SAR TEST REPORT

Test Report No.: 10048648S-A

Applicant : **Canon Inc.**
Type of Equipment : **Wireless Module**
Model No. : **WM223** (*. Installed into the WM223's platform (1))
FCC ID : **AZD223**
Test Standard : **FCC 47CFR §2.1093**
Test Result : **Complied**

Highest Reported SAR(1g) Value	Platform #	Platform type	Platform model	Remarks
0.86 W/kg	Platform (1)	Digital camera	PC2071	(DTS) 2462MHz, IEEE 802.11b, (1Mbps, DBPSK/DSSS)) *. Highest measured SAR(1g) value: 0.658 W/kg (output power: 13.83dBm)

*. **Highest reported SAR (1g) across exposure conditions = "0.86 W/kg" = grant listing.**
*. Since highest reported SAR (1g) on this platform (1) which obtained in accordance with KDB447498 (v05) was under 1.2 W/kg, this EUT was approved to operate a single platform which was tested in this report.

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6. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.

Date of test: September 19, 20 and October 4, 2013

Test engineer: H. Naka

Hiroshi Naka
Engineer of WiSE Japan, UL Verification Service

Approved by: T. Imamura

Toyokazu Imamura
Leader of WiSE Japan, UL Verification Service

☐ The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
☒ There is no testing item of "Non-accreditation".

JAB Testing RTL02610

REVISION HISTORY

Revision	Test report No.	Date	Page revised	Contents
Original	10048648S-A	October 29, 2013	-	-

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

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Contents of appendixes

SECTION 1: Customer information

Company Name	Canon Inc.
Brand Name	Canon
Address	30-2, Shimomaruko 3-chome, Ohta-ku, Tokyo 146-8501 Japan
Telephone Number	+81-3-5482-8070
Facsimile Number	+81-3-3757-8431
Contact Person	Hironobu Saida

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

Type of Equipment	Wireless Module	(*. Installed platform (1): digital camera)
Model Number	WM223	(*. Platform (1) model: PC2071)
Serial Number	E8F1	(*. Platform (1) serial number: 53)
Condition of EUT	WM223: Production model	(*. Platform (1): Engineering prototype) (*. Not for sale: This sample is equivalent to mass-produced items.)
Receipt Date of Sample	September 11, 2013 (*. EUT for power measurement.) *. No modification by the Lab. October 3, 2013(*. EUT for SAR test.) *. No modification by the Lab. (*. The EUT that had been measured the power of SAR test reference, was installed into the platform (1)-digital camera (model: PC2071) from the beginning. After power measurement, the EUT was returned to the customer, and the RF wiring was changed to the original antenna line form the antenna conducted power measurement line of the SAR test. The EUT was installed into a Platform (1) which SAR tested, by the customer.)	
Country of Mass-production	WM223: Philippines	(*. Platform (1): Japan, China)
Category Identified	Portable device *. Since EUT may contact and/or very close to a human body during Wi-Fi operation, the partial-body SAR (1g) shall be observed.	
Rating	DC3.3V and DC1.8V supplied form the platform *. The EUT is installed into the specified the platform that was operated by the re-chargeable Li-ion battery. Therefore, each SAR test, the platform which had built-in EUT was operated with full-charged battery.	
Feature of EUT	The EUT is a Wireless Module which installs into the specified platform.	
Platform model of EUT	Platform (1) - Digital camera, model: PC2071	
SAR Accessory	None	

2.2 Product Description (Wireless module: WM223)

Equipment type	Transceiver	
Frequency of operation	2412-2462MHz (11b,11g,,11n(20HT)), 2422-2452MHz (11n(40HT))	
Channel spacing	5MHz	
Bandwidth	20MHz(11b,11g,,11n(20HT)), 40MHz(11n(40HT))	
Type of modulation	DSSS(11b): CCK, DQPSK, DBPSK OFDM(11g,11n(20HT),11n(40HT)): 64QAM, 16QAM, QPSK, BPSK	
Q'ty of Antenna	1 pc.	
Antenna type	Monopole type chip antenna	
Antenna gain (peak)	-3.30dBi (2442MHz)	
Transmit power and tolerance (Manufacture variation)	11b: 13dBm +2dBm/-2.5dB	11g: 10.7dBm +2dBm/-2.5dB
	11n(20HT): 10.7dBm +2dBm/-2.5dB	11n(40HT): 10.7dBm +2dBm/-2.5dB
	*. Refer to clause 2.3 for more detail.	
	*. The measured Tx output power (conducted) refers to section 6 in this report.	
Maximum output power which may possible	11b: 15dBm	11g: 12.7dBm
	11n(20HT): 12.7dBm	11n(40HT): 12.7dBm
	*. Refer to clause 2.4 for more detail.	
Power supply	DC 3.3V, DC1.8V (*. The power of DC3.3V and DC1.8V are supplied from the platform via constant voltage circuit.)	
Operation temperature range	-20 to +55 deg.C	

