



# **RADIO TEST REPORT**

**Test Report No.: 10520101S-B**

**Applicant** : SEIKO EPSON CORPORATION  
**Type of Equipment** : GPS Sports Monitor  
**Model No.** : SF-110  
**FCC ID** : BKMAP007  
**Test regulation** : FCC Part15 Subpart C: 2014  
**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 limits of the above regulation.
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6. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.

**Date of test:** November 25 to December 25, 2014

**Representative  
test engineer:**

  
Kenichi Adachi  
Engineer  
Consumer Technology Division

**Approved by :**

  
Toyokazu Imamura  
Leader  
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 : 281 Fujimi, Fujimi-machi, Suwa-gun, Nagano-ken 399-0293 Japan  
Telephone Number : +81-266-61-0618  
Facsimile Number : +81-266-61-2045  
Contact Person : Junichi Kiryu

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

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

Type of equipment : GPS Sports Monitor  
Model No. : SF-110  
Serial No. : Refer to Section 4.2  
Rating : DC 3.7V  
Country of Mass-production : Japan  
Condition of EUT : Production prototype  
(Not for Sale: This sample is equivalent to mass-produced items.)  
Receipt Date of Sample : November 13, 2014  
Modification of EUT : The test lab did not make the modification to the EUT supplied from the customer to have it pass the tests.

### **2.2 Product description**

Model: SF-110 (referred to as the EUT in this report) is a GPS Sports Monitor.

Clock frequency(ies) in the system : 26MHz, 32MHz, 48MHz, 32kHz

#### **<Radio part>**

Equipment type : Transceiver  
Frequency of operation : 2402-2480MHz  
Bandwidth / Channel spacing : 1MHz / 2MHz  
Type of modulation : GFSK  
Antenna type / Antenna connector type : Chip Antenna / None  
Antenna gain : 1.5dBi  
ITU code : F1D  
Operation temperature range : -5 to +50 deg.C

#### **FCC 15.31 (e)**

The EUT is a battery-operated device and test was performed with the full-charged battery. Therefore, the EUT complies with the requirement.

#### **FCC 15.203**

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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## SECTION 3: Test specification, procedures & results

### 3.1 Test specification

Test specification : FCC Part 15 Subpart C: 2014, final revised on December 23, 2014  
Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators  
Section 15.207 Conducted limits  
Section 15.209 Radiated emission limits, general requirements  
Section 15.247 Operation within the bands 902-928MHz, 2400-2483.5MHz,  
and 5725-5850MHz

\* The revision on December 23, 2014 does not affect the test specification applied to the EUT.

\* The EUT has been tested for compliance with FCC Part 15 Subpart B by the customer.

### 3.2 Procedures & Results

| Item                                         | Test Procedure   | Specification                   | Remarks              | Deviation | Worst Margin                                       | Results  |
|----------------------------------------------|------------------|---------------------------------|----------------------|-----------|----------------------------------------------------|----------|
| Conducted Emission                           | ANSI C63.10:2009 | FCC 15.207                      | -                    | N/A *2)   | N/A                                                | N/A      |
| 6dB Bandwidth                                | ANSI C63.10:2009 | FCC 15.247 (a)(2)               | Conducted            | N/A       | * See data                                         | Complied |
| Maximum Peak Conducted Output Power          | ANSI C63.10:2009 | FCC 15.247 (b)(3)               | Conducted            | N/A       |                                                    | Complied |
| Out of Band Emission & Restricted Band Edges | ANSI C63.10:2009 | FCC 15.109, 15.247 (d) & 15.209 | Conducted / Radiated | N/A       | 6.4dB (12400.000MHz, AV, Horizontal, Tx 2480MHz, ) | Complied |
| Maximum Power Spectral Density               | ANSI C63.10:2009 | FCC 15.247 (e)                  | Conducted            | N/A       | * See data                                         | Complied |

Note: UL Japan's EMI Work Procedures No.13-EM-W0420 and 13-EM-W0422.

\*1) These tests were also referred to KDB 558074 v03r02 (FCC), "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

\*2) The EUT operates with a battery. AC Line can be connected to the EUT via PC or AC adapter; however, the EUT stops transmission during recharging. Therefore, the test is not applicable to the EUT.

### 3.3 Addition to standard

| Item                     | Test Procedure                                                           | Specification | Remarks   | Worst Margin | Results |
|--------------------------|--------------------------------------------------------------------------|---------------|-----------|--------------|---------|
| Occupied Bandwidth (99%) | ANSI C63.4:2009<br>13. Measurement of intentional radiators, RSS-Gen 6.6 | -             | Conducted | -            | -       |

Note: UL Japan's EMI Work Procedures No.13-EM-W0420 and 13-EM-W0422.

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

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### 3.4 Uncertainty

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

| Item                                                    | Frequency range | No.1 SAC <sup>*1</sup> /SR <sup>*2</sup><br>(±) | No.2 SAC/SR<br>(±) | No.3 SAC/SR<br>(±) |
|---------------------------------------------------------|-----------------|-------------------------------------------------|--------------------|--------------------|
| <b>Radiated emission<br/>(Measurement distance: 3m)</b> | 30MHz-300MHz    | 4.9 dB                                          | 4.9 dB             | 4.7 dB             |
|                                                         | 300MHz-1GHz     | 5.0 dB                                          | 5.0 dB             | 4.8 dB             |
|                                                         | 1GHz-15GHz      | 4.9 dB                                          | 4.9 dB             | 4.9 dB             |
| <b>Radiated emission<br/>(Measurement distance: 1m)</b> | 15GHz-18GHz     | 5.7 dB                                          | 5.7 dB             | 5.7 dB             |
|                                                         | 18GHz-40GHz     | 4.5 dB                                          | 4.3 dB             | 4.3 dB             |

\*1: SAC=Semi-Anechoic Chamber

\*2: SR= Shielded Room is applied besides radiated emission

#### Radiated emission test

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

#### Antenna port conducted test

Power measurement uncertainty above 1GHz for this test was: (±) 0.68dB

Conducted emissions, Power Density Measurement (below 1GHz) uncertainty for this test was: (±) 1.5dB

Conducted emissions, Power Density Measurement (1G-3GHz) uncertainty for this test was: (±) 1.7dB

Conducted emissions, Power Density Measurement (3G-18GHz) uncertainty for this test was: (±) 2.4dB

Conducted emissions Measurement (18G-26.5GHz) uncertainty for this test was: (±) 2.5dB

Bandwidth Measurement uncertainty for this test was: (±) 0.66%

### 3.5 Test location

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JAB Accreditation No. : RTL02610

|                                                                | IC<br>Registration<br>No. | Width x Depth x<br>Height (m) | Size of reference<br>ground plane (m) /<br>horizontal<br>conducting plane | Maximum<br>measurement<br>distance |
|----------------------------------------------------------------|---------------------------|-------------------------------|---------------------------------------------------------------------------|------------------------------------|
| <input checked="" type="checkbox"/> No.1 Semi-anechoic chamber | 2973D-1                   | 20.6 x 11.3 x 7.65            | 20.6 x 11.3                                                               | 10m                                |
| <input checked="" type="checkbox"/> No.2 Semi-anechoic chamber | 2973D-2                   | 20.6 x 11.3 x 7.65            | 20.6 x 11.3                                                               | 10m                                |
| <input type="checkbox"/> No.3 Semi-anechoic chamber            | 2973D-3                   | 12.7 x 7.7 x 5.35             | 12.7 x 7.7                                                                | 5m                                 |
| <input type="checkbox"/> No.4 Semi-anechoic chamber            | -                         | 8.1 x 5.1 x 3.55              | 8.1 x 5.1                                                                 | -                                  |
| <input type="checkbox"/> No.1 Shielded room                    | -                         | 6.8 x 4.1 x 2.7               | 6.8 x 4.1                                                                 | -                                  |
| <input type="checkbox"/> No.2 Shielded room                    | -                         | 6.8 x 4.1 x 2.7               | 6.8 x 4.1                                                                 | -                                  |
| <input type="checkbox"/> No.3 Shielded room                    | -                         | 6.3 x 4.7 x 2.7               | 6.3 x 4.7                                                                 | -                                  |
| <input type="checkbox"/> No.4 Shielded room                    | -                         | 4.4 x 4.7 x 2.7               | 4.4 x 4.7                                                                 | -                                  |
| <input checked="" type="checkbox"/> No.5 Shielded room         | -                         | 7.8 x 6.4 x 2.7               | 7.8 x 6.4                                                                 | -                                  |
| <input type="checkbox"/> No.6 Shielded room                    | -                         | 7.8 x 6.4 x 2.7               | 7.8 x 6.4                                                                 | -                                  |
| <input type="checkbox"/> No.7 Shielded room                    | -                         | 2.76 x 3.76 x 2.4             | 2.76 x 3.76                                                               | -                                  |
| <input type="checkbox"/> No.8 Shielded room                    | -                         | 3.45 x 5.5 x 2.4              | 3.45 x 5.5                                                                | -                                  |
| <input type="checkbox"/> No.1 Measurement room                 | -                         | 2.55 x 4.1 x 2.5              | 2.55 x 4.1                                                                | -                                  |

### 3.6 Test setup, Data of EMI & Test instruments

Refer to APPENDIX 1 to 3.

