REPORT No.: SZ22110152W02

TEST REPORT

APPLICANT	:	MiMOMax Wireless Limited
PRODUCT NAME	:	900MHz TornadoX Transceiver
MODEL NAME	:	MWL-TORNADOX-*G*D/E
BRAND NAME	:	MiMOMax Wireless
FCC ID	:	XMK-MMXTRNXB004
STANDARD(S)	:	47 CFR Part 2 47 CFR Part 24
RECEIPT DATE	:	2022-11-30
TEST DATE	:	2022-12-08 to 2023-02-02
ISSUE DATE	:	2023-02-23

Tested by: Li Huaijie (Rapporteur)

Approved by: Shen Junsheng(Supervisor)

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MORLAB

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Change History		
Issue	Date	Reason for change
1.0	2023-02-23	First edition

1. Technical Information

Note: Provide by applicant.

1.1. Applicant and ManufacturerInformation

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_04.08.00.HPT76	
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
		8.0 dBi
		10.0 dBi
	Panel Antenna	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 Date	Test Engineer	Result	Method Determination /Remark
2.1046 24.132	Transmitter Conducted Output Power and ERP/EIRP	2022/12/08-2022/12/13	Li Huaijie	PASS	No deviation
2.1049	Occupied Bandwidth	2022/12/09-2022/12/13	Li Huaijie	PASS	No deviation
2.1051 24.133	Conducted Spurious Emissions	2022/12/09-2023/02/02	Li Huaijie	PASS	No deviation
2.1053 24.133	Radiated Spurious Emissions	2023/01/09	Li Hanbin	PASS	No deviation
2.1055 24.135	Frequency stability	2022/12/09-2022/12/13	Li Huaijie	PASS	No deviation

Note 1: The TornadoX 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 TornadoX Transceiver supports 2 Tx antenna ports, which was defined as Channel H &Channel V separately.

Note 3: The path loss during the conducted RF test is calibrated to correct the results by the Ext Gain setting. The Ext Gain contains two parts that cable loss of 0.5dB 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
Atmospheric Pressure (kPa):	86-106

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	33.18	2.080	2.50	35.03	3.184	47.03	50.466
12.5	16QAM	24	33.38	2.178	2.50	35.23	3.334	47.23	52.845
12.5	64QAM	24	33.44	2.208	2.50	35.29	3.381	47.29	53.580
12.5	256QAM	24	34.14	2.594	2.50	35.99	3.972	47.99	62.951
25.0	QPSK	24	34.25	2.661	2.50	36.10	4.074	48.10	64.565
25.0	16QAM	24	34.14	2.594	2.50	35.99	3.972	47.99	62.951
25.0	64QAM	24	34.35	2.723	2.50	36.20	4.169	48.20	66.069
25.0	256QAM	24	34.46	2.793	2.50	36.31	4.276	48.31	67.764
50.0	QPSK	24	34.44	2.780	2.50	36.29	4.256	48.29	67.453
50.0	16QAM	24	34.42	2.767	2.50	36.27	4.236	48.27	67.143
50.0	64QAM	24	34.37	2.735	2.50	36.22	4.188	48.22	66.374
50.0	256QAM	24	34.52	2.831	2.50	36.37	4.335	48.37	68.707

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	33.40	2.188	2.50	35.25	3.350	47.25	53.088
12.5	16QAM	24	33.42	2.198	2.50	35.27	3.365	47.27	53.333
12.5	64QAM	24	34.02	2.523	2.50	35.87	3.864	47.87	61.235
12.5	256QAM	24	33.81	2.404	2.50	35.66	3.681	47.66	58.345

25.0	QPSK	24	34.34	2.716	2.50	36.19	4.159	48.19	65.917
25.0	16QAM	24	34.40	2.754	2.50	36.25	4.217	48.25	66.834
25.0	64QAM	24	34.45	2.786	2.50	36.30	4.266	48.30	67.608
25.0	256QAM	24	34.06	2.547	2.50	35.91	3.899	47.91	61.802
50.0	QPSK	24	34.41	2.761	2.50	36.26	4.227	48.26	66.988
50.0	16QAM	24	34.43	2.773	2.50	36.28	4.246	48.28	67.298
50.0	64QAM	24	34.38	2.742	2.50	36.23	4.198	48.23	66.527
50.0	256QAM	24	34.59	2.877	2.50	36.44	4.406	48.44	69.823

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	33.52	2.249	2.50	35.37	3.443	47.37	54.576
12.5	16QAM	24	33.66	2.323	2.50	35.51	3.556	47.51	56.364
12.5	64QAM	24	33.98	2.500	2.50	35.83	3.828	47.83	60.674
12.5	256QAM	24	33.48	2.228	2.50	35.33	3.412	47.33	54.075
25.0	QPSK	24	33.36	2.168	2.50	35.21	3.319	47.21	52.602
25.0	16QAM	24	33.45	2.213	2.50	35.30	3.388	47.30	53.703
25.0	64QAM	24	33.46	2.218	2.50	35.31	3.396	47.31	53.827
25.0	256QAM	24	33.41	2.193	2.50	35.26	3.357	47.26	53.211
50.0	QPSK	24	33.78	2.388	2.50	35.63	3.656	47.63	57.943
50.0	16QAM	24	33.93	2.472	2.50	35.78	3.784	47.78	59.979
50.0	64QAM	24	33.81	2.404	2.50	35.66	3.681	47.66	58.345
50.0	256QAM	24	33.87	2.438	2.50	35.72	3.733	47.72	59.156

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	33.69	2.339	2.50	35.54	3.581	47.54	56.754

