RADIO TEST REPORT

Test Report No.: 10054519S-A

Applicant	:	**TOKYO COSMOS ELECTRIC CO., LTD.**
Type of Equipment	:	**TOCOS wireless engine**
Model No.	:	**TWE-001 Lite**
FCC ID	:	**Z7W-L1**
Test regulation	:	**FCC Part15 Subpart C: 2013**
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 limits of the above regulation.
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6. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.

Date of test: October 7 to 14, 2013

Tested by:

Kenichi Adachi
Engineer of WiSE Japan,
UL Verification Service

Approved by :

Toyokazu Imamura
Leader of WiSE Japan,
UL Verification Service

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

RTL02610

UL Japan, Inc.
Shonan EMC Lab.
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN
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REVISION HISTORY

Original Test Report No.: 10054519S-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	10054519S-A	October 28, 2013	-	-

UL Japan, Inc.
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Telephone : +81 463 50 6400
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Contents

SECTION 1: Customer information

Company Name	:	TOKYO COSMOS ELECTRIC CO., LTD.
Address	:	2-268 Sobudai, Zama, Kanagawa, 252-8550 Japan
Telephone Number	:	+81-46-253-2117
Facsimile Number	:	+81-46-253-6816
Contact Person	:	Takahiro Oguchi

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

2.1 Identification of E.U.T.

Type of Equipment	:	TOCOS wireless engine
Model Number	:	TWE-001 Lite
Serial Number	:	Refer to 4.2 in this report.
Rating	:	DC2.7V (Typical), DC2.0V-3.6V
Country of Mass-production	:	Japan
Condition of EUT	:	type 1, with wire antenna: Production model type 2, with pattern antenna: Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Receipt Date of Sample	:	October 2, 2013
Modification of EUT	:	No modification by the test lab.

2.2 Product description

Model: TWE-001 Lite (referred to as the EUT in this report) is a TOCOS wireless engine.

Clock frequency(ies) in the system : 32MHz

Radio specification:

Equipment type	:	Transceiver
Frequency of operation	:	2405-2475MHz
Bandwidth	:	2MHz
Channel spacing	:	5MHz
Type of modulation	:	O-QPSK, DSSS
Antenna type	:	type 1: Wire antenna: TWE-AN-001L-01 type 2: Pattern antenna: TWE-AN-P1934
Antenna gain	:	2dBi
Antenna connector type	:	None
ITU code	:	G1D
Operation temperature range	:	-40 to +105 deg.C

FCC 15.31 (e) / 212
The RF Module has its own regulator.
The RF Module is constantly provided voltage (DC1.8V) through the regulator regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC 15.203 / 212
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.

SECTION 3: Test specification, procedures & results

3.1 Test specification

Test specification : FCC Part 15 Subpart C: 2013, final revised on June 11, 2013 and effective July 11, 2013
Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits
Section 15.209 Radiated emission limits, general requirements
Section 15.247 Operation within the bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz

3.2 Procedures & Results

Item	Test Procedure *1)	Specification	Remarks	Deviation	Worst Margin	Results
Conducted emission	ANSI C63.10:2009	FCC 15.207	-	N/A	15.3dB Mode: Tx 2405MHz Antenna: 2 Freq.: 6.27814 MHz Detection: Quasi-Peak Phase: L1 Freq.: 24.00836 MHz Detection: Average Phase: L1	Complied
6dB bandwidth	ANSI C63.10:2009	FCC 15.247 (a)(2)	Conducted	N/A	* See data	Complied
Maximum peak output power	ANSI C63.10:2009	FCC 15.247 (b)(3)	Conducted	N/A		Complied
Out of band emission & Restricted band edges	ANSI C63.10:2009	FCC 15.109, 15.247 (d) & 15.209	Conducted / Radiated	N/A	0.3dB Freq.: 7318.674 MHz Polarization: Vertical Detection: Average Mode: Tx 2440MHz Antenna: 1	Complied
Power density	ANSI C63.10:2009	FCC 15.247 (e)	Conducted	N/A	* See data	Complied
Note: UL Japan's EMI Work Procedures No.13-EM-W0420 and 13-EM-W0422. *1) These tests were also referred to KDB 558074 v03 r01 (FCC), "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".						

3.3 Addition to standard

Item	Test Procedure	Specification	Remarks	Worst Margin	Results
Occupied Bandwidth (99%)	ANSI C63.10:2009, RSS-Gen 4.6.1	-	Conducted	-	-
Note: UL Japan's Work Procedures No. 13-EM-W0420 and 13-EM-W0422					

* Other than above, no addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

The following uncertainties have been calculated to provide a confidence level of 95% using a coverage factor k=2.

Item	Frequency range	No.1 SAC[*1]/SR[*2] (±)	No.2 SAC/SR (±)	No.3 SAC/SR (±)
Conducted emission (AC Mains) LISN	150kHz-30MHz	3.6 dB	3.6 dB	3.5 dB
Radiated emission (Measurement distance: 3m)	9kHz-30MHz	3.7 dB	3.7 dB	3.6 dB
	30MHz-300MHz	4.8 dB	5.0 dB	4.8 dB
	300MHz-1GHz	5.0 dB	5.0 dB	4.8 dB
	1GHz-15GHz	4.9 dB	4.9 dB	4.9 dB
Radiated emission (Measurement distance: 1m)	15GHz-18GHz	5.7 dB	5.6 dB	5.6 dB
	18GHz-40GHz	5.2 dB	4.3 dB	4.3 dB

*1: SAC=Semi-Anechoic Chamber
*2: SR= Shielded Room is applied besides radiated emission

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.

Antenna port conducted test

Power measurement uncertainty above 1GHz for this test was: (±) 1.5dB
Spurious emission (Conducted) measurement (below 1GHz) uncertainty for this test was: (±) 1.6dB
Spurious emission (Conducted) measurement (1G-3GHz) uncertainty for this test was: (±) 1.4dB
Spurious emission (Conducted) measurement (3G-18GHz) uncertainty for this test was: (±) 2.8dB
Spurious emission (Conducted) measurement (18G-26.5GHz) uncertainty for this test was: (±) 2.5dB
Bandwidth measurement uncertainty for this test was: (±) 5.4%

3.5 Test location

UL Japan, Inc. Shonan EMC Lab.
1-22-3, Megumigaoka, Hiratsuka-shi, Kanagawa-ken 259-1220 JAPAN
Telephone number : +81 463 50 6400
Facsimile number : +81 463 50 6401
JAB Accreditation No. : RTL02610

	FCC Registration No.	IC Registration No.	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
☐ No.1 semi-anechoic chamber	697847	2973D-1	20.6 x 11.3 x 7.65	20.6 x 11.3	10m
☐ No.2 semi-anechoic chamber	697847	2973D-2	20.6 x 11.3 x 7.65	20.6 x 11.3	10m
☒ No.3 semi-anechoic chamber	697847	2973D-3	12.7 x 7.7 x 5.35	12.7 x 7.7	5m
☐ No.4 semi-anechoic chamber	-	-	8.1 x 5.1 x 3.55	8.1 x 5.1	-
☒ No.1 shielded room	-	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
☐ No.2 shielded room	-	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
☐ No.3 shielded room	-	-	6.3 x 4.7 x 2.7	6.3 x 4.7	-
☐ No.4 shielded room	-	-	4.4 x 4.7 x 2.7	4.4 x 4.7	-
☐ No.5 shielded room	-	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
☐ No.6 shielded room	-	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
☐ No.7 shielded room	-	-	2.76 x 3.76 x 2.4	2.76 x 3.76	-
☒ No.1 measurement room	-	-	2.55 x 4.1 x 2.5	-	-

3.6 Test setup, Test data & Test instruments

Refer to APPENDIX 1 to 3.

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

4.1 Operating mode

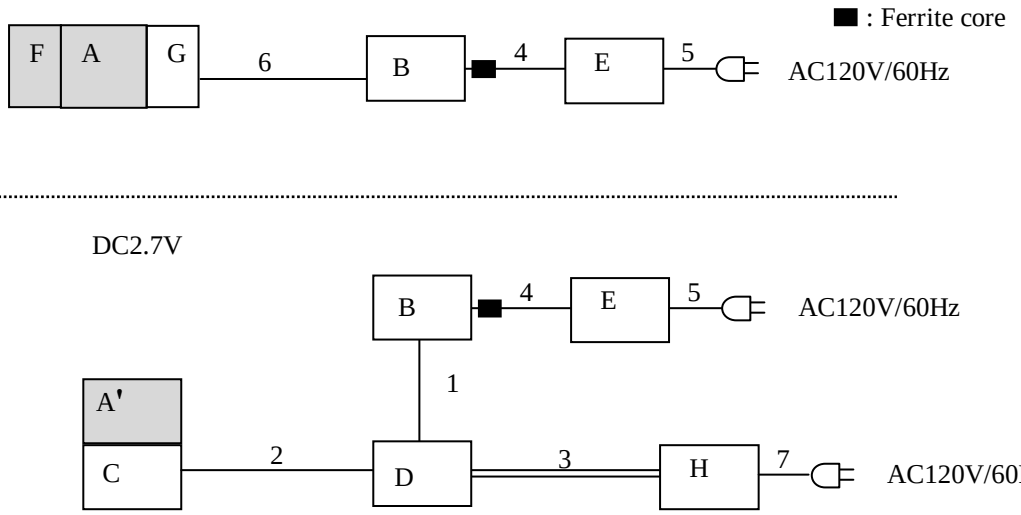
Test item	Mode	Tested frequency
All items	Transmitting IEEE 802.15.4	2405MHz, 2440MHz, 2475MHz
*1) Software: Tera Term Version 4.7.8 *2) Power setting: 3		

Antenna port used:

Conducted emission test	Antenna type 1, type 2
Radiated emission test	Antenna type 1, type 2
Antenna port conducted tests	-

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

4.2 Configuration and peripherals



* Test data was taken under worse case conditions.

Description of EUT and support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	TOCOS wireless engine	TWE-001 Lite	*1)	TOCOS	EUT (type 1)
A'	TOCOS wireless engine	TWE-001 Lite	*2)	TOCOS	EUT (type 2)
B	Laptop PC	NY2300S	818017507	EPSON	-
C	Jig 1	-	-	TOCOS	-
D	Jig 2	-	-	TOCOS	-
E	AC Adaptor	ADP-65JH CB	6A8W32L00X7	DELTA ELECTRONICS	-
F	Antenna	-	-	TOCOS	For EUT (type 1)
G	Jig 3	-	-	TOCOS	-
H	DC Power Supply	PAN35-10A	ML002085	Kikkusui	-

1) 100160E: Conducted emission and Radiated emission, 100030D: Other test
2) 100323: Conducted emission and Radiated emission, 100030D: Other test

List of cables used

No.	Cable Name	Length (m)	Shield		Remark
			Cable	Connector	
1	USB	1.7	Shielded	Shielded	-
2	Signal	2.4	Unshielded	Unshielded	-
3	DC	1.0	Unshielded	Unshielded	DC 2.7V
4	DC	1.8	Unshielded	Unshielded	-
5	AC	0.9	Unshielded	Unshielded	-
6	USB	1.7	Shielded	Shielded	-
7	AC	1.8	Unshielded	Unshielded	-

SECTION 5: Conducted emission

5.1 Operating environment

Test place : See test data (APPENDIX 1)
Temperature : See test data (APPENDIX 1)
Humidity : See test data (APPENDIX 1)

5.2 Test configuration

EUT was placed on a platform of nominal size, 1m by 1.5m, raised 0.8m above the conducting ground plane.
The table is made of Styrofoam and covered with polyvinyl chloride. That has very low permittivity.
The rear of tabletop was located 40cm to the vertical conducting plane. The rear of EUT, including peripherals was aligned and was flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. EUT was located 80cm from LISN.
Each EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the input power source. All unused 50ohm connectors of the LISN were resistively terminated in 50ohm when not connected to the measuring equipment.
Photographs of the set up are shown in APPENDIX 3.

5.3 Test conditions

Frequency range : 0.15 - 30MHz
EUT position : Table top

5.4 Test procedure

The AC Mains Terminal Continuous disturbance Voltage had been measured with the EUT via Laptop PC (Type1) / DC power supply (Type2) within a Shielded room. The EUT was connected to a Line Impedance Stabilization Network (LISN).
An overview sweep with peak detection has been performed.
The measurements had been performed with a quasi-peak detector and if required, a CISPR average detector.
The conducted emission measurements were made with the following detection of the test receiver.

Detection Type : Quasi-Peak/ CISPR Average
IF Bandwidth : 9kHz

5.5 Results

Summary of the test results : Pass
Refer to APPENDIX 1

SECTION 6: Radiated emission

6.1 Operating environment

Test place : See test data (APPENDIX 1)
Temperature : See test data (APPENDIX 1)
Humidity : See test data (APPENDIX 1)

6.2 Test configuration

EUT was placed on a urethane platform of nominal size, 0.5m by 0.5m, raised 0.8m above the conducting ground plane. Photographs of the set up are shown in APPENDIX 3.

6.3 Test conditions

Frequency range : 30 - 25GHz
EUT position : Table top

6.4 Test procedure

The Radiated Electric Field Strength intensity has been measured on a semi-anechoic chamber with a ground plane and at a distance of 3m (below 15GHz) / 1m (above 15GHz) (Refer to Figure 1). Measurements were performed with quasi-peak, peak and average detector. The measuring antenna height was 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.
The radiated emission measurements were made with the following detection.

