



FCC RF Co-location Test Report

APPLICANT : Senao Networks, Inc.
EQUIPMENT : Wireless 802.11 ac/a/b/g/n Access Point
BRAND NAME : Senao Networks
MODEL NAME : CAP7253AG
FCC ID : U2M-CAP7252AG
STANDARD : FCC Part 15 Subpart C §15.247
CLASSIFICATION : (DTS) Digital Transmission System

The product was received on Jan. 28, 2016 and testing was completed on Mar. 29, 2016. 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



SPORTON INTERNATIONAL INC.

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR5D2212E2	Rev. 01	Initial issue of report	Sep. 21, 2016
FR5D2212E2	Rev. 02	Revising FCC KDB Publication No. 558074 D01 DTS Meas. Guidance from v03r04 to v03r05 and FCC KDB 789033 D02 General UNII Test Procedures New Rules from v01r01 to v01r03.	Sep. 30, 2016



SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(d)	Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.36 dB at 41.610 MHz
3.2	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-



1 General Description

1.1 Applicant

Senao Networks, Inc.

3F, No. 529, Chung Cheng Rd., Hsintien, Taipei, Taiwan, R.O.C

1.2 Manufacturer

Senao Networks, Inc.

3F, No. 529, Chung Cheng Rd., Hsintien, Taipei, Taiwan, R.O.C

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Wireless 802.11 ac/a/b/g/n Access Point
Brand Name	Senao Networks
Model Name	CAP7253AG
FCC ID	U2M-CAP7252AG
EUT supports Radios application	WLAN 11 a/b/g/n HT20/HT40 WLAN 11 ac VHT20/VHT40/VHT80
EUT Stage	Production Unit

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



1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Channel Frequency Range	802.11b/g/n : 2412 MHz ~ 2462 MHz 802.11a/n/ac : 5180 MHz ~ 5240 MHz. 5745 MHz ~ 5825 MHz
Antenna Type	<2412 MHz ~ 2462 MHz> <Ant 1> 802.11b/g/n : Dipole Antenna type with gain 4.42 dBi <Ant 2> 802.11b/g/n : Dipole Antenna type with gain 4.42 dBi <5180 MHz ~ 5240 MHz> <Ant 1> 802.11a/n/ac : Dipole Antenna type with gain 3.18 dBi <Ant 2> 802.11a/n/ac : Dipole Antenna type with gain 3.18 dBi <5745 MHz ~ 5825 MHz> <Ant 1> 802.11a/n/ac : Dipole Antenna type with gain 2.95 dBi <Ant 2> 802.11a/n/ac : Dipole Antenna type with gain 2.95 dBi
Type of Modulation	802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11a/g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ac : OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM)

1.5 Modification of EUT

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



1.6 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW1022 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd Rd. Guishan Dist, Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No.
	03CH12-HY

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

1.7 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 789033 D02 General UNII Test Procedures New Rules v01r03
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r05.
- ♦ 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

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: radiated emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (Y plane) were recorded in this report.

The final configuration from all the combinations and the worst-case data rates were investigated by measuring the maximum power across all the data rates and modulation modes under section 2.2.

Based on the worst configuration found above, the RF power setting is set individually to meet FCC compliance limit for the final conducted and radiated tests shown in section 2.3.

2.1 Carrier Frequency Channel

2400-2483.5 MHz		5150-5250 MHz Band 1 (U-NII-1)	
Channel	Freq. (MHz)	Channel	Freq. (MHz)
6	2437	159	5795

