



RADIO TEST REPORT

Test Report No. : 12223183H-A-R1

Applicant : Mitsubishi Electric Corporation Himeji works
Type of Equipment : Smart Keyless System (Hand Unit)
Model No. : SKE8AD-02
Test regulation : FCC Part 15 Subpart C: 2018
FCC ID : WAZSKE8AD02
Test Result : Complied

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report covers EMC technical requirements. It does not cover administrative issues such as Manual or non-EMC 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. This report is a revised version of 12223183H-A. 12223183H-A is replaced with this report.

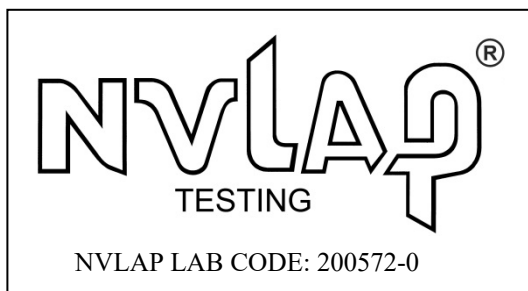
Date of test: April 18 and 24, 2018

Representative test engineer:

Shinya Watanabe
Engineer
Consumer Technology Division

Approved by:

Motoya Imura
Leader
Consumer Technology Division



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13-EM-F0429

REVISION HISTORY

Original Test Report No.: 12223183H-A

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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	:	+81-79-298-7363
Facsimile Number	:	+81-79-298-9929
Contact Person	:	Shinichi Furuta

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.	:	SKE8AD-02
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 3.0 V
Receipt Date of Sample	:	April 11, 2018
Country of Mass-production	:	Japan
Condition of EUT	:	Production 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 No: SKE8AD-02 (referred to as the EUT in this report) is the Smart Keyless System (Hand Unit).

Radio Specification

RF Part

Equipment Type	:	Transmitter
Type of modulation	:	FSK
Frequency of operation	:	315 MHz
Other clock frequency	:	9.84375 MHz
Antenna Type	:	PCB Pattern
Clock frequency	:	615.2 kHz (2 MHz) (CPU), 9.84375 MHz (RF IC)

LF Part *

Type of Receiver	:	Receiver
Frequency of operation	:	125 kHz
Other clock frequency	:	615.2 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. 12223183H-B (FCC15B).

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	FCC: Section 15.207	N/A *1)	N/A	-
	IC: RSS-Gen 8.8	IC: RSS-Gen 8.8			
Automatically Deactivate	FCC: ANSI C63.10:2013 6 Standard test methods	FCC: Section 15.231(a)(1)	N/A	Complied	Radiated
	IC: -	IC: RSS-210 A1.1			
Electric Field Strength of Fundamental Emission	FCC: ANSI C63.10:2013 6 Standard test methods	FCC: Section 15.231(b)	4.4 dB Horizontal (PK with Duty factor)	Complied	Radiated
	IC: RSS-Gen 6.12	IC: RSS-210 A1.2			
Electric Field Strength of Spurious Emission	FCC: ANSI C63.10:2013 6 Standard test methods	FCC: Section 15.205 Section 15.209 Section 15.231(b)	4.4 dB 2520.000 MHz Vertical (PK with Duty factor)	Complied	Radiated
	IC: RSS-Gen 6.13	IC: RSS-210 A1.2, 4.4 RSS-Gen 8.9			
-20dB Bandwidth	FCC: ANSI C63.10:2013 6 Standard test methods	FCC: Section 15.231(c)	N/A	Complied	Radiated
	IC: -	IC: Reference data			
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.					

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 6.6	IC: RSS-210 A1.3	N/A	Complied	Radiated

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

3.4 Uncertainty

EMI

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

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
5.2 dB	5.5 dB	5.9 dB	5.9 dB	5.5 dB

* Measurement distance

Radiated emission test (3 m)

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

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	N/A	-	-
No.9 measurement room	-	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.11 measurement room	-	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 m x 2.0 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 Modes

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

4.2 Configuration and peripherals

A

* 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)	SKE8AD-02	20180410-T1 (No.1) *1) 20180410-T2 (No.2) *2)	Mitsubishi Electric Corporation Himeji works	EUT

*1) Used for Transmitting mode.

