



RADIO TEST REPORT

Test Report No. : 11145762H-A-R1

Applicant : Mitsubishi Electric Corporation Himeji works
Type of Equipment : Smart Keyless System Hand Unit
Model No. : SKEA7A-03
Test regulation : FCC Part 15 Subpart C: 2016
FCC ID : WAZSKEA7A03
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 above regulation.
4. The test results in this report are traceable to the national or international standards.
5. 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.
6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. This report is a revised version of 11145762H-A. 11145762H-A is replaced with this report.

Date of test: June 4 and 5, 2016

Representative test engineer:

Shinya Watanabe
Engineer
Consumer Technology Division

Approved by:

Motoya Imura
Engineer
Consumer Technology Division



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13-EM-F0429

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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. : SKEA7A-03
Serial No. : Refer to Clause 4.2
Rating : DC 3.0 V
Receipt Date of Sample : May 25, 2016
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: SKEA7A-03 (referred to as the EUT in this report) is the Smart Keyless System Hand Unit.
The clock frequency of EUT is 615.2kHz(CPU) and 9.84375MHz(RF IC).

Radio Specification

RF Part

Equipment Type : Transmitter
Type of modulation : FSK
Frequency of operation : 315 MHz
Antenna Type : PCB Pattern
Method of Frequency Generation : Crystal
Operating voltage (inner) : DC 3.0 V

LF Part *

Type of Receiver : Receiver
Frequency of operation : 125 kHz
Intermediate frequency : -
Antenna Type : Inductive
Method of Frequency Generation : Crystal
Operating voltage (inner) : DC 3.0 V

* The test of receiver part was performed separately from this test report, and the conformability is confirmed.
LF Part test report No. 11145762 H-B (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 April 6, 2016.

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

* 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	N/A*1)	-
	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 A1.1.1			
Electric Field Strength of Fundamental Emission	FCC: ANSI C63.10:2013 6 Standard test methods	FCC: Section 15.231(b)	5.4 dB 315.000 MHz Horizontal, AV (PK with Duty factor)	Complied	Radiated
	IC: RSS-Gen 6.12	IC: RSS-210 A1.1.2			
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)	1.4 dB 2835.000 MHz Vertical, AV (PK with Duty factor)	Complied	Radiated
	IC: RSS-Gen 6.13	IC: RSS-210 A1.1.2, 2.5.1 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 A1.1.3	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 1GHz)			
	(3 m*)(+dB)		(10 m*)(+dB)	
	30 – 200 MHz	200 – 1000MHz	30 – 200 MHz	200 – 1000MHz
Horizontal	4.9 dB	5.2 dB	4.9 dB	5.0 dB
Vertical	4.6 dB	5.9 dB	5.0 dB	5.0 dB

Radiated emission				
(3 m*)(+dB)		(1 m*)(+dB)		(10 m*)(+dB)
1 – 6GHz	6 – 18GHz	10 – 26.5 GHz	26.5 – 40GHz	1 -18 GHz
5.1 dB	5.3 dB	5.1 dB	5.1 dB	5.3 dB

* Measurement distance

Radiated emission test(3 m)

[Electric Field Strength of Fundamental Emission]

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

[Electric Field Strength of Spurious Emission]

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

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3.5 Test Location

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	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms
No.1 semi-anechoic chamber	2973C-1	19.2 x 11.2 x 7.7m	7.0 x 6.0m	No.1 Power source room
No.2 semi-anechoic chamber	2973C-2	7.5 x 5.8 x 5.2m	4.0 x 4.0m	-
No.3 semi-anechoic chamber	2973C-3	12.0 x 8.5 x 5.9m	6.8 x 5.75m	No.3 Preparation room
No.3 shielded room	-	4.0 x 6.0 x 2.7m	N/A	-
No.4 semi-anechoic chamber	2973C-4	12.0 x 8.5 x 5.9m	6.8 x 5.75m	No.4 Preparation room
No.4 shielded room	-	4.0 x 6.0 x 2.7m	N/A	-
No.5 semi-anechoic chamber	-	6.0 x 6.0 x 3.9m	6.0 x 6.0m	-
No.6 shielded room	-	4.0 x 4.5 x 2.7m	4.0 x 4.5 m	-
No.6 measurement room	-	4.75 x 5.4 x 3.0m	4.75 x 4.15 m	-
No.7 shielded room	-	4.7 x 7.5 x 2.7m	4.7 x 7.5m	-
No.8 measurement room	-	3.1 x 5.0 x 2.7m	N/A	-
No.9 measurement room	-	8.0 x 4.6 x 2.8m	2.4 x 2.4m	-
No.11 measurement room	-	6.2 x 4.7 x 3.0m	4.8 x 4.6m	-

