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Appendix B: 802.11ax Test Plot

FCC ID
A3LSMS926B

REVISION HISTORY

The revision history for this document is shown in table.

Revision No.	Date of Issue	Description
0	October 17, 2023	Initial Release
1	November 02, 2023	Added the CBP Plot on page 34-44

Note:

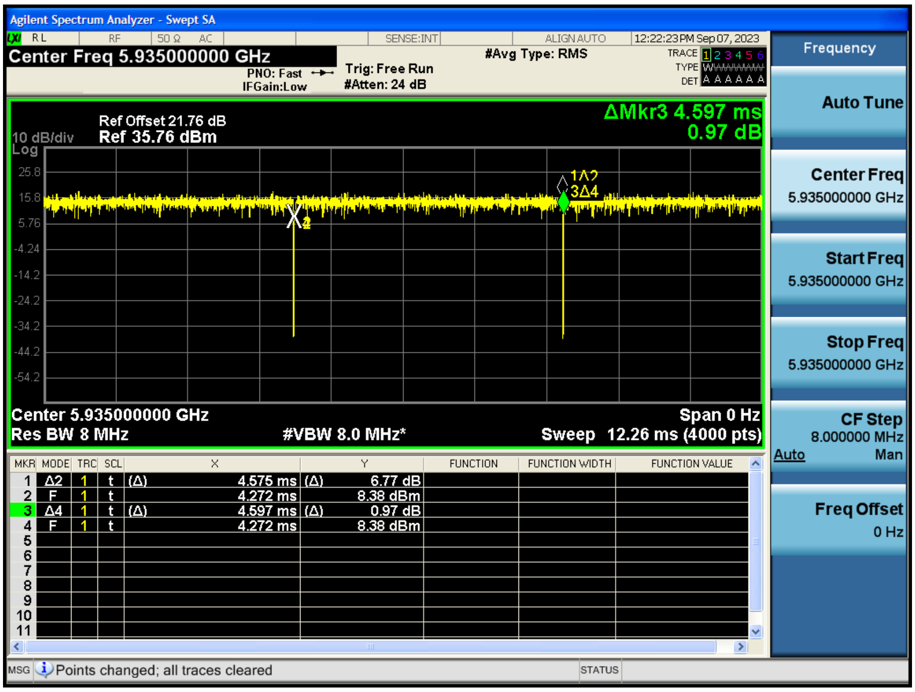
In order to simplify the report, attached plots were only the most lowest datarate.

1. Duty Cycle

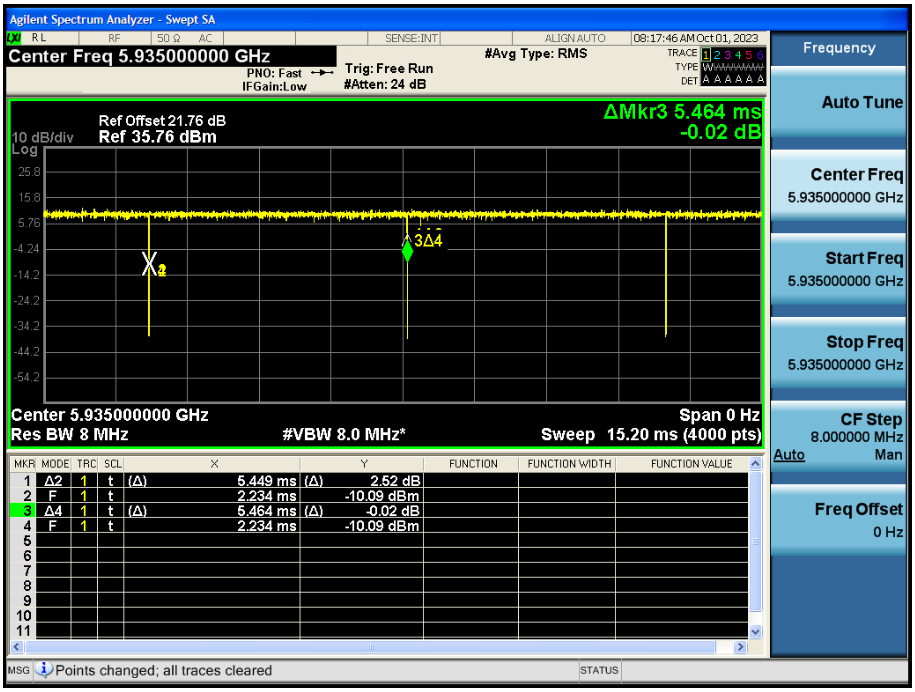
Note:

1. In order to simplify the report, attached plots were only the lowest datarate .

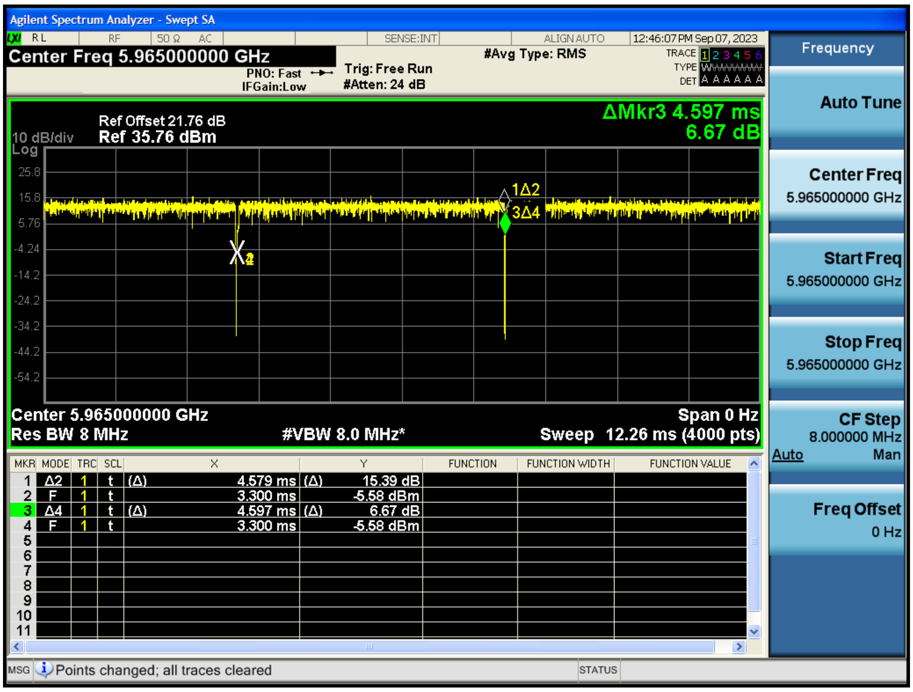
802.11ax HE 20 Ch.2(5935 MHz) 26 Tones MCS0



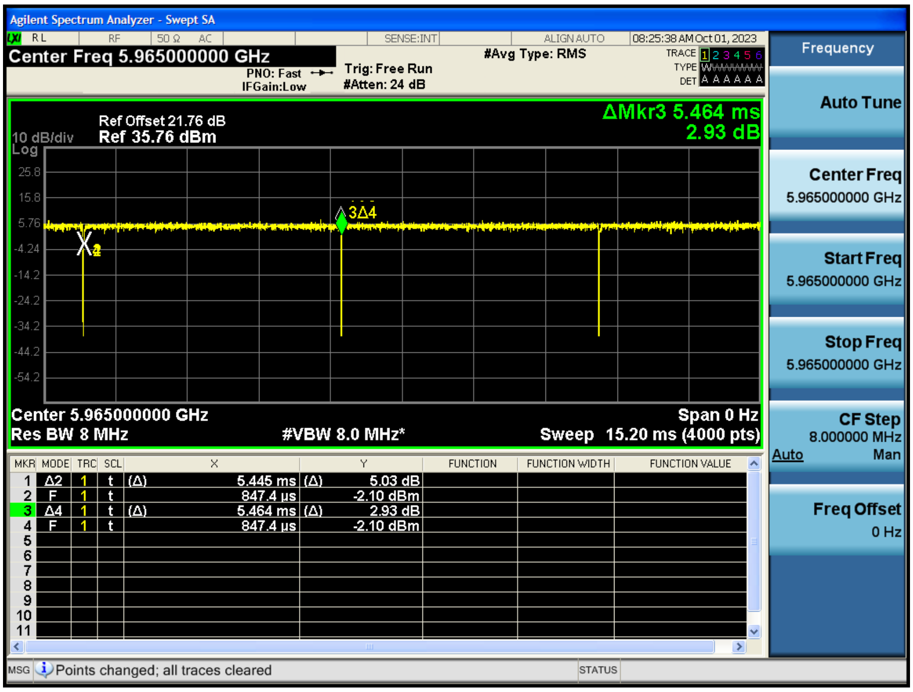
802.11ax HE 20 Ch.2(5935 MHz) SU MCS0



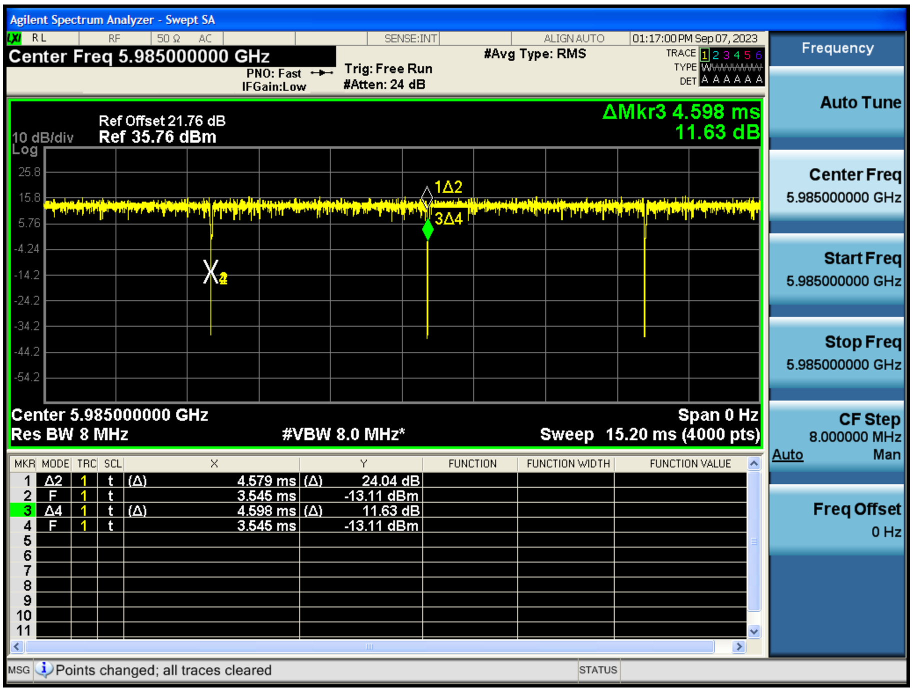
802.11ax HE 40 Ch.3(5965 MHz) 26 Tones MCS0



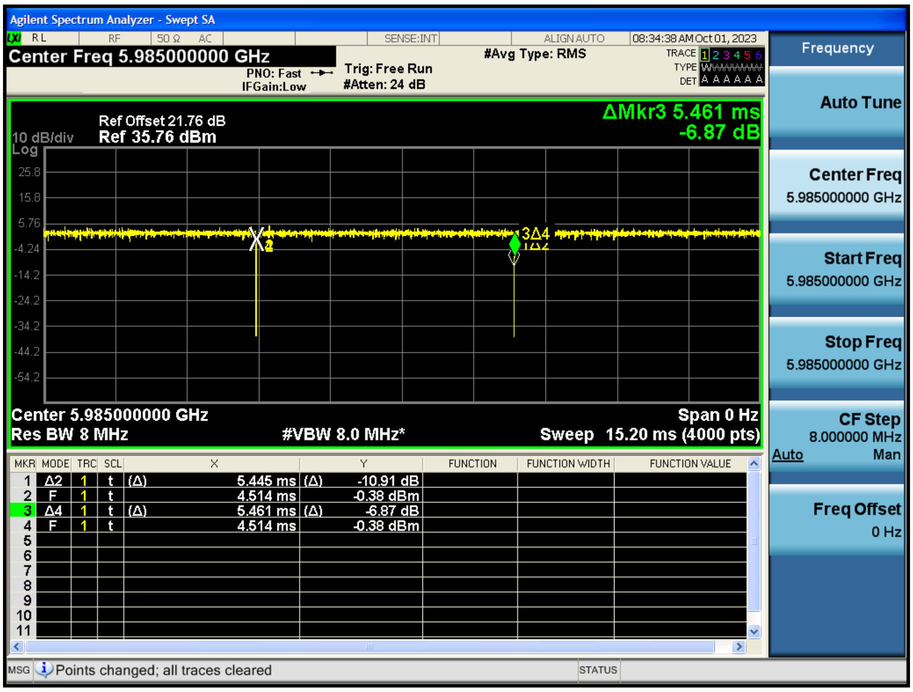
802.11ax HE 40 Ch.3(5965 MHz) SU MCS0



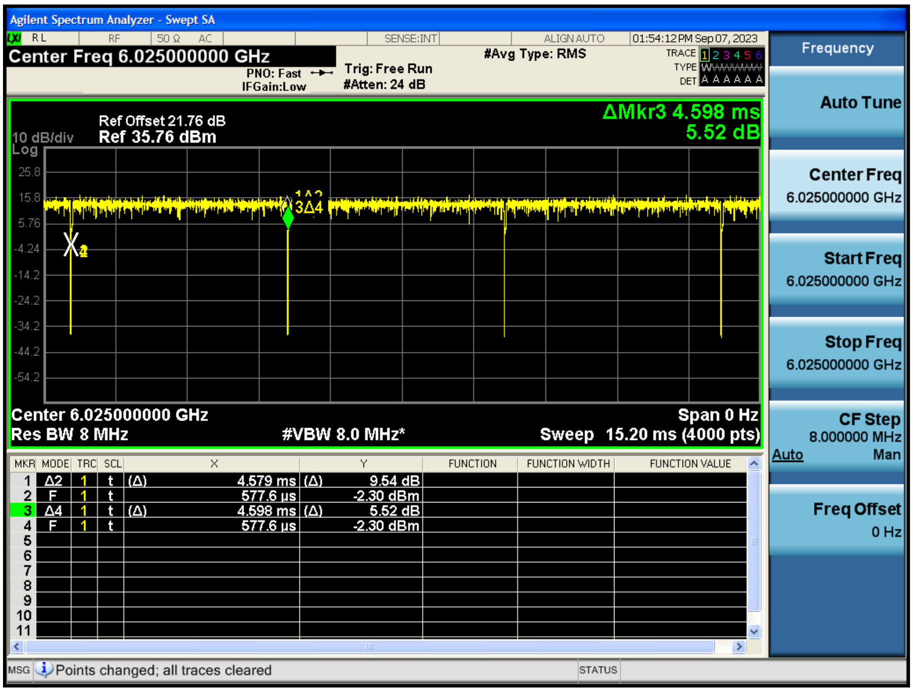
802.11ax HE 80 Ch.7(5985 MHz) 26 Tones MCS0



