



RADIO TEST REPORT


Test Report No. : 12717479H-C-R1

Applicant : Mitsubishi Electric Corporation Himeji works
Type of Equipment : Smart Keyless System Hand Unit
Model No. : SKESAD-02
FCC ID : WAZSKESAD02
Test regulation : FCC Part 15 Subpart C: 2018
Test Result : Complied (Refer to SECTION 3.2)


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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 12717479H-C. 12717479H-C is replaced with this report.

Date of test: February 6 to 17, 2019

Representative test engineer:


Akihiko Maeda
Engineer
Consumer Technology Division

Approved by:


Motoya Imura
Leader
Consumer Technology Division



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REVISION HISTORY

Original Test Report No.: 12717479H-C

[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.	:	SKESAD-02
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 3.0 V
Receipt Date of Sample (Information from test lab.)	:	February 4, 2019
Country of Mass-production	:	Japan
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: SKESAD-02 (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	:	Patter antenna
Clock frequency	:	9.84375 MHz

LF Part *

Type of Receiver	:	Receiver
Frequency of operation	:	125 kHz
Other clock frequency	:	615.2 kHz (CPU)
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. 12717479H-D (FCC15B).

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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 15.231 Periodic operation in the band 40.66-40.70 MHz and above 70 MHz.

* 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	3.5 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	2.3 dB 2835.000 MHz Vertical 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

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	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 $k = 2$.

Test distance	Radiated emission (+/-)
	9 kHz to 30 MHz
3 m	3.3 dB
10 m	3.2 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

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

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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	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 m 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

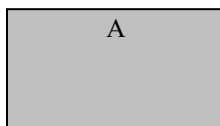
Refer to APPENDIX.

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.	

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	SKESAD-02	20190131-T1 (No.1) *1) 20190131-T2 (No.2) *2)	Mitsubishi Electric Corporation Himeji works	EUT

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

*2) Used for Normal use mode only

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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.

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.

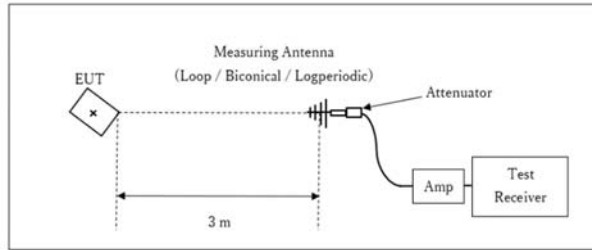
Test Antennas are used as below;

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]

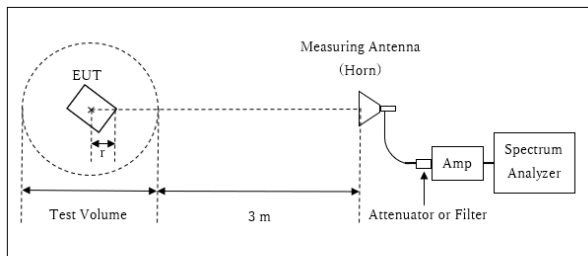
Below 1 GHz



x : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



r : Radius of an outer periphery of EUT

x : Center of turn table

Distance Factor: $20 \times \log (3.7 \text{ m} / 3.0 \text{ m}) = 1.82 \text{ dB}$

* Test Distance: $(3 + \text{Test Volume} / 2) - r = 3.7 \text{ m}$

Test Volume : 1.5 m

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

$r = 0.05 \text{ m}$

- 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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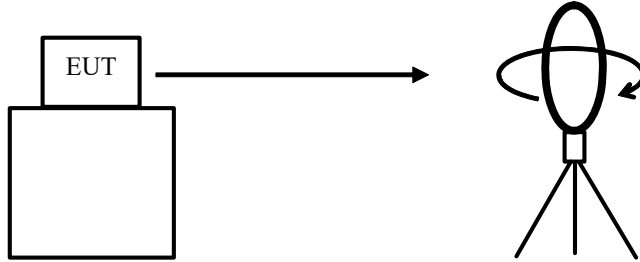
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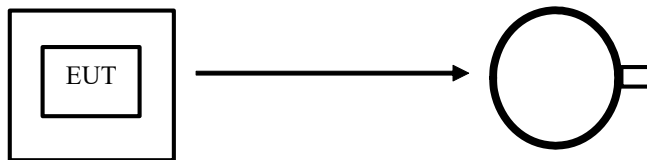
Figure 1: Direction of the Loop Antenna

Side View (Vertical)



.....

