



SAR EVALUATION REPORT

Applicant Name:Motorola Mobility, Inc.
8000 W. Sunrise Blvd.
Plantation, FL 33322 USA
USA**Date of Testing:**

11/17/11

Test Site/Location:

PCTEST Lab, Columbia, MD, USA

Test Report Serial No.:

0Y1111162003.IHD

FCC ID:**IHDP56MF2****APPLICANT:****MOTOROLA MOBILITY, INC.****EUT Type:**

Portable Tablet Computer

Application Type:

Certification (5 GHz SAR Only)

FCC Rule Part(s):

CFR §2.1093

Test Device Serial No.:

Pre-Production [S/N: TA30200108]

Band & Mode	Tx Frequency	Conducted Power [dBm]	SAR
			1 gm Body (W/kg)
5.8 GHz WLAN	5745 - 5825 MHz	12.51	0.67
5.2 GHz WLAN	5180 - 5240 MHz	12.65	1.00

Note: Powers in the above table represent output powers for the SAR test configurations and may not represent the highest output powers for all modes.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.


Randy Ortanez
President

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 1 of 22

T A B L E O F C O N T E N T S

1	INTRODUCTION	3
2	TEST SITE LOCATION	4
3	FCC RF EXPOSURE LIMITS	5
4	SAR MEASUREMENT SETUP	6
5	DASY E-FIELD PROBE SYSTEM	8
6	PHANTOM AND EQUIVALENT TISSUES	9
7	DOSIMETRIC ASSESSMENT	10
8	WIFI ANTENNA LOCATION AND INFO	11
9	SAR TESTING WITH IEEE 802.11 TRANSMITTERS	13
10	RF OUTPUT POWERS	14
11	SAR SYSTEM VERIFICATION	14
12	DETAILED SAR TEST DATA	17
13	EQUIPMENT LIST	18
14	MEASUREMENT UNCERTAINTIES	19
15	CONCLUSION	20
16	REFERENCES	21

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 2 of 22

1 INTRODUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [24]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,” Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

1.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 1-1).

$$SAR = \frac{d}{dt} \left(\frac{dU}{dm} \right) = \frac{d}{dt} \left(\frac{dU}{\rho dV} \right)$$

Figure 1-1
SAR Mathematical Equation

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

$$SAR = \frac{\sigma \cdot E^2}{\rho}$$

where:

- σ = conductivity of the tissue-simulating material (S/m)
- ρ = mass density of the tissue-simulating material (kg/m³)
- E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

FCC ID: IHDP56MF2	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 3 of 22

3 FCC RF EXPOSURE LIMITS

3.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

3.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Table 3-1
SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6

HUMAN EXPOSURE LIMITS		
	UNCONTROLLED ENVIRONMENT <i>General Population</i> (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT <i>Occupational</i> (W/kg) or (mW/g)
SPATIAL PEAK SAR Brain	1.6	8.0
SPATIAL AVERAGE SAR Whole Body	0.08	0.4
SPATIAL PEAK SAR Hands, Feet, Ankles, Wrists	4.0	20

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 5 of 22

4 SAR MEASUREMENT SETUP

4.1 Robotic System

Measurements are performed using the DASY5 automated dosimetric assessment system. The DASY5 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of a high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the SAM phantom containing the head or body equivalent material. The robot is a six-axis industrial robot, performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Figure 4-1).

4.2 System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the SAR Measurement Software DASY5, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, A/D conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal from the DAE and transfers data to the PC card.

4.3 System Electronics

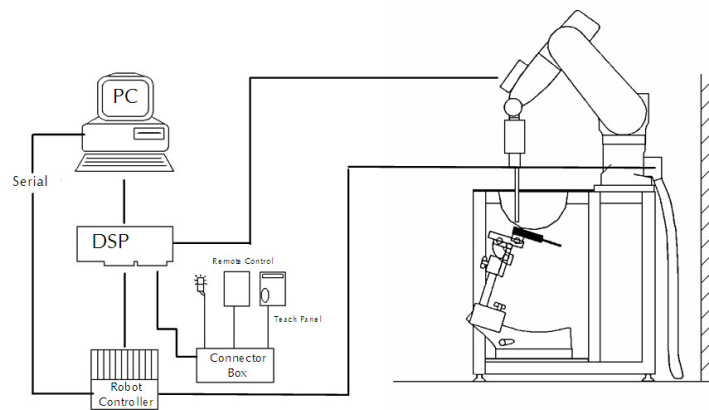


Figure 4-1
SAR Measurement System Setup

The DAE consists of a highly sensitive electrometer-grade auto-zeroing preamplifier, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

