Appendix C: Test results for the U-NII-3: 5.725 GHz - 5.85 GHz Band

INDEX

TEST CONDITIONS 140

SAMPLE CALCULATION 145

TEST CASES DETAILS 146

RSS-247 7.3.4.2 / FCC 15.407 (e) 6 dB Emission Bandwidth 146
RSS-247 7.3.4.3 / FCC 15.407 (a) (3) Maximum Conducted output power UNII-3 166
RSS-247 7.3.4.3 / FCC 15.407 (a) (3) Transmitter Maximum Power Spectral Density UNII-3 168
RSS-247 7.3.4.4 / FCC 15.407 (b) (4) Transmitter Out of Band Radiated Emissions For transmitters operating solely in the 5.725-5.850 GHz band 188

TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal: 12 Vdc

Type of Power Supply: car battery /attenuator (9.5 - 15.5 V normal operation)

ANTENNA (*):

Type of Antenna: Internal

Maximum Declared Antenna Gain: +5.81 dBi

TEST FREQUENCIES (*):

Technology Tested:	WLAN (IEEE 802.11 a,n,ac) / U-NII-3	
	802.11a OFDM 6 Mbit/s SISO	
	802.11 n HT20: MCS0 to MCS23 SISO	
	802.11 n HT40: MCS0 to MCS23 SISO	
	802.11 ac VHT20: MCS0 to MCS9 SISO	
	802.11 ac VHT40: MCS0 to MCS9 SISO	
	802.11 ac VHT80: MCS0 to MCS9 SISO	
Setting of cores / ports:	1	
Beamforming:	No.	
	5725 MHz to 5850 MHz	
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 OFDM 6 Mbit/s
- 802.11 n HT20: MCS0
- 802.11 n HT40: MCS0
- 802.11 ac VHT20: MCS0
- 802.11 ac VHT40: MCS0
- 802.11 ac VHT80: MCS0

CONDUCTED MEASUREMENTS:

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

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-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1.5 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

For radiated emissions in the range 17 GHz-26 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.

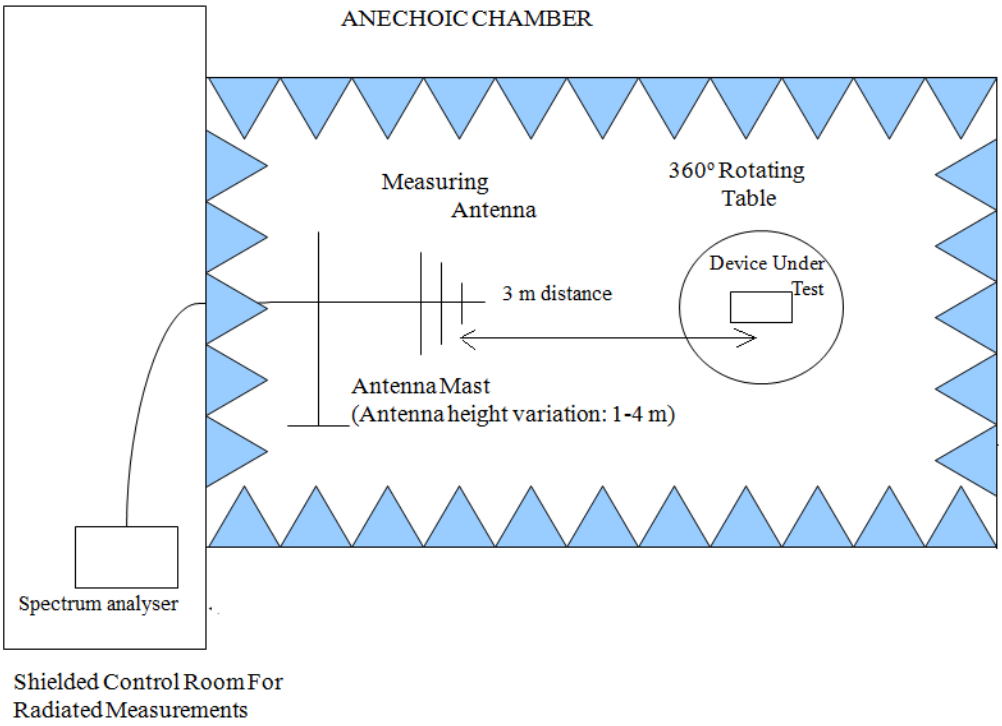
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find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

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

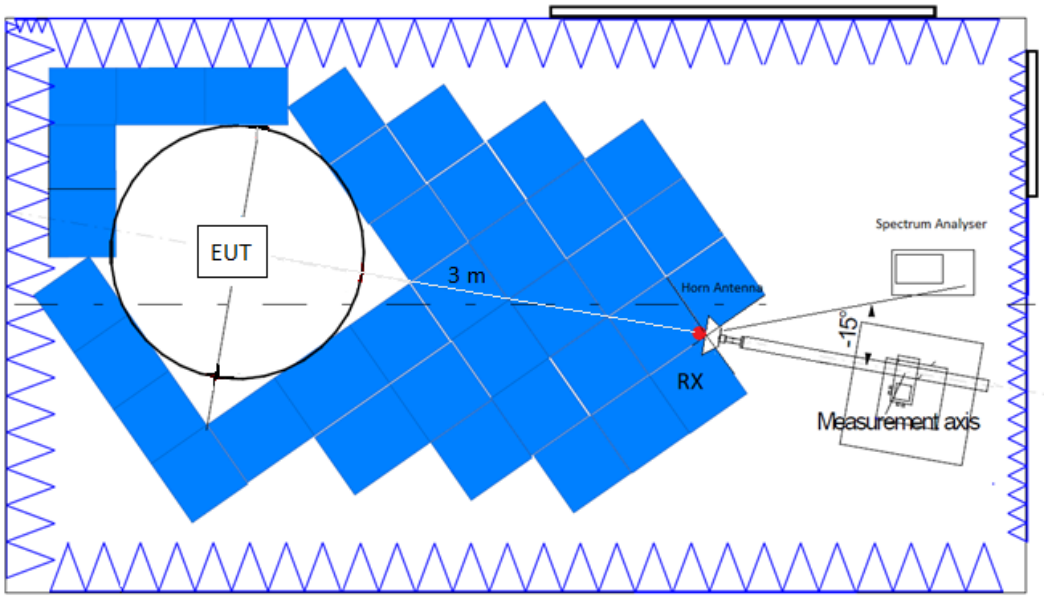
The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

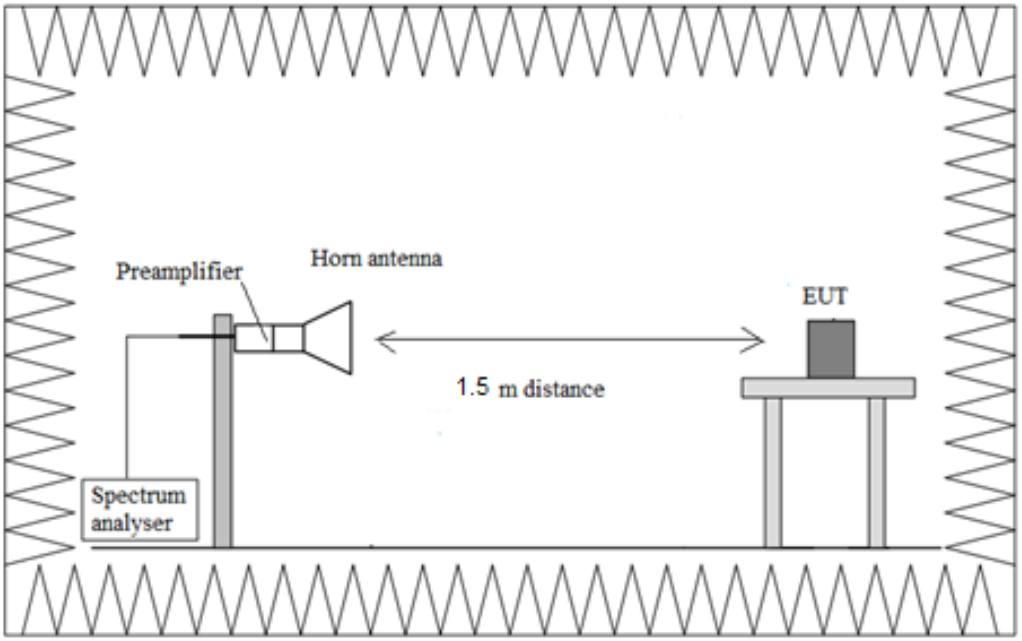
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



SAMPLE CALCULATION

For radiated measurements:

Values measures by the test receiver / analyzer are converted to field strength, in dBuV/m, at the regulatory distance using the following calculation:

Unwanted Lvl (dBuV/m) = Raw Rec (dBuV) + Preamp (dB) + Trd Corre. (dB/m) + SigPath (dB)

Where,

Raw Rec (dBuV): Measured voltage in the receiver / spectrum analyzer in dBuV

Preamp (dB): Path loses due to preamplifier

Trd Corr. (dB/m): Antenna factor in dB/m

SigPath (dB) = Cable loss (dB) – External Gain amplifier (dB) – Distance factor (dB)

Cable loss (dB): Cable loss

External Gain amplifier (dB): Gain from external amplifier (when used)

Distance factor (dB): Distance factor in dB. When measurement distance is different to limit distance

The field strength, calculated by this way is compared with the regulatory limit.

TEST CASES DETAILS

RSS-247 7.3.4.2 / FCC 15.407 (e) 6 dB Emission Bandwidth

Limits

* 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.

Modulation: 802.11a (OFDM 6 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	Ebw (MHz)
[5725, 5850]	1	5745.00000	16.400
		5785.00000	16.400
		5825.00000	16.400

Verdict

Pass

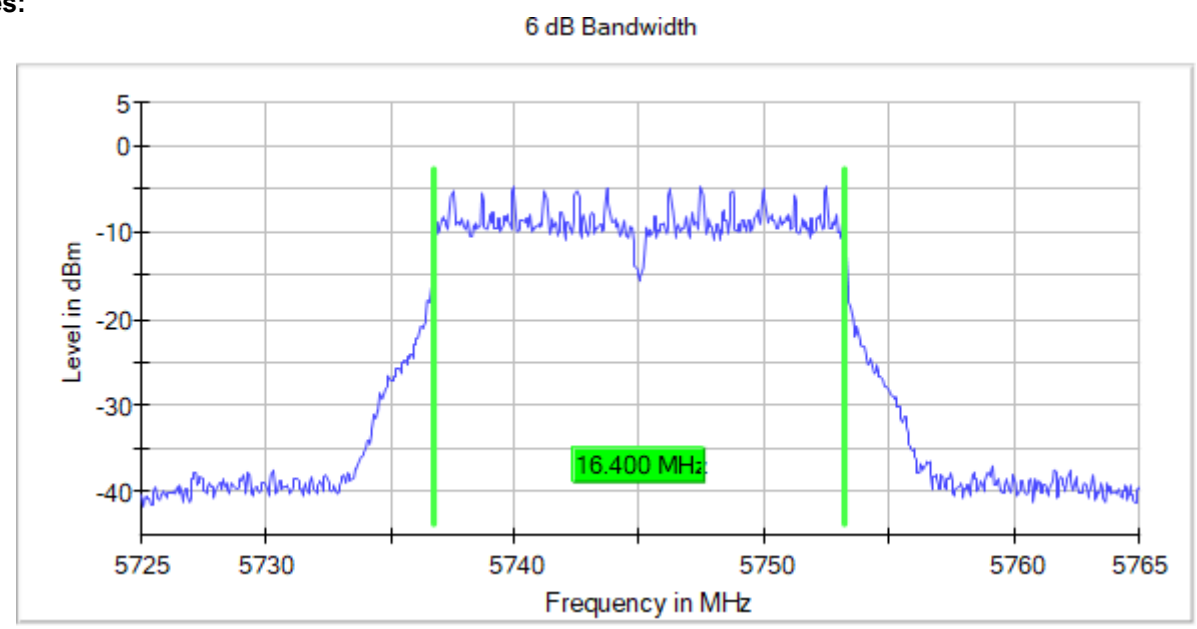
Attachments

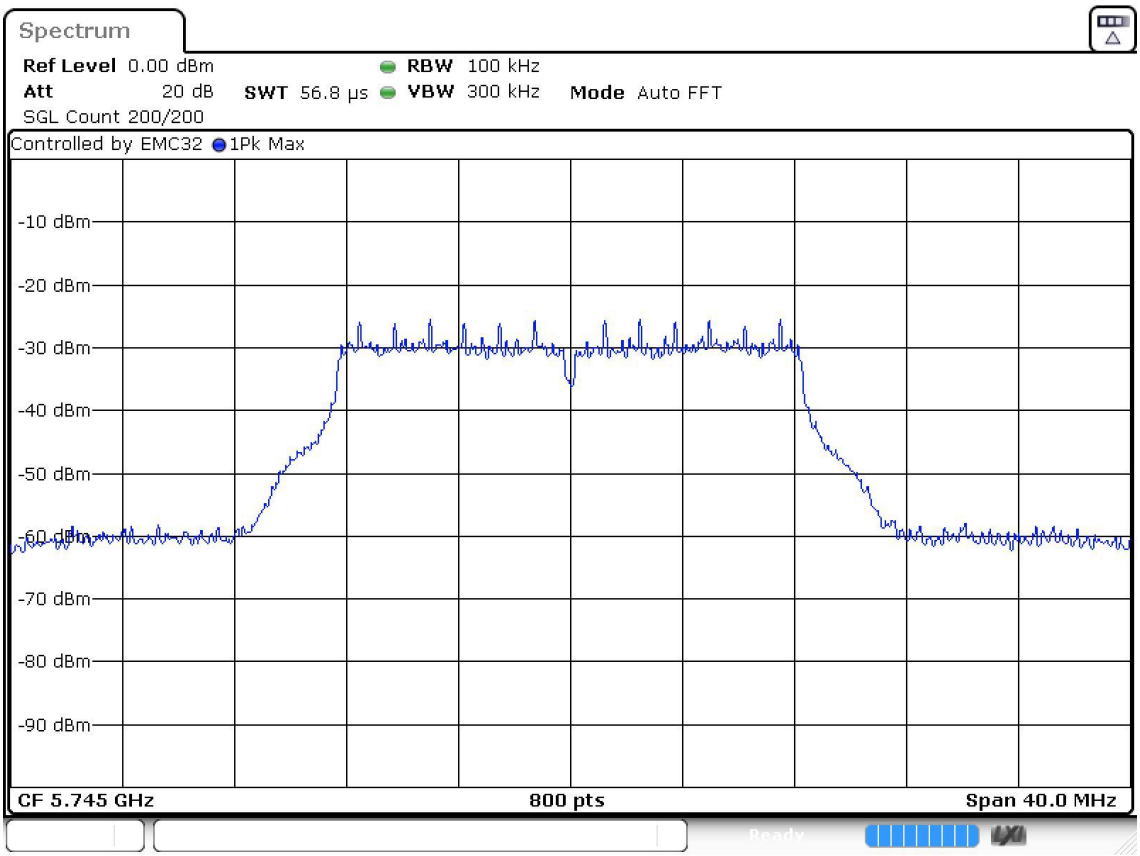
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5745.00000 Modulation = 802.11a (OFDM 6 Mbit/s)

MIMO Mode = SISO

Images:



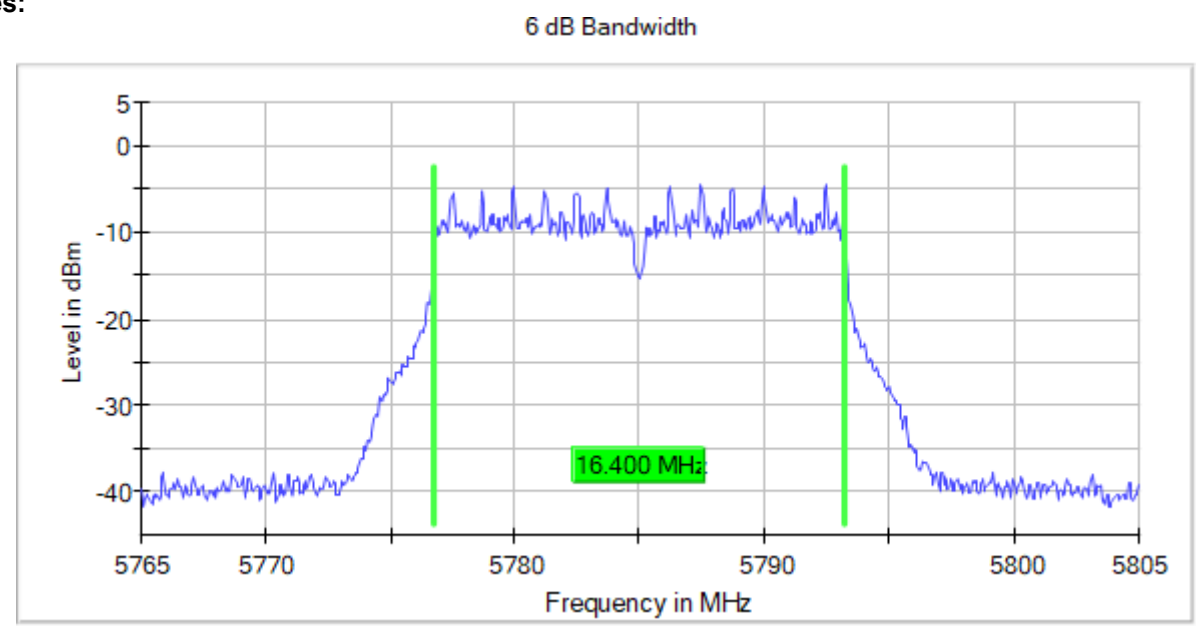


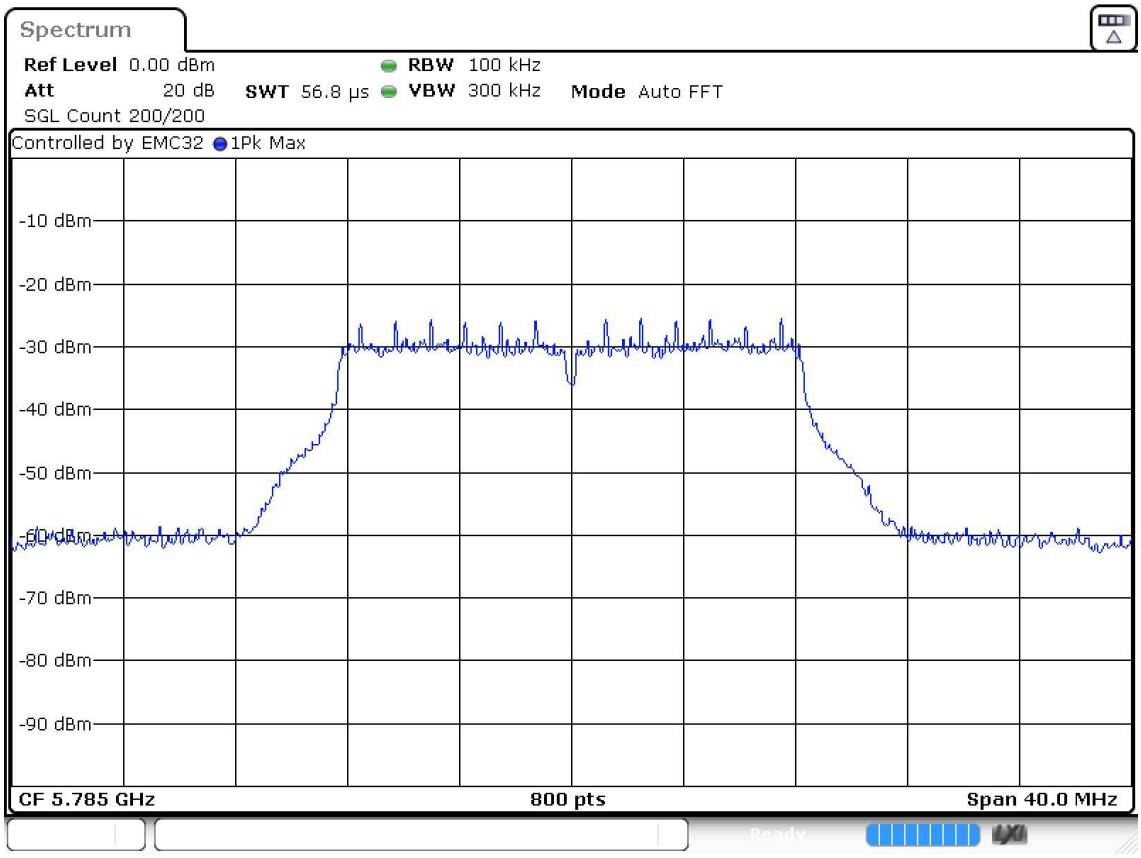
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5785.00000 Modulation = 802.11a (OFDM 6 Mbit/s)

MIMO Mode = SISO

Images:



