SAR TEST REPORT

Test Report No.: 13705879S-A-R1

Applicant : **RICOH IMAGING COMPANY, LTD.**

Type of Equipment : **Digital Camera**

Model Number of EUT : **R05010**

FCC ID : **2ACZS-R05010**

Test Standard : **FCC 47CFR §2.1093**

Test Result : **Complied** (Refer to Section 3.5)

Highest Reported SAR(1g)	SAR Type	SAR Limit	Frequency [MHz]	Mode	Output power (burst average)	
					Measured	Max.
1.35 W/kg	Body-worn	1.6 W/kg	2462	IEEE 802.11b (2Mbps)	11.34 dBm	12.5 dBm

*. **Highest reported SAR (1g) across all exposure conditions of this device is " 1.35 W/kg (body-worn, DTS band)."**

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7. The all test items in this test report are conducted by UL Japan, Inc. Shonan EMC Lab.
8. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
9. The information provided from the customer for this report is identified in SECTION 1.
10. This report (-R1) is a revised version of 13705879S-A. 13705879S-A report is replaced with this report.

Date of test: February 24 and 25, 2021

Test engineer: H. Naka
Hiroshi Naka (Title: Engineer)

Approved by: T. Imamura
Toyokazu Imamura (Title: Leader)

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

CERTIFICATE 1266.03

REVISION HISTORY

Revision	Test report No.	Date	Page revised	Contents
Original	13705879S-A	March 26, 2021	-	-
-R1	13705879S-A-R1	June 22, 2021	-	p13, Corrected a mistake (e, 2412MHz) (was, 37.92->to, 37.82) p1, updated cover page issue (was, #18.0->to, #19.0)

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

Reference : Abbreviations (Including words undescribed in this report) (radio_r0v03_200214)

A2LA	The American Association for Laboratory Accreditation
AC	Alternating Current
AFH	Adaptive Frequency Hopping
AM	Amplitude Modulation
Amp, AMP	Amplifier
ANSI	American National Standards Institute
Ant, ANT	Antenna
AP	Access Point
ASK	Amplitude Shift Keying
Atten., ATT	Attenuator
AV	Average
BPSK	Binary Phase-Shift Keying
BR	Bluetooth Basic Rate
BT	Bluetooth
BT LE	Bluetooth Low Energy
BW	BandWidth
Cal Int	Calibration Interval
CCK	Complementary Code Keying
Ch., CH	Channel
CISPR	Comite International Special des Perturbations Radioelectriques
CW	Continuous Wave
DBPSK	Differential BPSK
DC	Direct Current
D-factor	Distance factor
DFS	Dynamic Frequency Selection
DQPSK	Differential QPSK
DSSS	Direct Sequence Spread Spectrum
DUT	Device Under Test
EDR	Enhanced Data Rate
EIRP, e.i.r.p.	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
EN	European Norm
ERP, e.r.p.	Effective Radiated Power
EU	European Union
EUT	Equipment Under Test
Fac.	Factor
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
FM	Frequency Modulation
Freq.	Frequency
FSK	Frequency Shift Keying
GFSK	Gaussian Frequency-Shift Keying
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hori.	Horizontal
ICES	Interference-Causing Equipment Standard
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
ILAC	International Laboratory Accreditation Conference
ISED	Innovation, Science and Economic Development Canada
ISO	International Organization for Standardization
JAB	Japan Accreditation Board
LAN	Local Area Network
LIMS	Laboratory Information Management System
MCS	Modulation and Coding Scheme
MRA	Mutual Recognition Arrangement
N/A	Not Applicable
NIST	National Institute of Standards and Technology
NS	No signal detect.
NSA	Normalized Site Attenuation
NVLAP	National Voluntary Laboratory Accreditation Program
OBW	Occupied Band Width
OFDM	Orthogonal Frequency Division Multiplexing
P/M	Power meter
PCB	Printed Circuit Board
PER	Packet Error Rate
PHY	Physical Layer
PK	Peak
PN	Pseudo random Noise
PRBS	Pseudo-Random Bit Sequence
PSD	Power Spectral Density
QAM	Quadrature Amplitude Modulation
QP	Quasi-Peak
QPSK	Quadrature Phase Shift Keying
RBW	Resolution Band Width
RDS	Radio Data System
RE	Radio Equipment
RF	Radio Frequency
RMS	Root Mean Square
RSS	Radio Standards Specifications
Rx	Receiving
SA, S/A	Spectrum Analyzer
SAR	Specific Absorption Rate
SG	Signal Generator
SVSWR	Site-Voltage Standing Wave Ratio
TR	Test Receiver
Tx	Transmitting
VBW	Video BandWidth
Vert.	Vertical
WLAN	Wireless LAN

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Contents of appendixes

SECTION 1: Customer information

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

The information provided from the customer is as follows;
- Applicant, Type of EUT, Model Number of EUT, FCC IDon the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (EUT)
- SECTION 4: Operation of EUT during testing
- Appendix 1: The part of Antenna location information, Description of EUT and Support Equipment

* The laboratory is exempted from liability of any test results affected from the above information in SECTION 2, SECTION 4 and Appendix 1.

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

Type of EUT	Digital Camera
Model Number	R05010
Serial Number	0000061
Condition of EUT	Production prototype (Not for sale: This samples is equivalent to mass-produced items.)
Receipt Date of Sample	February 9, 2021 (*. No modification by the test Lab.)
Country of Mass-production	Vietnam
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	Model: R05010 (referred to as the EUT in this report) is a Digital Camera which support wireless LAN (Wi-Fi) and Bluetooth version 4.2 (Low Energy).
Category Identified	Portable device *. Since this EUT may contact to a human body during Wi-Fi and BT LE operation, the partial-body SAR (1g) shall be observed.
SAR Accessory	None

2.2 Product Description (Wireless LAN + Bluetooth Combo Module)

Equipment type		Transceiver									
Transmit average power (*. The measured Tx output power (antenna terminal conducted) refers to section 6 in this report.)		Mode		channel	Operation frequency [MHz]	Data rate [Mbps]	Modulation	Channel spacing [MHz]	Band width [MHz]	**Average power [dBm]**		
										Min.	**Typical**	**Max.**
		Bluetooth v4.2	**Low Energy**	0~39	2402~2480	1	FHSS	2	2	**3.5**	**6.5**	**8.5**
		11b		1~11	2412~2462	1~11	DSSS	5	20	**6.5**	**9.5**	**12.5**
		11g		1~11	2412~2462	6~54	OFDM	5	20	**6.5**	**9.5**	**12.5**
		11n(20HT)		1~11	2412~2462	MCS0~7	OFDM	5	20	**6.5**	**9.5**	**12.5**
Type of modulation	Bluetooth	FHSS: GFSK										
	Wi-Fi	DSSS: DBPSK, DQPSK, CCK / OFDM: BPSK, QPSK, 16QAM, 64QAM										
Power supply		DC 1.8V and DC 3.3V (*. These power are supplied via constant voltage circuit.)										
Quantity of Antenna		1 piece										
Antenna type		λ/4 Monopole Antenna (Model: Embedded antenna)		Antenna connector type		Module side: High-frequency coaxial cable connector Antenna side: molded						
Antenna gain (Peak)		-2.1 dBi										

