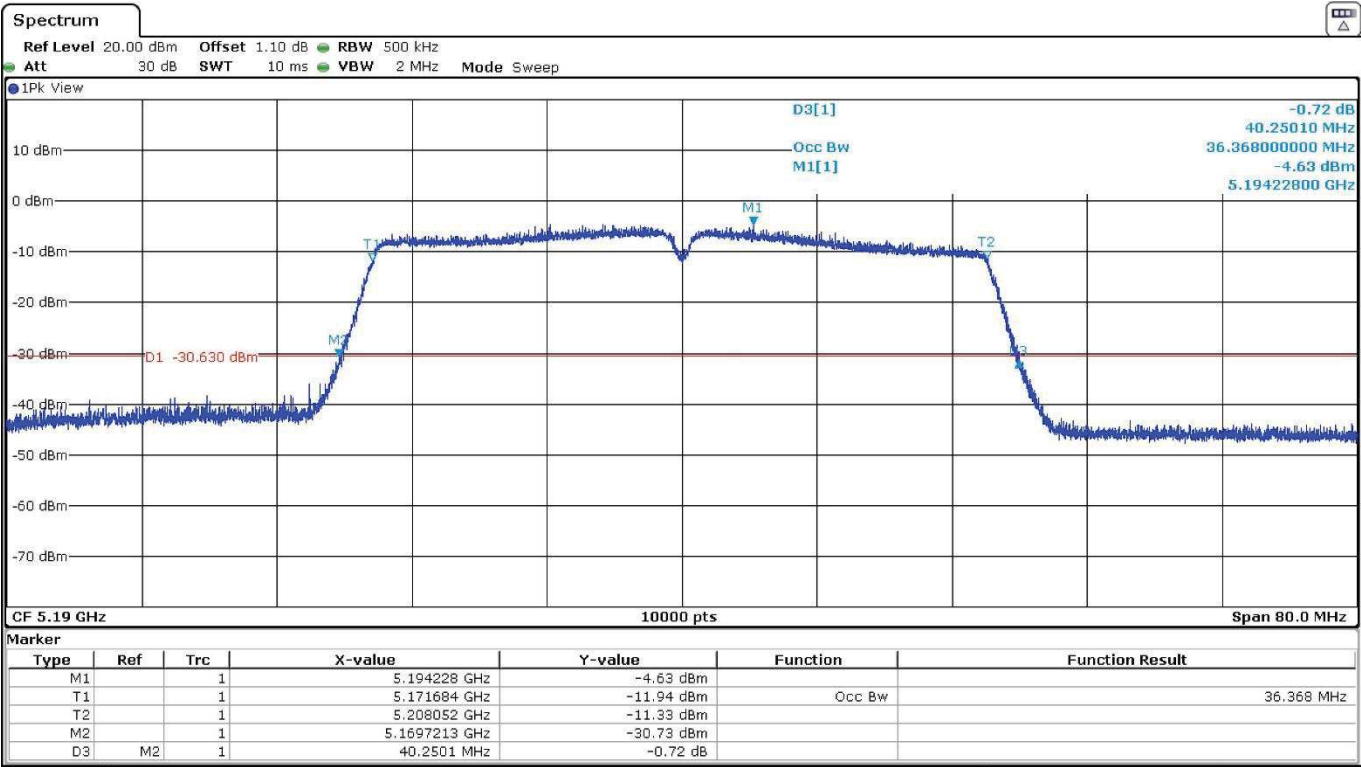


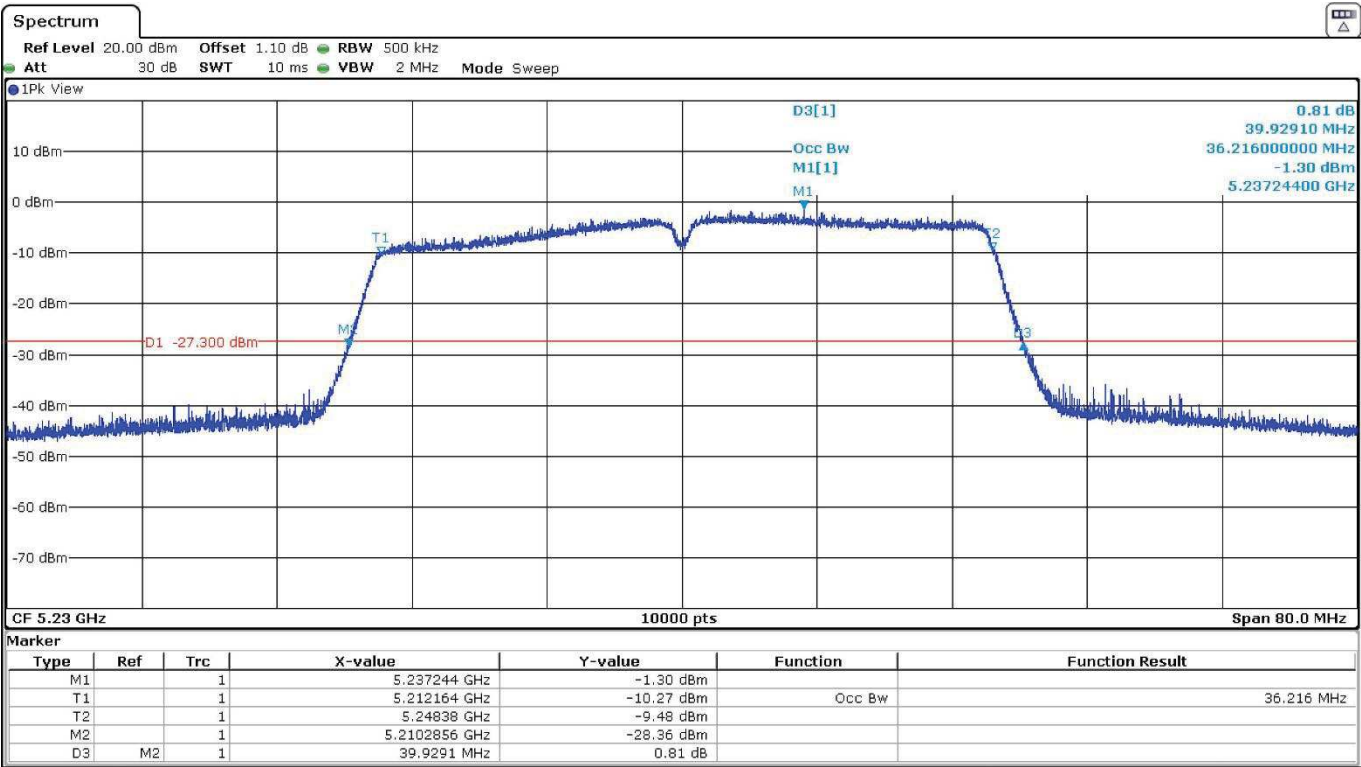
SISO 802.11 ac40 (VHT40):

U-NII-1 (5150-5250 MHz)

- Low Channel 38 (5190 MHz):

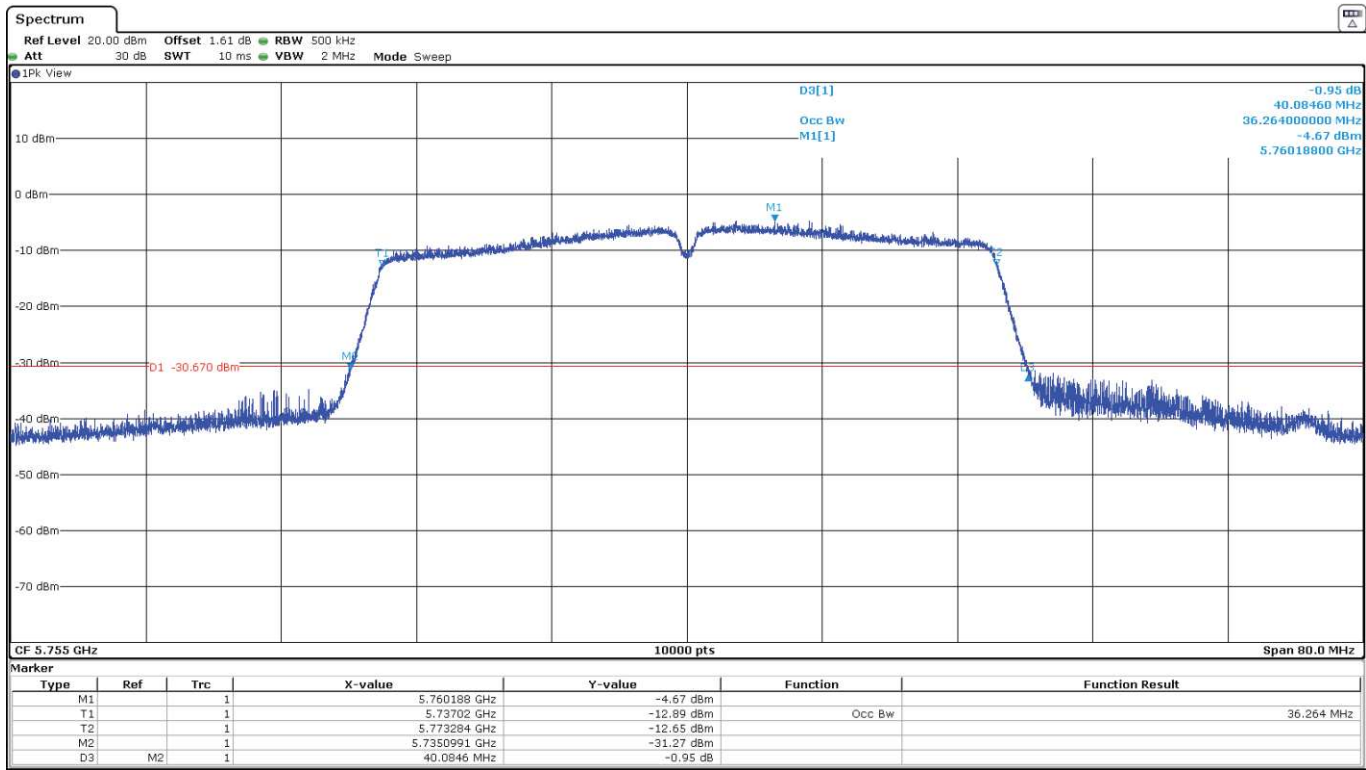


- High Channel 46 (5230 MHz):

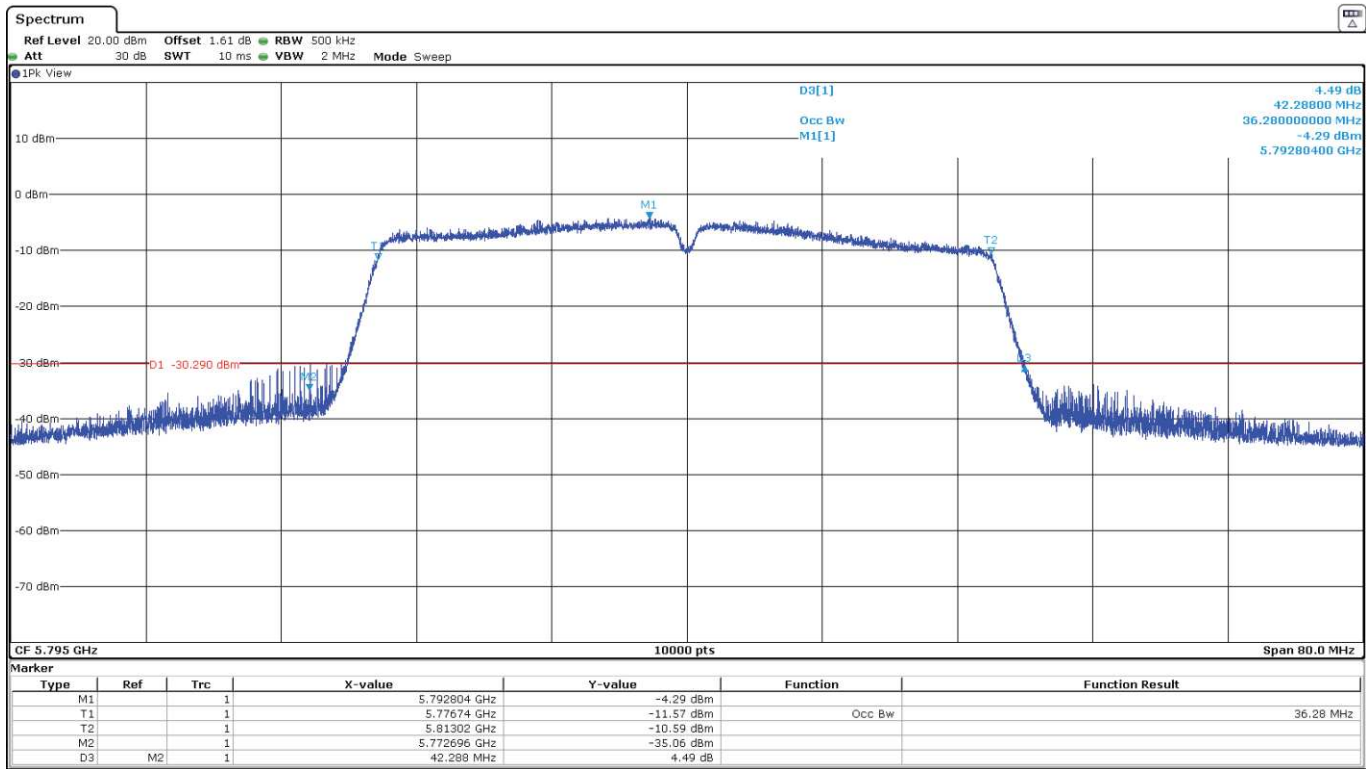


U-NII-3 (5725-5850 MHz)

- Low Channel 151 (5755 MHz):



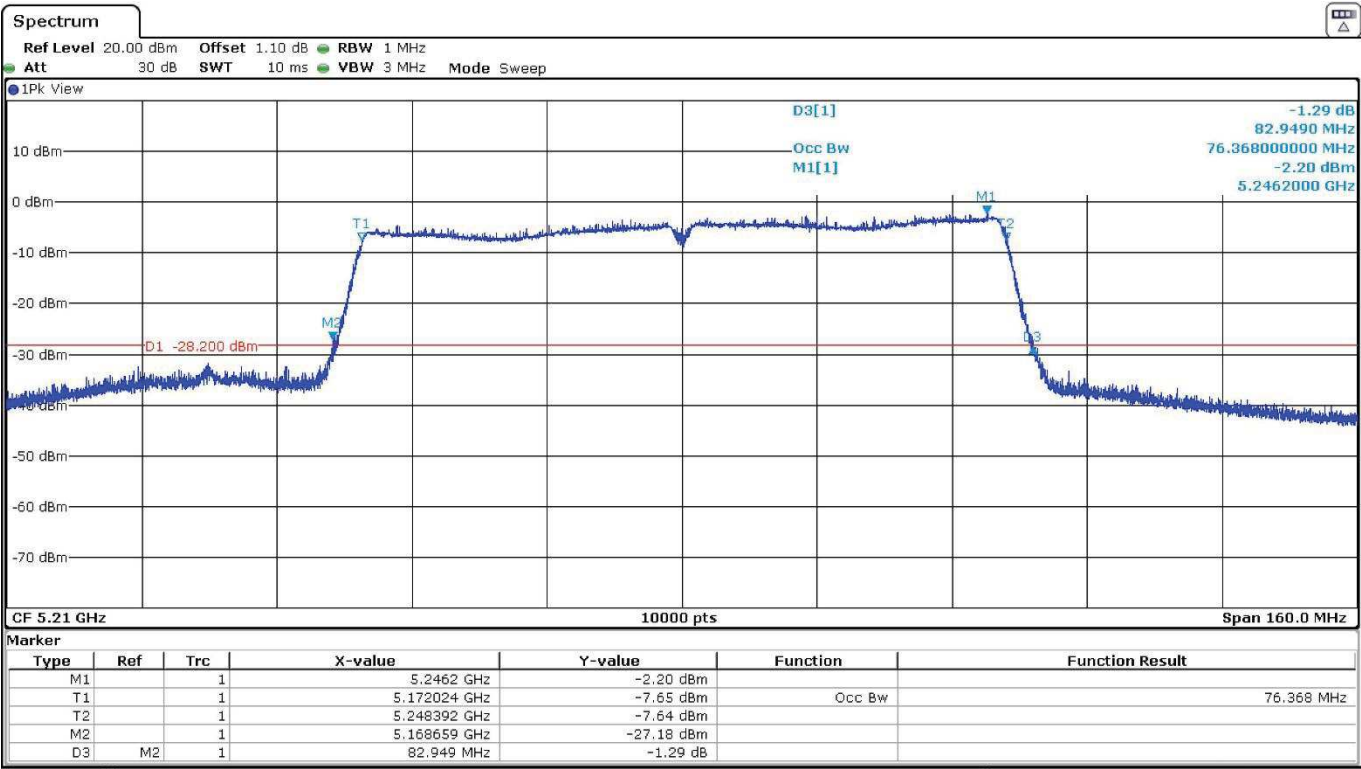
- High Channel 159 (5795 MHz):



SISO 802.11 ac80 (VHT80):

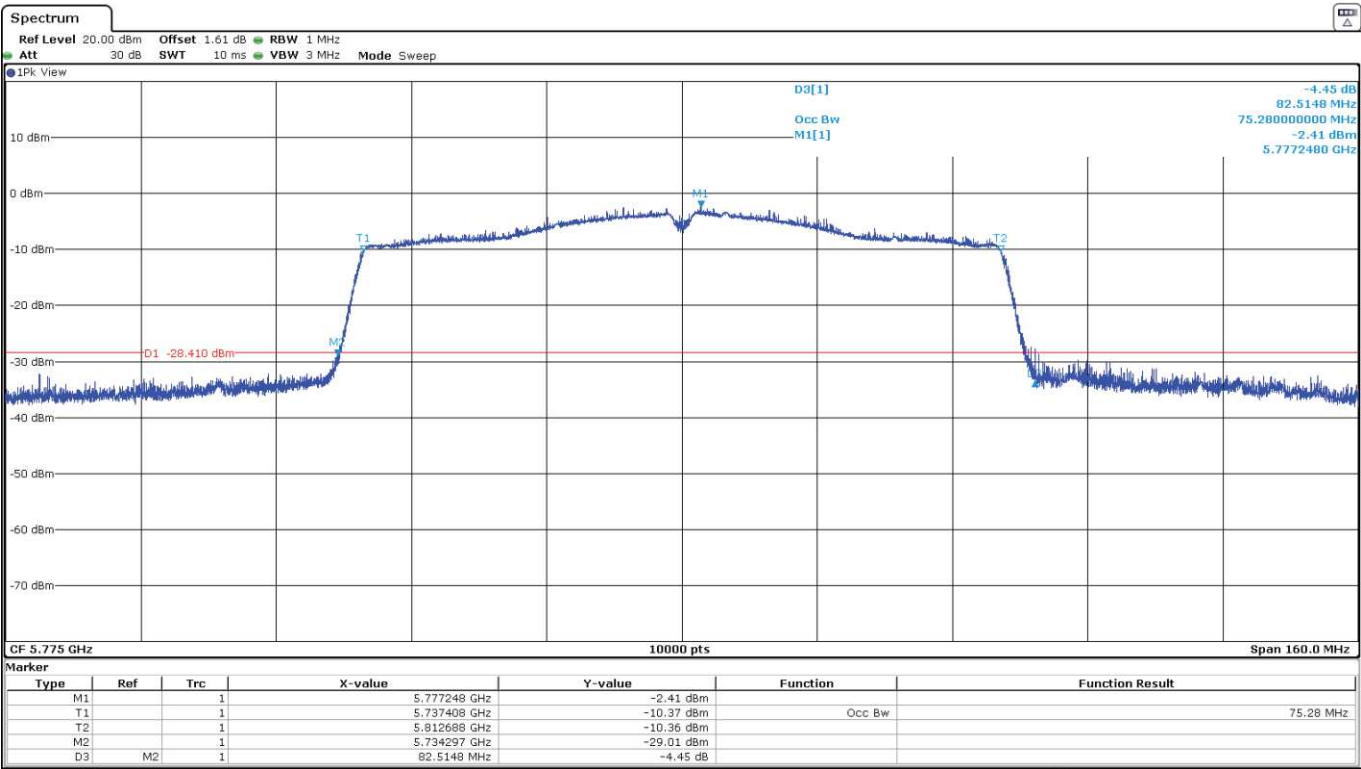
U-NII-1 (5150-5250 MHz)

