



SAR TEST REPORT

Test Report No.: 32LE0134-HO-01-R1

Applicant : ROHM Co., Ltd.
Type of Equipment : Wireless LAN module
Model No. : BP3591
FCC ID : ANSBP3591
Test Standard : FCC 47CFR §2.1093,
Supplement C (Edition 01-01) to OET Bulletin 65
Test Result : Complied

Maximum SAR(1g) Value	Platform #	Platform type	Platform model	Remarks
0.41 W/kg	Platform(1)	Mobile Printer	PJ-673	(DTS) 2412MHz, IEEE 802.11b, (1Mbps, DBPSK/DSSS))

The highest reported SAR(1g) Value for the device is 0.41 W/kg

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Date of test: July 25, 2012

Test engineer:

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Leader of WiSE Japan, UL Verification Service

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SECTION 1: Customer information

Company Name	ROHM Co., Ltd.
Brand Name	ROHM
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Contact Person	YUSAKU KAWAKUBO

SECTION 2: Equipment under test (EUT)

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

Type of Equipment	Wireless LAN module
Model Number	BP3591
Serial Number	001D12CF3877
Condition of EUT	Production prototype (*. Not for sale: This sample is equivalent to mass-produced items.)
Receipt Date of Sample	July 24, 2012 (*. No modification by the Lab.)
Country of Mass-production	Japan
Rating	DC3.3V * The EUT operates with a bus power from laptop PC, and test mode was controlled by laptop PC.
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.
Feature of EUT	The EUT is a Wireless LAN module which installs into the mobile printer.
Accessory of EUT	Any accessories of body-worn application were not supplied for the EUT. Therefore, the SAR test was applied with touch conditions (0mm for separation distance).

2.2 Product Description (*.Antenna and RF module)

Equipment type	Transceiver
Frequency of operation channel	2412-2462 MHz
Channel spacing	5MHz
Bandwidth	20MHz
ITU code	G1D(11b), D1D(11g,11n(20HT))
Type of modulation	DSSS(11b), OFDM(11g,11n(20HT))
Q'ty of Antenna	1 pc.
Antenna type	Chip antenna (Internal Antenna)
Antenna gain (peak)	1.1 dBi
Transmit power	Refer to section 6 in this report.
Power supply	DC3.3V (*. with constantly voltage circuit operation.)

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:

- KDB 447498 D01 (v04) (11/13/2009):** Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
- KDB 248227 (rev.1.2) (5/29/2007):** SAR Measurement Procedures for 802.11a/b/g Transmitters
- KDB 450824 D01 (v01r01) (Jan.2007):** SAR Probe Calibration and System Verification Considerations for Measurements at 150MHz-3GHz
- 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

RF Type	Wi-Fi (DTS)
Test Procedure	FCC OET Bulletin 65, Supplement C SAR
Category	FCC 47CFR §2.1093
Results (SAR(1g))	(Built-in) Complied (0.41W/kg)

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

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

Data rate

*. The power corresponding with the data rate was measured. The following table is reference of modulation.

11b		11g		11n(20HT)			
Modulation	Data rate	Modulation	Data rate	Modulation	Data rate	Modulation	MCS
DBPSK/DSSS	1 Mbps	BPSK/OFDM	6 Mbps	16QAM/OFDM	24 Mbps	BPSK/OFDM	MCS0
DQPSK/DSSS	2 Mbps	BPSK/OFDM	9 Mbps	16QAM/OFDM	36 Mbps	QPSK/OFDM	MCS1
CCK/DSSS	5.5 Mbps	QPSK/OFDM	12 Mbps	64QAM/OFDM	48 Mbps	QPSK/OFDM	MCS2
CCK/DSSS	11 Mbps	QPSK/OFDM	18 Mbps	64QAM/OFDM	54 Mbps	16QAM/OFDM	MCS3

Decision of SAR test channel

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

Mode	MHz	Channel	default	SAR tested channel			Remarks
			11b/g/n(20HT)	11b	11g	11n(20HT)	
802.11 b/g/n	2412	1 (*1)	✓	#	n/a (*2)	n/a (*2)	*2. Since the average power of 11g and 11n(20HT) were enough lower than the corresponded 11b power, the SAR test was not applied to 11g and 11n(20HT) mode. (KDB248227)
	2437	6	✓	#	n/a (*2)	n/a (*2)	
	2462	11 (*1)	✓	#	n/a (*2)	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.

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] = $10\log(P_{drift}) = 10\log(1.05/1) = 10\log(1.05) - 10\log(1) = 0.212\text{dB}$
 from E-filed relations with power.

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

Therefore, The correlation of power and the E-filed

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

From the above mentioned, the calculated power drift of DASY4 system must be the less than $\pm 0.212\text{dB}$.

