RADIO TEST REPORT

Test Report No. : 12547242H-A-R1

Applicant	:	**Roland Corporation**
Type of Equipment	:	**Wireless Transmitter**
Model No.	:	**WL-60T**
FCC ID	:	**SOP421721A**
Test regulation	:	**FCC Part 15 Subpart C: 2018**
Test Result	:	**Complied (Refer to SECTION 3.2)**

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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. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
6. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
7. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 12547242H-A. 12547242H-A is replaced with this report.

Date of test: February 26 to 28, 2019

Representative test engineer:
Akihiko Maeda
Engineer
Consumer Technology Division

Approved by:
Tsubasa Takayama
Leader
Consumer Technology Division

NVLAP LAB CODE: 200572-0

This laboratory is accredited by the NVLAP LAB CODE 200572-0, U.S.A. The tests reported herein have been performed in accordance with its terms of accreditation.
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☐ The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
☒ There is no testing item of "Non-accreditation".

UL Japan, Inc.
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REVISION HISTORY

Original Test Report No.: 12547242H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	12547242H-A	March 19, 2019	-	-
1	12547242H-A-R1	April 2, 2019	P 21, 23, 24	Addition of *1) (Frequency: 2338.147 MHz, 2314.112 MHz, 2350.000 MHz, 2606.000 MHz) to Radiated Spurious Emission data in APPENDIX 1
1	12547242H-A-R1	April 2, 2019	P 32	Correction to Test instruments in APPENDIX 2

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	Roland Corporation
Address	:	1-5-3 Shinmiyakoda, Kita-ku, Hamamatsu, Shizuoka 431-2103, JAPAN
Telephone Number	:	+81-53-428-5101
Facsimile Number	:	+81-53-428-5109
Contact Person	:	Hiroshi Yamate

The information provided from the customer is as follows;
- Applicant, Type of Equipment, Model No., FCC ID on the cover and other relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (E.U.T.)
- SECTION 4: Operation of E.U.T. during testing

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

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

2.1 Identification of E.U.T.

Type of Equipment	:	Wireless Transmitter
Model No.	:	WL-60T
Serial No.	:	Refer to SECTION 4.2
Rating	:	DC 3.0 V
Receipt Date of Sample	:	February 25, 2019 (for Radiated Emission test)
(Information from test lab.)		February 27, 2019 (For Antenna Terminal Conducted test)
Country of Mass-production	:	Malaysia
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: WL-60T (referred to as the EUT in this report) is a Wireless Transmitter.

Radio Specification

Radio Type	:	Transmitter
Frequency of Operation	:	2402 MHz - 2478 MHz
Modulation	:	GFSK
Antenna type	:	Pattern Antenna
Antenna Gain	:	-0.19 dBi
Clock frequency (Maximum)	:	32 MHz

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C

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

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted Emission	**FCC:** ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.207	N/A	N/A	*1)
	IC: RSS-Gen 8.8	**IC:** RSS-Gen 8.8			
6dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r01	**FCC:** Section 15.247(a)(2)	See data.	Complied a)	Conducted
	IC: -	**IC:** RSS-247 5.2(a)			
Maximum Peak Output Power	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r01	**FCC:** Section 15.247(b)(3)		Complied b)	Conducted
	IC: RSS-Gen 6.12	**IC:** RSS-247 5.4(d)			
Power Density	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r01	**FCC:** Section 15.247(e)		N/A c)	Conducted
	IC: -	**IC:** RSS-247 5.2(b)			
Spurious Emission Restricted Band Edges	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r01	**FCC:** Section15.247(d)	2.1 dB 4956.000 MHz, AV, Vert.	Complied# d), e)	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)
	IC: RSS-Gen 6.13	**IC:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10			

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 is a battery operated device.
*2) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 15.247 Meas Guidance v05r01 8.5 and 8.6.

a) Refer to APPENDIX 1 (data of 6 dB Bandwidth and 99 % Occupied Bandwidth)
b) Refer to APPENDIX 1 (data of Maximum Peak Output Power)
c) Refer to APPENDIX 1 (data of Power Density)
d) Refer to APPENDIX 1 (data of Conducted Spurious Emission)
e) Refer to APPENDIX 1 (data of Radiated Spurious Emission)

Symbols:
Complied The data of this test item has enough margin, more than the measurement uncertainty.
Complied# The data of this test item meets the limits unless the measurement uncertainty is taken into consideration.

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

FCC Part 15.31 (e)
The test was performed with the New Battery and the stable voltage was supplied to the EUT during the tests. 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 of Section 15.203.

3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99% Occupied Bandwidth	RSS-Gen 6.7	**IC:** -	N/A	- a)	Conducted
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422. a) Refer to APPENDIX 1 (data of 6 dB Bandwidth and 99 % Occupied Bandwidth)					

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

3.4 Uncertainty

EMI

There is no applicable rule of uncertainty in this applied standard. Therefore, the following results are derived depending on whether or not laboratory uncertainty is applied.

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

Antenna Terminal test

Test Item	Uncertainty (+/-)
20 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %
Maximum Peak Output Power / Average Output Power	1.3 dB
Carrier Frequency Separation	0.42 %
Dwell time / Burst rate	0.10 %
Conducted Spurious Emission	2.7 dB

Conducted emission

using Item	Frequency range	Uncertainty (+/-)
AMN (LISN)	0.009 MHz to 0.15 MHz	3.8 dB
	0.15 MHz to 30 MHz	3.4 dB

Radiated emission

Measurement distance	Frequency range	Uncertainty (+/-)
3 m	9 kHz to 30 MHz	3.3 dB
10 m		3.2 dB
3 m	30 MHz to 200 MHz (Horizontal)	4.8 dB
	(Vertical)	5.0 dB
	200 MHz to 1000 MHz (Horizontal)	5.2 dB
	(Vertical)	6.3 dB
10 m	30 MHz to 200 MHz (Horizontal)	4.8 dB
	(Vertical)	4.9 dB
	200 MHz to 1000 MHz (Horizontal)	5.0 dB
	(Vertical)	5.0 dB
3 m	1 GHz to 6 GHz	5.0 dB
	6 GHz to 18 GHz	5.3 dB
1 m	10 GHz to 26.5 GHz	5.8 dB
	26.5 GHz to 40 GHz	5.8 dB
10 m	1 GHz to 18 GHz	5.2 dB

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8999, Facsimile: +81 596 24 8124
NVLAP Lab. code: 200572-0 / FCC Test Firm Registration Number: 199967

