



# **RADIO TEST REPORT**

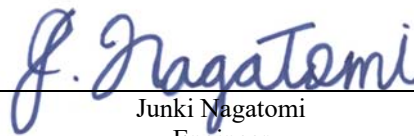
**Test Report No. : 13092632H-R1**

**Applicant** : **DENSO CORPORATION**  
**Type of Equipment** : **Electronic Key**  
**Model No.** : **14FFC**  
**FCC ID** : **HYQ14FFC**  
**Test regulation** : **FCC Part 15 Subpart C: 2019**  
**Test Result** : **Complied (Refer to SECTION 3.2)**

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 above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
6. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
7. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 13092632H. 13092632H is replaced with this report.

**Date of test:** October 23, 2019

**Representative test engineer:**

  
Junki Nagatomi  
Engineer  
Consumer Technology Division

**Approved by:**

  
Motoya Imura  
Leader  
Consumer Technology Division



This laboratory is accredited by the NVLAP LAB CODE 200572-0, U.S.A. The tests reported herein have been performed in accordance with its terms of accreditation.  
\*As for the range of Accreditation in NVLAP, you may refer to the WEB address,  
[http://japan.ul.com/resources/emc\\_accredited/](http://japan.ul.com/resources/emc_accredited/)

- ☐ 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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## **REVISION HISTORY**

**Original Test Report No.: 13092632H**

| Revision        | Test report No. | Date              | Page revised | Contents                                                             |
|-----------------|-----------------|-------------------|--------------|----------------------------------------------------------------------|
| -<br>(Original) | 13092632H       | November 6, 2019  | -            | -                                                                    |
| 1               | 13092632H-R1    | November 11, 2019 | P.17         | Correction of horizontal axis in Plot data;<br>From 4 GHz to 4.4 GHz |

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## **SECTION 1: Customer information**

|                  |   |                                                        |
|------------------|---|--------------------------------------------------------|
| Company Name     | : | DENSO CORPORATION                                      |
| Address          | : | 1-1, Showa-cho, Kariya-shi, Aichi-ken, 448-8661, Japan |
| Telephone Number | : | +81-566-20-3955                                        |
| Facsimile Number | : | +81-566-25-4837                                        |
| Contact Person   | : | TAKAYUKI HATTORI                                       |

The information provided from the customer is as follows;

- Applicant, Type of Equipment, Model No. FCC ID on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (E.U.T.)
- SECTION 4: Operation of E.U.T. during testing

\* The laboratory is exempted from liability of any test results affected from the above information in SECTION 2 and 4.

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

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

|                                                        |   |                                                                                            |
|--------------------------------------------------------|---|--------------------------------------------------------------------------------------------|
| Type of Equipment                                      | : | Electronic Key                                                                             |
| Model No.                                              | : | 14FFC                                                                                      |
| Serial No.                                             | : | Refer to Section 4, Clause 4.2                                                             |
| Rating                                                 | : | DC 3.0 V                                                                                   |
| Receipt Date of Sample<br>(Information from test lab.) | : | October 18, 2019                                                                           |
| Country of Mass-production                             | : | Japan, United States of America, China                                                     |
| Condition of EUT                                       | : | Engineering 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: 14FFC (referred to as the EUT in this report) is a Electronic Key.

#### **Radio Specification**

|                           |   |                                                                  |
|---------------------------|---|------------------------------------------------------------------|
| Radio Type                | : | Transceiver                                                      |
| Frequency of Operation    | : | 433.58 MHz / 434.42 MHz*                                         |
|                           |   | *These two different frequencies are not emitted simultaneously. |
| Modulation                | : | FSK (F1D)                                                        |
| Type of Battery           | : | One lithium battery                                              |
| Antenna type              | : | Built-in type (Fixed)                                            |
| Clock frequency (Maximum) | : | 13.08 MHz Crystal                                                |
| Radio Type                | : | Receiver                                                         |
| Frequency of Operation    | : | 134.2 kHz *1)                                                    |

\*1) The test of receiver part was performed separately from this test report, and the conformability is confirmed.

\* Original model: 14FFC has two types; Type A and Type B.  
The worst case was confirmed with Type A and Type B at pre check.  
The test was performed with Type B, which had the worst result.

\*Original model No.: 14FFC has 4 switches.  
Variation model have 3 switches and 2 switches.

The difference of Original model and Variation models is only the number and / or location of switches.  
They are completely identical in RF characteristics.  
Therefore the test was performed with the representative original type which was the worst one.

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

### **3.1 Test Specification**

Test Specification : FCC Part 15 Subpart C  
FCC Part 15 final revised on July 19, 2019 and effective August 19, 2019 except 15.258

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators  
Section 15.231 Periodic operation in the band 40.66-40.70 MHz and above 70 MHz.

### **3.2 Procedures and results**

| Item                                               | Test Procedure                                                                  | Specification                                                                                                 | Worst margin                                                   | Results         | Remarks  |
|----------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|-----------------|----------|
| Conducted emission                                 | FCC: ANSI C63.10:2013<br>6 Standard test methods<br>-----<br>ISED: RSS-Gen 8.8  | FCC: Section 15.207<br>-----<br>ISED: RSS-Gen 8.8                                                             | N/A                                                            | N/A             | *1)      |
| Automatically Deactivate                           | FCC: ANSI C63.10:2013<br>6 Standard test methods<br>-----<br>ISED: -            | FCC: Section 15.231(a)(1)<br>-----<br>ISED: RSS-210 A1.1                                                      | N/A                                                            | Complied<br>a)  | Radiated |
| Electric Field Strength<br>of Fundamental Emission | FCC: ANSI C63.10:2013<br>6 Standard test methods<br>-----<br>ISED: RSS-Gen 6.12 | FCC: Section 15.231(b)<br>-----<br>ISED: RSS-210 A1.2                                                         | 4.4 dB<br>433.58 MHz<br>Vertical<br>PK with Duty<br>Factor     | Complied#<br>b) | Radiated |
| Electric Field Strength<br>of Spurious Emission    | FCC: ANSI C63.10:2013<br>6 Standard test methods<br>-----<br>ISED: RSS-Gen 6.13 | FCC: Section 15.205<br>Section 15.209<br>Section 15.231(b)<br>-----<br>ISED: RSS-210 A1.2, 4.4<br>RSS-Gen 8.9 | 3.60 dB<br>4335.80 MHz<br>Horizontal<br>PK with Duty<br>Factor | Complied<br>b)  | Radiated |
| -20dB Bandwidth                                    | FCC: ANSI C63.10:2013<br>6 Standard test methods<br>-----<br>ISED: -            | FCC: Section 15.231(c)<br>-----<br>ISED: Reference data                                                       | N/A                                                            | Complied<br>c)  | Radiated |

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 does not have AC Mains.

a) Refer to APPENDIX 1 (data of Automatically deactivate)

b) Refer to APPENDIX 1 (data of Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission))

c) Refer to APPENDIX 1 (data of -20dB and 99% Occupied Bandwidth)

Symbols:

Complied The data of this test item has enough margin, more than the measurement uncertainty.