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

2.3 Tx output power specification (antenna port terminal conducted)

		Target Power [dBm] (average)																											
		11b				11g								11n(20HT)															
[MHz]	CH	1	2	5.5	11	6	9	12	18	24	36	48	54	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2412	1	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2417	2	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2422	3	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2427	4	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2432	5	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2437	6	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2442	7	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2447	8	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2452	9	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2457	10	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2462	11	13	13	13	13	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-

		Target Power [dBm] (average)															
		11n(40HT)															
[MHz]	CH	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2422	3	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2427	4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2432	5	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2437	6	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2442	7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2447	8	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-
2452	9	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	-	-	-	-	-	-	-	-

2.4. Maximum output power which may possible

		Target Power [dBm] (average)																											
		11b				11g								11n(20HT)															
[MHz]	CH	1	2	5.5	11	6	9	12	18	24	36	48	54	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2412	1	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2417	2	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2422	3	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2427	4	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2432	5	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2437	6	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2442	7	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2447	8	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2452	9	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2457	10	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2462	11	15	15	15	15	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-

		Target Power [dBm] (average)															
		11n(40HT)															
[MHz]	CH	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
2422	3	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2427	4	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2432	5	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2437	6	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2442	7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2447	8	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-
2452	9	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	-	-	-	-	-	-	-	-

SECTION 3: Test specification, procedures and results

3.1 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. 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 in accordance with the following measurement procedures..

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.

KDB 447498 D01 (v05r01): General RF exposure guidance
KDB 248227 D01 (v01r02): SAR Measurement Procedures for 802.11a/b/g Transmitters
KDB 865664 D01 (v01r01): SAR measurement 100MHz to 6GHz
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

*. In this report, IEC 62209-1:2005 and IEC 62209-2:2010-03 are also considered as reference. The comment is attached to the portion to which IEC 62209-1 and IEC 62209-2 were referred to specially.

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

	Wi-Fi (DTS) / in Platform (1)
Test Procedure	SAR measurement: KDB 447498, KDB 248227, KDB 865664, IEC 6220-9-2, IEEE Std.1528
Category	FCC 47CFR §2.1093 (Portable device)
Results (SAR(1g))	**Complied**
Reported SAR value (*. Scaled)	**0.86 W/kg**
Measured SAR value	0.658 W/kg
Operation mode, channel	11b, 1Mbps, 2462MHz (11ch)
Power measured/max. (scaled factor)	13.83 dBm/15dBm (×1.31)

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: Where this product is built into a new platform, it was verified whether multiplatform conditions can be suited in according with section 2) of 5.2.2 2 in KDB447498 D01 (v05).

Consideration of the test results: **The highest reported SAR (1g) of Platform (1) was > 0.8 W/kg and ≤ 1.2W/kg.**
Since highest reported SAR (1g) on this platform (1) which obtained in accordance with KDB447498 (v05) was under 1.2 W/kg, this EUT was approved to operate a single platform which was tested in this report。

3.4 Test Location

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

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3.5 Confirmation before SAR testing

3.5.1 Average power for SAR tests

Before SAR test, the RF wiring for the sample had been switched to the antenna conducted power measurement line from the antenna line and the average power was measured. The result is shown in Section 6.

*. The EUT transmission power was verified that it was within 2dB lower than the maximum tune-up tolerance limit when it was set the rated power. (Clause 4.1, KDB447498 D01(v05r01))

Step.1 Data rate check

The data rate check was measured for all modes in one of default frequency.