2.2 Test Mode

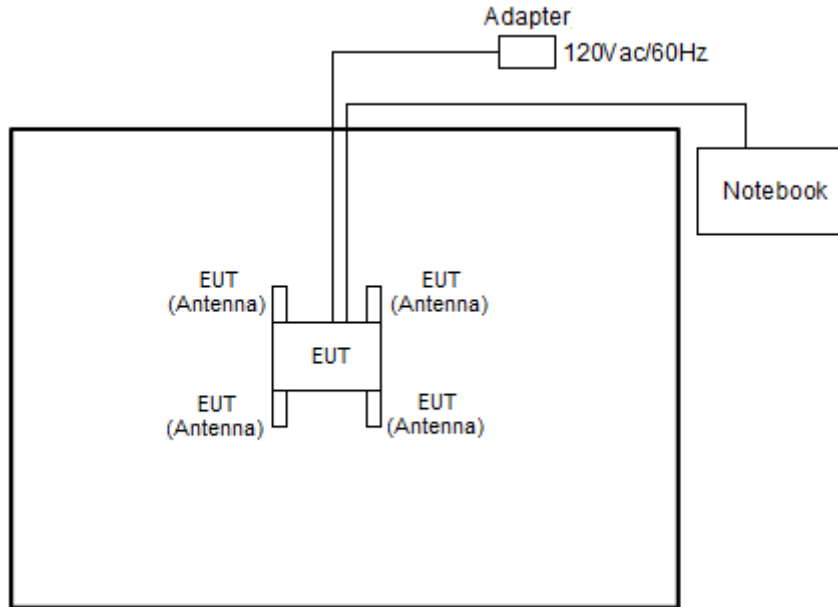
Final test mode of radiated spurious emissions are considering the modulation and worse data rates from the power table described in section 2.2.

<Co-Location>

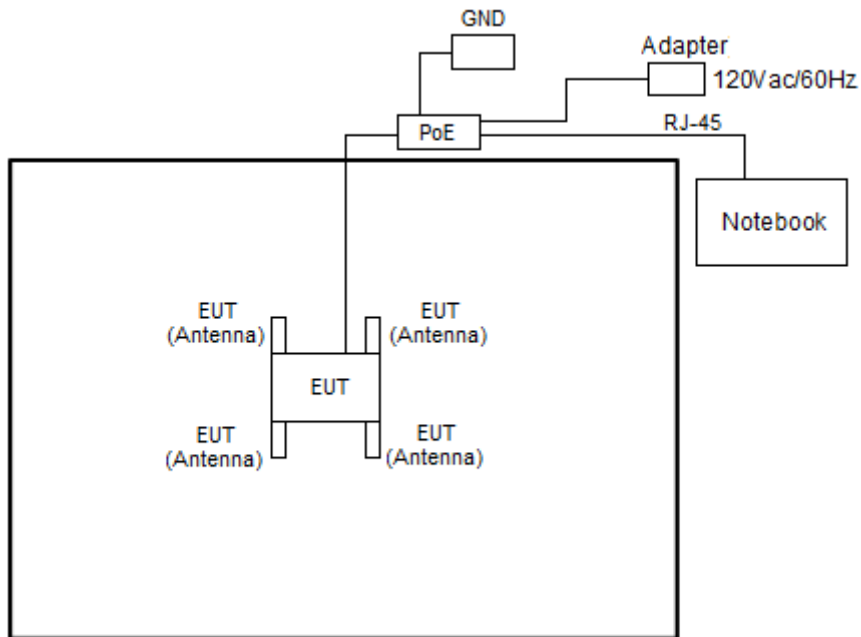
Modulation	Data Rate
802.11n HT40 + 802.11ac VHT40	MCS0

2.3 Connection Diagram of Test System

<EUT with Adapter Mode>



<EUT with POE Mode>





2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Notebook	Lenovo	IdeaPad (80Q7)	PPD-QCNFA	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
2.	POE Adapter	Powertron Electronics Corp	PA1040-480IB080	N/A	N/A	1.5m
3.	POE	N/A	NPE-5818	N/A	N/A	N/A
4.	Adapter	Powertron Electronics Corp.	PA1015-2I/PA1015-2I PA1015-2I120125	N/A	N/A	1.2m

2.5 EUT Operation Test Setup

For WLAN function, programmed RF utility, “Art2-gui Tool” installed in the notebook make the EUT provide functions like channel selection and power level for continuous transmitting and receiving signals.



3 Test Result

3.1 Radiated Spurious Emission Measurement

3.1.1 Limit of Radiated Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 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

3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.



3.1.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r05.
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 measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
7. 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; $VBW \geq RBW$; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.
 For average measurement:
 - $VBW = 10$ Hz, when duty cycle is no less than 98 percent.
 - $VBW \geq 1/T$, 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.