12.5	16QAM	24	33.65	2.317	2.50	35.50	3.548	47.50	56.234
12.5	64QAM	24	33.65	2.317	2.50	35.50	3.548	47.50	56.234
12.5	256QAM	24	33.97	2.495	2.50	35.82	3.819	47.82	60.534
25.0	QPSK	24	33.44	2.208	2.50	35.29	3.381	47.29	53.580
25.0	16QAM	24	33.54	2.259	2.50	35.39	3.459	47.39	54.828
25.0	64QAM	24	33.51	2.244	2.50	35.36	3.436	47.36	54.450
25.0	256QAM	24	33.62	2.301	2.50	35.47	3.524	47.47	55.847
50.0	QPSK	24	33.76	2.377	2.50	35.61	3.639	47.61	57.677
50.0	16QAM	24	33.85	2.427	2.50	35.70	3.715	47.70	58.884
50.0	64QAM	24	34.16	2.606	2.50	36.01	3.990	48.01	63.241
50.0	256QAM	24	34.00	2.512	2.50	35.85	3.846	47.85	60.954

Note1: Measurements were carried out at the RF output terminals of the transmitter using spectrum analyzer. The path loss during the conducted R0F test is calibrated to correct the results by the Ext Gain setting. The Ext Gain contains two parts that cable loss of 0.5dB 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

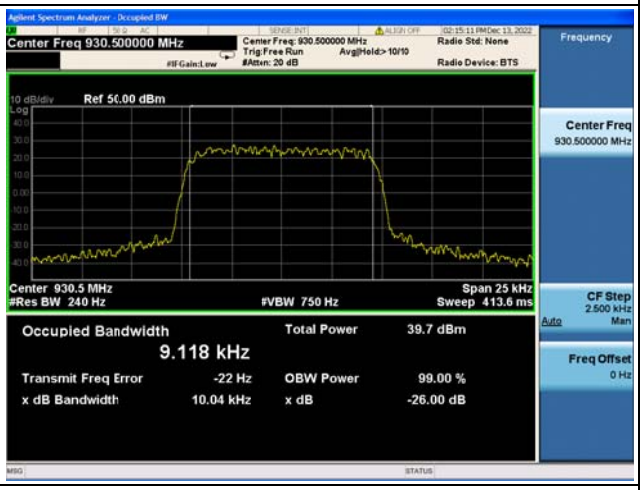
Nominal Frequency: 930.50 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	9.118
		16QAM	8.905
		64QAM	9.020
		256QAM	9.050
	25.0	QPSK	18.819
		16QAM	18.959
		64QAM	18.819
		256QAM	18.834
	50.0	QPSK	41.206
		16QAM	41.147
		64QAM	41.387
		256QAM	41.101
Channel V	12.5	QPSK	9.009
		16QAM	8.978
		64QAM	8.920
		256QAM	9.140
	25.0	QPSK	18.928
		16QAM	18.681
		64QAM	18.569
		256QAM	18.715
	50.0	QPSK	41.235
		16QAM	41.295
		64QAM	41.282
		256QAM	41.623

Nominal Frequency: 940.50 MHz

Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	9.062
		16QAM	8.994
		64QAM	8.939
		256QAM	8.968
	25.0	QPSK	18.755
		16QAM	18.641
		64QAM	18.828
		256QAM	18.567
	50.0	QPSK	41.574
		16QAM	41.293
		64QAM	41.095
		256QAM	41.599
Channel V	12.5	QPSK	9.085
		16QAM	9.085
		64QAM	9.018
		256QAM	9.101
	25.0	QPSK	18.654
		16QAM	18.831
		64QAM	18.835
		256QAM	18.779
	50.0	QPSK	41.674
		16QAM	41.341
		64QAM	41.198
		256QAM	41.403

930.50MHz/Channel H/12.5kHz/QPSK



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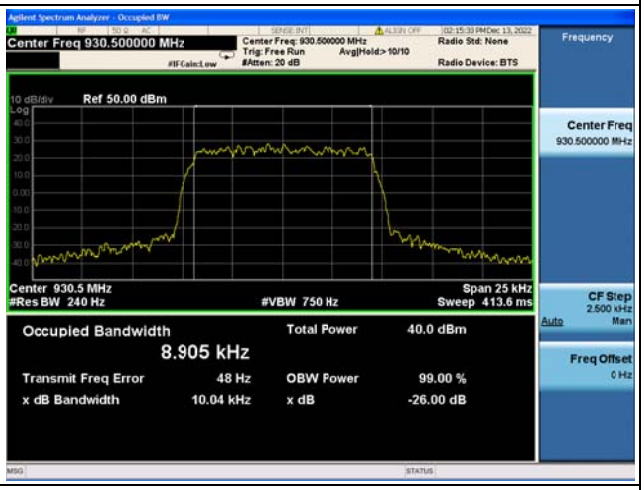
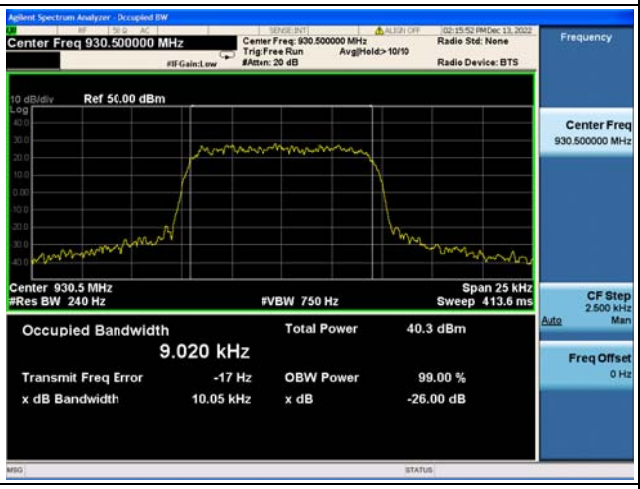


