




RADIO TEST REPORT

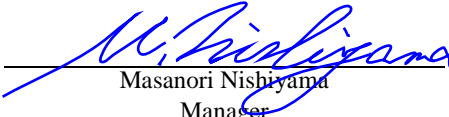
Test Report No. : 11032863M-B-R1

Applicant : TAIYO YUDEN CO., LTD.
Type of Equipment : Radio Frequency Transceiver Module (IEEE802.15.4 conformity)
Model No. : ZYSFCN
FCC ID : RYYZYSFCN
Test regulation : FCC Part 15 Subpart C: 2015
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. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
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 This test report has been replaced by the previous issued test report 11032863M-B.

Date of test: December 3, 4, 7, 2015

Representative test engineer: 
Kazuhiro Ando
Engineer
Consumer Technology Division

Approved by: 
Masanori Nishiyama
Manager
Consumer Technology Division



CERTIFICATE 1266.01

- The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
 There is no testing item of "Non-accreditation".

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Facsimile : +81-478-82-3373

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SECTION 1: Customer information

Company Name : TAIYO YUDEN CO., LTD.
Address : 8-1 Sakae-cho, Takasaki-shi, Gunma, 370-8522, Japan
Telephone Number : +81-27-324-2350
Facsimile Number : +81-27-324-2354
Contact Person : Yuji Ebinuma

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

2.1 Identification of E.U.T.

Type of Equipment : Radio Frequency Transceiver Module (IEEE802.15.4 conformity)
Model No. : ZYSFCN
Serial No. : Refer to Section 4, Clause 4.2
Rating : DC 3.0V
Receipt Date of Sample : November 11, 2015
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: ZYSFCN (referred to as the EUT in this report) is a Radio Frequency Transceiver Module (IEEE802.15.4 conformity).

General Specification

Clock frequency(ies) in the system : CPU: 32 MHz

Radio Specification

ZigBee (IEEE802.15.4)

Radio Type : Transceiver
Frequency of Operation : 2405 - 2470 MHz
Modulation : QPSK, DSSS
Power Supply (inner) : DC 1.8V
Antenna type : PCB Antenna
Antenna Gain : 2.2 dBi
Operating Temperature : -40 deg. C - +85 deg. C

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SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C: 2015, final revised on November 23, 2015
*Some parts are effective on and after December 17, 2015 or December 23, 2015. The revision does not affect the test specification applied to the EUT.

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
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	QP 35.6 dB, 21.74810 MHz, L AV 29.6 dB, 21.74810 MHz, L	Complied	-
6dB Bandwidth	FCC: KDB 558074 D01 DTS Meas Guidance v03r04 IC: -	FCC: Section 15.247(a)(2) IC: RSS-247 5.2(1)	See data.	Complied	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 DTS Meas Guidance v03r04 IC: RSS-Gen 6.12	FCC: Section 15.247(b)(3) IC: RSS-247 5.4(4)		Complied	Conducted
Power Density	FCC: KDB 558074 D01 DTS Meas Guidance v03r04 IC: -	FCC: Section 15.247(e) IC: RSS-247 5.2(2)		Complied	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 DTS Meas Guidance v03r04 IC: RSS-Gen 6.13	FCC: Section 15.247(d) IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	1.7 dB 7410.000 MHz, AV, Vertical	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *1)

Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.
*1) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 DTS Meas Guidance v03r04 12.2.7.

* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

FCC Part 15.31 (e)

This EUT provides stable voltage (DC 1.8V) constantly to RF Module regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC Part 15.203/212 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 15.203/212.

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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: -	N/A	-	Conducted

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 $k = 2$.

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Item	Frequency range	Uncertainty (+/-)
Conducted emission	0.15MHz - 30MHz	2.8dB
Radiated emission (Measurement distance: 3m)	30MHz - 300MHz	4.7dB
	300MHz - 1GHz	3.6dB
	1GHz - 13GHz	5.1dB
Radiated emission (Measurement distance: 1m)	13GHz - 18GHz	5.7dB
	18GHz - 26.5GHz	5.1dB

Antenna terminal test	Uncertainty (+/-)
Power Measurement above 1GHz	0.7dB
Spurious emission (Conducted) below 1GHz	1.6dB
Spurious emission (Conducted) 1GHz - 3GHz	1.4dB
Spurious emission (Conducted) 3GHz - 18GHz	2.8dB
Spurious emission (Conducted) 18GHz - 26.5GHz	2.5dB
Bandwidth Measurement	5.4%

Conducted Emission test

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

Radiated emission test

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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Kashima EMC Lab.
1614 Mushihata, Katori-shi, Chiba-ken, 289-0341 JAPAN
Telephone number : +81 478 88 6500
Facsimile number : +81 478 82 3373
A2LA Accreditation No. : 1266-01

	FCC Registration No.	IC Registration No.	Width x Depth x Height (m)	Size of reference ground plane/horizontal conducting plane (m)	Maximum measurement distance
No.1 Open site	90558	IC 4659A-1	6.0 x 5.5 x 2.5	20 x 40	10 m
No.2 Open site	510504	IC 4659A-2	4.4 x 4.4 x 2.15	18 x 20	10 m
No.5 Open site	99356	IC 4659A-5	8.6 x 7.1 x 2.4	18 x 23	10 m
No.1 Shielded room	90558	IC 4659A-1	5.4 x 4.5 x 2.3	-	-
No.2 Shielded room	510504	IC 4659A-2	3.6 x 2.7 x 2.3	-	-
No.3 Shielded room	-	-	5.4 x 3.6 x 2.3	-	-
No.4 Shielded Room	-	-	6.1 x 6.1 x 3.1	-	-
No.5 Shielded Room	99356	IC 4659A-5	4.2 x 3.1 x 2.5	-	-
No.3 Fully Anechoic Chamber	-	-	7.0 x 3.5 x 3.5	-	-
No.6 Semi-anechoic Chamber	372431	IC 4659A-6	8.5 x 5.5 x 5.2	-	3 m
No.10 Semi-anechoic Chamber	682397	IC 4659A-10	18.4 x 9.9 x 7.7	-	10 m
No.11 Semi-anechoic Chamber	718605	IC 4659A-7	9.0 x 6.5 x 5.2	-	3 m
No.1 Measurement room	-	-	5.0 x 3.7 x 2.6	-	-
No.2 Measurement room	-	-	4.3 x 4.4 x 2.7	-	-
No.3 Measurement room	-	-	4.5 x 5.3 x 2.7	-	-

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 Mode(s)

Test Item	Operating Mode	Tested frequency
Conducted Emission	Transmitting (Tx), IEEE 802.15.4, QPSK	2405 MHz 2440 MHz 2470 MHz
Spurious Emission	Transmitting (Tx), IEEE 802.15.4, QPSK	2405 MHz 2440 MHz 2470 MHz
6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth	Transmitting (Tx), IEEE 802.15.4, QPSK	2405 MHz 2440 MHz 2470 MHz
<p>*Transmitting duty was 100 % on all tests. *EUT has the power settings by the software as follows; - Power Setting: 3 - Software: Tera Term Version 4.88 This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.</p>		

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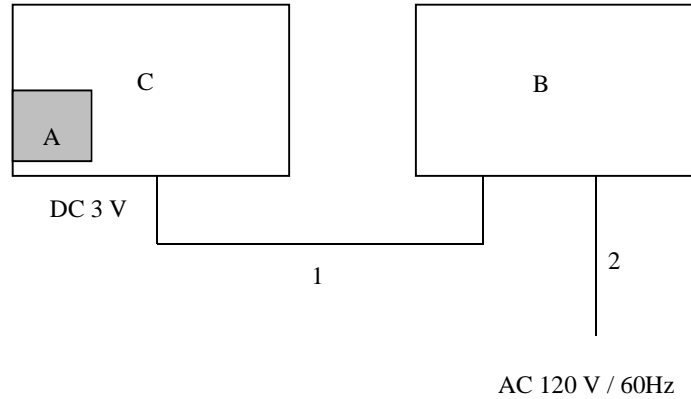
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4.2 Configuration and peripherals



