TEST REPORT

APPLICANT	:	MiMOMax Wireless Limited
PRODUCT NAME	:	900MHz TornadoXR Transceiver
MODEL NAME	:	MWL-TORNADOX-*G*A/B/C
BRAND NAME	:	MiMOMax Wireless
FCC ID	:	XMK-MMXTRNXB003
STANDARD(S)	:	47 CFR Part 2 47 CFR Part 24
RECEIPT DATE	:	2022-11-30
TEST DATE	:	2022-12-05 to 2023-02-02
ISSUE DATE	:	2023-02-23

Tested by: Li Huaijie (Rapporteur)

Approved by: Shen Junsheng(Supervisor)

NOTE: This document is issued by Shenzhen Morlab Communication Technology Co., Ltd., the test report shall not be reproduced except in full without prior written permission of the company. The test results apply only to the particular sample(s) tested and to the specific tests carried out which is available on request for validation and information confirmed at our website.

MORLAB

Shenzhen Morlab Communication Technology Co., Ltd.
FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road,
Block67, BaoAn District, ShenZhen , GuangDong Province, P. R. China

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

DIRECTORY

1. Technical Information ····· 3
1.1. Applicant and ManufacturerInformation ····· 3
1.2. Equipment Under Test (EUT) Description ····· 3
1.3. Test Standards and Results ····· 4
1.4. Environmental Conditions ····· 5
2. 47 CFR Part 2 and Part 24 Requirements ····· 6
2.1. Radio Frequency Power Output and E.R.P. ····· 6
2.2. Occupied Bandwidth ····· 9
2.3. Spurious Emissions At Antenna Terminals ····· 20
2.4. Radiated Spurious Emissions ····· 54
2.5. Frequency Stability ····· 57
Annex A Test Uncertainty ····· 61
Annex B Testing Laboratory Information ····· 62

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 TornadoXR 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	2022/12/05-2022/12/07	Li Huaijie	PASS	No deviation
2.1049	Occupied Bandwidth	2022/12/05-2022/12/07	Li Huaijie	PASS	No deviation
2.1051 24.133	Conducted Spurious Emissions	2022/12/05-2023/02/02	Li Huaijie	PASS	No deviation
2.1053 24.133	Radiated Spurious Emissions	2023/01/10	Li Hanbin	PASS	No deviation
2.1055 24.135	Frequency stability	2022/12/05-2022/12/07	Li Huaijie	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 0.5dB 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	33.64	2.312	2.50	35.49	3.540	47.49	56.105
12.5	16QAM	24	33.66	2.323	2.50	35.51	3.556	47.51	56.364
12.5	64QAM	24	33.73	2.360	2.50	35.58	3.614	47.58	57.280
12.5	256QAM	24	34.00	2.512	2.50	35.85	3.846	47.85	60.954
25.0	QPSK	24	33.24	2.109	2.50	35.09	3.228	47.09	51.168
25.0	16QAM	24	33.22	2.099	2.50	35.07	3.214	47.07	50.933
25.0	64QAM	24	33.44	2.208	2.50	35.29	3.381	47.29	53.580
25.0	256QAM	24	33.45	2.213	2.50	35.30	3.388	47.30	53.703
50.0	QPSK	24	33.93	2.472	2.50	35.78	3.784	47.78	59.979
50.0	16QAM	24	33.90	2.455	2.50	35.75	3.758	47.75	59.566
50.0	64QAM	24	34.25	2.661	2.50	36.10	4.074	48.10	64.565
50.0	256QAM	24	34.32	2.704	2.50	36.17	4.140	48.17	65.615

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	33.76	2.377	2.50	35.61	3.639	47.61	57.677
12.5	16QAM	24	33.79	2.393	2.50	35.64	3.664	47.64	58.076
12.5	64QAM	24	33.98	2.500	2.50	35.83	3.828	47.83	60.674
12.5	256QAM	24	34.06	2.547	2.50	35.91	3.899	47.91	61.802

25.0	QPSK	24	33.41	2.193	2.50	35.26	3.357	47.26	53.211
25.0	16QAM	24	33.42	2.198	2.50	35.27	3.365	47.27	53.333
25.0	64QAM	24	33.59	2.286	2.50	35.44	3.499	47.44	55.463
25.0	256QAM	24	33.63	2.307	2.50	35.48	3.532	47.48	55.976
50.0	QPSK	24	34.12	2.582	2.50	35.97	3.954	47.97	62.661
50.0	16QAM	24	34.60	2.884	2.50	36.45	4.416	48.45	69.984
50.0	64QAM	24	34.28	2.679	2.50	36.13	4.102	48.13	65.013
50.0	256QAM	24	34.28	2.679	2.50	36.13	4.102	48.13	65.013

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	33.60	2.291	2.50	35.45	3.508	47.45	55.590
12.5	16QAM	24	33.62	2.301	2.50	35.47	3.524	47.47	55.847
12.5	64QAM	24	33.84	2.421	2.50	35.69	3.707	47.69	58.749
12.5	256QAM	24	33.72	2.355	2.50	35.57	3.606	47.57	57.148
25.0	QPSK	24	33.27	2.123	2.50	35.12	3.251	47.12	51.523
25.0	16QAM	24	33.34	2.158	2.50	35.19	3.304	47.19	52.360
25.0	64QAM	24	33.40	2.188	2.50	35.25	3.350	47.25	53.088
25.0	256QAM	24	33.70	2.344	2.50	35.55	3.589	47.55	56.885
50.0	QPSK	24	33.83	2.415	2.50	35.68	3.698	47.68	58.614
50.0	16QAM	24	33.78	2.388	2.50	35.63	3.656	47.63	57.943
50.0	64QAM	24	34.08	2.559	2.50	35.93	3.917	47.93	62.087
50.0	256QAM	24	34.17	2.612	2.50	36.02	3.999	48.02	63.387

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	33.82	2.410	2.50	35.67	3.690	47.67	58.479

12.5	16QAM	24	33.72	2.355	2.50	35.57	3.606	47.57	57.148
12.5	64QAM	24	33.81	2.404	2.50	35.66	3.681	47.66	58.345
12.5	256QAM	24	33.77	2.382	2.50	35.62	3.648	47.62	57.810
25.0	QPSK	24	33.40	2.188	2.50	35.25	3.350	47.25	53.088
25.0	16QAM	24	33.33	2.153	2.50	35.18	3.296	47.18	52.240
25.0	64QAM	24	33.53	2.254	2.50	35.38	3.451	47.38	54.702
25.0	256QAM	24	33.51	2.244	2.50	35.36	3.436	47.36	54.450
50.0	QPSK	24	34.19	2.624	2.50	36.04	4.018	48.04	63.680
50.0	16QAM	24	34.08	2.559	2.50	35.93	3.917	47.93	62.087
50.0	64QAM	24	34.21	2.636	2.50	36.06	4.036	48.06	63.973
50.0	256QAM	24	34.25	2.661	2.50	36.10	4.074	48.10	64.565

