



SAR TEST REPORT

Test Report No.: 32CE0083-SH-01-D

Applicant : Honda Engineering Co., Ltd.

Type of Equipment : Wireless LAN Card

Model No. : E1600-12A

FCC ID : N43E160012A

Test Standard : FCC 47CFR §2.1093,
Supplement C (Edition 01-01) to OET Bulletin 65

Test Result : Complied

The highest reported SAR for the device is 1.13 W/kg. (DTS)

*: The SAR(1g) was <1.2W/kg. Therefore according to the KDB447498 D01, this EUT was approved for used in PDA type single platform.

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Date of test: April 9, 2012

Test engineer:

Hiroshi Naka
Engineer of WiSE Japan, UL Verification Service

Approved by:

Toyokazu Imamura
Leader of WiSE Japan, UL Verification Service

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REVISION HISTORY

Revision	Test report No.	Date	Page revised	Contents
Original	32CE0083-SH-01-D	June 13, 2012	-	-
-R01	32CE0083-SH-01-D	July 6, 2012	2, 22	Updated the remarks of the equipment list.

*: By issue of new revision report, the report of an old revision becomes invalid.

SECTION 1: Customer information

Company Name	Honda Engineering Co., Ltd.
Brand Name	-
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Telephone Number	+81-28-677-6946
Facsimile Number	+81-28-677-6946
Contact Person	Kazumori Sakai

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT (*.Main unit including antenna and RF module)

Type of Equipment	Wireless LAN Card
Model Number	E1600-12A
Serial Number	001723146B56 (Mac.id)
Condition of EUT	Production prototype (*. Not for sale: This sample is equivalent to mass-produced items.)
Receipt Date of Sample	March 22, 2012 (*. No modification by the Lab.)
Country of Mass-production	Japan
Rating	DC 3.3V supplied from host equipment.
Size	42.8mm(Width) × 54.5mm(Depth) × 16.7mm(Height, for antenna housing)
Feature of EUT	E1600-12A is a Mini-Compact Flash slot type IEEE 802.11b/g Wi-Fi module.
Accessories for SAR	Any accessories for body touch and body-worn application were not supplied for the EUT. The EUT is installed into the mini-contact flash slot of a PDA host device typically. Therefore, the SAR test was considered with touch conditions and PDA condition in accordance with KDB447498.
Category Identified	Portable device *. This EUT is hand-held and hand-operated device with output power < 645 mW (1000×[2.4GHz] ^{-0.5}). Therefore, the hand-SAR is not required (KDB447498). *. This EUT may contact a human body during Wi-fi operation.

2.2 Product Description

Equipment type	Transceiver
Model of RF module	SDC-MCF10G
Frequency of operation channel	2412-2462 MHz
Channel spacing	5MHz
Bandwidth	20MHz
ITU code	GID(11b), DID(11g)
Type of modulation	DSSS(11b):CCK, DQPSK, DBPSK / OFDM(11g): 64QAM, 16QAM, QPSK, BPSK
Model of antenna	2450AT42A100
Antenna type	Chip antenna
Antenna connector type	U.FL connector (RF module side: SDC-MCF10G) / soldering (antenna side: 2450AT42A100)
Q'ty of Antenna	Tx: 1 piece (Main), Rx: 2 pieces (Main / Aux)
Peak antenna gain with cable loss	0.64 dBi
Transmit power	*. Refers to section 6 in this report. (Target power: 18dBm(11b)/13dBm(11g))
Power supply	DC3.3V

*. The EUT do not use the special transmitting technique such as "beam-forming" and "time-space code diversity."

SECTION 3: Test specification, procedures and results

3.1 Requirements for compliance testing defined by the FCC / Test specification

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. 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 mW/g for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992. According to the Supplement C of OET Bulletin 65 "Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under "worst-case" conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

1. Specific Absorption Rate (SAR) is a measure of the rate of energy absorption due to exposure to an RF transmitting source (wireless portable device).
2. IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET Docket 93-62.

Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01):

Supplement C (Edition 01-01) - Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions

OET Bulletin 65 (Edition 97-01) - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

IEEE Std. 1528-2003:

IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques Supplement C

In additions:

<input checked="" type="checkbox"/> KDB 447498 D01 (v04) (11/13/2009):	Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
<input checked="" type="checkbox"/> KDB 248227 (rev.1.2) (5/29/2007):	SAR Measurement Procedures for 802.11a/b/g Transmitters
<input checked="" type="checkbox"/> KDB 450824 D01 (v01r01) (Jan.2007):	SAR Probe Calibration and System Verification Considerations for Measurements at 150MHz-3GHz
<input checked="" type="checkbox"/> KDB 450824 D02 (v01) (11/13/2009):	Dipole Requirements for SAR System Validation and Verification

3.2 Exposure limit

Environments of exposure limit	Whole-Body (averaged over the entire body)	Partial-Body (averaged over any 1g of tissue)	Hands, Wrists, Feet and Ankles (averaged over any 10g of tissue)
(A) Limits for Occupational /Controlled Exposure (W/kg)	0.4	8.0	20.0
(B) Limits for General population /Uncontrolled Exposure (W/kg)	0.08	1.6	4.0

*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).

*General Population/Uncontrolled Environments: are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

The limit applied in this test report is:

General population / uncontrolled exposure, Partial-Body (averaged over any 1g of tissue) limit: **1.6 W/kg**

3.3 Procedures and Results

	WiFi (DTS)
Test Procedure	FCC OET Bulletin 65, Supplement C SAR
Category	FCC 47CFR §2.1093
Results (SAR(1g)) (Standalone)	Complied (1.13W/kg) (DTS)

Note: UL Japan's SAR Work Procedures No.13-EM-W0429 and 13-EM-W0430. No addition, deviation nor exclusion has been made from standards

Test outline:

This EUT is a limited module approval according to section 15.212 (b). The procedure of SAR was measured according to the KDB447498 2).

Consideration of the test results:

The SAR(1g) was <1.2W/kg for all configurations. EUT was approved for used in a PDA type single host platform. (KDB447498 D01)

3.4 Test Location

No.7 shielded room (2.76(Width) × 3.76m(Depth) × 2.4m(Height)) for SAR testing.

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3.5 Confirmation before SAR testing

3.5.1 Correlation of Output Power between EMC and SAR tests

It was checked that the antenna port power was correlated within 0~+5% (FCC requirements). The result is shown in Section 6.

Test	Remarks	Serial number
SAR	Before SAR test, the RF wiring for the sample that was actually used for the SAR test, had been switched to the antenna conducted power measurement line from the antenna line, and then the average power was measured. The average power of specified operation mode(s) were measured at default channel. After power measurement, the RF wiring was changed to the antenna line from the antenna conducted power measurement line for the SAR test. *. The power was measured by the calibrated power sensor and power meter (65MHz measurement bandwidth).	001723146B56 (Mac.id)
EMC	EMC power was measured during EMC testing. (Refer to the test report: 32CE0083-SH-01-A) For the EMC test, the antenna terminal conducted average output power was measured at 11b and 11g mode.	001723146B56 (Mac.id)

3.5.2 Average power for SAR tests

Step.1 Data rate check

The average powers related with all data rate were measured on a channel of specified operation mode. The EUT supported the following data rate in each operation mode.

11b		11g			
Modulation	Data rate [Mbps]	Modulation	Data rate [Mbps]	Modulation	Data rate [Mbps]
DBPSK/DSSS	1	BPSK/OFDM	6	16QAM/OFDM	24
DQPSK/DSSS	2	BPSK/OFDM	9	16QAM/OFDM	36
CCK/DSSS	5.5	QPSK/OFDM	12	64QAM/OFDM	48
CCK/DSSS	11	QPSK/OFDM	18	64QAM/OFDM	54

Step.2 Decision of SAR test channel

The following operation mode, data rate and channels were determined by the SAR reference power measured.

Mode	MHz	Channel	default 11b/g	SAR tested channel		Remarks
				11b	11g	
802.11 b/g	2412	1 (*1)	✓	#	n/a (*2)	SAR test was only applied to 11b mode, lowest data rate. (*2).
	2437	6	✓	#	n/a (*2)	
	2462	11 (*1)	✓	#	n/a (*2)	

✓ = "default test channels of requested by KDB248227", n/a: SAR test was not applied, # = SAR test was applied.

*1. Any output power reducing for channel 1 and 11 to meet restricted band requirements was not observed. Therefore channel 1 and 11 was selected for the default channels and SAR test was applied.

*2. Since the average power of 11g was lower than the corresponded 11b power, SAR test was not applied to 11g mode in accordance with KDB248227. (Refer to Section 6.)

The average power of higher data rate was less than 0.25dB higher than the lowest data rate. Therefore, SAR test was only applied to the lowest data rate. (Refer to Section 6.)

3.6 Confirmation after SAR testing

It was checked that the power drift [W] is within $\pm 5\%$ in the evaluation procedure of SAR testing. The verification of power drift during the SAR test is that DASY4 system calculates the power drift by measuring the e-filed at the same location at beginning and the end of the scan measurement for each test position.

