SAR TEST REPORT

Test Report No.: 11641159S-A

Applicant : **RICOH COMPANY, LTD.**

Type of Equipment : **Digital Camera**

Model No. : **RICOH THETA V**

FCC ID : **BBP-RR214**

Test Standard : **FCC 47CFR §2.1093**

Test Result : **Complied**

Highest Reported SAR(1g) [W/kg]				Remarks (DTS band)				Remarks (UNII band)			
DTS band	UNII band	Type	Limit	Frequency [MHz]	Mode	Output power (average) [dBm]		Frequency [MHz]	Mode	Output power (average) [dBm]	
						Measured	Max.			Measured	Max
1.28	1.41	Body-worn	1.6	2412	11n(20HT)(MCS0)	13.84	14	5210	11ac(80VHT)(MCS0)	13.13	14

*. **Highest reported SAR of this device for body-worn and simultaneous transmission (Bluetooth + Wi-Fi(W52); 0.13(estimated)+1.41=1.54 W/kg) are "1.41 W/kg" and "1.54 W/kg".**

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Date of test: May 8~17, 2017

Test engineer: Hiroshi Naka
Engineer, Consumer Technology Division

Approved by: Toyokazu Imamura
Leader, Consumer Technology Division

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☒ There is no testing item of "Non-accreditation".

RTL02610

REVISION HISTORY

Revision	Test report No.	Date	Page revised	Contents
Original	11641159S-A	July 11, 2017	-	-

*. 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	RICOH COMPANY, LTD.
Brand Name	RICOH
Address	1-3-6 Nakamagome, Ohta-ku, Tokyo 143-8555, Japan
Telephone Number	+81-50-3534-5213
Contact Person	Kenji Daigo

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

Type of Equipment	Digital Camera
Model Number	RICOH THETA V
Serial Number	YL00000260
Condition of EUT	Production prototype (Not for sale: This samples is equivalent to mass-produced items.)
Receipt Date of Sample	April 27, 2017 (*. EUT for power measurement.) *. No modification by the Lab. May 12, 2017 (*. EUT for SAR test.) *. No modification by the Lab. (*. After power measurement, the EUT was returned to the customer, and the RF wiring was changed to the original antenna line from the antenna conducted power measurement line for SAR test.)
Country of Mass-production	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	DC 3.6V (Li-ion battery operation), DC 5V (USB BUS power operation) *. The EUT was operated by either the build-in re-chargeable Li-ion battery or USB BUS power via USB cable.
Feature of EUT	The EUT is a Digital Camera which support wireless LAN and Bluetooth 4.2.
SAR Accessory	None

2.2 Product Description (Wireless Module)

		Mode	channel	Operation frequency [MHz]	Data rate [Mbps]	Modulation	Channel spacing [MHz]	Band width [MHz]	Average power [dBm] Min.	Typical	Max.
Transmit average power (*. The measured Tx output power (antenna terminal conducted) refers to section 6 in this report.)	**Bluetooth (Ver.4.2)**	**BDR/EDR**	0~79	2402~2480	1~3	FHSS	1	1	**-6**	**0.2**	**4**
		Low energy	0~39	2402~2480	1	FHSS	2	2	**-6**	**0.2**	**4**
	11b		1~11	2412~2462	1~11	DSSS	5	20	**10**	**12**	**14**
	11g		1~11	2412~2462	6~54	OFDM	5	20	**10**	**12**	**14**
	11n(20HT)		1~11	2412~2462	MCS0~7	OFDM	5	20	**10**	**12**	**14**
	11a		36,40,44,48	5180~5240	6~54	OFDM	20	20	**10**	**12**	**14**
	11n(20HT)		36,40,44,48	5180~5240	MCS0~7	OFDM	20	20	**10**	**12**	**14**
	11ac(20VHT)		36,40,44,48	5180~5240	MCS0~8	OFDM	20	20	**10**	**12**	**14**
	11n(40HT)		38,46	5190 5230	MCS0~7	OFDM	20	40	**10**	**12**	**14**
	11ac(40VHT)		38,46	5190 5230	MCS0~9	OFDM	20	40	**10**	**12**	**14**
	11ac(80VHT)		42	5210	MCS0~9	OFDM	20	80	**10**	**12**	**14**
Equipment type		Transceiver									
Type of modulation	Bluetooth	FHSS: GFSK (*. EDR: GFSK+ π/4-DQPSK, GFSK+ 8DPSK)									
	Wi-Fi	DSSS: DBPSK, DQPSK, CCK / OFDM: BPSK, QPSK, 16QAM, 64QAM, 256QAM (*.256QAM is supported by 11ac mode.)									
Power supply		DC 1.3V, DC 1.8V, DC 3.0V (*. These power are supplied via constant voltage circuit.)									

Quantity of Antenna	1 piece		
Antenna type	λ/4 Monopole antenna	Antenna connector type	This antenna is printed on the print circuit board.
Antenna gain (Peak)	0.119 dBi (2.4GHz band), -3.803 dBi (W52 band) (*.including cable loss)		

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

*. This Wireless module supports both Wi-Fi and Bluetooth. Wi-Fi of 2.4GHz and Bluetooth were not transmitted simultaneously. Wi-Fi of5GHz and Bluetooth were transmitted simultaneously at same antenna. Therefore simultaneously transmitted SAR was only considered for Wi-Fi of 5GHz band operation.

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..

KDB 447498 D01 (v06): General RF exposure guidance
KDB 248227 D01 (v02r02): SAR Guidance for IEEE 802.11 (Wi-Fi) transmitters
KDB 865664 D01 (v01r04): SAR measurement 100MHz to 6GHz
IEEE Std. 1528-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

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
General population / uncontrolled exposure, Hands (averaged over any 10g of tissue) limit: 4 W/kg

3.3 Procedures and Results

Band (Operation frequency [MHz])	Bluetooth (BT) (2402-2480)	Wi-Fi (DTS) (2412-2462)	Wi-Fi (U-NII-1) (5180~5240)(W52)	Simultaneous transmission (Bluetooth+Wi-Fi(U-NII-1,W52))(*1)
Test Procedure	SAR measurement; KDB 447498, KDB 248227, KDB 865664, IEEE Std.1528			
Category	FCC 47CFR §2.1093 (Portable device)		SAR type	Body touch
Results (Reported SAR(1g))	Complied	Complied	Complied	Complied
SAR (1g) Limit [W/kg]	1.6	1.6	1.6	1.6
Reported SAR(1g) value	0.12 W/kg (*. Estimated SAR: 0.13 W/kg)	1.28 W/kg	1.41 W/kg	1.54 W/kg (BT: 0.13 W/kg (Estimated) + Wi-Fi(W52): 1.41 W/kg)
Measured SAR value	0.108 W/kg	1.23 W/kg	1.13 W/kg	(Refer to left column)
Mode, frequency[MHz]	BDR(DH5), 2441	11n(20HT)(MCS0), 2412	11ac(80VHT)(MCS0), 5210	(Refer to left column)
Duty cycle [%] (scaled factor)	77.8 (×1.02 (*1))	99.7 (×1.00)	97.7 (×1.02)	(Refer to left column)
Output average power [dBm] (max. power, scaled factor)	3.66 (4, ×1.08)	13.84 (14, ×1.04)	13.13 (14, ×1.22)	(Refer to left column)

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
*. (Calculating formula) Corrected SAR to max.power (W/kg) = (Measured SAR (W/kg)) × (Duty scaled) × (Tune-up factor)
where; Tune-up factor [-] = 1 / (10 ^ ("Δmax (max.power - burst average power), dB" / 10)), Duty scaled factor [-] = 100(%) / (duty cycle, %)
*1. This Wireless module supports both Wi-Fi and Bluetooth. Wi-Fi of 2.4GHz and Bluetooth were not transmitted simultaneously. Wi-Fi of5GHz and Bluetooth were transmitted simultaneously at same antenna. Therefore simultaneously transmitted SAR was only considered for Wi-Fi of 5GHz band operation.
*2. The measured duty cycle number of BDR was nearly equal to highest theory duty cycle. Therefore the duty scaled factor for SAR was decided by "×1.00".