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 0.5dB 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

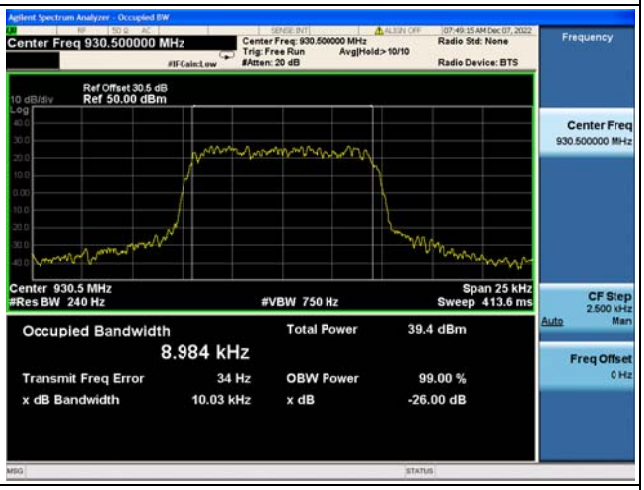
Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	8.991
		16QAM	8.984
		64QAM	9.045
		256QAM	9.028
	25.0	QPSK	18.721
		16QAM	18.598
		64QAM	18.828
		256QAM	18.842
	50.0	QPSK	41.545
		16QAM	41.493
		64QAM	41.516
		256QAM	41.239
Channel V	12.5	QPSK	8.966
		16QAM	9.103
		64QAM	8.990
		256QAM	9.037
	25.0	QPSK	18.628
		16QAM	18.735
		64QAM	18.697
		256QAM	18.778
	50.0	QPSK	41.332
		16QAM	41.476
		64QAM	41.320
		256QAM	41.735

Nominal Frequency: 940.50 MHz

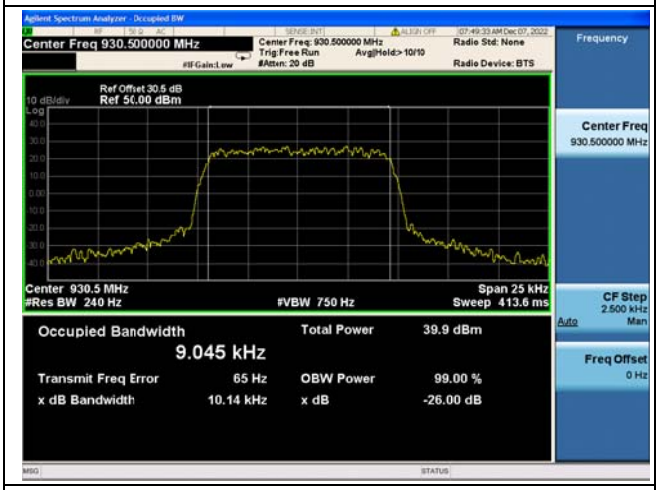
Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
Channel H	12.5	QPSK	8.890
		16QAM	8.956
		64QAM	9.083
		256QAM	9.010
	25.0	QPSK	18.891
		16QAM	18.692
		64QAM	19.001
		256QAM	18.691
	50.0	QPSK	41.272
		16QAM	41.303
		64QAM	41.699
		256QAM	42.012
Channel V	12.5	QPSK	9.014
		16QAM	9.070
		64QAM	8.955
		256QAM	9.024
	25.0	QPSK	18.862
		16QAM	18.634
		64QAM	18.825
		256QAM	18.626
	50.0	QPSK	41.438
		16QAM	41.243
		64QAM	41.520
		256QAM	41.505