930.50MHz/Channel H/12.5kHz/64QAM



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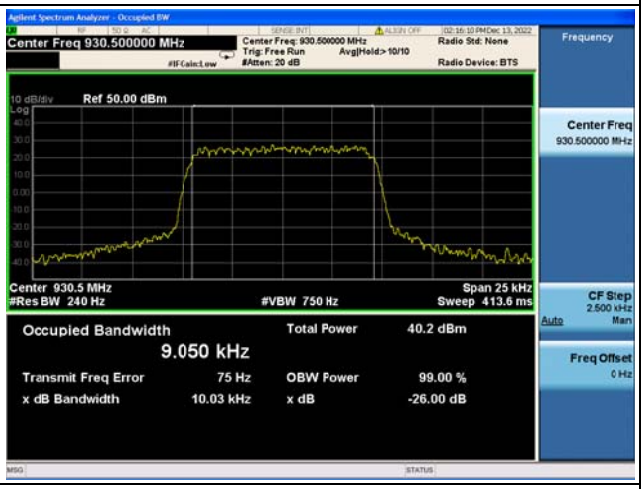

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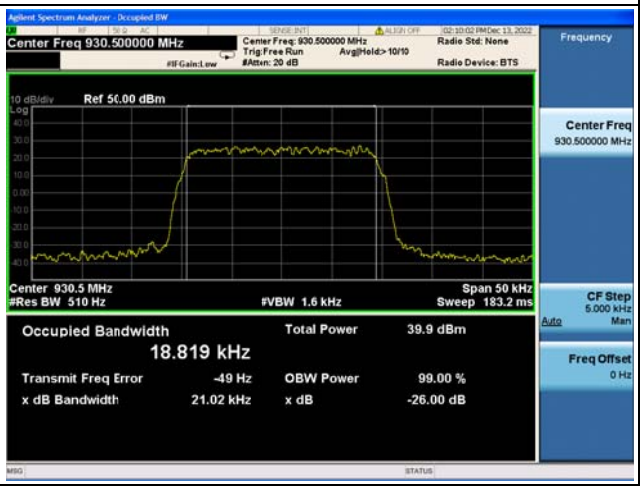

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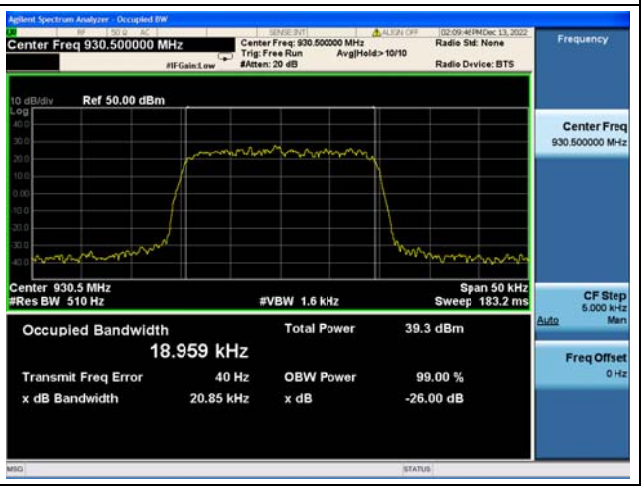

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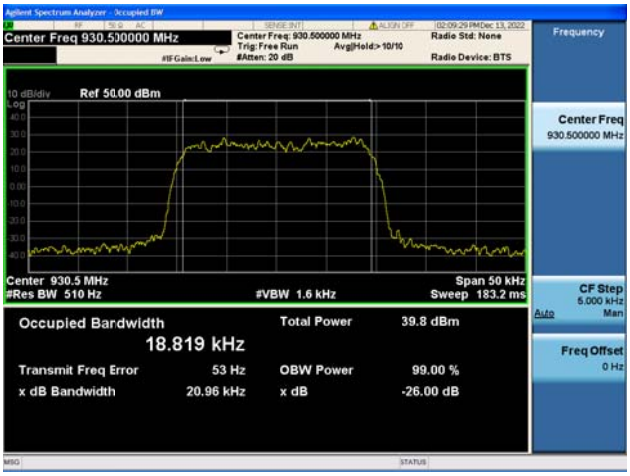

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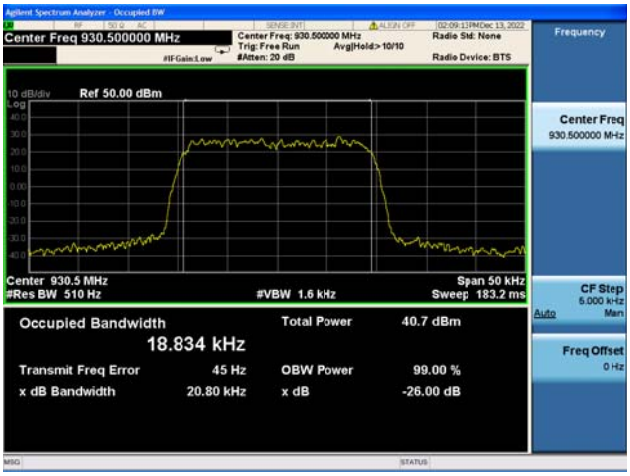
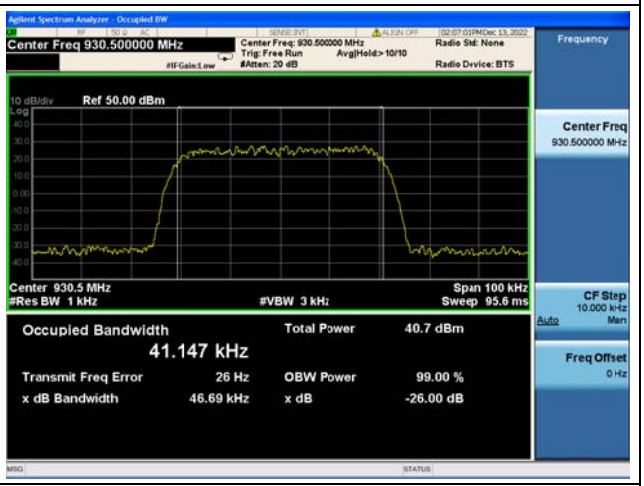


