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FCC RADIO TEST REPORT

Applicant's company	**Aptos Technology**
Applicant Address	No. 398, Youyi Rd., Jhunan Township, Miaoli County 350, Taiwan R.O.C.
FCC ID	**XPQAMWZ5168CL**
Manufacturer's company	**Aptos Technology**
Manufacturer Address	No. 398, Youyi Rd., Jhunan Township, Miaoli County 350, Taiwan R.O.C.

Product Name	ZigBee module
Brand Name	Aptos
Model No.	AMWZ5168-CL
Test Rule	47 CFR FCC Part 15 Subpart C § 15.247
Test Freq. Range	2405~ 2475MHz
Received Date	Jan. 29, 2014
Final Test Date	Feb. 19, 2014
Submission Type	Original Equipment

Statement

Test result included is only for the IEEE 802.15.4 ZigBee part of the product.

The test result in this report refers exclusively to the presented test model / sample.

Without written approval of SPORTON International Inc., the test report shall not be reproduced except in full.

The measurements and test results shown in this test report were made in accordance with the procedures and found in compliance with the limit given in **ANSI C63.10-2009**, **47 CFR FCC Part 15 Subpart C** and **KDB 558074 D01 v03r01**.

The test equipment used to perform the test is calibrated and traceable to NML/ROC.

Testing Laboratory
1190

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History of This Test Report

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR422138	Rev. 01	Initial issue of report	Mar. 04, 2014

Certificate No.: CB10302145

1. CERTIFICATE OF COMPLIANCE

Product Name	:	ZigBee module
Brand Name	:	Aptos
Model No.	:	AMWZ5168-CL
Applicant	:	Aptos Technology
Test Rule Part(s)	:	47 CFR FCC Part 15 Subpart C § 15.247

Sporton International as requested by the applicant to evaluate the EMC performance of the product sample received on Jan. 29, 2014 would like to declare that the tested sample has been evaluated and found to be in compliance with the tested rule parts. The data recorded as well as the test configuration specified is true and accurate for showing the sample's EMC nature.

Sam Chen

Sam Chen

SPORTON INTERNATIONAL INC.

2. SUMMARY OF THE TEST RESULT

Applied Standard: 47 CFR FCC Part 15 Subpart C				
Part	Rule Section	Description of Test	Result	Under Limit
4.1	15.207	AC Power Line Conducted Emissions	Complies	16.04 dB
4.2	15.247(b)(3)	Maximum Conducted Output Power	Complies	26.59 dB
4.3	15.247(e)	Power Spectral Density	Complies	16.69 dB
4.4	15.247(a)(2)	6dB Spectrum Bandwidth	Complies	-
4.5	15.247(d)	Radiated Emissions	Complies	2.54 dB
4.6	15.247(d)	Band Edge Emissions	Complies	6.78 dB
4.7	15.203	Antenna Requirements	Complies	-

3. GENERAL INFORMATION

3.1. Product Details

Items	Description
Power Type	From host system
Modulation	DSSS (O-QPSK)
Data Rate (Mbps)	DSSS (250kbps)
Frequency Range	2405～ 2475MHz
Channel Number	15
Channel Band Width (99%)	2.29 MHz
Maximum Conducted Output Power	3.41 dBm
Carrier Frequencies	Please refer to section 3.4
Antenna	Please refer to section 3.3

3.2. Accessories

N/A

3.3. Table for Filed Antenna

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)	Cable Loss (dB)	Test Gain (dBi)
1	REYAX	ANT-GSC1	Dipole Antenna	SMA Female	3	0.6	2.4

3.4. Table for Carrier Frequencies

Frequency Band	Channel No.	Frequency	Channel No.	Frequency
2405 ～ 2475MHz	11	2405 MHz	19	2445 MHz
	12	2410 MHz	20	2450 MHz
	13	2415 MHz	21	2455 MHz
	14	2420 MHz	22	2460 MHz
	15	2425 MHz	23	2465 MHz
	16	2430 MHz	24	2470 MHz
	17	2435 MHz	25	2475 MHz
	18	2440 MHz	-	-

3.5. Table for Test Modes

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. Investigation has been done on all the possible configurations for searching the worst cases. The following table is a list of the test modes shown in this test report.

Test Items	Mode	Data Rate	Channel	Antenna
AC Power Line Conducted Emissions	CTX	-	-	-
Maximum Conducted Output Power	TX Mode	250 kbps	11/19/25	-
Power Spectral Density 6dB Spectrum Bandwidth	TX Mode	250 kbps	11/19/25	-
Radiated Emissions 9kHz～1GHz	CTX	-	-	-
Radiated Emissions 1GHz～10th Harmonic	TX Mode	250 kbps	11/19/25	1
Band Edge Emissions	TX Mode	250 kbps	11/19/25	1

The following test modes were performed for all tests:

For Conducted Emission test:

Mode 1. CTX

For Radiated Emission test:

Mode 1. CTX

3.6. Table for Testing Locations

Test Site Location				
Address:	No.8, Lane 724, Bo-ai St., Jhubei City, Hsinchu County 302, Taiwan, R.O.C.			
TEL:	886-3-656-9065			
FAX:	886-3-656-9085			
Test Site No.	**Site Category**	**Location**	**FCC Reg. No.**	**IC File No.**
03CH01-CB	SAC	Hsin Chu	262045	IC 4086D
CO01-CB	Conduction	Hsin Chu	262045	IC 4086D
TH01-CB	OVEN Room	Hsin Chu	-	-

Open Area Test Site (OATS); Semi Anechoic Chamber (SAC).

3.7. Table for Supporting Units

For Test Site No: 03CH01-CB

Support Unit	Brand	Model	FCC ID
Notebook	DELL	M1330	DoC
Fixture	NXP	DR1174 1V3	N/A

For Test Site No: CO01-CB / TH01-CB

Support Unit	Brand	Model	FCC ID
Notebook	DELL	E6430	DoC
Fixture	NXP	DR1174 1V3	N/A

3.8. Table for Parameters of Test Software Setting

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

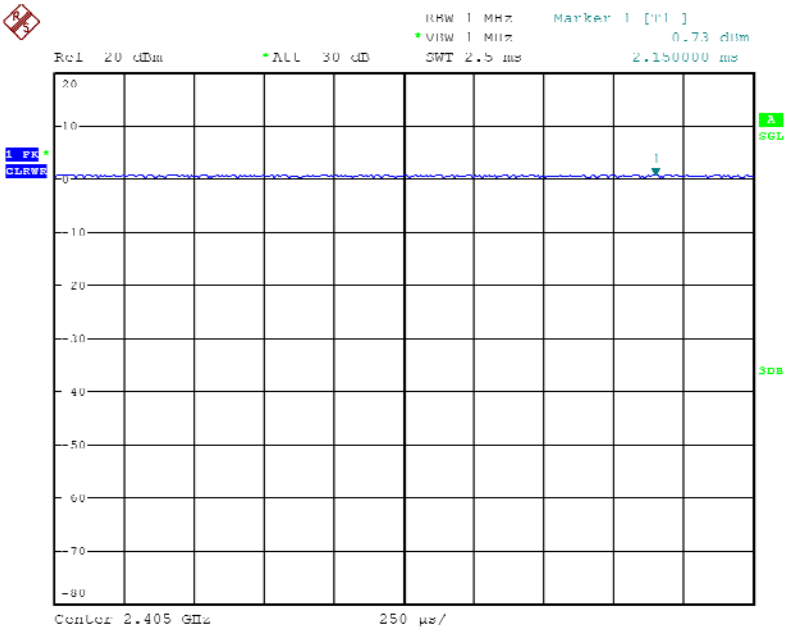
Power Parameters of IEEE 802.15.4 ZigBee

Test Software Version	HyperTrm		
Frequency	2405 MHz	2445 MHz	2475 MHz
IEEE 802.15.4 ZigBee	3	3	3