*. The EUT do not use the special transmitting technique such as "beam-forming" and "time-space code diversity."
*. Wi-Fi and Bluetooth Low Energy were not transmitted simultaneously. Therefore simultaneously transmitted SAR was not considered.
*. For Bluetooth, this module is not supported for BDR and EDR operation.
*. Max. Maximum tune-up limit power, N/A: Not applicable; (Mode) 11b: IEEE 802.11b, 11g: IEEE 802.11g, 11n(20HT): IEEE 802.11n(20HT).

SECTION 3: Test specification, procedures and results

3.1 Test specification

FCC47CFR §2.1093: Radiofrequency radiation exposure evaluation: portable devices.

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.

The tests documented in this report were performed in accordance with FCC 47 CFR Parts 2, IEEE Std.1528-2013 (latest), the following FCC Published RF exposure KDB procedures, and TCB workshop updates.

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 (body touch)

3.3 Addition, deviation and exclusion to the test procedure

No addition, exclusion nor deviation has been made from the test procedure.

3.4 Test Location

UL Japan, Inc., Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken 259-1220 JAPAN
Telephone number: +81 463 50 6400 / Facsimile number: +81 463 50 6401
*. A2LA Certificate Number: 1266.03 (FCC Test Firm Registration Number: 626366, ISED Lab Company Number: 2973D / CAB identifier: JP0001)

Used?	Place	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
☐	No.1 Semi-anechoic chamber	20.6 × 11.3 × 7.65	20.6 × 11.3	10 m
☐	No.2 Semi-anechoic chamber	20.6 × 11.3 × 7.65	20.6 × 11.3	10 m
☐	No.3 Semi-anechoic chamber	12.7 × 7.7 × 5.35	12.7 × 7.7	5 m
☐	No.4 Semi-anechoic chamber	8.1 × 5.1 × 3.55	8.1 × 5.1	-
☐	No.1 Shielded room	6.8 × 4.1 × 2.7	6.8 × 4.1	-
☐	No.2 Shielded room	6.8 × 4.1 × 2.7	6.8 × 4.1	-
☐	No.3 Shielded room	6.3 × 4.7 × 2.7	6.3 × 4.7	-
☐	No.4 Shielded room	4.4 × 4.7 × 2.7	4.4 × 4.7	-
☐	No.5 Shielded room	7.8 × 6.4 × 2.7	7.8 × 6.4	-
☐	No.6 Shielded room	7.8 × 6.4 × 2.7	7.8 × 6.4	-
☒	**No.7 Shielded room**	**2.76 × 3.76 × 2.4**	**2.76 × 3.76**	-
☐	No.8 Shielded room	3.45 × 5.5 × 2.4	3.45 × 5.5	-
☐	No.1 Measurement room	2.55 × 4.1 × 2.5	2.55 × 4.1	-

3.5 Procedures and Results

Test Procedure		SAR measurement: KDB 447498 D01, KDB 248227 D01, KDB 865664 D01, KDB 914225 D07, IEC Std. 1528		
Category		FCC 47CFR §2.1093 (Portable device)	SAR type	Body worn (body touch)

Band (Operation frequency [MHz])		Bluetooth (Low Energy) (2402-2480)	Wi-Fi (DTS) (2412-2462)	Simultaneous transmission (Bluetooth Low Energy +Wi-Fi (*1)
Results (Reported SAR value)		Complied (*. lower power, SAR test was exempt, Refer to Section 4.3)	Complied (Refer to Section 7.1)	N/A (This device is not supported the simultaneously transmission.)
SAR [W/kg]	Type	1g	1g	-
	Limit	1.6	1.6	-
	Reported	N/A	1.35 W/kg	-
	Measured	N/A	1.01 W/kg	-
	Liquid type	-	Head	-
Operation mode		-	IEEE 802.11b	-
Data rate		-	2 Mbps	-
Frequency[MHz]		-	2462	-
Output power	Burst average	-	11.34 dBm	-
	Tune-up limit (Max.)	8.5 dBm	12.5 dBm	-
	Tune-up factor	-	1.31	-
Duty cycle		-	97.9 %	-
Duty scaled factor		-	1.02	-

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

*. N/A: Not applied.

*. (Calculating formula) Corrected SAR to max.power (as Reported SAR) (W/kg) = (Measured SAR (W/kg)) × (Duty scaled factor) × (Tune-up factor) where; Tune-up factor [-] = 1 / (10 ^ ("Δmax (max.power - burst average power), dB" / 10)), Duty scaled factor [-] = 100(%) / (duty cycle, %)

*1. Wi-Fi and Bluetooth Low Energy were not transmitted simultaneously. Therefore simultaneously transmitted SAR was not considered.

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg for partial body) specified in FCC 47 CFR part 2 (2.1093) and had been tested in accordance with the measurement methods and procedures specified in FCC KDB publications and IEEE 1528-2013.

3.6 SAR measurement procedure

3.6.1 Normal SAR measurement procedure

Step 1: Confirmation before SAR testing

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 SAR test reference power measurement and the SAR test were proceeded with the lowest data rate (which has the higher time-based average power typically) on each operation mode. Therefore, the average output power was measured on the lower, middle (or near middle), upper and specified channels with the lowest data rate of each operation mode. The power of other data rate was also measured to confirm the time-base average power and when if it's required. The power measurement 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 2: Power reference measurement

Measurement of the E-field at a fixed location above the central position of flat phantom (or/and furthermore an interpolated peak SAR location of area scan in step 2) was used as a reference value for assessing the power drop.

Step 3: Area Scan (Area scan parameters: KDB 865664 D01 (v01r04).)

The SAR distribution at the exposed side of head or body position was measured at a distance of each device from the inner surface of the shell. The area covered the entire dimension of the antenna of EUT and suitable horizontal grid spacing of EUT. Based on these data, the area of the maximum absorption was determined by splines interpolation.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 4: Zoom Scan and post-processing (Zoom scan parameters: KDB 865664 D01 (v01r04).)

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure.

A volume of 30 mm (X) × 30 mm (Y) × 30 mm (Z) (or more) was assessed by measuring 7×7×7 points (or more), ≤ 3GHz.

