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:	901-902 MHz, 2Tx/2Rx	
Channel Bandwidth:	12.5kHz; 25kHz; 50kHz	
Modulation Type:	QPSK; 16QAM; 64QAM; 256QAM	
Operating Voltage:	10.5-60V	
Antenna Gain:	Omni Antenna	2.5 dBi
		4.0 dBi
		6.0 dBi
	Panel Antenna	8.0 dBi
		10.0 dBi
		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	Gao Jianrou	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.

Note 5: The prototype has two kinds of power under different conditions, we define Type 1 in the case of 28dBm power and Type 2 in the case of 34dBm power.

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

Type 1:

Nominal Frequency: 901.5 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 = 12.0dBi)	
						dBm	Watt	dBm	Watt
12.5	QPSK	24	27.82	0.605	0.63	29.67	0.927	37.67	5.848
12.5	16QAM	24	27.66	0.583	0.63	29.51	0.893	37.51	5.636
12.5	64QAM	24	28.19	0.659	0.63	30.04	1.009	38.04	6.368
12.5	256QAM	24	28.21	0.662	0.63	30.06	1.014	38.06	6.397
25.0	QPSK	24	27.60	0.575	0.63	29.45	0.881	37.45	5.559
25.0	16QAM	24	27.80	0.603	0.63	29.65	0.923	37.65	5.821
25.0	64QAM	24	28.23	0.665	0.63	30.08	1.019	38.08	6.427
25.0	256QAM	24	28.11	0.647	0.63	29.96	0.991	37.96	6.252
50.0	QPSK	24	27.28	0.535	0.63	29.13	0.818	37.13	5.164
50.0	16QAM	24	27.26	0.532	0.63	29.11	0.815	37.11	5.140
50.0	64QAM	24	27.45	0.556	0.63	29.30	0.851	37.30	5.370
50.0	256QAM	24	27.67	0.585	0.63	29.52	0.895	37.52	5.649

Nominal Frequency: 901.5 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 = 12.0dBi)	
						dBm	Watt	dBm	Watt
12.5	QPSK	24	27.99	0.630	0.63	29.84	0.964	37.84	6.081
12.5	16QAM	24	27.76	0.597	0.63	29.61	0.914	37.61	5.768
12.5	64QAM	24	28.25	0.668	0.63	30.10	1.023	38.10	6.457
12.5	256QAM	24	28.29	0.675	0.63	30.14	1.033	38.14	6.516
25.0	QPSK	24	28.19	0.659	0.63	30.04	1.009	38.04	6.368

25.0	16QAM	24	28.05	0.638	0.63	29.90	0.977	37.90	6.166
25.0	64QAM	24	27.94	0.622	0.63	29.79	0.953	37.79	6.012
25.0	256QAM	24	28.31	0.678	0.63	30.16	1.038	38.16	6.546
50.0	QPSK	24	28.00	0.631	0.63	29.85	0.966	37.85	6.095
50.0	16QAM	24	27.84	0.608	0.63	29.69	0.931	37.69	5.875
50.0	64QAM	24	28.05	0.638	0.63	29.90	0.977	37.90	6.166
50.0	256QAM	24	28.43	0.697	0.63	30.28	1.067	38.28	6.730

Type 2:

Nominal Frequency: 901.5 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 = 6.0dBi)	
						dBm	Watt	dBm	Watt
12.5	QPSK	24	33.66	2.323	2.50	35.51	3.556	37.51	5.636
12.5	16QAM	24	33.61	2.296	2.50	35.46	3.516	37.46	5.572
12.5	64QAM	24	33.91	2.460	2.50	35.76	3.767	37.76	5.970
12.5	256QAM	24	33.72	2.355	2.50	35.57	3.606	37.57	5.715
25.0	QPSK	24	34.02	2.523	2.50	35.87	3.864	37.87	6.124
25.0	16QAM	24	33.77	2.382	2.50	35.62	3.648	37.62	5.781
25.0	64QAM	24	34.08	2.559	2.50	35.93	3.917	37.93	6.209
25.0	256QAM	24	33.91	2.460	2.50	35.76	3.767	37.76	5.970
50.0	QPSK	24	33.73	2.360	2.50	35.58	3.614	37.58	5.728
50.0	16QAM	24	33.91	2.460	2.50	35.76	3.767	37.76	5.970
50.0	64QAM	24	33.83	2.415	2.50	35.68	3.698	37.68	5.861
50.0	256QAM	24	34.12	2.582	2.50	35.97	3.954	37.97	6.266

Nominal Frequency: 901.5 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 = 6.0dBi)	
						dBm	Watt	dBm	Watt
12.5	QPSK	24	33.90	2.455	2.50	35.75	3.758	37.75	5.957
12.5	16QAM	24	33.74	2.366	2.50	35.59	3.622	37.59	5.741
12.5	64QAM	24	34.10	2.570	2.50	35.95	3.936	37.95	6.237
12.5	256QAM	24	33.75	2.371	2.50	35.60	3.631	37.60	5.754

25.0	QPSK	24	33.49	2.234	2.50	35.34	3.420	37.34	5.420
25.0	16QAM	24	33.56	2.270	2.50	35.41	3.475	37.41	5.508
25.0	64QAM	24	33.85	2.427	2.50	35.70	3.715	37.70	5.888
25.0	256QAM	24	33.82	2.410	2.50	35.67	3.690	37.67	5.848
50.0	QPSK	24	34.09	2.564	2.50	35.94	3.926	37.94	6.223
50.0	16QAM	24	34.14	2.594	2.50	35.99	3.972	37.99	6.295
50.0	64QAM	24	34.16	2.606	2.50	36.01	3.990	38.01	6.324
50.0	256QAM	24	34.18	2.618	2.50	36.03	4.009	38.03	6.353

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 0.7B 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.

Stations transmitting in the 901-902 MHz band are limited to 7 watts e.r.p.

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: This product is based on the interactive calculation of erp limits and conducted power. In the 901-902MHz range, an antenna with a maximum gain of 12dBi can be used when the conducted power is 28dBm, or an antenna with a maximum gain of 6dBi can be used when the conducted power is 34dBm to meet the erp requirements.

2.2. Occupied Bandwidth

2.2.1. Definition

Emission Designator:

Frequency (MHz)	BW(kHz)	Designator
901-902MHz	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.

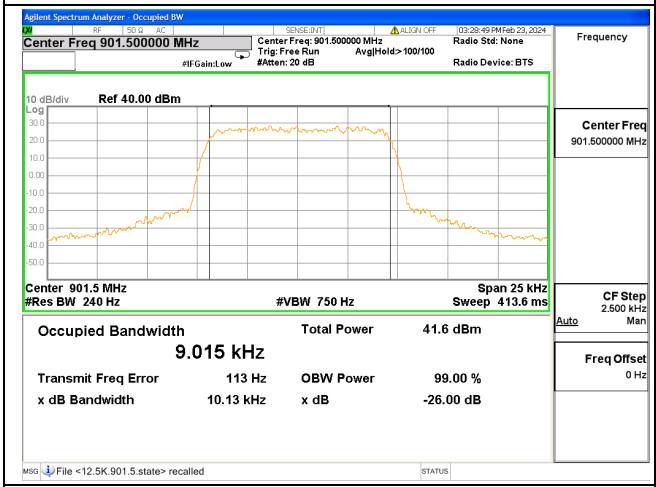
2.2.2. Test Description

Measurements have been made of each modulation type using a spectrum analyzer operating in occupied bandwidth mode.

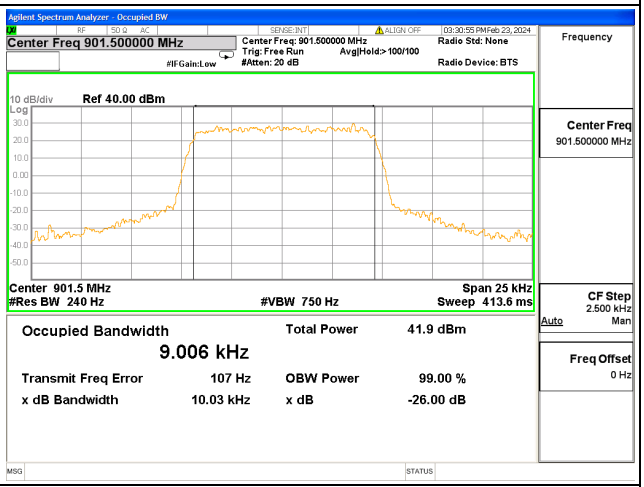
2.2.3. Test Result

901.50 MHz			
Tx Port	**Channel Bandwidth(kHz)**	**Emission Type**	**Occupied Bandwidth(kHz)**
H	12.5	QPSK	9.015
		16QAM	9.006
		64QAM	8.990
		256QAM	8.970
	25.0	QPSK	18.817
		16QAM	18.751
		64QAM	18.757
		256QAM	18.757
	50.0	QPSK	41.557
		16QAM	41.656
		64QAM	41.943
		256QAM	41.277
V	12.5	QPSK	9.005
		16QAM	9.008
		64QAM	8.993
		256QAM	9.018
	25.0	QPSK	18.816
		16QAM	18.689
		64QAM	18.927
		256QAM	18.717
	50.0	QPSK	41.156
		16QAM	41.095
		64QAM	41.203
		256QAM	41.325

901.50MHz/Channel H/12.5kHz/QPSK



901.50MHz/Channel H/12.5kHz/16QAM



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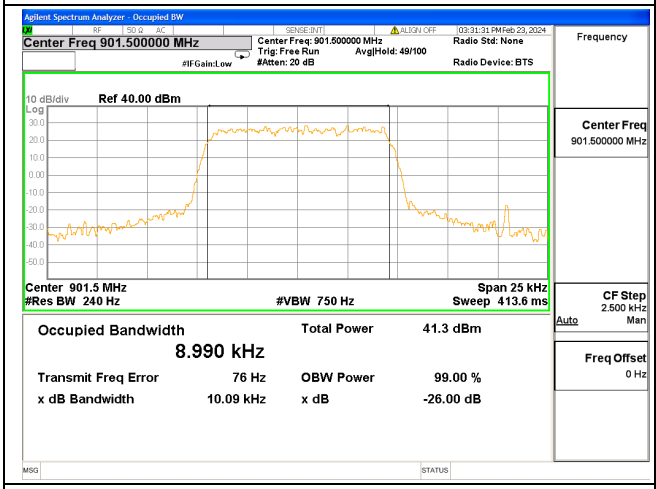

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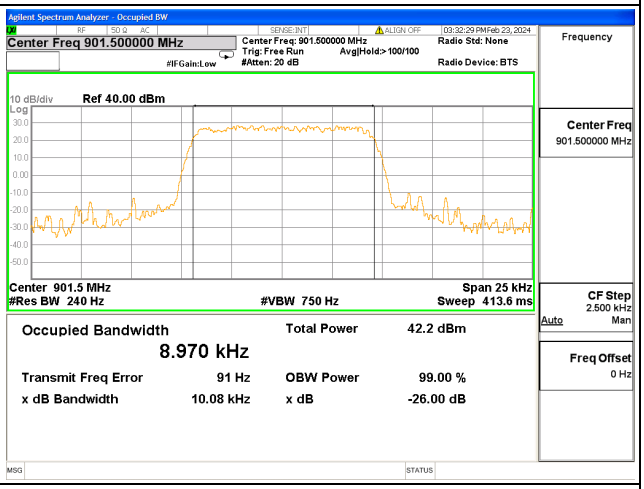

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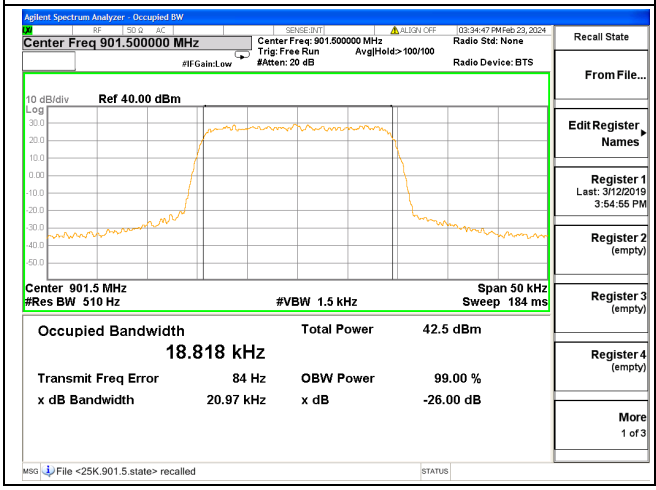

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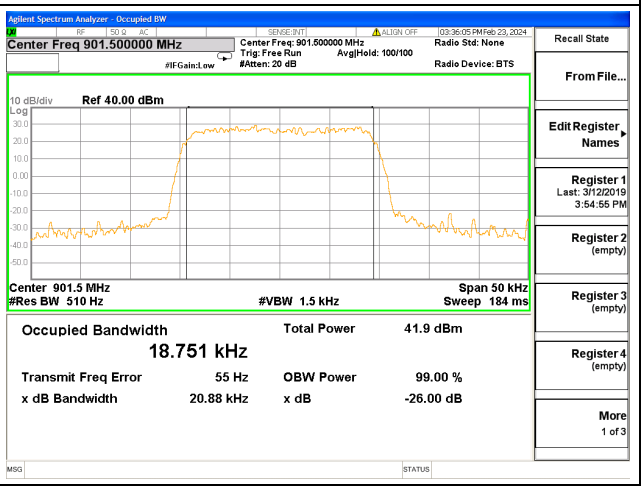

