



RADIO TEST REPORT

Test Report No. : 11384033H

Applicant : Phoenix Engineering Corp.
Type of Equipment : Bluetooth Low Energy Module
Model No. : PX-BML
FCC ID : 2AJCWPXPML1
Test regulation : FCC Part 15 Subpart C: 2016
Test Result : Complied

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
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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)

Date of test: July 27 and 28, 2016

Representative test engineer:

Yuta Moriya

Engineer

Consumer Technology Division

Approved by:

Takayuki Shimada

Engineer

Consumer Technology Division



NVLAP LAB CODE: 200572-0

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13-EM-F0429

REVISION HISTORY

Original Test Report No.: 11384033H

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SECTION 1: Customer information

Company Name	:	Phoenix Engineering Corp.
Address	:	466-3 Fujikubo Miyoshi-machi, Iruma-gun, Saitama-ken 354-0041 Japan
Telephone Number	:	+81-49-258-1771
Facsimile Number	:	+81-49-258-2370
Contact Person	:	Yoshitaka Okubo

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

2.1 Identification of E.U.T.

Type of Equipment	:	Bluetooth Low Energy Module
Model No.	:	PX-BML
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 3.0 V (DC 1.9 to 3.3 V)
Receipt Date of Sample	:	July 26, 2016
Country of Mass-production	:	Japan
Condition of EUT	:	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT	:	No Modification by the test lab

2.2 Product Description

Model: PX-BML (referred to as the EUT in this report) is a Bluetooth Low Energy Module.

Radio Specification

Bluetooth Low Energy

Radio Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480 MHz
Modulation	:	GFSK
Power Supply (radio part input)	:	DC 1.35 V
Antenna type	:	Pattern Antenna
Antenna Gain	:	0.1 dBi
Clock frequency	:	32.768 kHz, 16.000 MHz

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC part 15 final revised on April 6, 2016.

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

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	QP 30.9 dB, 0.15000 MHz, L AV 36.9 dB, 0.50365 MHz, L	Complied	-
6dB Bandwidth	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: -	FCC: Section 15.247(a)(2) IC: RSS-247 5.2(1)	See data.	Complied	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: RSS-Gen 6.12	FCC: Section 15.247(b)(3) IC: RSS-247 5.4(4)		Complied	Conducted
Power Density	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: -	FCC: Section 15.247(e) IC: RSS-247 5.2(2)		Complied	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: RSS-Gen 6.13	FCC: Section 15.247(d) IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	14.8 dB 2483.500 MHz AV, Vertical	Complied	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) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 DTS Meas Guidance v03r05 12.2.7.

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

FCC Part 15.31 (e)

This EUT provides stable voltage (DC 1.35 V) constantly to RF Module regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC Part 15.203/212 Antenna requirement

The antenna is not removable from the EUT. Therefore, the equipment complies with the antenna requirement of Section 15.203.

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3.3 Addition to standard

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

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

3.4 Uncertainty

EMI

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k = 2$.
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Antenna terminal test Uncertainty (+/-)							
Power meter		Conducted emission and Power density			Conducted emission		Channel power
Below 1 GHz	Above 1 GHz	Below 1 GHz	1 GHz - 3 GHz	3 GHz - 18 GHz	18 GHz - 26.5 GHz	26.5 GHz - 40 GHz	
0.9 dB	1.0 dB	1.4 dB	1.7 dB	2.8 dB	2.8 dB	2.9 dB	2.6 dB

Frequency range	Conducted emission using AMN(LISN) (+/-)
0.009 – 0.15MHz	3.5 dB
0.15 – 30MHz	3.0 dB

Test distance	Radiated emission (+/-) 9 kHz - 30 MHz
3m	3.8 dB
10m	3.7 dB

Polarity	Radiated emission (Below 1GHz)			
	(3 m*) (+/-)		(10 m*) (+/-)	
	30 – 200 MHz	200 – 1000MHz	30 – 200 MHz	200 – 1000MHz
Horizontal	5.0 dB	5.3 dB	5.0 dB	5.0 dB
Vertical	4.7 dB	5.9 dB	5.0 dB	5.1 dB

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

*Measurement distance

Conducted Emission test

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

Radiated emission test

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

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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	-	-

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

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

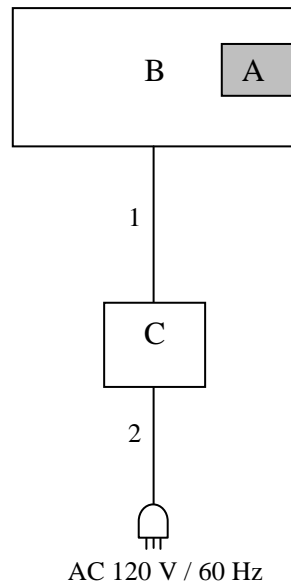
4.1 Operating Mode(s)

Mode	Remarks*
Bluetooth Low Energy (BT LE)	Maximum Packet Size, PRBS9
*Power of the EUT was set by the software as follows; Power settings: 0dBm Software: Remote, Version: V03 *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
Conducted Emission, Spurious Emission (Radiated / Conducted), 6dB Bandwidth, Maximum Peak Output Power, Power Density, 99% Occupied Bandwidth	BT LE Tx	2402 MHz 2440 MHz 2480 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	Bluetooth Low Energy Module	PX-BML	C88ED1D000BB for AT, CE* C88ED1D000BC for RE*	Phoenix Engineering Corp.	EUT
B	Jig board	PML-EVAB-01	001	Phoenix Engineering Corp.	*1)
C	DC Power Supply	PMC35-2A	13090501	KIKUSUI	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	1.1	Unshielded	Unshielded	-
2	AC Cable	2.2	Unshielded	Unshielded	

*AT: Antenna Terminal Conducted test, CE: Conducted Emission test, RE: Radiated Spurious Emission

*1) Jig board does not affect RF characteristics.

SECTION 5: Conducted Emission

Test Procedure and conditions

EUT was placed on a urethane platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane.

The rear of tabletop was located 40 cm to the vertical conducting plane. The rear of EUT, including peripherals aligned and flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. EUT was located 80 cm from a Line Impedance Stabilization Network (LISN) / Artificial mains Network (AMN) and excess AC cable was bundled in center.

For the tests on EUT with other peripherals (as a whole system)

I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane. All unused 50ohm connectors of the LISN (AMN) were resistivity terminated in 50 ohm when not connected to the measuring equipment.

The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Semi Anechoic Chamber.

The EUT was connected to a LISN (AMN).

An overview sweep with peak detection has been performed.