*2) Used for Normal use mode.

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

Test Procedure and conditions

[For below 1GHz]

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 1GHz]

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.

Test was made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna was varied in height above the conducting ground plane to obtain the maximum signal strength. Photographs of the set up are shown in Appendix 3.

[Transmitting mode]

(Below 30 MHz)

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

(Above 30 MHz)

The Radiated Electric Field Strength has been measured on Semi anechoic chamber with a ground plane and at a distance of 3 m. 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	9.1 kHz	9.1 kHz	120 kHz	PK: S/A: RBW 1 MHz, VBW: 3 MHz

- 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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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	2 MHz	5.1 kHz	15 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 *1)	Max Hold *1)	Spectrum Analyzer

*1) The measurement was performed with Peak detector, Max Hold since the duty cycle was not 100 %.
Peak hold was applied as Worst-case measurement.

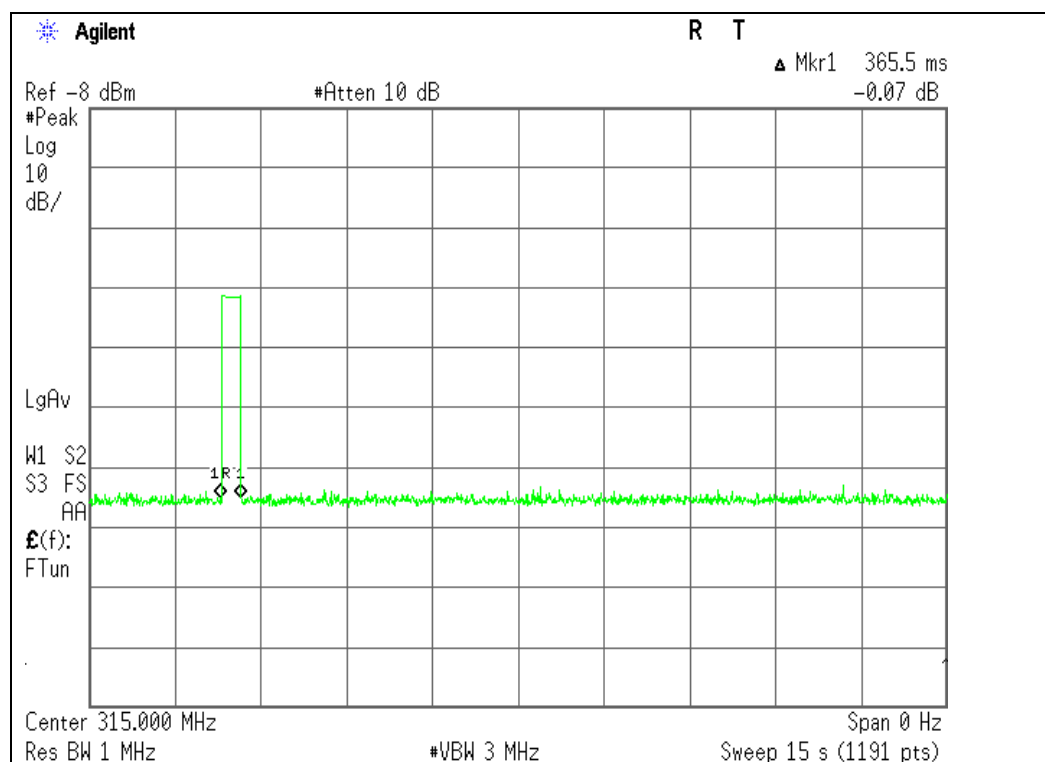
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Automatically deactivate

Test place	Ise EMC Lab. No.4 shielded room
Report No.	12223183H
Date	04/24/2018
Temperature/ Humidity	24 deg. C / 37% RH
Engineer	Shinya Watanabe
Mode	Normal use mode 315 MHz

Time of Transmitting [sec]	Limit [sec]	Result
0.3655	5.00	Pass



* The EUT transmits UHF when LF signal is received from an outboard system 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)

