



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-MMXTRNXB005

STANDARD(S) : 47 CFR Part 2
: 47 CFR Part 24

RECEIPT DATE : 2022-11-30

TEST DATE : 2022-12-05 to 2023-10-10

ISSUE DATE : 2023-11-10



Tested by: Li Huaijie
Li Huaijie (Rapporteur)

Approved by: Shen Junsheng
Shen Junsheng(Supervisor)

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Change History		
Issue	Date	Reason for change
1.0	2023-11-10	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 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:	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
		10.0 dBi
	Panel Antenna	8.0 dBi
		12.0 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- 2023/09/21	Li Huaijie	PASS	No deviation
2.1049	Occupied Bandwidth	2022/12/05- 2023/09/21	Li Huaijie	PASS	No deviation
2.1051 24.133	Conducted Spurious Emissions	2022/12/05- 2023/09/21	Li Huaijie	PASS	No deviation
2.1053 24.133	Radiated Spurious Emissions	2023/01/10- 2023/10/10	Gao Jianrou	PASS	No deviation
2.1055 24.135	Frequency stability	2022/12/05- 2023/09/21	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.

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



Note 6: This is a variant report of original report (Report No.: SZ22110153W01, FCC ID: XMK-MMXTRNXB003), only change 901-902MHz RF power by software and add a 6dBi antenna, apply for new FCC ID certification. No other changes.

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

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	27.50	0.562	0.63	29.35	0.861	37.35	5.433
12.5	16QAM	24	27.73	0.593	0.63	29.58	0.908	37.58	5.728
12.5	64QAM	24	27.81	0.604	0.63	29.66	0.925	37.66	5.834
12.5	256QAM	24	27.91	0.618	0.63	29.76	0.946	37.76	5.970
25.0	QPSK	24	28.13	0.650	0.63	29.98	0.995	37.98	6.281
25.0	16QAM	24	27.81	0.604	0.63	29.66	0.925	37.66	5.834
25.0	64QAM	24	27.95	0.624	0.63	29.80	0.955	37.80	6.026
25.0	256QAM	24	28.02	0.634	0.63	29.87	0.971	37.87	6.124
50.0	QPSK	24	28.03	0.635	0.63	29.88	0.973	37.88	6.138
50.0	16QAM	24	27.82	0.605	0.63	29.67	0.927	37.67	5.848
50.0	64QAM	24	28.06	0.640	0.63	29.91	0.979	37.91	6.180
50.0	256QAM	24	28.11	0.647	0.63	29.96	0.991	37.96	6.252

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	28.20	0.661	0.63	30.05	1.012	38.05	6.383
12.5	16QAM	24	28.07	0.641	0.63	29.92	0.982	37.92	6.194
12.5	64QAM	24	28.21	0.662	0.63	30.06	1.014	38.06	6.397
12.5	256QAM	24	27.93	0.621	0.63	29.78	0.951	37.78	5.998
25.0	QPSK	24	27.85	0.610	0.63	29.70	0.933	37.70	5.888



25.0	16QAM	24	28.00	0.631	0.63	29.85	0.966	37.85	6.095
25.0	64QAM	24	27.93	0.621	0.63	29.78	0.951	37.78	5.998
25.0	256QAM	24	27.94	0.622	0.63	29.79	0.953	37.79	6.012
50.0	QPSK	24	27.66	0.583	0.63	29.51	0.893	37.51	5.636
50.0	16QAM	24	28.13	0.650	0.63	29.98	0.995	37.98	6.281
50.0	64QAM	24	27.84	0.608	0.63	29.69	0.931	37.69	5.875
50.0	256QAM	24	27.73	0.593	0.63	29.58	0.908	37.58	5.728

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	34.05	2.541	2.50	35.90	3.890	37.90	6.166
12.5	16QAM	24	34.01	2.518	2.50	35.86	3.855	37.86	6.109
12.5	64QAM	24	34.18	2.618	2.50	36.03	4.009	38.03	6.353
12.5	256QAM	24	34.21	2.636	2.50	36.06	4.036	38.06	6.397
25.0	QPSK	24	34.00	2.512	2.50	35.85	3.846	37.85	6.095
25.0	16QAM	24	34.11	2.576	2.50	35.96	3.945	37.96	6.252
25.0	64QAM	24	34.24	2.655	2.50	36.09	4.064	38.09	6.442
25.0	256QAM	24	34.30	2.692	2.50	36.15	4.121	38.15	6.531
50.0	QPSK	24	33.79	2.393	2.50	35.64	3.664	37.64	5.808
50.0	16QAM	24	33.71	2.350	2.50	35.56	3.597	37.56	5.702
50.0	64QAM	24	33.81	2.404	2.50	35.66	3.681	37.66	5.834
50.0	256QAM	24	33.91	2.460	2.50	35.76	3.767	37.76	5.970

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	34.25	2.661	2.50	36.10	4.074	38.10	6.457
12.5	16QAM	24	34.20	2.630	2.50	36.05	4.027	38.05	6.383



12.5	64QAM	24	34.31	2.698	2.50	36.16	4.130	38.16	6.546
12.5	256QAM	24	34.34	2.716	2.50	36.19	4.159	38.19	6.592
25.0	QPSK	24	34.15	2.600	2.50	36.00	3.981	38.00	6.310
25.0	16QAM	24	34.22	2.642	2.50	36.07	4.046	38.07	6.412
25.0	64QAM	24	34.39	2.748	2.50	36.24	4.207	38.24	6.668
25.0	256QAM	24	34.53	2.838	2.50	36.38	4.345	38.38	6.887
50.0	QPSK	24	34.14	2.594	2.50	35.99	3.972	37.99	6.295
50.0	16QAM	24	34.12	2.582	2.50	35.97	3.954	37.97	6.266
50.0	64QAM	24	34.26	2.667	2.50	36.11	4.083	38.11	6.471
50.0	256QAM	24	34.32	2.704	2.50	36.17	4.140	38.17	6.561

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 .2512 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 12.6dBi can be used when the conducted power is 28dBm, or an antenna with a maximum gain of 6.6dBi 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

Type 1:

901.50 MHz			
Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
H	12.5	QPSK	8.945
		16QAM	8.942
		64QAM	8.940
		256QAM	8.985
	25.0	QPSK	18.787
		16QAM	18.705
		64QAM	18.735
		256QAM	18.696
	50.0	QPSK	41.275
		16QAM	41.395
		64QAM	41.132
		256QAM	41.416
V	12.5	QPSK	9.055
		16QAM	9.010
		64QAM	8.961
		256QAM	8.971
	25.0	QPSK	18.765
		16QAM	18.689
		64QAM	18.538
		256QAM	18.700
	50.0	QPSK	41.390
		16QAM	41.224
		64QAM	41.069
		256QAM	41.663