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

Detector	: QP and CISPR AV
Measurement range	: 0.15 MHz – 30 MHz
Test data	: APPENDIX
Test result	: Pass

SECTION 6: Radiated Spurious Emission

Test Procedure

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

[For below 1 GHz]

EUT was placed on a 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	Below 30 MHz	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Loop	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	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	Average Power Method: RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces If duty cycle was less than 98%, a duty factor was added to the results.	RBW: 100 kHz VBW: 300kHz
Test Distance	3 m	3 m *1) (1 GHz – 10 GHz), 1 m *2) (10 GHz – 26.5 GHz)		3 m *1) (1 GHz – 10 GHz), 1 m *2) (10 GHz – 26.5 GHz)

*1) Distance Factor: $20 \times \log (4.5 \text{ m} / 3.0 \text{ m}) = 3.53 \text{ dB}$

*2) Distance Factor: $20 \times \log (1.0 \text{ m} / 3.0 \text{ m}) = -9.5 \text{ dB}$

- 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 M - 26.5 GHz

Test data : APPENDIX

Test result : Pass

SECTION 7: 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	2 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 v03r05".
 *4) In the frequency range below 30MHz, RBW was narrowed to separate the noise contents.
 Then, wide-band noise near the limit was checked separately, however the noise was not detected as shown in the chart.
 (9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 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

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

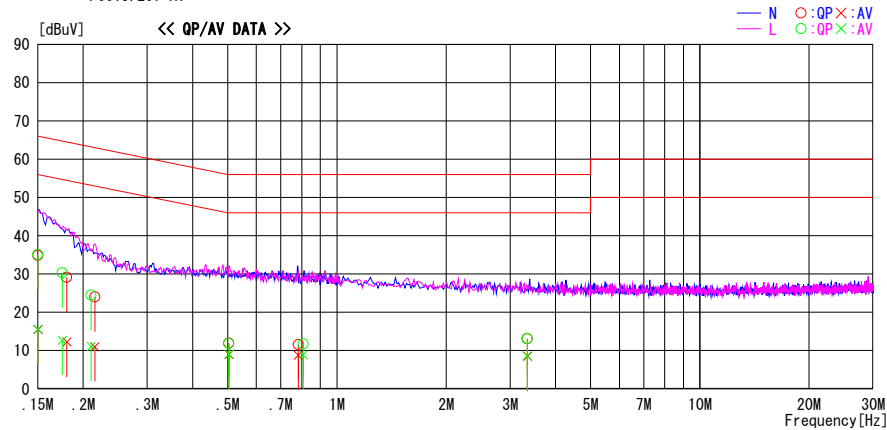
UL Japan, Inc. Ise EMC Lab. No.3 Semi Anechoic Chamber
Date : 2016/07/27

Report No. : 11384033H

Temp./Humi. : 23deg. C / 54% RH
Engineer : Keisuke Kawamura

Mode / Remarks : BT LE Tx 2480

LIMIT : FCC15.207 QP
FCC15.207 AV

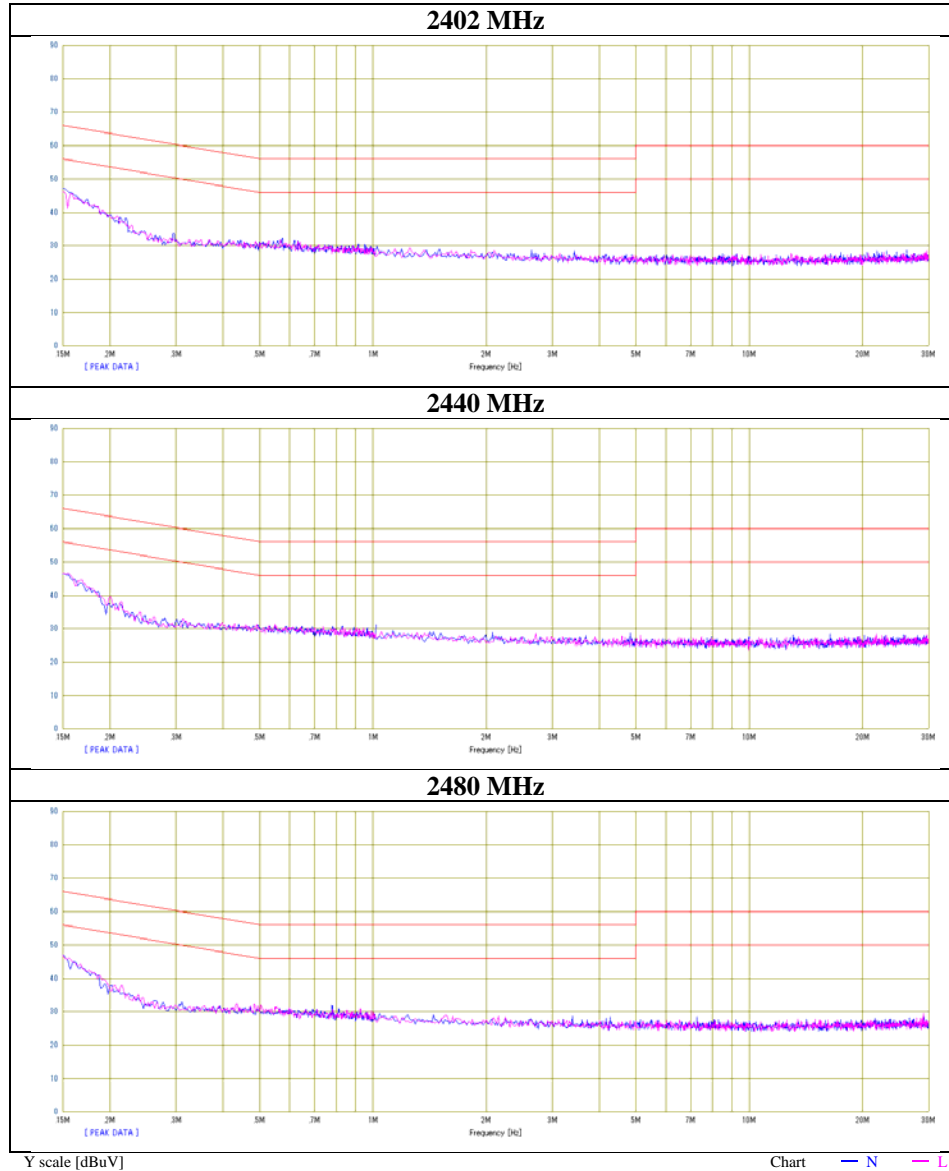


Frequency [MHz]	Reading Level		Corr. Factor	Results		Limit		Margin		Phase	Comment
	QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dB]	AV [dB]		
0.15000	21.6	2.3	13.2	34.8	15.5	66.0	56.0	31.2	40.5	N	
0.18012	15.9	-1.0	13.2	29.1	12.2	64.5	54.5	35.4	42.3	N	
0.21525	10.8	-2.2	13.2	24.0	11.0	63.0	53.0	39.0	42.0	N	
0.50389	-1.4	-4.3	13.3	11.9	9.0	56.0	46.0	44.1	37.0	N	
0.78243	-1.7	-4.5	13.3	11.6	8.8	56.0	46.0	44.4	37.2	N	
3.34628	-0.5	-5.1	13.6	13.1	8.5	56.0	46.0	42.9	37.5	N	
0.15000	21.9	2.4	13.2	35.1	15.6	66.0	56.0	30.9	40.4	L	
0.17514	17.1	-0.5	13.2	30.3	12.7	64.7	54.7	34.4	42.0	L	
0.21036	11.3	-2.1	13.2	24.5	11.1	63.2	53.2	38.7	42.1	L	
0.50365	-1.5	-4.2	13.3	11.8	9.1	56.0	46.0	44.2	36.9	L	
0.80720	-1.6	-4.4	13.3	11.7	8.9	56.0	46.0	44.3	37.1	L	
3.34141	-0.5	-5.0	13.6	13.1	8.6	56.0	46.0	42.9	37.4	L	

CHART : WITH FACTOR, Peak hold data. CALCULATION : RESULT = READING + C.F (LISN + ATTEN. + CABLE)
Except for the above table : adequate margin data below the limits.