3.4 Test Location

No.7 shielded room (2.76 m (Width) × 3.76 m (Depth) × 2.4 m (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 (v06))

Step.1 Data rate check (*. The EUT supported the following data rate in each operation mode.)

802.11b		802.11g		802.11a		802.11n(HT20)			802.11n(HT40)		
Modulation	Data rate	Modulation	Data rate	Modulation	Data rate	MCS	SS	Modulation	MCS	SS	Modulation
DBPSK/DSSS	1 Mbps	BPSK/OFDM	6 Mbps	BPSK/OFDM	6 Mbps	0	1	BPSK/OFDM	0	1	BPSK/OFDM
DQPSK/DSSS	2 Mbps	BPSK/OFDM	9 Mbps	BPSK/OFDM	9 Mbps	1	1	QPSK/OFDM	1	1	QPSK/OFDM
CCK/DSSS	5.5 Mbps	QPSK/OFDM	12 Mbps	QPSK/OFDM	12 Mbps	2	1	QPSK/OFDM	2	1	QPSK/OFDM
CCK/DSSS	11 Mbps	QPSK/OFDM	18 Mbps	QPSK/OFDM	18 Mbps	3	1	16QAM/OFDM	3	1	16QAM/OFDM
		16QAM/OFDM	24 Mbps	16QAM/OFDM	24 Mbps	4	1	16QAM/OFDM	4	1	16QAM/OFDM
		16QAM/OFDM	36 Mbps	16QAM/OFDM	36 Mbps	5	1	64QAM/OFDM	5	1	64QAM/OFDM
		64QAM/OFDM	48 Mbps	64QAM/OFDM	48 Mbps	6	1	64QAM/OFDM	6	1	64QAM/OFDM
		64QAM/OFDM	54 Mbps	64QAM/OFDM	54 Mbps	7	1	64QAM/OFDM	7	1	64QAM/OFDM

802.11ac(VHT20)			802.11ac(VHT40)			802.11ac(VHT80)			Bluetooth		
MCS	SS	Modulation	MCS	SS	Modulation	MCS	SS	Modulation	Type	Modulation	Packet type
0	1	BPSK/OFDM	0	1	BPSK/OFDM	0	1	BPSK/OFDM	BLE	GFSK/FHSS	BLE (1Mbps)
1	1	QPSK/OFDM	1	1	QPSK/OFDM	1	1	QPSK/OFDM	BDR	GFSK/FHSS	DH1 (1Mbps)
2	1	QPSK/OFDM	2	1	QPSK/OFDM	2	1	QPSK/OFDM	BDR	GFSK/FHSS	DH3 (1Mbps)
3	1	16QAM/OFDM	3	1	16QAM/OFDM	3	1	16QAM/OFDM	BDR	GFSK/FHSS	DH5 (1Mbps)
4	1	16QAM/OFDM	4	1	16QAM/OFDM	4	1	16QAM/OFDM	EDR2	π/4-DQPSK/FHSS	2-DH1 (2Mbps)
5	1	64QAM/OFDM	5	1	64QAM/OFDM	5	1	64QAM/OFDM	EDR2	π/4-DQPSK/FHSS	2-DH3 (2Mbps)
6	1	64QAM/OFDM	6	1	64QAM/OFDM	6	1	64QAM/OFDM	EDR2	π/4-DQPSK/FHSS	2-DH5 (2Mbps)
7	1	64QAM/OFDM	7	1	64QAM/OFDM	7	1	64QAM/OFDM	EDR3	8DPSK/FSSS	3-DH1 (3Mbps)
8	1	256QAM/OFDM	8	1	256QAM/OFDM	8	1	256QAM/OFDM	EDR3	8DPSK/FSSS	3-DH3 (3Mbps)
*. SS: Spatial Stream			9	1	256QAM/OFDM	9	1	256QAM/OFDM	EDR3	8DPSK/FSSS	3-DH5 (3Mbps)

Step.2 Consideration of SAR test channel

For the SAR test reference, on each operation band, the average output power was measured on the low/middle/upper and specified channels with the worst data rate condition in step 1 in the above.

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.

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

Therefore, The correlation of power and the E-filed

Power drift limit (X) dB=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

Antenna separation distances in each test setup plan are shown as follows.

Setup plan	Explanation of SAR test setup plan (*. Refer to Appendix 1 for test setup photographs which had been tested.)	D [mm]	SAR Tested /Reduced (*1)	SAR type
Front-right	The right portion of front of camera(shutter button side) is touched to the Flat phantom with tilted.	**2.1**	**Tested**	Body-touch
Front	The front lens of camera (shutter button side) is touched to the Flat phantom.	**2.8**	**Tested**	
Right	The right surface (switch side) of camera is touched to the Flat phantom.	**6.2**	**Tested**	
Back	The back lens of camera is touched to the Flat phantom.	**≈13**	**Tested**	
Left	The left surface of camera is touched to the Flat phantom.	**32.3**	**Reduced**	
Top	When test is required, the top of camera is touched to the Flat phantom.	**46.6**	**Reduced**	
Bottom	When test is required, the bottom of camera is touched to the Flat phantom.	**75.6**	**Reduced**	

*. **D:** Antenna separation distance. It is the distance from the antenna inside EUT to the outer surface of EUT which an operator may touch.
*. Size of EUT: 45.2 mm (width) × 130.9 mm (height) × 22.9 mm (depth)

***1. Consideration for SAR evaluation exemption**

KDB 447498 D01 (v06) was taken into consideration to reduce SAR test.

Consideration of SAR test reduction by the antenna separation distance (100MHz~6GHz, ≤50mm)

Band, Mode	Setup Position	Minimum distance [mm]	Minimum distance [mm] (rounded)	Upper frequency [GHz]	Maximum power [dBm]	Maximum power [mW]	Maximum power [mW] (rounded)	Calculation of exclusion (*2)	SAR type	SAR test exclusion: Judge for Exclusion	SAR test exclusion: Standalone SAR test required?	Remarks
Bluetooth (BDR/EDR,LE)	Front-right	2.1	**≤5**	2.480	4.0	2.5	**3**	**0.9**	1g	**≤3.0**	*Reduced*	*. SAR test was applied.
WLAN 2.4GHz b,g,n(20HT)	Front-right	2.1	**≤5**	2.462	15.0	31.6	**32**	**10.0**	1g	**≤3.0**	**(>3) Required**	-
	Front	2.8	**≤5**					**10.0**	1g	**≤3.0**	**(>3) Required**	
	Right	6.2	**6**					**8.4**	1g	**≤3.0**	**(>3) Required**	-
	Back	≈13	**13**					**3.9**	1g	**≤3.0**	**(>3) Required**	-
	Left	32.3	**32**					**1.6**	1g	**≤3.0**	*Reduced*	≥32mm can reduce SAR test.
	Top	46.6	**47**					**1.1**	1g	**≤3.0**	*Reduced*	-
WLAN W52 a,n(20/40HT), ac(20/40/80HT)	Front-right	2.1	**≤5**	5.240	15.0	31.6	**32**	**14.7**	1g	**≤3.0**	**(>3) Required**	-
	Front	2.8	**≤5**					**14.7**	1g	**≤3.0**	**(>3) Required**	
	Right	6.2	**6**					**12.2**	1g	**≤3.0**	**(>3) Required**	-
	Back	≈13	**13**					**5.6**	1g	**≤3.0**	**(>3) Required**	-
	Left	32.3	**32**					**1.6**	1g	**≤3.0**	*Reduced*	≥32mm can reduce SAR test.
	Top	46.6	**47**					**1.5**	1g	**≤3.0**	*Reduced*	-