930.50MHz/Channel H/12.5kHz/QPSK

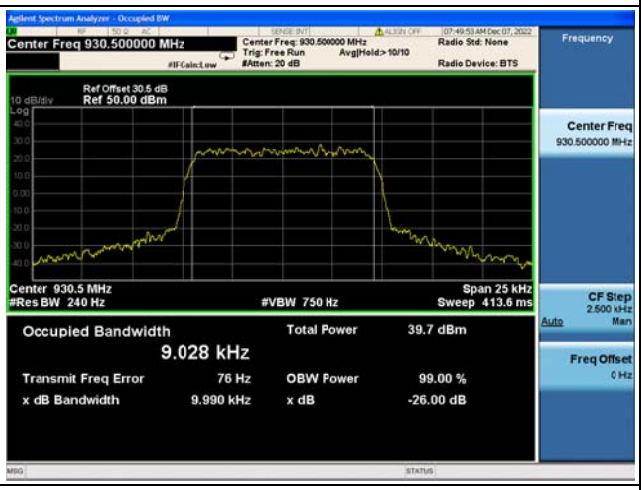
930.50MHz/Channel H/12.5kHz/16QAM



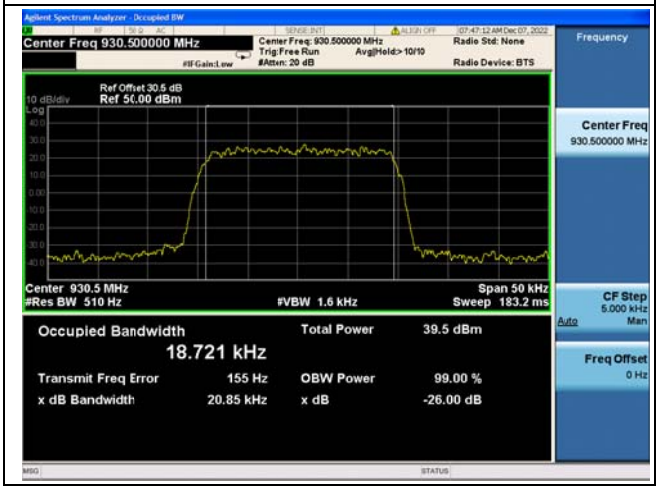
930.50MHz/Channel H/12.5kHz/64QAM



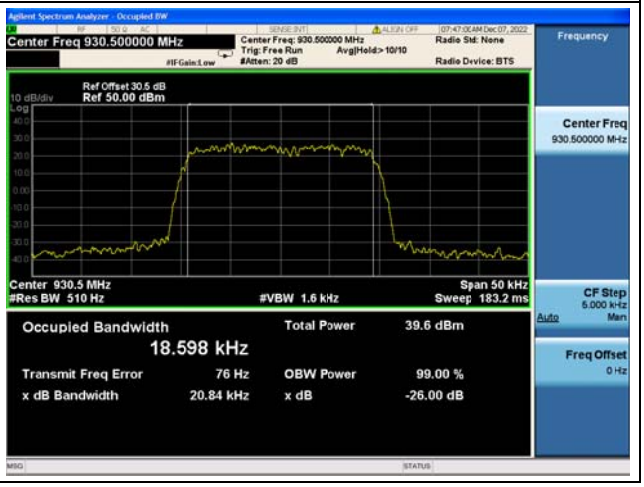
930.50MHz/Channel H/12.5 kHz/256QAM



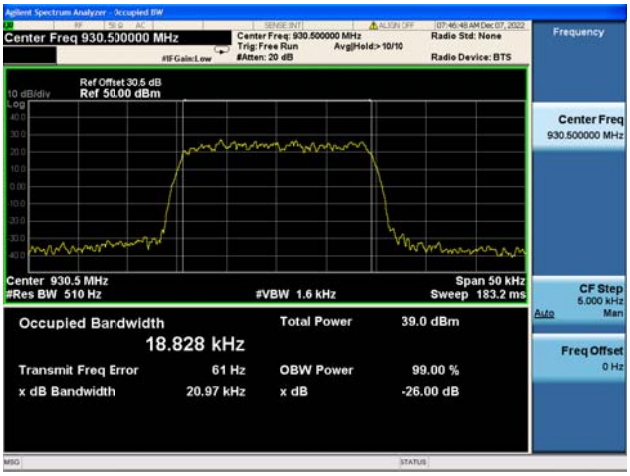
930.50MHz/Channel H/25.0 kHz/QPSK



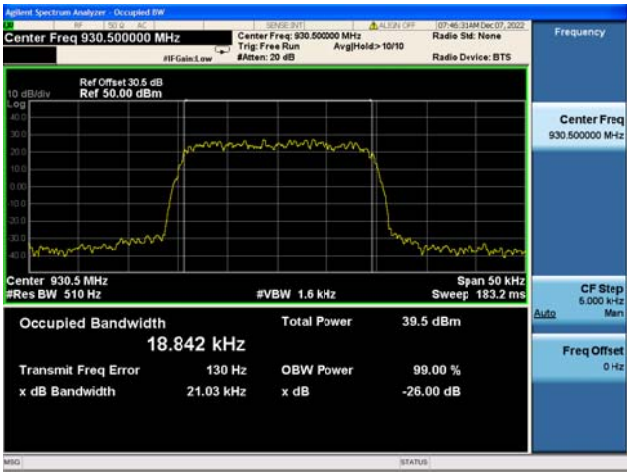
930.50MHz/Channel H/25.0 kHz/16QAM



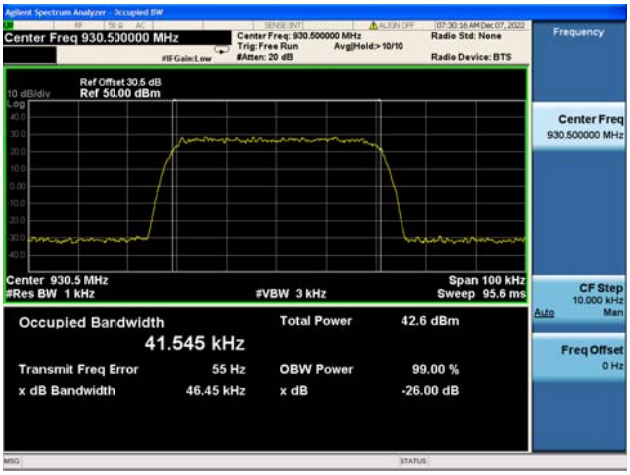
930.50MHz/Channel H/25.0 kHz/64QAM



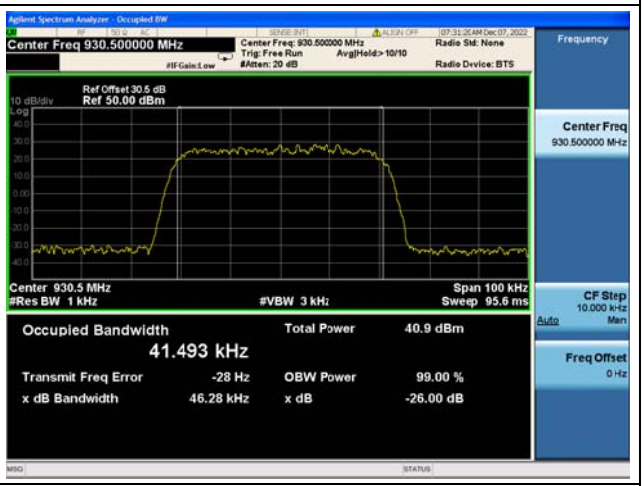
