



# **RADIO TEST REPORT**

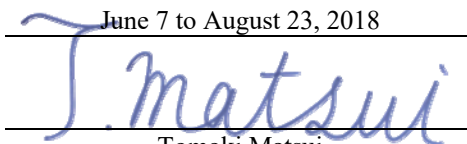
**Test Report No. : 12311663H-A-R1**

**Applicant** : Sumitomo Wiring Systems, Ltd.  
**Type of Equipment** : BCM(Body Control Module)  
**Model No.** : K68PB  
**FCC ID** : 2AKB8K68PB  
**Test regulation** : FCC Part 15 Subpart C: 2018  
**Test Result** : Complied

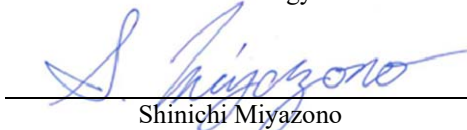
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6. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
7. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
8. This report is a revised version of 12311663H-A. 12311663H-A is replaced with this report.

**Date of test:** June 7 to August 23, 2018

**Representative test engineer:**

  
Tomoki Matsui  
Engineer  
Consumer Technology Division

**Approved by:**

  
Shinichi Miyazono  
Engineer  
Consumer Technology Division



NVLAP LAB CODE: 200572-0

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**UL Japan, Inc.**

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13-EM-F0429

## REVISION HISTORY

**Original Test Report No.: 12311663H-A**

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## **SECTION 1: Customer information**

|                  |   |                                                                         |
|------------------|---|-------------------------------------------------------------------------|
| Company Name     | : | Sumitomo Wiring Systems, Ltd.                                           |
| Address          | : | 1820 Nakanoike, Mikkaichi-cho, Suzuka-City, Mie Pref. 513-8631<br>JAPAN |
| Telephone Number | : | +81-59-340-1137                                                         |
| Facsimile Number | : | +81-59-383-3943                                                         |
| Contact Person   | : | Toshiyuki Sonoda                                                        |

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

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

|                            |   |                                                                                           |
|----------------------------|---|-------------------------------------------------------------------------------------------|
| Type of Equipment          | : | BCM (Body Control Module)                                                                 |
| Model No.                  | : | K68PB                                                                                     |
| Serial No.                 | : | Refer to Clause 4.2                                                                       |
| Rating                     | : | DC 12 V                                                                                   |
| Receipt Date of Sample     | : | May 18, 2018                                                                              |
| Country of Mass-production | : | Japan                                                                                     |
| Condition of EUT           | : | Production prototype<br>(Not for Sale: This sample is equivalent to mass-produced items.) |
| Modification of EUT        | : | No Modification by the test lab                                                           |

### **2.2 Product Description**

Model No: K68PB (referred to as the EUT in this report) is the BCM (Body Control Module).

#### **Radio Specification**

##### **[LF Transmitter]**

|                                |   |                          |
|--------------------------------|---|--------------------------|
| Radio Type                     | : | Transmitter              |
| Frequency of Operation         | : | 125 kHz                  |
| Modulation                     | : | OOK (ASK)                |
| Method of Frequency Generation | : | Ceramic resonator        |
| Operating temperature range    | : | -40 deg. C to +85 deg. C |
| Clock Frequency (maximum)      | : | 4.002 MHz                |

##### **[RF Receiver]\***

|                                |   |                          |
|--------------------------------|---|--------------------------|
| Radio Type                     | : | Receiver                 |
| Frequency of Operation         | : | 433.92 MHz               |
| Method of Frequency Generation | : | Crystal                  |
| Operating temperature range    | : | -40 deg. C to +85 deg. C |
| Receiver Bandwidth             | : | 60.06 kHz                |
| Clock Frequency (maximum)      | : | 21.948717 MHz            |

\*The test of receiver part was performed separately from this test report, and the conformability is confirmed.

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

#### **3.1 Test Specification**

Test Specification : FCC Part 15 Subpart C  
FCC Part 15 final revised on March 12, 2018 and effective April 11, 2018

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators  
Section 15.207 Conducted limits  
Section 15.209 Radiated emission limits; general requirements.

\* Also the EUT complies with FCC Part 15 Subpart B.

#### **3.2 Procedures and results**

| No. | Item                                            | Test Procedure                                                                    | Specification                                                 | Remarks  | Deviation | Worst margin                                        | Results  |
|-----|-------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------|----------|-----------|-----------------------------------------------------|----------|
| 1   | Conducted Emission                              | <FCC><br>ANSI C63.10:2013<br>6 Standard test methods<br><IC><br>RSS-Gen 8.8       | <FCC><br>Section 15.207<br><IC><br>RSS-Gen 8.8                | -        | N/A *1)   | N/A                                                 | N/A      |
| 2   | Electric Field Strength of Fundamental Emission | <FCC><br>ANSI C63.10:2013<br>6 Standard test methods<br><IC><br>RSS-Gen 6.4, 6.12 | <FCC><br>Section 15.209<br><IC><br>RSS-210 4.4<br>RSS-Gen 8.9 | Radiated | N/A       | 6.5 dB<br>125 kHz<br>0 deg.,<br>PK with Duty factor | Complied |
| 3   | Electric Field Strength of Spurious Emission    | <FCC><br>ANSI C63.10:2013<br>6 Standard test methods<br><IC><br>RSS-Gen 6.4, 6.13 | <FCC><br>Section 15.209<br><IC><br>RSS-210 4.4<br>RSS-Gen 8.9 | Radiated | N/A       | 12.9 dB<br>64.031MHz,<br>Horiozntal, QP             | Complied |
| 4   | -26dB Bandwidth                                 | <FCC><br>ANSI C63.10:2013<br>6 Standard test methods<br><IC><br>-                 | <FCC><br>Reference data<br><IC><br>-                          | Radiated | N/A       | N/A                                                 | N/A      |

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

\*1) The test is not applicable since the EUT is not the device that is designed to be connected to the public utility (AC) power line.

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

The battery voltage (DC 12V) is provided to the EUT. Input voltage to RF part doesn't go through the regulator. So the test was performed with the supply voltage varied between 85 % and 115% of the nominal rated supply voltage (DC 12 V) and the variation of the input power does not affect the test result, therefore the EUT complies with the requirement.

