



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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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



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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 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 ^{*1} /SR ^{*2} (±) | No.2 SAC/SR (±) | No.3 SAC/SR (±) |
|---|-----------------|---|--------------------|--------------------|
| Radiated emission (Measurement distance: 3m) | 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 |
| Radiated emission (Measurement distance: 1m) | 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 Registration No. | Width x Depth x Height (m) | Size of reference ground plane (m) / horizontal conducting plane | Maximum measurement 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

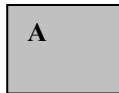
| Test item | Mode | Tested frequency |
|------------------|--|---------------------------|
| All items | Transmitting (Tx), Hopping OFF Bluetooth Low Energy (LE), Payload: PN9 | 2402MHz, 2440MHz, 2480MHz |

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 RBW: 1MHz VBW: 3MHz | RBW: 1MHz VBW: 3MHz Detector: Linear Voltage Averaging | RBW: 100kHz 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.

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 *2) | Spurious | | | |
|----------------------|-----------|-------------|------------|---------|----------|----------|
| | | | Below 1GHz | 1-15GHz | 15-18GHz | 15-25GHz |
| Horizontal | X | X | X | Z | Z | Z |
| Vertical | Y | Y | X | Z | Z | Z |

*2) with spurious emissions near carrier frequency.

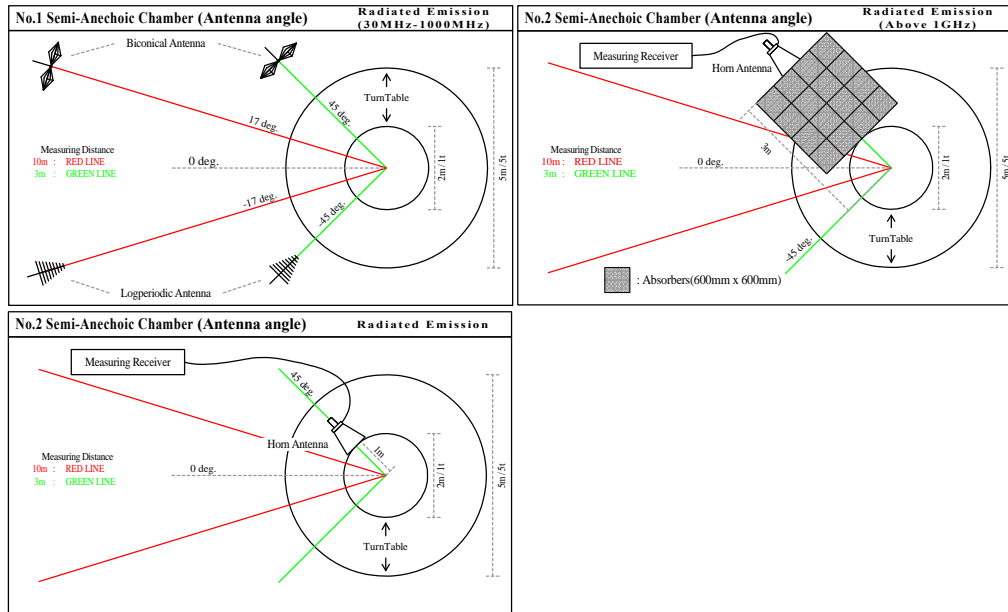


Figure 1. Antenna angle

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 5th order harmonics.
Refer to APPENDIX 1