3.9. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

3.10. Duty Cycle



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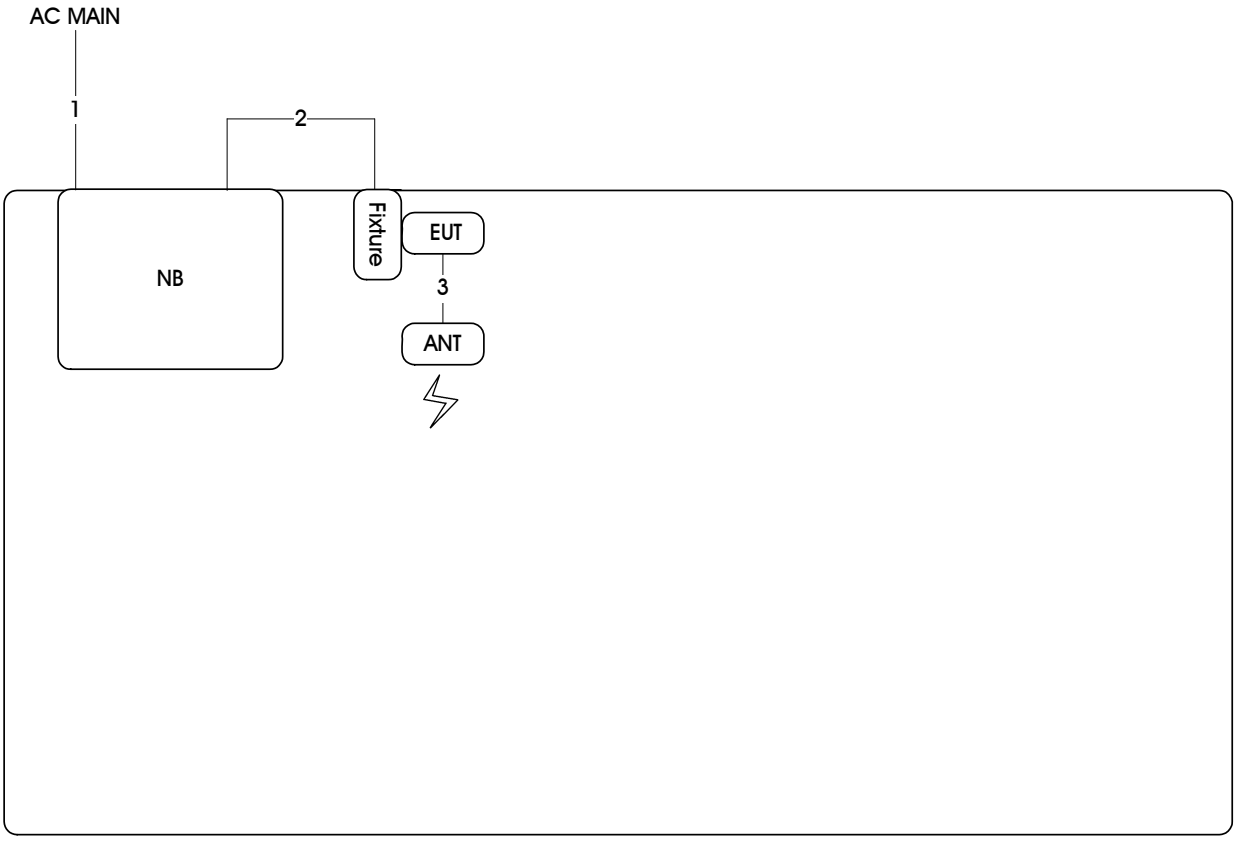
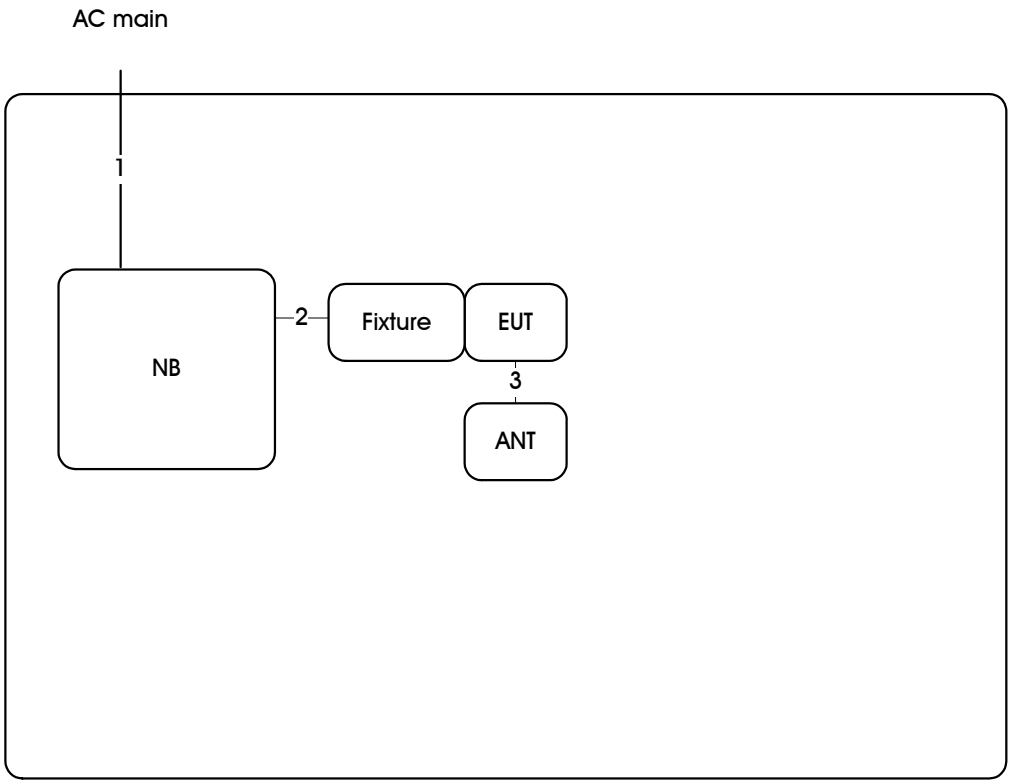
3.11. Test Configurations

3.11.1. AC Power Line Conduction Emissions Test Configuration



Item	Connection	Shield	Length
1	Power cable	No	2.6m
2	USB cable	No	0.9m
3	ANT cable	Yes	0.1m

3.11.2. Radiation Emissions Test Configuration



Item	Connection	Shield	Length
1	Power cable	No	2.6m
2	USB cable	No	0.9m
3	ANT cable	No	0.1m

4. TEST RESULT

4.1. AC Power Line Conducted Emissions Measurement

4.1.1. Limit

For a Low-power Radio-frequency Device which is designed to be connected to the AC power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed below limits table.

Frequency (MHz)	QP Limit (dBuV)	AV Limit (dBuV)
0.15~0.5	66~56	56~46
0.5~5	56	46
5~30	60	50

4.1.2. Measuring Instruments and Setting

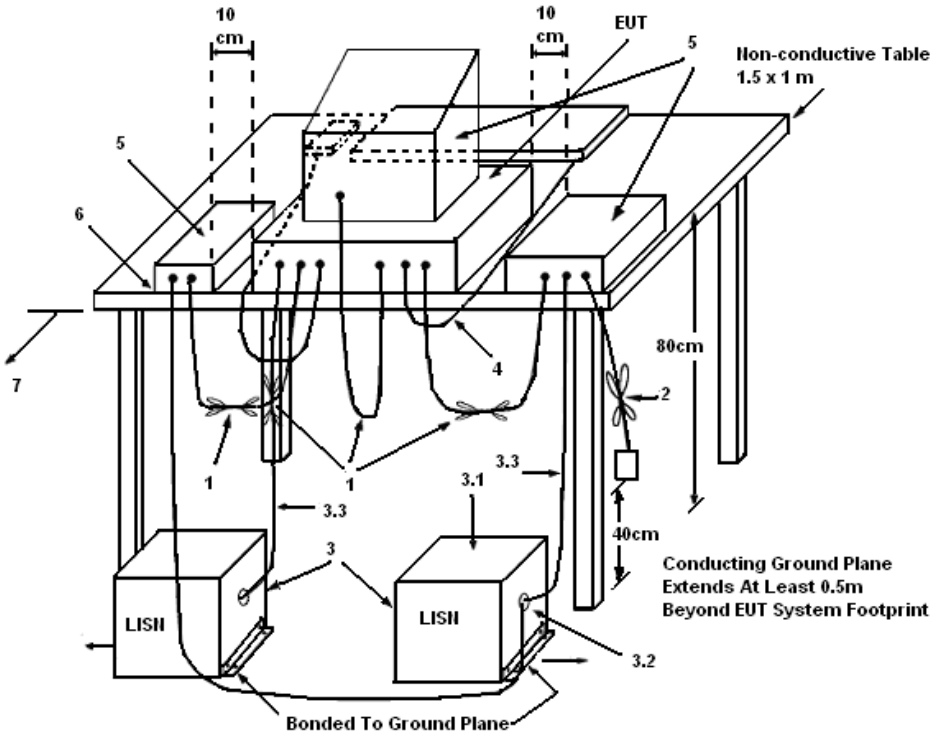
Please refer to section 5 of equipments list in this report. The following table is the setting of the receiver.

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

4.1.3. Test Procedures

1. Configure the EUT according to ANSI C63.10. The EUT or host of EUT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT or host of EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connected to the other LISNs. The LISN should provide 50uH/50ohms coupling impedance.
4. The frequency range from 150 kHz to 30 MHz was searched.
5. Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. The measurement has to be done between each power line and ground at the power terminal.

4.1.4. Test Setup Layout



LEGEND:

(1) Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

(2) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

(3) EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω. LISN can be placed on top of, or immediately beneath, reference ground plane.

(3.1) All other equipment powered from additional LISN(s).

(3.2) Multiple outlet strip can be used for multiple power cords of non-EUT equipment.

(3.3) LISN at least 80 cm from nearest part of EUT chassis.

(4) Cables of hand-operated devices, such as keyboards, mice, etc., shall be placed as for normal use.

(5) Non-EUT components of EUT system being tested.

(6) Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop.

(7) Rear of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane.