FCC ID: IHDP56MF2	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 6 of 22

4.4 Automated Test System Specifications

Test Software: SPEAG DASY5 version 52.6.2.482 Measurement Software
Robot: Stäubli Unimation Corp. Robot TX90 XL
Repeatability: 0.02 mm
No. of Axes: 6

Data Acquisition Electronic System (DAE)

Data Converter

Features: Signal Amplifier, multiplexer, A/D converter & control logic
Software: SEMCAD X software
Connecting Lines: Optical Downlink for data and status info
Optical upload for commands and clock

PC Interface Card

Function: Link to DAE
16-bit A/D converter for surface detection system
Two Serial & Ethernet link to robotics
Direct emergency stop output for robot

Phantom

Type: SAM Twin Phantom (V4.0)
Shell Material: Composite
Thickness: 2.0 ± 0.2 mm



Figure 4-2
SAR Measurement System

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 7 of 22

5.1 Probe Measurement System



**Figure 5-1
SAR System**

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration (see Figure 5-3) and optimized for dosimetric evaluation [9]. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection during a software approach and looks for the

maximum using a 2nd order curve fitting (see **Error! Reference source not found.**). The approach is stopped at reaching the maximum.

5.2 Probe Specifications

Model(s):	ES3DV2, ES3DV3, EX3DV4
Frequency	10 MHz – 6.0 GHz (EX3DV4)
Range:	10 MHz – 4 GHz (ES3DV3)
Calibration:	In head and body simulating tissue at Frequencies from 300 up to 6000MHz
Linearity:	± 0.2 dB (30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB (30 MHz to 4 GHz) for ES3DV3
Dynamic Range:	10 mW/kg – 100 W/kg
Probe Length:	330 mm
Probe Tip	
Length:	20 mm
Body Diameter:	12 mm
Tip Diameter:	2.5 mm (3.9mm for ES3DV3)
Tip-Center:	1 mm (2.0 mm for ES3DV3)
Application:	SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields



**Figure 5-2
Near-Field Probe**



**Figure 5-3
Triangular Probe
Configuration**

FCC ID: IHDP56MF2	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 8 of 22

6 PHANTOM AND EQUIVALENT TISSUES

6.1 Specific Anthropomorphic Mannequin (SAM) Specifications

The phantom for handset SAR assessment testing is a low-loss dielectric shell, with shape and dimensions derived from the anthropometric data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM Twin Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Figure 6-1). The perimeter sidewalls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimize reflections from the upper surface. The liquid depth is maintained at a minimum depth of 15 cm.



Figure 6-1
SAM Twin Phantom Shell

6.2 Tissue Simulating Mixture Characterization



Figure 6-2
SAM Phantom with
Simulating Tissue

The mixture is characterized to obtain proper dielectric constant (permittivity) and conductivity of the tissue of interest. The tissue dielectric parameters recommended in IEEE 1528 and IEC 62209 have been used as targets for the compositions, and are to match within 5%, per the FCC recommendations.

Table 6-1
Composition of the Tissue Equivalent Matter

Frequency (MHz)	5200-5800
Tissue	Body
Ingredients (% by weight)	
Polysorbate (Tween) 80	20
DI Water	80

6.3 Device Holder

The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$.

FCC ID: IHDP56MF2	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer	Page 9 of 22	

7 DOSIMETRIC ASSESSMENT

7.1 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR distribution area was ensured to cover the entire dimension of the body phantom area with the DUT positioned against the phantom. The horizontal grid resolution was 10mm x 10mm (for 5-6 GHz frequencies per KDB 865664 pub).
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during testing the 1 gram cube. This fixed point was measured and used as a reference value.
3. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation. Around this point, a fine resolution volume scan, "zoom scan," was assessed. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual for more details):
 - a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the diodes from the tip of the probe housing plus the distance between the phantom outer surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
 - b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points were obtained through interpolation, in order to calculate the averaged SAR.
 - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete. If the value deviated by more than 5%, the evaluation was repeated.