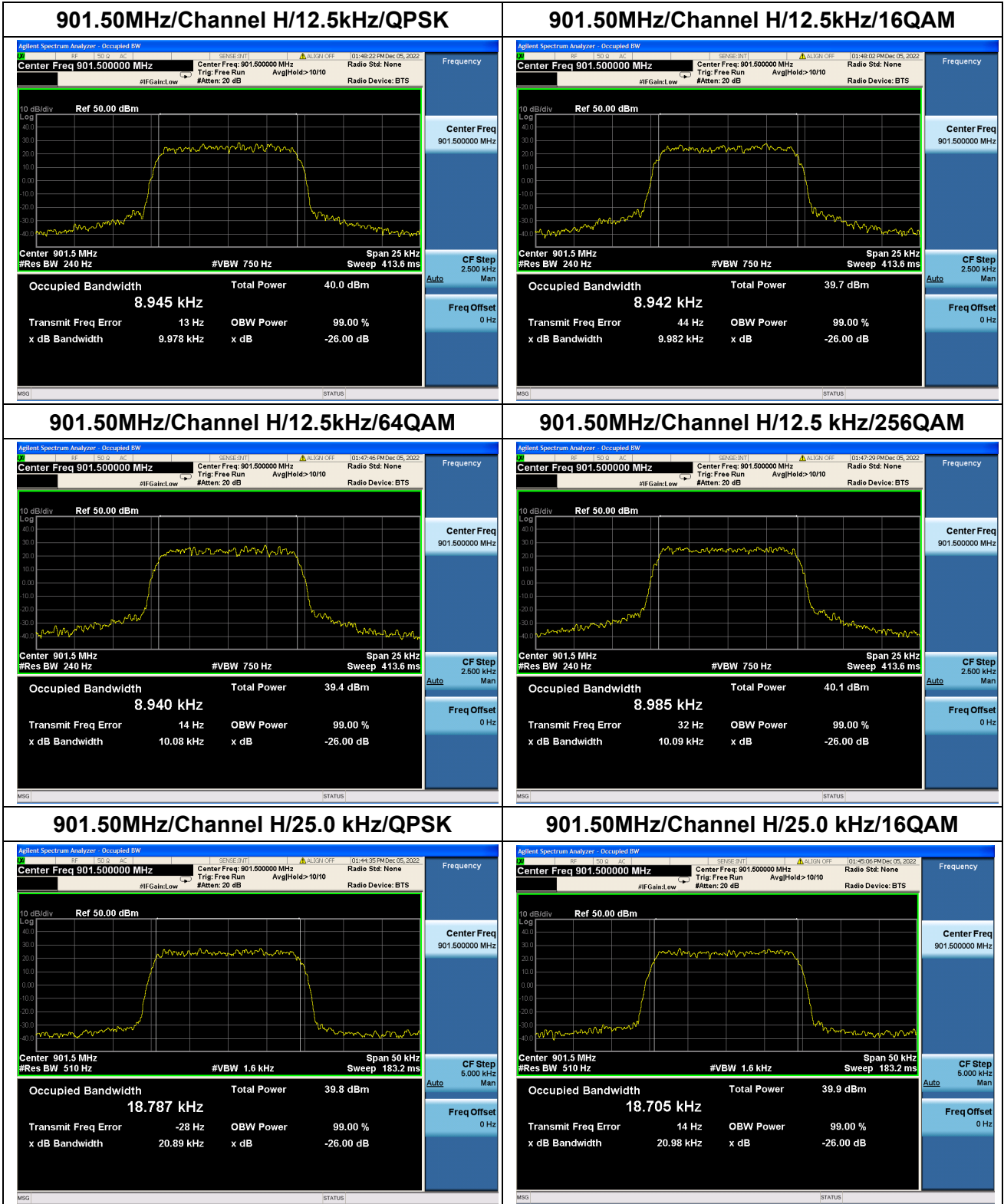


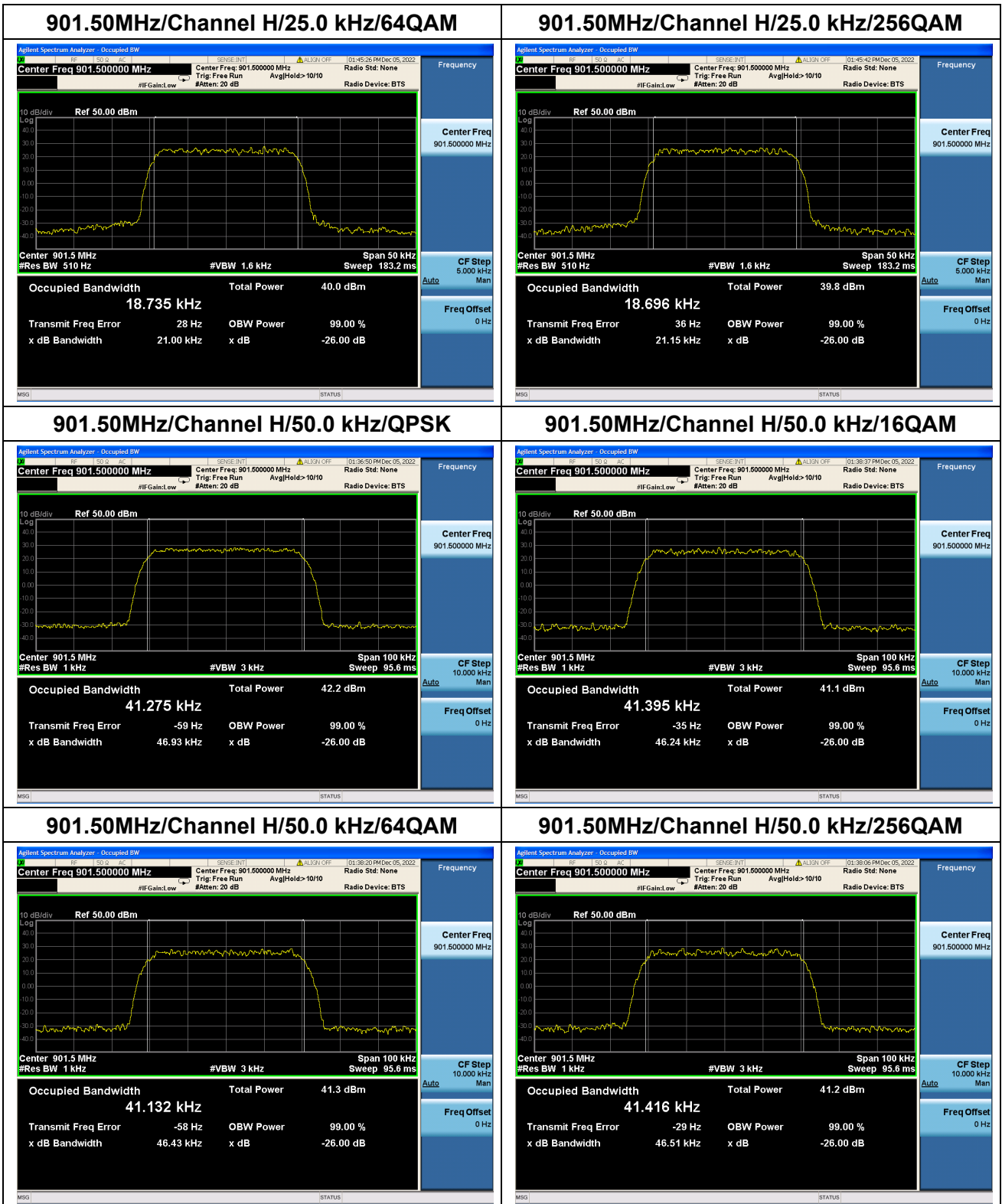
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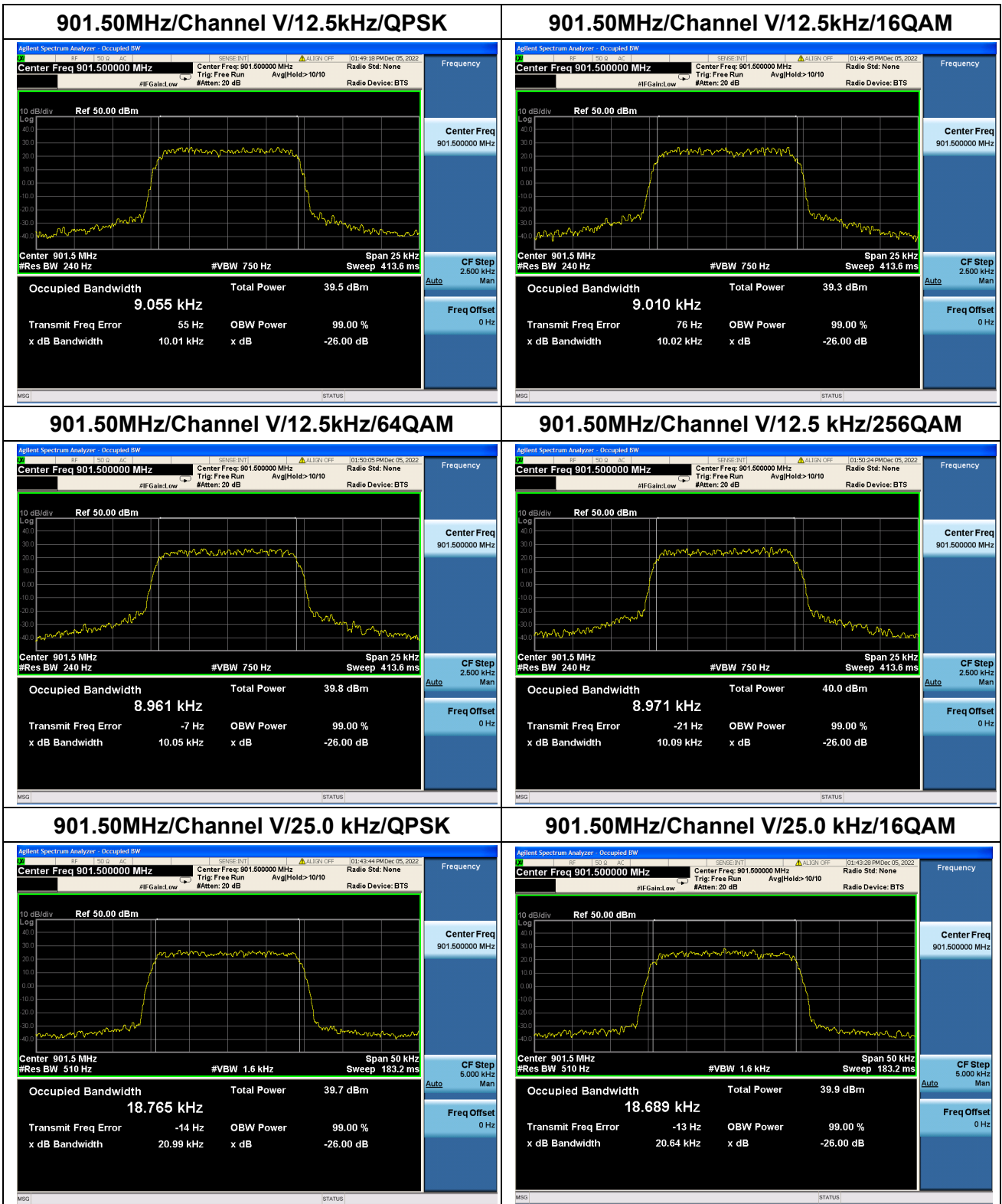
901.50 MHz			
Tx Port	Channel Bandwidth(kHz)	Emission Type	Occupied Bandwidth(kHz)
H	12.5	QPSK	8.946
		16QAM	9.004
		64QAM	8.984
		256QAM	9.087
	25.0	QPSK	18.615
		16QAM	18.745
		64QAM	18.669
		256QAM	18.707
	50.0	QPSK	41.410
		16QAM	41.380
		64QAM	41.275
		256QAM	41.312
V	12.5	QPSK	8.956
		16QAM	8.920
		64QAM	8.978
		256QAM	9.089
	25.0	QPSK	18.682
		16QAM	18.671
		64QAM	18.729
		256QAM	18.549
	50.0	QPSK	41.198
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		64QAM	41.105
		256QAM	41.281



Type 1:

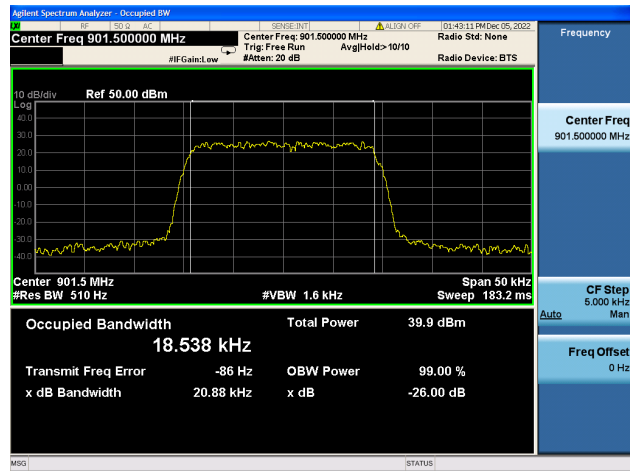




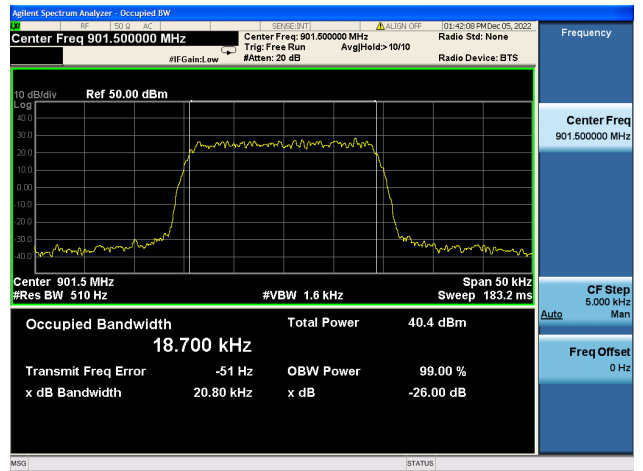




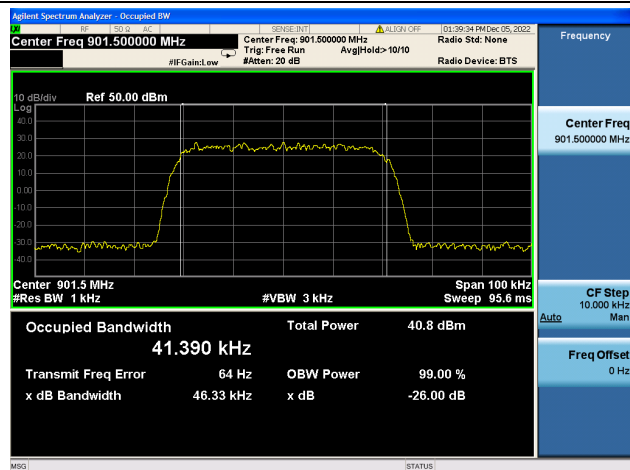
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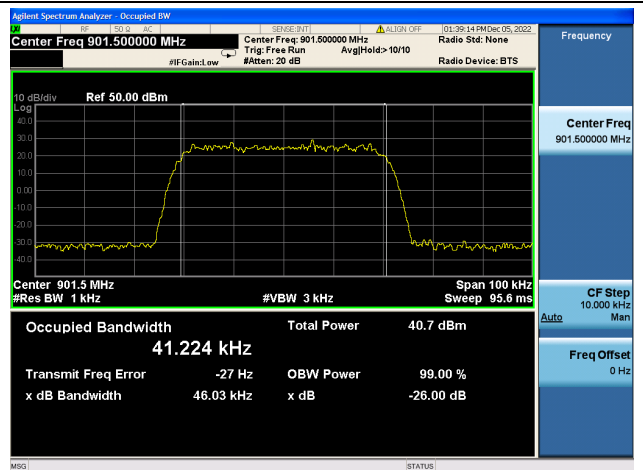
901.50MHz/Channel V/25.0 kHz/256QAM