930.50MHz/Channel H/50.0 kHz/QPSK

930.50MHz/Channel H/50.0 kHz/16QAM



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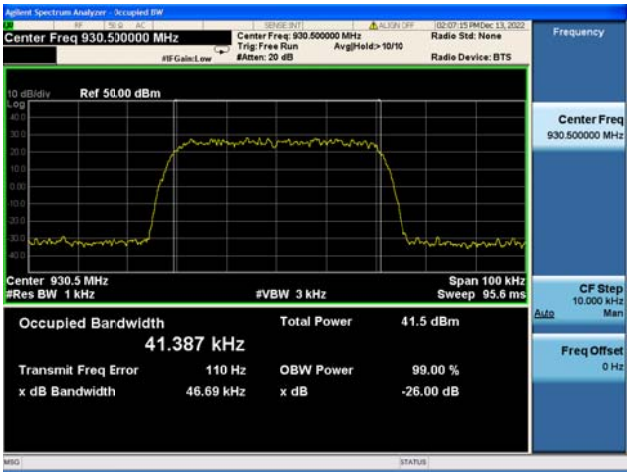

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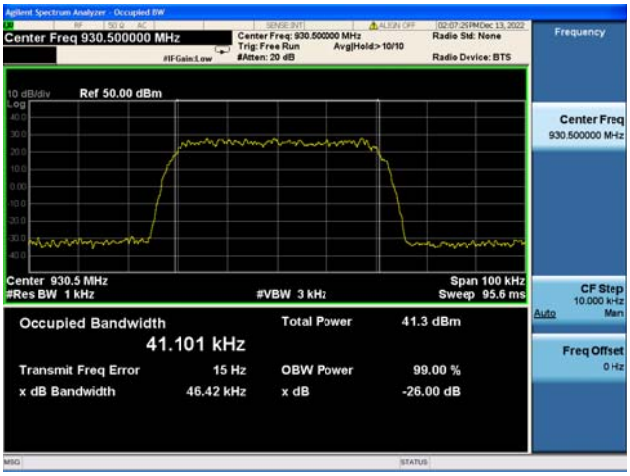
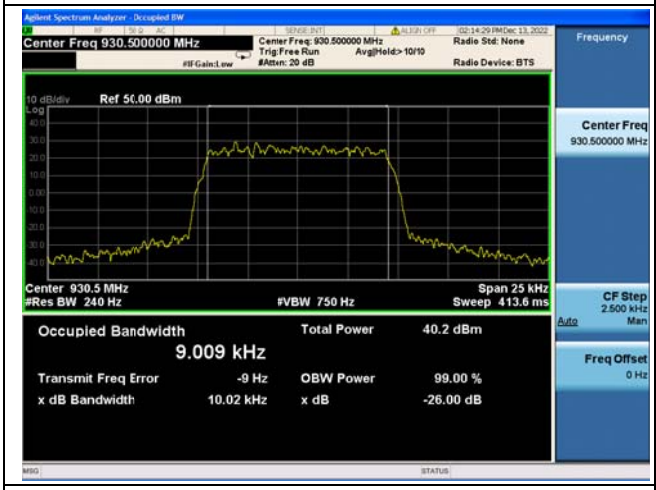
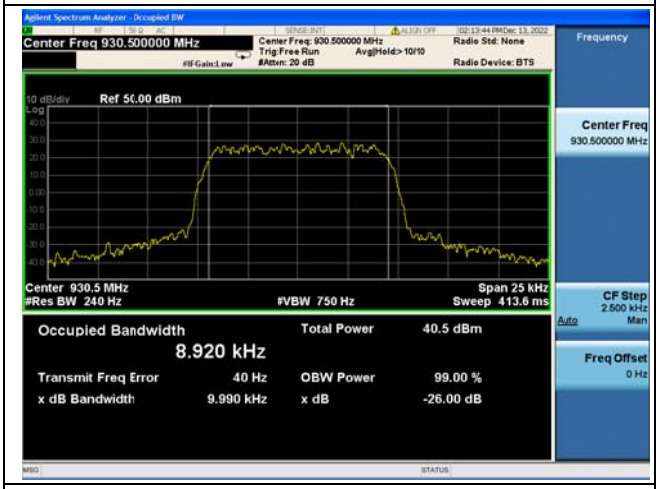


930.50MHz/Channel V/12.5kHz/QPSK



930.50MHz/Channel V/12.5kHz/16QAM

930.50MHz/Channel V/12.5kHz/64QAM



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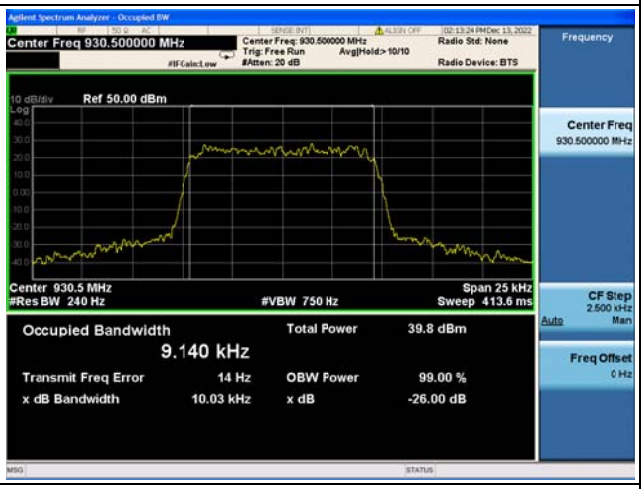

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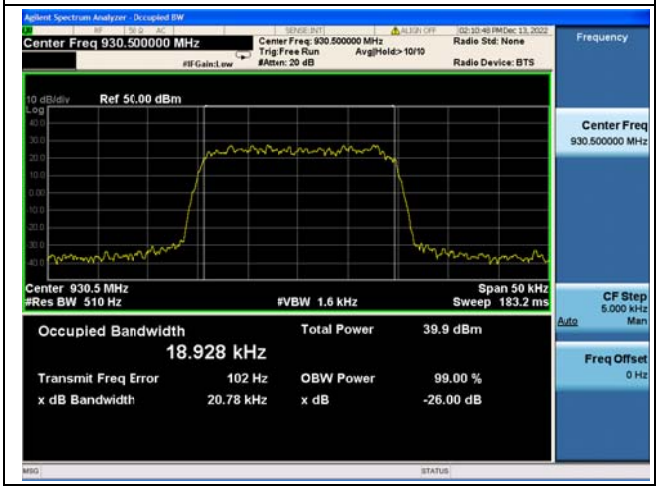