Conducted Emission

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11384033H
Date	July 27, 2016
Temperature / Humidity	23 deg. C / 54 % RH
Engineer	Keisuke Kawamura
Mode	Tx BT LE



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6dB Bandwidth

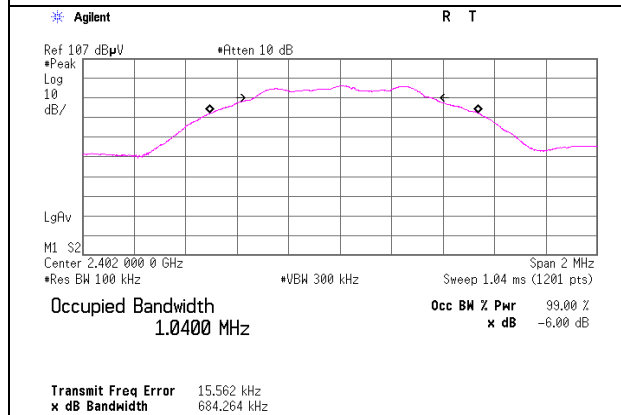
Test place Ise EMC Lab. No.11 Measurement Room
Report No. 11384033H
Date July 28, 2016
Temperature / Humidity 25 deg. C / 39 % RH
Engineer Yuta Moriya
Mode Tx BT LE

Mode	Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
BTLE	2402	0.684	> 500
	2440	0.681	> 500
	2480	0.689	> 500

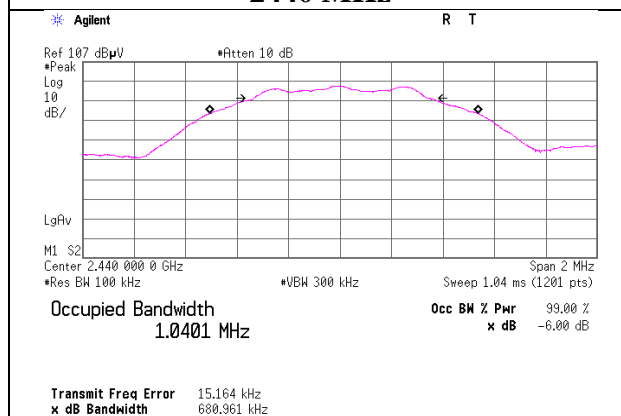
6dB Bandwidth

BT LE

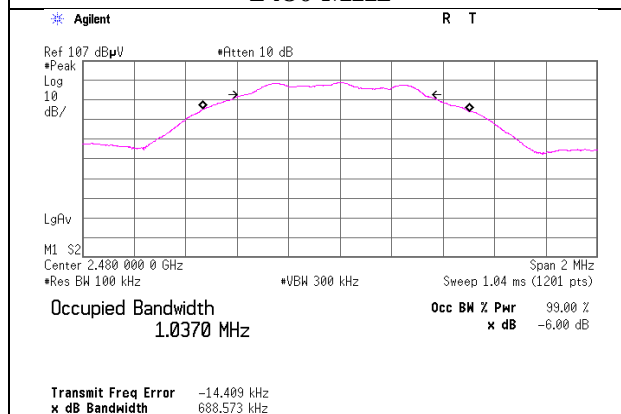
2402 MHz



2440 MHz



2480 MHz



Maximum Peak Output Power

Test place Ise EMC Lab. No.11 Measurement Room
Report No. 11384033H
Date July 28, 2016
Temperature / Humidity 25 deg. C / 39 % RH
Engineer Yuta Moriya
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]	
2402	-13.44	1.01	10.09	-2.34	0.58	30.00	1000	32.34
2440	-12.17	1.02	10.09	-1.06	0.78	30.00	1000	31.06
2480	-10.90	1.02	10.09	0.21	1.05	30.00	1000	29.79

Sample Calculation:

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

Average Output Power
(Reference data for RF Exposure)

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11384033H
Date	July 28, 2016
Temperature / Humidity	25 deg. C / 39 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
				[dBm]	[mW]		[dBm]	[mW]
2402	-16.42	1.01	10.09	-5.32	0.29	1.81	-3.51	0.45
2440	-15.04	1.02	10.09	-3.93	0.40	1.81	-2.12	0.61
2480	-13.69	1.02	10.09	-2.58	0.55	1.81	-0.77	0.84

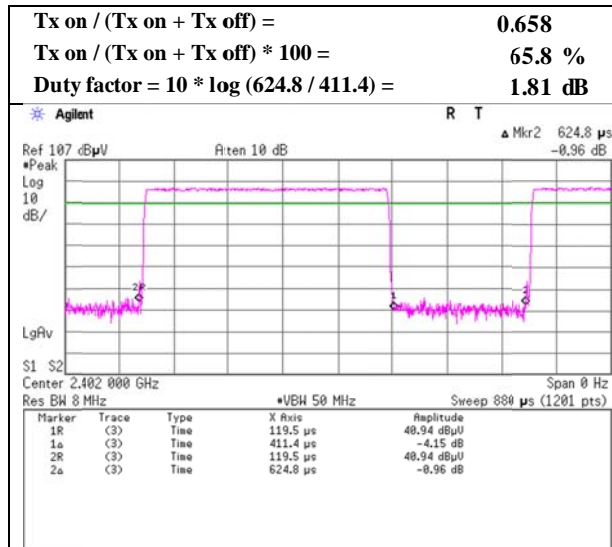
Sample Calculation:

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

Result (Burst power average) = Time average + Duty factor

Burst rate confirmation

Test place : Ise EMC Lab. No.11 Measurement Room
Report No. : 11384033H
Date : July 28, 2016
Temperature / Humidity : 25 deg. C / 39 % RH
Engineer : Yuta Moriya
Mode : Tx BT LE