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

It is impossible for end users to replace the antenna, because the antenna is mounted inside of the vehicle. Therefore, the equipment complies with the antenna requirement of Section 15.203.

### 3.3 Addition to standard

| No. | Item                     | Test Procedure | Specification | Remarks  | Deviation | Worst margin | Results  |
|-----|--------------------------|----------------|---------------|----------|-----------|--------------|----------|
| 1   | 99 % Occupied Band Width | RSS-Gen 6.6    | -             | Radiated | N/A       | N/A          | Complied |

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

### 3.4 Uncertainty

#### EMI

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

| Test distance | Radiated emission (+/-) |
|---------------|-------------------------|
|               | 9 kHz to 30 MHz         |
| 3 m           | 3.8 dB                  |
| 10 m          | 3.6 dB                  |

\*Measurement distance

| Polarity   | Radiated emission (Below 1 GHz) |                     |                   |                     |
|------------|---------------------------------|---------------------|-------------------|---------------------|
|            | (3 m*)(+/-)                     |                     | (10 m*)(+/-)      |                     |
|            | 30 MHz to 200 MHz               | 200 MHz to 1000 MHz | 30 MHz to 200 MHz | 200 MHz to 1000 MHz |
| Horizontal | 4.8 dB                          | 5.2 dB              | 4.8 dB            | 5.0 dB              |
| Vertical   | 5.0 dB                          | 6.3 dB              | 4.9 dB            | 5.0 dB              |

\*Measurement distance

#### Radiated emission test(3 m)

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

### 3.5 Test Location

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Telephone: +81 596 24 8999, Facsimile: +81 596 24 8124  
NVLAP Lab. code: 200572-0 / FCC Test Firm Registration Number: 199967

| Test site                  | IC Registration Number | Width x Depth x Height (m) | Size of reference ground plane (m) / horizontal conducting plane | Other rooms            | Maximum measurement distance |
|----------------------------|------------------------|----------------------------|------------------------------------------------------------------|------------------------|------------------------------|
| No.1 semi-anechoic chamber | 2973C-1                | 19.2 x 11.2 x 7.7          | 7.0 x 6.0                                                        | No.1 Power source room | 10 m                         |
| No.2 semi-anechoic chamber | 2973C-2                | 7.5 x 5.8 x 5.2            | 4.0 x 4.0                                                        | -                      | 3 m                          |
| No.3 semi-anechoic chamber | 2973C-3                | 12.0 x 8.5 x 5.9           | 6.8 x 5.75                                                       | No.3 Preparation room  | 3 m                          |
| No.3 shielded room         | -                      | 4.0 x 6.0 x 2.7            | N/A                                                              | -                      | -                            |
| No.4 semi-anechoic chamber | 2973C-4                | 12.0 x 8.5 x 5.9           | 6.8 x 5.75                                                       | No.4 Preparation room  | 3 m                          |
| No.4 shielded room         | -                      | 4.0 x 6.0 x 2.7            | N/A                                                              | -                      | -                            |
| No.5 semi-anechoic chamber | -                      | 6.0 x 6.0 x 3.9            | 6.0 x 6.0                                                        | -                      | -                            |
| No.6 shielded room         | -                      | 4.0 x 4.5 x 2.7            | 4.0 x 4.5                                                        | -                      | -                            |
| No.6 measurement room      | -                      | 4.75 x 5.4 x 3.0           | 4.75 x 4.15                                                      | -                      | -                            |
| No.7 shielded room         | -                      | 4.7 x 7.5 x 2.7            | 4.7 x 7.5                                                        | -                      | -                            |
| No.8 measurement room      | -                      | 3.1 x 5.0 x 2.7            | N/A                                                              | -                      | -                            |
| No.9 measurement room      | -                      | 8.8 x 4.6 x 2.8            | 2.4 x 2.4                                                        | -                      | -                            |
| No.11 measurement room     | -                      | 6.2 x 4.7 x 3.0            | 4.8 x 4.6                                                        | -                      | -                            |

\* Size of vertical conducting plane (for Conducted Emission test) : 2.0 m x 2.0m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

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

Refer to APPENDIX.

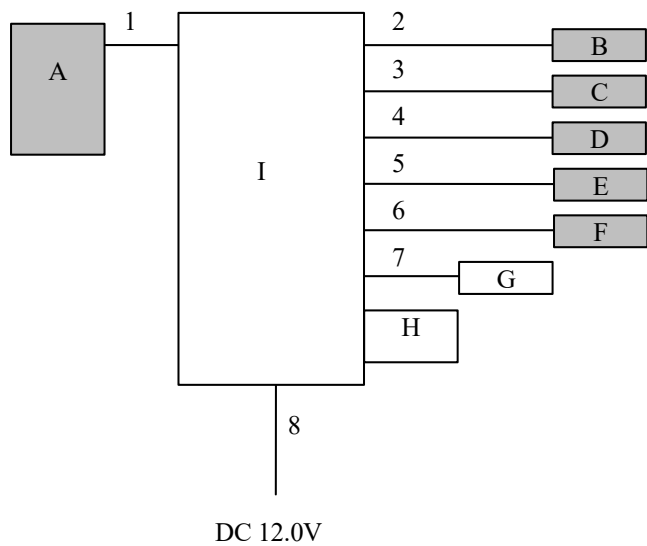
## SECTION 4: Operation of E.U.T. during testing

### 4.1 Operating Modes

| Test mode                     | Remarks |
|-------------------------------|---------|
| Transmitting mode (Tx) 125kHz | -       |

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

### 4.2 Configuration and peripherals



- \* Cabling and setup were taken into consideration and test data was taken under worse case conditions.
- \* The input voltage (DC 12 V) passes through Item No. I without affecting it and is supplied to the LF antennas (Item No. B to F) without any drop in voltage.
- \* The EUT does not transmit simultaneously from multiple antennas.
- \* Antenna was evaluated with the worst duty respectively.
- \* The EUT was set to transmit the data continuously from one antenna as a worst case, not to transmit it randomly from each antenna.
- \* According to the result of pre-check to LF Antenna (AND), LF Antenna (ANA) and LF Antenna (ANL), it was confirmed that there was no difference in RF characteristics among antennas. So the test was performed with one antenna F (LF Antenna (ANL)) as a representative.
- \* According to the result of pre-check to LF Antenna (ANB) and LF Antenna (ANI), it was confirmed that there was no difference in RF characteristics among antennas. So the test was performed with one antenna D (LF Antenna (ANB)) as a representative.

