REPORT No. : SZ21040239W01

TEST REPORT

APPLICANT	:	MiMOMax Wireless Limited
PRODUCT NAME	:	700MHz Upper A Block TornadoXR Transceiver
MODEL NAME	:	MWL-TORNADOX-*H*A/B/C
BRAND NAME	:	MiMOMax Wireless
FCC ID	:	XMK-MMXTRNXB002
STANDARD(S)	:	47 CFR Part 2 47 CFR Part 27
RECEIPT DATE	:	2021-04-21
TEST DATE	:	2021-04-22 to 2021-06-10
ISSUE DATE	:	2021-07-01

Tested by: Ling Keye (Rapporteur)

Approved by: Shen Junsheng (Supervisor)

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MORLAB

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Change History		
Issue	**Date**	**Reason for change**
1.0	2021-07-01	First edition

1. Technical Information

Note: Provide by applicant.

1.1. Applicant and Manufacturer Information

Applicant:	MiMOMax Wireless Limited
Applicant Address:	540 Wairakei Road, Christchurch 8053, New Zealand
Manufacturer:	MiMOMax Wireless Limited
Manufacturer Address:	540 Wairakei Road, Christchurch 8053, New Zealand

1.2. Equipment Under Test (EUT) Description

Product Name:	700MHz Upper A Block TornadoXR Transceiver
EUT Serial No:	(N/A, marked 6# by test site)
Hardware Version:	P001
Software Version:	TRN_04.08.00.dev12
Operating Frequency Range:	757-758 MHz & 787-788 MHz, 2Tx/2Rx
Channel Bandwidth:	12.5kHz; 25kHz; 50kHz
Modulation Type:	QPSK; 16QAM; 64QAM; 256QAM
Operating Voltage:	10.5-60Vdc
Antenna Type & Gain:	Omni Antenna: 4.0dBi; Panel Antenna: 12.0dBi; Panel Antenna: 16.0dBi
Emission Designator:	12.5kHz:10K3W1W 25.0kHz:21K1W1W 50.0kHz:42K0W1W

1.3. Test Standards and Results

The objective of the report is to perform testing according to 47 CFR Part 2 and Part 27 for the EUT FCC ID Certification:

No.	Identity	Document Title
1	47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
2	47 CFR Part 27	Miscellaneous Wireless Communications Services

Test detailed items/section required by FCC rules and results are listed as below:

No.	Section	Description	Test Date	Test Engineer	Result
1	27.50 2.1046	Power and antenna height limits Radio frequency power output	April 23, 2021	Ling Keye	Complies
2	2.1049	Occupied bandwidth	April 26, 2021	Ling Keye	PASS
3	2.1051 27.53 27.53(c) 27.53(c)(1) 27.53(c)(2) 27.53(c)(3) 27.53(c)(5) 27.53(c)(6)	Conducted spurious emissions at antenna terminals with DUT Operations in the 746 - 758 MHz band 776 - 788 MHz band emissions in763 - 775 MHz and 793 - 805MHz band	May 9, 2021	Ling Keye	PASS
4	2.1053 27.53 27.53(c) 27.53(c)(1) 27.53(c)(2) 27.53(c)(3) 27.53(c)(5) 27.53(c)(6)	Field strength of radiated spurious emissions with DUT Operations in the 746 - 758 MHz band 776 - 788 MHz band Emissions in 763 - 775 MHz and 793 - 805MHz band	April 30, 2021	Gao Jianrou	PASS
5	27.53(f)	Additional emission requirement in 1559 - 1610	May 17, 2021 June 2, 2021	Gao Jianrou	PASS

		MHz band			
6	27.54 2.1055	Frequency stability	May 15, 2021	Ling Keye	PASS

Note 1: The TornadoXR Transceiver complies with FCC 47 CFR Part 2 and Part 27 when tested in accordance with the test methods described in 47 CFR Part 2 and Part 27.
Note 2: The TornadoXR Transceiver supports 2 Tx antenna ports, which was defined as Channel H & Channel V separately.
Note 3: The path loss during the conducted RF test is calibrated to correct the results by the Ext Gain setting. The Ext Gain contains two parts that cable loss of 0.6dB and attenuator of 30.0dB.

1.4. Environmental Conditions

During the measurement, the environmental conditions were within the listed ranges:

Temperature (°C):	15 - 35
Relative Humidity (%):	30 - 60
Atmospheric Pressure (kPa):	86 -106

2. 47 CFR Part 2 and Part 27 Requirements

2.1. Radio Frequency Power Output and E.R.P.

2.1.1. Test result

Nominal Frequency: 757.050 MHz Tx Port: Channel H

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Rated Power (Watt)	E.R.P. (ANT Gain = 4.0dBi)		E.R.P. (ANT Gain = 16.0dBi)	
					dBm	Watt	dBm	Watt
12.5	QPSK	24	34.02	2.51	35.87	3.864	47.87	61.235
12.5	16QAM	24	33.95	2.51	35.80	3.802	47.80	60.256
12.5	64QAM	24	34.03	2.51	35.88	3.873	47.88	61.376
12.5	256QAM	24	34.08	2.51	35.93	3.917	47.93	62.087
25.0	QPSK	24	33.97	2.51	35.82	3.819	47.82	60.534
25.0	16QAM	24	33.97	2.51	35.82	3.819	47.82	60.534
25.0	64QAM	24	33.98	2.51	35.83	3.828	47.83	60.674
25.0	256QAM	24	33.91	2.51	35.76	3.767	47.76	59.704
50.0	QPSK	24	33.98	2.51	35.83	3.828	47.83	60.674
50.0	16QAM	24	33.92	2.51	35.77	3.776	47.77	59.841
50.0	64QAM	24	33.96	2.51	35.81	3.811	47.81	60.395
50.0	256QAM	24	34.01	2.51	35.86	3.855	47.86	61.094

Nominal Frequency: 757.050 MHz Tx Port: Channel V

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Rated Power (Watt)	E.R.P. (ANT Gain = 4.0dBi)		E.R.P. (ANT Gain = 16.0dBi)	
					dBm	Watt	dBm	Watt
12.5	QPSK	24	33.94	2.51	35.79	3.793	47.79	60.117
12.5	16QAM	24	33.92	2.51	35.77	3.776	47.77	59.841
12.5	64QAM	24	34.06	2.51	35.91	3.899	47.91	61.802
12.5	256QAM	24	34.09	2.51	35.94	3.926	47.94	62.230
25.0	QPSK	24	33.93	2.51	35.78	3.784	47.78	59.979

25.0	16QAM	24	33.98	2.51	35.83	3.828	47.83	60.674
25.0	64QAM	24	34.00	2.51	35.85	3.846	47.85	60.954
25.0	256QAM	24	34.05	2.51	35.90	3.890	47.90	61.660
50.0	QPSK	24	34.04	2.51	35.89	3.882	47.89	61.518
50.0	16QAM	24	33.95	2.51	35.80	3.802	47.80	60.256
50.0	64QAM	24	34.04	2.51	35.89	3.882	47.89	61.518
50.0	256QAM	24	34.02	2.51	35.87	3.864	47.87	61.235

Nominal Frequency: 787.950 MHz Tx Port: Channel H

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Rated Power (Watt)	E.R.P. (ANT Gain = 4.0dBi)		E.R.P. (ANT Gain = 12.0dBi)	
					dBm	Watt	dBm	Watt
12.5	QPSK	24	33.90	2.51	35.75	3.758	43.75	23.714
12.5	16QAM	24	33.89	2.51	35.74	3.750	43.74	23.659
12.5	64QAM	24	33.94	2.51	35.79	3.793	43.79	23.933
12.5	256QAM	24	34.06	2.51	35.91	3.899	43.91	24.604
25.0	QPSK	24	33.96	2.51	35.81	3.811	43.81	24.044
25.0	16QAM	24	33.93	2.51	35.78	3.784	43.78	23.878
25.0	64QAM	24	34.03	2.51	35.88	3.873	43.88	24.434
25.0	256QAM	24	34.05	2.51	35.90	3.890	43.90	24.547
50.0	QPSK	24	34.03	2.51	35.88	3.873	43.88	24.434
50.0	16QAM	24	33.97	2.51	35.82	3.819	43.82	24.099
50.0	64QAM	24	34.04	2.51	35.89	3.882	43.89	24.491
50.0	256QAM	24	34.03	2.51	35.88	3.873	43.88	24.434

Nominal Frequency: 787.950 MHz Tx Port: Channel V

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Rated Power (Watt)	E.R.P. (ANT Gain = 4.0dBi)		E.R.P. (ANT Gain = 12.0dBi)	
					dBm	Watt	dBm	Watt
12.5	QPSK	24	33.97	2.51	35.82	3.819	43.82	24.099
12.5	16QAM	24	33.96	2.51	35.81	3.811	43.81	24.044
12.5	64QAM	24	33.94	2.51	35.79	3.793	43.79	23.933

12.5	256QAM	24	34.05	2.51	35.90	3.890	43.90	24.547
25.0	QPSK	24	33.92	2.51	35.77	3.776	43.77	23.823
25.0	16QAM	24	33.90	2.51	35.75	3.758	43.75	23.714
25.0	64QAM	24	33.96	2.51	35.81	3.811	43.81	24.044
25.0	256QAM	24	34.03	2.51	35.88	3.873	43.88	24.434
50.0	QPSK	24	33.97	2.51	35.82	3.819	43.82	24.099
50.0	16QAM	24	33.90	2.51	35.75	3.758	43.75	23.714
50.0	64QAM	24	33.91	2.51	35.76	3.767	43.76	23.768
50.0	256QAM	24	33.93	2.51	35.78	3.784	43.78	23.878

Note 1: Measurements were carried out at the RF output terminals of the transmitter using spectrum analyzer. The path loss during the conducted RF test is calibrated to correct the results by the Ext Gain setting. The Ext Gain contains two parts that cable loss of 0.6dB and attenuator of 30.0dB.

Note 2: The transmitter has a rated output power of 2.51 Watt(34dBm). The measured power has been shown to be within +/- 1 dB of the rated power.

Note 3: E.I.R.P. (dBm) = Conducted Output Power (dBm) + Antenna Gain (dBi); E.R.P. (dBm) = E.I.R.P. (dBm) - 2.15.

Note 4: Part 27 does not specify the transmitter output power.

Subpart C Section 27.50 (b)(1) states that fixed and base station transmitters in the 757-758 MHz band must not exceed 1000 watts ERP.

Subpart C Section 27.50 (b)(9) states that for control stations and mobile stations transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands and fixed stations transmitting in the 787-788 MHz and 805-806 MHz bands are limited to 30 watts ERP.

Note 5: The product's antenna is a special MIMO antenna with cross-polarization which is able to transmit and receive on both the vertical and horizontal polarizations at the same time, the MIMO antennas are essentially two antennas in one.

Note 6: According to KDB 662911, the MIMO directional gain is the gain of an individual antenna.

Note 7: The DUT transmitter ports are completely uncorrelated. According to KDB 662911 the conducted power or E.R.P is measured on each port individually and it complies with the regulations.

Note 8: The product based on the interactive calculation of E.R.P limit value and conducted power, allows the use of an antenna with a maximum gain of 28.06dBi for 757-758MHz and 12.86dBi for 787-788MHz respectively, or an antenna of higher gain with the transmitter power tuned down so can meet the E.R.P requirement.

2.2. Occupied Bandwidth

2.2.1. Definition

The client has declared the following occupied bandwidths for each channel bandwidth:

Frequency(MHz)	Channel Bandwidth(kHz)	Occupied Bandwidth(kHz)
757.050	12.5, 25.0, 50.0	10.3, 21.1, 42.0
787.950	12.5, 25.0, 50.0	10.3, 21.1, 42.0

Note: The above data combined with uncertainty and rounding calculations are consistent with the actual test data.

According to FCC section 2.1049, the occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.
Occupied bandwidth is also known as the 99% emission bandwidth.

2.2.2. Test Description

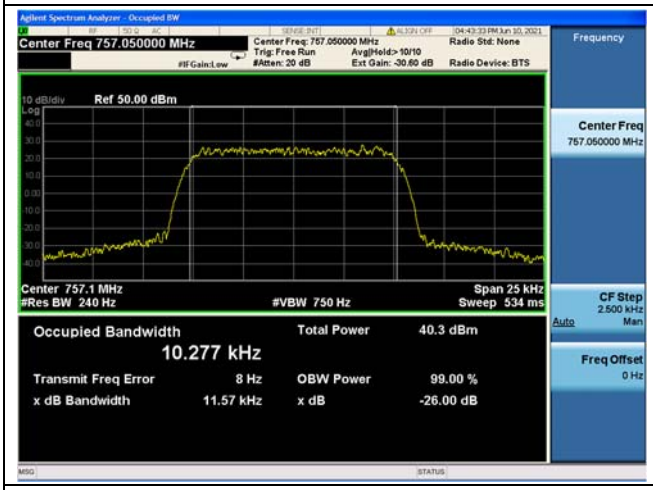
Measurements have been made to verify these declared bandwidths using the generic frequencies that are listed in the table above.
The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client.
Measurements have been made of each modulation type using a spectrum analyzer operating in occupied bandwidth mode.

2.2.3. Test Result

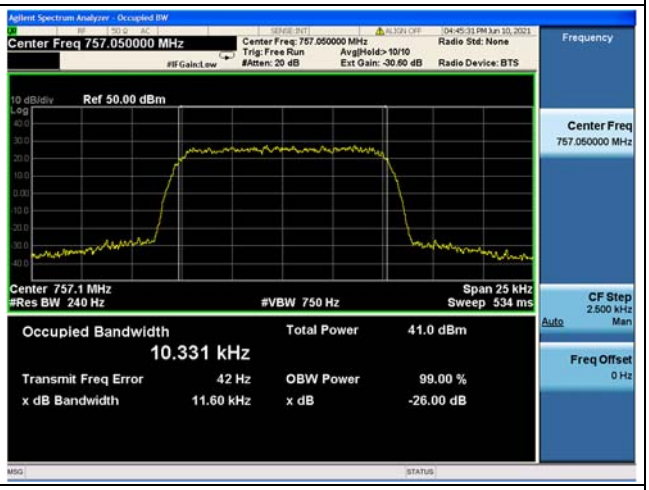
Nominal Frequency: 757.050 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	10.277
		16QAM	10.331
		64QAM	10.325
		256QAM	10.320
	25.0	QPSK	20.828
		16QAM	20.675
		64QAM	20.710
		256QAM	20.694
	50.0	QPSK	41.073
		16QAM	41.032
		64QAM	41.272
		256QAM	41.298
Channel V	12.5	QPSK	10.316
		16QAM	10.311
		64QAM	10.297
		256QAM	10.299
	25.0	QPSK	20.739
		16QAM	20.572
		64QAM	20.606
		256QAM	20.717
	50.0	QPSK	41.306
		16QAM	41.257
		64QAM	41.259
		256QAM	41.292

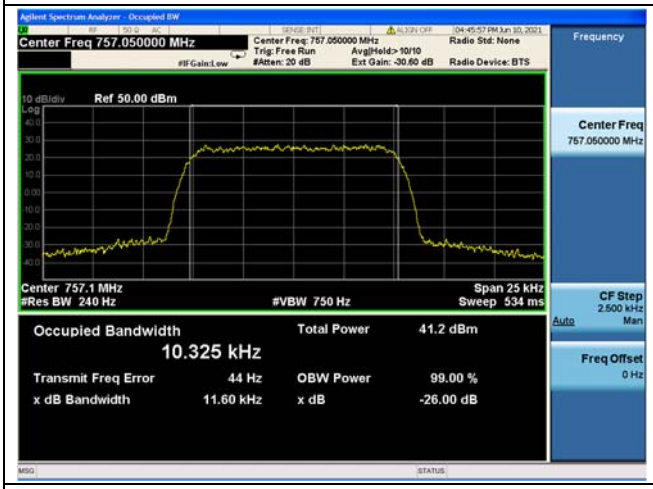
757.050MHz/Channel H/12.5kHz/QPSK



757.050MHz/Channel H/12.5kHz/16QAM



757.050MHz/Channel H/12.5kHz/64QAM



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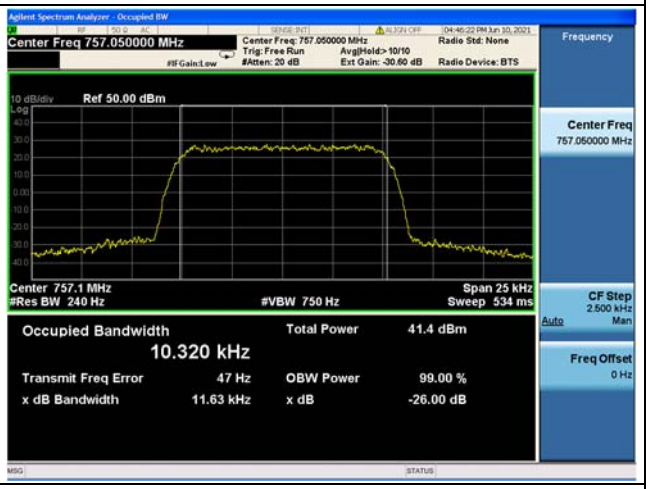