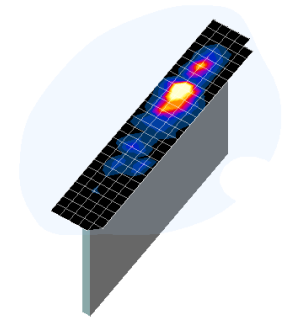


Figure 7-1
Sample SAR Area Scan

7.2 5 GHz SAR Testing Considerations per KDB 865664 publication

For 5 GHz testing, finer resolution Area scans were performed as specified by FCC SAR Measurement Requirements for 3 – 6 GHz, KDB pub 865664. The 5 GHz Area Scan requires a minimum resolution of 10mm on the x and y axis for each grid measurement point.

For 5 GHz testing finer resolution zoom scans were performed as specified by FCC SAR Measurement Requirements for 3 – 6 GHz, KDB pub 865664. The 5 GHz zoom scan requires a minimum volume of 24mm x 24mm x 20mm and 7 x 7 x 11 points.

FCC ID: IHDP56MF2	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 10 of 22

8 WIFI ANTENNA LOCATION AND INFORMATION

8.1 Antenna and Key Feature Information

Table 8-1 Antenna Information

Bluetooth/Wi-Fi 2.45 / 5 GHz Antenna

Type	Internal	
Location	Top of Transceiver	
Dimensions	Width	3.67 mm
	Length	10.04 mm