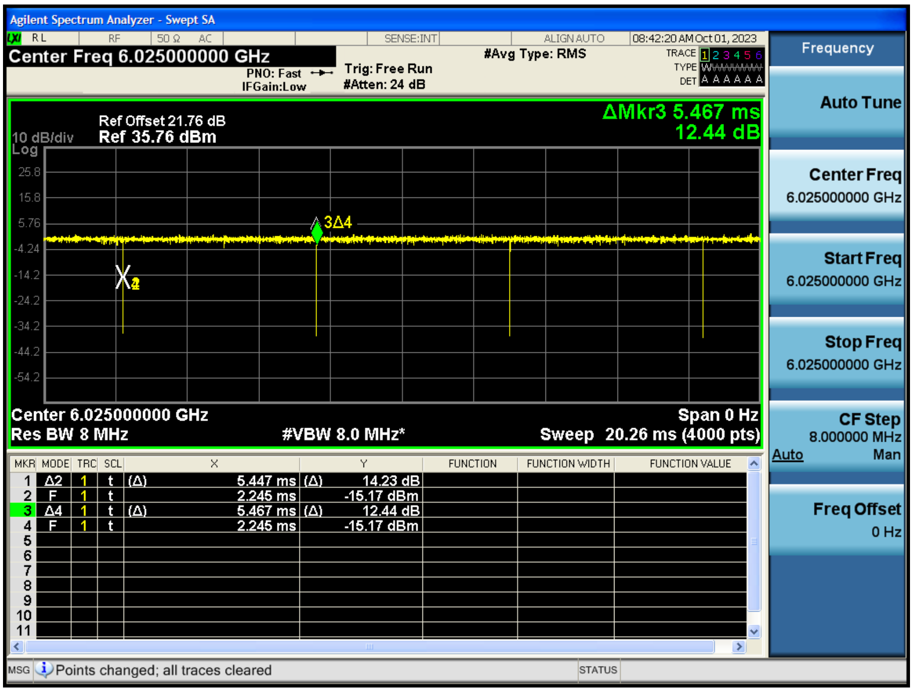
802.11ax HE 80 Ch.7(5985 MHz) SU MCS0



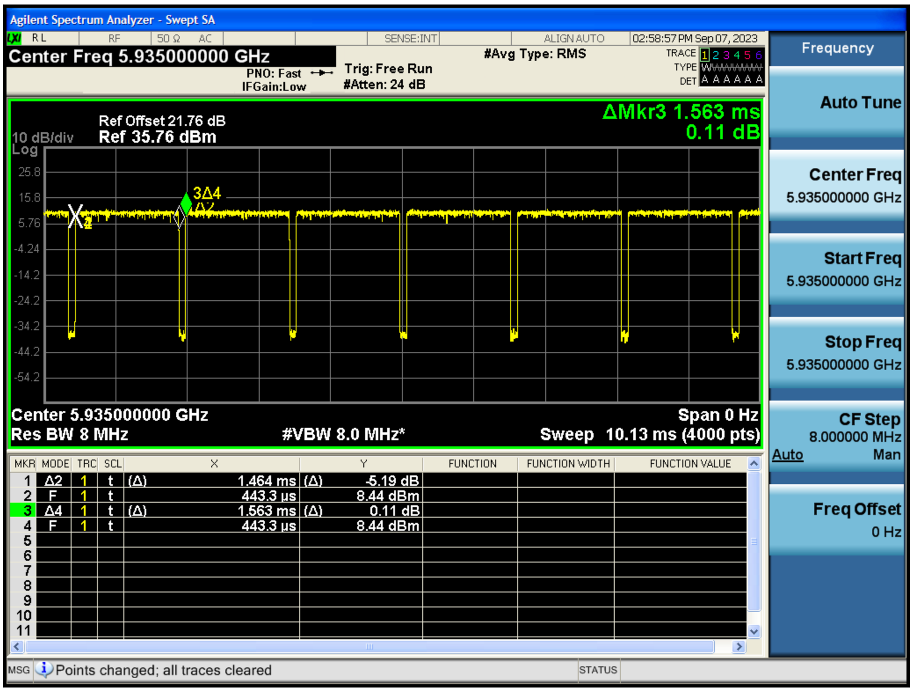
802.11ax HE 160 Ch.15(6025 MHz) 26 Tones MCS0



802.11ax HE 160 Ch.15(6025 MHz) SU MCS0



802.11a Ch.2(5935 MHz) 6 Mbps



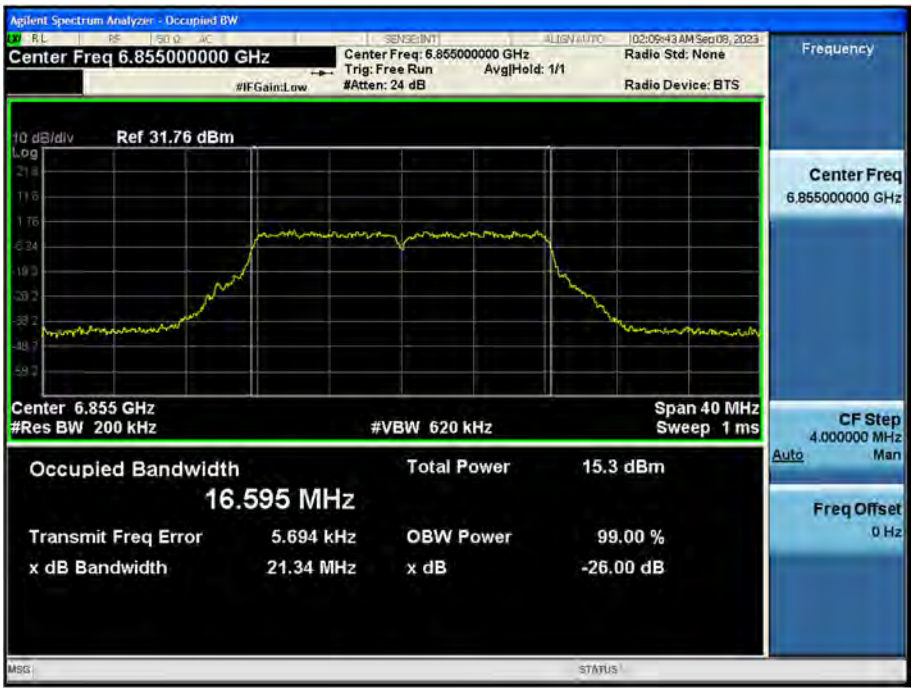
2. 26dB Bandwidth

2.1 Indoor / Standard client

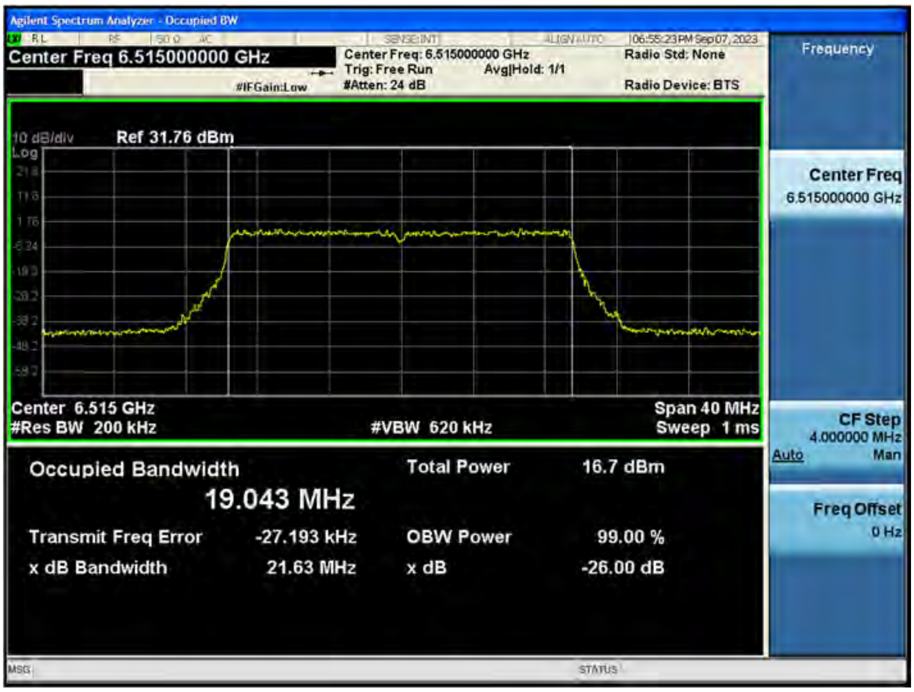
Note:
1. In order to simplify the report, attached plots were only the widest channel.

Ant.1

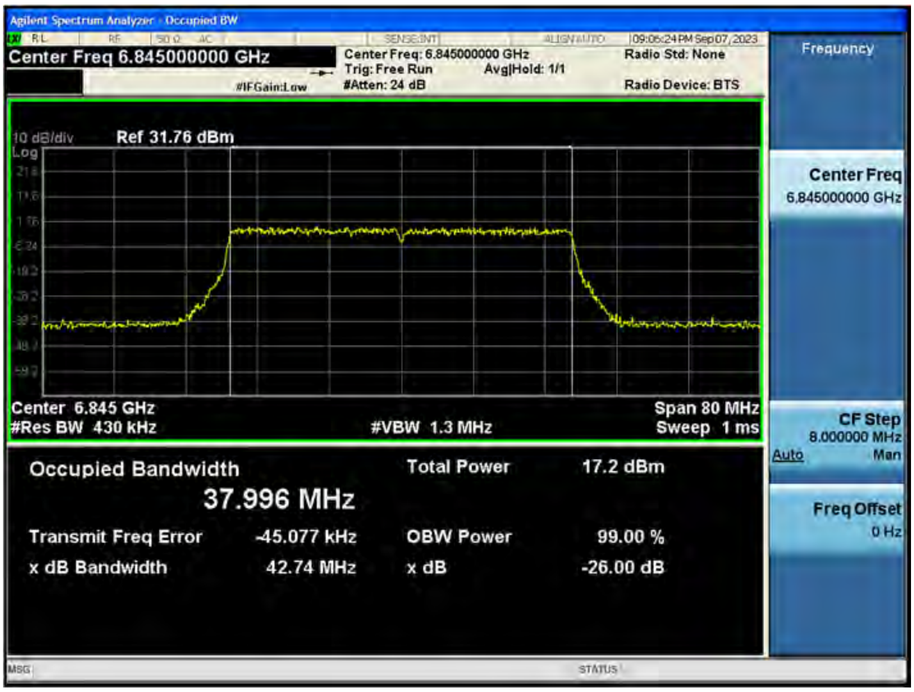
802.11a Ch.181(6855 MHz)