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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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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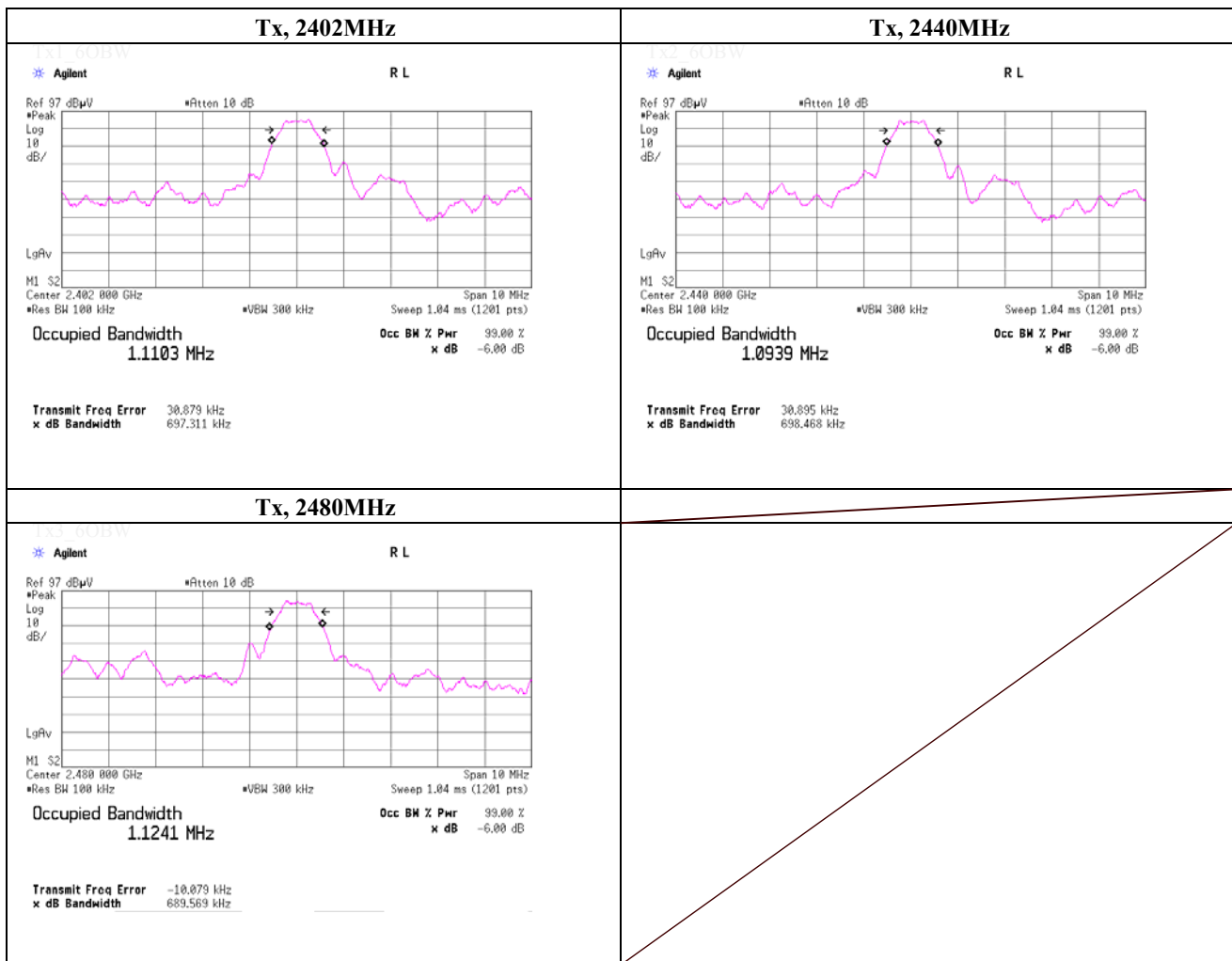
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APPENDIX 1: Data of Radio tests

-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. [MHz] | -6dB Bandwidth [MHz] | Limit [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. [MHz] | P/M (Peak) Reading [dBm] | Cable Loss [dB] | Atten. Loss [dB] | Result | | Limit | | Margin [dB] |
|------|----------------|--------------------------------|-----------------------|------------------------|--------|------|-------|------|----------------|
| | | | | | [dBm] | [mW] | [dBm] | [mW] | |
| 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. [MHz] | P/M (AV) Reading [dBm] | Cable Loss [dB] | Atten. Loss [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 [MHz] | Detector | Reading [dBuV] | Ant.Fac. [dB/m] | Loss [dB] | Gain [dB] | Result [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Height [cm] | Angle [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 [MHz] | Detector | Reading [dBuV] | Ant.Fac. [dB/m] | Loss [dB] | Gain [dB] | Result [dBuV/m] | Limit [dBuV/m] | Margin [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 Tx, Bluetooth Low Energy | |