930.50MHz/Channel H/25.0 kHz/256QAM



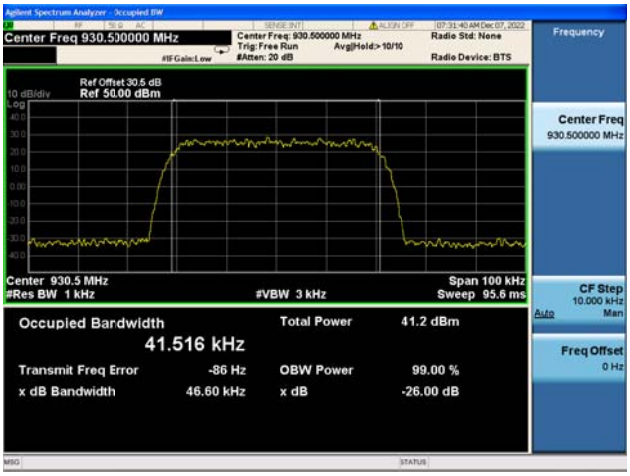
930.50MHz/Channel H/50.0 kHz/QPSK



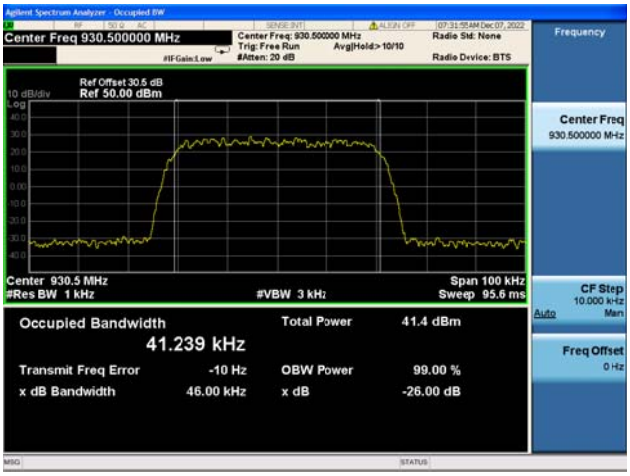
930.50MHz/Channel H/50.0 kHz/16QAM



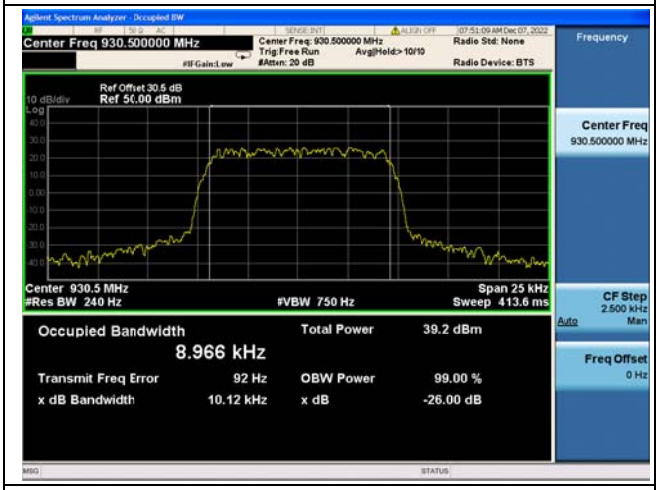
930.50MHz/Channel H/50.0 kHz/64QAM



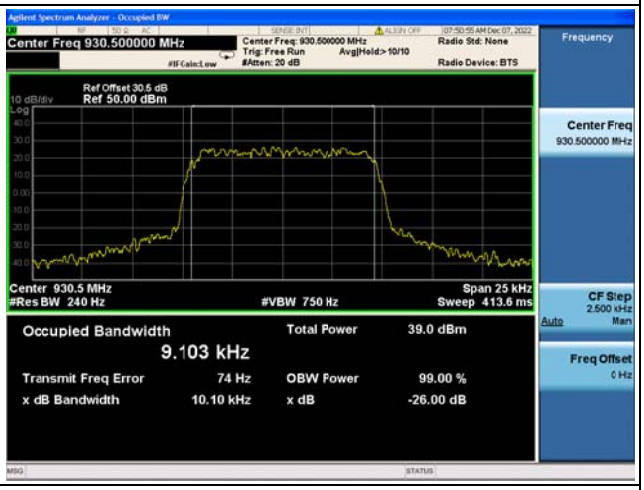
930.50MHz/Channel H/50.0 kHz/256QAM



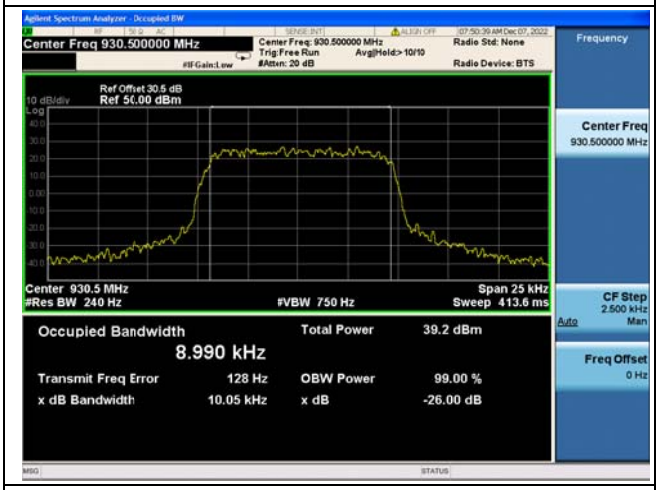
930.50MHz/Channel V/12.5kHz/QPSK



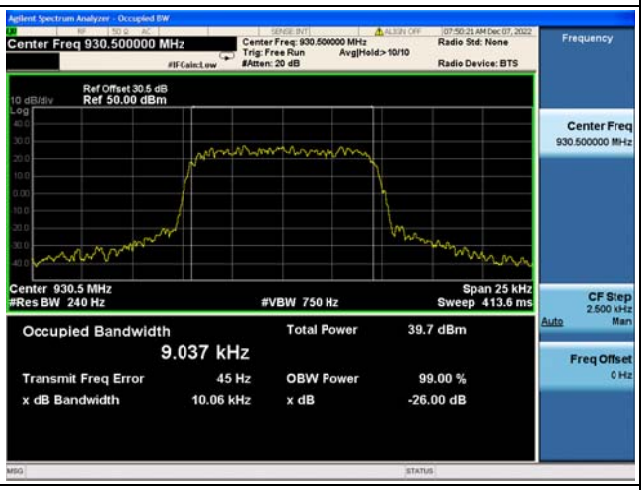
930.50MHz/Channel V/12.5kHz/16QAM



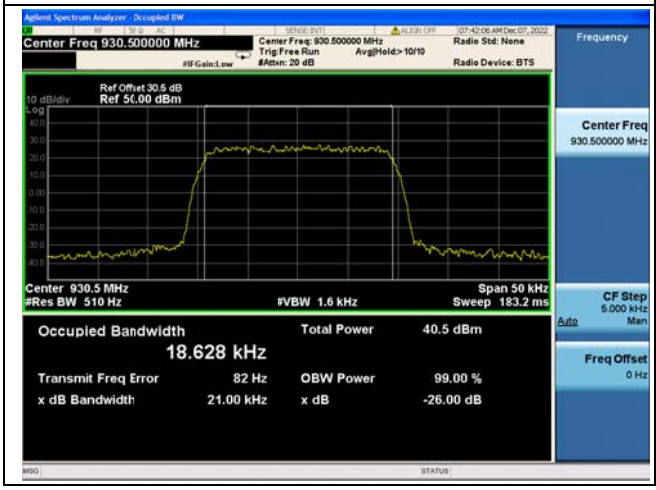
930.50MHz/Channel V/12.5kHz/64QAM



