



# RADIO TEST REPORT

Test Report No. : 11724216S-A-R1

**Applicant** : SEIKO EPSON CORPORATION  
**Type of Equipment** : Expanded sensor  
**Model No.** : MB00  
**FCC ID** : BKMAP013  
**Test regulation** : FCC Part 15 Subpart C: 2016  
**Test Result** : Complied

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. This report is a revised version of 11724216S-A. 11724216S-A is replaced with this report.

**Date of test:** May 9 to 12, 2017

**Representative test engineer:**

Hikaru Shirasawa  
Engineer  
Consumer Technology Division

**Approved by:**

Shinichi Takano  
Engineer  
Consumer Technology Division



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

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13-EM-F0429



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## **SECTION 1: Customer information**

Company Name : SEIKO EPSON CORPORATION  
Address : 390, Shiojiri-machi, Shiojiri-shi, Nagano-ken 399-0796 Japan  
Telephone Number : +81 263 54 5863  
Facsimile Number : +81 263 54 5761  
Contact Person : Junya Kondo

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

### **2.1 Identification of E.U.T.**

Type of Equipment : Expanded sensor  
Model No. : MB00  
Serial No. : Refer to Section 4, Clause 4.2  
Rating : DC 3 V  
Receipt Date of Sample : May 8, 2017  
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: MB00 (referred to as the EUT in this report) is a Expanded sensor.

## **Radio Specification**

### **Bluetooth Low Energy**

Radio Type : Transceiver  
Frequency of Operation : 2402 MHz - 2480 MHz  
Modulation : DSSS  
Power Supply (radio part input) : DC 2 V  
Antenna type :  $1/4 \lambda$  monopole Antenna  
Antenna Gain : 0.9 dBi  
Clock frequency (Maximum) : 16 MHz

## **SECTION 3: Test specification, procedures & results**

### **3.1 Test Specification**

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

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

\* 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	N/A	*1)
6dB Bandwidth	FCC: KDB 558074 D01 DTS Meas Guidance v04 IC: -	FCC: Section 15.247(a)(2) IC: RSS-247 5.2(a)	See data.	Complied	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 DTS Meas Guidance v04 IC: RSS-Gen 6.12	FCC: Section 15.247(b)(3) IC: RSS-247 5.4(d)		Complied	Conducted
Power Density	FCC: KDB 558074 D01 DTS Meas Guidance v04 IC: -	FCC: Section 15.247(e) IC: RSS-247 5.2(b)		Complied	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 DTS Meas Guidance v04 IC: RSS-Gen 6.13	FCC: Section15.247(d) IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	8.4 dB 9608.000 MHz, AV, Vert. BLE 2402 MHz	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)

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

\*1) The test is not applicable since the EUT does not have AC power ports.

\*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 2 V) constantly to the wireless transmitter regardless of input voltage.

#### **Radiated Spurious Emission**

The test was performed with the New Battery and the stable voltage was supplied to the EUT during the tests.

Therefore, the EUT complies with the requirement.

#### **Antenna Terminal Conducted Tests**

Instead of a new battery, DC power supply was used for the test. That does not affect the test result, therefore the EUT complies with the requirement.

#### **FCC Part 15.203 Antenna requirement**

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

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### 3.3 Addition to standard

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

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

### 3.4 Uncertainty

#### EMI

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

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

SAC=Semi-Anechoic Chamber

SR= Shielded Room is applied besides radiated emission

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

#### Radiated emission test

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

### 3.5 Test Location

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JAB Accreditation No. RTL02610

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

### 3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

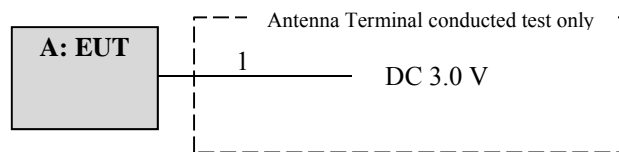
## **SECTION 4: Operation of E.U.T. during testing**

### **4.1 Operating Mode(s)**

\*The details of Operating mode(s)

<b>Mode</b>	<b>Operating Mode</b>	<b>Tested frequency</b>
Spurious Emission	Bluetooth Low Energy	2402 MHz 2440 MHz 2480 MHz
6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth	Bluetooth Low Energy	2402 MHz 2440 MHz 2480 MHz
*Transmitting duty was 100 % on all tests. *The worst condition was determined based on the test result of Maximum Peak Output Power (Mid Channel)		
*Power of the EUT was set by the software as follows; Power settings: Fixed Software: Ver: 0A03.0A10/0067.0A21.0A07 *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**



#### **Description of EUT**

<b>No.</b>	<b>Item</b>	<b>Model number</b>	<b>Serial number</b>	<b>Manufacturer</b>	<b>Remarks</b>
A	Expanded sensor	MB00	029 *1) 081 *2)	Seiko Epson	EUT

\*1) Used for Antenna Terminal conducted test

\*2) Used for Radiated Emission test

#### **List of cables used**

<b>No.</b>	<b>Name</b>	<b>Length (m)</b>	<b>Shield</b>		<b>Remarks</b>
			<b>Cable</b>	<b>Connector</b>	
1	DC	1.5	Unshielded	Unshielded	-

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## **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 v04".

[For below 1 GHz]

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

[For above 1 GHz]

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

The height of the measuring antenna varied between 1 m 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	Average Power Method: <u>12.2.5.2</u> RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (Linear voltage) Trace: 100 traces Duty factor was added to the results.	RBW: 100 kHz VBW: 300 kHz
Test Distance	3 m	3.97 m *2) (1 GHz – 13 GHz), 1 m *3) (13 GHz – 26.5 GHz)		3.97 m *2) (1 GHz – 13 GHz), 1 m *3) (13 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:  $20 \times \log(3.97 \text{ m} / 3.0 \text{ m}) = 2.43 \text{ dB}$

\*3) Distance Factor:  $20 \times \log(1.0 \text{ m} / 3.0 \text{ m}) = -9.54 \text{ dB}$

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

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

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

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

## **SECTION 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	10 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Sample	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/Average *2)	-	Power Meter (Sensor: 50 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *3) *4)
Conducted Spurious Emission *5)	9kHz to 150kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	10 kHz	30 kHz				

\*1) Peak hold was applied as Worst-case measurement.

\*2) Reference data

\*3) Section 10.2 Method PKPSD (peak PSD) of "KDB 558074 D01 DTS Meas Guidance v04".

\*4) The test was not performed at RBW:3 kHz however the measurement is to be performed with RBW:3kHz in the regulation, because, the measurement value with RBW:3 kHz is less than the value of RBW:30 kHz and the test data met the limit with RBW:30 kHz.

