RADIO TEST REPORT

Test Report No. : 12571601H-A-R1

Applicant	:	**ALPS ALPINE CO., LTD.**
Type of Equipment	:	**Virtual key module (VKM)**
Model No.	:	**TWD5E0011**
FCC ID	:	**CWTWD5E0011**
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 12571601H-A. 12571601H-A is replaced with this report.

Date of test: December 19 and 25, 2018

Representative test engineer:
T. Nakagawa
Tomohisa Nakagawa
Engineer
Consumer Technology Division

Approved by:
S. Miyazono
Shinichi Miyazono
Engineer
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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☐ 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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REVISION HISTORY

Original Test Report No.: 12571601H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	12571601H-A	March 1, 2019	-	-
1	12571601H-A-R1	March 25, 2019	P.5	Correction of Worst margin for Spurious Emission Restricted Band Edges test; From 14.4 dB, 2493.730 MHz to 13.1 dB, 2483.500 MHz
1	12571601H-A-R1	March 25, 2019	P.5	Correction of the note *2) KDB 558074 version
1	12571601H-A-R1	March 25, 2019	P.12	Correction of the note sentence *3)
1	12571601H-A-R1	March 25, 2019	P.21	Addition of "* 1)" to 2493.730 MHz, AV in the Tx BT LE 2480 MHz data

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	ALPS ALPINE CO., LTD.
Address	:	6-3-36, Furukawanakazato, Osaki-city, Miyagi-pref. 989-6181 Japan
Telephone Number	:	+81-229-23-5111
Facsimile Number	:	+81-229-22-6290
Contact Person	:	Yasuhiro Yabe

The information provided from the customer is as follows;
- Applicant, Type of Equipment, Model No. 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	:	Virtual key module (VKM)
Model No.	:	TWD5E0011
Serial No.	:	Refer to Clause 4.2
Rating	:	DC 12 V
Receipt Date of Sample	:	December 14, 2018
Country of Mass-production (Information from test lab.)	:	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: TWD5E0011 (referred to as the EUT in this report) is a Virtual key module (VKM).

Radio Specification

Radio Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480 MHz
Modulation	:	GFSK
Antenna type	:	Inverted F antenna
Antenna Gain	:	2.0 dBi
Clock frequency	:	32.768 kHz (Crystal) at BLE Block , 26 MHz (Crystal) at BLE Block, 20 MHz (Crystal) at CPU Block

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on March 12, 2018 and effective April 11, 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

* 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	**FCC:** ANSI C63.10-2013 6. Standard test methods **IC:** RSS-Gen 8.8	**FCC:** Section 15.207 **IC:** RSS-Gen 8.8	N/A *1)	N/A	-
6dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05 **IC:** -	**FCC:** Section 15.247(a)(2) **IC:** RSS-247 5.2(a)	See data.	Complied a)	Conducted
Maximum Peak Output Power	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05 **IC:** RSS-Gen 6.12	**FCC:** Section 15.247(b)(3) **IC:** RSS-247 5.4(d)		Complied b)	Conducted
Power Density	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05 **IC:** -	**FCC:** Section 15.247(e) **IC:** RSS-247 5.2(b)		Complied c)	Conducted
Spurious Emission Restricted Band Edges	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05 **IC:** RSS-Gen 6.13	**FCC:** Section15.247(d) **IC:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	13.1 dB 2483.500 MHz, AV, Horizontal	Complied d), e)	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *1)

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 not the device that is designed to be connected to the public utility (AC) power line.
*2) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 15.247 Meas Guidance v05 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)
This EUT provides stable voltage constantly to RF Module regardless of input voltage. Therefore, this 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	Complied 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)					
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.					

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 (+/-)
6 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %
Maximum Peak Output Power / Average Output Power	1.3 dB
Burst Rate	0.10 %
Power Density	2.7 dB
Conducted Spurious Emission	2.7 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

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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

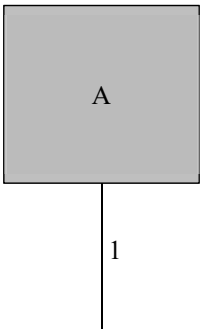
4.1 Operating Mode(s)

Bluetooth Low energy version 4.2 (for BTLE): Transmitting (Tx) GFSK

*The details of Operating mode(s)

Test Item	Operating Mode	Tested Frequency
Spurious Emission 6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth	Tx BT LE	2402MHz 2440MHz 2480MHz
*The power value of the EUT was set for testing as follows (setting value might be different from product specification value); Power settings: 0dBm Software: HCI tester 1.00 (TOSHIBA) *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



DC 12 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	Remark
A	Virtual key module (VKM)	TWD5E0011	1118340000000037	ALPS ALPINE CO., LTD.	EUT

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	2.5	Unshielded	Unshielded	-

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 v05".

[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.

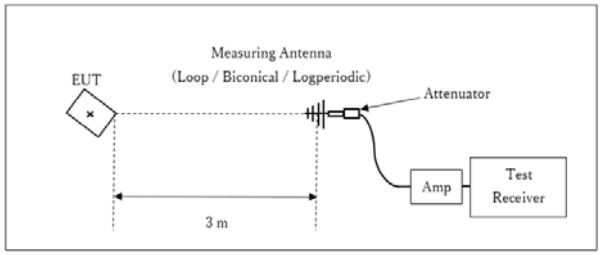
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(IC) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (IC).

