REPORT No. : SZ21040240W01

TEST REPORT

APPLICANT	:	MiMOMax Wireless Limited
PRODUCT NAME	:	700MHz Upper A Block TornadoX Transceiver
MODEL NAME	:	MWL-TORNADOX-*H*D/E
BRAND NAME	:	MiMOMax Wireless
FCC ID	:	XMK-MMXTRNXB001
STANDARD(S)	:	47 CFR Part 2 47 CFR Part 27
RECEIPT DATE	:	2021-04-22
TEST DATE	:	2021-04-30 to 2021-06-10
ISSUE DATE	:	2021-07-01

Tested by: Ling Keye (Rapporteur)

Approved by: Shen Junsheng (Supervisor)

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MORLAB

Shenzhen Morlab Communications Technology Co., Ltd.
FL1-3, Building A, FeiYang Science Park, No.8 LongChang Road,
Block67, BaoAn District, ShenZhen ,GuangDong Province, P. R. China

Tel: 86-755-36698555 Fax: 86-755-36698525
Http://www.morlab.cn E-mail: service@morlab.cn

DIRECTORY

1. Technical Information ····· 4
1.1. Applicant and Manufacturer Information ····· 4
1.2. Equipment Under Test (EUT) Description ····· 4
1.3. Test Standards and Results ····· 5
1.4. Environmental Conditions ····· 6
2. 47 CFR Part 2 and Part 27 Requirements ····· 7
2.1. Radio Frequency Power Output and E.R.P. ····· 7
2.2. Occupied Bandwidth ····· 10
2.3. Spurious Emissions At Antenna Terminals ····· 21
2.4. Radiated Spurious Emissions ····· 62
2.5. Frequency Stability ····· 69
Annex A Test Uncertainty ····· 73
Annex B Testing Laboratory Information ····· 74

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 TornadoX Transceiver
EUT Serial No:	(N/A, marked 1# 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 30, 2021	Ling Keye	Complies
2	2.1049	Occupied bandwidth	May 6, 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 8, 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	May 18, 2021	Gao Jianrou	PASS
5	27.53(f)	Additional emission requirement in 1559 - 1610 MHz band	May 17, 2021 June 2, 2021	Gao Jianrou	PASS

6	27.54 2.1055	Frequency stability	May 19, 2021	Ling Keye	PASS

Note 1: The TornadoX 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 TornadoX 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	33.92	2.51	35.77	3.776	47.77	59.841
12.5	16QAM	24	33.91	2.51	35.76	3.767	47.76	59.704
12.5	64QAM	24	33.97	2.51	35.82	3.819	47.82	60.534
12.5	256QAM	24	33.95	2.51	35.80	3.802	47.80	60.256
25.0	QPSK	24	33.96	2.51	35.81	3.811	47.81	60.395
25.0	16QAM	24	33.91	2.51	35.76	3.767	47.76	59.704
25.0	64QAM	24	33.98	2.51	35.83	3.828	47.83	60.674
25.0	256QAM	24	34.03	2.51	35.88	3.873	47.88	61.376
50.0	QPSK	24	33.91	2.51	35.76	3.767	47.76	59.704
50.0	16QAM	24	33.93	2.51	35.78	3.784	47.78	59.979
50.0	64QAM	24	33.96	2.51	35.81	3.811	47.81	60.395
50.0	256QAM	24	34.06	2.51	35.91	3.899	47.91	61.802

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	33.93	2.51	35.78	3.784	47.78	59.979
12.5	16QAM	24	33.96	2.51	35.81	3.811	47.81	60.395
12.5	64QAM	24	33.97	2.51	35.82	3.819	47.82	60.534
12.5	256QAM	24	34.02	2.51	35.87	3.864	47.87	61.235
25.0	QPSK	24	33.92	2.51	35.77	3.776	47.77	59.841

25.0	16QAM	24	33.95	2.51	35.80	3.802	47.80	60.256
25.0	64QAM	24	33.99	2.51	35.84	3.837	47.84	60.814
25.0	256QAM	24	34.04	2.51	35.89	3.882	47.89	61.518
50.0	QPSK	24	33.96	2.51	35.81	3.811	47.81	60.395
50.0	16QAM	24	34.01	2.51	35.86	3.855	47.86	61.094
50.0	64QAM	24	34.04	2.51	35.89	3.882	47.89	61.518
50.0	256QAM	24	34.08	2.51	35.93	3.917	47.93	62.087

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	33.93	2.51	35.78	3.784	43.78	23.878
12.5	16QAM	24	33.92	2.51	35.77	3.776	43.77	23.823
12.5	64QAM	24	34.02	2.51	35.87	3.864	43.87	24.378
12.5	256QAM	24	34.04	2.51	35.89	3.882	43.89	24.491
25.0	QPSK	24	33.95	2.51	35.80	3.802	43.80	23.988
25.0	16QAM	24	33.93	2.51	35.78	3.784	43.78	23.878
25.0	64QAM	24	34.02	2.51	35.87	3.864	43.87	24.378
25.0	256QAM	24	34.03	2.51	35.88	3.873	43.88	24.434
50.0	QPSK	24	33.96	2.51	35.81	3.811	43.81	24.044
50.0	16QAM	24	33.95	2.51	35.80	3.802	43.80	23.988
50.0	64QAM	24	34.04	2.51	35.89	3.882	43.89	24.491
50.0	256QAM	24	34.08	2.51	35.93	3.917	43.93	24.717

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	33.93	2.51	35.78	3.784	43.78	23.878
12.5	16QAM	24	33.95	2.51	35.80	3.802	43.80	23.988
12.5	64QAM	24	33.97	2.51	35.82	3.819	43.82	24.099

12.5	256QAM	24	34.03	2.51	35.88	3.873	43.88	24.434
25.0	QPSK	24	34.01	2.51	35.86	3.855	43.86	24.322
25.0	16QAM	24	34.06	2.51	35.91	3.899	43.91	24.604
25.0	64QAM	24	33.93	2.51	35.78	3.784	43.78	23.878
25.0	256QAM	24	33.99	2.51	35.84	3.837	43.84	24.210
50.0	QPSK	24	33.98	2.51	35.83	3.828	43.83	24.155
50.0	16QAM	24	34.02	2.51	35.87	3.864	43.87	24.378
50.0	64QAM	24	33.96	2.51	35.81	3.811	43.81	24.044
50.0	256QAM	24	34.07	2.51	35.92	3.908	43.92	24.660

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 28.07dBi for 757-758MHz and 12.84dBi 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

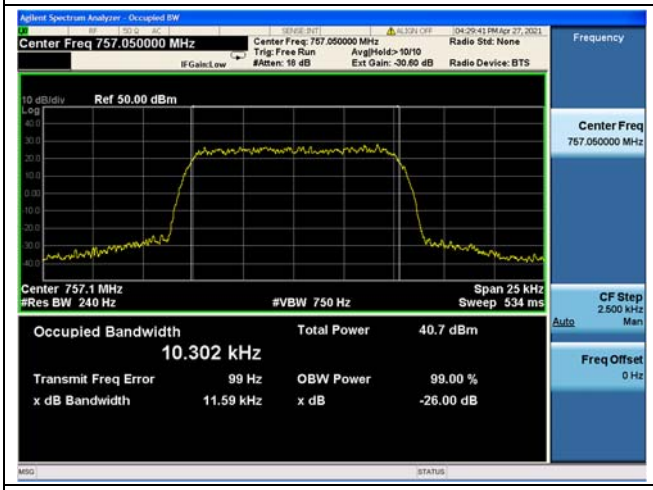
Measurements have been made to verify these declared bandwidths using the generic frequencies that are listed in the table above.
The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client.
Measurements have been made of each modulation type using a spectrum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

2.2.3. Test Result

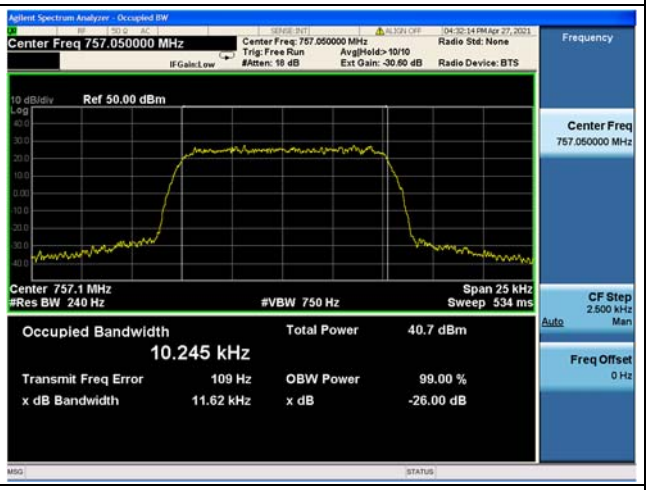
Nominal Frequency: 757.050 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	10.302
		16QAM	10.245
		64QAM	10.254
		256QAM	10.276
	25.0	QPSK	20.695
		16QAM	20.742
		64QAM	20.616
		256QAM	20.530
	50.0	QPSK	41.162
		16QAM	41.293
		64QAM	41.278
		256QAM	41.393
Channel V	12.5	QPSK	10.299
		16QAM	10.294
		64QAM	10.300
		256QAM	10.308
	25.0	QPSK	20.743
		16QAM	20.643
		64QAM	20.681
		256QAM	20.667
	50.0	QPSK	41.393
		16QAM	41.249
		64QAM	41.244
		256QAM	41.472

