TEST REPORT

APPLICANT	:	MiMOMax Wireless Limited
PRODUCT NAME	:	900MHz TornadoX Transceiver
MODEL NAME	:	MWL-TORNADOX-*G*D/E
BRAND NAME	:	Ubiik Mimomax
FCC ID	:	XMK-MMXTRNXB006
STANDARD(S)	:	47 CFR Part 2 47 CFR Part 24
RECEIPT DATE	:	2024-02-01
TEST DATE	:	2024-02-21 to 2024-02-28
ISSUE DATE	:	2024-03-05

Tested by: Gan Jing

Gan Jing (Rapporteur)

Approved by: Shen Junsheng

Shen Junsheng(Supervisor)

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MORLAB

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Change History		
Issue	Date	Reason for change
1.0	2024-03-05	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:	900MHz TornadoX Transceiver	
EUT Serial No:	(N/A, marked 1# by test site)	
Hardware Version:	P001	
Software Version:	TRN_04.08.04	
Operating Frequency Range:	930-931 MHz&940-941 MHz, 2Tx/2Rx	
Channel Bandwidth:	12.5kHz; 25kHz; 50kHz	
Modulation Type:	QPSK; 16QAM; 64QAM; 256QAM	
Operating Voltage:	10.5-60Vdc	
Antenna Gain:	Omni Antenna	2.5 dBi
		4.0 dBi
		6.0 dBi
	Panel Antenna	8.0 dBi
		10.0dBi
		12.0 dBi
		16.0 dBi
Emission Designator:	BW(kHz)	Designator
	12.5kHz	10K0W1W
	25.0kHz	20K0W1W
	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 24 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 24	Personal Communications Services

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

Section	Description	Test Engineer	Result	Method Determination /Remark
2.1046 24.132	Transmitter Conducted Output Power and ERP/EIRP	Gan Jing	PASS	No deviation
2.1049	Occupied Bandwidth	Gan Jing	PASS	No deviation
2.1051 24.133	Conducted Spurious Emissions	Gan Jing	PASS	No deviation
2.1053 24.133	Radiated Spurious Emissions	Li Hanbin	PASS	No deviation
2.1055 24.135	Frequency stability	Gan Jing	PASS	No deviation

Note 1: The TornadoXR Transceiver complies with FCC 47 CFR Part 2 and Part 24 when tested in accordance with the test methods described in 47 CFR Part 2 and Part 24.

Note 2: The TornadoXR Transceiver supports 2 Tx antenna ports, which was defined as Channel H &Channel V separately.

Note 3: The path loss during the conducted RF test is calibrated to correct the results by the Ext Gain setting. The Ext Gain contains two parts that cable loss of 0.7B and attenuator of 30.0dB.

Note 4: When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.

1.4. Environmental Conditions

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

Temperature (°C):	15 - 35
Relative Humidity (%):	30 -60

2. 47 CFR Part 2 and Part 24 Requirements

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

2.1.1. Test result

Nominal Frequency: 930.50 MHz Tx Port: Channel H

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Measured Power (Watt)	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	33.80	2.399	2.50	35.65	3.673	47.65	58.210
12.5	16QAM	24	33.96	2.489	2.50	35.81	3.811	47.81	60.395
12.5	64QAM	24	34.01	2.518	2.50	35.86	3.855	47.86	61.094
12.5	256QAM	24	33.94	2.477	2.50	35.79	3.793	47.79	60.117
25.0	QPSK	24	33.96	2.489	2.50	35.81	3.811	47.81	60.395
25.0	16QAM	24	33.98	2.500	2.50	35.83	3.828	47.83	60.674
25.0	64QAM	24	34.02	2.523	2.50	35.87	3.864	47.87	61.235
25.0	256QAM	24	33.97	2.495	2.50	35.82	3.819	47.82	60.534
50.0	QPSK	24	33.88	2.443	2.50	35.73	3.741	47.73	59.293
50.0	16QAM	24	33.64	2.312	2.50	35.49	3.540	47.49	56.105
50.0	64QAM	24	33.93	2.472	2.50	35.78	3.784	47.78	59.979
50.0	256QAM	24	34.12	2.582	2.50	35.97	3.954	47.97	62.661

Nominal Frequency: 930.50 MHz Tx Port: Channel V

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Measured Power (Watt)	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	33.60	2.291	2.50	35.45	3.508	47.45	55.590
12.5	16QAM	24	33.73	2.360	2.50	35.58	3.614	47.58	57.280
12.5	64QAM	24	34.07	2.553	2.50	35.92	3.908	47.92	61.944
12.5	256QAM	24	33.81	2.404	2.50	35.66	3.681	47.66	58.345

25.0	QPSK	24	33.70	2.344	2.50	35.55	3.589	47.55	56.885
25.0	16QAM	24	33.62	2.301	2.50	35.47	3.524	47.47	55.847
25.0	64QAM	24	33.88	2.443	2.50	35.73	3.741	47.73	59.293
25.0	256QAM	24	33.91	2.460	2.50	35.76	3.767	47.76	59.704
50.0	QPSK	24	34.01	2.518	2.50	35.86	3.855	47.86	61.094
50.0	16QAM	24	33.78	2.388	2.50	35.63	3.656	47.63	57.943
50.0	64QAM	24	33.86	2.432	2.50	35.71	3.724	47.71	59.020
50.0	256QAM	24	33.98	2.500	2.50	35.83	3.828	47.83	60.674

Nominal Frequency: 940.50 MHz Tx Port: Channel H

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Measured Power (Watt)	Rated Power (Watt)	E.R.P. (ANT Gain = 4.0dBi)		E.R.P. (ANT Gain = 16.0dBi)	
						dBm	Watt	dBm	Watt
12.5	QPSK	24	34.12	2.582	2.50	35.97	3.954	47.97	62.661
12.5	16QAM	24	33.77	2.382	2.50	35.62	3.648	47.62	57.810
12.5	64QAM	24	33.97	2.495	2.50	35.82	3.819	47.82	60.534
12.5	256QAM	24	33.97	2.495	2.50	35.82	3.819	47.82	60.534
25.0	QPSK	24	33.53	2.280	2.50	35.38	3.451	47.38	54.702
25.0	16QAM	24	33.56	2.415	2.50	35.41	3.475	47.41	55.081
25.0	64QAM	24	33.69	2.455	2.50	35.54	3.581	47.54	56.754
25.0	256QAM	24	33.62	2.636	2.50	35.47	3.524	47.47	55.847
50.0	QPSK	24	33.58	2.280	2.50	35.43	3.491	47.43	55.335
50.0	16QAM	24	33.83	2.415	2.50	35.68	3.698	47.68	58.614
50.0	64QAM	24	33.90	2.455	2.50	35.75	3.758	47.75	59.566
50.0	256QAM	24	34.21	2.636	2.50	36.06	4.036	48.06	63.973

Nominal Frequency: 940.50 MHz Tx Port: Channel V

Channel Bandwidth (kHz)	Modulation Type	Voltage (Vdc)	Measured Power (dBm)	Measured Power (Watt)	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	33.55	2.265	2.50	35.40	3.467	47.40	54.954

12.5	16QAM	24	34.11	2.576	2.50	35.96	3.945	47.96	62.517
12.5	64QAM	24	34.17	2.612	2.50	36.02	3.999	48.02	63.387
12.5	256QAM	24	33.88	2.443	2.50	35.73	3.741	47.73	59.293
25.0	QPSK	24	33.76	2.377	2.50	35.61	3.639	47.61	57.677
25.0	16QAM	24	33.72	2.355	2.50	35.57	3.606	47.57	57.148
25.0	64QAM	24	33.96	2.489	2.50	35.81	3.811	47.81	60.395
25.0	256QAM	24	33.93	2.472	2.50	35.78	3.784	47.78	59.979
50.0	QPSK	24	33.84	2.421	2.50	35.69	3.707	47.69	58.749
50.0	16QAM	24	33.99	2.506	2.50	35.84	3.837	47.84	60.814
50.0	64QAM	24	34.13	2.588	2.50	35.98	3.963	47.98	62.806
50.0	256QAM	24	34.12	2.582	2.50	35.97	3.954	47.97	62.661

Note1: 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 0.7dB and attenuator of 30.0dB.

Note 2: The transmitter has a rated output power of 2.512 Watt (34dBm).The measured power has been shown to be within +/- 1 dB of the rated power.

Note3:E.I.R.P. (dBm) = Conducted Output Power (dBm) + Antenna Gain (dBi); E.R.P. (dBm) = E.I.R.P. (dBm) - 2.15.

Note4: Part 24 does not specify the transmitter output power.

Base stations transmitting in the 930-931 MHz and 940-941 MHz bands are limited to 3500 watts e.r.p. per authorized channel and are unlimited in antenna height except as provided in paragraph (d) of this section.

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.

Note7: 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.

2.2. Occupied Bandwidth

2.2.1. Definition

Emission Designator:

Frequency (MHz)	BW(kHz)	Designator
930-931MHz 940-941MHz	12.5kHz	10K0W1W
	25.0kHz	20K0W1W
	50.0kHz	42K0W1W

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 of each modulation type using a spectrum analyzer operating in occupied bandwidth mode.

2.2.3. Test Result

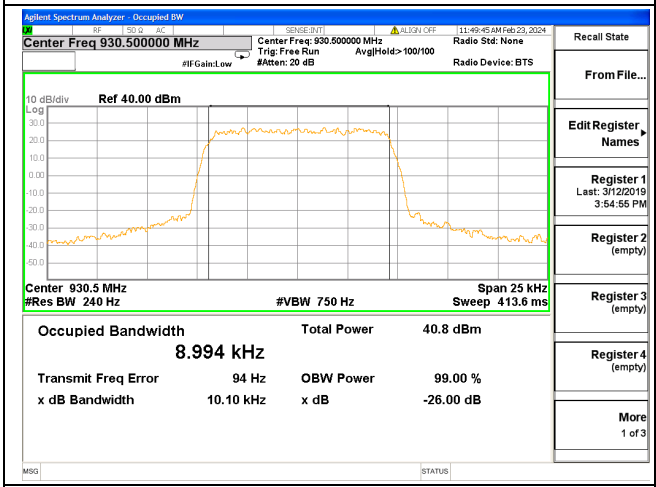
Nominal Frequency: 930.50 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
H	12.5	QPSK	8.994
		16QAM	9.020
		64QAM	8.993
		256QAM	8.993
	25.0	QPSK	18.707
		16QAM	18.713
		64QAM	18.779
		256QAM	18.712
	50.0	QPSK	41.372
		16QAM	41.222
		64QAM	41.473
		256QAM	41.181
V	12.5	QPSK	8.999
		16QAM	8.992
		64QAM	9.004
		256QAM	8.972
	25.0	QPSK	18.826
		16QAM	18.695
		64QAM	18.838
		256QAM	18.623
	50.0	QPSK	41.237
		16QAM	41.372
		64QAM	41.263
		256QAM	41.206

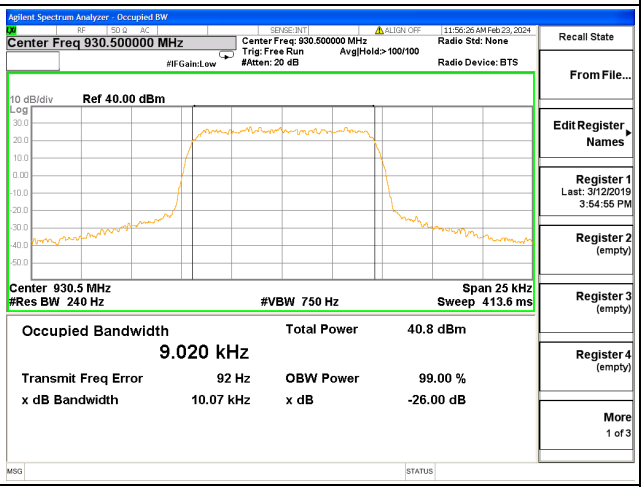
Nominal Frequency: 940.50 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
H	12.5	QPSK	8.966
		16QAM	9.021
		64QAM	9.014
		256QAM	8.972
	25.0	QPSK	18.945
		16QAM	19.233
		64QAM	18.932
		256QAM	18.933
	50.0	QPSK	41.373
		16QAM	41.378
		64QAM	41.421
		256QAM	42.531
V	12.5	QPSK	8.988
		16QAM	8.980
		64QAM	8.999
		256QAM	8.983
	25.0	QPSK	18.674
		16QAM	18.788
		64QAM	18.622
		256QAM	18.665
	50.0	QPSK	41.090
		16QAM	41.164
		64QAM	41.174
		256QAM	41.388

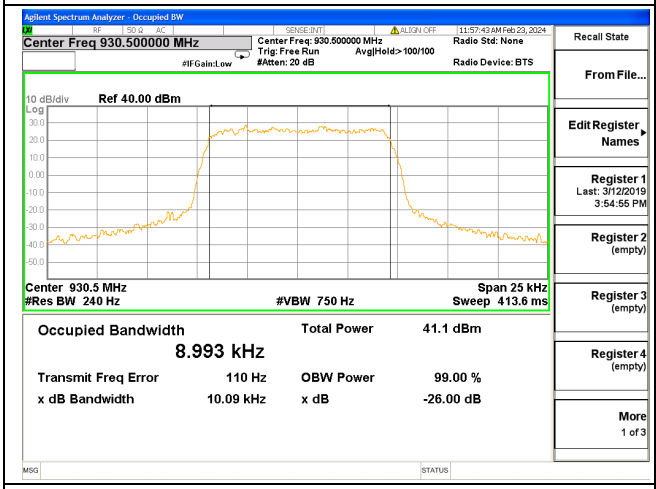
930.50MHz/Channel H/12.5kHz/QPSK



930.50MHz/Channel H/12.5kHz/16QAM



930.50MHz/Channel H/12.5kHz/64QAM



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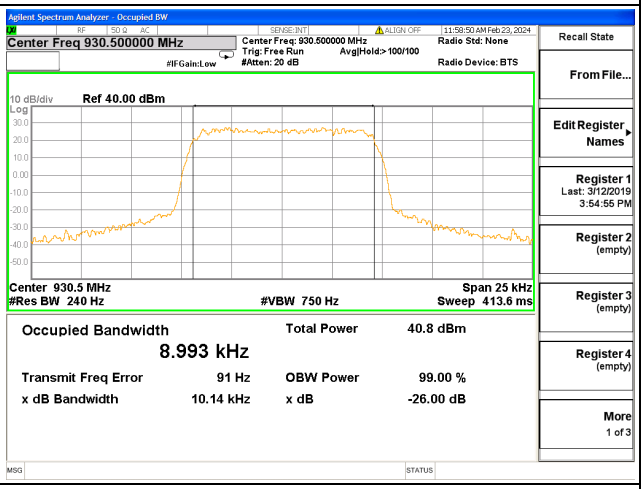

