FCC RF Test Report

APPLICANT	:	Nimbostratus LLC
EQUIPMENT	:	Digital Media Receiver
MODEL NAME	:	ZE39KL
FCC ID	:	2AHUF-6294
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DTS) Digital Transmission System

The testing was completed on May 07, 2017. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

Reviewed by: Joseph Lin / Supervisor

Approved by: Jones Tsai / Manager

Testing Laboratory
1190

TABLE OF CONTENTS

REVISION HISTORY **3**

SUMMARY OF TEST RESULT **4**

1 GENERAL DESCRIPTION **5**

1.1 Applicant 5
1.2 Product Feature of Equipment Under Test 5
1.3 Product Specification of Equipment Under Test 5
1.4 Modification of EUT 5
1.5 Testing Location 6
1.6 Applicable Standards 6

2 TEST CONFIGURATION OF EQUIPMENT UNDER TEST **7**

2.1 Descriptions of Test Mode 7
2.2 Test Mode 8
2.3 Connection Diagram of Test System 9
2.4 Support Unit used in test configuration and system 10
2.5 EUT Operation Test Setup 10
2.6 Measurement Results Explanation Example 10

3 TEST RESULT **11**

3.1 6dB and 99% Bandwidth Measurement 11
3.2 Peak Output Power Measurement 16
3.3 Power Spectral Density Measurement 17
3.4 Conducted Band Edges and Spurious Emission Measurement 22
3.5 Spurious Emission Measurement in the Restricted Band 28
3.6 AC Conducted Emission Measurement 32
3.7 Antenna Requirements 34

4 LIST OF MEASURING EQUIPMENT **35**

5 UNCERTAINTY OF EVALUATION **36**

APPENDIX A. CONDUCTED TEST RESULTS
APPENDIX B. AC CONDUCTED EMISSION TEST RESULT
APPENDIX C. RADIATED SPURIOUS EMISSION
APPENDIX D. RADIATED SPURIOUS EMISSION PLOTS
APPENDIX E. DUTY CYCLE PLOTS

REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR693034-02C	Rev. 01	Initial issue of report	May 15, 2017

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass
3.1	-	99% Bandwidth	-	Pass
3.2	15.247(b)(3)	Peak Output Power	≤ 30dBm	Pass
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	≤ 20dBc	Pass
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass
3.6	15.207	AC Conducted Emission	15.207(a)	Pass
3.7	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass

1 General Description

1.1 Applicant

Nimbostratus LLC
945 Concord St. Framingham, MA 01701

1.2 Product Feature of Equipment Under Test

Product Feature	
Equipment	Digital Media Receiver
Model Name	ZE39KL
FCC ID	2AHUF-6294
EUT supports Radios application	WLAN 11b/g/n HT20 WLAN 11a/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE Zigbee

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.3 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2405 MHz ~ 2480 MHz
Number of Channels	16
Maximum Output Power to Antenna	18.52 dBm (0.0711 W)
99% Occupied Bandwidth	2.25MHz
Antenna Type / Gain	Fixed Internal Antenna type with gain 4.90 dBi
Type of Modulation	Zigbee : BPSK

1.4 Modification of EUT

No modifications are made to the EUT during all test items.

1.5 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW0007 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

Test Site	SPORTON INTERNATIONAL INC.	
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978	
Test Site No.	**Sporton Site No.**	
	TH05-HY	CO05-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No.**
	03CH11-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

1.6 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- ANSI C63.10-2013

Remark: All test items were verified and recorded according to the standards and without any deviation during the test.

2 Test Configuration of Equipment Under Test

2.1 Descriptions of Test Mode

The RF output power was recorded in the following table:

Channel	Frequency	Zigbee RF Output Power
		Data Rate / Modulation
		BPSK
		250kbps
CH 11	2405 MHz	18.52 dBm
CH 17	2435 MHz	18.40 dBm
CH 25	2475 MHz	18.40 dBm
CH 26	2480 MHz	5.71 dBm

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction (150 kHz to 30 MHz), radiation (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). Pre-scanned tests, X, Y, Z in three orthogonal panels to determine the final configuration (Y plane as worst plane) from all possible combinations.

b. AC power line Conducted Emission was tested under maximum output power.

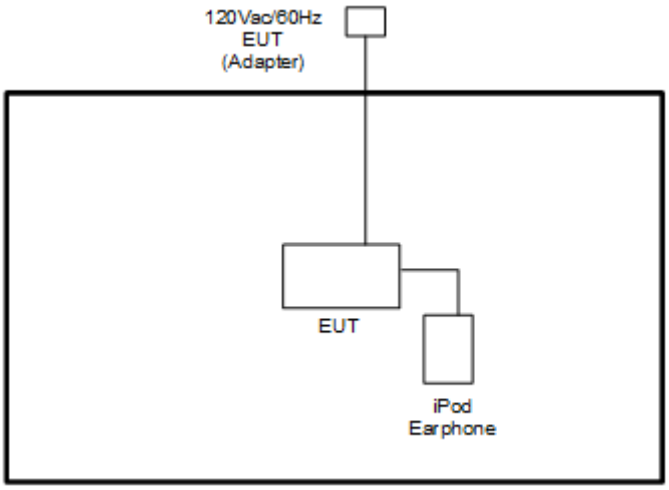
2.2 Test Mode

The following summary table is showing all test modes to demonstrate in compliance with the standard.

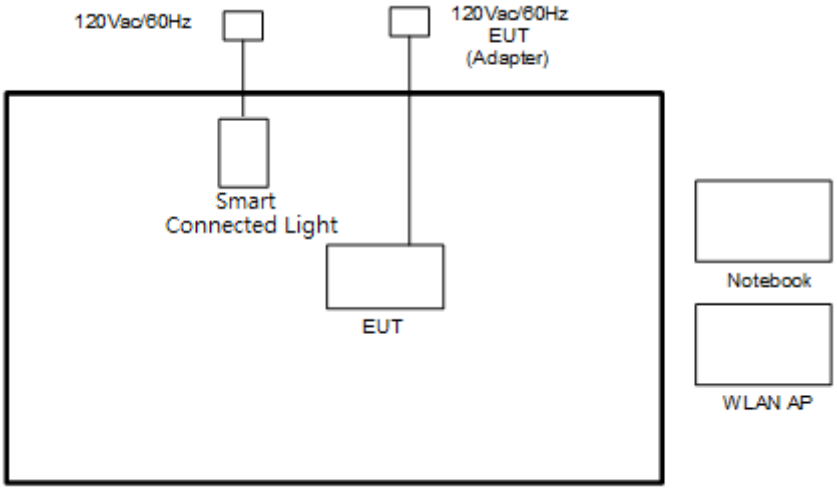
Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
	250kbps / Zigbee
Conducted TCs	Mode 1: Zigbee Tx CH11_2405 MHz Mode 2: Zigbee Tx CH17_2435 MHz Mode 3: Zigbee Tx CH25_2475 MHz Mode 4: Zigbee Tx CH26_2480 MHz
Radiated TCs	Mode 1: Zigbee Tx CH11_2405 MHz Mode 2: Zigbee Tx CH17_2435 MHz Mode 3: Zigbee Tx CH25_2475 MHz Mode 4: Zigbee Tx CH26_2480 MHz
AC Conducted Emission	Mode 1: WLAN (2.4GHz) Link + Zigbee Link + MP3 + Adapter

2.3 Connection Diagram of Test System

<Zigbee Tx Mode>



<AC Conducted Emission Mode>



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	ASUS	RT-AC66U	MSQ-RTAC66U	N/A	Unshielded, 1.8 m
2.	Notebook	DELL	Latitude E6320	FCC DoC/ Contains FCC ID: QDS-BRCM1054	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
3.	Bluetooth Speaker	JAWBONE	JAWBONE JAMBOX	V3J-JBE	N/A	N/A
4.	iPod Earphone	Apple	N/A	Verification	Unshielded, 1.0 m	N/A
5.	Smart Connected light	OSRAM	73739	DZ0-IQHIME	N/A	N/A

2.5 EUT Operation Test Setup

For RF test item, programmed RF utility, “Compliance.exe” installed in the notebook make the EUT provide functions like channel selection and power level for continuous transmitting and receiving signals.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).

= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

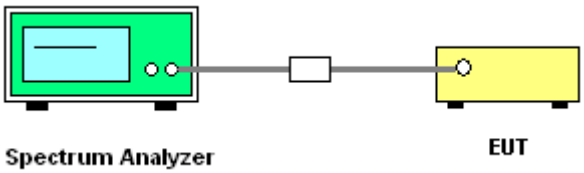
3.1.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.1.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 30kHz and set the Video bandwidth (VBW) = 100kHz.
6. Measure and record the results in the test report.

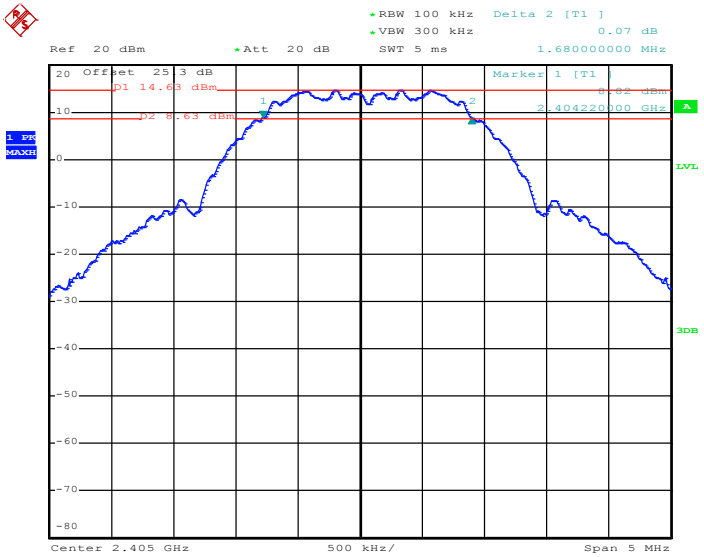
3.1.4 Test Setup



3.1.5 Test Result of 6dB Bandwidth

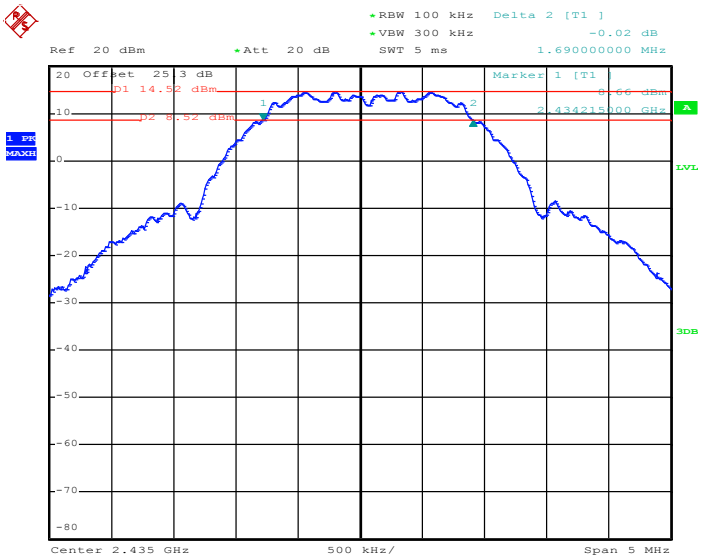
Test data refer to Appendix A.