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

| Polarity | Frequency [MHz] | Detector | Reading [dBuV] | Ant.Fac. [dB/m] | Loss [dB] | Gain [dB] | Result [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Height [cm] | Angle [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(Ampriifier)

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 Tx, Bluetooth Low Energy | |

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

| Polarity | Frequency [MHz] | Detector | Reading [dBuV] | Ant.Fac. [dB/m] | Loss [dB] | Gain [dB] | Result [dBuV/m] | Limit [dBuV/m] | Margin [dB] | Height [cm] | Angle [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 | 6.4 | 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(Ampriifier)

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

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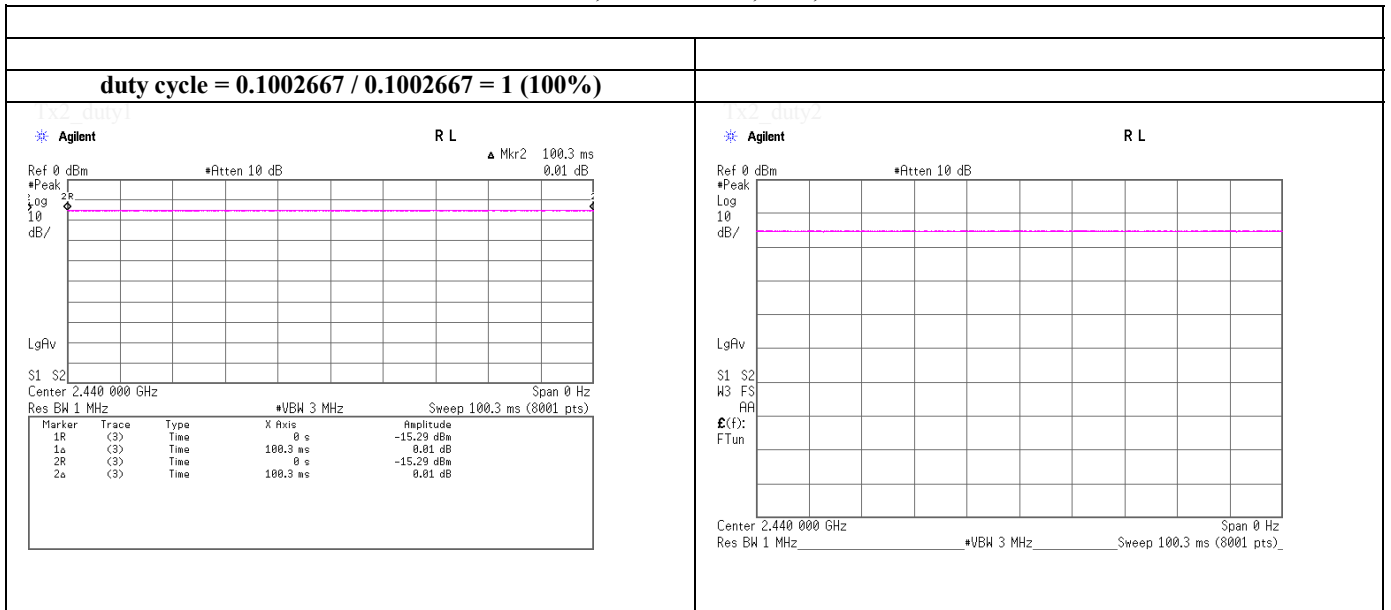
Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