*2. Parenthesis 1), Clause 4.3.1, KDB 447498 D01 (v06) 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)), 7.5(for SAR(10g)) ··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 (2a)

<Conclusion for consideration for SAR test reduction>

1) **The SAR setups of the near antenna which includes "Front-right", "Front", "Right" and "Back" are applied the SAR test in body-liquid.**
2) **The SAR tests of "Left", "Top" and "Bottom" setup are reduced because there is enough antenna separation distance.**
3) **The antenna section did not touch a human head because of the structure of the camera lens (360 degrees view camera), therefore SAR test for the head was reduced**

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

Step 1	On 2.4GHz band, in body liquid, worst SAR search by DSSS mode with a highest measurement output power channel. Add test for OFDM mode, if it's necessary.
Step 2	On W52 band, in body liquid, worst SAR search by largest channel bandwidth mode with a highest measurement output power channel. Add test for other bandwidth mode, if it's necessary.

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

SECTION 4: Operation of EUT during testing

4.1 Operation mode for SAR testing

The EUT has Bluetooth (BDR, EDR, Low energy) and IEEE 802.11b, g, a, n(20HT), n(40HT), ac(20VHT), ac(40VHT) and ac(80VHT) continuous transmitting modes. The frequency and the modulation used in the SAR testing are shown as a following.

Operation mode	BDR	EDR	LE	b		g	n20	a	n20	ac20	n40	ac40	ac80
band	Bluetooth			2.4GHz band				U-NII-1(W52)					
Tx band [MHz]	2402~2480			2412~2462				5180~5240			5190, 5230		5210
Bandwidth [MHz]	1	1	2	20		20	20	20	20	20	40	40	80
Max.power [dBm]	4	4	4	14		14	14	14	14	14	14	14	14
Modulation	FHSS	FHSS	FHSS	DSSS		OFDM	OFDM	OFDM	OFDM	OFDM	OFDM	OFDM	OFDM
Data rate [Mbps]	1	-	1	1	5.5Short	6	MCS0	MCS0	6	MCS0	MCS0	MCS0	MCS0
Frequency tested [MHz]	2441 (*1)	n/a	n/a	2412, 2437, 2462	2412 (*1)	2412, 2437, 2462	2412, 2437, 2462	5180, 5220, 5240	5180, 5220, 5240	5180, 5220, 5240	5190, 5230	5190, 5230	5210

Controlled software	Bluetooth operation: Bluetooth test: RICOH BT RF TEST Version 4 / Wi-Fi operation: RICOH BT WLAN TEST Version 4 (Firmware version of RICOH THETA V: 00500000.)

*. n/a: SAR test was not applied.
*1. This channel has a highest measured average output power.

SAR test reduction consideration

[Table 1. Output power and Body-SAR test channel selection and Reported SAR(1g) [W/kg] (Results) and test reduction plan]

802.11 Modes	b	g	n(20HT)	a	n(20HT)	ac(20HT)	n(40HT)	ac(40VHT)	ac(80VHT)
Data rate [Mbps]	1	6	MCS0	6	MCS0	MCS0	MCS0	MCS0	MCS0
2.4GHz, Ch.	*1* / *6* / *11*	*1* / *6* / *11*	*1* / *6* / *11*						
Max. power [mW]	32 / 32 / 32	32 / 32 / 32	32 / 32 / 32						
Measured Ave. [mW]	24 / 23 / 23	24 / 24 / 23	24 / 24 / 24						
Reported SAR 1g	**1.25** / **1.21** / **1.21**	**1.26** / **1.19** / **1.20**	**1.28** / **1.22** / **1.20**						
W52, Ch.				*36* / *40* / *44* / *48*	*36* / *40* / *44* / *48*	*36* / *40* / *44* / *48*	*38* / *46*	*38* / *46*	*42*
Max. power [mW]				32 / 32 / 32 / 32	32 / 32 / 32 / 32	32 / 32 / 32 / 32	32 / 32	32 / 32	32
Measured Ave. [mW]				24 / 24 / 25 / 24	25 / 24 / 24 / 25	25 / 24 / 24 / 25	24 / 24	24 / 24	25
Reported SAR 1g				**1.32** / **1.37** / **1.40**	**1.32** / **1.34** / **1.40**	**1.29** / **1.38** / **1.37**	**1.31** / **1.35**	**1.32** / **1.35**	**1.41**

SECTION 5: Uncertainty Assessment (SAR measurement)

Uncertainty of SAR measurement (2.4-6GHz) (*.ε&σ: ≤ ± 5%, DAK3.5, Tx: ≈100% duty cycle) (v08)	**1g SAR**	**10g SAR**
Combined measurement uncertainty of the measurement system (k=1)	**± 13.7%**	**± 13.6%**
Expanded uncertainty (k=2)	**± 27.4%**	**± 27.2%**

	Error Description (2.4-6GHz) (v08)	**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	±6.55 %	Normal	1	1	1	±6.55 %	±6.55 %	∞
2	Axial isotropy Error	±4.7 %	Rectangular	√3	√0.5	√0.5	±1.9 %	±1.9 %	∞
3	Hemispherical isotropy Error	±9.6 %	Rectangular	√3	√0.5	√0.5	±3.9 %	±3.9 %	∞
4	Linearity Error	±4.7 %	Rectangular	√3	1	1	±2.7 %	±2.7 %	∞
5	Probe modulation response	±2.4 %	Rectangular	√3	1	1	±1.4 %	±1.4 %	∞
6	Sensitivity Error (detection limit)	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
7	Boundary effects Error	±4.3%	Rectangular	√3	1	1	±2.5 %	±2.5 %	∞
8	Readout Electronics Error(DAE)	±0.3 %	Rectangular	√3	1	1	±0.3 %	±0.3 %	∞
9	Response Time Error	±0.8 %	Normal	1	1	1	±0.8 %	±0.8 %	∞
10	Integration Time Error (≈100% duty cycle)	±0 %	Rectangular	√3	1	1	0 %	0 %	∞
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	±3.3 %	Rectangular	√3	1	1	±1.9 %	±1.9 %	∞
14	Probe Positioning with respect to phantom shell	±6.7 %	Rectangular	√3	1	1	±3.9 %	±3.9 %	∞
15	Max. SAR evaluation (Post-processing)	±4.0 %	Rectangular	√3	1	1	±2.3 %	±2.3 %	∞
B	**Test Sample Related**								
16	Device Holder or Positioner Tolerance	±3.6 %	Normal	1	1	1	±3.6 %	±3.6 %	5
17	Test Sample Positioning Error	±5.0 %	Normal	1	1	1	±5.0 %	±5.0 %	145
18	Power scaling	±0%	Rectangular	√3	1	1	±0 %	±0 %	∞
19	Drift of output power (measured, <0.2dB)	±2.3%	Rectangular	√3	1	1	±2.9 %	±2.9 %	∞
C	**Phantom and Setup**								
20	Phantom uncertainty (shape, thickness tolerances)	±7.5 %	Rectangular	√3	1	1	±4.3 %	±4.3 %	∞
21	Algorithm for correcting SAR (e',σ: ≤5%)	±1.2 %	Normal	1	1	0.84	±1.2 %	±0.97 %	∞
22	Measurement Liquid Conductivity Error (DAK3.5)	±3.0 %	Normal	1	0.78	0.71	±2.3 %	±2.1 %	7
23	Measurement Liquid Permittivity Error (DAK3.5)	±3.1 %	Normal	1	0.23	0.26	±0.7 %	±0.8 %	7
24	Liquid Conductivity-temp.uncertainty (≤2deg.C.)	±5.3 %	Rectangular	√3	0.78	0.71	±2.4 %	±2.2 %	∞
25	Liquid Permittivity-temp.uncertainty (≤2deg.C.)	±0.9 %	Rectangular	√3	0.23	0.26	±0.1 %	±0.1 %	∞
	Combined Standard Uncertainty						**±13.7** %	**±13.6** %	733
	Expanded Uncertainty (k=2)						**±27.4 %**	**±27.2 %**	

*. Table of uncertainties are listed for ISO/IEC 17025.
*. This measurement uncertainty budget is suggested by IEEE Std.1528(2013) and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget). Per KDB 865664 D01 (v01r04) SAR Measurement 100 MHz to 6 GHz 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 (2013) is not required in SAR reports submitted for equipment approval.

