

5. Average Power Spectral Density

5.1 Test Specification

FCC Part 27.50(a)(1)(A)

5.2 Test Procedure

The method that used as detailed in FCC KDB 971168.

Average PSD in any 1MHz must not exceed 400 Watts (56dBm) and in any 5MHz, must not exceed 2000 Watts (63dBm).

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator, D.C block and an appropriate coaxial cable (loss=31.1dB).

Duty cycle was calculated for total EIRP (1.9dB).

The E.U.T. RF output was modulated. Special attention was taken to prevent Spectrum Analyzer RF input overload. The Spectrum Analyzer was set to 1000 kHz RBW. The output power level was measured at the low, mid and high channels of each modulation.

For PSD in any 5MHz the equation: $10 \log \left(\frac{5\text{MHz}}{1\text{MHz}} \right) = 7\text{dB}$. This factor was added to the test results in 1MHz. The total results were compared to the PSD 5MHz limit as detailed above.

5.3 Test Results

BW (Hz)	Operation Freq (MHz)	PSD Port1 (dBm)	PSD Port2 (dBm)	PSD Port3 (dBm)	PSD Port4 (dBm)	Calculated Power (dBm)	Ant Gain (dBi)	EIRP (dBm)	Spec (dBm)	Margin (dB)
5M	2307.5	33.6	33.9	33.8	34.5	39.98	15.6	55.58	56.0	-0.42
5M	2312.5	33.6	33.6	33.8	34.2	39.83	15.6	55.43	56.0	-0.57
10M	2310.0	30.8	30.6	30.7	30.7	36.72	15.6	52.32	56.0	-3.68
5M	2352.5	34.0	34.1	34.0	34.0	40.05	15.6	55.65	56.0	-0.35
5M	2357.5	33.2	34.5	34.0	33.6	39.87	15.6	55.47	56.0	-0.53
10M	2355.0	31.0	30.9	30.6	31.0	36.90	15.6	52.50	56.0	-3.50

Figure 1 1MHz - Average Power Spectral Density QPSK

BW (Hz)	Operation Freq (MHz)	PSD Port1 (dBm)	PSD Port2 (dBm)	PSD Port3 (dBm)	PSD Port4 (dBm)	Calculated Power (dBm)	Ant Gain (dBi)	EIRP (dBm)	Spec (dBm)	Margin (dB)
5M	2307.5	33.7	33.9	33.6	33.9	39.80	15.6	55.4	56.0	-0.6
5M	2312.5	33.8	33.7	34.0	34.0	39.80	15.6	55.4	56.0	-0.6
10M	2310.0	30.7	30.5	31.6	31.4	36.90	15.6	52.5	56.0	-3.5
5M	2352.5	34.0	34.0	33.5	33.8	39.80	15.6	55.4	56.0	-0.6
5M	2357.5	34.4	33.4	34.0	33.8	39.94	15.6	55.54	56.0	-0.5
10M	2355.0	31.2	30.9	31.9	31.1	37.20	15.6	52.8	56.0	-3.2

Figure 2 1 MHz - Average Power Spectral Density 16QAM

BW	Operation Freq	PSD Port1	PSD Port2	PSD Port3	PSD Port4	Calculated Power	Ant Gain	EIRP	Spec	Margin
(Hz)	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBi)	(dBm)	(dBm)	(dB)
5M	2307.5	33.7	34.1	33.9	34.1	39.9	15.6	55.5	56.0	-0.5
5M	2312.5	33.8	33.8	34.0	34.0	39.9	15.6	55.5	56.0	-0.5
10M	2310.0	29.8	29.7	29.9	30.3	35.8	15.6	51.4	56.0	-4.6
5M	2352.5	34.0	34.0	33.8	33.6	39.8	15.6	55.4	56.0	-0.6
5M	2357.5	33.7	33.8	33.3	33.8	39.5	15.6	55.1	56.0	-0.9
10M	2355.0	30.4	30.0	30.4	29.9	36.2	15.6	51.8	56.0	-4.2

Figure 3 1MHz - Average Power Spectral Density 64QAM

BW	Operation Freq	PSD Port1	PSD Port2	PSD Port3	PSD Port4	Calculated Power	Ant Gain	EIRP	Spec	Margin
(Hz)	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBi)	(dBm)	(dBm)	(dB)
5M	2307.5	40.6	40.9	40.8	41.5	46.98	15.6	62.58	63.0	-0.42
5M	2312.5	40.6	40.6	40.8	41.2	46.83	15.6	62.43	63.0	-0.57
10M	2310.0	37.8	37.6	37.7	37.7	43.72	15.6	59.32	63.0	-3.68
5M	2352.5	41.0	41.1	41.0	41.0	47.05	15.6	62.65	63.0	-0.35
5M	2357.5	40.2	41.5	41.0	40.6	46.88	15.6	62.48	63.0	-0.52
10M	2355.0	38.0	37.9	37.6	38.0	43.90	15.6	59.50	63.0	-3.50

Figure 4 5MHz - Average Power Spectral Density QPSK

BW	Operation Freq	PSD Port1	PSD Port2	PSD Port3	PSD Port4	Calculated Power	Ant Gain	EIRP	Spec	Margin
(Hz)	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dBi)	(dBm)	(dBm)	(dB)
5M	2307.5	40.7	40.9	40.6	40.9	46.80	15.6	62.40	63.0	-0.60
5M	2312.5	40.8	40.7	41.0	41.0	46.90	15.6	62.50	63.0	-0.50
10M	2310.0	37.7	37.5	38.6	38.4	44.09	15.6	59.69	63.0	-3.31
5M	2352.5	41.0	41.0	40.5	40.8	46.85	15.6	62.45	63.0	-0.55
5M	2357.5	41.4	40.4	41.0	40.8	46.94	15.6	62.54	63.0	-0.46
10M	2355.0	38.2	37.9	38.9	38.1	44.31	15.6	59.91	63.0	-3.09

Figure 5 5MHz - Average Power Spectral Density 16QAM

BW (Hz)	Operation Freq (MHz)	PSD Port1 (dBm)	PSD Port2 (dBm)	PSD Port3 (dBm)	PSD Port4 (dBm)	Calculated Power (dBm)	Ant Gain (dBi)	EIRP (dBm)	Spec (dBm)	Margin (dB)
5M	2307.5	40.7	41.1	40.9	41.1	46.98	15.6	62.58	63.0	-0.42
5M	2312.5	40.8	40.8	41.0	41.0	46.92	15.6	62.52	63.0	-0.48
10M	2310.0	36.8	36.7	36.9	37.3	42.98	15.6	58.58	63.0	-4.42
5M	2352.5	41.0	41.0	40.8	40.6	46.88	15.6	62.48	63.0	-0.52
5M	2357.5	40.7	40.8	40.3	40.8	46.67	15.6	62.27	63.0	-0.73
10M	2355.0	37.4	37.0	37.4	36.9	43.20	15.6	58.80	63.0	-4.20

Figure 6 5MHz - Average Power Spectral Density 64QAM

Note - Configuration of 4X4 (TX/RX), 1 sector, 1 carrier transmitting on same frequency on all 4 channels is regarded as worst case:

- 1) 2 transmitted channels use completely uncorrelated signals resulting 0dBi array gain.
- 2) 2 other transmitted channels using correlated signals and crossed polarized antennas resulting 0dBi array gain.
- 3) All 4 TX antennas have 15.6 dBi gain each.
- 4) Therefore total array gain is 0dBi.
- 5) Therefore total directional gain is 15.6 dBi.

JUDGEMENT: Passed by 0.35 dB

See additional information in *Figure 7* to *Figure 78*.