A volume of 28 mm (X) × 28 mm (Y) × 24mm (Z) (or more) was assessed by measuring 8×8×7 points (or more) (by "Ratio step" method (*1)), > 3 GHz.

When the SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are proceeded for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR. If the zoom scan measured as defined above complies with both of the following criteria. or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed.

*. The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal grid steps in both x and y directions and recorded.

*. The ratio of the SAR at the second measured point to the SAR at the closest measured point at the x-y location of the measured maximum SAR value shall be at least 30 % and recorded.

				f ≤ 3 GHz	3 GHz < f ≤ 6 GHz
1	Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
2	Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
3		graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
4			$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5 ·$\Delta z_{Zoom}(n-1)$ mm	
5	Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
	* The asterisk table-footnote is per KDB Pub. 865664 D01 v01r04. NOTE For uniformity purposes the integer frequency increments of rows 1 to 3 and 5 apply, rather than the corresponding variable and fixed parameters given in IEC 62209-1:2016 and IEC 62209-2:2010/AMD1:2019.				

Step 5: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 2. It was checked that the power drift is within ±5% in the evaluation procedure of SAR testing. The verification of power drift during the SAR test is that DASY 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 SAR plot data of APPENDIX 2.

*. DASY 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 DASY system must be the less than (±) 0.21dB.**

Step 6: Z-Scan

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation the extrapolated distance should not be larger than the step size in Z-direction.

*. The all SAR tests were conservatively performed with test separation distance 0 mm. The phantom bottom thickness is approx. 2mm. Typical distance from probe tip to dipole centers is 1mm. The distance between the SAR probe tip to the surface of test device which is touched the bottom surface of the phantom is approx. 3 mm for 2.4GHz band and 2.4 mm for 5GHz band.

*1. "Ratio step" method parameters used; the first measurement point: "1.4mm" from the phantom surface, the initial z grid separation: "1.4mm", subsequent graded grid ratio: "1.4". These parameters comply with the requirement of KDB 865664 D01and recommended by Schmid & Partner Engineering AG (DASY5 manual).

SECTION 4: Operation of EUT during testing

4.1 Operating modes for SAR testing

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

Operation mode		BT LE	11b		11g	11n20HT
Tx frequency band		(2402~2480) MHz	(2412~2462) MHz			
Maximum power [dBm]		8.5	12.5	12.5	12.5	12.5
SAR tested condition	Frequency [MHz]	-	2412, 2437, 2462	2412, 2437, 2462	2412, 2437, 2462	2412, 2437, 2462
	Modulation	FHSS	DSSS	DSSS	OFDM	OFDM
	Data rate [Mbps]	1	1 (*.Initial test mode)	2	6	6.5(MCS0)
SAR tested/reduced?		Reduced	Tested	Tested	Tested	Tested
Power setting	Power measurement	fix (*. Fimware)	fix (*. Fimware)	fix (*. Fimware)	fix (*. Fimware)	fix (*. Fimware)
	SAR	fix (*. Fimware)	fix (*. Fimware)	fix (*. Fimware)	fix (*. Fimware)	fix (*. Fimware)

	Test name	Software name	Version	Date	Storage location / Remarks
Controlled software	Power measurement, SAR	R05010 Camera FW	Ver011_001	2021/02/09	Memory of digital camera (firmware)
		00078490.609	-	2021/02/09	SD card, Script for RF TEST
		DEVELOP.MOD	-	2021/02/09	SD card, Debug mode

*. (mode) BT LE: Bluetooth Low Energy, 11b: IEEE 802.11b, 11g: IEEE 802.11g, 11n20HT: IEEE 802.11n(20HT); n/a: not applied.
*. Any output power reducing for channel 1 and 11 to meet restricted band requirements was not observed.

4.2 RF exposure conditions

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

Mode:		Wi-Fi		BT LE		
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	D [mm]	SAR Tested /Reduced	SAR type
Right-front	A front edge of right surface of a camera is touched to the Flat phantom.	2.2	Tested	2.2	*Reduced*	Body-touch
Front-right	A right portion (hand grip) of camera is touched to the Flat phantom.	2.7	Tested	2.7	*Reduced*	
Front	A front of camera is touched to the Flat phantom.	≈3	Tested	≈3	*Reduced*	
Right	A right surface of camera is touched to the Flat phantom.	4.2	Tested	4.2	*Reduced*	
Top-front	A right-front portion of top surface of a camera is touched to the Flat phantom.	≈10	Tested	≈10	*Reduced*	
Top	A top surface of camera is touched to the Flat phantom.	≈18	Tested	≈18	*Reduced*	
Bottom	A bottom surface of camera is touched to the Flat phantom.	17.9	Tested	17.9	*Reduced*	
Rear (LCD)	A rear of camera (LCD side) is touched to the Flat phantom.	27	Tested	27	*Reduced*	
Left	A left surface of camera is touched to the Flat phantom.	≈98	*Reduced*	≈98	*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 (digital camera): Refer to Appendix 1-1.

4.3 SAR test exclusion considerations accordance to KDB 447498 D01

The following is based on KDB447498D01.

Step 1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(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 (2)
1. The upper frequency of the frequency band was used in order to calculate standalone SAR test exclusion considerations.
2. Power and distance are rounded to the nearest mW and mm before calculation
3. The result is rounded to one decimal place for comparison
4. The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

When the calculated threshold value by a numerical formula above-mentioned in the following table is 3.0 or less, SAR test can be excluded.

Step 2) At 1500 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following,
[test exclusion thresholds, mW] = [(Power allowed at numeric threshold for 50mm in formula (1))] + [(test separation distance, mm) - (50mm)] × 10 ··formula (3)
1. The upper frequency of the frequency band was used in order to calculate standalone SAR test exclusion considerations.
2. Power and distance are rounded to the nearest mW and mm before calculation

When output power is less than the calculated threshold value by a numerical formula above-mentioned in the following table, SAR test is excluded.

[SAR exclusion calculations for step 1) antenna ≤50mm from the user, and for step 2) antenna > 50mm from the user.]

				Step 1) SAR exclusion calculations for antenna ≤50mm from the user.									Step 2) > 50mm from the user
Tx mode	Upper frequency	Maximum output power		Calculated threshold value									
				Setup	Right-front	Front-right	Front	Right	Top-front	Top	Bottom	Rear	Left
	[MHz]	[dBm]	[mW]	D[mm]	≤5 (2.2)	≤5 (2.7)	≤5 (≈3)	≤5 (4.2)	≈10	≈18	18	27	≈98
b	2462	12.5	18	Judge	5.6, Measure				2.8, Reduce	1.6, Reduce	1.6, Reduce	0.8, Reduce	576mW, Reduce
g, n20	2462	12.5	18	Judge	5.6, Measure				2.8, Reduce	1.6, Reduce	1.6, Reduce	0.8, Reduce	576mW, Reduce
BT LE	2480	8.5	7	Judge	2.2, Reduce				1.1, Reduce	0.6, Reduce	0.6, Reduce	0.4, Reduce	576mW, Reduce

*. The table shows the upper frequency which has the maximum power (as "Tune-up limit") in each operation band, in mode and on the single antenna transmission.
*. Tx mode; 11b: IEEE 802.11b, 11g: IEEE 802.11g, n20: IEEE 802.11n(20HT).
Notes: 1. Power and distance are rounded to the nearest mW and mm before calculation.