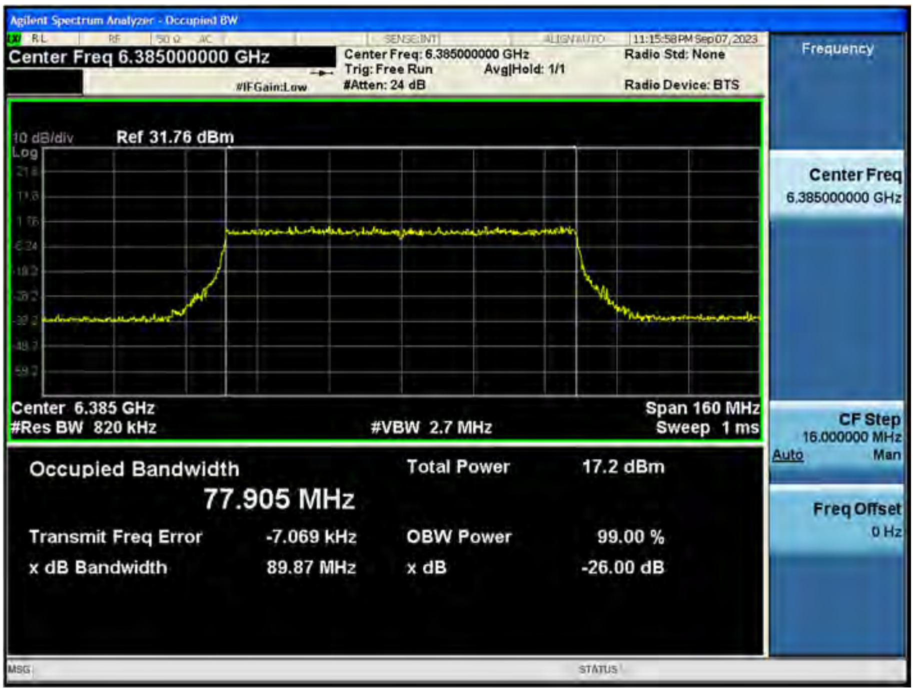
802.11ax HE20 Ch.113(6515 MHz) SU



802.11ax HE40 Ch.179(6845 MHz) SU

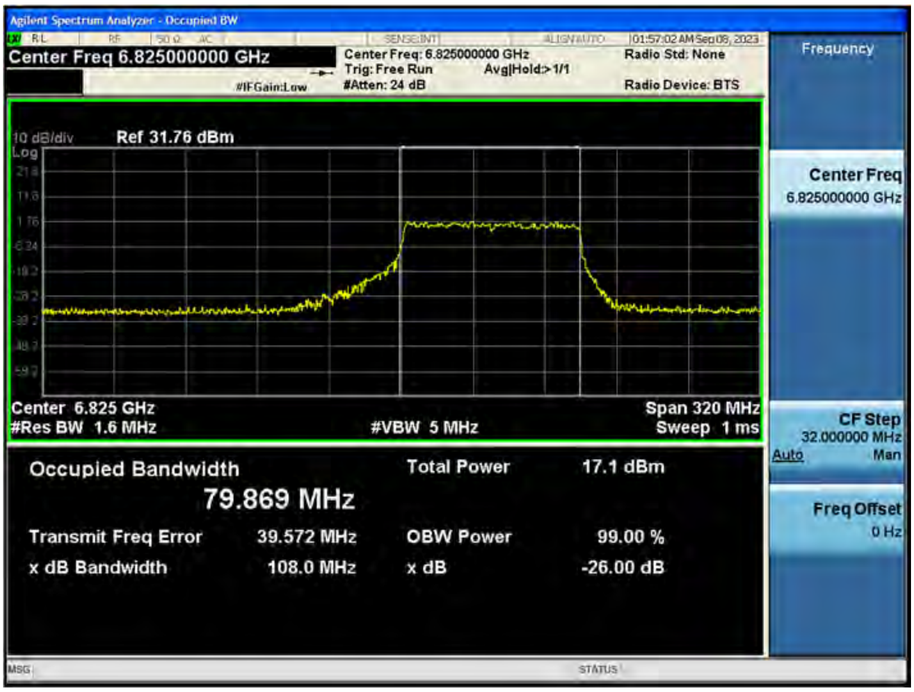


802.11ax HE80 Ch.87(6385 MHz) SU

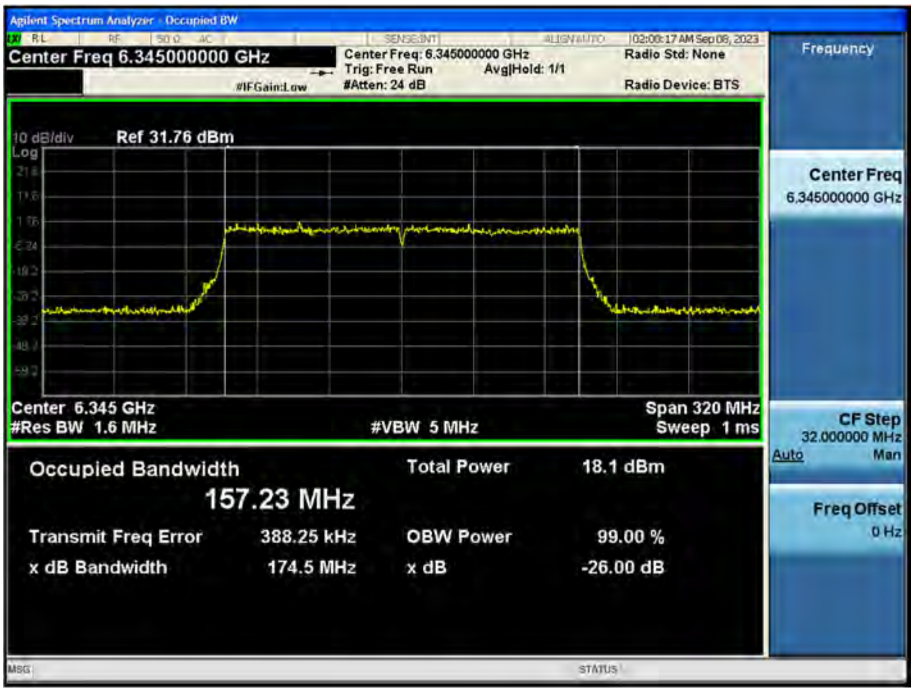


802.11ax HE160, 80_L Ch.47(6185 MHz) 996 Tones 67 RU

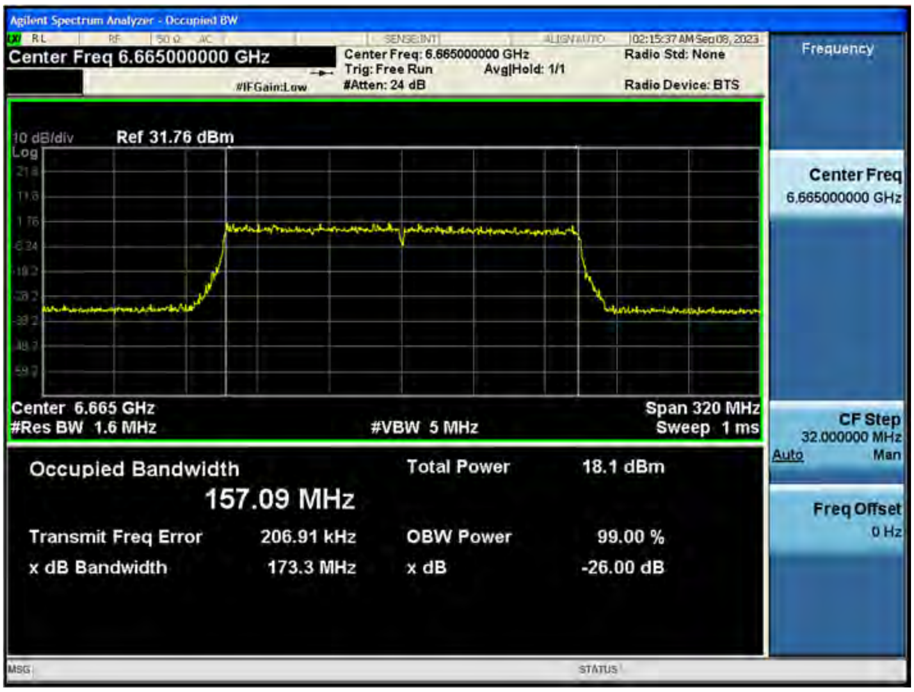
802.11ax HE160, 80_U Ch.175(6825 MHz) 996 Tones 67 RU



Bandwidth 160M, SU Ch. 79(6345 MHz)



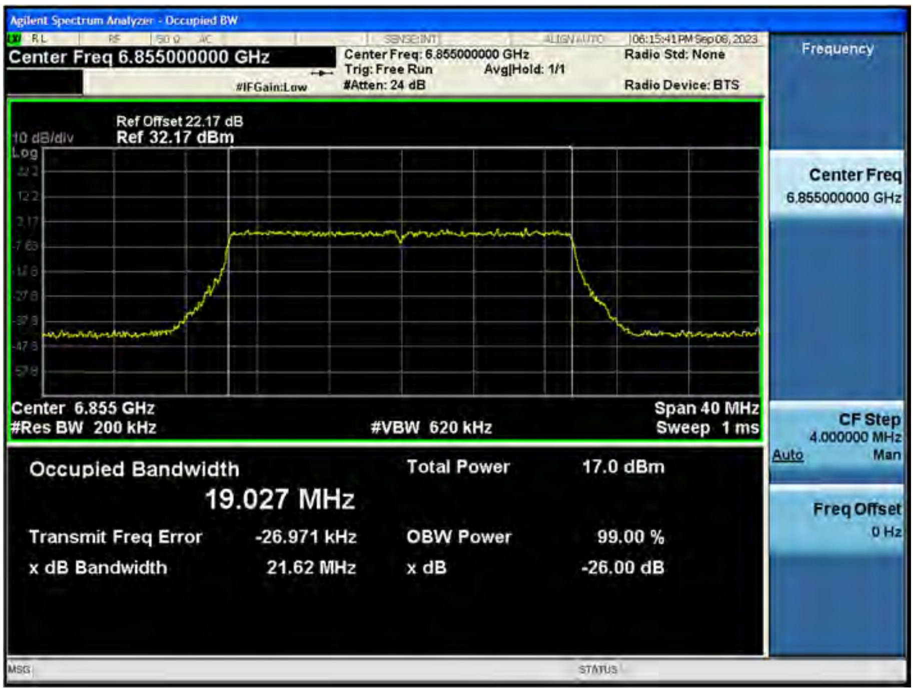
Bandwidth 160M, Ch. 143(6665 MHz) 2x996 Tones 68 RU



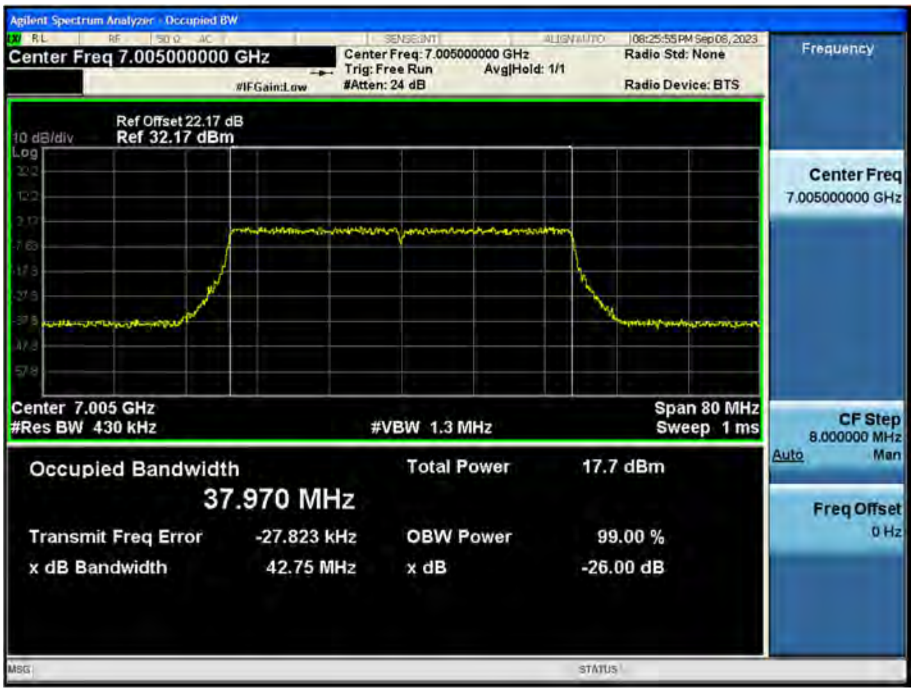
Ant.2

802.11a Ch.233(7115 MHz)