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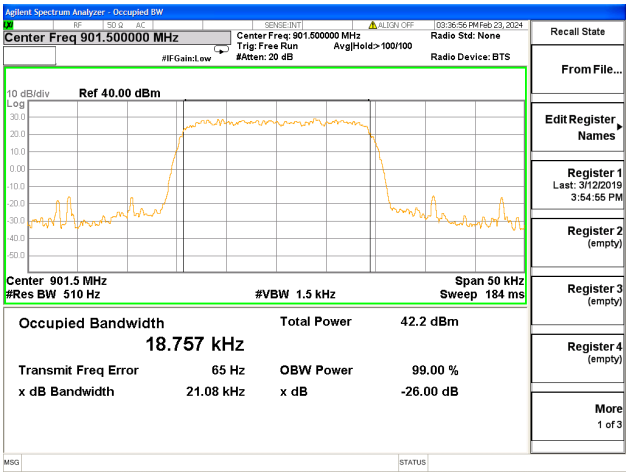

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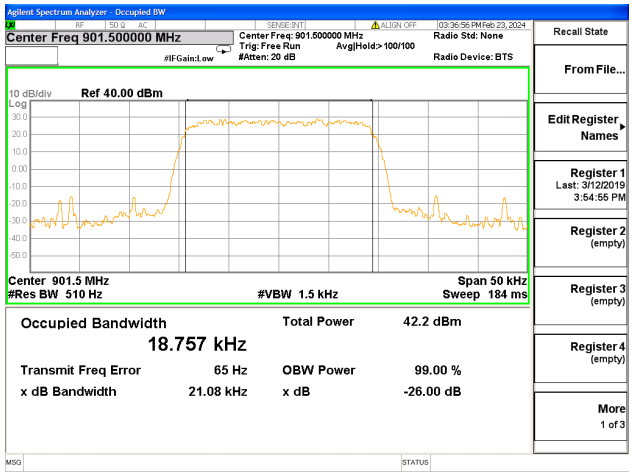

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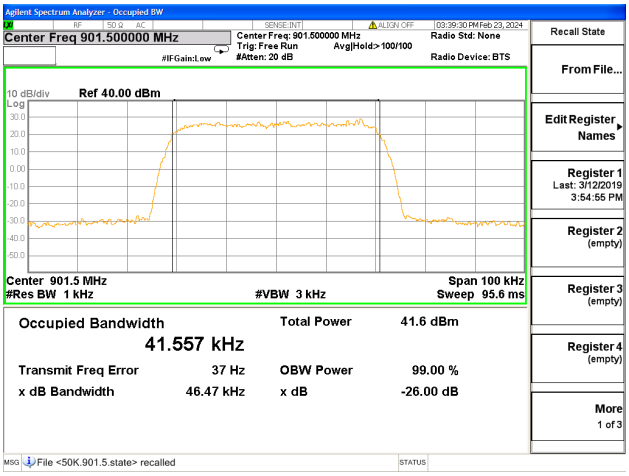

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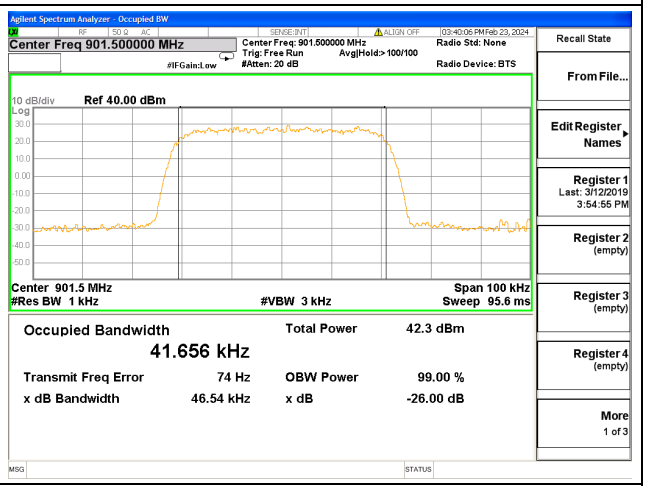

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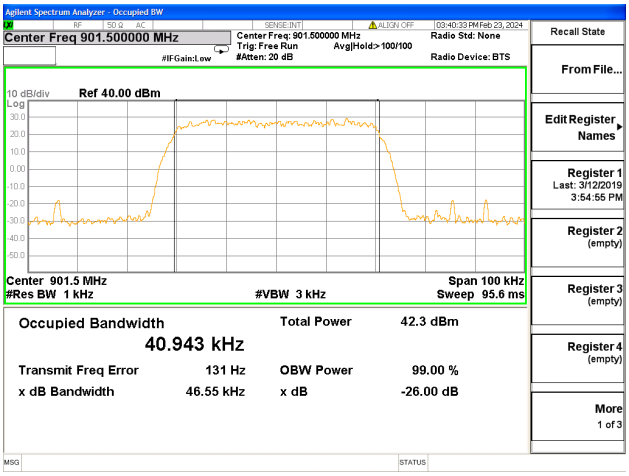

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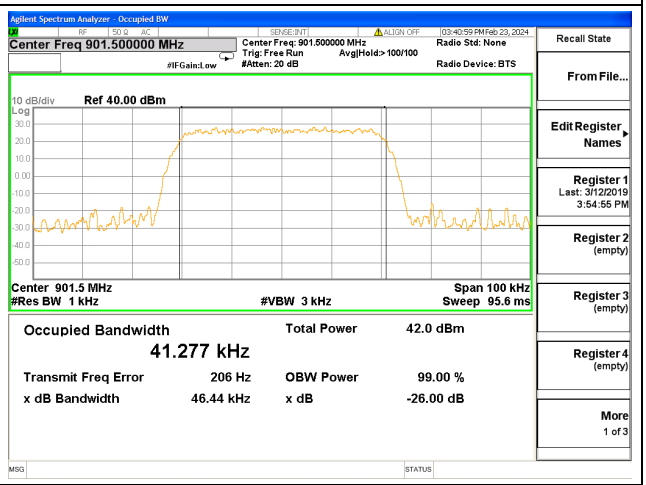
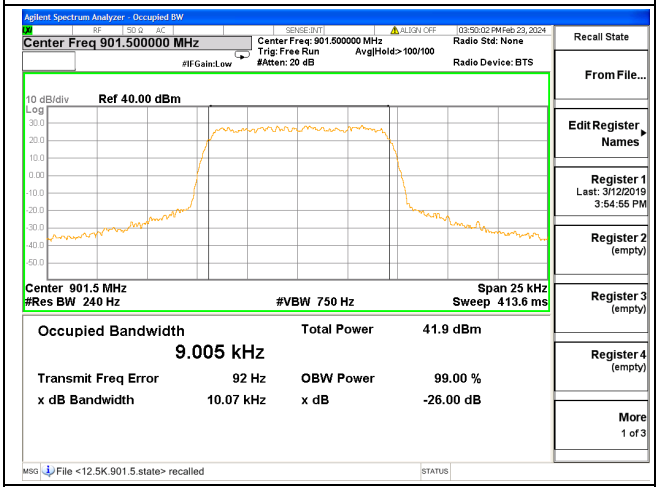


901.50MHz/Channel V/12.5kHz/QPSK



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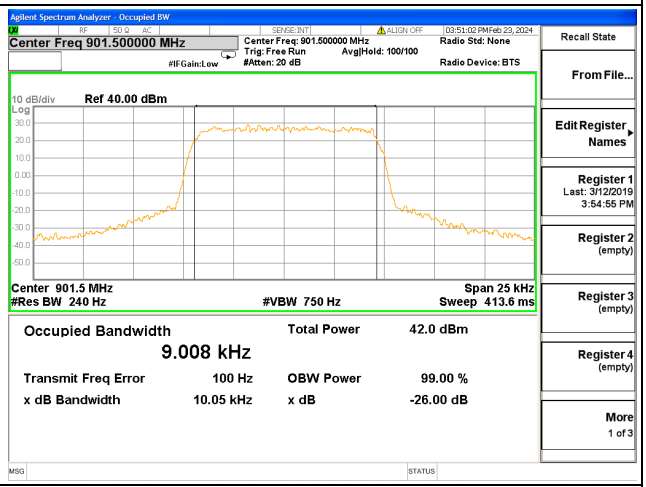

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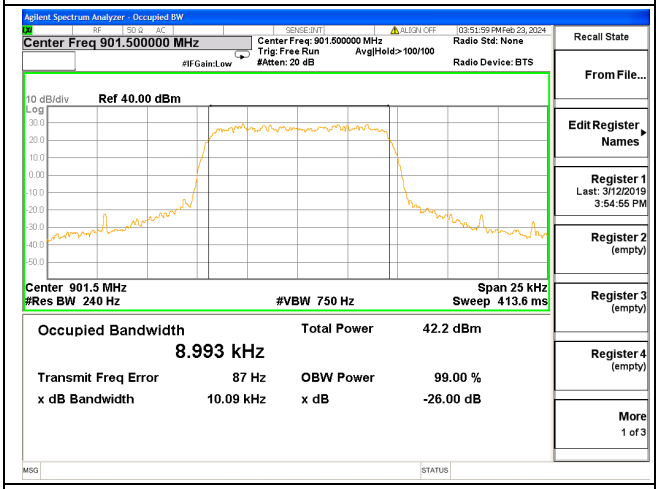

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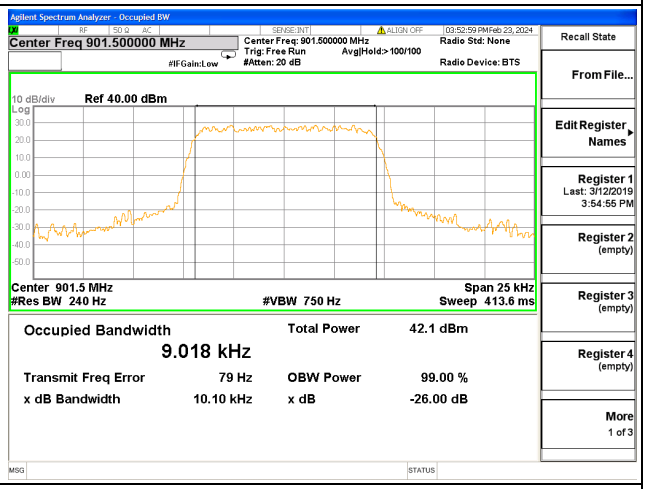

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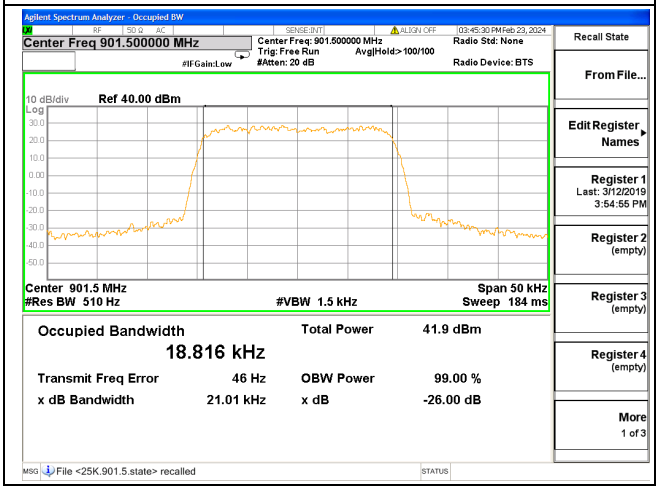

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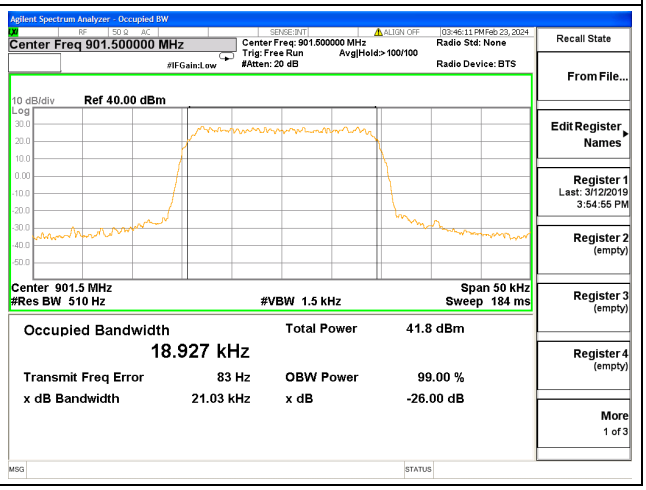

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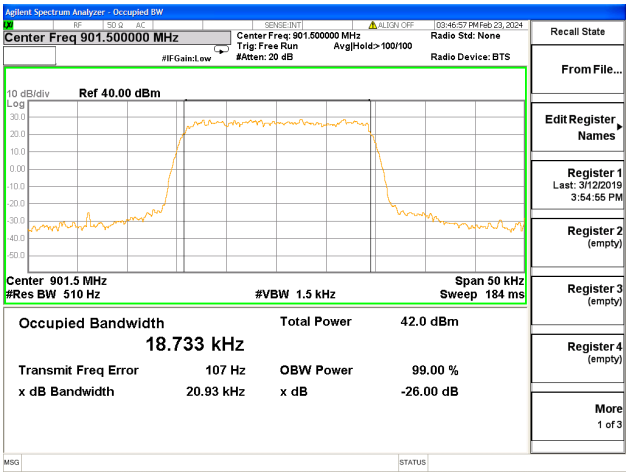

