

Model Number: BCM94330LGA

Date of Test: October 02 ~ October 09, 2013

Device Category: PORTABLE DEVICES

Exposure Category: GENERAL POPULATION/UNCONTROLLED EXPOSURE

Applicable Standards	
FCC	<ul style="list-style-type: none"> ● IEEE 1528 2003 ● KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r01 ● 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 DESCRIPTION OF EQUIPMENT UNDER TEST

Product		802.11abgn WLAN + Bluetooth Card		
Trade Name		Broadcom		
Model Number		BCM94330LGA		
Transmitters		Wi-Fi		
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:	INPAQ TECHNOLOGY CO., LTD
			Parts Number:	Main:WA-P-LA-01-042
			Type:	PIFA
			Brand Name:	INPAQ TECHNOLOGY CO., LTD
			Parts Number:	Aux:WA-P-LC-02-009
		Type:	Dipole	
FCC Rule Parts	Band	Frequency Range	Highest Reported 1-g SAR	
15.247	2.4GHz	2412 - 2462 MHz	0.584 W/kg (Rear)	
	5.8GHz	5725 - 5850 MHz	1.347 W/kg (Rear)	
15.407	5.2GHz	5150 - 5250 MHz	0.961 W/kg (Rear)	
	5.3GHz	5250 - 5350 MHz	0.804 W/kg (Rear)	
	5.5GHz	5500 - 5700 MHz	1.328 W/kg (Rear)	
Rechargeable Li-polymer Battery–alternate		Sample 1	Brand:	Simplo
			Model:	TMX-S28W38V25A
			Rating:	3.8V 7500mAh
		Sample 2	Brand:	Simplo
			Model:	TMX-S23W38V25A
			Rating:	3.8V 6200mAh
Note: Battery sample 1 was performed the SAR testing.Sample 2 was performed the spot check of SAR only.				

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

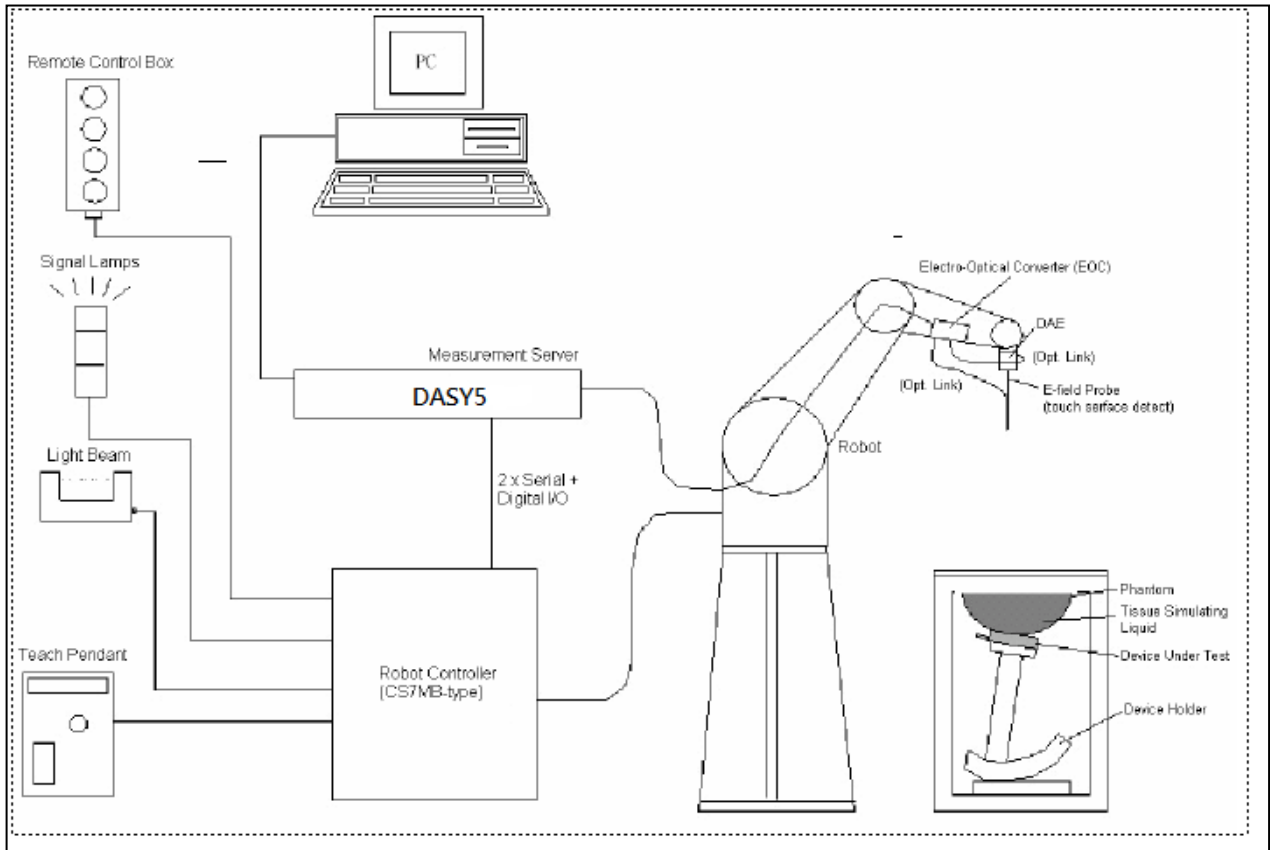
The US Federal Communications Commission has released the report and order "Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996 [1]. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including 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 and probe EX3DV4-SN: 3898 (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 $\pm 10\%$. 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 (Stäubli 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 200M Ω ; 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 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB
(noise: typically < 1 μ W/g)



