RADIO TEST REPORT

Test Report No. : 11740660H-A-R1

Applicant	:	**Braveridge Co., Ltd.**
Type of Equipment	:	**MaBeee**
Model No.	:	**MB-3002WB**
FCC ID	:	**2ABXRMB3002WB**
Test regulation	:	**FCC Part 15 Subpart C: 2018**
Test Result	:	**Complied**

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
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 must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
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 11740660H-A. 11740660H-A is replaced with this report..

Date of test: July 20 and September 12, 2017

Representative test engineer:

Takafumi Noguchi
Engineer
Consumer Technology Division

Approved by:

Takayuki Shimada
Leader
Consumer Technology Division

NVLAP TESTING
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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http://japan.ul.com/resources/emc_accredited/

REVISION HISTORY

Original Test Report No.: 11740660H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	11740660H-A	October 11, 2017	-	-
1	11740660H-A-R1	January 19, 2018	P.1, P.5	Cover page and Section 3.1 Update of FCC Version
1	11740660H-A-R1	January 19, 2018	P.4	Section 2.2 Radio specification Correction of Modulation from GPSK to GFSK.

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	Braveridge Co., Ltd.
Address	:	3-27-2, Susenji, Nishi-ku, Fukuoka-shi, Fukuoka 819-0373, Japan
Telephone Number	:	+81-92-834-5789
Facsimile Number	:	+81-92-807-7718
Contact Person	:	Yasunari Kohashi

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

2.1 Identification of E.U.T.

Type of Equipment	:	MaBeee
Model No.	:	MB-3002WB
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 0.7 V to 1.6 V
Receipt Date of Sample	:	July 19, 2017 (for Antenna Terminal Conducted test) August 2, 2017 (for Radiated emission test)
Country of Mass-production	:	Japan
Condition of EUT	:	Production 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: MB-3002WB (referred to as the EUT in this report) is a MaBeee.

Clock frequencies in system(s): 32 MHz

Radio Specification

Radio Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480 MHz
Modulation	:	GFSK
Power Supply (radio part input)	:	DC 3.0 V
Antenna type	:	Ceramic chip antenna
Antenna Gain	:	0.9 dBi

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	:	FCC Part 15 Subpart C FCC Part 15 final revised on January 2, 2018 and effective February 1, 2018
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 January 2, 2018, does not affect the test specification applied to the EUT.

* Also the EUT complies with FCC Part 15 Subpart B.

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted Emission	ANSI C63.10-2013 6. Standard test methods	Section 15.207	N/A *1)	N/A	-
6dB Bandwidth	KDB 558074 D01 DTS Meas Guidance v04	Section 15.247(a)(2)	See data.	Complied	Conducted
Maximum Peak Output Power	KDB 558074 D01 DTS Meas Guidance v04	Section 15.247(b)(3)		Complied	Conducted
Power Density	KDB 558074 D01 DTS Meas Guidance v04	Section 15.247(e)		Complied	Conducted
Spurious Emission Restricted Band Edges	KDB 558074 D01 DTS Meas Guidance v04	Section15.247(d)	14.4 dB 2483.500 MHz, AV, Vert.	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) This test was not performed 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 DTS Meas Guidance v04 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 3.0 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 of Section 15.203.

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.
Ise EMC Lab.

Antenna terminal test	Uncertainty (+/-)
RF output power	1.2 dB
Antenna terminal conducted emission / Power density / Burst power	3.1 dB
Adjacent channel power / Channel power	
Below 3 GHz	1.8 dB
3 GHz to 6 GHz	2.7 dB

Test distance	Radiated emission (+/-) 9 kHz - 30 MHz
3 m	3.8 dB
10 m	3.6 dB

Polarity	Radiated emission (Below 1 GHz)			
	(3 m*) (+/-)		(10 m*) (+/-)	
	30 MHz - 200 MHz	200 MHz - 1000 MHz	30 MHz - 200 MHz	200 MHz - 1000 MHz
Horizontal	5.0 dB	5.3 dB	5.0 dB	5.0 dB
Vertical	5.2 dB	6.3 dB	5.0 dB	5.0 dB

Radiated emission (Above 1 GHz)				
(3 m*) (+/-)		(1 m*) (+/-)		(10 m*) (+/-)
1 GHz - 6 GHz	6 GHz - 18 GHz	10 GHz - 26.5 GHz	26.5 GHz - 40 GHz	1 GHz - 18 GHz
5.2 dB	5.5 dB	5.5 dB	5.4 dB	5.5 dB

*Measurement distance

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

3.5 Test Location

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

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	N/A	-	-
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

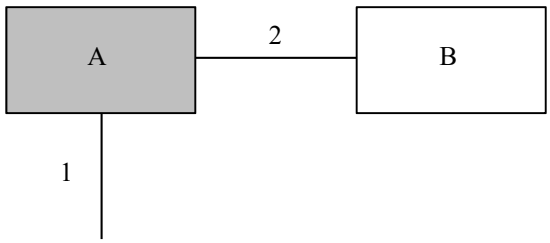
4.1 Operating Mode(s)

Mode	Remarks*
Bluetooth Low Energy (BT LE)	Maximum Packet Size, PRBS9
*The worst condition was determined based on the test result of Maximum Peak Output Power (Low Channel)	
*Power of the EUT was set by the software as follows; Power settings: 0 dBm Software: nRFgoStudio *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
6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth Spurious Emission (Radiated / Conducted)	Tx BT LE	2402 MHz 2440 MHz 2480 MHz

4.2 Configuration and peripherals



DC 1.5 V

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

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	MaBeee	MB-3002WB	00001 for RE* 00002 for AT*	Braveridge	EUT
B	Jig Board	-	-	Braveridge	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.0	Unshielded	Unshielded	-
2	DC & Signal Cable	0.1	Unshielded	Unshielded	-

*RE: Radiated emission, AT: Antenna Terminal Conducted test

SECTION 5: Radiated Spurious Emission

Test Procedure

It was measured based on "11.0 Emissions in non-restricted frequency bands" of "KDB 558074 D01 DTS Meas Guidance v04".

