

**Mode: 64QAM – 20MHz**

Declared antenna gain: 6 dBi

	channel 52 5260 MHz	Channel56 5280 MHz	channel 64 5320 MHz
Max. conducted power (dBm)	22.30	21.86	21.72
Conducted Power Limit (dBm)	23.528		
Margin (dB)	1.22	1.66	1.80
Maximum EIRP power (dBm)	28.30	27.86	27.72
EIRP power Limit (dBm)	29.52		
Margin (dB)	1.22	1.66	1.80
Measurement uncertainty (dB)	<±1.20		

**Mode: 256QAM – 20MHz**

Declared antenna gain: 6 dBi

	channel 52 5260 MHz	Channel56 5280 MHz	channel 64 5320 MHz
Max. conducted power (dBm)	22.96	23.51	23.06
Conducted Power Limit (dBm)	23.52		
Margin (dB)	0.56	0.01	0.46
Maximum EIRP power (dBm)	28.96	29.51	29.06
EIRP power Limit (dBm)	29.52		
Margin (dB)	0.56	0.01	0.46
Measurement uncertainty (dB)	<±1.20		

## FCC Section 15.407 Subclause (a) (2) / RSS-247 Clause 6.2.2.1. Transmitter Maximum Power Spectral Density

FCC 15.407: The maximum power spectral density shall not exceed 11 dBm in any 1 megahertz 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.

RSS-247: The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

Within the emission bandwidth, when the peak spectral density per MHz over any continuous transmission exceeds the average ( $10 \log_{10} B$ ) value by more than 3 dB, the permissible power spectral density shall be reduced by the excess amount.

### 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.

**FCC power setting**

**Mode: QSPK – 20MHz**

	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	9.13	9.72	10.01
PSD Limit (dBm/MHz)	11		
Margin (dB)	1.83	1.27	0.98
Measurement uncertainty (dB)	<±1.20		

**Mode: 16QAM – 20MHz**

	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	9.87	10.85	10.97
PSD Limit (dBm/MHz)	11		
Margin (dB)	1.12	0.14	0.02
Measurement uncertainty (dB)	<±1.20		

**Mode: 64QAM – 20MHz**

	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	10.41	10.77	10.63
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.58	0.22	0.36
Measurement uncertainty (dB)	<±1.20		

**Mode: 256QAM – 20MHz**

	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	10.23	10.74	10.73
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.77	0.26	0.27
Measurement uncertainty (dB)	<±1.20		

**Canada power setting**

**Mode: QSPK – 20MHz**

	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	10.78	10.53	10.40
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.22	0.47	0.60
Measurement uncertainty (dB)	<±1.20		

**Mode: 16QAM – 20MHz**

	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	9.99	9.88	9.80
PSD Limit (dBm/MHz)	11		
Margin (dB)	1.01	1.12	1.20
Measurement uncertainty (dB)	<±1.20		

**Mode: 64QAM – 20MHz**

	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	10.66	10.34	10.22
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.34	0.66	0.78
Measurement uncertainty (dB)	<±1.20		

**Mode: 256QAM – 20MHz**

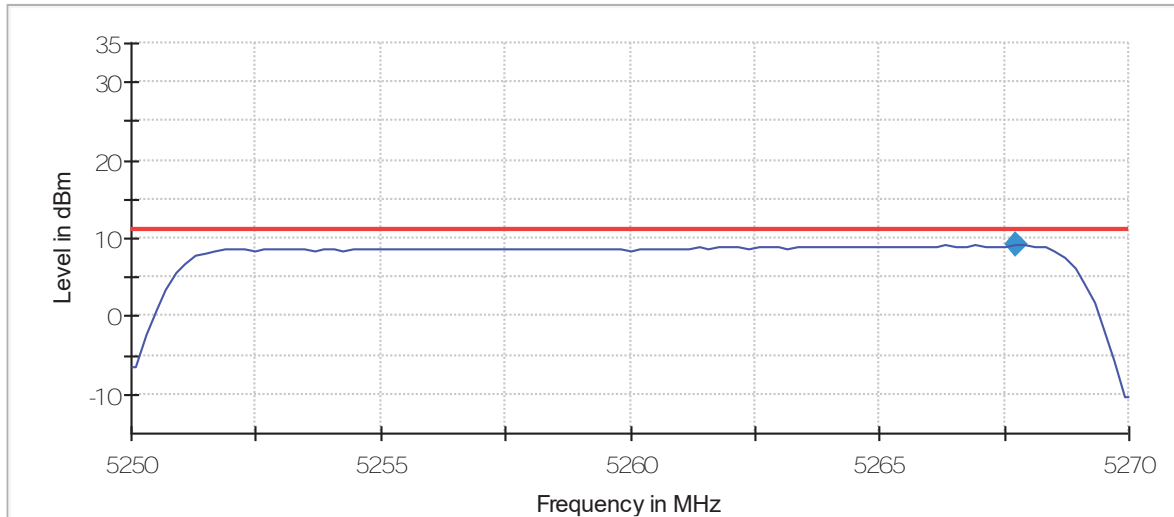
	channel 52 5260 MHz	channel 56 5280 MHz	channel 64 5320 MHz
PSD (dBm/MHz)	10.23	10.74	10.73
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.77	0.26	0.27
Measurement uncertainty (dB)	<±1.20		

### FCC Power Setting

Mode: QSPK – 20MHz

Channel 52

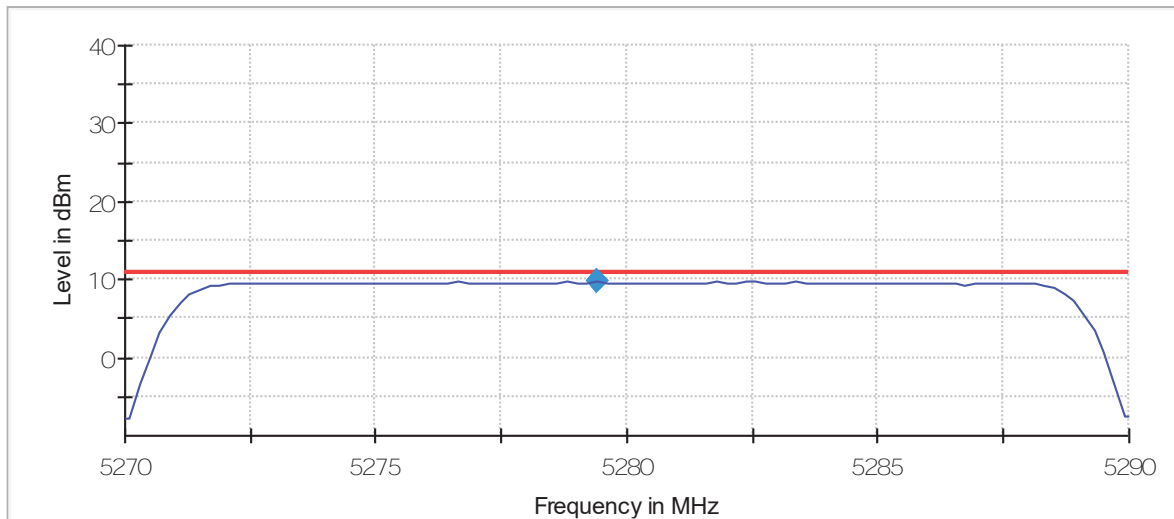
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 56

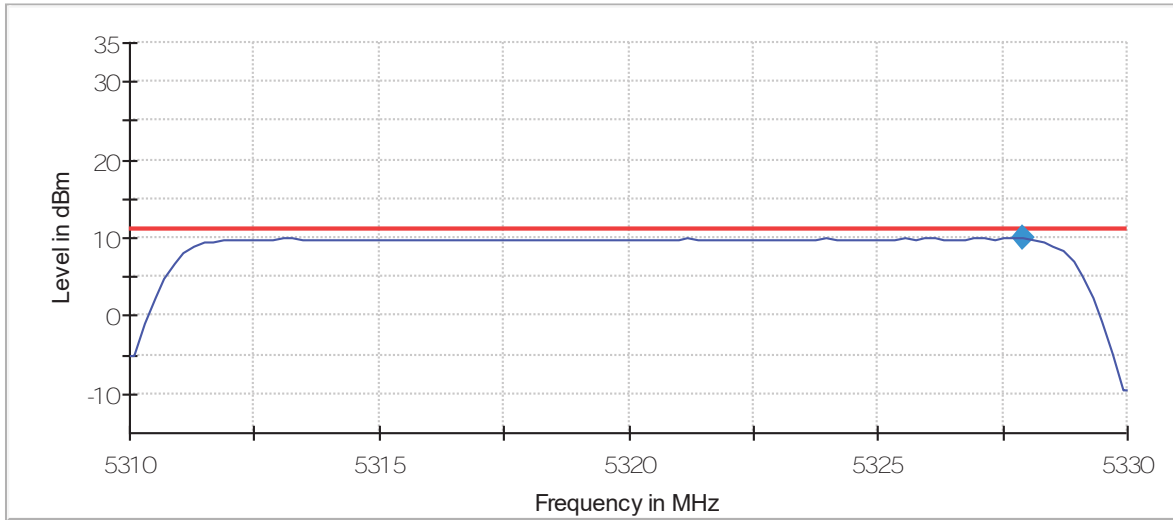
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 64

Power Spectral Density (SA-1)

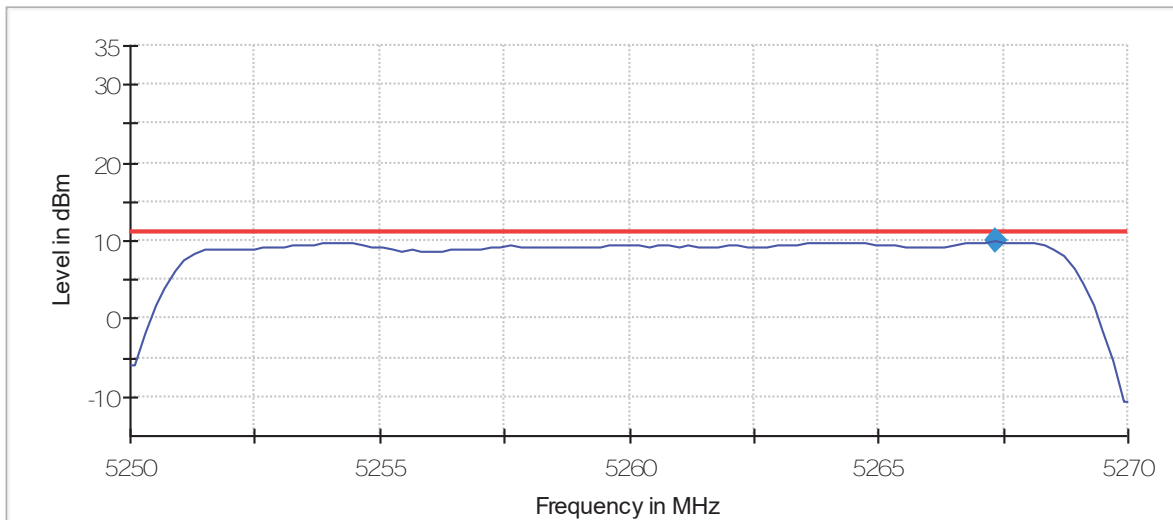


— Li.m    ◆ PSD    — S.m Level

Mode: 16QAM – 20MHz

Channel 52

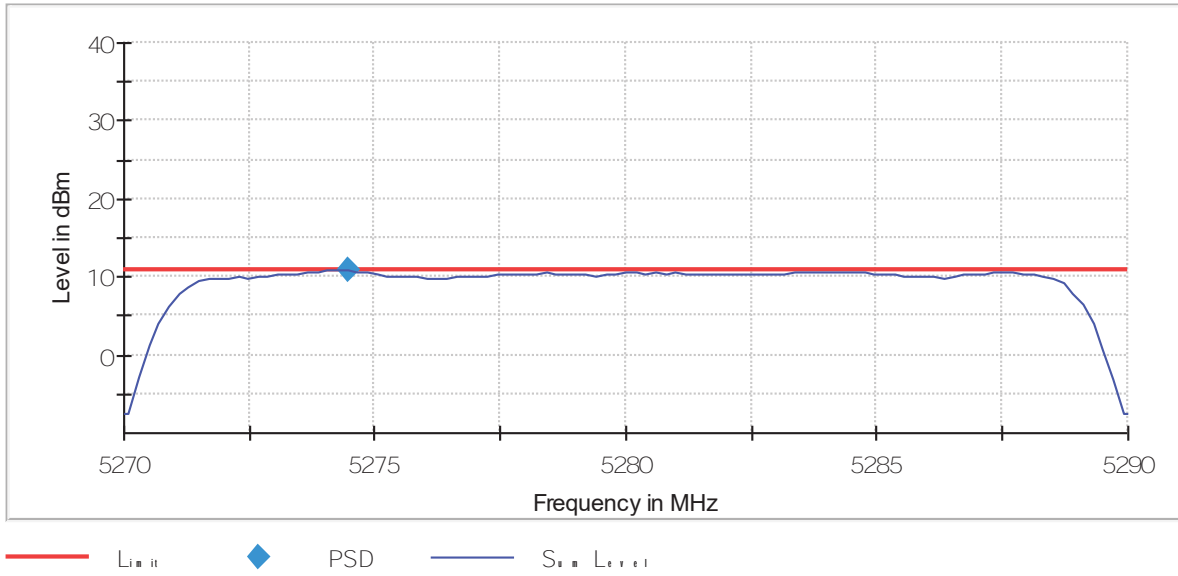
Power Spectral Density (SA-1)



— Li.m    ◆ PSD    — S.m Level

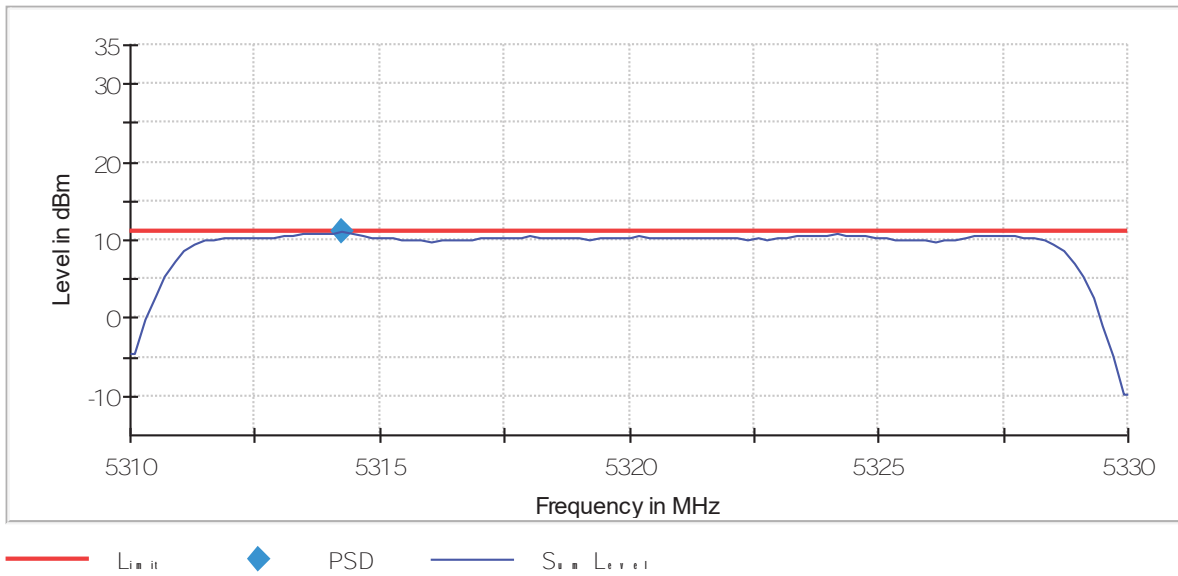
Channel 56

Power Spectral Density (SA-1)



Channel 64

Power Spectral Density (SA-1)

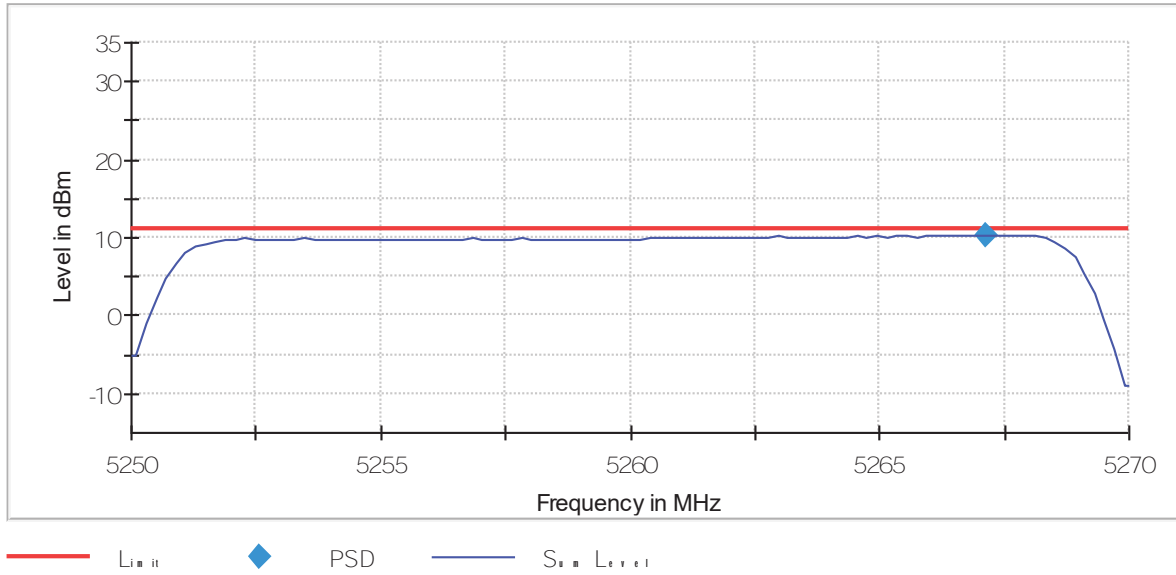




**Mode: 64QAM – 20MHz**

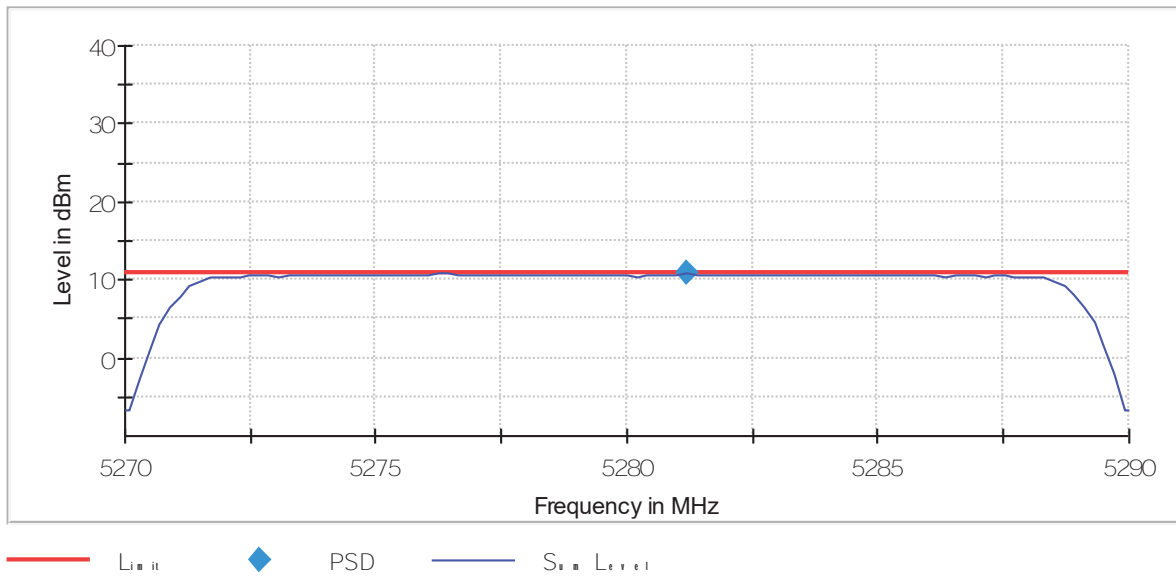
Channel 52

Power Spectral Density (SA-1)



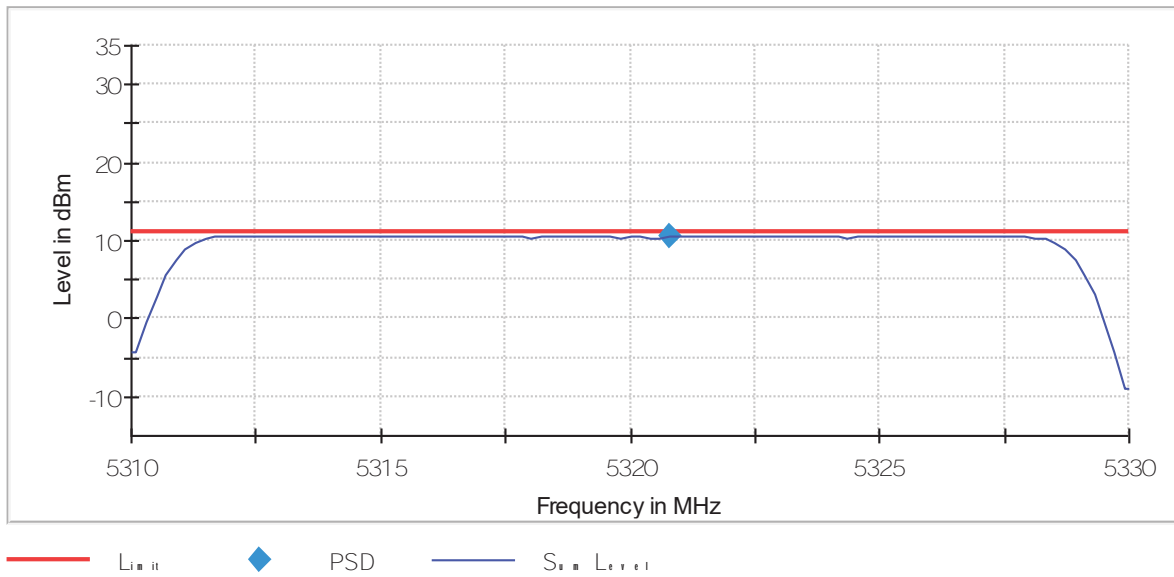
Channel 56

Power Spectral Density (SA-1)



Channel 64

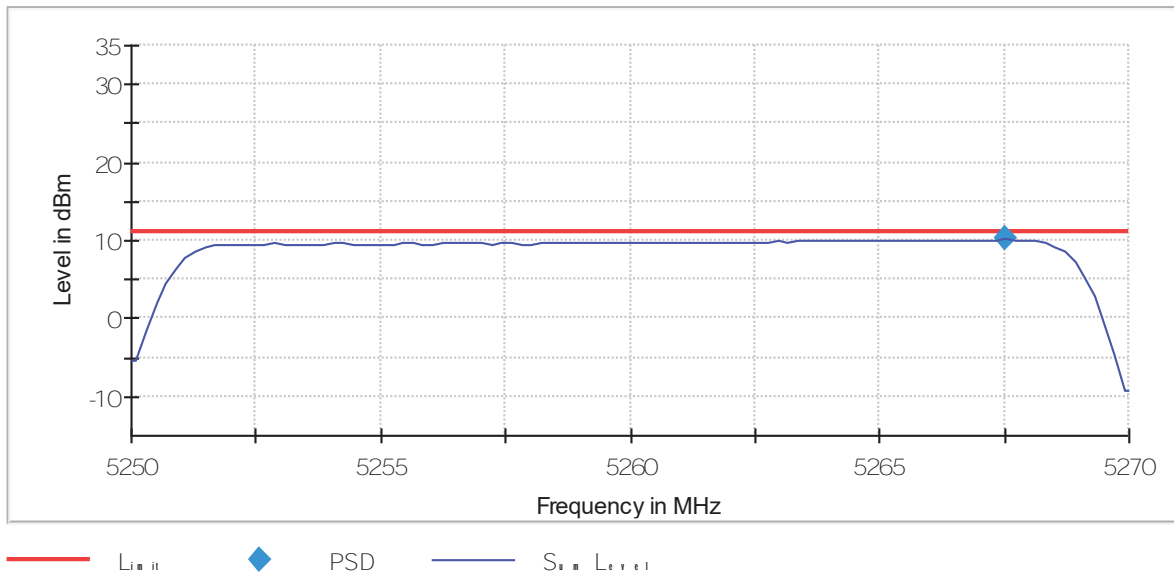
Power Spectral Density (SA-1)



Mode: 256QAM – 20MHz

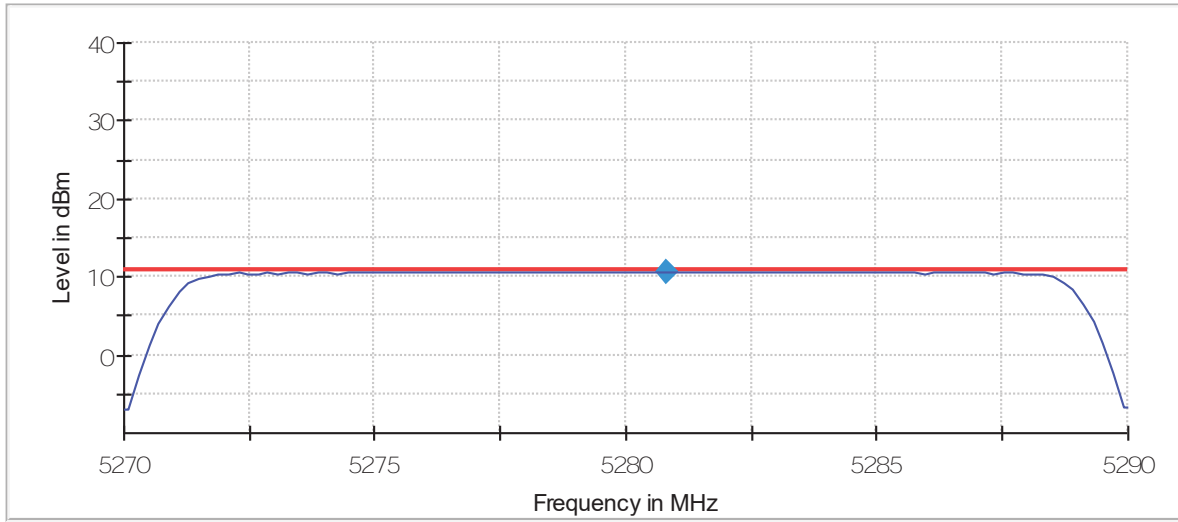
Channel 52

Power Spectral Density (SA-1)



