



RADIO TEST REPORT

Test Report No. : 11145757H-A

Applicant : Mitsubishi Electric Corporation Himeji Works
Type of Equipment : Smart Keyless System (Smart Unit)
Model No. : SKEA7D-01
FCC ID : WAZSKEA7D01
Test regulation : FCC Part 15 Subpart C: 2016
Test Result : Complied

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2. The results in this report apply only to the sample tested.
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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)

Date of test: June 3 and 4, 2016

Representative test engineer:

Hiroyuki Furutaka
Engineer

Consumer Technology Division

Approved by:

Motoya Imura
Engineer

Consumer Technology Division



NVLAP LAB CODE: 200572-0

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13-EM-F0429

REVISION HISTORY

Original Test Report No.: 11145757H-A

Revision	Test report No.	Date	Page revised	Contents
-	11145757H-A	July 5, 2016	-	-
(Original)				

CONTENTS	PAGE
SECTION 1: Customer information	4
SECTION 2: Equipment under test (E.U.T.).....	4
SECTION 3: Test specification, procedures & results	5
SECTION 4: Operation of E.U.T. during testing	8
SECTION 5: Radiated emission (Fundamental and Spurious Emission)	9
SECTION 6: -26dB Bandwidth.....	11
SECTION 7: 99% Occupied Bandwidth.....	11
APPENDIX 1: Test data	12
Radiated Emission below 30MHz (Fundamental and Spurious Emission)	12
Radiated Emission above 30MHz (Spurious Emission).....	13
-26dB Bandwidth and 99% Occupied Bandwidth	14
APPENDIX 2: Test instruments	15
APPENDIX 3: Photographs of test setup	16
Radiated Emission.....	16
Worst Case Position	17

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 (Smart Unit)
Model No. : SKEA7D-01
Serial No. : Refer to Section 4, Clause 4.2
Rating : DC 12.0 V
Receipt Date of Sample : May 12, 2016
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: SKEA7D-01 (referred to as the EUT in this report) is the Smart Keyless System (Smart Unit).
The clock frequency of EUT is 8 MHz (CPU) and 30.32 MHz (RF IC).

Radio Specification

LF Part

Equipment Type : Transmitter
Type of modulation : ASK
Bandwidth : 2.5 kHz
Frequency of operation : 125 kHz
Other clock frequency : 30.32 MHz
Antenna Type : Inductive
Method of Frequency Generation : Crystal
Operating voltage (inner) : DC +12.0V

RF Part *

Type of Receiver : Receiver
Frequency of operation : 315 MHz
Other clock frequency : 8 MHz
Intermediate frequency : 200 kHz
Antenna Type : Bar Antenna
Method of Frequency Generation : Crystal
Operating voltage (inner) : DC +5.0V

* The test of receiver part was performed separately from this test report, and the conformability is confirmed.
LF Part test report No. 11145757H-C (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 15.207 Conducted Emission
Section 15.209 Radiated emission limits, general requirements

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

3.2 Procedures and results

No.	Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
1	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	N/A
2	Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> RSS-Gen 6.4, 6.12	<FCC> Section 15.209 <IC> RSS-210 2.5.1 RSS-Gen 8.9	Radiated	N/A	12.0 dB 0.12500MHz, 0 deg. AV (PK with Duty factor)	Complied
3	Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> RSS-Gen 6.4, 6.13	<FCC> Section 15.209 <IC> RSS-210 2.5.1 RSS-Gen 8.9	Radiated	N/A	17.9 dB 917.329 MHz, Horizontal, QP	Complied
4	-26dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> -	<FCC> Reference data <IC> -	Radiated	N/A	N/A	N/A

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 is not the device that is designed to be connected to the public utility (AC) power line.

FCC 15.31 (e)

The test was performed with the New Battery (DC 12.0 V) and the EUT constantly provides the stable voltage to RF part through the regulator regardless of input voltage from New Battery. Therefore, this 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

No.	Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
1	99% Occupied Band Width	RSS-Gen 4.6.1	RSS-Gen 4.6.1	Radiated	N/A	N/A	N/A

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

* Measurement distance

Radiated emission test (3m)

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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	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.

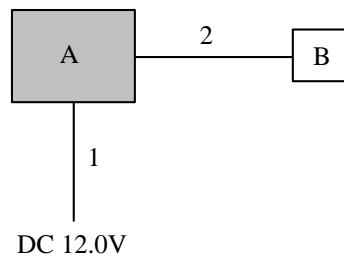
SECTION 4: Operation of E.U.T. during testing

4.1 Operating Modes

The mode is used : Transmitting mode (125kHz)

Justification : The system was configured in typical fashion (as a customer would normally use it) for testing.