Complied# The data of this test item meets the limits unless the measurement uncertainty is taken into consideration.

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

This test was performed with the New Battery (DC 3.0 V) and the constant voltage was supplied to the EUT during the tests. Therefore, the EUT complies with the requirement.

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

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

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### 3.3 Addition to standard

| Item                    | Test Procedure    | Specification      | Worst margin | Results | Remarks  |
|-------------------------|-------------------|--------------------|--------------|---------|----------|
| 99 % Occupied Bandwidth | ISED: RSS-Gen 6.7 | ISED: RSS-210 A1.3 | N/A          | -       | Radiated |

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

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

### 3.4 Uncertainty

There is no applicable rule of uncertainty in this applied standard. Therefore, the following results are derived depending on whether or not laboratory uncertainty is applied.

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

#### Radiated emission

| Measurement distance | Frequency range                  | Uncertainty (+/-) |
|----------------------|----------------------------------|-------------------|
| 3 m                  | 9 kHz to 30 MHz                  | 3.3 dB            |
| 10 m                 |                                  | 3.2 dB            |
| 3 m                  | 30 MHz to 200 MHz (Horizontal)   | 4.8 dB            |
|                      | (Vertical)                       | 5.0 dB            |
|                      | 200 MHz to 1000 MHz (Horizontal) | 5.2 dB            |
|                      | (Vertical)                       | 6.3 dB            |
| 10 m                 | 30 MHz to 200 MHz (Horizontal)   | 4.8 dB            |
|                      | (Vertical)                       | 4.8 dB            |
|                      | 200 MHz to 1000 MHz (Horizontal) | 5.0 dB            |
|                      | (Vertical)                       | 5.0 dB            |
| 3 m                  | 1 GHz to 6 GHz                   | 4.9 dB            |
|                      | 6 GHz to 18 GHz                  | 5.2 dB            |
| 1 m                  | 10 GHz to 26.5 GHz               | 5.5 dB            |
|                      | 26.5 GHz to 40 GHz               | 5.5 dB            |
| 10 m                 | 1 GHz to 18 GHz                  | 5.2 dB            |

#### Antenna Terminal test

| Test Item                                          | Uncertainty (+/-) |
|----------------------------------------------------|-------------------|
| Automatically Deactivate                           | 0.10 %            |
| -20dB Emission Bandwidth / 99 % Occupied Bandwidth | 0.96 %            |

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### 3.5 Test Location

UL Japan, Inc. Ise EMC Lab.

\*NVLAP Lab. code: 200572-0 / FCC Test Firm Registration Number: 199967 / ISED Lab Company Number: 2973C

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| Test site                  | 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 | 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 | 7.5 x 5.8 x 5.2            | 4.0 x 4.0                                                        | -                      | 3 m                          |
| No.3 semi-anechoic chamber | 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 | 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.5 measurement room      | 6.4 x 6.4 x 3.0            | 6.4 x 6.4                                                        | -                      | -                            |
| 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            | 3.1 x 5.0                                                        | -                      | -                            |
| 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 x 2.0 m 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.

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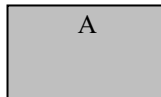
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## **SECTION 4: Operation of E.U.T. during testing**

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

| Test Item*                                                                                                                                                                | Mode                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Automatically Deactivate                                                                                                                                                  | Normal use mode        |
| Electric Field Strength of Fundamental Emission<br>Electric Field Strength of Spurious Emission<br>-20 dB & 99 % Occupied Bandwidth<br>Duty Cycle                         | Transmitting mode (Tx) |
| * The system was configured in typical fashion (as a user would normally use it) for testing.<br>End users cannot change the settings of the output power of the product. |                        |

### **4.2 Configuration and peripherals**



\* Setup was taken into consideration and test data was taken under worse case conditions.

#### **Description of EUT**

| No. | Item           | Model number | Serial number        | Manufacturer      | Remarks |
|-----|----------------|--------------|----------------------|-------------------|---------|
| A   | Electronic Key | 14FFC        | No.1 *1)<br>No.2 *2) | DENSO CORPORATION | EUT     |

\*1) Used for Normal use mode

\*2) Used for Transmitting mode

## **SECTION 5: Radiated emission (Electric Field Strength of Fundamental and Spurious Emission)**

### **Test Procedure and conditions**

[For below 30 MHz]

The noise level was checked by moving a search-coil (Loop Antenna) close to the EUT.

[For 30 MHz to 1 GHz]

EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 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.

[For above 1 GHz]

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

The measuring antenna height was varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.

Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.

The measurements were performed for both vertical and horizontal antenna polarization.

The radiated emission measurements were made with the following detector function of the test receiver / spectrum analyzer.

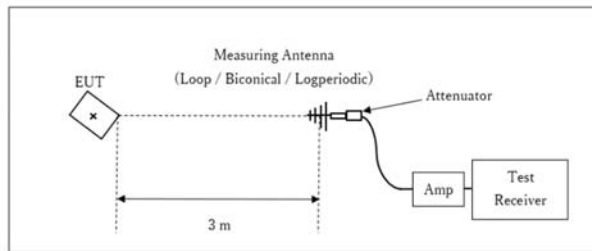
### **Test Antennas are used as below;**

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

|                  | From 9 kHz<br>to 90 kHz and<br>From 110 kHz<br>to 150 kHz | From<br>90 kHz<br>to 110 kHz | From<br>150 kHz<br>to 490 kHz | From<br>490 kHz<br>to 30 MHz | From<br>30 MHz<br>to 1 GHz           | Above 1 GHz                       |
|------------------|-----------------------------------------------------------|------------------------------|-------------------------------|------------------------------|--------------------------------------|-----------------------------------|
| Detector<br>Type | Peak                                                      | Peak                         | Peak                          | Peak                         | Peak and<br>Peak with<br>Duty factor | Peak and<br>Peak with Duty factor |
| IF Bandwidth     | 200 Hz                                                    | 200 Hz                       | 9.0 kHz                       | 9.0 kHz                      | 120 kHz                              | PK: S/A: RBW 1 MHz,<br>VBW: 3 MHz |