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

Burst rate confirmation

Tx, Bluetooth LE, PN9,



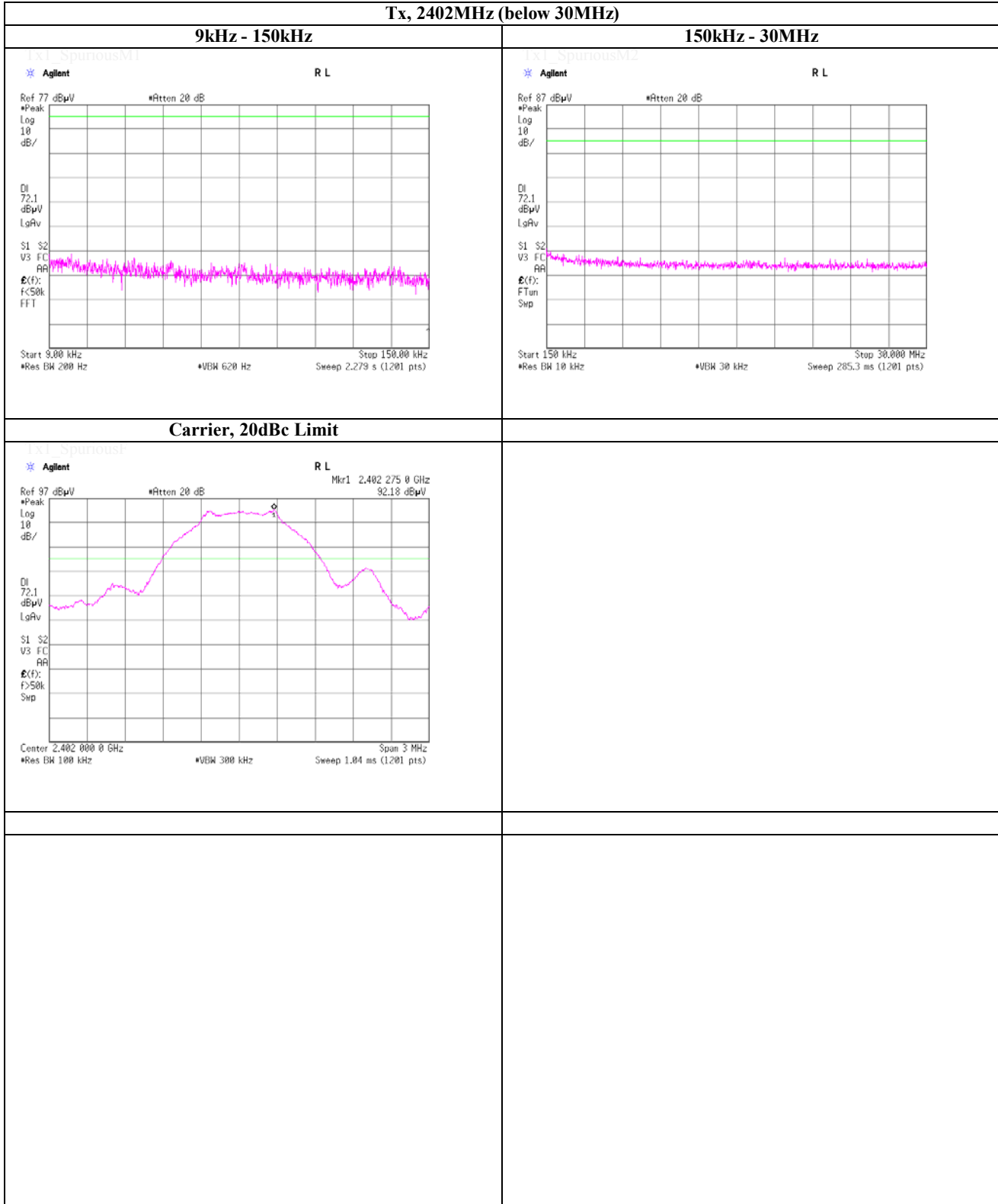
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Test place UL Japan, Inc. Shonan EMC Lab. No.5 Shielded Room
Date November 25, 2014
Temperature / Humidity 21deg.C , 50%RH
Engineer Kenichi Adachi

Spurious emission (Conducted)

Tx, Bluetooth LE, PN9,

Tx, 2402MHz (below 30MHz)