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

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

Refer to APPENDIX.

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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), *2)
<p>* The system was configured in typical fashion (as a customer would normally use it) for testing.</p> <p>*1) The software of this mode is the same as one of normal product, except that EUT continues to transmit when transmitter button is being pressed (For Normal use mode, EUT stops to transmit in a given time, even if transceiver button is being pressed.)</p> <p>End users cannot change the settings of the output power of the product.</p> <p>*2) Hand Unit has two functions; Smart keyless function and Normal keyless function (Hand Unit function). The difference of these functions is the gap of operation timing.</p> <p>There is no difference in Output power of these functions (It was confirmed in pre check.).</p> <p>Therefore the test was performed with Normal keyless function.</p>	

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	SKEA7A-03	20160524-T1 (No.9) *1) 20160524-T3 (No.11) *2)	Mitsubishi Electric Corporation Himeji works	EUT

*1) Used for Transmitting mode.

*2) Used 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 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.

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 without mechanical key was the worst case. Therefore the test without 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 - 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	1 MHz	6.8 kHz	22 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	Spectrum Analyzer
Peak hold was applied as Worst-case measurement.							

Test data : APPENDIX
Test result : Pass

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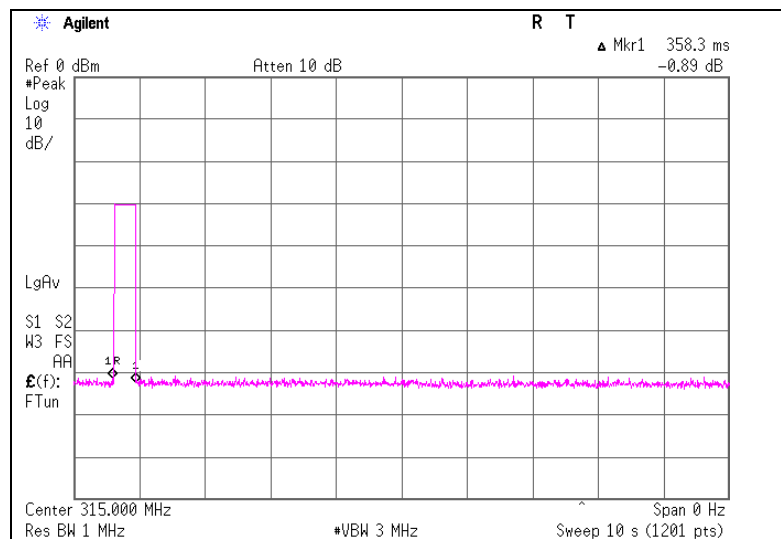
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APPENDIX 1: Test data

Automatically deactivate

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. : 11145762H
Date : 06/04/2016
Temperature/ Humidity : 23 deg. C / 58% RH
Engineer : Shinya Watanabe
Mode : Normal use mode 315 MHz

