FCC TEST REPORT

Product Name:	Industrial Cellular Router
Trade Mark:	N/A
Model No.:	IR611-S
Report Number:	180119001RFC-1
Test Standards:	FCC 47 CFR Part 15 Subpart C
FCC ID:	2AANYIR611S
Test Result:	PASS
Date of Issue:	March 21, 2018

Prepared for:

Beijing Inhand Networks Technology Co., Ltd.
101, West Wing, 11th Floor, No.101 Lize central Park, Wangjing
Chaoyang District, Beijing 100102 China

Prepared by:

Shenzhen UnionTrust Quality and Technology Co., Ltd.
16/F, Block A, Building 6, Baoneng Science and Technology Park,
Qingxiang Road No.1, Longhua New District, Shenzhen, China
TEL: +86-755-2823 0888
FAX: +86-755-2823 0886

Tested by: Hoping Chen
Hoping Chen
Engineer

Reviewed by:
Kevin Liang
Team Leader

Approved by: Jim Long
Jim Long
Assistant Manager

Date: March 21, 2018

UnionTrust Laboratories * Certified *

Version

Version No.	Date	Description
V1.0	March 21, 2018	Original

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1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Beijing Inhand Networks Technology Co., Ltd.
Address of Applicant:	101, West Wing, 11th Floor, No.101 Lize central Park, Wangjing Chaoyang District, Beijing 100102 China
Manufacturer:	Beijing Inhand Networks Technology Co., Ltd.
Address of Manufacturer:	101, West Wing, 11th Floor, No.101 Lize central Park, Wangjing Chaoyang District, Beijing 100102 China

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	Industrial Cellular Router	
Model No.:	IR611-S	
Add. Model No.:	IR601-S, IR621-S, IR631-S, IR641-S, IR651-S, IR661-S, IR671-S, IR681-S, IR691-S	
Trade Mark:	N/A	
DUT Stage:	Identical Prototype	
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n
Software Version:	V2.3.0.r4537	
Hardware Version:	V3.4	
Sample Received Date:	January 20, 2018	
Sample Tested Date:	January 20, 2018 to March 12, 2018	
Note: These models are identical in interior structure, electrical circuits and components, and the differences as follows: software, the number of network ports and model name, declared by the manufacturer.		

1.2.2 Description of Accessories

Adapter	
Trade Mark:	KUANTEN
Model No.:	KT10W120100CHD
Input:	100-240V~ 50/60Hz 0.4A
Output:	12V ⎓ 1A
AC Cable:	N/A
DC Cable:	1.20 Meter, Shielded without ferrite
Manufacturer:	KUANTEN LIMITED

Cable(1)	
Trade Mark:	N/A
Model No.:	N/A
Description:	RJ45
Cable Type:	Unshielded without ferrite
Length:	1.50 Meter

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Range:	2400 MHz to 2483.5 MHz
Support Standards:	IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40
Type of Modulation:	IEEE 802.11b: DSSS(CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM(64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT20: OFDM(64-QAM, 16-QAM, QPSK, BPSK)

	IEEE 802.11n-HT40: OFDM(64-QAM, 16-QAM, QPSK, BPSK)	
Data Rate:	IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n-HT20: Up to MCS15 IEEE 802.11n-HT40: Up to MCS15	
Number of Channels:	IEEE 802.11b: 11 IEEE 802.11g: 11 IEEE 802.11n-HT20: 11 IEEE 802.11n-HT40: 7	
Channel Separation:	5 MHz	
Antenna Type:	Chain 0	Sucker antenna
	Chain 1	Sucker antenna
Antenna Gain:	Chain 0	2 dBi
	Chain 1	2 dBi
Directional gain:	2 dBi	
Maximum Peak Power:	SISO_ Chain 0	IEEE 802.11b: 20.24 dBm IEEE 802.11g: 24.08 dBm IEEE 802.11n-HT20: 23.88 dBm IEEE 802.11n-HT40: 23.18 dBm
	SISO_ Chain 1	IEEE 802.11b: 19.83 dBm IEEE 802.11g: 23.69 dBm IEEE 802.11n-HT20: 23.39 dBm IEEE 802.11n-HT40: 22.33 dBm
	MIMO_ Chain 0+1	IEEE 802.11n-HT20: 26.65 dBm IEEE 802.11n-HT40: 25.79 dBm
Normal Test Voltage:	120V~ 60Hz	

1.4 OTHER INFORMATION

Operation Frequency Each of Channel	
IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20	**f = 2407 + 5k MHz, k = 1,…,11**
IEEE 802.11n-HT40	**f = 2407 + 5k MHz, k = 3,…,9**
Note: **f** is the operating frequency (MHz); **k** is the operating channel.	

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	Lenovo	B40-80	MP12NEQ6	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.30 Meter	UnionTrust
2	WIFI Antenna	SMA	2.5m	Applicant
3	WIFI Antenna	SMA	2.5m	Applicant
4	4G Antenna	SMA-J	2.0m	Applicant
5	4G Antenna	SMA-J	2.0m	Applicant

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China 518109
Telephone: +86 (0) 755 2823 0888
Fax: +86 (0) 755 2823 0886

1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L9069
The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

IC-Registration No.: 21600-1
The 3m Semi-anechoic chamber of Shenzhen UnionTrust Quality and Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 21600-1.

A2LA-Lab Certificate No.: 4312.01
Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

FCC Accredited Lab.
Designation Number: CN1194
Test Firm Registration Number: 259480

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

No.	Item	Measurement Uncertainty
1	Conducted emission 9KHz-150KHz	±3.8 dB
2	Conducted emission 150KHz-30MHz	±3.4 dB

3	Radiated emission 9KHz-30MHz	±4.9 dB
4	Radiated emission 30MHz-1GHz	±4.7 dB
5	Radiated emission 1GHz-18GHz	±5.1 dB
6	Radiated emission 18GHz-26GHz	±5.2 dB
7	Radiated emission 26GHz-40GHz	±5.2 dB

2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart C Test Cases			
Test Item	**Test Requirement**	**Test Method**	**Result**
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (c)	ANSI C63.10-2013	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)	KDB 558074 D01 v04 Section 9.1.3	PASS
6dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)	KDB 558074 D01 v04 Section 8.1	PASS
Power Spectral Density	FCC 47 CFR Part 15 Subpart C Section 15.247 (e)	KDB 558074 D01 v04 Section 10.2	PASS
Conducted Out of Band Emission	FCC 47 CFR Part 15 Subpart C Section 15.247(d)	KDB 558074 D01 v04 Section 11	PASS
Radiated Spurious Emissions	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	KDB 558074 D01 v04 Section 12.1	PASS
Band Edge Measurements (Radiated)	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	KDB 558074 D01 v04 Section 12.1	PASS
Note: 1) N/A: In this whole report not application.			

3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date (mm dd, yyyy)**	**Cal. Due date (mm dd, yyyy)**
☑	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	N/A	Dec. 20, 2015	Dec. 19, 2018
☑	Receiver	R&S	ESIB26	100114	Dec. 10, 2017	Dec. 10, 2018
☑	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Dec. 10, 2017	Dec. 10, 2018
☑	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Dec. 17, 2017	Dec. 17, 2018
☑	Preamplifier	HP	8447F	2805A02960	Dec. 10, 2017	Dec. 10, 2018
☑	Horn Antenna	ETS-LINDGREN	3117	00164202	Dec. 17, 2017	Dec. 17, 2018
☑	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Dec. 17, 2017	Dec. 17, 2018
☑	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☑	Band Rejection Filter (2400MHz~2500MHz)	Micro-Tronics	BRM50702	G248	Jun. 21, 2017	Jun. 21, 2018
☑	Test Software	Audix	e3	Software Version: 9.160323		

Conducted Emission Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date (mm dd, yyyy)**	**Cal. Due date (mm dd, yyyy)**
☑	Receiver	R&S	ESR7	1316.3003K07 -101181-K3	Dec. 10, 2017	Dec. 10, 2018
☑	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	Dec. 10, 2017	Dec. 10, 2018
☑	LISN	R&S	ESH2-Z5	860014/024	Dec. 10, 2017	Dec. 10, 2018
☑	LISN	ETS-Lindgren	3816/2SH	00201088	Dec. 10, 2017	Dec. 10, 2018
☑	Test Software	Audix	e3	Software Version: 9.160323		

Conducted RF test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date (mm dd, yyyy)**	**Cal. Due date (mm dd, yyyy)**
☑	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Dec. 10, 2017	Dec. 10, 2018
☑	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Dec. 10, 2017	Dec. 10, 2018
☑	Power Meter	Anritsu	ML2495A	1204003	Feb. 21, 2017	Feb. 21, 2018
☑	Power Sensor	Anritsu	MA2411B	1126150	Feb. 21, 2017	Feb. 21, 2018

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage (V)	Relative Humidity (%)
NT/NV	+15 to +35	120V~60Hz	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment

Test Item	Temperature (°C)	Relative Humidity (%)	Pressure (Kpa)	Tested by
AC Power Line Conducted Emission	23.8	50	99.9	Warlen Song
Conducted Peak Output Power	22.5	45	101.3	Warlen Song
6dB Bandwidth	22.5	45	101.3	Warlen Song
Power Spectral Density	22.5	45	101.3	Warlen Song
Conducted Out of Band Emission	22.5	45	101.3	Warlen Song
Radiated Spurious Emissions	22.5	45	101.3	Warlen Song
Band Edge Measurements (Radiated)	22.5	45	101.3	Warlen Song

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists		
		Lowest(L)	Middle(M)	Highest(H)
IEEE 802.11b	2412 MHz to 2462 MHz	Channel 1	Channel 7	Channel 11
		2412 MHz	2437 MHz	2462 MHz
IEEE 802.11g	2412 MHz to 2462 MHz	Channel 1	Channel 7	Channel 11
		2412 MHz	2437 MHz	2462 MHz
IEEE 802.11n-HT20	2412 MHz to 2462 MHz	Channel 1	Channel 7	Channel 11
		2412 MHz	2437 MHz	2462 MHz
IEEE 802.11n-HT40	2422 MHz to 2452 MHz	Channel 3	Channel 7	Channel 9
		2422 MHz	2437 MHz	2452 MHz

4.3 EUT TEST STATUS

Mode	Tx Function	Description
IEEE 802.11b IEEE 802.11g IEEE 802.11n-HT20 IEEE 802.11n-HT40	1Tx	1. Keep the EUT in continuously transmitting with modulation test single.
IEEE 802.11n-HT20 IEEE 802.11n-HT40	2Tx	2. Keep the EUT in continuously transmitting with modulation test single.