4.1.5. Test Deviation

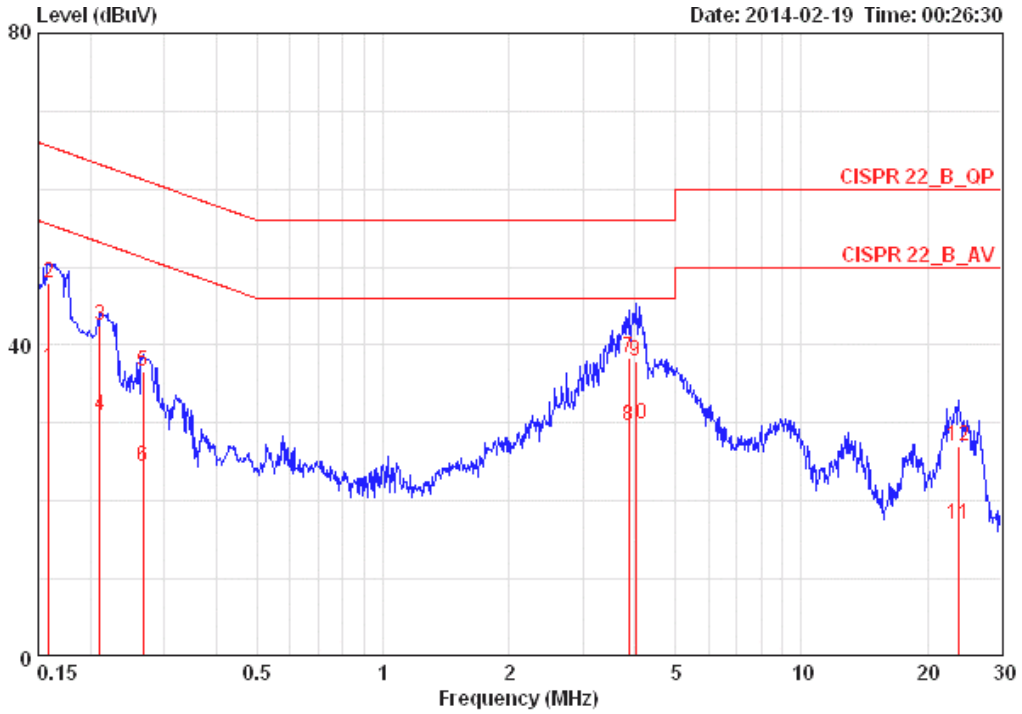
There is no deviation with the original standard.

4.1.6. EUT Operation during Test

The EUT was placed on the test table and programmed in normal function.

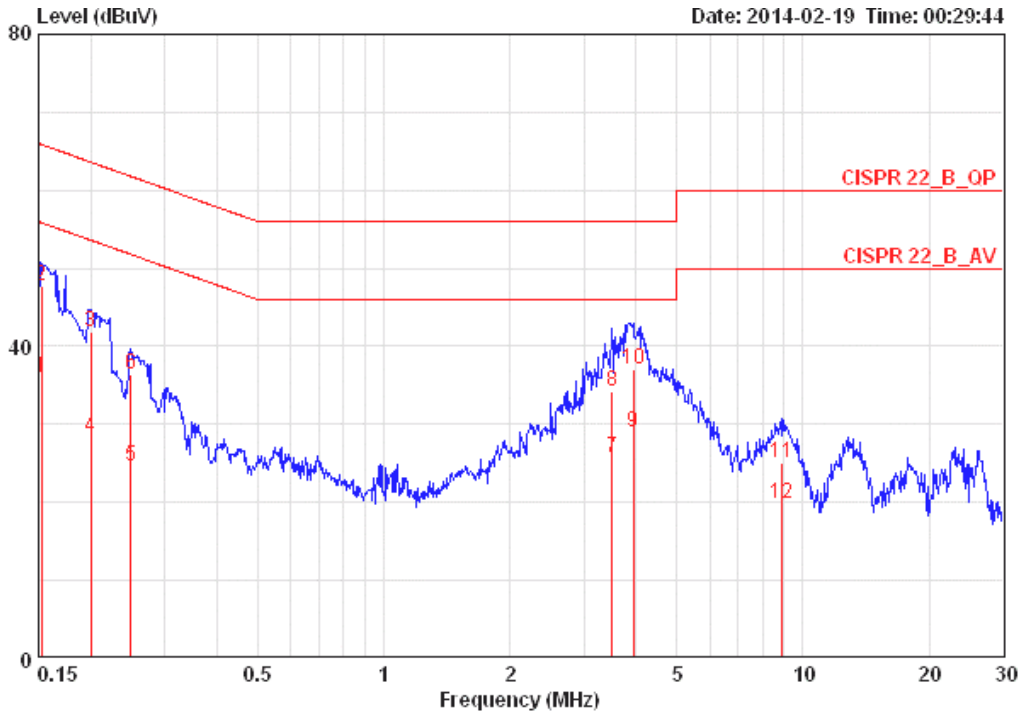
4.1.7. Results of AC Power Line Conducted Emissions Measurement

Temperature	22°C	Humidity	65%
Test Engineer	Ryo Fan	Phase	Line
Configuration	CTX	Test Mode	Mode 1



	Freq	Level	Over Limit	Limit Line	LISN Factor	Read Level	Cable Loss	Pol/Phase	Remark
	MHz	dBuV	dB	dBuV	dB	dBuV	dB		
1	0.15900	37.10	-18.41	55.52	0.15	36.77	0.18	LINE	AVERAGE
2	0.15900	47.96	-17.55	65.52	0.15	47.63	0.18	LINE	QP
3	0.21055	42.48	-20.70	63.18	0.15	42.13	0.20	LINE	QP
4	0.21055	31.00	-22.18	53.18	0.15	30.65	0.20	LINE	AVERAGE
5	0.26724	36.55	-24.65	61.20	0.15	36.20	0.20	LINE	QP
6	0.26724	24.51	-26.69	51.20	0.15	24.16	0.20	LINE	AVERAGE
7	3.860	38.44	-17.56	56.00	0.27	37.87	0.29	LINE	QP
8 @	3.860	29.63	-16.37	46.00	0.27	29.06	0.29	LINE	AVERAGE
9	4.006	37.98	-18.02	56.00	0.28	37.40	0.30	LINE	QP
10 @	4.006	29.96	-16.04	46.00	0.28	29.38	0.30	LINE	AVERAGE
11	23.762	16.97	-33.03	50.00	0.72	15.71	0.55	LINE	AVERAGE
12	23.762	26.94	-33.06	60.00	0.72	25.68	0.55	LINE	QP

Temperature	22°C	Humidity	65%
Test Engineer	Ryo Fan	Phase	Neutral
Configuration	CTX	Test Mode	Mode 1



	Freq	Level	Over Limit	Limit Line	LISN Factor	Read Level	Cable Loss	Pol/Phase	Remark
	MHz	dBuV	dB	dBuV	dB	dBuV	dB		
1	0.15240	35.94	-19.93	55.87	0.07	35.69	0.18	NEUTRAL	AVERAGE
2	0.15240	47.83	-18.04	65.87	0.07	47.58	0.18	NEUTRAL	QP
3	0.19969	41.93	-21.69	63.62	0.07	41.66	0.20	NEUTRAL	QP
4	0.19969	28.25	-25.37	53.62	0.07	27.98	0.20	NEUTRAL	AVERAGE
5	0.24945	24.62	-27.16	51.78	0.07	24.35	0.20	NEUTRAL	AVERAGE
6	0.24945	36.49	-25.29	61.78	0.07	36.22	0.20	NEUTRAL	QP
7	3.509	25.64	-20.36	46.00	0.13	25.24	0.28	NEUTRAL	AVERAGE
8	3.509	34.26	-21.74	56.00	0.13	33.86	0.28	NEUTRAL	QP
9 @	3.943	28.89	-17.11	46.00	0.13	28.46	0.30	NEUTRAL	AVERAGE
10	3.943	37.14	-18.86	56.00	0.13	36.71	0.30	NEUTRAL	QP
11	8.869	25.00	-35.00	60.00	0.24	24.46	0.30	NEUTRAL	QP
12	8.869	19.82	-30.18	50.00	0.24	19.28	0.30	NEUTRAL	AVERAGE

Note:

Level = Read Level + LISN Factor + Cable Loss.

4.2. Maximum Conducted Output Power Measurement

4.2.1. Limit

For systems using digital modulation in the 2400-2483.5MHz, the limit for output power is 30dBm. The limited has to be reduced by the amount in dB that the gain of the antenna exceed 6dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

4.2.2. Measuring Instruments and Setting

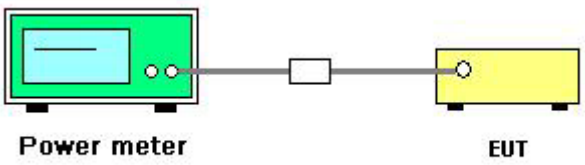
Please refer to section 5 of equipments list in this report. The following table is the setting of the power meter.

Power Meter Parameter	Setting
Bandwidth	50MHz bandwidth is greater than the EUT emission bandwidth
Detector	Average

4.2.3. Test Procedures

1. Test procedures refer KDB 558074 D01 v03r01 section 9.2.2 Measurement using a power meter (PM).
2. This procedure provides an alternative for determining the RMS output power using a broadband RF average power meter with a thermocouple detector.

4.2.4. Test Setup Layout



4.2.5. Test Deviation

There is no deviation with the original standard.

4.2.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.2.7. Test Result of Maximum Conducted Output Power

Temperature	20°C	Humidity	54%
Test Engineer	Wen Chao	Configurations	802.15.4 Zigbee
Test Date	Feb. 11, 2014		

Configuration IEEE 802.15.4 Zigbee

Channel	Frequency	Conducted Power (dBm)	Max. Limit (dBm)	Result
11	2405 MHz	3.08	30.00	Complies
19	2445 MHz	3.41	30.00	Complies
25	2475 MHz	2.82	30.00	Complies

4.3. Power Spectral Density Measurement

4.3.1. Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.3.2. Measuring Instruments and Setting

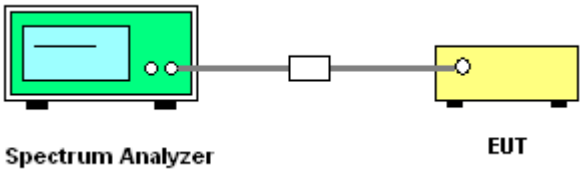
Please refer to section 5 of equipments list in this report. The following table is the setting of Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	5-30 % greater than the DTS channel bandwidth.
RBW	3 kHz ≤ RBW ≤ 100kHz
VBW	≥ 3 x RBW
Detector	Peak
Trace	Max Hold
Sweep Time	Auto couple

4.3.3. Test Procedures

1. Test procedures refer KDB 558074 D01 v03r01 section 10.2 Method PKPSD (peak PSD) and sum spectral maximal across the outputs.
2. Use this procedure when the maximum conducted output power in the fundamental emission is used to demonstrate compliance. The EUT must be configured to transmit continuously at full power over the measurement duration.
3. Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW (use of a greater number of measurement points than this minimum requirement is recommended).
4. Use the peak marker function to determine the maximum level in any 3 kHz band segment within the fundamental EBW.
5. The resulting PSD level must be ≤ 8 dBm.