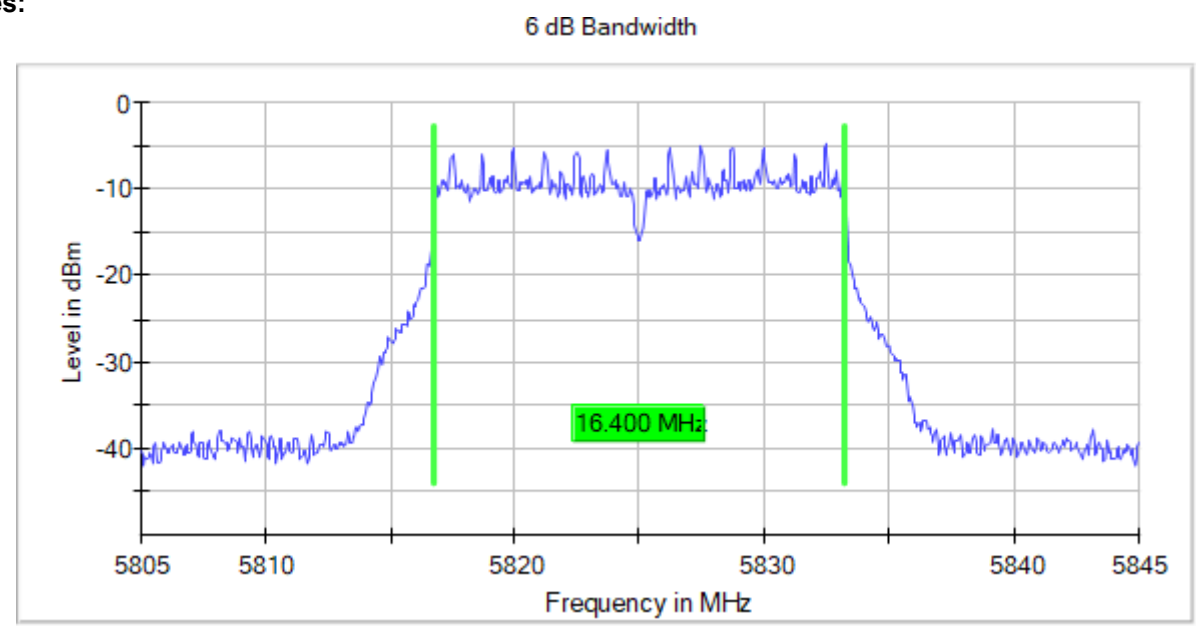


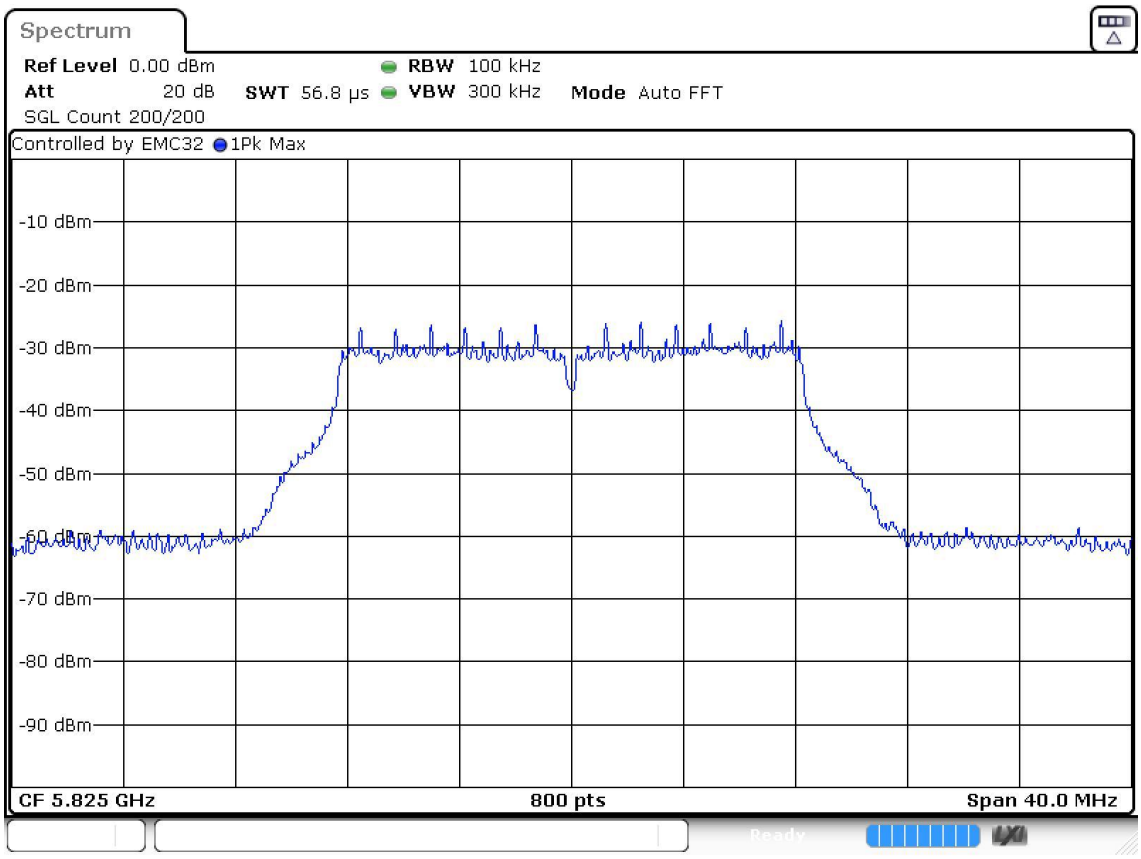
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5825.00000 Modulation = 802.11a (OFDM 6 Mbit/s)

MIMO Mode = SISO

Images:





Modulation: 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	Ebw (MHz)
[5725, 5850]	1	5745.00000	17.700
		5785.00000	17.700
		5825.00000	17.700

Verdict

Pass

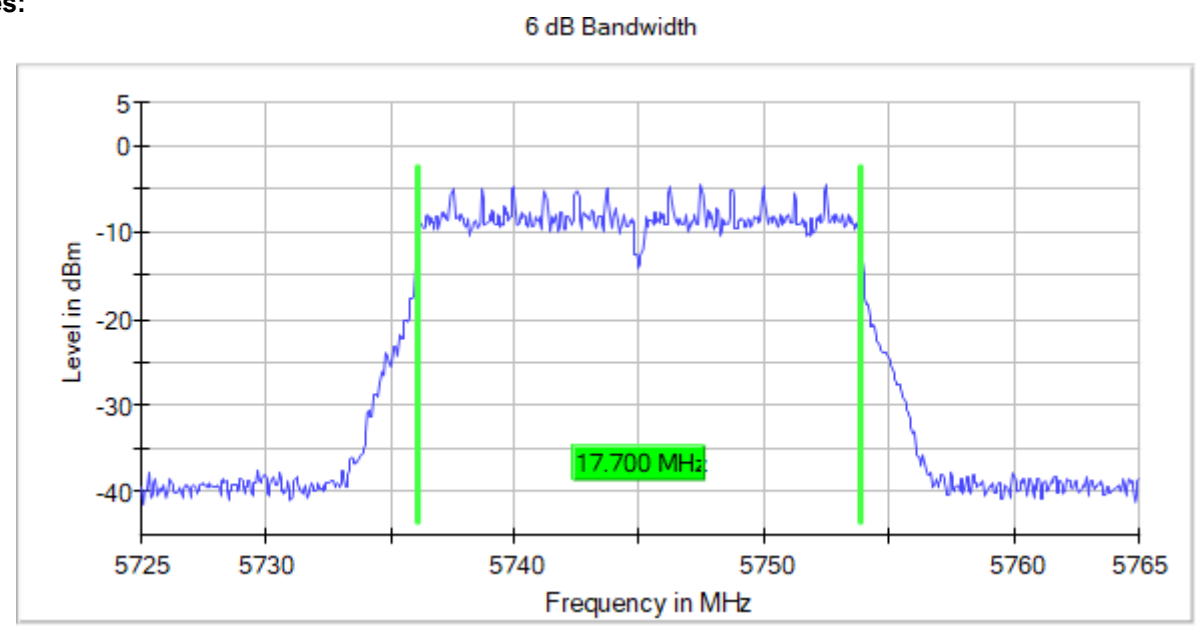
Attachments

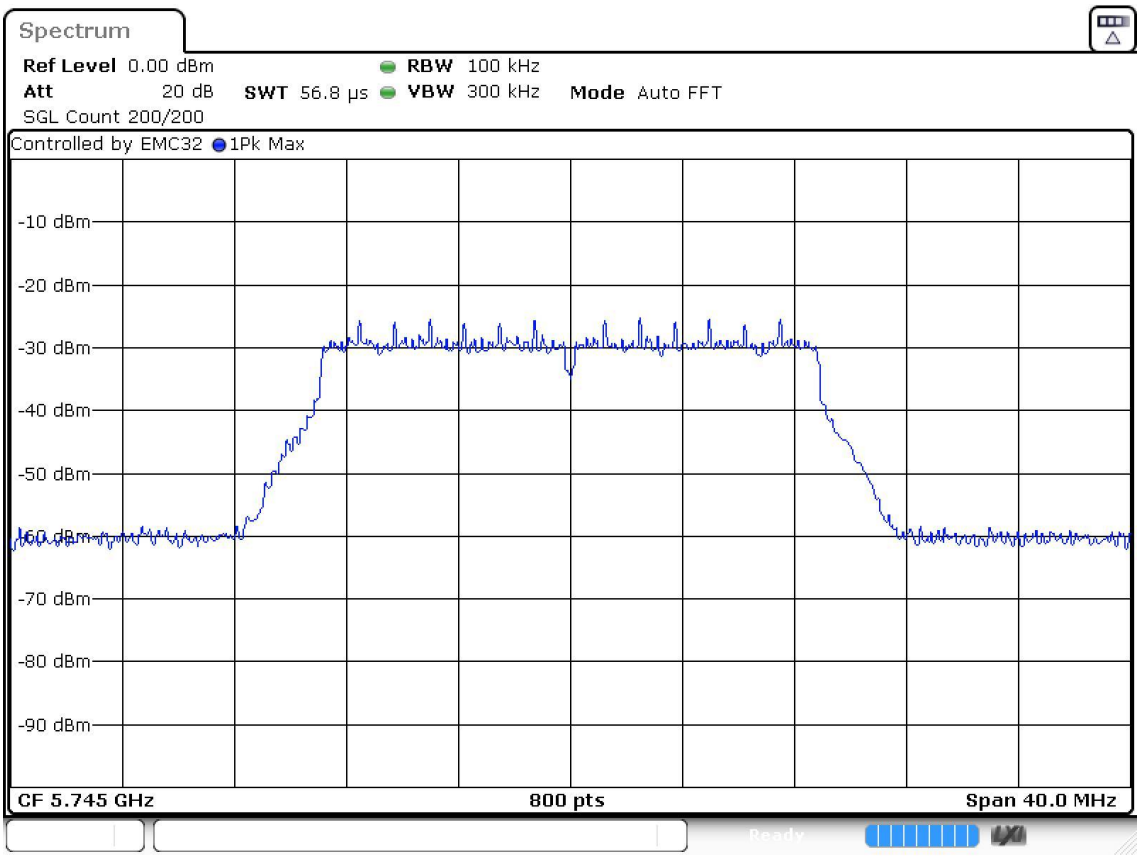
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5745.00000 Modulation = 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)

MIMO Mode = SISO

Images:



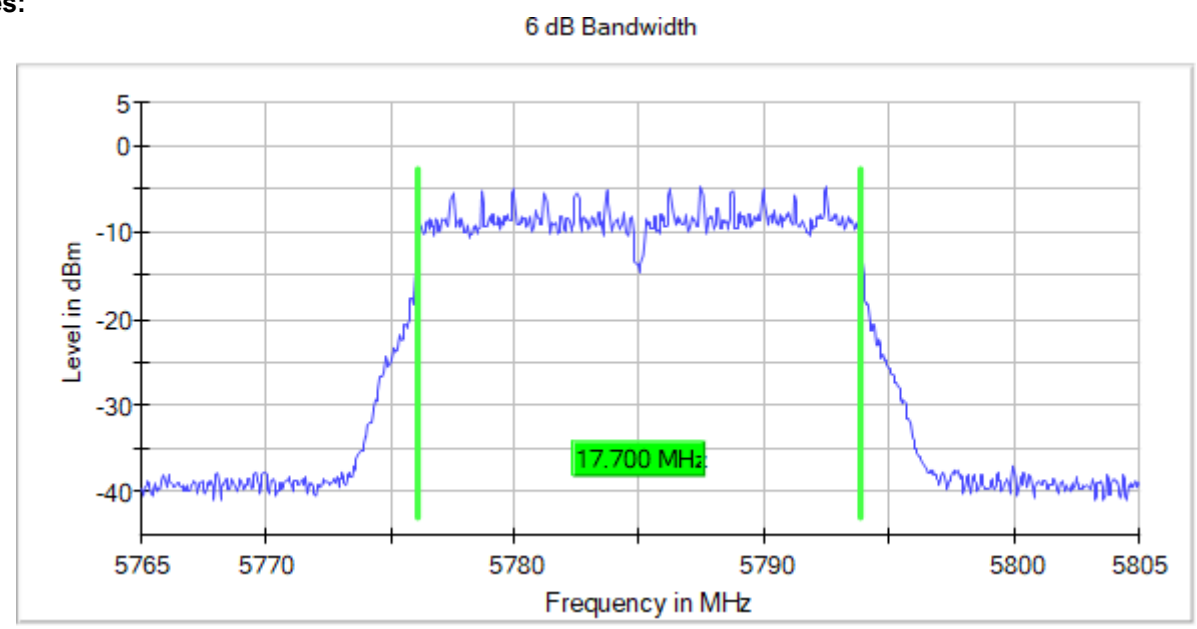


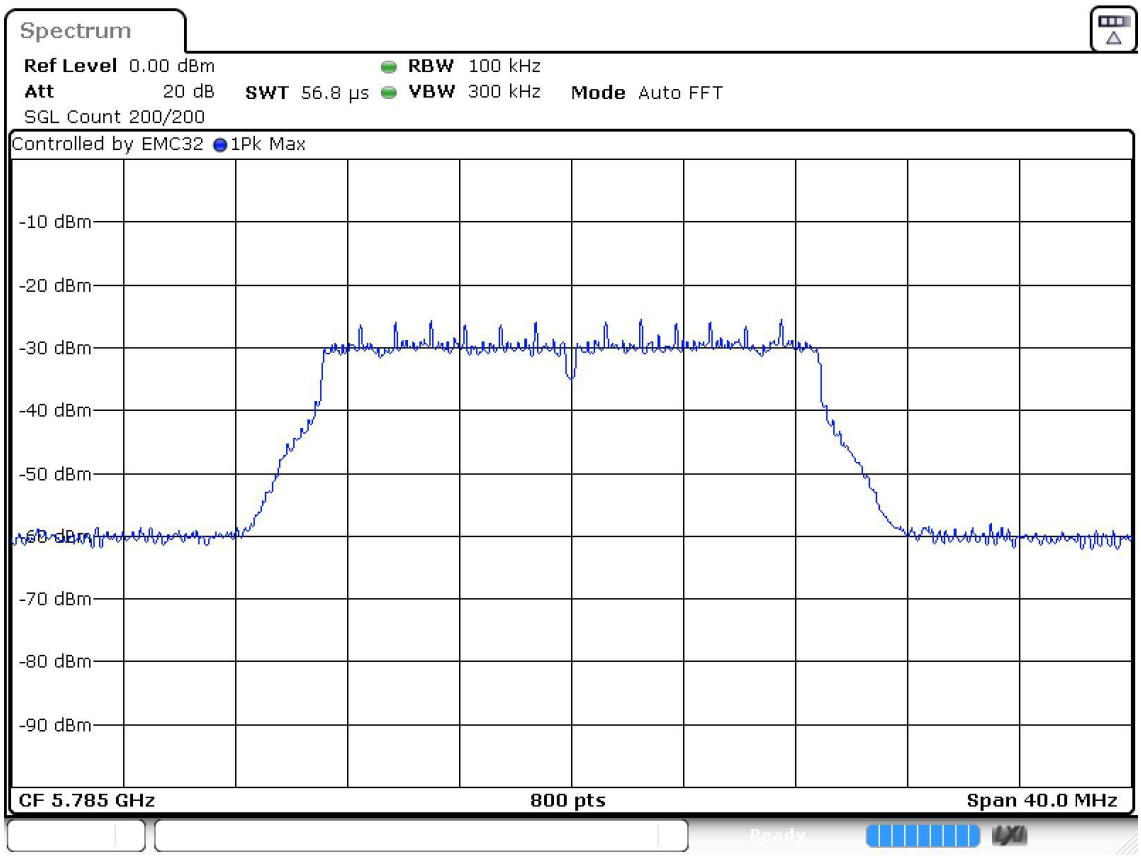
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5785.00000 Modulation = 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)

MIMO Mode = SISO

Images:



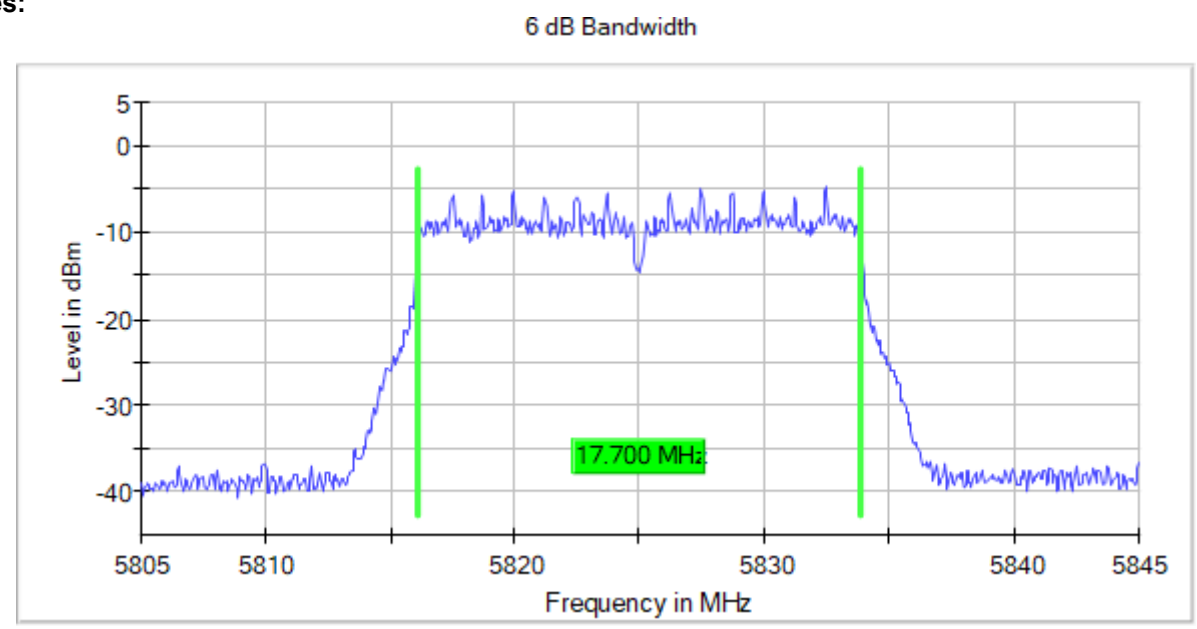


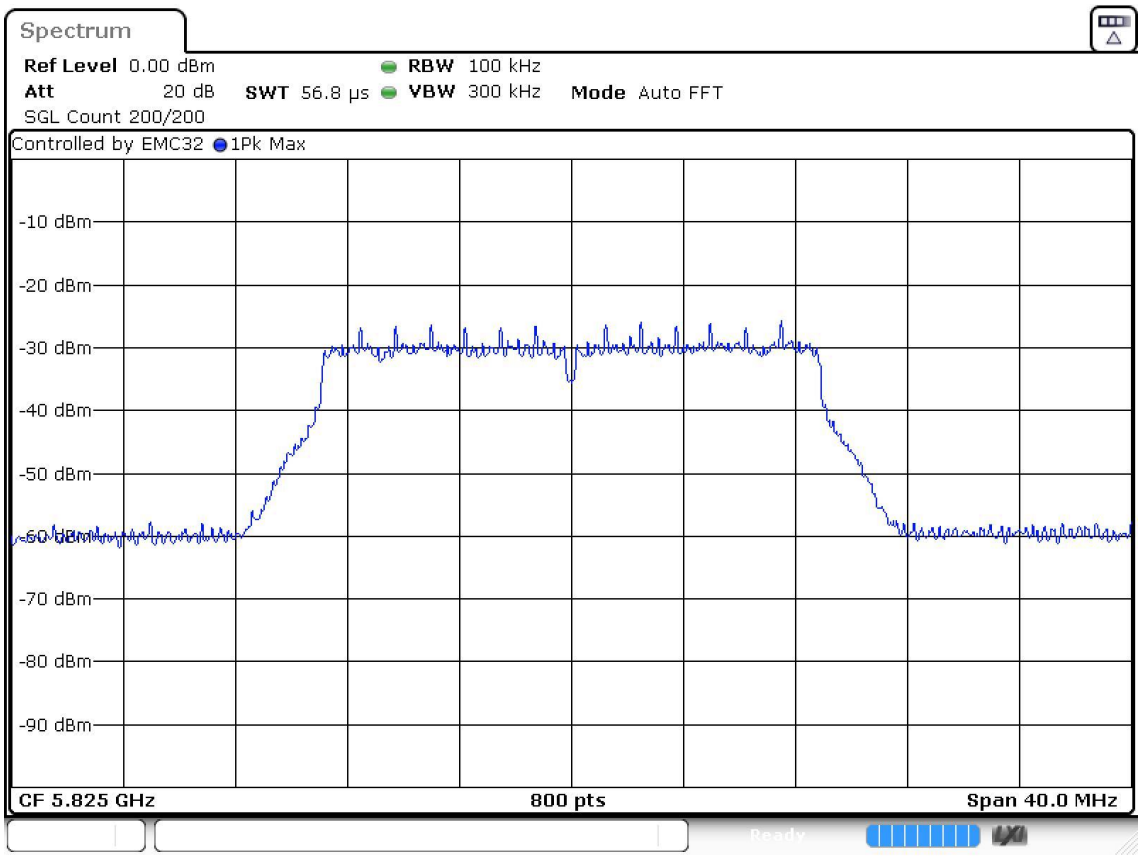
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5825.00000 Modulation = 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)