#### Description of EUT and Support equipment

| No. | Item                         | Model number | Serial number | Manufacturer                     | Remark |
|-----|------------------------------|--------------|---------------|----------------------------------|--------|
| A   | BCM<br>(Body Control Module) | K68PB        | 002           | Sumitomo Wiring Systems,<br>Ltd. | EUT    |
| B   | LF Antenna (AND)             | LF Antenna B | 001           | Sumitomo Wiring Systems,<br>Ltd. | EUT    |
| C   | LF Antenna (ANA)             | LF Antenna B | 002           | Sumitomo Wiring Systems,<br>Ltd. | EUT    |
| D   | LF Antenna (ANB)             | LF Antenna C | 003           | Sumitomo Wiring Systems,<br>Ltd. | EUT    |
| E   | LF Antenna (ANI)             | LF Antenna C | 004           | Sumitomo Wiring Systems,<br>Ltd. | EUT    |
| F   | LF Antenna (ANL)             | LF Antenna A | 005           | Sumitomo Wiring Systems,<br>Ltd. | EUT    |
| G   | Steering Lock                | -            | 001           | -                                | -      |
| H   | Push SW                      | -            | 001           | -                                | -      |
| I   | Checker BOX                  | -            | 1             | -                                | -      |

#### List of cables used

| No. | Name              | Length (m) | Shield     |            | Remark |
|-----|-------------------|------------|------------|------------|--------|
|     |                   |            | Cable      | Connector  |        |
| 1   | Signal & DC Cable | 1.5        | Unshielded | Unshielded | -      |
| 2   | Antenna Cable     | 2.0        | Unshielded | Unshielded | -      |
| 3   | Antenna Cable     | 2.0        | Unshielded | Unshielded | -      |
| 4   | Antenna Cable     | 2.0        | Unshielded | Unshielded | -      |
| 5   | Antenna Cable     | 2.0        | Unshielded | Unshielded | -      |
| 6   | Antenna Cable     | 2.0        | Unshielded | Unshielded | -      |
| 7   | Signal Cable      | 0.3        | Unshielded | Unshielded | -      |
| 8   | DC Cable          | 1.8        | Unshielded | Unshielded | -      |

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## **SECTION 5: Radiated emission (Fundamental and Spurious Emission)**

### **Test Procedure**

EUT was placed on a urethane platform of nominal size, 1.0 m by 0.5 m, raised 0.8 m above the conducting ground plane.

The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

Frequency : From 9 kHz to 30 MHz

The EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

The measurements were performed for vertical polarization (antenna angle: 0 deg., 45 deg., 90 deg., and 135 deg.) and horizontal polarization.

\*Refer to Figure 1 about Direction of the Loop Antenna.

Frequency: From 30 MHz to 1 GHz

The measuring antenna height varied between 1 and 4 m 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 test was made with the detector (RBW / VBW) in the following table.

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

### **Test Antennas are used as below;**

|              |              |                   |                  |
|--------------|--------------|-------------------|------------------|
| Frequency    | Below 30 MHz | 30 MHz to 200 MHz | 200 MHz to 1 GHz |
| Antenna Type | Loop         | Biconical         | Logperiodic      |

|                 |                                                        |                        |                         |                        |                      |
|-----------------|--------------------------------------------------------|------------------------|-------------------------|------------------------|----------------------|
| Frequency       | From 9 kHz to 90 kHz<br>and<br>From 110 kHz to 150 kHz | From 90 kHz to 110 kHz | From 150 kHz to 490 kHz | From 490 kHz to 30 MHz | From 30 MHz to 1 GHz |
| Instrument used | Test Receiver                                          |                        |                         |                        |                      |
| Detector        | PK / AV                                                | QP                     | PK / AV                 | QP                     | QP                   |
| IF Bandwidth    | 200 Hz                                                 | 200 Hz                 | 9 kHz                   | 9 kHz                  | 120 kHz              |
| Test Distance   | 3 m *1)                                                | 3 m *1)                | 3 m *1)                 | 3 m *2)                | 3 m                  |

\*1) Distance Factor:  $40 \times \log(3 \text{ m} / 300 \text{ m}) = -80 \text{ dB}$

\*2) Distance Factor:  $40 \times \log(3 \text{ m} / 30 \text{ m}) = -40 \text{ dB}$

Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

These tests were performed in semi anechoic chamber. Therefore the measured level of emissions may be higher than if measurements were made without a ground plane.

However test results were confirmed to pass against standard limit.

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

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

**Measurement range** : 9 kHz - 1 GHz

**Test data** : APPENDIX 1

**Test result** : Pass

Date: June 7, 2018

Test engineer: Tomoki Matsui, Hiroyuki Furutaka

**UL Japan, Inc.**

**Ise EMC Lab.**

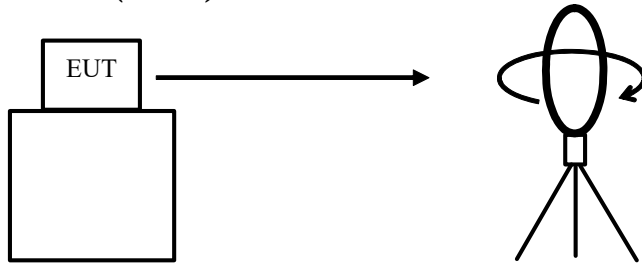
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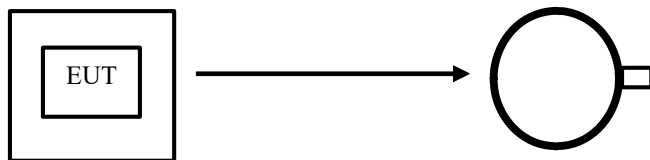
Facsimile : +81 596 24 8124

**Figure 1: Direction of the Loop Antenna**

*Side View (Vertical)*

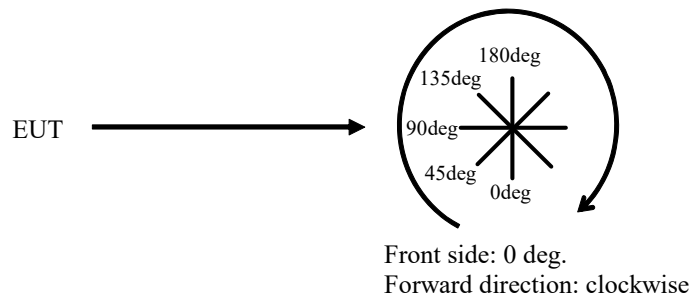


.....  
*Top View (Horizontal)*



Antenna was not rotated.

