



RADIO TEST REPORT

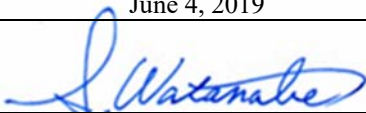
Test Report No. : 12871604H-A-R1

Applicant : Mitsubishi Electric Corporation Himeji works
Type of Equipment : Smart Keyless System (Hand Unit)
Model No. : SKEA7D-03
FCC ID : WAZSKEA7D03
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 12871604H-A. 12871604H-A is replaced with this report.

Date of test: June 4, 2019

Representative test engineer:


Shinya Watanabe
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/

- ☐ 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.: 12871604H-A

[illegible]

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SECTION 1: Customer information

Company Name	:	Mitsubishi Electric Corporation Himeji works
Address	:	840 Chiyoda-machi, Himeji, Hyogo 670-8677, Japan
Telephone Number	:	+81-79-298-9580
Facsimile Number	:	+81-79-298-9929
Contact Person	:	Shinichi Furuta

The information provided from the customer is as follows;

- Applicant, Type of Equipment, Model No. on the cover and other 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	:	Smart Keyless System (Hand Unit)
Model No.	:	SKEA7D-03
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 3.0 V
Receipt Date of Sample (Information from test lab.)	:	June 1, 2019
Country of Mass-production	:	Thailand
Condition of EUT	:	Engineering prototype (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: SKEA7D-03 (referred to as the EUT in this report) is a Smart Keyless System (Hand Unit).

Radio Specification

RF Part

Equipment Type	:	Transmitter
Type of modulation	:	FSK
Frequency of operation	:	315 MHz
Other clock frequency	:	-
Antenna Type	:	PCB Pattern antenna
Clock frequency	:	27.6 MHz (CPU)

LF Part *

Type of Receiver	:	Receiver
Frequency of operation	:	125 kHz
Intermediate frequency	:	-
Antenna Type	:	Inductive

* The test of receiver part was performed separately from this test report, and the conformability is confirmed.
LF Part test report No. 12871604H-B (FCC15B).

*EUT has two types; Case 1 and Case 2.

The difference of these types is only the part number display.

- example: IC:IC1 (Case1) / IC101 (Case2)

The test was performed with Case 1, since there was no difference in Radio characteristics at pre check.

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on June 4, 2019 and effective July 5, 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.

* The revision on June 4, 2019, does not affect the test specification applied to the EUT.

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

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted emission	FCC: ANSI C63.10:2013 6 Standard test methods ----- IC: RSS-Gen 8.8	FCC: Section 15.207 ----- IC: RSS-Gen 8.8	N/A *1)	N/A	-
Automatically Deactivate	FCC: ANSI C63.10:2013 6 Standard test methods ----- IC: -	FCC: Section 15.231(a)(1) ----- IC: RSS-210 A1.1	N/A	Complied a)	Radiated
Electric Field Strength of Fundamental Emission	FCC: ANSI C63.10:2013 6 Standard test methods ----- IC: RSS-Gen 6.12	FCC: Section 15.231(b) ----- IC: RSS-210 A1.2	4.0 dB 315.000 MHz Horizontal, PK with Duty Factor	Complied# b)	Radiated
Electric Field Strength of Spurious Emission	FCC: ANSI C63.10:2013 6 Standard test methods ----- IC: RSS-Gen 6.13	FCC: Section 15.205 Section 15.209 Section 15.231(b) ----- IC: RSS-210 A1.2, 4.4 RSS-Gen 8.9	1.6 dB 2835.000 MHz Horizontal PK with Duty Factor	Complied# b)	Radiated
-20dB Bandwidth	FCC: ANSI C63.10:2013 6 Standard test methods ----- IC: -	FCC: Section 15.231(c) ----- IC: Reference data	N/A	Complied 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 15.31 (e)

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

FCC Part 15.203 Antenna requirement

The antenna is not removable from 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	IC: RSS-Gen 6.7	IC: 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 $k = 2$.