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

### **4.1 Operating mode**

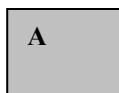
| Test item | Mode                                                                         | Tested frequency          |
|-----------|------------------------------------------------------------------------------|---------------------------|
| All items | Transmitting (Tx), Hopping OFF<br>Bluetooth Low Energy (LE),<br>Payload: PN9 | 2402MHz, 2440MHz, 2480MHz |

Power settings: 0dBm

Test software: WS LOGGER VER 2.00

**Justification:** The system was configured in typical fashion (as customer would normally use it) for testing.

### **4.2 Configuration and peripherals**



\* Test data was taken under worse case conditions.

#### **Description of EUT and Support equipment**

| No. | Item               | Model number | Serial number | Manufacturer | Remarks |
|-----|--------------------|--------------|---------------|--------------|---------|
| A   | GPS Sports Monitor | SF-110       | *1)           | SEIKO EPSON  | EUT     |

\*1) Radiated emission: A18, Other tests: A16

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## **SECTION 5: Radiated emission**

### **5.1 Operating environment**

Test place : See test data (APPENDIX 1)  
Temperature : See test data (APPENDIX 1)  
Humidity : See test data (APPENDIX 1)

### **5.2 Test configuration**

EUT was placed on a platform of nominal size, 0.5m by 0.5m, raised 80cm above the conducting ground plane. Photographs of the set up are shown in APPENDIX 3.

### **5.3 Test conditions**

Frequency range : 30MHz to 25GHz \*)  
Test distance : 3m(below 15GHz) / 1m(above15GHz)  
EUT position : Table top  
EUT operation mode : Refer to SECTION 4.1

\*) It was not measured the radiated emissions from 9kHz to 30MHz, because it had been not detected the noise from 9kHz to 30MHz with the antenna terminal.

### **5.4 Test procedure**

The Radiated Electric Field Strength intensity has been measured on a semi-anechoic chamber with a ground plane and at a distance of 3m(below 15GHz) / 1m(above 15GHz) (Refer to Figure 1). Measurements were performed with quasi-peak, peak and average detector. The measuring antenna height was varied between 1 and 4m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity. The measurements were performed for both vertical and horizontal antenna polarization.

The radiated emission measurements were made with the following detection of the test receiver.

| Frequency      | 30-1000MHz | Above 1GHz                               |                                                                 | 20dBc                      |
|----------------|------------|------------------------------------------|-----------------------------------------------------------------|----------------------------|
| Detection type | Quasi-Peak | Peak                                     | * Average *1)                                                   | Peak                       |
| IF Bandwidth   | 120kHz     | Detector: Peak<br>RBW: 1MHz<br>VBW: 3MHz | RBW: 1MHz<br>VBW: 3MHz<br>Detector: Linear Voltage<br>Averaging | RBW: 100kHz<br>VBW: 300kHz |

\*1) Average Power Measurement was measured based on 13.3.2 of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

\* When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

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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.

Combinations of the worst case

| Antenna polarization | Frequency | Carrier<br>*2) | Spurious   |         |          |          |
|----------------------|-----------|----------------|------------|---------|----------|----------|
|                      |           |                | Below 1GHz | 1-15GHz | 15-18GHz | 15-25GHz |
| Horizontal           | X         | X              | X          | Z       | Z        | Z        |
| Vertical             | Y         | X              | X          | Z       | Z        | Z        |

\*2) with spurious emissions near carrier frequency.

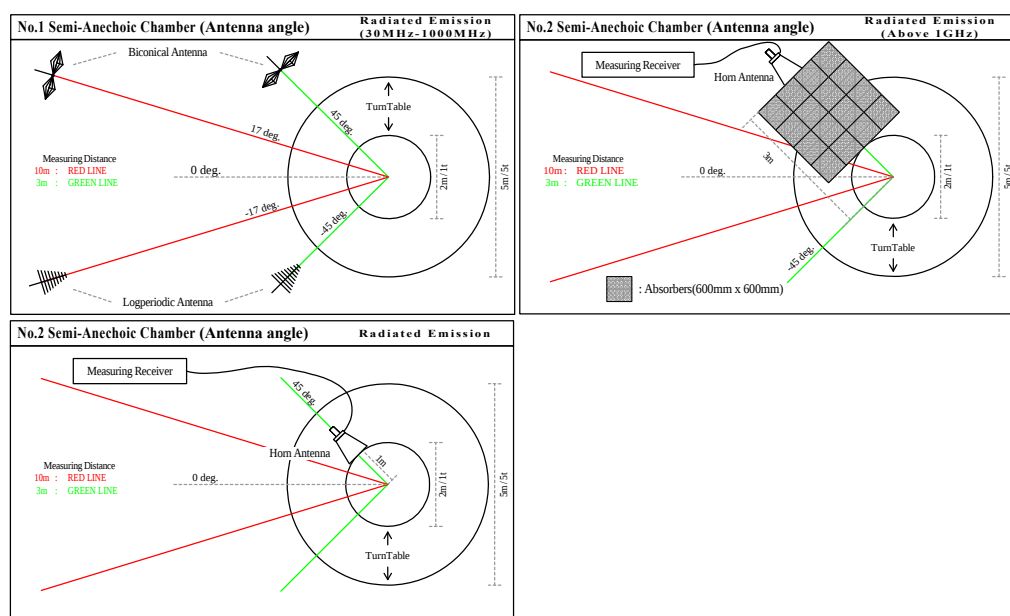


Figure 1. Antenna angle

## 5.5 Band edge

Band edge level at 2400MHz is less than 20dB of peak point of the carrier.  
Band edge level at 2390MHz and 2483.5MHz is below the limits of FCC 15.209.  
Refer to the data of Radiated emission.

## 5.6 Results

Summary of the test results : Pass \*No noise was detected above the 5<sup>th</sup> order harmonics.  
Refer to APPENDIX 1

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## **SECTION 6: Out of band emissions (Antenna port conducted)**

### **Test procedure**

The Out of Band Emissions was measured with a spectrum analyzer connected to the antenna port.

In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.

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. (9kHz-150kHz:RBW=200Hz, 150kHz-30MHz:RBW=10kHz)

Summary of the test results: Pass

Refer to APPENDIX 1

## **SECTION 7: 6dB bandwidth & Occupied bandwidth (99%)**

### **Test procedure**

The bandwidth was measured with a spectrum analyzer connected to the antenna port.

Summary of the test results: Pass

Refer to APPENDIX 1

## **SECTION 8: Maximum peak conducted output power**

### **Test procedure**

The maximum peak conducted output power was measured with a power meter connected to the antenna port.

The test was measured based on Method 9.1.3, method PKPM1 of KDB 558074 ("Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247").

Detection type: Peak / Average \*1)

Summary of the test results: Pass

Refer to APPENDIX 1

## **SECTION 9: Maximum power spectral density**

### **Test procedure**

The maximum power spectral density was measured with a spectrum analyzer connected to the antenna port.

Instrument used : Spectrum Analyzer \*1)

RBW / VBW : 3kHz / 9.1kHz

The test was measured based on Method 10.2, method PKPSD of KDB 558074 ("Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247").