11b		11g		11n(20HT)			11n(40HT)		
Modulation	Data rate [Mbps]	Modulation	Data rate [Mbps]	MCS Index	Spatial Stream	Modulation	MCS Index	Spatial Stream	Modulation
DBPSK/DSSS	1	BPSK/OFDM	6	MCS0	1	BPSK/OFDM	MCS0	1	BPSK/OFDM
DQPSK/DSSS	2	BPSK/OFDM	9	MCS1	1	QPSK/OFDM	MCS1	1	QPSK/OFDM
CCK/DSSS	5.5	QPSK/OFDM	12	MCS2	1	QPSK/OFDM	MCS2	1	QPSK/OFDM
CCK/DSSS	11	QPSK/OFDM	18	MCS3	1	16QAM/OFDM	MCS3	1	16QAM/OFDM
		16QAM/OFDM	24	MCS4	1	16QAM/OFDM	MCS4	1	16QAM/OFDM
		16QAM/OFDM	36	MCS5	1	64QAM/OFDM	MCS5	1	64QAM/OFDM
		64QAM/OFDM	48	MCS6	1	64QAM/OFDM	MCS6	1	64QAM/OFDM
		64QAM/OFDM	54	MCS7	1	64QAM/OFDM	MCS7	1	64QAM/OFDM

Step.2 Consideration of SAR test channel

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

Mode	MHz	Channel	default	SAR Tested/Reduced				Remarks
			11b/g/n(20HT)	11b	11g	11n(20HT)	11n(40HT)	
802.11 b/g/n	2412	1 (*1)	√	Tested	Reduced (*2)	Reduced (*2)		SAR test were applied to 11b and 11n(40HT) mode, in lowest data rate. (*3)
	2422	3					Reduced (*4)	
	2437	6	√	Tested	Reduced (*2)	Reduced (*2)	Reduced (*4)	
	2452	9					Tested	
	2462	11 (*1)	√	Tested	Reduced (*2)	Reduced (*2)		

√ = "default test channels of requested by KDB248227"

*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 of power measurement and SAR test plan.

*2. Since the target average power of 11g and 11n(20HT) were more than 2dB lower than the corresponded 11b power, SAR test was only applied to the 11b mode for 20MHz BW operation.. (KDB248227) (Refer to Section 6.)

*3. In 11b and 11n(40HT) mode, since the average power of higher data rate were less than 0.25dB higher than the lowest data rate, SAR test were only applied to the lowest data rate. (KDB248227) (Refer to Section 6.)

*4. Since the extrapolated maximum peak SAR for the maximum output channel was ≤1.6W/kg and the 1g averaged SAR was ≤0.8W/kg, the testing for other channels were omitted. (KDB248227)

3.6 Confirmation after SAR testing

It was checked that the power drift [W] is within ±5% in the evaluation procedure of SAR testing. The verification of power drift during the SAR test is that DASY5 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.

*. DASY5 system calculation Power drift value[dB] =20log(Ea)/(Eb) (where, Before SAR testing: Eb[V/m] / After SAR testing: Ea[V/m])

Limit of power drift[W] = ±5%

Power drift limit (X) [dB] = 10log(P_drift)=10log(1.05/1)=10log(1.05)-10log(1)=0.21dB

from E-filed relations with power.

S=E×H=E^2/η=P/(4×π×r^2) (η: Space impedance) → P=(E^2×4×π×r^2)/η

Therefore, The correlation of power and the E-filed

Power drift limit (X) dB=10log(P_drift)=10log(E_drift)^2=20log(E_drift)

From the above mentioned, the calculated power drift of DASY5 system must be the less than ±0.21dB.

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.

Setup	Explanation of EUT setup position (*. Refer to Appendix 1 for test setup photographs.)	Antenna distance [mm]	SAR Tested /Reduced	SAR type
Top	The top surface of digital camera was touched to the Flat phantom.	3.70	**Tested**	Body (touch)
Top-front	The top-front portion (lens side) of digital camera was touched to the Flat phantom.	≈5	**Tested**	
Top-rear	The top-rear portion (LCD side) of digital camera was touched to the Flat phantom.	3.60	**Tested**	
Front (Lens)	The front section (lens side) of digital camera was touched to the Flat phantom.	12.62	**Tested**	
Rear (LCD)	The rear section (LCD side) of digital camera was touched to the Flat phantom.	7.34	**Tested**	
Left	The left surface of platform was touched to the Flat phantom.	36.54	**Tested**	
Right	The right surface of platform was touched to the Flat phantom.	62.10	**Tested**	
Bottom	The bottom flat surface of platform was touched to the Flat phantom.	56.90	**Tested**	

*. **Antenna distance**: this means the distance from the EUT antenna inside a platform to the outer surface of platform which an operator may touch.
*. **Size of EUT: 22.5mm (width) × 11.5mm (depth) × 2.05mm max (height)**
*. Size of platform: 103.8mm (width) × 26.0mm (depth) × 61.0mm (height)

*. **SAR test reduction consideration**

KDB 447498 D01 (v05r01) was taken into consideration as other approaches to reduce SAR test..
Parenthesis 1), Clause 4.3.1, KDB 447498 D01 (v05r01) gives the following formula to calculate the SAR(1g) test exclusion thresholds for 100MHz-6GHz at test separation distance ≤50mm.

