



RADIO TEST REPORT

Test Report No. : 11617860S-A-R1

Applicant : CASIO COMPUTER CO., LTD.
Type of Equipment : Watch
Model No. : MRG-G2000
FCC ID : BBQS05W
Test regulation : FCC Part 15 Subpart C: 2016
Test Result : Complied

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. This report is a revised version of 11617860S-A. 11617860S-A is replaced with this report.

Date of test:

November 11, 2016
January 23, 2017

Representative test engineer:

Hiroyuki Morikawa
Engineer
Consumer Technology Division

Approved by:

Akio Hayashi
Leader
Consumer Technology Division



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

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13-EM-F0429

REVISION HISTORY

Original Test Report No.: 11617860S-A

[illegible]

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SECTION 1: Customer information

Company Name	:	CASIO COMPUTER CO., LTD.
Address	:	2-1, Sakaecho 3 chome, Hamura-shi, Tokyo 205-8555 Japan
Telephone Number	:	+81-42-579-7282
Facsimile Number	:	+81-42-579-7702
Contact Person	:	Hiroaki Suzuki

SECTION 2: Equipment under test (E.U.T.)

2.1 Identification of E.U.T.

Type of Equipment	:	Watch
Model No.	:	MRG-G2000
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	Typical: Nom : DC 2.5 V, Min.: DC 1.9 V, Max.: DC 2.7 V CW5501 (Module): Min.: DC 1.9 V, Max.: DC 3.3 V
Receipt Date of Sample	:	October 26, 2016
Country of Mass-production	:	China, Thailand, Japan
Condition of EUT	:	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT	:	No Modification by the test lab.

2.2 Product Description

Model: MRG-G2000 (referred to as the EUT in this report) is a Watch.

* MRG-G2000 has alternative name as R006.

Clock frequency(ies) in the system	:	32.768 kHz
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Radio Specification

Equipment Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480 MHz
Type of Modulation	:	GFSK
Channel spacing	:	2 MHz
Antenna Type	:	Chip Antenna
Antenna Gain	:	2.5 dBi

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
 FCC Part 15 final revised on November 14, 2016 and effective December 14, 2016

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
 Section 15.207 Conducted limits
 Section 15.247 Operation within the bands 902-928MHz,
 2400-2483.5MHz, and 5725-5850MHz

* The revision on November 14, 2016, does not affect the test specification applied to the EUT.

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted Emission	FCC: ANSI C63.10-2013 6. Standard test methods IC: RSS-Gen 8.8	FCC: Section 15.207 IC: RSS-Gen 8.8	-	-	NA *1)
6dB Bandwidth	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: -	FCC: Section 15.247(a)(2) IC: RSS-247 5.2(1)	See data.	Complied	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: RSS-Gen 6.12	FCC: Section 15.247(b)(3) IC: RSS-247 5.4(4)		Complied	Conducted
Power Density	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: -	FCC: Section 15.247(e) IC: RSS-247 5.2(2)		Complied	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: RSS-Gen 6.13	FCC: Section 15.247(d) IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	7.4 dB 4960.00 MHz, AV, Horizontal Tx 2480 MHz	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)

Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.

*1) The test is not applicable since the EUT has no AC mains.

*2) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 DTS Meas Guidance v03r05 12.2.7.

* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

FCC Part 15.31 (e)

The EUT provides stable voltage (DC 1.35 V) constantly to the wireless transmitter regardless of input voltage. Instead of a new battery, DC power supply was used for the test. That does not affect the test result, therefore the EUT complies with the requirement.

FCC Part 15.203 Antenna requirement

It is impossible for end users to replace the antenna, because the antenna is mounted inside of the EUT. Therefore, the equipment complies with the antenna requirement.

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3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99% Occupied Bandwidth	IC: RSS-Gen 6.6	IC: -	N/A	-	Conducted

Other than above, no addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k = 2$.

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Item	Frequency range	Uncertainty (+/-)				
		No. 1 SAC / SR	No. 2 SAC / SR	No. 3 SAC / SR	No. 4 SAC / SR	No. 5,6,8 SR
Conducted emission (AC Mains) LISN	150 kHz-30 MHz	2.6 dB	2.5 dB	2.6 dB	2.5 dB	2.5 dB
Radiated emission (Measurement distance: 3 m)	9 kHz-30 MHz	3.1 dB	3.1 dB	3.1 dB	-	-
	30 MHz-200 MHz	4.6 dB	4.4 dB	4.6 dB	-	-
	200 MHz-1 GHz	5.8 dB	5.7 dB	5.8 dB	-	-
	1 GHz-13 GHz	4.9 dB	4.9 dB	4.9 dB	-	-
Radiated emission (Measurement distance: 1 m)	13 GHz-18 GHz	4.6 dB	4.6 dB	4.6 dB	-	-
	18 GHz-40 GHz	4.9 dB	4.9 dB	4.9 dB	-	-

SAC=Semi-Anechoic Chamber

SR= Shielded Room is applied besides radiated emission

Antenna terminal test	Uncertainty (+/-)
Power Measurement above 1 GHz (Average Detector)_SPM-06	0.72 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-06	0.85 dB
Power Measurement above 1 GHz (Average Detector)_SPM-07	0.74 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-07	0.91 dB
Spurious emission (Conducted) below 1GHz	1.6 dB
Spurious emission (Conducted) 1 GHz-3 GHz	1.3 dB
Spurious emission (Conducted) 3 GHz-18 GHz	2.2 dB
Spurious emission (Conducted) 18 GHz-26.5 GHz	2.3 dB
Spurious emission (Conducted) 26.5 GHz-40 GHz	2.4 dB
Bandwidth Measurement	1.01 %
Duty cycle and Time Measurement	0.012 %

Radiated emission test

The data listed in this test report has enough margin, more than the site margin.

3.5 Test Location

Test site	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber	2973D-1	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.2 Semi-anechoic chamber	2973D-2	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber	2973D-3	12.7 x 7.7 x 5.35	12.7 x 7.7	5 m
No.4 Semi-anechoic chamber	-	8.1 x 5.1 x 3.55	8.1 x 5.1	-
No.1 Shielded room	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.2 Shielded room	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.3 Shielded room	-	6.3 x 4.7 x 2.7	6.3 x 4.7	-
No.4 Shielded room	-	4.4 x 4.7 x 2.7	4.4 x 4.7	-
No.5 Shielded room	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.6 Shielded room	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.8 shielded room	-	3.45 x 5.5 x 2.4	3.45 x 5.5	-
No.1 Measurement room	-	2.55 x 4.1 x 2.5	-	-

3.6 Test data, Test instruments, and Test set up

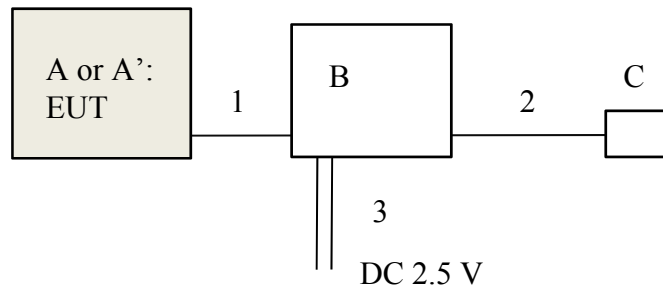
Refer to APPENDIX.