Channel 56

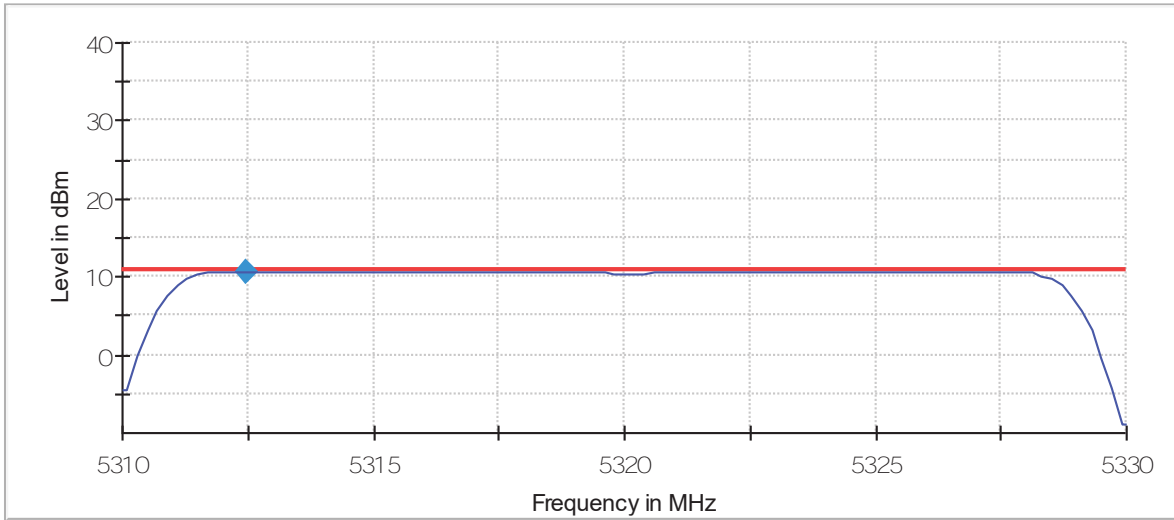
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 64

Power Spectral Density (SA-1)

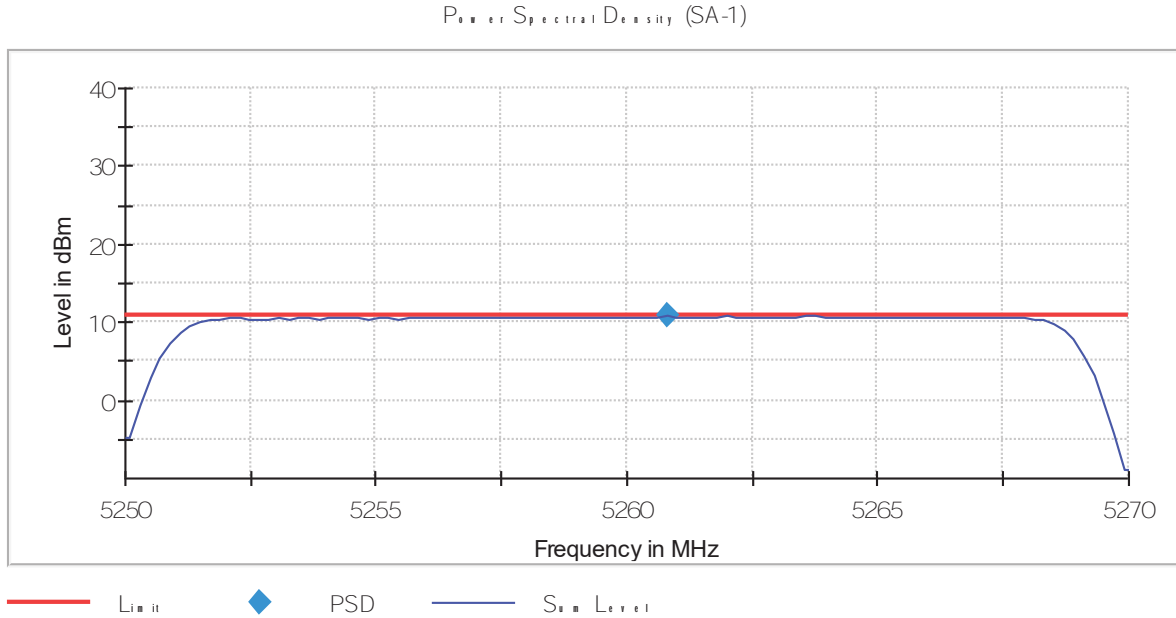


— Limit    ◆ PSD    — Signal Level

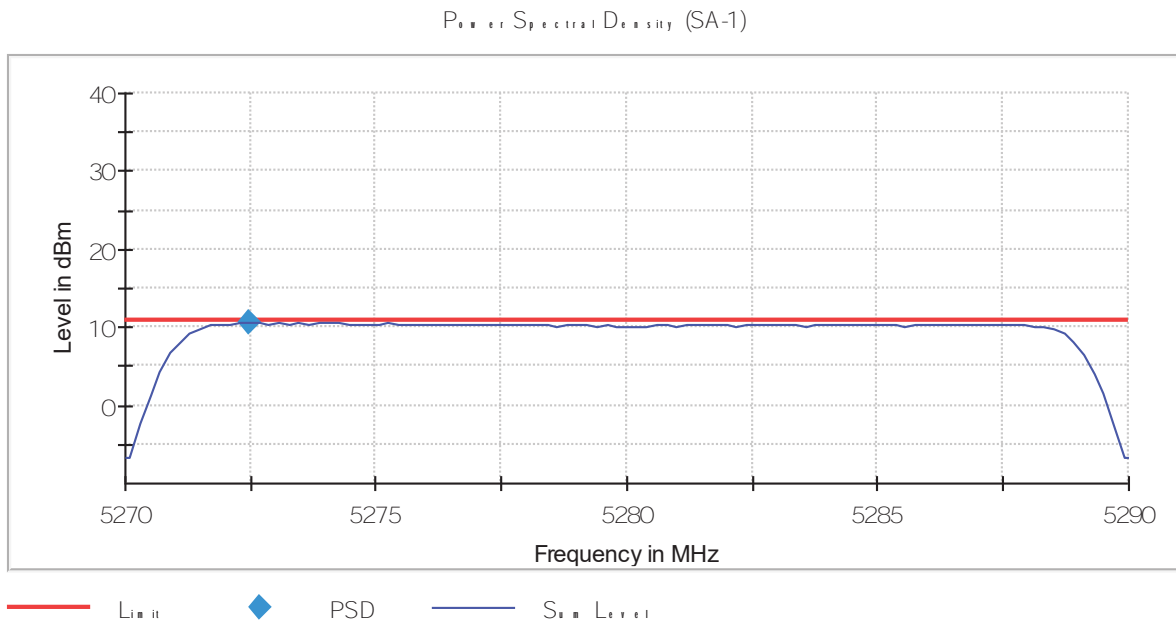
### Canada power setting

Mode: QSPK – 20MHz

Channel 52

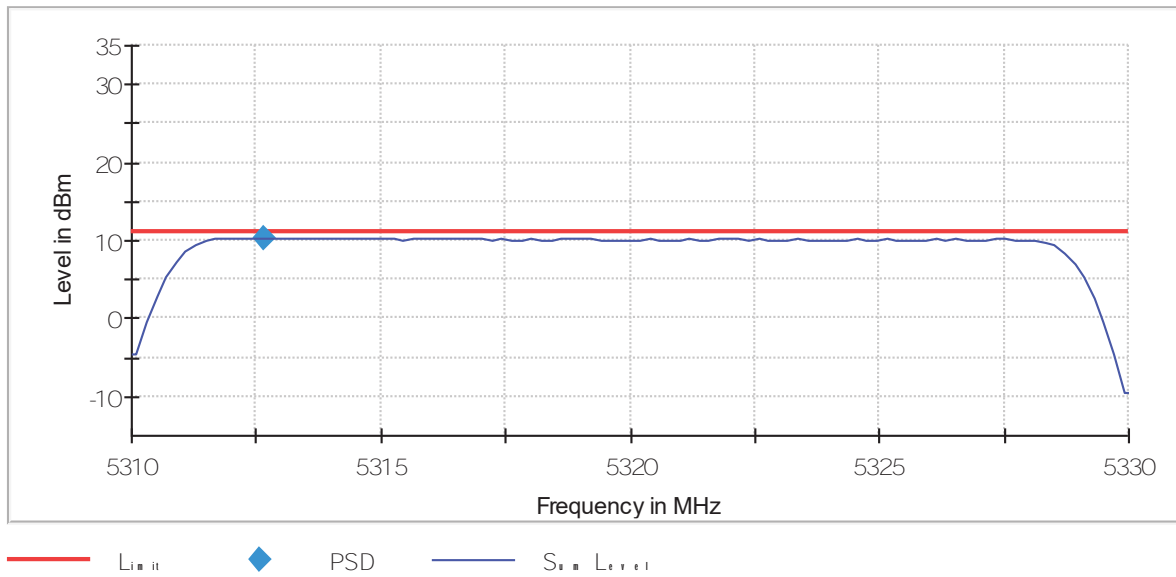


Channel 56



Channel 64

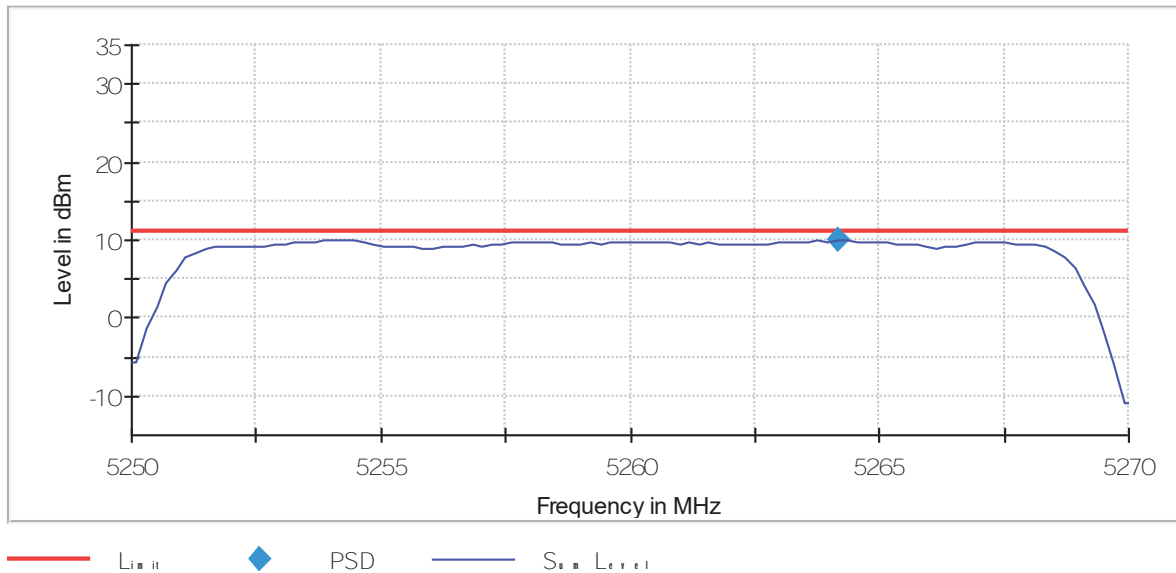
Power Spectral Density (SA-1)



Mode: 16QAM – 20MHz

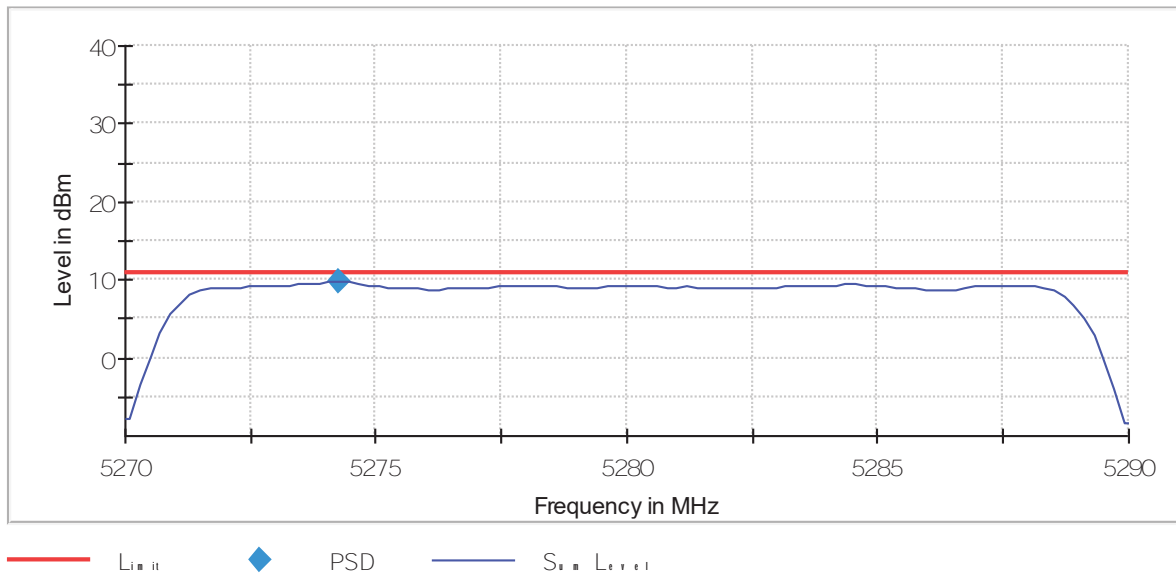
Channel 52

Power Spectral Density (SA-1)



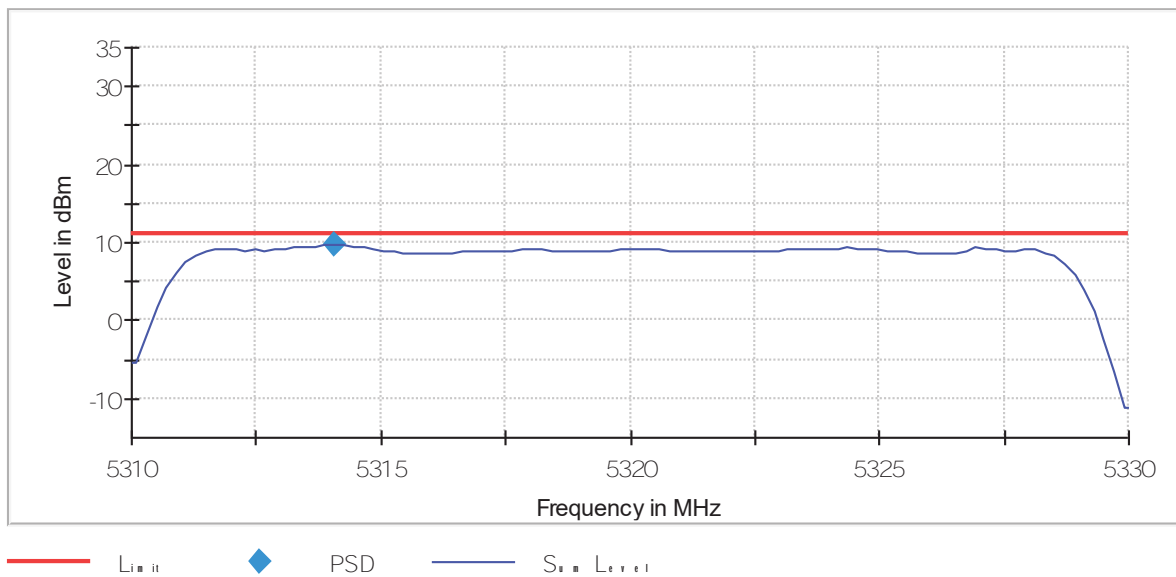
Channel 56

Power Spectral Density (SA-1)



Channel 64

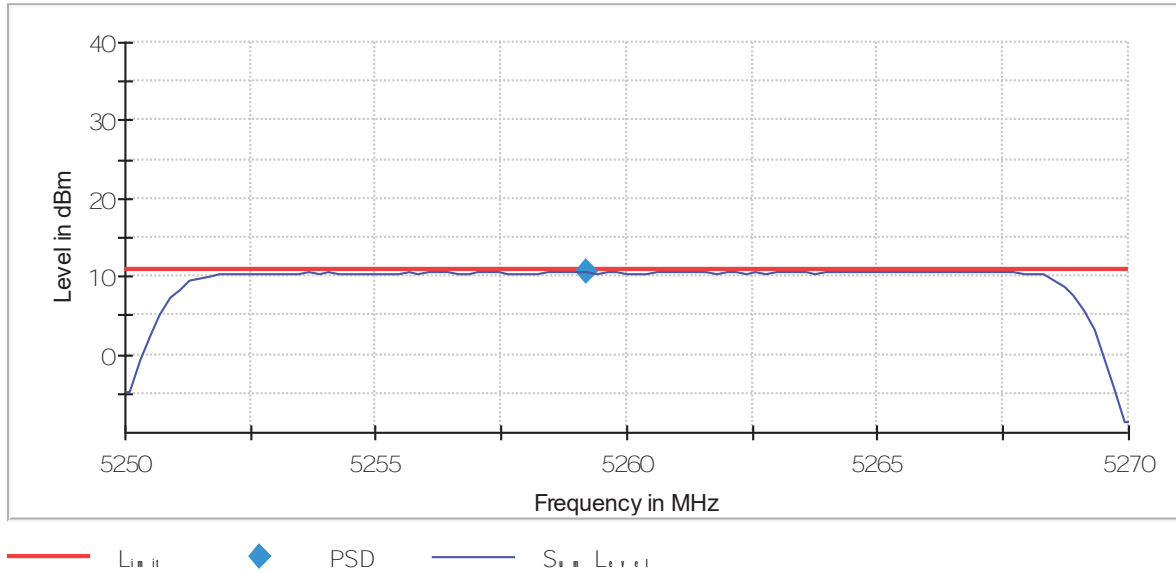
Power Spectral Density (SA-1)



### Mode: 64QAM – 20MHz

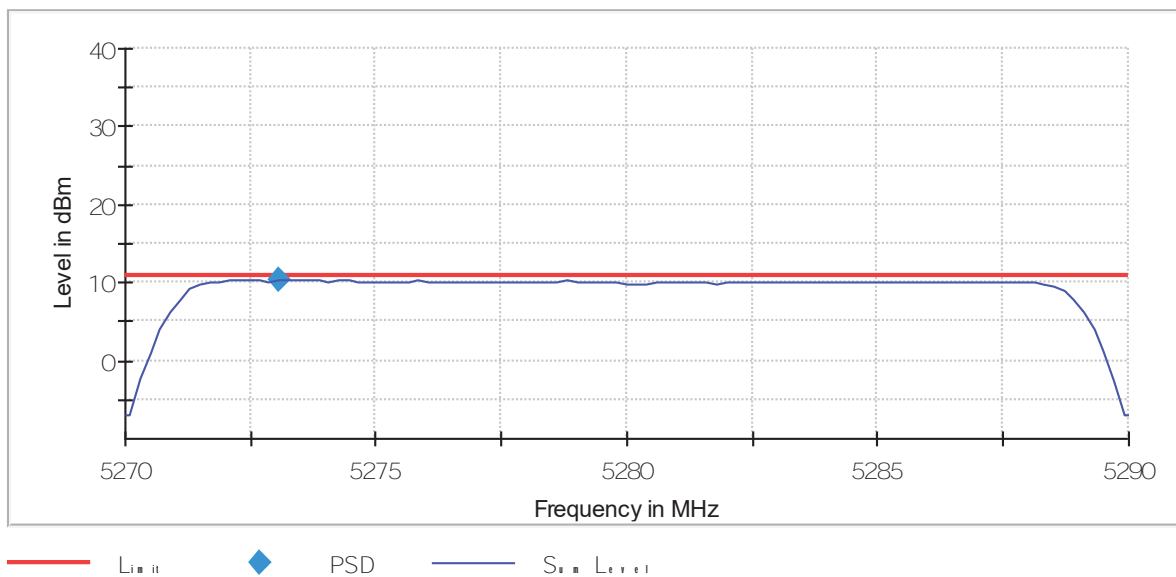
Channel 52

Power Spectral Density (SA-1)



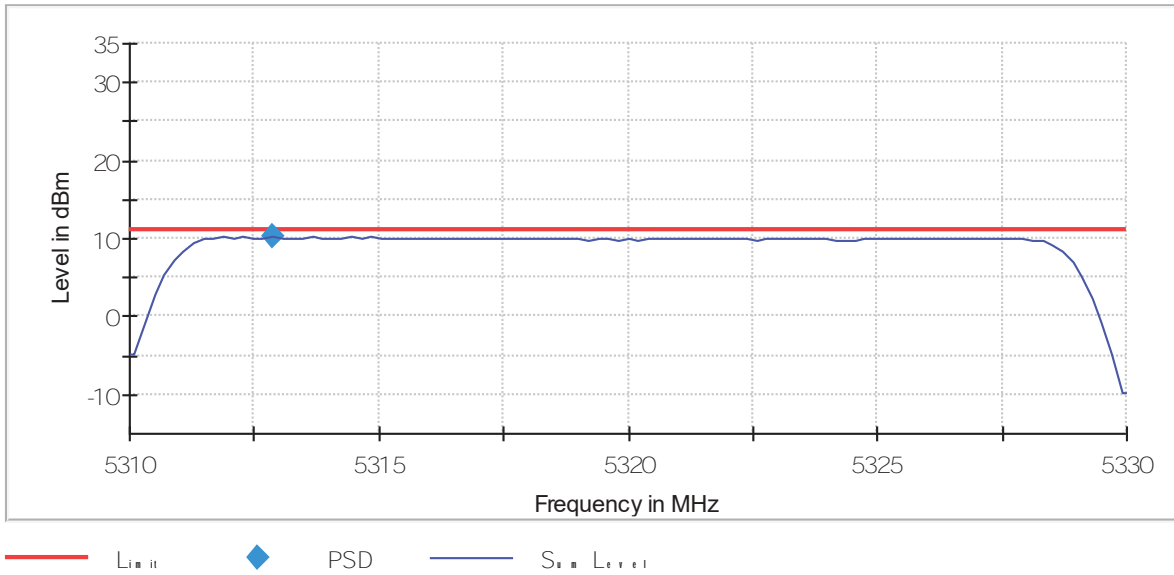
Channel 56

Power Spectral Density (SA-1)



Channel 64

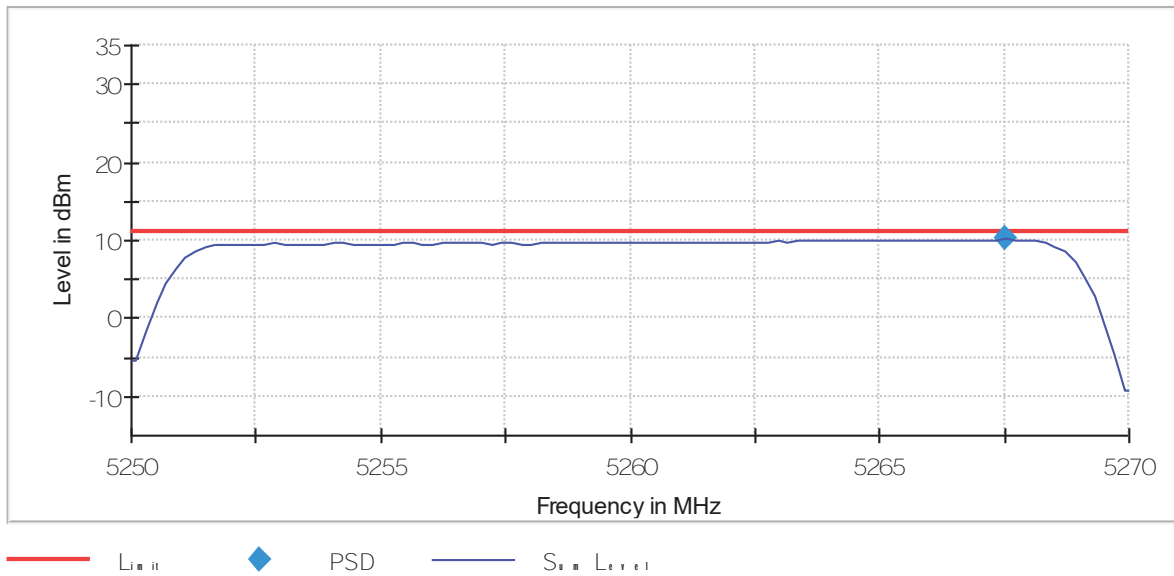
Power Spectral Density (SA-1)



Mode: 256QAM – 20MHz

Channel 52

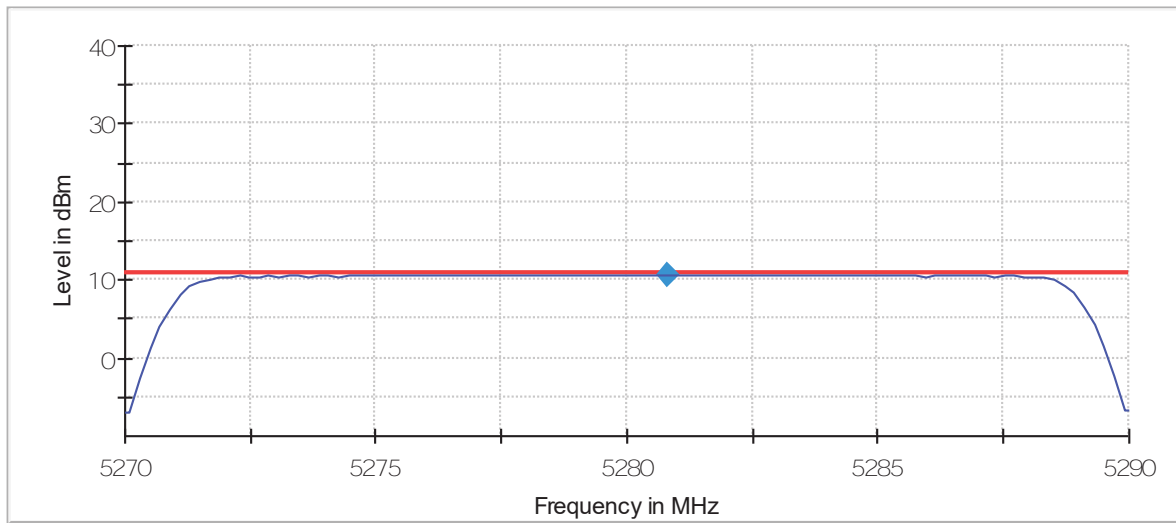
Power Spectral Density (SA-1)





Channel 56

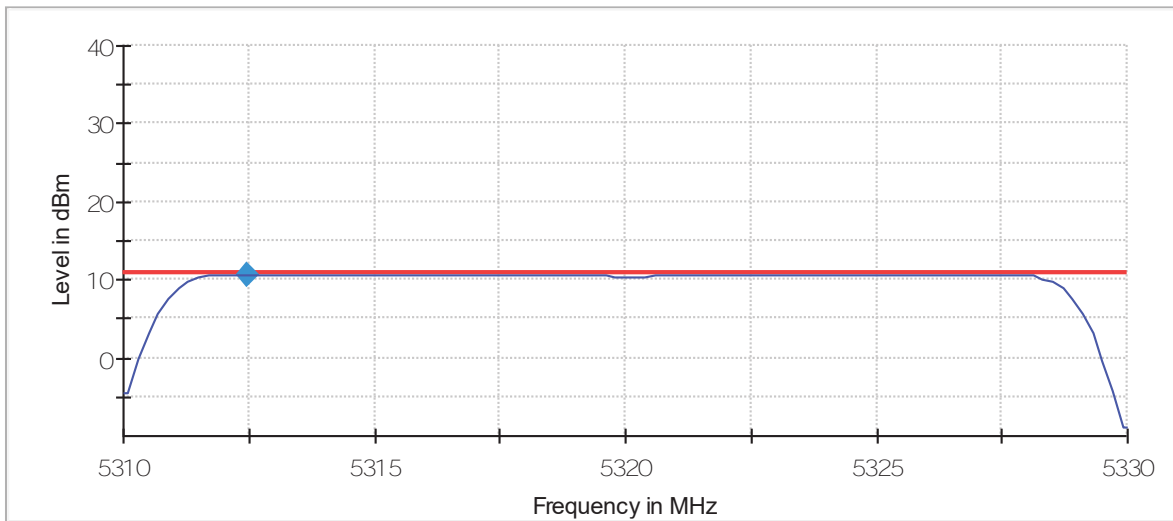
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 64

Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

## FCC Section 15.407(b)(2)(6) /RSS-247 6.2.2.2. Transmitter Out of Band Radiated Emissions

### SPECIFICATION

For transmitters operating in the 5.25–5.35 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.23 dBμV/m at 3 m distance).