Test site	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms	Maximum measurement distance
No.1 semi-anechoic chamber	2973C-1	19.2 x 11.2 x 7.7	7.0 x 6.0	No.1 Power source room	10 m
No.2 semi-anechoic chamber	2973C-2	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	2973C-3	12.0 x 8.5 x 5.9	6.8 x 5.75	No.3 Preparation room	3 m
No.3 shielded room	-	4.0 x 6.0 x 2.7	N/A	-	-
No.4 semi-anechoic chamber	2973C-4	12.0 x 8.5 x 5.9	6.8 x 5.75	No.4 Preparation room	3 m
No.4 shielded room	-	4.0 x 6.0 x 2.7	N/A	-	-
No.5 semi-anechoic chamber	-	6.0 x 6.0 x 3.9	6.0 x 6.0	-	-
No.6 shielded room	-	4.0 x 4.5 x 2.7	4.0 x 4.5	-	-
No.6 measurement room	-	4.75 x 5.4 x 3.0	4.75 x 4.15	-	-
No.7 shielded room	-	4.7 x 7.5 x 2.7	4.7 x 7.5	-	-
No.8 measurement room	-	3.1 x 5.0 x 2.7	3.1 x 5.0	-	-
No.9 measurement room	-	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.11 measurement room	-	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 m x 2.0m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

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

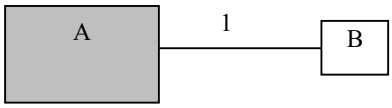
4.1 Operating Mode(s)

Mode	Remarks*
Tx GFSK	PN9
*The worst condition was determined based on the test result of Maximum Peak Output Power (Mid Channel)	
*Power of the EUT was set by the software as follows; Power settings: 0 dBm Software: V061R0016_20190130-1255_wl60t *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.	

*The details of Operating mode(s)

Test Item	Operating Mode	Tested frequency
6 dB Bandwidth 99% Occupied Bandwidth Maximum Peak Output Power Power Density Spurious Emission (Conducted/ Radiated)	Tx GFSK	2402 MHz 2442 MHz 2478 MHz

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	Wireless Transmitter	WL-60T	1 *1) 2 *2)	Roland Corporation	EUT
B	iPod touch	MKJ22J/A	CCQV734HGGNM	Apple	-

*1) Used for Radiated Emission test
*2) Used for Antenna Terminal conducted test

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Audio Cable	0.8	Shielded	Shielded	-

SECTION 5: Radiated Spurious Emission

Test Procedure

It was measured based on "8.5 and 8.6 of KDB 558074 D01 15.247 Meas Guidance v05r01".

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 m, raised 0.8 m above the conducting ground plane. 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.

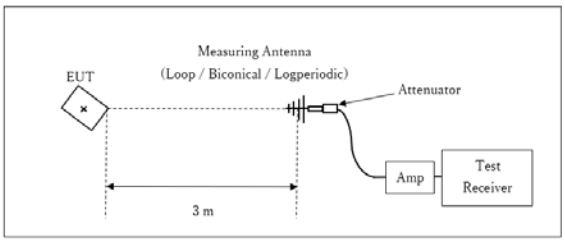
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(IC) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (IC).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *1)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	11.12.2.5.1 RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces 11.12.2.5.2 The duty cycle was less than 98% for detected noise, a duty factor was added to the 11.12.2.5.1 results.	RBW: 100 kHz VBW: 300kHz

*1) Average Power Measurement was performed based on ANSI C63.10-2013.

Radiated emission

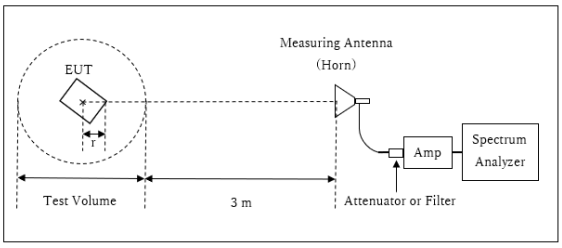
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz

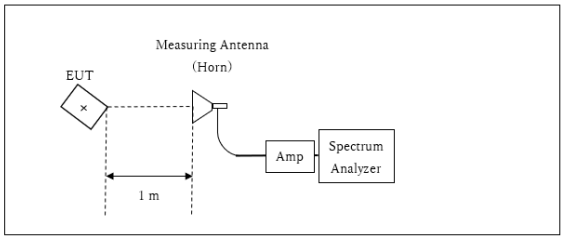


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.95 m / 3.0 m) = 2.39 dB
* Test Distance: (3 + Test Volume /2) - r = 3.95 m

Test Volume : 2.0 m
(Test Volume has been calibrated based on CISPR 16-1-4.)
r = 0.05 m

10 GHz - 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.5 dB
*Test Distance: 1 m

- 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.

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	3 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	Peak	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	10 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	9.1 kHz	27 kHz				

*1) Peak hold was applied as Worst-case measurement.
*2) Reference data
*3) Section 11.10.2 Method PKPSD (peak PSD) of "ANSI C63.10-2013".
*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 = 9.1 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

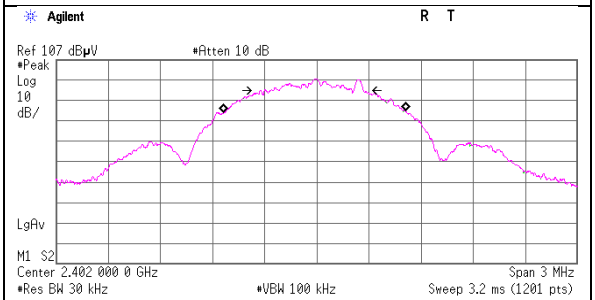
6 dB Bandwidth and 99 % Occupied Bandwidth

Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx

Frequency [MHz]	6dB Bandwidth [MHz]	99% Occupied Bandwidth [kHz]	Limit for 6dB Bandwidth [kHz]
2402	0.696	1045.7	> 500
2442	0.711	1057.5	> 500
2478	0.699	1059.3	> 500

