TEST REPORT

Product Name:	WIFI Module
Trade Mark:	RF-LINK
Model No.:	RL-UM02SPC-8812BU-V1.0
Report Number:	180327015RFC-2
Test Standards:	FCC 47 CFR Part 15 Subpart E
FCC ID:	QCIIDXMOD1
Test Result:	PASS
Date of Issue:	April 18, 2018

Prepared for:

SMART Technologies Inc.
3636 Research Road NW Calgary, AB T2L 1Y1, Canada

Prepared by:

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Tested by: _____ Henry Lu, Engineer

Reviewed by: _____ Kevin Liang, Team Leader

Approved by: _____ Jim Long, Assistant Manager

Date: April 18, 2018

UnionTrust Testing Laboratories * Certified *

Version

Version No.	Date	Description
V1.0	April 18, 2018	Original
V2.0	April 18, 2018	Add 5.9 section on page 82

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1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	SMART Technologies Inc.
Address of Applicant:	3636 Research Road NW Calgary, AB T2L 1Y1, Canada
Manufacturer:	SMART Technologies Inc.
Address of Manufacturer:	3636 Research Road NW Calgary, AB T2L 1Y1, Canada

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	WIFI Module		
Model No.:	RL-UM02SPC-8812BU-V1.0		
Add. Model No.:	N/A		
Trade Mark:	RF-LINK		
DUT Stage:	Identical Prototype		
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
	5 GHz U-NII Bands:	5150 MHz to 5250 MHz	IEEE 802.11a/n/ac
		5250 MHz to 5350 MHz	IEEE 802.11a/n/ac
		5470 MHz to 5600 MHz	IEEE 802.11a/n/ac
		5650 MHz to 5725 MHz	IEEE 802.11a/n/ac
Sample Received Date:	February 1, 2018		
Sample Tested Date:	February 2, 2018 to March 19, 2018		

1.2.2 Description of Accessories

None.

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Range:	5150 MHz to 5250 MHz
	5250 MHz to 5350 MHz
	5470 MHz to 5600 MHz
	5650 MHz to 5725 MHz
Support Standards:	IEEE 802.11a/n/ac
TPC Function:	Not Support
DFS Operational mode:	Slave without radar Interference detection function
Type of Modulation:	IEEE 802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK)
	IEEE 802.11n: OFDM(64QAM, 16QAM, QPSK, BPSK)
	IEEE 802.11ac: OFDM(256QAM, 64QAM, 16QAM, QPSK, BPSK)
Channel Spacing:	IEEE 802.11a/n-HT20/ac-VHT20: 20 MHz
	IEEE 802.11n-HT40/ac-VHT40: 40 MHz
	IEEE 802.11ac-VHT80/: 80 MHz
Data Rate:	IEEE 802.11a: Up to 54 Mbps
	IEEE 802.11n-HT20: Up to MCS15
	IEEE 802.11n-HT40: Up to MCS15
	IEEE 802.11ac-VHT20: Up to MCS8
	IEEE 802.11ac-VHT40: Up to MCS9
	IEEE 802.11ac-VHT80: Up to MCS9

Number of Channels:	5150 MHz to 5250 MHz: 4 for IEEE 802.11a/n-HT20/ac-VHT20 2 for IEEE 802.11n-HT40)/ac-VHT40 1 for IEEE 802.11acVHT80				
	5250 MHz to 5350 MHz: 4 for IEEE 802.11a/n-HT20/ac-VHT20 2 for IEEE 802.11n-HT40)/ac-VHT40 1 for IEEE 802.11acVHT80				
	5470 MHz to 5725 MHz: 8 for IEEE 802.11a/n-HT20/ac-VHT20 3 for IEEE 802.11n-HT40/ac-VHT40 1 for IEEE 802.11ac-VHT80				
Antenna Type:	Chain 0	Diple Antenna			
	Chain 1	Diple Antenna			
Antenna Gain:	Chain 0	5150 MHz to 5250 MHz: 3.20 dBi			
		5250 MHz to 5350 MHz: 3.40 dBi			
		5470 MHz to 5725 MHz: 5.36 dBi			
	Chain 1	5150 MHz to 5250 MHz: 3.20 dBi			
		5250 MHz to 5350 MHz: 3.40 dBi			
		5470 MHz to 5725 MHz: 5.36 dBi			
Directional gain:	5150 MHz to 5250 MHz:	6.21 dBi			
	5250 MHz to 5350 MHz:	6.41 dBi			
	5470 MHz to 5725 MHz:	8.37 dBi			
Maximum conducted output power (dBm):	**CDD_Chain 0+1**	**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11a:	12.44	12.18	10.98	N/A
	MIMO_Chain 0+1	**U-NII-1**	**U-NII-2A**	**U-NII-2C**	**U-NII-3**
	IEEE 802.11n-HT20:	11.21	11.72	11.15	N/A
	IEEE 802.11n-HT40:	9.72	9.57	9.63	N/A
	IEEE 802.11ac-VHT80:	9.46	9.33	10.97	N/A
Normal Test Voltage:	3.3 Vdc				
Extreme Test Voltage:	3.0 to 3.6 Vdc				
Extreme Test Temperature:	0 °C to +70 °C				

1.4 OTHER INFORMATION

Operation Frequency Each of Channel				
	U-NII-1	U-NII-2A	U-NII-2C	U-NII-3
IEEE 802.11a, IEEE 802.11n-HT20, IEEE 802.11ac-VHT20	f = 5000 + 5k, k = 32 + 4n			f = 5000 + 5k, k = 145 + 4n
	n = 1,…, 4	n = 5,…, 8	n = 17,…, 27	n = 1,…, 5
IEEE 802.11n-HT40, IEEE 802.11ac-VHT40	f = 5000 + 5k, k = 30 + 8n			f = 5000 + 5k, k = 143 + 8n
	n = 1, 2	n = 1,…, 5	n = 9,…, 13	n = 1, 2
IEEE 802.11ac-VHT80	f = 5000 + 5k, k = 26 + 16n			f = 5000 + 5k, k = 155
	n = 1	n = 1, 2	n = 5, 6	

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	FCC ID	Supplied by
Notebook	Lenovo	E450	SL10G10780	N/A	UnionTrust
Wireless AP	Alcatel-Lucent	G-240W-B	N/A	2ADZRG240WB	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable * 2	SMA	0.30 Meter	UnionTrust

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 E Test Cases			
Test Item	**Test Requirement**	**Test Method**	**Result**
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203 FCC 47 CFR Part 15 Subpart C Section 15.407(a)(1) (2)	ANSI C63.10-2013	PASS
26 dB emission bandwidth	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(2)(5)	KDB 789033 D02 v02r01 Section C.1	PASS
6 dB bandwidth	FCC 47 CFR Part 15 Subpart E Section 15.407 (e)	KDB 789033 D02 v02r01 Section C.2	PASS
Maximum conducted output power	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)	KDB 789033 D02 v02r01 Section E.3.a(Method PM)	PASS
Peak Power Spectral Density	FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)	KDB 789033 D02 v02r01 Section F	PASS
Frequency stability	FCC 47 CFR Part 15 Subpart E Section 15.407 (g)	ANSI C63.10-2013	PASS
Radiated Emissions and Band Edge Measurement	FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(1)(2)(3)(4)(6) FCC 47 CFR Part 15 Subpart C Section 15.209/205	KDB 789033 D02 v02r01 Section G.3, G.4, G.5, and G.6	PASS
Dynamic Frequency Selection	FCC 47 CFR Part 15 Subpart E Section 15.407 (h)	KDB 905462 D03 Client Without DFS New Rules v01r02	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart E Section 15.407 (b)(6) FCC 47 CFR Part 15 Subpart C	ANSI C63.10-2013	N/A NOTE 1, 2

Note:

1) N/A: In this whole report not application.
2) This EUT is powered by DC from PCB.