<Conclusion for consideration for SAR test reduction>

1) The test was conservatively performed with test separation distance 0mm.
2) For Wi-Fi operation, setup of "Right-front", "Front-right", "Front" and "Right" are applied the SAR test in IEC head-liquid.
   The SAR test of "Top-front", "Top", "Bottom" and "Rear" setups are also applied because the digital camera (EUT) is small device.
   The SAR test of "Left" setup is reduced because the SAR test exclusion judge value are smaller than "3." and they have enough antenna separation distance (as the threshold power value).
3) For Bluetooth operation, the SAR test is reduced for all setups, because the SAR test exclusion judge value are smaller than "3."
4) The EUT (digital camera) didn't have view finder, so SAR test of front-of-face condition wasn't considered.

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

1) Search worst SAR setup condition by a channel which has maximum measured output power of IEEE 802.11b(1Mbps DSSS mode (*. This mode has highest power and lowest data rate (as lowest modulation)).
2) Determine the highest reported SAR(1g) of DSSS mode. (*. Change the channel and data rate , if it is required.)
3) Check the SAR of OFDM mode, if it is required.

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

SECTION 5: Uncertainty Assessment (SAR measurement/Daily check)

*. Although this standard determines only the limit value of uncertainty, there is no applicable rule of uncertainty in this. Therefore, the following results are derived depending on whether or not laboratory uncertainty is applied.

Uncertainty of SAR measurement (2.4GHz~6GHz) (*.ε&σ: ≤±5%, DAK3.5, Tx: ≈100% duty cycle) (v09r01)	**1g SAR**	**10g SAR**
Combined measurement uncertainty of the measurement system (k=1)	**± 13.0 %**	**± 12.9 %**
Expanded uncertainty (k=2)	**± 26.0 %**	**± 25.8 %**

	Error Description (2.4-6GHz)	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	0.71	0.71	±1.9 %	±1.9 %	∞
3	Hemispherical isotropy Error	±9.6 %	Rectangular	√3	0.71	0.71	±3.9 %	±3.9 %	∞
4	Linearity Error	±4.7 %	Rectangular	√3	1	1	±2.7 %	±2.7 %	∞
5	Probe modulation response (v09)	±5.5 %	Rectangular	√3	1	1	±3.2 %	±3.2 %	∞
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	±0.5 %	±0.5 %	∞
10	Integration Time Error (≈100% duty cycle)	±0 %	Rectangular	√3	1	1	0 %	0 %	∞
11	RF ambient conditions-noise (v09)	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
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 (v09)	±3.2 %	Normal	1	1	1	±3.2 %	±3.2 %	5
17	Test Sample Positioning Error (v09)	±2.1 %	Normal	1	1	1	±2.1 %	±2.1 %	10
18	Power scaling	±0 %	Rectangular	√3	1	1	±0 %	±0 %	∞
19	Drift of output power (measured, <0.2dB)	±5.0 %	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 (v09r01)						**± 13.0** %	**± 12.9** %	945
	Expanded Uncertainty (k=2) (v09r01)						**± 26.0 %**	**± 25.8 %**	

*. 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.

Uncertainty of daily check (2.4~6GHz) (*.ε&σ tolerance: ≤±5%, DAK3.5, CW) (v09r00)	**1g SAR**	**10g SAR**
Combined measurement uncertainty of the measurement system (k=1)	**± 10.6 %**	**± 10.5 %**
Expanded uncertainty (k=2)	**± 21.2 %**	**± 21.0 %**

	Error Description (v08r00)	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	0.71	0.71	±1.9 %	±1.9 %	∞
3	Hemispherical isotropy error	±9.6 %	Rectangular	√3	0	0	0 %	0 %	∞
4	Probe linearity	±4.7 %	Rectangular	√3	1	1	±2.7 %	±2.7 %	∞
5	Probe modulation response (CW)	±0.0 %	Rectangular	√3	1	1	0 %	0 %	∞
6	System detection limit	±1.0 %	Rectangular	√3	1	1	±0.6 %	±0.6 %	∞
7	Boundary effects	±4.3 %	Rectangular	√3	1	1	±2.5 %	±2.5 %	∞
8	System readout electronics (DAE)	±0.3 %	Normal	1	1	1	±0.3 %	±0.3 %	∞
9	Response Time Error (<5ms/100ms wait)	±0.0 %	Rectangular	√3	1	1	0 %	0 %	∞
10	Integration Time Error (CW)	±0.0 %	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	Deviation of the experimental source	±1.9 %	Normal	1	1	1	±1.9 %	±1.9 %	∞
17	Dipole to liquid distance (10mm±0.2mm,<2deg.)	±2.0 %	Rectangular	√3	1	1	±1.2 %	±1.2 %	∞
18	Drift of output power (measured, <0.1dB)	±2.3 %	Rectangular	√3	1	1	±1.3 %	±1.3 %	∞
C	**Phantom and Setup**								
19	Phantom uncertainty	±2.0 %	Rectangular	√3	1	1	±1.2 %	±1.2%	∞
20	Algorithm for correcting SAR (e',σ: ≤5%)	±1.2 %	Normal	1	1	0.84	±1.2 %	±0.97 %	∞
21	Liquid conductivity (meas.) (DAK3.5)	±3.0 %	Normal	1	0.78	0.71	±2.3 %	±2.1 %	∞
22	Liquid permittivity (meas.) (DAK3.5)	±3.1 %	Normal	1	0.23	0.26	±0.7 %	±0.8 %	∞
23	Liquid Conductivity-temp.uncertainty (≤2deg.C.)	±5.3 %	Rectangular	√3	0.78	0.71	±2.4 %	±2.2 %	∞
24	Liquid Permittivity-temp.uncertainty (≤2deg.C.)	±0.9 %	Rectangular	√3	0.23	0.26	±0.1 %	±0.1 %	∞
	Combined Standard Uncertainty (v09r00)						**±10.6** %	**±10.5** %	
	Expanded Uncertainty (k=2) (v09r00)						**±21.2** %	**±21.0** %	

*. This measurement uncertainty budget is suggested by IEEE Std. 1528(2013) and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget).