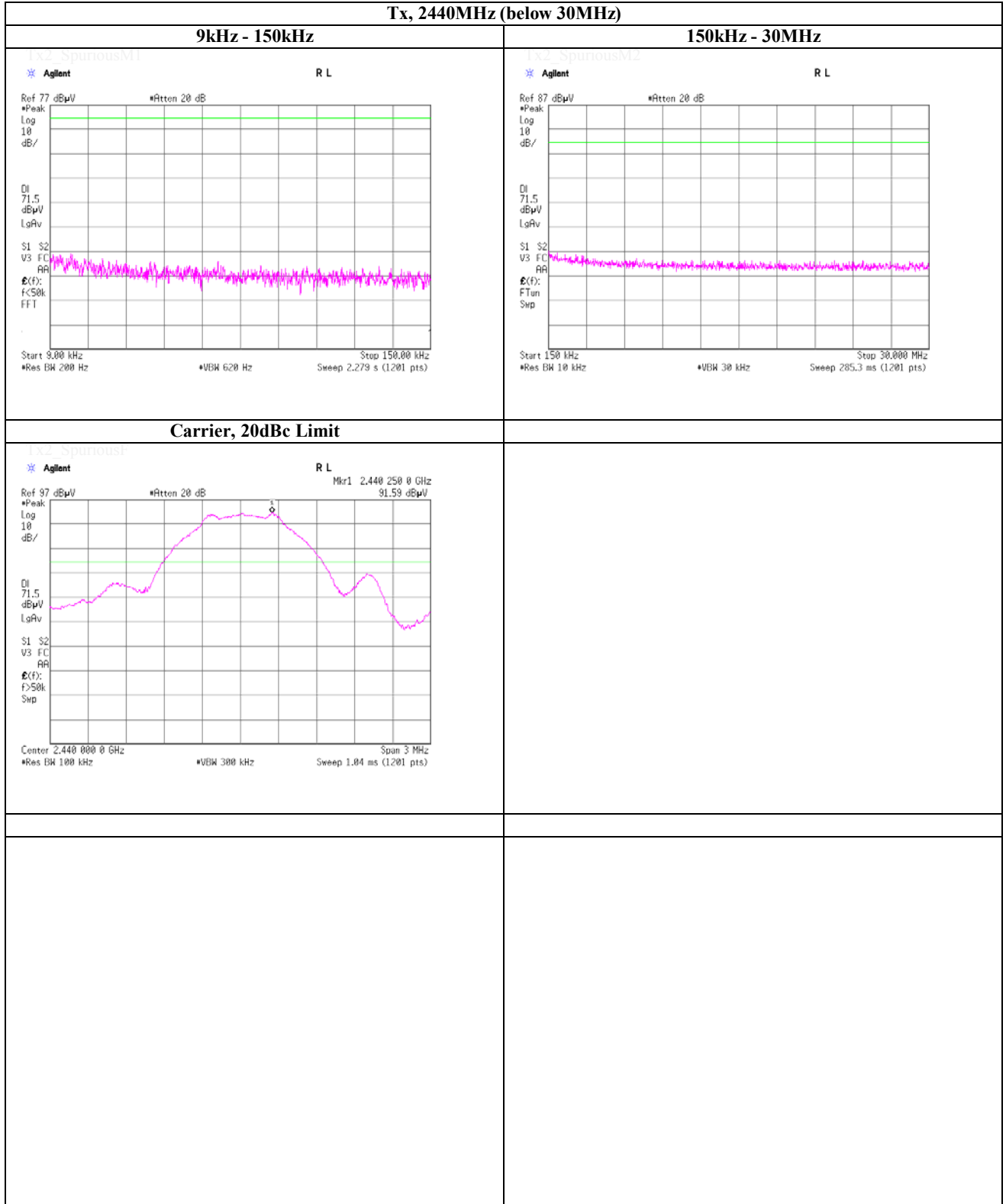


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Test place UL Japan, Inc. Shonan EMC Lab. No.5 Shielded Room
 Date November 25, 2014
 Temperature / Humidity 21deg.C , 50%RH
 Engineer Kenichi Adachi

Spurious emission (Conducted)