For Dynamic Frequency Selection

Test Case	Result
Channel Availability Check Time	N/A[1]
U-NII Detection Bandwidth	N/A[1]
Channel Closing Transmission Time	PASS
Channel Move Time	PASS
DFS Detection Threshold	N/A[1]
Non- Occupancy Period	N/A[1]

Note:

1) The EUT is slave, NA In this whole report not application.

3. EQUIPMENT LIST

Radiated Emission Test Equipment List (3M Chamber)						
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
☑	Loop Antenna	ETS-LINDGREN	6502	00202525	Dec. 17, 2017	Dec. 17, 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 (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	Dec. 17, 2017	Dec. 17, 2018
☑	Horn Antenna	ETS-LINDGREN	3116C	00200180	Jul. 28, 2015	Jul. 27, 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
☑	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
☑	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	Dec. 10, 2017	Dec. 10, 2018
☐	EXG-B RF Analog Signal Generator	KEYSIGHT	N5171B	MY53051777	Dec. 10, 2017	Dec. 10, 2018
☑	MXG X-Series RF Vector Signal Generator	KEYSIGHT	N5182B	MY51350267	Dec. 14, 2017	Dec. 14, 2018
☑	DC Source	KIKUSUI	PWR400L	LK003024	Sep. 14, 2017	Sep. 13, 2018
☑	Temp & Humidity chamber	Espec	GL(U)04KA(W)	16921H201P3	Sep. 14, 2017	Sep. 13, 2018
☑	Temp & Humidity chamber	Votisch	VT4002	58566133290020	Jun. 19, 2017	Jun. 18, 2018

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Test Environment	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage (V)	Relative Humidity (%)
TN/VN	+15 to +35	3.3	20 to 75
TL/VL	0	3.0	20 to 75
TH/VL	+70	3.0	20 to 75
TL/VH	0	3.6	20 to 75
TH/VH	+70	3.6	20 to 75

Remark:

1) The EUT just work in such extreme temperature of 0 °C to +70 °C and the extreme voltage of 3.0 V to 3.6 V, so here the EUT is tested in the temperature of 0 °C to +70 °C and the voltage of 3.0 V to 3.6 V.
2) VN: Normal Voltage; TN: Normal Temperature;
TL: Low Extreme Test Temperature; TH: High Extreme Test Temperature;
VL: Low Extreme Test Voltage; VH: High Extreme Test Voltage.

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists		
		Lowest(L)	Middle(M)	Highest(H)
IEEE 802.11a IEEE 802.11n-HT20	5150 MHz to 5250 MHz	Channel 36	Channel 44	Channel 48
		5180 MHz	5220 MHz	5240 MHz
	5250 MHz to 5350 MHz	Channel 52	Channel 60	Channel 64
		5260 MHz	5300 MHz	5320 MHz
	5470 MHz to 5725 MHz	Channel 100	Channel 116	Channel 140
		5500 MHz	5580 MHz	5700 MHz
IEEE 802.11n-HT40	5150 MHz to 5250 MHz	Channel 38	--	Channel 46
		5190 MHz	--	5230 MHz
	5250 MHz to 5350 MHz	Channel 54	--	Channel 62
		5270 MHz	--	5310 MHz
	5470 MHz to 5725 MHz	Channel 102	Channel 110	Channel 134
		5510 MHz	5550 MHz	5670 MHz
IEEE 802.11ac-VHT80	5150 MHz to 5250 MHz	--	Channel 42	--
		--	5210 MHz	--
	5250 MHz to 5350 MHz	--	Channel 58	--
		--	5290 MHz	--
	5470 MHz to 5725 MHz	Channel 106	--	--
		5530 MHz	--	--

4.3 EUT TEST STATUS

Mode	Tx/Rx Function	Description
IEEE 802.11a	1Tx/1Rx	1. Keep the EUT in transmitting mode with all kind of modulation and all kind of data rate.
IEEE 802.11a/n/ac	2Tx/2Rx	

4.4 PRE-SCAN

4.4.1 Pre-scan under all rates

Mode and Frequency	Maximum Conducted Average Power (dBm) for Data Rates (Mbps)							
IEEE 802.11a 5180 MHz	6	9	12	18	24	36	48	54
	9.53	9.44	9.23	9.05	8.87	8.65	8.32	7.84
IEEE 802.11n-HT20 5180 MHz	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
	8.51	8.32	8.18	7.94	7.85	7.73	7.68	7.52
	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
	7.27	6.92	6.78	6.54	6.26	5.97	5.83	5.76
IEEE 802.11n-HT40 5190 MHz	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
	6.65	6.61	6.54	6.37	6.38	6.28	6.12	6.18
	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
	5.89	5.94	5.82	5.67	5.72	5.58	5.55	5.49
	5.32	5.30						
IEEE 802.11ac-VHT80 5210 MHz	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
	6.46	6.42	6.38	6.36	6.33	6.17	5.94	5.97
	MCS8	MCS9						
	5.68	5.57						

4.4.2 Worst-case data rates

Mode	Worst-case data rates
IEEE 802.11a	6 Mbps
IEEE 802.11n-HT20	MCS0
IEEE 802.11n-HT40	MCS0
IEEE 802.11ac-VHT80	MCS0

