



RADIO TEST REPORT

Test Report No.: 32BE0326-SH-01-A

Applicant : Tokyo Cosmos Electric Co., Ltd.
Type of Equipment : TOCOS wireless engine
Model No. : TWE-001
FCC ID : Z7W-TWE-001
Test regulation : FCC Part15 Subpart C: 2011
Test result : Complied

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3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this test report are traceable to the national or international standards.
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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: November 21 to December 2, 2011

Representative test engineer:

Hikaru Shirasawa
Engineer of WiSE Japan,
UL Verification Service

Approved by :

Go Ishiwata
Manager 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".



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Shonan EMC Lab.

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13-EM-F0429

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SECTION 1: Customer information

Company Name : Tokyo Cosmos Electric Co., Ltd.
Brand Name : TOCOS
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
Serial Number : Refer to Section 4.2.
Rating : DC2.0V-3.6V
Country of Mass-production : Japan
Condition of EUT : Production model
Receipt Date of Sample : November 21, 2011
Modification of EUT : No modification by the test lab.

2.2 Product description

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

Clock frequency in the system : 32MHz

<Radio part>

Equipment type : Transceiver
Frequency of operation : 2405-2475MHz
Bandwidth / Channel spacing : 2MHz & 5MHz
Type of modulation : O-QPSK, DSSS
Antenna type : Pattern (Internal) Antenna
Antenna connector type : N/A
Antenna gain : +4.68dBi (max)
ITU code : G1D
Operation temperature range : -40 to +85 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 of 15.203/212.

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 of Section 15.203/212.

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SECTION 3: Test specification, procedures & results**3.1 Test specification**

Test specification : FCC Part 15 Subpart C: 2011, final revised on July 8, 2011
and effective August 8, 2011

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	Specification	Remarks	Deviation	Worst Margin	Results
Conducted emission	ANSI C63.4:2003 7. AC powerline conducted emission measurements	FCC 15.207	-	N/A	23.6dB Freq.: 4.90215MHz Phase: N Detection: Quasi-Peak Mode: Tx 2475MHz	Complied
6dB bandwidth	"Guidance on Measurement for Digital Transmission Systems Section 15.247" & ANSI C63.4:2003 13. Measurement of intentional radiators	FCC 15.247 (a)(2)	Conducted	N/A	See data	Complied
Maximum peak output power	"Guidance on Measurement for Digital Transmission Systems Section 15.247" & ANSI C63.4:2003 13. Measurement of intentional radiators	FCC 15.247 (b)(3)	Conducted	N/A		Complied
Spurious emission & Restricted band edges	"Guidance on Measurement for Digital Transmission Systems Section 15.247" & ANSI C63.4:2003 13. Measurement of intentional radiators	FCC 15.109, 15.247 (d) & 15.209	Conducted / Radiated	N/A	0.6dB Freq.: 7426.633 MHz Polarization: Vertical Detection: Average Mode: Tx 2475MHz	Complied
Power density	"Guidance on Measurement for Digital Transmission Systems Section 15.247" & ANSI C63.4:2003 13. Measurement of intentional radiators	FCC 15.247 (e)	Conducted	N/A	See data	Complied

Note: UL Japan's Work Procedures No. 13-EM-W0420 and 13-EM-W0422

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3.3 Addition to standard

Item	Test Procedure	Specification	Remarks	Worst Margin	Results
Occupied Bandwidth (99%)	ANSI C63.4:2003 13. Measurement of intentional radiators, RSS-Gen 4.6.1	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) AMN/LISN	150kHz-30MHz	3.6 dB	3.6 dB	3.6 dB
Radiated emission (Measurement distance: 3m)	9kHz-30MHz	3.7 dB	3.7 dB	3.6 dB
	30MHz-300MHz	4.9 dB	5.1 dB	5.0 dB
	300MHz-1GHz	5.0 dB	5.2 dB	5.0 dB
	1GHz-13GHz	4.8 dB	4.8 dB	4.9 dB
Radiated emission (Measurement distance: 1m)	13GHz-18GHz	5.6 dB	5.6 dB	5.6 dB
	18GHz-40GHz	4.8 dB	4.3 dB	4.4 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 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: (±) 1.9dB

Spurious emission (Conducted), Power density Measurement (below 1GHz) uncertainty for this test was: (±) 1.8dB

Spurious emission (Conducted), Power density Measurement (1G-3GHz) uncertainty for this test was: (±) 2.3dB

Spurious emission (Conducted), Power density Measurement (3G-18GHz) uncertainty for this test was: (±) 3.6dB

Spurious emission (Conducted), Power density Measurement (18G-26.5GHz) uncertainty for this test was: (±) 4.0dB

Bandwidth Measurement uncertainty for this test was: (±) 5.4%

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3.5 Test location

UL Japan, Inc. Shonan EMC Lab.

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Telephone number : +81 463 50 6400

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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
<input type="checkbox"/> No.1 Semi-anechoic chamber	697847	2973D-1	20.6 x 11.3 x 7.65	20.6 x 11.3	10m
<input checked="" type="checkbox"/> No.2 Semi-anechoic chamber	697847	2973D-2	20.6 x 11.3 x 7.65	20.6 x 11.3	10m
<input type="checkbox"/> No.3 Semi-anechoic chamber	697847	2973D-3	12.7 x 7.7 x 5.35	12.7 x 7.7	5m
<input type="checkbox"/> No.4 Full-anechoic chamber	-	-	8.1 x 5.1 x 3.55	8.1 x 5.1	-
<input type="checkbox"/> No.1 shielded room	-	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
<input checked="" type="checkbox"/> No.2 shielded room	-	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
<input type="checkbox"/> No.3 shielded room	-	-	6.3 x 4.7 x 2.7	6.3 x 4.7	-
<input type="checkbox"/> No.4 shielded room	-	-	4.4 x 4.7 x 2.7	4.4 x 4.7	-
<input checked="" type="checkbox"/> No.5 shielded room	-	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
<input type="checkbox"/> No.6 shielded room	-	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-

3.6 Test setup, Data of test & Test instruments

Refer to Appendix 1 to 3.

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

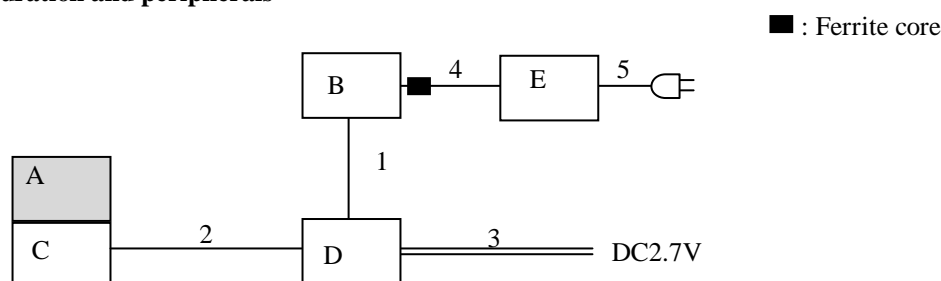
4.1 Operating mode

The EUT exercise program used during testing was designed to exercise the various system components in a manner similar to typical use.

Test item	Mode	Tested frequency	Data rate
All items	Transmitting IEEE 802.15.4	2405MHz, 2440MHz, 2475MHz	250kbps
*1) Software: Customer Module Evaluation Tool (Ver 1.02)			
*2) Power setting: 3			
*3) The worst rate was determined based on the test result of Maximum Peak Output Power (Middle Channel).			

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	*1)	TOCOS	EUT
B	Laptop PC	LATITUDE D400	07898349890122	DELL	-
C	Jig 1	-	-	TOCOS	-
D	Jig 2	-	-	TOCOS	-
E	AC Adaptor	ADP-65JB B	CN-0F8834-48661-57E-6EES	DELL	-

1) 070101D: Conducted emission and Radiated emission, 0800427: Other test

List of cables used

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

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SECTION 5: Conducted emission

5.1 Operating environment

The test was carried out in No.2 shielded room.

Temperature : Refer to test data (APPENDIX 2)
Humidity : Refer to test data (APPENDIX 2)

5.2 Test configuration

EUT was placed on a platform of nominal size, 1m by 1.5m, raised 80cm 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 was aligned and was flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. DC Power Supply was located 80cm from LISN and excess AC cable was bundled in center. Photographs of the set up are shown in Appendix 1.

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 within a screened room. The EUT was connected to a Line Impedance Stabilization Network (LISN) via DC Power Supply. An overview sweep with peak detection has been performed. The measurements had been performed with a quasi-peak detector and if required, an average detector. The conducted emission measurements were made with the following detector of the test receiver.