4.4 PRE-SCAN

4.4.1 Pre-scan under all rates

Mode and Frequency	Maximum Conducted Peak Power (dBm)_Chain 0							
	1		2		5.5		11	
IEEE 802.11b 2437 MHz	19.47		19.34		19.22		19.13	
IEEE 802.11g 2437 MHz	6	9	12	18	24	36	48	54
	23.80	23.62	23.51	23.48	23.39	23.31	23.22	23.17
IEEE 802.11n-HT20 2437 MHz	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
	23.26	23.16	23.05	22.98	22.87	22.81	22.67	22.80
	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
	23.29	23.18	23.11	23.02	22.91	22.83	22.65	22.72
IEEE 802.11n-HT40 2437 MHz	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
	22.91	22.80	22.63	22.40	22.37	22.33	22.21	22.05
	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
	22.97	22.87	22.61	22.46	22.41	22.36	22.23	22.09

4.4.2 Worst-case data rates

Mode	Worst-case data rates
IEEE 802.11b	1 Mbps
IEEE 802.11g	6 Mbps
IEEE 802.11n-HT20	MCS8
IEEE 802.11n-HT40	MCS8

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

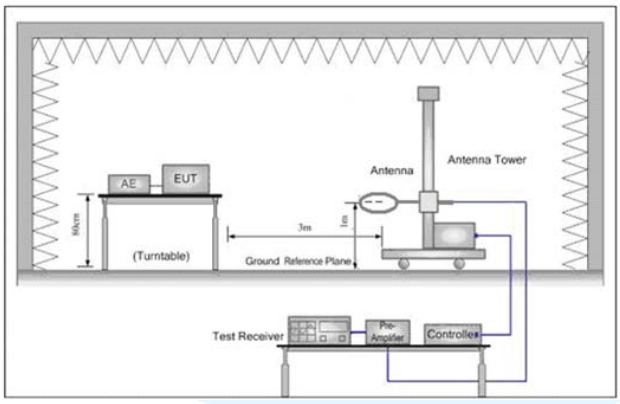


Figure 1. Below 30MHz

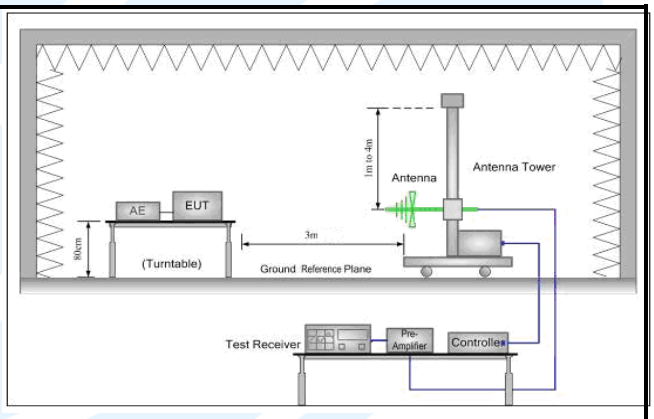


Figure 2. 30MHz to 1GHz

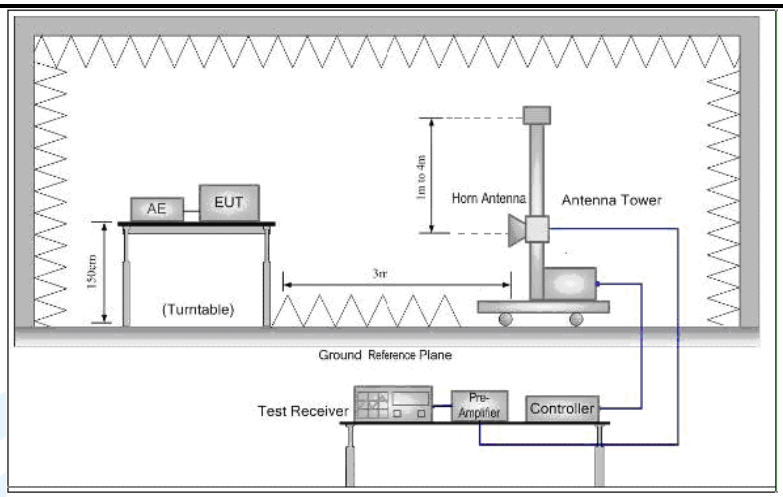
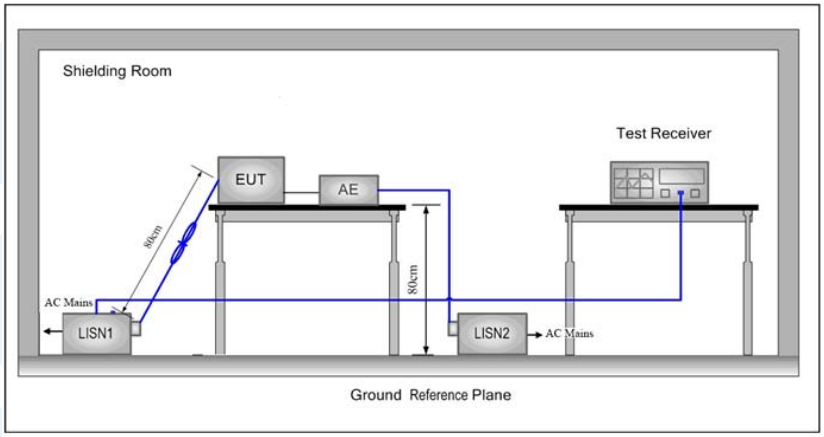


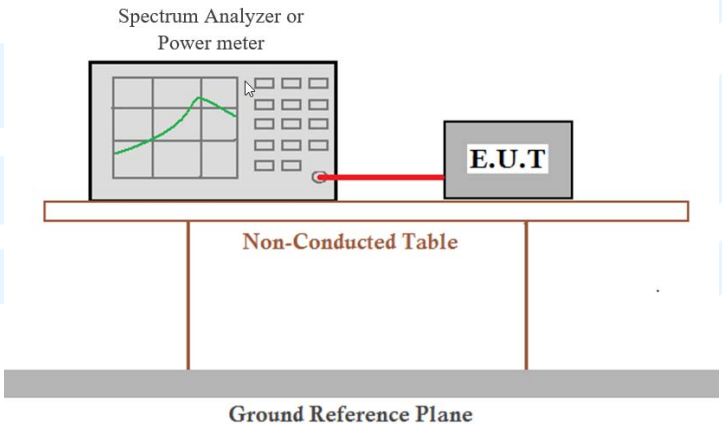
Figure 3. Above 1GHz

4.5.2 For Conducted Emissions test setup

Figure 3. Conducted Emissions setup



4.5.3 For Conducted RF test setup



4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by 12Vdc from AC adapter. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

Frequency	Mode	Antenna Port	Worst-case axis positioning
Above 1GHz	1TX	Chain 0	Y axis
	1TX	Chain 1	Y axis
	2TX	Chain 0+1	Y axis

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

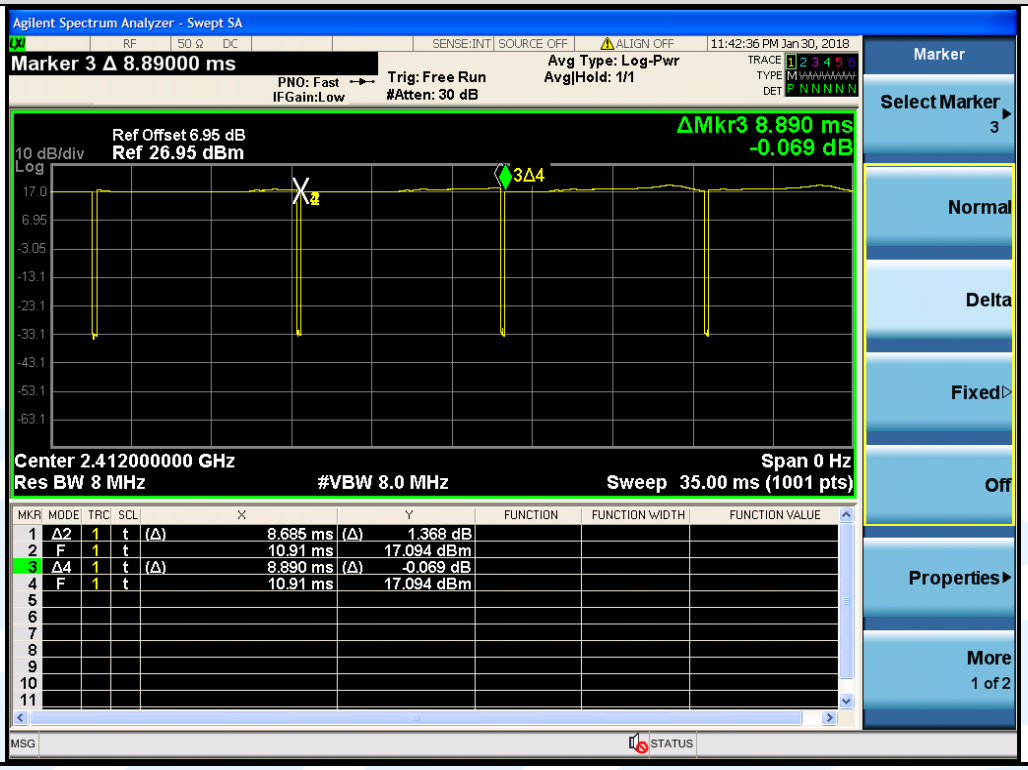
4.7 DUTY CYCLE

Mode	Data rates (Mbps)	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/ T Minimum VBW (kHz)	Average Factor (dB)
IEEE 802.11b	1	8.685	8.89	0.98	97.69	0.10	0.12	-0.20
IEEE 802.11g	6	1.44	1.645	0.88	87.54	0.58	0.69	-1.16
IEEE 802.11n-HT20	MCS8	0.695	0.895	0.78	77.65	1.10	1.44	-2.20
IEEE 802.11n-HT20	MCS8	0.352	0.552	0.64	63.77	1.95	2.84	-3.91

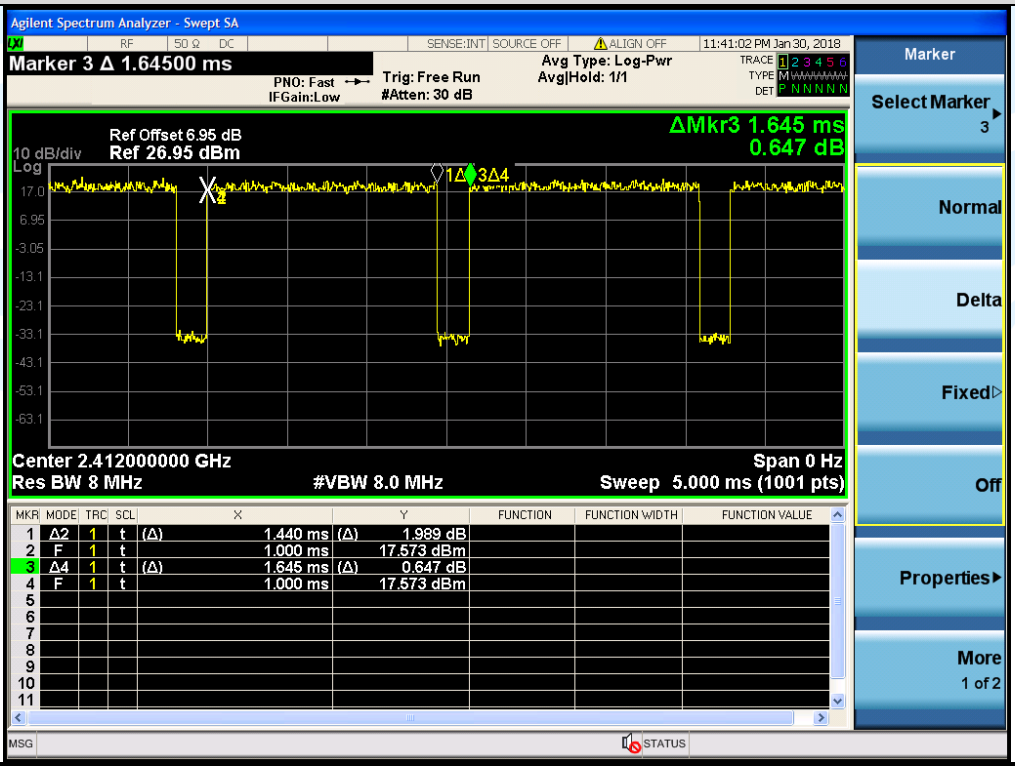
Remark:
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log(1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