## [Test Setup]

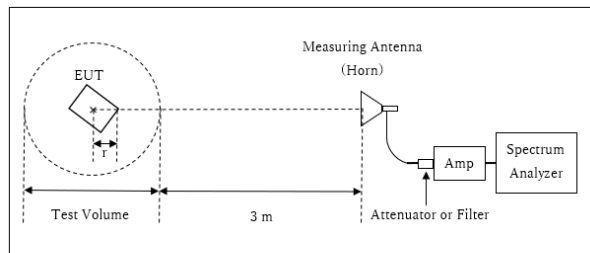
Below 1 GHz



x : Center of turn table

Test Distance: 3 m

1 GHz – 3.2 GHz



r : Radius of an outer periphery of EUT

x : Center of turn table

Distance Factor:  $20 \times \log (4.0 \text{ m} / 3.0 \text{ m}) = 2.5 \text{ dB}$

\* Test Distance:  $(3 + \text{Test Volume} / 2) - r = 4.0 \text{ m}$

Test Volume : 2.0 m

(Test Volume has been calibrated based on CISPR 16-1-4.)

$r = 0.0 \text{ m}$

\* The test was performed with  $r = 0.0 \text{ m}$  since EUT is small and it was the rather conservative condition.

- The carrier level (or, noise levels) was (or were) measured at each position of all three axes X, Y and Z, and the position that has the maximum noise was determined.

Noise levels of all the frequencies were measured at the position.

This EUT has two modes which mechanical key is inserted or not. The worst case was confirmed with and without mechanical key, as a result, the test with mechanical key was the worst case. Therefore the test with mechanical key was performed only.

\*The result is rounded off to the second decimal place, so some differences might be observed.

**Measurement range** : 9 kHz - 4.4 GHz

**Test data** : APPENDIX

**Test result** : Pass

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## **SECTION 6: Automatically deactivate**

### **Test Procedure**

The measurement was performed with Electric field strength using a spectrum analyzer.

Test data : APPENDIX  
Test result : Pass

## **SECTION 7: -20 dB and 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   |
|--------------------------------------------------|-----------------------------------------|-----------------|--------------------|-------|----------|----------|-------------------|
| 20 dB Bandwidth                                  | 150 kHz                                 | 1 kHz           | 3 kHz              | Auto  | Peak     | Max Hold | Spectrum Analyzer |
| 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. |                                         |                 |                    |       |          |          |                   |

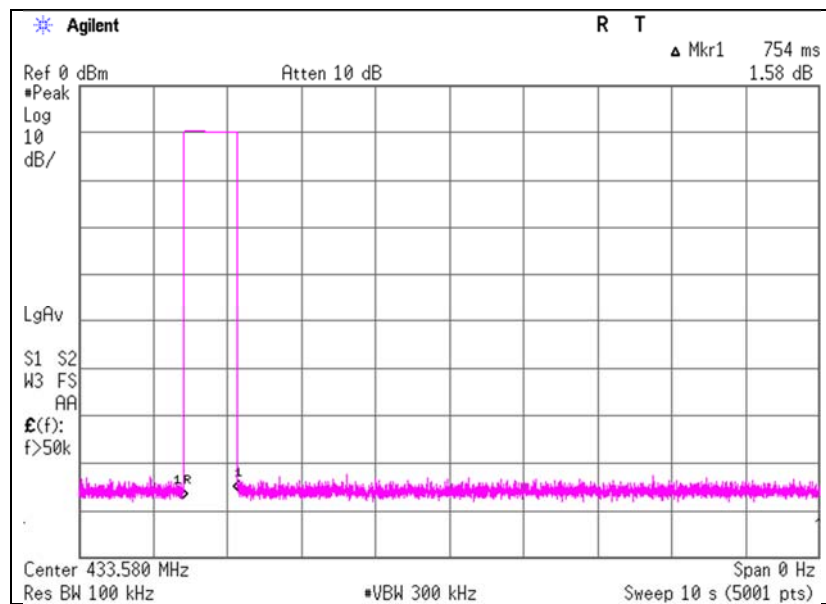
Test data : APPENDIX  
Test result : Pass

## APPENDIX 1: Test data

### Automatically deactivate

|                        |                            |
|------------------------|----------------------------|
| Report No.             | 13092632H                  |
| Test place             | Ise EMC Lab.               |
| Semi Anechoic Chamber  | No.2                       |
| Date                   | October 23, 2019           |
| Temperature / Humidity | 23 deg. C / 52 % RH        |
| Engineer               | Junki Nagatomi             |
| Mode                   | Normal use mode 433.58 MHz |

| Time of Transmitting<br>[sec] | Limit<br>[sec] | Result |
|-------------------------------|----------------|--------|
| 0.754                         | 5.00           | Pass   |



\* The EUT transmits UHF when LF signal is received from a car or a button on the EUT is pressed. In both cases, the UHF transmission is stopped within 5 seconds. So the test was performed by a button-pressed operation as the worst case. Please refer to the “Theory of Operation” for details.

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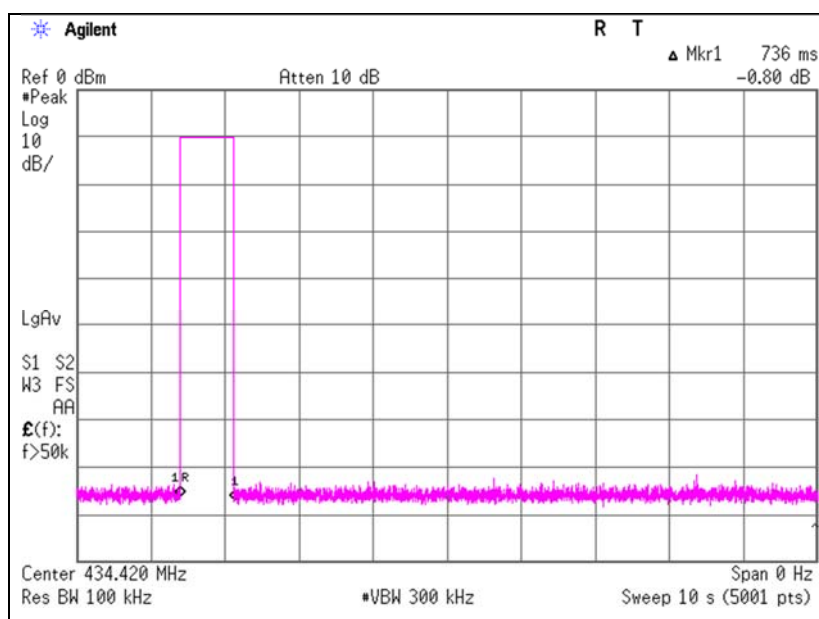
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### Automatically deactivate