SECTION 4: Operation of E.U.T. during testing

4.1 Operating Mode(s)

Mode	Frequency	Remarks*
Bluetooth Low Energy	2402 MHz, 2440 MHz, 2480 MHz	PN9
*Power of the EUT was set by the software as follows; Power settings: 0 dBm Software Version: RF_Test_Tool_Ver2.01 *This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.		

4.2 Configuration and peripherals



* Cabling and setup(s) were taken into consideration and test data was taken under worse case conditions.

Description of EUT and support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Watch	MRG-G2000	48	CASIO	EUT *2)
A'	Watch	GPW-2000	87	CASIO	EUT *1)
B	Control Board	-	-	-	-
C	USB dongle	-	-	-	-

*1) Used for Antenna Terminal conducted test

*2) Used for Radiated Emission test

The result of antenna terminal conducted test is carried out with GPW-2000 because MRG-G2000 and GPW-2000 have same modules. These modules have same specification about firmware, channel, bandwidth, power setting. (GPW-2000 report is 11502772S-A)

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Signal	0.2	Unshielded	Unshielded	*3)
2	Signal	0.15	Unshielded	Unshielded	-
3	DC	1.4	Unshielded	Unshielded	-

*3) Cable for test operation

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SECTION 5: Radiated Spurious Emission

Test Procedure

It was measured based on "11.0 Emissions in non-restricted frequency bands" of "558074 D01 DTS Meas Guidance v03r05".

[For below 1 GHz]

EUT was placed on a platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane. The table is made of Styrofoam and covered with polyvinyl chloride. That has very low permittivity. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]

EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.

The height of the measuring antenna varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.

The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.

The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).

The test was made with the detector (RBW/VBW) in the following table.

When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

Frequency	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Biconical	Logperiodic	Horn

In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.

20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(IC) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (IC).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *3)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	Average Power Method: RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces If duty cycle was less than 98%, a duty factor was added to the results.	RBW: 100 kHz VBW: 300kHz
Test Distance	3 m	3.95 m *1) (1 GHz – 13 GHz), 1 m *2) (13 GHz – 26.5 GHz)		3.95 m *1) (1 GHz – 13 GHz), 1 m *2) (13 GHz – 26.5 GHz)

*1) Distance Factor: $20 \times \log(3.95 \text{ m} / 3.0 \text{ m}) = 2.39 \text{ dB}$

*2) Distance Factor: $20 \times \log(1.0 \text{ m} / 3.0 \text{ m}) = -9.54 \text{ dB}$

*3) Average Power Measurement was performed based on 6.0 & 12.2.5 of "KDB 558074 D01 DTS Meas Guidance v03r05"

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The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

Antenna polarization	Carrier	Spurious (Below 1 GHz)	Spurious (1 GHz -13 GHz)	Spurious (13 GHz -26.5 GHz)
Horizontal	Y	Y	Y	X
Vertical	Y	Y	Y	X

The test results and limit are rounded off to one decimal place, so some differences might be observed.

Measurement range : 30 MHz – 26.5 GHz
Test data : APPENDIX
Test result : Pass

SECTION 6: Antenna Terminal Conducted Tests

Test Procedure

The tests were made with below setting connected to the antenna port.

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument used
6dB Bandwidth	10 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Sample	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak / Average *2)	-	Power Meter (Sensor: 50 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *3)
Conducted Spurious Emission *4)	9kHz to 150kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	10 kHz	30 kHz				
*1) Peak hold was applied as Worst-case measurement. *2) Reference data *3) Section 10.2 Method PKPSD (peak PSD) of "KDB 558074 D01 DTS Meas Guidance v03r05". *4) In the frequency range below 30MHz, RBW was narrowed to separate the noise contents. Then, wide-band noise near the limit was checked separately, however the noise was not detected as shown in the chart. (9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 10 kHz)							

The test results and limit are rounded off to two decimals place, so some differences might be observed.

Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

6dB Bandwidth

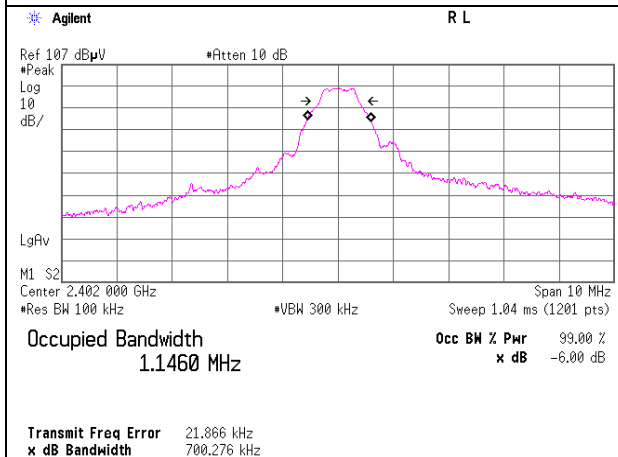
Test place	Shonan EMC Lab. No.3 Shielded Room
Report No.	11617860S-A-R1
Date	November 11, 2016
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Hiroyuki Morikawa
Mode	Tx BT LE

Mode	Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
BT LE	2402	0.700	> 500
	2440	0.724	> 500
	2480	0.722	> 500

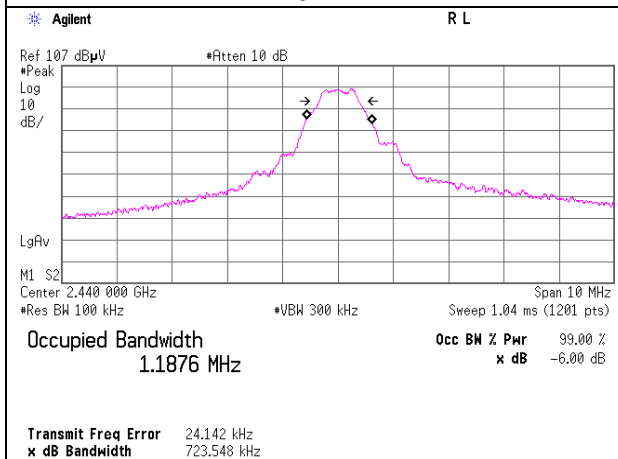
6dB Bandwidth

BT LE

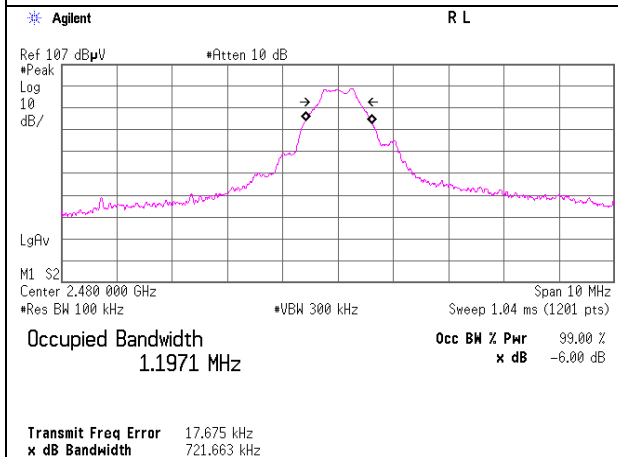
2402 MHz



2440 MHz



2480 MHz



Maximum Peak Output Power

Test place Shonan EMC Lab. No.3 Shielded Room
Report No. 11617860S-A-R1
Date November 11, 2016
Temperature / Humidity 22 deg. C / 38 % RH
Engineer Hiroyuki Morikawa
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]	
2402	-10.09	1.28	10.01	1.20	1.32	30.00	1000	28.80
2440	-10.23	1.29	10.01	1.07	1.28	30.00	1000	28.93
2480	-10.5	1.29	10.01	0.80	1.20	30.00	1000	29.20

Sample Calculation:

Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

*The equipment and cables were not used for factor 0 dB of the data sheets.