REV. 01



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

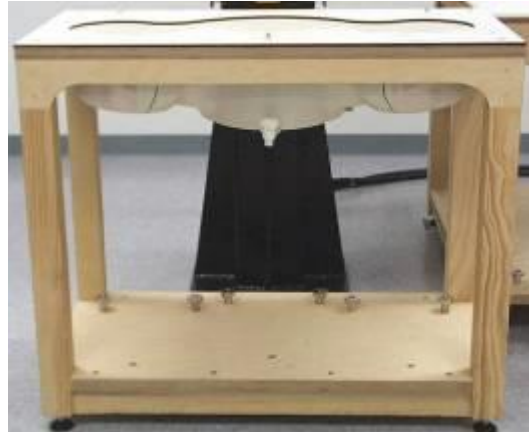
SAM Phantom (V4.0)

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 I/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 ($f < 1\text{GHz}$); > 40 W ($f > 1\text{GHz}$)

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 I/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 ($f < 1\text{GHz}$); > 40 W ($f > 1\text{GHz}$)

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 DASYS4/DASYS5 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 DASYS 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:
$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

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

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)
E_i	= Electric field strength of channel i in V/m
H_i	= Magnetic field strength of channel i in A/m



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

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

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/cm³

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/cm²
 - E_{tot} = total electric field strength in V/m
 - H_{tot} = total magnetic field strength in A/m



6 SAR Measurement Procedures

6.1 Normal SAR Test Procedure

- **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 v01r01

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx _{Zoom} , Δy _{Zoom}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	



• **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 ≤ 2 GHz. (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 than one maximum, the number of Zoom Scans has to be enlarged accordingly.

According to KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r01

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: $\Delta x_{Zoom}, \Delta y_{Zoom}$			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm	3 – 4 GHz: ≤ 5 mm 4 – 6 GHz: ≤ 4 mm
Maximum zoom scan spatial resolution, normal to phantom surface	Uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1 st two points losest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Maximum zoom scan volume	x, y, z	≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm	

• **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.