[(max.power of channel, including tune-up tolerance, mW) / (min.test separation distance, mm)] × [√f (GHz)] ≤ 3.0 (for SAR(1g)) ·····(formula (1))

If power is calculated from the upper formula (1);

[SAR(1g) test exclusion thresholds, mW] = 3 × [test separation distance, mm] / [√f (GHz)] ·····(formula (2))

Parenthesis 2), Clause 4.3.1, KDB 447498 D01 (v05r01) gives the following formula to calculate the SAR(1g) test exclusion thresholds for 1.5-6GHz at test separation distance >50mm.

[test exclusion thresholds, mW] = [(Power allowed at numeric threshold for 50mm in formula (1))] + [(test separation distance, mm) - (50mm)] × 10 (formula (3))

According to this formula, the calculated results in typical antenna distance of platform are shown in the following table.

SAR(1g) test exclusion thresholds [mW]					
Frequency	**Antenna separation distance [mm]**				
[GHz]	**4**	**8**	**13**	**20**	**35**
2.462	**7.7** (8.9dBm)	**15.3** (11.9dBm)	**24.9** (14.0dBm)	**38.3** (15.8dBm)	**66.9** (18.3dBm)

*. The measured average power of EUT was shown in Section 6: Confirmation before SAR testing.

Since the maximum power (including tune-up tolerance) of EUT was 15dBm, SAR test may exclude with the test separation distance of 20mm or more.

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

Step 1	Change the setup positions. (*. Change the battery type at worst SAR condition.)
Step 2	Change the operation mode. (at the worst position.)

*. 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, 11g, 11n(20HT) and 11n(40HT) continuous transmitting modes.
The frequency and the modulation used in the SAR testing are shown as a following.

Operation mode	11b	11g	11n(20HT)	11n(40HT)
Tx frequency band	2412-2462MHz			2422-2452MHz
Tested frequency	2412, 2437, 2462MHz	Reduced (*2)	Reduced (*2)	2452MHz (*1)
Modulation	DBPSK/DSSS	-	-	BPSK/OFDM
Data rate	1Mbps (*3)	-	-	MCS0 (*3)
Crest factor	1.0 (100% duty cycle)	-	-	1.0 (100% duty cycle)
Controlled software	"RF TEST" mode. (*. Power setting (for power measurement, SAR test): 14(11b), 12(11g, 11n(20HT), 11n(40HT))			

*1. SAR test was only applied to a highest output channel of 11n(40HT), because the reported SAR (1g) value were less than 0.8W/kg and the peak-SAR were less than 1.6W/kg. (KDB248227)
*2. Since the target average power of 11g and 11n(20HT) were more than 2dB lower than the corresponded 11b power, SAR test was only applied to the 11b mode for 20MHz BW operation.. (KDB248227)
*3. Since the average powers of higher data rate were less than 0.25dB higher than the lowest data rate, SAR test was only applied to the lowest data rate. (KDB248227)

SECTION 5: Uncertainty Assessment (SAR measurement)

Uncertainty of SAR measurement(v07) (*. Body tissue, ε & σ tolerance: ≤ ± 5%, DAK3.5, Tx: ≈100% duty cycle)	Under 3 GHz	
	1g SAR	10g SAR
Combined measurement uncertainty of the measurement system (k=1)	± 12.5%	± 12.2%
Expanded uncertainty (k=2)	± 25.0%	± 24.4%