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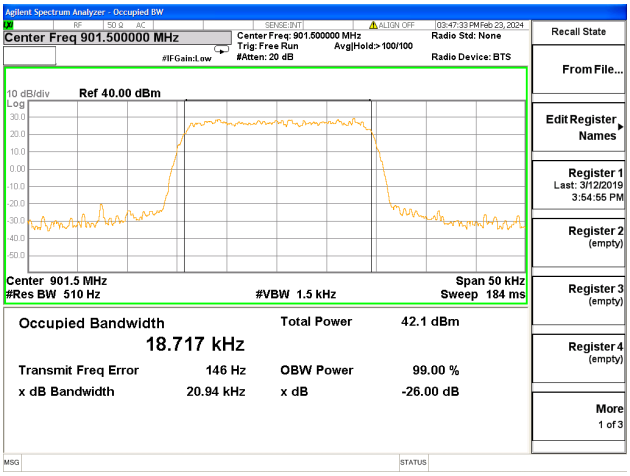
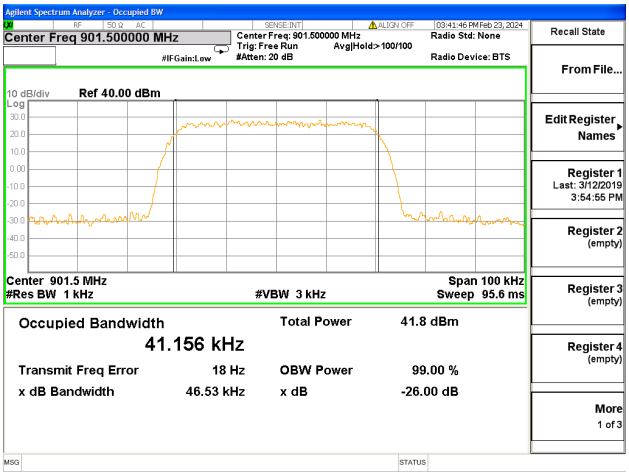
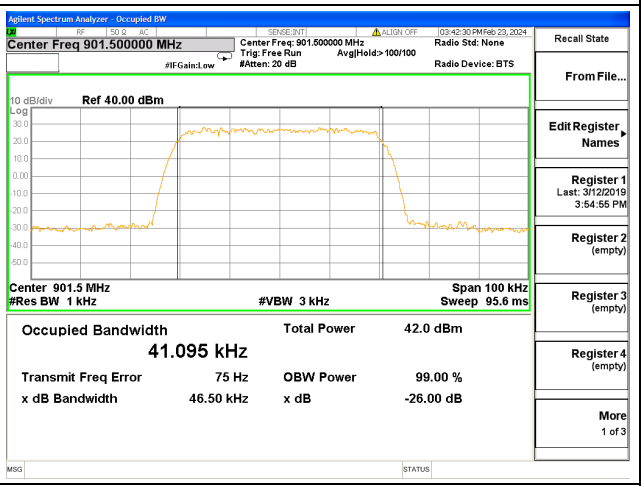


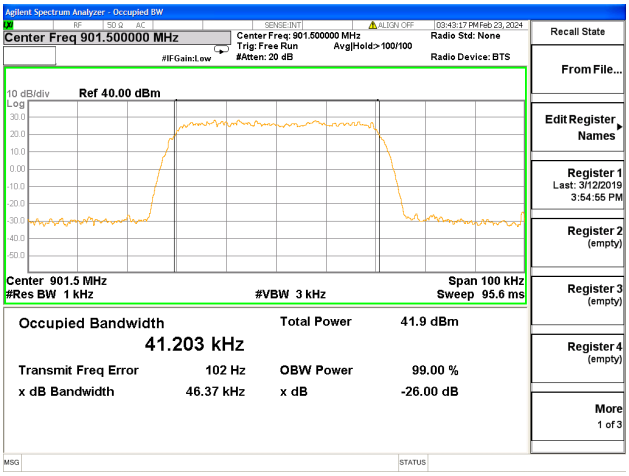
901.50MHz/Channel V/50.0 kHz/QPSK



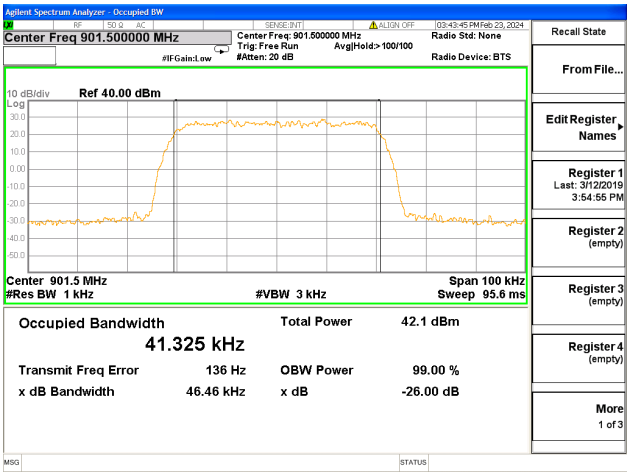
901.50MHz/Channel V/50.0 kHz/16QAM



901.50MHz/Channel V/50.0 kHz/64QAM



901.50MHz/Channel V/50.0 kHz/256QAM



2.3. Spurious Emissions At Antenna Terminals

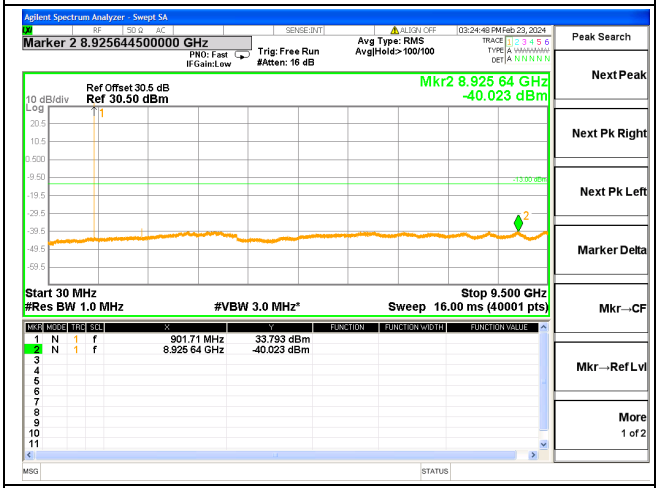
2.3.1. Test Requirement

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.