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 40000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

### RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-40 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Test performed on the following worst case of modulation QPSK.

**Mode QPSK:**

**Frequency range 30 MHz-1000 MHz.**

Note: The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
37.6145	Vertical	Quasi-Peak	17.22	40.0	22.78	± 4.99
533.6240	Vertical	Quasi-Peak	28.29	46.0	17.71	± 4.99
930.8390	Horizontal	Quasi-Peak	33.13	46.0	12.87	± 4.99

**Frequency range 1 GHz-40 GHz**

**Channel 52:**

No spurious were found at less than 20 dB below the limit inside restricted bands.

**Channel 56:**

No spurious were found at less than 20 dB below the limit inside restricted bands.

**Channel 64:**

No spurious were found at less than 20 dB below the limit inside restricted bands.

Measurement Uncertainty (dB): 1GHz to 17GHz <± 4.98

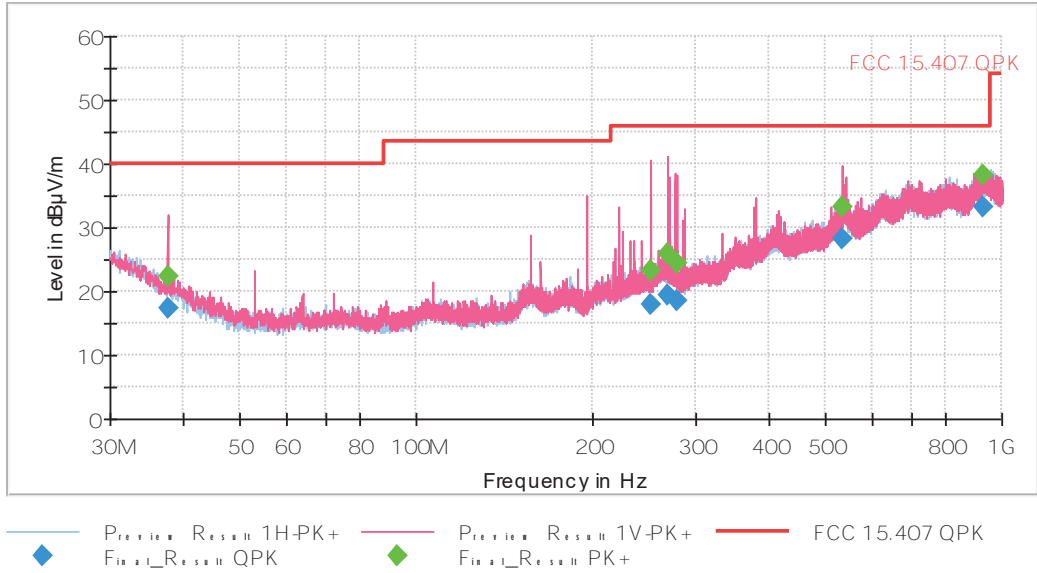
17GHz to 26.5GHz <± 5.08

26.5GHz to 40GHz <± 5.33

Verdict: PASS

**FREQUENCY RANGE 30 MHz-1000 MHz.**

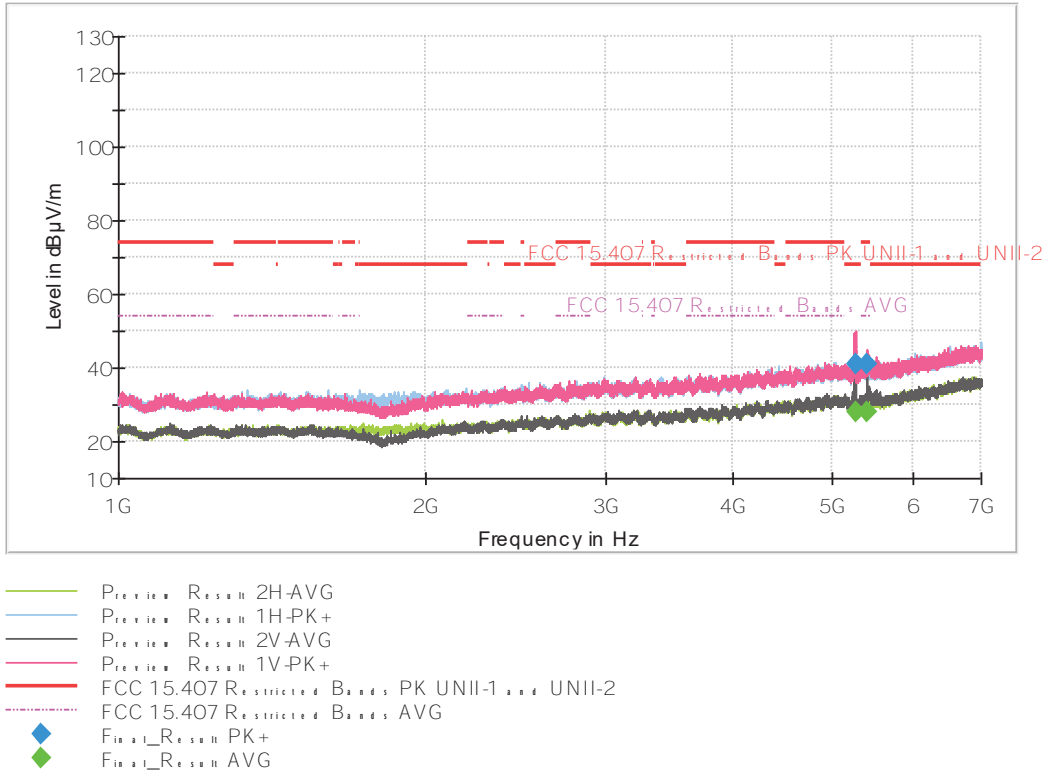
This plot is valid for all channels.



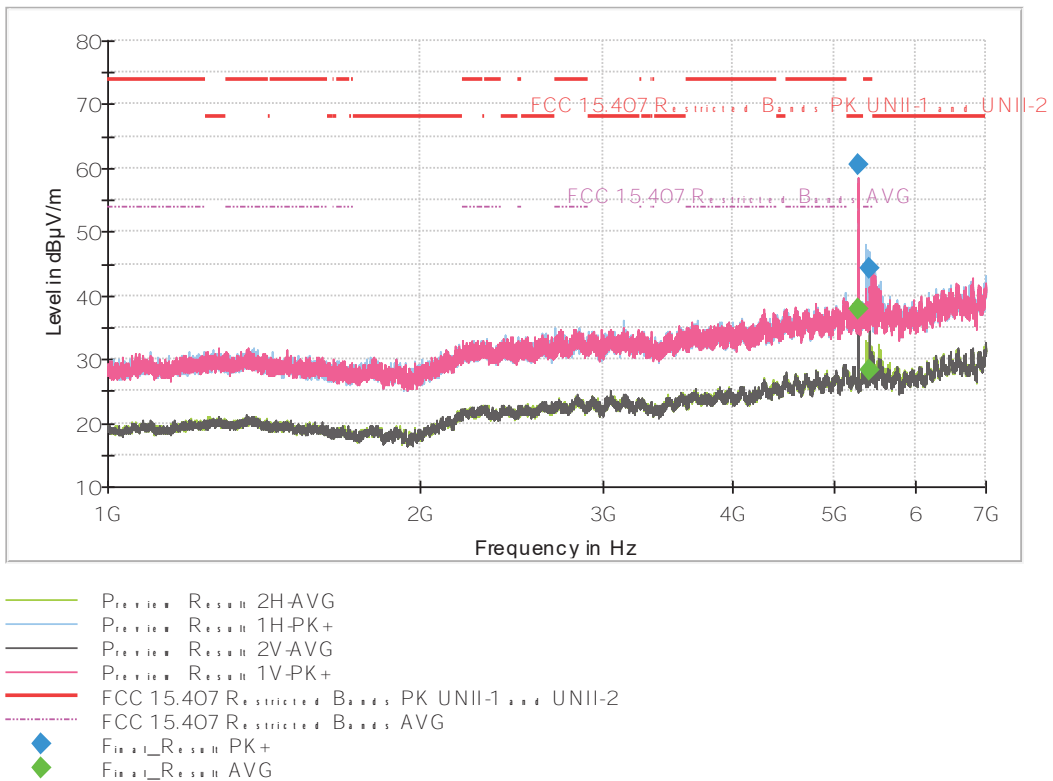
**FREQUENCY RANGE 1 GHz to 7 GHz.**

**Mode QPSK:**

**Channel 52**

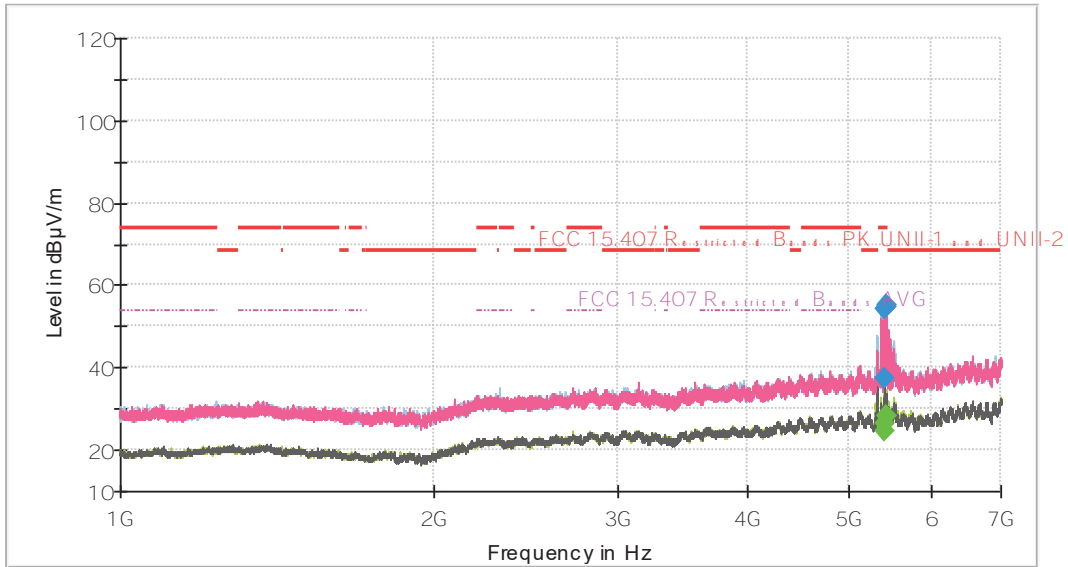


**Channel 56**



Note: The peak shown in the plot above the limit is the carrier frequency.

Channel 64



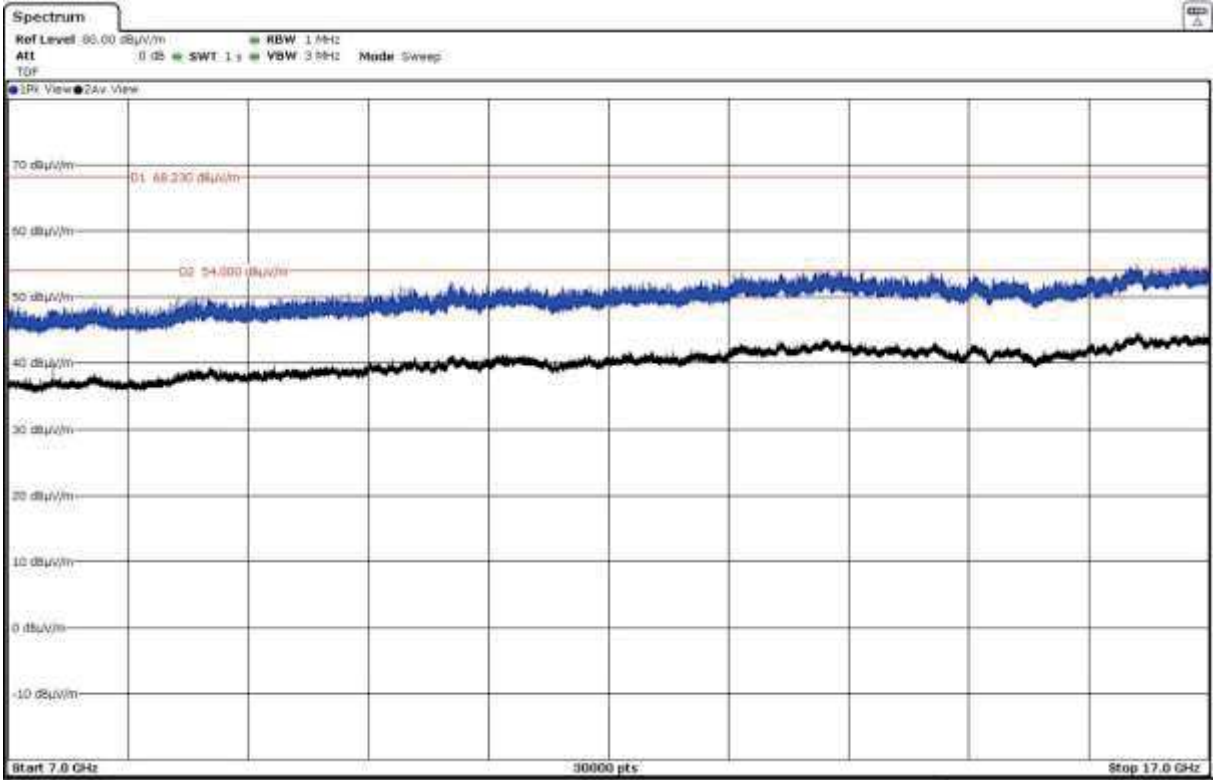
- Preview Result 2H-AVG
- Preview Result 1H-PK+
- Preview Result 2V-AVG
- Preview Result 1V-PK+
- FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
- FCC 15.407 Restricted Bands AVG
- Final Result PK+
- Final Result AVG

Note: The peak shown in the plot above the limit is the carrier frequency.

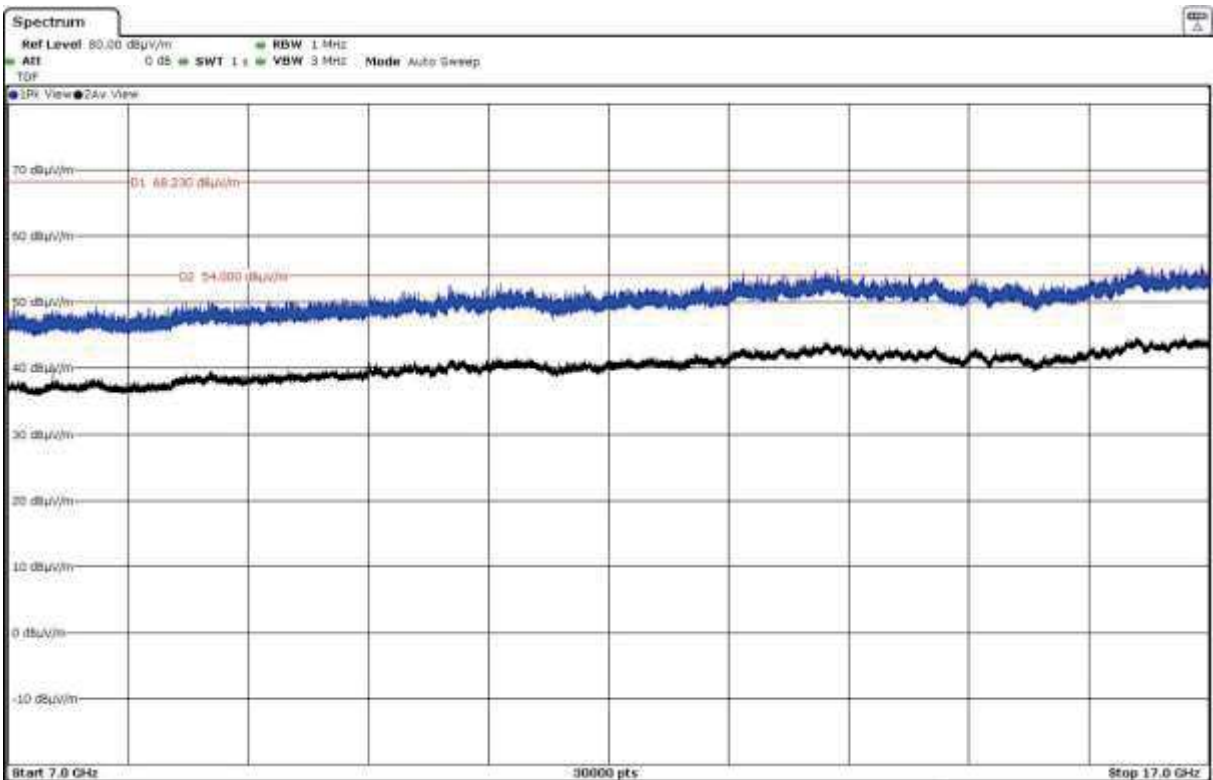
**FREQUENCY RANGE 7 GHz to 17 GHz.**

**Mode QPSK:**

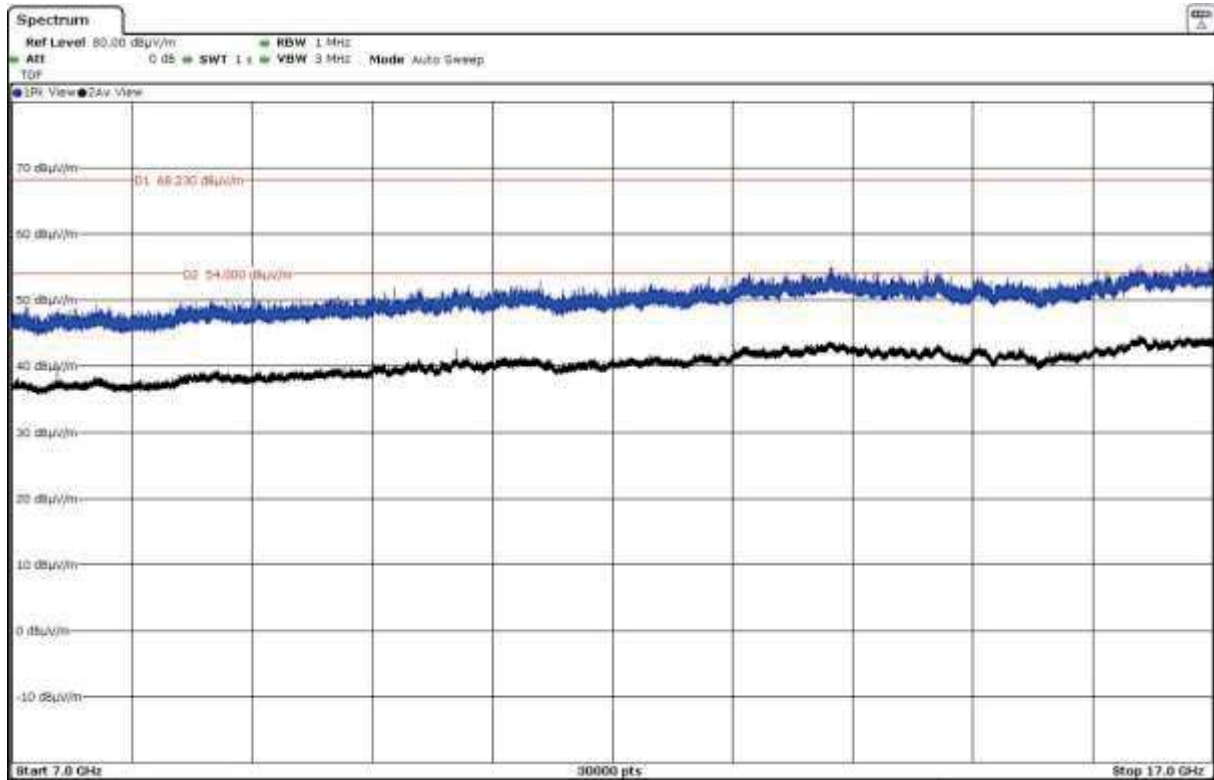
**Channel 52**



**Channel 56**



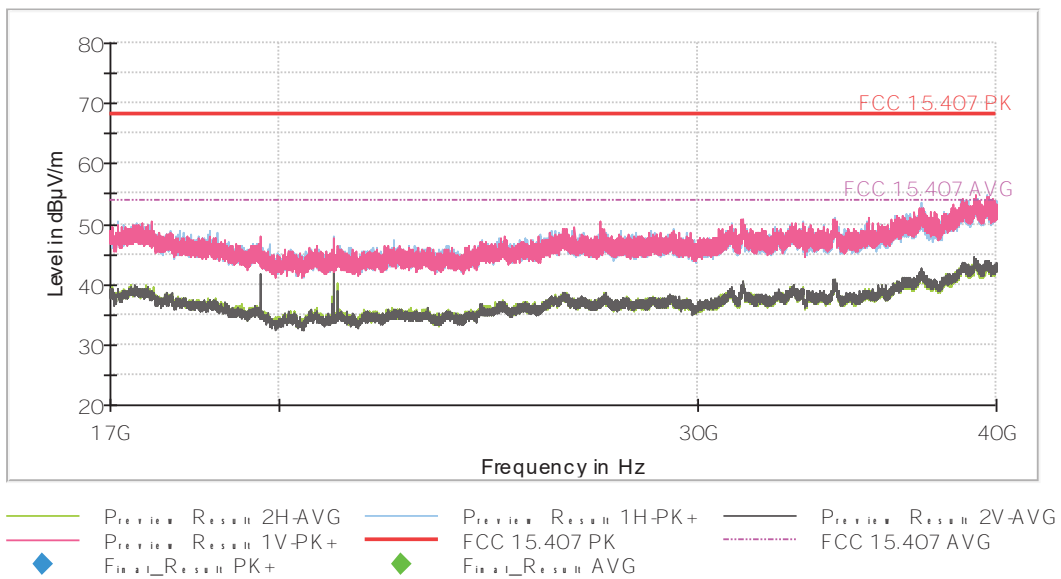
**Channel 64**



**FREQUENCY RANGE 17 GHz to 40 GHz.**

**Mode QPSK:**

This plot is valid for all channels. Spurious founded do not depend the operating channel





## FCC Section 15.407 Subclause (b) (2) / RSS-247 6.2.2.2. Transmitter Band Edge Radiated Emissions.

### SPECIFICATION

For transmitters operating in the 5.25–5.35 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.20 dBµV/m at 3 m distance).

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 40000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

### RESULTS:

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

All emissions outside of the 5.15-5.35GHz band shall not exceed an EIRP of -27dBm/MHz. There are restricted bands of operation below band edge at 4.5-5.15 GHz also above the upper band edge at 5.35-5.46GHz therefore the provision of FCC Part 15.205 apply.

Field strength measurements using peak and average detector were performed in the restricted bands below 5.15GHz and above 5.35 GHz.