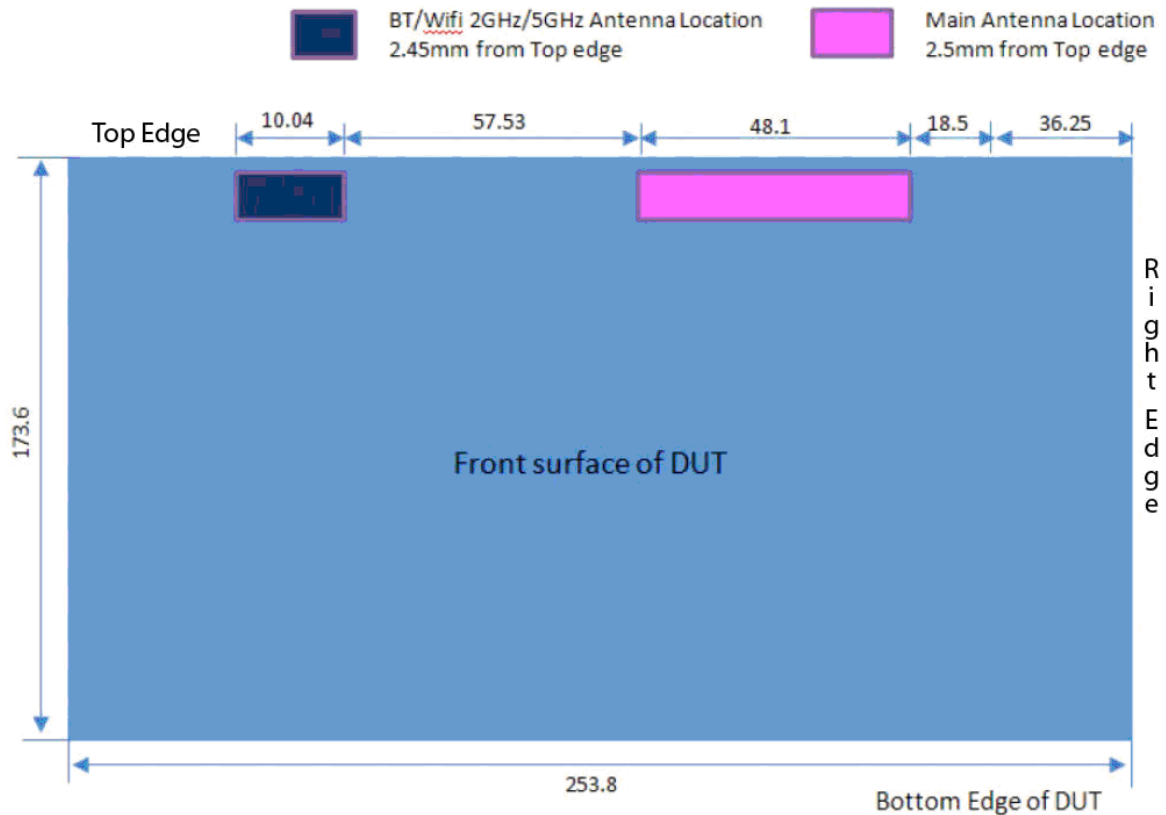


Figure 8-1 Front View of Device

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 11 of 22

8.2 SAR Testing for Tablet per KDB Publication 447498 Section 4

Lap-touching devices that have transmitting antennas located less than 20 cm from the body of the user require routine SAR evaluation. Such devices are considered portable, and are capable of being held to the body. Devices are to be setup according to KDB publication 447498 requirements and are configured with maximum output power during SAR assessment for a worst-case SAR evaluation.

Per KDB 447498 4) b) i), the bottom face (back of the device) is required to be tested touching the flat phantom.

Per KDB Publication 447498 4) b) ii) (2), SAR testing applies for the tablet edges with antennas located within 5 cm of each tablet edge closest to the user (with KDB Publication 616217 applied to edges with antennas located ≥ 5 cm from the user). According to KDB Publication 447498 4) b) ii) (2), for each antenna, SAR is only required for the edge with the most conservative exposure condition. Since the diagonal dimension of the device is more than 20 cm, this device is a tablet (not a mini-tablet).

8.3 Display Orientation Capabilities

This device is capable of multiple display orientations supporting both portrait and landscape positions. Therefore per KDB 447498 4) b) ii) (2), SAR testing applies for the tablet edges with antennas located within 5 cm of each tablet edge closest to the user (with KDB 616217 applied to edges with antennas located ≥ 5 cm from the user). According to KDB 447498 4) b) ii) (2), for each antenna, SAR is only required for the edge with the most conservative exposure condition.

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer	Page 12 of 22	

Per KDB 248227 publication, normal network operating configurations are not suitable for measuring the SAR of 802.11 WIFI transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable.

9.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

9.2 Frequency Channel Configurations [27]

802.11 a/n operating modes are tested independently according to the service requirements in each frequency band. 802.11a/n is tested for UNII operations on channels 36 and 48 in the 5.15-5.25 GHz band and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz §15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. These are referred to as the "default test channels". For 5 GHz, 802.11n modes were evaluated only if the output power was 0.25 dB higher than the 802.11a mode.

Table 9-1
802.11 Test Channels per FCC Requirements

Mode	GHz	Channel	Turbo Channel	"Default Test Channels"		
				§15.247	802.11b	802.11g
802.11 b/g	2.412	1		✓	✓	
	2.437	6	6	✓	✓	
	2.462	11		✓	✓	
	5.18	36				✓
802.11a	5.20	40	42 (5.21 GHz)			✓
	5.22	44				✓
	5.24	48	50 (5.25 GHz)			✓
	5.26	52				✓
	5.28	56	58 (5.29 GHz)			✓
	5.30	60				✓
	5.32	64				✓
	5.500	100				✓
	5.520	104				✓
	5.540	108				✓
	5.560	112				✓
	5.580	116				✓
	5.600	120				✓
	5.620	124				✓
	5.640	128				✓
	5.660	132				✓
	5.680	136				✓
	5.700	140				✓
	5.745	149		✓	✓	✓
	5.765	153	152 (5.76 GHz)	✓	✓	✓
	5.785	157		✓	✓	✓
UNII or §15.247	5.805	161	160 (5.80 GHz)	✓	✓	✓
	5.825	165		✓	✓	✓

Per FCC KDB Publication 443999 and RSS-210 A9.2(3), transmission on channels which overlap the 5600-5650 MHz is prohibited as a client.