Average Output Power
(Reference data for RF Exposure)

Test place Shonan EMC Lab. No.3 Shielded Room
Report No. 11617860S-A-R1
Date November 11, 2016
Temperature / Humidity 22 deg. C / 38 % RH
Engineer Hiroyuki Morikawa
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
				[dBm]	[mW]		[dBm]	[mW]
2402	-10.38	1.28	10.01	0.91	1.23	0.00	0.91	1.23
2440	-10.51	1.29	10.01	0.79	1.20	0.00	0.79	1.20
2480	-10.84	1.29	10.01	0.46	1.11	0.00	0.46	1.11

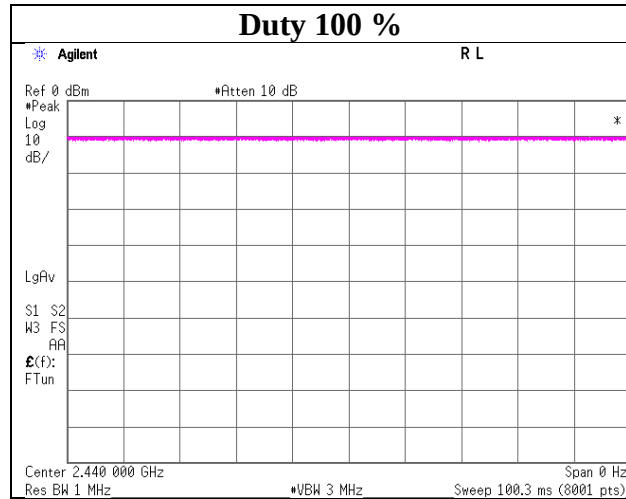
Sample Calculation:

Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator
Result (Burst power average) = Time average + Duty factor

*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst rate confirmation

Test place Shonan EMC Lab. No.3 Shielded Room
Report No. 11617860S-A-R1
Date November 11, 2016
Temperature / Humidity 22 deg. C / 38 % RH
Engineer Hiroyuki Morikawa
Mode Tx BT LE



Radiated Spurious Emission

Test place : Shonan EMC Lab. No.3 Semi Anechoic Chamber
Report No. : 11617860S-A-R1
Date : January 23, 2017 January 23, 2017
Temperature / Humidity : 22 deg. C / 32 % RH 24 deg. C / 33 % RH
Engineer : Kazutaka Takeyama Hiroyuki Morikawa
(30 MHz – 1 GHz, (1 GHz – 13 GHz,
13 GHz – 18 GHz) 18 GHz – 26.5 GHz)
Mode : Tx BT LE 2402 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	87.928	QP	23.80	7.81	7.33	32.15	0.00	6.79	40.00	33.2	100	0	
Hori.	246.485	QP	22.60	17.15	8.39	31.99	0.00	16.15	46.00	29.8	150	291	
Hori.	2390.000	PK	45.98	27.41	13.77	40.70	2.39	48.85	73.90	25.0	171	236	
Hori.	4804.000	PK	47.57	31.13	5.95	41.54	2.39	45.50	73.90	28.4	151	294	
Hori.	7206.000	PK	46.38	36.44	7.38	41.12	2.39	51.47	73.90	22.4	150	0	
Hori.	9608.000	PK	44.98	38.63	8.32	40.49	2.39	53.83	73.90	20.0	150	0	
Hori.	2390.000	AV	37.34	27.41	13.77	40.70	2.39	40.21	53.90	13.6	171	236	
Hori.	4804.000	AV	38.95	31.13	5.95	41.54	2.39	36.88	53.90	17.0	151	294	
Hori.	7206.000	AV	37.37	36.44	7.38	41.12	2.39	42.46	53.90	11.4	150	0	
Hori.	9608.000	AV	36.28	38.63	8.32	40.49	2.39	45.13	53.90	8.7	150	0	
Vert.	45.005	QP	25.40	12.28	6.92	32.17	0.00	12.43	40.00	27.5	100	8	
Vert.	49.161	QP	27.70	10.98	6.97	32.17	0.00	13.48	40.00	26.5	100	61	
Vert.	85.859	QP	32.40	7.39	7.31	32.15	0.00	14.95	40.00	25.0	116	307	
Vert.	173.923	QP	25.90	16.01	7.96	32.07	0.00	17.80	43.50	25.7	100	346	
Vert.	223.096	QP	25.30	16.69	8.26	32.02	0.00	18.23	46.00	27.7	100	0	
Vert.	404.702	QP	22.60	15.96	9.19	31.95	0.00	15.80	46.00	30.2	100	280	
Vert.	946.664	QP	20.50	22.31	11.18	30.62	0.00	23.37	46.00	22.6	100	153	
Vert.	2390.000	PK	45.92	27.41	13.77	40.70	2.39	48.79	73.90	25.1	140	87	
Vert.	4804.000	PK	48.60	31.13	5.95	41.54	2.39	46.53	73.90	27.3	221	18	
Vert.	7206.000	PK	47.07	36.44	7.38	41.12	2.39	52.16	73.90	21.7	150	0	
Vert.	9608.000	PK	45.04	38.63	8.32	40.49	2.39	53.89	73.90	20.0	150	0	
Vert.	2390.000	AV	37.23	27.41	13.77	40.70	2.39	40.10	53.90	13.8	140	87	
Vert.	4804.000	AV	39.94	31.13	5.95	41.54	2.39	37.87	53.90	16.0	221	18	
Vert.	7206.000	AV	37.58	36.44	7.38	41.12	2.39	42.67	53.90	11.2	150	0	
Vert.	9608.000	AV	36.15	38.63	8.32	40.49	2.39	45.00	53.90	8.9	150	0	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : 20log(3.95 m / 3.0 m) = 2.39 dB

13 GHz - 40 GHz : 20log(1.0 m / 3.0 m) = -9.54 dB

20 dBc Data Sheet (RBW 100 kHz, VBW 300 kHz)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	75.44	27.46	13.78	40.70	2.39	78.37	-	-	Carrier
Hori.	2400.000	PK	38.16	27.45	13.78	40.70	2.39	41.08	58.37	17.3	
Vert.	2402.000	PK	75.09	27.46	13.78	40.70	2.39	78.02	-	-	Carrier
Vert.	2400.000	PK	38.20	27.45	13.78	40.70	2.39	41.12	58.02	16.9	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : 20log(3.95 m / 3.0 m) = 2.39 dB