Test place : Ise EMC Lab. No.2 Semi Anechoic Chamber
Report No. : 12223183H
Date : 04/18/2018
Temperature/ Humidity : 24 deg. C / 48% RH
Engineer : Shinya Watanabe
Mode : Transmitting mode 315 MHz

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	77.7	73.9	13.8	9.0	29.3	-	71.2	67.4	95.6	24.4	28.2	Carrier
630.000	PK	33.1	33.1	19.3	10.3	29.6	-	33.1	33.1	75.6	42.5	42.5	Outside
945.000	PK	28.8	28.7	22.1	11.5	27.8	-	34.6	34.5	75.6	41.0	41.1	Outside
1260.000	PK	50.1	50.7	25.5	3.8	35.3	-	44.1	44.7	75.6	31.5	30.9	Outside
1575.000	PK	51.3	51.6	26.0	4.0	35.0	-	46.3	46.6	73.9	27.6	27.3	Inside
1890.000	PK	51.3	54.2	25.9	4.2	34.7	-	46.7	49.6	75.6	28.9	26.0	Outside
2205.000	PK	51.5	50.6	26.6	4.3	34.5	-	47.9	47.0	73.9	26.0	26.9	Inside
2520.000	PK	51.5	53.6	27.5	4.5	34.4	-	49.1	51.2	75.6	26.5	24.4	Outside
2835.000	PK	50.0	49.3	28.2	4.7	34.4	-	48.5	47.8	73.9	25.4	26.1	Inside
3150.000	PK	44.5	45.8	28.5	4.8	34.2	-	43.6	44.9	75.6	32.0	30.7	Outside

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

AV (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	77.7	73.9	13.8	9.0	29.3	0.0	71.2	67.4	75.6	4.4	8.2	Carrier
630.000	PK	33.1	33.1	19.3	10.3	29.6	0.0	33.1	33.1	55.6	22.5	22.5	Outside
945.000	PK	28.8	28.7	22.1	11.5	27.8	0.0	34.6	34.5	55.6	21.0	21.1	Outside
1260.000	PK	50.1	50.7	25.5	3.8	35.3	0.0	44.1	44.7	55.6	11.5	10.9	Outside
1575.000	PK	51.3	51.6	26.0	4.0	35.0	0.0	46.3	46.6	53.9	7.6	7.3	Inside
1890.000	PK	51.3	54.2	25.9	4.2	34.7	0.0	46.7	49.6	55.6	8.9	6.0	Outside
2205.000	PK	51.5	50.6	26.6	4.3	34.5	0.0	47.9	47.0	53.9	6.0	6.9	Inside
2520.000	PK	51.5	53.6	27.5	4.5	34.4	0.0	49.1	51.2	55.6	6.5	4.4	Outside
2835.000	PK	50.0	49.3	28.2	4.7	34.4	0.0	48.5	47.8	53.9	5.4	6.1	Inside
3150.000	PK	44.5	45.8	28.5	4.8	34.2	0.0	43.6	44.9	55.6	12.0	10.7	Outside

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

*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) - Gain (Amplifier)