Summary of the test results: Pass

Refer to APPENDIX 1

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## **Contents of APPENDIXES**

### **APPENDIX 1: Data of Radio tests**

6dB Bandwidth  
Maximum peak conducted output power  
Radiated emission  
Spurious emission (Antenna port conducted)  
Maximum power spectral density  
Occupied Bandwidth

### **APPENDIX 2: Test instruments**

Test instruments

### **APPENDIX 3: Photographs of test setup**

Radiated emission  
Pre-check of worst position

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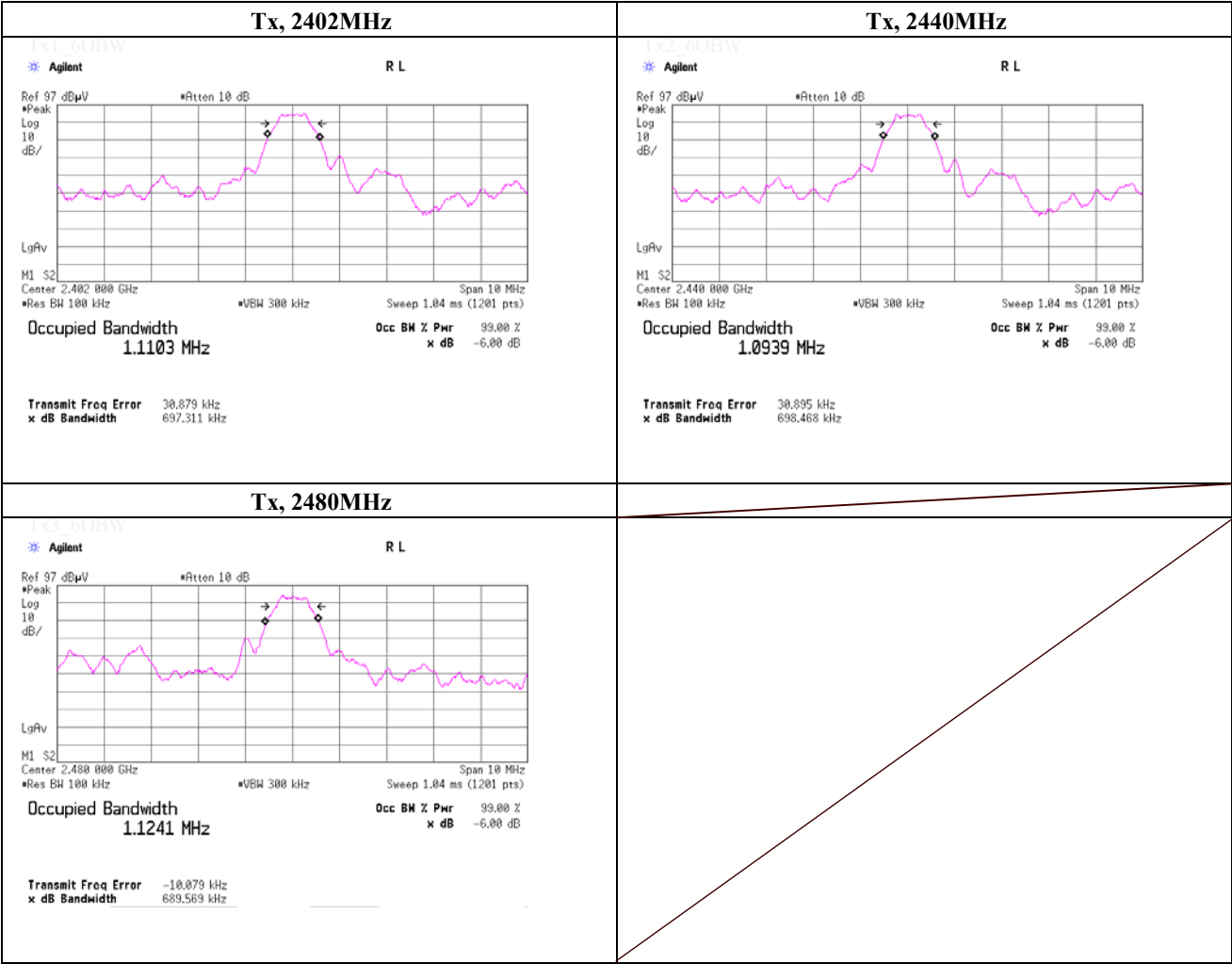
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APPENDIX 1: Data of Radio tests

-6dB Bandwidth

|                        |                                |                    |
|------------------------|--------------------------------|--------------------|
| Test place             | UL Japan, Inc. Shonan EMC Lab. | No.5 Shielded Room |
| Date                   | November 25, 2014              |                    |
| Temperature / Humidity | 21deg.C , 50%RH                |                    |
| Engineer               | Kenichi Adachi                 |                    |
| Mode                   | Tx, Bluetooth LE, PN9,         |                    |

| Freq.<br>[MHz] | -6dB Bandwidth<br>[MHz] | Limit<br>[MHz] |
|----------------|-------------------------|----------------|
| 2402.0000      | 0.697                   | > 0.500        |
| 2440.0000      | 0.698                   | > 0.500        |
| 2480.0000      | 0.690                   | > 0.500        |



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## Maximum Peak Conducted Output Power

(PKPM1)

Test place                    UL Japan, Inc. Shonan EMC Lab.            No.5 Shielded Room  
 Date                        November 25, 2014  
 Temperature / Humidity    21deg.C            , 50%RH  
 Engineer                  Kenichi Adachi  
 Mode                        Tx, Bluetooth LE, PN9,

(\* P/M: Power Meter with power sensor)

| Ch   | Freq.  | P/M (Peak)<br>Reading | Cable<br>Loss | Atten.<br>Loss | Result |      | Limit |      | Margin |
|------|--------|-----------------------|---------------|----------------|--------|------|-------|------|--------|
|      | [MHz]  | [dBm]                 | [dB]          | [dB]           | [dBm]  | [mW] | [dBm] | [mW] | [dB]   |
| Low  | 2402.0 | -13.10                | 2.38          | 9.65           | -1.07  | 0.78 | 30.00 | 1000 | 31.07  |
| Mid  | 2440.0 | -13.71                | 2.39          | 9.66           | -1.66  | 0.68 | 30.00 | 1000 | 31.66  |
| High | 2480.0 | -13.94                | 2.40          | 9.66           | -1.88  | 0.65 | 30.00 | 1000 | 31.88  |

Sample Calculation:

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

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**Maximum Conducted Output Power (Reference data)**  
(AVGPM)

Test place                   UL Japan, Inc. Shonan EMC Lab.       No.5 Shielded Room  
Date                        November 25, 2014  
Temperature / Humidity    21deg.C       , 50%RH  
Engineer                  Kenichi Adachi  
Mode                       Tx, Bluetooth LE, PN9,

(\* P/M: Power Meter with power sensor, AV: Average)

| Ch   | Freq.<br>[MHz] | P/M (AV)<br>Reading<br>[dBm] | Cable<br>Loss<br>[dB] | Atten.<br>Loss<br>[dB] |  | Result |      |
|------|----------------|------------------------------|-----------------------|------------------------|--|--------|------|
|      |                |                              |                       |                        |  | [dBm]  | [mW] |
| Low  | 2402.0         | -13.86                       | 2.38                  | 9.65                   |  | -1.83  | 0.66 |
| Mid  | 2440.0         | -14.94                       | 2.39                  | 9.66                   |  | -2.89  | 0.51 |
| High | 2480.0         | -15.57                       | 2.40                  | 9.66                   |  | -3.51  | 0.45 |

Sample Calculation:

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

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## Radiated Emission

|                        |                                        |                                         |
|------------------------|----------------------------------------|-----------------------------------------|
| Test place             | No.2 Semi Anechoic Chamber (1-26.5GHz) | No.1 Semi Anechoic Chamber (30-1000MHz) |
| Date                   | December 24, 2014                      | December 25, 2014                       |
| Temperature / Humidity | 25 deg.C, 30 %RH                       | 23 deg.C, 26 %RH                        |
| Engineer               | Hikaru Shirasawa                       | Akio Hayashi                            |
| Mode                   | Tx, 2402 MHz                           |                                         |
|                        | Tx, Bluetooth Low Energy               |                                         |