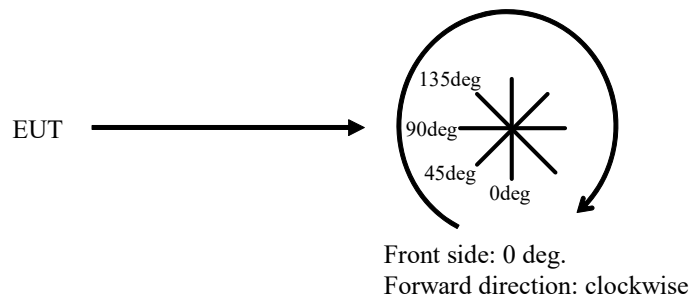
Top View (Horizontal)



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.							

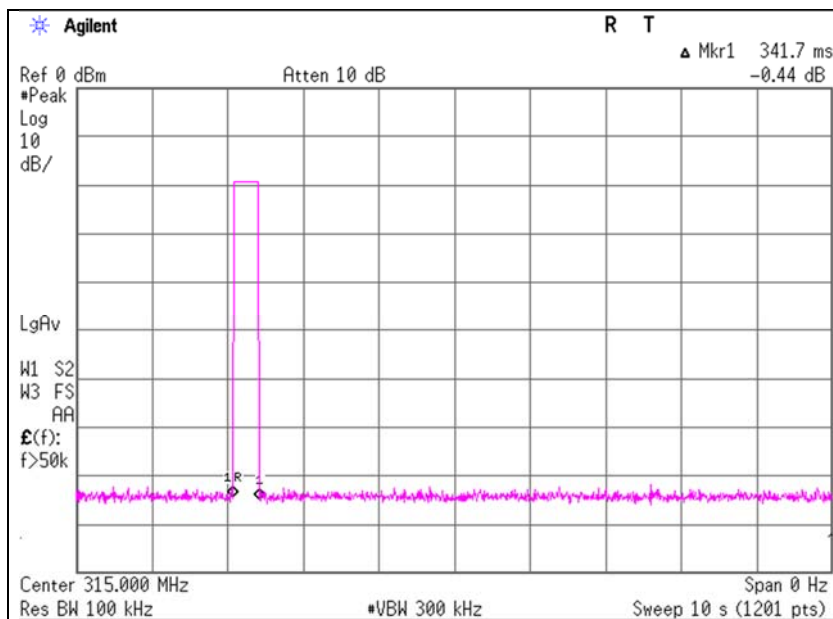
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Automatically deactivate

Report No.	12717479H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	February 17, 2019
Temperature / Humidity	20 deg. C / 51 % RH
Engineer	Akihiko Maeda
Mode	Mode 1

