



# **RADIO TEST REPORT**

**Test Report No. : 32IE0110-SH-01-C**

**Applicant** : Sato Corporation

**Type of Equipment** : RFID Reader Module

**Model No.** : M5e

**FCC ID** : MMFRWMTM2

**Test regulation** : FCC Part15 Subpart C: 2012

**Test result** : Complied

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
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.
4. The test results in this test report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by any agency of the Federal Government.
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:** May 6 to 9, 2012

**Representative test engineer:**

Hikaru Shirasawa  
Engineer of WiSE Japan,  
UL Verification Service

**Approved by :**

Toyokazu Imamura  
Leader of WiSE Japan,  
UL Verification Service

- ☐ 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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**Shonan EMC Lab.**

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13-EM-F0429

**Original Test Report No.: 32IE0110-SH-01-C**

[illegible]

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## **SECTION 1: Customer information**

Company Name : Sato Corporation  
Brand Name : SATO  
Address : 1-7-1 Shimomeguro, Meguro-ku, Tokyo, 153-0064, Japan  
Telephone Number : +81-3-6665-0610  
Facsimile Number : +81-3-5487-8525  
Contact Person : Norikazu Koshizuka

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

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

Type of Equipment : RFID Reader Module  
Model No. : M5e  
Serial No. : 101101400912  
Rating : DC5.0V  
Receipt Date of Sample : April 27, 2012  
Country of Mass-production : USA  
Condition of EUT : Production model  
Modification of EUT : No modification by the test lab.

### **2.2 Product description**

Model: M5e (referred to as the EUT in this report) is a RFID Reader Module.

Clock frequency(ies) in the system : 18.43MHz

### **Radio specification**

Equipment type : Transceiver  
Frequency of operation : 902.75-927.25MHz  
Type of modulation : FHSS: ASK  
Antenna type : Dipole  
Antenna connector type : MMCX  
Antenna gain with cable loss : -15.47 dBi  
ITU code : G1D  
Operation temperature range : -20 to +60 deg.C.

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

The host device provides the Wireless transmitter with stable power supply (DC5.0V), therefore, the equipment complies with the requirement.

### **FCC 15.203**

The EUT has a unique coupling/antenna connector (MMCX). Therefore the equipment complies with the requirement of 15.203.

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**SECTION 3: Test specification, procedures & results****3.1 Test specification**

Test specification : FCC Part 15 Subpart C: 2012,  
final revised on March 30, 2012 and effective April 30, 2012

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 EUT complies with FCC Part 15 Subpart B. Refer to the test report 28JE0227-YK-B.

**3.2 Procedures & Results**

| Item                                                                                                                                   | Test Procedure                                                                                     | Specification             | Remarks                | Deviation | Worst Margin                                                                                                   | Results  |
|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------|------------------------|-----------|----------------------------------------------------------------------------------------------------------------|----------|
| Conducted emission                                                                                                                     | ANSI C63.4:2009<br>7. AC powerline<br>conducted emission<br>measurements                           | FCC 15.207                | -                      | N/A       | 22.9dB<br>Freq.: 3.12447MHz<br>Phase: N<br>Detection: Average<br>Mode: Transmitting 915.250MHz                 | Complied |
| Carrier frequency separation                                                                                                           | FCC Public Notice<br>DA 00-705 &<br>ANSI C63.4:2009<br>13. Measurement of<br>intentional radiators | FCC 15.247<br>(a)(1)      | Conducted              | *1)       | N/A                                                                                                            | N/A      |
| 20dB bandwidth                                                                                                                         | FCC Public Notice<br>DA 00-705 &<br>ANSI C63.4:2009<br>13. Measurement of<br>intentional radiators | FCC 15.247<br>(a)(1)      | Conducted              | *1)       |                                                                                                                | N/A      |
| Number of hopping frequency                                                                                                            | FCC Public Notice<br>DA 00-705 &<br>ANSI C63.4:2009<br>13. Measurement of<br>intentional radiators | FCC 15.247<br>(a)(1)(iii) | Conducted              | *1)       |                                                                                                                | N/A      |
| Dwell time                                                                                                                             | FCC Public Notice<br>DA 00-705 &<br>ANSI C63.4:2009<br>13. Measurement of<br>intentional radiators | FCC 15.247<br>(a)(1)(iii) | Conducted              | *1)       |                                                                                                                | N/A      |
| Maximum peak output power                                                                                                              | FCC Public Notice<br>DA 00-705 &<br>ANSI C63.4:2009<br>13. Measurement of<br>intentional radiators | FCC 15.247<br>(b)(1)      | Conducted              | *1)       |                                                                                                                | N/A      |
| Band edge compliance & Spurious emission                                                                                               | FCC Public Notice<br>DA 00-705 &<br>ANSI C63.4:2009<br>13. Measurement of<br>intentional radiators | FCC 15.247 (d)<br>15.209  | Conducted/<br>Radiated | N/A       | 0.9dB<br>Freq.: 108.102MHz<br>Polarization: Vertical<br>Detection: Quasi-Peak<br>Mode: Transmitting 902.750MHz | Complied |
| Note: UL Japan's Work Procedures No. 13-EM-W0420 and 13-EM-W0422<br>*1) Refer to the test report No.28JE0227-YK-B (FCC ID: MMFRWMTM2). |                                                                                                    |                           |                        |           |                                                                                                                |          |

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### 3.3 Addition to standard

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

### 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> (±) | No.2 SAC/SR (±) | No.3 SAC/SR (±) |
|-------------------------------------------------|-----------------|----------------------------------------------|-----------------|-----------------|
| Conducted emission<br>(AC Mains) AMN/LISN       | 150kHz-30MHz    | 3.6 dB                                       | 3.6 dB          | 3.6 dB          |
| Radiated emission<br>(Measurement distance: 3m) | 9kHz-30MHz      | 3.7 dB                                       | 3.7 dB          | 3.6 dB          |
|                                                 | 30MHz-300MHz    | 4.9 dB                                       | 5.1 dB          | 5.0 dB          |
|                                                 | 300MHz-1GHz     | 5.0 dB                                       | 5.2 dB          | 5.0 dB          |
|                                                 | 1GHz-15GHz      | 4.8 dB                                       | 4.8 dB          | 4.9 dB          |

\*1: SAC=Semi-Anechoic Chamber

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

### Conducted emission test

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

### Radiated emission test

The data listed in this report meets the limits unless the uncertainty is taken into consideration.

