RADIO TEST REPORT

Product	:	35b & G.Fast Security Router
Model Name	:	Vigor2866FVax
Series Model	:	Refer to Ch.6.1
FCC ID	:	VGY2865AX
Test Regulation	:	FCC 47 CFR Part 15 Subpart E (Section 15.407)
Received Date	:	Jul. 7, 2020
Test Date	:	Sep. 10, 2020 ~ Dec. 25, 2020
Issued Date	:	Mar. 31, 2021
Applicant	:	DrayTek Corp. No.26 Fu Shing Rd., HuKou County, Hsin-Chu Industrial Park, Hsin-Chu, Taiwan 303 R.O.C
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Testing Laboratory
3398

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REVISION HISTORY

Original Test Report No.: 4789400505B-US-R1-V0

Rev.	Test report No.	Date	Page revised	Contents
Original	4789400505B-US-R1-V0	Mar. 31, 2021	-	Initial issue

Table Of Contents

1. Attestation of Test Results

APPLICANT:	DrayTek Corp. No.26 Fu Shing Rd., HuKou County, Hsin-Chu Industrial Park, Hsin-Chu, Taiwan 303 R.O.C
MANUFACTURER	DrayTek Corp. No.26 Fu Shing Rd., HuKou County, Hsin-Chu Industrial Park, Hsin-Chu, Taiwan 303 R.O.C
EUT DESCRIPTION:	35b & G.Fast Security Router
BRAND:	DrayTek
MODEL:	Vigor2866FVax
SERIES MODEL:	Refer to Ch.6.1
SAMPLE STAGE:	Engineering sample
DATE of TESTED:	Sep. 10, 2020 ~ Dec. 25, 2020

APPLICABLE STANDARDS	
STANDARD	**Test Results**
FCC 47 CFR PART 15 Subpart E (Section 15.407)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

Sally Lu Date : Mar. 31, 2021
Project Handler

Approved and Authorized By:

Mike Cai Date : Mar. 31, 2021
Engineer Project Associate

2. Summary of Test Results

Summary of Test Results		
FCC Clause	**Test Items**	**Result**
15.407(e)	6dB Bandwidth	PASS
15.403(i)	26dB Bandwidth	PASS
2.1049	Occupied Bandwidth	See Note2
15.407(a)(1/3)	Conducted Output Power	PASS
15.407(a)(1/3)	Power Spectral Density	PASS
15.407(g)	Frequency Stability	PASS
15.407(b) (1/4(i/ii)/6)	Radiated Emissions and Band Edge Measurement	PASS
15.407(b)(6)	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS

Note:
1. For the Radiated Band Edge and OOBE test plots were recorded in Appendix I, the Radiated Emissions test plots were recorded in Appendix II.
2. The Occupied Bandwidth was reference only.

3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB 789033 D02 General UNII Test Procedure New Rules v02r01, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013 and KDB 662911 D01 Multiple Transmitter Output v02r01.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398. The full scope of accreditation can be viewed at http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398

5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor k=2.

Test Item	Measurement Frequency Range	K	U(dB)
Conducted disturbance at mains terminals ports	0.15MHz ~ 30MHz	2	1.5
RF Conducted	9 kHz - 40GHz	2	1.0
Radiated disturbance below 30MHz	9 kHz - 30 MHz	2	1.9
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	2	5.4
Radiated disturbance above 1GHz	1GHz ~ 40GHz	2	4.7

6. Equipment under Test

6.1. Description of EUT

Product	35b & G.Fast Security Router	
Brand Name	DrayTek	
Model Name	Vigor2866FVax	
Series Model	Vigor2865ax, Vigor2865Vax, Vigor2865Fax, Vigor2865FVax, Vigor2866ax, Vigor2866Vax, Vigor2866Fax, Vigor2927ax, Vigor2927Vax, Vigor2927Fax, Vigor2927FVax, Vigor2923ax, Vigor2923Vax, Vigor2923Fax, Vigor2923FVax, Vigor2925ax, Vigor2925Vax, Vigor2925Fax, Vigor2925FVax, Vigor2926_v1ax, Vigor2926_v1Vax, Vigor2926_v1Fax, Vigor2926_v1FVax	
S/N	2031449BC0800C8	
Operating Frequency	5180 ~ 5240 MHz 5745 ~ 5825 MHz	
Modulation	1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK	
Transfer Rate	802.11a: up to 54 Mbps 802.11n: up to MCS15 802.11ac: up to MCS9 802.11ax: up to HE11	
Number of Channel	5180 ~ 5240 MHz	4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)
	5745 ~ 5825 MHz	5 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)

Maximum Output Power	Non-Beamforming Mode: 5180 ~ 5240 MHz: 26.95 dBm 5745 ~ 5825 MHz: 28.21 dBm Beamforming Mode: 5180 ~ 5240 MHz: 17.38 dBm 5745 ~ 5825 MHz: 25.48 dBm
Normal Voltage	12Vdc from adapter

Note:

1. The models difference table as below:

Main Model Name	DSL	G. fast	SFP	WWAN	LAN	Wi-Fi 2.4G	Wi-Fi 5G	FXS
Vigor2866FVax	VDSL2/35b	V	V	-	Eth/RJ45x5	V	V	V
Series Model Name	**DSL**	**G. fast**	**SFP**	**WWAN**	**LAN**	**Wi-Fi 2.4G**	**Wi-Fi 5G**	**FXS**
Vigor2865ax	VDSL2/35b	-	-	-	Eth/RJ45x6	V	V	-
Vigor2865Vax	VDSL2/35b	-	-	-	Eth/RJ45x6	V	V	V
Vigor2865Fax	VDSL2/35b	-	V	-	Eth/RJ45x5	V	V	-
Vigor2865FVax	VDSL2/35b	-	V	-	Eth/RJ45x5	V	V	V
Vigor2866ax	VDSL2/35b	V	-	-	Eth/RJ45x6	V	V	-
Vigor2866Vax	VDSL2/35b	V	-	-	Eth/RJ45x6	V	V	V
Vigor2866Fax	VDSL2/35b	V	V	-	Eth/RJ45x5	V	V	-
Vigor2927ax	-	-	-	-	Eth/RJ45x6	V	V	-
Vigor2927Vax	-	-	-	-	Eth/RJ45x6	V	V	V
Vigor2927Fax	-	-	V	-	Eth/RJ45x6	V	V	-
Vigor2927FVax	-	-	V	-	Eth/RJ45x6	V	V	V
Vigor2923ax	-	-	-	-	Eth/RJ45x6	V	V	-
Vigor2923Vax	-	-	-	-	Eth/RJ45x6	V	V	V
Vigor2923Fax	-	-	V	-	Eth/RJ45x6	V	V	-
Vigor2923FVax	-	-	V	-	Eth/RJ45x6	V	V	V
Vigor2925ax	-	-	-	-	Eth/RJ45x6	V	V	-
Vigor2925Vax	-	-	-	-	Eth/RJ45x6	V	V	V
Vigor2925Fax	-	-	V	-	Eth/RJ45x6	V	V	-
Vigor2925FVax	-	-	V	-	Eth/RJ45x6	V	V	V
Vigor2926_v1ax	-	-	-	-	Eth/RJ45x6	V	V	-
Vigor2926_v1Vax	-	-	-	-	Eth/RJ45x6	V	V	V
Vigor2926_v1Fax	-	-	V	-	Eth/RJ45x6	V	V	-
Vigor2926_v1FVax	-	-	V	-	Eth/RJ45x6	V	V	V

Note:

The above model are declared by manufacturer for market segmentation that difference between main model and the series model is the combination of hardware design and appearance, there is nothing changed to RF related part that does not affect the RF characteristics.

2. The EUT incorporates a MIMO function. Physically, the EUT provides two completed transmitters and two receivers.

Modulation Mode	Tx,Rx Function
802.11a	2TX,2RX
802.11n (HT20)	2TX,2RX
802.11n (HT40)	2TX,2RX
802.11ac (VHT20)	2TX,2RX
802.11ac (VHT40)	2TX,2RX
802.11ac (VHT80)	2TX,2RX
802.11ax (HE20)	2TX,2RX
802.11ax (HE40)	2TX,2RX
802.11ax (HE80)	2TX,2RX

* The modulation and bandwidth are similar for 802.11n mode for HT20 / HT40 and 802.11ac mode for VHT20 / VHT40 / VHT80 and 802.11ax mode for HE20 / HE40 / HE80, therefore investigated worst case to representative mode in test report.