Test performed on the following worst cases modes in all relevant tests channels:

**Results for Mode: QPSK**

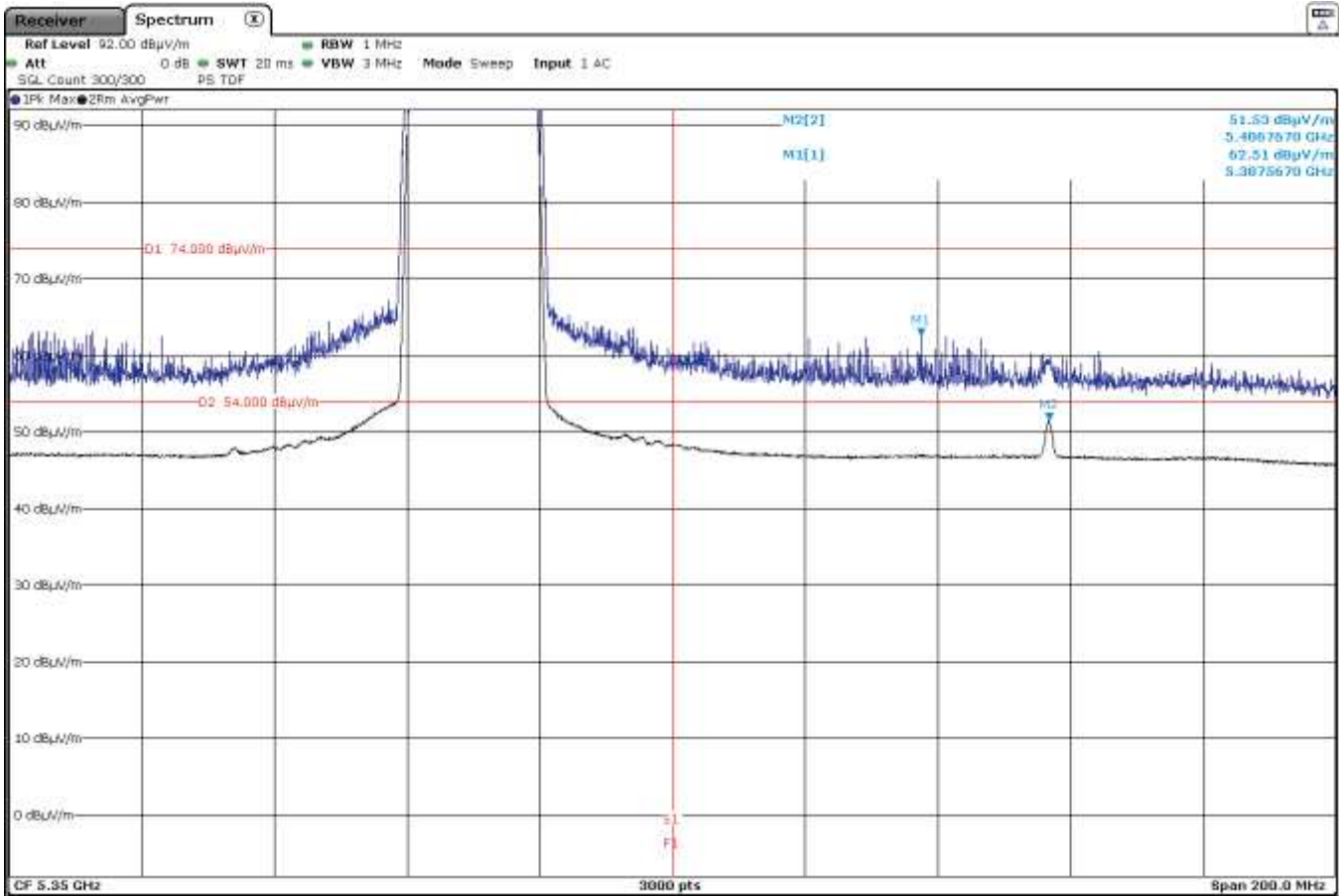
**Results: Peak / Channel 64**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5387.5670	Horizontal	62.51	74	11.49	<± 3.98	PASS

**Results: Average / Channel 64**

Frequency (MHz)	Antenna Polarity	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5406.7670	Horizontal	51.53	54	2.47	<± 3.98	PASS

### 5350 MHz to 5460 MHz Upper Band Edge Channel 64



**Results for Mode: 16QAM**

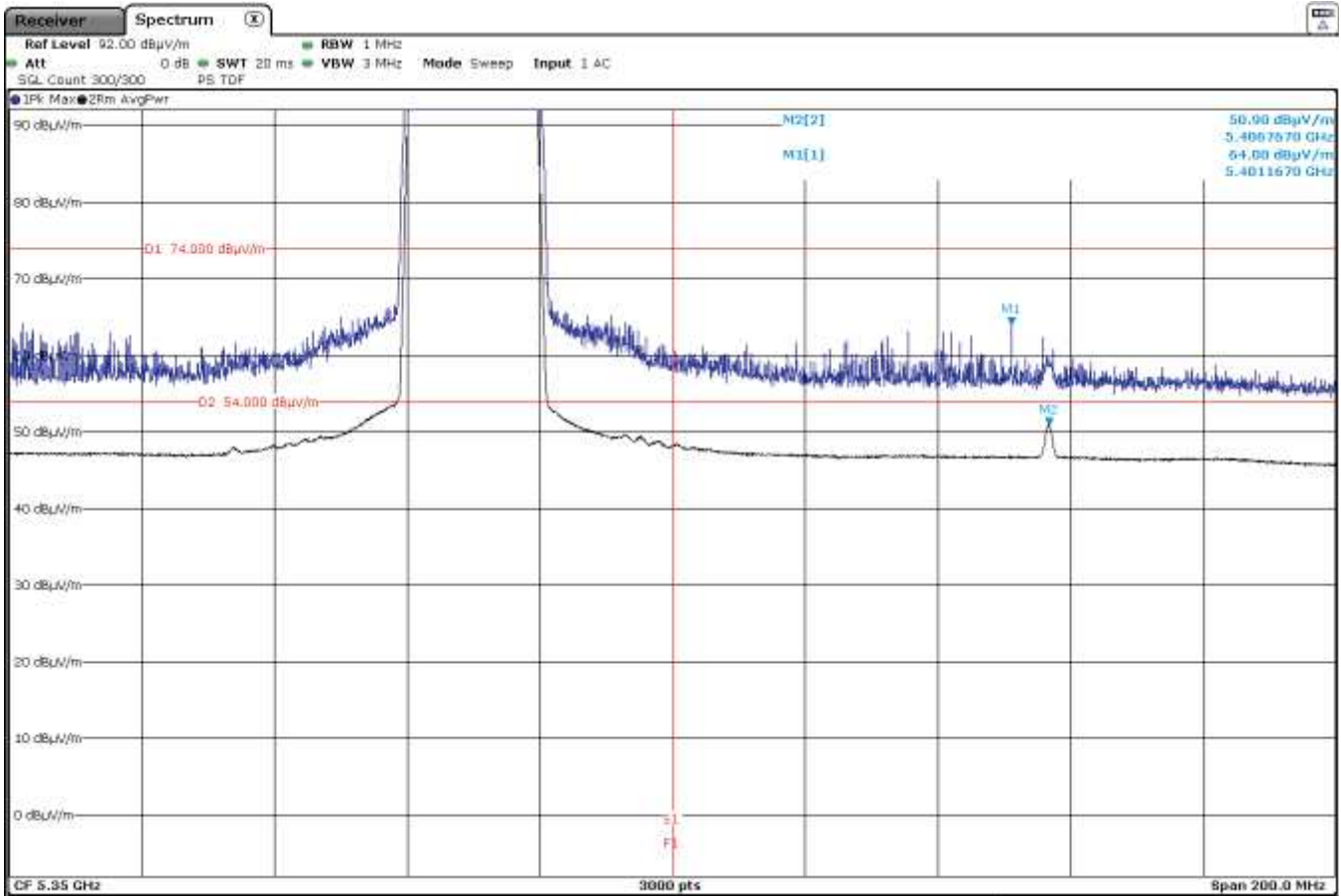
**Results: Peak / Channel 64**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5401.1670	Horizontal	64	74	10	<± 3.98	PASS

**Results: Average / Channel 64**

Frequency (MHz)	Antenna Polarity	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5406.7670	Horizontal	50.90	54	3.10	<± 3.98	PASS

### 5350 MHz to 5460 MHz Upper Band Edge Channel 64



**Results for Mode: 64QAM**

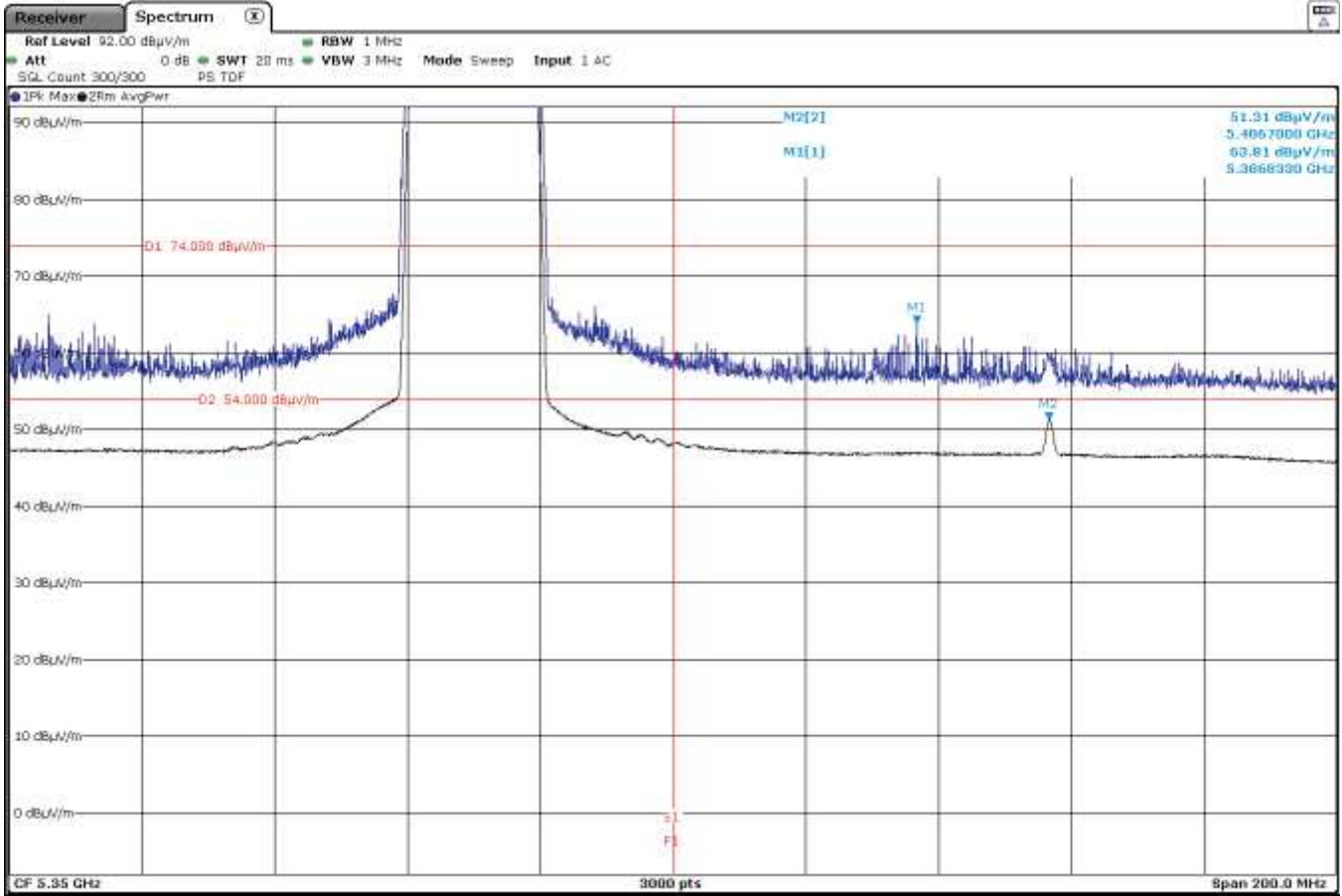
**Results: Peak / Channel 64**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5386.8330	Horizontal	63.81	74	10.19	<± 3.98	PASS

**Results: Average / Channel 64**

Frequency (MHz)	Antenna Polarity	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5406.7000	Horizontal	51.31	54	2.69	<± 3.98	PASS

### 5350 MHz to 5460 MHz Upper Band Edge Channel 64



**Results for Mode: 256QAM**

**Results: Peak / Channel 64**

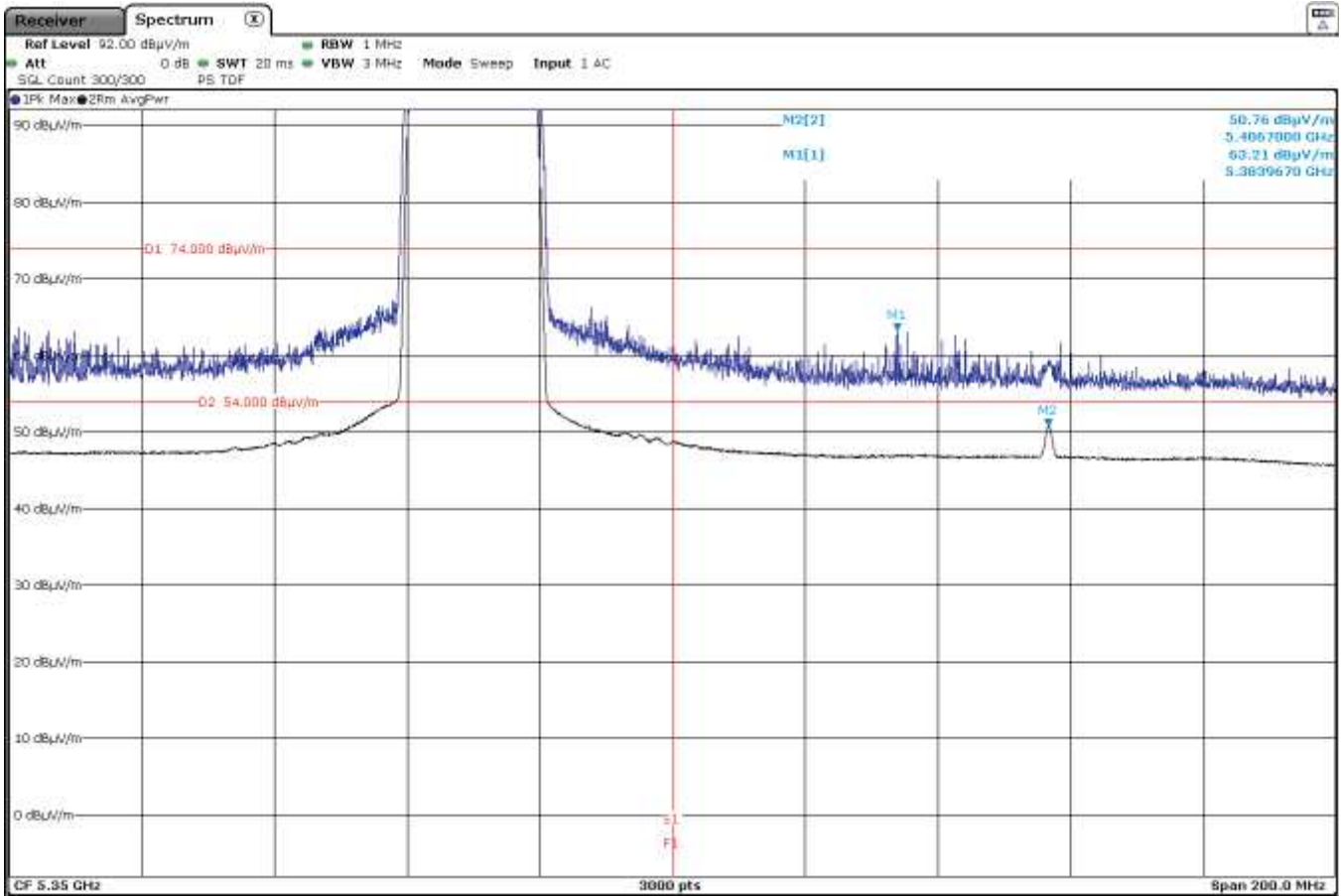
Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5383.9670	Horizontal	63.21	74	10.79	<± 3.98	PASS

**Results: Average / Channel 64**

Frequency (MHz)	Antenna Polarity	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5406.7000	Horizontal	50.76	54	3.24	<± 3.98	PASS



### 5350 MHz to 5460 MHz Upper Band Edge Channel 64



## FCC Section 15.407(h)(1) / RSS-247 6.2.2.1 Transmitter Power Control

### **SPECIFICATION**

FCC 15.407/RSS247: Transmit power control (TPC). U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW (27dBm).

### **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%.

In the measure-and-sum approach for MIMO mode, the conducted emission level (*e.g.*, transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units (mW—not dBm).

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

**FCC and Canada power setting**

**Mode: QPSK – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 52 5260 MHz	Channel56 5280 MHz	channel 64 5320 MHz
Max. conducted power (dBm)	17.31	16.90	17.37
Maximum EIRP power (dBm)	23.31	22.90	23.37
EIRP power Limit (dBm)	24		
Margin (dB)	0.69	1.1	0.63
Measurement uncertainty (dB)	<±1.20		

**Mode: 16QAM – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 52 5260 MHz	Channel56 5280 MHz	channel 64 5320 MHz
Max. conducted power (dBm)	17.32	17.52	17.32
Maximum EIRP power (dBm)	23.32	23.52	23.32
EIRP power Limit (dBm)	24		
Margin (dB)	0.68	0.48	0.68
Measurement uncertainty (dB)	<±1.20		

**Mode: 64QAM – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 52 5260 MHz	Channel56 5280 MHz	channel 64 5320 MHz
Max. conducted power (dBm)	17.24	17.24	17.63
Maximum EIRP power (dBm)	23.24	23.24	23.63
EIRP power Limit (dBm)	24		
Margin (dB)	0.76	0.76	0.37
Measurement uncertainty (dB)	<±1.20		

**Mode: 256QAM – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 52 5260 MHz	Channel56 5280 MHz	channel 64 5320 MHz
Max. conducted power (dBm)	17.34	17.50	16.86
Maximum EIRP power (dBm)	23.34	23.50	22.86
EIRP power Limit (dBm)	24		
Margin (dB)	0.66	0.50	1.14
Measurement uncertainty (dB)	<±1.20		

## Appendix D: Test result for 5.47GHz – 5.725GHz.

## INDEX

TEST CONDITIONS.....	152
FCC Section 15.407 Subclause (a)(2). Transmitter Maximum Conducted Output Power / RSS-247 Clause 6.2.3.1. Transmitter Maximum Equivalent Isotropically Radiated Power .....	155
FCC Section 15.407 Subclause (a) (2) / RSS-247 Clause 6.2.3.1. Transmitter Maximum Power Spectral Density .....	158
FCC Section 15.407(b)(3)(6) /RSS-247 6.2.3.2. Transmitter Out of Band Radiated Emissions .....	169
FCC Section 15.407 Subclause (b) (2) / RSS-247 6.2.3.2. Transmitter Band Edge Radiated Emissions.....	176
FCC Section 15.407(h)(1) / RSS-247 6.2.3.1 Transmitter Power Control.....	185

## TEST CONDITIONS

Power supply (V):

Vnominal = 120 Vac

Type of power supply = AC voltage main supply.

Type of antenna = External antenna.

Declared Gain for antenna MIMO (maximum):  $G_{ANTENNA1+2} = 6 \text{ dBi}$  (\*)

(\*) According to KDB 662911 D01 antennas are cross-polarized with fixed orientations that the user cannot change.

Technology Tested:	MulleFire 1.0	
Modes:	QPSK, 16QAM, 64QAM and 256QAM	
Beamforming:	No	
Frequency Range:	5470 MHz to 5725 MHz	
Channel Spacing:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Lowest: 100	5500
	Middle: 116	5580
	Highest: 140	5700

For RSS-247 (Canada Standard), this device shall not be capable of transmitting in the band 5600-5650 MHz. This restriction is for the protection of Environment Canada’s weather radars operating in this band.

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 for the channel under test.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes. FCC and Canada power setting used during the test were different to be in compliance with both limits.

Channel	Channel Frequency (MHz)	FCC & Canada Power Value
Lowest: 100	5500	19
Middle: 116	5580	19
Highest: 140	5700	19

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.



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

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the center of the chamber turntable to perform the measurements below 1GHz and The EUT was placed at a height of 1.5 meters above the test chamber floor in the center of the chamber turntable to perform the measurements above 1GHz. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

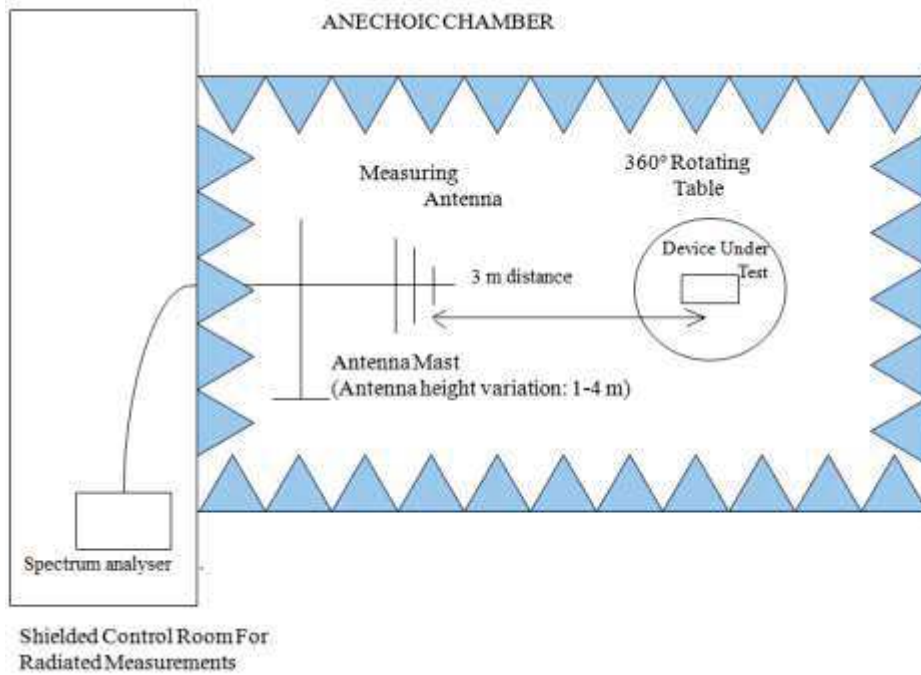
Measurements were made in both horizontal and vertical planes of polarization.

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

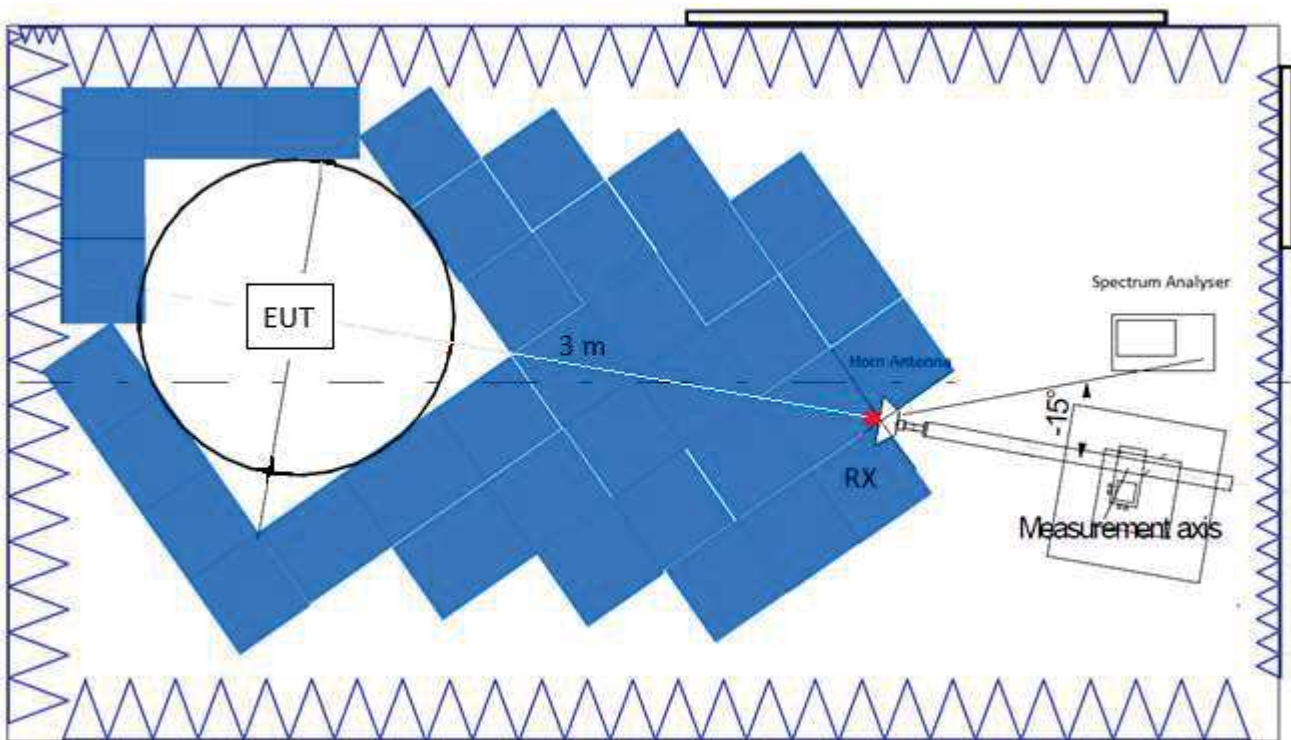
A resolution bandwidth/video bandwidth of 100 kHz/300 kHz was used for frequencies below 1 GHz and 1MHz/3MHz for frequencies above 1 GHz.



Radiated measurements setup  $f < 1$  GHz



Radiated measurements setup  $f > 1$  GHz



## FCC Section 15.407 Subclause (a)(2). Transmitter Maximum Conducted Output Power / RSS-247 Clause 6.2.3.1. Transmitter Maximum Equivalent Isotropically Radiated Power

### **SPECIFICATION**

**FCC 15.407:** For the 5.47-5.725 GHz band, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW (24 dBm) or  $11 \text{ dBm} + 10 \log B$ , where B is the 26 dB emission bandwidth in megahertz. 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:** The maximum conducted output power shall not exceed 250 mW (24 dBm) or  $11 + 10 \log_{10} B$ , dBm, whichever power is less. B is the 99% emission bandwidth in MHz.  
The maximum e.i.r.p. shall not exceed 1.0 W (30 dBm) or  $17 + 10 \log_{10} B$ , dBm, whichever is less. B is the 99% emission bandwidth in megahertz.

### **RESULTS:**

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

In the measure-and-sum approach for MIMO mode, the conducted emission level (*e.g.*, transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units (mW—not dBm).