Frequency	30-1000MHz	1-25GHz		20dBc
Detection type	Quasi-Peak	Peak	Average *1)	Peak
IF Bandwidth	120kHz	RBW: 1MHz VBW: 3MHz	RBW: 1MHz VBW: 10Hz Detector: Peak Method: Reduced VBW	RBW: 100kHz VBW: 300kHz

*1) Average Power Measurement was measured based on 12.2.5.3 of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".
(Carrier and spurious were duty 100%)

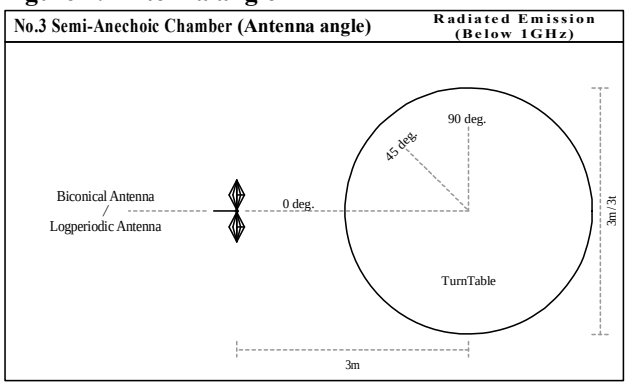
The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

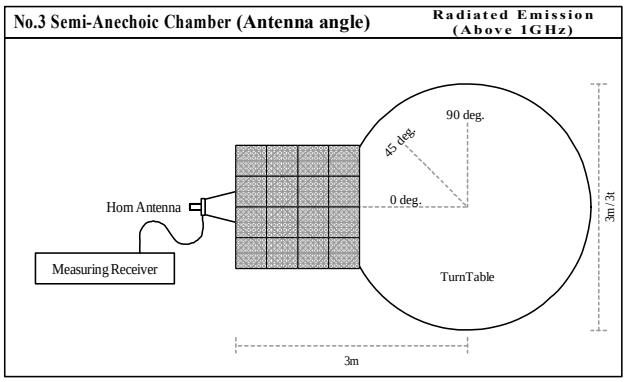
Combinations of the worst case

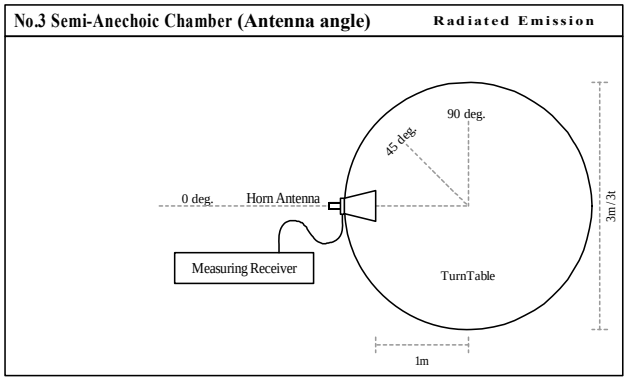
	Frequency / Antenna polarization	Carrier *2)	Spurious			
			Below 1GHz	1-15GHz	15-18GHz	15-25GHz
antenna type 1	Horizontal	X	X	X	X	X
	Vertical	Z	Z	Z	Z	Z
antenna type 2	Horizontal	Y	Y	Y	Y	Y
	Vertical	X	X	Z	Z	Z

*2) with spurious emissions near carrier frequency

Figure 1. Antenna angle







6.5 Band edge

Band edge level at 2390MHz and 2483.5MHz is below the limits of FCC 15.209 and band edge level at 2400MHz is below the 20dBc. Refer to the data.

6.6 Results

Summary of the test results : Pass
* No noise was detected above the 5th order harmonics.

Refer to APPENDIX 1

SECTION 7: Out of band emissions (Antenna port conducted)

Test procedure
The Out of Band Emissions was measured with a spectrum analyzer connected to the antenna port.
In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.
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.
(9kHz-150kHz:RBW=200Hz, 150kHz-30MHz:RBW=10kHz)

Summary of the test results: Pass
Refer to APPENDIX 1

SECTION 8: 6dB bandwidth & Occupied bandwidth (99%)

Test procedure
The bandwidth was measured with a spectrum analyzer connected to the antenna port.
The test was measured based on Method 8.1 Option 1 and 8.2 Option 2 of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

Summary of the test results: Pass
Refer to APPENDIX 1

SECTION 9: Maximum peak output power

Test procedure
The Maximum Peak Output Power was measured with a power meter connected to the antenna port.
The test was measured based on Method 9.1.3 PKPM1 of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

Summary of the test results: Pass
Refer to APPENDIX 1

SECTION 10: Peak power density

Test procedure
The peak power density was measured with a spectrum analyzer connected to the antenna port.
Instrument used : Spectrum Analyzer
RBW / VBW : 3kHz / 9.1kHz

The test was measured based on Method 10.2 PKPSD of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

Summary of the test results: Pass
Refer to APPENDIX 1

Contents of APPENDIXES

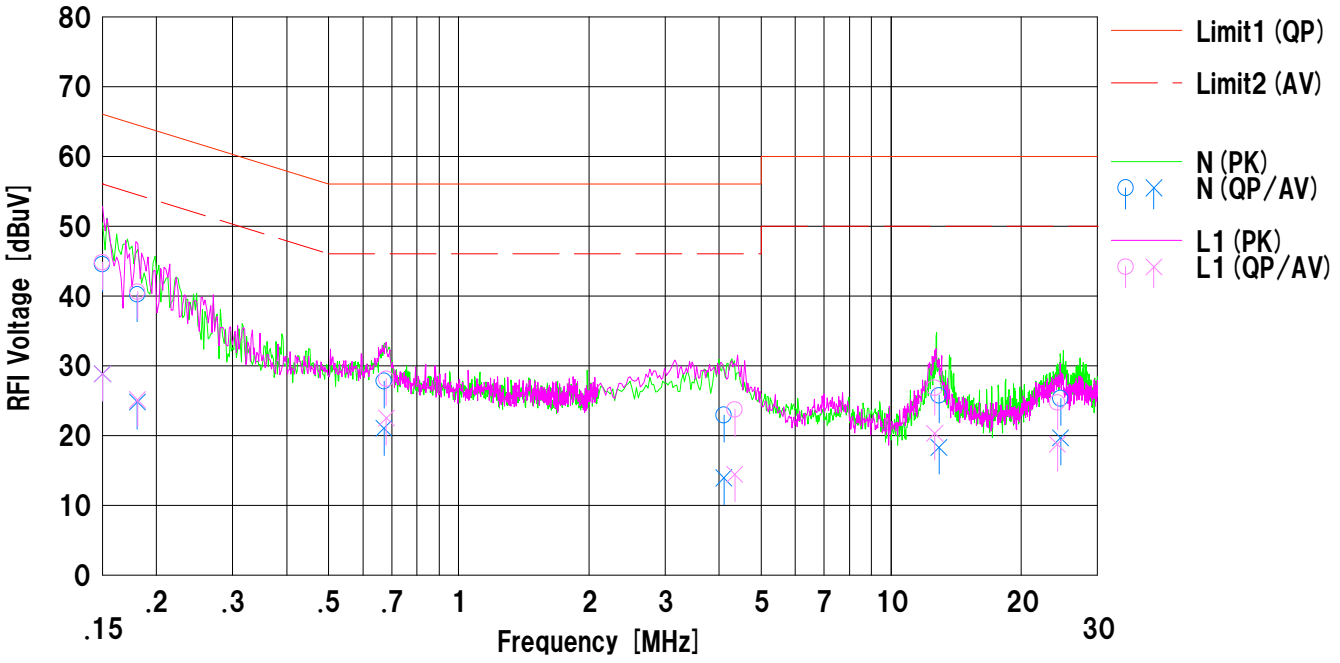
DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No.1 Shielded Room
Date : 2013/10/14

Company	: TOKYO COSMOS ELECTRIC CO.,LTD.	Mode	: Transmitting 2405MHz
Kind of EUT	: TOCOS wireless engine	Order No.	: 10054519S
Model No.	: TWE-001 Lite (antenna type1)	Power	: AC120V/60Hz (EUT:DC5V (USB))
Serial No.	: 100160E	Temp./Humi.	: 24deg.C / 38%RH
Remarks	: -		

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

Engineer : Akio Hayashi



No.	Freq.	Reading <QP>	Reading <AV>	C.Fac	Results <QP>	Results <AV>	Limit <QP>	Limit <AV>	Margin <QP>	Margin <AV>	Phase	Comment
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.150000	32.0	16.3	12.5	44.5	28.8	66.0	56.0	21.5	27.2	N	
2	0.180588	27.7	12.3	12.5	40.2	24.8	64.4	54.4	24.2	29.6	N	
3	0.671866	15.3	8.5	12.5	27.8	21.0	56.0	46.0	28.2	25.0	N	
4	4.102522	10.1	1.1	12.8	22.9	13.9	56.0	46.0	33.1	32.1	N	
5	12.902182	12.2	4.8	13.5	25.7	18.3	60.0	50.0	34.3	31.7	N	
6	24.623972	10.8	5.1	14.5	25.3	19.6	60.0	50.0	34.7	30.4	N	
7	0.150000	32.3	16.3	12.5	44.8	28.8	66.0	56.0	21.2	27.2	L1	
8	0.180711	28.1	12.6	12.5	40.6	25.1	64.4	54.4	23.8	29.3	L1	
9	0.679744	15.6	10.0	12.5	28.1	22.5	56.0	46.0	27.9	23.5	L1	
10	4.349944	10.9	1.6	12.8	23.7	14.4	56.0	46.0	32.3	31.6	L1	
11	12.609744	13.3	6.8	13.5	26.8	20.3	60.0	50.0	33.2	29.7	L1	
12	24.250032	10.2	4.2	14.5	24.7	18.7	60.0	50.0	35.3	31.3	L1	

Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]
LISN:SLS-02

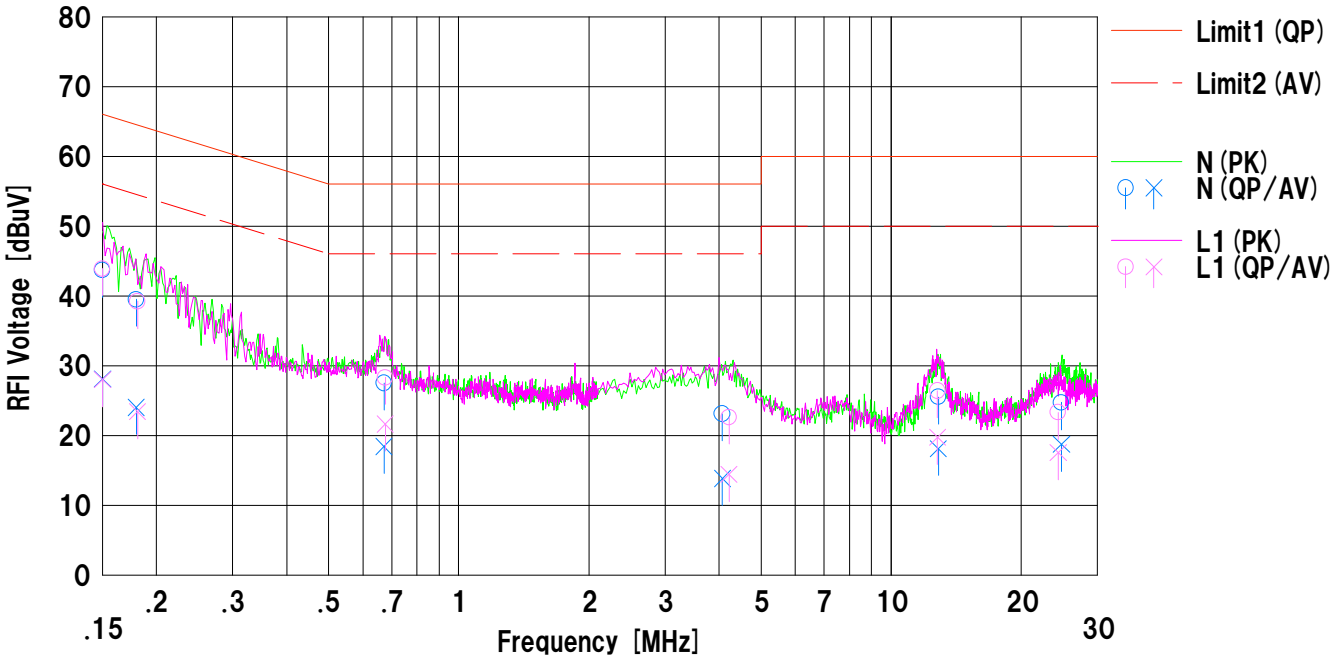
DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No.1 Shielded Room
Date : 2013/10/14

Company	: TOKYO COSMOS ELECTRIC CO.,LTD.	Mode	: Transmitting 2440MHz
Kind of EUT	: TOCOS wireless engine	Order No.	: 10054519S
Model No.	: TWE-001 Lite (antenna type1)	Power	: AC120V/60Hz (EUT:DC5V (USB))
Serial No.	: 100160E	Temp./Humi.	: 24deg.C / 38%RH
Remarks	: -		

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

Engineer : Akio Hayashi



No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		<QP>	<AV>		<QP>	<AV>	<QP>	<AV>	<QP>	<AV>		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15000	31.2	15.6	12.5	43.7	28.1	66.0	56.0	22.3	27.9	N	
2	0.17965	27.0	11.5	12.5	39.5	24.0	64.5	54.5	25.0	30.5	N	
3	0.67181	15.0	5.9	12.5	27.5	18.4	56.0	46.0	28.5	27.6	N	
4	4.06928	10.3	1.0	12.8	23.1	13.8	56.0	46.0	32.9	32.2	N	
5	12.86051	12.0	4.6	13.5	25.5	18.1	60.0	50.0	34.5	31.9	N	
6	24.75058	10.2	4.2	14.5	24.7	18.7	60.0	50.0	35.3	31.3	N	
7	0.15000	31.4	15.5	12.5	43.9	28.0	66.0	56.0	22.1	28.0	L1	
8	0.18077	26.7	10.9	12.5	39.2	23.4	64.4	54.4	25.2	31.0	L1	
9	0.67587	15.8	9.1	12.5	28.3	21.6	56.0	46.0	27.7	24.4	L1	
10	4.22104	9.8	1.6	12.8	22.6	14.4	56.0	46.0	33.4	31.6	L1	
11	12.79782	12.9	6.2	13.5	26.4	19.7	60.0	50.0	33.6	30.3	L1	
12	24.33051	8.8	3.0	14.5	23.3	17.5	60.0	50.0	36.7	32.5	L1	

Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]
LISN:SLS-02

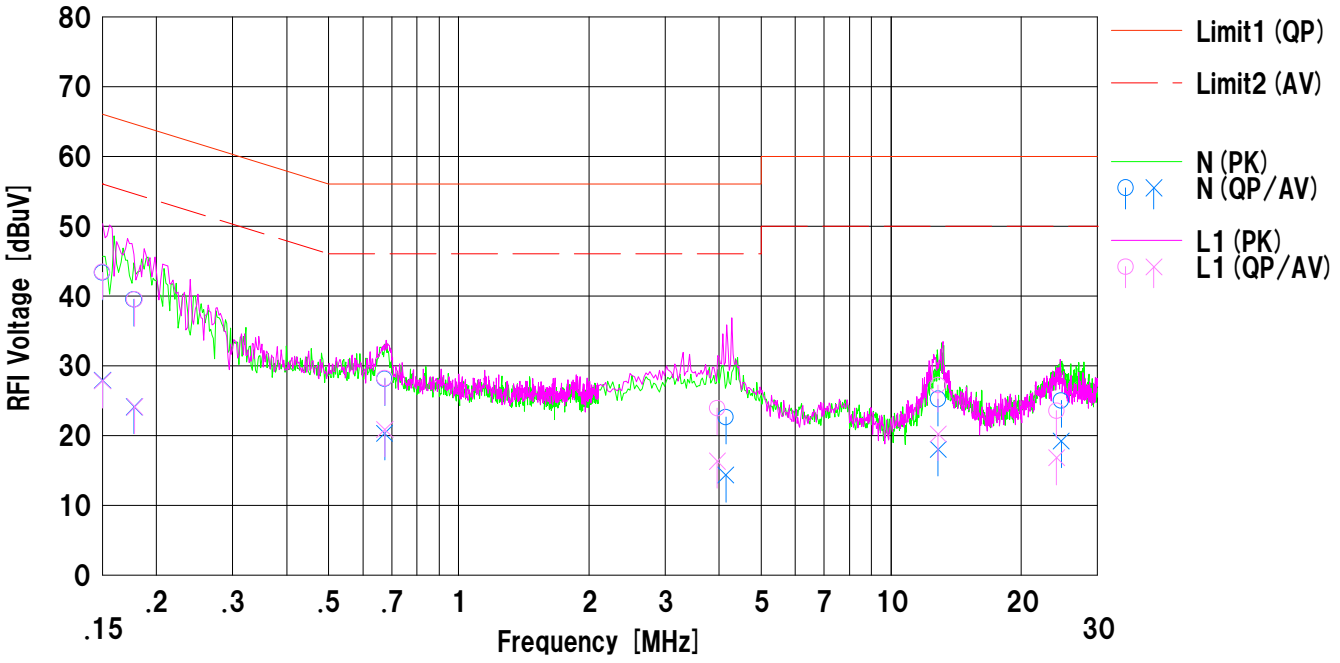
DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No.1 Shielded Room
Date : 2013/10/14