Result of PK with Duty factor = Reading + Ant Factor + Loss (Cable + Attenuator +Filter) - 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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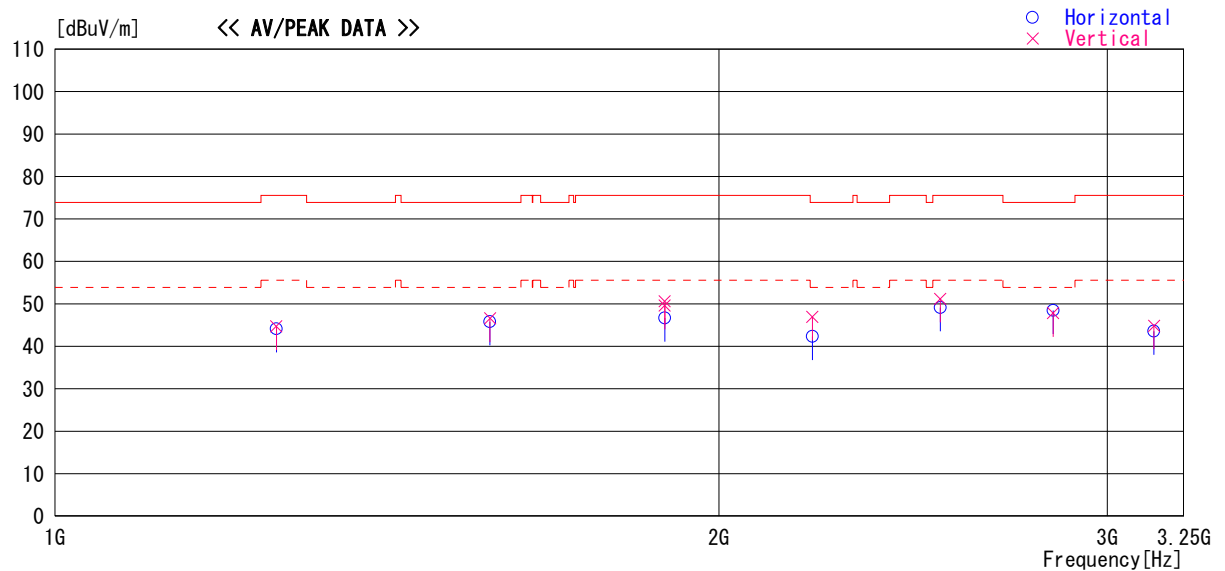
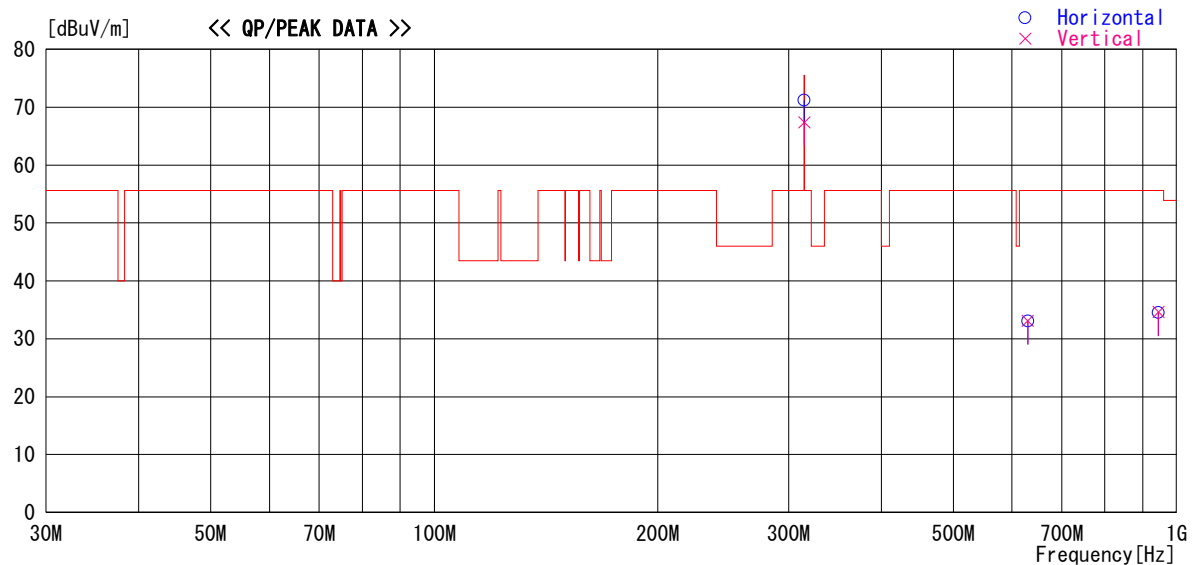
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Radiated Spurious Emission
(Plot data, Worst case)

Test place : Ise EMC Lab. No.2 Semi Anechoic Chamber
Report No. : 12223183H
Date : 04/18/2018
Temperature/ Humidity : 24 deg. C / 48% RH
Engineer : Shinya Watanabe
Mode : Transmitting mode 315 MHz