* Cabling and setup(s) 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	Radio Frequency Transceiver Module	ZYSFCN	00158D0000953670 *1) 00158D0000951D82 *2)	TAIYO YUDEN	EUT
B	DC Power Supply	GSV3000	60645741	DIAMOND ANTENNA	-
C	Jig board	-	-	-	-

*1) Used for Antenna Terminal conducted test

*2) Used for Conducted Emission test and Radiated Emission test

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	2.3	Unshielded	Unshielded	-
2	AC Cable	1.7	Unshielded	Unshielded	-

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SECTION 5: Conducted Emission

Test Procedure and conditions

EUT was placed on a wooden table of nominal size, 1.0 m by 2.0 m, raised 0.8 m above the conducting ground plane. The rear of tabletop was located 40 cm to the vertical conducting plane. The rear of EUT, including peripherals aligned and flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. EUT was located 80 cm from a Line Impedance Stabilization Network (LISN) / Artificial mains Network (AMN) and excess AC cable was bundled in center.

For the tests on EUT with other peripherals (as a whole system)

I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane. All unused 50ohm connectors of the LISN (AMN) were resistivity terminated in 50 ohm when not connected to the measuring equipment.

The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Shielded room. The EUT was connected to a LISN (AMN).
An overview sweep with peak detection has been performed.

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

Detector : QP and CISPR AV
Measurement range : 0.15 MHz – 30 MHz
Test data : APPENDIX
Test result : Pass

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SECTION 6: Radiated Spurious Emission

Test Procedure

It was measured based on "11.0 Emissions in non-restricted frequency bands" of "558074 D01 DTS Meas Guidance v03r04".

[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.

The height of the measuring antenna 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 with the Test Receiver, or the Spectrum Analyzer.

The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).

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	30 MHz to 1 GHz	Above 1 GHz
Antenna Type	Hybrid	Horn

In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.

20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(IC) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (IC).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *3)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	Average Power Method: <u>12.2.5.1</u> RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces	RBW: 100 kHz VBW: 300kHz
Test Distance	3m	4.5 m *1) (below 10 GHz), 1 m *2) (above 10 GHz)		3 m (below 10 GHz), 1 m *2) (above 10 GHz)

*1) Distance Factor: $20 \times \log(3.0 \text{ m} / 4.5 \text{ m}) = -3.5 \text{ dB}$

*2) Distance Factor: $20 \times \log(3.0 \text{ m} / 1.0 \text{ m}) = 9.5 \text{ dB}$

*3) Average Power Measurement was performed based on 6.0 & 12.2.5 of "KDB 558074 D01 DTS Meas Guidance v03r04"

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- 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 : 30 M - 26 GHz
Test data : APPENDIX
Test result : Pass

SECTION 7: Antenna Terminal Conducted Tests

Test Procedure

The tests were made with below setting connected to the antenna port.

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument used
6dB Bandwidth	10 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/Average *2)	-	Power Meter (Sensor: 160 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *3)
Conducted Spurious Emission *4)	9kHz to 150kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	10 kHz	30 kHz				
*1) Peak hold was applied as Worst-case measurement. *2) Reference data *3) Section 10.2 Method PKPSD (peak PSD) of "KDB 558074 D01 DTS Meas Guidance v03r04". *4) In the frequency range below 30MHz, RBW was narrowed to separate the noise contents. Then, wide-band noise near the limit was checked separately, however the noise was not detected as shown in the chart. (9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 9.1 kHz)							

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

Test data : APPENDIX
Test result : Pass

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APPENDIX 1: Test data

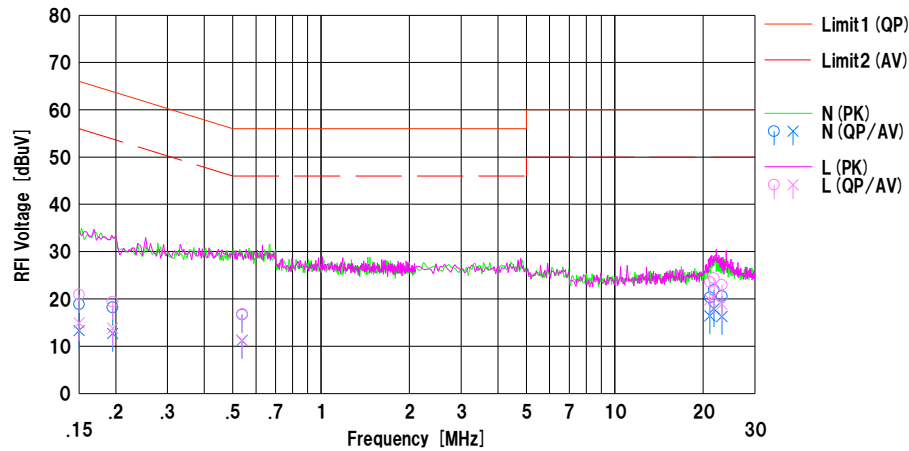
Conducted Emission

UL Japan, Inc. Kashima EMC Lab, No.5 Shielded Room
Date : 2015/12/07

Company : TAIYO YUDEN CO., LTD.
Kind of EUT : Radio Frequency Transceiver Module
Model No. : ZYSFCN
Serial No. : 00158D0000951D82
Remarks :
Mode : Tx, IEEE802.15.4, 2405MHz
Order No. : 11032863M-C
Power : DC 3V (AC 120V / 60Hz)
Temp./Humi. : 22deg.C. / 41%RH