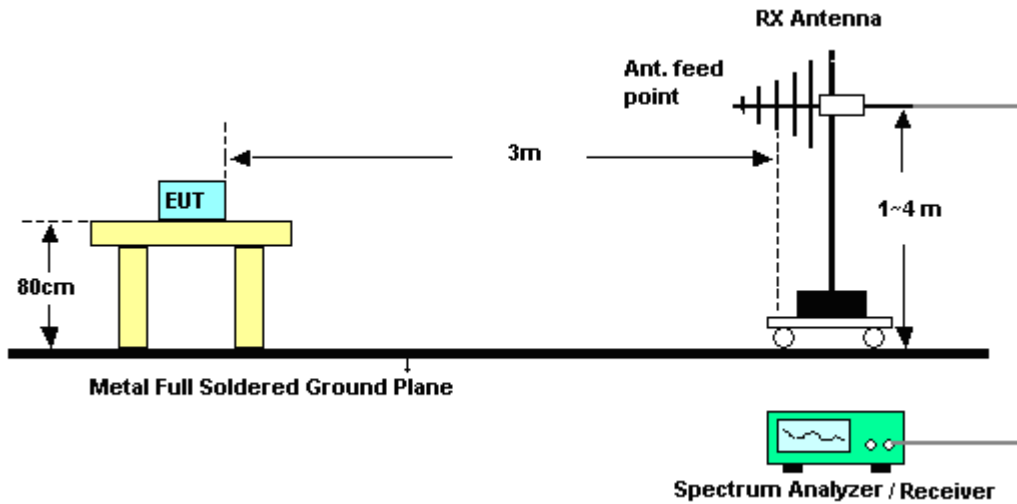
Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
1+2	2.4GHz 802.11n HT40 for Ant 1	95.88	930	1.08	3kHz
1+2	2.4GHz 802.11n HT40 for Ant 2	95.88	930	1.08	3kHz
1+2	5GHz 802.11ac VHT40 for Ant 1	93.07	940	1.06	3kHz
1+2	5GHz 802.11ac VHT40 for Ant 2	93.07	940	1.06	3kHz

3.1.4 Test Setup

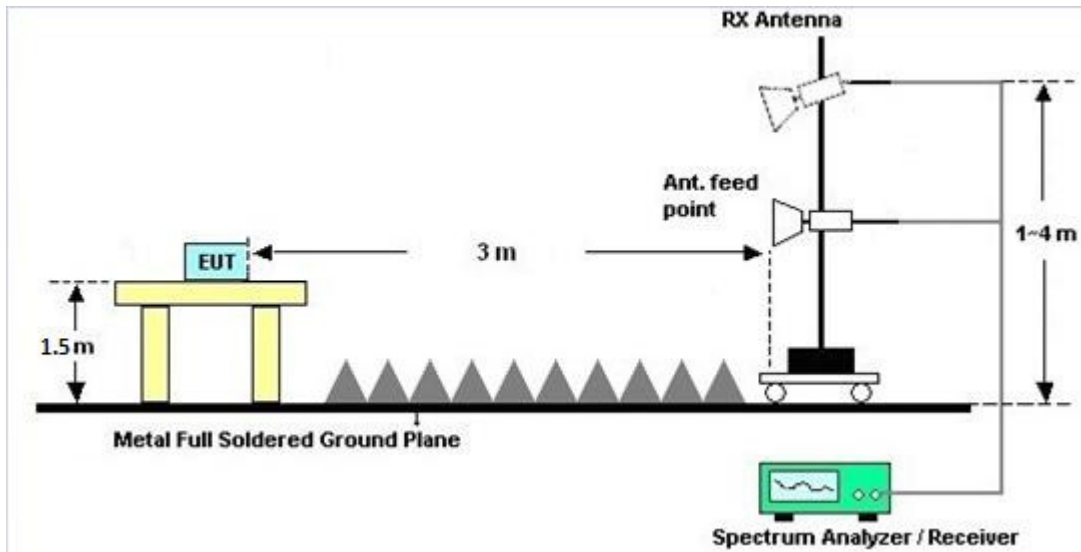
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

3.1.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

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

Please refer to Appendix A and B.



3.2 Antenna Requirements

3.2.1 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. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. 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 FCC rule.