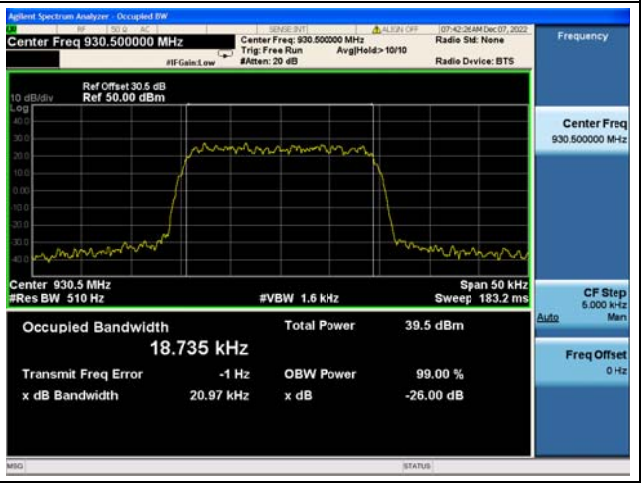
930.50MHz/Channel V/12.5 kHz/256QAM



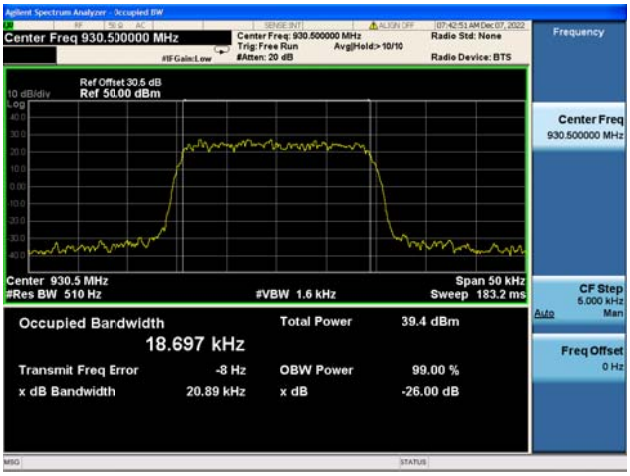
930.50MHz/Channel V/25.0 kHz/QPSK



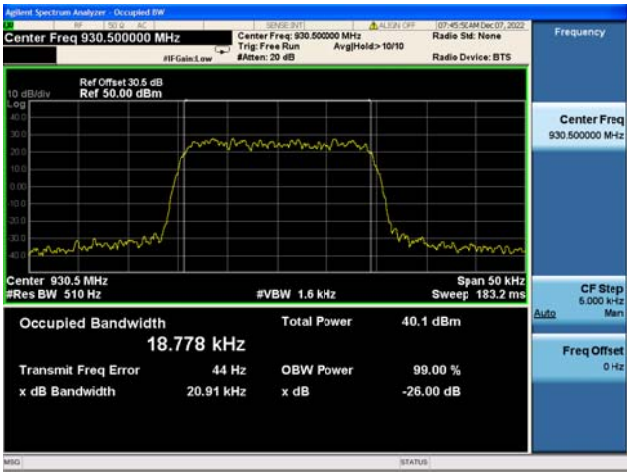
930.50MHz/Channel V/25.0 kHz/16QAM



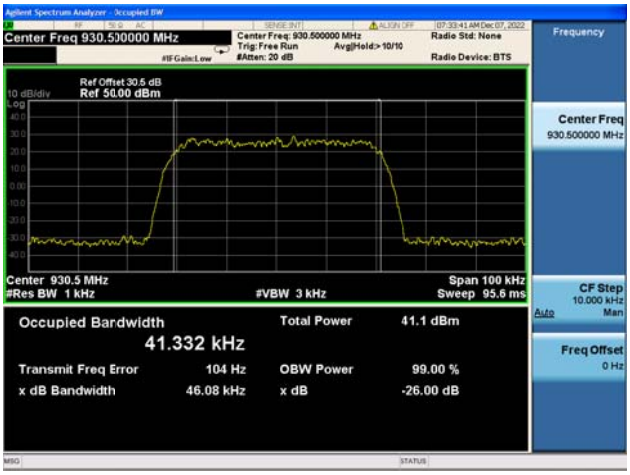
930.50MHz/Channel V/25.0 kHz/64QAM



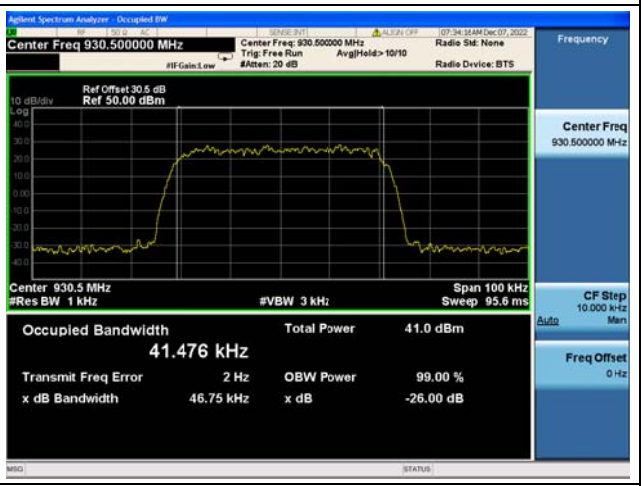
930.50MHz/Channel V/25.0 kHz/256QAM



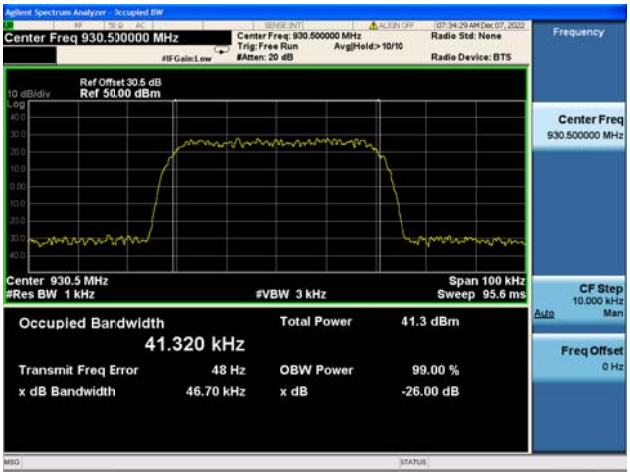
930.50MHz/Channel V/50.0 kHz/QPSK



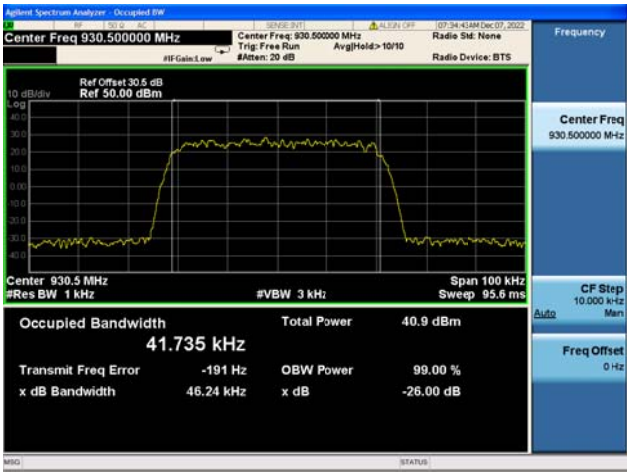
930.50MHz/Channel V/50.0 kHz/16QAM



