

RF TEST REPORT

Test Equipment : Digital Cabinet Lock
Model Name : ML52RA
FCC ID : 2AJUHML52RA
Date of receipt : 2017.10.26
Test duration : 2017.11.20 ~ 2017.11.23
Date of issue : 2017.11.28

Applicant : ASSA ABLOY KOREA Co.,Ltd Unilock
5F iRevo Bldg., 205-29 Gasan Digital 1-ro, Geumcheon-gu, Seoul
08503, South Korea

Test Laboratory : Lab-T, Inc.
2182-42, Baegok-daero, Mohyeon-myeon, Cheoin-gu, Yongin-si
Gyeonggi-do, 17036, Korea

Test specification : FCC Part 15 Subpart C 15.225
RF Output Power : 46.20 dB μ V/m
Test result : Pass

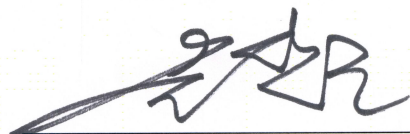
The above equipment was tested by Lab-T Testing Laboratory for compliance with the requirements of FCC Rules and Regulations.
The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose.
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Tested by:



Engineer
SuHyun Seo

Reviewed by:



Technical Manager
SangHoon Yu

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1. Applicant Information

Applicant : ASSA ABLOY KOREA Co., Ltd Unilock
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South Korea
Telephone No. : +82 1644-3526
Person in charge : Sangjin, Park / sjpark@unilock.co.kr

Manufacturer : ASSA ABLOY KOREA Co., Ltd Unilock
Address : 5F iRevo Bldg., 205-29 Gasan Digital 1-ro, Geumcheon-gu, Seoul 08503,
South Korea

2. Laboratory Information

Test Laboratory : Lab-T, Inc.
Address : 2182-42, Baegok-daero, Mohyeon-myeon, Cheoin-gu, Yongin-si Gyeonggi-do,
17036, Korea
Telephone No. : +82 31-322-6767
Facsimile No. : +82 31-322-6768

Certificate

FCC Site
Registration No. : 133186
Designation No. : KR0159

3. Information About Test Equipment

3.1 Equipment Information

Equipment type	Digital Cabinet Lock
Model name	ML52RA
Variant model name ^(Note 2)	-
Frequency range	RFID : 13.56 MHz
Modulation type	ASK(RFID)
Power supply	DC 4.5 V
H/W version	Main Board : ULI200-191-002 Antenna Board : UL200-192-001
S/W version	RP5171115

Note 1 :The above EUT information was declared by the manufacturer.

3.2 Antenna Information

Type	Gain
Loop Antenna	-

3.3 Test Frequency

Test mode	Test frequency (MHz)		
	Lowest Frequency	Middle Frequency	Highest Frequency
RFID	13.56	-	-

3.4 Worst-Case

RFID	-
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3.5 Tested Companion Device Information

Type	Manufacturer	Model	Note
-	-	-	-
-	-	-	-

4. Test Report

4.1 Summary

FCC Part 15				
FCC Rule	IC Rule	Parameter	Clause	Status
Transmitter Requirements				
15.203 15.247(c)	-	Antenna Requirement	4.4.1	C
15.225(a,b,c)	RSS-210 Issue9, B.6 (a,b,c)	In-band Fundamental&Spurious Emission	4.4.2	C
15.225(d) 15.209	RSS-210 Issue9, B.6 (d) RSS-GEN, 8.9	Out-of-band Spurious Emission	4.4.3	C
15.225(e)	RSS-210 Issue9, B.6	Frequency Tolerance	4.4.4	C
-	RSS-GEN 6.6	Emission Bandwidth	4.4.5	C
15.207(a)	RSS-GEN 8.8	Conducted Emissions	4.4.6	N/A
NOTE 1 : C = Comply N/C = Not Comply N/T = Not Tested N/A = Not Applicable				

4.2 Measurement Uncertainty

Measurement items	Expanded Uncertainty	
Occupied Channel Bandwidth	0.08 %	(The confidence level is about 95 %, k=2)
Radiated Spurious Emissions (1 GHz under)	4.56 dB	(The confidence level is about 95 %, k=2)

4.3 Test Report Version

Test Report No.	Date	Description
TRRFCC17-0012	17.11.28	Initial issue

4.4 Transmitter Requirements

4.4.1 Antenna Requirement

4.4.1.1 Regulation

According to §15.203 An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

4.4.1.2 Result

Comply

(The Loop antenna is permanently attached on PCB board.)