	Error Description (Under 3GHz) (v07)	Uncertainty Value	Probability distribution	Divisor	ci (1g)	ci (10g)	ui (1g)	ui (10g)	Vi, veff
A	**Measurement System** (DASY5)						(std. uncertainty)	(std. uncertainty)	
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	Probe modulation response (CW)	±0.0 %	Rectangular	√3	1	1	±0.0 %	±0.0 %	∞
7	Sensitivity Error (detection limit)	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
8	Response Time Error (<5ms/100ms wait)	±0.0 %	Normal	1	1	1	±0.0 %	±0.0 %	∞
9	Integration Time Error (100% duty cycle)	±0.0 %	Rectangular	√3	1	1	±0.0 %	±0.0 %	∞
10	Readout Electronics Error(DAE)	±0.3 %	Rectangular	√3	1	1	±0.3 %	±0.3 %	∞
11	RF ambient conditions-noise	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
12	RF ambient conditions-reflections	±3.0 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
13	Probe positioner mechanical tolerance	±1.1 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
14	Probe Positioning with respect to phantom shell	±2.9 %	Rectangular	√3	1	1	±1.7 %	±1.7 %	∞
15	Errors: Extrapol., Interpol. & Integration Algorithms	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
B	**Test Sample Related**								
16	Test Sample Positioning Error	±5.0 %	Normal	1	1	1	±5.0 %	±5.0 %	145
17	Device Holder or Positioner Tolerance	±3.6 %	Normal	1	1	1	±3.6 %	±3.6 %	5
18	Test Sample Output Power Drift Error	±5.0 %	Rectangular	√3	1	1	±2.9 %	±2.9 %	∞
C	**Phantom and Setup**								
19	Phantom uncertainty (shape, thickness tolerances)	±7.5 %	Rectangular	√3	1	1	±4.3 %	±4.3 %	∞
20	Target Liquid Conductivity Tolerance (≤5%)	±5.0 %	Rectangular	√3	0.64	0.43	±1.8 %	±1.2 %	∞
21	Measurement Liquid Conductivity Error (DAK3.5)	±3.0 %	Normal	1	0.64	0.43	±1.9 %	±1.3 %	7
22	Target Liquid Permittivity Tolerance (≤5%)	±5.0 %	Rectangular	√3	0.6	0.49	±1.7 %	±1.4 %	∞
23	Measurement Liquid Permittivity Error (DAK3.5)	±2.9 %	Normal	1	0.6	0.49	±1.7 %	±1.4 %	7
24	Liquid Conductivity-temp.uncertainty (≤2deg.C.)	±5.2 %	Rectangular	√3	0.78	0.71	±2.3 %	±2.1 %	∞
25	Liquid Permittivity-temp.uncertainty (≤2deg.C.)	±0.8 %	Rectangular	√3	0.23	0.26	±0.1 %	±0.1 %	∞
	Combined Standard Uncertainty						**±12.5** %	**±12.2** %	523
	Expanded Uncertainty (k=2)						**±25.0 %**	**±24.4 %**	

*. Table of uncertainties are listed for ISO/IEC 17025
*. This measurement uncertainty budget is suggested by IEEE 1528, IEC 62209-2 and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget). Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r01 Section 2.8.1., when the highest measured SAR(1g) within a frequency band is < 1.5W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2003 is not required in SAR reports submitted for equipment approval.