13 GHz - 40 GHz : 20log(1.0 m / 3.0 m) = -9.54 dB

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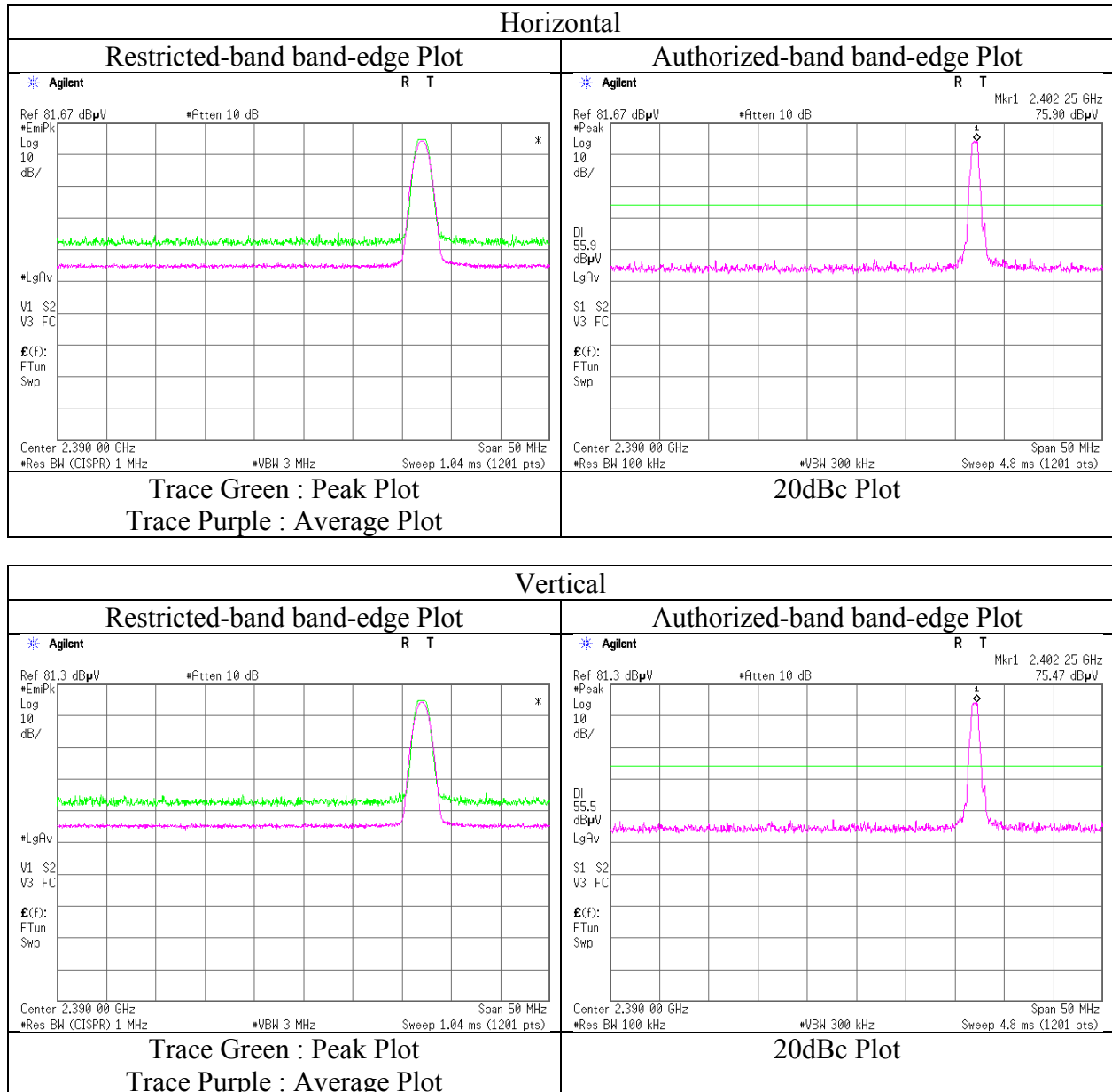
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

Telephone : +81 463 50 6400

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Radiated Spurious Emission (Reference Plot for band-edge)

Test place	Shonan EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11617860S-A-R1
Date	January 23, 2017
Temperature / Humidity	24 deg. C / 33 % RH
Engineer	Hiroyuki Morikawa
	(1 GHz – 13 GHz, 18 GHz – 26.5 GHz)
Mode	Tx BT LE 2402 MHz



* Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission

Test place : Shonan EMC Lab. No.3 Semi Anechoic Chamber
Report No. : 11617860S-A-R1
Date : January 23, 2017 January 23, 2017
Temperature / Humidity : 22 deg. C / 32 % RH 24 deg. C / 33 % RH
Engineer : Kazutaka Takeyama Hiroyuki Morikawa
(30 MHz – 1 GHz, (1 GHz – 13 GHz,
13 GHz – 18 GHz) 18 GHz – 26.5 GHz)
Mode : Tx BT LE 2440 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	36.943	QP	23.10	15.29	6.83	32.18	0.00	13.04	40.00	26.9	100	0	
Hori.	234.001	QP	25.00	16.90	8.32	32.01	0.00	18.21	46.00	27.7	132	124	
Hori.	4880.000	PK	49.77	31.29	5.97	41.39	2.39	48.03	73.90	25.8	166	200	
Hori.	7320.000	PK	47.20	36.77	7.36	41.24	2.39	52.48	73.90	21.4	150	0	
Hori.	9760.000	PK	45.65	38.75	8.35	40.41	2.39	54.73	73.90	19.1	150	0	
Hori.	4880.000	AV	41.79	31.29	5.97	41.39	2.39	40.05	53.90	13.8	166	200	
Hori.	7320.000	AV	38.24	36.77	7.36	41.24	2.39	43.52	53.90	10.3	150	0	
Hori.	9760.000	AV	36.43	38.75	8.35	40.41	2.39	45.51	53.90	8.3	150	0	
Vert.	38.162	QP	24.10	14.90	6.84	32.18	0.00	13.66	40.00	26.3	103	206	
Vert.	50.065	QP	23.40	10.70	6.98	32.17	0.00	8.91	40.00	31.0	100	82	
Vert.	85.795	QP	30.90	7.37	7.31	32.15	0.00	13.43	40.00	26.5	103	291	
Vert.	170.693	QP	25.70	15.87	7.94	32.07	0.00	17.44	43.50	26.0	112	314	
Vert.	362.233	QP	23.30	15.09	9.02	31.93	0.00	15.48	46.00	30.5	113	182	
Vert.	940.263	QP	20.90	22.24	11.16	30.68	0.00	23.62	46.00	22.3	100	215	
Vert.	4880.000	PK	49.81	31.29	5.97	41.39	2.39	48.07	73.90	25.8	249	145	
Vert.	7320.000	PK	47.47	36.77	7.36	41.24	2.39	52.75	73.90	21.1	150	0	
Vert.	9760.000	PK	45.57	38.75	8.35	40.41	2.39	54.65	73.90	19.2	150	0	
Vert.	4880.000	AV	42.39	31.29	5.97	41.39	2.39	40.65	53.90	13.2	249	145	
Vert.	7320.000	AV	37.99	36.77	7.36	41.24	2.39	43.27	53.90	10.6	150	0	
Vert.	9760.000	AV	36.58	38.75	8.35	40.41	2.39	45.66	53.90	8.2	150	0	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : $20\log(3.95\text{ m} / 3.0\text{ m}) = 2.39\text{ dB}$