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

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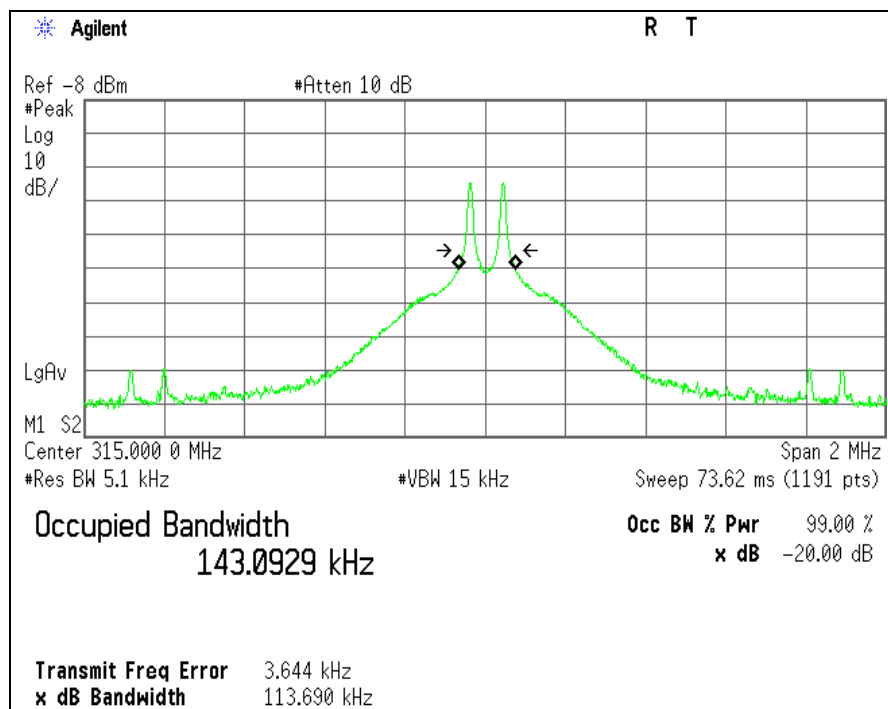
-20dB and 99% Occupied Bandwidth

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. : 12223183H
Date : 04/24/2018
Temperature/ Humidity : 23 deg. C / 33% RH
Engineer : Shinya Watanabe
Mode : Transmitting mode 315 MHz

Bandwidth Limit : Fundamental Frequency $315 \text{ MHz} \times 0.25\% = 787.50$

-20dB Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
113.690	787.50	Pass

99% Occupied Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
143.0929	787.50	Pass



APPENDIX 2: Test Instruments

Test equipment

Test item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
RE	141942	Test Receiver	ROHDE & SCHWARZ	ESCI	100300	8/21/2017	8/31/2018	12
RE	142182	Measure	KOMELON	KMC-36	-	-	-	-
RE	141578	Pre Amplifier	AGILENT	8447D	2944A10845	9/27/2017	9/30/2018	12
RE	141317	Coaxial Cable	Fujikura/Agilent	-	-	2/23/2018	2/28/2019	12
RE	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/14/2017	11/30/2018	12
RE	141265	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-190	12/10/2017	12/31/2018	12
RE	141427	Biconical Antenna	Schwarzbeck	VHA9103B	8031	9/13/2017	9/30/2018	12
RE	141583	Pre Amplifier	SONOMA INSTRUMENT	11/5/1900	260833	2/27/2018	2/28/2019	12
RE	141556	Thermo-Hygrometer	CUSTOM	CTH-201	0003	12/21/2017	12/31/2018	12
RE	141901	Spectrum Analyzer	AGILENT	E4440A	MY48250080	10/18/2017	10/31/2018	12
RE	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	8/7/2017	8/31/2018	12
RE	142004	AC2_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	-	8/31/2018	12
RE	141579	Pre Amplifier	AGILENT	8449B	3008A02142	1/23/2018	1/31/2019	12
RE	141392	Microwave Cable	Junkosha	MWX221	1604S253(1 m) / 1608S087(5 m)	8/4/2017	8/31/2018	12
RE	141512	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	254	2/25/2018	2/27/2019	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
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, and Automatically deactivate tests

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