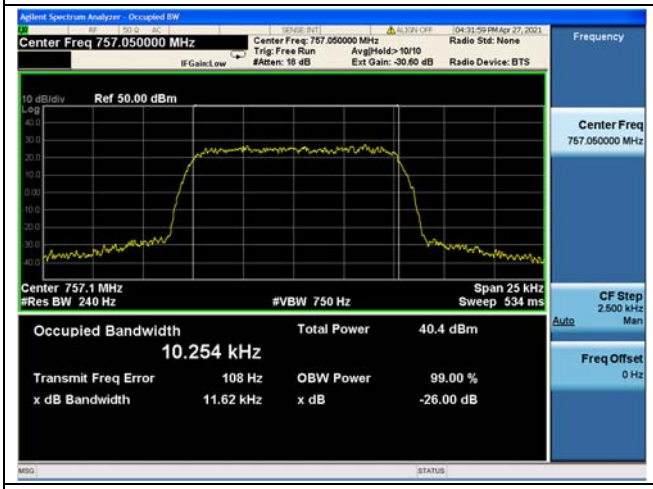
757.050MHz/Channel H/12.5kHz/QPSK



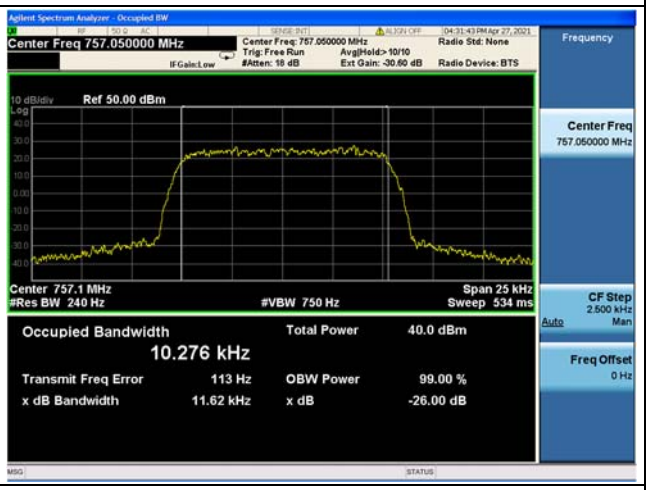
757.050MHz/Channel H/12.5kHz/16QAM



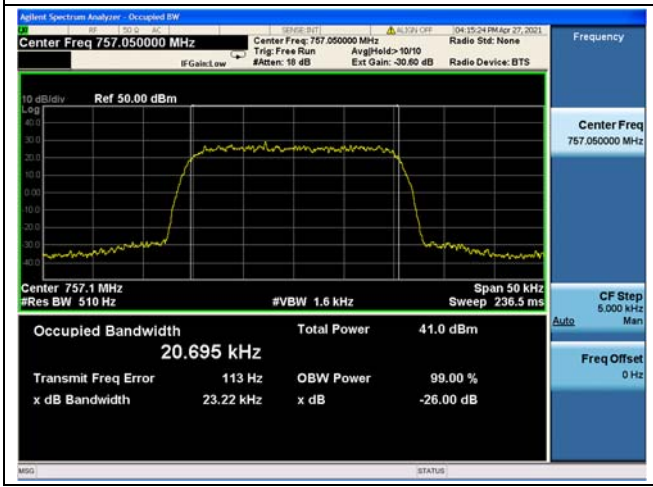
757.050MHz/Channel H/12.5kHz/64QAM



757.050MHz/Channel H/12.5 kHz/256QAM



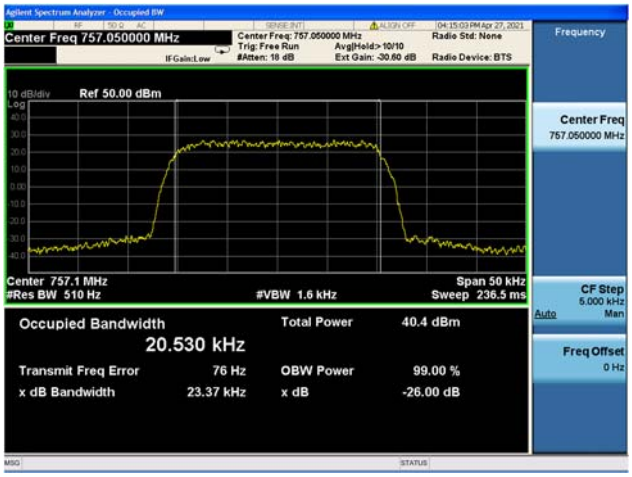
757.050MHz/Channel H/25.0 kHz/QPSK



757.050MHz/Channel H/25.0 kHz/16QAM

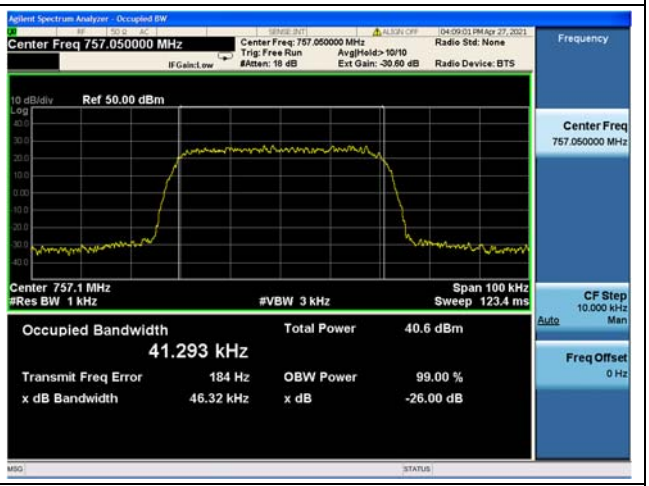
757.050MHz/Channel H/25.0 kHz/64QAM

757.050MHz/Channel H/25.0 kHz/256QAM



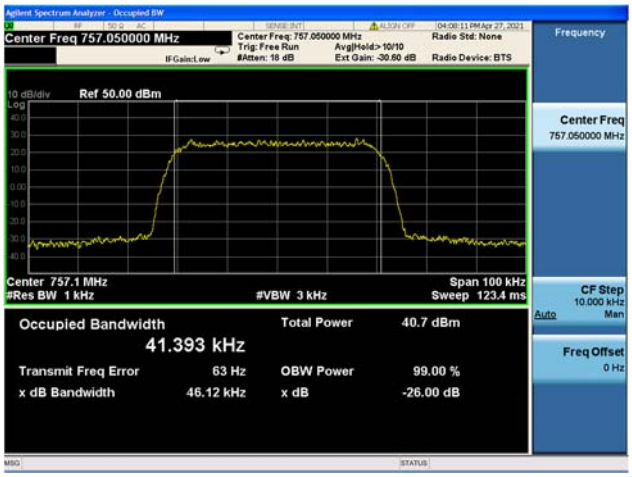
757.050MHz/Channel H/50.0 kHz/QPSK

757.050MHz/Channel H/50.0 kHz/16QAM



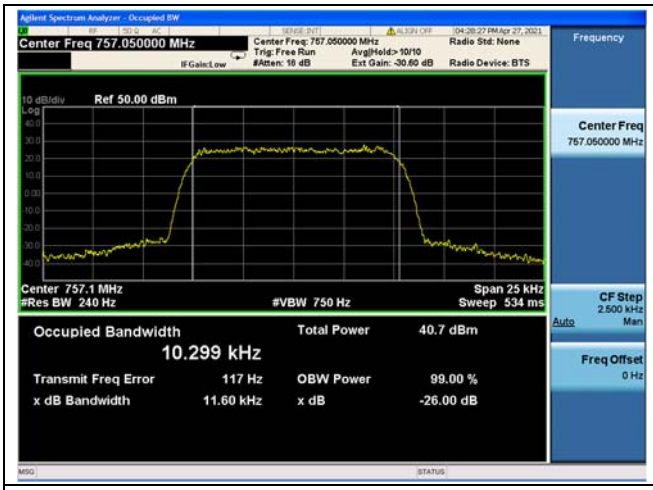
757.050MHz/Channel H/50.0 kHz/64QAM

757.050MHz/Channel H/50.0 kHz/256QAM

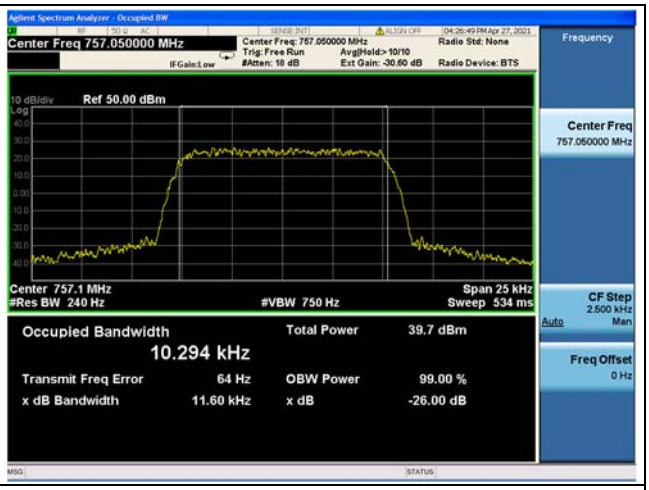


757.050MHz/Channel V/12.5kHz/QPSK

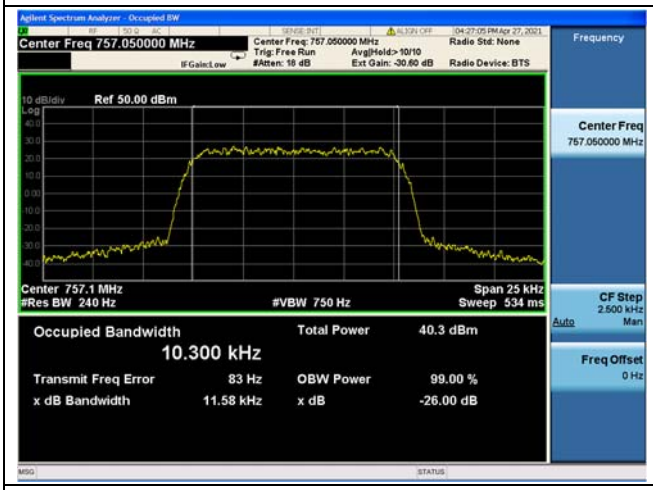
757.050MHz/Channel V/12.5kHz/16QAM



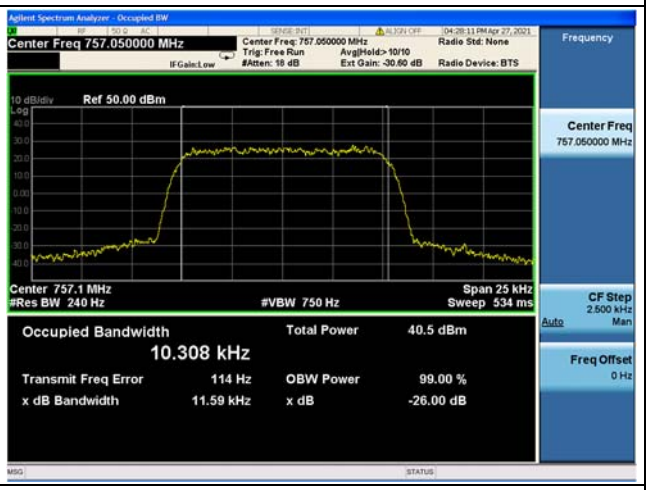
757.050MHz/Channel V/12.5kHz/64QAM



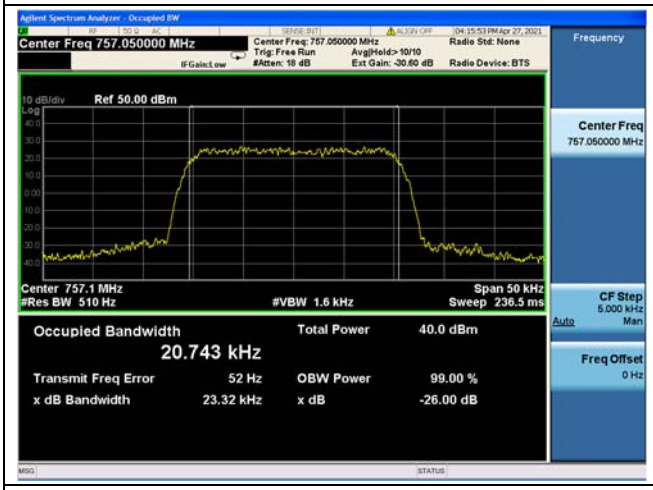
757.050MHz/Channel V/12.5 kHz/256QAM



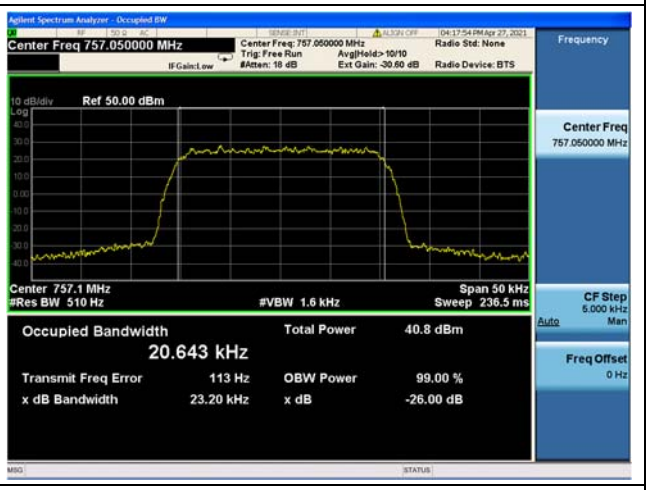
757.050MHz/Channel V/25.0 kHz/QPSK



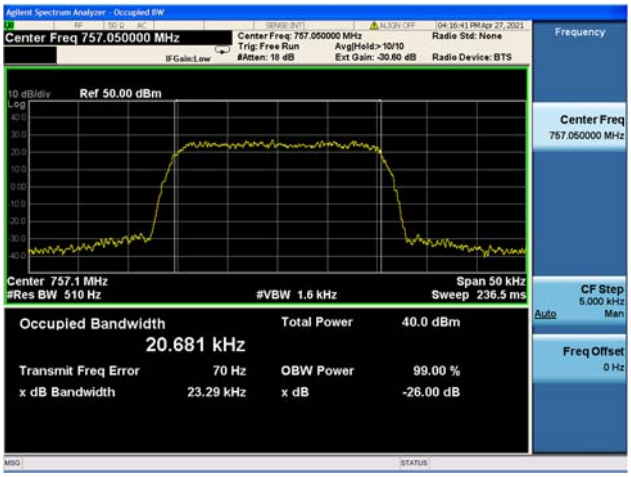
757.050MHz/Channel V/25.0 kHz/16QAM



757.050MHz/Channel V/25.0 kHz/64QAM

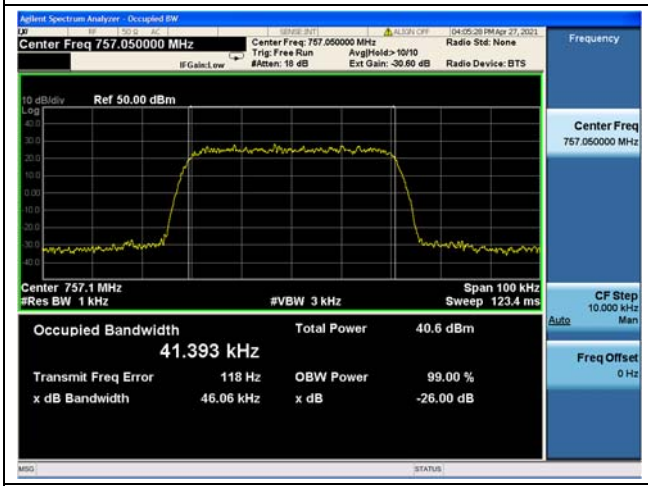


757.050MHz/Channel V/25.0 kHz/256QAM

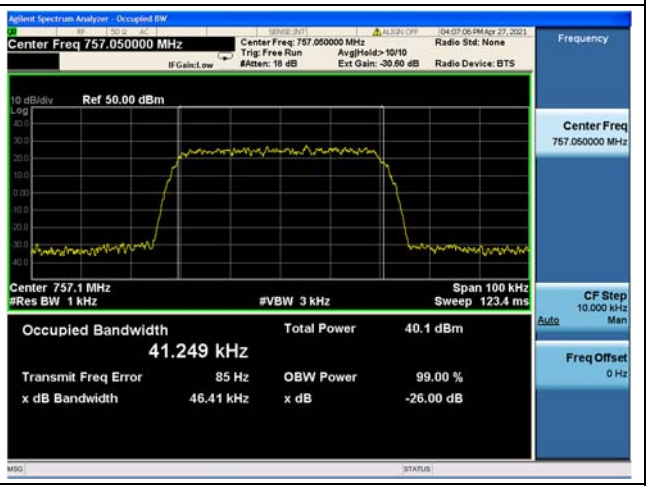


757.050MHz/Channel V/50.0 kHz/QPSK

757.050MHz/Channel V/50.0 kHz/16QAM



757.050MHz/Channel V/50.0 kHz/64QAM



757.050MHz/Channel V/50.0 kHz/256QAM

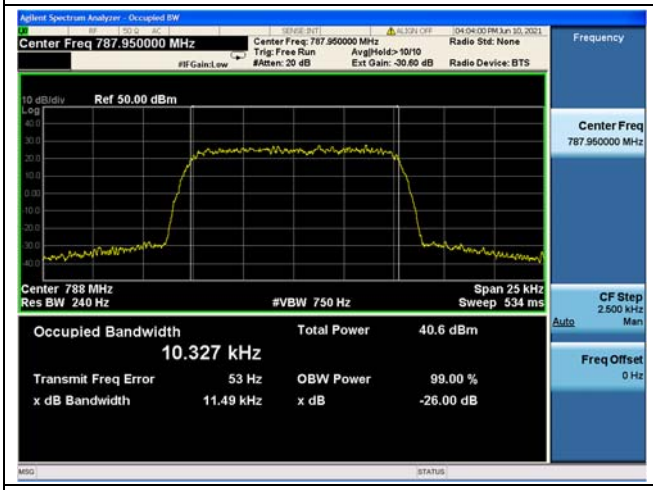
757.050MHz/Channel V/50.0 kHz/64QAM

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	10.327
		16QAM	10.313
		64QAM	10.295
		256QAM	10.320
	25.0	QPSK	20.687
		16QAM	20.561
		64QAM	20.749
		256QAM	20.722
	50.0	QPSK	41.336
		16QAM	41.345
		64QAM	41.252
		256QAM	41.290
Channel V	12.5	QPSK	10.304
		16QAM	10.297
		64QAM	10.309
		256QAM	10.284
	25.0	QPSK	20.527
		16QAM	20.672
		64QAM	20.780
		256QAM	20.663
	50.0	QPSK	41.179
		16QAM	41.321
		64QAM	41.608
		256QAM	41.348

787.950MHz/Channel H/12.5kHz/QPSK



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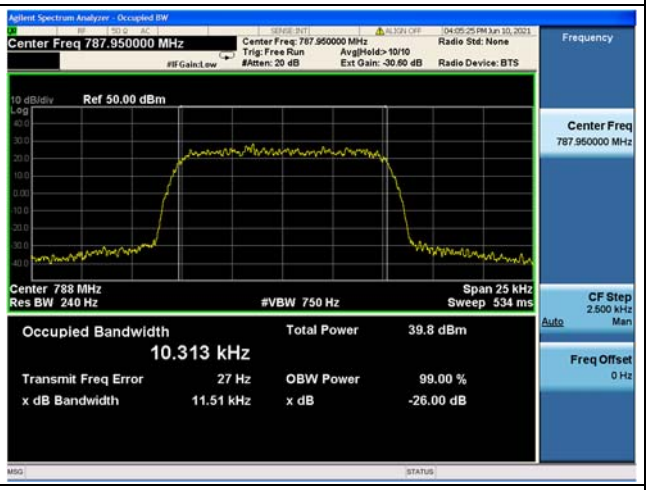

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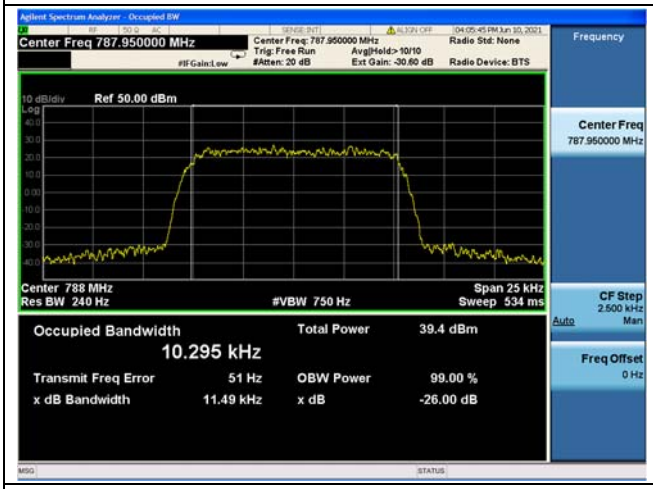

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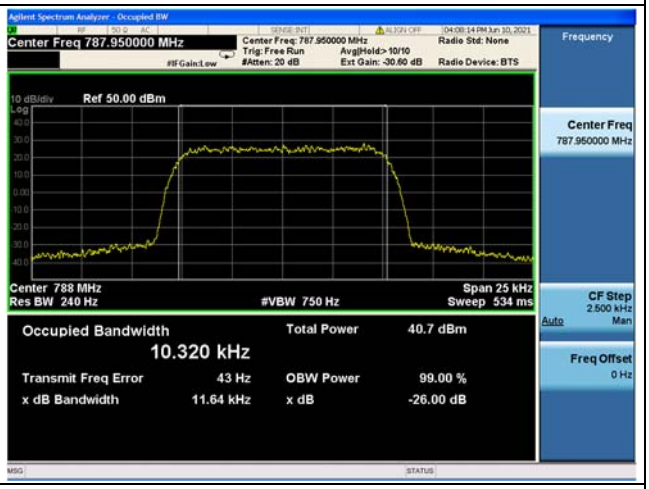

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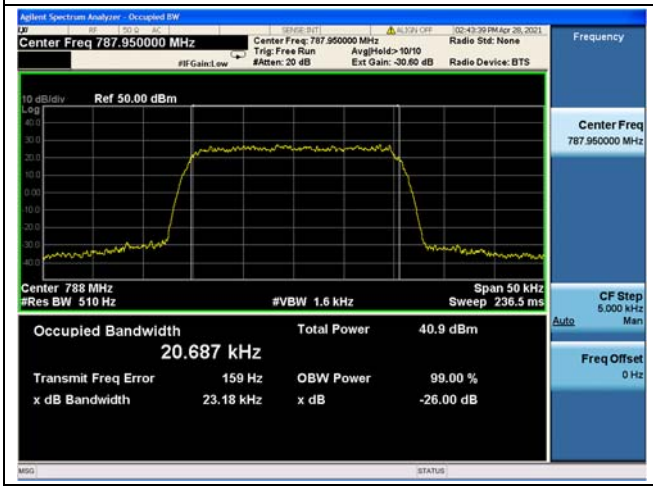