4.3.4. Test Setup Layout



4.3.5. Test Deviation

There is no deviation with the original standard.

4.3.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.3.7. Test Result of Power Spectral Density

Temperature	20°C	Humidity	54%
Test Engineer	Wen Chao	Configurations	802.15.4 Zigbee

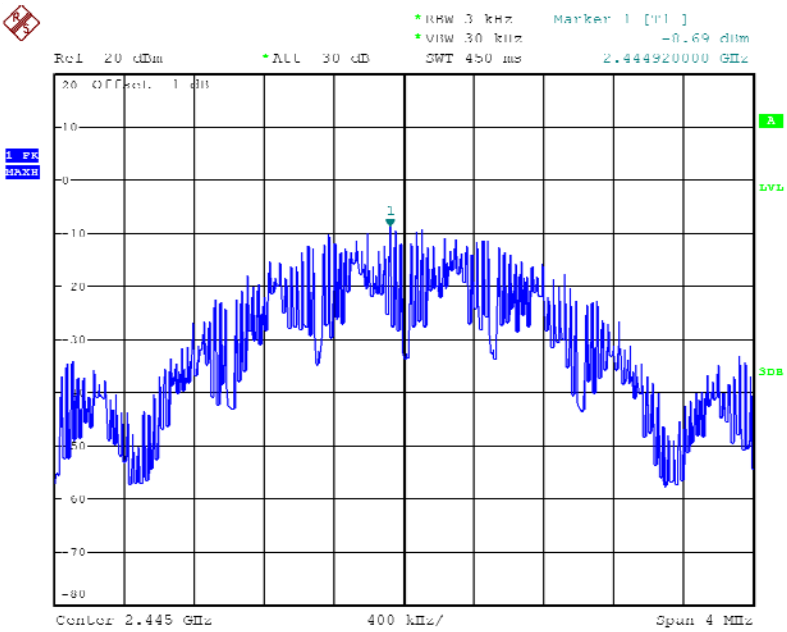
Configuration IEEE 802.15.4 Zigbee

Frequency	Power Density (dBm/3kHz)	Power Density Limit (dBm/3kHz)	Result
2405 MHz	-9.46	8.00	Complies
2445 MHz	-8.69	8.00	Complies
2475 MHz	-9.68	8.00	Complies

Note: All the test values were listed in the report.

For plots, only the channel with worse result was shown.

Power Density Plot on Configuration 802.15.4 Zigbee / 2445 MHz



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4.4. 6dB Spectrum Bandwidth Measurement

4.4.1. Limit

For digital modulation systems, the minimum 6dB bandwidth shall be at least 500 kHz.

4.4.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameters	Setting
Attenuation	Auto
Span Frequency	> 6dB Bandwidth
RBW	100kHz
VBW	≥ 3 x RBW
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

4.4.3. Test Procedures

For Radiated 6dB Bandwidth Measurement:

7. The transmitter was radiated to the spectrum analyzer in peak hold mode.
8. Test was performed in accordance with KDB 558074 D01 v03r01 for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8.0 DTS 6-dB signal bandwidth option 1.
9. Measured the spectrum width with power higher than 6dB below carrier.

4.4.4. Test Setup Layout

For Radiated 6dB Bandwidth Measurement:

This test setup layout is the same as that shown in section 4.5.4.

4.4.5. Test Deviation

There is no deviation with the original standard.

4.4.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.4.7. Test Result of 6dB Spectrum Bandwidth

Temperature	20°C	Humidity	54%
Test Engineer	Wen Chao	Configurations	802.15.4 Zigbee

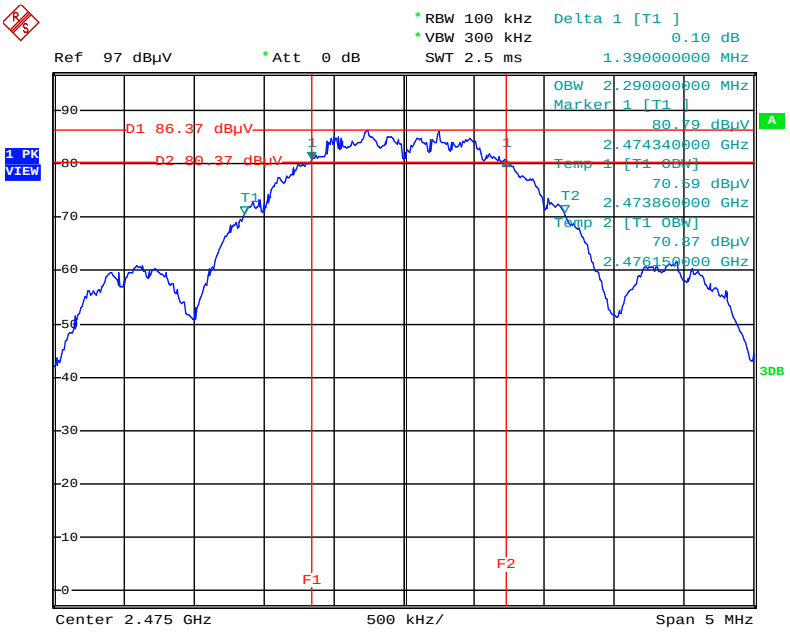
Configuration 802.15.4 Zigbee

Channel	Frequency	6dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	Min. Limit (kHz)	Test Result
11	2405 MHz	1.47	2.22	500.00	Complies
19	2445 MHz	1.40	2.26	500.00	Complies
25	2475 MHz	1.39	2.29	500.00	Complies

Note: All the test values were listed in the report.

For plots, only the channel with worse result was shown.

6 dB Bandwidth Plot on Configuration 802.15.4 Zigbee / 2475 MHz



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4.5. Radiated Emissions Measurement

4.5.1. Limit

30dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(kHz)	300
0.490~1.705	24000/F(kHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

4.5.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 10Hz for Average
RBW / VBW (Emission in non-restricted band)	100kHz / 300kHz for peak

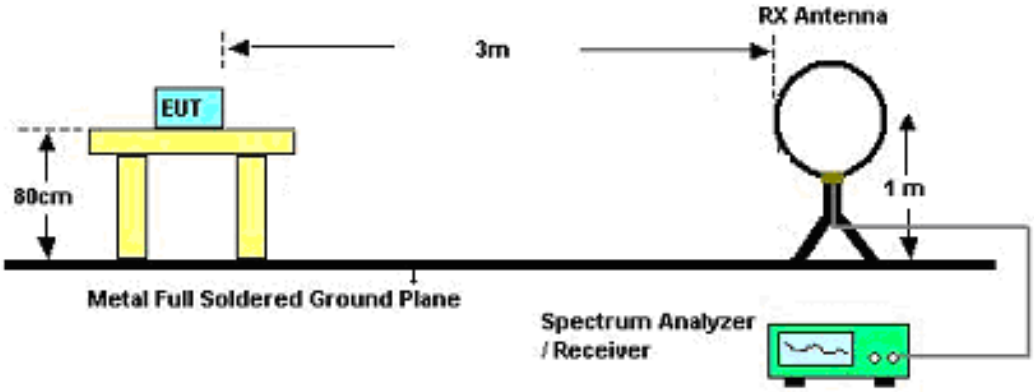
Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RBW 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RBW 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RBW 120kHz for QP

4.5.3. Test Procedures

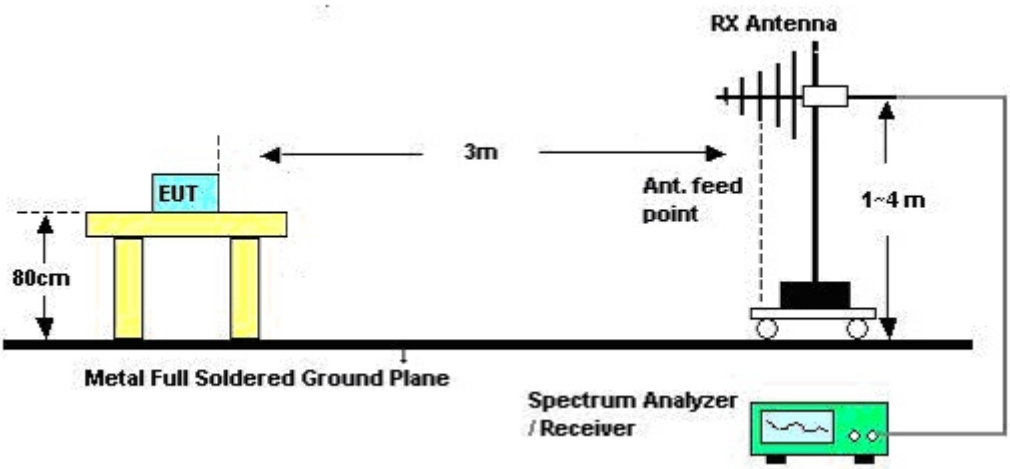
1. Configure the EUT according to ANSI C63.10. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
6. For emissions above 1GHz, use 1MHz VBW and 3MHz RBW for peak reading. Then 1MHz RBW and 10Hz VBW for average reading in spectrum analyzer.
7. When the radiated emissions limits are expressed in terms of the average value of the emissions, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.
8. If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
9. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
10. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High – Low scan is not required in this case.