Radiated Spurious Emission

Test place : Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No. : 11384033H
Date : July 27, 2016 July 27, 2016
Temperature / Humidity : 23 deg. C / 54 % RH 23 deg. C / 59 % RH
Engineer : Keisuke Kawamura Takafumi Noguchi
(Below 1GHz) (Above 1GHz)
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	40.000	QP	23.1	14.0	7.2	32.2	-	12.1	40.0	27.9	
Hori	80.000	QP	22.6	6.3	7.8	32.2	-	4.5	40.0	35.5	
Hori	170.000	QP	22.1	15.8	8.8	32.1	-	14.6	43.5	28.9	
Hori	300.000	QP	22.2	13.5	9.8	31.9	-	13.6	46.0	32.4	
Hori	610.000	QP	22.0	19.2	11.9	32.1	-	21.0	46.0	25.0	
Hori	960.000	QP	21.2	22.3	13.7	30.6	-	26.6	46.0	19.4	
Hori	2390.000	PK	42.8	26.7	6.8	32.7	-	43.6	73.9	30.3	
Hori	4804.000	PK	39.6	31.0	8.1	31.8	-	46.9	73.9	27.0	Floor noise
Hori	7206.000	PK	40.3	35.7	8.9	32.6	-	52.3	73.9	21.6	Floor noise
Hori	9608.000	PK	41.6	37.2	9.6	33.2	-	55.2	73.9	18.7	Floor noise
Hori	2390.000	AV	33.4	26.7	6.8	32.7	1.8	36.0	53.9	17.9	*1)
Hori	4804.000	AV	30.9	31.0	8.1	31.8	-	38.2	53.9	15.7	Floor noise
Hori	7206.000	AV	32.3	35.7	8.9	32.6	-	44.3	53.9	9.6	Floor noise
Hori	9608.000	AV	33.3	37.2	9.6	33.2	-	46.9	53.9	7.0	Floor noise
Vert	41.254	QP	24.4	13.5	7.2	32.2	-	12.9	40.0	27.1	
Vert	80.000	QP	22.9	6.3	7.8	32.2	-	4.8	40.0	35.2	
Vert	170.000	QP	22.1	15.8	8.8	32.1	-	14.6	43.5	28.9	
Vert	300.000	QP	22.2	13.5	9.8	31.9	-	13.6	46.0	32.4	
Vert	610.000	QP	22.0	19.2	11.9	32.1	-	21.0	46.0	25.0	
Vert	960.000	QP	21.3	22.3	13.7	30.6	-	26.7	46.0	19.3	
Vert	2390.000	PK	43.2	26.7	6.8	32.7	-	44.0	73.9	29.9	
Vert	4804.000	PK	39.5	31.0	8.1	31.8	-	46.8	73.9	27.1	Floor noise
Vert	7206.000	PK	40.2	35.7	8.9	32.6	-	52.2	73.9	21.7	Floor noise
Vert	9608.000	PK	41.5	37.2	9.6	33.2	-	55.1	73.9	18.8	Floor noise
Vert	2390.000	AV	33.8	26.7	6.8	32.7	1.8	36.4	53.9	17.5	*1)
Vert	4804.000	AV	30.8	31.0	8.1	31.8	-	38.1	53.9	15.8	Floor noise
Vert	7206.000	AV	32.3	35.7	8.9	32.6	-	44.3	53.9	9.6	Floor noise
Vert	9608.000	AV	33.2	37.2	9.6	33.2	-	46.8	53.9	7.1	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 (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	88.0	26.7	6.8	32.7	88.8	-	-	Carrier
Hori	2400.000	PK	38.4	26.7	6.8	32.7	39.2	68.8	29.6	
Vert	2402.000	PK	87.9	26.7	6.8	32.7	88.7	-	-	Carrier
Vert	2400.000	PK	37.1	26.7	6.8	32.7	37.9	68.7	30.8	

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

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Ise EMC Lab.

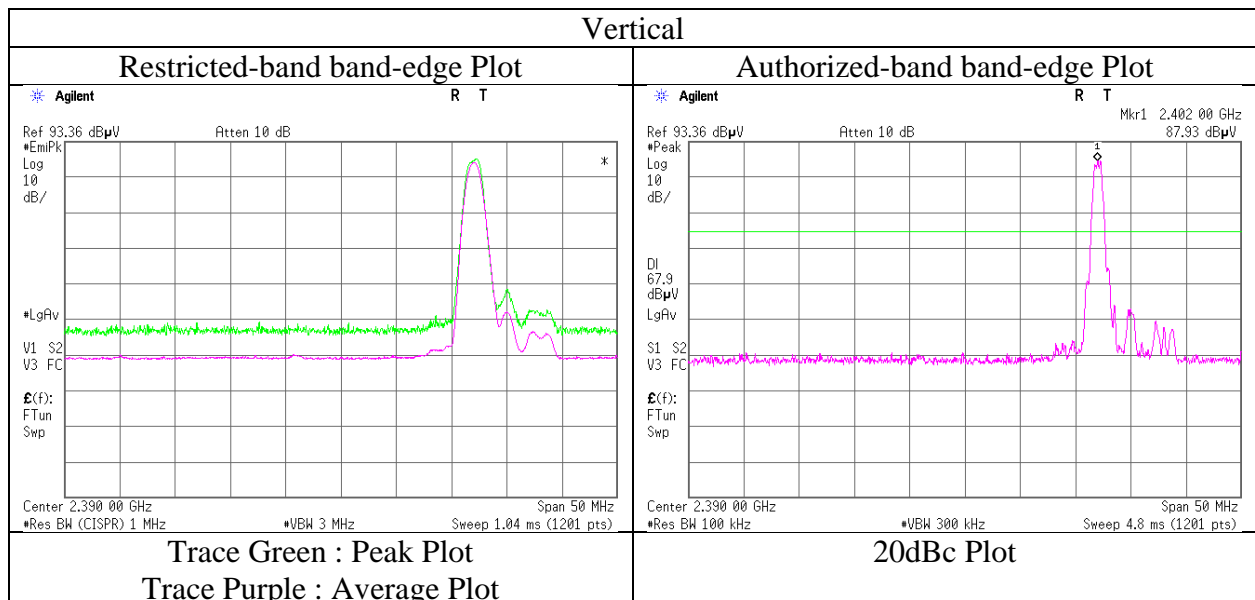
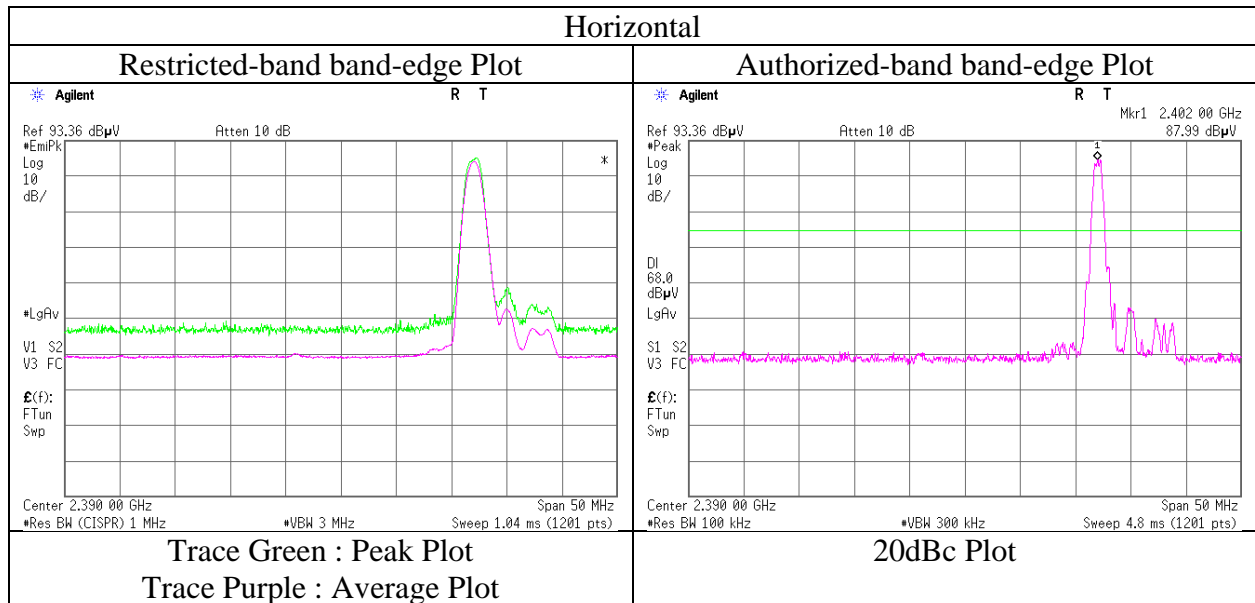
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Facsimile : +81 596 24 8124

Radiated Spurious Emission (Reference Plot for band-edge)

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11384033H
Date	July 27, 2016
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Takafumi Noguchi (Above 1GHz)
Mode	Tx BT LE 2402 MHz



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

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Ise EMC Lab.