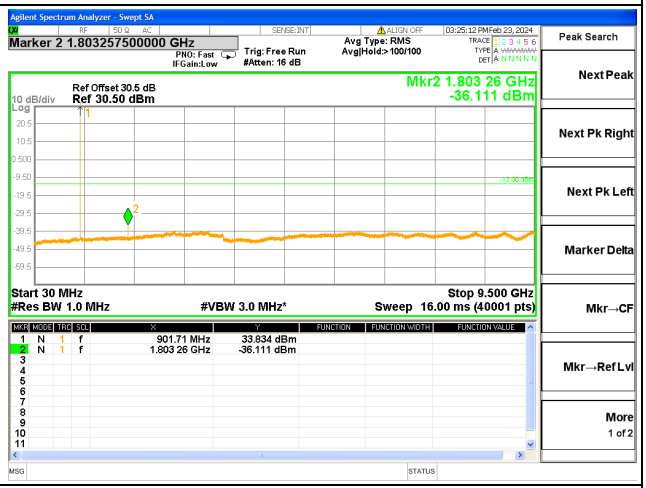
2.3.2. Test Result

Nominal Frequency: 901.50 MHz Tx Port: Channel H

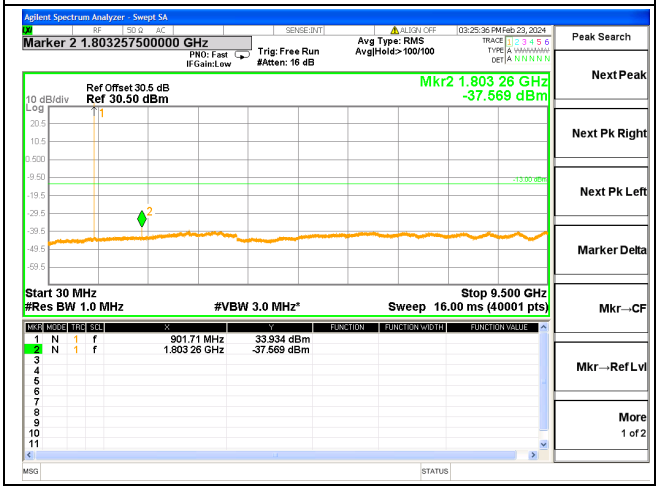
12.5kHz/QPSK



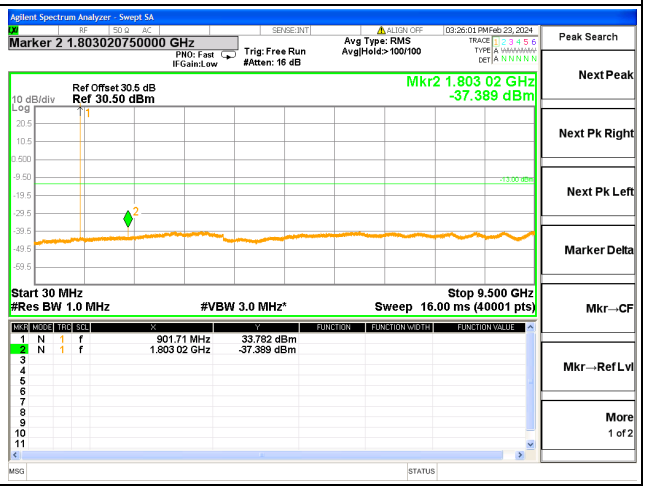
12.5kHz/16QAM



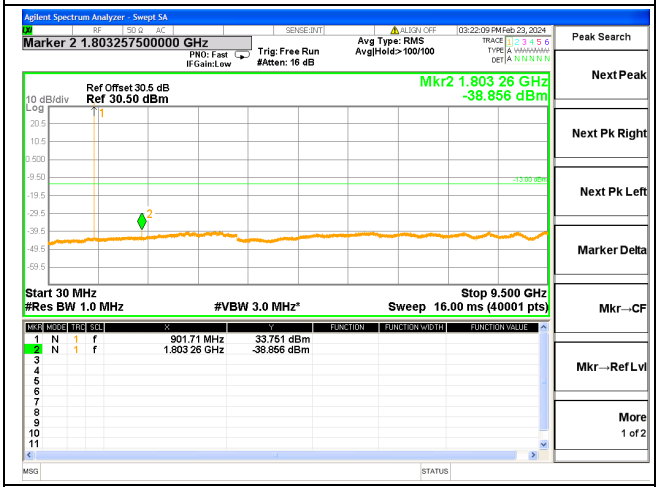
12.5kHz/64QAM



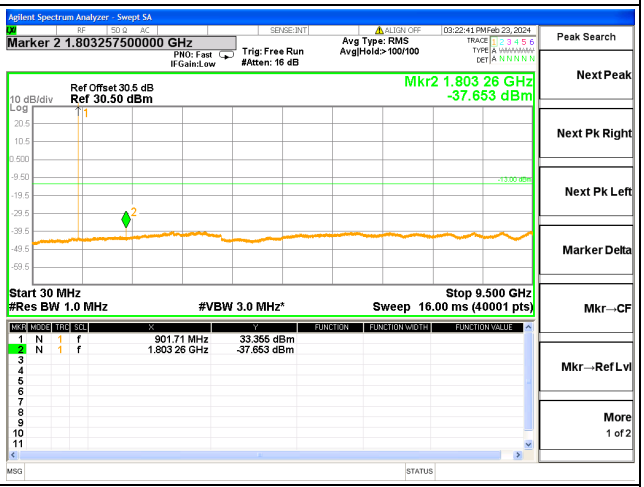
12.5kHz/256QAM



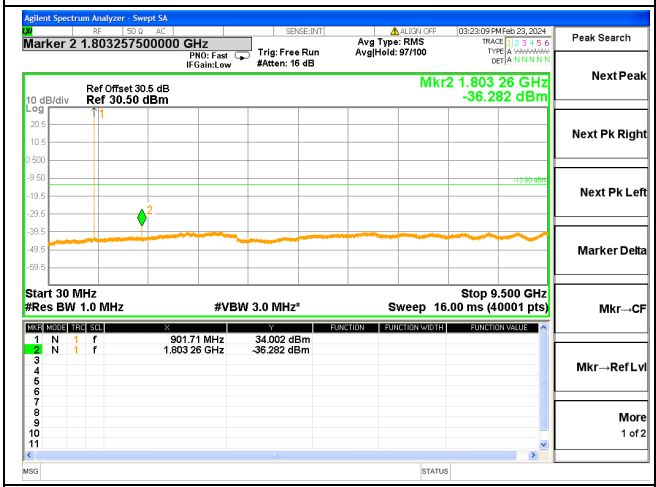
25.0kHz/QPSK



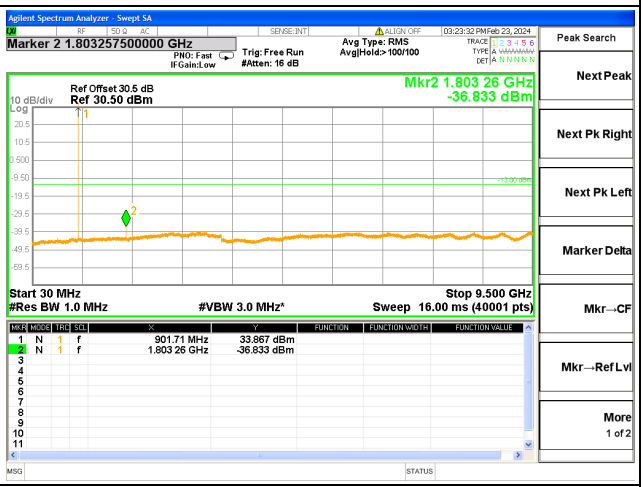
25.0kHz /16QAM



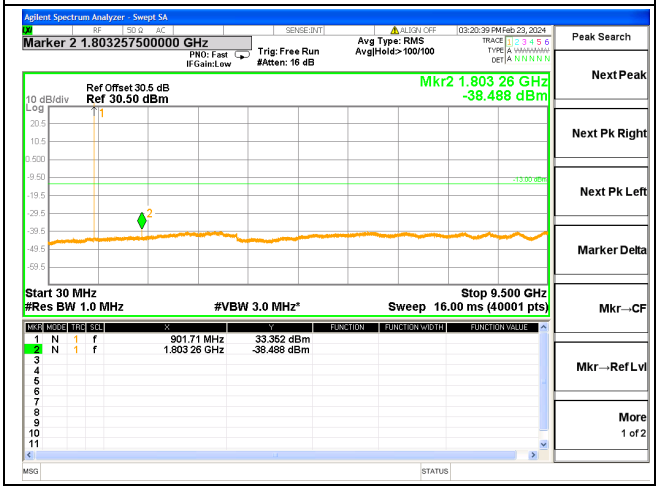
25.0kHz /64QAM



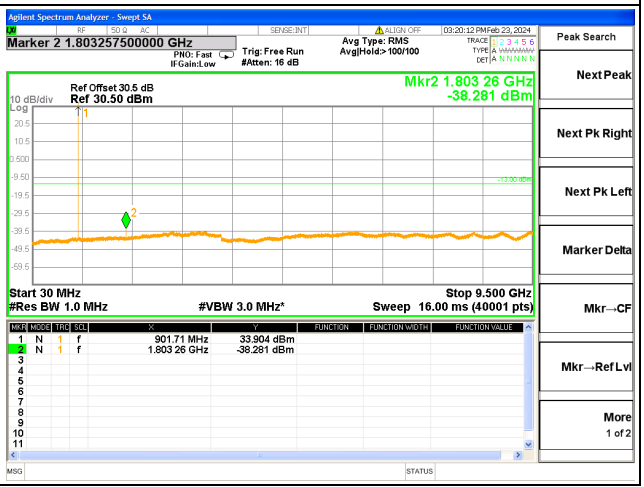
25.0kHz /256QAM

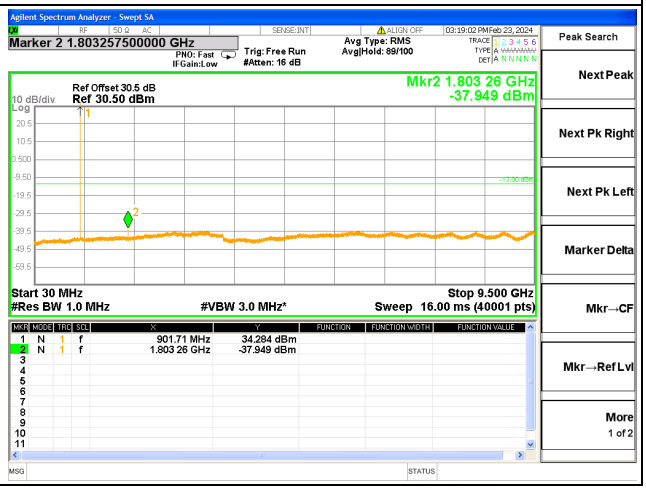


50.0kHz/QPSK

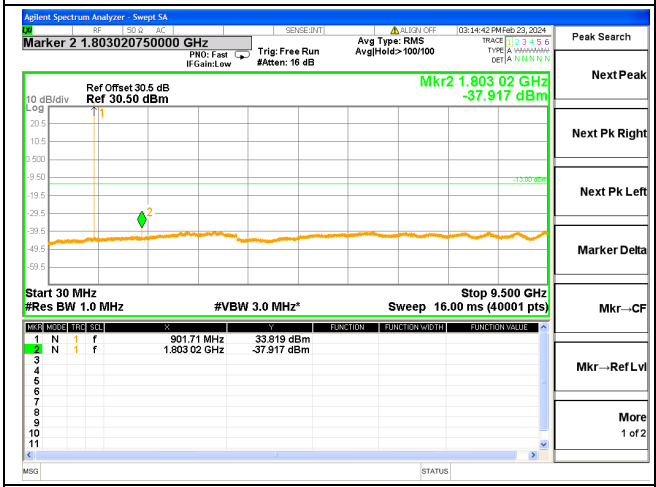
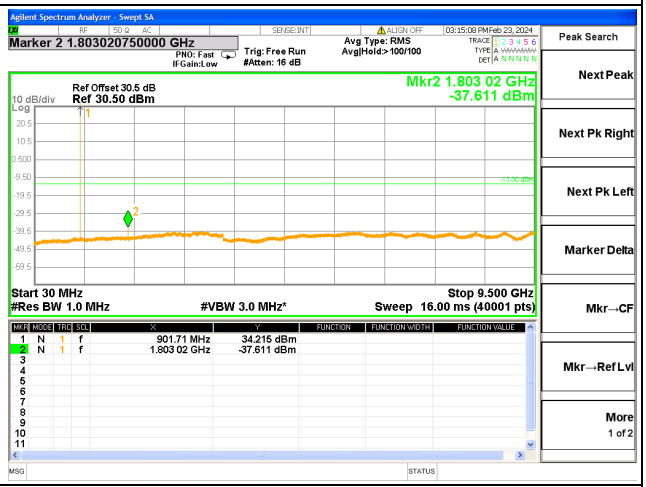