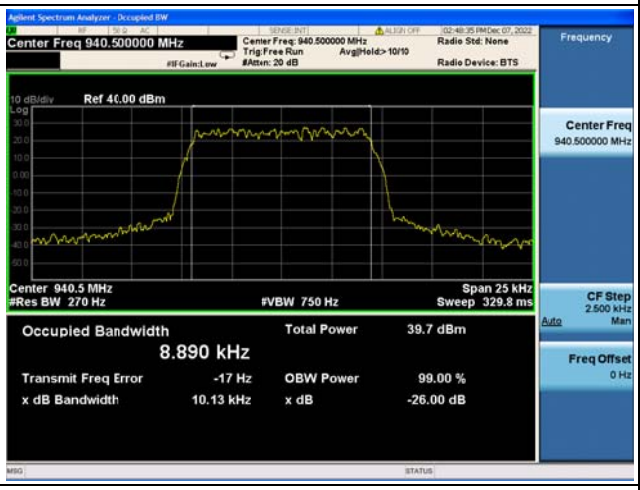
930.50MHz/Channel V/50.0 kHz/64QAM



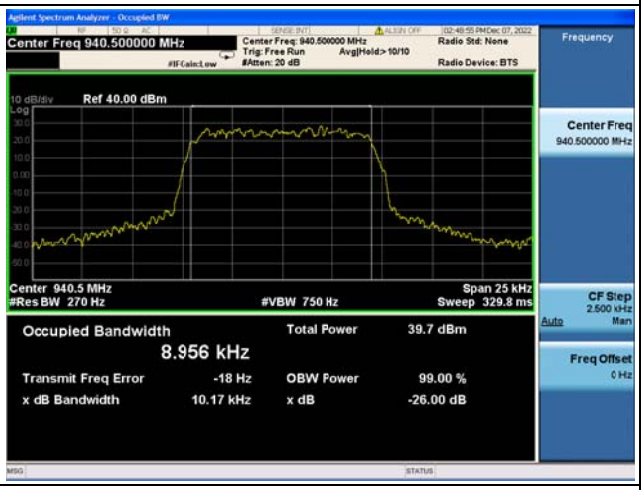
930.50MHz/Channel V/50.0 kHz/256QAM



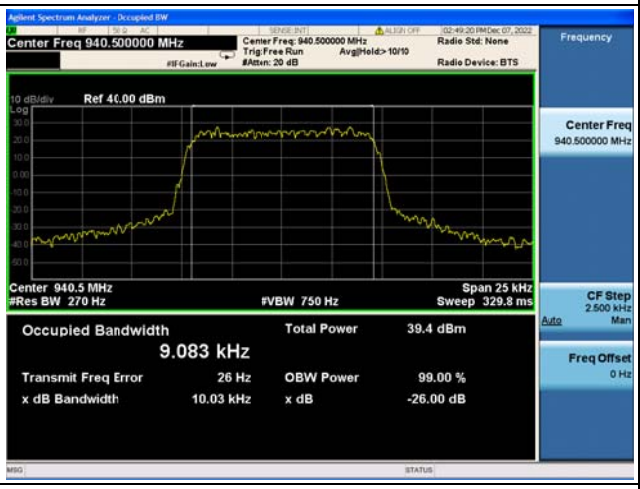
940.50MHz/Channel H/12.5kHz/QPSK



940.50MHz/Channel H/12.5kHz/16QAM

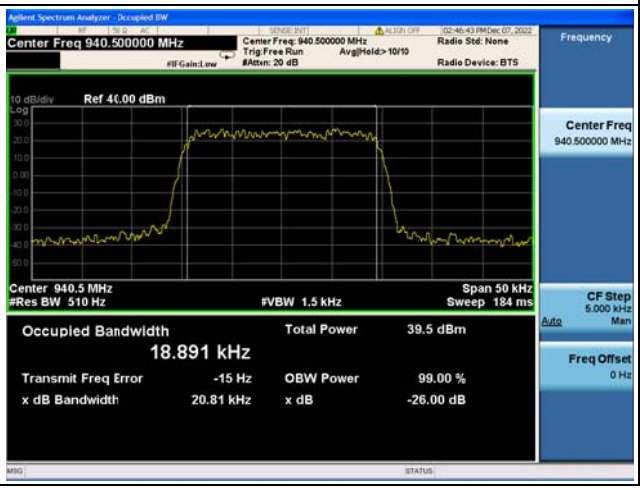


940.50MHz/Channel H/12.5kHz/64QAM

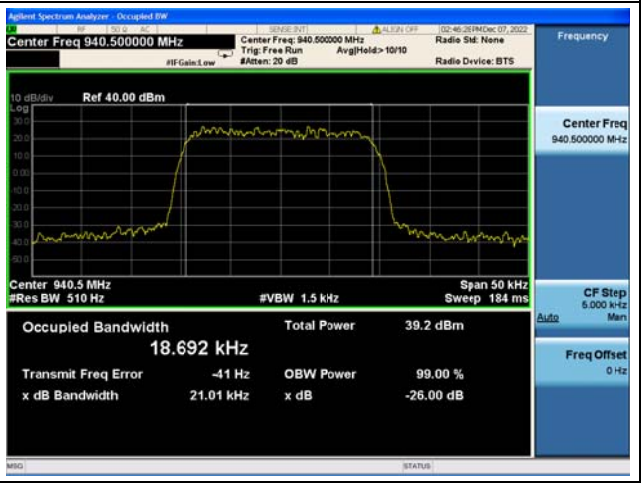


940.50MHz/Channel H/12.5 kHz/256QAM

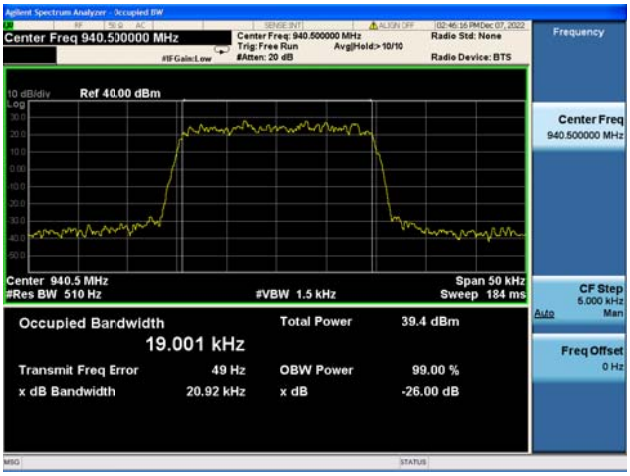
940.50MHz/Channel H/25.0 kHz/QPSK



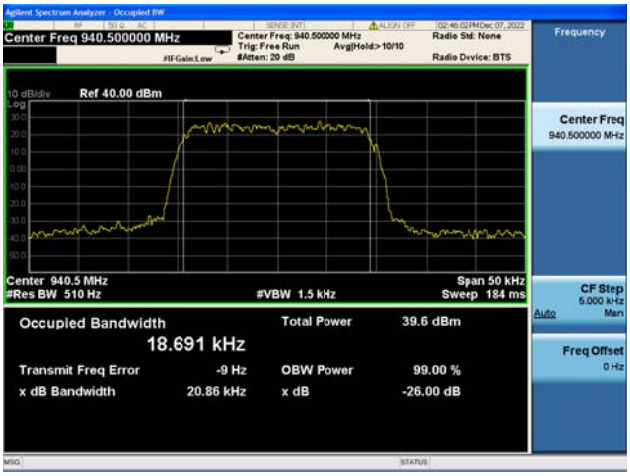
940.50MHz/Channel H/25.0 kHz/16QAM



