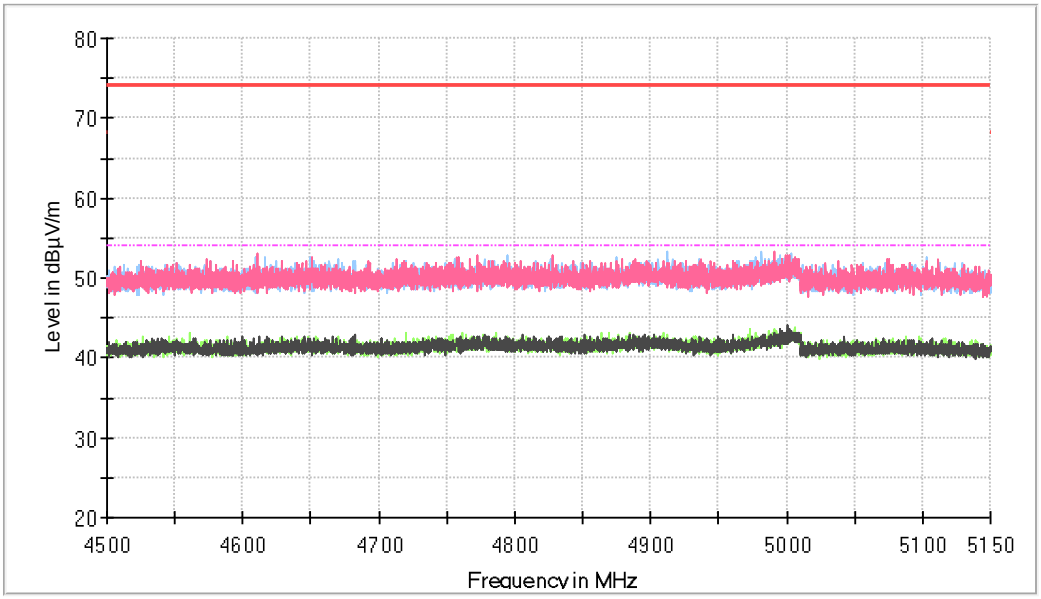
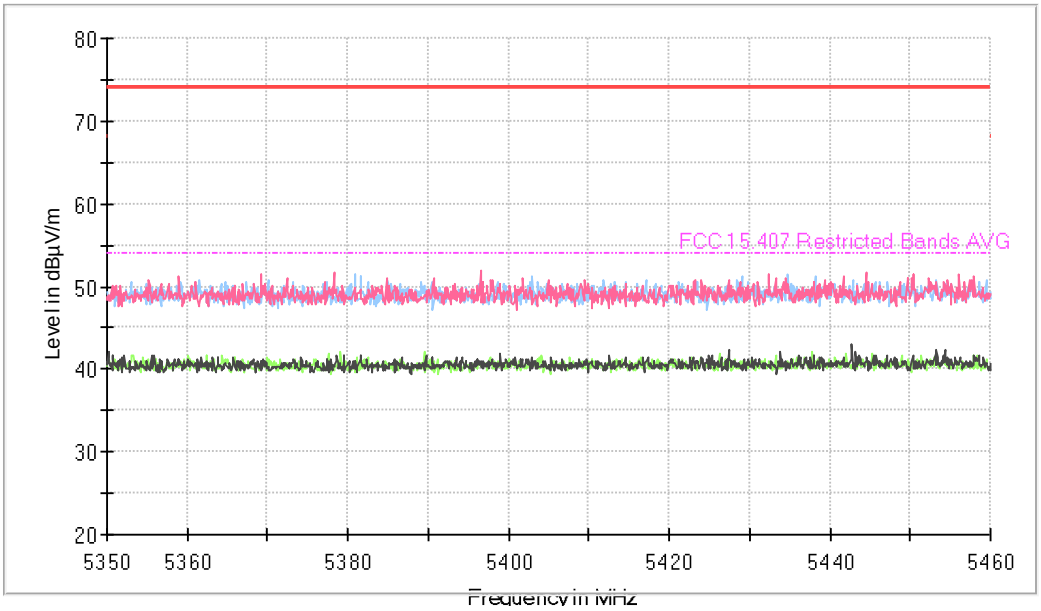
- Lower Band Edge and Upper Band Edge Channel 122 (5610 MHz):

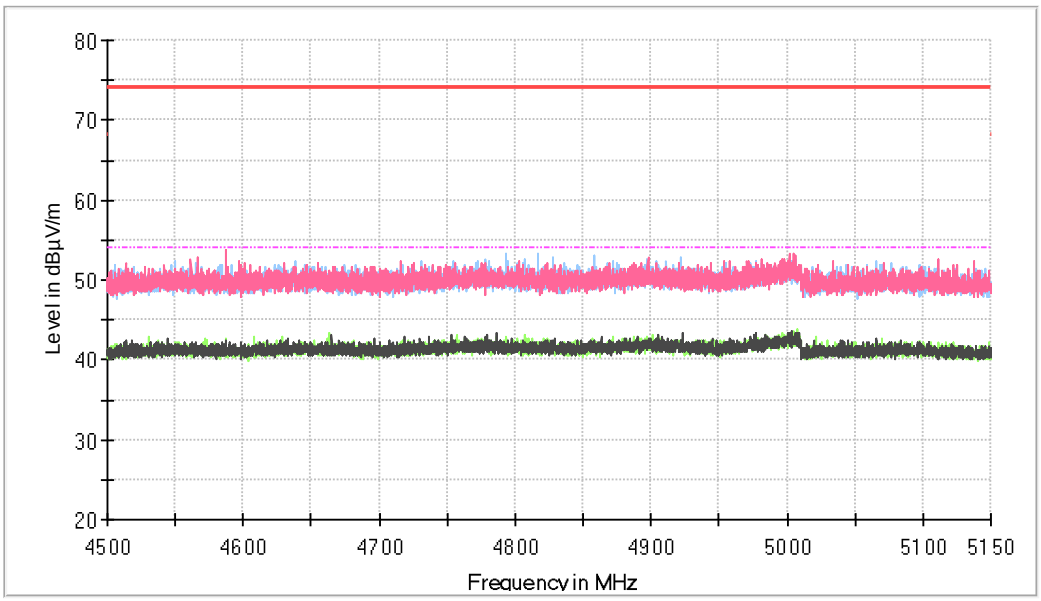


Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
FCC 15.407 Restricted Bands AVG
Final_Result PK+
Final_Result AVG

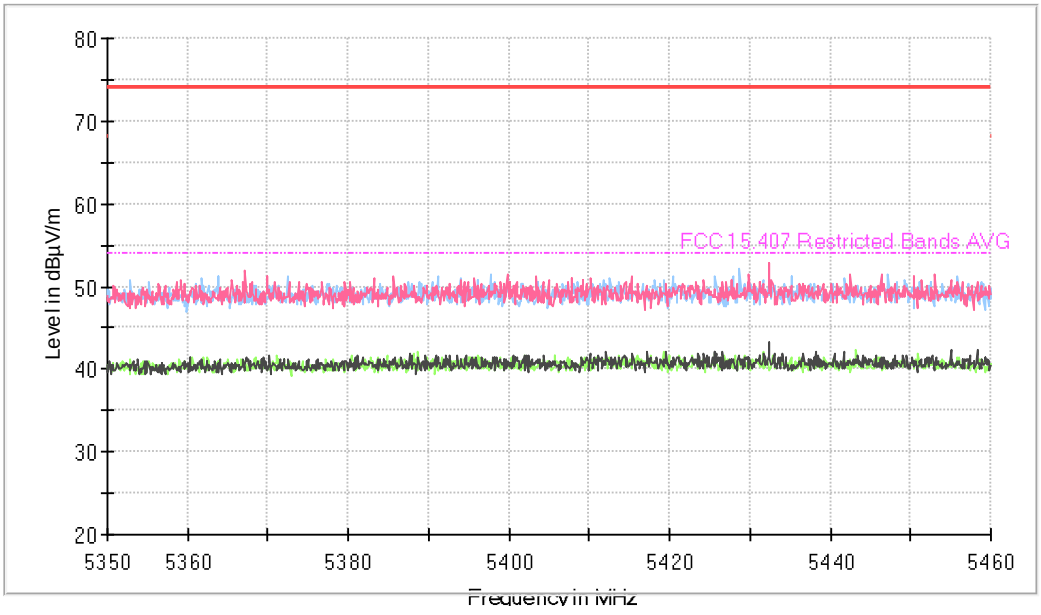


Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
FCC 15.407 Restricted Bands AVG
Final_Result PK+
Final_Result AVG

- Lower Band Edge and Upper Band Edge Straddle Channel 138 (5690 MHz):



Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
FCC 15.407 Restricted Bands AVG
Final_Result PK+
Final_Result AVG



Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
FCC 15.407 Restricted Bands AVG
Final_Result PK+
Final_Result AVG

Appendix E: Tests results for the U-NII-3: 5.725 GHz – 5.85 GHz Band

INDEX

TEST CONDITIONS

(*) Declared by the Client.

POWER SUPPLY (*):

Vnominal:	115 Vac
Type of Power Supply:	AC power

ANTENNA (*):

Type of Antennas:	Monopoles (printed on PCB). 2 antennas.
Maximum Declared Antenna Gain Chain 0:	+3.1 dBi
Maximum Declared Antenna Gain Chain 1:	+5.0 dBi

Directional Antenna Gain Calculations for CDD MIMO In-Band Measurements:

U-NII-1, U-NII-2A, U-NII-2C & U-NII-3:

For 2Tx CDD MIMO modes, in accordance with KDB 662911 D01 v02r01 Section F)2)f)(ii) y F)2)e)ii), directional gain, directional gain was calculated as follows:

$N_{ss} = 1$, $N_{ANT} = 2$, $G_{ANT0} = +3.1$ dBi, $G_{ANT1} = +5.0$ dBi

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

$$= 10\log\left[\frac{(g_{1,1}+g_{1,2})^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{G_1}{20}}+10^{\frac{G_2}{20}}\right)^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{3.1}{20}}+10^{\frac{5.0}{20}}\right)^2}{2}\right] = 7.12 \text{ dBi}$$

TEST FREQUENCIES (*):

Technology Tested:	WLAN (IEEE 802.11 a20 / n2040 / ac204080 1x1 & 2x2)
Modes:	802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO)
	802.11n HT20: MCS0 to MCS23 (1 or 2 spatial stream with either SISO or 2 chain MIMO CDD).
	802.11n HT40: MCS0 to MCS23 (1 or 2 spatial stream with either SISO or 2 chain MIMO CDD).
	802.11ac VHT20: MCS0 to MCS9 (1 or 2 spatial stream) (SISO, or MIMO with CDD without TxBF).
	802.11ac VHT40: MCS0 to MCS9 (1 or 2 spatial stream) (SISO, or MIMO with CDD without TxBF).
	802.11ac VHT80: MCS0 to MCS9 (1 or 2 spatial stream) (SISO, or MIMO with CDD without TxBF).
Setting of cores / ports:	Chain 0, Chain 1, Chain 0 & 1
Beamforming:	No.

Band U-NII-3:

Operating Channel Bandwidth:	20 MHz	
Transmission Channels:	Channel	Channel Frequency (MHz)
	Low (149)	5745
	Middle (157)	5785
	High (165)	5825
Operating Channel Bandwidth:	40 MHz	
Transmission Channels:	Channel	Channel Frequency (MHz)
	Low (151)	5755
	High (159)	5795
Operating Channel Bandwidth:	80 MHz	
Transmission Channels:	Single (155)	5775

The test set-up was made in accordance to the general provisions of FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

The EUT was tested in the following operating mode:

- Continuously transmitting with a modulated carrier at maximum power in all required channels using the supported data rates/modulations types.

The field strength at the band edges was evaluated for each mode on the lowest and highest channels at the rated power for the channel under test.

For all modes, the EUT was configured in test mode using a software application. The application was used to enable a continuous transmission and to select the test channels as required. The client supplied instructions to configure the EUT. The customer supplied a document containing the setup instructions.

The worst cases for testing were identified for output power and spurious levels at the band edges which were selected based on preliminary testing that correspond to next data rates:

- 802.11a:	6 Mbps SISO 1Tx on Chain 1.
- 802.11n HT20:	MCS0 SISO 1Tx on Chain 1 / MIMO 2Tx on Chain 0+1.
- 802.11n HT40:	MCS0 SISO 1Tx on Chain 1 / MIMO 2Tx on Chain 0+1.
- 802.11ac VHT20:	MCS0 SISO 1Tx on Chain 1 / MIMO 2Tx on Chain 0+1.
- 802.11ac VHT40:	MCS0 SISO 1Tx on Chain 1 / MIMO 2Tx on Chain 0+1.
- 802.11ac VHT80:	MCS0 SISO 1Tx on Chain 1 / MIMO 2Tx on Chain 0+1.

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and connected to the TS8997 using a low-loss RF cable. The reading in the spectrum analyzer is corrected taking into account the internal and external RF cable loss.

For all modes:

RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) and 1 GHz-18 GHz Double ridge horn antenna is situated at a distance of 3 m and a distance of 1.5 m for the frequency range 17 GHz-40 GHz (18 GHz-40 GHz horn antenna).

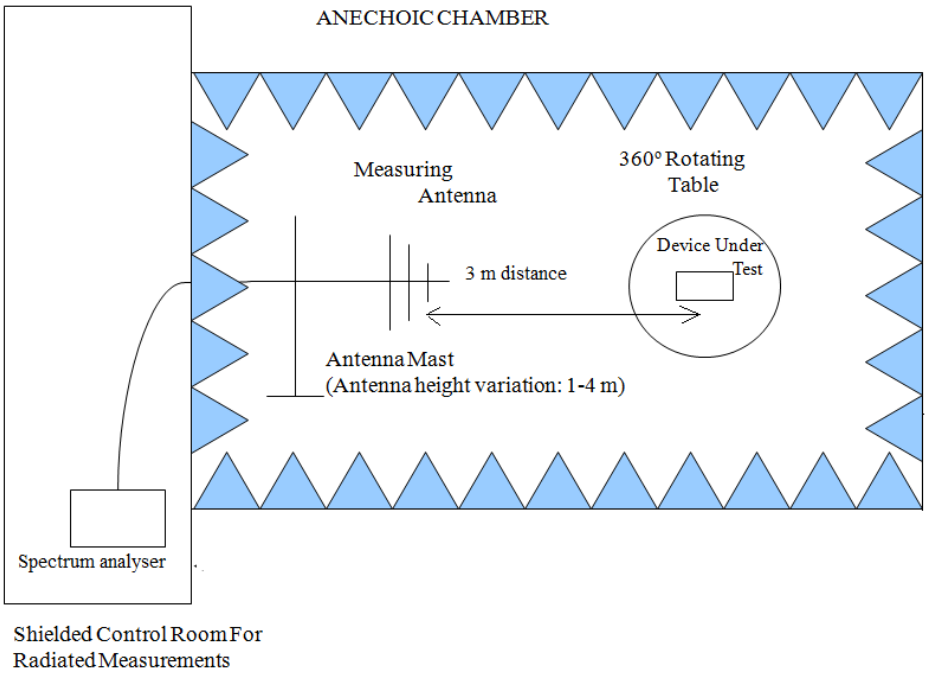
For radiated emissions in the range 17 GHz-40 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

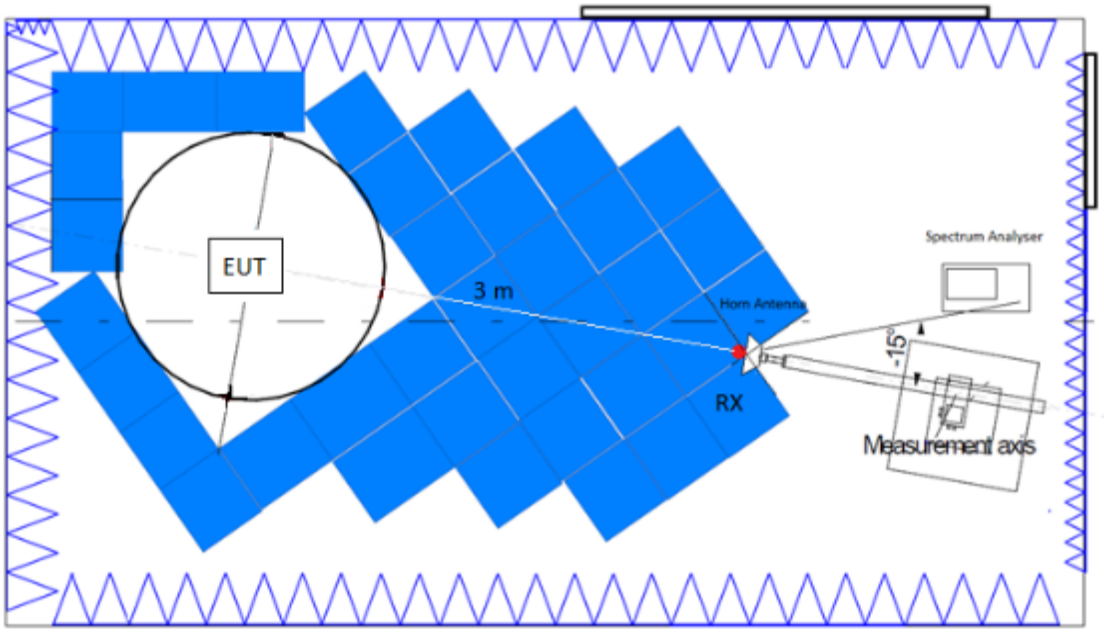
Measurements were made in both horizontal and vertical planes of polarization.

The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.

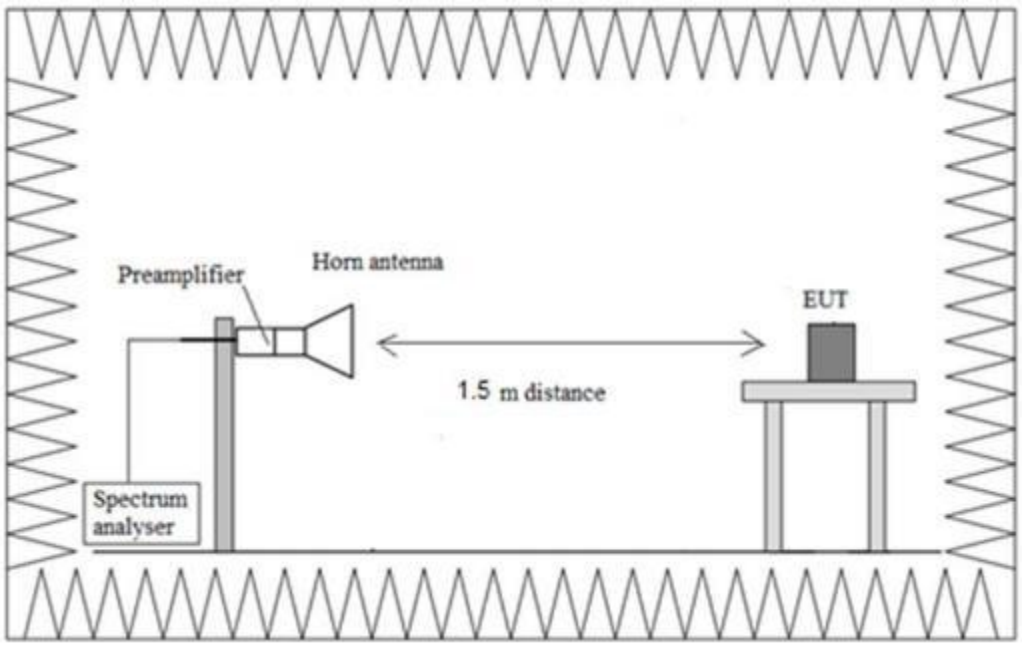
Radiated measurements setup f < 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



FCC 15.407 (e) / RSS-247 6.2.4.1. 6 dB Bandwidth

SPECIFICATION:

* FCC 15.407: The minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

* RSS-247: For equipment operating in the band 5725-5850 MHz, the minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS:

- Preliminary tests determined the SISO worst-case: Chain 1.
- Preliminary tests determined the MIMO worst-case: Chain 0+1.

Antenna Gain:

- SISO Antenna – Chain 0: +3.1 dBi
- SISO Antenna – Chain 1: +5.0 dBi
- MIMO Antennas – Chain 0 & 1: +7.12 dBi

SISO worst case:

SISO 802.11 a20:

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	16.45	16.45	16.45

SISO 802.11 n20 (HT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	17.65	17.65	17.65

SISO 802.11 ac20 (VHT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	17.85	17.85	17.80

SISO 802.11 n40 (HT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
6 dB Bandwidth (MHz)	36.45	36.35

SISO 802.11 ac40 (VHT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
6 dB Bandwidth (MHz)	36.55	36.55

SISO 802.11 ac80 (VHT80):

U-NII-3 (5725-5850 MHz):

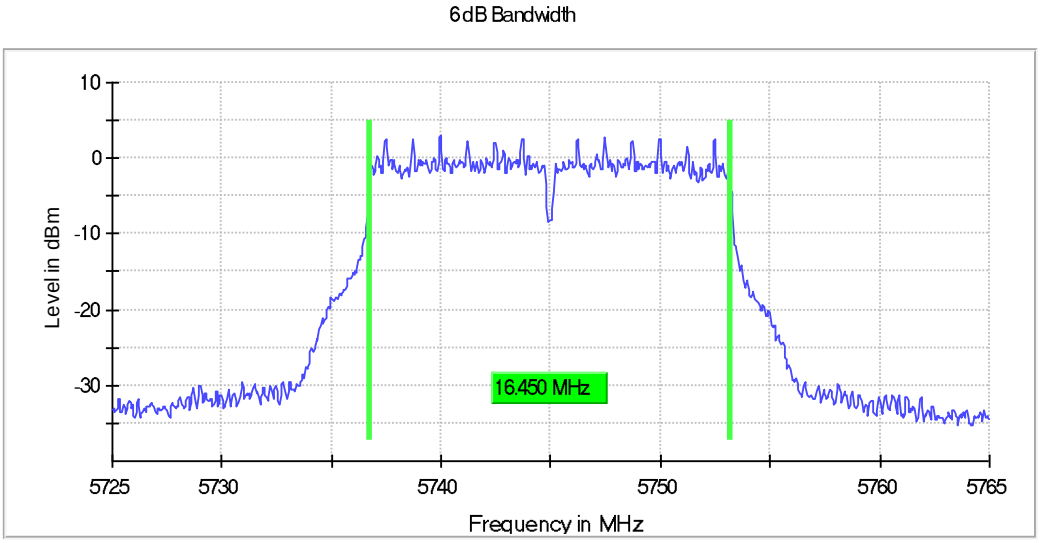
Channel	Single Channel 155 (5775 MHz)
6 dB Bandwidth (MHz)	76.50

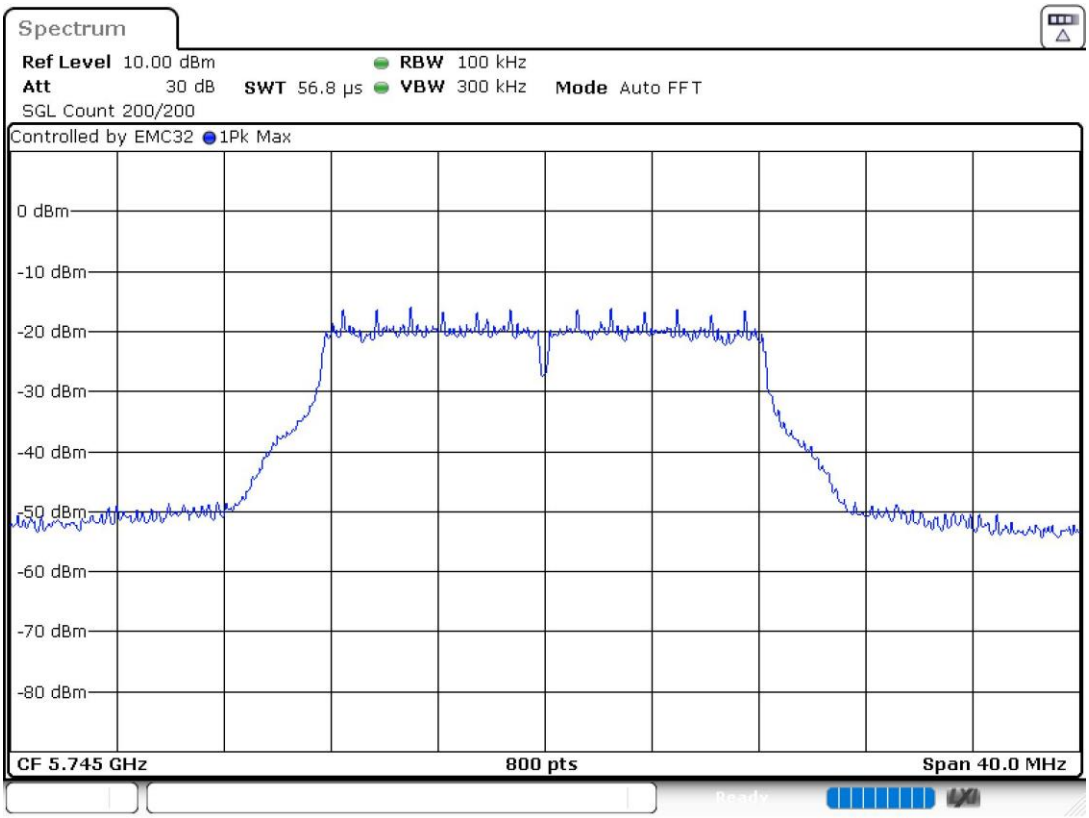
Verdict: PASS

SISO 802.11 a20:

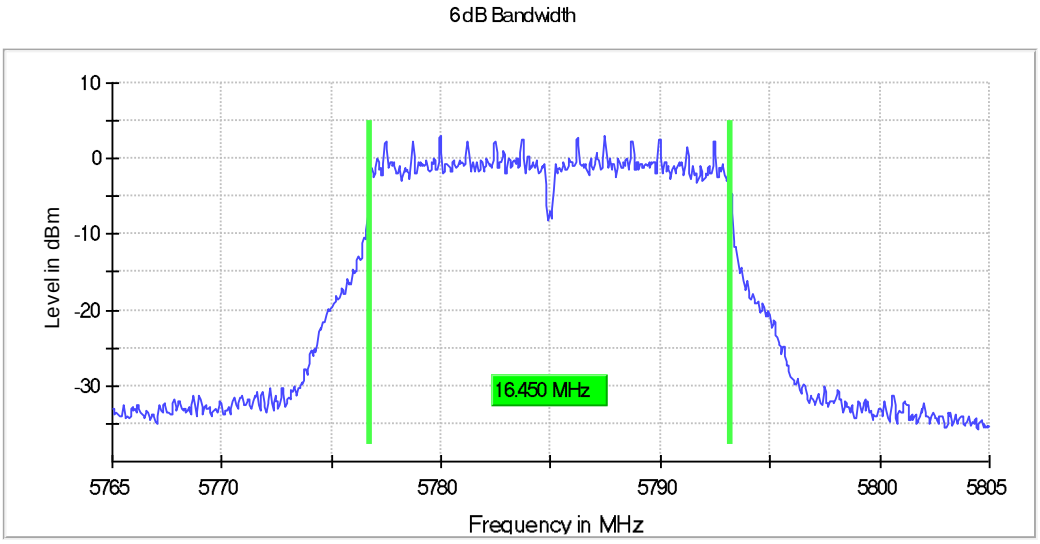
U-NII-3 (5725-5850 MHz)

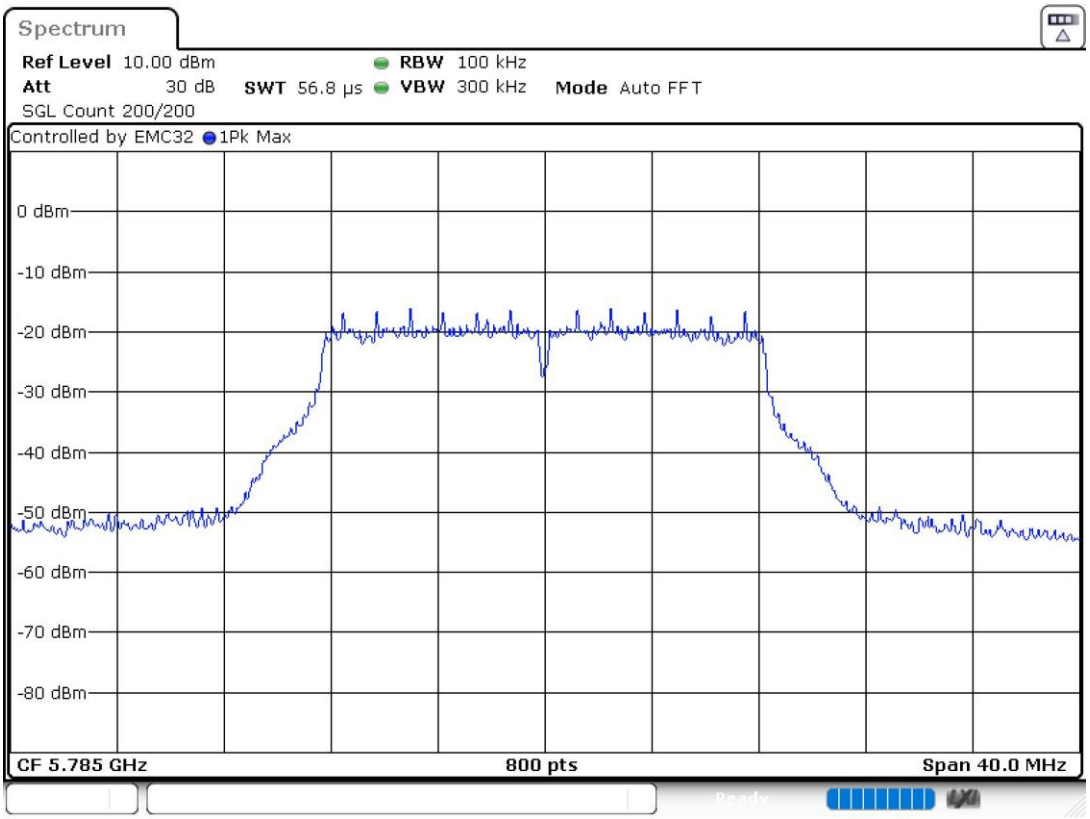
- Low Channel 149 (5745 MHz):



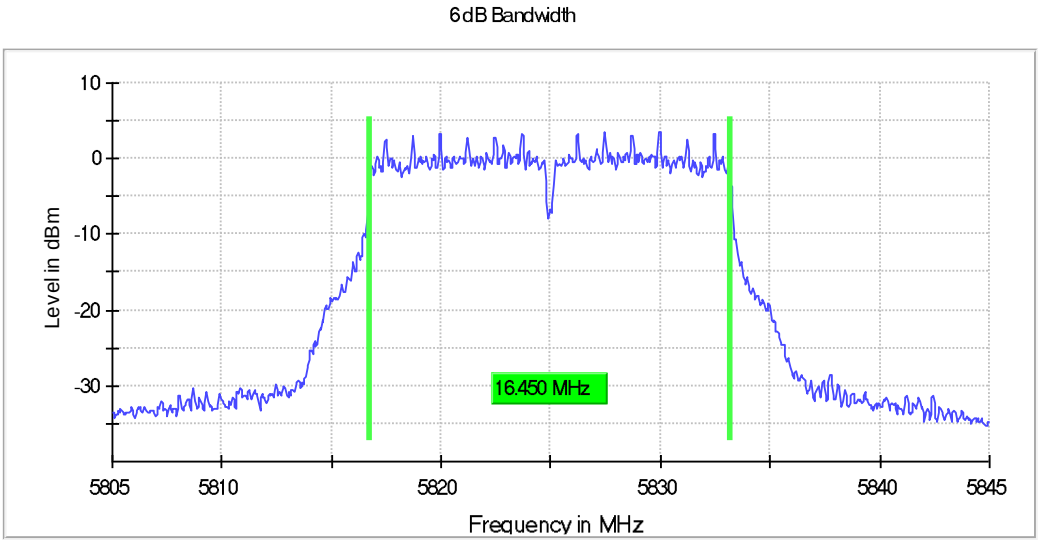


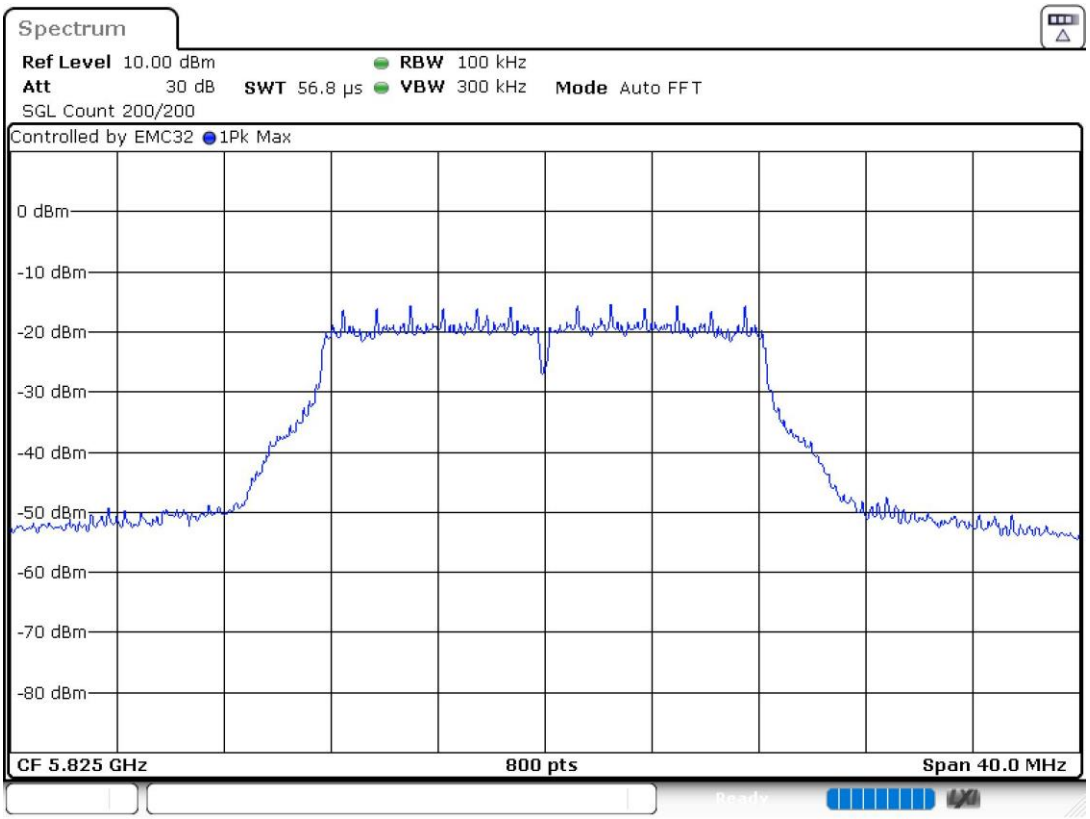
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

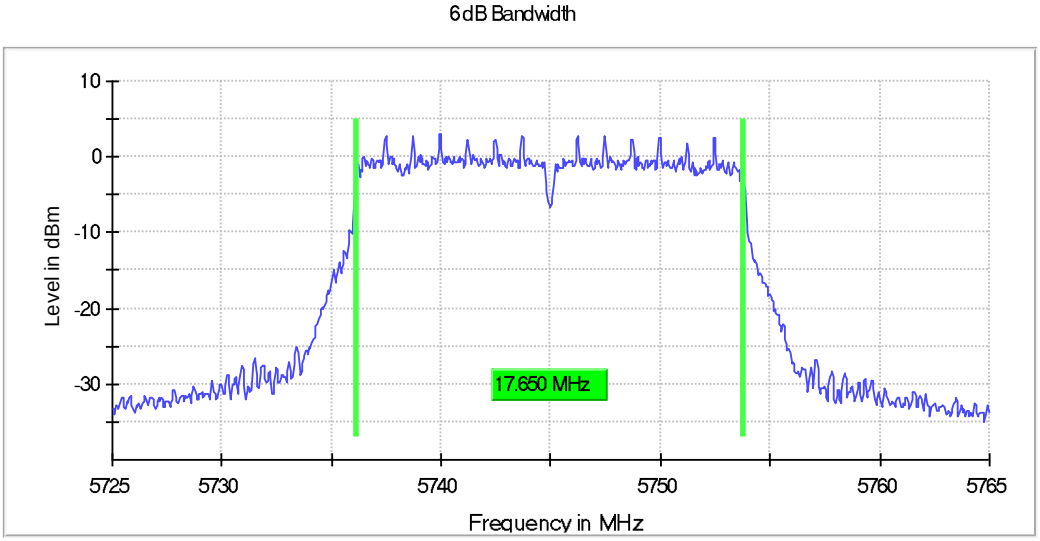


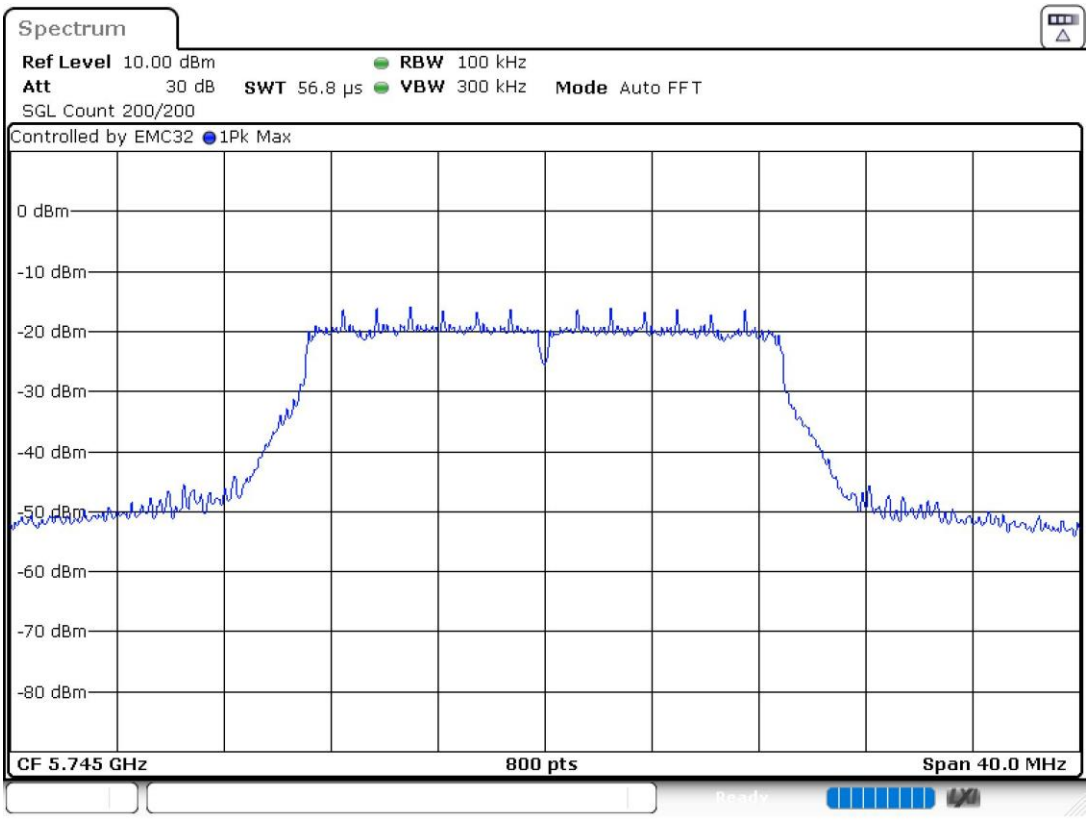


SISO 802.11 n20 (HT20):

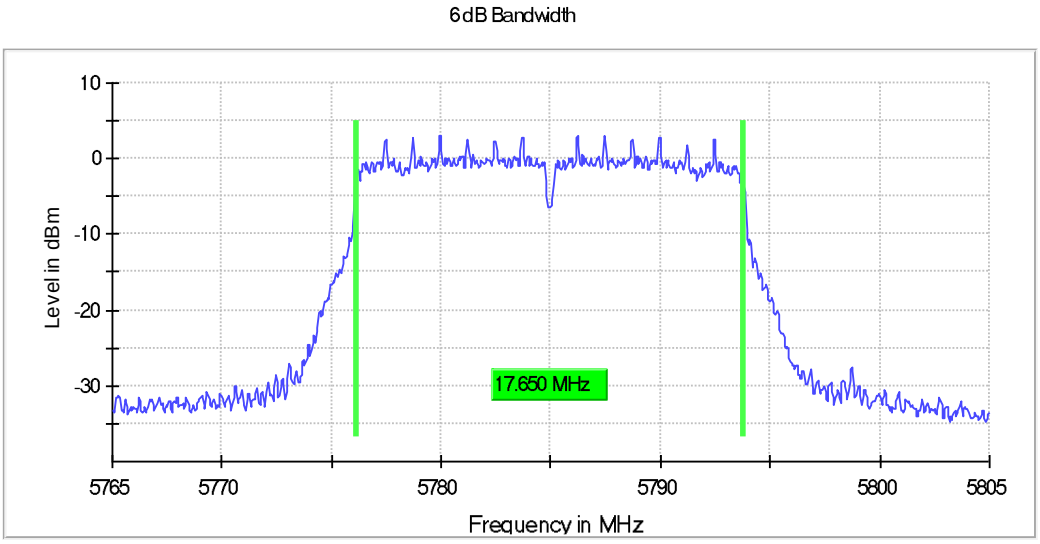
U-NII-3 (5725-5850 MHz)

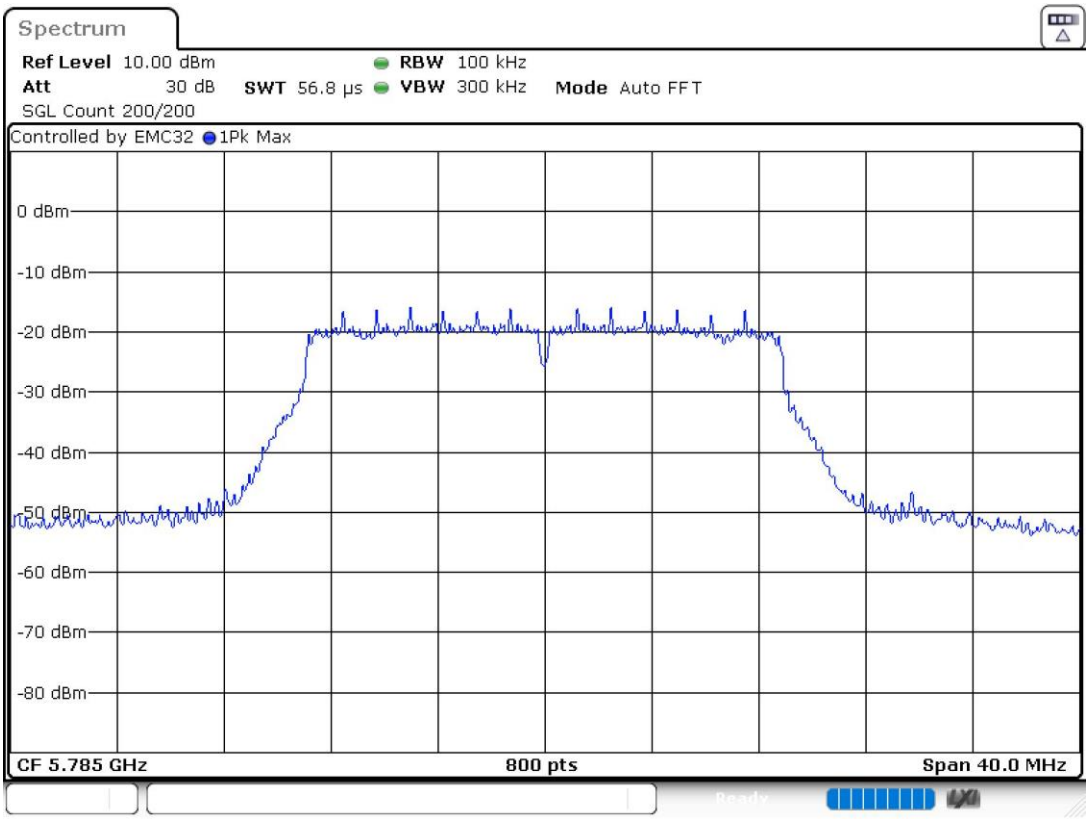
- Low Channel 149 (5745 MHz):



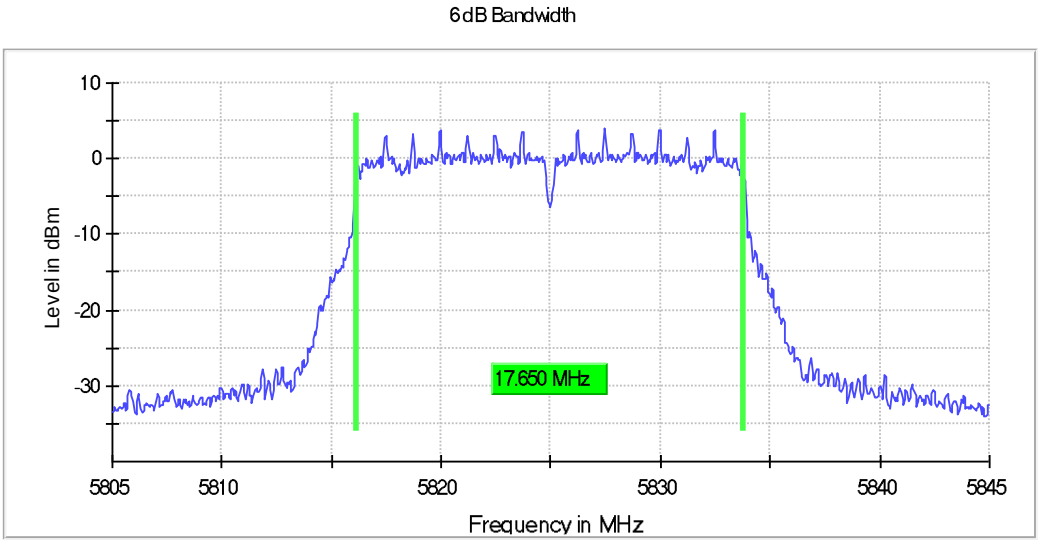


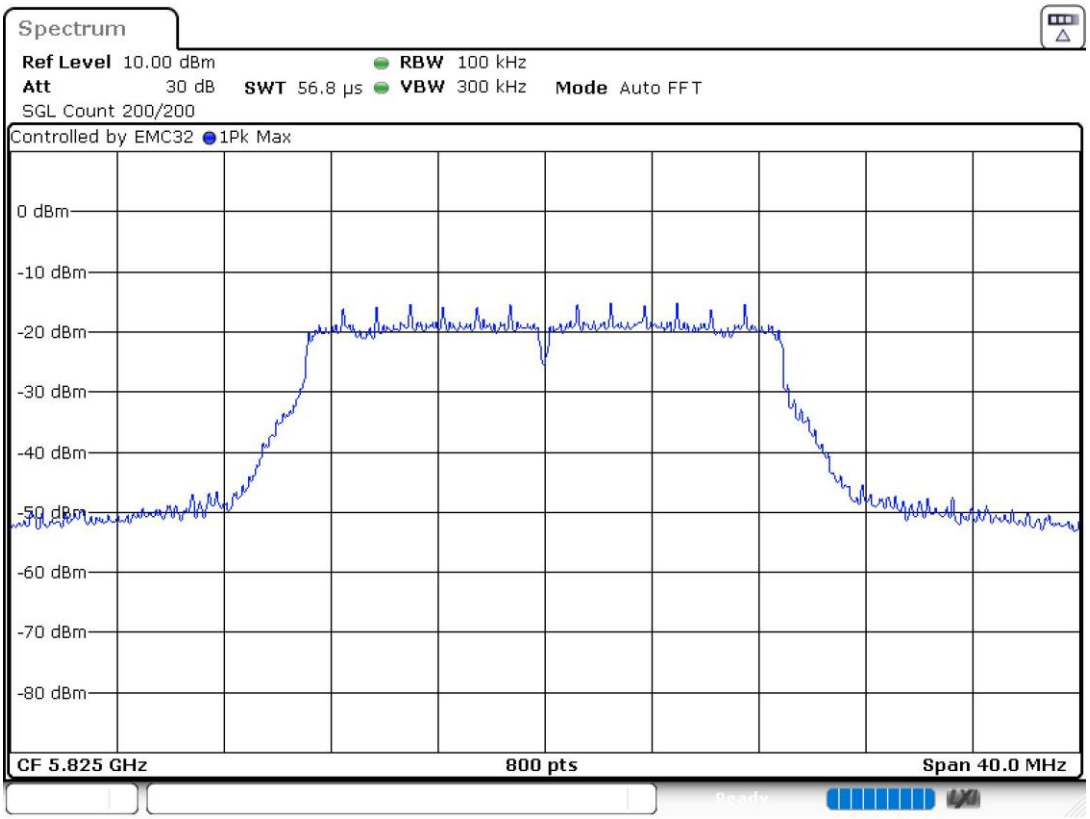
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