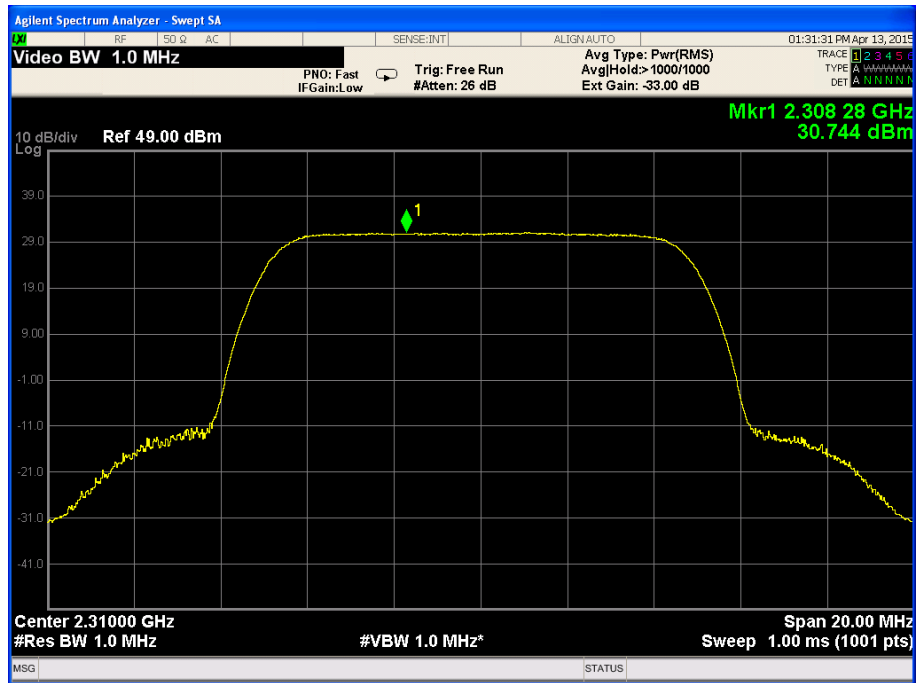


Figure 7.—QPSK 2310.0 MHz, BW 10MHz, Port 1

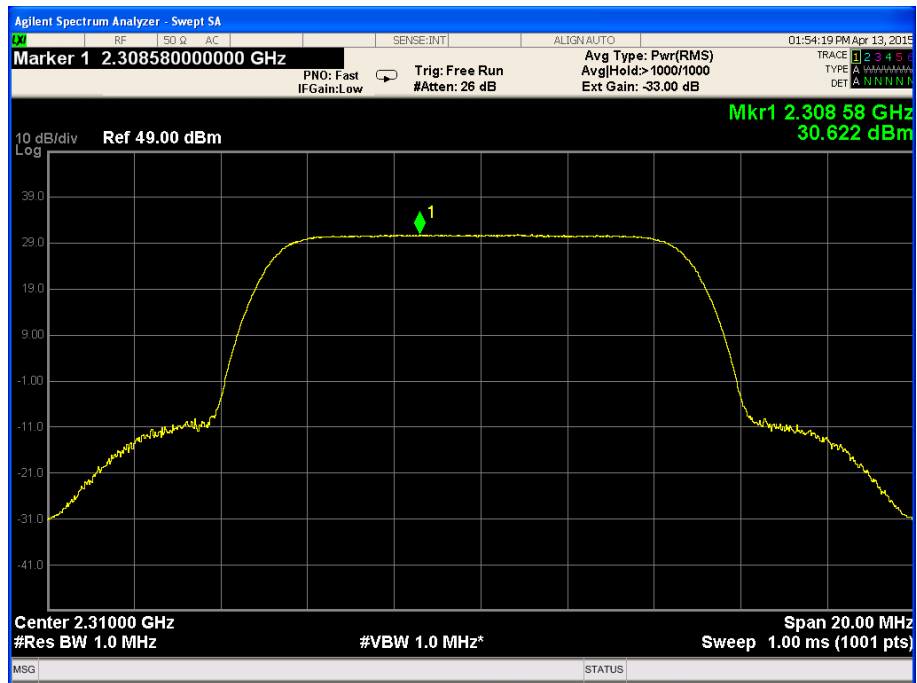


Figure 8.— QPSK 2310.0 MHz, BW 10MHz, Port 2

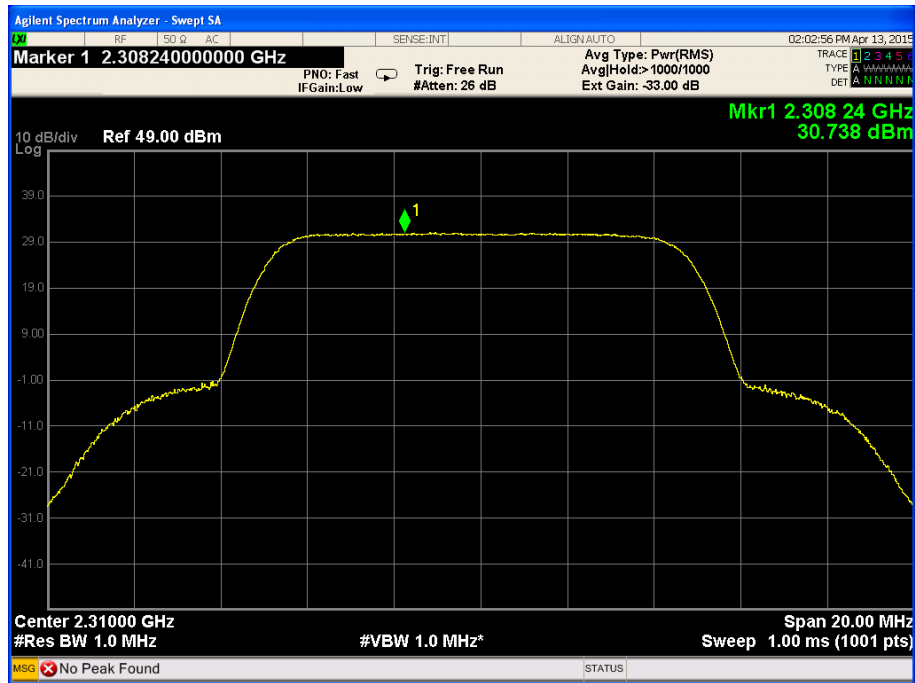


Figure 9.— QPSK 2310.0 MHz, BW 10MHz, Port 3

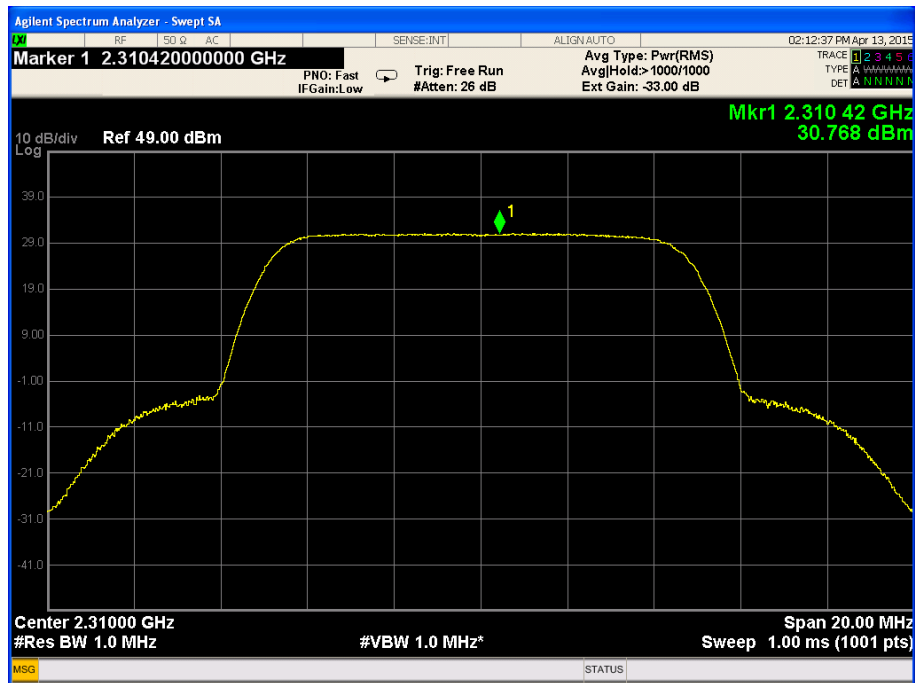


Figure 10.— QPSK 2310.0 MHz, BW 10MHz, Port 4

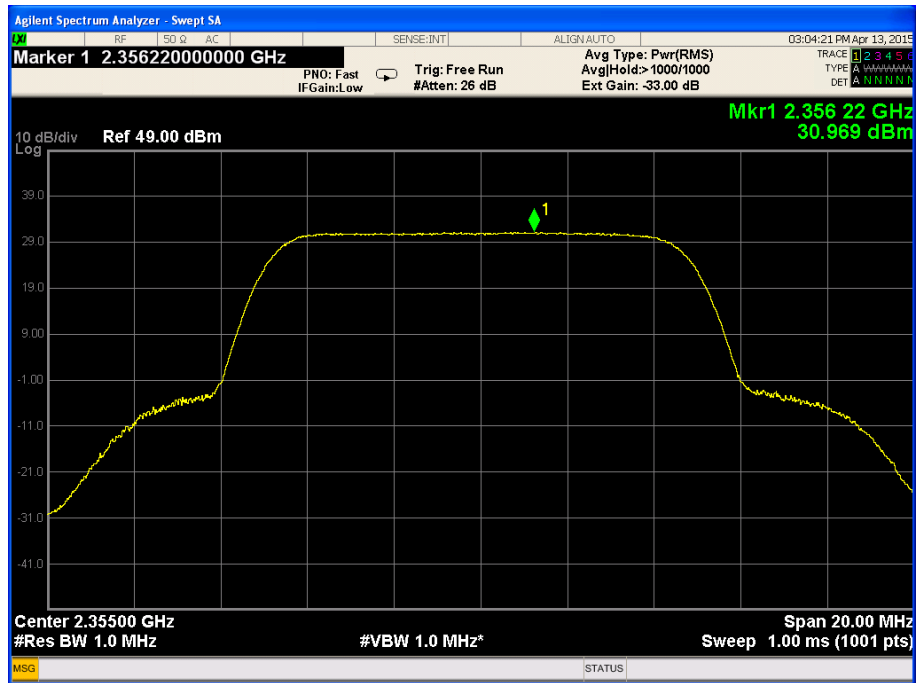


Figure 11.— QPSK 2355.0 MHz, BW 10MHz, Port 1

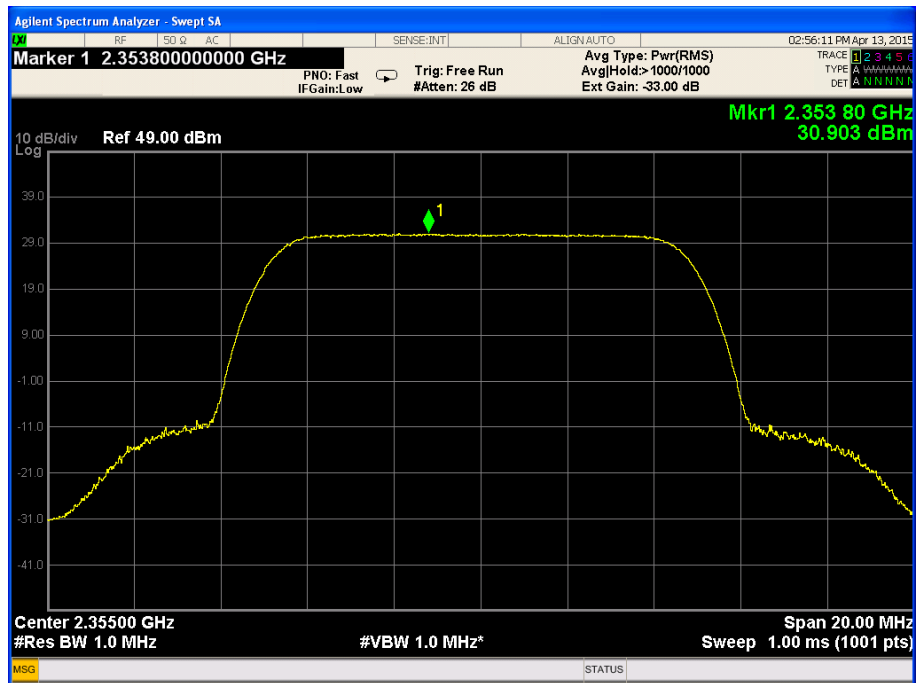


Figure 12.— QPSK 2355.0 MHz, BW 10MHz, Port 2

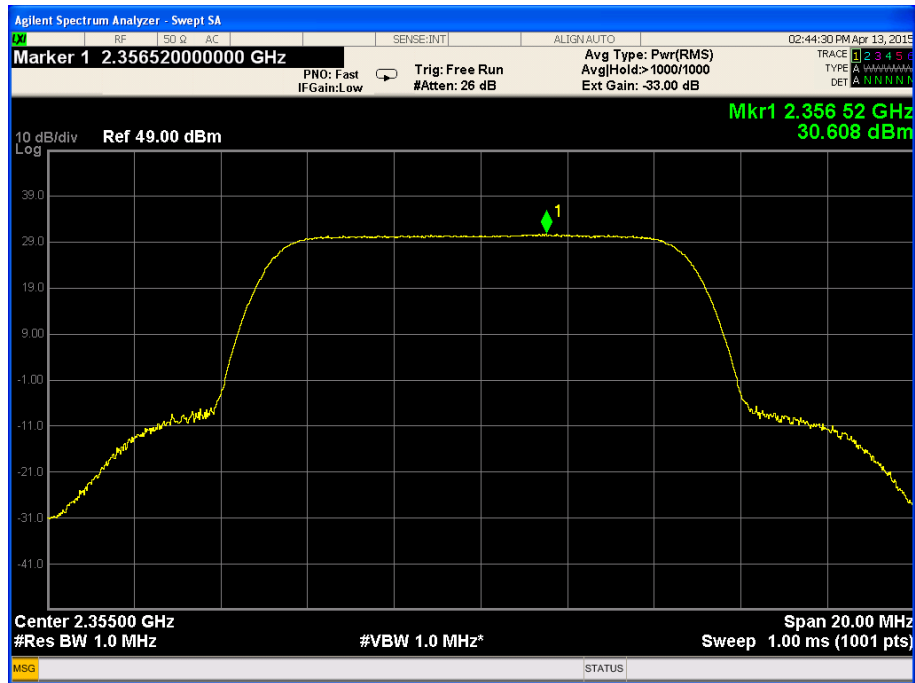


Figure 13.— QPSK 2355.0 MHz, BW 10MHz, Port 3

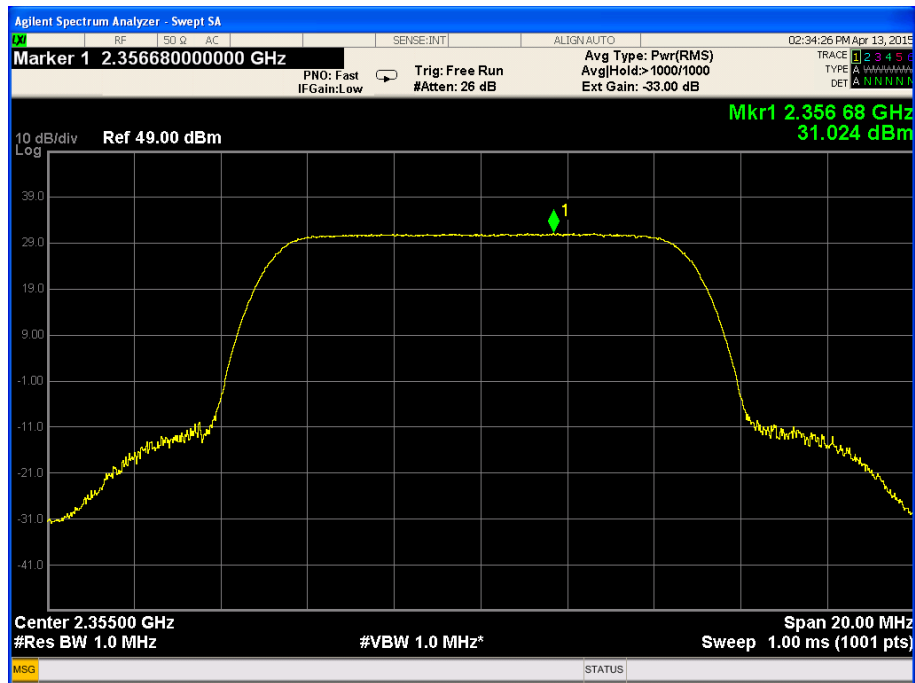


Figure 14.— QPSK 2355.0 MHz, BW 10MHz, Port 4

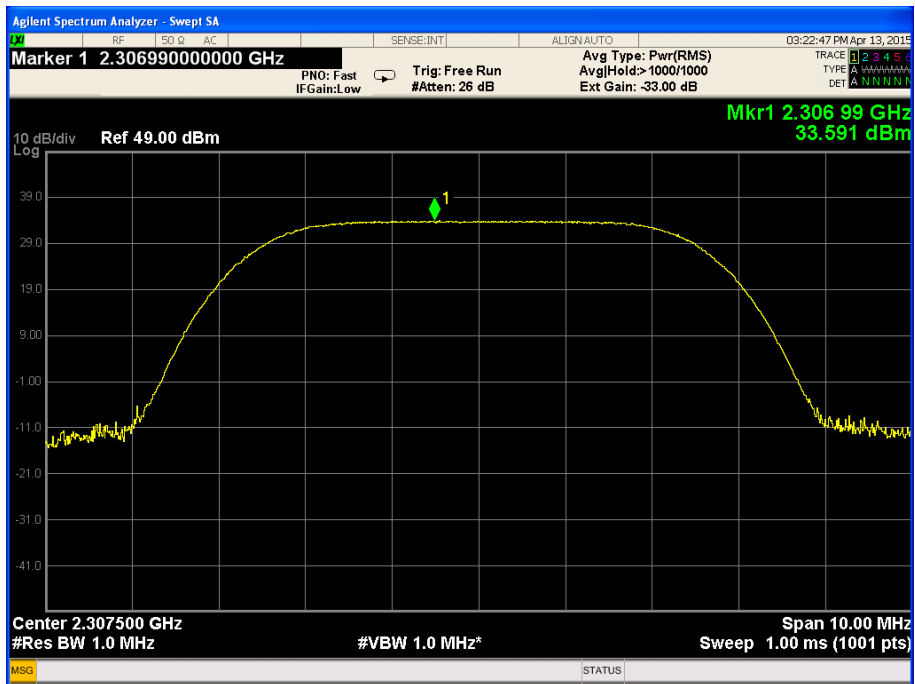


Figure 15.— QPSK 2307.5 MHz, BW 5MHz, Port 1

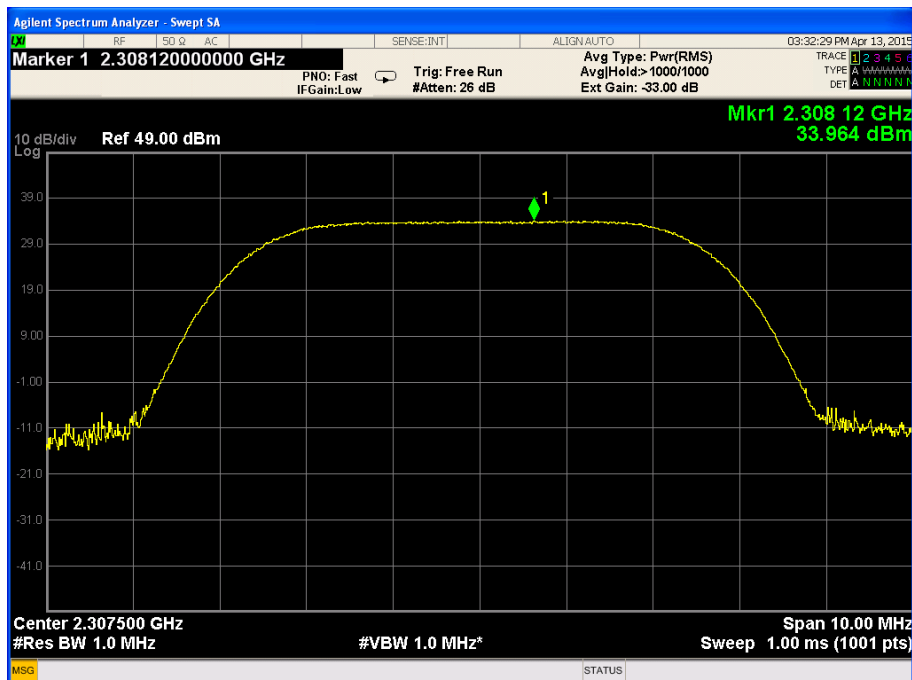


Figure 16.— QPSK 2307.5 MHz, BW 5MHz, Port 2

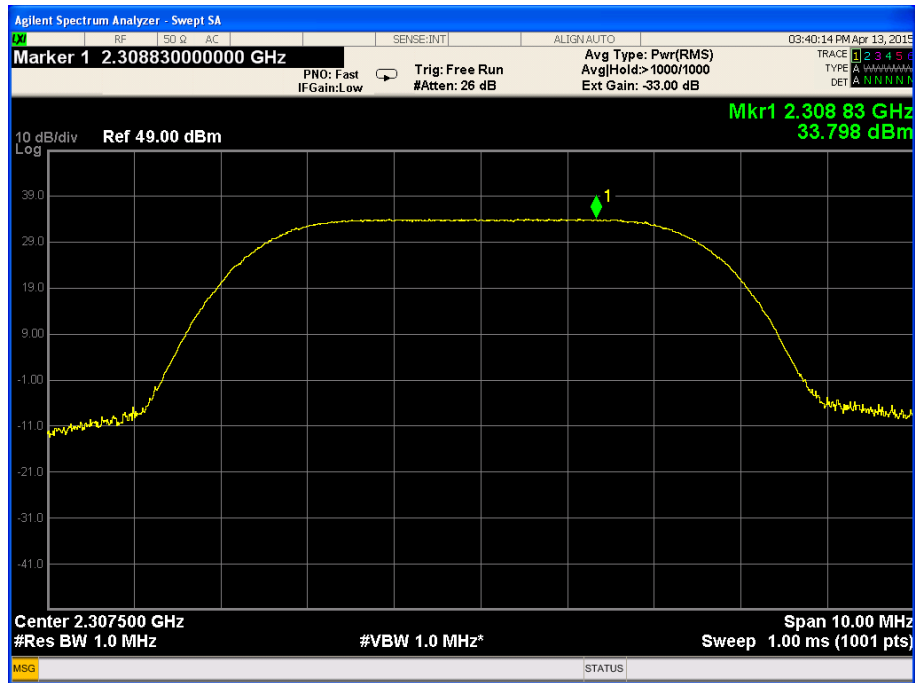


Figure 17.— QPSK 2307.5 MHz, BW 5MHz, Port 3

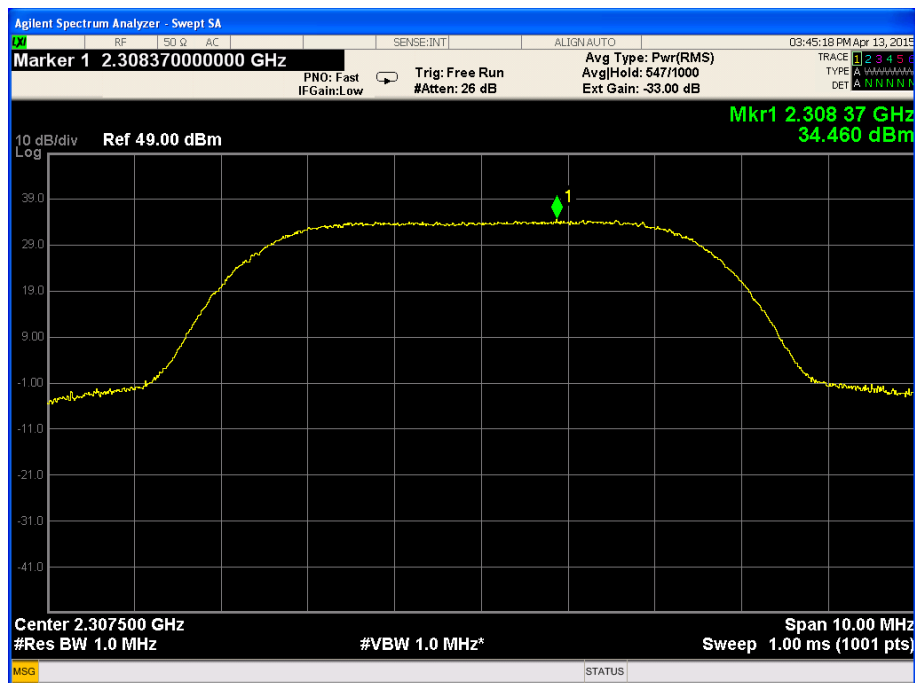


Figure 18.— QPSK 2307.5 MHz, BW 5MHz, Port 4

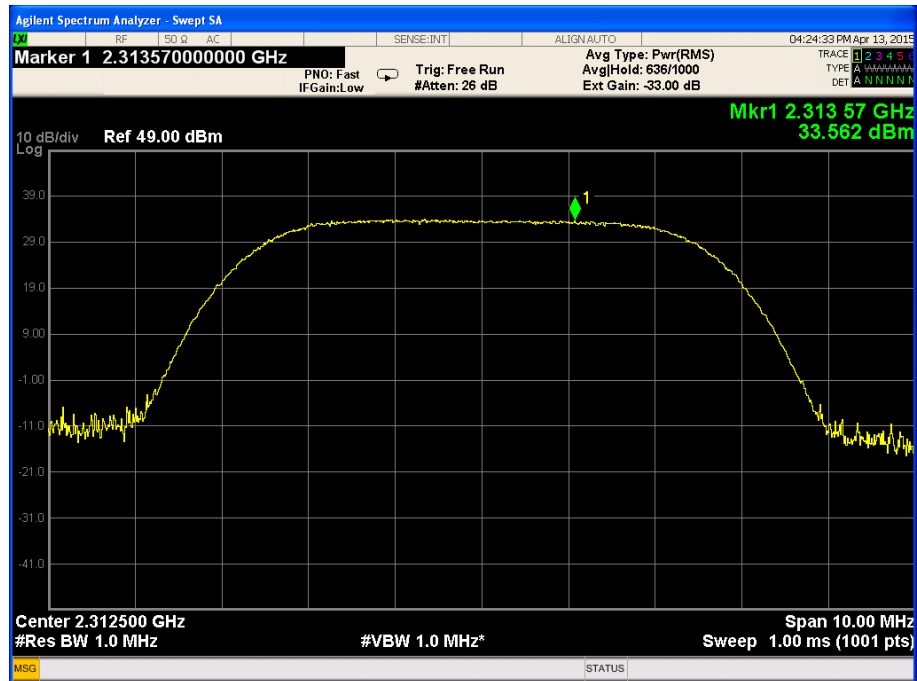


Figure 19.— QPSK 2312.5 MHz, BW 5MHz, Port 1

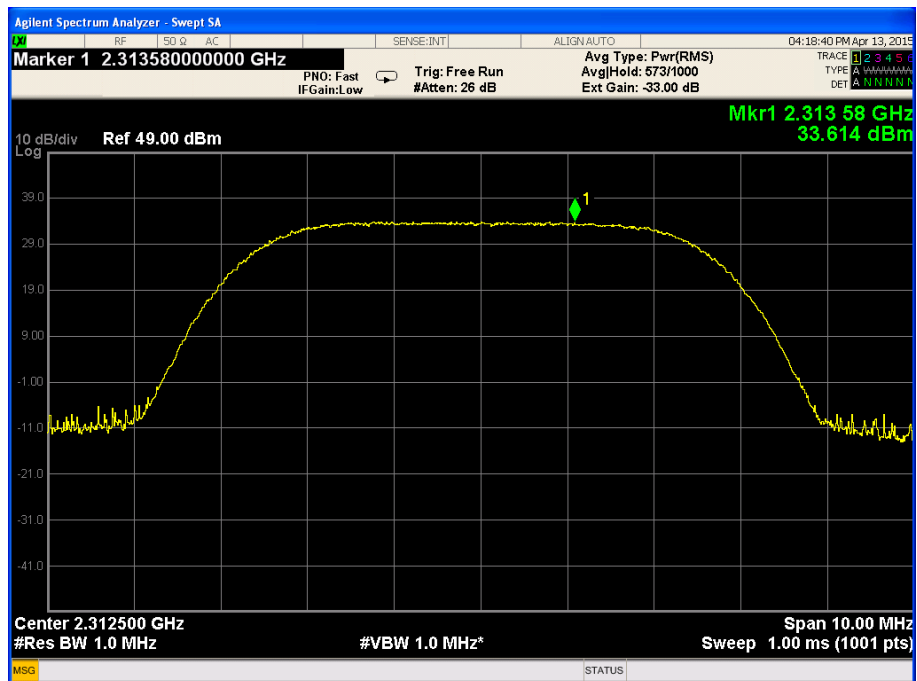


Figure 20.— QPSK 2312.5 MHz, BW 5MHz, Port 2

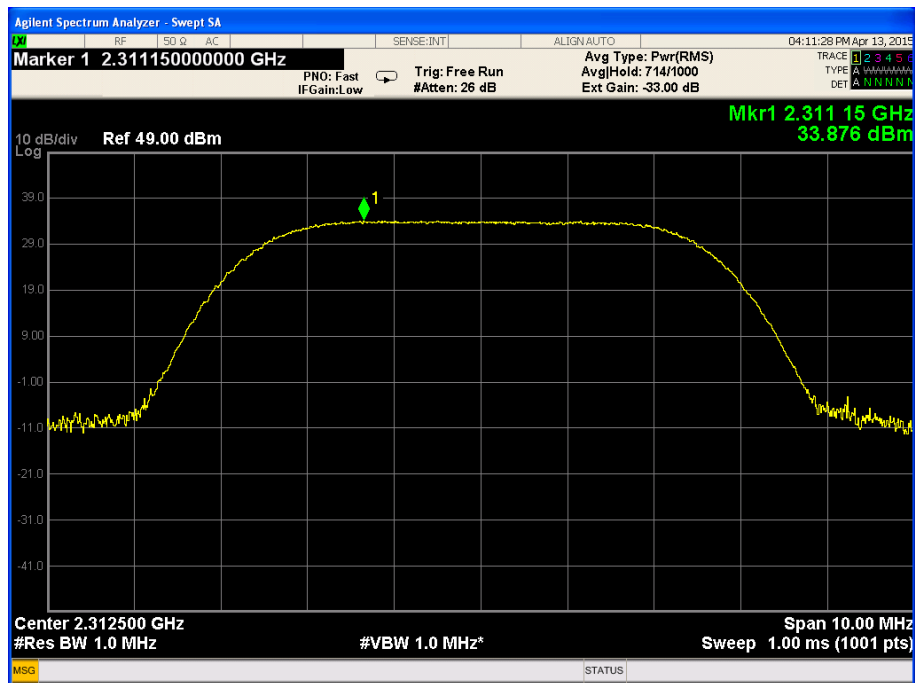


Figure 21.— QPSK 2312.5 MHz, BW 5MHz, Port 3

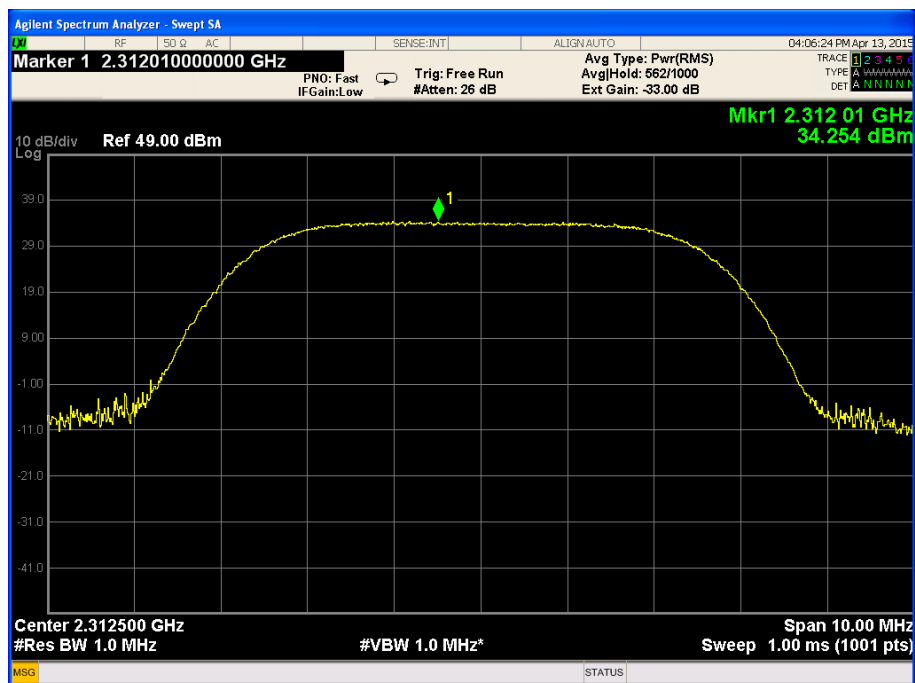


Figure 22.— QPSK 2312.5 MHz, BW 5MHz, Port 4

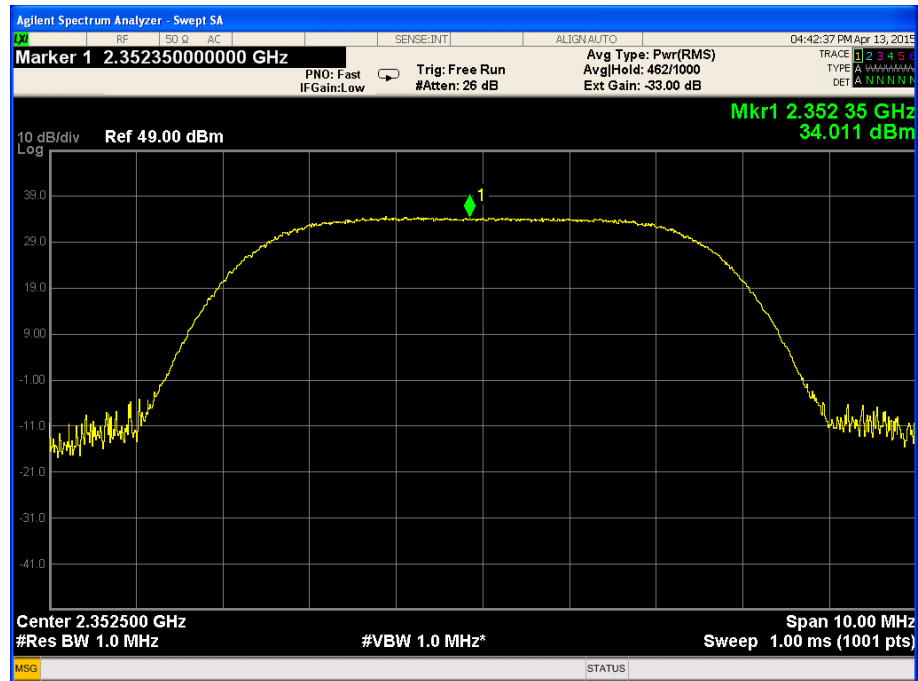


Figure 23.— QPSK 2352.5 MHz, BW 5MHz, Port 1