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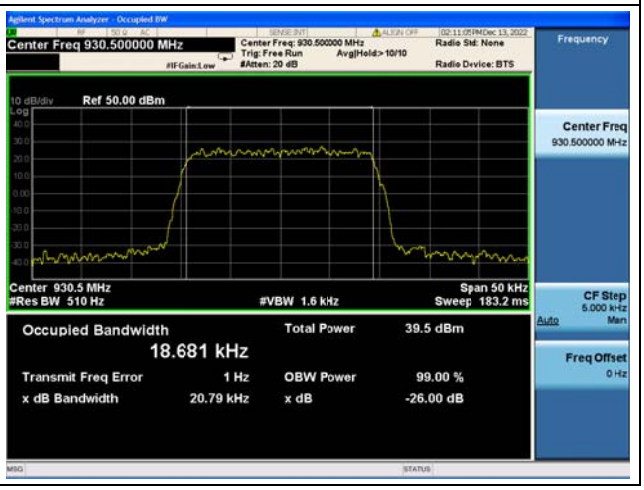

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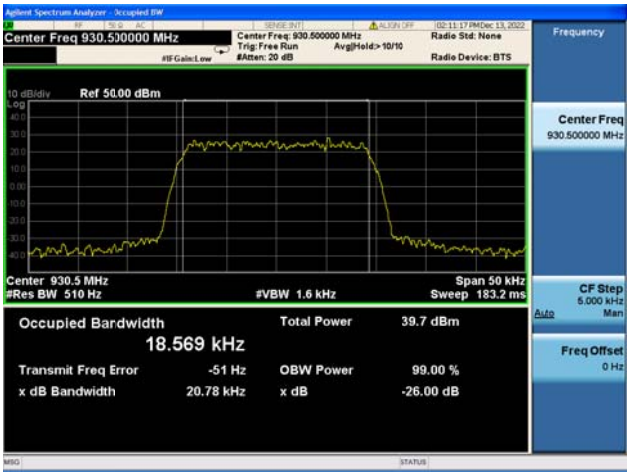
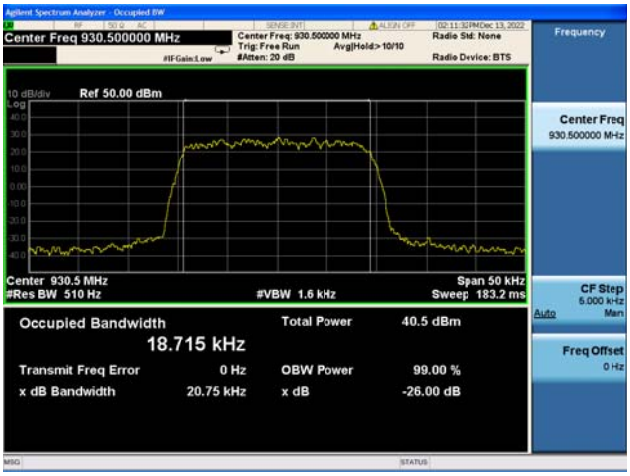
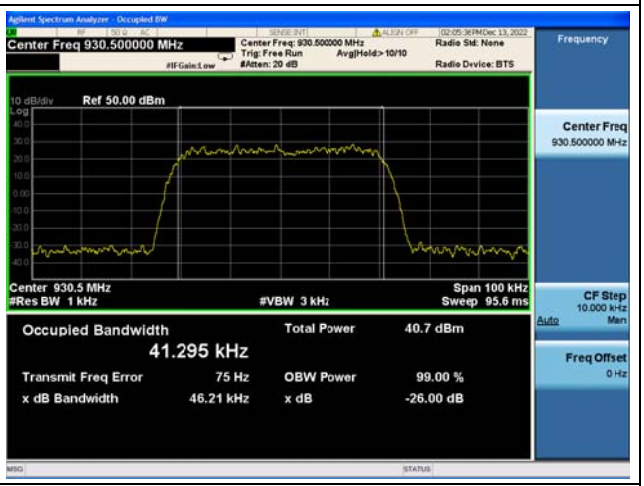


