REPORT No. : SZ21010246W01

TEST REPORT

APPLICANT	:	MiMOMax Wireless Limited
PRODUCT NAME	:	700MHz Upper A Block Tornado Transceiver
MODEL NAME	:	MWL-TORNADO-*H A/B/C *
BRAND NAME	:	MiMOMax Wireless
FCC ID	:	XMK-MMXTRNB006
STANDARD(S)	:	47 CFR Part 2 47 CFR Part 27
RECEIPT DATE	:	2021-02-23
TEST DATE	:	2021-03-02 to 2021-05-25
ISSUE DATE	:	2021-05-25

Tested by: Ling Keye(Rapporteur)

Approved by: Peng Huarui(Supervisor)

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MORLAB

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Change History		
Issue	**Date**	**Reason for change**
1.0	2021-05-25	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 Tornado Transceiver
Hardware Version:	P001
Software Version:	TRN-04.06.02
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: 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	Mar 3, 2021	Ling Keye	Complies
2	2.1049	Occupied bandwidth	Mar 5, 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	Mar5, 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	Mar 4, May 25, 2021	Gao Jianrou	PASS
5	27.53(f)	Additional emission requirement in 1559 - 1610 MHz band	Mar 15, 2021	Gao Jianrou	PASS

6	27.54 2.1055	Frequency stability	Mar 7, 2021	Ling Keye	PASS

Note 1: The TORNADO 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 TORNADO 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 0.8dB and Attenuator 29.0dB.

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	24.04	0.25	25.89	0.388	37.89	6.152
12.5	16QAM	24	24.02	0.25	25.87	0.386	37.87	6.124
12.5	64QAM	24	24.08	0.25	25.93	0.392	37.93	6.209
12.5	256QAM	24	24.09	0.25	25.94	0.393	37.94	6.223
25.0	QPSK	24	24.04	0.25	25.89	0.388	37.89	6.152
25.0	16QAM	24	24.05	0.25	25.90	0.389	37.90	6.166
25.0	64QAM	24	24.07	0.25	25.92	0.391	37.92	6.194
25.0	256QAM	24	24.09	0.25	25.94	0.393	37.94	6.223
50.0	QPSK	24	23.99	0.25	25.84	0.384	37.84	6.081
50.0	16QAM	24	24.01	0.25	25.86	0.385	37.86	6.109
50.0	64QAM	24	24.08	0.25	25.93	0.392	37.93	6.209
50.0	256QAM	24	24.08	0.25	25.93	0.392	37.93	6.209

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	23.97	0.25	25.82	0.382	37.82	6.053
12.5	16QAM	24	23.94	0.25	25.79	0.379	37.79	6.012
12.5	64QAM	24	24.01	0.25	25.86	0.385	37.86	6.109
12.5	256QAM	24	24.08	0.25	25.93	0.392	37.93	6.209
25.0	QPSK	24	23.96	0.25	25.81	0.381	37.81	6.039

25.0	16QAM	24	24.01	0.25	25.86	0.385	37.86	6.109
25.0	64QAM	24	24.08	0.25	25.93	0.392	37.93	6.209
25.0	256QAM	24	24.07	0.25	25.92	0.391	37.92	6.194
50.0	QPSK	24	24.00	0.25	25.85	0.385	37.85	6.095
50.0	16QAM	24	23.95	0.25	25.80	0.380	37.80	6.026
50.0	64QAM	24	23.98	0.25	25.83	0.383	37.83	6.067
50.0	256QAM	24	24.04	0.25	25.89	0.388	37.89	6.152

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 = 16.0dBi)	
					dBm	Watt	dBm	Watt
12.5	QPSK	24	23.96	0.25	25.81	0.381	37.81	6.039
12.5	16QAM	24	23.93	0.25	25.78	0.378	37.78	5.998
12.5	64QAM	24	24.02	0.25	25.87	0.386	37.87	6.124
12.5	256QAM	24	24.03	0.25	25.88	0.387	37.88	6.138
25.0	QPSK	24	23.97	0.25	25.82	0.382	37.82	6.053
25.0	16QAM	24	23.93	0.25	25.78	0.378	37.78	5.998
25.0	64QAM	24	23.97	0.25	25.82	0.382	37.82	6.053
25.0	256QAM	24	24.04	0.25	25.89	0.388	37.89	6.152
50.0	QPSK	24	24.06	0.25	25.91	0.390	37.91	6.180
50.0	16QAM	24	24.01	0.25	25.86	0.385	37.86	6.109
50.0	64QAM	24	24.05	0.25	25.90	0.389	37.90	6.166
50.0	256QAM	24	24.08	0.25	25.93	0.392	37.93	6.209

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 = 16.0dBi)	
					dBm	Watt	dBm	Watt
12.5	QPSK	24	23.94	0.25	25.79	0.379	37.79	6.012
12.5	16QAM	24	23.95	0.25	25.80	0.380	37.80	6.026
12.5	64QAM	24	23.93	0.25	25.78	0.378	37.78	5.998

12.5	256QAM	24	24.02	0.25	25.87	0.386	37.87	6.124
25.0	QPSK	24	24.01	0.25	25.86	0.385	37.86	6.109
25.0	16QAM	24	23.91	0.25	25.76	0.377	37.76	5.970
25.0	64QAM	24	23.98	0.25	25.83	0.383	37.83	6.067
25.0	256QAM	24	23.94	0.25	25.79	0.379	37.79	6.012
50.0	QPSK	24	23.97	0.25	25.82	0.382	37.82	6.053
50.0	16QAM	24	23.96	0.25	25.81	0.381	37.81	6.039
50.0	64QAM	24	23.98	0.25	25.83	0.383	37.83	6.067
50.0	256QAM	24	24.05	0.25	25.90	0.389	37.90	6.166

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 0.8dB and Attenuator 29.0dB.

Note 2: The transmitter has a rated output power of 0.25 watt(24dBm). 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 38.06dBi for 757-758MHz and 22.83dBi 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

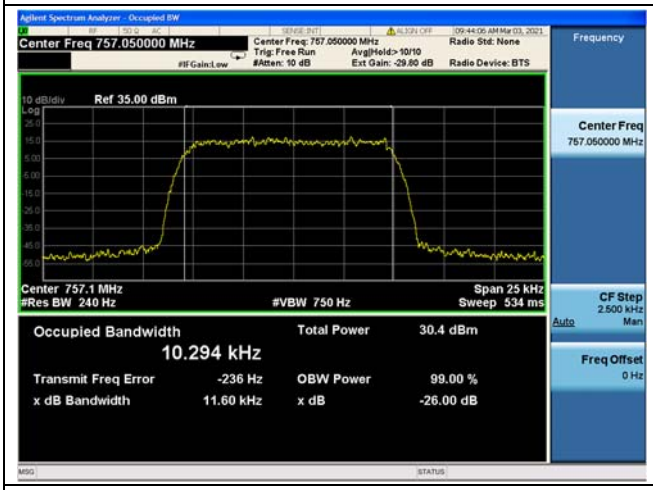
Measurements have been made to verify these declared bandwidths using the generic frequencies that are listed in the table above.
The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client.
Measurements have been made of each modulation type using a spectrum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

2.2.3. Test Result

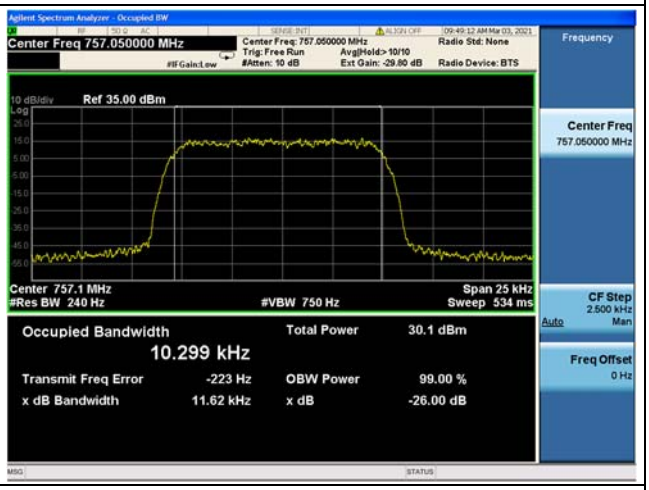
Nominal Frequency: 757.050 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	10.294
		16QAM	10.299
		64QAM	10.292
		256QAM	10.293
	25.0	QPSK	20.680
		16QAM	20.700
		64QAM	20.892
		256QAM	20.807
	50.0	QPSK	41.153
		16QAM	41.435
		64QAM	41.126
		256QAM	41.327
Channel V	12.5	QPSK	10.297
		16QAM	10.293
		64QAM	10.288
		256QAM	10.278
	25.0	QPSK	20.608
		16QAM	20.624
		64QAM	20.765
		256QAM	20.630
	50.0	QPSK	41.331
		16QAM	41.344
		64QAM	41.194
		256QAM	41.192

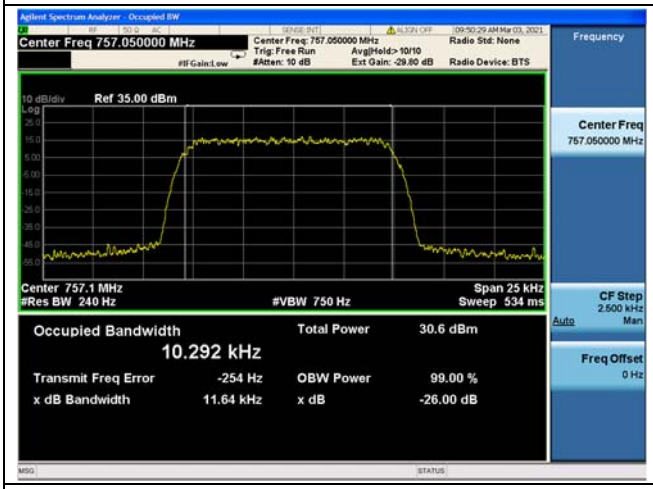
757.050MHz/Channel H/12.5kHz/QPSK



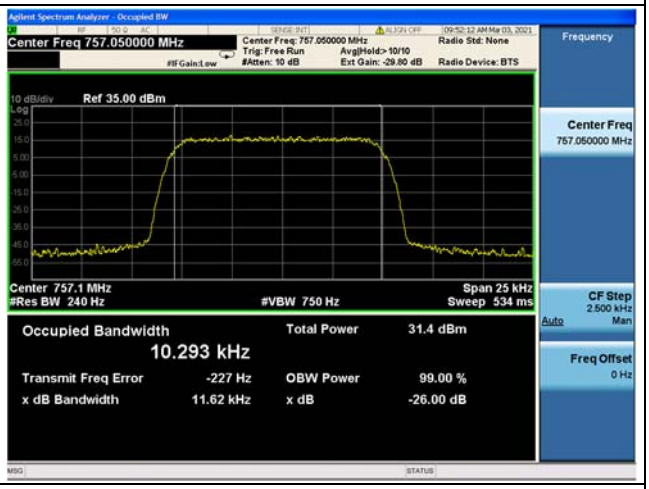
757.050MHz/Channel H/12.5kHz/16QAM



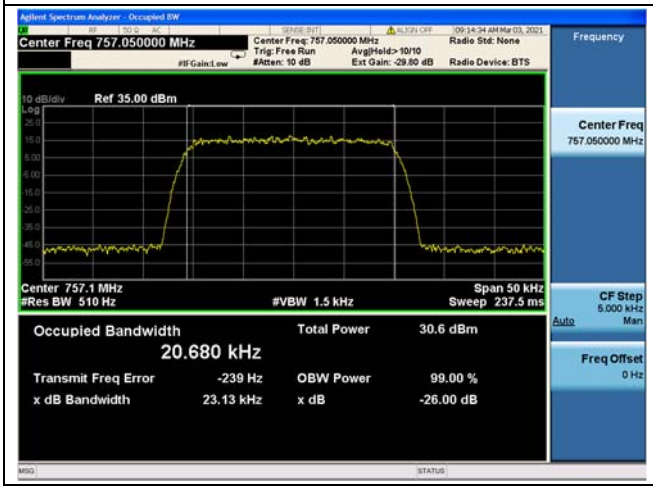
757.050MHz/Channel H/12.5kHz/64QAM



757.050MHz/Channel H/12.5 kHz/256QAM



757.050MHz/Channel H/25.0 kHz/QPSK



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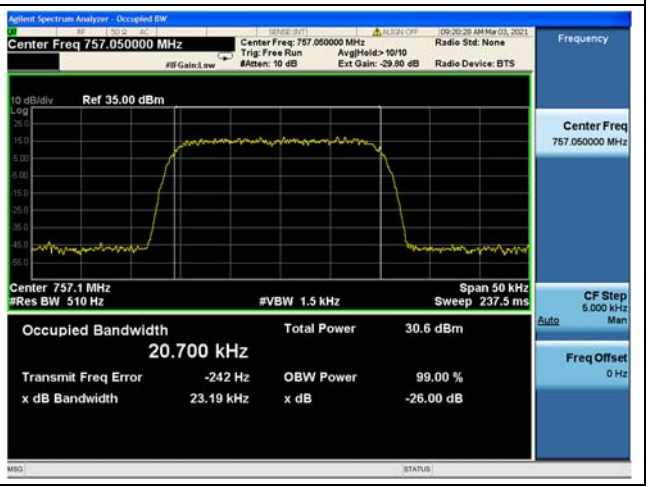
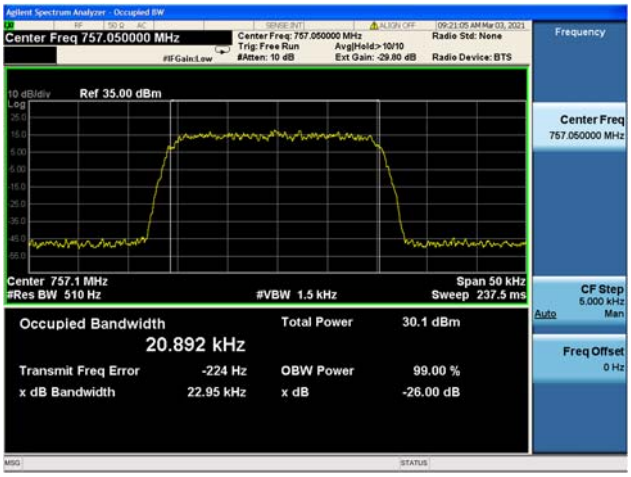
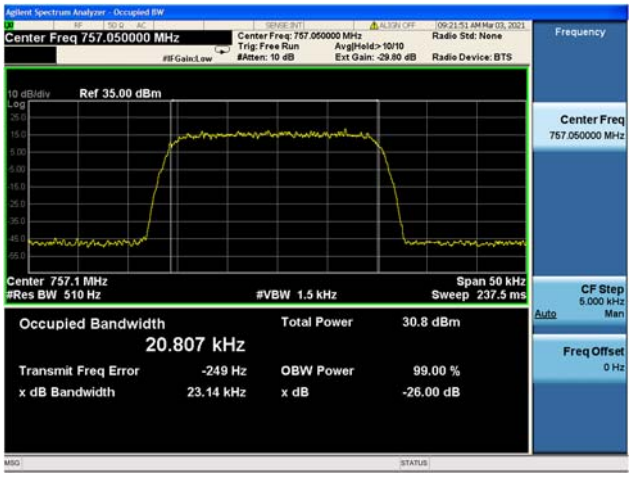