6 dB Bandwidth Plot on Channel 11



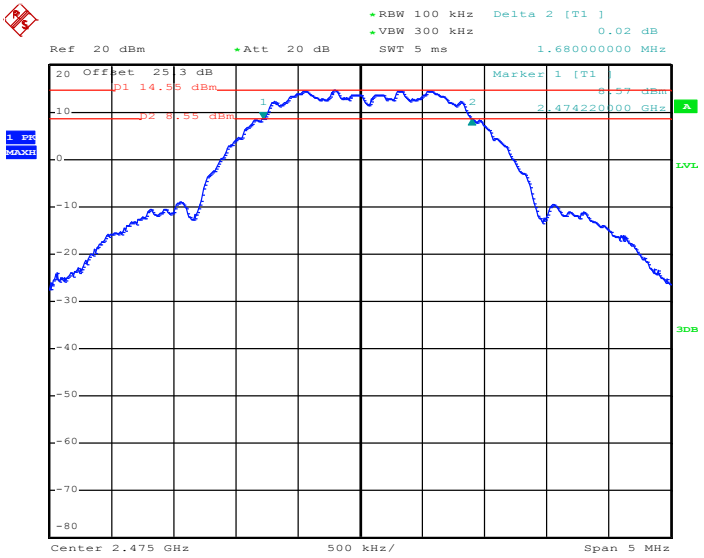
Date: 22.APR.2017 09:21:04

6 dB Bandwidth Plot on Channel 17



Date: 22.APR.2017 10:06:49

6 dB Bandwidth Plot on Channel 25



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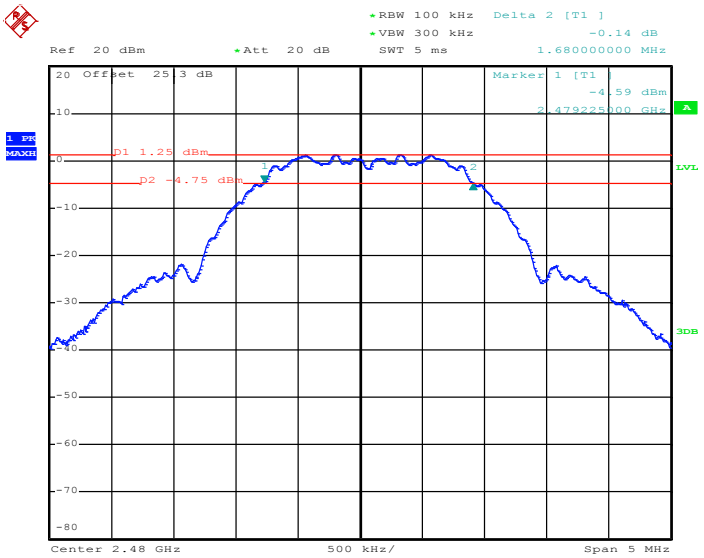
6 dB Bandwidth Plot on Channel 26

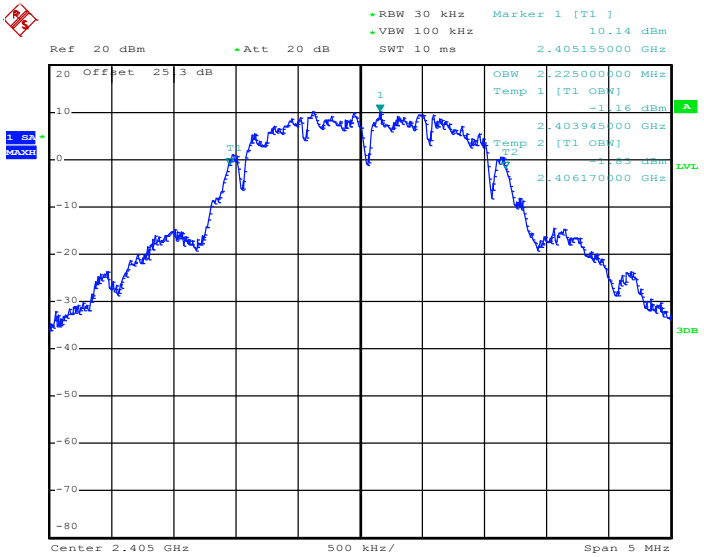


Date: 22.APR.2017 11:20:02

3.1.6 Test Result of 99% Occupied Bandwidth

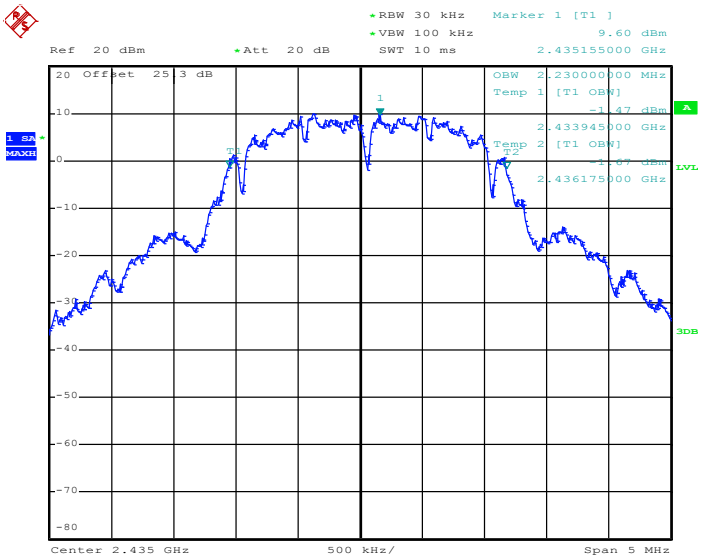
Test data refer to Appendix A.

99% Bandwidth Plot on Channel 11



Date: 22.APR.2017 10:02:30

99% Bandwidth Plot on Channel 17



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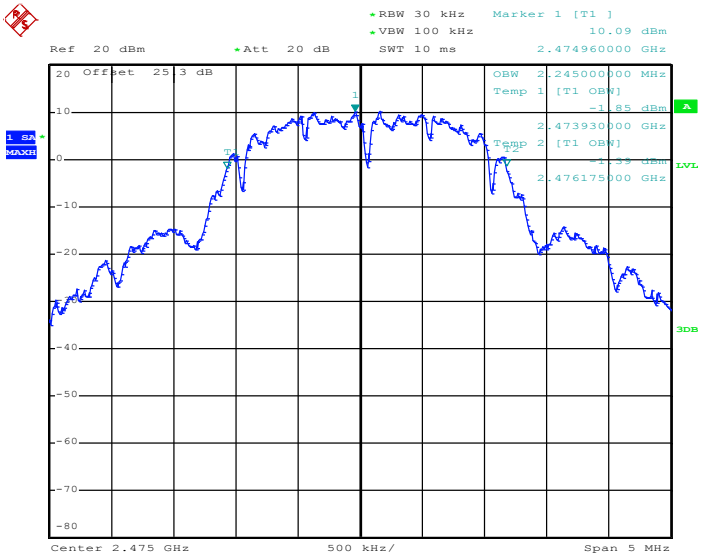
99% Occupied Bandwidth Plot on Channel 25



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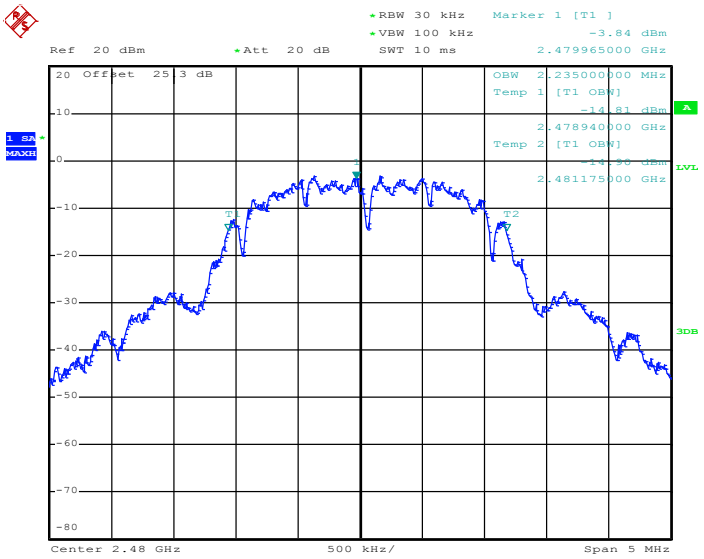
99% Occupied Bandwidth Plot on Channel 26



Date: 22.APR.2017 11:23:59

Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.2 Peak Output Power Measurement

3.2.1 Limit of Peak Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. 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.

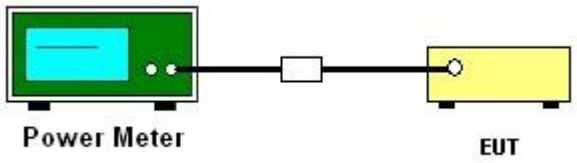
3.2.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.1.3 PKPM1 Peak power meter method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Test data refers to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

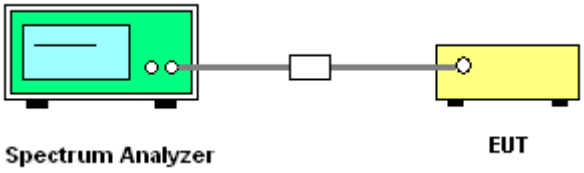
3.3.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.3.3 Test Procedures

1. The testing follows Measurement Procedure 10.2 Method PKPSD of FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup

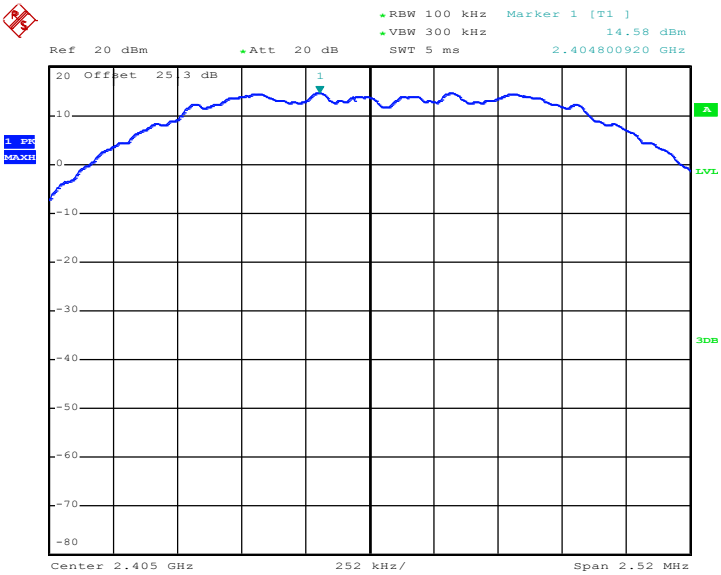


3.3.5 Test Result of Power Spectral Density

Test data refers to Appendix A.