13 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Radiated Spurious Emission

Test place : Shonan EMC Lab. No.3 Semi Anechoic Chamber
Report No. : 11617860S-A-R1
Date : January 23, 2017 January 23, 2017
Temperature / Humidity : 22 deg. C / 32 % RH 24 deg. C / 33 % RH
Engineer : Kazutaka Takeyama Hiroyuki Morikawa
(30 MHz – 1 GHz, (1 GHz – 13 GHz,
13 GHz – 18 GHz) 18 GHz – 26.5 GHz)
Mode : Tx BT LE 2480 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	270.833	QP	22.40	17.94	8.53	31.99	0.00	16.88	46.00	29.1	300	316	
Hori.	2483.500	PK	47.32	27.79	13.86	40.69	2.39	50.67	73.90	23.2	151	234	
Hori.	4960.000	PK	52.88	31.45	5.98	41.23	2.39	51.47	73.90	22.4	183	341	
Hori.	7440.000	PK	46.96	37.11	7.33	41.37	2.39	52.42	73.90	21.4	150	0	
Hori.	9920.000	PK	45.09	38.87	8.38	40.32	2.39	54.41	73.90	19.4	150	0	
Hori.	2483.500	AV	38.35	27.79	13.86	40.69	2.39	41.70	53.90	12.2	151	234	
Hori.	4960.000	AV	47.84	31.45	5.98	41.23	2.39	46.43	53.90	7.4	183	341	
Hori.	7440.000	AV	38.31	37.11	7.33	41.37	2.39	43.77	53.90	10.1	150	0	
Hori.	9920.000	AV	36.24	38.87	8.38	40.32	2.39	45.56	53.90	8.3	150	0	
Vert.	43.567	QP	23.10	12.86	6.91	32.18	0.00	10.69	40.00	29.3	112	257	
Vert.	51.002	QP	23.50	10.43	6.99	32.17	0.00	8.75	40.00	31.2	137	67	
Vert.	85.120	QP	31.00	7.23	7.31	32.15	0.00	13.39	40.00	26.6	102	265	
Vert.	170.477	QP	26.40	15.86	7.94	32.07	0.00	18.13	43.50	25.3	106	357	
Vert.	351.329	QP	23.90	14.85	8.97	31.92	0.00	15.80	46.00	30.2	108	222	
Vert.	954.433	QP	20.50	22.39	11.21	30.56	0.00	23.54	46.00	22.4	100	0	
Vert.	2483.500	PK	47.07	27.79	13.86	40.69	2.39	50.42	73.90	23.4	127	86	
Vert.	4960.000	PK	50.57	31.45	5.98	41.23	2.39	49.16	73.90	24.7	137	59	
Vert.	7440.000	PK	47.54	37.11	7.33	41.37	2.39	53.00	73.90	20.9	150	0	
Vert.	9920.000	PK	45.33	38.87	8.38	40.32	2.39	54.65	73.90	19.2	150	0	
Vert.	2483.500	AV	37.51	27.79	13.86	40.69	2.39	40.86	53.90	13.0	127	86	
Vert.	4960.000	AV	44.29	31.45	5.98	41.23	2.39	42.88	53.90	11.0	137	59	
Vert.	7440.000	AV	38.18	37.11	7.33	41.37	2.39	43.64	53.90	10.2	150	0	
Vert.	9920.000	AV	36.44	38.87	8.38	40.32	2.39	45.76	53.90	8.1	150	0	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : $20\log(3.95\text{ m} / 3.0\text{ m}) = 2.39\text{ dB}$

13 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

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Shonan EMC Lab.

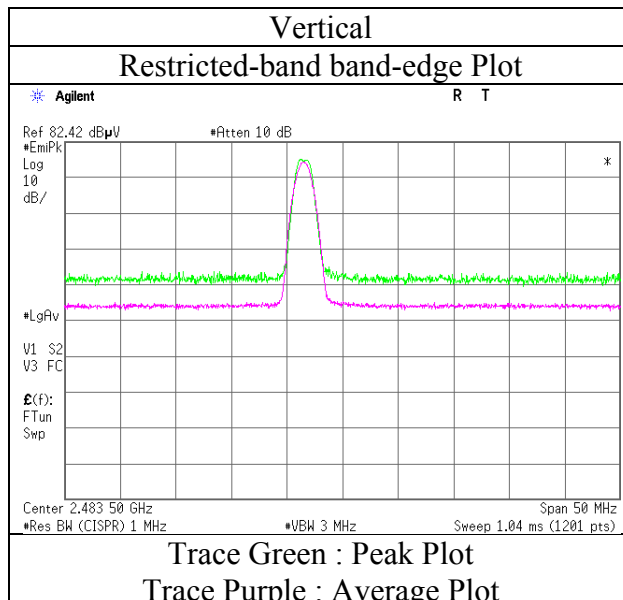
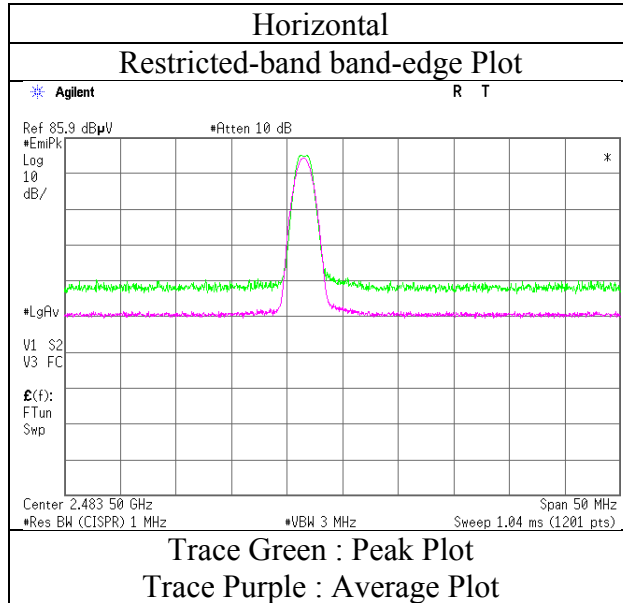
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

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Radiated Spurious Emission (Reference Plot for band-edge)