\*5) 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**

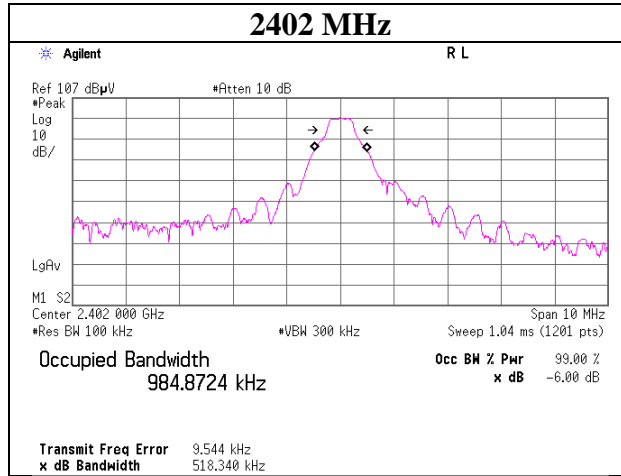
Test place                      Shonan EMC Lab. No.5 Shielded Room  
Report No.                      11724216S-A-R1  
Date                              May 9, 2017  
Temperature / Humidity        26 deg. C / 34 % RH  
Engineer                        Hikaru Shirasawa  
Mode                              Tx BT LE

Mode	Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
BT LE	2402	0.518	> 500
	2440	0.523	> 500
	2480	0.522	> 500

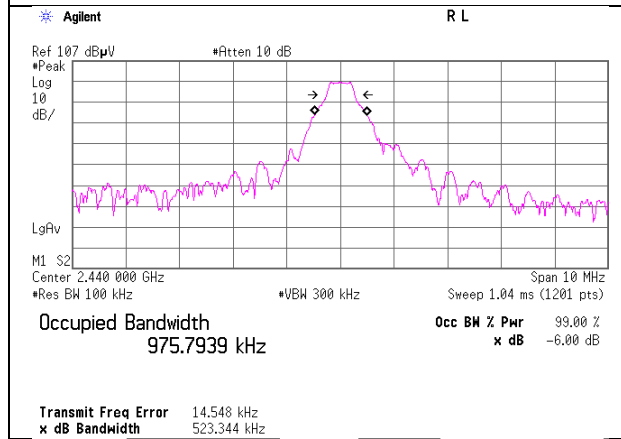
## 6dB Bandwidth

### BT LE

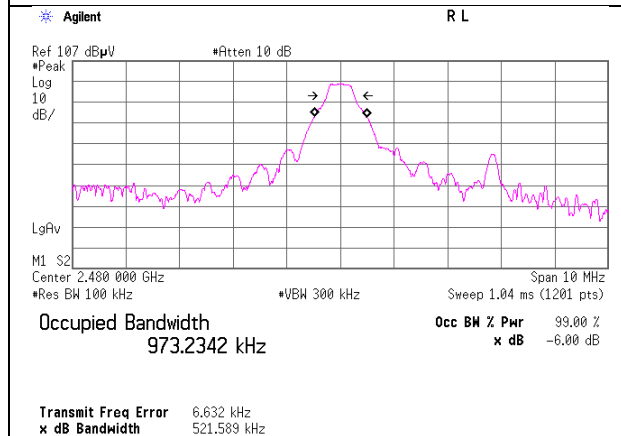
#### 2402 MHz



#### 2440 MHz



#### 2480 MHz



### Maximum Peak Output Power

Test place                      Shonan EMC Lab. No.5 Shielded Room  
Report No.                      11724216S-A-R1  
Date                              May 9, 2017  
Temperature / Humidity      26 deg. C / 34 % RH  
Engineer                        Hikaru Shirasawa  
Mode                              Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]	
2402	-9.49	0.84	9.64	0.99	1.26	30.00	1000	29.01
2440	-10.01	0.84	9.64	0.47	1.11	30.00	1000	29.53
2480	-10.43	0.84	9.65	0.06	1.01	30.00	1000	29.94

Sample Calculation:

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

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

**Average Output Power**  
**(Reference data for RF Exposure)**

Test place                      Shonan EMC Lab. No.5 Shielded Room  
Report No.                      11724216S-A-R1  
Date                              May 9, 2017  
Temperature / Humidity        26 deg. C / 34 % RH  
Engineer                        Hikaru Shirasawa  
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	-9.91	0.84	9.64	0.57	1.14	0.00	0.57	1.14
2440	-10.47	0.84	9.64	0.01	1.00	0.00	0.01	1.00
2480	-11.25	0.84	9.65	-0.76	0.84	0.00	-0.76	0.84

Sample Calculation:

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

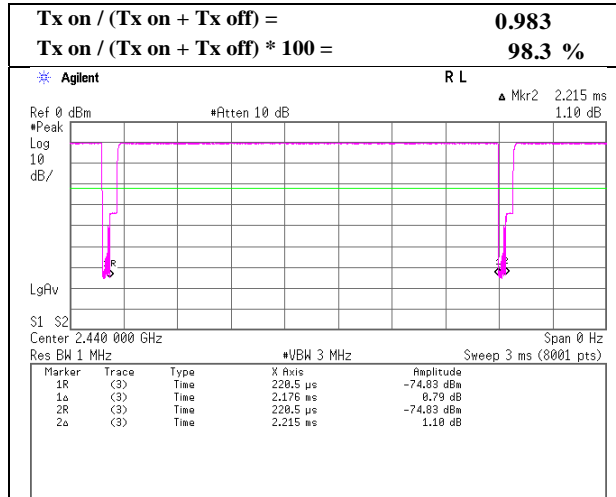
Result (Burst power average) = Time average + Duty factor

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

**The average output power was measured with the lowest order modulation and  
lowest data rate configuration in each IEEE 802.11 mode based on KDB 248227 D01.**

### Burst rate confirmation

Test place	Shonan EMC Lab. No.5 Shielded Room
Report No.	11724216S-A-R1
Date	May 9, 2017
Temperature / Humidity	26 deg. C / 34 % RH
Engineer	Hikaru Shirasawa
Mode	Tx BT LE



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



## Radiated Spurious Emission

Test place	Shonan EMC Lab. No.1 Semi Anechoic Chamber		
Report No.	11724216S-A-R1		
Date	May 12, 2017	May 11, 2017	May 12, 2017
Temperature / Humidity	24 deg. C / 40 % RH	23 deg. C / 51 % RH	24 deg. C / 40 % RH
Engineer	Yosuke Ishikawa (30 - 1000 MHz)	Yosuke Ishikawa (1 - 13 GHz)	Yosuke Ishikawa (13-26.5 GHz)
Mode	BLE 2402 MHz		