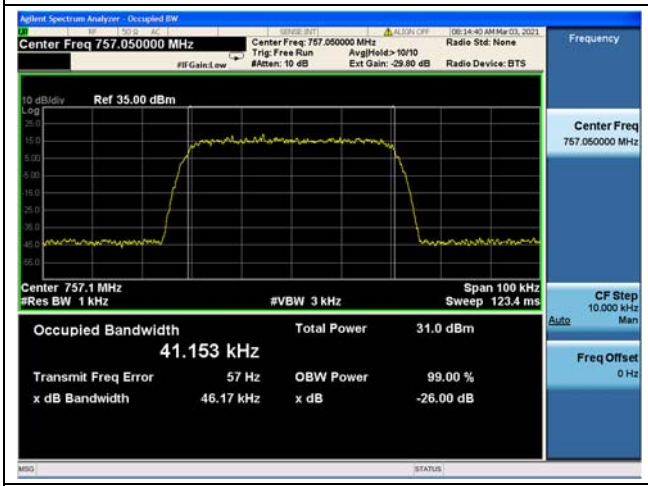
757.050MHz/Channel H/25.0 kHz/64QAM



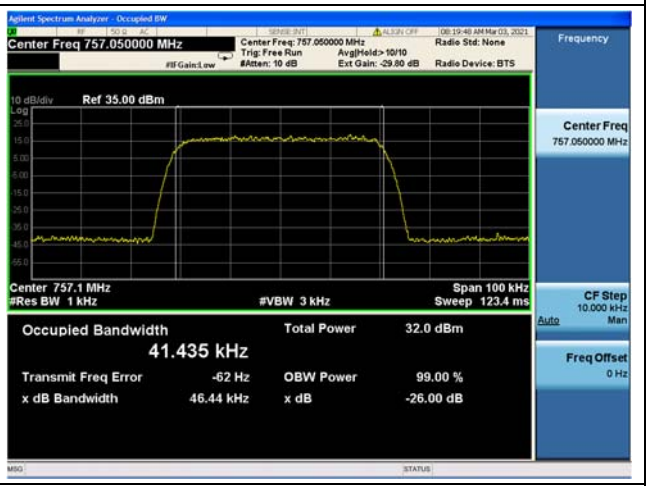
757.050MHz/Channel H/25.0 kHz/256QAM



757.050MHz/Channel H/50.0 kHz/QPSK



757.050MHz/Channel H/50.0 kHz/16QAM

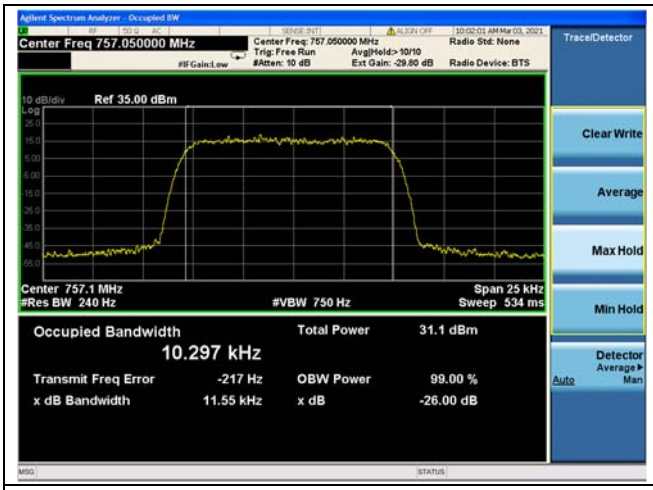


757.050MHz/Channel H/50.0 kHz/64QAM

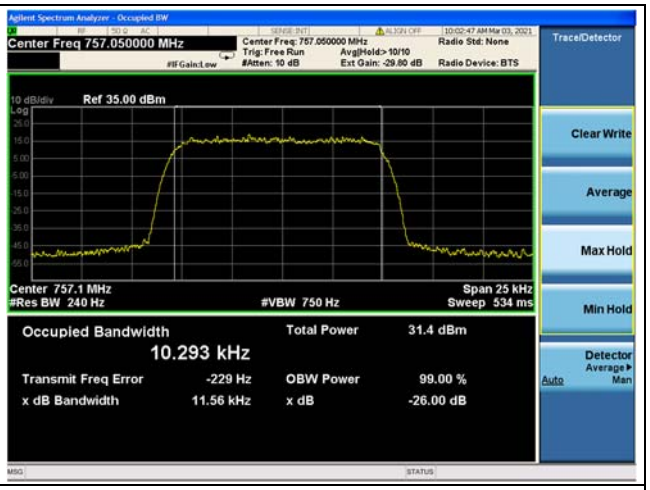
757.050MHz/Channel H/50.0 kHz/256QAM

757.050MHz/Channel V/12.5kHz/QPSK

757.050MHz/Channel V/12.5kHz/16QAM



757.050MHz/Channel V/12.5kHz/64QAM



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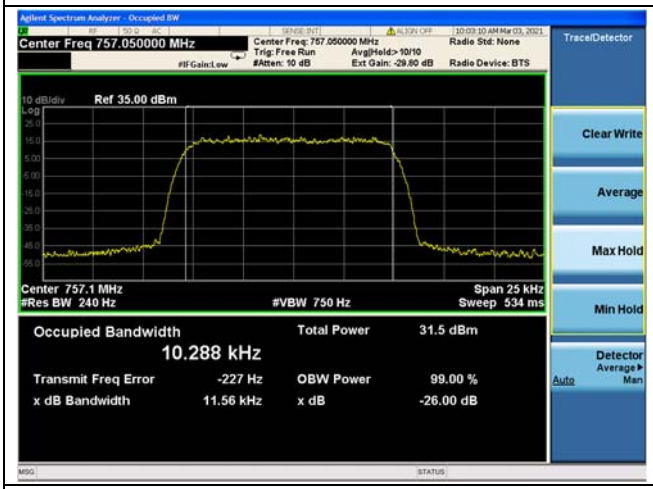
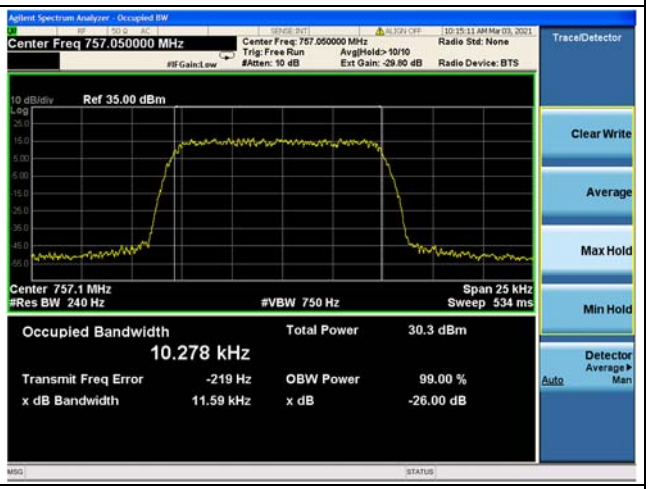
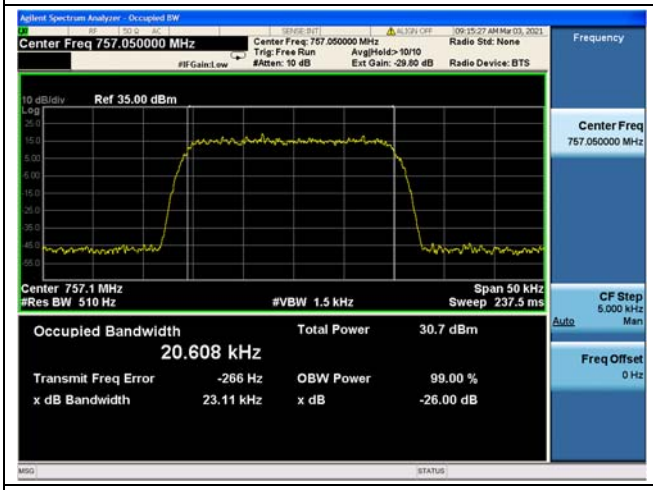


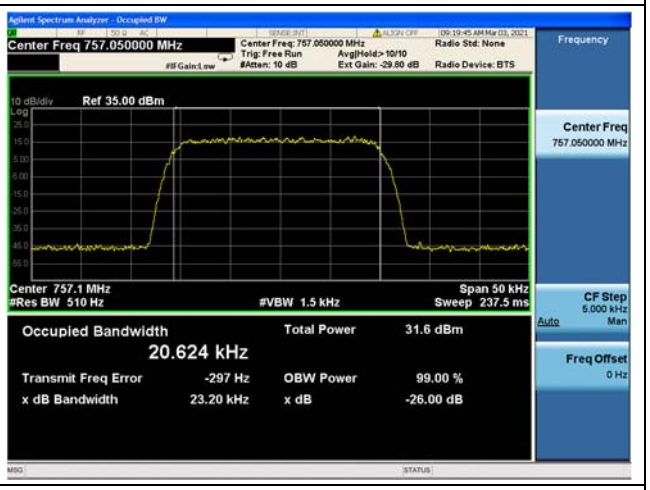
757.050MHz/Channel V/25.0 kHz/QPSK



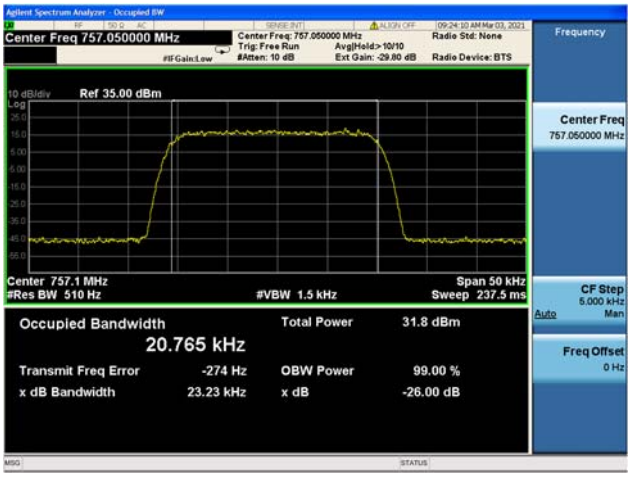
757.050MHz/Channel V/25.0 kHz/16QAM



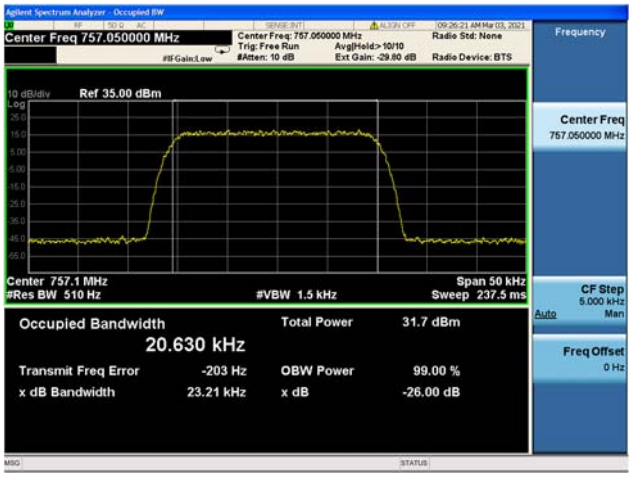
757.050MHz/Channel V/25.0 kHz/64QAM



757.050MHz/Channel V/25.0 kHz/256QAM



757.050MHz/Channel V/50.0 kHz/QPSK



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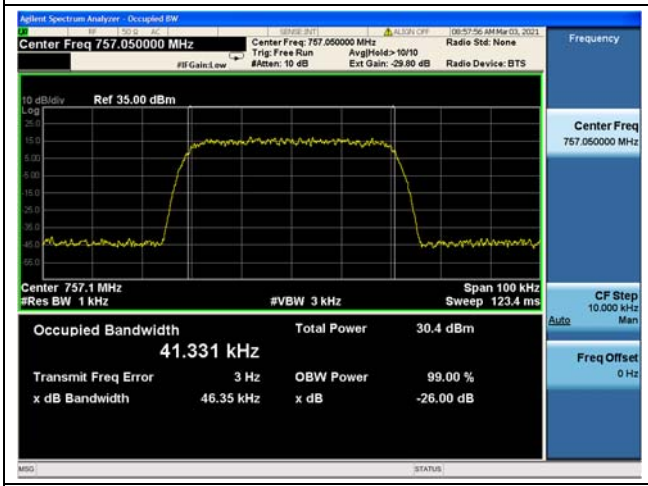
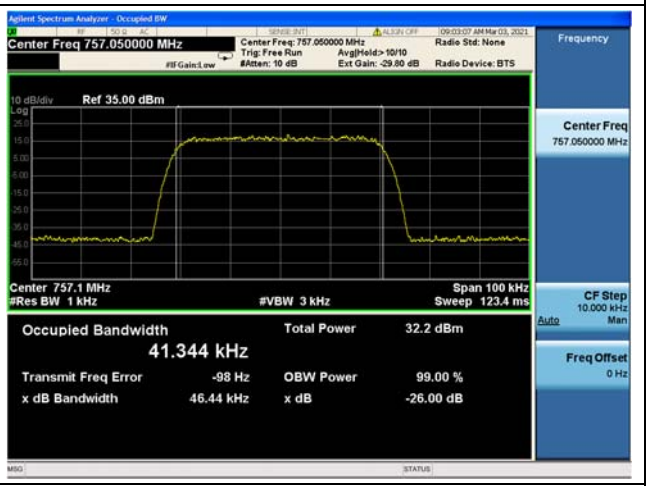


757.050MHz/Channel V/50.0 kHz/64QAM

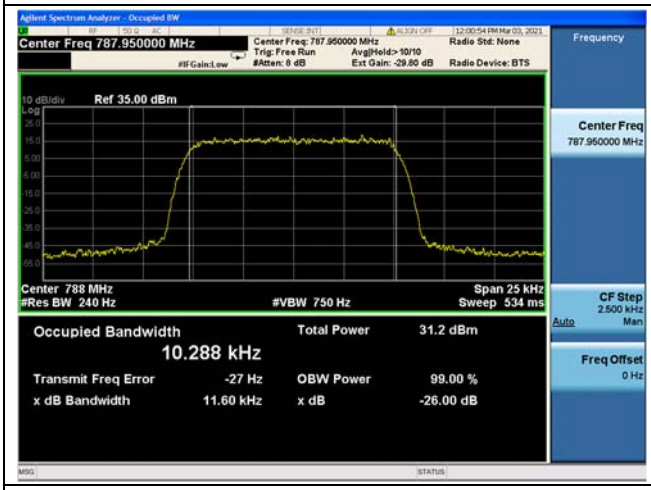


757.050MHz/Channel V/50.0 kHz/256QAM

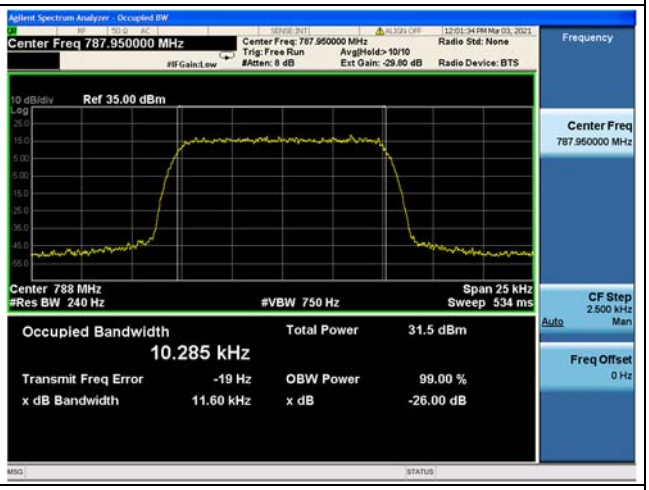
Nominal Frequency: 787.950 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	10.288
		16QAM	10.285
		64QAM	10.294
		256QAM	10.299
	25.0	QPSK	20.763
		16QAM	20.519
		64QAM	20.669
		256QAM	20.733
	50.0	QPSK	41.208
		16QAM	41.427
		64QAM	41.173
		256QAM	41.312
Channel V	12.5	QPSK	10.308
		16QAM	10.306
		64QAM	10.292
		256QAM	10.300
	25.0	QPSK	20.672
		16QAM	20.559
		64QAM	20.631
		256QAM	20.686
	50.0	QPSK	41.255
		16QAM	41.598
		64QAM	41.143
		256QAM	41.268