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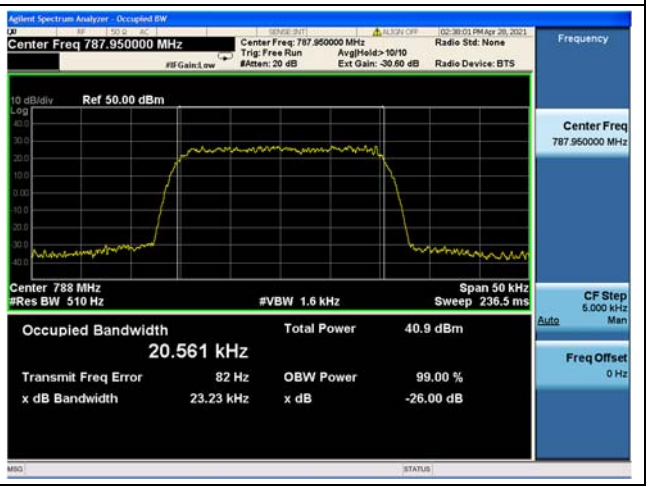

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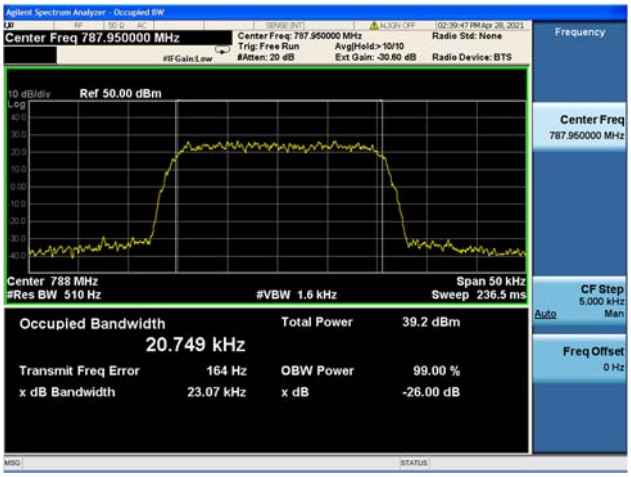

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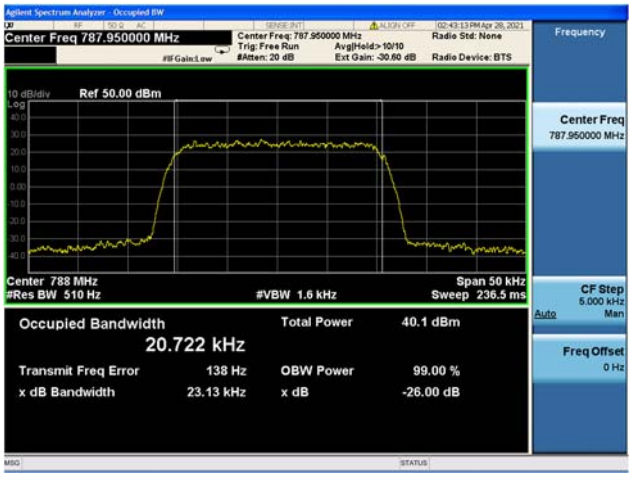
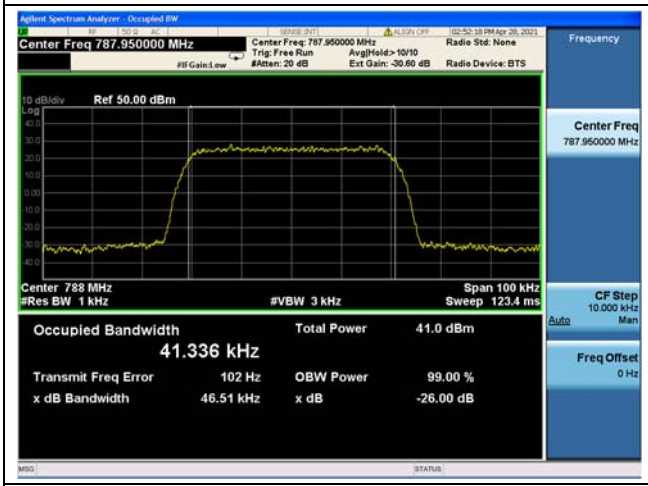


787.950MHz/Channel H/50.0 kHz/QPSK



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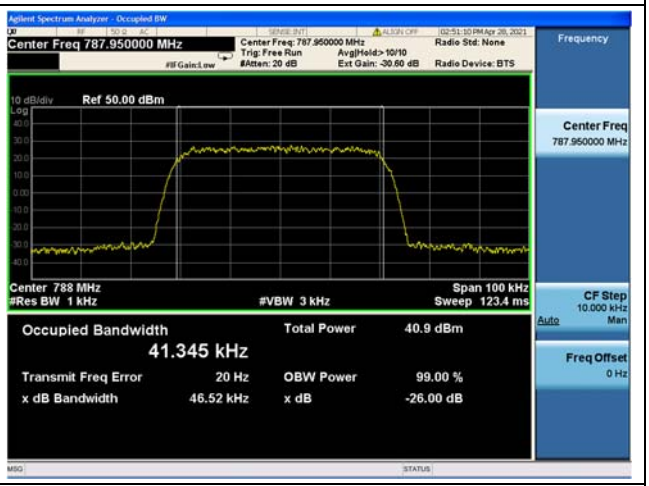

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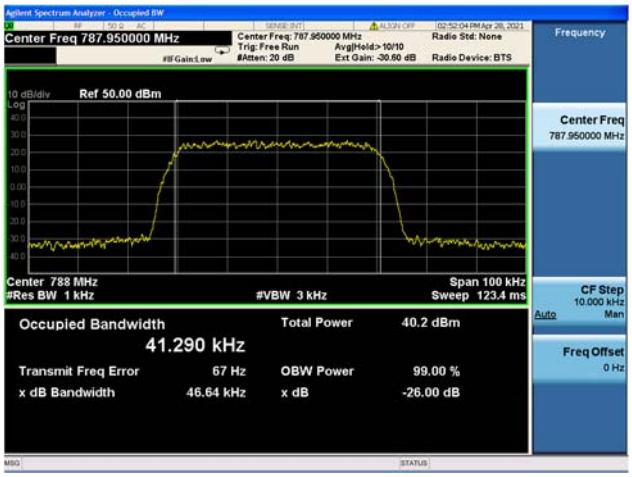
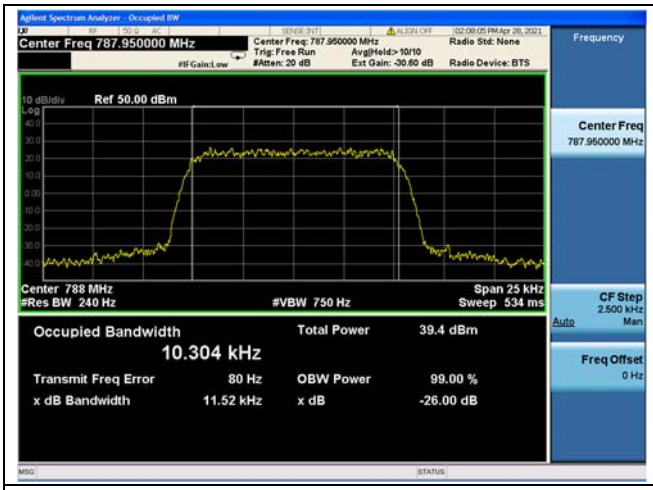
787.950MHz/Channel H/50.0 kHz/256QAM

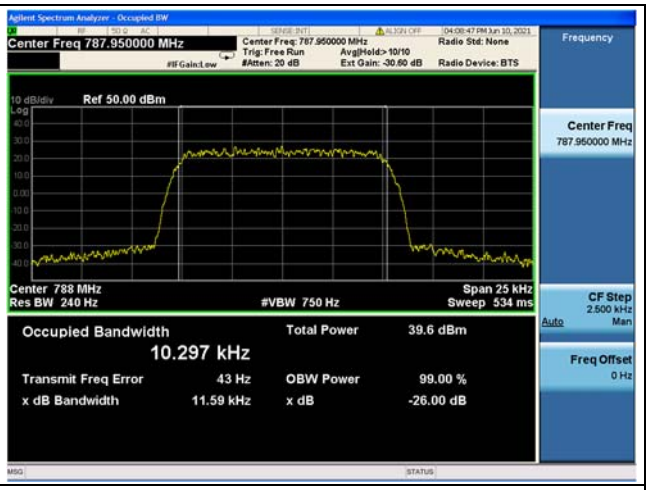


787.950MHz/Channel V/12.5kHz/QPSK

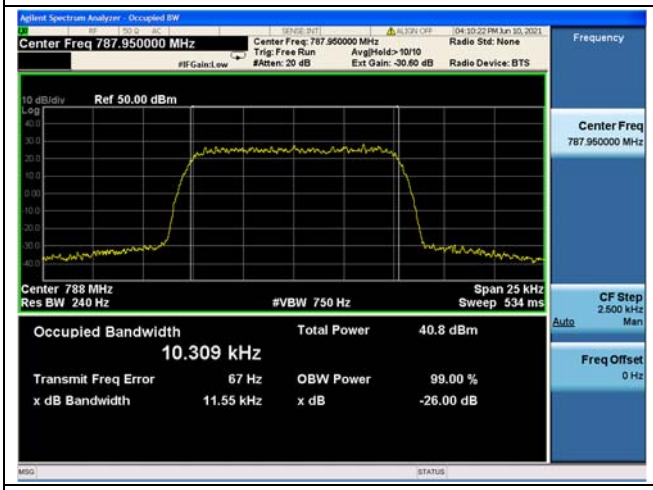
787.950MHz/Channel V/12.5kHz/16QAM



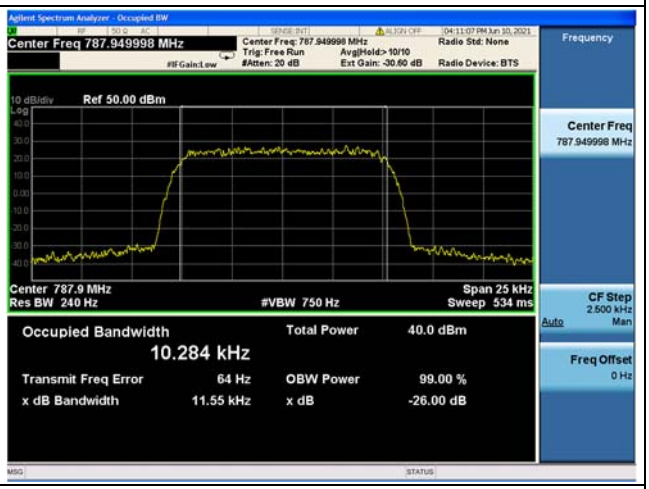
787.950MHz/Channel V/12.5kHz/64QAM



787.950MHz/Channel V/12.5 kHz/256QAM



787.950MHz/Channel V/25.0 kHz/QPSK



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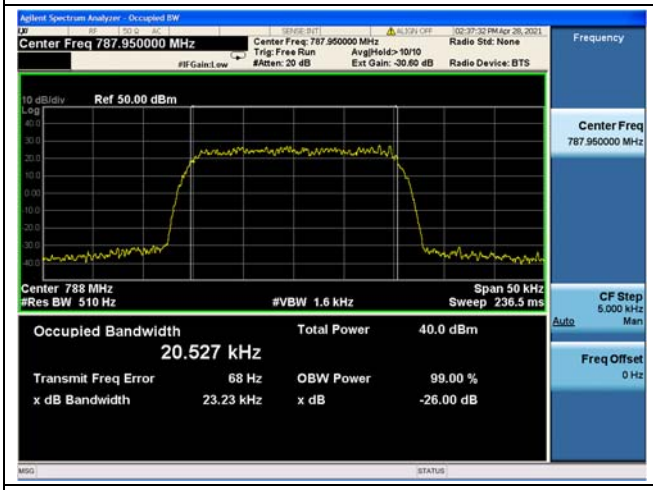
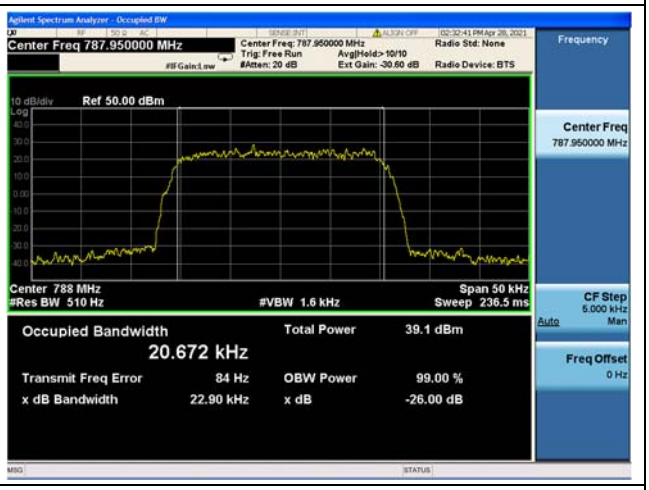
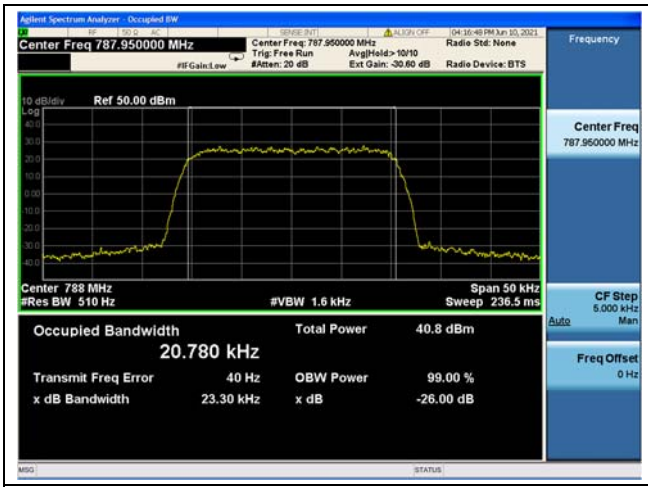


787.950MHz/Channel V/25.0 kHz/64QAM



787.950MHz/Channel V/25.0 kHz/256QAM



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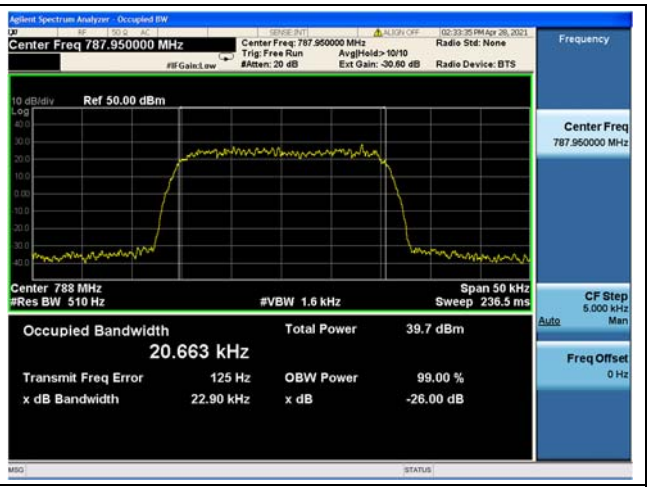
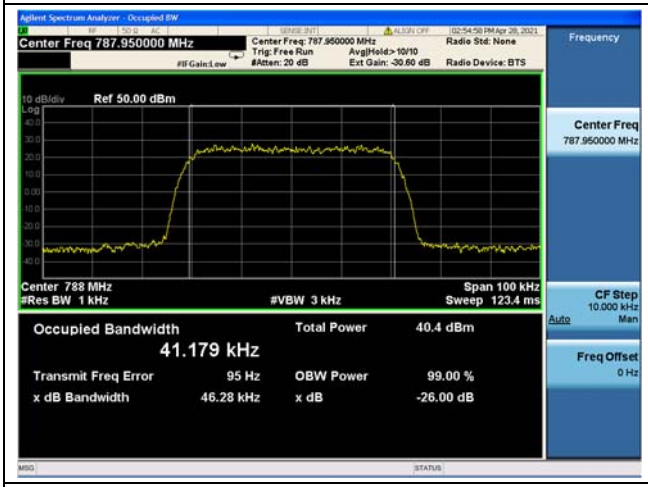
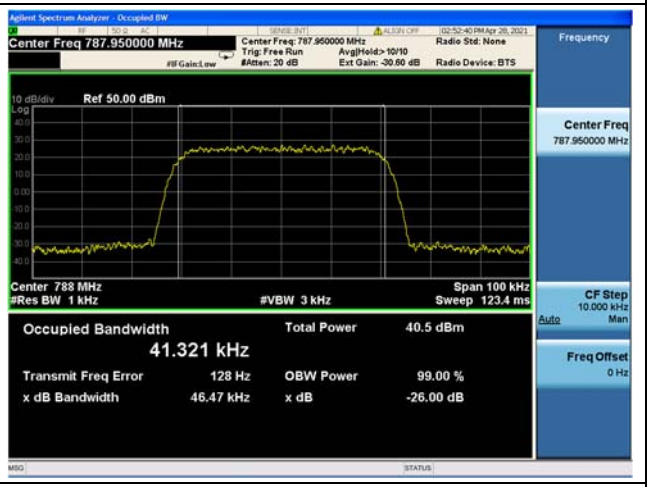