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	143.841	QP	22.00	14.63	8.70	31.77	0.00	13.56	43.50	29.9	100	13	
Hori.	161.108	QP	21.90	15.38	8.95	31.77	0.00	14.46	43.50	29.0	100	22	
Hori.	677.506	QP	21.70	19.61	8.98	31.99	0.00	18.30	46.00	27.7	100	7	
Hori.	930.930	QP	21.00	22.21	10.09	31.08	0.00	22.22	46.00	23.7	100	57	
Hori.	2322.001	PK	55.44	26.99	14.13	40.88	2.43	58.11	73.90	15.7	165	15	
Hori.	2377.899	PK	57.45	27.17	14.18	40.85	2.43	60.38	73.90	13.5	162	189	
Hori.	2390.000	PK	50.81	27.21	14.19	40.85	2.43	53.79	73.90	20.1	197	189	
Hori.	4804.000	PK	46.97	31.13	6.64	41.86	2.43	45.31	73.90	28.5	154	215	
Hori.	7206.000	PK	46.40	36.24	8.07	41.18	2.43	51.96	73.90	21.9	150	0	
Hori.	9608.000	PK	45.44	38.13	8.98	40.59	2.43	54.39	73.90	19.5	150	0	
Hori.	2322.001	AV	37.37	26.99	14.13	40.88	2.43	40.04	53.90	13.8	165	15	
Hori.	2377.899	AV	37.36	27.17	14.18	40.85	2.43	40.29	53.90	13.6	162	189	
Hori.	2390.000	AV	36.30	27.21	14.19	40.85	2.43	39.28	53.90	14.6	197	189	
Hori.	4804.000	AV	39.33	31.13	6.64	41.86	2.43	37.67	53.90	16.2	154	215	
Hori.	7206.000	AV	37.55	36.24	8.07	41.18	2.43	43.11	53.90	10.7	150	0	
Hori.	9608.000	AV	36.42	38.13	8.98	40.59	2.43	45.37	53.90	8.5	150	0	
Vert.	36.439	QP	22.50	15.70	7.18	31.83	0.00	13.55	40.00	26.4	100	26	
Vert.	611.151	QP	21.90	19.22	8.64	31.97	0.00	17.79	46.00	28.2	100	65	
Vert.	804.516	QP	21.40	20.84	9.51	31.77	0.00	19.98	46.00	26.0	100	4	
Vert.	875.797	QP	21.60	21.74	9.88	31.46	0.00	21.76	46.00	24.2	100	15	
Vert.	2321.968	PK	58.02	26.99	14.13	40.88	2.43	60.69	73.90	13.2	165	133	
Vert.	2377.730	PK	57.20	27.17	14.18	40.85	2.43	60.13	73.90	13.7	162	121	
Vert.	2390.000	PK	50.53	27.21	14.19	40.85	2.43	53.51	73.90	20.3	137	123	
Vert.	4804.000	PK	47.63	31.13	6.64	41.86	2.43	45.97	73.90	27.9	146	352	
Vert.	7206.000	PK	46.34	36.24	8.07	41.18	2.43	51.90	73.90	22.0	150	0	
Vert.	9608.000	PK	45.14	38.13	8.98	40.59	2.43	54.09	73.90	19.8	150	0	
Vert.	2321.968	AV	38.01	26.99	14.13	40.88	2.43	40.68	53.90	13.2	165	133	
Vert.	2377.730	AV	36.77	27.17	14.18	40.85	2.43	39.70	53.90	14.2	162	121	
Vert.	2390.000	AV	36.68	27.21	14.19	40.85	2.43	39.66	53.90	14.2	137	123	
Vert.	4804.000	AV	38.44	31.13	6.64	41.86	2.43	36.78	53.90	17.1	146	352	
Vert.	7206.000	AV	37.45	36.24	8.07	41.18	2.43	43.01	53.90	10.8	150	0	
Vert.	9608.000	AV	36.55	38.13	8.98	40.59	2.43	45.50	53.90	8.4	150	0	

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

Distance factor : 1 GHz - 13 GHz : 20log(3.97 m / 3.0 m) = 2.43 dB

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

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	88.85	27.25	14.20	40.84	2.43	91.89	-	-	Carrier
Hori.	2400.000	PK	46.67	27.25	14.19	40.84	2.43	49.70	71.89	22.2	
Vert.	2402.000	PK	88.44	27.25	14.20	40.84	2.43	91.48	-	-	Carrier
Vert.	2400.000	PK	46.18	27.25	14.19	40.84	2.43	49.21	71.48	22.3	

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

Distance factor : 1 GHz - 13 GHz : 20log(3.97 m / 3.0 m) = 2.43 dB

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

**UL Japan, Inc.**

**Shonan EMC Lab.**

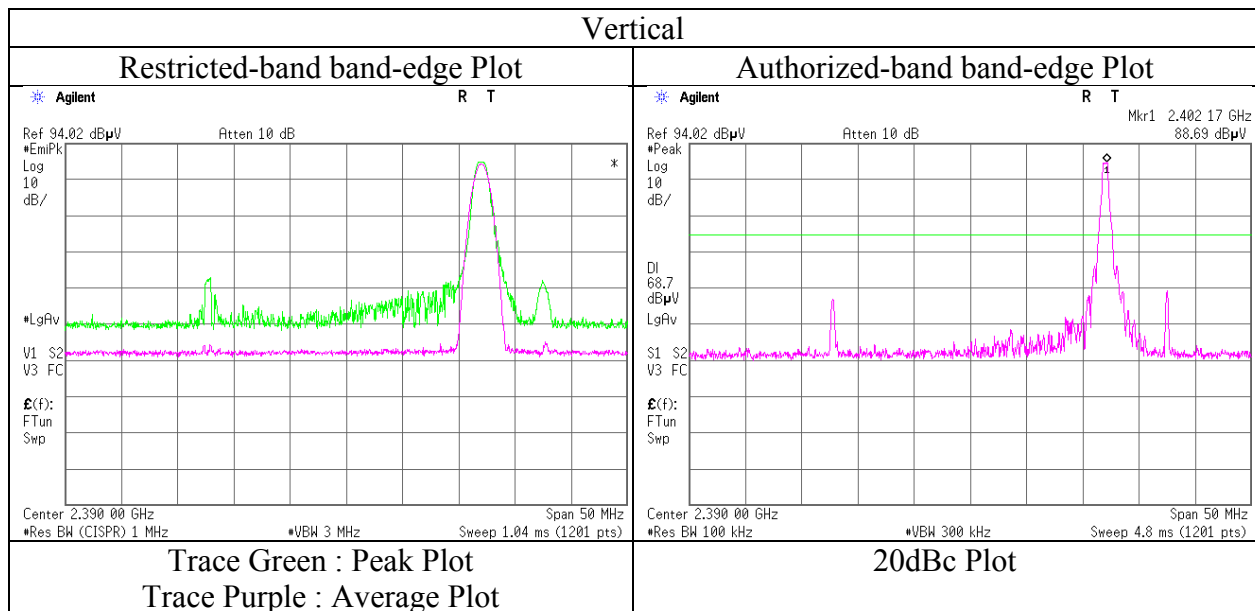
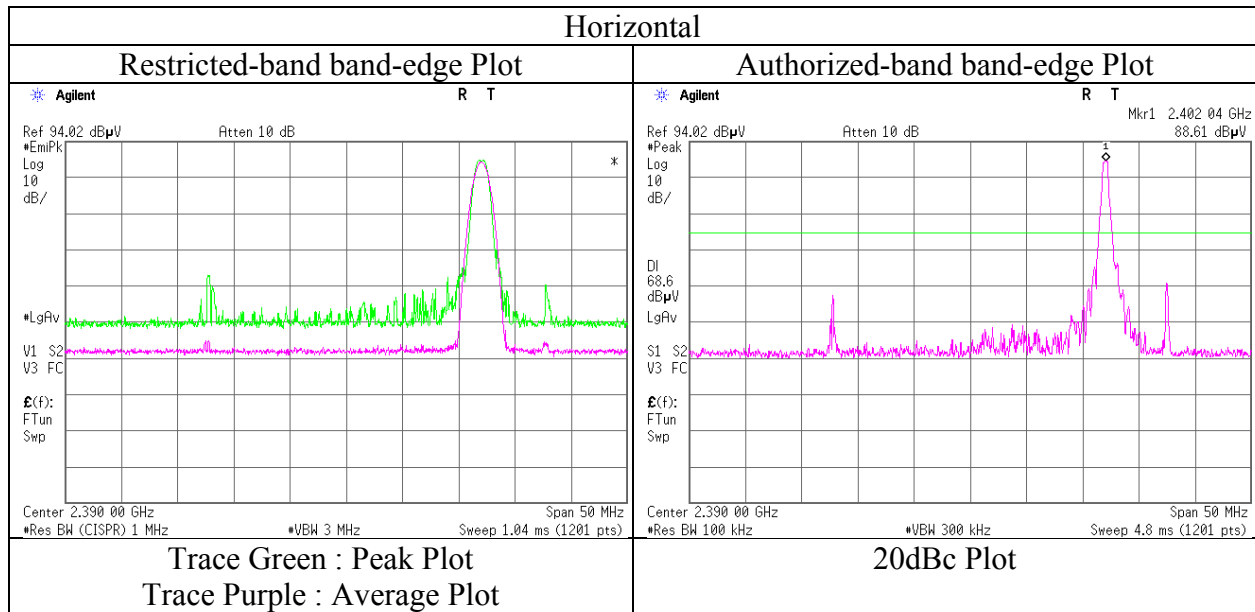
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