802.11ax HE20 Ch.181(6855 MHz) SU



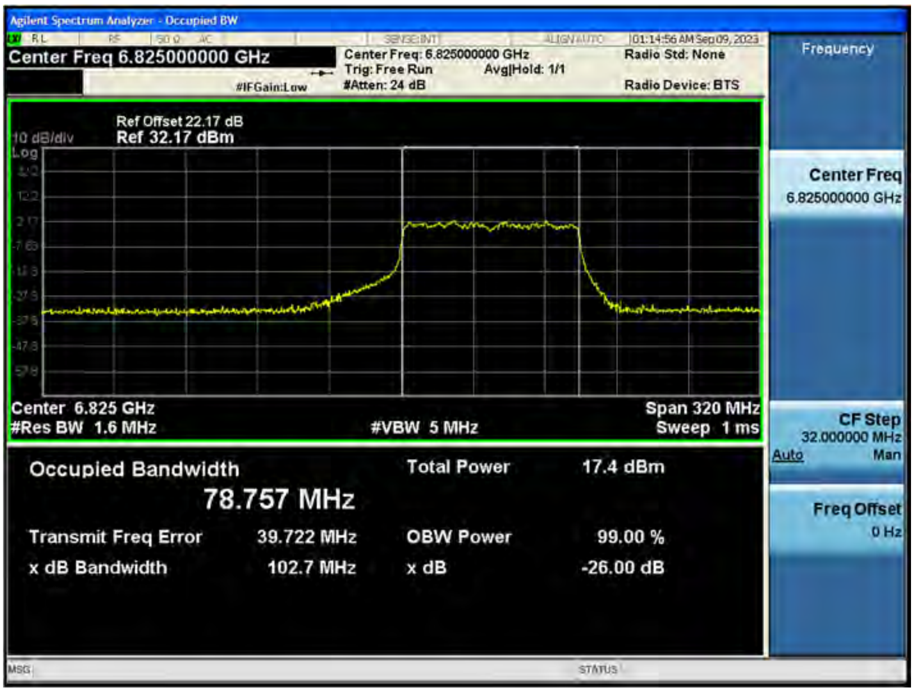
802.11ax HE40 Ch.211(7005 MHz) SU



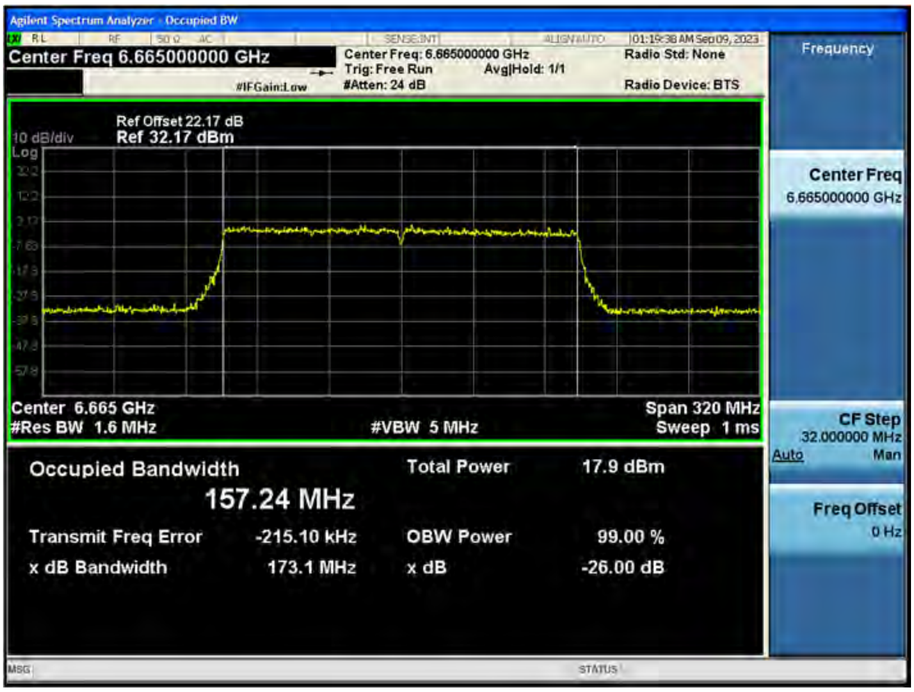
802.11ax HE80 Ch.215(7025 MHz) SU

802.11ax HE160, 80_L Ch.15(6025 MHz) 996 Tones 67 RU

802.11ax HE160, 80_U Ch.175(6825 MHz) 996 Tones 67 RU



Bandwidth 160M, SU Ch. 143(6665 MHz) SU



Bandwidth 160M, Ch. 15(6025 MHz) 2x996 Tones 68 RU

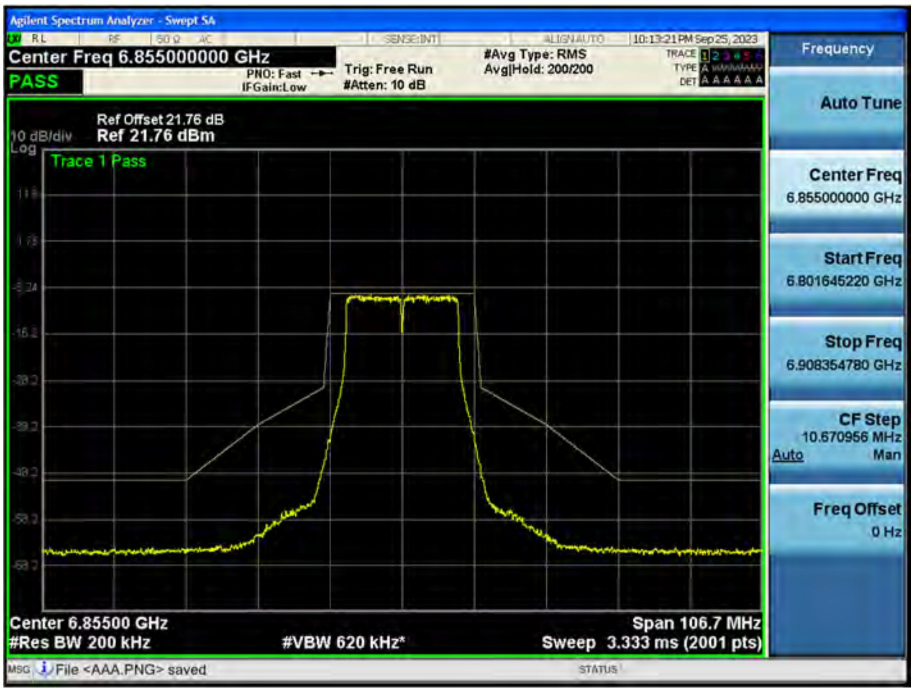
3. In-Band Emission (Emission Mask)

3.1 Indoor / Standard client

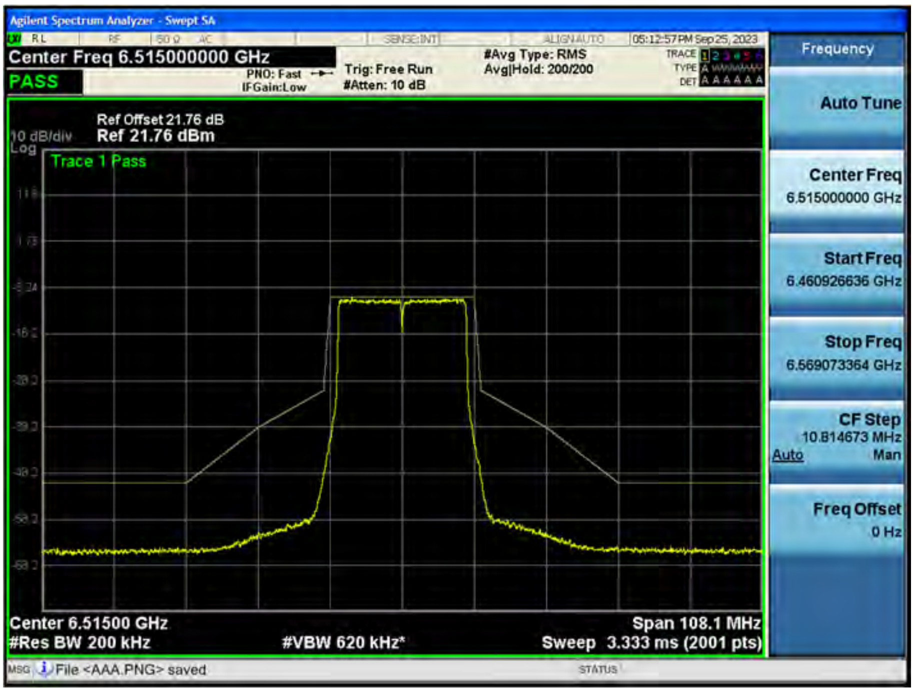
Note:
1. In order to simplify the report, attached plots were only the widest channel.

Ant.1

802.11a Ch.181(6855 MHz)



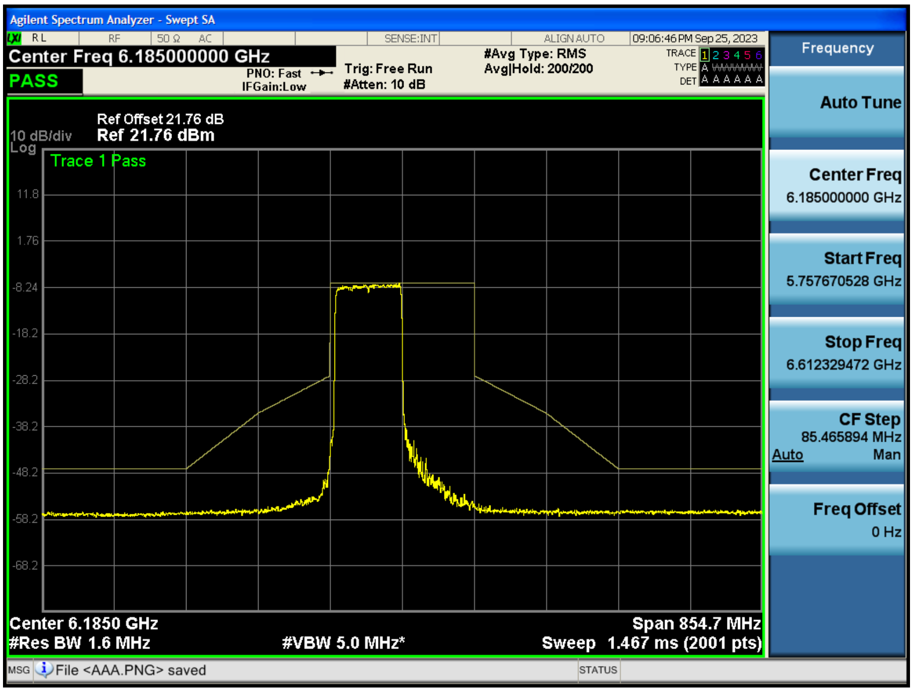
802.11ax HE20 Ch.113(6515 MHz) SU



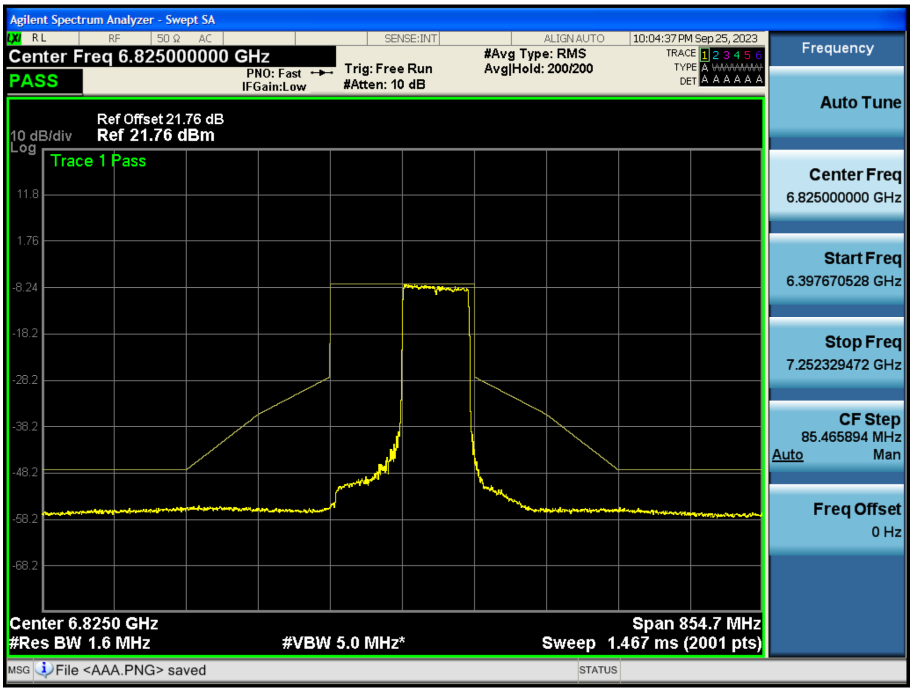
802.11ax HE40 Ch.179(6845 MHz) SU

802.11ax HE80 Ch.87(6385 MHz) SU

802.11ax HE160, 80_L Ch.47(6185 MHz) 996 Tones 67 RU

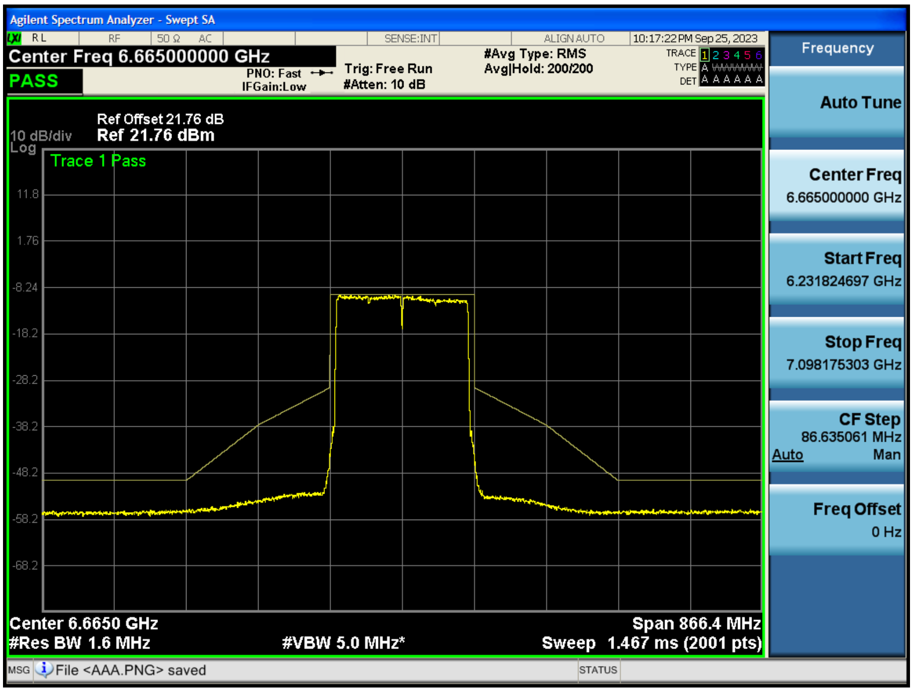


802.11ax HE160, 80_U Ch.175(6825 MHz) 996 Tones 67 RU



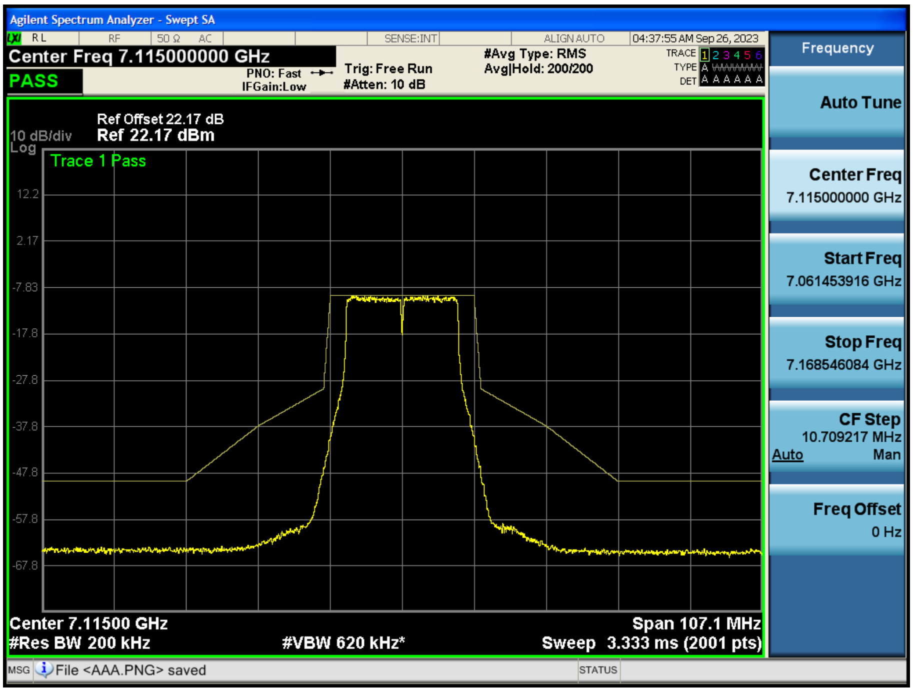
Bandwidth 160M, SU Ch. 79(6345 MHz)