Limit1 : FCC 15C (15.207) QP
Limit2 : FCC 15C (15.207) AV

Tested by : Kazuhiro Ando

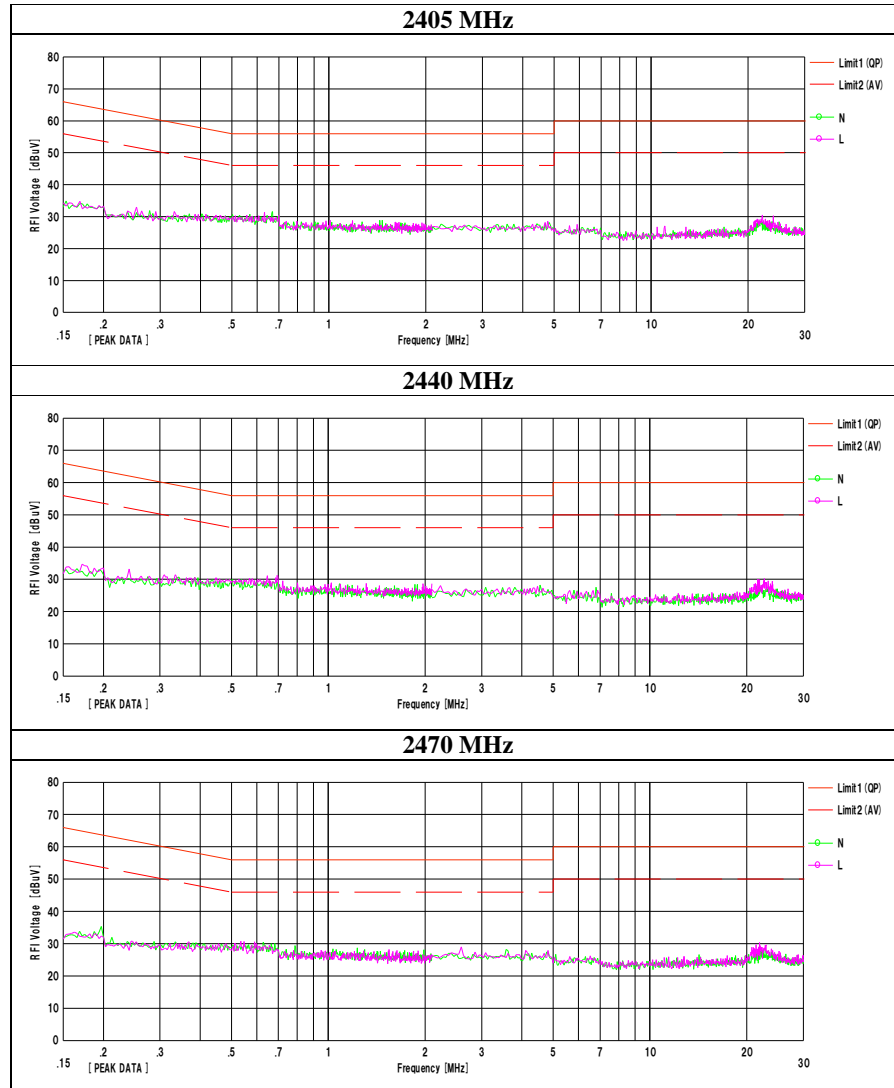


No.	Freq. [MHz]	Reading		C.Fac [dB]	Results		Limit		Margin		Phase	Comment
		<QP> [dBuV]	<AV> [dBuV]		<QP> [dBuV]	<AV> [dBuV]	<QP> [dBuV]	<AV> [dBuV]	<QP> [dB]	<AV> [dB]		
1	0.15000	8.7	3.1	10.2	18.9	13.3	66.0	56.0	47.1	42.7	N	
2	0.19508	8.0	2.5	10.2	18.2	12.7	63.8	53.8	45.6	41.1	N	
3	0.53852	6.5	1.0	10.2	16.7	11.2	56.0	46.0	39.3	34.8	N	
4	21.08500	8.5	4.6	11.8	20.3	16.4	60.0	50.0	39.7	33.6	N	
5	21.74810	10.1	6.1	11.8	21.9	17.9	60.0	50.0	38.1	32.1	N	
6	23.14560	8.6	4.3	12.0	20.6	16.3	60.0	50.0	39.4	33.7	N	
7	0.15000	10.7	4.7	10.2	20.9	14.9	66.0	56.0	45.1	41.1	L	
8	0.19508	9.2	3.6	10.2	19.4	13.8	63.8	53.8	44.4	40.0	L	
9	0.53852	6.6	1.1	10.2	16.8	11.3	56.0	46.0	39.2	34.7	L	
10	21.08500	11.8	8.0	11.8	23.6	19.8	60.0	50.0	36.4	30.2	L	
11	21.74810	12.6	8.6	11.8	24.4	20.4	60.0	50.0	35.6	29.6	L	
12	23.14560	11.0	6.9	12.0	23.0	18.9	60.0	50.0	37.0	31.1	L	

Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]
LISN:CLS-11

Conducted Emission

Test place : Kashima EMC Lab. No.5 Shield Room
Report No. : 11032863M-B-R1
Date : December 7, 2015
Temperature / Humidity : 22 deg. C / 41 % RH
Engineer : Kazuhiro Ando
Mode : Tx, IEEE802.15.4, QPSK



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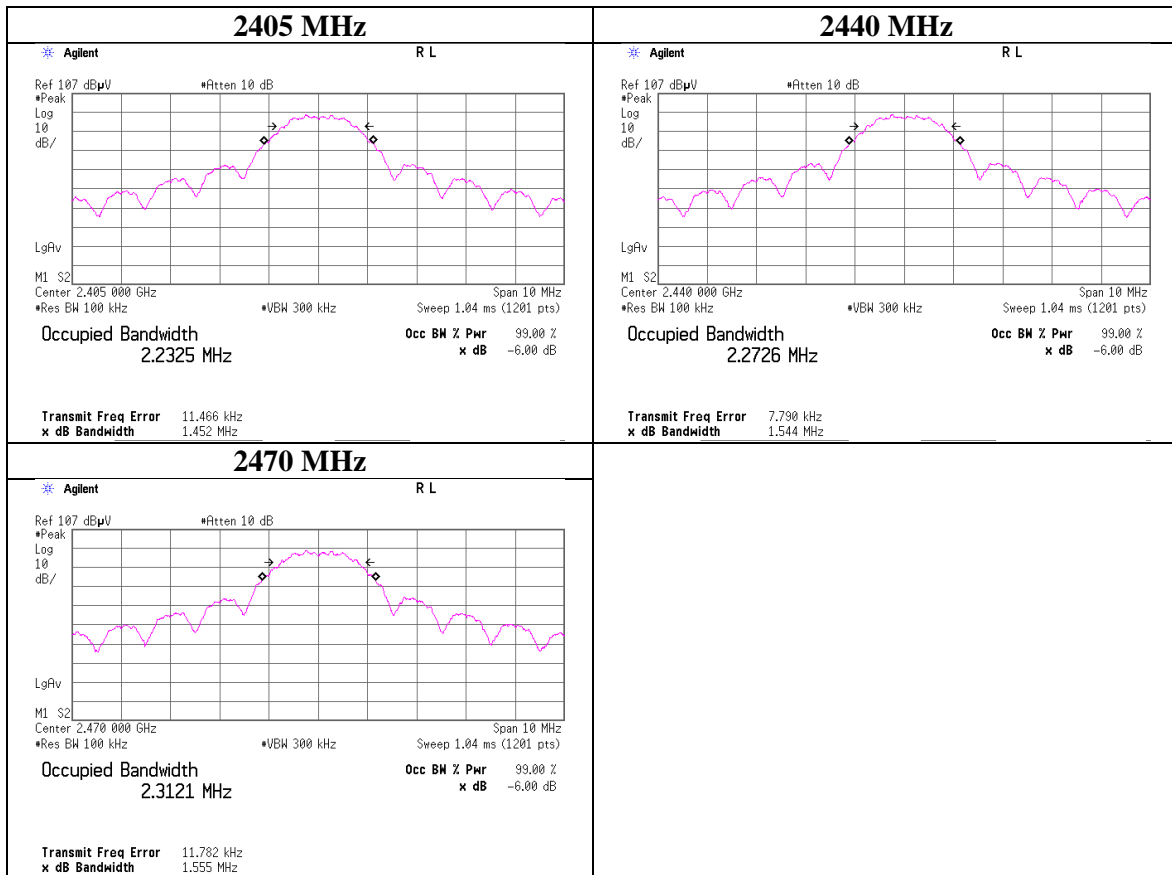
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6dB Bandwidth / 99% Occupied Bandwidth

Test place	Kashima EMC Lab. No.2 Measurement Room
Report No.	11032863M-B-R1
Date	December 7, 2015
Temperature / Humidity	20 deg. C / 38 % RH
Engineer	Kazuhiro Ando
Mode	Tx, IEEE802.15.4, QPSK

Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
2405	1.452	> 500
2440	1.544	> 500
2470	1.555	> 500



Maximum Peak Output Power

Test place Kashima EMC Lab. No.2 Measurement Room
Report No. 11032863M-B-R1
Date December 7, 2015
Temperature / Humidity 20 deg. C / 38 % RH
Engineer Kazuhiro Ando
Mode Tx, IEEE802.15.4, QPSK