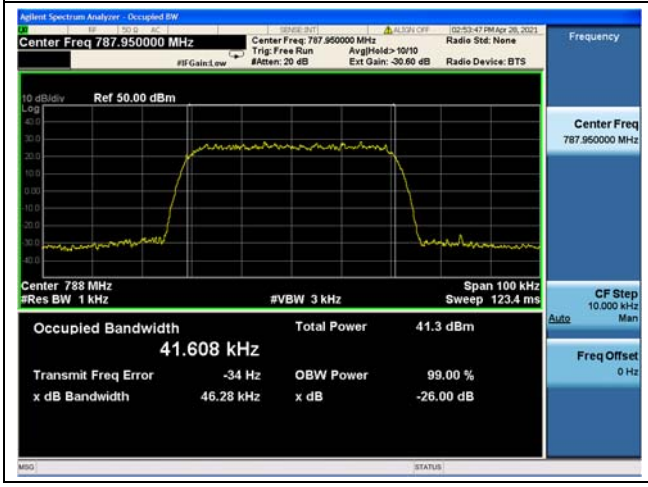
787.950MHz/Channel V/50.0 kHz/16QAM



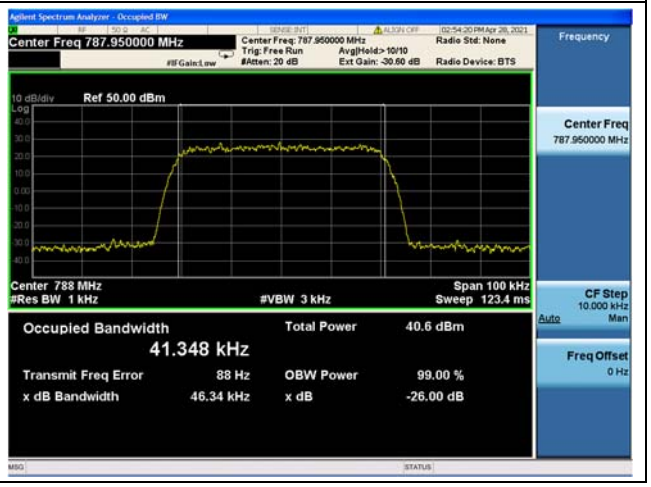
787.950MHz/Channel V/50.0 kHz/64QAM



787.950MHz/Channel V/50.0 kHz/256QAM



787.950MHz/Channel V/50.0 kHz/64QAM



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;

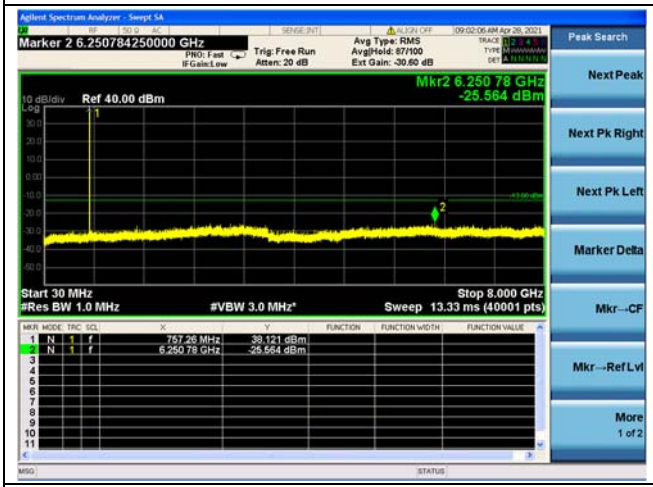
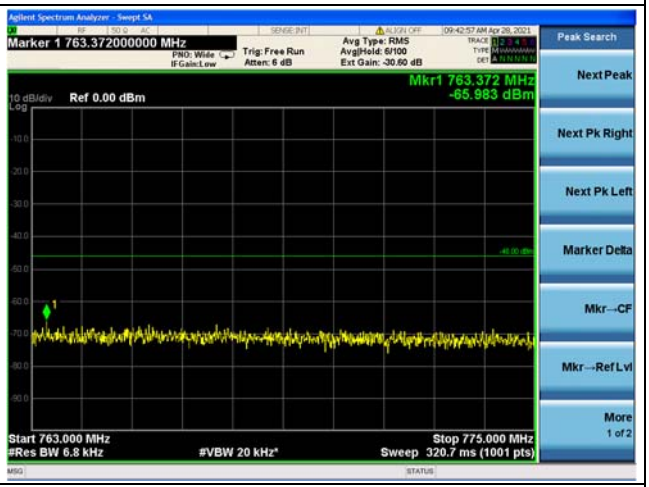
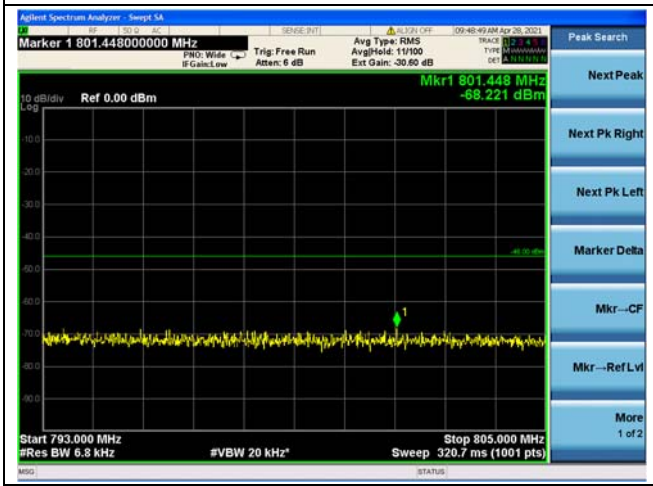
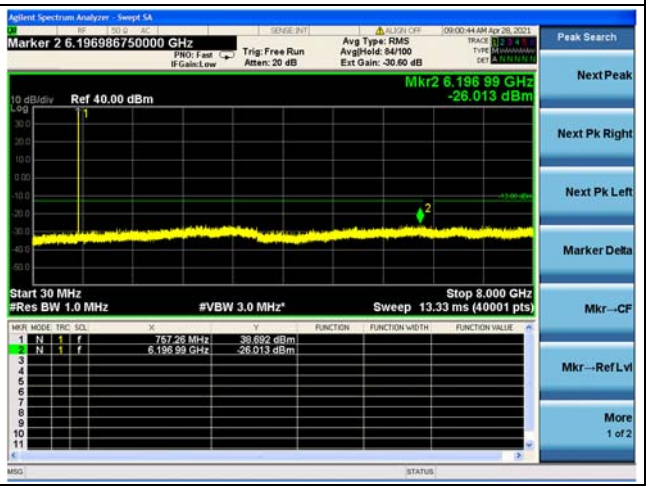
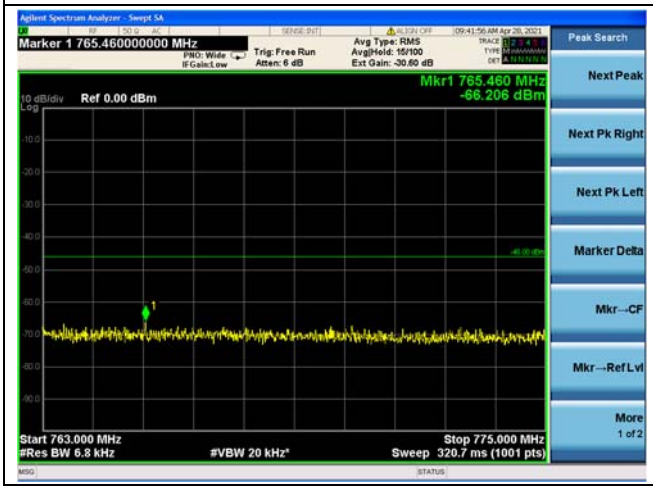
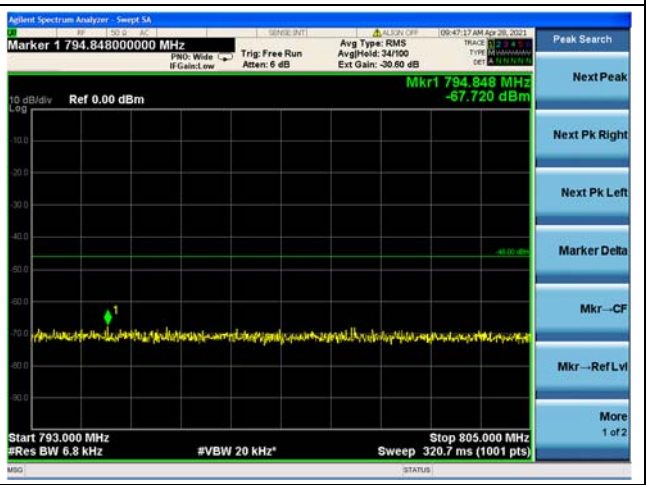
(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 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.

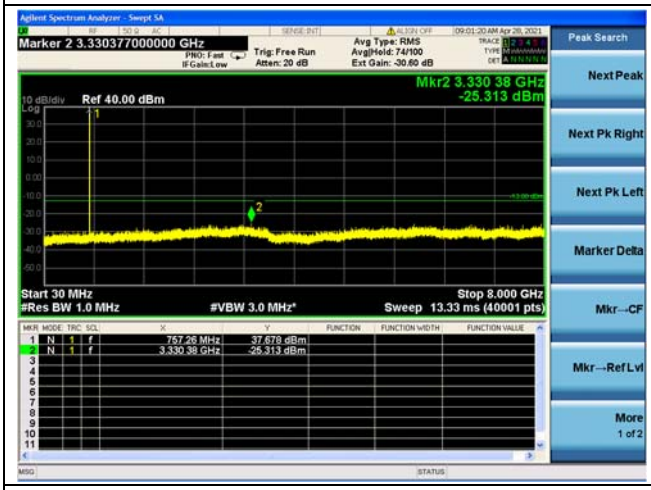
2.3.2. Test Result

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

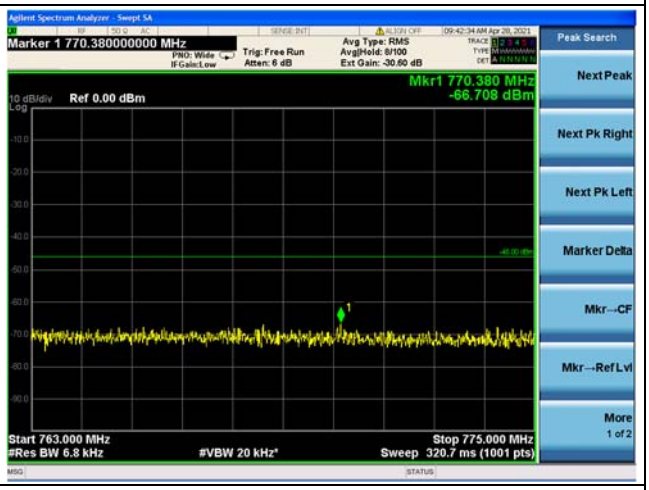
Nominal Frequency: 757.050 MHz Tx Port: Channel H

