



RADIO TEST REPORT

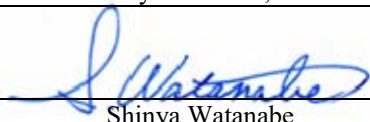
Test Report No. : 12095693H-A-R1

Applicant : Mitsubishi Electric Corporation Himeji works
Type of Equipment : Keyless System Hand Unit
Model No. : SKE11D-01
Test regulation : FCC Part 15 Subpart C: 2018
FCC ID : WAZSKE11D01
Test Result : Complied

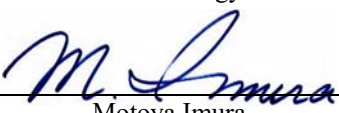
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4. The test results in this report are traceable to the national or international standards.
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6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. This report is a revised version of 12095693H-A. 12095693H-A is replaced with this report.

Date of test: January 15 and 25, 2018

Representative test engineer:


Shinya Watanabe
Engineer
Consumer Technology Division

Approved by:


Motoya Imura
Leader
Consumer Technology Division



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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	:	+81-79-298-8994
Facsimile Number	:	+81-79-298-9929
Contact Person	:	Masashi Nojima

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

2.1 Identification of E.U.T.

Type of Equipment	:	Keyless System Hand Unit
Model No.	:	SKE11D-01
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 3.0 V
Receipt Date of Sample	:	January 10 and 25, 2018
Country of Mass-production	:	Thailand
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: SKE11D-01 (referred to as the EUT in this report) is the Keyless System Hand Unit.

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
Clock Frequency (maximum)	:	24.305 MHz

LF Part *

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

* The test of receiver part was performed separately from this test report, and the conformability is confirmed.
LF Part test report No. 12095693H-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 February 2, 2018 and effective March 5, 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.

* The revision on February 2, 2018, 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	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			
Electric Field Strength of Fundamental Emission	FCC: ANSI C63.10:2013 6 Standard test methods	FCC: Section 15.231(b)	1.1 dB 314.932 MHz 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)	10.1 dB 1889.592 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)

[Electric Field Strength of Fundamental Emission]

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

[Electric Field Strength of Spurious Emission]

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

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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	Keyless System Hand Unit	SKE11D-01	20180109-T1 (No.1) *1) 20180124-T4 (No.4) *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	2MHz	9.1 kHz	30 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 Max hold was applied as Worst-case measurement.							

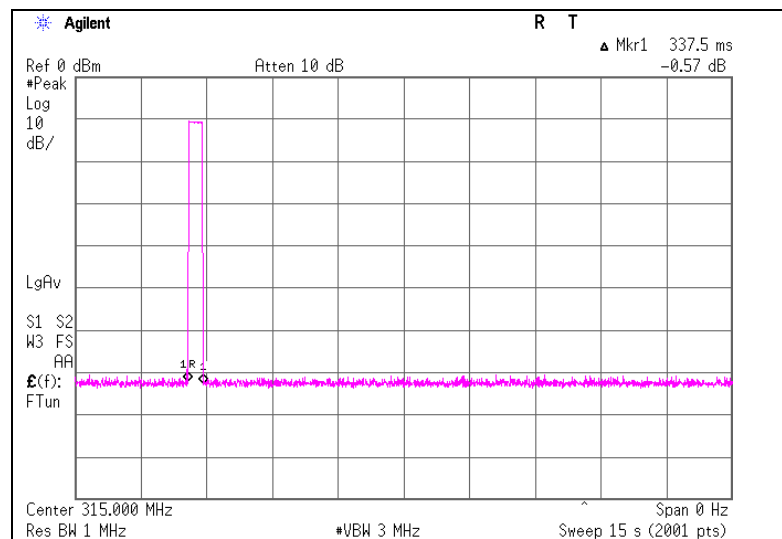
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Automatically deactivate

Test place	Ise EMC Lab. No.7 shielded room
Report No.	12095693H
Date	01/25/2018
Temperature/ Humidity	23 deg. C / 33% RH
Engineer	Shinya Watanabe
Mode	Normal use mode 315 MHz

Time of Transmitting [sec]	Limit [sec]	Result
0.3375	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)