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]	
2405	-9.07	1.72	10.03	2.68	1.85	30.00	1000	27.32
2440	-8.79	1.73	10.03	2.97	1.98	30.00	1000	27.03
2470	-8.54	1.73	10.03	3.22	2.10	30.00	1000	26.78

Sample Calculation:

Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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Average Output Power (Reference data)

Test place Kashima EMC Lab. No.2 Measurement Room
Report No. 11032863M-B-R1
Date December 7, 2015
Temperature / Humidity 20 deg. C / 38 % RH
Engineer Kazuhiro Ando
Mode Tx, IEEE802.15.4, QPSK

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Frame power)		Duty factor [dB]	Result (Burst power)	
				[dBm]	[mW]		[dBm]	[mW]
2405	-9.40	1.72	10.03	2.35	1.72	0.00	2.35	1.72
2440	-9.11	1.73	10.03	2.65	1.84	0.00	2.65	1.84
2470	-8.84	1.73	10.03	2.92	1.96	0.00	2.92	1.96

Sample Calculation:

Result (Frame power) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

Result (Burst power) = Frame power + Duty factor

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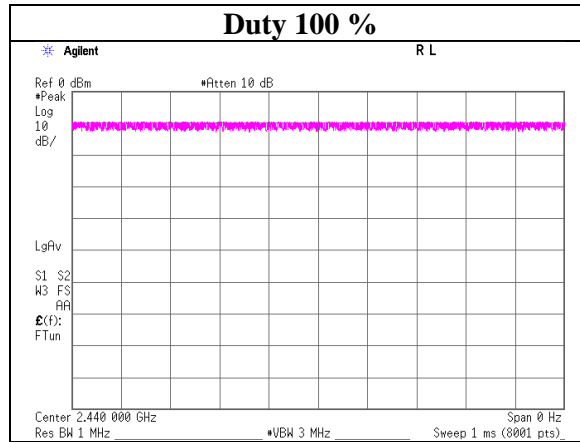
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Burst rate confirmation

Test place Kashima EMC Lab. No.2 Measurement Room
Report No. 11032863M-B-R1
Date December 7, 2015
Temperature / Humidity 20 deg. C / 38 % RH
Engineer Kazuhiro Ando
Mode Tx, IEEE802.15.4, QPSK



UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81-478-88-6500

Facsimile : +81-478-82-3373

Radiated Spurious Emission

Test place : Kashima EMC Lab. No.10 Semi Anechoic Chamber
Report No. : 11032863M-B-R1
Date : December 4, 2015 December 3, 2015
Temperature / Humidity : 21 deg. C / 40 % RH 22 deg. C / 41 % RH
Engineer : Kazuhiro Ando Kazuhiro Ando
(30-1000MHz) (1-26GHz)
Mode : Tx, IEEE802.15.4, 2405 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	D.Fac [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2372.920	PK	44.7	27.7	13.9	38.3	-3.5	51.5	73.9	22.4	153	110	
Hori.	2390.000	PK	43.8	27.6	13.9	38.3	-3.5	50.5	73.9	23.4	186	211	
Hori.	4810.000	PK	54.3	31.3	6.2	39.3	-3.5	56.0	73.9	17.9	136	10	
Hori.	7215.000	PK	47.2	36.3	7.7	38.4	-3.5	56.3	73.9	17.6	107	46	
Hori.	9620.000	PK	40.8	39.1	8.7	37.0	-3.5	55.1	73.9	18.8	150	0	Floor Noise
Hori.	2372.920	AV	34.3	27.7	13.9	38.3	-3.5	41.1	53.9	12.8	153	110	
Hori.	2390.000	AV	31.8	27.6	13.9	38.3	-3.5	38.5	53.9	15.4	186	211	
Hori.	4810.000	AV	49.2	31.3	6.2	39.3	-3.5	50.9	53.9	3.0	136	10	
Hori.	7215.000	AV	37.7	36.3	7.7	38.4	-3.5	46.8	53.9	7.1	107	46	
Hori.	9620.000	AV	30.4	39.1	8.7	37.0	-3.5	44.7	53.9	9.2	150	0	Floor Noise
Vert.	32.000	QP	20.8	12.7	4.2	26.9	0.0	10.8	40.0	29.2	100	0	Floor Noise
Vert.	64.000	QP	20.7	12.5	4.8	26.8	0.0	11.2	40.0	28.8	100	0	Floor Noise
Vert.	96.000	QP	20.3	8.4	5.2	26.7	0.0	7.2	43.5	36.3	100	0	Floor Noise
Vert.	128.000	QP	20.0	12.2	5.6	26.6	0.0	11.2	43.5	32.3	100	0	Floor Noise
Vert.	2390.000	PK	43.4	27.6	13.9	38.3	-3.5	50.1	73.9	23.8	150	98	
Vert.	4810.000	PK	47.3	31.3	6.2	39.3	-3.5	49.0	73.9	24.9	137	41	
Vert.	7215.000	PK	49.1	36.3	7.7	38.4	-3.5	58.2	73.9	15.7	162	90	
Vert.	9620.000	PK	40.7	39.1	8.7	37.0	-3.5	55.0	73.9	18.9	150	0	Floor Noise
Vert.	2390.000	AV	32.8	27.6	13.9	38.3	-3.5	39.5	53.9	14.4	150	98	
Vert.	4810.000	AV	38.8	31.3	6.2	39.3	-3.5	40.5	53.9	13.4	137	41	
Vert.	7215.000	AV	40.8	36.3	7.7	38.4	-3.5	49.9	53.9	4.0	162	90	
Vert.	9620.000	AV	30.6	39.1	8.7	37.0	-3.5	44.9	53.9	9.0	150	0	Floor Noise

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 1GHz) - Gain(Amplifier)

Distance factor : 1GHz - 10GHz : 20log(3.0m/4.5m)= -3.5dB

Distance factor : 10GHz - 26GHz : 20log(3.0m/1.0m)= 9.5dB

20dBc Data Sheet (RBW 100kHz, VBW 300kHz)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	D.Fac [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2405.000	PK	85.8	27.6	14.0	38.3	-3.5	92.6	-	-	Carrier
Hori.	2400.000	PK	42.4	27.6	13.9	38.3	-3.5	49.1	72.6	23.5	
Vert.	2405.000	PK	80.0	27.6	14.0	38.3	-3.5	86.8	-	-	Carrier
Vert.	2400.000	PK	37.8	27.6	13.9	38.3	-3.5	44.5	66.8	22.3	

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 1GHz) - Gain(Amplifier)