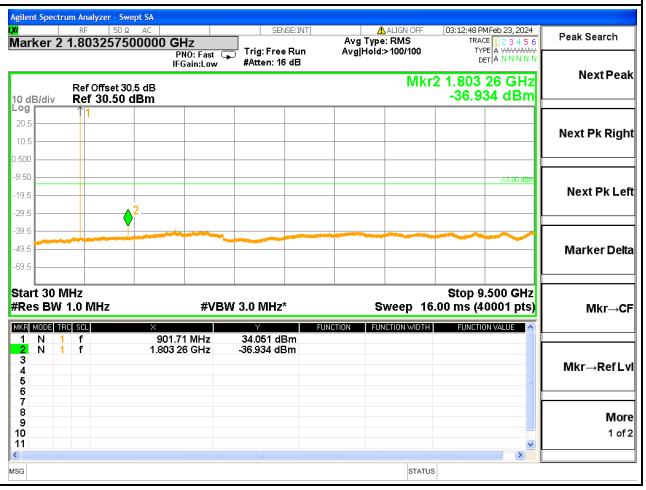
50.0kHz /16QAM



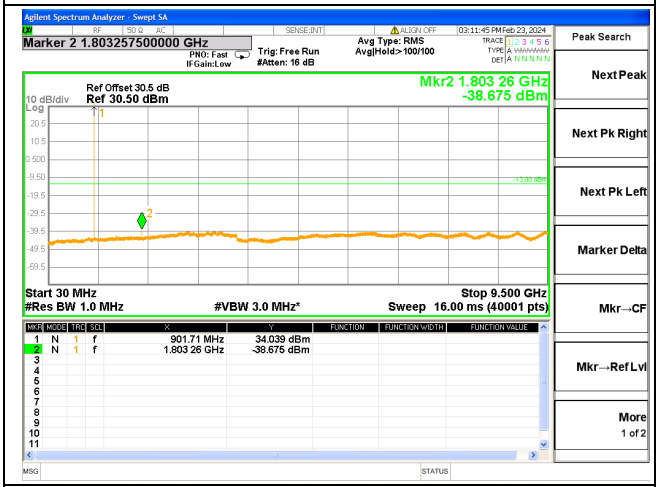
50.0kHz /64QAM	50.0kHz /256QAM
	

Nominal Frequency: 901.50 MHz Tx Port: Channel V

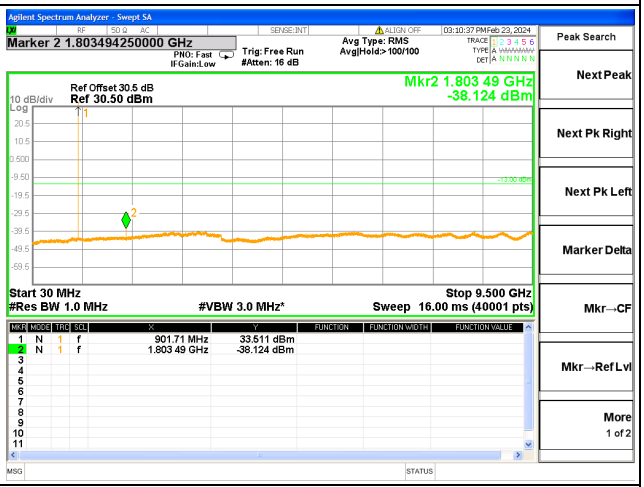
12.5kHz/QPSK	12.5kHz/16QAM
	

12.5kHz/64QAM	12.5kHz/256QAM
	

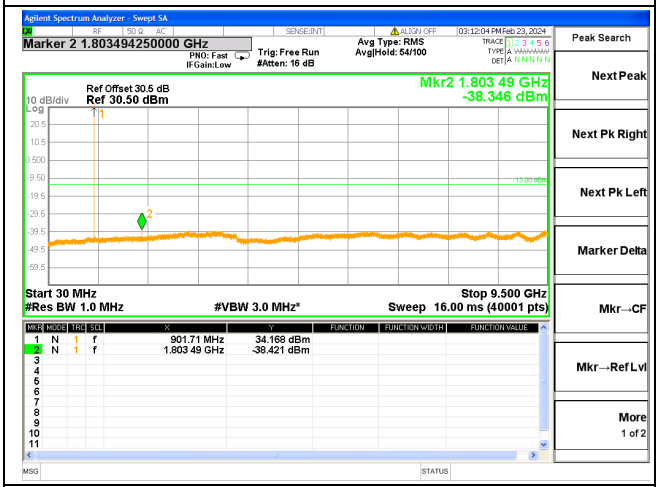
25.0kHz/QPSK



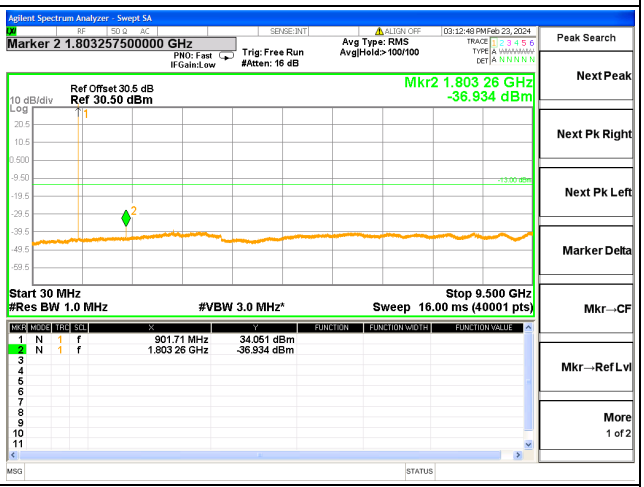
25.0kHz /16QAM



25.0kHz /64QAM

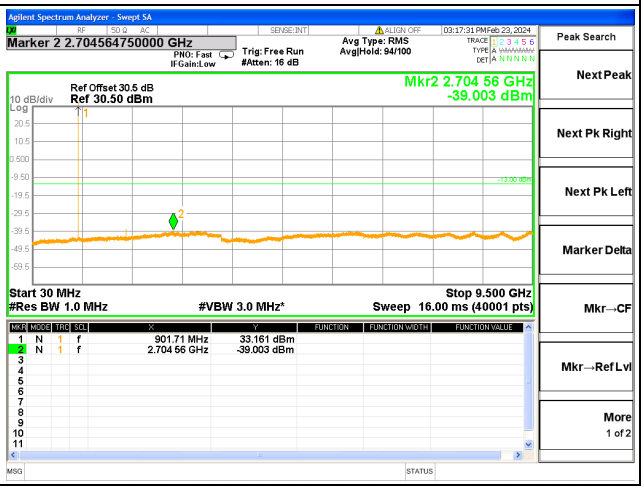


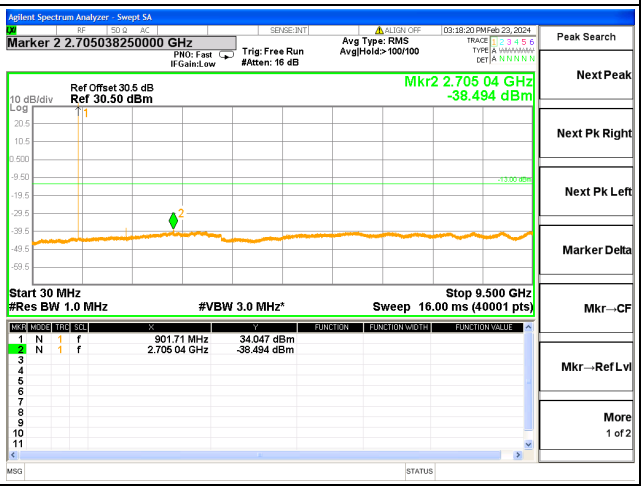
25.0kHz /256QAM



50.0kHz/QPSK

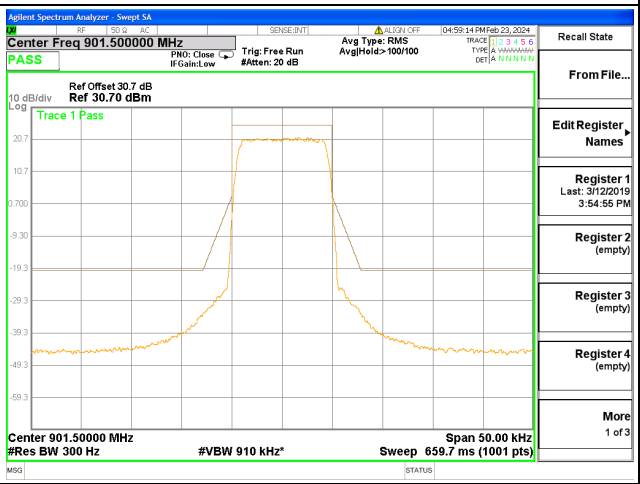
50.0kHz /16QAM



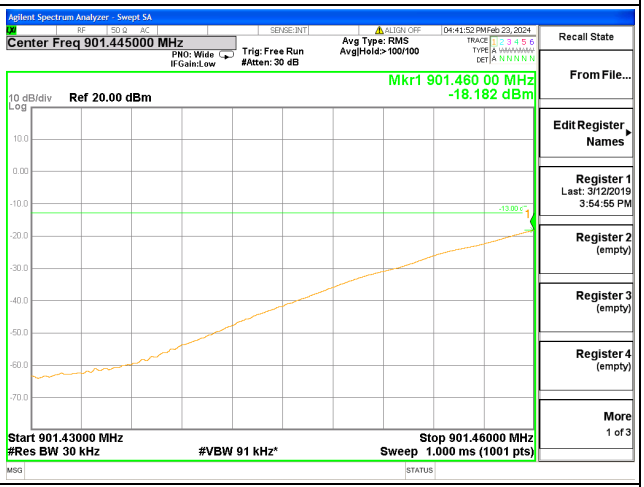
50.0kHz /64QAM	50.0kHz /256QAM
	

Nominal Frequency: 901.50 MHz Tx Port: Channel H

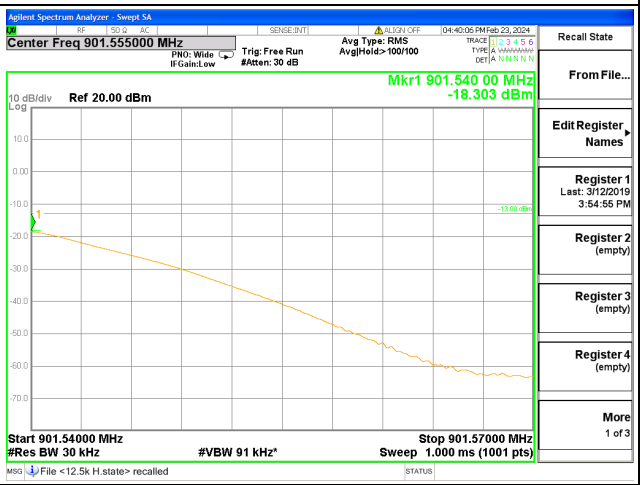
12.5kHz/ QPSK



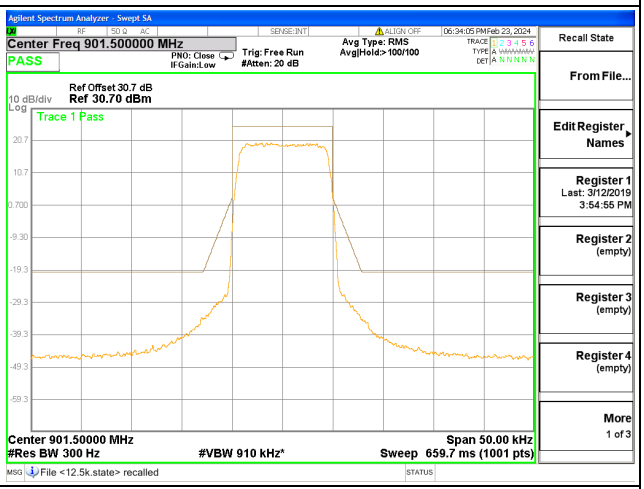
12.5kHz/ QPSK/901.4300 -901.4600 MHz



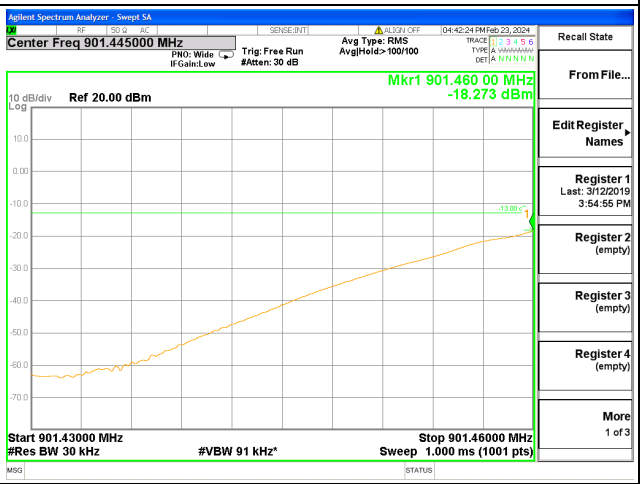
12.5kHz/ QPSK/901.5400 -901.5700 MHz



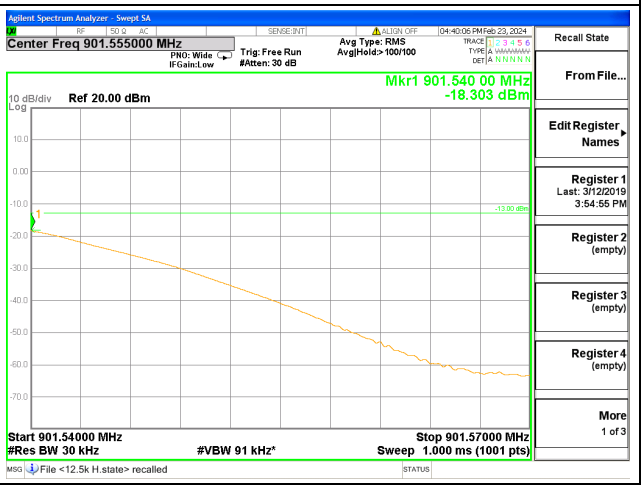
12.5kHz/16QAM



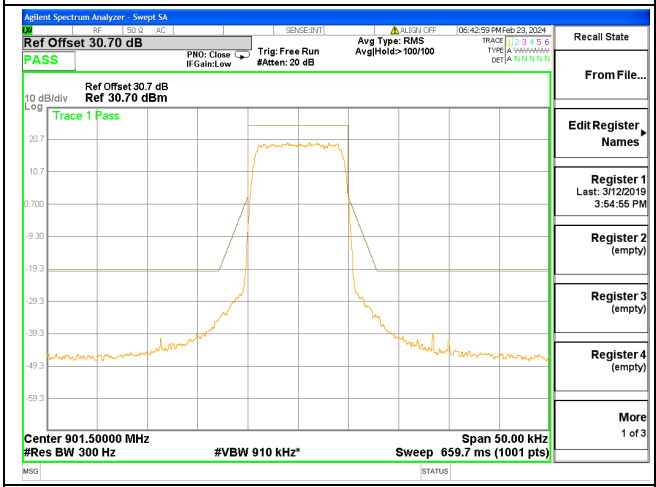
12.5kHz/ 16QAM /901.4300 -901.4600 MHz



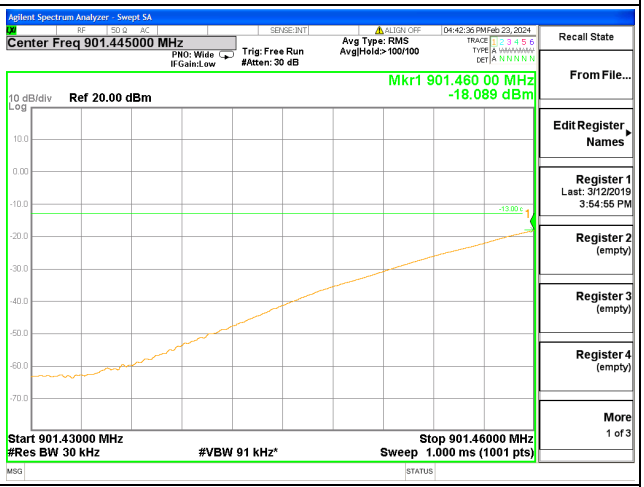