Detector Type : Quasi-Peak/ Average
IF Bandwidth : 9kHz

5.5 Results

Summary of the test results : Pass
Refer to APPENDIX 2

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

Test procedure

The bandwidth was measured with a spectrum analyzer connected to the antenna port.

Summary of the test results: Pass
Refer to APPENDIX 2

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SECTION 7: Maximum peak output power

Test procedure

The Maximum Peak Output Power was measured with a power meter connected to the antenna port.

Summary of the test results: Pass

Refer to APPENDIX 2

SECTION 8: Spurious emission (Antenna port conducted)

Test procedure

The spurious emission 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 2

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SECTION 9: Radiated emission

9.1 Operating environment

The test was carried out in No.2 Semi-Anechoic Chamber.

Temperature : Refer to test data (APPENDIX 2)

Humidity : Refer to test data (APPENDIX 2)

9.2 Test configuration

EUT was placed on a platform of nominal size, 1m by 1.5m, raised 80cm above the conducting ground plane.

The table is made of Styrofoam and covered with polyvinyl chloride. That has very low permittivity.

The rear of EUT, including its peripherals was aligned and flushed with rear of tabletop.

Test was made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna was varied in height above the conducting ground plane to obtain the maximum signal strength.

Photographs of the set up are shown in Appendix 1.

9.3 Test conditions

Frequency range : 30MHz to 26.5GHz

EUT position : Table top

9.4 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 13GHz) / 1m (above 13GHz). 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 of the test receiver and Spectrum Analyzer.

Frequency	:	30-1000MHz	1000-26500MHz	
Detection Type	:	Quasi-Peak	Peak	* Average
IF Bandwidth	:	120kHz	RBW: 1MHz/VBW: 3MHz	RBW: 1MHz/VBW: 10Hz

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

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.

Worst position:

	Carrier	Spurious			
		30M-1GHz	1-13GHz	13-18GHz	18-26.5GHz
Horizontal	X	X	Z	Z	Z
Vertical	Z	X	Z	Z	Z

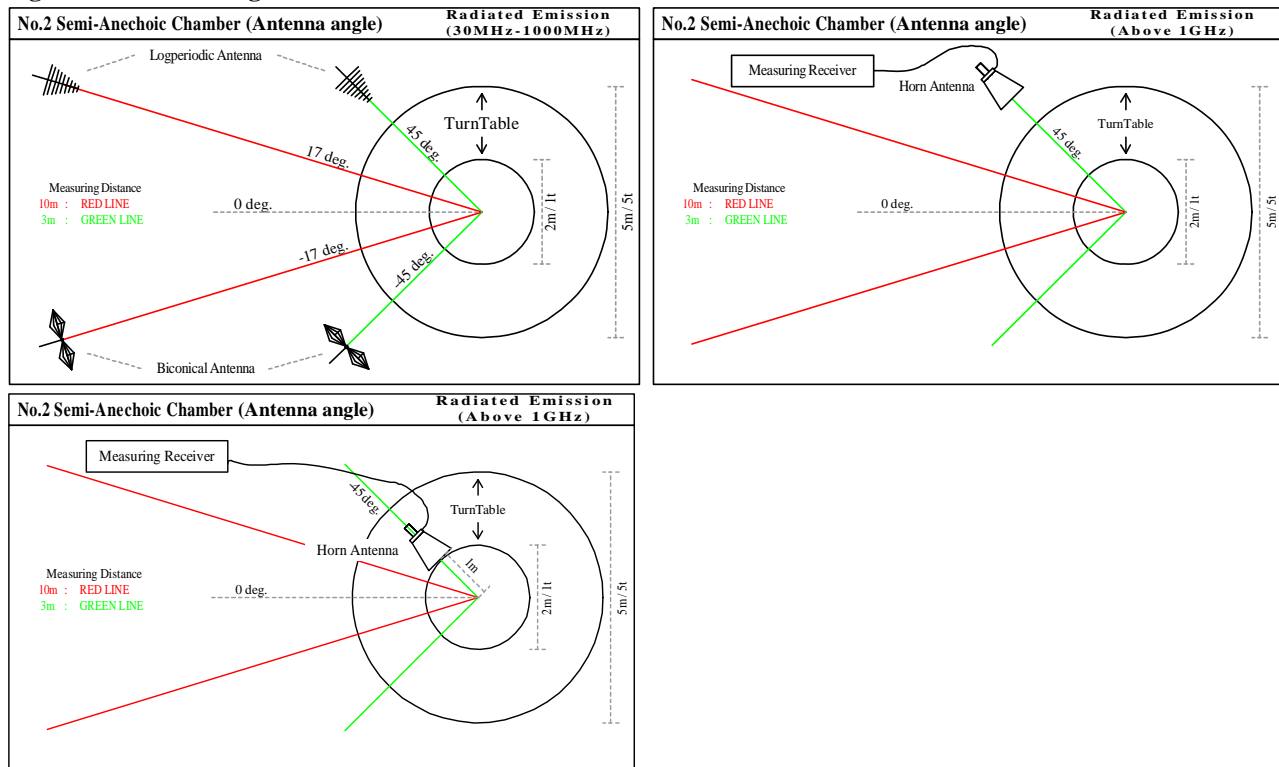
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Figure 1. Antenna angle

9.5 Band edge

Band edge level at 2400MHz is less than 20dB of peak point of the carrier. Refer to the data of Spurious emission (Conducted). Band edge level at 2390MHz and 2483.5MHz are below the limits of FCC 15.209. Refer to the data of Radiated emission.

9.6 Results

Summary of the test results : Pass *No noise was detected above the 5th order harmonics.
Refer to APPENDIX 2

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 *1)
RBW / VBW : 30kHz / 100kHz *2)

*1) PSD Option 1 of " Measurement of Digital Transmission Systems Operating under Section 15.247".

*2) The test was not performed at RBW: 3kHz that was stated in the Regulation. However, the measurement value with RBW: 3kHz is less than the value of RBW: 30kHz and the test data met the limit with RBW: 30kHz.

Summary of the test results: Pass
Refer to APPENDIX 2

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Contents of appendixes

APPENDIX 1: Test data

Conducted emission
6dB bandwidth
Maximum peak output power
Radiated emission
Spurious emission (Antenna port conducted)
Peak power density
99% Occupied bandwidth

APPENDIX 2: Test instruments

Test instruments

APPENDIX 3: Photographs of test setup

Conducted emission
Radiated emission
Pre-check of the worst position

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APPENDIX 1: Test data

DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No. Shielded Room
Date : 2011/12/01

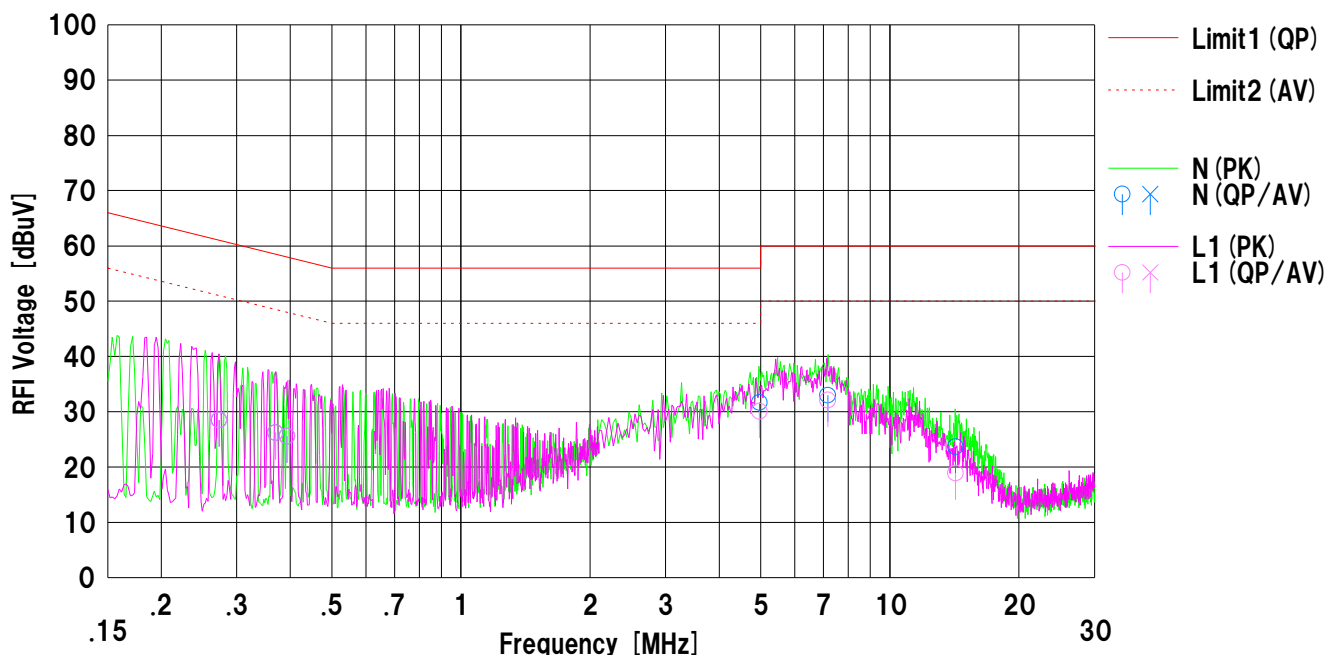
Company : TOKYO COSMOS ELECTRIC CO.,LTD.
Kind of EUT : TOCOS wireless engine
Model No. : TWE-001
Serial No. : 070101D

