

6 Band Edge Spectrum - 5G

6.1 Test Specification

FCC Part 27, Subpart C, Section 27.53 (c)(1)

6.2 Test Procedure

(Temperature (22°C)/ Humidity (35%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (39.7 dB).

The spectrum analyzer was set to 100 kHz R.B.W.

6.3 Test Limit

The power of any emission outside of the authorized operating frequency ranges (862-894MHz) must be attenuated below the transmitting power (P) by a factor of at least $43 + \log(P)$ dB, yielding -13dBm.

6.4 Test Results

JUDGEMENT: Passed

See additional information in Table 11 to Table 14 and Figure 110 to Figure 157.

Modulation	Bandwidth	Sub Carrier	Band Edge Frequency	Reading	Limit
	(MHz)	(kHz)	(MHz)	(dBm)	(dBm)
16QAM	5	15	864.5	-23.976	-13.0
			891.5	-30.108	
		30	864.5	-30.904	
			891.5	-41.403	
	10	15	867.0	-33.471	
			889.0	-36.253	
		30	867.0	-30.793	
			889.0	-38.513	
	15	15	869.5	-34.993	
			886.5	-35.627	
		30	869.5	-36.399	
			886.5	-37.287	

Table 11 Band Edge Spectrum Results 16QAM – 5G

Modulation	Bandwidth	Sub Carrier	Band Edge Frequency	Reading	Limit
	(MHz)	(kHz)	(MHz)	(dBm)	(dBm)
64QAM	5	15	864.5	-23.406	-13.0
			891.5	-30.231	
		30	864.5	-31.784	
			891.5	-43.620	
	10	15	867.0	-32.298	
			889.0	-39.291	
		30	867.0	-32.072	
			889.0	-36.441	
	15	15	869.5	-34.461	
			886.5	-37.077	
		30	869.5	-36.214	
			886.5	-37.715	

Table 12 Band Edge Spectrum Results 64QAM – 5G

Modulation	Bandwidth	Sub Carrier	Band Edge Frequency	Reading	Limit
	(MHz)	(kHz)	(MHz)	(dBm)	(dBm)
256QAM	5	15	864.5	-23.029	-13.0
			891.5	-30.546	
		30	864.5	-29.827	
			891.5	-43.516	
	10	15	867.0	-33.821	
			889.0	-40.554	
		30	867.0	-33.132	
			889.0	-35.960	
	15	15	869.5	-36.153	
			886.5	-36.122	
		30	869.5	-35.587	
			886.5	-36.961	

Table 13 Band Edge Spectrum Results 256QAM – 5G

Modulation	Bandwidth	Sub Carrier	Band Edge Frequency	Reading	Limit
	(MHz)	(kHz)	(MHz)	(dBm)	(dBm)
QPSK	5	15	864.5	-23.456	-13.0
			891.5	-30.271	
		30	864.5	-29.566	
			891.5	-44.091	
	10	15	867.0	-34.271	
			889.0	-37.839	
		30	867.0	-31.420	
			889.0	-36.809	
	15	15	869.5	-35.155	
			886.5	-34.950	
		30	869.5	-35.292	
			886.5	-35.967	