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**
	

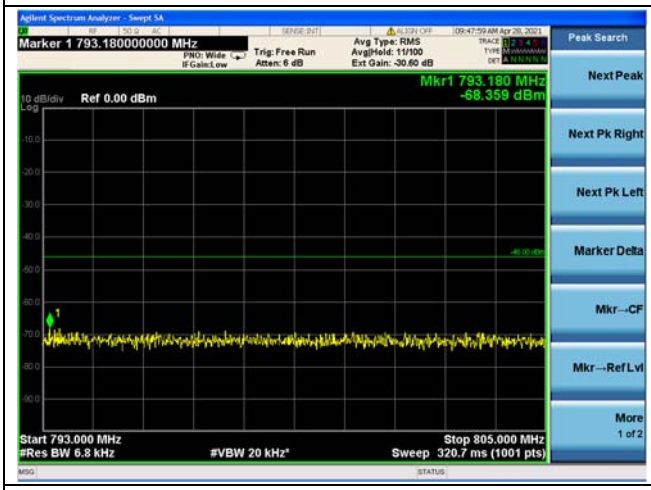
12.5kHz/64QAM



12.5kHz/64QAM 763-775MHz

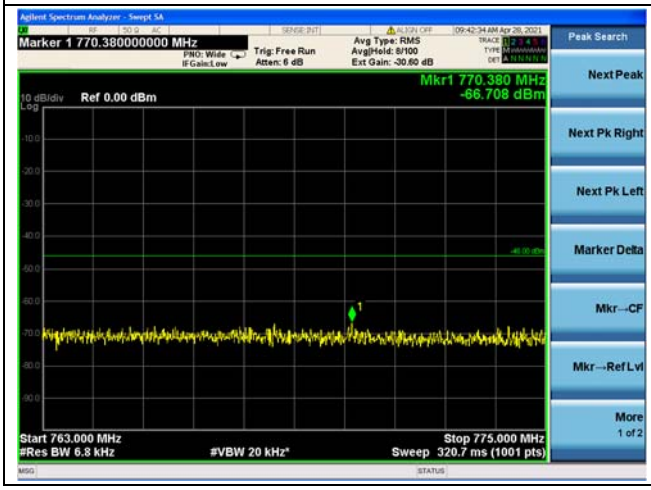


12.5kHz/64QAM 793-805MHz

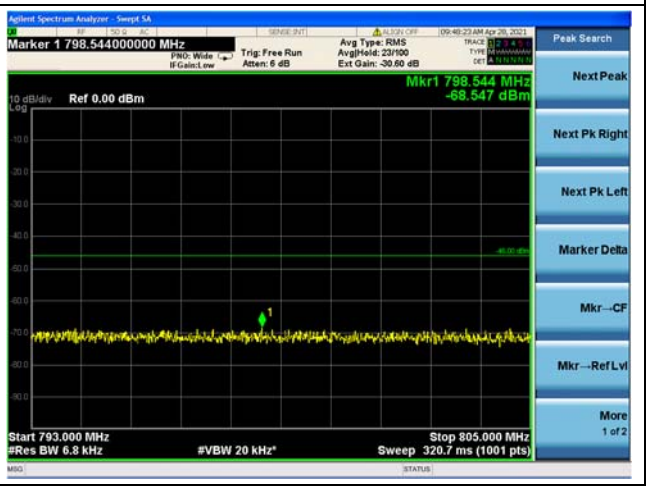


12.5kHz/256QAM

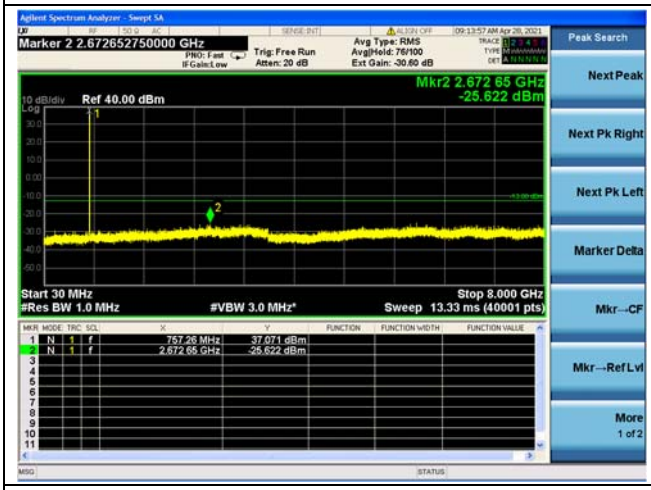
12.5kHz/256QAM 763-775MHz



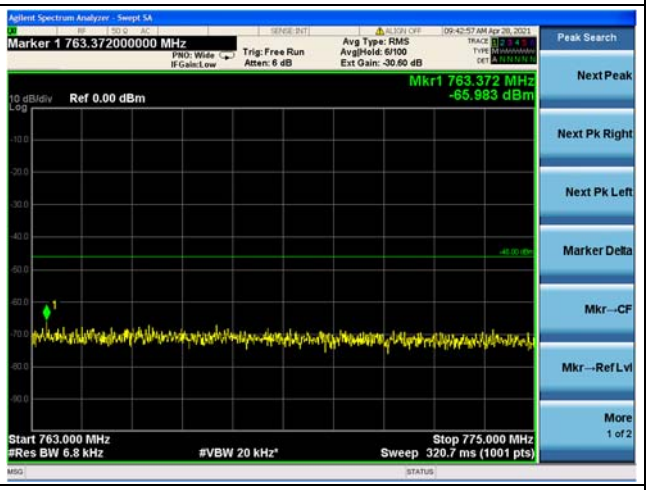
12.5kHz/256QAM 793-805MHz



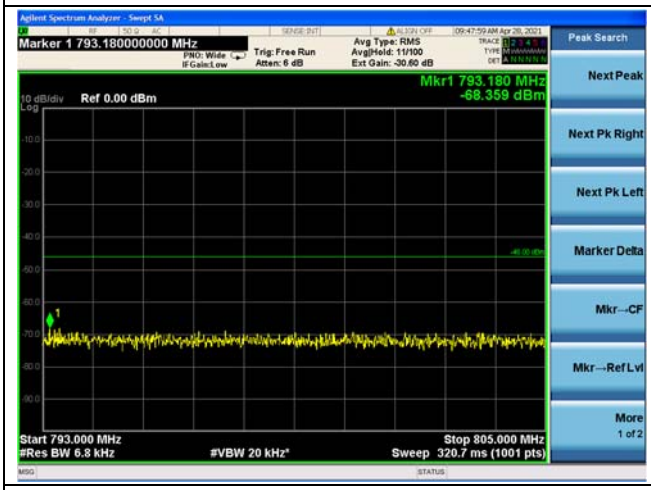
25kHz/QPSK



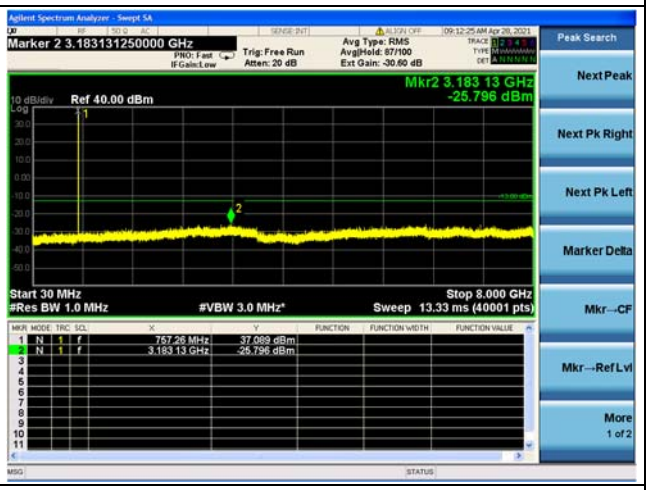
25kHz/QPSK 763-775MHz



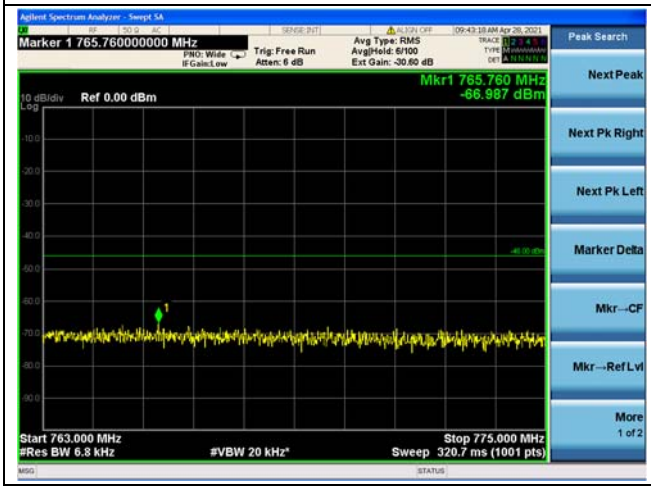
25kHz/QPSK 793-805MHz



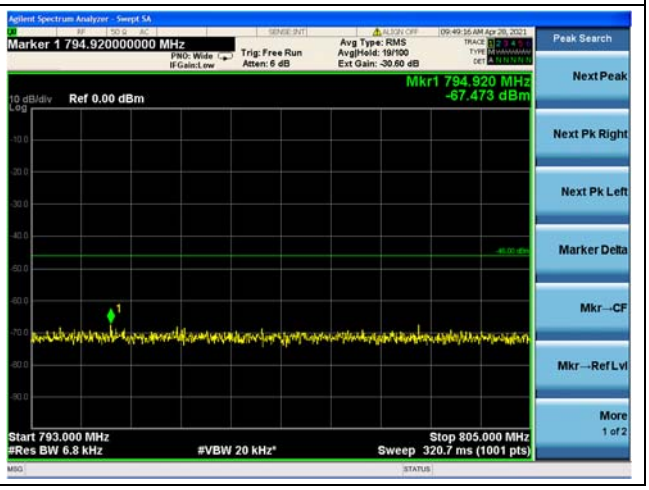
25kHz/16QAM



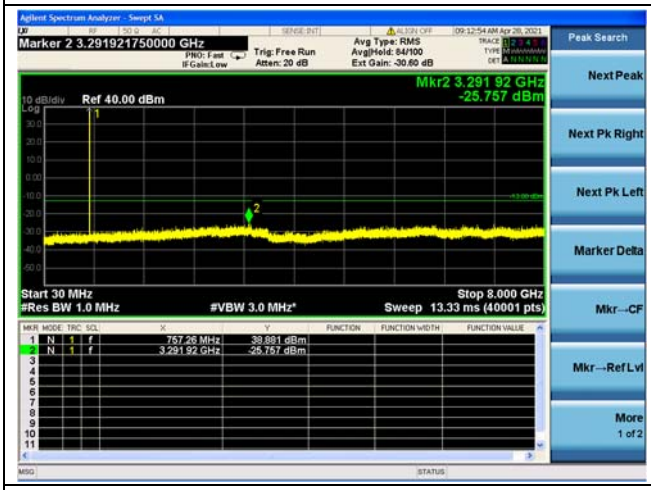
25kHz/16QAM 763-775MHz



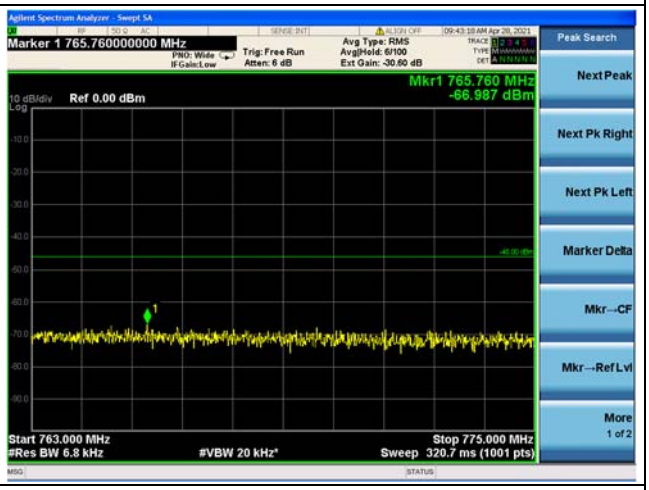
25kHz/16QAM 793-805MHz



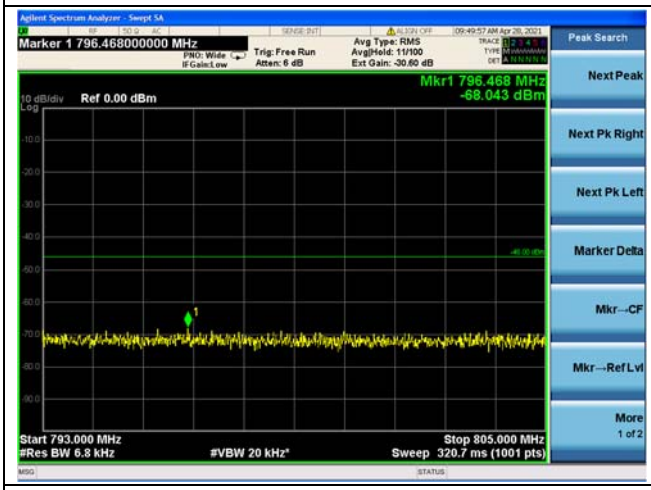
25kHz/64QAM



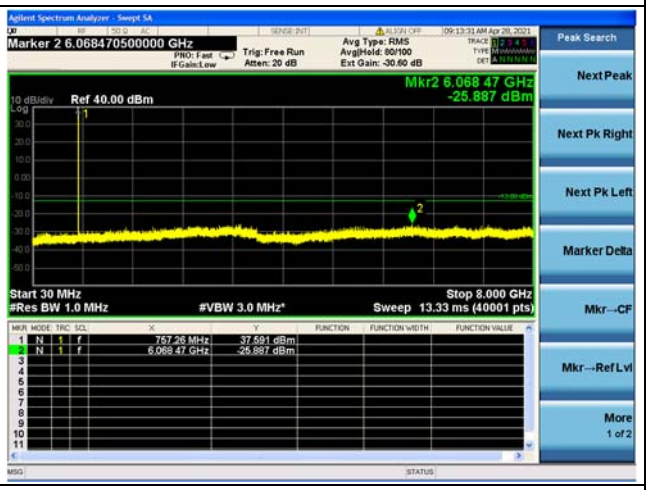
25kHz/64QAM 763-775MHz



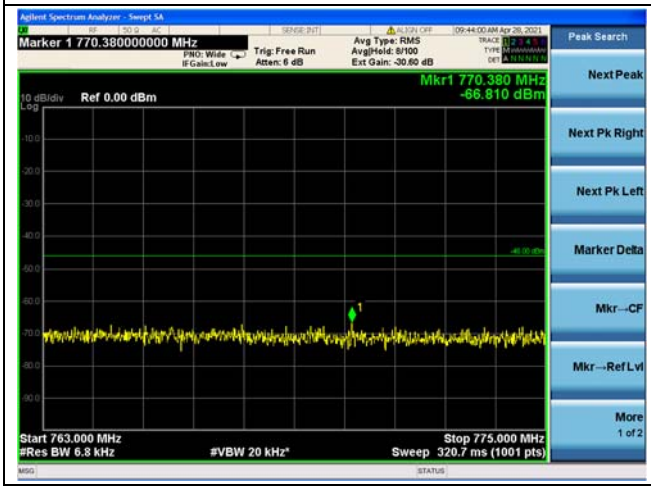
25kHz/64QAM 793-805MHz



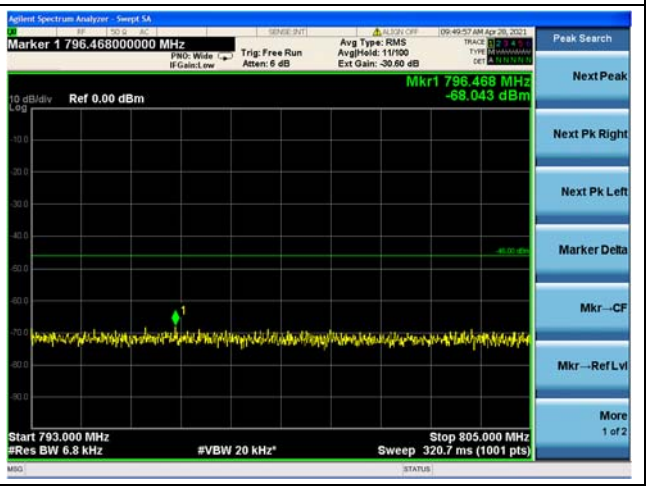