Bandwidth 160M, Ch. 143(6665 MHz) 2x996 Tones 68 RU

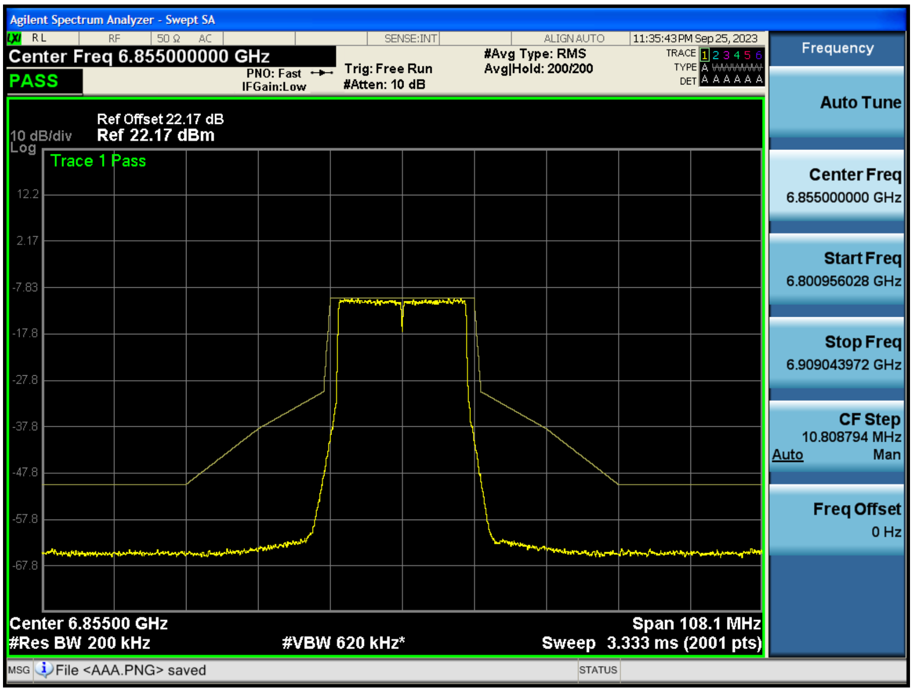


Ant.2

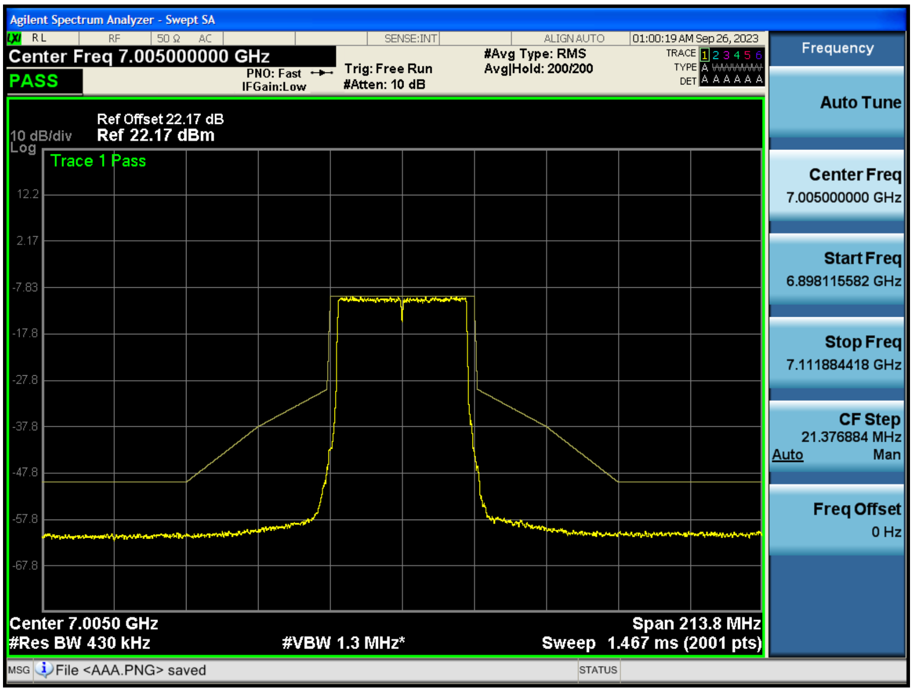
802.11a Ch.233(7115 MHz)



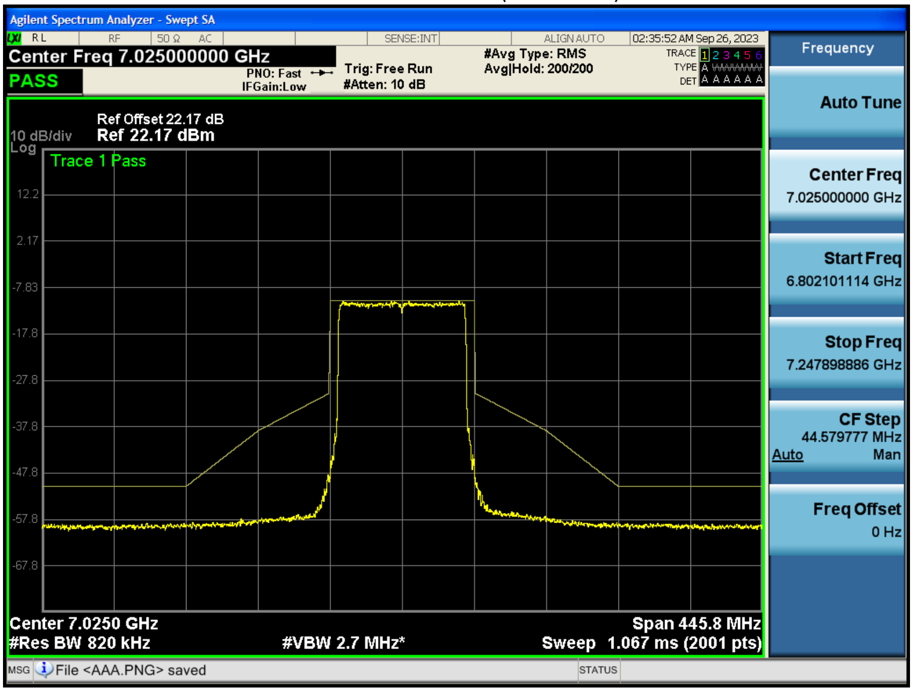
802.11ax HE20 Ch.181(6855 MHz) SU



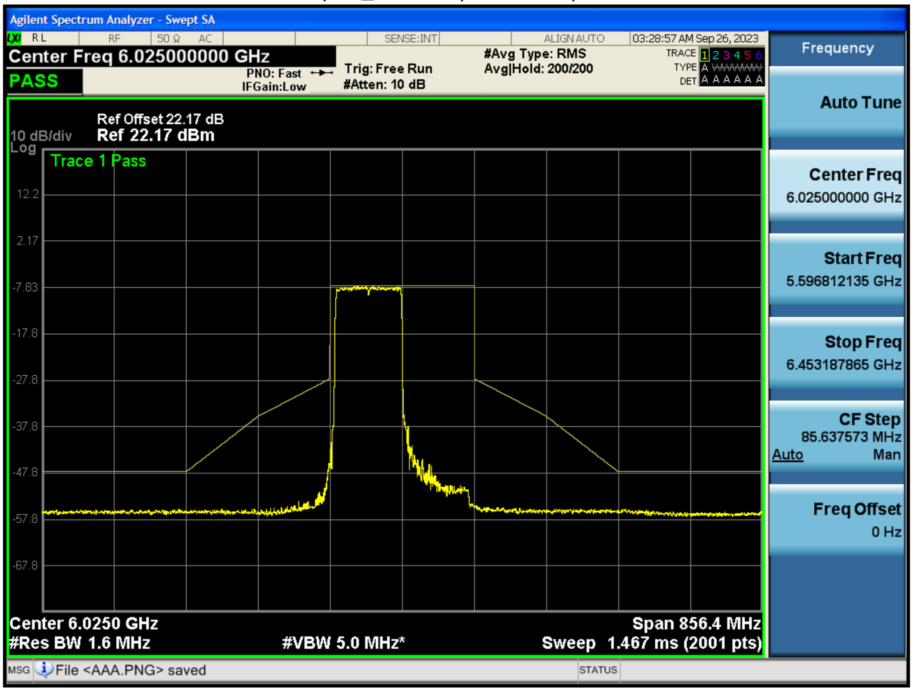
802.11ax HE40 Ch.211(7005 MHz) SU



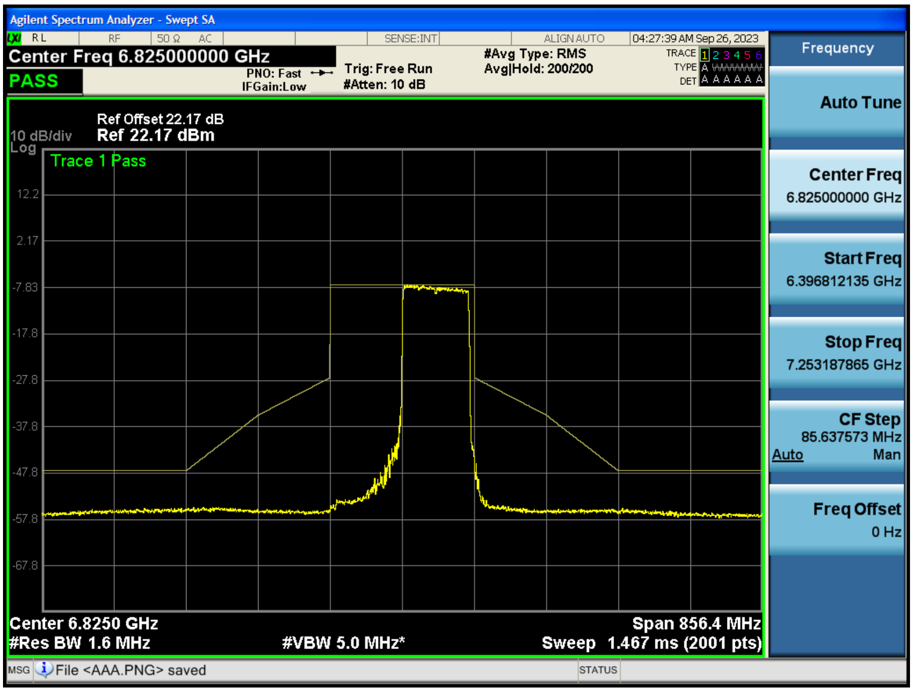
802.11ax HE80 Ch.215(7025 MHz) SU



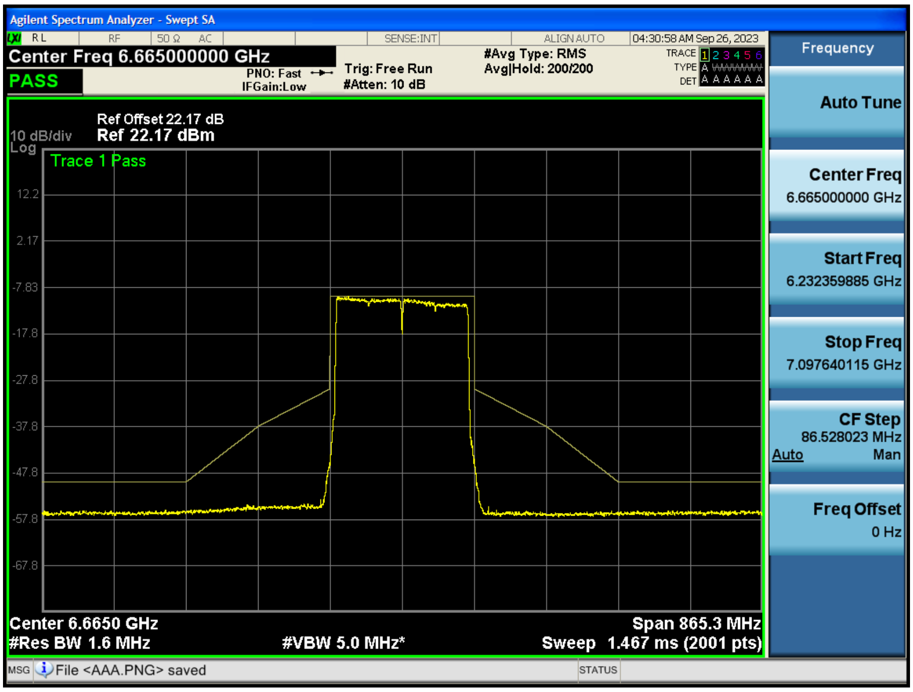
802.11ax HE160, 80_L Ch.15(6025 MHz) 996 Tones 67 RU



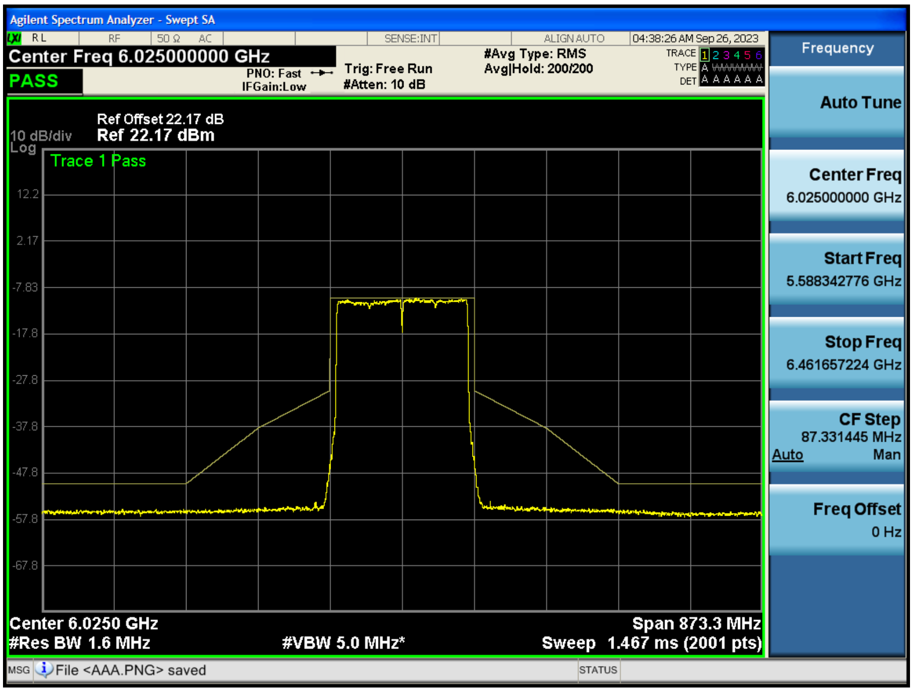
802.11ax HE160, 80_U Ch.175(6825 MHz) 996 Tones 67 RU