SECTION 6: Confirmation before testing

6.1 SAR reference power measurement (*. Antenna terminal conducted average power of EUT)

*. Antenna gain (peak): 0.119 dBi (2.4 GHz band) / -3.803 dBi (W52 band)

Mode	Frequency		Data rate	Power Setting (software)	Duty cycle	Duty factor	Duty scaled factor	Measurement Result				Power correction			Power Tune-up?	Remarks
								Time average power		Burst power		Max. power	Δ from max.	Tune-up factor		
	[MHz]	CH	[Mbps]	[-]	[%]	[dB]	[-]	[dBm]	[mW]	[dBm]	[mW]	[dBm]	[dB]	[-]		
BLE	2402	0	1	07	66.3	1.78	×1.00	**-0.63**	0.86	**1.15**	1.30	4	-2.85	×1.93	default	(*1)
	2440	19		07	66.3	1.78	×1.00	**-0.07**	0.98	**1.71**	1.48	4	-2.29	×1.69	default	(*1)
	2480	39		07	66.3	1.78	×1.00	**-0.72**	0.85	**1.06**	1.28	4	-2.94	×1.97	default	(*1)
BT, BDR	2402	0	1 (DH5)	07	77.8	1.09	×1.00	**0.50**	1.12	**1.59**	1.44	4	-2.41	×1.74	default	(*1)
	2441	39		07	77.8	1.09	×1.00	**0.83**	1.21	**1.92**	1.56	4	-2.08	×1.61	default	(*1)
	2480	78		07	77.8	1.09	×1.00	**0.33**	1.08	**1.42**	1.39	4	-2.58	×1.81	default	(*1)
BT, BDR	2402	0	1 (DH5)	08,-2.4	77.8	1.09	×1.00	**2.12**	1.63	**3.21**	2.09	4	-0.79	×1.20	tuning	(*1)
	2441	39		08,-2.4	77.8	1.09	×1.00	**2.57**	1.81	**3.66**	2.32	4	-0.34	×1.08	tuning	(*1)
	2480	78		08,-2.4	77.8	1.09	×1.00	**1.78**	1.51	**2.87**	1.94	4	-1.13	×1.30	tuning	(*1)
BT, EDR	2402	0	2 (2-DH5)	07	77.6	1.10	×1.00	**-1.79**	0.66	**-0.69**	0.85	4	-4.69	×2.94	default	(*1)
	2441	39		07	77.6	1.10	×1.00	**-1.30**	0.74	**-0.20**	0.95	4	-4.20	×2.63	default	(*1)
	2480	78		07	77.6	1.10	×1.00	**-1.87**	0.65	**-0.77**	0.84	4	-4.77	×3.00	default	(*1)
BT, EDR	2402	0	3 (3-DH5)	07	77.8	1.09	×1.00	**-1.79**	0.66	**-0.70**	0.85	4	-4.70	×2.95	default	(*1)
	2441	39		07	77.8	1.09	×1.00	**-1.29**	0.74	**-0.20**	0.95	4	-4.20	×2.63	default	(*1)
	2480	78		07	77.8	1.09	×1.00	**-1.87**	0.65	**-0.78**	0.84	4	-4.78	×3.01	default	(*1)

*1. The measured duty cycle number of BLE, BDR and EDR was nearly equal to highest theory duty cycle. Therefore the duty scaled factor for SAR was decided by "×1.00".

11b	2412	1	1	14(SAR)	≈100	0.00	×1.00	**13.75**	23.71	**13.75**	23.71	14	-0.25	×1.06	tuning	-
	2437	6	1	14(SAR)	≈100	0.00	×1.00	**13.64**	23.12	**13.64**	23.12	14	-0.36	×1.09	tuning	-
	2462	11	1	14(SAR)	≈100	0.00	×1.00	**13.59**	22.86	**13.59**	22.86	14	-0.41	×1.10	tuning	-
11b	2412	1	5.5Short	14(SAR)	99.6	0.01	×1.00	**13.98**	25.00	**13.99**	25.06	14	-0.01	×1.00	tuning	-
	2437	6	5.5Short	14(SAR)	99.6	0.01	×1.00	**13.85**	24.27	**13.86**	24.32	14	-0.14	×1.03	tuning	-
	2462	11	5.5Short	14(SAR)	99.6	0.01	×1.00	**13.94**	24.77	**13.95**	24.83	14	-0.05	×1.01	tuning	-
11g	2412	1	6	14(SAR)	99.8	0.01	×1.00	**13.79**	23.93	**13.80**	23.99	14	-0.20	×1.05	tuning	-
	2437	6	6	14(SAR)	99.8	0.01	×1.00	**13.77**	23.82	**13.78**	23.88	14	-0.22	×1.05	tuning	-
	2462	11	6	14(SAR)	99.8	0.01	×1.00	**13.67**	23.28	**13.68**	23.33	14	-0.32	×1.08	tuning	-
11n (20HT)	2412	1	MCS0	14(SAR)	99.7	0.01	×1.00	**13.83**	24.15	**13.84**	24.21	14	-0.16	×1.04	tuning	-
	2437	6	MCS0	14(SAR)	99.7	0.01	×1.00	**13.85**	24.27	**13.86**	24.32	14	-0.14	×1.03	tuning	-
	2462	11	MCS0	14(SAR)	99.7	0.01	×1.00	**13.83**	24.15	**13.84**	24.21	14	-0.16	×1.04	tuning	-
11a	5180	36	6	14(SAR)	99.7	0.01	×1.00	**13.85**	24.27	**13.86**	24.32	14	-0.14	×1.03	tuning	-
	5200	40	6	14(SAR)	99.7	0.01	×1.00	**13.88**	24.43	**13.89**	24.49	14	-0.11	×1.03	tuning	-
	5220	44	6	14(SAR)	99.7	0.01	×1.00	**13.89**	24.49	**13.90**	24.55	14	-0.10	×1.02	tuning	-
	5240	48	6	14(SAR)	99.7	0.01	×1.00	**13.86**	24.32	**13.87**	24.38	14	-0.13	×1.03	tuning	-
11n (20HT)	5180	36	MCS0	14(SAR)	99.8.	0.01	×1.00	**13.96**	24.89	**13.97**	24.95	14	-0.03	×1.01	tuning	-
	5200	40	MCS0	14(SAR)	99.8.	0.01	×1.00	**13.96**	24.89	**13.97**	24.95	14	-0.03	×1.01	tuning	-
	5220	44	MCS0	14(SAR)	99.8.	0.01	×1.00	**13.97**	24.95	**13.98**	25.00	14	-0.02	×1.00	tuning	-
	5240	48	MCS0	14(SAR)	99.8.	0.01	×1.00	**13.91**	24.60	**13.92**	24.66	14	-0.08	×1.02	tuning	-
11ac (20VHT)	5180	36	MCS0	14(SAR)	99.7	0.01	×1.00	**13.98**	25.00	**13.99**	25.06	14	-0.01	×1.00	tuning	-
	5200	40	MCS0	14(SAR)	99.7	0.01	×1.00	**13.85**	24.27	**13.86**	24.32	14	-0.14	×1.03	tuning	-
	5220	44	MCS0	14(SAR)	99.7	0.01	×1.00	**13.85**	24.27	**13.86**	24.32	14	-0.14	×1.03	tuning	-
	5240	48	MCS0	14(SAR)	99.7	0.01	×1.00	**13.91**	24.60	**13.92**	24.66	14	-0.08	×1.02	tuning	-
11n (40HT)	5190	38	MCS0	15(Up)	99.3	0.03	×1.01	**13.81**	24.04	**13.84**	24.21	14	-0.16	×1.04	Up tuning	-
	5230	46	MCS0	15(Up)	99.3	0.03	×1.01	**13.84**	24.21	**13.87**	24.38	14	-0.13	×1.03	Up tuning	-
11ac (40VHT)	5190	38	MCS0	15(Up)	99.2	0.03	×1.01	**13.79**	23.93	**13.82**	24.10	14	-0.18	×1.04	Up tuning	-
	5230	46	MCS0	15(Up)	99.2	0.03	×1.01	**13.82**	24.10	**13.85**	24.27	14	-0.15	×1.04	Up tuning	-
11ac (80VHT)	5210	42	MCS0	14(SAR)	97.7	0.10	×1.02	**13.03**	20.09	**13.13**	20.56	14	-0.87	×1.22	tuning	-