*. Table of uncertainties are listed for ISO/IEC 17025.

SECTION 6: Confirmation before testing

6.1 SAR reference power measurement (antenna terminal conducted average power of EUT)

Mode	Frequency		Data rate	Power Setting (software)	Duty cycle	Duty factor	Duty scaled factor	Measurement Result				Power correction					Power tuning applied?	Remarks *. Antenna gain (peak): -2.1 dBi
								Time average power		Burst average power		Min. power	TYP. power	Max. power	Δ from max. (*1)	Tune-up factor		
	[MHz]	CH	[Mbps]	[-]	[%]	[dB]	[-]	[dBm]	[mW]	[dBm]	[mW]	[dBm]	[dBm]	[dBm]	[dB]	[-]		
11b	2412	1	1	fix	98.9	0.05	1.01	10.84	12.13	**10.89**	12.27	6.5	9.5	12.5	-1.07	1.28	n/a (fix)	USB adaptor operation.
	2437	6	1	fix	98.9	0.05	1.01	11.03	12.68	**11.08**	12.82	6.5	9.5	12.5	-0.87	1.22	n/a (fix)	USB adaptor operation.
	2462	11	1	fix	98.9	0.05	1.01	10.89	12.27	**10.94**	12.42	6.5	9.5	12.5	-1.01	1.26	n/a (fix)	USB adaptor operation.
	2412	1	2	fix	97.9	0.09	1.02	11.34	13.61	**11.43**	13.90	6.5	9.5	12.5	-0.80	1.20	n/a (fix)	USB adaptor operation.
	2437	6	2	fix	97.9	0.09	1.02	11.54	14.26	**11.63**	14.55	6.5	9.5	12.5	-0.82	1.21	n/a (fix)	USB adaptor operation.
	2462	11	2	fix	97.9	0.09	1.02	11.40	13.80	**11.49**	14.09	6.5	9.5	12.5	-0.24	1.06	n/a (fix)	USB adaptor operation.
	2437	6	5.5	fix	94.7	0.24	1.06	11.46	14.00	**11.70**	14.79	6.5	9.5	12.5	-0.22	1.05	n/a (fix)	USB adaptor operation.
	2437	6	11	fix	90.3	0.44	1.11	11.24	13.30	**11.68**	14.72	6.5	9.5	12.5	-0.31	1.07	n/a (fix)	USB adaptor operation.
11g	2412	1	6	fix	93.5	0.29	1.07	11.97	15.74	**12.26**	16.83	6.5	9.5	12.5	-0.81	1.21	n/a (fix)	USB adaptor operation.
	2437	6	6	fix	93.5	0.29	1.07	11.99	15.81	**12.28**	16.90	6.5	9.5	12.5	-0.67	1.17	n/a (fix)	USB adaptor operation.
	2462	11	6	fix	93.5	0.29	1.07	11.90	15.49	**12.19**	16.56	6.5	9.5	12.5	-0.73	1.18	n/a (fix)	USB adaptor operation.
11n20HT	2412	1	MCS0	fix	93.1	0.31	1.07	11.38	13.74	**11.69**	14.76	6.5	9.5	12.5	-1.61	1.45	n/a (fix)	USB adaptor operation.
	2437	6	MCS0	fix	93.1	0.31	1.07	11.52	14.19	**11.83**	15.24	6.5	9.5	12.5	-1.42	1.39	n/a (fix)	USB adaptor operation.
	2462	11	MCS0	fix	93.1	0.31	1.07	11.46	14.00	**11.77**	15.03	6.5	9.5	12.5	-1.56	1.43	n/a (fix)	USB adaptor operation.
BT LE (*2)	2402	0	1	fix	64.1	1.93	1.56	3.23	2.10	**5.16**	3.28	3.5	6.5	8.5	-3.34	2.16	n/a (fix)	Battery operation.
	2440	19	1	fix	64.1	1.93	1.56	3.42	2.20	**5.35**	3.43	3.5	6.5	8.5	-3.15	2.07	n/a (fix)	Battery operation.
	2480	38	1	fix	64.1	1.93	1.56	2.81	2.19	**4.74**	2.98	3.5	6.5	8.5	-3.76	2.38	n/a (fix)	Battery operation.
11b	2412	1	1	fix	98.9	0.05	1.01	10.81	12.05	**10.86**	12.19	6.5	9.5	12.5	-1.64	1.46	n/a (fix)	Battery operation.
	2437	6	1	fix	98.9	0.05	1.01	11.02	12.65	**11.07**	12.79	6.5	9.5	12.5	-1.43	1.39	n/a (fix)	Battery operation.
	2462	11	1	fix	98.9	0.05	1.01	10.86	12.19	**10.91**	12.33	6.5	9.5	12.5	-1.59	1.44	n/a (fix)	Battery operation.
	2412	1	2	fix	97.9	0.09	1.02	11.31	13.52	**11.40**	13.80	6.5	9.5	12.5	-1.10	1.29	n/a (fix)	Battery operation.
	2437	6	2	fix	97.9	0.09	1.02	11.53	14.22	**11.62**	14.52	6.5	9.5	12.5	-0.88	1.22	n/a (fix)	Battery operation.
	2462	11	2	fix	97.9	0.09	1.02	11.25	13.34	**11.34**	13.61	6.5	9.5	12.5	-1.16	1.31	n/a (fix)	Battery operation.
11g	2412	1	6	fix	93.5	0.29	1.07	11.92	15.56	**12.21**	16.63	6.5	9.5	12.5	-0.29	1.07	n/a (fix)	Battery operation.
	2437	6	6	fix	93.5	0.29	1.07	11.94	15.63	**12.23**	16.71	6.5	9.5	12.5	-0.27	1.06	n/a (fix)	Battery operation.
	2462	11	6	fix	93.5	0.29	1.07	11.87	15.38	**12.16**	16.44	6.5	9.5	12.5	-0.34	1.08	n/a (fix)	Battery operation.
11n20HT	2412	1	MCS0	fix	93.1	0.31	1.07	11.38	13.74	**11.69**	14.76	6.5	9.5	12.5	-0.81	1.21	n/a (fix)	Battery operation.
	2437	6	MCS0	fix	93.1	0.31	1.07	11.53	14.22	**11.84**	15.28	6.5	9.5	12.5	-0.66	1.16	n/a (fix)	Battery operation.
	2462	11	MCS0	fix	93.1	0.31	1.07	11.48	14.06	**11.79**	15.10	6.5	9.5	12.5	-0.71	1.18	n/a (fix)	Battery operation.

*. ☐: SAR test was applied., "shaded yellow marker": Initial SAR test channel, it has the highest tune-up power and lowest data rate (lowest modulation).