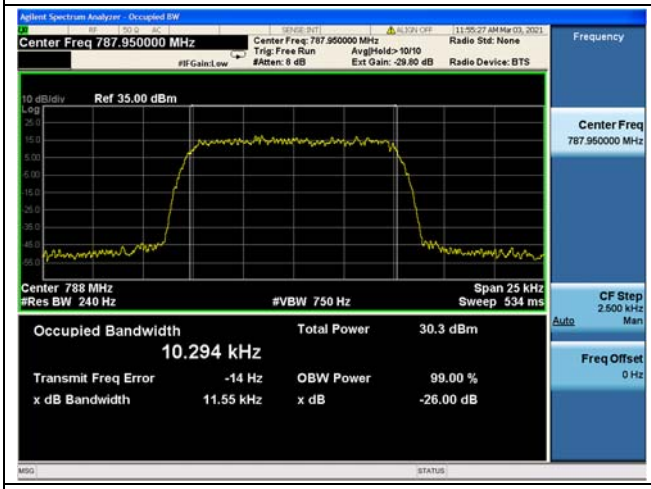
787.950MHz/Channel H/12.5kHz/QPSK



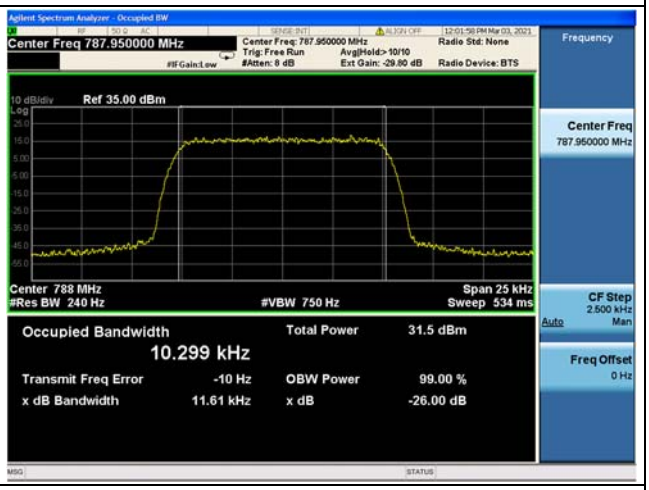
787.950MHz/Channel H/12.5kHz/16QAM



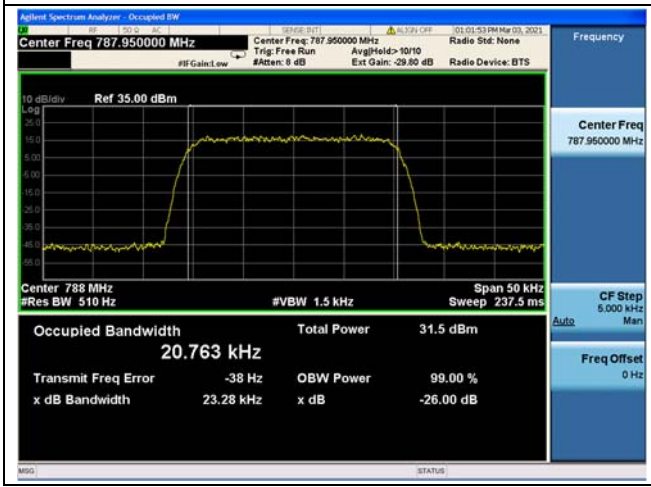
787.950MHz/Channel H/12.5kHz/64QAM



787.950MHz/Channel H/12.5 kHz/256QAM



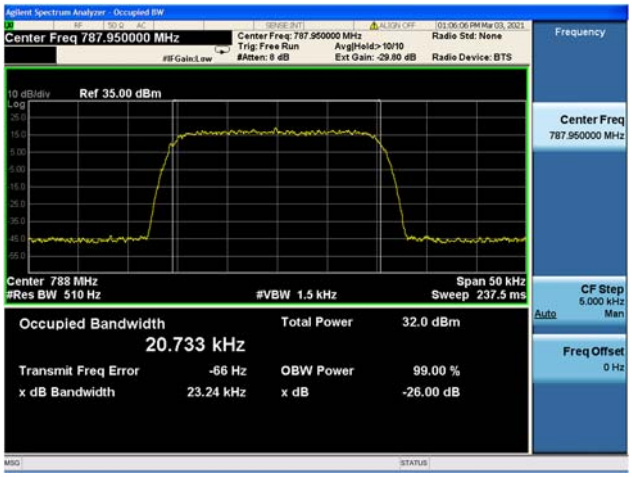
787.950MHz/Channel H/25.0 kHz/QPSK



787.950MHz/Channel H/25.0 kHz/16QAM

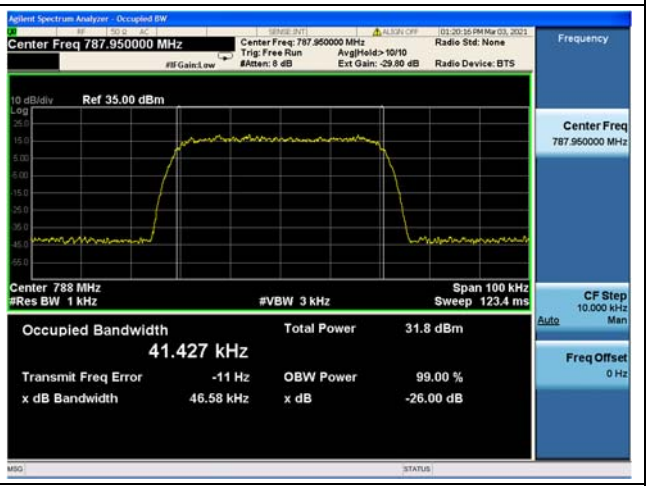
787.950MHz/Channel H/25.0 kHz/64QAM

787.950MHz/Channel H/25.0 kHz/256QAM



787.950MHz/Channel H/50.0 kHz/QPSK

787.950MHz/Channel H/50.0 kHz/16QAM



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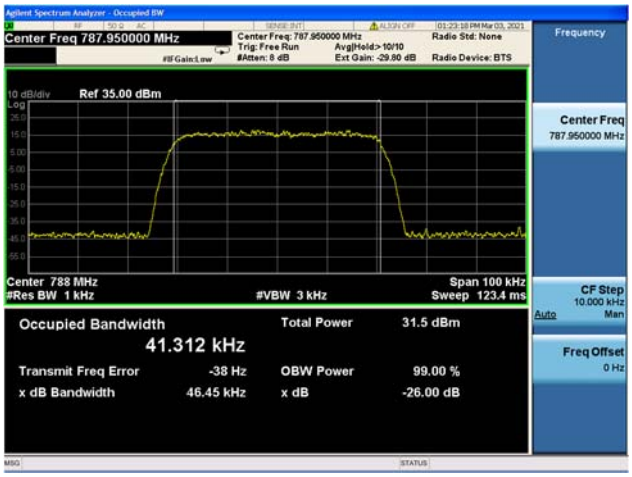
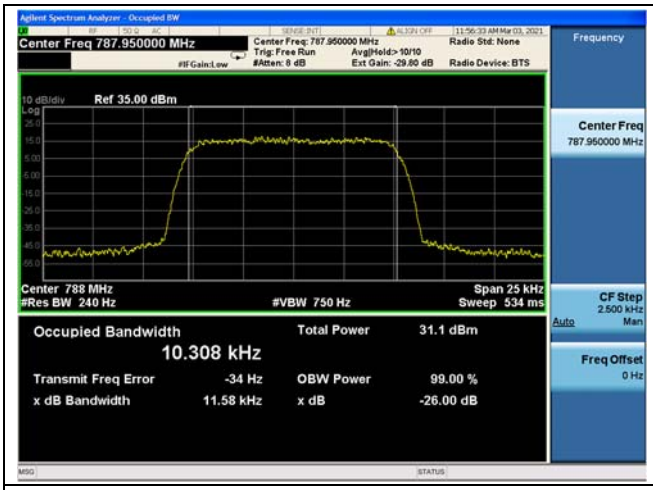
787.950MHz/Channel H/50.0 kHz/256QAM