MIMO Mode = SISO

Images:





Results

Modulation: 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	Ebw (MHz)
[5725, 5850]	1	5755.00000	36.400
		5795.00000	36.400

Verdict

Pass

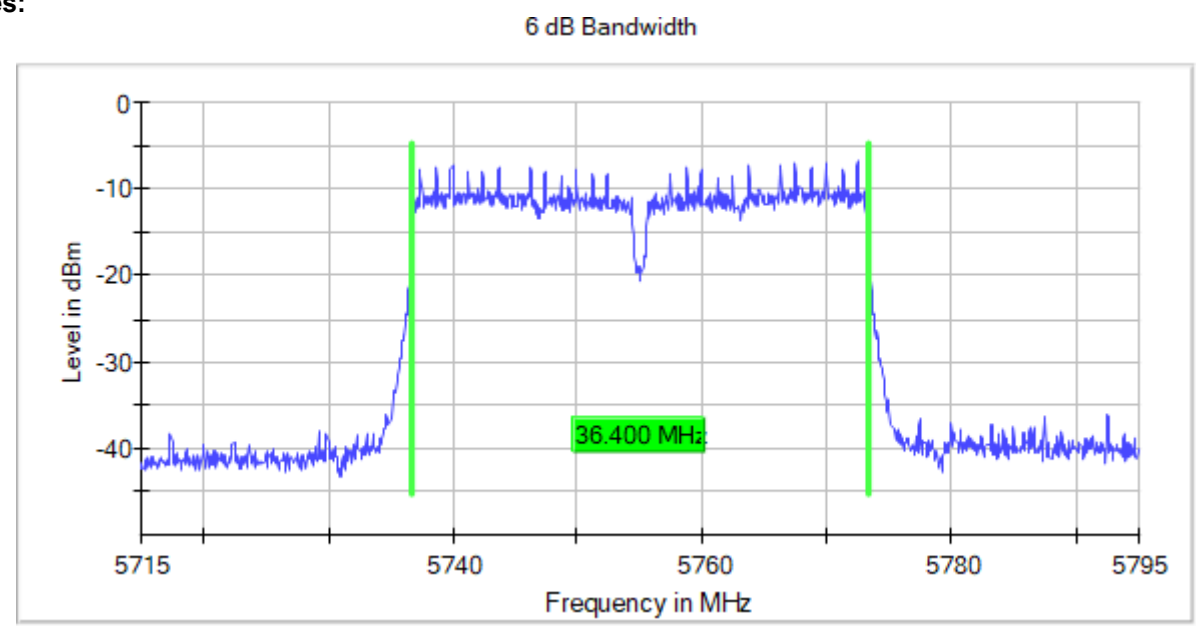
Attachments

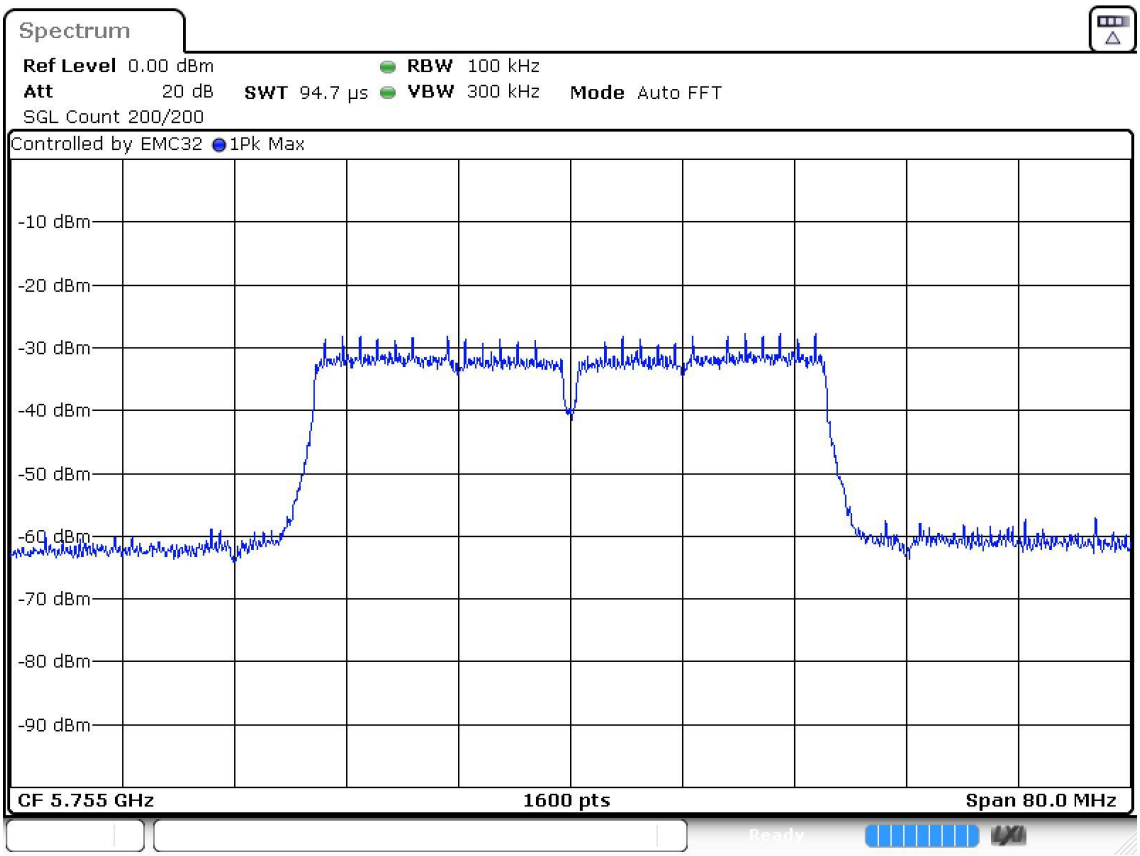
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5755.00000 Modulation = 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

MIMO Mode = SISO

Images:



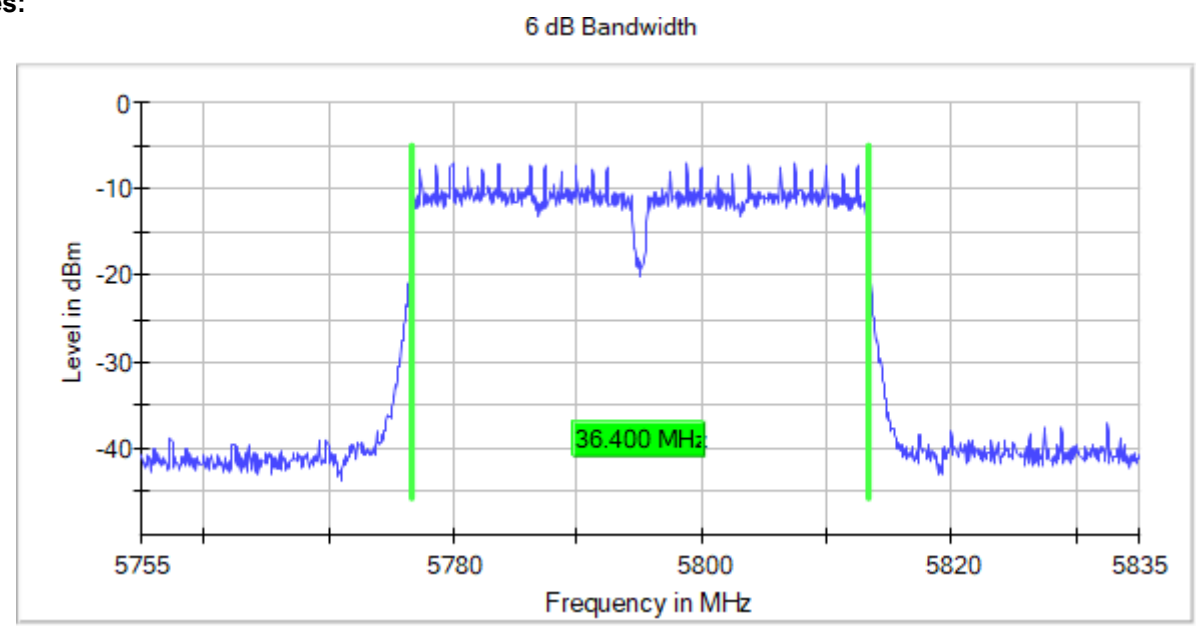


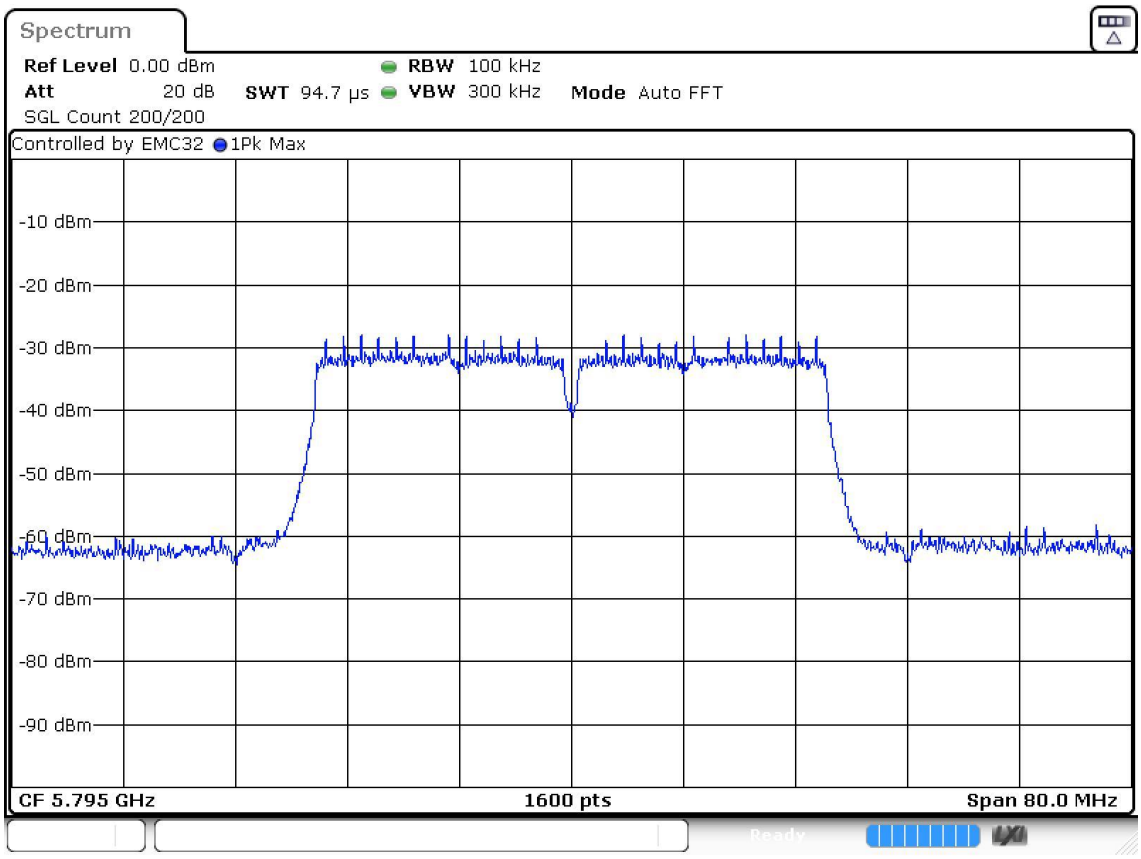
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5795.00000 Modulation = 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

MIMO Mode = SISO

Images:





Modulation: 802.11ac VHT20 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	Ebw (MHz)
[5725, 5850]	1	5745.00000	17.700
		5785.00000	17.700
		5825.00000	17.700

Verdict

Pass

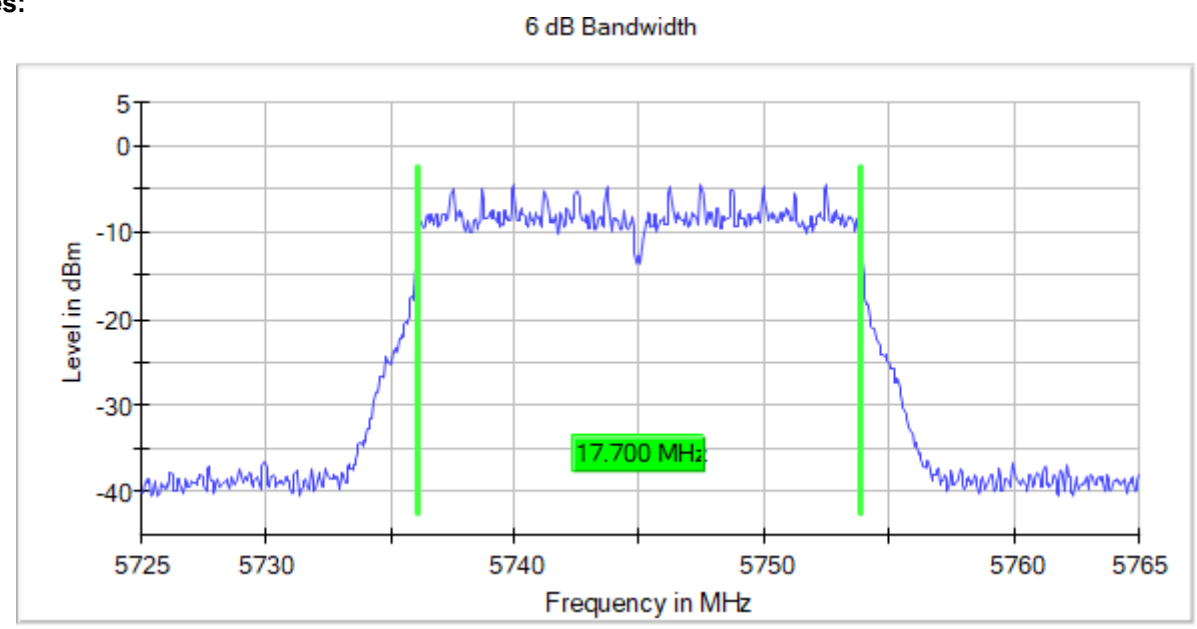
Attachments

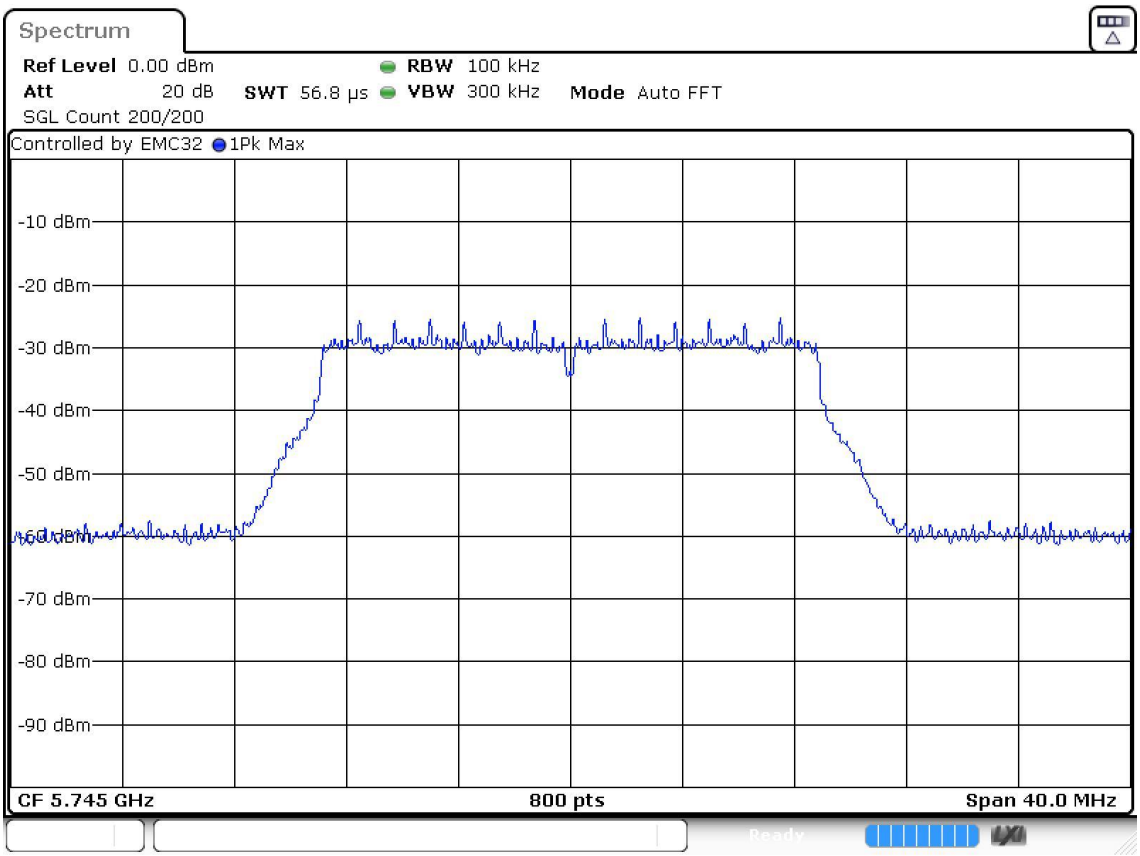
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5745.00000 Modulation = 802.11ac VHT20 (OFDM MCS0)

MIMO Mode = SISO

Images:



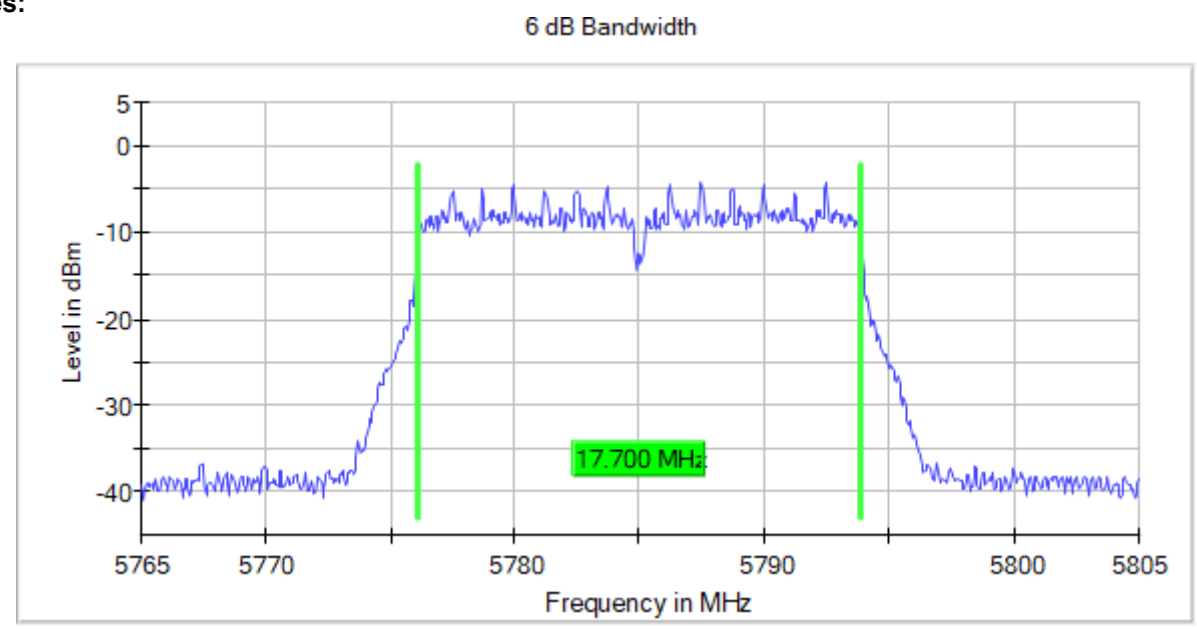


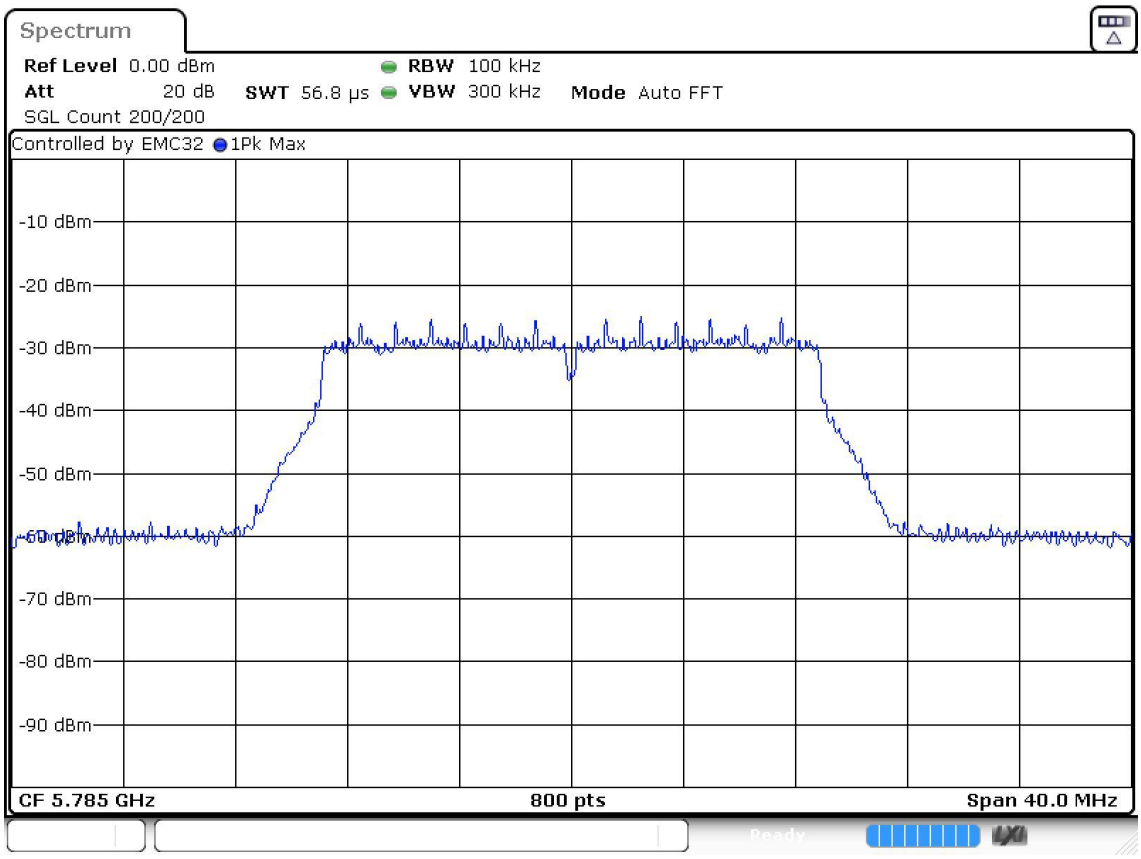
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5785.00000 Modulation = 802.11ac VHT20 (OFDM MCS0)