7 Device Under Test

7.1 Band Interface

Tx Frequency Bands	<ul style="list-style-type: none">802.11a/b/g/n: 2412 - 2462 MHz 5180 - 5240 MHz 5745 - 5825 MHz
Mode	<ul style="list-style-type: none">802.11a/b/g/n HT20/HT40



8 Summary of Test Configurations

Antenna	Wireless Interface
Main Ant.	WLAN 2.4GHz
Aux Ant.	WLAN 5GHz

8.1 SAR Exclusion Calculations

Wi-Fi Antenna < 50mm from the User

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)						Calculated Threshold Value					
			dBm	mW	Rear	Edge1	Edge2	Edge3	Edge4	Front	Rear	Edge1	Edge2	Edge3	Edge4	Front
Wi-Fi Main	2.4GHz	2437	16.5	45	7.6	3	97	164	139		9.2	23.4	>50mm	>50mm	>50mm	N/A
Wi-Fi Aux	5.2GHz	5180	13	20	4.85	36.5	6	114.5	252		9.4	1.2	7.6	>50mm	>50mm	N/A
Wi-Fi Aux	5.3GHz	5260	13	20	4.85	36.5	6	114.5	252		9.5	1.3	7.6	>50mm	>50mm	N/A
Wi-Fi Aux	5.5GHz	5500	13	20	4.85	36.5	6	114.5	252		9.7	1.3	7.8	>50mm	>50mm	N/A
Wi-Fi Aux	5.8GHz	5745	13	20	4.85	36.5	6	114.5	252		9.9	1.3	8.0	>50mm	>50mm	N/A

Note(s):

1. According to KDB 447498 v05 r01 in section 4.3.1, if the calculated threshold value is > 3 then SAR testing required.

Wi-Fi Antenna > 50mm from the User

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)						Calculated Threshold Value					
			dBm	mW	Rear	Edge1	Edge2	Edge3	Edge4	Front	Rear	Edge1	Edge2	Edge3	Edge4	Front
Wi-Fi Main	2.4GHz	2437	16.5	45	7.6	3	97	164	139		<50mm	<50mm	471.4	1141.4	891.4	N/A
Wi-Fi Aux	5.2GHz	5180	13	20	4.85	36.5	6	114.5	252		<50mm	<50mm	<50mm	646.2	2021.2	N/A
Wi-Fi Aux	5.3GHz	5260	13	20	4.85	36.5	6	114.5	252		<50mm	<50mm	<50mm	646.2	2021.2	N/A
Wi-Fi Aux	5.5GHz	5500	13	20	4.85	36.5	6	114.5	252		<50mm	<50mm	<50mm	646.2	2021.2	N/A
Wi-Fi Aux	5.8GHz	5745	13	20	4.85	36.5	6	114.5	252		<50mm	<50mm	<50mm	646.2	2021.2	N/A

Note(s):

1. According to KDB 447498 v05 r01, if the calculated Power threshold is less than the output power of DUT, the SAR testing is required.



8.2 Required Test Configuration

Separation Distance (mm)	Wi-Fi Antenna (Main)	Wi-Fi Antenna (Aux)
Top-Edge (Edge1)	3	36.5
Right-Edge (Edge2)	97	6
Bottom-Edge (Edge3)	164	114.5
Left-Edge (Edge4)	139	252
Rear Surface	7.6	4.85

Test Configurations	Rear	Edge1	Edge2	Edge3	Edge4
WiFi Main 2.4GHz	Yes	Yes	No	No	No
WiFi Aux 5GHz	Yes	No	Yes	No	No

Note(s):

1. Yes = SAR is required.
No = SAR is not required.



9 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 V_{eff}
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	-1.52	Normal	1	0.64	-0.97	39
Liquid Permittivity - deviation from target values	3.92	Rectangular	$\sqrt{3}$	0.6	1.36	∞
Liquid Permittivity - measurement uncertainty	2.82	Normal	1	0.6	1.69	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			11.27	611
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =		$k=2$				22.53%
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 V_{eff}
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	-3.60	Normal	1	0.64	-2.30	39
Liquid Permittivity - deviation from target values	5.00	Rectangular	$\sqrt{3}$	0.6	1.73	∞
Liquid Permittivity - measurement uncertainty	-2.52	Normal	1	0.6	-1.51	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			12.63	611
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =		$k=2$				25.25%
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =		$k=2$				1.96dB



10 Exposure Limit

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

<u>Whole-Body</u>	<u>Partial-Body</u>	<u>Hands, Wrists, Feet and Ankles</u>
0.4	8.0	2.0

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

<u>Whole-Body</u>	<u>Partial-Body</u>	<u>Hands, Wrists, Feet and Ankles</u>
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