3. The EUT contains following accessory devices

Product	Brand	Model	Description	Remark
AC adapter 1	Channel Well Technology	2ABN036F	Input: 100-240Vac, 1.0A Output:12Vdc, 3A Length: 1.5m	Optional
AC adapter 2	Channel Well Technology	2ABL030F	Input: 100-240Vac, 1.0A Output:12Vdc, 2.5A Length: 1.5m	Optional
AC adapter 3	Channel Well Technology	2ABL024F	Input: 100-240Vac, 0.8A Output:12Vdc, 2A Length: 1.5m	Optional
RJ-45 Cable (Ethernet)	Tung-Li	5U422-20	Length: 3meter, non-shielded cable	-
RJ-11 Cable	N/A	N/A	Length: 1.8meter, non-shielded cable, 6P4C	-

4. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

6.2. Channel List

FOR 5180 ~ 5240MHz

4 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
36	5180 MHz	44	5220 MHz
40	5200 MHz	48	5240 MHz

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40):

Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz

1 channel is provided for 802.11ac (VHT80), 802.11ax (HE80):

Channel	Frequency
42	5210MHz

FOR 5745 ~ 5825MHz:

5 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20):

Channel	Frequency	Channel	Frequency
149	5745MHz	161	5805MHz
153	5765MHz	165	5825MHz
157	5785MHz	-	-

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40), 802.11ax (HE40):

Channel	Frequency	Channel	Frequency
151	5755MHz	159	5795MHz

1 channel is provided for 802.11ac (VHT80), 802.11ax (HE80):

Channel	Frequency
155	5775MHz

6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	22~24°C / 59~69%RH	120Vac / 60 Hz	Sep. 17, 2020 ~ Dec. 25, 2020	WaterNil Guan
Radiated Spurious Emission	966-2	20~26°C / 63~70%RH	120Vac / 60 Hz	Sep. 10, 2020 ~ Dec. 22, 2020	WaterNil Guan
AC power Line Conducted Emission	SR1	22~24°C / 58~62%RH	120Vac / 60 Hz	Dec. 24, 2020 ~ Dec. 25, 2020	Patrick Kuan

FCC Test Firm Registration Number: 498077

6.4. Description Of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Antenna Type	Maximum Gain (dBi)
1	Chain (0)+(1)	Walsin	RFDPA131300SBLB805	Dipole	3.9
2	Chain (0)+(1)	Walsin	RFDPA131300SBLB806	Dipole	3.9
3	Chain (0)+(1)	Angeei	DPD2430SRW	Dipole	3.5
4	Chain (0)+(1)	Angeei	DPD2430SRB	Dipole	3.5

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual. The antenna RFDPA131300SBLB805 is the worst case. Therefore, all of the test items are represented by this model.

6.5. Test Mode Applicability and Tested Channel Detail

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- The fundamental of the EUT was investigated in three orthogonal axes XY/YZ/XZ, it was determined that XY axis was worst-case . Therefore, all final radiated testing was performed with the EUT in XY axis.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For AC power line conducted emissions, the pre-scan has been determined by 2ABL030F adapter of AC power 120Vac/60Hz (worst case)
- Pre-scan radiation has been determined by the Model: Vigor2866FVax (the worst case).

Non-Beamforming Mode

Test item	Mode	Frequency Band (MHz)	Modulation Technology	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11a	5180-5240 5745-5825	OFDM	36 to 48 149 to 165	36, 44, 48 149, 157, 165	6Mbps
	802.11ax (HE20)		OFDMA	36 to 48 149 to 165	36, 44, 48 149, 157, 165	MCS0
	802.11ax (HE40)		OFDMA	38 to 46 151 to 159	38, 46 151, 159	MCS0
	802.11ax (HE80)		OFDMA	42, 155	42, 155	MCS0
Radiated Emissions (Below 1GHz)	802.11a	5180-5240 5745-5825	OFDM	36 to 48 149 to 165	149	MCS0
AC Power Line Conducted Emission	802.11a	5180-5240 5745-5825	OFDM	36 to 48 149 to 165	149	MCS0
Antenna Port Conducted Measurement	802.11a	5180-5240 5745-5825	OFDM	36 to 48 149 to 165	36, 44, 48 149, 157, 165	6Mbps
	802.11ax (HE20)		OFDMA	36 to 48 149 to 165	36, 44, 48 149, 157, 165	MCS0
	802.11ax (HE40)		OFDMA	38 to 46 151 to 159	38, 46 151, 159	MCS0
	802.11ax (HE80)		OFDMA	42, 155	42, 155	MCS0

Beamforming Mode

Test item	Mode	Frequency Band (MHz)	Modulation Technology	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11ax (HE20)	5180-5240 5745-5825	OFDMA	36 to 48 149 to 165	36, 44, 48 149, 157, 165	MCS0
	802.11ax (HE40)		OFDMA	38 to 46 151 to 159	38, 46 151, 159	MCS0
	802.11ax (HE80)		OFDMA	42, 155	42, 155	MCS0
Radiated Emissions (Below 1GHz)	802.11ax (HE20)	5180-5240 5745-5825	OFDMA	38 to 46 151 to 159	159	MCS0
Antenna Port Conducted Measurement	802.11ax (HE20)	5180-5240 5745-5825	OFDMA	36 to 48 149 to 165	36, 44, 48 149, 157, 165	MCS0
	802.11ax (HE40)		OFDMA	38 to 46 151 to 159	38, 46 151, 159	MCS0
	802.11ax (HE80)		OFDMA	42, 155	42, 155	MCS0

Co-Location Mode

Non-Beamforming Mode

Test item	Mode	Modulation Technology	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions	802.11b	DSSS	DBPSK	1 to 11	11+149	1Mbps
	802.11a	OFDM	BPSK	36 to 48 149 to 165		6Mbps

Beamforming Mode

Test item	Mode	Modulation Technology	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions	802.11ax(HE20)	OFDMA	BPSK	1 to 11	6+165	MCS0
	802.11ax(HE20)	OFDMA	BPSK	36 to 48 149 to 165		MCS0

6.6. Duty cycle

Non-Beamforming Mode

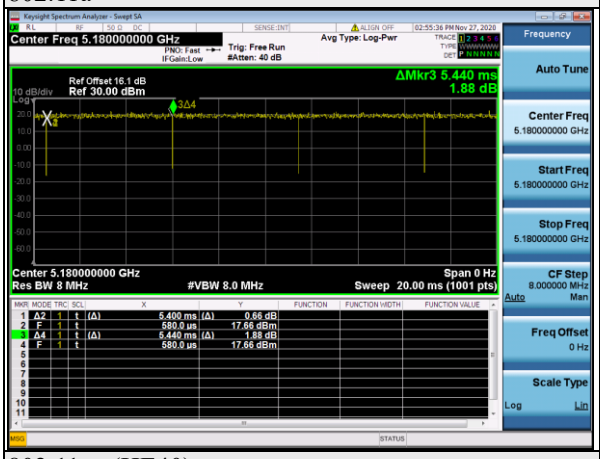
802.11a: Duty cycle = 5.4/5.44 = 0.993, duty cycle of test signal is ≥ 98 %, duty factor is not required.

802.11ax (HE20): Duty cycle of test signal is 100 %, duty factor is not required.

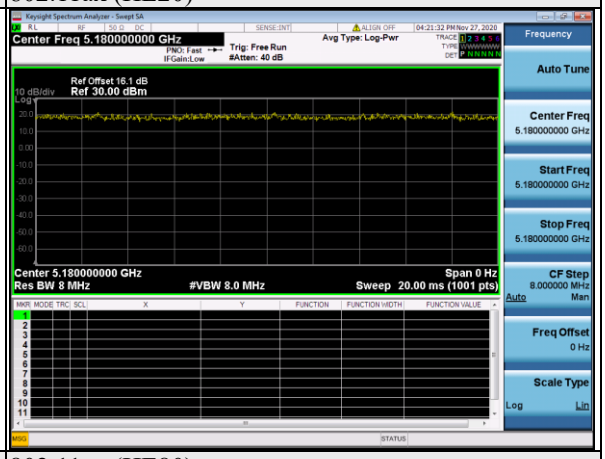
802.11ax (HE40): Duty cycle = 7.74/7.78 = 0.995, duty cycle of test signal is ≥ 98 %, duty factor is not required.

802.11ax (HE80): Duty cycle = 2.86/2.9 = 0.986, duty cycle of test signal is ≥ 98 %, duty factor is not required.

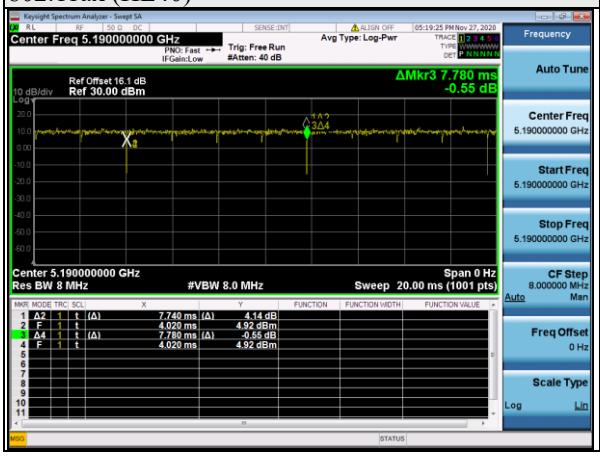
802.11a



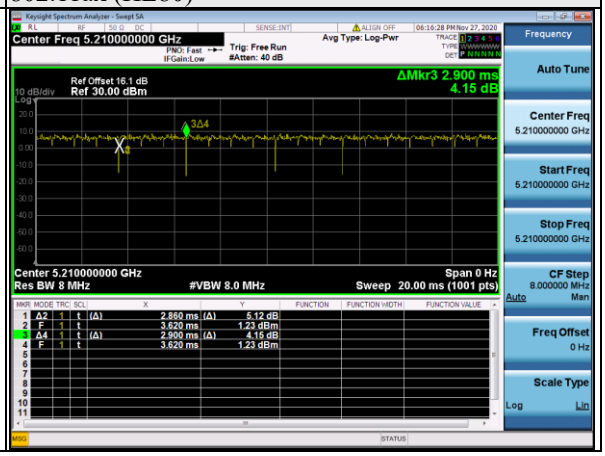
802.11ax (HE20)



802.11ax (HE40)



802.11ax (HE80)