MIMO Mode = SISO

Images:



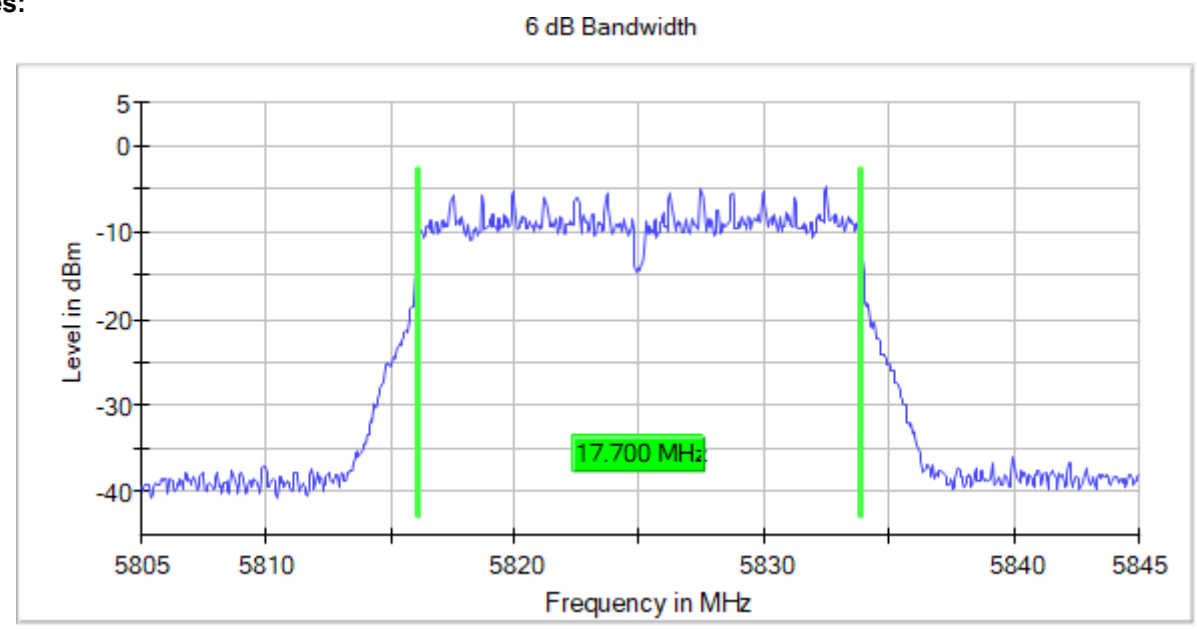


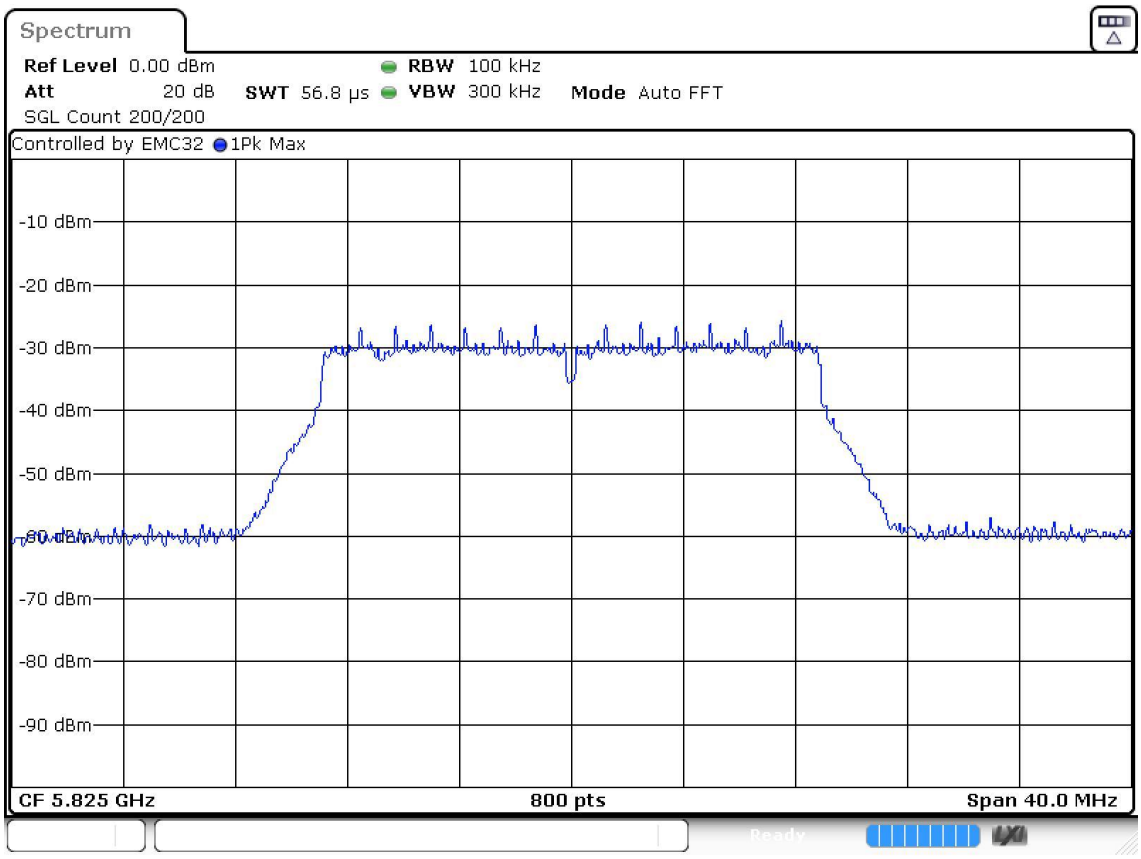
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5825.00000 Modulation = 802.11ac VHT20 (OFDM MCS0)

MIMO Mode = SISO

Images:





Modulation: 802.11ac VHT40 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	Ebw (MHz)
[5725, 5850]	1	5755.00000	36.400
		5795.00000	36.400

Verdict

Pass

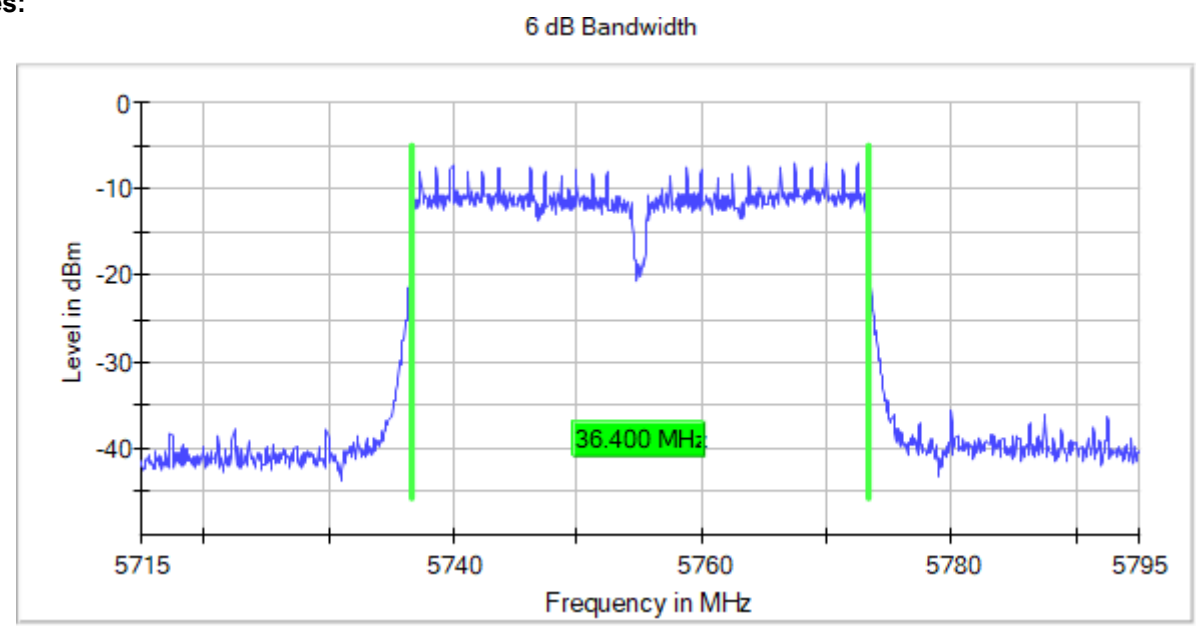
Attachments

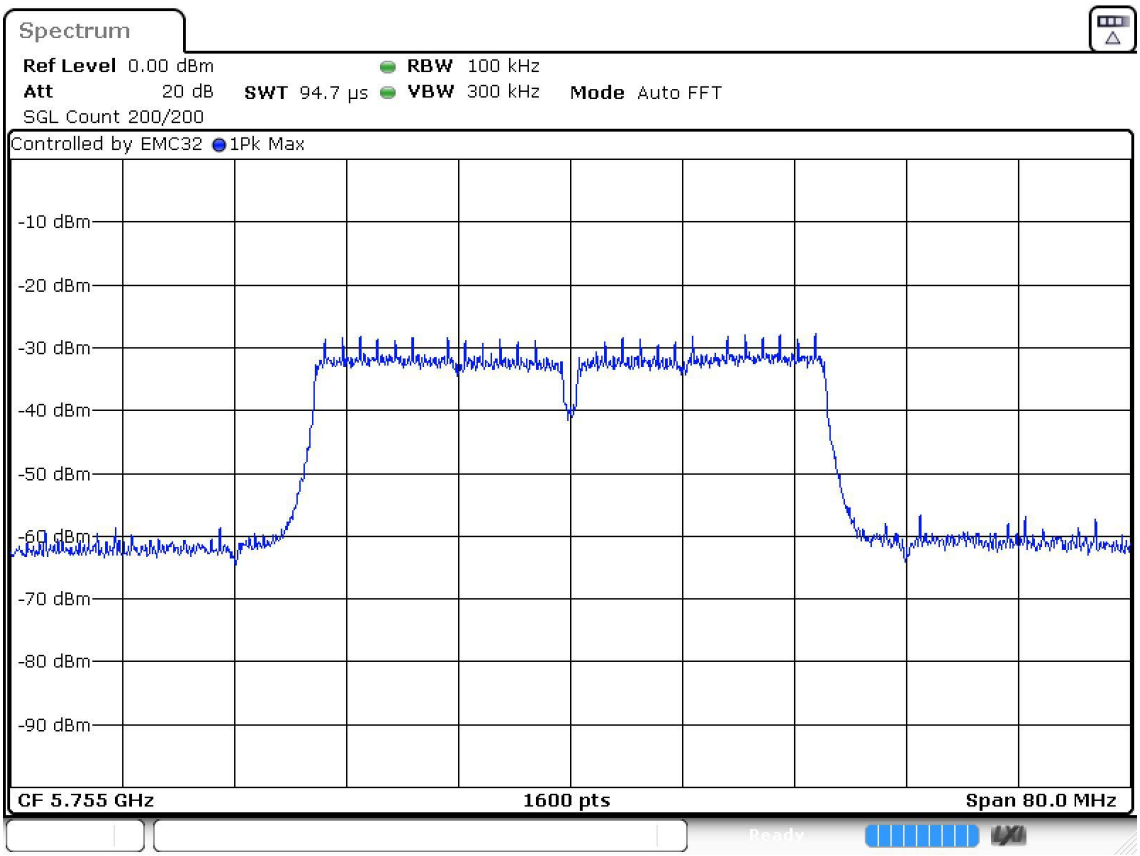
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5755.00000 Modulation = 802.11ac VHT40 (OFDM MCS0)

MIMO Mode = SISO

Images:



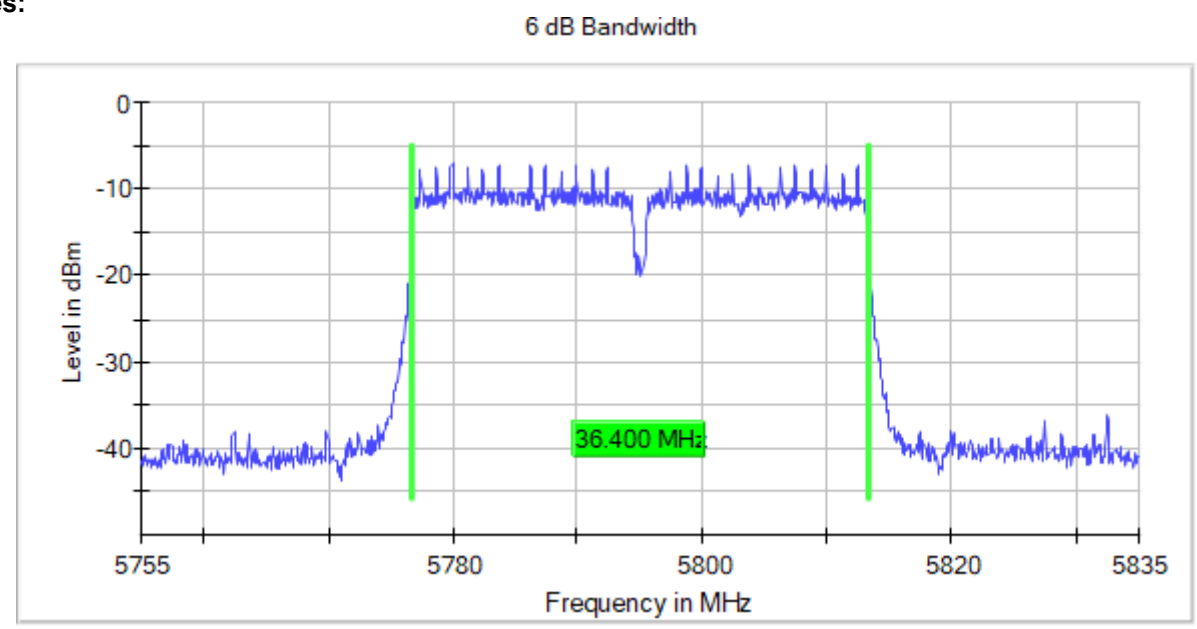


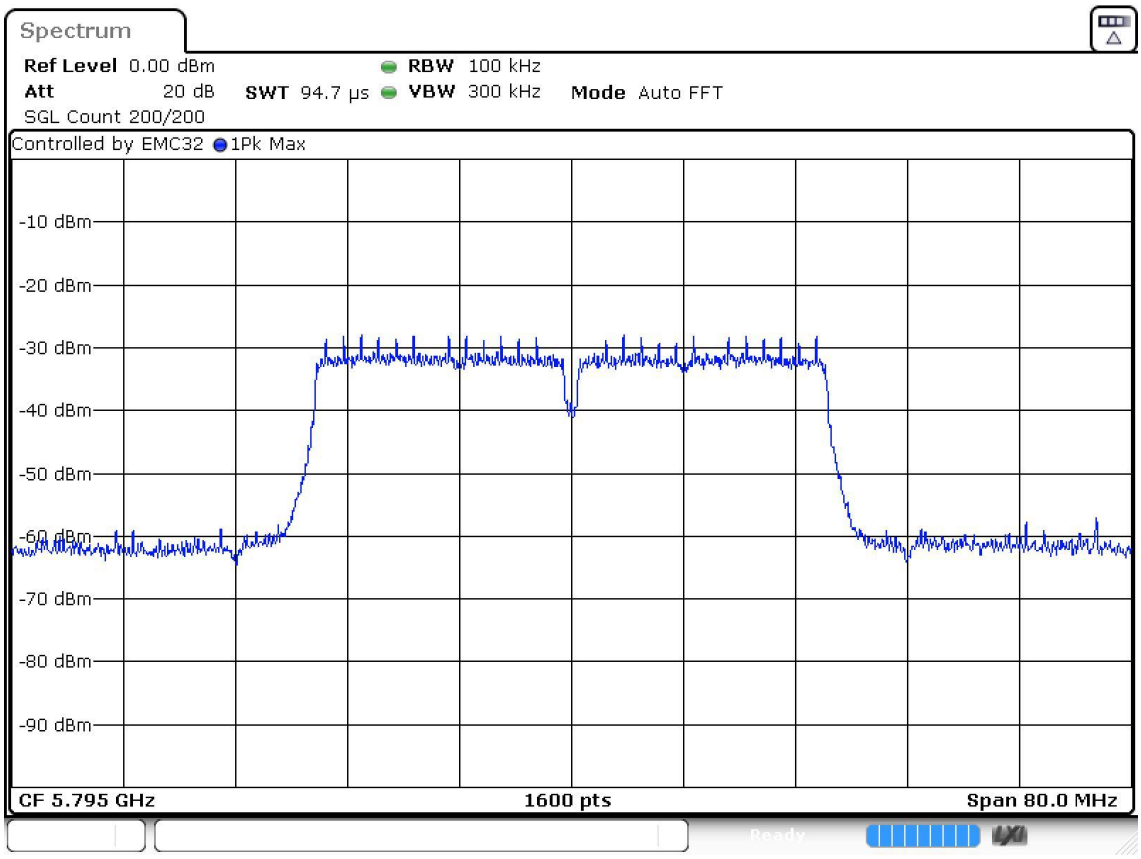
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5795.00000 Modulation = 802.11ac VHT40 (OFDM MCS0)

MIMO Mode = SISO

Images:





Modulation: 802.11ac VHT80 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	Ebw (MHz)
[5725, 5850]	1	5775.00000	75.500