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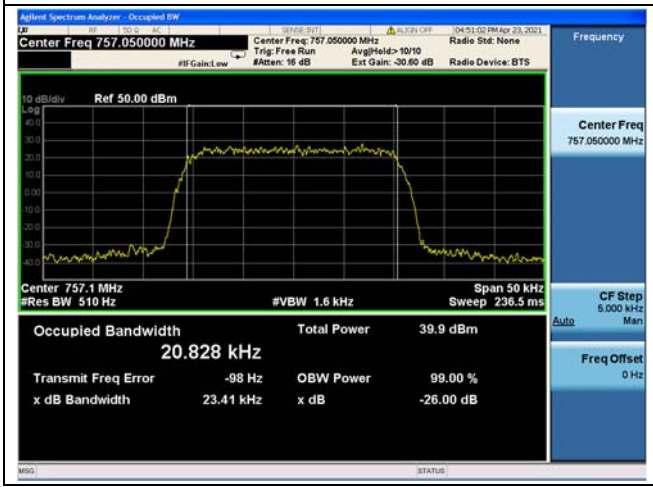

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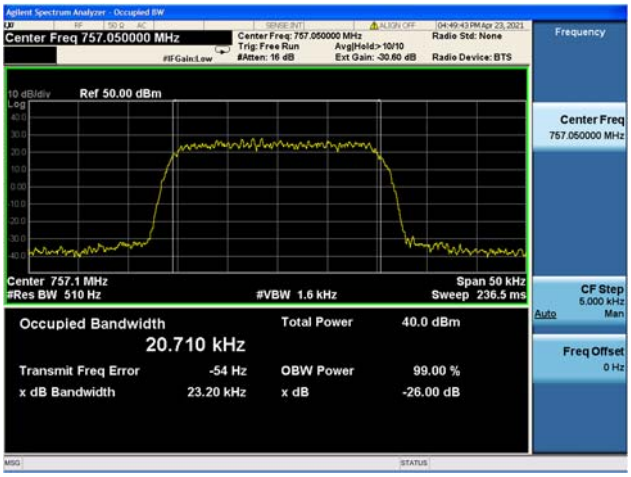
757.050MHz/Channel H/25.0 kHz/64QAM



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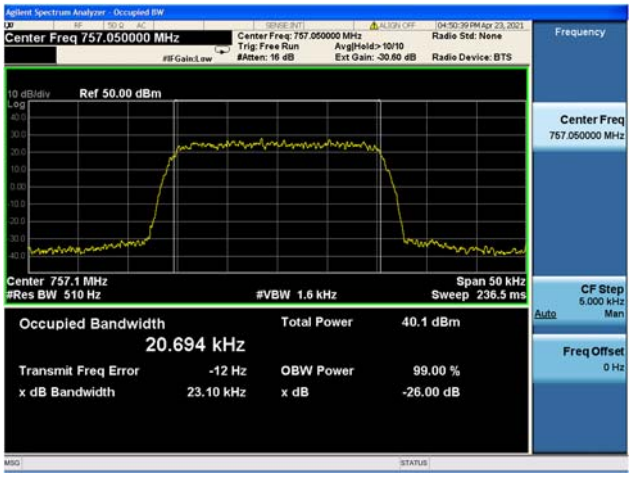
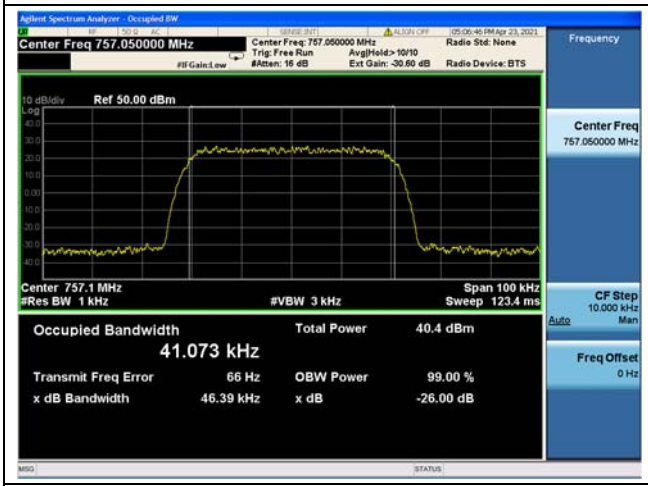


757.050MHz/Channel H/50.0 kHz/QPSK



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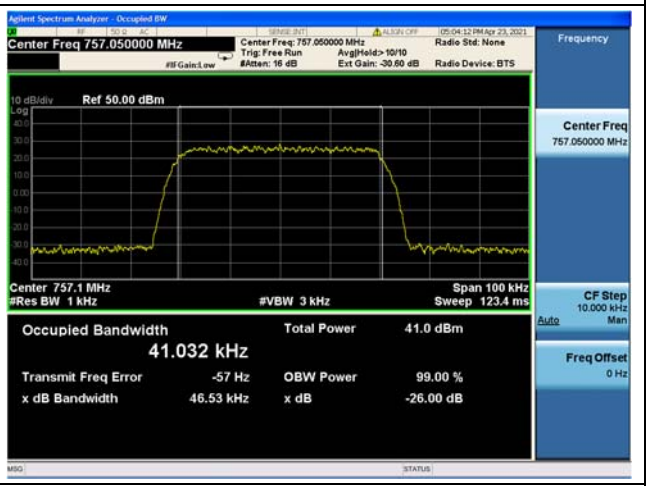
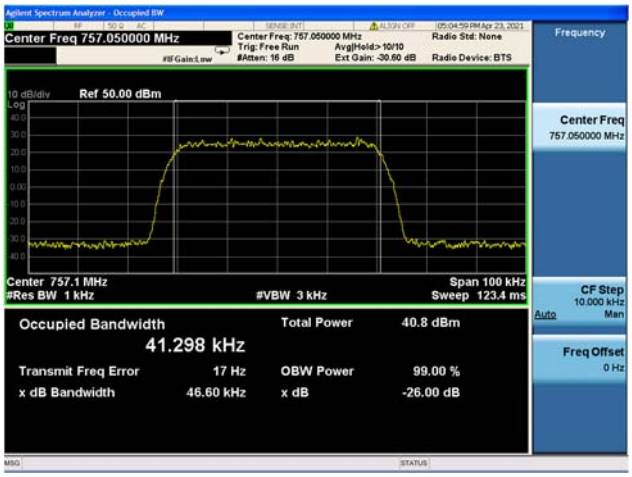


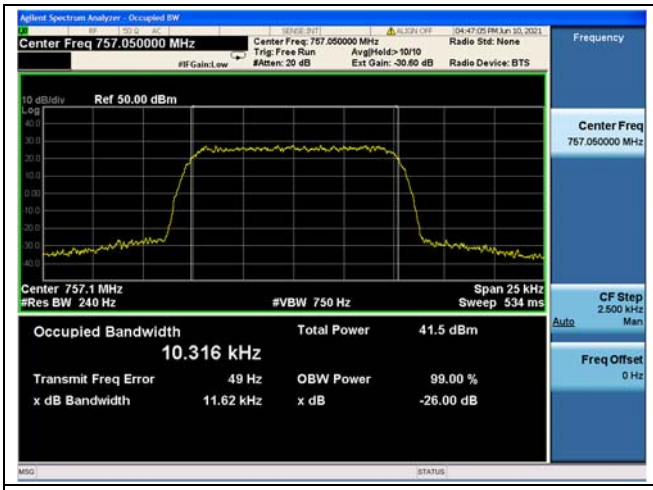
757.050MHz/Channel H/50.0 kHz/64QAM

757.050MHz/Channel H/50.0 kHz/256QAM



757.050MHz/Channel V/12.5kHz/QPSK

757.050MHz/Channel V/12.5kHz/16QAM



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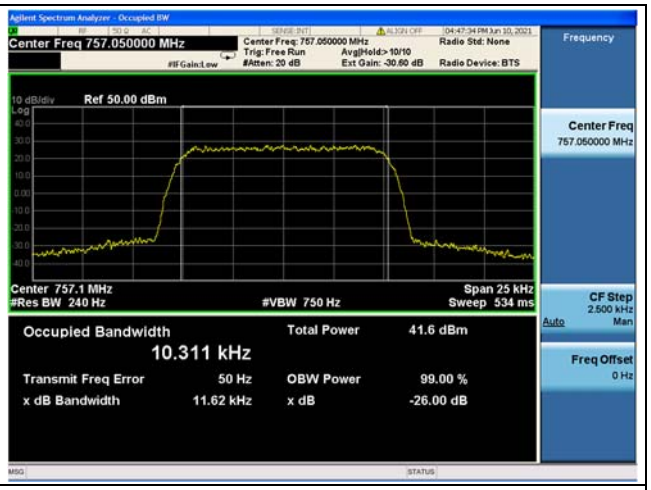

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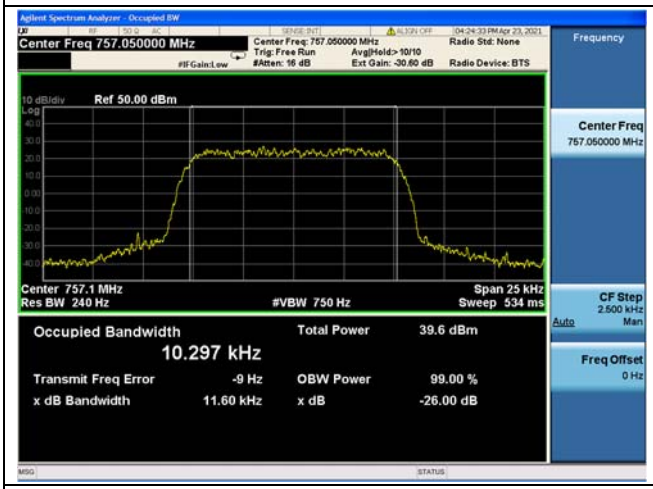

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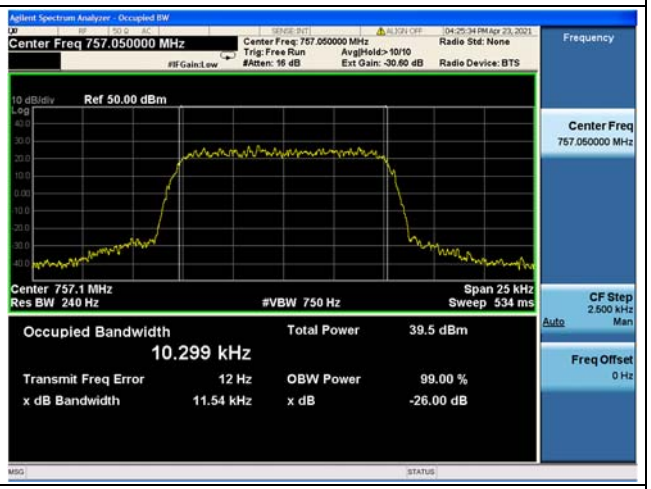

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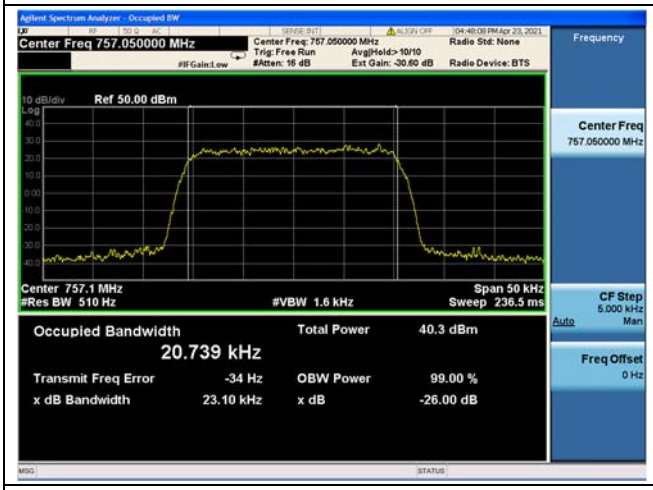

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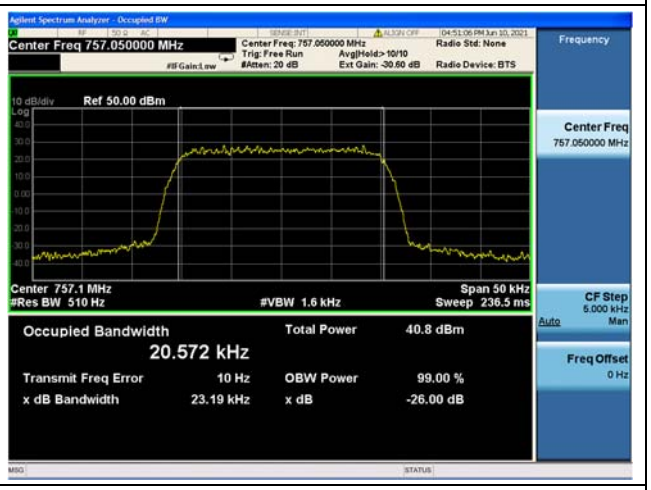
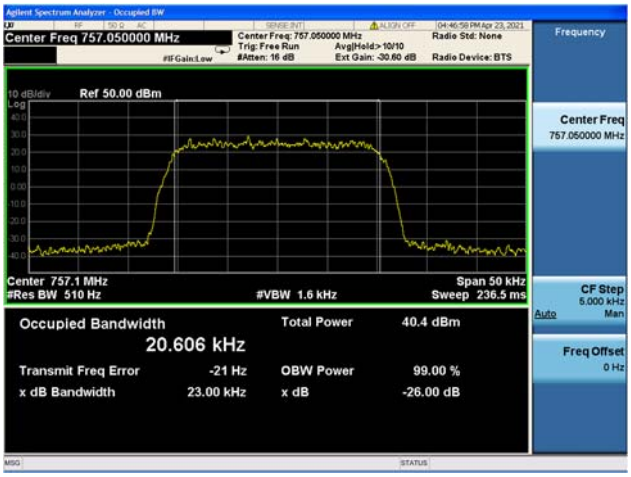


757.050MHz/Channel V/25.0 kHz/256QAM



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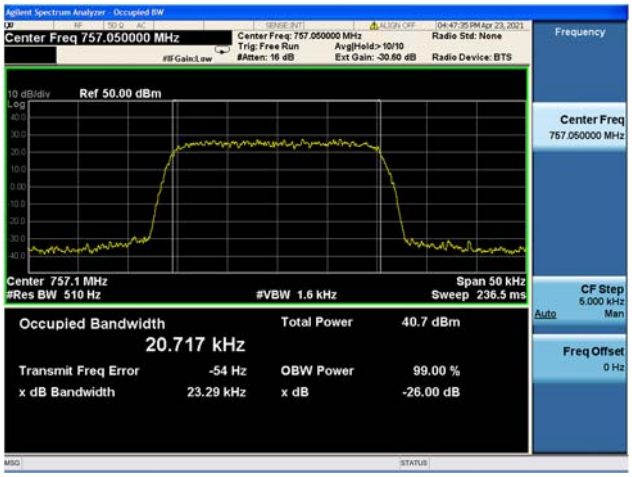

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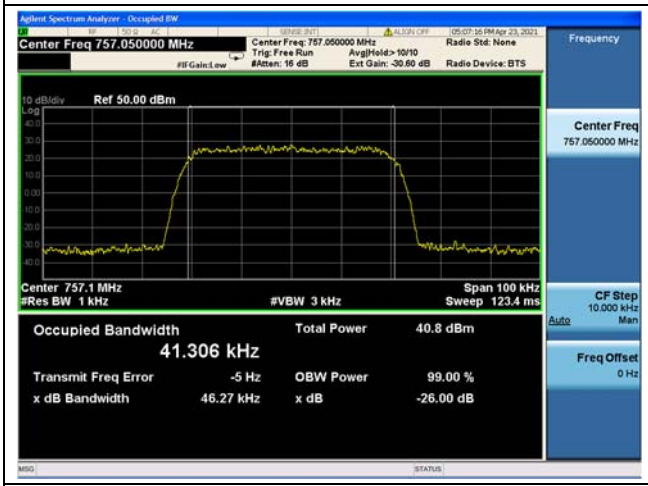