Bandwidth 160M, SU Ch. 143(6665 MHz) SU



Bandwidth 160M, Ch. 15(6025 MHz) 2x996 Tones 68 RU



4. Power Spectral Density

Note:

1. In order to simplify the report, attached plots were only channel of highest EIRP PSD.

2. According to KDB 662911 D01 Multiple Transmitter Output v02r01 F) 2) f) (ii)

$$\text{Directional gain(SDM)} = G_{max} + 10 \cdot \log(N_{ANT} / N_{SS}),$$

$$\text{Directional Gain(CDD)} = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\{\sum_{k=1}^{N_{ANT}} g_{j,k}\}^2}{N_{ANT}}\right]$$

Band	Ant Gain (dBi)		N_{ANT}/N_{SS}	Directional Gain CDD (dBi)	Directional Gain SDM (dBi)
	ANT1	ANT2			
UNII 5	-4.70	-4.22	2 / 2	-1.45	-4.22
UNII 6	-4.65	-4.54		-1.58	-4.54
UNII 7	-4.65	-4.88		-1.75	-4.65
UNII 8	-6.61	-4.44		-2.45	-4.44

Note

According to Ansi C63.10-2013 section 14.4.3, the directional gain is calculated using the formula, where GN is the gain of the nth antenna and NANT is the total number of antennas used.

$$\text{Directional Gain(CDD)} = 10 \cdot \log(((10^{(ANT1\ Gain/20)} + 10^{(ANT2\ Gain/20)})^2)/2)\ \text{dBi}$$

$$\text{Directional gain(SDM)} = G_{max} + 10 \cdot \log(N_{ANT} / N_{SS}),$$

Sample Calculation (Conducted Power, MIMO):

Ex) Ant 1 : 11.58 dBm   Ant 2 : 12.08 dBm

Ant1 + Ant 2 = MIMO

(11.58 dBm + 12.08 dBm) = (14.387 mW + 16.143 mW) = 30.53 mW = 14.88 dBm

Sample Calculation (E.I.R.P & E.I.R.P Spectral Density, MIMO):

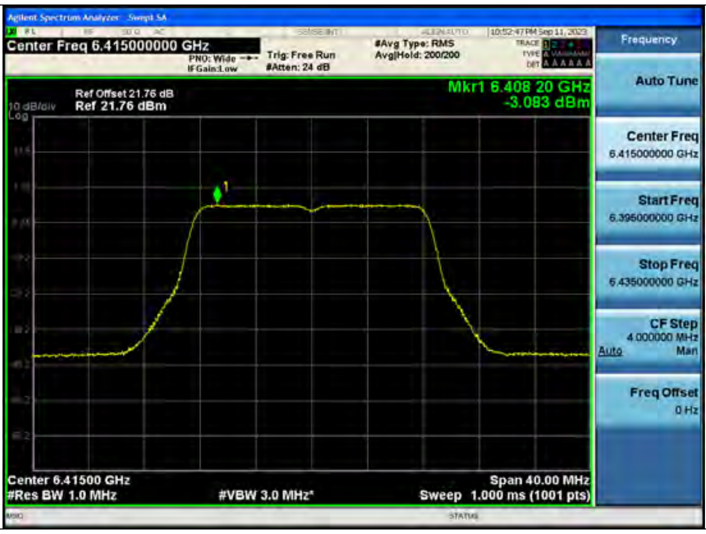
Ex) ANT1 : 15.35 dBm , ANT2 : 15.12 dBm, Directional Gain : 3 dBi

Conducted Power = (15.35 dBm + 15.12 dBm) = (34.276 mW + 32.508 mW) = 66.784 mW = 18.25 dBm

E.I.R.P = 18.25 dBm + 3 dBi = 21.25 dBm

4.1 Indoor / Standard client

[MIMO_CDD(Ant1+Ant2)]

802.11a Ch.93(6415 MHz)	
Ant1	Ant2
	

SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
0.063	0.284	0.347	-1.103

Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

802.11ax HE20 Ch.97(6435 MHz) 242 Tones RU 61

Ant1	Ant2
	

SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
0.235	0.078	0.313	-1.267

Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

802.11ax HE40 Ch.43(6165 MHz) 242 Tones RU 61

Ant1	Ant2
	

SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
-0.279	0.068	-0.211	-1.661

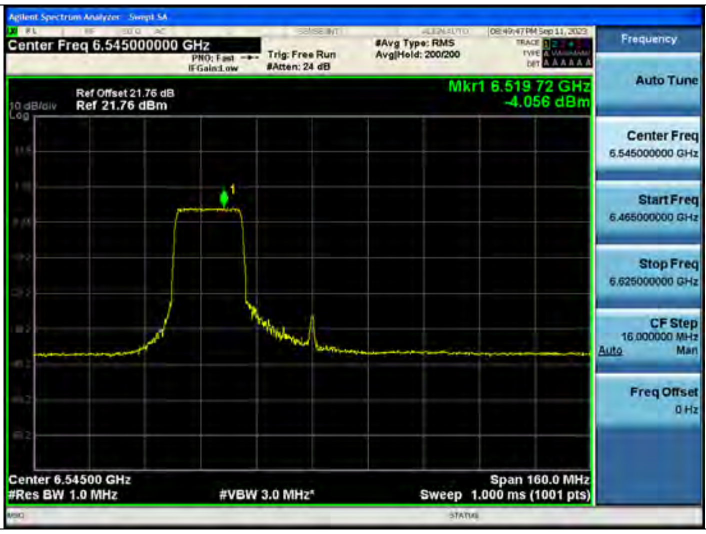
Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

802.11ax HE80 Ch.119(6545 MHz) 242 Tones RU 61

Ant1	Ant2
	

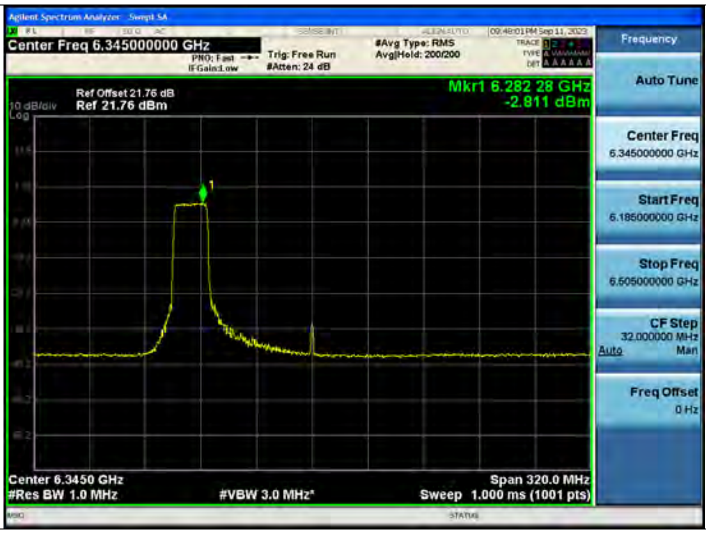
SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
-0.394	0.068	-0.325	-1.905

Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

802.11ax HE160 80_L Ch.79(6345 MHz) 242 Tones RU 61	
Ant1	Ant2
	

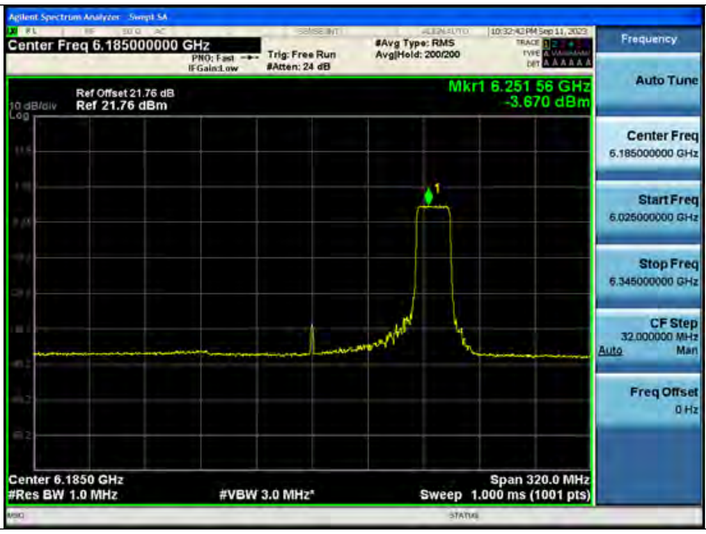
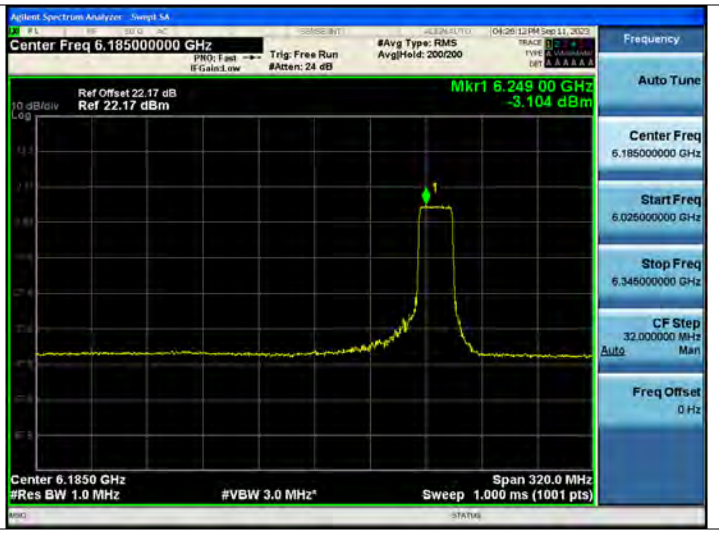
SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
0.034	0.068	0.102	-1.348

Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

802.11ax HE160 80_U Ch.47(6185 MHz) 242 Tones RU 64	
Ant1	Ant2
	

SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
-0.367	0.068	-0.299	-1.749

Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

802.11ax HE160 Ch.111(6505 MHz) SU

Ant1

Ant2

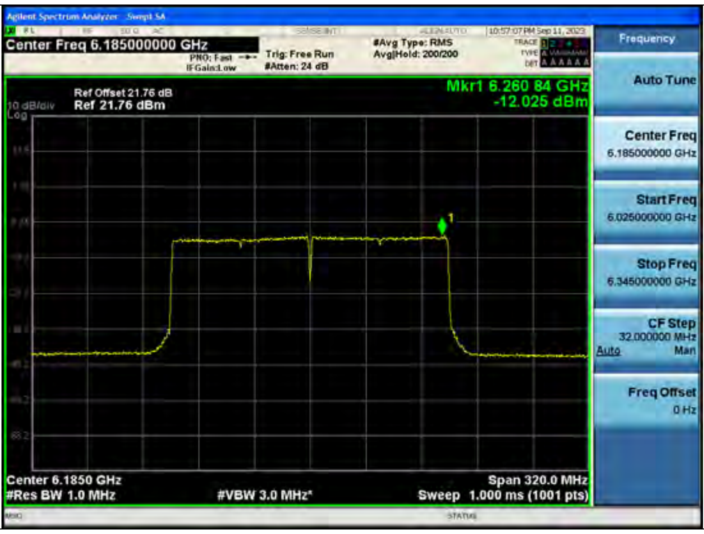
SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
-8.830	0.016	-8.814	-10.394

Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

802.11ax HE160 Ch.47(6185 MHz) 2x996 Tones RU 68	
Ant1	Ant2
	

SUM PSD (dBm/MHz)	Duty Cycle Factor (dB)	Total PSD (dBm/MHz)	EIRP PSD (dBm/MHz)
-8.932	0.012	-8.920	-10.370

Note:

SUM PSD(dBm/MHz) = 10log(((10^(Ant 1 PSD /10)+10^(Ant 2 PSD/10))) (dBm/MHz)

Total PSD (dBm/MHz) = SUM PSD(dBm/MHz) + Duty Cycle Factor (dB)

EIRP PSD(dBm/MHz) = Total PSD (dBm/MHz) + Directional Gain(dBi)

5. Contention Based Protocol

Note:

1. In order to simplify the report, Only worst case for each band have been inserted.
2. The worst case antenna gain(Minimum Gain) is selected from the table.
3. The lowest gain according to the incumbent frequency is applied.