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: 300 kHz

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

Figure 2: Test Setup

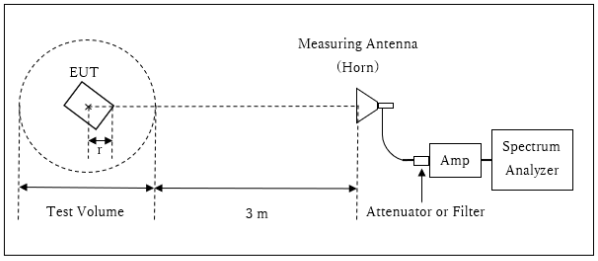
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz

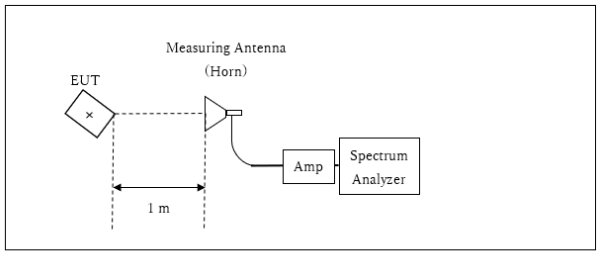


r : Radius of an outer periphery of EUT
× : Center of turn table

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	6 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.

The test results and limit are rounded off to two decimals place, so some differences might be observed.
The equipment and cables were not used for factor 0 dB of the data sheets.

Test data : APPENDIX
Test result : Pass

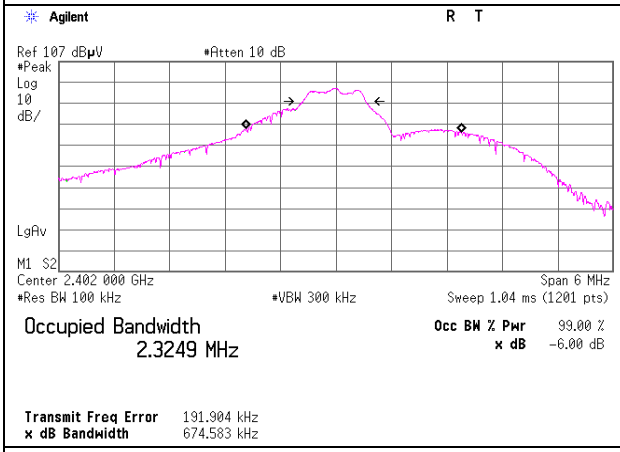
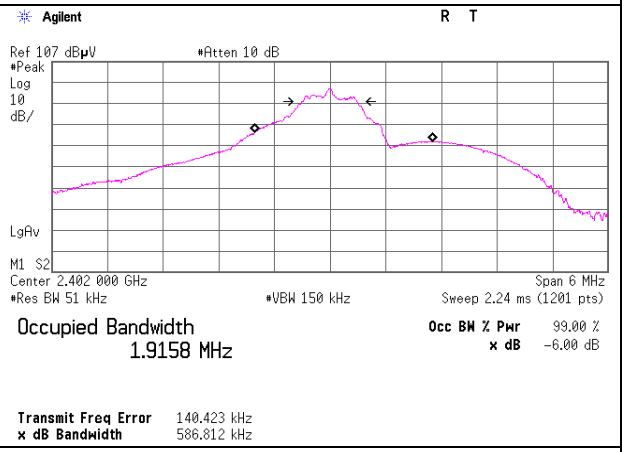
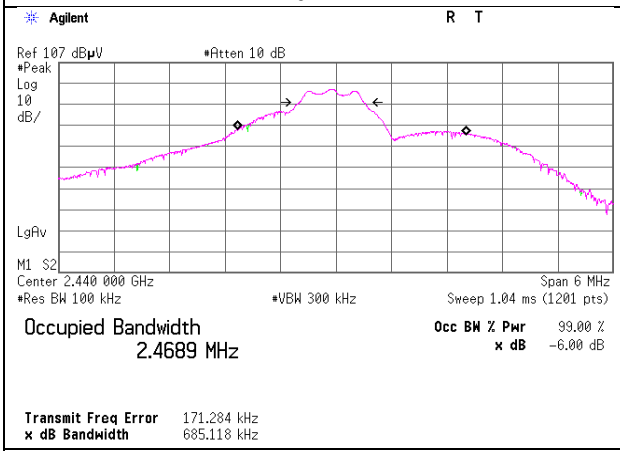
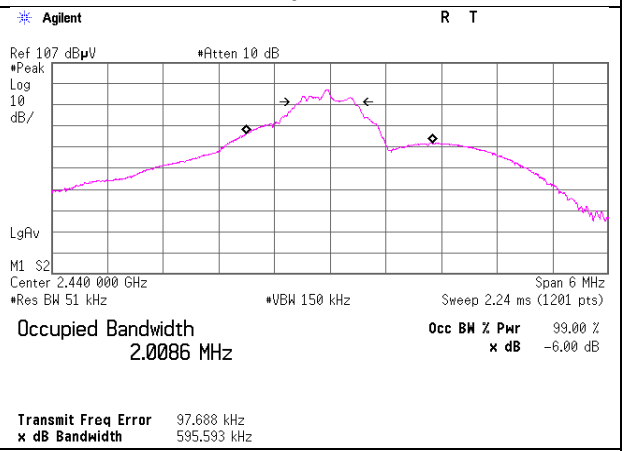
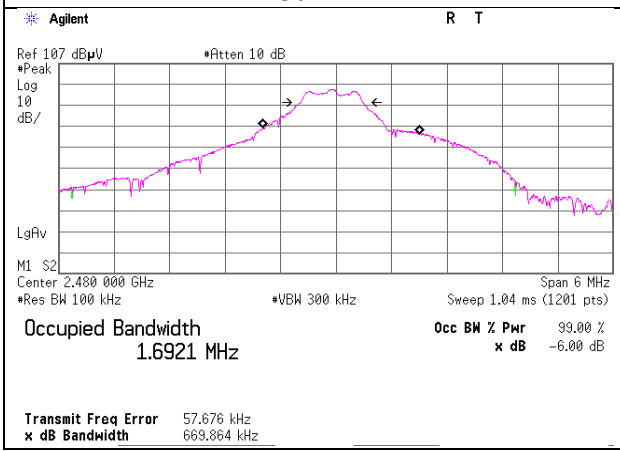
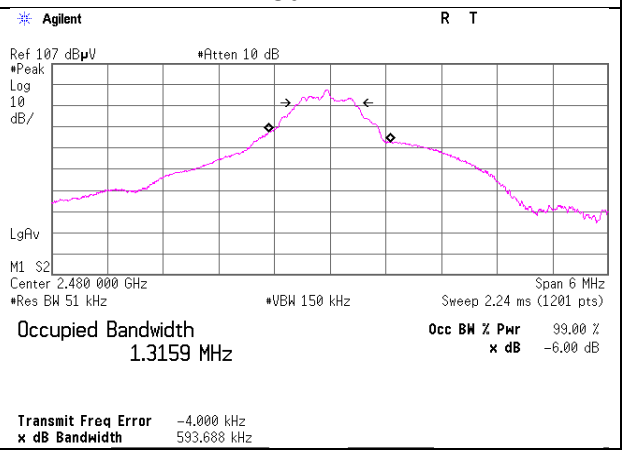
APPENDIX 1: Test data