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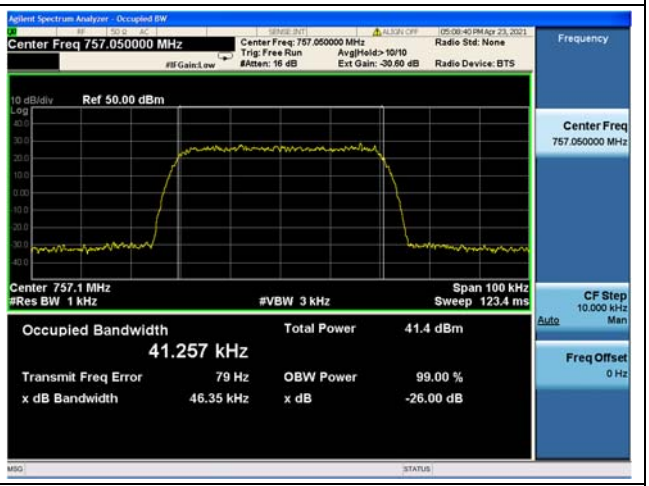
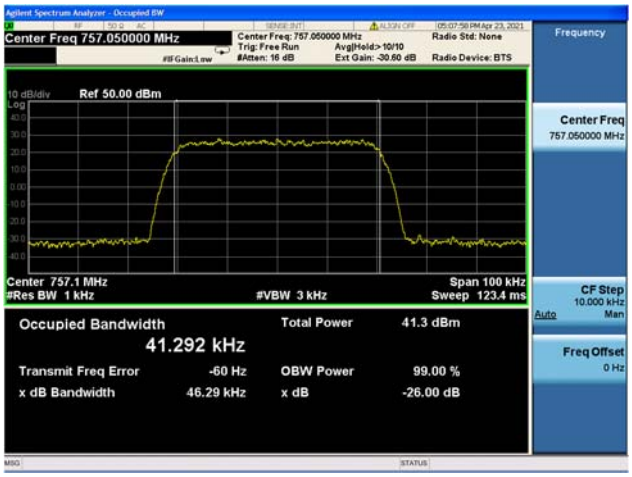


757.050MHz/Channel V/50.0 kHz/256QAM

757.050MHz/Channel V/50.0 kHz/64QAM

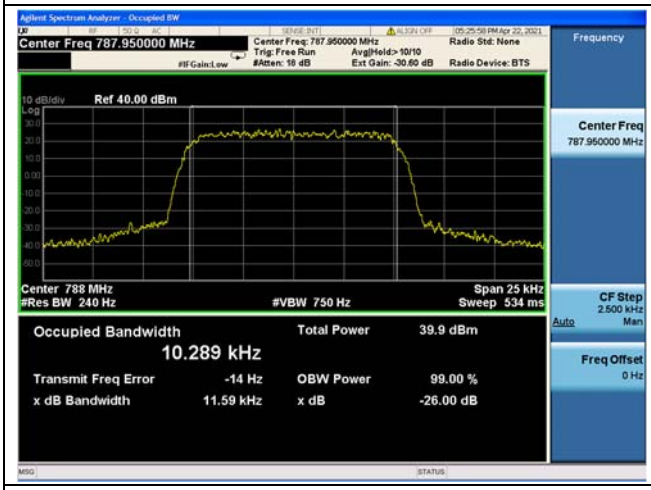


757.050MHz/Channel V/50.0 kHz/256QAM

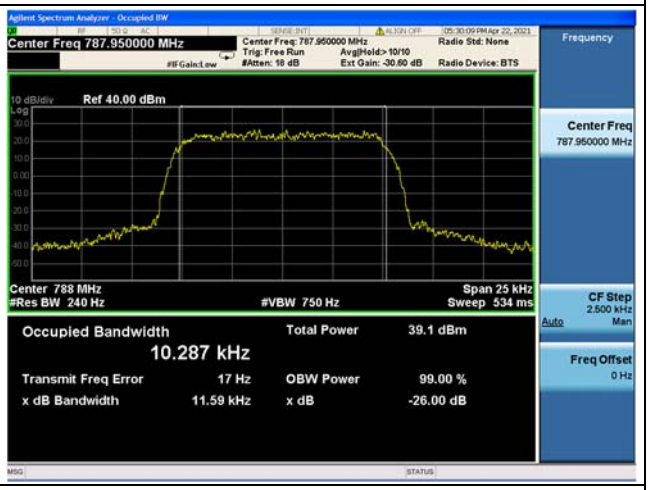
Nominal Frequency: 787.950 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	10.289
		16QAM	10.287
		64QAM	10.299
		256QAM	10.257
	25.0	QPSK	20.693
		16QAM	20.632
		64QAM	20.697
		256QAM	20.767
	50.0	QPSK	41.298
		16QAM	41.277
		64QAM	41.297
		256QAM	41.248
Channel V	12.5	QPSK	10.302
		16QAM	10.291
		64QAM	10.317
		256QAM	10.318
	25.0	QPSK	20.647
		16QAM	20.663
		64QAM	20.780
		256QAM	20.567
	50.0	QPSK	41.260
		16QAM	41.204
		64QAM	41.264
		256QAM	41.256