Mode : Tx 2405MHz
Report No. : 32BE0326-SH-01-A
Power : AC120V/60Hz (EUT:DC2.7V)
Temp./Humi. : 20deg.C /32%RH

Remarks : Internal Antenna

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

Engineer : Hikaru Shirasawa



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	0.27299	15.9	---	12.6	28.5	---	61.0	51.0	32.5	---	N	
2	0.36949	13.5	---	12.7	26.2	---	58.5	48.5	32.3	---	N	
3	0.39282	12.9	---	12.7	25.6	---	58.0	48.0	32.4	---	N	
4	4.96895	18.8	---	12.9	31.7	---	56.0	46.0	24.3	---	N	
5	7.16866	19.9	---	13.1	33.0	---	60.0	50.0	27.0	---	N	
6	14.22243	10.4	---	13.3	23.7	---	60.0	50.0	36.3	---	N	
7	0.27264	15.9	---	12.6	28.5	---	61.0	51.0	32.5	---	L1	
8	0.36949	13.5	---	12.7	26.2	---	58.5	48.5	32.3	---	L1	
9	0.39282	12.9	---	12.7	25.6	---	58.0	48.0	32.4	---	L1	
10	4.96895	17.2	---	12.9	30.1	---	56.0	46.0	25.9	---	L1	
11	7.16866	19.0	---	13.1	32.1	---	60.0	50.0	27.9	---	L1	
12	14.22243	5.6	---	13.3	18.9	---	60.0	50.0	41.1	---	L1	

Calculation: Result [dBuV] = Reading [dBuV] + C.Fac (LISN+Cable+HighPassFilter) [dB]
LISN: SLS-03

DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No.2 Shielded Room
Date : 2011/12/02

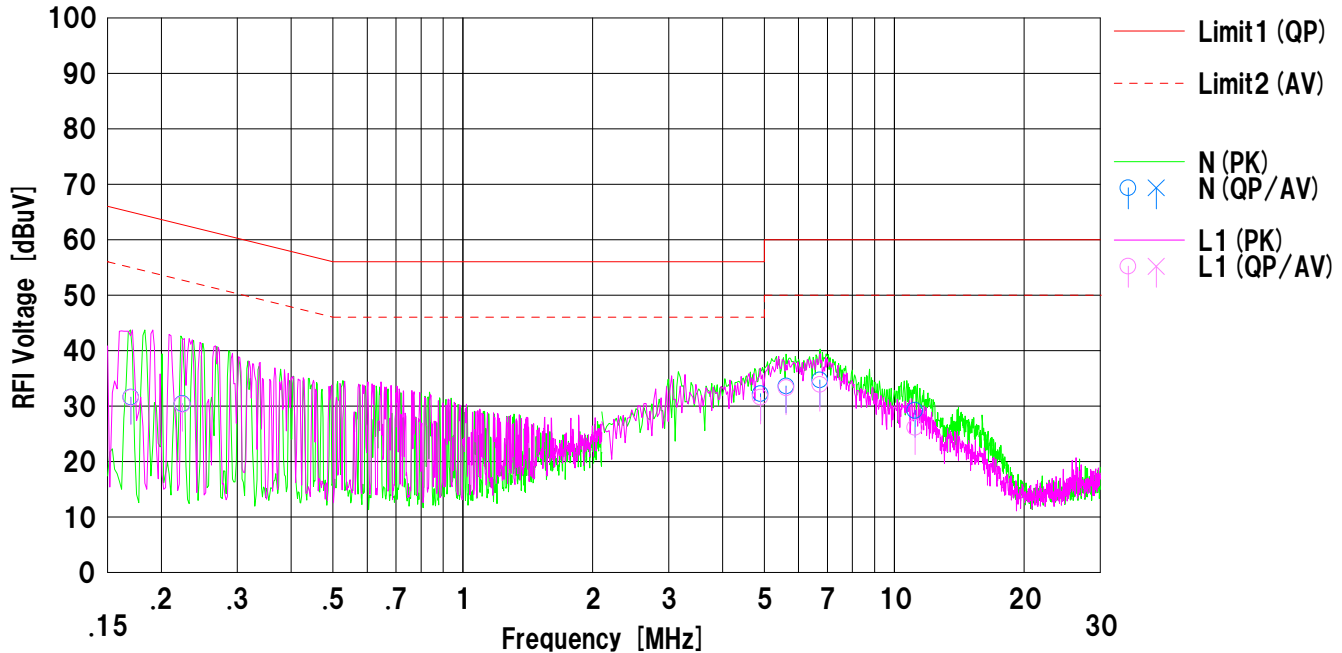
Company : TOKYO COSMOS ELECTRIC CO.,LTD.
Kind of EUT : TOCOS wireless engine
Model No. : TWE-001
Serial No. : 070101D

Mode : Tx 2440MHz
Report No. : 32BE0326-SH-01-A
Power : AC120V/60Hz (EUT:DC2.7V)
Temp./Humi. : 20deg.C / 32%RH

Remarks : Internal Antenna

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

Engineer : Hikaru Shirasawa



No.	Freq. [MHz]	Reading		C.Fac [dB]	Results		Limit		Margin		Phase	Comment
		<QP>	<AV>		<QP>	<AV>	<QP>	<AV>	<QP>	<AV>		
		[dBuV]	[dBuV]		[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.16985	18.9	---	12.7	31.6	---	64.9	54.9	33.3	---	N	
2	0.22372	17.8	---	12.6	30.4	---	62.6	52.6	32.2	---	N	
3	4.89317	19.3	---	12.9	32.2	---	56.0	46.0	23.8	---	N	
4	5.61706	20.6	---	13.0	33.6	---	60.0	50.0	26.4	---	N	
5	6.72061	21.6	---	13.1	34.7	---	60.0	50.0	25.3	---	N	
6	11.17218	15.9	---	13.3	29.2	---	60.0	50.0	30.8	---	N	
7	0.16985	18.8	---	12.7	31.5	---	64.9	54.9	33.4	---	L1	
8	0.22372	17.7	---	12.6	30.3	---	62.6	52.6	32.3	---	L1	
9	4.89317	18.7	---	12.9	31.6	---	56.0	46.0	24.4	---	L1	
10	5.61706	20.3	---	13.0	33.3	---	60.0	50.0	26.7	---	L1	
11	6.72061	20.8	---	13.1	33.9	---	60.0	50.0	26.1	---	L1	
12	11.17202	12.8	---	13.3	26.1	---	60.0	50.0	33.9	---	L1	

Calculation: Result [dBuV] = Reading [dBuV] + C.Fac (ISN+Cable) [dB]
LISN: SLS-03