|                        |                            |
|------------------------|----------------------------|
| Report No.             | 13092632H                  |
| Test place             | Ise EMC Lab.               |
| Semi Anechoic Chamber  | No.2                       |
| Date                   | October 23, 2019           |
| Temperature / Humidity | 23 deg. C / 52 % RH        |
| Engineer               | Junki Nagatomi             |
| Mode                   | Normal use mode 434.42 MHz |

| Time of Transmitting<br>[sec] | Limit<br>[sec] | Result |
|-------------------------------|----------------|--------|
| 0.736                         | 5.00           | Pass   |



\* The EUT transmits UHF when LF signal is received from a car or a button on the EUT is pressed. In both cases, the UHF transmission is stopped within 5 seconds. So the test was performed by a button-pressed operation as the worst case. Please refer to the “Theory of Operation” for details.

## Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No. 13092632H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.3  
Date October 23, 2019  
Temperature / Humidity 22 deg. C / 64 % RH  
Engineer Junya Okuno  
Mode Transmitting mode 433.58 MHz

### QP or PK

| 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<br>Inside or Outside<br>of Restricted Bands |
|--------------------|----------|-------------------|------|-------------------------|--------------|--------------|------------------------|--------------------|------|-------------------|----------------|------|----------------------------------------------------|
|                    |          | Hor               | Ver  |                         |              |              |                        | Hor                | Ver  |                   | Hor            | Ver  |                                                    |
| 433.58             | PK       | 78.2              | 81.2 | 16.2                    | 10.9         | 32.0         | -                      | 73.4               | 76.4 | 100.8             | 27.4           | 24.4 | Carrier                                            |
| 867.16             | PK       | 27.9              | 28.6 | 21.8                    | 13.3         | 31.1         | -                      | 31.9               | 32.6 | 80.8              | 48.9           | 48.2 | Outside                                            |
| 1300.74            | PK       | 44.7              | 44.4 | 25.4                    | 6.0          | 34.6         | -                      | 41.5               | 41.2 | 73.9              | 32.4           | 32.7 | Inside                                             |
| 1734.32            | PK       | 51.3              | 51.6 | 25.0                    | 5.5          | 33.6         | -                      | 48.3               | 48.6 | 80.8              | 32.5           | 32.2 | Outside                                            |
| 2167.90            | PK       | 44.5              | 43.9 | 28.0                    | 5.6          | 32.9         | -                      | 45.3               | 44.6 | 80.8              | 35.5           | 36.2 | Outside                                            |
| 2601.48            | PK       | 43.3              | 44.0 | 27.7                    | 5.7          | 32.7         | -                      | 44.1               | 44.7 | 80.8              | 36.7           | 36.1 | Outside                                            |
| 3035.06            | PK       | 43.3              | 42.8 | 28.7                    | 5.9          | 32.4         | -                      | 45.4               | 44.9 | 80.8              | 35.4           | 35.9 | Outside                                            |
| 3468.64            | PK       | 45.6              | 45.6 | 28.7                    | 6.0          | 32.3         | -                      | 48.1               | 48.0 | 80.8              | 32.7           | 32.8 | Outside                                            |
| 3902.22            | PK       | 45.1              | 45.3 | 29.7                    | 6.2          | 32.1         | -                      | 49.0               | 49.2 | 73.9              | 24.9           | 24.7 | Inside                                             |
| 4335.80            | PK       | 45.6              | 45.3 | 30.3                    | 6.4          | 31.9         | -                      | 50.3               | 50.1 | 73.9              | 23.6           | 23.9 | Inside                                             |

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

### PK with Duty factor

| 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  |
|--------------------|----------|-------------------|------|-------------------------|--------------|--------------|------------------------|--------------------|------|-------------------|----------------|------|---------|
|                    |          | Hor               | Ver  |                         |              |              |                        | Hor                | Ver  |                   | Hor            | Ver  |         |
| 433.58             | PK       | 78.2              | 81.2 | 16.2                    | 10.9         | 32.0         | 0.0                    | 73.4               | 76.4 | 80.8              | 7.4            | 4.4  | Carrier |
| 867.16             | PK       | 27.9              | 28.6 | 21.8                    | 13.3         | 31.1         | 0.0                    | 31.9               | 32.6 | 60.8              | 28.9           | 28.2 | Outside |
| 1300.74            | PK       | 44.7              | 44.4 | 25.4                    | 6.0          | 34.6         | 0.0                    | 41.5               | 41.2 | 53.9              | 12.4           | 12.7 | Inside  |
| 1734.32            | PK       | 51.3              | 51.6 | 25.0                    | 5.5          | 33.6         | 0.0                    | 48.3               | 48.6 | 60.8              | 12.5           | 12.2 | Outside |
| 2167.90            | PK       | 44.5              | 43.9 | 28.0                    | 5.6          | 32.9         | 0.0                    | 45.3               | 44.6 | 60.8              | 15.5           | 16.2 | Outside |
| 2601.48            | PK       | 43.3              | 44.0 | 27.7                    | 5.7          | 32.7         | 0.0                    | 44.1               | 44.7 | 60.8              | 16.7           | 16.1 | Outside |
| 3035.06            | PK       | 43.3              | 42.8 | 28.7                    | 5.9          | 32.4         | 0.0                    | 45.4               | 44.9 | 60.8              | 15.4           | 15.9 | Outside |
| 3468.64            | PK       | 45.6              | 45.6 | 28.7                    | 6.0          | 32.3         | 0.0                    | 48.1               | 48.0 | 60.8              | 12.7           | 12.8 | Outside |
| 3902.22            | PK       | 45.1              | 45.3 | 29.7                    | 6.2          | 32.1         | 0.0                    | 49.0               | 49.2 | 53.9              | 4.9            | 4.7  | Inside  |
| 4335.80            | PK       | 45.6              | 45.3 | 30.3                    | 6.4          | 31.9         | 0.0                    | 50.3               | 50.1 | 53.9              | 3.6            | 3.9  | Inside  |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amplifier) + Duty factor (Refer to Duty factor data sheet)

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

Sample calculation:

Result of PK = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier)

Result of PK with Duty factor = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1 GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier) + Duty factor

For above 1GHz : Distance Factor:  $20 \times \log(4.0 \text{ m}/3.0 \text{ m}) = 2.5 \text{ dB}$

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

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

Although Duty of this product was 100% or less, the result of AV (PK with Duty factor) was calculated by applying Duty 100% as worst.