4.4.2 In-band Fundamental & Spurious Emission

4.4.2.1 Regulation

15.225 (a) The field strength of any emission within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

15.225 (b) With in the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

15.225 (c) With in the bands 13.110-13.410 MHz and 13.710-14.010 MHz, the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

4.4.2.2 Measurement Procedure

Test Procedure The Radiated Electric Field Strength intensity has been measured on semi anechoic chamber with a ground plane and at a distance of 3m.

Frequency : From 9 kHz to 30 MHz at distance 3m The EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

Frequency : From 30 MHz to 1 GHz at distance 3m The measuring antenna height varied between 1 and 4m 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.

Measurements were performed with a QP, PK, and AV detector. The radiated emission measurements were made with the following detector function of the test receiver (below 1 GHz).

Frequency	9 - 90 kHz	90 - 110 kHz	110 - 490 kHz	490 kHz - 30 MHz	30 MHz - 1 Ghz
Detector type	PK/AV	QP	PK/AV	QP	QP
IF bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz

Note 1 : Part 15 Section 15.31 (f)(2) Below 30 MHz
Limit at 3 m = Limit at 300 m - 40log(3 m/300 m)
Limit at 3 m = Limit at 30 m - 40log(3 m/30 m)

4.4.2.3 Result

Comply (measurement data : refer to the next page)

4.4.2.4 Measurement data_In-band Fundamental

Test mode : 13.56 MHz RFID

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dB μ V)	Ant Factor (dB)	Loss (dB)	Result (dB μ V/m) at 3 m	Limit (dB μ V/m) at 3 m	Margin (dB)
13.561	QP	H	65.8	10.2	-29.8	46.2	124	77.8

Note 1 : Limit at 3 m = Limit at 30 m - 40log(3 m/30 m)

Note 2 : Limit at 30 m = 20log(microvolts/meter)

Note 3 : Measured Distance : 3m

4.4.2.5 Measurement data_In-band Spurious Emission

Test mode : 13.56 MHz RFID

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dB μ V)	Ant Factor (dB)	Loss (dB)	Result (dB μ V/m) at 3 m	Limit (dB μ V/m) at 3 m	Margin (dB)
13.180	QP	V	36.2	10.2	-29.8	16.6	80.5	63.9
13.437	QP	H	39.3	10.2	-29.8	19.7	90.5	70.8
13.684	QP	H	35.5	10.1	-29.8	15.8	90.5	74.7
13.770	QP	H	37.9	10.1	-29.8	18.2	80.5	62.3

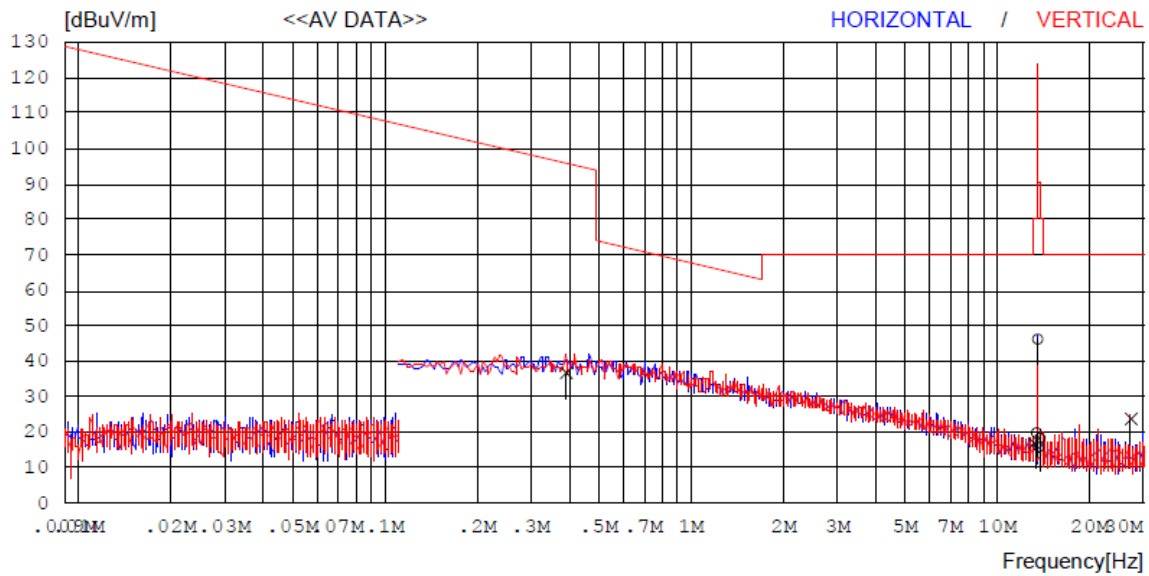
Note 1 : Limit at 3 m = Limit at 30 m - 40log(3 m/30 m)