11 Tissue Dielectric Properties

11.1 Test Liquid Confirmation

Simulating Liquids Parameter Check

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

The relative permittivity and conductivity of the tissue material should be within $\pm 5\%$ of the values given in the table below. $\pm 5\%$ 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



11.2 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



11.3 Simulating Liquids Parameter Check Results

Date	Band	Freq(MHz)	Measured			Standard		Δ		Limit
			e' (εr)	e''	σ	e' (εr)	σ	e' (εr)	σ	±5
2013/10/2	Body 2450	2412	54.24	14.06	1.88	52.75	1.91	2.82%	-1.52%	±5
		2437	54.15	14.18	1.92	52.72	1.94	2.72%	-0.93%	±5
		2442	54.14	14.20	1.93	52.71	1.94	2.71%	-0.85%	±5
		2462	54.09	14.29	1.95	52.68	1.97	2.67%	-0.62%	±5
		2472	54.07	14.34	1.97	52.67	1.98	2.66%	-0.62%	±5
2013/10/4	Body 5000	5180	49.46	17.96	5.17	49.07	5.25	0.79%	-1.62%	±5
		5200	49.42	17.95	5.19	49.04	5.28	0.78%	-1.71%	±5
		5300	49.32	18.00	5.30	48.88	5.41	0.90%	-2.05%	±5
		5500	49.08	18.18	5.55	48.64	5.62	0.91%	-1.25%	±5
		5600	48.96	18.25	5.68	48.47	5.76	1.00%	-1.43%	±5
		5700	48.84	18.36	5.81	48.33	5.88	1.06%	-1.13%	±5
		5800	48.71	18.46	5.95	48.23	5.97	0.98%	-0.41%	±5
		5825	48.19	17.87	5.78	48.20	6.00	-0.02%	-3.60%	±5
2013/10/7	Body 5000	5180	49.43	17.97	5.17	49.07	5.25	0.73%	-1.59%	±5
		5200	49.41	18.01	5.20	49.04	5.28	0.76%	-1.37%	±5
		5300	49.27	18.02	5.30	48.88	5.41	0.80%	-1.95%	±5
		5500	49.13	18.25	5.58	48.64	5.62	1.02%	-0.83%	±5
		5600	48.99	18.41	5.73	48.47	5.76	1.07%	-0.58%	±5
		5700	48.80	18.52	5.86	48.33	5.88	0.98%	-0.27%	±5
		5800	48.62	18.58	5.99	48.23	5.97	0.79%	0.26%	±5
		5825	48.16	18.04	5.84	48.20	6.00	-0.08%	-2.68%	±5
2013/10/8	Body 5000	5180	48.24	17.97	5.17	49.07	5.25	-1.70%	-1.58%	±5
		5200	48.17	17.99	5.20	49.04	5.28	-1.77%	-1.53%	±5
		5300	48.05	18.04	5.31	48.88	5.41	-1.69%	-1.84%	±5
		5500	47.91	18.29	5.59	48.64	5.62	-1.50%	-0.61%	±5
		5600	47.69	18.43	5.73	48.47	5.76	-1.62%	-0.48%	±5
		5700	47.55	18.55	5.87	48.33	5.88	-1.61%	-0.10%	±5
		5800	47.42	18.67	6.02	48.23	5.97	-1.68%	0.74%	±5
		5825	46.98	18.09	5.86	48.20	6.00	-2.52%	-2.41%	±5



12 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: 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	05/02/2013	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



12.1 System Performance Check Results

Date	System Dipole			Parameters	Target	Measured	Deviation[%]	Limited[%]
	Type	Serial No.	Liquid					
10/2/2013	D2450V2	728	Body	1g SAR:	51.10	50.70	-0.78	± 5
				10g SAR:	23.90	24.00	0.42	± 5
10/4/2013	D5GHzV2 (5.2GHz)	1004	Body	1g SAR:	71.80	70.20	-2.23	± 5
				10g SAR:	20.10	19.90	-1.00	± 5
10/4/2013	D5GHzV2 (5.3GHz)	1004	Body	1g SAR:	75.40	73.60	-2.39	± 5
				10g SAR:	21.20	20.90	-1.42	± 5
10/7/2013	D5GHzV2 (5.6GHz)	1004	Body	1g SAR:	78.80	77.70	-1.40	± 5
				10g SAR:	21.80	22.20	1.83	± 5
10/8/2013	D5GHzV2 (5.8GHz)	1004	Body	1g SAR:	73.50	72.80	-0.95	± 5
				10g SAR:	20.40	20.40	0.00	± 5