DATA OF CONDUCTED EMISSION TEST

UL Japan, Inc. Shonan EMC Lab. No. Shielded Room
Date : 2011/12/02

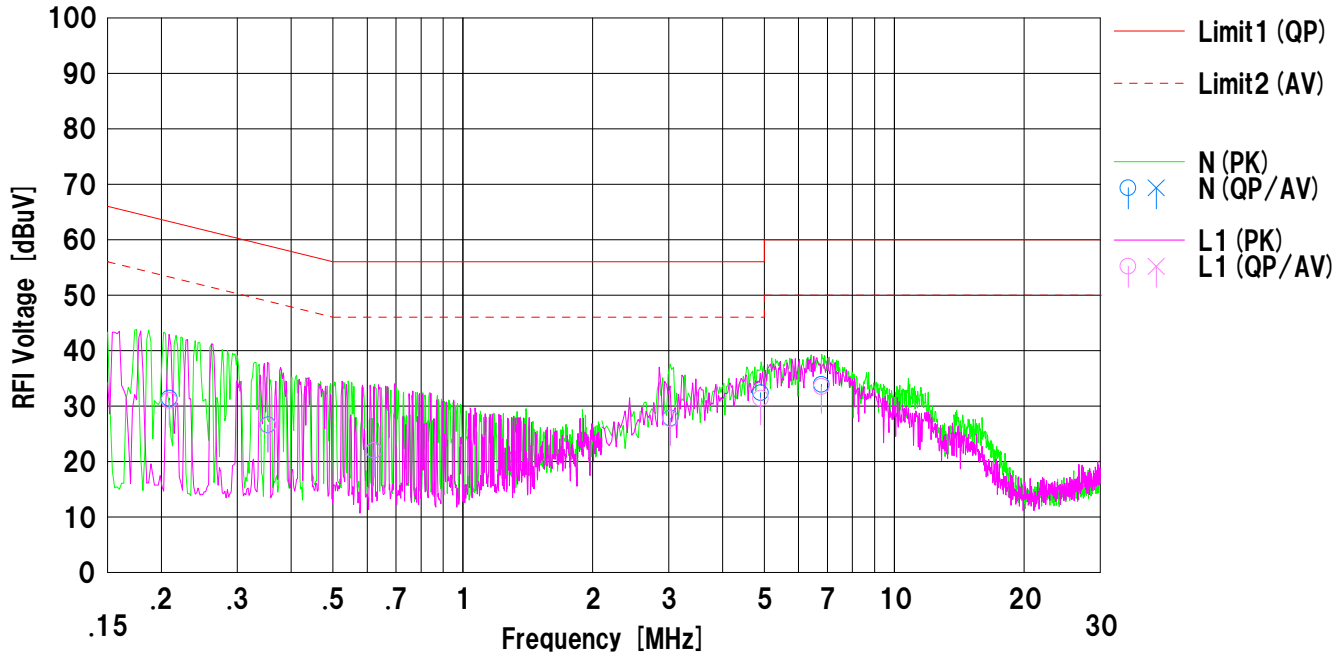
Company : TOKYO COSMOS ELECTRIC CO.,LTD.
Kind of EUT : TOCOS wireless engine
Model No. : TWE-001
Serial No. : 070101D

Mode : Tx 2475MHz
Report No. : 32BE0326-SH-01-A
Power : AC120V/60Hz (EUT:DC2.7V)
Temp./Humi. : 20deg.C / 32%RH

Remarks : Internal Antenna

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

Engineer : Hikaru Shirasawa



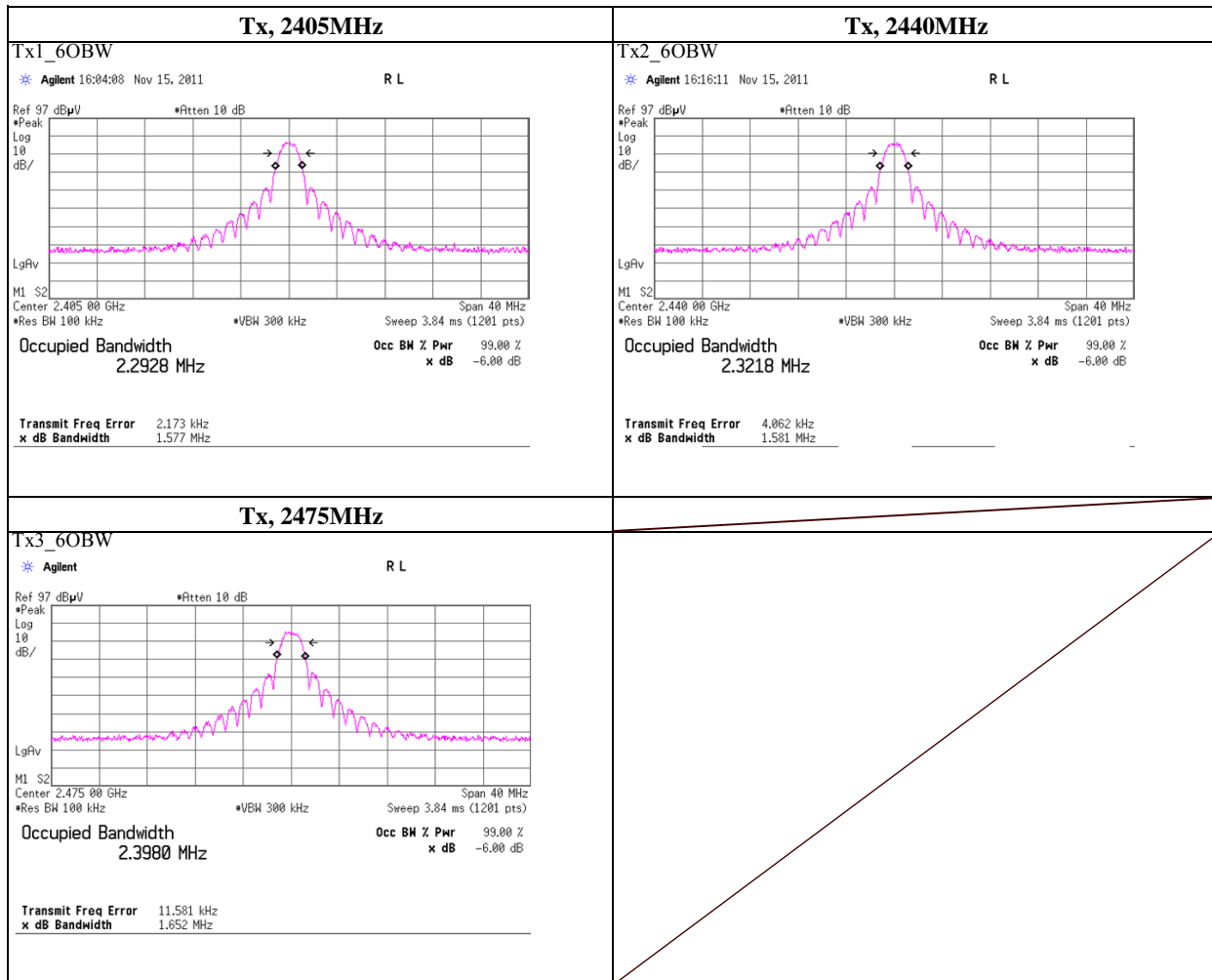
No.	Freq. [MHz]	Reading		C.Fac [dB]	Results		Limit		Margin		Phase	Comment
		<QP>	<AV>		<QP>	<AV>	<QP>	<AV>	<QP>	<AV>		
		[dBuV]	[dBuV]		[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.20868	18.8	---	12.6	31.4	---	63.2	53.2	31.8	---	N	
2	0.35343	13.9	---	12.7	26.6	---	58.8	48.8	32.2	---	N	
3	0.62224	9.3	---	12.7	22.0	---	56.0	46.0	34.0	---	N	
4	3.02892	14.9	---	12.9	27.8	---	56.0	46.0	28.2	---	N	
5	4.90215	19.5	---	12.9	32.4	---	56.0	46.0	23.6	---	N	
6	6.77526	20.8	---	13.1	33.9	---	60.0	50.0	26.1	---	N	
7	0.20868	18.4	---	12.6	31.0	---	63.2	53.2	32.2	---	L1	
8	0.35343	13.8	---	12.7	26.5	---	58.8	48.8	32.3	---	L1	
9	0.62224	9.3	---	12.7	22.0	---	56.0	46.0	34.0	---	L1	
10	3.02892	14.8	---	12.9	27.7	---	56.0	46.0	28.3	---	L1	
11	4.90215	18.5	---	12.9	31.4	---	56.0	46.0	24.6	---	L1	
12	6.77526	20.4	---	13.1	33.5	---	60.0	50.0	26.5	---	L1	

Calculation: Result [dBuV] = Reading [dBuV] + C.Fac (LISN+Cable+HighPassFilter) [dB]
LISN: SLS-03

-6dB Bandwidth

Test place	UL Japan, Inc. Shonan EMC Lab.	No.5 Shielded Room
Date	November 21, 2011	
Temperature / Humidity	21deg.C , 47%RH	
Engineer	Tatsuya Arai	
Mode	Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps	