Distance factor : 1GHz - 10GHz : 20log(3.0m/4.5m)= -3.5dB

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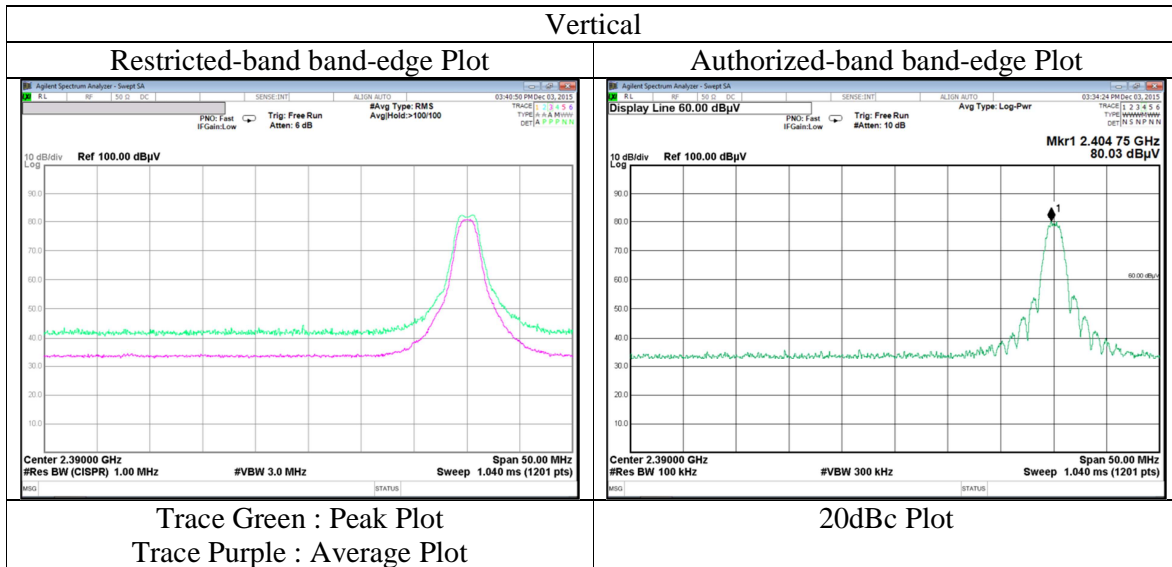
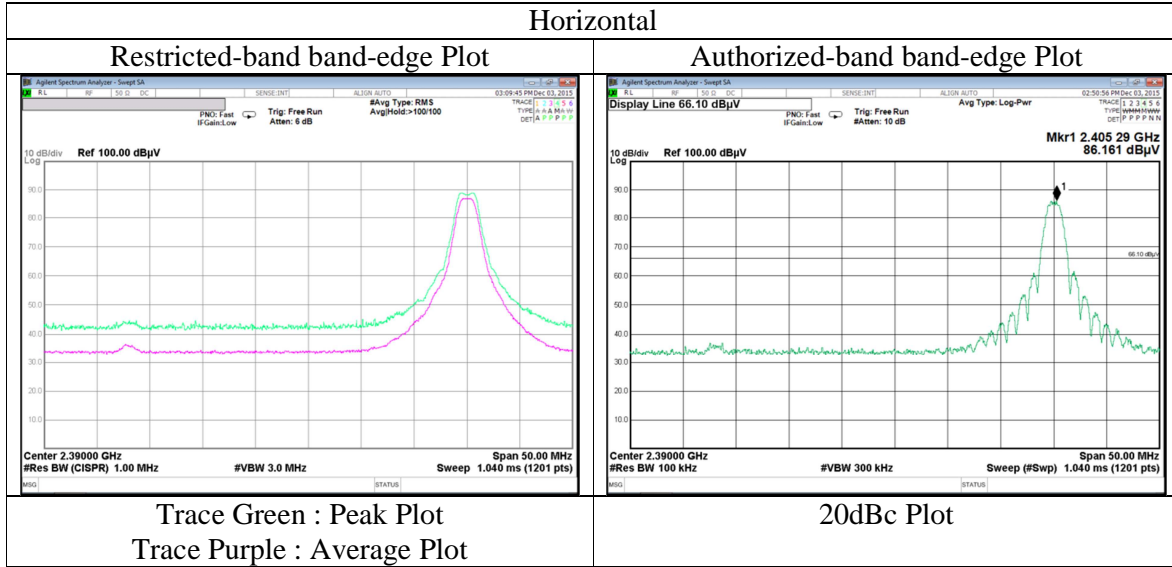
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Telephone : +81-478-88-6500

Facsimile : +81-478-82-3373

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Kashima EMC Lab. No.10 Semi Anechoic Chamber
Report No.	11032863M-B-R1
Date	December 3, 2015
Temperature / Humidity	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando
	(1-26GHz)
Mode	Tx, IEEE802.15.4, 2405 MHz



* Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission

Test place : Kashima EMC Lab. No.10 Semi Anechoic Chamber
 Report No. : 11032863M-B-R1
 Date : December 4, 2015 December 3, 2015
 Temperature / Humidity : 21 deg. C / 40 % RH 22 deg. C / 41 % RH
 Engineer : Kazuhiro Ando Kazuhiro Ando
 (30-1000MHz) (1-26GHz)
 Mode : Tx, IEEE802.15.4, 2440 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	D.Fac [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	4880.000	PK	56.0	31.2	6.4	39.3	-3.5	57.8	73.9	16.1	152	5	
Hori.	7320.000	PK	43.0	36.4	7.8	38.4	-3.5	52.3	73.9	21.6	117	23	
Hori.	9760.000	PK	40.8	39.5	8.8	36.9	-3.5	55.7	73.9	18.2	150	0	Floor Noise
Hori.	4880.000	AV	50.1	31.2	6.4	39.3	-3.5	51.9	53.9	2.0	152	5	
Hori.	7320.000	AV	33.9	36.4	7.8	38.4	-3.5	43.2	53.9	10.7	117	23	
Hori.	9760.000	AV	30.4	39.5	8.8	36.9	-3.5	45.3	53.9	8.6	150	0	Floor Noise
Vert.	32.000	QP	20.9	12.7	4.2	26.9	0.0	10.9	40.0	29.1	100	0	Floor Noise
Vert.	64.000	QP	20.7	12.5	4.8	26.8	0.0	11.2	40.0	28.8	100	0	Floor Noise
Vert.	96.000	QP	20.2	8.4	5.2	26.7	0.0	7.1	43.5	36.4	100	0	Floor Noise
Vert.	128.000	QP	20.0	12.2	5.6	26.6	0.0	11.2	43.5	32.3	100	0	Floor Noise
Vert.	4880.000	PK	48.9	31.2	6.4	39.3	-3.5	50.7	73.9	23.2	126	26	
Vert.	7320.000	PK	46.1	36.4	7.8	38.4	-3.5	55.4	73.9	18.5	155	95	
Vert.	9760.000	PK	40.7	39.5	8.8	36.9	-3.5	55.6	73.9	18.3	150	0	Floor Noise
Vert.	4880.000	AV	40.8	31.2	6.4	39.3	-3.5	42.6	53.9	11.3	126	26	
Vert.	7320.000	AV	37.4	36.4	7.8	38.4	-3.5	46.7	53.9	7.2	155	95	
Vert.	9760.000	AV	30.3	39.5	8.8	36.9	-3.5	45.2	53.9	8.7	150	0	Floor Noise

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 1GHz) - Gain(Amplifier)

Distance factor : 1GHz - 10GHz : $20\log(3.0\text{m}/4.5\text{m}) = -3.5\text{dB}$

Distance factor : 10GHz - 26GHz : $20\log(3.0\text{m}/1.0\text{m}) = 9.5\text{dB}$

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Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