13 RF Output Power Measurement

13.1 Wi-Fi (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	15.5			+1/-2	16.5	15.4		
			6	2437	15.5			+1/-2	16.5	15.7		
			11	2462	15.5			+1/-2	16.5	15.5		
	802.11g	6	1	2412	14.5			+1/-2	15.5	14.5		
			6	2437	14.5			+1/-2	15.5	14.6		
			11	2462	14.5			+1/-2	15.5	14.7		
	802.11n HT20	MCS8	1	2412	13.5			+1/-2	14.5	13.5		
			6	2437	13.5			+1/-2	14.5	13.5		
			11	2462	13.5			+1/-2	14.5	13.4		

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



13.2 Wi-Fi (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		13.0		+1/-2	14.0		13.1	
			40	5200		13.0		+1/-2	14.0		13.0	
			44	5220		13.0		+1/-2	14.0		13.1	
			48	5240		13.0		+1/-2	14.0		13.0	
	802.11n (HT20)	MCS8	36	5180		12.0		+1/-2	13.0		12.0	
			40	5200		12.0		+1/-2	13.0		12.0	
			44	5220		12.0		+1/-2	13.0		12.1	
			48	5240		12.0		+1/-2	13.0		12.0	

Note(s):

SAR is not required for 802.11n HT20 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 5.2GHz 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
5.3	802.11a	6	52	5260		13.0		+1/-2	14.5		13.0	
			56	5280		13.0		+1/-2	14.5		12.8	
			60	5300		13.0		+1/-2	14.5		12.8	
			64	5320		13.0		+1/-2	14.5		12.9	
	802.11n (HT20)	MCS8	52	5260		12.0		+1/-2	13.5		12.1	
			56	5280		12.0		+1/-2	13.5		12.0	
			60	5300		12.0		+1/-2	13.5		12.0	
			64	5320		12.0		+1/-2	13.5		12.0	

Note(s):

SAR is not required for 802.11n HT20 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
5.5	802.11a	6	100	5500		13.0		+1/-2	14.5		13.1	
			104	5520		13.0		+1/-2	14.5		13.2	
			108	5540		13.0		+1/-2	14.5		13.2	
			112	5560		13.0		+1/-2	14.5		13.3	
			116	5580		13.0		+1/-2	14.5		12.9	
			132	5660		13.0		+1/-2	14.5		13.2	
			136	5680		13.0		+1/-2	14.5		13.3	
	140	5700		13.0		+1/-2	14.5		13.3			
	802.11n (HT20)	MCS8	100	5500		12.0		+1/-2	13.5		12.0	
			104	5520		12.0		+1/-2	13.5		12.1	
			108	5540		12.0		+1/-2	13.5		12.1	
			112	5560		12.0		+1/-2	13.5		12.1	
			116	5580		12.0		+1/-2	13.5		12.1	
			132	5660		12.0		+1/-2	13.5		12.2	
136			5680		12.0		+1/-2	13.5		12.1		
140	5700		12.0		+1/-2	13.5		11.9				

Note(s):

SAR is not required for 802.11n HT20 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		13.0		+1/-2	14.5		12.9	
			153	5765		13.0		+1/-2	14.5		12.9	
			157	5785		13.0		+1/-2	14.5		13.1	
			161	5805		13.0		+1/-2	14.5		13.3	
			165	5825		13.0		+1/-2	14.5		13.2	
	802.11n (HT20)	MCS8	149	5745		12.0		+1/-2	13.5		12.2	
			153	5765		12.0		+1/-2	13.5		12.2	
			157	5785		12.0		+1/-2	13.5		12.0	
			161	5805		12.0		+1/-2	13.5		12.3	
			165	5825		12.0		+1/-2	13.5		12.3	