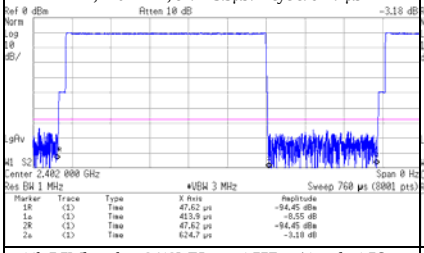
*. : SAR test was applied. *. xx.xx highlight is shown the higher measured output power in each operation mode, in each band. n/a: not applied; BT: Bluetooth

*. Preliminary tests were performed in different data rate and data rate associated with the highest power were chosen for full test in following tables.

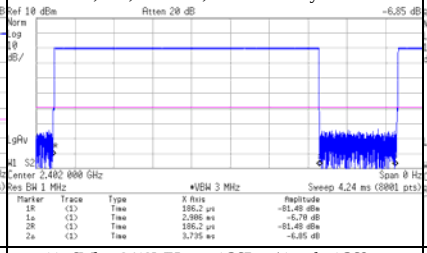
Data rate (D/R) vs Time average power (dBm) (*.The bold character shows the data rate which has the highest measured power.)																		
11b		11g		11n(20HT)		11a		11n(20HT)		11ac(20VHT)		11n(40HT)		11ac(40VHT)		11ac(80VHT)	
2412MHz		2412MHz		2412MHz		5180MHz		5180MHz		5180MHz		5190MHz		5190MHz		5210MHz	
D/R	Power	D/R	Power	D/R	Power	D/R	Power	D/R	Power	D/R	Power	D/R	Power	D/R	Power	D/R	Power
[Mbps]	**15**max	[Mbps]	**15**max	[Mbps]	**15**max	[Mbps]	**15**max	[Mbps]	**15**max	[Mbps]	**15**max	[Mbps]	**15**max	[Mbps]	**15**max	[Mbps]	**15**max
1	13.75	**6**	**13.79**	**MCS0**	**13.83**	**6**	**13.85**	**MCS0**	**13.96**	**MCS0**	**13.99**	**MCS0**	**12.74**	**MCS0**	**12.73**	**MCS0**	**13.03**
2 Long	13.71	9	13.55	MCS1	13.81	9	13.84	MCS1	13.93	MCS1	13.90	MCS1	12.69	MCS1	12.66	MCS1	12.81
5.5 Long	13.74	12	13.75	MCS2	13.76	12	13.84	MCS2	13.93	MCS2	13.85	MCS2	12.67	MCS2	12.62	MCS2	12.85
11 Long	13.65	18	13.72	MCS3	13.73	18	13.81	MCS3	13.83	MCS3	13.74	MCS3	12.58	MCS3	12.45	MCS3	12.76
2 Short	13.87	24	13.68	MCS4	13.70	24	13.77	MCS4	13.74	MCS4	13.70	MCS4	12.50	MCS4	12.45	MCS4	12.53
5.5 Short	**14.02**	36	13.64	MCS5	13.70	36	13.69	MCS5	13.79	MCS5	13.68	MCS5	12.43	MCS5	12.38	MCS5	12.53
11 Short	13.96	48	13.59	MCS6	13.61	48	13.69	MCS6	13.73	MCS6	13.67	MCS6	12.47	MCS6	12.44	MCS6	12.48
*. SAR test was applied to 11b mode with lowest data rate.		56	13.57	MCS7	13.63	56	13.64	MCS7	13.73	MCS7	13.61	MCS7	12.41	MCS7	12.35	MCS7	12.53
										MCS8	13.51			MCS8	12.37	MCS8	12.49
														MCS9	12.39	MCS9	12.47

*. Chart of the worst duty cycle for each operation mode.

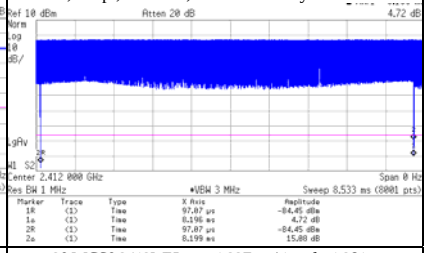
BLE, 2402MHz; on: 413.9µs / 1 cycle: 624.7µs



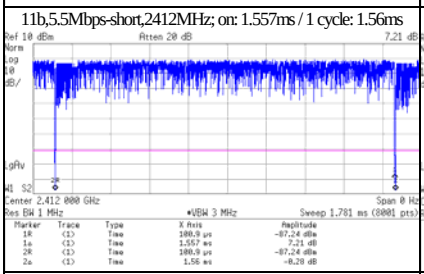
BT-BDR,DH5, 2402MHz; on: 2.906m / 1 cycle: 3.735ms



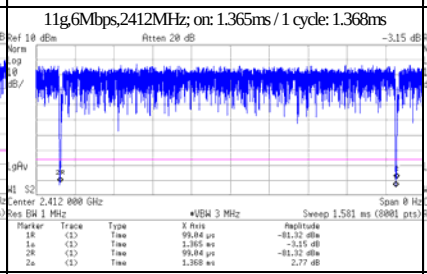
11b,1Mbps,2412MHz; on: 8.196ms / 1 cycle: 8.199ms



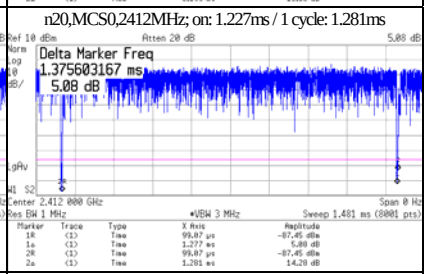
11b,5.5Mbps-short,2412MHz; on: 1.557ms / 1 cycle: 1.56ms



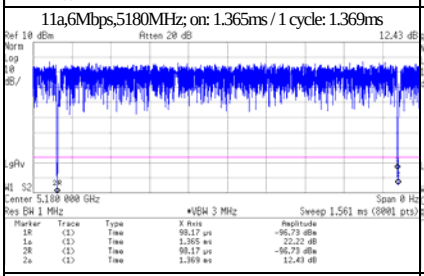
11g,6Mbps,2412MHz; on: 1.365ms / 1 cycle: 1.368ms