3.2.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.2.3 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
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Sep. 02, 2015	Mar. 29, 2016	Sep. 01, 2016	Radiation (03CH12-HY)
Bilog Antenna	TESEQ	CBL 6111D	37059	30MHz~1GHz	Dec. 29, 2015	Mar. 29, 2016	Dec. 28, 2016	Radiation (03CH12-HY)
EMI Test Receiver	Rohde & Schwarz	ESU26	100390	20Hz~26.5GHz	Dec. 21, 2015	Mar. 29, 2016	Dec. 20, 2016	Radiation (03CH12-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz ~ 44GHZ	Sep. 24, 2015	Mar. 29, 2016	Sep. 23, 2016	Radiation (03CH12-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-1328	1GHz ~ 18GHz	Nov. 02, 2015	Mar. 29, 2016	Nov. 01, 2016	Radiation (03CH12-HY)
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz- 40GHz	Nov. 02, 2015	Mar. 29, 2016	Nov. 01, 2016	Radiation (03CH12-HY)
Preamplifier	COM-POWER	PA-103A	161075	10MHz~1GHz	Apr. 09, 2015	Mar. 29, 2016	Apr. 08, 2016	Radiation (03CH12-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1815698	1GHz~18GHz	Dec. 14, 2015	Mar. 29, 2016	Dec. 13, 2016	Radiation (03CH12-HY)
Preamplifier	Agilent	8449B	3008A02375	1GHz~26.5GHz	Jan. 05, 2016	Mar. 29, 2016	Jan. 04, 2017	Radiation (03CH12-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Mar. 29, 2016	N/A	Radiation (03CH12-HY)
Turn Table	EMEC	TT2000	N/A	0-360 degree	N/A	Mar. 29, 2016	N/A	Radiation (03CH12-HY)
Preamplifier	MITEQ	JS44-1800400 0-33-8P	1840917	18GHz ~ 40GHz	Jun. 02, 2015	Mar. 29, 2016	Jun. 01, 2016	Radiation (03CH12-HY)



5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.40
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Appendix A. Radiated Spurious Emission

Test Engineer :	Citta Ke, Ricky Su, and Nick Chang	Temperature :	23~25°C
		Relative Humidity :	55~60%

**11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159
(Harmonic @ 3m)**

WIFI Ant. 1+2+3+4	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)	
11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159		3359	46.15	-27.85	74	42.78	28.64	8.81	34.08	155	56	P	H	
		3359	35.93	-18.07	54	32.56	28.64	8.81	34.08	155	56	A	H	
		8232	57.96	-16.04	74	40.69	36.97	15.28	34.98	100	350	P	H	
		8232	47.52	-6.48	54	30.25	36.97	15.28	34.98	100	350	A	H	
		11590	54.7	-19.3	74	54.05	39.91	18.54	57.8	305	242	P	H	
		11590	44.77	-9.23	54	44.12	39.91	18.54	57.8	305	242	A	H	
														H
														H
			3359	45.53	-28.47	74	42.16	28.64	8.81	34.08	100	276	P	V
			3359	35.51	-18.49	54	32.14	28.64	8.81	34.08	100	276	A	V
			8232	58.17	-15.83	74	40.9	36.97	15.28	34.98	250	295	P	V
			8232	47.91	-6.09	54	30.64	36.97	15.28	34.98	250	295	A	V
			11590	59.12	-14.88	74	58.47	39.91	18.54	57.8	132	87	P	V
			11590	49.2	-4.8	54	48.55	39.91	18.54	57.8	132	87	A	V
													V	
													V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.													



11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159
Adapter mode (LF)

Table with 14 columns: WIFI Ant. 1+2+3+4, 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). Rows contain frequency and level data for various channels.

Remark 1. No other spurious found. 2. All results are PASS against limit line.



11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159
POE mode (LF)

WIFI Ant. 1+2+3+4	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)	
11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159		80.49	33.29	-6.71	40	48.96	13.7	1.06	30.43			P	H	
		111.27	37.08	-6.42	43.5	48.86	17.19	1.43	30.4	185	215	P	H	
		286.5	34.18	-11.82	46	42.88	19.22	2.25	30.17			P	H	
		406.4	22.36	-23.64	46	27.38	22.32	2.68	30.02			P	H	
		661.2	28.12	-17.88	46	27.78	26.09	3.82	29.57			P	H	
		900.6	31.6	-14.4	46	27.34	28.93	4.6	29.27			P	H	
														H
														H
														H
														H
														H
														H
														H
														H
			40.8	35.17	-4.83	40	44.99	19.74	0.78	30.34	141	111	P	V
			88.86	35.96	-7.54	43.5	50.63	14.69	1.06	30.42			P	V
			205.5	37.93	-5.57	43.5	50.56	15.96	1.7	30.29			P	V
			303.5	25.88	-20.12	46	34.07	19.62	2.34	30.15			P	V
			690.6	28.18	-17.82	46	27.56	26.32	3.82	29.52			P	V
			946.8	31.87	-14.13	46	26.01	30.22	4.75	29.11			P	V
													V	
													V	
													V	
													V	
													V	
													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	Peak or Average
H/V	Horizontal or Vertical