SECTION 6: Confirmation before testing

6.1 Assessment for the conducted power of EUT

6.1.1 SAR test reference power (Worst data rate & worst channel determination)

Mode	Freq. [MHz]	D/R [Mbps]	Cable Loss [dB]	Att. [dB]	D/F [dB]	Average power			PAR [dB]	Power tolerance & correction				SAR Tested/ Reduced	Remarks
						P/M Reading	Result			Target & (+)tolerance	Deviation from max..	Scaled Factor	≤2 dB from max.?		
						[dBm]	[dBm]	[mW]		[dBm]	[dB]	[-]			
11b	2412	1	0.50	10.02	0.00	3.11	**13.63**	23.1	2.67	13.0 +2	-1.37	×1.37	Yes	Tested	-
	2412	2	0.50	10.02	0.00	3.13	13.65	23.2	2.61	13.0 +2	-1.35	×1.36	Yes	-	-
	2412	5.5	0.50	10.02	0.00	3.15	13.67	23.3	2.01	13.0 +2	-1.33	×1.36	Yes	(*1)	Highest in D/R.(11b)
	2412	11	0.50	10.02	0.00	3.13	13.65	23.2	2.63	13.0 +2	-1.35	×1.36	Yes	-	-
	2437	**1**	0.50	10.02	0.00	3.31	**13.83**	24.2	2.64	13.0 +2	-1.17	×1.31	Yes	Tested	Highest in channel.(11b)
	2462	**1**	0.50	10.02	0.00	3.31	**13.83**	24.2	2.62	13.0 +2	-1.17	×1.31	Yes	Tested	Highest in channel.(11b)
11g	2412	6	0.50	10.02	0.00	0.73	**11.25**	13.3	9.71	10.7 ± 2	-1.45	×1.40	Yes	Reduced(*2)	Highest in D/R.(11g)
	2412	9	0.50	10.02	0.00	0.67	11.19	13.2	9.14	10.7 ± 2	-1.51	×1.42	Yes	-	-
	2412	12	0.50	10.02	0.00	0.67	11.19	13.2	9.53	10.7 ± 2	-1.51	×1.42	Yes	-	-
	2412	18	0.50	10.02	0.00	0.70	11.22	13.2	8.89	10.7 ± 2	-1.48	×1.41	Yes	-	-
	2412	24	0.50	10.02	0.00	0.61	11.13	13.0	9.76	10.7 ± 2	-1.57	×1.44	Yes	-	-
	2412	36	0.50	10.02	0.00	0.59	11.11	12.9	9.61	10.7 ± 2	-1.59	×1.44	Yes	-	-
	2412	48	0.50	10.02	0.00	0.58	11.10	12.9	9.36	10.7 ± 2	-1.60	×1.45	Yes	-	-
	2412	56	0.50	10.02	0.00	0.56	11.08	12.8	9.58	10.7 ± 2	-1.62	×1.45	Yes	-	-
	2437	**6**	0.50	10.02	0.00	0.96	**11.48**	14.1	9.57	10.7 ± 2	-1.22	×1.32	Yes	Reduced(*2)	-
	2462	**6**	0.50	10.02	0.00	1.49	**12.01**	15.9	9.24	10.7 ± 2	-0.69	×1.17	Yes	Reduced(*2)	Highest in channel.(11g)
11n (20HT)	2412	MCS0	0.50	10.02	0.00	0.76	**11.28**	13.4	8.96	10.7 ± 2	-1.42	×1.39	Yes	Reduced(*2)	Highest in D/R.(n20)
	2412	MCS1	0.50	10.02	0.00	0.74	11.26	13.4	9.00	10.7 ± 2	-1.44	×1.39	Yes	-	-
	2412	MCS2	0.50	10.02	0.00	0.73	11.25	13.3	8.79	10.7 ± 2	-1.45	×1.40	Yes	-	-
	2412	MCS3	0.50	10.02	0.00	0.72	11.24	13.3	8.95	10.7 ± 2	-1.46	×1.40	Yes	-	-
	2412	MCS4	0.50	10.02	0.00	0.71	11.23	13.3	8.95	10.7 ± 2	-1.47	×1.40	Yes	-	-
	2412	MCS5	0.50	10.02	0.00	0.74	11.26	13.4	8.80	10.7 ± 2	-1.44	×1.39	Yes	-	-
	2412	MCS6	0.50	10.02	0.00	0.74	11.26	13.4	8.95	10.7 ± 2	-1.44	×1.39	Yes	-	-
	2412	MCS7	0.50	10.02	0.00	0.73	11.25	13.3	8.98	10.7 ± 2	-1.45	×1.40	Yes	-	-
	2437	**MCS0**	0.50	10.02	0.00	0.99	**11.51**	14.2	8.89	10.7 ± 2	-1.19	×1.32	Yes	Reduced(*2)	-
	2462	**MCS0**	0.50	10.02	0.00	1.46	**11.98**	15.8	8.63	10.7 ± 2	-0.72	×1.18	Yes	Reduced(*2)	Highest in channel.(n20)
11n (40HT)	2422	MCS0	0.50	10.02	0.00	0.79	**11.31**	13.5	8.94	10.7 ± 2	-1.39	×1.38	Yes	Reduced(*2)	Highest in D/R.(n40)
	2422	MCS1	0.50	10.02	0.00	0.78	11.30	13.5	8.82	10.7 ± 2	-1.40	×1.38	Yes	-	-
	2422	MCS2	0.50	10.02	0.00	0.77	11.29	13.5	9.20	10.7 ± 2	-1.41	×1.38	Yes	-	-
	2422	MCS3	0.50	10.02	0.00	0.74	11.26	13.4	9.58	10.7 ± 2	-1.44	×1.39	Yes	-	-
	2422	MCS4	0.50	10.02	0.00	0.75	11.27	13.4	9.46	10.7 ± 2	-1.43	×1.39	Yes	-	-
	2422	MCS5	0.50	10.02	0.00	0.71	11.23	13.3	9.56	10.7 ± 2	-1.47	×1.40	Yes	-	-
	2422	MCS6	0.50	10.02	0.00	0.78	11.30	13.5	9.25	10.7 ± 2	-1.40	×1.38	Yes	-	-
	2422	MCS7	0.50	10.02	0.00	0.72	11.24	13.3	9.21	10.7 ± 2	-1.46	×1.40	Yes	-	-
	2437	**MCS0**	0.50	10.02	0.00	0.94	**11.46**	14.0	8.84	10.7 ± 2	-1.24	×1.33	Yes	Reduced(*2)	-
	2452	**MCS0**	0.50	10.02	0.00	0.95	**11.47**	14.0	8.94	10.7 ± 2	-1.23	×1.33	Yes	Tested	Highest in channel.(n40)