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

Radiated emission (Above 1 GHz)				
(3 m*)(+/-)		(1 m*)(+/-)		(10 m*)(+/-)
1 GHz to 6 GHz	6 GHz to 18 GHz	10 GHz to 26.5 GHz	26.5 GHz to 40 GHz	1 GHz to 18 GHz
5.0 dB	5.3 dB	5.8 dB	5.8 dB	5.2 dB

* Measurement distance

Automatically Deactivate
0.10 %

Bandwidth
0.96 %

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

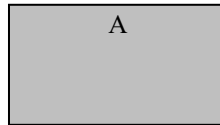
4.1 Operating Mode(s)

Test Item*	Mode
Automatically Deactivate	1) Normal use mode
Electric Field Strength of Fundamental Emission Electric Field Strength of Spurious Emission -20 dB & 99 % Occupied Bandwidth Duty Cycle	2) Transmitting mode (Tx) 315 MHz
* The system was configured in typical fashion (as a user would normally use it) for testing. End users cannot change the settings of the output power of the product.	

*The EUT has two mode; "Manual transmission (Normal Keyless function)" and "Transmission when receiving LF signal (Smart Keyless function)".

The test except for Transmit timing test was performed with the operation mode of Manual transmission since the transmission output and modulation except for the transmission timing (Transmit timing) are identical in the two modes.

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	Smart Keyless System (Hand Unit)	SKEA7D-03	20190530-T3 (No.29) *1) 20190530-T1 (No.27) *2)	Mitsubishi Electric Corporation Himeji works	EUT

*1) Used for Normal use mode only.

*2) Used for other tests except for Normal use mode.

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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.

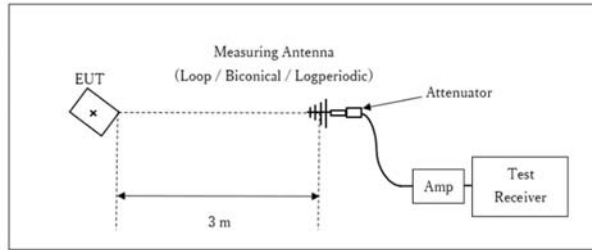
Test Antennas are used as below;

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 to 90 kHz and 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	Above 1 GHz
Detector Type	Peak	Peak	Peak	Peak	Peak and Peak with Duty factor	Peak and Peak with Duty factor
IF Bandwidth	200 Hz	200 Hz	9.0 kHz	9.0 kHz	120 kHz	PK: S/A: RBW 1 MHz, VBW: 3 MHz

[Test Setup]

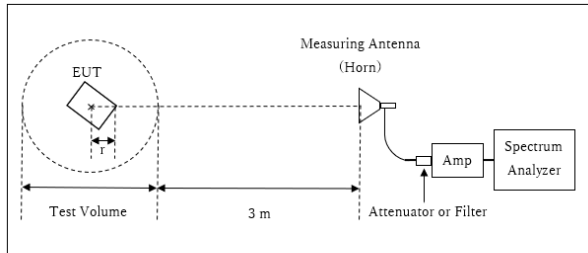
Below 1 GHz



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: $20 \times \log (3.75 \text{ m} / 3.0 \text{ m}) = 1.94 \text{ dB}$

* Test Distance: $(3 + \text{Test Volume} / 2) - r = 3.75 \text{ m}$

Test Volume : 1.5 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.

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

Measurement range : 9 kHz - 3.2 GHz

Test data : APPENDIX

Test result : Pass

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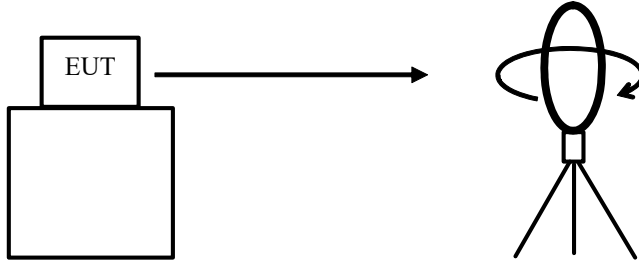
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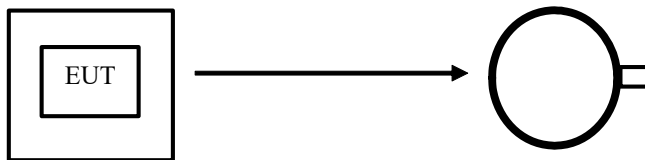
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Figure 1: Direction of the Loop Antenna