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



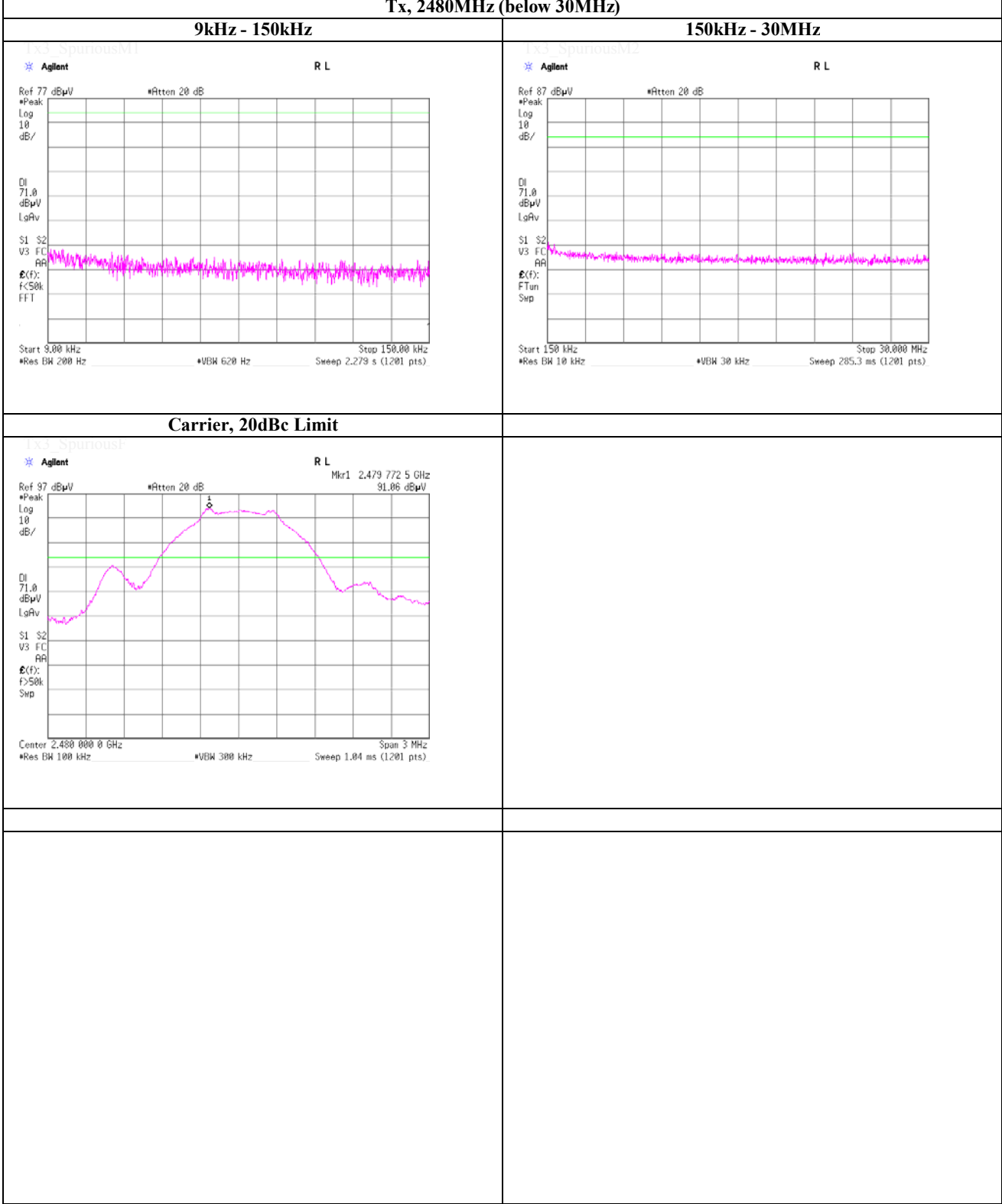
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Test place UL Japan, Inc. Shonan EMC Lab. No.5 Shielded Room
Date November 25, 2014
Temperature / Humidity 21deg.C , 50%RH
Engineer Kenichi Adachi

Spurious emission (Conducted)

Tx, Bluetooth LE, PN9,

Tx, 2480MHz (below 30MHz)



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Maximum Power Spectral Density