12.5kHz/ 16QAM /901.5400 -901.5700 MHz



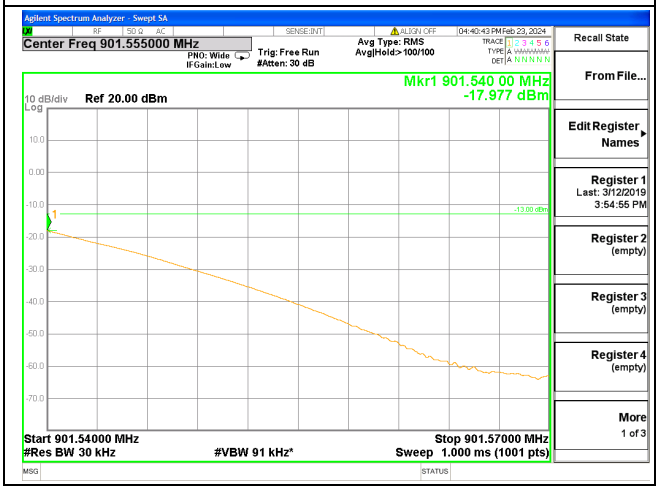
12.5kHz/ 64QAM



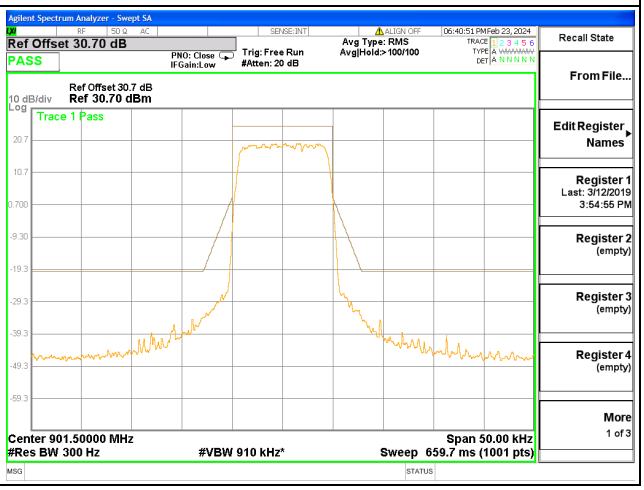
12.5kHz/ 64QAM /901.4300 -901.4600 MHz



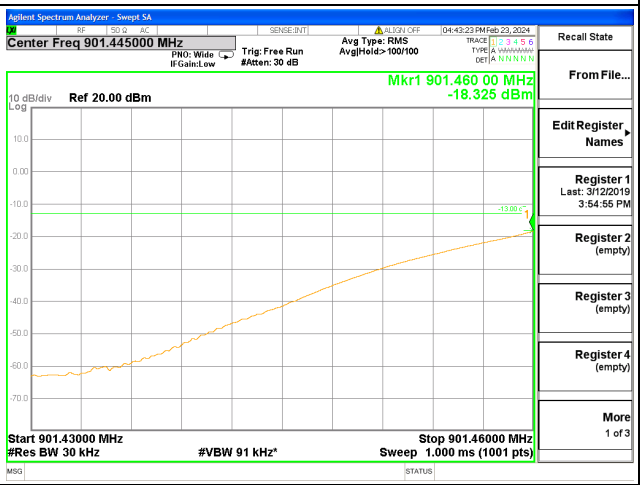
12.5kHz/ 64QAM /901.5400 -901.5700 MHz



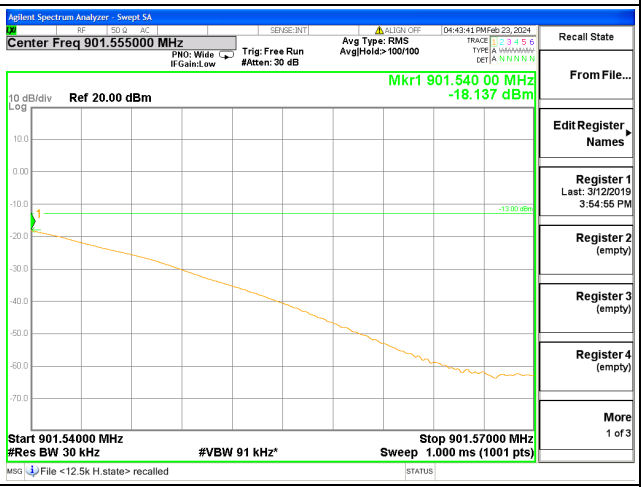
12.5kHz/256QAM



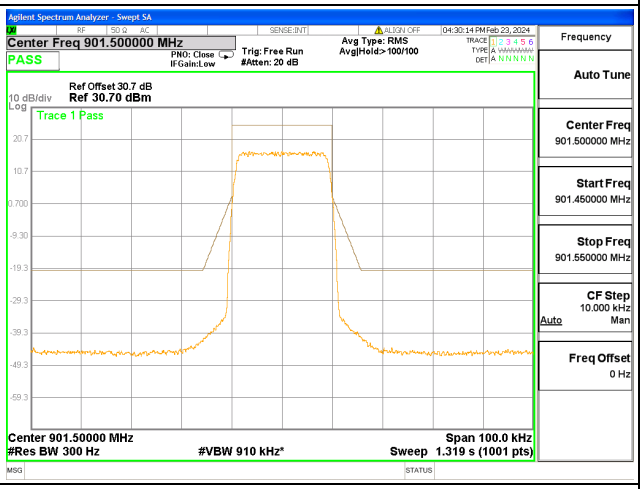
12.5kHz/ 256QAM /901.4300 -901.4600 MHz



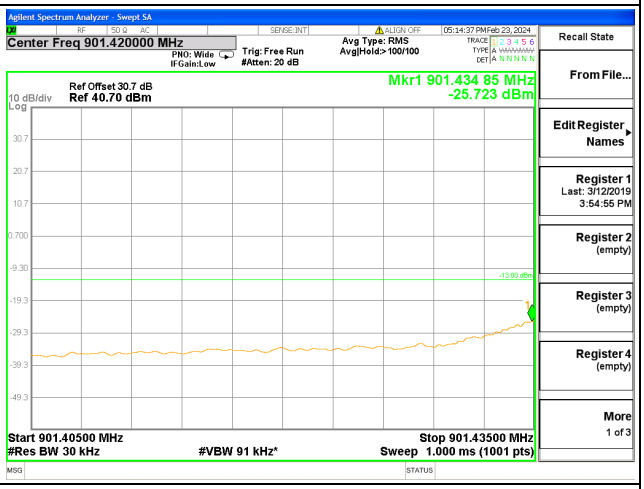
12.5kHz/ 256QAM /901.5400 -901.5700 MHz



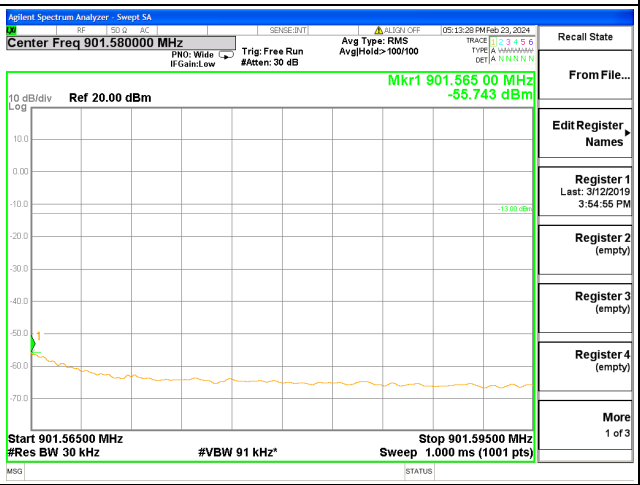
25kHz/ QPSK



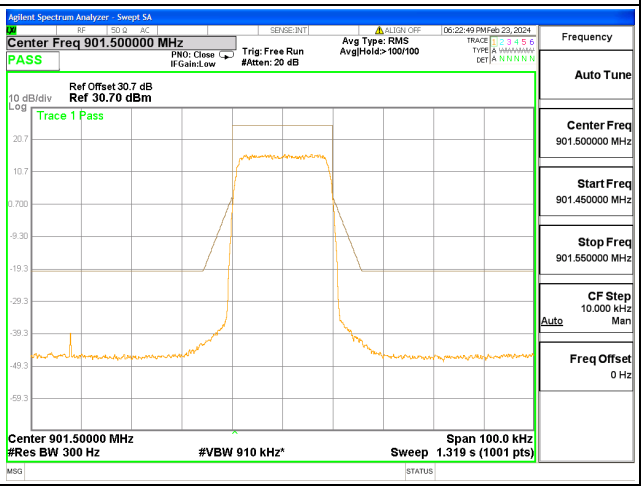
25kHz/ QPSK/901.4050 -901.4350 MHz



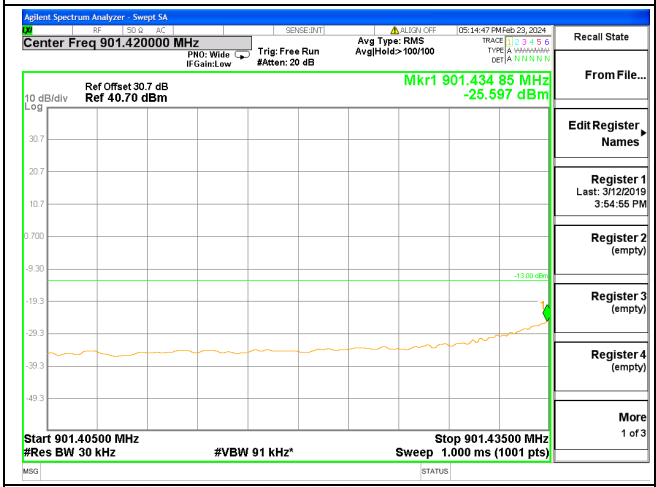
25kHz/ QPSK/901.5650 -901.5950 MHz



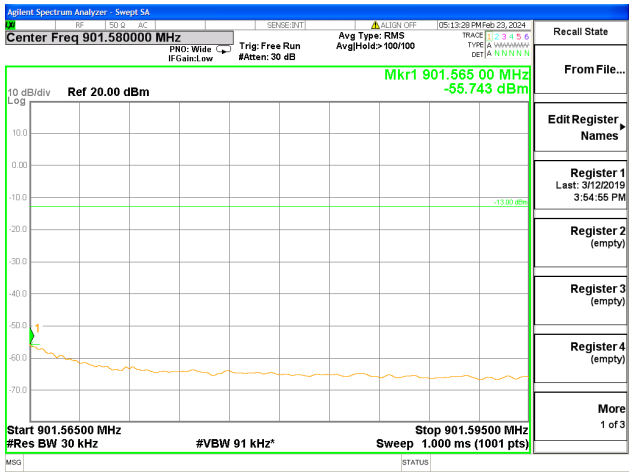
25kHz/16QAM



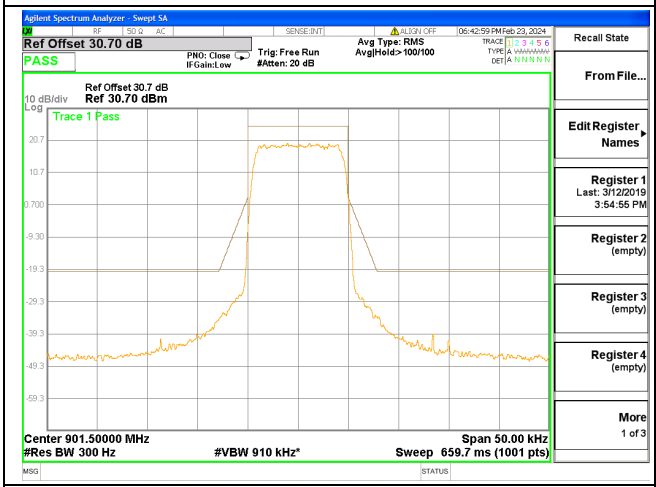
25kHz/ 16QAM /901.4050 -901.4350 MHz



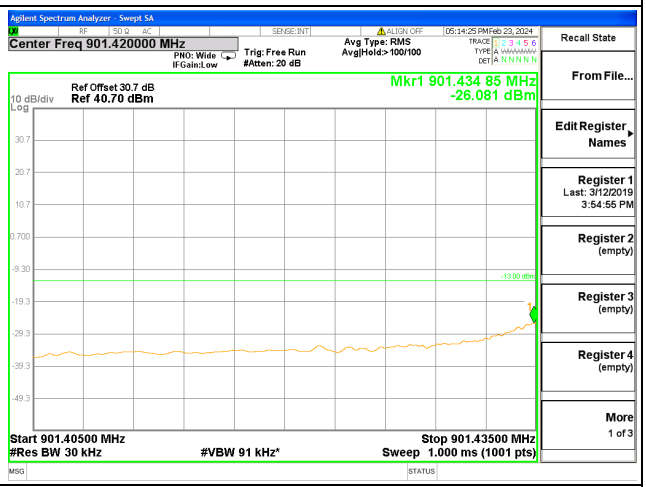
25kHz/ 16QAM /901.5650 -901.5950 MHz



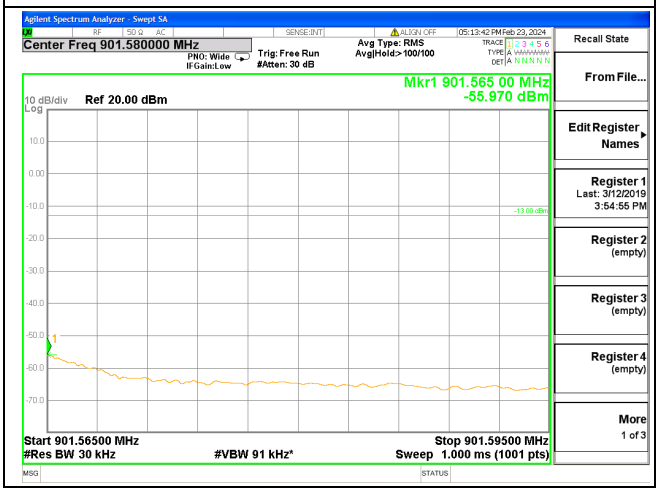
25kHz/ 64QAM



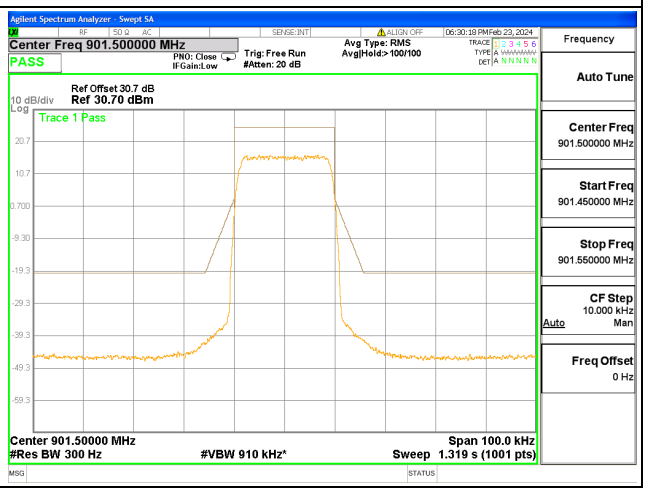
25kHz/ 64QAM /901.4050 -901.4350 MHz



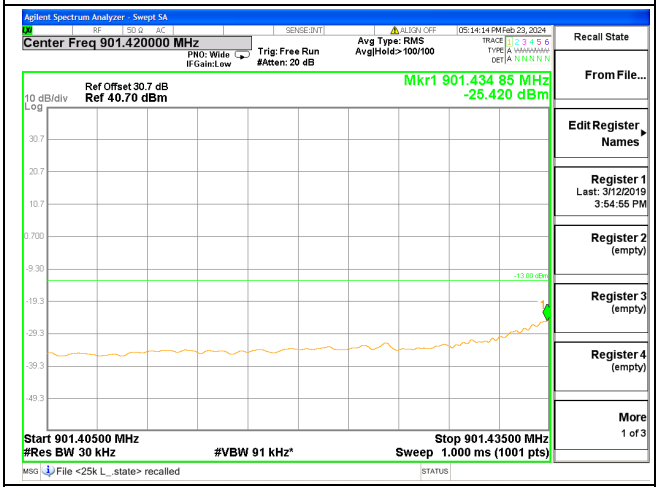