**Radiated Spurious Emission**  
**(Reference Plot for band-edge)**

Test place : Shonan EMC Lab. No.1 Semi Anechoic Chamber  
Report No. : 11724216S-A-R1  
Date : May 11, 2017  
Temperature / Humidity : 23 deg. C / 51 % RH  
Engineer : Yosuke Ishikawa  
(1 - 13 GHz)  
Mode : BLE 2402 MHz



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

## Radiated Spurious Emission

Test place : Shonan EMC Lab. No.1 Semi Anechoic Chamber  
Report No. : 11724216S-A-R1  
Date : May 12, 2017      May 11, 2017      May 12, 2017  
Temperature / Humidity : 24 deg. C / 40 % RH    23 deg. C / 51 % RH    24 deg. C / 40 % RH  
Engineer : Yosuke Ishikawa    Yosuke Ishikawa    Yosuke Ishikawa  
            (30 - 1000 MHz)    (1 - 13 GHz)        (13-26.5 GHz)  
Mode : BLE 2440 MHz

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	161.311	QP	22.00	15.39	8.94	31.77	0.00	14.56	43.50	28.9	100	51	
Hori.	187.970	QP	21.90	16.37	8.99	31.77	0.00	15.49	43.50	28.0	100	11	
Hori.	588.047	QP	22.00	18.98	8.55	31.95	0.00	17.58	46.00	28.4	100	35	
Hori.	902.522	QP	21.40	22.05	10.01	31.32	0.00	22.14	46.00	23.8	100	9	
Hori.	4880.000	PK	46.20	31.29	6.72	41.76	2.43	44.88	73.90	29.0	150	0	
Hori.	7320.000	PK	45.66	36.40	8.20	41.27	2.43	51.42	73.90	22.4	150	0	
Hori.	9760.000	PK	44.27	38.35	9.09	40.62	2.43	53.52	73.90	20.3	150	0	
Hori.	4880.000	AV	37.51	31.29	6.72	41.76	2.43	36.19	53.90	17.7	150	0	
Hori.	7320.000	AV	37.12	36.40	8.20	41.27	2.43	42.88	53.90	11.0	150	0	
Hori.	9760.000	AV	35.59	38.35	9.09	40.62	2.43	44.84	53.90	<b>9.0</b>	150	0	
Vert.	35.884	QP	22.40	15.90	7.17	31.83	0.00	13.64	40.00	26.3	100	29	
Vert.	175.130	QP	21.60	16.08	8.97	31.77	0.00	14.88	43.50	28.6	100	15	
Vert.	339.653	QP	21.70	14.41	7.12	31.75	0.00	11.48	46.00	34.5	100	48	
Vert.	917.435	QP	21.10	22.14	10.05	31.19	0.00	22.10	46.00	23.9	100	19	
Vert.	4880.000	PK	46.36	31.29	6.72	41.76	2.43	45.04	73.90	28.8	150	0	
Vert.	7320.000	PK	45.49	36.40	8.20	41.27	2.43	51.25	73.90	22.6	150	0	
Vert.	9760.000	PK	44.69	38.35	9.09	40.62	2.43	53.94	73.90	19.9	150	0	
Vert.	4880.000	AV	37.67	31.29	6.72	41.76	2.43	36.35	53.90	17.5	150	0	
Vert.	7320.000	AV	37.41	36.40	8.20	41.27	2.43	43.17	53.90	10.7	150	0	
Vert.	9760.000	AV	35.56	38.35	9.09	40.62	2.43	44.81	53.90	<b>9.0</b>	150	0	

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

Distance factor : 1 GHz - 13 GHz : 20log(3.97 m / 3.0 m) = 2.43 dB

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

## Radiated Spurious Emission

Test place : Shonan EMC Lab. No.1 Semi Anechoic Chamber  
Report No. : 11724216S-A-R1  
Date : May 12, 2017      May 11, 2017      May 12, 2017  
Temperature / Humidity : 24 deg. C / 40 % RH      23 deg. C / 51 % RH      24 deg. C / 40 % RH  
Engineer : Yosuke Ishikawa      Yosuke Ishikawa      Yosuke Ishikawa  
            (30 - 1000 MHz)      (1 - 13 GHz)      (13-26.5 GHz)  
Mode : BLE 2480 MHz