The result is shown in APPENDIX 2.

*. DASY4 system calculation Power drift value[dB] = $20\log(Ea)/(Eb)$ (where, Before SAR testing: Eb[V/m] / After SAR testing: Ea[V/m])

Limit of power drift[W] = $\pm 5\%$

Power drift limit (X) [dB] = $10\log(P_{\text{drift}}) = 10\log(1.05/1) = 10\log(1.05) - 10\log(1) = 0.21\text{dB}$

from E-filed relations with power.

$S = E \times H = E^2 / \eta = P / (4 \times \pi \times r^2)$ (η : Space impedance) $\rightarrow P = (E^2 \times 4 \times \pi \times r^2) / \eta$

Therefore, The correlation of power and the E-filed

Power drift limit (X) dB = $10\log(P_{\text{drift}}) = 10\log(E_{\text{drift}})^2 / 20\log(E_{\text{drift}})$

From the above mentioned, the calculated power drift of DASY4 system must be the less than $\pm 0.21\text{dB}$.

3.7 Test setup of EUT and SAR measurement procedure

After considering the outline of EUT, the SAR test was carried out on the following setup conditions.

*. Refer to Appendix 1 for test setup photographs.

Setup	Explanation	antenna to user distance	SAR test
Top	The top surface of EUT was 5mm away from the bottom of Flat phantom.	≈2mm	applied
Front-antenna	The portion with the front side of antenna located on the front side of EUT was touched to the bottom of Flat phantom. This section is the closest to an antenna.	≈1.6mm	applied
Front	The front surface of EUT was touched to the bottom of Flat phantom.	≈2mm	applied
Rear	The rear portion of EUT was touched to the bottom of Flat phantom.	>10mm	applied
Left	The left portion of EUT was touched to the bottom of Flat phantom.	>25mm	applied
Right	The right portion of EUT was touched to the bottom of Flat phantom.	>25mm	applied
Bottom	The SAR test was not applied to the bottom side of EUT. Because the bottom side of EUT was installed into the mini-compact flash slot of the host equipment (PDA). (*1)	>100mm	not applied

*1. Since the antenna to user distance was more than 100mm typically, the SAR test was not applied to the bottom side of the EUT.

By the determined test setup shown above, the SAR test was applied in the following procedures.

Step 1	Change the channels. (At the position nearest to an antenna.)
Step 2	Change the positions. (At worst SAR channel of step1.)

*. During SAR test, the radiated power is always monitored by Spectrum Analyzer.

SECTION 4: Operation of EUT during testing

4.1 Operating modes for SAR testing

This EUT has IEEE.802.11b and 11g continuous transmitting modes.

The operation mode, frequency and the modulation used in the SAR testing are shown as a following.

Operation mode	11b	11g
Tx frequency band		2412-2462MHz
Tested frequency	2412, 2437, 2462MHz	Not applied
Modulation	DBPSK/DSSS	Not applied
Data rate	1Mbps	Not applied
Crest factor	1.0	Not applied
Controlled software	Software name: SRU (v2.1.12), SCU (Summit Client Utility, Driver: v2.01.17/SCU: v2.01.12), SMU (v2.1.12, regulatory domain: ETSI) The EUT was installed into the mini-compact flash slot of the PDA. The maximum Tx power was transmitted at the selected frequency, at the selected data rate by the operation on the PDA screen. (Refer to Appendix A for the operation screen.)	

SECTION 5: Uncertainty Assessment (SAR measurement)

Uncertainty of SAR measurement system (v04)		Under 3 GHz (v04)	
		1g SAR	10g SAR
combined measurement uncertainty of the measurement system (k=1)		± 12.3%	± 12.0%
expanded uncertainty (k=2)		± 24.6%	± 24.0%