25kHz/ 64QAM /901.5650 -901.5950 MHz



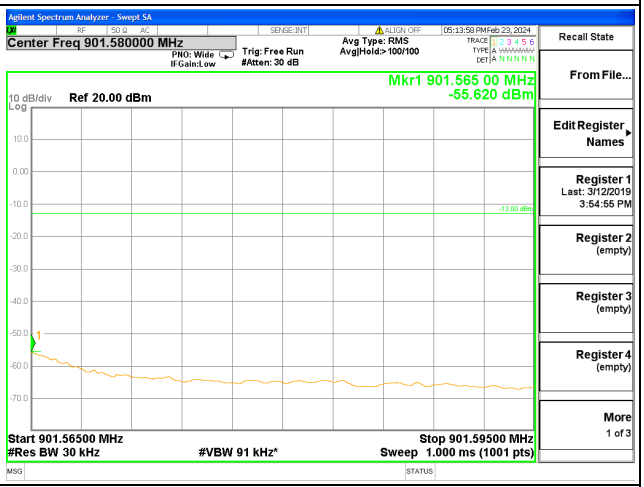
25kHz/256QAM



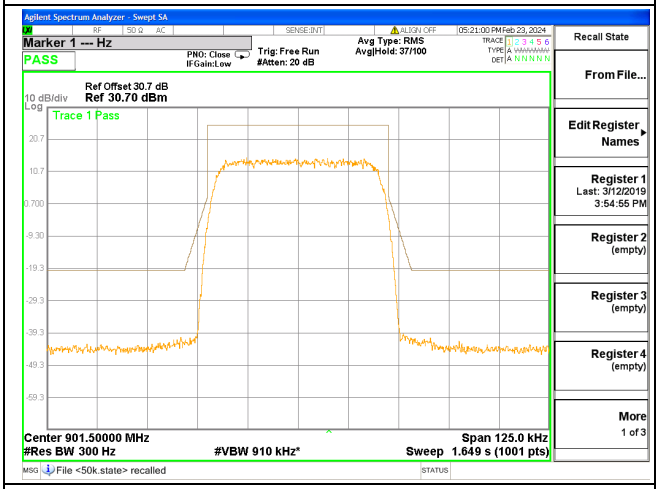
25kHz/ 256QAM /901.4050 -901.4350 MHz



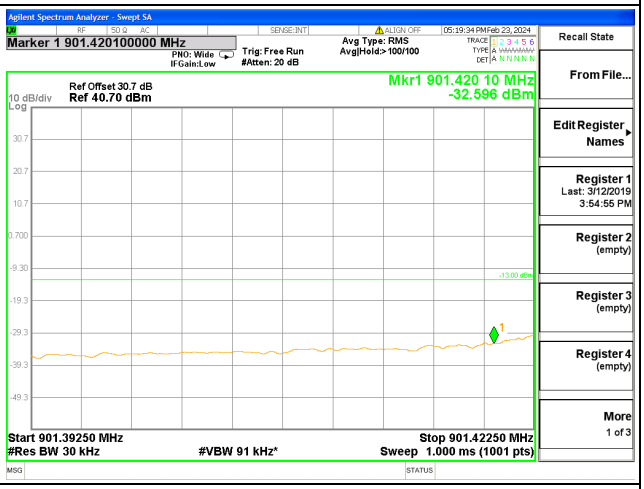
25kHz/ 256QAM /901.5650 -901.5950 MHz



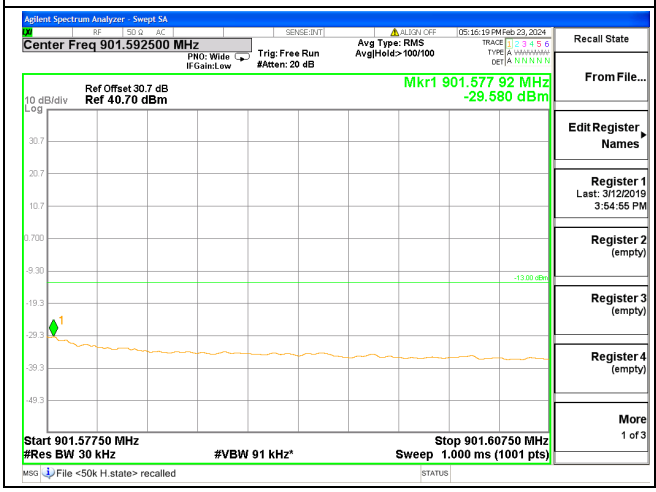
50kHz/ QPSK



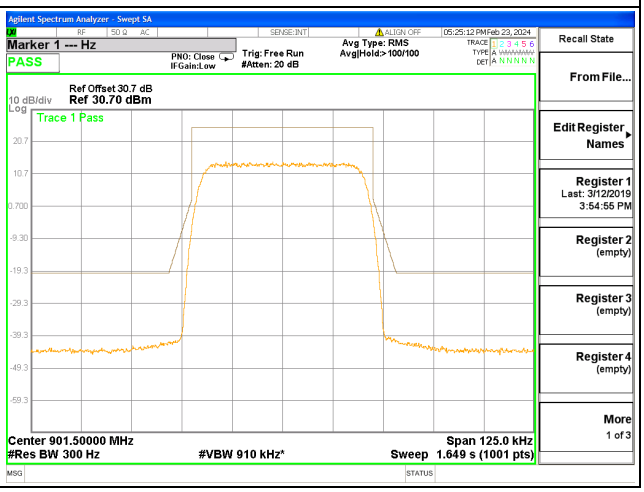
50kHz/ QPSK/901.3925 -901.4225 MHz



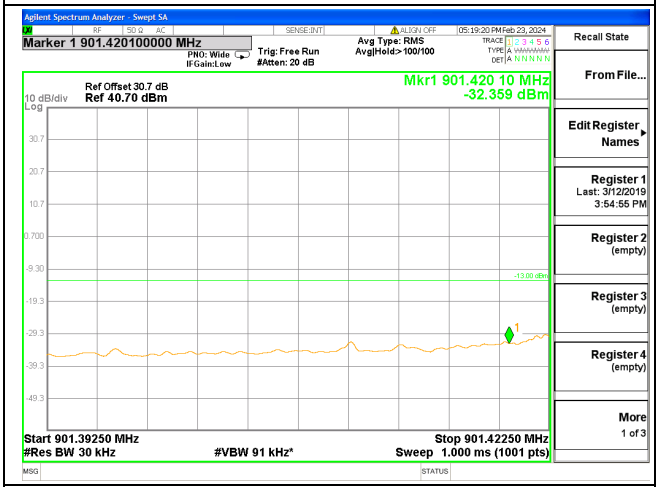
50kHz/ QPSK/901.5775 -901.6075 MHz



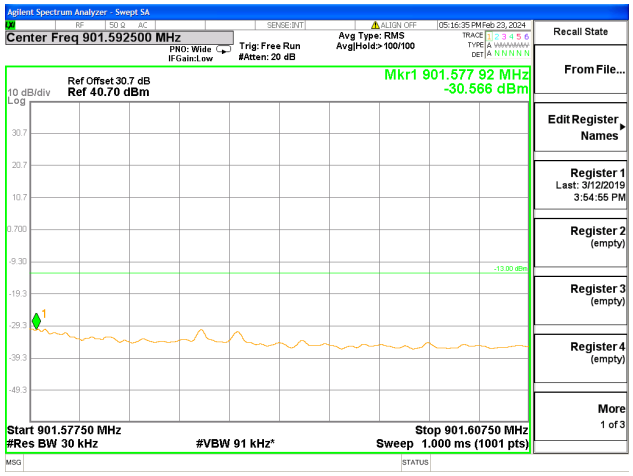
50kHz/16QAM



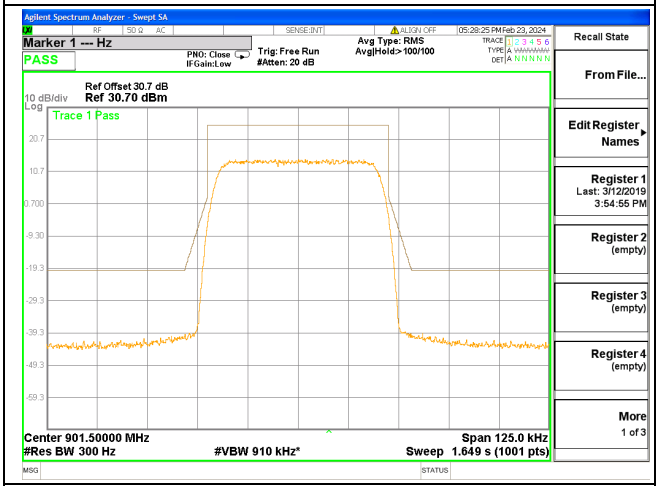
50kHz/ 16QAM /901.3925 -901.4225 MHz



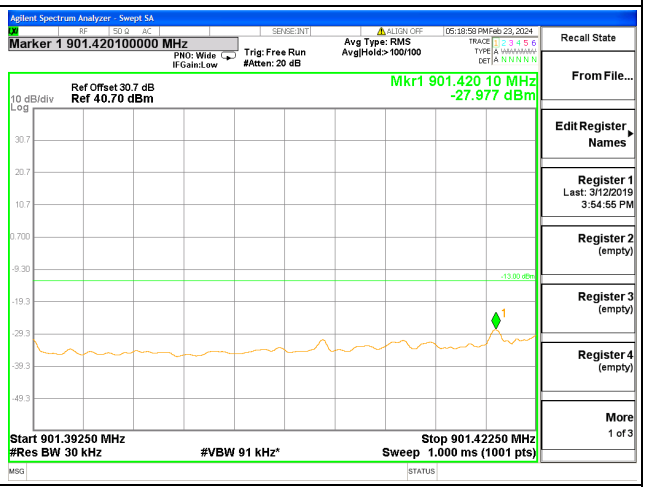
50kHz/ 16QAM /901.5775 -901.6075 MHz



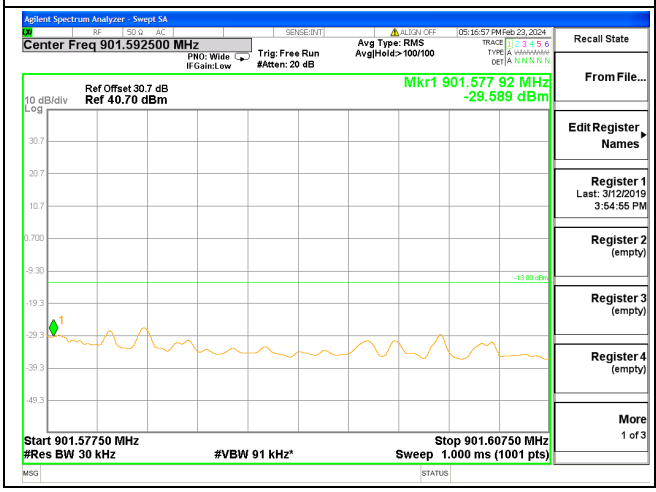
50kHz/ 64QAM



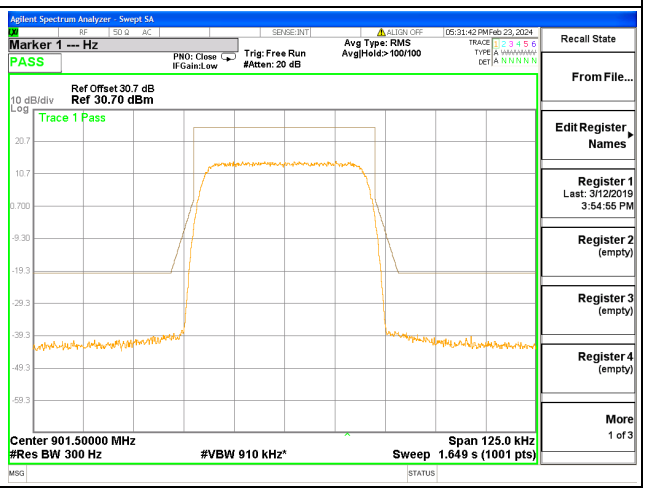
50kHz/ 64QAM /901.3925 -901.4225 MHz



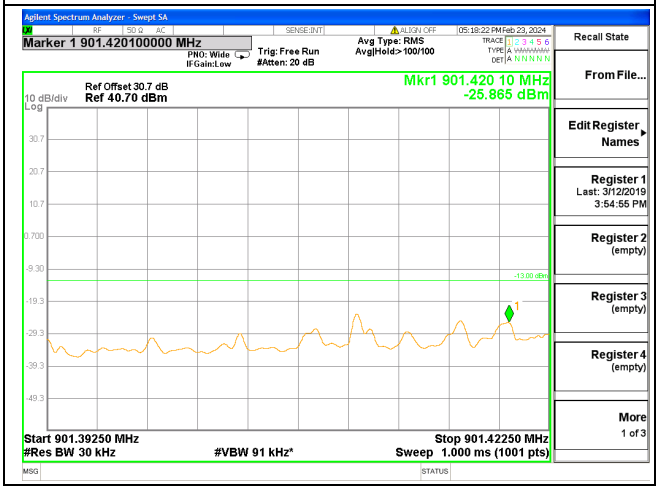
50kHz/ 64QAM /901.5775 -901.6075 MHz



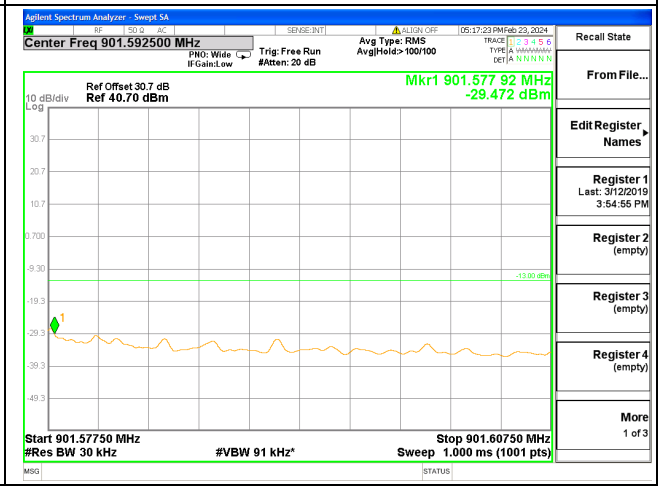
50kHz/256QAM



50kHz/ 256QAM /901.3925 -901.4225 MHz

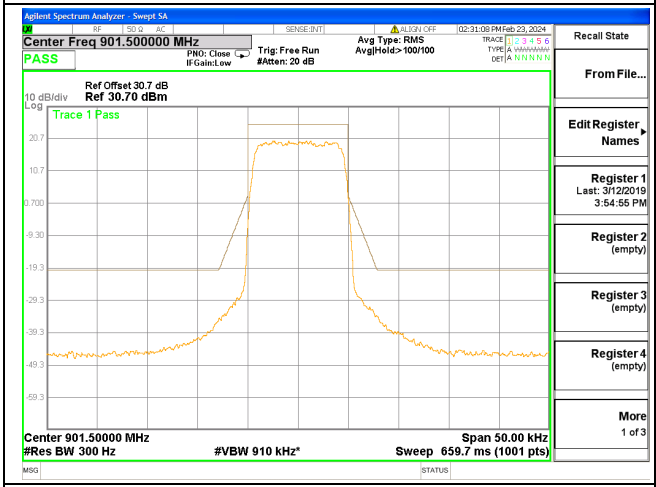


50kHz/ 256QAM /901.5775 -901.6075 MHz

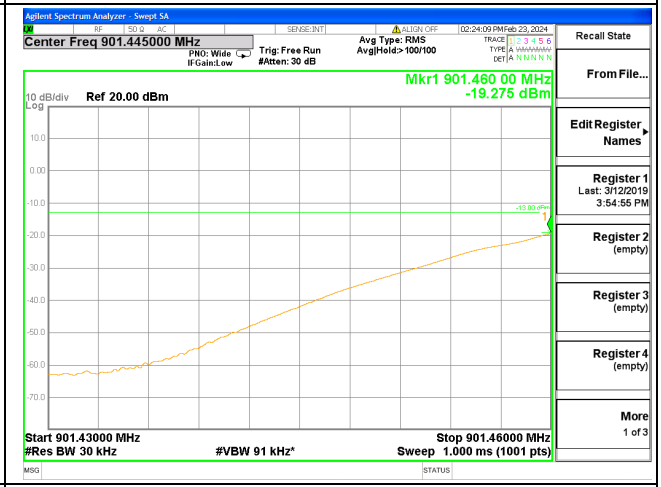