4.2 Configuration and peripherals



*Cabling and setup were taken into consideration and test data was taken under worse case conditions.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remark
A	Smart Keyless System (Smart Unit)	SKEA7D-01	20160511-E1(No.6)	Mitsubishi Electric Corporation Himeji works	EUT
B	Switch Box 1	-	No.17	Mitsubishi Electric Corporation Himeji works	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	1.4	Unshielded	Unshielded	(No.3)
2	Signal Cable	0.9	Unshielded	Unshielded	(No.3)

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SECTION 5: Radiated emission (Fundamental and Spurious Emission)

Test Procedure

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.

Frequency : From 9 kHz to 30 MHz

The EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

The measurements were performed for vertical polarization (antenna angle: 0 deg., 45 deg., 90 deg., and 135 deg.) and horizontal polarization.

*Refer to Figure 1 about Direction of the Loop Antenna.

Frequency: From 30 MHz to 1 GHz

The measuring antenna height varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

The measurements were performed for both vertical and horizontal antenna polarization.

The test was made with the detector (RBW / VBW) in the following table.

When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

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

Frequency	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	
Instrument used	Test Receiver					Spectrum Analyzer	
Detector	PK / AV	QP	PK / AV	QP	QP	PK	AV
IF Bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 10 Hz
Test Distance	3 m *1)	3 m *1)	3 m *1)	3 m *2)	3 m	3 m	3 m

*1) Distance Factor: $40 \times \log(3 \text{ m} / 300 \text{ m}) = -80 \text{ dB}$

*2) Distance Factor: $40 \times \log(3 \text{ m} / 30 \text{ m}) = -40 \text{ dB}$

Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606.

These tests were performed in semi anechoic chamber. Therefore the measured level of emissions may be higher than if measurements were made without a ground plane.

However test results were confirmed to pass against standard limit.

- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

The test results and limit are rounded off to one decimal place, so some differences might be observed.

Measurement range : 9 kHz - 1 GHz

Test data : APPENDIX 1

Test result : Pass

Date: June 3, 2016
June 4, 2016

Test engineer: Hiroyuki Furutaka
Takafumi Noguchi

UL Japan, Inc.

Ise EMC Lab.

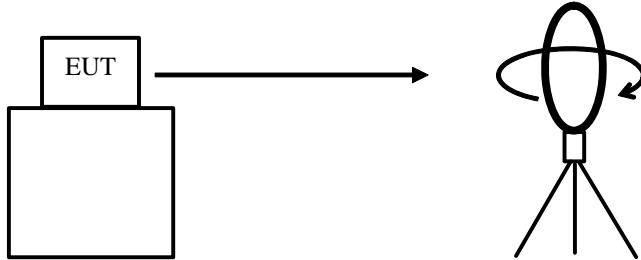
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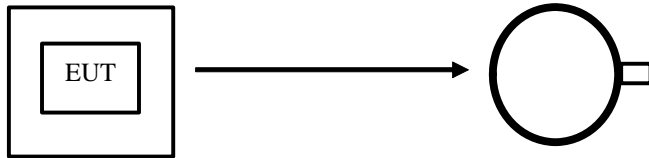
Facsimile : +81 596 24 8124

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

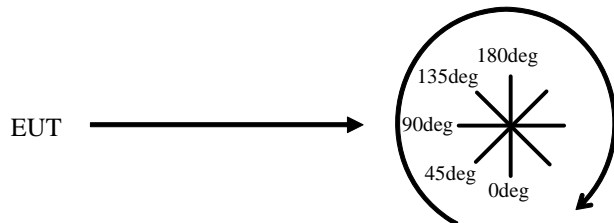


.....
Top View (Horizontal)



Antenna was not rotated.

.....
Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

SECTION 6: -26dB Bandwidth

Test Procedure

The test was measured with a spectrum analyzer using a test fixture.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
-26 dB Bandwidth	150 kHz	1 kHz	3 kHz	Auto	Peak	Max Hold	Spectrum Analyzer

Test data : APPENDIX 1
Test result : Pass

SECTION 7: 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
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 1
Test result : Pass

APPENDIX 1: Test data

Radiated Emission below 30MHz (Fundamental and Spurious Emission)

Test place : Ise EMC Lab. No.2 Semi Anechoic Chamber
Report No. : 11145757H
Date : 06/03/2016
Temperature/ Humidity : 24 deg. C / 48% RH
Engineer : Hiroyuki Furutaka
Mode : Tx 125kHz