4.5.4. Test Setup Layout

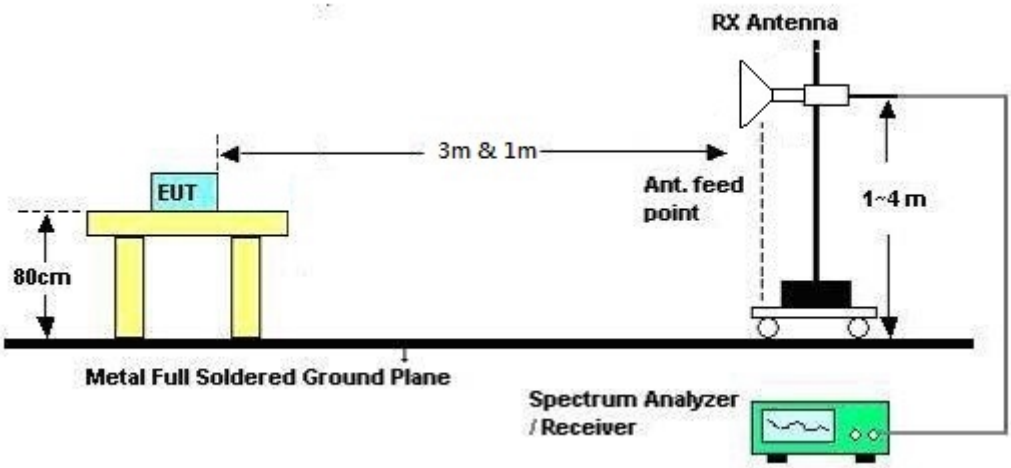
For Radiated Emissions: 9kHz ~30MHz



For Radiated Emissions: 30MHz~1GHz



For Radiated Emissions: Above 1GHz



4.5.5. Test Deviation

There is no deviation with the original standard.

4.5.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.5.7. Results of Radiated Emissions (9kHz~30MHz)

Temperature	21℃	Humidity	53%
Test Engineer	Nick Peng	Configurations	CTX
Test Date	Feb. 05, 2014	Test Mode	Mode 1

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Limit Line (dBuV)	Remark
-	-	-	-	See Note

Note:

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

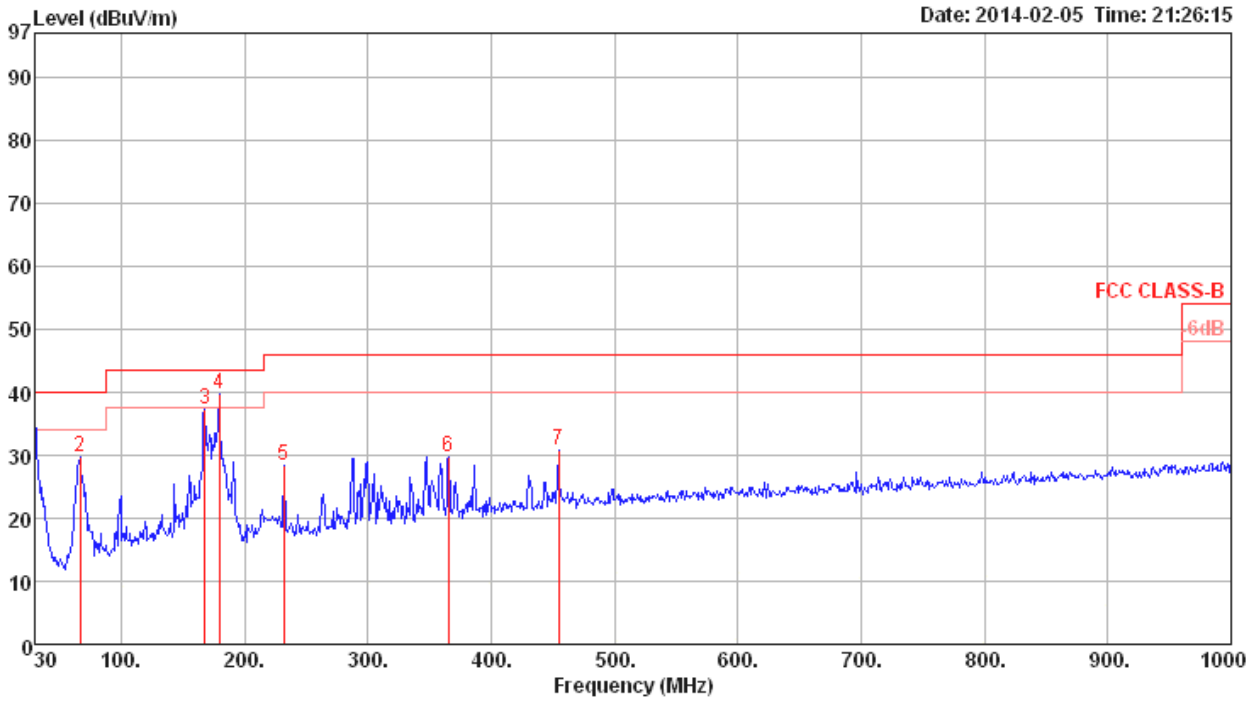
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor.

4.5.8. Results of Radiated Emissions (30MHz~1GHz)

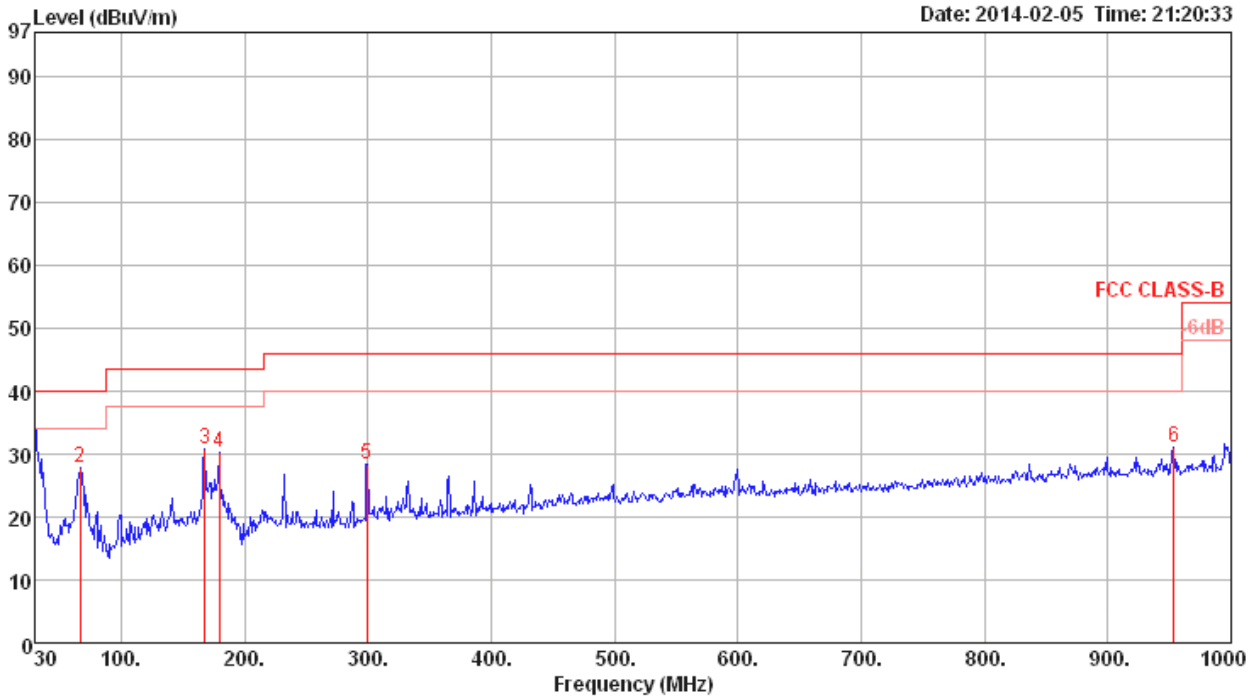
Temperature	21°C	Humidity	53%
Test Engineer	Nick Peng	Configurations	CTX
Test Mode	Mode 1		

Horizontal



	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	Remark	A/Pos	T/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB		cm	deg	
1	30.00	34.79	40.00	-5.21	43.22	0.61	18.76	27.80	Peak	100	0	HORIZONTAL
2	66.86	29.81	40.00	-10.19	49.90	0.96	6.68	27.73	Peak	100	0	HORIZONTAL
3	167.74	37.19	43.50	-6.31	50.38	1.46	12.61	27.26	Peak	100	0	HORIZONTAL
4	179.38	39.75	43.50	-3.75	52.25	1.56	13.14	27.20	Peak	100	0	HORIZONTAL
5	231.76	28.35	46.00	-17.65	42.24	1.74	11.41	27.04	Peak	100	0	HORIZONTAL
6	365.62	29.64	46.00	-16.36	39.70	2.16	15.14	27.36	Peak	100	0	HORIZONTAL
7	454.86	30.76	46.00	-15.24	39.22	2.49	16.92	27.87	Peak	100	0	HORIZONTAL

Vertical



	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	Remark	A/Pos	T/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB		cm	deg	
1	30.00	35.12	40.00	-4.88	43.55	0.61	18.76	27.80	Peak	400	0	VERTICAL
2	66.86	27.80	40.00	-12.20	47.89	0.96	6.68	27.73	Peak	400	0	VERTICAL
3	167.74	30.68	43.50	-12.82	43.87	1.46	12.61	27.26	Peak	400	0	VERTICAL
4	179.38	30.38	43.50	-13.12	42.88	1.56	13.14	27.20	Peak	400	0	VERTICAL
5	299.66	28.46	46.00	-17.54	39.97	2.03	13.36	26.90	Peak	400	0	VERTICAL
6	953.44	31.17	46.00	-14.83	33.89	3.53	20.94	27.19	Peak	400	0	VERTICAL

Note:

The amplitude of spurious emissions that are attenuated by more than 20dB below the permissible value has no need to be reported.