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

| Polarity | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant.Fac.<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Height<br>[cm] | Angle<br>[deg] | Remark |
|----------|--------------------|----------|-------------------|--------------------|--------------|--------------|--------------------|-------------------|----------------|----------------|----------------|--------|
| Hori.    | 48.000             | QP       | 21.5              | 11.4               | 7.4          | 31.8         | 8.5                | 40.0              | 31.5           | 150            | 0              |        |
| Hori.    | 240.000            | QP       | 21.8              | 16.9               | 9.4          | 31.8         | 16.3               | 46.0              | 29.7           | 100            | 356            |        |
| Hori.    | 2390.000           | PK       | 45.2              | 25.9               | 14.5         | 38.1         | 47.5               | 73.9              | 26.4           | 100            | 84             |        |
| Hori.    | 4804.000           | PK       | 44.9              | 30.4               | 7.5          | 36.8         | 46.0               | 73.9              | 27.9           | 103            | 123            |        |
| Hori.    | 7206.000           | PK       | 45.5              | 36.3               | 9.0          | 39.1         | 51.7               | 73.9              | 22.2           | 100            | 359            |        |
| Hori.    | 9608.000           | PK       | 42.3              | 38.3               | 9.8          | 36.9         | 53.5               | 73.9              | 20.4           | 100            | 0              |        |
| Hori.    | 12010.000          | PK       | 44.3              | 39.3               | 11.2         | 38.1         | 56.7               | 73.9              | 17.2           | 100            | 0              |        |
| Hori.    | 2390.000           | AV       | 35.9              | 25.9               | 14.5         | 38.1         | 38.2               | 53.9              | 15.7           | 100            | 84             |        |
| Hori.    | 4804.000           | AV       | 38.0              | 30.4               | 7.5          | 36.8         | 39.1               | 53.9              | 14.8           | 103            | 123            |        |
| Hori.    | 7206.000           | AV       | 35.2              | 36.3               | 9.0          | 39.1         | 41.4               | 53.9              | 12.5           | 100            | 359            |        |
| Hori.    | 9608.000           | AV       | 32.7              | 38.3               | 9.8          | 36.9         | 43.9               | 53.9              | 10.0           | 100            | 0              |        |
| Hori.    | 12010.000          | AV       | 34.2              | 39.3               | 11.2         | 38.1         | 46.6               | 53.9              | 7.3            | 100            | 0              |        |
| Vert.    | 48.000             | QP       | 21.6              | 11.4               | 7.4          | 31.8         | 8.6                | 40.0              | 31.4           | 100            | 255            |        |
| Vert.    | 240.000            | QP       | 21.8              | 16.9               | 9.4          | 31.8         | 16.3               | 46.0              | 29.7           | 100            | 359            |        |
| Vert.    | 2390.000           | PK       | 44.3              | 25.9               | 14.5         | 38.1         | 46.6               | 73.9              | 27.3           | 100            | 162            |        |
| Vert.    | 4804.000           | PK       | 43.5              | 30.4               | 7.5          | 36.8         | 44.6               | 73.9              | 29.3           | 100            | 260            |        |
| Vert.    | 7206.000           | PK       | 44.8              | 36.3               | 9.0          | 39.1         | 51.0               | 73.9              | 22.9           | 100            | 0              |        |
| Vert.    | 9608.000           | PK       | 41.2              | 38.3               | 9.8          | 36.9         | 52.4               | 73.9              | 21.5           | 100            | 0              |        |
| Vert.    | 12010.000          | PK       | 43.7              | 39.3               | 11.2         | 38.1         | 56.1               | 73.9              | 17.8           | 100            | 0              |        |
| Vert.    | 2390.000           | AV       | 35.8              | 25.9               | 14.5         | 38.1         | 38.1               | 53.9              | 15.8           | 100            | 162            |        |
| Vert.    | 4804.000           | AV       | 37.2              | 30.4               | 7.5          | 36.8         | 38.3               | 53.9              | 15.6           | 100            | 260            |        |
| Vert.    | 7206.000           | AV       | 35.2              | 36.3               | 9.0          | 39.1         | 41.4               | 53.9              | 12.5           | 100            | 0              |        |
| Vert.    | 9608.000           | AV       | 32.5              | 38.3               | 9.8          | 36.9         | 43.7               | 53.9              | 10.2           | 100            | 0              |        |
| Vert.    | 12010.000          | AV       | 34.4              | 39.3               | 11.2         | 38.1         | 46.8               | 53.9              | 7.1            | 100            | 0              |        |

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18GHz)-Distance factor(above 15GHz)) - Gain(Amplifier)

Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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

| Polarity | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant.Fac.<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark  |
|----------|--------------------|----------|-------------------|--------------------|--------------|--------------|--------------------|-------------------|----------------|---------|
| Hori.    | 2402.000           | PK       | 85.1              | 25.9               | 14.5         | 38.1         | 87.4               | -                 | -              | Carrier |
| Hori.    | 2400.000           | PK       | 46.1              | 25.9               | 14.5         | 38.1         | 48.4               | 67.4              | 19.0           |         |
| Vert.    | 2402.000           | PK       | 83.2              | 25.9               | 14.5         | 38.1         | 85.5               | -                 | -              | Carrier |
| Vert.    | 2400.000           | PK       | 44.1              | 25.9               | 14.5         | 38.1         | 46.4               | 65.5              | 19.1           |         |

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18GHz)-Distance factor(above 15GHz)) - Gain(Amplifier)

Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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## Radiated Emission

|                        |                                          |                                         |
|------------------------|------------------------------------------|-----------------------------------------|
| Test place             | No.2 Semi Anechoic Chamber (1-26.5GHz)   | No.1 Semi Anechoic Chamber (30-1000MHz) |
| Date                   | December 24, 2014                        | December 25, 2014                       |
| Temperature / Humidity | 25 deg.C, 30 %RH                         | 23 deg.C, 26 %RH                        |
| Engineer               | Hikaru Shirasawa                         | Akio Hayashi                            |
| Mode                   | Tx, 2440 MHz<br>Tx, Bluetooth Low Energy |                                         |

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

| Polarity | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant.Fac.<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Height<br>[cm] | Angle<br>[deg] | Remark |
|----------|--------------------|----------|-------------------|--------------------|--------------|--------------|--------------------|-------------------|----------------|----------------|----------------|--------|
| Hori.    | 48.000             | QP       | 21.6              | 11.4               | 7.4          | 31.8         | 8.6                | 40.0              | 31.4           | 150            | 355            |        |
| Hori.    | 240.000            | QP       | 21.9              | 16.9               | 9.4          | 31.8         | 16.4               | 46.0              | 29.6           | 100            | 7              |        |
| Hori.    | 4880.000           | PK       | 45.2              | 30.7               | 7.6          | 36.8         | 46.7               | 73.9              | 27.2           | 100            | 5              |        |
| Hori.    | 7320.000           | PK       | 45.0              | 36.4               | 8.9          | 39.1         | 51.2               | 73.9              | 22.7           | 100            | 359            |        |
| Hori.    | 9760.000           | PK       | 41.6              | 38.3               | 9.9          | 37.0         | 52.8               | 73.9              | 21.1           | 100            | 0              |        |
| Hori.    | 12200.000          | PK       | 44.0              | 39.2               | 11.2         | 38.0         | 56.4               | 73.9              | 17.5           | 100            | 359            |        |
| Hori.    | 4880.000           | AV       | 39.0              | 30.7               | 7.6          | 36.8         | 40.5               | 53.9              | 13.4           | 100            | 5              |        |
| Hori.    | 7320.000           | AV       | 35.5              | 36.4               | 8.9          | 39.1         | 41.7               | 53.9              | 12.2           | 100            | 359            |        |
| Hori.    | 9760.000           | AV       | 32.5              | 38.3               | 9.9          | 37.0         | 43.7               | 53.9              | 10.2           | 100            | 0              |        |
| Hori.    | 12200.000          | AV       | 34.3              | 39.2               | 11.2         | 38.0         | 46.7               | 53.9              | 7.2            | 100            | 359            |        |
| Vert.    | 48.000             | QP       | 21.7              | 11.4               | 7.4          | 31.8         | 8.7                | 40.0              | 31.3           | 100            | 0              |        |
| Vert.    | 240.000            | QP       | 21.7              | 16.9               | 9.4          | 31.8         | 16.2               | 46.0              | 29.8           | 100            | 0              |        |
| Vert.    | 4880.000           | PK       | 44.9              | 30.7               | 7.6          | 36.8         | 46.4               | 73.9              | 27.5           | 100            | 258            |        |
| Vert.    | 7320.000           | PK       | 45.3              | 36.4               | 8.9          | 39.1         | 51.5               | 73.9              | 22.4           | 100            | 0              |        |
| Vert.    | 9760.000           | PK       | 42.7              | 38.3               | 9.9          | 37.0         | 53.9               | 73.9              | 20.0           | 100            | 359            |        |
| Vert.    | 12202.000          | PK       | 43.4              | 39.2               | 11.2         | 38.0         | 55.8               | 73.9              | 18.1           | 100            | 0              |        |
| Vert.    | 4880.000           | AV       | 38.6              | 30.7               | 7.6          | 36.8         | 40.1               | 53.9              | 13.8           | 100            | 258            |        |
| Vert.    | 7320.000           | AV       | 35.6              | 36.4               | 8.9          | 39.1         | 41.8               | 53.9              | 12.1           | 100            | 0              |        |
| Vert.    | 9760.000           | AV       | 32.9              | 38.3               | 9.9          | 37.0         | 44.1               | 53.9              | 9.8            | 100            | 359            |        |
| Vert.    | 12202.000          | AV       | 33.9              | 39.2               | 11.2         | 38.0         | 46.3               | 53.9              | 7.6            | 100            | 0              |        |