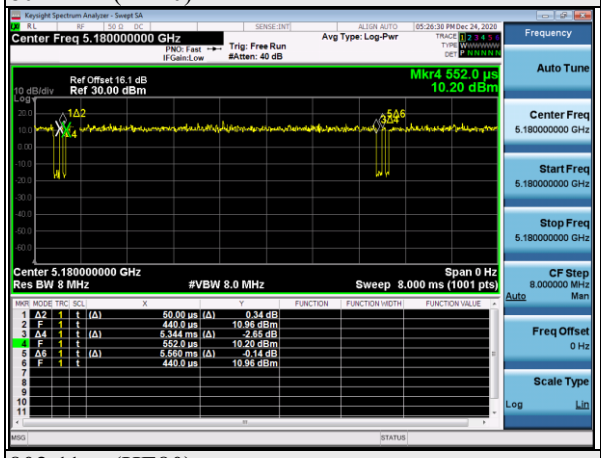
Beamforming Mode

802.11ax (HE20): Duty cycle = 5.394/5.56 = 0.97, Duty factor = 10 * log(1/0.97) = 0.13

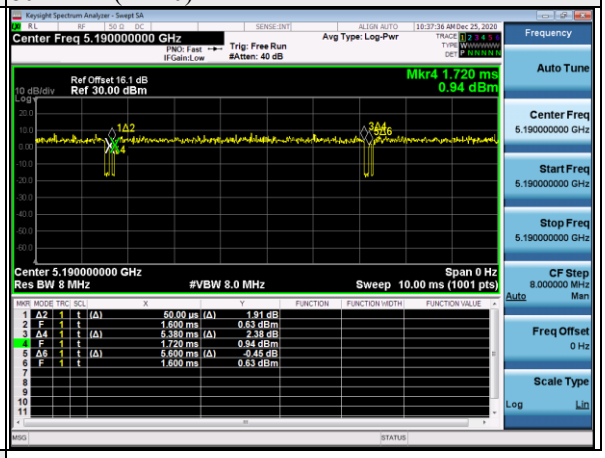
802.11ax (HE40): Duty cycle = 5.43/5.6 = 0.97, Duty factor = 10 * log(1/0.97) = 0.13

802.11ax (HE80): Duty cycle = 5.4/5.5 = 0.982, duty cycle of test signal is ≥ 98 %, duty factor is not required.

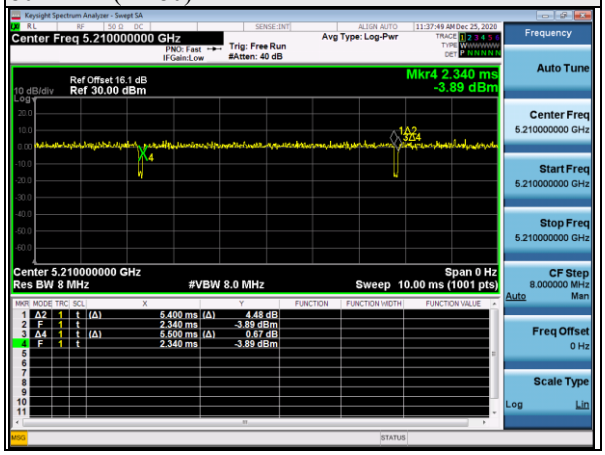
802.11ax (HE20)



802.11ax (HE40)



802.11ax (HE80)



7. Test Equipment

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2019/11/13	2020/11/12
				2020/11/11	2021/11/10
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2019/12/17	2020/12/16
				2020/12/11	2021/12/10
Loop Antenna	ETS lindgren	6502	00213440	2019/12/19	2020/12/18
				2020/12/25	2021/12/24
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2020/1/3	2021/1/2
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2020/1/3	2021/1/2
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2019/12/27	2020/12/26
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2020/6/9	2021/6/8
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2020/2/4	2021/2/2
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2020/5/19	2021/5/18
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2020/7/2	2021/7/1
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2020/1/8	2021/1/7

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	2019/11/6	2020/11/5
				2020/11/6	2021/11/5
Pulse Power Sensor	Anritsu	MA2411B	1531202	2019/12/23	2020/12/22
				2020/12/21	2021/12/20
Power Meter	Anritsu	ML2495A	1645002	2019/12/23	2020/12/22
				2020/12/21	2021/12/20
Temperature &Humidity Test Chamber	GIANT FORCE	GTH-150-40-CP-AR	MAA1701-010	2020/3/23	2021/3/22
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2020/11/17	2021/11/16
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2020/8/19	2021/8/18
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2020/8/12	2021/8/11
Cables	HARBOUR INDUSTRIES	LL142	170205-5000-1	2020/2/5	2021/2/4

UL Software		
Description	**Name**	**Version**
Radiated measurement	EZ_EMC	1.1.4.2
Conducted measurement	Keysight.TestSystem	1.0.0.0
AC power Line Conducted Emission	EZ_EMC	1.1.4.2

8. Description of Test Setup

Support Equipment

Equipment	Brand Name	Model Name	S/N	Remark
Notebook	DELL	Latitude E5470	3JFKWF2	N/A
Notebook	DELL	Latitude E5470	JVSKWF2	N/A
Connector	N/A	N/A	N/A	RJ-45 to RJ-45
USB Device	Transcend	N/A	N/A	8GB
Fiber Module	Fiberpon	SFP+10G-T	N/A	N/A
Rx Device (BF Client)	ASUS	RT-AX88U	K6ITHP000052	MSQ-RTAXHP00

I/O Cables

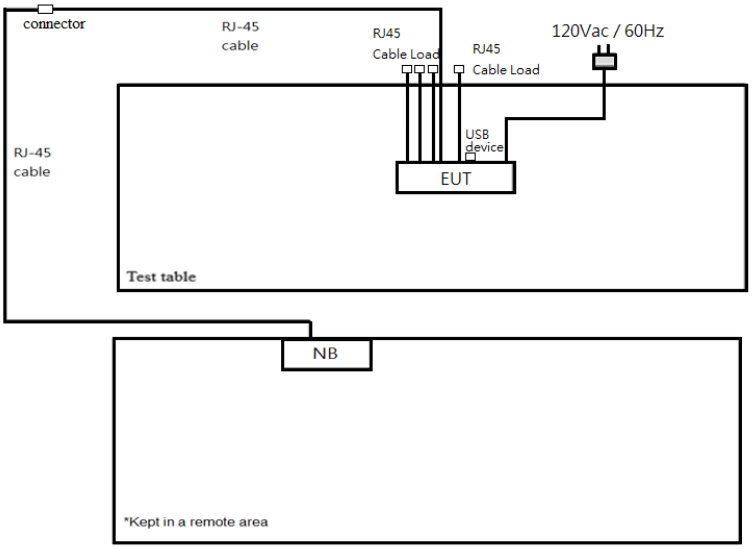
Equipment	Brand Name	Model Name	S/N	Remark
RJ-45 cable	Fastlink	FL-61STU-04	N/A	Length : 10m
RJ-45 cable	Fastlink	FL-61STU-04	N/A	Length : 1.5m
RJ-45 cable	Fastlink	FL-61STU-04	N/A	Length : 1.5m
RJ-45 cable	Fastlink	FL-61STU-04	N/A	Length : 1.5m
RJ-45 cable	Fastlink	FL-61STU-04	N/A	Length : 1.5m
RJ-45 cable	Fastlink	FL-61STU-04	N/A	Length : 1.5m

Test Setup

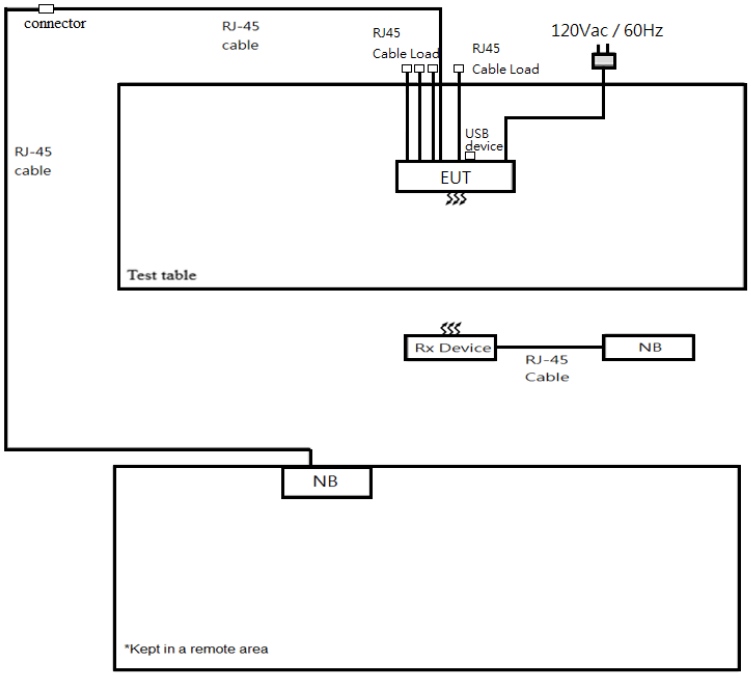
Controlled using a bespoke application (DUT GUI Version 6.10.26) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