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Radiated Spurious Emission

Test place : Kashima EMC Lab. No.10 Semi Anechoic Chamber
Report No. : 11032863M-B-R1
Date : December 4, 2015 December 3, 2015
Temperature / Humidity : 21 deg. C / 40 % RH 22 deg. C / 41 % RH
Engineer : Kazuhiro Ando Kazuhiro Ando
(30-1000MHz) (1-26GHz)
Mode : Tx, IEEE802.15.4, 2470 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	D.Fac [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2483.500	PK	44.1	27.5	14.0	38.4	-3.5	50.7	73.9	23.2	176	105	
Hori.	2501.750	PK	44.5	27.5	14.0	38.4	-3.5	51.1	73.9	22.8	170	107	
Hori.	4940.000	PK	55.3	31.3	6.4	39.3	-3.5	57.2	73.9	16.7	135	0	
Hori.	7410.000	PK	47.8	36.7	7.8	38.3	-3.5	57.5	73.9	16.4	110	38	
Hori.	9880.000	PK	41.8	39.6	8.8	36.8	-3.5	56.9	73.9	17.0	150	0	Floor Noise
Hori.	2483.500	AV	31.9	27.5	14.0	38.4	-3.5	38.5	53.9	15.4	176	105	
Hori.	2501.750	AV	34.5	27.5	14.0	38.4	-3.5	41.1	53.9	12.8	170	107	
Hori.	4940.000	AV	49.8	31.3	6.4	39.3	-3.5	51.7	53.9	2.2	135	0	
Hori.	7410.000	AV	38.3	36.7	7.8	38.3	-3.5	48.0	53.9	5.9	110	38	
Hori.	9880.000	AV	30.7	39.6	8.8	36.8	-3.5	45.8	53.9	8.1	150	0	Floor Noise
Vert.	32.000	QP	21.0	12.7	4.2	26.9	0.0	11.0	40.0	29.0	100	0	Floor Noise
Vert.	64.000	QP	20.9	12.5	4.8	26.8	0.0	11.4	40.0	28.6	100	0	Floor Noise
Vert.	96.000	QP	20.3	8.4	5.2	26.7	0.0	7.2	43.5	36.3	100	0	Floor Noise
Vert.	128.000	QP	20.0	12.2	5.6	26.6	0.0	11.2	43.5	32.3	100	0	Floor Noise
Vert.	2483.500	PK	43.5	27.5	14.0	38.4	-3.5	50.1	73.9	23.8	100	12	
Vert.	4940.000	PK	48.8	31.3	6.4	39.3	-3.5	50.7	73.9	23.2	142	24	
Vert.	7410.000	PK	49.5	36.7	7.8	38.3	-3.5	59.2	73.9	14.7	150	103	
Vert.	9880.000	PK	42.0	39.6	8.8	36.8	-3.5	57.1	73.9	16.8	150	0	Floor Noise
Vert.	2483.500	AV	31.5	27.5	14.0	38.4	-3.5	38.1	53.9	15.8	100	12	
Vert.	4940.000	AV	41.1	31.3	6.4	39.3	-3.5	43.0	53.9	10.9	142	24	
Vert.	7410.000	AV	42.5	36.7	7.8	38.3	-3.5	52.2	53.9	1.7	150	103	
Vert.	9880.000	AV	30.6	39.6	8.8	36.8	-3.5	45.7	53.9	8.2	150	0	Floor Noise

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 1GHz) - Gain(Amplifier)

Distance factor : 1GHz - 10GHz : $20\log(3.0m/4.5m) = -3.5dB$

Distance factor : 10GHz - 26GHz : $20\log(3.0m/1.0m) = 9.5dB$

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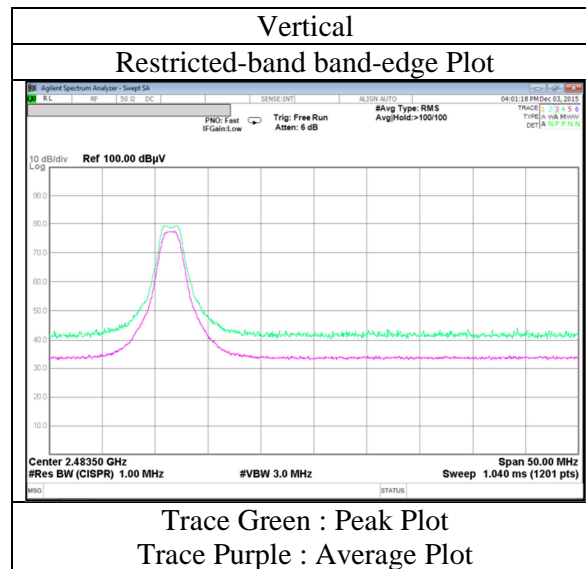
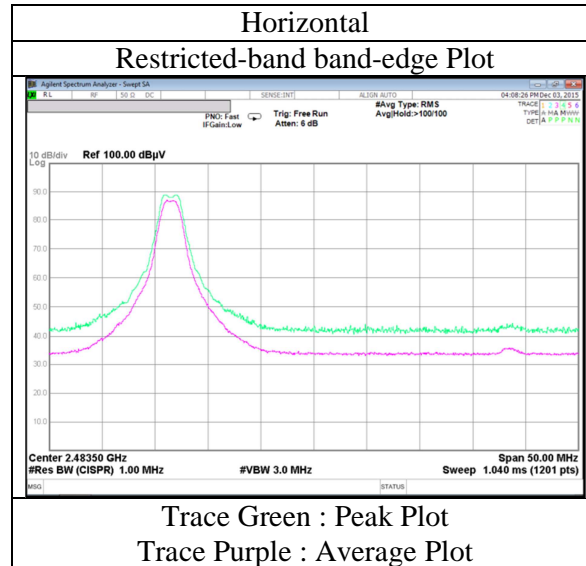
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Radiated Spurious Emission (Reference Plot for band-edge)

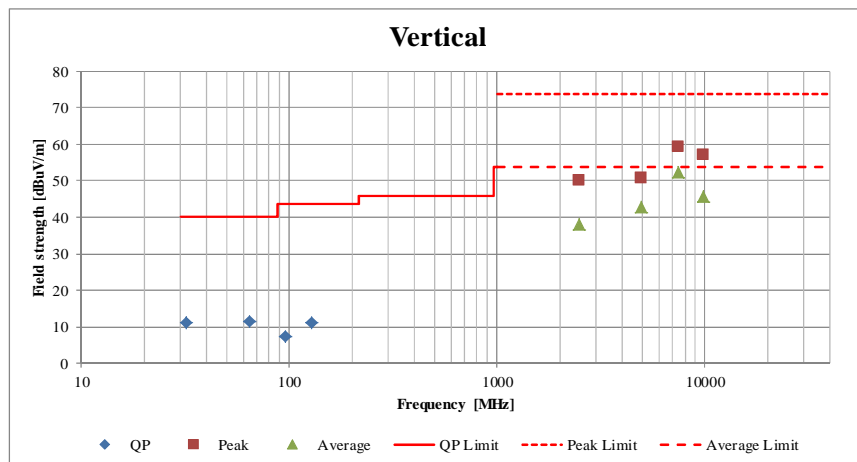
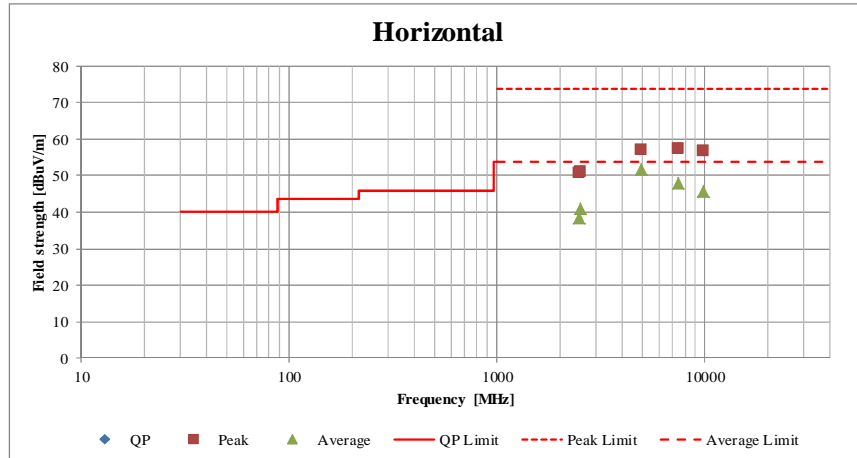
Test place	Kashima EMC Lab. No.10 Semi Anechoic Chamber
Report No.	11032863M-B-R1
Date	December 3, 2015
Temperature / Humidity	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando
	(1-26GHz)
Mode	Tx, IEEE802.15.4, 2470 MHz



* Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission (Plot data, Worst case)