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

**FCC & Canada power setting**

**Mode: QPSK – 20MHz**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	22.33	21.82	22.43
Conducted Power Limit (dBm)	23.528		
Margin (dB)	1.19	1.71	1.09
Maximum EIRP power (dBm)	28.33	27.82	28.43
EIRP power Limit (dBm)	29.528		
Margin (dB)	1.19	1.71	1.09
Measurement uncertainty (dB)	<±1.20		

**Mode: 16QAM – 20MHz**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	22.35	21.81	22.36
Conducted Power Limit (dBm)	23.528		
Margin (dB)	1.17	1.71	1.17
Maximum EIRP power (dBm)	28.35	27.82	28.36
EIRP power Limit (dBm)	29.528		
Margin (dB)	1.17	1.71	1.17
Measurement uncertainty (dB)	<±1.20		

**Mode: 64QAM – 20MHz**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	22.31	21.83	22.44
Conducted Power Limit (dBm)	23.528		
Margin (dB)	1.21	1.69	1.09
Maximum EIRP power (dBm)	28.31	27.83	28.44
EIRP power Limit (dBm)	29.528		
Margin (dB)	1.21	1.69	1.09
Measurement uncertainty (dB)	<±1.20		

**Mode: 256QAM – 20MHz**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	22.30	21.83	22.41
Conducted Power Limit (dBm)	23.528		
Margin (dB)	1.23	1.69	1.12
Maximum EIRP power (dBm)	28.30	27.83	28.41
EIRP power Limit (dBm)	29.528		
Margin (dB)	1.23	1.69	1.12
Measurement uncertainty (dB)	<±1.20		

## FCC Section 15.407 Subclause (a) (2) / RSS-247 Clause 6.2.3.1. Transmitter Maximum Power Spectral Density

FCC 15.407: The maximum power spectral density shall not exceed 11 dBm in any 1 megahertz 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.

RSS-247: The power spectral density shall not exceed 11 dBm 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) of Guidance 789033 D02 General UNII Test Procedures New Rules v02r01.

**FCC & Canada power setting**

**Mode: QPSK – 20MHz**

	Channel 100 5500 MHz	Channel 116 5580 MHz	Channel 140 5700 MHz
PSD (dBm/MHz)	10.66	10.40	10.58
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.34	0.60	0.42
Measurement uncertainty (dB)	<±1.20		

**Mode: 16QAM – 20MHz**

	Channel 100 5500 MHz	Channel 116 5580 MHz	Channel 140 5700 MHz
PSD (dBm/MHz)	10.99	10.85	10.69
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.01	0.15	0.31
Measurement uncertainty (dB)	<±1.20		

**Mode: 64QAM – 20MHz**

	Channel 100 5500 MHz	Channel 116 5580 MHz	Channel 140 5700 MHz
PSD (dBm/MHz)	10.72	10.43	10.66
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.28	0.57	0.34
Measurement uncertainty (dB)	<±1.20		

**Mode: 256QAM – 20MHz**

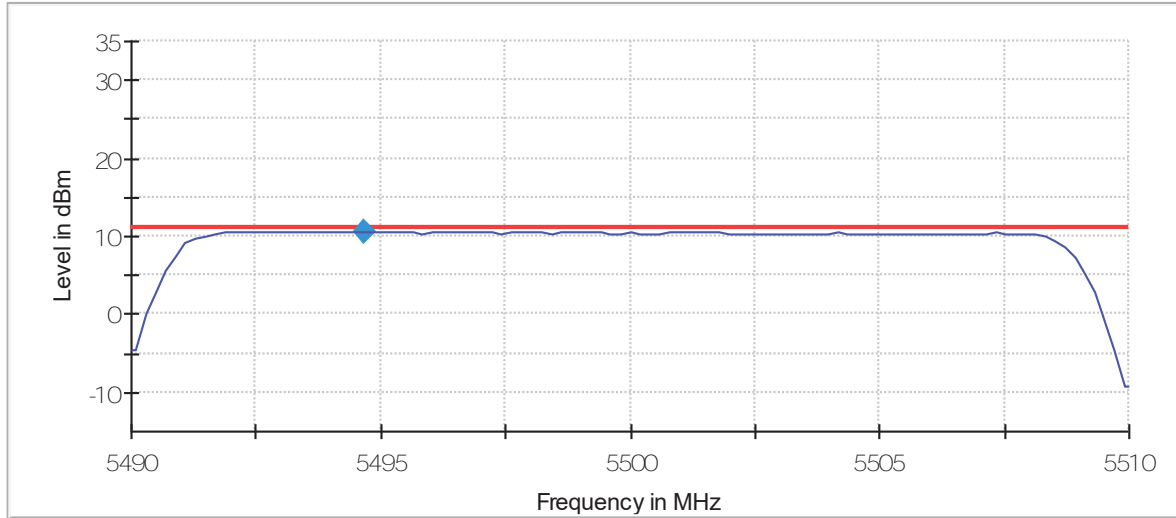
	Channel 100 5500 MHz	Channel 116 5580 MHz	Channel 140 5700 MHz
PSD (dBm/MHz)	10.70	10.55	10.55
PSD Limit (dBm/MHz)	11		
Margin (dB)	0.30	0.45	0.45
Measurement uncertainty (dB)	<±1.20		

### FCC & Canada Power Setting

Mode: QSPK – 20MHz

Channel 100

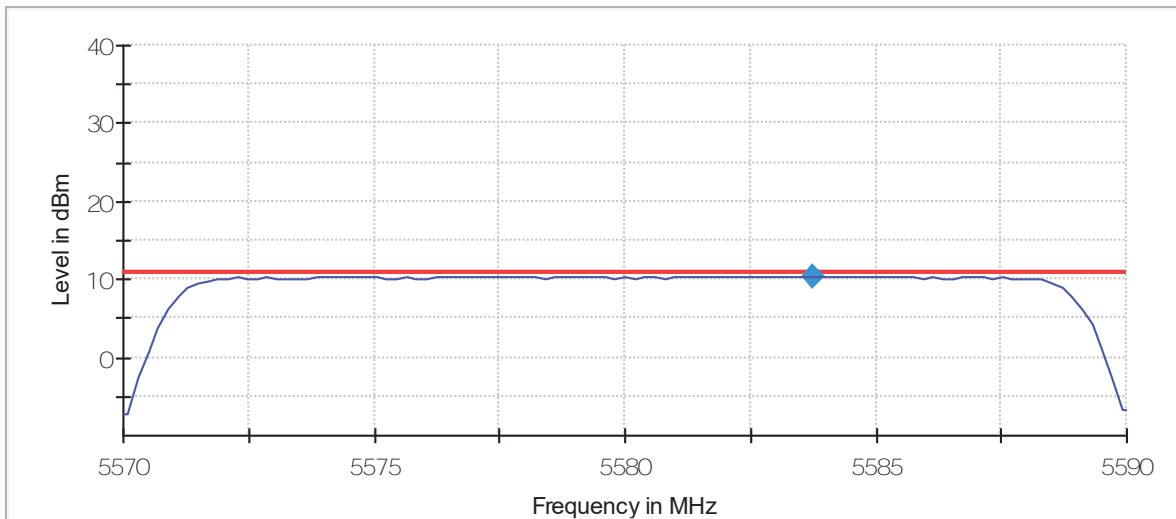
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 116

Power Spectral Density (SA-1)

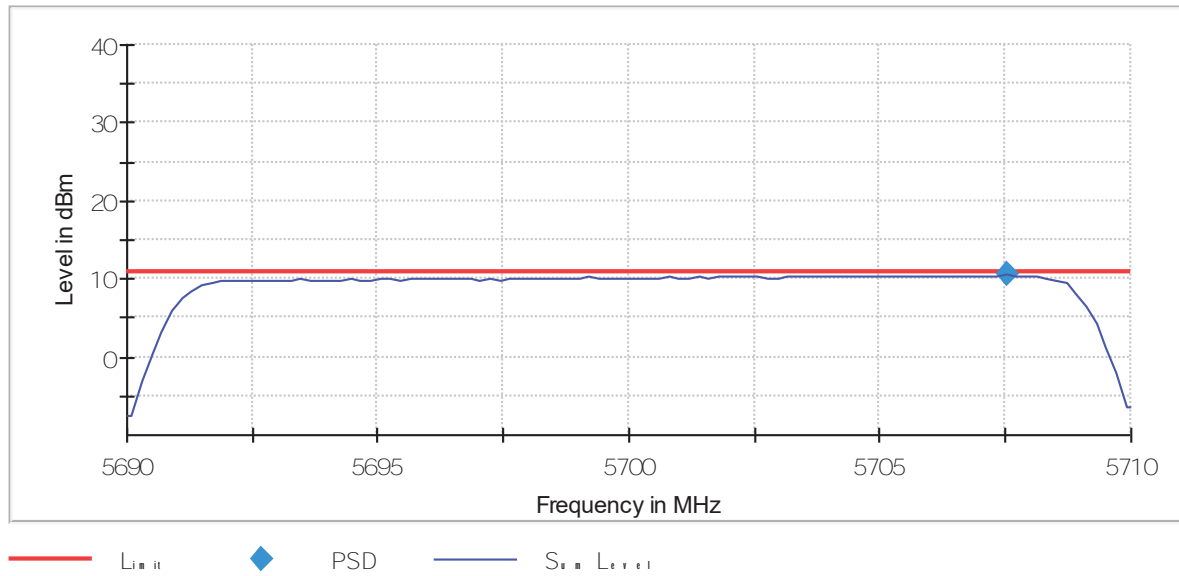


— Limit    ◆ PSD    — Signal Level



Channel 140

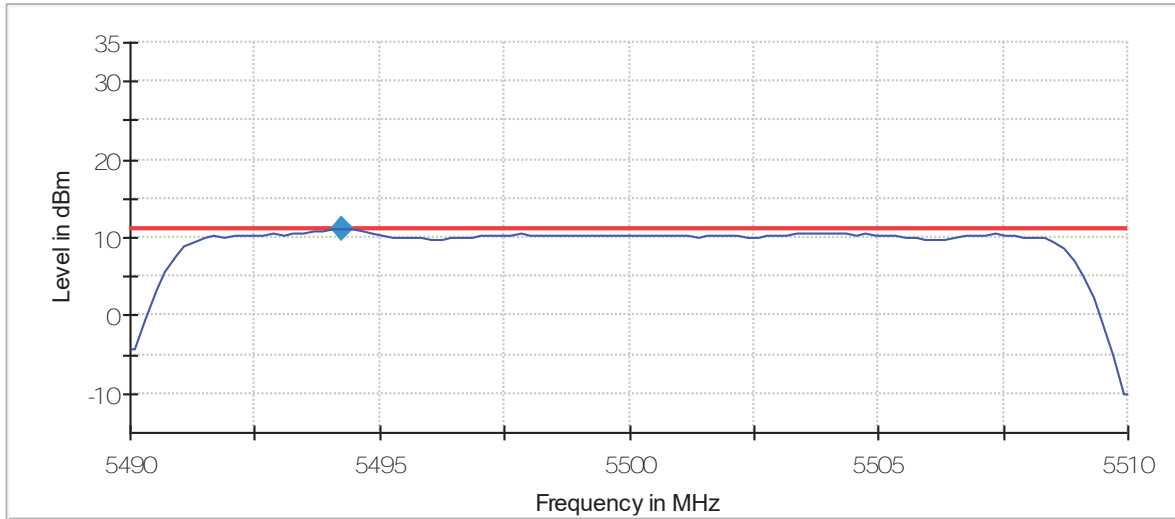
Power Spectral Density (SA-1)



Mode: 16QAM – 20MHz

Channel 100

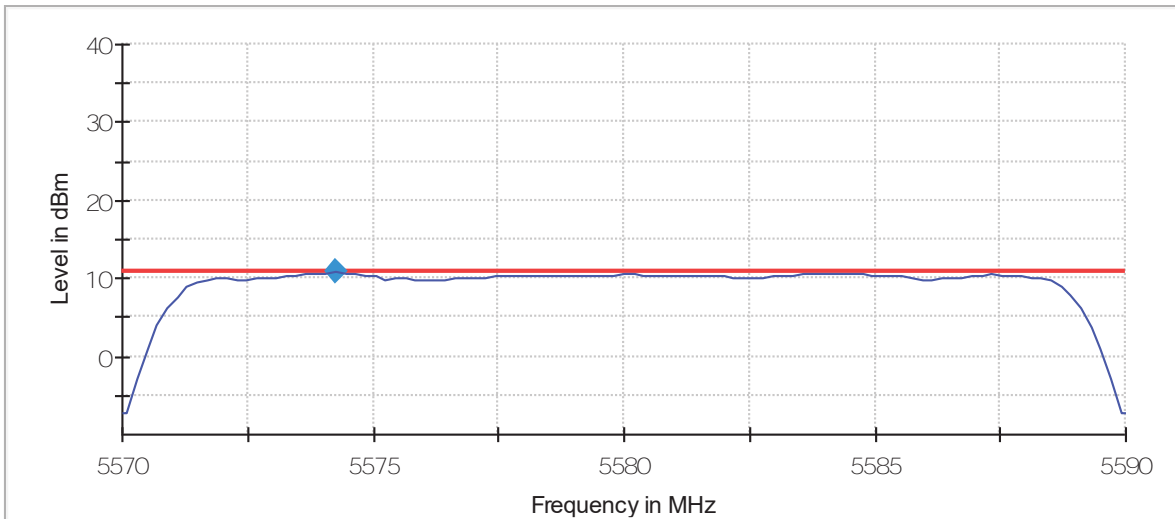
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 116

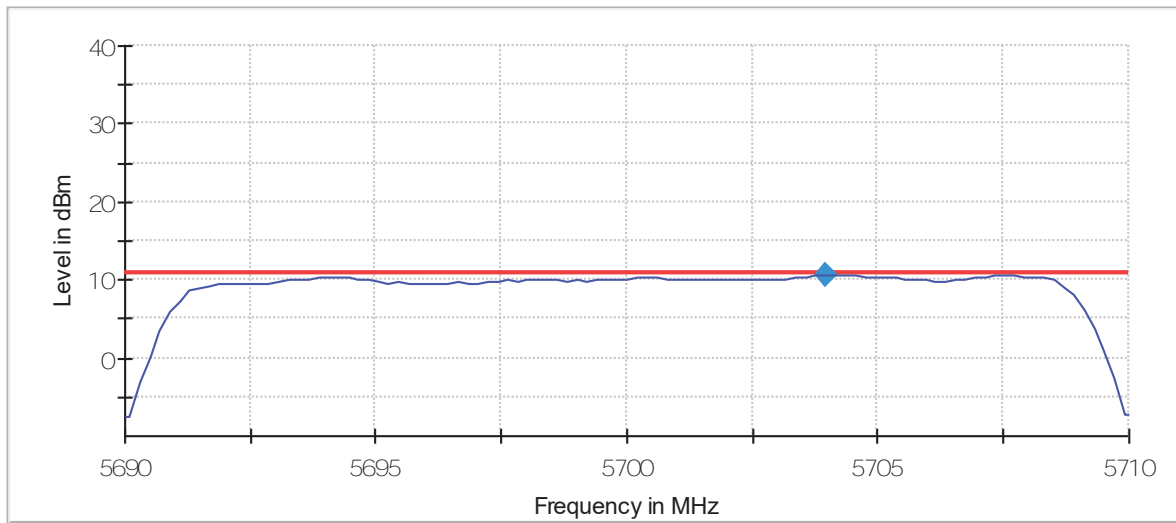
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 140

Power Spectral Density (SA-1)

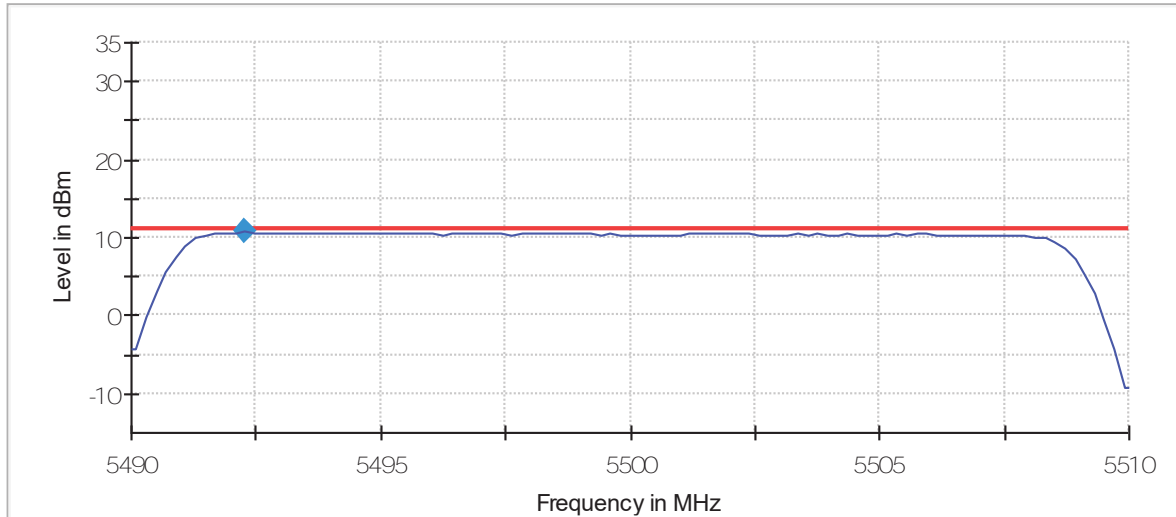


— Limit    ◆ PSD    — Signal Level

**Mode: 64QAM – 20MHz**

Channel 100

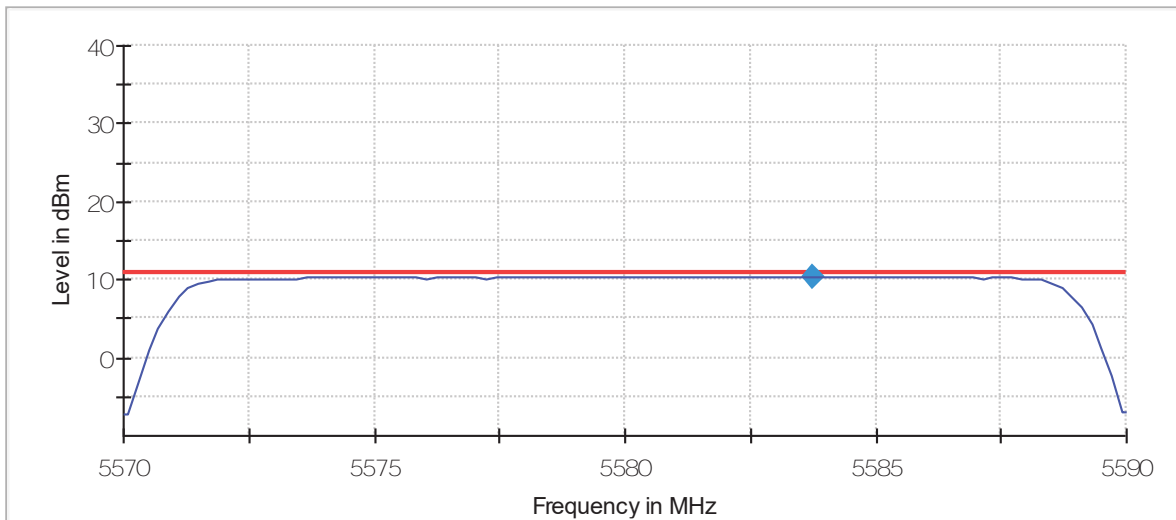
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 116

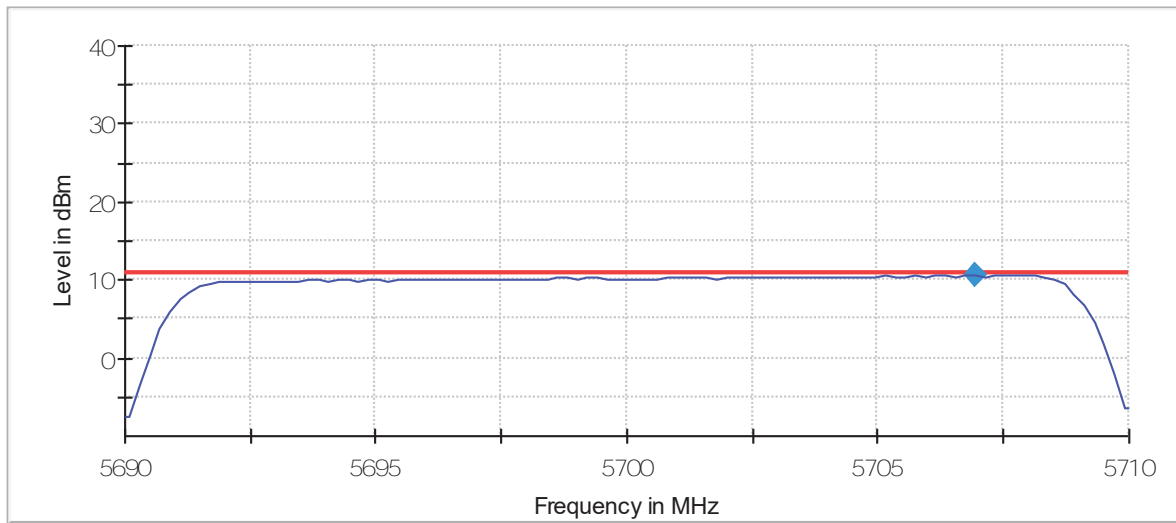
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 140

Power Spectral Density (SA-1)

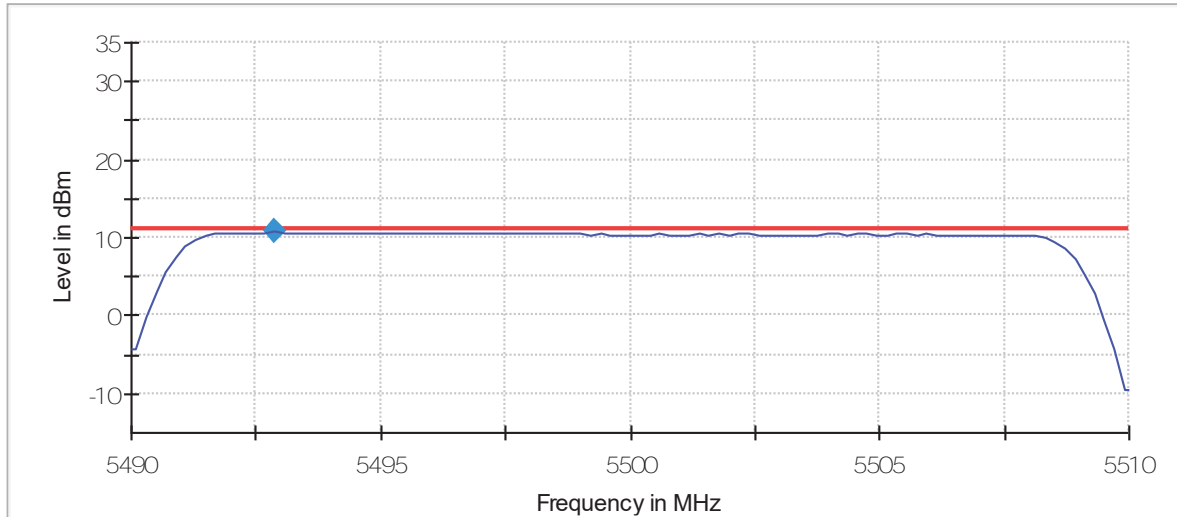


— Limit    ◆ PSD    — Signal Level

### Mode: 256QAM – 20MHz

Channel 100

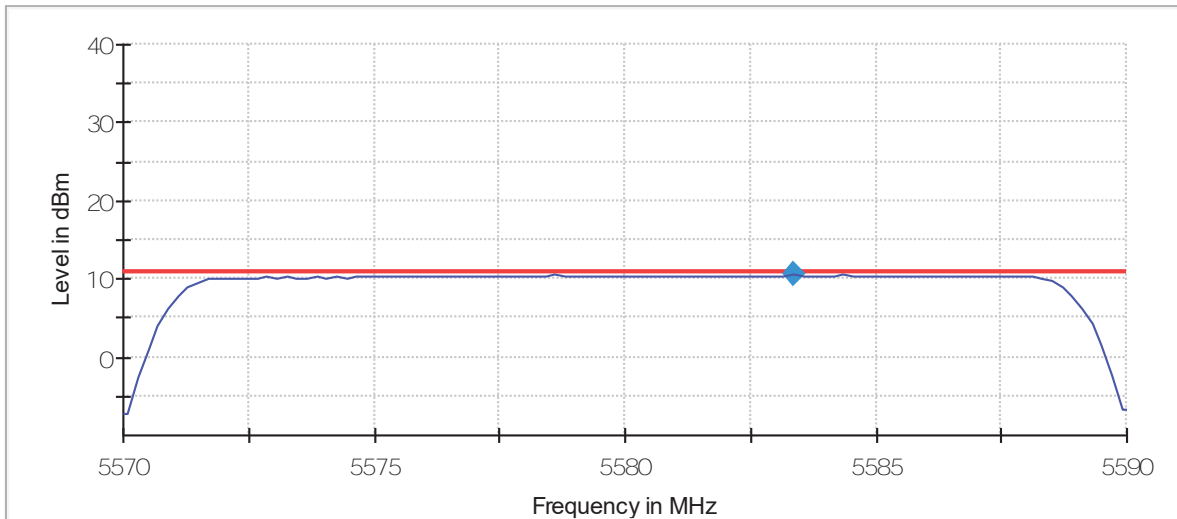
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 116

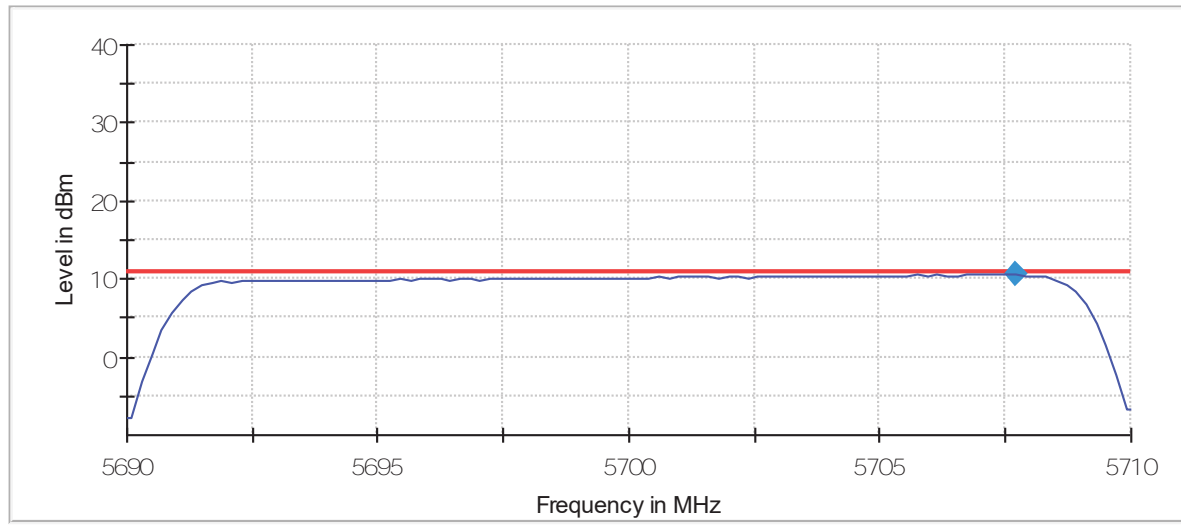
Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal Level

Channel 140

Power Spectral Density (SA-1)



— Limit    ◆ PSD    — Signal

## FCC Section 15.407(b)(3)(6) /RSS-247 6.2.3.2. Transmitter Out of Band Radiated Emissions

### SPECIFICATION

For transmitters operating in the 5.47–5.725 GHz band: all emissions outside of the 5.47–5.725 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.23 dBμV/m at 3 m distance).