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18GHz)-Distance factor(above 15GHz)) - Gain(Amplifier)

Distance factor : 15GHz -40GHz :  $20\log(3.0\text{m}/1.0\text{m}) = 9.5\text{dB}$ **UL Japan, Inc.****Shonan EMC Lab.**

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## Radiated Emission

|                        |                                          |                                         |
|------------------------|------------------------------------------|-----------------------------------------|
| Test place             | No.2 Semi Anechoic Chamber (1-26.5GHz)   | No.1 Semi Anechoic Chamber (30-1000MHz) |
| Date                   | December 24, 2014                        | December 25, 2014                       |
| Temperature / Humidity | 25 deg.C, 30 %RH                         | 23 deg.C, 26 %RH                        |
| Engineer               | Hikaru Shirasawa                         | Akio Hayashi                            |
| Mode                   | Tx, 2480 MHz<br>Tx, Bluetooth Low Energy |                                         |

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

| Polarity | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant.Fac.<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Height<br>[cm] | Angle<br>[deg] | Remark |
|----------|--------------------|----------|-------------------|--------------------|--------------|--------------|--------------------|-------------------|----------------|----------------|----------------|--------|
| Hori.    | 48.000             | QP       | 21.5              | 11.4               | 7.4          | 31.8         | 8.5                | 40.0              | 31.5           | 150            | 354            |        |
| Hori.    | 240.000            | QP       | 21.8              | 16.9               | 9.4          | 31.8         | 16.3               | 46.0              | 29.7           | 100            | 0              |        |
| Hori.    | 2483.500           | PK       | 48.2              | 25.9               | 14.6         | 38.0         | 50.7               | 73.9              | 23.2           | 100            | 0              |        |
| Hori.    | 4960.000           | PK       | 45.4              | 31.0               | 7.7          | 36.7         | 47.4               | 73.9              | 26.5           | 100            | 102            |        |
| Hori.    | 7440.000           | PK       | 45.1              | 36.5               | 9.0          | 39.2         | 51.4               | 73.9              | 22.5           | 100            | 359            |        |
| Hori.    | 9920.000           | PK       | 43.0              | 38.4               | 9.8          | 37.1         | 54.1               | 73.9              | 19.8           | 100            | 0              |        |
| Hori.    | 12400.000          | PK       | 43.9              | 39.1               | 11.4         | 37.9         | 56.5               | 73.9              | 17.4           | 100            | 359            |        |
| Hori.    | 2483.500           | AV       | 40.0              | 25.9               | 14.6         | 38.0         | 42.5               | 53.9              | 11.4           | 100            | 0              |        |
| Hori.    | 4960.000           | AV       | 38.8              | 31.0               | 7.7          | 36.7         | 40.8               | 53.9              | 13.1           | 100            | 102            |        |
| Hori.    | 7440.000           | AV       | 35.5              | 36.5               | 9.0          | 39.2         | 41.8               | 53.9              | 12.1           | 100            | 359            |        |
| Hori.    | 9920.000           | AV       | 33.6              | 38.4               | 9.8          | 37.1         | 44.7               | 53.9              | 9.2            | 100            | 0              |        |
| Hori.    | 12400.000          | AV       | 34.9              | 39.1               | 11.4         | 37.9         | 47.5               | 53.9              | <b>6.4</b>     | 100            | 359            |        |
| Vert.    | 48.000             | QP       | 21.6              | 11.4               | 7.4          | 31.8         | 8.6                | 40.0              | 31.4           | 100            | 10             |        |
| Vert.    | 240.000            | QP       | 21.9              | 16.9               | 9.4          | 31.8         | 16.4               | 46.0              | 29.6           | 100            | 359            |        |
| Vert.    | 2483.500           | PK       | 46.9              | 25.9               | 14.6         | 38.0         | 49.4               | 73.9              | 24.5           | 100            | 0              |        |
| Vert.    | 4960.000           | PK       | 46.2              | 31.0               | 7.7          | 36.7         | 48.2               | 73.9              | 25.7           | 100            | 238            |        |
| Vert.    | 7440.000           | PK       | 44.7              | 36.5               | 9.0          | 39.2         | 51.0               | 73.9              | 22.9           | 100            | 0              |        |
| Vert.    | 9920.000           | PK       | 42.8              | 38.4               | 9.8          | 37.1         | 53.9               | 73.9              | 20.0           | 100            | 359            |        |
| Vert.    | 12400.000          | PK       | 44.7              | 39.1               | 11.4         | 37.9         | 57.3               | 73.9              | 16.6           | 100            | 0              |        |
| Vert.    | 2483.500           | AV       | 39.1              | 25.9               | 14.6         | 38.0         | 41.6               | 53.9              | 12.3           | 100            | 0              |        |
| Vert.    | 4960.000           | AV       | 41.0              | 31.0               | 7.7          | 36.7         | 43.0               | 53.9              | 10.9           | 100            | 238            |        |
| Vert.    | 7440.000           | AV       | 35.4              | 36.5               | 9.0          | 39.2         | 41.7               | 53.9              | 12.2           | 100            | 0              |        |
| Vert.    | 9920.000           | AV       | 33.4              | 38.4               | 9.8          | 37.1         | 44.5               | 53.9              | 9.4            | 100            | 359            |        |
| Vert.    | 12400.000          | AV       | 34.7              | 39.1               | 11.4         | 37.9         | 47.3               | 53.9              | 6.6            | 100            | 0              |        |

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18GHz)-Distance factor(above 15GHz)) - Gain(Amplifier)

Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

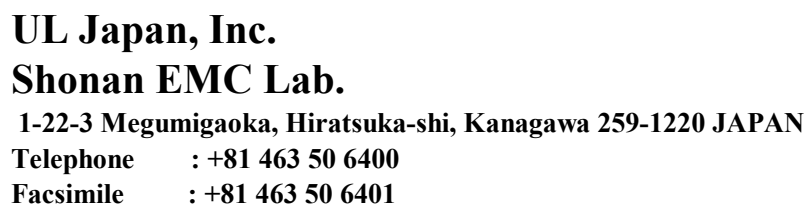
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**Tx, Bluetooth LE, PN9,**