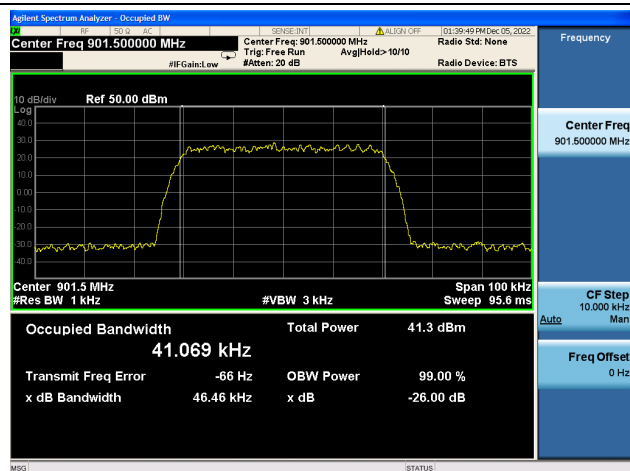
901.50MHz/Channel V/50.0 kHz/QPSK



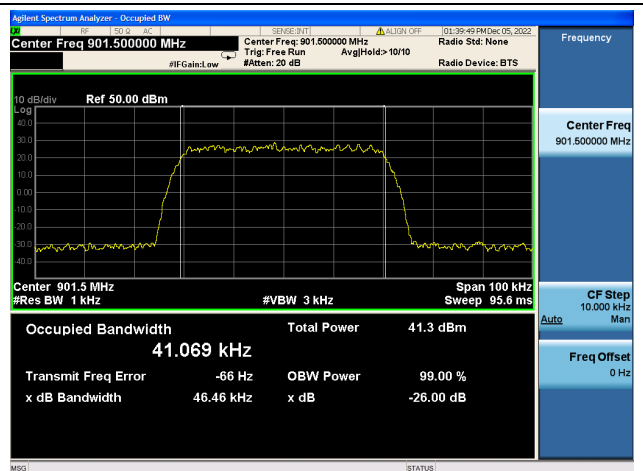
901.50MHz/Channel V/50.0 kHz/16QAM



901.50MHz/Channel V/50.0 kHz/64QAM

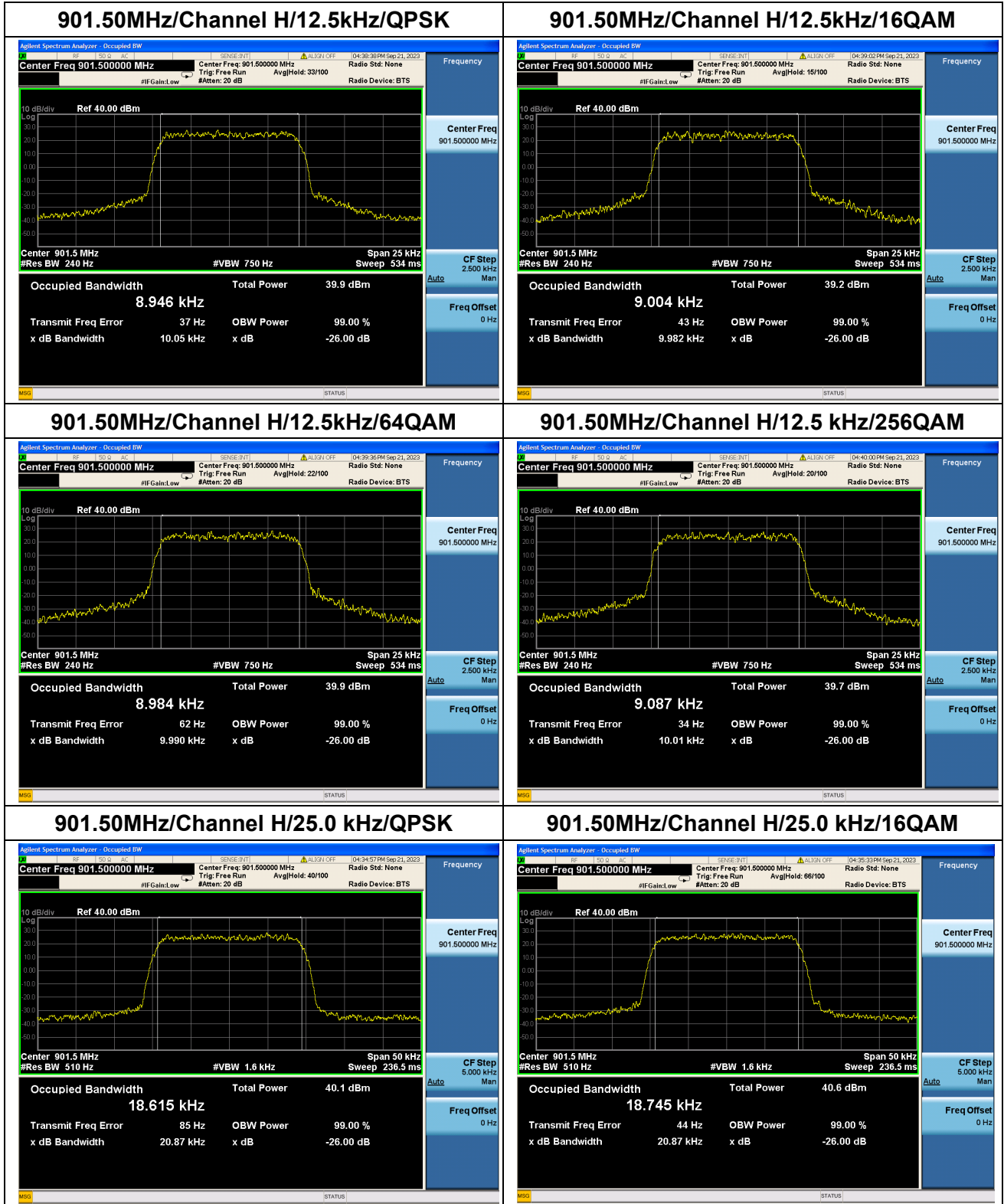


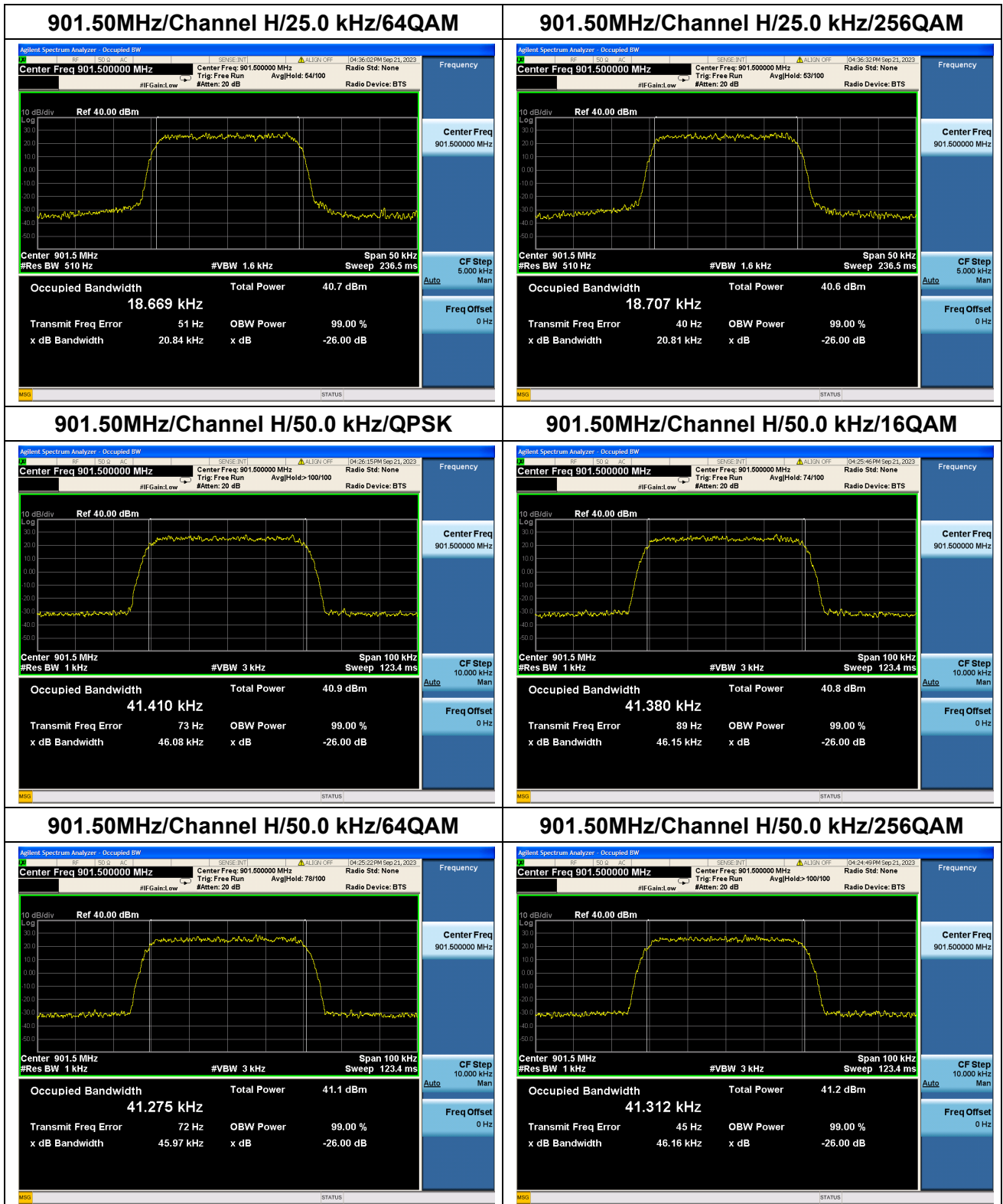
901.50MHz/Channel V/50.0 kHz/256QAM

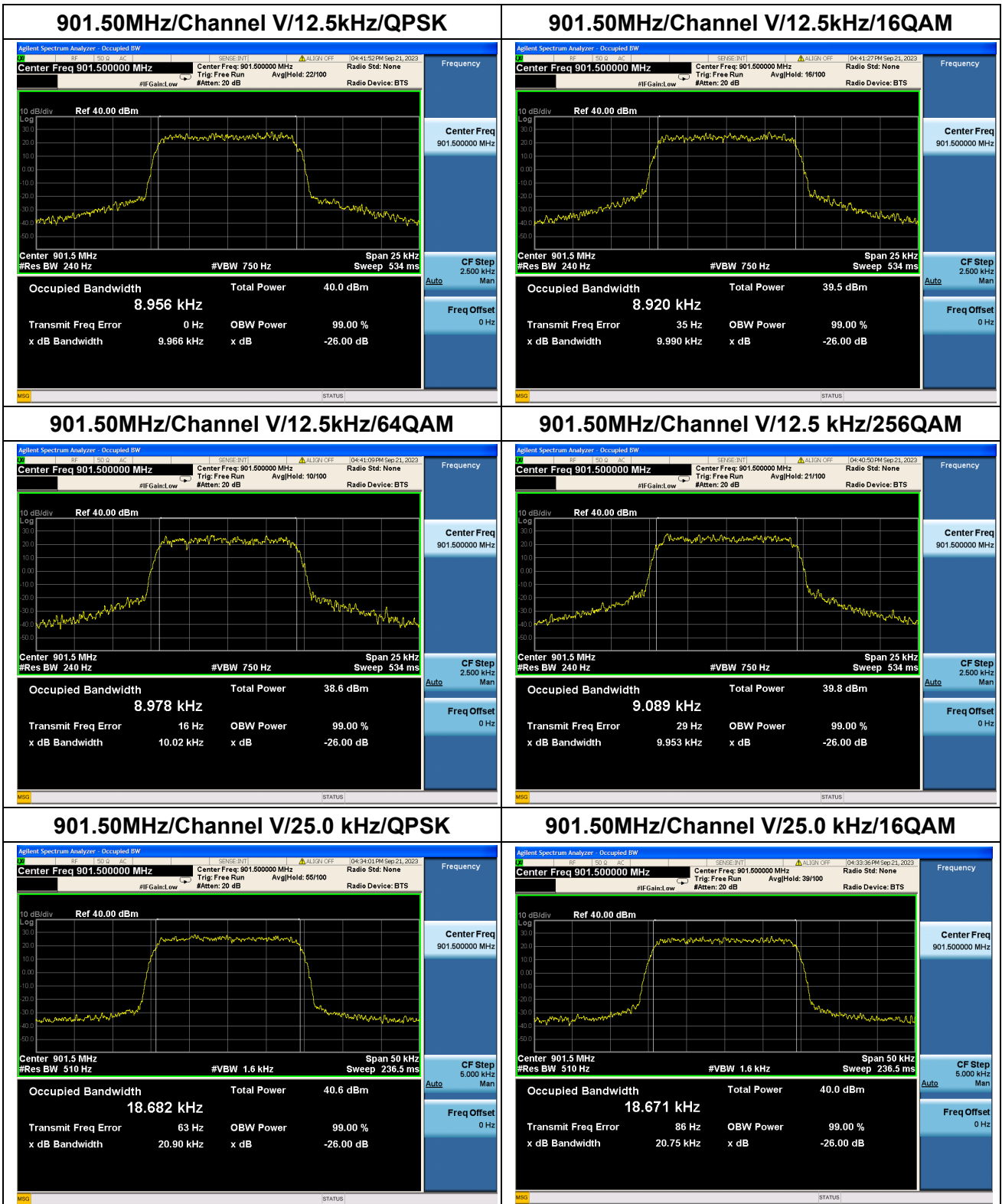


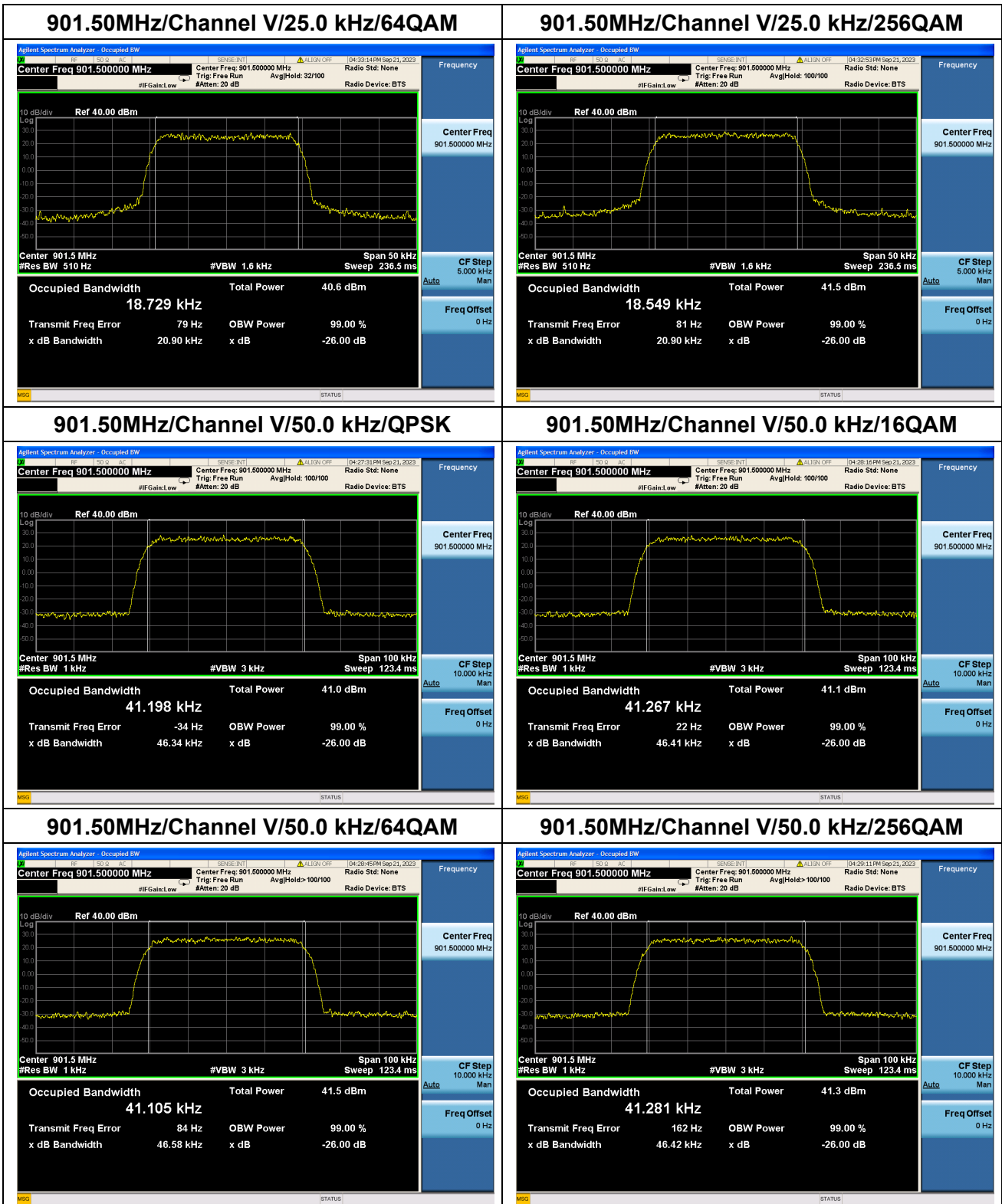


Type 2:











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 (f_d in kHz) of up to and including 40 kHz: at least $116 \text{ Log}_{10} ((f_d + 10)/6.1)$ decibels or $50 + 10 \text{ Log}_{10} (P)$ 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 (f_d in kHz) of more than 40 kHz: at least $43 + 10 \text{ Log}_{10} (P)$ decibels or 80 decibels, whichever is the lesser attenuation;

For transmitters authorized a bandwidth of 10 kHz:

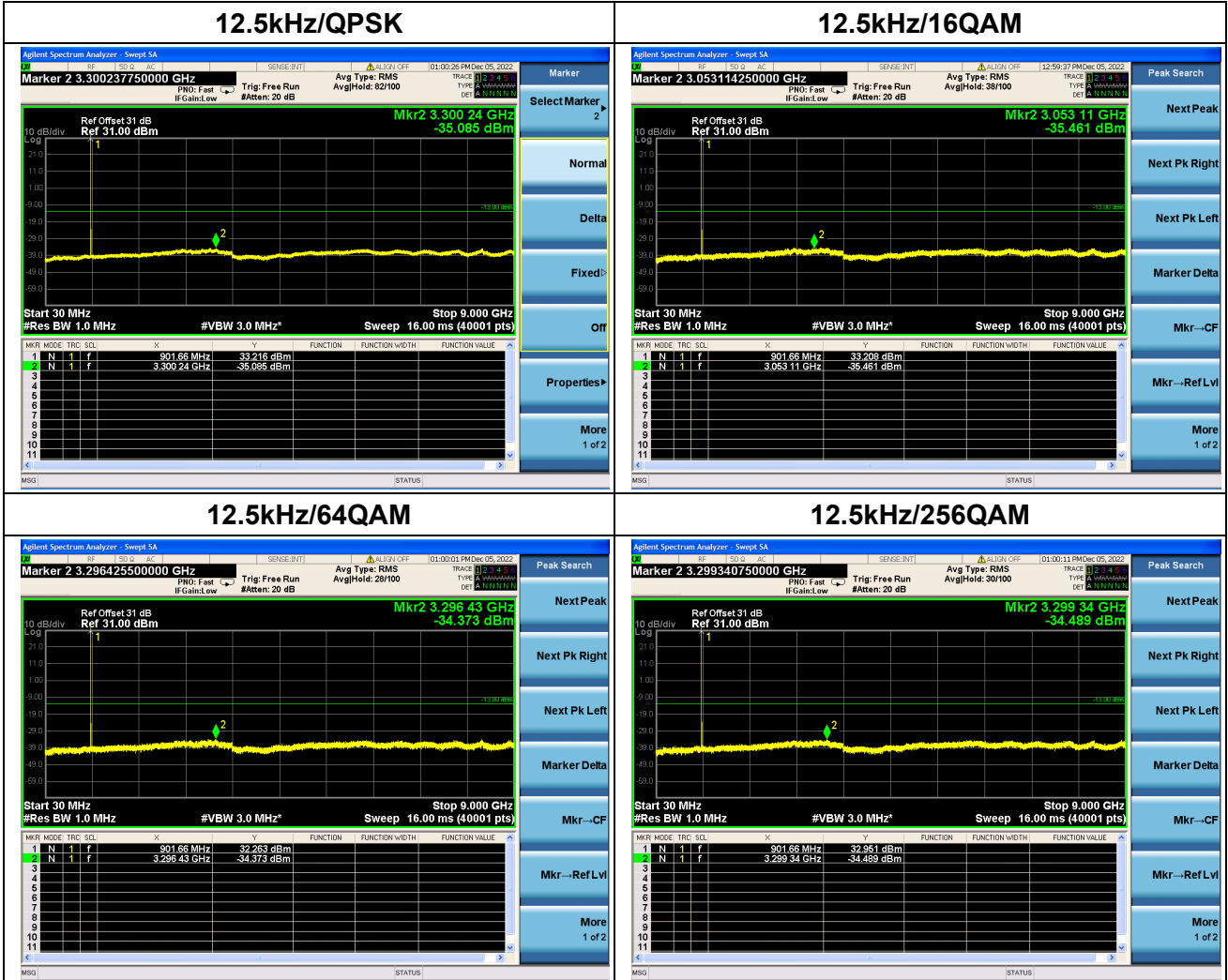
1. On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of up to and including 20 kHz: at least $116 \times \text{Log}_{10} ((f_d + 5)/3.05)$ decibels or $50 + 10 \times \text{Log}_{10} (P)$ decibels or 70 decibels, 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 (f_d in kHz) of more than 20 kHz: at least $43 + 10 \text{ Log}_{10} (P)$ decibels or 80 decibels, whichever is the lesser attenuation.