*. Freq.: Frequency, D/R: Data Rate, Att.: Attenuator loss, D/F: Duty Factor (0dB=100% duty cycle), n/a: not applied, P/M: Power Meter, PAR: Peak average ratio.
*. Calculating formula:
Results (Ave, dBm) = (P/M Reading, dBm)+(Cable loss, dBm)+(Attenuator, dBm)+(duty factor, dBm), where (duty factor, dBm)=10 × log (100/(duty cycle, %))
Deviation form max.: (Power deviation, dB) = (results power (average, dBm)) - (Max.-specification output power (average, dBm))
Scaled Factor: Power scaled factor for obtained SAR value, Scaled Factor [-] = 1 / (10 ^ ("Deviation from max." / 10))
*. Uncertainty of antenna port conducted test; Power measurement uncertainty above 1GHz for this test was: (±) 1.5dB
*. SAR reference; Date measured: September 19 and 20, 2013 / measured by: Hiroshi Naka / (Sept.14; 24deg.C./49%RH, Sept.20; 24deg.C./54%RH)

*1. 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. (KDB248227)

*2. Since the extrapolated maximum peak SAR for the maximum output channel was ≤1.6W/kg and the 1g averaged SAR was ≤0.8W/kg, the testing for other channels were omitted. (KDB248227)

*. Since the target average power of 11g and 11n(20HT) were more than 2dB lower than the corresponded 11b power, SAR test was only applied to 11b mode for 20MHz BW mode. (KDB248227)

*. **EUT serial number: "E8F1"**

SECTION 7: Measurement results

7.1 SAR (Body) in the platform (1)-Digital camera (model: PC2071)

Measurement date: October 4, 2013 Measurement by: Hiroshi Naka

[Liquid measurement]

Target Frequency [MHz]	Liquid type	Liquid parameters						Temp. [deg.C.]	Depth [mm]	ΔSAR Coefficients (*1)		Remarks / Environment
		Permittivity (εr) [-]			Conductivity [S/m]					ΔSAR (1g) [%]	Correction required?	
		Target	Measured (Δεr)		Target	Measured (Δσ)						
2412	Body	***52.75***	50.80	-3.7%	***1.914***	1.927	+0.7%	22.2	155	(+1.16)	not required.	October 4, 2013, before SAR test /ambient; 22.2 deg.C., 52%RH
2437		***52.72***	50.74	-3.7%	***1.938***	1.957	+1.0%			(+1.33)	not required.	
2452		***52.70***	50.72	-3.8%	***1.953***	1.979	+1.3%			(+1.49)	not required.	
2462		***52.68***	50.67	-3.8%	***1.967***	1.991	+1.2%			(+1.45)	not required.	

*. The target value is a parameter defined in Appendix A of KDB865664 D01 (v01r01), the dielectric parameters suggested for head and body tissue simulating liquid are given at 2000, 2450 and 3000MHz. As an intermediate solution, dielectric parameters for the frequencies between 2000 to 3000 MHz were obtained using linear interpolation. (Refer to Appendix 3-4)

[SAR measurement results (Partial-Body)]