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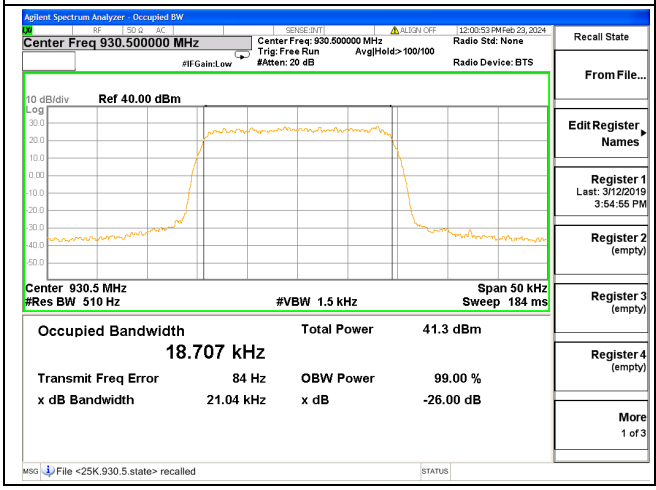

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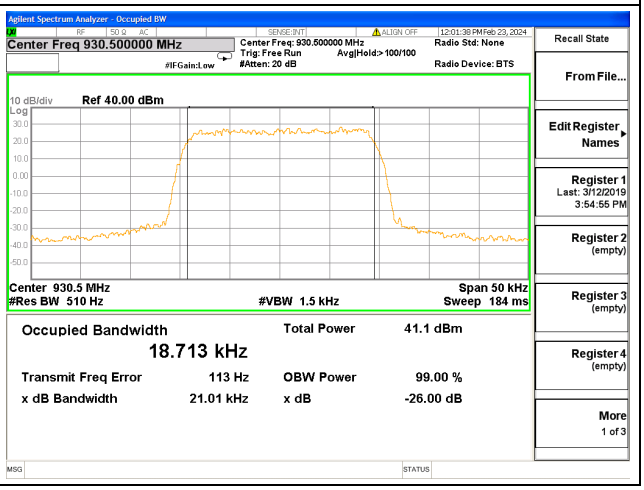

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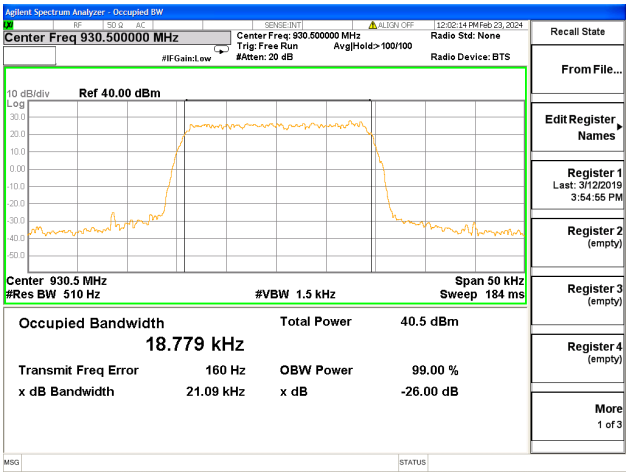

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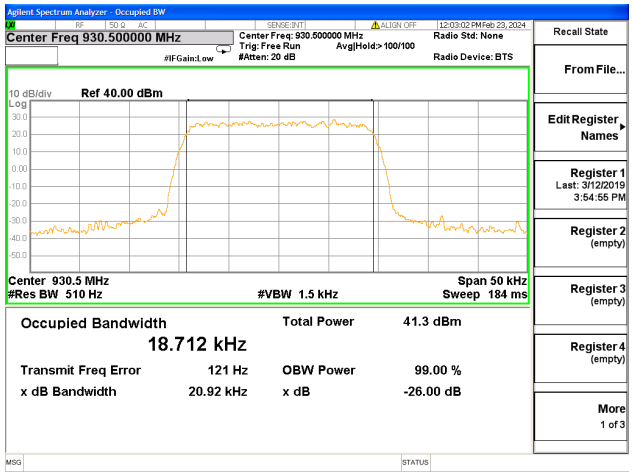

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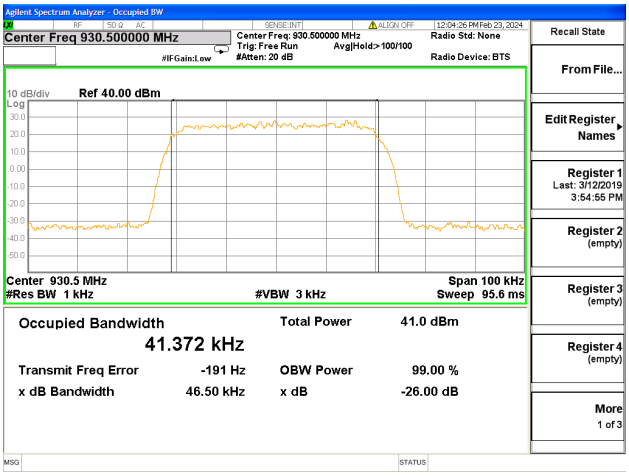

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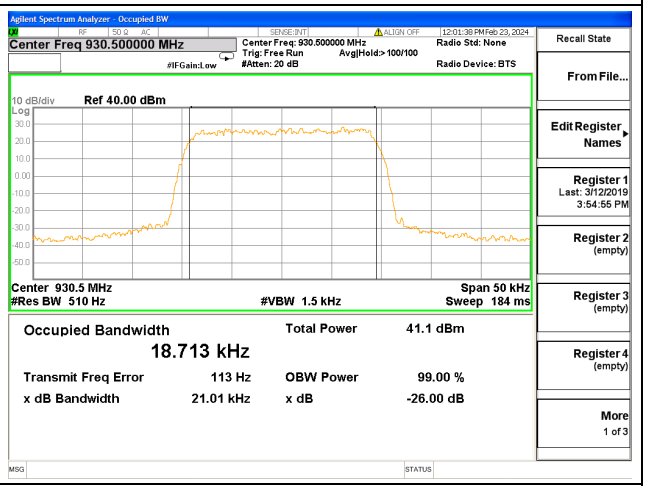

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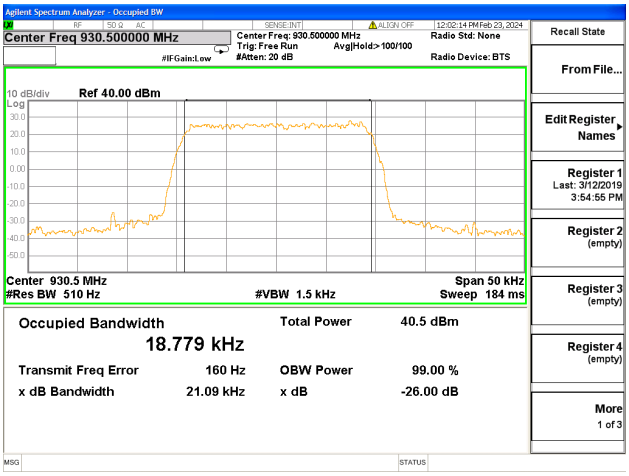

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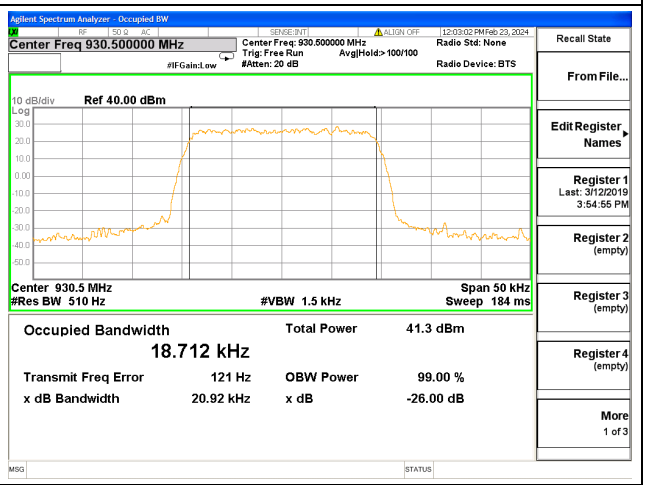
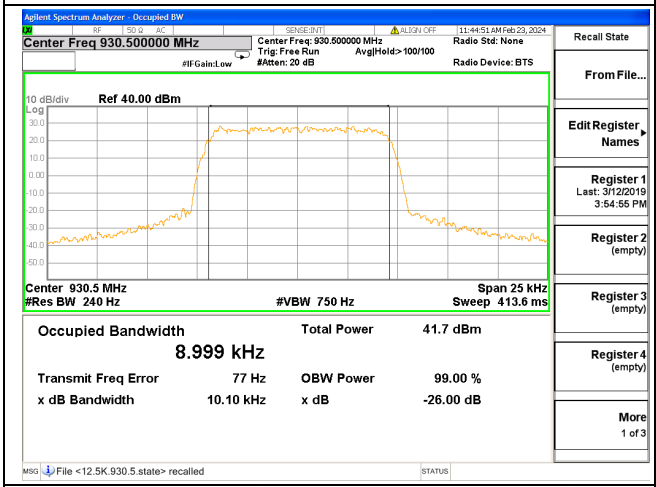


930.50MHz/Channel V/12.5kHz/QPSK



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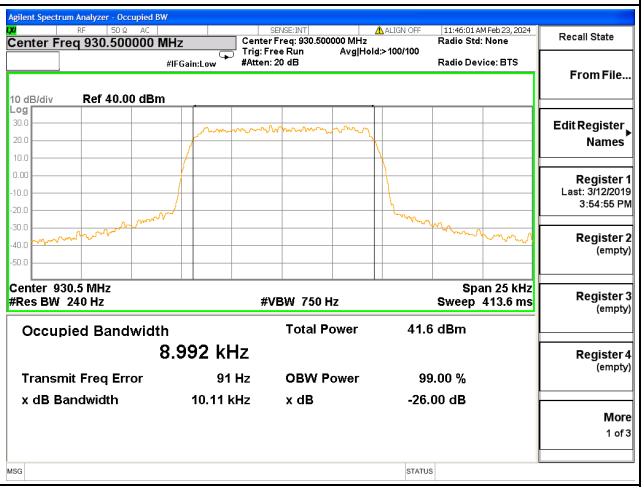

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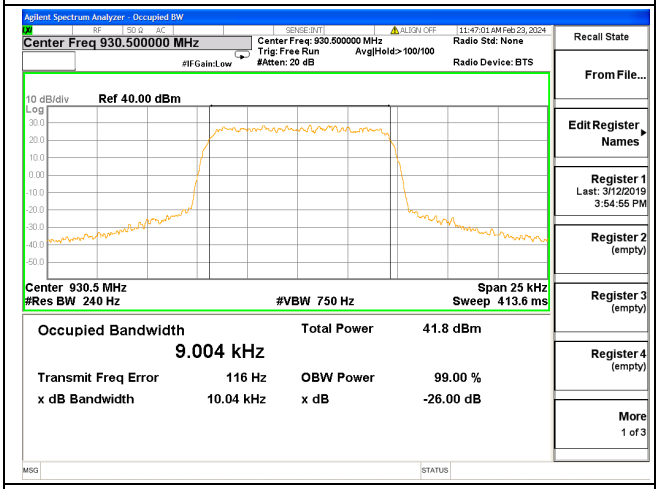
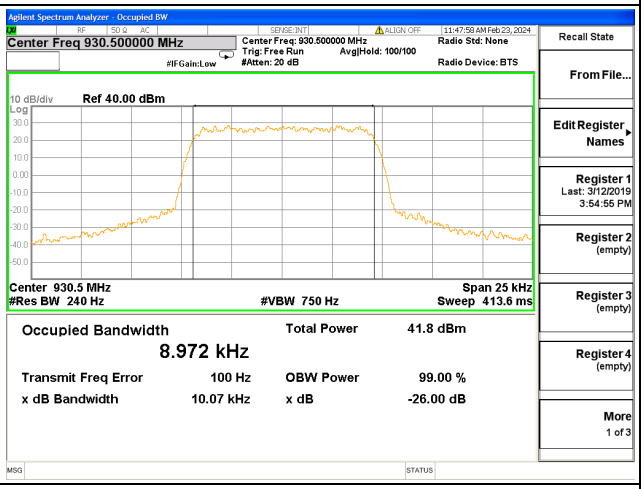