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### 3.5 Test location

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JAB Accreditation No. : RTL02610

|                                                                | FCC<br>Registration<br>No. | 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 type="checkbox"/> No.1 Semi-anechoic chamber            | 697847                     | 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 | 697847                     | 2973D-2                   | 20.6 x 11.3 x 7.65            | 20.6 x 11.3                                                               | 10m                                |
| <input type="checkbox"/> No.3 Semi-anechoic chamber            | 697847                     | 2973D-3                   | 12.7 x 7.7 x 5.35             | 12.7 x 7.7                                                                | 5m                                 |
| <input type="checkbox"/> No.4 Full-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 checked="" 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 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                                                                 | -                                  |

### 3.6 Test setup, Data of test & 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                                                             | Operating mode               | Tested frequency                                                                |
|-----------------------------------------------------------------------|------------------------------|---------------------------------------------------------------------------------|
| Conducted emission,<br>Band edge<br>compliance &<br>Spurious emission | Transmitting<br>-Hopping OFF | Band edge compliance:<br>902.75MHz, 927.25MHz                                   |
| (Radiated)                                                            | Transmitting                 | Conducted emission and Spurious<br>emission:<br>902.75MHz, 915.25MHz, 927.25MHz |

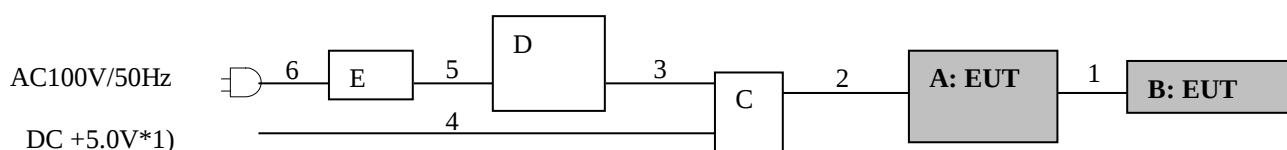
\*EUT has the power settings by the software as follows;

Power settings: 24dBm

Software: M5e TEST command VER 0.0

**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   | RFID Reader Module | M5e          | 101101400912             | ThingMagic   | EUT     |
| B   | Antenna            | -            | -                        | SATO         | EUT     |
| C   | RS232C Converter   | -            | -                        | SATO         | -       |
| D   | Laptop PC          | PP10L        | CN-0H2049-48643-541-2264 | DELL         | -       |
| E   | AC adapter         | PA-1650-05D  | CN-05U092-71615-543-6ABB | DELL         | -       |

\*1) DC Power supply (Model No.: PAN35-60A) was used DC Input

#### List of cables used

| No. | Cable    | Length (m) | Shield-Cable | Shield-Connector | Remarks |
|-----|----------|------------|--------------|------------------|---------|
| 1   | Antenna  | 0.45       | Shielded     | Shielded         | -       |
| 2   | Control  | 0.45       | Unshielded   | Unshielded       | -       |
| 3   | RS232C   | 0.9        | Shielded     | Shielded         | -       |
| 4   | DC Power | 1.0        | Unshielded   | Unshielded       | -       |
| 5   | DC       | 1.8        | Shielded     | Unshielded       | -       |
| 6   | AC Power | 0.9        | Unshielded   | Unshielded       | -       |

\* All cables used for the measurement are exclusive use or marketed.

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## **SECTION 5: Conducted 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, 1m by 2.0m, raised 0.8m above the conducting ground plane.

The table is made of Styrofoam and covered with polyvinyl chloride. That has very low permittivity.

The rear of tabletop was located 40cm to the vertical conducting plane. The rear of EUT, including peripherals was aligned and was flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. EUT was located 80cm from LISN and excess AC cable was bundled in center.

Each EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the input power source. All unused 50ohm connectors of the LISN were resistively terminated in 50ohm when not connected to the measuring equipment.

Photographs of the set up are shown in APPENDIX 3.

### **5.3 Test conditions**

Frequency range : 0.15 - 30MHz  
EUT position : Table top

### **5.4 Test procedure**

The AC Mains Terminal Continuous disturbance Voltage had been measured with the EUT via DC power supply within a shielded room. The EUT was connected to a Line Impedance Stabilization Network (LISN) via DC power supply.

An overview sweep with peak detection has been performed.

The measurements had been performed with a quasi-peak detector and if required, an average detector.

The conducted emission measurements were made with the following detector of the test receiver.

Detector Type : Quasi-Peak/ Average  
IF Bandwidth : 9kHz

### **5.5 Results**

Summary of the test results : Pass  
Refer to APPENDIX 1

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## **SECTION 9: Radiated emission**

### **9.1 Operating environment**

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

### **9.2 Test configuration**

EUT was placed on a styrofoam platform of nominal size, 0.5m by 0.5m, raised 0.8m above the conducting ground plane. Test was made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna was varied in height above the conducting ground plane to obtain the maximum signal strength. Photographs of the set up are shown in APPENDIX 3.

### **9.3 Test conditions**

Frequency range : 30MHz to 10GHz  
 EUT position : Table top

### **9.4 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. 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 and spectrum analyzer.

| Frequency      | 30 - 1000MHz | 1 - 10GHz         |                   |
|----------------|--------------|-------------------|-------------------|
| Detection Type | : Quasi-Peak | Peak              | * Average         |
| IF Bandwidth   | : 120kHz     | RBW:1MHz/VBW:3MHz | RBW:1MHz/VBW:10Hz |

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

\* Although 00-705 accepts VBW=10Hz for AV measurements, confirmed that superfluous smoothing was not performed.

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.

|         | Carrier                    | Spurious                   |                            |
|---------|----------------------------|----------------------------|----------------------------|
|         |                            | Below 1GHz                 | Above 1GHz                 |
| Module  | Horizontal :X, Vertical :Z | Horizontal :X, Vertical :Z | Horizontal :Y, Vertical :X |
| Antenna | Horizontal :Y, Vertical :Z | Horizontal :Y, Vertical :Z | Horizontal :X, Vertical :Z |

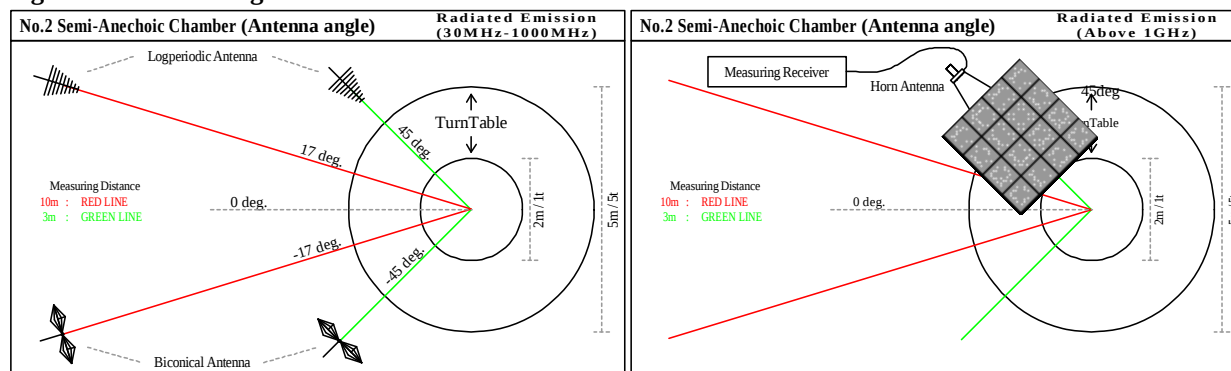
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**Figure 1. Antenna angle**

## 9.5 Band edge

Band edge level is below the limits of FCC 15.209. Refer to the data.