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## Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No. 13092632H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.3  
Date October 23, 2019  
Temperature / Humidity 22 deg. C / 64 % RH  
Engineer Junya Okuno  
Mode Transmitting mode 434.42 MHz

### QP or PK

| 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<br>Inside or Outside<br>of Restricted Bands |
|--------------------|----------|-------------------|------|-------------------------|--------------|--------------|------------------------|--------------------|------|-------------------|----------------|------|----------------------------------------------------|
|                    |          | Hor               | Ver  |                         |              |              |                        | Hor                | Ver  |                   | Hor            | Ver  |                                                    |
| 434.42             | PK       | 79.3              | 80.6 | 16.3                    | 10.9         | 32.0         | -                      | 74.5               | 75.8 | 100.8             | 26.3           | 25.0 | Carrier                                            |
| 868.84             | PK       | 27.3              | 26.9 | 21.8                    | 13.4         | 31.1         | -                      | 31.3               | 30.9 | 80.8              | 49.5           | 49.9 | Outside                                            |
| 1303.26            | PK       | 44.4              | 44.2 | 25.4                    | 6.0          | 34.6         | -                      | 41.2               | 41.0 | 73.9              | 32.7           | 32.9 | Inside                                             |
| 1737.68            | PK       | 51.3              | 51.1 | 25.1                    | 5.5          | 33.6         | -                      | 48.3               | 48.1 | 80.8              | 32.5           | 32.7 | Outside                                            |
| 2172.10            | PK       | 44.9              | 43.3 | 28.1                    | 5.6          | 32.9         | -                      | 45.7               | 44.1 | 80.8              | 35.1           | 36.8 | Outside                                            |
| 2606.52            | PK       | 43.8              | 43.5 | 27.7                    | 5.7          | 32.7         | -                      | 44.5               | 44.3 | 80.8              | 36.3           | 36.5 | Outside                                            |
| 3040.94            | PK       | 43.3              | 43.8 | 28.7                    | 5.9          | 32.4         | -                      | 45.4               | 45.9 | 80.8              | 35.4           | 34.9 | Outside                                            |
| 3475.36            | PK       | 45.8              | 45.6 | 28.7                    | 6.0          | 32.3         | -                      | 48.3               | 48.1 | 80.8              | 32.5           | 32.7 | Outside                                            |
| 3909.78            | PK       | 45.0              | 44.9 | 29.7                    | 6.2          | 32.1         | -                      | 48.9               | 48.7 | 73.9              | 25.0           | 25.2 | Inside                                             |
| 4344.20            | PK       | 45.1              | 45.2 | 30.3                    | 6.4          | 31.9         | -                      | 49.8               | 49.9 | 73.9              | 24.1           | 24.0 | Inside                                             |

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

### PK with Duty factor

| 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  |
|--------------------|----------|-------------------|------|-------------------------|--------------|--------------|------------------------|--------------------|------|-------------------|----------------|------|---------|
|                    |          | Hor               | Ver  |                         |              |              |                        | Hor                | Ver  |                   | Hor            | Ver  |         |
| 434.42             | PK       | 79.3              | 80.6 | 16.3                    | 10.9         | 32.0         | 0.0                    | 74.5               | 75.8 | 80.8              | 6.3            | 5.0  | Carrier |
| 868.84             | PK       | 27.3              | 26.9 | 21.8                    | 13.4         | 31.1         | 0.0                    | 31.3               | 30.9 | 60.8              | 29.5           | 29.9 | Outside |
| 1303.26            | PK       | 44.4              | 44.2 | 25.4                    | 6.0          | 34.6         | 0.0                    | 41.2               | 41.0 | 53.9              | 12.7           | 12.9 | Inside  |
| 1737.68            | PK       | 51.3              | 51.1 | 25.1                    | 5.5          | 33.6         | 0.0                    | 48.3               | 48.1 | 60.8              | 12.5           | 12.7 | Outside |
| 2172.10            | PK       | 44.9              | 43.3 | 28.1                    | 5.6          | 32.9         | 0.0                    | 45.7               | 44.1 | 60.8              | 15.1           | 16.8 | Outside |
| 2606.52            | PK       | 43.8              | 43.5 | 27.7                    | 5.7          | 32.7         | 0.0                    | 44.5               | 44.3 | 60.8              | 16.3           | 16.5 | Outside |
| 3040.94            | PK       | 43.3              | 43.8 | 28.7                    | 5.9          | 32.4         | 0.0                    | 45.4               | 45.9 | 60.8              | 15.4           | 14.9 | Outside |
| 3475.36            | PK       | 45.8              | 45.6 | 28.7                    | 6.0          | 32.3         | 0.0                    | 48.3               | 48.1 | 60.8              | 12.5           | 12.7 | Outside |
| 3909.78            | PK       | 45.0              | 44.9 | 29.7                    | 6.2          | 32.1         | 0.0                    | 48.9               | 48.7 | 53.9              | 5.0            | 5.2  | Inside  |
| 4344.20            | PK       | 45.1              | 45.2 | 30.3                    | 6.4          | 31.9         | 0.0                    | 49.8               | 49.9 | 53.9              | 4.1            | 4.0  | Inside  |

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amplifier) + Duty factor (Refer to Duty factor data sheet)

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

Sample calculation:

Result of PK = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier)

Result of PK with Duty factor = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1 GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier) + Duty factor

For above 1GHz : Distance Factor:  $20 \times \log(4.0 \text{ m}/3.0 \text{ m}) = 2.50 \text{ dB}$

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

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

Although Duty of this product was 100% or less, the result of AV (PK with Duty factor) was calculated by applying Duty 100% as worst.