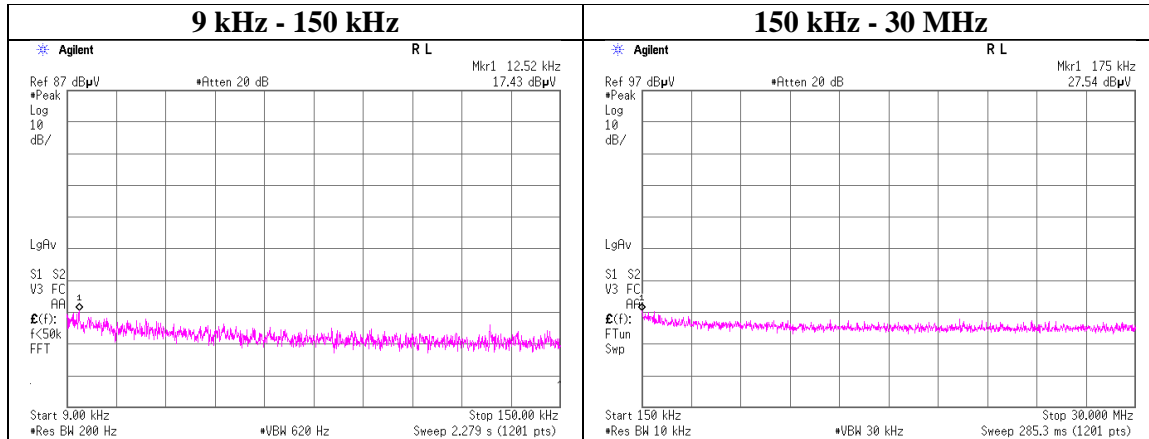
Test place	Kashima EMC Lab. No.10 Semi Anechoic Chamber	
Report No.	11032863M-B-R1	
Date	December 4, 2015	December 3, 2015
Temperature / Humidity	21 deg. C / 40 % RH	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando	Kazuhiro Ando
	(30-1000MHz)	(1-26GHz)
Mode	Tx, IEEE802.15.4, 2470 MHz	



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

Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Report No.	11032863M-B-R1
Date	December 7, 2015
Temperature / Humidity	20 deg. C / 38 % RH
Engineer	Kazuhiro Ando
Mode	Tx, IEEE802.15.4, QPSK, 2405MHz



Frequency [kHz]	Reading [dBuV]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
12.52	17.43	0.19	9.97	2.2	1	-77.2	300	6.0	-16.0	45.6	61.6	
175.00	27.54	0.19	9.97	2.2	1	-67.1	300	6.0	-5.8	22.7	28.5	

$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

$\text{EIRP} = (\text{Reading} - 107) + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$

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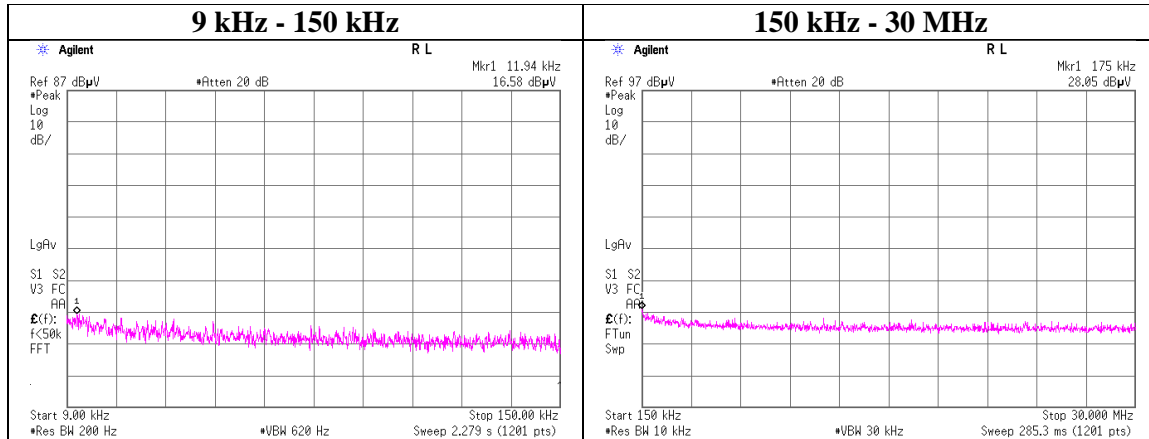
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Facsimile : +81-478-82-3373

Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Report No.	11032863M-B-R1
Date	December 7, 2015
Temperature / Humidity	20 deg. C / 38 % RH
Engineer	Kazuhiro Ando
Mode	Tx, IEEE802.15.4, QPSK, 2440MHz



Frequency [kHz]	Reading [dBuV]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
11.94	16.58	0.19	9.97	2.2	1	-78.1	300	6.0	-16.8	46.0	62.8	
175.00	28.05	0.19	9.97	2.2	1	-66.6	300	6.0	-5.3	22.7	28.0	

$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

$\text{EIRP} = (\text{Reading} - 107) + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$

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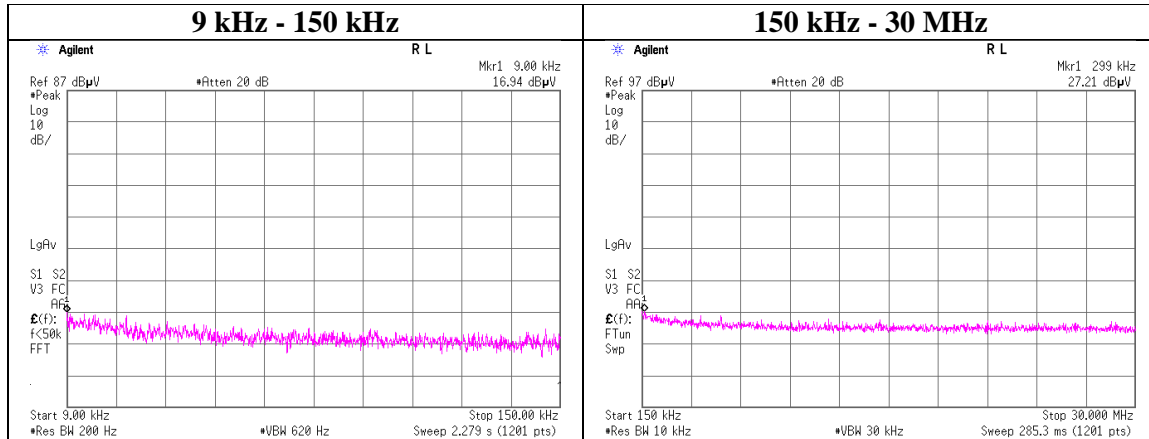
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Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Report No.	11032863M-B-R1
Date	December 7, 2015
Temperature / Humidity	20 deg. C / 38 % RH
Engineer	Kazuhiro Ando
Mode	Tx, IEEE802.15.4, QPSK, 2470MHz



Frequency [kHz]	Reading [dBuV]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
9.00	16.94	0.19	9.97	2.2	1	-77.7	300	6.0	-16.4	48.5	64.9	
299.00	27.21	0.19	9.97	2.2	1	-67.4	300	6.0	-6.2	18.0	24.2	

$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

$\text{EIRP} = (\text{Reading} - 107) + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$