Note 2 : Limit at 30 m = 20log(microvolts/meter)

Note 3 : Measured Distance : 3m

4.4.2.6 Test Plot_Below 30 MHz

Test mode : 13.56 MHz RFID



No.	FREQ [MHz]	READING CAV [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	13.437	39.3	10.2	0.6	30.4	19.7	90.5	70.8	100	349
2	13.561	65.8	10.2	0.6	30.4	46.2	124.0	77.8	100	194
3	13.684	35.5	10.1	0.6	30.4	15.8	90.5	74.7	100	0
4	13.770	37.9	10.1	0.6	30.4	18.2	80.5	62.3	100	16
----- Vertical -----										
5	0.390	54.8	11.5	0.2	29.9	36.6	95.8	59.2	100	0
6	13.180	36.2	10.2	0.6	30.4	16.6	80.5	63.9	100	359
7	27.124	45.3	7.8	0.7	30.3	23.5	69.5	46.0	100	0

4.4.3 Out-of-band Spurious Emission

4.4.3.1 Regulation

15.225 (d) The Field Strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in 15.209

Frequency(MHz)	Field Strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30(29.54 dBuV/m)	30
30.0-88.0	100(40.00 dBuV//m)	3
88-216	150(43.52 dBuV//m)	3
216-960	200(46.02 dBuV//m)	3
Above 960	500(53.98 dBuV /m)	3

4.4.3.2 Measurement Procedure

The spurious emissions from the EUT will be measured on an 10 m Anechoic chamber in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna.

The antenna was positioned 3, 10 or 30 meters horizontally from the EUT.

Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions.

In the case where larger measuring distances are required the results will be extrapolated based on the values measuring on the closer distances according to Section 15.31 (f) (2) [2].

The final measurement will be performed with an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 to 490 kHz where an average detector will be used according to Section 15.209 (d) [2].

The final level, expressed in dBuV/m, is arrived at by taking the reading from the EMI receiver (Level dBuV) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit. The resolution bandwidth during the measurement is as follows:

9 kHz – 150 kHz: ResBW: 200 Hz

150 kHz – 30 MHz: ResBW: 9 kHz

The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.

The EUT was placed on the top of the 0.8 meter height, 1 x 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.

The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 30 to 1 000 MHz using the BILOG antenna. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 10 m chamber. The EUT was tested at a distance 3 meters.

Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

4.4.3.3 Result

Comply (measurement data : refer to the next page)

4.4.3.4 Measurement data

Test mode : 13.56 MHz RFID

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBμV)	Ant Factor (dB)	Loss (dB)	Result (dBμV/m) at 3 m	Limit (dBμV/m) at 3 m	Margin (dB)
0.390	QP	V	54.8	11.5	-29.7	36.6	95.8	59.2
27.124	QP	V	45.3	7.8	-29.6	23.5	69.5	46.0
515.317	QP	V	40.9	18.3	-20.5	38.7	46.0	7.3