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	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
0	0.12500	PK	100.3	19.6	-73.9	32.4	-	13.6	45.6	32.0	Fundamental
45	0.12500	PK	98.4	19.6	-73.9	32.4	-	11.7	45.6	33.9	
90	0.12500	PK	95.8	19.6	-73.9	32.4	-	9.1	45.6	36.5	
135	0.12500	PK	98.7	19.6	-73.9	32.4	-	12.0	45.6	33.6	
180	0.12500	PK	99.3	19.6	-73.9	32.4	-	12.6	45.6	33.0	
180	0.12500	PK	90.7	19.6	-73.9	32.4	-	4.0	45.6	41.6	ANT Hor.
0	0.25000	PK	68.9	19.6	-73.9	32.4	-	-17.8	39.6	57.4	
0	0.37500	PK	67.2	19.6	-73.9	32.3	-	-19.4	36.1	55.5	
0	0.50000	QP	41.9	19.5	-33.9	32.3	-	-4.8	33.6	38.4	
0	0.62500	QP	49.1	19.5	-33.8	32.3	-	2.5	31.7	29.2	
0	0.75000	QP	37.1	19.5	-33.8	32.3	-	-9.5	30.1	39.6	
0	0.87500	QP	42.1	19.5	-33.8	32.3	-	-4.5	28.7	33.2	
0	1.00000	QP	34.0	19.5	-33.8	32.3	-	-12.6	27.6	40.2	
0	1.12500	QP	37.1	19.5	-33.8	32.3	-	-9.5	26.5	36.0	
0	1.50000	QP	31.2	19.5	-33.7	32.3	-	-15.3	24.0	39.3	NS

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier)

PK with Duty factor

Ant Deg [deg]	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
0	0.125	PK	100.3	19.6	-73.9	32.4	0.0	13.6	25.6	12.0	Fundamental
45	0.125	PK	98.4	19.6	-73.9	32.4	0.0	11.7	25.6	13.9	
90	0.125	PK	95.8	19.6	-73.9	32.4	0.0	9.1	25.6	16.5	
135	0.125	PK	98.7	19.6	-73.9	32.4	0.0	12.0	25.6	13.6	
180	0.125	PK	99.3	19.6	-73.9	32.4	0.0	12.6	25.6	13.0	
180	0.125	PK	90.7	19.6	-73.9	32.4	0.0	4.0	25.6	21.6	ANT Hor.
0	0.250	PK	68.9	19.6	-73.9	32.4	0.0	-17.8	19.6	37.4	
0	0.375	PK	67.2	19.6	-73.9	32.3	0.0	-19.4	16.1	35.5	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + D.Factor) - Gain(Amprifier) + Duty factor *

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

Result of the fundamental emission at 3m without Distance factor

PK or QP (Result of the fundamental emission at 3m without Distance factor)

Ant Deg [deg]	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
0.000	0.125	PK	100.3	19.6	6.1	32.4	-	93.6	-	-	Fundamental

* All spurious emissions lower than this result.

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Radiated Emission above 30MHz (Spurious Emission)

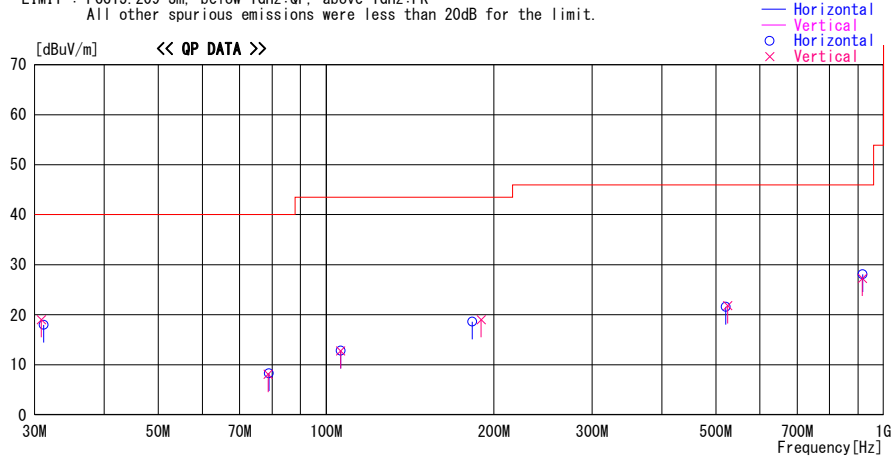
DATA OF RADIATED EMISSION TEST

UL Japan, Inc. Ise EMC Lab. No.2 Semi Anechoic Chamber
Date : 2016/06/04

Report No. : 11145757H
Temp./Humi. : 21deg. C / 49% RH
Engineer : Takafumi Noguchi

Mode / Remarks : Tx 125kHz Worst axis (Hori:Z-axis, Vert:Z-axis)

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK
All other spurious emissions were less than 20dB for the limit.