Time of Transmitting [sec]	Limit [sec]	Result
0.3417	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.	12717479H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	February 6, 2019	February 7, 2019
Temperature / Humidity	23 deg. C / 45 % RH	23 deg. C / 48 % RH
Engineer	Akihiko Maeda	Akihiko Maeda
	(Below 1 GHz)	(Above 1 GHz)
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	78.5	76.8	13.9	9.0	29.3	-	72.1	70.4	95.6	23.5	25.2	Carrier
630.000	PK	35.4	35.7	19.3	10.3	29.6	-	35.5	35.8	75.6	40.2	39.9	Outside
945.000	PK	32.0	32.0	21.9	11.5	27.8	-	37.6	37.6	75.6	38.0	38.0	Outside
1260.000	PK	48.3	46.7	25.3	5.5	35.1	-	44.0	42.4	75.6	31.6	33.2	Outside
1575.000	PK	51.7	48.0	25.4	5.0	34.8	-	47.3	43.6	73.9	26.6	30.3	Inside
1890.000	PK	50.6	49.7	25.8	5.0	34.5	-	46.9	46.0	75.6	28.7	29.6	Outside
2205.000	PK	47.6	47.0	27.9	5.1	34.3	-	46.3	45.6	73.9	27.7	28.3	Inside
2520.000	PK	48.9	48.8	27.8	5.2	34.2	-	47.7	47.5	75.6	27.9	28.1	Outside
2835.000	PK	51.3	52.0	28.4	5.3	34.1	-	50.9	51.6	73.9	23.0	22.3	Inside
3150.000	PK	51.1	50.1	28.6	5.4	34.0	-	51.1	50.1	75.6	24.5	25.5	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	78.5	76.8	13.9	9.0	29.3	0.0	72.1	70.4	75.6	3.5	5.2	Carrier
630.000	PK	35.4	35.7	19.3	10.3	29.6	0.0	35.5	35.8	55.6	20.2	19.9	Outside
945.000	PK	32.0	32.0	21.9	11.5	27.8	0.0	37.6	37.6	55.6	18.0	18.0	Outside
1260.000	PK	48.3	46.7	25.3	5.5	35.1	0.0	44.0	42.4	55.6	11.6	13.2	Outside
1575.000	PK	51.7	48.0	25.4	5.0	34.8	0.0	47.3	43.6	53.9	6.6	10.3	Inside
1890.000	PK	50.6	49.7	25.8	5.0	34.5	0.0	46.9	46.0	55.6	8.7	9.6	Outside
2205.000	PK	47.6	47.0	27.9	5.1	34.3	0.0	46.3	45.6	53.9	7.7	8.3	Inside
2520.000	PK	48.9	48.8	27.8	5.2	34.2	0.0	47.7	47.5	55.6	7.9	8.1	Outside
2835.000	PK	51.3	52.0	28.4	5.3	34.1	0.0	50.9	51.6	53.9	3.0	2.3	Inside
3150.000	PK	51.1	50.1	28.6	5.4	34.0	0.0	51.1	50.1	55.6	4.5	5.5	Outside

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)

For above 1GHz : Distance Factor: $20 \times \log(3.7 \text{ m}/3.0 \text{ m}) = 1.82 \text{ dB}$