99 % Occupied Bandwidth

2402 MHz

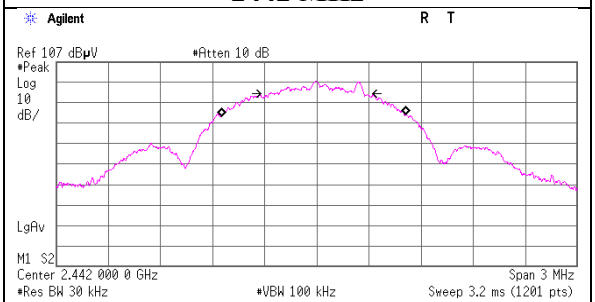


Occupied Bandwidth
1.0457 MHz

Occ BW % Pwr 99.00 %
x dB -6.00 dB

Transmit Freq Error -13.514 kHz
x dB Bandwidth 596.738 kHz

2442 MHz

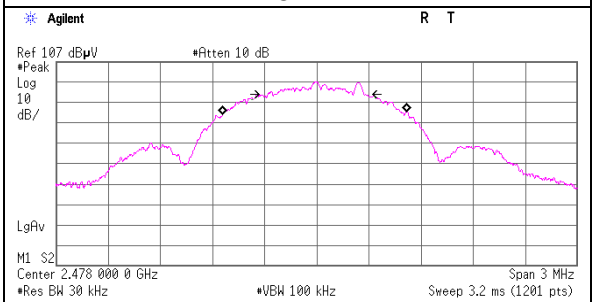


Occupied Bandwidth
1.0575 MHz

Occ BW % Pwr 99.00 %
x dB -6.00 dB

Transmit Freq Error -17.324 kHz
x dB Bandwidth 540.318 kHz

2478 MHz



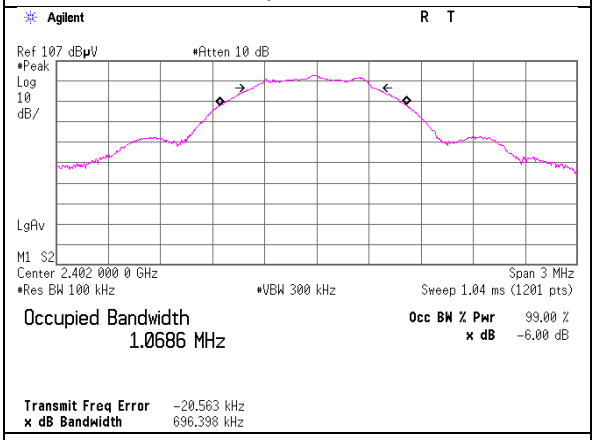
Occupied Bandwidth
1.0593 MHz

Occ BW % Pwr 99.00 %
x dB -6.00 dB

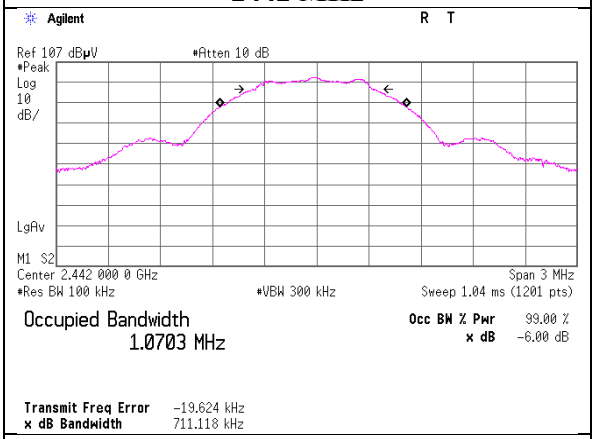
Transmit Freq Error -12.155 kHz
x dB Bandwidth 547.693 kHz

6 dB Bandwidth

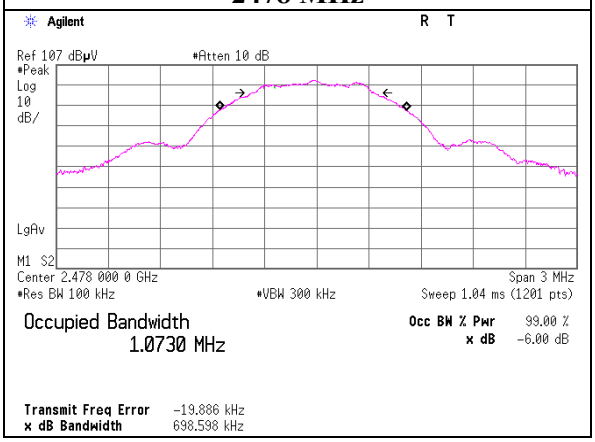
2402 MHz



2442 MHz



2478 MHz



Maximum Peak Output Power

Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx

				Conducted Power					e.i.r.p. for RSS-247					
Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin	Antenna Gain	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]	[dBi]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-7.25	0.40	10.09	3.24	2.11	30.00	1000	26.77	-0.19	3.05	2.02	36.02	4000	32.98
2442	-7.50	0.42	10.09	3.01	2.00	30.00	1000	26.99	-0.19	2.82	1.91	36.02	4000	33.20
2478	-7.74	0.43	10.09	2.78	1.90	30.00	1000	27.22	-0.19	2.59	1.82	36.02	4000	33.43

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
e.i.r.p. Result = Conducted Power Result + Antenna Gain

Average Output Power
(Reference data for RF Exposure / SAR testing)

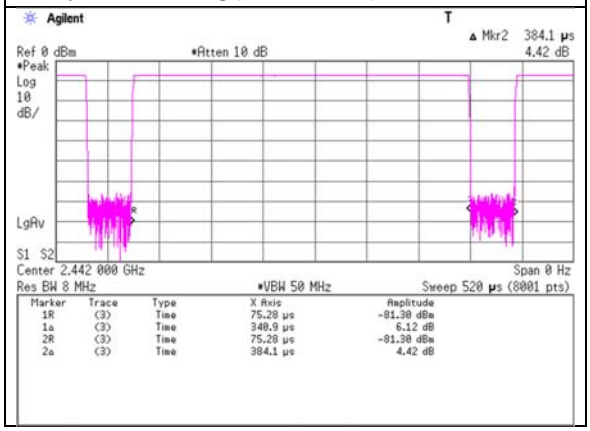
Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx

Freq.	Reading	Cable Loss	Atten. Loss	Result (Time average)		Duty factor	Result (Burst power average)	
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dB]	[dBm]	[mW]
2402	-7.91	0.40	10.09	2.58	1.81	0.52	3.10	2.04
2442	-8.17	0.42	10.09	2.34	1.71	0.52	2.86	1.93
2478	-8.42	0.43	10.09	2.10	1.62	0.52	2.62	1.83

Burst rate confirmation

Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx 2442MHz

Tx on / (Tx on + Tx off) =	**0.888**
Tx on / (Tx on + Tx off) * 100 =	**88.8 %**
Duty factor = 10 * log (0.3841 / 0.3409) =	**0.52 dB**



* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Radiated Spurious Emission

Report No.	12547242H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	February 26, 2019	February 28, 2019
Temperature / Humidity	20 deg. C / 37 % RH	22 deg. C / 33 % RH
Engineer	Akihiko Maeda	Akihiko Maeda
	(Above 1 GHz)	(Below 1 GHz)
Mode	Tx GFSK, 2402MHz	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	32.000	QP	23.2	17.6	7.3	32.2	-	15.9	40.0	24.1	
Hori	64.000	QP	23.1	6.8	7.8	32.1	-	5.6	40.0	34.4	
Hori	110.983	QP	37.4	11.8	8.3	32.1	-	25.4	43.5	18.1	
Hori	336.273	QP	22.4	14.7	10.2	31.9	-	15.4	46.0	30.6	
Hori	544.690	QP	22.4	18.0	11.5	32.0	-	19.9	46.0	26.1	
Hori	852.507	QP	22.5	21.7	13.0	31.3	-	25.9	46.0	20.1	
Hori	2338.147	PK	46.1	27.8	5.6	31.4	-	48.1	73.9	25.8	
Hori	2390.000	PK	42.3	27.6	5.8	31.3	-	44.4	73.9	29.5	
Hori	4804.000	PK	47.1	31.4	8.0	30.6	-	55.9	73.9	18.0	
Hori	7206.000	PK	42.2	36.2	9.0	31.8	-	55.6	73.9	18.3	Floor noise
Hori	9608.000	PK	40.8	37.9	10.2	32.1	-	56.8	73.9	17.1	Floor noise
Hori	2338.147	AV	39.5	27.8	5.6	31.4	0.5	42.0	53.9	11.9	*1)
Hori	2390.000	AV	33.0	27.6	5.8	31.3	0.5	35.6	53.9	18.3	*1)
Hori	4804.000	AV	41.8	31.4	8.0	30.6	0.5	51.1	53.9	2.8	
Hori	7206.000	AV	33.8	36.2	9.0	31.8	-	47.2	53.9	6.7	Floor noise
Hori	9608.000	AV	31.8	37.9	10.2	32.1	-	47.8	53.9	6.1	Floor noise
Vert	32.000	QP	23.1	17.6	7.3	32.2	-	15.8	40.0	24.2	
Vert	64.000	QP	23.1	6.8	7.8	32.1	-	5.6	40.0	34.4	
Vert	110.983	QP	32.4	11.8	8.3	32.1	-	20.4	43.5	23.1	
Vert	336.273	QP	22.4	14.7	10.2	31.9	-	15.4	46.0	30.6	
Vert	544.690	QP	22.6	18.0	11.5	32.0	-	20.1	46.0	25.9	
Vert	852.507	QP	22.5	21.7	13.0	31.3	-	25.9	46.0	20.1	
Vert	2338.147	PK	47.6	27.8	5.6	31.4	-	49.6	73.9	24.3	
Vert	2390.000	PK	42.5	27.6	5.8	31.3	-	44.6	73.9	29.3	
Vert	4804.000	PK	47.4	31.4	8.0	30.6	-	56.2	73.9	17.7	
Vert	7206.000	PK	42.2	36.2	9.0	31.8	-	55.6	73.9	18.3	Floor noise
Vert	9608.000	PK	40.8	37.9	10.2	32.1	-	56.8	73.9	17.1	Floor noise
Vert	2338.147	AV	41.3	27.8	5.6	31.4	0.5	43.8	53.9	10.1	*1)
Vert	2390.000	AV	33.7	27.6	5.8	31.3	0.5	36.3	53.9	17.6	*1)
Vert	4804.000	AV	42.3	31.4	8.0	30.6	0.5	51.6	53.9	2.3	
Vert	7206.000	AV	33.8	36.2	9.0	31.8	-	47.2	53.9	6.7	Floor noise
Vert	9608.000	AV	31.8	37.9	10.2	32.1	-	47.8	53.9	6.1	Floor noise

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB
*1) Not Out of Band emission(Leakage Power)

20dBc Data Sheet

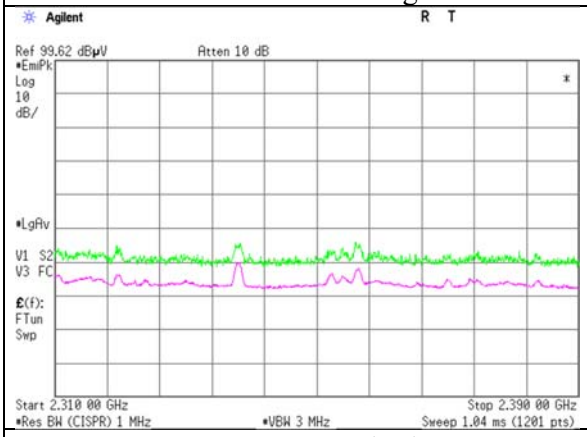
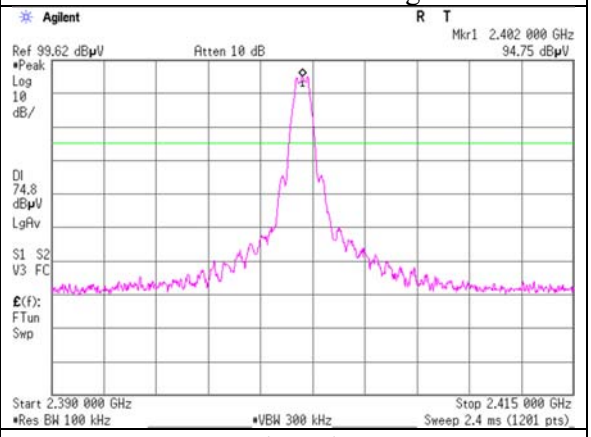
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2402.000	PK	94.8	27.6	5.8	31.3	96.9	-	-	Carrier
Hori	2400.000	PK	47.1	27.6	5.8	31.3	49.2	76.9	27.7	
Vert	2402.000	PK	96.4	27.6	5.8	31.3	98.5	-	-	Carrier
Vert	2400.000	PK	49.4	27.6	5.8	31.3	51.5	78.5	27.0	