- Single Channel 42 (5210 MHz):



U-NII-3 (5725-5850 MHz)

- Single Channel 155 (5775 MHz):



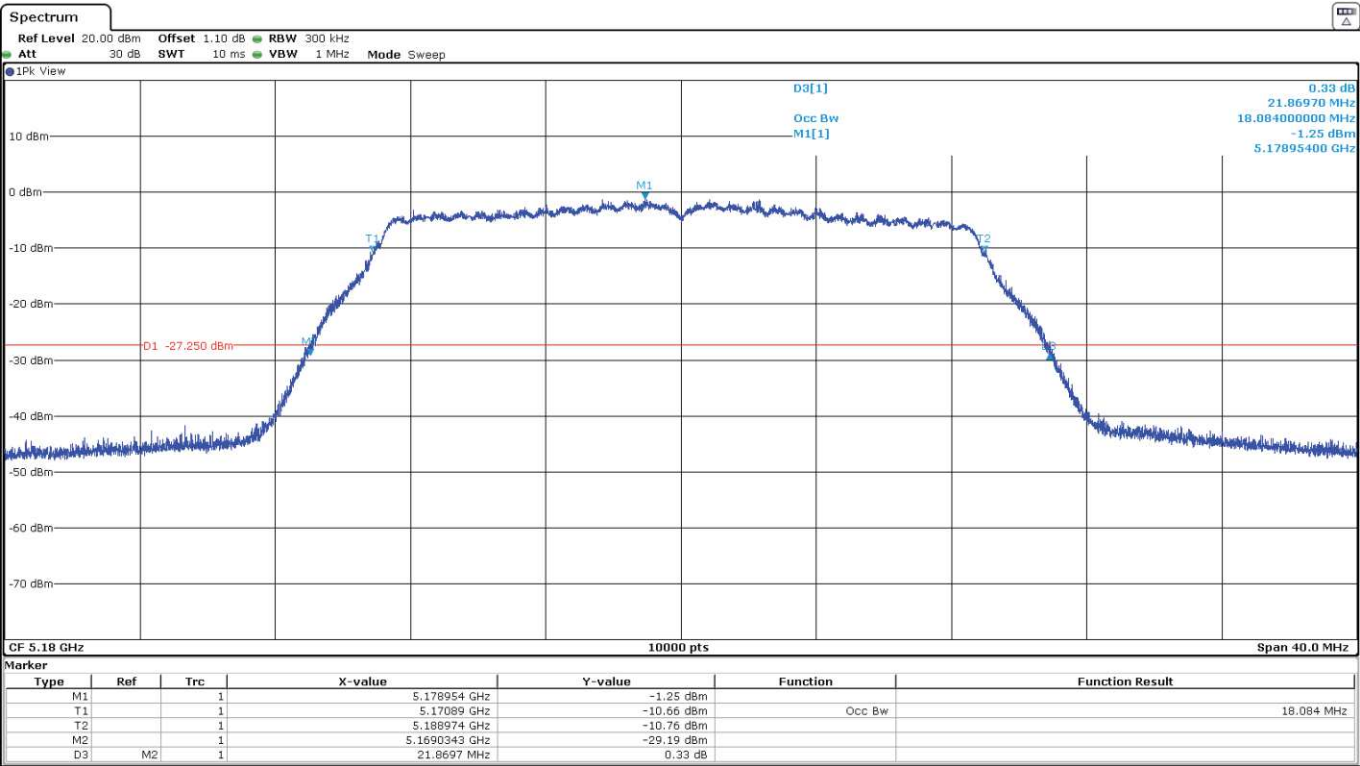
MIMO worst case:

Mode 802.11 ac20 VHT20:

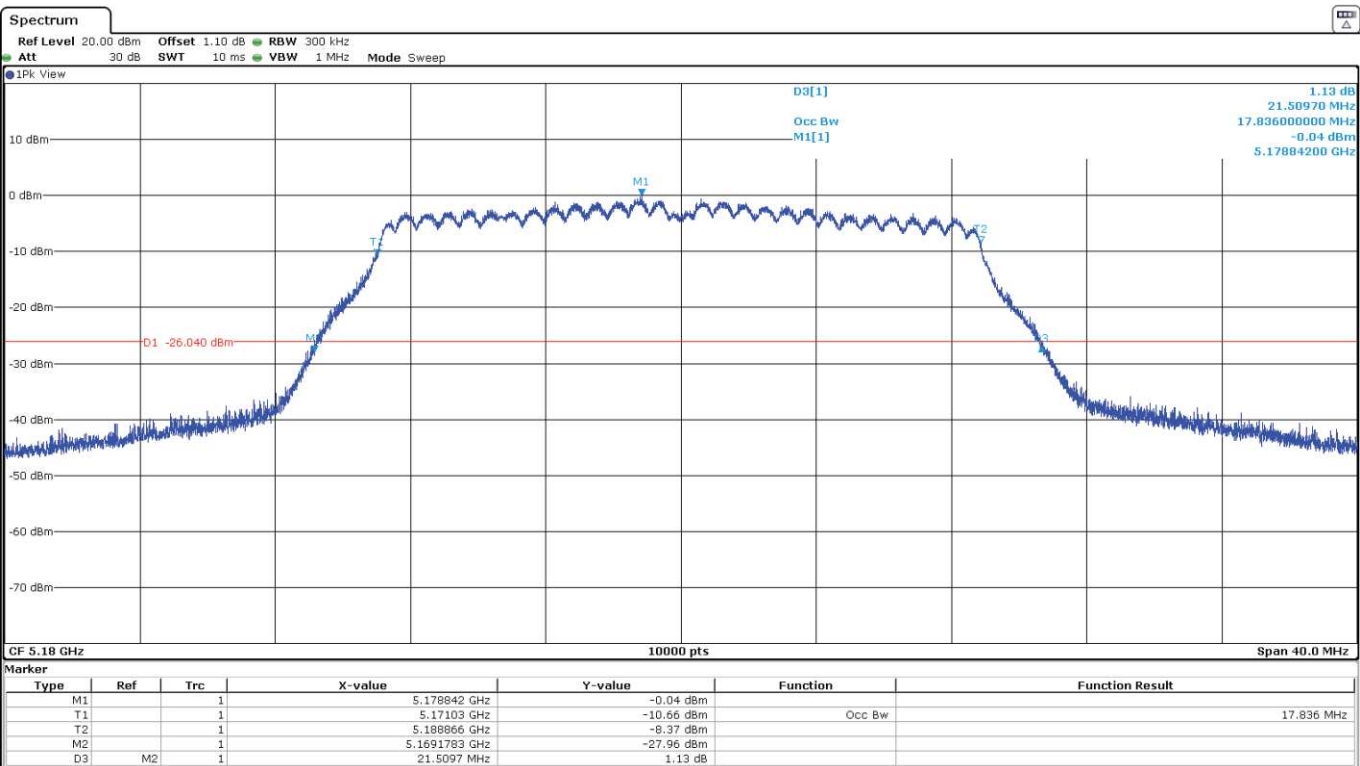
U-NII-1 (5150-5250 MHz)

- Low Channel 36 (5180 MHz):

Port 1

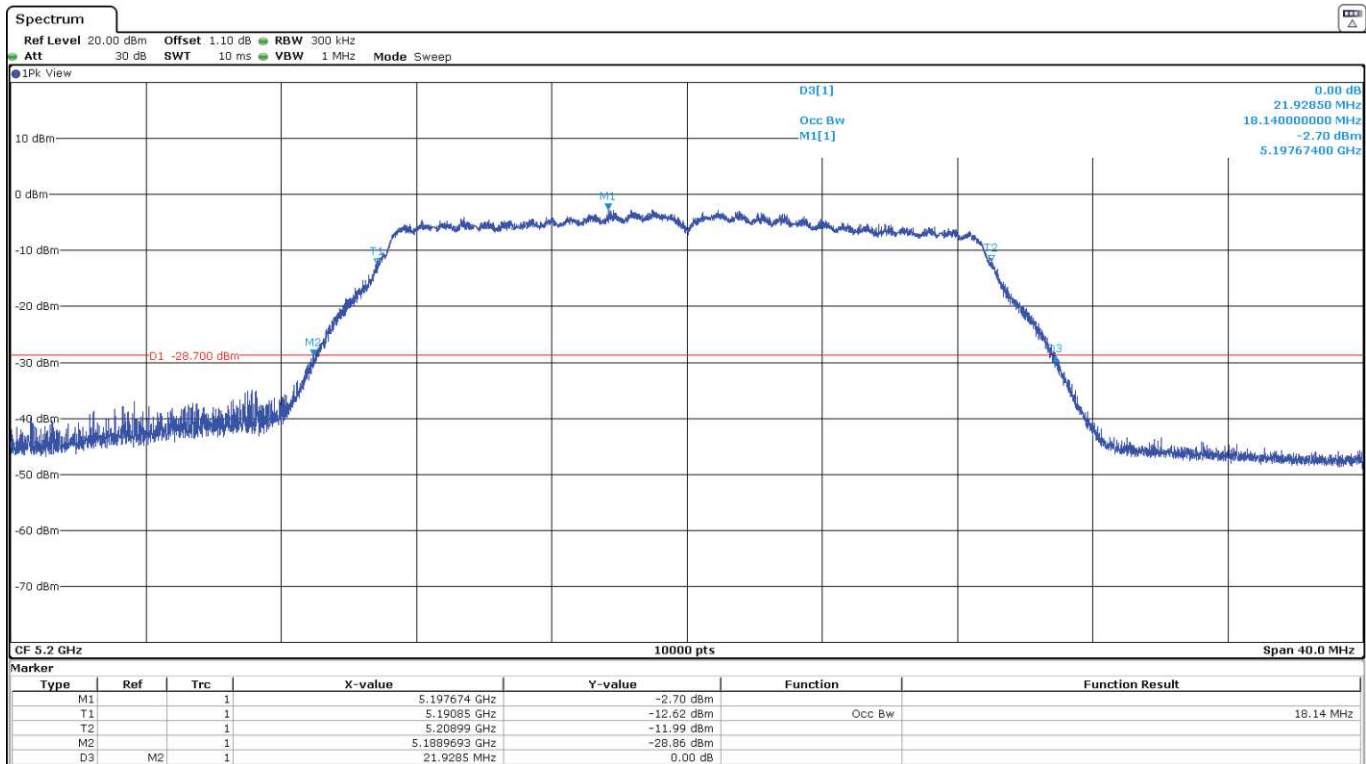


Port 4

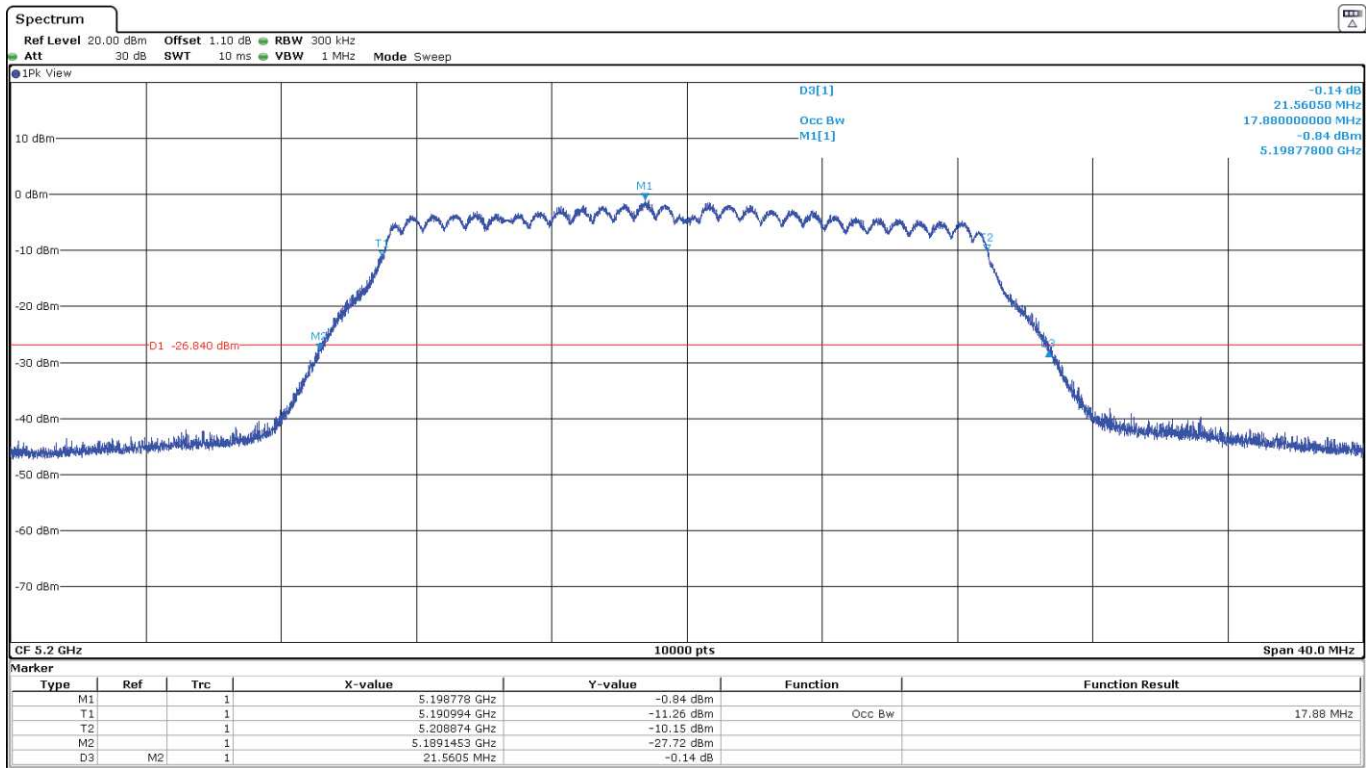


- Middle Channel 40 (5200 MHz):