Band	Ant 1 Gain (dBi)	Ant 2 Gain (dBi)
UNII-5	-6.32	-
UNII-6	-4.88	-
UNII-7	6 580 MHz, 6 615 MHz, 6 590 MHz: -6.36 6 665 MHz, 6 740 MHz: -6.84	-
UNII-8	7 015 MHz, 6 910 MHz, 6 985 MHz: -7.76 7 060 MHz: -8.63	-

Incumbent Detection Result

UNII 5

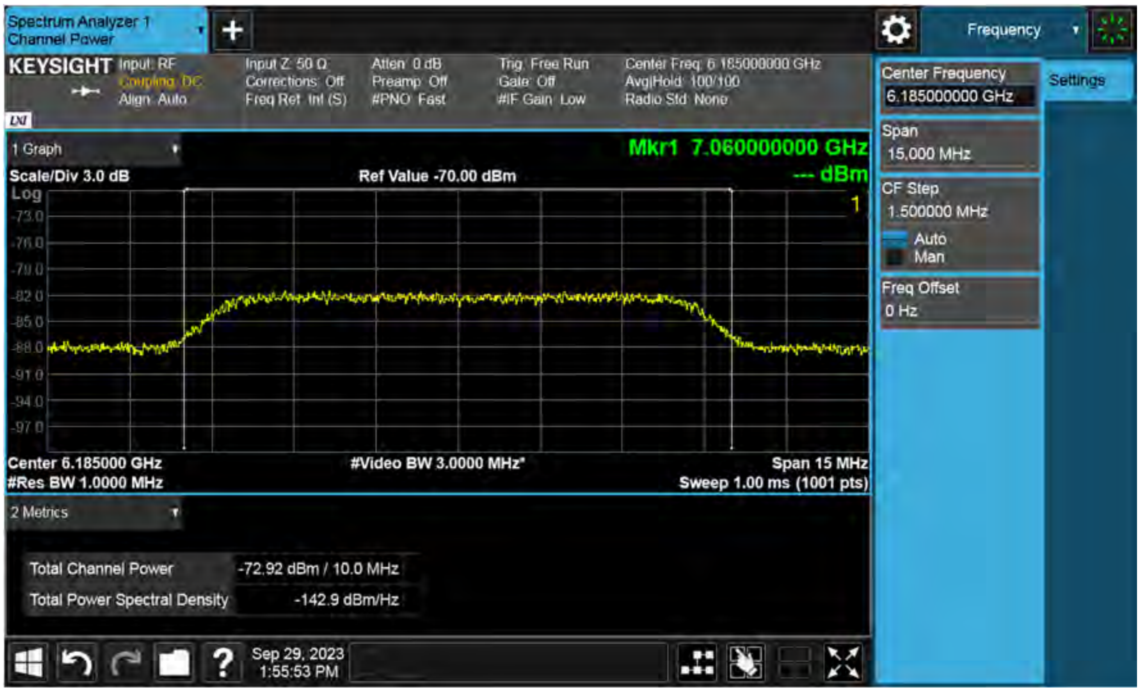
802.11ax HE160 Ch.47(6185 MHz) Incumbent signal (Ceased)

Note :

Marker 2 : AWGN Signal On

Marker 1△2 : AWGN signal Off (limit > 10s)

802.11ax HE160 Ch.47(6185 MHz) Detection Level



Bandwidth reduction plot (AWGN injected at low end)

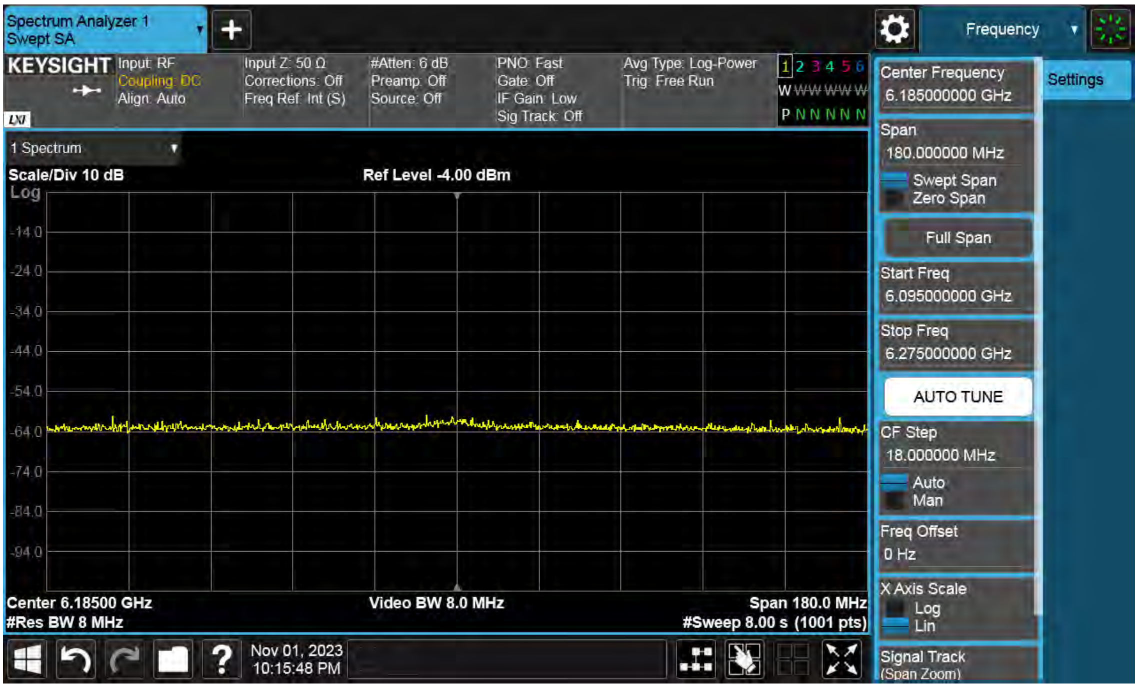
: A 10 MHz AWGN signal (centered at 6110 MHz) is injected.

The channel reduces to an 80 MHz channel centered around 6225 MHz.

Bandwidth reduction plot (AWGN injected at center)

: A 10 MHz AWGN signal (centered at 6185 MHz) is injected.

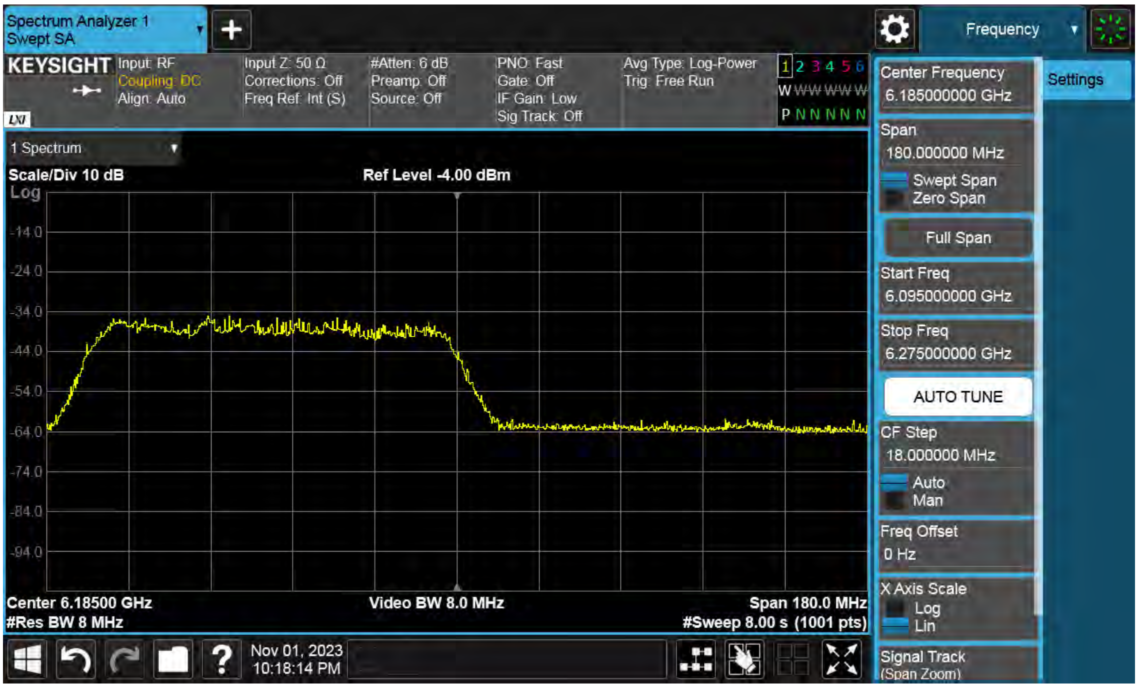
The channel completely ceases operation.



Bandwidth reduction plot (AWGN injected at high end)

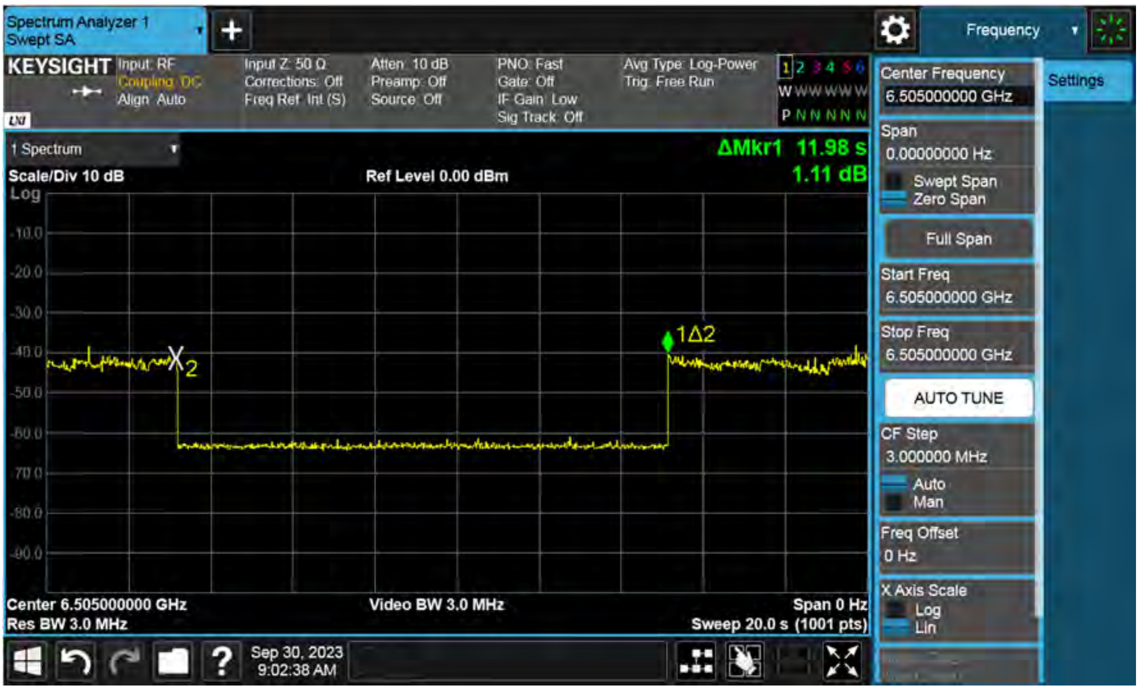
: A 10 MHz AWGN signal (centered at 6250 MHz) is injected.

The channel reduces to a 80 MHz channel centered around 6145 MHz.



UNII 6

802.11ax HE160 Ch.111(6505 MHz) Incumbent signal (Ceased)

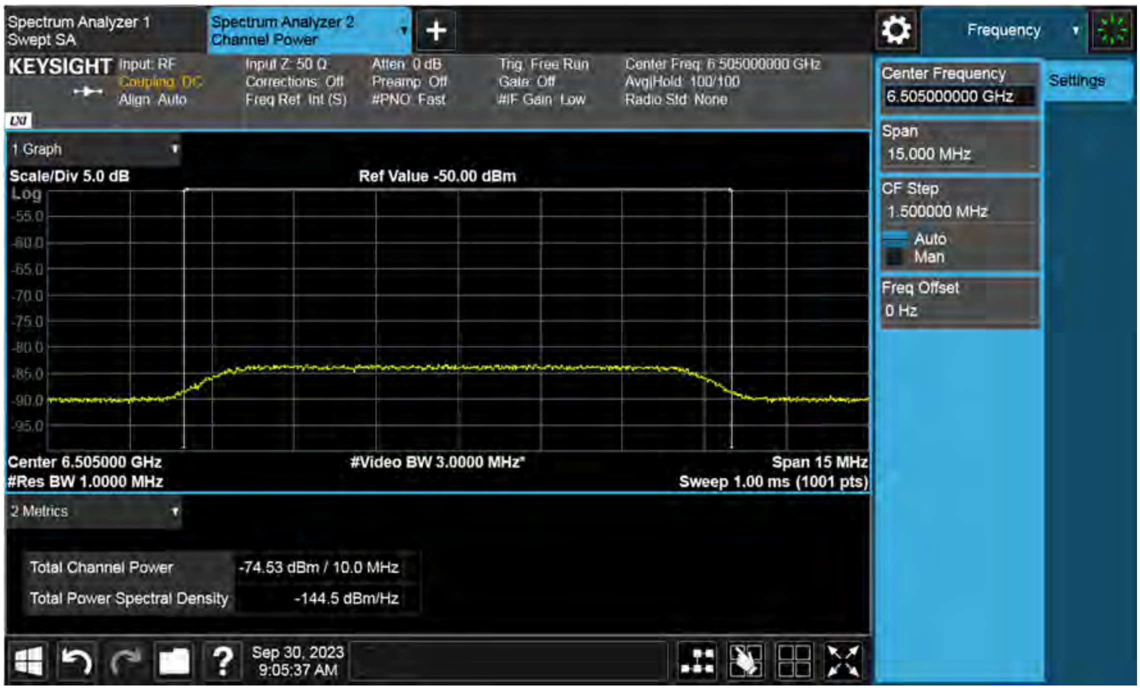


Note :

Marker 2 : AWGN Signal On

Marker 1△2 : AWGN signal Off (limit > 10s)

802.11ax HE160 Ch.111(6505 MHz) Detection Level



Bandwidth reduction plot (AWGN injected at low end)

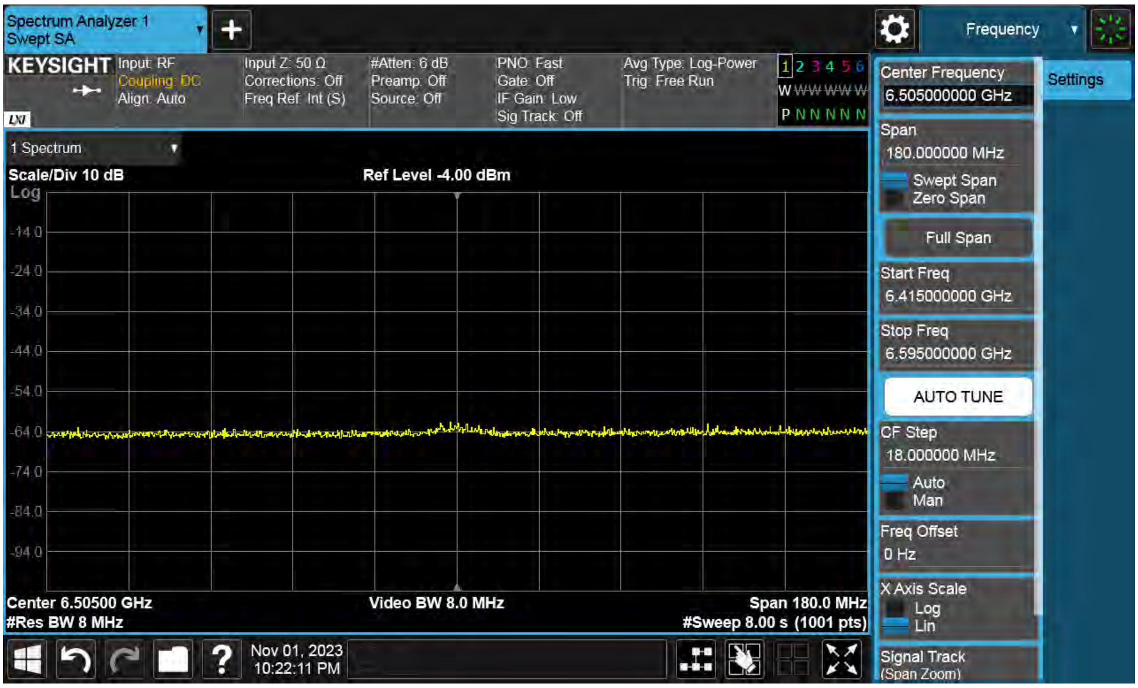
: A 10 MHz AWGN signal (centered at 6430 MHz) is injected.