Setup Diagram for Test

Non-Beamforming Mode



Beamforming Mode



9. Test Results

9.1. 6dB Bandwidth

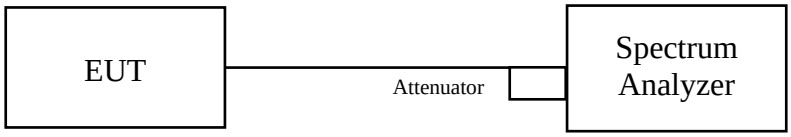
Requirements

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

Test procedure

a. Set resolution bandwidth (RBW) = 100kHz
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Sweep = auto couple.
e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	16.32	16.5	0.5	Pass
157	5785	16.47	16.35	0.5	Pass
165	5825	16.41	16.38	0.5	Pass

802.11ax (HE20)

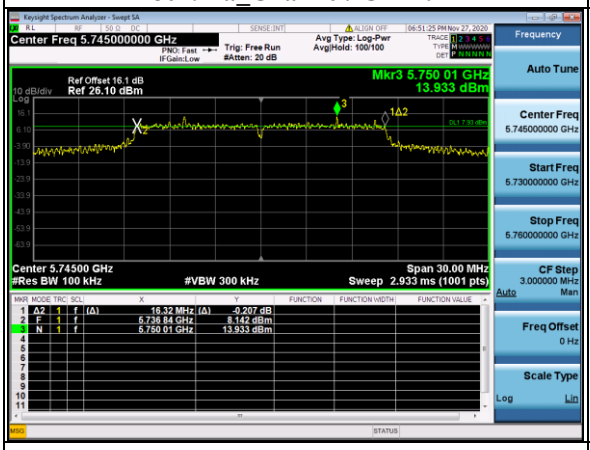
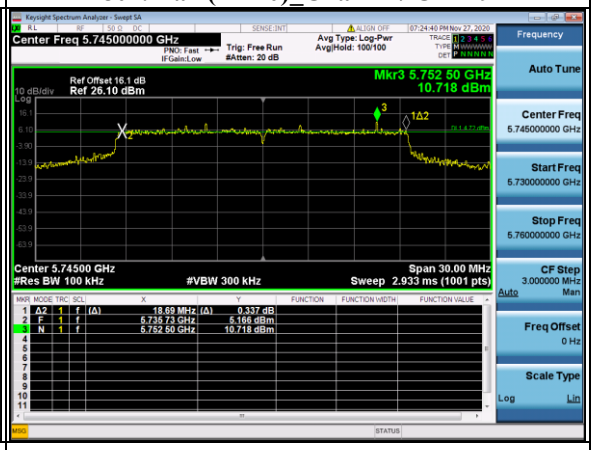
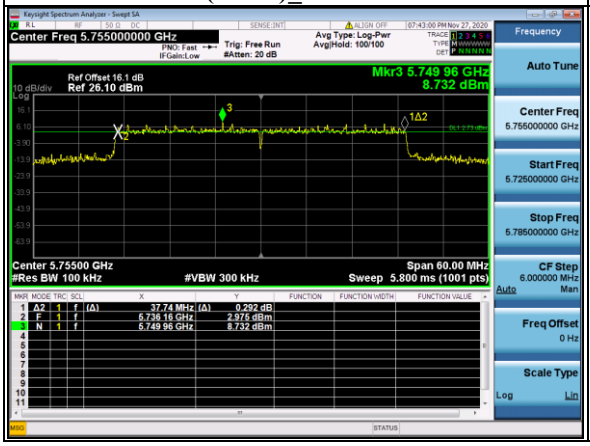
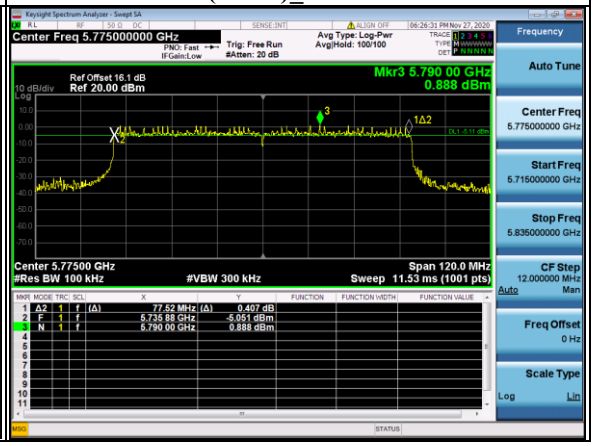
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	19.02	18.69	0.5	Pass
157	5785	18.96	18.99	0.5	Pass
165	5825	18.75	18.84	0.5	Pass

802.11ax (HE40)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
151	5755	37.74	38.04	0.5	Pass
159	5795	38.1	38.1	0.5	Pass

802.11ax (HE80)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
155	5775	78	77.52	0.5	Pass

Spectrum Plot of Worst Value	
802.11a_Chain 0 / CH149	**802.11ax (HE20)_Chain 1 / CH149**
	
802.11ax (HE40)_Chain 0 / CH151	**802.11ax (HE80)_Chain 1 / CH155**
	

Beamforming Mode

802.11ax (HE20)

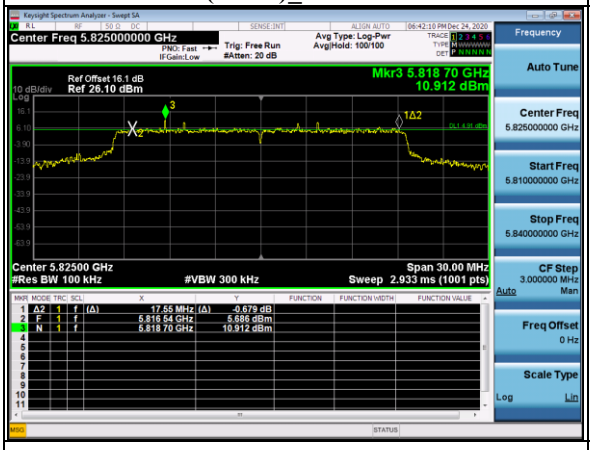
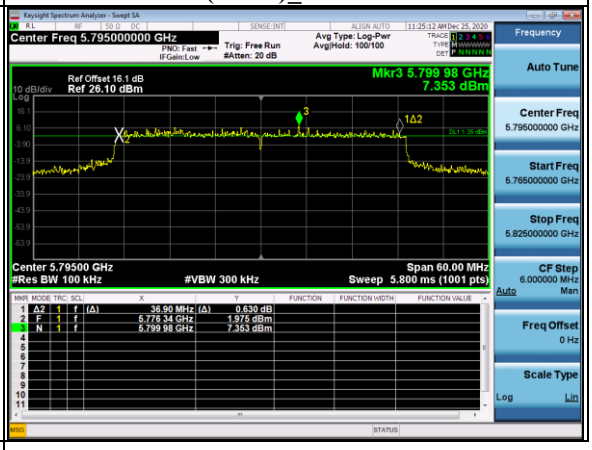
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
149	5745	18.81	18.81	0.5	Pass
157	5785	18.9	18.78	0.5	Pass
165	5825	17.91	17.55	0.5	Pass

802.11ax (HE40)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
151	5755	37.98	37.8	0.5	Pass
159	5795	37.44	36.9	0.5	Pass

802.11ax (HE80)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
155	5775	77.76	77.64	0.5	Pass

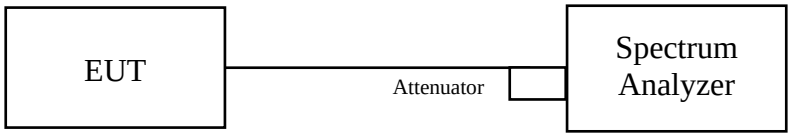
Spectrum Plot of Worst Value	
802.11ax (HE20)_Chain 1 / CH165	**802.11ax (HE40)_Chain 1 / CH159**
	
802.11ax (HE80)_Chain 1 / CH155	
	

9.2. 26dB Bandwidth

Test procedure

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%.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	24.49	23.51
44	5220	30	29.79
48	5240	30	30

802.11ax (HE20)