## 9.6 Results

Summary of the test results : Pass \*No noise was detected above the 6th order harmonics.  
Refer to APPENDIX 1

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## **Contents of APPENDIXES**

### **APPENDIX 1: Test data**

Conducted emission

Radiated emission

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

Test instruments

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

Conducted emission

Radiated emission

Pre-check of the worst position

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# DATA OF CONDUCTED EMISSION TEST

UL Japan,Inc. Shonan EMC Lab. No.2 Shielded Room  
Date : 2012/05/09

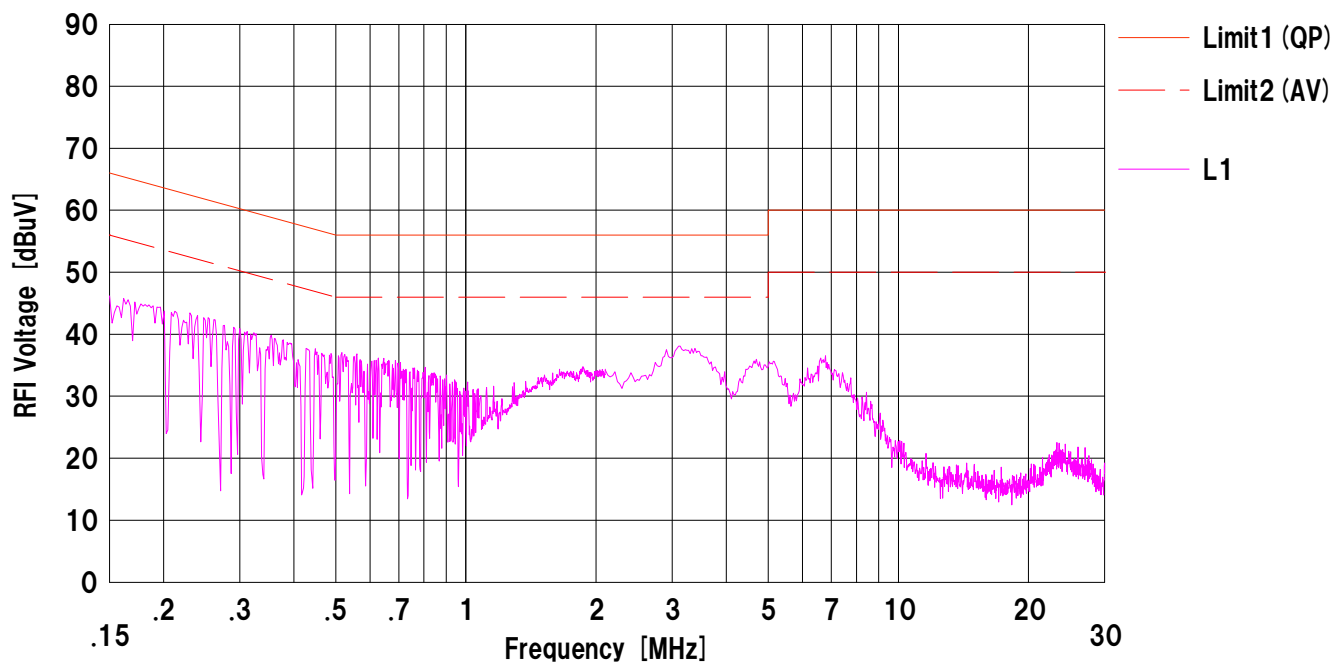
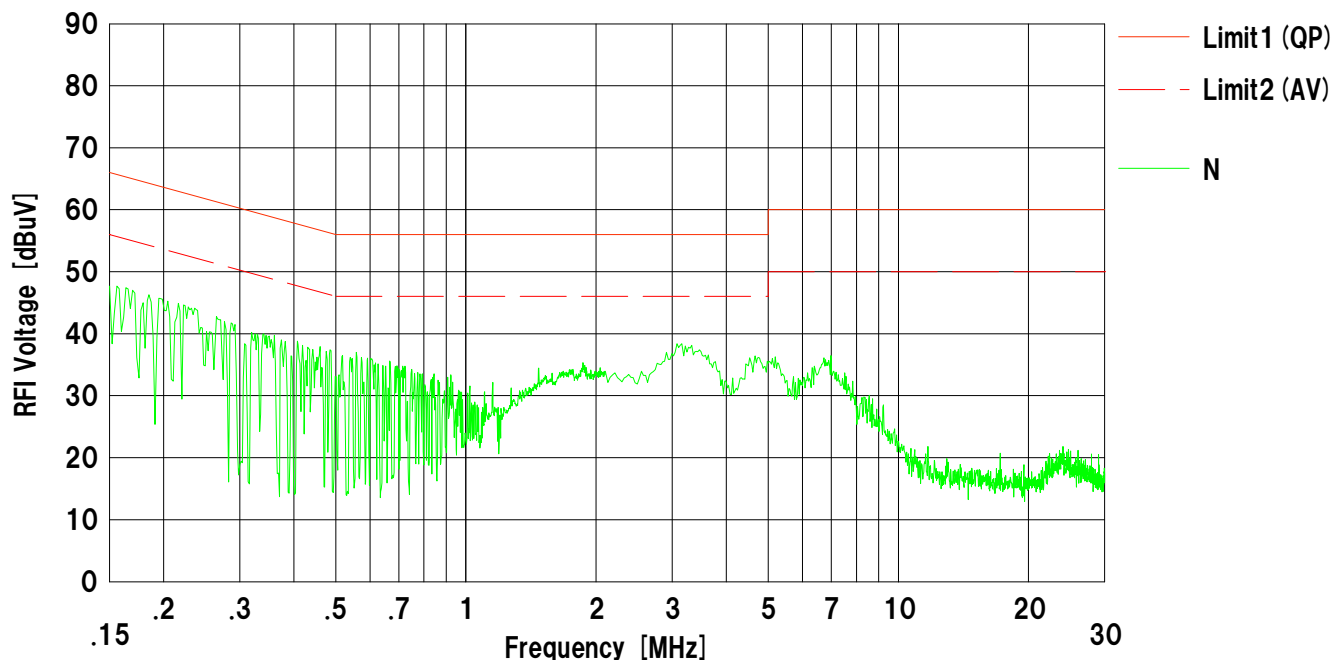
Company : Sato Corporation  
Kind of EUT : RFID Reader Module  
Model No. : M5e  
Serial No. : 101101400912

Mode : Transmitting (902.750MHz)  
Report No. : 32IE0110-SH-01-C  
Power : DC 5V  
Temp./Humi. : 25deg.C / 51%RH

Remarks : -

Limit1 : FCC 15C (15.207) QP  
Limit2 : FCC 15C (15.207) AV

Engineer : Hikaru Shirasawa



Calculation: Result [dBuV] = Reading [dBuV] + C.Fac (LISN+Cable+ATT) [dB]  
LISN: SLS-03