*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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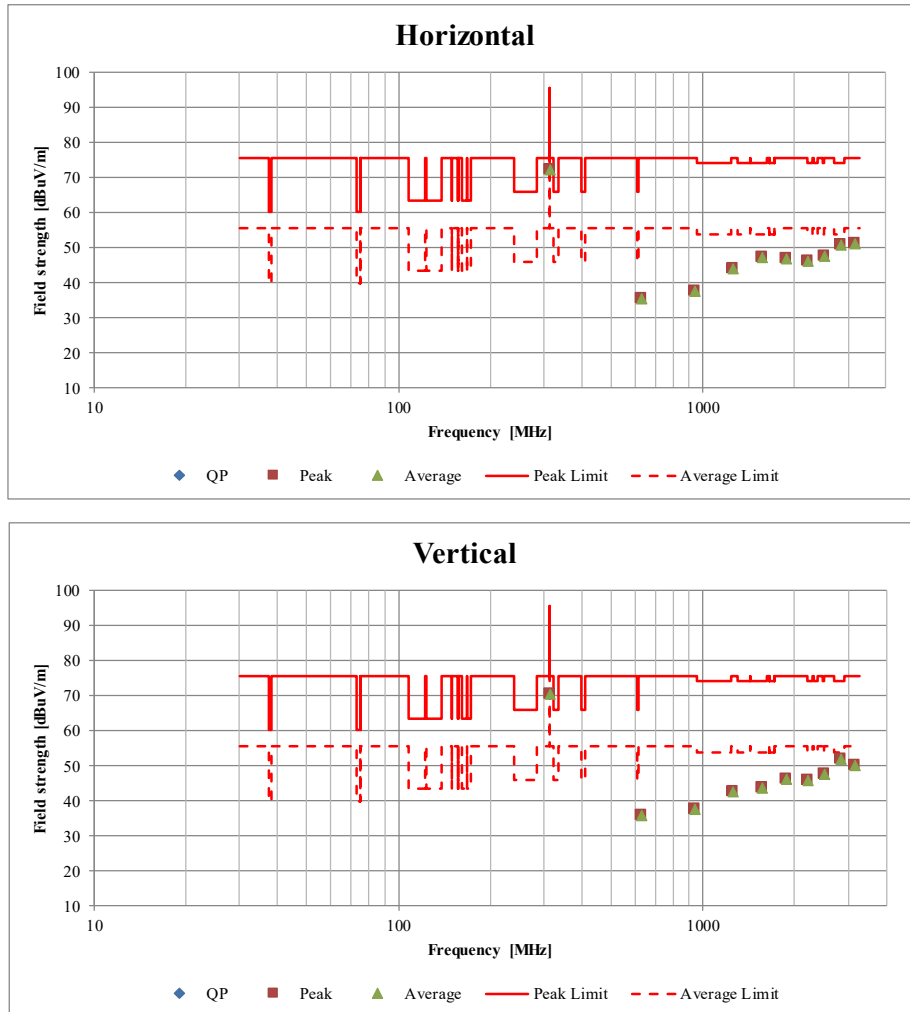
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Radiated Spurious Emission
(Plot data, Worst case)

Report No.	12717479H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	February 6, 2019	February 7, 2019
Temperature / Humidity	23 deg. C / 45 % RH	23 deg. C / 48 % RH
Engineer	Akihiko Maeda (Below 1 GHz)	Akihiko Maeda (Above 1 GHz)
Mode	Mode 2	



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

-20dB and 99% Occupied Bandwidth

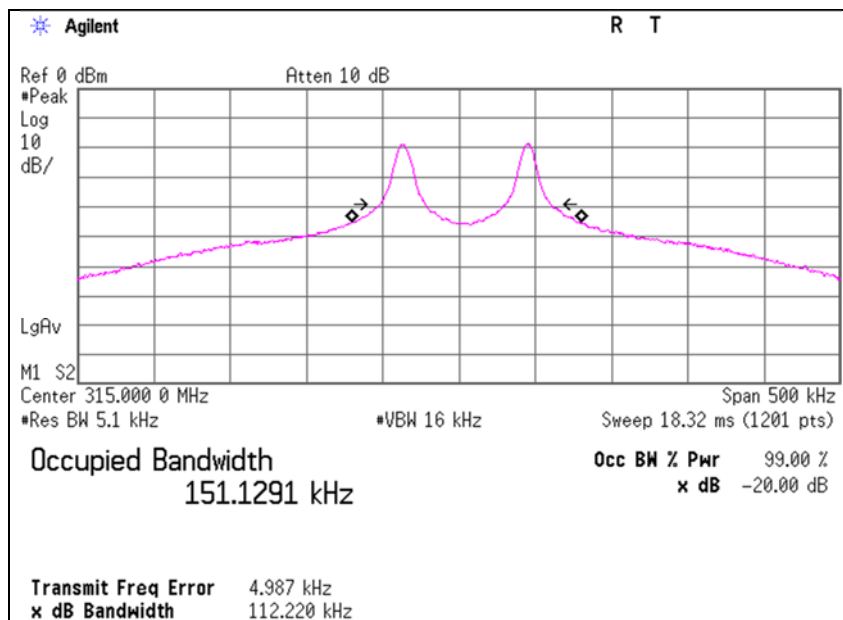
Report No.	12717479H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	February 17, 2019
Temperature / Humidity	20 deg. C / 51 % RH
Engineer	Akihiko Maeda
Mode	Mode 2