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 – 960	200	46	3
960 – 40000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

### RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-40 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Test performed on the following worst case of modulation QPSK



**Mode QPSK:**

**Frequency range 30 MHz-1000 MHz.**

Note: The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
652.9340	Horizontal	Quasi-Peak	19.01	46.0	26.99	± 4.99
824.9635	Horizontal	Quasi-Peak	21.22	46.0	24.78	± 4.99
879.8655	Vertical	Quasi-Peak	21.20	46.0	24.80	± 4.99

**Frequency range 1 GHz-40 GHz**

**Channel 100:**

Spurious signals were detected at less than 20 dB respect to the limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
7372.5000	Vertical	Peak	46.98	68.23	21.25	± 4.98
11060.0000	Vertical	Peak	49.40	68.23	18.83	± 4.98

**Channel 116:**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Channel 140:**

Spurious signals were detected at less than 20 dB respect to the limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Measurement Uncertainty (dB)
7372.5000	Vertical	Peak	46.76	68.23	21.47	± 4.98
11380.0000	Vertical	Peak	47.46	68.23	20.77	± 4.98

Measurement Uncertainty (dB): 1GHz to 17GHz <± 4.98

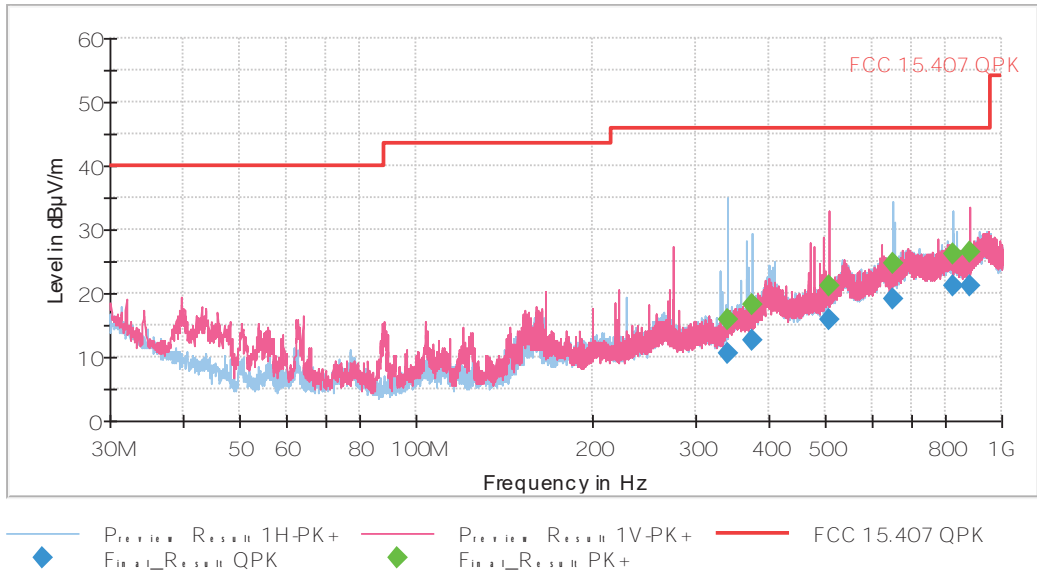
17GHz to 26.5GHz <± 5.08

26.5GHz to 40GHz <± 5.33

Verdict: PASS

**FREQUENCY RANGE 30 MHz-1000 MHz.**

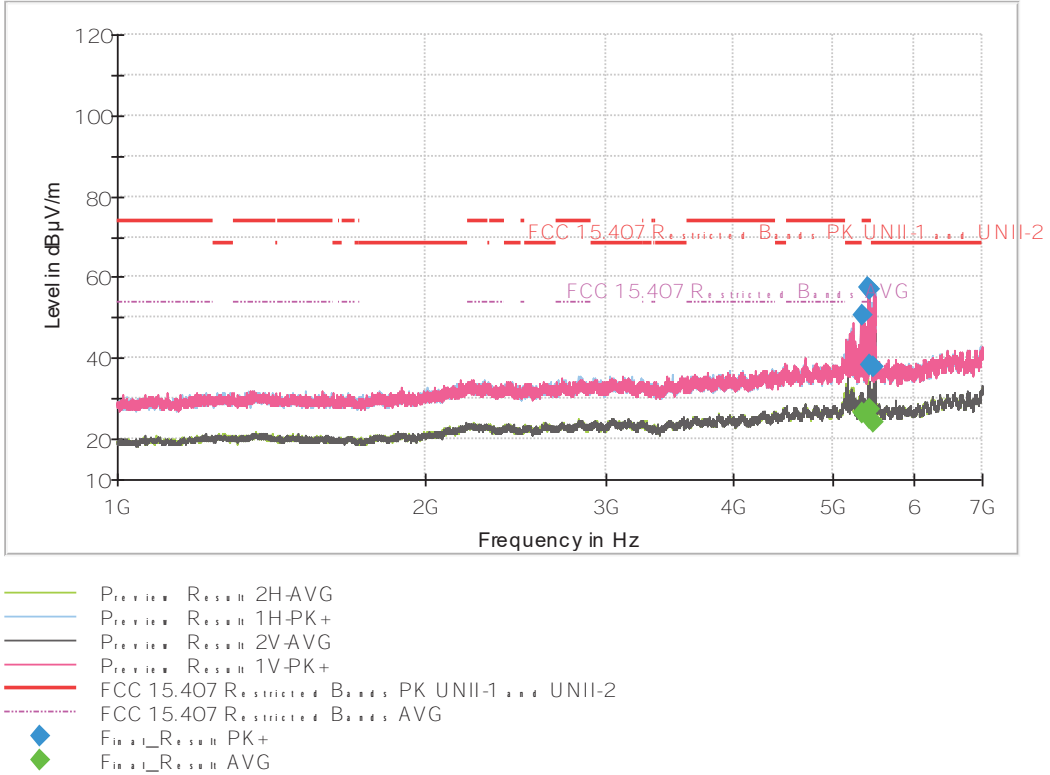
This plot is valid for all channels



**FREQUENCY RANGE 1 GHz to 7 GHz.**

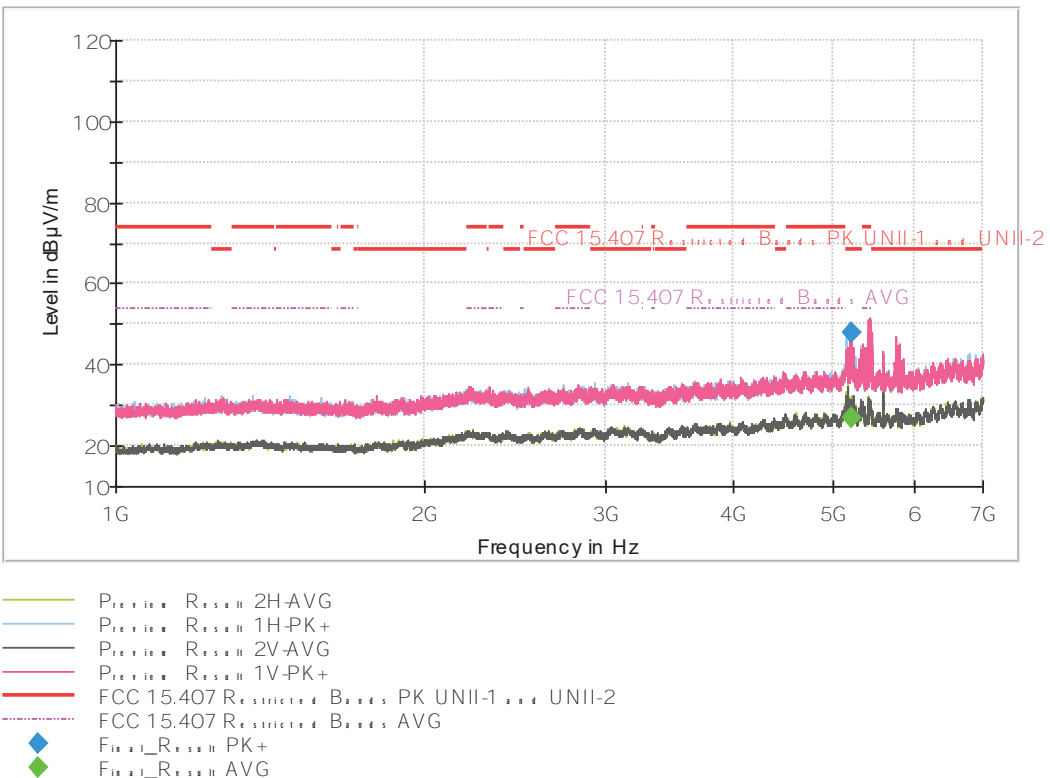
**Mode QPSK:**

**Channel 100**

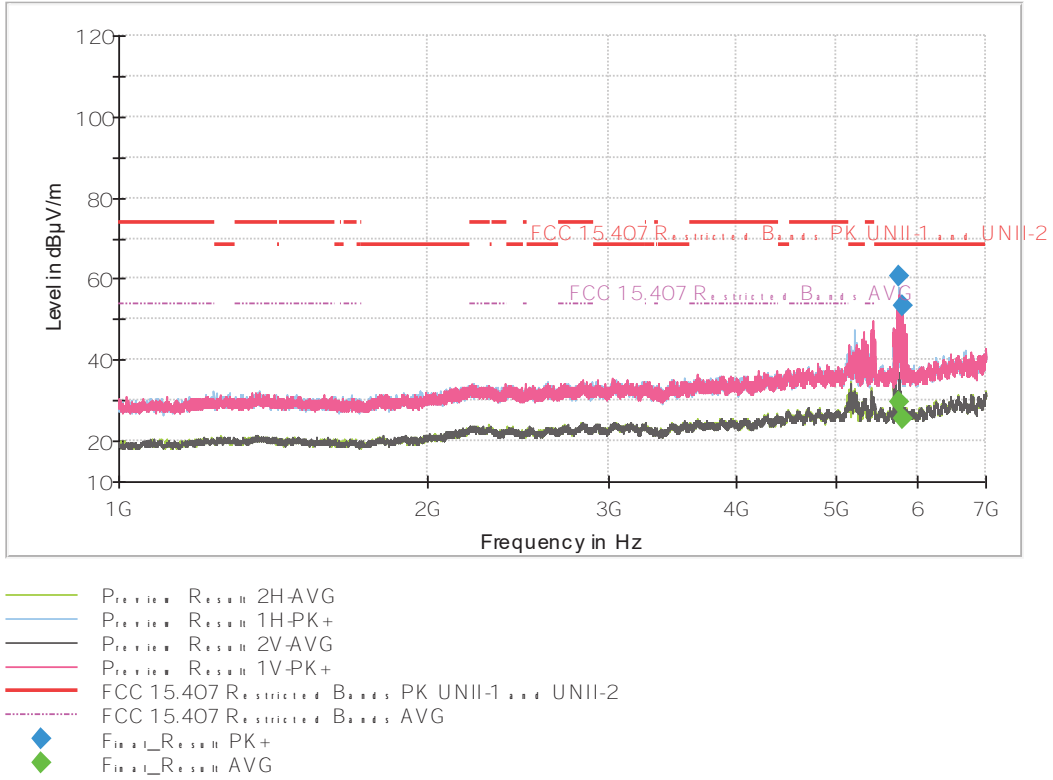


Note: The peak shown in the plot above the limit is the carrier frequency.

**Channel 116**



**Channel 140**

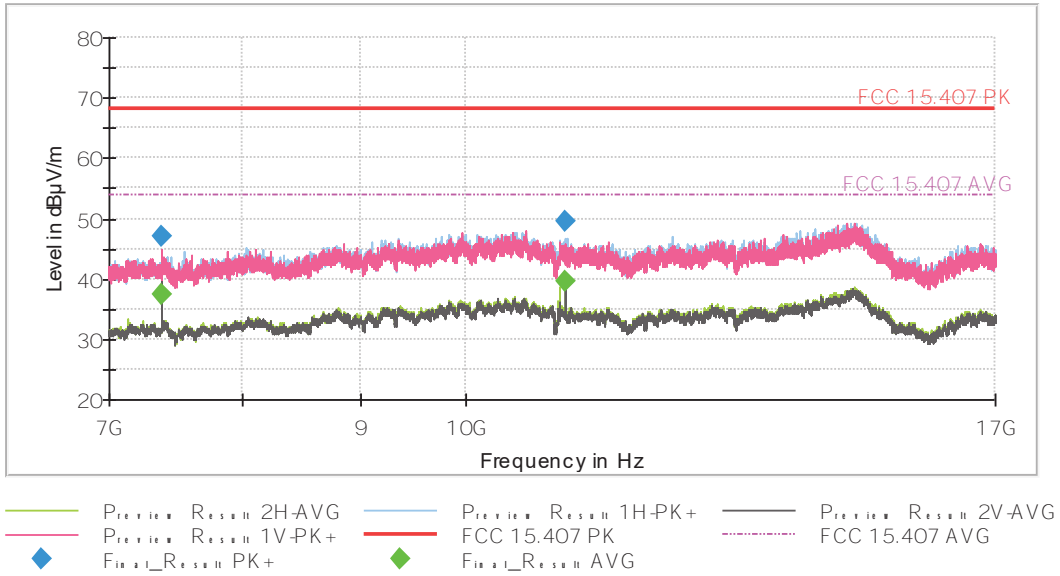


Note: The peak shown in the plot above the limit is the carrier frequency.

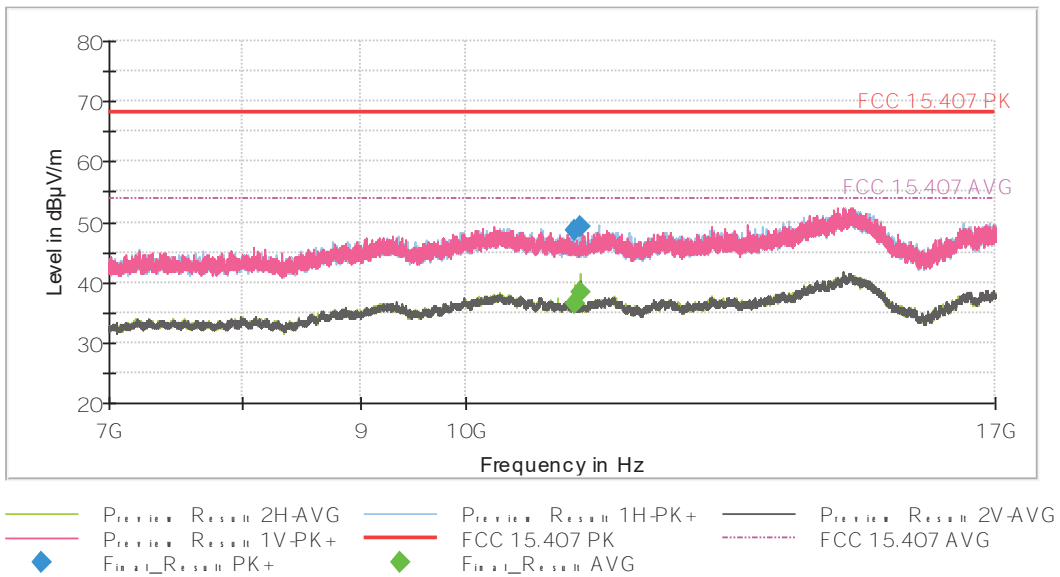
**FREQUENCY RANGE 7 GHz to 17 GHz.**

**Mode QPSK:**

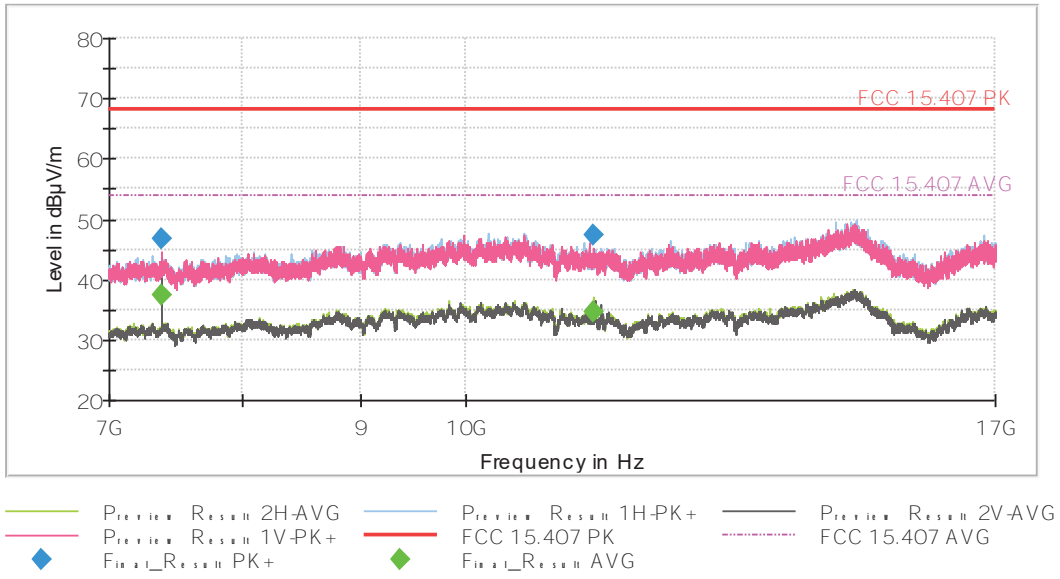
Channel 100:



Channel 116:



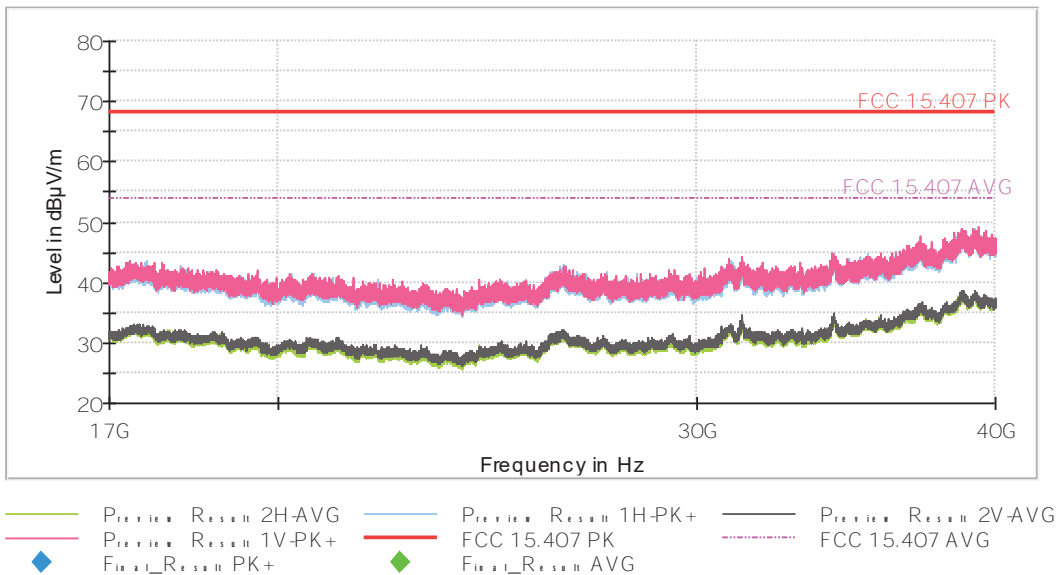
Channel 140:



**FREQUENCY RANGE 17 GHz to 26 GHz.**

**Mode QPSK:**

This plot is valid for all channels. Spurious founded do not depend the operating channel



## FCC Section 15.407 Subclause (b) (2) / RSS-247 6.2.3.2. Transmitter Band Edge Radiated Emissions.

### SPECIFICATION

For transmitters operating in the 5.47–5.725 GHz band: all emissions outside of the 5.47–5.725 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.23 dB $\mu$ V/m at 3 m distance).

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength ( $\mu$ V/m)	Field strength (dB $\mu$ V/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 40000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

### RESULTS:

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

All emissions outside of the 5.47–5.725 GHz band shall not exceed an EIRP of -27dBm/MHz. There are restricted bands of operation below band edge at 5.35-5.46GHz therefore the provision of FCC Part 15.205 apply.

Field strength measurements using peak and average detector performed in the restricted bands below 5.47 GHz and above 5.725 GHz.

Test performed on the following worst cases modes in all relevant tests channels:

**Results for Mode: QPSK**

**Results: Peak / Channel 100**

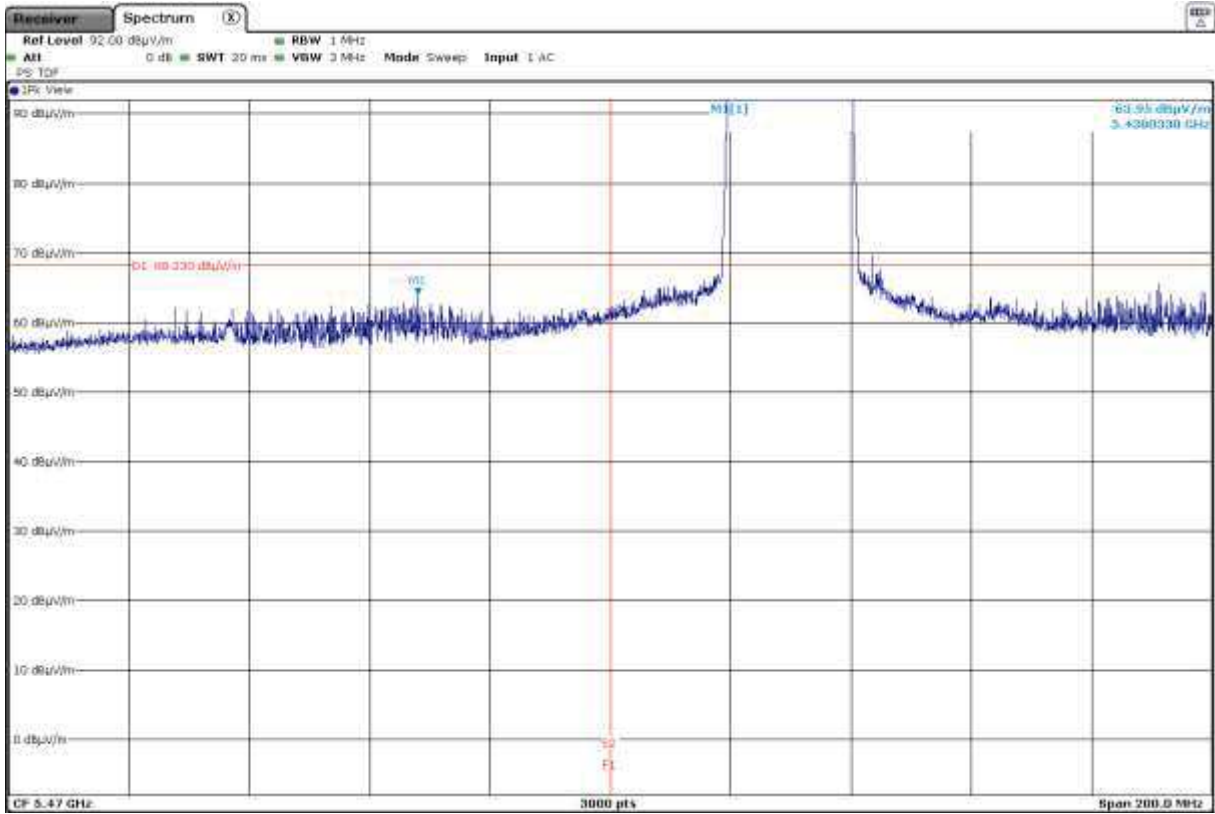
Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5438.0330	Horizontal	63.95	68.20	4.25	<± 3.98	PASS