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	149.505	QP	21.80	14.87	8.82	31.77	0.00	13.72	43.50	29.7	100	4	
Hori.	187.614	QP	21.80	16.37	8.99	31.77	0.00	15.39	43.50	28.1	100	15	
Hori.	654.812	QP	21.60	19.47	8.87	32.02	0.00	17.92	46.00	28.0	100	39	
Hori.	905.156	QP	21.40	22.07	10.01	31.30	0.00	22.18	46.00	23.8	100	26	
Hori.	2483.500	PK	47.11	27.52	14.27	40.81	2.43	50.52	73.90	23.3	185	184	
Hori.	4960.000	PK	45.66	31.45	6.79	41.65	2.43	44.68	73.90	29.2	150	0	
Hori.	7440.000	PK	45.31	36.57	8.35	41.36	2.43	51.30	73.90	22.6	150	0	
Hori.	9920.000	PK	43.97	38.58	9.21	40.66	2.43	53.53	73.90	20.3	150	0	
Hori.	2483.500	AV	36.55	27.52	14.27	40.81	2.43	39.96	53.90	13.9	185	184	
Hori.	4960.000	AV	37.15	31.45	6.79	41.65	2.43	36.17	53.90	17.7	150	0	
Hori.	7440.000	AV	36.57	36.57	8.35	41.36	2.43	42.56	53.90	11.3	150	0	
Hori.	9920.000	AV	35.09	38.58	9.21	40.66	2.43	44.65	53.90	9.2	150	0	
Vert.	32.194	QP	22.50	17.08	7.08	31.83	0.00	14.83	40.00	25.1	100	65	
Vert.	177.127	QP	21.80	16.18	8.97	31.77	0.00	15.18	43.50	28.3	100	80	
Vert.	505.440	QP	21.70	17.78	8.19	31.88	0.00	15.79	46.00	30.2	100	5	
Vert.	849.084	QP	21.60	21.40	9.75	31.60	0.00	21.15	46.00	24.8	100	43	
Vert.	2483.500	PK	47.86	27.52	14.27	40.81	2.43	51.27	73.90	22.6	168	153	
Vert.	4960.000	PK	45.82	31.45	6.79	41.65	2.43	44.84	73.90	29.0	157	352	
Vert.	7440.000	PK	45.34	36.57	8.35	41.36	2.43	51.33	73.90	22.5	150	0	
Vert.	9920.000	PK	44.32	38.58	9.21	40.66	2.43	53.88	73.90	20.0	150	0	
Vert.	2483.500	AV	36.90	27.52	14.27	40.81	2.43	40.31	53.90	13.5	168	153	
Vert.	4960.000	AV	37.89	31.45	6.79	41.65	2.43	36.91	53.90	16.9	157	352	
Vert.	7440.000	AV	36.54	36.57	8.35	41.36	2.43	42.53	53.90	11.3	150	0	
Vert.	9920.000	AV	34.98	38.58	9.21	40.66	2.43	44.54	53.90	9.3	150	0	

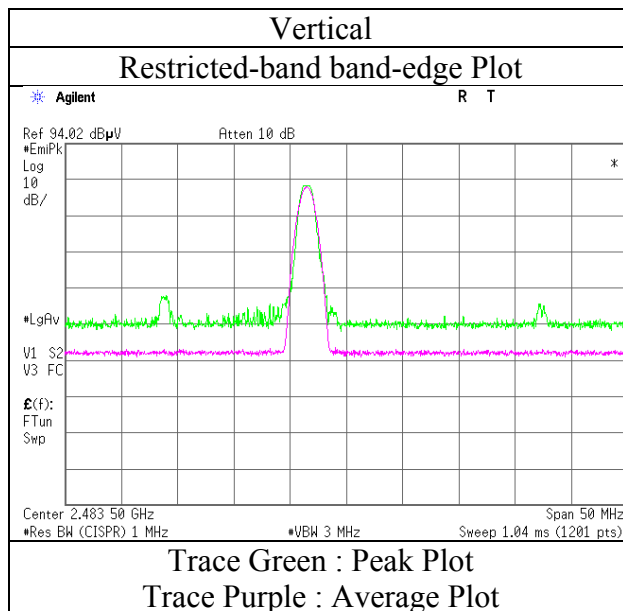
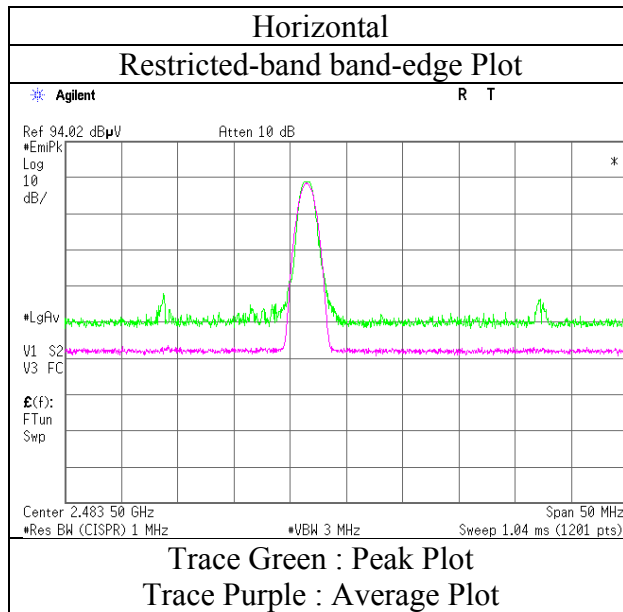
Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : 20log(3.97 m / 3.0 m) = 2.43 dB

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

**Radiated Spurious Emission**  
**(Reference Plot for band-edge)**

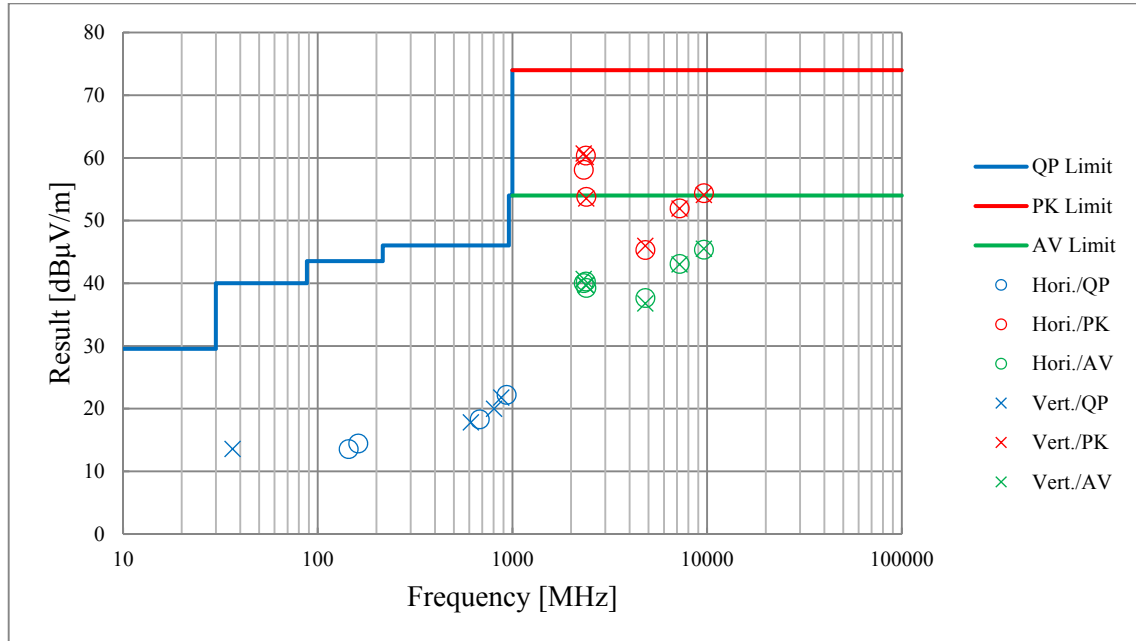
Test place : Shonan EMC Lab. No.1 Semi Anechoic Chamber  
Report No. : 11724216S-A-R1  
Date : May 11, 2017  
Temperature / Humidity : 23 deg. C / 51 % RH  
Engineer : Yosuke Ishikawa  
(1 - 13 GHz)  
Mode : BLE 2480 MHz