Note(s):

SAR is not required for 802.11n HT20 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



14 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	Rear	6	2437	0	0	16.5	15.7	0.485	0.584	
			6	2437	0	0	16.5	15.7	0.371	0.447	1
		Edge 1	6	2437	0	0	16.5	15.7	0.336	0.405	

Note(s):

1. Sample 2 was performed the spot check of SAR only.



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	Rear	36	5180	1	0	14.0	13.1	0.770	0.947	
			44	5220	1	0	14.0	13.1	0.781	0.961	
			44	5220	1	0	14.0	13.1	0.714	0.878	1
		Edge2	36	5180	1	0	14.0	13.1	0.314	0.386	
			44	5220	1	0	14.0	13.1	0.392	0.482	

Note(s):

- Sample 2 was performed the spot check of SAR only.

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	Rear	52	5260	1	0	14.0	13.0	0.639	0.804	
			52	5260	1	0	14.0	13.0	0.585	0.736	1
			64	5320	1	0	14.0	12.9	0.574	0.739	
		Edge2	52	5260	1	0	14.0	13.0	0.319	0.402	
			64	5320	1	0	14.0	12.9	0.389	0.501	

Note(s):

- Sample 2 was performed the spot check of SAR only.

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	Rear	104	5520	1	0	14.0	13.2	0.698	0.839	
			112	5560	1	0	14.0	13.3	0.813	0.955	
			140	5700	1	0	14.0	13.3	1.110	1.304	
			140	5700	1	0	14.0	13.3	1.130	1.328	1
			140	5700	1	0	14.0	13.3	1.010	1.187	2
		Edge2	104	5520	1	0	14.0	13.2	0.564	0.678	
			112	5560	1	0	14.0	13.3	0.659	0.774	

Note(s):

- 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 $\leq 20\%$ 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)
 - Original SAR = 1.110W/kg, therefore two times repeat SAR is required.
 - Reported SAR = 1.130 W/kg < 1.45 W/Kg
 - SAR variation = 1.7 % $< 20\%$
- Sample 2 was performed the spot check of SAR only.



Wi-Fi (5.8GHz 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	Rear	153	5765	1	0	14.0	12.9	0.954	1.229	
			161	5805	1	0	14.0	13.3	0.958	1.126	
			165	5825	1	0	14.0	13.2	1.120	1.347	
			165	5825	1	0	14.0	13.2	0.983	1.182	1
		165	5825	1	0	14.0	13.2	0.982	1.181	2	
		Edge2	153	5765	1	0	14.0	12.9	0.877	1.130	
			161	5805	1	0	14.0	13.3	1.030	1.210	
			165	5825	1	0	14.0	13.2	1.100	1.322	

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 $\leq 20\%$ 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 = 1.120W/kg, therefore two times repeat SAR is required.
 - 1.2 Reported SAR = 0.983 W/kg < 1.45 W/Kg
 - 1.3 SAR variation = 13.9 % $< 20\%$
- 2 Sample 2 was performed the spot check of SAR only.