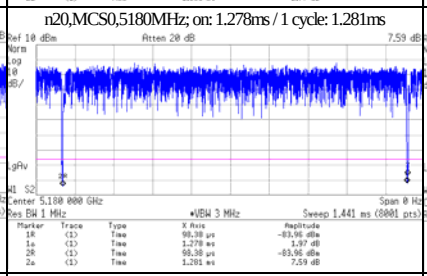
n20,MCS0,2412MHz; on: 1.227ms / 1 cycle: 1.281ms



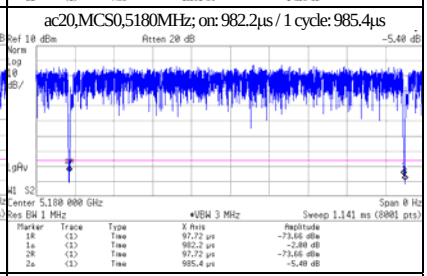
11a,6Mbps,5180MHz; on: 1.365ms / 1 cycle: 1.369ms



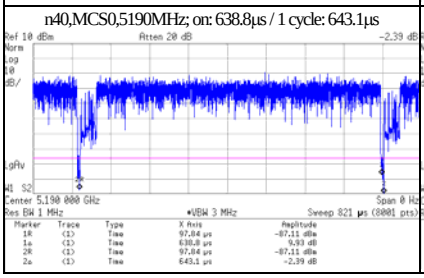
n20,MCS0,5180MHz; on: 1.278ms / 1 cycle: 1.281ms



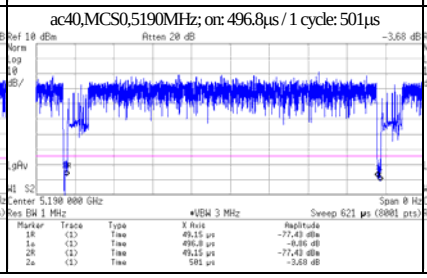
ac20,MCS0,5180MHz; on: 982.2µs / 1 cycle: 985.4µs



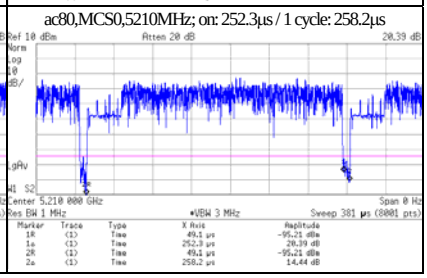
n40,MCS0,5190MHz; on: 638.8µs / 1 cycle: 643.1µs



ac40,MCS0,5190MHz; on: 496.8µs / 1 cycle: 501µs



ac80,MCS0,5210MHz; on: 252.3µs / 1 cycle: 258.2µs



*. CH: channel, Max: Maximum.

*. Calculating formula: Result-Time average power (dBm) = (P/M Reading, dBm)+(Cable loss, dB)+(Attenuator, dB)
Result-Burst power (dBm) (*.equal to 100% duty cycle) = (P/M Reading, dBm)+(Cable loss, dB)+(Attenuator, dB)+(duty factor, dB)
Duty factor (dBm) = 10 × log (100/(duty cycle, %))
Δ form max. (dB) = (Results-Burst power (average, dBm)) - (Max.-specification output power (average, dBm))
Duty scaled factor (Duty cycle correction factor for obtained SAR value) (unit: (-)) = 100(%) / (duty cycle, %)
Tune-up factor (Power tune-up factor for obtained SAR value) (unit: (-)) = 1 / (10 ^ (“Deviation from max., dB” / 10))

*. Date measured: May 8 and 9, 2017 / Measured by: Hiroshi Naka / Place: preparation room of No. 7 shielded room. ((25±1) deg.C. / (40~50) %RH)

*. Uncertainty of antenna port conducted test; Power measurement uncertainty above 1GHz for this test was: (±) 0.72 dB(Average)/(±) 0.85 dB(Peak).

*. Uncertainty of antenna port conducted test; Duty cycle and time measurement: (±) 0.012 %.

SECTION 7: SAR Measurement results

7.1 SAR measurement results

Measurement date: May 12~17, 2017 Measurement by: Hiroshi Naka

[Liquid measurement]

Frequency [MHz] (Channel)	Liquid type	Liquid parameters (*a)								ΔSAR Coefficients(*b)		Date measured
		Permittivity (εr) [-]				Conductivity [S/m]				ΔSAR		
		Target	Measured		Limit	Target	Measured		Limit	1g [%]	Correction required?	
			Meas.	Δεr [%]			Meas.	Δσ [%]				
2412 (1)	Body	*52.75*	50.54	-4.2	-5% ≤ εr-meas. ≤ 0%	*1.914*	1.941	+1.5	0% ≤ σ-meas. ≤ +5%	+1.65	not required.	May 12, 2017, before SAR test
2437 (6)		*52.72*	50.46	-4.3		*1.938*	1.968	+1.6		+1.71	not required.	
2462 (11)		*52.68*	50.30	-4.5		*1.967*	2.011	+2.3		+2.09	not required.	
2412 (1)	Body	*52.75*	50.70	-3.9	-5% ≤ εr-meas. ≤ 0%	*1.914*	1.935	+1.1	0% ≤ σ-meas. ≤ +5%	+1.42	not required.	May 17, 2017, before SAR test
2437 (6)		*52.72*	50.60	-4.0		*1.938*	1.970	+1.7		+1.70	not required.	
2462 (11)		*52.68*	50.46	-4.2		*1.967*	2.005	+1.9		+1.87	not required.	
2441(39)		*52.71*	50.59	-4.0		*1.941*	1.975	+1.7		+1.73	not required.	
5180 (36)	Body	*49.04*	47.17	-3.8	-5% ≤ εr-meas. ≤ 0%	*5.276*	5.429	+2.9	0% ≤ σ-meas. ≤ +5%	+0.70	not required.	May 15~16, 2017 (*1), before SAR test
5190 (38)		*49.03*	47.28	-3.6		*5.288*	5.437	+2.8		+0.65	not required.	
5210 (42)		*49.00*	47.12	-3.9		*5.311*	5.466	+2.9		+0.63	not required.	
5220 (44)		*48.99*	47.02	-4.0		*5.323*	5.480	+3.0		+0.73	not required.	
5230 (46)		*48.97*	47.16	-3.7		*5.334*	5.485	+2.8		+0.67	not required.	
5240 (48)		*48.96*	47.14	-3.7		*5.346*	5.511	+3.1		+0.66	not required.	