Port 1

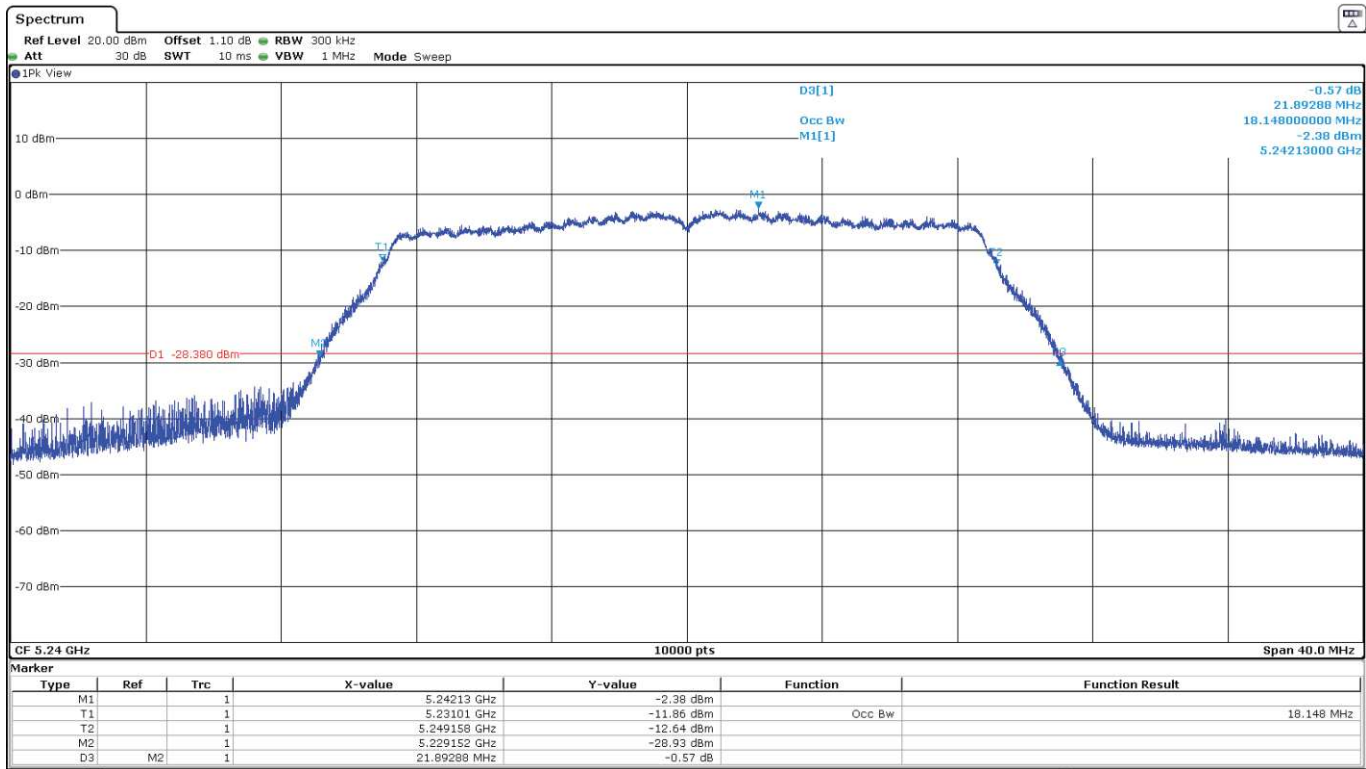


Port 4

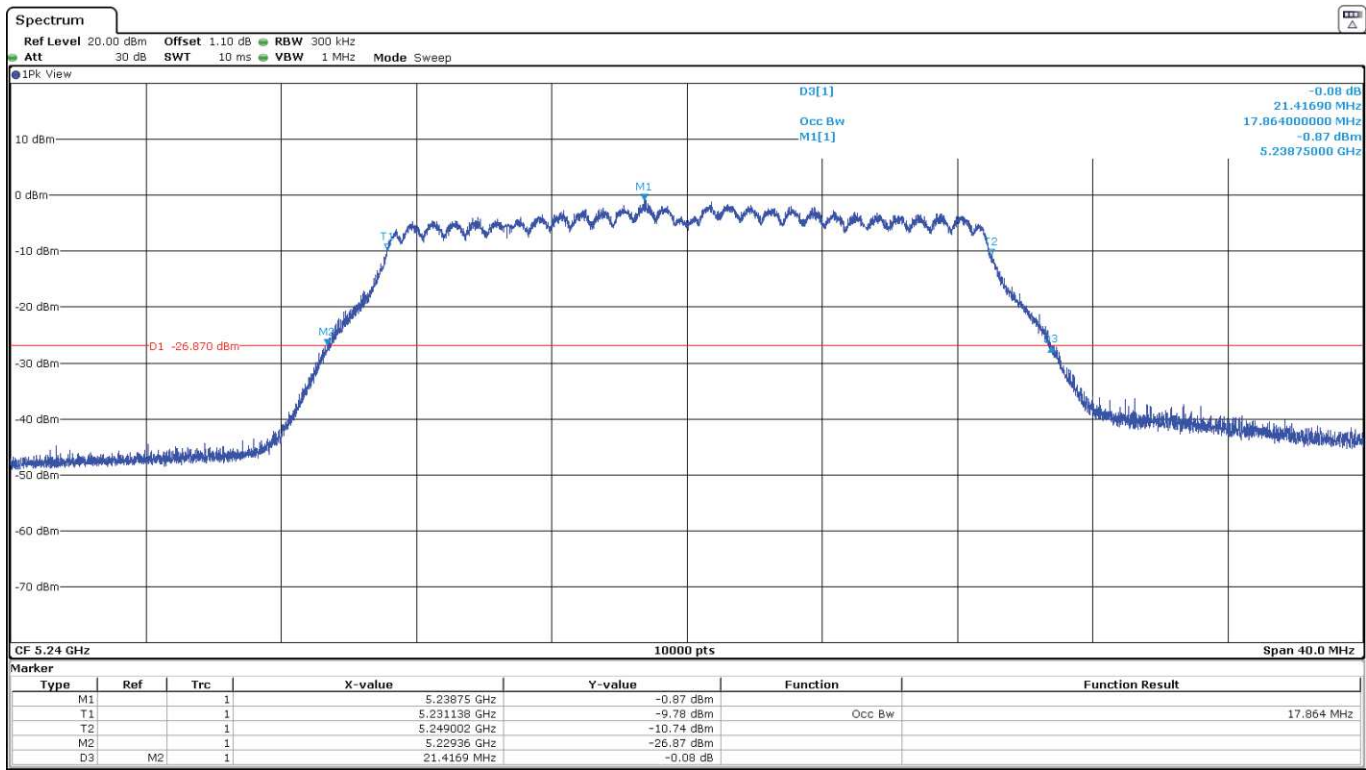


- High Channel 48 (5240 MHz):

Port 1



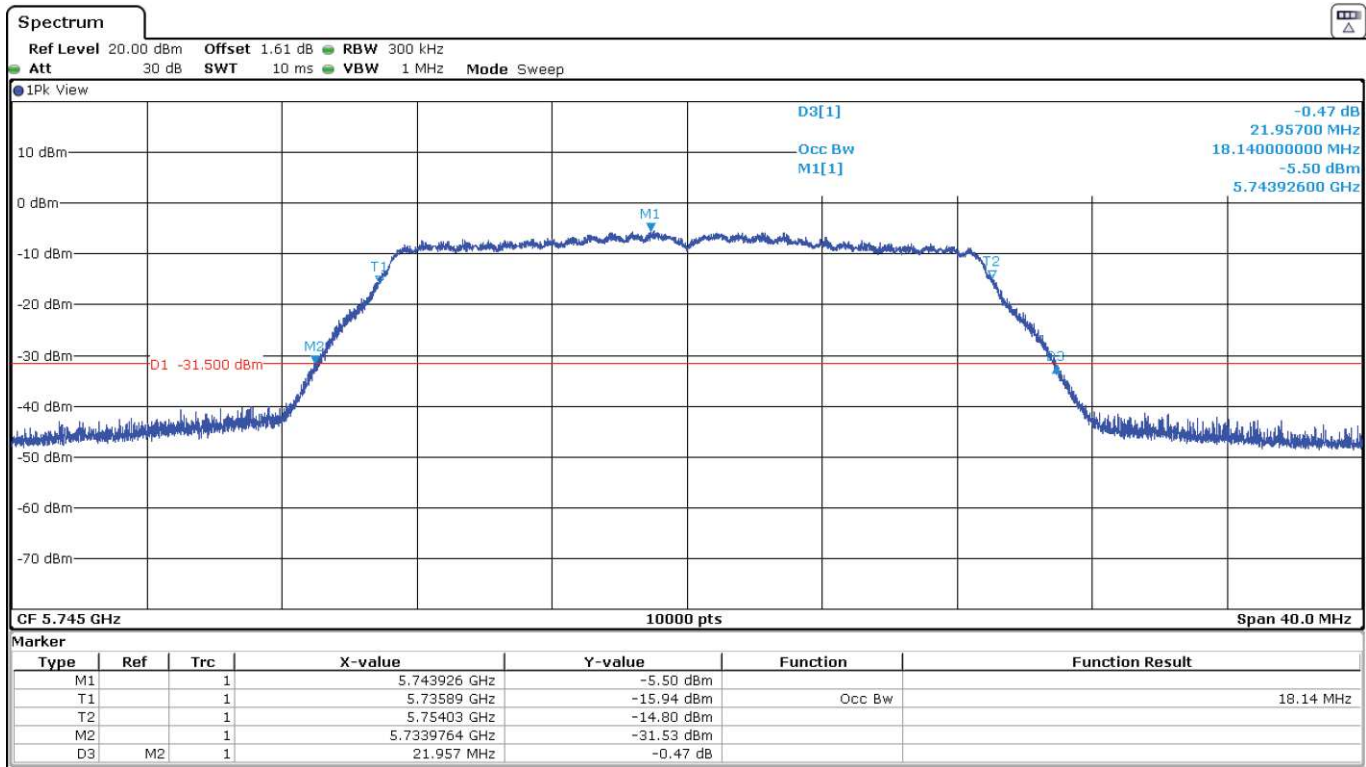
Port 4



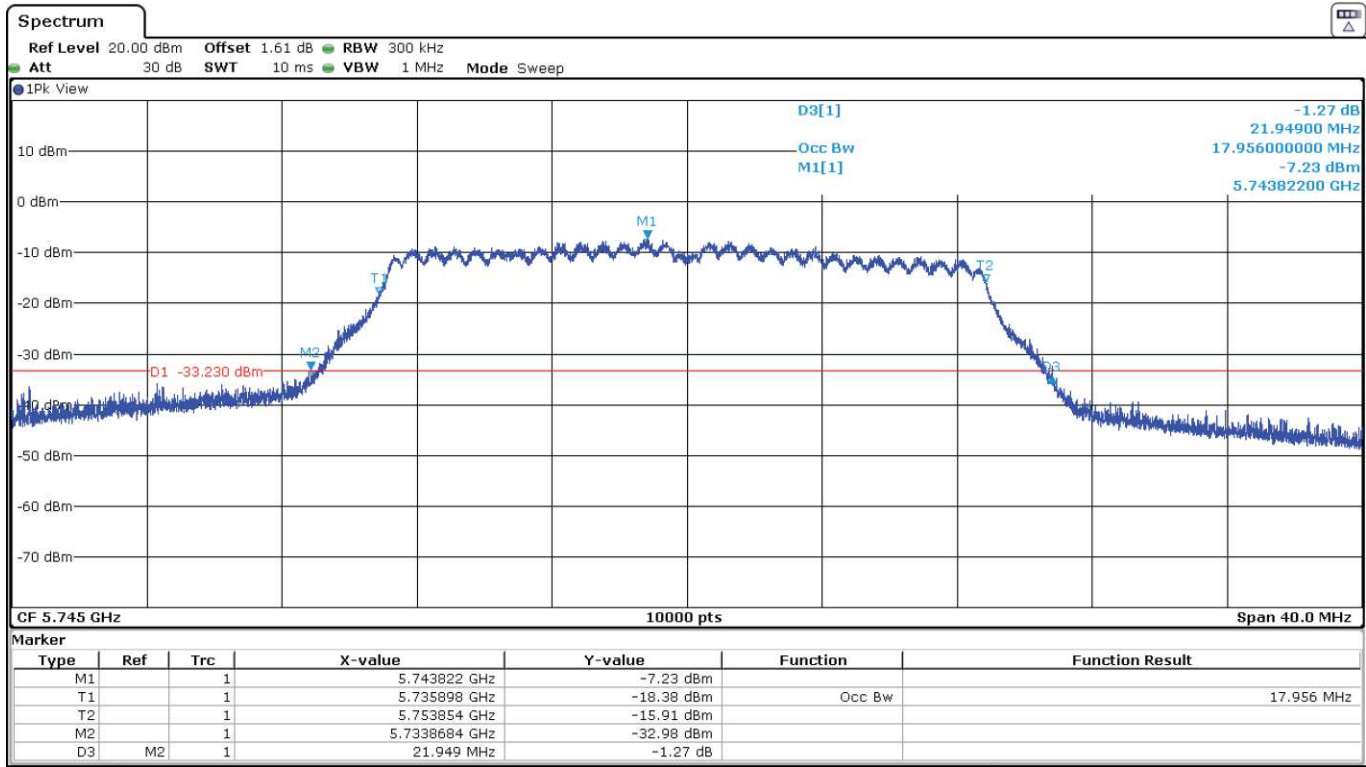
U-NII-3 (5725-5850 MHz)

- Low Channel 149 (5745 MHz):

Port 1

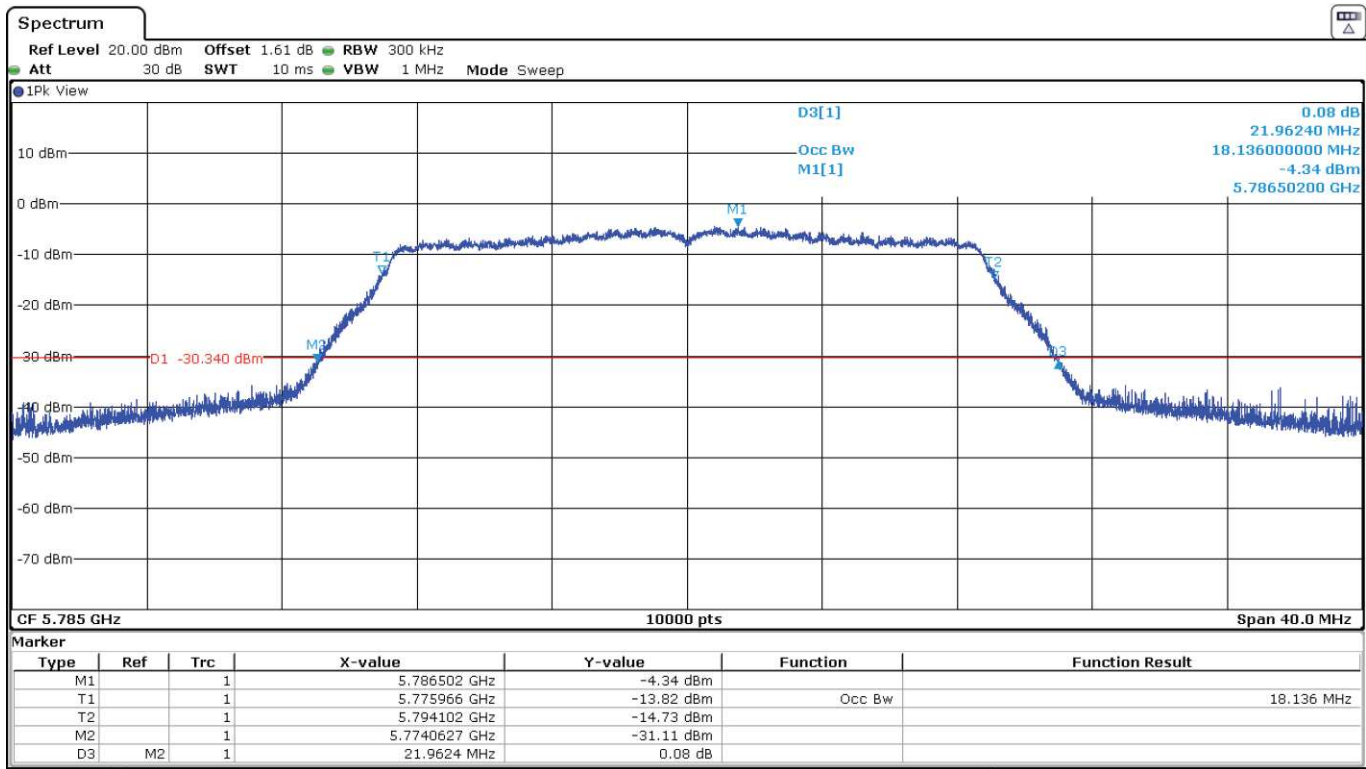


Port 4

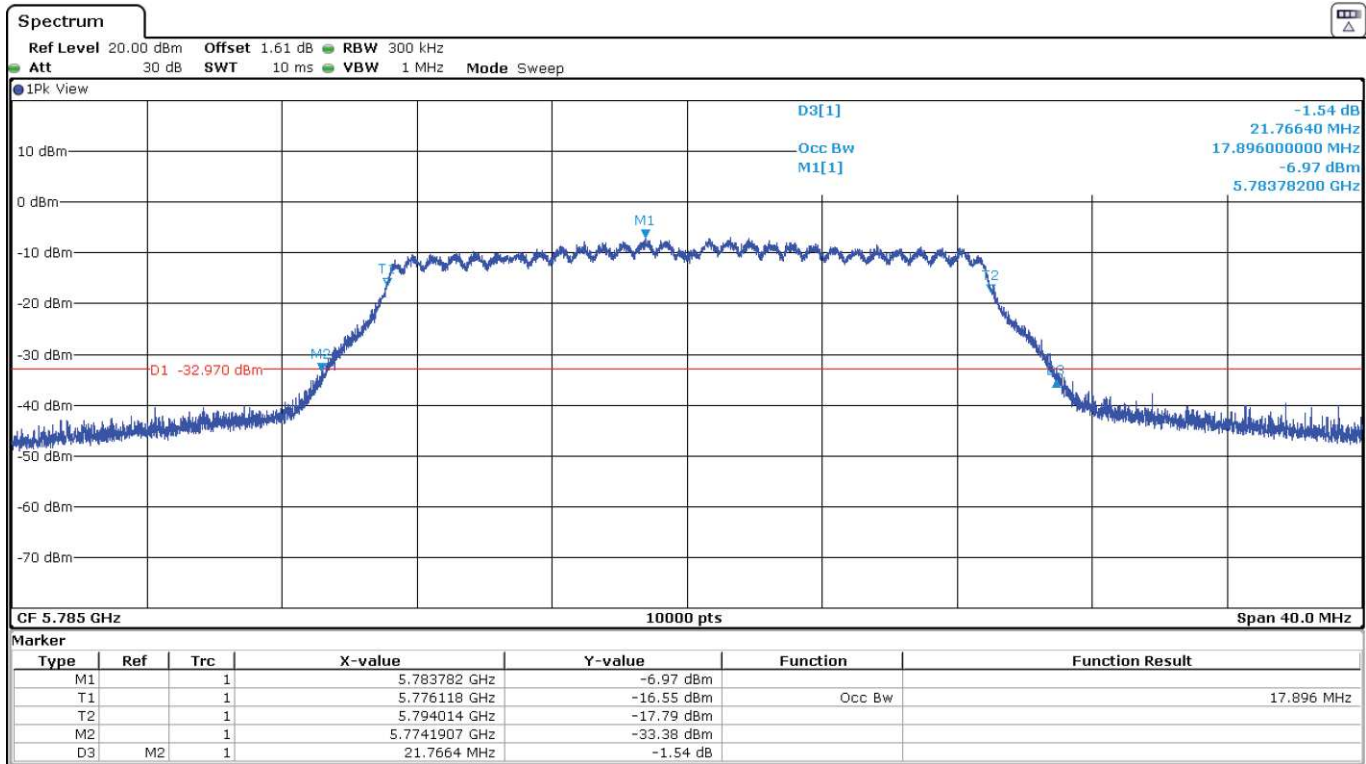


- Middle Channel 157 (5785 MHz):