[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 and outside the restricted band of FCC15.205.

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	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	4.5 m *2) (1 GHz - 10 GHz), 1 m *3) (10 GHz - 26.5 GHz)		4.5 m *2) (1 GHz - 10 GHz), 1 m *3) (10 GHz - 26.5 GHz)

*1) Average Power Measurement was performed based on 6. 0 & 12.2.5 of "KDB 558074 D01 DTS Meas Guidance v04".
*2) Distance Factor: 20 x log (4.5 m / 3.0 m) = 3.53 dB
*3) Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.5 dB

- 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 10.2 Method PKPSD (peak PSD) of "KDB 558074 D01 DTS Meas Guidance v04".
*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

6dB Bandwidth

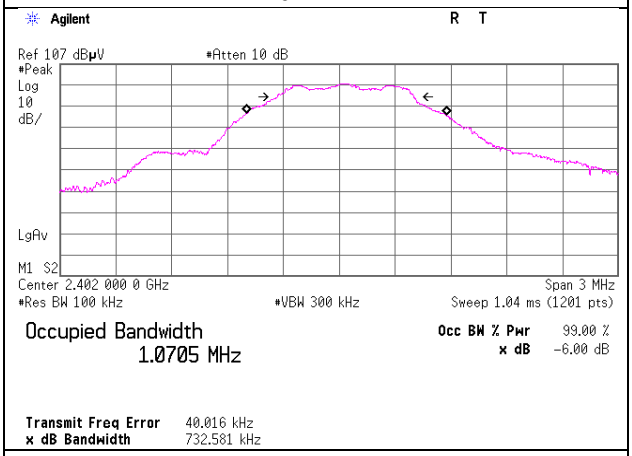
Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE

Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
2402	0.733	> 500
2440	0.727	> 500
2480	0.738	> 500

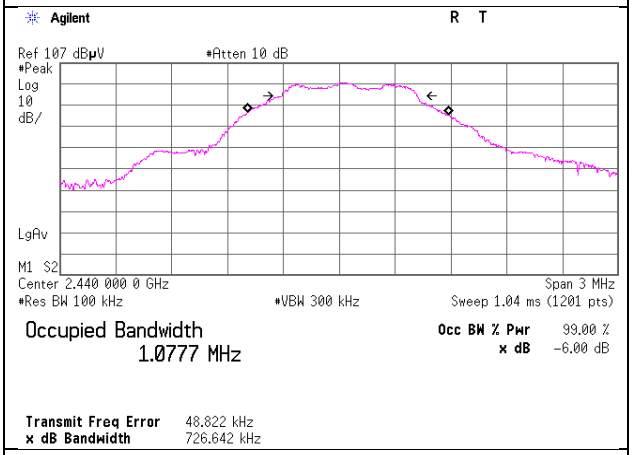
6dB Bandwidth

BT LE

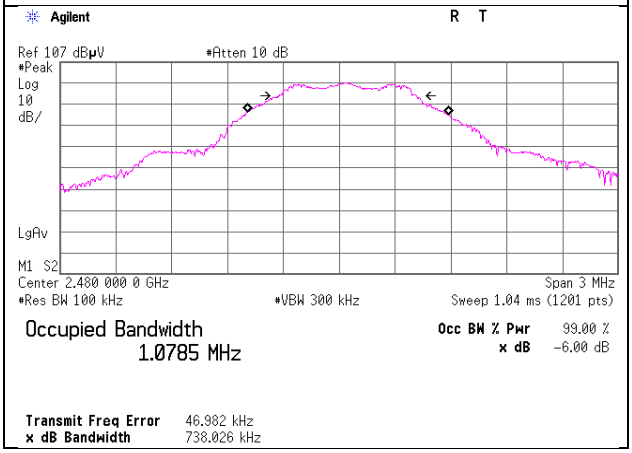
2402 MHz



2440 MHz



2480 MHz



Maximum Peak Output Power

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE

Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-9.19	0.20	10.00	1.01	1.26	30.00	1000	28.99
2440	-9.37	0.20	10.00	0.83	1.21	30.00	1000	29.17
2480	-9.72	0.20	10.00	0.48	1.12	30.00	1000	29.52

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	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE

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	-11.23	0.20	10.00	-1.03	0.79	0.86	-0.17	0.96
2440	-11.40	0.20	10.00	-1.20	0.76	0.86	-0.34	0.92
2480	-11.79	0.20	10.00	-1.59	0.69	0.86	-0.73	0.85

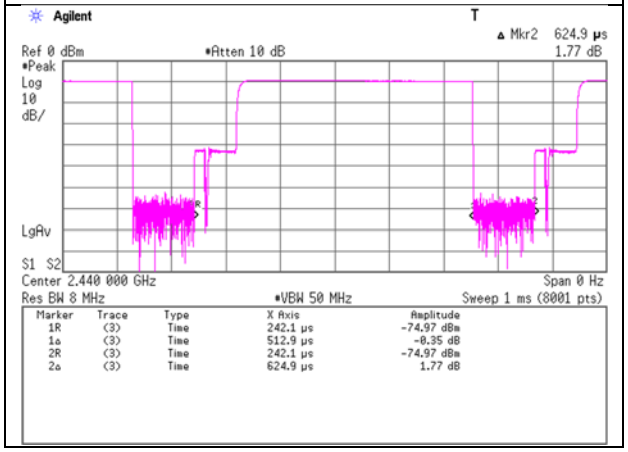
Sample Calculation:
Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
Result (Burst power average) = Time average + Duty factor

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

Burst rate confirmation

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE

Tx on / (Tx on + Tx off) =	**0.821**
Tx on / (Tx on + Tx off) * 100 =	**82.1 %**
Duty factor = 10 * log (624.9 / 512.9) =	**0.86 dB**