.....  
*Top View (Vertical)*



## **SECTION 6: -26dB Bandwidth**

### **Test Procedure**

The test was measured with a spectrum analyzer using a test fixture.

| Test             | Span   | RBW    | VBW     | Sweep | Detector | Trace    | Instrument used   |
|------------------|--------|--------|---------|-------|----------|----------|-------------------|
| -26 dB Bandwidth | 50 kHz | 510 Hz | 1.6 kHz | Auto  | Peak     | Max Hold | Spectrum Analyzer |

**Test data** : APPENDIX 1

**Test result** : Pass

## **SECTION 7: 99% Occupied Bandwidth**

### **Test Procedure**

The test was measured with a spectrum analyzer using a test fixture.

| Test                                             | Span                                    | RBW             | VBW                | Sweep | Detector | Trace    | Instrument used   |
|--------------------------------------------------|-----------------------------------------|-----------------|--------------------|-------|----------|----------|-------------------|
| 99 % Occupied Bandwidth                          | Enough width to display emission skirts | 1 to 5 % of OBW | Three times of RBW | Auto  | Peak     | Max Hold | Spectrum Analyzer |
| Peak hold was applied as Worst-case measurement. |                                         |                 |                    |       |          |          |                   |

**Test data** : APPENDIX 1

**Test result** : Pass

## APPENDIX 1: Test data

### Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Test place : Ise EMC Lab. No.4 and No.3 Semi Anechoic Chamber  
Order No. : 12316663H  
Date : 06/07/2018 08/23/2018  
Temperature/ Humidity : 23 deg. C / 67 % RH 24 deg. C / 65 % RH  
Engineer : Tomoki Matsui Takumi Shimada  
Mode : Tx 125 kHz LF Antenna (ANL)

#### LF Antenna(ANL)

##### PK or QP

| Ant Deg [deg]<br>or<br>Polarity [Hori/Vert] | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Duty<br>Factor<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark                 |
|---------------------------------------------|--------------------|----------|-------------------|-------------------------|--------------|--------------|------------------------|--------------------|-------------------|----------------|------------------------|
| 0                                           | 0.12500            | PK       | 105.3             | 19.8                    | -74.0        | 32.3         | -                      | 18.8               | 45.6              | 26.8           | Fundamental (DC 10.2V) |
| 0                                           | 0.12500            | PK       | 105.2             | 19.8                    | -73.9        | 32.2         | -                      | 18.9               | 45.6              | 26.7           | Fundamental (DC 12.0V) |
| 0                                           | 0.12500            | PK       | 105.4             | 19.8                    | -74.0        | 32.3         | -                      | 18.9               | 45.6              | 26.7           | Fundamental (DC 13.8V) |
| 0                                           | 0.25000            | PK       | 80.1              | 19.7                    | -73.9        | 32.2         | -                      | -6.3               | 39.6              | 45.9           |                        |
| 0                                           | 0.37500            | PK       | 65.8              | 19.7                    | -73.9        | 32.2         | -                      | -20.6              | 36.1              | 56.7           |                        |
| 0                                           | 0.50000            | QP       | 42.8              | 19.7                    | -33.8        | 32.1         | -                      | -3.4               | 33.6              | 37.0           |                        |
| 0                                           | 0.62500            | QP       | 41.9              | 19.7                    | -33.8        | 32.2         | -                      | -4.4               | 31.7              | 36.1           |                        |
| 0                                           | 0.75000            | QP       | 38.1              | 19.7                    | -33.8        | 32.2         | -                      | -8.2               | 30.1              | 38.3           |                        |
| 0                                           | 0.87500            | QP       | 36.7              | 19.7                    | -33.8        | 32.2         | -                      | -9.6               | 28.7              | 38.3           |                        |
| 0                                           | 1.00000            | QP       | 37.0              | 19.7                    | -33.8        | 32.2         | -                      | -9.3               | 27.6              | 36.9           |                        |
| 0                                           | 1.12500            | QP       | 37.2              | 19.7                    | -33.8        | 32.2         | -                      | -9.1               | 26.5              | 35.6           |                        |
| 0                                           | 1.25000            | QP       | 37.5              | 19.7                    | -33.8        | 32.2         | -                      | -8.8               | 25.6              | 34.4           |                        |

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier)

##### PK with Duty factor

| Ant Deg [deg] | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Duty<br>Factor<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark                 |
|---------------|--------------------|----------|-------------------|-------------------------|--------------|--------------|------------------------|--------------------|-------------------|----------------|------------------------|
| 0             | 0.12500            | PK       | 105.3             | 19.8                    | -74.0        | 32.3         | 0.0                    | 18.8               | 25.6              | 6.8            | Fundamental (DC 10.2V) |
| 0             | 0.12500            | PK       | 105.2             | 19.8                    | -73.9        | 32.2         | 0.0                    | 18.9               | 25.6              | 6.7            | Fundamental (DC 12.0V) |
| 0             | 0.12500            | PK       | 105.4             | 19.8                    | -74.0        | 32.3         | 0.0                    | 18.9               | 25.6              | 6.7            | Fundamental (DC 13.8V) |
| 0             | 0.25000            | PK       | 80.1              | 19.7                    | -73.9        | 32.2         | 0.0                    | -6.3               | 19.6              | 25.9           |                        |
| 0             | 0.37500            | PK       | 65.8              | 19.7                    | -73.9        | 32.2         | 0.0                    | -20.6              | 16.1              | 36.7           |                        |

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier) + Duty factor \*

\* Since the peak emission result satisfied the average limit, duty factor was omitted.

#### Result of the fundamental emission at 3m without Distance factor

##### PK or QP

| Ant Deg [deg] | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Duty<br>Factor<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark      |
|---------------|--------------------|----------|-------------------|-------------------------|--------------|--------------|------------------------|--------------------|-------------------|----------------|-------------|
| 0             | 0.12500            | PK       | 105.2             | 19.8                    | 6.1          | 32.2         | -                      | 98.9               | -                 | -              | Fundamental |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amplifier)

\* All spurious emissions lower than this result.