Company	: TOKYO COSMOS ELECTRIC CO.,LTD.	Mode	: Transmitting 2475MHz
Kind of EUT	: TOCOS wireless engine	Order No.	: 10054519S
Model No.	: TWE-001 Lite (antenna type1)	Power	: AC120V/60Hz (EUT:DC5V (USB))
Serial No.	: 100160E	Temp./Humi.	: 24deg.C / 38%RH
Remarks	: -		

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

Engineer : Akio Hayashi



No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		<QP>	<AV>		<QP>	<AV>	<QP>	<AV>	<QP>	<AV>		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.150000	30.8	15.4	12.5	43.3	27.9	66.0	56.0	22.7	28.1	N	
2	0.177420	27.0	11.6	12.5	39.5	24.1	64.6	54.6	25.1	30.5	N	
3	0.674200	15.6	7.8	12.5	28.1	20.3	56.0	46.0	27.9	25.7	N	
4	4.149000	9.8	1.5	12.8	22.6	14.3	56.0	46.0	33.4	31.7	N	
5	12.826470	11.7	4.5	13.5	25.2	18.0	60.0	50.0	34.8	32.0	N	
6	24.744080	10.5	4.7	14.5	25.0	19.2	60.0	50.0	35.0	30.8	N	
7	0.150000	30.9	15.3	12.5	43.4	27.8	66.0	56.0	22.6	28.2	L1	
8	0.178100	27.0	11.6	12.5	39.5	24.1	64.5	54.5	25.0	30.4	L1	
9	0.674480	15.7	8.3	12.5	28.2	20.8	56.0	46.0	27.8	25.2	L1	
10	3.963880	11.1	3.5	12.8	23.9	16.3	56.0	46.0	32.1	29.7	L1	
11	12.831920	13.7	6.7	13.5	27.2	20.2	60.0	50.0	32.8	29.8	L1	
12	24.127540	9.1	2.4	14.4	23.5	16.8	60.0	50.0	36.5	33.2	L1	

Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]
LISN:SLS-02

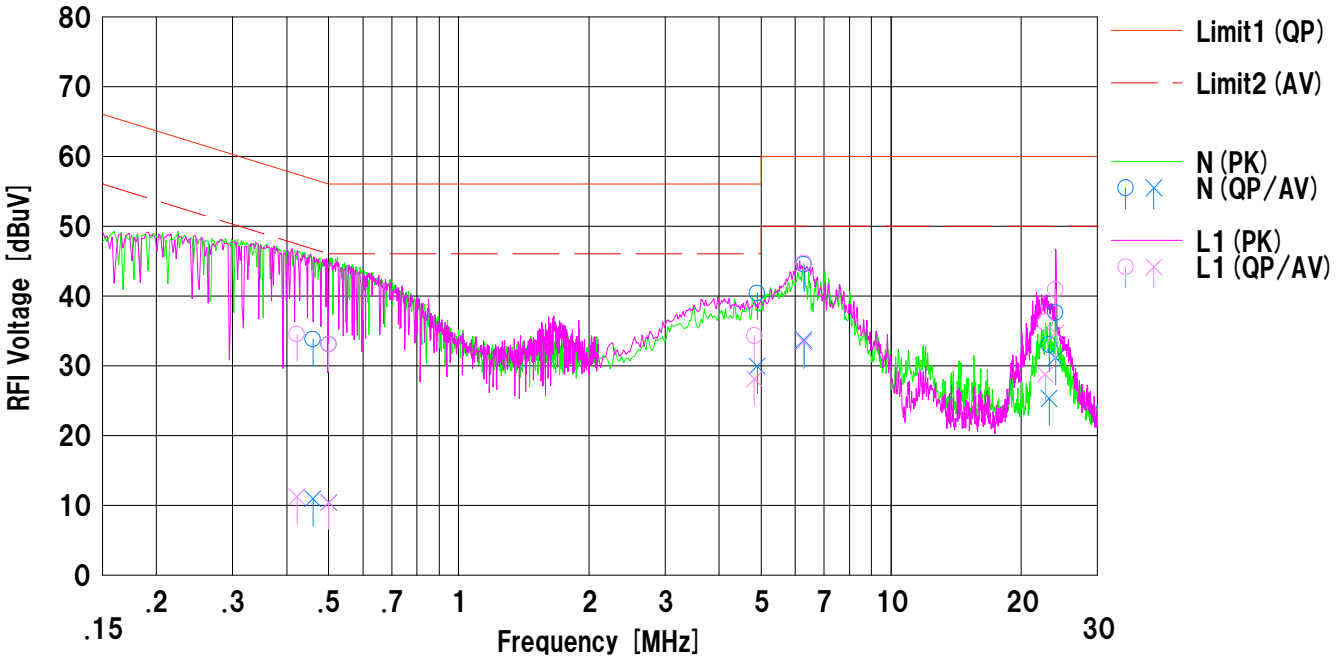
DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No.1 Shielded Room
Date : 2013/10/14

Company	: TOKYO COSMOS ELECTRIC CO.,LTD.	Mode	: Transmitting 2405MHz
Kind of EUT	: TOCOS wireless engine	Order No.	: 10054519S
Model No.	: TWE-001 Lite (antenna type2)	Power	: AC120V/60Hz (EUT:DC2.7V)
Serial No.	: 100323	Temp./Humi.	: 24deg.C / 38%RH
Remarks	: -		

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

Engineer : Akio Hayashi



No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		<QP>	<AV>		<QP>	<AV>	<QP>	<AV>	<QP>	<AV>		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.46026	21.3	-1.6	12.5	33.8	10.9	56.6	46.6	22.8	35.7	N	
2	0.50001	20.6	-2.1	12.5	33.1	10.4	56.0	46.0	22.9	35.6	N	
3	4.89821	27.5	17.0	12.9	40.4	29.9	56.0	46.0	15.6	16.1	N	
4	6.28058	31.5	20.7	13.0	44.5	33.7	60.0	50.0	15.5	16.3	N	
5	23.19269	18.6	10.9	14.4	33.0	25.3	60.0	50.0	27.0	24.7	N	
6	24.00496	23.2	16.7	14.4	37.6	31.1	60.0	50.0	22.4	18.9	N	
7	0.42220	22.0	-1.3	12.5	34.5	11.2	57.4	47.4	22.9	36.2	L1	
8	0.50001	20.6	-2.1	12.5	33.1	10.4	56.0	46.0	22.9	35.6	L1	
9	4.82889	21.4	15.2	12.9	34.3	28.1	56.0	46.0	21.7	17.9	L1	
10	6.27814	31.7	20.4	13.0	44.7	33.4	60.0	50.0	15.3	16.6	L1	
11	22.71397	21.8	14.3	14.4	36.2	28.7	60.0	50.0	23.8	21.3	L1	
12	24.00836	26.5	20.3	14.4	40.9	34.7	60.0	50.0	19.1	15.3	L1	

Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]
LISN:SLS-02

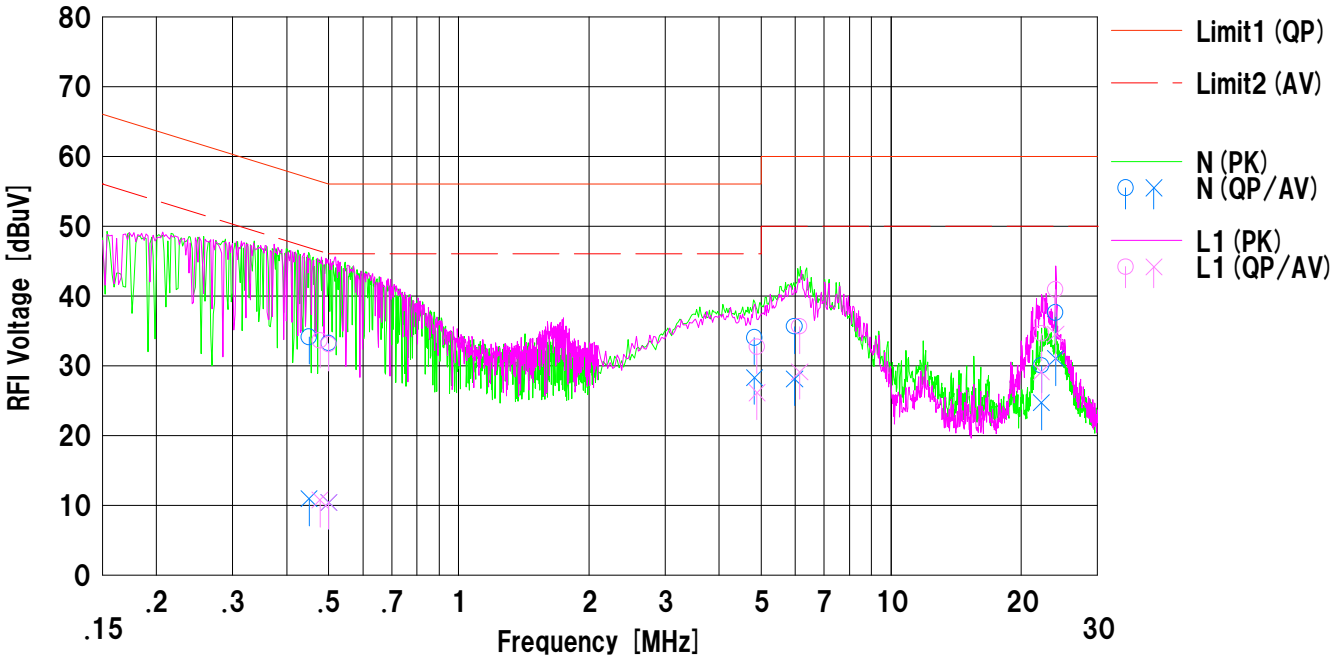
DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No.1 Shielded Room
Date : 2013/10/14

Company	: TOKYO COSMOS ELECTRIC CO.,LTD.	Mode	: Transmitting 2440MHz
Kind of EUT	: TOCOS wireless engine	Order No.	: 10054519S
Model No.	: TWE-001 Lite (antenna type2)	Power	: AC120V/60Hz (EUT:DC2.7V)
Serial No.	: 100323	Temp./Humi.	: 24deg.C / 38%RH
Remarks	: -		

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

Engineer : Akio Hayashi



No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		<QP>	<AV>		<QP>	<AV>	<QP>	<AV>	<QP>	<AV>		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.45066	21.6	-1.6	12.5	34.1	10.9	56.8	46.8	22.7	35.9	N	
2	0.50001	20.7	-2.1	12.5	33.2	10.4	56.0	46.0	22.8	35.6	N	
3	4.82822	21.1	15.4	12.9	34.0	28.3	56.0	46.0	22.0	17.7	N	
4	5.97608	22.6	15.1	13.0	35.6	28.1	60.0	50.0	24.4	21.9	N	
5	22.24718	15.7	10.4	14.3	30.0	24.7	60.0	50.0	30.0	25.3	N	
6	24.00359	23.2	16.6	14.4	37.6	31.0	60.0	50.0	22.4	19.0	N	
7	0.47746	21.1	-1.8	12.5	33.6	10.7	56.3	46.3	22.7	35.6	L1	
8	0.50001	20.6	-2.1	12.5	33.1	10.4	56.0	46.0	22.9	35.6	L1	
9	4.89412	19.8	13.2	12.9	32.7	26.1	56.0	46.0	23.3	19.9	L1	
10	6.14200	22.6	16.1	13.0	35.6	29.1	60.0	50.0	24.4	20.9	L1	
11	22.25218	20.3	14.8	14.3	34.6	29.1	60.0	50.0	25.4	20.9	L1	
12	24.00865	26.5	20.1	14.4	40.9	34.5	60.0	50.0	19.1	15.5	L1	

Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]
LISN:SLS-02

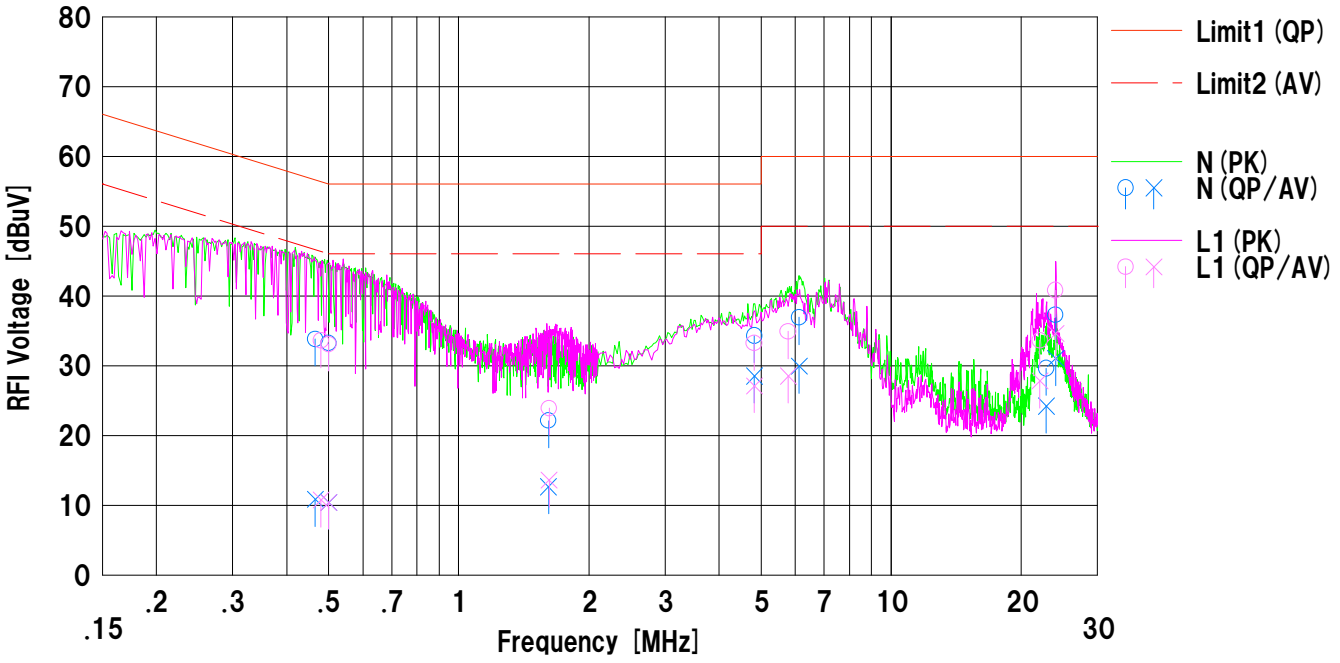
DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No.1 Shielded Room
Date : 2013/10/14