6 dB Bandwidth and 99 % Occupied Bandwidth

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
Mode	Tx BT LE

Mode	Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
BT LE	2402	0.675	> 500
	2440	0.685	> 500
	2480	0.670	> 500

6 dB Bandwidth and 99%Occupied Bandwidth

6dB Bandwidth	99% bandwidth
2402 MHz	**2402 MHz**
	
2440 MHz	**2440 MHz**
	
2480 MHz	**2480 MHz**
	

Maximum Peak Output Power

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
Mode	Tx BT LE

BT LE

Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-12.96	0.50	9.51	-2.95	0.51	30.00	1000	32.95
2440	-12.70	0.50	9.51	-2.69	0.54	30.00	1000	32.69
2480	-12.44	0.50	9.51	-2.43	0.57	30.00	1000	32.43

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

Average Output Power
(Reference data for RF Exposure)

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
Mode	Tx BT LE

BT LE

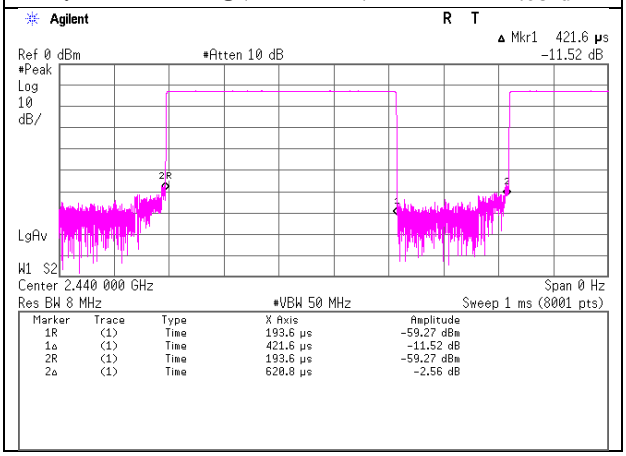
Freq.	Reading	Cable Loss	Atten. Loss	Result (Time average)		Duty factor	Result (Burst power average)	
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dB]	[dBm]	[mW]
2402	-15.05	0.50	9.51	-5.04	0.31	1.68	-3.36	0.46
2440	-14.78	0.50	9.51	-4.77	0.33	1.68	-3.09	0.49
2480	-14.50	0.50	9.51	-4.49	0.36	1.68	-2.81	0.52

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

Burst rate confirmation

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
Mode	Tx BT LE

Tx on / (Tx on + Tx off) = 0.679
Tx on / (Tx on + Tx off) * 100 = 67.9 %
Duty factor = 10 * log (620.8 / 421.6) = 1.68 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.	12571601H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	December 25, 2018
Temperature / Humidity	18 deg. C / 39 % RH
Engineer	Akihiko Maeda
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	50.004	QP	23.0	11.3	7.5	32.2	-	9.6	40.0	30.4	
Hori	53.513	QP	22.6	9.9	7.5	32.2	-	7.8	40.0	32.2	
Hori	58.156	QP	23.0	8.5	7.6	32.2	-	6.9	40.0	33.1	
Hori	73.395	QP	22.7	6.3	7.8	32.2	-	4.6	40.0	35.4	
Hori	369.334	QP	21.8	15.1	10.6	32.1	-	15.4	46.0	30.6	
Hori	799.997	QP	21.8	21.1	13.2	31.6	-	24.5	46.0	21.5	
Hori	2390.000	PK	52.6	27.8	5.6	32.7	-	53.3	73.9	20.6	
Hori	4804.000	PK	40.0	31.7	8.0	31.8	-	47.9	73.9	26.0	Floor noise
Hori	7206.000	PK	40.7	35.7	9.2	32.6	-	53.0	73.9	20.9	Floor noise
Hori	9608.000	PK	40.8	38.6	9.6	33.3	-	55.7	73.9	18.2	Floor noise
Hori	2390.000	AV	36.5	27.8	5.6	32.7	1.7	38.9	53.9	15.0	*1)
Hori	4804.000	AV	31.9	31.7	8.0	31.8	-	39.8	53.9	14.1	Floor noise
Hori	7206.000	AV	32.9	35.7	9.2	32.6	-	45.2	53.9	8.7	Floor noise
Hori	9608.000	AV	32.7	38.6	9.6	33.3	-	47.6	53.9	6.3	Floor noise
Vert	50.004	QP	23.4	11.3	7.5	32.2	-	10.0	40.0	30.0	
Vert	53.513	QP	24.5	9.9	7.5	32.2	-	9.7	40.0	30.3	
Vert	58.156	QP	25.3	8.5	7.6	32.2	-	9.2	40.0	30.8	
Vert	73.395	QP	23.4	6.3	7.8	32.2	-	5.3	40.0	34.7	
Vert	369.334	QP	21.8	15.1	10.6	32.1	-	15.4	46.0	30.6	
Vert	799.997	QP	21.9	21.1	13.2	31.6	-	24.6	46.0	21.4	
Vert	2390.000	PK	48.5	27.8	5.6	32.7	-	49.2	73.9	24.7	
Vert	4804.000	PK	39.8	31.7	8.0	31.8	-	47.7	73.9	26.2	Floor noise
Vert	7206.000	PK	39.7	35.7	9.2	32.6	-	52.0	73.9	21.9	Floor noise
Vert	9608.000	PK	40.8	38.6	9.6	33.3	-	55.7	73.9	18.2	Floor noise
Vert	2390.000	AV	34.8	27.8	5.6	32.7	1.7	37.2	53.9	16.7	*1)
Vert	4804.000	AV	31.9	31.7	8.0	31.8	-	39.8	53.9	14.1	Floor noise
Vert	7206.000	AV	32.7	35.7	9.2	32.6	-	45.0	53.9	8.9	Floor noise
Vert	9608.000	AV	32.7	38.6	9.6	33.3	-	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)