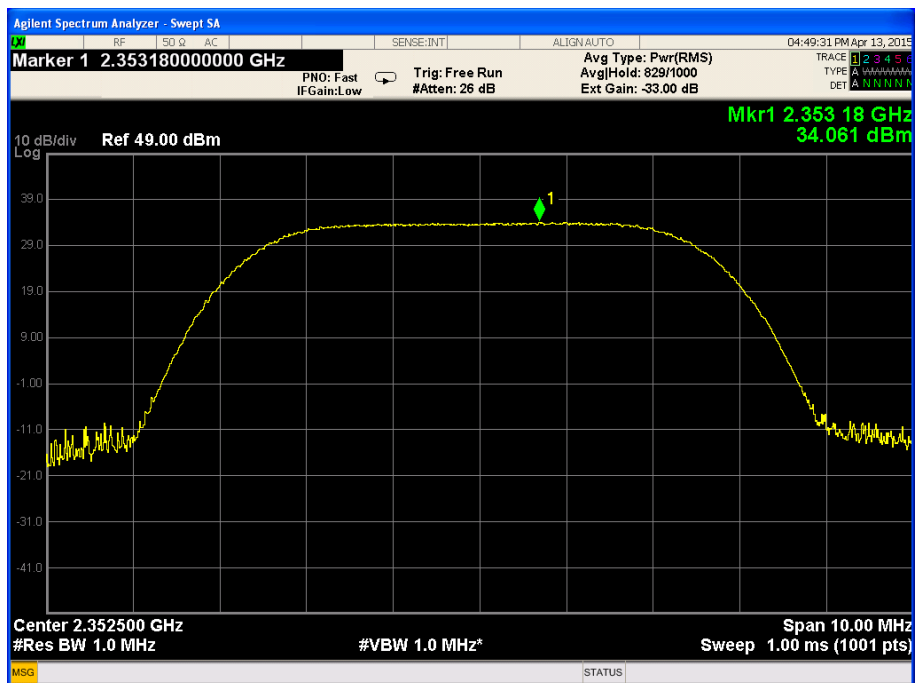


Figure 24.— QPSK 2352.5 MHz, BW 5MHz, Port 2

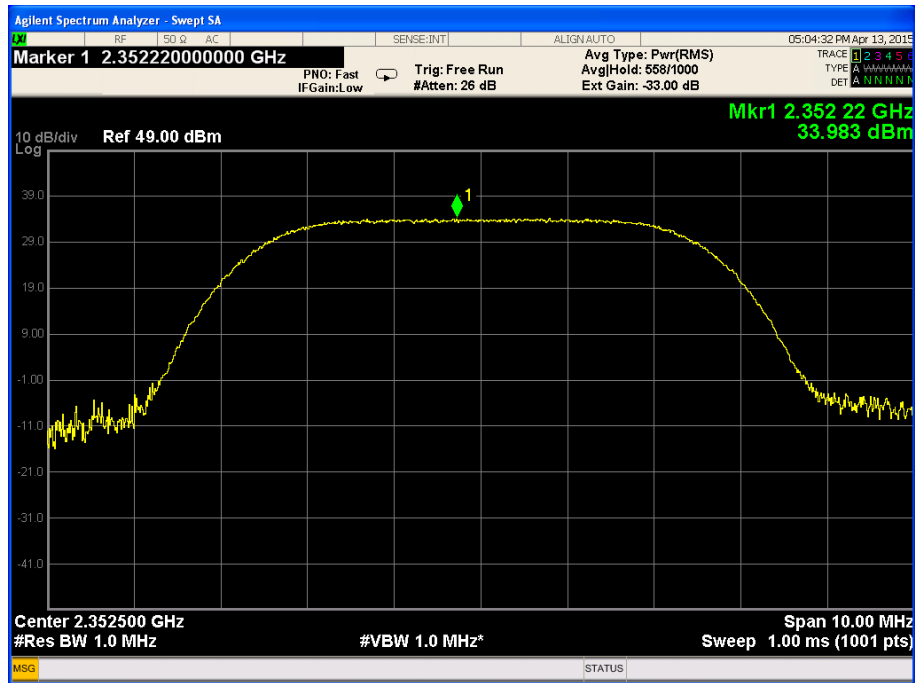


Figure 25.— QPSK 2352.5 MHz, BW 5MHz, Port 3

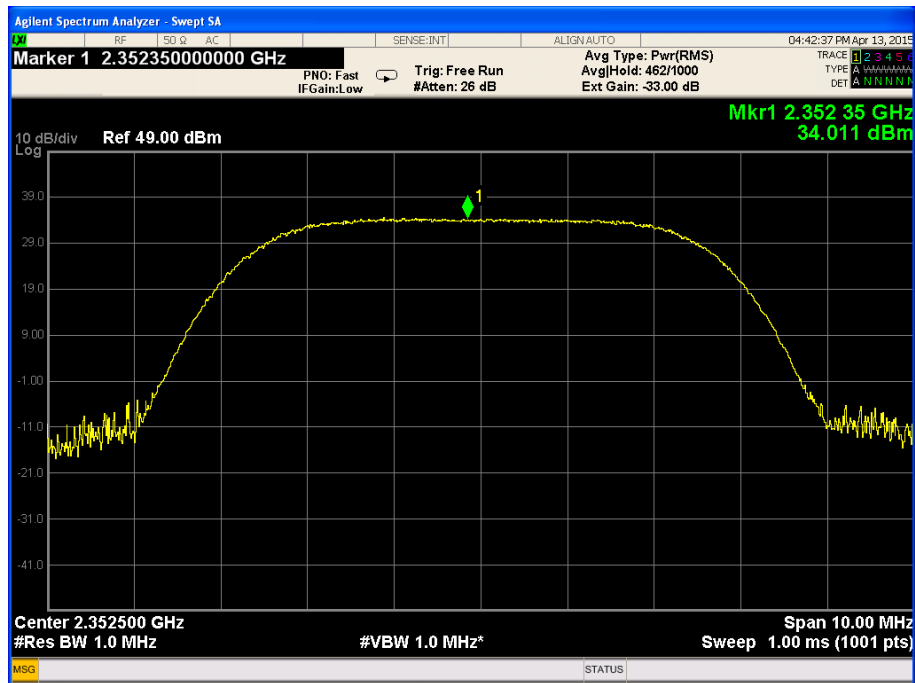


Figure 26.— QPSK 2352.5 MHz, BW 5MHz, Port 4

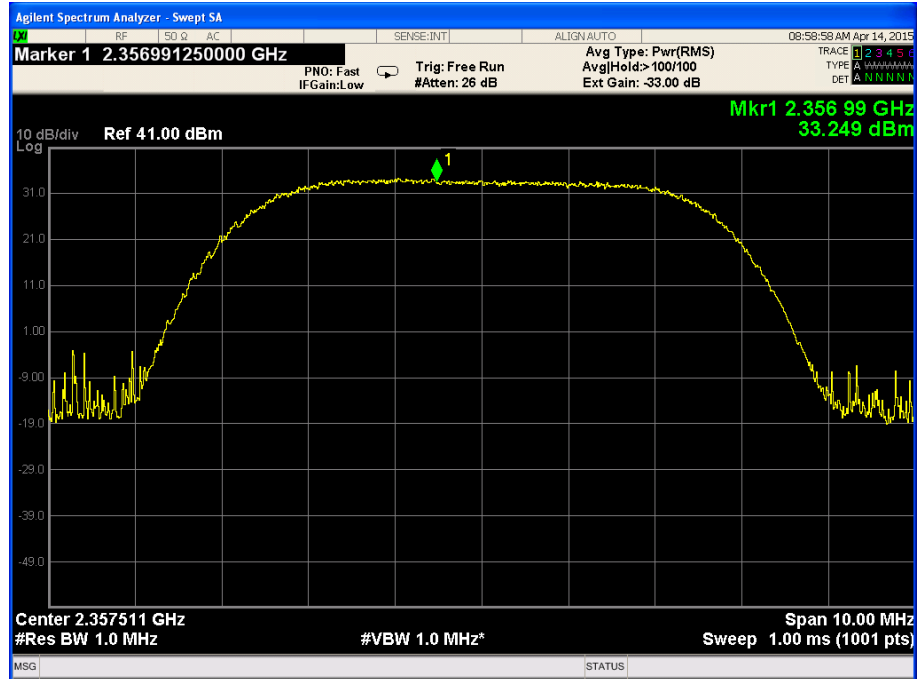


Figure 27.— QPSK 2357.5 MHz, BW 5MHz, Port 1

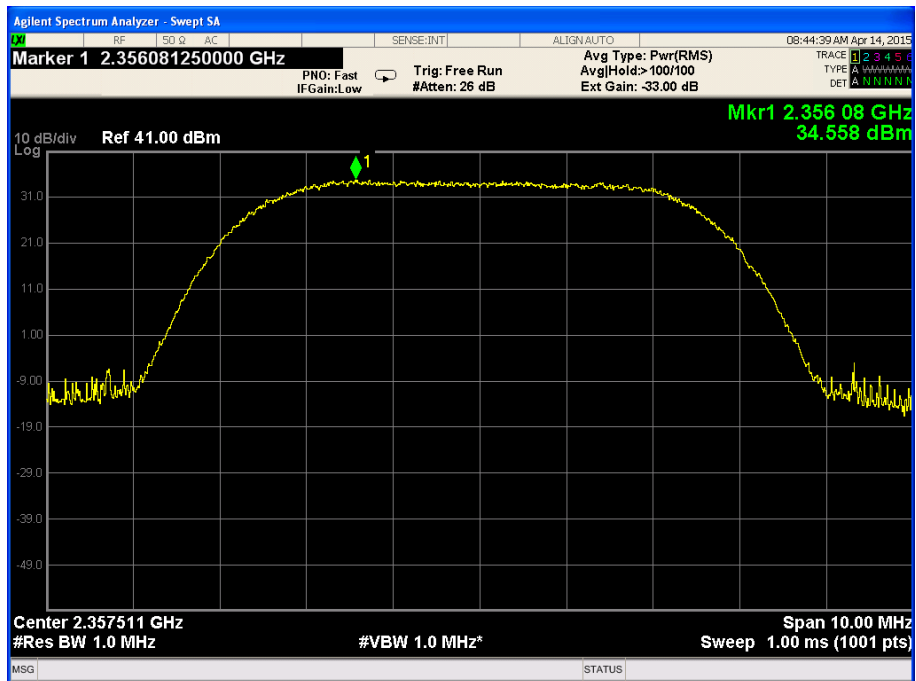


Figure 28.— QPSK 2357.5 MHz, BW 5MHz, Port 2

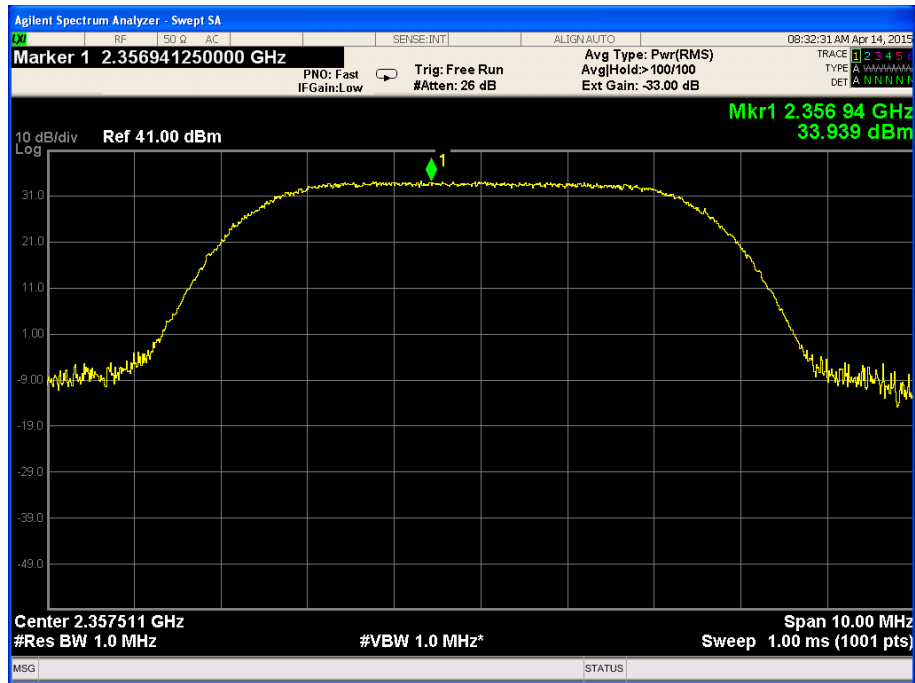


Figure 29.— QPSK 2357.5 MHz, BW 5MHz, Port 3

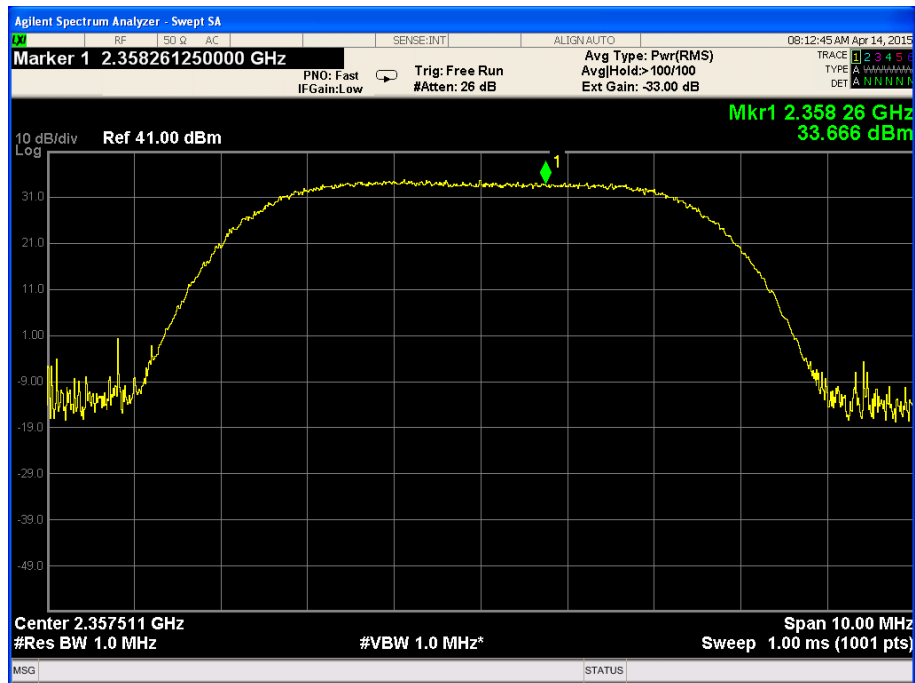


Figure 30.— QPSK 2357.5 MHz, BW 5MHz, Port 4

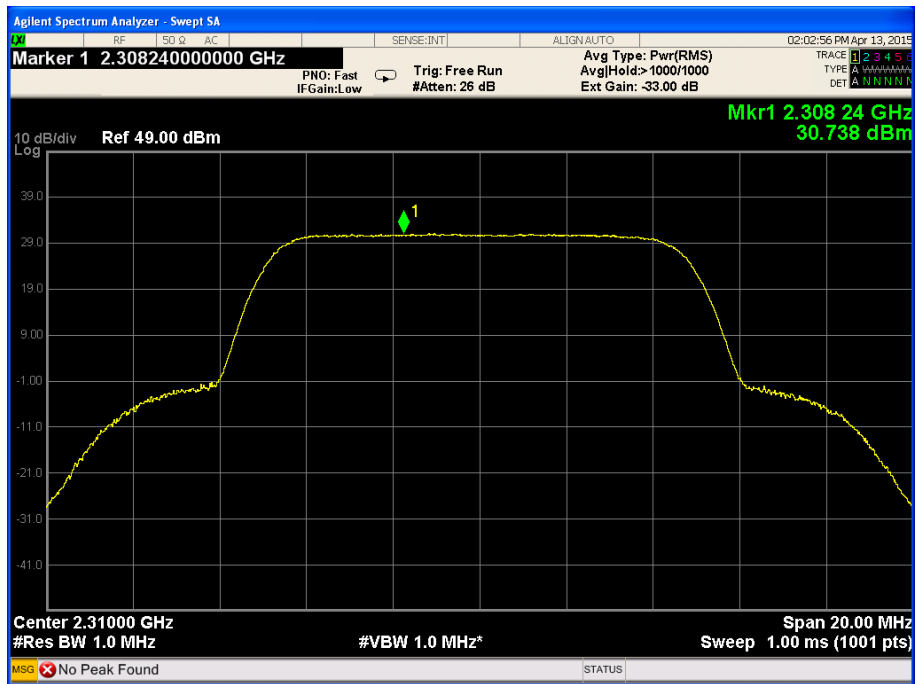


Figure 31.—16QAM 2310.0 MHz, BW 10MHz Port 1

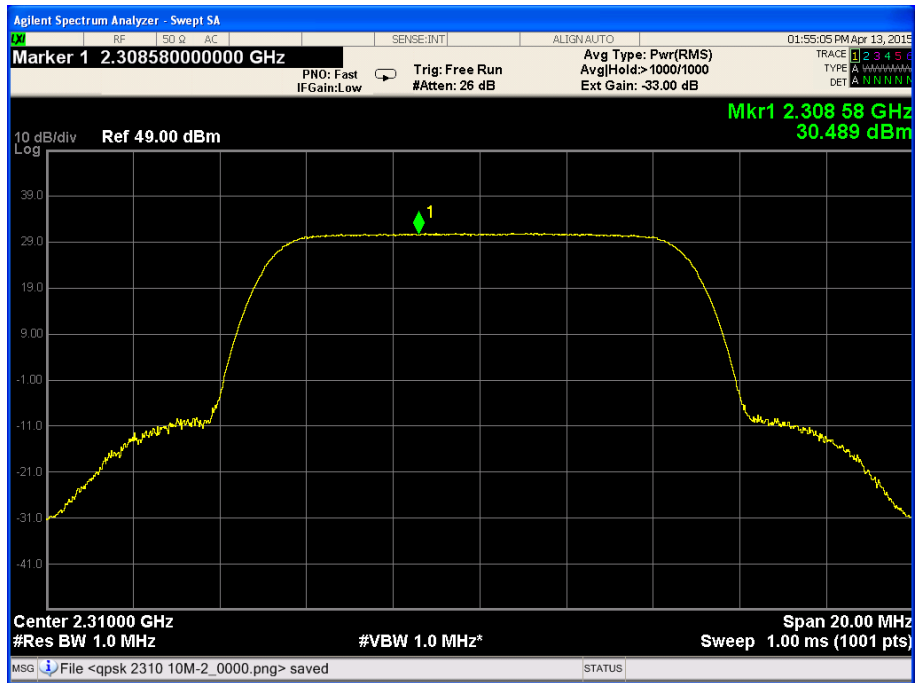


Figure 32.— 16QAM 2310.0 MHz, BW 10MHz, Port 2

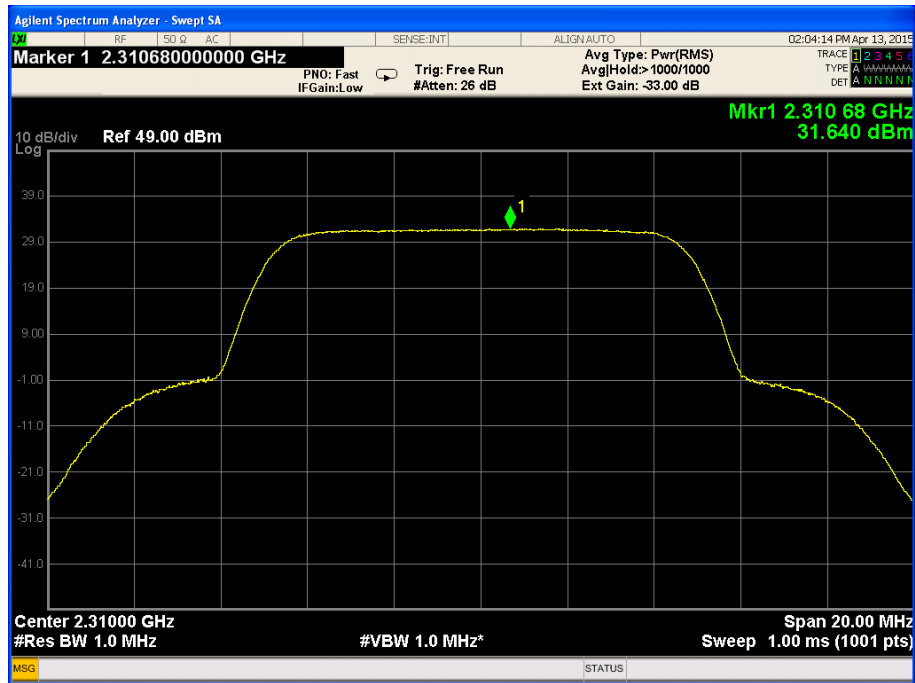


Figure 33.— 16QAM 2310.0 MHz, BW 10MHz, Port 3

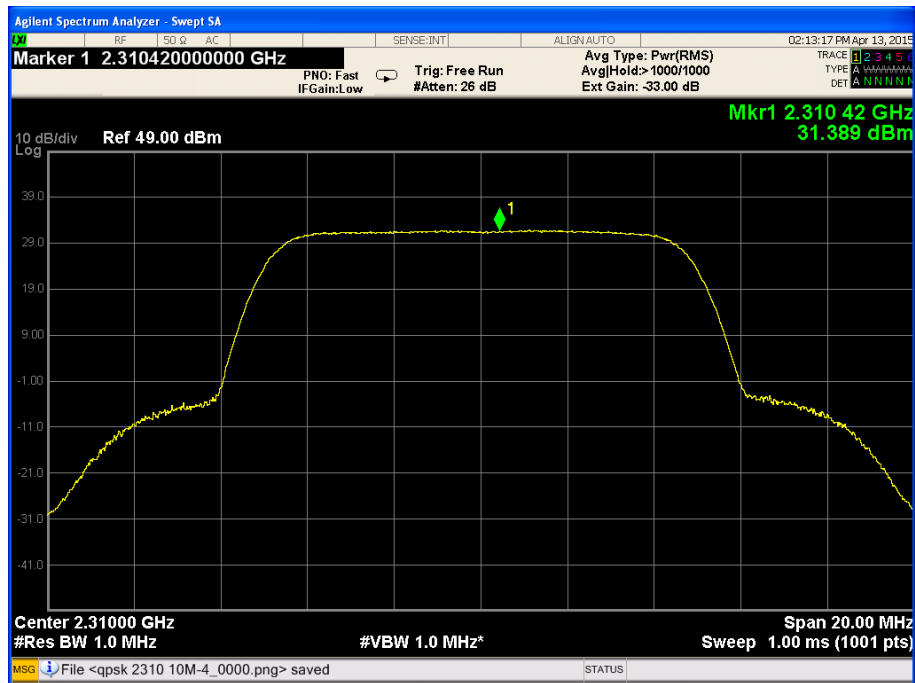


Figure 34.— 16QAM 2310.0 MHz, BW 10MHz, Port 4

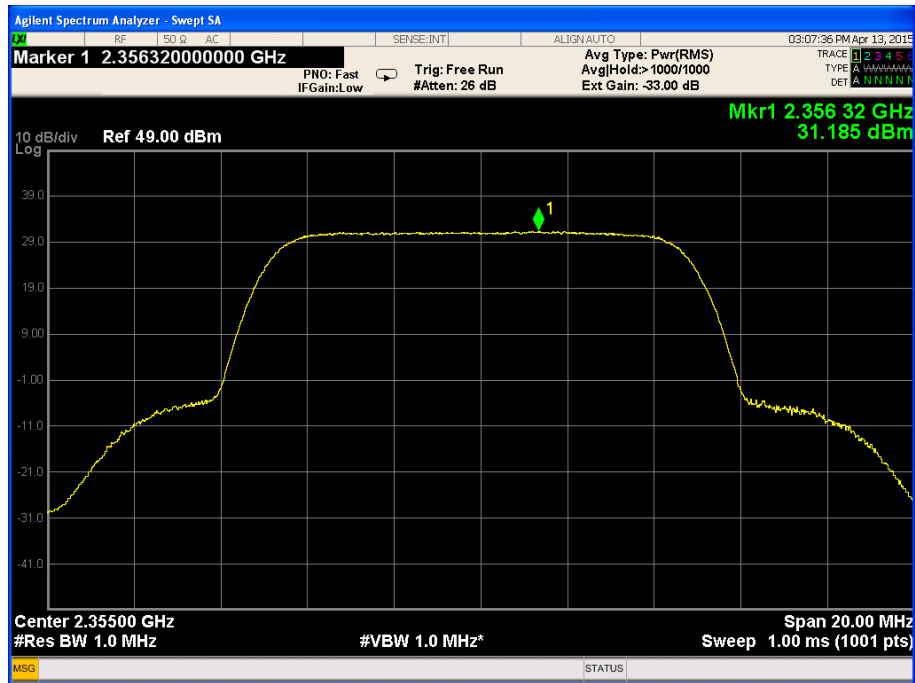


Figure 35.— 16QAM 2355.0 MHz, BW 10MHz, Port 1

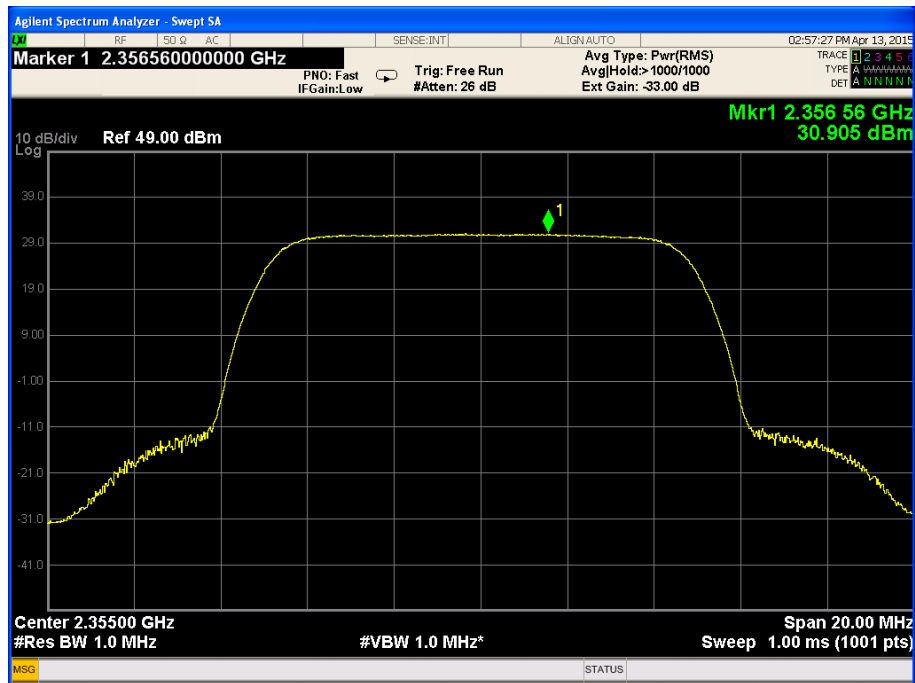


Figure 36.— 16QAM 2355.0 MHz, BW 10MHz, Port 2

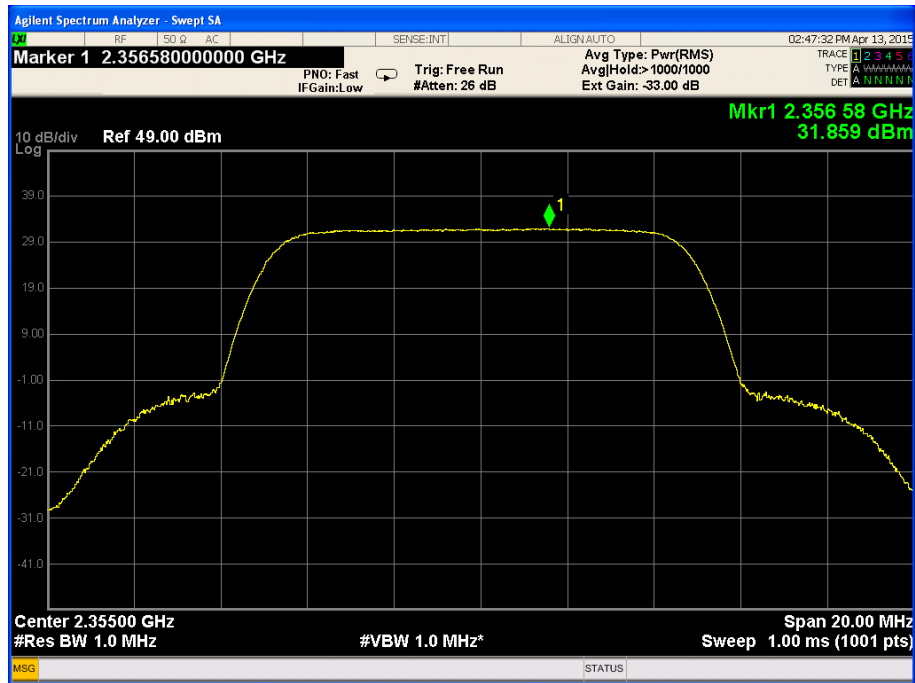


Figure 37.— 16QAM 2355.0 MHz, BW 10MHz, Port 3

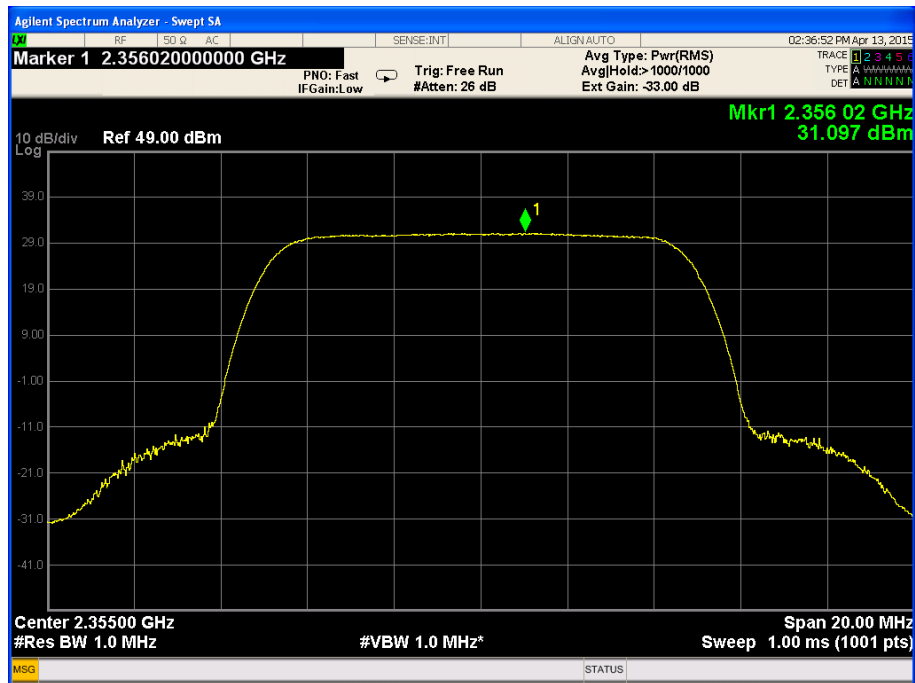


Figure 38.— 16QAM 2355.0 MHz, BW 10MHz, Port 4

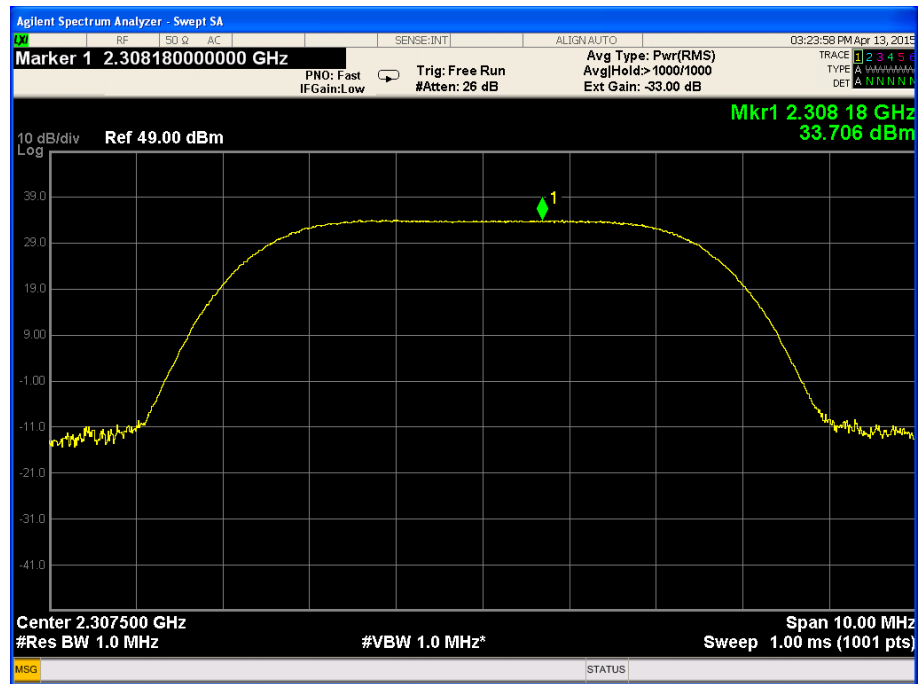


Figure 39.— 16QAM 2307.5 MHz, BW 5MHz, Port 1

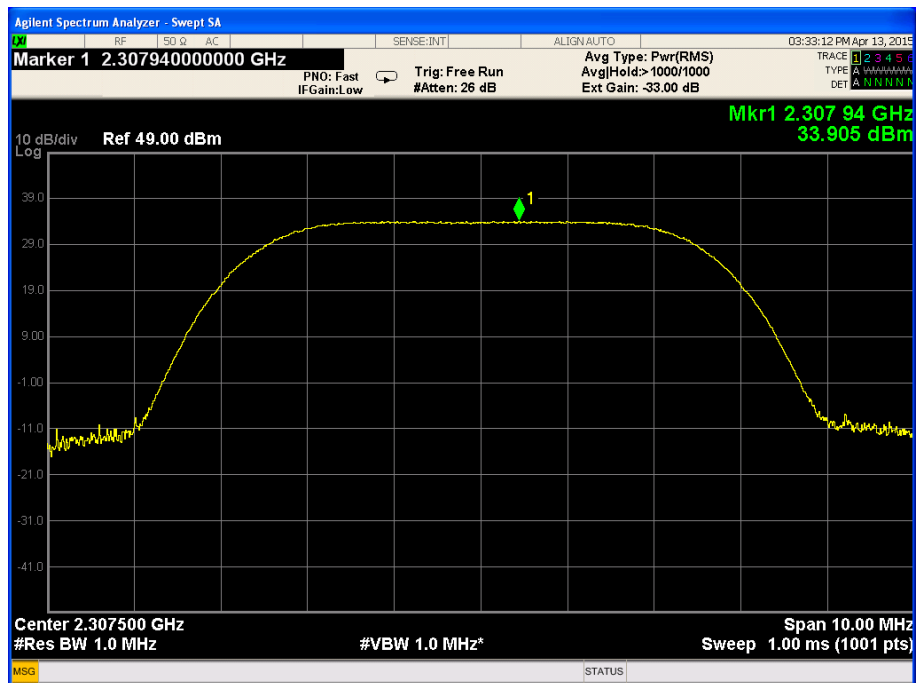