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

4.5.9. Results for Radiated Emissions (1GHz~10th Harmonic)

Temperature	21°C	Humidity	53%
Test Engineer	Nick Peng	Configurations	802.15.4 Zigbee CH 11
Test Date	Jan. 29, 2014		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Preamp Factor	Factor	Remark	T/Pos	A/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB/m		deg	cm	
1	4810.75	48.15	74.00	-25.85	46.13	4.20	34.70	2.02	Peak	158	100	HORIZONTAL
2	4810.85	37.14	54.00	-16.86	35.12	4.20	34.70	2.02	Average	158	100	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Preamp Factor	Factor	Remark	T/Pos	A/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB/m		deg	cm	
1	4808.97	56.73	74.00	-17.27	54.71	4.20	34.70	2.02	Peak	350	142	VERTICAL
2	4808.97	46.97	54.00	-7.03	44.95	4.20	34.70	2.02	Average	350	142	VERTICAL

Temperature	21°C	Humidity	53%
Test Engineer	Nick Peng	Configurations	802.15.4 Zigbee CH 19
Test Date	Jan. 29, 2014		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Preamp Factor	Factor	Remark	T/Pos	A/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB/m		deg	cm	
1	4888.87	46.14	74.00	-27.86	43.89	4.22	34.66	2.25	Peak	72	100	HORIZONTAL
2	4888.99	34.17	54.00	-19.83	31.92	4.22	34.66	2.25	Average	72	100	HORIZONTAL
3	7333.48	60.09	74.00	-13.91	52.67	5.35	34.94	7.42	Peak	210	100	HORIZONTAL
4	7333.61	49.66	54.00	-4.34	42.24	5.35	34.94	7.42	Average	210	100	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Preamp Factor	Factor	Remark	T/Pos	A/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB/m		deg	cm	
1	4888.97	40.88	54.00	-13.12	38.63	4.22	34.66	2.25	Average	326	124	VERTICAL
2	4889.15	51.23	74.00	-22.77	48.98	4.22	34.66	2.25	Peak	326	124	VERTICAL
3	7336.20	50.34	54.00	-3.66	42.92	5.35	34.94	7.42	Average	207	100	VERTICAL
4	7336.58	60.55	74.00	-13.45	53.13	5.35	34.94	7.42	Peak	207	100	VERTICAL

Temperature	21°C	Humidity	53%
Test Engineer	Nick Peng	Configurations	802.15.4 Zigbee CH 25
Test Date	Feb. 12, 2014		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	Remark	A/Pos	T/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB		cm	deg	
1	4949.81	43.61	74.00	-30.39	41.95	3.37	33.30	35.01	Peak	101	298	HORIZONTAL
2	4950.95	31.25	54.00	-22.75	29.59	3.37	33.30	35.01	Average	101	298	HORIZONTAL
3	7423.47	59.95	74.00	-14.05	55.12	4.07	36.16	35.40	Peak	102	156	HORIZONTAL
4	7423.71	49.94	54.00	-4.06	45.11	4.07	36.16	35.40	Average	102	156	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	Remark	A/Pos	T/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB		cm	deg	
1	4949.04	38.84	54.00	-15.16	37.18	3.37	33.30	35.01	Average	101	61	VERTICAL
2	4950.85	49.26	74.00	-24.74	47.60	3.37	33.30	35.01	Peak	101	61	VERTICAL
3	7426.37	51.46	54.00	-2.54	46.63	4.07	36.16	35.40	Average	100	90	VERTICAL
4	7426.37	60.56	74.00	-13.44	55.73	4.07	36.16	35.40	Peak	100	90	VERTICAL

Note:

The amplitude of spurious emissions that are attenuated by more than 20dB below the permissible value has no need to be reported.

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

4.6. Emissions Measurement

4.6.1. Limit

30dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(kHz)	300
0.490~1.705	24000/F(kHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

4.6.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	100 MHz
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 10Hz for Average
RBW / VBW (Emission in non-restricted band)	100 kHz /300 kHz for Peak

4.6.3. Test Procedures

For Radiated band edges Measurement:

1. The test procedure is the same as section 4.5.3, only the frequency range investigated is limited to 100MHz around band edges.

For Radiated Out of Band Emission Measurement:

1. Test was performed in accordance with KDB 558074 D01 v03r01 for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10.1 Unwanted Emissions into Non-Restricted Frequency Bands Measurement Procedure.
2. The radiated emission test is performed on each TX port of operating mode without summing or adding 10log (N) since the limit is relative emission limit.
   Only worst data of each operating mode is presented.

4.6.4. Test Setup Layout

For Radiated band edges Measurement:

This test setup layout is the same as that shown in section 4.5.4.

For Radiated Out of Band Emission Measurement:

This test setup layout is the same as that shown in section 4.5.4.

4.6.5. Test Deviation

There is no deviation with the original standard.

4.6.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.6.7. Test Result of Band Edge and Fundamental Emissions

Temperature	21°C	Humidity	53%
Test Engineer	Nick Peng	Configurations	802.15.4 Zigbee CH 11, 19, 25
Test Date	Jan. 29, 2014& Feb. 12, 2014		

Channel 11

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Preamp Factor	Factor	Remark	T/Pos	A/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB/m		deg	cm	
1	2372.92	47.22	54.00	-6.78	16.43	2.90	0.00	30.79	Average	277	100	VERTICAL
2	2373.50	58.73	74.00	-15.27	27.94	2.90	0.00	30.79	Peak	277	100	VERTICAL
3	2404.57	104.07			73.31	2.92	0.00	30.76	Peak	277	100	VERTICAL
4	2405.00	101.35			70.59	2.92	0.00	30.76	Average	277	100	VERTICAL

Item 3, 4 are the fundamental frequency at 2405 MHz.

Channel 19

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Preamp Factor	Factor	Remark	T/Pos	A/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB/m		deg	cm	
1	2382.76	58.24	74.00	-15.76	27.45	2.90	0.00	30.79	Peak	279	100	VERTICAL
2	2390.00	43.98	54.00	-10.02	13.20	2.91	0.00	30.78	Average	279	100	VERTICAL
3	2445.00	101.13			70.41	2.94	0.00	30.72	Average	279	100	VERTICAL
4	2445.58	104.00			73.28	2.94	0.00	30.72	Peak	279	100	VERTICAL
5	2483.50	44.38	54.00	-9.62	13.69	2.96	0.00	30.69	Average	279	100	VERTICAL
6	2492.18	57.60	74.00	-16.40	26.93	2.97	0.00	30.67	Peak	279	100	VERTICAL

Item 3, 4 are the fundamental frequency at 2445 MHz.

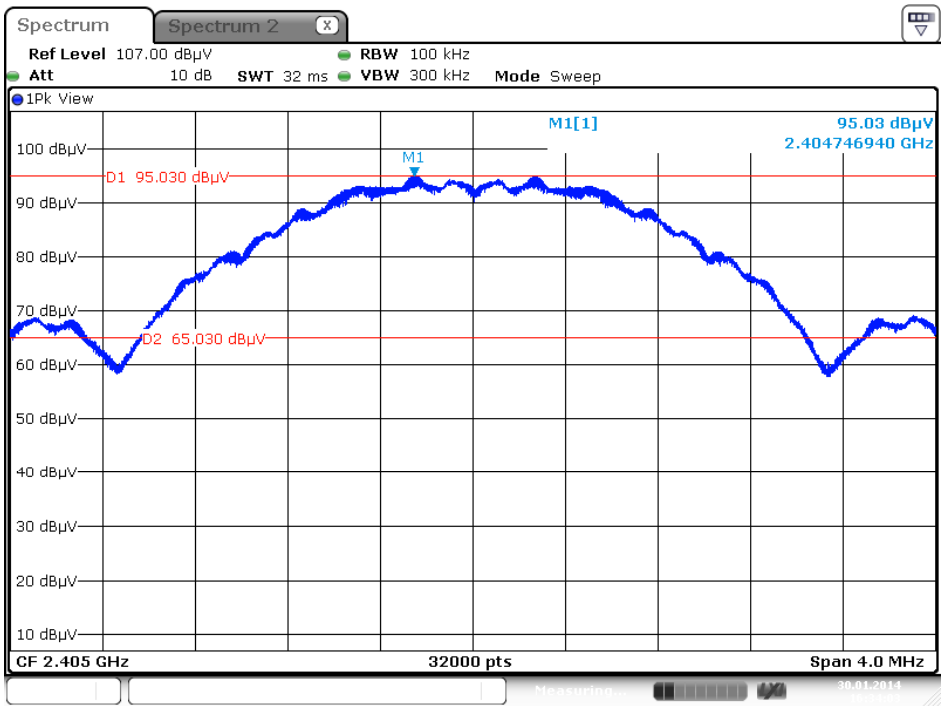
Channel 25

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	Remark	A/Pos	T/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB		cm	deg	
1	2474.60	101.53			70.90	2.26	28.37	0.00	Peak	100	213	VERTICAL
2	2475.00	97.28			66.65	2.26	28.37	0.00	Average	100	213	VERTICAL
3	2483.50	43.76	54.00	-10.24	13.13	2.26	28.37	0.00	Average	100	213	VERTICAL
4	2483.50	55.25	74.00	-18.75	24.62	2.26	28.37	0.00	Peak	100	213	VERTICAL

Item 1, 2 are the fundamental frequency at 2475 MHz.