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

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

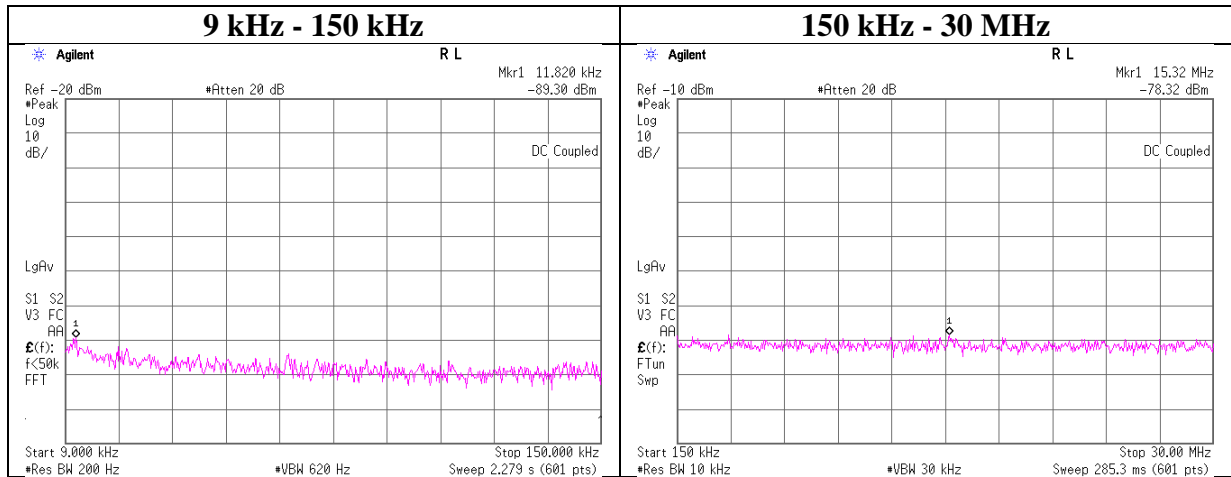
Test place	Shonan EMC Lab. No.1 Semi Anechoic Chamber		
Report No.	11724216S-A-R1		
Date	May 12, 2017	May 11, 2017	May 12, 2017
Temperature / Humidity	24 deg. C / 40 % RH	23 deg. C / 51 % RH	24 deg. C / 40 % RH
Engineer	Yosuke Ishikawa (30 - 1000 MHz)	Yosuke Ishikawa (1 - 13 GHz)	Yosuke Ishikawa (13-26.5 GHz)
Mode	BLE 2402 MHz		



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

### Conducted Spurious Emission

Test place : Shonan EMC Lab. No.5 Shielded Room  
Report No. : 11724216S-A-R1  
Date : May 9, 2017  
Temperature / Humidity : 26 deg. C / 34 % RH  
Engineer : Hikaru Shirasawa  
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
11.82	-89.3	0.00	9.5	2.0	1	-77.8	300	6.0	-16.5	46.1	62.6	
1532.00	-78.3	0.02	9.5	2.0	1	-66.7	30	6.0	14.5	23.8	9.3	

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

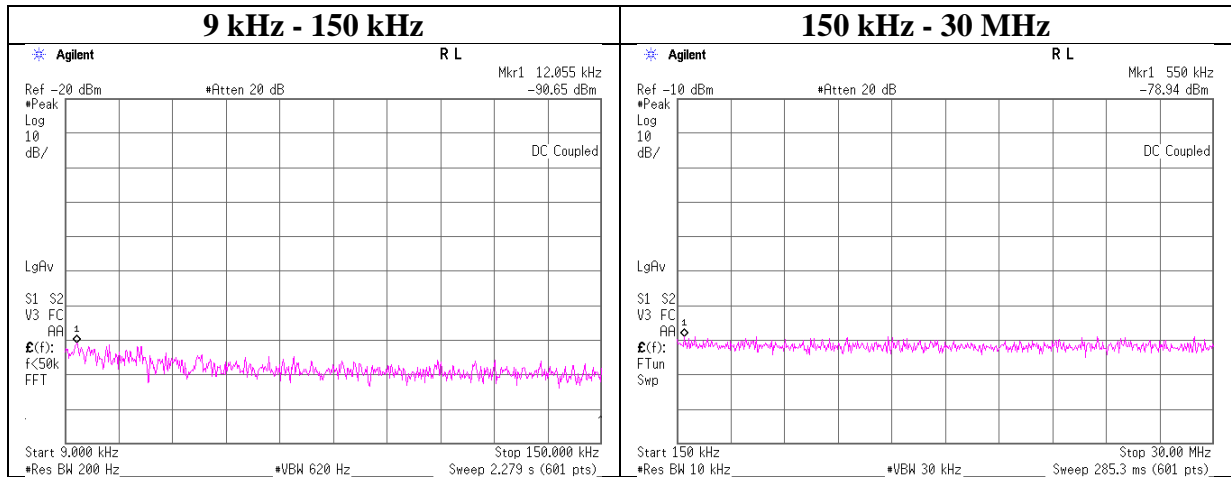
$EIRP [dBm] = Reading [dBm] + Cable\ loss [dB] + Attenuator\ Loss [dB] + Antenna\ gain [dBi] + 10 * \log (N)$

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	Shonan EMC Lab. No.5 Shielded Room
Report No.	11724216S-A-R1
Date	May 9, 2017
Temperature / Humidity	26 deg. C / 34 % RH
Engineer	Hikaru Shirasawa
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
12.06	-90.7	0.00	9.5	2.0	1	-79.1	300	6.0	-17.9	45.9	63.8	
550.00	-78.9	0.01	9.5	2.0	1	-67.4	30	6.0	13.9	32.7	18.8	