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

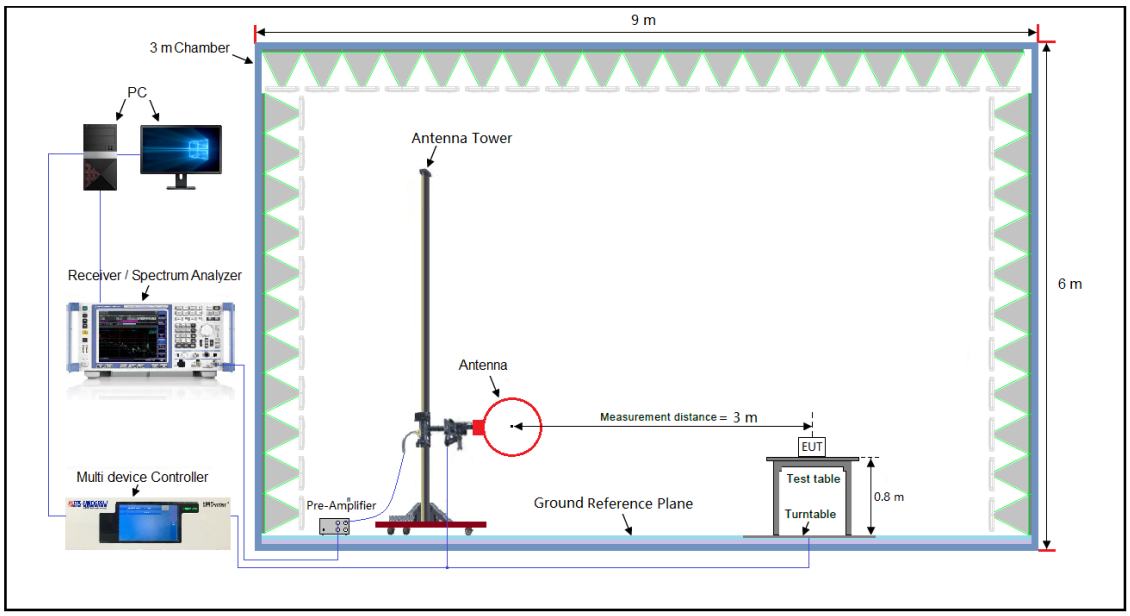


Figure 1. Below 30MHz

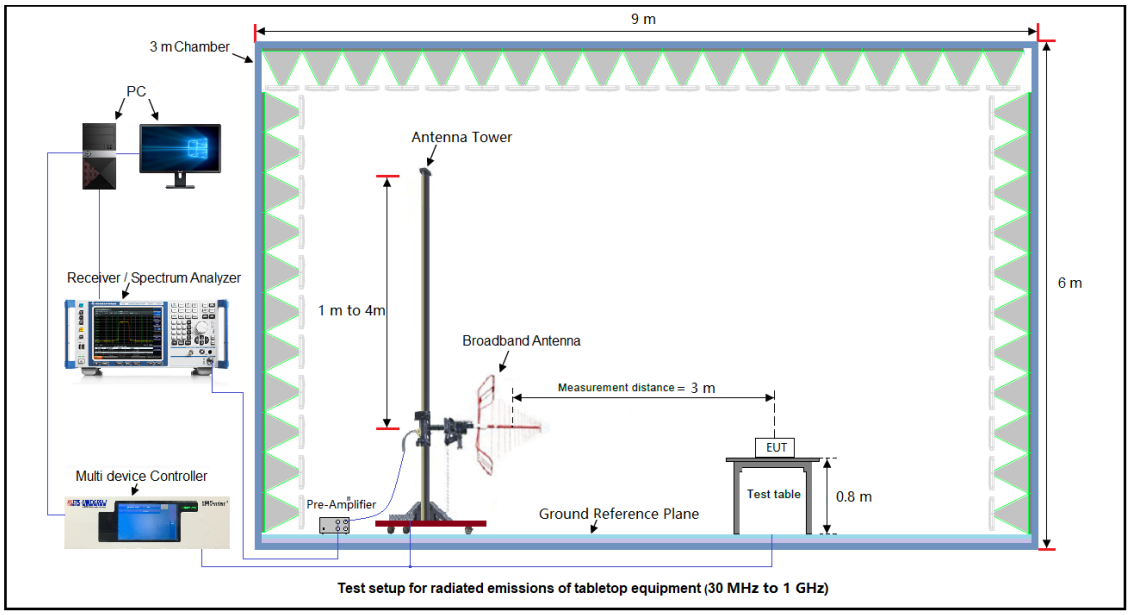


Figure 2. 30MHz to 1GHz

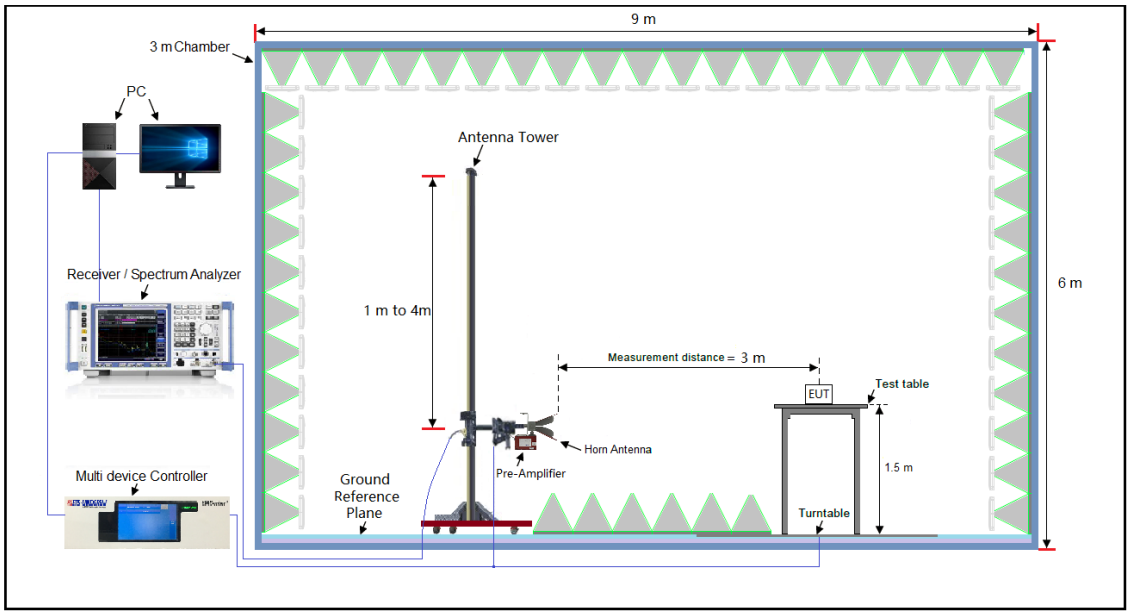
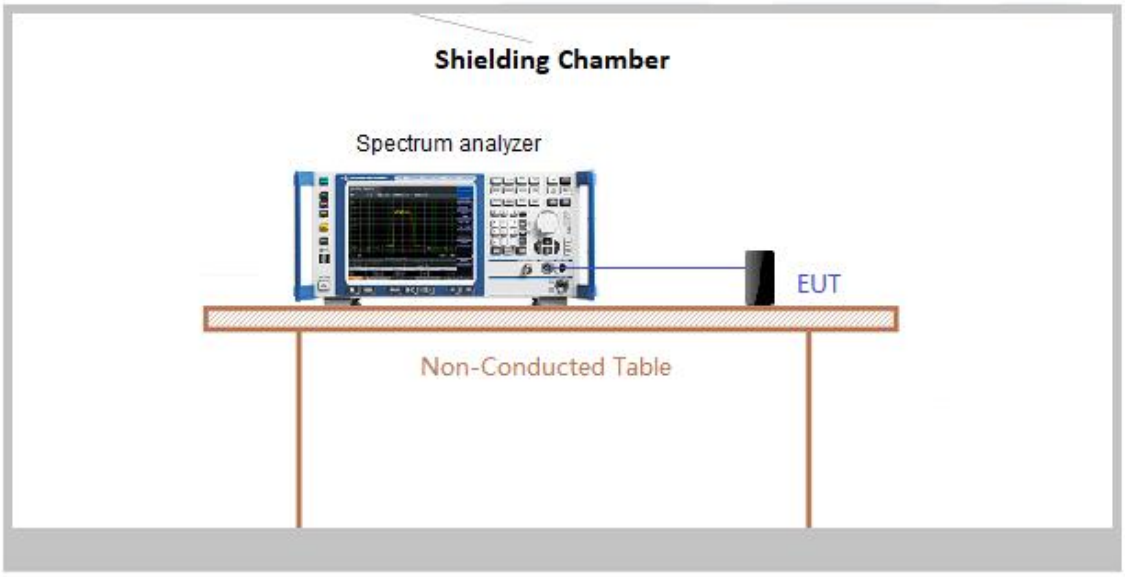
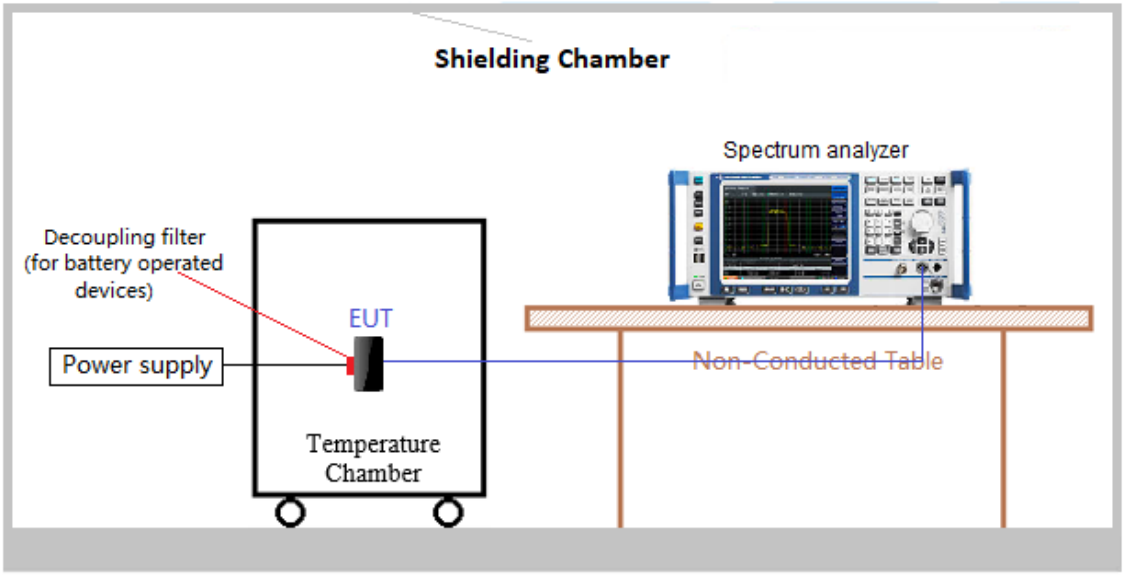