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 13 of 22

10 RF OUTPUT POWERS

Table 10-1
IEEE 802.11a/n Average RF Power

Mode	Freq [MHz]	Channel	Conducted Power [dBm]							
			Data Rate [Mbps]							
			6	9	12	18	24	36	48	54
802.11a	5180	36	11.01	10.95	8.85	8.89	9.46	9.35	9.44	9.45
802.11a	5200	40	12.65	12.64	10.55	10.67	10.95	10.94	11.03	11.01
802.11a	5220	44	11.75	11.74	9.66	9.74	10.18	10.23	10.32	10.24
802.11a	5240	48	12.31	12.29	10.23	10.20	10.69	10.64	10.75	10.77
802.11a	5745	149	8.78	8.77	6.66	6.70	7.12	7.12	7.19	7.19
802.11a	5765	153	9.58	9.49	7.57	7.62	7.84	7.93	7.91	7.95
802.11a	5785	157	9.70	9.58	7.54	7.62	7.84	7.93	7.91	7.95
802.11a	5805	161	9.71	9.52	7.58	7.82	8.05	8.02	8.22	8.16
802.11a	5825	165	12.51	12.48	10.56	10.63	10.91	10.88	10.97	10.95

Mode	Freq [MHz]	Channel	Conducted Power [dBm] 20 MHz Channel, 400 ns Guard Interval							
			Data Rate [Mbps]							
			7.2	14.4	22	29	43	58	65	72
802.11n	5180	36	10.72	8.92	8.83	9.43	9.44	9.44	9.45	9.45
802.11n	5200	40	12.40	10.51	10.42	10.94	10.94	10.84	10.84	10.97
802.11n	5220	44	11.51	9.65	9.55	10.20	10.11	10.22	10.15	10.22
802.11n	5240	48	11.97	10.24	10.11	10.59	10.66	10.66	10.69	10.79
802.11n	5745	149	8.54	6.53	6.65	7.10	7.08	7.03	7.01	7.18
802.11n	5765	153	9.35	7.44	7.46	7.83	7.80	7.78	7.81	7.89
802.11n	5785	157	9.49	7.60	7.50	7.86	7.87	7.87	7.93	8.04
802.11n	5805	161	9.49	7.66	7.54	8.02	8.00	8.12	8.04	8.14
802.11n	5825	165	12.26	10.29	10.30	10.76	10.77	10.81	10.76	10.84

Mode	Freq [MHz]	Channel	Conducted Power - 800ns Guard Interval [dBm]							
			Data Rate [Mbps]							
			6.5	13	20	26	39	52	58	65
802.11n	5180	36	10.75	8.94	8.96	9.46	9.49	9.50	9.50	9.54
802.11n	5200	40	12.41	10.51	10.54	10.98	11.00	11.01	11.00	11.06
802.11n	5220	44	11.52	9.65	9.66	10.25	10.20	10.27	10.26	10.32
802.11n	5240	48	12.07	10.21	10.12	10.79	10.67	10.71	10.64	10.80
802.11n	5745	149	8.57	6.64	6.65	7.08	7.09	7.71	7.12	7.20
802.11n	5765	153	9.42	7.37	7.40	7.79	7.80	7.82	7.82	7.92
802.11n	5785	157	9.51	7.56	7.52	7.97	7.96	7.93	7.97	8.10
802.11n	5805	161	9.57	7.65	7.58	8.08	8.06	8.17	8.09	8.15
802.11n	5825	165	12.39	10.43	10.45	10.93	10.88	10.91	10.86	10.90

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes:

- Justification for reduced test configurations for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation (as the default channel). Higher data rates and IEEE 802.11n were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding channel in the lowest data rate IEEE 802.11a modes.
- Per FCC Publication 248227 D01 when the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is >1.6 W/kg or the 1g averaged SAR is >0.8 W/kg, SAR testing was additionally performed on the corresponding default test channels or required test channel based on highest output power.
- The bolded data rates and channels above were tested for SAR.

FCC ID: IHDP56MF2	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 14 of 22

11 SAR SYSTEM VERIFICATION

11.1 Tissue Verification

Table 11-1
Measured Tissue Properties

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (C°)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ϵ	% dev σ	% dev ϵ
11/17/2011	5200B-5800B	23.8	5200	5.198	49.48	5.299	49.014	-1.91%	0.95%
			5240	5.391	49.21	5.346	48.933	0.84%	0.57%
			5765	6.246	48.03	5.959	48.220	4.82%	-0.39%
			5785	6.230	47.95	5.982	48.242	4.15%	-0.61%
			5800	6.242	47.79	6.000	48.200	4.03%	-0.85%
			5825	6.327	47.52	6.029	48.132	4.94%	-1.27%

Note: KDB Publication 450824 was ensured to be applied for probe calibration frequencies greater than or equal to 50 MHz of the DUT frequencies.