Freq. [MHz]	-6dB Bandwidth [MHz]	Limit [MHz]
2405.0000	1.577	> 0.500
2440.0000	1.581	> 0.500
2475.0000	1.652	> 0.500

**UL Japan, Inc.****Shonan EMC Lab.**

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worst data mode : 250 kbps

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	-18.37	1.61	20.14	3.38	2.18	30.00	1000	26.62
Mid	2440.0	-18.40	1.63	20.14	3.37	2.17	30.00	1000	26.63
High	2475.0	-18.77	1.64	20.14	3.01	2.00	30.00	1000	26.99

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

[illegible]

Worst

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

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Radiated Emission

Test place: UL Japan, Inc. Shonan EMC Lab. No.2 Semi Anechoic Chamber
 Date: November 30, 2011 December 1, 2011
 Temperature / Humidity: 23deg.C , 49%RH 23deg.C , 45%RH
 Engineer: Hikaru Shirasawa Hikaru Shirasawa
 Mode: Tx, 2405 MHz
 Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps

(* 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.	749.992	QP	29.5	20.5	9.3	31.5	27.8	46	18.2	121	107	
Hori.	2373.000	PK	43.4	27.2	23.9	37.8	56.7	73.9	17.2	100	287	
Hori.	2390.000	PK	42.7	27.2	23.9	37.8	56	73.9	17.9	100	354	
Hori.	4808.880	PK	50.3	31.2	5.8	36.6	50.7	73.9	23.2	132	182	
Hori.	9620.000	PK	31.6	38.4	8.7	37.1	41.6	73.9	32.3	100	0	
Hori.	12025.000	PK	40.5	39.3	9.3	37.9	51.2	73.9	22.7	100	0	
Hori.	2373.000	AV	34.5	27.2	23.9	37.8	47.8	53.9	6.1	100	287	
Hori.	2390.000	AV	33.2	27.2	23.9	37.8	46.5	53.9	7.4	100	354	
Hori.	4808.880	AV	45.2	31.2	5.8	36.6	45.6	53.9	8.3	132	182	
Hori.	9620.000	AV	31.5	38.4	8.7	37.1	41.5	53.9	12.4	100	0	
Hori.	12025.000	AV	32.6	39.3	9.3	37.9	43.3	53.9	10.6	100	0	
Vert.	64.001	QP	45.9	7.3	7.5	31.9	28.8	40	11.2	100	356	
Vert.	114.275	QP	41.4	12.2	8.2	31.8	30	43.5	13.5	100	248	
Vert.	399.645	QP	37.6	16.4	7.6	31.7	29.9	46	16.1	100	206	
Vert.	588.182	QP	34.2	19	8.5	31.6	30.1	46	15.9	100	137	
Vert.	600.153	QP	37.2	19.3	8.6	31.6	33.5	46	12.5	100	147	
Vert.	2373.000	PK	41.9	27.2	23.9	37.8	55.2	73.9	18.7	100	254	
Vert.	2390.000	PK	43.5	27.2	23.9	37.8	56.8	73.9	17.1	108	241	
Vert.	4808.880	PK	49.8	31.2	5.8	36.6	50.2	73.9	23.7	109	193	
Vert.	9620.000	PK	31.8	38.4	8.7	37.1	41.8	73.9	32.1	100	0	
Vert.	12025.000	PK	43.5	39.3	9.3	37.9	54.2	73.9	19.7	100	256	
Vert.	2373.000	AV	33.4	27.2	23.9	37.8	46.7	53.9	7.2	100	254	
Vert.	2390.000	AV	33.3	27.2	23.9	37.8	46.6	53.9	7.3	108	241	
Vert.	4808.880	AV	43.6	31.2	5.8	36.6	44	53.9	9.9	109	193	
Vert.	9620.000	AV	31.3	38.4	8.7	37.1	41.3	53.9	12.6	100	0	
Vert.	12025.000	AV	37.5	39.3	9.3	37.9	48.2	53.9	5.7	100	256	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 13GHz)) - Gain(Amplifier)

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

*The 10th harmonic was not seen so the result was its base noise level.

Distance factor: 13GHz-40GHz 20log(3.0m/1.0m)= 9.5dB

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2405.000	PK	87.3	27.3	23.9	37.8	100.7	-	-	Carrier
Hori.	2400.000	PK	43.4	27.3	23.9	37.8	56.8	80.7	23.9	-
Hori.	7215.000	PK	43.8	36.5	6.8	38.4	48.7	80.7	32.0	-
Vert.	2405.000	PK	81.5	27.3	23.9	37.8	94.9	-	-	Carrier
Vert.	2400.000	PK	38.7	27.3	23.9	37.8	52.1	74.9	22.8	-
Vert.	7213.660	PK	44.1	36.5	6.8	38.4	49.0	74.9	25.9	-

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 13GHz)) - Gain(Amplifier)

UL Japan, Inc.**Shonan EMC Lab.**

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Radiated Emission

Test place UL Japan, Inc. Shonan EMC Lab. No.2 Semi Anechoic Chamber
 Date November 30, 2011 December 1, 2011
 Temperature / Humidity 23deg.C , 49%RH 23deg.C , 45%RH
 Engineer Hikaru Shirasawa Hikaru Shirasawa
 Mode Tx, 2440 MHz
 Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps

(* 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.	749.992	QP	29.5	20.5	9.3	31.5	27.8	46	18.2	121	107	
Hori.	4879.100	PK	47.6	31.4	5.8	36.6	48.2	73.9	25.7	100	225	
Hori.	7318.600	PK	50.3	36.7	6.9	38.4	55.5	73.9	18.4	104	185	
Hori.	9760.000	PK	43.6	38.7	8.6	37.1	53.8	73.9	20.1	100	0	
Hori.	12200.000	PK	43.2	39.4	9.2	38	53.8	73.9	20.1	100	0	
Hori.	4879.100	AV	42.3	31.4	5.8	36.6	42.9	53.9	11.0	100	225	
Hori.	7318.600	AV	46.4	36.7	6.9	38.4	51.6	53.9	2.3	104	185	
Hori.	9760.000	AV	35.4	38.7	8.6	37.1	45.6	53.9	8.3	100	0	
Hori.	12200.000	AV	35.5	39.4	9.2	38	46.1	53.9	7.8	100	0	
Vert.	64.001	QP	45.9	7.3	7.5	31.9	28.8	40	11.2	100	356	
Vert.	114.275	QP	41.4	12.2	8.2	31.8	30	43.5	13.5	100	248	
Vert.	399.645	QP	37.6	16.4	7.6	31.7	29.9	46	16.1	100	206	
Vert.	588.182	QP	34.2	19	8.5	31.6	30.1	46	15.9	100	137	
Vert.	600.153	QP	37.2	19.3	8.6	31.6	33.5	46	12.5	100	147	
Vert.	4879.100	PK	49.3	31.4	5.8	36.6	49.9	73.9	24.0	100	180	
Vert.	7318.600	PK	48.6	36.7	6.9	38.4	53.8	73.9	20.1	104	297	
Vert.	9760.000	PK	43.2	38.7	8.6	37.1	53.4	73.9	20.5	100	0	
Vert.	12200.000	PK	43.9	39.4	9.2	38	54.5	73.9	19.4	100	311	
Vert.	4879.100	AV	41.3	31.4	5.8	36.6	41.9	53.9	12.0	100	180	
Vert.	7318.600	AV	42.5	36.7	6.9	38.4	47.7	53.9	6.2	104	297	
Vert.	9760.000	AV	34.3	38.7	8.6	37.1	44.5	53.9	9.4	100	0	
Vert.	12200.000	AV	36.2	39.4	9.2	38	46.8	53.9	7.1	100	311	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 13GHz)) - Gain(Amplifier)

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

*The 10th harmonic was not seen so the result was its base noise level.