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

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

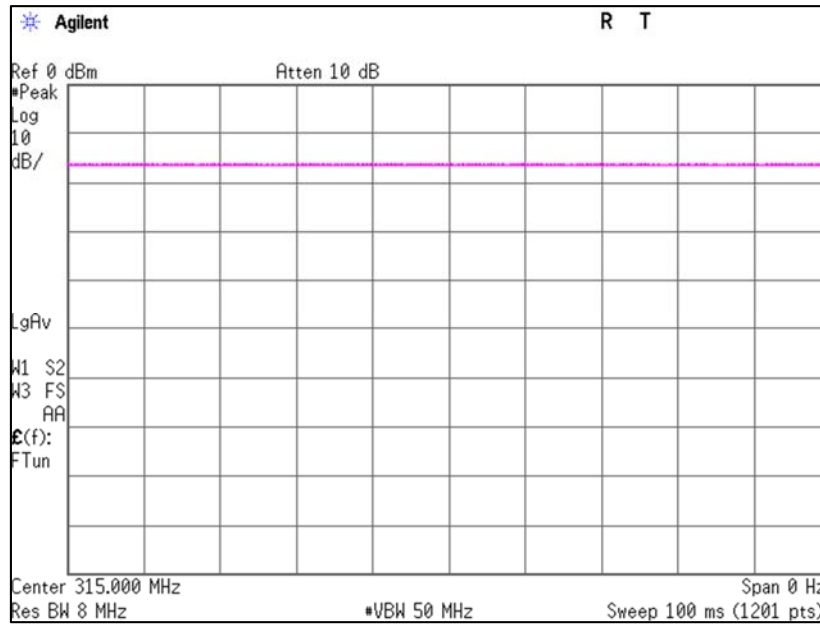
-20dB Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
112.220	787.50	Pass

99% Occupied Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
151.1291	787.50	Pass



Duty Cycle

Report No. 12717479H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date February 17, 2019
Temperature / Humidity 20 deg. C / 51 % RH
Engineer Akihiko Maeda
Mode Mode 2



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APPENDIX 2: Test instruments

Test Instruments

Test item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
RE	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	06/15/2018	06/30/2019	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	08/06/2018	08/31/2019	12
RE	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/05/2018	11/30/2019	12
RE	141317	Coaxial Cable	Fujikura/Agilent	-	-	02/23/2018	02/28/2019	12
RE	141265	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-190	05/31/2018	05/31/2019	12
RE	141578	Pre Amplifier	AGILENT	8447D	2944A10845	09/19/2018	09/30/2019	12
RE	141427	Biconical Antenna	Schwarzbeck	VHA9103B	8031	05/31/2018	05/31/2019	12
RE	141297	High Pass Filter(1.1-10GHz)	TOKYO KEIKI	TF219CD1	1001	01/10/2019	01/31/2020	12
RE	141579	Pre Amplifier	AGILENT	8449B	3008A02142	01/21/2019	01/31/2020	12
RE	141393	Microwave Cable	Junkosha	MWX221	1604S254(1 m) / 1608S088(5 m)	08/08/2018	08/31/2019	12
RE	141512	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	254	06/06/2018	06/30/2019	12
RE	142228	Measure	KOMELON	KMC-36	-	-	-	-
RE	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/21/2018	08/31/2019	12
RE	141556	Thermo-Hygrometer	CUSTOM	CTH-201	0003	12/05/2018	12/31/2019	12
RE	142004	AC2_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	06/29/2018	06/30/2020	24
RE	142006	AC2_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-06902	04/01/2018	04/29/2019	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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