**UL Japan, Inc.**

**Ise EMC Lab.**

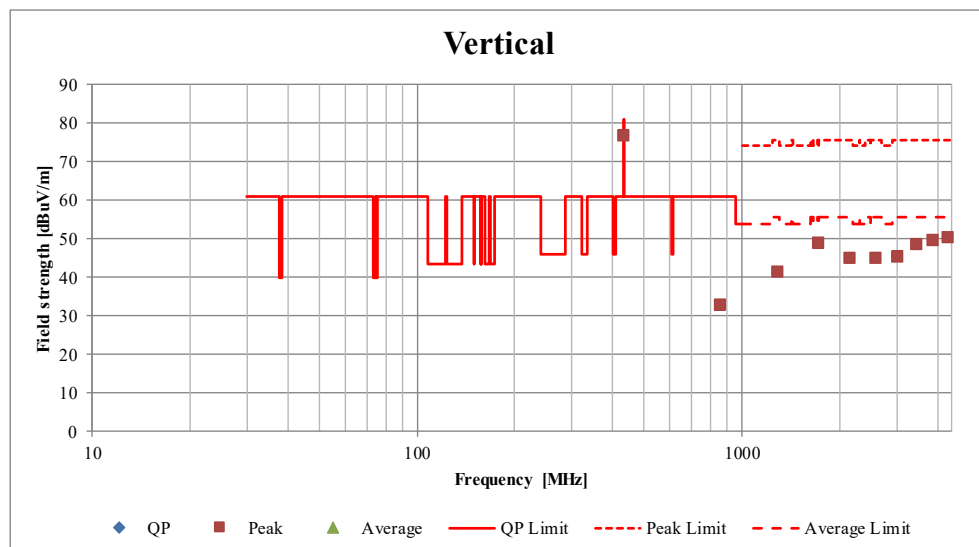
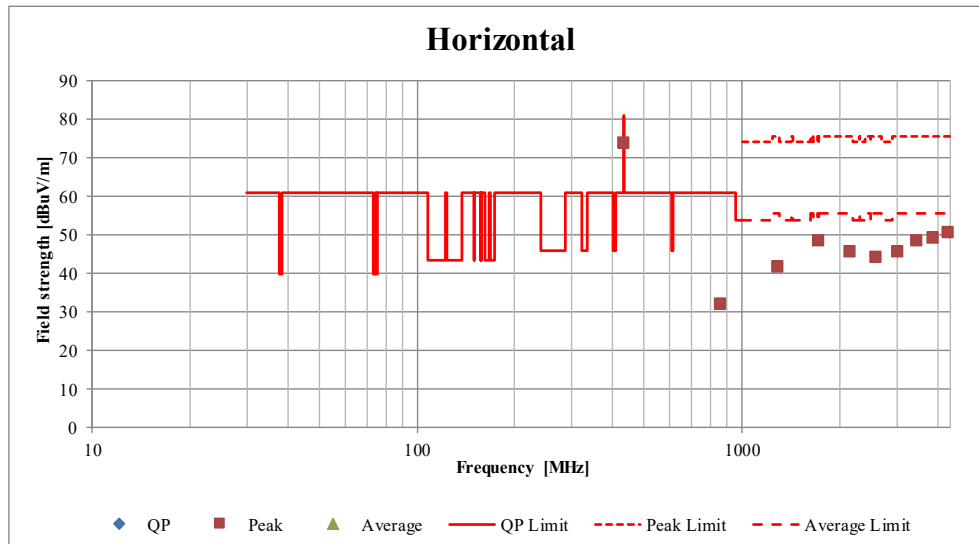
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## Radiated Spurious Emission (Plot data, Worst case)

Report No. 13092632H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.3  
Date October 23, 2019  
Temperature / Humidity 22 deg. C / 64 % RH  
Engineer Junya Okuno  
Mode Transmitting mode 433.58 MHz



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

## -20dB and 99% Occupied Bandwidth

|                        |                                           |
|------------------------|-------------------------------------------|
| Report No.             | 13092632H                                 |
| Test place             | Ise EMC Lab.                              |
| Semi Anechoic Chamber  | No.2                                      |
| Date                   | October 23, 2019                          |
| Temperature / Humidity | 23 deg. C / 52 % RH                       |
| Engineer               | Junki Nagatomi                            |
| Mode                   | Transmitting mode 433.58 MHz / 434.42 MHz |

Bandwidth Limit : Fundamental Frequency     **433.58** MHz x 0.25% =     1083.95     kHz

\* The above limit was calculated from more stringent nominal frequency.

\* Method of KDB 926416 for systems employing non sweeping frequencies was referred.

### 433.58 MHz

| -20dB Bandwidth<br>[kHz] |
|--------------------------|
| 37.227                   |

### 434.42 MHz

| -20dB Bandwidth<br>[kHz] |
|--------------------------|
| 37.130                   |

| -20dB Bandwidth<br>[kHz] | Bandwidth Limit<br>[kHz] | Result |
|--------------------------|--------------------------|--------|
| 74.357                   | 1083.95                  | Pass   |

Bandwidth Limit : Fundamental Frequency     **433.58** MHz x 0.25% =     1083.95     kHz

| 99% Occupied Bandwidth<br>[kHz] | Bandwidth Limit<br>[kHz] | Result |
|---------------------------------|--------------------------|--------|
| 37.7860                         | 1083.95                  | Pass   |

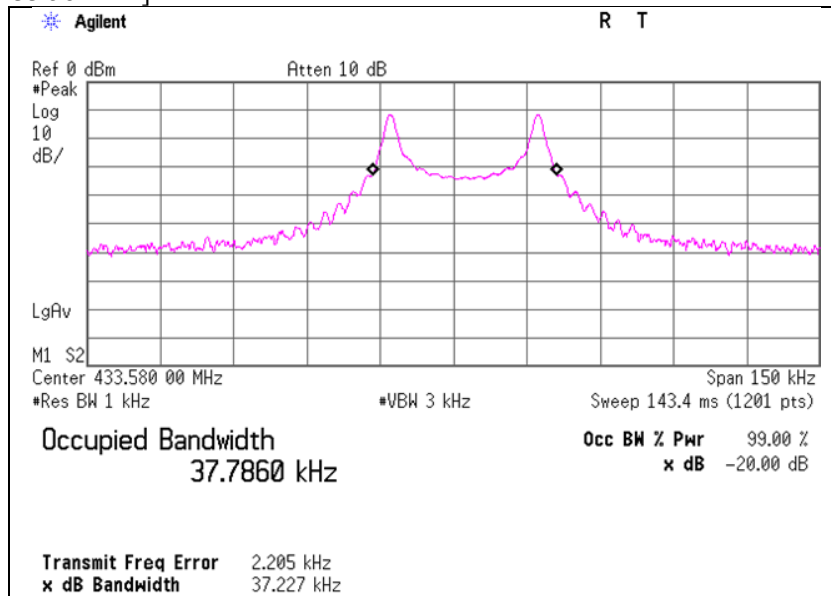
Bandwidth Limit : Fundamental Frequency     **434.42** MHz x 0.25% =     1086.05     kHz