Frequency [MHz]	Reading [dBuV]	DET	Antenna	Loss&	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Gain [dB]							
30.850	24.2	QP	16.6	-21.8	19.0	96	100	Vert.	40.0	21.0	
31.133	23.3	QP	16.5	-21.8	18.0	0	400	Hori.	40.0	22.0	
78.733	22.9	QP	6.3	-21.1	8.1	0	100	Vert.	40.0	31.9	
79.017	23.0	QP	6.3	-21.0	8.3	0	400	Hori.	40.0	31.7	
106.217	22.8	QP	10.6	-20.6	12.8	5	100	Hori.	43.5	30.7	
106.217	22.8	QP	10.6	-20.6	12.8	0	100	Vert.	43.5	30.7	
183.001	22.2	QP	16.2	-19.8	18.6	357	100	Hori.	43.5	24.9	
189.801	22.2	QP	16.4	-19.6	19.0	45	100	Vert.	43.5	24.5	
521.335	22.5	QP	17.8	-18.7	21.6	0	100	Hori.	46.0	24.4	
525.335	22.6	QP	17.9	-18.7	21.8	283	100	Vert.	46.0	24.2	
915.996	21.5	QP	21.9	-16.1	27.3	0	100	Vert.	46.0	18.7	
917.329	22.3	QP	21.9	-16.1	28.1	125	100	Hori.	46.0	17.9	

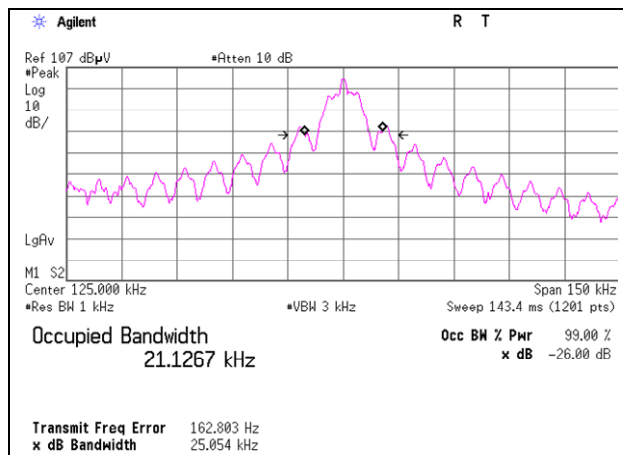
CHART: WITH FACTOR ANT TYPE: -30MHz: LOOP, 30-200MHz: BICONICAL, 200MHz-1000MHz: LOGPERIODIC, 1000MHz-: HORN
CALCULATION : RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATTEN - GAIN (AMP))

*The test result is rounded off to one or two decimal places, so some differences might be observed.

-26dB Bandwidth and 99% Occupied Bandwidth

Test place	Head Office EMC Lab. No.2 Semi Anechoic Chamber
Report No.	11145757H
Date	06/03/2016
Temperature/ Humidity	24 deg. C / 48% RH
Engineer	Hiroyuki Furutaka
Mode	Tx 125kHz

Mode	Frequency [kHz]	-26dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
Tx 125kHz	125	25.054	21.127



APPENDIX 2: Test instruments

EMI test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-02	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	RE	2015/07/01 * 12
MOS-22	Thermo-Hygrometer	Custom	CTH-201	0003	RE	2016/01/21 * 12
MJM-14	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	-
MSA-10	Spectrum Analyzer	Agilent	E4448A	MY46180655	RE	2016/02/24 * 12
MTR-03	Test Receiver	Rohde & Schwarz	ESCI	100300	RE	2015/10/11 * 12
MLPA-01	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	RE	2015/10/24 * 12
MCC-13	Coaxial Cable	Fujikura	3D-2W(12m)/ 5D-2W(5m)/ 5D-2W(0.8m)/ 5D-2W(1m)	-	RE	2016/02/08 * 12
MCC-143	Coaxial Cable	UL Japan	-	-	RE	2015/06/24 * 12
MPA-13	Pre Amplifier	SONOMA INSTRUMENT	310	260834	RE	2016/03/24 * 12
MAT-07	Attenuator(6dB)	Weinschel Corp	2	BK7970	RE	2015/11/10 * 12
MMM-01	Digital Tester	Fluke	FLUKE 26-3	78030611	RE	2015/08/19 * 12
MBA-03	Biconical Antenna	Schwarzbeck	BBA9106	1915	RE	2015/10/11 * 12
MLA-21	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-190	RE	2016/01/30 * 12
MCC-12	Coaxial Cable	Fujikura/Agilent	-	-	RE	2016/02/08 * 12
MPA-09	Pre Amplifier	Agilent	8447D	2944A10845	RE	2015/09/04 * 12

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: Spurious emission

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