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Radiated Spurious Emission

Test place : Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No. : 11384033H
Date : July 27, 2016 July 27, 2016
Temperature / Humidity : 23 deg. C / 54 % RH 23 deg. C / 59 % RH
Engineer : Keisuke Kawamura Takafumi Noguchi
(Below 1GHz) (Above 1GHz)
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	40.000	QP	23.2	14.0	7.2	32.2	-	12.2	40.0	27.8	
Hori	80.000	QP	22.6	6.3	7.8	32.2	-	4.5	40.0	35.5	
Hori	170.000	QP	22.0	15.8	8.8	32.1	-	14.5	43.5	29.0	
Hori	300.000	QP	22.3	13.5	9.8	31.9	-	13.7	46.0	32.3	
Hori	610.000	QP	22.0	19.2	11.9	32.1	-	21.0	46.0	25.0	
Hori	960.000	QP	21.2	22.3	13.7	30.6	-	26.6	46.0	19.4	
Hori	4880.000	PK	39.7	31.3	8.1	31.7	-	47.4	73.9	26.5	Floor noise
Hori	7320.000	PK	40.2	35.6	8.9	32.6	-	52.1	73.9	21.8	Floor noise
Hori	9760.000	PK	41.2	37.2	9.6	33.3	-	54.7	73.9	19.2	Floor noise
Hori	4880.000	AV	30.7	31.3	8.1	31.7	-	38.4	53.9	15.5	Floor noise
Hori	7320.000	AV	32.0	35.6	8.9	32.6	-	43.9	53.9	10.0	Floor noise
Hori	9760.000	AV	31.9	37.2	9.6	33.3	-	45.4	53.9	8.5	Floor noise
Vert	41.269	QP	24.4	13.4	7.2	32.2	-	12.8	40.0	27.2	
Vert	80.000	QP	22.7	6.3	7.8	32.2	-	4.6	40.0	35.4	
Vert	170.000	QP	22.1	15.8	8.8	32.1	-	14.6	43.5	28.9	
Vert	300.000	QP	22.2	13.5	9.8	31.9	-	13.6	46.0	32.4	
Vert	610.000	QP	22.0	19.2	11.9	32.1	-	21.0	46.0	25.0	
Vert	960.000	QP	21.2	22.3	13.7	30.6	-	26.6	46.0	19.4	
Vert	4880.000	PK	39.5	31.3	8.1	31.7	-	47.2	73.9	26.7	Floor noise
Vert	7320.000	PK	40.2	35.6	8.9	32.6	-	52.1	73.9	21.8	Floor noise
Vert	9760.000	PK	40.9	37.2	9.6	33.3	-	54.4	73.9	19.5	Floor noise
Vert	4880.000	AV	30.9	31.3	8.1	31.7	-	38.6	53.9	15.3	Floor noise
Vert	7320.000	AV	31.8	35.6	8.9	32.6	-	43.7	53.9	10.2	Floor noise
Vert	9760.000	AV	31.6	37.2	9.6	33.3	-	45.1	53.9	8.8	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. : 11384033H
Date : July 27, 2016 July 27, 2016
Temperature / Humidity : 23 deg. C / 54 % RH 23 deg. C / 59 % RH
Engineer : Keisuke Kawamura Takafumi Noguchi
(Below 1GHz) (Above 1GHz)
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	40.000	QP	23.1	14.0	7.2	32.2	-	12.1	40.0	27.9	
Hori	80.000	QP	22.7	6.3	7.8	32.2	-	4.6	40.0	35.4	
Hori	170.000	QP	22.1	15.8	8.8	32.1	-	14.6	43.5	28.9	
Hori	300.000	QP	22.2	13.5	9.8	31.9	-	13.6	46.0	32.4	
Hori	610.000	QP	22.0	19.2	11.9	32.1	-	21.0	46.0	25.0	
Hori	960.000	QP	21.3	22.3	13.7	30.6	-	26.7	46.0	19.3	
Hori	2483.500	PK	45.3	26.8	6.9	32.6	-	46.4	73.9	27.5	
Hori	4960.000	PK	39.4	31.5	8.1	31.7	-	47.3	73.9	26.6	Floor noise
Hori	7440.000	PK	40.1	35.5	9.0	32.7	-	51.9	73.9	22.0	Floor noise
Hori	9920.000	PK	40.3	37.2	9.7	33.4	-	53.8	73.9	20.1	Floor noise
Hori	2483.500	AV	35.8	26.8	6.9	32.6	1.8	38.7	53.9	15.2	*1)
Hori	4960.000	AV	30.5	31.5	8.1	31.7	-	38.4	53.9	15.5	Floor noise
Hori	7440.000	AV	31.8	35.5	9.0	32.7	-	43.6	53.9	10.3	Floor noise
Hori	9920.000	AV	31.9	37.2	9.7	33.4	-	45.4	53.9	8.5	Floor noise
Vert	41.262	QP	24.5	13.4	7.2	32.2	-	12.9	40.0	27.1	
Vert	80.000	QP	22.9	6.3	7.8	32.2	-	4.8	40.0	35.2	
Vert	170.000	QP	22.1	15.8	8.8	32.1	-	14.6	43.5	28.9	
Vert	300.000	QP	22.1	13.5	9.8	31.9	-	13.5	46.0	32.5	
Vert	610.000	QP	22.0	19.2	11.9	32.1	-	21.0	46.0	25.0	
Vert	960.000	QP	21.2	22.3	13.7	30.6	-	26.6	46.0	19.4	
Vert	2483.500	PK	45.7	26.8	6.9	32.6	-	46.8	73.9	27.1	
Vert	4960.000	PK	39.3	31.5	8.1	31.7	-	47.2	73.9	26.7	Floor noise
Vert	7440.000	PK	40.4	35.5	9.0	32.7	-	52.2	73.9	21.7	Floor noise
Vert	9920.000	PK	40.4	37.2	9.7	33.4	-	53.9	73.9	20.0	Floor noise
Vert	2483.500	AV	36.2	26.8	6.9	32.6	1.8	39.1	53.9	14.8	*1)
Vert	4960.000	AV	30.5	31.5	8.1	31.7	-	38.4	53.9	15.5	Floor noise
Vert	7440.000	AV	31.7	35.5	9.0	32.7	-	43.5	53.9	10.4	Floor noise
Vert	9920.000	AV	31.7	37.2	9.7	33.4	-	45.2	53.9	8.7	Floor noise