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

Radiated Spurious Emission

Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No. 11740660H
Date September 12, 2017
Temperature / Humidity 24 deg. C / 65 % RH
Engineer Takumi Shimada

Mode Tx BT LE 2402 MHz

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	22.5	16.8	7.1	32.2	-	14.2	40.0	25.8	Floor noise
Hori	96.000	QP	22.2	9.2	8.1	32.2	-	7.3	43.5	36.2	Floor noise
Hori	160.000	QP	21.9	15.5	8.8	32.1	-	14.1	43.5	29.4	Floor noise
Hori	256.000	QP	21.8	15.3	9.7	32.0	-	14.8	46.0	31.2	Floor noise
Hori	320.000	QP	22.4	15.0	10.2	32.0	-	15.6	46.0	30.4	Floor noise
Hori	640.000	QP	21.6	19.8	12.1	32.1	-	21.4	46.0	24.6	Floor noise
Hori	2386.710	PK	49.1	27.7	6.8	32.4	-	51.2	73.9	22.7	
Hori	2390.000	PK	45.4	27.7	6.8	32.4	-	47.5	73.9	26.4	
Hori	4804.000	PK	40.6	31.6	8.0	31.4	-	48.8	73.9	25.1	Floor noise
Hori	7206.000	PK	42.8	36.0	8.9	32.1	-	55.6	73.9	18.3	Floor noise
Hori	9608.000	PK	42.3	38.5	9.6	32.9	-	57.5	73.9	16.4	Floor noise
Hori	2386.710	AV	34.1	27.7	6.8	32.4	0.9	37.1	53.9	16.8	
Hori	2390.000	AV	33.7	27.7	6.8	32.4	0.9	36.7	53.9	17.2	*1)
Hori	4804.000	AV	32.5	31.6	8.0	31.4	-	40.7	53.9	13.2	Floor noise
Hori	7206.000	AV	34.4	36.0	8.9	32.1	-	47.2	53.9	6.7	Floor noise
Hori	9608.000	AV	32.5	38.5	9.6	32.9	-	47.7	53.9	6.2	Floor noise
Vert	32.000	QP	22.5	16.8	7.1	32.2	-	14.2	40.0	25.8	Floor noise
Vert	96.000	QP	22.6	9.2	8.1	32.2	-	7.7	43.5	35.8	Floor noise
Vert	160.000	QP	22.0	15.5	8.8	32.1	-	14.2	43.5	29.3	Floor noise
Vert	256.000	QP	21.8	15.3	9.7	32.0	-	14.8	46.0	31.2	Floor noise
Vert	320.000	QP	22.7	15.0	10.2	32.0	-	15.9	46.0	30.1	Floor noise
Vert	640.000	QP	21.0	19.8	12.1	32.1	-	20.8	46.0	25.2	Floor noise
Vert	2386.710	PK	48.5	27.7	6.8	32.4	-	50.6	73.9	23.3	
Vert	2390.000	PK	40.5	27.7	6.8	32.4	-	42.6	73.9	31.3	
Vert	4804.000	PK	40.3	31.6	8.0	31.4	-	48.5	73.9	25.4	Floor noise
Vert	7206.000	PK	41.9	36.0	8.9	32.1	-	54.7	73.9	19.2	Floor noise
Vert	9608.000	PK	41.4	38.5	9.6	32.9	-	56.6	73.9	17.3	Floor noise
Vert	2386.710	AV	33.4	27.7	6.8	32.4	0.9	36.4	53.9	17.5	
Vert	2390.000	AV	32.3	27.7	6.8	32.4	0.9	35.3	53.9	18.6	*1)
Vert	4804.000	AV	31.3	31.6	8.0	31.4	-	39.5	53.9	14.4	Floor noise
Vert	7206.000	AV	32.9	36.0	8.9	32.1	-	45.7	53.9	8.2	Floor noise
Vert	9608.000	AV	32.5	38.5	9.6	32.9	-	47.7	53.9	6.2	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 (4.5 m / 3.0 m) = 3.53 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB
*1) Not Out of Band emission(Leakage Power)

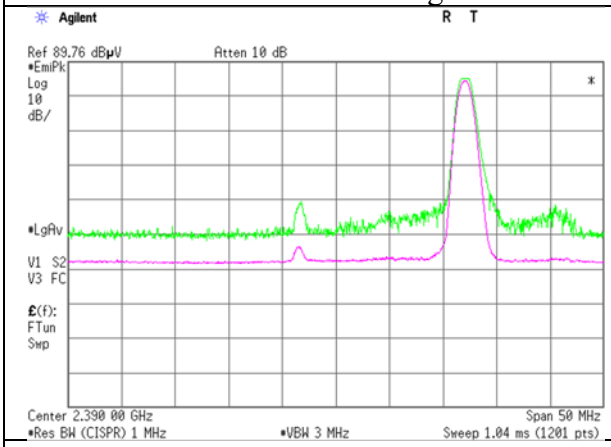
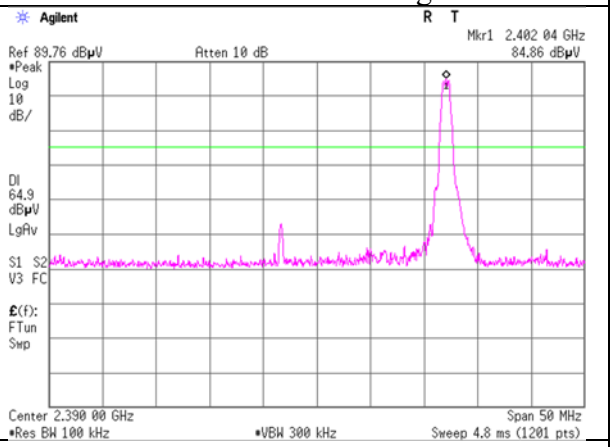
20dBc Data Sheet