3.3.6 Test Result of Power Spectral Density Plots (100kHz)

PSD 100kHz Plot on Channel 11



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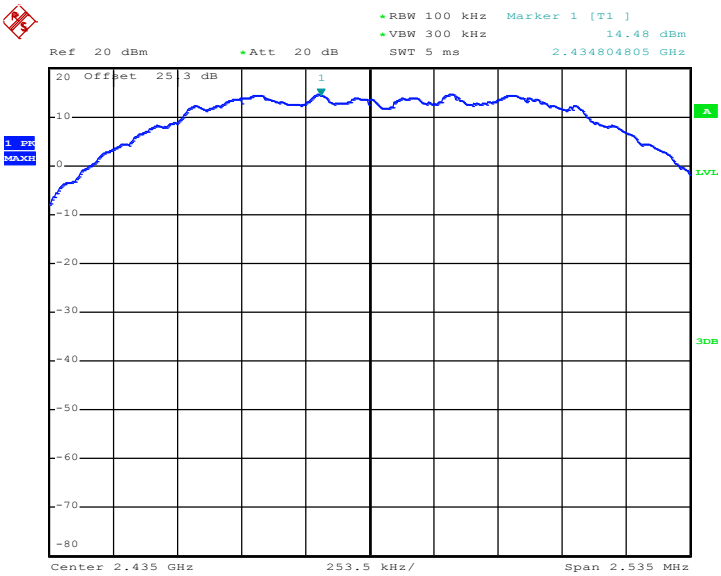
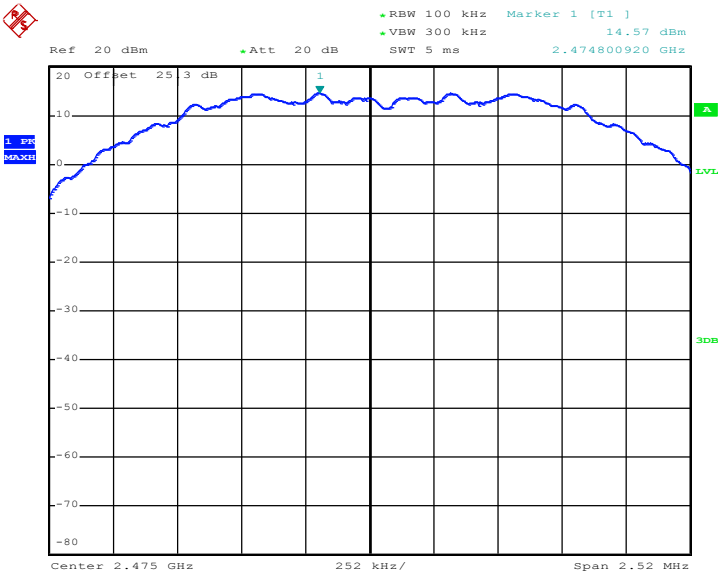
PSD 100kHz Plot on Channel 17



Date: 22.APR.2017 10:12:34

PSD 100kHz Plot on Channel 25



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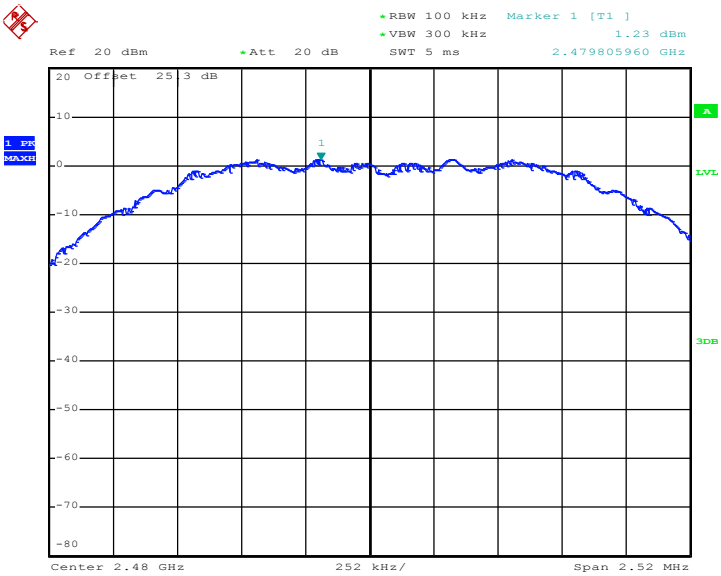
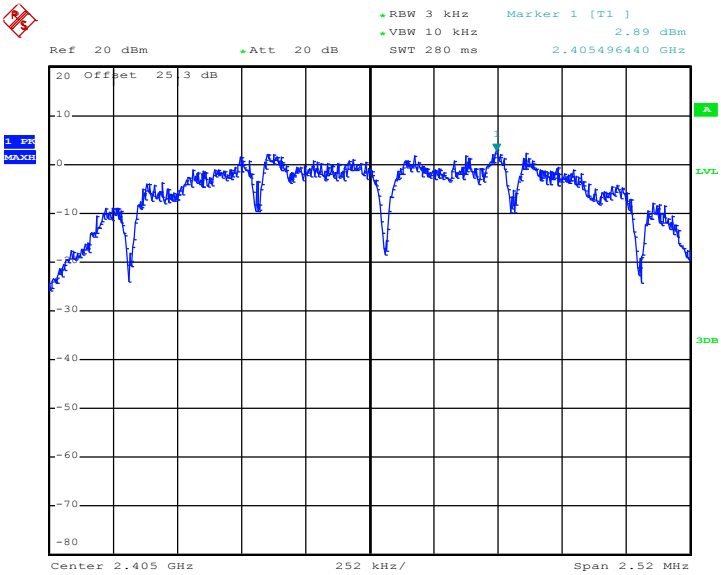
PSD 100kHz Plot on Channel 26



Date: 22.APR.2017 11:20:59

3.3.7 Test Result of Power Spectral Density Plots (3kHz)

PSD 3kHz Plot on Channel 11



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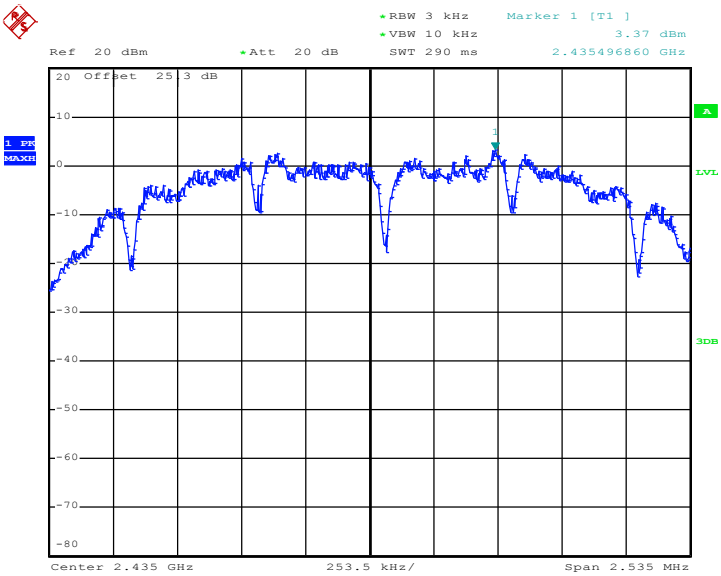
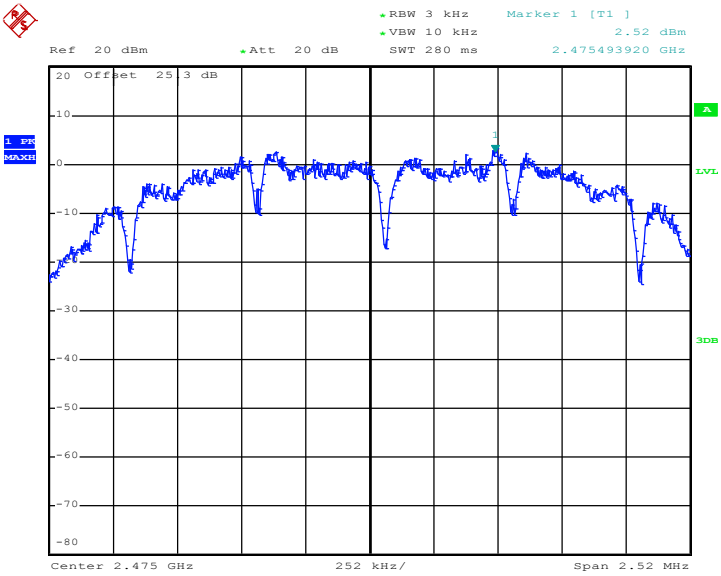
PSD 3kHz Plot on Channel 17



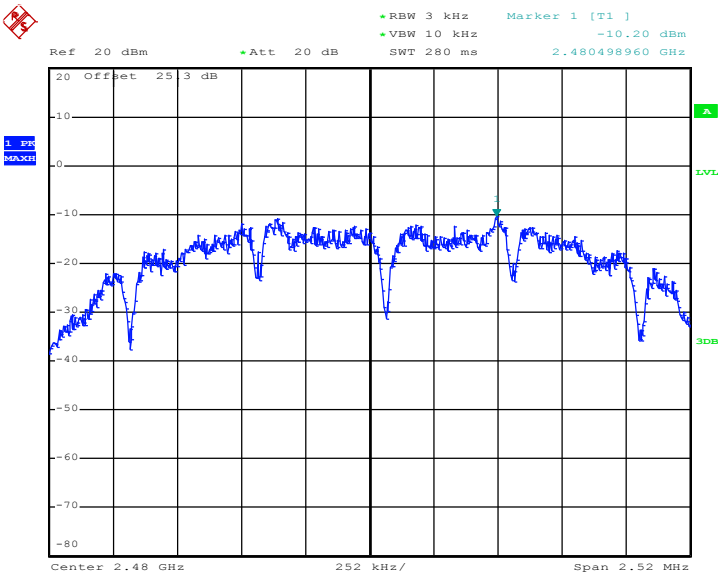
Date: 22.APR.2017 10:10:36

PSD 3kHz Plot on Channel 25



Date: 22.APR.2017 10:30:13

PSD 3kHz Plot on Channel 26



Date: 22.APR.2017 11:20:35

3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

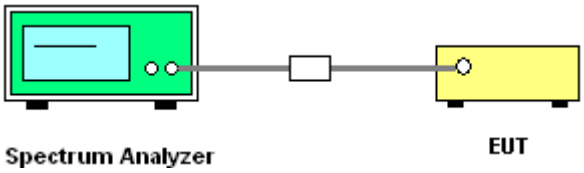
3.4.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.4.3 Test Procedure

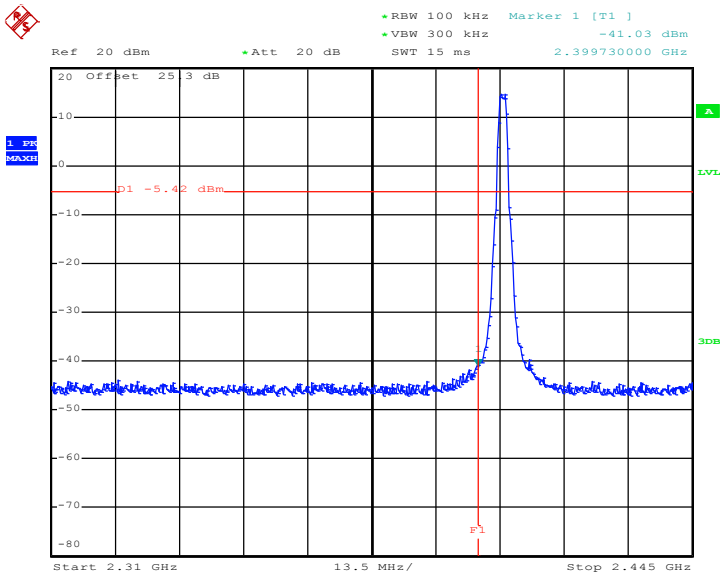
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup



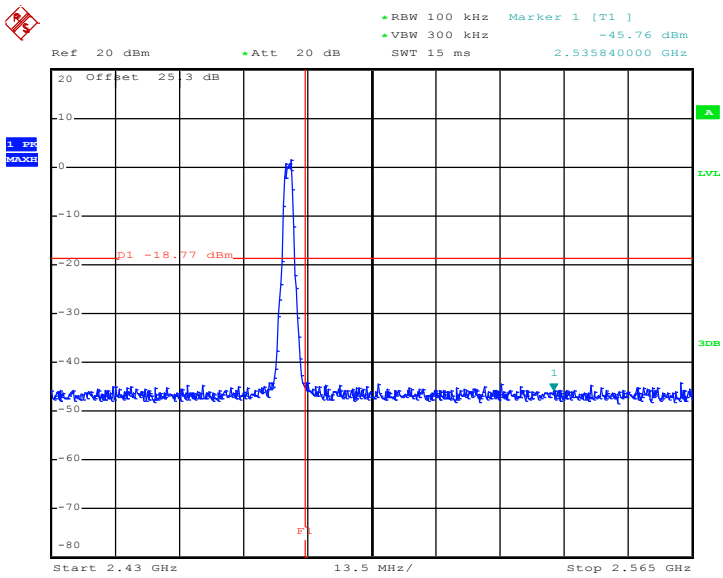
3.4.5 Test Result of Conducted Band Edges Plots