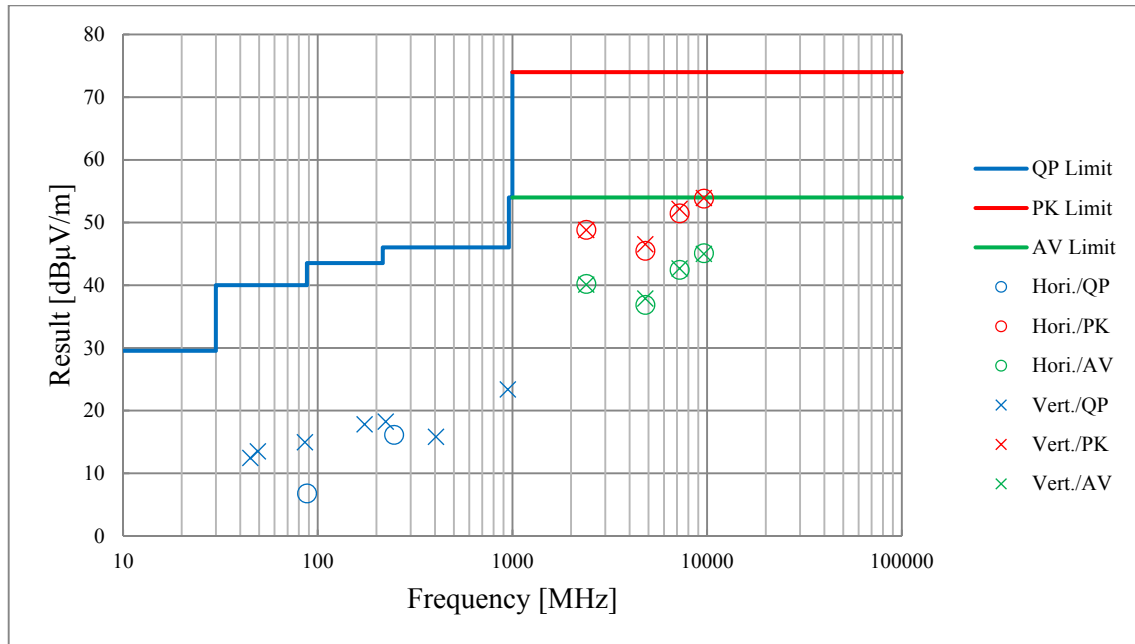
Test place	Shonan EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11617860S-A-R1
Date	January 23, 2017
Temperature / Humidity	24 deg. C / 33 % RH
Engineer	Hiroyuki Morikawa (1 GHz – 13 GHz, 18 GHz – 26.5 GHz)
Mode	Tx BT LE 2480 MHz



* Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission
(Plot data, Worst case)

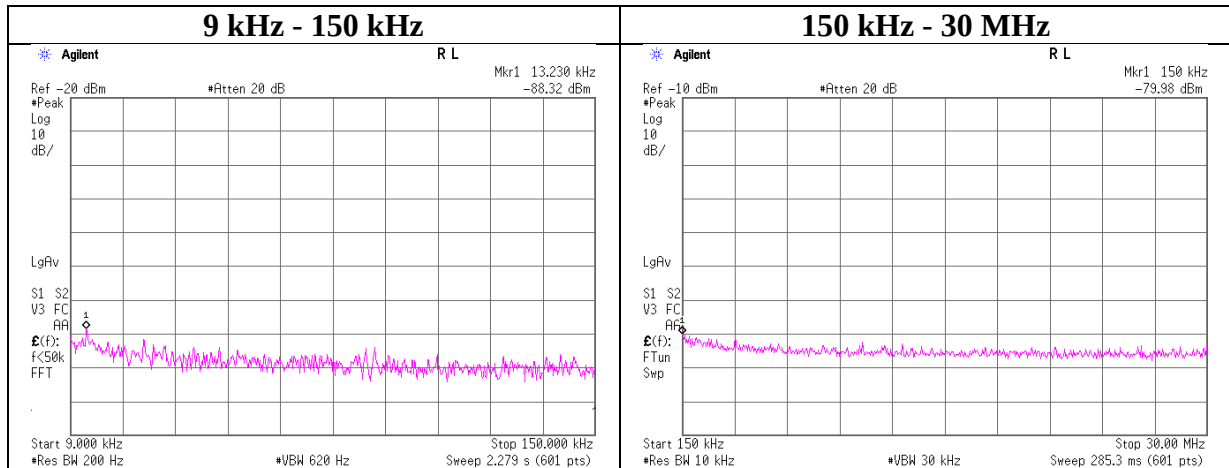
Test place	Shonan EMC Lab. No.3 Semi Anechoic Chamber		
Report No.	11617860S-A-R1		
Date	January 23, 2017	January 23, 2017	
Temperature / Humidity	22 deg. C / 32 % RH	24 deg. C / 33 % RH	
Engineer	Kazutaka Takeyama	Hiroyuki Morikawa	
	(30 MHz – 1 GHz,	(1 GHz – 13 GHz,	
	13 GHz – 18 GHz)	18 GHz – 26.5 GHz)	
Mode	Tx BT LE 2402 MHz		



*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

Test place : Shonan EMC Lab. No.3 Shielded Room
Report No. : 11617860S-A-R1
Date : November 11, 2016
Temperature / Humidity : 22 deg. C / 38 % RH
Engineer : Hiroyuki Morikawa
Mode : Tx BT LE 2402 MHz



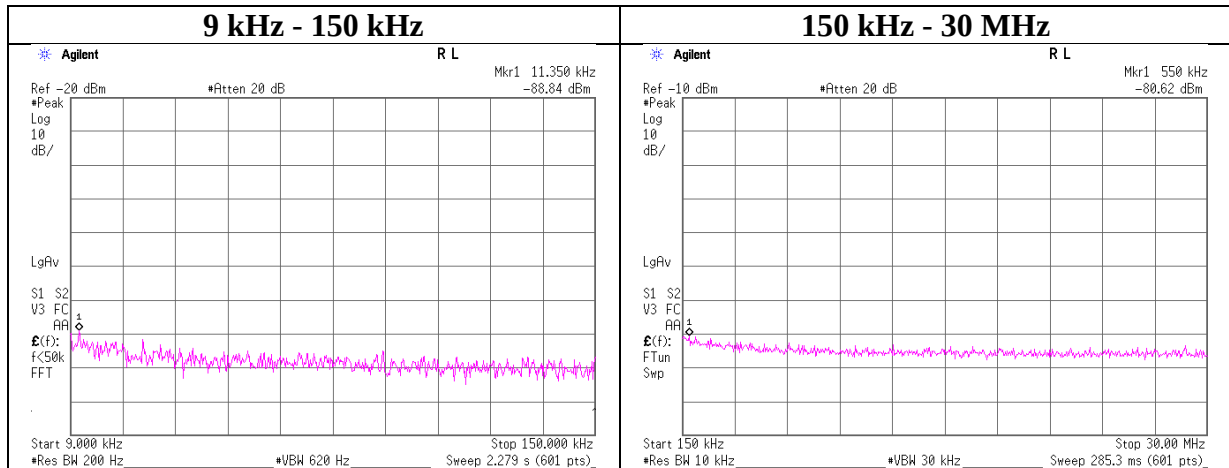
Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
13.23	-88.3	0.01	9.9	2.5	1	-75.9	300	6.0	-14.6	45.1	59.7	
150.00	-80.0	0.01	9.9	2.5	1	-67.5	300	6.0	-6.3	24.0	30.3	