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 of EUT setup position	Antenna to user distance	SAR test	SAR type
Top	The top surface of EUT was touched to the Flat phantom. This section is the closest to an antenna.	$\approx 5.6 \text{ mm}$	applied	Body-touch
Rear	The rear surface of EUT was touched to the Flat phantom.	$\approx 10.5 \text{ mm}$	applied	Body-touch
Right	The left surface of EUT was touched to the Flat phantom.	$\approx 6.6 \text{ mm}$	applied	Body-touch
Bottom	The bottom surface of EUT was touched to the Flat phantom.	$\approx 31.4 \text{ mm}$	applied	Body-touch
Left	The right surface of EUT was touched to the Flat phantom.	$\approx 241.8 \text{ mm}$	not applied (*1)	Body-touch
Front	The front surface of EUT was touched to the Flat phantom.	$\approx 44.2 \text{ mm}$	not applied (*1)	Body-touch

*. Size of EUT(platform): 255 (width) x 55 (depth) x 30 (thickness)[mm]

*1. This surface is not closest surface distance to a phantom.

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

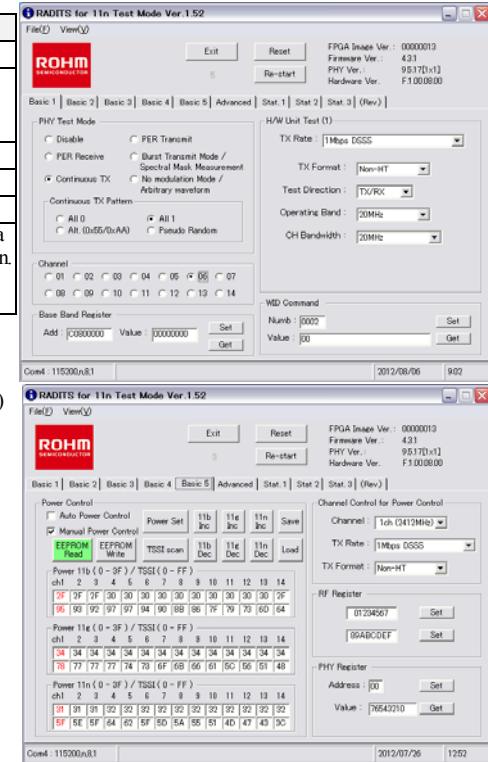
Step 1	Worst position search.
Step 2	Change the channels.

SECTION 4: Operation of EUT during testing

This EUT has IEEE.802.11b, 11g and 11n(20HT) continuous transmitting modes. The frequency and the modulation used in the SAR testing are shown as a following.

Operation mode	11b	11g	11n(20HT)
Tx frequency band	2412-2462MHz		
Tested frequency	2412MHz, 2437MHz, 2462MHz	not applied (*1)	not applied (*1)
Modulation	DBPSK/DSSS(*2)	not applied (*1)	not applied (*1)
Data rate	1Mbps (*2)	not applied (*1)	not applied (*1)
Crest factor	1.0 (~100% duty cycle)	not applied (*1)	not applied (*1)
Controlled software	* During SAR test, the EUT was connected with the host PC via RS232-C - USB cable in order to set the transmission condition. * The sample photograph of setting parameters and setting window is in right.		

- *1. Since the average power of 11g and 11n(20HT) was enough lower than the corresponded 11b power, the SAR test was not applied to 11g and 11n(20HT) mode.
- *2. Since the average power of higher data rate was less than 0.25dB higher than the lowest data rate, the SAR test was only applied to the lowest data rate. (KDB248227)



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)	$\pm 12.3\%$		$\pm 12.0\%$
expanded uncertainty (k=2)	$\pm 24.6\%$		$\pm 24.0\%$

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

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

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SECTION 6: Confirmation before testing

6.1 Assessment for the conducted power of EUT

6.1.1 Worst data rate & worst channel determination of SAR

Mode	Freq. [MHz]	Data Rate [Mbps]	P/M Reading Average [dBm]	Cable Loss [dB]	Attenuator [dB]	Duty Factor [dB]	Results (Average)		Remarks
							[dB]	[mW]	
802. 11b	2412	1	3.01	1.24	10.00	0.01	14.26	26.65	Worst Data Rate with the maximum power in 11b.
	2412	2	2.32	1.24	10.00	0.03	13.59	22.85	-
	2412	5.5	2.09	1.24	10.00	0.12	13.45	22.12	-
	2412	11	1.73	1.24	10.00	0.10	13.07	20.27	-
	2437	1	3.35	1.24	10.00	0.01	14.61	28.89	Maximum power of 11b mode and in all of modes.
	2462	1	3.14	1.24	10.00	0.01	14.40	27.53	-
802. 11g	2412	6	0.68	1.24	10.00	0.06	11.98	15.76	Worst Data Rate with the maximum power in 11g.
	2412	9	0.46	1.24	10.00	0.08	11.78	15.07	-
	2412	12	0.33	1.24	10.00	0.07	11.64	14.59	-
	2412	18	0.24	1.24	10.00	0.21	11.69	14.75	-
	2412	24	0.22	1.24	10.00	0.16	11.62	14.52	-
	2412	36	-0.12	1.24	10.00	0.15	11.27	13.39	-
	2412	48	-0.8	1.24	10.00	0.28	10.72	11.80	-
	2412	54	-1.1	1.24	10.00	0.30	10.44	11.06	-
	2437	6	0.69	1.24	10.00	0.06	11.99	15.80	Maximum power of 11g mode.
	2462	6	0.65	1.24	10.00	0.06	11.95	15.65	-
802. 11n (20HT)	2412	MCS0	-0.74	1.24	10.00	0.05	10.55	11.36	Worst Data Rate with the maximum power in 11n(20HT).
	2412	MCS1	-1.06	1.24	10.00	0.08	10.26	10.63	-
	2412	MCS2	-1.21	1.24	10.00	0.08	10.11	10.26	-
	2412	MCS3	-1.72	1.24	10.00	0.24	9.76	9.45	-
	2412	MCS4	-2.20	1.24	10.00	0.22	9.26	8.44	-
	2412	MCS5	-2.54	1.24	10.00	0.35	9.05	8.03	-
	2412	MCS6	-3.20	1.24	10.00	0.27	8.31	6.78	-
	2412	MCS7	-3.32	1.24	10.00	0.14	8.06	6.40	-
	2437	MCS0	-0.31	1.24	10.00	0.05	10.98	12.54	Maximum power of 11n(20HT) mode.
	2462	MCS0	-0.40	1.24	10.00	0.05	10.89	12.28	-