25kHz/256QAM



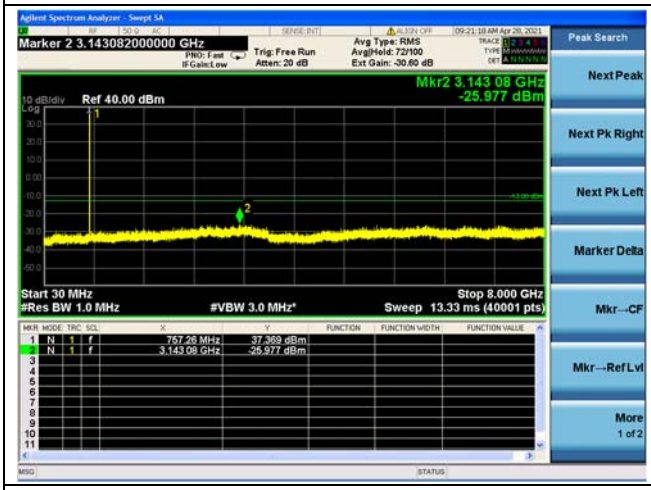
25kHz/256QAM 763-775MHz



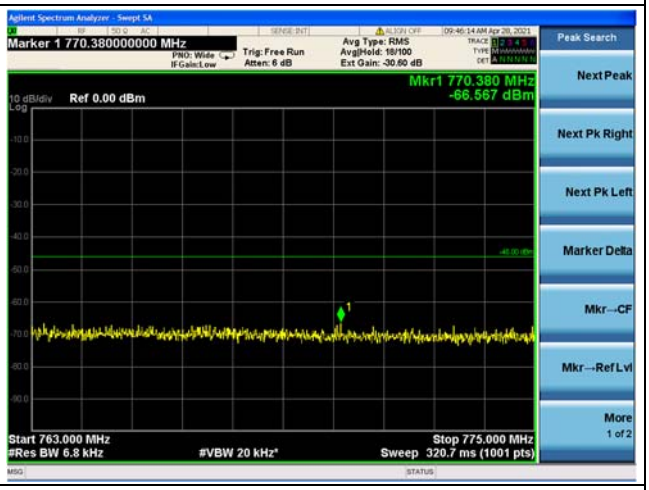
25kHz/256QAM 793-805MHz



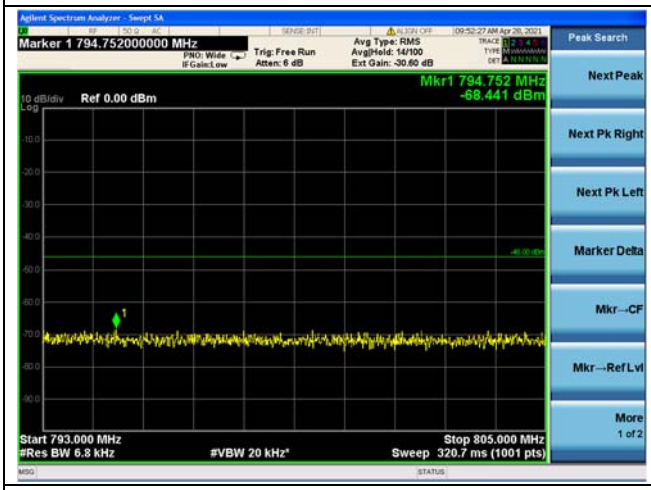
50kHz/QPSK



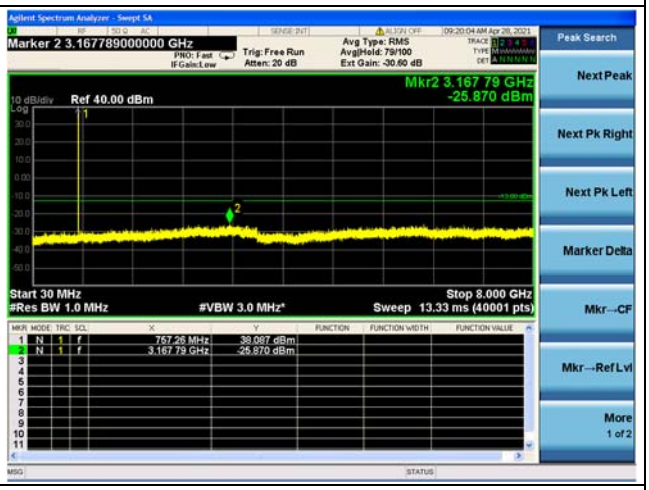
50kHz/QPSK 763-775MHz



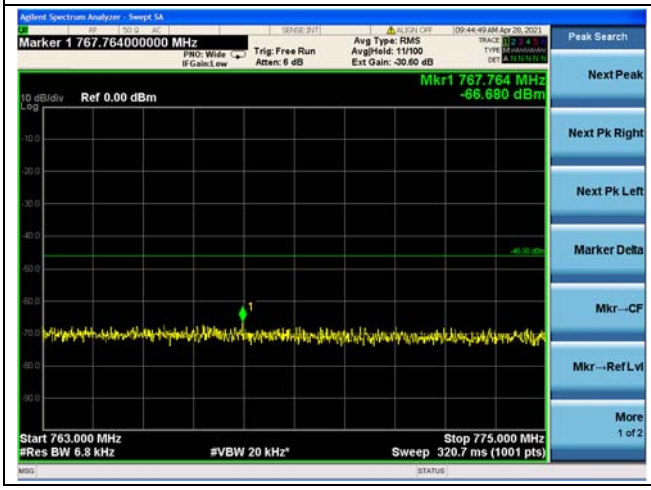
50kHz/QPSK 793-805MHz



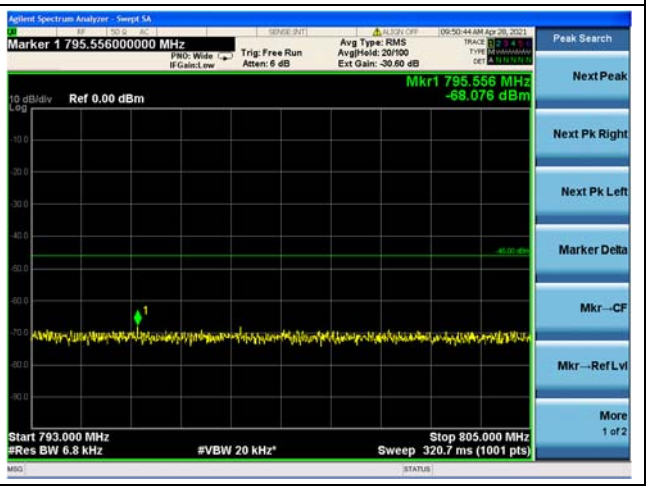
50kHz/16QAM



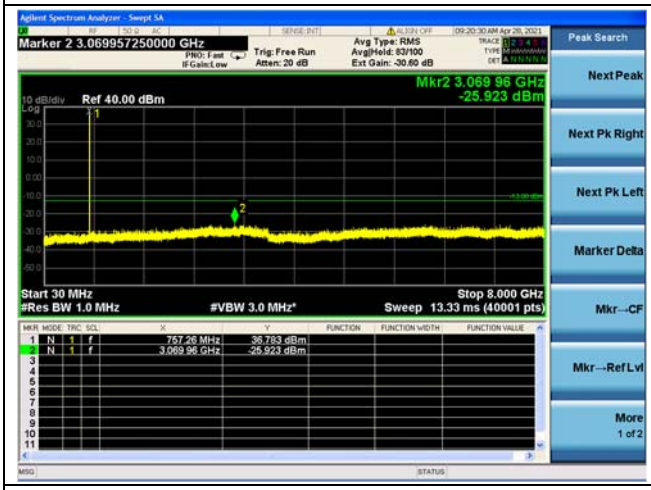
50kHz/16QAM 763-775MHz



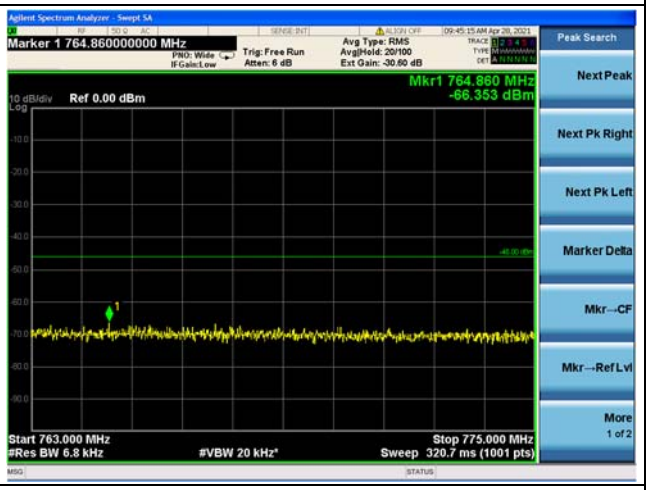
50kHz/16QAM 793-805MHz



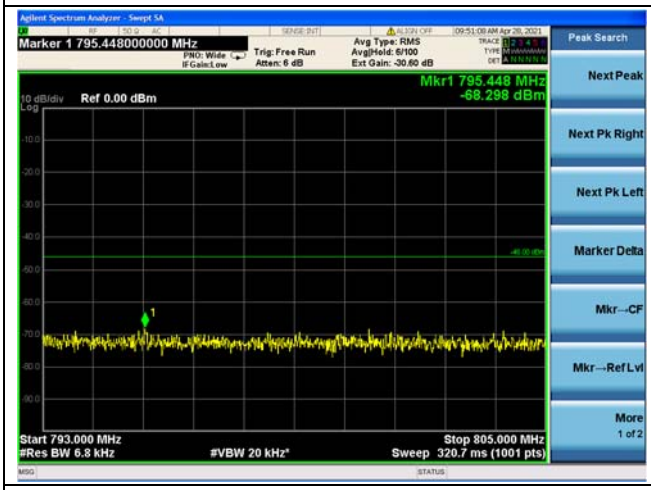
50kHz/64QAM



50kHz/64QAM 763-775MHz

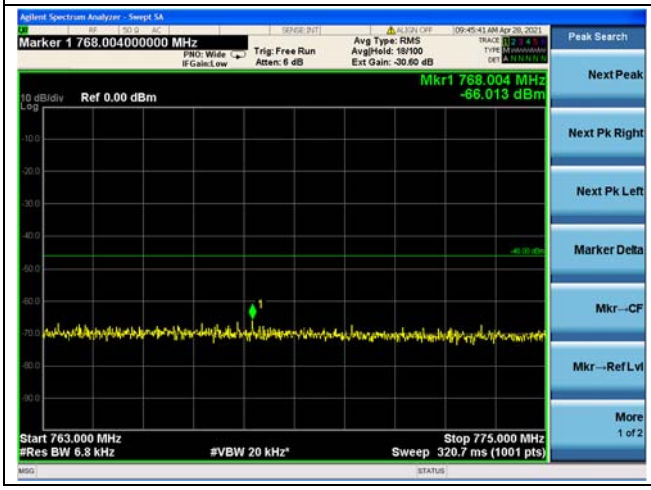


50kHz/64QAM 793-805MHz

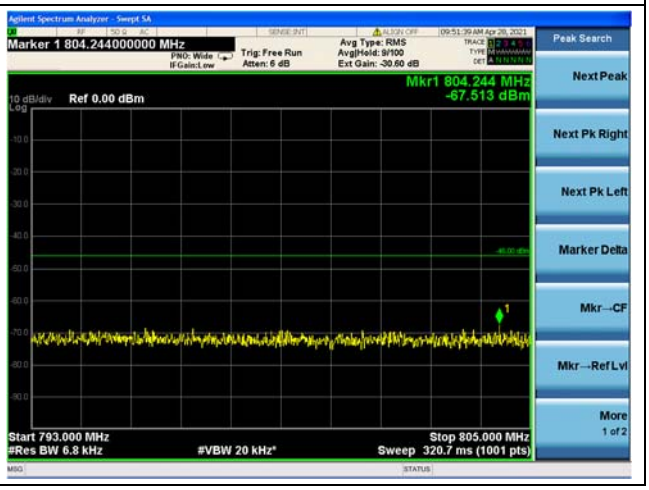


50kHz/256QAM

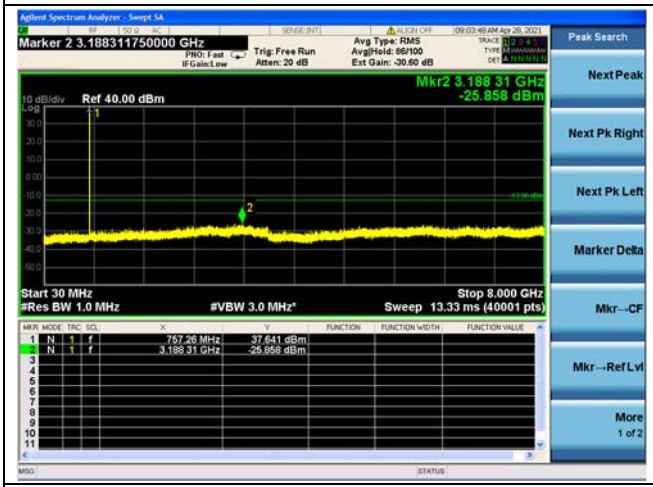
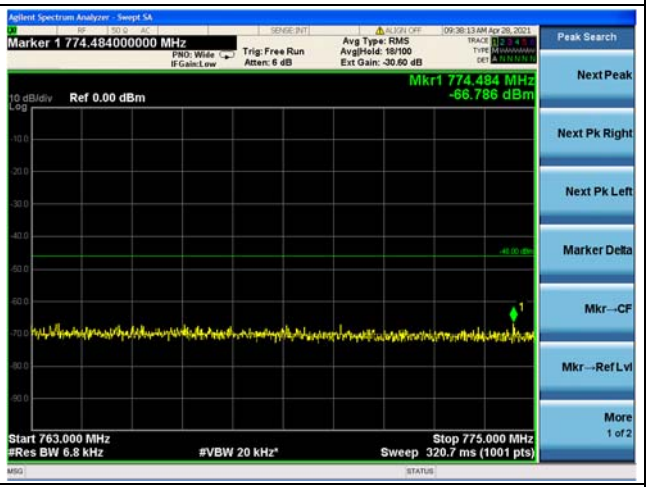
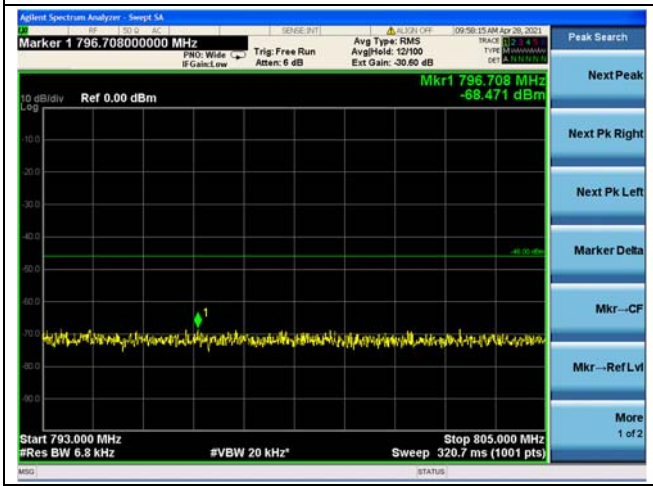
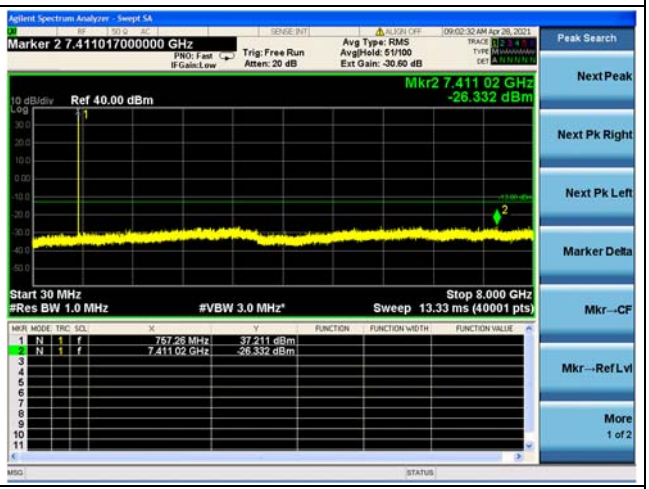
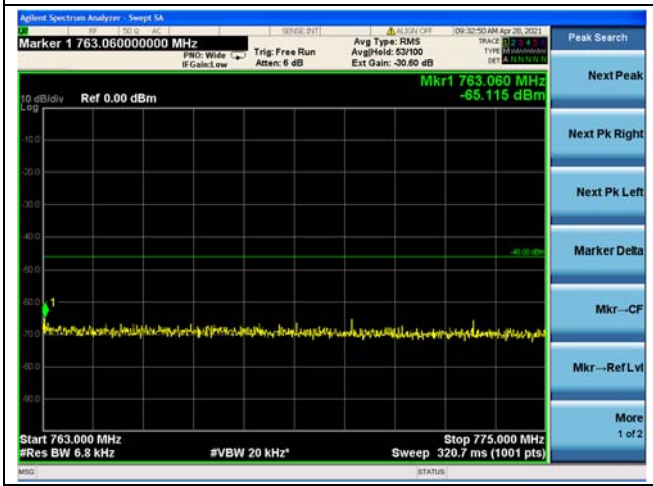
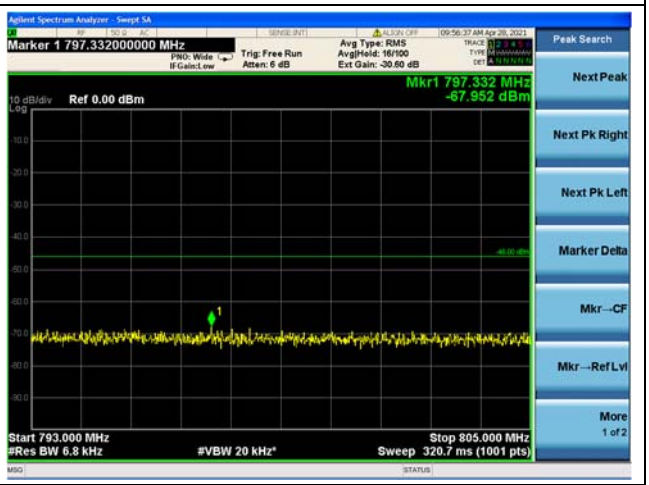
50kHz/256QAM 763-775MHz