*1. The SAR test power of Wi-Fi was checked to not more than 2dB lower than maximum tune-up power (KDB 447498 D01 (v06) requirement).

*2. The measured duty cycle number of BT LE (smaller than 85%) was nearly equal to highest theory duty cycle.
The measured burst average power of BT LE was more than 2dB lower than maximum tune-up power. However, it was within the power specification range and enough higher than minimum power specification. Since maximum tune-up power of BT LE is 4 dB lower than Wi-Fi power, it is judged that the measured BT LE power can use the SAR test to estimate the SAR value of BT LE for the reference purpose.

*. CH: Channel; Min.power: Minimum power; TYP.power: Typical power; Max.power: Maximum power; n/a: Not applied/Not applicable; (mode) 11b: IEEE 802.11b, 11g: IEEE 802.11g, 11n20HT: IEEE 802.11n(20HT).

*. For IEEE 802.11b (DSSS) mode, the lowest data rate (lowest modulation) mode (1Mbps) was selected for the initial SAR test.
Since the higher data rate of IEEE 802.11b (DSSS) mode had more than 0.5 dB higher measured time-average power, the power measurement was applied to the higher data rate of IEEE 802.11b (DSSS) mode. The lowest data rate of OFDM mode had higher measured time-average power.

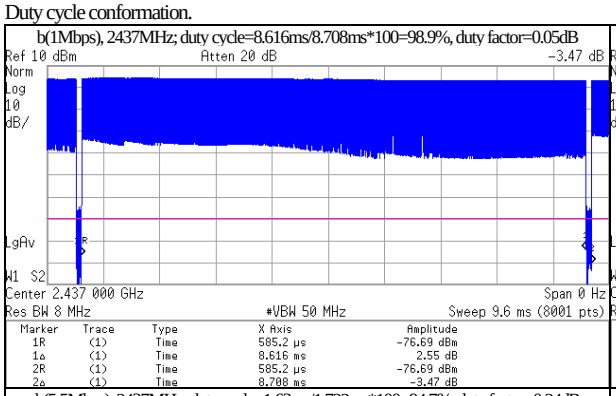
*. Calculating formula: Time average power (dBm): Average power of on/off cycle (including off-time).
Burst average power (dBm) = (Time average power, dBm)+(duty factor, dB)
Duty cycle: (duty cycle, %) = (Tx on time) / (1 cycle time) × 100, Duty factor (dB) = 10 × log (100/(duty cycle, %))
Duty cycle scaled factor (duty cycle correction factor for obtained SAR value) [-] = 100(%) / (duty cycle, %)
Δ from max. (Deviation form maximum power, dB) = (Burst power measured (average, dBm)) - (Tune-up limit power (average, dBm))
Tune-up factor (power tune-up factor for obtained SAR value) [-] = 1 / (10 ^ ("Deviation from max (Δ from max)., dB" / 10))

*. Date measured: February 16, 2021 / Measured by: H. Naka / Place: preparation room of No. 7 shielded room. (24 ± 1 deg.C./ (30~40) %RH)

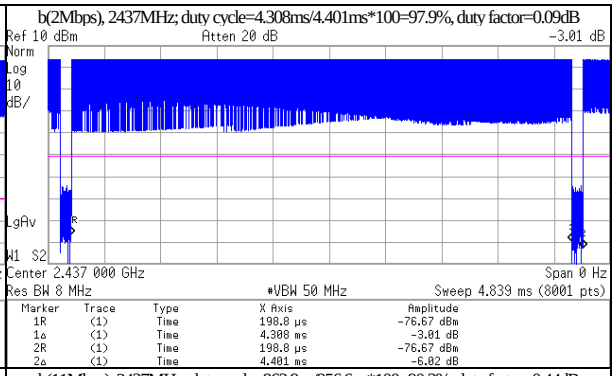
*. Uncertainty of antenna port conducted test; (±) 0.89 dB (Average power), (±) 0.27 % (duty cycle).

*. Duty cycle conformation.

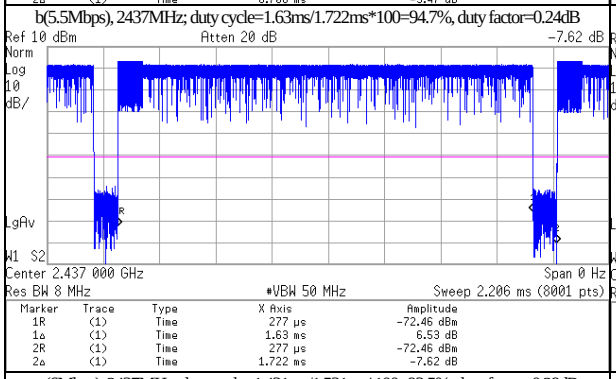
b(1Mbps), 2437MHz; duty cycle=8.616ms/8.708ms*100=98.9%, duty factor=0.05dB



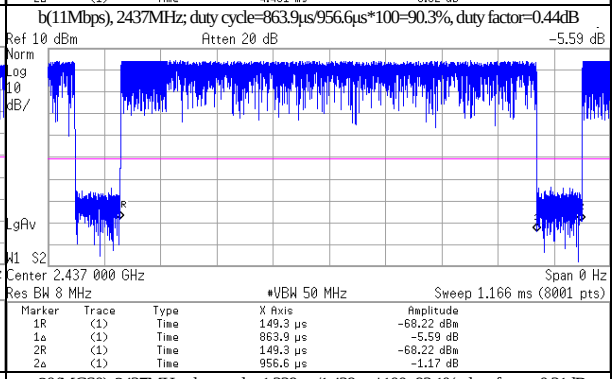
b(2Mbps), 2437MHz; duty cycle=4.308ms/4.401ms*100=97.9%, duty factor=0.09dB



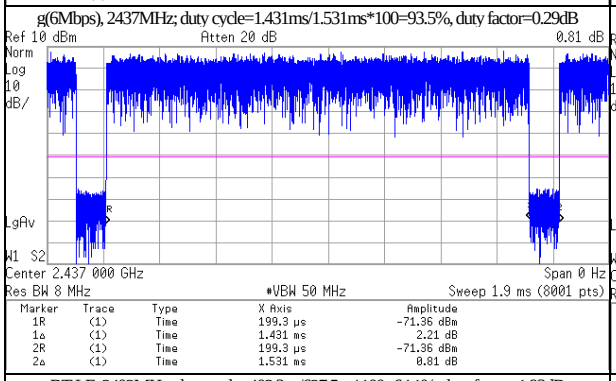
b(5.5Mbps), 2437MHz; duty cycle=1.63ms/1.722ms*100=94.7%, duty factor=0.24dB