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. : 12095693H
Date : 01/15/2018
Temperature/ Humidity : 21 deg. C / 41% 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	
314.932	PK	87.8	83.5	13.9	10.0	31.9	-	79.8	75.5	95.6	15.8	20.1	Carrier
314.935	PK	87.0	83.6	13.9	10.0	31.9	-	79.0	75.6	95.6	16.6	20.0	Carrier with KEY
629.866	PK	47.2	46.0	19.5	11.9	32.1	-	46.5	45.3	75.6	29.1	30.3	Outside
944.798	PK	29.1	28.3	22.4	13.4	30.9	-	34.0	33.2	75.6	41.6	42.4	Outside NS
1260.000	PK	43.2	42.8	24.9	4.4	34.0	-	38.5	38.1	75.6	37.1	37.5	Outside NS
1575.000	PK	42.8	42.0	25.2	4.7	33.2	-	39.5	38.7	73.9	34.4	35.2	Inside NS
1889.592	PK	46.3	46.5	26.6	4.9	32.5	-	45.3	45.5	75.6	30.3	30.1	Outside
2204.524	PK	41.9	41.5	27.3	5.1	32.2	-	42.1	41.7	73.9	31.8	32.2	Inside NS
2519.456	PK	40.9	41.3	27.5	5.3	32.0	-	41.7	42.1	75.6	33.9	33.5	Outside NS
2834.388	PK	40.9	41.1	28.0	5.4	31.9	-	42.4	42.6	73.9	31.5	31.3	Inside NS
3150.000	PK	41.3	41.8	28.3	5.6	31.8	-	43.4	43.9	75.6	32.2	31.7	Outside NS

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	
314.932	PK	87.8	83.5	13.9	10.0	31.9	-5.3	74.5	70.2	75.6	1.1	5.4	Carrier
314.935	PK	87.0	83.6	13.9	10.0	31.9	-5.3	73.7	70.3	75.6	1.9	5.3	Carrier with KEY
629.866	PK	47.2	46.0	19.5	11.9	32.1	-5.3	41.2	40.0	55.6	14.4	15.6	Outside
944.798	PK	29.1	28.3	22.4	13.4	30.9	-5.3	28.7	27.9	55.6	26.9	27.7	Outside NS
1260.000	PK	43.2	42.8	24.9	4.4	34.0	0.0	38.5	38.1	55.6	17.1	17.5	Outside NS
1575.000	PK	42.8	42.0	25.2	4.7	33.2	0.0	39.5	38.7	53.9	14.4	15.2	Inside NS
1889.592	PK	46.3	46.5	26.6	4.9	32.5	0.0	45.3	45.5	55.6	10.3	10.1	Outside
2204.524	PK	41.9	41.5	27.3	5.1	32.2	0.0	42.1	41.7	53.9	11.8	12.2	Inside NS
2519.456	PK	40.9	41.3	27.5	5.3	32.0	0.0	41.7	42.1	55.6	13.9	13.5	Outside NS
2834.388	PK	40.9	41.1	28.0	5.4	31.9	0.0	42.4	42.6	53.9	11.5	11.3	Inside NS
3150.000	PK	41.3	41.8	28.3	5.6	31.8	0.0	43.4	43.9	55.6	12.2	11.7	Outside NS

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: $20 \times \log(4.0 \text{ m}/3.0 \text{ m}) = 2.50 \text{ dB}$

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

* As for Average value, the measured duty factor obtained by tuning to noise peak was applied since fundamental and harmonic (below 1GHz) are bigger than 120 kHz (RBW bandwidth).

Harmonic test (Above 1GHz) was applied to worst 100% (Duty factor = 0) although Duty Factor was applied in harmonic test which peak to peak frequency bandwidth of FSK modulation is equal to or more than measurement bandwidth (1MHz).