\*It was confirmed that there was no difference by the input voltage in the spurious emission.

\*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Ise EMC Lab.

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Facsimile : +81 596 24 8124

## Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Test place : Ise EMC Lab. No.4 and No.3 Semi Anechoic Chamber  
Order No. : 12316663H  
Date : 06/07/2018 08/23/2018  
Temperature/ Humidity : 23 deg. C / 67 % RH 24 deg. C / 65 % RH  
Engineer : Tomoki Matsui Takumi Shimada  
Mode : Tx 125 kHz LF Antenna (ANB)

### LF Antenna(ANB)

#### PK or QP

| Ant Deg [deg]<br>or<br>Polarity [Hori/Vert] | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Duty<br>Factor<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark                 |
|---------------------------------------------|--------------------|----------|-------------------|-------------------------|--------------|--------------|------------------------|--------------------|-------------------|----------------|------------------------|
| 0                                           | 0.12500            | PK       | 105.6             | 19.8                    | -74.0        | 32.3         | -                      | 19.1               | 45.6              | 26.5           | Fundamental (DC 10.2V) |
| 0                                           | 0.12500            | PK       | 105.4             | 19.8                    | -73.9        | 32.2         | -                      | 19.1               | 45.6              | 26.5           | Fundamental (DC 12.0V) |
| 0                                           | 0.12500            | PK       | 105.6             | 19.8                    | -74.0        | 32.3         | -                      | 19.1               | 45.6              | 26.5           | Fundamental (DC 13.8V) |
| 0                                           | 0.25000            | PK       | 80.0              | 19.7                    | -73.9        | 32.2         | -                      | -6.4               | 39.6              | 46.0           |                        |
| 0                                           | 0.37500            | PK       | 66.6              | 19.7                    | -73.9        | 32.2         | -                      | -19.8              | 36.1              | 55.9           |                        |
| 0                                           | 0.50000            | QP       | 43.9              | 19.7                    | -33.8        | 32.1         | -                      | -2.3               | 33.6              | 35.9           |                        |
| 0                                           | 0.62500            | QP       | 38.3              | 19.7                    | -33.8        | 32.2         | -                      | -8.0               | 31.7              | 39.7           |                        |
| 0                                           | 0.75000            | QP       | 31.7              | 19.7                    | -33.8        | 32.2         | -                      | -14.6              | 30.1              | 44.7           |                        |
| 0                                           | 0.87500            | QP       | 31.3              | 19.7                    | -33.8        | 32.2         | -                      | -15.0              | 28.7              | 43.7           |                        |
| 0                                           | 1.00000            | QP       | 31.0              | 19.7                    | -33.8        | 32.2         | -                      | -15.3              | 27.6              | 42.9           |                        |
| 0                                           | 1.12500            | QP       | 31.3              | 19.7                    | -33.8        | 32.2         | -                      | -15.0              | 26.5              | 41.5           |                        |
| 0                                           | 1.25000            | QP       | 30.8              | 19.7                    | -33.8        | 32.2         | -                      | -15.5              | 25.6              | 41.1           |                        |

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier)

#### PK with Duty factor

| Ant Deg [deg] | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Duty<br>Factor<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark                 |
|---------------|--------------------|----------|-------------------|-------------------------|--------------|--------------|------------------------|--------------------|-------------------|----------------|------------------------|
| 0             | 0.12500            | PK       | 105.6             | 19.8                    | -74.0        | 32.3         | 0.0                    | 19.1               | 25.6              | 6.5            | Fundamental (DC 10.2V) |
| 0             | 0.12500            | PK       | 105.4             | 19.8                    | -73.9        | 32.2         | 0.0                    | 19.1               | 25.6              | 6.5            | Fundamental (DC 12.0V) |
| 0             | 0.12500            | PK       | 105.6             | 19.8                    | -74.0        | 32.3         | 0.0                    | 19.1               | 25.6              | 6.5            | Fundamental (DC 13.8V) |
| 0             | 0.25000            | PK       | 80.0              | 19.7                    | -73.9        | 32.2         | 0.0                    | -6.4               | 19.6              | 26.0           |                        |
| 0             | 0.37500            | PK       | 66.6              | 19.7                    | -73.9        | 32.2         | 0.0                    | -19.8              | 16.1              | 35.9           |                        |

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amplifier) + Duty factor \*

\* Since the peak emission result satisfied the average limit, duty factor was omitted.

### Result of the fundamental emission at 3m without Distance factor

#### PK or QP

| Ant Deg [deg] | Frequency<br>[MHz] | Detector | Reading<br>[dBuV] | Ant<br>Factor<br>[dB/m] | Loss<br>[dB] | Gain<br>[dB] | Duty<br>Factor<br>[dB] | Result<br>[dBuV/m] | Limit<br>[dBuV/m] | Margin<br>[dB] | Remark      |
|---------------|--------------------|----------|-------------------|-------------------------|--------------|--------------|------------------------|--------------------|-------------------|----------------|-------------|
| 0             | 0.12500            | PK       | 105.4             | 19.8                    | 6.1          | 32.2         | -                      | 99.1               | -                 | -              | Fundamental |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amplifier)

\* All spurious emissions lower than this result.

\*It was confirmed that there was no difference by the input voltage in the spurious emission.

\*The test result is rounded off to one or two decimal places, so some differences might be observed.