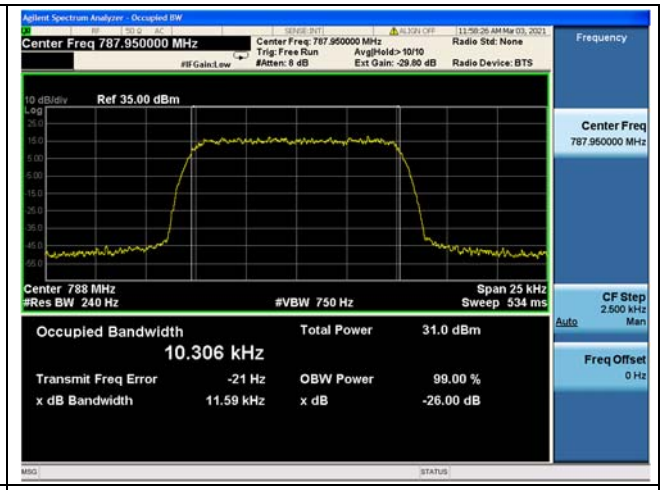


787.950MHz/Channel V/12.5kHz/QPSK

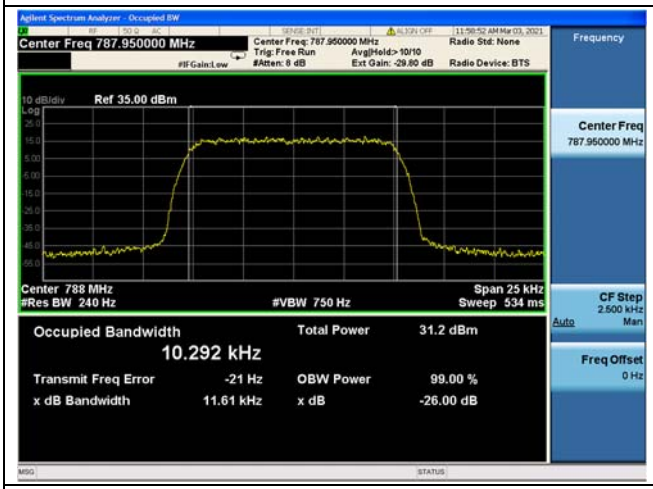
787.950MHz/Channel V/12.5kHz/16QAM



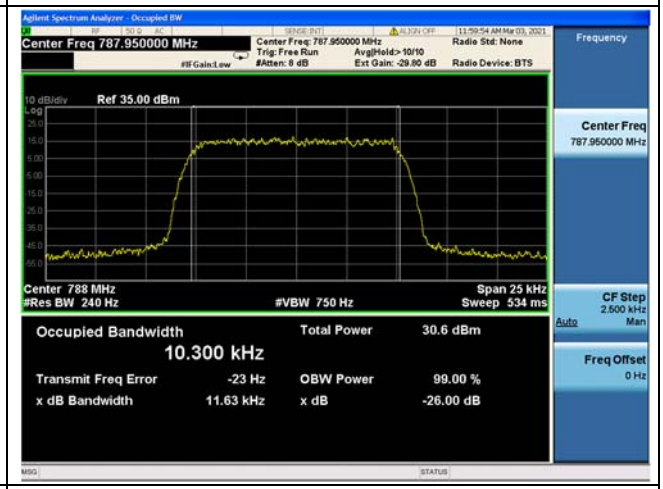
787.950MHz/Channel V/12.5kHz/64QAM



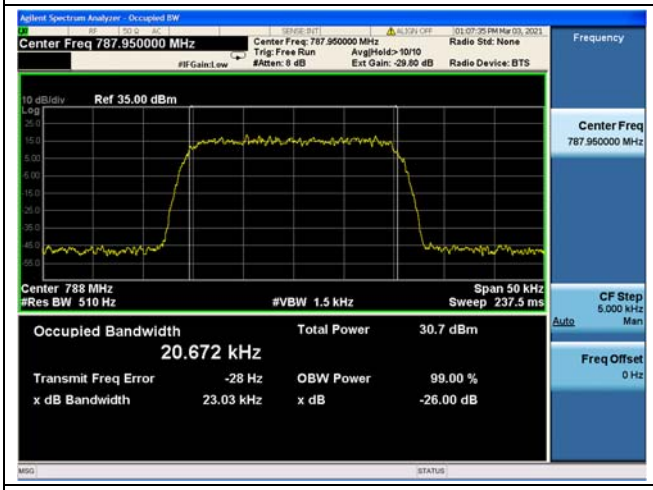
787.950MHz/Channel V/12.5 kHz/256QAM



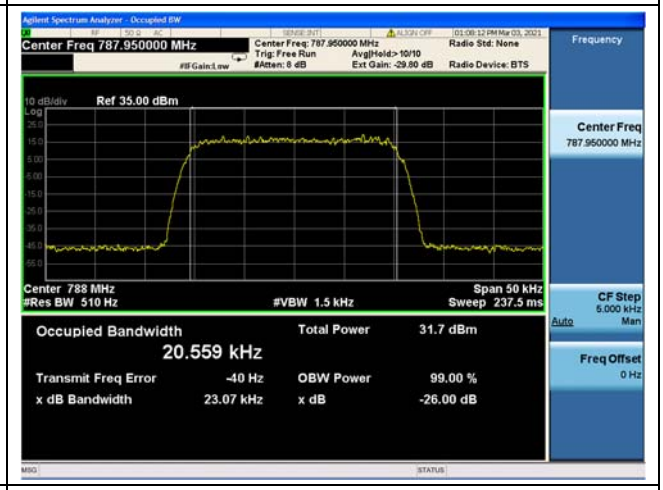
787.950MHz/Channel V/25.0 kHz/QPSK



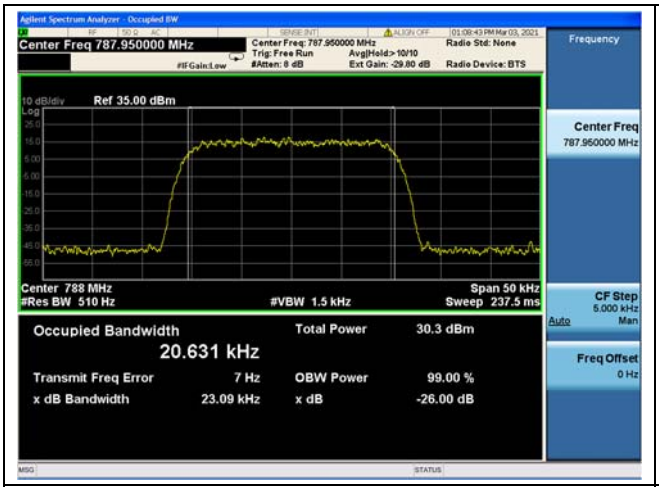
787.950MHz/Channel V/25.0 kHz/16QAM



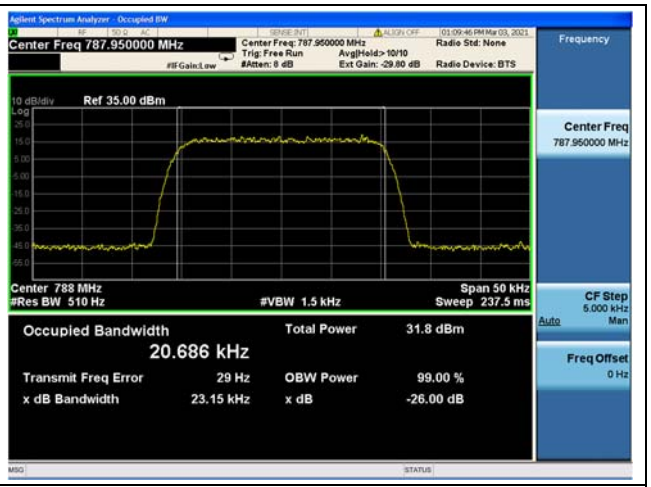
787.950MHz/Channel V/25.0 kHz/64QAM



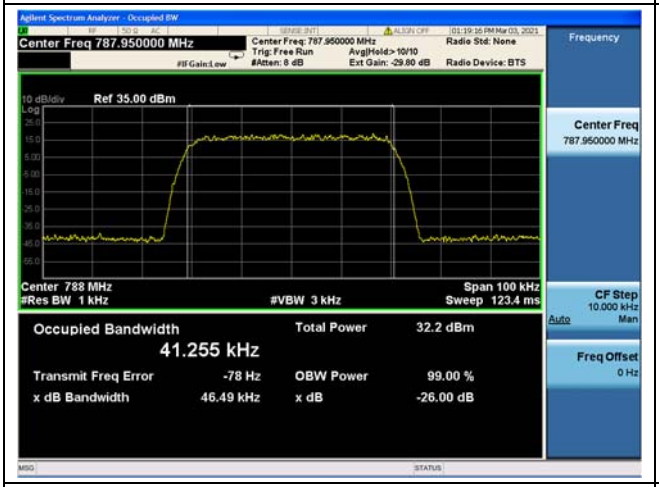
787.950MHz/Channel V/25.0 kHz/256QAM



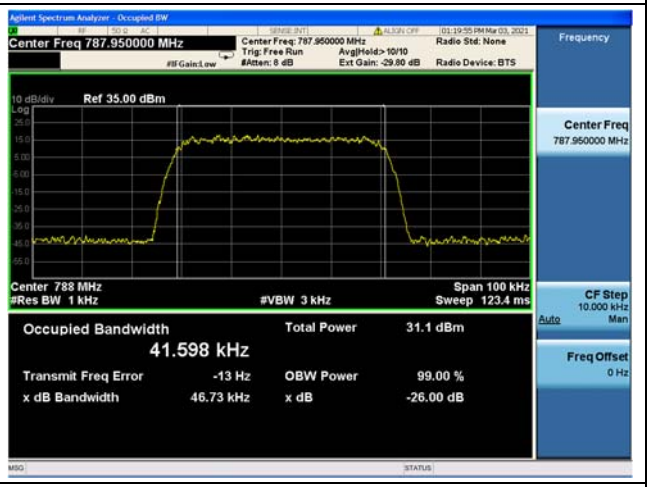
787.950MHz/Channel V/50.0 kHz/QPSK



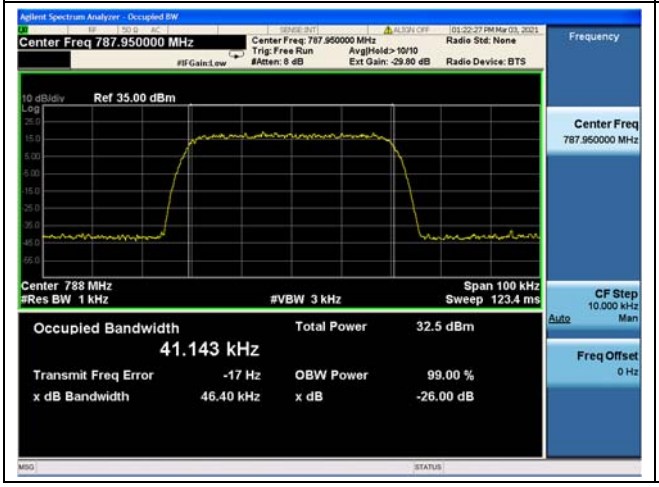
787.950MHz/Channel V/50.0 kHz/16QAM

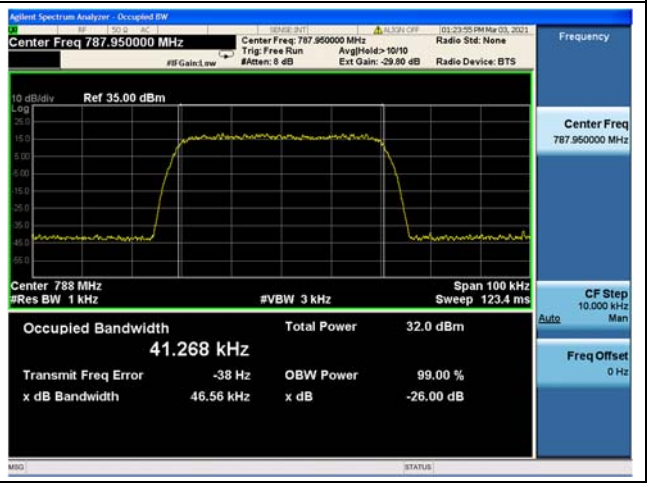


787.950MHz/Channel V/50.0 kHz/64QAM



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;

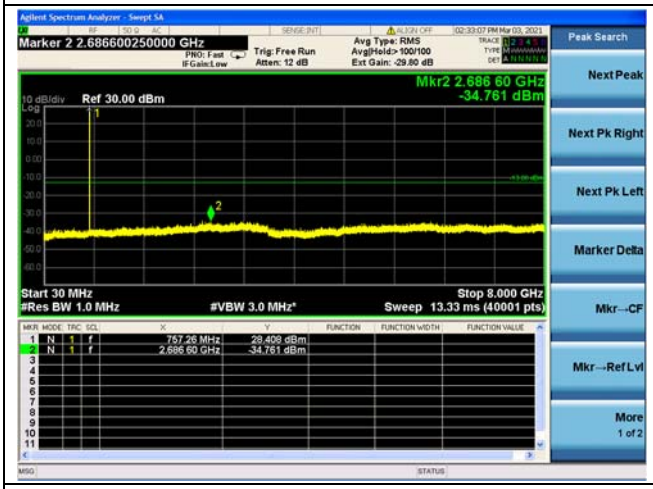
(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

2.3.2. Test Result

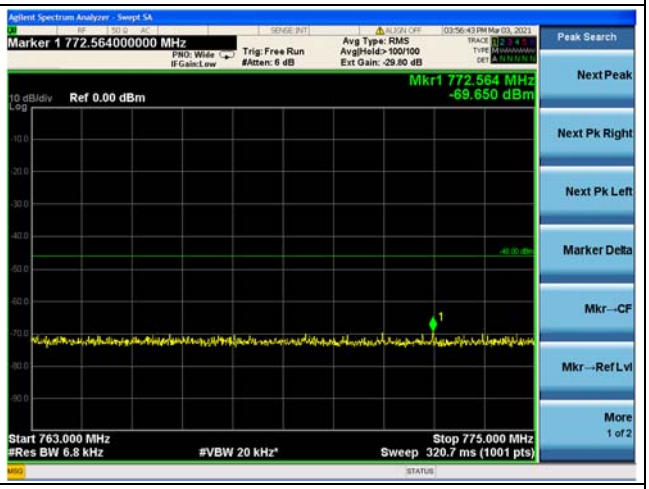
Frequency (MHz)	Tx Port	Measurement Bandwidth	Spurious Span (MHz)	Limit (dBm)	Verdict
757.050	Channel H	1MHz	30 - 8000	-13	Pass
	Channel V	6.25kHz	763-775 & 793-805	-46	Pass
	Channel H	30kHz	Adjacent 100kHz Lower edge	-13	Pass
	Channel V	30kHz	Adjacent 100kHz Lower edge	-13	Pass
	Channel H	30kHz	Adjacent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