# DATA OF CONDUCTED EMISSION TEST

UL Japan,Inc. Shonan EMC Lab. No.2 Shielded Room  
Date : 2012/05/09

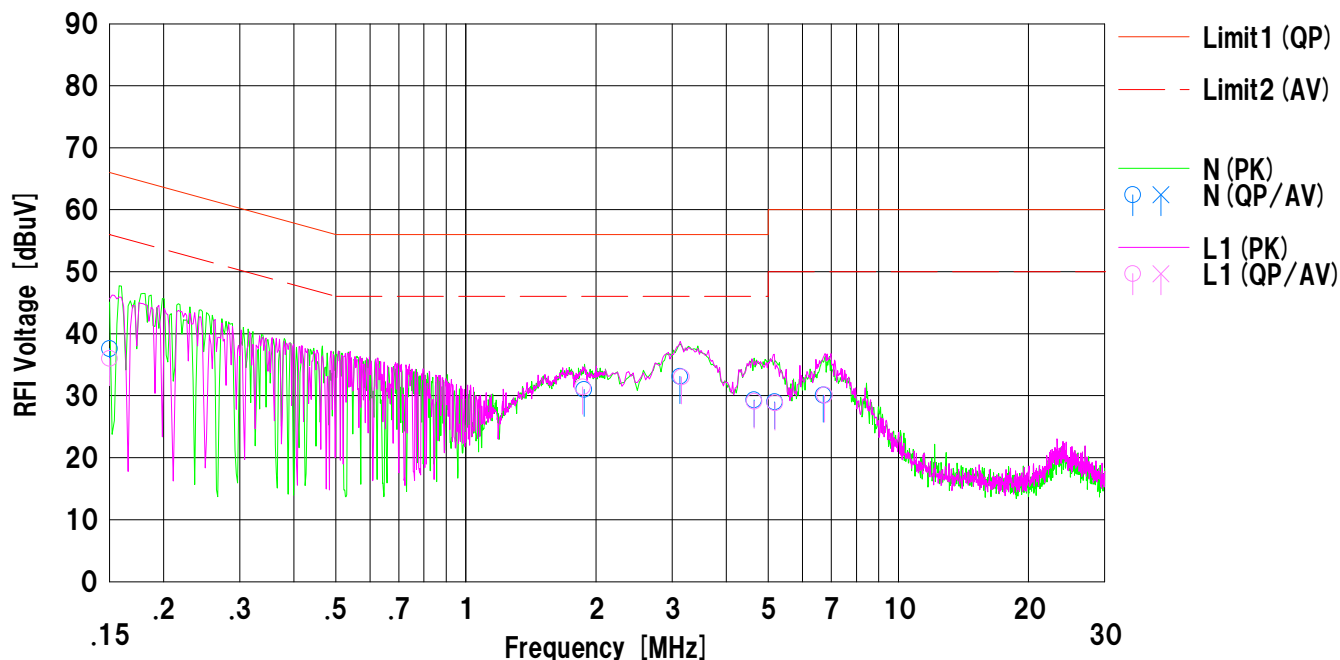
Company : Sato Corporation  
Kind of EUT : RFID Reader Module  
Model No. : M5e  
Serial No. : 101101400912

Mode : Transmitting (915.250MHz)  
Report No. : 32IE0110-SH-01-C  
Power : DC 5V  
Temp./Humi. : 25deg.C / 51%RH

Remarks : -

Limit1 : FCC 15C (15.207) QP  
Limit2 : FCC 15C (15.207) AV

Engineer : Hikaru Shirasawa



| No. | Freq.<br>[MHz] | Reading        |                | C.Fac | Results        |                | Limit          |                | Margin       |              | Phase | Comment |
|-----|----------------|----------------|----------------|-------|----------------|----------------|----------------|----------------|--------------|--------------|-------|---------|
|     |                | <QP><br>[dBuV] | <AV><br>[dBuV] |       | <QP><br>[dBuV] | <AV><br>[dBuV] | <QP><br>[dBuV] | <AV><br>[dBuV] | <QP><br>[dB] | <AV><br>[dB] |       |         |
| 1   | 0.15000        | 24.9           | ---            | 12.7  | 37.6           | ---            | 66.0           | 56.0           | 28.4         | ---          | N     |         |
| 2   | 1.87640        | 18.2           | ---            | 12.8  | 31.0           | ---            | 56.0           | 46.0           | 25.0         | ---          | N     |         |
| 3   | 3.12447        | 20.2           | ---            | 12.9  | 33.1           | ---            | 56.0           | 46.0           | 22.9         | ---          | N     |         |
| 4   | 4.63640        | 16.4           | ---            | 12.9  | 29.3           | ---            | 56.0           | 46.0           | 26.7         | ---          | N     |         |
| 5   | 5.17500        | 15.9           | ---            | 13.1  | 29.0           | ---            | 60.0           | 50.0           | 31.0         | ---          | N     |         |
| 6   | 6.70600        | 17.0           | ---            | 13.1  | 30.1           | ---            | 60.0           | 50.0           | 29.9         | ---          | N     |         |
| 7   | 0.15000        | 23.3           | ---            | 12.7  | 36.0           | ---            | 66.0           | 56.0           | 30.0         | ---          | L1    |         |
| 8   | 1.86260        | 18.6           | ---            | 12.8  | 31.4           | ---            | 56.0           | 46.0           | 24.6         | ---          | L1    |         |
| 9   | 3.15300        | 20.1           | ---            | 12.9  | 33.0           | ---            | 56.0           | 46.0           | 23.0         | ---          | L1    |         |
| 10  | 4.64200        | 16.2           | ---            | 12.9  | 29.1           | ---            | 56.0           | 46.0           | 26.9         | ---          | L1    |         |
| 11  | 5.18600        | 15.7           | ---            | 13.1  | 28.8           | ---            | 60.0           | 50.0           | 31.2         | ---          | L1    |         |
| 12  | 6.75760        | 17.0           | ---            | 13.1  | 30.1           | ---            | 60.0           | 50.0           | 29.9         | ---          | L1    |         |

Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]  
LISN:SLS-03

# DATA OF CONDUCTED EMISSION TEST

UL Japan,Inc. Shonan EMC Lab. No.2 Shielded Room  
Date : 2012/05/09

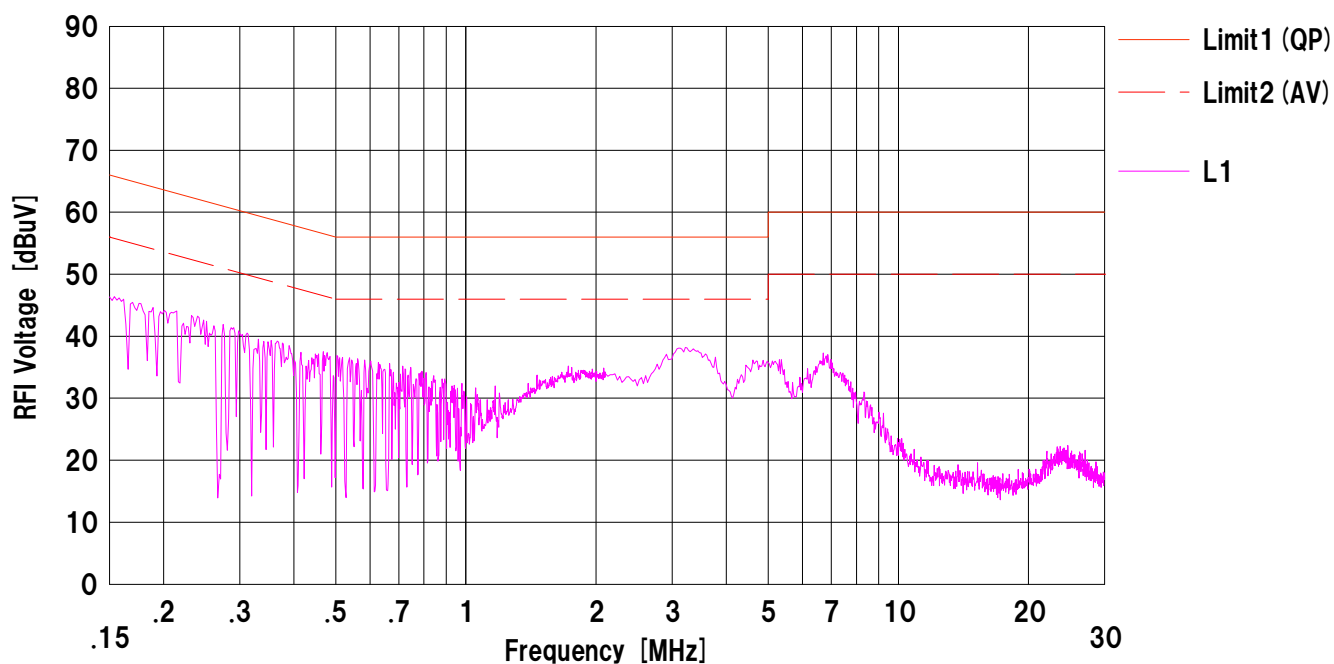
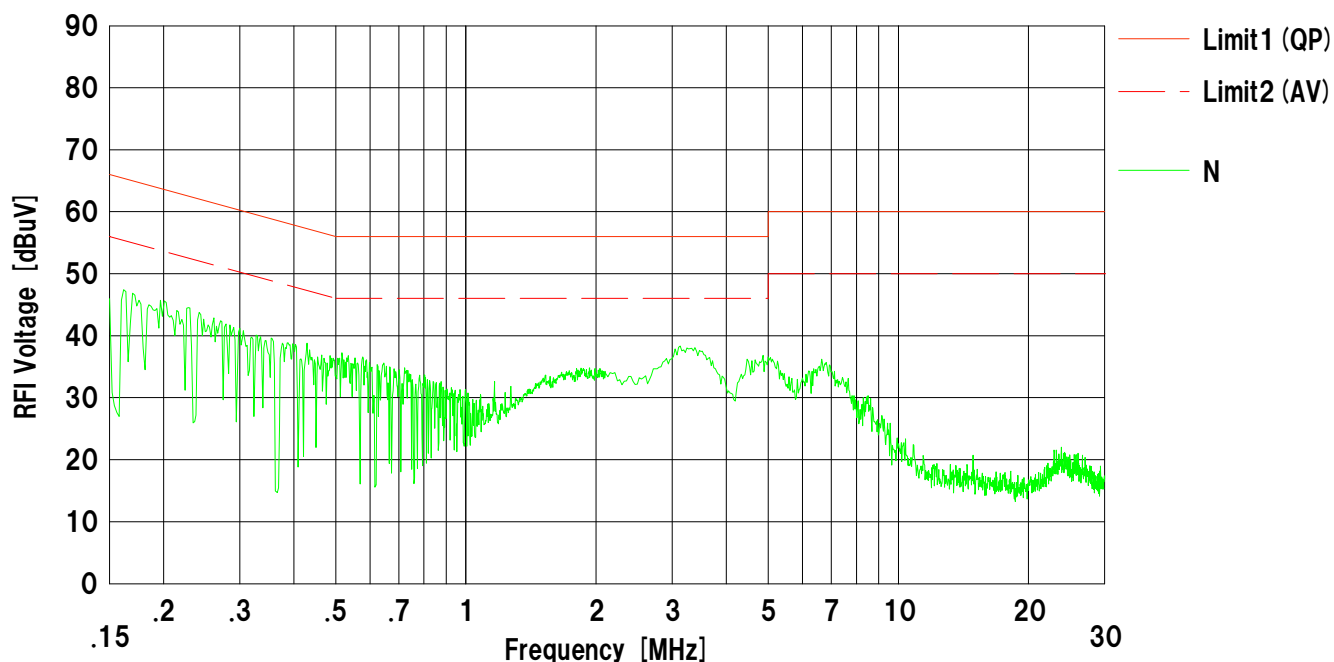
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Kind of EUT : RFID Reader Module  
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Serial No. : 101101400912

Mode : Transmitting (927.250MHz)  
Report No. : 32IE0110-SH-01-C  
Power : DC 5V  
Temp./Humi. : 25deg.C / 51%RH

Remarks : -

Limit1 : FCC 15C (15.207) QP  
Limit2 : FCC 15C (15.207) AV

Engineer : Hikaru Shirasawa



Calculation: Result [dBuV] = Reading [dBuV] + C.Fac (LISN+Cable+ATT) [dB]  
LISN: SLS-03

## Radiated Emission

|                        |                                               |                            |
|------------------------|-----------------------------------------------|----------------------------|
| Test place             | UL Japan, Inc. Shonan EMC Lab.                | No.2 Semi Anechoic Chamber |
| Date                   | May 6, 2012                                   | May 8, 2012                |
| Temperature / Humidity | 22deg.C / 59%RH                               | 23deg.C / 50%RH            |
| Engineer               | Kenichi Adachi                                | Hikaru Shirasawa           |
| Mode                   | Tx, 902.75 MHz, modulation mode (without tag) |                            |