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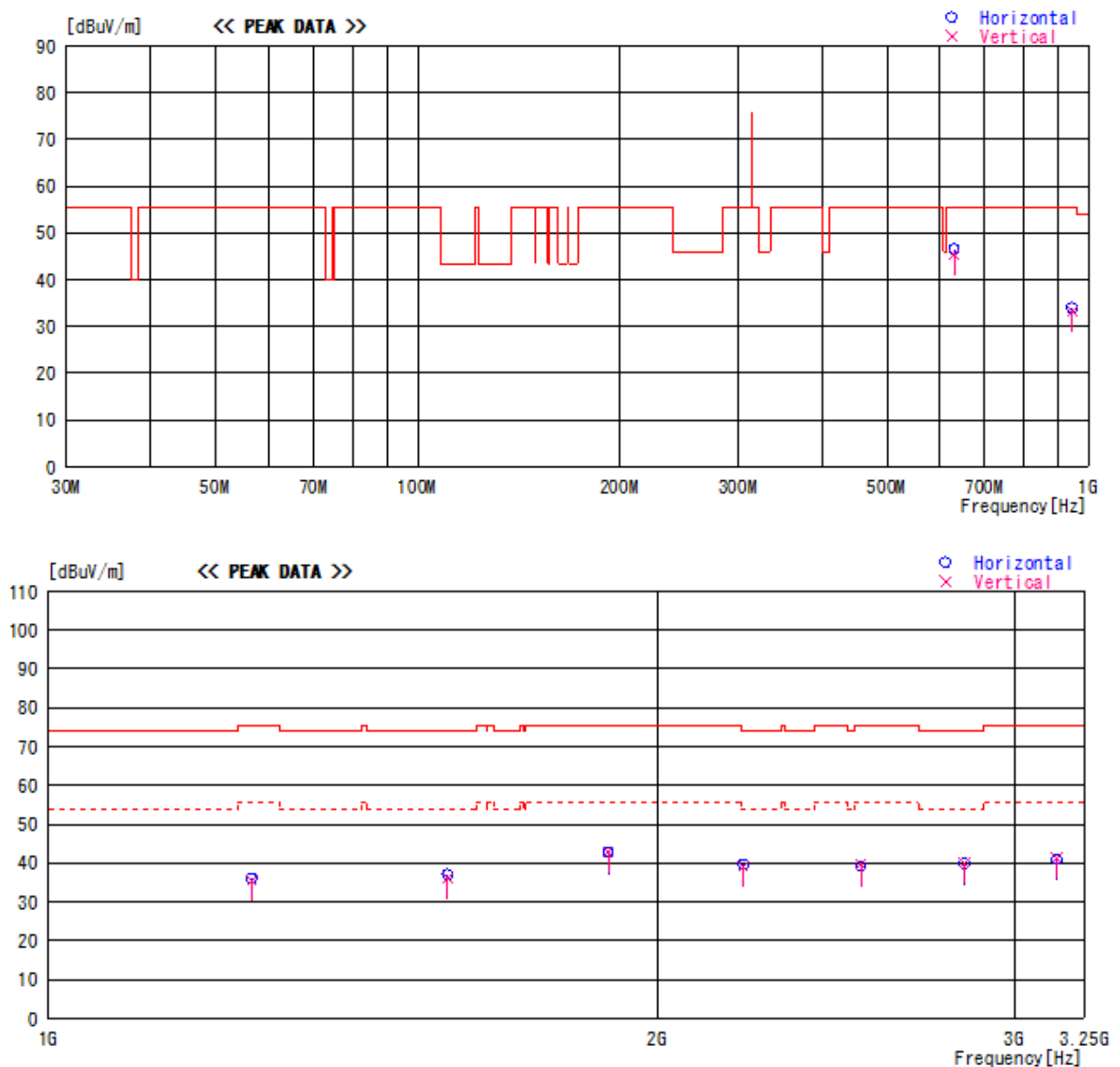
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Radiated Spurious Emission (Plot data, Worst case)

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. : 12095693H
Date : 01/15/2018
Temperature/ Humidity : 21 deg. C / 41% 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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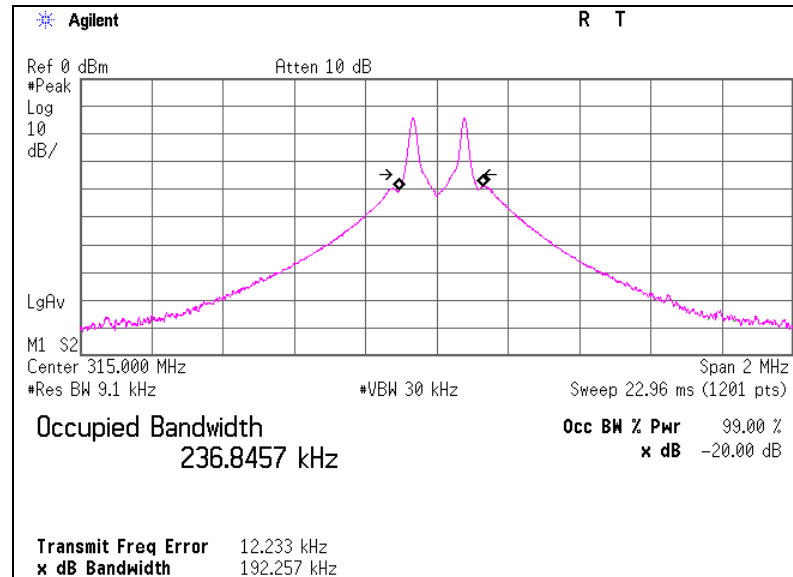
-20dB and 99% Occupied Bandwidth