20dBc Data Sheet

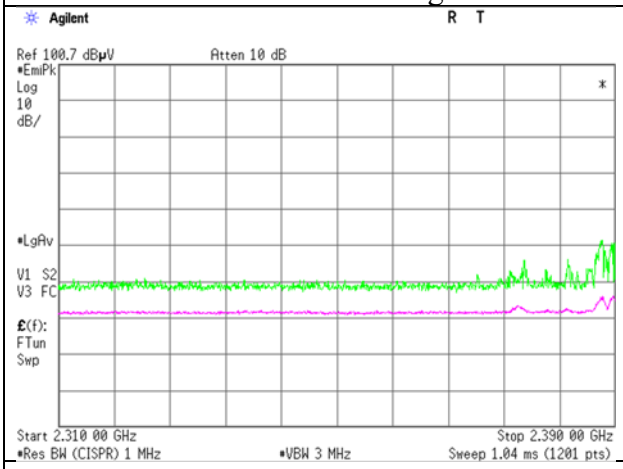
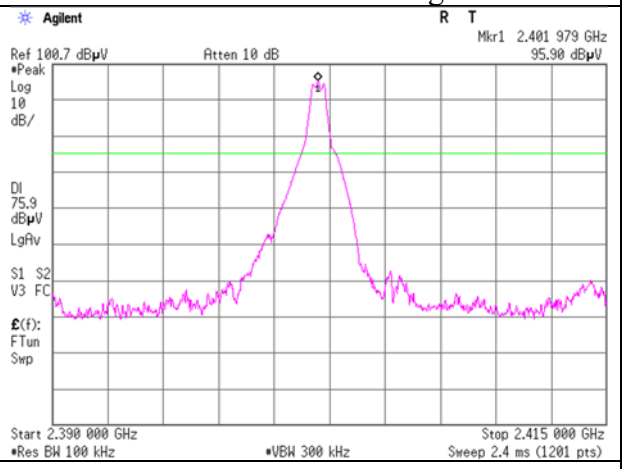
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2402.000	PK	95.9	27.8	5.6	32.7	96.6	-	-	Carrier
Hori	2400.000	PK	54.0	27.8	5.6	32.7	54.7	76.6	21.9	
Vert	2402.000	PK	93.1	27.8	5.6	32.7	93.8	-	-	Carrier
Vert	2400.000	PK	51.0	27.8	5.6	32.7	51.7	73.8	22.1	

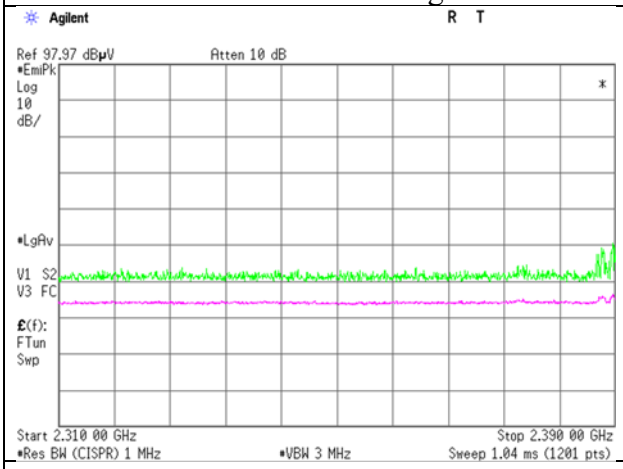
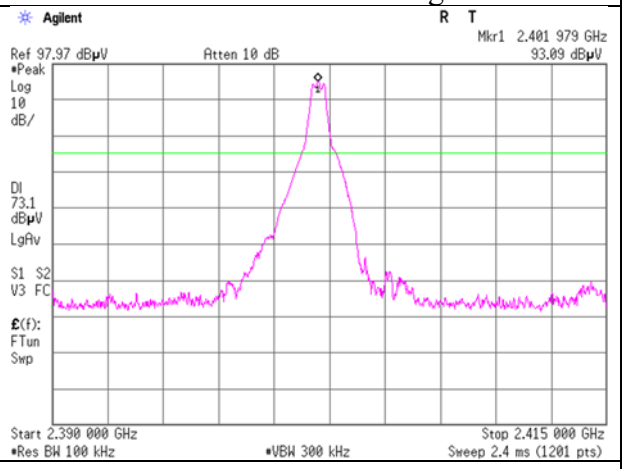
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

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.	12571601H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	December 25, 2018
Temperature / Humidity	18 deg. C / 39 % RH
Engineer	Akihiko Maeda
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