	Error Description (Under 3GHz) (v04)	Uncertainty Value	Probability distribution	Divisor	ci (1g)	ci (10g)	ui (1g)	ui (10g)	Vi, eff
A Measurement System									
1	Probe Calibration Error	±6.0 %	Normal	1	1	1	±6.0 %	±6.0 %	∞
2	Axial isotropy Error	±4.7 %	Rectangular	√3	0.7	0.7	±1.9 %	±1.9 %	∞
3	Hemispherical isotropy Error (<5deg, flat phantom)	±9.6 %	Rectangular	√3	0.7	0.7	±3.9 %	±3.9 %	∞
4	Boundary effects Error	±1.4 %	Rectangular	√3	1	1	±0.8 %	±0.8 %	∞
5	Linearity Error	±4.7 %	Rectangular	√3	1	1	±2.7 %	±2.7 %	∞
6	Sensitivity Error (detection limit)	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
7	Response Time Error (<5ms/100ms wait)	±0.0 %	Normal	1	1	1	±0.0 %	±0.0 %	∞
8	Integration Time Error (100% duty cycle)	±0.0 %	Rectangular	√3	1	1	±0.0 %	±0.0 %	∞
9	Readout Electronics Error(DAE)	±0.3 %	Rectangular	√3	1	1	±0.3 %	±0.3 %	∞
10	RF ambient conditions-noise (<0.01mW/g)	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
11	RF ambient conditions-reflections (<0.12mW/g)	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
12	Probe positioner mechanical tolerance	±1.1 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
13	Probe Positioning with respect to phantom shell	±2.9 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
14	Errors: Extrapol., Interpol. & Integration Algorithms	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
B Test Sample Related									
15	Test Sample Positioning Error	±5.0 %	Normal	1	1	1	±5.0 %	±5.0 %	145
16	Device Holder or Positioner Tolerance	±3.6 %	Normal	1	1	1	±3.6 %	±3.6 %	5
17	Test Sample Output Power Drift Error	±5.0 %	Rectangular	√3	1	1	±2.9 %	±2.9 %	∞
C Phantom and Setup									
18	Phantom uncertainty(shape, thickness tolerances)	±7.5 %	Rectangular	√3	1	1	±4.3 %	±4.3 %	∞
19	Target Liquid Conductivity Tolerance	±5.0 %	Rectangular	√3	0.64	0.43	±1.8 %	±1.2 %	∞
20	Measurement Liquid Conductivity Error	±2.9 %	Normal	1	0.64	0.43	±1.9 %	±1.2 %	3
21	Target Liquid Permittivity Tolerance	±5.0 %	Rectangular	√3	0.6	0.49	±1.7 %	±1.4 %	∞
22	Measurement Liquid Permittivity Error	±2.9 %	Normal	1	0.6	0.49	±1.7 %	±1.4 %	3
Combined Standard Uncertainty							±12.3 %	±12.0 %	479
Expanded Uncertainty (k=2)							±24.6 %	±24.0 %	

*. This measurement uncertainty budget is suggested by IEEE 1528 and determined by Schmid & Partner Engineering AG (DASY4 Uncertainty Budget). [6]

SECTION 6: Confirmation before testing

6.1 Assessment for the conducted power of EUT

Worst data rate & worst channel determination of SAR (EUT serial number: 001723146B56 (Mac.id))

/ Correction of the power at SAR test and EMC test (EUT serial number: 001723146B56 (Mac.id))

[Output power]	Tx mode:	IEEE 802.11b						*PAR=Peak(dB)-Ave(dB) dB	Power (EMC test)												
		Ch.	Freq. [MHz]	D/R [Mbps]	Ant. No.	Max.Ave. pwr.:o	Modulation		P/M Reading Ave.[dBm]	Cable Loss Pk[dB]	Attenuator [dB]	duty factor [dB]	Power Results (SAR Ref.) Ave[dBm]	Pk[dBm]	Ave[mW]	Pk[mW]	Δworst ave [dB]	PAR [dB]	Ave [dB]	Δsar	Pk[dB]
6	2437	1	main	o	DBPSK	DSSS	7.38	11.16	0.75	10.00	0.07	18.20	21.98	66.11	157.85	0.00	3.78	18.01	0.19	21.93	0.05
6	2437	2	main	o	DQPSK	DSSS	7.38	11.50	0.75	10.00	0.07	18.20	22.32	66.07	170.61	0.00	4.12	18.18	0.02	22.31	0.01
6	2437	5.5	main	o	COFDM	DSSS	7.27	11.35	0.75	10.00	0.12	18.14	22.22	65.16	166.72	-0.06	4.08	18.12	0.02	22.20	0.02
6	2437	11	main	o	COFDM	DSSS	6.11	10.75	0.75	10.00	0.29	17.15	21.79	51.88	151.01	-0.99	4.64	17.05	0.10	21.71	0.08

Mode	Freq. [MHz]	Ch.	D/R [Mbps]	Cable loss [dB]	Attn. [dB]	Duty factor	P/M reading Ave. [dBm]	Power results (Ave.)	Remarks	SAR test?	Crest factor of DASY4 [-]
IEEE 802.11b	2412	1	1	0.75	10.00	0.07	7.25	18.07	64.16	-	yes
	2437	6	1	0.75	10.00	0.07	7.38	18.20	66.11	Max channel	yes
	2462	11	1	0.75	10.00	0.07	7.33	18.15	65.35	-	yes

*. D/R: Data Rate, Attn: Attenuator, P/M: Power Meter Reading, Ave.: Average

*. Calculating formula: Results(Ave)=(P/M Reading Ave.)+(Cable loss)+(Attenuator)+(Duty factor)

*. The average power of higher data rate was less than 0.25dB higher than the lowest data rate. Therefore, SAR test was only applied to the lowest data rate.