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No.	12095693H
Date	01/15/2018
Temperature/ Humidity	21 deg. C / 41% 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
192.257	787.50	Pass

99% Occupied Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
236.8457	787.50	Pass



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Duty Cycle

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. : 12095693H
Date : 01/15/2018
Temperature/ Humidity : 21 deg. C / 41% RH
Engineer : Shinya Watanabe
Mode : Transmitting mode 315 MHz

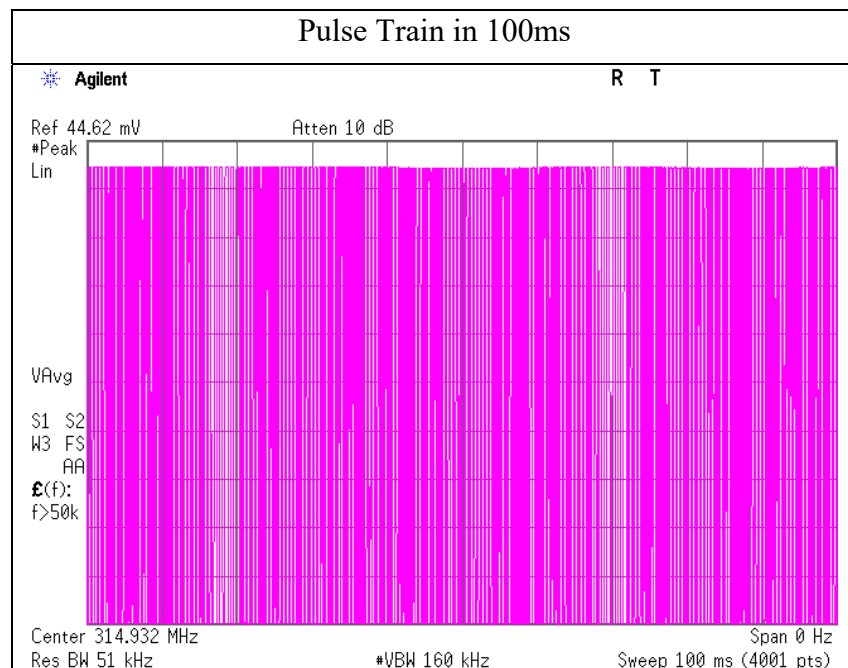
Pulse type	ON time(One pulse) [ms]	Pulse count (Sweep time : 4mS)					Pulse count sum (in 20ms)	ON time(in 20ms) [ms]
		1	2	3	4	5		
A	0.264	5	3	4	3	3	18	4.752
B	0.139	6	10	8	2	4	30	4.17
C	0.389	0	0	0	3	2	5	1.945
Total on time in 20mS								10.867

The train of pulses was exceeding 100msec, and that sampled 100msec was the worst case against the pulse train.

(Total)

ON time in 100mS ^{*1)} [ms]	Cycle [ms]	Duty (On time/Cycle)	Duty [dB]
54.34	100.00	0.54	-5.30