| 99% Occupied Bandwidth<br>[kHz] | Bandwidth Limit<br>[kHz] | Result |
|---------------------------------|--------------------------|--------|
| 37.8983                         | 1086.05                  | Pass   |

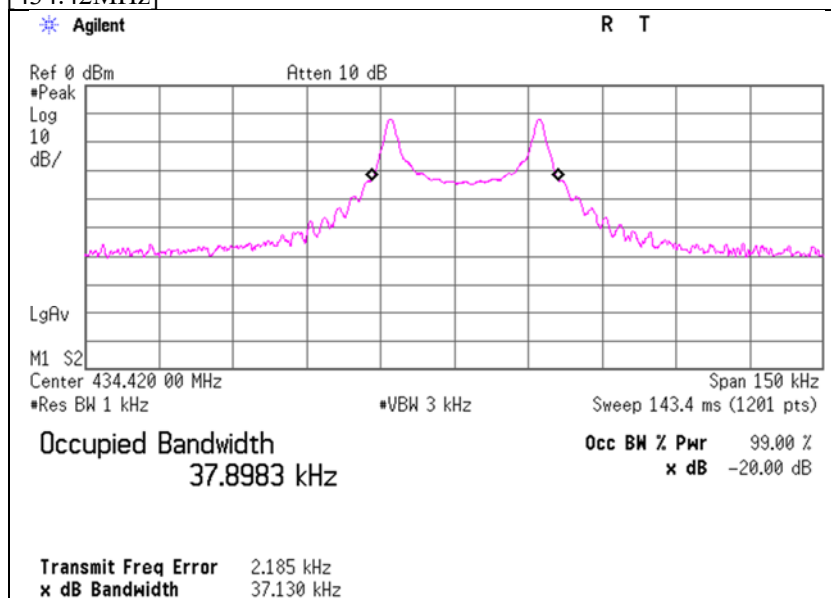
## -20dB and 99% Occupied Bandwidth

Report No. 13092632H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.2  
Date October 23, 2019  
Temperature / Humidity 23 deg. C / 52 % RH  
Engineer Junki Nagatomi  
Mode Transmitting mode 433.58 MHz / 434.42 MHz

[433.58 MHz]



[434.42MHz]



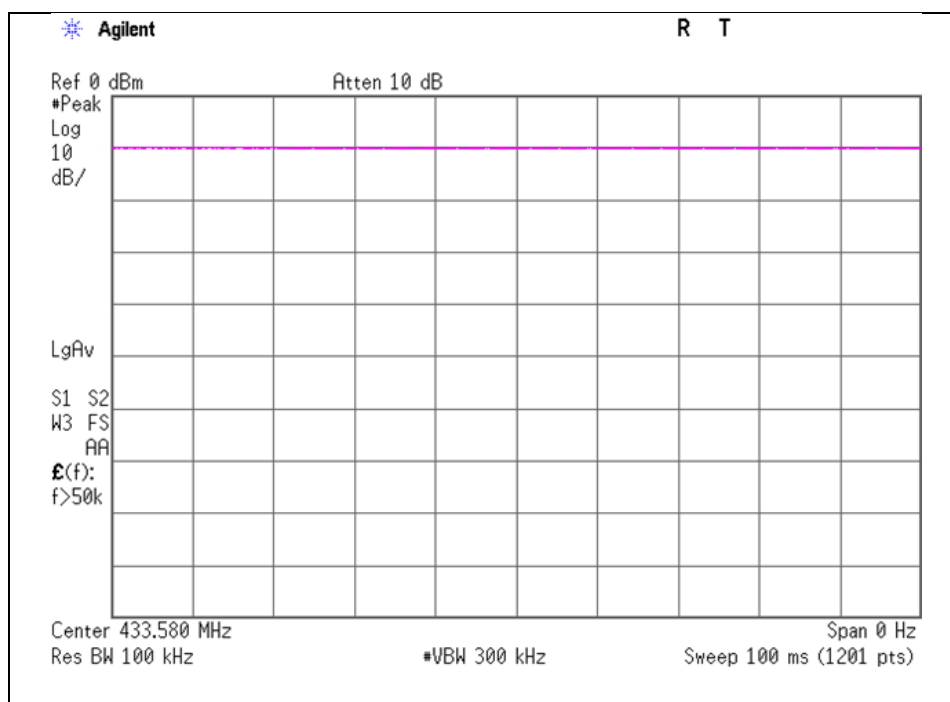
## Duty Cycle

|                        |                              |
|------------------------|------------------------------|
| Report No.             | 13092632H                    |
| Test place             | Ise EMC Lab.                 |
| Semi Anechoic Chamber  | No.2                         |
| Date                   | October 23, 2019             |
| Temperature / Humidity | 23 deg. C / 52 % RH          |
| Engineer               | Junki Nagatomi               |
| Mode                   | Transmitting mode 433.58 MHz |

| ON time<br>[ms] | Cycle<br>[ms] | Duty<br>(On time/Cycle) | Duty factor<br>[dB] |
|-----------------|---------------|-------------------------|---------------------|
| 100.00          | 100.00        | 1.00                    | 0.0                 |

Duty factor= 20log10(ON time/Cycle)

\*The test was performed by a button-pressed operation as the worst case.  
Please refer to the “Theory of Operation” for details.