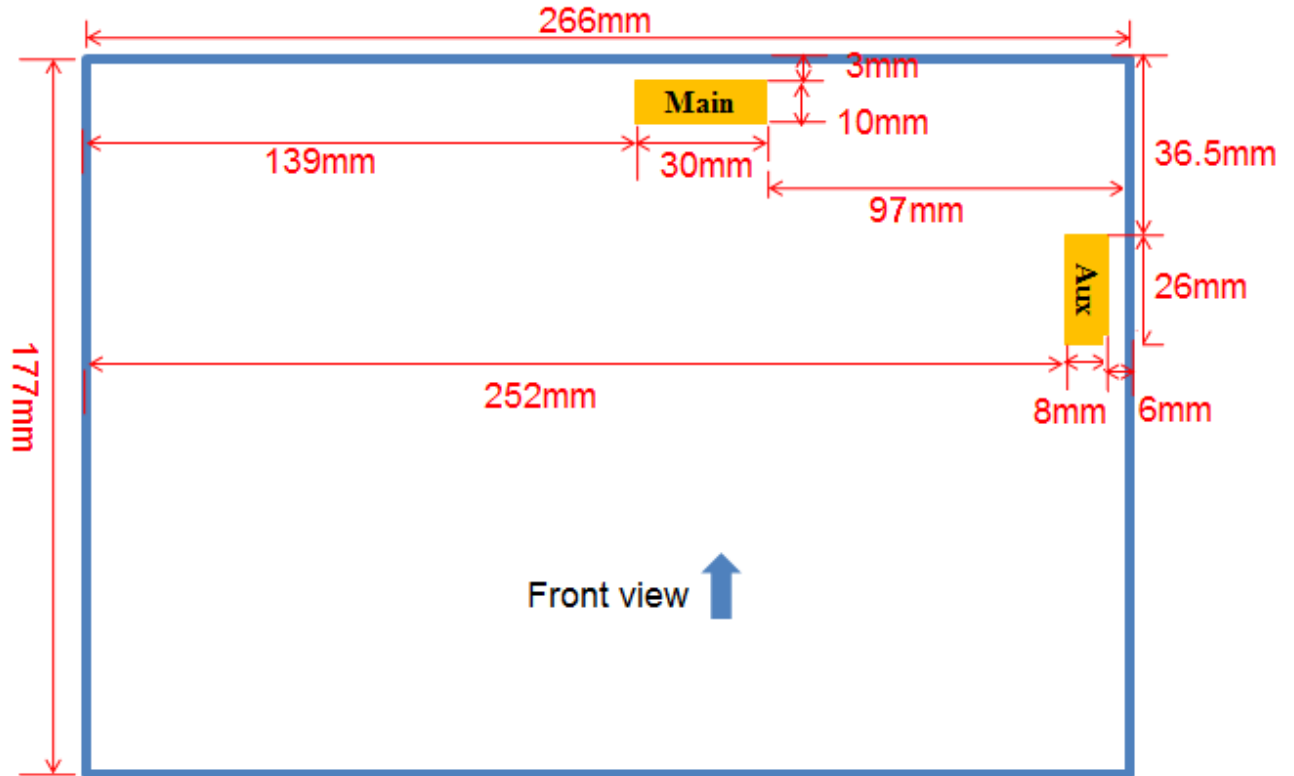
14.1 Summary of Highest SAR Values

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	0.584
WiFi 5.2 GHz	Rear	802.11a	0.961
WiFi 5.3 GHz	Rear	802.11a	0.804
WiFi 5.2 GHz	Rear	802.11a	1.328
WiFi 5.8 GHz	Rear	802.11a	1.347



15 Antenna Locations & Separation Distances





16 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
Data Acquisition Electronics (DAE)	SPEAG	DAE4	558	1	07/24/2014
Dosimetric E-Field Probe	SPEAG	EX3DV4	3898	1	01/13/2014
Dosimetric E-Field Probe	SPEAG	EX3DV4	3554	1	09/25/2014
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/03	N/A	N/A



17 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.

18 Reference

- [1] Federal Communications Commission, \Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.
- [2] David L. Means Kwok Chan, Robert F. Cleveland, \Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, Office of Engineering & Technology, Washington, DC, 1997.
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-field scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.
- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, \Dosimetric evaluation of mobile communications equipment with known precision", IEEE Transactions on Communications, vol. E80-B, no. 5, pp. 645{652, May 1997.
- [5] CENELEC, \Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.
- [6] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM '97, Dubrovnik, October 15{17, 1997, pp. 120{124.
- [8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172{175.
- [9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard Kuhn, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 10, pp. 1865{1873, Oct. 1996.
- [10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.
- [11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992. Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, \The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, \Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10



19 Attachments

Exhibit	Content
1	System Performance Check Plots
2	SAR test plots for Wi-Fi 2.4GHz Band
3	SAR test plots for Wi-Fi 5 GHz Band
4	SAR_Probe_EX3DV4_sn3898
5	SAR_Probe_EX3DV4_sn3554
6	SAR_DAE4_sn558
7	SAR_Dipole_D2450v2_sn728
8	SAR_Dipole_D5GHzv2_sn1004
9	T130823D03-SF PHOTOS

END OF REPORT