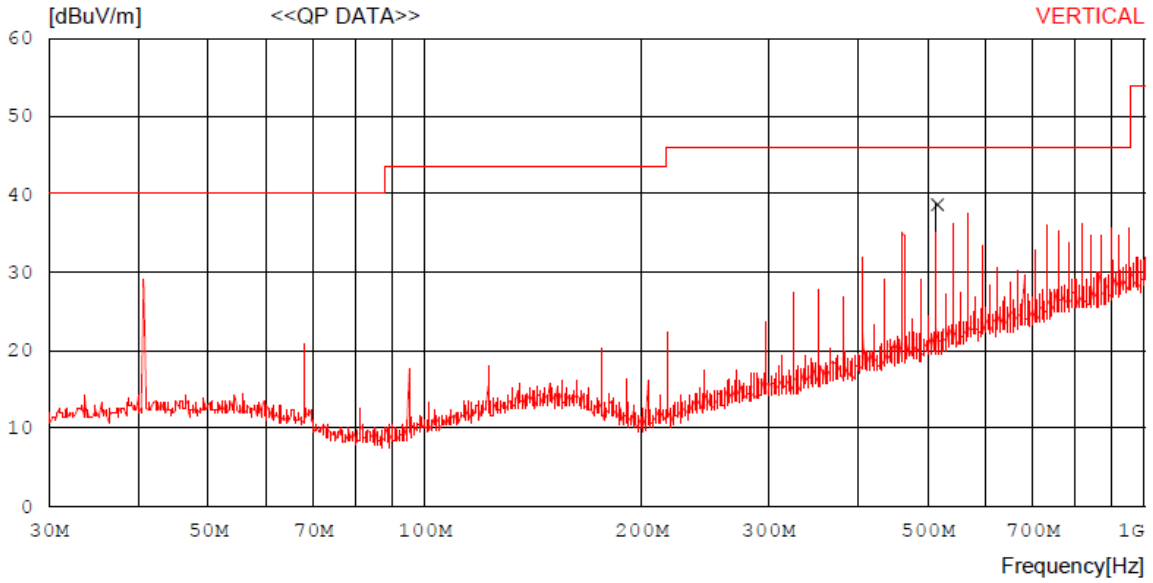
Note 1 : Limit at 3 m = Limit at 30 m - 40log(3 m/30 m)

Note 2 : Limit at 30 m = 20log(microvolts/meter)

Note 3 : Measured Distance : 3m

4.4.3.5 Test Plot

Test mode : 13.56 MHz RFID



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Vertical -----										
1	515.317	40.9	18.3	-20.5	0.0	38.7	46.0	7.3	100	225

4.4.4 Frequency Tolerance

4.4.4.1 Regulation

15.225 (e) The frequency tolerance of the carrier signal shall be maintained within ± 0.01 % of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

4.4.4.2 Result

Comply (measurement data : refer to the next page)

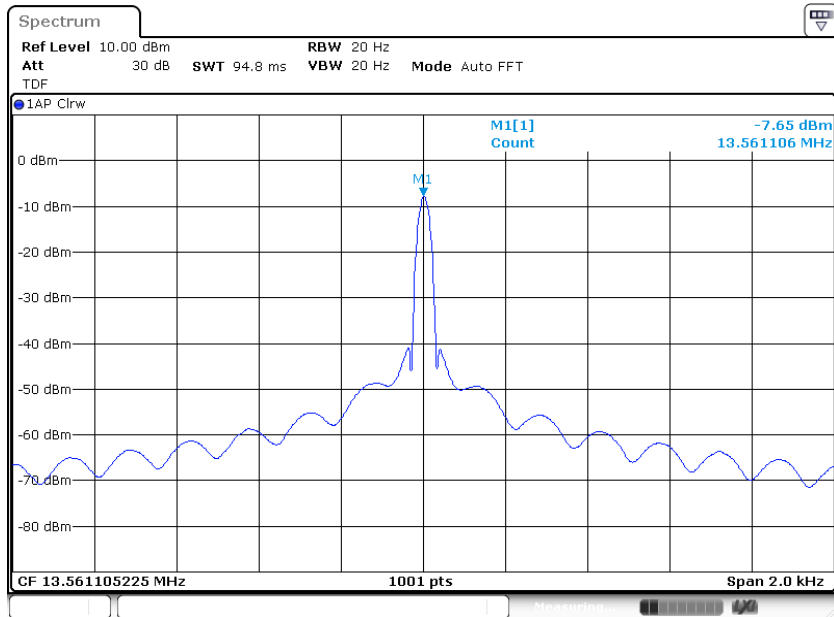
4.4.4.3 Measurement data

Test mode : 13.56 MHz RFID

Voltage (%)	Voltage (V)	Temp (°C)	Frequency (Hz)	Freq. Dev (Hz)	Deviation (%)
100	4.5	-20	13 561 182	182	0.001 342
		-10	13 561 204	204	0.001 504
		0	13 561 194	194	0.001 431
		10	13 561 169	169	0.001 246
		20	13 561 106	106	0.000 782
		30	13 561 106	106	0.000 782
		40	13 561 055	55	0.000 406
		50	13 561 035	35	0.000 258
85	4.05	20	13 561 096	96	0.000 708
Maximum Voltage	4.88	20	13 561 103	103	0.000 760