Low Band Edge Plot on Channel 11



Date: 22.APR.2017 09:57:07

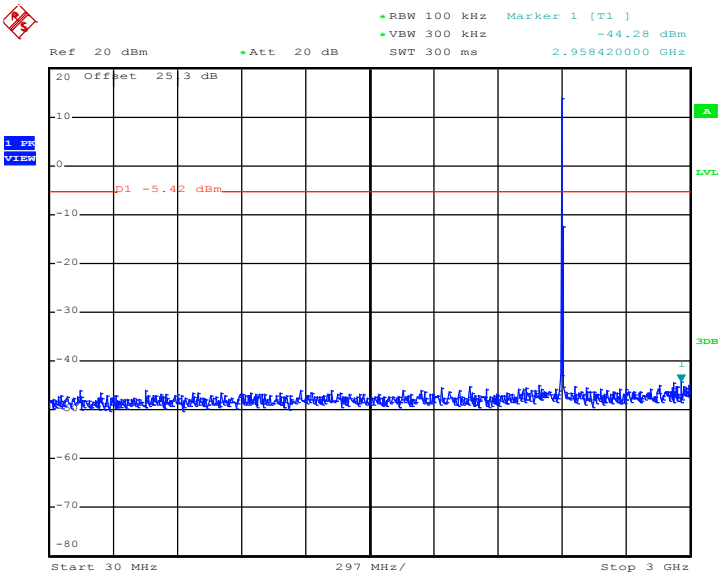
High Band Edge Plot on Channel 26



Date: 22.APR.2017 11:22:07

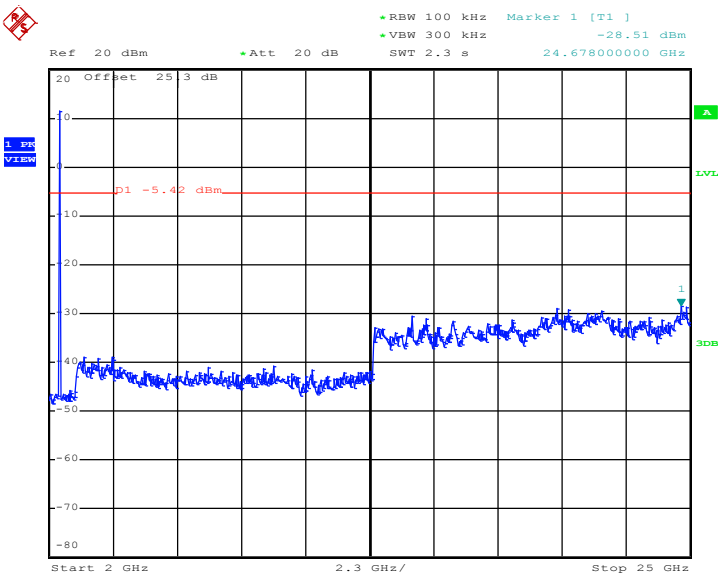
3.4.6 Test Result of Conducted Spurious Emission Plots

Conducted Spurious Emission Plot on Zigbee Channel 11



Date: 22.APR.2017 09:58:43

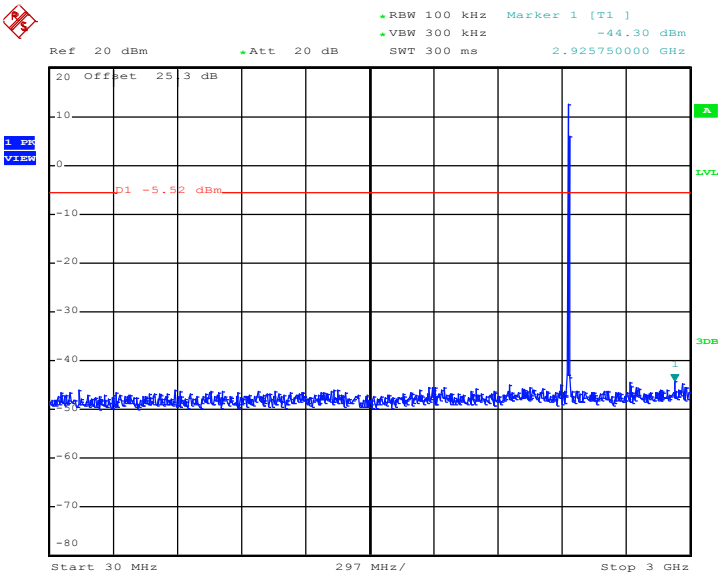
Conducted Spurious Emission Plot on Zigbee Channel 11



Date: 22.APR.2017 09:58:52

Conducted Spurious Emission Plot on Zigbee

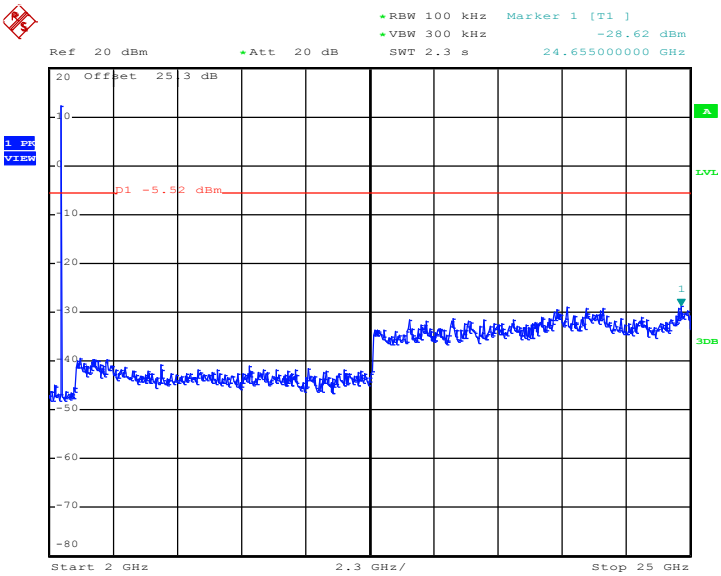
Channel 17



Date: 22.APR.2017 10:13:16

Conducted Spurious Emission Plot on Zigbee

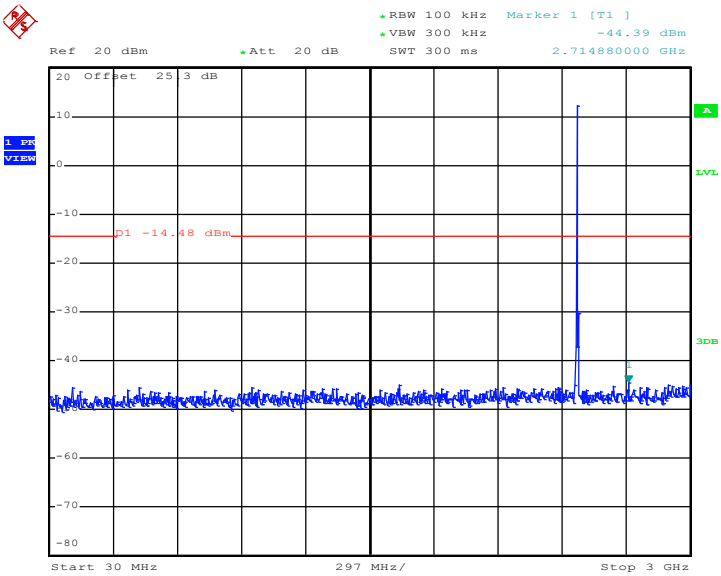
Channel 17



Date: 22.APR.2017 10:13:24

Conducted Spurious Emission Plot on Zigbee

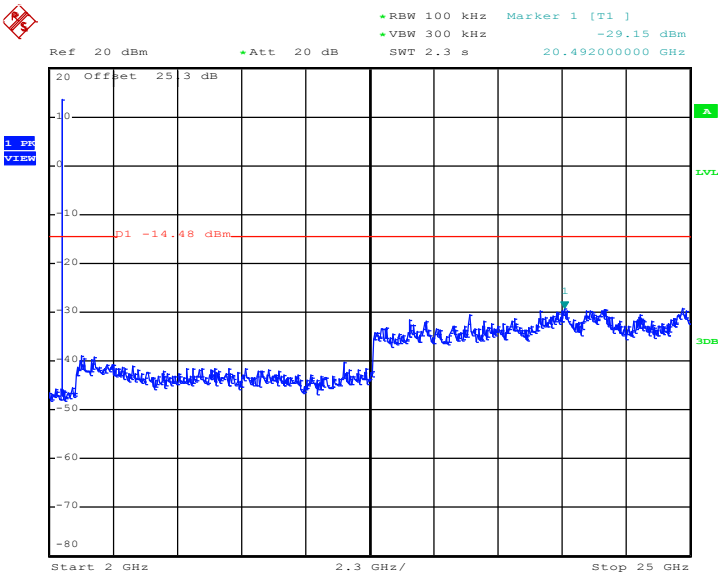
Channel 25



Date: 22.APR.2017 10:37:07

Conducted Spurious Emission Plot on Zigbee

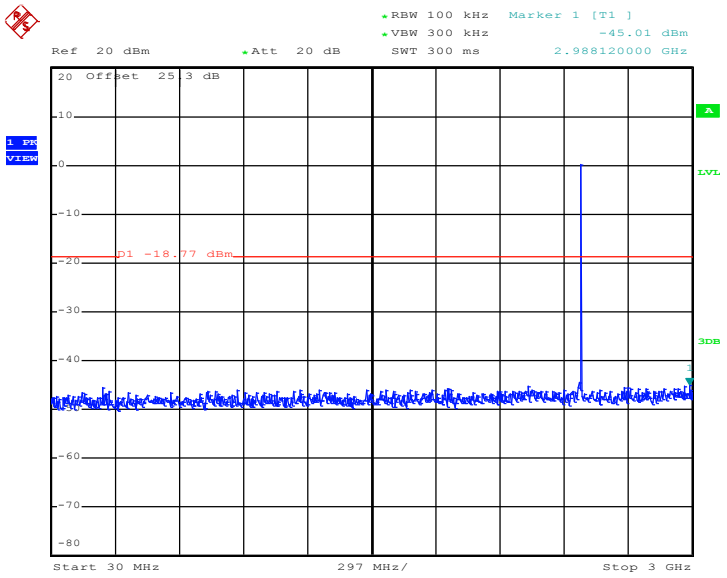
Channel 25



Date: 22.APR.2017 10:37:15

Conducted Spurious Emission Plot on Zigbee

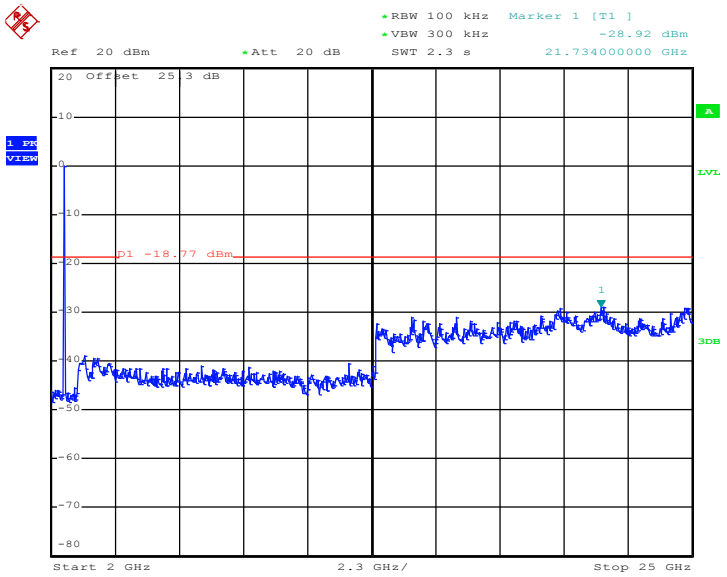
Channel 26



Date: 22.APR.2017 11:22:36

Conducted Spurious Emission Plot on Zigbee

Channel 26



Date: 22.APR.2017 11:22:44

3.5 Spurious Emission Measurement in the Restricted Band

3.5.1 Limit of Spurious Emission Measurement in the Restricted Band

Emissions which fall in the restricted bands must also comply with the limits as below.