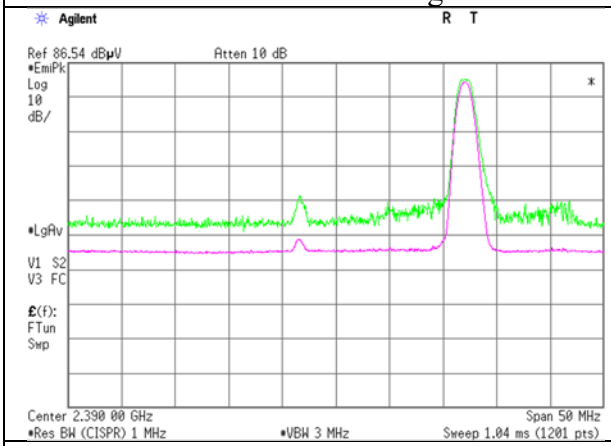
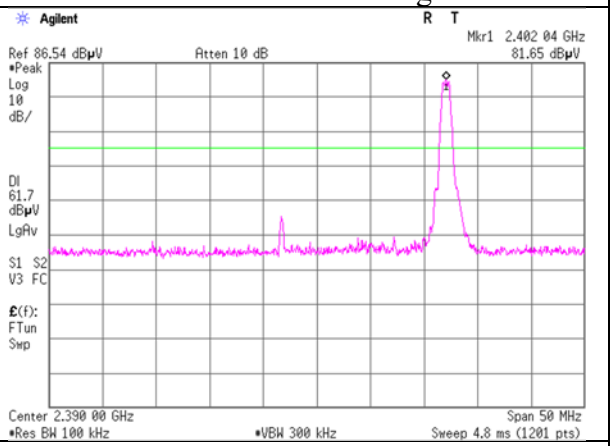
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2402.000	PK	84.9	27.7	6.9	32.4	87.1	-	-	Carrier
Hori	2400.000	PK	34.9	27.7	6.9	32.4	37.1	67.1	30.0	
Vert	2402.000	PK	81.7	27.7	6.9	32.4	83.9	-	-	Carrier
Vert	2400.000	PK	32.9	27.7	6.9	32.4	35.1	63.9	28.8	

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

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11740660H
Date	September 12, 2017
Temperature / Humidity	24 deg. C / 65 % RH
Engineer	Takumi Shimada
Mode	Tx BT LE 2402 MHz

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.

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

Radiated Spurious Emission

Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No. 11740660H
Date September 12, 2017
Temperature / Humidity 24 deg. C / 65 % RH
Engineer Takumi Shimada

Mode Tx BT LE 2440 MHz

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	22.2	16.8	7.1	32.2	-	13.9	40.0	26.1	Floor noise
Hori	96.000	QP	22.2	9.2	8.1	32.2	-	7.3	43.5	36.2	Floor noise
Hori	160.000	QP	22.1	15.5	8.8	32.1	-	14.3	43.5	29.2	Floor noise
Hori	256.000	QP	21.7	15.3	9.7	32.0	-	14.7	46.0	31.3	Floor noise
Hori	320.000	QP	22.5	15.0	10.2	32.0	-	15.7	46.0	30.3	Floor noise
Hori	640.000	QP	21.6	19.8	12.1	32.1	-	21.4	46.0	24.6	Floor noise
Hori	4880.000	PK	40.7	31.9	8.0	31.4	-	49.2	73.9	24.7	Floor noise
Hori	7320.000	PK	41.3	36.2	8.9	32.2	-	54.2	73.9	19.7	Floor noise
Hori	9760.000	PK	41.4	38.7	9.7	33.0	-	56.8	73.9	17.1	Floor noise
Hori	4880.000	AV	31.8	31.9	8.0	31.4	-	40.3	53.9	13.6	Floor noise
Hori	7320.000	AV	32.3	36.2	8.9	32.2	-	45.2	53.9	8.7	Floor noise
Hori	9760.000	AV	32.3	38.7	9.7	33.0	-	47.7	53.9	6.2	Floor noise
Vert	32.000	QP	23.1	16.8	7.1	32.2	-	14.8	40.0	25.2	Floor noise
Vert	96.000	QP	22.5	9.2	8.1	32.2	-	7.6	43.5	35.9	Floor noise
Vert	160.000	QP	22.1	15.5	8.8	32.1	-	14.3	43.5	29.2	Floor noise
Vert	256.000	QP	21.8	15.3	9.7	32.0	-	14.8	46.0	31.2	Floor noise
Vert	320.000	QP	22.2	15.0	10.2	32.0	-	15.4	46.0	30.6	Floor noise
Vert	640.000	QP	21.6	19.8	12.1	32.1	-	21.4	46.0	24.6	Floor noise
Vert	4880.000	PK	41.4	31.9	8.0	31.4	-	49.9	73.9	24.0	Floor noise
Vert	7320.000	PK	41.1	36.2	8.9	32.2	-	54.0	73.9	19.9	Floor noise
Vert	9760.000	PK	41.3	38.7	9.7	33.0	-	56.7	73.9	17.2	Floor noise
Vert	4880.000	AV	32.0	31.9	8.0	31.4	-	40.5	53.9	13.4	Floor noise
Vert	7320.000	AV	32.3	36.2	8.9	32.2	-	45.2	53.9	8.7	Floor noise
Vert	9760.000	AV	32.3	38.7	9.7	33.0	-	47.7	53.9	6.2	Floor noise

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
*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 (4.5 m / 3.0 m) = 3.53 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No. 11740660H
Date September 12, 2017
Temperature / Humidity 24 deg. C / 65 % RH
Engineer Takumi Shimada