*1)ON time in 100mS = Total on time in 20mS * 5



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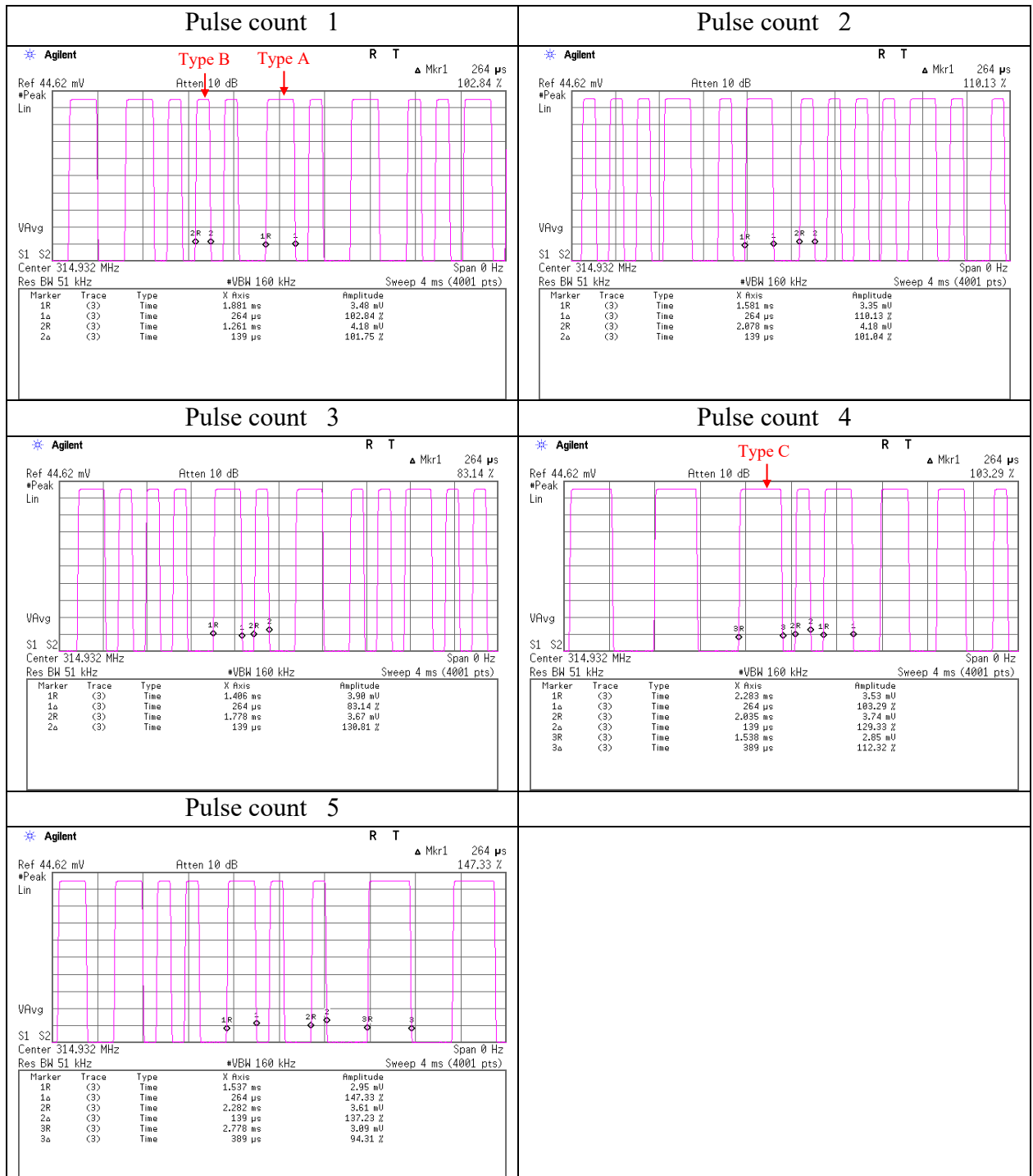
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Duty Cycle



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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	2017/10/30 * 12
MOS-15	Thermo-Hygrometer	Custom	CTH-180	1501	RE	2017/01/20 * 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	2017/01/12 * 12
MBA-05	Biconical Antenna	Schwarzbeck	BBA9106	1302	RE	2017/11/23 * 12
MLA-23	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-192	RE	2017/12/10 * 12
MCC-50	Coaxial Cable	UL Japan	-	-	RE	2017/06/26 * 12
MAT-97	Attenuator	KEYSIGHT	8491A	MY52462282	RE	2017/10/12 * 12
MPA-14	Pre Amplifier	SONOMA INSTRUMENT	310	260833	RE	2017/03/27 * 12
MMM-10	DIGITAL HiTESTER	Hioki	3805	051201148	RE	2018/01/09 * 12
MHA-21	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	9120D-557	RE	2017/09/15 * 12
MPA-12	MicroWave System Amplifier	Agilent	83017A	00650	RE	2017/10/06 * 12
MCC-141	Microwave Cable	Junkosha	MWX221	1305S002R(1m) / 1405S146(5m)	RE	2017/06/23 * 12
MSA-15	Spectrum Analyzer	Agilent	E4440A	MY46187105	RE	2017/10/16 * 12
MOS-34	Thermo-Hygrometer	Custom	CTH-201	3401	RE	2017/01/20 * 12
MLPA-10	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

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