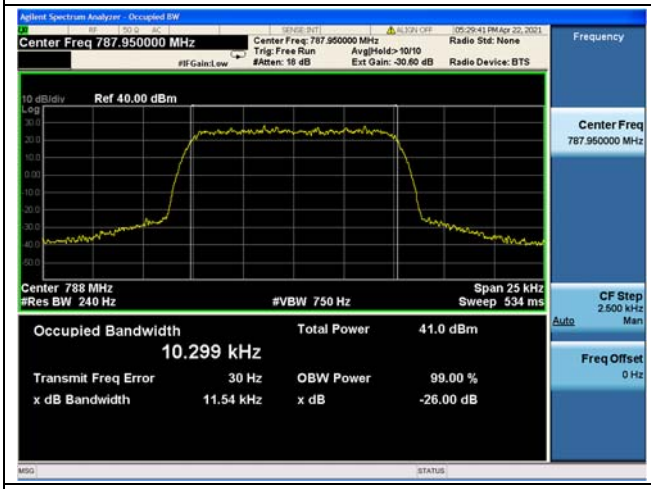
787.950MHz/Channel H/12.5kHz/QPSK



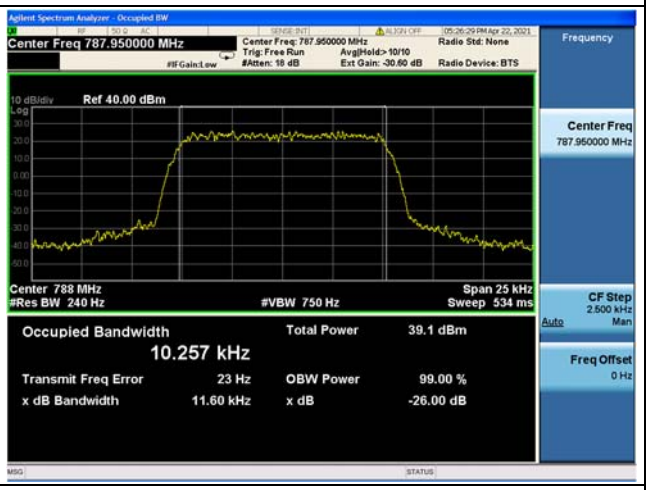
787.950MHz/Channel H/12.5kHz/16QAM



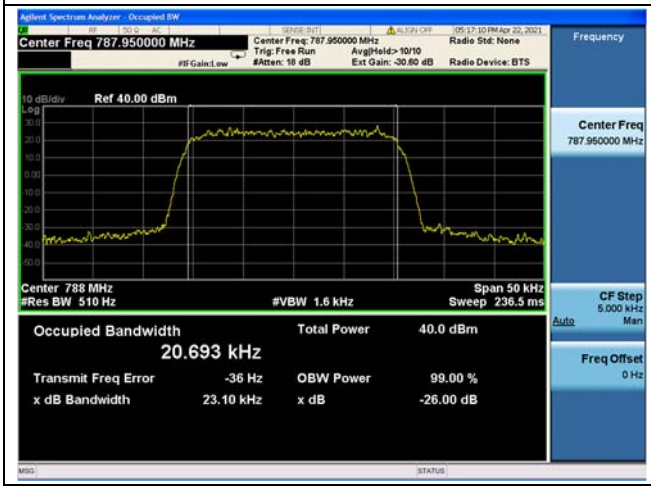
787.950MHz/Channel H/12.5kHz/64QAM



787.950MHz/Channel H/12.5 kHz/256QAM



787.950MHz/Channel H/25.0 kHz/QPSK

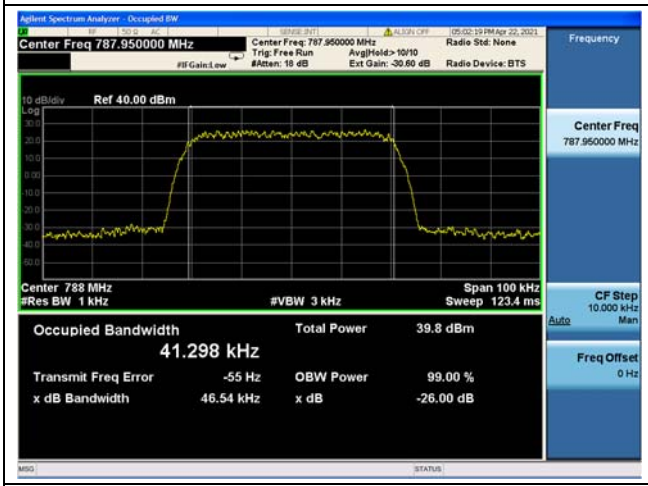


787.950MHz/Channel H/25.0 kHz/16QAM

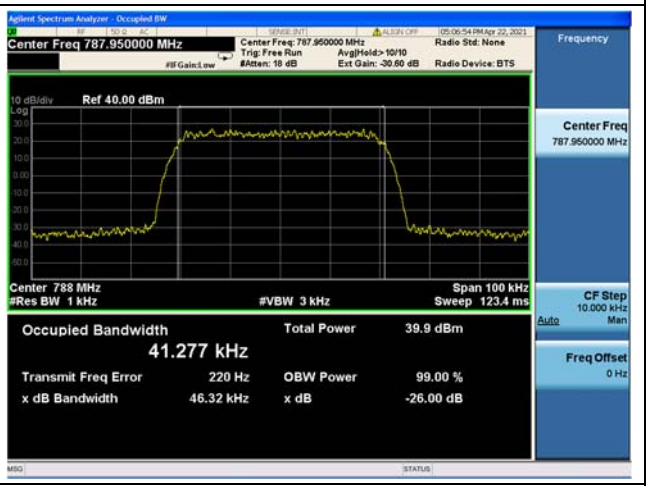
787.950MHz/Channel H/25.0 kHz/64QAM

787.950MHz/Channel H/25.0 kHz/256QAM

787.950MHz/Channel H/50.0 kHz/QPSK

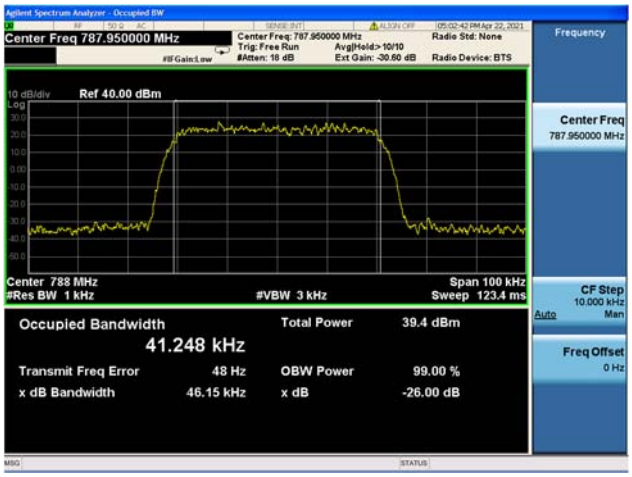


787.950MHz/Channel H/50.0 kHz/16QAM



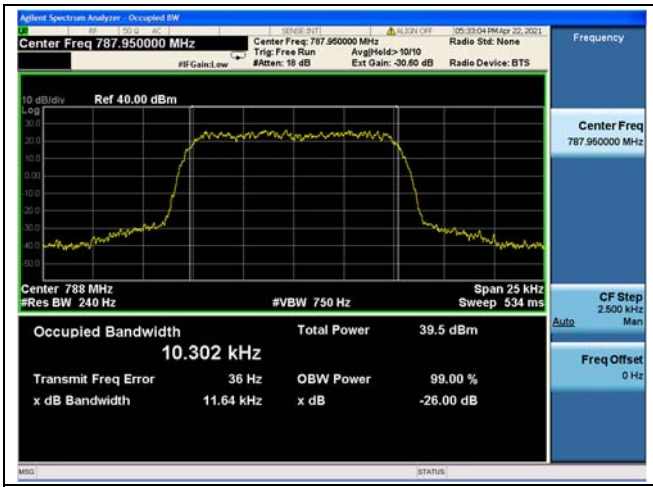
787.950MHz/Channel H/50.0 kHz/64QAM

787.950MHz/Channel H/50.0 kHz/256QAM

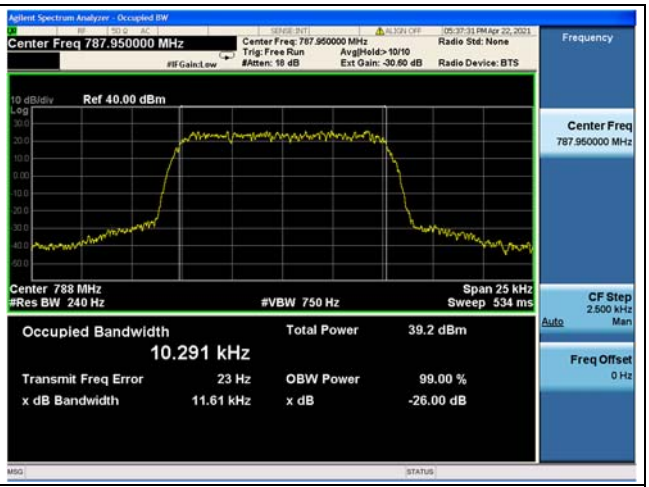


787.950MHz/Channel V/12.5kHz/QPSK

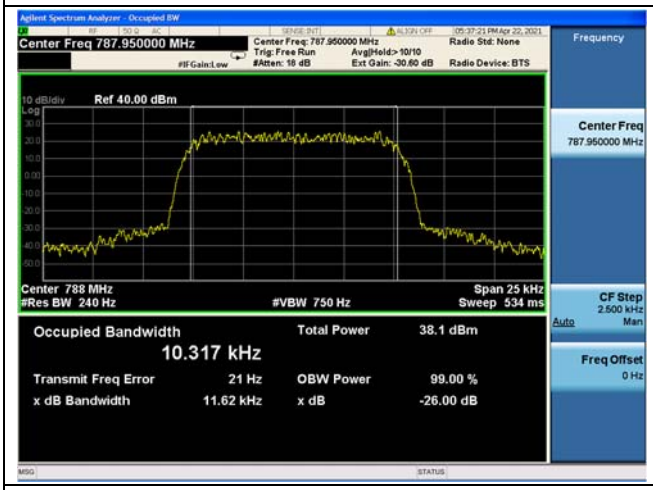
787.950MHz/Channel V/12.5kHz/16QAM



787.950MHz/Channel V/12.5kHz/64QAM

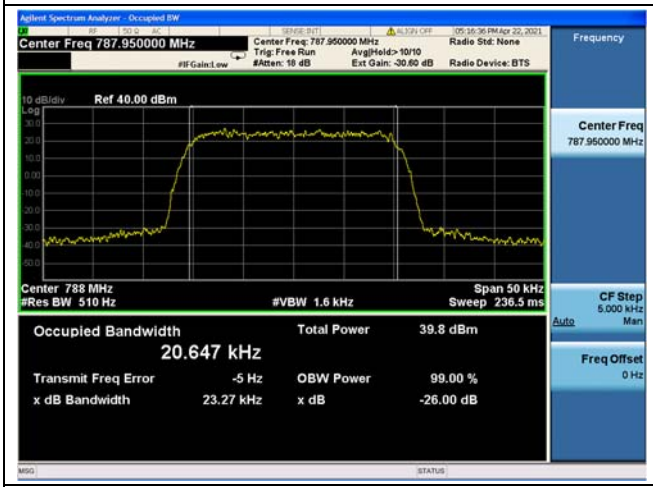


787.950MHz/Channel V/12.5 kHz/256QAM

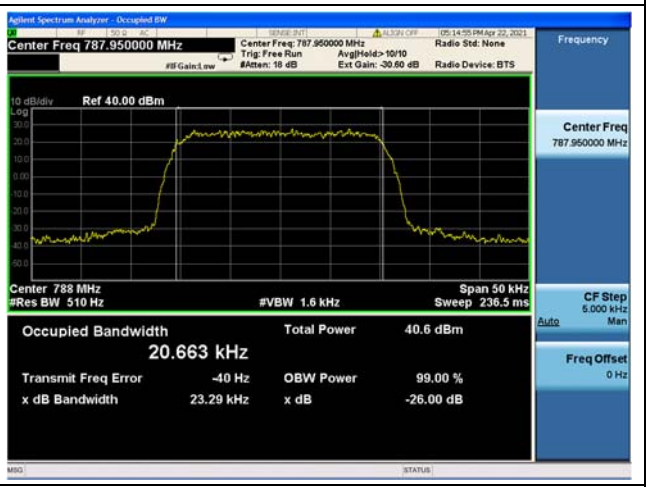


787.950MHz/Channel V/25.0 kHz/QPSK

787.950MHz/Channel V/25.0 kHz/16QAM

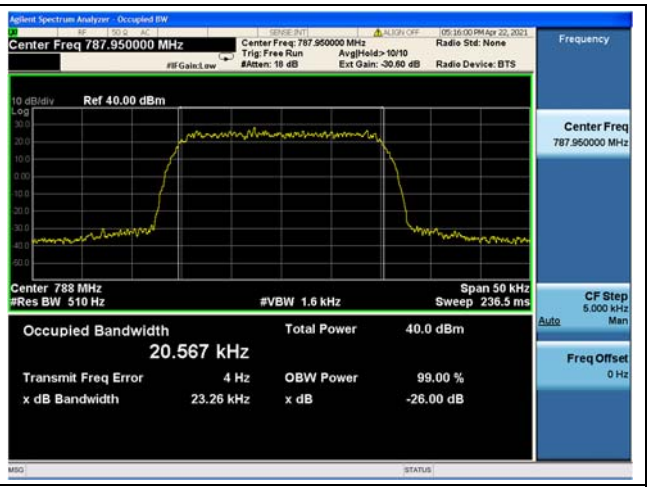


787.950MHz/Channel V/25.0 kHz/64QAM



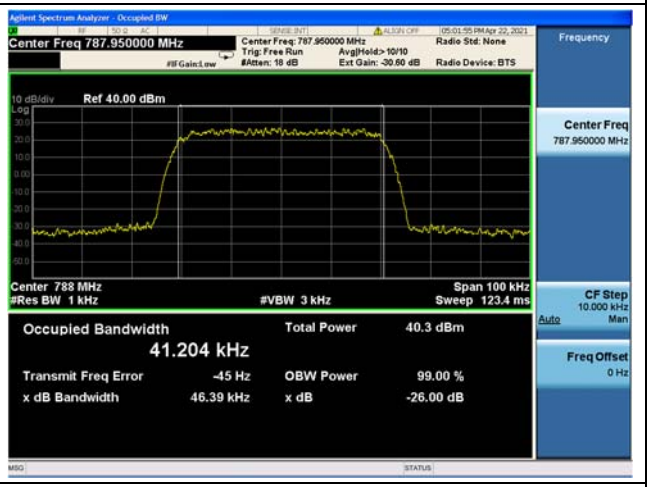
787.950MHz/Channel V/25.0 kHz/256QAM

787.950MHz/Channel V/50.0 kHz/QPSK

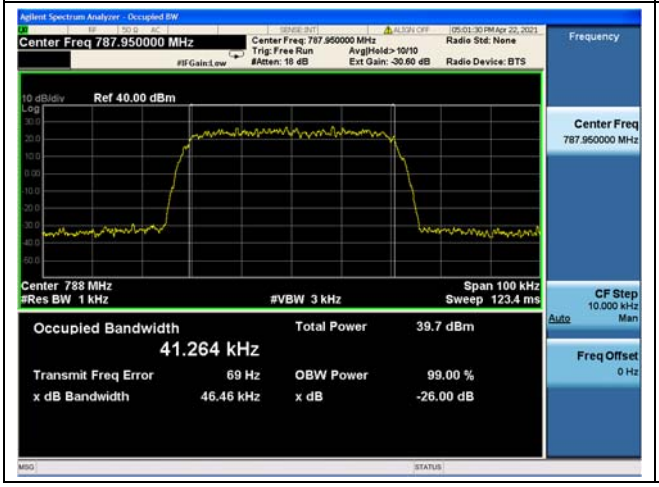


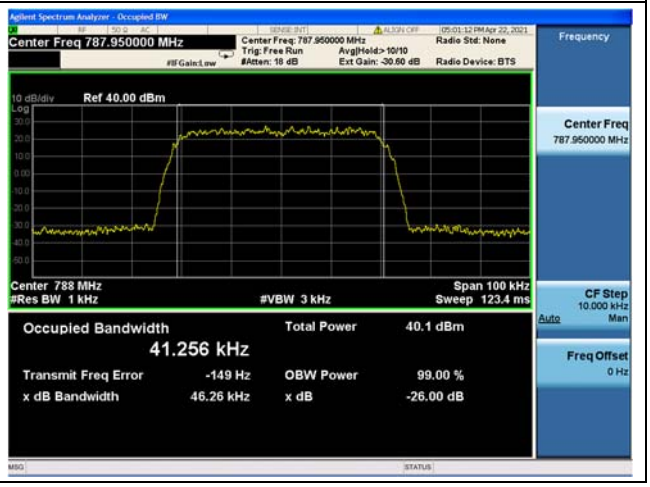
787.950MHz/Channel V/50.0 kHz/16QAM

787.950MHz/Channel V/50.0 kHz/64QAM



787.950MHz/Channel V/50.0 kHz/256QAM





2.3. Spurious Emissions At Antenna Terminals

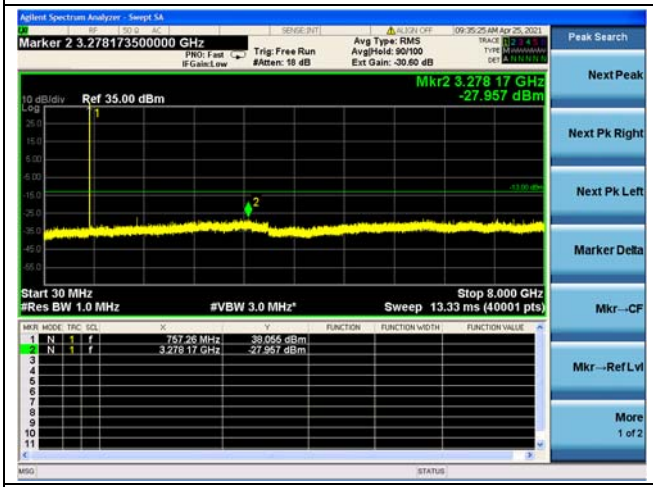
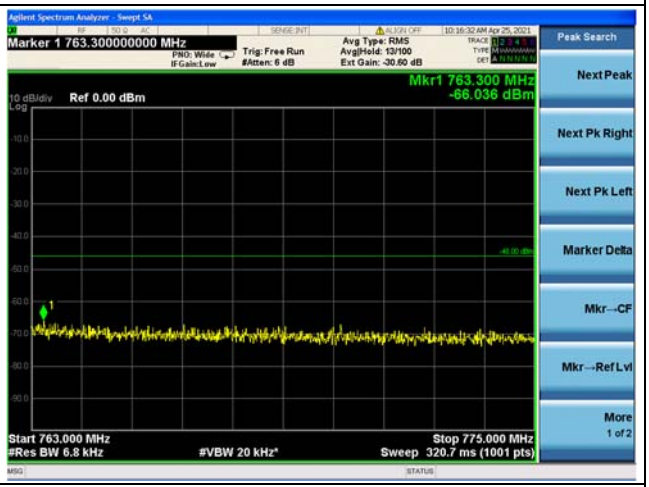
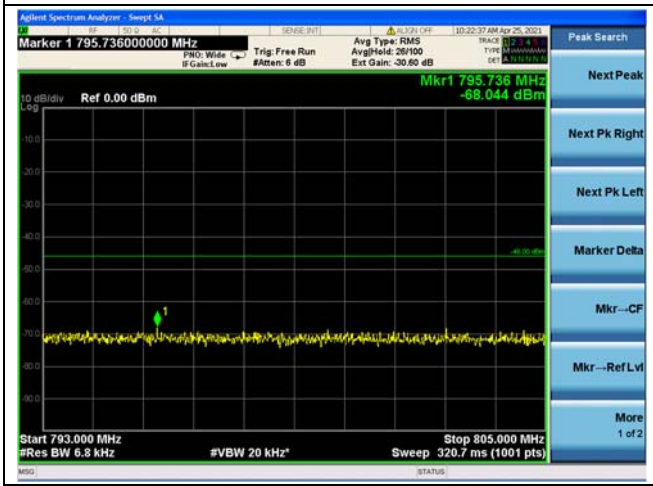
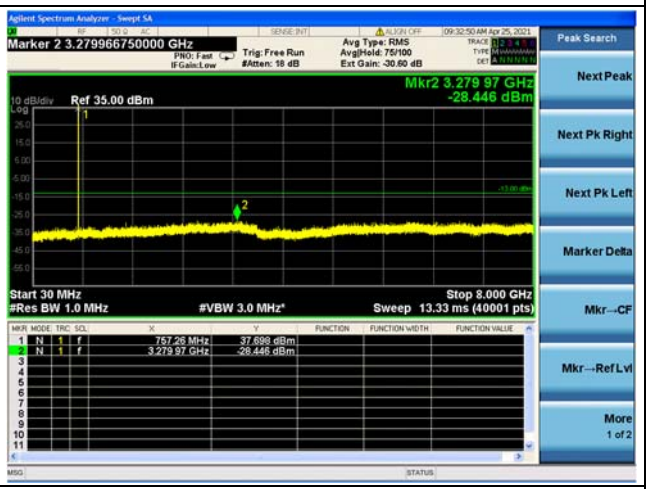
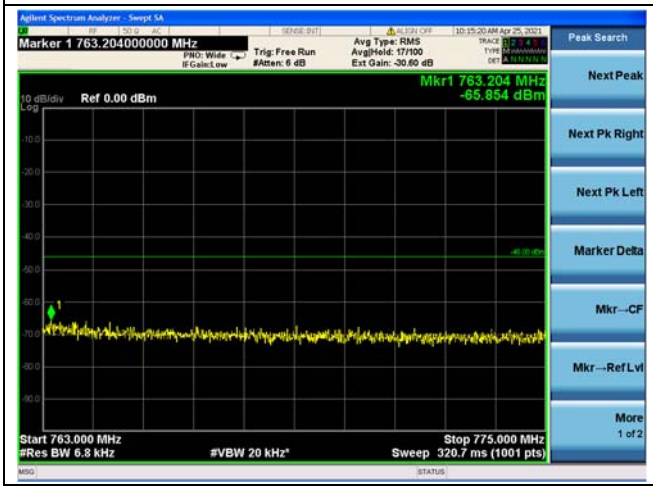
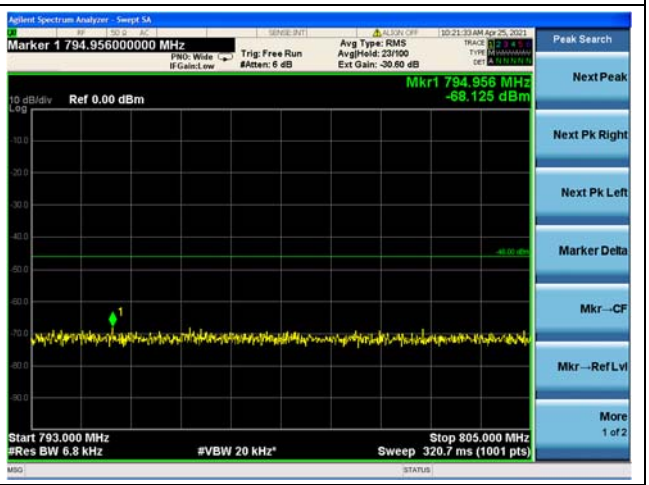
2.3.1. Test Requirement

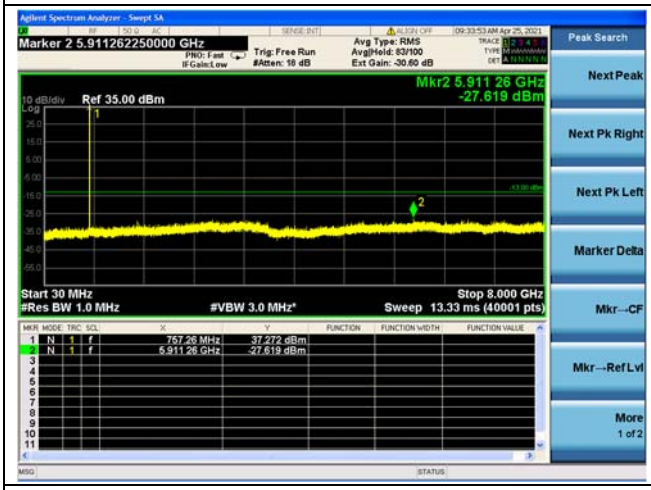
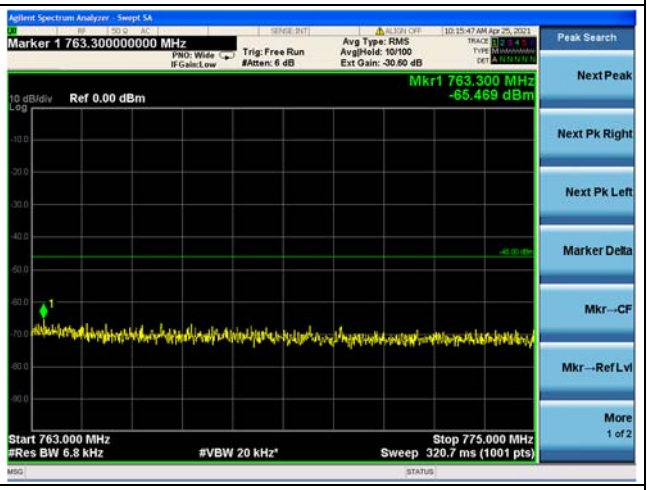
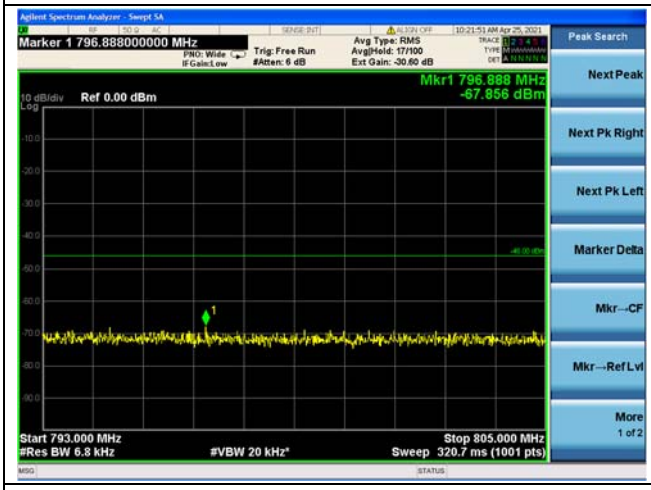
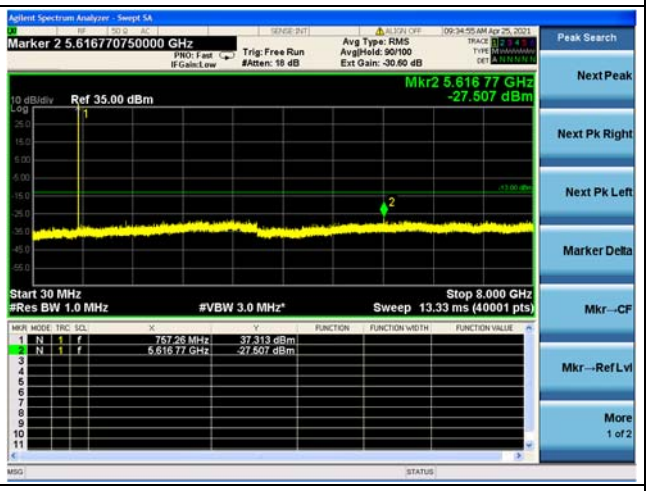
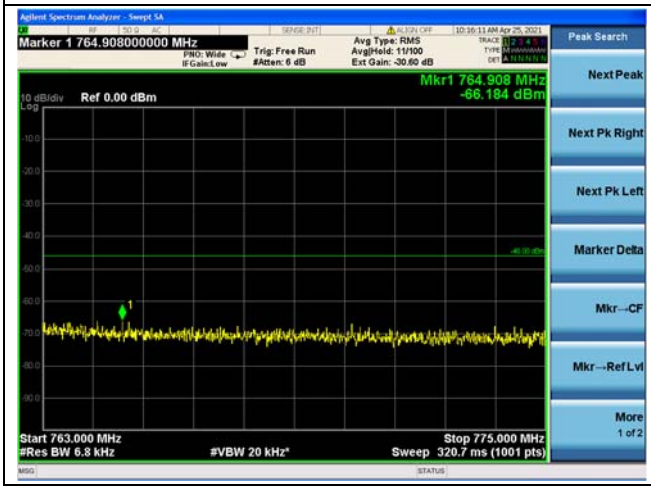
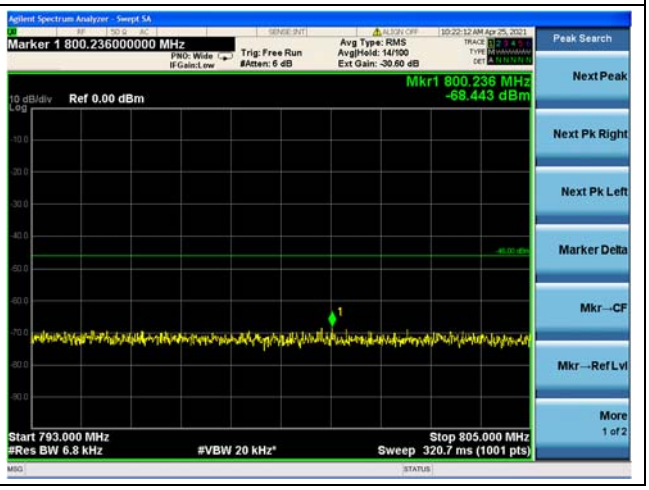
According to FCC section 2.1051 and section 27.53(c). For operations in the 746-758 MHz band and the 776-788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power within the licensed band(s) of operation, measured in watts, in accordance with the following:
(1) On any frequency outside the 746-758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;
(2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;
(3) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations;
(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;
(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