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

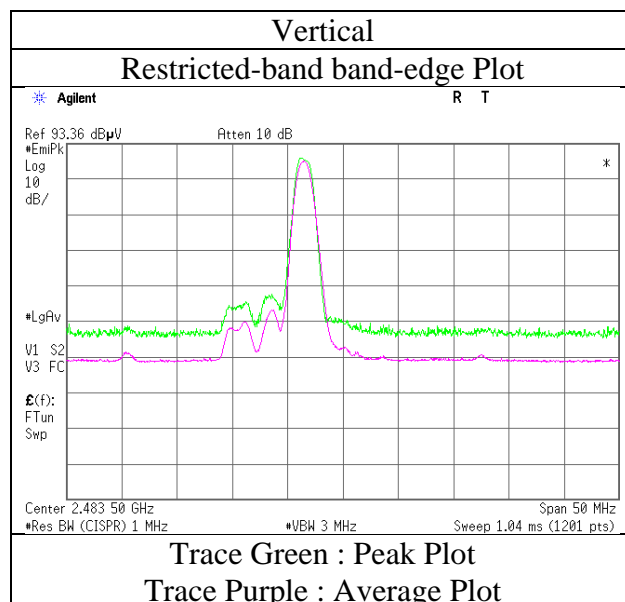
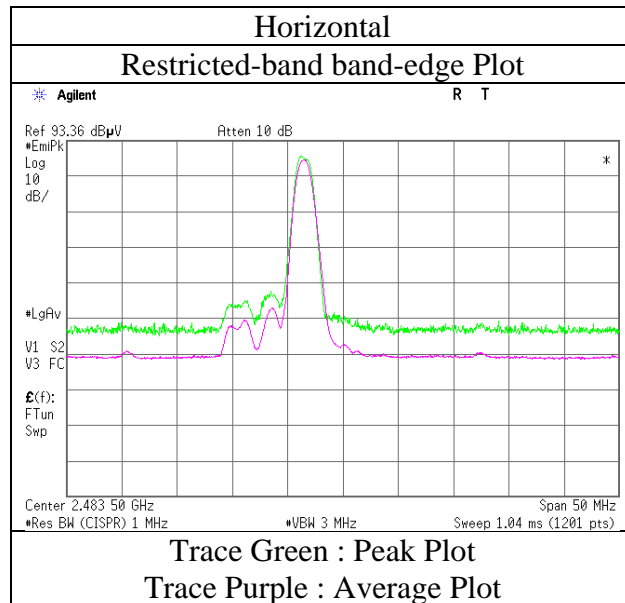
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz $20\log(4.5\text{ m} / 3.0\text{ m}) = 3.53\text{ dB}$
10 GHz - 26.5 GHz $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

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

Radiated Spurious Emission (Reference Plot for band-edge)

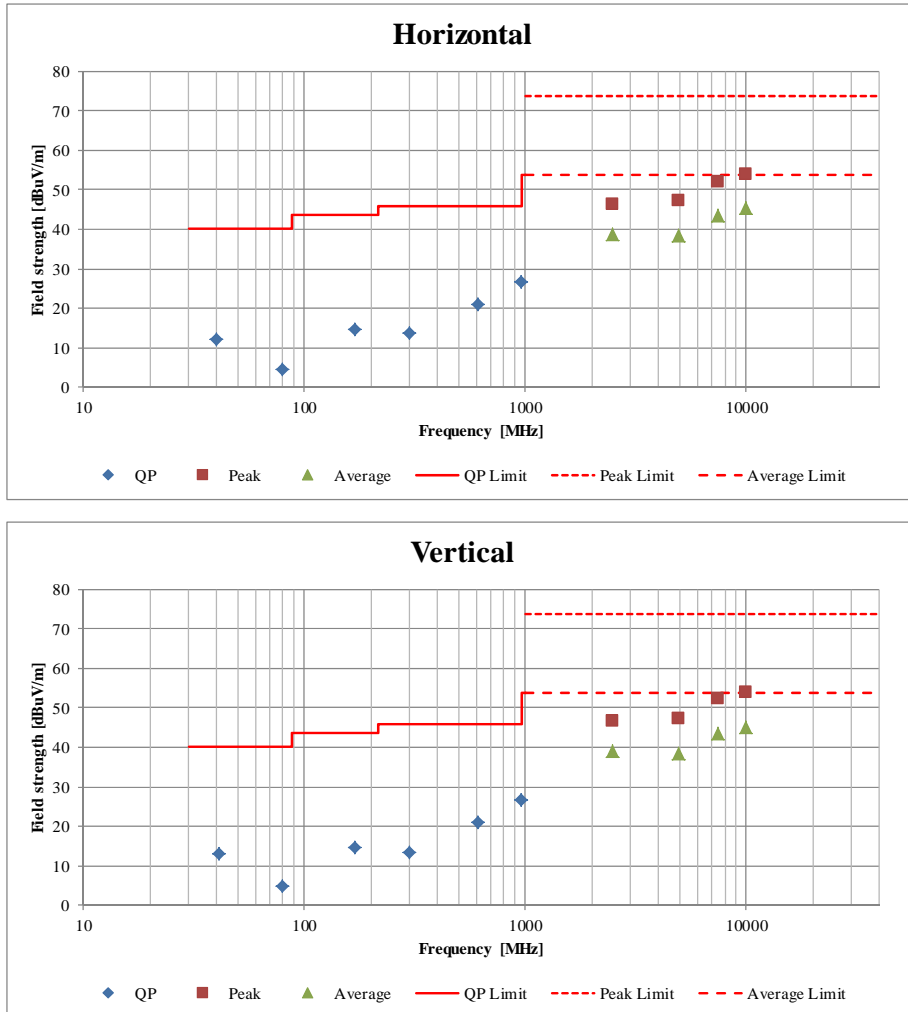
Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11384033H
Date	July 27, 2016
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Takafumi Noguchi (Above 1GHz)
Mode	Tx BT LE 2480 MHz



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

Radiated Spurious Emission **(Plot data, Worst case)**

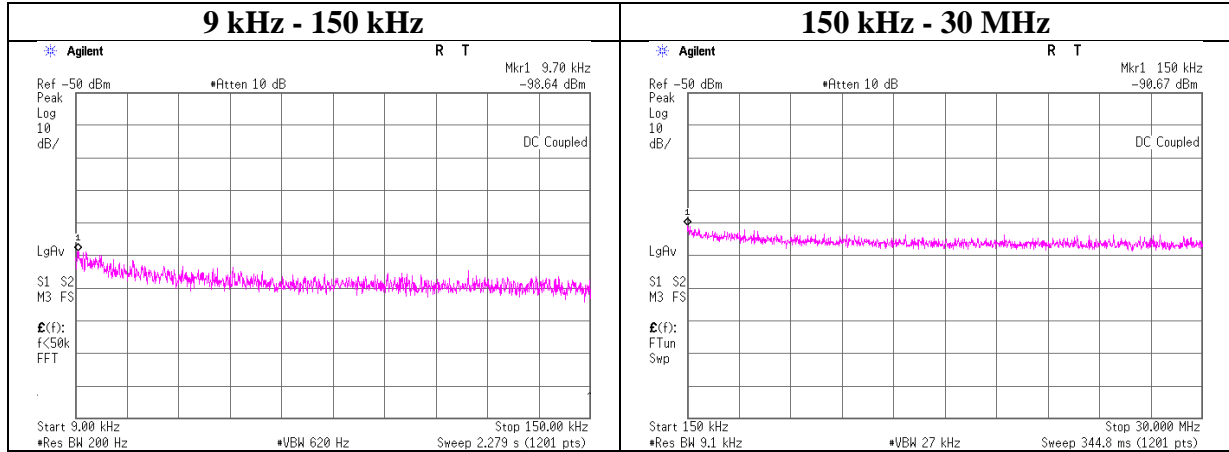
Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber	
Report No.	11384033H	
Date	July 27, 2016	July 27, 2016
Temperature / Humidity	23 deg. C / 54 % RH	23 deg. C / 59 % RH
Engineer	Keisuke Kawamura (Below 1GHz)	Takafumi Noguchi (Above 1GHz)
Mode	Tx BT LE 2480 MHz	



*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.	11384033H
Date	July 28, 2016
Temperature / Humidity	25 deg. C / 39 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE 2402 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
9.70	-98.6	0.01	9.8	2.0	1	-86.8	300	6.0	-25.6	47.8	73.4	
150.00	-90.7	0.01	9.8	2.0	1	-78.8	300	6.0	-17.6	24.0	41.6	

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

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

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Ise EMC Lab.