Probe calibration used within ± 100 MHz of the test frequency in 5.725 - 5.85 is acceptable per KDB Publication 865664 since the design of the SAR probe supports the extended frequency, provided the DASY software version recommended is used for the tests, and the expanded calibration uncertainty ($k=2$) is less than or equal to 15% (See SAR probe calibration certificate for this information). The dielectric and conductivities measured are within 10% and 5% respectively of the target parameters specified in Supplement C 01-01.

The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies (per IEEE 1528 6.6.1.2). The SAR test plots may slightly differ from the table above since the DASY software rounds to three significant digits.

11.2 Measurement Procedure for Tissue verification

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the sample which was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured
- 4) The complex relative permittivity, for example from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r'\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 15 of 22

11.3 Test System Verification

Prior to assessment, the system is verified to $\pm 10\%$ of the manufacturer SAR measurement on the reference dipole at the time of calibration.

Table 11-2
System Verification Results

System Verification TARGET & MEASURED											
Date:	Amb. Temp (°C)	Liquid Temp (°C)	Input Power (W)	Tissue Frequency (MHz)	Dipole SN	Probe SN	Tissue Type	Measured SAR _{1g} (W/kg)	1 W Target SAR _{1g} (W/kg)	1 W Normalized SAR _{1g} (W/kg)	Deviation (%)
11/17/2011	23.2	22.2	0.025	5200	1057	3550	Body	1.99	77.700	79.600	2.45%
11/17/2011	23.5	22.0	0.025	5800	1057	3550	Body	1.9	75.000	76.000	1.33%

Note: Per KDB Publication 865664, when a reference dipole is not defined within $\pm 100\text{MHz}$ of the test frequency, the system verification may be conducted within $\pm 200\text{ MHz}$ of the center frequency of the measurement frequencies if the SAR probe calibration is valid and the same tissue-equivalent matter is used for verification and test measurements.

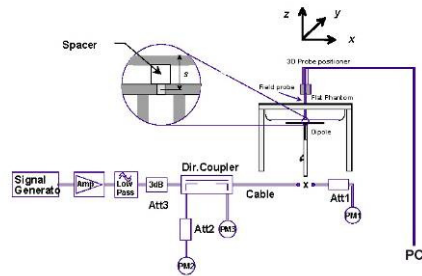


Figure 11-1
System Verification Setup Diagram



Figure 11-2
System Verification Setup Photo

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 16 of 22

12 DETAILED SAR TEST DATA

Table 12-1
5 GHz Body SAR Results

MEASUREMENT RESULTS									
FREQUENCY		Mode	Service	Conducted Power [dBm]	Power Drift [dB]	Spacing	Data Rate (Mbps)	Side	SAR (1g)
MHz	Ch.								(W/kg)
5765	153	IEEE 802.11a	OFDM	9.58	-0.05	0.0 cm	6	back	0.567
5785	157	IEEE 802.11a	OFDM	9.70	-0.03	0.0 cm	6	back	0.535
5825	165	IEEE 802.11a	OFDM	12.51	-0.03	0.0 cm	6	back	0.490
5765	153	IEEE 802.11a	OFDM	9.58	-0.19	0.0 cm	6	top	0.613
5785	157	IEEE 802.11a	OFDM	9.70	-0.12	0.0 cm	6	top	0.668
5825	165	IEEE 802.11a	OFDM	12.51	-0.16	0.0 cm	6	top	0.562
5200	40	IEEE 802.11a	OFDM	12.65	-0.09	0.0 cm	6	back	0.892
5240	48	IEEE 802.11a	OFDM	12.31	0.01	0.0 cm	6	back	0.920
5200	40	IEEE 802.11a	OFDM	12.65	-0.09	0.0 cm	6	top	0.993
5240	48	IEEE 802.11a	OFDM	12.31	0.17	0.0 cm	6	top	0.995
ANSI / IEEE C95.1 1992 - SAFETY LIMIT						Body			
Spatial Peak						1.6 W/kg (mW/g)			
Uncontrolled Exposure/General Population						averaged over 1 gram			