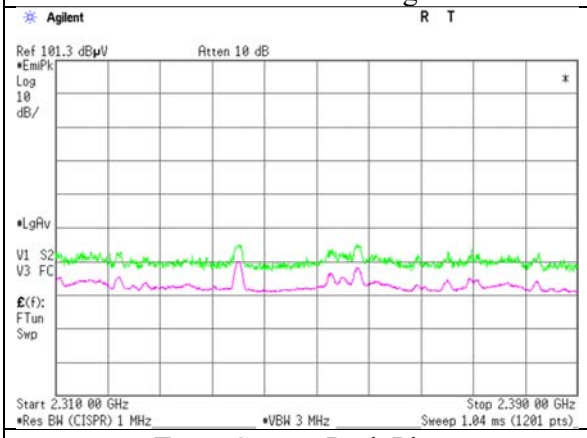
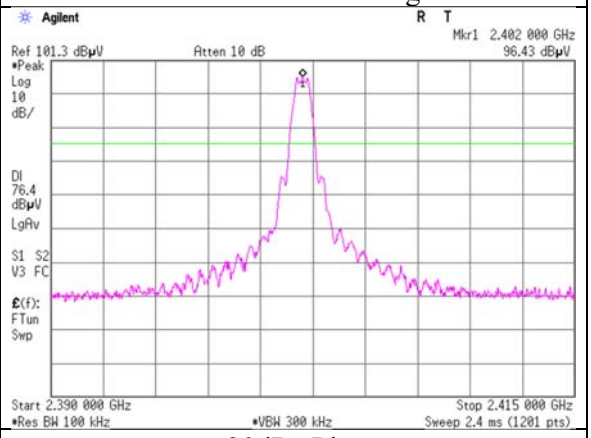
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	12547242H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	February 26, 2019
Temperature / Humidity	20 deg. C / 37 % RH
Engineer	Akihiko Maeda (Above 1 GHz)
Mode	Tx GFSK, 2402MHz

Horizontal	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

Vertical	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

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

Radiated Spurious Emission

Report No.	12547242H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	February 26, 2019	February 28, 2019
Temperature / Humidity	20 deg. C / 37 % RH	22 deg. C / 33 % RH
Engineer	Akihiko Maeda	Akihiko Maeda
	(Above 1 GHz)	(Below 1 GHz)
Mode	Tx GFSK, 2442MHz	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	32.000	QP	23.1	17.6	7.3	32.2	-	15.8	40.0	24.2	
Hori	64.000	QP	23.2	6.8	7.8	32.1	-	5.7	40.0	34.3	
Hori	110.985	QP	37.6	11.8	8.3	32.1	-	25.6	43.5	17.9	
Hori	336.643	QP	22.3	14.7	10.2	31.9	-	15.3	46.0	30.7	
Hori	544.973	QP	22.5	18.0	11.5	32.0	-	20.0	46.0	26.0	
Hori	852.457	QP	22.5	21.7	13.0	31.3	-	25.9	46.0	20.1	
Hori	2314.112	PK	49.8	27.9	5.6	31.4	-	51.9	73.9	22.0	
Hori	4884.000	PK	46.1	31.5	8.0	30.6	-	55.0	73.9	18.9	
Hori	7326.000	PK	41.2	36.3	9.0	31.9	-	54.6	73.9	19.3	Floor noise
Hori	9768.000	PK	40.6	38.3	10.3	32.1	-	57.1	73.9	16.8	Floor noise
Hori	2314.112	AV	44.7	27.9	5.6	31.4	0.5	47.3	53.9	6.6	*1)
Hori	4884.000	AV	40.8	31.5	8.0	30.6	0.5	50.2	53.9	3.7	
Hori	7326.000	AV	33.9	36.3	9.0	31.9	-	47.3	53.9	6.6	Floor noise
Hori	9768.000	AV	31.4	38.3	10.3	32.1	-	47.9	53.9	6.0	Floor noise
Vert	32.000	QP	23.1	17.6	7.3	32.2	-	15.8	40.0	24.2	
Vert	64.000	QP	23.1	6.8	7.8	32.1	-	5.6	40.0	34.4	
Vert	110.985	QP	33.1	11.8	8.3	32.1	-	21.1	43.5	22.4	
Vert	336.643	QP	22.4	14.7	10.2	31.9	-	15.4	46.0	30.6	
Vert	544.973	QP	22.4	18.0	11.5	32.0	-	19.9	46.0	26.1	
Vert	852.457	QP	22.5	21.7	13.0	31.3	-	25.9	46.0	20.1	
Vert	2314.112	PK	49.7	27.9	5.6	31.4	-	51.8	73.9	22.1	
Vert	4884.000	PK	47.0	31.5	8.0	30.6	-	55.9	73.9	18.0	
Vert	7326.000	PK	41.2	36.3	9.0	31.9	-	54.6	73.9	19.3	Floor noise
Vert	9768.000	PK	40.6	38.3	10.3	32.1	-	57.1	73.9	16.8	Floor noise
Vert	2314.112	AV	44.8	27.9	5.6	31.4	0.5	47.4	53.9	6.5	*1)
Vert	4884.000	AV	41.9	31.5	8.0	30.6	0.5	51.3	53.9	2.6	
Vert	7326.000	AV	33.9	36.3	9.0	31.9	-	47.3	53.9	6.6	Floor noise
Vert	9768.000	AV	31.4	38.3	10.3	32.1	-	47.9	53.9	6.0	Floor noise

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

*1) Not Out of Band emission(Leakage Power)