Time of Transmitting [sec]	Limit [sec]	Result
0.3583	5.00	Pass



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

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber	
Report No.	11145762H	
	Below 1GHz	Above 1GHz
Date	06/04/2016	06/05/2016
Temperature/ Humidity	23 deg. C / 58% RH	22 deg. C / 61% RH
Engineer	Shinya Watanabe	Takumi Shimada
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	78.3	74.2	13.8	10.0	31.9	-	70.2	66.1	95.6	25.4	29.5	Carrier
630.000	PK	34.3	34.5	19.3	11.9	32.2	-	33.3	33.5	75.6	42.3	42.1	Outside
945.000	PK	31.6	33.4	22.1	13.5	30.9	-	36.3	38.1	75.6	39.3	37.5	Outside
1260.000	PK	48.1	47.3	24.9	5.5	34.2	-	44.3	43.5	75.6	31.3	32.1	Outside
1575.000	PK	52.8	51.3	25.7	5.8	33.3	-	51.0	49.5	73.9	22.9	24.4	Inside
1890.000	PK	47.2	48.1	27.0	5.9	32.5	-	47.6	48.5	75.6	28.0	27.1	Outside
2205.000	PK	47.2	46.0	27.7	6.1	32.2	-	48.8	47.6	73.9	25.1	26.3	Inside
2520.000	PK	48.7	48.3	28.1	6.3	32.1	-	51.0	50.6	75.6	24.6	25.0	Outside
2835.000	PK	47.8	49.8	28.2	6.5	32.0	-	50.5	52.5	73.9	23.4	21.4	Inside
3150.000	PK	44.5	47.7	28.4	6.6	31.8	-	47.7	50.9	75.6	27.9	24.7	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	78.3	74.2	13.8	10.0	31.9	0.0	70.2	66.1	75.6	5.4	9.5	Carrier
630.000	PK	34.3	34.5	19.3	11.9	32.2	0.0	33.3	33.5	55.6	22.3	22.1	Outside
945.000	PK	31.6	33.4	22.1	13.5	30.9	0.0	36.3	38.1	55.6	19.3	17.5	Outside
1260.000	PK	48.1	47.3	24.9	5.5	34.2	0.0	44.3	43.5	55.6	11.3	12.1	Outside
1575.000	PK	52.8	51.3	25.7	5.8	33.3	0.0	51.0	49.5	53.9	2.9	4.4	Inside
1890.000	PK	47.2	48.1	27.0	5.9	32.5	0.0	47.6	48.5	55.6	8.0	7.1	Outside
2205.000	PK	47.2	46.0	27.7	6.1	32.2	0.0	48.8	47.6	53.9	5.1	6.3	Inside
2520.000	PK	48.7	48.3	28.1	6.3	32.1	0.0	51.0	50.6	55.6	4.6	5.0	Outside
2835.000	PK	47.8	49.8	28.2	6.5	32.0	0.0	50.5	52.5	53.9	3.4	1.4	Inside
3150.000	PK	44.5	47.7	28.4	6.6	31.8	0.0	47.7	50.9	55.6	7.9	4.7	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).

Sample calculation:

Result of PK = Reading + Ant Factor + Loss (Cable + Attenuator +Distance factor) - Gain (Amplifier)

Result of PK with Duty factor = Reading + Ant Factor + Loss (Cable + Attenuator +Distance factor) - 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).