The channel reduces to an 80 MHz channel centered around 6545 MHz.

Bandwidth reduction plot (AWGN injected at center)

: A 10 MHz AWGN signal (centered at 6505 MHz) is injected.

The channel completely ceases operation.



Bandwidth reduction plot (AWGN injected at high end)

: A 10 MHz AWGN signal (centered at 6580 MHz) is injected.

The channel reduces to a 80 MHz channel centered around 6465 MHz.

UNII 7

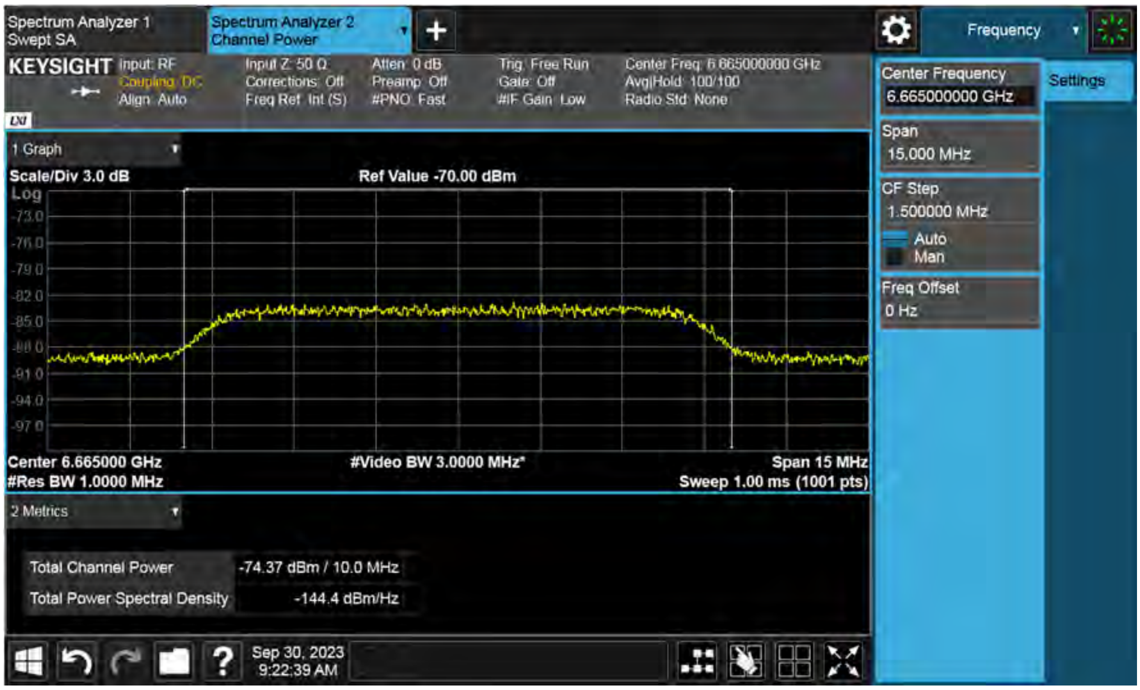
802.11ax HE160 Ch.143(6665 MHz) Incumbent signal (Ceased)

Note :

Marker 2 : AWGN Signal On

Marker 1△2 : AWGN signal Off (limit > 10s)

802.11ax HE160 Ch.143(6665 MHz) Detection Level



Bandwidth reduction plot (AWGN injected at low end)

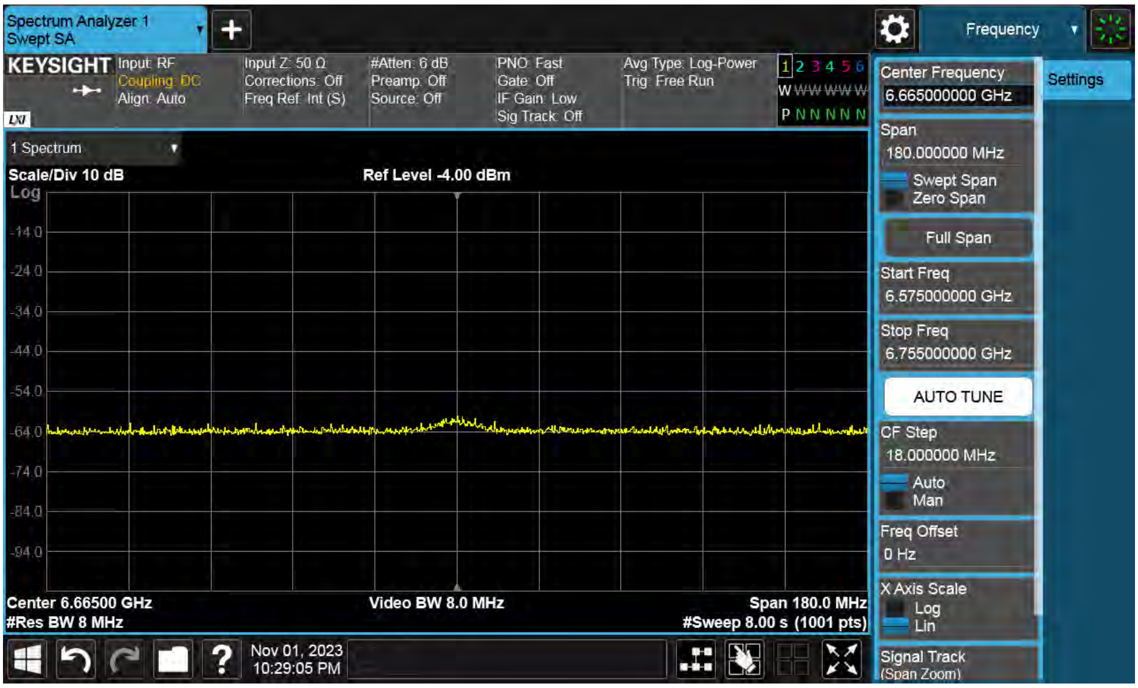
: A 10 MHz AWGN signal (centered at 6590 MHz) is injected.

The channel reduces to an 80 MHz channel centered around 6705 MHz.

Bandwidth reduction plot (AWGN injected at center)

: A 10 MHz AWGN signal (centered at 6665 MHz) is injected.

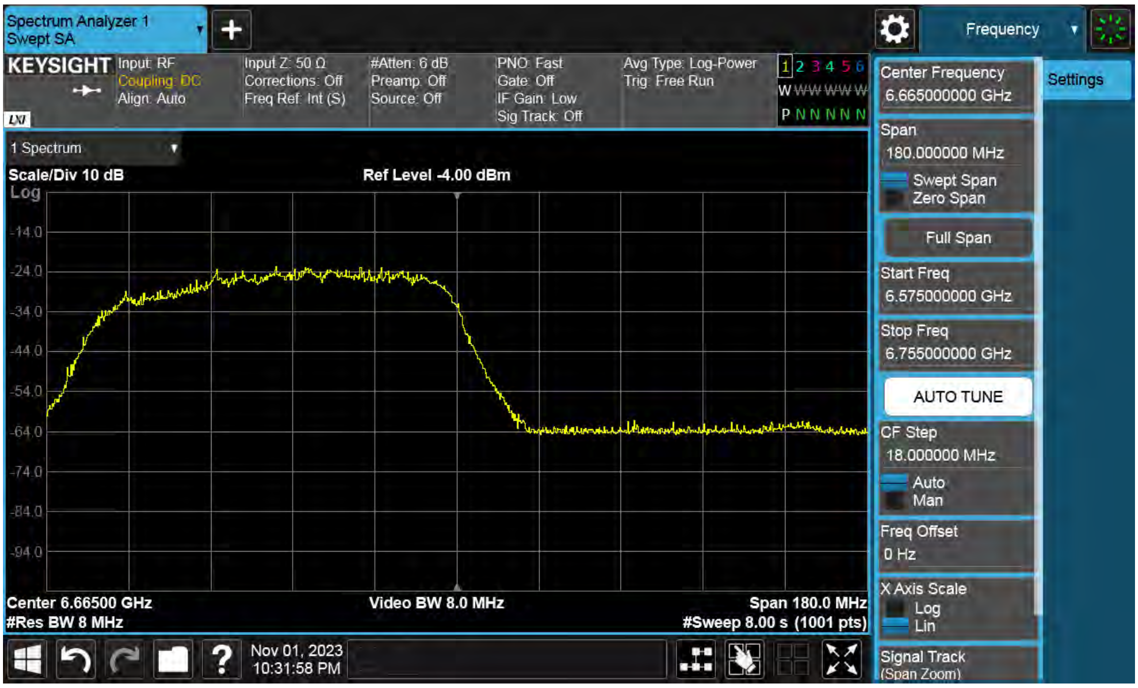
The channel completely ceases operation.



Bandwidth reduction plot (AWGN injected at high end)

: A 10 MHz AWGN signal (centered at 6740 MHz) is injected.

The channel reduces to a 80 MHz channel centered around 6625 MHz.



UNII 8

802.11ax HE160 Ch.207(6985 MHz) Incumbent signal (Ceased)

Note :

Marker 2 : AWGN Signal On

Marker 1△2 : AWGN signal Off (limit > 10s)

802.11ax HE160 Ch.207(6985 MHz) Detection Level

Bandwidth reduction plot (AWGN injected at low end)

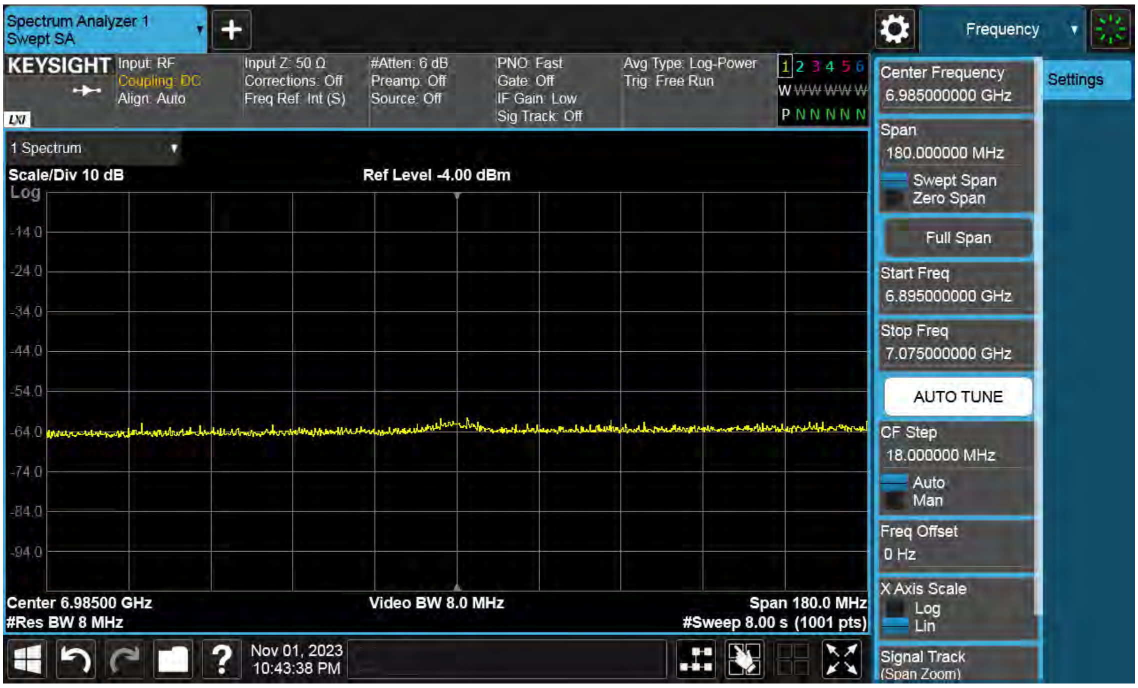
: A 10 MHz AWGN signal (centered at 6910 MHz) is injected.

The channel reduces to an 80 MHz channel centered around 7025 MHz.

Bandwidth reduction plot (AWGN injected at center)

: A 10 MHz AWGN signal (centered at 6985 MHz) is injected.

The channel completely ceases operation.



Bandwidth reduction plot (AWGN injected at high end)

: A 10 MHz AWGN signal (centered at 7060 MHz) is injected.

The channel reduces to a 80 MHz channel centered around 6945 MHz.