930.50MHz/Channel V/25.0 kHz/256QAM

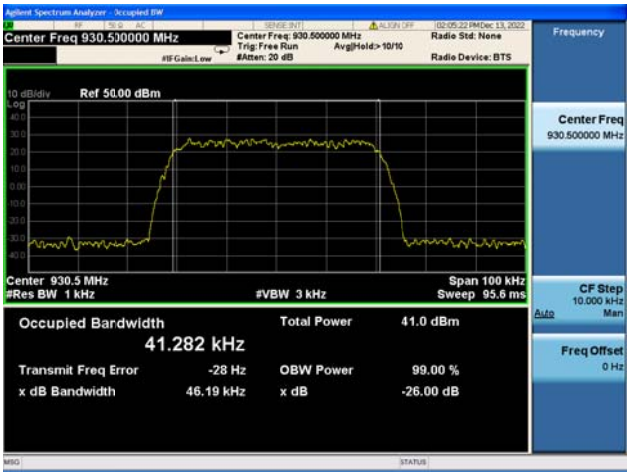


930.50MHz/Channel V/50.0 kHz/QPSK

930.50MHz/Channel V/50.0 kHz/16QAM

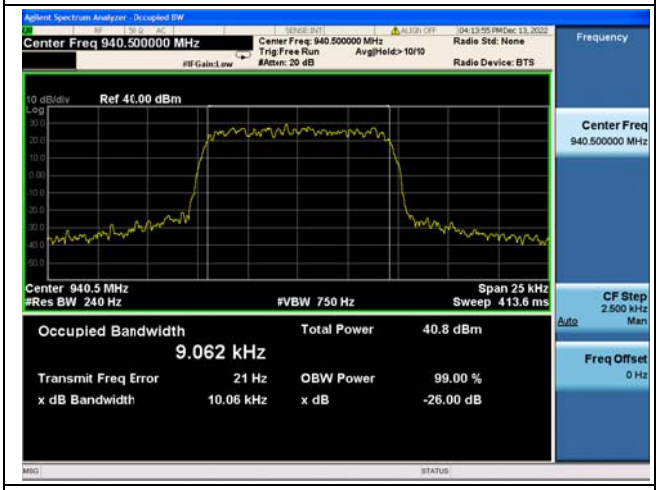


930.50MHz/Channel V/50.0 kHz/64QAM

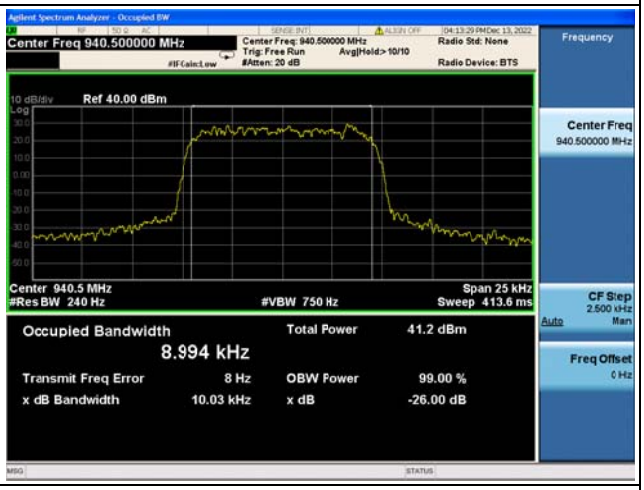


930.50MHz/Channel V/50.0 kHz/256QAM

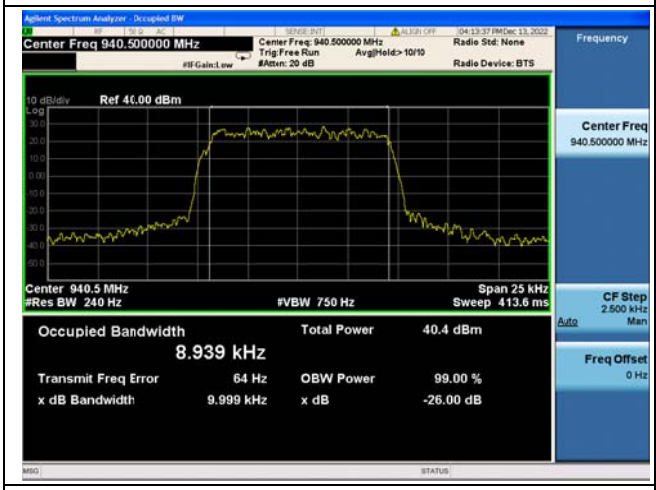
940.50MHz/Channel H/12.5kHz/QPSK



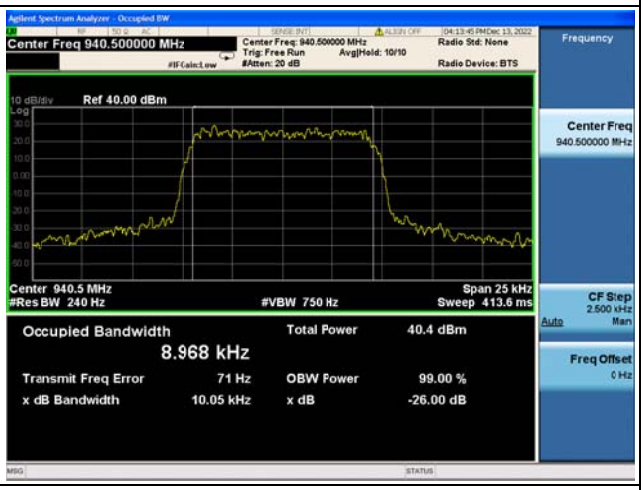
940.50MHz/Channel H/12.5kHz/16QAM



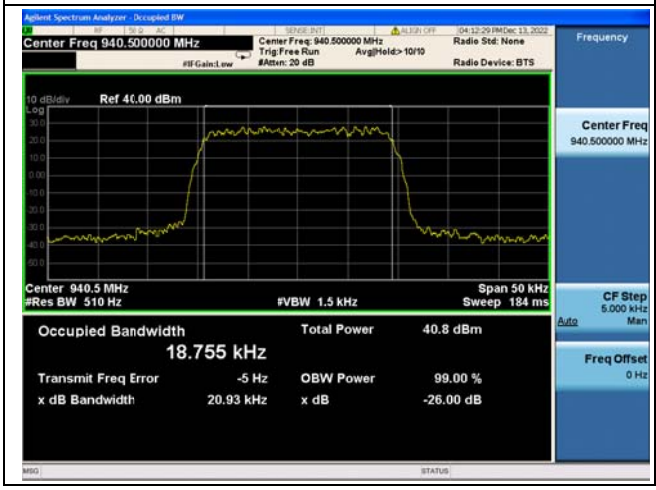
940.50MHz/Channel H/12.5kHz/64QAM



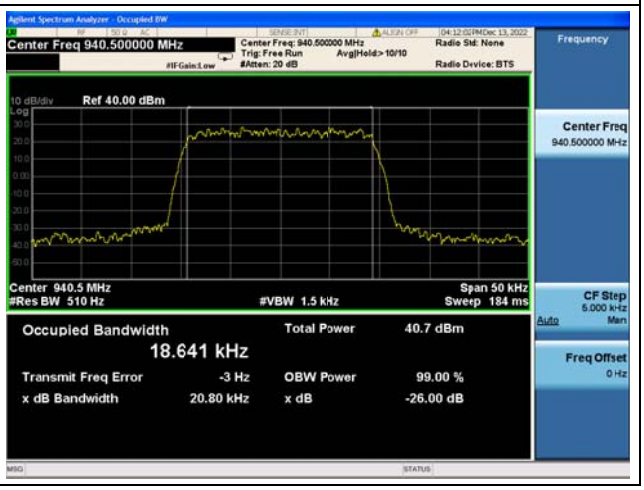
940.50MHz/Channel H/12.5 kHz/256QAM