Verdict

Pass

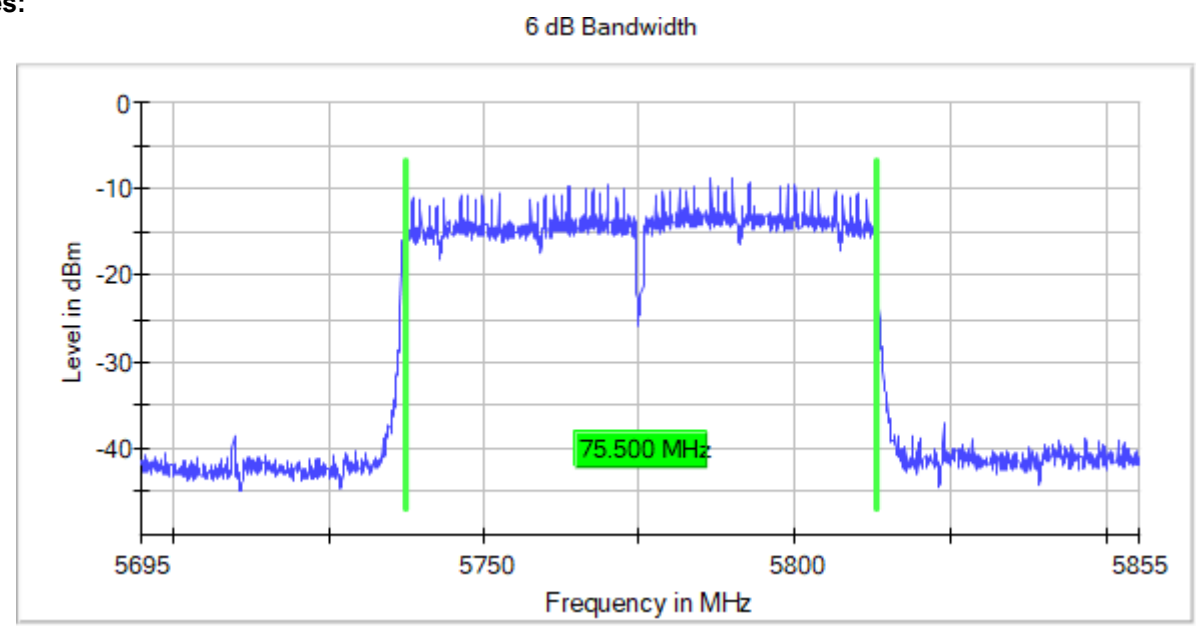
Attachments

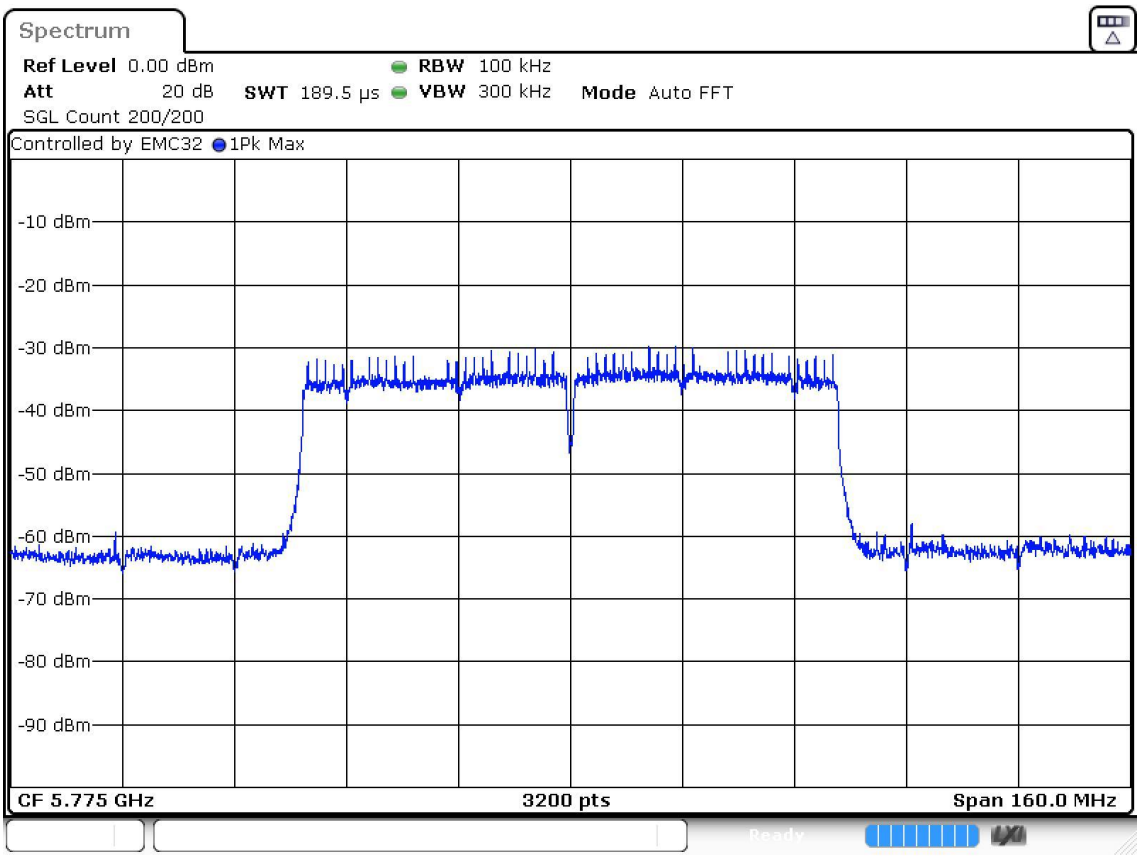
Operation Band MHz = [5725, 5850] Active Port = 1

Frequency MHz = 5775.00000 Modulation = 802.11ac VHT80 (OFDM MCS0)

MIMO Mode = SISO

Images:





RSS-247 7.3.4.3 / FCC 15.407 (a) (3) Maximum Conducted output power UNII-3

Limits

* 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: Equipment operating in the band 5725-5850 shall comply with the following power limits: the maximum conducted output power shall not exceed 1 W.
When using transmitting antennas with a directional gain exceeding 6 dBi, 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.

Results

Modulation: 802.11a (OFDM 6 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5725, 5850]	1	5785.00000	No	7.56	13.37
		5785.00000		6.84	12.54
		5825.00000		6.44	12.14

Modulation: 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5725, 5850]	1	5745.00000	No	7.05	12.75
		5785.00000		6.74	12.44
		5825.00000		6.42	12.12

Modulation: 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5725, 5850]	1	5755.00000	No	7.52	13.22
		5795.00000		7.60	13.30

Modulation: 802.11ac VHT20 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5725, 5850]	1	5745.00000	No	7.20	12.90
		5785.00000		6.86	12.56
		5825.00000		6.42	12.12

Modulation: 802.11ac VHT40 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5725, 5850]	1	5755.00000	No	7.46	13.16
		5795.00000		7.56	13.26

Modulation: 802.11ac VHT80 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Avg Power (dBm)	Max EIRP (dBm)
[5725, 5850]	1	5775.00000	No	7.76	13.46

Verdict

Pass

RSS-247 7.3.4.3 / FCC 15.407 (a) (3) Transmitter Maximum Power Spectral Density UNII-3

Limits

* 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: Equipment operating in the band 5725-5850 shall comply with the following power limits: the maximum output power spectral density shall not exceed 30 dBm/500 kHz.

When using transmitting antennas with a directional gain exceeding 6 dBi, 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.

Modulation: 802.11a (OFDM 6 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5725, 5850]	1	5745.00000	No	5751.534653	-8.63
		5785.00000		5791.732673	-8.11
		5825.00000		5820.049505	-8.72

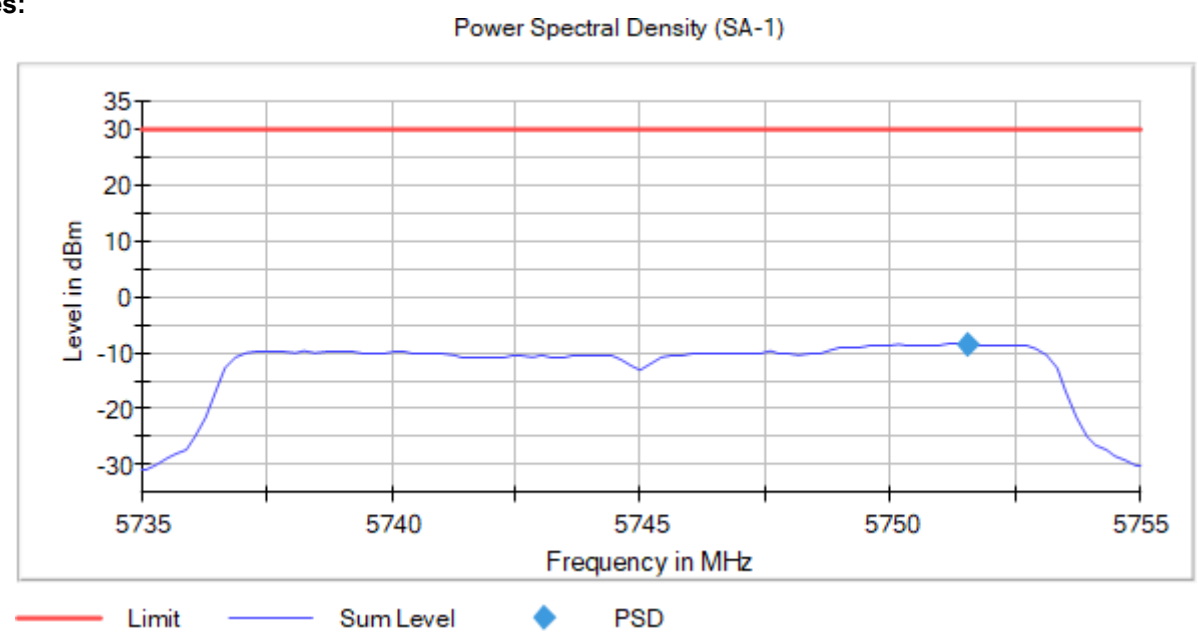
Verdict

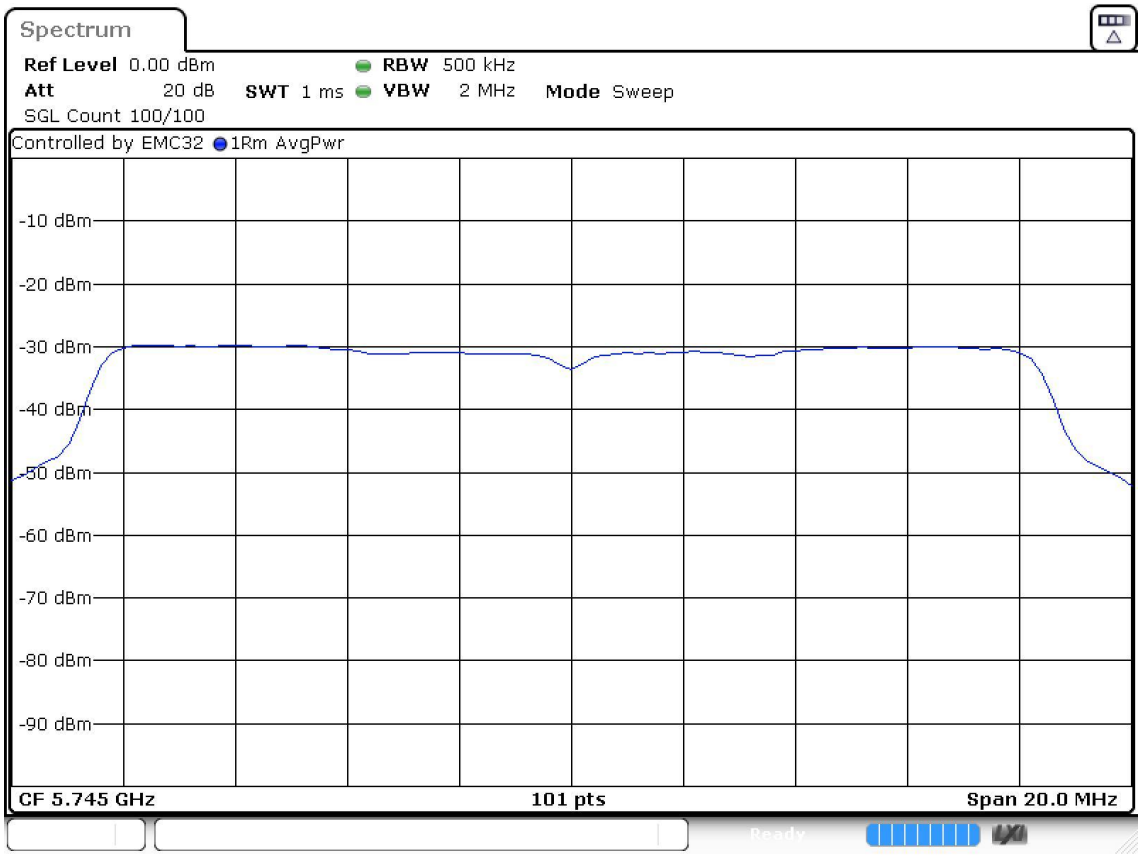
Pass

Attachments

Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5745.00000	Modulation = 802.11a (OFDM 6 Mbit/s)
TPC = No	MIMO Mode = SISO

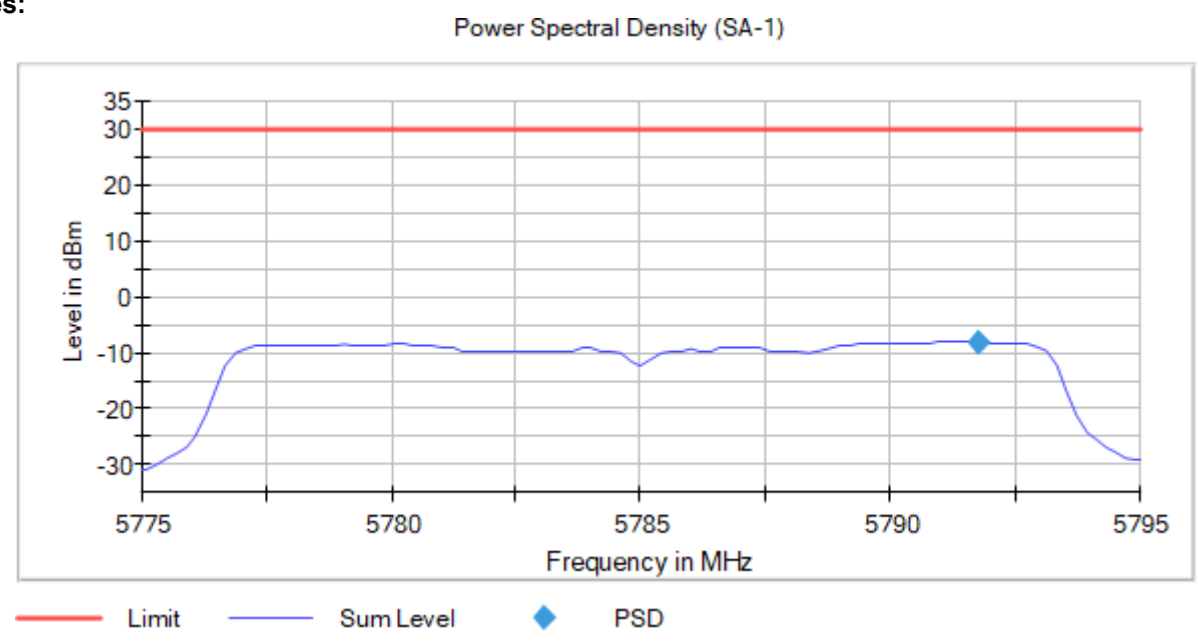
Images:

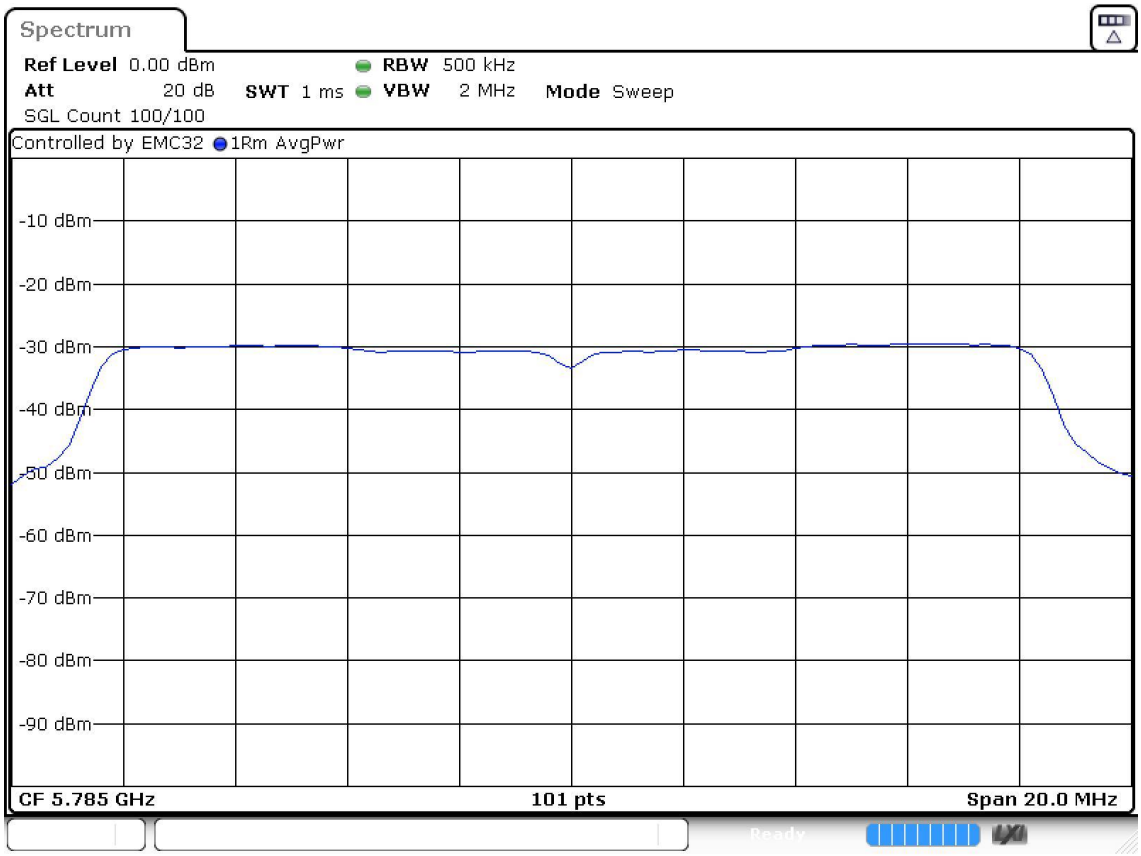




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5785.00000	Modulation = 802.11a (OFDM 6 Mbit/s)
TPC = No	MIMO Mode = SISO

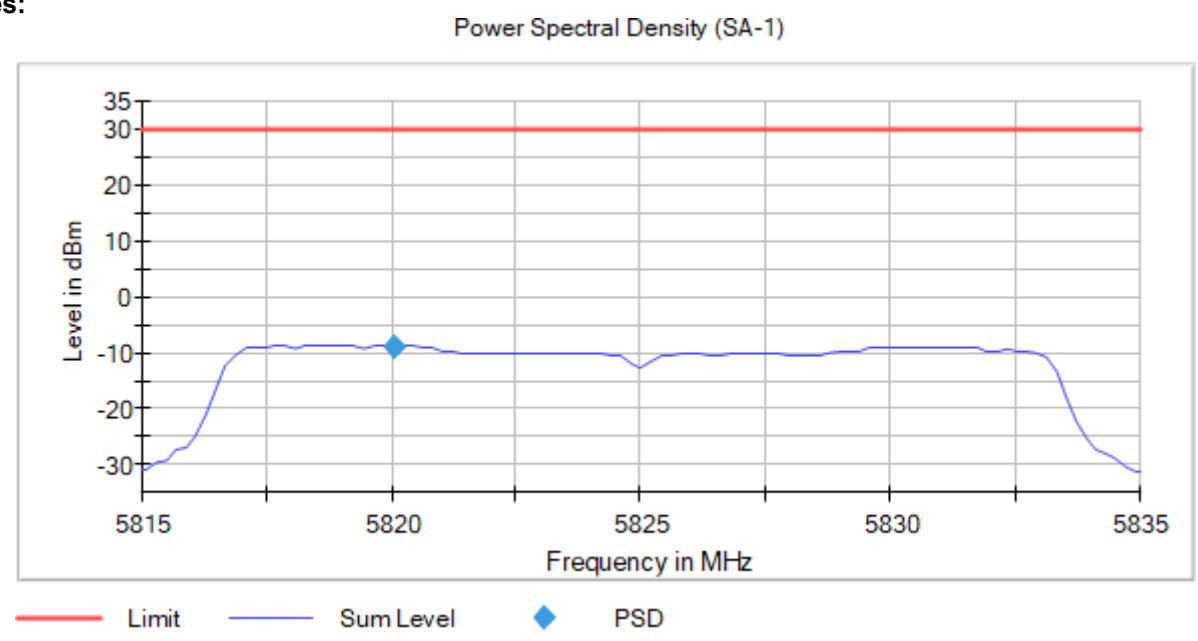
Images:

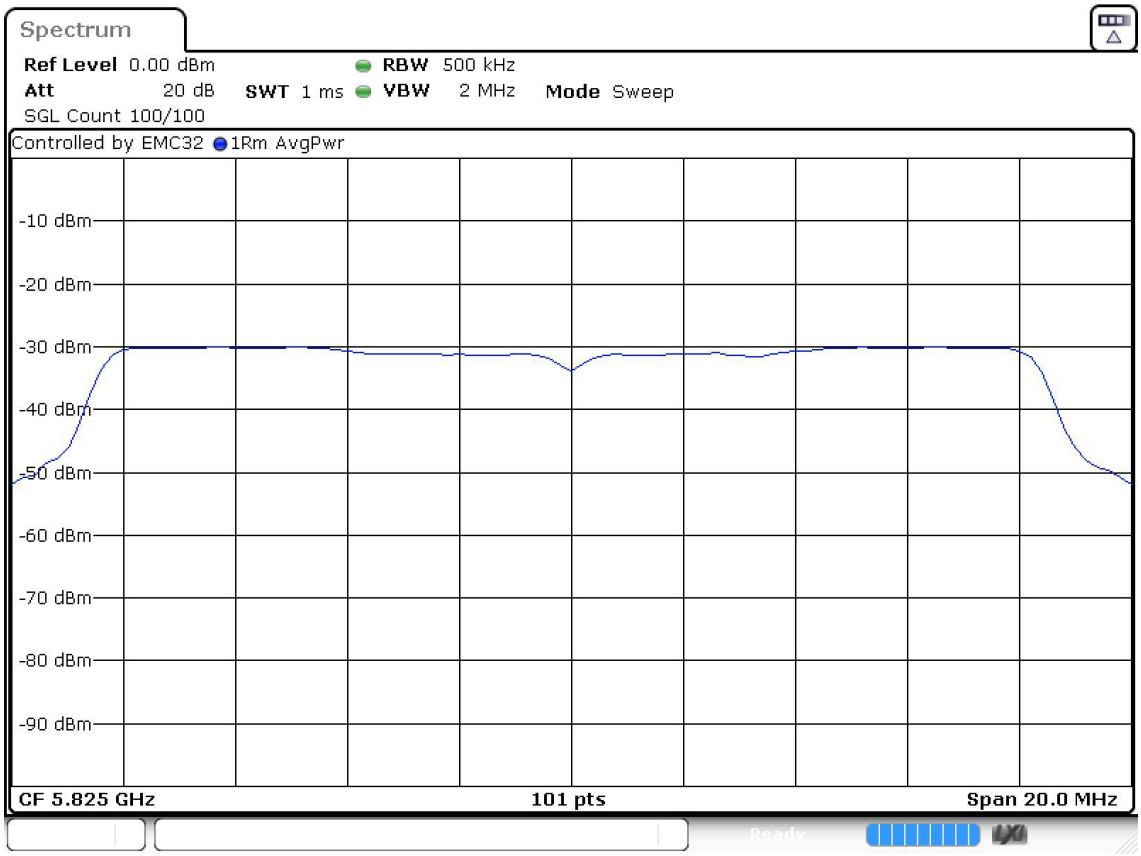




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5825.00000	Modulation = 802.11a (OFDM 6 Mbit/s)
TPC = No	MIMO Mode = SISO