Side View (Vertical)

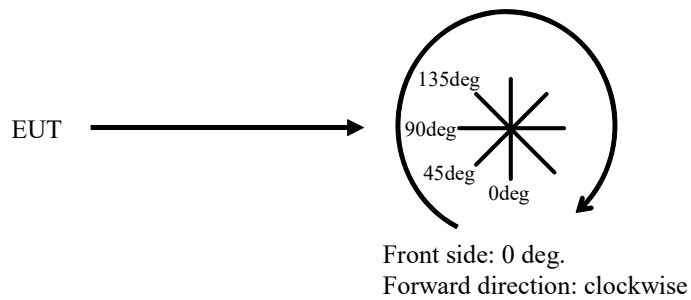


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



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	500 kHz	5.1 kHz	16 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.							

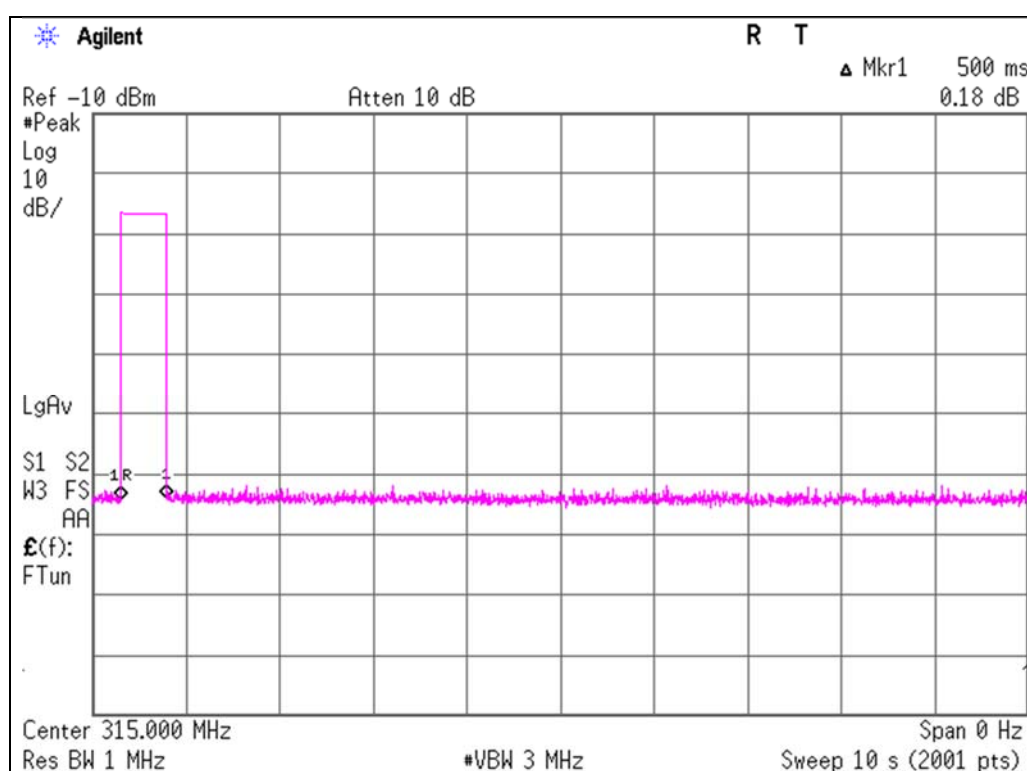
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Automatically deactivate

Report No.	12871604H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	June 04, 2019
Temperature / Humidity	22 deg. C / 68 % RH
Engineer	Shinya Watanabe
Mode	Mode 1

Time of Transmitting [sec]	Limit [sec]	Result
0.500	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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Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No. 12871604H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date June 04, 2019
Temperature / Humidity 22 deg. C / 68 % RH
Engineer Shinya Watanabe
Mode Mode 2