SAR Test Notes:

- The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC/OET Bulletin 65, Supplement C [June 2001].
- Per KDB Pub. 448498 4) b) i) the back side is required to be tested touching the flat phantom.
- This device is capable of multiple display orientations supporting both portrait and landscape positions. Therefore per KDB Pub. 447498 4) b) ii) (2), SAR testing applies for the tablet edges with antennas located within 5 cm of each tablet edge closest to the user (with KDB Pub. 616217 applied to edges with antennas located ≥ 5 cm from the user). According to KDB Pub. 447498 4) b) ii) (2), for each antenna, SAR is only required for the edge with the most conservative exposure condition.
- Batteries are fully charged for all readings.
- Tissue parameters and temperatures are listed on the SAR plots.
- Liquid tissue depth is was at least 15.0 cm.
- Justification for reduced test configurations for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation (as the default channel). Higher data rates and IEEE 802.11n were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding channel in the lowest data rate IEEE 802.11a modes.
- Per FCC Publication 248227 D01 when the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is >1.6 W/kg or the 1g averaged SAR is >0.8 W/kg, SAR testing was additionally performed on the corresponding default test channels or required test channel based on highest output power.
- There is no power reduction for WIFI.
- To confirm the proper SAR liquid depth, the z-axis plots from the system verifications were included since the system verifications were performed using the same liquid, probe, DAE and phantom as the SAR tests.

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 17 of 22

13 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Anritsu	MA2481A	Power Sensor	2/7/2011	Annual	2/7/2012	5318
Anritsu	MA2481A	Power Sensor	2/7/2011	Annual	2/7/2012	5442
Anritsu	ML2438A	Power Meter	2/7/2011	Annual	2/7/2012	1190013
Anritsu	ML2438A	Power Meter	2/7/2011	Annual	2/7/2012	98150041
Anritsu	ML2438A	Power Meter	2/7/2011	Annual	2/7/2012	1070030
Anritsu	MA2481A	Power Sensor	2/7/2011	Annual	2/7/2012	5821
Anritsu	MA2481A	Power Sensor	2/7/2011	Annual	2/7/2012	8013
Anritsu	MA2481A	Power Sensor	2/7/2011	Annual	2/7/2012	5605
Anritsu	MA2481A	Power Sensor	2/7/2011	Annual	2/7/2012	2400
SPEAG	D5GHzV2	5 GHz SAR Dipole	2/11/2011	Annual	2/11/2012	1057
SPEAG	EX3DV4	SAR Probe	2/14/2011	Annual	2/14/2012	3550
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/21/2011	Annual	2/21/2012	649
VWR	36934-158	Wall-Mounted Thermometer	2/26/2010	Biennial	2/26/2012	101536273
Agilent	8648D	Signal Generator	4/5/2011	Annual	4/5/2012	3629U00687
Rohde & Schwarz	SMIQ03B	Signal Generator	4/6/2011	Annual	4/6/2012	DE27259
Agilent	E8257D	(250kHz-20GHz) Signal Generator	4/8/2011	Annual	4/8/2012	MY45470194
Agilent	8753E	(30kHz-6GHz) Network Analyzer	4/21/2011	Annual	4/21/2012	JP38020182
VWR	36934-158	Wall-Mounted Thermometer	5/26/2010	Biennial	5/26/2012	101718589
SPEAG	DAE4	Dasy Data Acquisition Electronics	9/16/2011	Annual	9/16/2012	704
Gigatronics	80701A	(0.05-18GHz) Power Sensor	10/12/2011	Annual	10/12/2012	1833460
Gigatronics	8651A	Universal Power Meter	10/12/2011	Annual	10/12/2012	8650319
VWR	36934-158	Wall-Mounted Thermometer	1/21/2011	Biennial	1/21/2013	111286445
VWR	36934-158	Wall-Mounted Thermometer	1/21/2011	Biennial	1/21/2013	111286460
VWR	36934-158	Wall-Mounted Thermometer	1/21/2011	Biennial	1/21/2013	111286454
Control Company	61220-416	Long-Stem Thermometer	2/15/2011	Biennial	2/15/2013	111331322
Control Company	61220-416	Long-Stem Thermometer	2/15/2011	Biennial	2/15/2013	111331323
Control Company	61220-416	Long-Stem Thermometer	2/15/2011	Biennial	2/15/2013	111331330
Control Company	61220-416	Long-Stem Thermometer	2/15/2011	Biennial	2/15/2013	111331332
Control Company	61220-416	Long-Stem Thermometer	3/16/2011	Biennial	3/16/2013	111391601
Rohde & Schwarz	NRVD	Dual Channel Power Meter	4/8/2011	Biennial	4/8/2013	101695
Index SAR	IXTL-010	Dielectric Measurement Kit	N/A		N/A	N/A
Index SAR	IXTL-030	30MM TEM line for 6 GHz	N/A		N/A	N/A
Pasternack	PE2208-6	Bidirectional Coupler	N/A		N/A	N/A
Pasternack	PE2209-10	Bidirectional Coupler	N/A		N/A	N/A
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	N/A		N/A	N/A
Narda	4772-3	Attenuator (3dB)	N/A		N/A	9406
Narda	BW-S3W2	Attenuator (3dB)	N/A		N/A	120
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	N/A		N/A	N/A