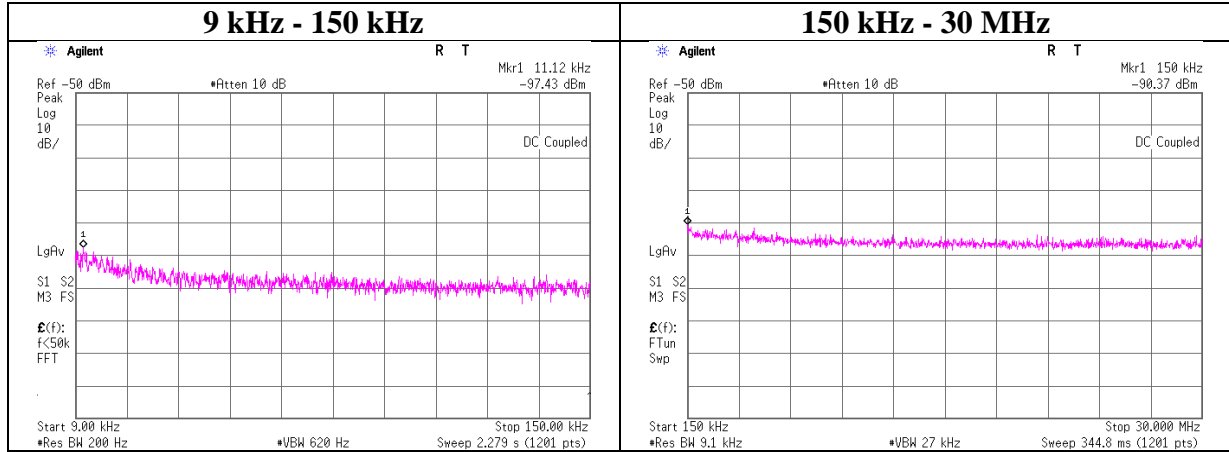
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Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11384033H
Date	July 28, 2016
Temperature / Humidity	25 deg. C / 39 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE 2440 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
11.12	-97.4	0.01	9.8	2.0	1	-85.6	300	6.0	-24.3	46.6	70.9	
150.00	-90.4	0.01	9.8	2.0	1	-78.5	300	6.0	-17.3	24.0	41.3	

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

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

UL Japan, Inc.

Ise EMC Lab.

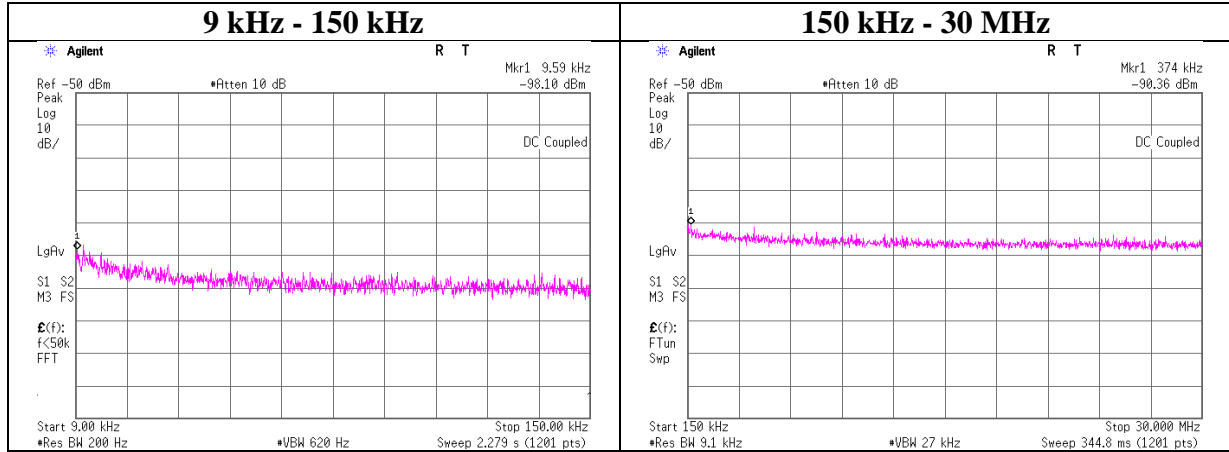
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Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11384033H
Date	July 28, 2016
Temperature / Humidity	25 deg. C / 39 % RH
Engineer	Yuta Moriya
Mode	Tx BT LE 2480 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
9.59	-98.1	0.01	9.8	2.0	1	-86.3	300	6.0	-25.0	47.9	72.9	
374.00	-90.4	0.01	9.9	2.0	1	-78.5	300	6.0	-17.2	16.1	33.3	

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

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

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Power Density

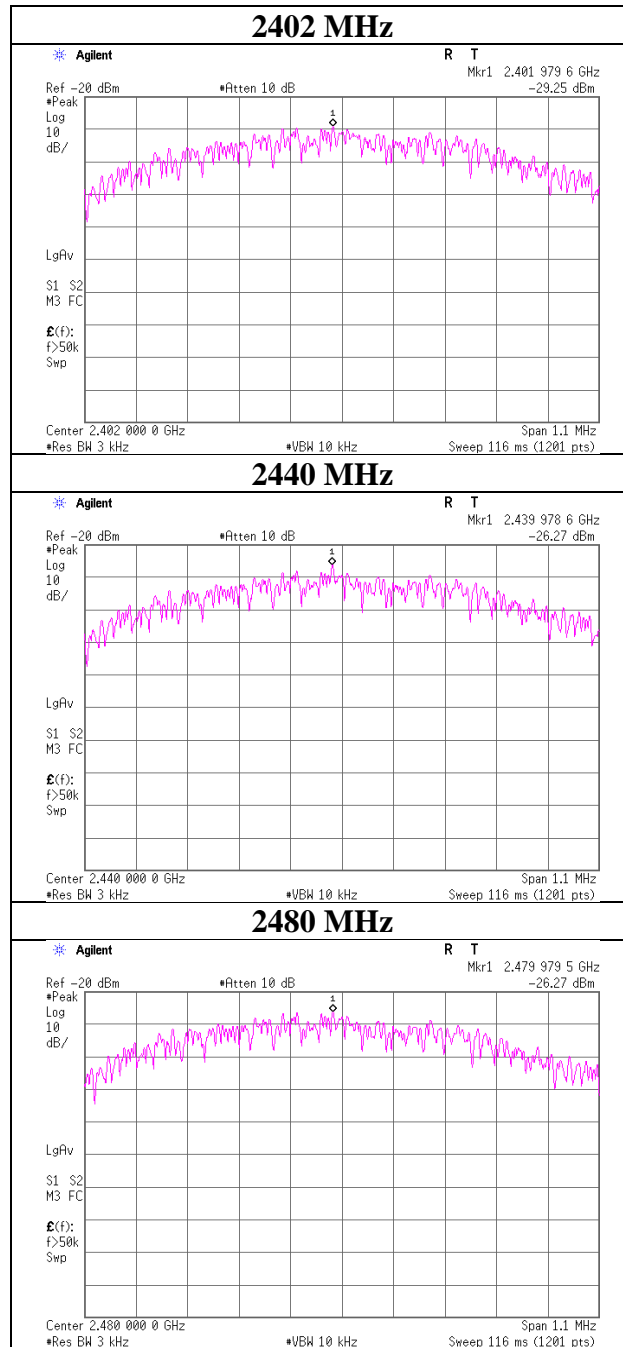
Test place Ise EMC Lab. No.11 Measurement Room
Report No. 11384033H
Date July 28, 2016
Temperature / Humidity 25 deg. C / 39 % RH
Engineer Yuta Moriya
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-29.25	1.01	10.09	-18.15	8.00	26.15
2440.00	-26.27	1.02	10.09	-15.16	8.00	23.16
2480.00	-26.27	1.02	10.09	-15.16	8.00	23.16