940.50MHz/Channel H/25.0 kHz/64QAM



940.50MHz/Channel H/25.0 kHz/256QAM

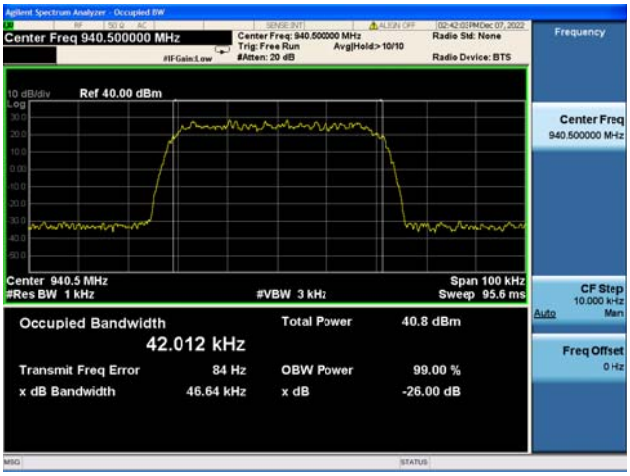


940.50MHz/Channel H/50.0 kHz/QPSK

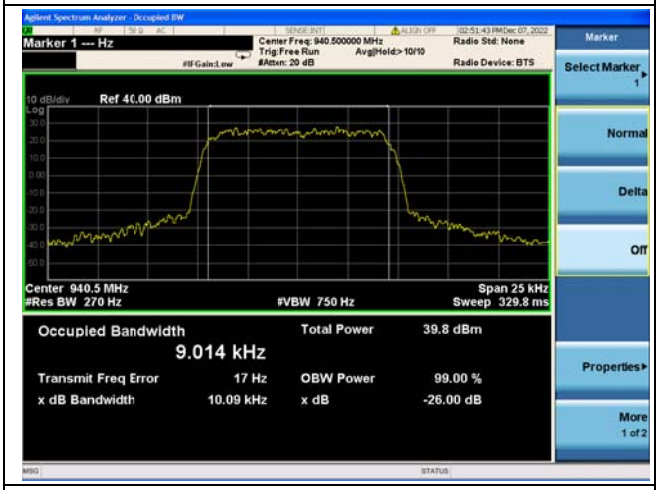
940.50MHz/Channel H/50.0 kHz/16QAM

940.50MHz/Channel H/50.0 kHz/64QAM

940.50MHz/Channel H/50.0 kHz/256QAM

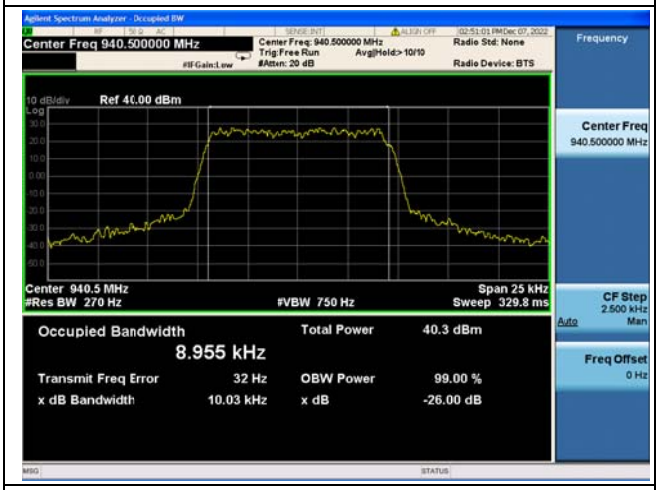


940.50MHz/Channel V/12.5kHz/QPSK



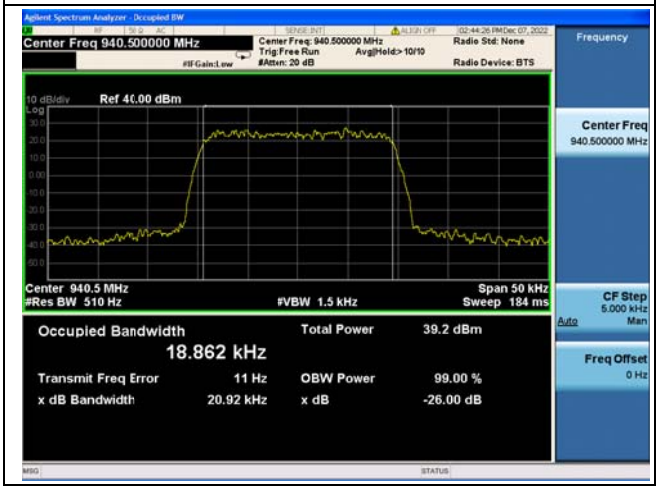
940.50MHz/Channel V/12.5kHz/16QAM

940.50MHz/Channel V/12.5kHz/64QAM

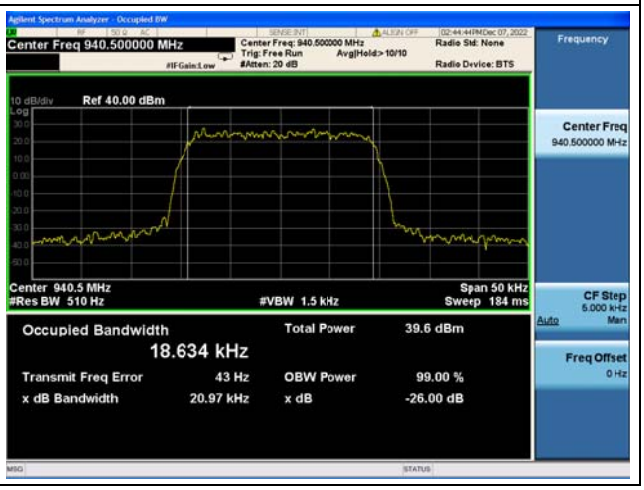


940.50MHz/Channel V/12.5 kHz/256QAM