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 18 of 22

14 MEASUREMENT UNCERTAINTIES

Applicable for 5 GHz.

a	b	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	IEEE 1528 Sec.	Tol. (± %)	Prob. Dist.	Div.	c _i 1gm	c _i 10 gms	1gm u _i (± %)	10gms u _i (± %)	v _i
Measurement System									
Probe Calibration	E.2.1	6.55	N	1	1.0	1.0	6.6	6.6	∞
Axial Isotropy	E.2.2	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemishperical Isotropy	E.2.2	1.3	N	1	1.0	1.0	1.3	1.3	∞
Boundary Effect	E.2.3	0.4	N	1	1.0	1.0	0.4	0.4	∞
Linearity	E.2.4	0.3	N	1	1.0	1.0	0.3	0.3	∞
System Detection Limits	E.2.5	5.1	N	1	1.0	1.0	5.1	5.1	∞
Readout Electronics	E.2.6	1.0	N	1	1.0	1.0	1.0	1.0	∞
Response Time	E.2.7	0.8	R	1.73	1.0	1.0	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	1.73	1.0	1.0	1.5	1.5	∞
RF Ambient Conditions	E.6.1	3.0	R	1.73	1.0	1.0	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.4	R	1.73	1.0	1.0	0.2	0.2	∞
Probe Positioning w/ respect to Phantom	E.6.3	2.9	R	1.73	1.0	1.0	1.7	1.7	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E.5	1.0	R	1.73	1.0	1.0	0.6	0.6	∞
Test Sample Related									
Test Sample Positioning	E.4.2	6.0	N	1	1.0	1.0	6.0	6.0	287
Device Holder Uncertainty	E.4.1	3.32	R	1.73	1.0	1.0	1.9	1.9	∞
Output Power Variation - SAR drift measurement	6.6.2	5.0	R	1.73	1.0	1.0	2.9	2.9	∞
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E.3.1	4.0	R	1.73	1.0	1.0	2.3	2.3	∞
Liquid Conductivity - deviation from target values	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Conductivity - measurement uncertainty	E.3.3	3.8	N	1	0.64	0.43	2.4	1.6	6
Liquid Permittivity - deviation from target values	E.3.2	5.0	R	1.73	0.60	0.49	1.7	1.4	∞
Liquid Permittivity - measurement uncertainty	E.3.3	4.5	N	1	0.60	0.49	2.7	2.2	6
Combined Standard Uncertainty (k=1)							RSS	12.4	12.0
Expanded Uncertainty (95% CONFIDENCE LEVEL)							k=2	24.7	24.0
									299

The above measurement uncertainties are according to IEEE Std. 1528-2003

FCC ID: IHDP56MF2	 PCTEST ENGINEERING LABORATORY, INC.	SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 19 of 22

15 CONCLUSION

15.1 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Industry Canada, with respect to all parameters indicated in this test report for 5 GHz WIFI only. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 20 of 22

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FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 21 of 22

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FCC ID: IHDP56MF2		SAR EVALUATION REPORT		Reviewed by: Quality Manager
Filename: 0Y1111162003.IHD	Test Dates: 11/17/11	EUT Type: Portable Tablet Computer		Page 22 of 22