930.50MHz/Channel V/12.5 kHz/256QAM



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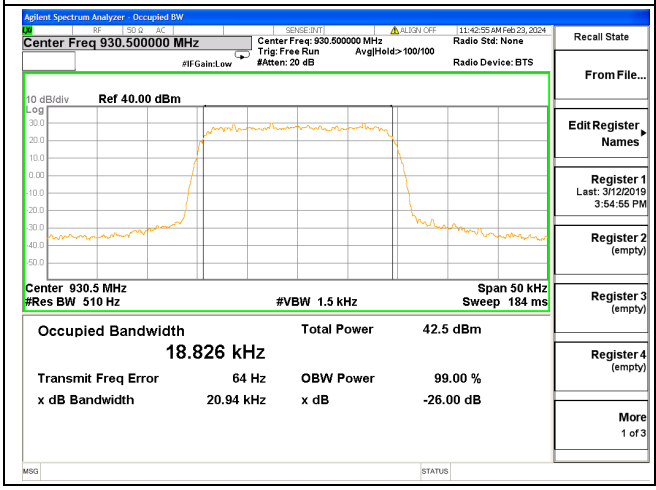
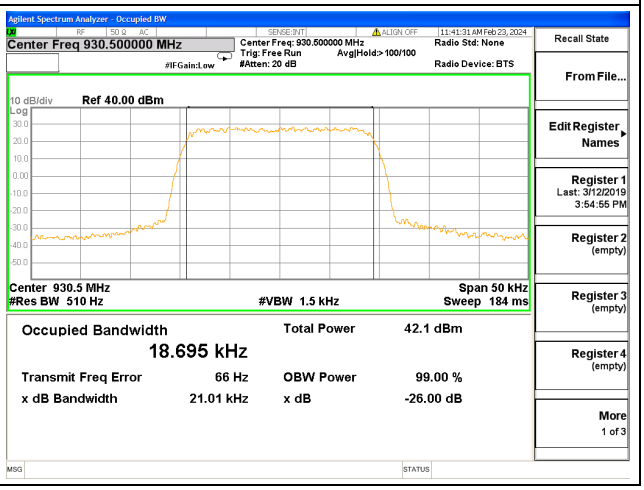
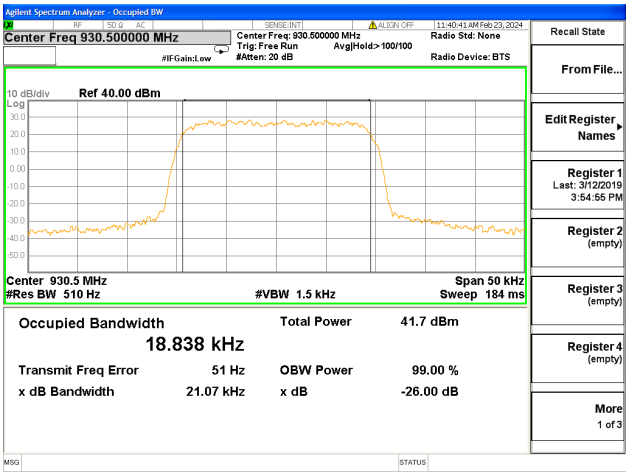