4.4.4.4 Test Plot_Normal Voltage, Temp 20 °C

Test mode : 13.56 MHz RFID



4.4.5 Emission Bandwidth

4.4.5.1 Regulation

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

4.4.5.2 Measurement Procedure

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

4.4.5.3 Result

Comply (measurement data : refer to the next page)

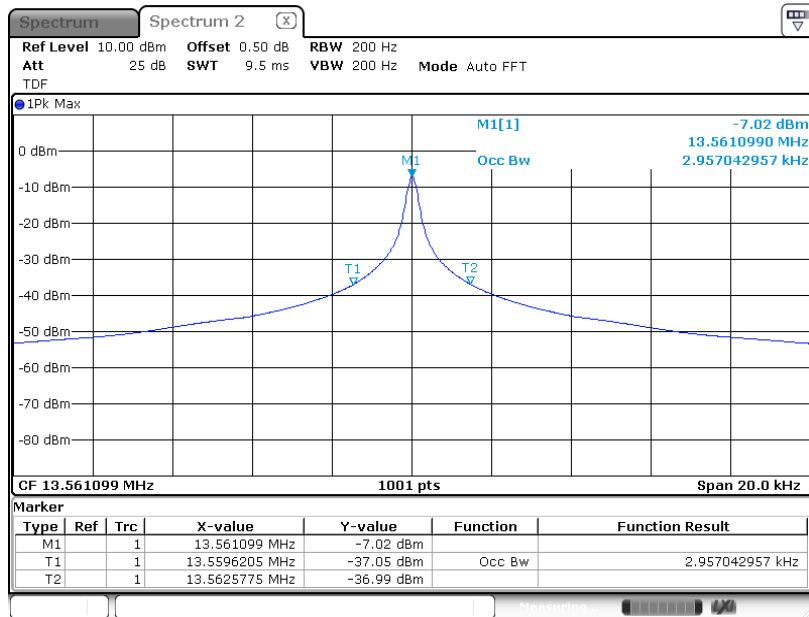
4.4.5.4 Measurement data

Test mode : 13.56 MHz RFID

Frequency (MHz)	Lowest Frequency (MHz)	Highest Frequency (MHz)	Result (kHz)
13.561	13.559 621	13.562 578	2.957

4.4.5.5 Test Plot

Test mode : 13.56 MHz RFID



4.4.6 Conducted Emission

4.4.6.1 Regulation

According to §15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Qausi-peak	Average
0.15 – 0.5	66 to 56 *	56 to 46 *
0.5 – 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

4.4.6.2 Measurement Procedure

1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5 m away from the side wall of the shielded room.

2) Each current-carrying conductor of the EUT power cord was individually connected through a 50 Ω /50 μ H LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.

3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.

4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.

5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASIPeAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

4.4.6.3 Result

Not Applicable (This device is used battery for power supplying.(DC 4.5 V(Battery))
Therefore this test item was not performed)

APPENDIX I

TEST EQUIPMENT USED FOR TESTS

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment.

Equipment	Manufacturer	Model	Serial No.	Cal. Date (yy.mm.dd)	Next Cal.Date (yy.mm.dd)
FSV Signal Analyzer	ROHDE&SCHWARZ	FSV30	103370	2017.10.17	2018.10.17
DC Power Supply	AGILENT	E3632A	MY51160055	2017.04.26	2018.04.26
Temp & Humi Test Chamber	ESPEC	SH-241	92004150	2017.04.24	2018.04.24
HUMIDITY/TEMP DATA RECORDER	LUTRON	MHB-382SD	79735	2017.04.25	2018.04.25
Digital MultiMeter	HP	34401A	US36025428	2017.01.12	2018.01.12
Signal Generator	ROHDE&SCHWARZ	SMB100A	178384	2017.10.16	2018.10.16
EMI Test Receiver	ROHDE&SCHWARZ	ESU40	100445	2016.12.16	2017.12.16
BiLog Antenna	Schwarzbeck	VULB9160	9160-3381	2017.04.11	2019.04.11
Preamplifier	TSJ	MLA-10k01-b01-27	1870369	2017.04.24	2018.04.24
Antenna Mast(10 m)	TOKIN	5977	-	-	-
Controller(10 m)	TOKIN	5909L	141909L-1	-	-
Turn Table(10 m)	TOKIN	5983-1.5	-	-	-
10 m Semi-Anechoic Chamber	SY CORPORATION	-	-	-	-
Active Loop H-Field	ETS	6502	00150598	2017.06.01	2019.06.01