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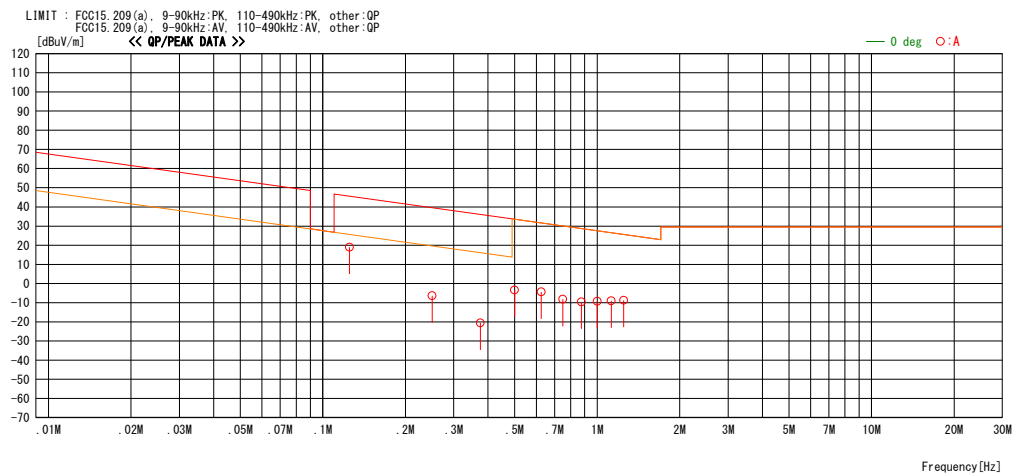
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**Radiated Emission below 30 MHz (Fundamental and Spurious Emission)**  
**(Plot data, Worst case)**

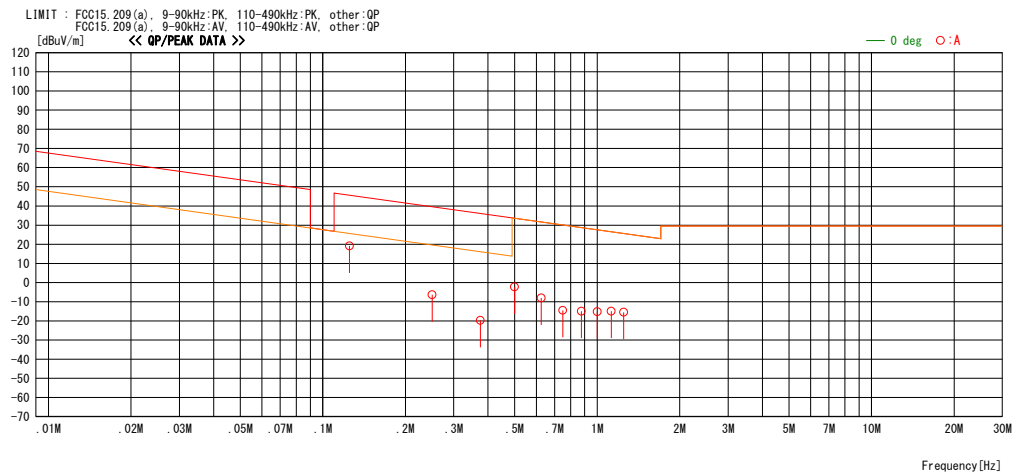
Test place                      Ise EMC Lab. No.4 Semi Anechoic Chamber  
Order No.                      12316663H  
Date                              06/07/2018  
Temperature/ Humidity        23 deg. C / 67 % RH  
Engineer                        Tomoki Matsui  
Mode                              Tx 125 kHz LF Antenna (ANL)



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

**Radiated Emission below 30 MHz (Fundamental and Spurious Emission)**  
**(Plot data, Worst case)**

|                       |                                         |
|-----------------------|-----------------------------------------|
| Test place            | Ise EMC Lab. No.4 Semi Anechoic Chamber |
| Order No.             | 12316663H                               |
| Date                  | 06/07/2018                              |
| Temperature/ Humidity | 23 deg. C / 67 % RH                     |
| Engineer              | Tomoki Matsui                           |
| Mode                  | Tx 125 kHz LF Antenna (ANB)             |

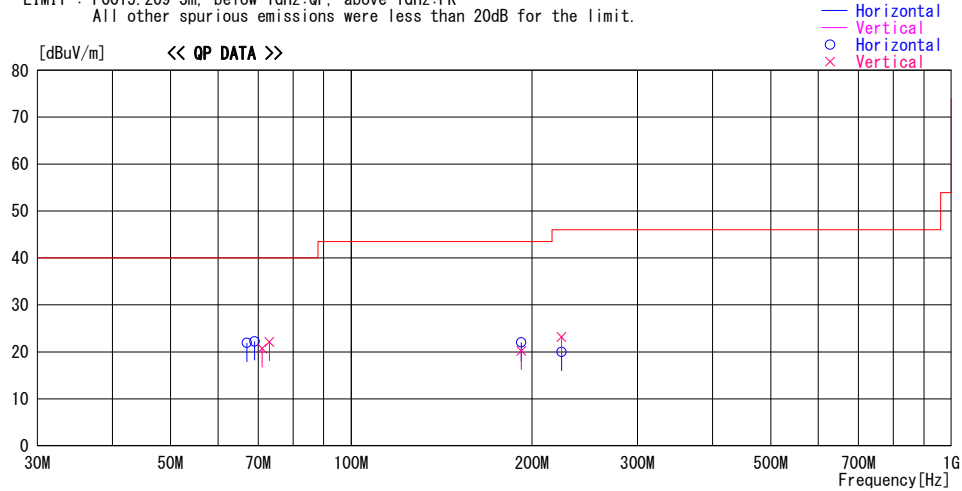


\*These plots data contains sufficient number to show the trend of characteristic features for EUT.

## Radiated Emission above 30 MHz (Spurious Emission)

Test place : Ise EMC Lab. No.3 Semi Anechoic Chamber  
Order No. : 12316663H  
Date : 06/09/2018  
Temperature/ Humidity : 24 deg. C / 53 % RH  
Engineer : Hiroyuki Furutaka  
Mode : Tx 125 kHz LF Antenna (ANL)

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK  
All other spurious emissions were less than 20dB for the limit.



| Frequency<br>[MHz] | Reading<br>[dBuV] | DET | Antenna          | Loss&        | Level<br>[dBuV/m] | Angle<br>[Deg] | Height<br>[cm] | Polar. | Limit    | Margin | Comment |
|--------------------|-------------------|-----|------------------|--------------|-------------------|----------------|----------------|--------|----------|--------|---------|
|                    |                   |     | Factor<br>[dB/m] | Gain<br>[dB] |                   |                |                |        | [dBuV/m] | [dB]   |         |
| 67.028             | 39.7              | QP  | 6.7              | -24.5        | 21.9              | 0              | 400            | Hori.  | 40.0     | 18.1   |         |
| 69.034             | 40.2              | QP  | 6.4              | -24.4        | 22.2              | 174            | 400            | Hori.  | 40.0     | 17.8   |         |
| 71.040             | 38.8              | QP  | 6.3              | -24.4        | 20.7              | 250            | 100            | Vert.  | 40.0     | 19.3   |         |
| 73.035             | 40.2              | QP  | 6.3              | -24.4        | 22.1              | 249            | 100            | Vert.  | 40.0     | 17.9   |         |
| 192.110            | 28.4              | QP  | 16.6             | -23.0        | 22.0              | 139            | 170            | Hori.  | 43.5     | 21.5   |         |
| 192.096            | 26.6              | QP  | 16.6             | -23.0        | 20.2              | 338            | 100            | Vert.  | 43.5     | 23.3   |         |
| 224.112            | 31.3              | QP  | 11.4             | -22.7        | 20.0              | 147            | 144            | Hori.  | 46.0     | 26.0   |         |
| 224.098            | 34.5              | QP  | 11.4             | -22.7        | 23.2              | 178            | 100            | Vert.  | 46.0     | 22.8   |         |