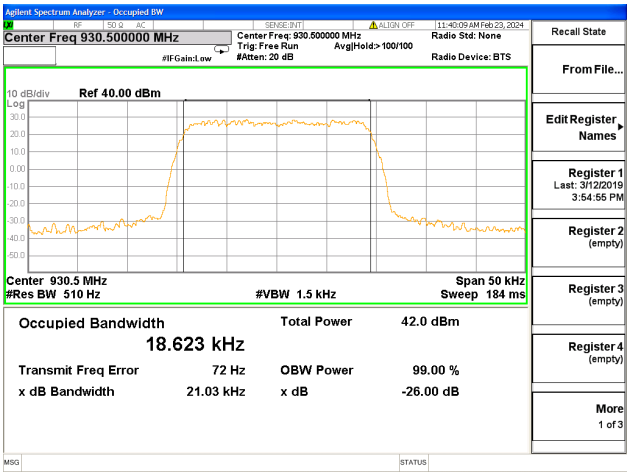
930.50MHz/Channel V/25.0 kHz/16QAM



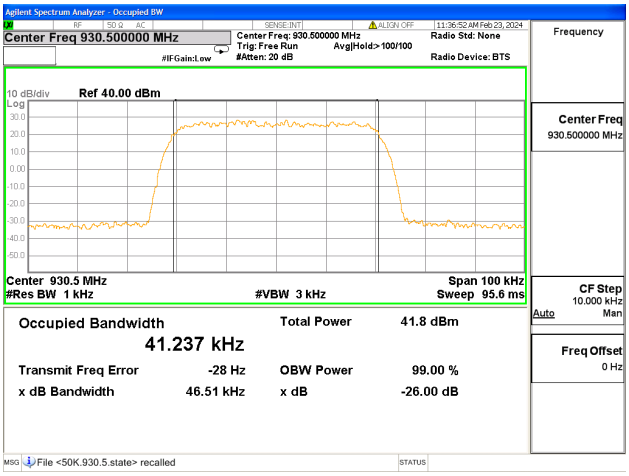
930.50MHz/Channel V/25.0 kHz/64QAM



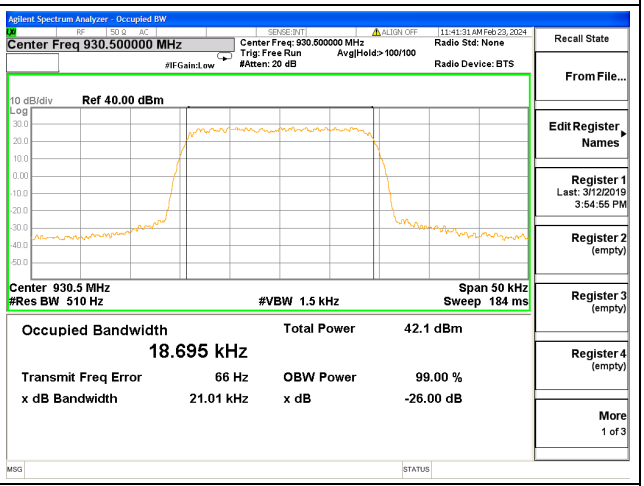
930.50MHz/Channel V/25.0 kHz/256QAM



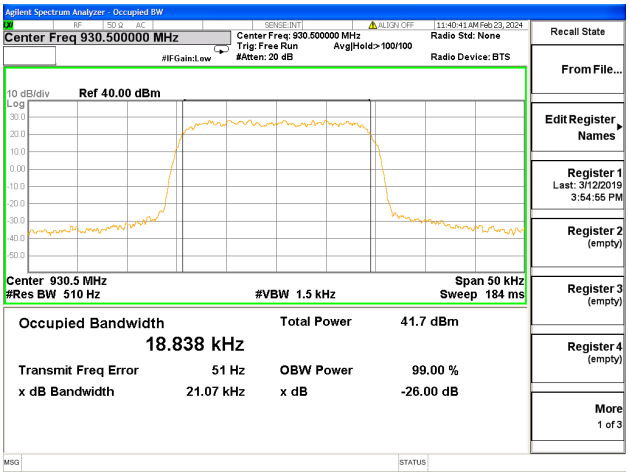
930.50MHz/Channel V/50.0 kHz/QPSK



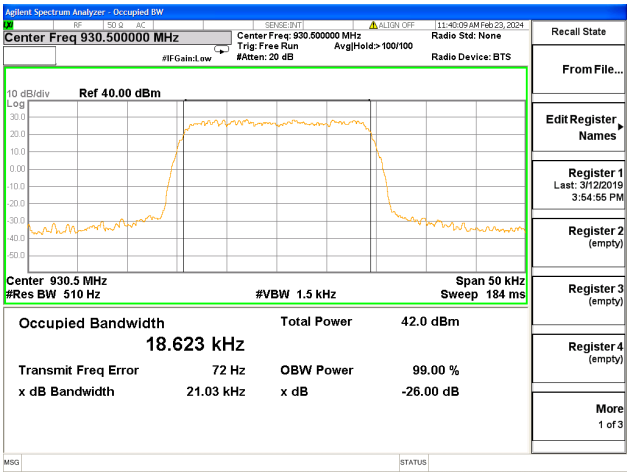
930.50MHz/Channel V/50.0 kHz/16QAM



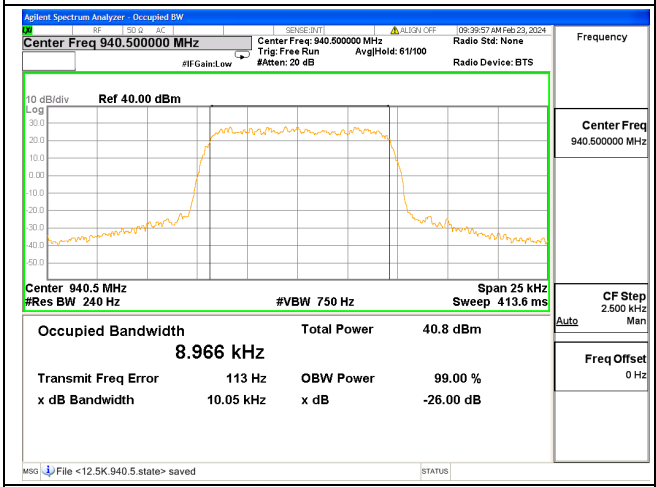
930.50MHz/Channel V/50.0 kHz/64QAM



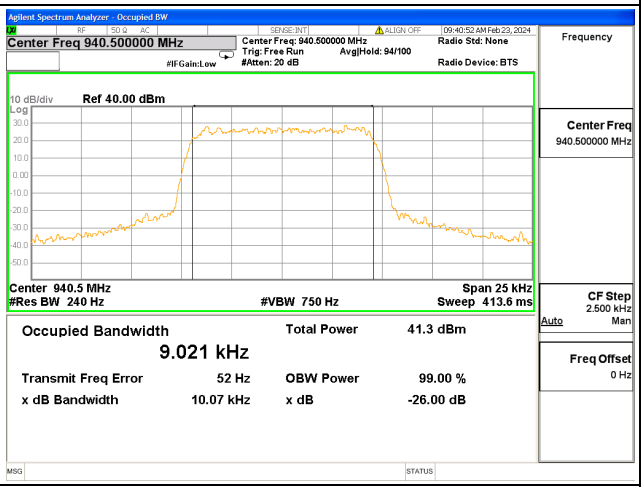
930.50MHz/Channel V/50.0 kHz/256QAM



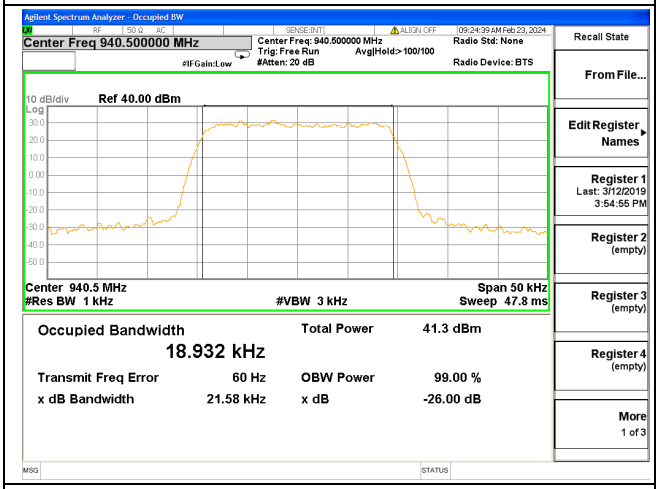
940.50MHz/Channel H/12.5kHz/QPSK



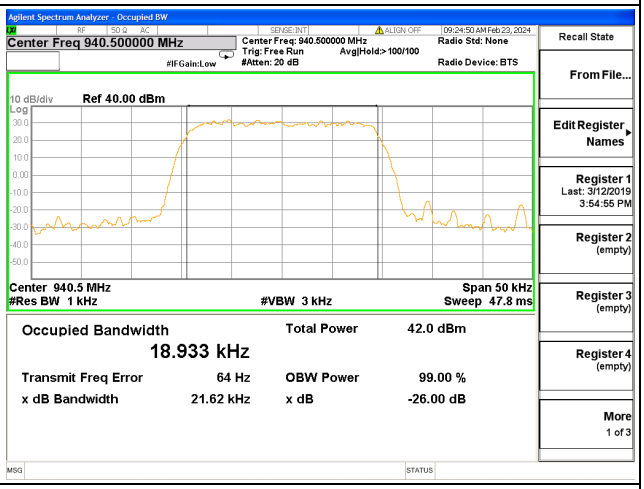
940.50MHz/Channel H/12.5kHz/16QAM



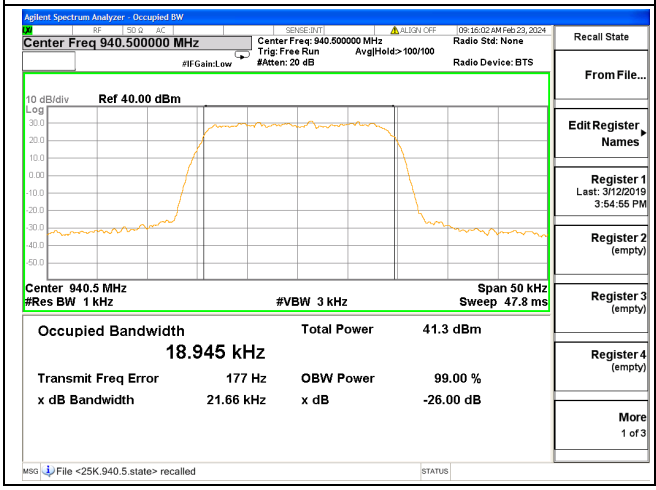
940.50MHz/Channel H/12.5kHz/64QAM



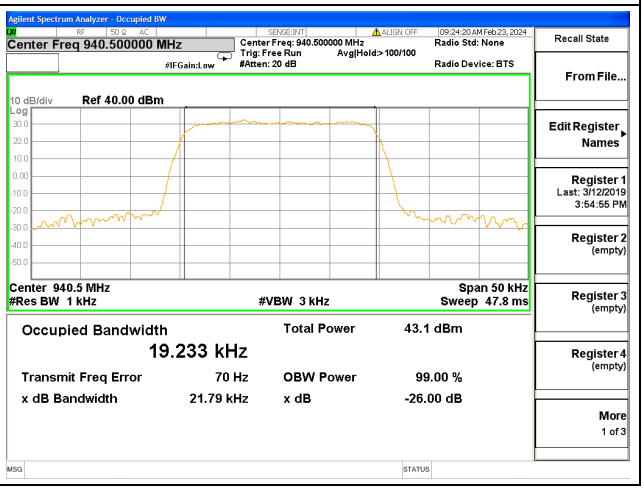
940.50MHz/Channel H/12.5 kHz/256QAM



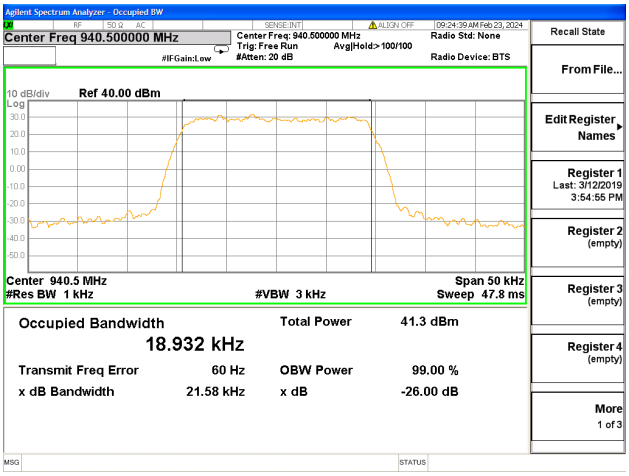
940.50MHz/Channel H/25.0 kHz/QPSK



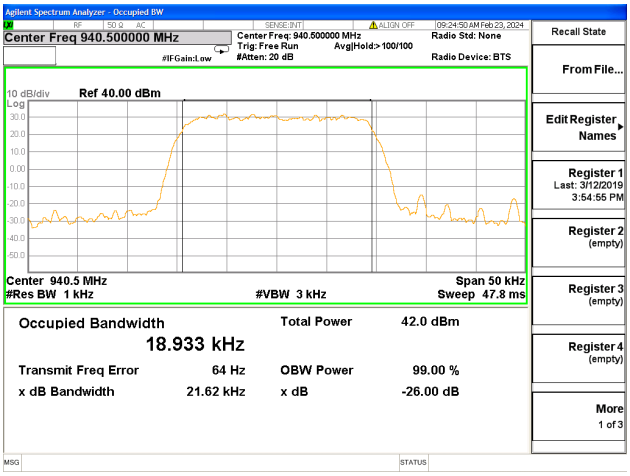
940.50MHz/Channel H/25.0 kHz/16QAM



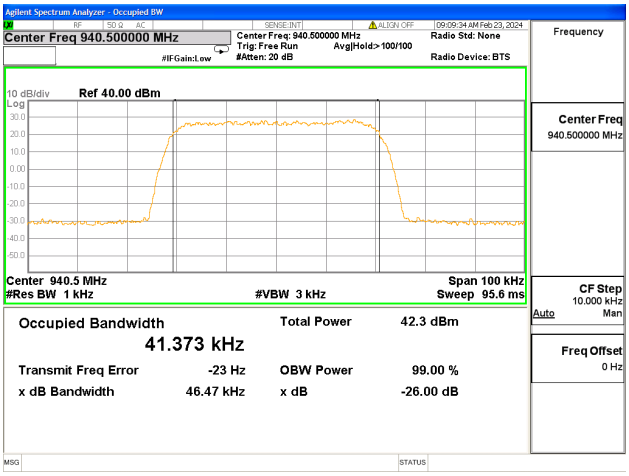
940.50MHz/Channel H/25.0 kHz/64QAM



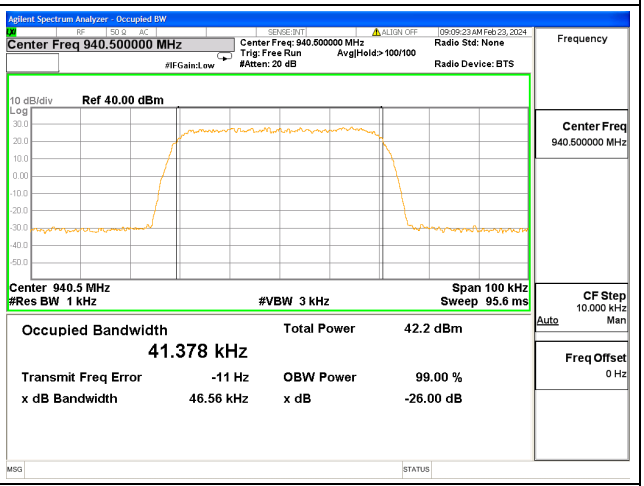
940.50MHz/Channel H/25.0 kHz/256QAM



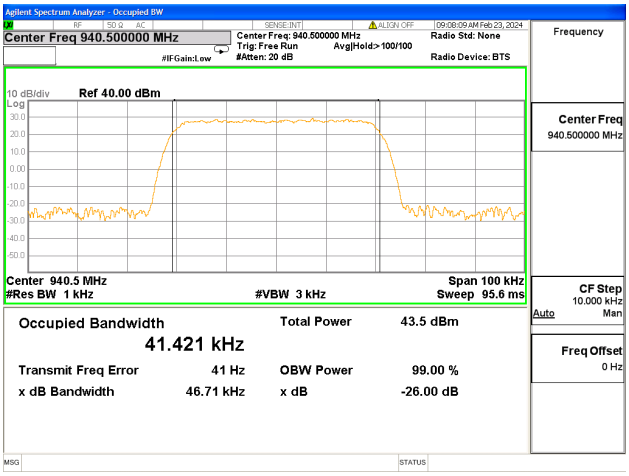
940.50MHz/Channel H/50.0 kHz/QPSK



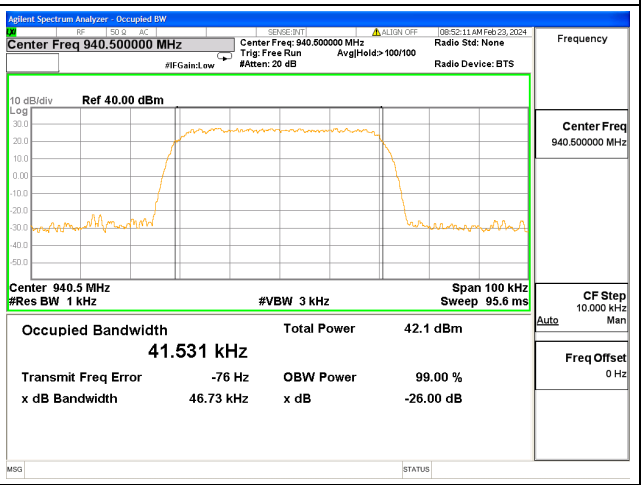
940.50MHz/Channel H/50.0 kHz/16QAM



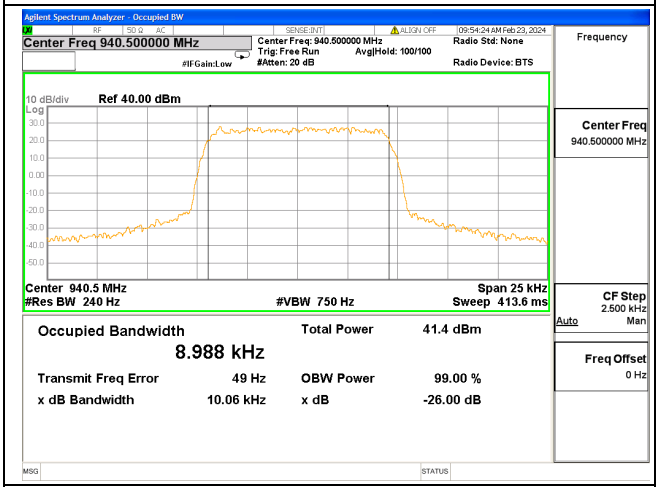
940.50MHz/Channel H/50.0 kHz/64QAM



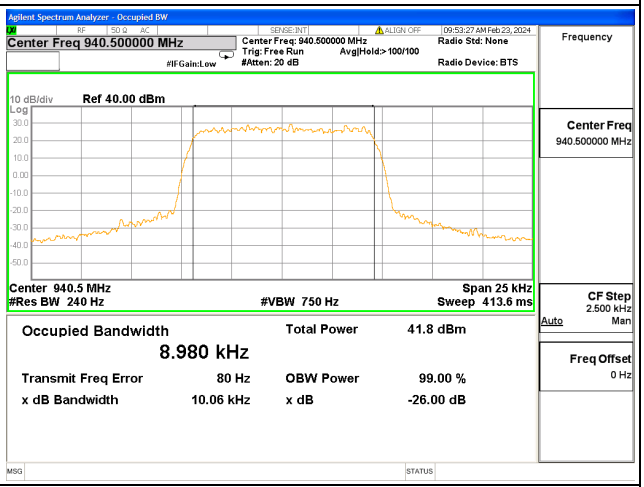
940.50MHz/Channel H/50.0 kHz/256QAM



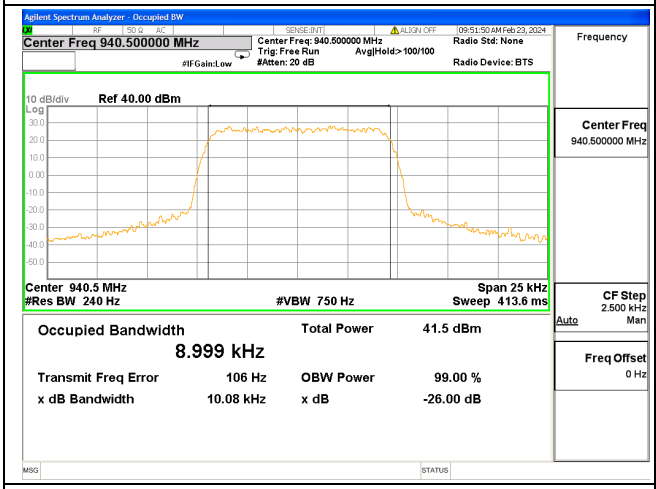
940.50MHz/Channel V/12.5kHz/QPSK



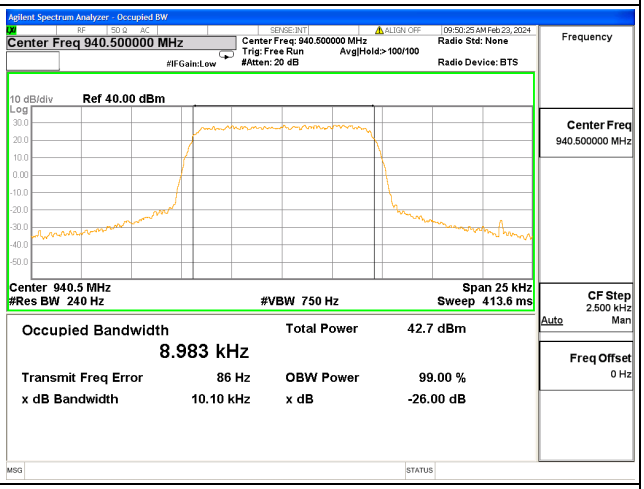
940.50MHz/Channel V/12.5kHz/16QAM



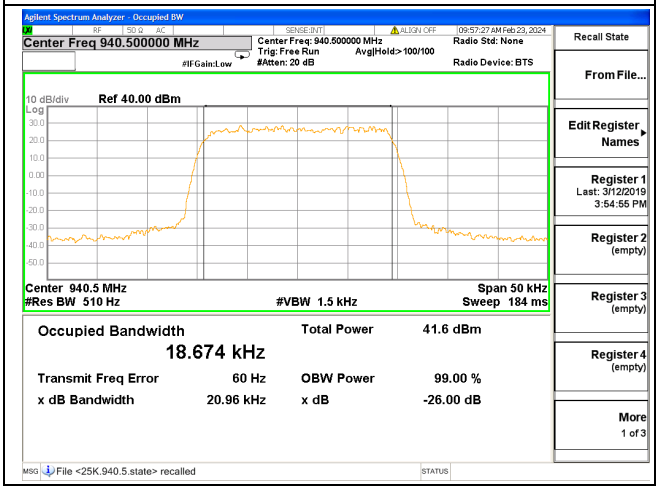
940.50MHz/Channel V/12.5kHz/64QAM



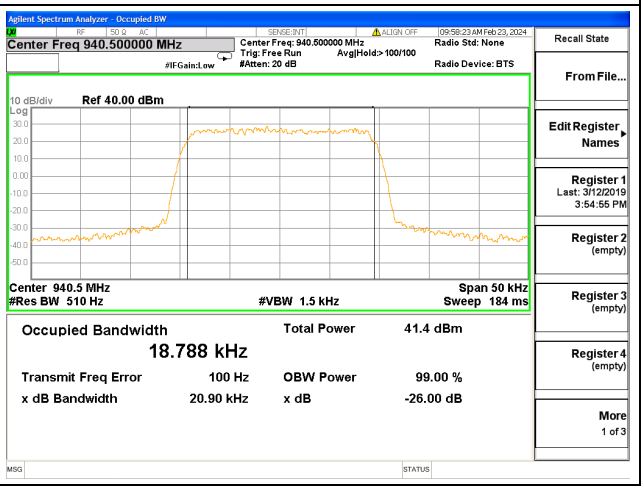
940.50MHz/Channel V/12.5 kHz/256QAM



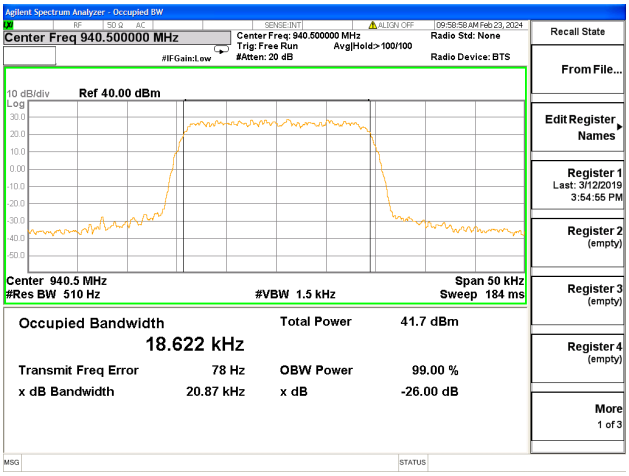