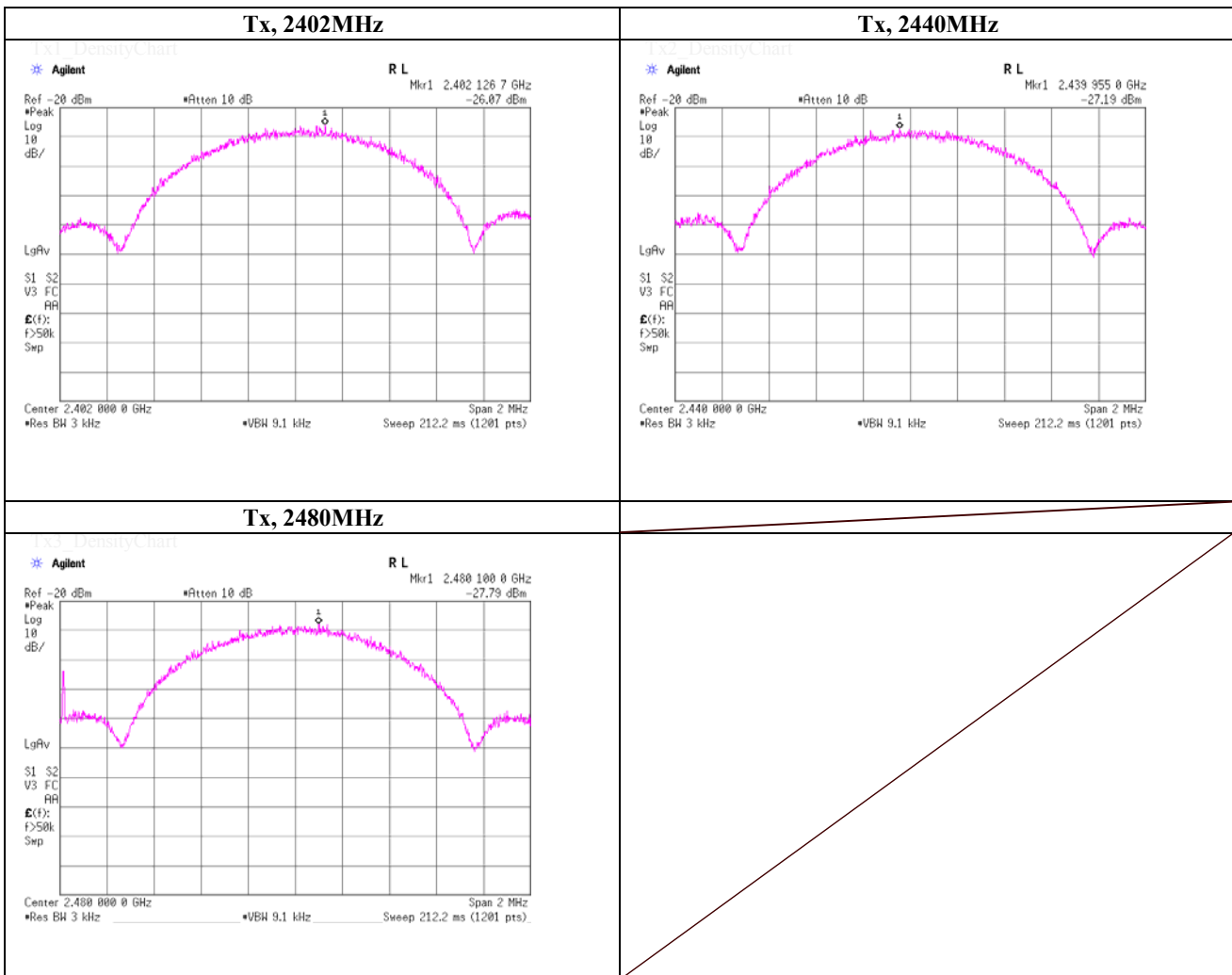
(PKPSD)

| | | |
|------------------------|--------------------------------|--------------------|
| 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. [MHz] | Freq. Reading [MHz] | Reading [dBm] | Cable Loss [dB] | Atten. [dB] | Result [dBm] | Limit [dBm] | Margin [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



UL Japan, Inc.

Shonan EMC Lab.