SAR measurement results (Body simulated tissue)													Reported SAR		
Mode	[MHz] (CH)	Modulation /Data rate / Crest factor	EUT setup conditions: Position	Gap [mm]	Battery ID	Liquid temp. [deg.C.]: Before	After	Power drift [dB]	SAR (1g) [W/kg] maximum value of multi-peak: Observed	ΔSAR [%]	ΔSAR corrected	Data# in Appendix 2-2	SAR (1g) [W/kg]: Scaled factor	tune-up SAR	Remarks
Step 1: Change the setup positions (*. Change the battery type at worst SAR condition.)															
11b	2462(11)	DBPSK&DSSS /1Mbps /1.0	**Rear (LCD)**	0	#3	22.5	22.6	-	(0.086)	*. Fast SAR (*2)		-	n/a	n/a	*.Polynomial-fit
			Front (Lens)	0	#3	22.6	22.6	-	(0.130)	*. Fast SAR (*2)		-	n/a	n/a	*.Polynomial-fit
			Right	0	#3	22.6	22.6	-	(0.061)	*. Fast SAR (*2)		-	n/a	n/a	*.Polynomial-fit
			Left	0	#1	22.6	22.6		(0.089)	*. Fast SAR (*2)		-	n/a	n/a	*.Polynomial-fit
			Bottom	0	#1	22.6	22.6	-	(0.155)	*. Fast SAR (*2)		-	n/a	n/a	*.Polynomial-fit
			Top-front	0	#1	22.5	22.4	-0.05	**0.329**	-	-	Step 1-1	×1.31	**0.43**	-
			Top-rear	0	#1	22.4	22.4	-0.03	**0.420**	-	-	Step 1-2	×1.31	**0.55**	-
			Top	0	#2	22.4	22.4	-0.20	**0.658**	-	-	Step 1-3	×1.31	**0.86**	<-Highest SAR.
	2437(6)			0	#2	22.4	22.4	0.03	**0.580**	-	-	Step 1-4	×1.31	**0.76**	-
	2412(1)			0	#2	22.4	22.4	0.03	**0.531**	-	-	Step 1-5	×1.37	**0.72**	-
	2462(11)			0	LH#1	22.4	22.4	0.06	**0.645**	-	-	Step 1-6	×1.31	**0.84**	*.Change battery type-.
Step 2: Change the operation mode															
11n (40HT)	2452(9)	BPSK&OFDM /MCS0 /1.0	**Top**	0	#1	22.4	22.5	0.04	**0.346**	-	-	Step 2-1	×1.33	**0.46**	(*3)

Notes:

*. Gap: It is the separation distance between the nearest position of EUT outer surface and the bottom outer surface of phantom; n/a: not applied.

*1. The number of ΔSAR(1g) of body simulated tissue was reference purpose only. ΔSAR correction was only applied to head simulated tissue. The coefficients are parameters defined in Annex F, IEC 62209-2:2010. Since the measured liquid parameters were ≤ the target εr and ≥ the target σ values and also within 5% of the required target dielectric parameters, the measured SAR was not compensated by ΔSAR coefficients (Clause 2) of 2.6, KDB865664 D01 (v01r01)). In addition, in accordance with clause 6.1.1 of IEC62209-2; "If the correction ΔSAR has a negative sign, the measured SAR results shall not be corrected", the calculated ΔSAR values of the tested liquid had shown negative correction. Therefore the measured SAR was not required ΔSAR correction.
ΔSAR(1g)= Cεr ×Δεr + Cσ ×Δσ, Cεr=-7.854E-4×f^3+9.402E-3×f^2-2.742E-2×f-0.2026 / Cσ =9.804E-3×f^3-8.661E-2×f^2+2.981E-2×f+0.7829

*2. Algorithm: Douglas, M.G., Chou, C-K.; Accurate and Fast Estimation of Volumetric SAR from Planner Scans from 30 MHz to 6 GHz," Bioelectromagnetics Society 29th Annual Meeting, June 2007.

*3. Since the extrapolated maximum peak SAR for the maximum output channel was ≤1.6W/kg and the 1g averaged SAR was ≤0.8W/kg, the testing for other channels were omitted. (KDB248227)

*. Battery No.#1, #2 and #3 were same model. Battery No.LH#1 was large capacity model. Refer to Appendix 1 for more details.

*. Since the target average power of 11g and 11n(20HT) were more than 2dB lower than the corresponded 11b power, SAR test were not applied to the 11g and 11n(20HT) mode. (KDB248227)

*. 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	Probe calibration frequency	Validity	Conversion factor	Uncertainty
2412, 2437, 2452, 2462MHz	2450MHz	within ±50MHz of calibration frequency	6.82	±12.0%

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