Figure 40.— 16QAM 2307.5 MHz, BW 5MHz, Port 2

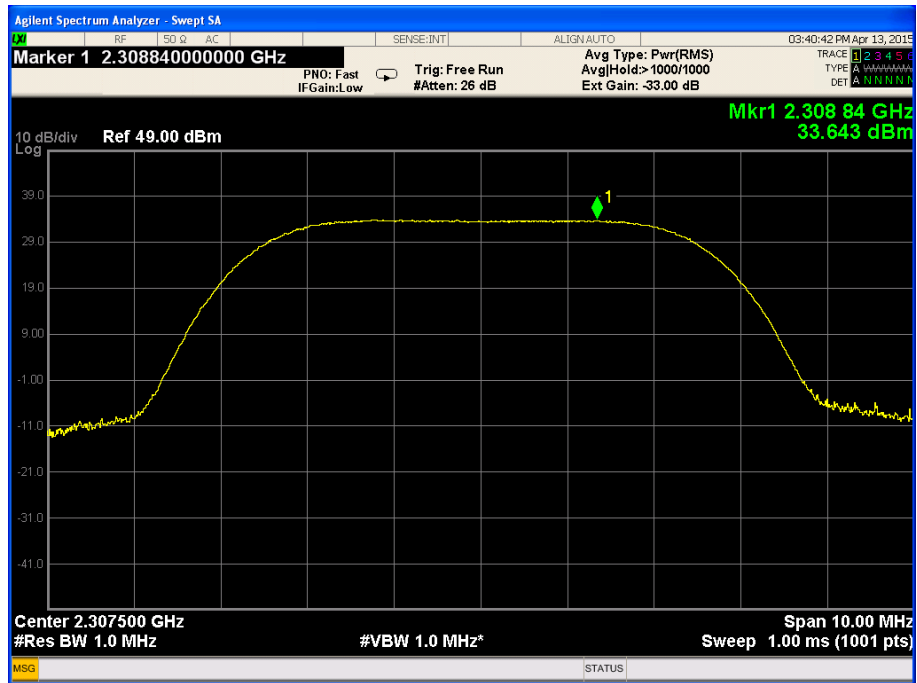


Figure 41.— 16QAM 2307.5 MHz, BW 5MHz, Port 3

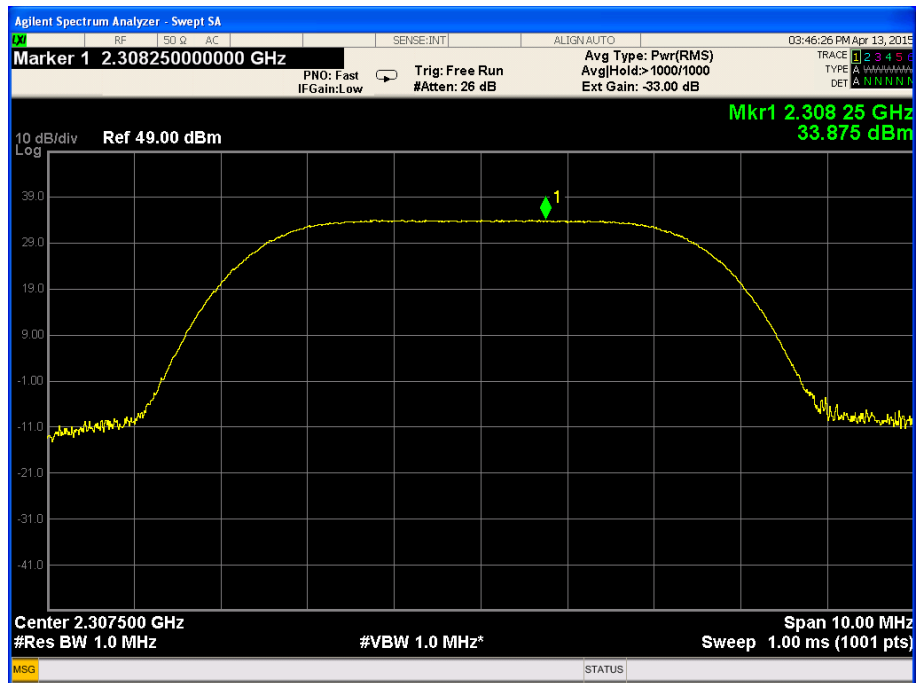


Figure 42.— 16QAM 2307.5 MHz, BW 5MHz, Port 4

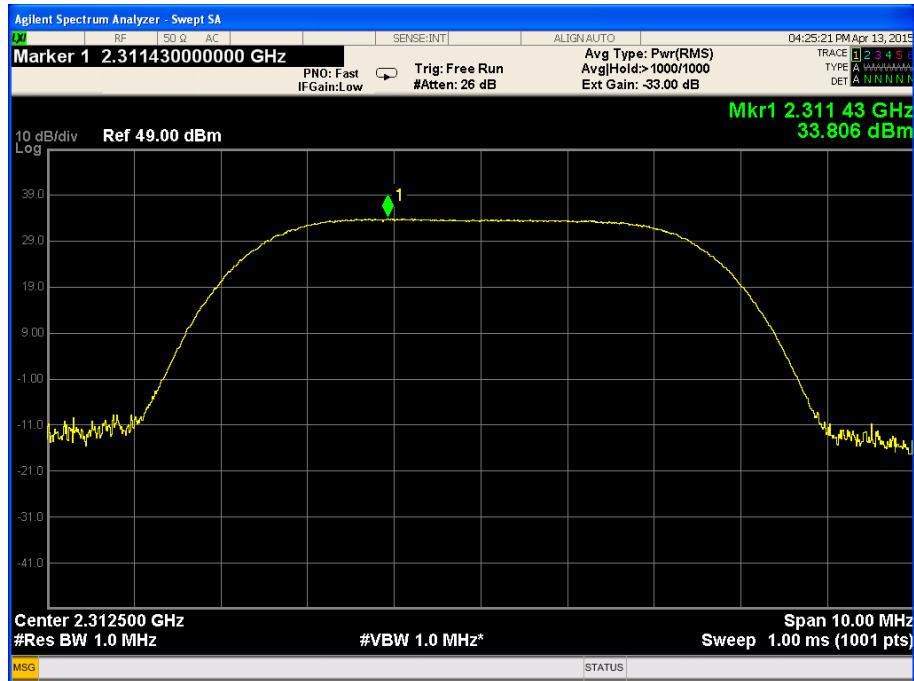


Figure 43.— 16QAM 2312.5 MHz, BW 5MHz, Port 1

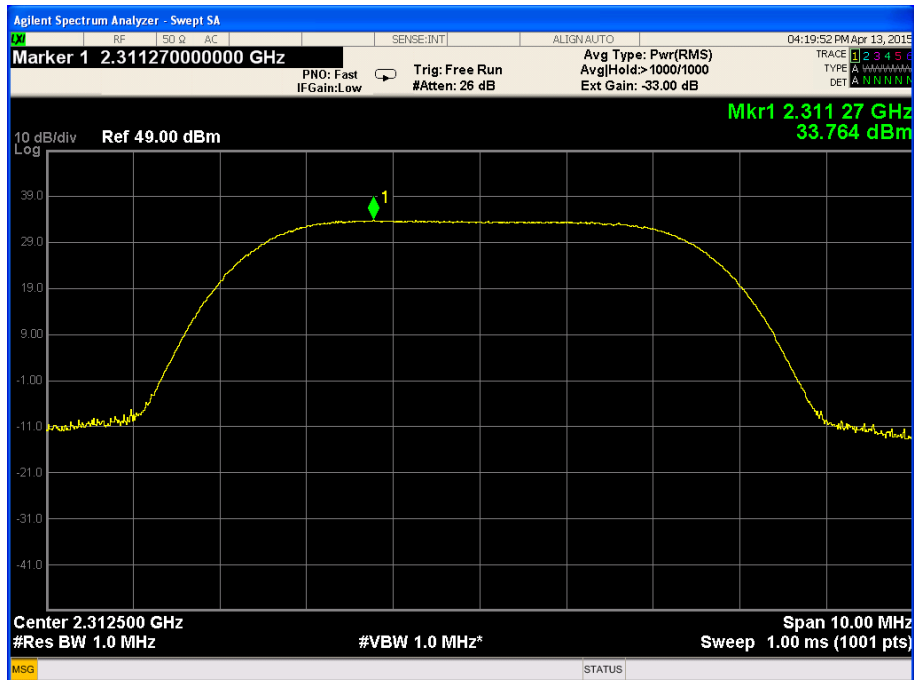


Figure 44.— 16QAM 2312.5 MHz, BW 5MHz, Port 2

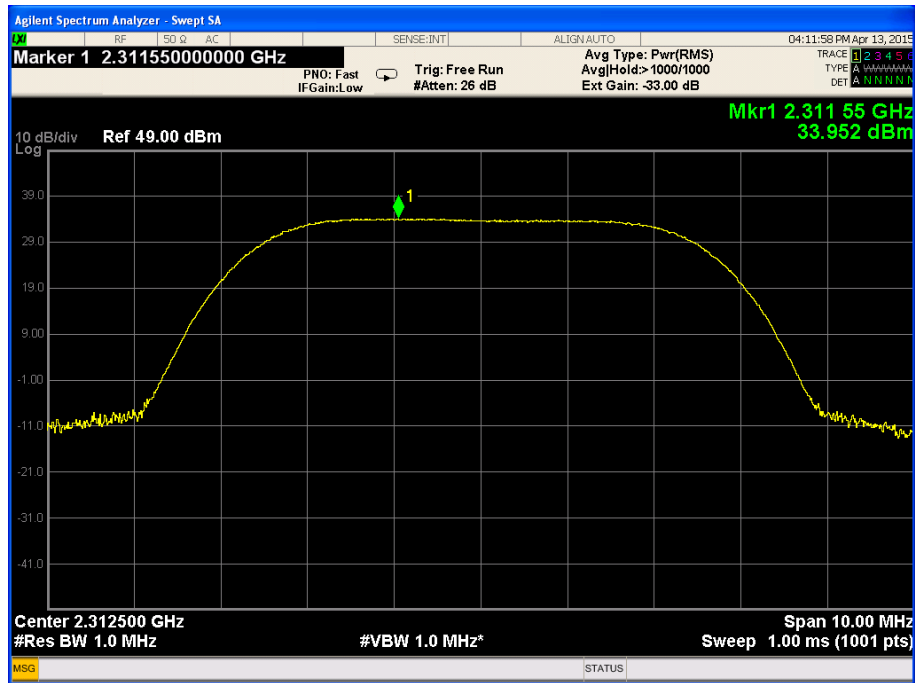


Figure 45.—2312.5 MHz, BW 5MHz, Port 3

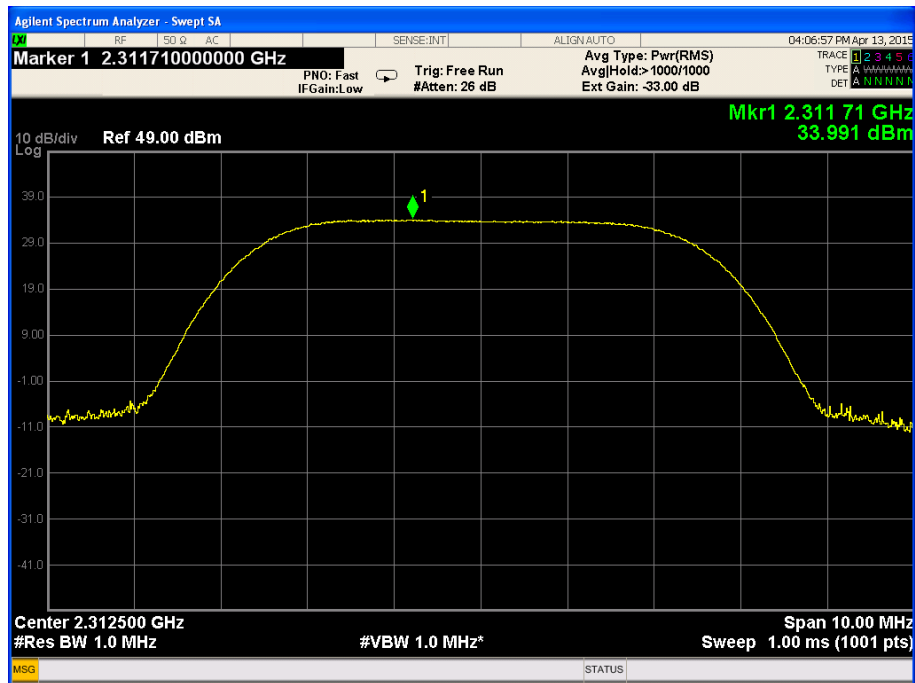


Figure 46.— 16QAM 2312.5 MHz, BW 5MHz, Port 4

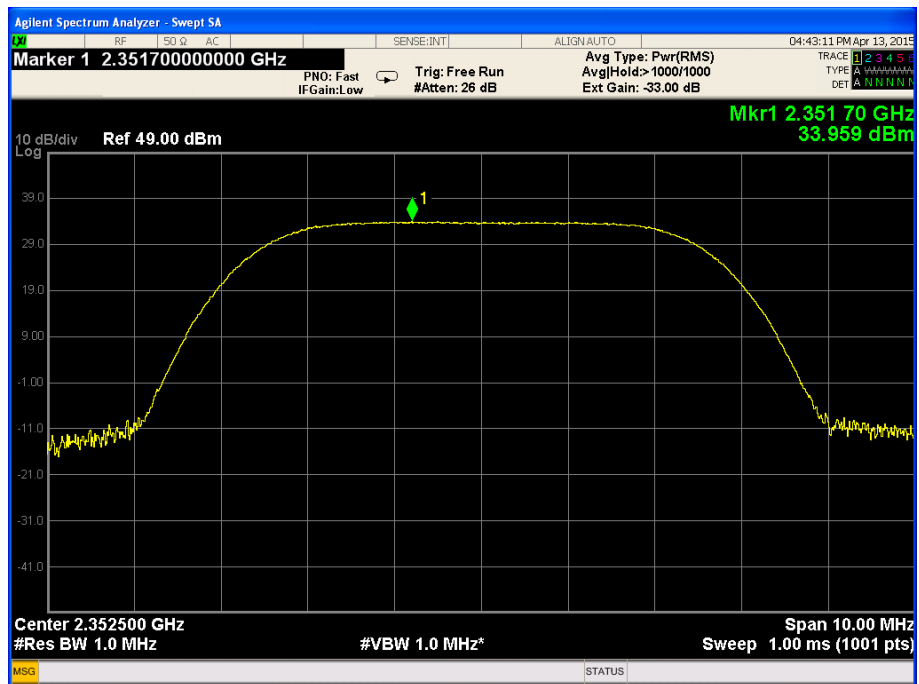


Figure 47.— 16QAM 2352.5 MHz, BW 5MHz, Port 1

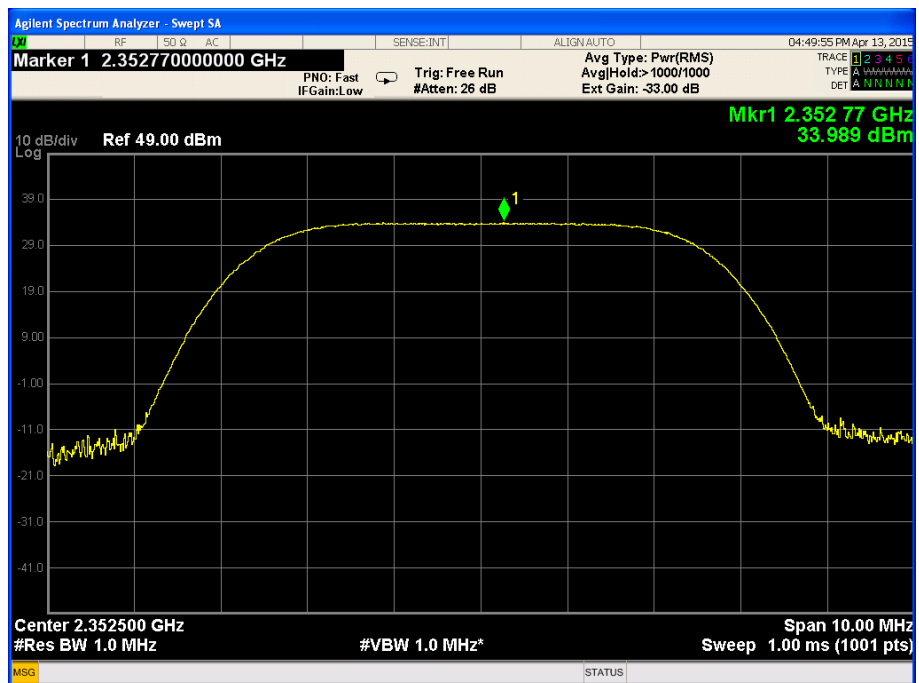


Figure 48.— 16QAM 2352.5 MHz, BW 5MHz, Port 2

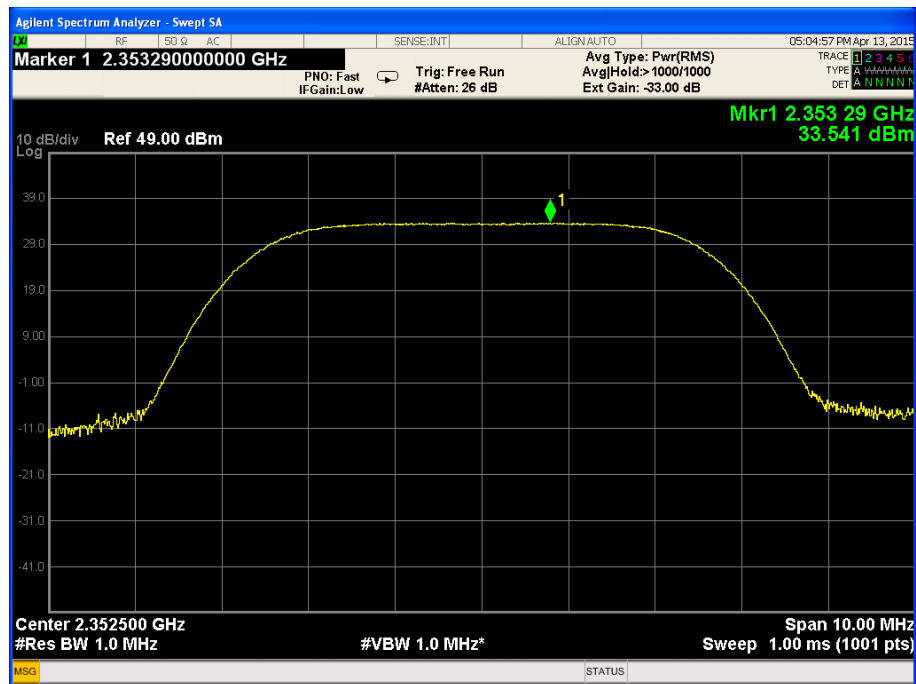


Figure 49.— 16QAM 2352.5 MHz, BW 5MHz Port 3

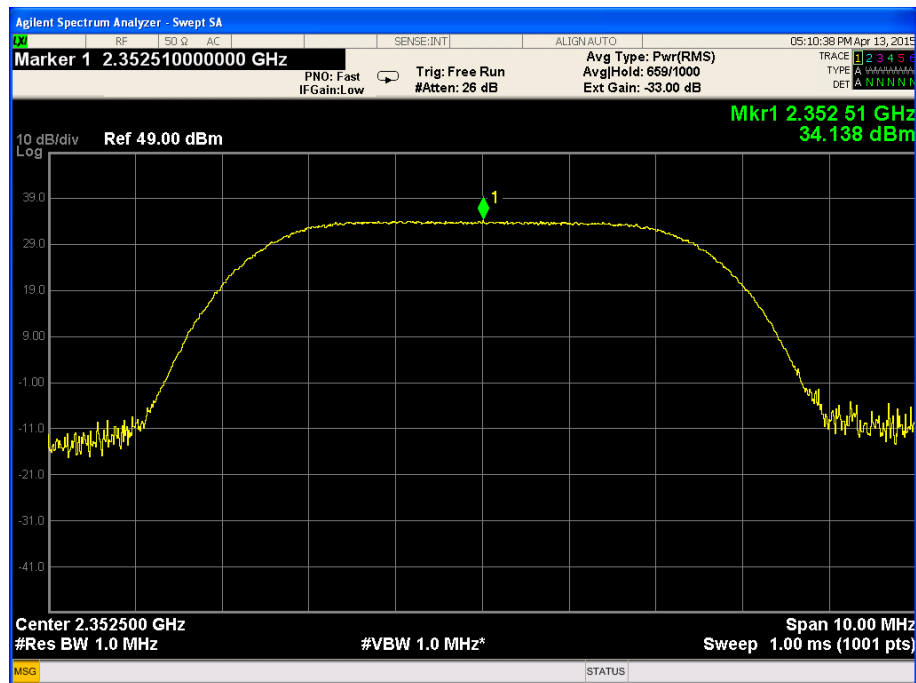


Figure 50.— 16QAM 2352.5 MHz, BW 5MHz, Port 4

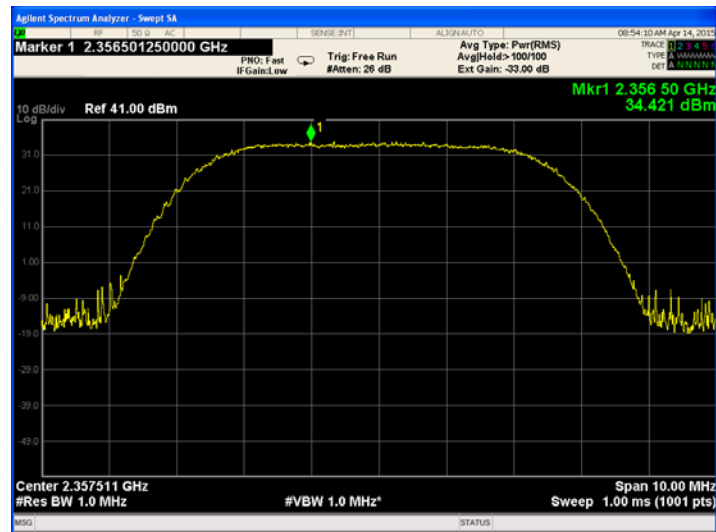


Figure 51.— 16QAM 2357.5 MHz, BW 5MHz, Port 1

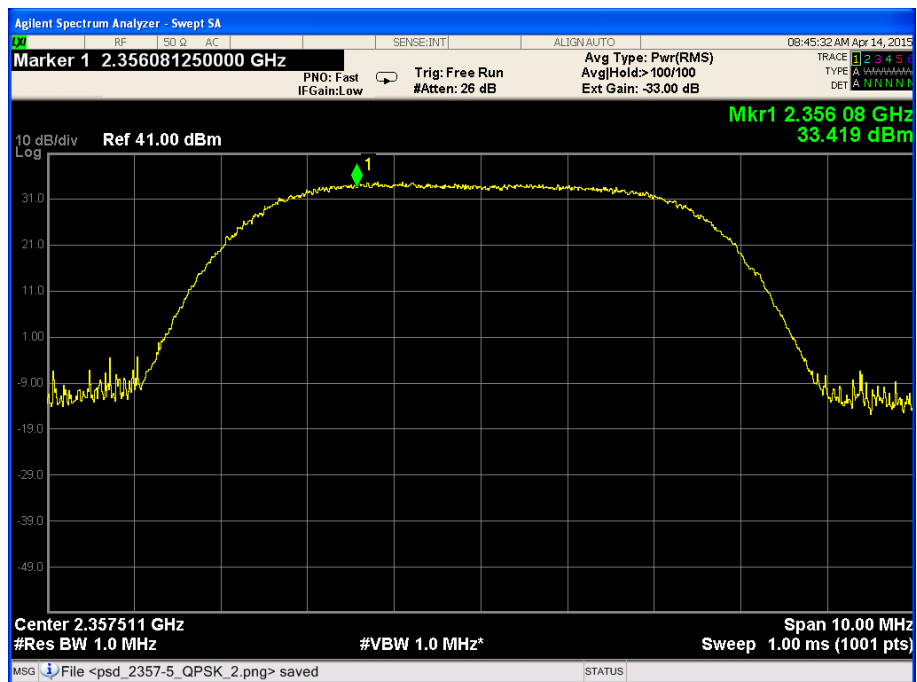


Figure 52.— 16QAM 2357.5 MHz, BW 5MHz, Port 2

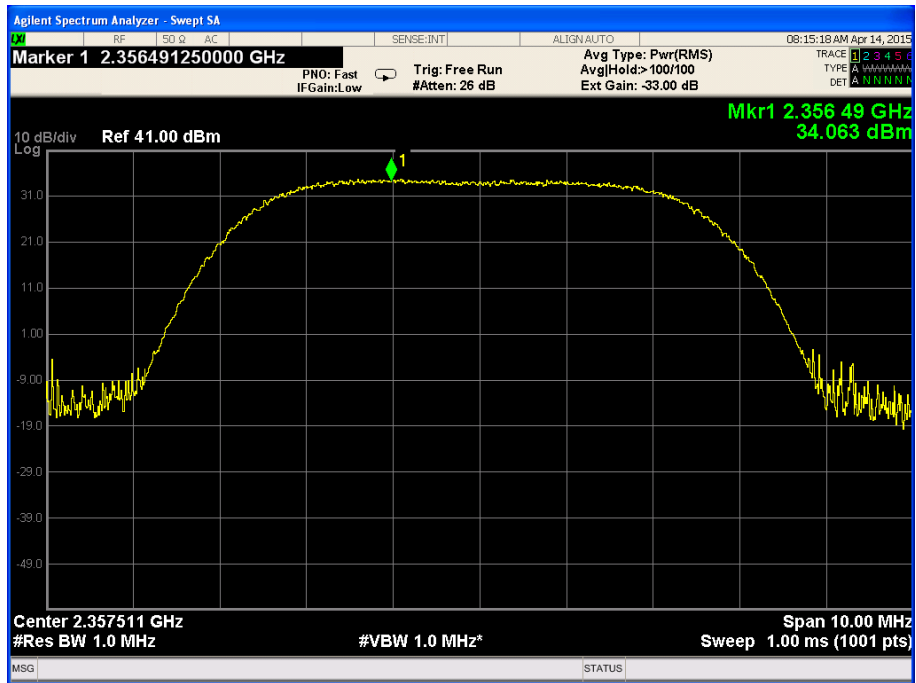


Figure 53.— 16QAM 2357.5 MHz, BW 5MHz, Port 3

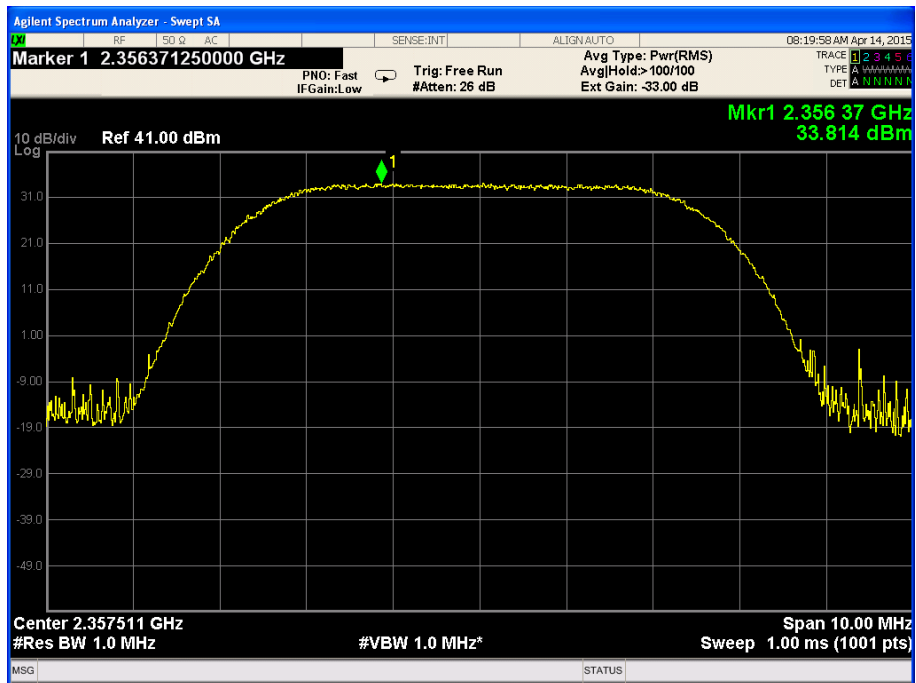


Figure 54.— 16QAM 2357.5 MHz, BW 5MHz, Port 4

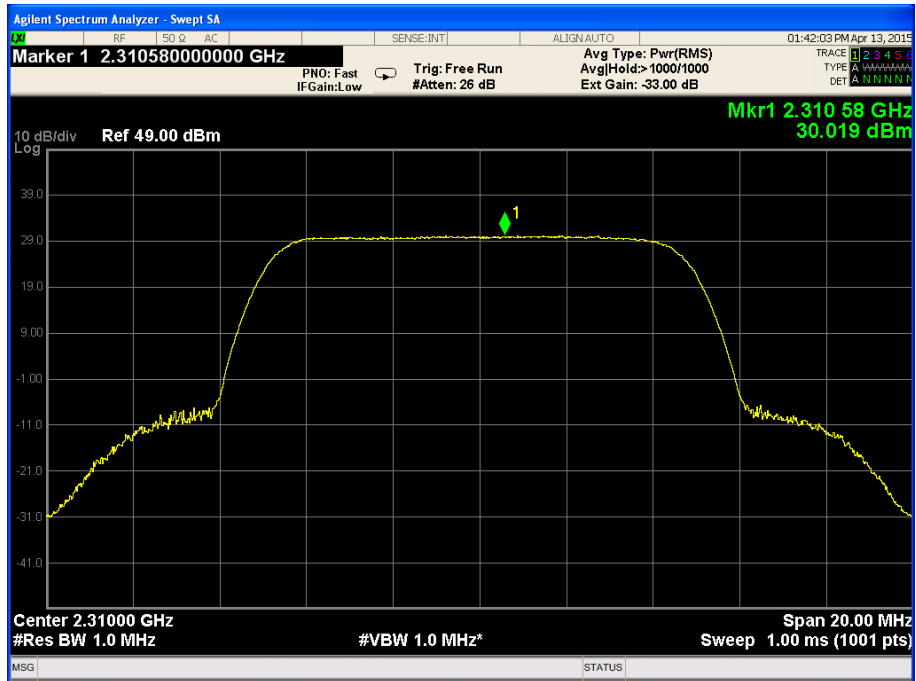


Figure 55.—64QAM 2310.0 MHz, BW 10MHz, Port 1

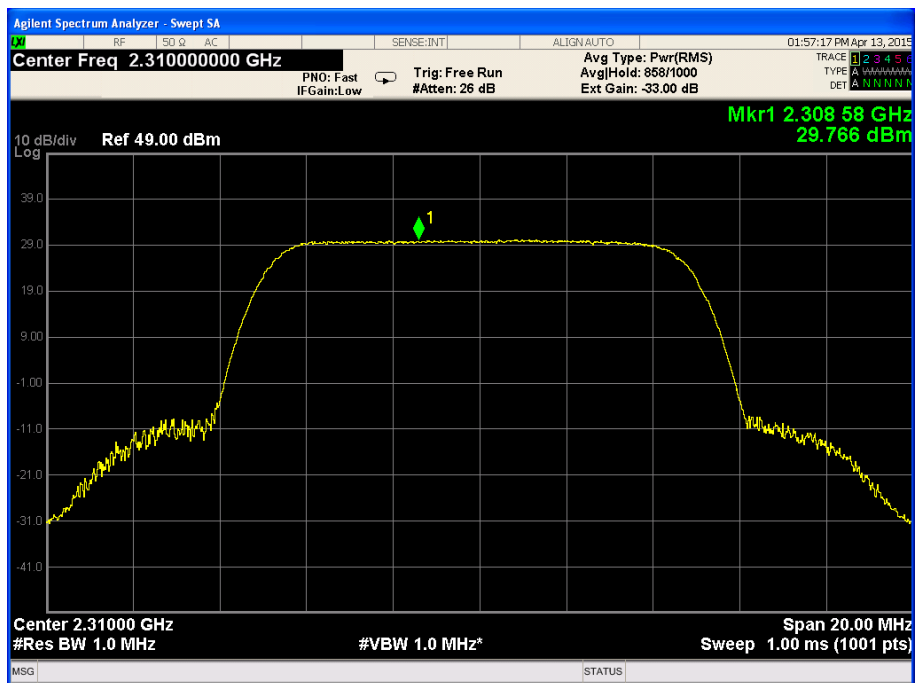


Figure 56.— 64QAM 2310.0 MHz, BW 10MHz, Port 2