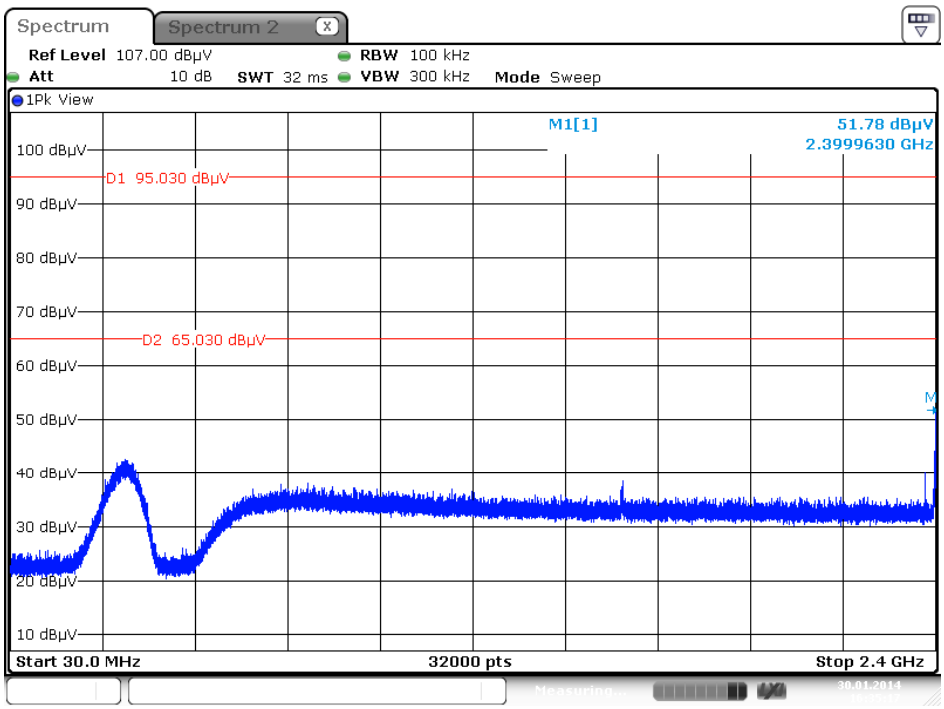
For Emission not in Restricted Band

Plot on Configuration 802.15.4 Zigbee / Reference Level



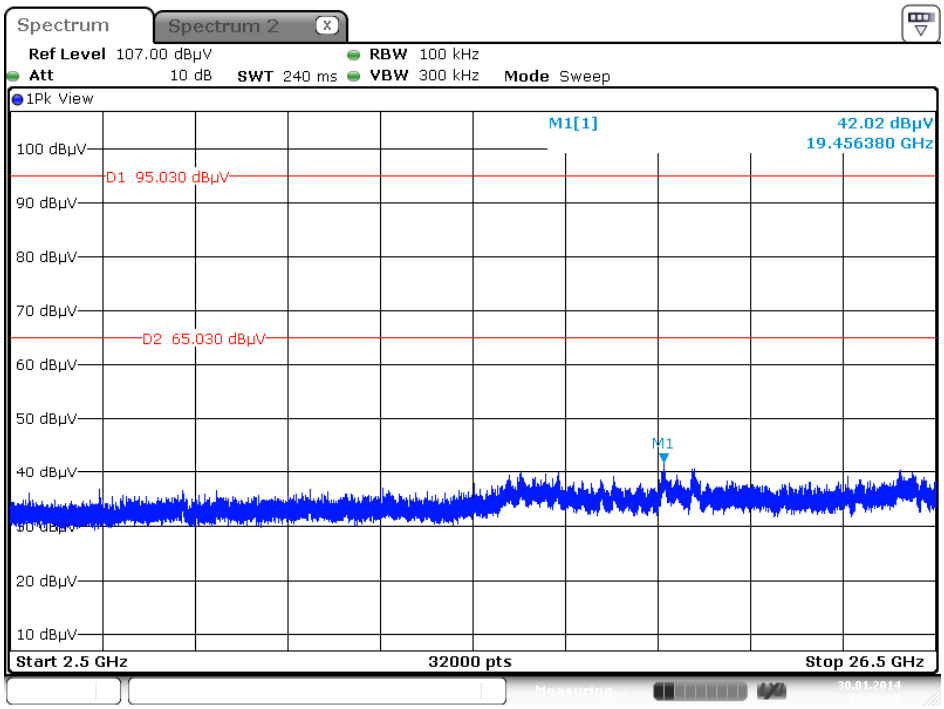
Date: 30.JAN.2014 16:34:03

Plot on Configuration 802.15.4 Zigbee / CH 11 / 30MHz~2400MHz (down 30dBc)



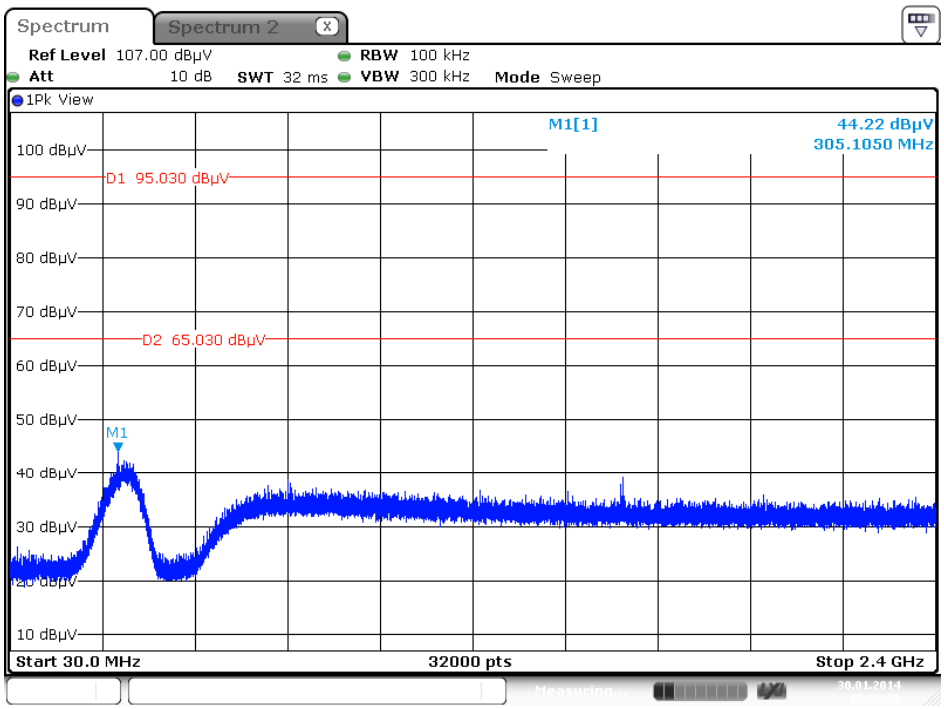
Date: 30.JAN.2014 16:35:18

Plot on Configuration 802.15.4 Zigbee / CH 11 / 2500MHz~26500MHz (down 30dBc)



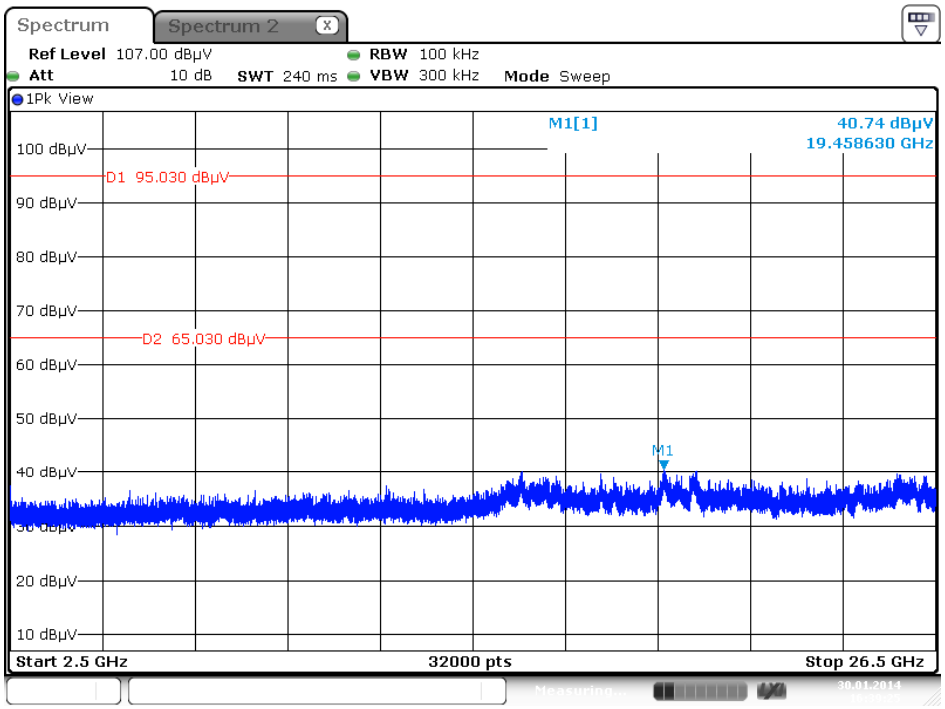
Date: 30.JAN.2014 16:36:38

Plot on Configuration 802.15.4 Zigbee / CH 25 / 30MHz~2400MHz (down 30dBc)



Date: 30.JAN.2014 16:38:36

Plot on Configuration 802.15.4 Zigbee / CH 25 / 2500MHz~26500MHz (down 30dBc)



Date: 30.JAN.2014 16:39:25

4.7. Antenna Requirements

4.7.1. Limit

Except for special regulations, the Low-power Radio-frequency Devices must not be equipped with any jacket for installing an antenna with extension cable. An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

4.7.2. Antenna Connector Construction

Please refer to section 3.3 in this test report; antenna connector complied with the requirements.