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission

Report No.	12571601H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	December 25, 2018
Temperature / Humidity	18 deg. C / 39 % RH
Engineer	Akihiko Maeda
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	50.004	QP	23.1	11.3	7.5	32.2	-	9.7	40.0	30.3	
Hori	53.513	QP	23.0	9.9	7.5	32.2	-	8.2	40.0	31.8	
Hori	58.156	QP	23.1	8.5	7.6	32.2	-	7.0	40.0	33.0	
Hori	73.395	QP	22.8	6.3	7.8	32.2	-	4.7	40.0	35.3	
Hori	369.334	QP	22.0	15.1	10.6	32.1	-	15.6	46.0	30.4	
Hori	799.997	QP	21.8	21.1	13.2	31.6	-	24.5	46.0	21.5	
Hori	4880.000	PK	40.2	31.7	8.0	31.7	-	48.2	73.9	25.7	Floor noise
Hori	7320.000	PK	41.1	36.3	9.2	32.7	-	53.9	73.9	20.0	Floor noise
Hori	9760.000	PK	40.9	39.1	9.6	33.4	-	56.2	73.9	17.7	Floor noise
Hori	4880.000	AV	31.9	31.7	8.0	31.7	-	39.9	53.9	14.0	Floor noise
Hori	7320.000	AV	33.3	36.3	9.2	32.7	-	46.1	53.9	7.8	Floor noise
Hori	9760.000	AV	32.1	39.1	9.6	33.4	-	47.4	53.9	6.5	Floor noise
Vert	50.004	QP	23.4	11.3	7.5	32.2	-	10.0	40.0	30.0	
Vert	53.513	QP	24.7	9.9	7.5	32.2	-	9.9	40.0	30.1	
Vert	58.156	QP	25.4	8.5	7.6	32.2	-	9.3	40.0	30.7	
Vert	73.395	QP	23.8	6.3	7.8	32.2	-	5.7	40.0	34.3	
Vert	369.334	QP	21.8	15.1	10.6	32.1	-	15.4	46.0	30.6	
Vert	799.997	QP	21.8	21.1	13.2	31.6	-	24.5	46.0	21.5	
Vert	4880.000	PK	41.1	31.7	8.0	31.7	-	49.1	73.9	24.8	Floor noise
Vert	7320.000	PK	41.7	36.3	9.2	32.7	-	54.5	73.9	19.4	Floor noise
Vert	9760.000	PK	41.9	39.1	9.6	33.4	-	57.2	73.9	16.7	Floor noise
Vert	4880.000	AV	31.8	31.7	8.0	31.7	-	39.8	53.9	14.1	Floor noise
Vert	7320.000	AV	33.0	36.3	9.2	32.7	-	45.8	53.9	8.1	Floor noise
Vert	9760.000	AV	31.9	39.1	9.6	33.4	-	47.2	53.9	6.7	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 (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Report No.	12571601H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	December 25, 2018
Temperature / Humidity	18 deg. C / 39 % RH
Engineer	Akihiko Maeda
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	50.004	QP	23.0	11.3	7.5	32.2	-	9.6	40.0	30.4	
Hori	53.513	QP	22.8	9.9	7.5	32.2	-	8.0	40.0	32.0	
Hori	58.156	QP	23.0	8.5	7.6	32.2	-	6.9	40.0	33.1	
Hori	73.395	QP	22.9	6.3	7.8	32.2	-	4.8	40.0	35.2	
Hori	369.334	QP	21.9	15.1	10.6	32.1	-	15.5	46.0	30.5	
Hori	799.997	QP	21.9	21.1	13.2	31.6	-	24.6	46.0	21.4	
Hori	2483.500	PK	51.9	27.5	5.7	32.7	-	52.4	73.9	21.5	
Hori	2493.730	PK	53.9	27.5	5.7	32.7	-	54.4	73.9	19.5	
Hori	4960.000	PK	39.9	31.8	8.0	31.7	-	48.0	73.9	25.9	Floor noise
Hori	7440.000	PK	40.9	36.6	9.2	32.7	-	54.0	73.9	19.9	Floor noise
Hori	9920.000	PK	41.1	39.1	9.5	33.4	-	56.3	73.9	17.6	Floor noise
Hori	2483.500	AV	38.6	27.5	5.7	32.7	1.7	40.8	53.9	13.1	*1)
Hori	2493.730	AV	37.3	27.5	5.7	32.7	1.7	39.5	53.9	14.4	*1)
Hori	4960.000	AV	31.8	31.8	8.0	31.7	-	39.9	53.9	14.0	Floor noise
Hori	7440.000	AV	32.7	36.6	9.2	32.7	-	45.8	53.9	8.1	Floor noise
Hori	9920.000	AV	32.4	39.1	9.5	33.4	-	47.6	53.9	6.3	Floor noise
Vert	50.004	QP	23.2	11.3	7.5	32.2	-	9.8	40.0	30.2	
Vert	53.513	QP	24.3	9.9	7.5	32.2	-	9.5	40.0	30.5	
Vert	58.156	QP	25.1	8.5	7.6	32.2	-	9.0	40.0	31.0	
Vert	73.395	QP	23.5	6.3	7.8	32.2	-	5.4	40.0	34.6	
Vert	369.334	QP	22.0	15.1	10.6	32.1	-	15.6	46.0	30.4	
Vert	799.997	QP	21.9	21.1	13.2	31.6	-	24.6	46.0	21.4	
Vert	2483.500	PK	50.6	27.5	5.7	32.7	-	51.1	73.9	22.8	
Vert	2493.730	PK	51.6	27.5	5.7	32.7	-	52.1	73.9	21.8	
Vert	4960.000	PK	40.3	31.8	8.0	31.7	-	48.4	73.9	25.5	Floor noise
Vert	7440.000	PK	40.6	36.6	9.2	32.7	-	53.7	73.9	20.2	Floor noise
Vert	9920.000	PK	40.7	39.1	9.5	33.4	-	55.9	73.9	18.0	Floor noise
Vert	2483.500	AV	36.5	27.5	5.7	32.7	1.7	38.7	53.9	15.2	*1)
Vert	2493.730	AV	36.5	27.5	5.7	32.7	1.7	38.7	53.9	15.2	*1)
Vert	4960.000	AV	31.7	31.8	8.0	31.7	-	39.8	53.9	14.1	Floor noise
Vert	7440.000	AV	32.6	36.6	9.2	32.7	-	45.7	53.9	8.2	Floor noise
Vert	9920.000	AV	32.4	39.1	9.5	33.4	-	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