940.50MHz/Channel V/25.0 kHz/QPSK



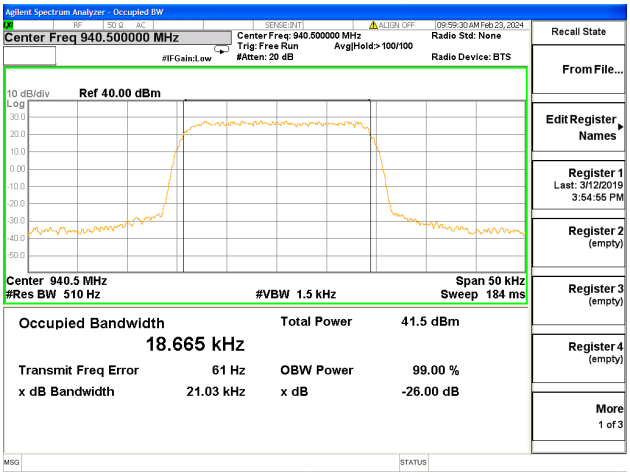
940.50MHz/Channel V/25.0 kHz/16QAM



940.50MHz/Channel V/25.0 kHz/64QAM



940.50MHz/Channel V/25.0 kHz/256QAM



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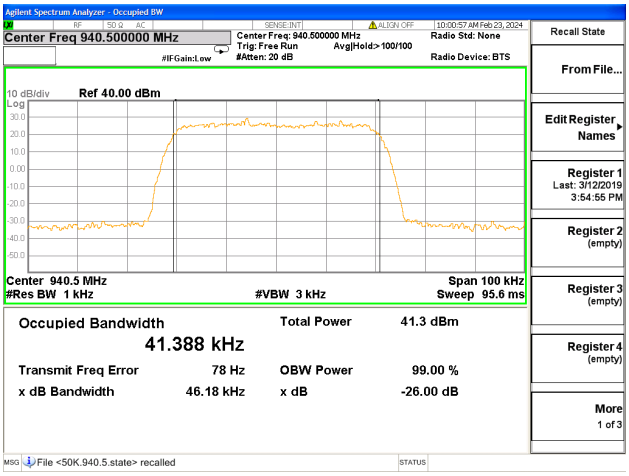
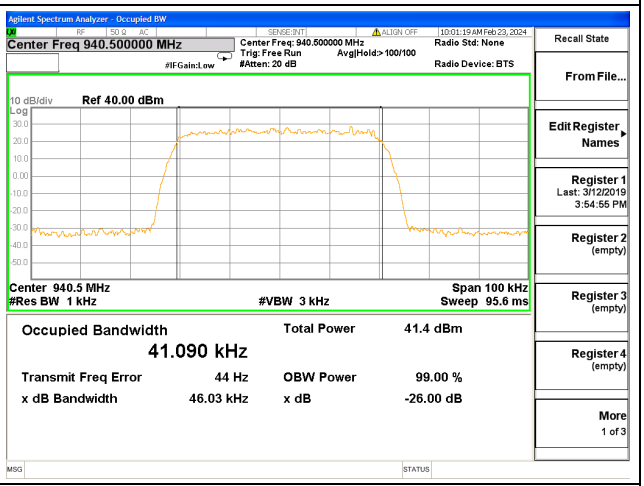
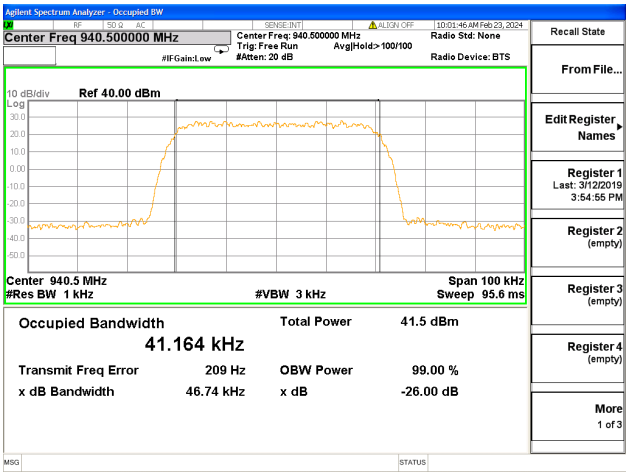


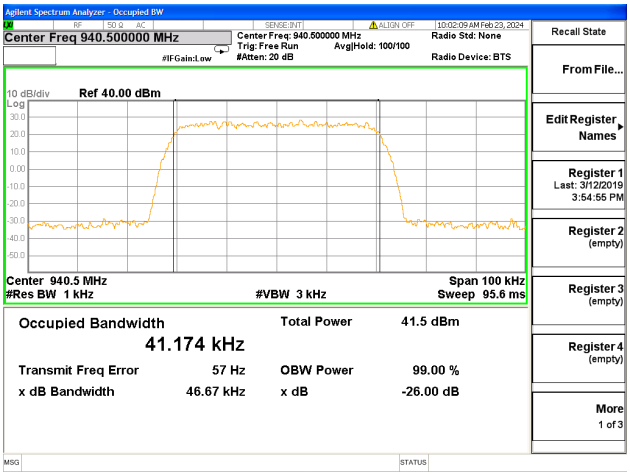
940.50MHz/Channel V/50.0 kHz/16QAM



940.50MHz/Channel V/50.0 kHz/64QAM



940.50MHz/Channel V/50.0 kHz/256QAM



2.3. Spurious Emissions At Antenna Terminals

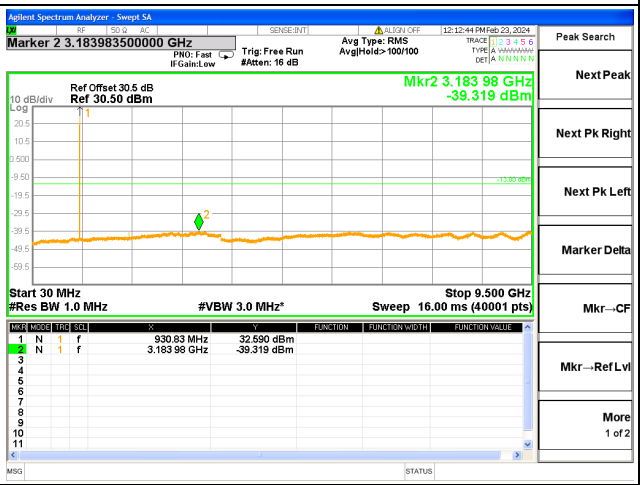
2.3.1. Test Requirement

According to FCC section 2.1051, 24.131 and 24. 133(a) section
The authorized bandwidth of narrowband PCS channels will be 10 kHz for 12.5 kHz channels and 45 kHz for 50 kHz channels. For aggregated adjacent channels, a maximum authorized bandwidth of 5 kHz less than the total aggregated channel width is permitted.
For transmitters authorized a bandwidth greater than 10 kHz**:**
1. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of up to and including 40 kHz: at least 116 Log10 ((fd + 10)/6.1) decibels or 50 plus 10 Log10 (P) decibels or 70 decibels, whichever is the lesser attenuation;
2. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 40 kHz: at least 43 + 10 Log10 (P) decibels or 80 decibels, whichever is the lesser attenuation;
For transmitters authorized a bandwidth of 10 kHz**:**
1. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of up to and including 20 kHz: at least 116 × Log10 ((fd + 5)/3.05) decibels or 50 + 10 × Log10 (P) decibels or 70 decibels, whichever is the lesser attenuation;
2. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 20 kHz: at least 43 + 10 Log10 (P) decibels or 80 decibels, whichever is the lesser attenuation.