Nominal Frequency: 901.50 MHz Tx Port: Channel V

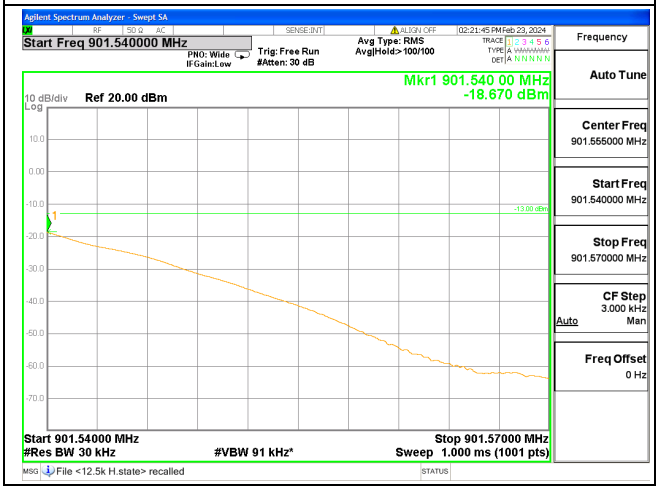
12.5kHz/ QPSK



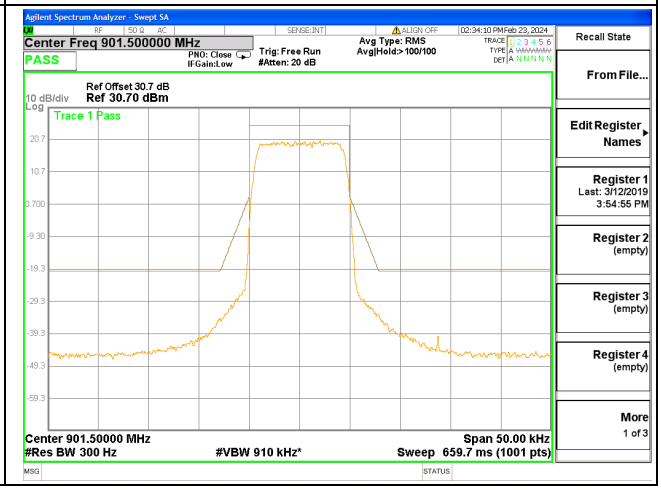
12.5kHz/ QPSK/901.4300 -901.4600 MHz



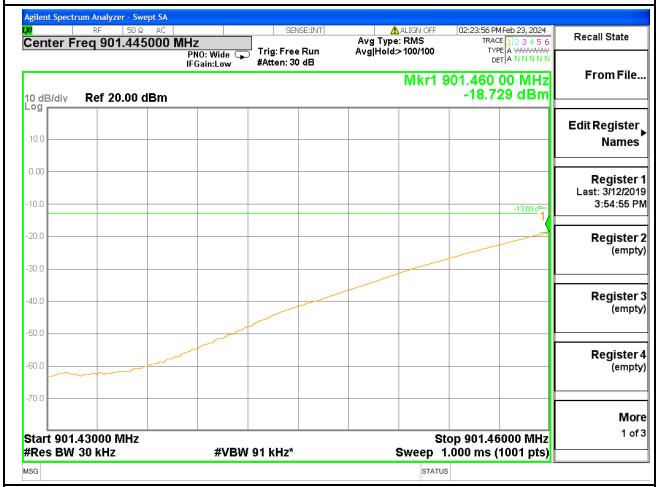
12.5kHz/ QPSK/901.5400 -901.5700 MHz



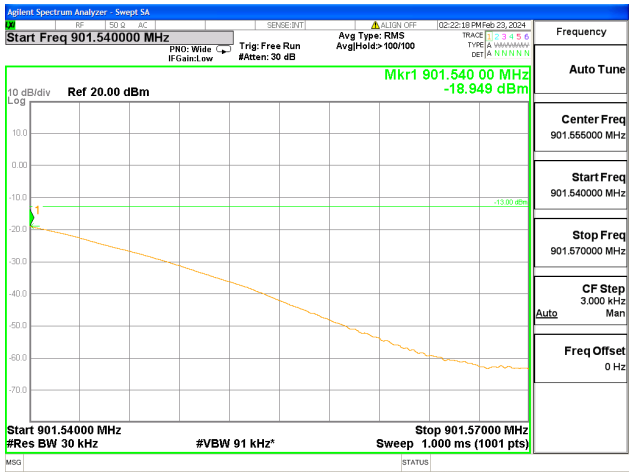
12.5kHz/16QAM



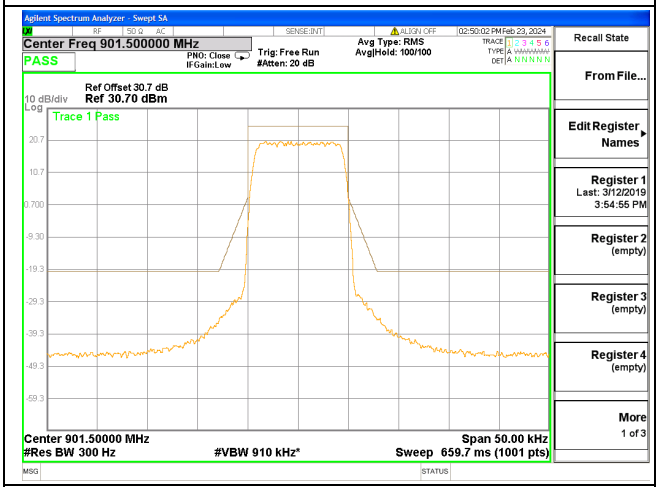
12.5kHz/ 16QAM /901.4300 -901.4600 MHz



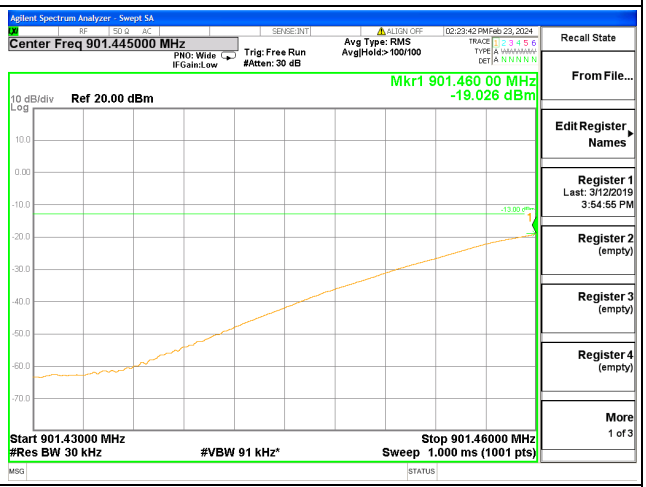
12.5kHz/ 16QAM /901.5400 -901.5700 MHz



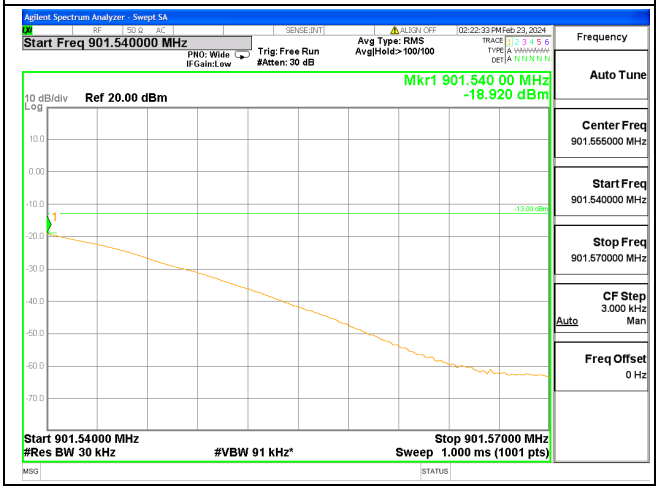
12.5kHz/ 64QAM



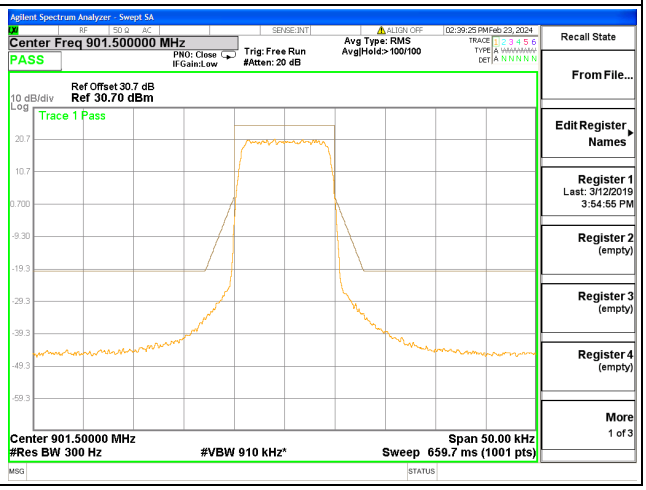
12.5kHz/ 64QAM /901.4300 -901.4600 MHz



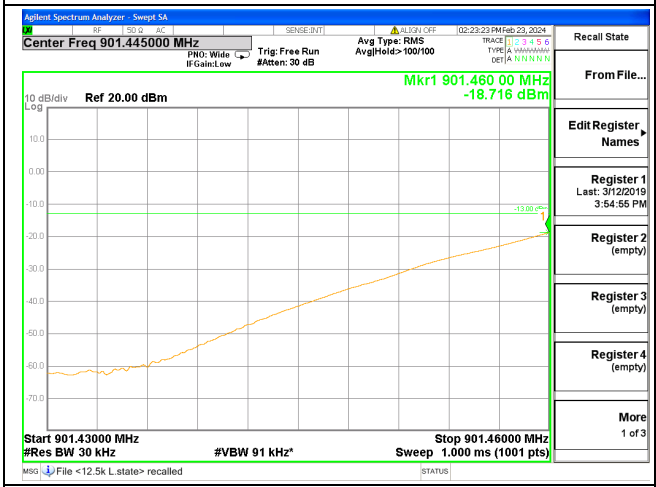
12.5kHz/ 64QAM /901.5400 -901.5700 MHz



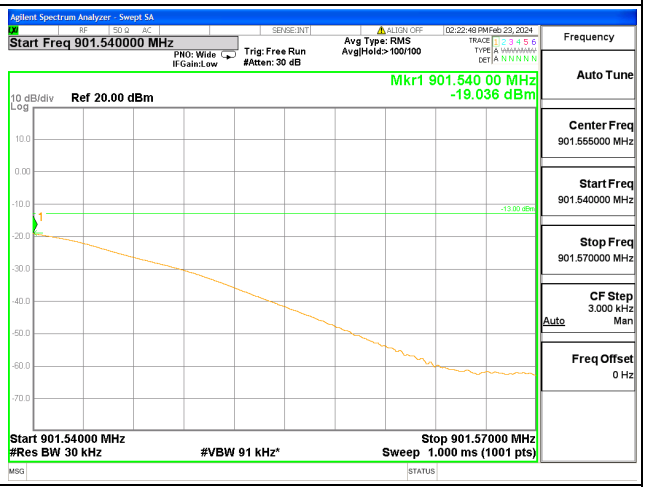
12.5kHz/256QAM



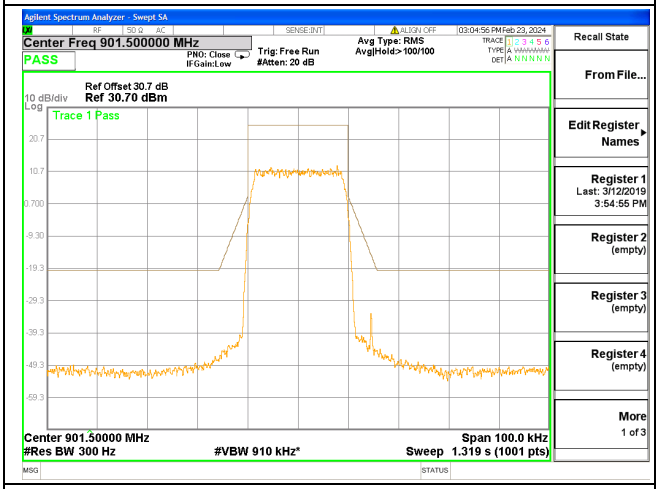
12.5kHz/ 256QAM /901.4300 -901.4600 MHz



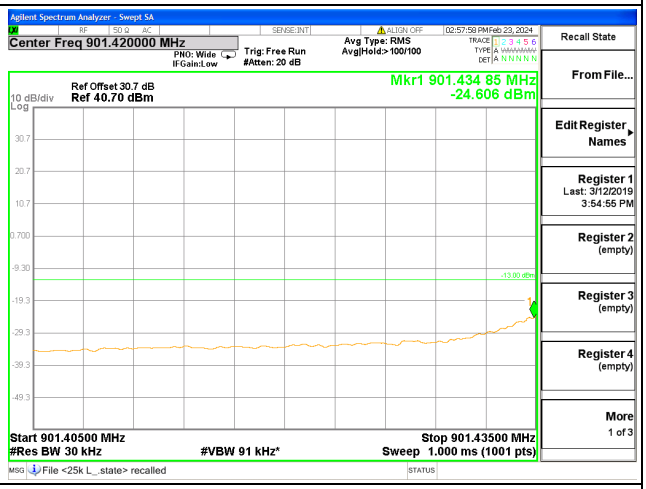
12.5kHz/ 256QAM /901.5400 -901.5700 MHz



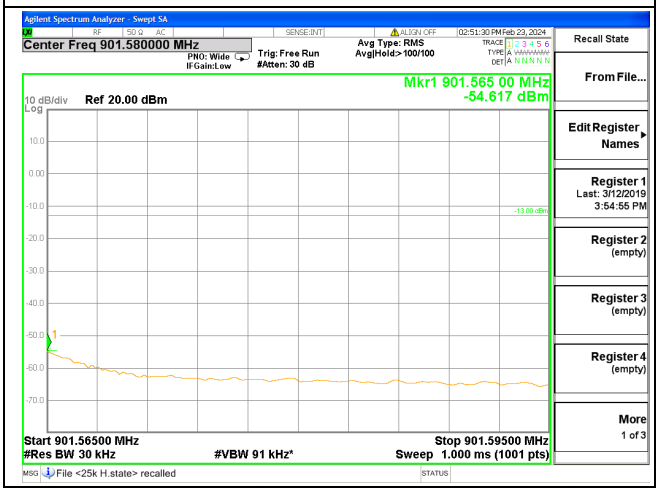
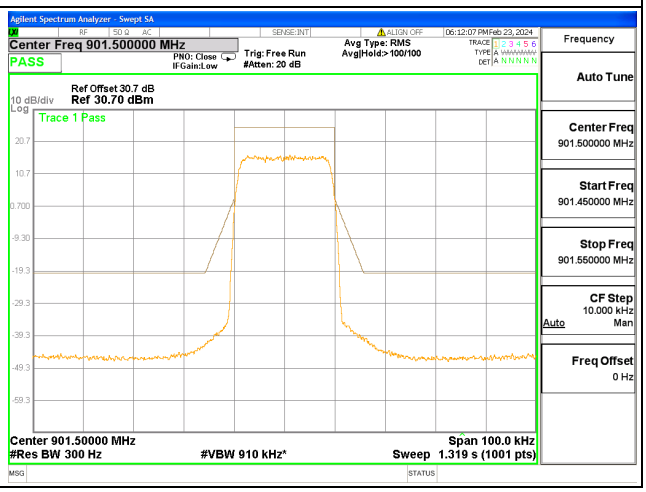
25kHz/ QPSK



25kHz/ QPSK/901.4050 -901.4350 MHz



25kHz/ QPSK/901.5650 -901.5950 MHz



25kHz/16QAM