Figure 3. Above 1GHz

4.5.2 For Conducted RF test setup



Normal Environment



Extreme Environment

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 a 3.3Vdc. 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

The EUT working with 100% duty cycle for continue transimit

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 789033 D02 General U-NII Test Procedures New Rules v02r01	Guidelines for compliance testing of unlicensed national information infrastructure (U-NII) device part 15 subpart E
5	905462 D06 802.11 Channel Plans New Rules v02	Operation in U-NII bands -802.11 channel PLAN(§15.407)
6	KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02	Compliance measurement procedures for Unlicensed –National Information Infrastructure devices operates in the frequency bands 5250 MHz to 5350 MHz and 5470 MHz to 5725 MHz bands incorporating dynamic frequency selection
7	KDB 905462 D03 Client Without DFS New Rules v01r02	U-NII client devices without radar detection capability
8	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. **15.407(a)(1) (2) requirement:** The conducted output power limit specified in paragraph (a) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (a) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power and the peak power spectral density shall be reduced by the 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 Tx chains are correlated and the antenna gain is unequal among the chains and the best case directional gain of the antenna is 6.21dBi@5150MHz~5250MHz, 6.41dBi@5250MHz~5350MHz, 8.37dBi@5470MHz~5725MHz (See section 5.5).

5.3 26 DB BANDWIDTH & OCCUPIED BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a) (2)(5)

Test Method: KDB 789033 D02 v02r01 Section C.1

Limit: None; for reporting purposes only.

Test Procedure:

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum analyzer.

Spectrum analyzer according to the following Settings:
a) Set RBW = approximately 1 % of the emission bandwidth.
b) Set the VBW > RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1 %.

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

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

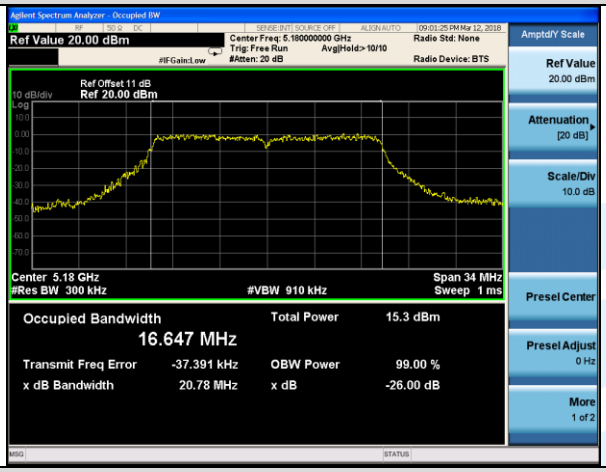
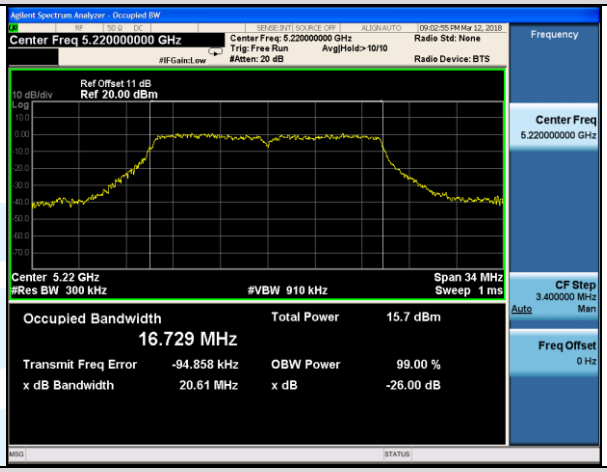
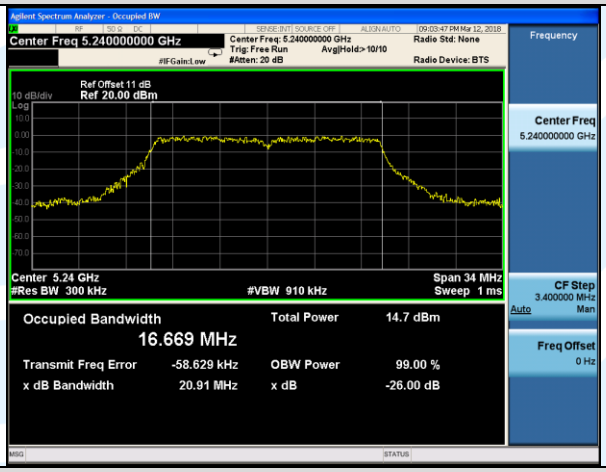
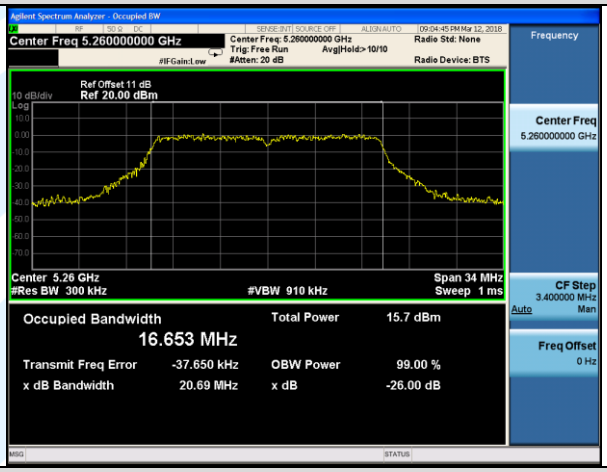
Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Mode	Channel	26 dB Bandwidth (MHz)	99% Bandwidth (MHz)
The worst case test data: Chain 1			
IEEE 802.11a	36 (5180)	20.780	16.647
	44 (5220)	20.610	16.729
	48 (5240)	20.910	16.669
	52 (5260)	20.690	16.653
	60 (5300)	20.730	16.722
	64 (5320)	20.640	16.606
	100 (5500)	20.700	16.667
	116 (5580)	20.890	16.674
	140 (5700)	20.630	16.677
IEEE 802.11n-HT20	36 (5180)	21.390	17.728
	44 (5220)	21.160	17.739
	48 (5240)	20.920	17.733
	52 (5260)	21.210	17.725
	60 (5300)	21.070	17.705
	64 (5320)	20.920	17.703
	100 (5500)	21.140	17.756
	116 (5580)	21.260	17.724
	140 (5700)	21.170	17.757
IEEE 802.11n-HT40	38 (5190)	43.650	36.431
	46 (5230)	43.010	36.333
	54 (5270)	42.840	36.415
	62 (5310)	42.010	36.375
	102 (5510)	42.560	36.340
	110 (5550)	42.090	36.281
	134 (5670)	42.440	36.346
IEEE 802.11ac-VHT80	42 (5230)	82.440	75.582
	58 (5290)	82.240	75.544
	106 (5530)	81.930	75.474