Company	: TOKYO COSMOS ELECTRIC CO.,LTD.	Mode	: Transmitting 2475MHz
Kind of EUT	: TOCOS wireless engine	Order No.	: 10054519S
Model No.	: TWE-001 Lite (antenna type2)	Power	: AC120V/60Hz (EUT:DC2.7V)
Serial No.	: 100323	Temp./Humi.	: 24deg.C / 38%RH
Remarks	: -		

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

Engineer : Akio Hayashi



No.	Freq.	Reading <QP>	Reading <AV>	C.Fac	Results <QP>	Results <AV>	Limit <QP>	Limit <AV>	Margin <QP>	Margin <AV>	Phase	Comment
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.466044	21.3	-1.7	12.5	33.8	10.8	56.5	46.5	22.7	35.7	N	
2	0.500011	20.7	-2.1	12.5	33.2	10.4	56.0	46.0	22.8	35.6	N	
3	1.613855	9.4	-0.1	12.7	22.1	12.6	56.0	46.0	33.9	33.4	N	
4	4.830400	21.4	15.6	12.9	34.3	28.5	56.0	46.0	21.7	17.5	N	
5	6.129555	23.9	16.9	13.0	36.9	29.9	60.0	50.0	23.1	20.1	N	
6	22.820133	15.2	9.8	14.4	29.6	24.2	60.0	50.0	30.4	25.8	N	
7	24.006066	22.9	16.6	14.4	37.3	31.0	60.0	50.0	22.7	19.0	N	
8	0.480588	21.1	-1.8	12.5	33.6	10.7	56.3	46.3	22.7	35.6	L1	
9	0.500011	20.6	-2.1	12.5	33.1	10.4	56.0	46.0	22.9	35.6	L1	
10	1.619911	11.2	0.9	12.7	23.9	13.6	56.0	46.0	32.1	32.4	L1	
11	4.823977	20.3	14.2	12.9	33.2	27.1	56.0	46.0	22.8	18.9	L1	
12	5.778466	21.9	15.5	13.0	34.9	28.5	60.0	50.0	25.1	21.5	L1	
13	22.092955	19.3	13.5	14.3	33.6	27.8	60.0	50.0	26.4	22.2	L1	
14	24.008466	26.4	20.2	14.4	40.8	34.6	60.0	50.0	19.2	15.4	L1	

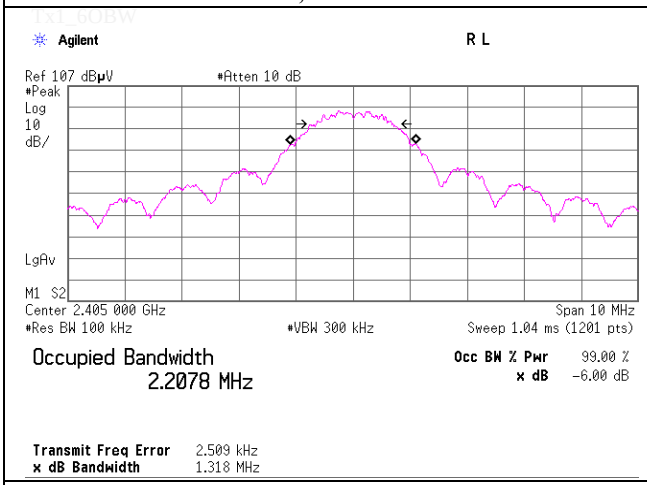
Calculation:Result [dBuV] =Reading [dBuV] +C.Fac (LISN+Cable+ATT) [dB]
LISN:SLS-02

-6dB Bandwidth

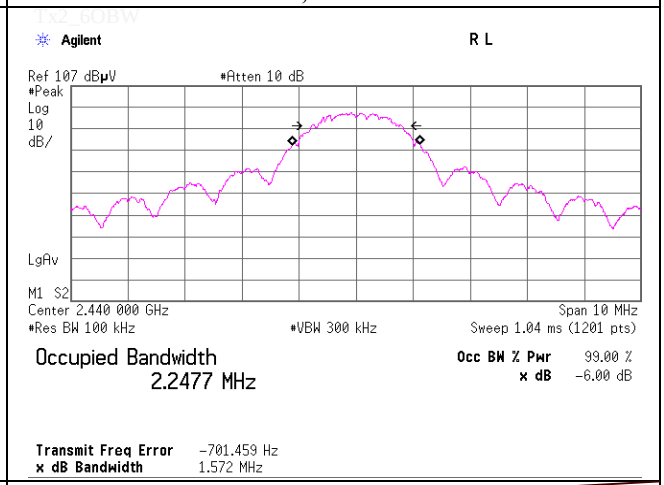
Test place	UL Japan, Inc. Shonan EMC Lab.	No.1 Measurement Room
Date	October 7, 2013	
Temperature / Humidity	25deg.C , 56%RH	
Engineer	Tatsuya Arai	
Mode	Tx, IEEE 802.15.4, PN9	

Freq. [MHz]	-6dB Bandwidth [MHz]	Limit [MHz]
2405.0000	1.318	> 0.500
2440.0000	1.572	> 0.500
2475.0000	1.570	> 0.500

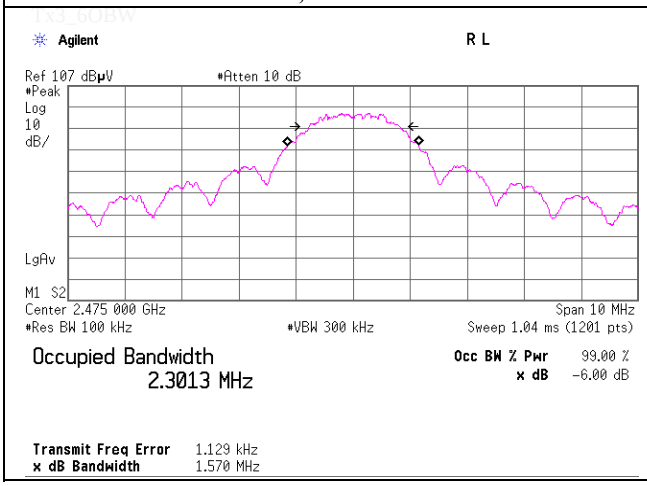
Tx, 2405MHz

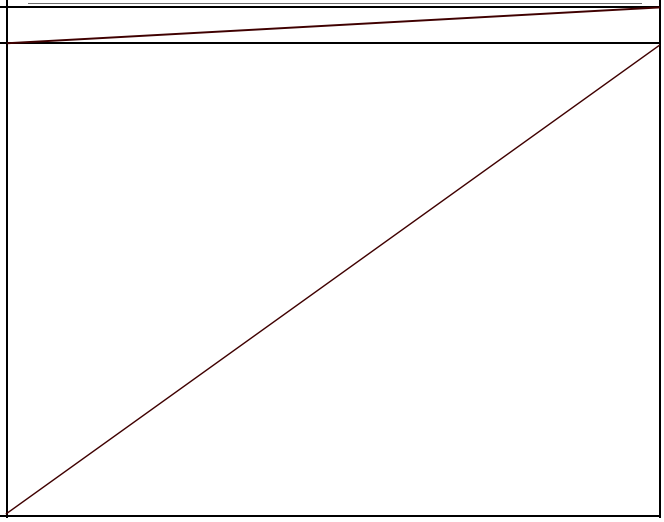


Tx, 2440MHz



Tx, 2475MHz





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Maximum Peak Conducted Output Power

(PKPM1)

Test place	UL Japan, Inc. Shonan EMC Lab.	No.1 Measurement Room
Date	October 7, 2013	
Temperature / Humidity	25deg.C , 56%RH	
Engineer	Tatsuya Arai	
Mode	Tx, IEEE 802.15.4, PN9,	

(* P/M: Power Meter with power sensor)

Ch	Freq.	P/M (Peak) Reading	Cable Loss	Atten. Loss	Result		Limit		Margin
	[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]
Low	2405.0	-9.36	1.52	10.04	2.20	1.66	30.00	1000	27.80
Mid	2440.0	-9.42	1.51	10.04	2.13	1.63	30.00	1000	27.87
High	2475.0	-9.50	1.51	10.04	2.05	1.60	30.00	1000	27.95

Sample Calculation:
Result = Reading + Cable Loss + Atten. Loss

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Radiated Emission

Test place	No.3 Semi Anechoic Chamber	
Date	October 7, 2013	October 8, 2013
Temperature / Humidity	24deg.C, 53%RH	24deg.C, 59%RH
Engineer	Kenichi Adachi	Kenichi Adachi
Mode	Tx, 2405 MHz	antenna type 1
	IEEE 802.15.4 (ZigBee)	EUT-axis: (Carrier): H: X, V: Z, (Spurious): H: X, V: Z

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	46.058	QP	30.9	12.1	6.7	32.2	17.5	40.0	22.5	400	246	
Hori.	96.080	QP	36.7	9.4	7.4	32.1	21.4	43.5	22.1	318	251	
Hori.	192.714	QP	40.2	16.1	7.8	32.0	32.1	43.5	11.4	167	250	
Hori.	409.524	QP	42.9	16.3	9.1	31.9	36.4	46.0	9.6	100	220	
Hori.	626.260	QP	33.9	19.2	9.9	32.0	31.0	46.0	15.0	120	206	
Hori.	2372.823	PK	46.7	26.8	14.7	41.1	47.1	73.9	26.8	100	202	
Hori.	2390.000	PK	43.8	26.8	14.7	41.1	44.2	73.9	29.7	100	202	
Hori.	4809.158	PK	57.5	31.0	7.5	41.2	54.8	73.9	19.1	100	166	
Hori.	9618.066	PK	45.8	38.6	10.2	38.9	55.7	73.9	18.2	100	111	
Hori.	12025.000	PK	46.6	39.6	11.5	39.1	58.6	73.9	15.3	100	0	noise floor level
Hori.	2372.823	AV	39.9	26.8	14.7	41.1	40.3	53.9	13.6	100	202	
Hori.	2390.000	AV	35.0	26.8	14.7	41.1	35.4	53.9	18.5	100	202	
Hori.	4809.158	AV	49.6	31.0	7.5	41.2	46.9	53.9	7.0	100	166	
Hori.	9618.066	AV	34.9	38.6	10.2	38.9	44.8	53.9	9.1	100	111	
Hori.	12025.000	AV	35.0	39.6	11.5	39.1	47.0	53.9	6.9	100	0	noise floor level
Vert.	46.058	QP	47.4	12.1	6.7	32.2	34.0	40.0	**6.0**	100	169	
Vert.	96.080	QP	51.0	9.4	7.4	32.1	35.7	43.5	7.8	100	135	
Vert.	180.794	QP	30.7	15.8	7.7	32.0	22.2	43.5	21.3	100	202	
Vert.	409.524	QP	41.4	16.3	9.1	31.9	34.9	46.0	11.1	146	154	
Vert.	626.260	QP	38.5	19.2	9.9	32.0	35.6	46.0	10.4	100	263	
Vert.	2372.823	PK	48.0	26.8	14.7	41.1	48.4	73.9	25.5	100	133	
Vert.	2390.000	PK	43.7	26.8	14.7	41.1	44.1	73.9	29.8	100	133	
Vert.	4809.158	PK	55.5	31.0	7.5	41.2	52.8	73.9	21.1	100	240	
Vert.	9618.066	PK	45.7	38.6	10.2	38.9	55.6	73.9	18.3	116	314	
Vert.	12025.000	PK	46.7	39.6	11.5	39.1	58.7	73.9	15.2	100	0	noise floor level
Vert.	2372.823	AV	39.8	26.8	14.7	41.1	40.2	53.9	13.7	100	133	
Vert.	2390.000	AV	34.9	26.8	14.7	41.1	35.3	53.9	18.6	100	133	
Vert.	4809.158	AV	47.6	31.0	7.5	41.2	44.9	53.9	9.0	100	240	
Vert.	9618.066	AV	34.4	38.6	10.2	38.9	44.3	53.9	9.6	116	314	
Vert.	12025.000	AV	35.1	39.6	11.5	39.1	47.1	53.9	6.8	100	0	noise floor level

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter-Distance factor(above 15GHz)) - Gain(Amprifier)
Distance factor : 15GHz -40GHz : 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]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2405.000	PK	95.5	26.8	14.7	41.1	95.9	-	-	100	202	carrier
Hori.	2400.000	PK	53.1	26.8	14.7	41.1	53.5	75.9	22.4	100	202	
Hori.	7213.791	PK	48.3	37.1	9.1	41.0	53.5	75.9	22.4	124	140	
Vert.	2405.000	PK	95.0	26.8	14.7	41.1	95.4	-	-	100	133	carrier
Vert.	2400.000	PK	52.5	26.8	14.7	41.1	52.9	75.4	22.5	100	133	
Vert.	7213.791	PK	48.4	37.1	9.1	41.0	53.6	75.4	21.8	100	354	

Result = Reading + Ant.Fac. + Loss(Cable+Attenuator+Filter) - Gain(Amplifier)

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Radiated Emission

Test place	No.3 Semi Anechoic Chamber	
Date	October 7, 2013	October 8, 2013
Temperature / Humidity	24deg.C, 53%RH	24deg.C, 59%RH
Engineer	Kenichi Adachi	Kenichi Adachi
Mode	Tx, 2440 MHz	antenna type 1
	IEEE 802.15.4 (ZigBee)	EUT-axis: (Carrier): H: X, V: Z, (Spurious): H: X, V: Z