Distance factor: 13GHz-40GHz $20\log(3.0\text{m}/1.0\text{m}) = 9.5\text{dB}$

Radiated Emission

Test place UL Japan, Inc. Shonan EMC Lab. No.2 Semi Anechoic Chamber
 Date November 30, 2011 December 1, 2011
 Temperature / Humidity 23deg.C , 49%RH 23deg.C , 45%RH
 Engineer Hikaru Shirasawa Hikaru Shirasawa
 Mode Tx, 2475 MHz
 Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps

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

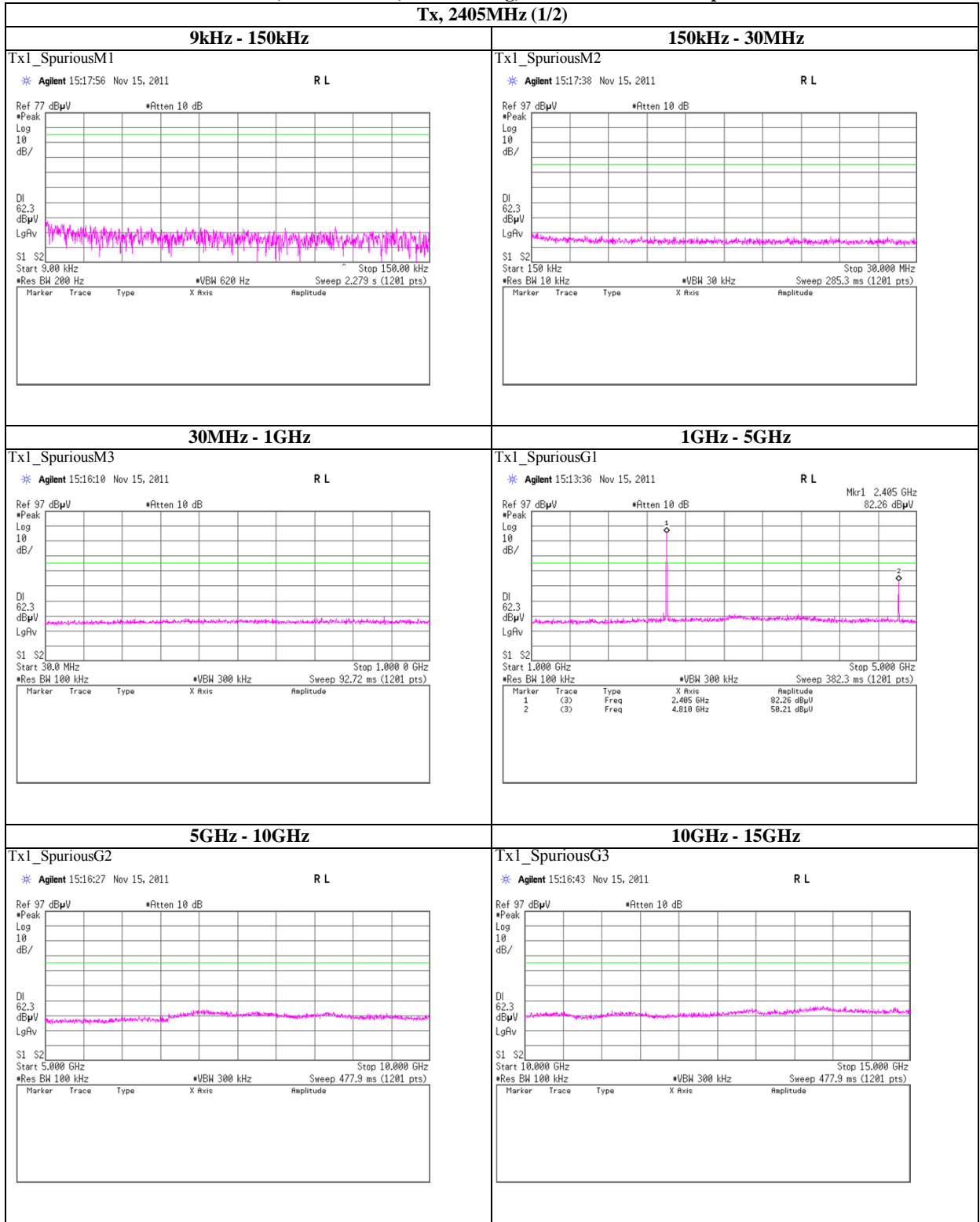
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg.]	Remark
Hori.	749.684	QP	29.6	20.5	9.3	31.5	27.9	46	18.1	100	69	
Hori.	2483.500	PK	43.6	27.5	23.9	37.6	57.4	73.9	16.5	117	335	
Hori.	2484.920	PK	42.5	27.5	23.9	37.6	56.3	73.9	17.6	117	335	
Hori.	2506.500	PK	43.6	27.6	23.9	37.6	57.5	73.9	16.4	117	335	
Hori.	4949.030	PK	44.3	31.5	5.7	36.5	45	73.9	28.9	100	190	
Hori.	7426.633	PK	52.7	36.9	6.9	38.4	58.1	73.9	15.8	100	231	
Hori.	9900.000	PK	43	39	8.6	37.2	53.4	73.9	20.5	100	0	
Hori.	12375.000	PK	44.2	39.5	9.2	38	54.9	73.9	19.0	100	0	
Hori.	2483.500	AV	33.4	27.5	23.9	37.6	47.2	53.9	6.7	117	335	
Hori.	2484.920	AV	33.5	27.5	23.9	37.6	47.3	53.9	6.6	117	335	
Hori.	2506.500	AV	33.9	27.6	23.9	37.6	47.8	53.9	6.1	117	335	
Hori.	4949.030	AV	40.5	31.5	5.7	36.5	41.2	53.9	12.7	100	190	
Hori.	7426.633	AV	45.7	36.9	6.9	38.4	51.1	53.9	2.8	100	231	
Hori.	9900.000	AV	33.6	39	8.6	37.2	44	53.9	9.9	100	0	
Hori.	12375.000	AV	33.8	39.5	9.2	38	44.5	53.9	9.4	100	0	
Vert.	65.997	QP	45.3	7	7.5	31.9	27.9	40	12.1	100	327	
Vert.	114.243	QP	40.8	12.1	8.2	31.8	29.3	43.5	14.2	100	221	
Vert.	399.654	QP	35.8	16.4	7.6	31.7	28.1	46	17.9	120	208	
Vert.	589.750	QP	34.8	19.1	8.5	31.6	30.8	46	15.2	100	21	
Vert.	599.543	QP	35.8	19.3	8.6	31.6	32.1	46	13.9	112	142	
Vert.	2483.500	PK	43.5	27.5	23.9	37.6	57.3	73.9	16.6	100	210	
Vert.	2484.920	PK	42.8	27.5	23.9	37.6	56.6	73.9	17.3	100	210	
Vert.	2506.500	PK	44.6	27.6	23.9	37.6	58.5	73.9	15.4	100	210	
Vert.	4949.030	PK	45.3	31.5	5.7	36.5	46	73.9	27.9	100	192	
Vert.	7426.633	PK	55.2	36.9	6.9	38.4	60.6	73.9	13.3	100	126	
Vert.	9900.000	PK	44.2	39	8.6	37.2	54.6	73.9	19.3	100	0	
Vert.	12375.000	PK	43.1	39.5	9.2	38	53.8	73.9	20.1	100	0	
Vert.	2483.500	AV	33.8	27.5	23.9	37.6	47.6	53.9	6.3	100	210	
Vert.	2484.920	AV	33.8	27.5	23.9	37.6	47.6	53.9	6.3	100	210	
Vert.	2506.500	AV	33.7	27.6	23.9	37.6	47.6	53.9	6.3	100	210	
Vert.	4949.030	AV	39.2	31.5	5.7	36.5	39.9	53.9	14.0	100	192	
Vert.	7426.633	AV	47.9	36.9	6.9	38.4	53.3	53.9	0.6	100	126	
Vert.	9900.000	AV	33.8	39	8.6	37.2	44.2	53.9	9.7	100	0	
Vert.	12375.000	AV	36.5	39.5	9.2	38	47.2	53.9	6.7	100	0	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 13GHz)) - Gain(Amplifier)

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

*The 10th harmonic was not seen so the result was its base noise level.