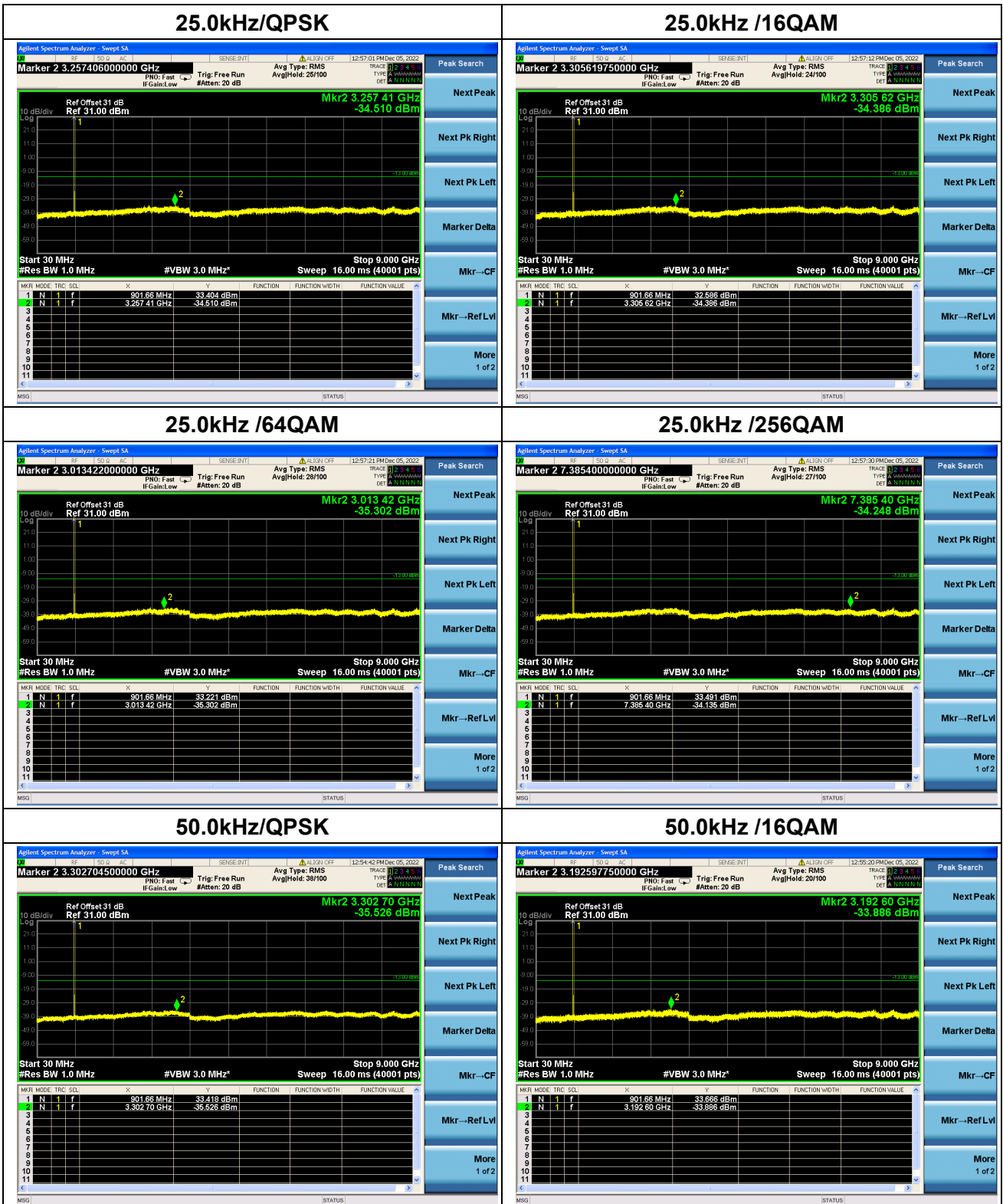


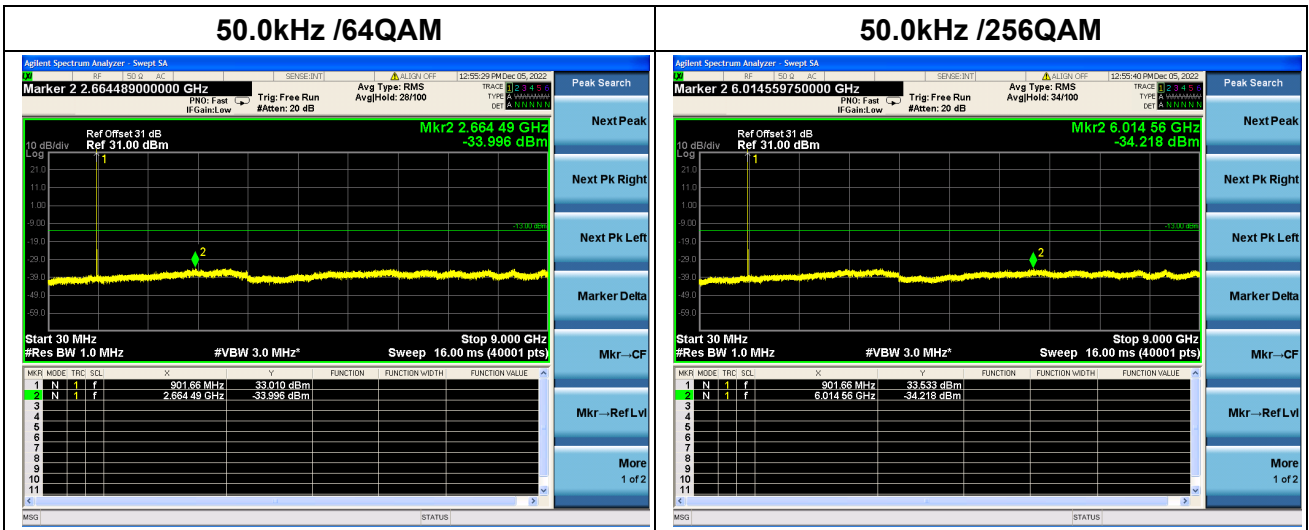
2.3.2. Test Result

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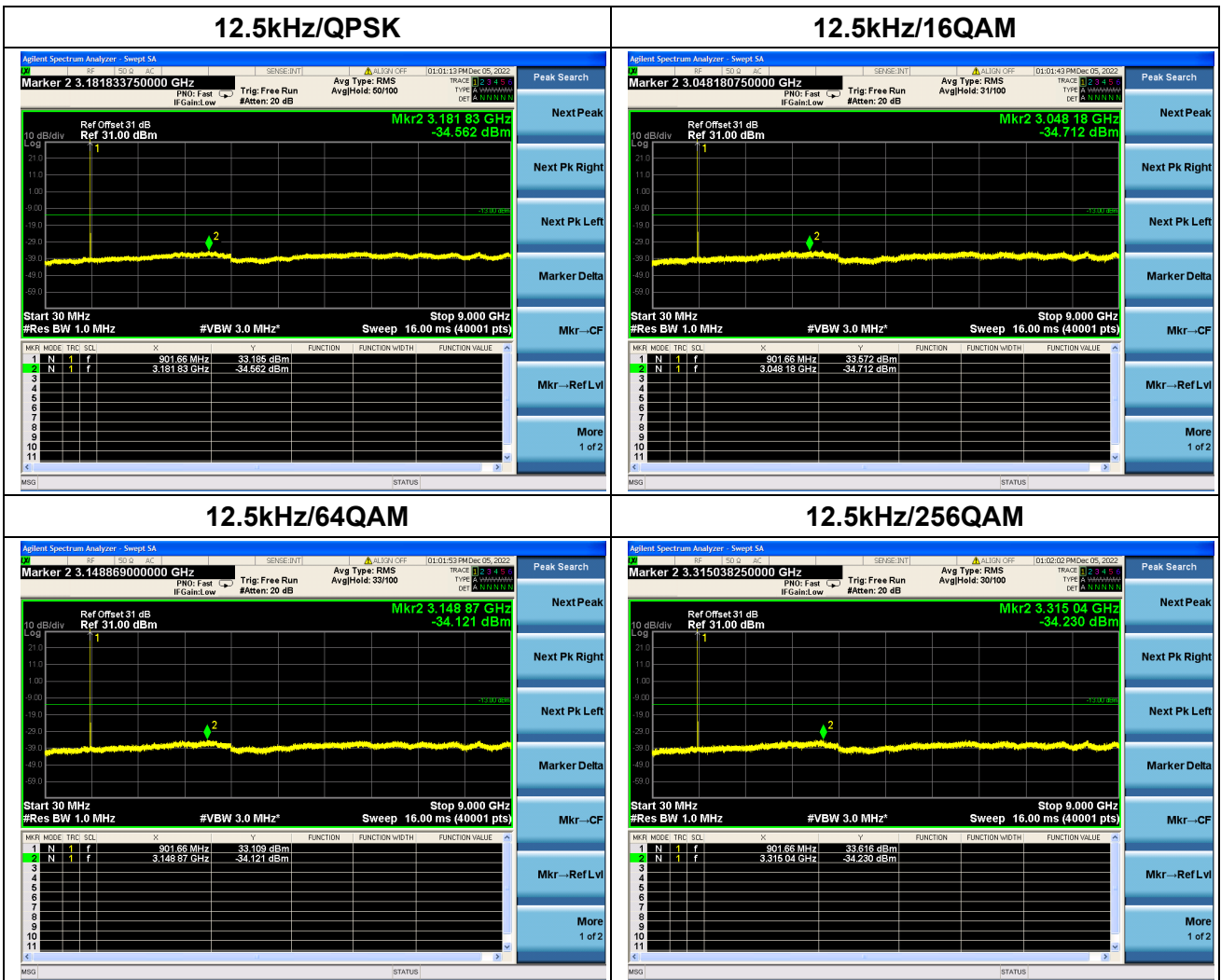