Images:





Modulation: 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5725, 5850]	1	5745.00000	No	5751.138614	-8.98
		5785.00000		5778.861386	-8.94
		5825.00000		5831.336634	-9.65

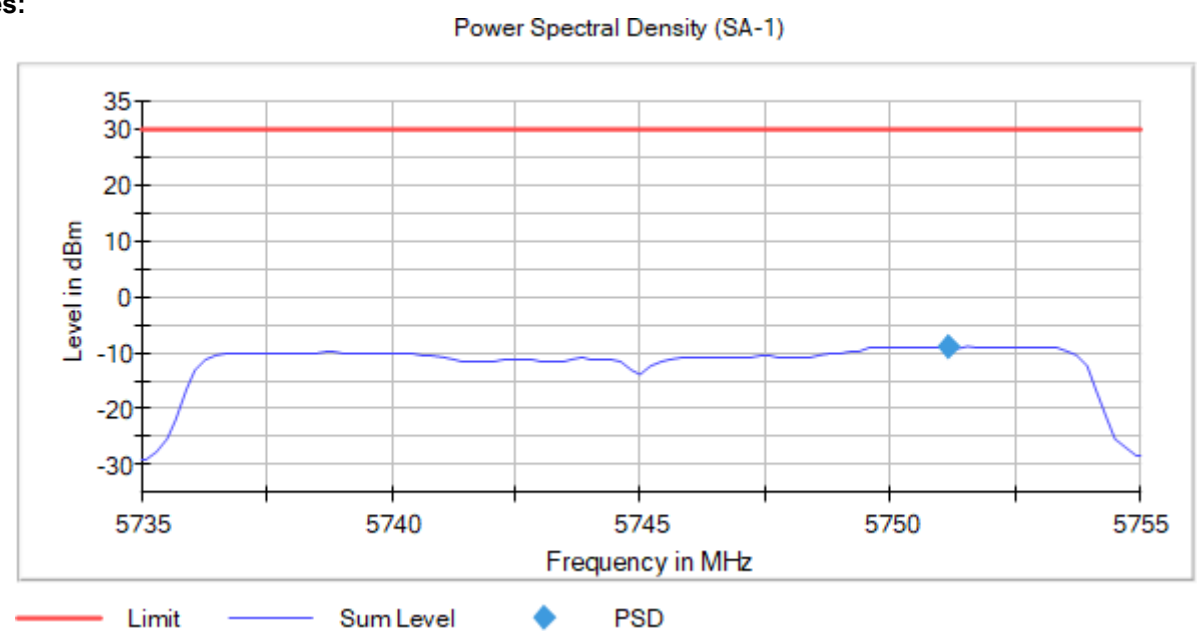
Verdict

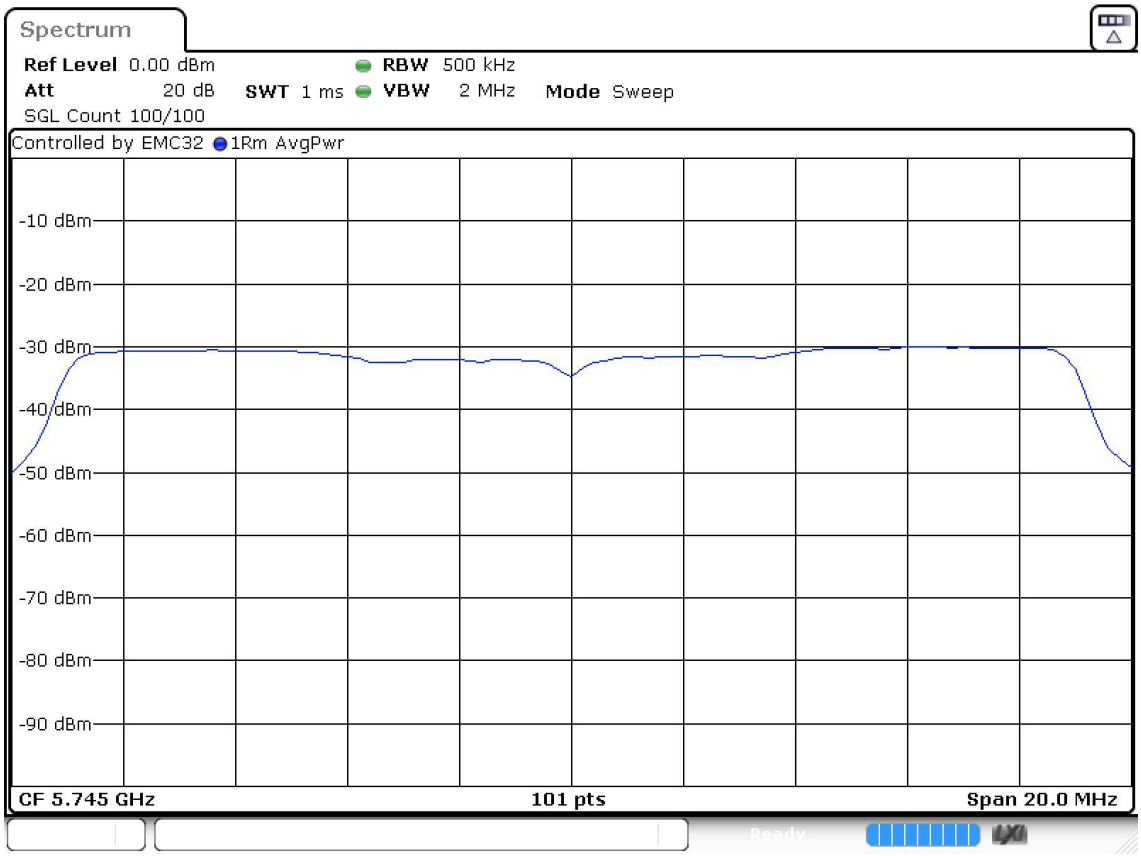
Pass

Attachments

Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5745.00000	Modulation = 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)
TPC = No	MIMO Mode = SISO

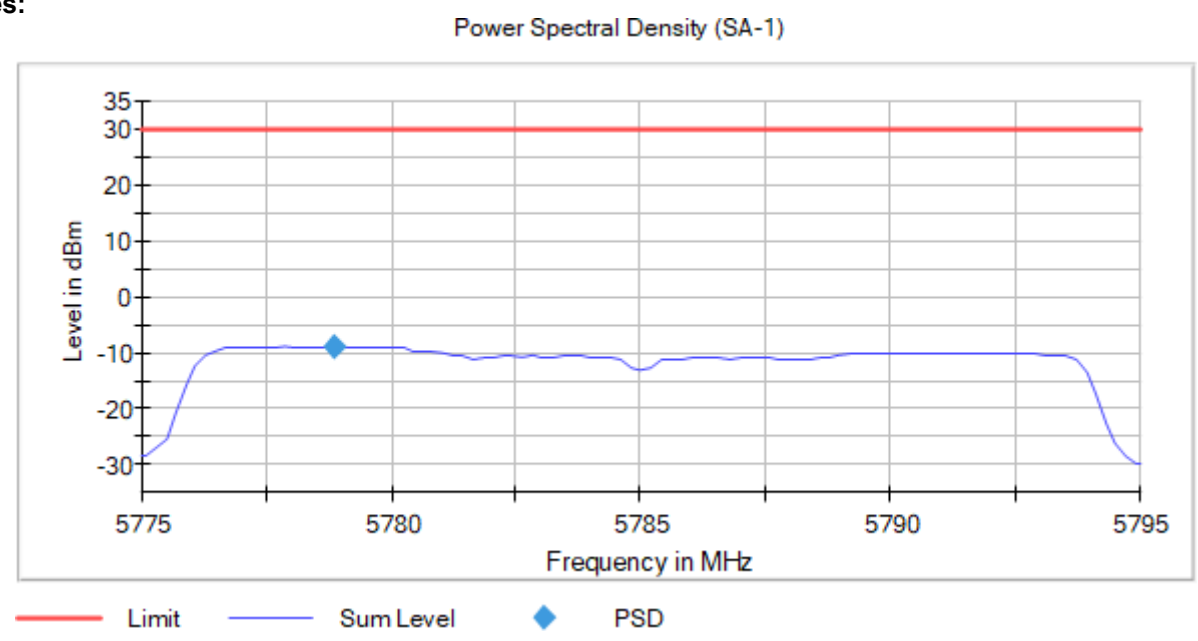
Images:

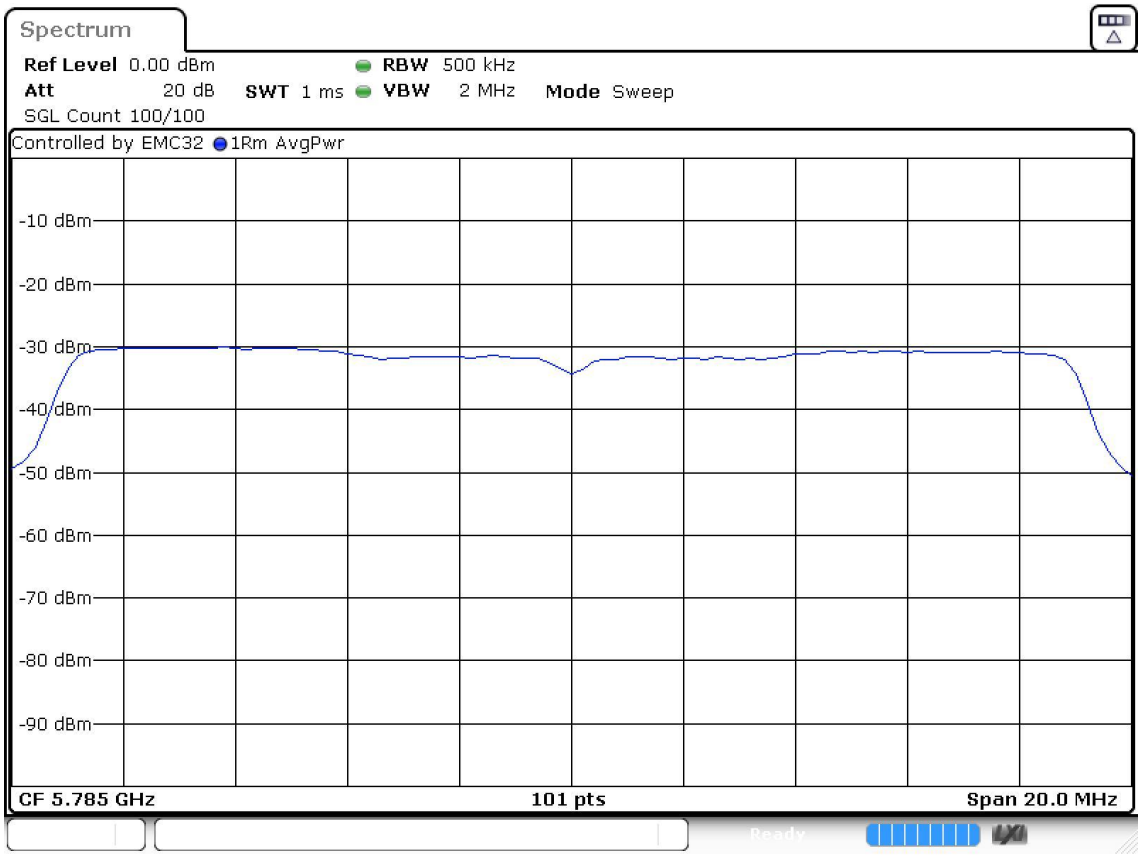




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5785.00000	Modulation = 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)
TPC = No	MIMO Mode = SISO

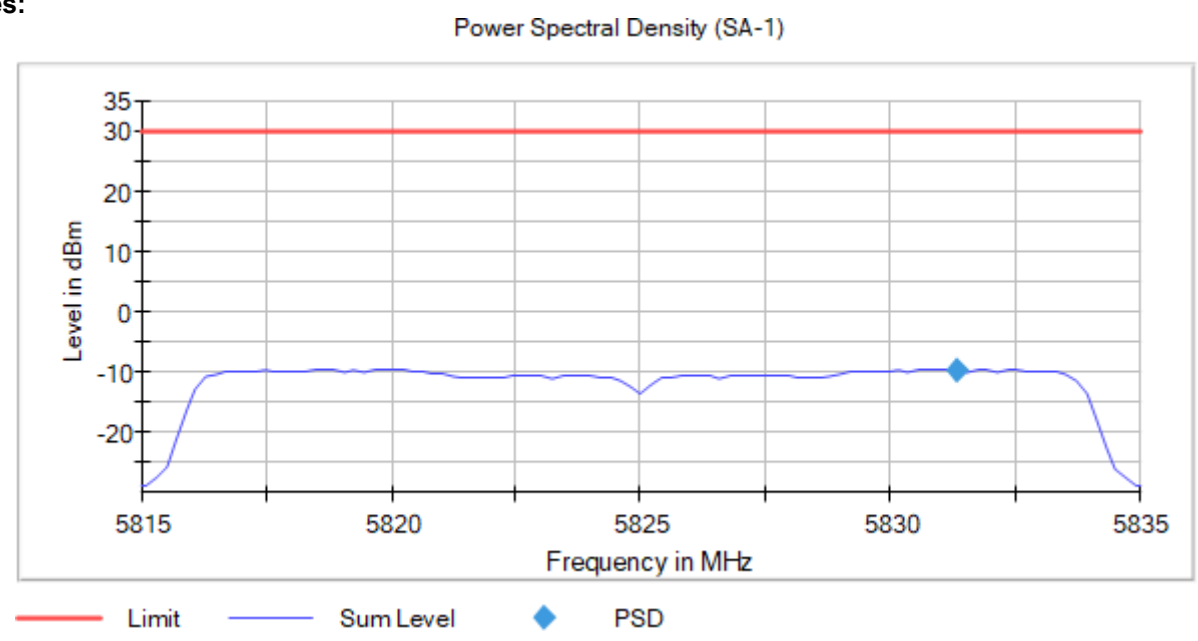
Images:

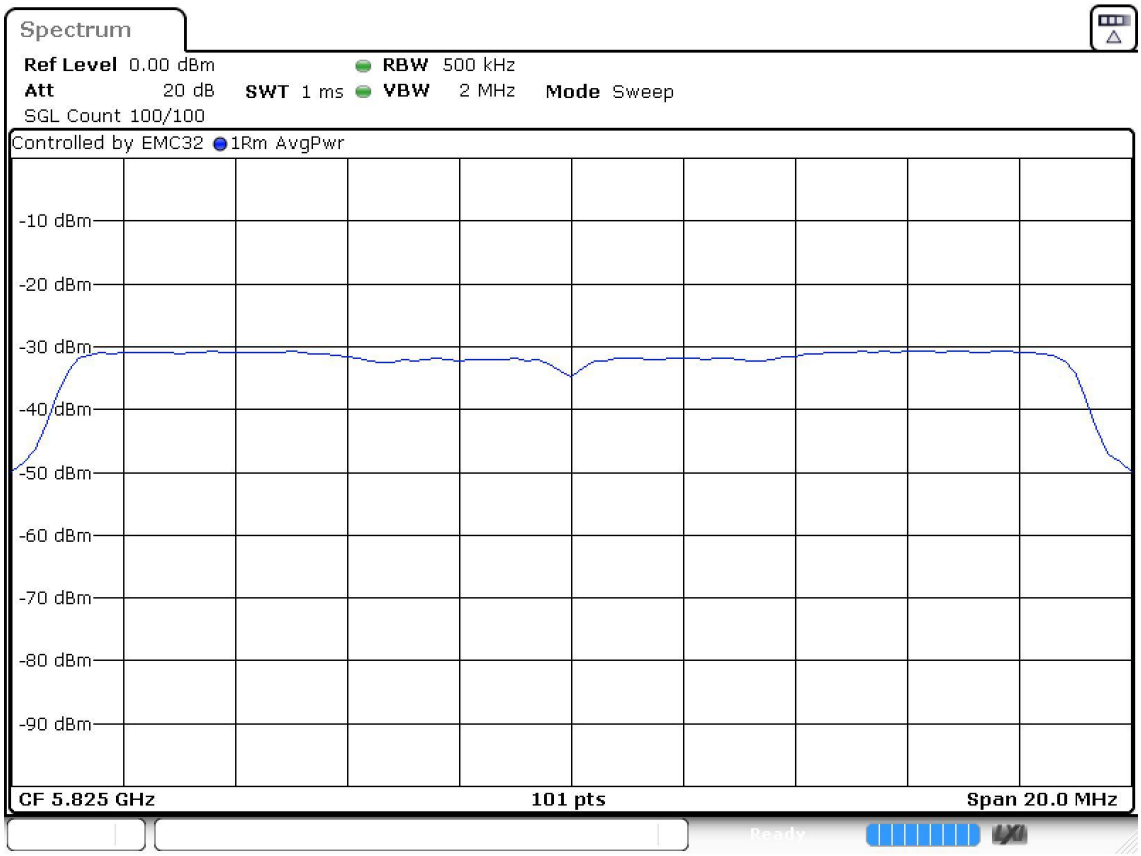




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5825.00000	Modulation = 802.11n HT20 (OFDM MCS0 6.5 Mbit/s)
TPC = No	MIMO Mode = SISO

Images:





Modulation: 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5725, 5850]	1	5755.00000	No	5767.875000	-12.54
		5795.00000		5781.125000	-12.25

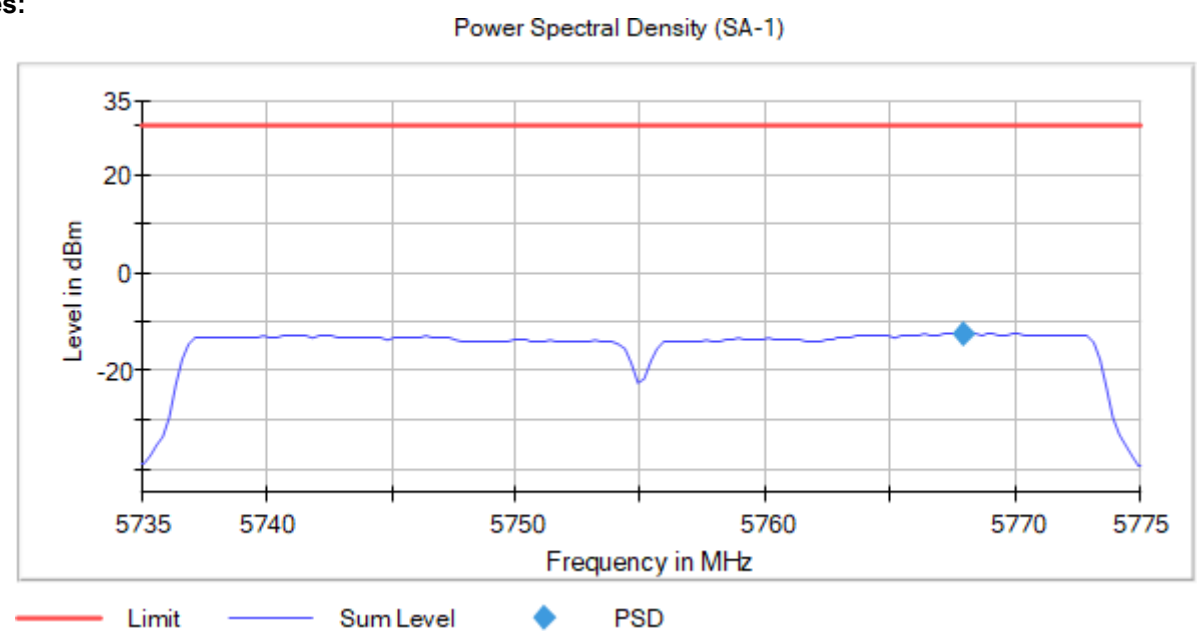
Verdict

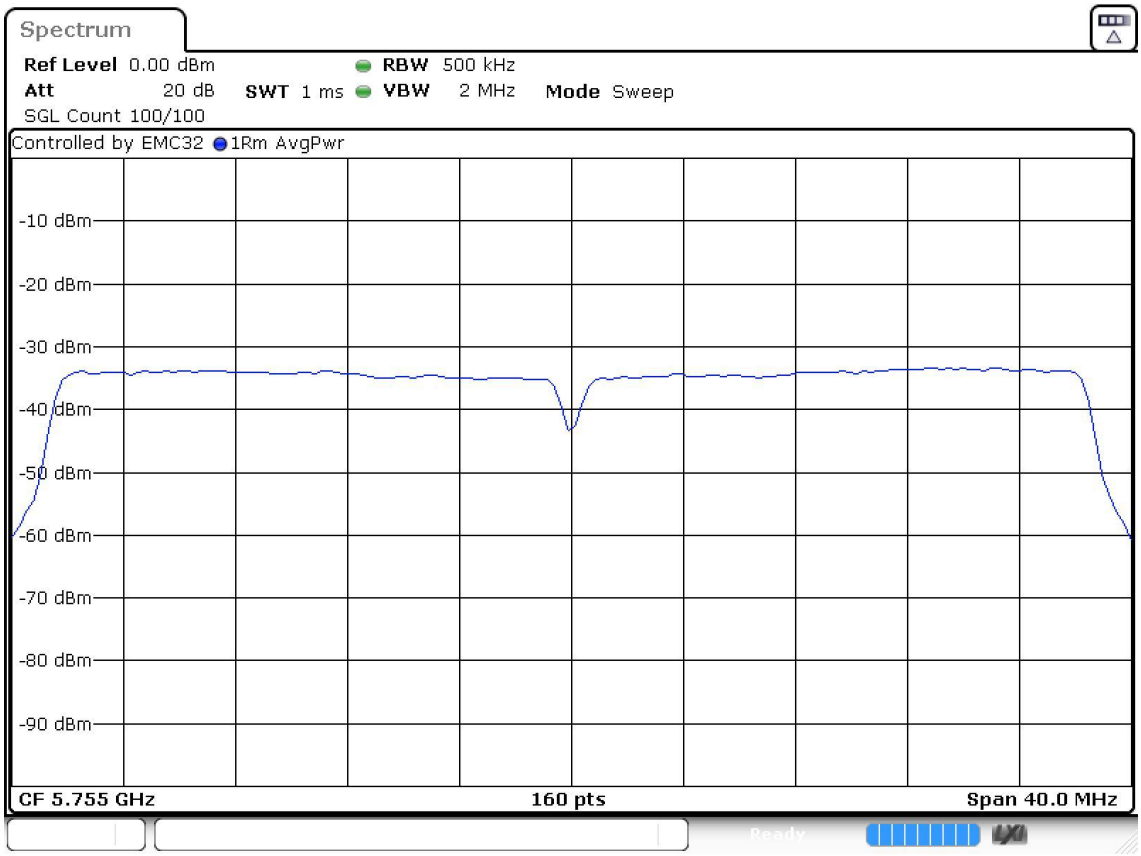
Pass

Attachments

Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5755.00000	Modulation = 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)
TPC = No	MIMO Mode = SISO