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

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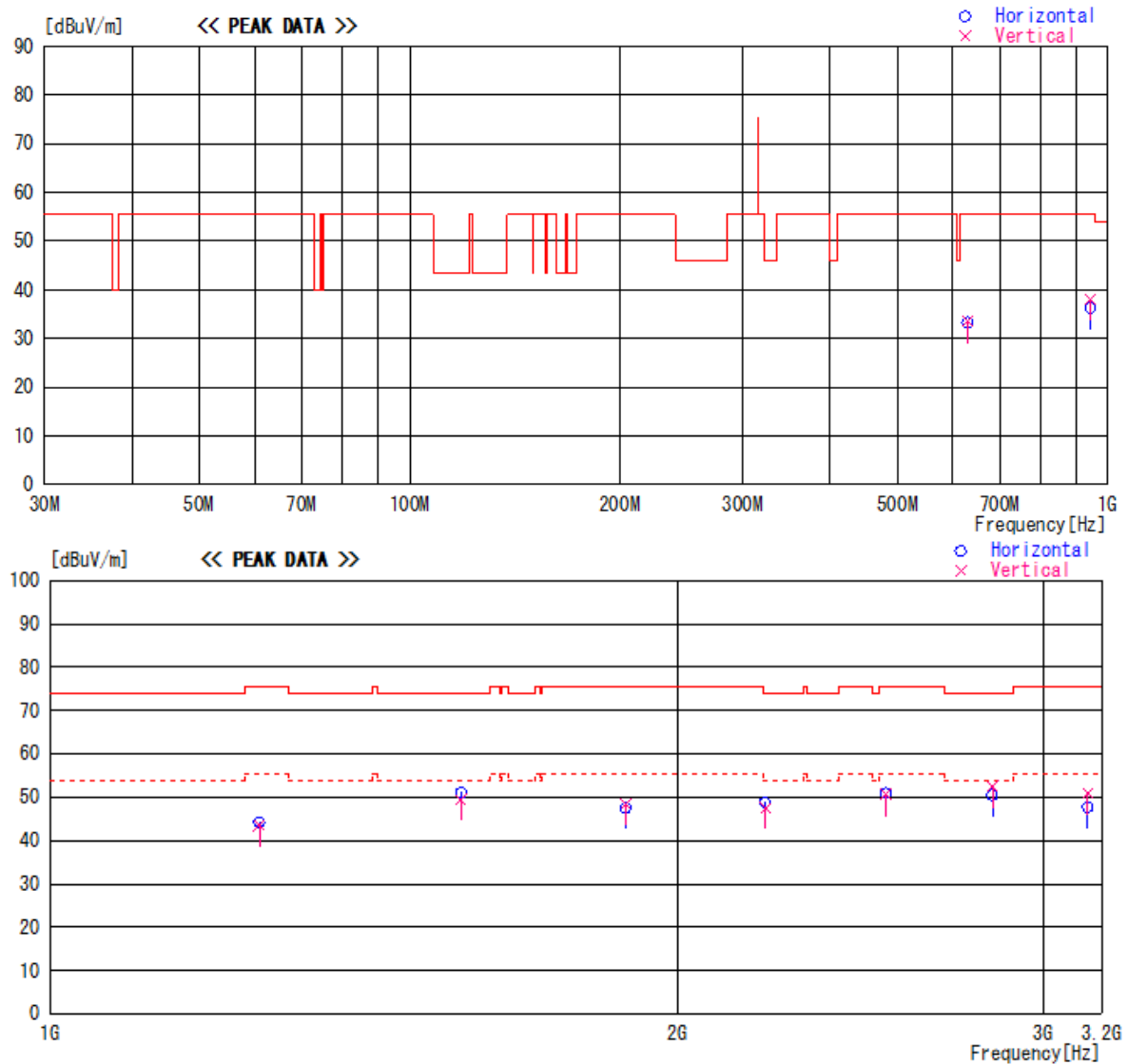
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Radiated Spurious Emission
(Plot data, Worst case)

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber	
Report No.	11145762H	
	Below 1GHz	Above 1GHz
Date	06/04/2016	06/05/2016
Temperature/ Humidity	23 deg. C / 58% RH	22 deg. C / 61% RH
Engineer	Shinya Watanabe	Takumi Shimada
Mode	Transmitting mode 315 MHz	



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

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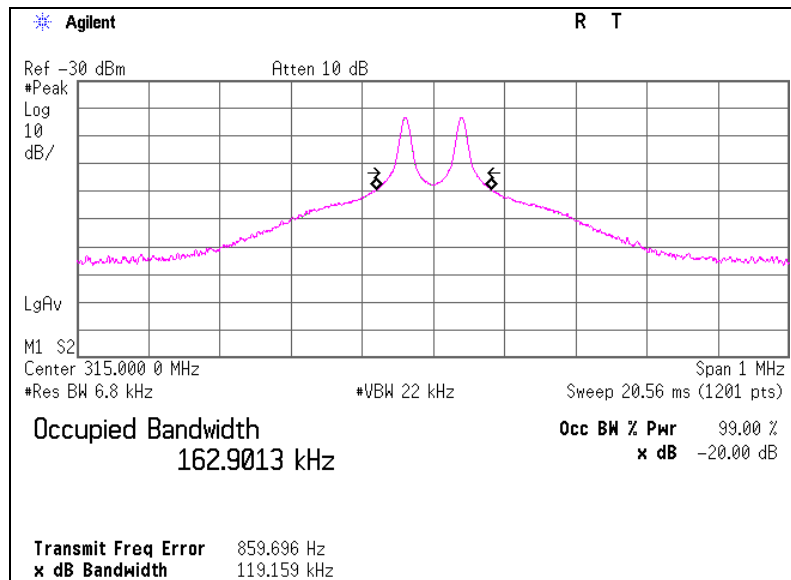
-20dB and 99% Occupied Bandwidth