Table 14 Band Edge Spectrum Results QPSK – 5G

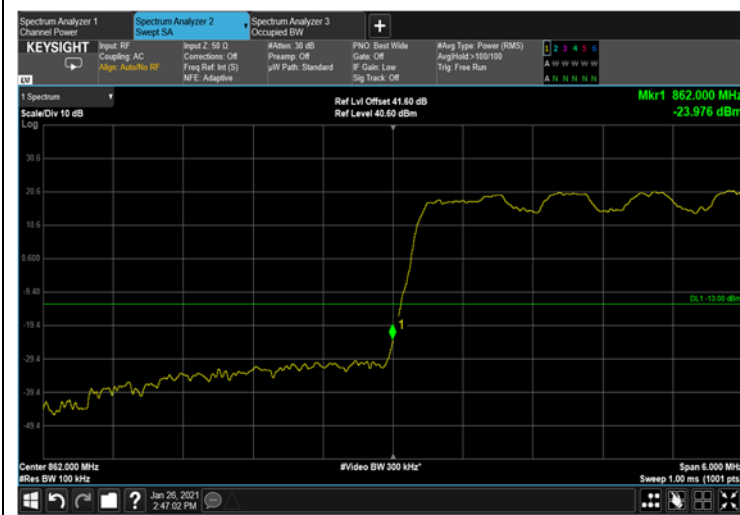


Figure 110: 16QAM 5MHz B.W.; 864.5MHz, 15kHz
Lower Edge

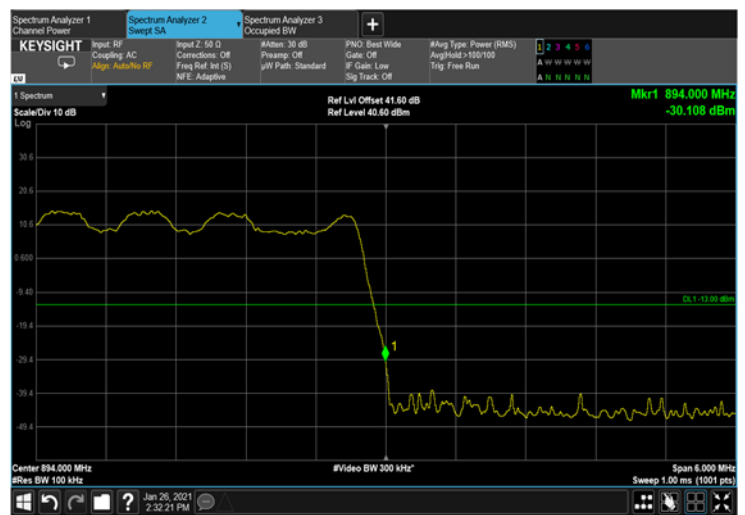


Figure 111: 16QAM 5MHz B.W.; 891.5MHz, 15kHz
Upper Edge



Figure 112: 16QAM 5MHz B.W.; 864.5MHz, 30kHz
Lower Edge

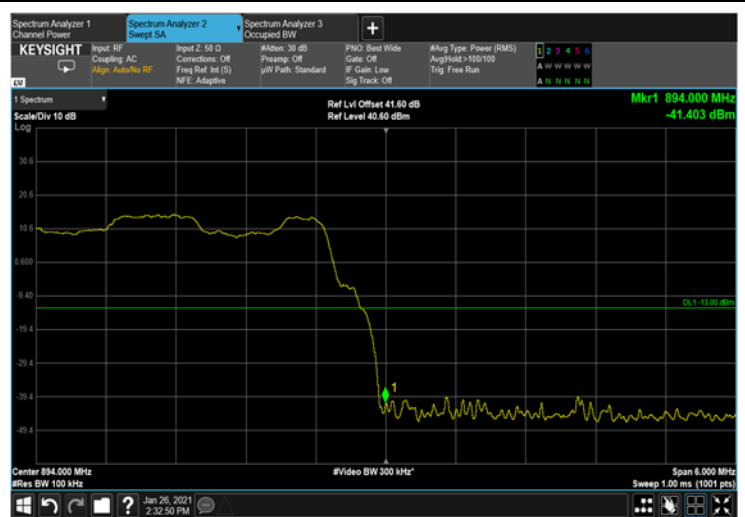


Figure 113: 16QAM 5MHz B.W.; 891.5MHz, 30kHz
Upper Edge

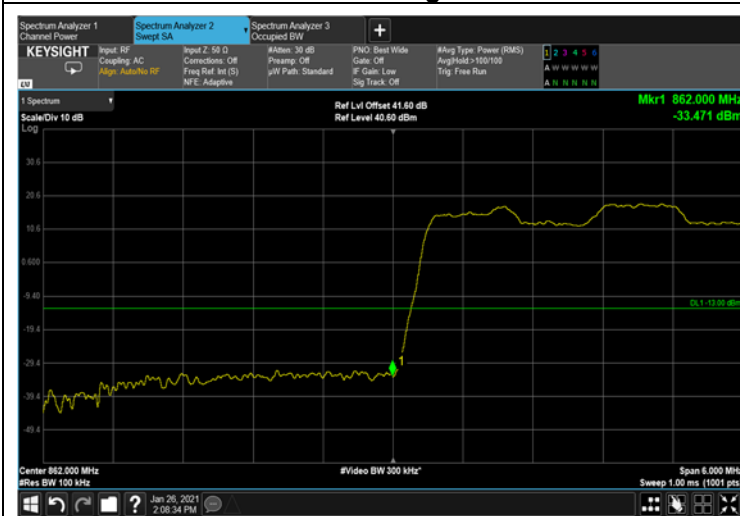