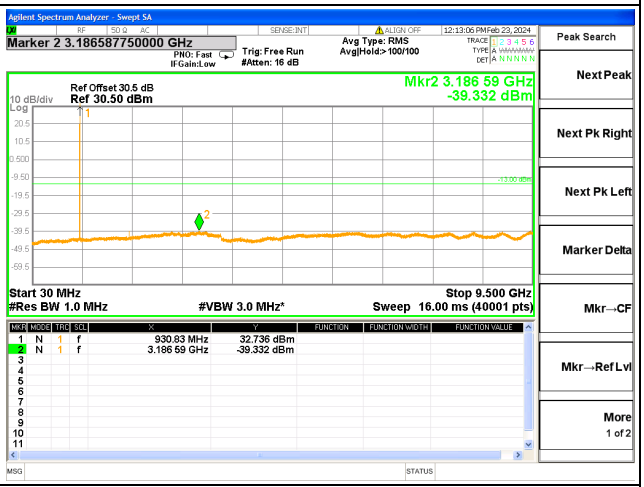
2.3.2. Test Result

Nominal Frequency: 930.50 MHz Tx Port: Channel H

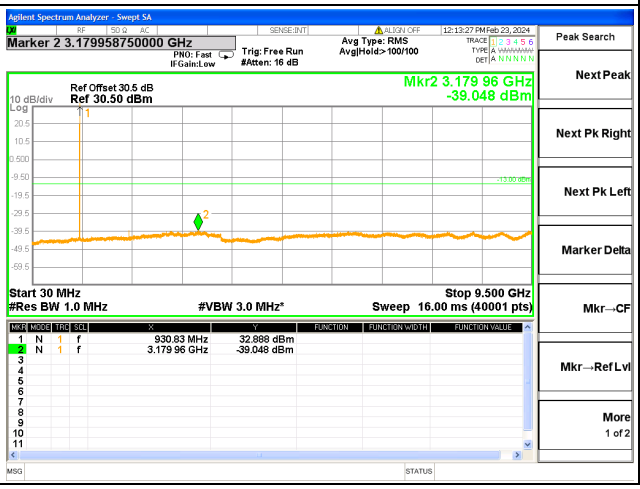
12.5kHz/QPSK



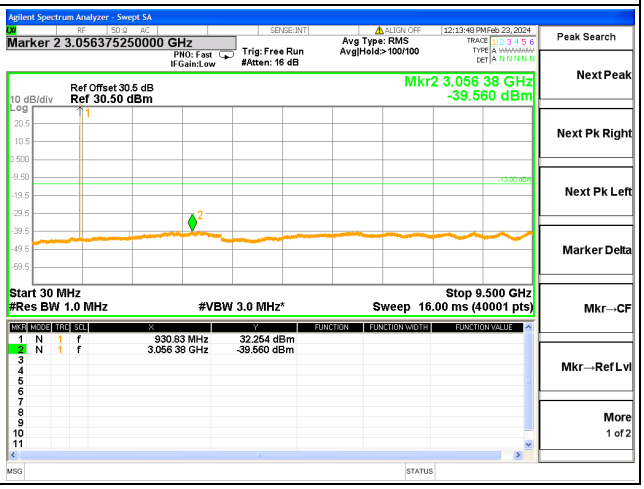
12.5kHz/16QAM



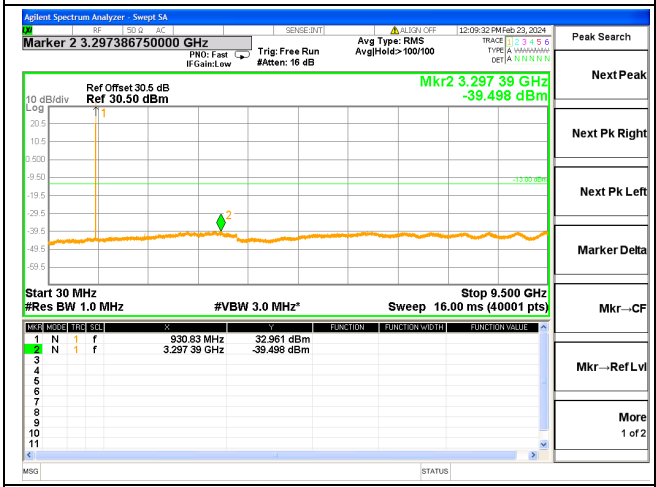
12.5kHz/64QAM



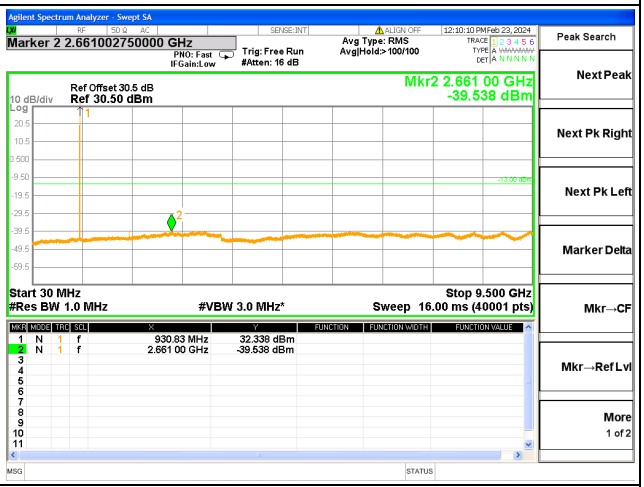
12.5kHz/256QAM



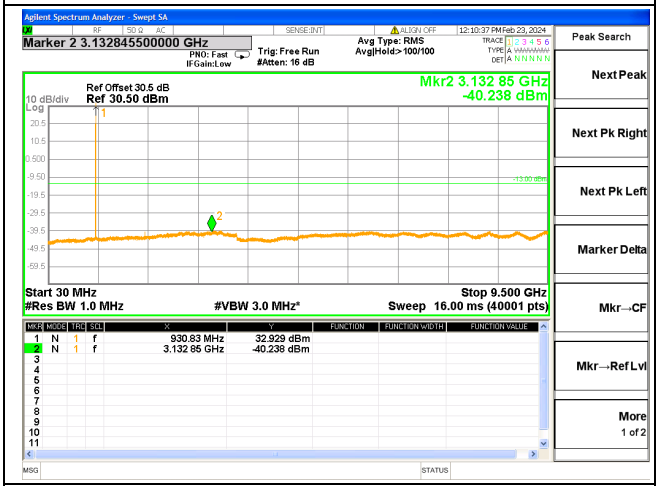
25.0kHz/QPSK



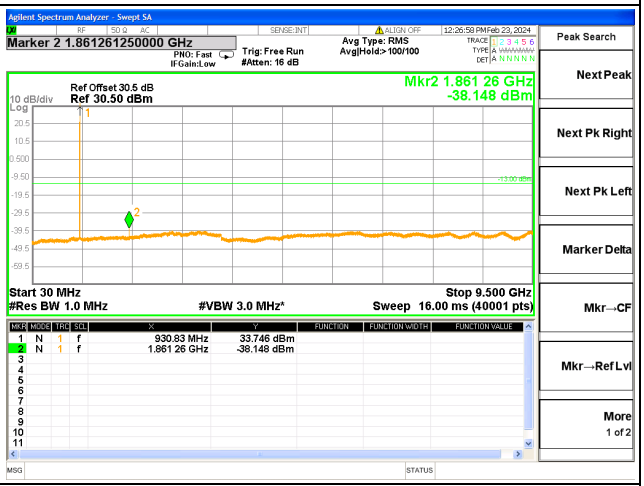
25.0kHz /16QAM



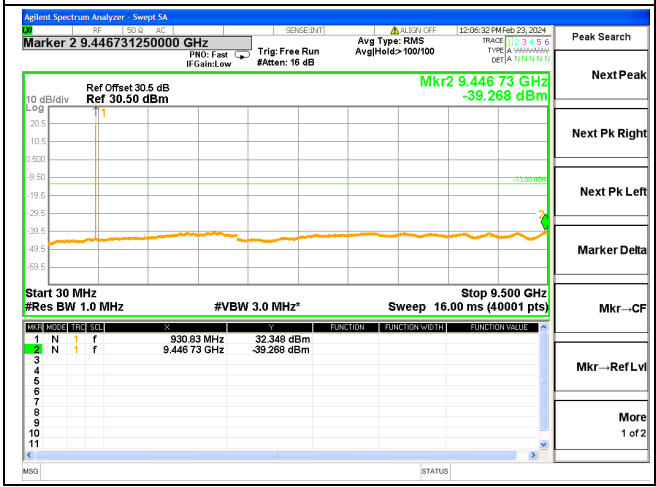
25.0kHz /64QAM



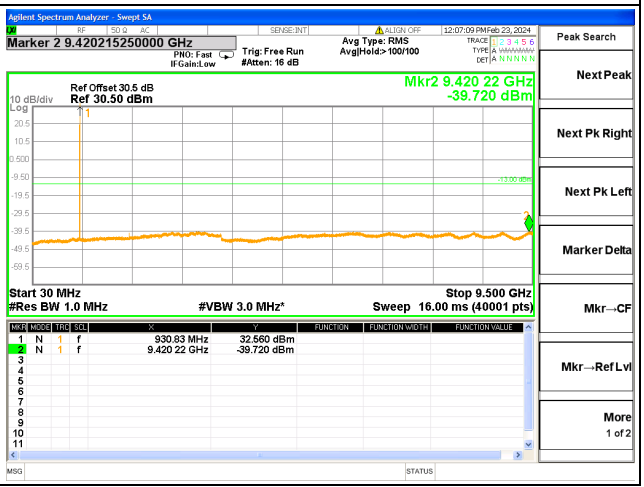
25.0kHz /256QAM

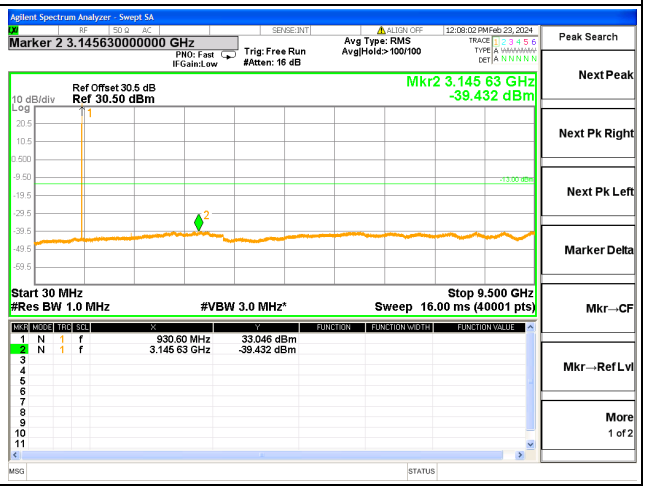


50.0kHz/QPSK

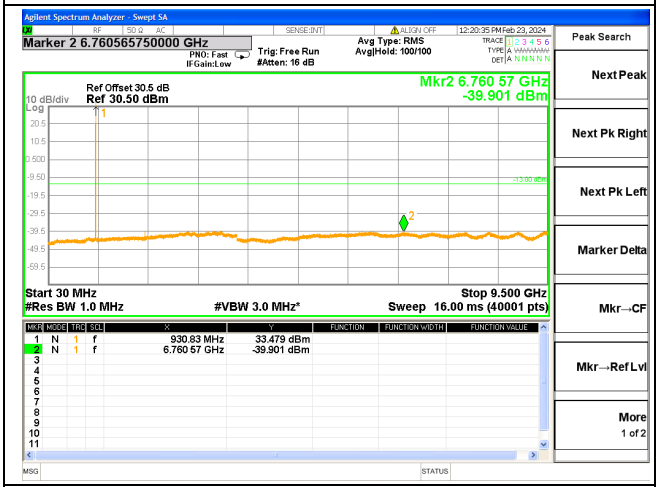
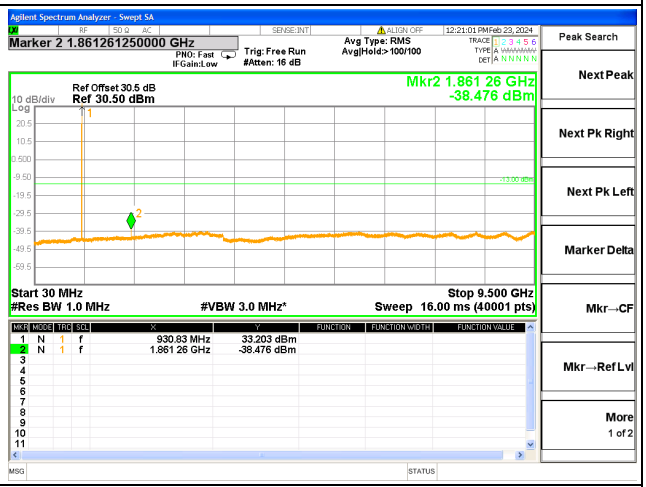


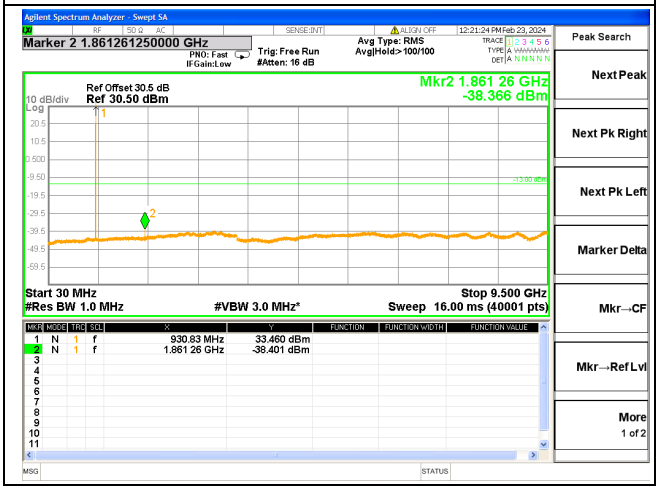
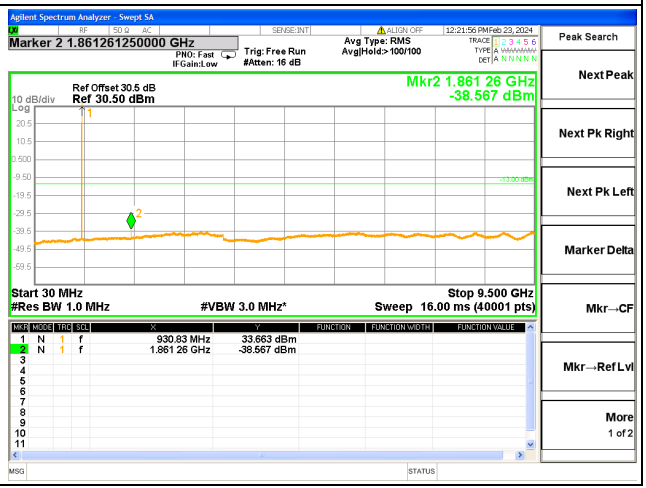
50.0kHz /16QAM



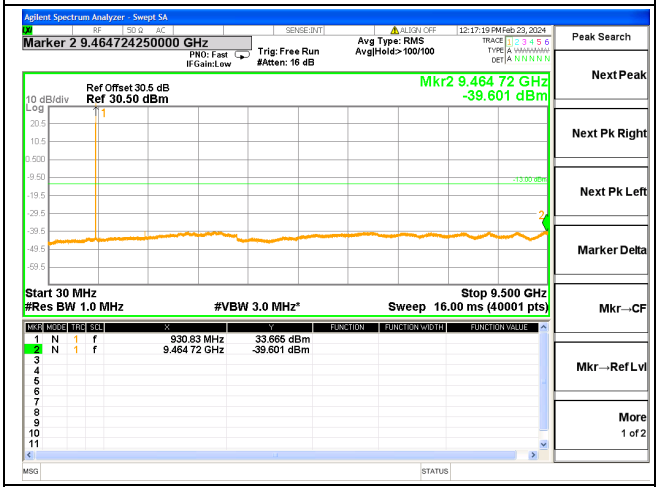
50.0kHz /64QAM	50.0kHz /256QAM
	

Nominal Frequency: 930.50 MHz Tx Port: Chan nel V

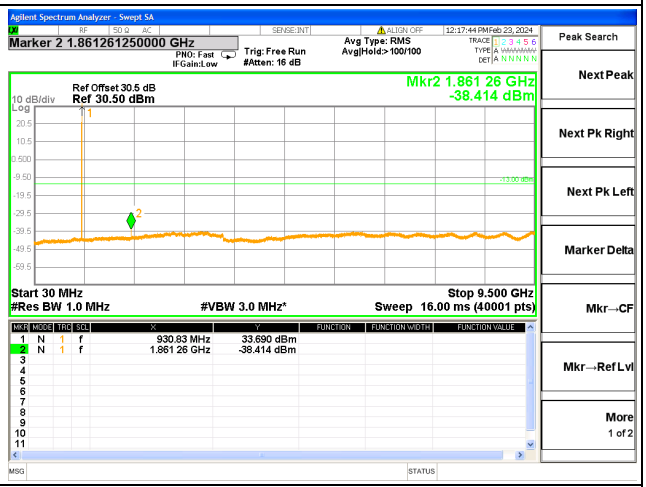
12.5kHz/QPSK	12.5kHz/16QAM
	

12.5kHz/64QAM	12.5kHz/256QAM
	

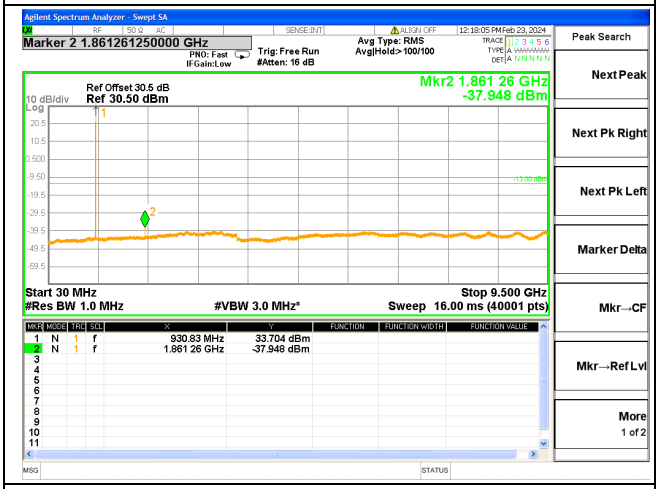
25.0kHz/QPSK



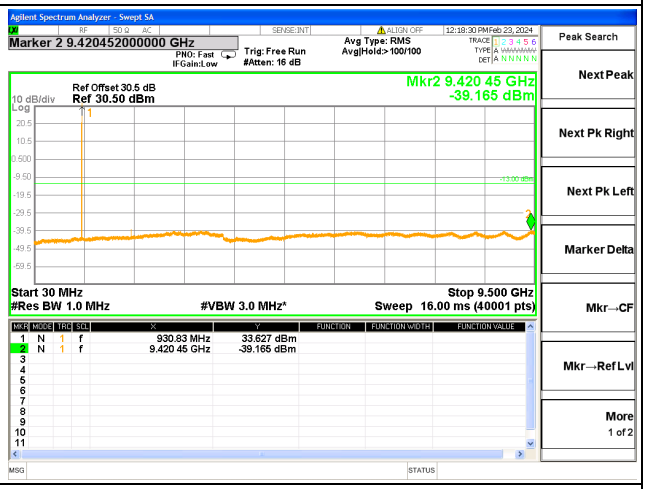
25.0kHz /16QAM



25.0kHz /64QAM

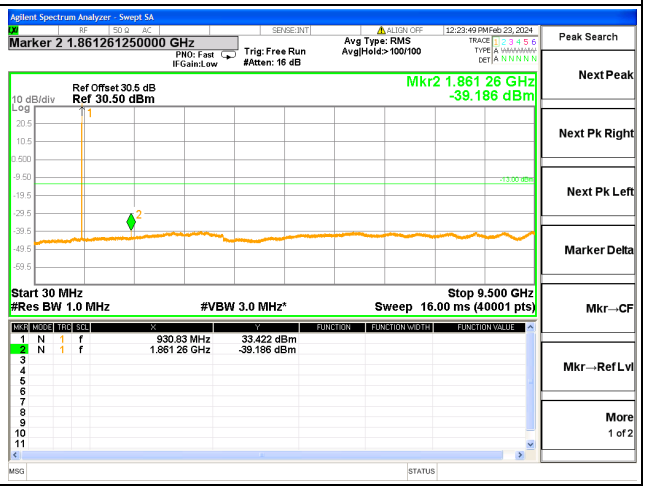


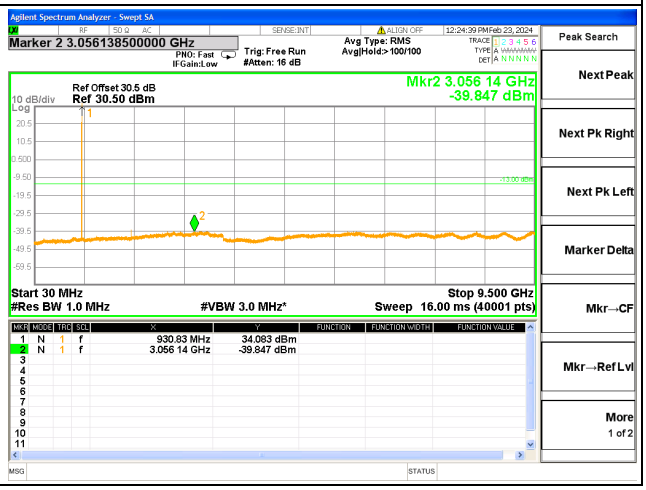
25.0kHz /256QAM



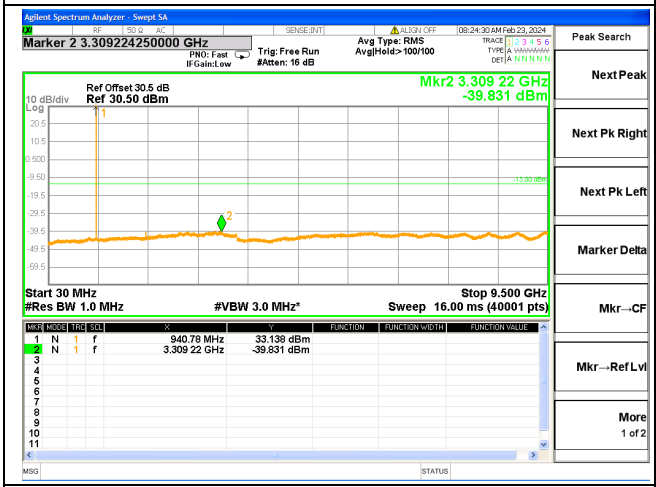
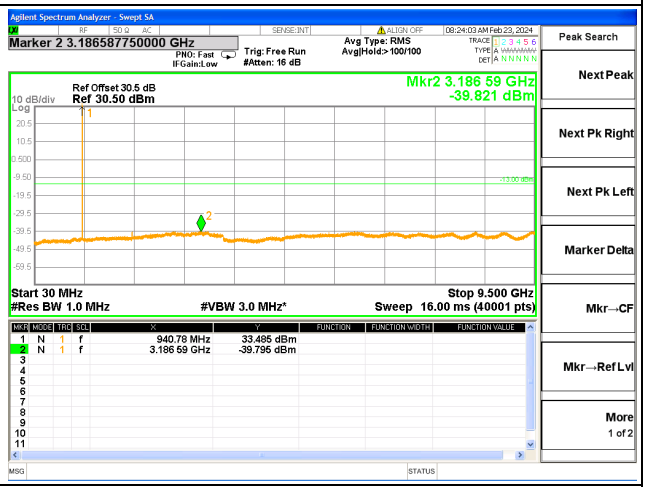
50.0kHz/QPSK