Radiated Spurious Emission

Report No.	12547242H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	February 26, 2019	February 28, 2019
Temperature / Humidity	20 deg. C / 37 % RH	22 deg. C / 33 % RH
Engineer	Akihiko Maeda	Akihiko Maeda
	(Above 1 GHz)	(Below 1 GHz)
Mode	Tx GFSK, 2478MHz	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	32.000	QP	23.2	17.6	7.3	32.2	-	15.9	40.0	24.1	
Hori	64.000	QP	23.1	6.8	7.8	32.1	-	5.6	40.0	34.4	
Hori	110.944	QP	37.3	11.8	8.3	32.1	-	25.3	43.5	18.2	
Hori	340.117	QP	22.4	14.9	10.2	31.9	-	15.6	46.0	30.4	
Hori	549.708	QP	22.4	18.1	11.5	32.0	-	20.0	46.0	26.0	
Hori	854.442	QP	22.5	21.7	13.0	31.3	-	25.9	46.0	20.1	
Hori	2350.000	PK	49.8	27.7	5.6	31.3	-	51.8	73.9	22.1	
Hori	2483.500	PK	50.6	27.5	5.8	31.3	-	52.6	73.9	21.3	
Hori	2606.000	PK	49.0	28.2	5.9	31.2	-	51.9	73.9	22.0	
Hori	4956.000	PK	46.6	31.7	8.0	30.6	-	55.7	73.9	18.2	
Hori	7434.000	PK	43.1	36.3	9.0	31.9	-	56.5	73.9	17.4	Floor noise
Hori	9912.000	PK	40.7	38.4	10.4	32.2	-	57.3	73.9	16.6	Floor noise
Hori	2350.000	AV	44.7	27.7	5.6	31.3	0.5	47.2	53.9	6.7	*1)
Hori	2483.500	AV	37.0	27.5	5.8	31.3	0.5	39.5	53.9	14.4	*1)
Hori	2606.000	AV	43.6	28.2	5.9	31.2	0.5	47.0	53.9	6.9	*1)
Hori	4956.000	AV	40.8	31.7	8.0	30.6	0.5	50.4	53.9	3.5	
Hori	7434.000	AV	33.9	36.3	9.0	31.9	-	47.3	53.9	6.6	Floor noise
Hori	9912.000	AV	31.0	38.4	10.4	32.2	-	47.6	53.9	6.3	Floor noise
Vert	32.000	QP	23.2	17.6	7.3	32.2	-	15.9	40.0	24.1	
Vert	64.000	QP	23.2	6.8	7.8	32.1	-	5.7	40.0	34.3	
Vert	110.944	QP	31.9	11.8	8.3	32.1	-	19.9	43.5	23.6	
Vert	340.117	QP	22.4	14.9	10.2	31.9	-	15.6	46.0	30.4	
Vert	549.708	QP	22.6	18.1	11.5	32.0	-	20.2	46.0	25.8	
Vert	854.442	QP	22.5	21.7	13.0	31.3	-	25.9	46.0	20.1	
Vert	2350.000	PK	49.8	27.7	5.6	31.3	-	51.8	73.9	22.1	
Vert	2483.500	PK	51.4	27.5	5.8	31.3	-	53.4	73.9	20.5	
Vert	2606.000	PK	49.5	28.2	5.9	31.2	-	52.4	73.9	21.5	
Vert	4956.000	PK	47.0	31.7	8.0	30.6	-	56.1	73.9	17.8	
Vert	7434.000	PK	43.1	36.3	9.0	31.9	-	56.5	73.9	17.4	Floor noise
Vert	9912.000	PK	40.7	38.4	10.4	32.2	-	57.3	73.9	16.6	Floor noise
Vert	2350.000	AV	45.3	27.7	5.6	31.3	0.5	47.8	53.9	6.1	*1)
Vert	2483.500	AV	38.4	27.5	5.8	31.3	0.5	40.9	53.9	13.0	*1)
Vert	2606.000	AV	44.4	28.2	5.9	31.2	0.5	47.8	53.9	6.1	*1)
Vert	4956.000	AV	42.2	31.7	8.0	30.6	0.5	51.8	53.9	2.1	
Vert	7434.000	AV	33.9	36.3	9.0	31.9	-	47.3	53.9	6.6	Floor noise
Vert	9912.000	AV	31.0	38.4	10.4	32.2	-	47.6	53.9	6.3	Floor noise

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor

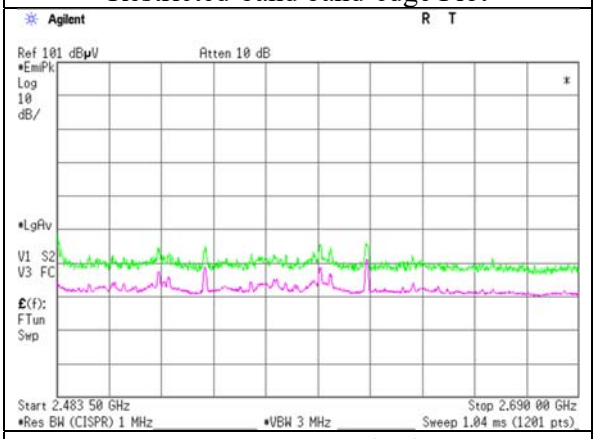
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

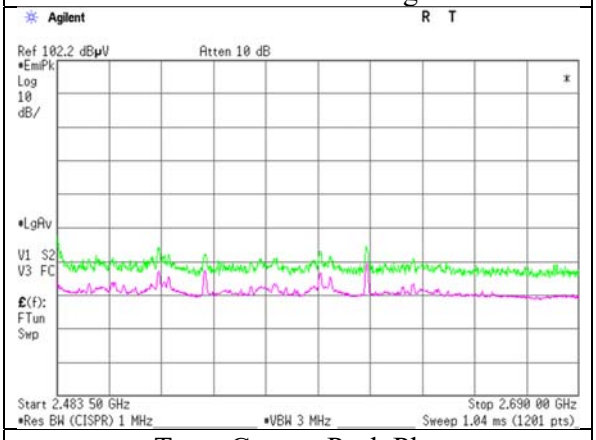
Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

*1) Not Out of Band emission(Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	12547242H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	February 26, 2019
Temperature / Humidity	20 deg. C / 37 % RH
Engineer	Akihiko Maeda (Above 1 GHz)
Mode	Tx GFSK, 2478MHz

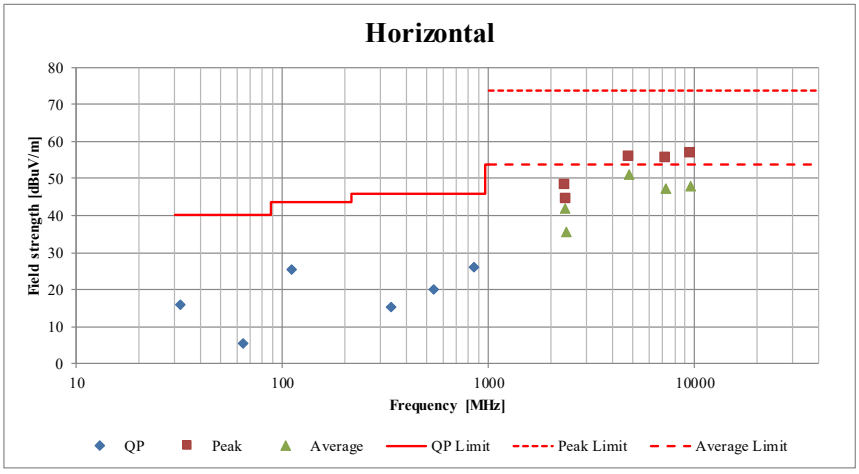
Horizontal
Restricted-band band-edge Plot