(\* 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] | S.Fac<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Height<br>[cm] | Angle<br>[deg.] | Remark |
|----------|--------------------|----------|-------------------|--------------------|--------------|--------------|---------------|--------------------|-------------------|----------------|----------------|-----------------|--------|
| Hori.    | 52.054             | QP       | 39.0              | 10.2               | 7.1          | 31.9         | -0.1          | 24.3               | 40.0              | 15.7           | 305            | 287             |        |
| Hori.    | 111.108            | QP       | 47.5              | 11.7               | 7.9          | 31.9         | -0.1          | 35.1               | 43.5              | 8.4            | 287            | 325             |        |
| Hori.    | 166.382            | QP       | 39.9              | 15.4               | 8.5          | 31.8         | 0.1           | 32.1               | 43.5              | 11.4           | 201            | 15              |        |
| Hori.    | 960.001            | QP       | 38.5              | 22.6               | 13.0         | 30.5         | 0.0           | 43.6               | 53.9              | 10.3           | 100            | 256             |        |
| Hori.    | 1805.500           | PK       | 47.9              | 25.6               | 3.8          | 38.5         | 0.0           | 38.8               | 73.9              | 35.1           | 100            | 220             |        |
| Hori.    | 2708.250           | PK       | 47.3              | 28.0               | 4.8          | 38.0         | 0.0           | 42.1               | 73.9              | 31.8           | 100            | 0               |        |
| Hori.    | 3611.000           | PK       | 48.8              | 29.2               | 5.1          | 37.8         | 0.0           | 45.3               | 73.9              | 28.6           | 100            | 88              |        |
| Hori.    | 4513.750           | PK       | 46.6              | 30.5               | 5.9          | 37.2         | 0.0           | 45.8               | 73.9              | 28.1           | 100            | 0               |        |
| Hori.    | 1805.500           | AV       | 34.9              | 25.6               | 3.8          | 38.5         | 0.0           | 25.8               | 53.9              | 28.1           | 100            | 220             |        |
| Hori.    | 2708.250           | AV       | 34.5              | 28.0               | 4.8          | 38.0         | 0.0           | 29.3               | 53.9              | 24.6           | 100            | 0               |        |
| Hori.    | 3611.000           | AV       | 37.6              | 29.2               | 5.1          | 37.8         | 0.0           | 34.1               | 53.9              | 19.8           | 100            | 88              |        |
| Hori.    | 4513.750           | AV       | 34.3              | 30.5               | 5.9          | 37.2         | 0.0           | 33.5               | 53.9              | 20.4           | 100            | 0               |        |
| Vert.    | 43.049             | QP       | 45.3              | 13.5               | 7.0          | 31.9         | 0.0           | 33.9               | 40.0              | 6.1            | 100            | 75              |        |
| Vert.    | 108.102            | QP       | 55.5              | 11.3               | 7.8          | 31.9         | -0.1          | 42.6               | 43.5              | 0.9            | 100            | 218             |        |
| Vert.    | 960.001            | QP       | 35.0              | 22.6               | 13.0         | 30.5         | 0.0           | 40.1               | 53.9              | 13.8           | 100            | 216             |        |
| Vert.    | 1805.500           | PK       | 48.7              | 25.6               | 3.8          | 38.5         | 0.0           | 39.6               | 73.9              | 34.3           | 100            | 0               |        |
| Vert.    | 2708.250           | PK       | 47.7              | 28.0               | 4.8          | 38.0         | 0.0           | 42.5               | 73.9              | 31.4           | 100            | 359             |        |
| Vert.    | 3611.000           | PK       | 47.3              | 29.2               | 5.1          | 37.8         | 0.0           | 43.8               | 73.9              | 30.1           | 100            | 269             |        |
| Vert.    | 4513.750           | PK       | 46.9              | 30.5               | 5.9          | 37.2         | 0.0           | 46.1               | 73.9              | 27.8           | 100            | 0               |        |
| Vert.    | 1805.500           | AV       | 34.8              | 25.6               | 3.8          | 38.5         | 0.0           | 25.7               | 53.9              | 28.2           | 100            | 0               |        |
| Vert.    | 2708.250           | AV       | 34.5              | 28.0               | 4.8          | 38.0         | 0.0           | 29.3               | 53.9              | 24.6           | 100            | 359             |        |
| Vert.    | 3611.000           | AV       | 35.7              | 29.2               | 5.1          | 37.8         | 0.0           | 32.2               | 53.9              | 21.7           | 100            | 269             |        |
| Vert.    | 4513.75            | AV       | 34.3              | 30.5               | 5.9          | 37.2         | 0.0           | 33.5               | 53.9              | 20.4           | 100            | 0               |        |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above)) - Gain(Amplifier) + S.Fac

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

\*The 10th harmonic was not seen so the result was its base noise level.

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

| Polarity | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | S.Fac<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark  |
|----------|--------------------|----------|-------------------|-------------------------|--------------|--------------|---------------|--------------------|-------------------|----------------|---------|
| Hori.    | 902.750            | Peak     | 97.6              | 22.1                    | 12.8         | 30.9         | 0.0           | 101.6              | -                 | -              | Carrier |
| Hori.    | 665.677            | Peak     | 45.7              | 19.9                    | 11.7         | 31.7         | 0.0           | 45.6               | 81.6              | 36.0           |         |
| Hori.    | 829.003            | Peak     | 40.4              | 21.2                    | 12.5         | 31.3         | 0.0           | 42.8               | 81.6              | 38.8           |         |
| Hori.    | 902.000            | Peak     | 40.5              | 22.1                    | 12.8         | 31.0         | 0.0           | 44.4               | 81.6              | 37.2           |         |
| Vert.    | 902.750            | Peak     | 95.2              | 22.1                    | 12.8         | 30.9         | 0.0           | 99.2               | -                 | -              | Carrier |
| Vert.    | 665.677            | Peak     | 46.8              | 19.9                    | 11.7         | 31.7         | 0.0           | 46.7               | 79.2              | 32.5           |         |
| Vert.    | 829.003            | Peak     | 41.9              | 21.2                    | 12.5         | 31.3         | 0.0           | 44.3               | 79.2              | 34.9           |         |
| Vert.    | 902.000            | Peak     | 39.3              | 22.1                    | 12.8         | 31.0         | 0.0           | 43.2               | 79.2              | 36.0           |         |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 13GHz)) - Gain(Amplifier)+S.Fac

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## Radiated Emission

|                        |                                               |                            |
|------------------------|-----------------------------------------------|----------------------------|
| Test place             | UL Japan, Inc. Shonan EMC Lab.                | No.2 Semi Anechoic Chamber |
| Date                   | May 6, 2012                                   | May 8, 2012                |
| Temperature / Humidity | 22deg.C / 59%RH                               | 23deg.C / 50%RH            |
| Engineer               | Kenichi Adachi                                | Hikaru Shirasawa           |
| Mode                   | Tx, 915.25 MHz, modulation mode (without tag) |                            |

(\* 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] | S.Fac<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Height<br>[cm] | Angle<br>[deg.] | Remark |
|----------|--------------------|----------|-------------------|--------------------|--------------|--------------|---------------|--------------------|-------------------|----------------|----------------|-----------------|--------|
| Hori.    | 52.049             | QP       | 38.6              | 10.2               | 7.1          | 31.9         | -0.1          | 23.9               | 40.0              | 16.1           | 301            | 291             |        |
| Hori.    | 111.083            | QP       | 47.2              | 11.7               | 7.9          | 31.9         | -0.1          | 34.8               | 43.5              | 8.7            | 276            | 322             |        |
| Hori.    | 960.002            | QP       | 38.1              | 22.6               | 13.0         | 30.5         | 0.0           | 43.2               | 53.9              | 10.7           | 100            | 255             |        |
| Hori.    | 1830.500           | PK       | 48.2              | 25.6               | 3.8          | 38.5         | 0.0           | 39.1               | 73.9              | 34.8           | 100            | 230             |        |
| Hori.    | 2745.750           | PK       | 47.6              | 28.1               | 4.7          | 38.0         | 0.0           | 42.4               | 73.9              | 31.5           | 100            | 0               |        |
| Hori.    | 3661.000           | PK       | 48.7              | 29.2               | 5.2          | 37.8         | 0.0           | 45.3               | 73.9              | 28.6           | 100            | 93              |        |
| Hori.    | 4576.250           | PK       | 46.9              | 30.6               | 5.9          | 37.2         | 0.0           | 46.2               | 73.9              | 27.7           | 100            | 0               |        |
| Hori.    | 1830.500           | AV       | 37.4              | 25.6               | 3.8          | 38.5         | 0.0           | 28.3               | 53.9              | 25.6           | 100            | 230             |        |
| Hori.    | 2745.750           | AV       | 34.5              | 28.1               | 4.7          | 38.0         | 0.0           | 29.3               | 53.9              | 24.6           | 100            | 0               |        |
| Hori.    | 3661.000           | AV       | 37.3              | 29.2               | 5.2          | 37.8         | 0.0           | 33.9               | 53.9              | 20.0           | 100            | 93              |        |
| Hori.    | 4576.250           | AV       | 34.4              | 30.6               | 5.9          | 37.2         | 0.0           | 33.7               | 53.9              | 20.2           | 100            | 0               |        |
| Vert.    | 52.053             | QP       | 47.5              | 10.2               | 7.1          | 31.9         | -0.1          | 32.8               | 40.0              | 7.2            | 100            | 82              |        |
| Vert.    | 108.113            | QP       | 55.1              | 11.3               | 7.8          | 31.9         | -0.1          | 42.2               | 43.5              | 1.3            | 100            | 203             |        |
| Vert.    | 960.002            | QP       | 34.8              | 22.6               | 13.0         | 30.5         | 0.0           | 39.9               | 53.9              | 14.0           | 100            | 211             |        |
| Vert.    | 1830.500           | PK       | 48.0              | 25.6               | 3.8          | 38.5         | 0.0           | 38.9               | 73.9              | 35.0           | 100            | 324             |        |
| Vert.    | 2745.750           | PK       | 47.0              | 28.1               | 4.7          | 38.0         | 0.0           | 41.8               | 73.9              | 32.1           | 100            | 0               |        |
| Vert.    | 3661.000           | PK       | 48.1              | 29.2               | 5.2          | 37.8         | 0.0           | 44.7               | 73.9              | 29.2           | 100            | 92              |        |
| Vert.    | 4576.250           | PK       | 47.0              | 30.6               | 5.9          | 37.2         | 0.0           | 46.3               | 73.9              | 27.6           | 100            | 0               |        |
| Vert.    | 1830.500           | AV       | 35.7              | 25.6               | 3.8          | 38.5         | 0.0           | 26.6               | 53.9              | 27.3           | 100            | 324             |        |
| Vert.    | 2745.750           | AV       | 34.5              | 28.1               | 4.7          | 38.0         | 0.0           | 29.3               | 53.9              | 24.6           | 100            | 0               |        |
| Vert.    | 3661.000           | AV       | 36.3              | 29.2               | 5.2          | 37.8         | 0.0           | 32.9               | 53.9              | 21.0           | 100            | 92              |        |
| Vert.    | 4576.250           | AV       | 34.4              | 30.6               | 5.9          | 37.2         | 0.0           | 33.7               | 53.9              | 20.2           | 100            | 0               |        |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above)) - Gain(Amplifier) + S.Fac