Mode Tx BT LE 2480 MHz

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	22.5	16.8	7.1	32.2	-	14.2	40.0	25.8	Floor noise
Hori	96.000	QP	22.2	9.2	8.1	32.2	-	7.3	43.5	36.2	Floor noise
Hori	160.000	QP	21.9	15.5	8.8	32.1	-	14.1	43.5	29.4	Floor noise
Hori	256.000	QP	21.8	15.3	9.7	32.0	-	14.8	46.0	31.2	Floor noise
Hori	320.000	QP	22.4	15.0	10.2	32.0	-	15.6	46.0	30.4	Floor noise
Hori	640.000	QP	21.7	19.8	12.1	32.1	-	21.5	46.0	24.5	Floor noise
Hori	2483.500	PK	45.5	27.8	6.9	32.4	-	47.8	73.9	26.1	
Hori	4960.000	PK	41.6	32.1	8.1	31.3	-	50.5	73.9	23.4	Floor noise
Hori	7440.000	PK	43.0	36.4	8.9	32.2	-	56.1	73.9	17.8	Floor noise
Hori	9920.000	PK	42.4	38.9	9.7	33.1	-	57.9	73.9	16.0	Floor noise
Hori	2483.500	AV	31.4	27.8	6.9	32.4	0.9	34.6	53.9	19.3	*1)
Hori	4960.000	AV	30.1	32.1	8.1	31.3	-	39.0	53.9	14.9	Floor noise
Hori	7440.000	AV	32.3	36.4	8.9	32.2	-	45.4	53.9	8.5	Floor noise
Hori	9920.000	AV	31.3	38.9	9.7	33.1	-	46.8	53.9	7.1	Floor noise
Vert	32.000	QP	22.5	16.8	7.1	32.2	-	14.2	40.0	25.8	Floor noise
Vert	96.000	QP	22.6	9.2	8.1	32.2	-	7.7	43.5	35.8	Floor noise
Vert	160.000	QP	22.0	15.5	8.8	32.1	-	14.2	43.5	29.3	Floor noise
Vert	256.000	QP	21.8	15.3	9.7	32.0	-	14.8	46.0	31.2	Floor noise
Vert	320.000	QP	22.1	15.0	10.2	32.0	-	15.3	46.0	30.7	Floor noise
Vert	640.000	QP	21.6	19.8	12.1	32.1	-	21.4	46.0	24.6	Floor noise
Vert	2483.500	PK	47.2	27.8	6.9	32.4	-	49.5	73.9	24.4	
Vert	4960.000	PK	41.0	32.1	8.1	31.3	-	49.9	73.9	24.0	Floor noise
Vert	7440.000	PK	43.6	36.4	8.9	32.2	-	56.7	73.9	17.2	Floor noise
Vert	9920.000	PK	41.6	38.9	9.7	33.1	-	57.1	73.9	16.8	Floor noise
Vert	2483.500	AV	36.3	27.8	6.9	32.4	0.9	39.5	53.9	14.4	*1)
Vert	4960.000	AV	30.2	32.1	8.1	31.3	-	39.1	53.9	14.8	Floor noise
Vert	7440.000	AV	32.2	36.4	8.9	32.2	-	45.3	53.9	8.6	Floor noise
Vert	9920.000	AV	30.7	38.9	9.7	33.1	-	46.2	53.9	7.7	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).

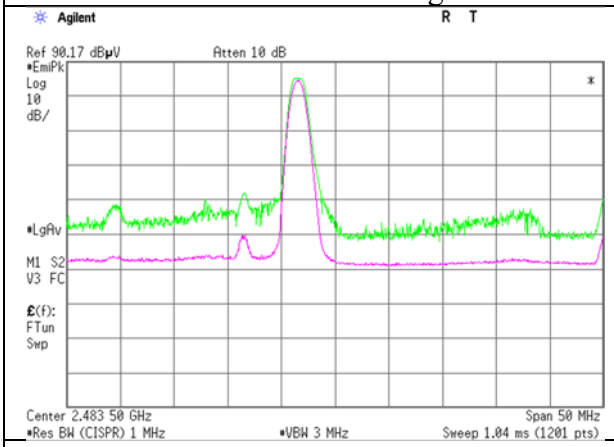
Distance factor: 1 GHz - 10 GHz 20log (4.5 m / 3.0 m) = 3.53 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB
*1) Not Out of Band emission(Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11740660H
Date	September 12, 2017
Temperature / Humidity	24 deg. C / 65 % RH
Engineer	Takumi Shimada
Mode	Tx BT LE 2480 MHz

Horizontal

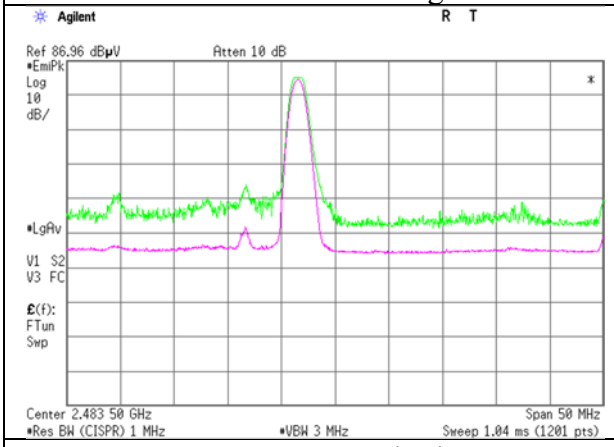
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