Nominal Frequency: 901.50 MHz Tx Port: Channel H



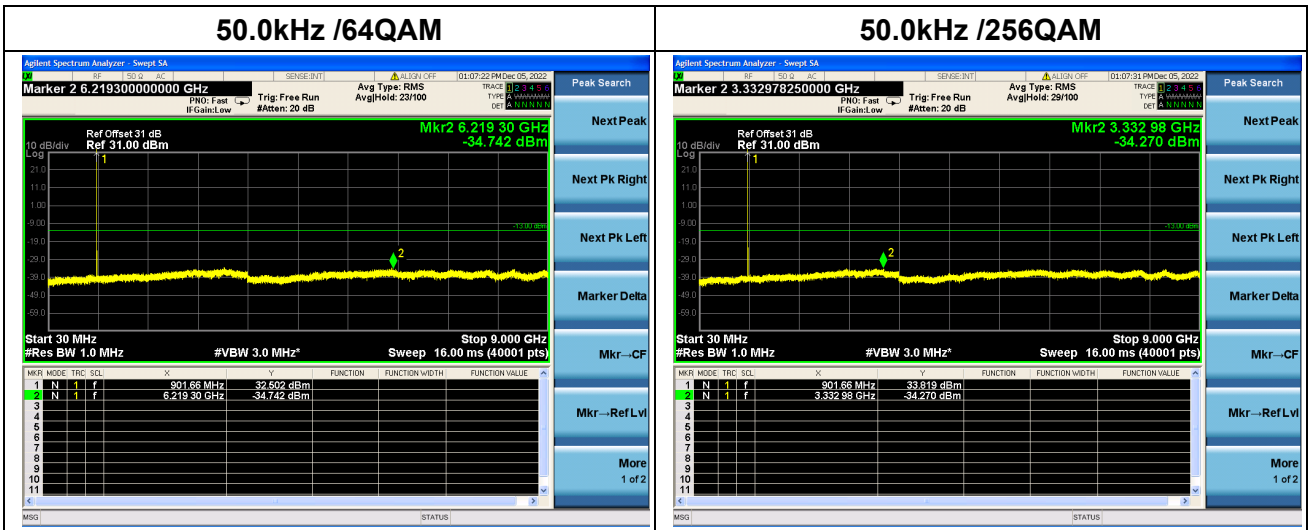




Nominal Frequency: 901.50 MHz Tx Port: Channel V







Type 2:

Nominal Frequency: 901.50 MHz Tx Port: Channel H