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

\*The 10th harmonic was not seen so the result was its base noise level.

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

| Polarity | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | S.Fac<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark  |
|----------|--------------------|----------|-------------------|-------------------------|--------------|--------------|---------------|--------------------|-------------------|----------------|---------|
| Hori.    | 915.250            | Peak     | 96.3              | 22.2                    | 12.8         | 30.8         | 0.0           | 100.5              | -                 | -              | Carrier |
| Hori.    | 665.675            | Peak     | 45.5              | 19.9                    | 11.7         | 31.7         | 0.0           | 45.4               | 80.5              | 35.1           |         |
| Hori.    | 829.002            | Peak     | 43.4              | 21.2                    | 12.5         | 31.3         | 0.0           | 45.8               | 80.5              | 34.7           |         |
| Vert.    | 915.250            | Peak     | 93.8              | 22.2                    | 12.8         | 30.8         | 0.0           | 98.0               | -                 | -              | Carrier |
| Vert.    | 665.675            | Peak     | 45.4              | 19.9                    | 11.7         | 31.7         | 0.0           | 45.3               | 78.0              | 32.7           |         |
| Vert.    | 829.002            | Peak     | 40.3              | 21.2                    | 12.5         | 31.3         | 0.0           | 42.7               | 78.0              | 35.3           |         |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 13GHz)) - Gain(Amplifier)+S.Fac

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## Radiated Emission

|                        |                                               |                            |
|------------------------|-----------------------------------------------|----------------------------|
| Test place             | UL Japan, Inc. Shonan EMC Lab.                | No.2 Semi Anechoic Chamber |
| Date                   | May 6, 2012                                   | May 8, 2012                |
| Temperature / Humidity | 22deg.C / 59%RH                               | 23deg.C / 50%RH            |
| Engineer               | Kenichi Adachi                                | Hikaru Shirasawa           |
| Mode                   | Tx, 927.25 MHz, modulation mode (without tag) |                            |

(\* 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] | S.Fac<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Height<br>[cm] | Angle<br>[deg.] | Remark |
|----------|--------------------|----------|-------------------|--------------------|--------------|--------------|---------------|--------------------|-------------------|----------------|----------------|-----------------|--------|
| Hori.    | 52.026             | QP       | 37.9              | 10.2               | 7.1          | 31.9         | -0.1          | 23.2               | 40.0              | 16.8           | 298            | 281             |        |
| Hori.    | 110.078            | QP       | 46.1              | 11.6               | 7.9          | 31.9         | -0.1          | 33.6               | 43.5              | 9.9            | 279            | 321             |        |
| Hori.    | 960.005            | QP       | 37.2              | 22.6               | 13.0         | 30.5         | 0.0           | 42.3               | 53.9              | 11.6           | 100            | 258             |        |
| Hori.    | 1854.500           | PK       | 55.1              | 25.7               | 3.8          | 38.5         | 0.0           | 46.1               | 73.9              | 27.8           | 100            | 236             |        |
| Hori.    | 2781.750           | PK       | 45.8              | 28.2               | 4.7          | 38.0         | 0.0           | 40.7               | 73.9              | 33.2           | 100            | 0               |        |
| Hori.    | 3709.000           | PK       | 46.9              | 29.3               | 5.3          | 37.8         | 0.0           | 43.7               | 73.9              | 30.2           | 100            | 202             |        |
| Hori.    | 4636.250           | PK       | 45.7              | 30.8               | 6.0          | 37.1         | 0.0           | 45.4               | 73.9              | 28.5           | 100            | 0               |        |
| Hori.    | 1854.500           | AV       | 48.8              | 25.7               | 3.8          | 38.5         | 0.0           | 39.8               | 53.9              | 14.1           | 100            | 236             |        |
| Hori.    | 2781.750           | AV       | 33.3              | 28.2               | 4.7          | 38.0         | 0.0           | 28.2               | 53.9              | 25.7           | 100            | 0               |        |
| Hori.    | 3709.000           | AV       | 36.2              | 29.3               | 5.3          | 37.8         | 0.0           | 33.0               | 53.9              | 20.9           | 100            | 202             |        |
| Hori.    | 4636.250           | AV       | 33.0              | 30.8               | 6.0          | 37.1         | 0.0           | 32.7               | 53.9              | 21.2           | 100            | 0               |        |
| Vert.    | 52.054             | QP       | 47.8              | 10.2               | 7.1          | 31.9         | -0.1          | 33.1               | 40.0              | 6.9            | 100            | 67              |        |
| Vert.    | 110.079            | QP       | 54.9              | 11.6               | 7.9          | 31.9         | -0.1          | 42.4               | 43.5              | 1.1            | 100            | 217             |        |
| Vert.    | 960.005            | QP       | 34.6              | 22.6               | 13.0         | 30.5         | 0.0           | 39.7               | 53.9              | 14.2           | 100            | 209             |        |
| Vert.    | 1854.500           | PK       | 54.1              | 25.7               | 3.8          | 38.5         | 0.0           | 45.1               | 73.9              | 28.8           | 160            | 24              |        |
| Vert.    | 2781.750           | PK       | 47.5              | 28.2               | 4.7          | 38.0         | 0.0           | 42.4               | 73.9              | 31.5           | 100            | 0               |        |
| Vert.    | 3709.000           | PK       | 46.9              | 29.3               | 5.3          | 37.8         | 0.0           | 43.7               | 73.9              | 30.2           | 100            | 78              |        |
| Vert.    | 4636.250           | PK       | 46.0              | 30.8               | 6.0          | 37.1         | 0.0           | 45.7               | 73.9              | 28.2           | 100            | 0               |        |
| Vert.    | 1854.500           | AV       | 46.4              | 25.7               | 3.8          | 38.5         | 0.0           | 37.4               | 53.9              | 16.5           | 160            | 24              |        |
| Vert.    | 2781.750           | AV       | 34.5              | 28.2               | 4.7          | 38.0         | 0.0           | 29.4               | 53.9              | 24.5           | 100            | 0               |        |
| Vert.    | 3709.000           | AV       | 34.8              | 29.3               | 5.3          | 37.8         | 0.0           | 31.6               | 53.9              | 22.3           | 100            | 78              |        |
| Vert.    | 4636.250           | AV       | 33.0              | 30.8               | 6.0          | 37.1         | 0.0           | 32.7               | 53.9              | 21.2           | 100            | 0               |        |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above)) - Gain(Amplifier) + S.Fac