QP or PK

Frequency [MHz]	Detector	Reading [dBuV]		Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]		Limit dBuV/m	Margin [dB]		Remark Inside or Outside of Restricted Bands
		Hor	Ver					Hor	Ver		Hor	Ver	
315.000	PK	77.9	74.8	14.0	9.0	29.3	-	71.6	68.5	95.6	24.0	27.1	Carrier
630.000	PK	27.2	27.7	19.5	10.3	29.6	-	27.4	27.9	75.6	48.2	47.7	Outside
945.000	PK	29.7	29.4	21.9	11.4	27.8	-	35.2	34.9	75.6	40.4	40.7	Outside
1260.000	PK	NS	NS	-	-	-	-	-	-	75.6	-	-	Outside
1575.000	PK	52.7	51.6	26.1	4.0	34.8	-	48.0	46.9	73.9	25.9	27.0	Inside
1890.000	PK	NS	NS	-	-	-	-	-	-	75.6	-	-	Outside
2205.000	PK	48.9	47.8	28.1	4.4	34.3	-	47.1	46.1	73.9	26.8	27.8	Inside
2520.000	PK	NS	NS	-	-	-	-	-	-	75.6	-	-	Outside
2835.000	PK	52.7	52.2	29.0	4.8	34.1	-	52.3	51.8	73.9	21.6	22.1	Inside
3150.000	PK	NS	NS	-	-	-	-	-	-	75.6	-	-	Outside

PK with Duty factor

Frequency [MHz]	Detector	Reading [dBuV]		Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]		Limit dBuV/m	Margin [dB]		Remark
		Hor	Ver					Hor	Ver		Hor	Ver	
315.000	PK	77.9	74.8	14.0	9.0	29.3	0.0	71.6	68.5	75.6	4.0	7.1	Carrier
630.000	PK	27.2	27.7	19.5	10.3	29.6	0.0	27.4	27.9	55.6	28.2	27.7	Outside
945.000	PK	29.7	29.4	21.9	11.4	27.8	0.0	35.2	34.9	55.6	20.4	20.7	Outside
1260.000	PK	NS	NS	-	-	-	0.0	-	-	55.6	-	-	Outside
1575.000	PK	52.7	51.6	26.1	4.0	34.8	0.0	48.0	46.9	53.9	5.9	7.0	Inside
1890.000	PK	NS	NS	-	-	-	0.0	-	-	55.6	-	-	Outside
2205.000	PK	48.9	47.8	28.1	4.4	34.3	0.0	47.1	46.1	53.9	6.8	7.8	Inside
2520.000	PK	NS	NS	-	-	-	0.0	-	-	55.6	-	-	Outside
2835.000	PK	52.7	52.2	29.0	4.8	34.1	0.0	52.3	51.8	53.9	1.6	2.1	Inside
3150.000	PK	NS	NS	-	-	-	0.0	-	-	55.6	-	-	Outside

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).
NS: No signal detected.

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: $20 \times \log(3.75 \text{ m}/3.0 \text{ m}) = 1.94 \text{ dB}$