Trace Green : Peak Plot Trace Purple : Average Plot

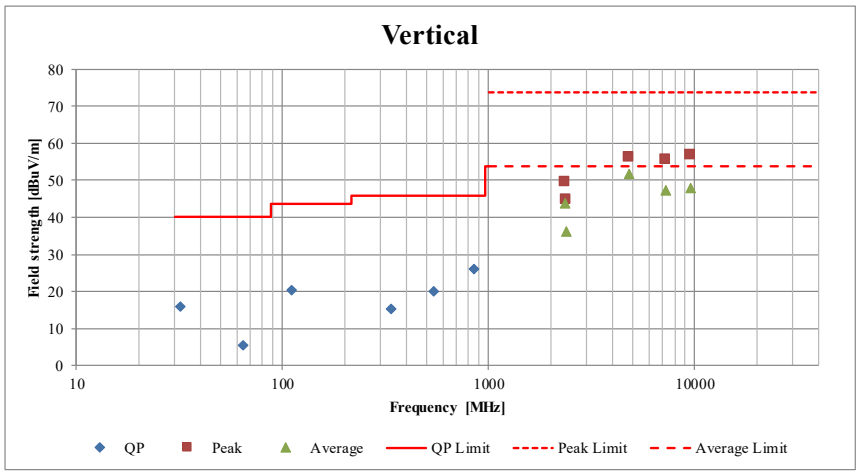
Vertical
Restricted-band band-edge Plot

Trace Green : Peak Plot Trace Purple : Average Plot

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

Radiated Spurious Emission
(Plot data, Worst case)

Report No.	12547242H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	February 26, 2019	February 28, 2019
Temperature / Humidity	20 deg. C / 37 % RH	22 deg. C / 33 % RH
Engineer	Akihiko Maeda	Akihiko Maeda
	(Above 1 GHz)	(Below 1 GHz)
Mode	Tx GFSK, 2402MHz	



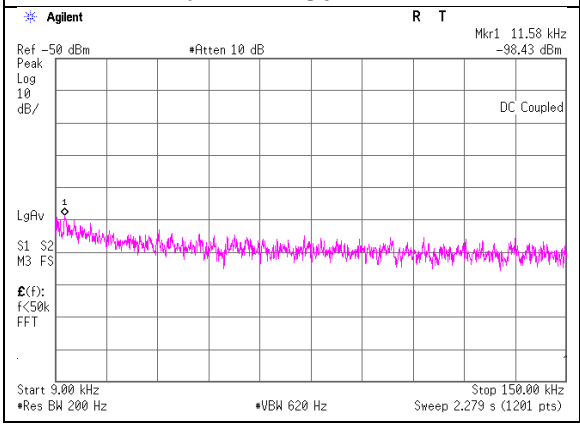


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

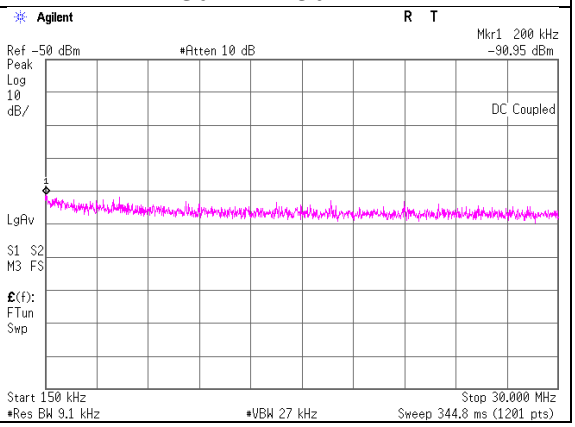
Conducted Spurious Emission

Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx 2402 MHz

9 kHz - 150 kHz



150 kHz - 30 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
11.58	-98.4	0.40	9.8	2.0	1	-86.2	300	6.0	-24.9	46.3	71.2	
200.00	-91.0	0.40	9.8	2.0	1	-78.7	300	6.0	-17.5	21.5	39.0	

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

EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

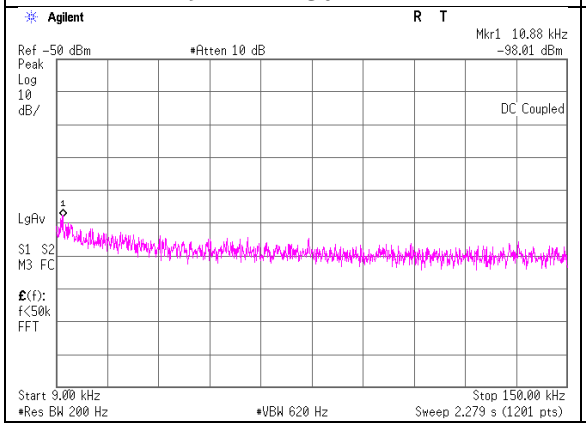
N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

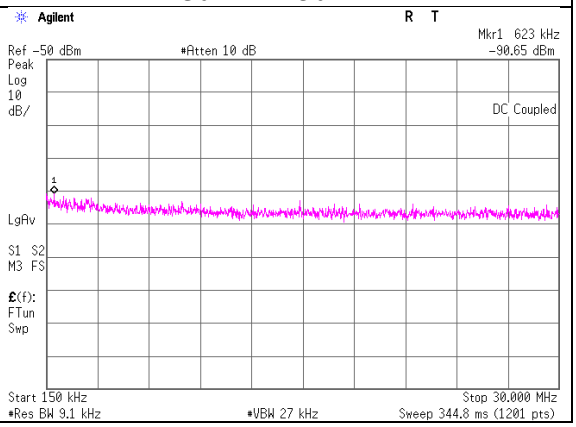
Conducted Spurious Emission

Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx 2442 MHz

9 kHz - 150 kHz



150 kHz - 30 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
10.88	-98.0	0.40	9.8	2.0	1	-85.8	300	6.0	-24.5	46.8	71.3	
623.00	-90.7	0.40	9.8	2.0	1	-78.4	30	6.0	2.8	31.7	28.9	

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

EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

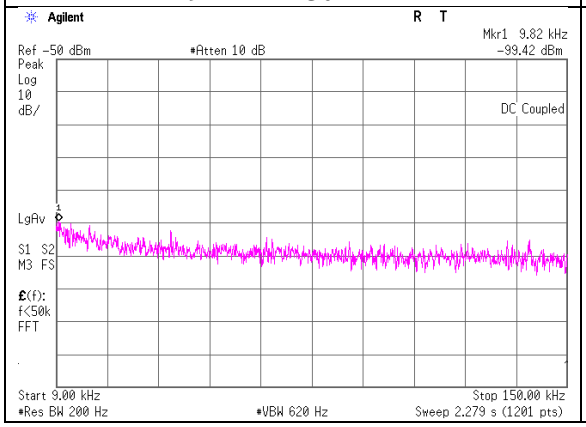
N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