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	45.494	QP	30.7	12.3	6.7	32.2	17.5	40.0	22.5	400	252	
Hori.	88.904	QP	36.8	8.0	7.5	32.1	20.2	43.5	23.3	314	273	
Hori.	192.722	QP	40.0	16.1	7.8	32.0	31.9	43.5	11.6	164	244	
Hori.	409.533	QP	43.0	16.3	9.1	31.9	36.5	46.0	9.5	100	223	
Hori.	626.246	QP	33.7	19.2	9.9	32.0	30.8	46.0	15.2	123	199	
Hori.	4879.048	PK	53.3	31.4	7.5	41.2	51.0	73.9	22.9	100	164	
Hori.	7318.674	PK	53.4	37.2	9.0	41.1	58.5	73.9	15.4	122	138	
Hori.	9758.067	PK	44.4	38.8	10.1	38.8	54.5	73.9	19.4	100	109	
Hori.	12200.000	PK	44.9	39.6	11.4	39.1	56.8	73.9	17.1	100	0	noise floor level
Hori.	4879.048	AV	45.4	31.4	7.5	41.2	43.1	53.9	10.8	100	164	
Hori.	7318.674	AV	44.3	37.2	9.0	41.1	49.4	53.9	4.5	122	138	
Hori.	9758.067	AV	32.9	38.8	10.1	38.8	43.0	53.9	10.9	100	109	
Hori.	12200.000	AV	33.4	39.6	11.4	39.1	45.3	53.9	8.6	100	0	noise floor level
Vert.	46.054	QP	47.2	12.1	6.7	32.2	33.8	40.0	6.2	100	163	
Vert.	96.047	QP	50.8	9.4	7.4	32.1	35.5	43.5	8.0	100	133	
Vert.	180.823	QP	30.8	15.8	7.7	32.0	22.3	43.5	21.2	100	206	
Vert.	409.533	QP	42.2	16.3	9.1	31.9	35.7	46.0	10.3	144	157	
Vert.	626.246	QP	37.8	19.2	9.9	32.0	34.9	46.0	11.1	100	268	
Vert.	4879.048	PK	55.0	31.4	7.5	41.2	52.7	73.9	21.2	100	239	
Vert.	7318.674	PK	57.3	37.2	9.0	41.1	62.4	73.9	11.5	100	353	
Vert.	9758.067	PK	44.3	38.8	10.1	38.8	54.4	73.9	19.5	111	309	
Vert.	12200.000	PK	44.8	39.6	11.4	39.1	56.7	73.9	17.2	100	0	noise floor level
Vert.	4879.048	AV	47.0	31.4	7.5	41.2	44.7	53.9	9.2	100	239	
Vert.	7318.674	AV	48.5	37.2	9.0	41.1	53.6	53.9	**0.3**	100	353	
Vert.	9758.067	AV	32.9	38.8	10.1	38.8	43.0	53.9	10.9	111	309	
Vert.	12200.000	AV	33.3	39.6	11.4	39.1	45.2	53.9	8.7	100	0	noise floor level

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter-Distance factor(above 15GHz)) - Gain(Amprifier)
Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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Radiated Emission

Test place	No.3 Semi Anechoic Chamber	
Date	October 7, 2013	October 8, 2013
Temperature / Humidity	24deg.C, 53%RH	24deg.C, 59%RH
Engineer	Kenichi Adachi	Kenichi Adachi
Mode	Tx, 2475 MHz	antenna type 1
	IEEE 802.15.4 (ZigBee)	EUT-axis: (Carrier): H: X, V: Z, (Spurious): H: X, V: Z

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	45.564	QP	30.2	12.2	6.7	32.2	16.9	40.0	23.1	400	249	
Hori.	84.256	QP	36.5	7.2	7.5	32.1	19.1	40.0	20.9	311	254	
Hori.	180.489	QP	36.9	15.8	7.7	32.0	28.4	43.5	15.1	169	252	
Hori.	409.511	QP	42.0	16.3	9.1	31.9	35.5	46.0	10.5	100	218	
Hori.	626.213	QP	34.0	19.2	9.9	32.0	31.1	46.0	14.9	131	210	
Hori.	2483.500	PK	48.9	26.9	14.8	41.0	49.6	73.9	24.3	100	206	
Hori.	2484.000	PK	49.0	26.9	14.8	41.0	49.7	73.9	24.2	100	206	
Hori.	2507.058	PK	48.6	26.9	14.9	41.0	49.4	73.9	24.5	100	206	
Hori.	4949.068	PK	49.9	31.7	7.5	41.1	48.0	73.9	25.9	100	167	
Hori.	7423.577	PK	54.2	37.3	9.0	41.1	59.4	73.9	14.5	119	137	
Hori.	9898.063	PK	43.6	38.9	10.0	38.8	53.7	73.9	20.2	100	107	
Hori.	12375.000	PK	43.8	39.7	11.3	39.1	55.7	73.9	18.2	100	0	noise floor level
Hori.	2483.500	AV	38.9	26.9	14.8	41.0	39.6	53.9	14.3	100	206	
Hori.	2484.000	AV	39.0	26.9	14.8	41.0	39.7	53.9	14.2	100	206	
Hori.	2507.058	AV	40.9	26.9	14.9	41.0	41.7	53.9	12.2	100	206	
Hori.	4949.068	AV	41.7	31.7	7.5	41.1	39.8	53.9	14.1	100	167	
Hori.	7423.577	AV	45.1	37.3	9.0	41.1	50.3	53.9	3.6	119	137	
Hori.	9898.063	AV	32.7	38.9	10.0	38.8	42.8	53.9	11.1	100	107	
Hori.	12375.000	AV	32.3	39.7	11.3	39.1	44.2	53.9	9.7	100	0	noise floor level
Vert.	46.124	QP	47.0	12.1	6.7	32.2	33.6	40.0	6.4	100	167	
Vert.	96.023	QP	50.7	9.4	7.4	32.1	35.4	43.5	8.1	100	138	
Vert.	180.489	QP	30.5	15.8	7.7	32.0	22.0	43.5	21.5	100	210	
Vert.	409.511	QP	41.2	16.3	9.1	31.9	34.7	46.0	11.3	148	151	
Vert.	626.213	QP	38.3	19.2	9.9	32.0	35.4	46.0	10.6	100	269	
Vert.	2483.500	PK	49.4	26.9	14.8	41.0	50.1	73.9	23.8	100	138	
Vert.	2484.000	PK	49.5	26.9	14.8	41.0	50.2	73.9	23.7	100	138	
Vert.	2507.058	PK	49.5	26.9	14.9	41.0	50.3	73.9	23.6	100	138	
Vert.	4949.068	PK	51.1	31.7	7.5	41.1	49.2	73.9	24.7	100	229	
Vert.	7423.577	PK	56.7	37.3	9.0	41.1	61.9	73.9	12.0	100	352	
Vert.	9898.063	PK	43.6	38.9	10.0	38.8	53.7	73.9	20.2	109	311	
Vert.	12375.000	PK	43.7	39.7	11.3	39.1	55.6	73.9	18.3	100	0	noise floor level
Vert.	2483.500	AV	39.4	26.9	14.8	41.0	40.1	53.9	13.8	100	138	
Vert.	2484.000	AV	39.5	26.9	14.8	41.0	40.2	53.9	13.7	100	138	
Vert.	2507.058	AV	41.5	26.9	14.9	41.0	42.3	53.9	11.6	100	138	
Vert.	4949.068	AV	43.0	31.7	7.5	41.1	41.1	53.9	12.8	100	229	
Vert.	7423.577	AV	47.7	37.3	9.0	41.1	52.9	53.9	**1.0**	100	352	
Vert.	9898.063	AV	32.8	38.9	10.0	38.8	42.9	53.9	11.0	109	311	
Vert.	12375.000	AV	32.2	39.7	11.3	39.1	44.1	53.9	9.8	100	0	noise floor level

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter-Distance factor(above 15GHz)) - Gain(Amprifier)
Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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Radiated Emission

Test place	No.3 Semi Anechoic Chamber	
Date	October 7, 2013	October 8, 2013
Temperature / Humidity	24deg.C, 53%RH	24deg.C, 59%RH
Engineer	Kenichi Adachi	Kenichi Adachi
Mode	Tx, 2405 MHz	antenna type 2
	IEEE 802.15.4 (ZigBee)	EUT-axis: (Carrier): H: Y, V: X, (Spurious, above 1GHz): H: Y, V: Z, (below 1GHz): H: Y, V: X

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	63.998	QP	25.5	7.4	6.4	32.1	7.2	40.0	32.8	268	115	
Hori.	80.001	QP	25.3	6.4	7.4	32.1	7.0	40.0	33.0	263	111	
Hori.	96.001	QP	22.5	9.4	7.4	32.1	7.2	43.5	36.3	168	113	
Hori.	2373.068	PK	49.2	26.8	14.7	41.1	49.6	73.9	24.3	100	255	
Hori.	2390.000	PK	45.5	26.8	14.7	41.1	45.9	73.9	28.0	100	255	
Hori.	4809.009	PK	50.6	31.0	7.5	41.2	47.9	73.9	26.0	100	69	
Hori.	7213.726	PK	50.9	37.1	9.1	41.0	56.1	73.9	17.8	100	164	
Hori.	9618.018	PK	45.9	38.6	10.2	38.9	55.8	73.9	18.1	100	176	
Hori.	12025.000	PK	46.7	39.6	11.5	39.1	58.7	73.9	15.2	100	0	noise floor level
Hori.	2373.068	AV	40.9	26.8	14.7	41.1	41.3	53.9	12.6	100	255	
Hori.	2390.000	AV	34.8	26.8	14.7	41.1	35.2	53.9	18.7	100	255	
Hori.	4809.009	AV	41.2	31.0	7.5	41.2	38.5	53.9	15.4	100	69	
Hori.	7213.726	AV	40.7	37.1	9.1	41.0	45.9	53.9	8.0	100	164	
Hori.	9618.018	AV	32.6	38.6	10.2	38.9	42.5	53.9	11.4	100	176	
Hori.	12025.000	AV	35.1	39.6	11.5	39.1	47.1	53.9	**6.8**	100	0	noise floor level
Vert.	32.003	QP	30.0	17.2	6.5	32.2	21.5	40.0	18.5	100	142	
Vert.	63.998	QP	35.8	7.4	6.4	32.1	17.5	40.0	22.5	100	207	
Vert.	80.001	QP	31.9	6.4	7.4	32.1	13.6	40.0	26.4	100	153	
Vert.	96.001	QP	27.1	9.4	7.4	32.1	11.8	43.5	31.7	100	112	
Vert.	2373.068	PK	49.6	26.8	14.7	41.1	50.0	73.9	23.9	100	220	
Vert.	2390.000	PK	44.4	26.8	14.7	41.1	44.8	73.9	29.1	100	220	
Vert.	4809.009	PK	47.6	31.0	7.5	41.2	44.9	73.9	29.0	100	344	
Vert.	7213.726	PK	50.8	37.1	9.1	41.0	56.0	73.9	17.9	100	310	
Vert.	9618.018	PK	45.8	38.6	10.2	38.9	55.7	73.9	18.2	100	23	
Vert.	12025.000	PK	46.6	39.6	11.5	39.1	58.6	73.9	15.3	100	0	noise floor level
Vert.	2373.068	AV	41.0	26.8	14.7	41.1	41.4	53.9	12.5	100	220	
Vert.	2390.000	AV	34.7	26.8	14.7	41.1	35.1	53.9	18.8	100	220	
Vert.	4809.009	AV	37.3	31.0	7.5	41.2	34.6	53.9	19.3	100	344	
Vert.	7213.726	AV	40.6	37.1	9.1	41.0	45.8	53.9	8.1	100	310	
Vert.	9618.018	AV	32.5	38.6	10.2	38.9	42.4	53.9	11.5	100	23	
Vert.	12025.000	AV	35.0	39.6	11.5	39.1	47.0	53.9	6.9	100	0	noise floor level

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter-Distance factor(above 15GHz)) - Gain(Amprifier)
Distance factor : 15GHz -40GHz : 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]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2405.000	PK	94.9	26.8	14.7	41.1	95.3	-	-	100	255	carrier
Hori.	2400.000	PK	51.2	26.8	14.7	41.1	51.6	75.3	23.7	100	255	
Vert.	2405.000	PK	95.1	26.8	14.7	41.1	95.5	-	-	100	220	carrier
Vert.	2400.000	PK	51.0	26.8	14.7	41.1	51.4	75.5	24.1	100	220	

Result = Reading + Ant.Fac. + Loss(Cable+Attenuator+Filter) - Gain(Amplifier)

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Radiated Emission

Test place	No.3 Semi Anechoic Chamber	
Date	October 7, 2013	October 8, 2013
Temperature / Humidity	24deg.C, 53%RH	24deg.C, 59%RH
Engineer	Kenichi Adachi	Kenichi Adachi
Mode	Tx, 2440 MHz	antenna type 2
	IEEE 802.15.4 (ZigBee)	EUT-axis: (Carrier): H: Y, V: X, (Spurious, above 1GHz): H: Y, V: Z, (below 1GHz): H: Y, V: X

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	63.999	QP	25.4	7.4	6.4	32.1	7.1	40.0	32.9	271	112	
Hori.	79.999	QP	25.2	6.4	7.4	32.1	6.9	40.0	33.1	266	109	
Hori.	96.000	QP	22.6	9.4	7.4	32.1	7.3	43.5	36.2	173	114	
Hori.	4879.009	PK	49.3	31.4	7.5	41.2	47.0	73.9	26.9	100	72	
Hori.	7318.723	PK	50.2	37.2	9.0	41.1	55.3	73.9	18.6	100	166	
Hori.	9758.019	PK	44.4	38.8	10.1	38.8	54.5	73.9	19.4	100	178	
Hori.	12200.000	PK	44.8	39.6	11.4	39.1	56.7	73.9	17.2	100	0	noise floor level
Hori.	4879.009	AV	39.0	31.4	7.5	41.2	36.7	53.9	17.2	100	72	
Hori.	7318.723	AV	40.0	37.2	9.0	41.1	45.1	53.9	8.8	100	166	
Hori.	9758.019	AV	32.9	38.8	10.1	38.8	43.0	53.9	10.9	100	178	
Hori.	12200.000	AV	33.3	39.6	11.4	39.1	45.2	53.9	8.7	100	0	noise floor level
Vert.	32.004	QP	30.1	17.2	6.5	32.2	21.6	40.0	18.4	100	145	
Vert.	63.999	QP	35.6	7.4	6.4	32.1	17.3	40.0	22.7	100	209	
Vert.	79.999	QP	31.7	6.4	7.4	32.1	13.4	40.0	26.6	100	155	
Vert.	96.000	QP	27.0	9.4	7.4	32.1	11.7	43.5	31.8	100	117	
Vert.	4879.009	PK	47.9	31.4	7.5	41.2	45.6	73.9	28.3	100	346	
Vert.	7318.723	PK	50.0	37.2	9.0	41.1	55.1	73.9	18.8	100	312	
Vert.	9758.019	PK	44.3	38.8	10.1	38.8	54.4	73.9	19.5	100	21	
Vert.	12200.000	PK	44.9	39.6	11.4	39.1	56.8	73.9	17.1	100	0	noise floor level
Vert.	4879.009	AV	37.5	31.4	7.5	41.2	35.2	53.9	18.7	100	346	
Vert.	7318.723	AV	39.8	37.2	9.0	41.1	44.9	53.9	9.0	100	312	
Vert.	9758.019	AV	32.8	38.8	10.1	38.8	42.9	53.9	11.0	100	21	
Vert.	12200.000	AV	33.4	39.6	11.4	39.1	45.3	53.9	**8.6**	100	0	noise floor level

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter-Distance factor(above 15GHz)) - Gain(Amprifier)
Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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Radiated Emission