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

\*The 10th harmonic was not seen so the result was its base noise level.

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

| Polarity | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | S.Fac<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark  |
|----------|--------------------|----------|-------------------|-------------------------|--------------|--------------|---------------|--------------------|-------------------|----------------|---------|
| Hori.    | 927.250            | Peak     | 98.5              | 22.3                    | 12.9         | 30.8         | 0.0           | 102.9              | -                 | -              | Carrier |
| Hori.    | 665.679            | Peak     | 42.8              | 19.9                    | 11.7         | 31.7         | 0.0           | 42.7               | 82.9              | 40.2           |         |
| Hori.    | 829.001            | Peak     | 42.1              | 21.2                    | 12.5         | 31.3         | 0.0           | 44.5               | 82.9              | 38.4           |         |
| Hori.    | 928.000            | Peak     | 41.7              | 22.3                    | 12.9         | 30.7         | 0.0           | 46.2               | 82.9              | 36.7           |         |
| Vert.    | 927.250            | Peak     | 96.2              | 22.3                    | 12.9         | 30.8         | 0.0           | 100.6              | -                 | -              | Carrier |
| Vert.    | 665.679            | Peak     | 42.8              | 19.9                    | 11.7         | 31.7         | 0.0           | 42.7               | 80.6              | 37.9           |         |
| Vert.    | 829.001            | Peak     | 41.5              | 21.2                    | 12.5         | 31.3         | 0.0           | 43.9               | 80.6              | 36.7           |         |
| Vert.    | 928.000            | Peak     | 40.5              | 22.3                    | 12.9         | 30.7         | 0.0           | 45.0               | 80.6              | 35.6           |         |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 13GHz)) - Gain(Amplifier)+S.Fac

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### APPENDIX 3 Test Instruments

#### EMI test equipment

| Control No.                    | Instrument                | Manufacturer                                       | Model No                                   | Serial No               | Test Item | Calibration Date * Interval(month) |
|--------------------------------|---------------------------|----------------------------------------------------|--------------------------------------------|-------------------------|-----------|------------------------------------|
| SAF-02                         | Pre Amplifier             | SONOMA                                             | 310N                                       | 290212                  | RE        | 2012/02/10 * 12                    |
| SAT6-02                        | Attenuator                | JFW                                                | 50HF-006N                                  | -                       | RE        | 2012/02/10 * 12                    |
| SBA-02                         | Biconical Antenna         | Schwarzbeck                                        | BBA9106                                    | 91032665                | RE        | 2011/11/16 * 12                    |
| SCC-B2/B4/B6/B7/B8/B13/SRSE-02 | Coaxial Cable&RF Selector | Fujikura/Fujikura/Suhner/Suhner/Suhner/Suhner/TOYO | 8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906 | -/0901-270(RF Selector) | RE        | 2012/04/10 * 12                    |
| SLA-02                         | Logperiodic Antenna       | Schwarzbeck                                        | UHALP9108A                                 | UHALP 9108-A 0893       | RE        | 2011/11/16 * 12                    |
| SOS-03                         | Humidity Indicator        | A&D                                                | AD-5681                                    | 4063325                 | RE        | 2012/02/06 * 12                    |
| STR-02                         | Test Receiver             | Rohde & Schwarz                                    | ESCI                                       | 100575                  | RE,CE     | 2011/08/04 * 12                    |
| SJM-02                         | Measure                   | KOMELON                                            | KMC-36                                     | -                       | RE,CE     | -                                  |
| SAEC-02(NSA)                   | Semi-Anechoic Chamber     | TDK                                                | SAEC-02(NSA)                               | 2                       | RE        | 2011/09/25 * 12                    |
| COTS-SEMI-1                    | EMI Software              | TSJ                                                | TEPTO-DV(RE,CE, RFI,MF)                    | -                       | RE,CE     | -                                  |
| SHA-02                         | Horn Antenna              | Schwarzbeck                                        | BBHA9120D                                  | 9120D-726               | RE        | 2011/08/28 * 12                    |
| SCC-G02                        | Coaxial Cable             | Suhner                                             | SUCOFLEX 104A                              | 46498/4A                | RE        | 2012/04/10 * 12                    |
| SFL-01                         | Highpass Filter           | MICRO-TRONICS                                      | HPM50115                                   | 001                     | RE        | 2011/12/27 * 12                    |
| SAF-05                         | Pre Amplifier             | TOYO Corporation                                   | TPA0118-36                                 | 1440490                 | RE        | 2012/03/12 * 12                    |
| SCC-G22                        | Coaxial Cable             | Suhner                                             | SUCOFLEX 104                               | 296199/4                | RE        | 2011/05/27 * 12                    |
| SSA-01                         | Spectrum Analyzer         | Agilent                                            | N9010A-526                                 | MY48031482              | RE        | 2012/04/11 * 12                    |
| SCC-B12/B13/SRSE-02            | Coaxial Cable&RF Selector | Suhner/Suhner/TOYO                                 | RG223U/141PE/NS4906                        | -/0901-270(RF Selector) | CE        | 2012/04/10 * 12                    |
| SLS-03                         | LISN                      | Rohde & Schwarz                                    | ENV216                                     | 100513                  | CE(EUT)   | 2012/02/23 * 12                    |
| SLS-04                         | LISN                      | Rohde & Schwarz                                    | ENV216                                     | 100514                  | CE(AE)    | 2012/02/20 * 12                    |
| SAT3-05                        | Attenuator                | JFW                                                | 50HF-003N                                  | -                       | CE        | 2012/02/17 * 12                    |
| SOS-04                         | Humidity Indicator        | A&D                                                | AD-5681                                    | 4061512                 | CE        | 2012/03/26 * 12                    |
| STM-03                         | Terminator                | TME                                                | CT-01 BP                                   | -                       | CE        | 2012/01/05 * 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 :

CE: Conducted emission ,  
RE: Radiated emission