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

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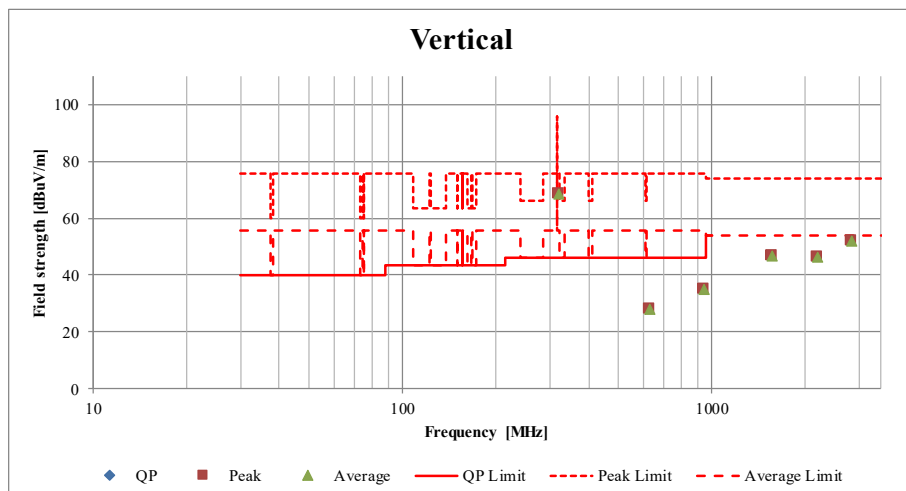
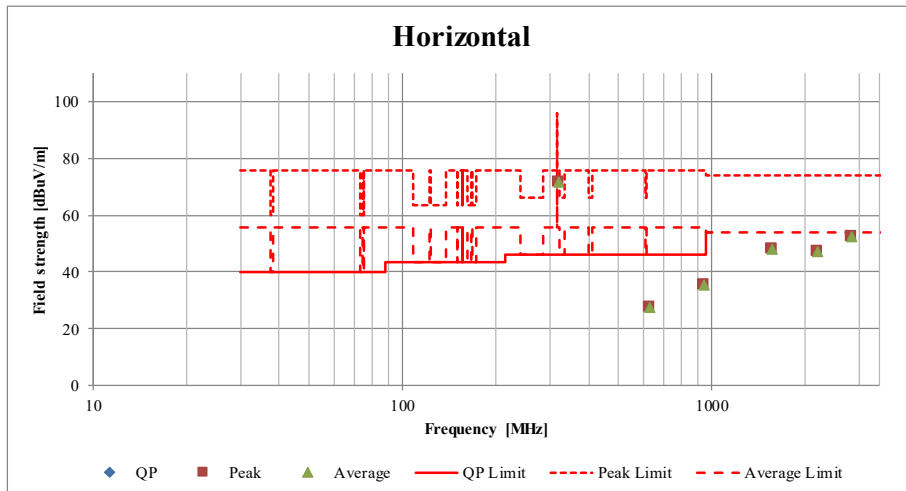
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Radiated Spurious Emission (Plot data, Worst case)

Report No. 12871604H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date June 04, 2019
Temperature / Humidity 22 deg. C / 68 % RH
Engineer Shinya Watanabe
Mode Mode 2



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

-20dB and 99% Occupied Bandwidth

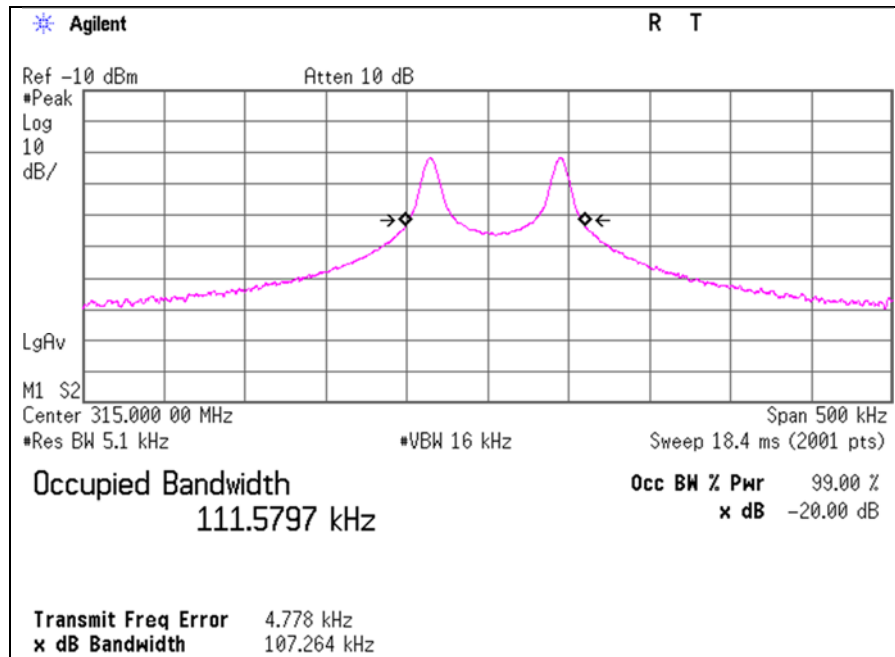
Report No.	12871604H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	June 04, 2019
Temperature / Humidity	22 deg. C / 68 % RH
Engineer	Shinya Watanabe
Mode	Mode 2