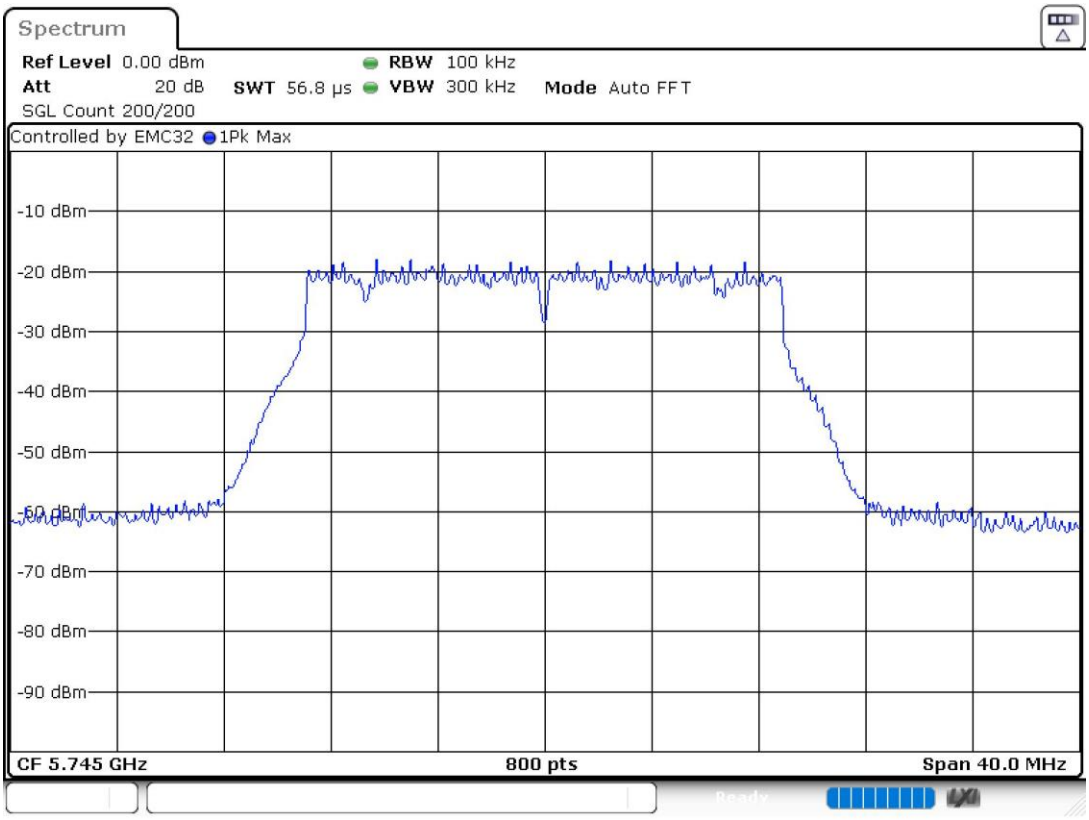




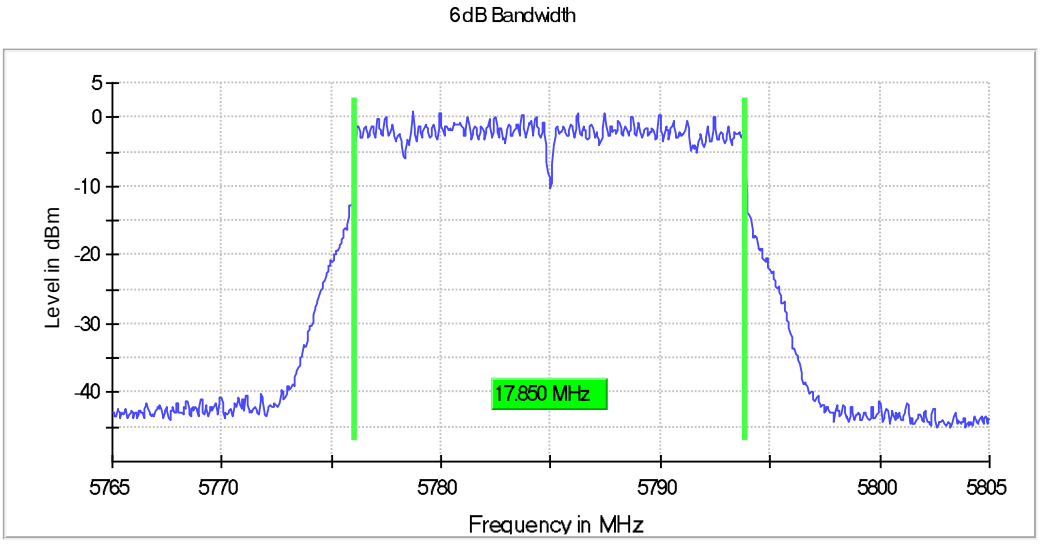
SISO 802.11 ac20 (VHT20):

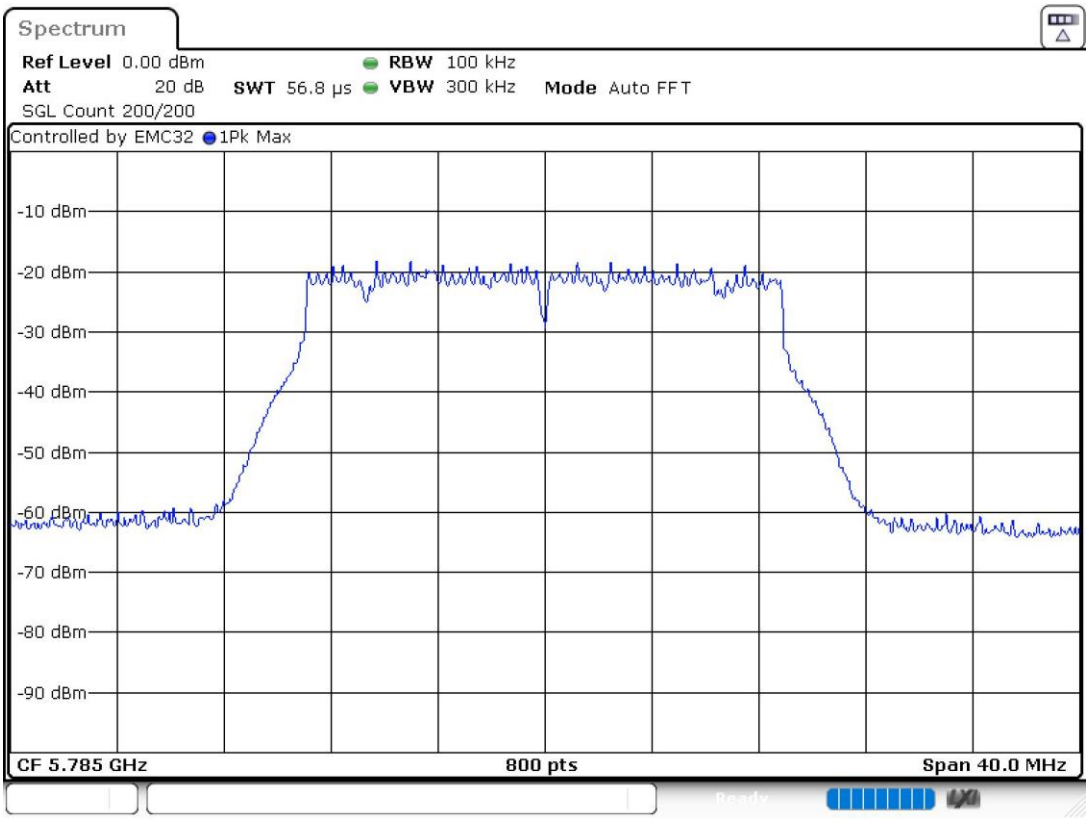
U-NII-3 (5725-5850 MHz)

- Low Channel 149 (5745 MHz):

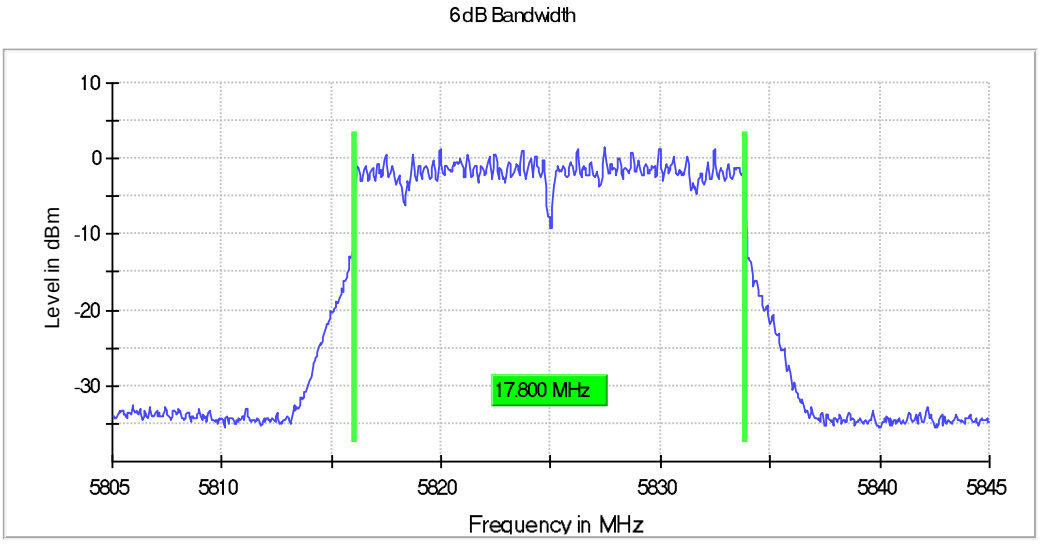


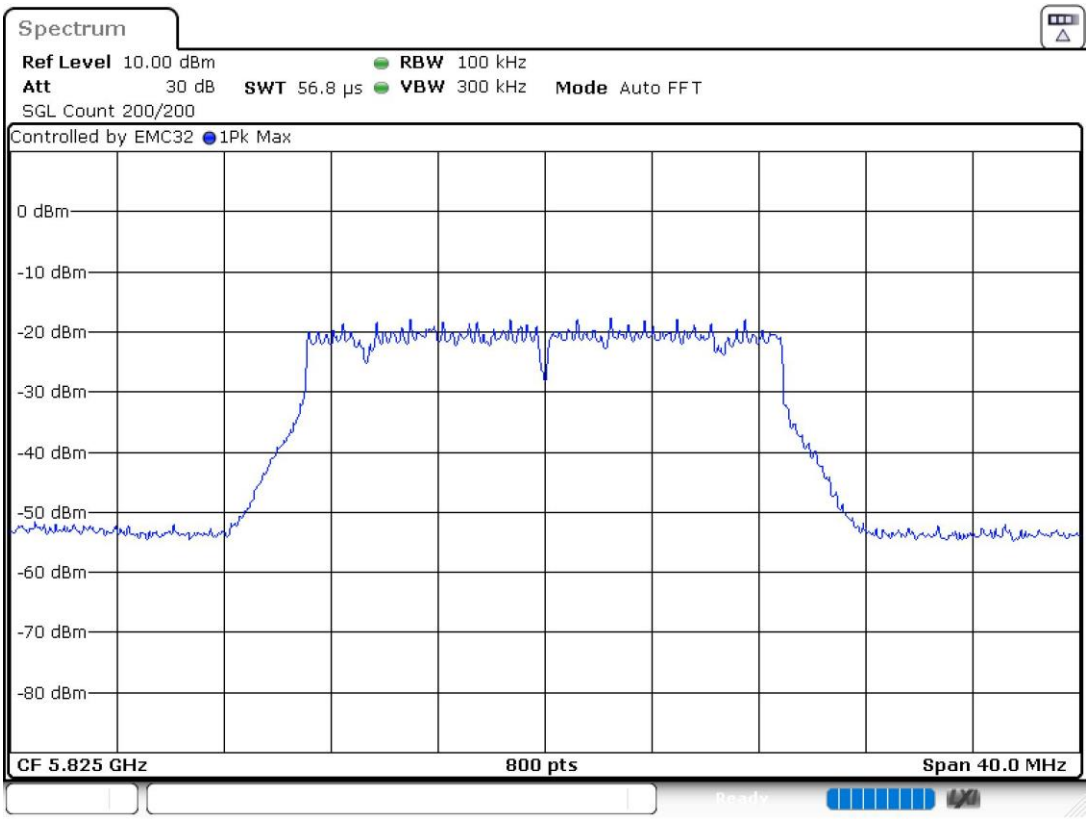
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

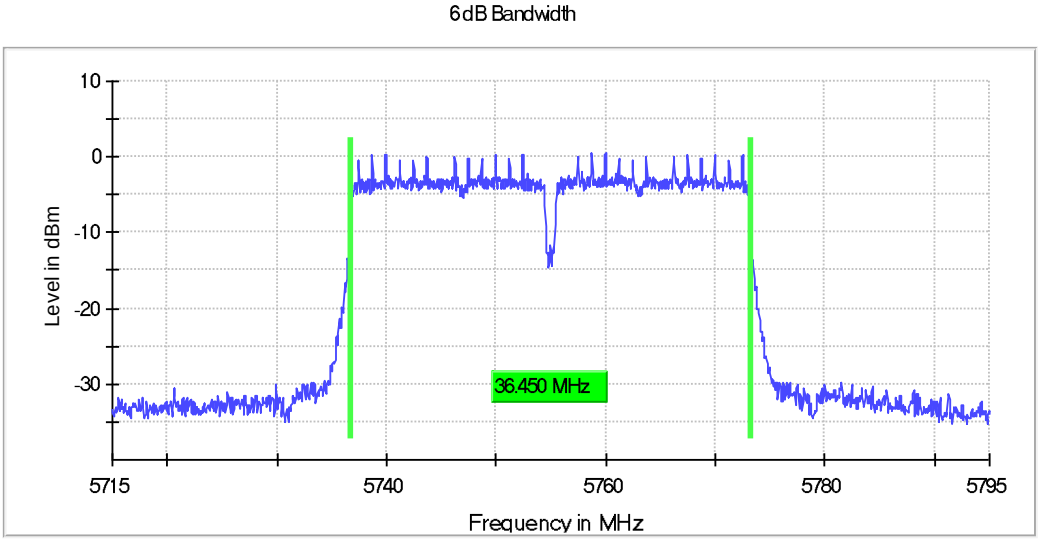


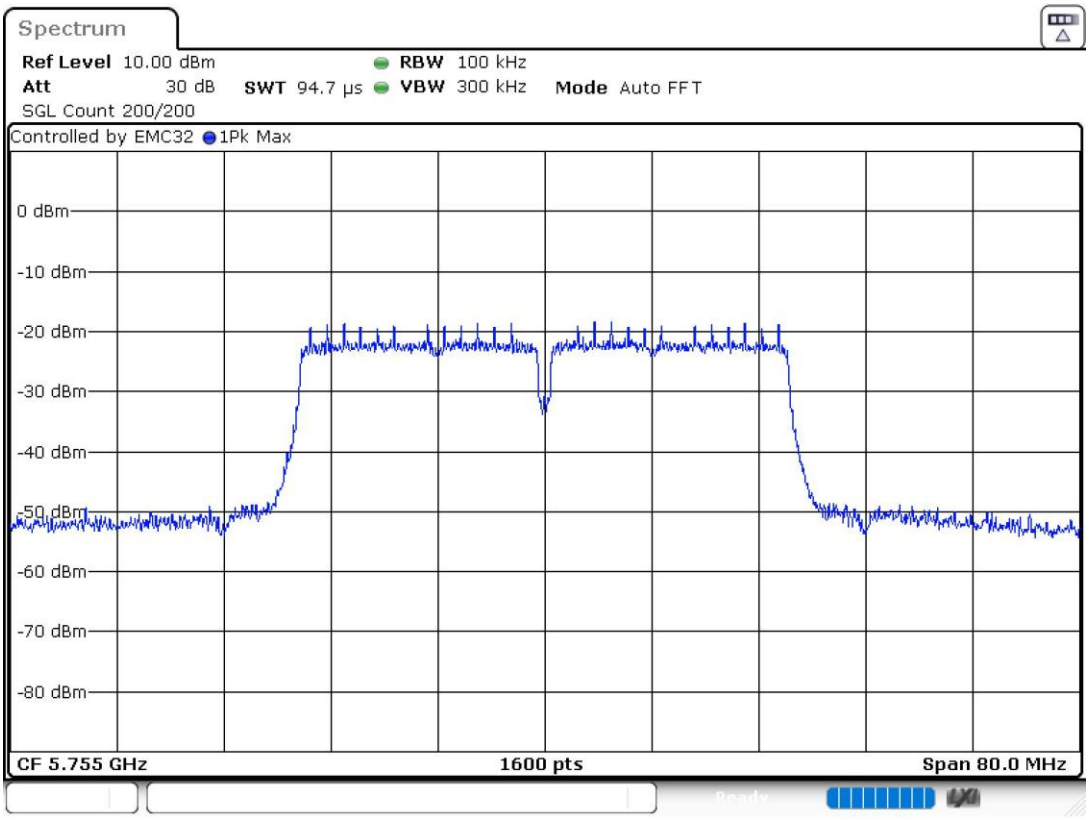


SISO 802.11 n40 (VHT40):

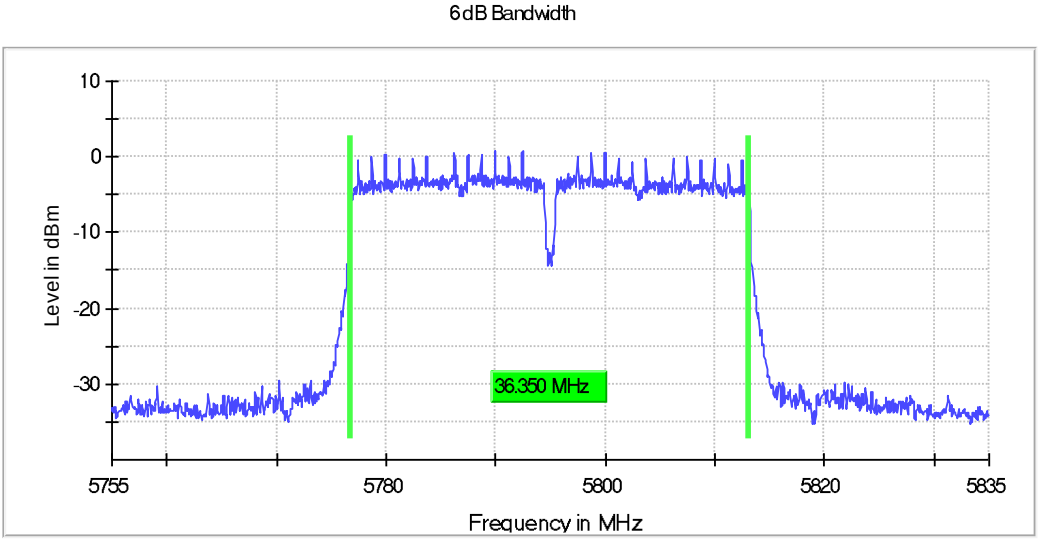
U-NII-3 (5725-5850 MHz)

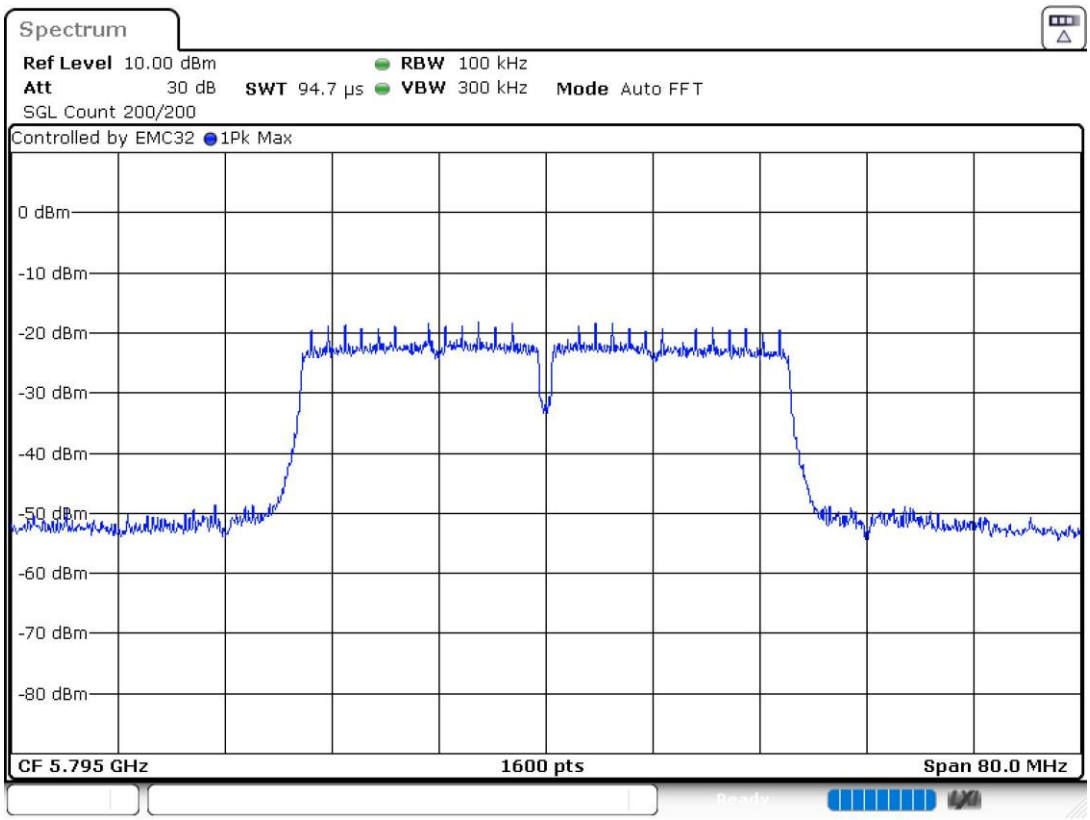
- Low Channel 151 (5755 MHz):





- High Channel 159 (5795 MHz):

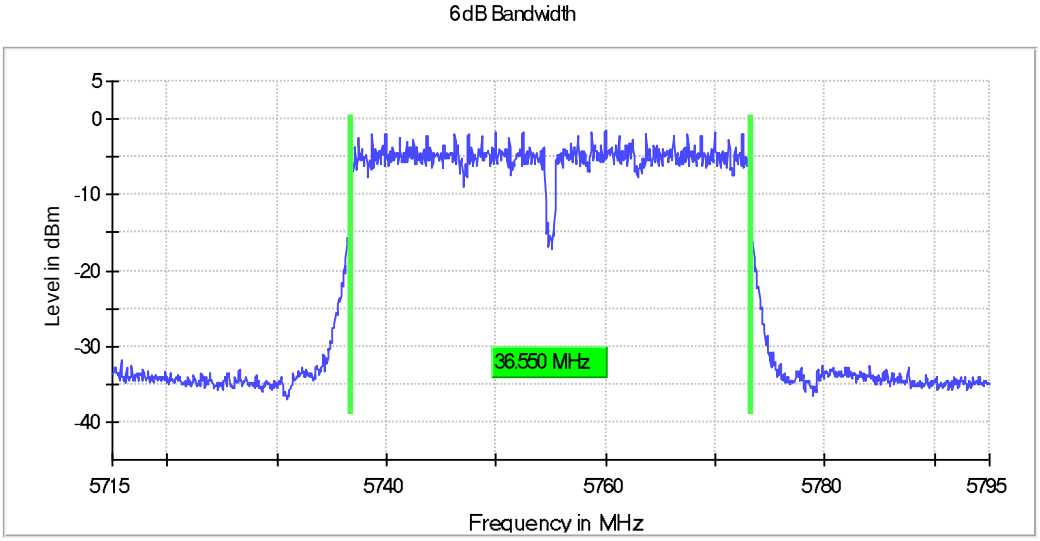


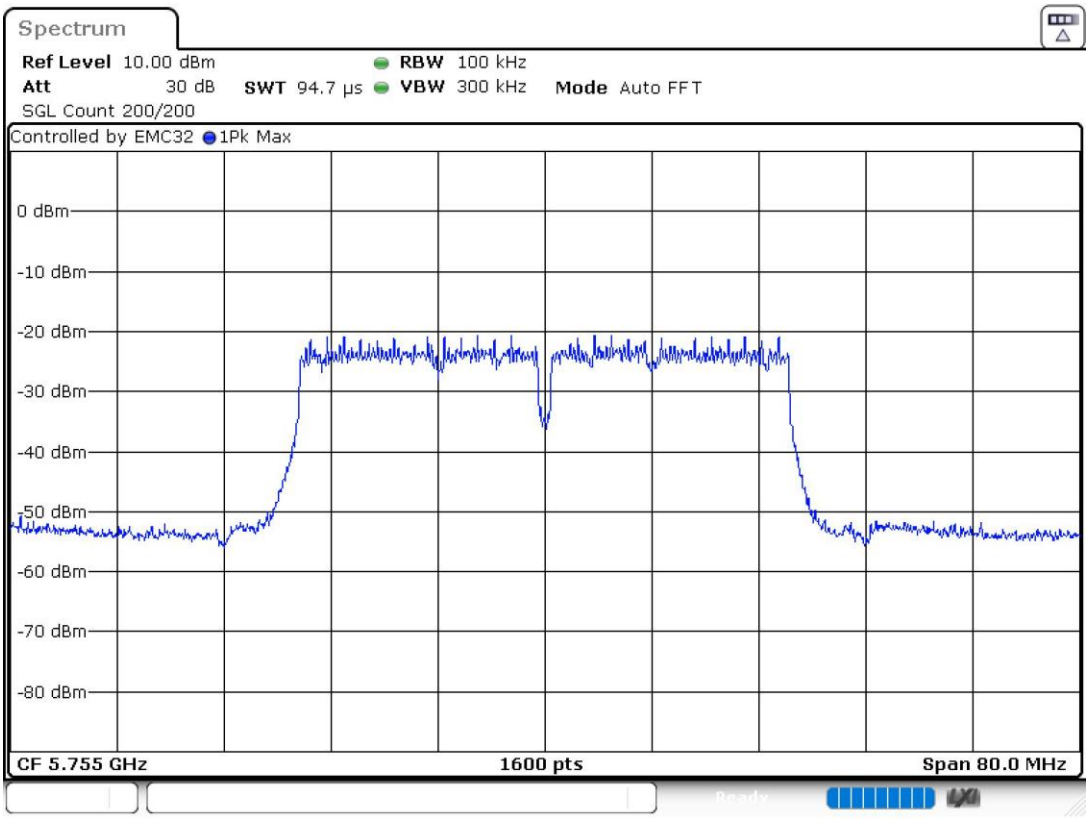


SISO 802.11 ac40 (VHT40):