Test place	No.3 Semi Anechoic Chamber	
Date	October 7, 2013	October 8, 2013
Temperature / Humidity	24deg.C, 53%RH	24deg.C, 59%RH
Engineer	Kenichi Adachi	Kenichi Adachi
Mode	Tx, 2475 MHz	antenna type 2
	IEEE 802.15.4 (ZigBee)	EUT-axis: (Carrier): H: Y, V: X, (Spurious, above 1GHz): H: Y, V: Z, (below 1GHz): H: Y, V: X

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	64.001	QP	25.6	7.4	6.4	32.1	7.3	40.0	32.7	266	113	
Hori.	79.999	QP	25.1	6.4	7.4	32.1	6.8	40.0	33.2	261	105	
Hori.	95.999	QP	22.4	9.4	7.4	32.1	7.1	43.5	36.4	167	111	
Hori.	2483.500	PK	46.5	26.9	14.8	41.0	47.2	73.9	26.7	100	251	
Hori.	2484.000	PK	46.4	26.9	14.8	41.0	47.1	73.9	26.8	100	251	
Hori.	2506.939	PK	48.9	26.9	14.9	41.0	49.7	73.9	24.2	100	251	
Hori.	4949.048	PK	47.9	31.7	7.5	41.1	46.0	73.9	27.9	100	75	
Hori.	7423.551	PK	49.8	37.3	9.0	41.1	55.0	73.9	18.9	100	161	
Hori.	9898.049	PK	43.6	38.9	10.0	38.8	53.7	73.9	20.2	100	174	
Hori.	12375.000	PK	43.7	39.7	11.3	39.1	55.6	73.9	18.3	100	0	noise floor level
Hori.	2483.500	AV	36.4	26.9	14.8	41.0	37.1	53.9	16.8	100	251	
Hori.	2484.000	AV	36.3	26.9	14.8	41.0	37.0	53.9	16.9	100	251	
Hori.	2506.939	AV	40.5	26.9	14.9	41.0	41.3	53.9	12.6	100	251	
Hori.	4949.048	AV	37.3	31.7	7.5	41.1	35.4	53.9	18.5	100	75	
Hori.	7423.551	AV	39.2	37.3	9.0	41.1	44.4	53.9	**9.5**	100	161	
Hori.	9898.049	AV	32.8	38.9	10.0	38.8	42.9	53.9	11.0	100	174	
Hori.	12375.000	AV	32.1	39.7	11.3	39.1	44.0	53.9	9.9	100	0	noise floor level
Vert.	32.001	QP	30.0	17.2	6.5	32.2	21.5	40.0	18.5	100	148	
Vert.	64.001	QP	35.7	7.4	6.4	32.1	17.4	40.0	22.6	100	211	
Vert.	79.999	QP	31.8	6.4	7.4	32.1	13.5	40.0	26.5	100	149	
Vert.	95.999	QP	27.1	9.4	7.4	32.1	11.8	43.5	31.7	100	119	
Vert.	2483.500	PK	46.9	26.9	14.8	41.0	47.6	73.9	26.3	100	224	
Vert.	2484.000	PK	46.8	26.9	14.8	41.0	47.5	73.9	26.4	100	224	
Vert.	2506.939	PK	49.8	26.9	14.9	41.0	50.6	73.9	23.3	100	224	
Vert.	4949.048	PK	49.2	31.7	7.5	41.1	47.3	73.9	26.6	100	341	
Vert.	7423.551	PK	49.5	37.3	9.0	41.1	54.7	73.9	19.2	100	308	
Vert.	9898.049	PK	43.7	38.9	10.0	38.8	53.8	73.9	20.1	100	19	
Vert.	12375.000	PK	43.8	39.7	11.3	39.1	55.7	73.9	18.2	100	0	noise floor level
Vert.	2483.500	AV	36.7	26.9	14.8	41.0	37.4	53.9	16.5	100	224	
Vert.	2484.000	AV	36.6	26.9	14.8	41.0	37.3	53.9	16.6	100	224	
Vert.	2506.939	AV	41.7	26.9	14.9	41.0	42.5	53.9	11.4	100	224	
Vert.	4949.048	AV	38.5	31.7	7.5	41.1	36.6	53.9	17.3	100	341	
Vert.	7423.551	AV	38.9	37.3	9.0	41.1	44.1	53.9	9.8	100	308	
Vert.	9898.049	AV	32.7	38.9	10.0	38.8	42.8	53.9	11.1	100	19	
Vert.	12375.000	AV	32.2	39.7	11.3	39.1	44.1	53.9	9.8	100	0	noise floor level

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter-Distance factor(above 15GHz)) - Gain(Amprifier)
Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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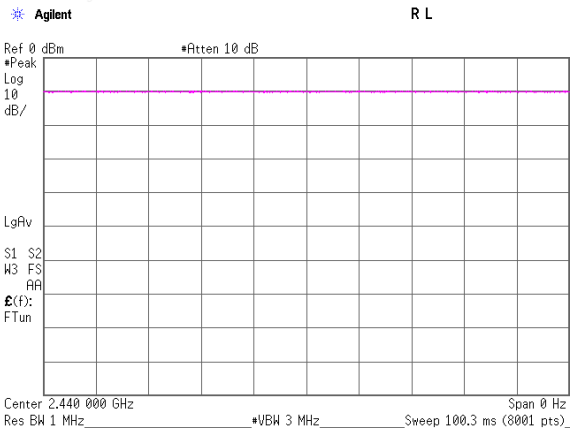
Burst rate confirmation

Tx, IEEE 802.15.4, PN9

Tx2_duty1  	Tx2_duty2

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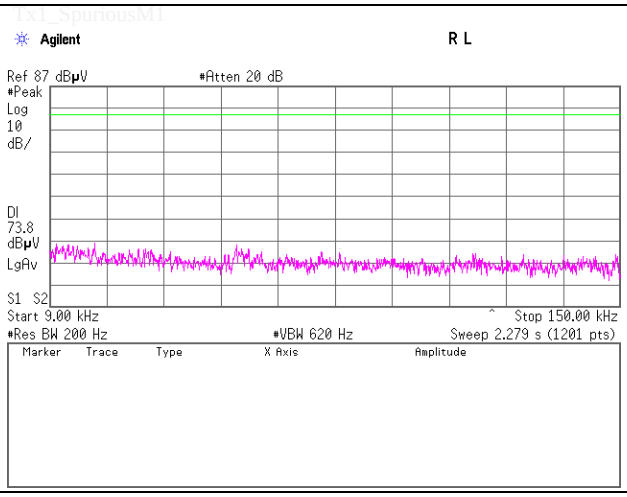
(Reference chart) Spurious emission (Conducted)

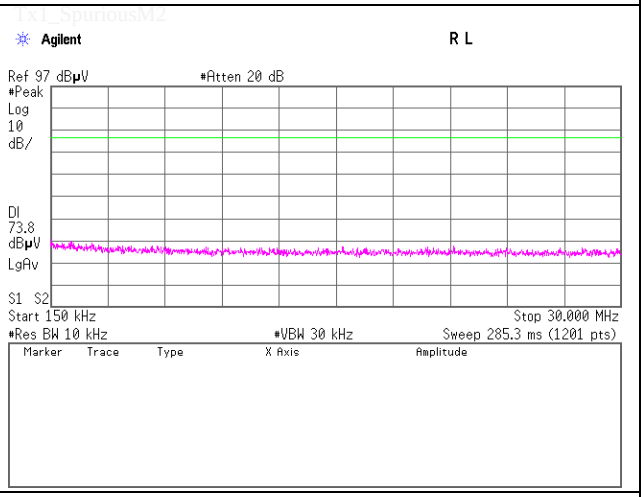
Tx, IEEE 802.15.4, PN9

Tx, 2405MHz (below 1GHz)

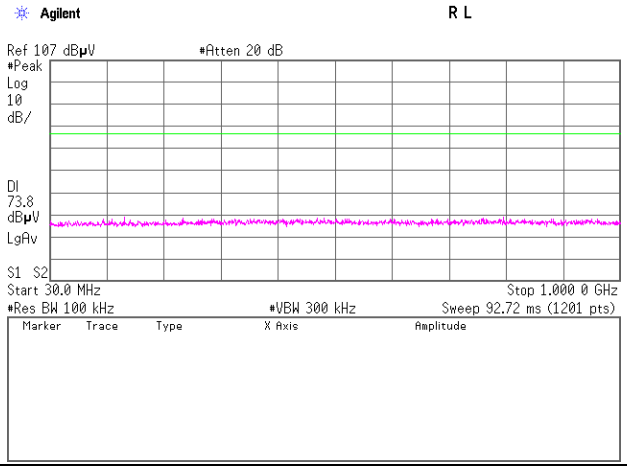
9kHz - 150kHz



150kHz - 30MHz



30MHz - 1GHz



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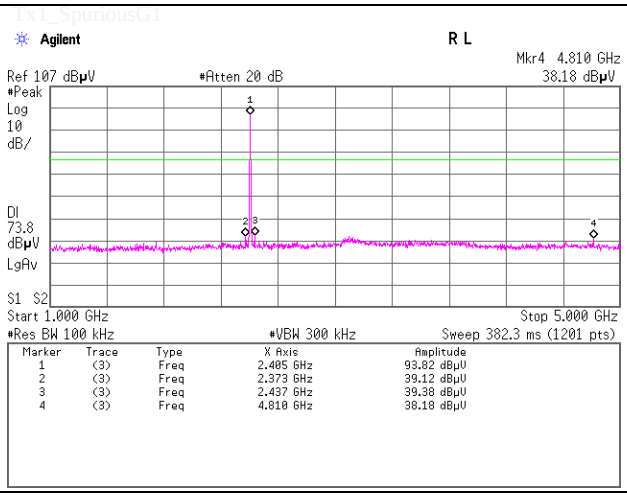
(Reference chart) Spurious emission (Conducted)

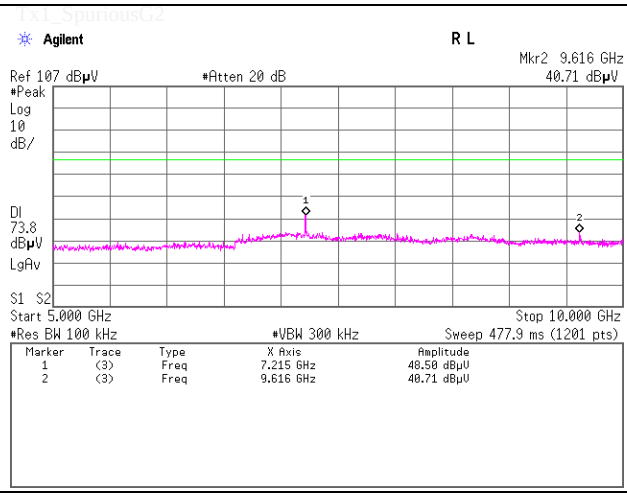
Tx, IEEE 802.15.4, PN9

Tx, 2405MHz (above 1GHz)

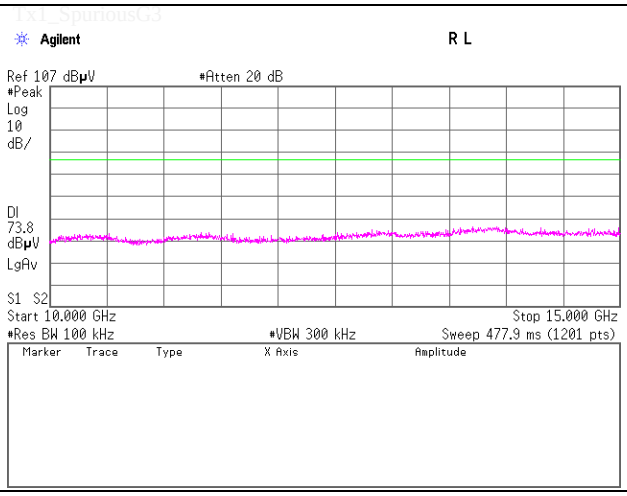
1GHz - 5GHz



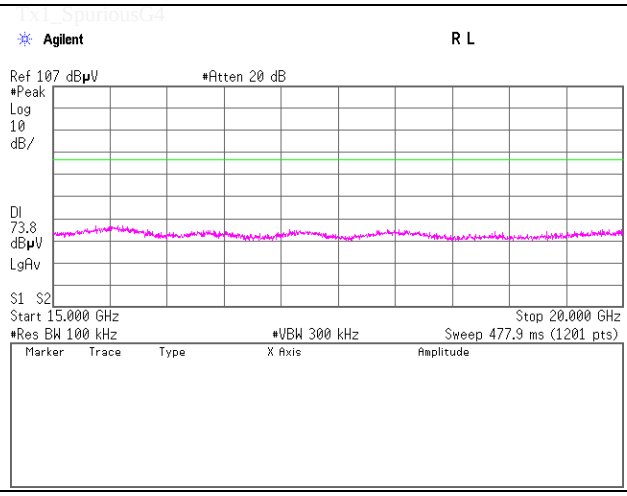
5GHz - 10GHz



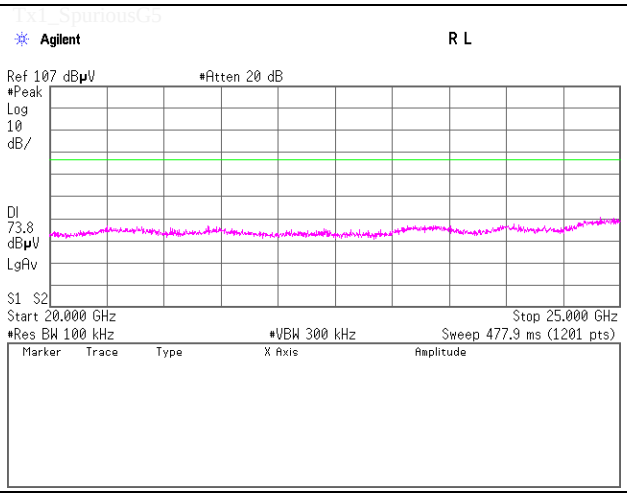
10GHz - 15GHz



15GHz - 20GHz



20GHz - 25GHz



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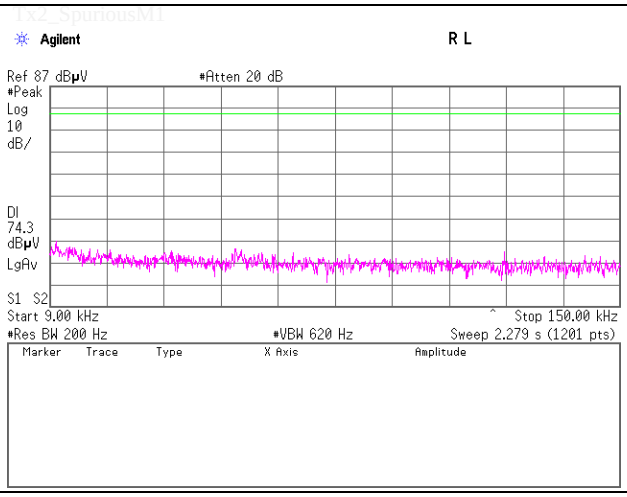
(Reference chart) Spurious emission (Conducted)