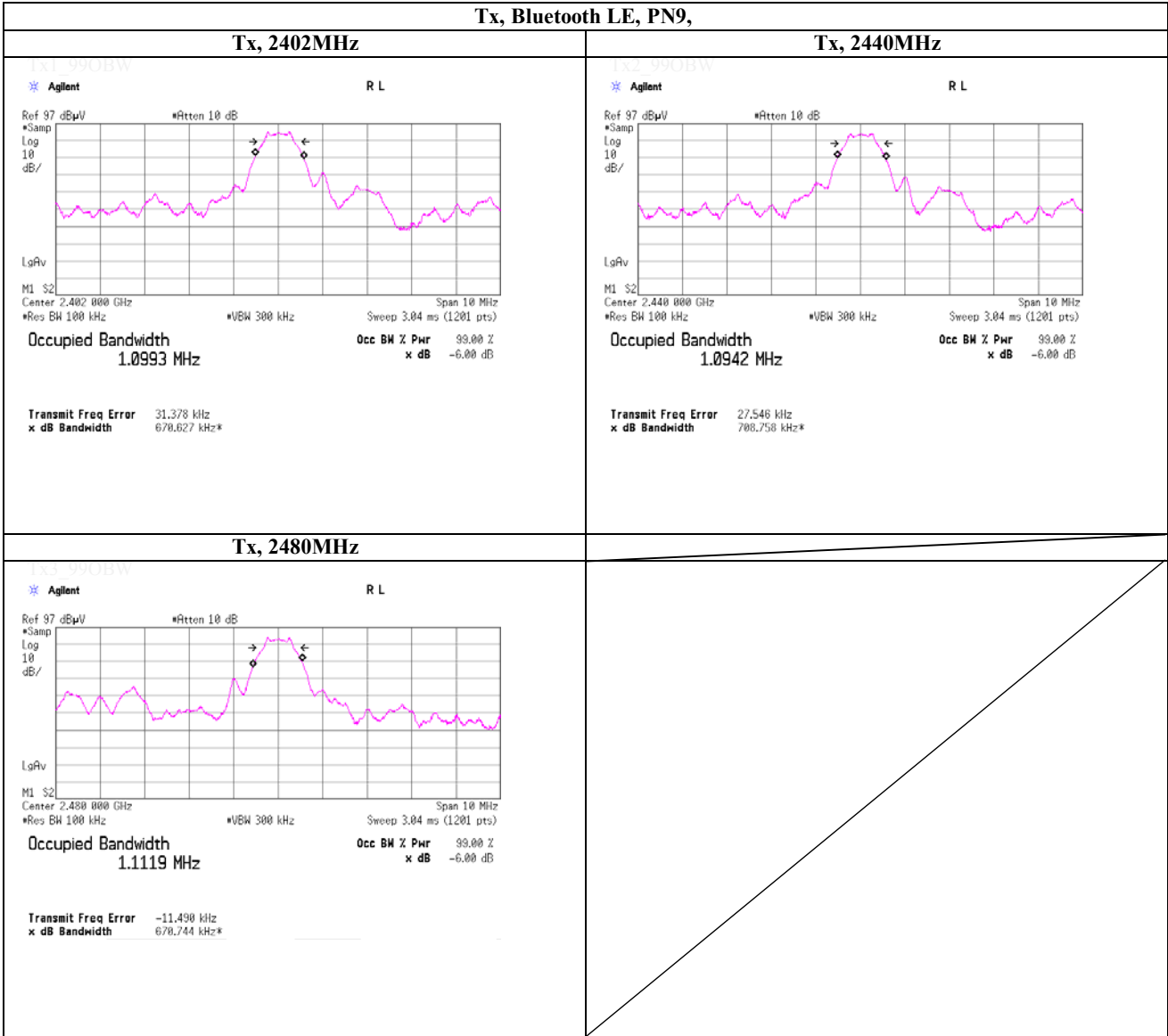
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa 259-1220 JAPAN

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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.
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APPENDIX 2 Test Instruments

EMI test equipment

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * 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, RFLMF) | - | 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-A0888 | 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