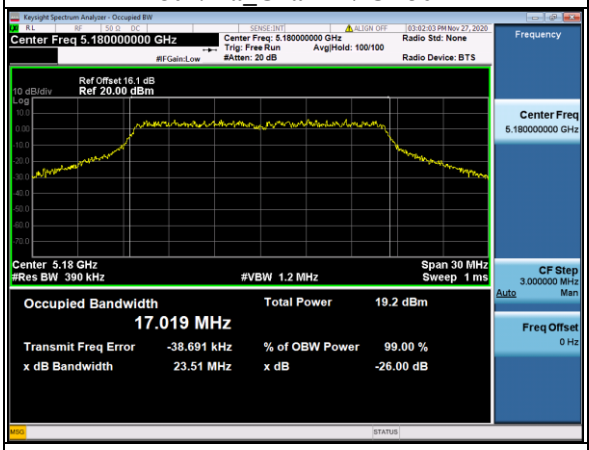
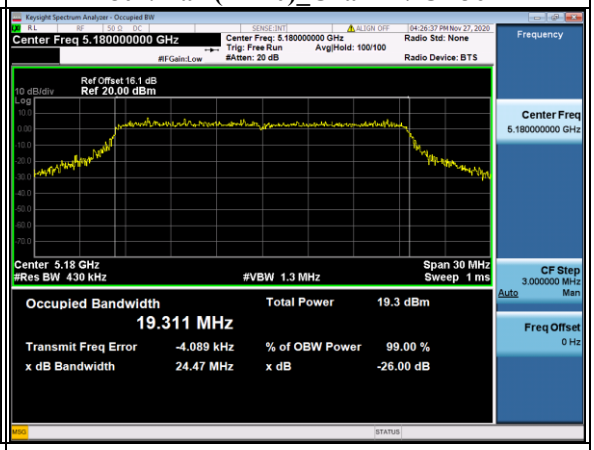
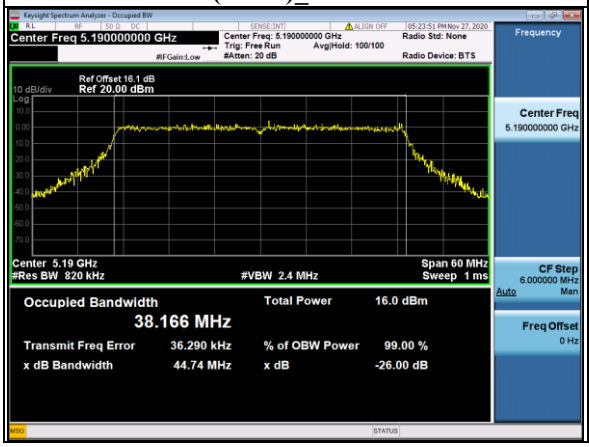
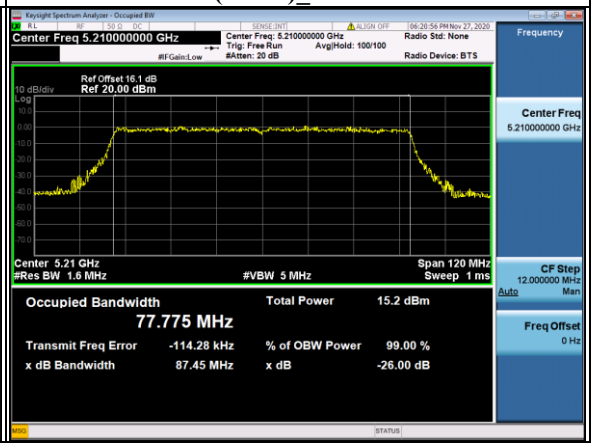
CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	25.23	24.47
44	5220	29.98	29.32
48	5240	30	29.22

802.11ax (HE40)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
38	5190	45.5	44.74
46	5230	46.83	45.45

802.11ax (HE80)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
42	5210	88.68	87.45

Spectrum Plot of Worst Value	
802.11a_Chain 1 / CH36	**802.11ax (HE20)_Chain 1 / CH36**
	
802.11ax (HE40)_Chain 1 / CH38	**802.11ax (HE80)_Chain 1 / CH42**
	

Beamforming Mode

802.11ax (HE20)

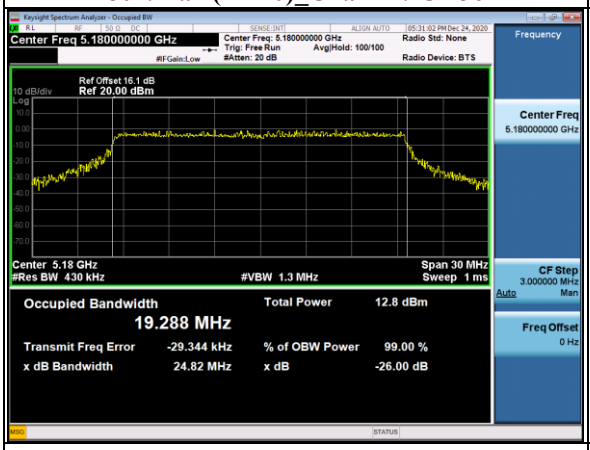
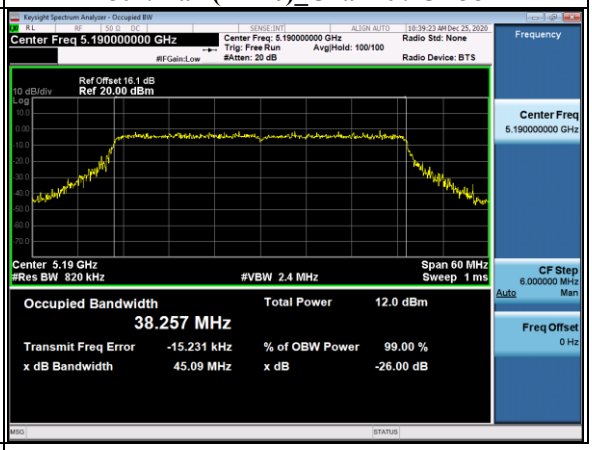
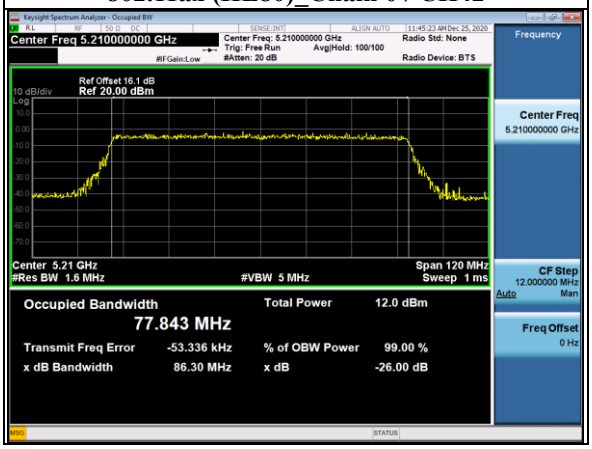
CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	26.15	24.82
44	5220	27.79	26.02
48	5240	26.48	25.06

802.11ax (HE40)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
38	5190	45.09	45.41
46	5230	45.93	45.16

802.11ax (HE80)

CHANNEL	CHANNEL FREQUENCY (MHz)	26 dB Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
42	5210	86.3	88.31

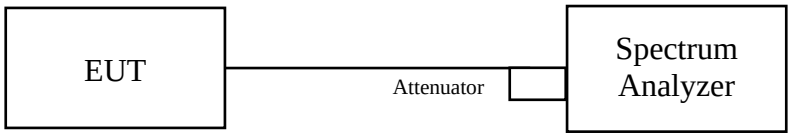
Spectrum Plot of Worst Value	
802.11ax (HE20)_Chain 1 / CH36	**802.11ax (HE40)_Chain 0 / CH38**
	
802.11ax (HE80)_Chain 0 / CH42	
	

9.3. Occupied Bandwidth

Test procedure

a. Set center frequency to the nominal EUT channel center frequency.
b. Set span = 1.5 times to 5.0 times the OBW.
c. Set RBW = 1% to 5% of the OBW
d. Set VBW ≥ 3 x RBW
e. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
f. Use the 99% power bandwidth function of the instrument (if available).
g. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	17.009	16.871
44	5220	19.065	17.589
48	5240	18.699	17.744
149	5745	23.909	18.714
157	5785	24.616	20.034
165	5825	24.162	19.298

802.11ax (HE20)

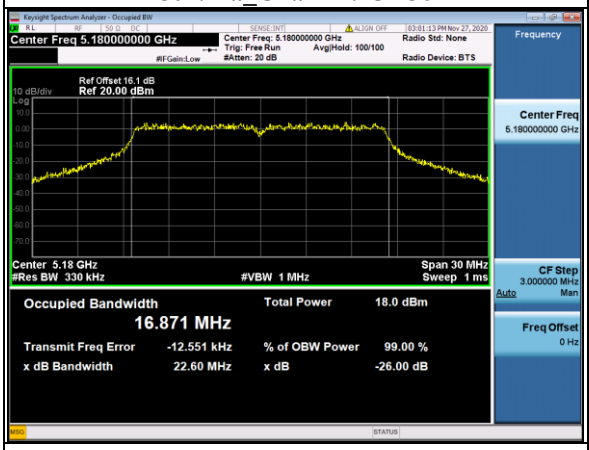
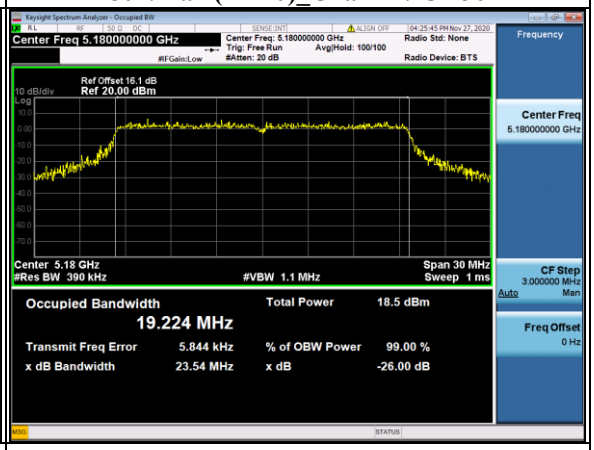
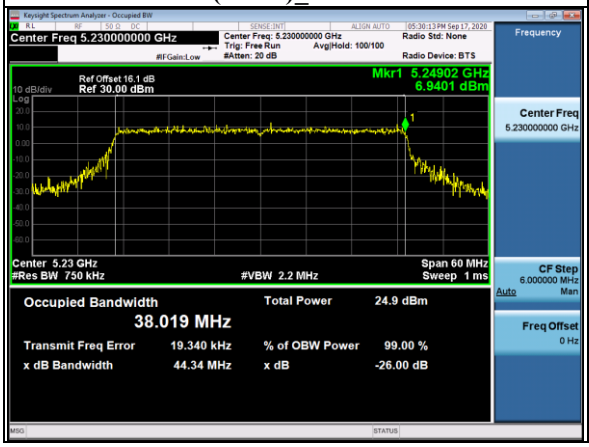
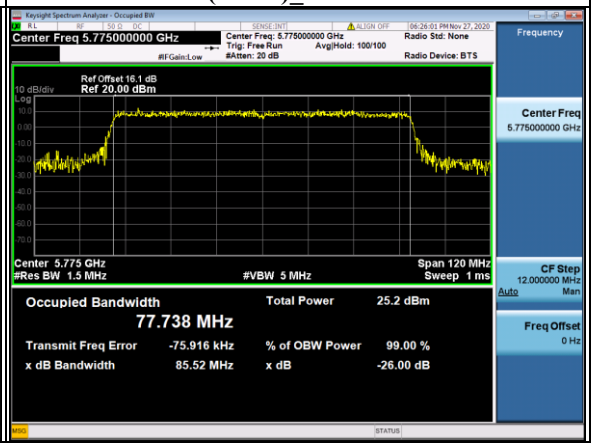
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	19.242	19.224
44	5220	19.443	19.286
48	5240	19.523	19.469
149	5745	23.289	19.773
157	5785	23.361	20.063
165	5825	23.105	19.885