*. SAR reference; Date tested: July 25, 2012 / Measured by: Tomochika Sato / Place: preparation room of No. 7 shielded room. (24.6 deg C / 55 %RH)

*. Calculating formula: Results = [“P/M Reading”] + [“Cbl.loss”(Cable loss)] + [“Att.loss”(Attenuator)]

*. A red figure indicates it is the maximum value in each operation condition.

*. Since the average power of 11g and 11n(20HT) was lower than the corresponded 11b power, the SAR test was not applied to 11g and 11n(20HT) mode. (KDB248227)

6.1.2 Comparison with the data of an original report

Mode	Freq. [MHz]	Original PK power *1 [dBm]	Measured PK power [dBm]	Original – Measured [dBm]	Remarks
802.11b	2412	16.98	17.10	-0.12	-
	2437	17.19	17.31	-0.12	-
	2462	16.90	17.10	-0.20	-
802.11g	2412	22.37	22.23	-0.14	-
	2437	22.15	22.13	-0.02	-
	2462	22.01	21.90	-0.11	-
802.11n 20HT	2412	21.09	21.03	-0.06	-
	2437	21.25	21.16	-0.09	-
	2462	20.99	20.75	-0.24	-

*1. The original report No. is 32EE0095-HO-01-A-R1.

SECTION 7: Measurement results

7.1 SAR test results

Measurement date: July 25, 2012

Measurement by: Tomochika Sato

[Liquid measurement (Body tissue)]

Used Target Frequency [MHz]	Target Body Tissue		Measured Body Tissue			Environment		Measured Date	
	Permittivity [-]	Conductivity [S/m]	Permittivity (ϵ_r) [-]	Conductivity (σ) [S/m]	Temp. [deg.C.]	Depth [mm]	Temp. [deg.C.]	Humidity [%RH]	
2450	52.7	1.95	51.32 (-2.6%)	1.98 (1.6%)	22.8	153	24	55	July 25, 2012, before SAR test.
2412	52.75	1.914	51.37 (-2.6%)	1.934 (1.0%)					
2437	52.72	1.938	51.30 (-2.7%)	1.974 (1.9%)					
2462	52.68	1.967	51.14 (-2.7%)	2.009 (2.1%)					

*. 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]

Mode	Frequency		Modulation /Data rate /crest factor	EUT setup conditions			Liquid temp. [deg.C]		Power drift [dB]	SAR(1g) [W/kg] max. value of multi-peak	Data# in Appendix 2-2	Remarks
				Position	Separation distance	Antenna to user distance	Before	After				
	Ch.	[MHz]										
Step 1: Worst position search												
11b	6	2437	DBPSK&DSSS /1Mbps/1.0	Top Rear Right Bottom	0 mm (touch)	≈5.6 mm	22.4	22.4	-0.19	0.374	Step 1-1	→Worst position
						≈10.5 mm	22.4	22.4	-0.168	0.212	Step 1-2	-
						≈6.6 mm	22.4	22.4	-0.034	0.133	Step 1-3	-
						≈31.4 mm	22.4	22.4	-	-	Step 1-4	SAR was not detected.
Step 2: Change the channels												
11b	1	2412	DBPSK&DSSS /1Mbps/1.0	Top	0 mm (touch)	≈5.6 mm	22.4	22.4	-0.213	0.414	Step 2-1	→Worst SAR Value
	11	2462					22.4	22.4	0.1	0.354	Step 2-2	-

Notes:

- *1. Since the average power of 11g and 11n(20HT) was lower than the corresponded 11b power, the SAR test was not applied to 11g and 11n(20HT) mode. (KDB248227)
- *. Calibration frequency of the SAR measurement probe: EX3DV4 (serial number: 3679) (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	6.77	±12.0%
2437	2450	-13MHz, within ±50 of cal.frequency	6.77	±12.0%
2462	2450	+12MHz, within ±50 of cal.frequency	6.77	±12.0%

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

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