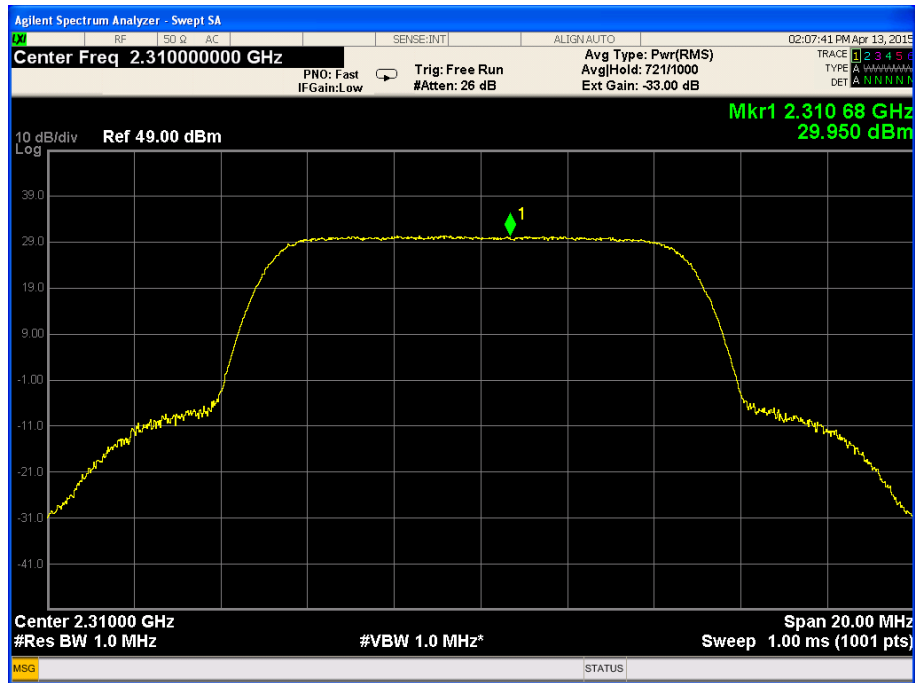


Figure 57.— 64QAM 2310.0 MHz, BW 10MHz, Port 3

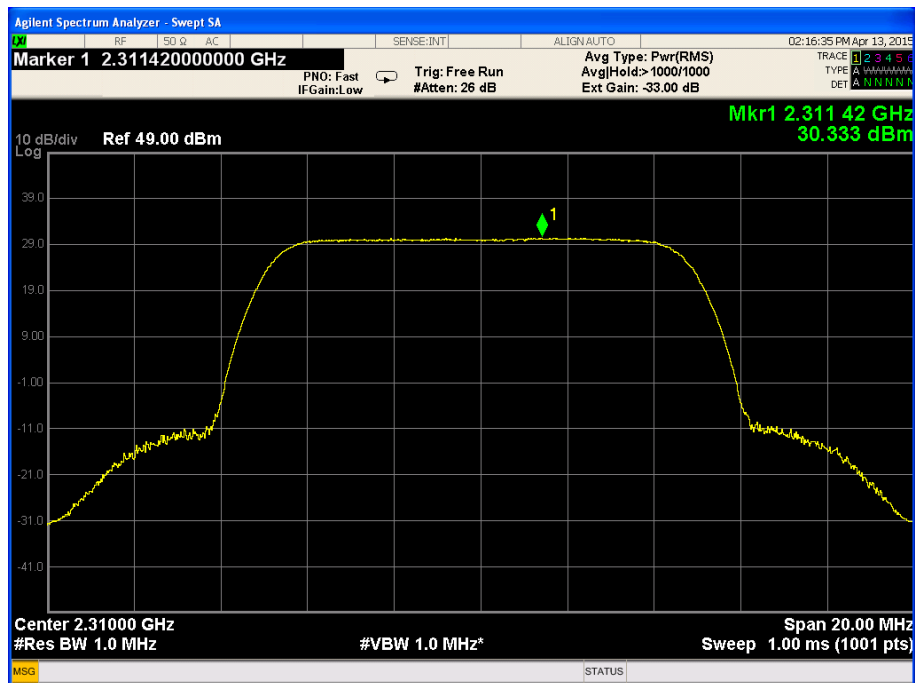


Figure 58.— 64QAM 2310.0 MHz, BW 10MHz, Port 4

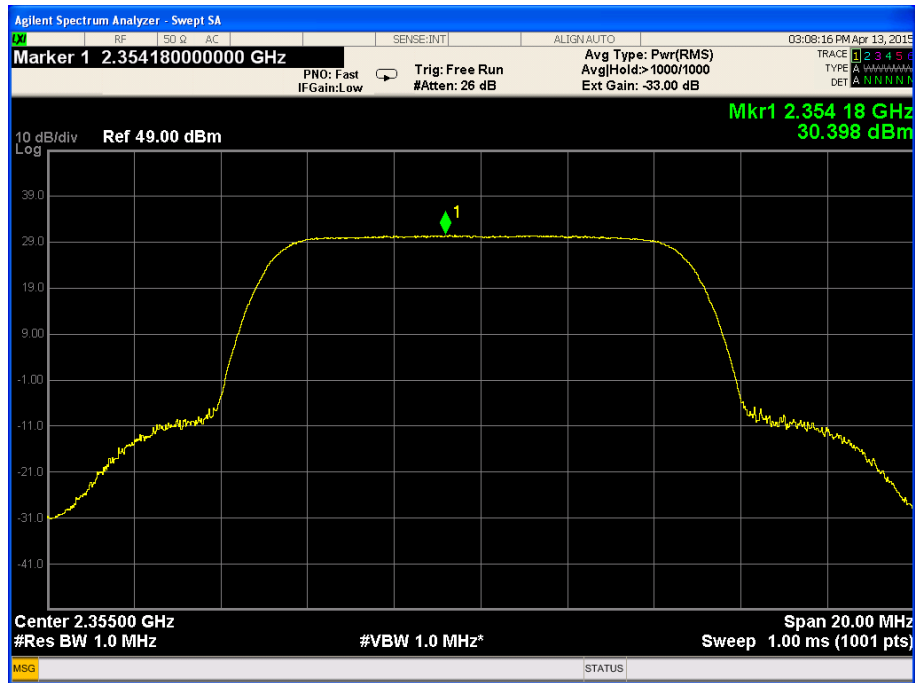


Figure 59.— 64QAM 2355.0 MHz, BW 10MHz, Port 1

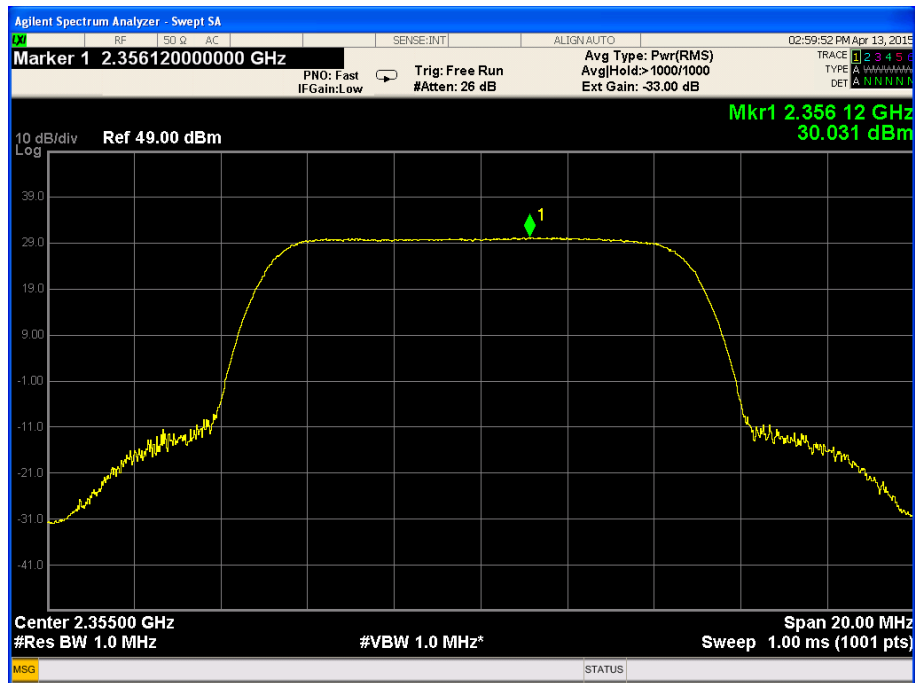


Figure 60.— 64QAM 2355.0 MHz, BW 10MHz, Port 2

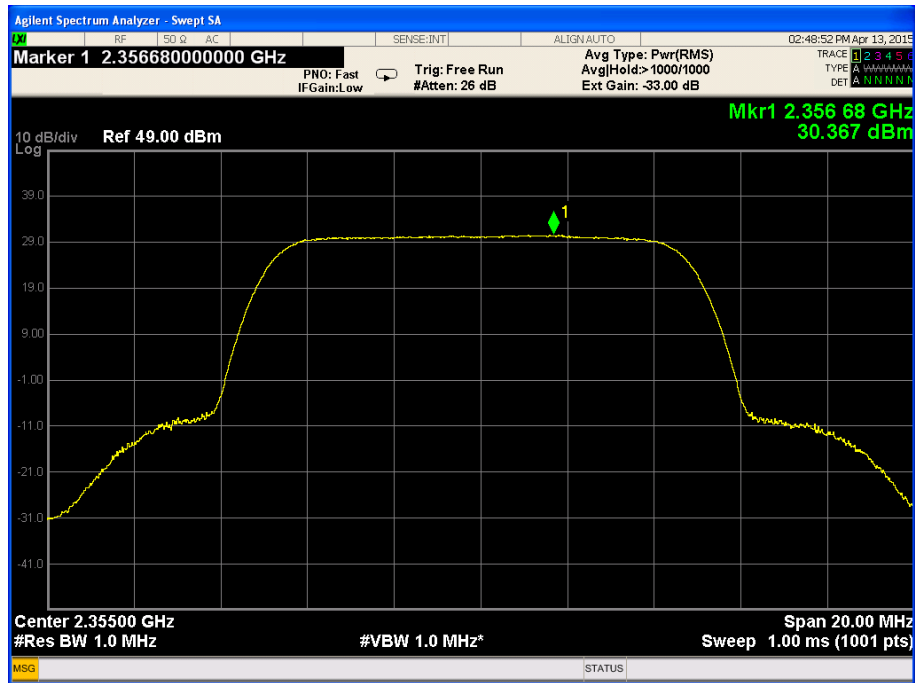


Figure 61.— 64QAM 2355.0 MHz, BW 10MHz, Port 3

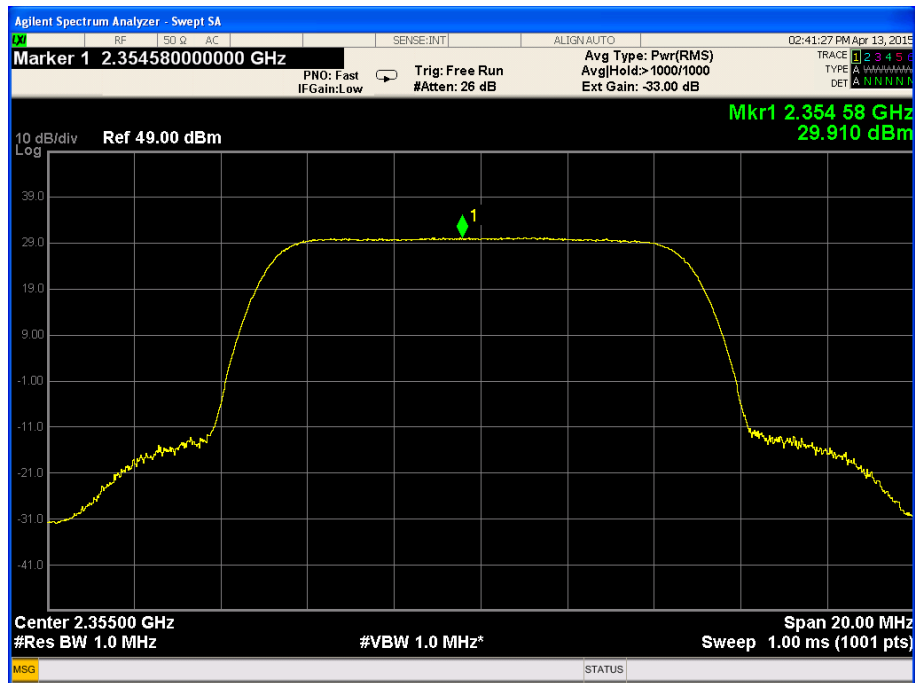


Figure 62.— 64QAM 2355.0 MHz, BW 10MHz, Port 4

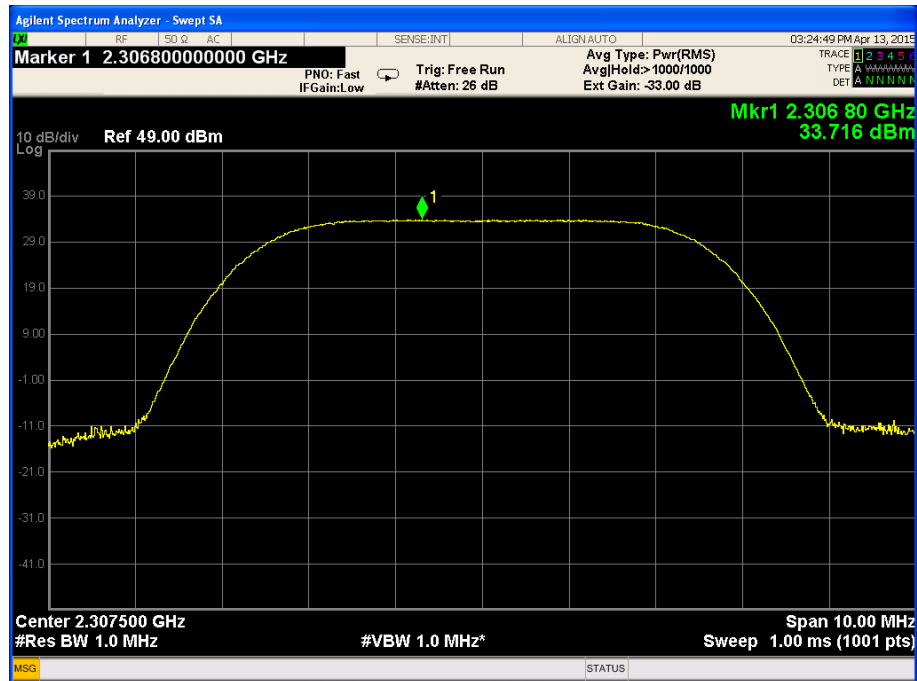


Figure 63.— 64QAM 2307.5 MHz, BW 5MHz, Port 1

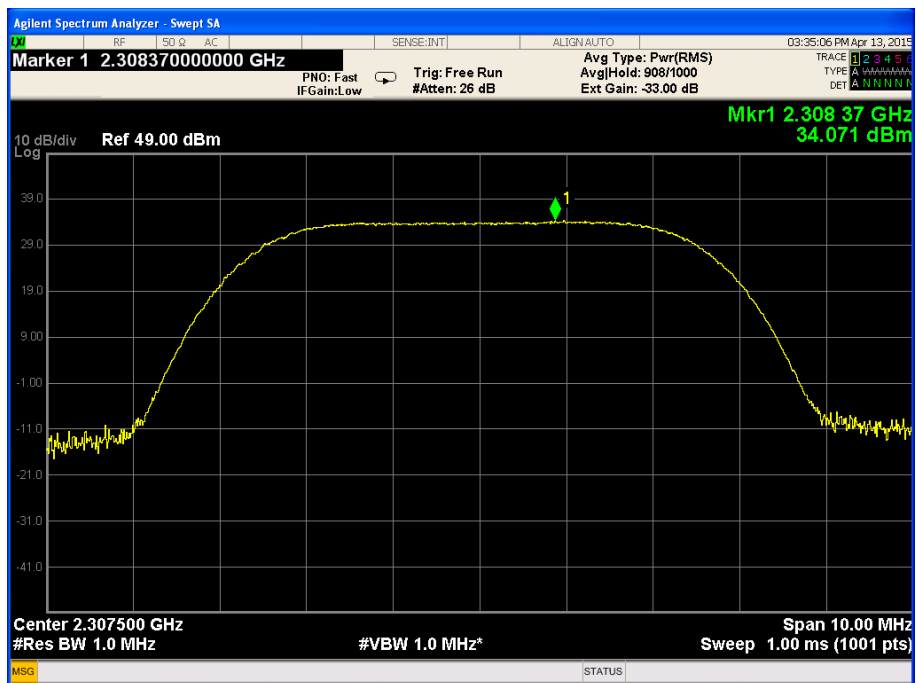


Figure 64.— 64QAM 2307.5 MHz, BW 5MHz, Port 2

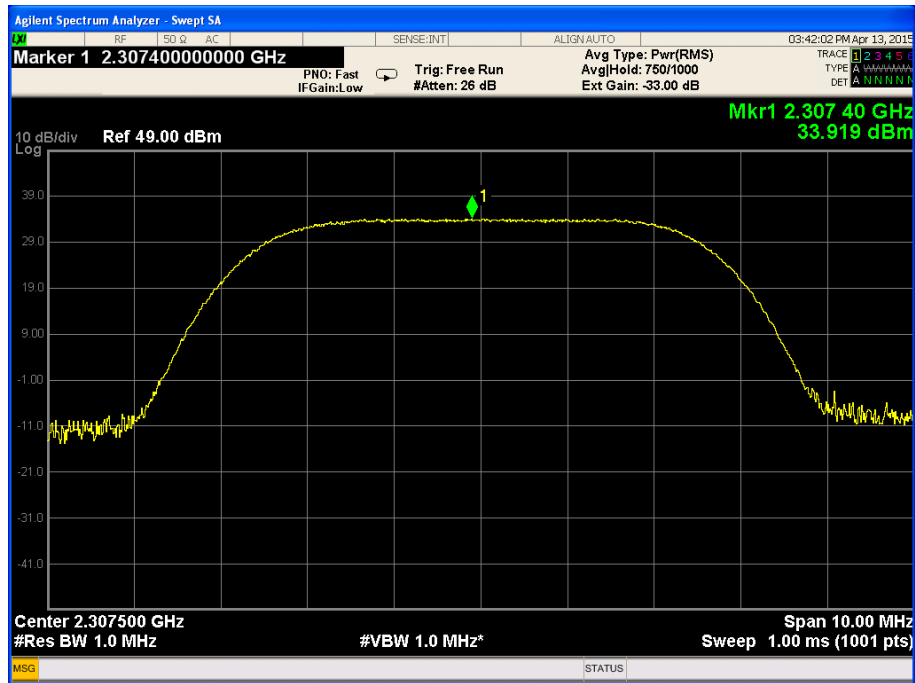


Figure 65.— 64QAM 2307.5 MHz, BW 5MHz, Port 3

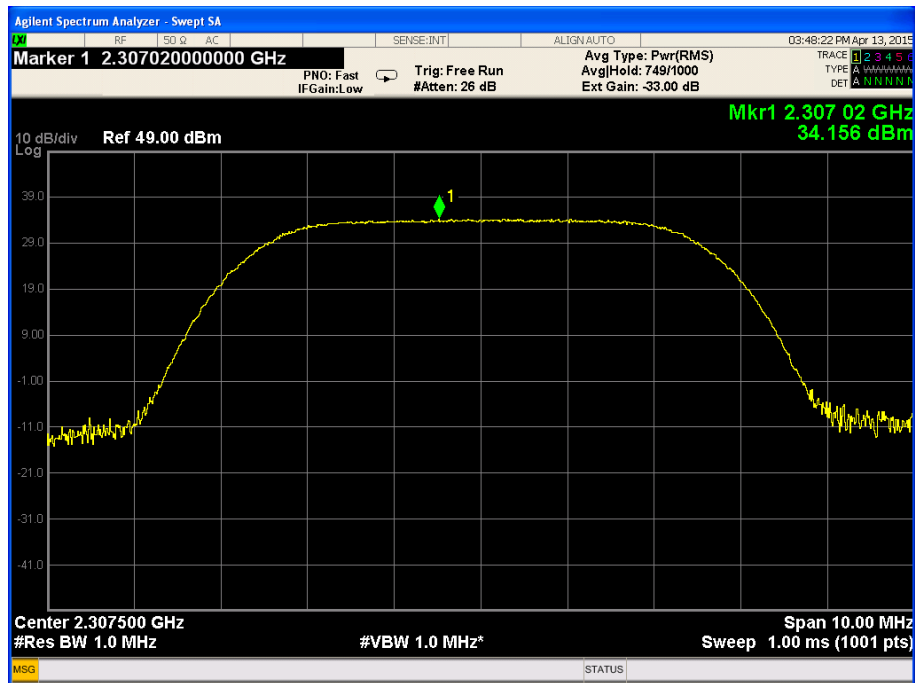


Figure 66.— 64QAM 2307.5 MHz, BW 5MHz, Port 4

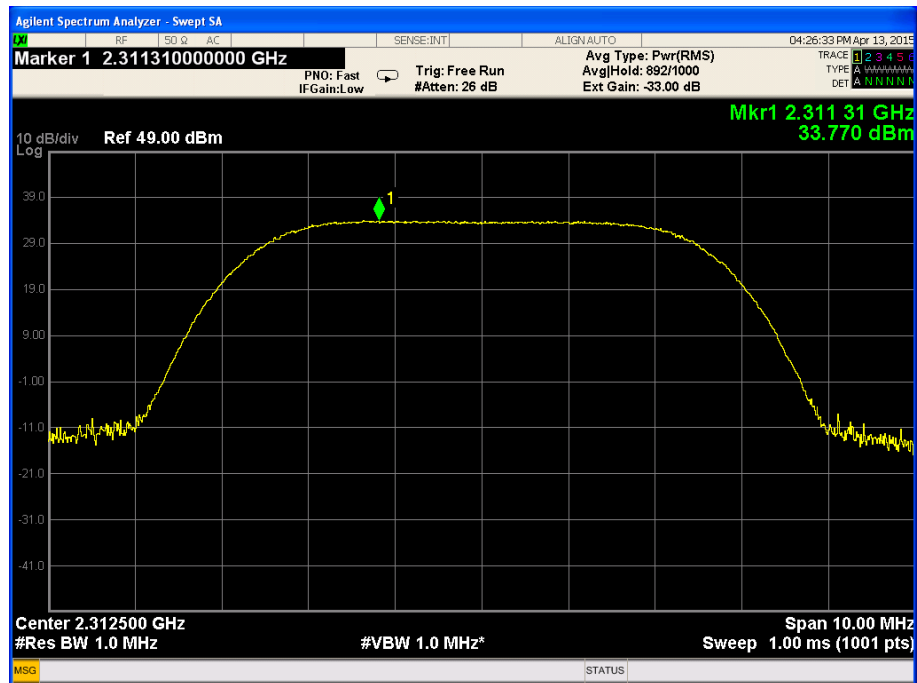


Figure 67.— 64QAM 2312.5 MHz, BW 5MHz, Port 1

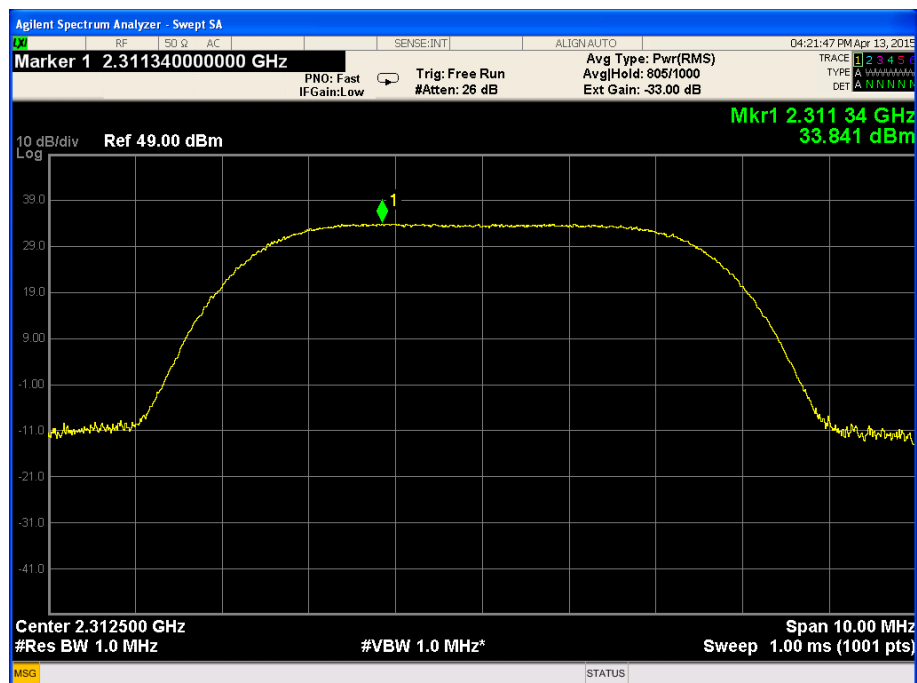


Figure 68.— 64QAM 2312.5 MHz, BW 5MHz, Port 2

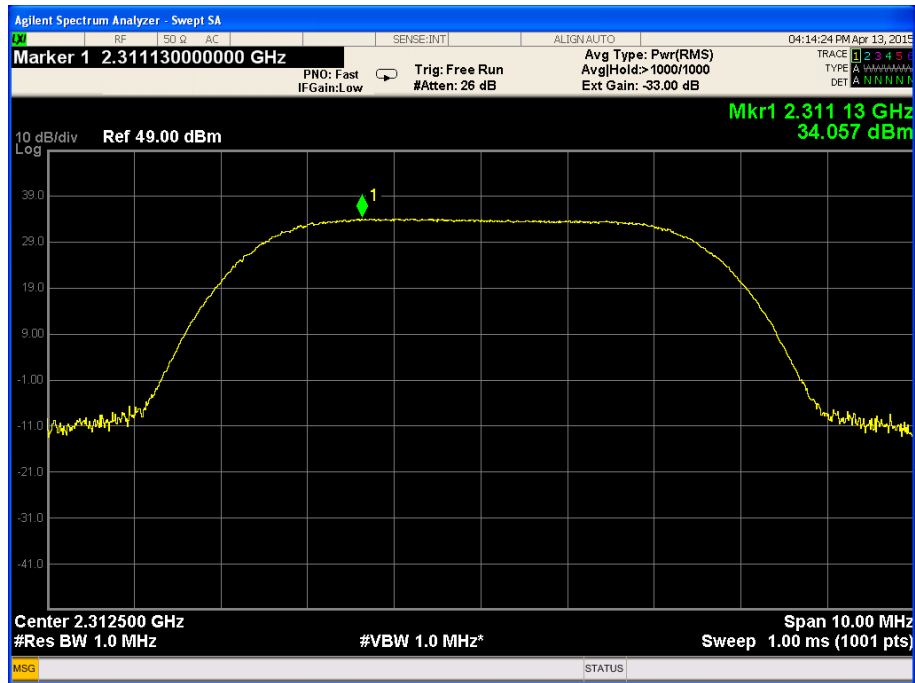


Figure 69.— 64QAM 2312.5 MHz, BW 5MHz, Port 3

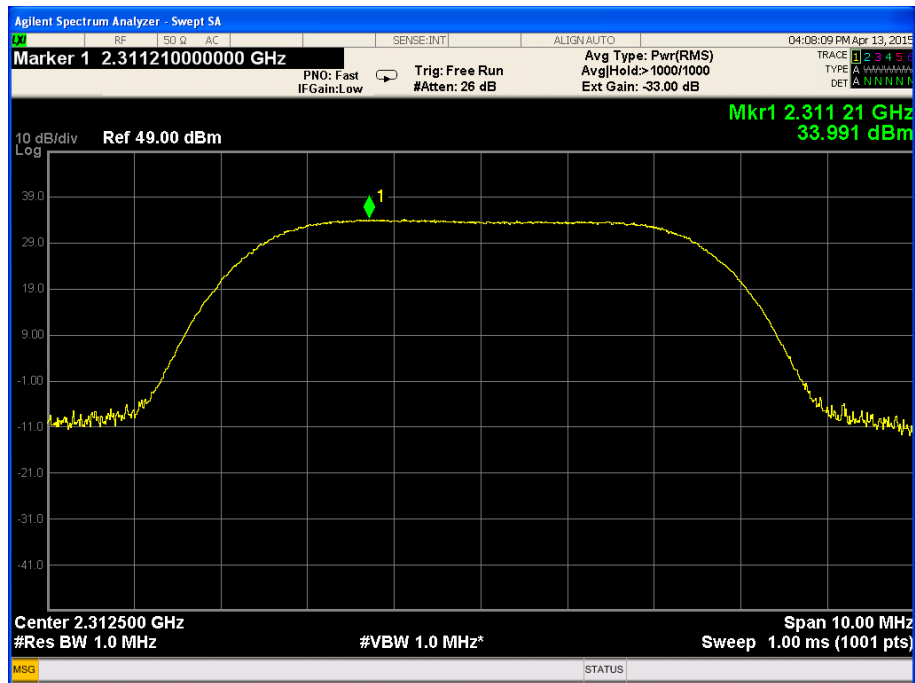


Figure 70.— 64QAM 2312.5 MHz, BW 5MHz, Port 4

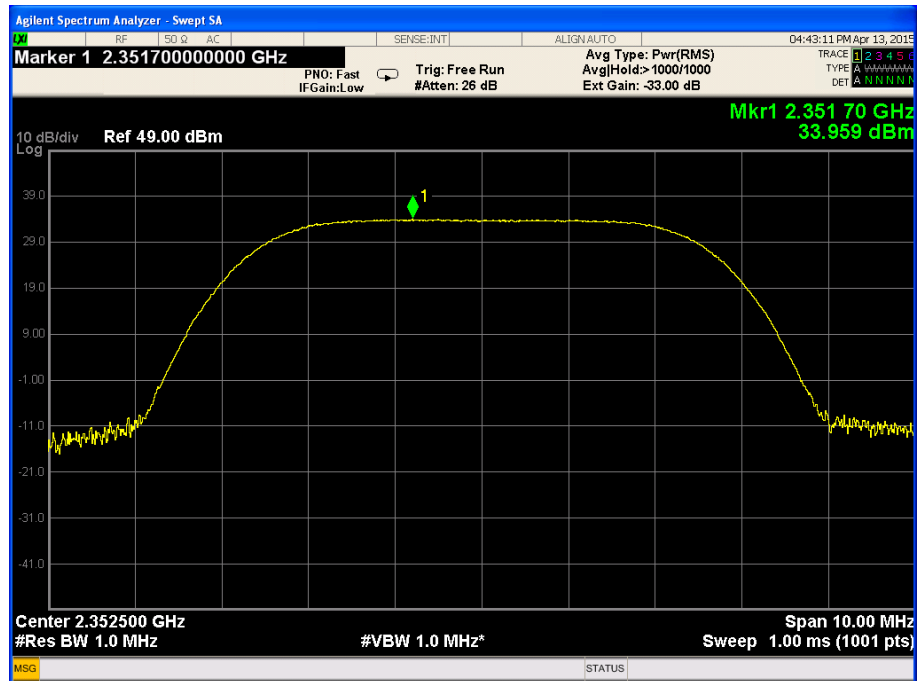


Figure 71.— 64QAM 2352.5 MHz, BW 5MHz, Port 1

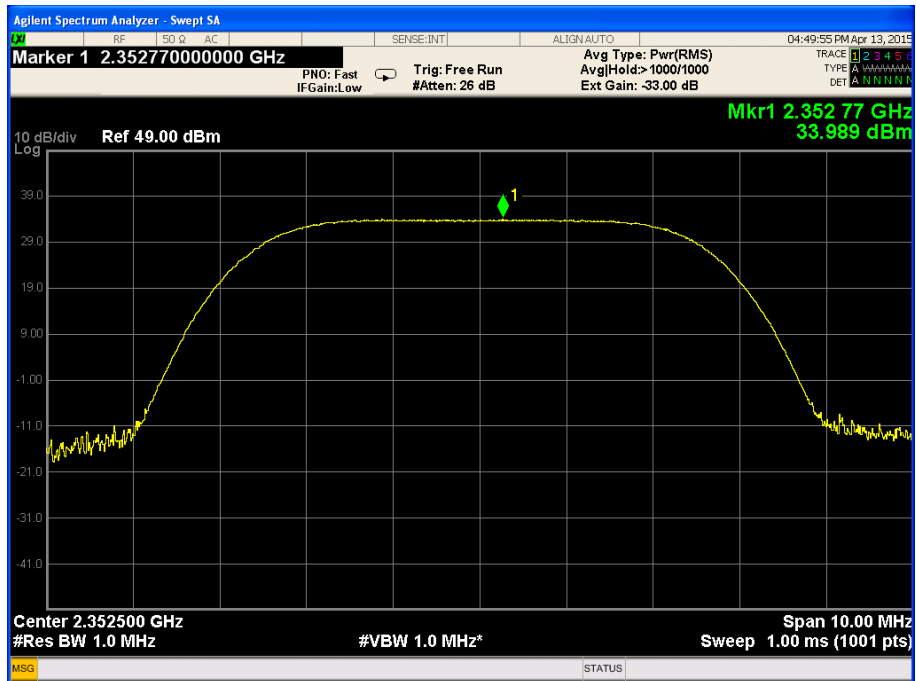


Figure 72.— 64QAM 2352.5 MHz, BW 5MHz, Port 2

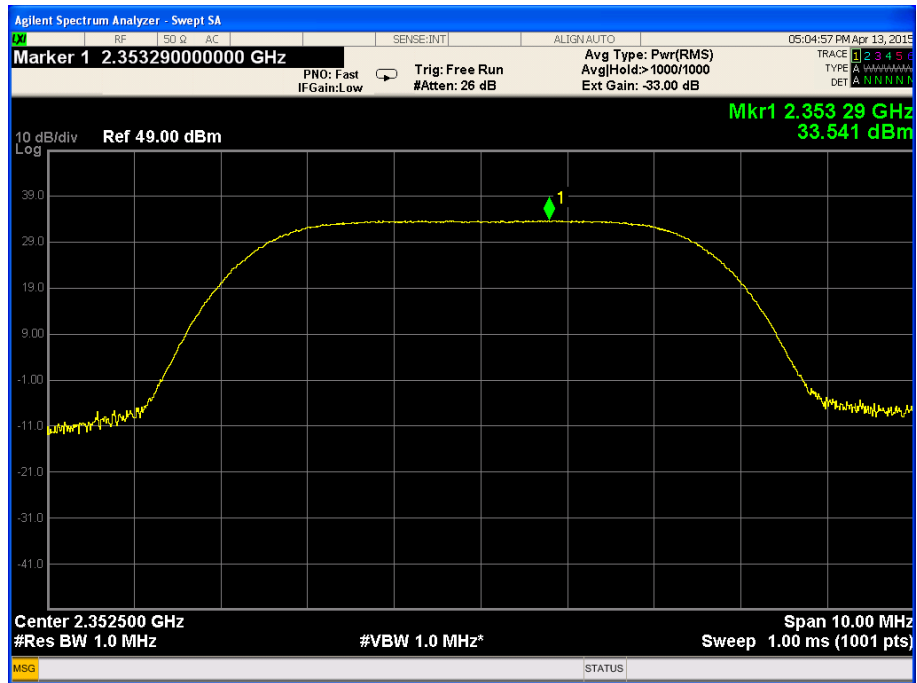