Temp. [deg.C.]	Depth [mm]
22.4	151
22.5	152
23.3	151

*1. On May 16, it was within 24 hours from measurement on May 15 and same liquid temperature, so measured parameters of May 15 were used continuously

[Measured and Reported (Scaled) SAR results]

Mode	Frequency [MHz] (Channel)	Data rate [Mbps]	SAR measurement results: EUT setup: Position	Gap [mm]	SAR (1g) [W/kg]: Max. value of multi-peak: Meas.	ΔSAR [%]	ΔSAR corrected	SAR plot # in Appendix 2-2	Reported SAR (1g) [W/kg]: Duty cycle correction: Duty [%]	Duty scaled	Output average power correction: Meas. [dBm].	Max. [dBm]	Tune-up factor	SAR Corrected (Scaled) (*d)	Remarks
Step 1: 2.4GHz Band															
11b	2412(1)	1	Front-right	0	**1.18**	+1.65	n/a (*c)	Plot 1-2	≈100	×1.00	13.75	14	×1.06	**1.251**	-
				0	**1.14**	+1.42	n/a (*c)	Plot 1-3	≈100	×1.00	13.75	14	×1.06	**1.208**	*. Battery operation.
			Front	0	**0.643**	+1.65	n/a (*c)	Plot 1-4	≈100	×1.00	13.75	14	×1.06	**0.682**	-
			Right	0	**0.238**	+1.65	n/a (*c)	Plot 1-5	≈100	×1.00	13.75	14	×1.06	**0.252**	-
			Back	0	**0.135**	+1.65	n/a (*c)	Plot 1-6	≈100	×1.00	13.75	14	×1.06	**0.143**	-
	2437(6)		Front-right	0	**1.11**	+1.71	n/a (*c)	Plot 1-7	≈100	×1.00	13.64	14	×1.09	**1.210**	-
	2462(11)			0	**1.1**	+2.09	n/a (*c)	Plot 1-8	≈100	×1.00	13.59	14	×1.10	**1.210**	-
	2412(1)	5.5		0	**1.21**	+1.42	n/a (*c)	Plot 1-9	99.8	×1.00	13.99	14	×1.00	**1.210**	-
11g	2412(1)	6		0	**1.2**	+1.65	n/a (*c)	Plot 1-10	99.8	×1.00	13.80	14	×1.05	**1.260**	-
	2437(6)			0	**1.13**	+1.71	n/a (*c)	Plot 1-11	99.8	×1.00	13.78	14	×1.05	**1.187**	-
	2462(11)			0	**1.11**	+2.09	n/a (*c)	Plot 1-12	99.8	×1.00	13.68	14	×1.08	**1.199**	-
n (20HT)	2412(1)	MCS0		0	**1.23**	+1.65	n/a (*c)	Plot 1-1	99.7	×1.00	13.84	14	×1.04	**1.279**	Higher Rep.&Meas.-SAR.
	2437(6)			0	**1.18**	+1.71	n/a (*c)	Plot 1-13	99.7	×1.00	13.86	14	×1.03	**1.215**	-
	2462(11)			0	**1.15**	+2.09	n/a (*c)	Plot 1-14	99.7	×1.00	13.84	14	×1.04	**1.196**	-
BDR	2441(39)	DH5		0	**0.108**	+1.73	n/a (*c)	Plot 1-15	77.8	×1.00	3.66	4	×1.08	**0.117**	*.Estimated SAR (1g) value is "0.126 W/kg" (Clause 7.3)
Step 2: W52 Band															
ac(80VHT)	5210(42)	MCS0	Front-right	0	**1.13**	+0.63	n/a (*c)	Plot 2-1	97.7	×1.02	13.13	14	×1.22	**1.406**	Higher Rep.-SAR.
				0	**0.999**	+0.63	n/a (*c)	Plot 2-2	97.7	×1.02	13.13	14	×1.22	**1.243**	*. Battery operation.
			Front	0	**0.563**	+0.63	n/a (*c)	Plot 2-3	97.7	×1.02	13.13	14	×1.22	**0.701**	-
			Right	0	**0.147**	+0.63	n/a (*c)	Plot 2-4	97.7	×1.02	13.13	14	×1.22	**0.183**	-
			Back	0	**0.171**	+0.63	n/a (*c)	Plot 2-5	97.7	×1.02	13.13	14	×1.22	**0.213**	-
n(40HT)	5190(38)	MCS0	Front-right	0	**1.25**	+0.65	n/a (*c)	Plot 2-6	99.3	×1.01	13.84	14	×1.04	**1.313**	-
	5230(46)			0	**1.3**	+0.67	n/a (*c)	Plot 2-7	99.3	×1.01	13.87	14	×1.03	**1.352**	-
ac(40VHT)	5190(38)	MCS0		0	**1.26**	+0.65	n/a (*c)	Plot 2-8	99.2	×1.01	13.82	14	×1.04	**1.324**	-
	5230(46)			0	**1.28**	+0.67	n/a (*c)	Plot 2-9	99.2	×1.01	13.85	14	×1.04	**1.345**	-
11a	5180(36)	6		0	**1.28**	+0.70	n/a (*c)	Plot 2-10	99.7	×1.00	13.86	14	×1.03	**1.318**	-
	5220(44)			0	**1.34**	+0.73	n/a (*c)	Plot 2-11	99.7	×1.00	13.90	14	×1.02	**1.367**	-
	5240(48)			0	**1.36**	+0.66	n/a (*c)	Plot 2-12	99.7	×1.00	13.87	14	×1.03	**1.401**	-
n(20HT)	5180(36)	MCS0		0	**1.31**	+0.70	n/a (*c)	Plot 2-13	99.8	×1.00	13.97	14	×1.01	**1.323**	-
	5220(44)			0	**1.34**	+0.73	n/a (*c)	Plot 2-14	99.8	×1.00	13.98	14	×1.00	**1.340**	-
	5240(48)			0	**1.37**	+0.66	n/a (*c)	Plot 2-15	99.8	×1.00	13.92	14	×1.02	**1.397**	Higher Meas.-SAR.
ac(20VHT)	5180(36)	MCS0		0	**1.29**	+0.70	n/a (*c)	Plot 2-16	99.7	×1.00	13.99	14	×1.00	**1.290**	-
	5220(44)			0	**1.34**	+0.73	n/a (*c)	Plot 2-17	99.7	×1.00	13.86	14	×1.03	**1.380**	-
	5240(48)			0	**1.34**	+0.66	n/a (*c)	Plot 2-18	99.7	×1.00	13.92	14	×1.02	**1.367**	-

Notes:

*. Gap: It is the separation distance between the EUT outer surface and the bottom outer surface of phantom; Max.: Maximum; Meas.: Measured value; Rep.: Reported; n/a: not applied;

*. During test, the EUT was operated with connecting the host pc via USB cable (battery charging).

*. Calibration frequency of the SAR measurement probe (and used conversion factors)

Liquid	SAR test frequency	Probe calibration frequency	Validity	Conversion factor	Uncertainty
Body	2412, 2437, 2441, 2462 MHz	2450 MHz	within ±50 MHz of calibration frequency	7.38	±12.0 %
Body	5180, 5190, 5210, 5220, 5230, 5240 MHz	5250 MHz	within ±110 MHz of calibration frequency	4.65	±13.1 %

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

Memo1 :

*a. The target value is a parameter defined in Appendix A of KDB865664 D01 (v01r04), the dielectric parameters suggested are given at 2000, 2450, 3000 and 5800MHz. Parameters for the frequencies between (2000~3000) MHz and (3000~5800) MHz were obtained using linear interpolation.

*b. Calculating formula: $\Delta SAR(1g) = C\varepsilon r \times \Delta\varepsilon r + C\sigma \times \Delta\sigma$, $C\varepsilon = -7.854E\text{-}4 \times f^3 + 9.402E\text{-}3 \times f^2 - 2.742E\text{-}2 \times f - 0.2026$ / $C\sigma = 9.804E\text{-}3 \times f^3 - 8.661E\text{-}2 \times f^2 + 2.981E\text{-}2 \times f + 0.7829$

*c. Since the calculated ΔSAR values of the tested liquid had shown positive correction, the measured SAR was not converted by ΔSAR correction.
Calculating formula: ΔSAR corrected SAR (W/kg) = (Meas. SAR (W/kg)) × (100 - (ΔSAR(%)) / 100

*d. Calculating formula: Reported SAR (W/kg) = (Measured SAR (W/kg)) × (Duty scaled) × (Tune-up factor)
Duty scaled = Duty scaled factor: Duty cycle correction factor for obtained SAR value, Duty scaled factor [-] = 100(%) / (duty cycle, %)
Tune-up factor: Power tune-up factor for obtained SAR value, Tune-up factor [-] = 1 / (10 ^ ("Deviation from max., dB" / 10))

Memo2 :

(Clause 5.2, 2.4GHz SAR Procedures for 2.4GHz band DSSS and OFDM, in KDB248227 D01 (v02r02))

5.2.1 802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the reported SAR of the highest measured maximum output power channel (section 3.1) for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

5.2.2 2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied (section 5.3, including sub-sections). SAR is not required for the following 2.4 GHz OFDM conditions.