940.50MHz/Channel H/25.0 kHz/QPSK

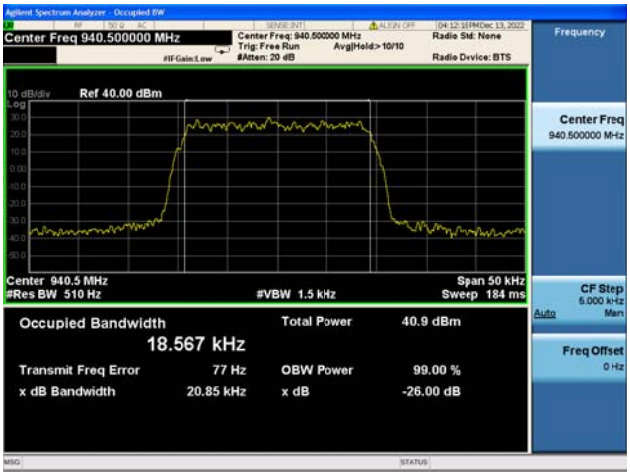


940.50MHz/Channel H/25.0 kHz/16QAM



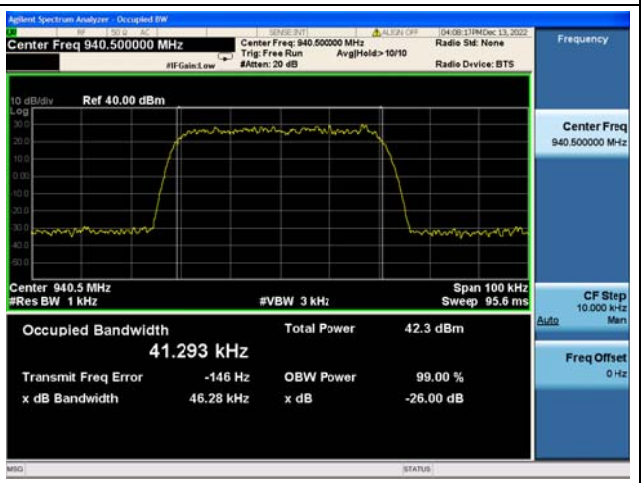
940.50MHz/Channel H/25.0 kHz/64QAM

940.50MHz/Channel H/25.0 kHz/256QAM



940.50MHz/Channel H/50.0 kHz/QPSK

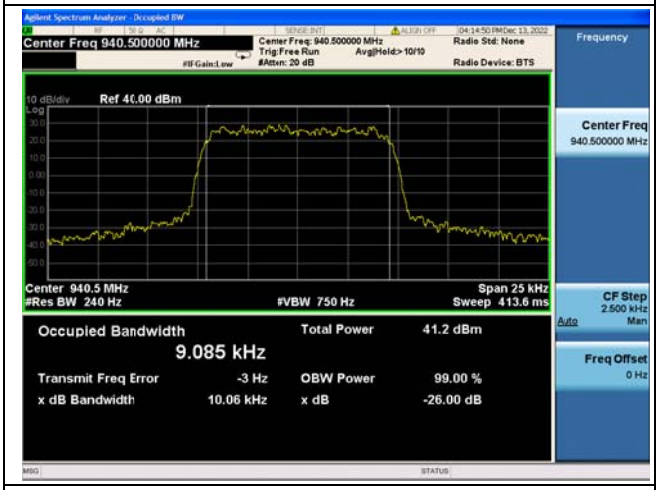
940.50MHz/Channel H/50.0 kHz/16QAM



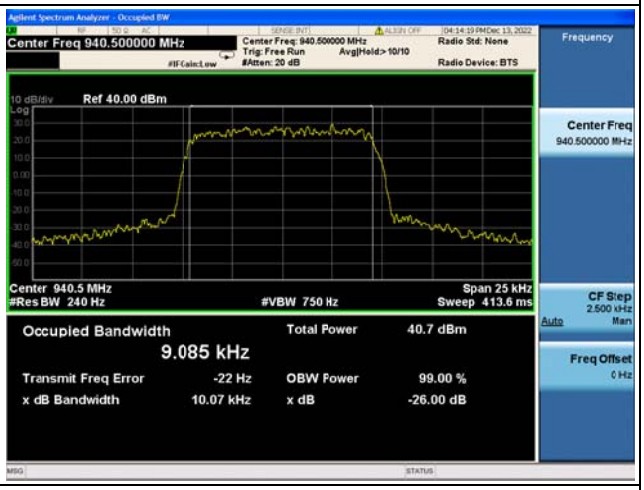
940.50MHz/Channel H/50.0 kHz/64QAM

940.50MHz/Channel H/50.0 kHz/256QAM

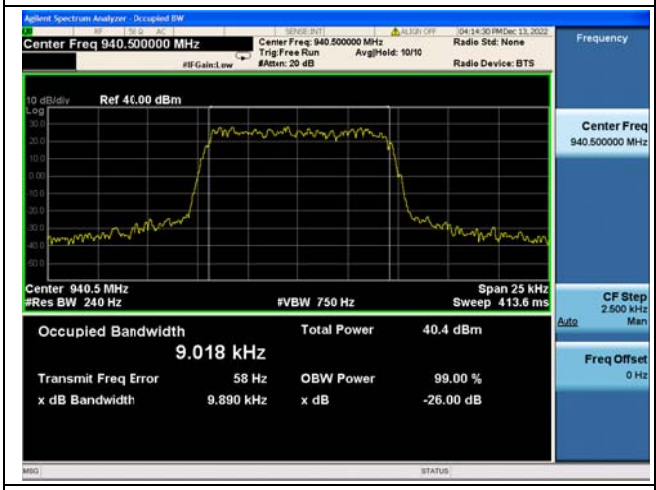
940.50MHz/Channel V/12.5kHz/QPSK



940.50MHz/Channel V/12.5kHz/16QAM

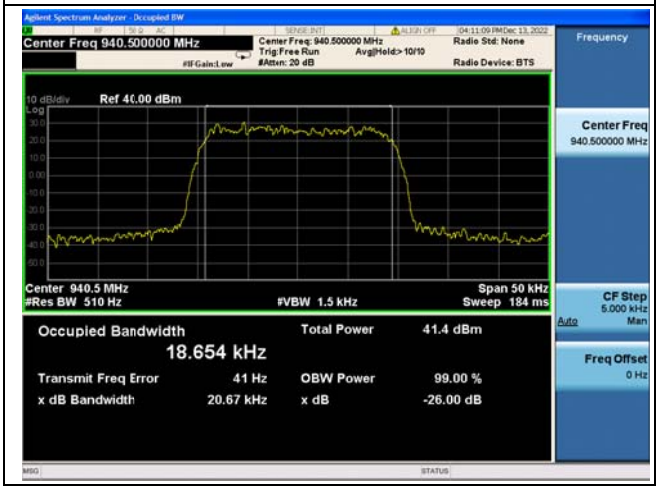