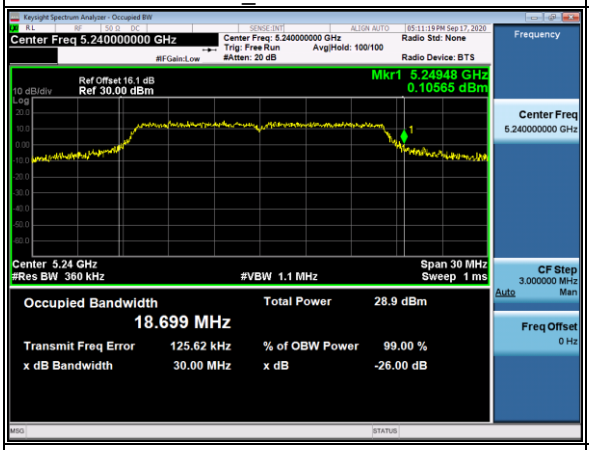
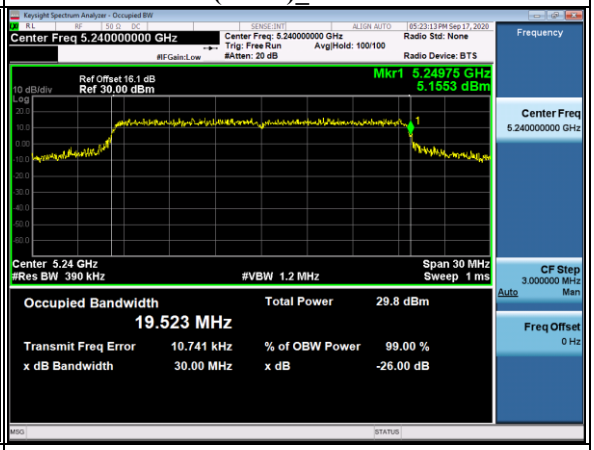
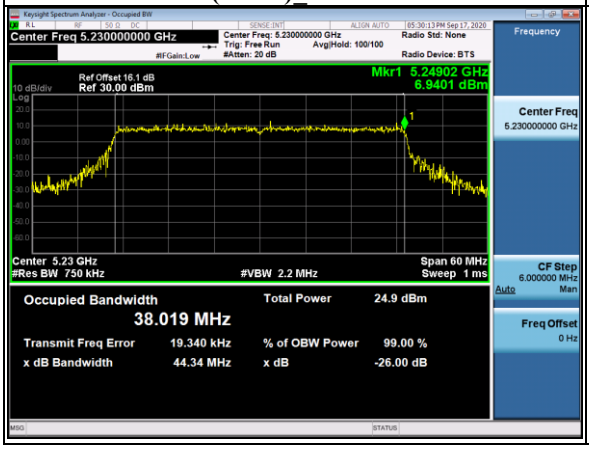
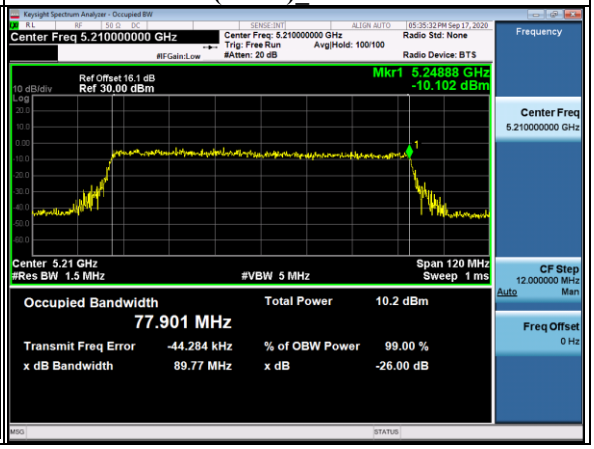
802.11ax (HE40)

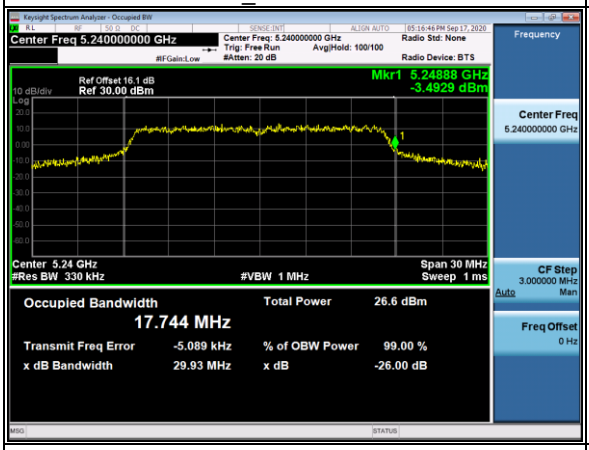
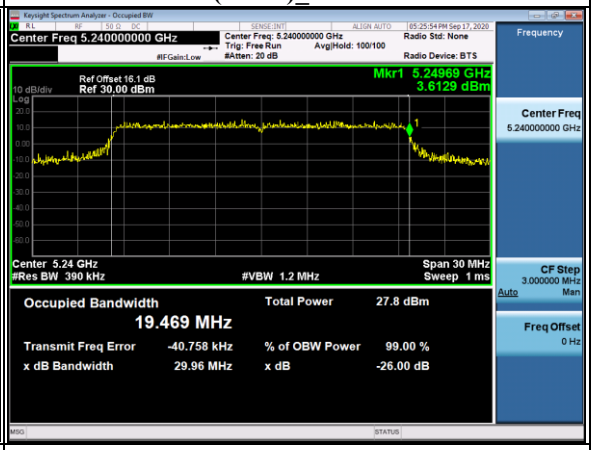
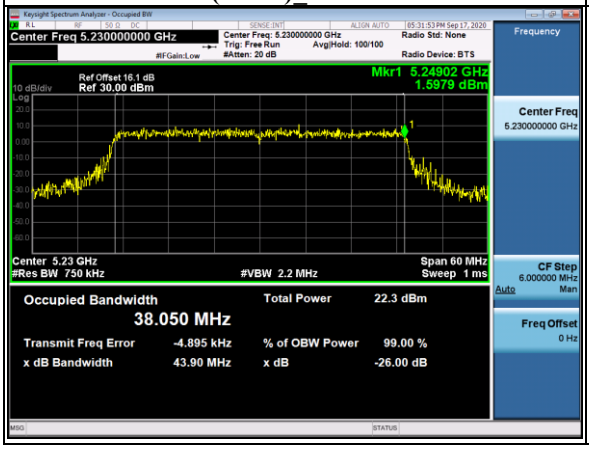
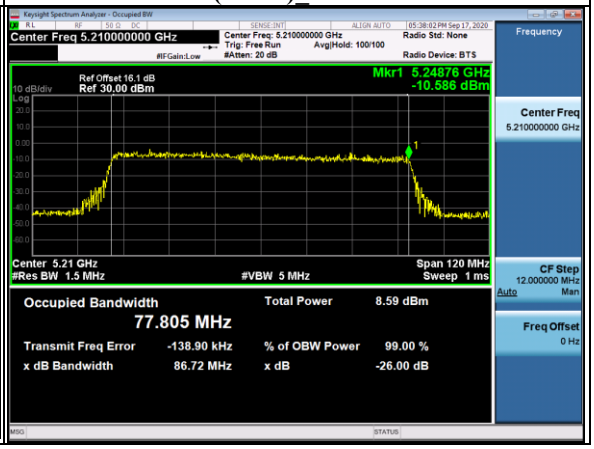
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
38	5190	38.086	38.059
46	5230	38.019	38.05
151	5755	38.938	38.539
159	5795	45.673	38.67

802.11ax (HE80)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
42	5210	77.901	77.805
155	5775	77.766	77.738

Spectrum Plot of Worst Value	
802.11a_Chain 1 / CH36	**802.11ax (HE20)_Chain 1 / CH36**
	
802.11ax (HE40)_Chain 0 / CH46	**802.11ax (HE80)_Chain 1 / CH155**
	

Spectrum Plot for near by DFS band (DFS is required, if 99% OCP straddle into U-NII-2A band)	
802.11a_Chain 0 / CH48	**802.11ax (HE20)_Chain 0 / CH48**
	