*. Since the average power of 11g was 5dB lower than corresponded 11b power in the specification, the average power of 11g mode was not measured for the SAR reference.

*. The difference between the SAR reference power and the power of EMC test was not less than 0dB and not higher than 0.21dB.
 SAR reference: Date tested: April 5, 2012 / Measured by: Hiroshi Naka / Place: preparation room of No. 7 shielded room. (25.0 deg C / 37 %RH)
 "Power (EMC test)", this reference is described in the test report of 32CE0083-SH-01-A.

SECTION 7: Measurement results

7.1 SAR test results

Measurement date: April 9, 2012

Measurement by: Hiroshi Naka

[Liquid measurement (Body simulated tissue)]

Used Target Frequency [MHz]	Target Body Tissue		Measured Body Tissue				Environment		Measured Date
	Permittivity [H]	Conductivity [S/m]	Permittivity (ϵ_r) [H]	Conductivity (σ) [S/m]	Temp. [deg.C.]	Depth [mm]	Temp. [deg.C.]	Humidity [%RH]	
2450	52.7	1.95	50.48 (-4.2%)	2.002 (+2.7%)					
2412	52.75	1.914	50.45 (-4.4%)	1.950 (+1.9%)					
2437	52.72	1.938	50.33 (-4.5%)	1.978 (+2.1%)					
2462	52.68	1.967	50.26 (-4.6%)	2.016 (+2.5%)					

*. The target value is a parameter defined in OET65 Supplement C. In the current standards (e.g., IEEE 1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given at 2450MHz. As an intermediate solution, dielectric parameters for the frequencies between 2000 to 2450 MHz and 2450 to 3000MHz were obtained using linear interpolation. (Refer to Appendix 3-7 in this report)

[SAR measurement results]

SAR measurement results										
Frequency		Modulation / Data rate [Mbps]		EUT setup conditions		Liquid temp. [deg.C]		Power drift [dB]	SAR(1g) [W/kg]	Remarks
Mode	Ch. [MHz]	/ crest factor		Position	Separation distance	Before	After			
Step 1: Change the channels										
IEEE 802.11b	6	2437	DBPSK&DSSS / 1Mbps / 1.0	Front-antenna	0mm	22.4	22.4	0.146	1.11	-
	1	2412	DBPSK&DSSS / 1Mbps / 1.0	Front-antenna	0mm	22.4	22.4	-0.149	1.09	-
	11	2462	DBPSK&DSSS / 1Mbps / 1.0	Front-antenna	0mm	22.4	22.4	-0.123	1.13	→Worst SAR.
Step 2: Change the positions										
802.11b	11	2462	DBPSK&DSSS / 1Mbps / 1.0	Top	5mm	22.4	22.4	-0.150	0.77	-
	11	2462	DBPSK&DSSS / 1Mbps / 1.0	Front	0mm	22.5	22.6	-0.105	0.64	-
	11	2462	DBPSK&DSSS / 1Mbps / 1.0	Rear	0mm	22.6	22.6	0.048	0.17	-
	11	2462	DBPSK&DSSS / 1Mbps / 1.0	Left	0mm	22.6	22.7	0.20	0.17	-
	11	2462	DBPSK&DSSS / 1Mbps / 1.0	Right	0mm	22.7	22.7	-0.20	0.12	-

Notes:

- *. The separation distance means the distance between the EUT surface and the bottom surface of the phantom.
- *. Since the average power of 11g was 5dB lower than corresponded 11b power in the specification, the SAR test of 11g mode was not applied.
- *. During test, the EUT was operated with full-charged battery and without all signal interface cables.
- *. Calibration frequency of the SAR measurement probe (and used conversion factors)

SAR test frequency [MHz]	Probe calibration frequency [MHz]	Validity [MHz]	Used conversion factor	Uncertainty
2412	2450	-38MHz, within ± 50 of cal.frequency	7.34	$\pm 12.0\%$
2437	2450	-13MHz, within ± 50 of cal.frequency	7.34	$\pm 12.0\%$
2462	2450	+12MHz, within ± 50 of cal.frequency	7.34	$\pm 12.0\%$

*. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.