The test plot as follows:

IEEE 802.11a	
Channel 36	**Channel 44**
	
Channel 48	**Channel 52**
	
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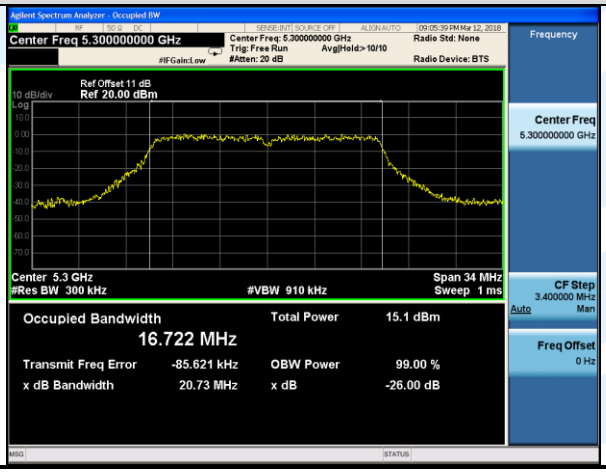
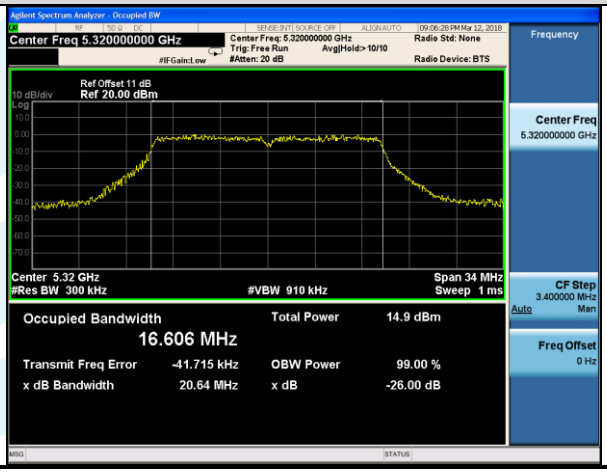
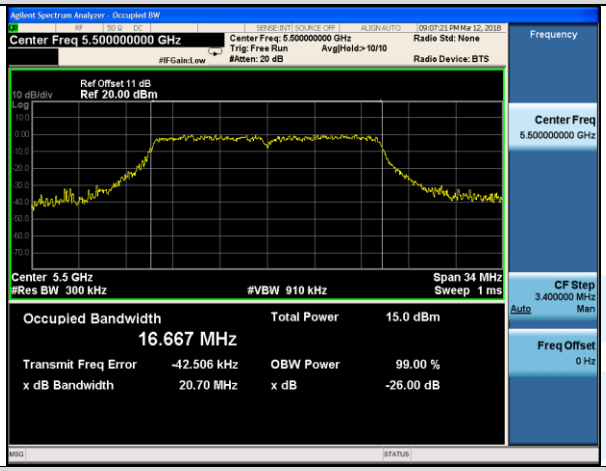
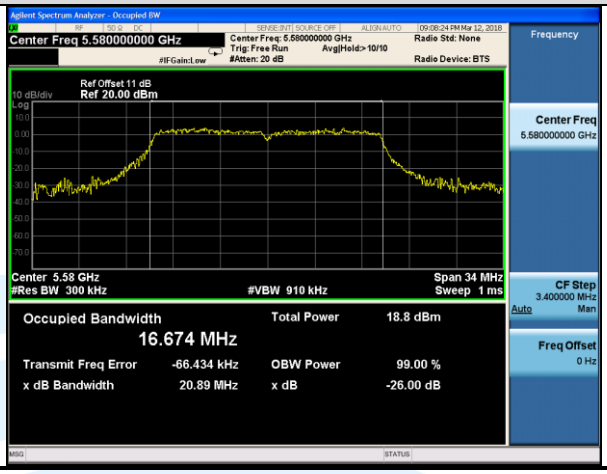
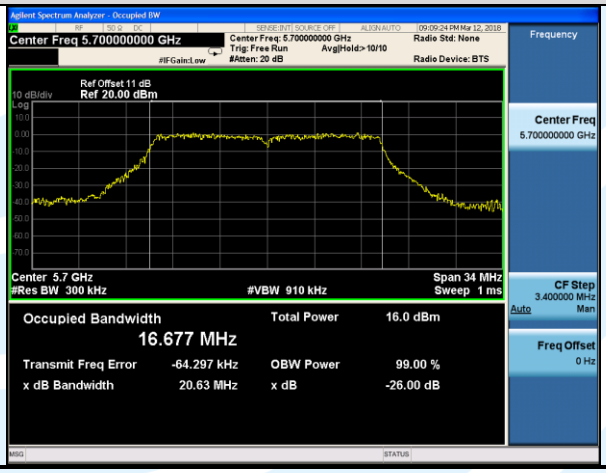
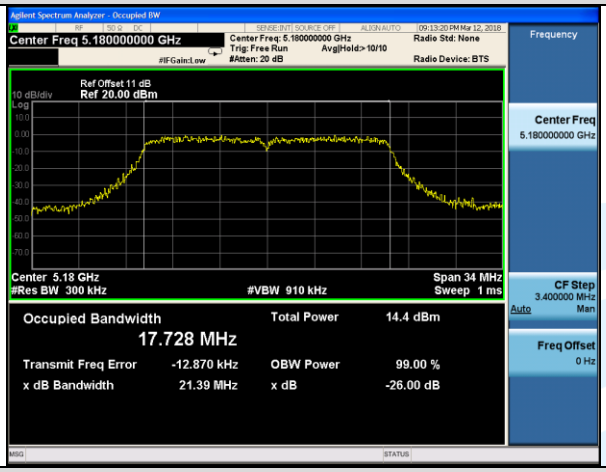
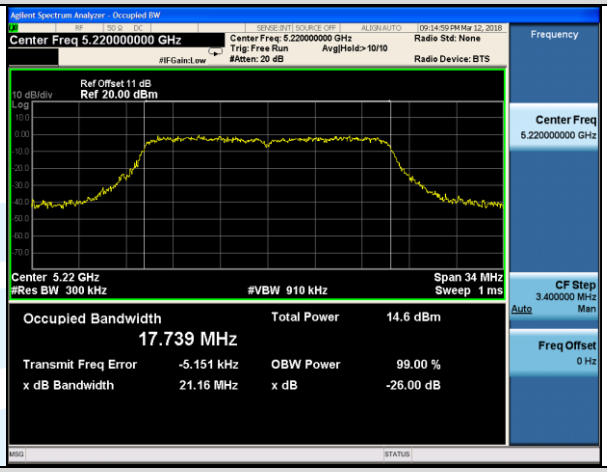
	