The test plot as follows

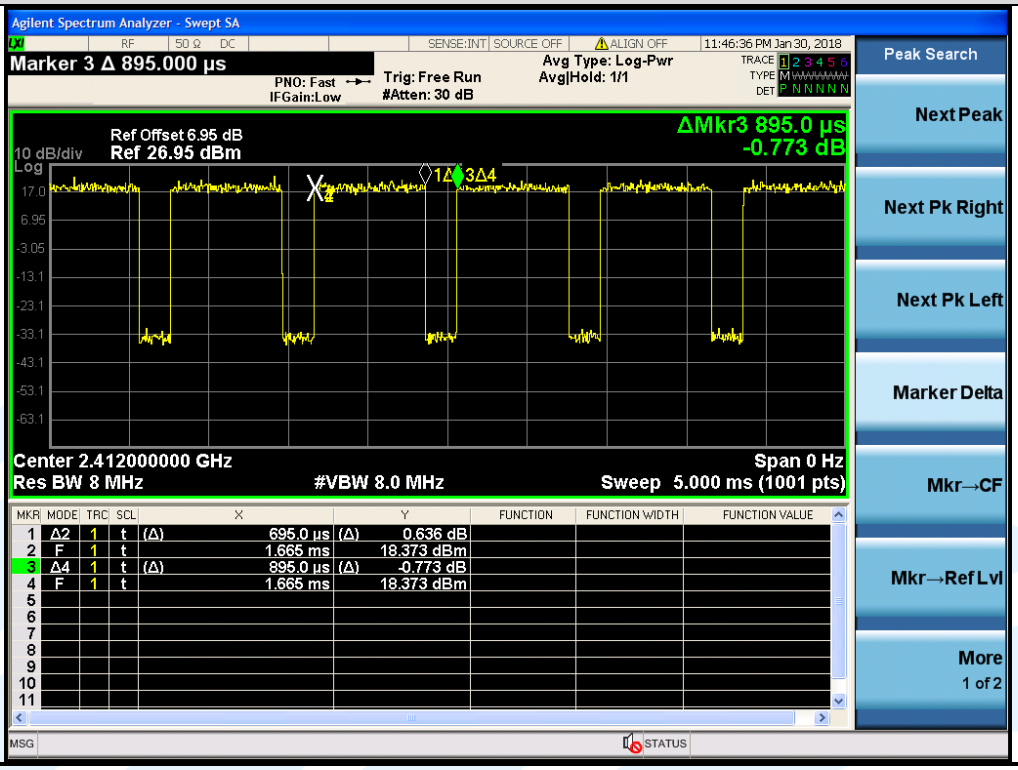
IEEE 802.11b



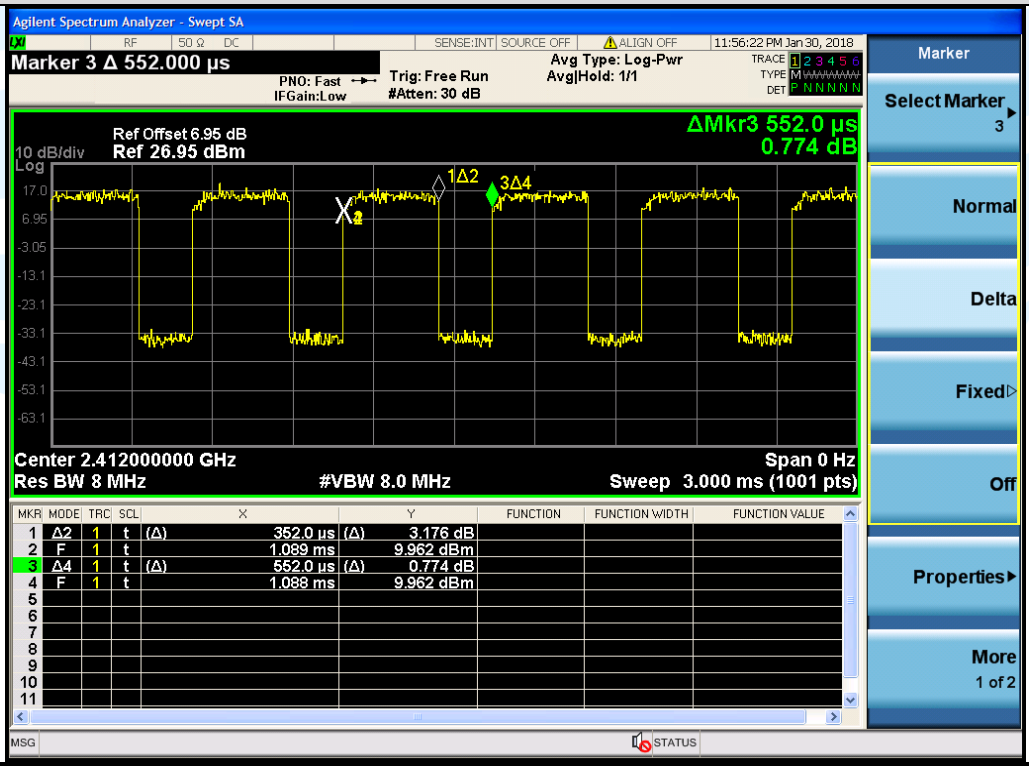
IEEE 802.11g



IEEE 802.11n-HT20



IEEE 802.11n-HT40



5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 2	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC 47 CFR Part 15	Radio Frequency Devices
3	ANSI C63.10-2013	American National Standard for Testing Unlicesed Wireless Devices
4	KDB 558074 D01 DTS Meas Guidance v04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
5	KDB 662911 D01 Multiple Transmitter Output v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 requirement: 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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. **15.247(b) (4) requirement:** The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
EUT Antenna:
Both antenna in the interior of the equipment and no consideration of replacement. The transmit signals are uncorrelated with each other, the best case directional gain of the antenna is 2 dBi (See section 5.3).

5.3 CONDUCTED PEAK OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart C Section15.247 (b)(3)

Test Method: KDB 558074 D01 v04, Section 9.1.3

Limit: For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

Test Procedure:
1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
2. Measure out each test modes' peak or average output power, record the power level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.4.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Mode	Channel/ Frequency (MHz)	Maximum Conducted Peak Output Power (dBm)				
		SISO_ Chain 0	SISO_ Chain 1	Total Power MIMO_ Chain 0+1	Limit (dBm)	Pass / Fail
IEEE 802.11b	1(2412)	19.59	19.46	---	30	Pass
	6(2437)	19.47	19.25	---	30	Pass
	11(2462)	20.24	19.83	---	30	Pass
IEEE 802.11g	1(2412)	23.75	23.25	---	30	Pass
	6(2437)	23.8	23.36	---	30	Pass
	11(2462)	24.08	23.69	---	30	Pass
IEEE 802.11n-HT20	1(2412)	23.19	22.92	26.07	30	Pass
	6(2437)	23.29	23.01	26.16	30	Pass
	11(2462)	23.88	23.39	**26.65**	30	Pass
IEEE 802.11n-HT40	3(2422)	22.91	21.83	25.41	30	Pass
	6(2437)	22.97	22.03	25.54	30	Pass
	9(2452)	23.18	22.33	25.79	30	Pass

Remark:
1. Power with Duty Factor = Measured Power + Duty Cycle Factor
2. Total (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$
3. Directional gain and the maximum conducted output power limit see table below:

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Completely uncorrelated chains directional gain (dBi)	Peak Power Limit (dBm)
2400 MHz to 2483.5 MHz	2.00	2.00	2.00	30
Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows: If all transmit signals are completely uncorrelated with each other, Directional gain = G_{ANT}				

Mode	Channel/ Frequency (MHz)	Maximum Conducted Average Power (dBm)					
		SISO Measured Power		Duty Cycle Factor (dB)	SISO Power with Duty Factor		MIMO Total Power
		Chain 0	Chain 1		Chain 0	Chain 1	Chain 0+1
IEEE 802.11b	1(2412)	16.77	16.28	-0.20	16.57	16.08	--
	6(2437)	16.47	15.94		16.27	15.74	--
	11(2462)	17.33	16.70		**17.13**	**16.50**	--
IEEE 802.11g	1(2412)	16.69	15.71	-1.16	15.53	14.55	--
	6(2437)	**16.79**	**15.97**		15.63	14.81	--
	11(2462)	17.41	16.73		16.25	15.57	--
IEEE 802.11n-HT20	1(2412)	15.06	15.25	-2.20	12.86	13.05	15.97
	6(2437)	15.05	15.53		12.85	13.33	16.11
	11(2462)	16.61	16.14		14.41	13.94	**17.19**
IEEE 802.11n-HT40	3(2422)	14.66	13.81	-3.91	10.75	9.90	13.36
	6(2437)	14.69	14.04		10.78	10.13	13.48
	9(2452)	14.99	14.93		11.08	11.02	14.06

Remark:
1. Power with Duty Factor = Measured Power + Duty Cycle Factor
2. Total (Chain 0+1) = $10*\log[(10^{\text{Chain 0}/10})+(10^{\text{Chain 1}/10})]$

5.46 DB BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)

Test Method: KDB 558074 D01 v04, Section 8.1

Limit: For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:
a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 x RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.4.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