2.3.2. Test Result

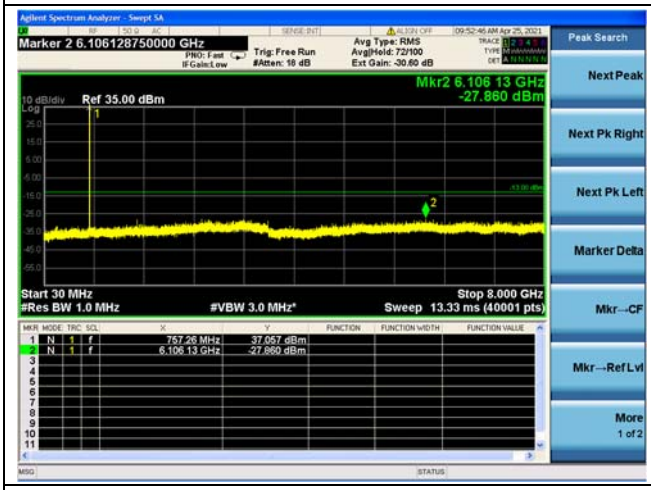
Frequency (MHz)	Tx Port	Measurement Bandwidth	Spurious Span (MHz)	Limit (dBm)	Verdict
757.050	Channel H	1MHz	30 - 8000	-13	Pass
	Channel V	6.25kHz	763-775 & 793-805	-46	Pass
	Channel H	30kHz	Adjacent 100kHz Lower edge	-13	Pass
	Channel V	30kHz	Adjacent 100kHz Lower edge	-13	Pass
	Channel H	30kHz	Adjacent 100kHz Upper edge	-13	Pass
	Channel V	30kHz	Adjacent 100kHz Upper edge	-13	Pass
787.950	Channel H	1MHz	30 - 8000	-13	Pass
	Channel V	6.25kHz	763-775 & 793-805	-46	Pass
	Channel H	30kHz	Adjacent 100kHz Lower edge	-13	Pass
	Channel V	30kHz	Adjacent 100kHz Lower edge	-13	Pass
	Channel H	30kHz	Adjacent 100kHz Upper edge	-13	Pass
	Channel V	30kHz	Adjacent 100kHz Upper edge	-13	Pass