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. : 11145762H
Date : 06/04/2016
Temperature/ Humidity : 23 deg. C / 58% RH
Engineer : Shinya Watanabe
Mode : Transmitting mode 315 MHz

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

-20dB Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
119.16	787.50	Pass

99% Occupied Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
162.90	787.50	Pass



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Duty Cycle

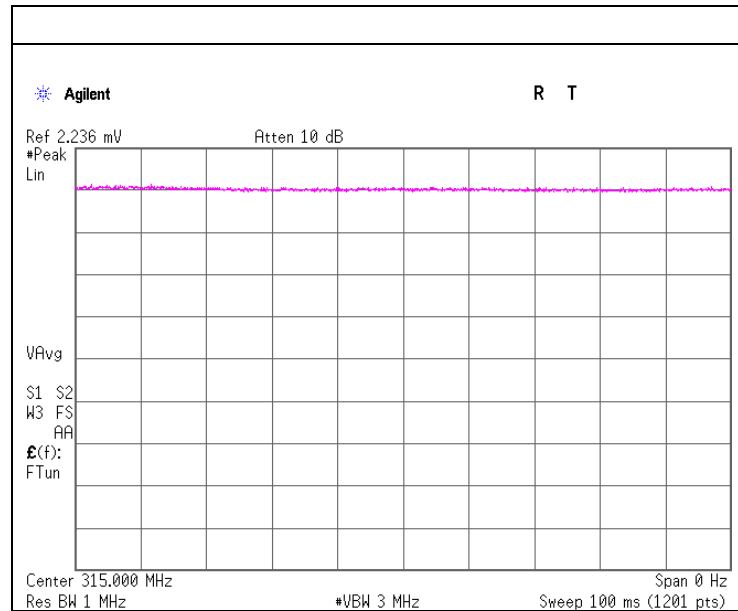
Test place Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. 11145762H
Date 06/04/2016
Temperature/ Humidity 23 deg. C / 58% RH
Engineer Shinya Watanabe
Mode Transmitting mode 315 MHz

(Total)

ON time [ms]	Cycle [ms]	Duty (On time/Cycle)	Duty [dB]
100.00	100.00	1.00	0.0

*1)ON time = Type A's ON time (in 100ms) + Type B's ON time (in 100ms)

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



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APPENDIX 2: Test Instruments

EMI test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-04	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2015/10/02 * 12
MOS-15	Thermo-Hygrometer	Custom	CTH-180	1501	RE	2016/01/21 * 12
MJM-26	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	-
MTR-10	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	RE	2016/01/29 * 12
MBA-05	Biconical Antenna	Schwarzbeck	BBA9106	1302	RE	2015/11/02 * 12
MLA-23	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-192	RE	2016/01/30 * 12
MCC-50	Coaxial Cable	UL Japan	-	-	RE	2015/06/19 * 12
MAT-68	Attenuator	Anritsu	MP721B	6200961025	RE	2015/11/12 * 12
MPA-14	Pre Amplifier	SONOMA INSTRUMENT	310	260833	RE	2016/03/18 * 12
MMM-10	DIGITAL HiTESTER	Hioki	3805	051201148	RE	2016/01/18 * 12
MSA-03	Spectrum Analyzer	Agilent	E4448A	MY44020357	RE	2016/05/19 * 12
MHA-21	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	9120D-557	RE	2015/08/10 * 12
MCC-141	Microwave Cable	Junkosha	MWX221	1305S002R(1m) / 1405S146(5m)	RE	2015/06/22 * 12
MPA-12	MicroWave System Amplifier	Agilent	83017A	00650	RE	2015/10/01 * 12
MLPA-07	Loop Antenna	UL Japan	-	-	RE	Pre Check

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

UL Japan, Inc.

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