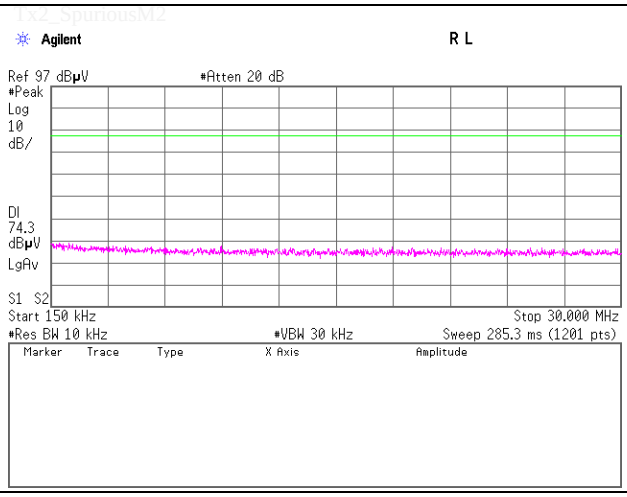
Tx, IEEE 802.15.4, PN9

Tx, 2440MHz (below 1GHz)

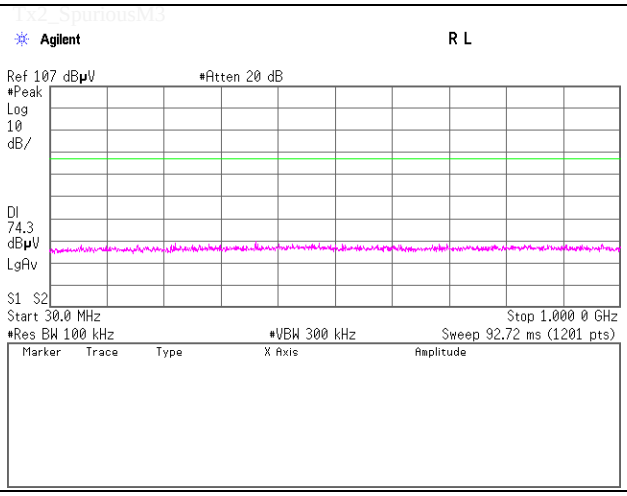
9kHz - 150kHz



150kHz - 30MHz



30MHz - 1GHz



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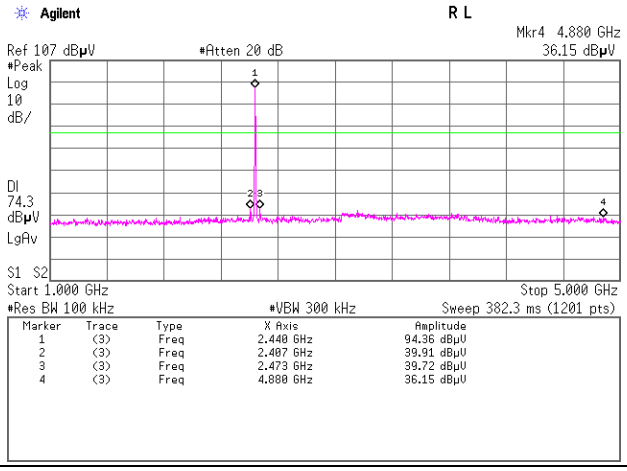
(Reference chart) Spurious emission (Conducted)

Tx, IEEE 802.15.4, PN9

Tx, 2440MHz (above 1GHz)

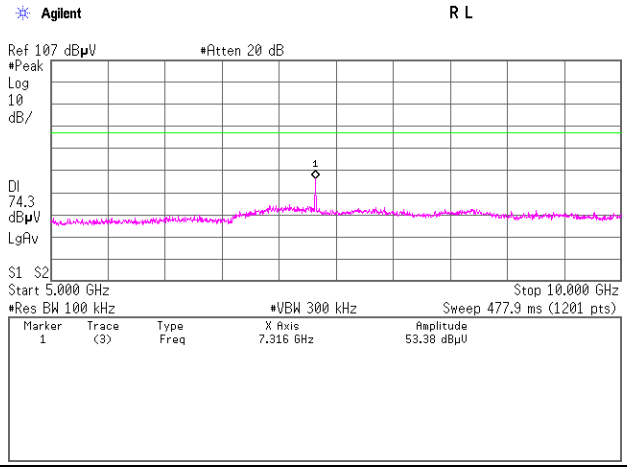
1GHz - 5GHz

Tx2_SpuriousG1



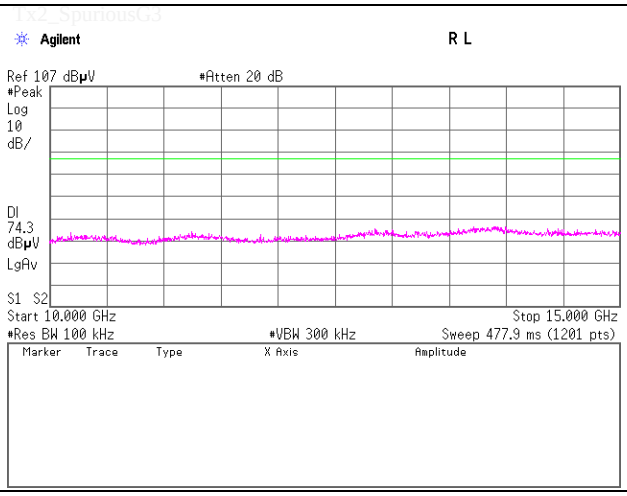
5GHz - 10GHz

Tx2_SpuriousG2



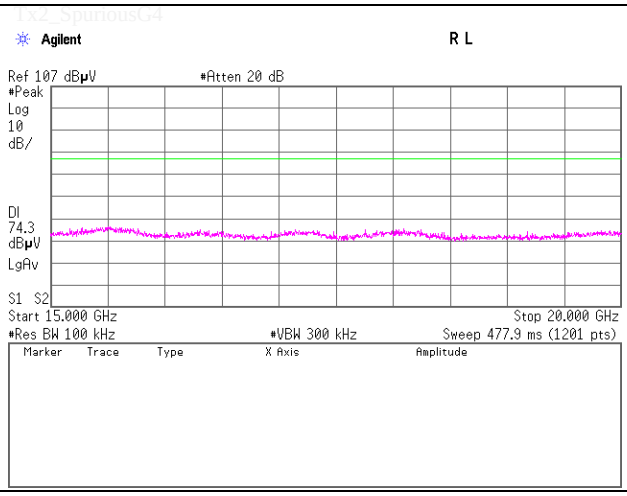
10GHz - 15GHz

Tx2_SpuriousG3



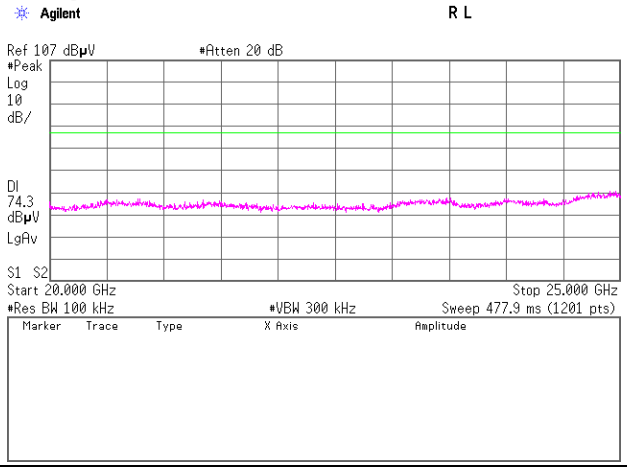
15GHz - 20GHz

Tx2_SpuriousG4



20GHz - 25GHz

Tx2_SpuriousG5



Tx2_SpuriousG6

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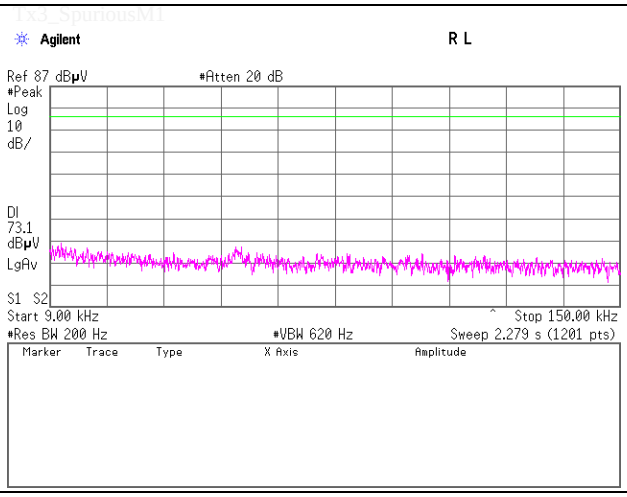
(Reference chart) Spurious emission (Conducted)

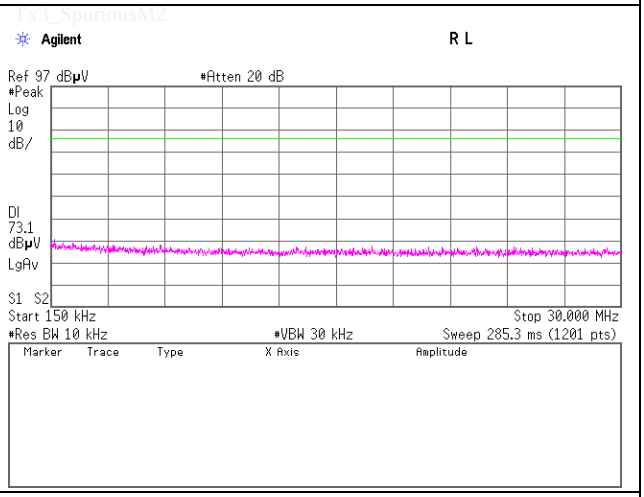
Tx, IEEE 802.15.4, PN9

Tx, 2475MHz (below 1GHz)

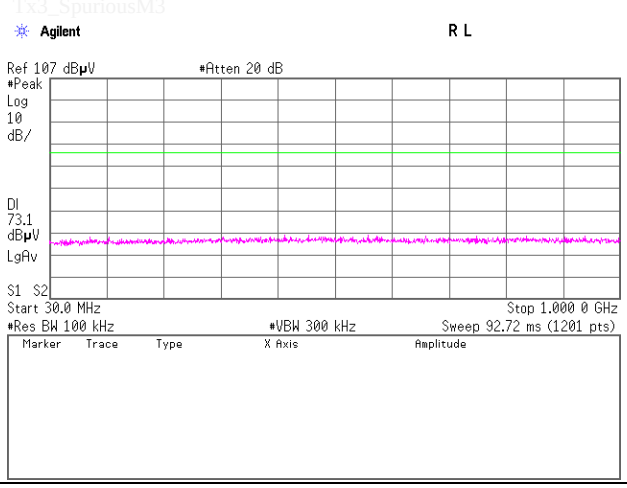
9kHz - 150kHz



150kHz - 30MHz



30MHz - 1GHz



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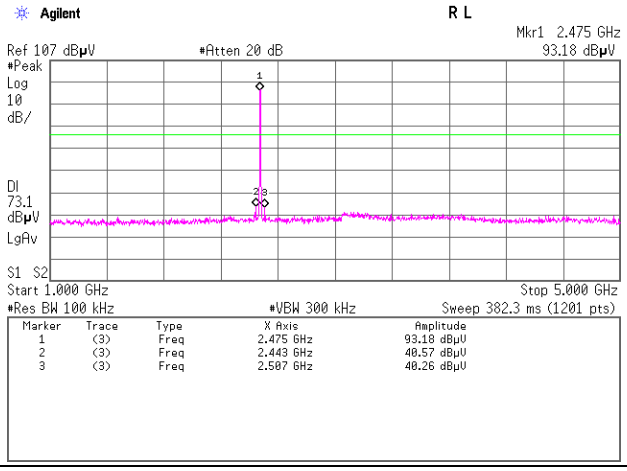
(Reference chart) Spurious emission (Conducted)

Tx, IEEE 802.15.4, PN9

Tx, 2475MHz (above 1GHz)