Test place

UL Japan, Inc. Shonan EMC Lab. No.5 Shielded Room

Date

November 25, 2014

Temperature / Humidity

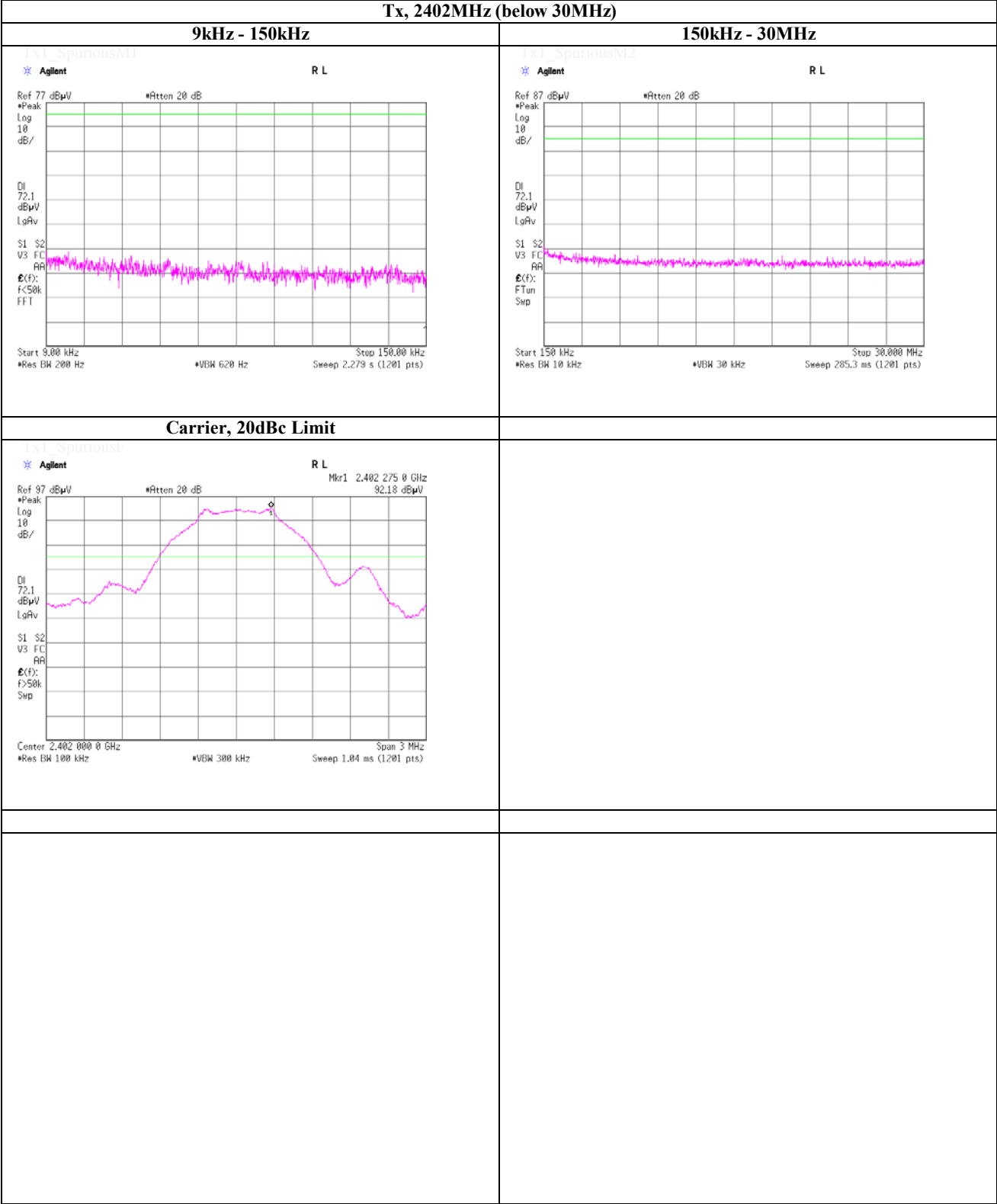
21deg.C , 50%RH

Engineer

Kenichi Adachi

Spurious emission (Conducted)

Tx, Bluetooth LE, PN9,  
Tx, 2402MHz (below 30MHz)



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Test place

UL Japan, Inc. Shonan EMC Lab. No.5 Shielded Room

Date

November 25, 2014

Temperature / Humidity

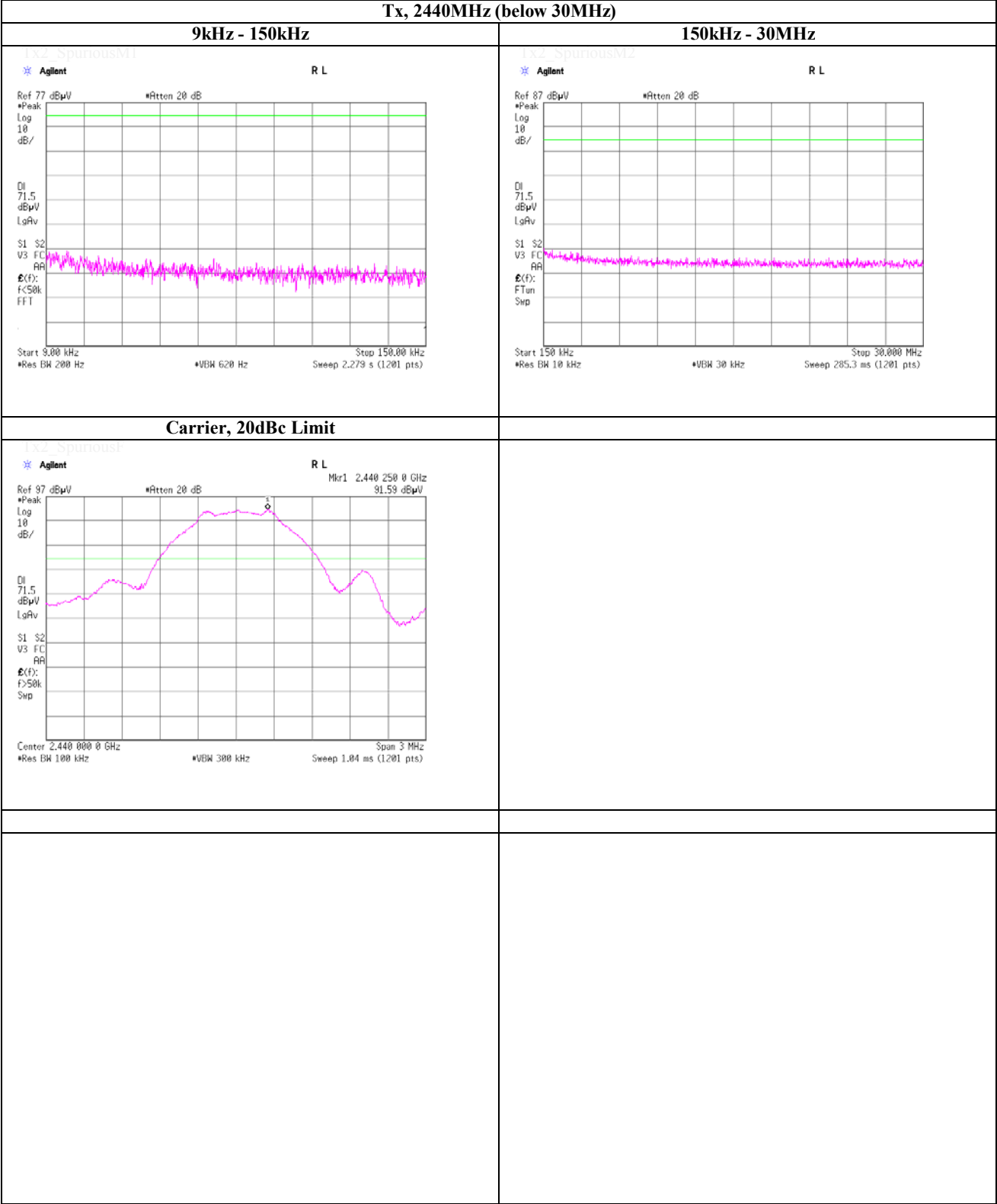
21deg.C , 50%RH

Engineer

Kenichi Adachi

Spurious emission (Conducted)

Tx, Bluetooth LE, PN9,  
Tx, 2440MHz (below 30MHz)