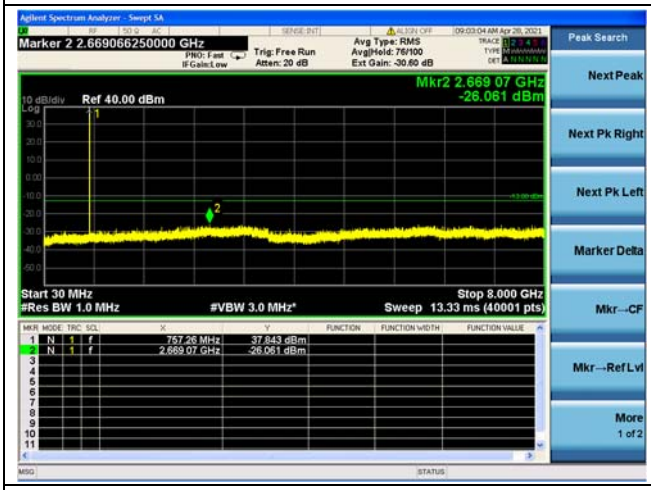
50kHz/256QAM 793-805MHz



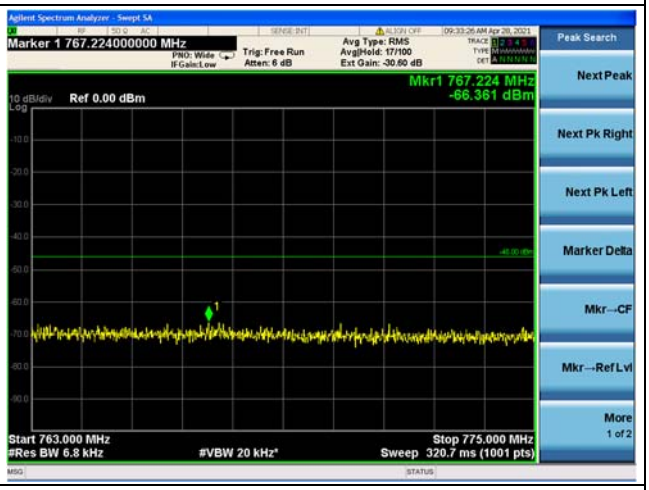
Nominal Frequency: 757.050 MHz Tx Port: Channel V