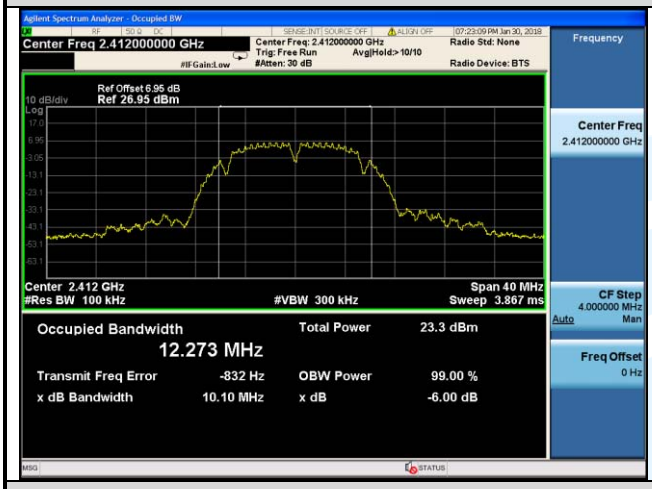
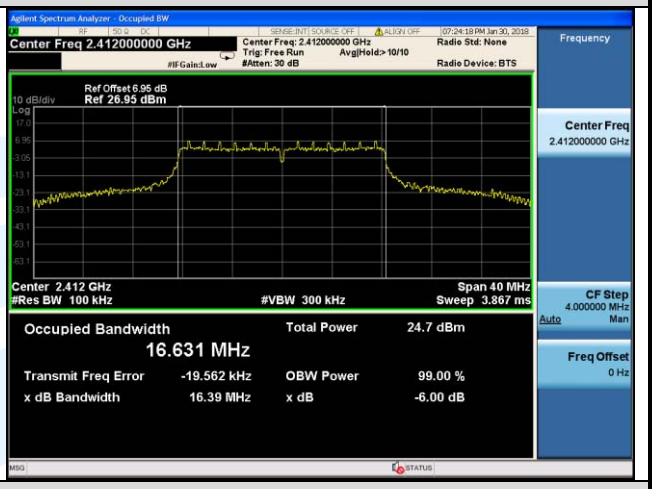
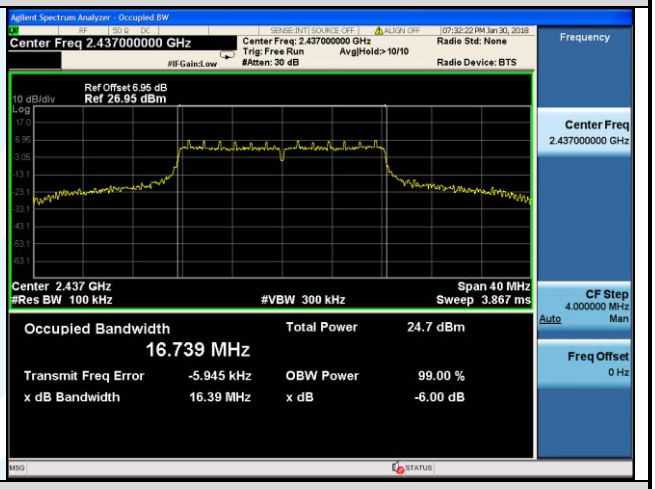
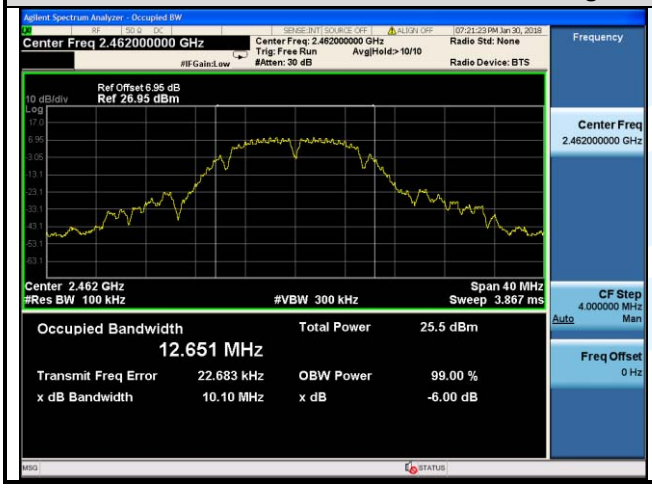
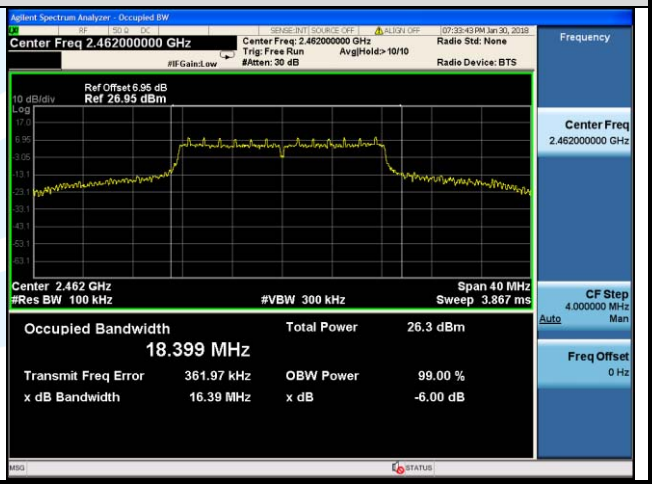
Test Data:

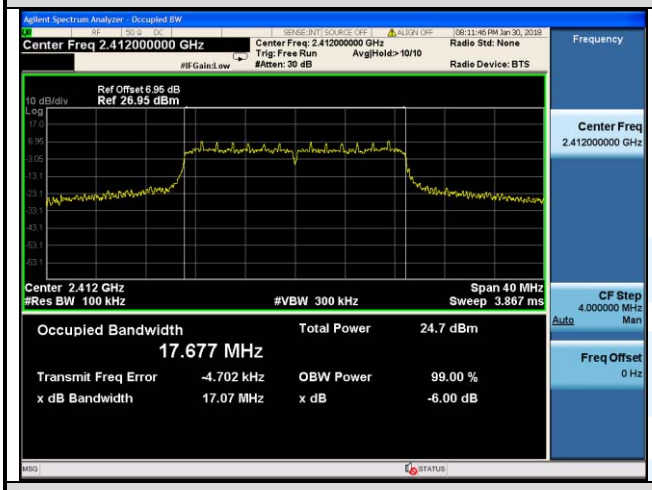
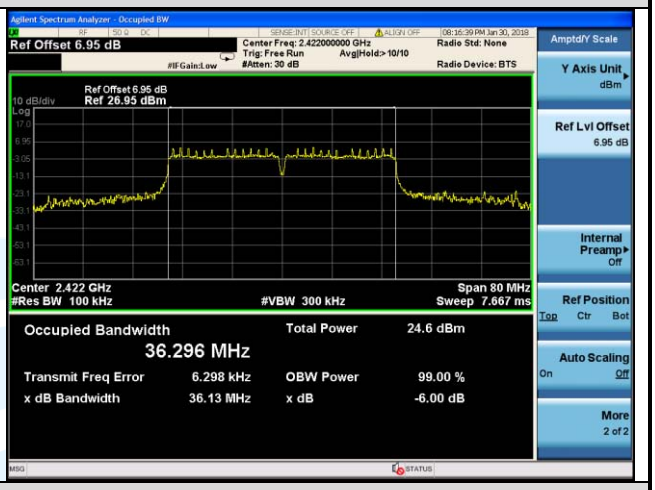
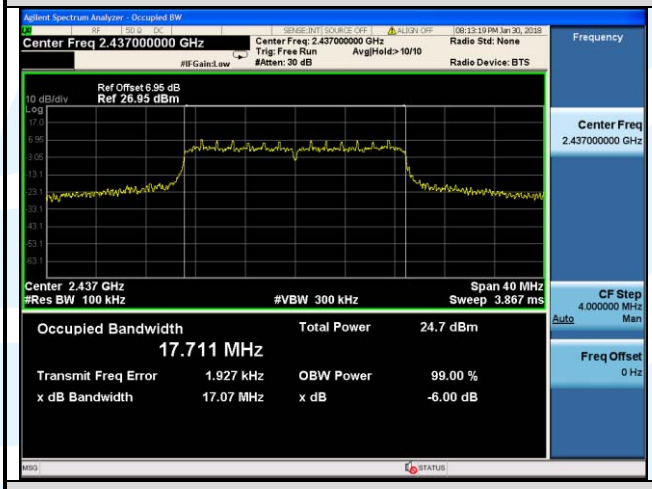
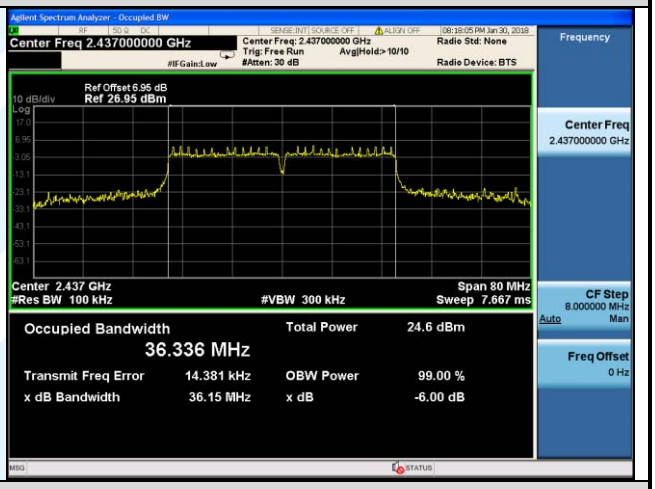
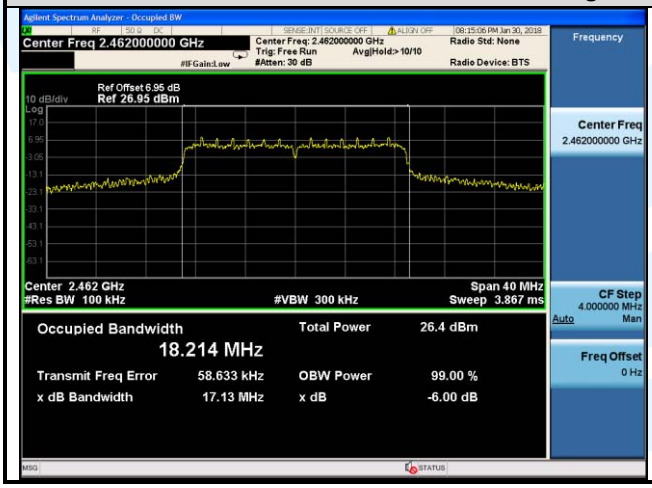
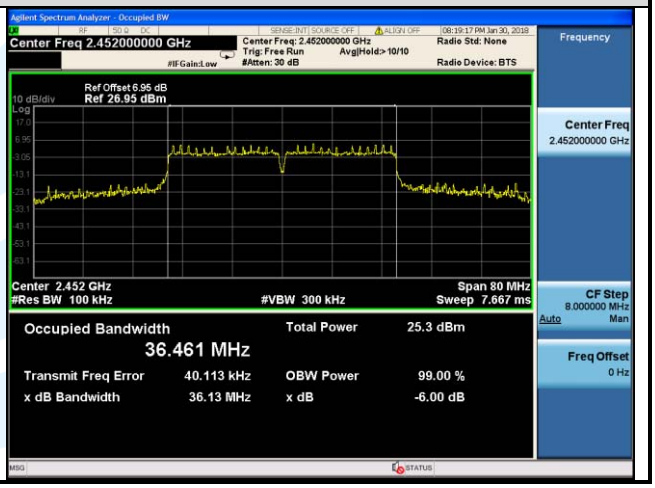
Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit	Pass / Fail
The worst case test data: Chain 0					
IEEE 802.11b	1(2412)	10.10	12.273	> 500 kHz	Pass
	6(2437)	10.10	12.313	> 500 kHz	Pass
	11(2462)	10.10	12.651	> 500 kHz	Pass
IEEE 802.11g	1(2412)	16.39	16.631	> 500 kHz	Pass
	6(2437)	16.39	16.739	> 500 kHz	Pass
	11(2462)	16.39	18.399	> 500 kHz	Pass
IEEE 802.11n-HT20	1(2412)	17.07	17.677	> 500 kHz	Pass
	6(2437)	17.07	17.711	> 500 kHz	Pass
	11(2462)	17.13	18.214	> 500 kHz	Pass
IEEE 802.11n-HT40	3(2422)	36.13	36.296	> 500 kHz	Pass
	6(2437)	36.15	36.336	> 500 kHz	Pass
	9(2452)	36.13	36.461	> 500 kHz	Pass

Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit	Pass / Fail
The worst case test data: Chain 1					
IEEE 802.11b	1(2412)	10.05	12.324	> 500 kHz	Pass
	6(2437)	10.07	12.385	> 500 kHz	Pass
	11(2462)	10.07	12.377	> 500 kHz	Pass
IEEE 802.11g	1(2412)	16.37	16.557	> 500 kHz	Pass
	6(2437)	16.38	16.618	> 500 kHz	Pass
	11(2462)	16.38	16.622	> 500 kHz	Pass
IEEE 802.11n-HT20	1(2412)	17.09	17.618	> 500 kHz	Pass
	6(2437)	17.09	17.657	> 500 kHz	Pass
	11(2462)	17.10	17.679	> 500 kHz	Pass
IEEE 802.11n-HT40	3(2422)	36.38	36.264	> 500 kHz	Pass
	6(2437)	36.36	36.287	> 500 kHz	Pass
	9(2452)	36.39	36.329	> 500 kHz	Pass