Figure 73.— 64QAM 2352.5 MHz, BW 5MHz, Port 3

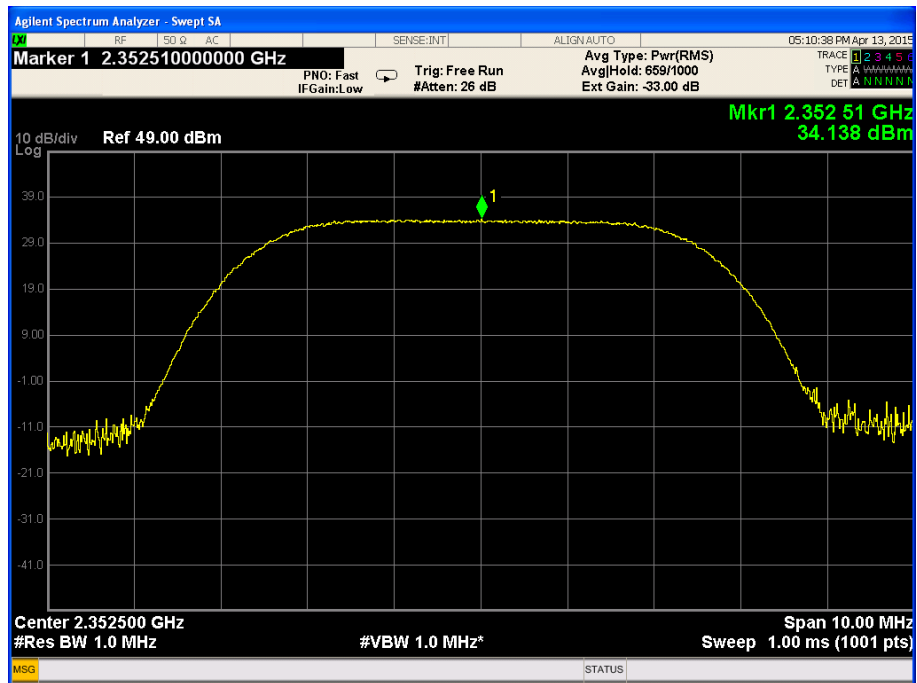


Figure 74.— 64QAM 2352.5 MHz, BW 5MHz, Port 4

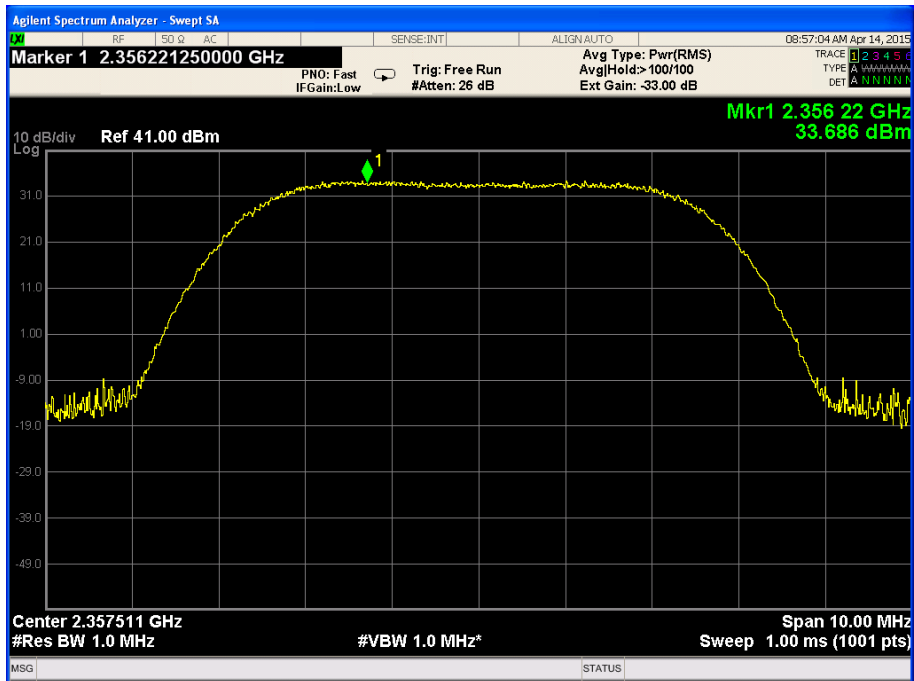


Figure 75.— 64QAM 2357.5 MHz, BW 5MHz, Port 1

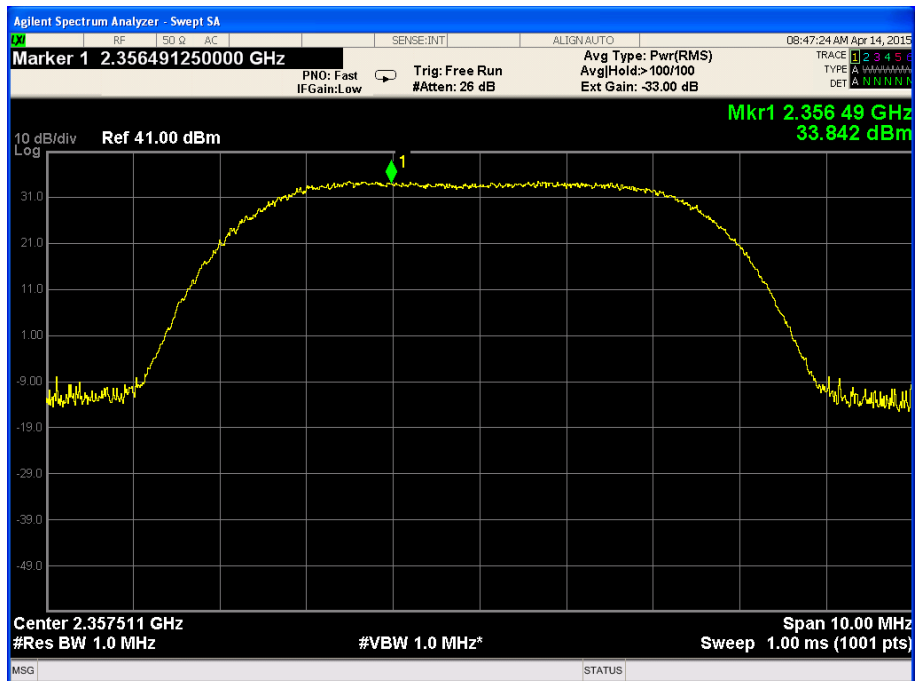


Figure 76.— 64QAM 2357.5 MHz, BW 5MHz, Port 2

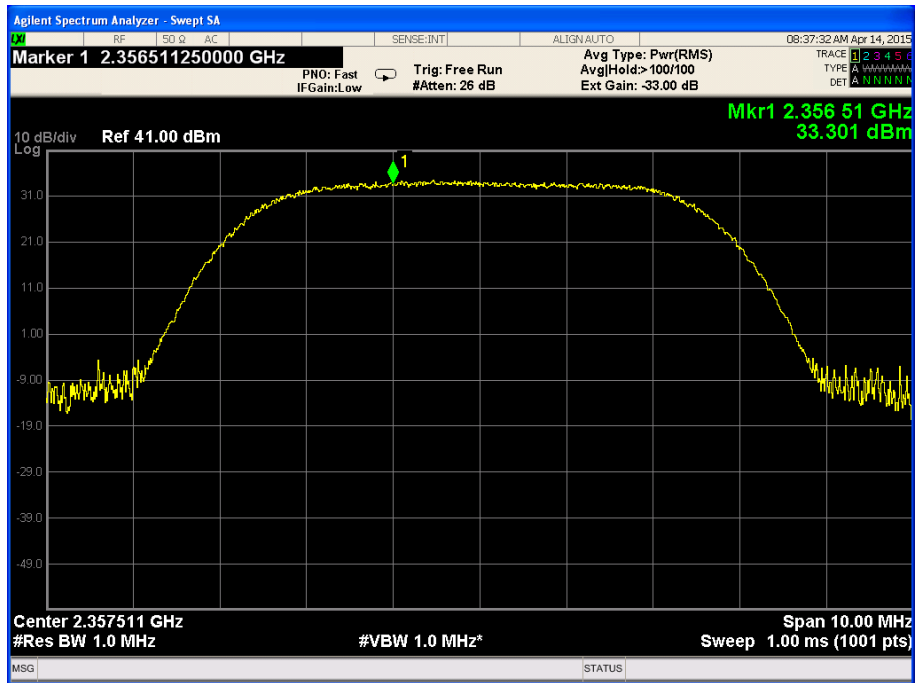


Figure 77.— 64QAM 2357.5 MHz, BW 5MHz, Port 3

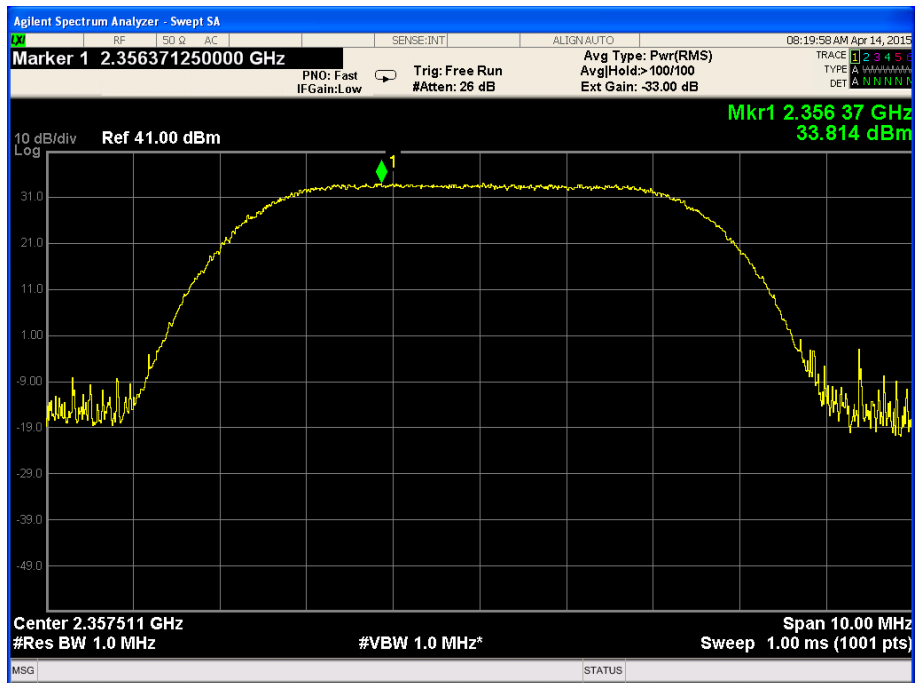


Figure 78.— 64QAM 2357.5 MHz, BW 5MHz, Port 4



5.4 Test Equipment Used; Peak Output Power

Instrument	Manufacturer	Model	Serial Number	Calibration	Period
EMI Receiver	R&S	ESIB7	100120	January 4, 2015	1 year
Spectrum Analyzer	R&S	FSL6	100194	January 1, 2015	1 year
Spectrum Analyzer	HP	8592L	3826A01204	March 4, 2015	1 year
Active Loop Antenna	EMCO	6502	2950	November 4, 2014	1 year
Biconical Log Antenna	EMCO	3142B	1078	May 22, 2014	2 years
Horn Antenna	ETS	3115	6142	March 14, 2012	3 years*
Horn Antenna	A.R.A	SWH-28	1007	March 30, 2014	2 years
D.C Block	JFW	50DB-007	1-23	N/A	N/A
Coupler	PULSAR	CS 10-05-436	10	N/A	N/A
Notch Filter	TELRAD	RMC2310_2355 D10M08	10050150	N/A	N/A
MXA Signal Analyzer	Agilent	N9020A	MY46471581	February 12 2015	2 years
Spectrum Analyzer	HP	8563E	3810A8846	November 30, 2014	1 year
10 dB Attenuator	Weinschel	33-10-34	BZ5739	N/A	N/A
5 dB Attenuator	Mini-circuits	VAT-5+	15542	N/A	N/A
Power Splitter	Mini-circuits	ZN2PD-63-S+	F442300839	N/A	N/A
Attenuator	Weinschel	24-20-34	BZ144	N/A	N/A
Attenuator	Weinschel	24-20-34	BY0842	N/A	N/A