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**
	

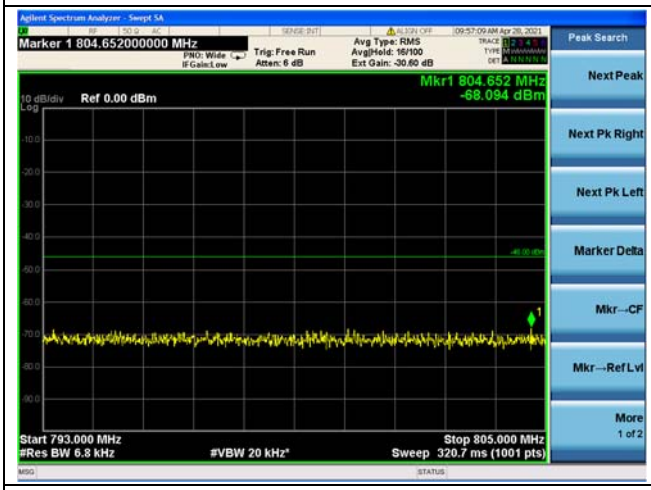
12.5kHz/64QAM



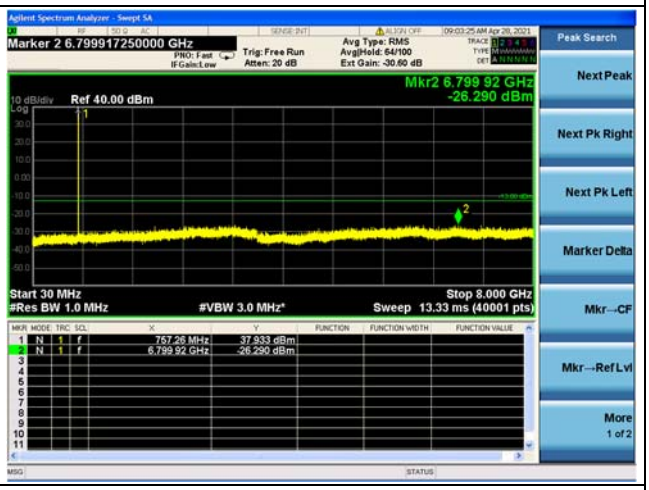
12.5kHz/64QAM 763-775MHz



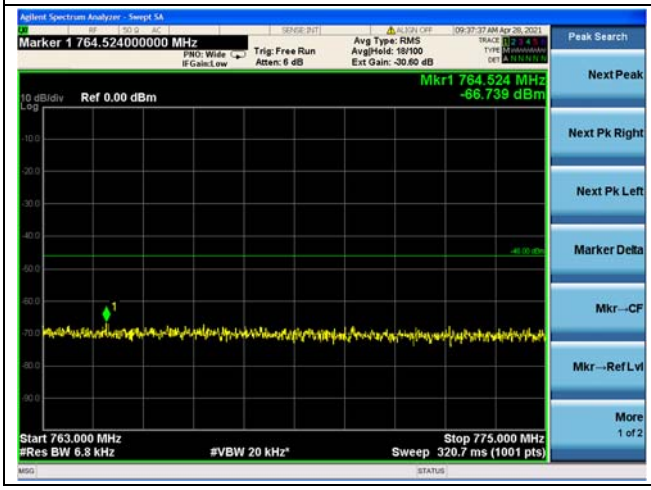
12.5kHz/64QAM 793-805MHz



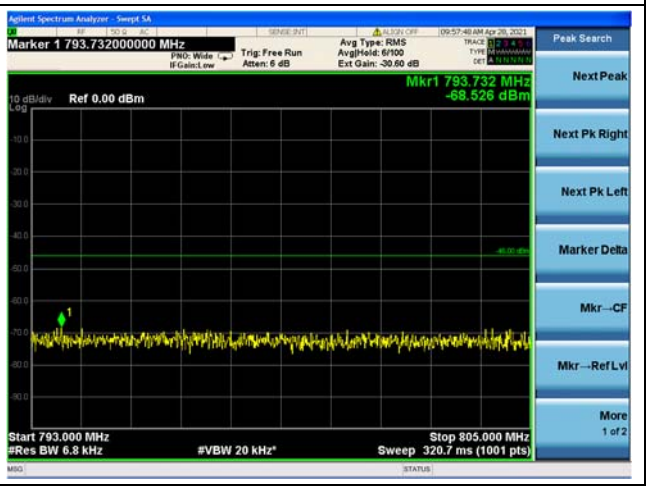
12.5kHz/256QAM



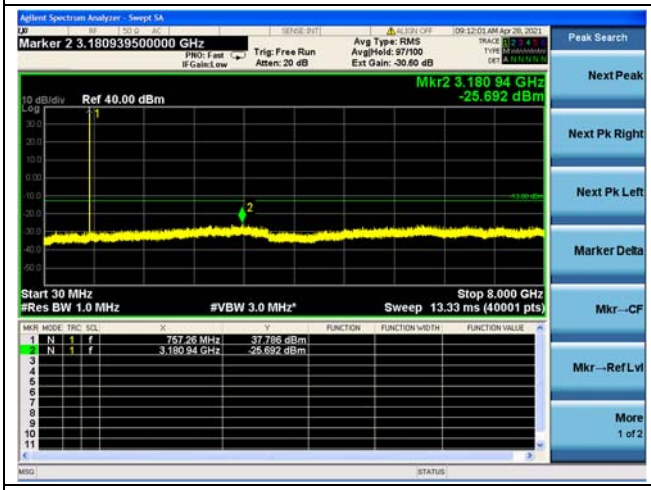
12.5kHz/256QAM 763-775MHz



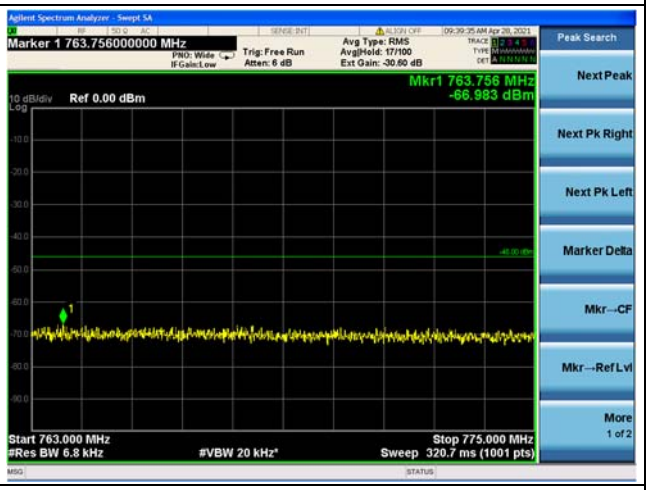
12.5kHz/256QAM 793-805MHz



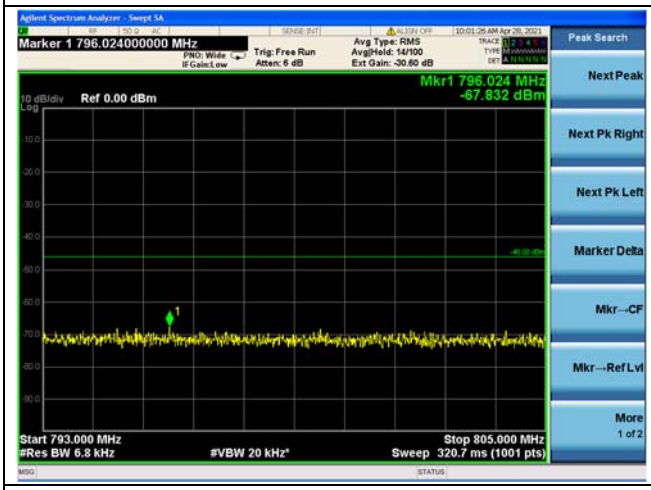
25kHz/QPSK



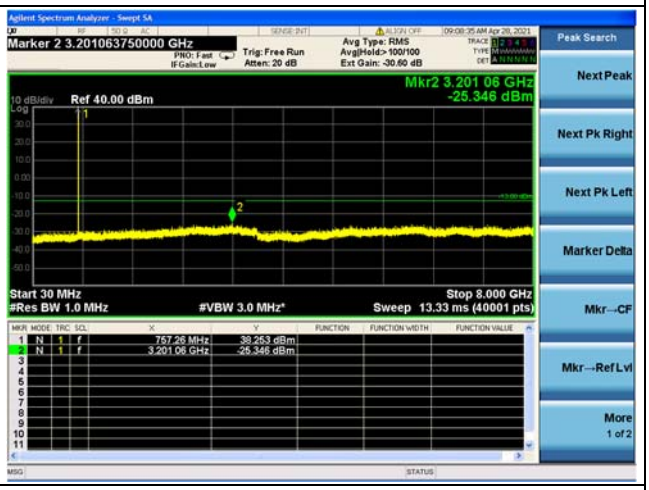
25kHz/QPSK 763-775MHz



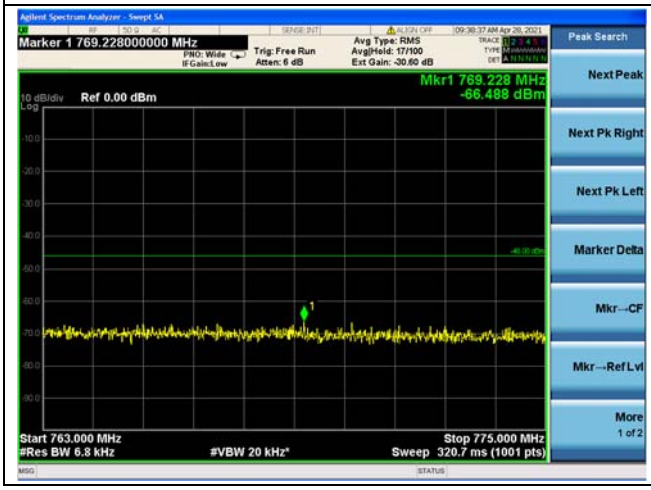
25kHz/QPSK 793-805MHz



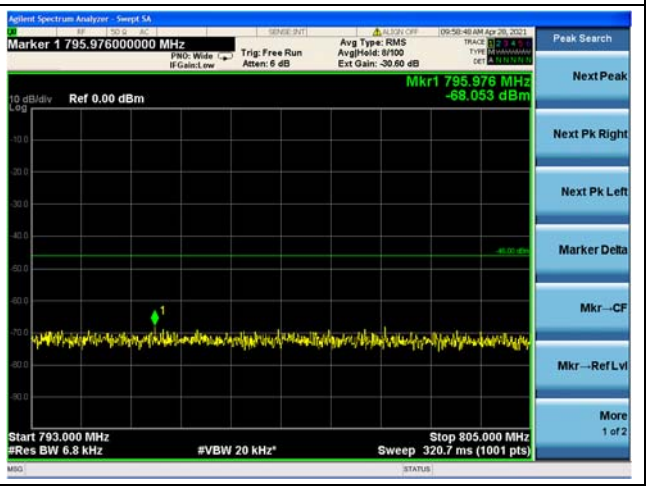
25kHz/16QAM



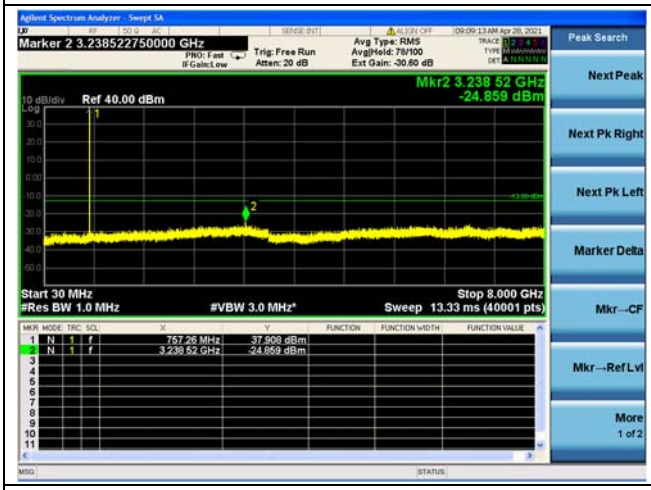
25kHz/16QAM 763-775MHz



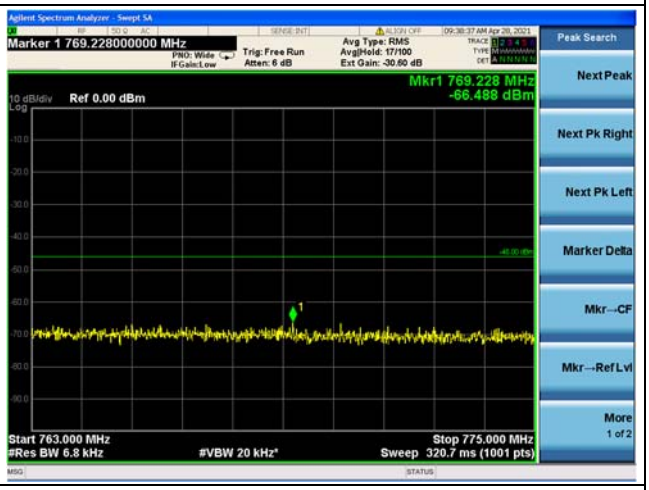
25kHz/16QAM 793-805MHz



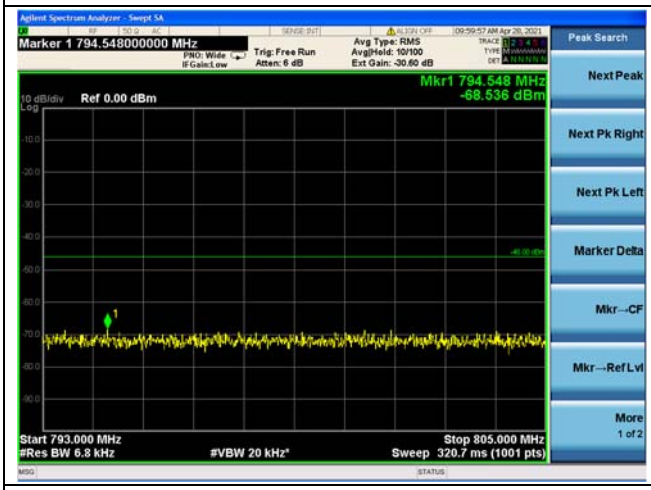
25kHz/64QAM



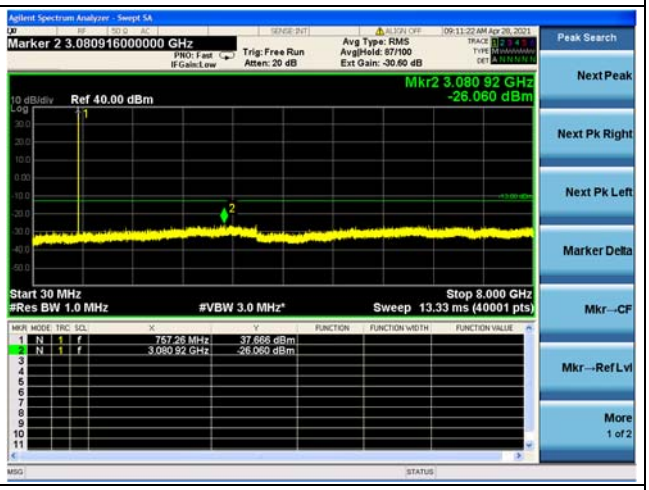
25kHz/64QAM 763-775MHz



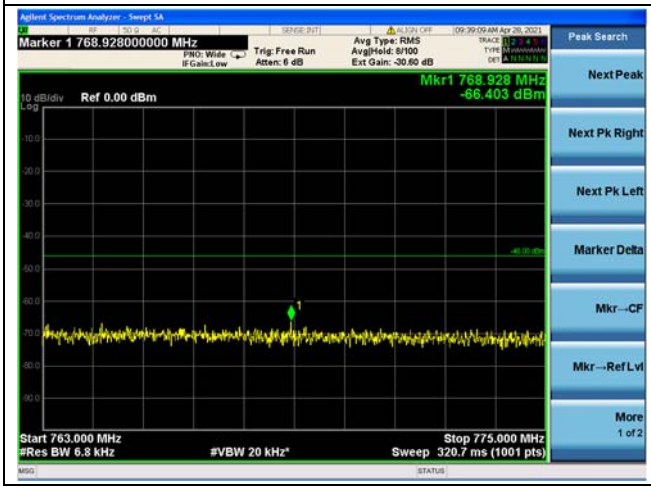
25kHz/64QAM 793-805MHz



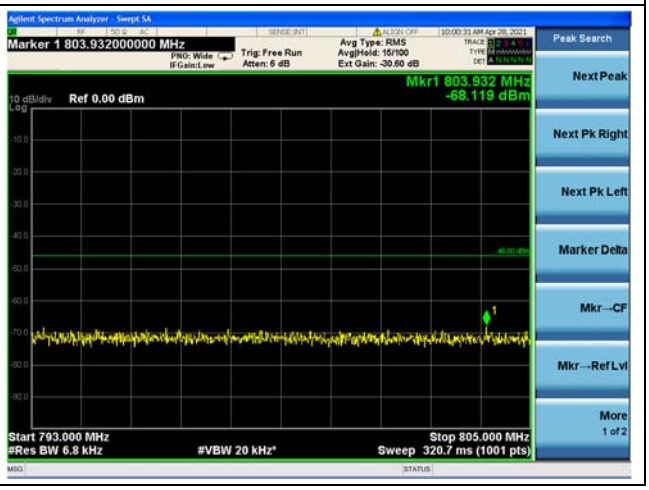
25kHz/256QAM



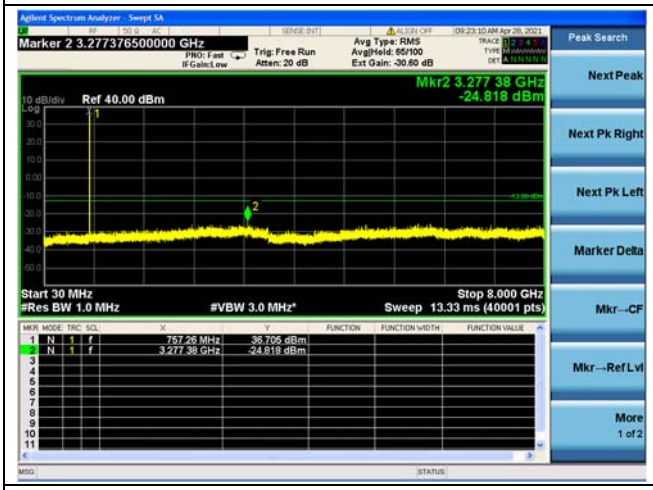
25kHz/256QAM 763-775MHz



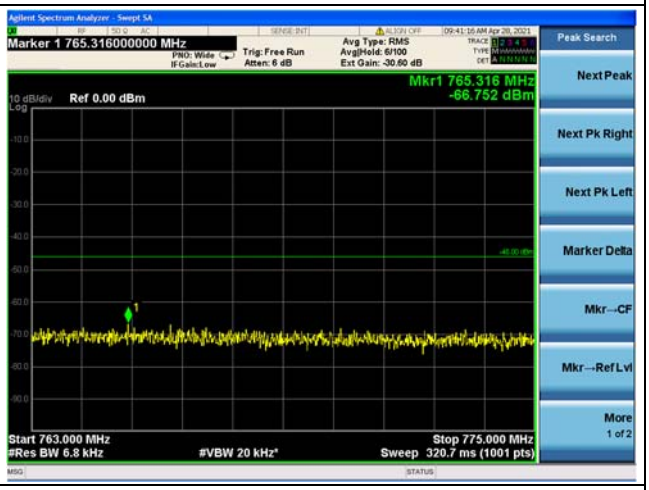
25kHz/256QAM 793-805MHz



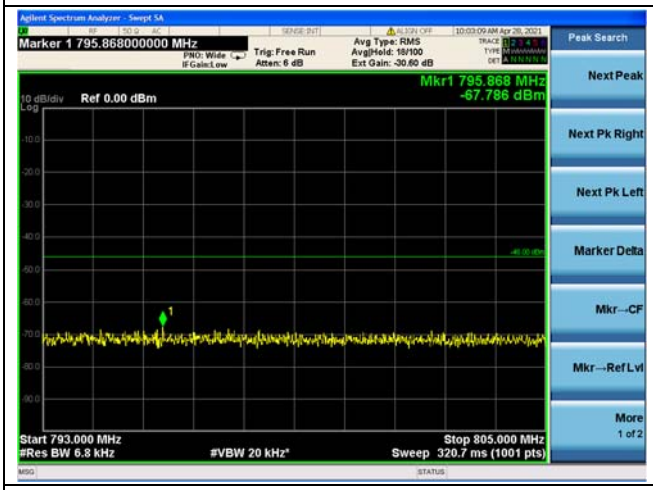
50kHz/QPSK



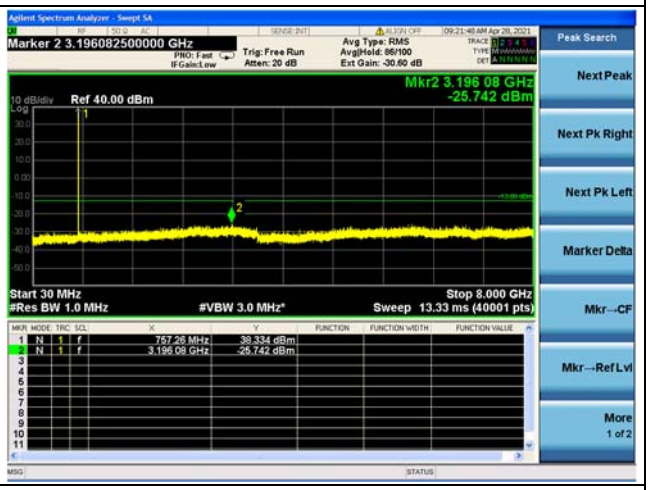
50kHz/QPSK 763-775MHz



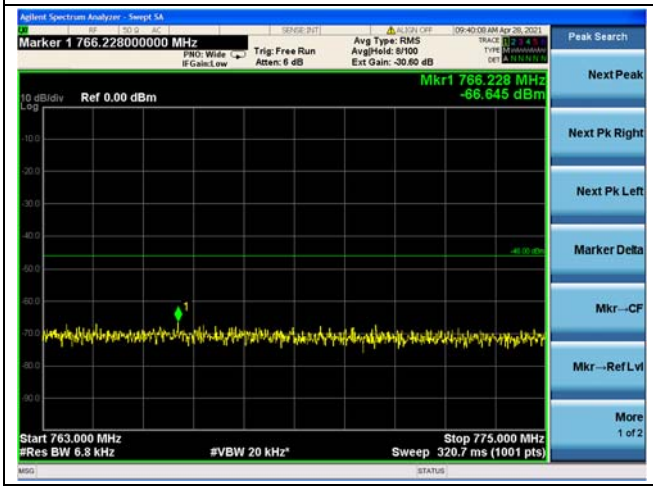
50kHz/QPSK 793-805MHz



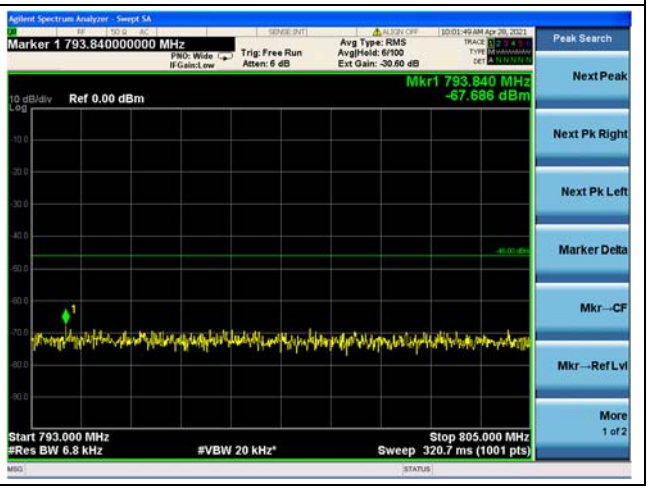
50kHz/16QAM



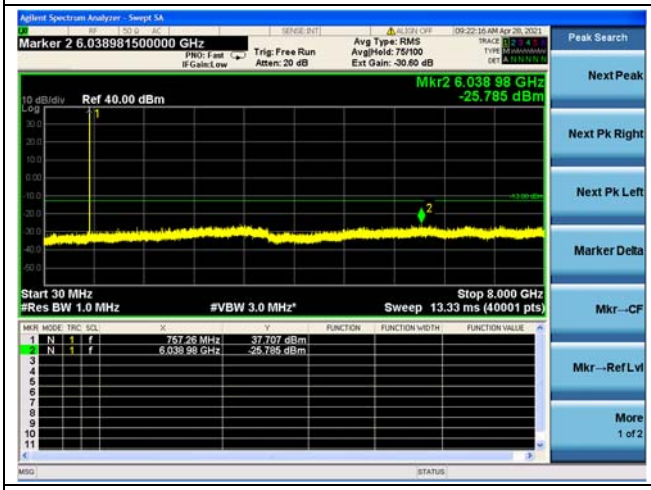
50kHz/16QAM 763-775MHz



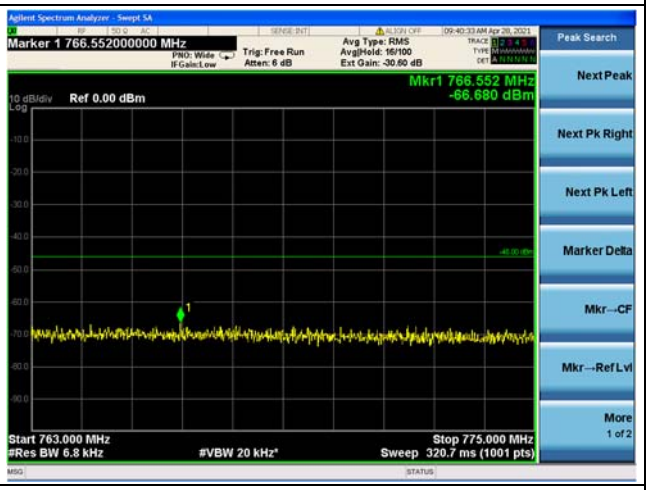
50kHz/16QAM 793-805MHz



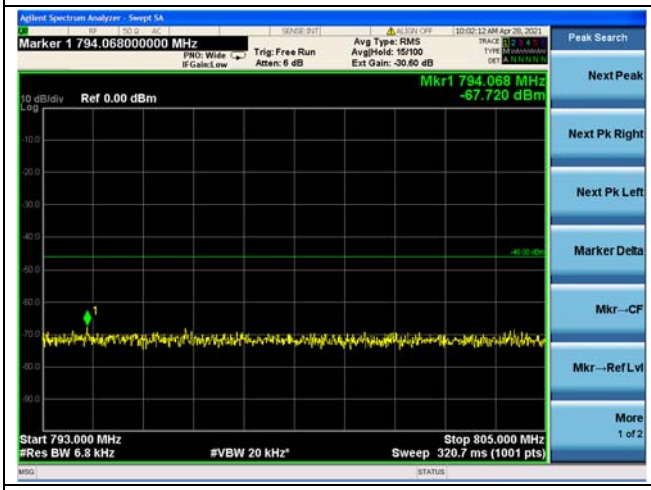
50kHz/64QAM



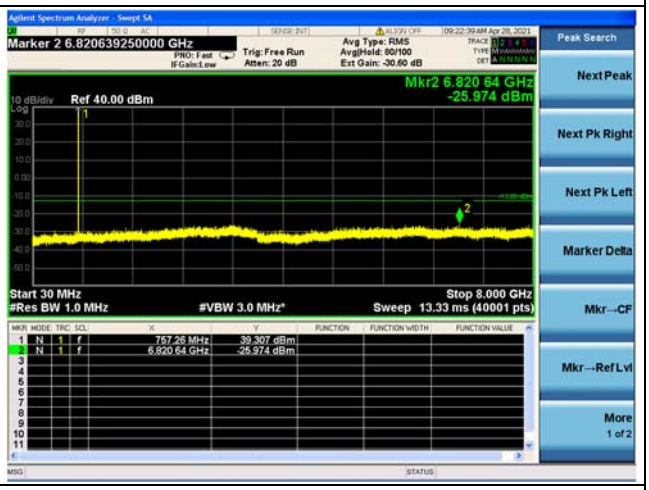
50kHz/64QAM 763-775MHz



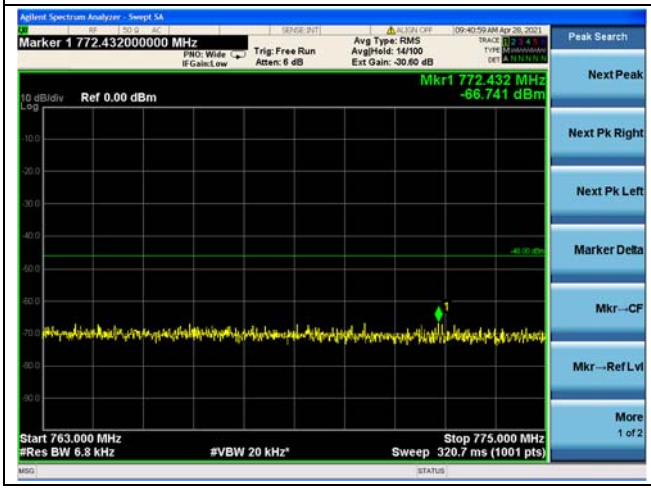
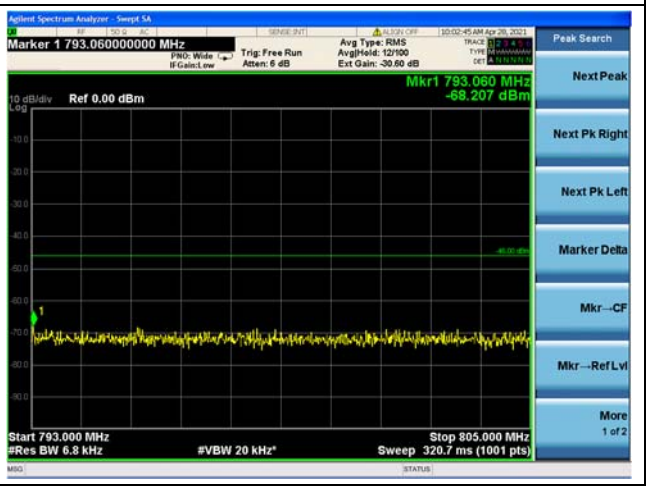
50kHz/64QAM 793-805MHz



50kHz/256QAM



50kHz/256QAM 763-775MHz



50kHz/256QAM 793-805MHz