Sample Calculation:

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

Power Density



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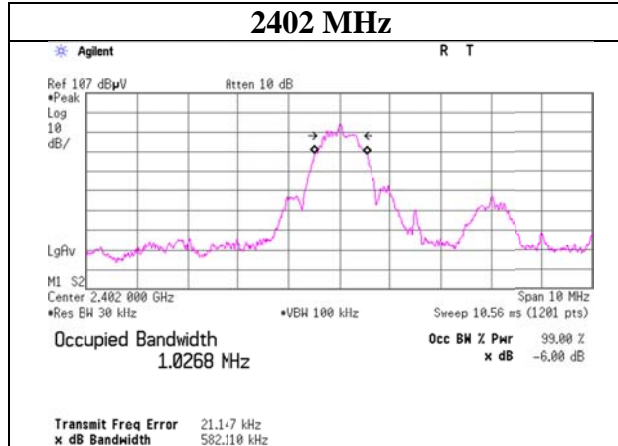
Facsimile : +81 596 24 8124

99%Occupied Bandwidth

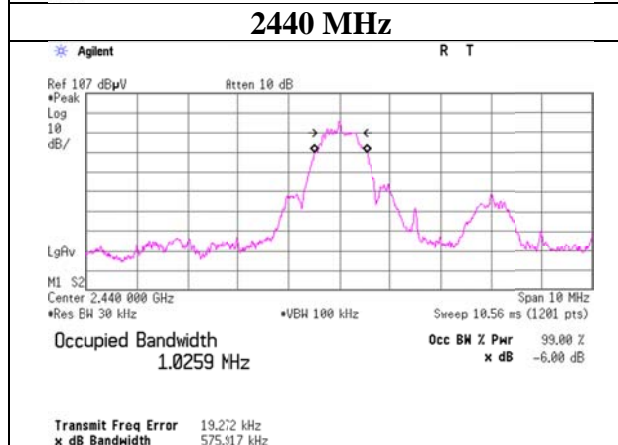
Test place Ise EMC Lab. No.11 Measurement Room
Report No. 11384033H
Date July 28, 2016
Temperature / Humidity 25 deg. C / 39 % RH
Engineer Yuta Moriya
Mode Tx BT LE

BT LE

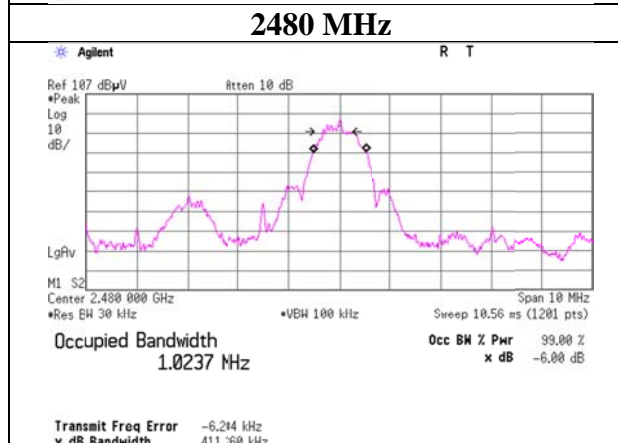
2402 MHz



2440 MHz



2480 MHz



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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	CE,RE	2015/10/01 * 12
MOS-13	Thermo-Hygrometer	Custom	CTH-180	1301	CE,RE	2016/01/21 * 12
MJM-16	Measure	KOMELON	KMC-36	-	CE,RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	CE,RE	-
MSA-03	Spectrum Analyzer	Agilent	E4448A	MY44020357	CE,RE	2016/05/19 * 12
MTR-08	Test Receiver	Rohde & Schwarz	ESCI	100767	CE,RE	2015/09/02 * 12
MLS-23	LISN(AMN)	Schwarzbeck	NSLK8127	8127-729	CE	2016/07/07 * 12
MCC-112	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W(10m)/SFM141(3m)/sucoform141-PE(1m)/421-010(1.5m)/RFM-E321(Switcher)	-/00640	CE	2016/07/26 * 12
MAT-66	Attenuator(13dB)	JFW Industries, Inc.	50FP-013H2 N	-	CE	2016/01/14 * 12
MMM-08	DIGITAL HiTESTER	Hioki	3805	051201197	CE,RE	2016/01/13 * 12
MBA-03	Biconical Antenna	Schwarzbeck	BBA9106	1915	RE	2015/10/11 * 12
MLA-22	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-191	RE	2016/01/30 * 12
MCC-51	Coaxial cable	UL Japan	-	-	RE	2016/07/26 * 12
MAT-70	Attenuator(6dB)	Agilent	8491A-006	MY52460153	RE	2016/04/05 * 12
MPA-13	Pre Amplifier	SONOMA INSTRUMENT	310	260834	RE	2016/03/24 * 12
MRENT-130	Spectrum Analyzer	Agilent	E4440A	MY46187750	AT	2016/06/03 * 12
MPM-08	Power Meter	Anritsu	ML2495A	6K00003338	AT	2015/10/08 * 12
MPSE-11	Power sensor	Anritsu	MA2411B	011737	AT	2015/10/08 * 12
MAT-23	Attenuator(10dB) 1-18GHz	Orient Microwave	BX10-0476-00	-	AT	2016/03/18 * 12
MCC-173	Microwave Cable	Junkosha	MWX221	1409S496	AT	2016/03/11 * 12
MAT-10	Attenuator(10dB)	Weinschel Corp	2	BL1173	AT	2015/11/10 * 12
MCC-64	Coaxial Cable	UL Japan	-	-	AT	2016/03/10 * 12
MOS-19	Thermo-Hygrometer	Custom	CTH-201	0001	AT	2015/12/08 * 12
MMM-17	DIGITAL HiTESTER	Hioki	3805	070900530	AT	2016/01/13 * 12
MHA-20	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	258	RE	2016/05/29 * 12
MCC-167	Microwave Cable	Junkosha	MWX221	1404S374(1m) / 1405S074(5m)	RE	2016/05/20 * 12
MPA-11	MicroWave System Amplifier	Agilent	83017A	MY39500779	RE	2016/03/24 * 12
MHA-16	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170306	RE	2016/05/29 * 12
MHF-25	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	RE	2015/09/16 * 12
MHF-06	High Pass Filter 3.5-24GHz	TOKIMEC	TF323DCA	601	RE	2016/05/16 * 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: CE: Conducted Emission test
RE: Radiated Emission test
AT: Antenna Terminal Conducted test

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