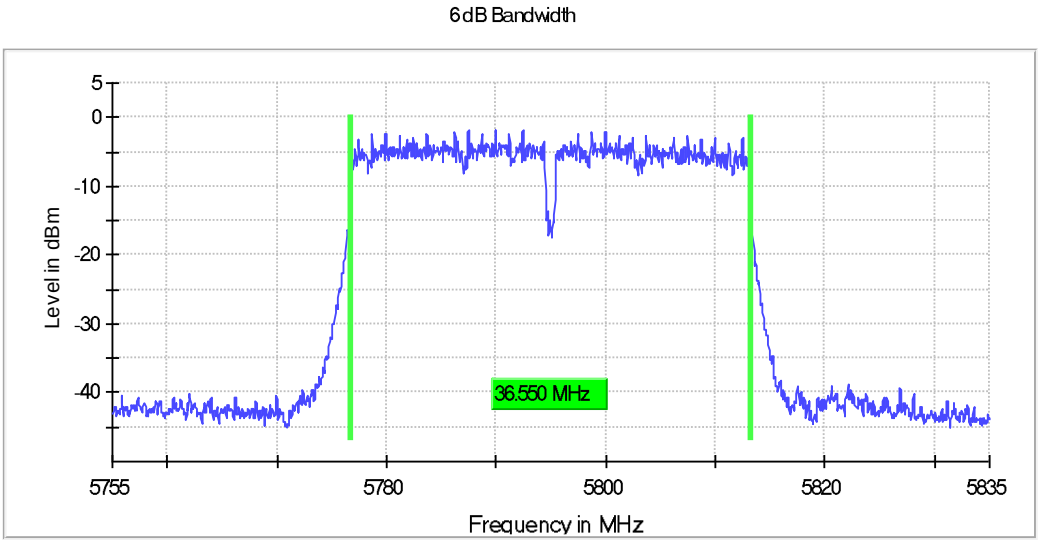
U-NII-3 (5725-5850 MHz)

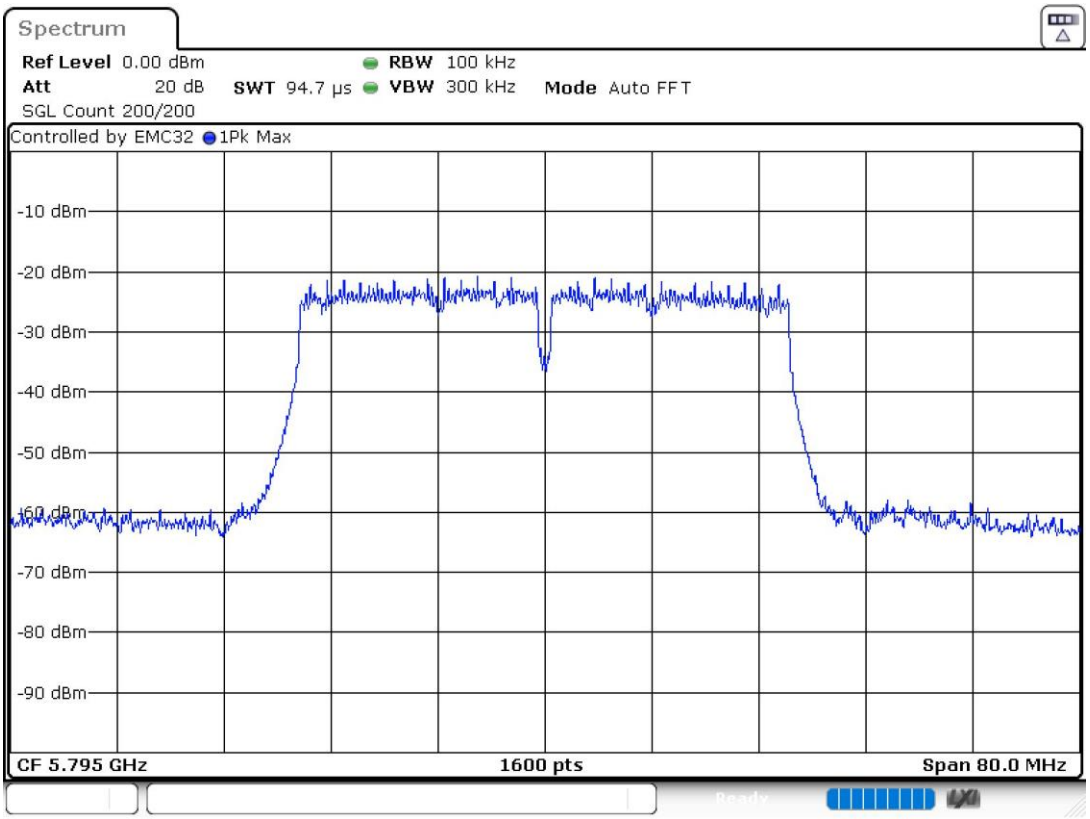
- Low Channel 151 (5755 MHz):





- High Channel 159 (5795 MHz):

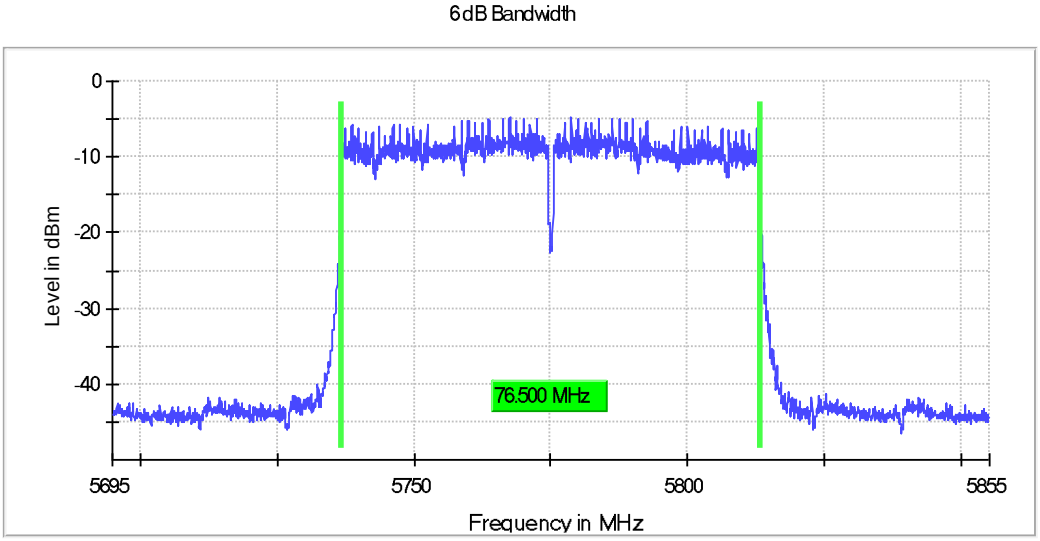


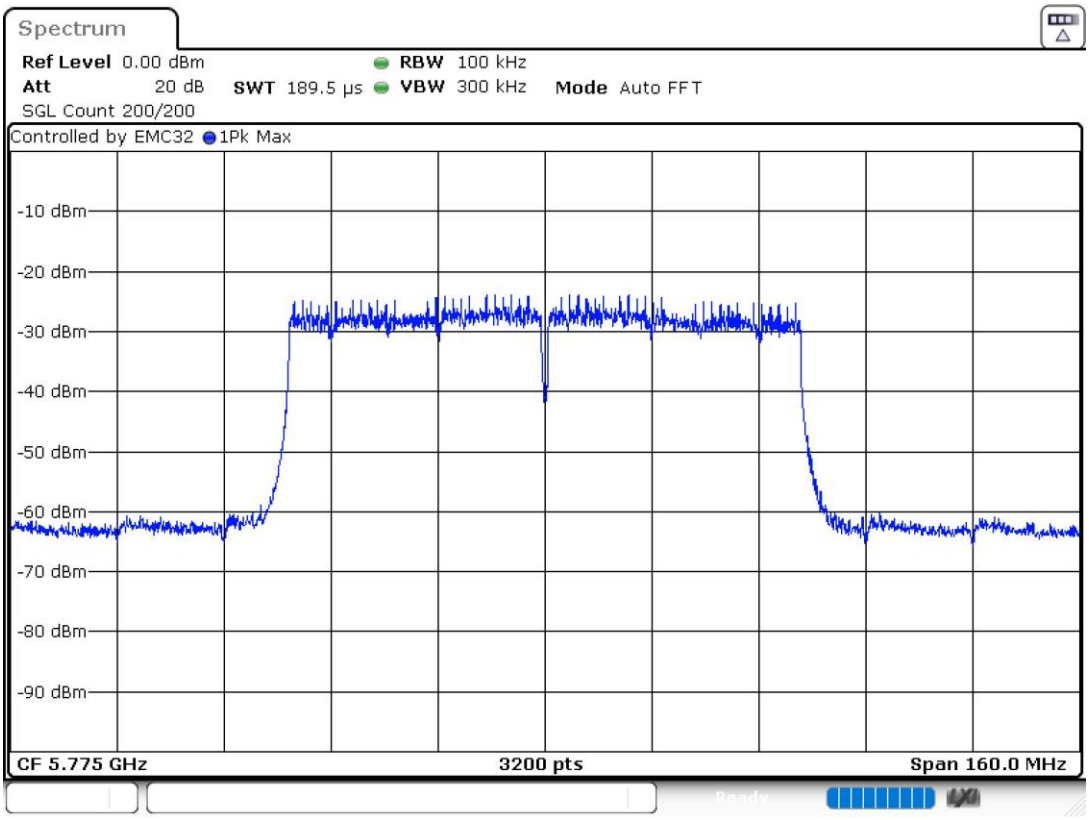


SISO 802.11 ac80 (VHT80):

U-NII-3 (5725-5850 MHz)

- Single Channel 155 (5775 MHz):





MIMO worst-case:

MIMO 802.11 n20 (HT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	16.05	15.70	15.50

MIMO 802.11 ac20 (VHT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
6 dB Bandwidth (MHz)	16.05	15.70	15.55

MIMO 802.11 n40 (HT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
6 dB Bandwidth (MHz)	35.60	35.25

MIMO 802.11 ac40 (VHT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
6 dB Bandwidth (MHz)	35.60	35.25

MIMO 802.11 ac80 (VHT80):

U-NII-3 (5725-5850 MHz):

Channel	Single Channel 155 (5775 MHz)
6 dB Bandwidth (MHz)	75.50

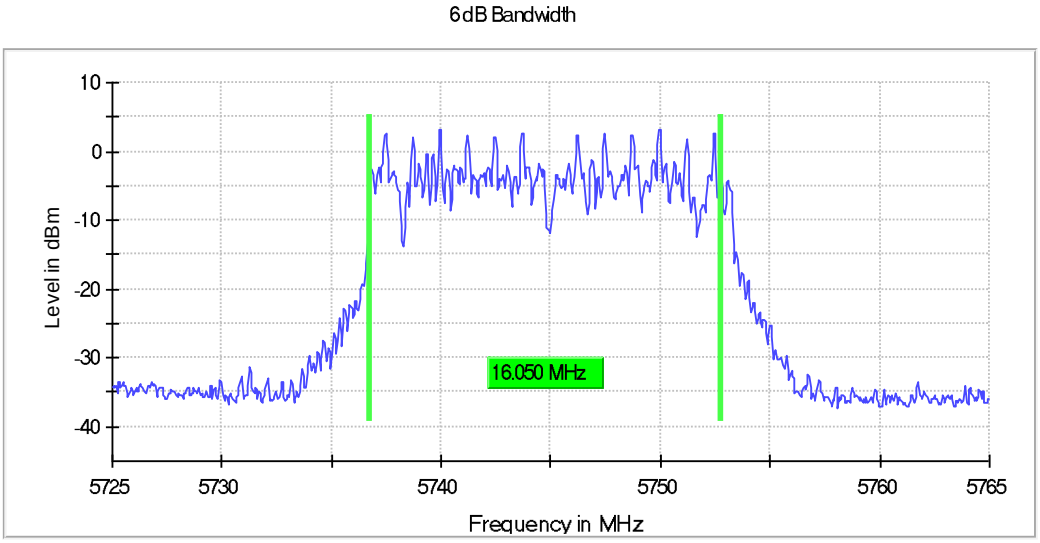
Verdict: PASS

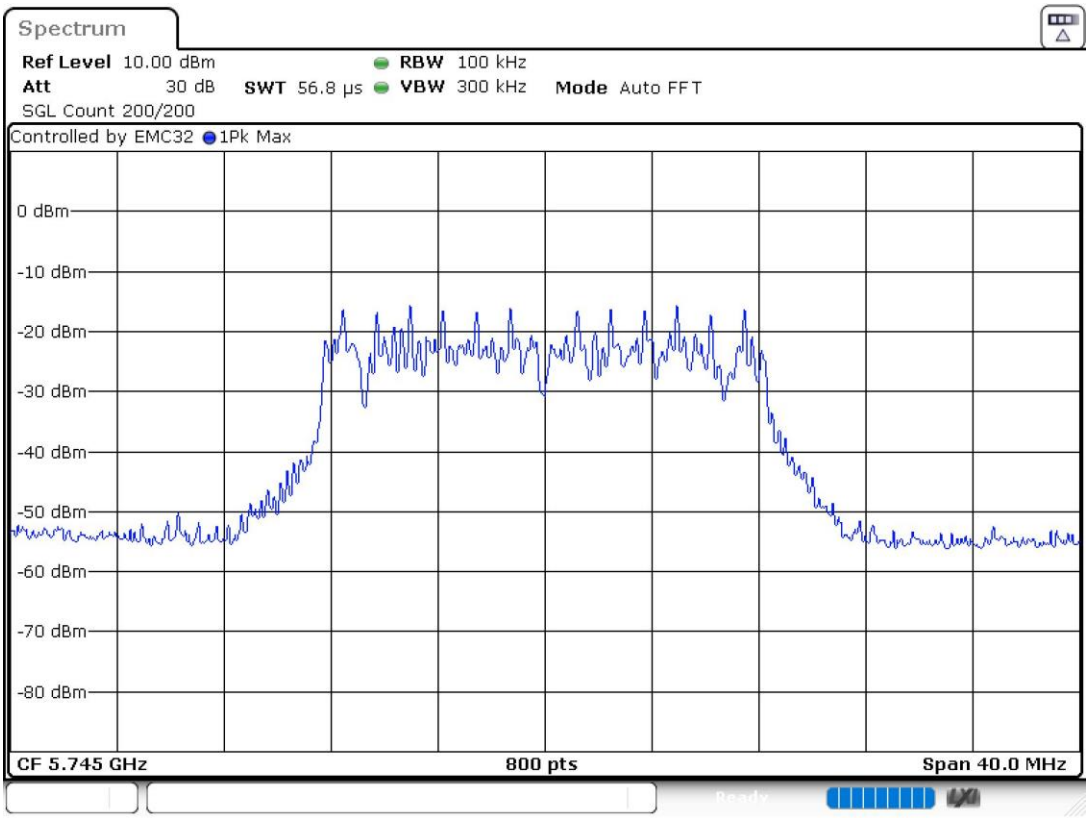
MIMO worst-case:

MIMO 802.11 n20 (HT20):

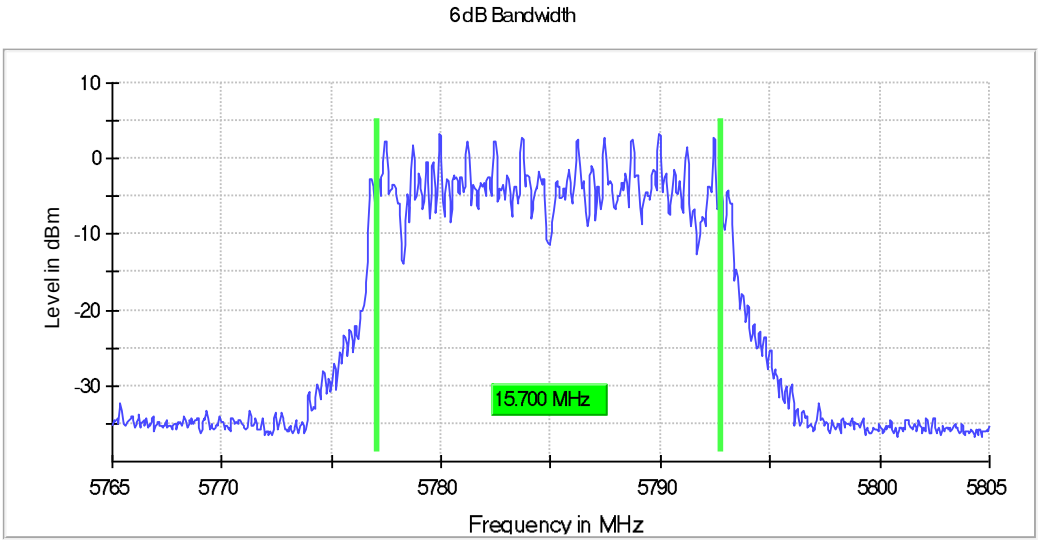
U-NII-3 (5725-5850 MHz)

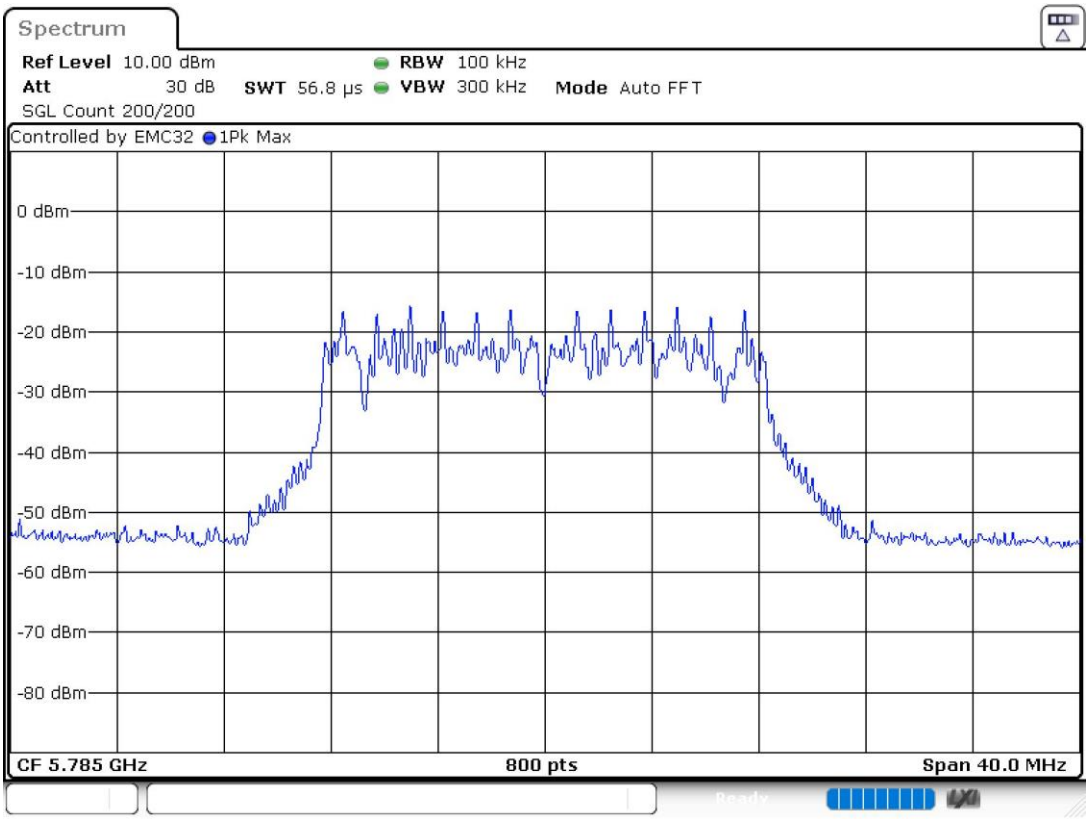
- Low Channel 149 (5745 MHz):



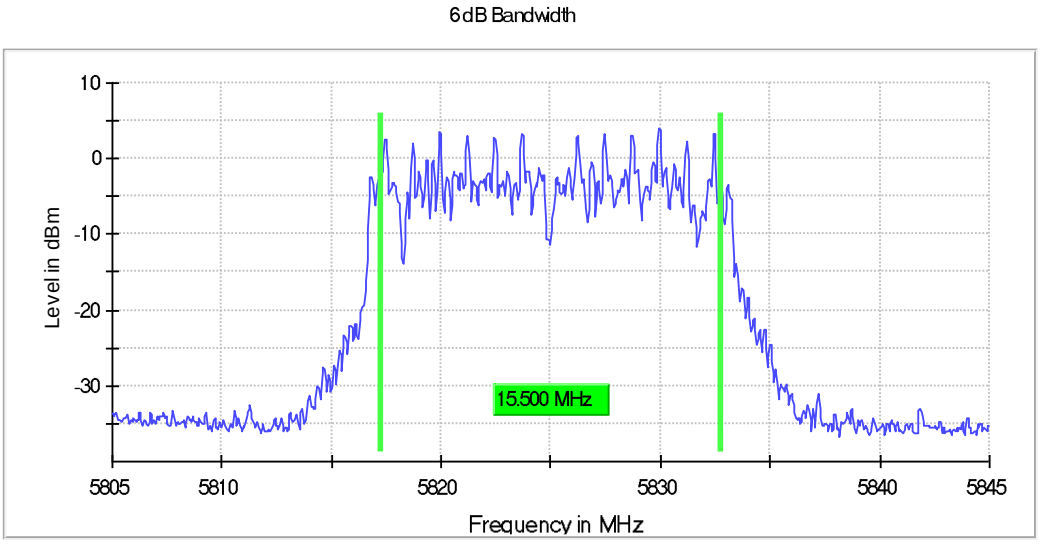


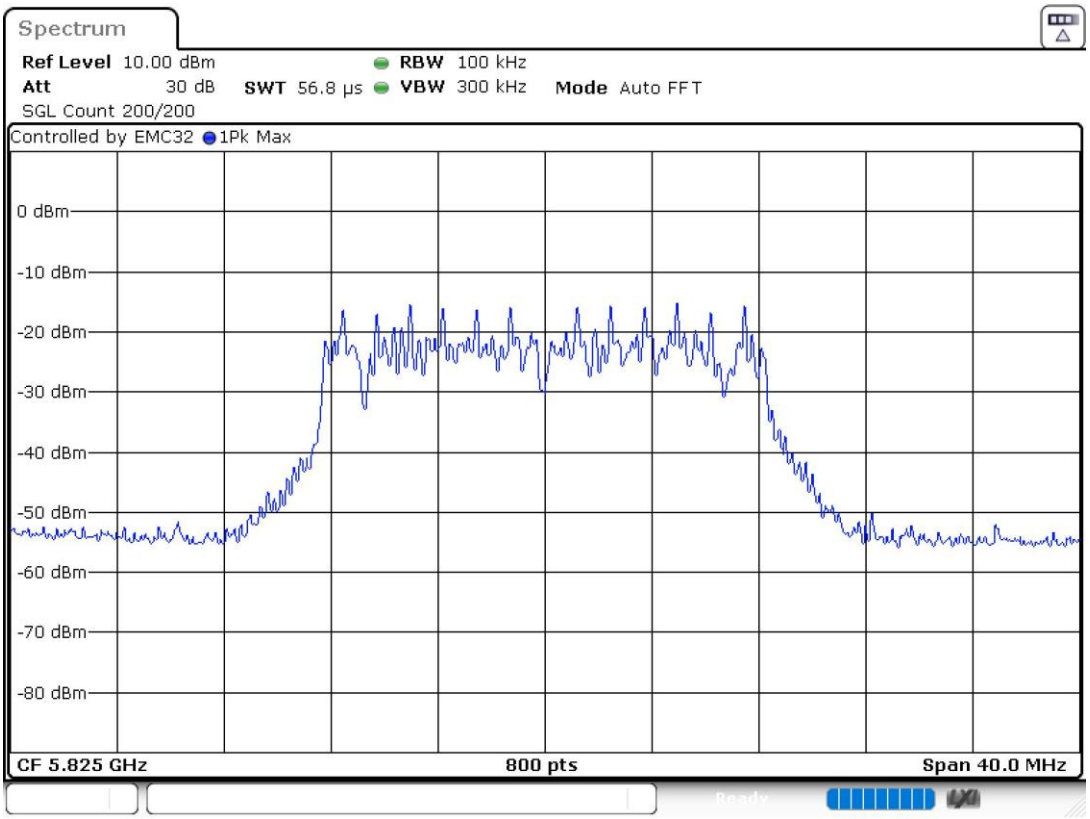
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