Nominal Frequency: 757.050 MHz Tx Port: Channel H

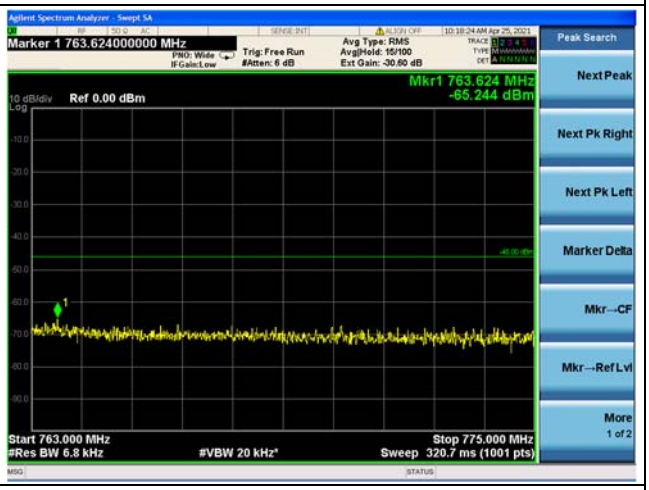
12.5kHz/QPSK	12.5kHz/QPSK 763-775MHz
	
12.5kHz/QPSK 793-805MHz	**12.5kHz/16QAM**
	
12.5kHz/16QAM 763-775MHz	**12.5kHz/16QAM 793-805MHz**
	

12.5kHz/64QAM	12.5kHz/64QAM 763-775MHz
	
12.5kHz/64QAM 793-805MHz	**12.5kHz/256QAM**
	
12.5kHz/256QAM 763-775MHz	**12.5kHz/256QAM 793-805MHz**
	

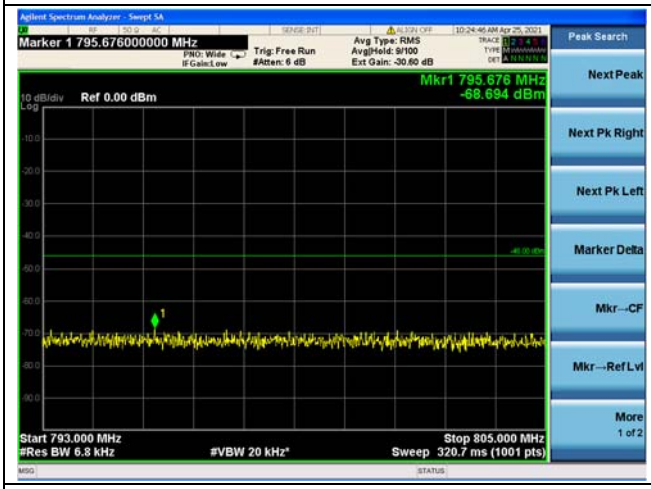
25kHz/QPSK



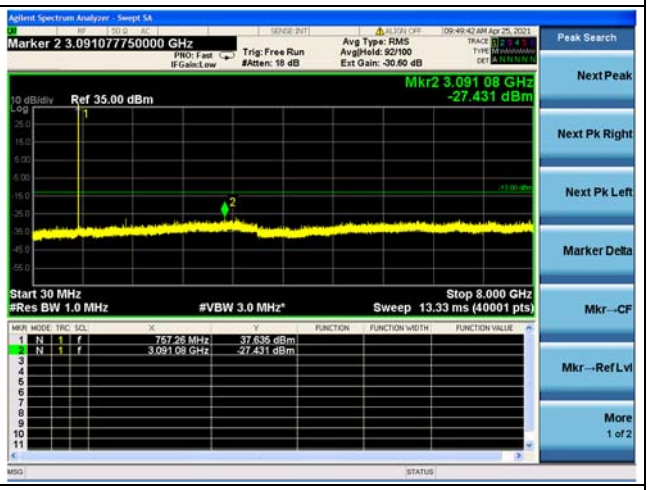
25kHz/QPSK 763-775MHz



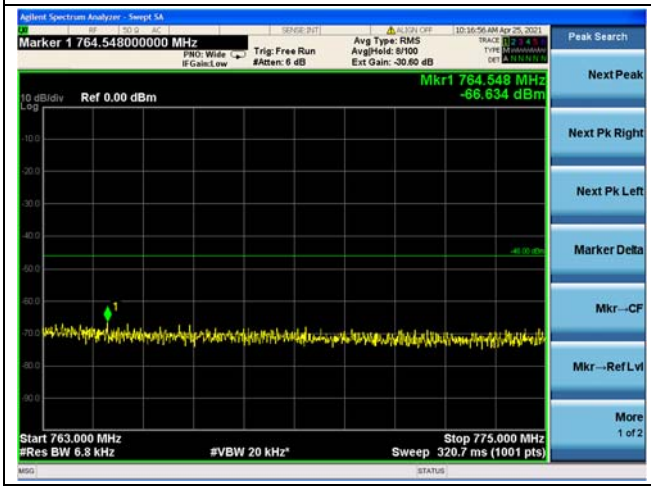
25kHz/QPSK 793-805MHz



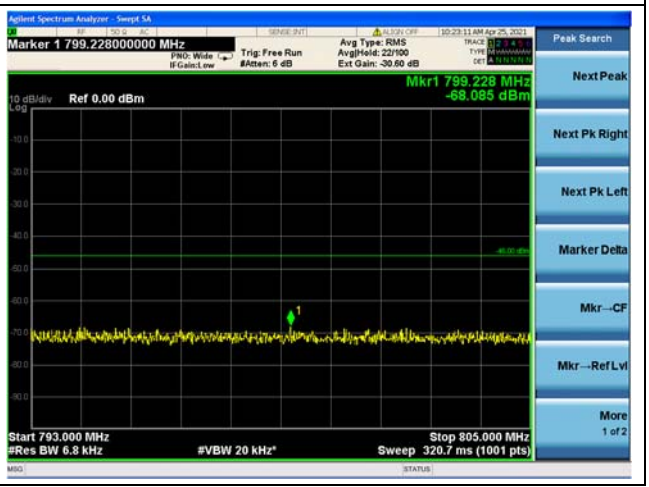
25kHz/16QAM



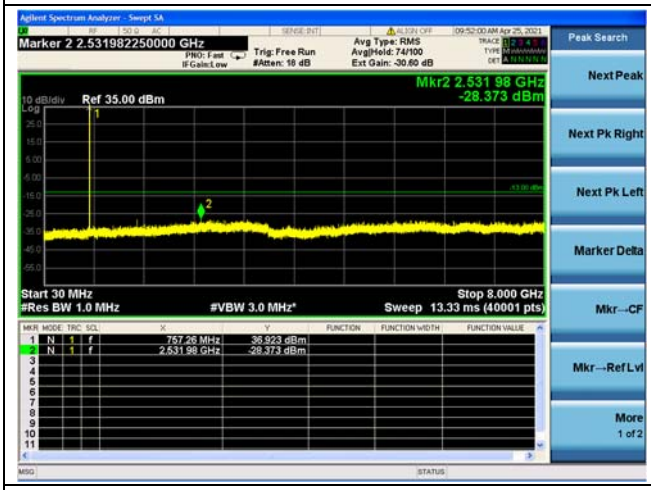
25kHz/16QAM 763-775MHz



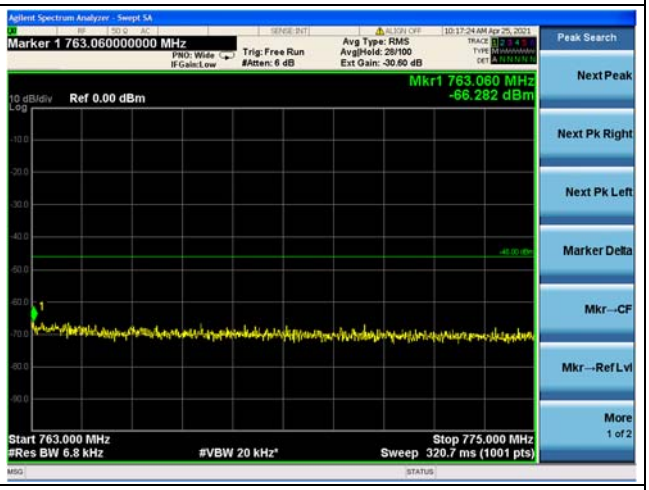
25kHz/16QAM 793-805MHz



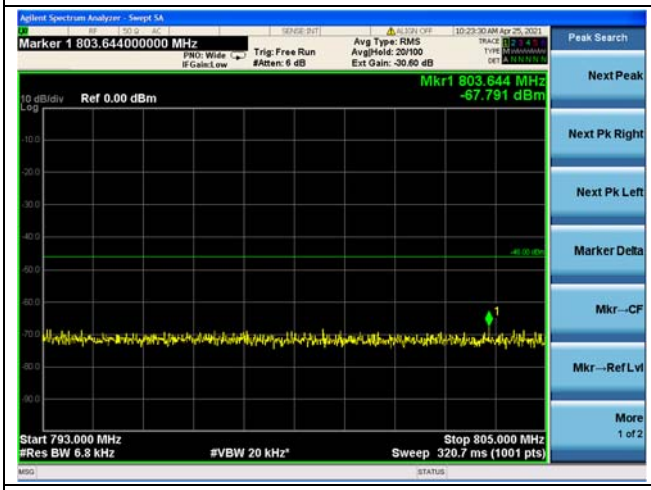
25kHz/64QAM



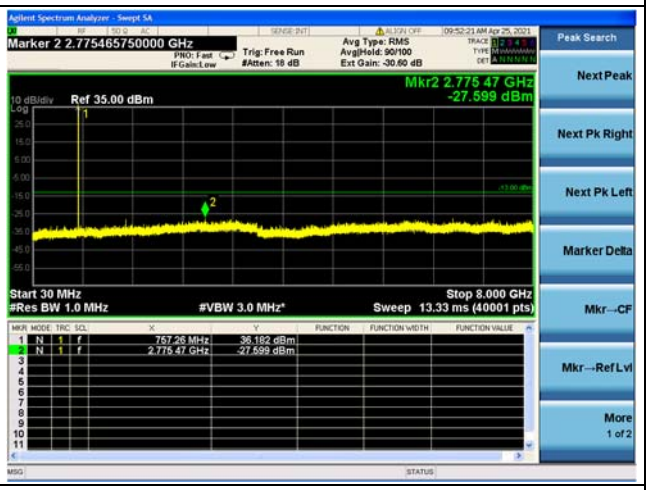
25kHz/64QAM 763-775MHz



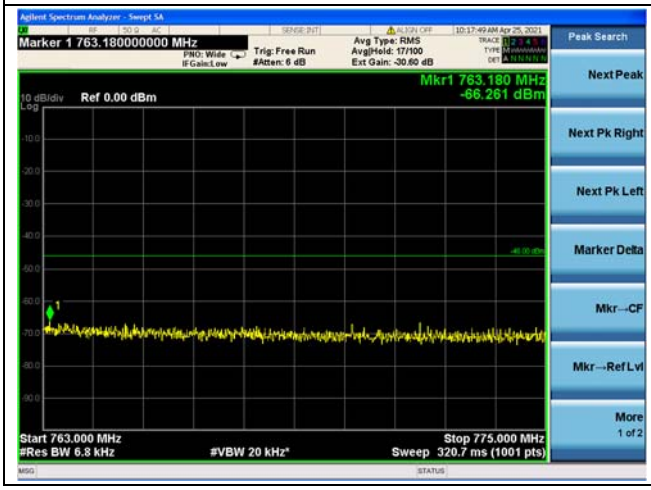
25kHz/64QAM 793-805MHz



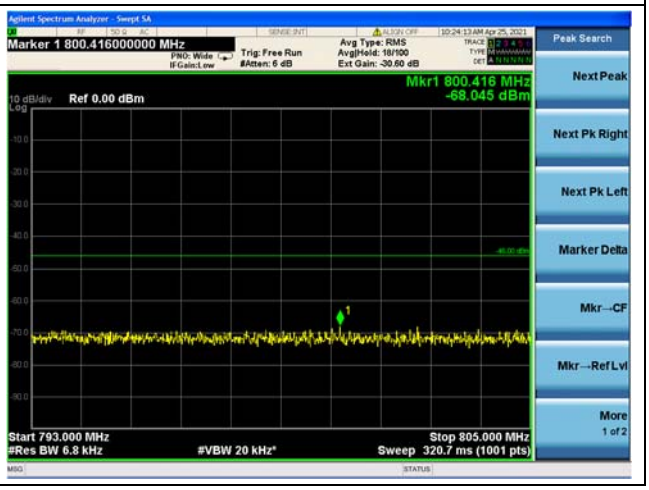
25kHz/256QAM



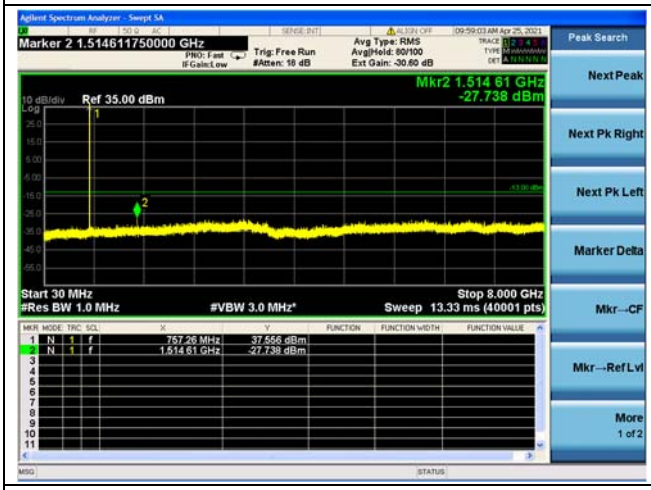
25kHz/256QAM 763-775MHz



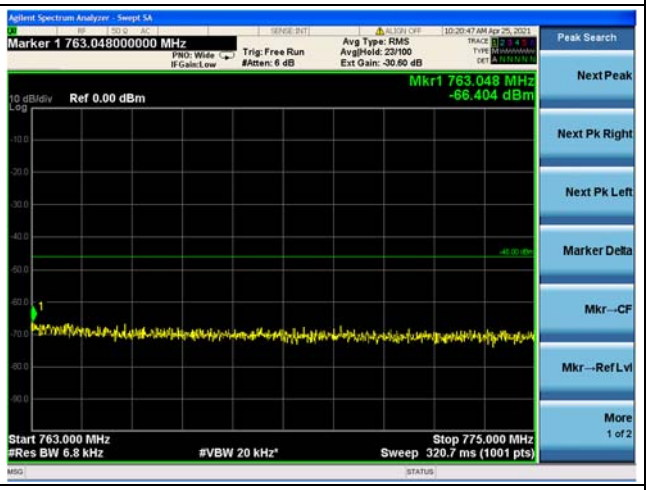
25kHz/256QAM 793-805MHz



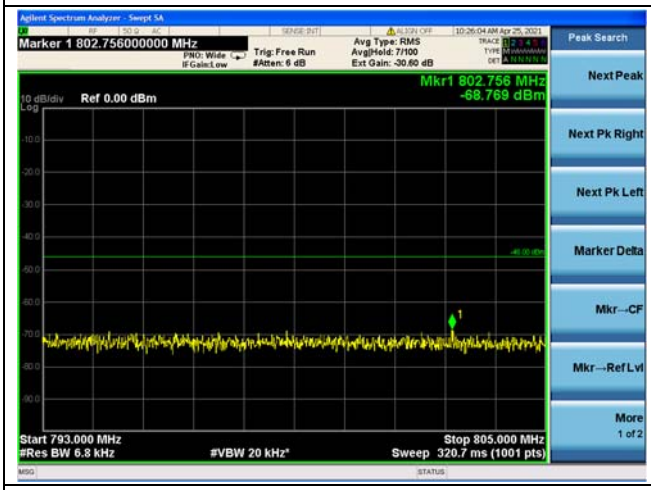
50kHz/QPSK



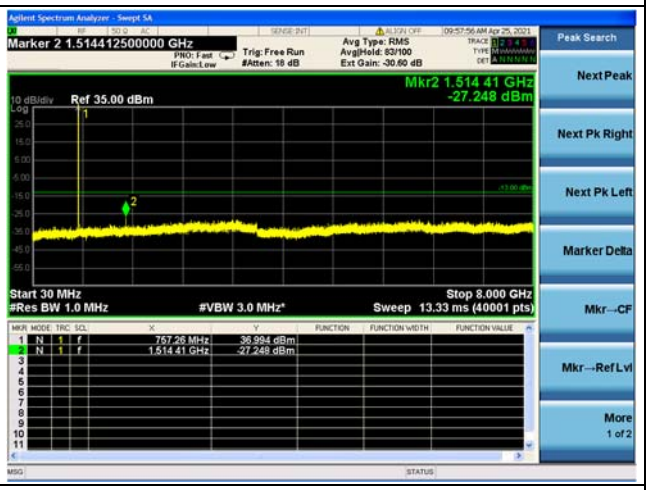
50kHz/QPSK 763-775MHz



50kHz/QPSK 793-805MHz



50kHz/16QAM



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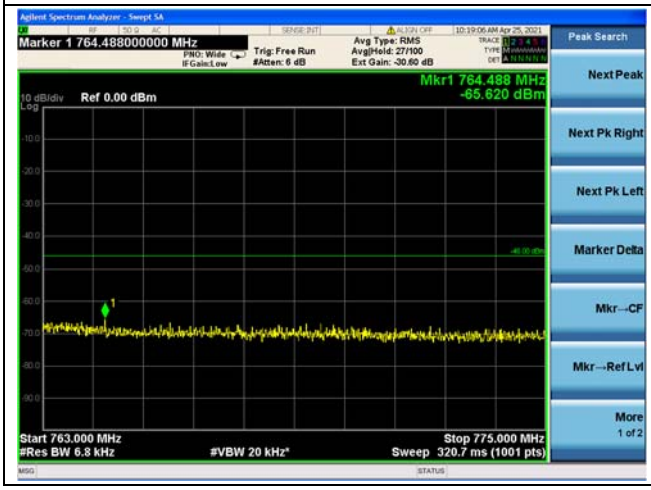
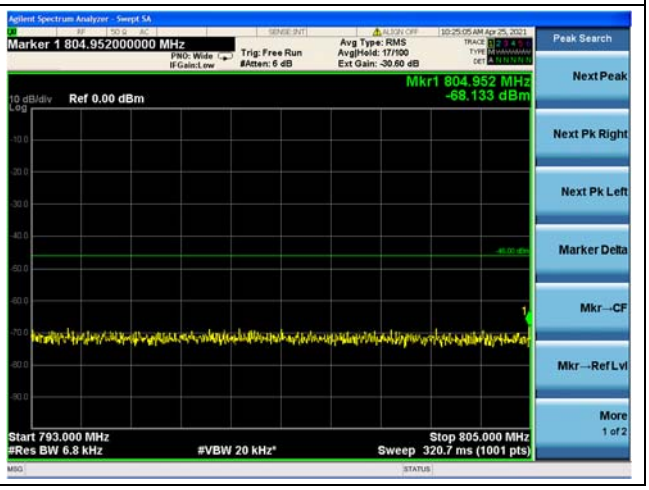
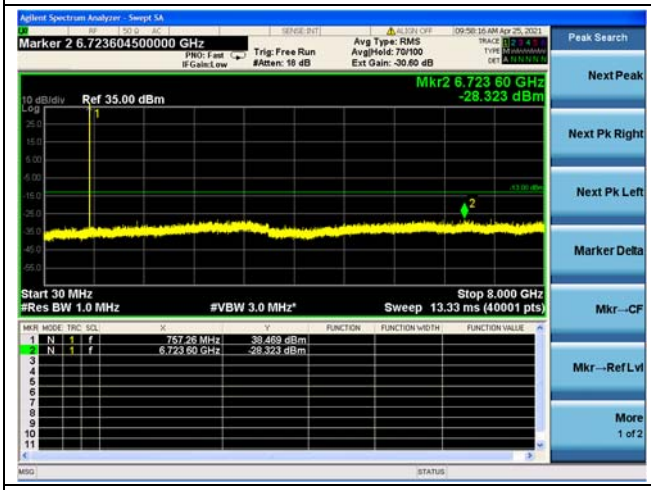


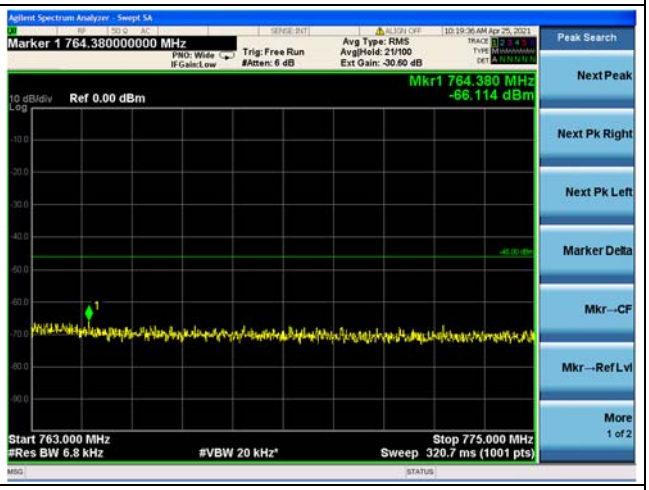
50kHz/16QAM 793-805MHz



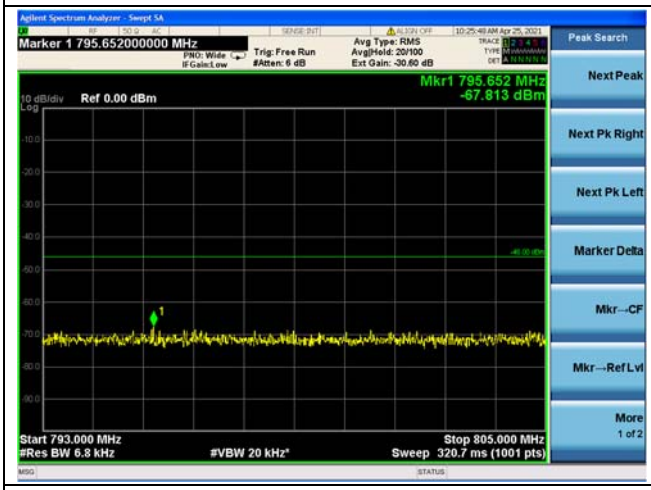
50kHz/64QAM



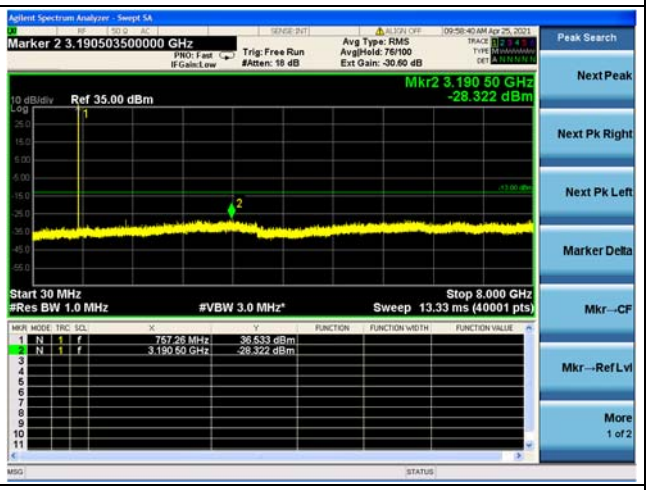
50kHz/64QAM 763-775MHz



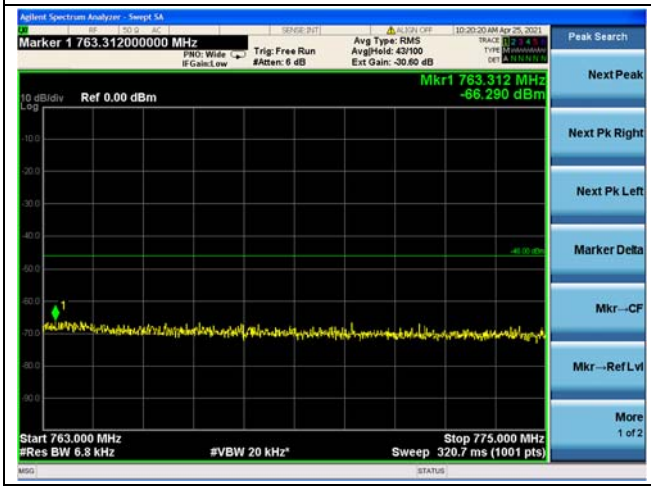
50kHz/64QAM 793-805MHz



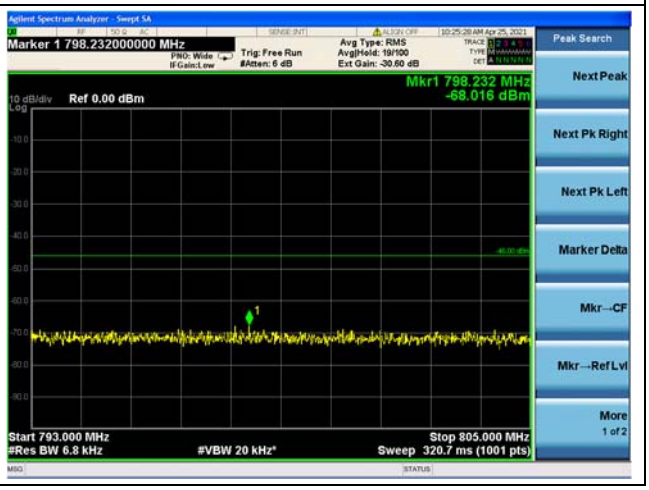
50kHz/256QAM



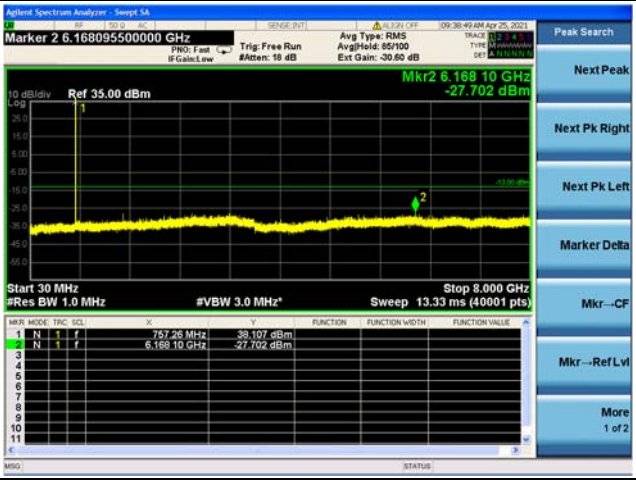
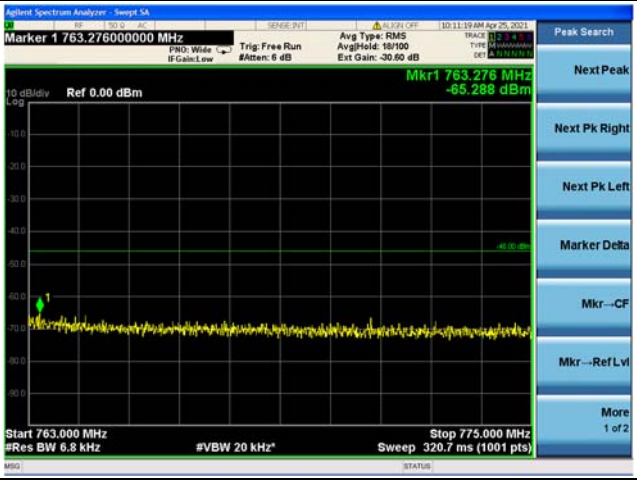
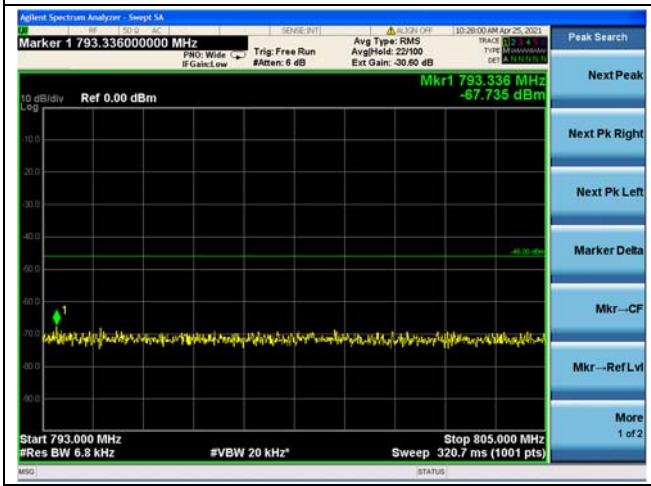
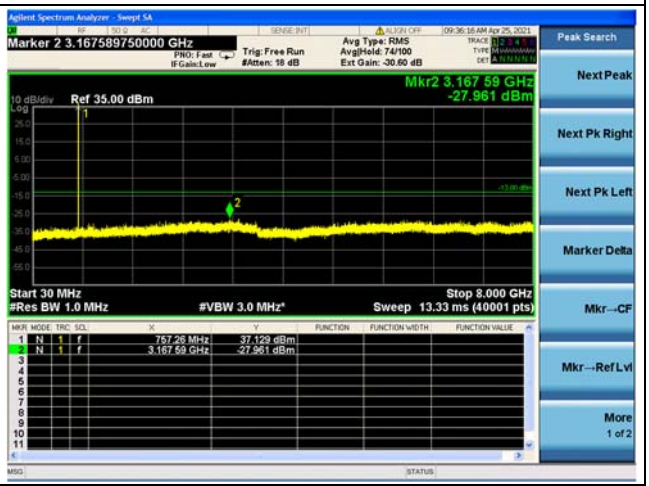
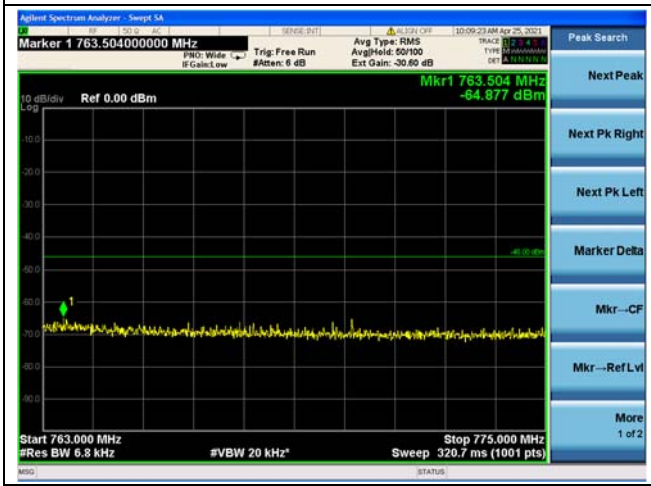
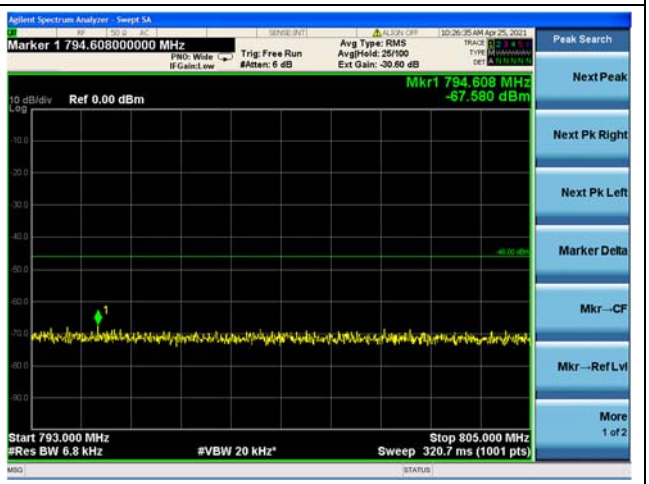
50kHz/256QAM 763-775MHz