**Results: Peak / Channel 140**

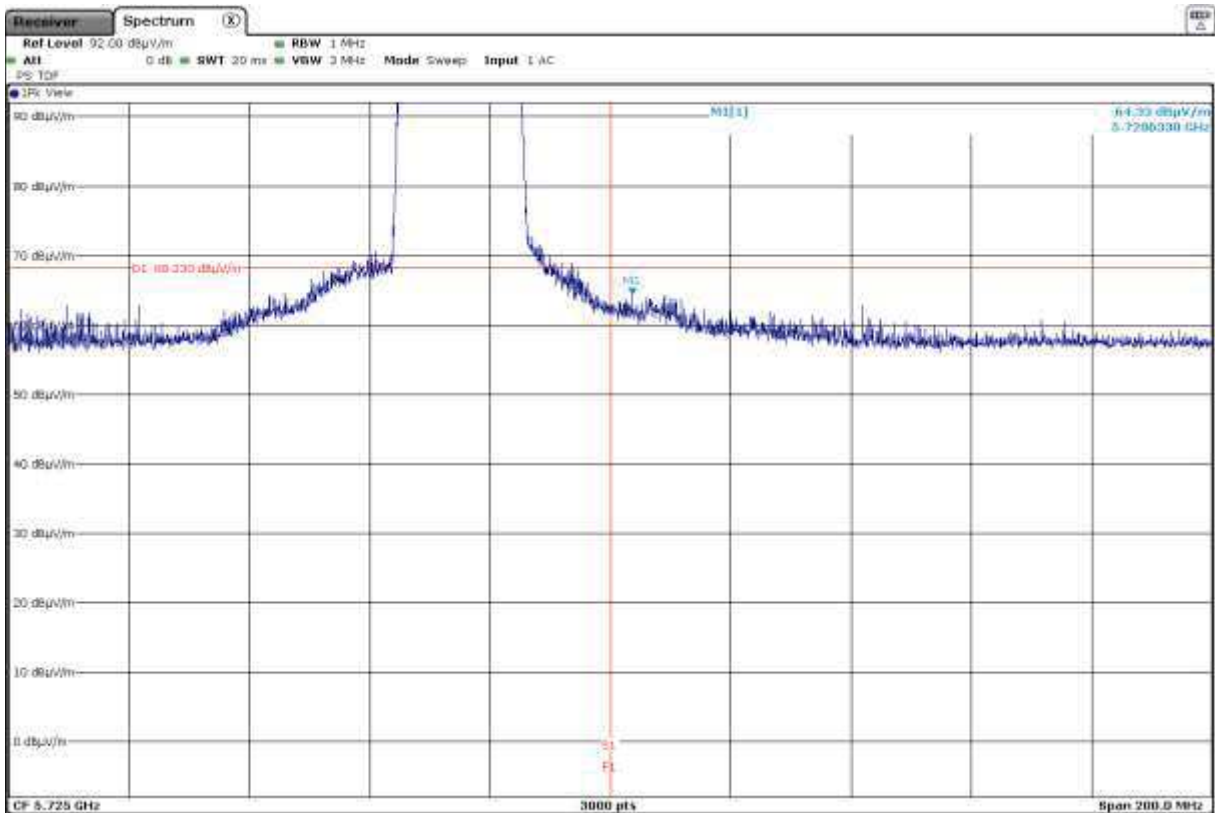
Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5728.6330	Horizontal	64.33	68.20	3.87	<± 3.98	PASS



### Lower Band Edge Channel 100



### Upper Band Edge Channel 140



**Results for Mode: 16QAM**

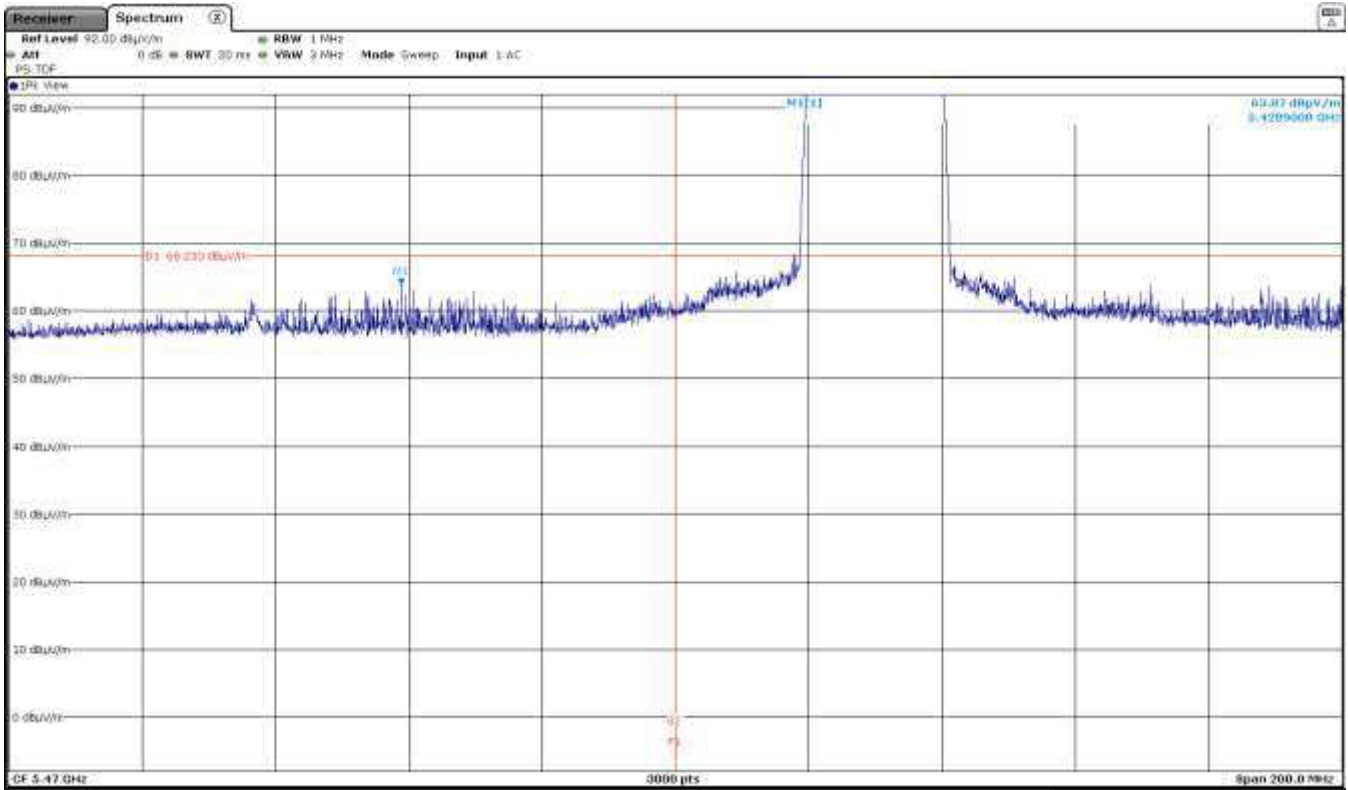
**Results: Peak / Channel 100**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5428.9000	Horizontal	63.87	68.20	4.33	<± 3.98	PASS

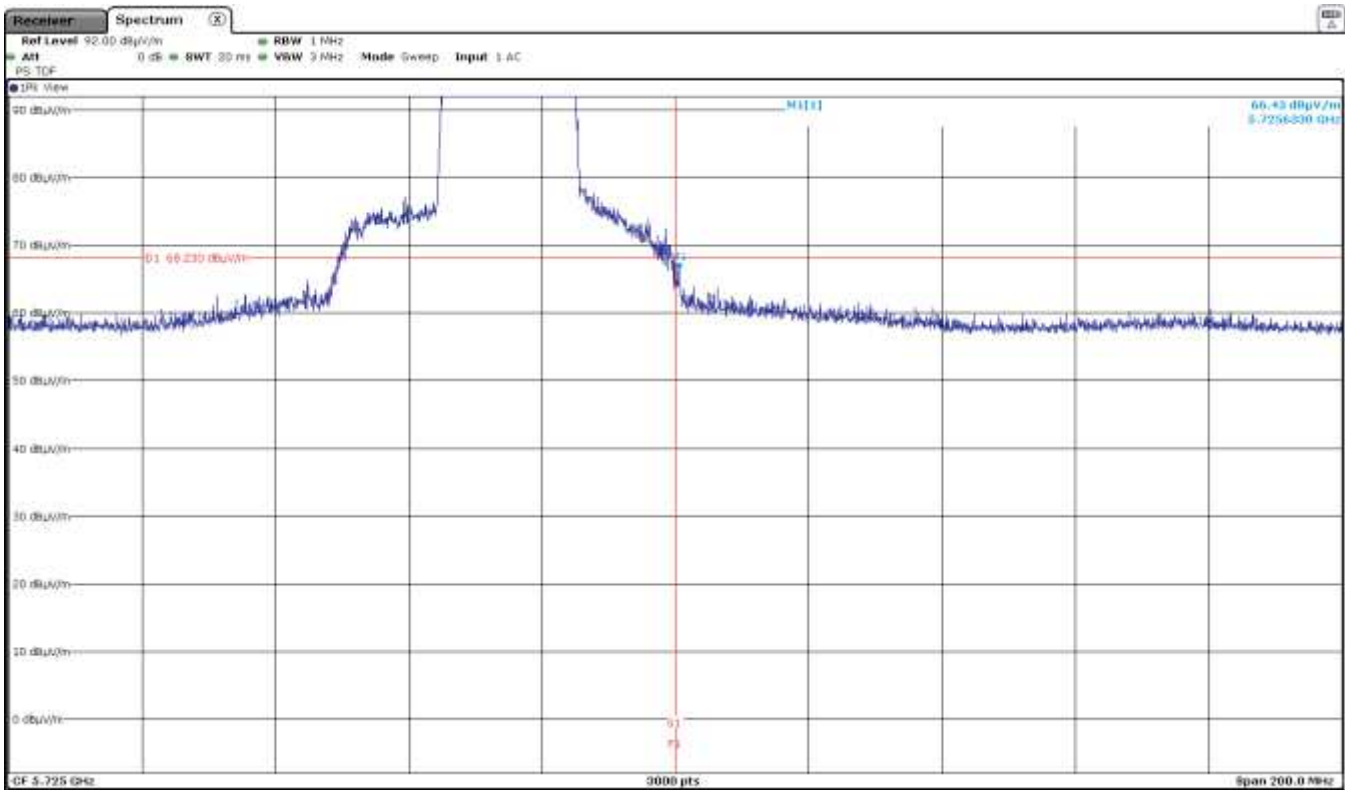
**Results: Peak / Channel 140**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5725.6330	Vertical	66.43	68.20	1.77	<± 3.98	PASS

### Lower Band Edge Channel 100



### Upper Band Edge Channel 140



**Results for Mode: 64QAM**

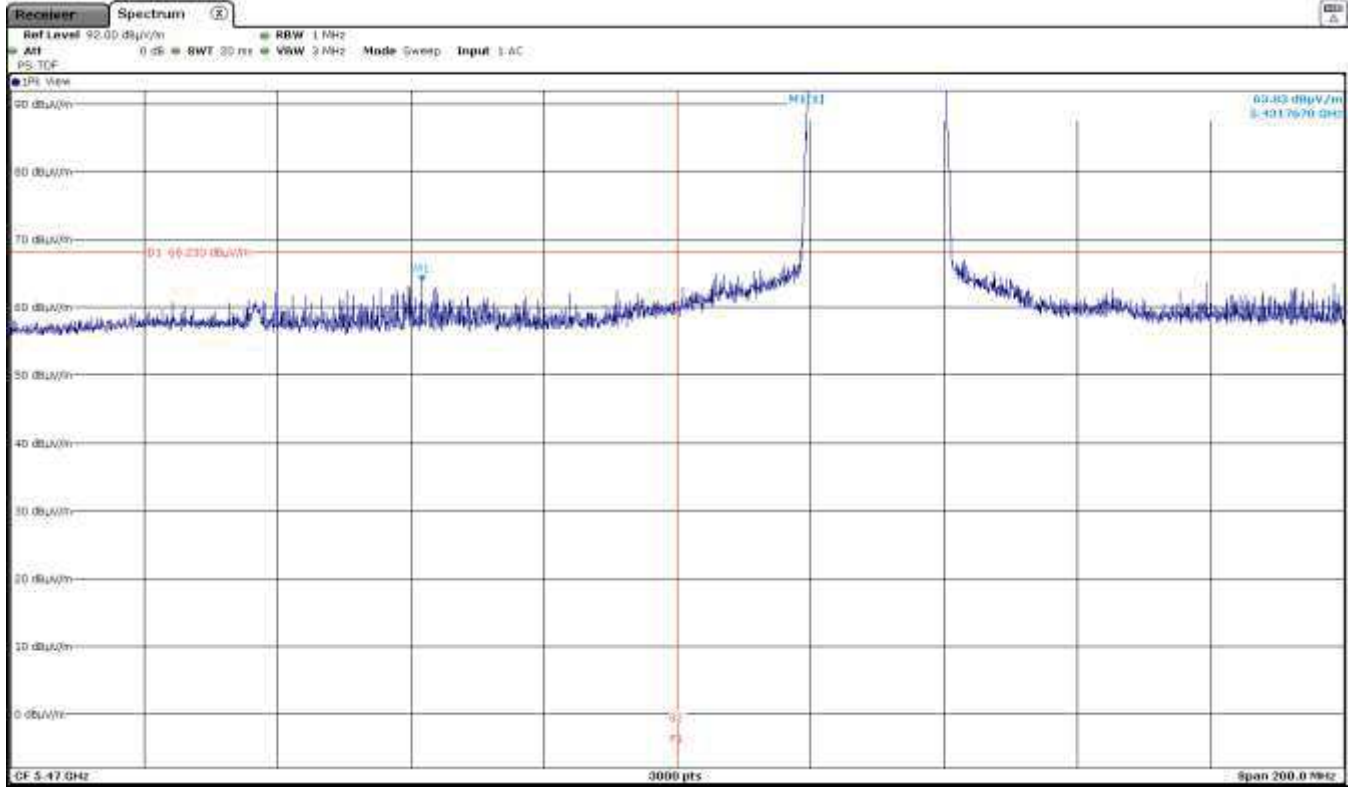
**Results: Peak / Channel 100**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5431.7670	Horizontal	63.83	68.20	4.37	<± 3.98	PASS

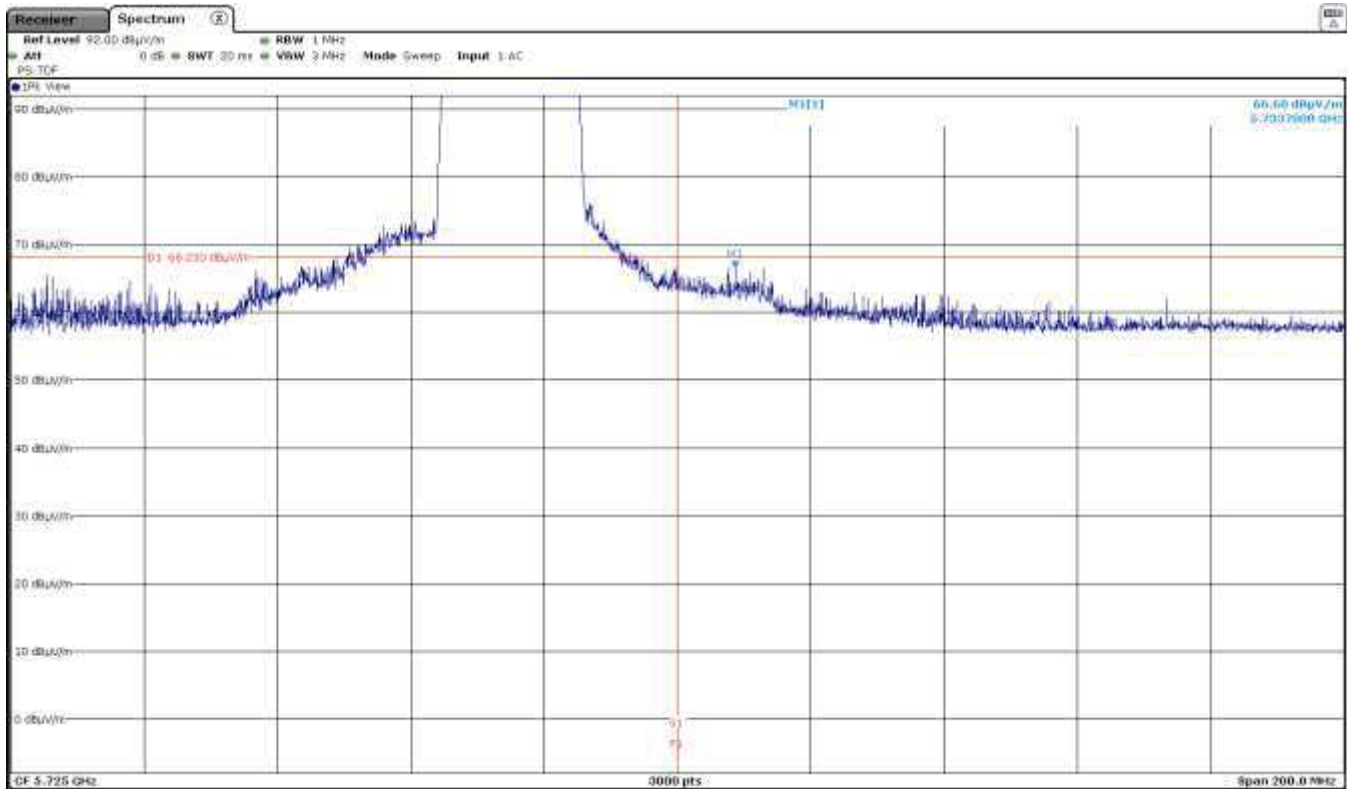
**Results: Peak / Channel 140**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5733.7000	Horizontal	66.60	68.20	1.60	<± 3.98	PASS

### Lower Band Edge Channel 100



### Upper Band Edge Channel 140



**Results for Mode: 256QAM**

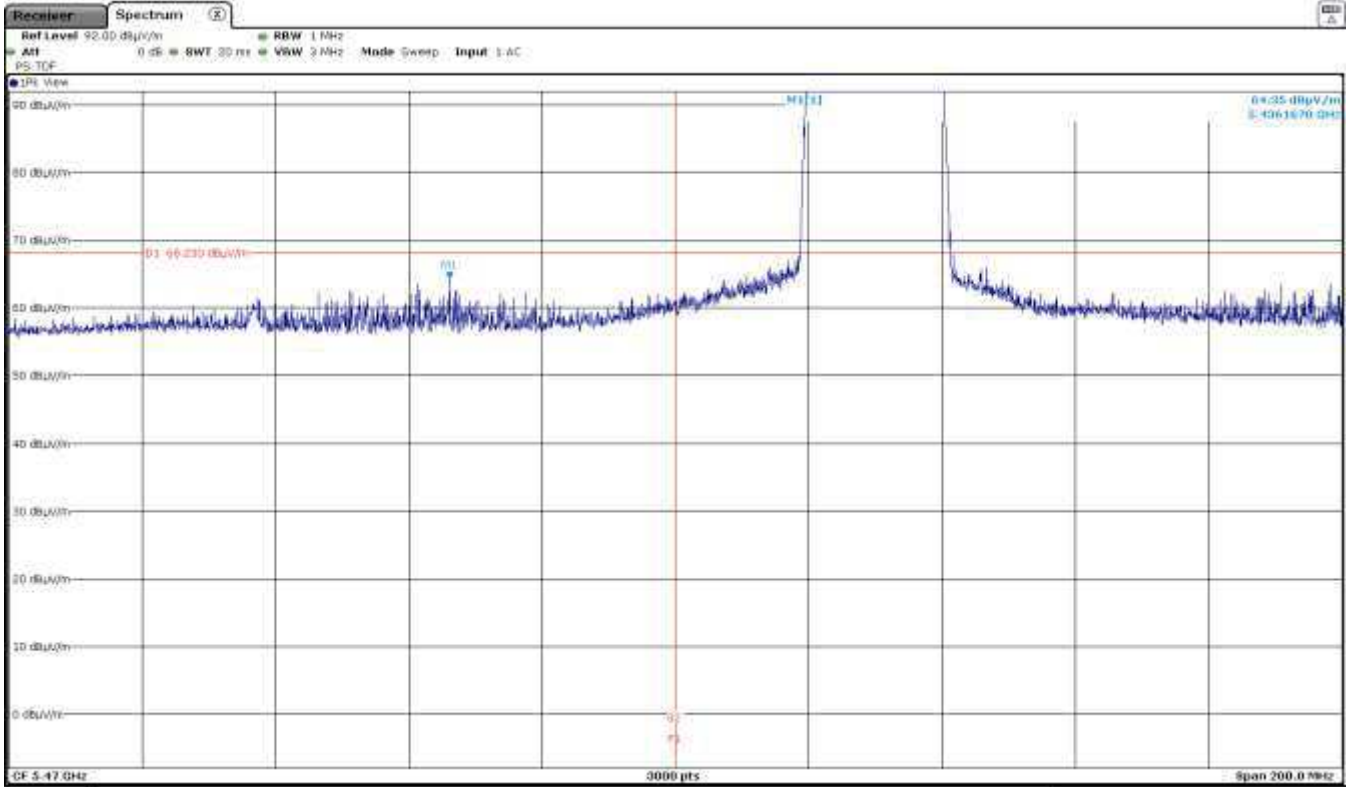
**Results: Peak / Channel 100**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5436.1670	Horizontal	64.35	68.20	3.85	<± 3.98	PASS

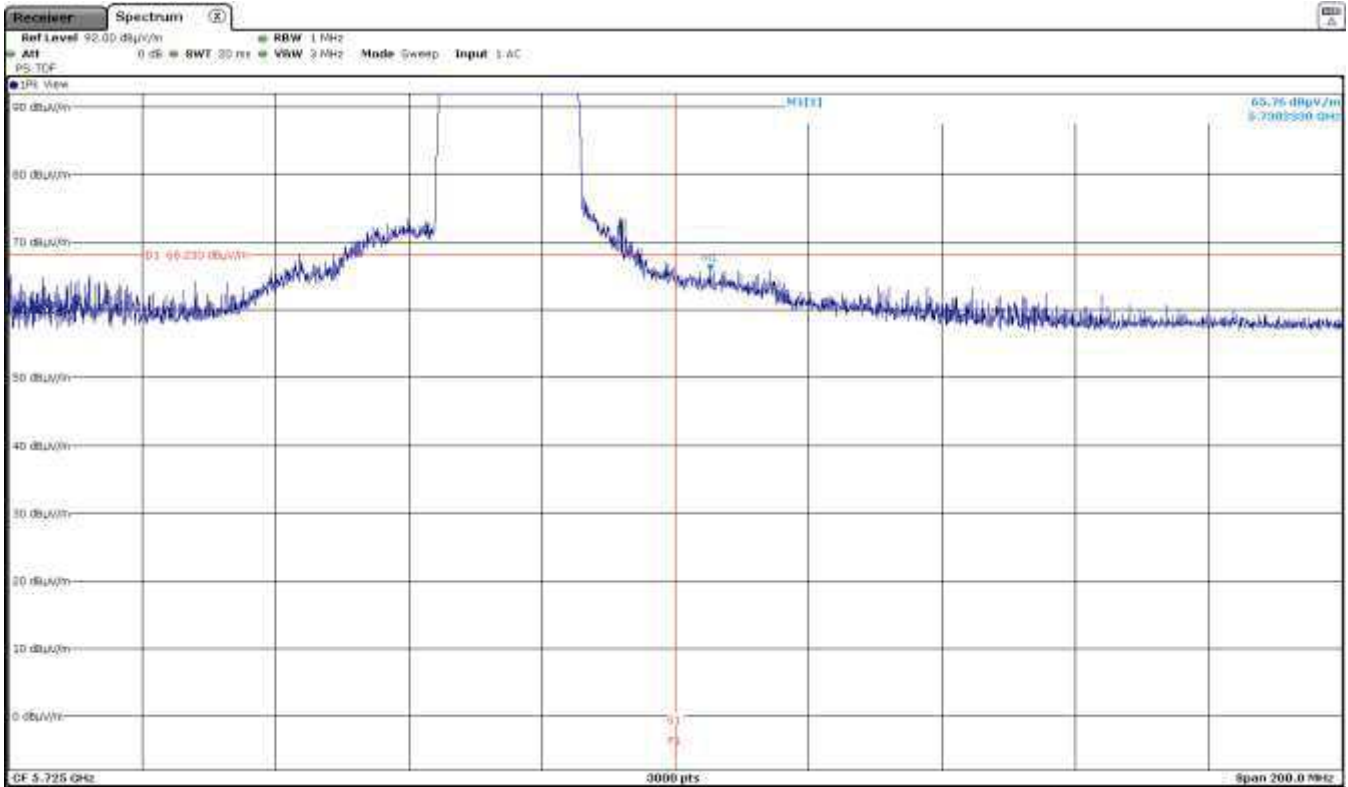
**Results: Peak / Channel 140**

Frequency (MHz)	Antenna Polarity	Peak Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
5730.2330	Horizontal	65.76	68.20	2.44	<± 3.98	PASS

### Lower Band Edge Channel 100



### Upper Band Edge Channel 140



## FCC Section 15.407(h)(1) / RSS-247 6.2.3.1 Transmitter Power Control

### **SPECIFICATION**

FCC 15.407/RSS247: Transmit power control (TPC). U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW (27dBm).

### **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%.

In the measure-and-sum approach for MIMO mode, the conducted emission level (*e.g.*, transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units (mW—not dBm).

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



**Mode: QPSK – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel 116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	16.12	16.19	16.39
Maximum EIRP power (dBm)	22.12	22.19	22.39
EIRP power Limit (dBm)	24		
Margin (dB)	1.88	1.81	1.61
Measurement uncertainty (dB)	<±1.20		

**Mode: 16QAM – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel 116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	16.41	15.94	16.76
Maximum EIRP power (dBm)	22.41	21.94	22.76
EIRP power Limit (dBm)	24		
Margin (dB)	1.59	2.06	1.24
Measurement uncertainty (dB)	<±1.20		

**Mode: 64QAM – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel 116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	16.13	16.16	16.55
Maximum EIRP power (dBm)	22.13	22.16	22.55
EIRP power Limit (dBm)	24		
Margin (dB)	1.87	1.84	1.45
Measurement uncertainty (dB)	<±1.20		

**Mode: 256QAM – 20MHz (TPC activate)**

Declared antenna gain: 6 dBi

	channel 100 5500 MHz	Channel 116 5580 MHz	channel 140 5700 MHz
Max. conducted power (dBm)	16.05	15.92	16.49
Maximum EIRP power (dBm)	22.05	21.95	22.49
EIRP power Limit (dBm)	24		
Margin (dB)	1.95	2.05	1.51
Measurement uncertainty (dB)	<±1.20		

## Appendix E: Test result for 5.725GHz – 5.850GHz.

## INDEX

TEST CONDITIONS.....	190
FCC Section 15.247 Subclause (e) / RSS-247 6.2.4.1. 6 dB Bandwidth.....	193
FCC Section 15.407 Subclause (a)(3). / RSS-247 Clause 6.2.4.1. Transmitter Maximum Conducted Output Power.....	201
FCC Section 15.407 Subclause (a) (3) / RSS-247 Clause 6.2.4.1. Transmitter Maximum Power Spectral Density .....	204
FCC Section 15.407(b)(4)(6) /RSS-247 6.2.4.2. Transmitter Out of Band Radiated Emissions.....	213
FCC Section 15.407 Subclause (b) (4) / RSS-247 6.2.4.2. Transmitter Band Edge Radiated Emissions.....	222

## TEST CONDITIONS

Power supply (V):

Vnominal = 120 Vac

Type of power supply = AC voltage main supply.

Type of antenna = External antenna.

Declared Gain for antenna MIMO (maximum):  $G_{\text{ANTENNA1+2}} = 6 \text{ dBi}$  (\*)

(\*) According to KDB 662911 D01 antennas are cross-polarized with fixed orientations that the user cannot change.