E = EIRP - 20 log (D) + Ground bounce + 104.8 [dBuV/m]

EIRP = Reading + Cable Loss + Attenuator Loss + Antenna Gain + 10 * log (N)

Conducted Spurious Emission

Test place	Shonan EMC Lab. No.3 Shielded Room
Report No.	11617860S-A-R1
Date	November 11, 2016
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Hiroyuki Morikawa
Mode	Tx BT LE 2440 MHz



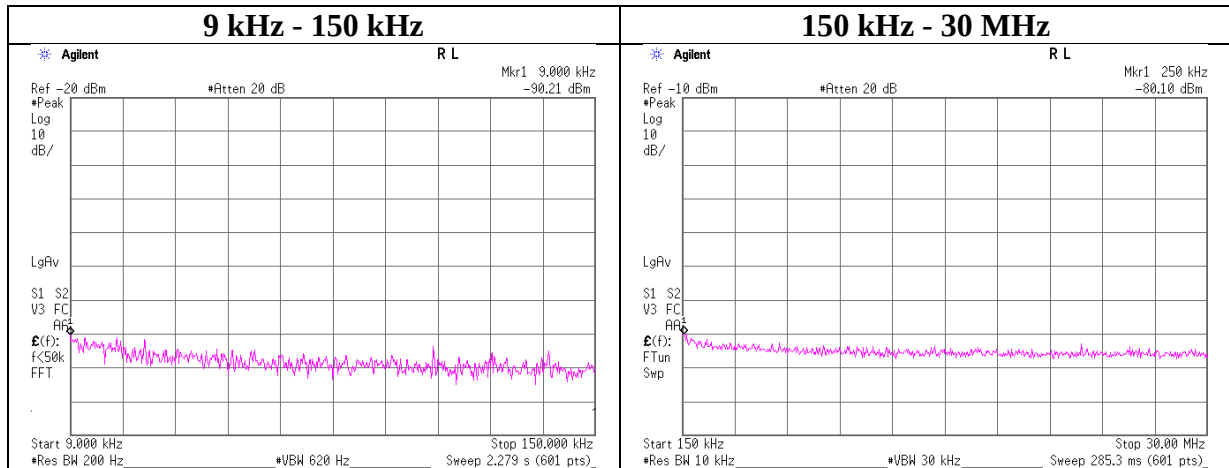
Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
11.35	-88.8	0.01	9.9	2.5	1	-76.4	300	6.0	-15.1	46.5	61.6	
550.00	-80.6	0.01	9.9	2.5	1	-68.2	30	6.0	13.1	32.7	19.6	

$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 [\text{dBuV/m}]$

$\text{EIRP} = \text{Reading} + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$

Conducted Spurious Emission

Test place : Shonan EMC Lab. No.3 Shielded Room
Report No. : 11617860S-A-R1
Date : November 11, 2016
Temperature / Humidity : 22 deg. C / 38 % RH
Engineer : Hiroyuki Morikawa
Mode : Tx BT LE 2480 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
9.00	-90.2	0.01	9.9	2.5	1	-77.8	300	6.0	-16.5	48.5	65.0	
250.00	-80.1	0.01	9.9	2.5	1	-67.7	300	6.0	-6.4	19.6	26.0	

$$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 [\text{dBuV/m}]$$

$$\text{EIRP} = \text{Reading} + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$$

Power Density

Test place Shonan EMC Lab. No.3 Shielded Room
Report No. 11617860S-A-R1
Date November 11, 2016
Temperature / Humidity 22 deg. C / 38 % RH
Engineer Hiroyuki Morikawa
Mode Tx BT LE

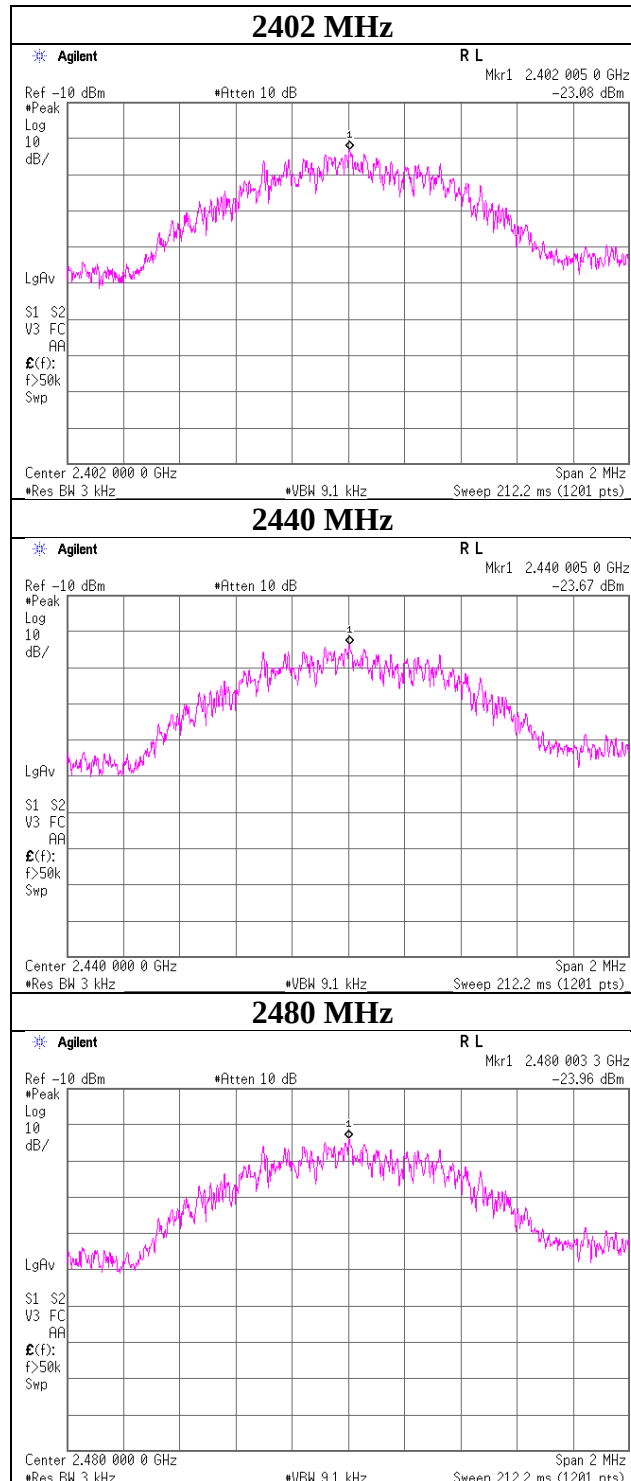
Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-23.08	1.28	10.01	-11.79	8.00	19.79
2440.00	-23.68	1.29	10.01	-12.38	8.00	20.38
2480.00	-23.96	1.29	10.01	-12.66	8.00	20.66

Sample Calculation:

Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

*The equipment and cables were not used for factor 0 dB of the data sheets.