Distance factor: 13GHz-40GHz $20\log(3.0\text{m}/1.0\text{m})= 9.5\text{dB}$

Spurious emission (Conducted)**Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps****Tx, 2405MHz (1/2)****UL Japan, Inc.****Shonan EMC Lab.**

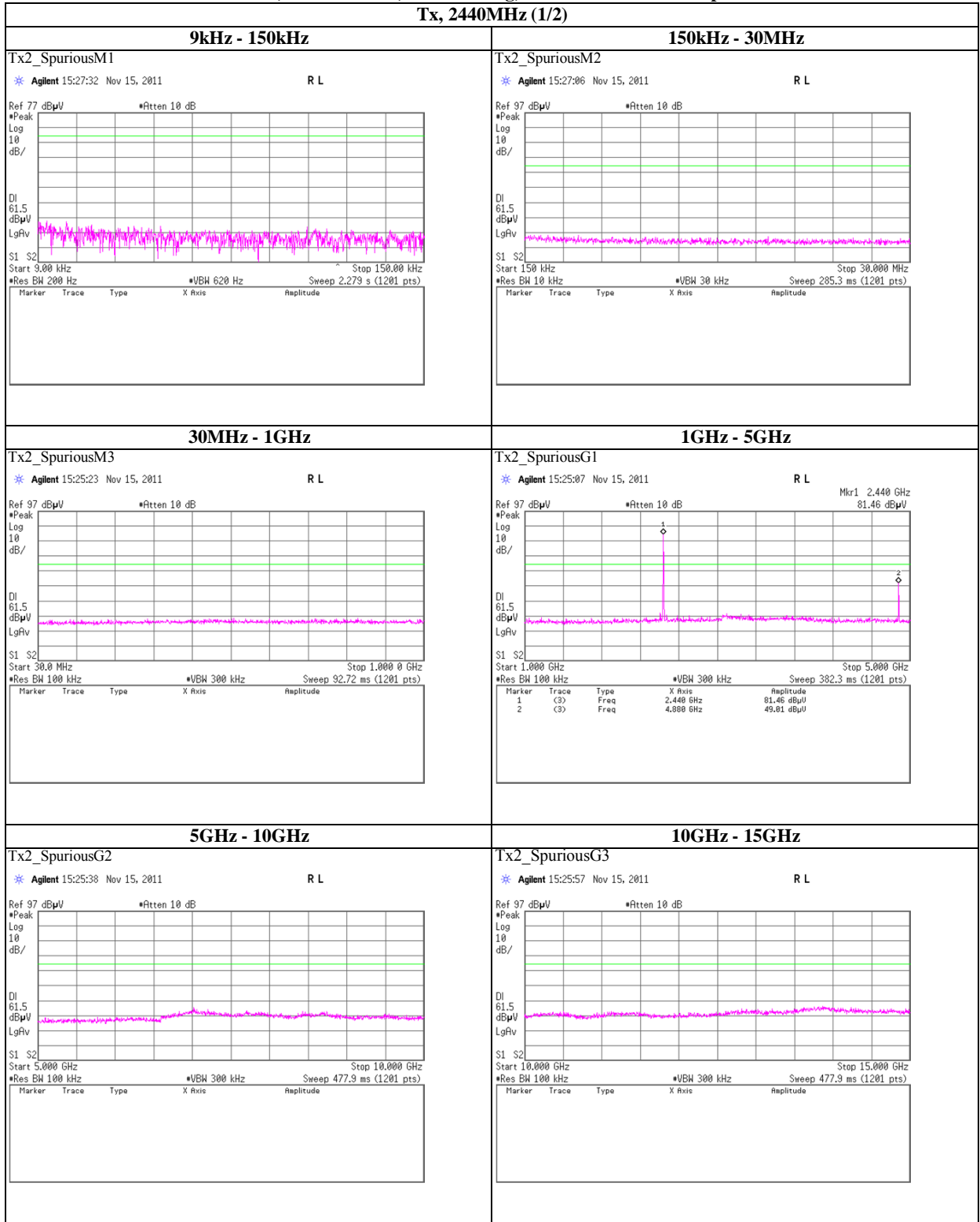
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Spurious emission (Conducted)
Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps
Tx, 2405MHz (2/2)

Tx, 2405MHz (2/2)	
15GHz - 20GHz	20GHz - 25GHz
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Spurious emission (Conducted)**Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps****Tx, 2440MHz (1/2)****UL Japan, Inc.****Shonan EMC Lab.**

1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa 259-1220 JAPAN

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

Spurious emission (Conducted)
Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps
Tx, 2440MHz (2/2)

Tx, 2440MHz (2/2)	
15GHz - 20GHz	20GHz - 25GHz
<div><div>Tx2_SpuriousG4</div><div><div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div><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Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps

Tx, 2475MHz (1/2)

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25

Tx, IEEE802.15.4, Transmitting, worst data mode 250kbps

Tx, 2475MHz (2/2)

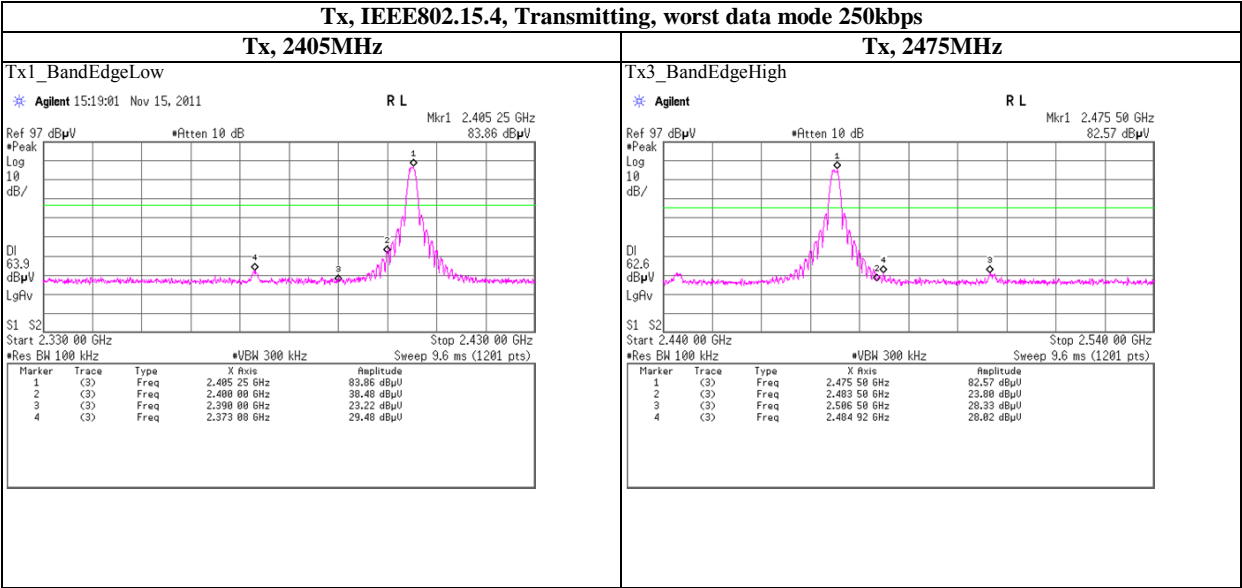
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26

Spurious emission (Conducted)