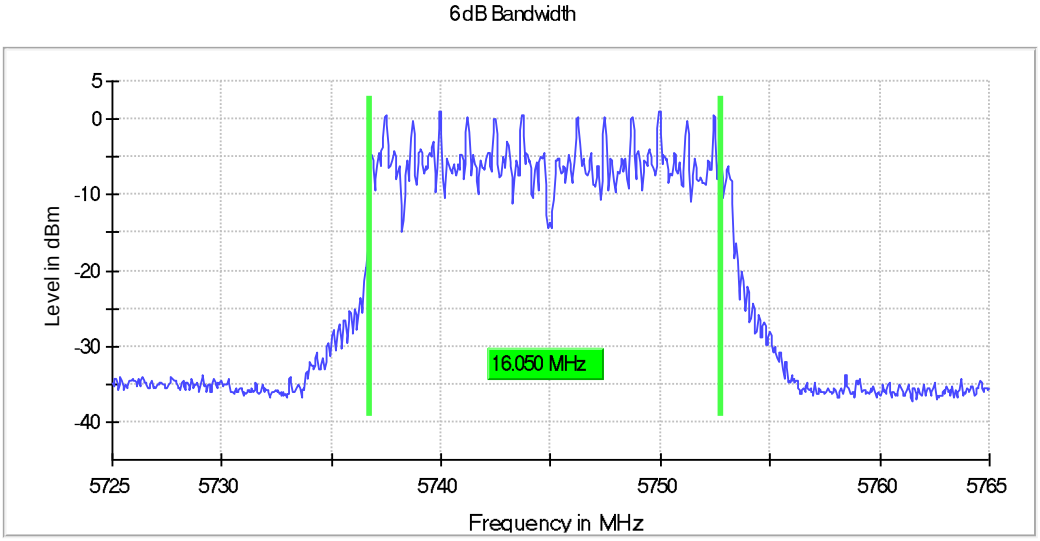


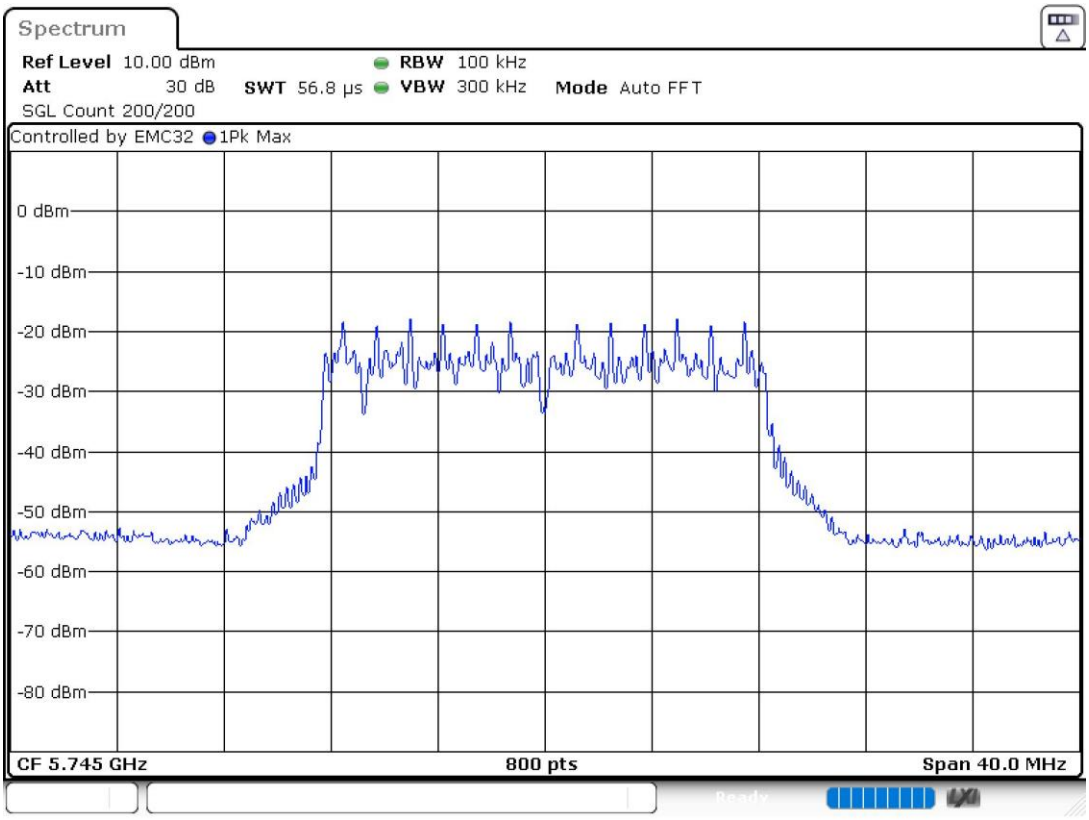


MIMO 802.11 ac20 (VHT20):

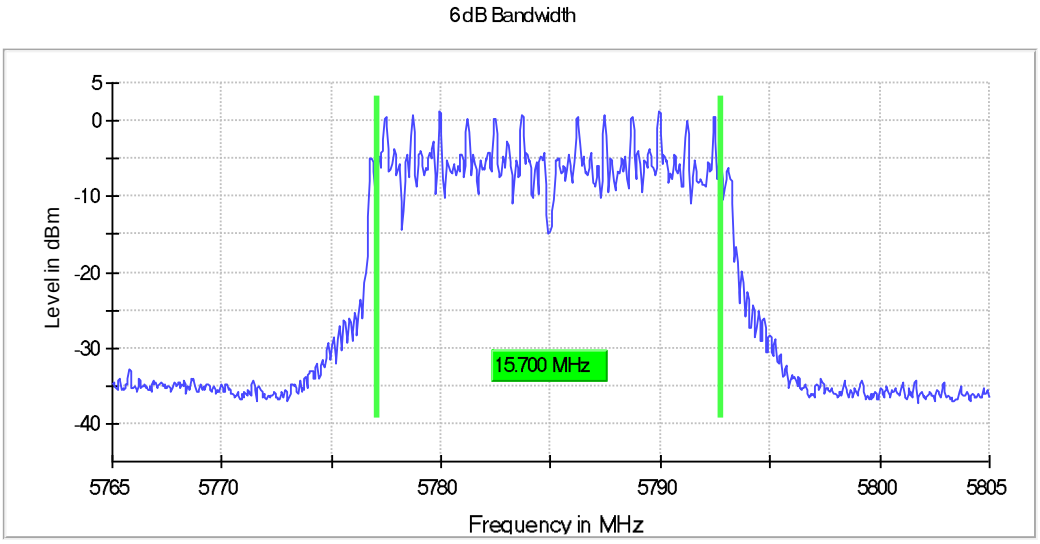
U-NII-3 (5725-5850 MHz)

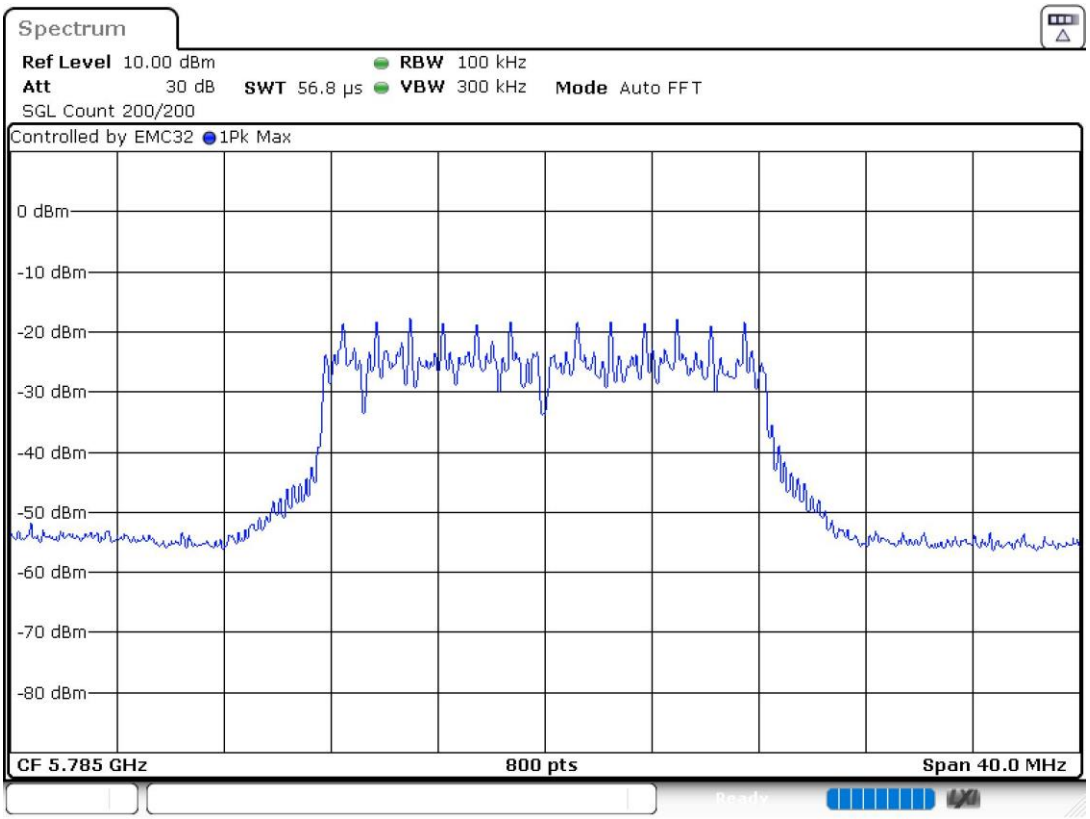
- Low Channel 149 (5745 MHz):



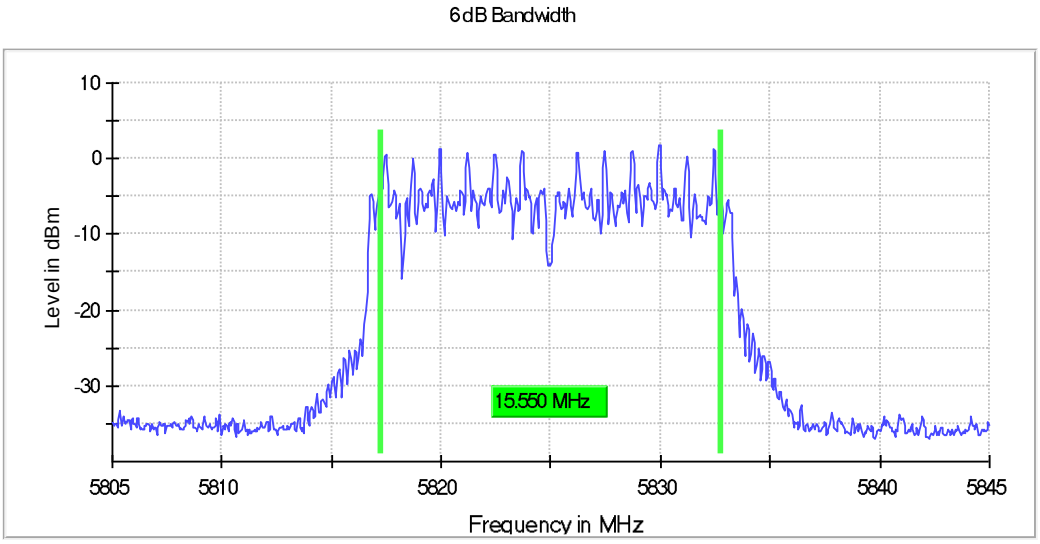


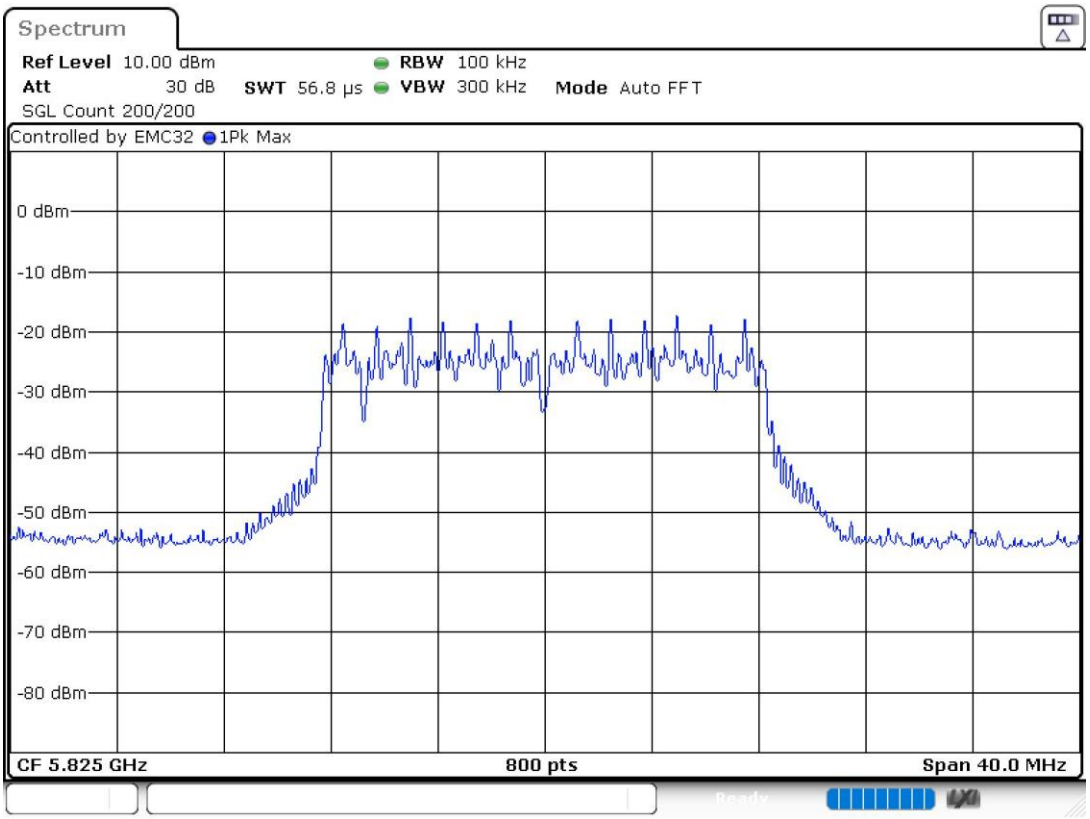
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

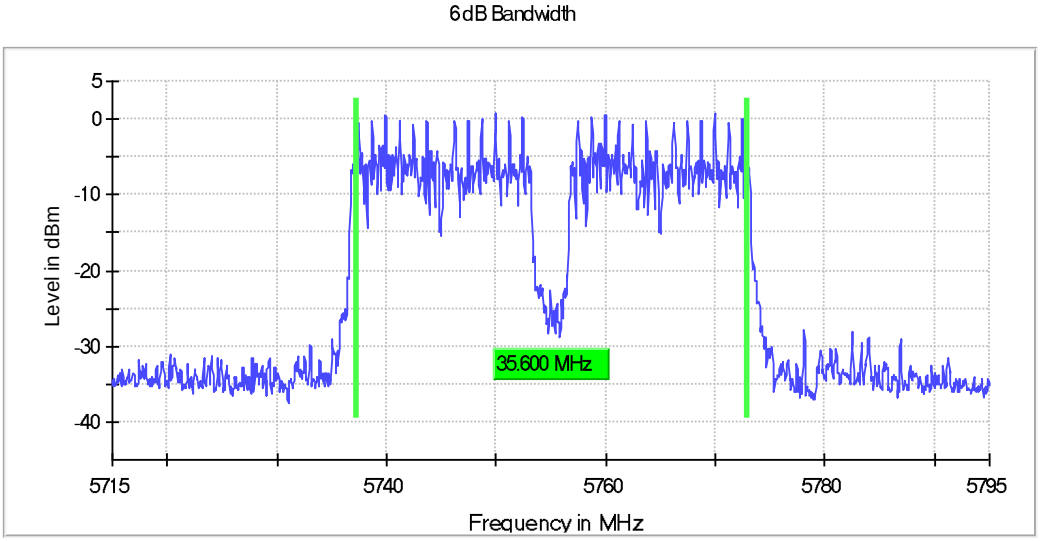


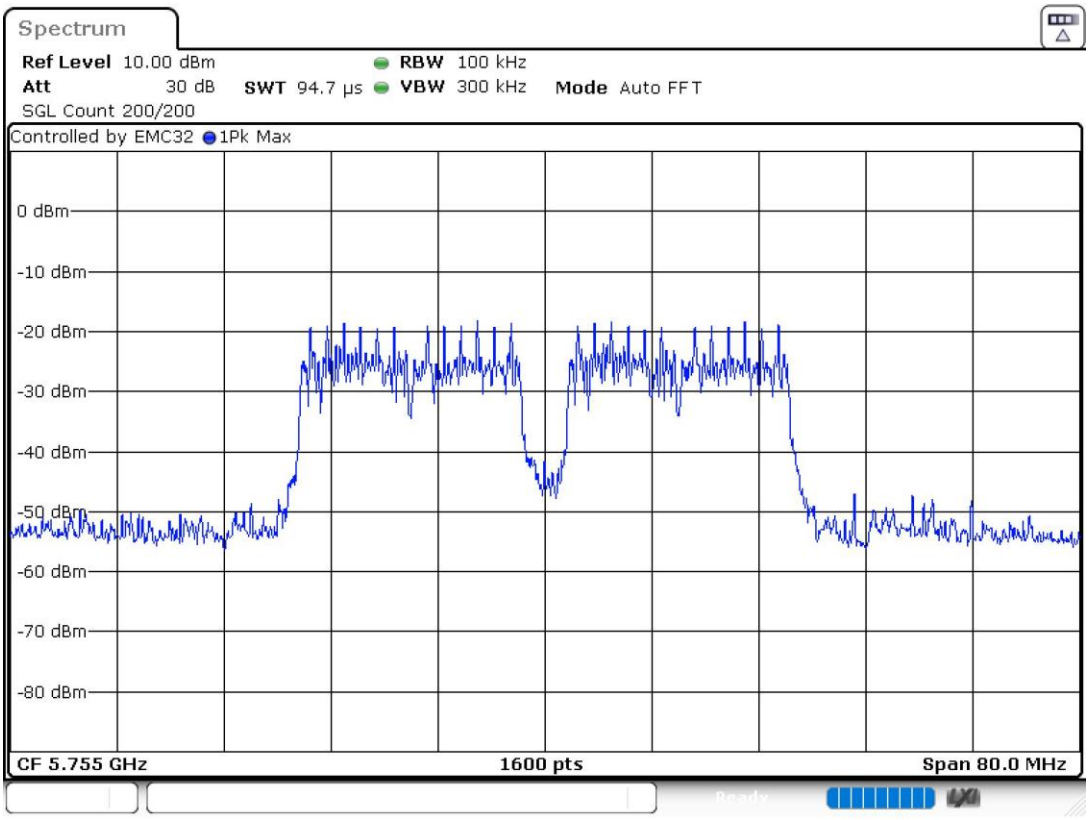


MIMO 802.11 n40 (VHT40):

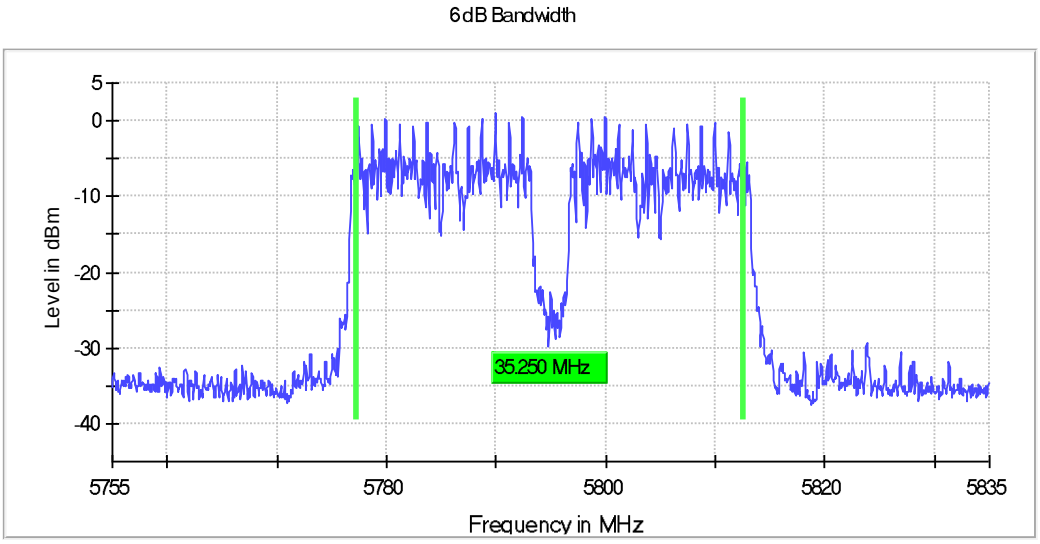
U-NII-3 (5725-5850 MHz)