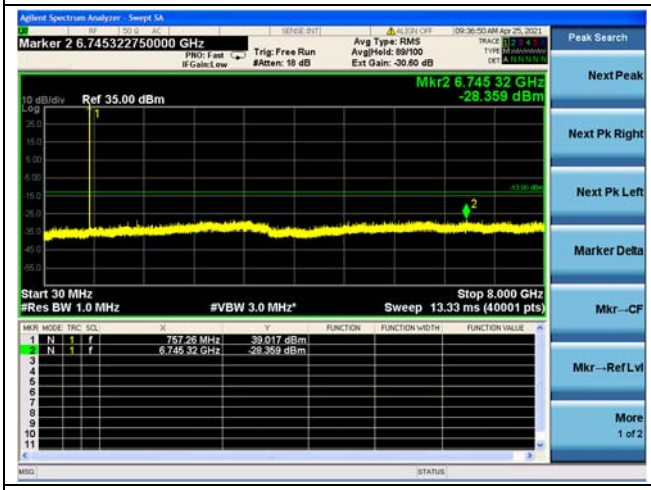
50kHz/256QAM 793-805MHz



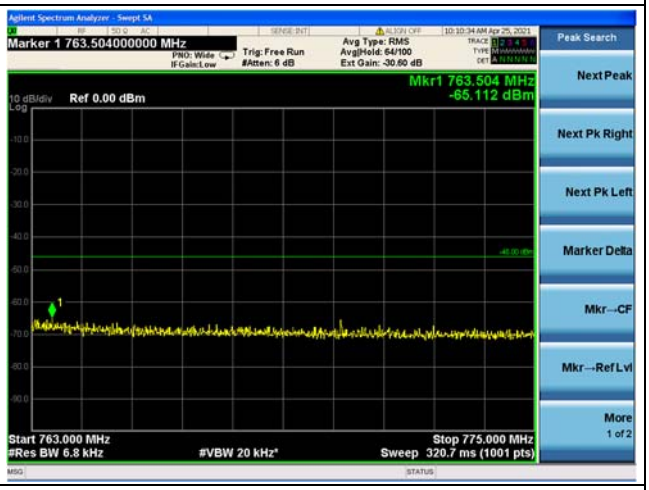
Nominal Frequency: 757.050 MHz Tx Port: Channel V