Technology Tested:	MulleFire 1.0	
Modes:	QPSK, 16QAM, 64QAM and 256QAM	
Beamforming:	No	
Frequency Range:	5725 MHz to 5850 MHz	
Channel Spacing:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Lowest: 149	5745
	Middle: 157	5785
	Highest: 165	5825

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 for the channel under test.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes. FCC and Canada power setting used during the test were different to be in compliance with both limits.

Channel	Channel Frequency (MHz)	FCC & Canada Power Value
Lowest: 149	5745	23
Middle: 157	5785	27
Highest: 165	5825	27

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.



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

RADIATED MEASUREMENTS

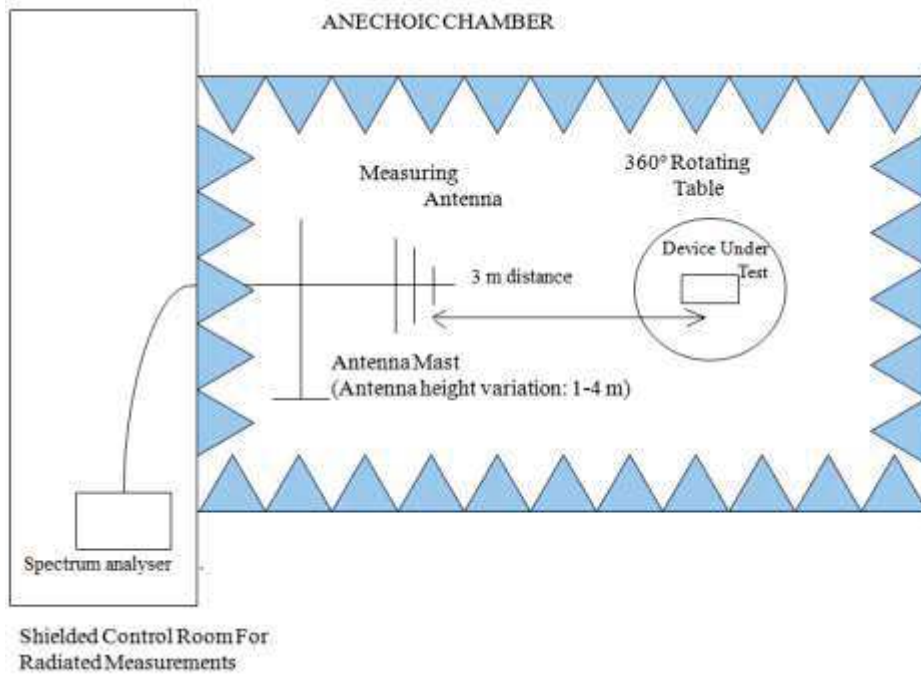
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the center of the chamber turntable to perform the measurements below 1GHz and The EUT was placed at a height of 1.5 meters above the test chamber floor in the center of the chamber turntable to perform the measurements above 1GHz. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

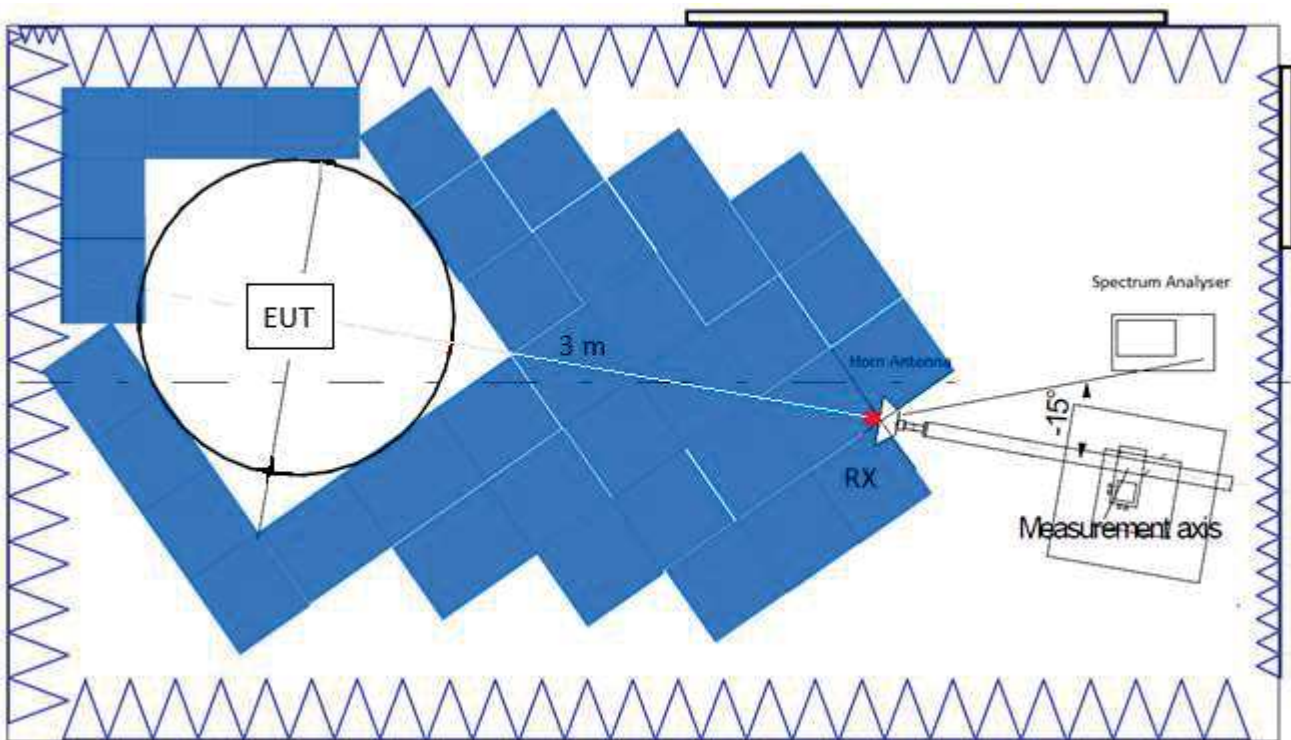
The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.

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

Radiated measurements setup  $f < 1$  GHz



Radiated measurements setup  $f > 1$  GHz



## FCC Section 15.247 Subclause (e) / RSS-247 6.2.4.1. 6 dB Bandwidth

### SPECIFICATION

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

### RESULTS:

6 dB Bandwidth (see next plots).

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



**Mode : QPSK – 20MHz**

**(5725-5850 Channels)**

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	18.100	18.100	18.150
Measurement uncertainty (kHz)	<± 25.02		

**Mode : 16QAM – 20MHz**

**(5725-5850 Channels)**

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	18.150	18.100	18.150
Measurement uncertainty (kHz)	<± 25.02		

**Mode : 64QAM – 20MHz**

**(5725-5850 Channels)**

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	18.150	18.150	18.150
Measurement uncertainty (kHz)	<± 25.02		

**Mode : 256QAM – 20MHz**

**(5725-5850 Channels)**

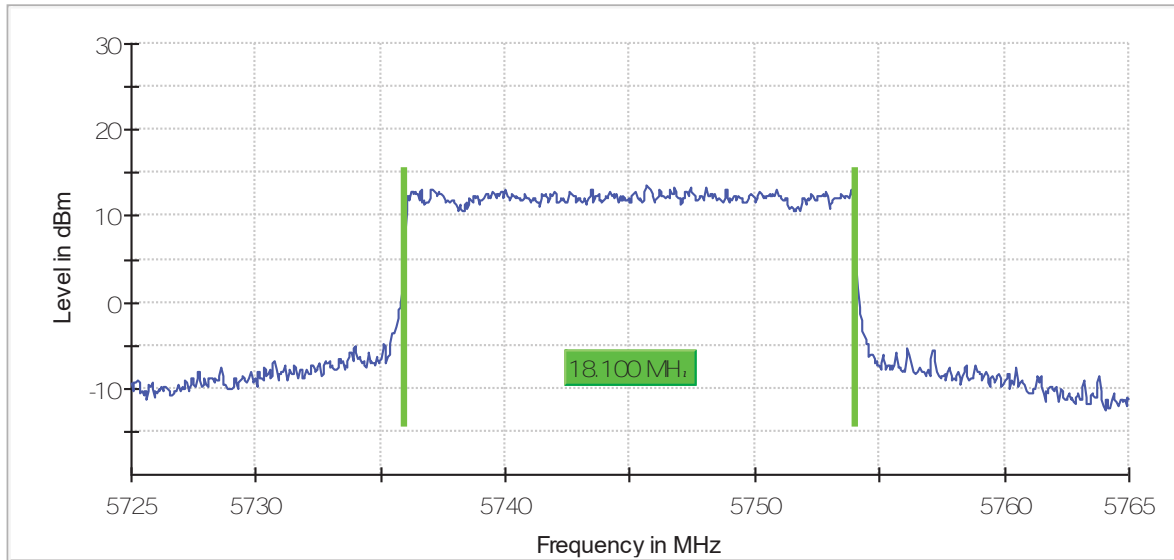
	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	18.100	18.100	18.150
Measurement uncertainty (kHz)	<± 25.02		

Verdict: PASS

### Mode: QPSK – 20 MHz

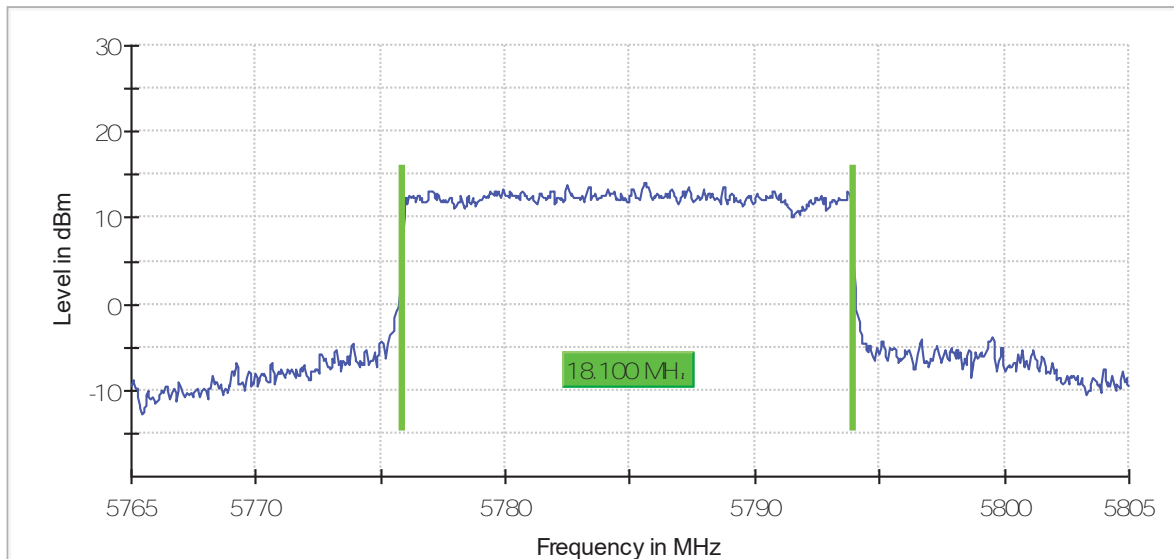
Channel 149

6.8 B B . . . . . id 13



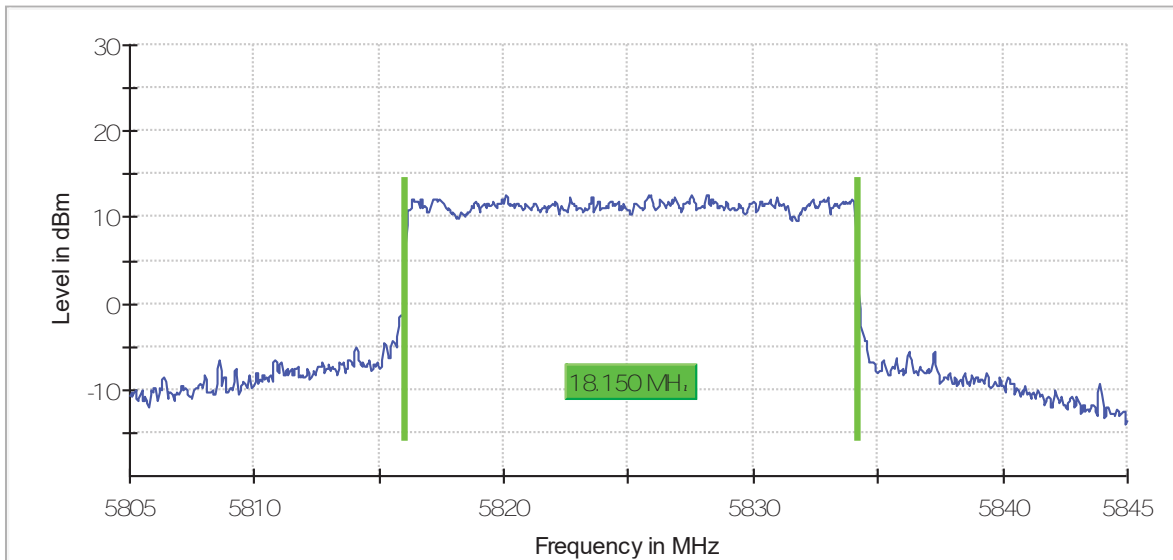
Channel 157

6.8 B B . . . . . id 13



### Channel 165

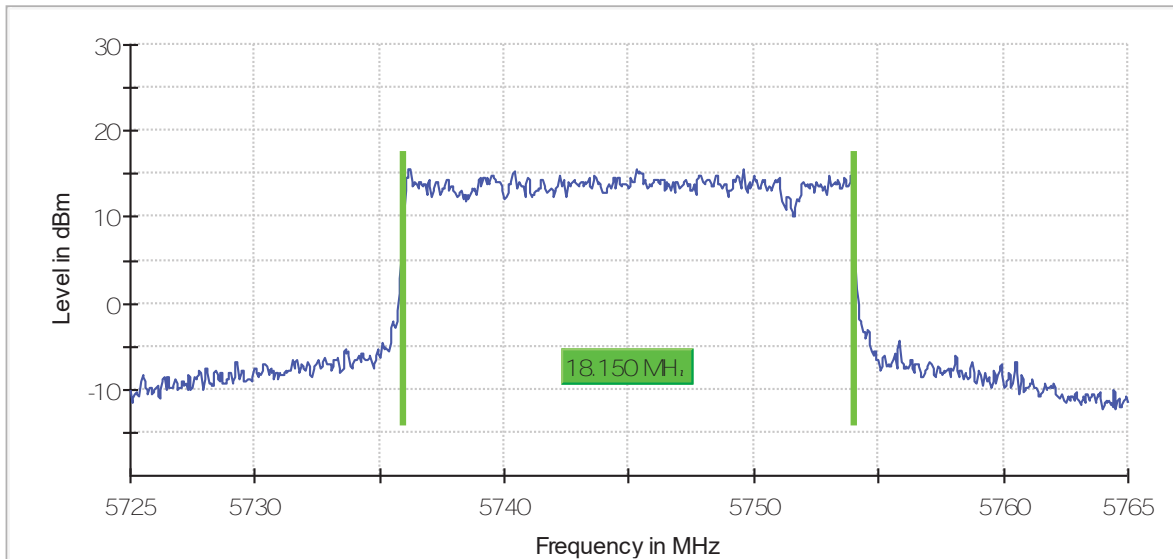
6.4 B B . . . . . i i i i i



### Mode: 16QAM – 20MHz

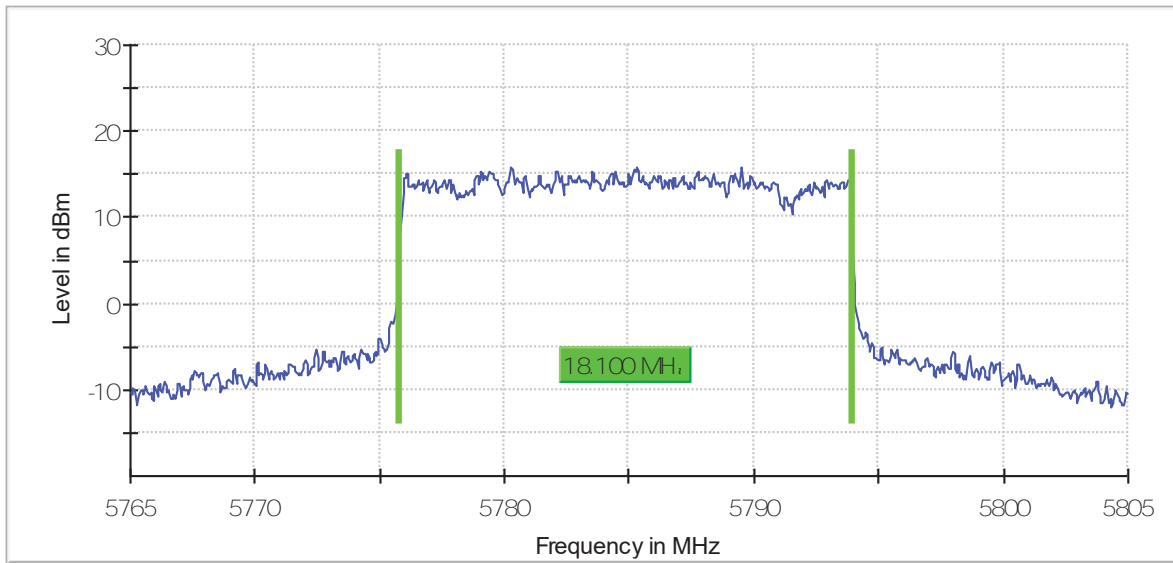
### Channel 149

6.4 B B . . . . . i i i i i



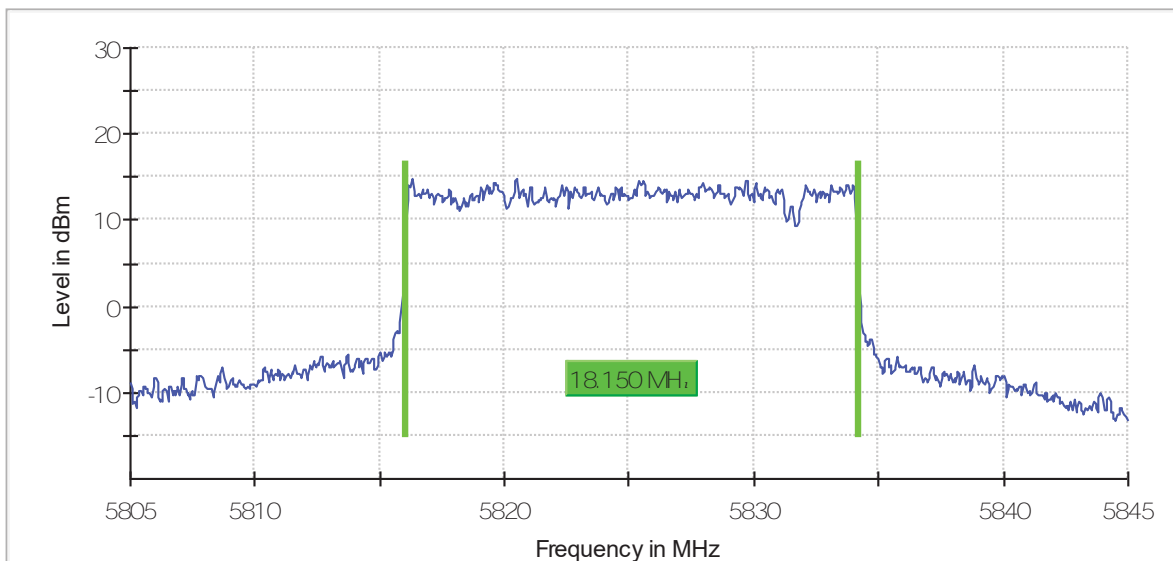
### Channel 157

6.4 B B . . . . .



### Channel 165

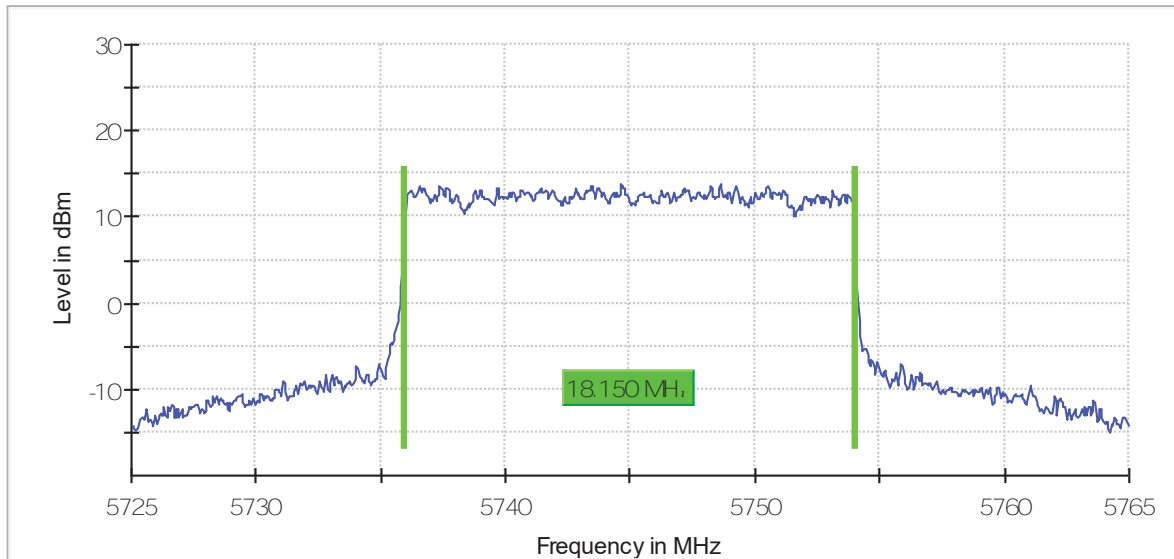
6.4 B B . . . . .



### Mode: 64QAM – 20MHz

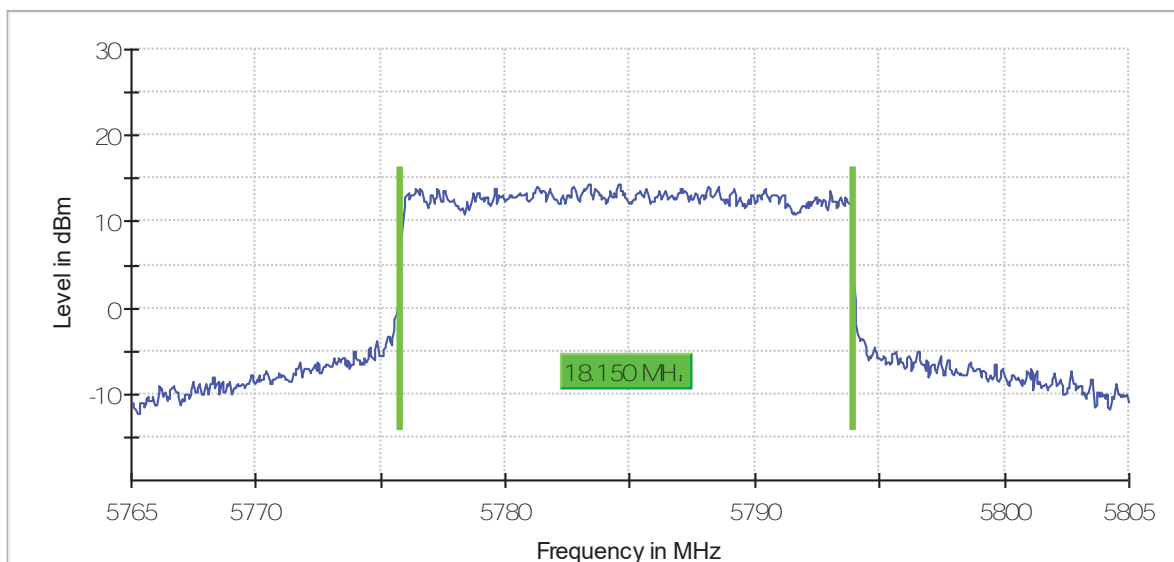
Channel 149

6.8 B B . . . . .



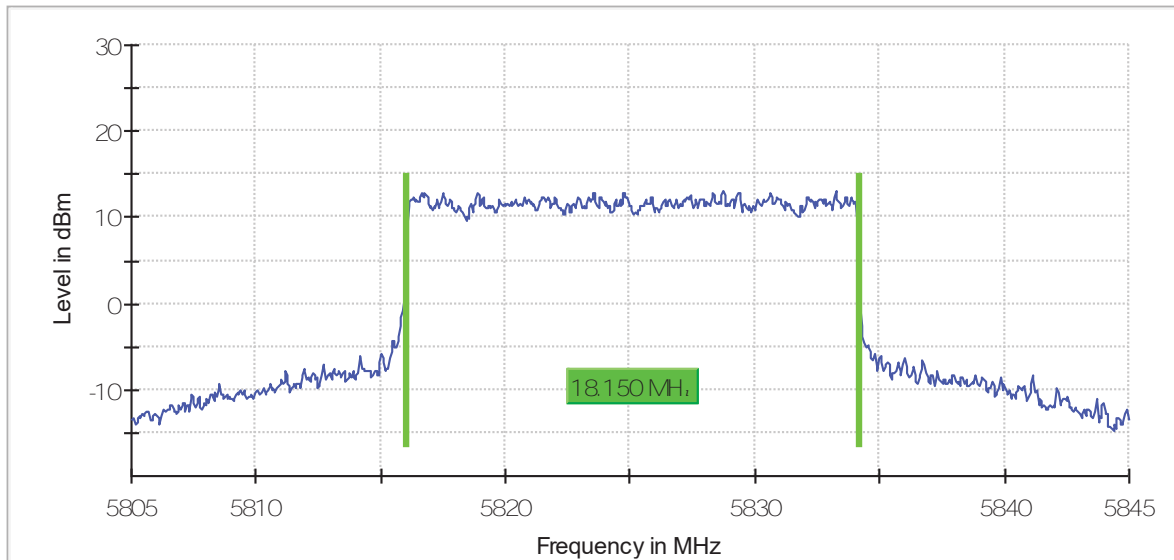
Channel 157

6.8 B B . . . . .



### Channel 165

6.4 B B . . . . .



### Mode: 256QAM – 20MHz

### Channel 149

6.4 B B . . . . .