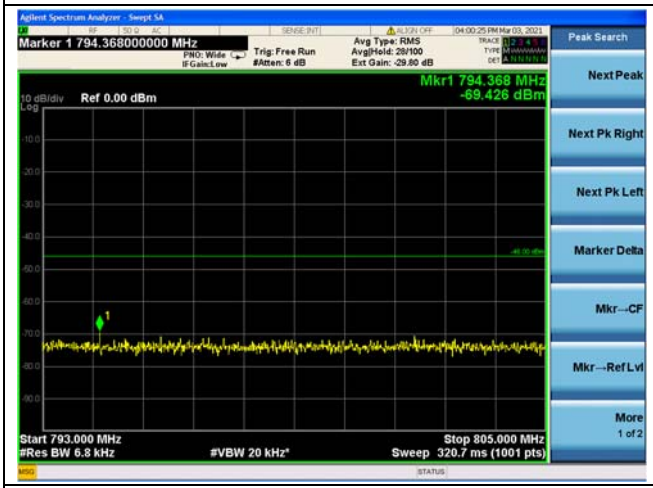
12.5kHz/QPSK



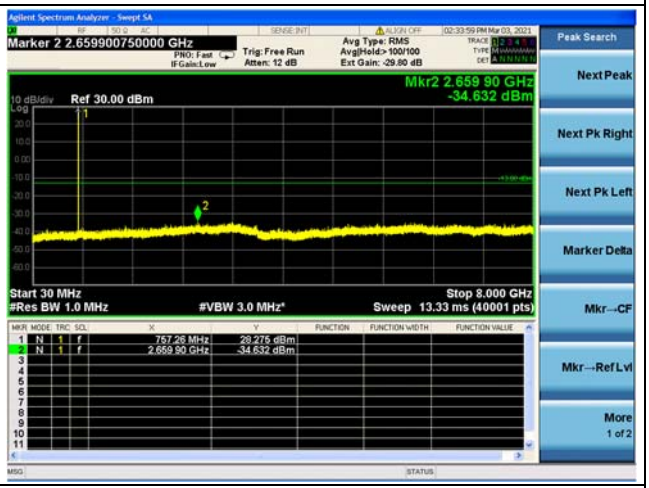
12.5kHz/QPSK 763-775MHz



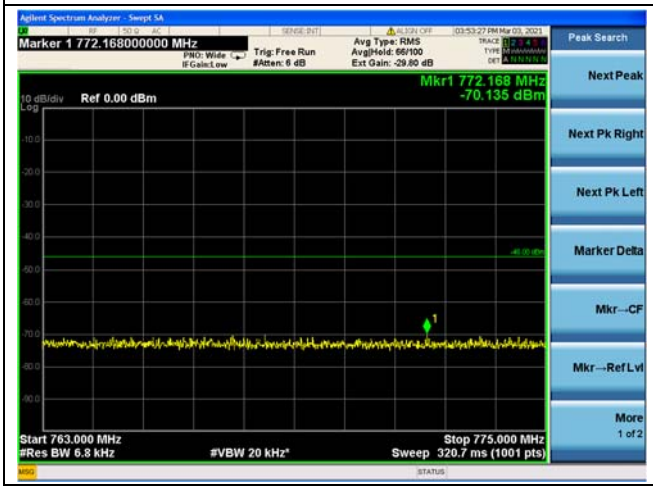
12.5kHz/QPSK 793-805MHz



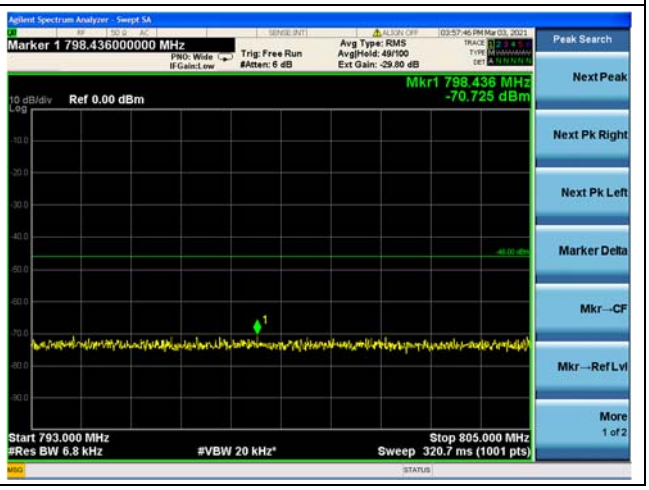
12.5kHz/16QAM



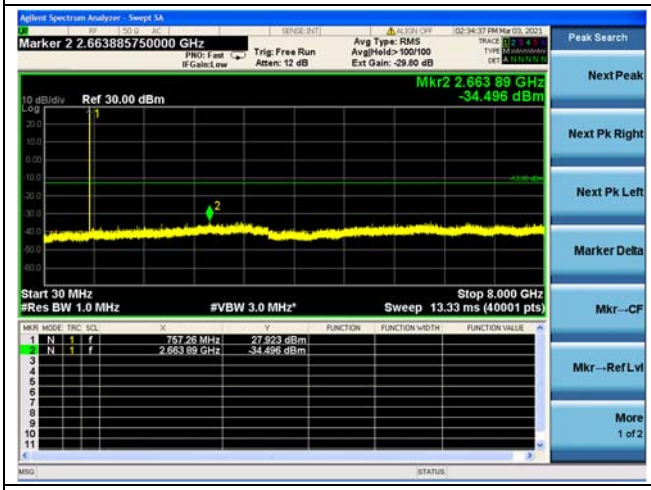
12.5kHz/16QAM 763-775MHz



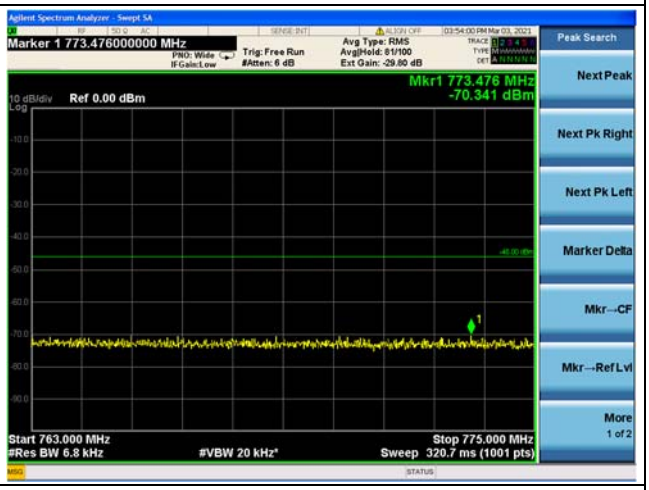
12.5kHz/16QAM 793-805MHz



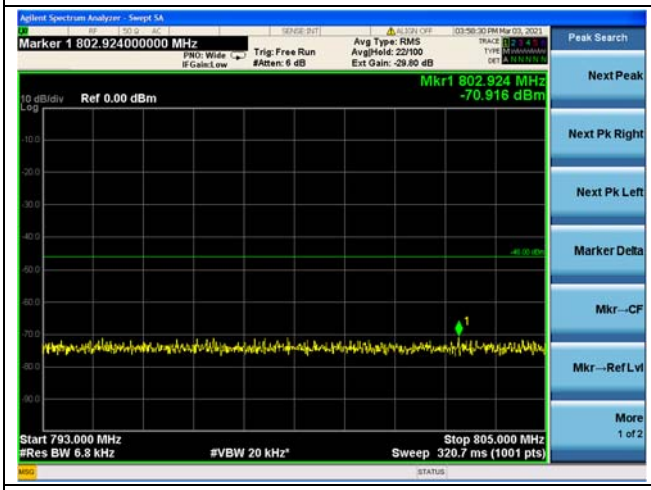
12.5kHz/64QAM



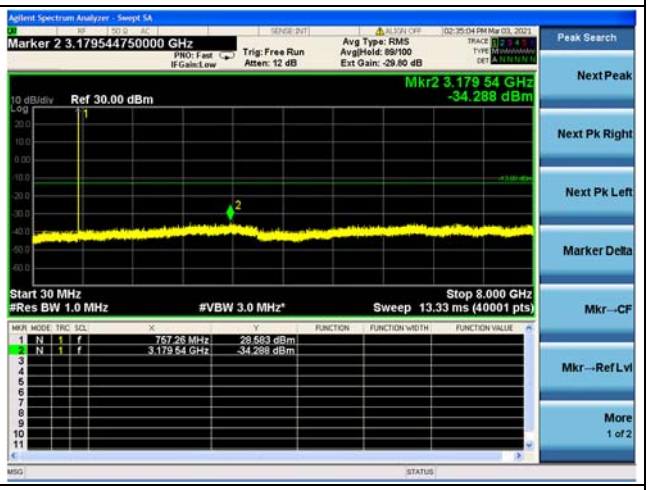
12.5kHz/64QAM 763-775MHz



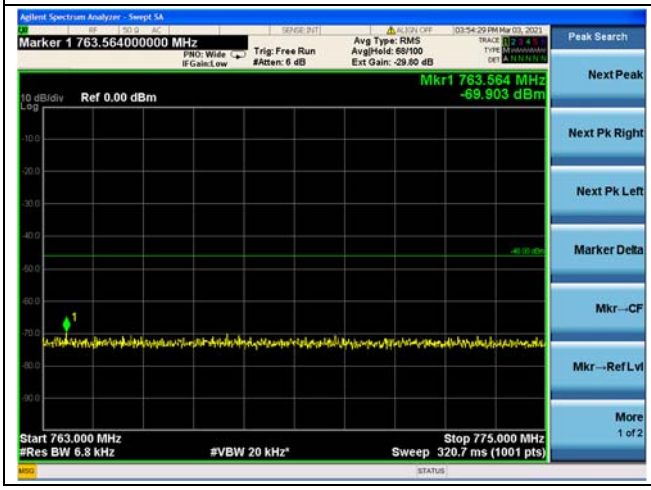
12.5kHz/64QAM 793-805MHz



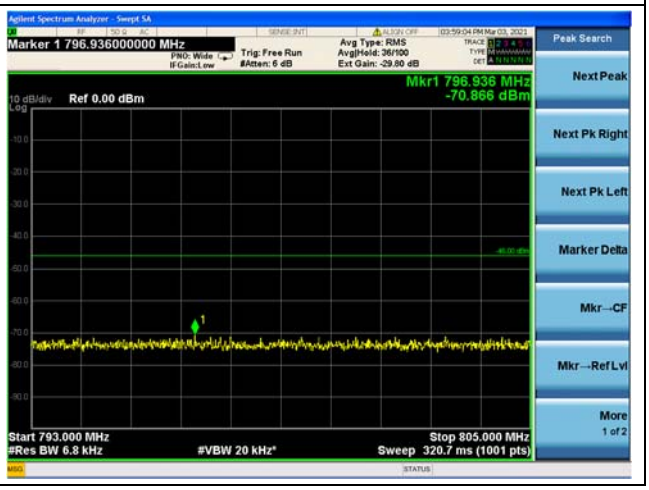
12.5kHz/256QAM



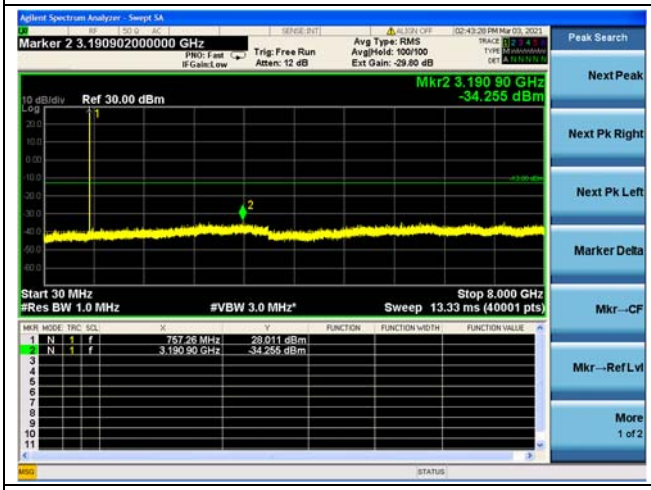
12.5kHz/256QAM 763-775MHz



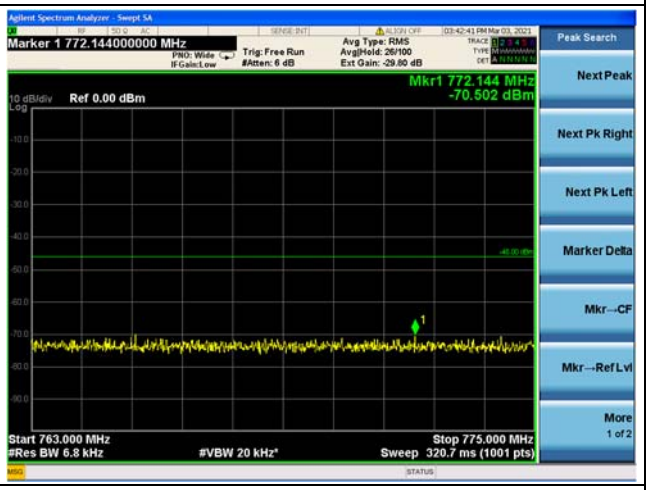
12.5kHz/256QAM 793-805MHz



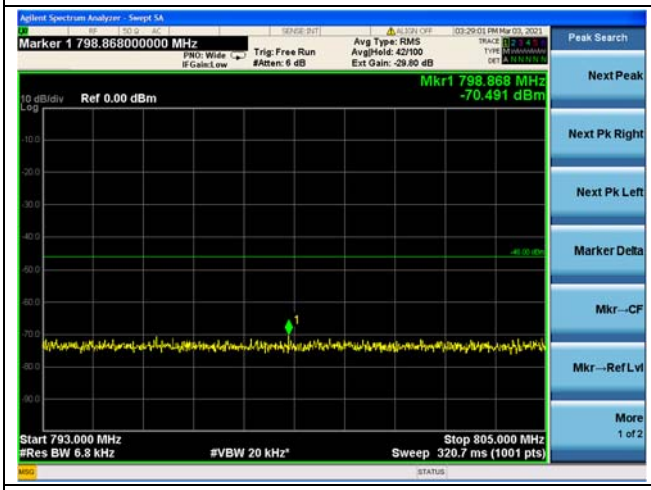
25kHz/QPSK



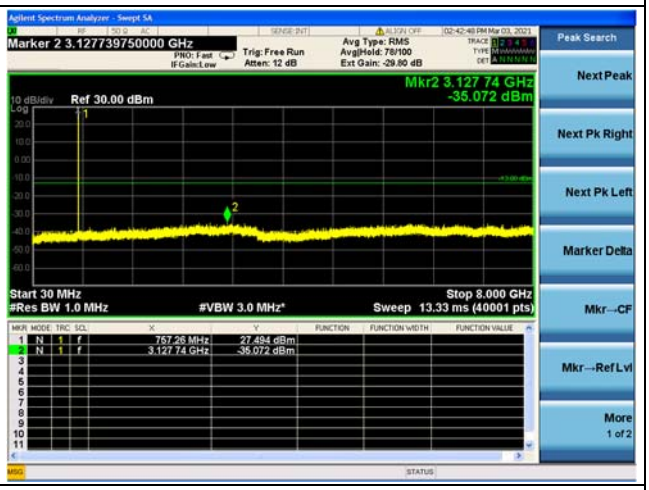
25kHz/QPSK 763-775MHz



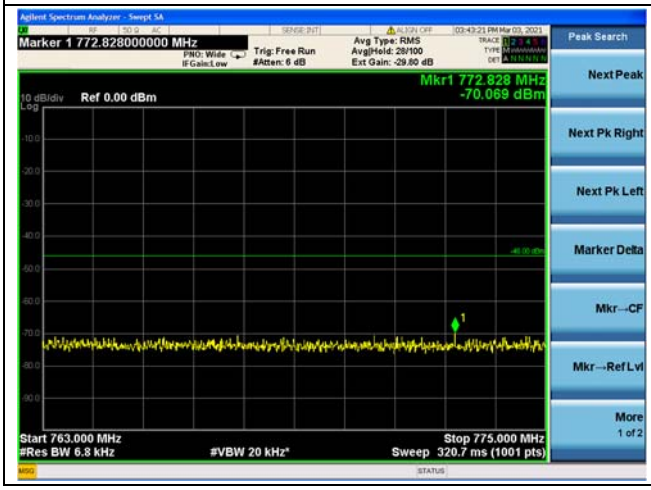
25kHz/QPSK 793-805MHz



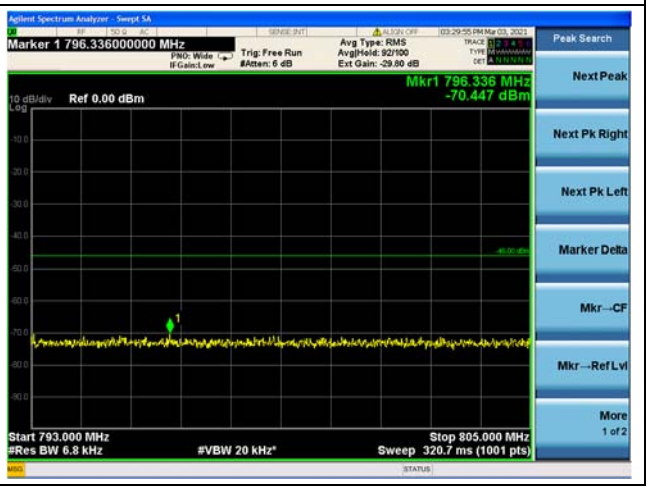
25kHz/16QAM



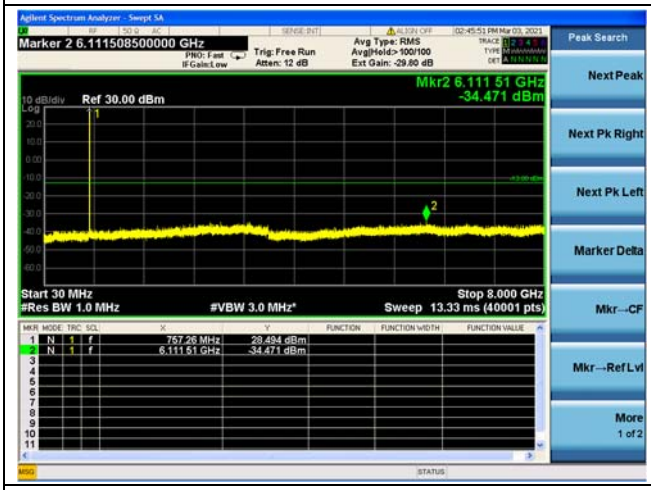
25kHz/16QAM 763-775MHz



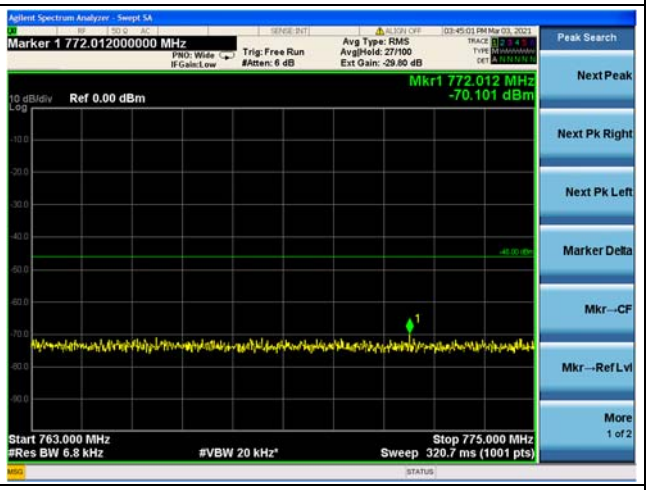
25kHz/16QAM 793-805MHz