802.11ax (HE40)_Chain 0 / CH46	**802.11ax (HE80)_Chain 0 / CH42**
	

Spectrum Plot for near by DFS band (DFS is required, if 99% OCP straddle into U-NII-2A band)	
802.11a_Chain 1 / CH48	**802.11ax (HE20)_Chain 1 / CH48**
	
802.11ax (HE40)_Chain 1 / CH46	**802.11ax (HE80)_Chain 1 / CH42**
	

Beamforming Mode

802.11ax (HE20)

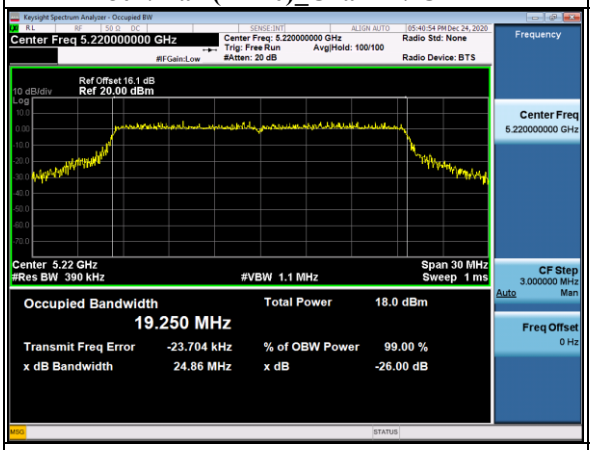
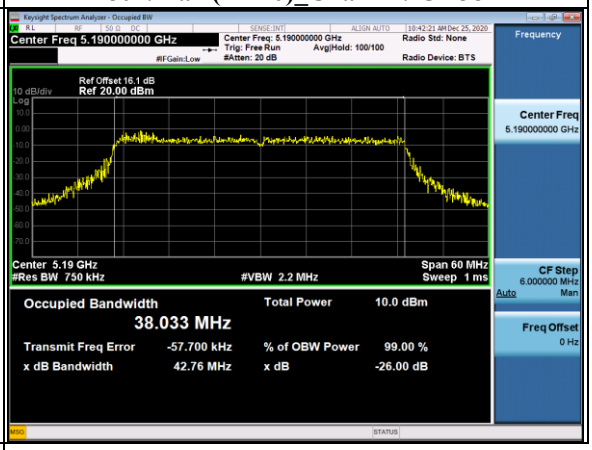
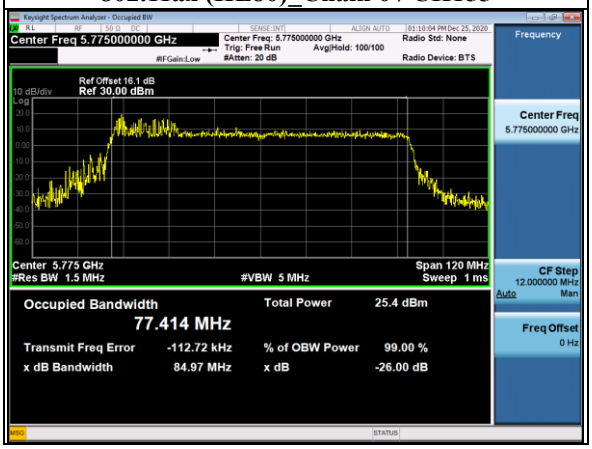
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
36	5180	19.299	19.276
44	5220	19.267	19.25
48	5240	19.253	19.262
149	5745	19.397	19.627
157	5785	19.425	19.745
165	5825	19.435	19.694

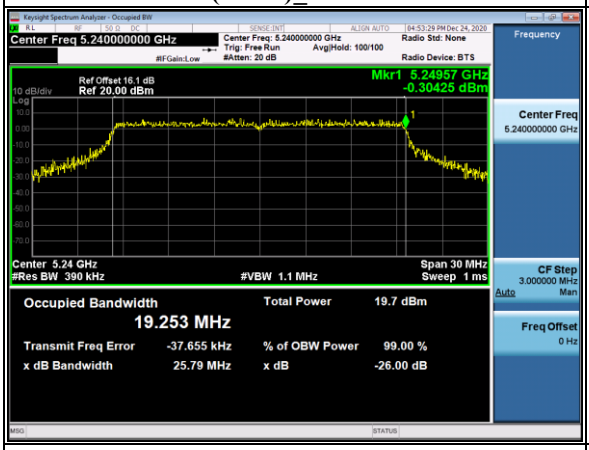
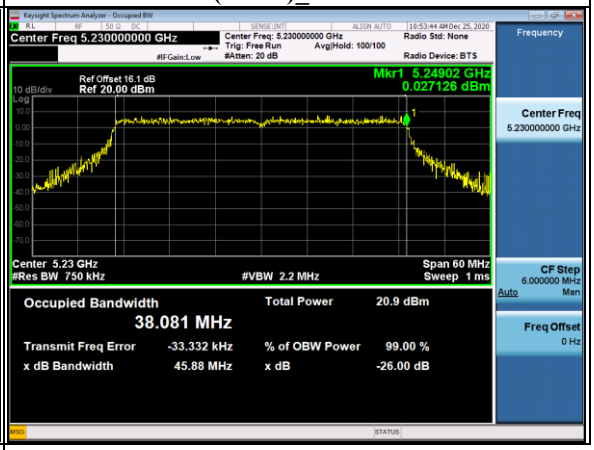
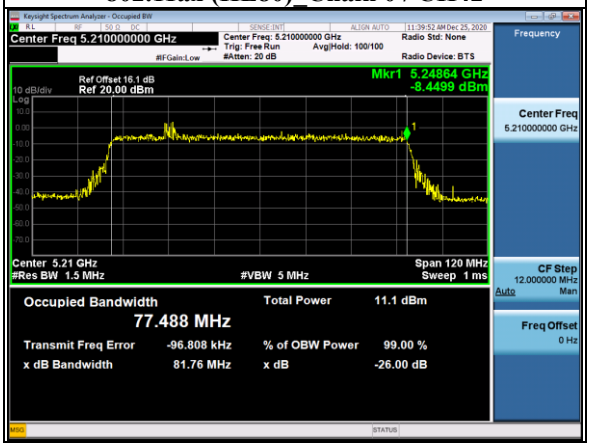
802.11ax (HE40)

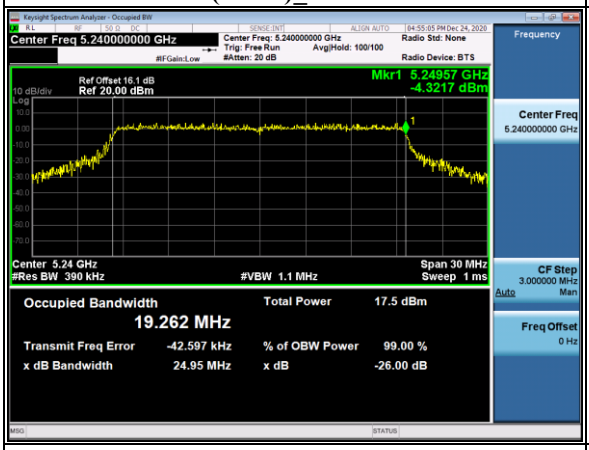
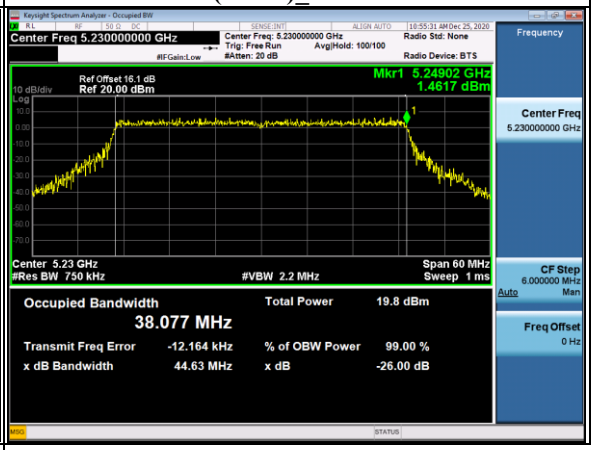
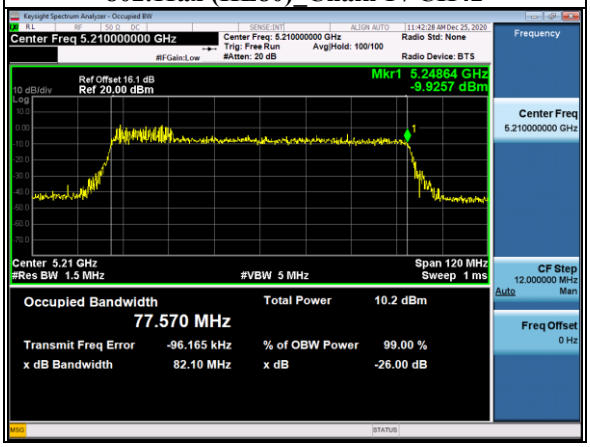
Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
38	5190	38.126	38.033
46	5230	38.081	38.077
151	5755	38.376	38.303
159	5795	38.334	38.364

802.11ax (HE80)

Channel	Channel Frequency (MHz)	Occupied Bandwidth (MHz)	
		CHAIN 0	CHAIN 1
42	5210	77.488	77.57
155	5775	77.414	77.785

Spectrum Plot of Worst Value	
802.11ax (HE20)_Chain 1 / CH44	**802.11ax (HE40)_Chain 1 / CH38**
	