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Test place

UL Japan, Inc. Shonan EMC Lab. No.5 Shielded Room

Date

November 25, 2014

Temperature / Humidity

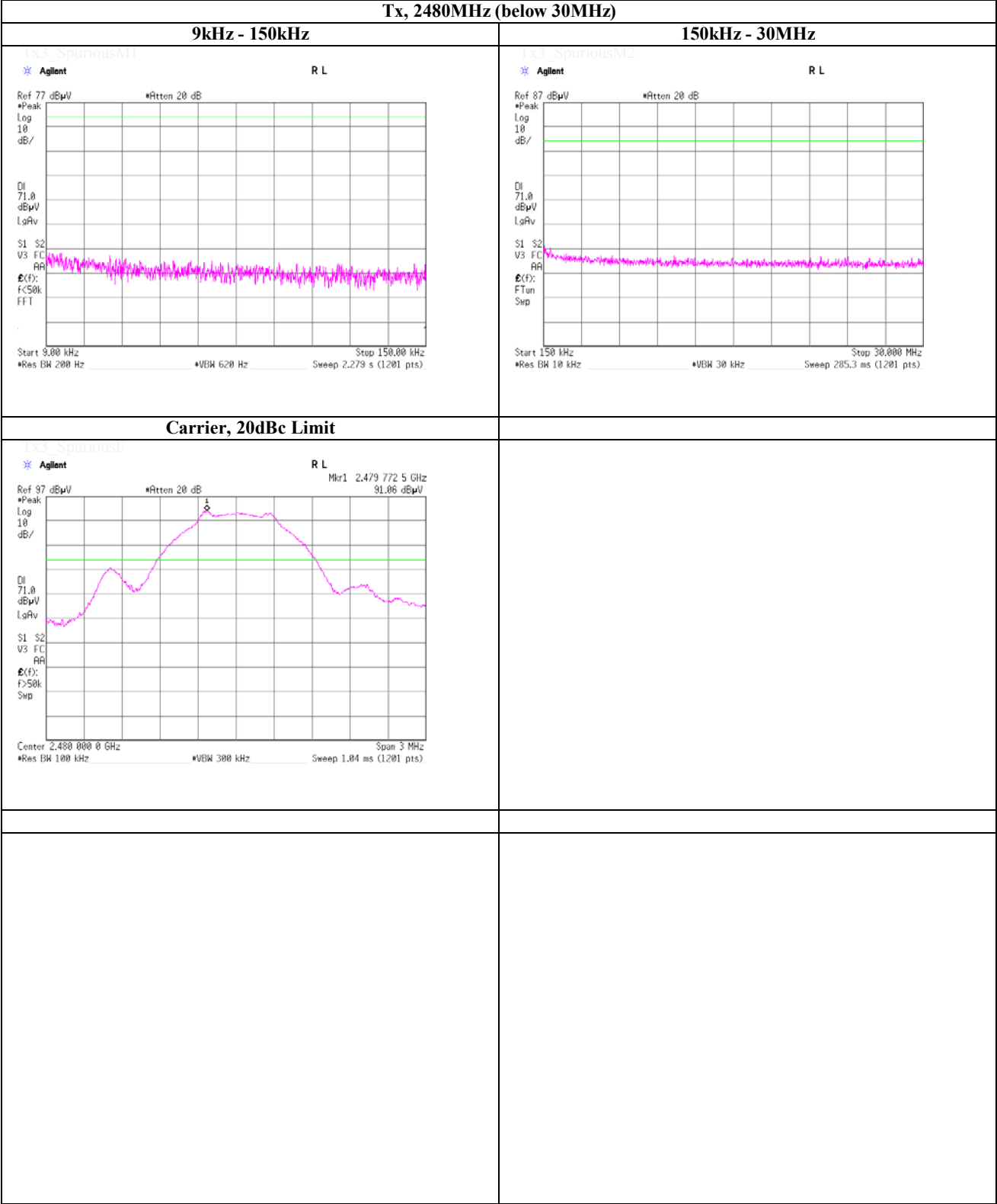
21deg.C , 50%RH

Engineer

Kenichi Adachi

Spurious emission (Conducted)

Tx, Bluetooth LE, PN9,  
Tx, 2480MHz (below 30MHz)



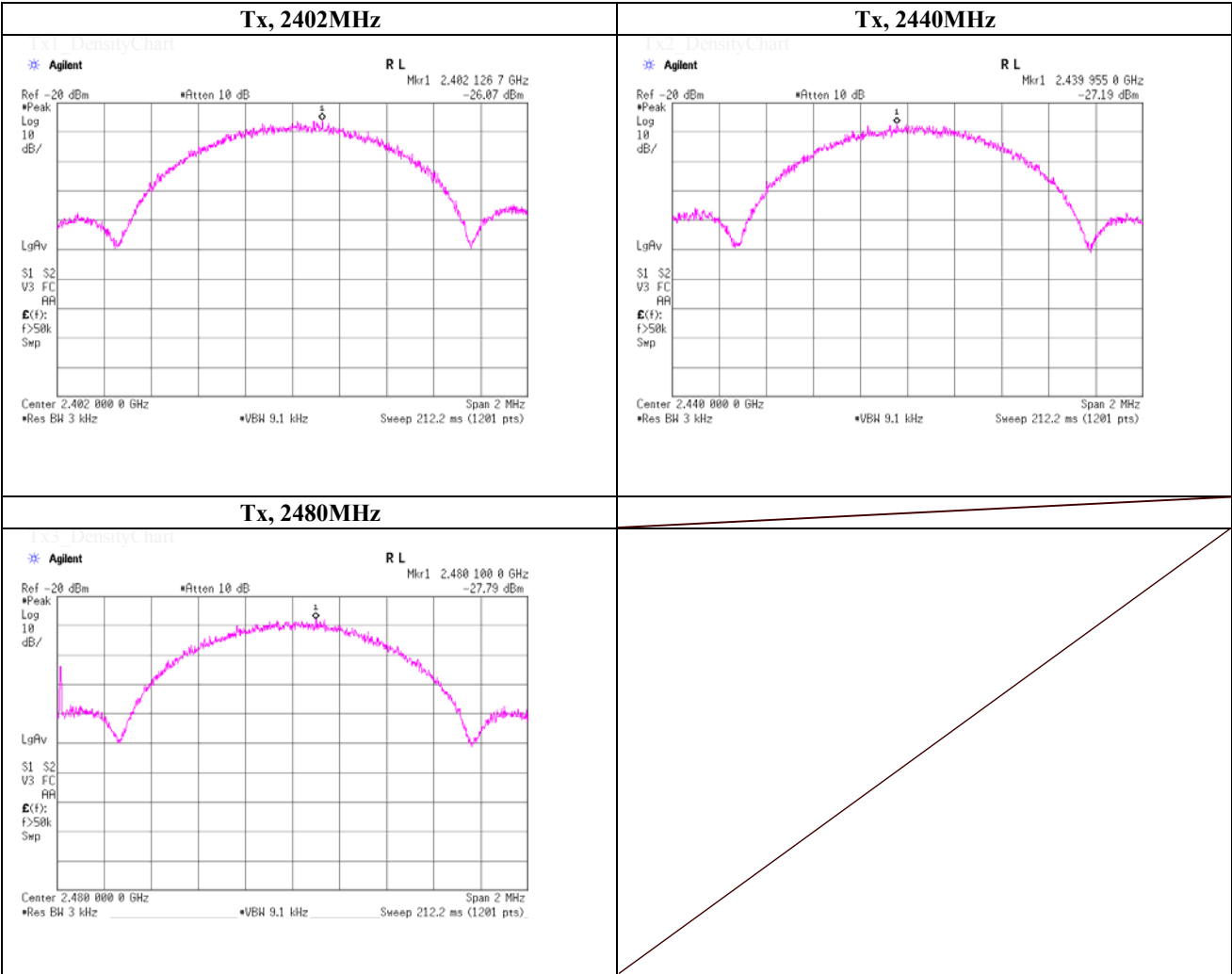
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**Maximum Power Spectral Density**  
(PKPSD)

|                        |                                |                    |
|------------------------|--------------------------------|--------------------|
| Test place             | UL Japan, Inc. Shonan EMC Lab. | No.5 Shielded Room |
| Date                   | November 25, 2014              |                    |
| Temperature / Humidity | 21deg.C , 50%RH                |                    |
| Engineer               | Kenichi Adachi                 |                    |
| Mode                   | Tx, Bluetooth LE, PN9,         |                    |

| Ch. Freq. | Freq. Reading | Reading | Cable Loss | Atten. | Result | Limit | Margin |
|-----------|---------------|---------|------------|--------|--------|-------|--------|
| [MHz]     | [MHz]         | [dBm]   | [dB]       | [dB]   | [dBm]  | [dBm] | [dB]   |
| 2402.0000 | 2402.13       | -26.07  | 2.38       | 9.65   | -14.04 | 8.00  | 22.04  |
| 2440.0000 | 2439.96       | -27.19  | 2.39       | 9.66   | -15.14 | 8.00  | 23.14  |
| 2480.0000 | 2480.10       | -27.79  | 2.40       | 9.66   | -15.73 | 8.00  | 23.73  |