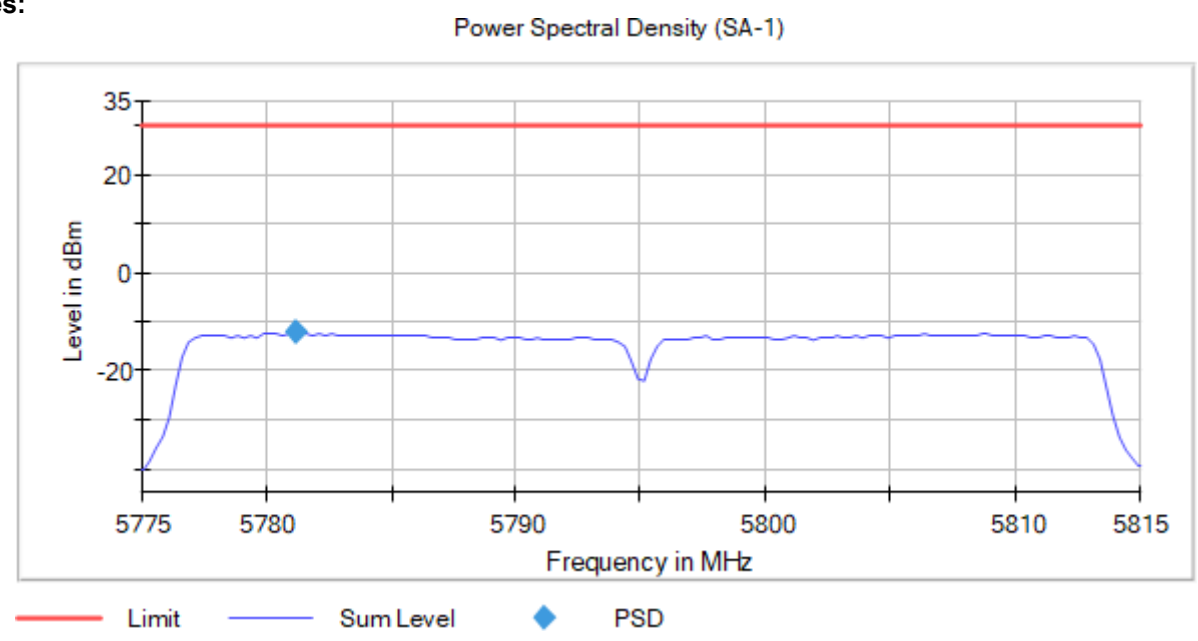
Images:

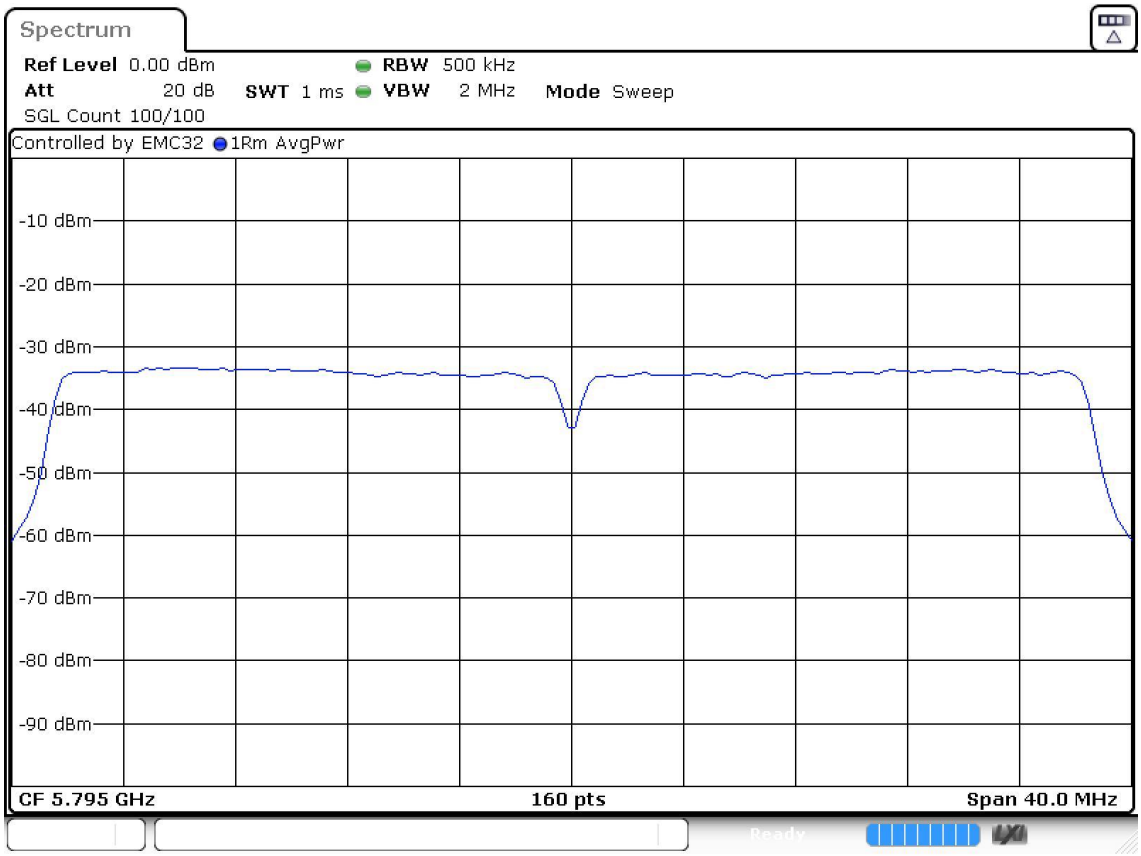




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5795.00000	Modulation = 802.11n HT40 (OFDM MCS0 13.5 Mbit/s)
TPC = No	MIMO Mode = SISO

Images:





Modulation: 802.11ac VHT20 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5725, 5850]	1	5745.00000	No	5752.722772	-8.57
		5785.00000		5777.673267	-9.28
		5825.00000		5832.524752	-9.37

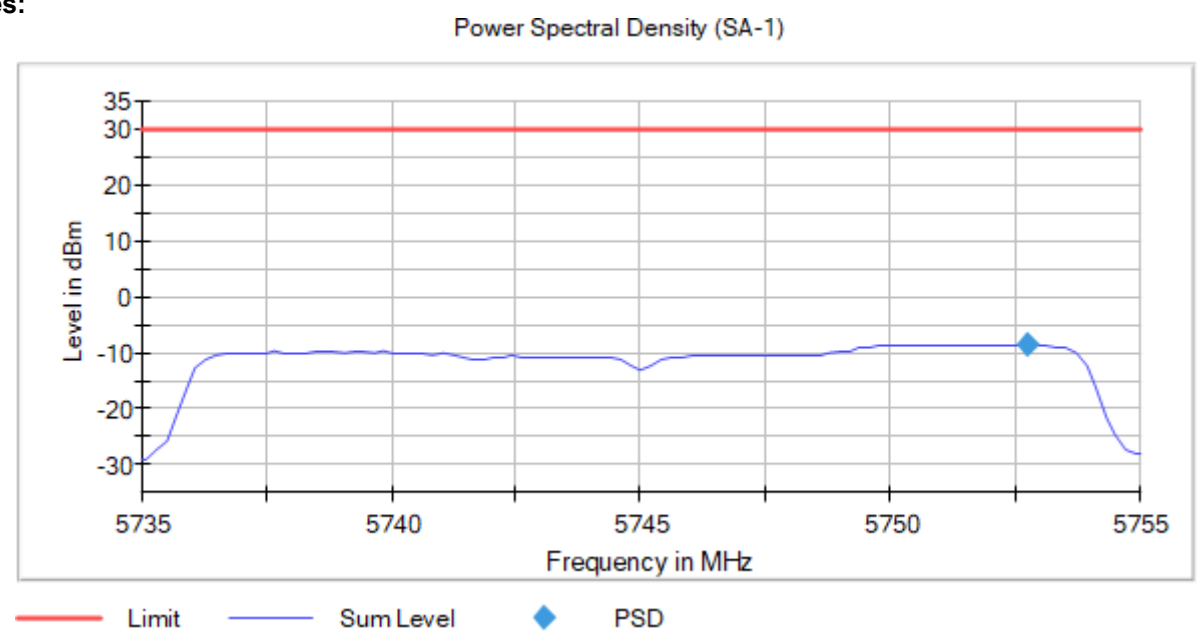
Verdict

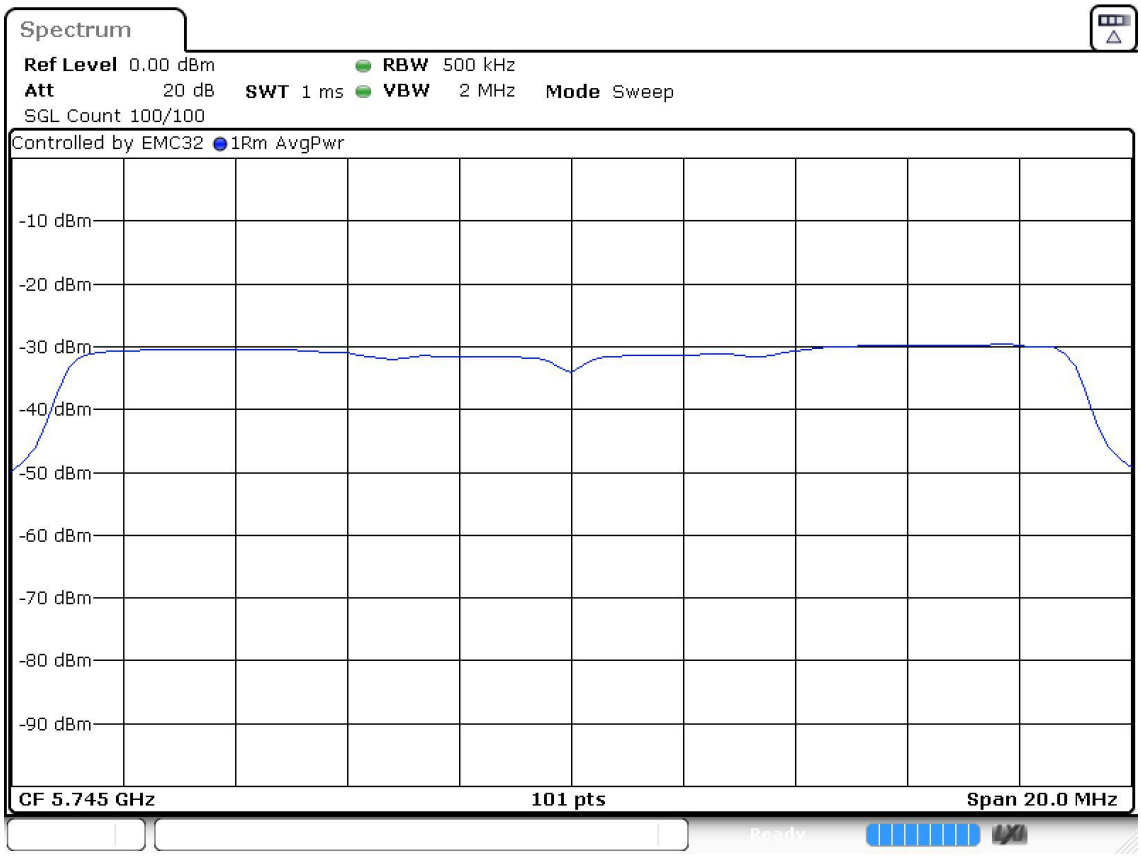
Pass

Attachments

Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5745.00000	Modulation = 802.11ac VHT20 (OFDM MCS0)
TPC = No	MIMO Mode = SISO

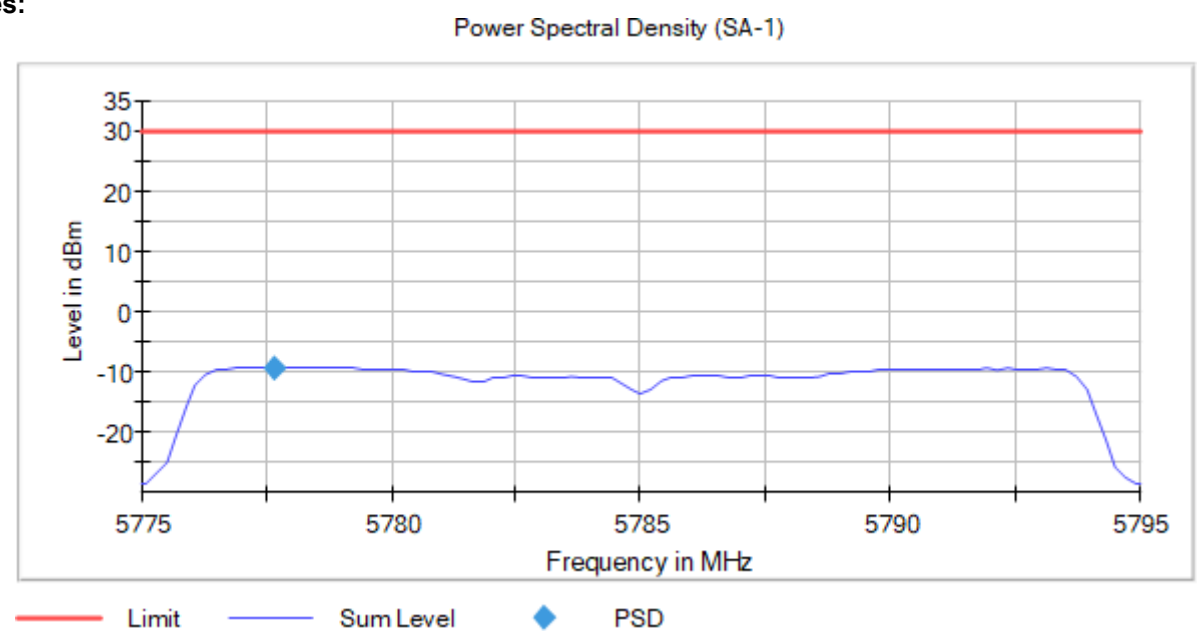
Images:

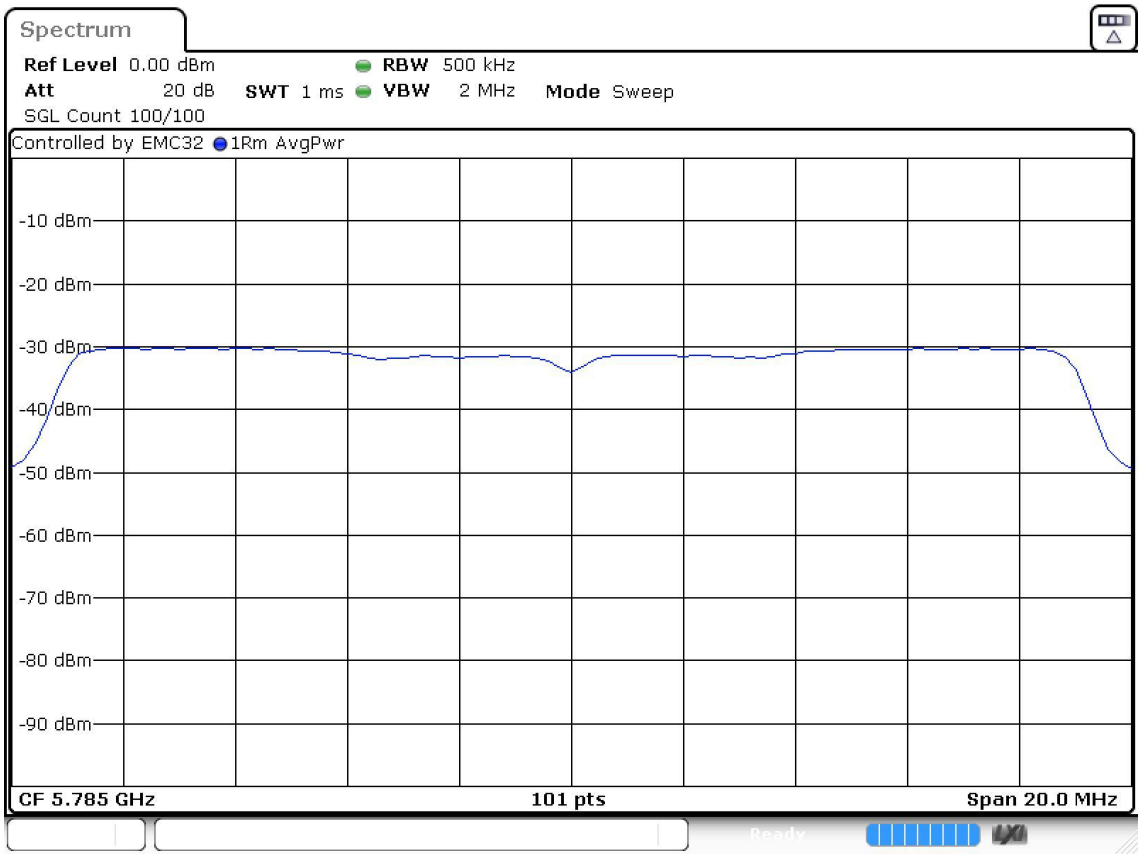




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5785.00000	Modulation = 802.11ac VHT20 (OFDM MCS0)
TPC = No	MIMO Mode = SISO

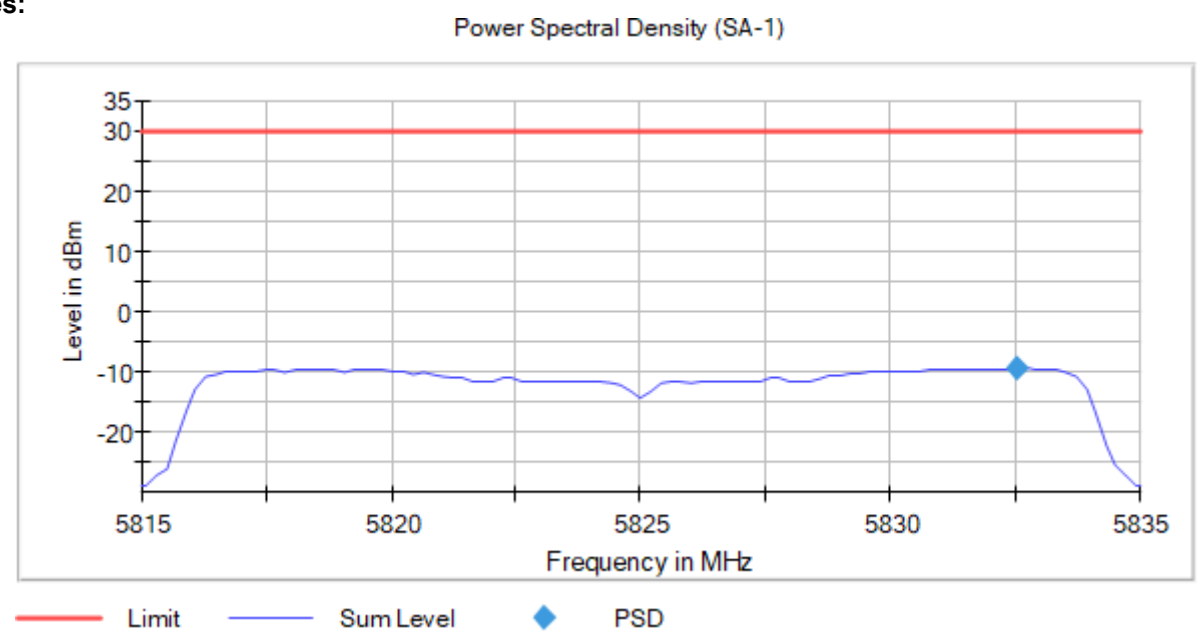
Images:

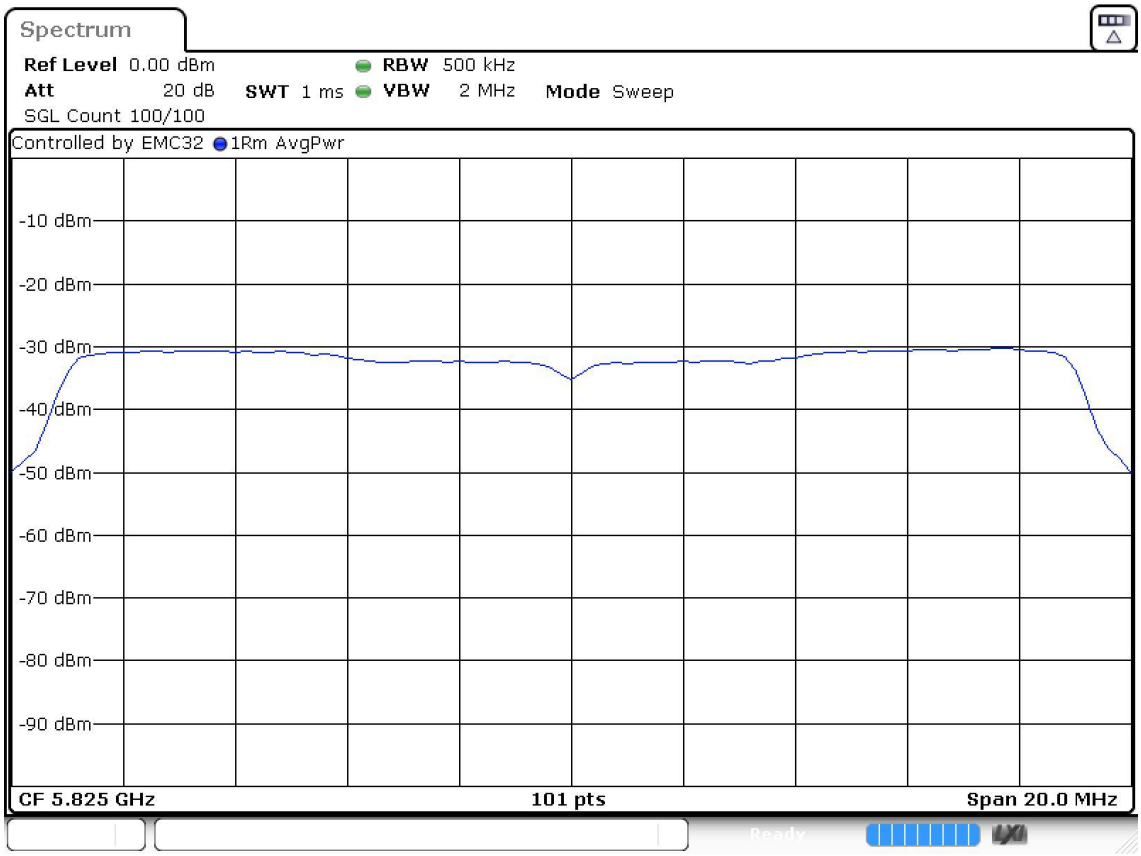




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5825.00000	Modulation = 802.11ac VHT20 (OFDM MCS0)
TPC = No	MIMO Mode = SISO

Images:





Modulation: 802.11ac VHT40 (OFDM MCS0)

SISO

Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5725, 5850]	1	5755.00000	No	5772.375000	-12.61
		5795.00000		5781.375000	-12.49

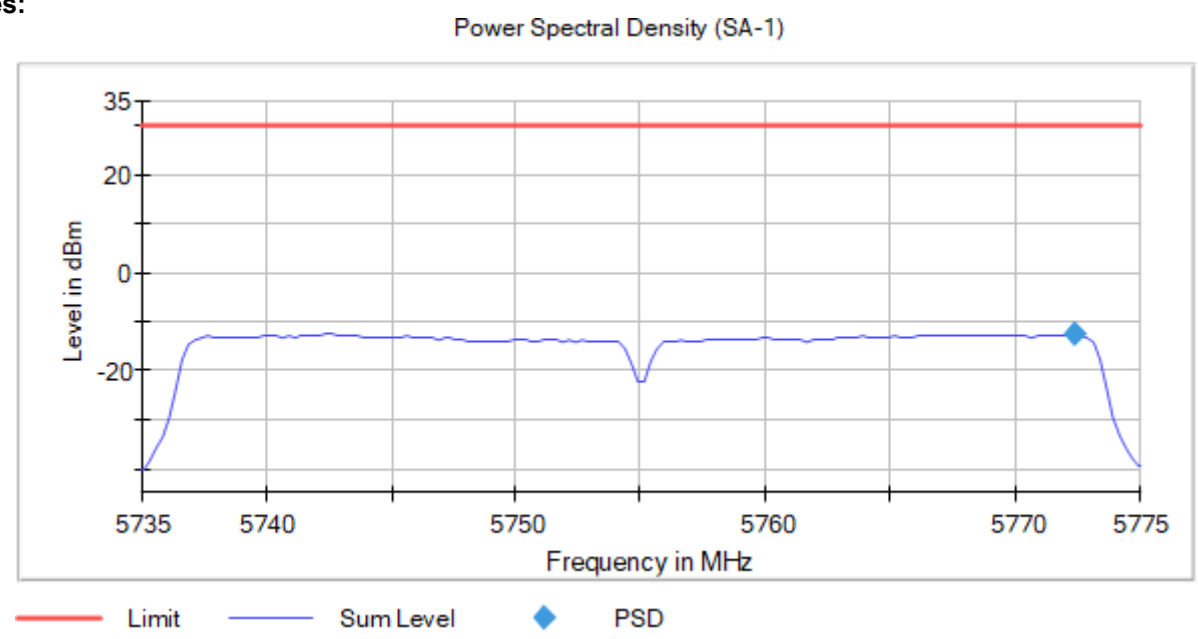
Verdict

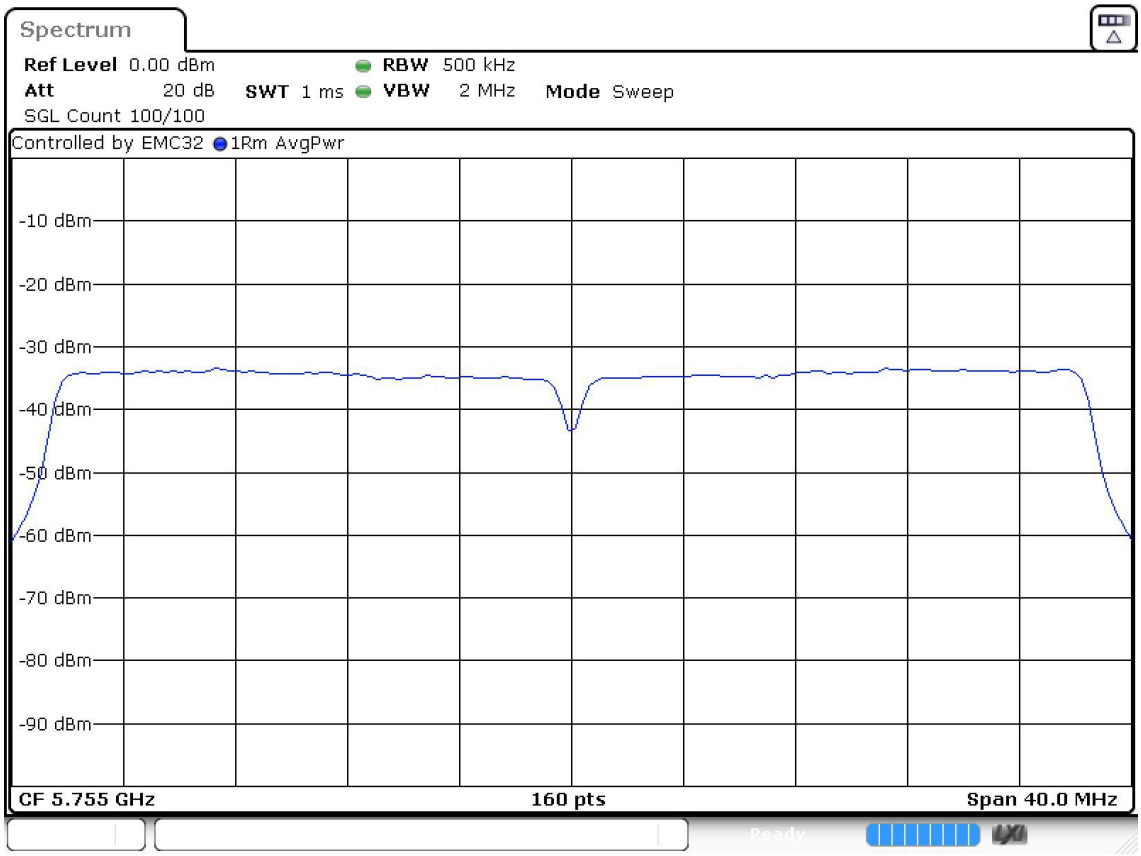
Pass

Attachments

Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5755.00000	Modulation = 802.11ac VHT40 (OFDM MCS0)
TPC = No	MIMO Mode = SISO

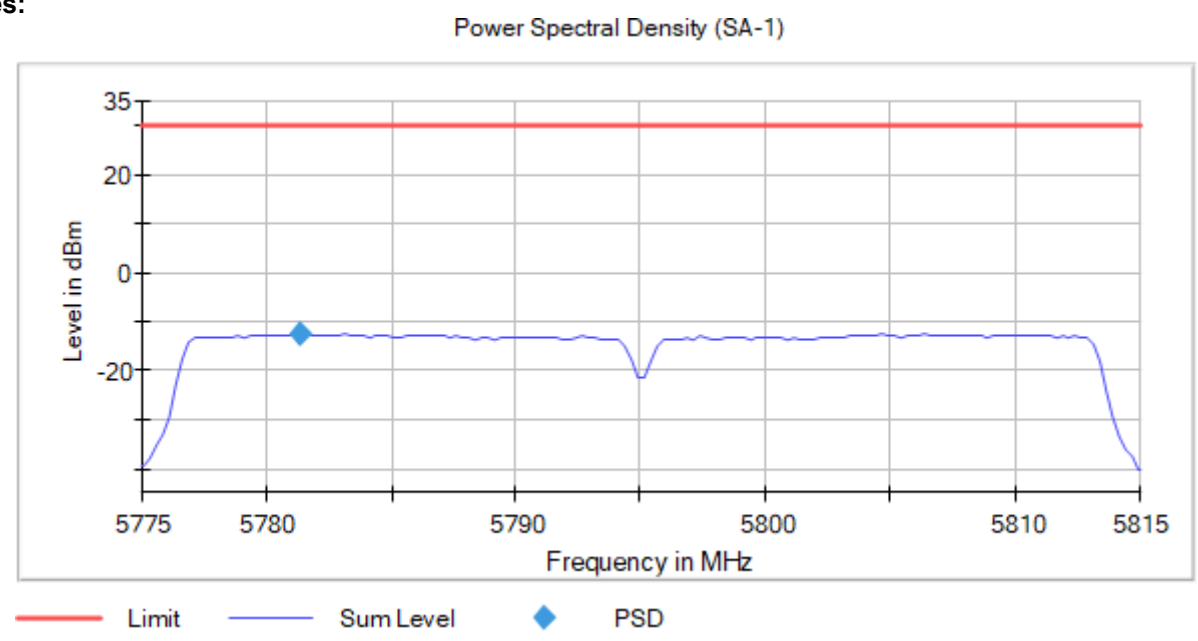
Images:

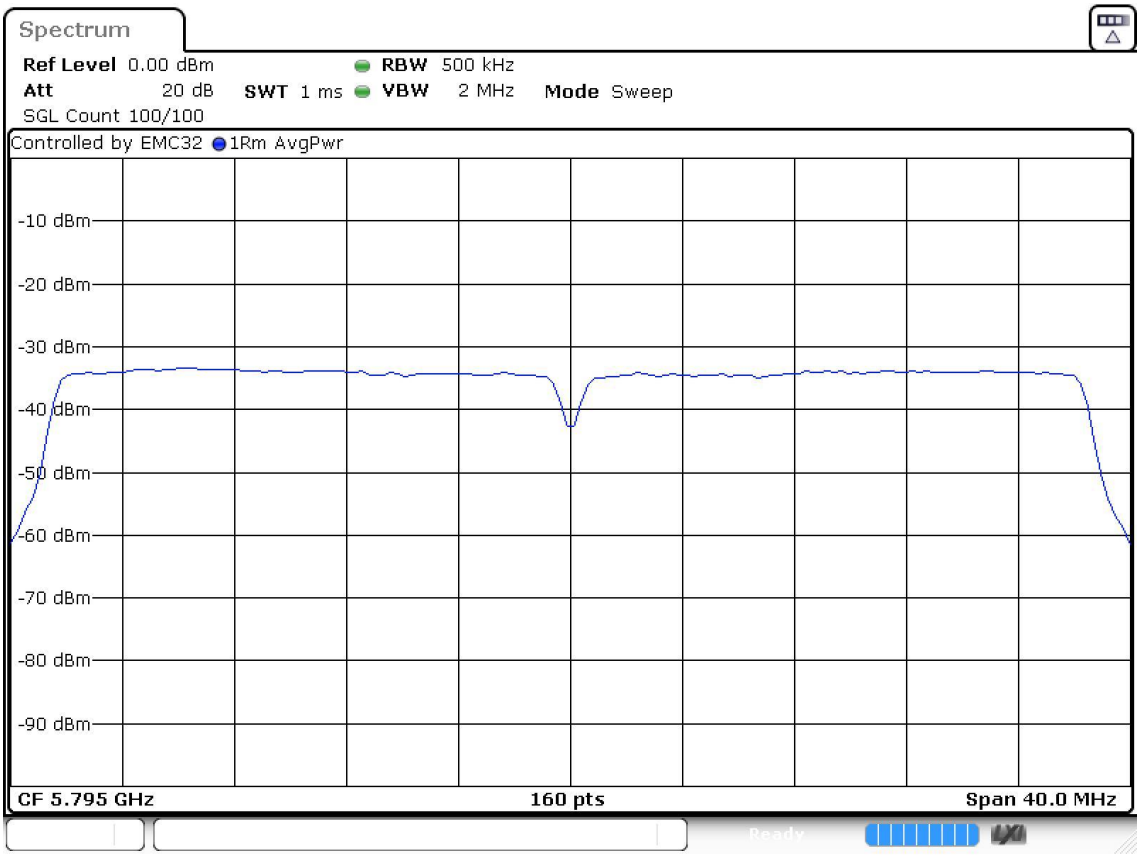




Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5795.00000	Modulation = 802.11ac VHT40 (OFDM MCS0)
TPC = No	MIMO Mode = SISO

Images:





Modulation: 802.11ac VHT80 (OFDM MCS0)

SISO

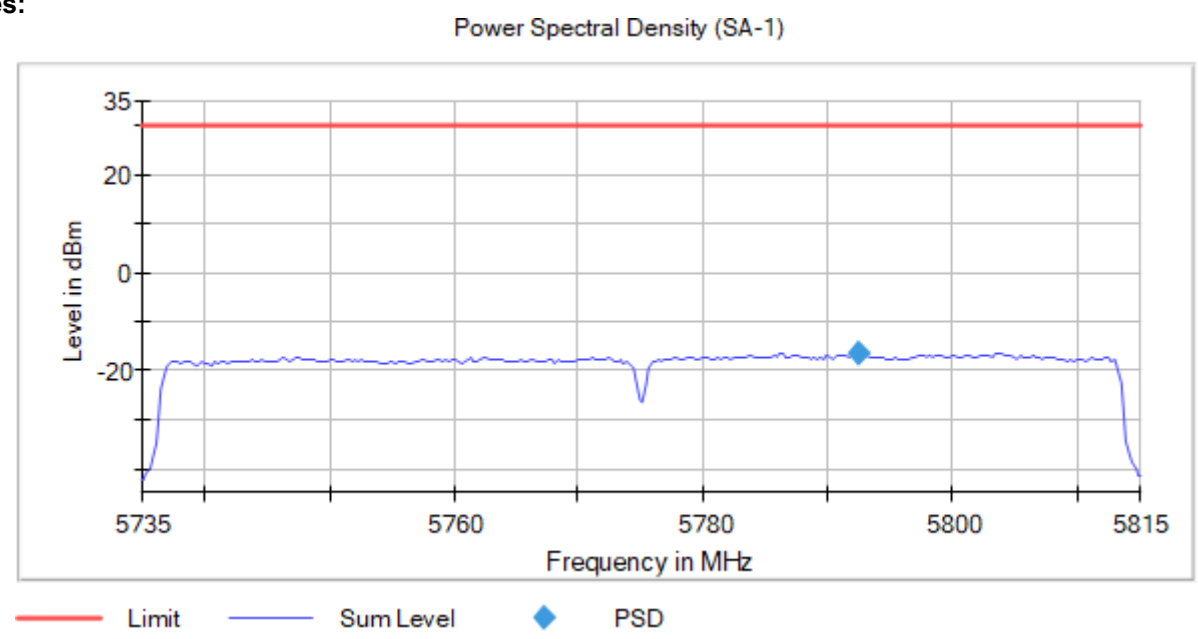
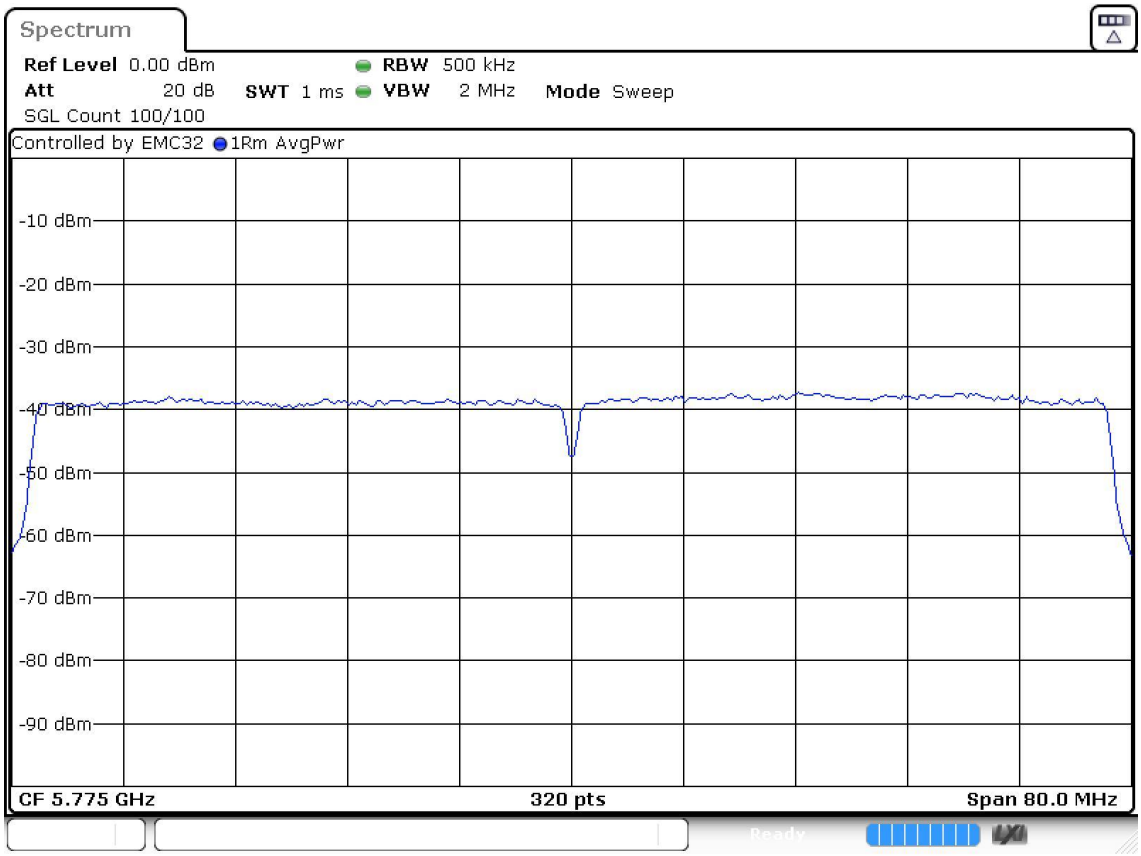
Results

Operation Band (MHz)	Port	Freq (MHz)	TPC	Freq (MHz)	PSD (dBm)
[5725, 5850]	1	5775.00000	No	5792.375000	-16.43

Verdict

Pass

Attachments

Operation Band MHz = [5725, 5850]	Active Port = 1
Frequency MHz = 5775.00000	Modulation = 802.11ac VHT80 (OFDM MCS0)
TPC = No	MIMO Mode = SISO

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