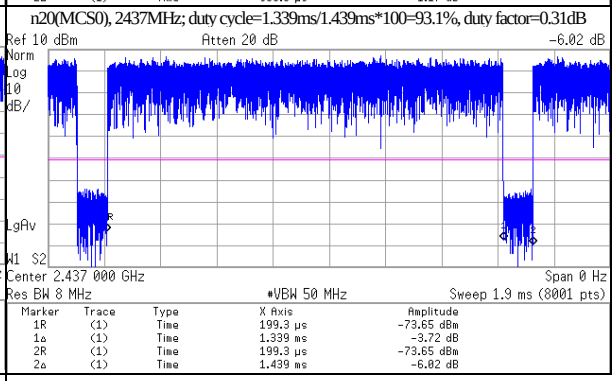
b(11Mbps), 2437MHz; duty cycle=863.9µs/956.6µs*100=90.3%, duty factor=0.44dB



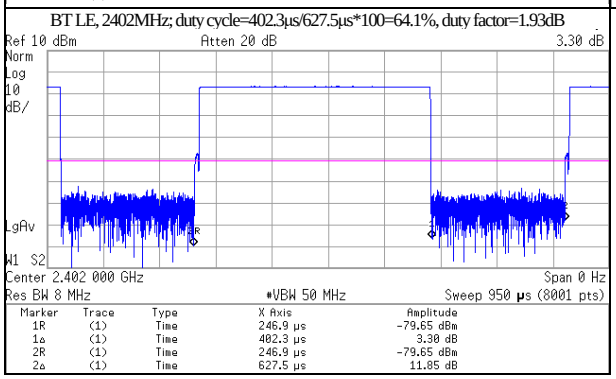
g(6Mbps), 2437MHz; duty cycle=1.431ms/1.531ms*100=93.5%, duty factor=0.29dB



n20(MCS0), 2437MHz; duty cycle=1.339ms/1.439ms*100=93.1%, duty factor=0.31dB



BT LE, 2402MHz; duty cycle=402.3µs/627.5µs*100=64.1%, duty factor=1.93dB



SECTION 7: SAR Measurement results

7.1 SAR results: 2.4 GHz band

Measurement date: February 24 and 25, 2020 Measurement by: Hiroshi Naka

[Liquid measurement]

Target Frequency [MHz]	Liquid type	Liquid parameters (*a)								Liquid Temp. [deg.C.]	Liquid Depth [mm]	ΔSAR Coefficients (*b)			Date measured
		Permittivity (εr) [-]				Conductivity [S/m]									
		Target	Measured		Limit	Target	Measured		Limit			ΔSAR [%] (1g)	ΔSAR [%] (10g)	Correction required?	
			Meas.	Δεr [%]			Meas.	Δσ [%]							
2412	Head	***39.27***	37.82	-3.7	±5%	***1.766***	1.837	+4.0	±5%	23.7	150	+2.80	-	not required.	February 24, 2021, before SAR test (February 25, 2021 (*1))
2437		***39.22***	37.71	-3.9		***1.788***	1.866	+4.3				+2.96	-	not required.	
2462		***39.18***	37.63	-4.0		***1.813***	1.896	+4.6				+3.07	-	not required.	

*1. On February 25, it was within 24 hours from measurement on February 24 and same liquid temperature, so parameters of February 24 were used continuously.

[SAR results]

Test setup			Mode and Frequency			Duty cycle		Power correction			SAR results [W/kg] (Max.value of multi-peak)				SAR plot # in Appendix 2-2	SAR type	SAR Limit [W/kg]	Remarks
Test position	Gap [mm]	Source power	Mode	[MHz]	CH	Duty [%]	Duty scaled factor	Tune-up limit [dBm]	Meas. [dBm]	Tune-up factor	Meas.	ΔSAR [%]	ΔSAR corrected	Reported (*b)				
			Mark with "*" is the initial mode & CH															
Front	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.723**	Positive	n/a (*c)	**1.015**	1-1	1g	1.6	-
	0	Battery	b (1Mbps)*	2462	11	98.9	1.01	12.5	10.91	1.44	**0.771**	Positive	n/a (*c)	**1.121**	1-2	1g	1.6	(< 1.2W/kg)
	0	Battery	b (1Mbps)*	2412	1	98.9	1.01	12.5	10.86	1.46	**0.674**	Positive	n/a (*c)	**0.994**	1-3	1g	1.6	-
Front-right(1)	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.813**	Positive	n/a (*c)	**1.141**	1-4	1g	1.6	-
	0	Battery	b (1Mbps)*	2462	11	98.9	1.01	12.5	10.91	1.44	**0.871**	Positive	n/a (*c)	**1.267**	1-5	1g	1.6	*.Worst SAR setup *.higher, >1.2W/kg
	0	Battery	b (1Mbps)*	2412	1	98.9	1.01	12.5	10.86	1.46	**0.828**	Positive	n/a (*c)	**1.221**	1-6	1g	1.6	-
Front-right(2)	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.765**	Positive	n/a (*c)	**1.074**	1-7	1g	1.6	-
	0	Battery	b (1Mbps)*	2462	11	98.9	1.01	12.5	10.91	1.44	**0.817**	Positive	n/a (*c)	**1.188**	1-8	1g	1.6	(< 1.2W/kg)
	0	Battery	b (1Mbps)*	2412	1	98.9	1.01	12.5	10.86	1.46	**0.801**	Positive	n/a (*c)	**1.181**	1-9	1g	1.6	-
Right-front	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.806**	Positive	n/a (*c)	**1.132**	1-10	1g	1.6	-
	0	Battery	b (1Mbps)*	2462	11	98.9	1.01	12.5	10.91	1.44	**0.814**	Positive	n/a (*c)	**1.184**	1-11	1g	1.6	-
	0	Battery	b (1Mbps)*	2412	1	98.9	1.01	12.5	10.86	1.46	**0.806**	Positive	n/a (*c)	**1.189**	1-12	1g	1.6	(< 1.2W/kg)
Right	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.728**	Positive	n/a (*c)	**1.022**	1-13	1g	1.6	-
	0	Battery	b (1Mbps)*	2462	11	98.9	1.01	12.5	10.91	1.44	**0.736**	Positive	n/a (*c)	**1.070**	1-14	1g	1.6	(< 1.2W/kg)
	0	Battery	b (1Mbps)*	2412	1	98.9	1.01	12.5	10.86	1.46	**0.624**	Positive	n/a (*c)	**0.920**	1-15	1g	1.6	-
Top-front	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.104**	Positive	n/a (*c)	**0.146**	1-16	1g	1.6	(< 0.8W/kg)
Top	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.070**	Positive	n/a (*c)	**0.098**	1-17	1g	1.6	(< 0.8W/kg)
Bottom	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**0.034**	Positive	n/a (*c)	**0.048**	1-18	1g	1.6	(< 0.8W/kg)
Rear (LCD)	0	Battery	b (1Mbps)*	2437*	6	98.9	1.01	12.5	11.07	1.39	**n/a**	Positive	n/a (*c)	**n/a**	1-19	1g	1.6	(*1)
Front-right(1) *.Worst SAR setup	0	Battery	b (2Mbps)	2437	6	97.9	1.02	12.5	11.62	1.22	**0.878**	Positive	n/a (*c)	**1.093**	1-20	1g	1.6	-
	0	Battery	b (2Mbps)	2462	11	97.9	1.02	12.5	11.34	1.31	**0.971**	Positive	n/a (*c)	**1.297**	1-21	1g	1.6	(>1.2W/kg)
	0	Battery	b (2Mbps)	2462	11	97.9	1.02	12.5	11.34	1.31	**1.01**	Positive	n/a (*c)	**1.350**	2-1	1g	1.6	*.Repeated, refer to section 7.2.
	0	USB	b (2Mbps)	2462	11	97.9	1.02	12.5	11.34	1.31	**0.972**	Positive	n/a (*c)	**1.299**	1-22	1g	1.6	*. With battery.
	0	Battery	b (2Mbps)	2412	1	97.9	1.02	12.5	11.40	1.29	**0.838**	Positive	n/a (*c)	**1.103**	1-23	1g	1.6	-
	0	Battery	g (6Mbps)	2437	6	93.5	1.07	12.5	12.23	1.06	**1.05**	Positive	n/a (*c)	**1.191**	1-24	1g	1.6	-
	0	Battery	g (6Mbps)	2462	11	93.5	1.07	12.5	12.16	1.08	**1.1**	Positive	n/a (*c)	**1.271**	1-25	1g	1.6	*.Highest measured, (>1.2W/kg)
	0	Battery	g (6Mbps)	2462	11	93.5	1.07	12.5	12.16	1.08	**1.12**	Positive	n/a (*c)	**1.294**	2-2	1g	1.6	*.Repeated, refer to section 7.2.
	0	Battery	g (6Mbps)	2412	1	93.5	1.07	12.5	12.21	1.07	**1.03**	Positive	n/a (*c)	**1.179**	1-26	1g	1.6	-
	0	Battery	n20 (MCS0)	2437	6	93.1	1.07	12.5	11.84	1.16	**0.891**	Positive	n/a (*c)	**1.106**	1-27	1g	1.6	-
	0	Battery	n20 (MCS0)	2462	11	93.1	1.07	12.5	11.79	1.18	**0.929**	Positive	n/a (*c)	**1.173**	1-28	1g	1.6	(< 1.2W/kg)
	0	Battery	n20 (MCS0)	2412	1	93.1	1.07	12.5	11.69	1.21	**0.848**	Positive	n/a (*c)	**1.098**	1-29	1g	1.6	-