940.50MHz/Channel V/25.0 kHz/QPSK

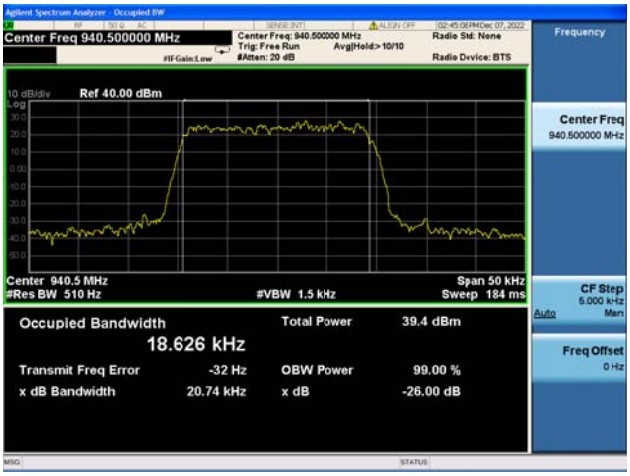


940.50MHz/Channel V/25.0 kHz/16QAM

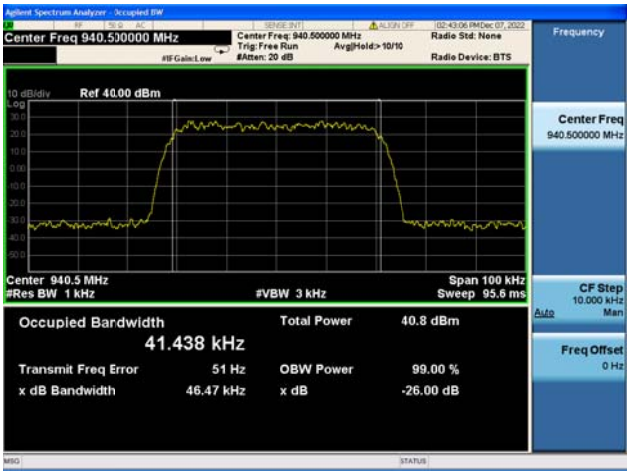


940.50MHz/Channel V/25.0 kHz/64QAM

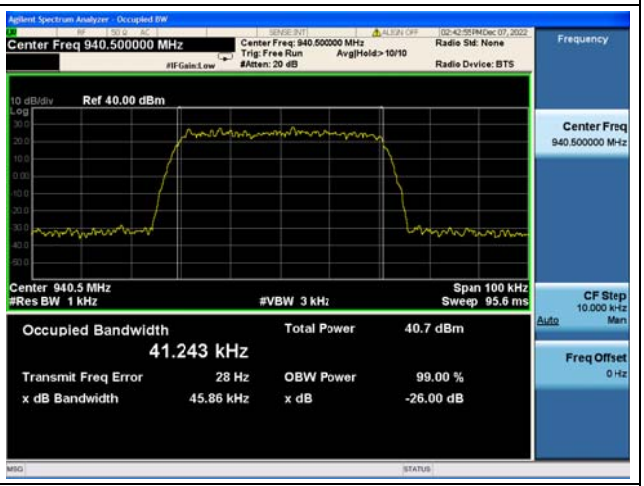
940.50MHz/Channel V/25.0 kHz/256QAM



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

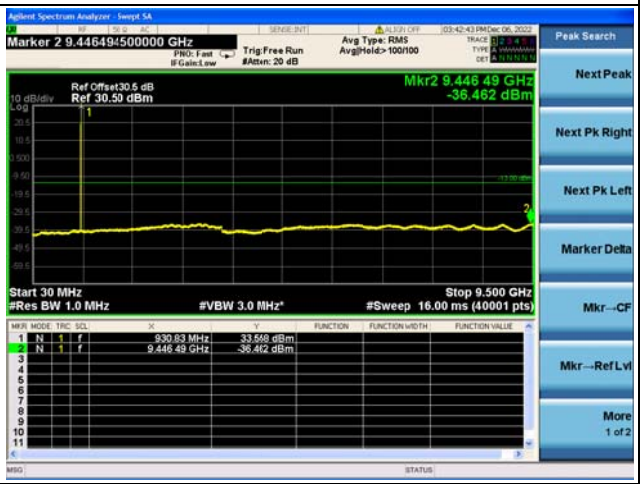
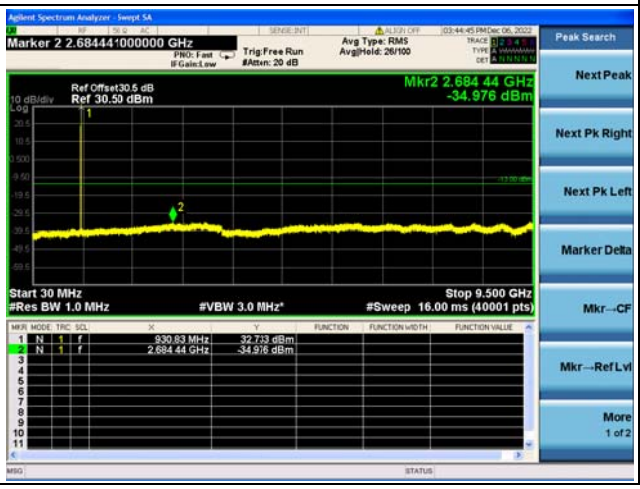
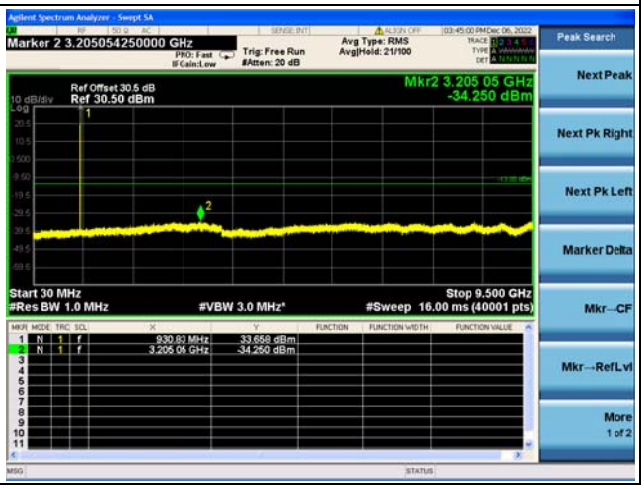
2.3. Spurious Emissions At Antenna Terminals

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**