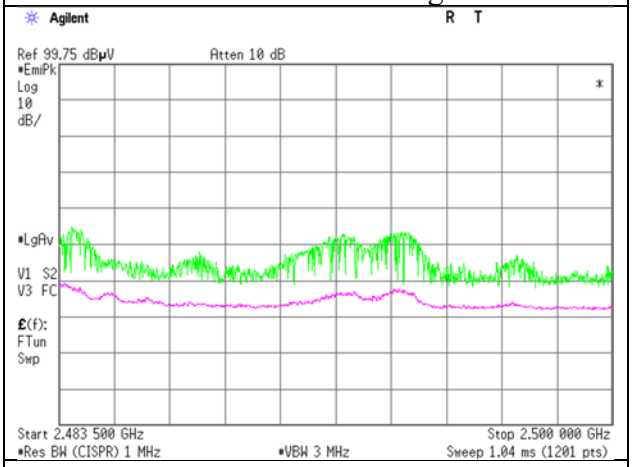
*1) Not Out of Band emission(Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	12571601H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	December 25, 2018
Temperature / Humidity	18 deg. C / 39 % RH
Engineer	Akihiko Maeda
Mode	Tx BT LE 2480 MHz

Horizontal

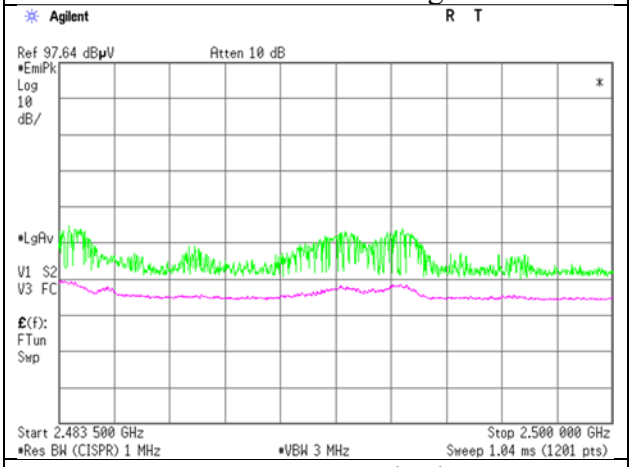
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

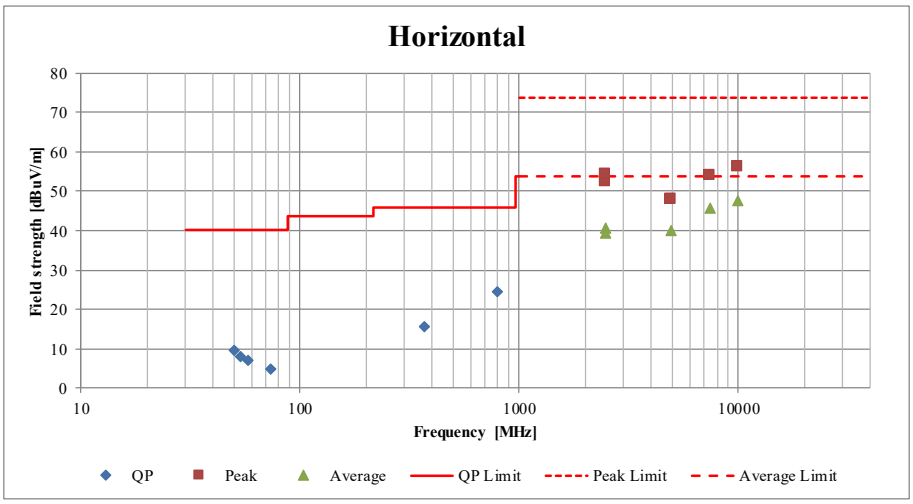


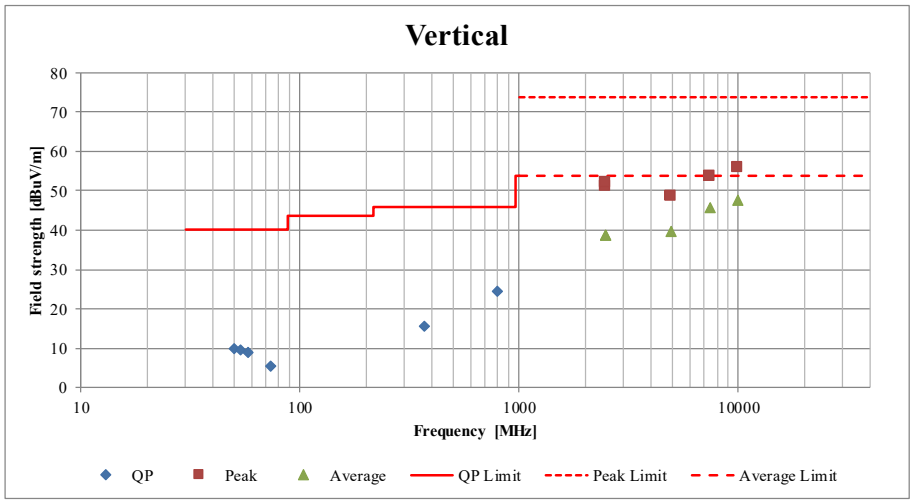
Trace Green : Peak Plot
Trace Purple : Average Plot

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions. Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission
(Plot data, Worst case)

Report No.	12571601H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	December 25, 2018
Temperature / Humidity	18 deg. C / 39 % RH
Engineer	Akihiko Maeda
Mode	Tx BT LE 2480 MHz