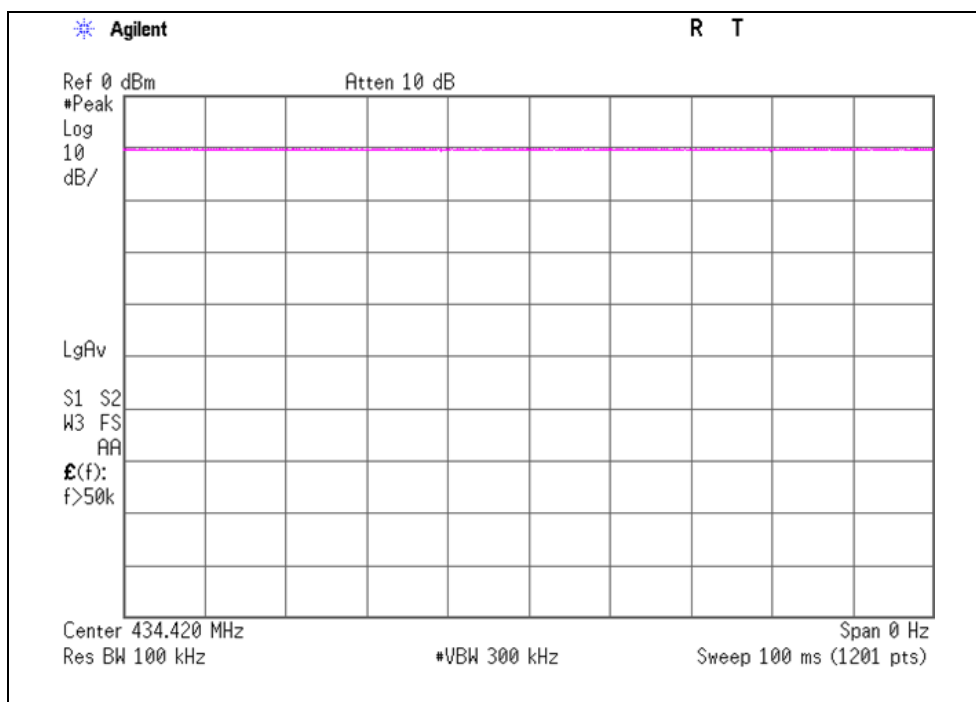
## Duty Cycle

|                        |                              |
|------------------------|------------------------------|
| Report No.             | 13092632H                    |
| Test place             | Ise EMC Lab.                 |
| Semi Anechoic Chamber  | No.2                         |
| Date                   | October 23, 2019             |
| Temperature / Humidity | 23 deg. C / 52 % RH          |
| Engineer               | Junki Nagatomi               |
| Mode                   | Transmitting mode 434.42 MHz |

| ON time<br>[ms] | Cycle<br>[ms] | Duty<br>(On time/Cycle) | Duty factor<br>[dB] |
|-----------------|---------------|-------------------------|---------------------|
| 100.00          | 100.00        | 1.00                    | 0.0                 |

Duty factor =  $20 \log_{10}(\text{ON time/Cycle})$

\*The test was performed by a button-pressed operation as the worst case.  
Please refer to the "Theory of Operation" for details.



## APPENDIX 2: Test instruments

### Test Instruments

| Test item | LIMS ID | Description                      | Manufacturer      | Model                    | Serial                        | Last Calibration Date | Calibration Due Date | Cal Int |
|-----------|---------|----------------------------------|-------------------|--------------------------|-------------------------------|-----------------------|----------------------|---------|
| RE        | 142013  | AC3_Semi Anechoic Chamber(SVSWR) | TDK               | Semi Anechoic Chamber 3m | DA-10005                      | 04/08/2019            | 04/30/2021           | 24      |
| RE        | 141855  | Spectrum Analyzer                | AGILENT           | E4440A                   | MY46187750                    | 11/09/2018            | 11/30/2019           | 12      |
| RE        | 141152  | EMI measurement program          | TSJ               | TEPTO-DV                 | -                             | -                     | -                    | -       |
| RE        | 141507  | Horn Antenna 1-18GHz             | Schwarzbeck       | BBHA9120D                | 258                           | 09/26/2019            | 09/30/2020           | 12      |
| RE        | 142183  | Measure                          | KOMELON           | KMC-36                   | -                             | -                     | -                    | -       |
| RE        | 141580  | MicroWave System Amplifier       | AGILENT           | 83017A                   | MY39500779                    | 03/05/2019            | 03/31/2020           | 12      |
| RE        | 177964  | Microwave Cable                  | Junkosha INC.     | MMX221                   | 1901S329(1m)/<br>1902S579(5m) | 03/05/2019            | 03/31/2020           | 12      |
| RE        | 142008  | AC3_Semi Anechoic Chamber(NSA)   | TDK               | Semi Anechoic Chamber 3m | DA-10005                      | 06/26/2018            | 06/30/2020           | 24      |
| RE        | 141554  | Thermo-Hygrometer                | CUSTOM            | CTH-180                  | 1301                          | 01/11/2019            | 01/31/2020           | 12      |
| RE        | 148897  | Attenuator                       | KEYSIGHT          | 8491A                    | MY52462349                    | 12/20/2018            | 12/31/2019           | 12      |
| RE        | 141424  | Biconical Antenna                | Schwarzbeck       | VHA9103+BBA9106          | 1915                          | 08/24/2019            | 08/31/2020           | 12      |
| RE        | 141323  | Coaxial cable                    | UL Japan          | -                        | -                             | 07/02/2019            | 07/31/2020           | 12      |
| RE        | 141532  | DIGITAL HiTESTER                 | HIOKI             | 3805                     | 51201197                      | 01/29/2019            | 01/31/2020           | 12      |
| RE        | 141266  | Logperiodic Antenna(200-1000MHz) | Schwarzbeck       | VUSLP9111B               | 9111B-191                     | 08/24/2019            | 08/31/2020           | 12      |
| RE        | 141582  | Pre Amplifier                    | SONOMA INSTRUMENT | 310                      | 260834                        | 02/08/2019            | 02/29/2020           | 12      |
| RE        | 141949  | Test Receiver                    | Rohde & Schwarz   | ESCI                     | 100767                        | 08/02/2019            | 08/31/2020           | 12      |
| RE        | 141297  | High Pass Filter(1.1-10GHz)      | TOKYO KEIKI       | TF219CD1                 | 1001                          | 01/10/2019            | 01/31/2020           | 12      |
| RE        | 142645  | Loop Antenna                     | UL Japan          | -                        | -                             | -                     | -                    | -       |

\*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: Radiated emission, 99 % Occupied Bandwidth, -20 dB bandwidth, Automatically deactivate and Duty cycle tests

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