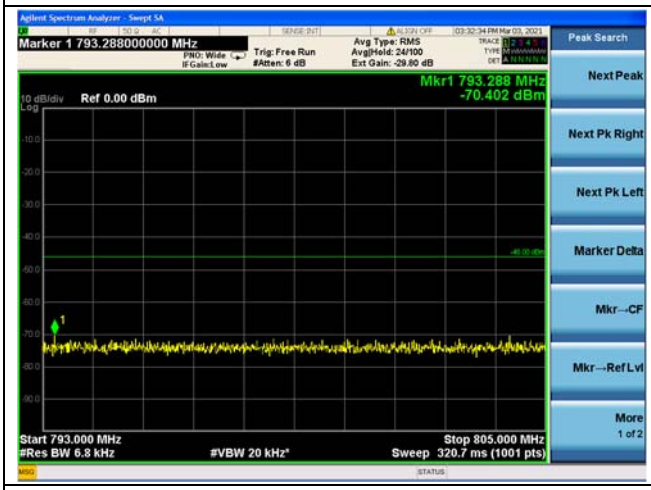
25kHz/64QAM



25kHz/64QAM 763-775MHz

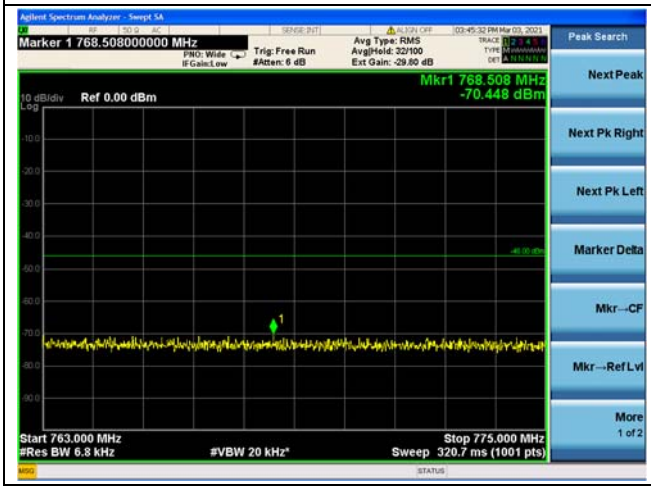


25kHz/64QAM 793-805MHz

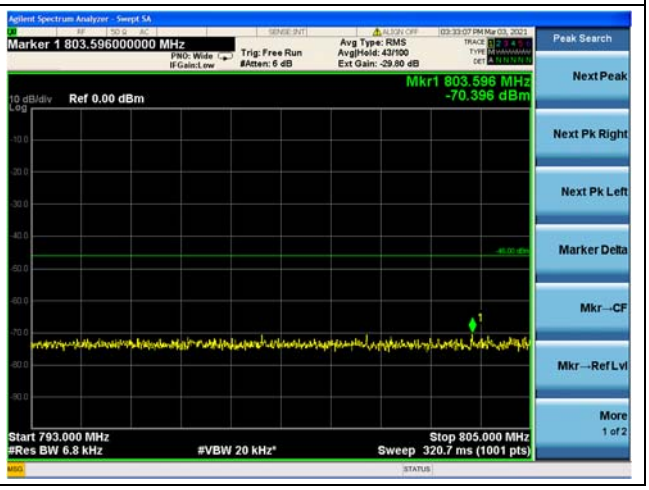


25kHz/256QAM

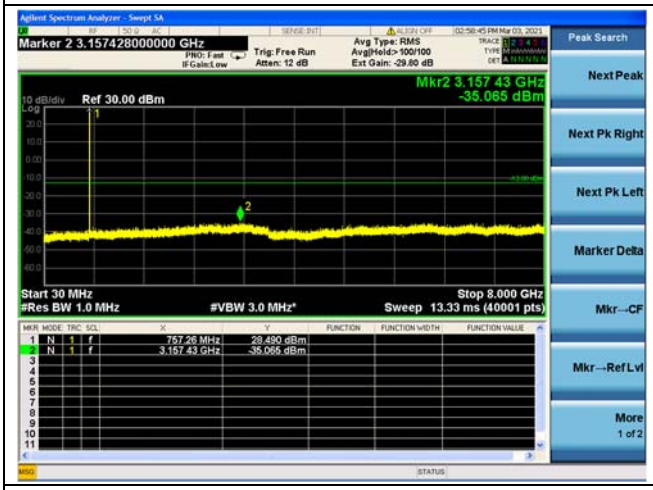
25kHz/256QAM 763-775MHz



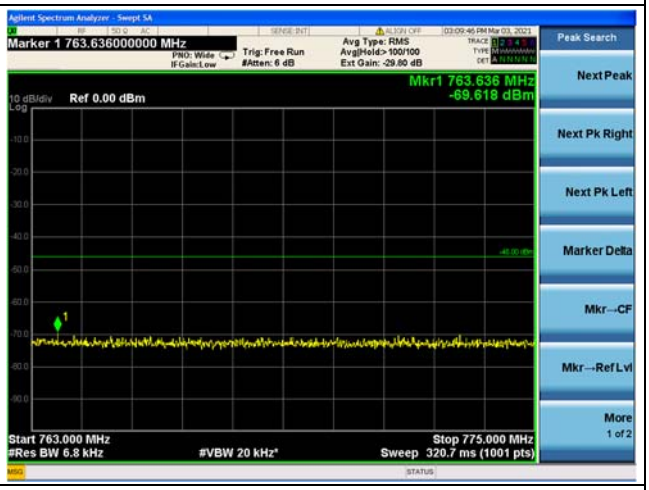
25kHz/256QAM 793-805MHz



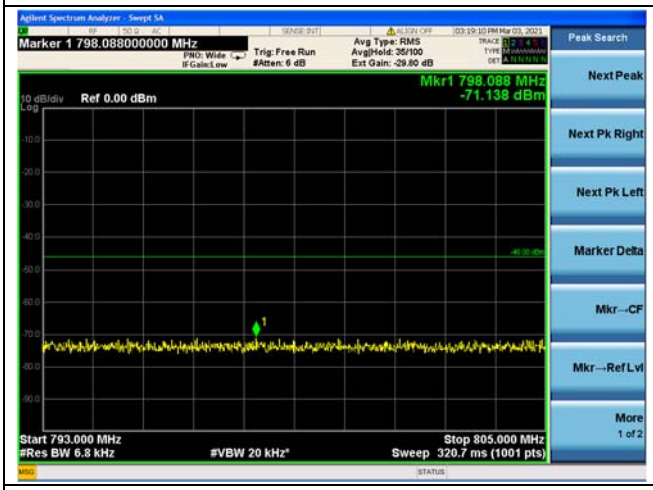
50kHz/QPSK



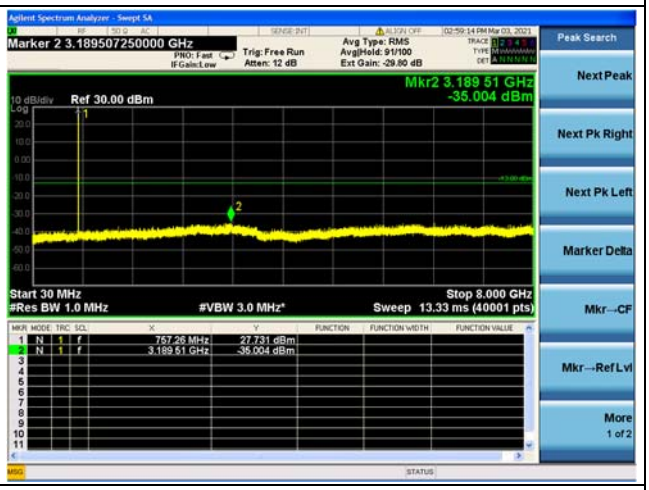
50kHz/QPSK 763-775MHz



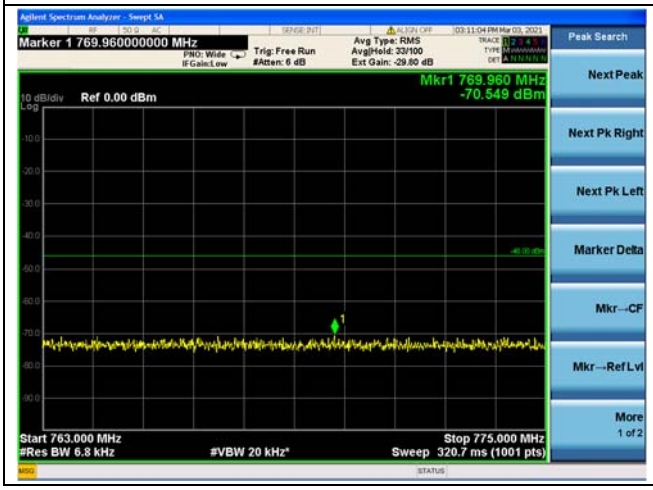
50kHz/QPSK 793-805MHz



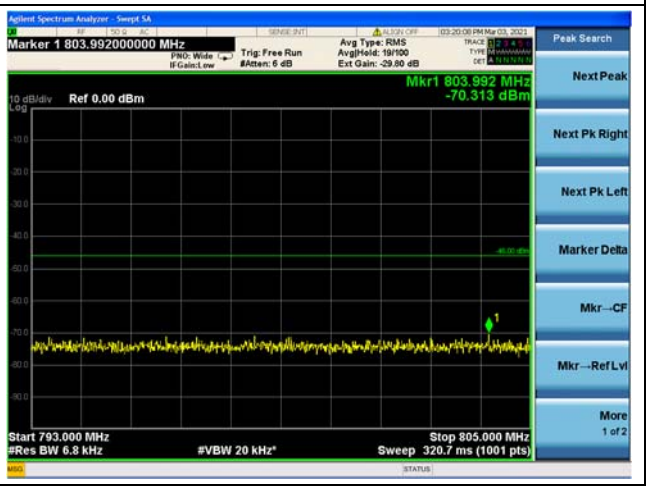
50kHz/16QAM



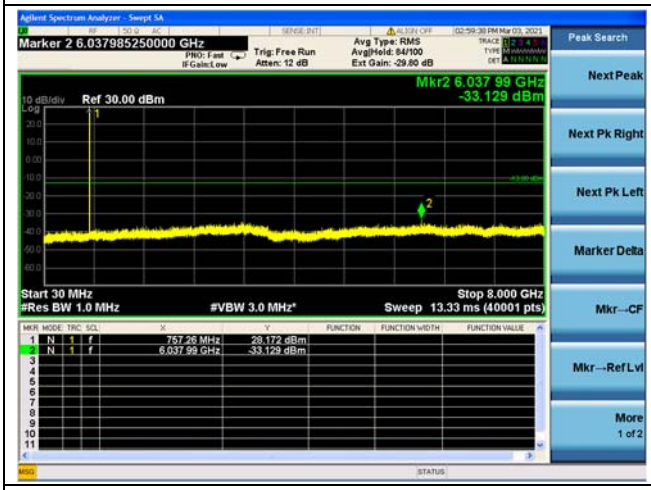
50kHz/16QAM 763-775MHz



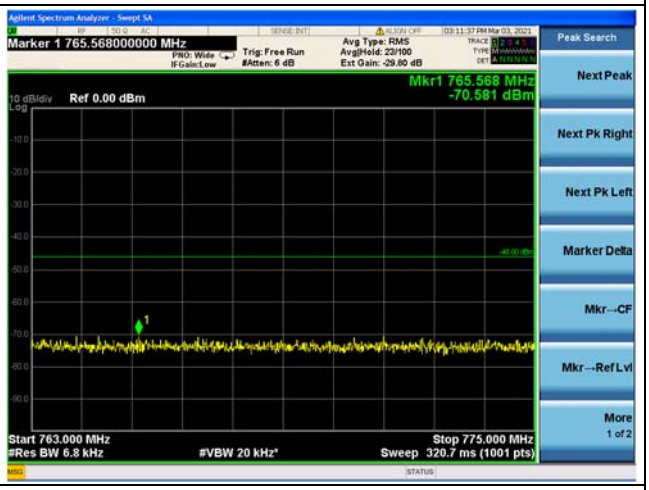
50kHz/16QAM 793-805MHz



50kHz/64QAM

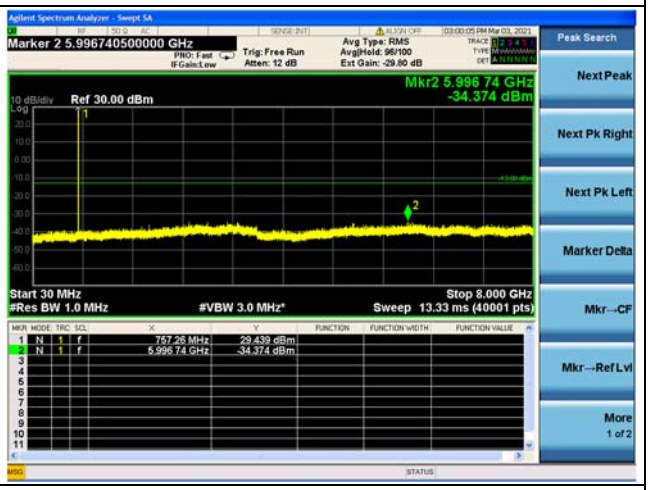


50kHz/64QAM 763-775MHz

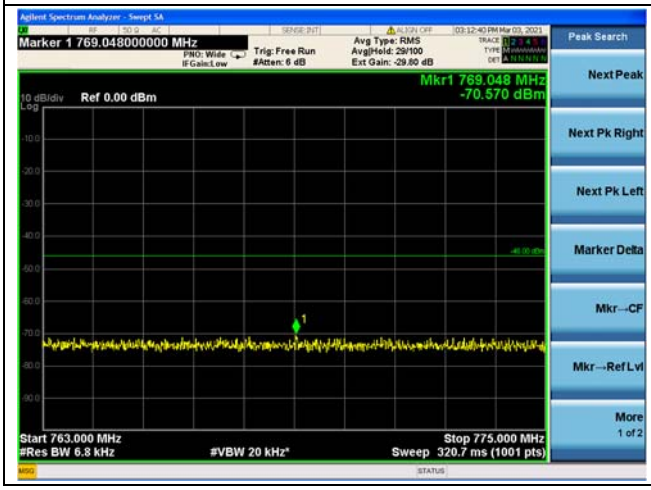


50kHz/64QAM 793-805MHz

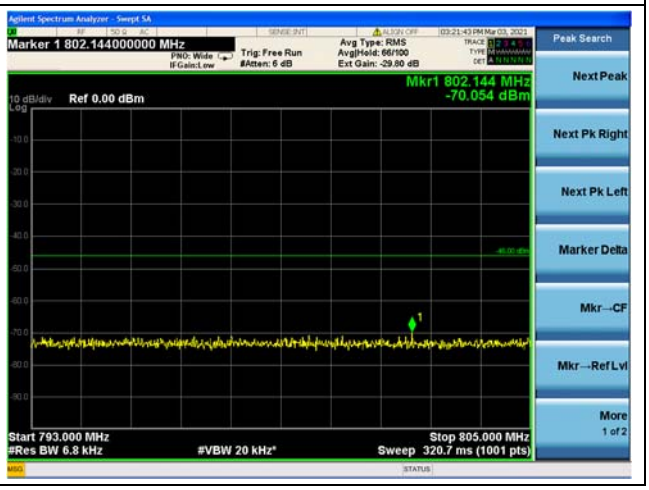
50kHz/256QAM



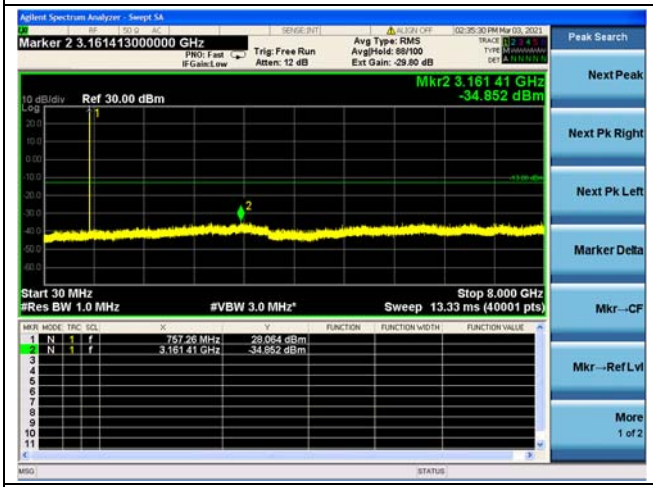
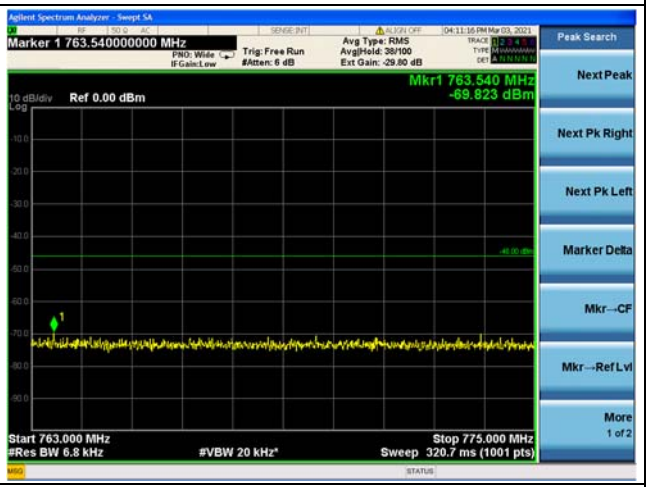
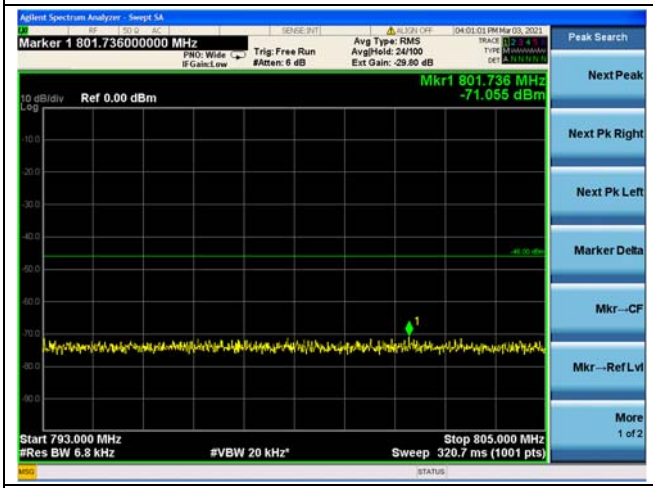
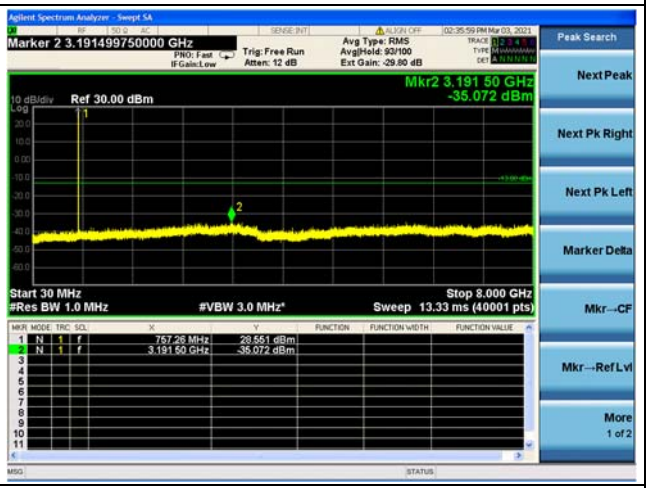
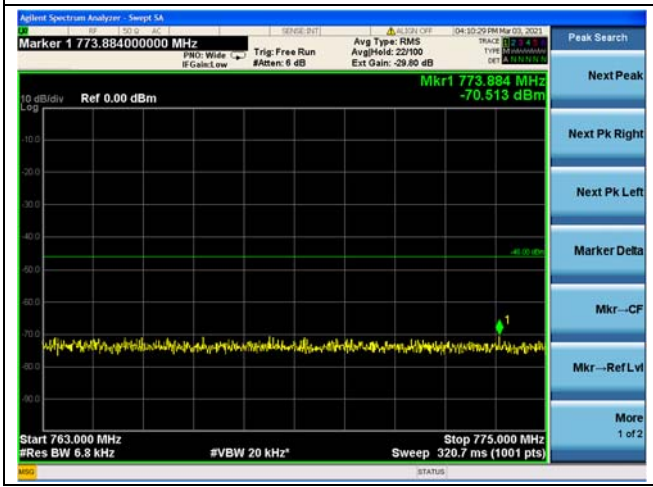
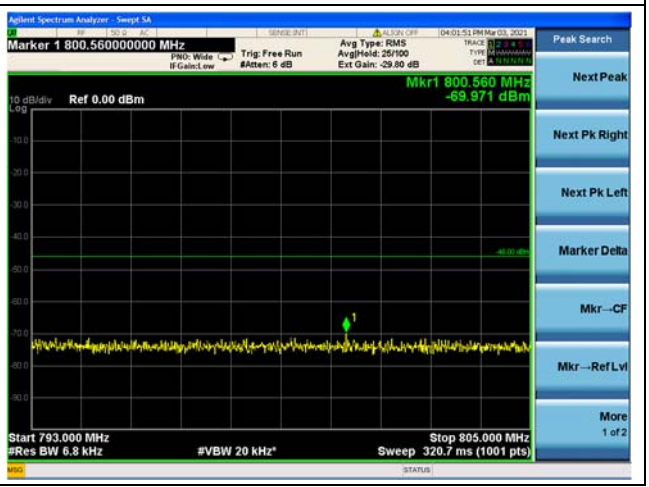
50kHz/256QAM 763-775MHz