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

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

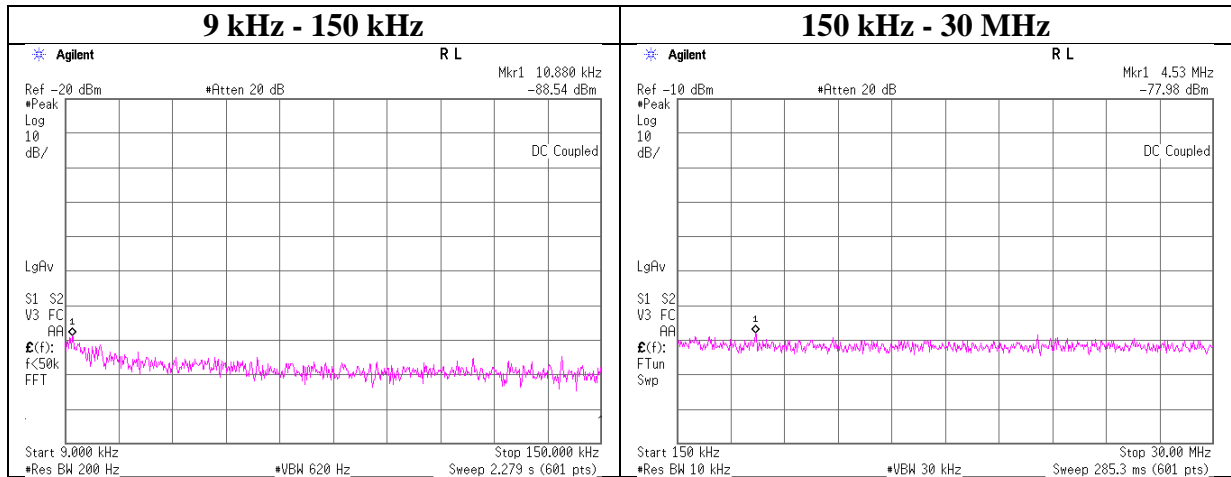
N: Number of output

\*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 : Shonan EMC Lab. No.5 Shielded Room  
Report No. : 11724216S-A-R1  
Date : May 9, 2017  
Temperature / Humidity : 26 deg. C / 34 % RH  
Engineer : Hikaru Shirasawa  
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
10.88	-88.5	0.00	9.5	2.0	1	-77.0	300	6.0	-15.7	46.8	62.5	
4530.00	-78.0	0.01	9.5	2.0	1	-66.4	30	6.0	14.8	29.5	14.7	

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

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

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                      Shonan EMC Lab. No.5 Shielded Room  
Report No.                      11724216S-A-R1  
Date                              May 9, 2017  
Temperature / Humidity      26 deg. C / 34 % RH  
Engineer                        Hikaru Shirasawa  
Mode                              Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-20.11	0.84	9.64	-9.63	8.00	17.63
2440.00	-20.56	0.84	9.64	-10.08	8.00	18.08
2480.00	-21.23	0.84	9.65	-10.74	8.00	18.74

Sample Calculation:

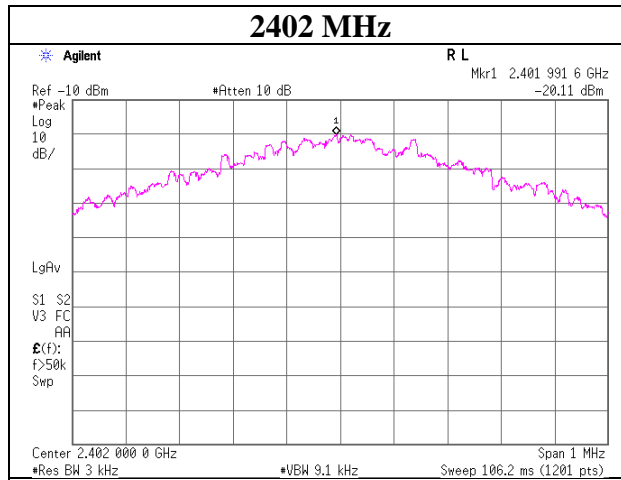
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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