*1. Since the measured interpolated max.SAR value of area scan was small enough, the zoom scan (SAR(10g) measurement step) was reduced.

*. The "shaded yellow marker" shows the "Highest reported SAR(1g)" value.

*a. The target values of (2000, 2450 and 3000) MHz are parameters defined in Appendix A of KDB 865664 D01. For other frequencies, the target nominal dielectric values shall be obtained by linear interpolation between the higher and lower tabulated figures.

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

*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

*. 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))

Notes:

*. Highest measured output power channel (in DSSS, lowest data rate) was tested initially according to KDB 248227 D01.

*. Gap: It is the separation distance between the outer surface of product and the bottom outer surface of phantom; CH: Channel; Meas.: Measured value; n/a: not applied; Max.: Maximum; (mode) b: IEEE 802.11b, g: IEEE 802.11g, n20: IEEE 802.11n(20HT).

*. During test, the EUT was operated by a full-charged rechargeable Li-ion battery.

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

Liquid	SAR test frequency	Probe calibration frequency	Validity	Conversion factor	Uncertainty
Head	(2412, 2437, 2462) MHz	2450 MHz	within ±50MHz of calibration frequency	7.26	±12.0%

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

*. 2.4GHz SAR test reduction procedures (clause 5.2 "2.4GHz SAR Procedure", in KDB248227 D01 (v02r02))

(DSSS) a) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg (SAR (1g)), no further SAR testing is required for 802.11b DSSS in that exposure configuration.

b) When the reported SAR is > 0.8 W/kg (SAR (1g)), 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 (1g)), SAR is required for the third channel; i.e., all channels require testing.

(OFDM) 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 (SAR(1g)).

7.2 SAR Measurement Variability (Repeated measurement requirement)

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(1g) 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.

EUT setup			Mode	Frequency [MHz] (Channel)	Measured SAR [W/kg]			Largest to Smallest SAR Ratio	SAR plot # in Appendix 2-2	
Position	Gap [mm]	Source power			Type	Original	Repeated		Original	Repeated
Front-right(1)	0	Battery	g (6Mbps)	2462 (11)	1g	**1.10** (*. Highest measured)	**1.12** (< 1.45)	**1.02** (≤1.20)	Plot 1-25	Plot 2-2
Front-right(1)	0	Battery	b (2Mbps)	2462 (11)	1g	**0.971** (*. Highest reported SAR(1g))	**1.01** (< 1.45)	**1.04** (≤1.20)	Plot 1-21	Plot 2-1

*. Calculating formula: Largest to Smallest SAR Ratio (%) = (Larger measured SAR (W/kg)) / (Smaller measured SAR (W/kg))

*. (mode) b: IEEE 802.11b, g: IEEE 802.11g.

7.3 Device holder perturbation verification

When the highest reported SAR of an antenna is > 1.2 W/kg, holder perturbation verification (by Urethane form alone) is required by using the highest SAR configuration among all applicable frequency bands.

*. During SAR measurement the EUT was not placed on the device holder directly. The EUT was mounted in the device holder using Urethane form (low-permittivity and low-loss foam) to avoid changes of EUT performance by the holder material (Refer to Appendix 1-3, photographs of test setup). However, the "Device holder perturbation" was confirmed by the setup for which device holder was not used in highest SAR configuration.

EUT setup			Mode	Frequency [MHz] (Channel)	Measured SAR [W/kg]			Device holder perturbation SAR Ratio	Remarks
Position	Gap [mm]	Source power			SAR type	Device holder			
						Exist	None		
Front-right(1)	0	Battery	b (2Mbps)	2462 (11)	1g	**0.971** (Reported: 1.30)	**0.967**	**-0.4 %**	*.It was smaller than 5% of uncertainty of the setup, so influence of a device holder was judged to be no problem.
					SAR plot #	Plot 1-21	Plot 3-1		

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

*. SAR plot is shown in Appendix 2-2. (mode) b: IEEE 802.11b.