CHART: WITH FACTOR

ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN  
CALCULATION: RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATT - GAIN(AMP))

\*It was confirmed that there was no difference by the input voltage in the spurious emission.

\*The test result is rounded off to one or two decimal places, so some differences might be observed.

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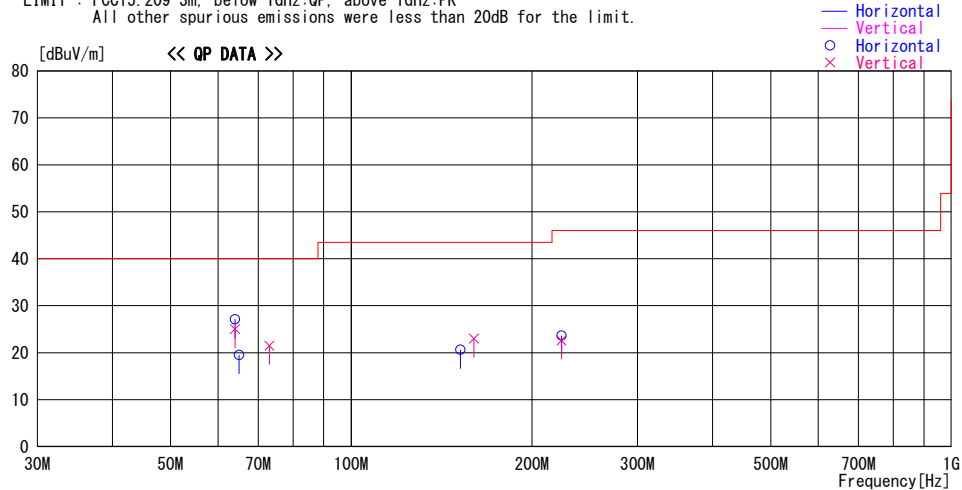
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Facsimile : +81 596 24 8124

## Radiated Emission above 30 MHz (Spurious Emission)

Test place Ise EMC Lab. No.3 Semi Anechoic Chamber  
Order No. 12316663H  
Date 06/09/2018  
Temperature/ Humidity 24 deg. C / 53 % RH  
Engineer Hiroyuki Furutaka  
Mode Tx 125 kHz LF Antenna (ANB)

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK  
All other spurious emissions were less than 20dB for the limit.



| Frequency<br>[MHz] | Reading<br>[dBuV] | DET | Antenna          | Loss&        | Level<br>[dBuV/m] | Angle<br>[Deg] | Height<br>[cm] | Polar. | Limit    | Margin | Comment |
|--------------------|-------------------|-----|------------------|--------------|-------------------|----------------|----------------|--------|----------|--------|---------|
|                    |                   |     | Factor<br>[dB/m] | Gain<br>[dB] |                   |                |                |        | [dBuV/m] | [dB]   |         |
| 64.030             | 42.4              | QP  | 7.1              | -24.5        | 25.0              | 263            | 100            | Vert.  | 40.0     | 15.0   |         |
| 64.031             | 44.5              | QP  | 7.1              | -24.5        | 27.1              | 7              | 298            | Hori.  | 40.0     | 12.9   |         |
| 65.031             | 37.0              | QP  | 7.0              | -24.5        | 19.5              | 353            | 293            | Hori.  | 40.0     | 20.5   |         |
| 73.041             | 39.6              | QP  | 6.3              | -24.4        | 21.5              | 249            | 100            | Vert.  | 40.0     | 18.5   |         |
| 152.078            | 29.1              | QP  | 15.0             | -23.5        | 20.6              | 235            | 118            | Hori.  | 43.5     | 22.9   |         |
| 160.074            | 31.0              | QP  | 15.4             | -23.4        | 23.0              | 199            | 100            | Vert.  | 43.5     | 20.5   |         |
| 224.112            | 33.9              | QP  | 11.4             | -22.7        | 22.6              | 166            | 100            | Vert.  | 46.0     | 23.4   |         |
| 224.114            | 34.9              | QP  | 11.4             | -22.7        | 23.6              | 340            | 140            | Hori.  | 46.0     | 22.4   |         |

CHART: WITH FACTOR

ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN  
CALCULATION: RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATT - GAIN(AMP))

\*It was confirmed that there was no difference by the input voltage in the spurious emission.

\*The test result is rounded off to one or two decimal places, so some differences might be observed.

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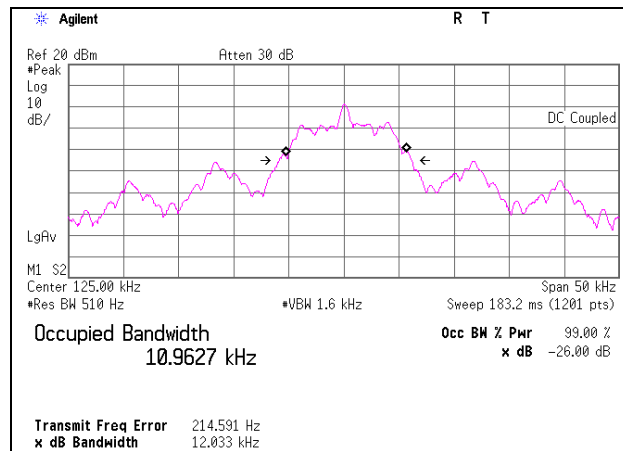
Facsimile : +81 596 24 8124