Bandwidth Limit : Fundamental Frequency **315.00** MHz x 0.25% = 787.50 kHz

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

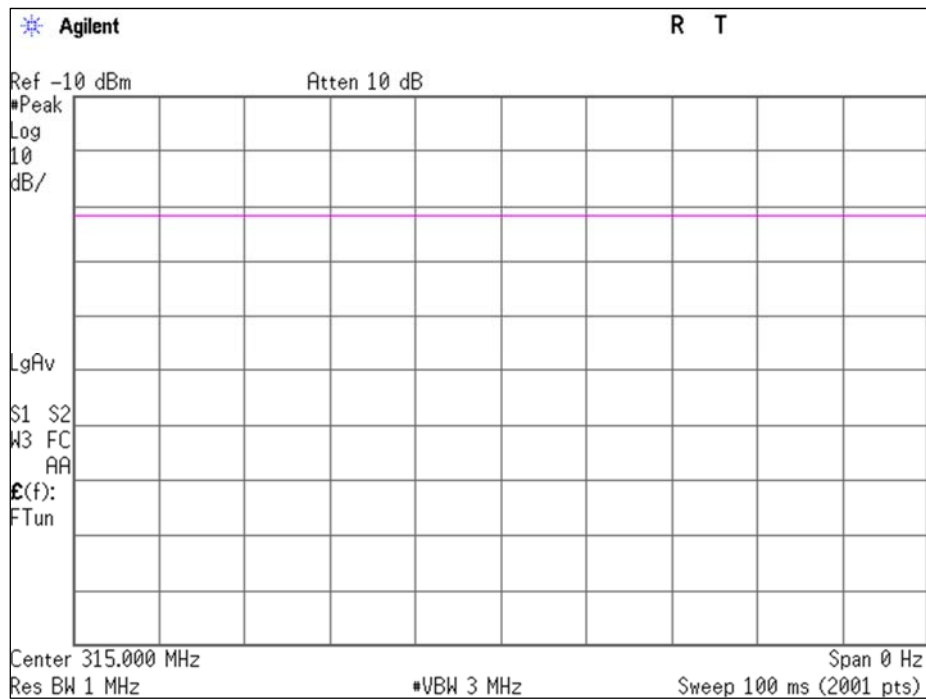
-20dB Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
107.264	787.50	Pass

99% Occupied Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
111.5797	787.50	Pass



Duty Cycle

Report No. 12871604H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date June 04, 2019
Temperature / Humidity 22 deg. C / 68 % RH
Engineer Shinya Watanabe
Mode Mode 2



APPENDIX 2: Test instruments

Test Instruments

Test item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
RE	141556	Thermo-Hygrometer	CUSTOM	CTH-201	0003	12/5/2018	12/31/2019	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	142228	Measure	KOMELON	KMC-36	-	-	-	-
RE	141427	Biconical Antenna	Schwarzbeck	VHA9103B	8031	4/12/2019	4/30/2020	12
RE	141265	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-190	3/25/2019	3/31/2020	12
RE	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/5/2018	11/30/2019	12
RE	141903	Spectrum Analyzer	AGILENT	E4440A	MY46186390	9/20/2018	9/30/2019	12
RE	141578	Pre Amplifier	AGILENT	8447D	2944A10845	9/19/2018	9/30/2019	12
RE	141512	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	254	5/9/2019	5/31/2020	12
RE	141392	Microwave Cable	Junkosha	MWX221	1604S253(1 m) / 1608S087(5 m)	8/8/2018	8/31/2019	12
RE	141579	Pre Amplifier	AGILENT	8449B	3008A02142	1/21/2019	1/31/2020	12
RE	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	8/8/2018	8/31/2019	12
RE	141317	Coaxial Cable	Fujikura/Agilent	-	-	2/25/2019	2/29/2020	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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