1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
2) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

(Clause 5: SAR TEST PROCEDURE for 5GHz OFDM band, in KDB248227 D01 (v02r02))

5.1.1 Initial Test Position SAR Test Reduction Procedure

1) When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other (remaining) test positions in that exposure configuration and 802.11 transmission mode combination within the frequency band or aggregated band. SAR is also not required for that exposure configuration in the subsequent test configuration(s).
2) When the reported SAR of the initial test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position using subsequent highest extrapolated or estimated 1-g SAR conditions determined by area scans or next closest/smallest test separation distance and maximum RF coupling test positions based on manufacturer justification, on the highest maximum output power channel, until the reported SAR is ≤ 0.8 W/kg or all required test positions (left, right, touch, tilt or subsequent surfaces and edges) are tested.
3) For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

7.2 SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 (v01r04) SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Mode	Frequency [MHz]	Data rate	EUT setup position	Measured SAR (1g) [W/kg]		Largest to Smallest SAR Ratio	SAR plot # in Appendix 2-2	Remarks
				Original	Repeated			
n(20HT)	2412 (1ch)	MCS0	**Front-right**	**1.23**	**1.21**	**1.017**	Original: Plot 1-1 Repeated: Plot 3-1	*. 2nd repeated measurement is not required since the ratio of the largest to smallest SAR for the original and 1st repeated measurement is not > 1.20.
n(20HT)	5240 (46ch)	MCS0	**Front-right**	**1.37**	**1.36**	**1.007**	Original: Plot 2-15 Repeated: Plot 3-2	*. 2nd repeated measurement is not required since the ratio of the largest to smallest SAR for the original and 1st repeated measurement is not > 1.20.

7.3 Simultaneous transmission evaluation

This Wireless module supports both Wi-Fi and Bluetooth. Wi-Fi of 2.4GHz and Bluetooth were not transmitted simultaneously. Wi-Fi of5GHz and Bluetooth were transmitted simultaneously at same antenna. Therefore simultaneously transmitted SAR was only considered for Wi-Fi of 5GHz band operation.

Simultaneous transmission scenario				Σ1g SAR [W/kg] (≤1.6)	SPLSR (Yes / No)	Calculated distance [mm]	SPLSR (≤ 0.04)	Volume Scan (Yes/No)	Figure	Remarks
Test position	Highest Reported SAR(1g) [W/kg] (Standalone base)									
	Wi-Fi: DTS Band	Wi-Fi: UNII band	Bluetooth (BT))							
Front-right	-	**1.41**	**0.13** (*.Estimated)	**1.54**	No	-	-	-	-	Wi-Fi(W52)+BT

General Note:
1) Bluetooth and Wi-Fi share the same antenna, and cannot transmit simultaneously on 2.4GHz band.
2) EUT will choose either Wi-Fi of 2.4GHz or 5GHz according to the network signal condition, therefore, Wi-Fi of 2.4GHz and 5GHz will not operate simultaneously.
3) The Reported SAR simulation is calculated based on the same configuration and test position.
4) Per KDB447498 D01(v06), simultaneously transmission SAR is compliant if;
   (1) Reported SAR summation < 1.6 W/kg
   (2) "SPLSR = (SAR1 + SAR2)^1.5 / (minimum antenna separation distance, mm)", and the peak separation distance is determined form the square root of [(x1-x2)^2 + (y1-y2)^2 + (z1-z2^2)], where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR location in the zoom scan.
   (where; "SAR1" is simulated SAR(1g) of Bluetooth, "SAR2" is highest reported SAR(1g) on antenna when it is 5GHz Wi-Fi operated.)
   (3) if SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary.
   (4) Simultaneously transmission SAR, and the reported multi-band SAR < 1.6 W/kg.
5) For simultaneously transmission analysis, Bluetooth SAR is estimated per KDB447498 D01(v06) based on the formula below.
   (1) [(max. power of channel, including tune-up tolerance, mW) / (minimum test separation distance, mm)]·[√ f(GHz)/x] W/kg, for test separation distances ≤ 50 mm; where x = 7.5 for 1-g SAR and x = 18.75 for 10-g SAR
   (2) When the minimum separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
   (3) Bluetooth estimated SAR is conservatively determined by 5mm separation, for all applicable exposure positions.

Maximum power	Exposure Position	Minimum separation distance	Estimated SAR(BT)	Remarks
4 dBm (3 mW) (Bluetooth)	All SAR test setup	< 5mm for all SAR test setup	0.126 W/kg	Actual measured reported SAR(1g) value was "0.117 W/kg". Refer to clause 7.1 and Plot 1-15.

Estimated SAR(BT) = (3mW) / (5mm)* (√2.480GHz) / (7.5) = 0.126 W/kg

7.4 Device holder perturbation verification

When the highest reported SAR of an antenna is > 1.2 W/kg, holder perturbation verification is required for each antenna, using the highest SAR configuration among all applicable frequency bands.

[Device holder perturbation verification; Measured and Reported (Scaled) SAR results]

SAR measurement results									Reported SAR (1g) [W/kg]						
Mode	Frequency [MHz] (Channel)	Data rate [Mbps]	EUT setup		SAR (1g) [W/kg]			SAR plot # in Appendix 2-2	Duty cycle correction		Output average power correction			SAR Corrected (Scaled) (*d)	Remarks
			Position	Gap [mm]	Max. value of multi-peak				Duty [%]	Duty scaled	Meas. [dBm].	Max. [dBm]	Tune-up factor		
					Meas.	ΔSAR [%]	ΔSAR corrected								
With device holder															
n (20HT)	2412(1)	MCS0	**Front-right**	0	**1.23**	+1.65	n/a (*c)	Plot 1-1	99.7	×1.00	13.84	14	×1.04	**1.279**	Higher Rep.&Meas.-SAR.
ac (80HT)	5210(42)	MCS0	**Front-right**	0	**1.13**	+0.63	n/a (*c)	Plot 2-1	97.7	×1.02	13.13	14	×1.22	**1.406**	Higher Rep.-SAR.
No device holder															
n (20HT)	2412(1)	MCS0	**Front-right**	0	**1.22**	+1.65	n/a (*c)	Plot 4-1	99.7	×1.00	13.84	14	×1.04	**1.269**	-
ac (80HT)	5210(42)	MCS0	**Front-right**	0	**1.1**	+0.63	n/a (*c)	Plot 4-2	97.7	×1.02	13.13	14	×1.22	**1.369**	-

[Device holder perturbation verification]

Mode	Frequency [MHz]	Data rate	EUT setup position	Reported SAR (1g) [W/kg] Device holder		Device holder perturbation SAR Ratio	Remarks
				Exist	None		
n(20HT)	2412 (1ch)	MCS0	**Front-right**	**1.279**	**1.269**	**- 0.8 %**	*.It was smaller than 5% of uncertainty of the setup, so influence of a device holder was judged to be no problem.
ac(80VHT)	5210 (42ch)	MCS0	**Front-right**	**1.406**	**1.369**	**- 2.6 %**	*.It was smaller than 5% of uncertainty of the setup, so influence of a device holder was judged to be no problem.

*. Calculating formula: Device holder perturbation SAR Ratio (%) = {{((Reported SAR-none (W/kg)) / Reported SAR-exist (W/kg))} - 1}*100