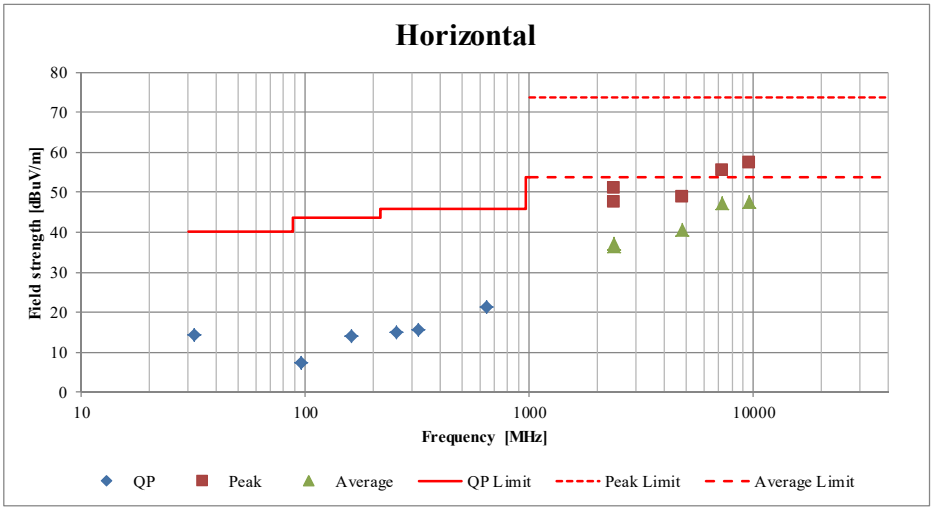


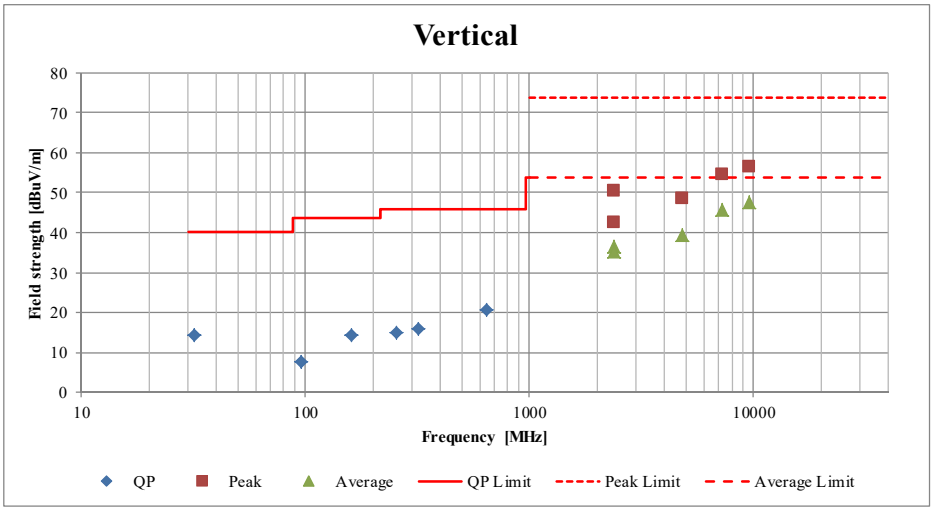
Trace Green : Peak Plot
Trace Purple : Average Plot

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

Radiated Spurious Emission
(Plot data, Worst case)

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11740660H
Date	September 12, 2017
Temperature / Humidity	24 deg. C / 65 % RH
Engineer	Takumi Shimada
Mode	Tx BT LE 2402 MHz



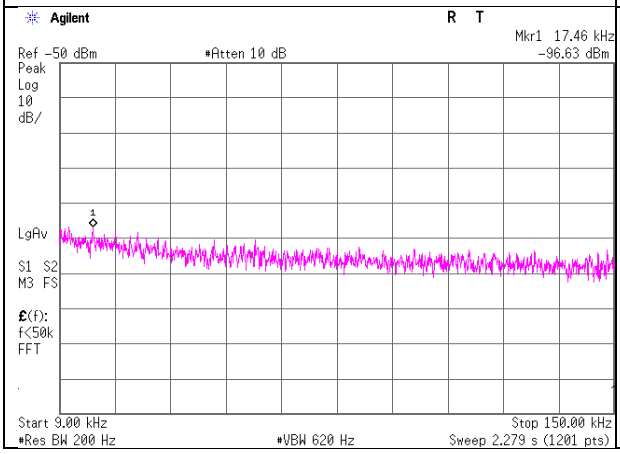


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

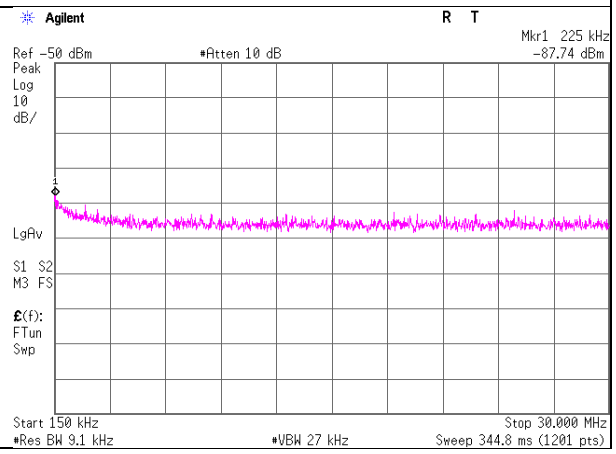
Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE 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
17.46	-96.6	0.20	9.8	2.0	1	-84.6	300	6.0	-23.4	42.7	66.1	
225.00	-87.7	0.20	9.8	2.0	1	-75.7	300	6.0	-14.4	20.5	34.9	

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)