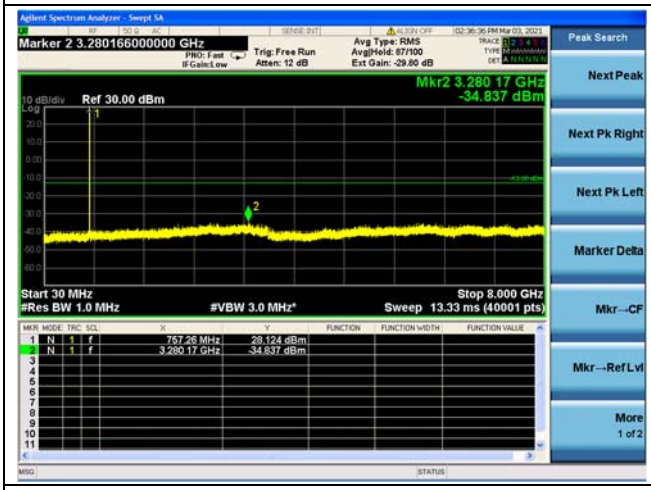
50kHz/256QAM 793-805MHz



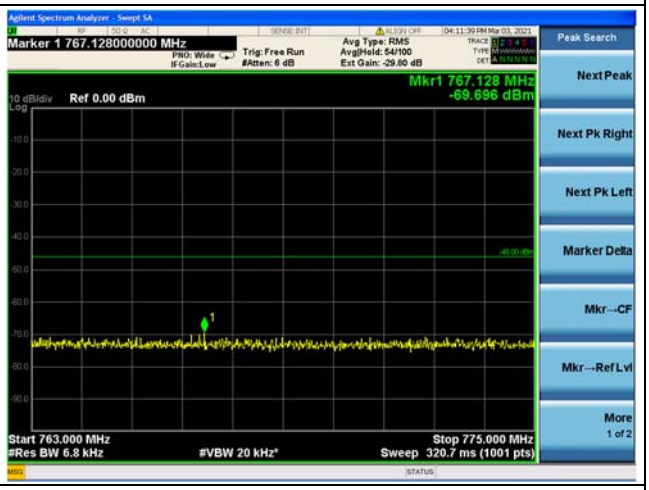
Nominal Frequency: 757.050 MHz Tx Port: Channel V