Port 1

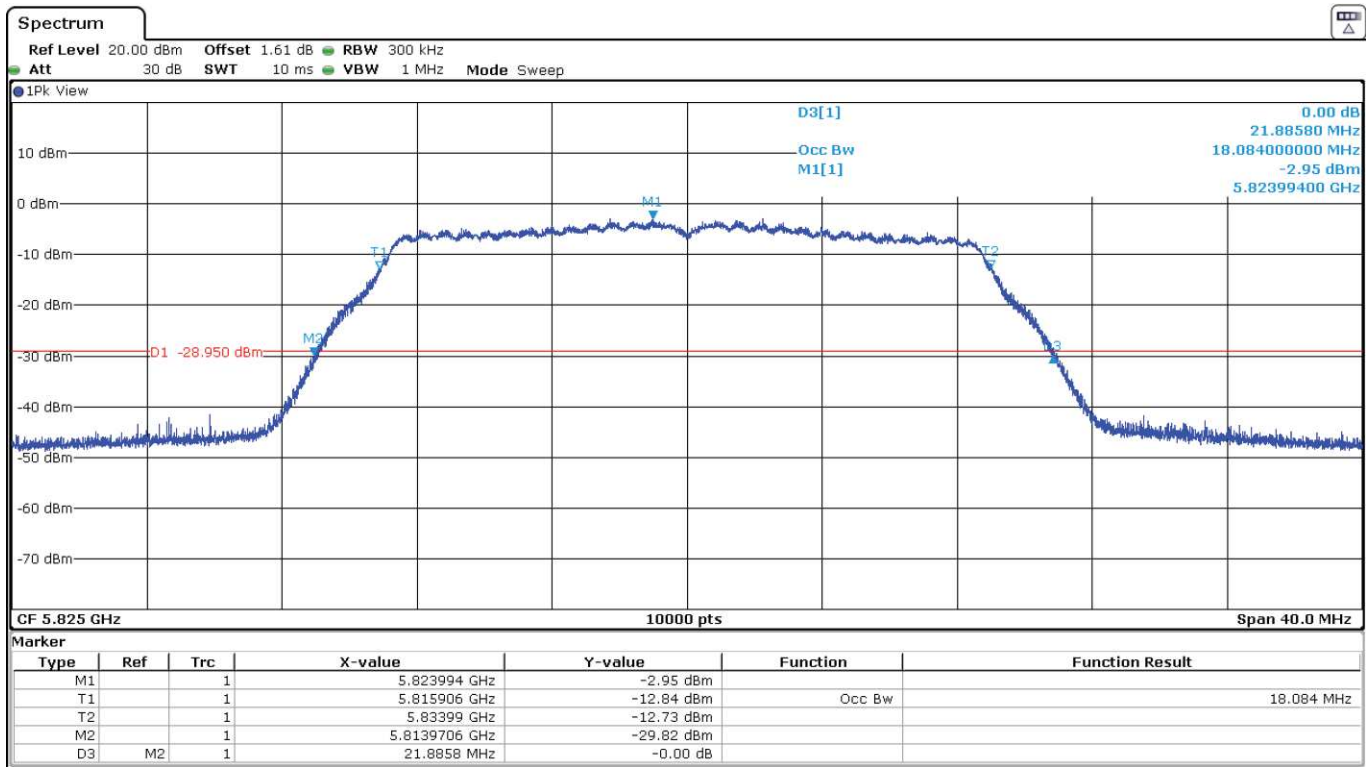


Port 4

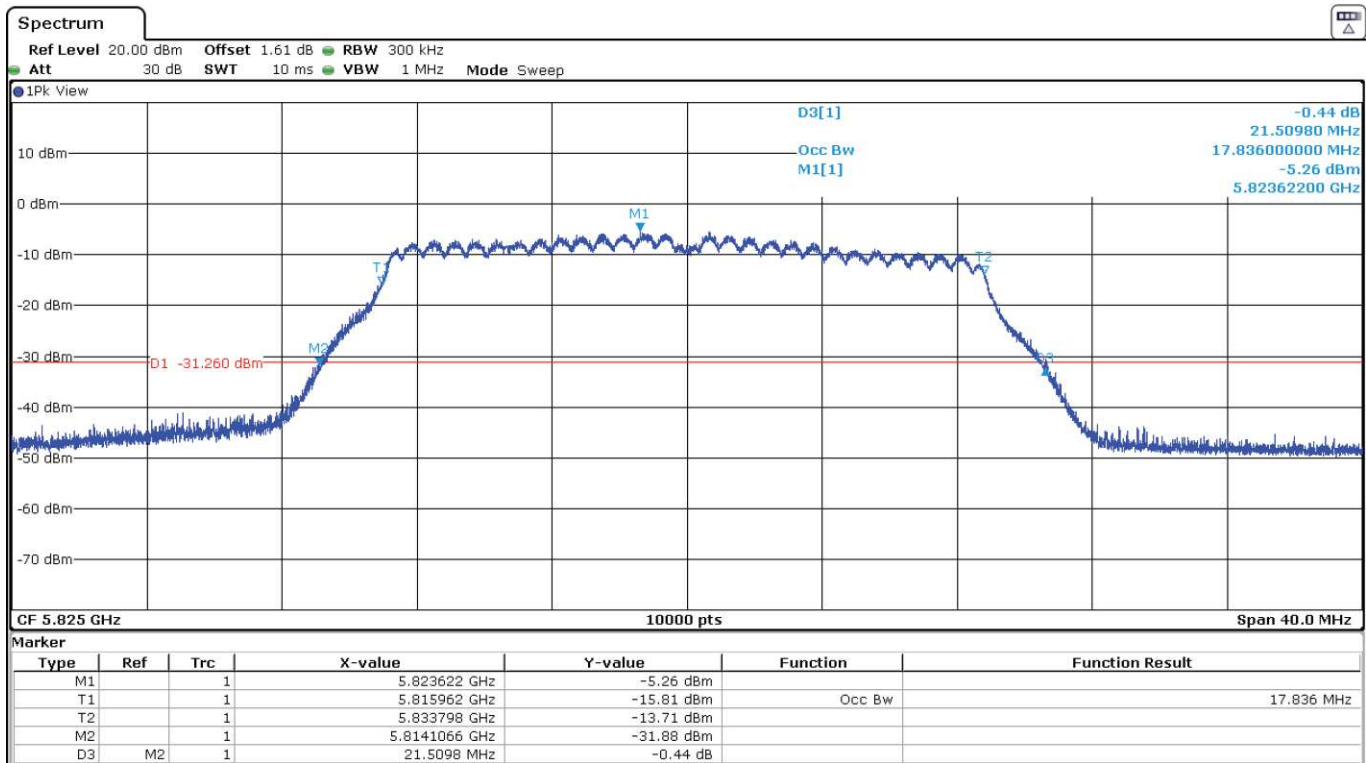


- High Channel 165 (5825 MHz):

Port 1



Port 4



Transmitter 26 dB Emission Bandwidth (EBW)

RESULTS:

The 26 dB Emission Bandwidth was measured using the method according to point C) 1) of 789033 D02 General UNII Test Procedures New Rules v02r01.

The following modes and data rates were selected based on preliminary testing that identified those corresponding to the worst cases:

- 802.11a: 6 Mbit/s.
- 802.11n HT20: MCS0.
- 802.11n HT40: MCS0.
- 802.11ac VHT80: MCS0

SISO worst case:

- Preliminary tests determined the SISO worst case: WLAN1_CORE-0_Port3.

SISO 802.11 a20:

U-NII-1 (5150-5250 MHz):

Channels	Low Channel 36 (5180 MHz)	Middle Channel 40 (5200 MHz)	High Channel 48 (5240 MHz)
26 dB Emission Bandwidth (MHz)	21.4753	21.4933	21.4104
Measurement uncertainty (kHz)	<±36.95		

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

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
26 dB Emission Bandwidth (MHz)	21.5521	21.415	21.58
Measurement uncertainty (kHz)	<±36.95		

SISO 802.11 n20 (HT20):

U-NII-1 (5150-5250 MHz):

Channels	Low Channel 36 (5180 MHz)	Middle Channel 40 (5200 MHz)	High Channel 48 (5240 MHz)
26 dB Emission Bandwidth (MHz)	21.9273	21.9333	21.7264
Measurement uncertainty (kHz)	<±36.95		

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

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
26 dB Emission Bandwidth (MHz)	22.1601	21.871	21.904
Measurement uncertainty (kHz)	<±36.95		

SISO 802.11 ac20 (VHT20):

U-NII-1 (5150-5250 MHz):

Channels	Low Channel 36 (5180 MHz)	Middle Channel 40 (5200 MHz)	High Channel 48 (5240 MHz)
26 dB Emission Bandwidth (MHz)	21.9953	21.9973	21.7744
Measurement uncertainty (kHz)	<±36.95		

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

Channels	Low Channel 149 (5745 MHz)	Middle Channel 157 (5785 MHz)	High Channel 165 (5825 MHz)
26 dB Emission Bandwidth (MHz)	21.9681	21.947	22.368
Measurement uncertainty (kHz)	<±36.95		

SISO 802.11 n40 (HT40):

U-NII-1 (5150-5250 MHz):

Channels	Low Channel 38 (5190 MHz)	High Channel 46 (5230 MHz)
26 dB Emission Bandwidth (MHz)	40.4821	40.1371
Measurement uncertainty (kHz)	<±62.36	

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

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
26 dB Emission Bandwidth (MHz)	40.2046	40.344
Measurement uncertainty (kHz)	<±62.36	

SISO 802.11 ac40 (VHT40):

U-NII-1 (5150-5250 MHz):

Channels	Low Channel 38 (5190 MHz)	High Channel 46 (5230 MHz)
26 dB Emission Bandwidth (MHz)	40.2501	39.9291
Measurement uncertainty (kHz)	<±62.36	

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

Channels	Low Channel 151 (5755 MHz)	High Channel 159 (5795 MHz)
26 dB Emission Bandwidth (MHz)	40.0846	42.288
Measurement uncertainty (kHz)	<±62.36	

SISO 802.11 ac80 (VHT80):

U-NII-1 (5150-5250 MHz):

Channel	Single Channel 42 (5210 MHz)
26 dB Emission Bandwidth (MHz)	82.949
Measurement uncertainty (kHz)	<±124.71

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

Channel	Single Channel 155 (5775 MHz)
26 dB Emission Bandwidth (MHz)	82.5148
Measurement uncertainty (kHz)	<±124.71

MIMO worst case:

- Preliminary tests determined the MIMO worst case: WLAN0_CORE-MIMO_Port1 & Port4.

MIMO 802.11 ac20 (VHT20):

U-NII-1 (5150-5250 MHz):

Channels	Low Channel 36 (5180 MHz)		Middle Channel 40 (5200 MHz)		High Channel 48 (5240 MHz)	
	WLAN0_COR E- MIMO_Port1	WLAN0_COR E- MIMO_Port4	WLAN0_COR E- MIMO_Port1	WLAN0_COR E- MIMO_Port4	WLAN0_COR E- MIMO_Port1	WLAN0_COR E- MIMO_Port4
26 dB Emission Bandwidth (MHz)	21.8697	21.5097	21.9285	21.5605	21.89288	21.4169
Measurement uncertainty (kHz)	<±23.02					

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

Channels	Low Channel 149 (5745 MHz)		Middle Channel 157 (5785 MHz)		High Channel 165 (5825 MHz)	
	WLAN0_COR E- MIMO_Port1	WLAN0_COR E- MIMO_Port4	WLAN0_COR E- MIMO_Port1	WLAN0_COR E- MIMO_Port4	WLAN0_COR E- MIMO_Port1	WLAN0_COR E- MIMO_Port4
26 dB Emission Bandwidth (MHz)	21.957	21.949	21.9624	21.7664	21.8858	21.5098
Measurement uncertainty (kHz)	<±23.02					

SISO & MIMO worst cases:

See the plots in the previous test "RSS-Gen 6.6 / RSS-247 6.2. 99% Occupied Bandwidth".

Appendix B: Tests results for the U-NII-1 Band 5.15 – 5.25 GHz

INDEX

TEST CONDITIONS 50

FCC 15.407 (a)(1)(iv) Maximum Conducted Output Power / RSS-247 6.2.1.1 Transmitter Maximum Equivalent
Isotropically Radiated Power 54

FCC 15.407 (a)(1)(iv) Transmitter Maximum Power Spectral Density / RSS-247 6.2.1.1. Transmitter EIRP
Spectral Density.....70

FCC 15.407 (b)(1)(6) / RSS-247 6.2.1.2. Out of Band Radiated Emissions 73

FCC 15.407 (b)(1) / RSS-247 6.2.1.2. Band Edge Radiated Emissions 84

TEST CONDITIONS

POWER SUPPLY:

V nominal: 12 Vdc
Type of Power Supply: DC External (Car Battery).

ANTENNAS:

Type of Antenna: External.

Maximum Declared Antenna Gain:

- SISO Antenna – WLAN1_CORE-0_Port3: +0.9 dBi
- MIMO Antennas – WLAN0_CORE-MIMO_Port1 & Port4:
 - Port1: +3.2 dBi
 - Port4: +2.3 dBi

TEST FREQUENCIES:

Technology Tested:	WLAN (IEEE 802.11 a,n,ac) / U-NII-1	
Modes:	802.11a20: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps	
	802.11n HT20: MCS0 to MCS23	
	802.11n HT40: MCS0 to MCS23	
	802.11ac VHT20: MCS0 to MCS9	
	802.11ac VHT40: MCS0 to MCS9	
	802.11ac VHT80: MCS0 to MCS9	
Setting of cores / ports:	3, 1+4.	
Beamforming:	No.	
Frequency Range:	5150 MHz to 5250 MHz	
Channel Spacing:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Low: 36	5180
	Middle: 40	5200
	High: 48	5240
Channel Spacing:	40 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Low: 38	5190
	High: 46	5230
Channel Spacing:	80 MHz	
Transmit Channels	Middle: 42	5210

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.

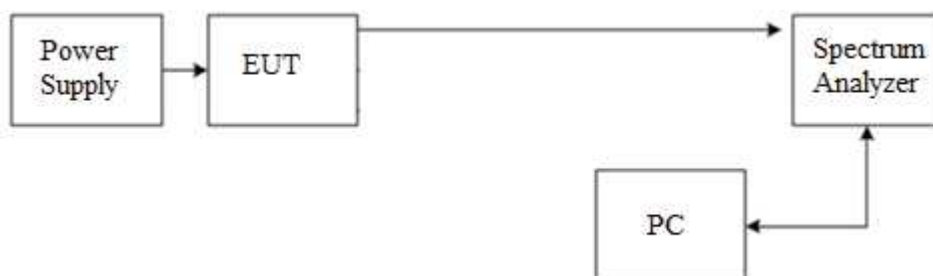
The worst cases for testing were identified for output power and spurious levels at the band edges which were selected based on preliminary testing that correspond to next data rates:

- 802.11a20: 6 Mbits
- 802.11n HT20: MCS0
- 802.11n HT40: MCS0
- 802.11ac VHT20: MCS0
- 802.11ac VHT40: MCS0
- 802.11ac VHT80: MCS0

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and connected to the spectrum analyzer 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:



The DC supply voltage is applied using an external power supply.

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 m for the frequency range 17 GHz-40 GHz (18 GHz-40 GHz horn antenna).

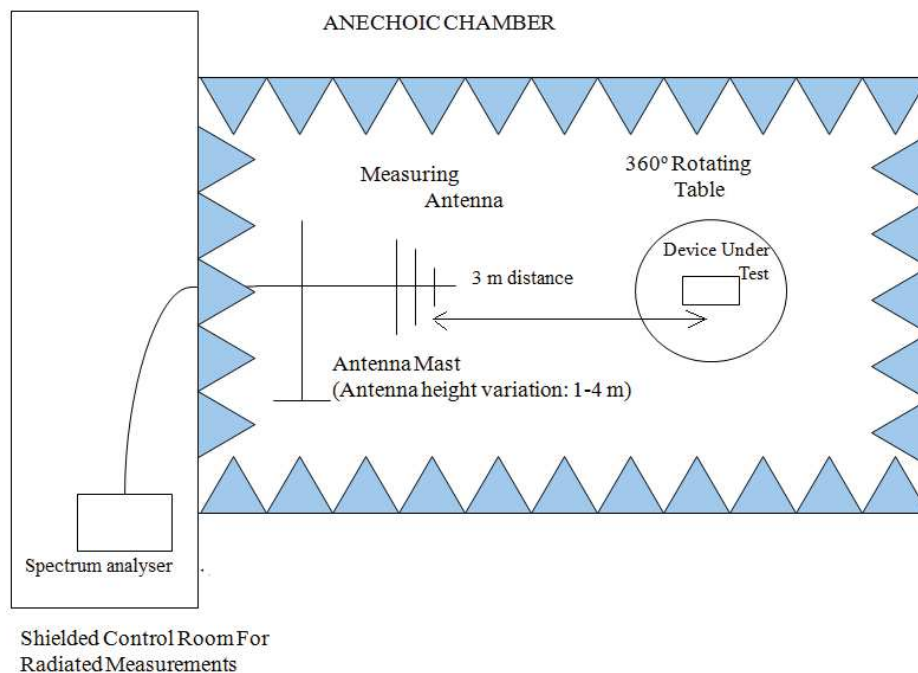
For radiated emissions in the range 17 GHz-40 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

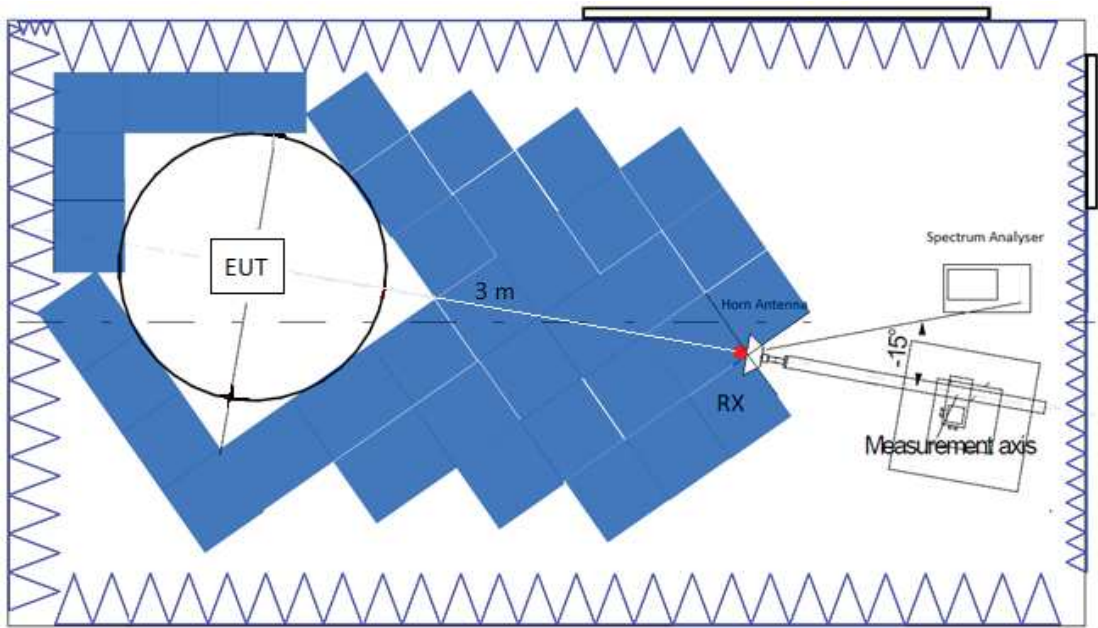
Measurements were made in both horizontal and vertical planes of polarization.