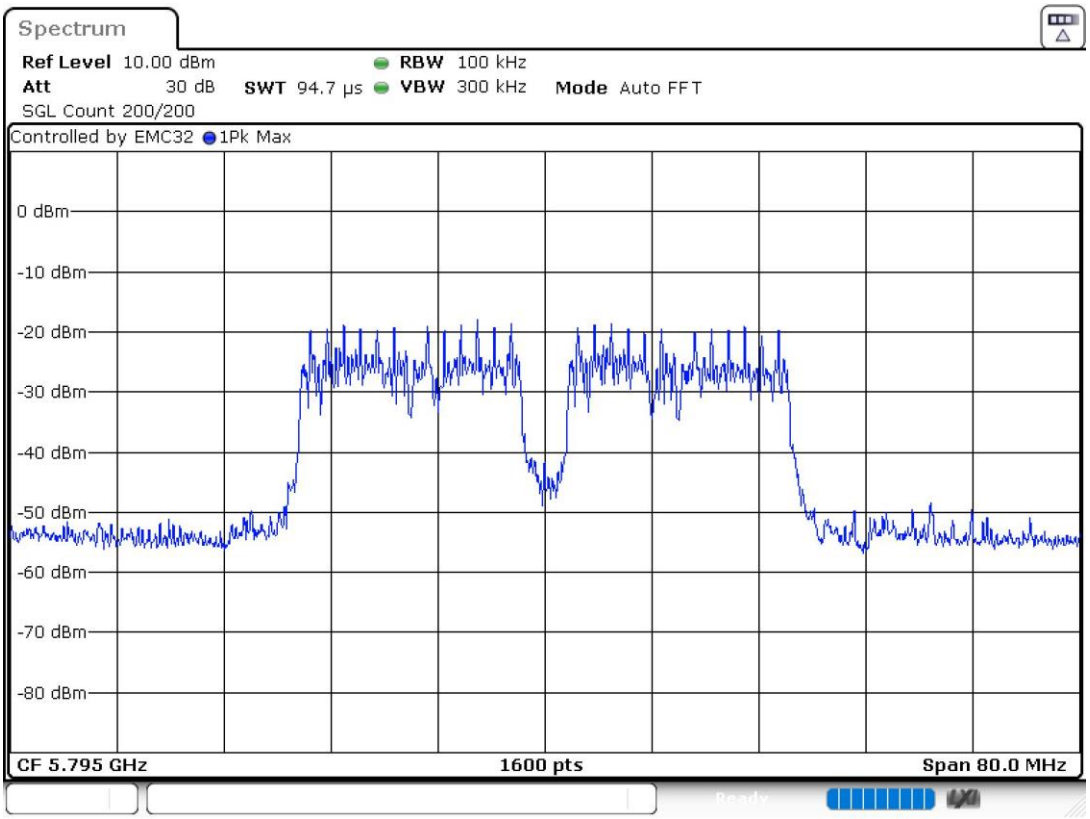
- Low Channel 151 (5755 MHz):





- High Channel 159 (5795 MHz):

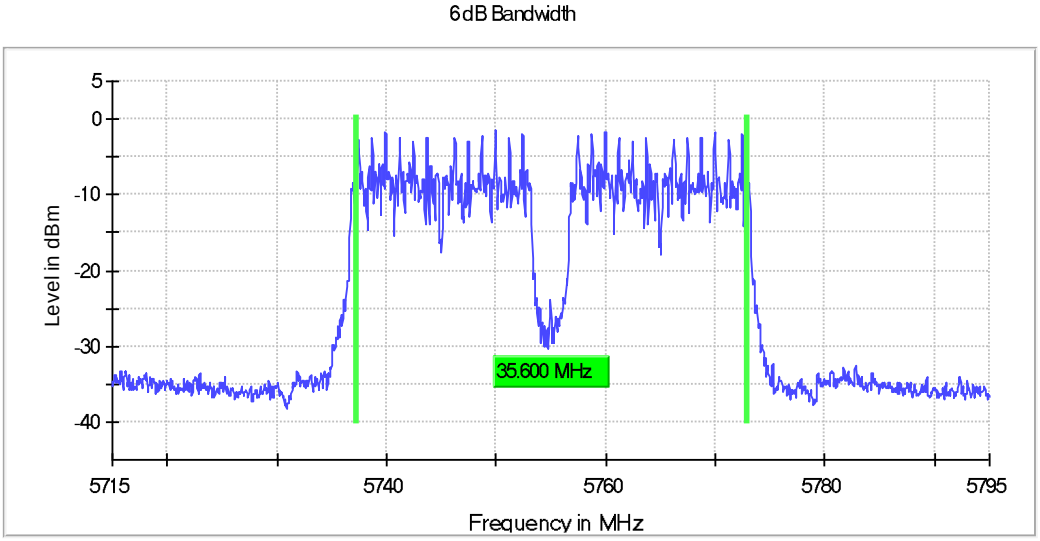


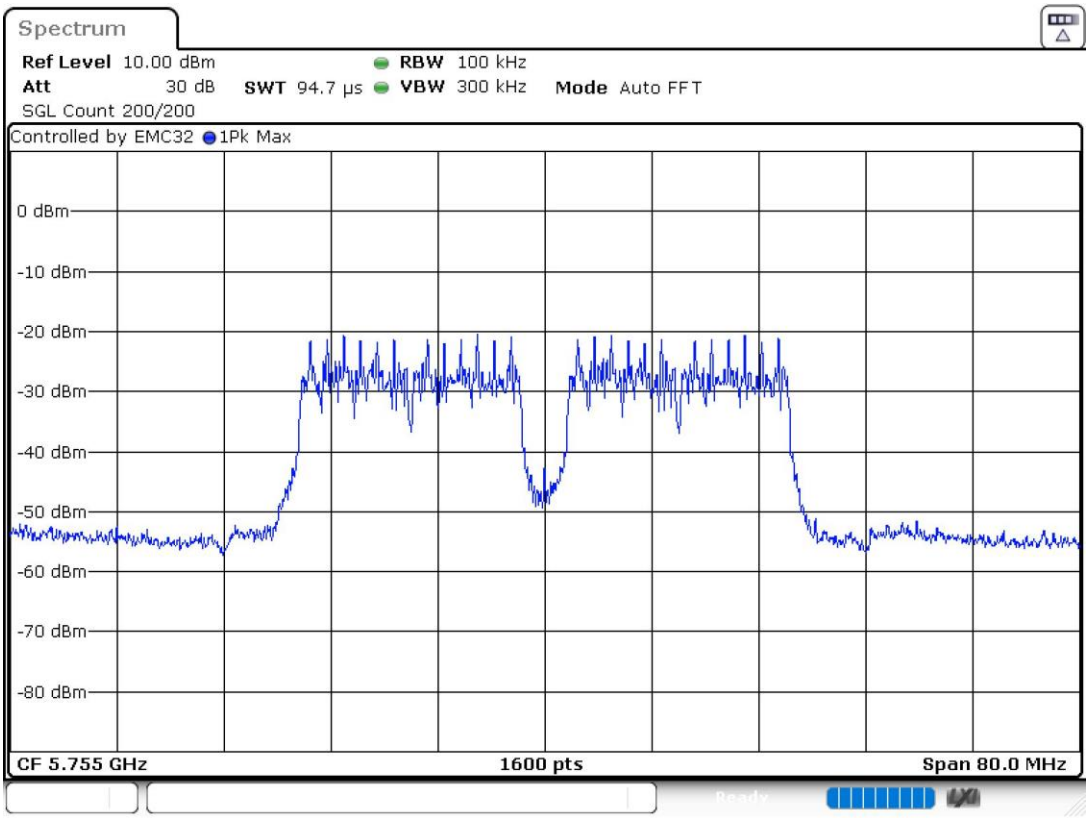


MIMO 802.11 ac40 (VHT40):

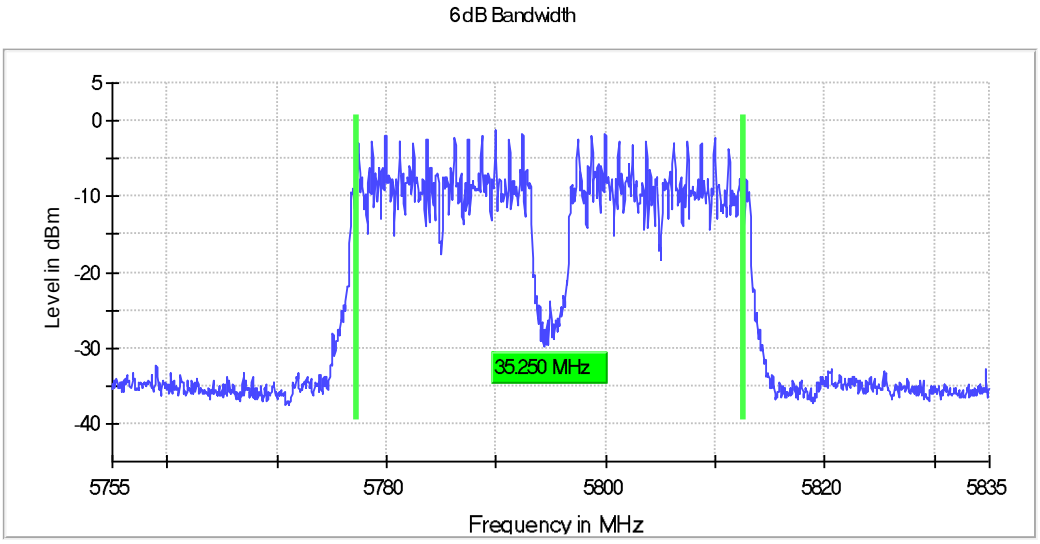
U-NII-3 (5725-5850 MHz)

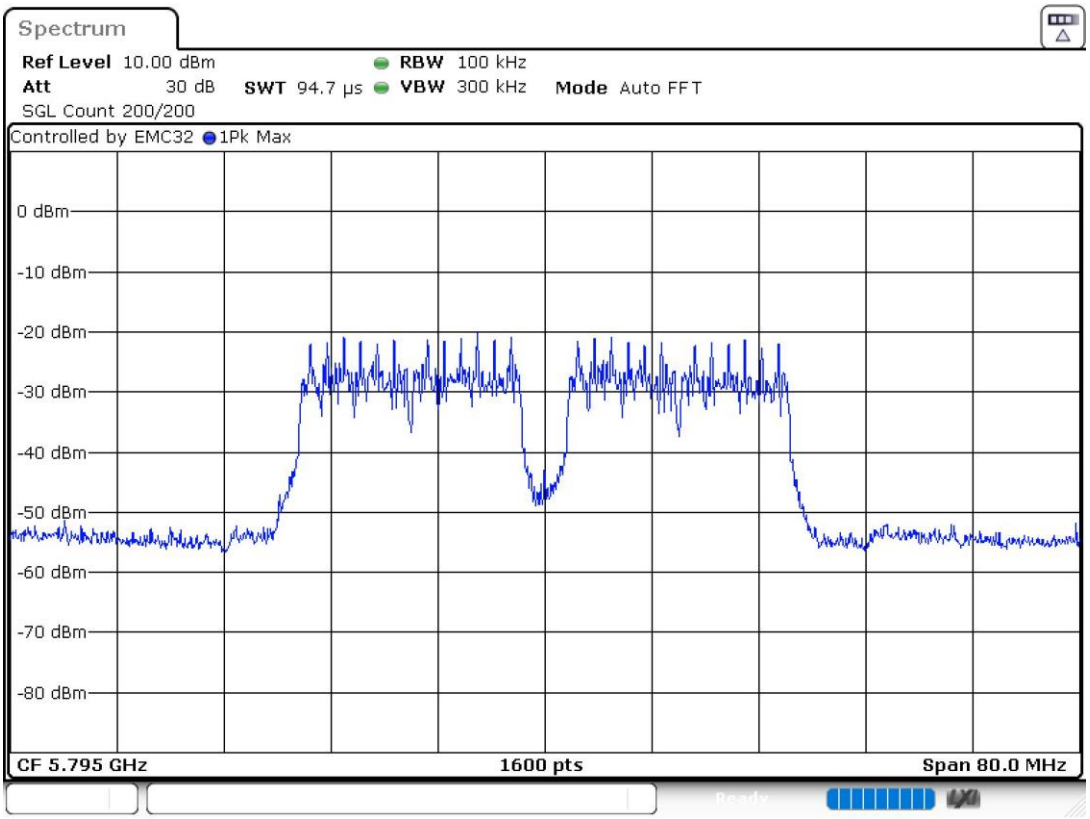
- Low Channel 151 (5755 MHz):





- High Channel 159 (5795 MHz):

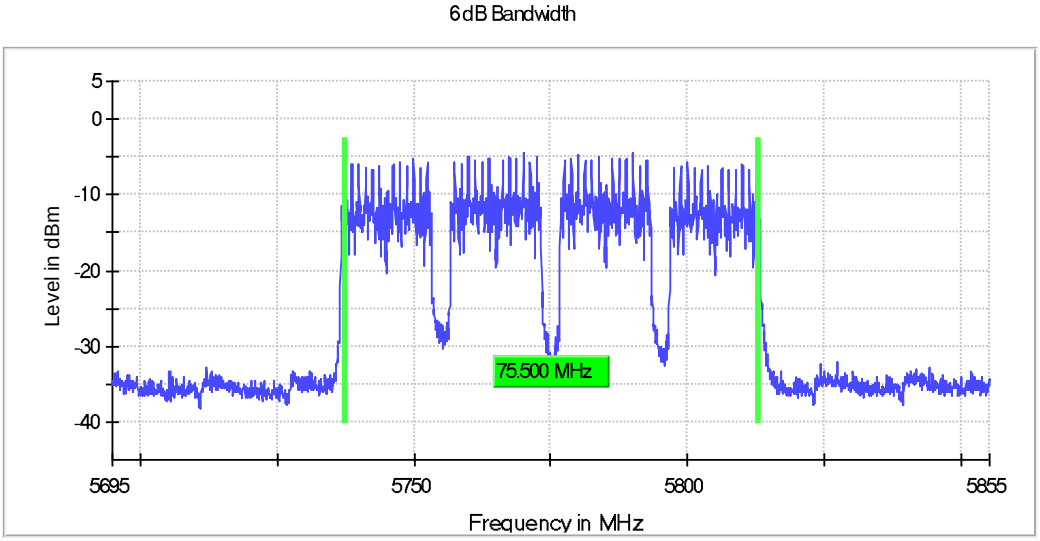


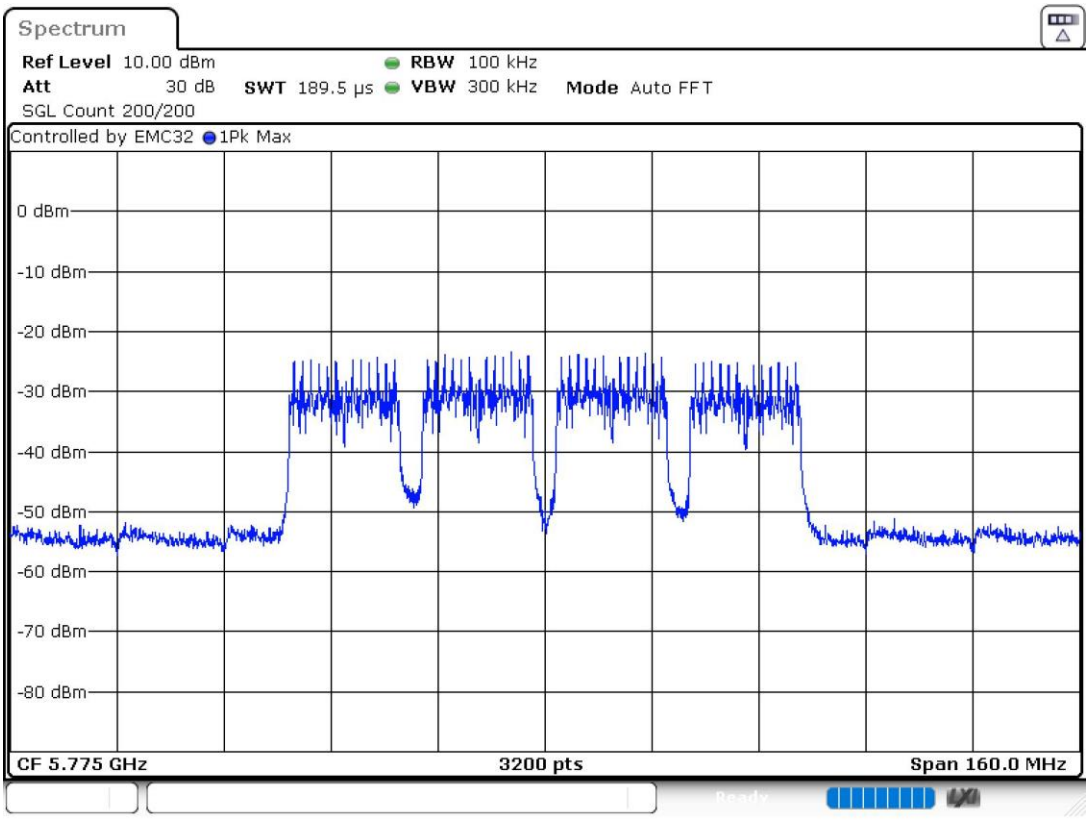


MIMO 802.11 ac80 (VHT80):

U-NII-3 (5725-5850 MHz)

- Single Channel 155 (5775 MHz):





FCC 15.407 (a)(3)(i) Transmitter Maximum Conducted Output Power / RSS-247 6.2.4.1 Transmitter Maximum Equivalent Isotropically Radiated Power

SPECIFICATION:

* FCC 15.407: For the band 5.725-5.850 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 30 dBm in any 500-kHz 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. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. 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.

* RSS-247: The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipointFootnote3 systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

RESULTS:

The maximum conducted output power was measured using the method according to point E) 3) b) (Method PM-G) of 789033 D02 General UNII Test Procedures New Rules v02r01.

The e.i.r.p. levels are calculated by adding the declared maximum antenna gain (dBi).

Preliminary tests determined the SISO worst case: Chain 1.
Preliminary tests determined the MIMO worst case: Chain 0+1.

Antenna Gain:

- SISO Antenna – Chain 0: +3.1 dBi
- SISO Antenna – Chain 1: +5.0 dBi
- MIMO Antennas – Chain 0 & 1: +7.12 dBi

For the SISO technique, the antenna gain is less than 6 dBi.
For the MIMO technique, the antenna gain is higher than 6 dBi.

SISO worst-case:

SISO 802.11 a20:

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Corrected Conducted Power (dBm)	14.95	15.28	15.74
Maximum EIRP Corrected Conducted Power (dBm)	19.95	20.28	20.74

SISO 802.11 n20 (HT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Corrected Conducted Power (dBm)	15.11	15.46	15.81
Maximum EIRP Corrected Conducted Power (dBm)	20.11	20.46	20.81

SISO 802.11 ac20 (VHT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Corrected Conducted Power (dBm)	12.63	12.93	13.29
Maximum EIRP Corrected Conducted Power (dBm)	17.63	17.93	18.29

SISO 802.11 n40 (HT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Corrected Conducted Power (dBm)	15.47	15.21
Maximum EIRP Corrected Conducted Power (dBm)	20.47	20.21

SISO 802.11 ac40 (VHT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Corrected Conducted Power (dBm)	13.03	12.93
Maximum EIRP Corrected Conducted Power (dBm)	18.03	17.93

SISO 802.11 ac80 (VHT80):

U-NII-3 (5725-5850 MHz):

Channel	Single Channel 155 (5775 MHz)
Maximum Corrected Conducted Power (dBm)	12.55
Maximum EIRP Corrected Conducted Power (dBm)	17.55

Verdict: PASS

MIMO worst-case:

MIMO 802.11 n20 (HT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Corrected Conducted Power (dBm)	14.18	14.01	14.30
Maximum EIRP Corrected Conducted Power (dBm)	21.30	21.13	21.42

MIMO 802.11 ac20 (VHT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Corrected Conducted Power (dBm)	12.88	12.83	13.19
Maximum EIRP Corrected Conducted Power (dBm)	20.00	19.95	20.31

MIMO 802.11 n40 (HT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Corrected Conducted Power (dBm)	14.26	14.12
Maximum EIRP Corrected Conducted Power (dBm)	21.38	21.24

MIMO 802.11 ac40 (VHT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Corrected Conducted Power (dBm)	13.26	13.24
Maximum EIRP Corrected Conducted Power (dBm)	20.38	20.36

MIMO 802.11 ac80 (VHT80):

U-NII-3 (5725-5850 MHz):

Channel	Single Channel 155 (5775 MHz)
Maximum Corrected Conducted Power (dBm)	13.47
Maximum EIRP Corrected Conducted Power (dBm)	20.59

Verdict: PASS

FCC 15.407 (a)(3)(i) Transmitter Maximum Power Spectral Density / RSS-247 6.2.4.1. Transmitter EIRP Spectral Density

SPECIFICATION:

* FCC 15.407: For the band 5.725-5.850 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 30 dBm in any 500-kHz 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. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. 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.

* RSS-247: The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipointFootnote3 systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

RESULTS:

The maximum Power Spectral Density (PSD) was measured using the method according to point F) referencing E.2.b) (Method SA-1) of Guidance 789033 D02 General UNII Test Procedures New Rules v02r01.

The e.i.r.p. levels are calculated by adding the declared maximum antenna gain (dBi).

Preliminary tests determined the SISO worst case: Chain 1.
Preliminary tests determined the MIMO worst case: Chain 0+1.

Antenna Gain:

- SISO Antenna – Chain 0: +3.1 dBi
- SISO Antenna – Chain 1: +5.0 dBi
- MIMO Antennas – Chain 0 & 1: +7.12 dBi

For the SISO technique, the antenna gain is less than 6 dBi.
For the MIMO technique, the antenna gain is higher than 6 dBi.

SISO worst-case:

SISO 802.11 a20:

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Conducted PSD (dBm)	-0.34	-0.26	0.30

SISO 802.11 n20 (HT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Conducted PSD (dBm)	-0.52	-0.44	0.13

SISO 802.11 ac20 (VHT20):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
Maximum Conducted PSD (dBm)	-3.48	-3.55	-3.08

SISO 802.11 n40 (HT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Conducted PSD (dBm)	-3.37	-3.37

SISO 802.11 ac40 (VHT40):

U-NII-3 (5725-5850 MHz):

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
Maximum Corrected Conducted PSD (dBm)	-6.65	-6.60

SISO 802.11 ac80 (VHT80):

U-NII-3 (5725-5850 MHz):

Channel	Single Channel 155 (5775 MHz)
Maximum Conducted PSD (dBm)	-9.52

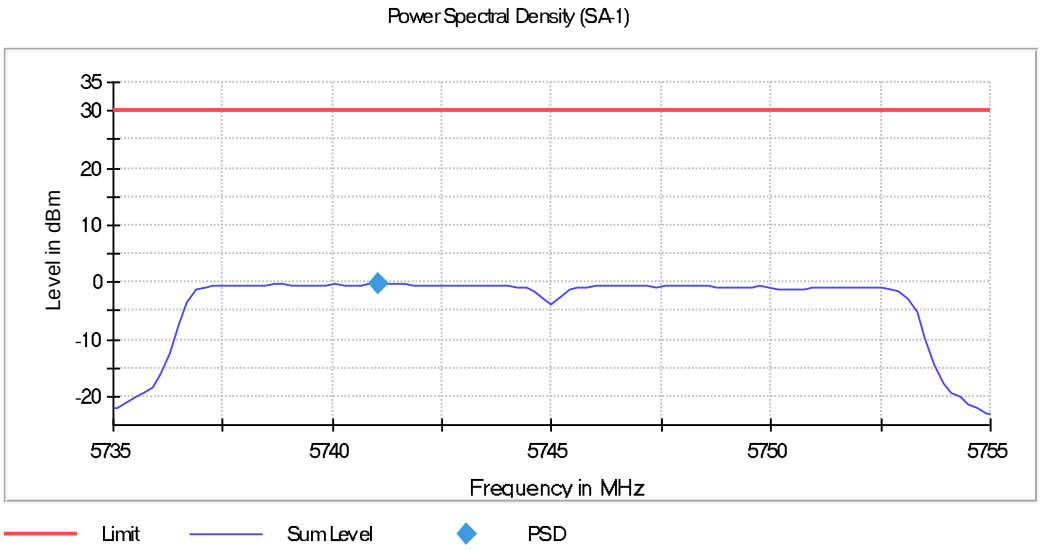
Verdict: PASS

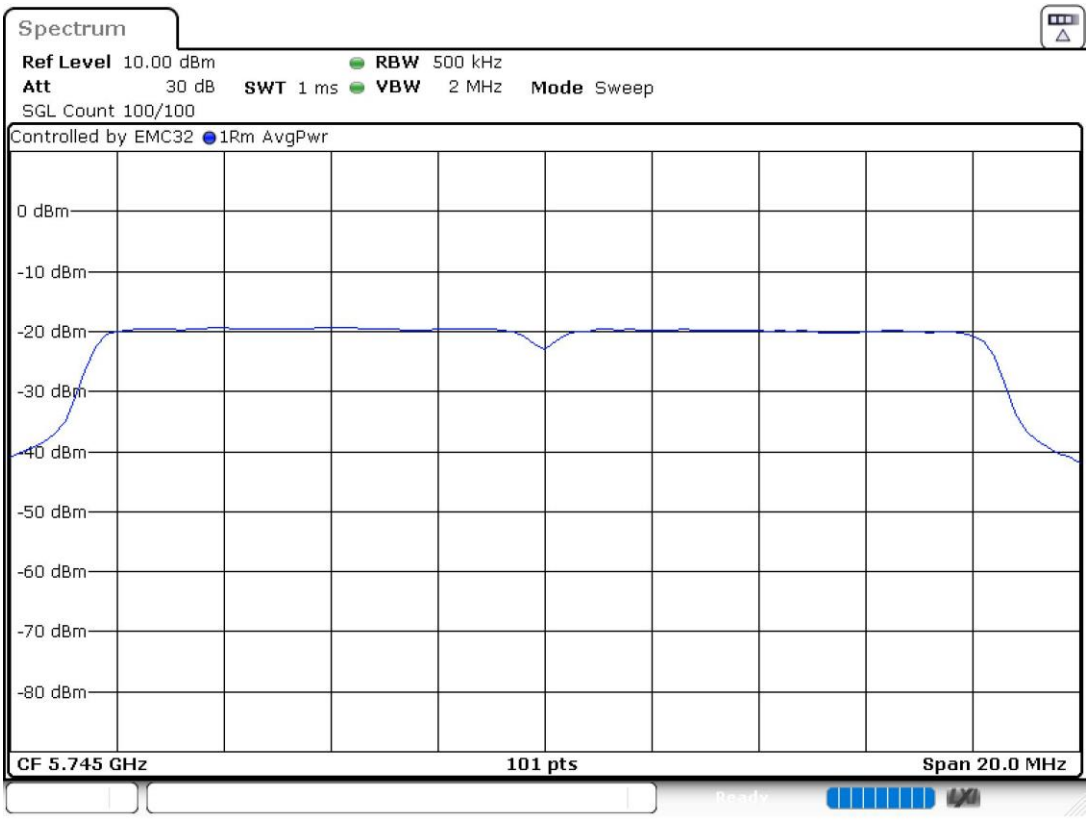
SISO worst-case:

SISO 802.11 a20:

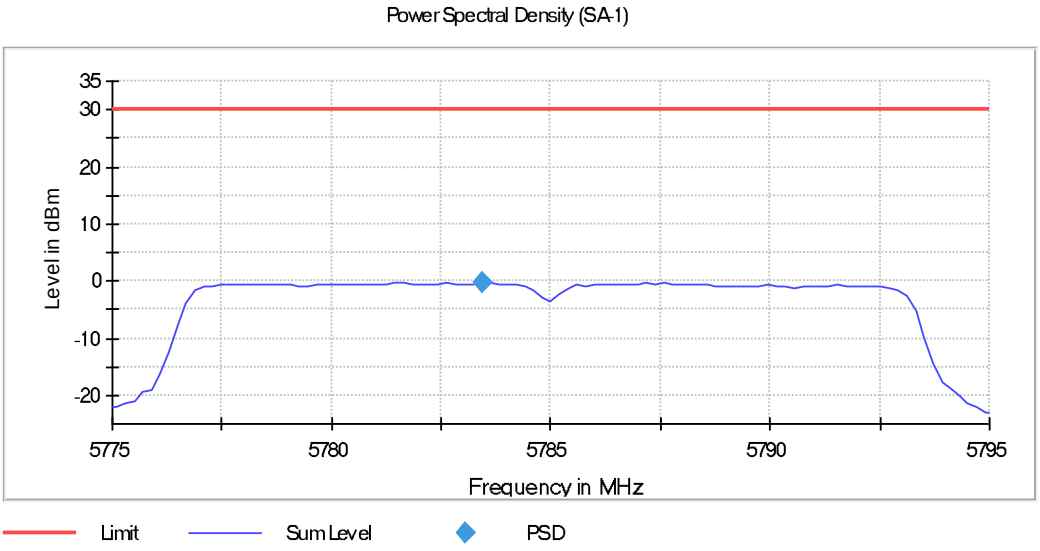
U-NII-3 (5725-5850 MHz)

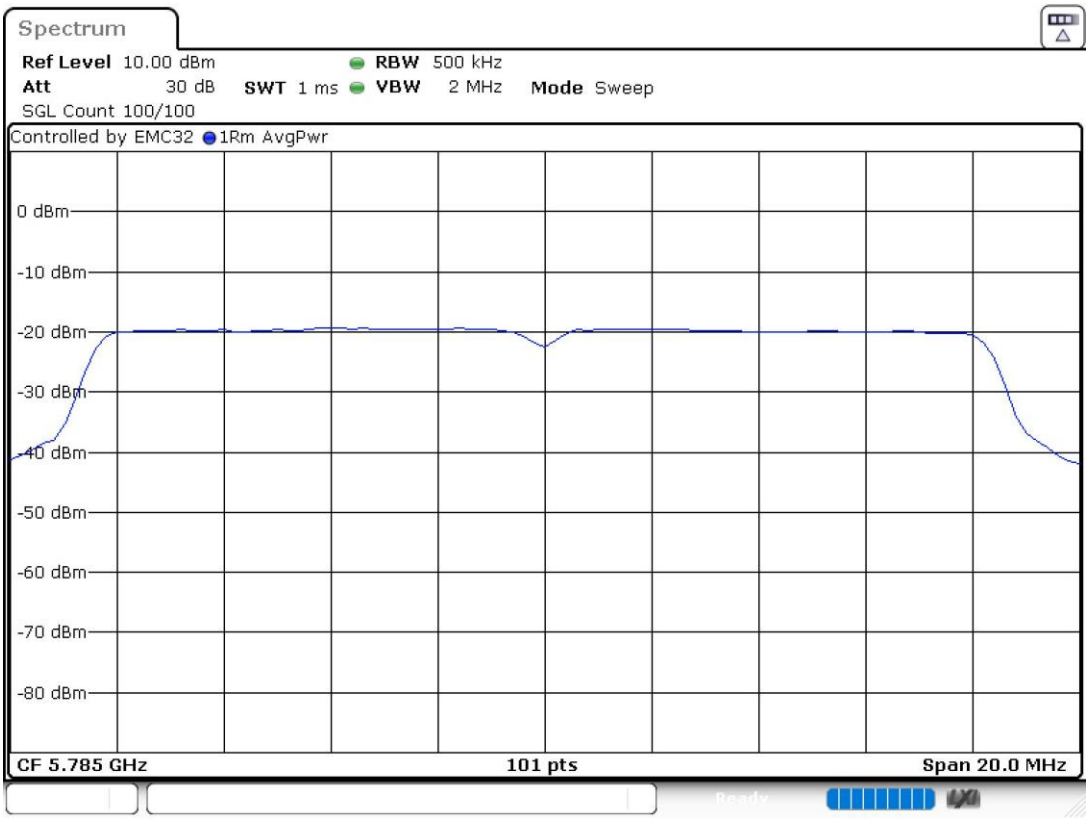
- Low Channel 149 (5745 MHz):



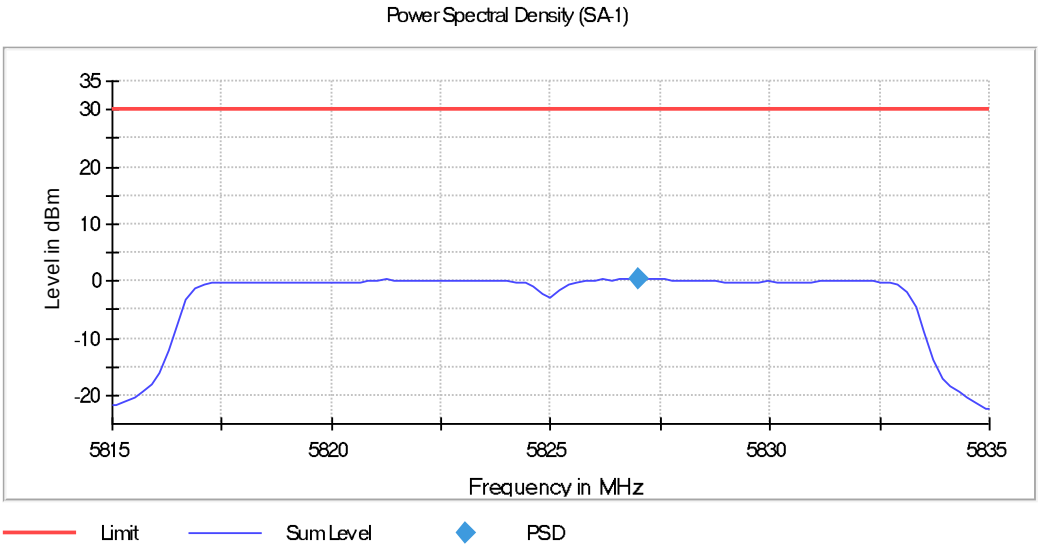


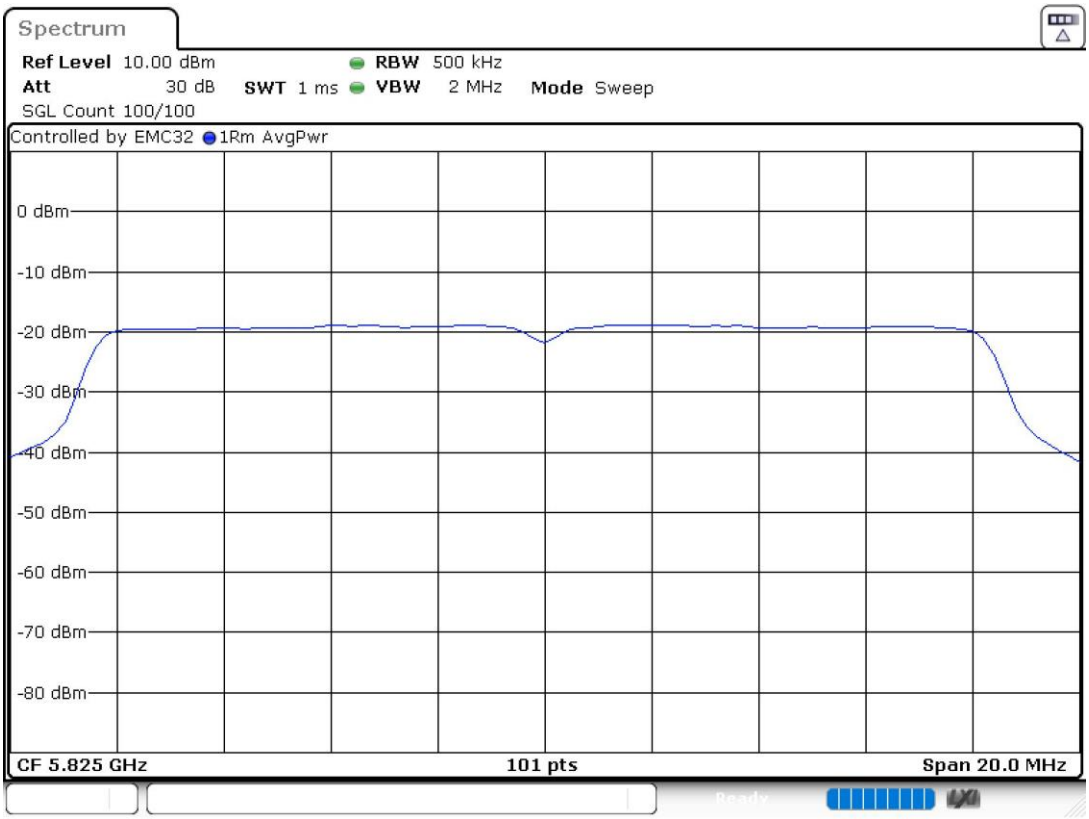
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

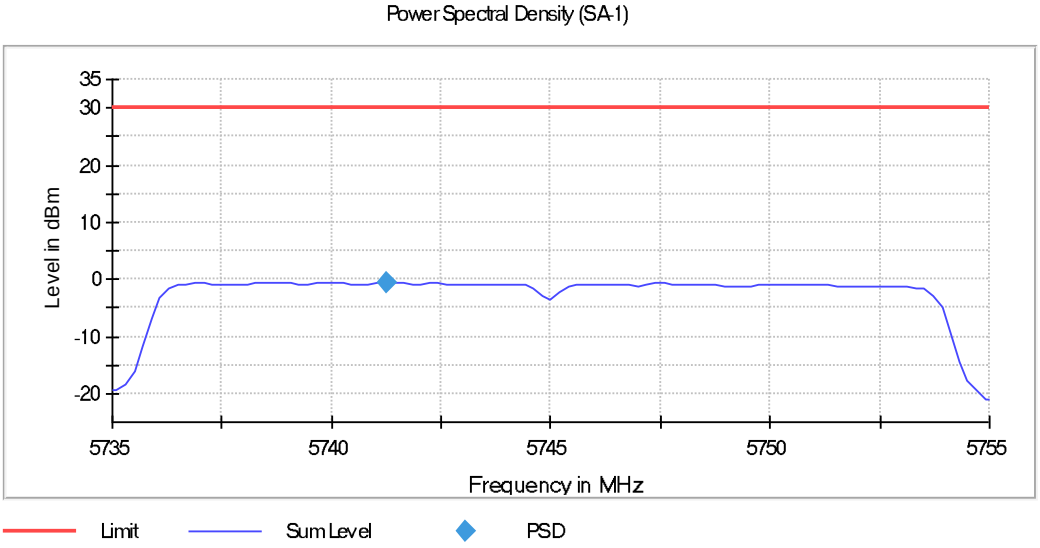


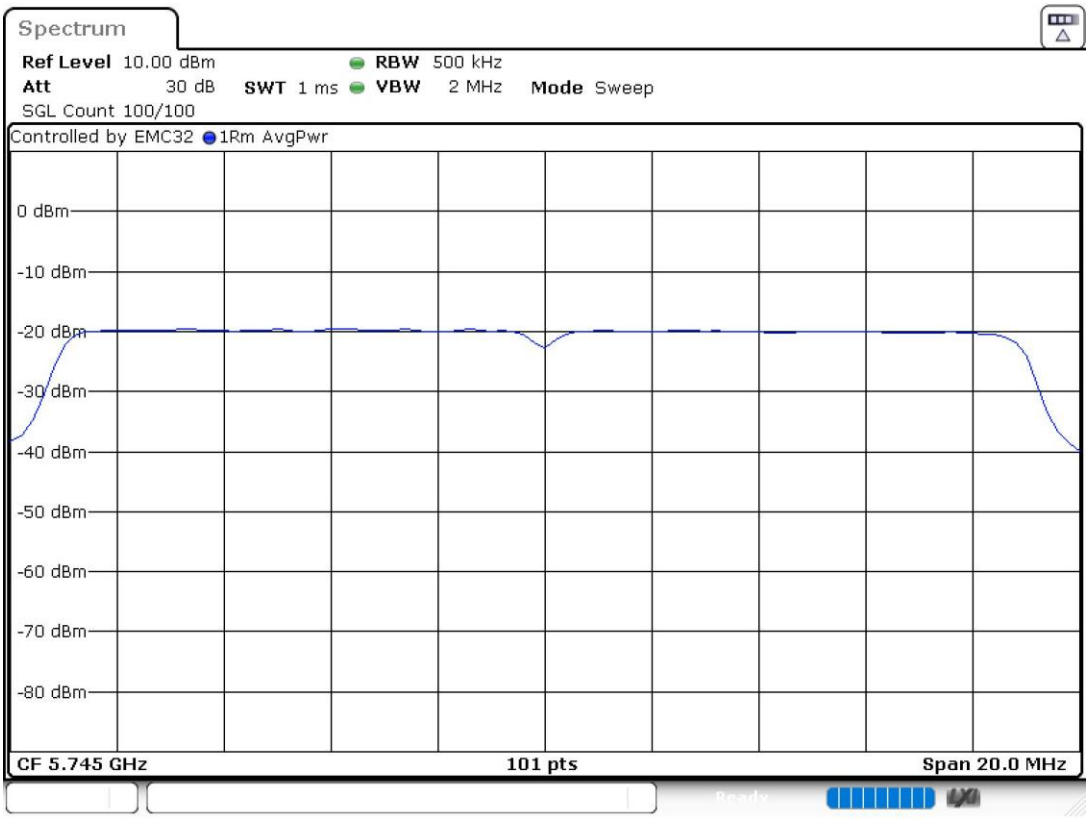


SISO 802.11 n20 (HT20):

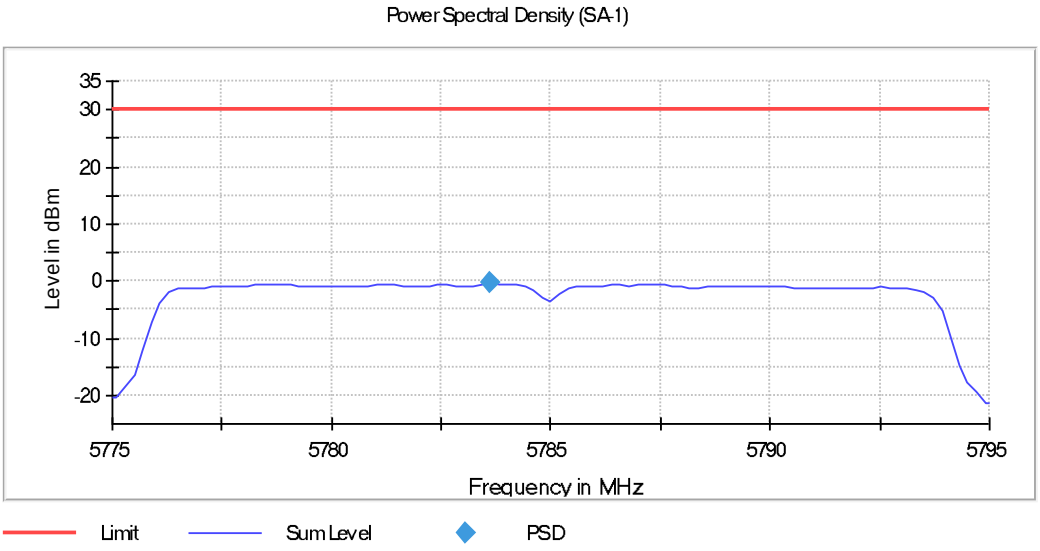
U-NII-3 (5725-5850 MHz)

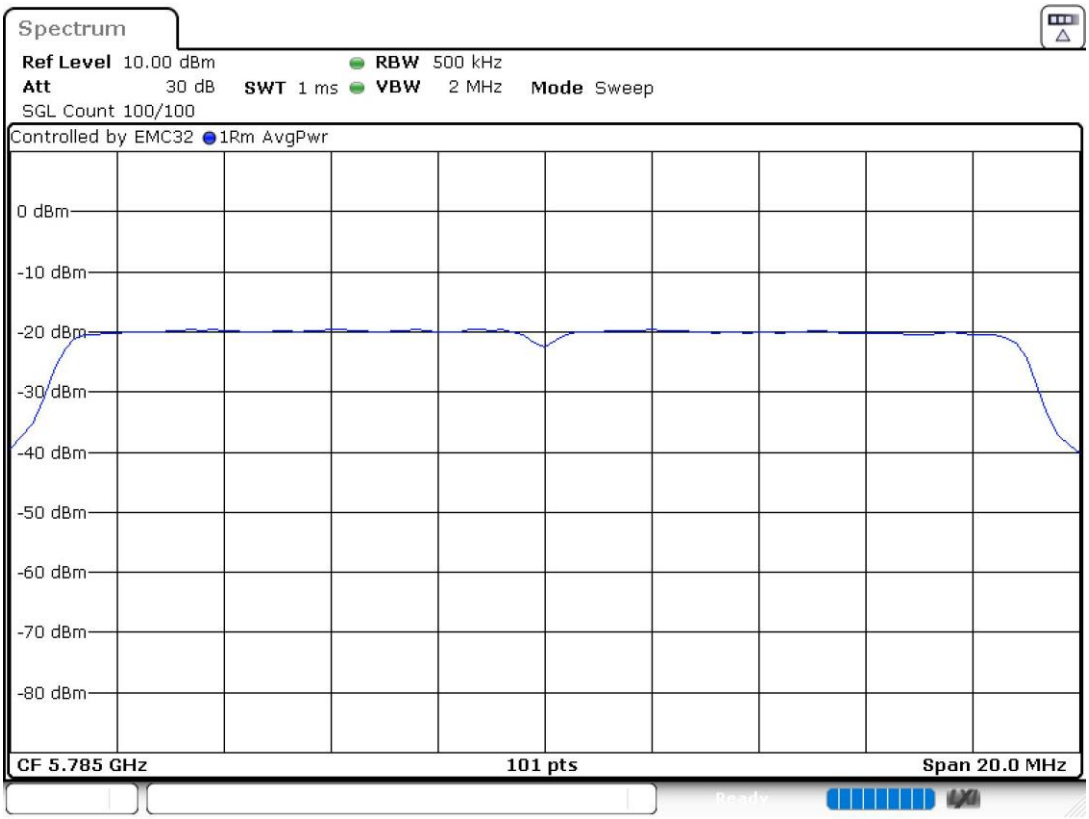
- Low Channel 149 (5745 MHz):



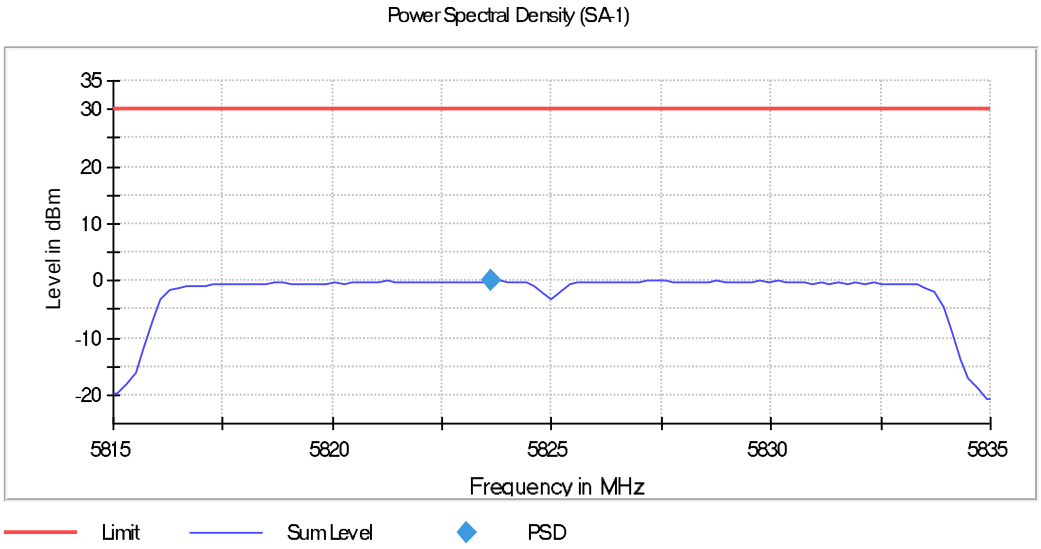


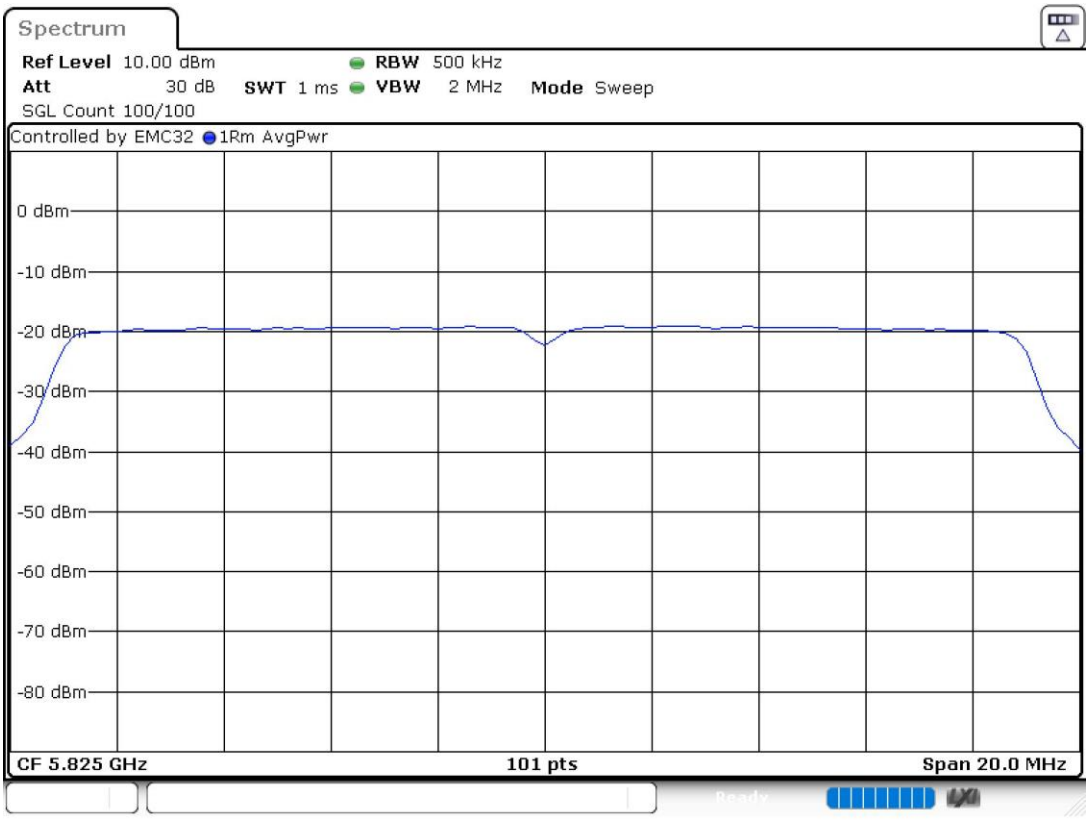
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