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		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 01													
2412MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

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

For Peak Limit @ 2390MHz:

- 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)
- Over Limit(dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 55.45(dBμV/m) – 74(dBμV/m)
= -18.55(dB)

For Average Limit @ 2390MHz:

- 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)
- 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 B. Radiated Spurious Emission Plots

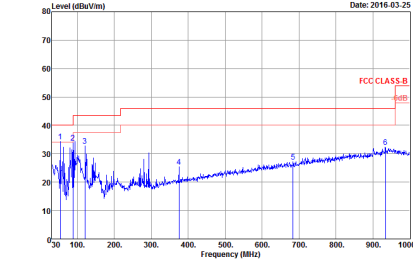
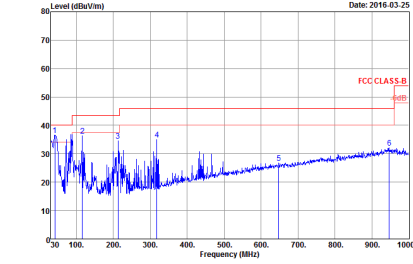
Test Engineer :	Citta Ke, Ricky Su, and Nick Chang	Temperature :	23~25°C
		Relative Humidity :	55~60%

11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159 (Harmonic @ 3m)

WIFI	Harmonic @ 3m	
ANT	11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159	
1+2+3+4	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH12-HY Condition : FCC CLASS-B 3m HORN_91200_1328 HORIZONTAL Detector : Peak Project : 5D2212 Mode : 1</p>	<p>Site : 03CH12-HY Condition : FCC CLASS-B 3m HORN_91200_1328 VERTICAL Detector : Peak Project : 5D2212 Mode : 1</p>

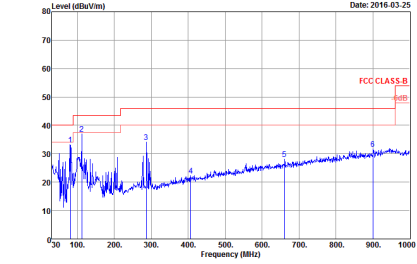
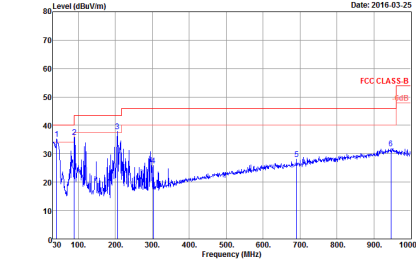


11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159
Adapter mode (LF)

WIFI	11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159	
ANT	Adapter mode (LF)	
1+2+3+4	Horizontal	Vertical
QP / Peak	 <p>Site : 03CH12-11F Condition : FCC CLASS-B 3m BILOG_6111D_37059 HORIZONTAL Detector : Peak Project : 502212 Mode : 2</p>	 <p>Site : 03CH12-11F Condition : FCC CLASS-B 3m BILOG_6111D_37059 VERTICAL Detector : Peak Project : 502212 Mode : 2</p>



11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159
POE mode (LF)

WIFI	11g(n40)_Tx_Ch06_11ac(40)_Tx_Ch159	
ANT	POE mode (LF)	
1+2+3+4	Horizontal	Vertical
QP / Peak	 <p>Site : 03CH12-1FF Condition : FCC CLASS-B 3m BILOG_6111D_37059 HORIZONTAL Detector : Peak Project : 502212 Mode : 3</p>	 <p>Site : 03CH12-1FF Condition : FCC CLASS-B 3m BILOG_6111D_37059 VERTICAL Detector : Peak Project : 502212 Mode : 3</p>