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

3.5.2 Measuring Instruments

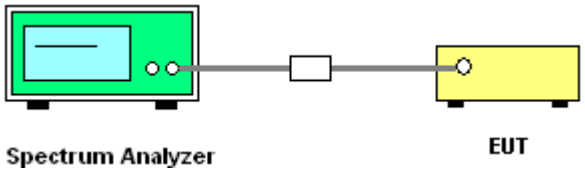
The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.5.3 Test Procedures

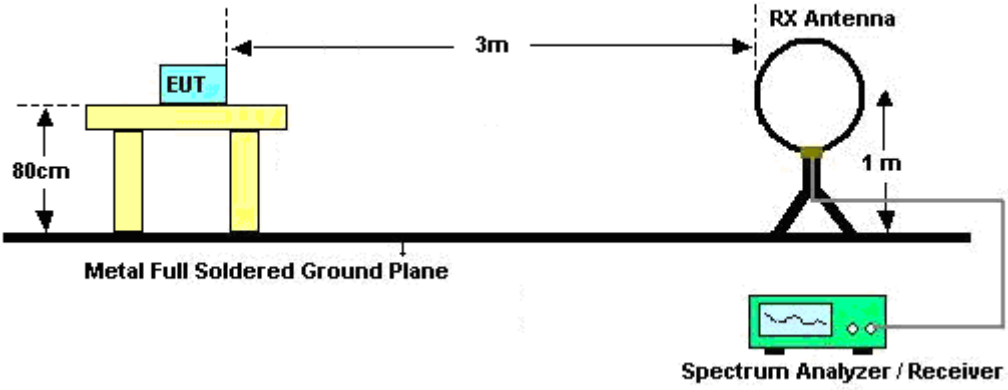
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For conducted spurious emission measurement in the restricted band, the RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
7. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
8. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
9. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

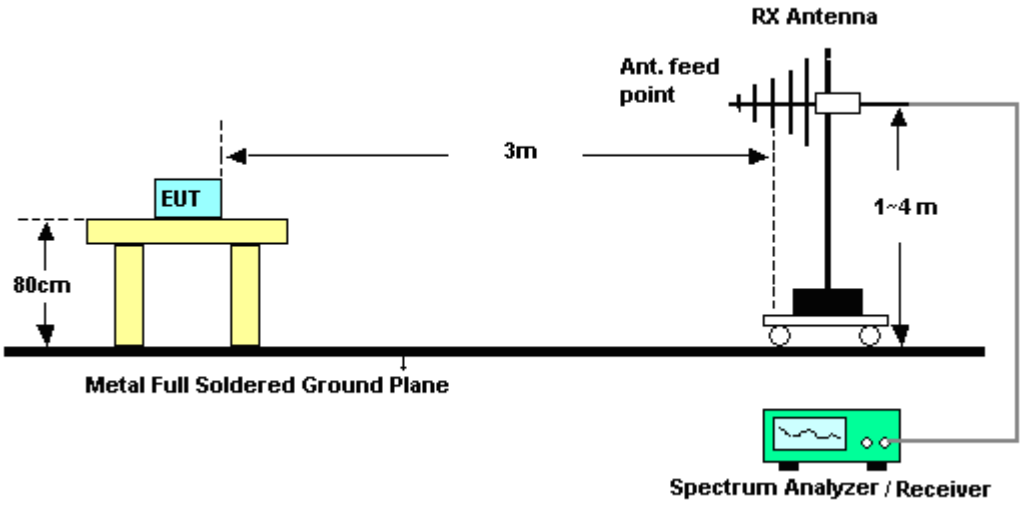
For Conducted Measurement:



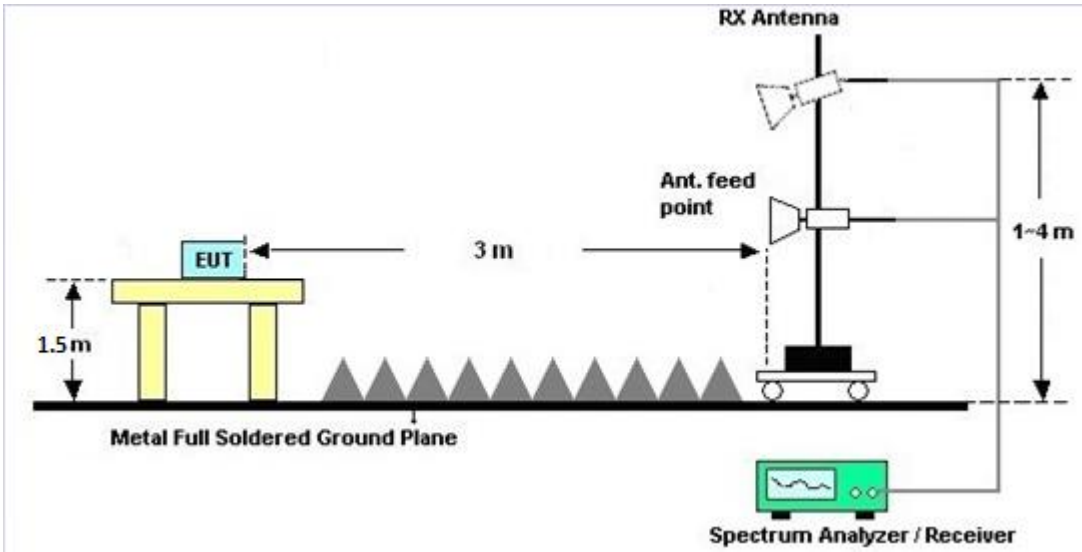
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.5.7 Duty Cycle

Please refer to Appendix E.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix C and D.

3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

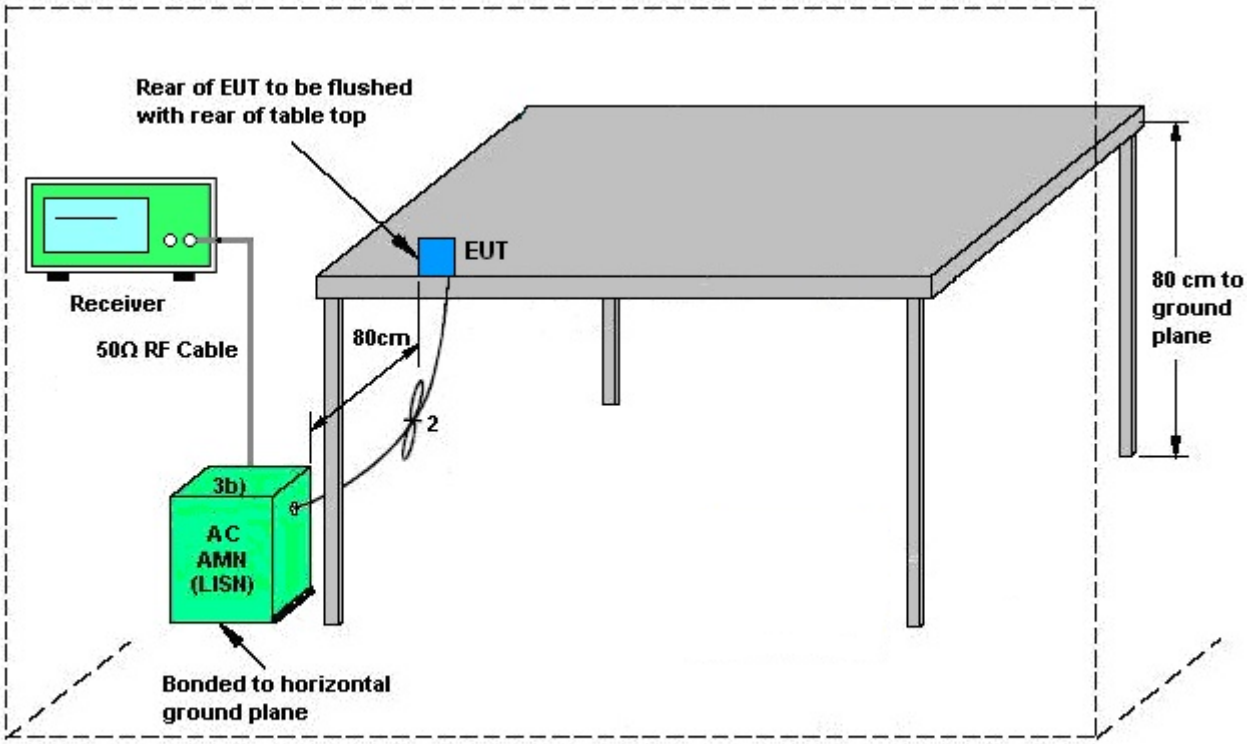
3.6.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.6.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. 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 rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Power Meter	Agilent	E4416A	GB41292344	300MHz~40GHz	Dec. 26, 2016	Mar. 27, 2017 ~ Apr. 22, 2017	Dec. 25, 2017	Conducted (TH05-HY)
Power Sensor	Agilent	E9327A	US40441548	300MHz~40GHz	Dec. 26, 2016	Mar. 27, 2017 ~ Apr. 22, 2017	Dec. 25, 2017	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSP40	100055	9kHz-40GHz	Jul. 17, 2016	Mar. 27, 2017 ~ Apr. 22, 2017	Jul. 16, 2017	Conducted (TH05-HY)
Amplifier	SONOMA	310N	187312	9kHz~1GHz	Nov. 10, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Nov. 09, 2017	Radiation (03CH11-HY)
Bilog Antenna	TESEQ	CBL 6111D&N-6-06	35414&AT-N0602	30MHz~1GHz	Oct. 15, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Oct. 14, 2017	Radiation (03CH11-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1326	1GHz ~ 18GHz	Oct. 07, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Oct. 06, 2017	Radiation (03CH11-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Oct. 20, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Oct. 19, 2018	Radiation (03CH11-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 10, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Nov. 09, 2017	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz ~ 44GHz	Oct. 12, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Oct. 11, 2017	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Mar. 28, 2017 ~ Apr. 17, 2017	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Mar. 28, 2017 ~ Apr. 17, 2017	N/A	Radiation (03CH11-HY)
Preamplifier	MITEQ	AMF-7D-00101800-30-10P	1815698	1GHz~18GHz	Dec. 01, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Nov. 30, 2017	Radiation (03CH11-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz- 40GHz	Nov. 08, 2016	Mar. 28, 2017 ~ Apr. 17, 2017	Nov. 07, 2017	Radiation (03CH11-HY)
EMI Test Receiver	Agilent	N9038A(MXE)	MY53290053	20Hz to 26.5GHz	Jan. 12, 2017	Mar. 28, 2017 ~ Apr. 17, 2017	Jan. 11, 2018	Radiation (03CH11-HY)
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	May 07, 2017	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESCI 7	100724	9kHz~7GHz	Aug. 30, 2016	May 07, 2017	Aug. 29, 2017	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Nov. 29, 2016	May 07, 2017	Nov. 28, 2017	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Dec. 06, 2016	May 07, 2017	Dec. 05, 2017	Conduction (CO05-HY)

5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.7

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.2

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.5

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.2

Appendix A. Conducted Test Results

Zigbee

Test Engineer:	Tommy Lee	Temperature:	21~25	°C
Test Date:	2017/3/28~4/22	Relative Humidity:	51~54	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
zigbee	250kbps	1	11	2405	2.23	1.68	0.50	Pass
zigbee	250kbps	1	17	2435	2.23	1.69	0.50	Pass
zigbee	250kbps	1	25	2475	2.25	1.68	0.50	Pass
zigbee	250kbps	1	26	2480	2.24	1.68	0.50	Pass

TEST RESULTS DATA
Peak Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
zigbee	250kbps	1	11	2405	18.52	30.00	4.90	23.42	36.00	Pass
zigbee	250kbps	1	17	2435	18.40	30.00	4.90	23.30	36.00	Pass
zigbee	250kbps	1	25	2475	18.40	30.00	4.90	23.30	36.00	Pass
zigbee	250kbps	1	26	2480	5.71	30.00	4.90	10.61	36.00	Pass

TEST RESULTS DATA
Average Power Table
(Reporting Only)

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)
zigbee	250kbps	1	11	2405	0.00	18.50
zigbee	250kbps	1	17	2435	0.00	18.40
zigbee	250kbps	1	25	2475	0.00	18.40
zigbee	250kbps	1	26	2480	0.00	5.10

TEST RESULTS DATA
Peak Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
zigbee	250kbps	1	11	2405	14.58	2.89	4.90	8.00	Pass
zigbee	250kbps	1	17	2435	14.48	3.37	4.90	8.00	Pass
zigbee	250kbps	1	25	2475	14.57	2.52	4.90	8.00	Pass
zigbee	250kbps	1	26	2480	1.23	-10.20	4.90	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 20dBc limit.