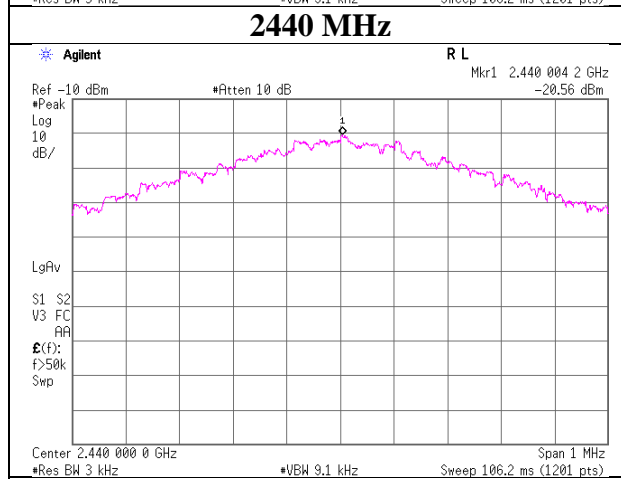
## Power Density

### BT LE

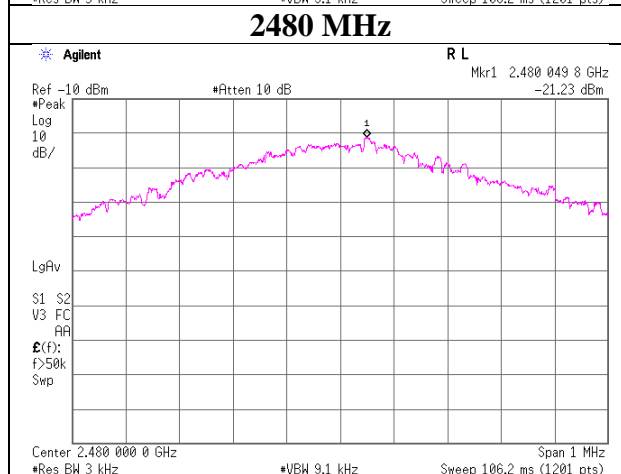
#### 2402 MHz



#### 2440 MHz

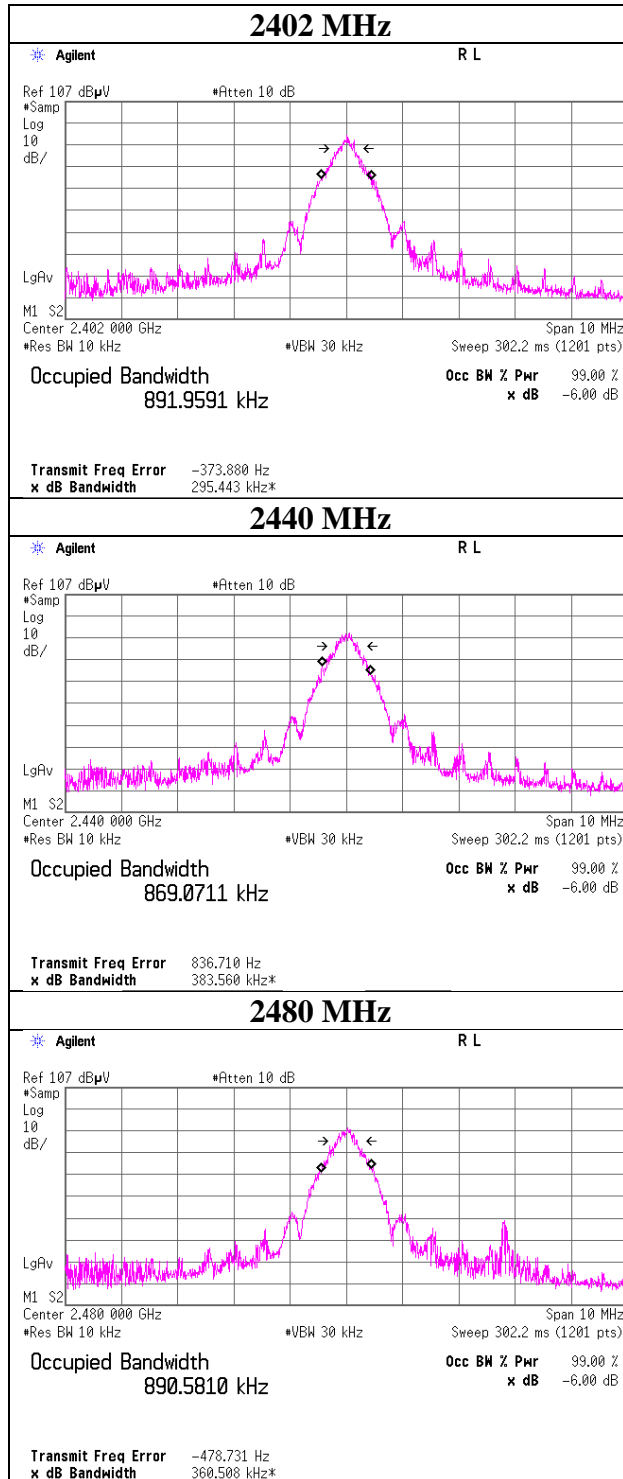


#### 2480 MHz



## 99% Occupied Bandwidth

Test place	Shonan EMC Lab. No.5 Shielded Room
Report No.	11724216S-A-R1
Date	May 9, 2017
Temperature / Humidity	26 deg. C / 34 % RH
Engineer	Hikaru Shirasawa
Mode	Tx BT LE



## APPENDIX 2: Test instruments

### Test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
SPM-06	Power Meter	Anritsu	ML2495A	0850009	AT	2017/04/25 * 12
SPSS-01	Power Sensor	Anritsu	MA2444D	0738366	AT	2017/04/25 * 12
SRENT-09	Spectrum Analyzer	Agilent	E4440A	MY46186392	AT	2016/11/01 * 12
SCC-G11	Coaxial Cable	Suhner	SUCOFLEX 102	31595/2	AT	2017/03/23 * 12
SAT10-09	Attenuator	Weinschel Corp.	54A-10	W5692	AT	2016/11/07 * 12
SOS-09	Humidity Indicator	A&D	AD-5681	4061484	AT	2016/12/13 * 12
STS-05	Digital Hitester	Hioki	3805-50	080997828	AT	2016/10/17 * 12
SAF-04	Pre Amplifier	TOYO Corporation	TPA0118-36	1440489	RE	2017/03/17 * 12
SCC-G05	Coaxial Cable	Junkosha	J12J102207-00	APR-30-15-0 37	RE	2017/01/08 * 12
SCC-G22	Coaxial Cable	Suhner	SUCOFLEX 104	296199/4	RE	2016/05/11 * 12
SHA-01	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-725	RE	2016/08/09 * 12
SOS-01	Humidity Indicator	A&D	AD-5681	4062555	RE	2016/10/12 * 12
SSA-02	Spectrum Analyzer	Agilent	E4448A	MY48250106	RE	2017/03/07 * 12
KJM-09	Measure	KOMELON	KMC-36	-	RE	-
SAEC-01(SVSW R)	Semi-Anechoic Chamber	TDK	SAEC-01(SVSW R)	1	RE	2016/07/24 * 12
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE ,CE,RFI,MF)	-	RE	-
SCC-G41	Coaxial Cable	Junkosha	MWX221-0100 ONFSNMS/B	1612S006	RE	2017/01/08 * 12
SAT10-05	Attenuator(above1GHz)	Agilent	8493C-010	74864	RE	2016/11/07 * 12
SFL-02	Highpass Filter	MICRO-TRONICS	HPM50111	051	RE	2016/11/29 * 12
SAF-01	Pre Amplifier	SONOMA	310N	290211	RE	2017/02/09 * 12
KAT6-04	Attenuator	INMET	18N-6dB	-	RE	2016/12/15 * 12
SAT3-09	Attenuator	JFW	50HF-003N	-	RE	2016/08/04 * 12
SBA-01	Biconical Antenna	Schwarzbeck	BBA9106	91032664	RE	2016/10/15 * 12
SCC-A1/A3/A5/ A7/A8/A13/SRS E-01	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner /Suhner/Suhner/Suhner/T OYO	8D2W/12DSFA /141PE/141PE/ 141PE/141PE/ NS4906	-/0901-269(R F Selector)	RE	2017/04/07 * 12
SCC-A2/A4/A6/ A7/A8/A13/SRS E-01	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner /Suhner/Suhner/Suhner/T OYO	8D2W/12DSFA /141PE/141PE/ 141PE/141PE/ NS4906	-/0901-269(R F Selector)	RE	2017/04/07 * 12
SLA-05	Logperiodic Antenna	Schwarzbeck	VUSLP9111B	193	RE	2017/01/05 * 12
STR-07	Test Receiver	Rohde & Schwarz	ESU26	100484	RE	2016/09/28 * 12
SAEC-01(NSA)	Semi-Anechoic Chamber	TDK	SAEC-01(NSA )	1	RE	2016/07/14 * 12
SCC-G20	Coaxial Cable	Junkosha	J12J102518-00	APR-15-15-0 03	RE	2017/04/20 * 12
SCC-G33	Coaxial Cable	Junkosha	MWX241-0100 0KMSKMS	-	RE	2017/04/20 * 12
SHA-05	Horn Antenna	ETS LINDGREN	3160-09	LM4210	RE	2017/03/15 * 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

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