802.11ax (HE80)_Chain 0 / CH155	
	

Spectrum Plot for near by DFS band (DFS is required, if 99% OCP straddle into U-NII-2A band)	
802.11ax (HE20)_Chain 0 / CH48	**802.11ax (HE40)_Chain 0 / CH46**
	
802.11ax (HE80)_Chain 0 / CH42	
	

Spectrum Plot for near by DFS band (DFS is required, if 99% OCP straddle into U-NII-2A band)	
802.11ax (HE20)_Chain 1 / CH48	**802.11ax (HE40)_Chain 1 / CH46**
	
802.11ax (HE80)_Chain 1 / CH42	
	

9.4. Conducted output power

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	1 Watt (30 dBm) Max. e.i.r.p ≦ 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon If G_{TX} > 6 dBi, then P_{Out} = 30 – (G_{TX} – 6)
		Fixed point-to-point Access Point	1 Watt (30 dBm) If G_{TX} > 23 dBi, then P_{Out} = 30 – (G_{TX} – 23)
	√	Indoor Access Point	1 Watt (30 dBm) If G_{TX} > 6 dBi, then P_{Out} = 30 – (G_{TX} – 6)
		Client device	250mW (24 dBm) If G_{TX} > 6 dBi, then P_{Out} = 24 – (G_{TX} – 6)
U-NII-3	---		For Point-to-multipoint systems (P2M): 1 Watt (30 dBm). If G_{TX} > 6 dBi, then P_{Out} = 30 – (G_{TX} – 6) For Point-to-point systems (P2P): 1 Watt (30 dBm)

Note:
1. P_{Out} = maximum conducted output power in dBm,
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. Directional Gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ +...+$10^{Gn/20}$)^2 / Nant] dBi.

   Nant: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas
4. B is the 26 dB emission bandwidth in megahertz

Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};
Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

For power measurements on all other devices: Array Gain = 10 log(N_{ANT}/N_{SS}) dB.

Test Procedure

Test method PM-G

For 802.11a, 802.11ax (HE20), 802.11ax (HE40)

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 and set the detector to AVERAGE. Duty factor is not added to measured value.

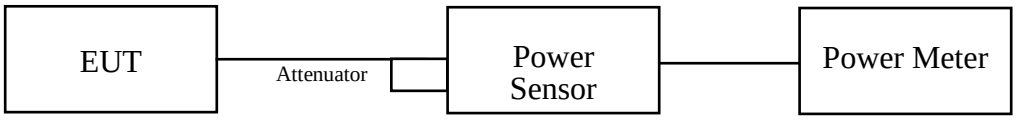
Test method SA-1

For 802.11ax (HE80)

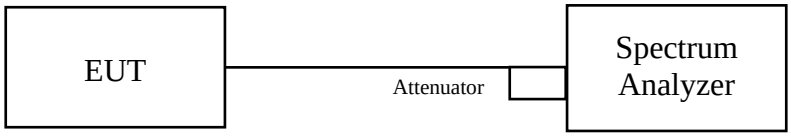
a. Set span to encompass the entire 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
b. Set sweep trigger*.
c. Set RBW = 1 MHz.
d. Set VBW ≥ 3 MHz
e. Number of points in sweep ≥ 2 Span / RBW.
f. Sweep time ≤ (number of points in sweep) * T
g. Using emission bandwidth to determine the frequency span for integration the channel bandwidth.
h. Detector = RMS.
i. Trace mode = max hold.
j. Allow max hold to run for at least 60 seconds, or longer as needed to allow the trace to stabilize.

* If transmit duty cycle < 98%, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run."

Test Setup



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Non-Beamforming Mode

802.11a

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
36	5180	17.07	15.33	85.052	19.30	30	PASS
44	5220	24.91	22.68	495.095	26.95	30	PASS
48	5240	24.24	21.98	423.222	26.27	30	PASS
149	5745	26.53	23.28	662.594	28.21	30	PASS
157	5785	26.08	23.02	605.956	27.82	30	PASS
165	5825	25.39	22.89	540.475	27.33	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

802.11ax (HE20)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
36	5180	16.58	15.28	79.228	18.99	30	PASS
44	5220	24.4	22.2	441.382	26.45	30	PASS
48	5240	24.63	22.35	462.193	26.65	30	PASS
149	5745	26.33	23.04	630.908	28.00	30	PASS
157	5785	25.91	22.91	585.376	27.67	30	PASS
165	5825	25.26	22.81	526.723	27.22	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

802.11ax (HE40)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
38	5190	11.21	10.05	23.329	13.68	30	PASS
46	5230	18.77	18.12	140.199	21.47	30	PASS
151	5755	23.86	22.73	430.719	26.34	30	PASS
159	5795	25.59	22.58	543.377	27.35	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

802.11ax (HE80)

CHAN.	CHAN. FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
42	5210	10.77	9.09	20.05	13.02	30	PASS
155	5775	19.79	20.23	200.719	23.03	30	PASS

NOTE: Directional gain = 3.9 dBi < 6 dBi, so the limit no need to reduced.

Beamforming Mode

802.11ax (HE20)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
36	5180	9.11	7.23	13.431	11.28	29.09	PASS
44	5220	15.04	12.9	51.413	17.11	29.09	PASS
48	5240	14.35	12.53	45.133	16.54	29.09	PASS
149	5745	22.66	22.28	353.546	25.48	29.09	PASS
157	5785	22.17	21.9	319.698	25.05	29.09	PASS
165	5825	21.95	21.67	303.568	24.82	29.09	PASS

NOTE: Directional gain = 6.91 dBi > 6 dBi, so the limit shall be reduced.

802.11ax (HE40)

CHAN.	FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
38	5190	4.90	3.76	5.467	7.38	29.09	PASS
46	5230	14.93	13.72	54.667	17.38	29.09	PASS
151	5755	22.74	21.90	342.814	25.35	29.09	PASS
159	5795	22.38	21.68	320.213	25.05	29.09	PASS

NOTE: Directional gain = 6.91 dBi > 6 dBi, so the limit shall be reduced.

802.11ax (HE80)

CHAN.	CHAN. FREQ. (MHz)	MAXIMUM CONDUCTED POWER (dBm)		TOTAL POWER (mW)	TOTAL POWER (dBm)	POWER LIMIT (dBm)	PASS / FAIL
		chain 0	chain 1				
42	5210	5.00	2.87	5.098	7.07	29.09	PASS
155	5775	17.30	17.20	106.184	20.26	29.09	PASS

NOTE: Directional gain = 6.91 dBi > 6 dBi, so the limit shall be reduced.

9.5. Power Spectral Density

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	17dBm/ MHz If G_{TX} > 6 dBi, then PSD = 17 – (G_{TX} – 6)
		Fixed point-to-point Access Point	17dBm/ MHz If G_{TX} > 23 dBi, then PSD = 17 – (G_{TX} – 23)
	√	Indoor Access Point	17dBm/ MHz If G_{TX} > 6 dBi, then PSD = 17 – (G_{TX} – 6)
		Client device	11dBm/ MHz If G_{TX} > 6 dBi, then PSD = 11 – (G_{TX} – 6)
U-NII-3	---		For Point-to-multipoint systems (P2M): 30dBm/ 500kHz. If G_{TX} > 6 dBi, then PSD = 30 – (G_{TX} – 6) For Point-to-point systems (P2P): 30dBm/ 500kHz

Note:
1. PSD = power spectral density that he same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. Directional Gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ +...+$10^{Gn/20}$)^2 / Nant] dBi.

   Nant: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas

Test procedure

For U-NII-1 band:

Non-Beamforming Mode

Using method SA-1_Duty cycle >98 %

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
c. Sweep time = auto, trigger set to “free run”.
d. Trace average at least 100 traces in power averaging mode.
e. Record the max value

Beamforming Mode

Using method SA-1_Duty cycle >98 % (802.11ax (HE80))

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
c. Sweep time = auto, trigger set to “free run”.
d. Trace average at least 100 traces in power averaging mode.
e. Record the max value

Using method SA-2_with Duty cycle <98 % (802.11ax (HE20), 802.11ax (HE40))

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 1 MHz, Set VBW ≥ 3 RBW, Detector = RMS
c. Sweep time = auto, trigger set to “free run”.
d. Trace average at least 100 traces in power averaging mode.
e. Record the max value and add 10 log (1/duty cycle)

For U-NII-3 band:

Non-Beamforming Mode

Duty cycle >98 %

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
c. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
d. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
e. Sweep time = auto, trigger set to "free run".
f. Trace average at least 100 traces in power averaging mode.
g. Record the max value.

Beamforming Mode

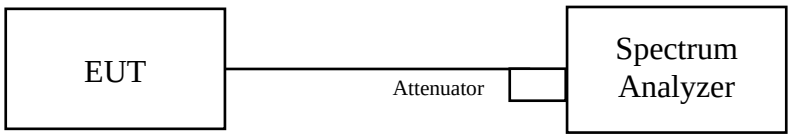
Duty cycle >98 % (802.11ax (HE80))

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
c. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
d. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
e. Sweep time = auto, trigger set to "free run".
f. Trace average at least 100 traces in power averaging mode.
g. Record the max value.

with Duty cycle <98 % (802.11ax (HE20), 802.11ax (HE40))

a. Set span to encompass the entire emission bandwidth (EBW) of the signal.
b. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
c. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
d. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
e. Sweep time = auto, trigger set to "free run".
f. Trace average at least 100 traces in power averaging mode.
g. Record the max value and add 10 log (1/duty cycle)

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.