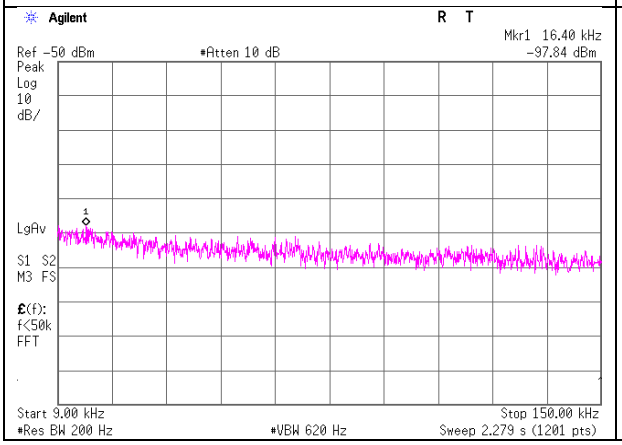


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

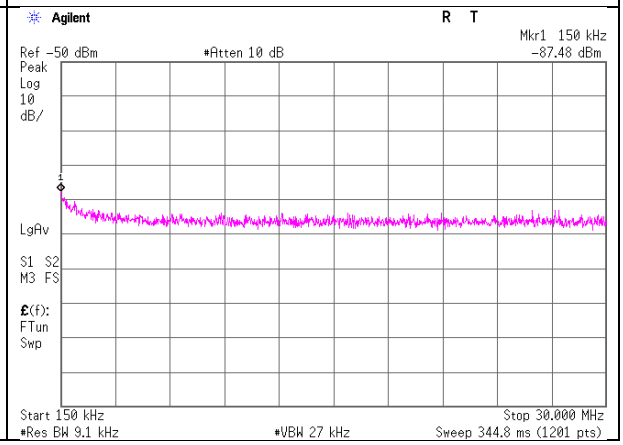
Conducted Spurious Emission

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
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
16.40	-97.8	0.50	9.8	2.0	1	-85.5	300	6.0	-24.2	43.3	67.5	
150.00	-87.5	0.50	9.8	2.0	1	-75.2	300	6.0	-13.9	24.0	37.9	

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

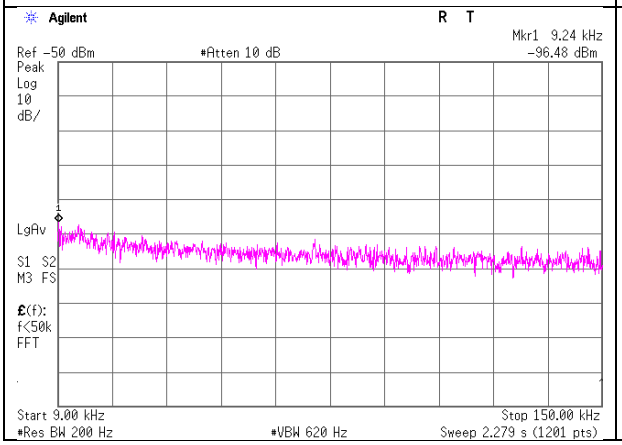
EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

N: Number of output

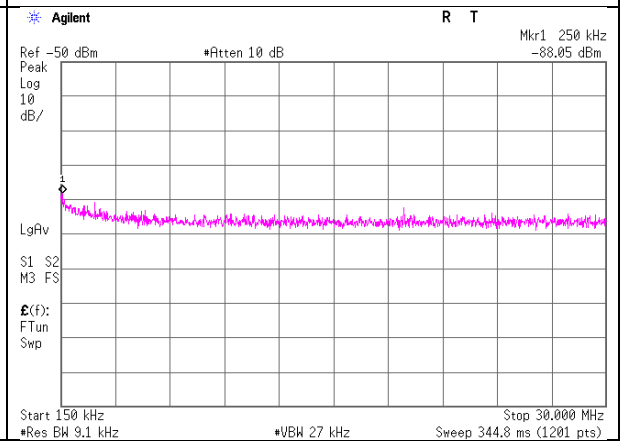
Conducted Spurious Emission

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
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
9.24	-96.5	0.50	9.8	2.0	1	-84.1	300	6.0	-22.9	48.2	71.1	
250.00	-88.1	0.50	9.8	2.0	1	-75.7	300	6.0	-14.5	19.6	34.1	

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

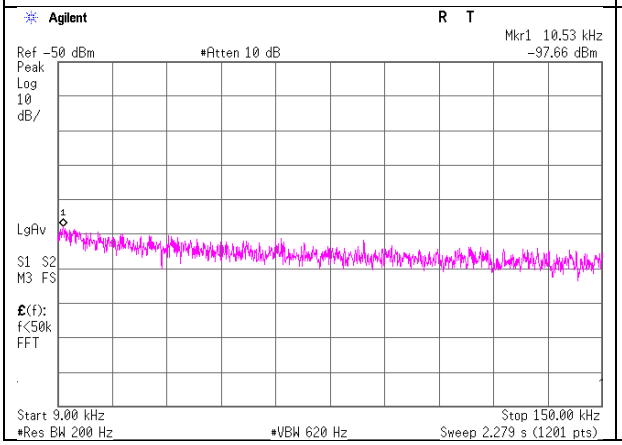
EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

N: Number of output

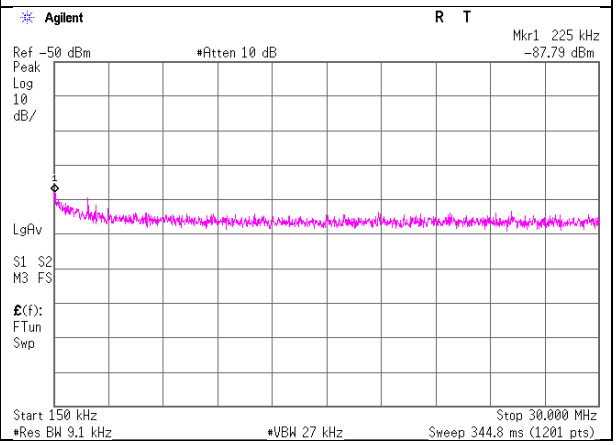
Conducted Spurious Emission

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
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
10.53	-97.7	0.50	9.8	2.0	1	-85.3	300	6.0	-24.1	47.1	71.2	
225.00	-87.8	0.50	9.8	2.0	1	-75.5	300	6.0	-14.2	20.5	34.7	