Channel 100	Channel 116
	

Channel 140


IEEE 802.11n-HT20	
Channel 36	**Channel 44**
	
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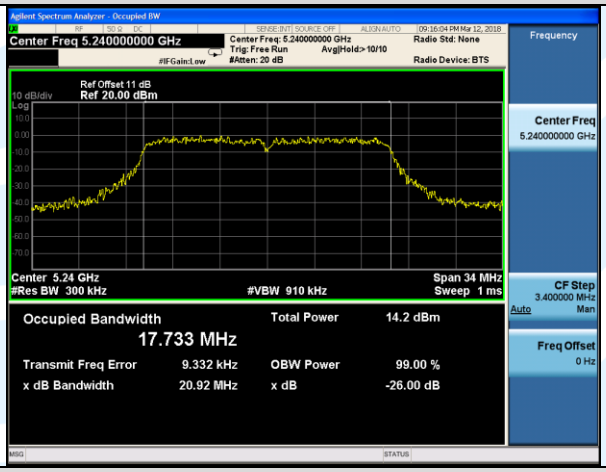	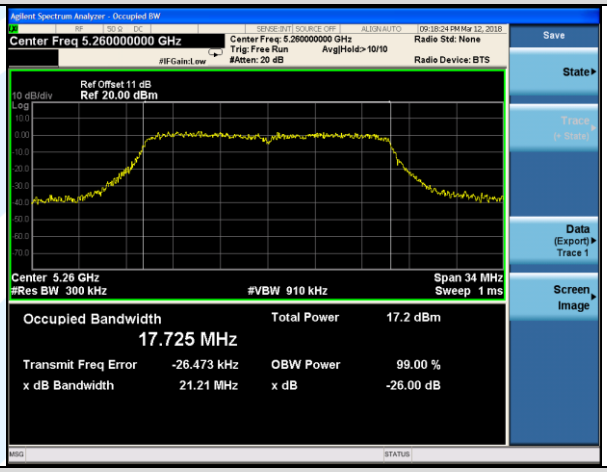
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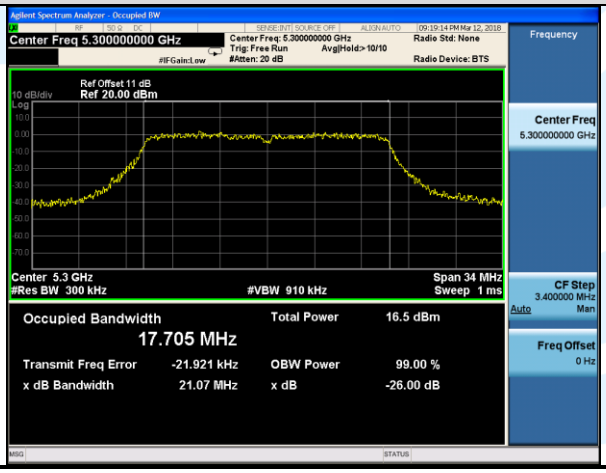
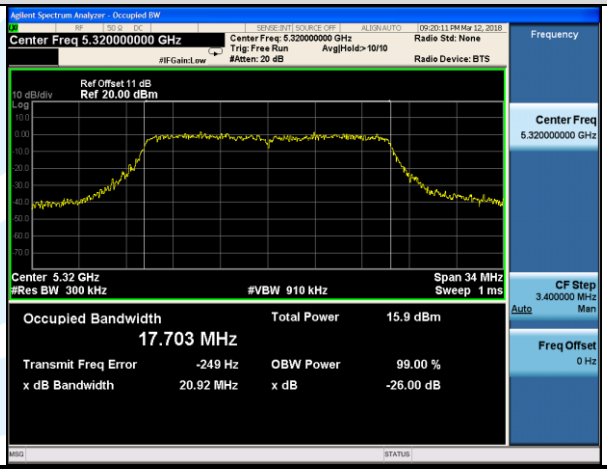
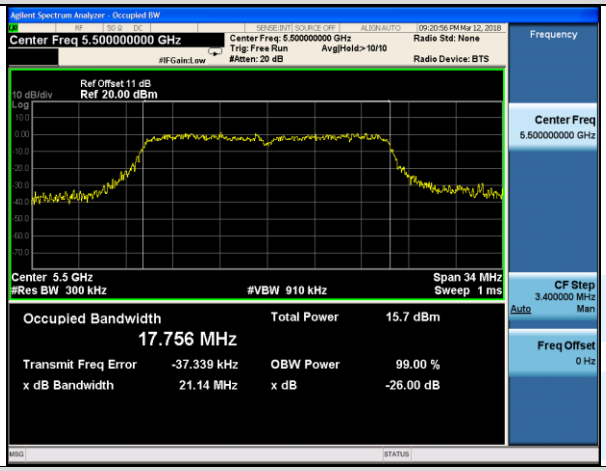
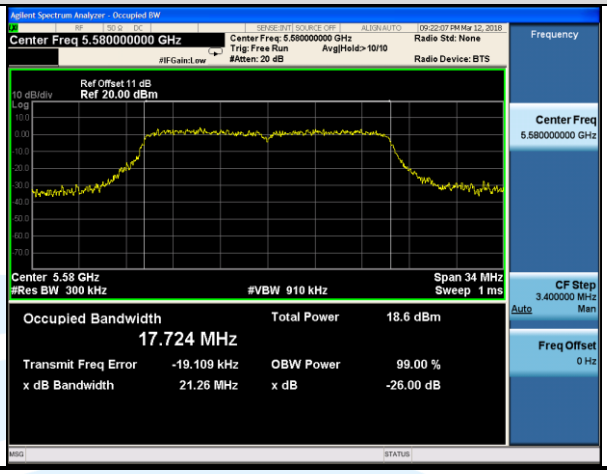