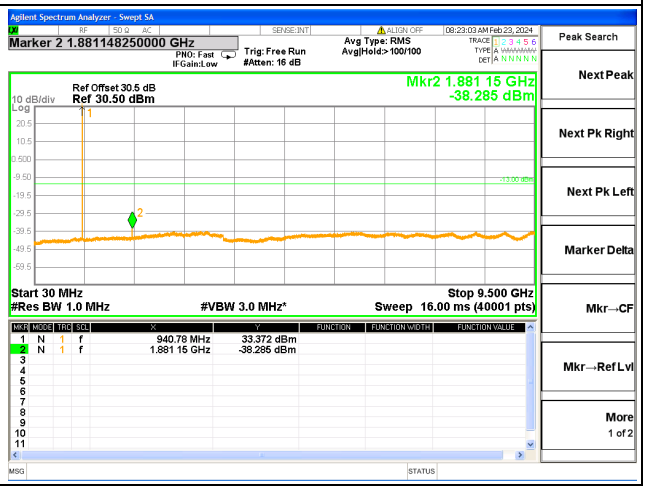
50.0kHz /16QAM



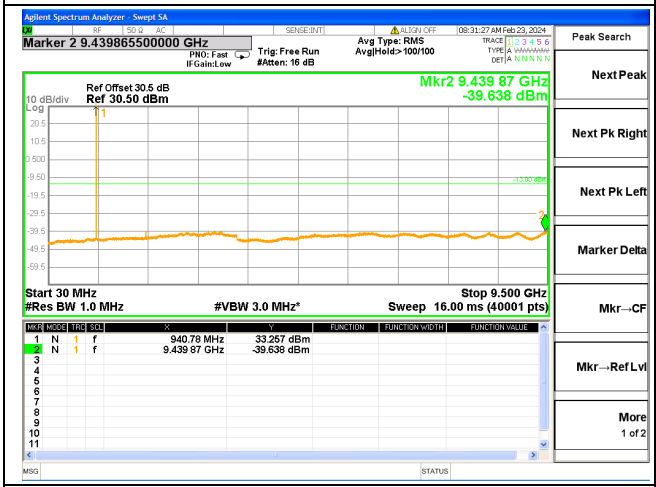
50.0kHz /64QAM	50.0kHz /256QAM
	

Nominal Frequency: 940.50 MHz Tx Port: Channel H

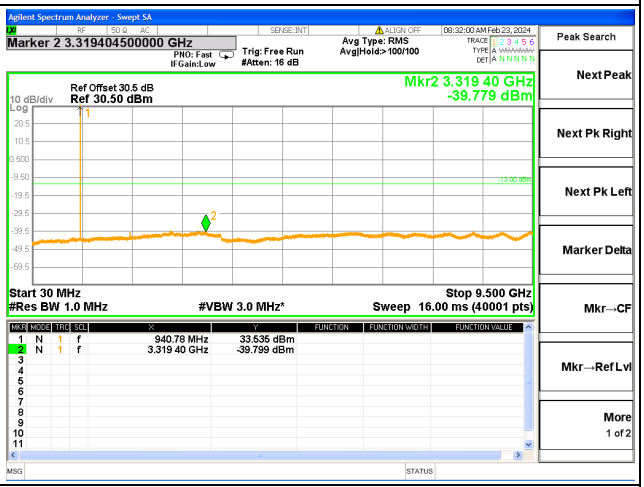
12.5kHz/QPSK	12.5kHz/16QAM
	

12.5kHz/64QAM	12.5kHz/256QAM
	

25.0kHz/QPSK

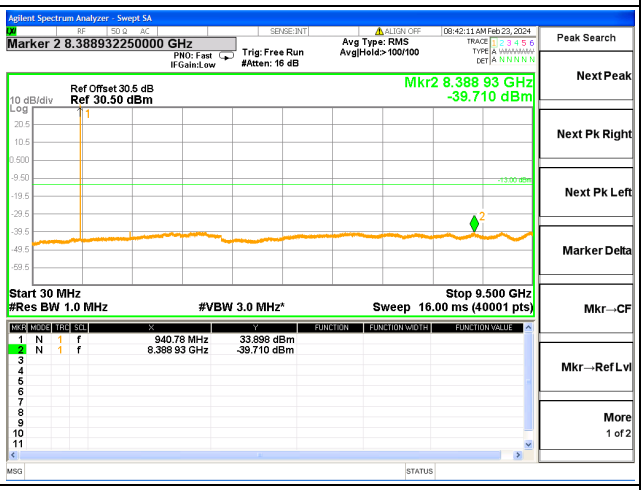


25.0kHz /16QAM



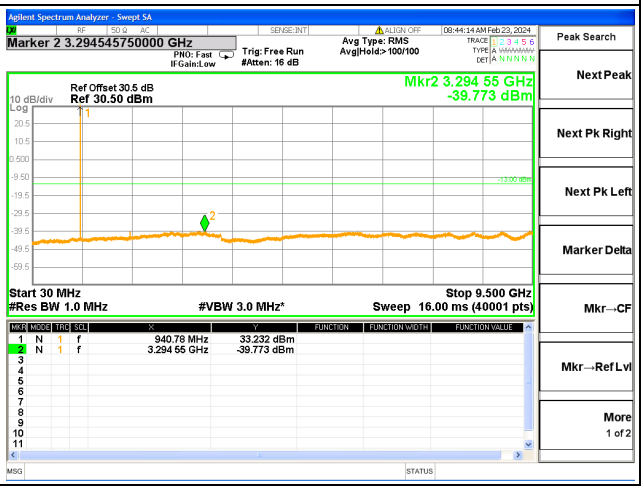
25.0kHz /64QAM

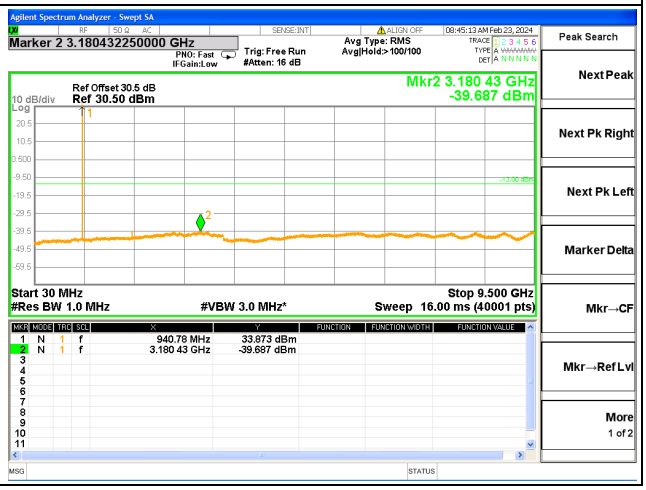
25.0kHz /256QAM



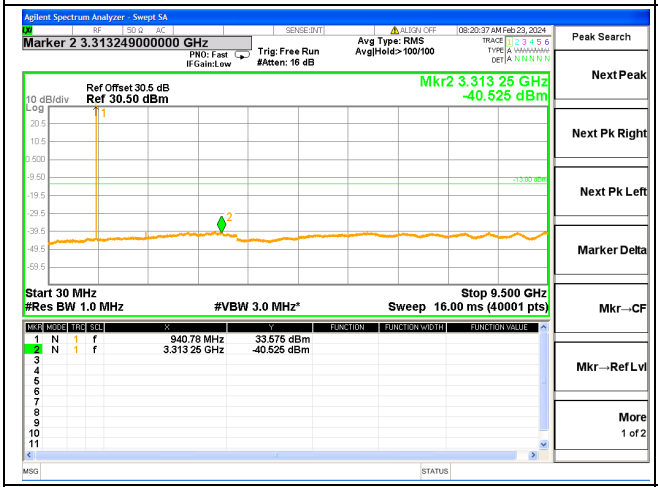
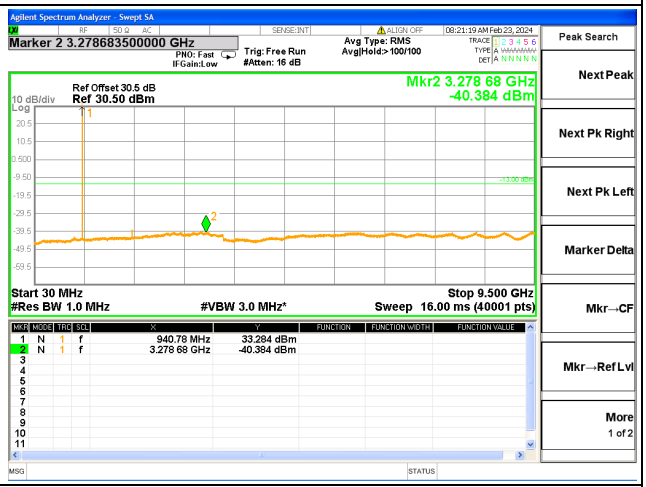
50.0kHz/QPSK

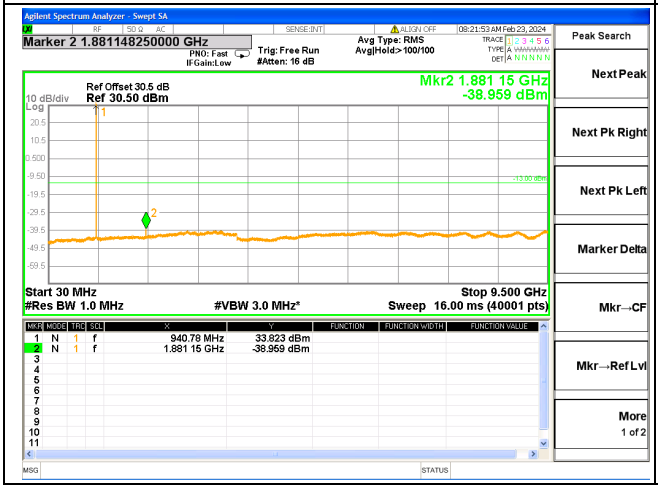
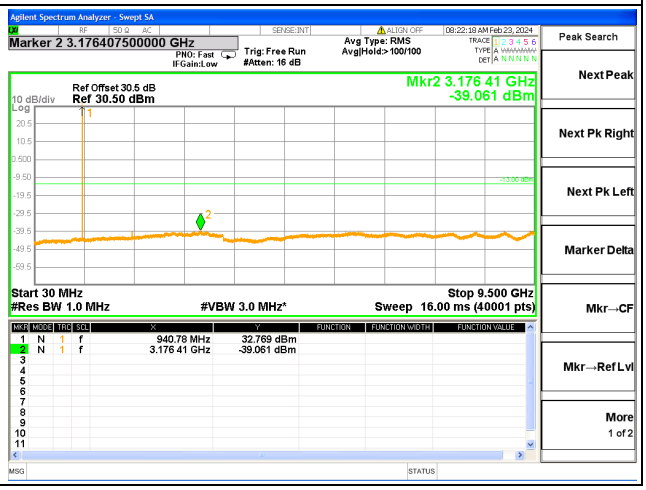
50.0kHz /16QAM