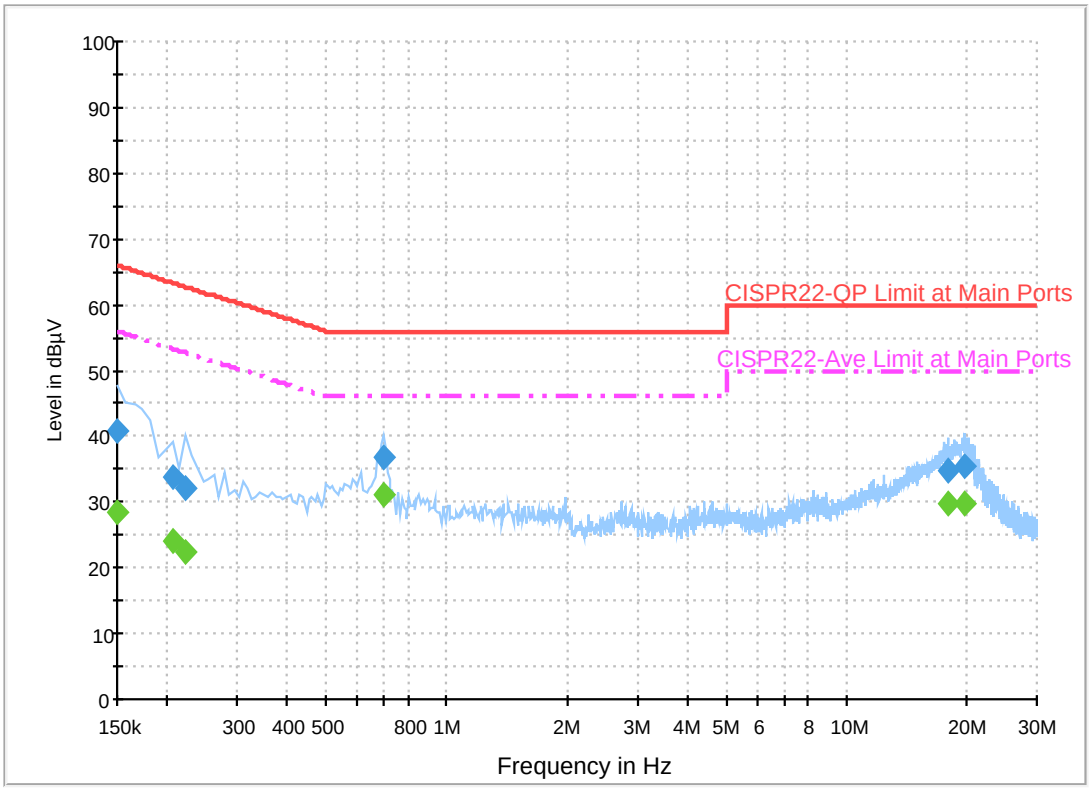
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Derreck Chen	**Temperature :**	20~22℃
		Relative Humidity :	50~52%

EUT Information

Report NO :	693034-02
Test Mode :	Mode 1
Test Voltage :	120Vac/60Hz
Phase :	Line

ENV216 Auto Test FCC Power Bar - L



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	41.0	Off	L1	19.6	25.0	66.0
0.206000	33.7	Off	L1	19.6	29.7	63.4
0.222000	32.2	Off	L1	19.6	30.5	62.7
0.694000	36.8	Off	L1	19.6	19.2	56.0
17.894000	34.9	Off	L1	20.5	25.1	60.0
19.838000	35.6	Off	L1	20.6	24.4	60.0

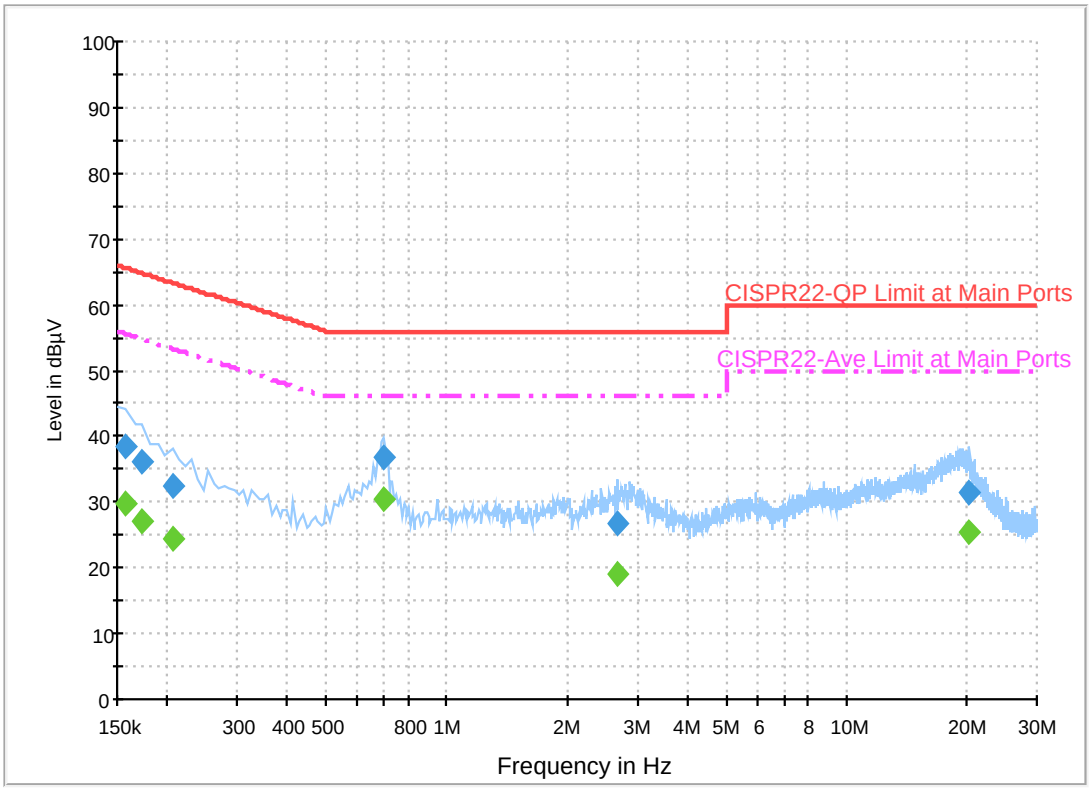
Final Result 2

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	28.3	Off	L1	19.6	27.7	56.0
0.206000	24.0	Off	L1	19.6	29.4	53.4
0.222000	22.4	Off	L1	19.6	30.3	52.7
0.694000	31.0	Off	L1	19.6	15.0	46.0
17.894000	29.6	Off	L1	20.5	20.4	50.0
19.838000	29.8	Off	L1	20.6	20.2	50.0

EUT Information

Report NO :	693034-02
Test Mode :	Mode 4
Test Voltage :	120Vac/60Hz
Phase :	Neutral

ENV216 Auto Test FCC Power Bar - N



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.158000	38.5	Off	N	19.5	27.1	65.6
0.174000	36.2	Off	N	19.5	28.6	64.8
0.206000	32.6	Off	N	19.5	30.8	63.4
0.694000	36.8	Off	N	19.5	19.2	56.0
2.670000	26.7	Off	N	19.4	29.3	56.0
20.366000	31.6	Off	N	20.7	28.4	60.0

Final Result 2

Frequency (MHz)	Average (dBµV)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.158000	29.8	Off	N	19.5	25.8	55.6
0.174000	27.0	Off	N	19.5	27.8	54.8
0.206000	24.5	Off	N	19.5	28.9	53.4
0.694000	30.3	Off	N	19.5	15.7	46.0
2.670000	19.2	Off	N	19.4	26.8	46.0
20.366000	25.3	Off	N	20.7	24.7	50.0

Appendix C. Radiated Spurious Emission

Test Engineer :	J.C. Liang, Jacky Hung, Ken Wu	Temperature :	20~24°C
		Relative Humidity :	55~60%

2.4GHz 2400~2483.5MHz

Zigbee (Band Edge @ 3m)

Zigbee	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
Zigbee CH 11 2405MHz		2359.665	52.37	-21.63	74	42.68	27.09	6.27	33.6	366	71	P	H
		2366.595	42.34	-11.66	54	32.65	27.09	6.27	33.6	366	71	A	H
	*	2405	110.55	-	-	100.61	27.24	6.36	33.59	366	71	P	H
	*	2405	108.23	-	-	98.29	27.24	6.36	33.59	366	71	A	H
		2381.925	54.13	-19.87	74	44.34	27.14	6.32	33.6	317	333	P	V
		2366.595	43.8	-10.2	54	34.11	27.09	6.27	33.6	317	333	A	V
	*	2405	116.17	-	-	106.23	27.24	6.36	33.59	317	333	P	V
	*	2405	113.84	-	-	103.9	27.24	6.36	33.59	317	333	A	V
Zigbee CH 17 2435MHz		2379.44	53.16	-20.84	74	43.37	27.14	6.32	33.6	347	70	P	H
		2389.66	41.35	-12.65	54	31.51	27.19	6.32	33.6	347	70	A	H
	*	2435	111.45	-	-	101.45	27.29	6.37	33.59	347	70	P	H
	*	2435	109.09	-	-	99.09	27.29	6.37	33.59	347	70	A	H
		2485.93	52.7	-21.3	74	42.51	27.45	6.39	33.58	347	70	P	H
		2484.32	41.68	-12.32	54	31.49	27.45	6.39	33.58	347	70	A	H
		2387.56	52.75	-21.25	74	42.91	27.19	6.32	33.6	345	332	P	V
		2383.92	41.49	-12.51	54	31.7	27.14	6.32	33.6	345	332	A	V
	*	2435	117.14	-	-	107.14	27.29	6.37	33.59	345	332	P	V
	*	2435	114.6	-	-	104.6	27.29	6.37	33.59	345	332	A	V
		2490.83	53.77	-20.23	74	43.53	27.5	6.39	33.58	345	332	P	V
		2483.62	41.91	-12.09	54	31.72	27.45	6.39	33.58	345	332	A	V