5. LIST OF MEASURING EQUIPMENTS

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
EMI Test Receiver	R&S	ESCS 30	100355	9kHz ~ 2.75GHz	Apr. 12, 2013	Conduction (CO01-CB)
LISN	F.C.C.	FCC-LISN-50-16-2	04083	150kHz ~ 100MHz	Nov. 23, 2013	Conduction (CO01-CB)
Arifical Mains Network	Schwarzbeck	NSLK 8127	8127647	9kHz ~ 30MHz	Nov. 23, 2013	Conduction (CO01-CB)
COND Cable	Woken	Cable	01	150kHz ~ 30MHz	Dec. 04, 2013	Conduction (CO01-CB)
Software	Audix	E3	5.410e	-	-	Conduction (CO01-CB)
BILOG ANTENNA	Schaffner	CBL6112D	22021	20MHz ~ 2GHz	Apr. 16, 2013	Radiation (03CH01-CB)
Loop Antenna	Teseq	HLA 6120	24155	9kHz – 30MHz	Nov. 05, 2012*	Radiation (03CH01-CB)
Horn Antenna	EMCO	3115	00075790	750MHz~18GHz	Nov. 01, 2013	Radiation (03CH01-CB)
Horn Antenna	SCHWARZBEAK	BBHA 9170	BBHA9170252	15GHz ~ 40GHz	Dec. 17, 2013	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8447D	2944A10991	0.1MHz ~ 1.3GHz	Nov. 12, 2013	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8449B	3008A02310	1GHz ~ 26.5GHz	Dec. 16, 2013	Radiation (03CH01-CB)
Pre-Amplifier	WM	TF-130N-R1	923365	26GHz ~ 40GHz	Oct. 23, 2013	Radiation (03CH01-CB)
Spectrum analyzer	R&S	FSP40	100019	9kHz~40GHz	Dec. 02, 2013	Radiation (03CH01-CB)
EMI Test Receiver	Agilent	N9038A	MY52260123	9kHz ~ 8GHz	Dec. 12, 2013	Radiation (03CH01-CB)
Turn Table	INN CO	CO 2000	N/A	0 ~ 360 degree	N.C.R	Radiation (03CH01-CB)
Antenna Mast	INN CO	CO2000	N/A	1 m - 4 m	N.C.R	Radiation (03CH01-CB)
RF Cable-low	Woken	Low Cable-1	N/A	30 MHz - 1 GHz	Nov. 17, 2013	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-1	N/A	1 GHz – 26.5 GHz	Nov. 17, 2013	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-2	N/A	1 GHz – 26.5 GHz	Nov. 17, 2013	Radiation (03CH01-CB)
RF Power Divider	Woken	2 Way	0120A02056002D	2GHz ~ 18GHz	Nov. 17, 2013	Conducted (TH01-CB)

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
RF Power Divider	Woken	3 Way	MDC2366	2GHz ~ 18GHz	Nov. 17, 2013	Conducted (TH01-CB)
RF Power Divider	Woken	4 Way	0120A04056002D	2GHz ~ 18GHz	Nov. 17, 2013	Conducted (TH01-CB)
RF Cable-high	Woken	High Cable-7	-	1GHz – 26.5GHz	Nov. 17, 2013	Conducted (TH01-CB)
RF Cable-high	Woken	High Cable-8	-	1GHz – 26.5GHz	Nov. 17, 2013	Conducted (TH01-CB)
RF Cable-high	Woken	High Cable-9	-	1GHz – 26.5GHz	Nov. 17, 2013	Conducted (TH01-CB)
RF Cable-high	Woken	High Cable-10	-	1GHz – 26.5GHz	Nov. 17, 2013	Conducted (TH01-CB)
RF Cable-high	Woken	High Cable-11	-	1GHz – 26.5GHz	Nov. 17, 2013	Conducted (TH01-CB)
Power Sensor	Anritsu	MA2411B	0917223	300MHz~40GHz	Sep. 18, 2013	Conducted (TH01-CB)
Power Meter	Anritsu	ML2495A	1035008	300MHz~40GHz	Sep. 18, 2013	Conducted (TH01-CB)

Note: Calibration Interval of instruments listed above is one year.

"*" Calibration Interval of instruments listed above is two years.

N.C.R. means Non-Calibration required.

6. MEASUREMENT UNCERTAINTY

Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)

Contribution	Uncertainty of x_i			$u(x_i)$
	Value	Unit	Probability Distribution k	
Receiver reading	0.026	dB	normal(k=2)	0.013
Cable loss	0.002	dB	normal(k=2)	0.001
AMN/LISN specification	1.200	dB	normal(k=2)	0.600
Mismatch Receiver VSWR 1= AMN/LISN VSWR 2=	-0.080	dB	U-shaped	0.060
Combined standard uncertainty Uc(y)				1.2
Measuring uncertainty for a level of confidence of 95% U=2Uc(y)				2.4

Uncertainty of Radiated Emission Measurement (30MHz ~ 1,000MHz)

Contribution	Uncertainty of x_i			$u(x_i)$
	Value	Unit	Probability Distribution k	
Receiver reading	±0.173	dB	K=1	0.086
Cable loss	±0.174	dB	K=2	0.087
Antenna gain	±0.169	dB	K=2	0.084
Site imperfection	±0.433	dB	Triangular	0.214
Pre-amplifier gain	±0.366	dB	K=2	0.183
Transmitter antenna	±1.200	dB	Rectangular	0.600
Signal generator	±0.461	dB	Rectangular	0.231
Mismatch	±0.080	dB	U-shape	0.040
Spectrum analyzer	±0.500	dB	Rectangular	0.250
Combined standard uncertainty Uc(y)				1.778
Measuring uncertainty for a level of confidence of 95% U=2Uc(y)				3.555

Uncertainty of Radiated Emission Measurement (1GHz ~ 18GHz)

Contribution	Uncertainty of x_i			$u(x_i)$
	Value	Unit	Probability Distribution k	
Receiver reading	±0.191	dB	K=1	0.095
Cable loss	±0.169	dB	K=2	0.084
Antenna gain	±0.191	dB	K=2	0.096
Site imperfection	±0.582	dB	Triangular	0.291
Pre-amplifier gain	±0.304	dB	K=2	0.152
Transmitter antenna	±1.200	dB	Rectangular	0.600
Signal generator	±0.461	dB	Rectangular	0.231
Mismatch	±0.080	dB	U-shape	0.040
Spectrum analyzer	±0.500	dB	Rectangular	0.250
Combined standard uncertainty Uc(y)				1.839
Measuring uncertainty for a level of confidence of 95% U=2Uc(y)				3.678

Uncertainty of Radiated Emission Measurement (18GHz ~ 40GHz)

Contribution	Uncertainty of x_i			$u(x_i)$
	Value	Unit	Probability Distribution k	
Receiver reading	±0.186	dB	K=1	0.093
Cable loss	±0.167	dB	K=2	0.083
Antenna gain	±0.190	dB	K=2	0.095
Site imperfection	±0.488	dB	Triangular	0.244
Pre-amplifier gain	±0.269	dB	K=2	0.134
Transmitter antenna	±1.200	dB	Rectangular	0.600
Signal generator	±0.461	dB	Rectangular	0.231
Mismatch	±0.080	dB	U-shape	0.040
Spectrum analyzer	±0.500	dB	Rectangular	0.250
Combined standard uncertainty Uc(y)				1.771
Measuring uncertainty for a level of confidence of 95% U=2Uc(y)				3.541

Uncertainty of Conducted Emission Measurement

Contribution	Uncertainty of x_i			$u(x_i)$
	Value	Unit	Probability Distribution k	
Cable loss	±0.038	dB	K=2	0.019
Attenuator	±0.047	dB	K=2	0.024
Power Meter specification	±0.300	dB	Triangular	0.150
Power Sensor specification	±0.300	dB	Rectangular	0.150
Signal generator	±0.461	dB	Rectangular	0.231
Mismatch	±0.080	dB	U-shape	0.040
Spectrum analyzer	±0.500	dB	Rectangular	0.250
Combined standard uncertainty Uc(y)				0.863
Measuring uncertainty for a level of confidence of 95% U=2Uc(y)				1.726