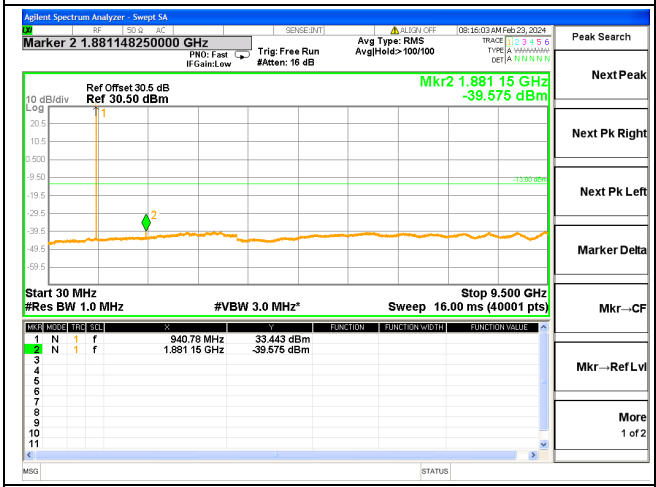
50.0kHz /64QAM	50.0kHz /256QAM
	

Nominal Frequency: 940.50 MHz Tx Port: Channel V

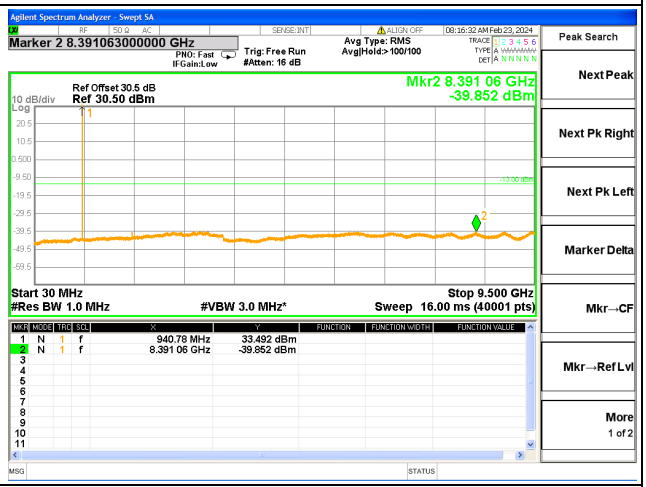
12.5kHz/QPSK	12.5kHz/16QAM
	

12.5kHz/64QAM	12.5kHz/256QAM
	

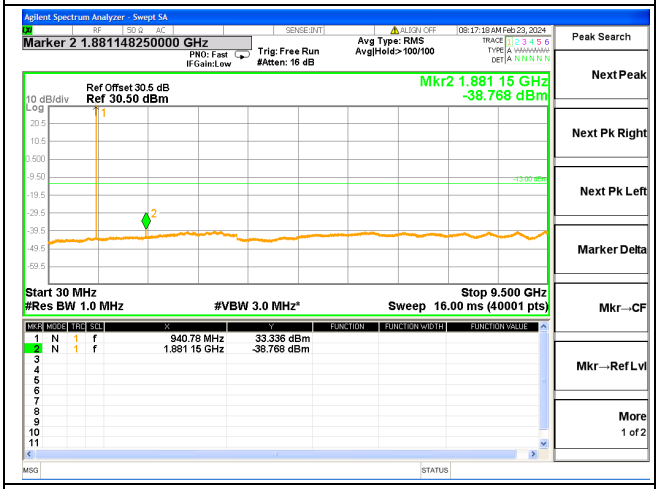
25.0kHz/QPSK



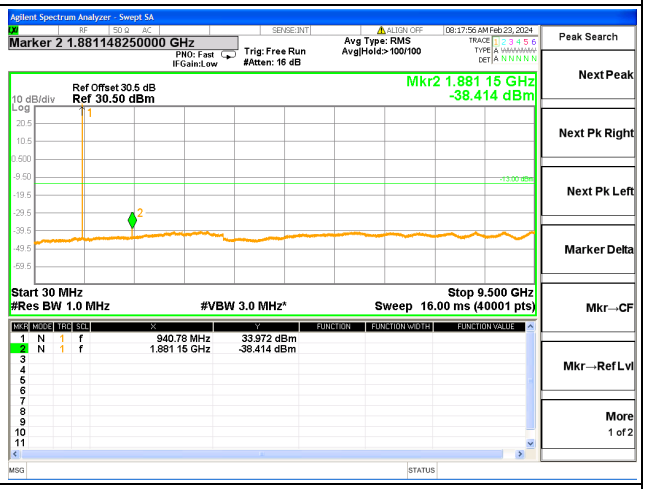
25.0kHz /16QAM



25.0kHz /64QAM



25.0kHz /256QAM



50.0kHz/QPSK

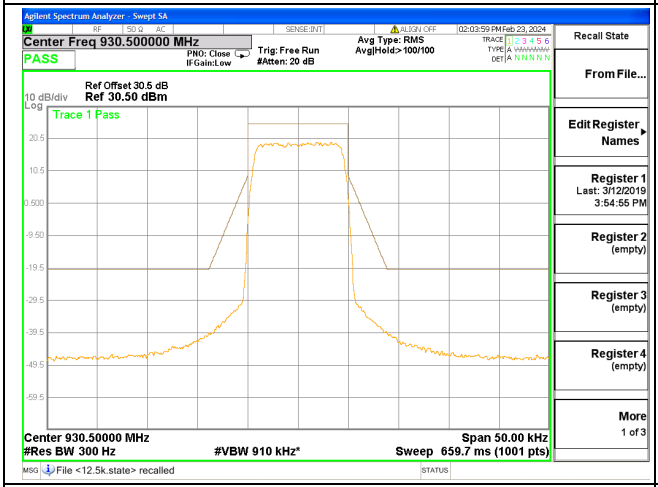
50.0kHz /16QAM

50.0kHz /64QAM

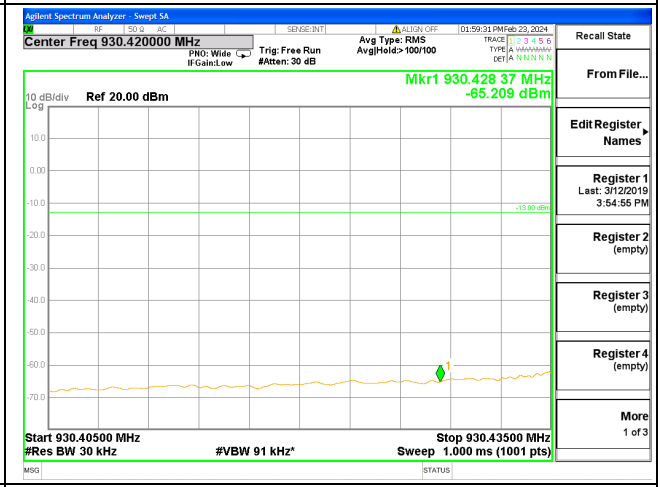
50.0kHz /256QAM

Nominal Frequency: 930.50 MHz Tx Port: Channel H

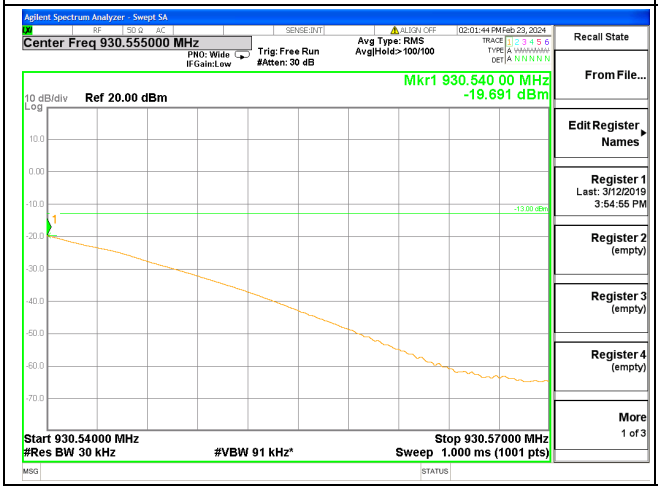
12.5kHz/ QPSK



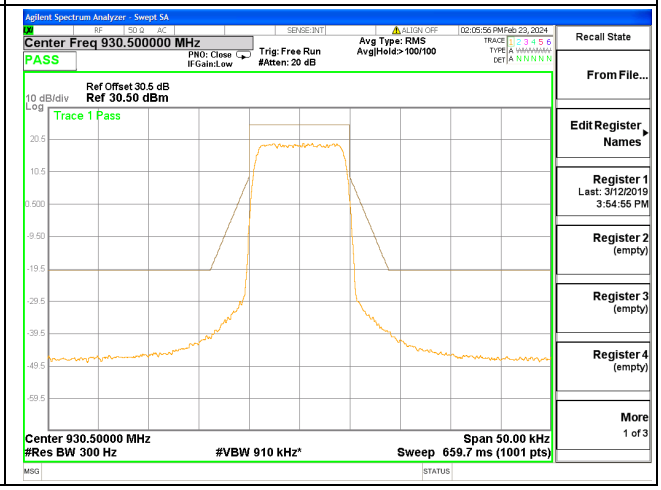
12.5kHz/ QPSK/930.4300 -930.4600 MHz



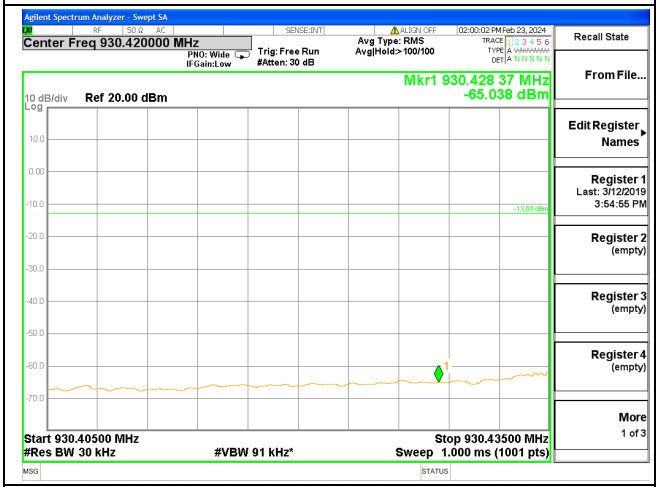
12.5kHz/ QPSK/930.5400 -930.5700 MHz



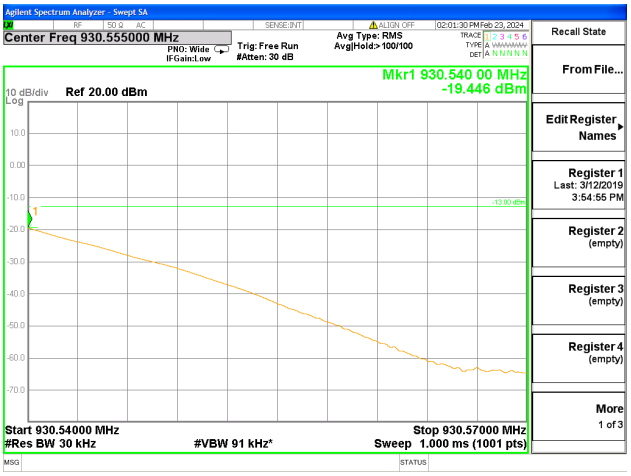
12.5kHz/16QAM



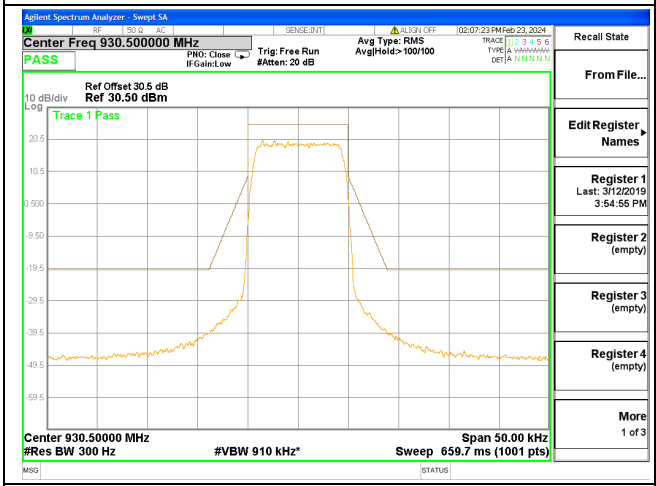
12.5kHz/ 16QAM /930.4300 -930.4600 MHz



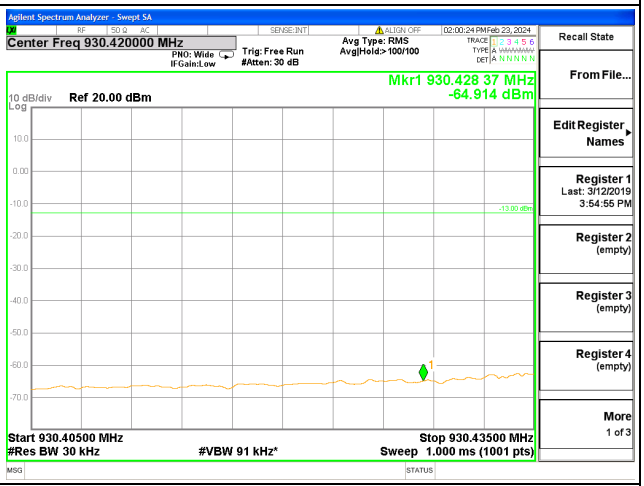
12.5kHz/ 16QAM /930.5400 -930.5700 MHz



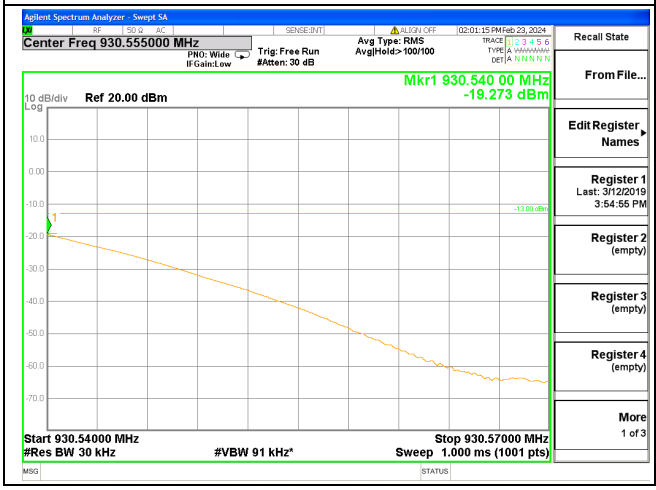
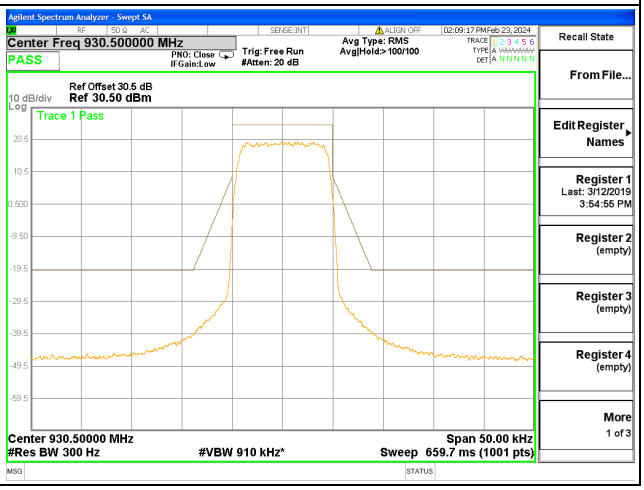
12.5kHz/ 64QAM



12.5kHz/ 64QAM /930.4300 -930.4600 MHz



12.5kHz/ 64QAM /930.5400 -930.5700 MHz



12.5kHz/256QAM