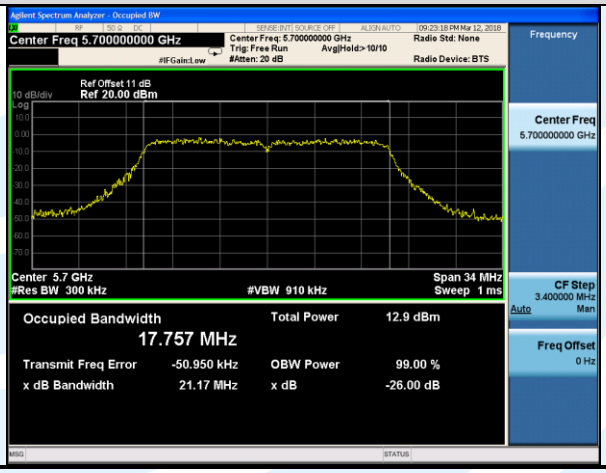
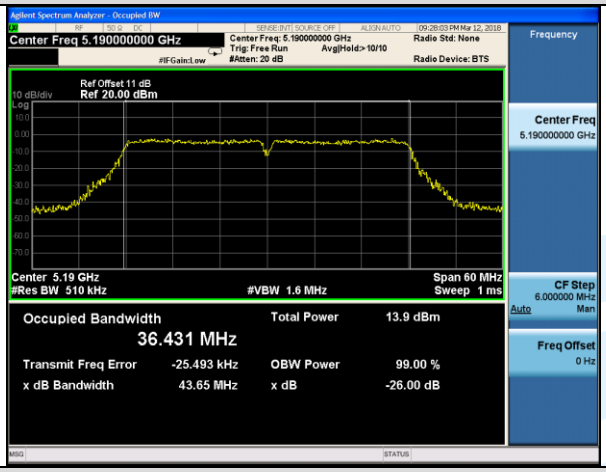
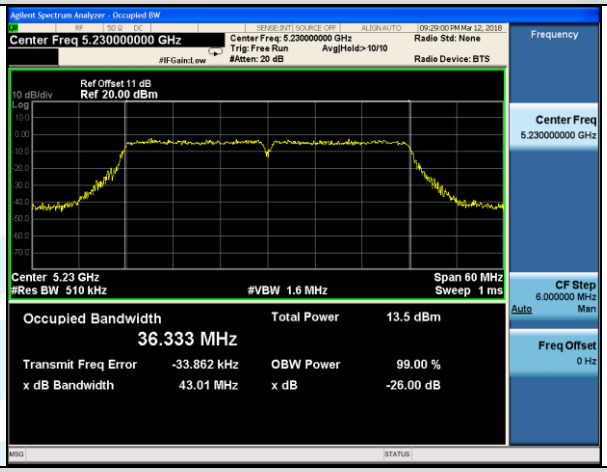
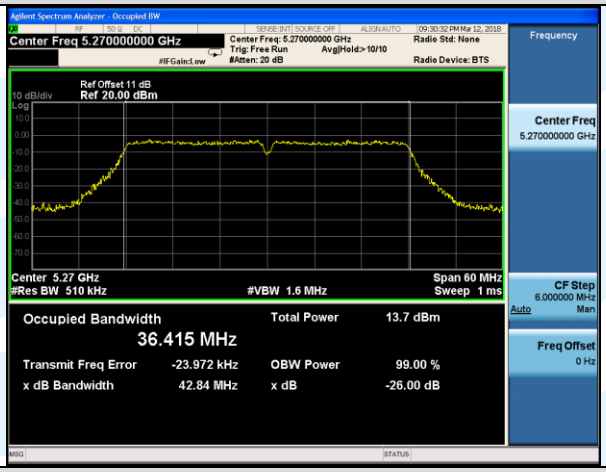
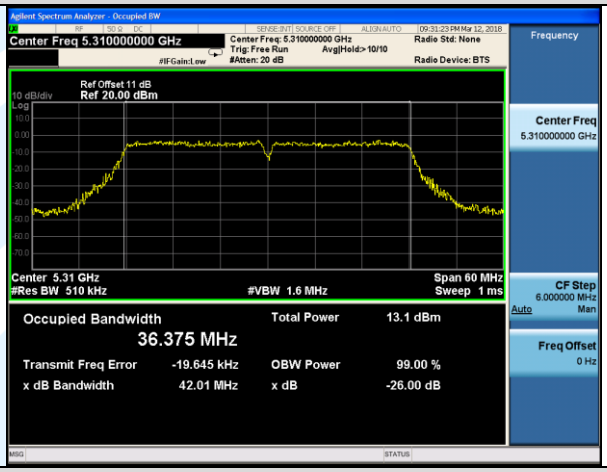
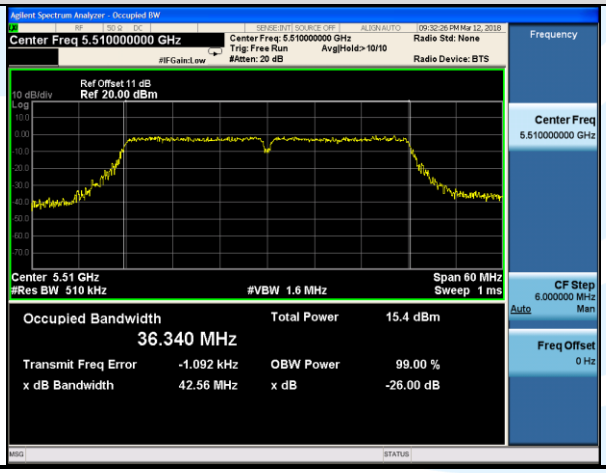
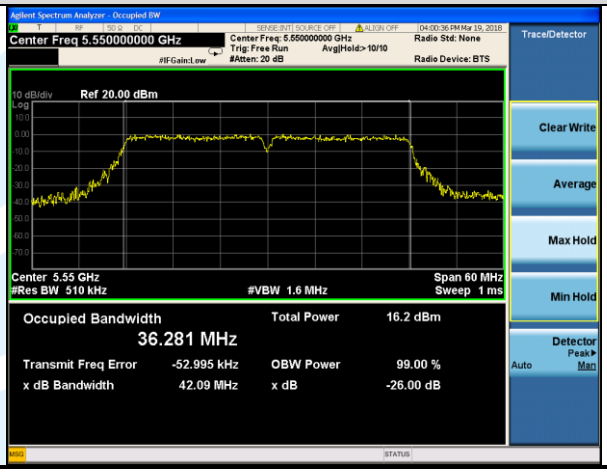
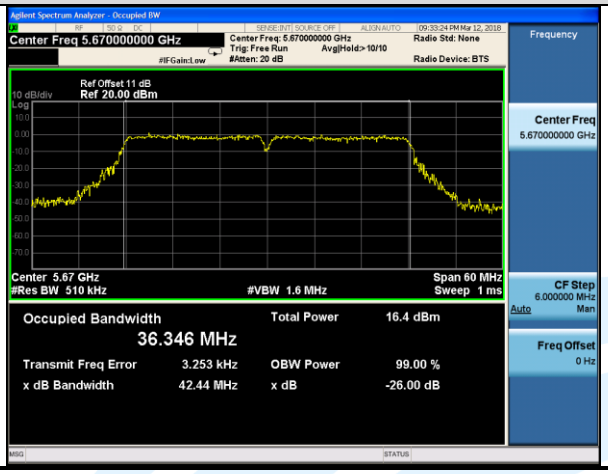
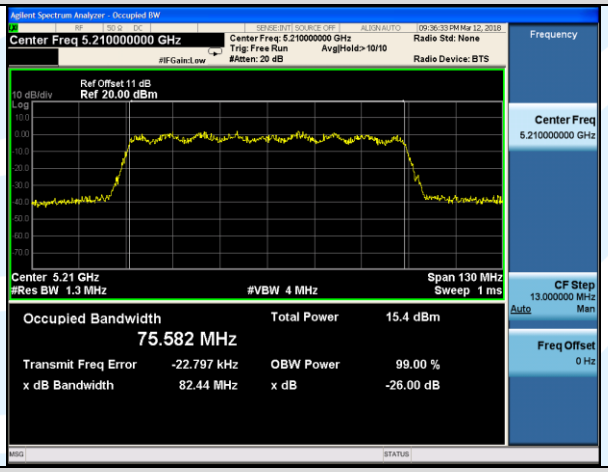
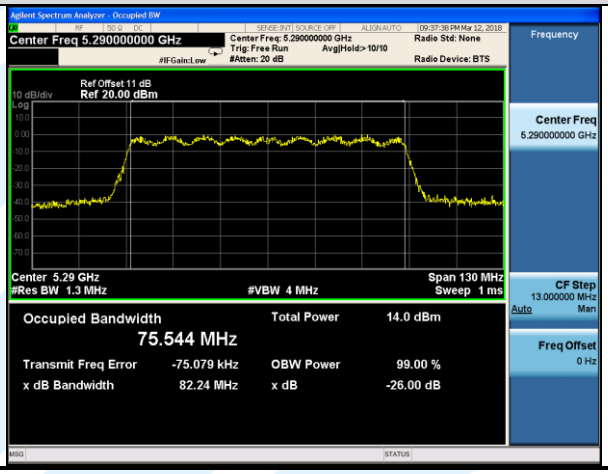
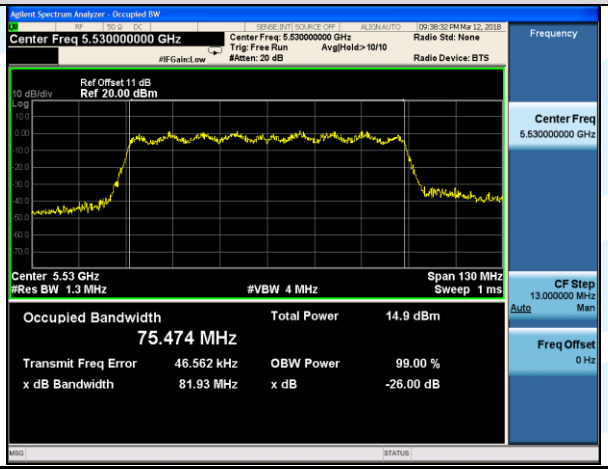
	