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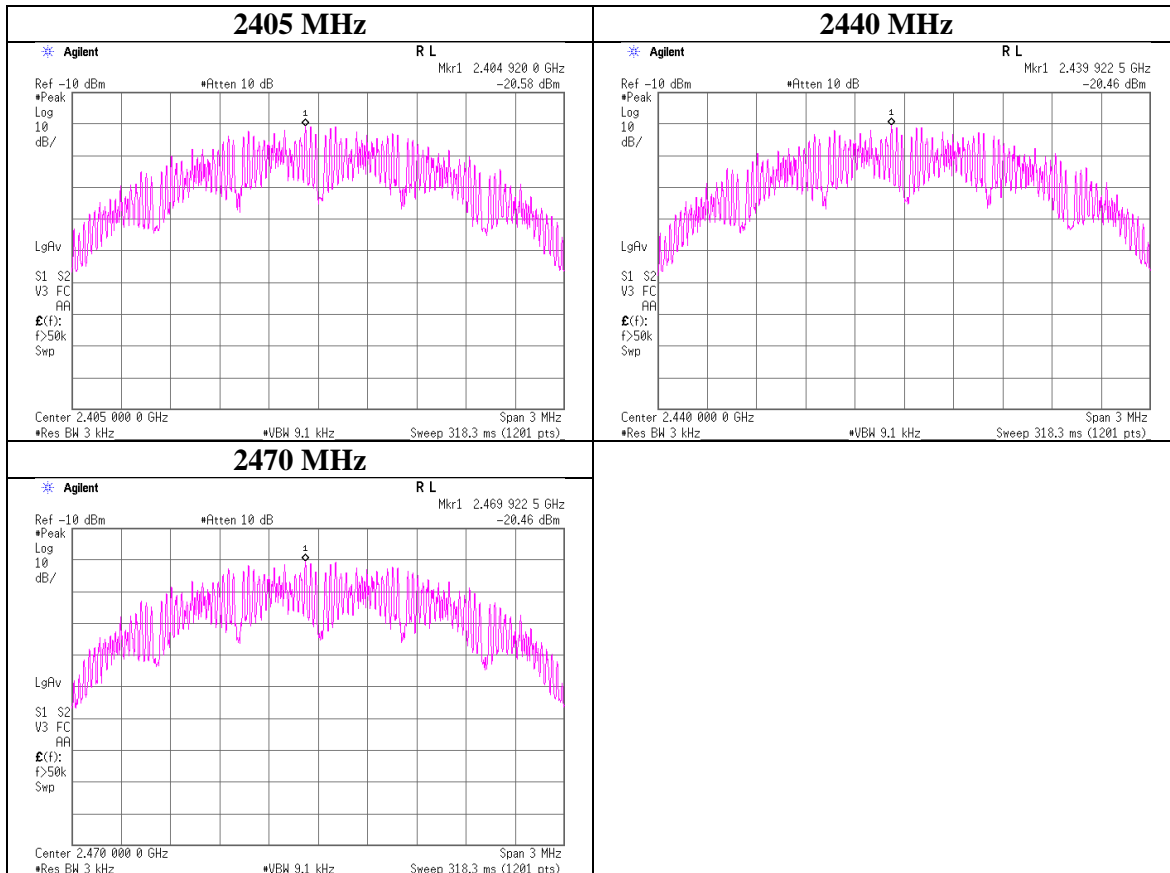
Power Density

Test place	Kashima EMC Lab. No.2 Measurement Room
Report No.	11032863M-B-R1
Date	December 7, 2015
Temperature / Humidity	20 deg. C / 38 % RH
Engineer	Kazuhiro Ando
Mode	Tx, IEEE802.15.4, QPSK

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2405.00	-20.58	1.72	10.03	-8.83	8.00	16.83
2440.00	-20.46	1.73	10.03	-8.70	8.00	16.70
2470.00	-20.46	1.73	10.03	-8.70	8.00	16.70

Sample Calculation:

Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator



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APPENDIX 2: Test instruments

Test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
CSA-07	Spectrum Analyzer	Agilent	E4448A	MY52490024	AT	2015/05/28 * 12
CAT10-17	10dB Fixed Atten.	Weinschel	54A-10	56251	AT	2015/05/26 * 12
CCC-W06	Micro Wave Cable	Junkosha	MWX241	MRA-12-14-146	AT	2015/05/26 * 12
CPM-16	Peak Power Analyzer	Agilent	8990B	MY51000276	AT	2015/06/16 * 12
CPSO-24	Power Sensor	Agilent	N1923A	MY54070024	AT	2015/06/16 * 12
COS-12	Temperature & Humidity Indicator	A&D	AD-5681	6876017	AT	2015/07/13 * 12
CLS-11	A.M.N.	Rohde & Schwarz	ESH3-Z5	835239/022	CE	2015/07/17 * 12
CCC-S5-C(2/9/ 10/11)	Coaxial Cable	Fujikura,Fujikura,Fuji kura,Fujikura	5D-2W,5D-2W,5D -2W,5D-2W	-	CE	2015/07/14 * 12
CTR-01	Test Receiver	Rohde & Schwarz	ESU40	100426	CE	2015/04/24 * 12
CSCL-06	Ruler	Tajima	L19-55S	none	CE	2015/02/18 * 12
COS-05	Temperature & Humidity Indicator	A&D	AD-5681	6975761	CE	2015/07/13 * 12
CTR-09	Test Receiver	Agilent	N9038A	MY53290016	RE	2015/06/28 * 12
CBL-08	LOGBICON	Schwarzbeck	VULB 9168	343	RE	2015/11/15 * 12
CCC-S10-R(2/4 /CATS-11/5/6/7 /8/11/12)	Coaxial Cable	Fujikura,Fujikura,Agil ent,Fujikura,Fujikura, Fujikura,Fuhjikura,Fu jikura,Fujikura	5D-2W,5D-2W,84 94A,5D-2W,5D-2 W,5D-2W,5D-2W, 5D-2W,5D-2W	MY41110200(Ste p Att)	RE	2015/08/11 * 12
CAF-08	Pre-Amplifier	Hewlett Packard	8447D	2944A09041	RE	2015/08/11 * 12
CSCL-13	Ruler	Tajima	L19-55	none	RE	2015/02/18 * 12
COS-10	Temperature & Humidity Indicator	HIOKI	3641/9680-50	090999895/09090 5406	RE	2015/05/17 * 12
COTS-CEMI-02	EMI Software	TSJ	TEPTO-DV(RE,C E,MF,PE)	Ver, RE: 2.5.0131, CE: 2.5.0131,	CE/RE	-
CSA-06	Spectrum Analyzer	Agilent	N9030A	MY53310670	RE	2015/05/28 * 12
CHA-20	Broad Band Horn	Schwarzbeck	BBHA 9120D	9120D-1270	RE	2015/07/31 * 12
CHA-07	Double Ridged Horn	ETS-Lindgren	3160-09	00166043	RE	2015/06/28 * 12
CAF-19	Pre-Amplifier	TOYO	HAP18-26W	00000035	RE	2015/06/28 * 12
CAF-18	Pre-Amplifier	TOYO	TPA0118-36	A-1001	RE	2015/07/15 * 12
CAT10-17	10dB Fixed Atten.	Weinschel	54A-10	56251	RE	2015/05/26 * 12
CHF-04	HPF	Micro-Tronics	HPM50111-02	009	RE	2015/05/25 * 12
CCC-W06	Micro Wave Cable	Junkosha	MWX241	MRA-12-14-146	RE	2015/05/26 * 12
CCC-W07	Micro Wave Cable	Junkosha	MWX221	MRA-12-14-148	RE	2015/05/26 * 12
CCC-W09	Micro Wave Cable	SUHNER	SUCOFLEX104	MY588/4	RE	2015/07/13 * 12
CAT3-04	3dB Fixed Atten.	TAMAGAWA	UFA-01	none	RE	2015/09/03 * 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: CE: Conducted Emission test

RE: Radiated Emission test

AT: Antenna Terminal Conducted test

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81-478-88-6500

Facsimile : +81-478-82-3373