Attenuator	Weinschel	24-20-34	BY0855	N/A	N/A
Attenuator	Weinschel	24-20-34	BY0842	N/A	N/A
Signal Generator	WILTRON	6747B	278007	October 23, 2014	1 year



Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	August 29, 2014	1 year
Low Noise Amplifier	DBS MICROWAVE	LNA-DBS-0411N313	013	August 22, 2014	1 year
Environmental Chamber	THERMOTRON CORP	SM 32C Mini Max	25-1030	February 24, 2015	1 year
Antenna Mast	ETS	2070-2	-	N/A	N/A
Turntable	ETS	2087	-	N/A	N/A
Mast & Table Controller	ETS/EMCO	2090	9608-1456	N/A	N/A

*Note – Extended to May 19, 2015

Figure 79 Test Equipment Used

6. Peak to Average Power Ratio

6.1 Test Specification

FCC Part 27.50(a)(1)(B)

RSS-195, Issue 2, April 2014, Section 5.51

6.2 Test Procedure

The method used is as detailed in FCC KDB 971168.

Measurements was using CCDF function for each modulation.

6.3 Test Results

MOD	BW	Operation Frequency (MHz)	0.1% PAPR (dB)	Specification (dB)	Margin (dB)
QPSK	5M	2307.5	9.7	13.0	-3.3
		2357.5	10.0	13.0	-3.0
	10M	2310.0	9.5	13.0	-3.5
		2355.0	9.6	13.0	-3.4
16QAM	5M	2307.5	9.4	13.0	-3.6
		2357.5	10.0	13.0	-3.0
	10M	2310.0	10.1	13.0	-2.9
		2355.0	10.1	13.0	-2.9
64QAM	5M	2307.5	9.7	13.0	-3.3
		2357.5	10.6	13.0	-2.4
	10M	2310.0	10.6	13.0	-2.4
		2355.0	10.4	13.0	-2.6

Figure 80 Test Results Peak to Average Power Ratio

JUDGEMENT: Passed

The E.U.T. met the requirements of FCC Part 27.50(a)(1)(B) and RSS-195, Issue 2, April 2014, Section 5.51

For additional information see *Figure 81* to *Figure 92*.