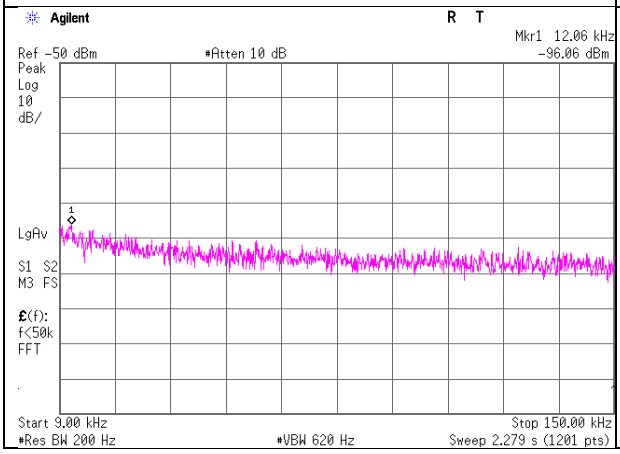
N: Number of output

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

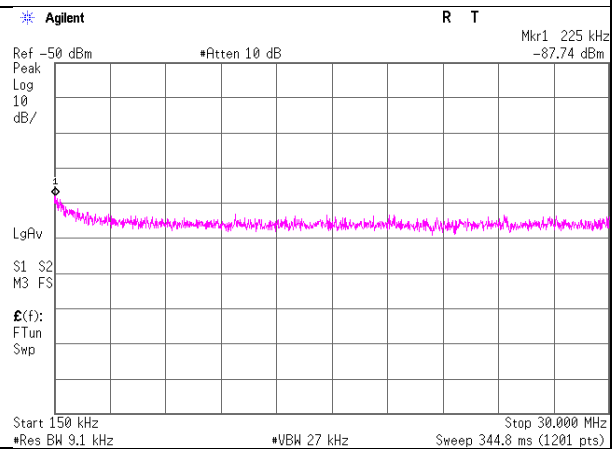
Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE 2440 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
12.06	-96.1	0.20	9.8	2.0	1	-84.0	300	6.0	-22.8	45.9	68.7	
225.00	-87.7	0.20	9.8	2.0	1	-75.7	300	6.0	-14.4	20.5	34.9	

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)

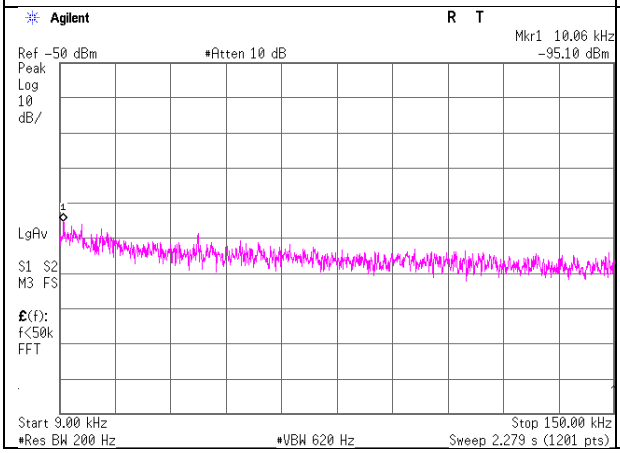
N: Number of output

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

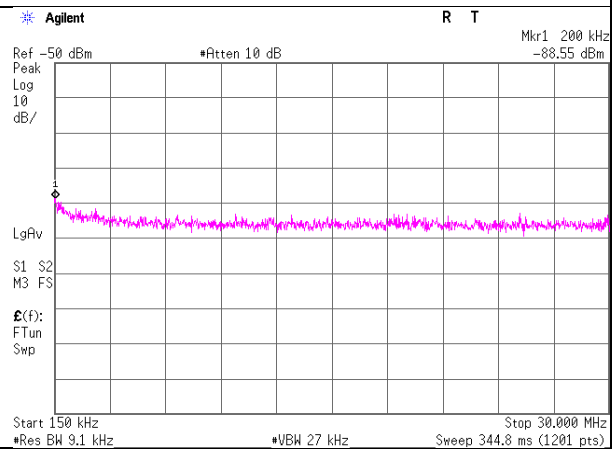
Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE 2480 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
10.06	-95.1	0.20	9.8	2.0	1	-83.1	300	6.0	-21.8	47.5	69.3	
200.00	-88.6	0.20	9.8	2.0	1	-76.5	300	6.0	-15.3	21.5	36.8	

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

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-21.65	0.20	10.00	-11.45	8.00	19.45
2440.00	-21.38	0.20	10.00	-11.18	8.00	19.18
2480.00	-20.78	0.20	10.00	-10.58	8.00	18.58

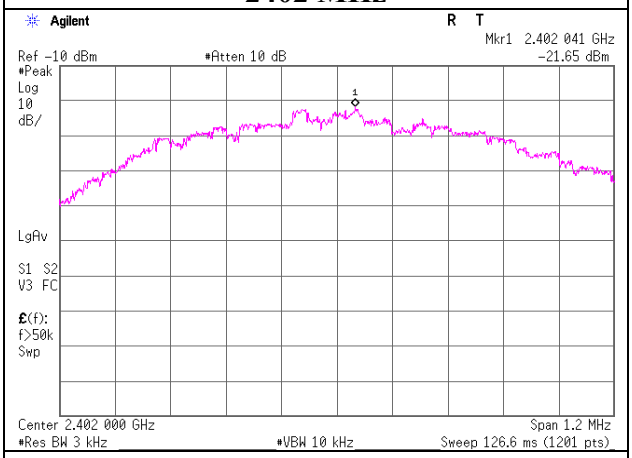
Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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