Power Density



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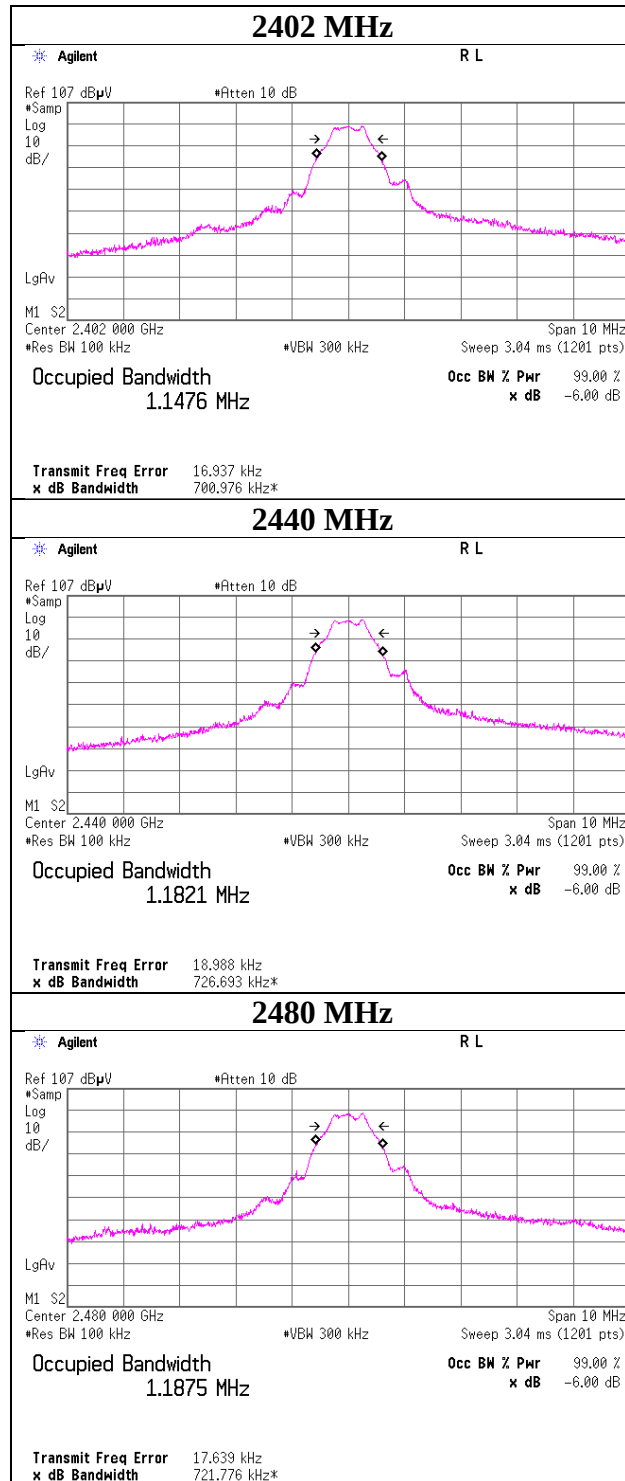
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

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99%Occupied Bandwidth

Test place	Shonan EMC Lab. No.3 Shielded Room
Report No.	11617860S-A-R1
Date	November 11, 2016
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Hiroyuki Morikawa
Mode	Tx BT LE



APPENDIX 2: Test instruments

Test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
STS-03	Digital Hitester	Hioki	3805-50	080997823	AT, RE	2016/10/17 * 12
SPM-06	Power Meter	Anritsu	ML2495A	0850009	AT	2016/04/01 * 12
SPSS-03	Power sensor	Anritsu	MA2411B	0917063	AT	2016/04/01 * 12
SSA-03	Spectrum Analyzer	Agilent	E4448A	MY48250152	AT	2016/09/26 * 12
SCC-G12	Coaxial Cable	Suhner	SUCOFLEX 102	30790/2	AT	2016/03/23 * 12
SAT10-06	Attenuator	Agilent	8493C-010	74865	AT	2016/11/07 * 12
SOS-06	Humidity Indicator	A&D	AD-5681	4062118	AT	2015/12/07 * 12 *1)
SAEC-03(NSA)	Semi-Anechoic Chamber	TDK	SAEC-03(NSA)	3	RE	2016/07/15 * 12
SBA-03	Biconical Antenna	Schwarzbeck	BBA9106	91032666	RE	2016/10/18 * 12
SLA-01	Logperiodic Antenna	Schwarzbeck	UHALP9108A	UHALP	RE	2016/10/15 * 12
SAT6-08	Attenuator	HIROSE ELECTRIC CO., LTD.	AT-406(40)	-	RE	2016/08/04 * 12
SCC-C1/C2/C3/C4/C5/C10/SRSE-03	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-271(RF Selector)	RE	2016/04/22 * 12
SAF-03	Pre Amplifier	SONOMA	310N	290213	RE	2016/02/25 * 12
STR-06	Test Receiver	Rohde & Schwarz	ESCI	101259	RE	2016/03/28 * 12
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE,CE,RFI,MF)	-	RE	-
SOS-05	Humidity Indicator	A&D	AD-5681	4062518	RE	2016/10/12 * 12
SJM-02	Measure	KOMELON	KMC-36	-	RE	-
SAF-04	Pre Amplifier	TOYO Corporation	TPA0118-36	1440489	RE	2016/03/22 * 12
SCC-G04	Coaxial Cable	Junkosha	J12J102207-00	JUN-12-14-018	RE	2016/06/23 * 12
SCC-G23	Coaxial Cable	Suhner	SUCOFLEX 104	297342/4	RE	2016/05/11 * 12
SHA-03	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-739	RE	2016/08/22 * 12
SRENT-08	Spectrum Analyzer	Agilent	E4448A	MY50180019	RE	2016/10/24 * 12
SAF-09	Pre Amplifier	TOYO Corporation	HAP18-26W	00000018	RE	2016/09/27 * 12
SHA-05	Horn Antenna	ETS LINDGREN	3160-09	LM4210	RE	2016/03/24 * 12
SCC-G20	Coaxial Cable	Junkosha	J12J102518-00	APR-15-15-00	RE	2016/04/18 * 12
SCC-G33	Coaxial Cable	Junkosha	MWX241-01000K MSKMS	-	RE	2016/04/18 * 12
SAEC-03(SVSWR)	Semi-Anechoic Chamber	TDK	SAEC-03(SVSWR)	3	RE	2016/07/25 * 12
SAT10-06	Attenuator	Agilent	8493C-010	74865	RE	2016/11/07 * 12
SFL-18	Highpass Filter	MICRO-TRONICS	HPM50111	119	RE	2016/04/18 * 12

*1) This test equipment was used for the tests before the expiration date of the calibration.

The expiration date of the calibration is the end of the expired month.

All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

Test Item: RE: Radiated Emission test
AT: Antenna Terminal Conducted test

UL Japan, Inc.

Shonan EMC Lab.

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