Channel 100	Channel 116
	

Channel 140


IEEE 802.11n-HT40	
Channel 38	Channel 46
	
Channel 54	Channel 62
	
Channel 102	Channel 110
	

Channel 134


IEEE 802.11ac-VHT80	
Channel 42	Channel 58
	
Channel 106	
	

5.4 MAXIMUM CONDUCTED OUTPUT POWER OR E.I.R.P

Test Requirement: FCC 47 CFR Part 15 Subpart E Section 15.407 (a)(1)(2)(3)
Test Method: KDB 789033 D02 v02r01 Section E.3.a(Method PM)
Limits: FCC 47 CFR Part 15 Subpart E

1. For the band 5.15-5.25 GHz.
   (i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

   (ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

   (iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

   (iv) For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2. For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure:
1. Connected the EUT's antenna port to measure device by 10dB attenuator.
2. Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of Tx on burst.

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

Test Setup: Refer to section 4.5.3 for details.
Instruments Used: Refer to section 3 for details
Test Mode: Transmitter mode
Test Results: Pass
Test Data:

Directional gain and the maximum output power limit.

FCC 47 CFR Part 15 Subpart E

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Max Conducted Power Limits (dBm)
U-NII-1	3.20	3.20	6.21	23.79
U-NII-2A	3.40	3.40	6.41	23.59
U-NII-2C	5.36	5.36	8.37	21.63
Unequal antenna gains, with equal transmit powers. Directional gain is to be computed as follows:				
If transmit signals are correlated, then				
Directional gain = 10 log[(10^G1 /20 + 10^G2 /20 + … + 10^GN /20)^2 /NANT] dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]				

Frequency band 5150-5250 MHz

FCC 47 CFR Part 15 Subpart E:

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Total Power Chain 0+1 (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1			
IEEE 802.11a (CDD)	36 (5180)	9.53	9.33	12.44	23.79	Pass
	44 (5220)	9.34	8.95	12.16	23.79	Pass
	48 (5240)	8.97	8.79	11.89	23.79	Pass
IEEE 802.11n-HT20 (MIMO)	36 (5180)	8.51	7.87	11.21	23.79	Pass
	44 (5220)	8.40	7.73	11.09	23.79	Pass
	48 (5240)	8.23	6.89	10.62	23.79	Pass
IEEE 802.11n-HT40 (MIMO)	38 (5190)	6.65	6.76	9.72	23.79	Pass
	46 (5230)	6.46	6.62	9.55	23.79	Pass
IEEE 802.11ac-VHT80 (MIMO)	42 (5210)	6.46	6.44	9.46	23.79	Pass

Remark:

1. Maximum conducted output power = Conducted output power + Duty Cycle Factor
2. Total Power (Chain 0+1) = $10*\log[(10^{\text{Chain 0}/10})+(10^{\text{Chain 1}/10})]$

Frequency band 5250-5350 MHz

FCC 47 CFR Part 15 Subpart E:

For IEEE 802.11 a/n/ac, the minimum 26 dB emission bandwidth is 20.61 MHz

11 dBm + $10\log_{10}$ (20.61) = 24.14 dBm > 23.59 dBm

So the 23.59 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Total Power Chain 0+1 (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1		FCC Part 15E	
IEEE 802.11a (CDD)	52 (5260)	9.45	8.87	12.18	23.59	Pass
	60 (5300)	9.23	8.67	11.97	23.59	Pass
	64 (5320)	8.89	8.64	11.78	23.59	Pass
IEEE 802.11n-HT20 (MIMO)	52 (5260)	9.44	7.83	11.72	23.59	Pass
	60 (5300)	9.27	7.26	11.39	23.59	Pass
	64 (5320)	8.84	6.99	11.02	23.59	Pass
IEEE 802.11n-HT40 (MIMO)	54 (5270)	6.55	6.54	9.56	23.59	Pass
	62 (5310)	6.73	6.39	9.57	23.59	Pass
IEEE 802.11ac-VHT80 (MIMO)	58 (5290)	6.27	6.37	9.33	23.59	Pass

Frequency bands 5470-5725 MHz (Not including 5600-5650 MHz)

FCC 47 CFR Part 15 Subpart E:

For IEEE 802.11 a/n/ac, the minimum 26 dB emission bandwidth is 20.63 MHz

11 dBm + $10\log_{10}$ (20.63) = 24.14 dBm > 24 dBm

So the 24.00 dB limit applicable

Mode	Channel/ Frequency (MHz)	Maximum conducted output power (dBm)		Total Power Chain 0+1 (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1		FCC Part 15E	
IEEE 802.11a (CDD)	100 (5500)	8.85	6.85	10.97	21.63	Pass
	116 (5580)	8.26	7.65	10.98	21.63	Pass
	140 (5700)	7.92	7.27	10.62	21.63	Pass
IEEE 802.11n-HT20 (MIMO)	100 (5500)	8.79	6.93	10.97	21.63	Pass
	116 (5580)	8.69	7.18	11.01	21.63	Pass
	140 (5700)	8.83	7.31	11.15	21.63	Pass
IEEE 802.11n-HT40 (MIMO)	102 (5510)	6.36	6.27	9.33	21.63	Pass
	110 (5550)	6.55	6.34	9.46	21.63	Pass
	134 (5670)	6.48	6.75	9.63	21.63	Pass
IEEE 802.11ac-VHT80 (MIMO)	106 (5530)	6.33	6.52	9.44	21.63	Pass