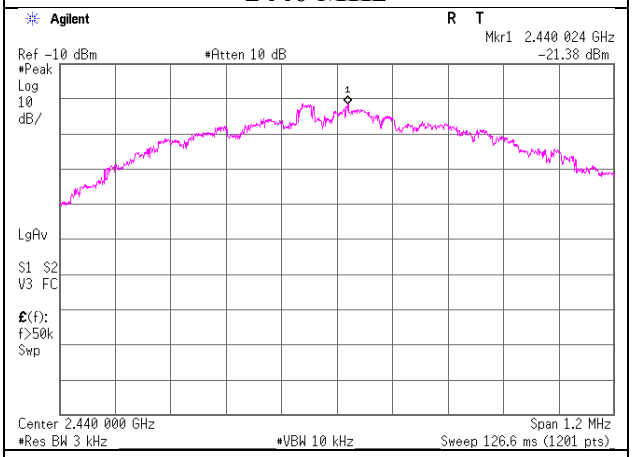
Power Density

BT LE

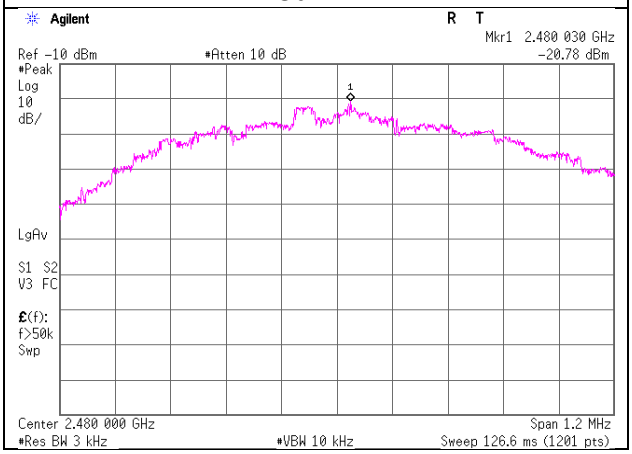
2402 MHz



2440 MHz



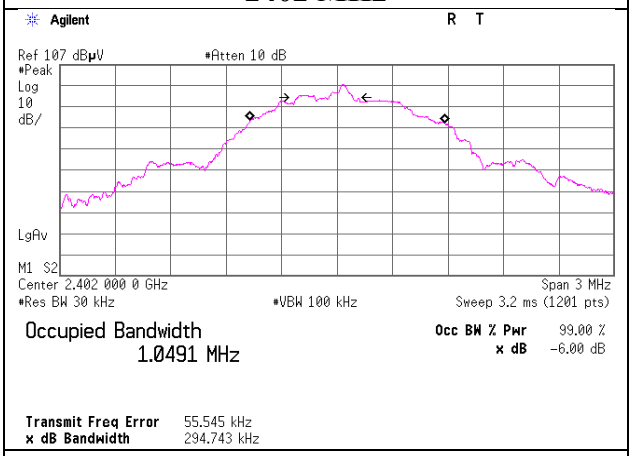
2480 MHz



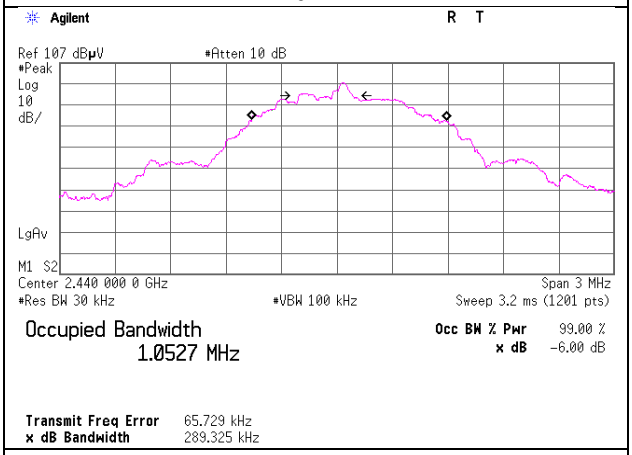
99%Occupied Bandwidth

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11740660H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 69 % RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE

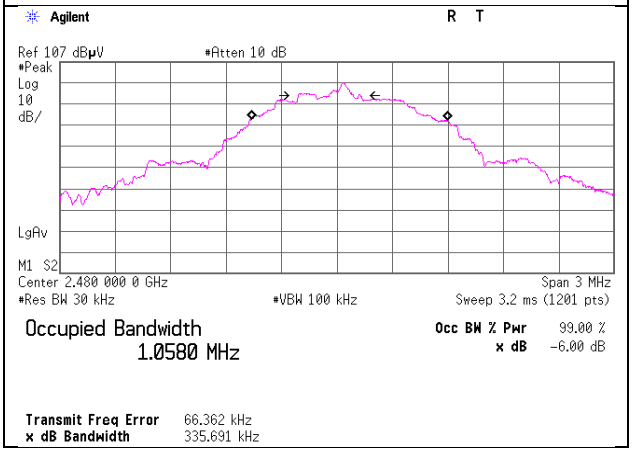
2402 MHz



2440 MHz



2480 MHz



APPENDIX 2: Test instruments

Test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-03	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2016/10/20 * 12
MOS-13	Thermo-Hygrometer	Custom	CTH-180	1301	RE	2017/01/20 * 12
MJM-16	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	-
MSA-10	Spectrum Analyzer	Agilent	E4448A	MY46180655	RE	2017/08/22 * 12
MHA-20	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	258	RE	2017/05/22 * 12
MCC-167	Microwave Cable	Junkosha	MWX221	1404S374(1m) / 1405S074(5m)	RE	2017/05/29 * 12
MPA-11	MicroWave System Amplifier	Agilent	83017A	MY39500779	RE	2017/03/21 * 12
MHA-16	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170306	RE	2017/05/14 * 12
MMM-08	DIGITAL HiTESTER	Hioki	3805	051201197	RE	2017/01/19 * 12
MHF-25	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	RE	2016/09/21 * 12
MHF-06	High Pass Filter 3.5-24GHz	TOKIMEC	TF323DCA	601	RE	2017/05/30 * 12
MTR-08	Test Receiver	Rohde & Schwarz	ESCI	100767	RE	2017/08/22 * 12
MBA-03	Biconical Antenna	Schwarzbeck	BBA9106	1915	RE	2016/10/15 * 12
MLA-22	Logperiodic Antenna (200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-191	RE	2017/01/26 * 12
MCC-51	Coaxial cable	UL Japan	-	-	RE	2017/07/12 * 12
MAT-98	Attenuator	KEYSIGHT	8491A	MY52462349	RE	2016/12/05 * 12
MPA-13	Pre Amplifier	SONOMA INSTRUMENT	310	260834	RE	2017/03/27 * 12
MSA-04	Spectrum Analyzer	Agilent	E4448A	US44300523	AT	2016/11/10 * 12
MAT-10	Attenuator(10dB)	Weinschel Corp	2	BL1173	AT	2016/11/28 * 12
MPM-12	Power Meter	Anritsu	ML2495A	0825002	AT	2017/06/20 * 12
MPSE-17	Power sensor	Anritsu	MA2411B	0738285	AT	2017/06/20 * 12
MOS-19	Thermo-Hygrometer	Custom	CTH-201	0001	AT	2016/12/13 * 12

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