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

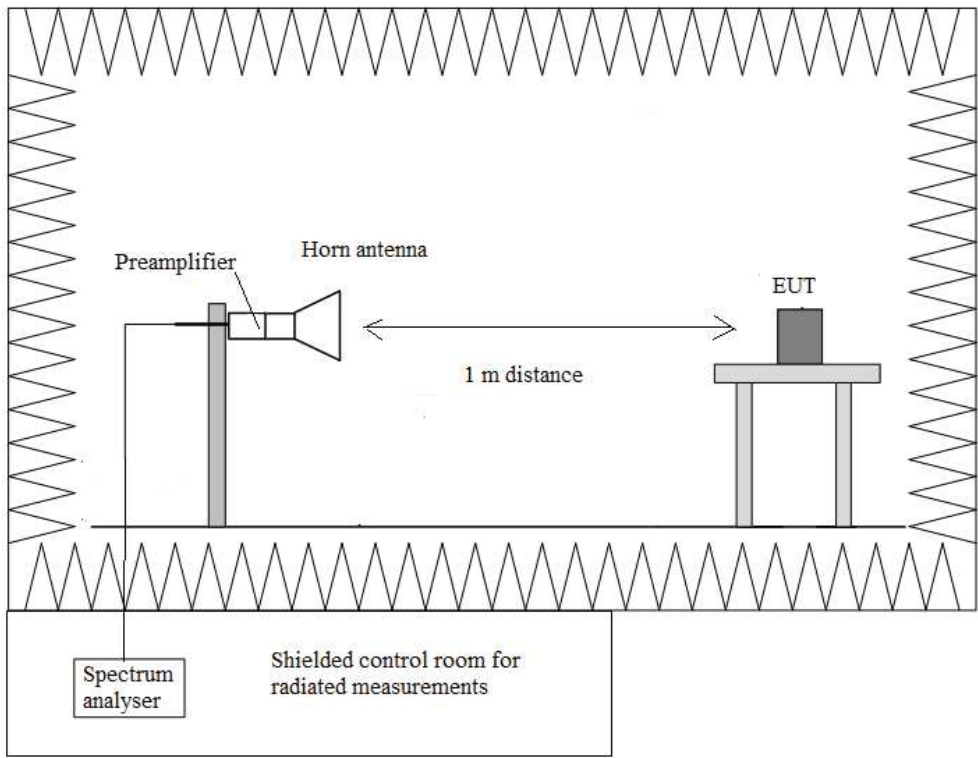
Radiated measurements setup $f < 1$ GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



FCC 15.407 (a)(1)(iv) Maximum Conducted Output Power / RSS-247 6.2.1.1 Transmitter Maximum Equivalent Isotropically Radiated Power

SPECIFICATION:

FCC 15.407: For client devices in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW (24 dBm) provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RSS-247: For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or $1.76 + 10 \log_{10} B$, dBm, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

RESULTS:

The maximum conducted output power was measured using the channel power integration method according to point E) 2) b) (Method SA-1) of 789033 D02 General UNII Test Procedures New Rules v02r01 when the duty cycle is >98% and the channel power integration method according to point E) 2) d) (Method SA-2) of 789033 D02 General UNII Test Procedures New Rules v02r01 when the duty cycle is <98%.

For data rates where the EUT was transmitting at <98% duty cycle, the duty calculated in Appendix A was added to the measured power in order to calculate the total average power during the actual transmission time.

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

- Preliminary tests determined the SISO worst case: WLAN1_CORE-0_Port3.
- Preliminary tests determined the MIMO worst case: WLAN0_CORE-MIMO_Port1 & Port4.

Maximum Declared Antenna Gain:

- SISO Antenna – WLAN1_CORE-0_Port3: +0.9 dBi
- MIMO Antennas – WLAN0_CORE-MIMO_Port1 & Port4:
 - Port1: +3.2 dBi
 - Port4: +2.3 dBi

For all modes of operation, the antenna gain is less than 6 dBi.

SISO worst case:

SISO 802.11 a20

	Low Channel 36 (5180 MHz)	Middle Channel 40 (5200 MHz)	High Channel 48 (5240 MHz)
Max. Conducted Power (dBm)	4.33	4.02	7.42
Maximum EIRP power (dBm)	5.23	4.92	8.32
Duty Cycle Correction Factor (dB)	0.946		
Max. Conducted Power Corrected (dBm)	5.276	4.966	8.366
Max. EIRP power Corrected (dBm)	6.176	5.866	9.266
Measurement uncertainty (dB)	<±2.00		

SISO 802.11 n20 (HT20)

	Low Channel 36 (5180 MHz)	Middle Channel 40 (5200 MHz)	High Channel 48 (5240 MHz)
Max. Conducted Power (dBm)	4.31	3.99	7.28
Maximum EIRP power (dBm)	5.21	4.89	8.18
Duty Cycle Correction Factor (dB)	1.007		
Max. Conducted Power Corrected (dBm)	5.317	4.997	8.287
Max. EIRP power Corrected (dBm)	6.217	5.897	9.187
Measurement uncertainty (dB)	<±2.00		

SISO 802.11 ac20 (VHT20)

	Low Channel 36 (5180 MHz)	Middle Channel 40 (5200 MHz)	High Channel 48 (5240 MHz)
Max. Conducted Power (dBm)	4.24	3.94	7.29
Maximum EIRP power (dBm)	5.14	4.84	8.19
Duty Cycle Correction Factor (dB)	1.002		
Max. Conducted Power Corrected (dBm)	5.242	4.942	8.292
Max. EIRP power Corrected (dBm)	6.142	5.842	9.192
Measurement uncertainty (dB)	<±2.00		

Mode 802.11 n40 (HT40)

	Low Channel 38 (5190 MHz)	High Channel 46 (5230 MHz)
Max. Conducted Power (dBm)	1.66	4.10
Maximum EIRP power (dBm)	2.56	5.00
Duty Cycle Correction Factor (dB)	1.851	
Max. Conducted Power Corrected (dBm)	3.511	5.951
Max. EIRP power Corrected (dBm)	4.411	6.851
Measurement uncertainty (dB)	<±2.00	

Mode 802.11 ac40 (VHT40)

	Low Channel 38 (5190 MHz)	High Channel 46 (5230 MHz)
Max. Conducted Power (dBm)	1.63	4.18
Maximum EIRP power (dBm)	2.53	5.08
Duty Cycle Correction Factor (dB)	1.837	
Max. Conducted Power Corrected (dBm)	3.467	6.017
Max. EIRP power Corrected (dBm)	4.367	6.917
Measurement uncertainty (dB)	<±2.00	

Mode 802.11 ac80 (VHT80)

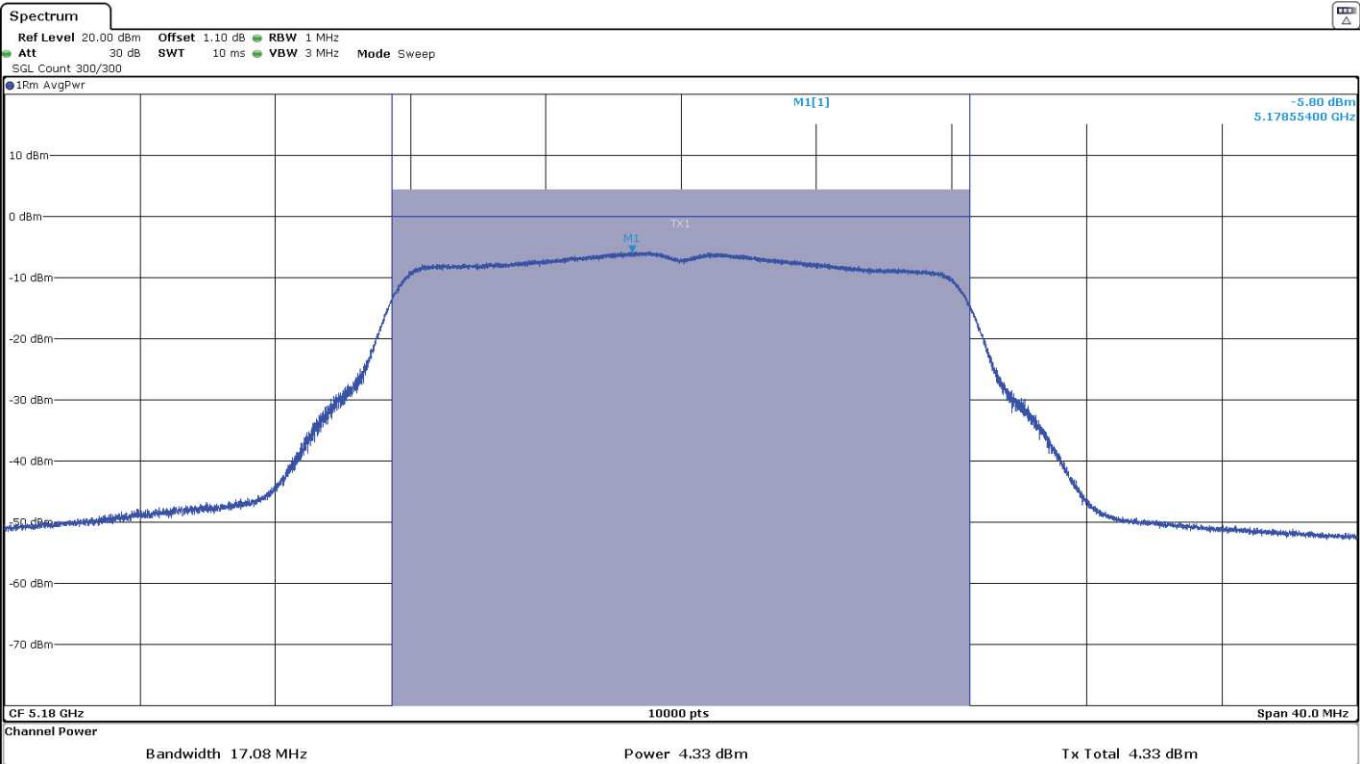
	Single Channel 42 (5210 MHz)
Max. Conducted Power (dBm)	2.41
Maximum EIRP power (dBm)	3.31
Duty Cycle Correction Factor (dB)	3.202
Max. Conducted Power Corrected (dBm)	5.612
Max. EIRP power Corrected (dBm)	6.512
Measurement uncertainty (dB)	<±2.00

Verdict: PASS

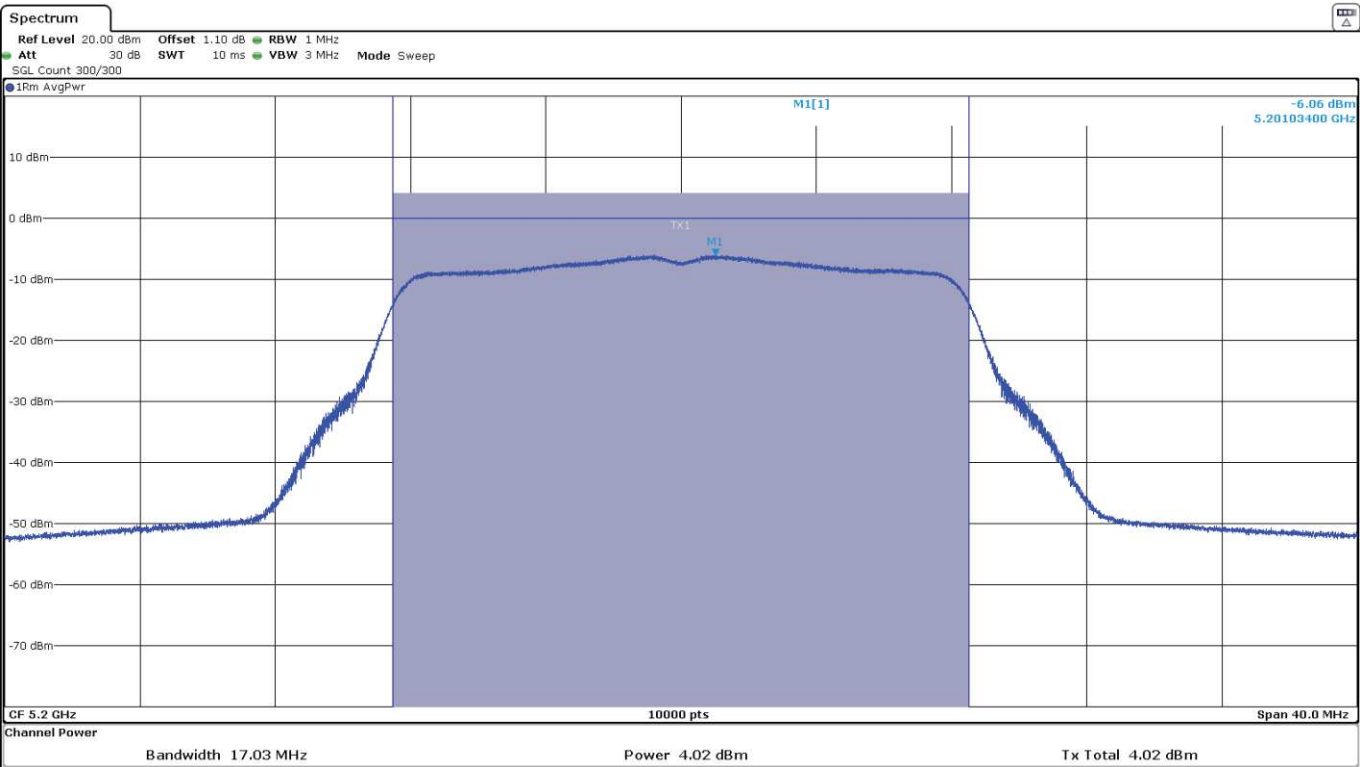
SISO worst case:

SISO 802.11 a20:

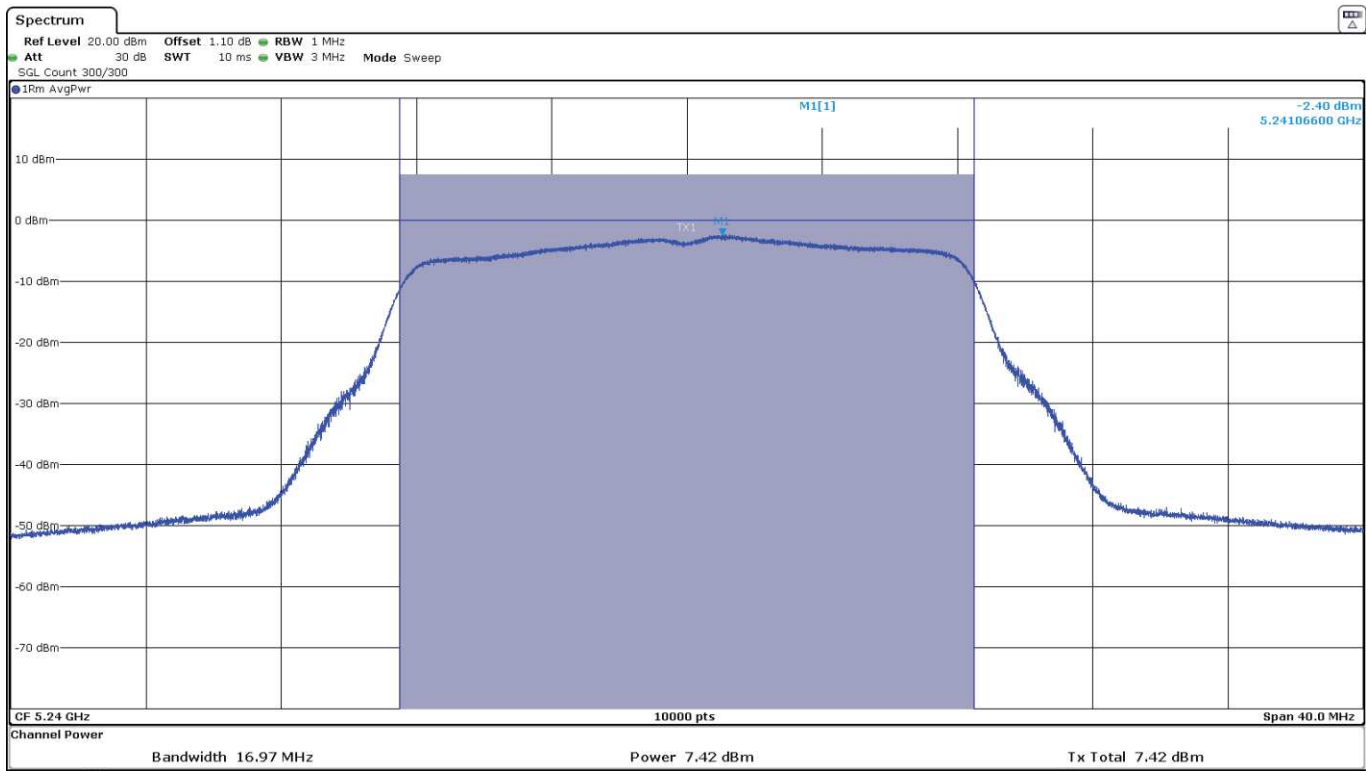
- Low Channel 36:



- Middle Channel 40:

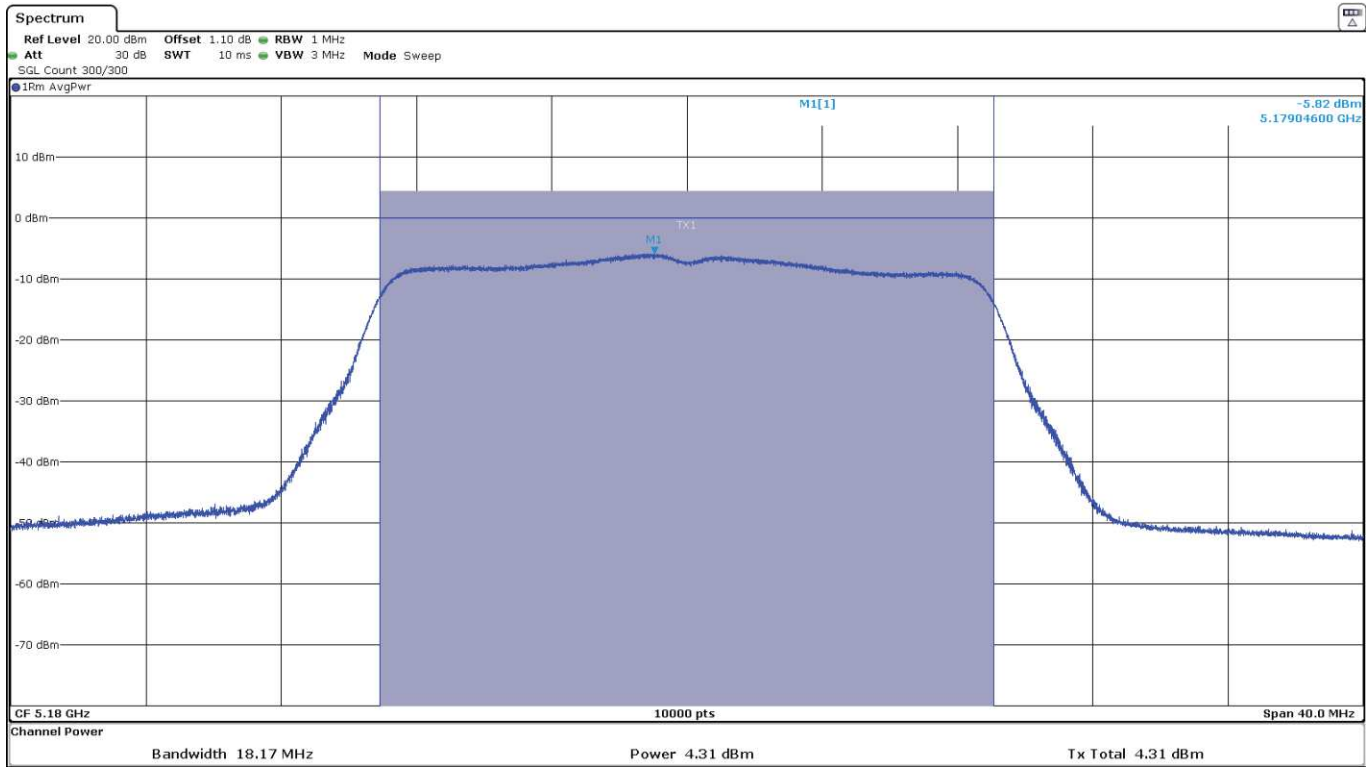


- High Channel 48:

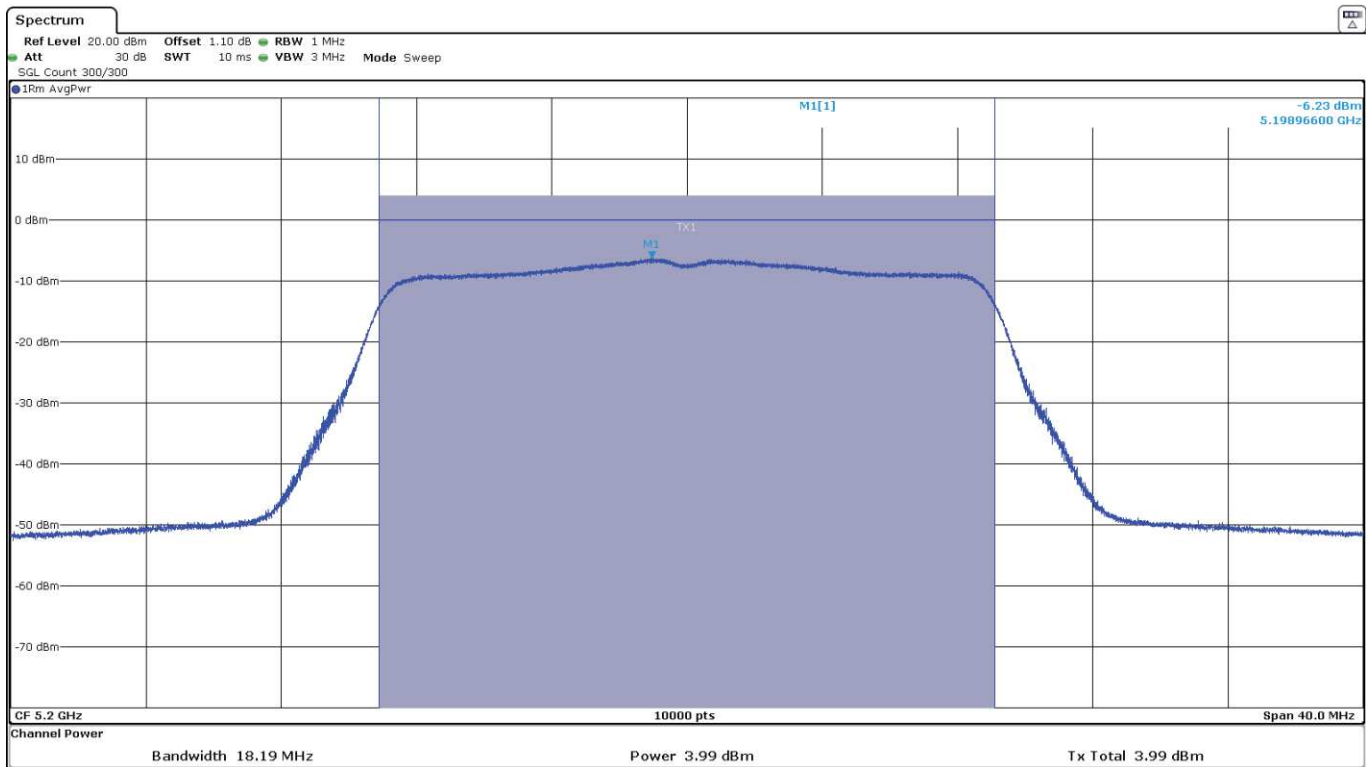


SISO 802.11 n20 (HT20):

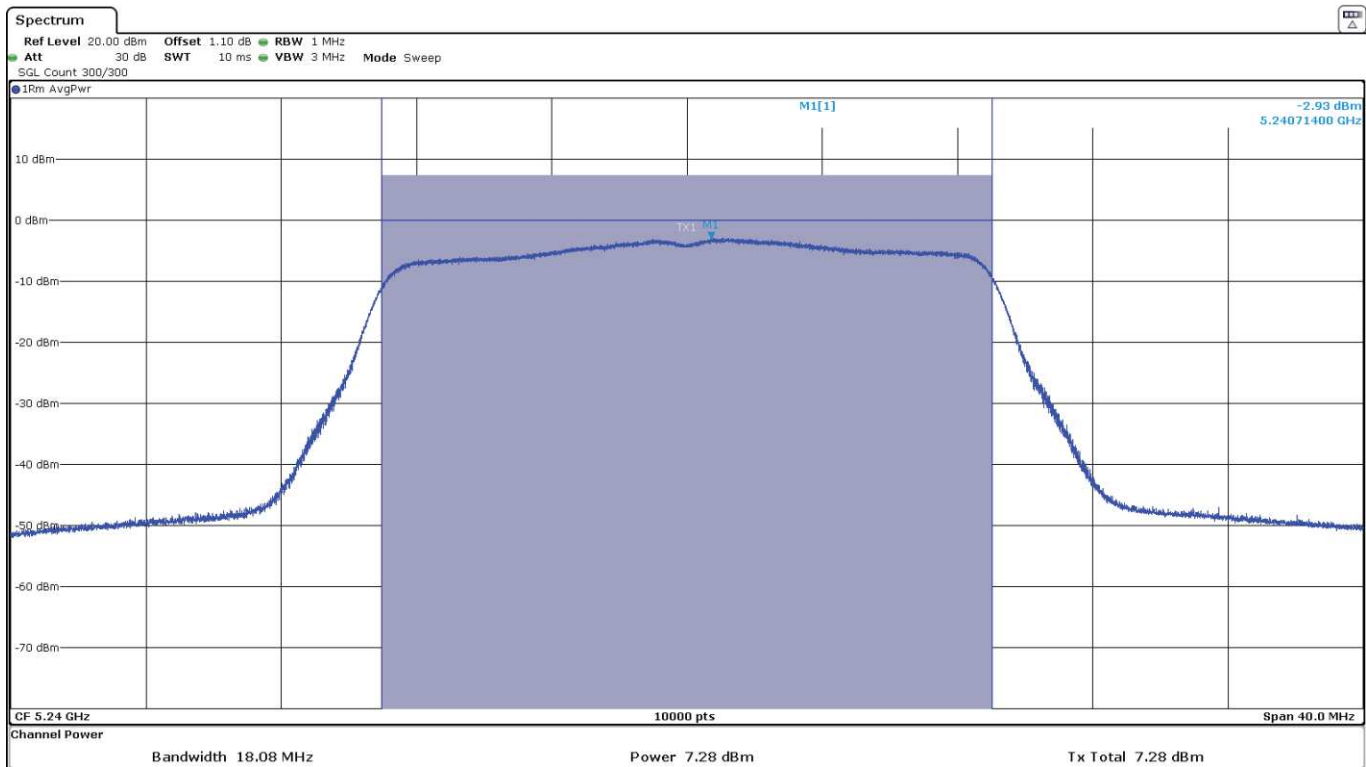
- Low Channel 36:



- Middle Channel 40:

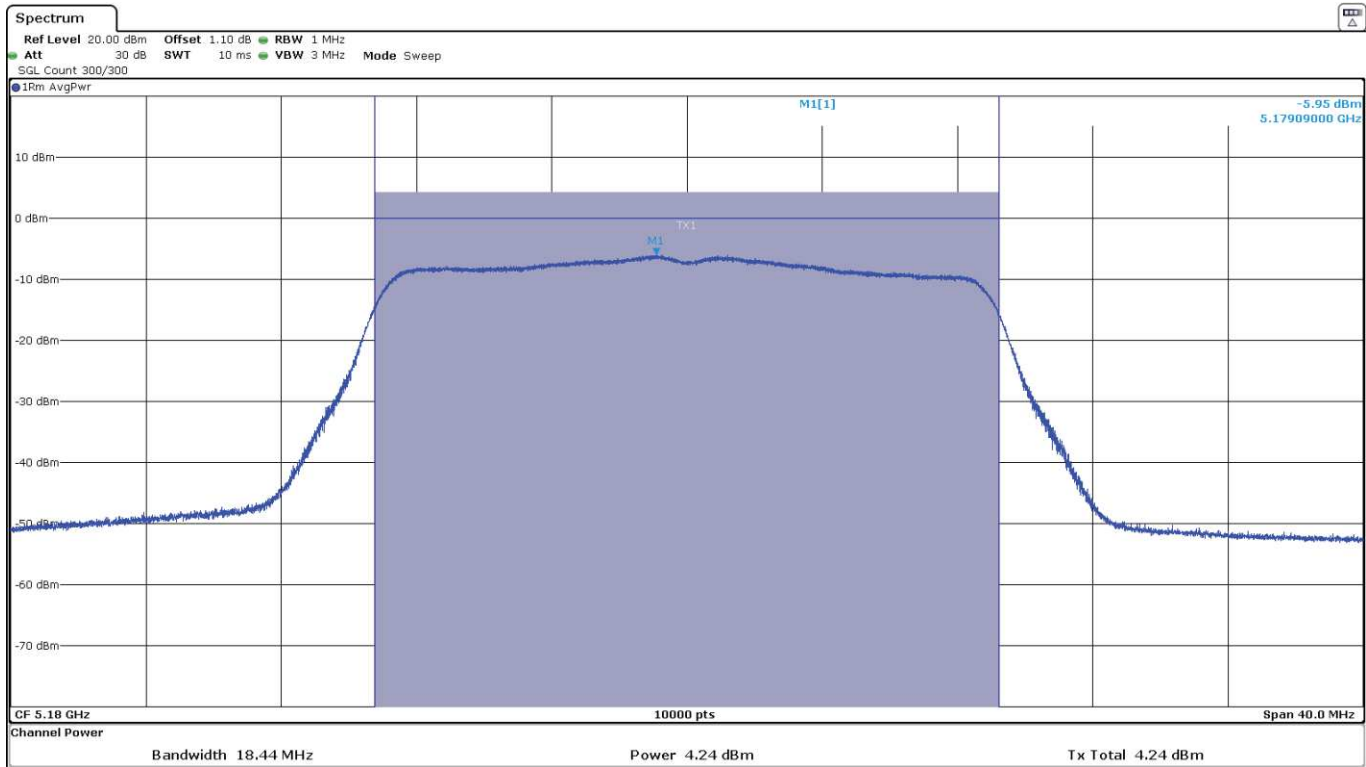


- High Channel 48:

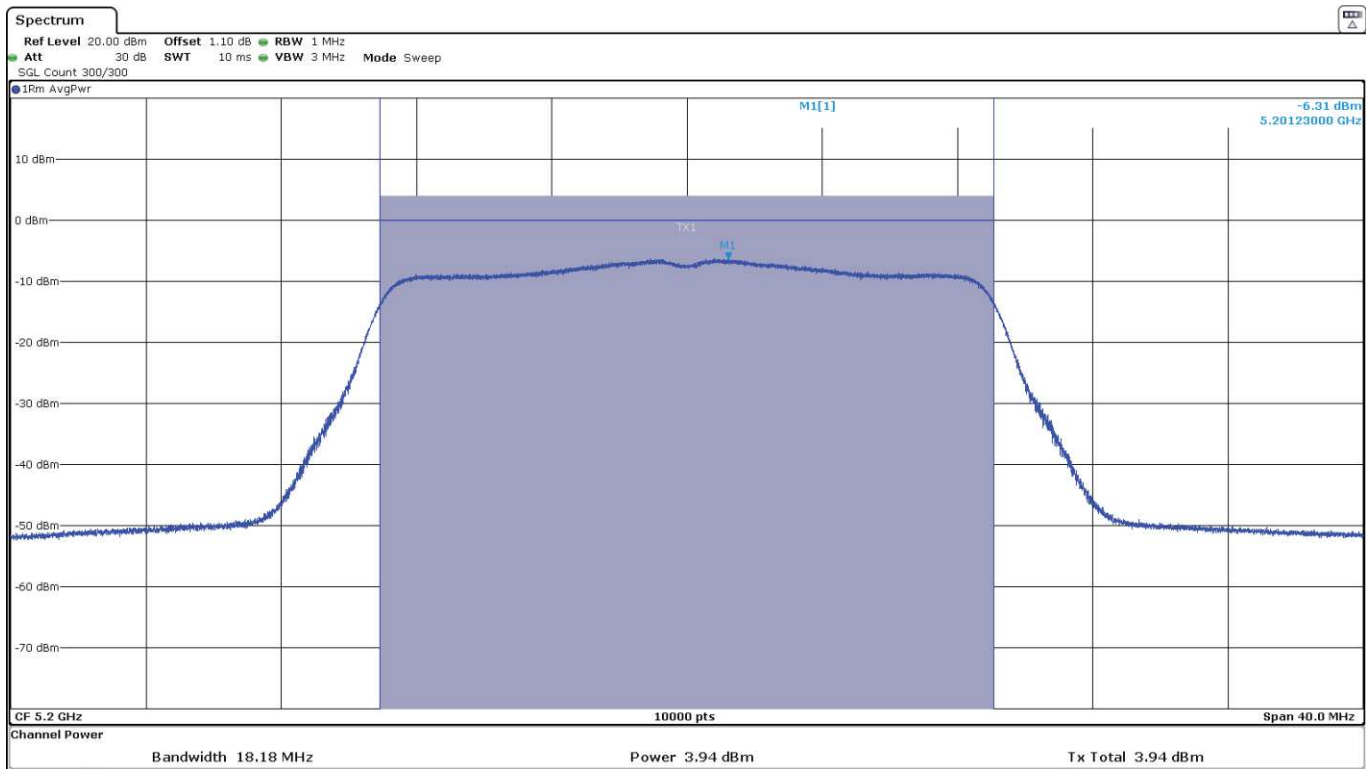


SISO 802.11 ac20 (VHT20):

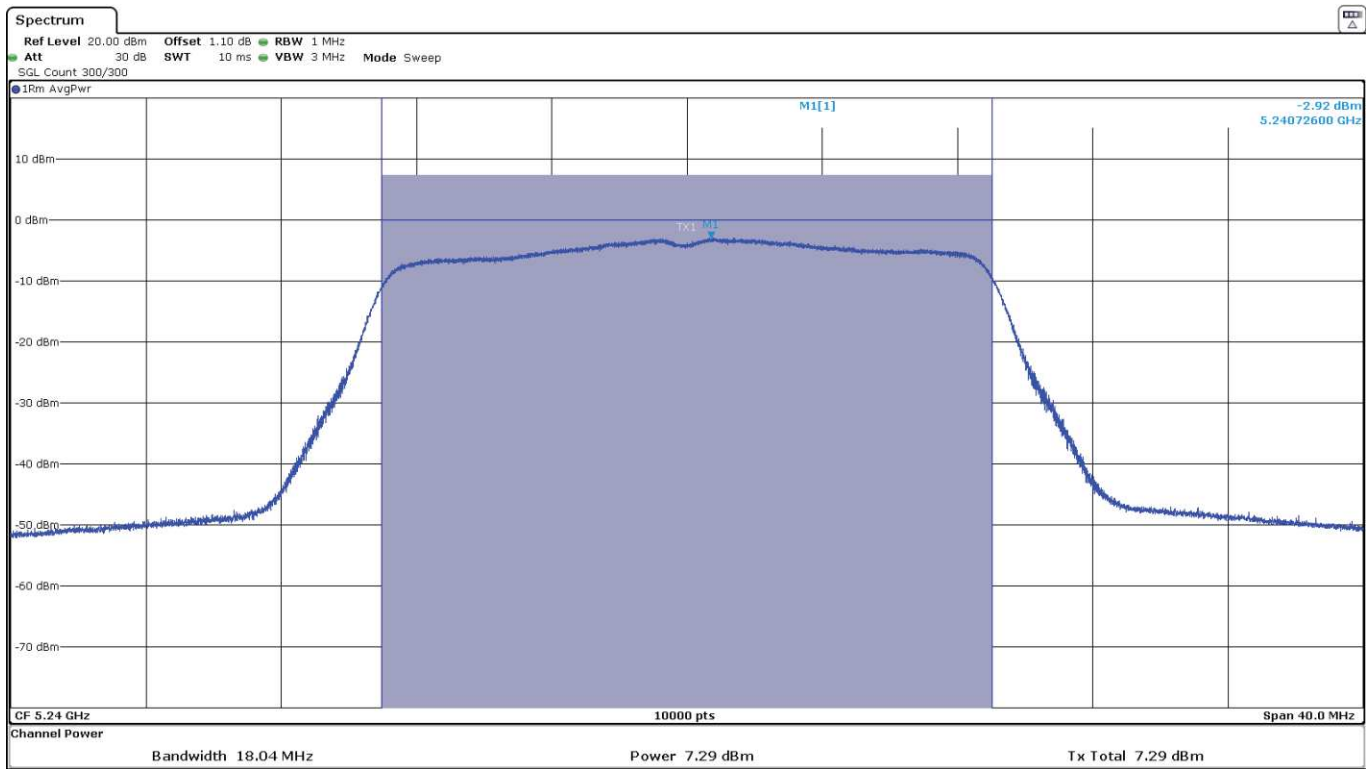
- Low Channel 36:



- Middle Channel 40:

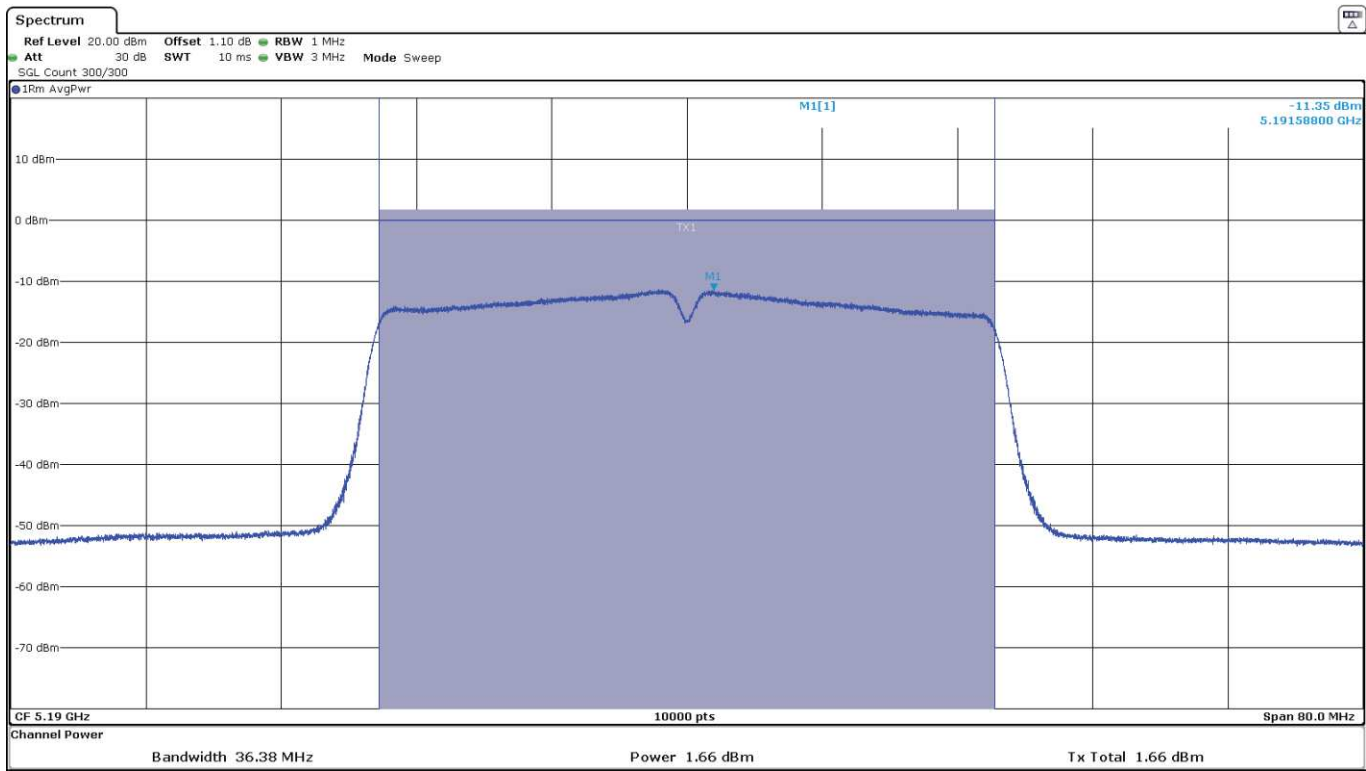


- High Channel 48:

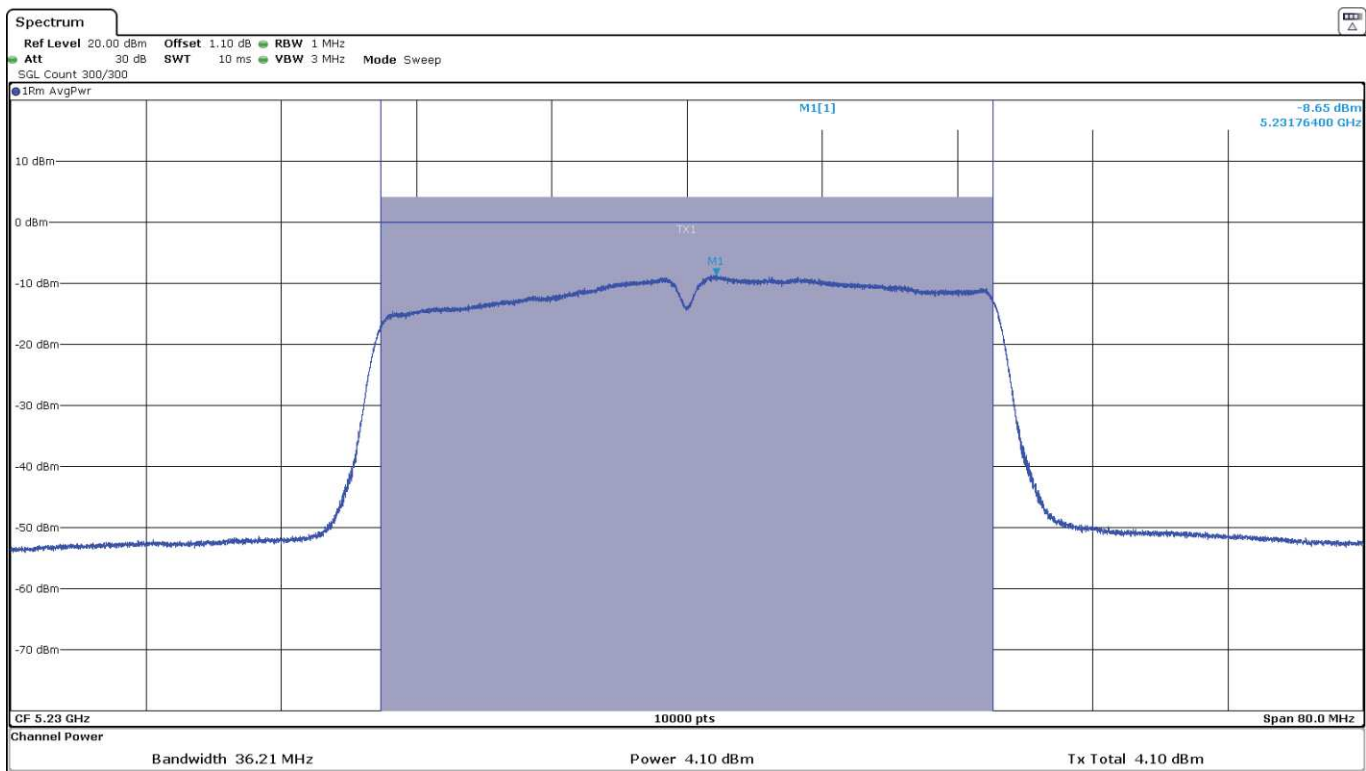


SISO 802.11 n40 (HT40):

- Low Channel 38:

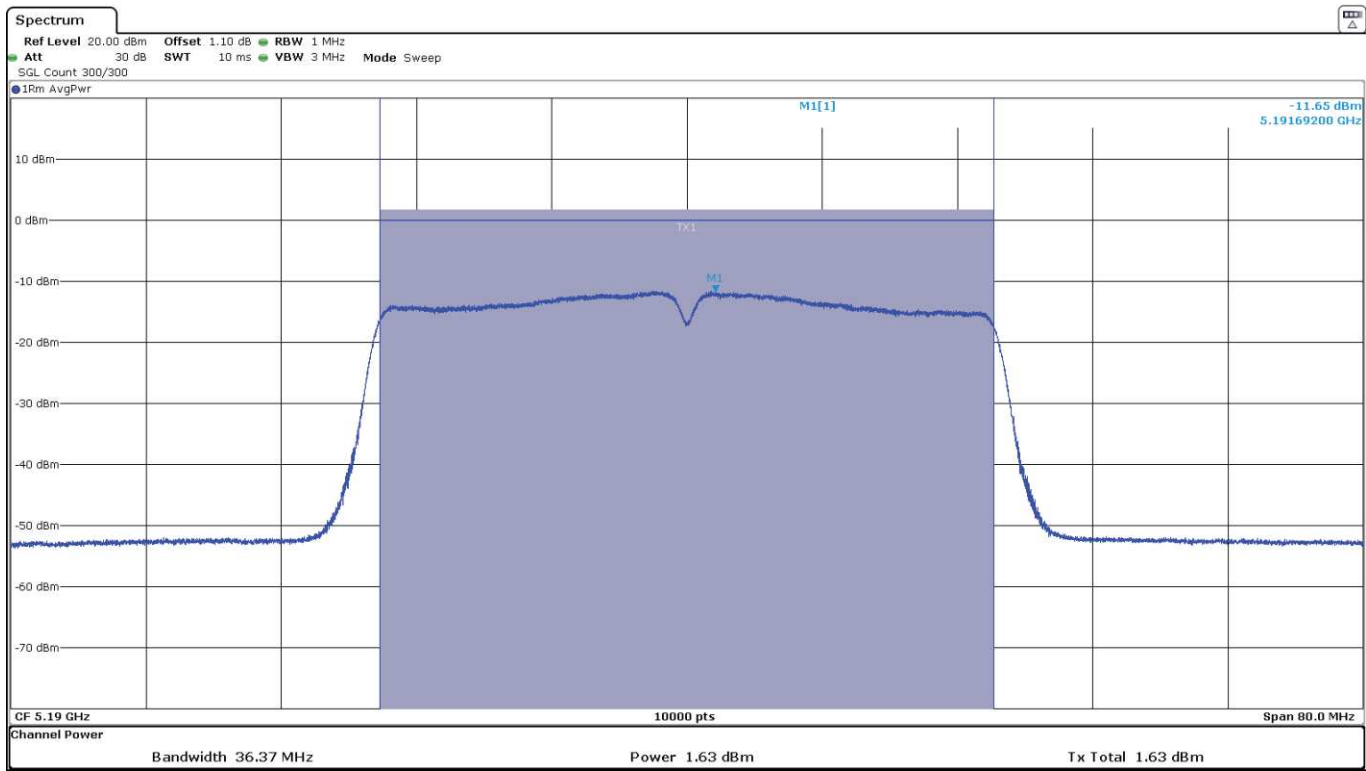


- High Channel 46:

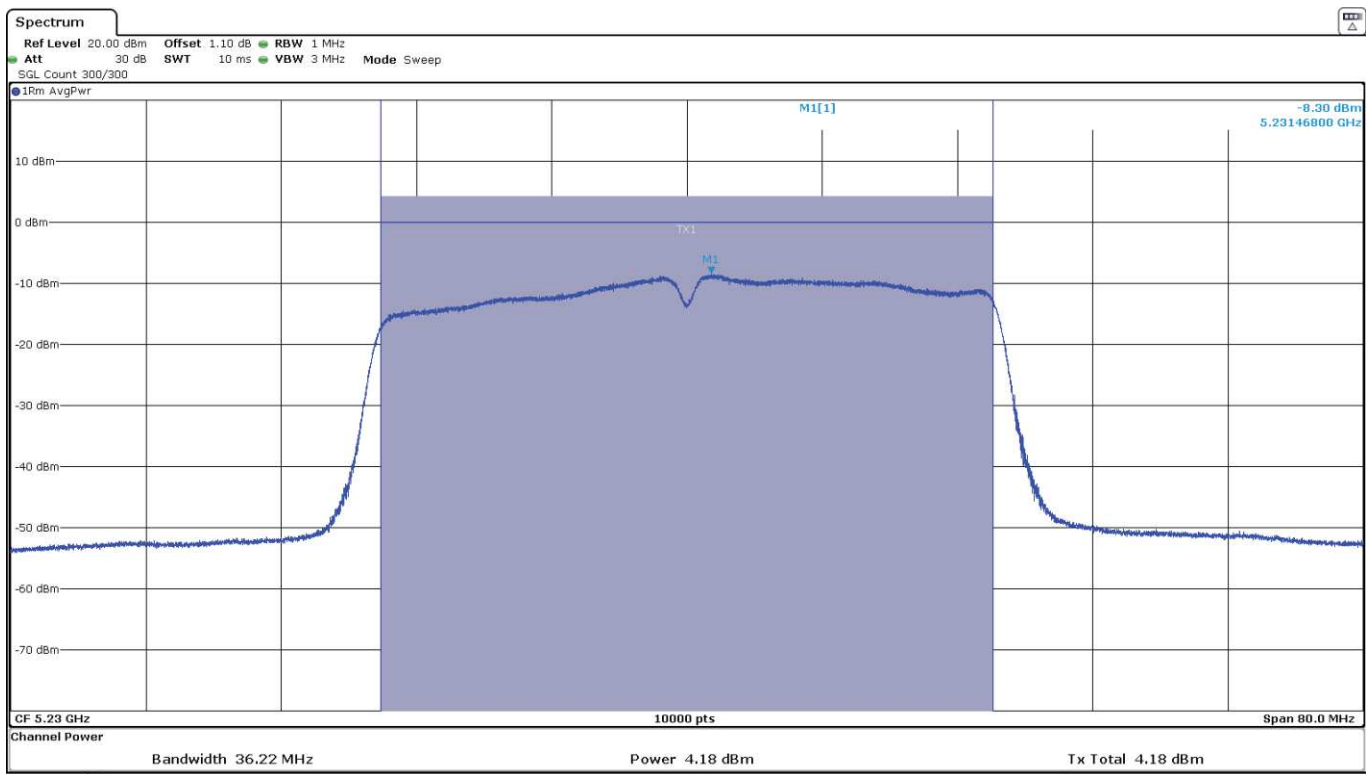


SISO 802.11 ac40 (VHT40):

- Low Channel 38:

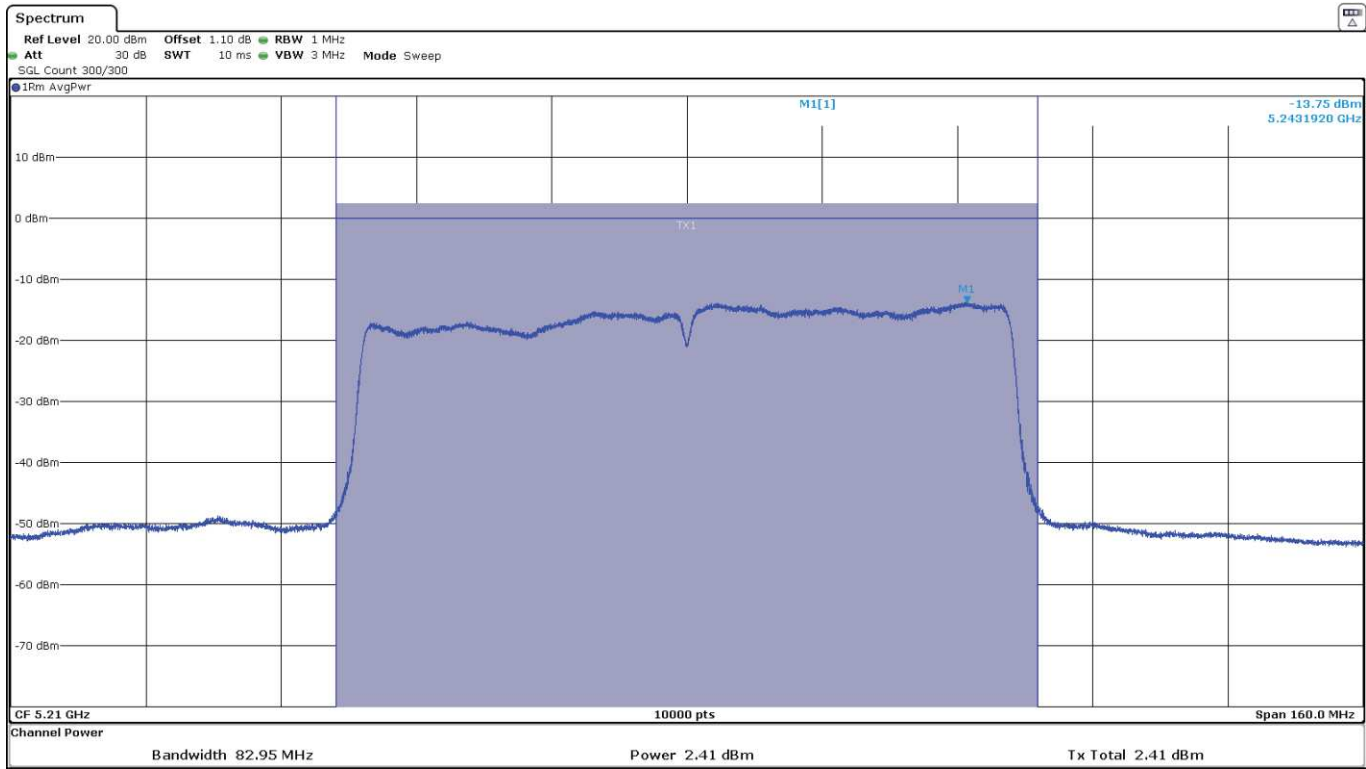


- High Channel 46:



SISO 802.11 ac80 (VHT80):

- Single Channel 42:



MIMO worst case:

- Preliminary testing determined the MIMO 802.11 ac20 as the worst case mode.

MIMO 802.11 ac20 (VHT20):

	Low Channel MHz		Middle Channel MHz		High Channel MHz	
	WLAN0_CO RE- MIMO Port1	WLAN0_CO RE- MIMO Port4	WLAN0_CO RE- MIMO Port1	WLAN0_CO RE- MIMO Port4	WLAN0_CO RE- MIMO Port1	WLAN0_CO RE- MIMO Port4
Maximum Average Conducted Power (dBm)	4.84	4.48	3.38	3,9	3,23	4,05
Duty Cycle Correction Factor (dB)	1.002	1.001	1.002	1.001	1.002	1.001
Max. Conducted Power Corrected (dBm)	5.842	5.481	4.382	4.901	3.232	5.051
	WLAN0_CORE-MIMO_Port1 + WLAN0_CORE-MIMO_Port4		WLAN0_CORE-MIMO_Port1 + WLAN0_CORE-MIMO_Port4		WLAN0_CORE-MIMO_Port1 + WLAN0_CORE-MIMO_Port4	
Maximum Combined Average Conducted Power (dBm)	7.674		6.658		6.669	
Maximum Combined Corrected EIRP Power (dBm)	11.467		10.405		10.401	
Measurement uncertainty (dB)	<±2.00					

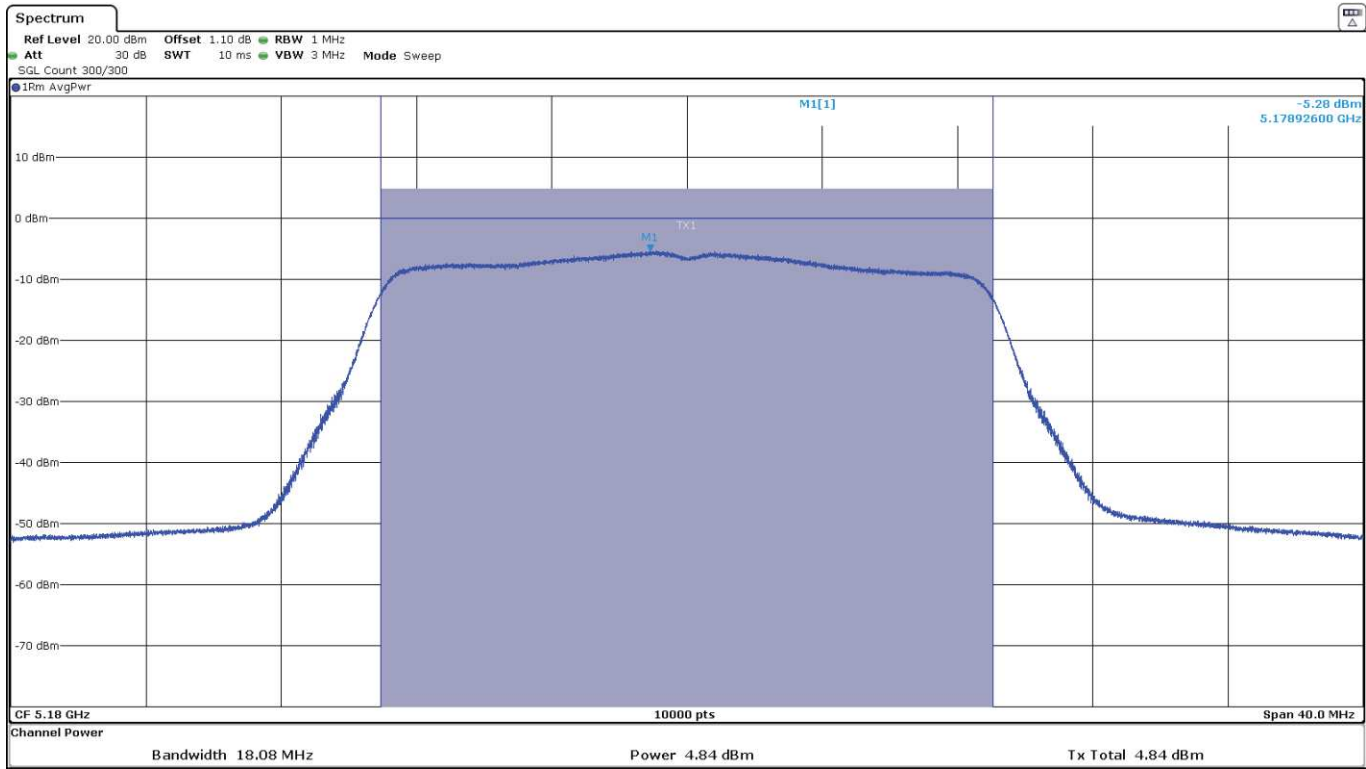
Verdict: PASS

MIMO worst case:

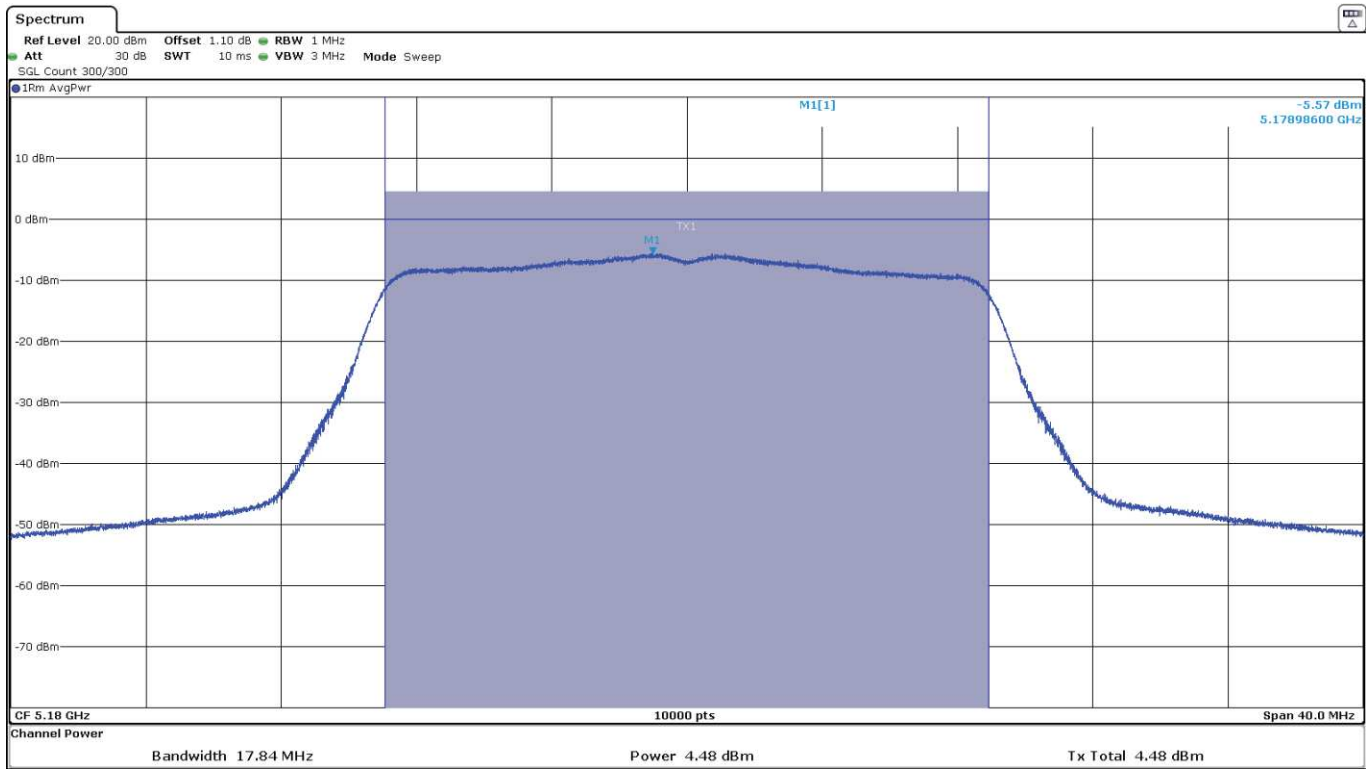
MIMO 802.11 ac20 (VHT20):

- Low Channel 36:

Port 1

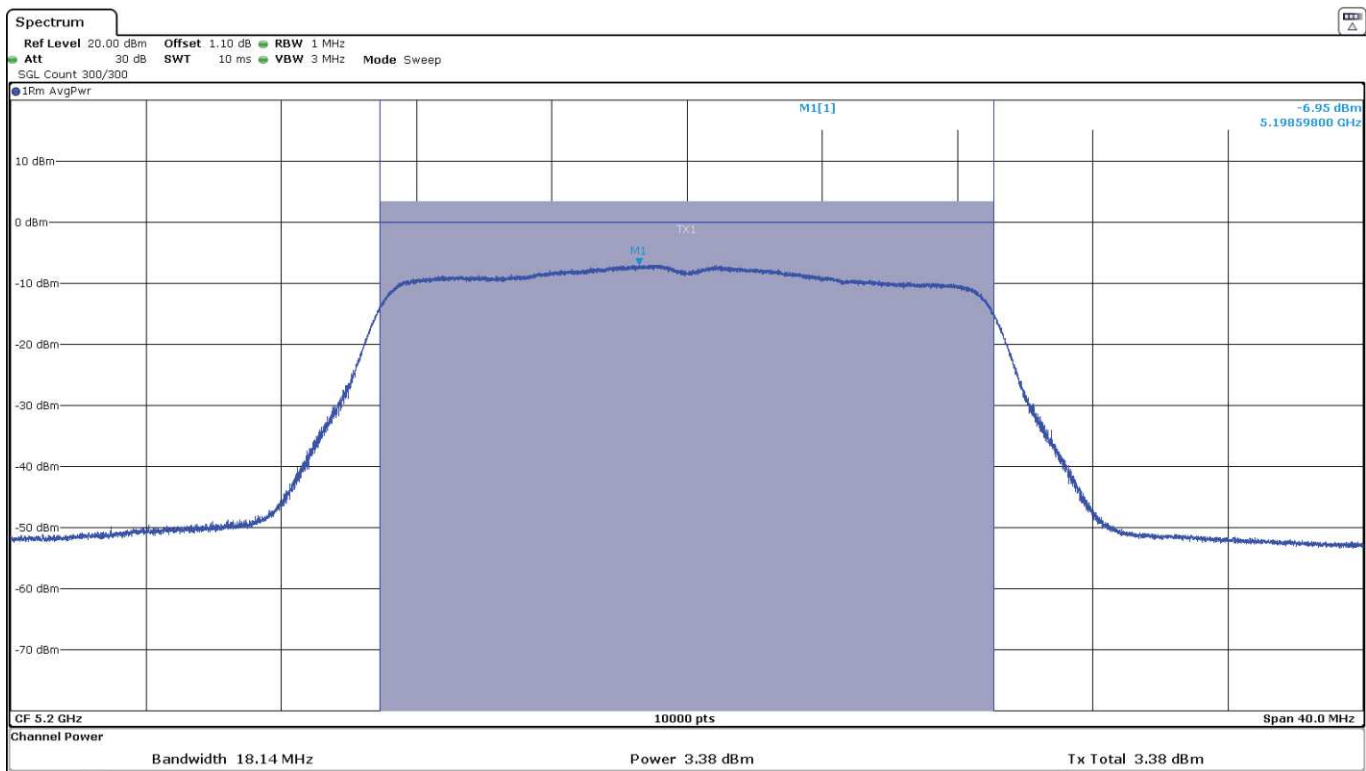


Port 4

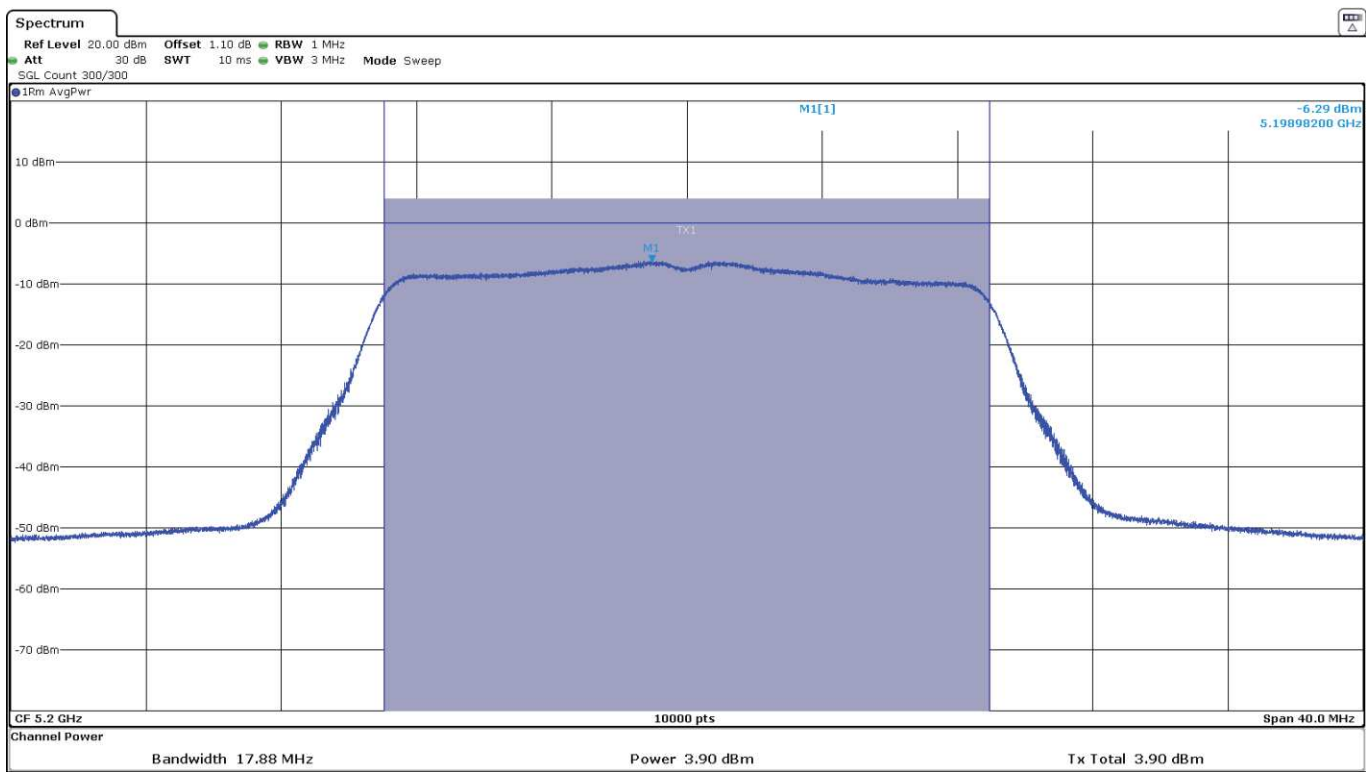


- Middle Channel 40:

Port 1

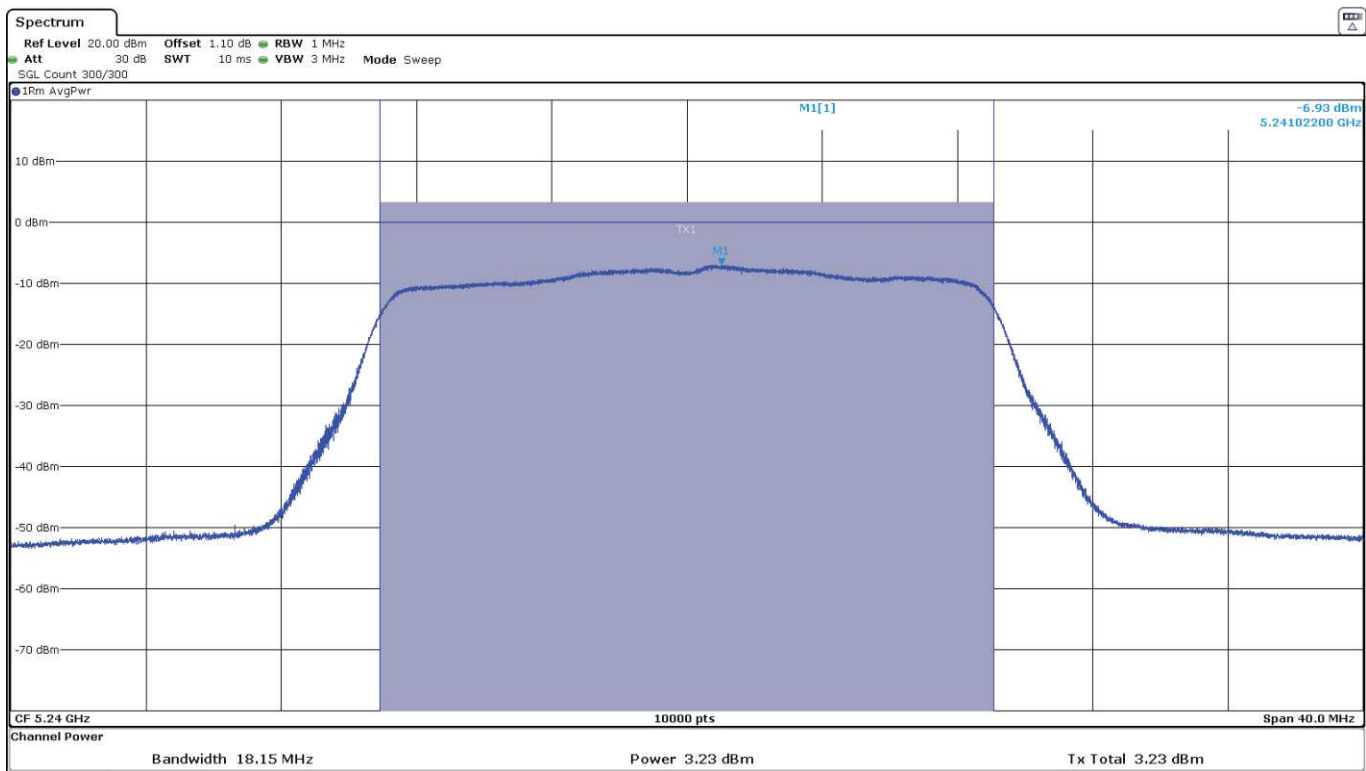


Port 4

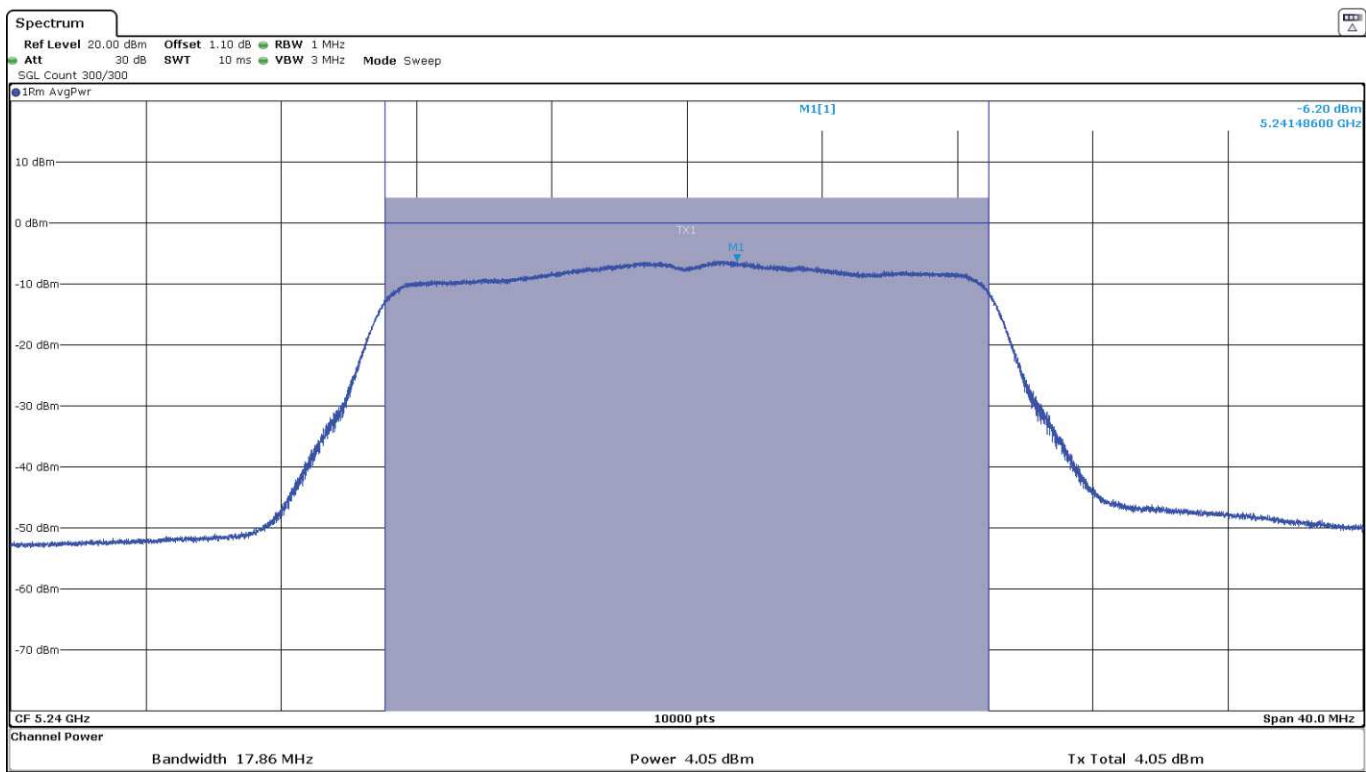


- High Channel 48:

Port 1



Port 4



FCC 15.407 (a)(1)(iv) Transmitter Maximum Power Spectral Density / RSS-247 6.2.1.1. Transmitter EIRP Spectral Density

SPECIFICATION:

FCC 15.407: The maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RSS-247: The e.i.r.p. spectral density shall not exceed 10dBm in any 1.0 MHz band.

RESULTS:

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

The PSD test uses the same setup as the transmitter maximum conducted output power test. The result of the Peak PSD was measured by colocation a marker on the peak of the signal and the results are in the tables below.

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

- Preliminary tests determined the SISO worst case: WLAN1_CORE-0_Port3.
- Preliminary tests determined the MIMO worst case: WLAN0_CORE-MIMO_Port1 & Port4.

Maximum Declared Antenna Gain:

- SISO Antenna – WLAN1_CORE-0_Port3: +0.9 dBi
- MIMO Antennas – WLAN0_CORE-MIMO_Port1 & Port4:
 - Port1: +3.2 dBi
 - Port4: +2.3 dBi

For all modes of operation, the antenna gain is < 6 dBi.