## -26 dB Bandwidth and 99% Occupied Bandwidth

Test place Ise EMC Lab. No.4 Semi Anechoic Chamber  
Order No. 12316663H  
Date 06/07/2018  
Temperature/ Humidity 23 deg. C / 67 % RH  
Engineer Tomoki Matsui  
Mode Tx 125 kHz LF Antenna (ANL)

### LF Antenna(ANL)

| -26 dB Bandwidth<br>[kHz] | 99% Occupied Bandwidth<br>[kHz] |
|---------------------------|---------------------------------|
| 12.033                    | 10.9627                         |



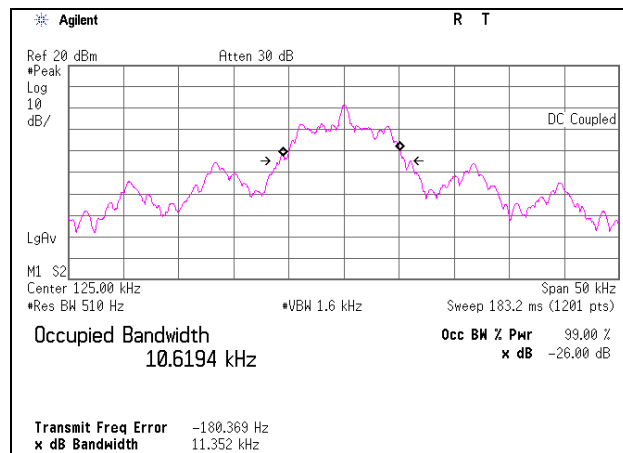
\*It was confirmed that there was no difference by the input voltage.

## -26 dB Bandwidth and 99% Occupied Bandwidth

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber  
Order No. : 12316663H  
Date : 06/07/2018  
Temperature/ Humidity : 23 deg. C / 67 % RH  
Engineer : Tomoki Matsui  
Mode : Tx 125kHz LF Antenna (ANB)

### LF Antenna (ANB)

| -26 dB Bandwidth<br>[kHz] | 99% Occupied Bandwidth<br>[kHz] |
|---------------------------|---------------------------------|
| 11.352                    | 10.6194                         |



\*It was confirmed that there was no difference by the input voltage.

## APPENDIX 2: Test instruments

### Test equipment

| Test item | LIMS ID | Description                      | Manufacturer        | Model                              | Serial     | Last Calibration Date | Calibration Due Date | Cal Int |
|-----------|---------|----------------------------------|---------------------|------------------------------------|------------|-----------------------|----------------------|---------|
| RE        | 148898  | Attenuator                       | KEYSIGHT            | 8491A                              | MY52462282 | 10/12/2017            | 10/31/2018           | 12      |
| RE        | 141413  | Coaxial Cable                    | UL Japan            | -                                  | -          | 6/12/2018             | 6/30/2019            | 12      |
| RE        | 141217  | Coaxial cable                    | Fujikura/Suhner/TSJ | 5D-2W/SFM141/421-010/sucoform141-P | -/04178    | 6/13/2018             | 6/30/2019            | 12      |
| RE        | 141254  | Loop Antenna                     | Rohde & Schwarz     | HFH2-Z2                            | 100017     | 10/11/2017            | 10/31/2018           | 12      |
| RE        | 141583  | Pre Amplifier                    | SONOMA INSTRUMENT   | 11/5/1900                          | 260833     | 2/27/2018             | 2/28/2019            | 12      |
| RE        | 142011  | AC4_Semi Anechoic Chamber(NSA)   | TDK                 | Semi Anechoic Chamber 3m           | DA-10005   | 10/30/2017            | 10/31/2018           | 12      |
| RE        | 141951  | EMI Test Receiver                | Rohde & Schwarz     | ESR26                              | 101408     | 1/30/2018             | 1/31/2019            | 12      |
| RE        | 142227  | Measure                          | KOMELON             | KMC-36                             | -          | -                     | -                    | -       |
| RE        | 141545  | DIGITAL HiTESTER                 | HIOKI               | 3805                               | 51201148   | 1/9/2018              | 1/31/2019            | 12      |
| RE        | 141562  | Thermo-Hygrometer                | CUSTOM              | CTH-180                            | 1501       | 1/24/2018             | 1/31/2019            | 12      |
| RE        | 141152  | EMI measurement program          | TSJ                 | TEPTO-DV                           | -          | -                     | -                    | -       |
| RE        | 141901  | Spectrum Analyzer                | AGILENT             | E4440A                             | MY48250080 | 10/18/2017            | 10/31/2018           | 12      |
| RE        | 141949  | Test Receiver                    | Rohde & Schwarz     | ESCI                               | 100767     | 8/22/2017             | 8/31/2018            | 12      |
| RE        | 141554  | Thermo-Hygrometer                | CUSTOM              | CTH-180                            | 1301       | 1/24/2018             | 1/31/2019            | 12      |
| RE        | 142008  | AC3_Semi Anechoic Chamber(NSA)   | TDK                 | Semi Anechoic Chamber 3m           | DA-10005   | 10/31/2017            | 10/31/2018           | 12      |
| RE        | 141582  | Pre Amplifier                    | SONOMA INSTRUMENT   | 11/5/1900                          | 260834     | 2/27/2018             | 2/28/2019            | 12      |
| RE        | 142183  | Measure                          | KOMELON             | KMC-36                             | -          | -                     | -                    | -       |
| RE        | 141266  | Logperiodic Antenna(200-1000MHz) | Schwarzbeck         | VUSLP9111B                         | 911B-191   | 1/30/2018             | 1/31/2019            | 12      |
| RE        | 141532  | DIGITAL HiTESTER                 | HIOKI               | 3805                               | 51201197   | 1/9/2018              | 1/31/2019            | 12      |
| RE        | 141323  | Coaxial cable                    | UL Japan            | -                                  | -          | 7/12/2017             | 7/31/2018            | 12 *1)  |
| RE        | 141424  | Biconical Antenna                | Schwarzbeck         | BBA9106                            | 1915       | 10/2/2017             | 10/31/2018           | 12      |
| RE        | 148897  | Attenuator                       | KEYSIGHT            | 8491A                              | MY52462349 | 12/18/2017            | 12/31/2018           | 12      |

\*1) This test equipment was used for the tests before the expiration date of the calibration.

\*Hyphens for Last Calibration Date, Calibration Due Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.

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

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

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

Test item:

RE: Spurious emission

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