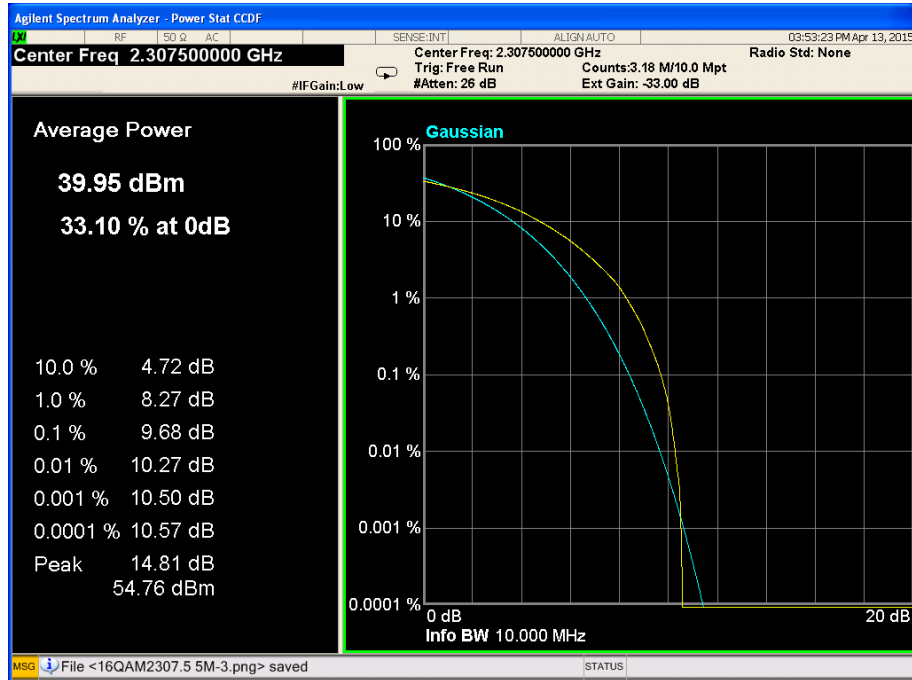


Figure 81.—QPSK, 2307.5 MHz, BW 5MHz

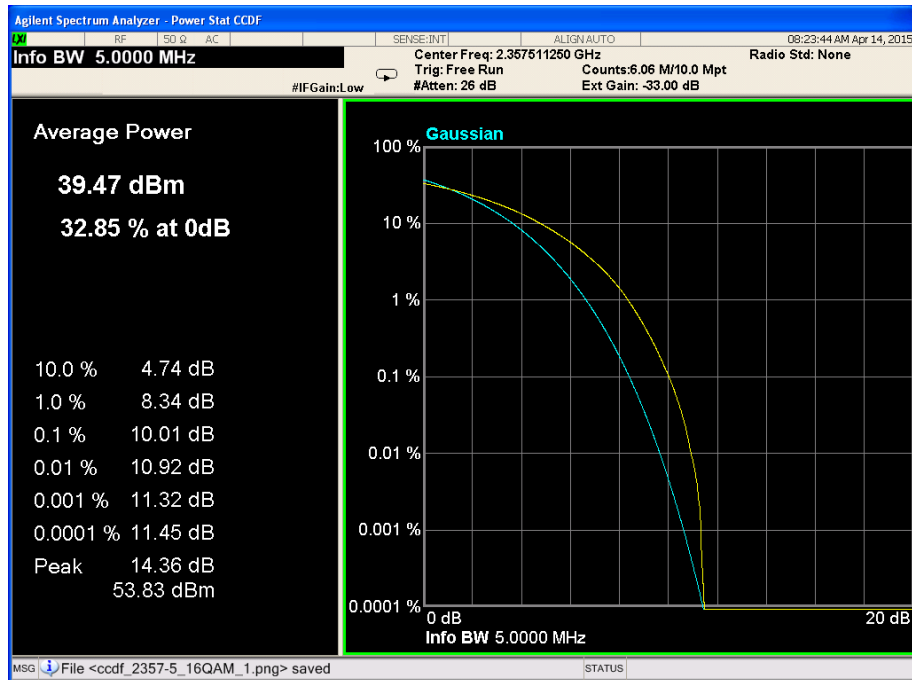


Figure 82.—QPSK, 2357.5 MHz, BW 5MHz

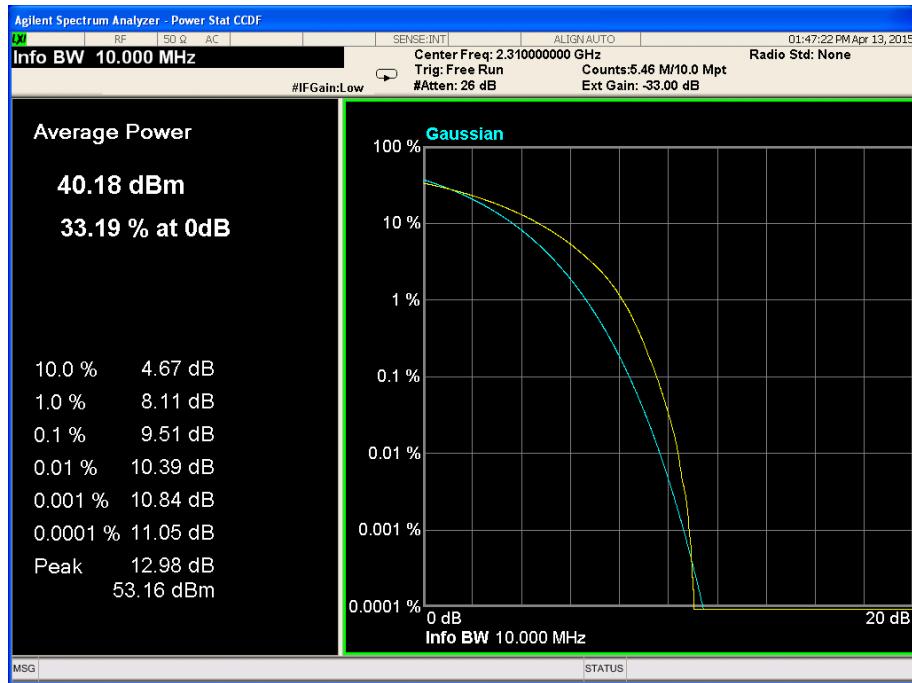


Figure 83.—QPSK, 2310.0 MHz, BW 10MHz

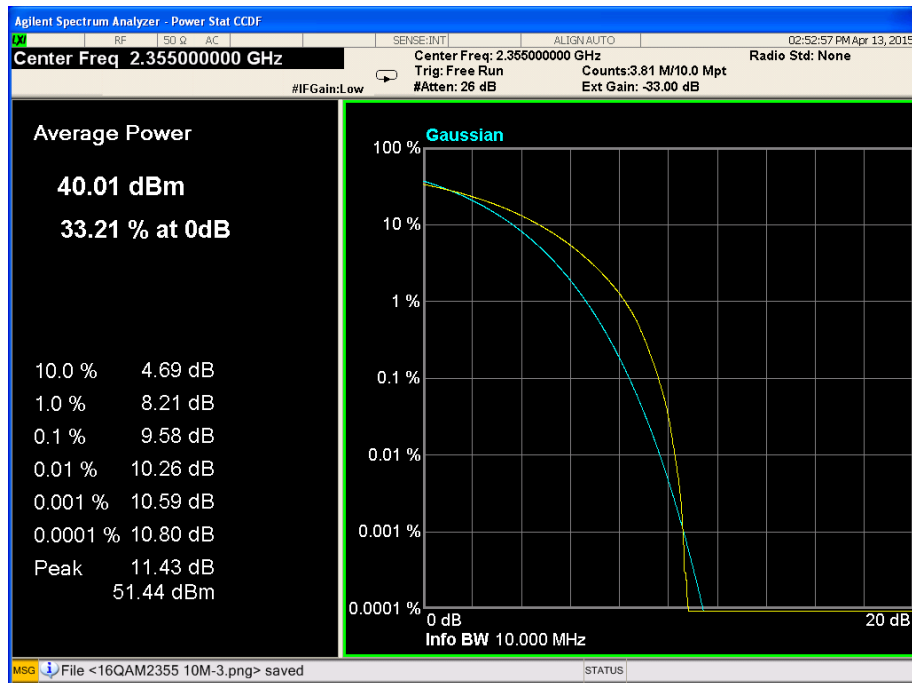


Figure 84.—QPSK, 2355.0 MHz, BW 10MHz

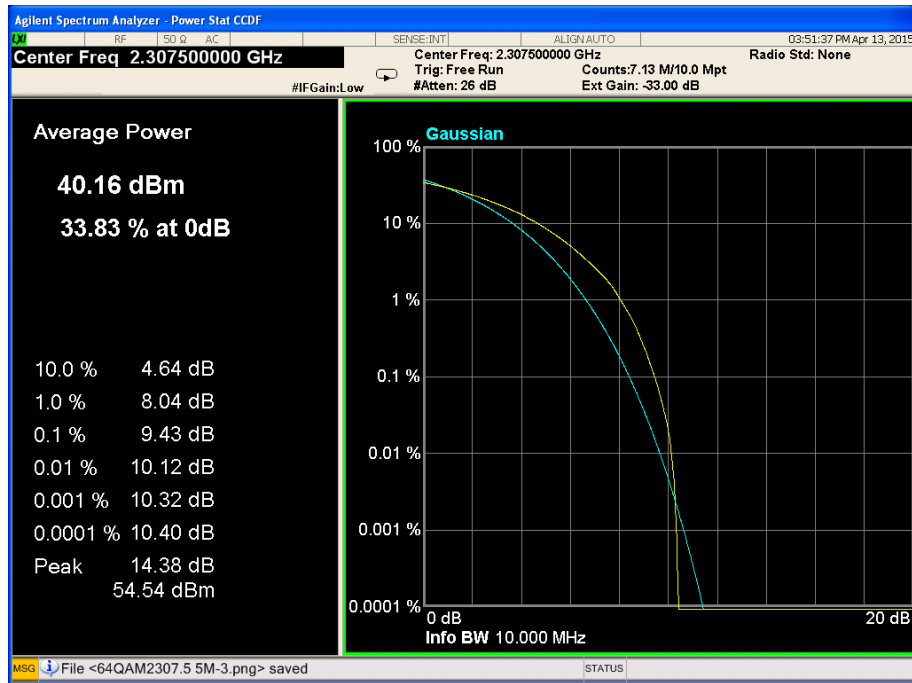


Figure 85.—16QAM, 2307.5 MHz, BW 5MHz

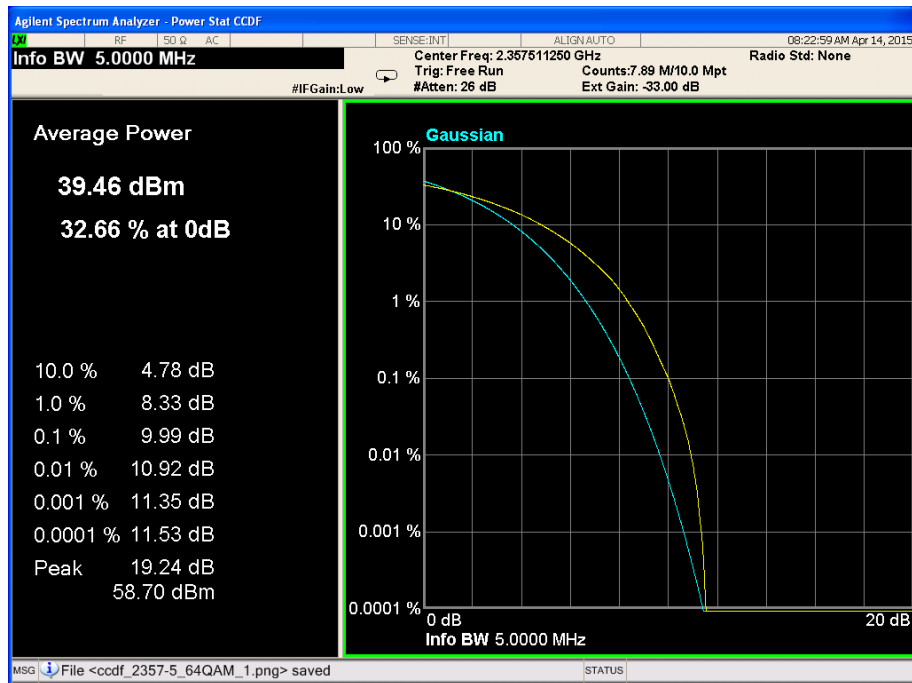


Figure 86. — 16QAM, 2357.5 MHz, BW 5MHz

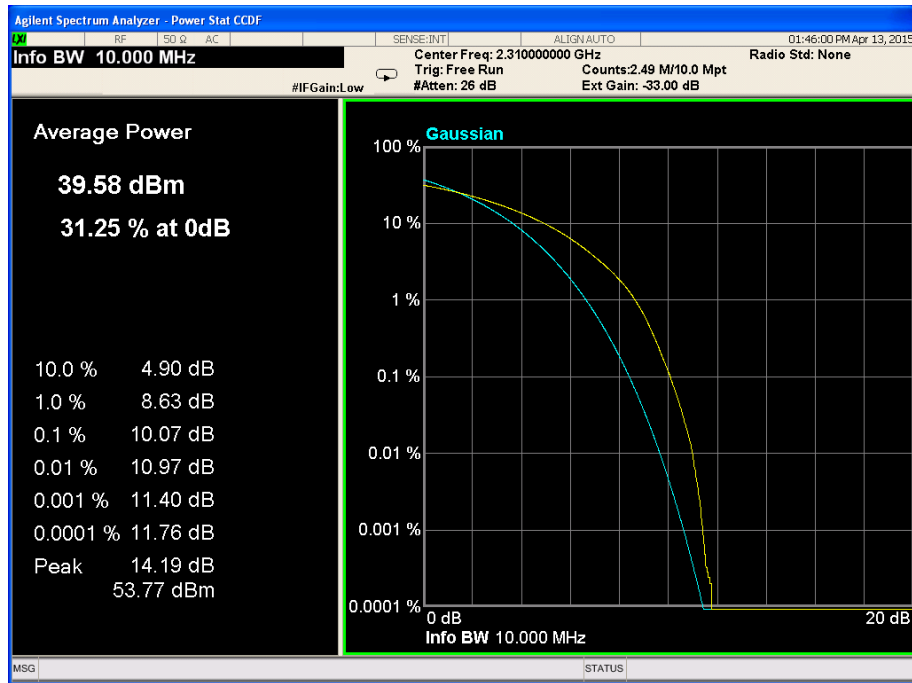


Figure 87. — 16QAM, 2310.0 MHz, BW 10MHz

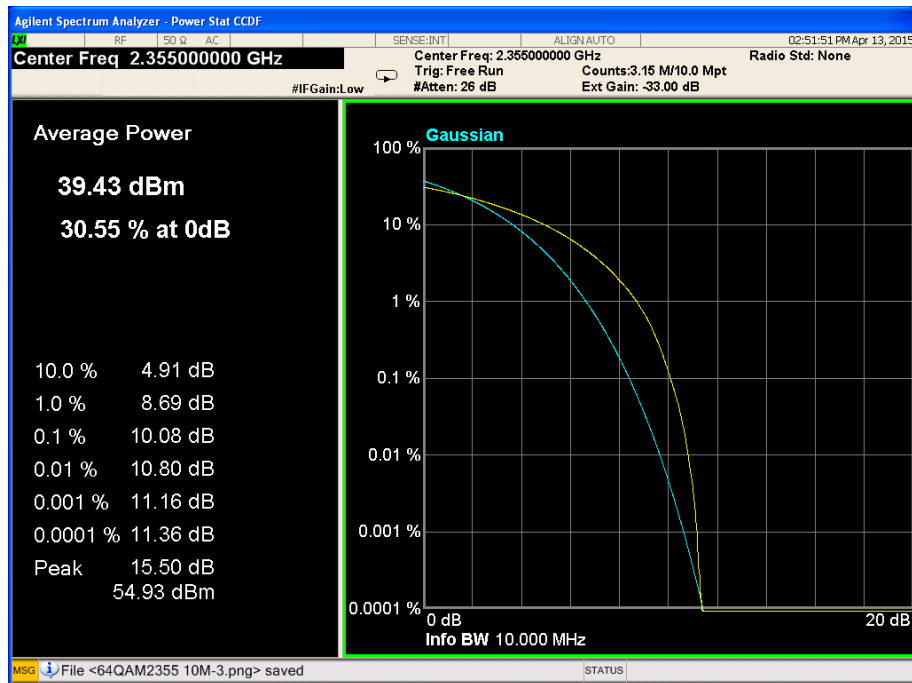


Figure 88. — 16QAM, 2355.0 MHz, BW 10MHz

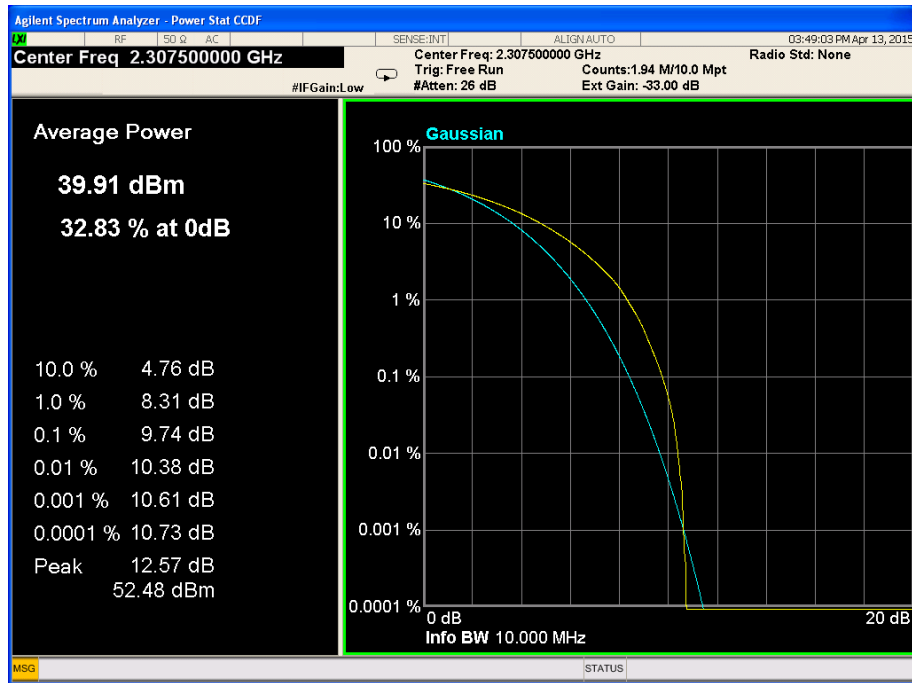


Figure 89.—64QAM, 2307.5 MHz, BW 5MHz

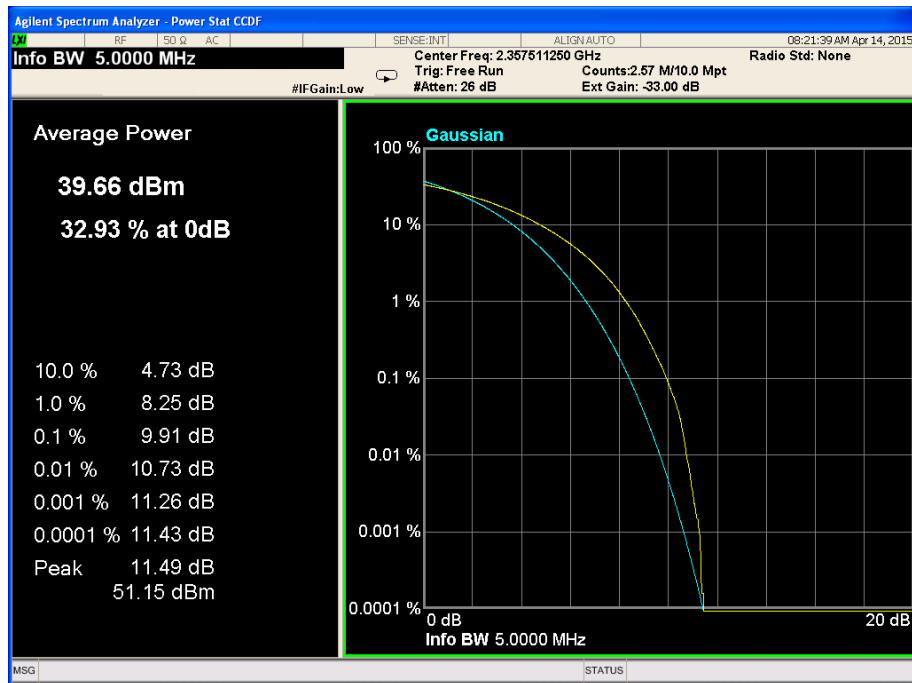


Figure 90. — 64QAM, 2357.5 MHz, BW 5MHz

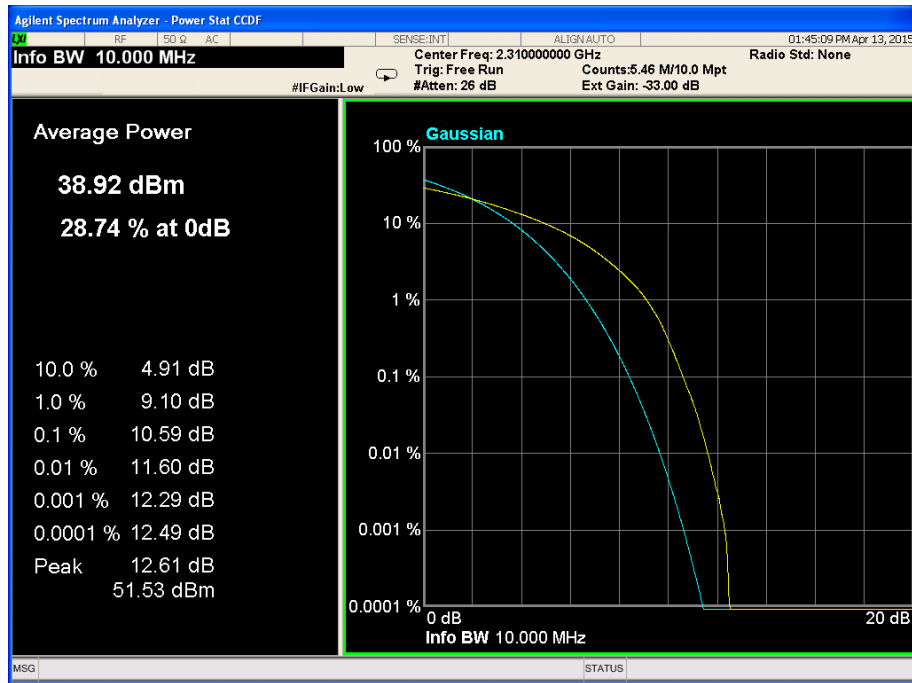


Figure 91. — 64QAM, 2310.0 MHz, BW 10MHz

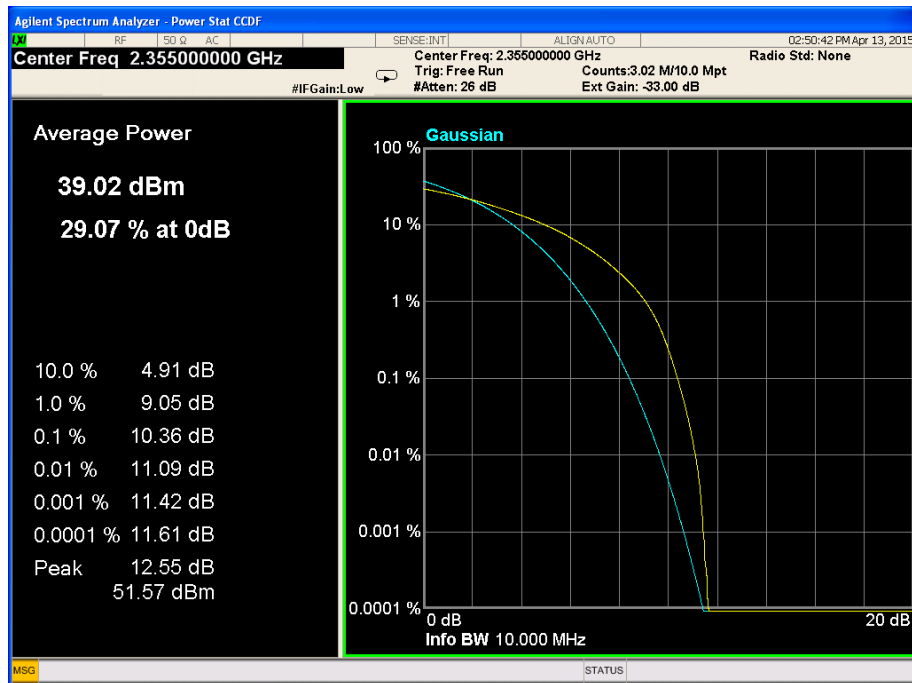


Figure 92. — 64QAM, 2355.0 MHz, BW 10MHz

6.4 Test Equipment Used; 0.1% PAPR

Instrument	Manufacturer	Model	Serial Number	Calibration	Period
EMI Receiver	R&S	ESIB7	100120	January 4, 2015	1 year
Spectrum Analyzer	R&S	FSL6	100194	January 1, 2015	1 year
Spectrum Analyzer	HP	8592L	3826A01204	March 4, 2015	1 year
Active Loop Antenna	EMCO	6502	2950	November 4, 2014	1 year
Biconical Log Antenna	EMCO	3142B	1078	May 22, 2014	2 years
Horn Antenna	ETS	3115	6142	March 14, 2012	3 years*
Horn Antenna	A.R.A	SWH-28	1007	March 30, 2014	2 years
D.C Block	JFW	50DB-007	1-23	N/A	N/A
Coupler	PULSAR	CS 10-05-436	10	N/A	N/A
Notch Filter	TEL RAD	RMC2310_2355 D10M08	10050150	N/A	N/A
MXA Signal Analyzer	Agilent	N9020A	MY46471581	February 12 2015	2 years
Spectrum Analyzer	HP	8563E	3810A8846	November 30, 2014	1 year
10 dB Attenuator	Weinschel	33-10-34	BZ5739	N/A	N/A
5 dB Attenuator	Mini-circuits	VAT-5+	15542	N/A	N/A
Power Splitter	Mini-circuits	ZN2PD-63-S+	F442300839	N/A	N/A
Attenuator	Weinschel	24-20-34	BZ144	N/A	N/A
Attenuator	Weinschel	24-20-34	BY0842	N/A	N/A
Attenuator	Weinschel	24-20-34	BY0855	N/A	N/A
Attenuator	Weinschel	24-20-34	BY0842	N/A	N/A



Signal Generator	WILTRON	6747B	278007	October 23, 2014	1 year
Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	August 29, 2014	1 year
Low Noise Amplifier	DBS MICROWAVE	LNA-DBS-0411N313	013	August 22, 2014	1 year
Environmental Chamber	THERMOTRON CORP	SM 32C Mini Max	25-1030	February 24, 2015	1 year
Antenna Mast	ETS	2070-2	-	N/A	N/A
Turntable	ETS	2087	-	N/A	N/A
Mast & Table Controller	ETS/EMCO	2090	9608-1456	N/A	N/A

*Note – Extended to May 19, 2015

Table 1 Test Equipment Used 0.1% PAPR