Zigbee CH 25 2475MHz	*	2475	110.75	-	-	100.57	27.45	6.38	33.58	358	66	P	H
	*	2475	108.43	-	-	98.25	27.45	6.38	33.58	358	66	A	H
		2484.4	54.64	-19.36	74	44.45	27.45	6.39	33.58	358	66	P	H
		2483.52	44.37	-9.63	54	34.18	27.45	6.39	33.58	358	66	A	H
	*	2475	117.85	-	-	107.67	27.45	6.38	33.58	295	329	P	V
	*	2475	115.51	-	-	105.33	27.45	6.38	33.58	295	329	A	V
		2483.56	60.52	-13.48	74	50.33	27.45	6.39	33.58	295	329	P	V
		2483.52	51.39	-2.61	54	41.2	27.45	6.39	33.58	295	329	A	V
Zigbee CH 26 2480MHz	*	2480	99.27	-	-	89.09	27.45	6.38	33.58	225	72	P	H
	*	2480	96.94	-	-	86.76	27.45	6.38	33.58	225	72	A	H
		2483.84	56.53	-17.47	74	46.34	27.45	6.39	33.58	225	72	P	H
		2483.52	47.64	-6.36	54	37.45	27.45	6.39	33.58	225	72	A	H
	*	2480	104.94	-	-	94.76	27.45	6.38	33.58	294	330	P	V
	*	2480	102.65	-	-	92.47	27.45	6.38	33.58	294	330	A	V
		2483.56	61.21	-12.79	74	51.02	27.45	6.39	33.58	294	330	P	V
		2483.52	52.17	-1.83	54	41.98	27.45	6.39	33.58	294	330	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2400~2483.5MHz

Zigbee (Harmonic @ 3m)

Zigbee	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
Zigbee CH 11 2405MHz		4810	45.08	-28.92	74	67.84	31.66	9.9	64.75	100	0	P	H
		4810	46.29	-27.71	74	69.48	31.66	9.9	64.75	100	0	P	V
Zigbee CH 17 2435MHz		4870	48.64	-25.36	74	71.26	31.78	9.87	64.7	100	0	P	H
		7305	43.85	-30.15	74	59.28	37.27	11.65	64.82	100	0	P	H
		4870	50	-24	74	72.62	31.78	9.87	64.7	200	293	P	V
		4870	42.59	-11.41	54	65.21	31.78	9.87	64.7	200	293	A	V
		7305	44.08	-29.92	74	59.51	37.27	11.65	64.82	100	0	P	V
Zigbee CH 25 2475MHz		4950	50.98	-23.02	74	73.46	31.91	9.81	64.64	100	142	P	H
		4950	42.96	-11.04	54	65.44	31.91	9.81	64.64	100	142	A	H
		7425	44.49	-29.51	74	59.89	37.42	11.68	64.87	100	0	P	H
		4950	54.27	-19.73	74	77.19	31.91	9.81	64.64	198	285	P	V
		4950	47.4	-6.6	54	70.32	31.91	9.81	64.64	198	285	A	V
		7425	44.95	-29.05	74	60.72	37.42	11.68	64.87	100	0	P	V
Zigbee CH 26 2480MHz		4960	44.24	-29.76	74	66.68	31.94	9.81	64.63	100	0	P	H
		7440	44.54	-29.46	74	59.92	37.44	11.68	64.88	100	0	P	H
		4960	47.89	-26.11	74	70.77	31.94	9.81	64.63	100	0	P	V
		7440	44.66	-29.34	74	60.42	37.44	11.68	64.88	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

2.4GHz Zigbee (LF)

Zigbee	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz Zigbee LF		95.88	24.74	-18.76	43.5	40.31	15.62	1.27	32.48	-	-	P	H
		182.28	34.41	-9.09	43.5	50.23	15.22	1.69	32.82	-	-	P	H
		201.72	37.87	-5.63	43.5	52.85	16.04	1.8	32.88	108	357	P	H
		316.8	30.94	-15.06	46	40.76	20.18	2.28	32.36	-	-	P	H
		730.5	29.08	-16.92	46	30.61	27.31	3.41	32.38	-	-	P	H
		958	33.11	-12.89	46	29.61	30.58	3.87	31.13	-	-	P	H
		95.88	24.74	-18.76	43.5	40.31	15.62	1.27	32.48	-	-	P	V
		182.28	34.41	-9.09	43.5	50.23	15.22	1.69	32.82	-	-	P	V
		201.72	37.87	-5.63	43.5	52.85	16.04	1.8	32.88	108	357	P	V
		316.8	30.94	-15.06	46	40.76	20.18	2.28	32.36	-	-	P	V
		730.5	29.08	-16.92	46	30.61	27.31	3.41	32.38	-	-	P	V
		958	33.11	-12.89	46	29.61	30.58	3.87	31.13	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is **over limit** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1+2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 01 2412MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Level(dBμV/m) =

Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is "PASS".

Appendix D. Radiated Spurious Emission Plots

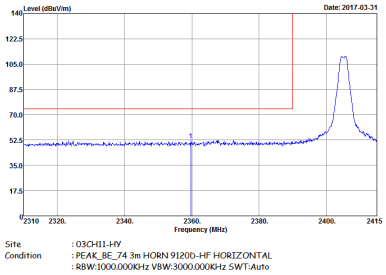
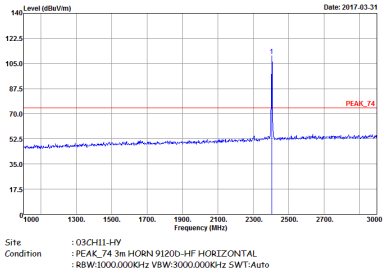
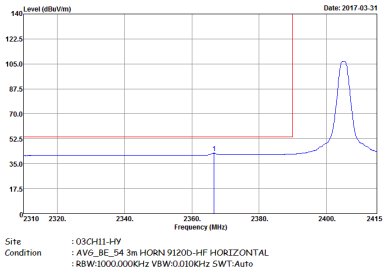
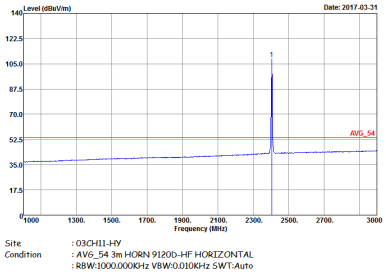
Test Engineer :	J.C. Liang, Jacky Hung, Ken Wu	**Temperature :**	20~24°C
		Relative Humidity :	55~60%

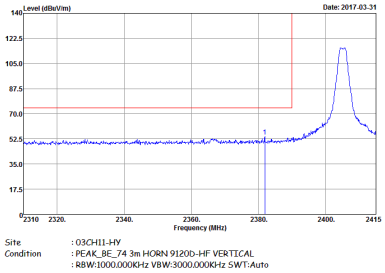
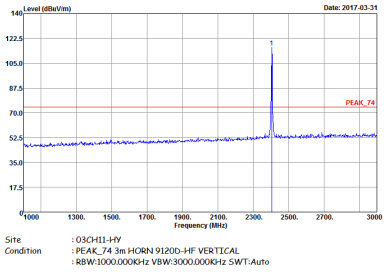
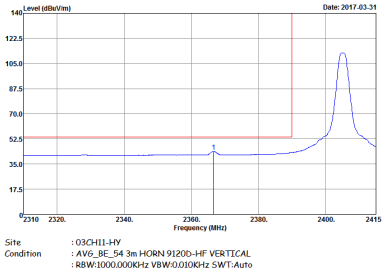
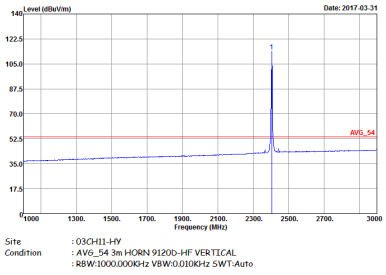
Note symbol

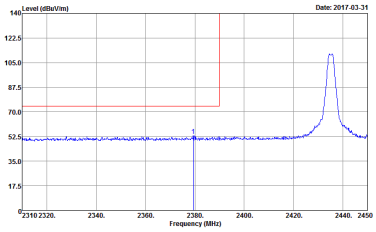
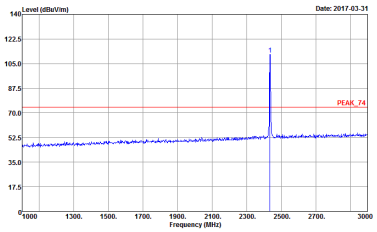
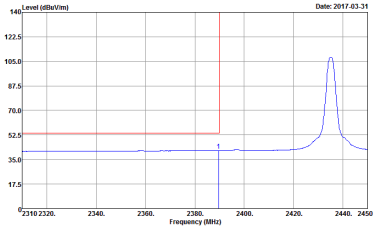
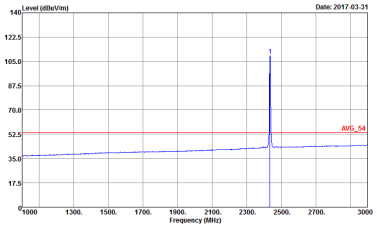
-L	**Low channel location**
-R	**High channel location**

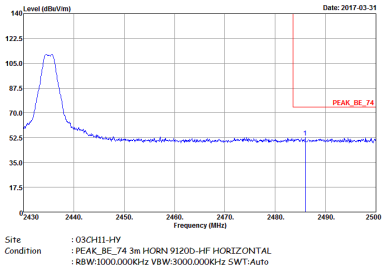
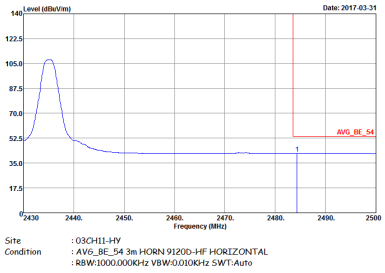
2.4GHz 2400~2483.5MHz

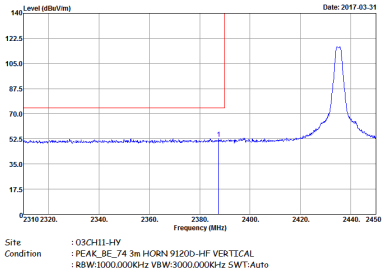
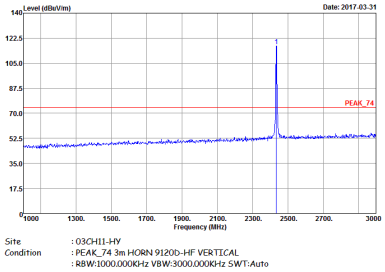
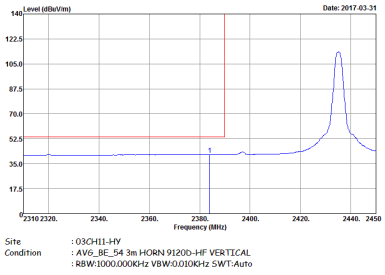
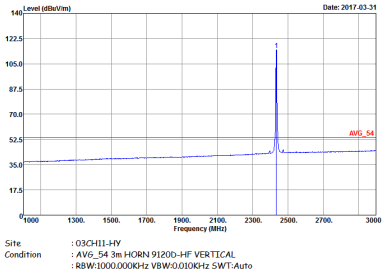
Zigbee (Band Edge @ 3m)

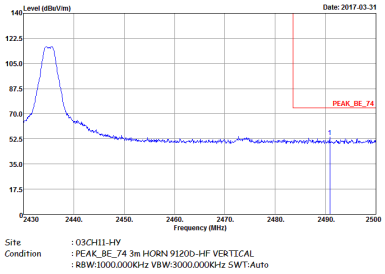
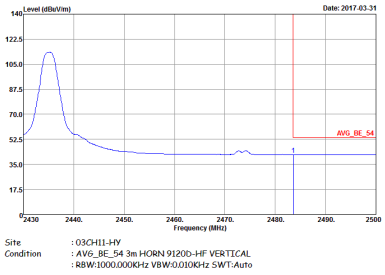
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH11 2405MHz	
	Horizontal	Fundamental
Peak		
Avg.		