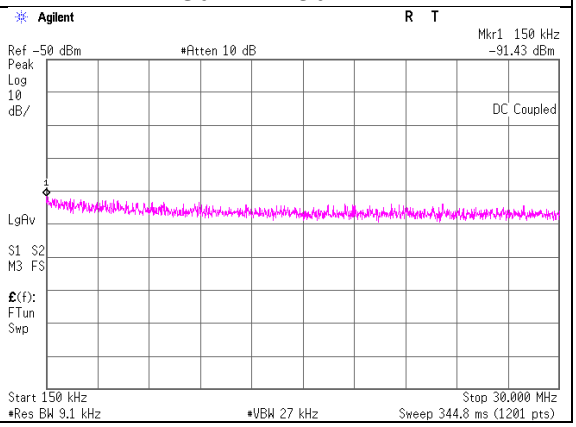
Conducted Spurious Emission

Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx 2478 MHz

9 kHz - 150 kHz



150 kHz - 30 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
9.82	-99.4	0.40	9.8	2.0	1	-87.2	300	6.0	-25.9	47.7	73.6	
150.00	-91.4	0.40	9.8	2.0	1	-79.2	300	6.0	-18.0	24.0	42.0	

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

EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

Power Density

Report No.	12547242H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	February 27, 2019
Temperature / Humidity	24 deg. C / 38 % RH
Engineer	Junki Nagatomi
Mode	Tx

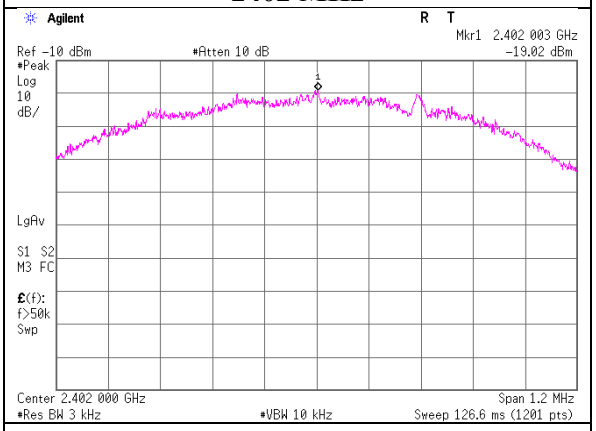
Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-19.02	0.40	10.09	-8.54	8.00	16.54
2442.00	-19.69	0.42	10.09	-9.18	8.00	17.18
2478.00	-19.17	0.43	10.09	-8.65	8.00	16.65

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

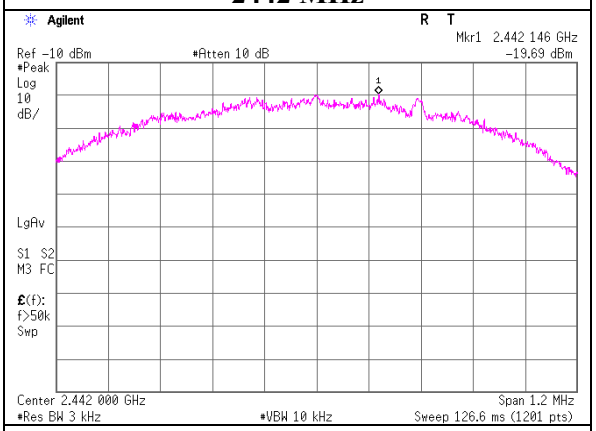
*The equipment and cables were not used for factor 0 dB of the data sheets.

Power Density

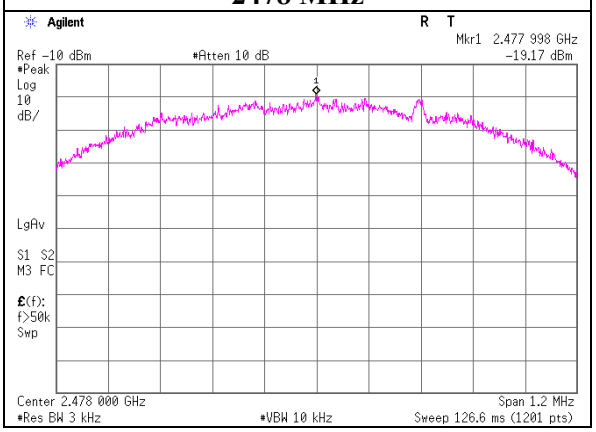
2402 MHz



2442 MHz



2478 MHz



APPENDIX 2: Test instruments

Test Instruments

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
RE	141562	Thermo-Hygrometer	CUSTOM	CTH-201	0010	1/11/2019	01/31/2020	12
RE	141506	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170307	6/8/2018	06/30/2019	12
RE	141412	Microwave Cable	Junkosha	MWX221	1305S002R(1m) / 1405S146(5m)	6/14/2018	06/30/2019	12
RE	141508	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	9120D-557	6/8/2018	06/30/2019	12
RE	141296	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	002	9/19/2018	09/30/2019	12
RE	141581	MicroWave System Amplifier	AGILENT	83017A	650	10/4/2018	10/31/2019	12
RE	141899	Spectrum Analyzer	AGILENT	E4448A	MY46180655	8/10/2018	08/31/2019	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	142017	AC4_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	4/7/2018	04/30/2019	12
RE	142228	Measure	KOMELON	KMC-36	-	-	-	-
RE	141545	DIGITAL HiTESTER	HIOKI	3805	51201148	1/29/2019	01/31/2020	12
AT	141567	Thermo-Hygrometer	CUSTOM	CTH-201	0008	1/11/2019	01/31/2020	12
AT	141156	Attenuator(10dB)	Weinschel Corp	2	BL1173	11/2/2018	11/30/2019	12
AT	141173	Attenuator(10dB) (above1GHz)	HIROSE ELECTRIC CO.,LTD.	AT-110	-	12/17/2018	12/31/2019	12
AT	141841	Power sensor	ANRITSU	MA2411B	11598	10/31/2018	10/31/2019	12
AT	141806	Power Meter	ANRITSU	ML2495A	6K00003348	10/31/2018	10/31/2019	12
AT	141855	Spectrum Analyzer	AGILENT	E4440A	MY46187750	11/9/2018	11/30/2019	12
RE	141397	Coaxial Cable	UL Japan	-	-	6/13/2018	06/30/2019	12
RE	148898	Attenuator	KEYSIGHT	8491A	MY52462282	10/3/2018	10/31/2019	12
RE	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-192	6/1/2018	06/30/2019	12
RE	141425	Biconical Antenna	Schwarzbeck	BBA9106	1302	6/1/2018	06/30/2019	12
RE	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	6/15/2018	06/30/2019	12
RE	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	2/8/2019	02/29/2020	12

***Hyphens for Last Calibration Date, Calibration Due Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.**

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