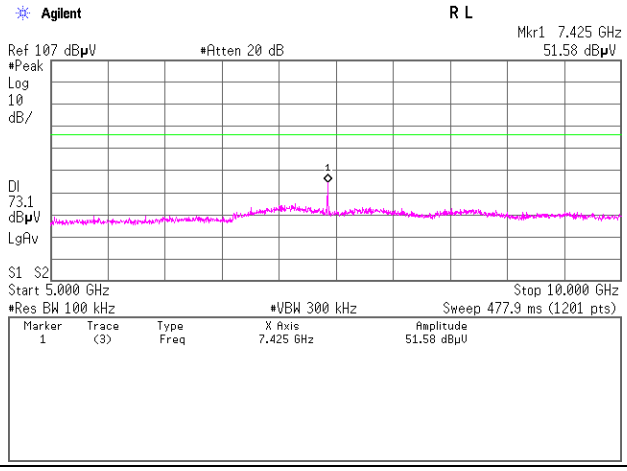
1GHz - 5GHz

Tx3_SpuriousG1



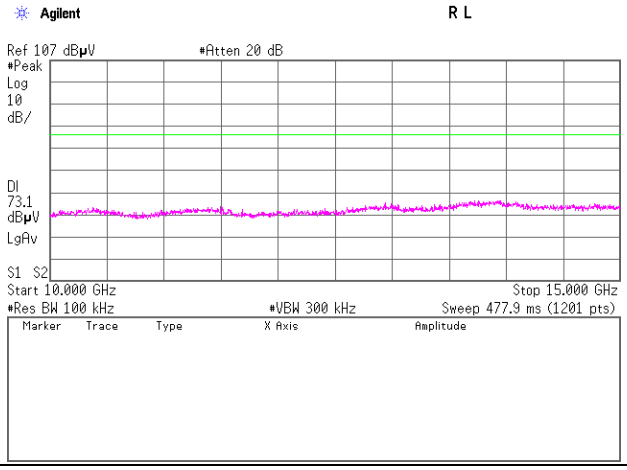
5GHz - 10GHz

Tx3_SpuriousG2



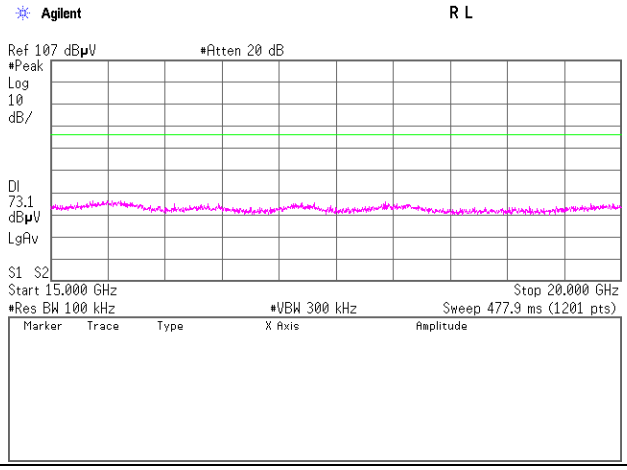
10GHz - 15GHz

Tx3_SpuriousG3



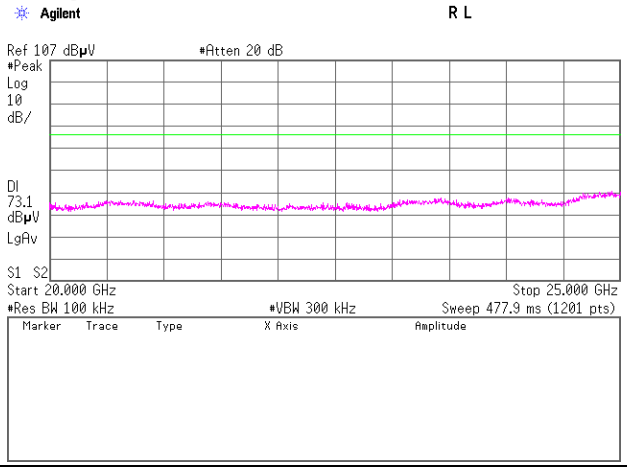
15GHz - 20GHz

Tx3_SpuriousG4



20GHz - 25GHz

Tx3_SpuriousG5



Tx3_SpuriousG6

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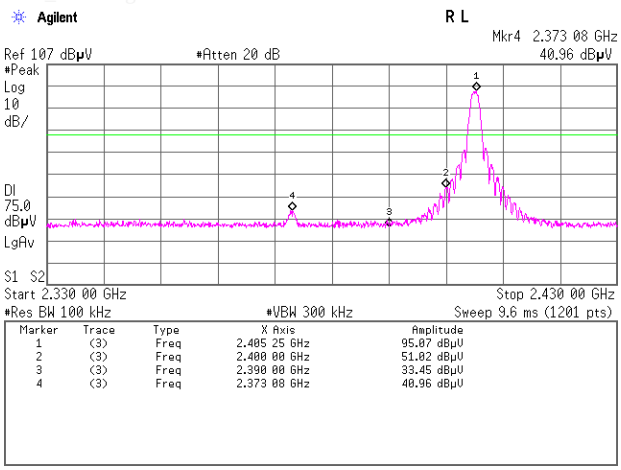
(Reference chart) Spurious emission (Conducted)

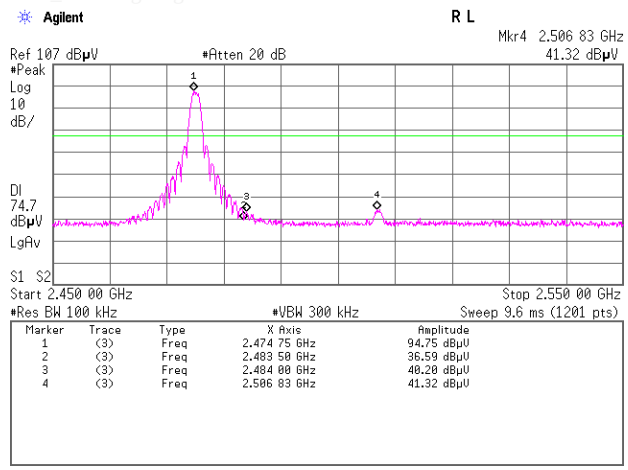
Band Edge compliance

Tx, IEEE 802.15.4, PN9	
Tx, 2405MHz	**Tx, 2475MHz**

TX1_BandEdgeLow



TX3_BandEdgeHigh



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Maximum Power Spectral Density

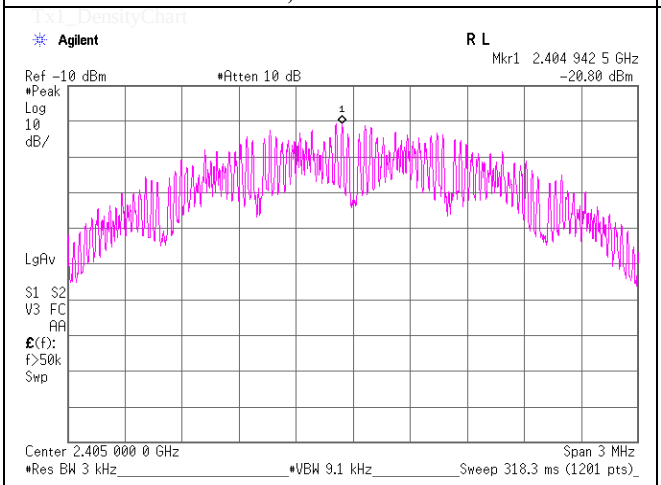
(PKPSD)

Test place	UL Japan, Inc. Shonan EMC Lab.	No.1 Measurement Room
Date	October 7, 2013	
Temperature / Humidity	25deg.C , 56%RH	
Engineer	Tatsuya Arai	
Mode	Tx, IEEE 802.15.4, PN9	

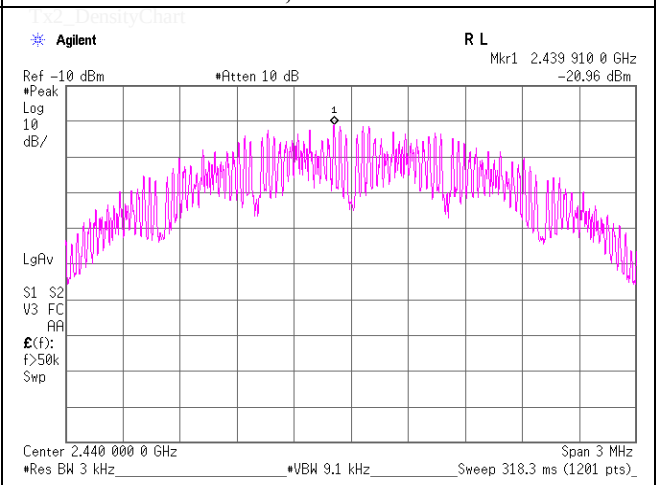
Ch. Freq. [MHz]	Freq. Reading [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2405.0000	2404.94	-20.80	1.52	10.04	-9.24	8.00	17.24
2440.0000	2439.91	-20.96	1.51	10.04	-9.41	8.00	17.41
2475.0000	2474.91	-21.34	1.51	10.04	-9.79	8.00	17.79

Sample Calculation:
Result = Reading + Cable Loss + Atten. Loss

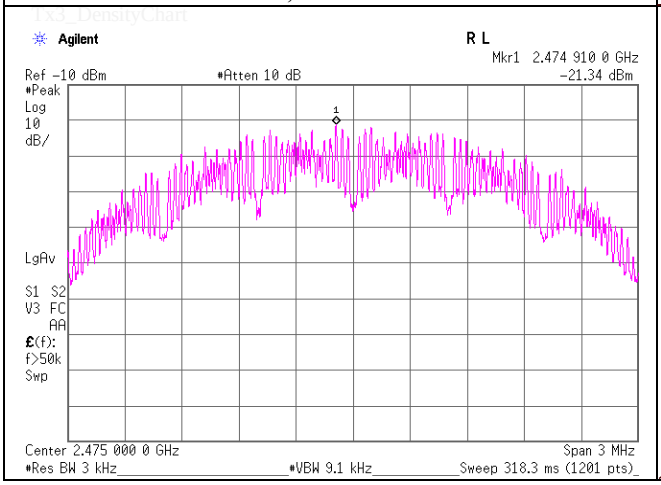
Tx, 2405MHz



Tx, 2440MHz



Tx, 2475MHz



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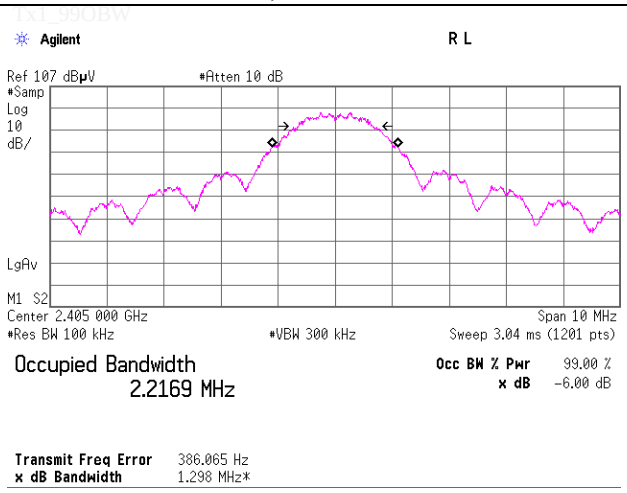
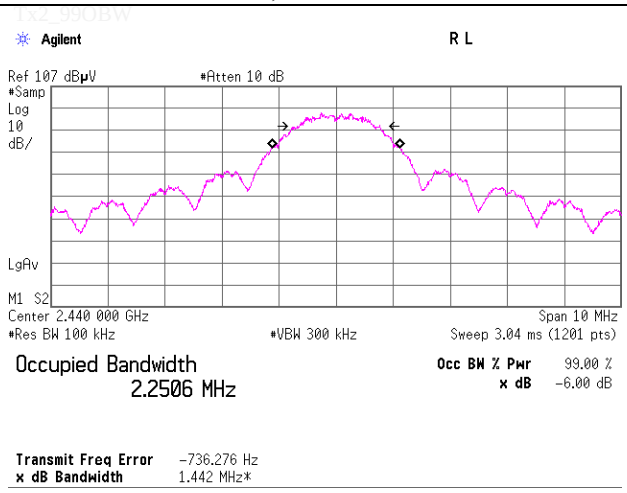
99% Occupied Bandwidth

Tx, IEEE 802.15.4, PN9

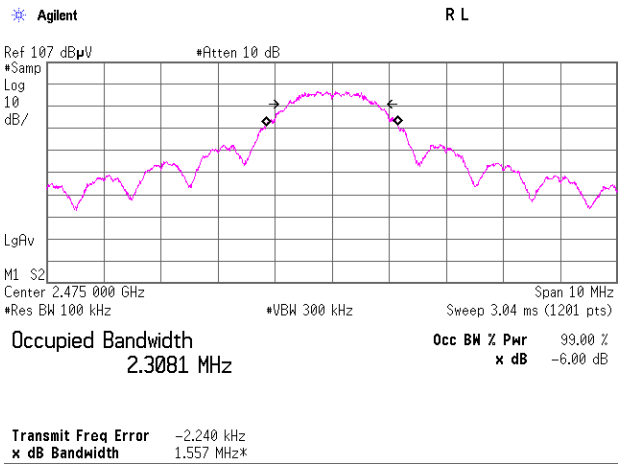
Tx, 2405MHz



Tx, 2440MHz



Tx, 2475MHz



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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)
SPM-06	Power Meter	Anritsu	ML2495A	0850009	AT	2013/04/09 * 12
SPSS-03	Power sensor	Anritsu	MA2411B	0917063	AT	2013/04/09 * 12
KSA-08	Spectrum Analyzer	Agilent	E4446A	MY46180525	AT	2013/03/04 * 12
SAT10-11	Attenuator	Weinschel Corp.	54A-10	37588	AT	2013/04/09 * 12
SCC-G12	Coaxial Cable	Suhner	SUCOFLEX 102	30790/2	AT	2013/03/16 * 12
SOS-09	Humidity Indicator	A&D	AD-5681	4061484	AT	2013/03/07 * 12
SAEC-03(NSA)	Semi-Anechoic Chamber	TDK	SAEC-03(NSA)	3	RE	2013/07/09 * 12
SHA-03	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-739	RE	2013/08/19 * 12
SCC-G03	Coaxial Cable	Suhner	SUCOFLEX 104A	46499/4A	RE	2013/04/11 * 12
SAT10-06	Attenuator	Agilent	8493C-010	74865	RE	2012/12/18 * 12
SFL-02	Highpass Filter	MICRO-TRONICS	HPM50111	051	RE	2012/12/18 * 12
SAF-06	Pre Amplifier	TOYO Corporation	TPA0118-36	1440491	RE	2013/07/22 * 12
SCC-G23	Coaxial Cable	Suhner	SUCOFLEX 104	297342/4	RE	2013/05/22 * 12
SSA-02	Spectrum Analyzer	Agilent	E4448A	MY48250106	RE	2013/03/28 * 12
SOS-05	Humidity Indicator	A&D	AD-5681	4062518	RE	2013/02/27 * 12
SJM-11	Measure	PROMART	SEN1935	-	RE	-
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE,CE, RFI,MF)	-	RE, CE	-
SHA-05	Horn Antenna	ETS LINDGREN	3160-09	LM4210	RE	2013/03/14 * 12
SAF-09	Pre Amplifier	TOYO Corporation	HAP18-26W	00000018	RE	2013/03/19 * 12
SCC-G18	Coaxial Cable	Suhner	SUCOFLEX 104A	46292/4A	RE	2013/03/16 * 12
SBA-03	Biconical Antenna	Schwarzbeck	BBA9106	91032666	RE	2012/10/08 * 12
SLA-03	Logperiodic Antenna	Schwarzbeck	UHALP9108A	UHALP 9108-A 0901	RE	2012/10/08 * 12
SAT6-06	Attenuator	JFW	50HF-006N	-	RE	2013/02/12 * 12
SCC-C1/C2/C3/C4/C5/C10/SRSE-03	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-271(RF Selector)	RE	2013/04/03 * 12
SAF-03	Pre Amplifier	SONOMA	310N	290213	RE	2013/02/12 * 12
STR-06	Test Receiver	Rohde & Schwarz	ESCI	101259	RE	2013/02/27 * 12
SCC-A12/A13/SRSE-01	Coaxial Cable&RF Selector	Suhner/Suhner/TOYO	RG223U/141PE/NS4906	-/0901-269(RF Selector)	CE	2013/04/04 * 12
SLS-02	LISN	Rohde & Schwarz	ENV216	100512	CE(EUT)	2013/02/21 * 12
SAT3-07	Attenuator	JFW	50HF-003N	-	CE	2013/09/04 * 12
SOS-02	Humidity Indicator	A&D	AD-5681	4063343	CE	2013/03/07 * 12
STR-01	Test Receiver	Rohde & Schwarz	ESU40	100093	CE	2012/10/04 * 12
SJM-08	Measure	PROMART	SEN1935	-	CE	-
SLS-01	LISN	Rohde & Schwarz	ENV216	100511	CE	2013/02/22 12
STM-01	Terminator	TME	CT-01 BP	-	CE	2013/01/16 12

The expiration date of the calibration is the end of the expired month .
As for some calibrations performed after the tested dates , those test equipment have been controlled by means of an unbroken chains of calibrations .

All equipment is calibrated with valid calibrations . Each measurement data is traceable to the national or international standards .
Test Item :
CE: Conducted Emission
RE: Spurious Emission (Radiated)
AT: Antenna terminal conducted test