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



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Test place

UL Japan, Inc. Shonan EMC Lab. No.5 Shielded Room

Date

November 25, 2014

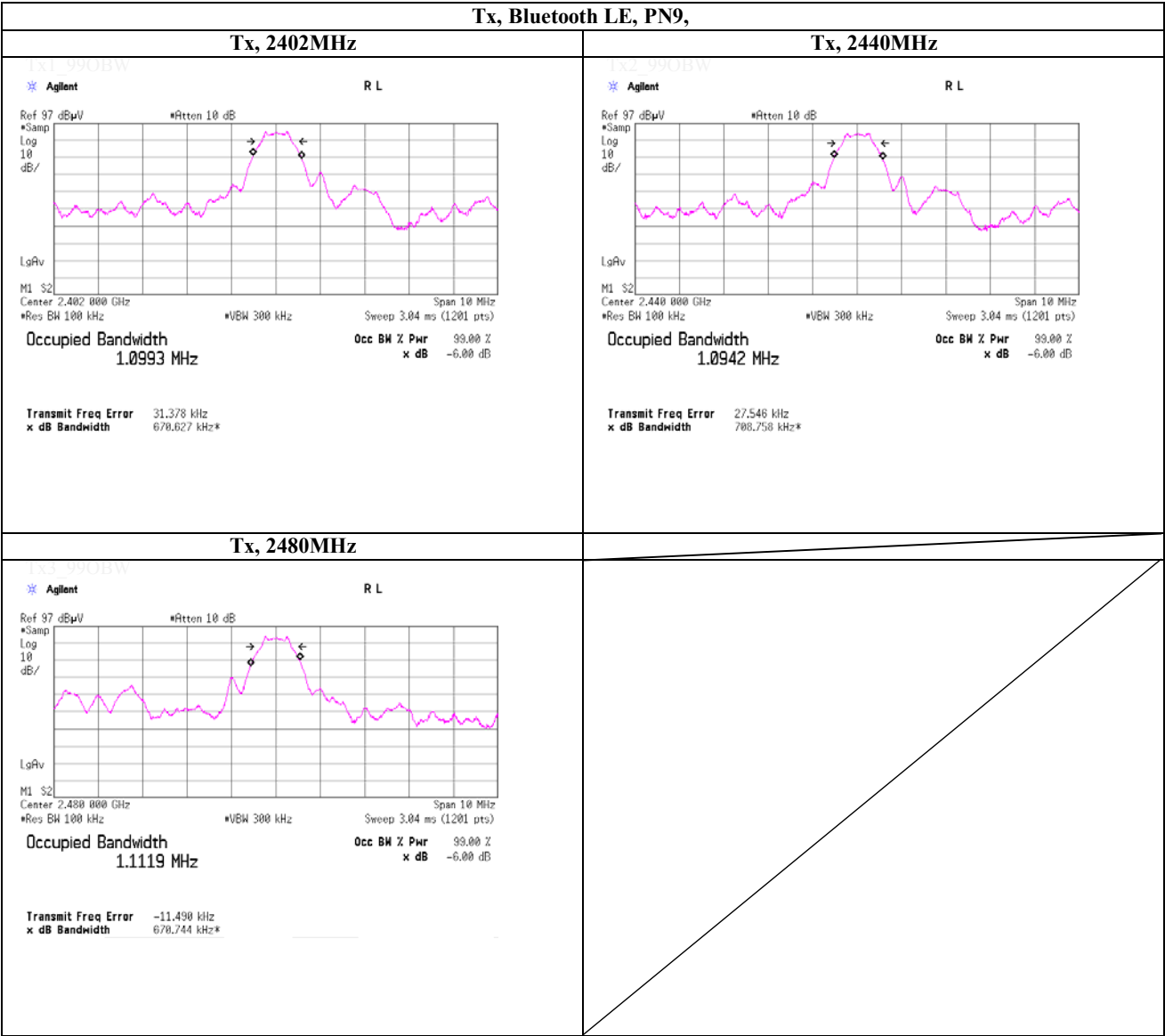
Temperature / Humidity

21deg.C , 50%RH

Engineer

Kenichi Adachi

99% Occupied Bandwidth



UL Japan, Inc.

Shonan EMC Lab.

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## APPENDIX 2

### Test Instruments

#### EMI test equipment

| Control No.                    | Instrument                | Manufacturer                                | Model No                                   | Serial No               | Test Item | Calibration Date<br>* Interval(month) |
|--------------------------------|---------------------------|---------------------------------------------|--------------------------------------------|-------------------------|-----------|---------------------------------------|
| SSA-03                         | Spectrum Analyzer         | Agilent                                     | E4448A                                     | MY48250152              | AT        | 2014/02/03 * 12                       |
| SPM-06                         | Power Meter               | Anritsu                                     | ML2495A                                    | 0850009                 | AT        | 2014/04/08 * 12                       |
| SPSS-03                        | Power sensor              | Anritsu                                     | MA2411B                                    | 0917063                 | AT        | 2014/04/08 * 12                       |
| SCC-G13                        | Coaxial Cable             | Suhner                                      | SUCOFLEX 102                               | 31599/2                 | AT        | 2014/03/14 * 12                       |
| SAT10-09                       | Attenuator                | Weinschel Corp.                             | 54A-10                                     | W5692                   | AT        | 2014/11/21 * 12                       |
| SOS-09                         | Humidity Indicator        | A&D                                         | AD-5681                                    | 4061484                 | AT        | 2014/12/24 * 12                       |
| SAEC-02(NSA)                   | Semi-Anechoic Chamber     | TDK                                         | SAEC-02(NSA)                               | 2                       | RE        | 2014/07/08 * 12                       |
| SAF-05                         | Pre Amplifier             | TOYO Corporation                            | TPA0118-36                                 | 1440490                 | RE        | 2014/11/21 * 12                       |
| SCC-G02                        | Coaxial Cable             | Suhner                                      | SUCOFLEX 104A                              | 46498/4A                | RE        | 2014/04/22 * 12                       |
| SCC-G22                        | Coaxial Cable             | Suhner                                      | SUCOFLEX 104                               | 296199/4                | RE        | 2014/05/15 * 12                       |
| SHA-02                         | Horn Antenna              | Schwarzbeck                                 | BBHA9120D                                  | 9120D-726               | RE        | 2014/08/12 * 12                       |
| SOS-03                         | Humidity Indicator        | A&D                                         | AD-5681                                    | 4063325                 | RE        | 2014/10/30 * 12                       |
| STR-07                         | Test Receiver             | Rohde & Schwarz                             | ESU26                                      | 100484                  | RE        | 2014/09/03 * 12                       |
| SJM-14                         | Measure                   | ASKUL                                       | -                                          | -                       | RE        | -                                     |
| COTS-SEMI-1                    | EMI Software              | TSJ                                         | TEPTO-DV(RE,CE,<br>RFL,MF)                 | -                       | RE        | -                                     |
| SAT10-06                       | Attenuator                | Agilent                                     | 8493C-010                                  | 74865                   | RE        | 2014/11/21 * 12                       |
| SFL-02                         | Highpass Filter           | MICRO-TRONICS                               | HPM50111                                   | 051                     | RE        | 2014/11/21 * 12                       |
| SHA-04                         | Horn Antenna              | ETS LINDGREN                                | 3160-09                                    | LM3640                  | RE        | 2014/03/15 * 12                       |
| SAF-08                         | Pre Amplifier             | TOYO Corporation                            | HAP18-26W                                  | 00000019                | RE        | 2014/03/14 * 12                       |
| SCC-G15                        | Coaxial Cable             | Suhner                                      | SUCOFLEX 102                               | 32703/2                 | RE        | 2014/03/13 * 12                       |
| SAF-01                         | Pre Amplifier             | SONOMA                                      | 310N                                       | 290211                  | RE        | 2014/02/17 * 12                       |
| KAT6-04                        | Attenuator                | INMET                                       | 18N-6dB                                    | -                       | RE        | 2014/12/19 * 12                       |
| SAT3-09                        | Attenuator                | JFW                                         | 50HF-003N                                  | -                       | RE        | 2014/09/02 * 12                       |
| SBA-01                         | Biconical Antenna         | Schwarzbeck                                 | BBA9106                                    | 91032664                | RE        | 2014/10/18 * 12                       |
| SCC-A1/A3/A5/A7/A8/A13/SRSE-01 | Coaxial Cable&RF Selector | Fujikura/Fujikura/Suhner/Suhner/Suhner/TOYO | 8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906 | -/0901-269(RF Selector) | RE        | 2014/04/25 * 12                       |
| SCC-A2/A4/A6/A7/A8/A13/SRSE-01 | Coaxial Cable&RF Selector | Fujikura/Fujikura/Suhner/Suhner/Suhner/TOYO | 8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906 | -/0901-269(RF Selector) | RE        | 2014/04/25 * 12                       |
| SLA-01                         | Logperiodic Antenna       | Schwarzbeck                                 | UHALP9108A                                 | UHALP 9108-A 0888       | RE        | 2014/10/18 * 12                       |
| SOS-01                         | Humidity Indicator        | A&D                                         | AD-5681                                    | 4062555                 | RE        | 2014/10/30 * 12                       |
| STR-01                         | Test Receiver             | Rohde & Schwarz                             | ESU40                                      | 100093                  | RE        | 2014/11/11 * 12                       |
| SJM-13                         | Measure                   | ASKUL                                       | -                                          | -                       | RE        | -                                     |
| SAEC-01(NSA)                   | Semi-Anechoic Chamber     | TDK                                         | SAEC-01(NSA)                               | 1                       | RE        | 2014/07/09 * 12                       |
|                                |                           |                                             |                                            |                         |           |                                       |
|                                |                           |                                             |                                            |                         |           |                                       |

The expiration date of the calibration is the end of the expired month .

As for some calibrations performed after the tested dates , those test equipment have been controlled by means of an unbroken chains of calibrations .

All equipment is calibrated with valid calibrations . Each measurement data is traceable to the national or international standards .

Test Item :

RE: Radiated emission,

AT: Antenna terminal disturbance voltage