940.50MHz/Channel V/12.5kHz/64QAM

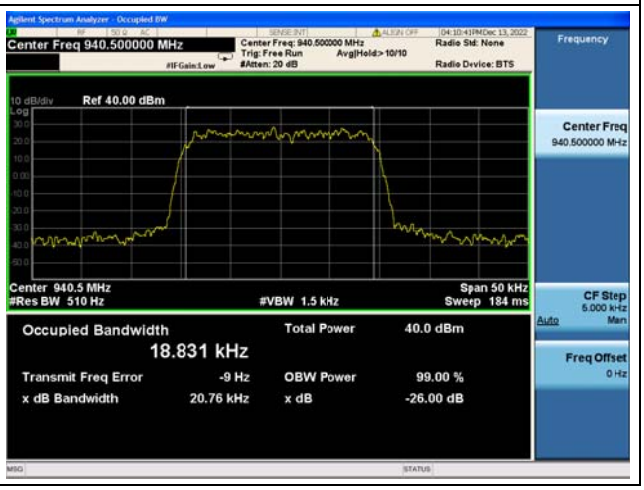


940.50MHz/Channel V/12.5 kHz/256QAM

940.50MHz/Channel V/25.0 kHz/QPSK



940.50MHz/Channel V/25.0 kHz/16QAM

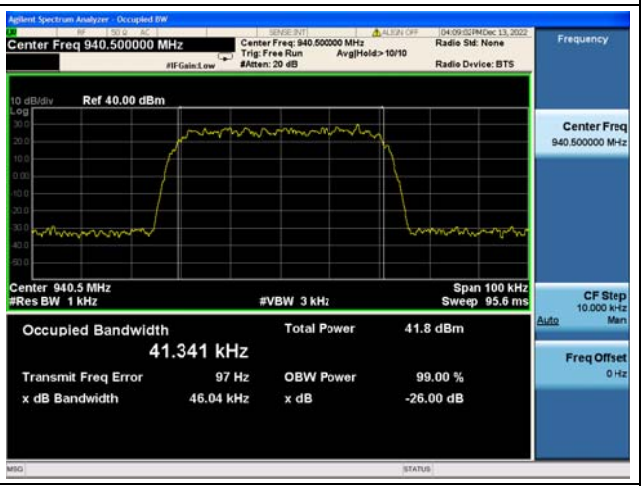


940.50MHz/Channel V/25.0 kHz/64QAM

940.50MHz/Channel V/25.0 kHz/256QAM

940.50MHz/Channel V/50.0 kHz/QPSK

940.50MHz/Channel V/50.0 kHz/16QAM



940.50MHz/Channel V/50.0 kHz/64QAM

940.50MHz/Channel V/50.0 kHz/256QAM

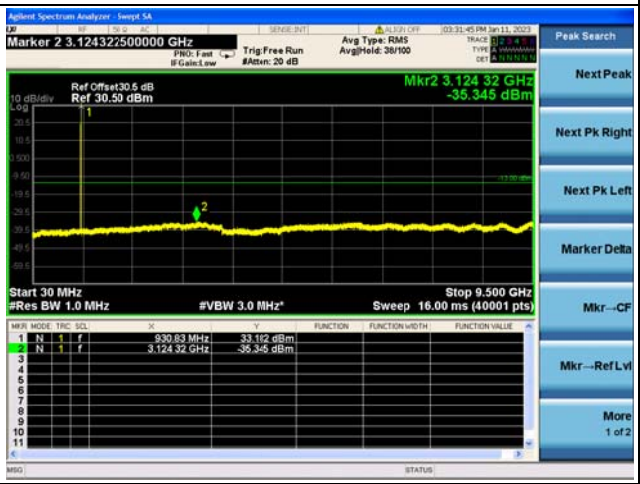
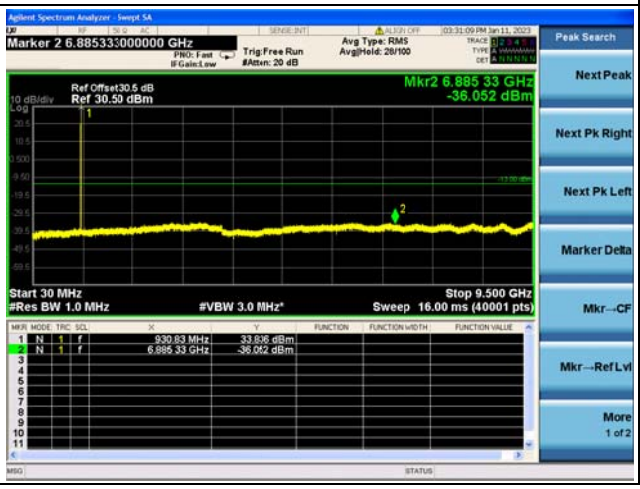
2.3. Spurious Emissions At Antenna Terminals

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**