12.5kHz/QPSK	12.5kHz/QPSK 763-775MHz
	
12.5kHz/QPSK 793-805MHz	**12.5kHz/16QAM**
	
12.5kHz/16QAM 763-775MHz	**12.5kHz/16QAM 793-805MHz**
	

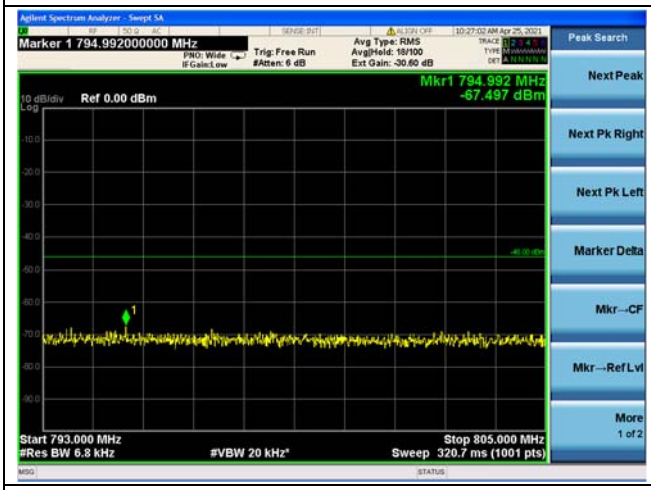
12.5kHz/64QAM



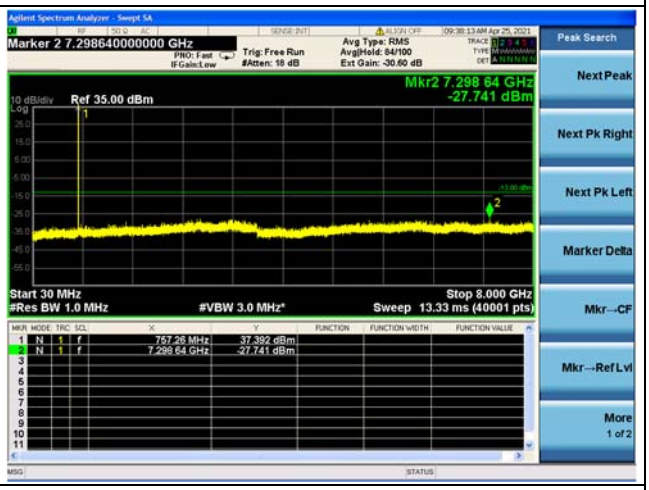
12.5kHz/64QAM 763-775MHz



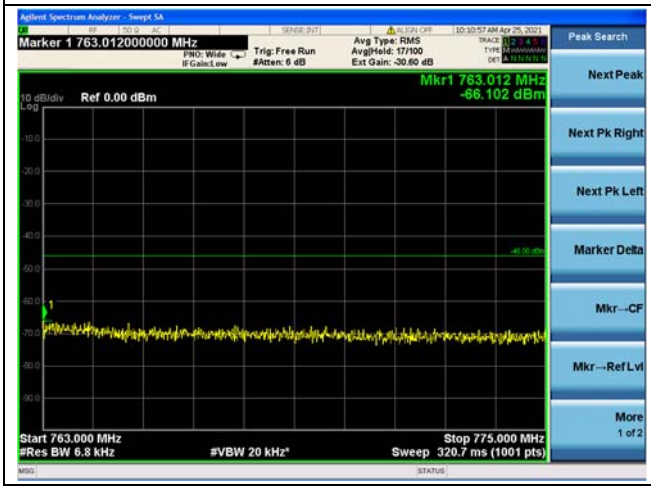
12.5kHz/64QAM 793-805MHz



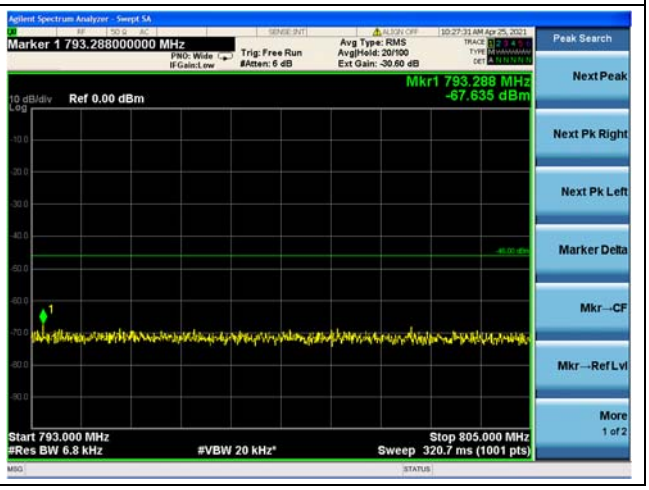
12.5kHz/256QAM



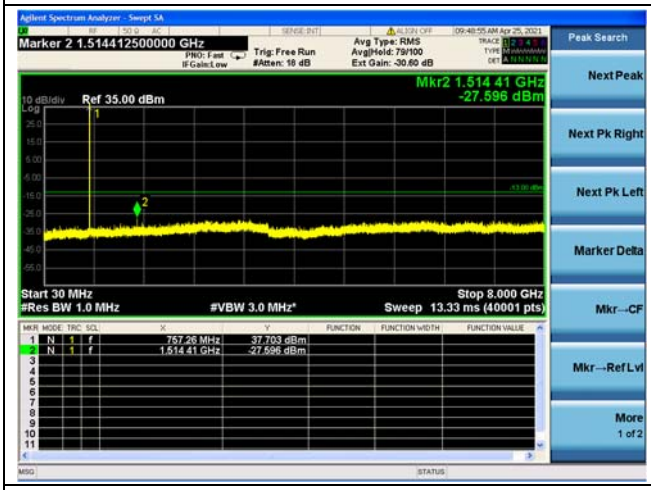
12.5kHz/256QAM 763-775MHz



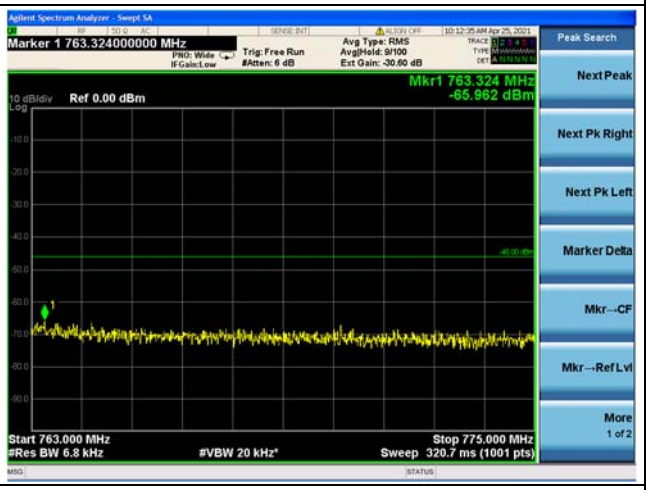
12.5kHz/256QAM 793-805MHz



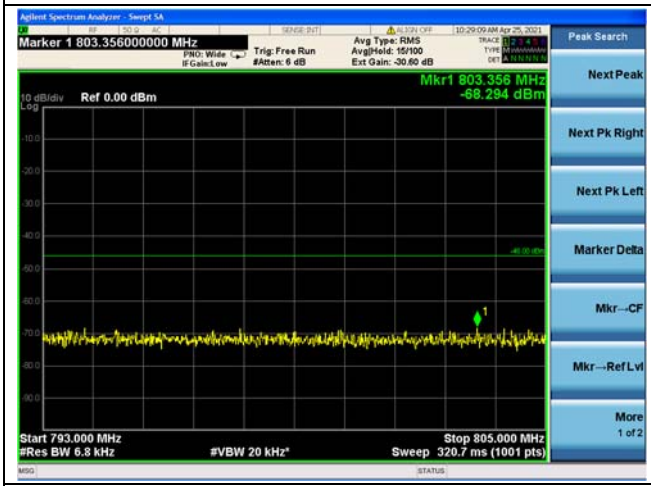
25kHz/QPSK



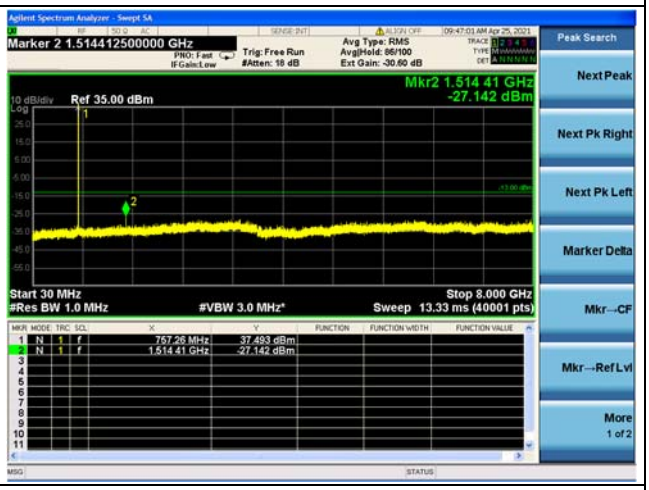
25kHz/QPSK 763-775MHz



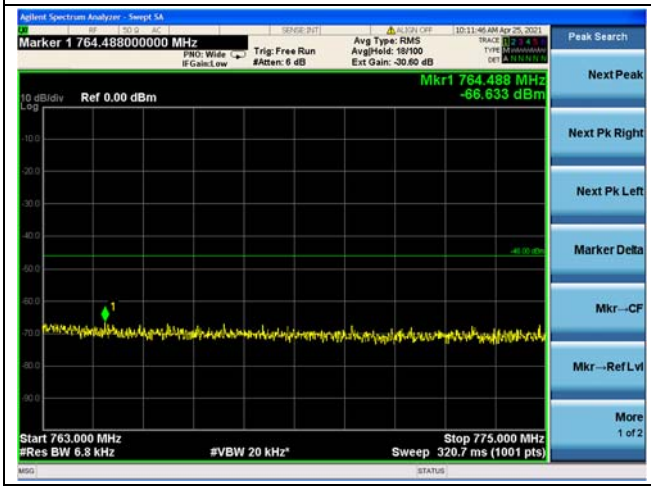
25kHz/QPSK 793-805MHz



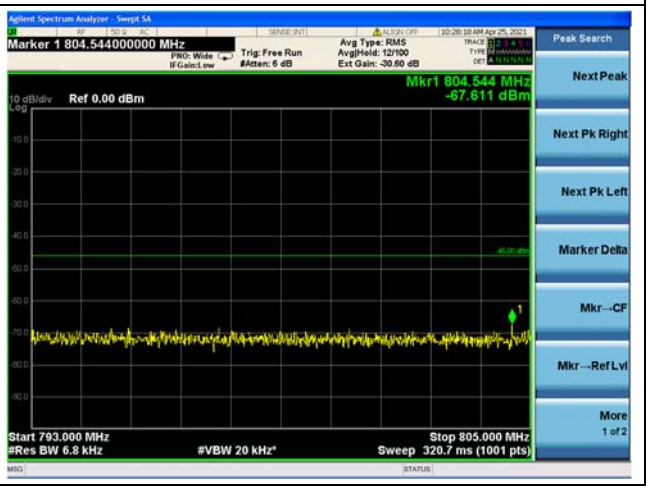
25kHz/16QAM



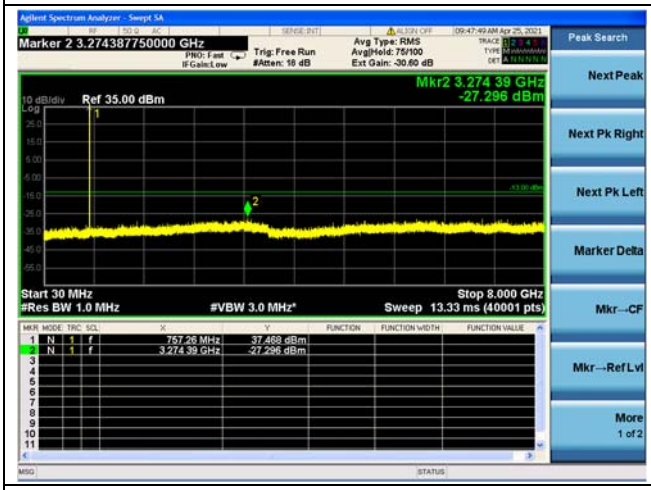
25kHz/16QAM 763-775MHz



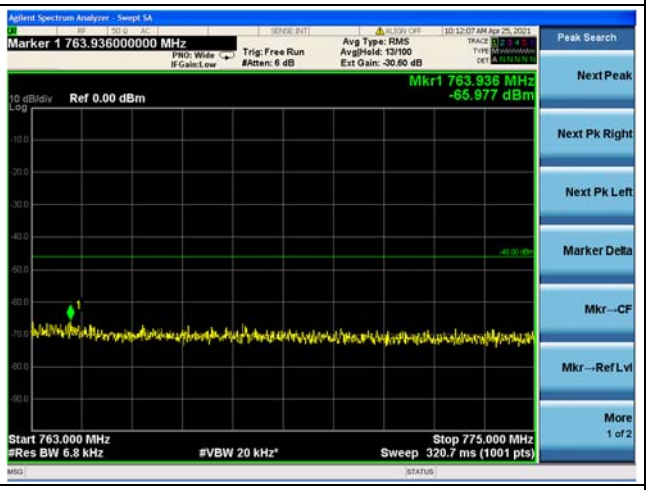
25kHz/16QAM 793-805MHz



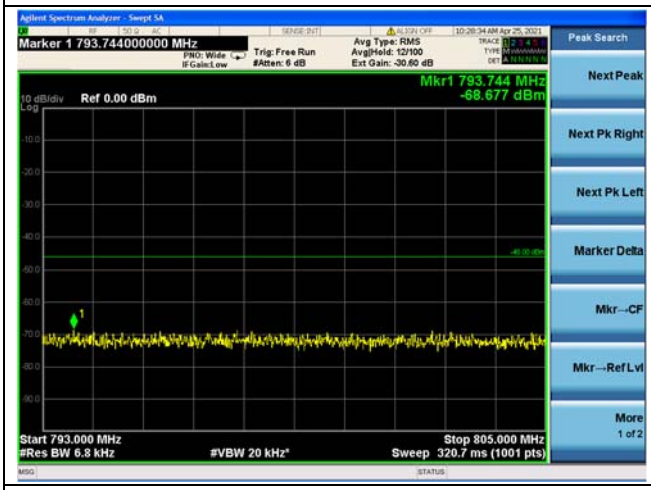
25kHz/64QAM



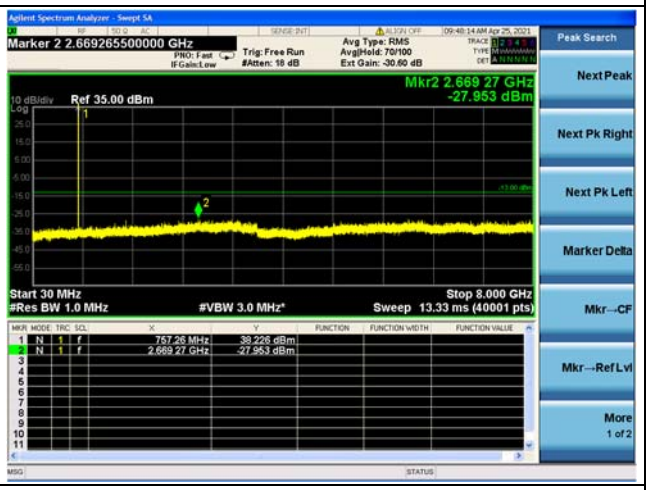
25kHz/64QAM 763-775MHz



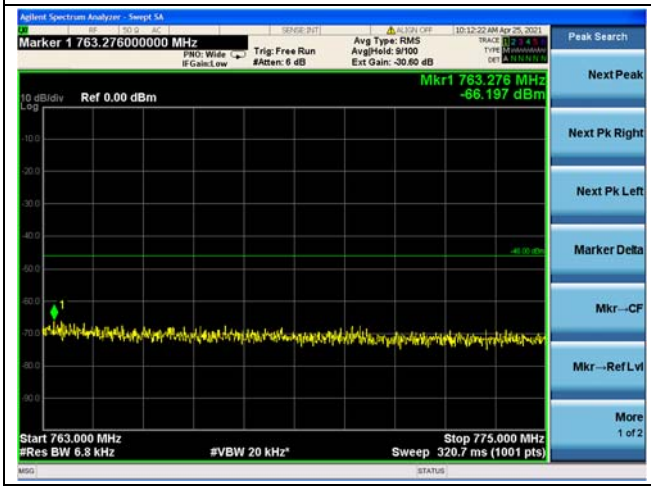
25kHz/64QAM 793-805MHz



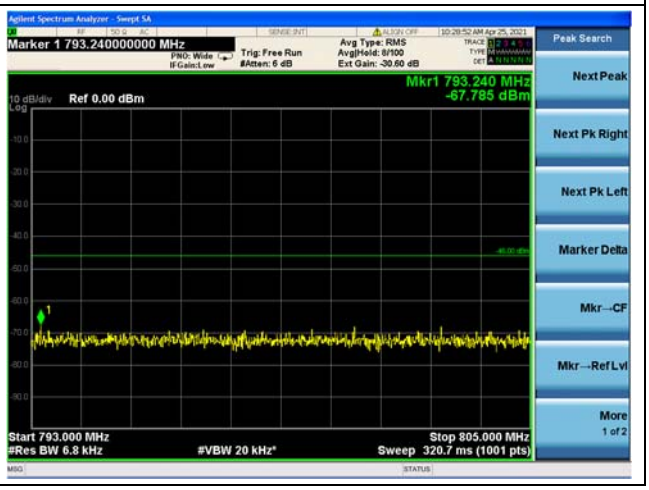
25kHz/256QAM



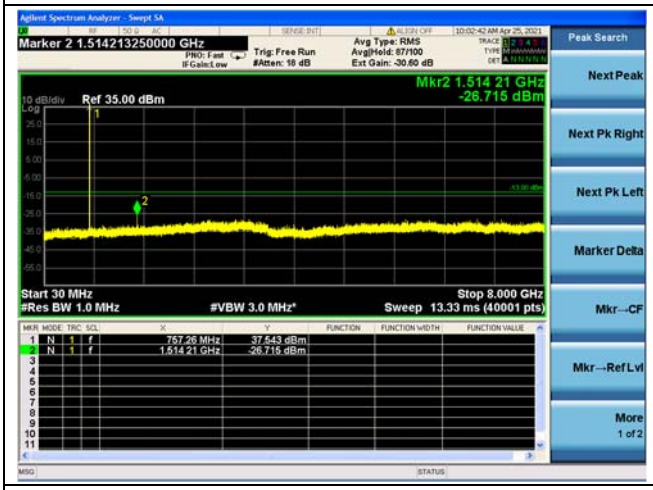
25kHz/256QAM 763-775MHz



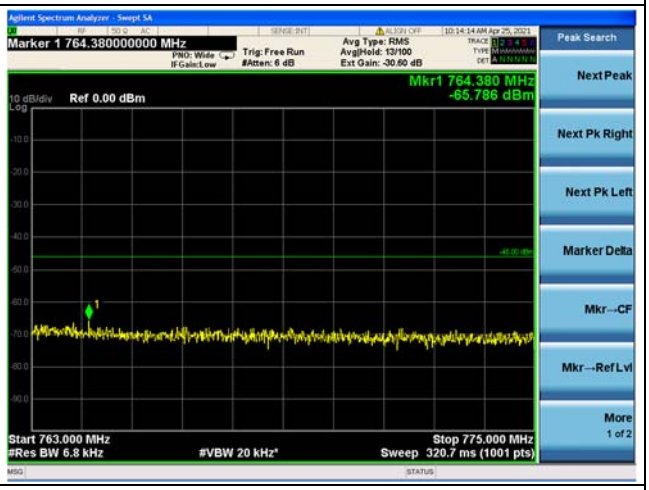
25kHz/256QAM 793-805MHz



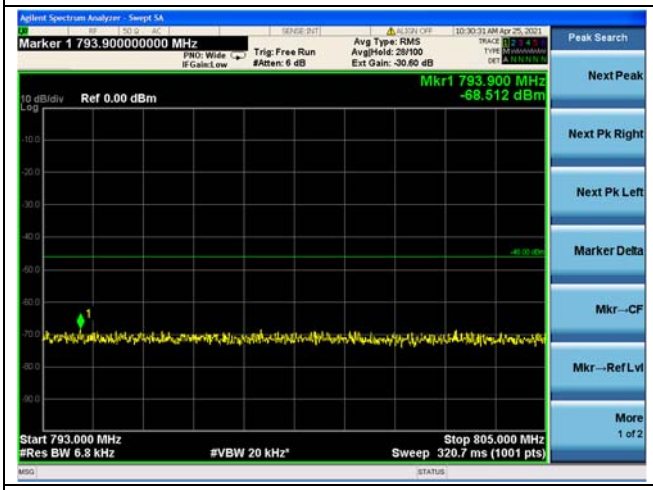
50kHz/QPSK



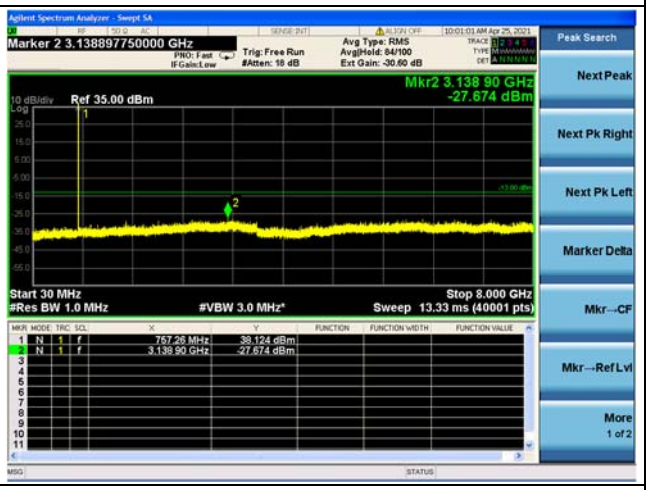
50kHz/QPSK 763-775MHz



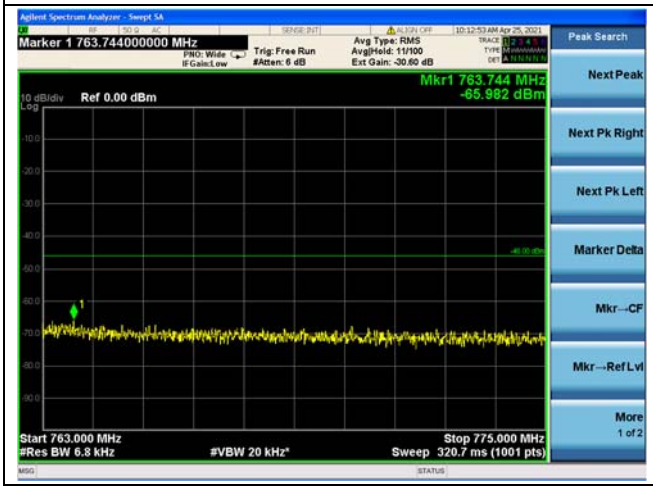
50kHz/QPSK 793-805MHz



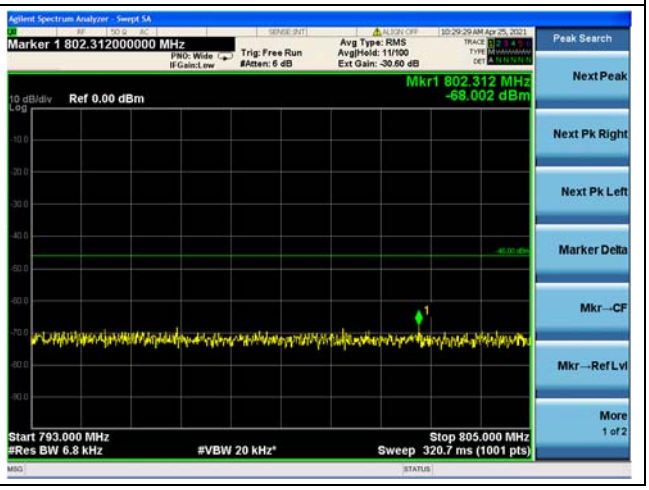
50kHz/16QAM



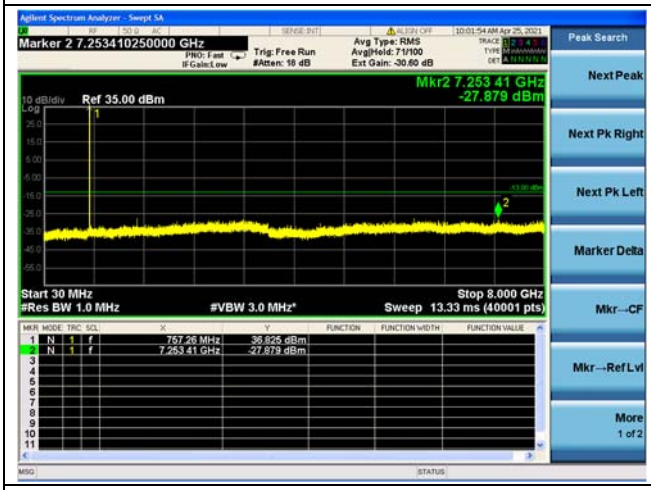
50kHz/16QAM 763-775MHz



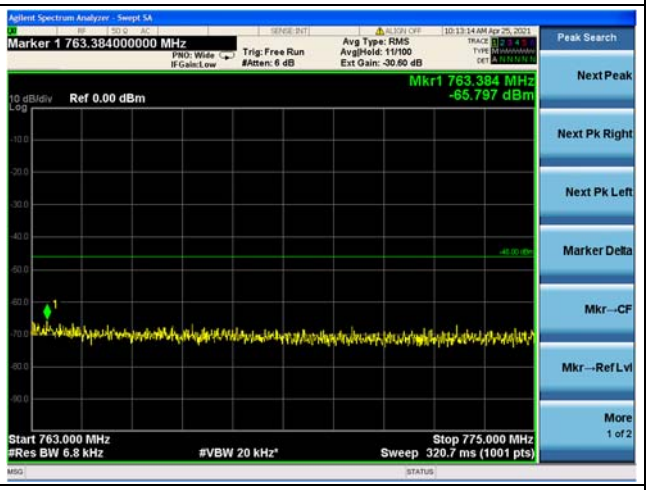
50kHz/16QAM 793-805MHz



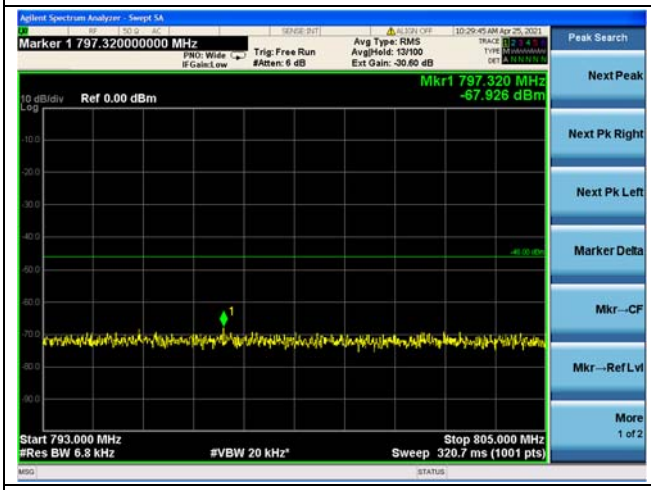
50kHz/64QAM



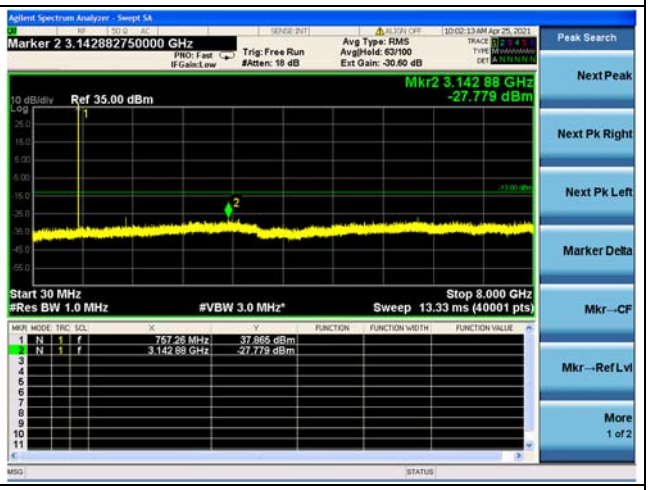
50kHz/64QAM 763-775MHz



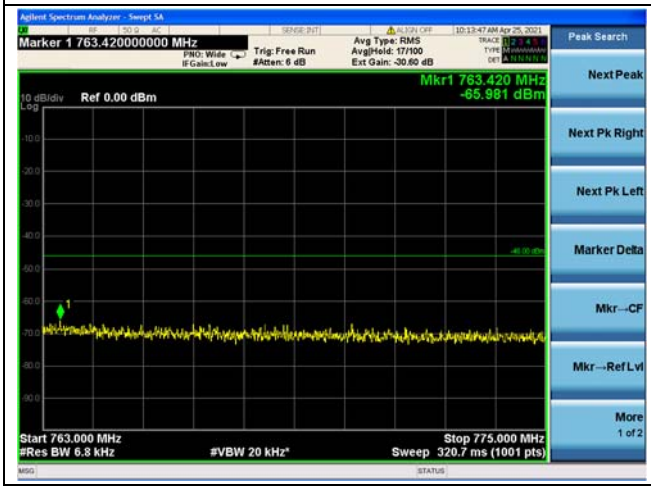
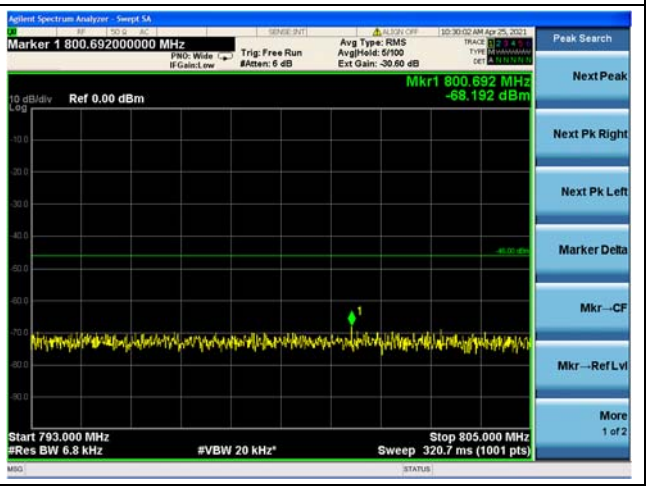
50kHz/64QAM 793-805MHz



50kHz/256QAM



50kHz/256QAM 763-775MHz



50kHz/256QAM 793-805MHz