Band Edge compliance



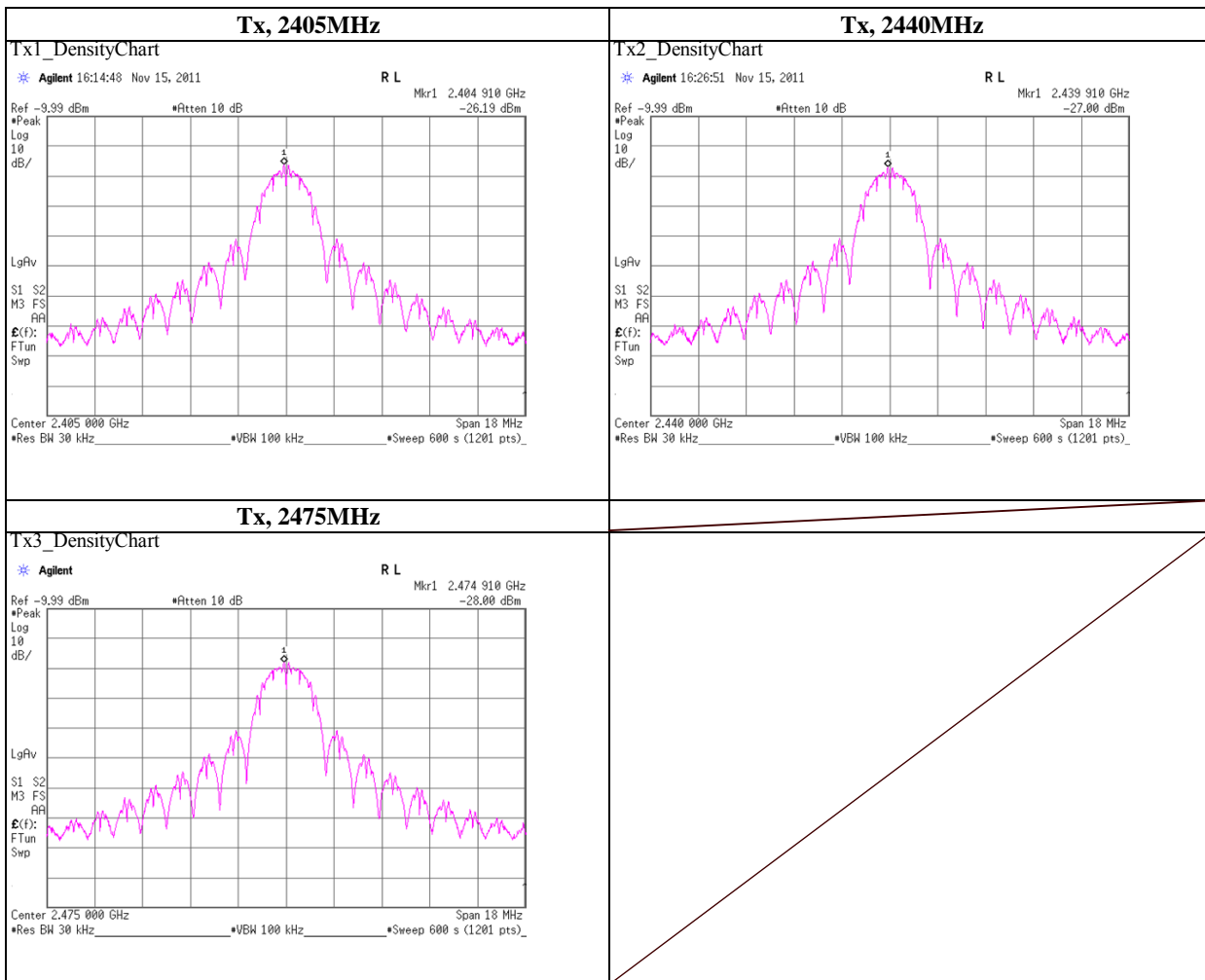
Power Density

Test place	UL Japan, Inc. Shonan EMC Lab.	No.5 Shielded Room
Date	November 21, 2011	
Temperature / Humidity	21deg.C , 47%RH	
Engineer	Tatsuya Arai	
Mode	Tx, IEEE802.15.4, worst data mode 250kbps	

Ch. Freq. [MHz]	Freq. Reading [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2405.0000	2404.91	-26.19	1.61	20.14	-4.44	8.00	12.44
2440.0000	2439.91	-27.00	1.63	20.14	-5.23	8.00	13.23
2475.0000	2474.91	-28.00	1.64	20.14	-6.22	8.00	14.22

Sample Calculation:

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



UL Japan, Inc.

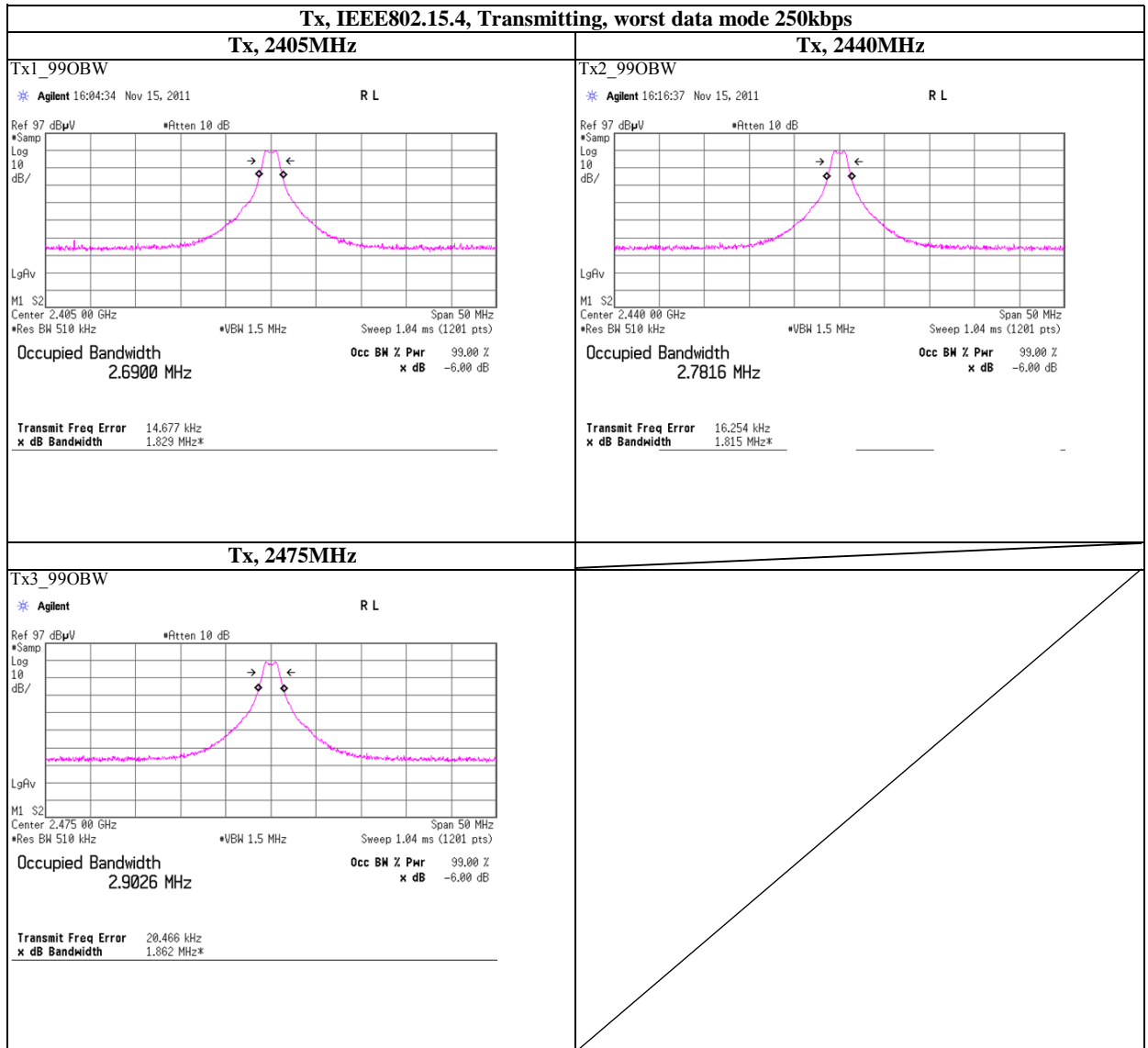
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99% Occupied Bandwidth



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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)
KSA-08	Spectrum Analyzer	Agilent	E4446A	MY46180525	AT	2011/02/02 * 12
SCC-G13	Coaxial Cable	Suhner	SUCOFLEX 102	31599/2	AT	2011/03/23 * 12
SAT20-03	Attenuator	Agilent	8493C-020	74891	AT	2011/03/23 * 12
SAF-05	Pre Amplifier	TOYO Corporation	TPA0118-36	1440490	RE	2011/03/23 * 12
SCC-G02	Coaxial Cable	Suhner	SUCOFLEX 104A	46498/4A	RE	2011/04/28 * 12
SCC-G22	Coaxial Cable	Suhner	SUCOFLEX 104	296199/4	RE	2011/05/27 * 12
SHA-02	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-726	RE	2011/08/28 * 12
SOS-03	Humidity Indicator	A&D	AD-5681	4063325	RE	2011/02/23 * 12
SJM-02	Measure	KOMELON	KMC-36	-	RE	-
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE,CE, RFLMF)	-	CE	-
SAF-04	Pre Amplifier	TOYO Corporation	TPA0118-36	1440489	RE	2011/03/23 * 12
SCC-G17	Coaxial Cable	Suhner	SUCOFLEX 104A	46291/4A	RE	2011/03/16 * 12
STR-02	Test Receiver	Rohde & Schwarz	ESCI	100575	CE,RE	2011/08/04 * 12
SCC-B12/B13/ SRSE-02	Coaxial Cable&RF Selector	Suhner/Suhner/TOYO	RG223U/141PE/N S4906	-/0901-270 (RF Selector)	CE	2011/04/28 * 12
SLS-03	LISN	Rohde & Schwarz	ENV216	100513	CE(EUT)	2011/02/23 * 12
SLS-04	LISN	Rohde & Schwarz	ENV216	100514	CE	2011/02/23 * 12
SAT3-05	Attenuator	JFW	50HF-003N	-	CE	2011/02/17 * 12
SOS-04	Humidity Indicator	A&D	AD-5681	4061512	CE	2011/03/02 * 12
STM-03	Terminator	TME	CT-01 BP	-	CE	2011/01/07 * 12
SJM-02	Measure	KOMELON	KMC-36	-	CE	-

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: Radiated emission ,

AT: Antenna terminal disturbance voltage