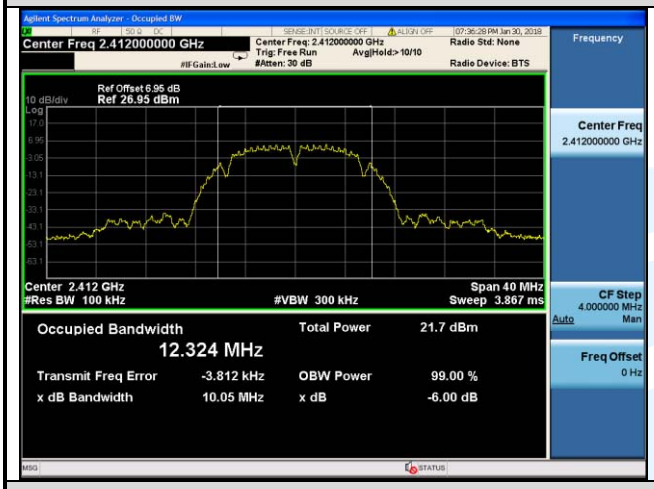
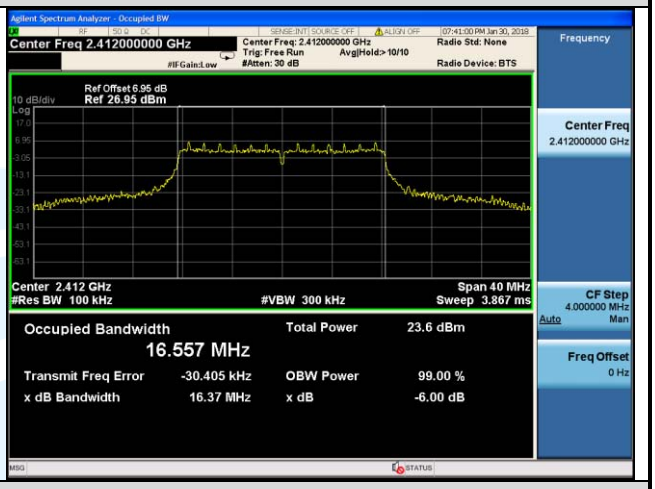
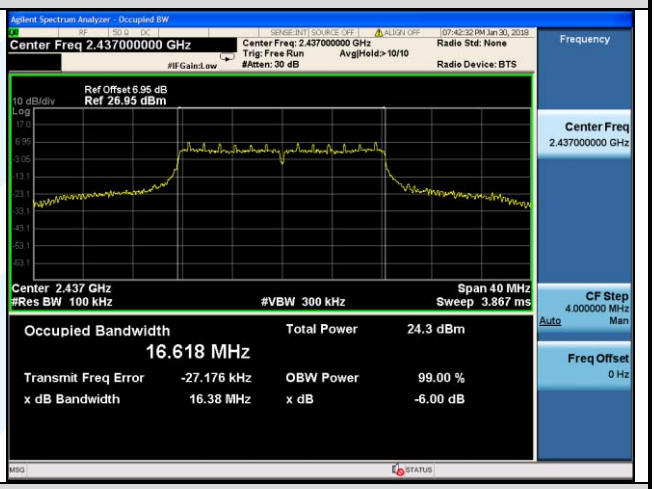
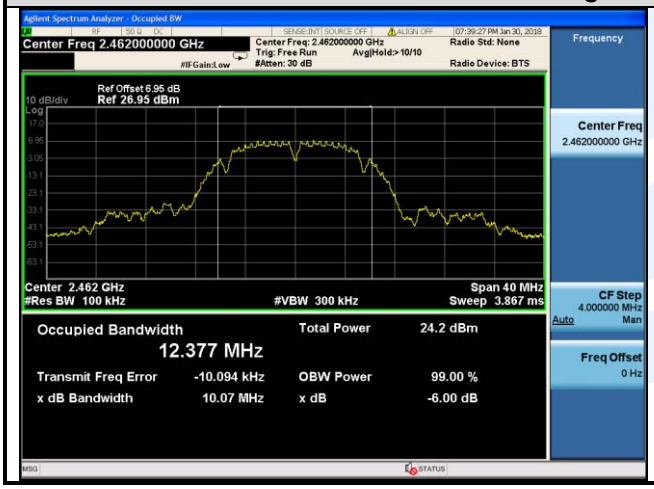
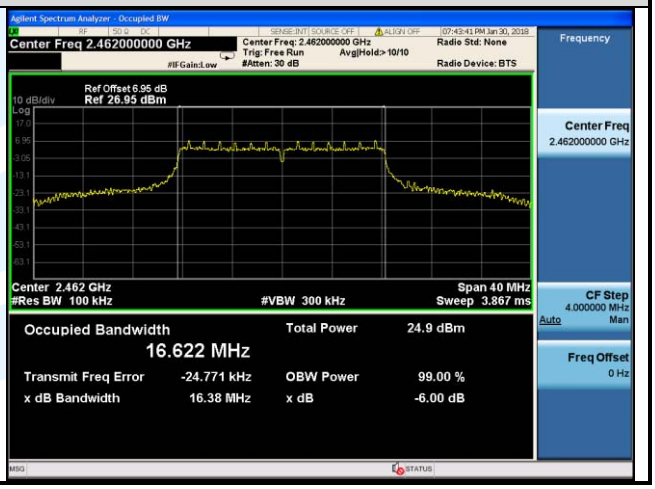
The test plot as follows:

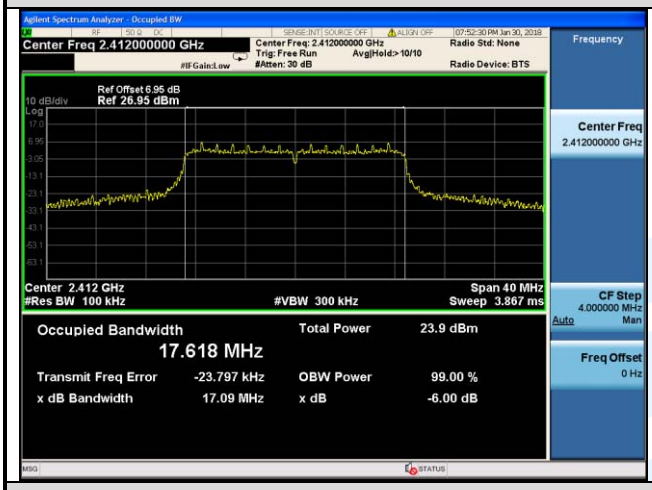
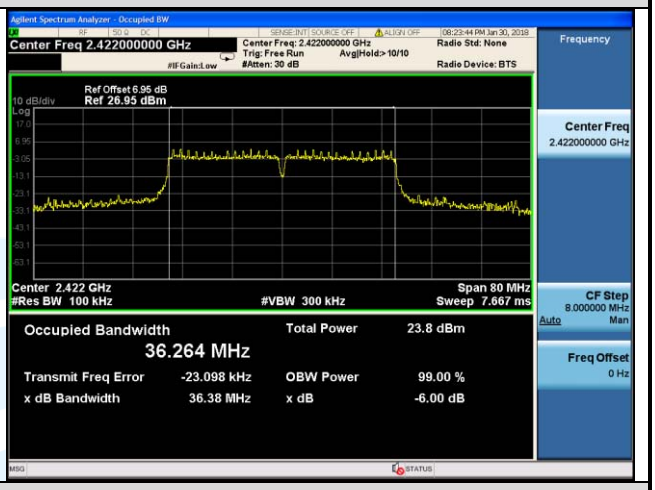
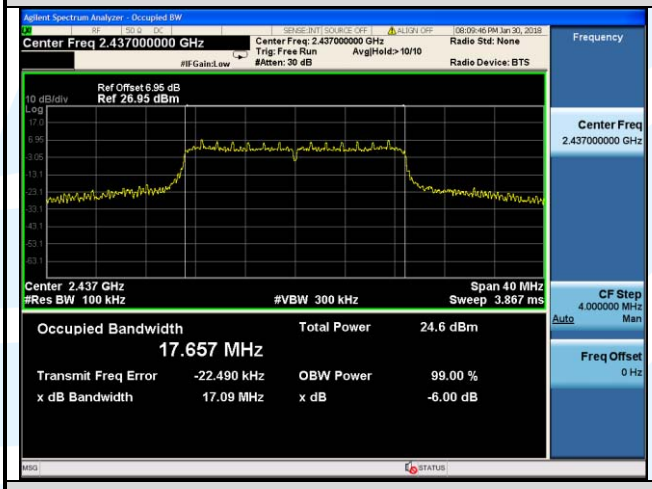
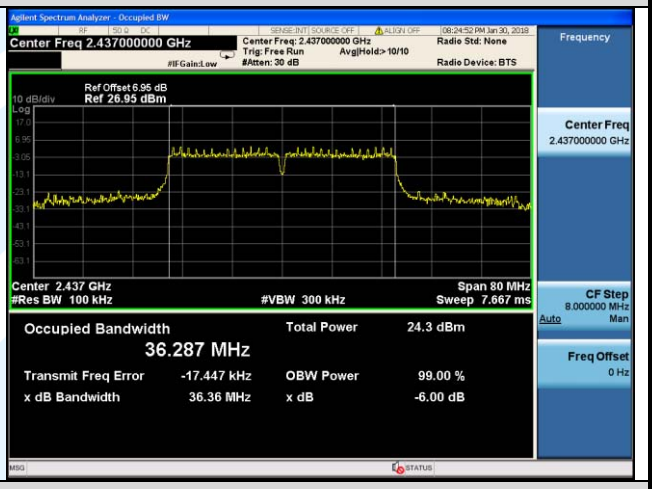
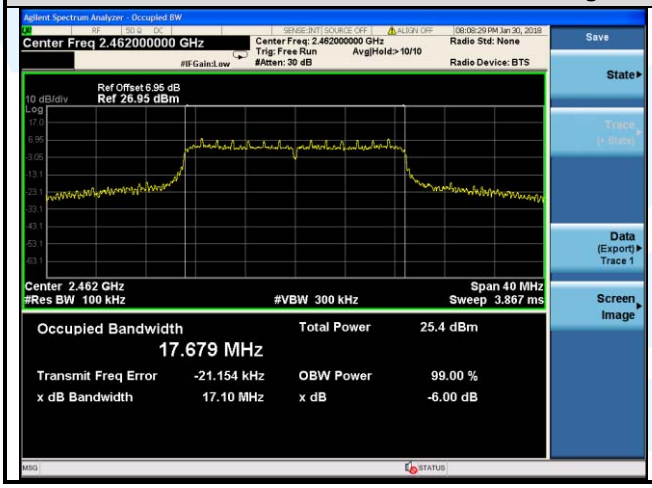
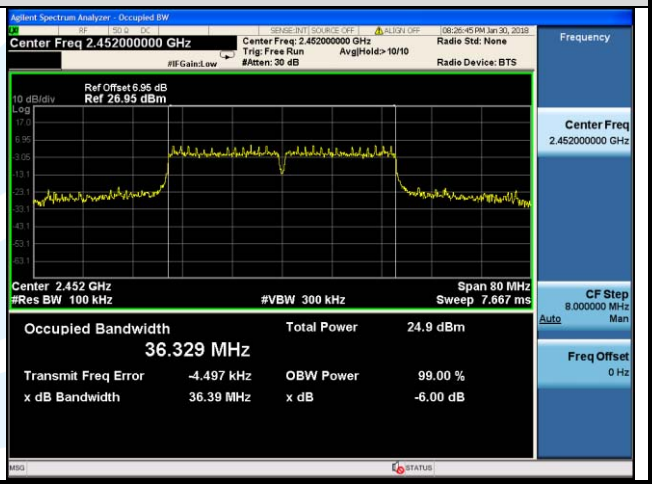
Chain 0:

IEEE 802.11b	IEEE 802.11g
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11n-HT20	IEEE 802.11n-HT40
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

Chain 1:

IEEE 802.11b	IEEE 802.11g
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11n-HT20	IEEE 802.11n-HT40
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

5.5 POWER SPECTRAL DENSITY

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (e)

Test Method: KDB 558074 D01 v04, Section 10.2

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

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Use the following spectrum analyzer settings:

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.4.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

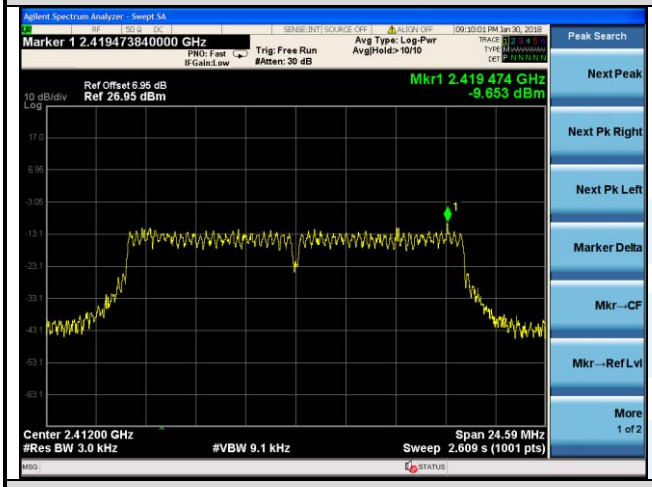
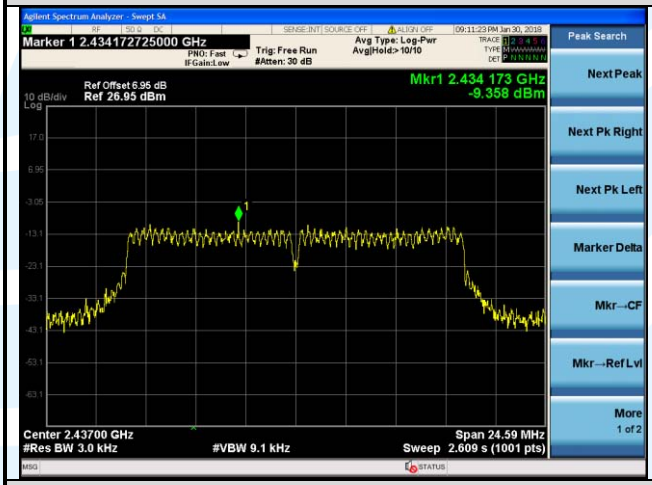
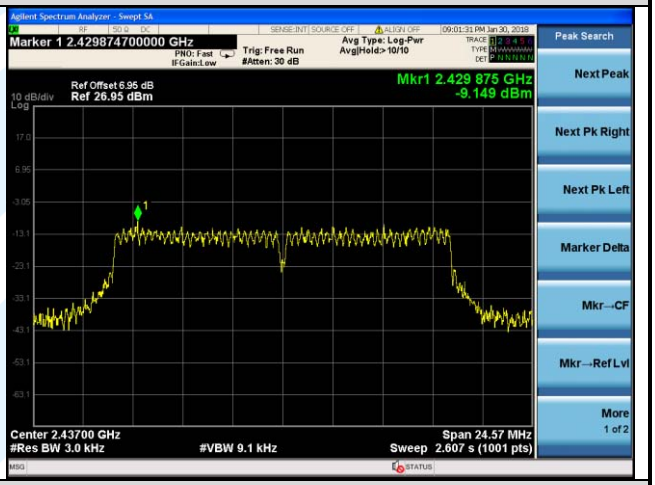
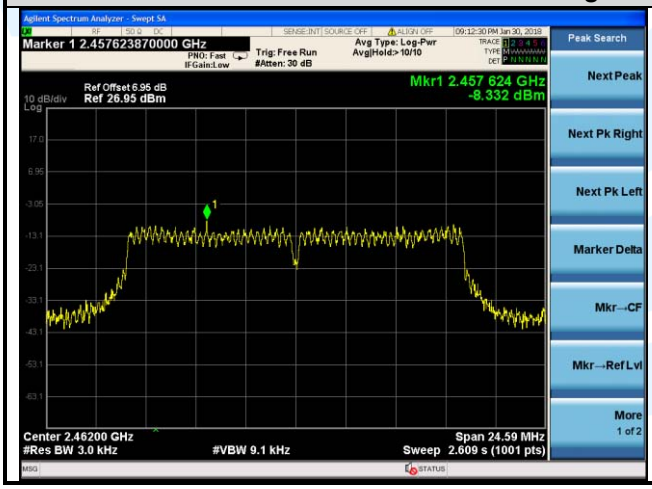
Mode	Channel/ Frequency (MHz)	Power spectral density (dBm)				
		SISO_ Chain 0	SISO_ Chain 1	Total Power MIMO_ Chain 0+1	Limit @3kHz (dBm)	Pass / Fail
IEEE 802.11b	1(2412)	-10.975	-9.902	---	8	Pass
	6(2437)	-10.76	-10.362	---	8	Pass
	11(2462)	-8.41	-9.335	---	8	Pass
IEEE 802.11g	1(2412)	-9.653	-14.178	---	8	Pass
	6(2437)	-9.358	-9.149	---	8	Pass
	11(2462)	-8.332	-9.861	---	8	Pass
IEEE 802.11n-HT20	1(2412)	-9.444	-10.301	-6.84	8	Pass
	6(2437)	-10.189	-9.769	-6.96	8	Pass
	11(2462)	-9.058	-7.693	**-5.31**	8	Pass
IEEE 802.11n-HT40	3(2422)	-12.624	-12.495	-9.55	8	Pass
	6(2437)	-12.743	-12.439	-9.58	8	Pass
	9(2452)	-11.723	-13.681	-9.58	8	Pass

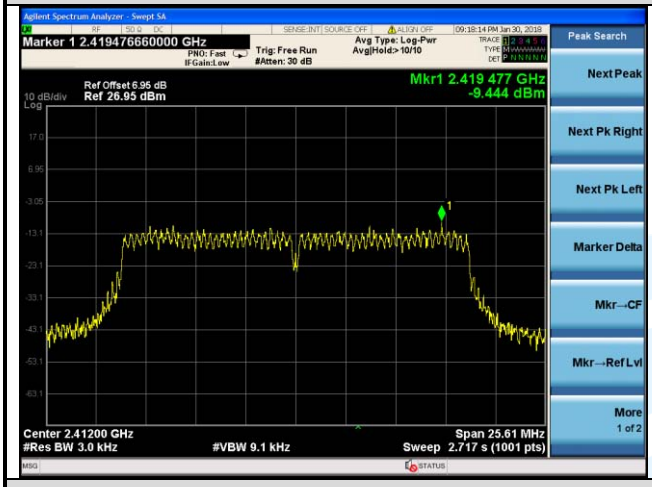
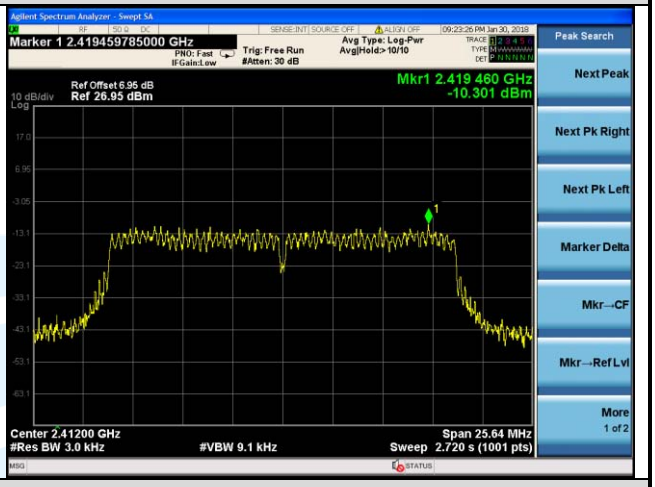
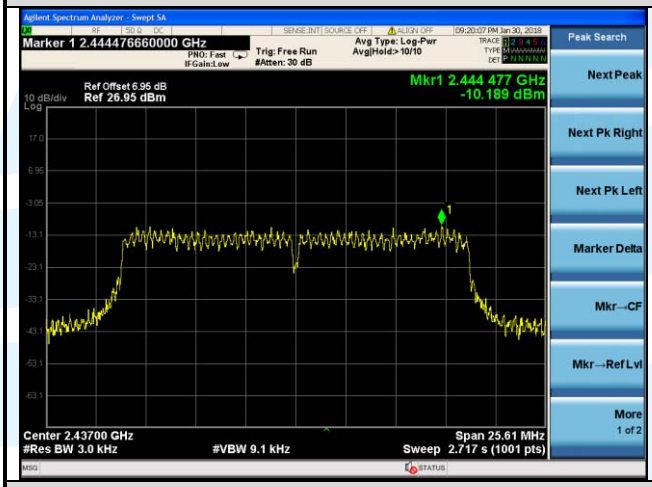
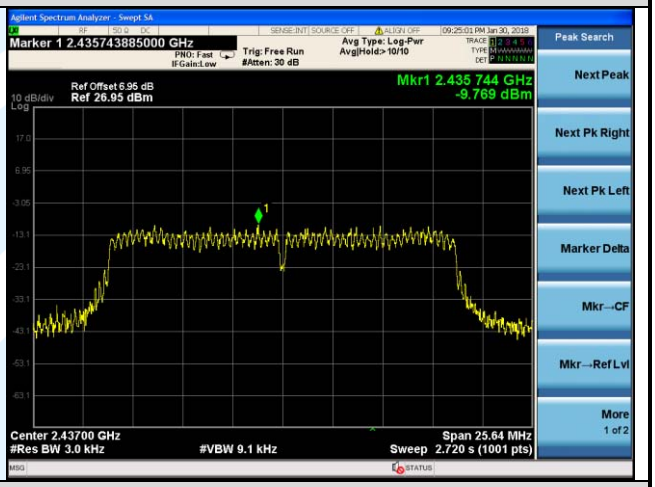
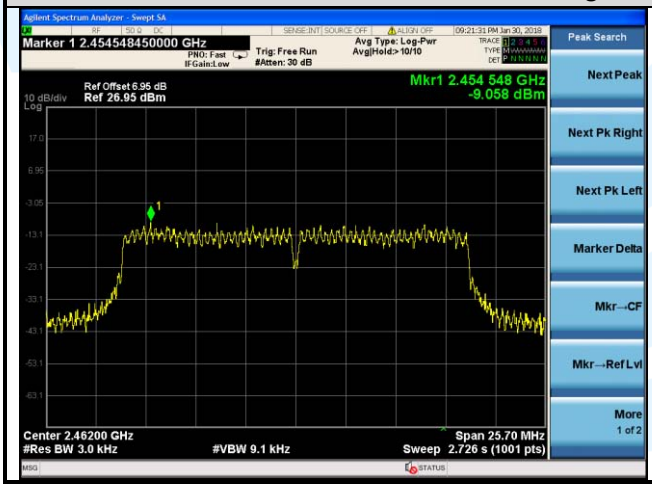
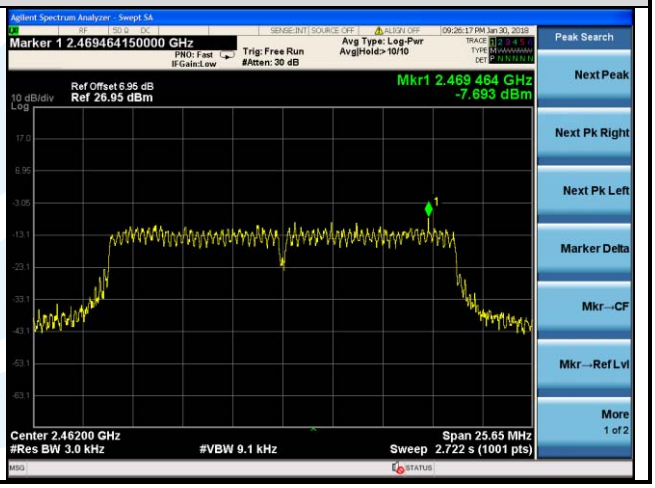
Remark:
1. Power with Duty Factor = Measured Power + Duty Cycle Factor
2. Total (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$
3. Directional gain and the maximum conducted power spectral density limit see table below:

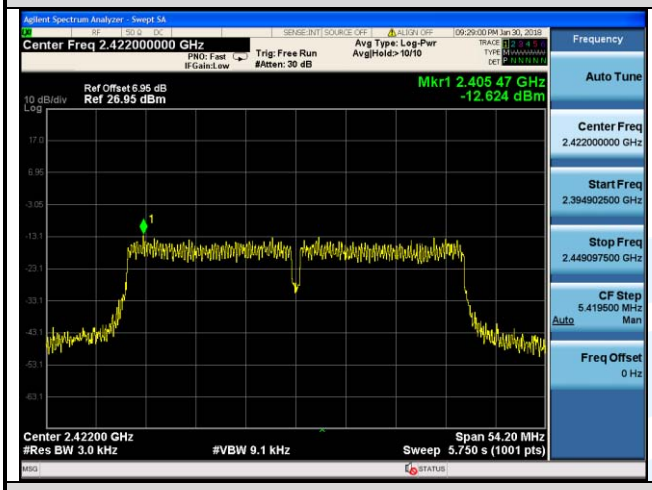
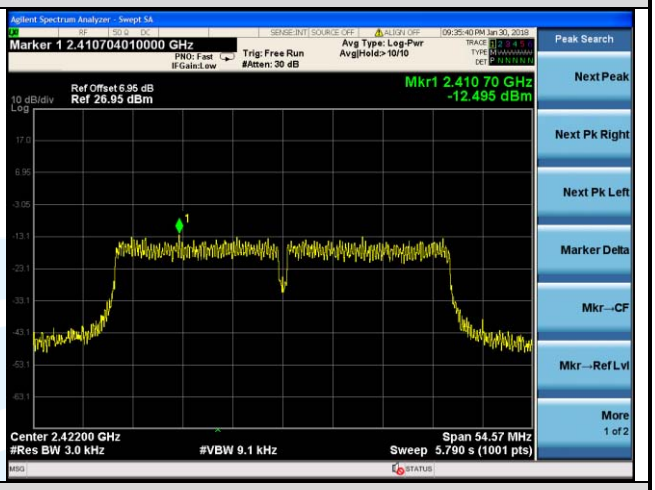
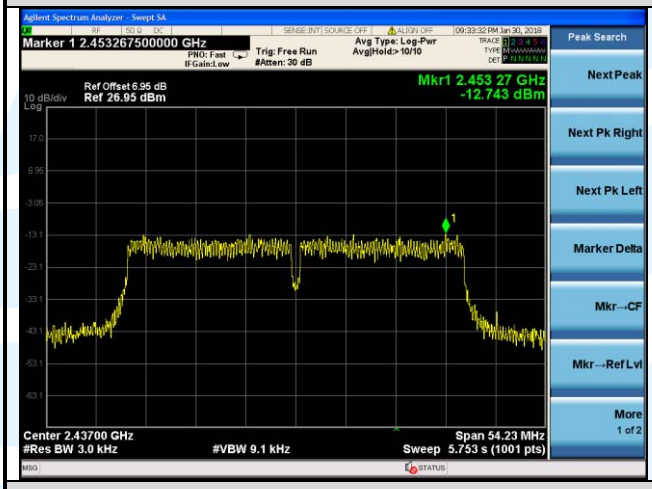
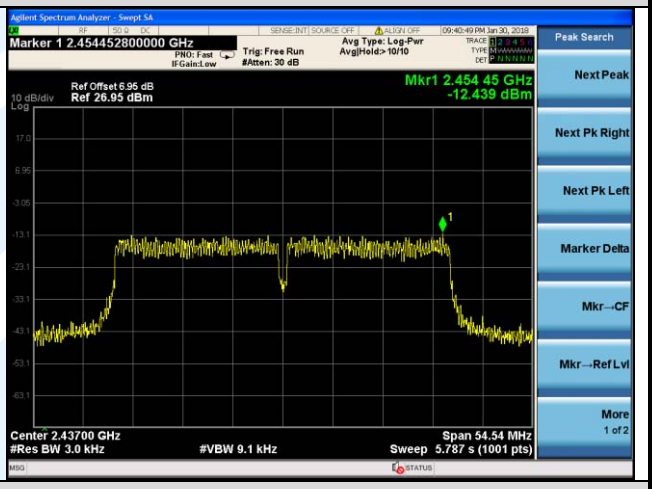
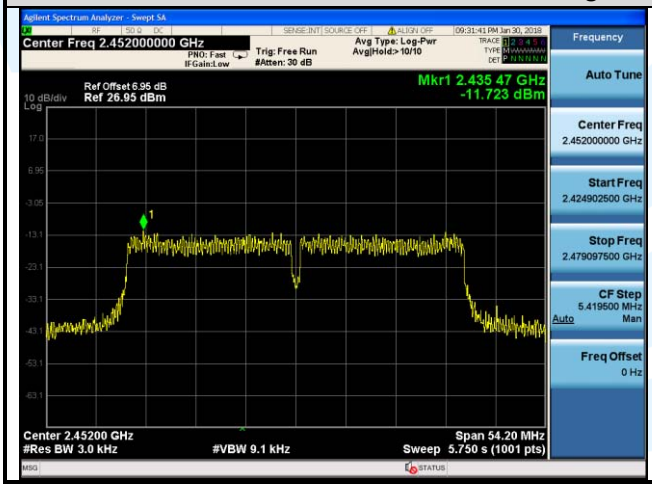
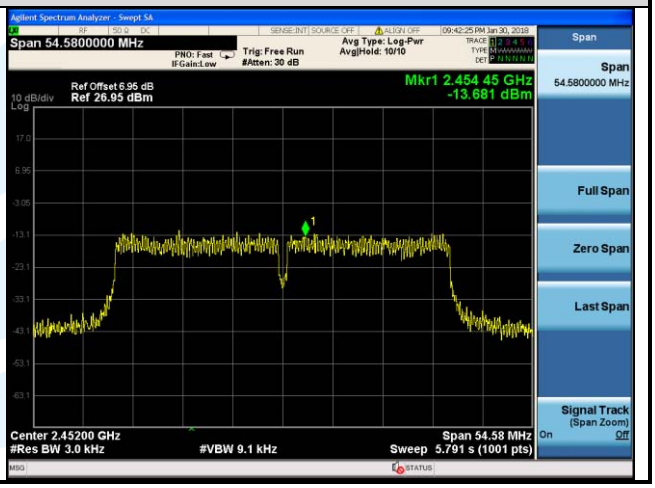
Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limit (dBm)
2400 MHz to 2483.5 MHz	2.00	2.00	5.01	8.00
Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:				
If *any* transmit signals are *correlated* with each other,				
Directional gain = G_{ANT} + 10 log(N_{ANT}) dBi				

The test plot as follows:

IEEE 802.11b_Chain 0	IEEE 802.11b_Chain 1
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11g_Chain 0	IEEE 802.11g_Chain 0
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11n-HT20_Chain 0	IEEE 802.11n-HT20_Chain 1
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11n-HT40_Chain 0	IEEE 802.11n-HT40_Chain 1
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

5.6 CONDUCTED OUT OF BAND EMISSION

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(d)

Test Method: KDB 558074 D01 v04, Section 11

Limit: In any 100kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Use the following spectrum analyzer settings:

Step 1:Measurement Procedure REF

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.
j) Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

Step 2:Measurement Procedure OOBE

a) Set RBW = 100 kHz.
b) Set VBW ≥ 300 kHz.
c) Detector = peak.
d) Sweep = auto couple.
e) Trace Mode = max hold.
f) Allow trace to fully stabilize.
g) Use the peak marker function to determine the maximum amplitude level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.4.3 for details.

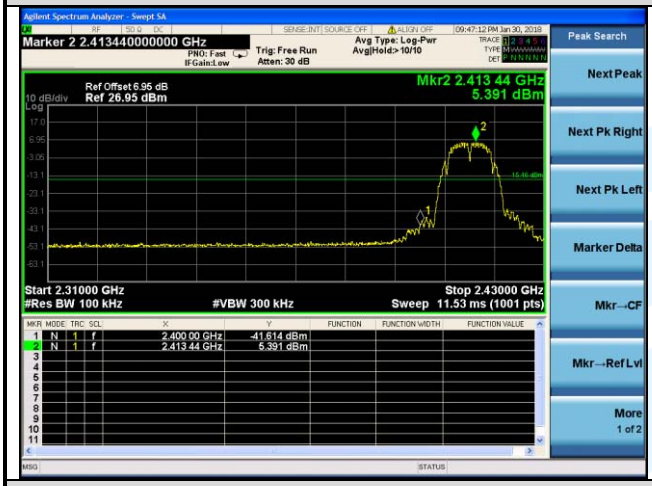
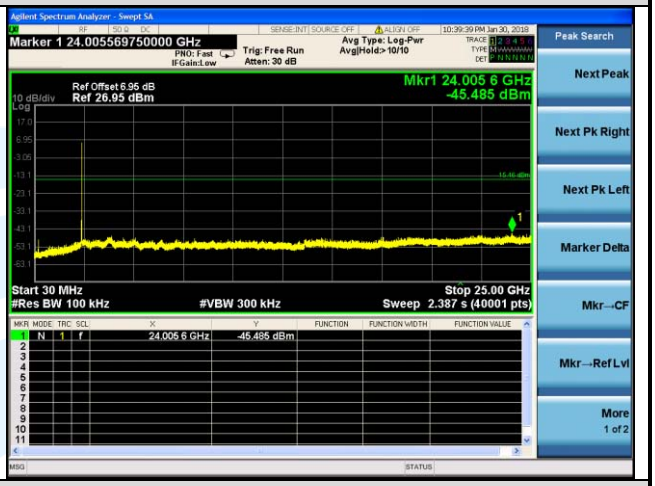
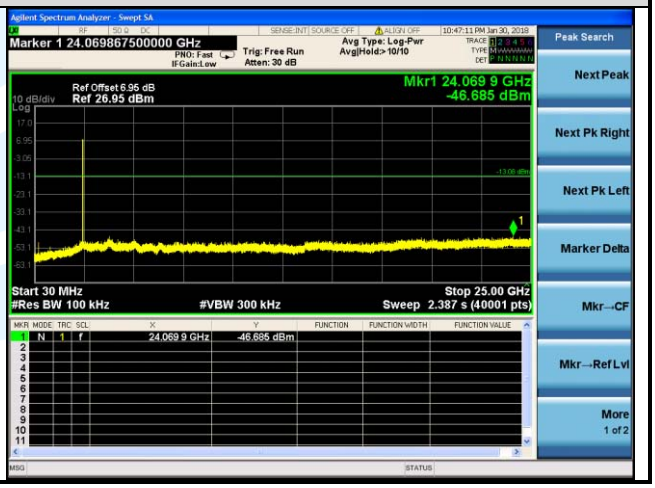
Instruments Used: Refer to section 3 for details