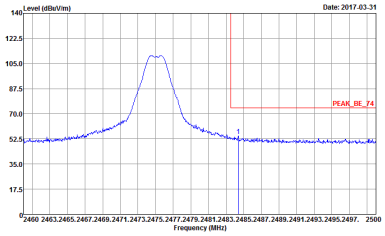
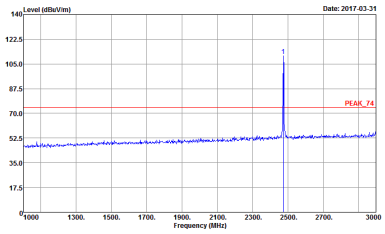
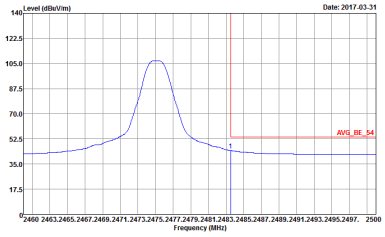
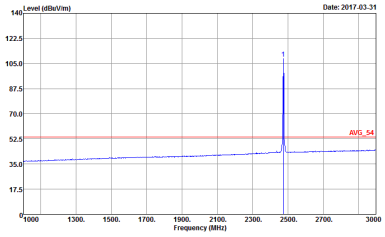
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH11 2405MHz	
	Vertical	Fundamental
Peak		
Avg		

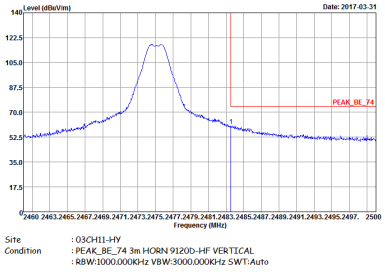
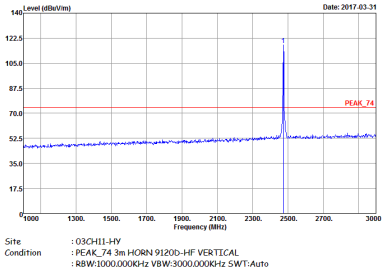
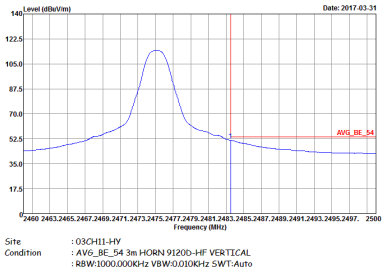
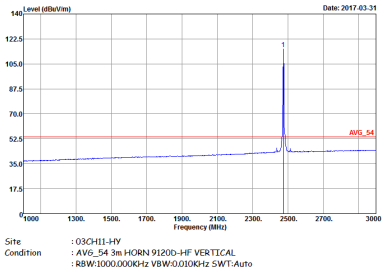
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH17 2435MHz - L	
	Horizontal	Fundamental
Peak	 Site : 03CH11-HY Condition : PEAK_BE_74 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH11-HY Condition : PEAK_74 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH11-HY Condition : AVG_BE_54 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH11-HY Condition : AVG_54 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto

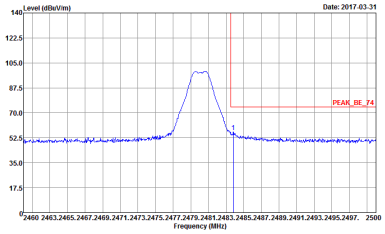
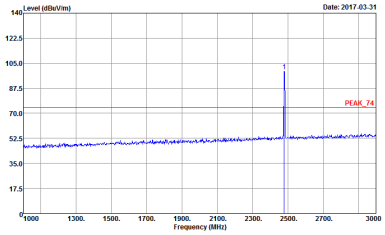
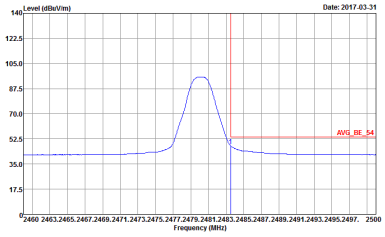
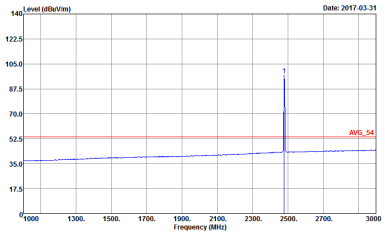
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH17 2435MHz - R	
	Horizontal	Fundamental
Peak		Left blank
Avg.		Left blank

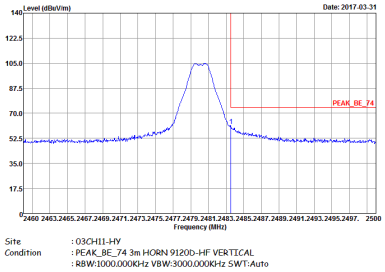
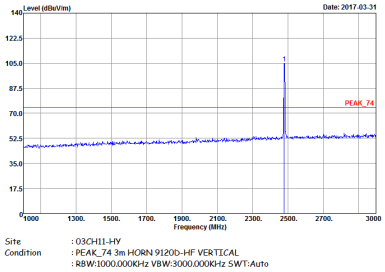
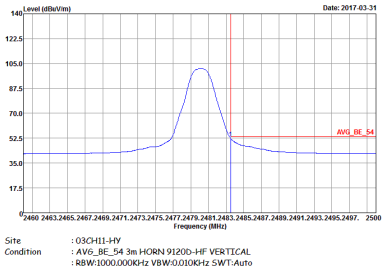
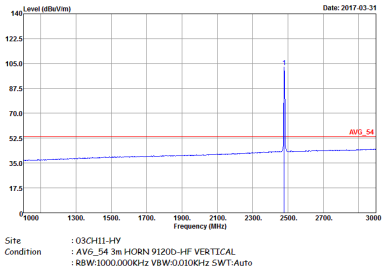
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH17 2435MHz - L	
	Vertical	Fundamental
Peak		
Avg.		

Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH17 2435MHz - R	
	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH25 2475MHz	
	Horizontal	Fundamental
Peak	 Site : 03CH11-HY Condition : PEAK_BE_74 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH11-HY Condition : PEAK_74 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH11-HY Condition : AVG_BE_54 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH11-HY Condition : AVG_54 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto

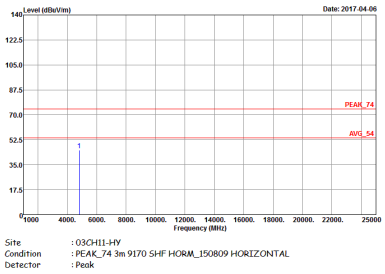
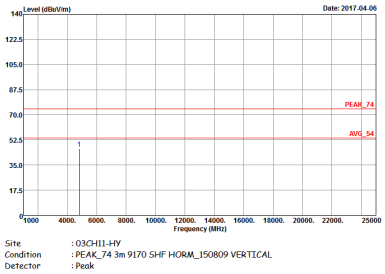
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH25 2475MHz	
	Vertical	Fundamental
Peak		
Avg.		

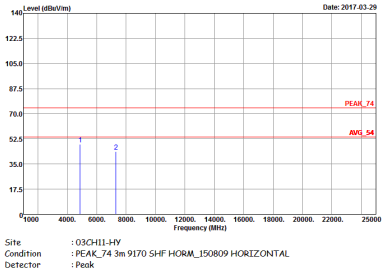
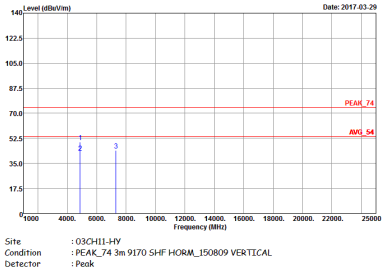
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH26 2480MHz	
	Horizontal	Fundamental
Peak	 Site : 03CH11-HY Condition : PEAK_BE_74 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH11-HY Condition : PEAK_74 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH11-HY Condition : AVG_BE_54 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH11-HY Condition : AVG_54 3m HORN 9120D-HF HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto

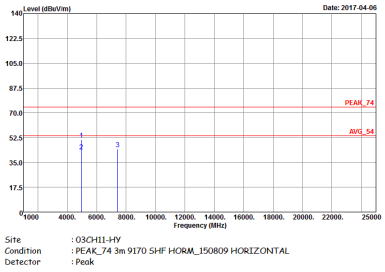
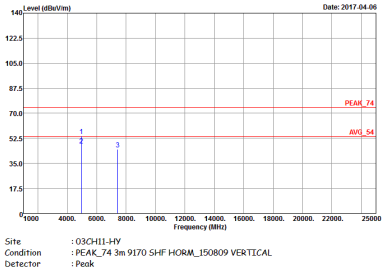
Zigbee	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	Zigbee CH26 2480MHz	
	Vertical	Fundamental
Peak		
Avg.		

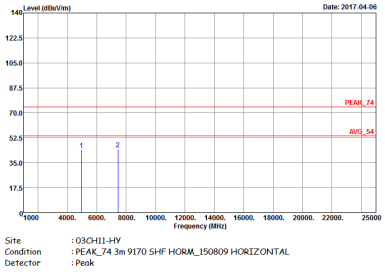
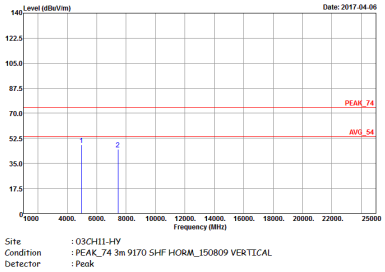
2.4GHz 2400~2483.5MHz

Zigbee (Harmonic @ 3m)

Zigbee	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	Zigbee CH11 2405MHz	
	Horizontal	Vertical
Peak Avg.		

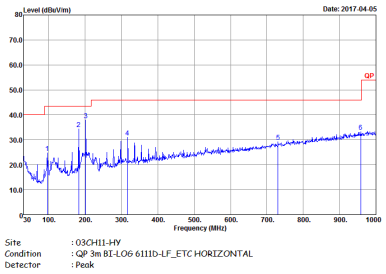
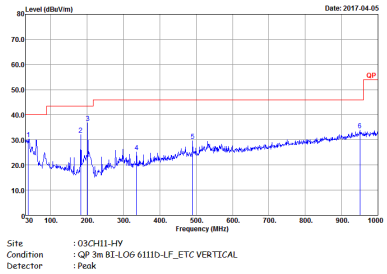
Zigbee	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	Zigbee CH17 2435MHz	
	Horizontal	Vertical
Peak Avg.		

Zigbee	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	Zigbee CH25 2475MHz	
	Horizontal	Vertical
Peak		

Zigbee	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	Zigbee CH26 2480MHz	
	Horizontal	Vertical
Peak		

Emission below 1GHz

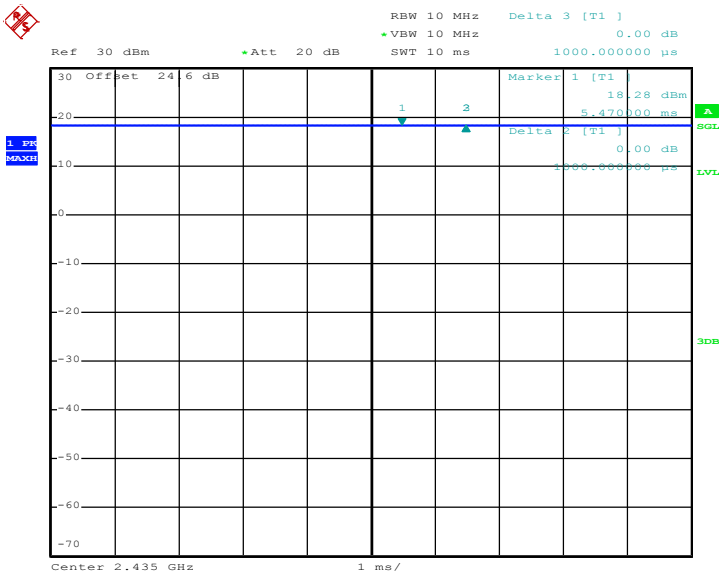
2.4GHz Zigbee (LF)

Zigbee	2.4GHz 2400~2483.5MHz	
	Zigbee LF	
	Horizontal	Vertical
QP / Peak		

Appendix E. Duty Cycle Plots

Band	Duty Cycle(%)	T(μs)	1/T(kHz)	VBW Setting
Zigbee	100	-	-	10Hz

Zigbee



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