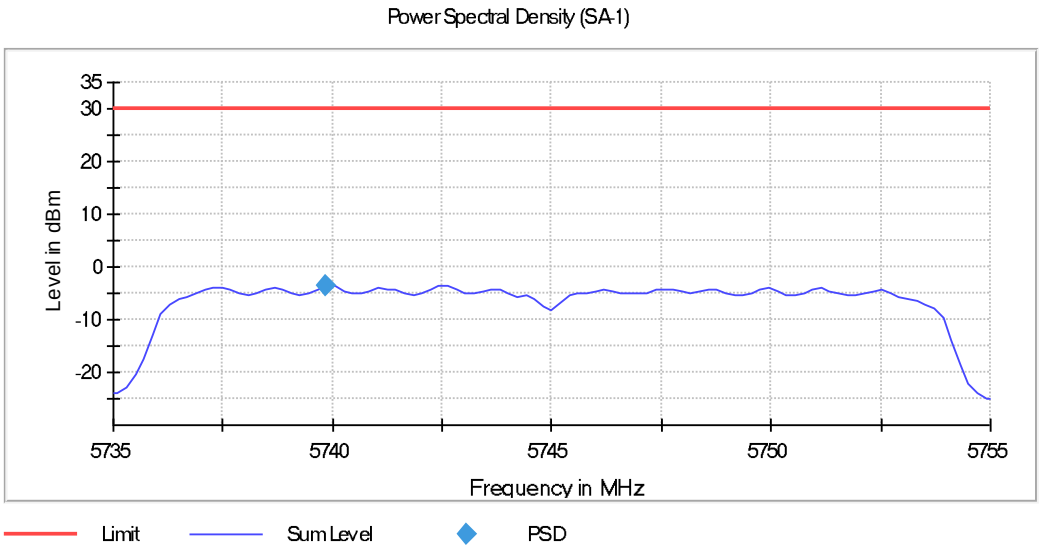


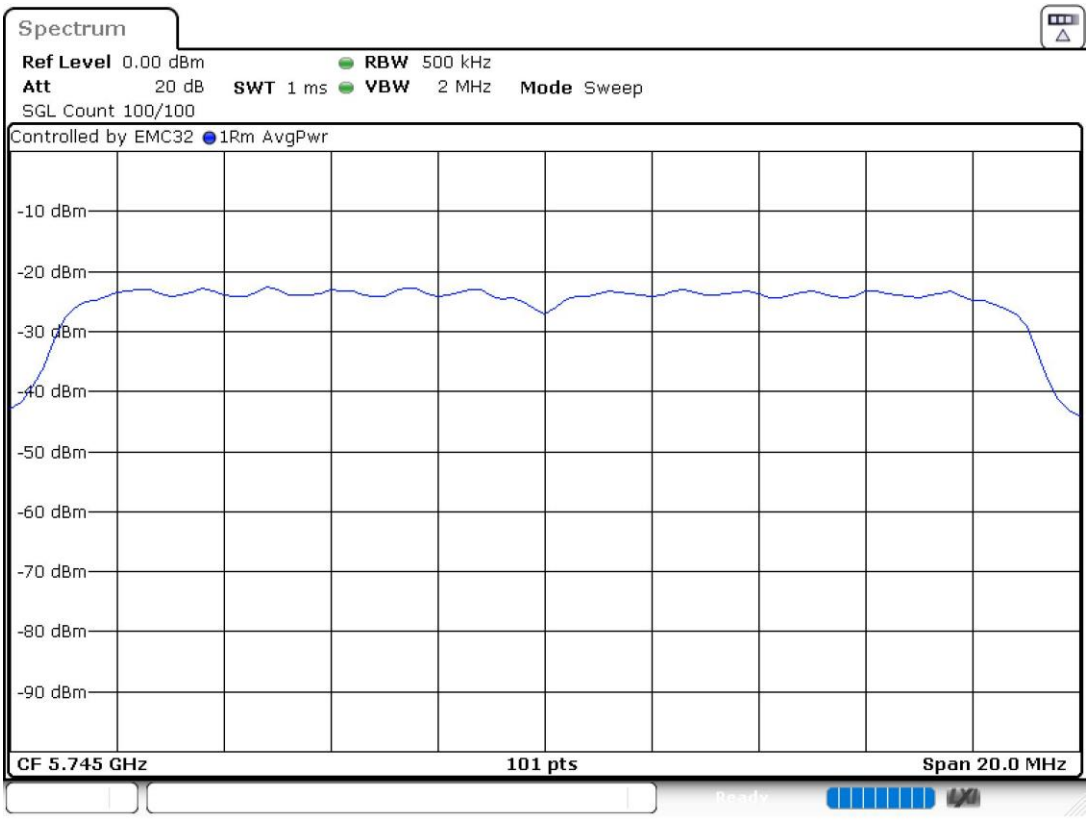


SISO 802.11 ac20 (VHT20):

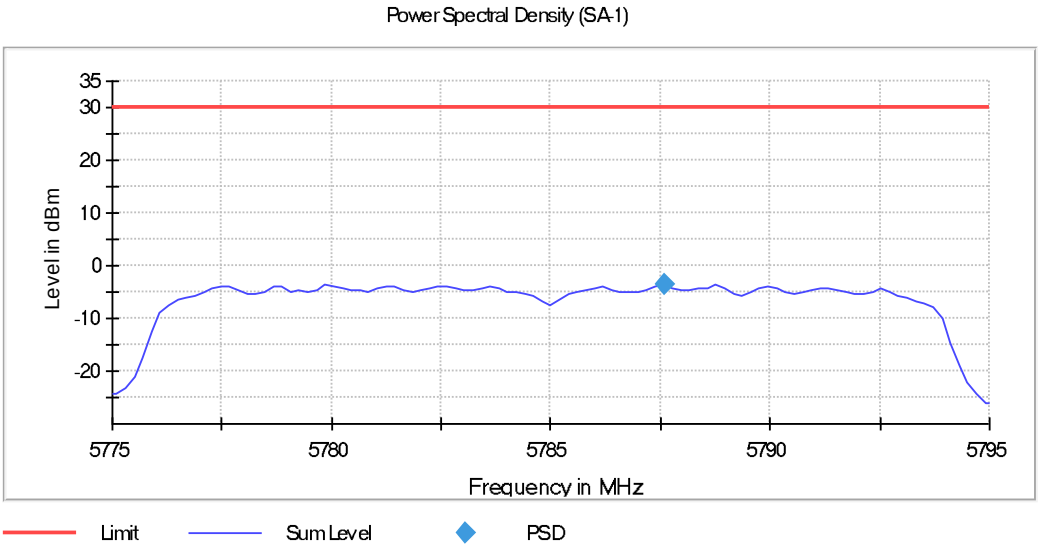
U-NII-3 (5725-5850 MHz)

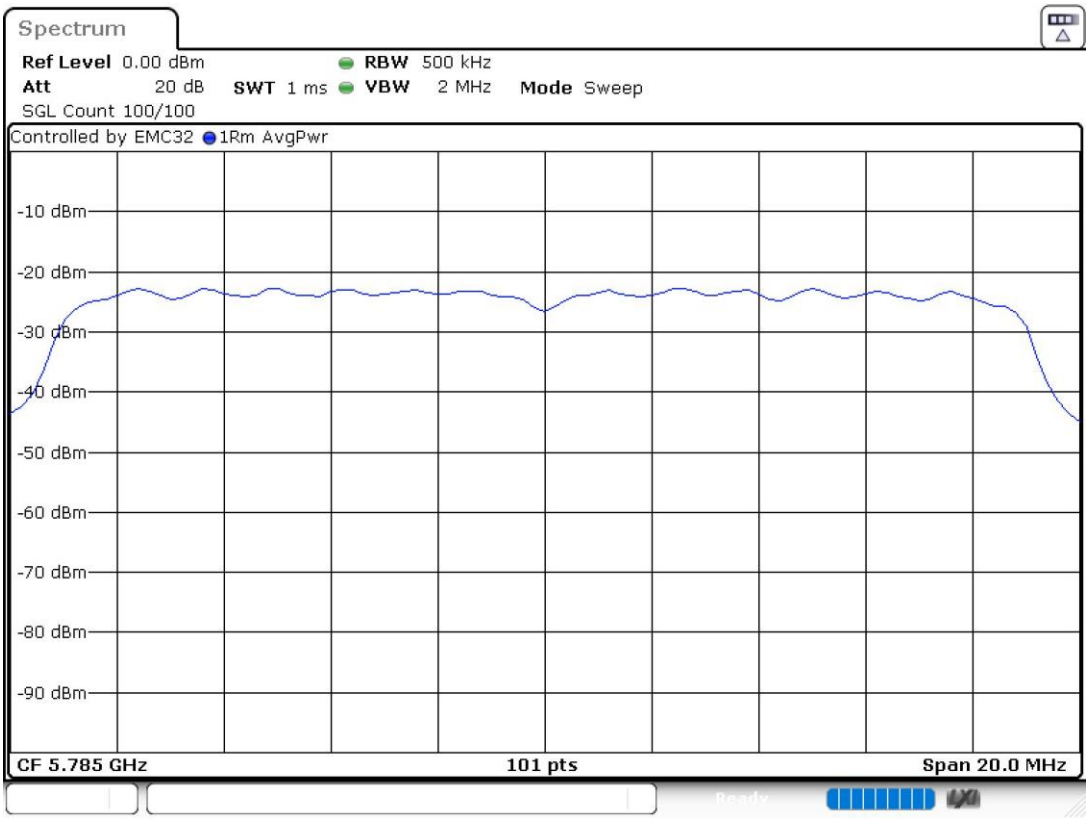
- Low Channel 149 (5745 MHz):



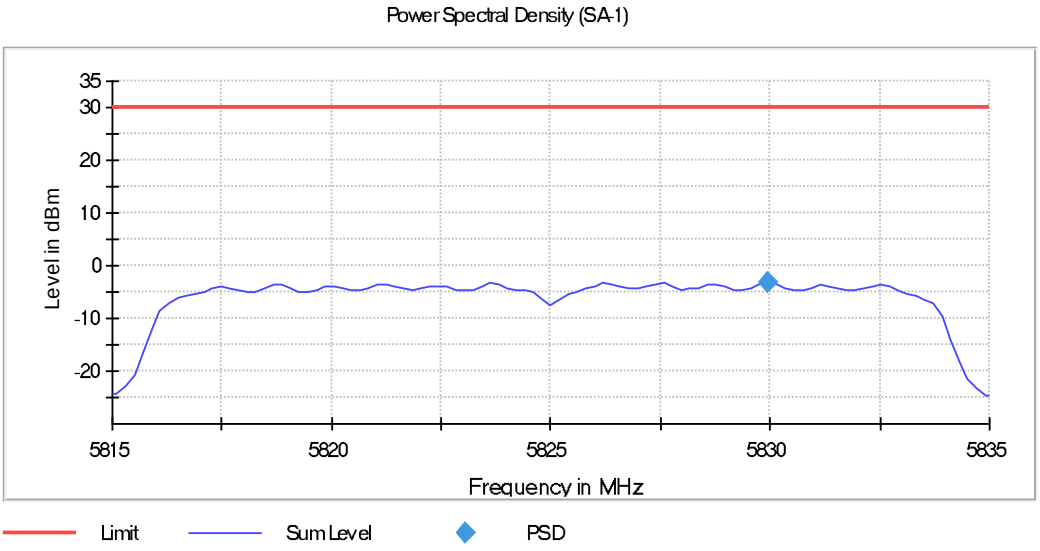


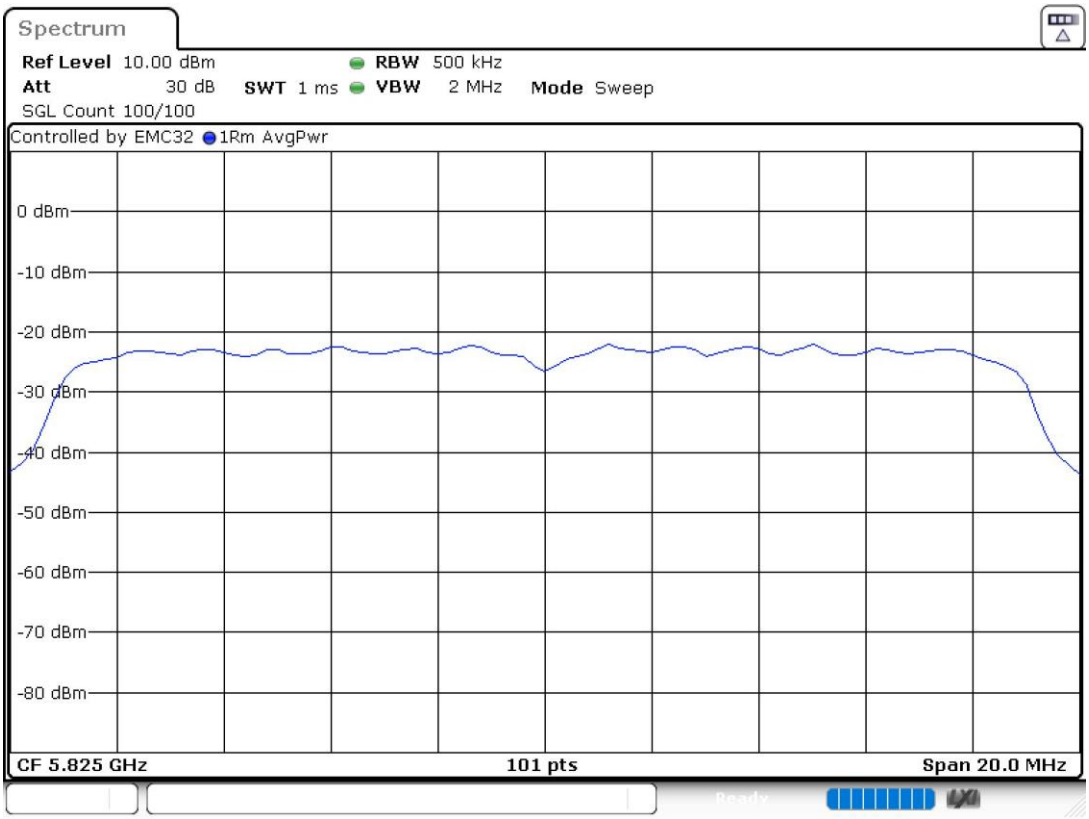
- Middle Channel 157 (5785 MHz):





- High Channel 165 (5825 MHz):

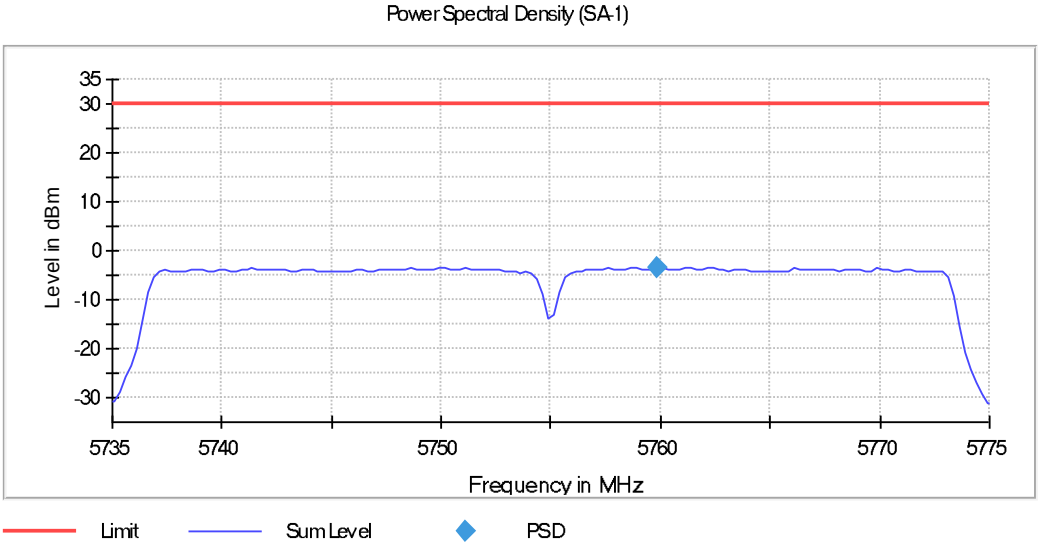


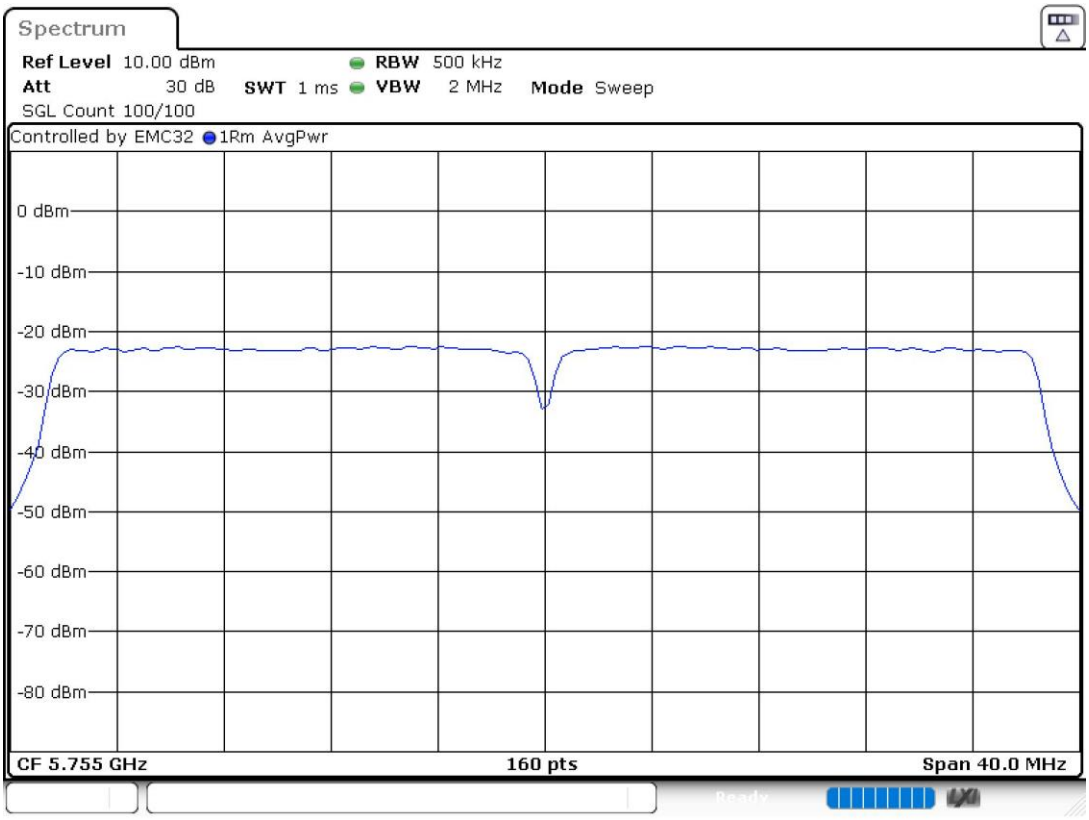


SISO 802.11 n40 (HT40):

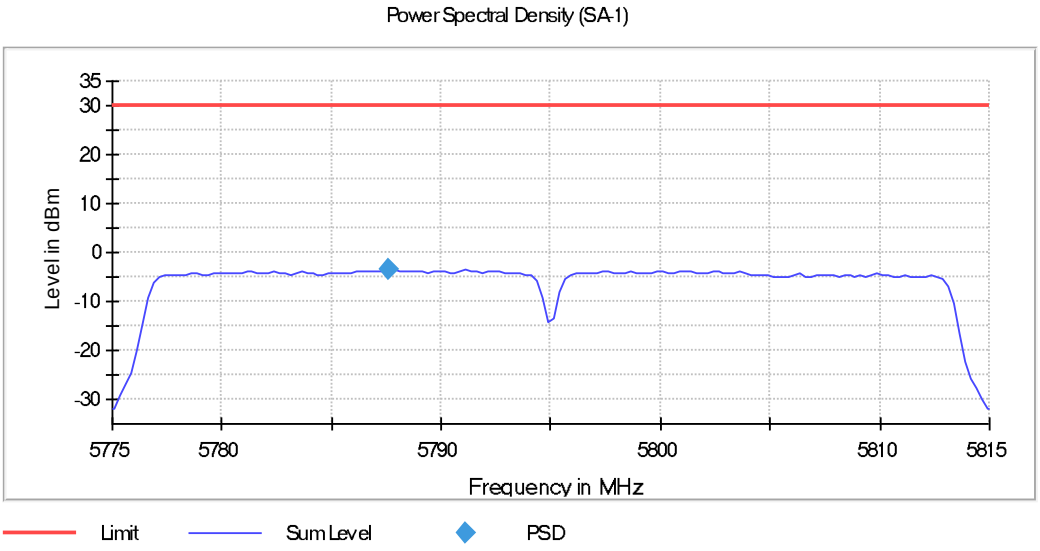
U-NII-3 (5725-5850 MHz)

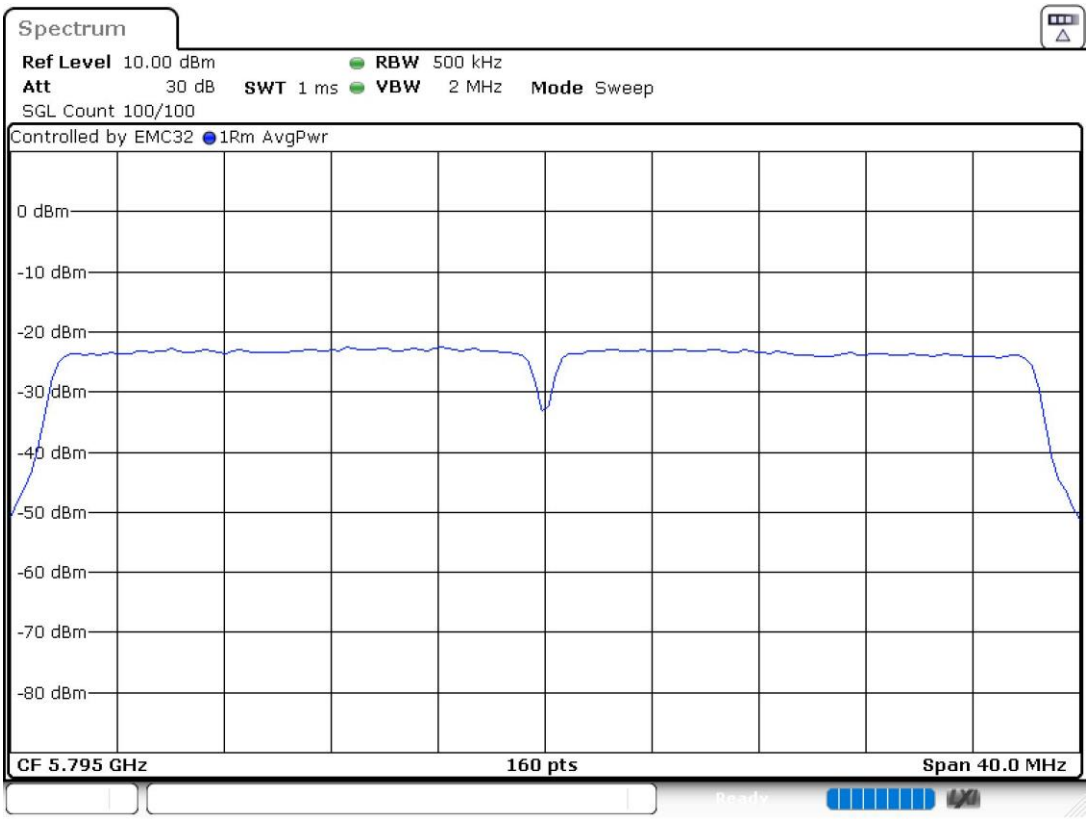
- Low Channel 151 (5755 MHz):





- High Channel 159 (5795 MHz):





SISO 802.11 ac40 (VHT40):

U-NII-3 (5725-5850 MHz)

- Low Channel 151 (5755 MHz):