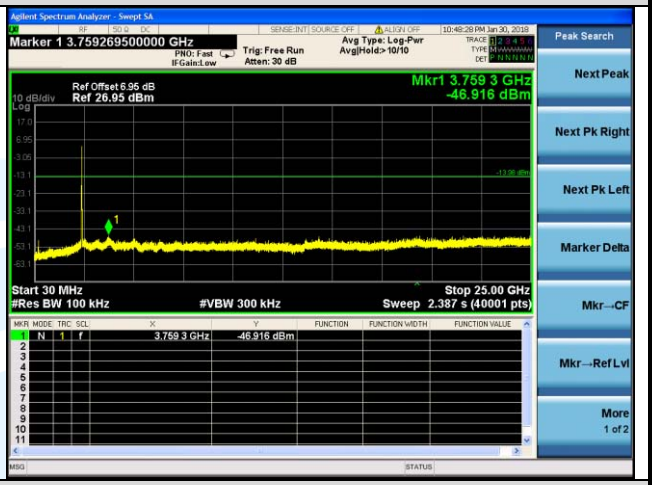
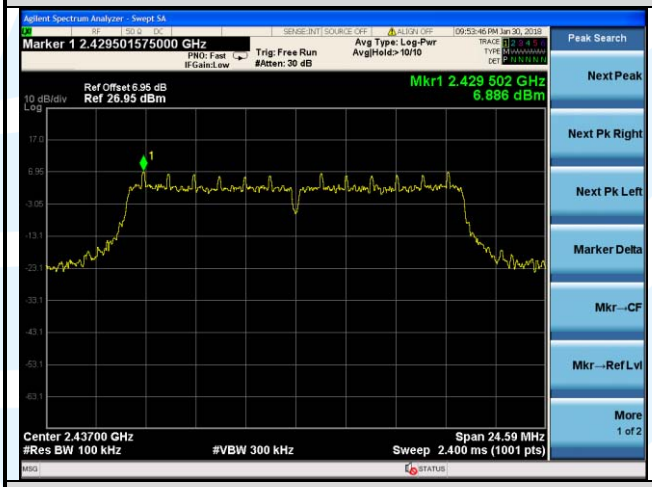
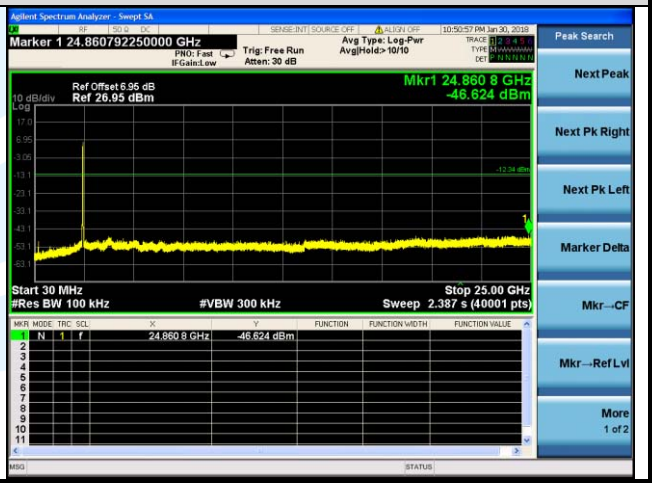
Test Mode: Transmitter mode

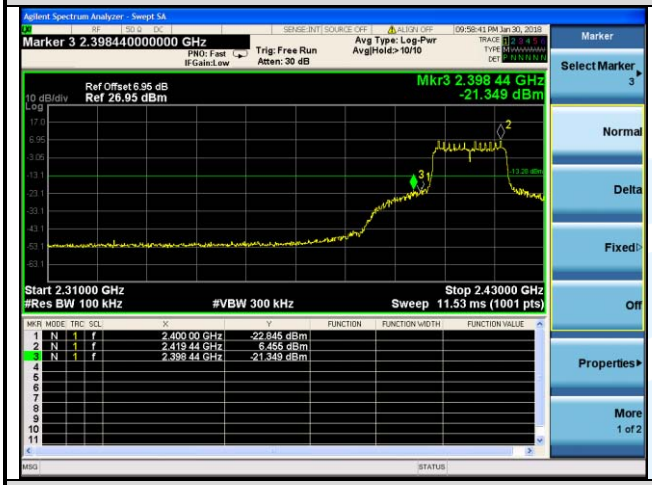
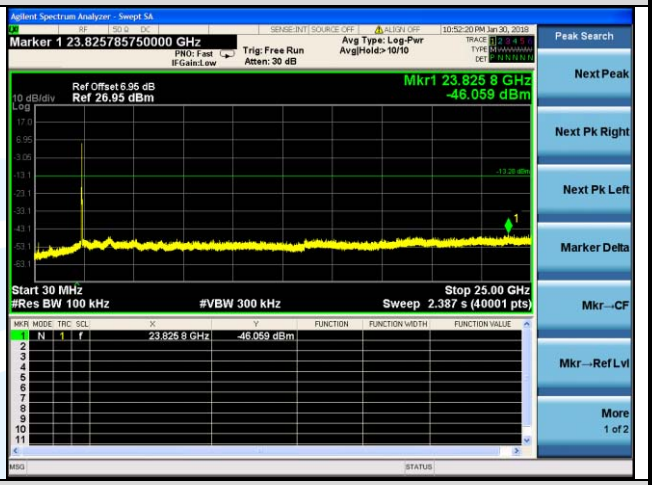
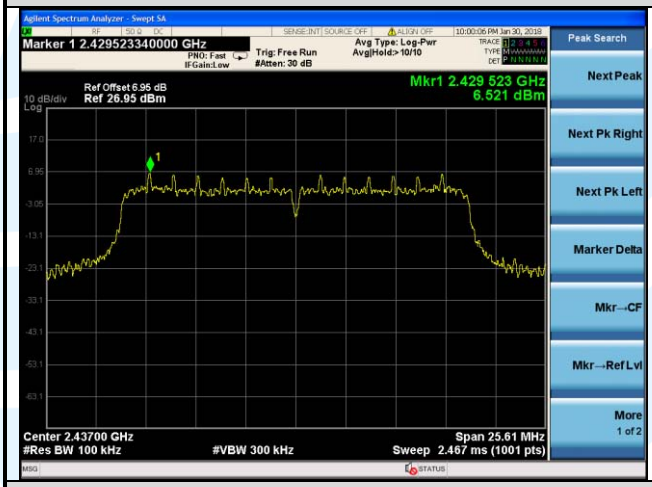
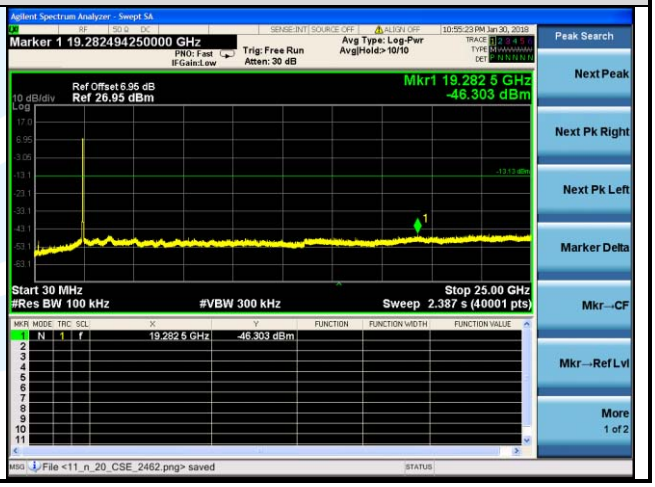
Test Results: Pass

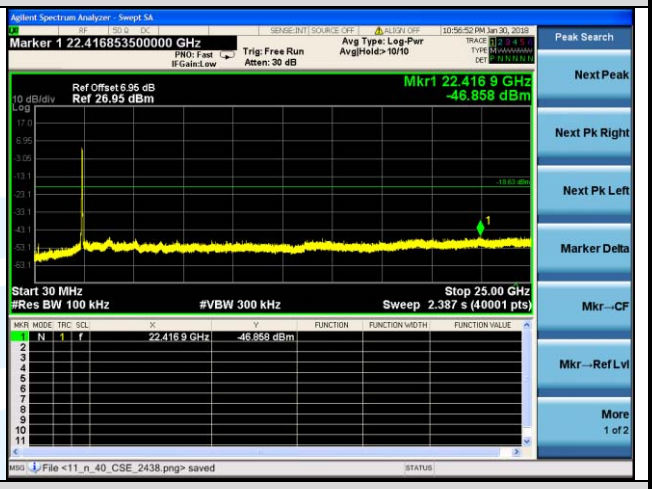
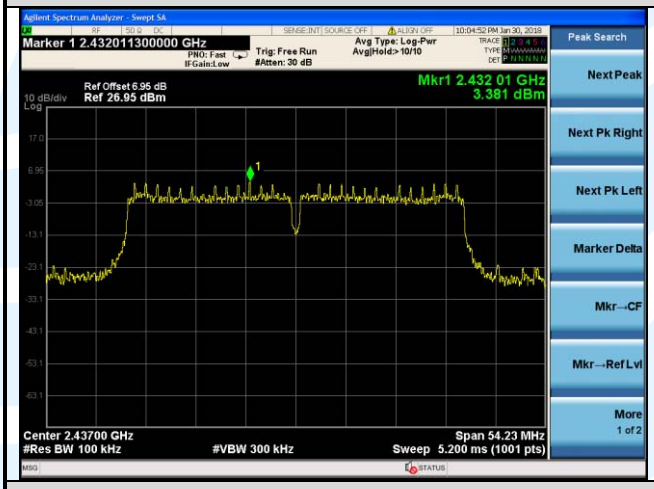
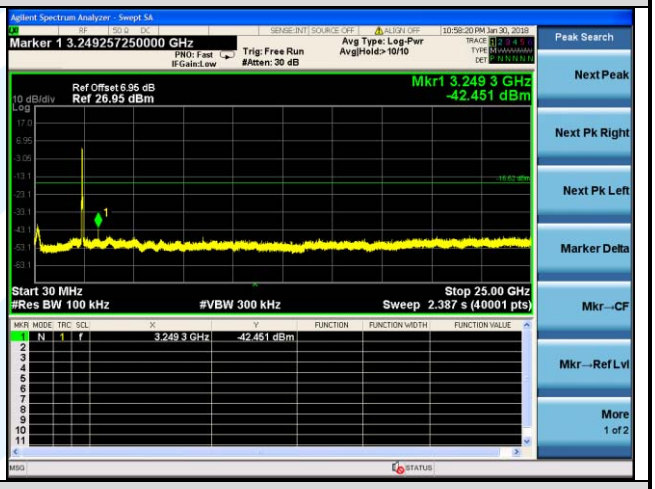
Test Data:

The test plot as follows:

IEEE 802.11b_Chain 0	
In-Band Reference Level	**Out of Band Emission**
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11g_Chain 0	
In-Band Reference Level	**Out of Band Emission**
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11n-HT20_Chain 0	
In-Band Reference Level	**Out of Band Emission**
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

IEEE 802.11n-HT40_Chain 0	
In-Band Reference Level	**Out of Band Emission**
Lowest Channel	
	
Middle Channel	
	
Highest Channel