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

Power Density

Report No.	12571601H
Test place	Ise EMC Lab. No.7 Shielded Room
Date	December 19, 2018
Temperature / Humidity	23 deg. C / 48 % RH
Engineer	Tomohisa Nakagawa
Mode	Tx BT LE

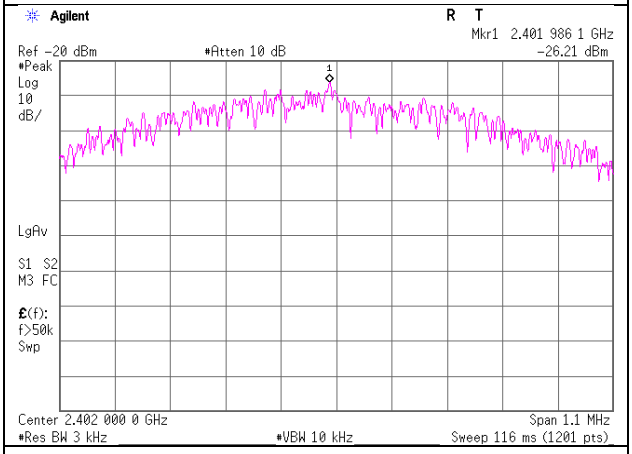
BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-26.21	0.50	9.51	-16.20	8.00	24.20
2440.00	-26.40	0.50	9.51	-16.39	8.00	24.39
2480.00	-25.63	0.50	9.51	-15.62	8.00	23.62

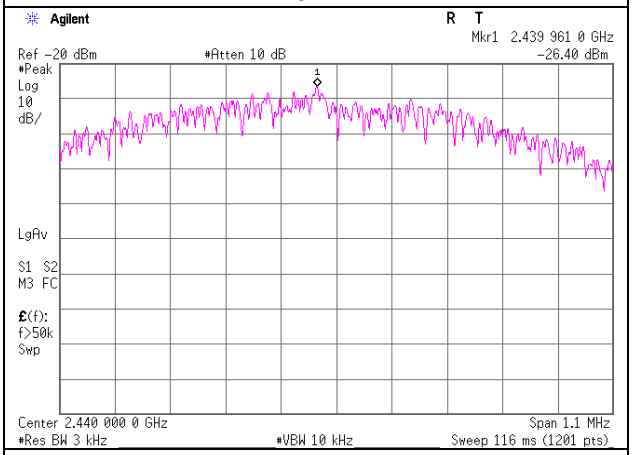
Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

Power Density

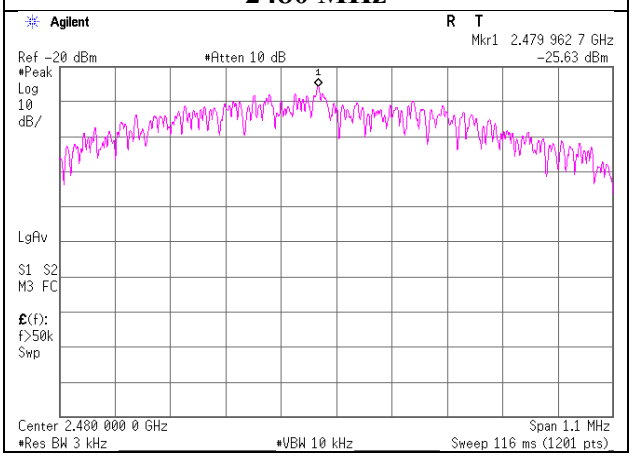
2402 MHz



2440 MHz



2480 MHz



APPENDIX 2: Test instruments

Test Instruments

Test item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
RE	141902	Spectrum Analyzer	AGILENT	E4440A	MY46187105	10/4/2018	10/31/2019	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141417	Microwave Cable	Junkosha	MWX221	1404S374(1m) / 1405S074(5m)	5/7/2018	5/31/2019	12
RE	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	9/19/2018	9/30/2019	12
RE	141580	MicroWave System Amplifier	AGILENT	83017A	MY39500779	3/13/2018	3/31/2019	12
RE	141513	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170306	6/7/2018	6/30/2019	12
RE	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	8/6/2018	8/31/2019	12
RE	141424	Biconical Antenna	Schwarzbeck	BBA9106	1915	6/4/2018	6/30/2019	12
RE	141266	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-191	6/4/2018	6/30/2019	12
RE	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	2/27/2018	2/28/2019	12
RE	141323	Coaxial cable	UL Japan	-	-	7/3/2018	7/31/2019	12
RE	148897	Attenuator	KEYSIGHT	8491A	MY52462349	12/20/2018	12/31/2019	12
RE	141532	DIGITAL HiTESTER	HIOKI	3805	51201197	1/9/2018	1/31/2019	12
RE	142227	Measure	KOMELON	KMC-36	-	-	-	-
RE	141554	Thermo-Hygrometer	CUSTOM	CTH-180	1301	1/24/2018	1/31/2019	12
RE	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	6/26/2018	6/30/2020	24
RE	142013	AC3_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	4/6/2018	4/30/2019	12
RE	141507	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	258	6/7/2018	6/30/2019	12
AT	141223	Attenuator	Weinschel Associates	WA56-10	56100306	5/29/2018	5/31/2019	12
AT	141156	Attenuator(10dB)	Weinschel Corp	2	BL1173	11/2/2018	11/30/2019	12
AT	141830	Power sensor	ANRITSU	MA2411B	738285	5/21/2018	5/31/2019	12
AT	141809	Power Meter	ANRITSU	ML2495A	825002	5/21/2018	5/31/2019	12
AT	141884	Spectrum Analyzer	AGILENT	E4448A	MY44020357	11/2/2018	11/30/2019	12
AT	141572	Thermo-Hygrometer	CUSTOM	CTH-201	3401	1/24/2018	1/31/2019	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