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**
	

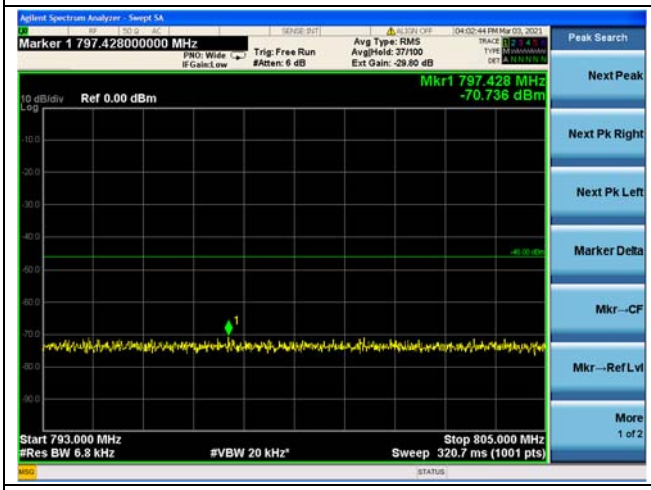
12.5kHz/64QAM



12.5kHz/64QAM 763-775MHz

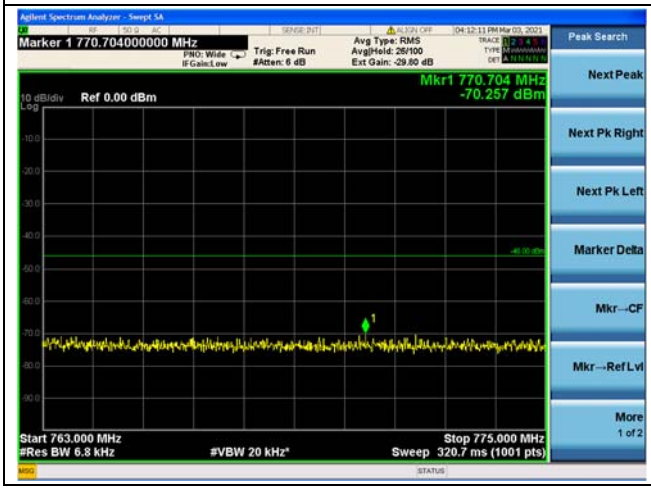


12.5kHz/64QAM 793-805MHz

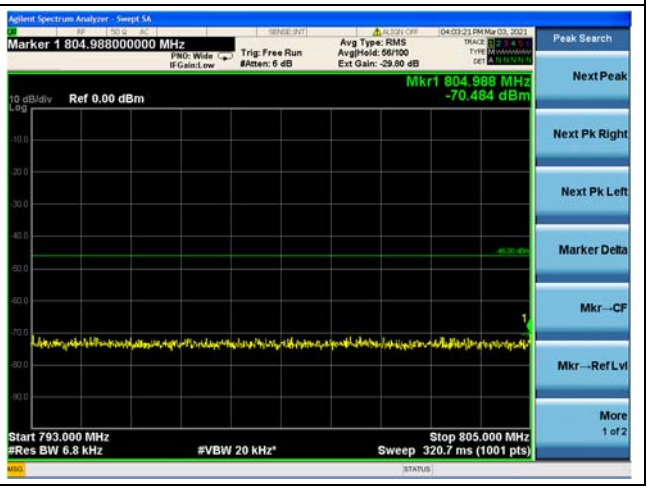


12.5kHz/256QAM

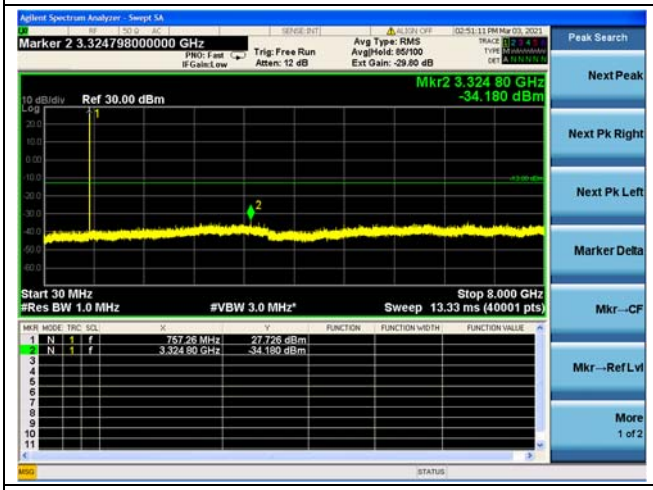
12.5kHz/256QAM 763-775MHz



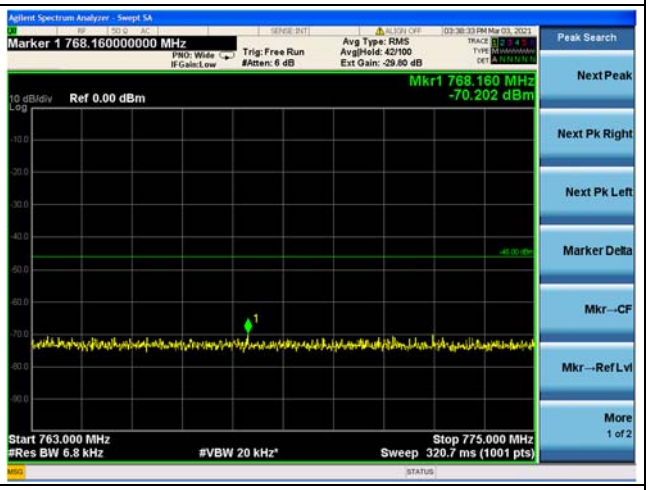
12.5kHz/256QAM 793-805MHz



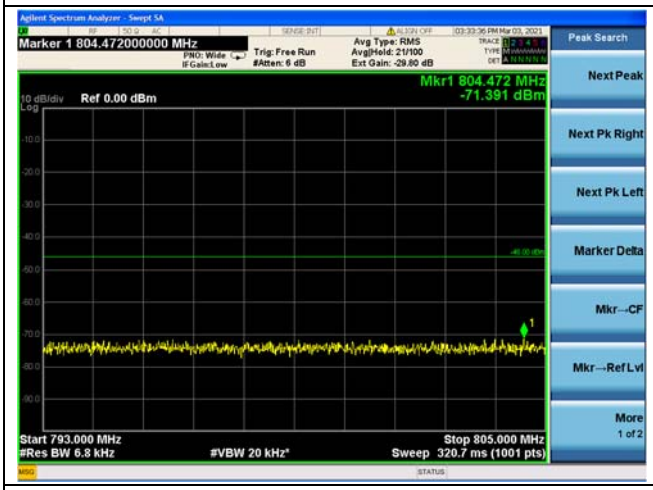
25kHz/QPSK



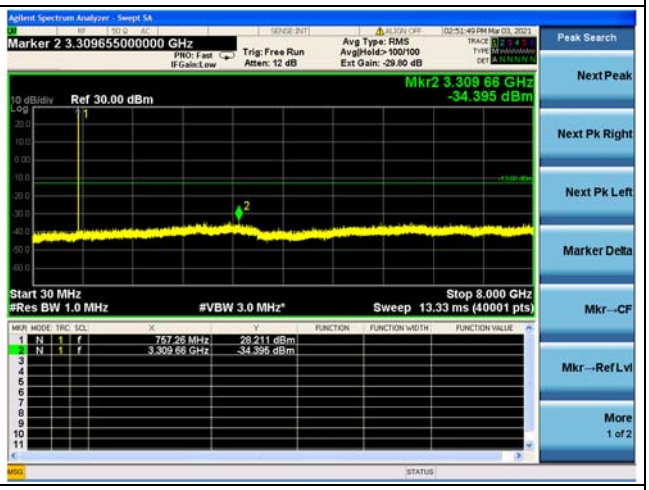
25kHz/QPSK 763-775MHz



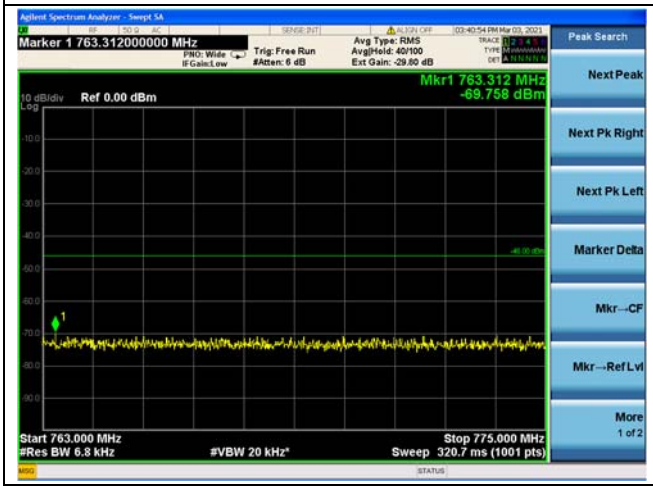
25kHz/QPSK 793-805MHz



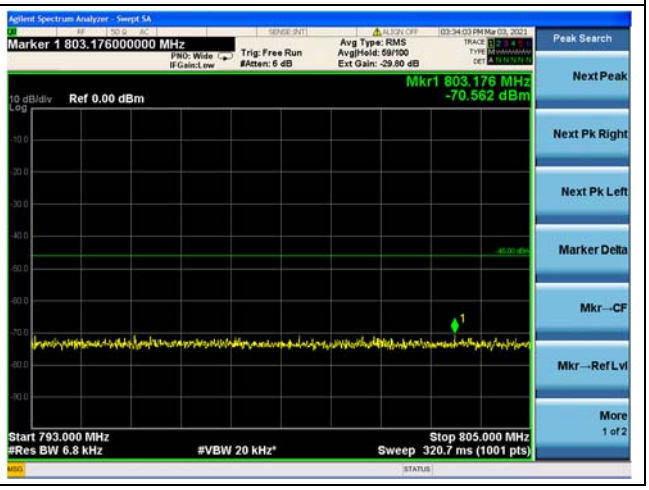
25kHz/16QAM



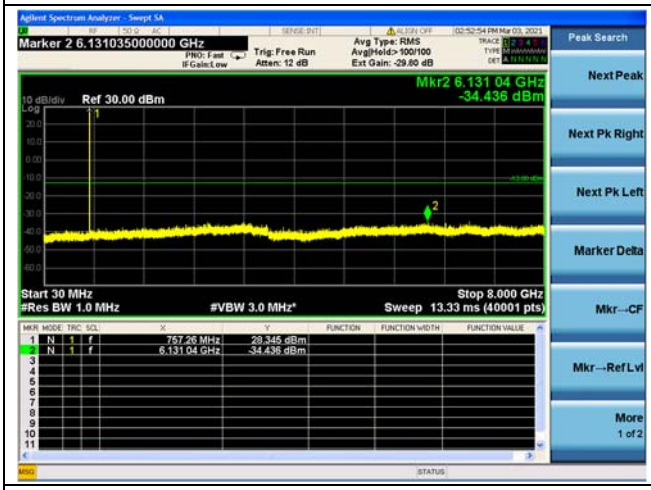
25kHz/16QAM 763-775MHz



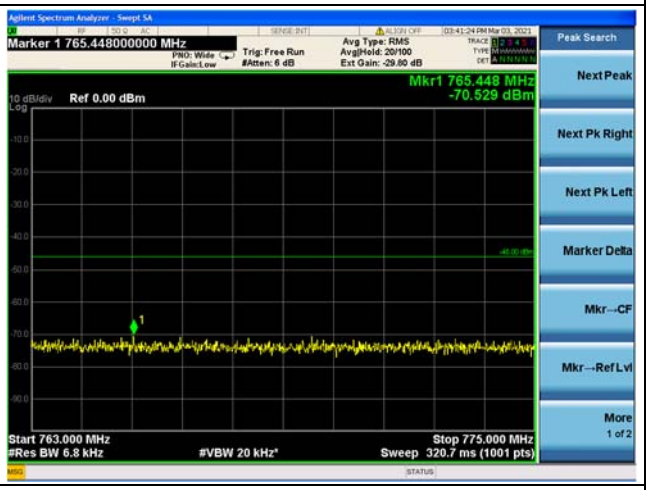
25kHz/16QAM 793-805MHz



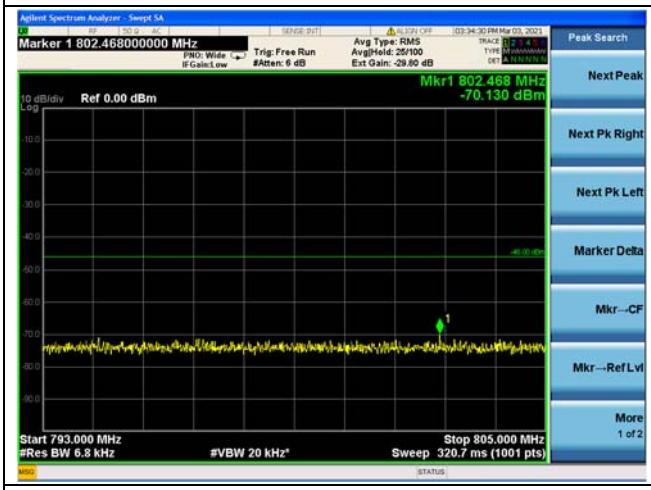
25kHz/64QAM



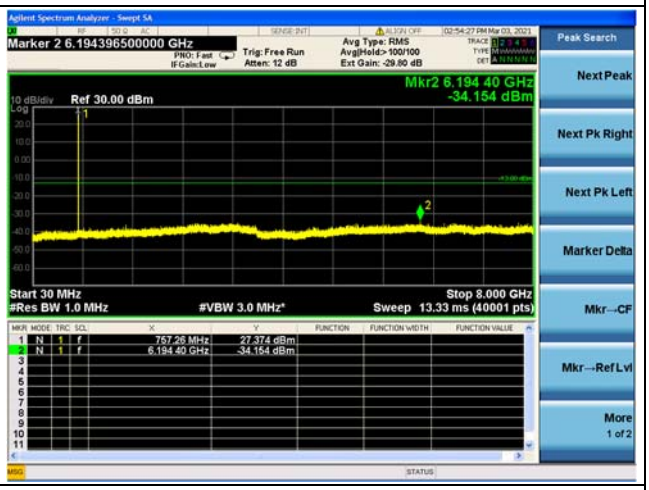
25kHz/64QAM 763-775MHz



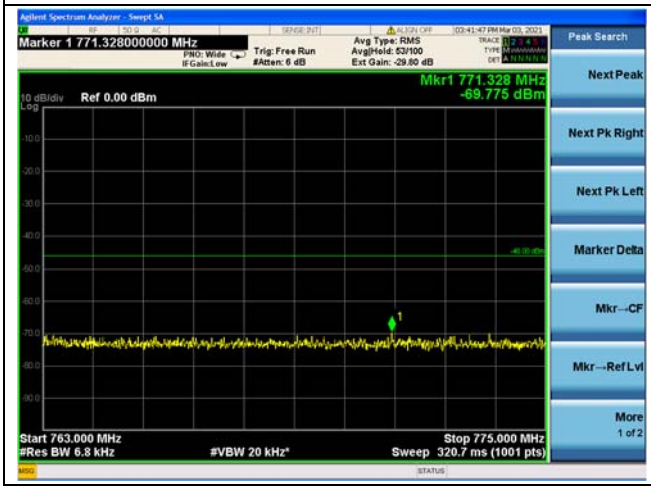
25kHz/64QAM 793-805MHz



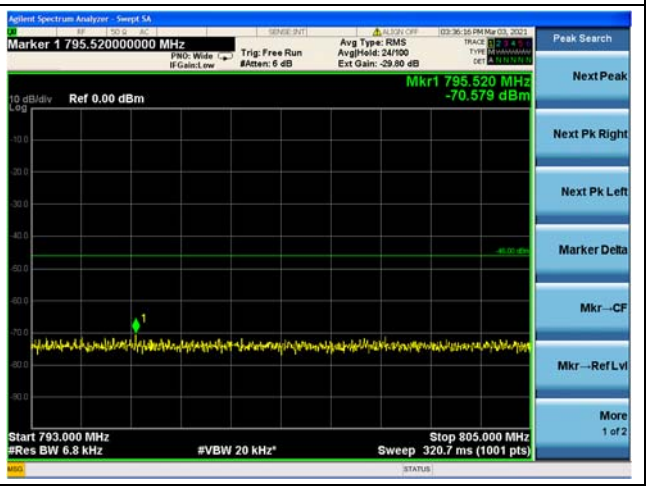
25kHz/256QAM



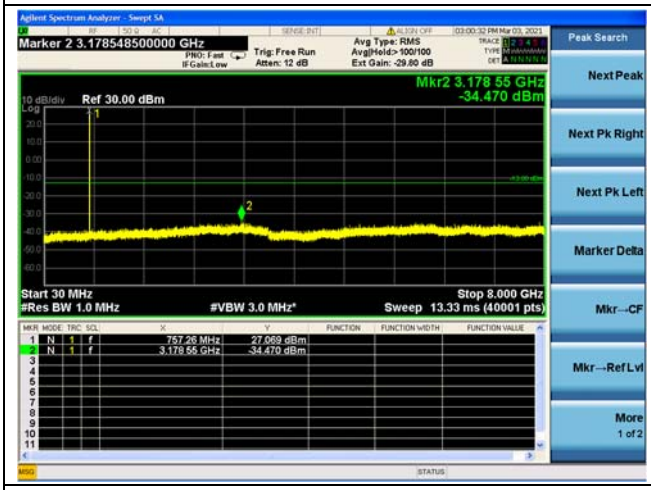
25kHz/256QAM 763-775MHz



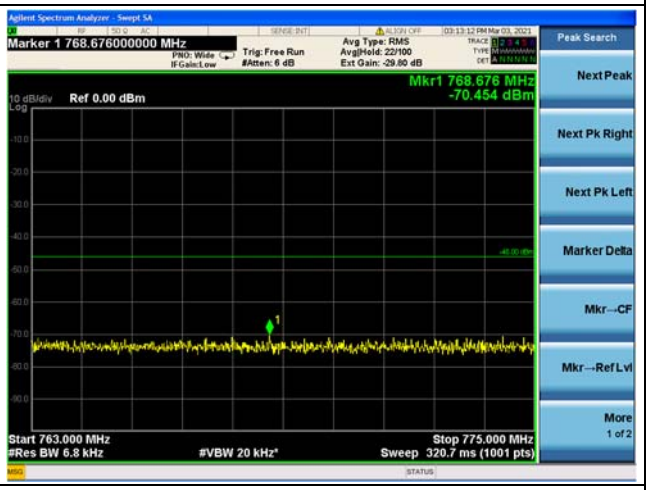
25kHz/256QAM 793-805MHz



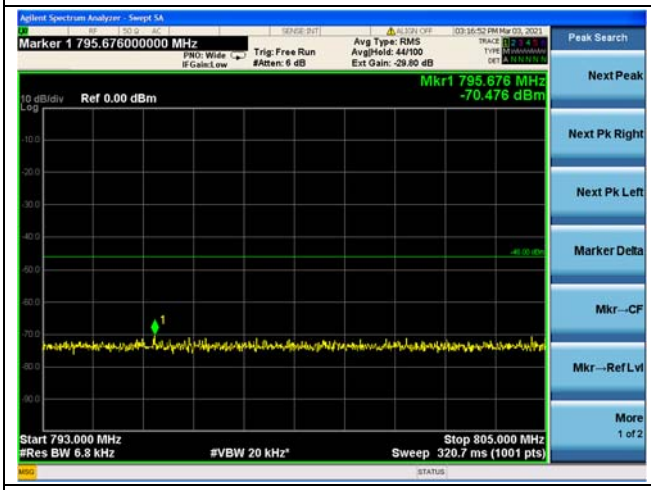
50kHz/QPSK



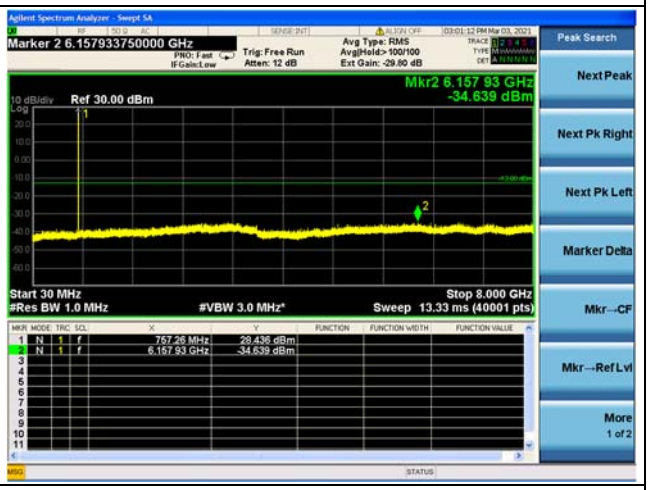
50kHz/QPSK 763-775MHz



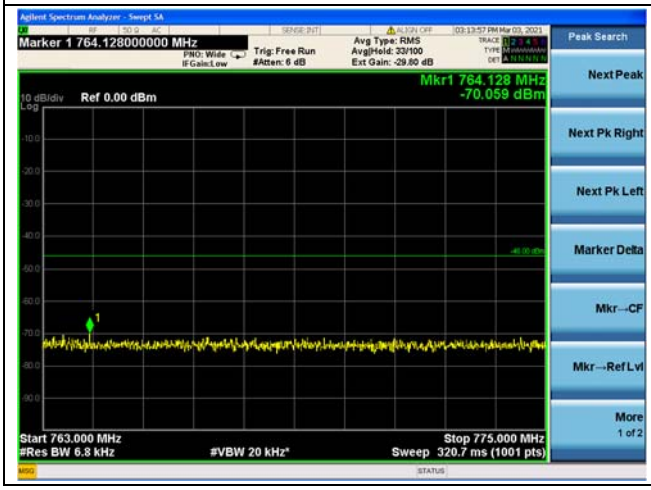
50kHz/QPSK 793-805MHz



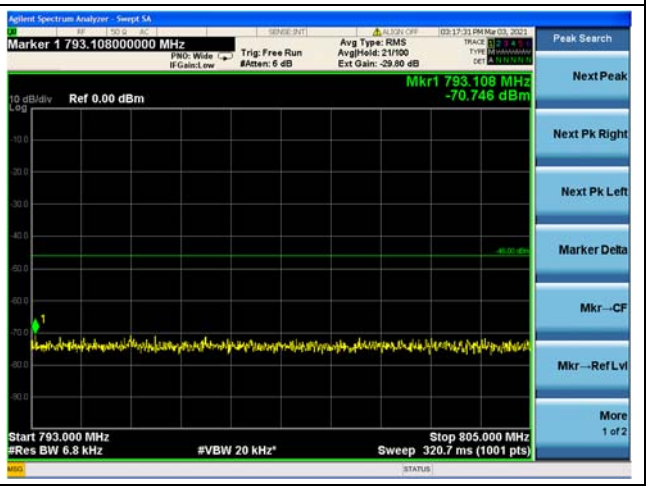
50kHz/16QAM



50kHz/16QAM 763-775MHz

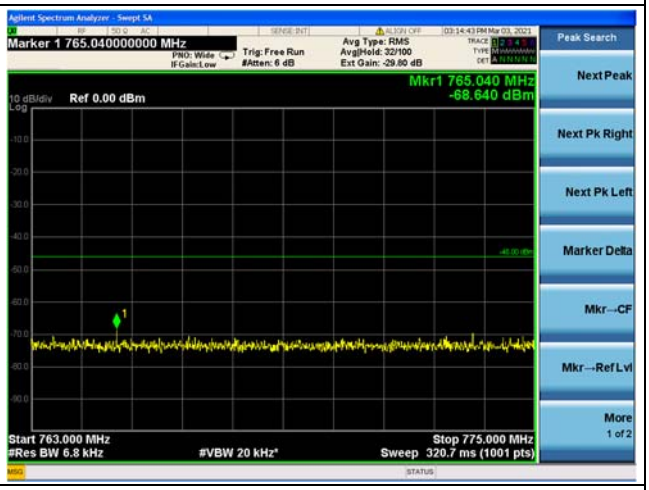


50kHz/16QAM 793-805MHz

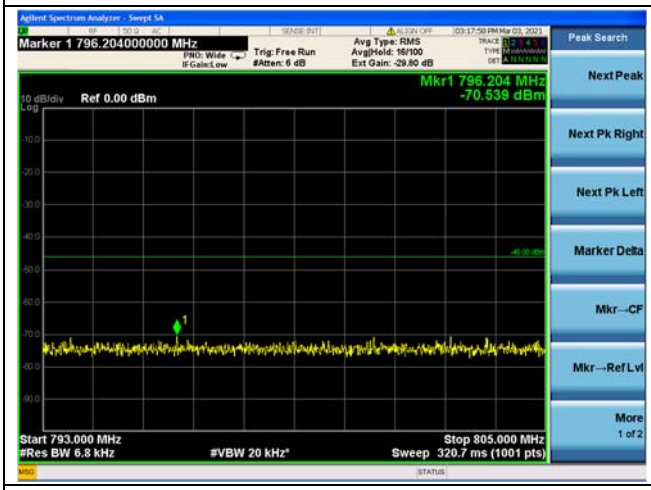


50kHz/64QAM

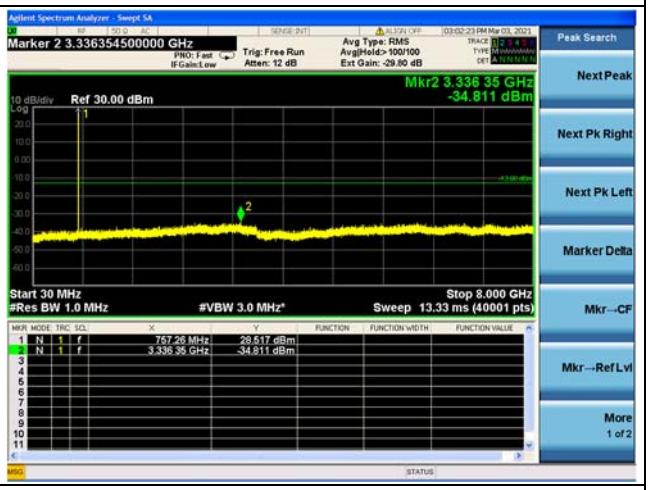
50kHz/64QAM 763-775MHz



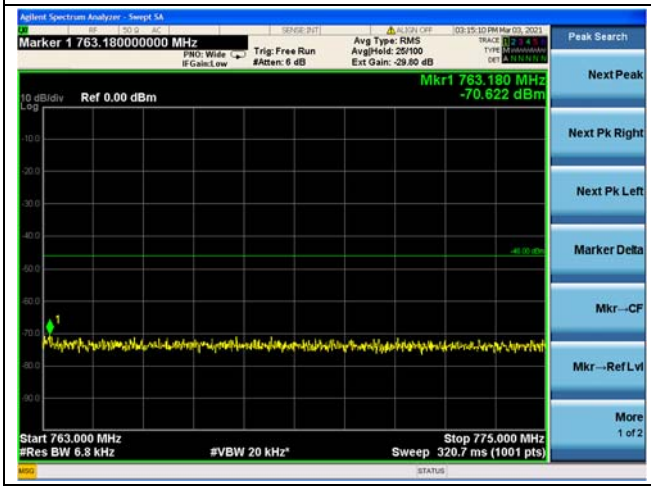
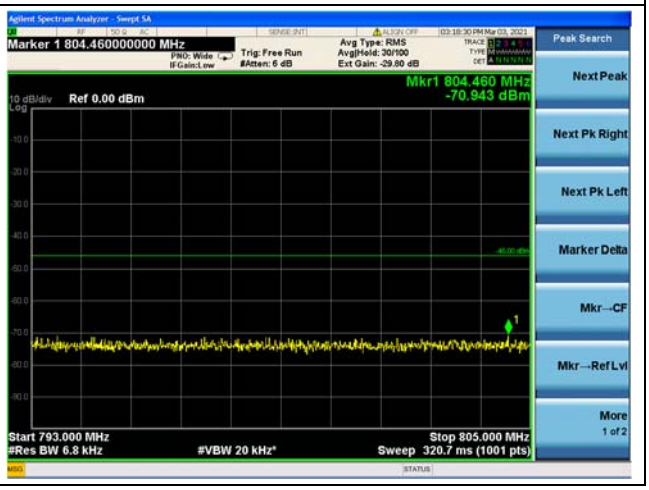
50kHz/64QAM 793-805MHz



50kHz/256QAM



50kHz/256QAM 763-775MHz



50kHz/256QAM 793-805MHz