Figure 114: 16QAM 10MHz B.W.; 867.0MHz, 15kHz
Lower Edge

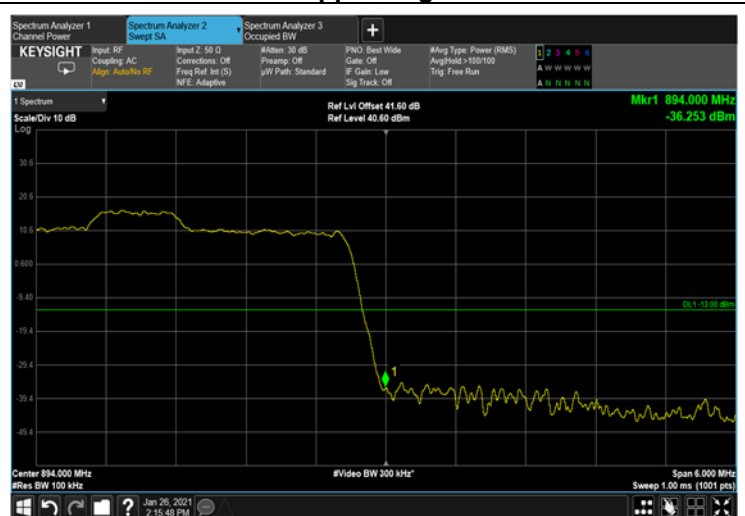


Figure 115: 16QAM 10MHz B.W.; 889.0MHz, 15kHz
Upper Edge

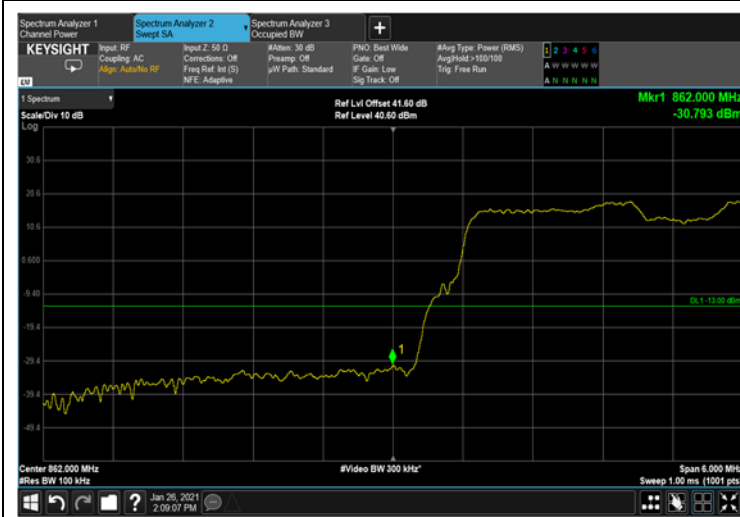


Figure 116: 16QAM 10MHz B.W.; 867.0MHz, 30kHz
Lower Edge

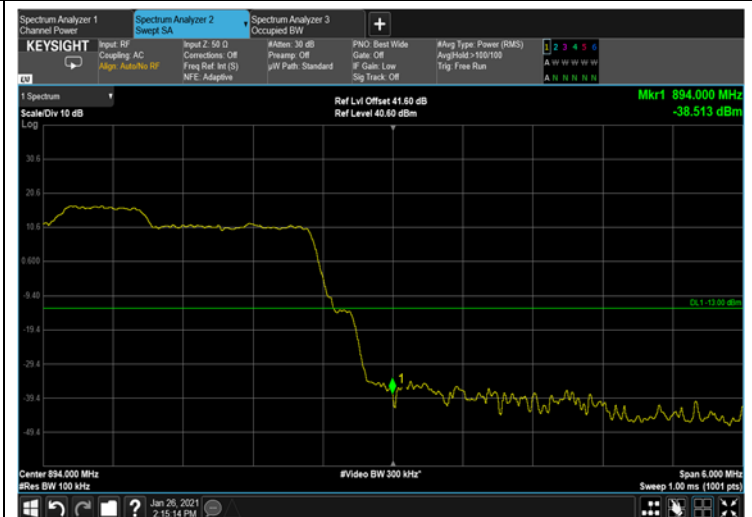


Figure 117: 16QAM 10MHz B.W.; 889.0MHz, 30kHz
Upper Edge

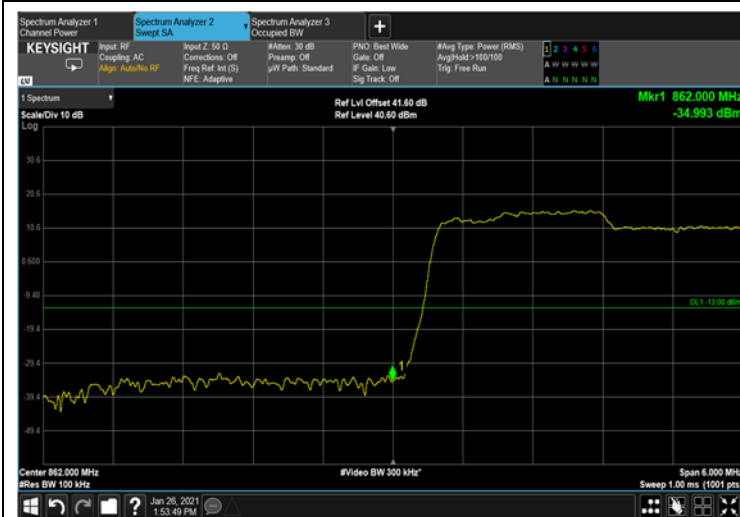


Figure 118: 16QAM 15MHz B.W.; 869.5MHz, 15kHz Lower
Edge

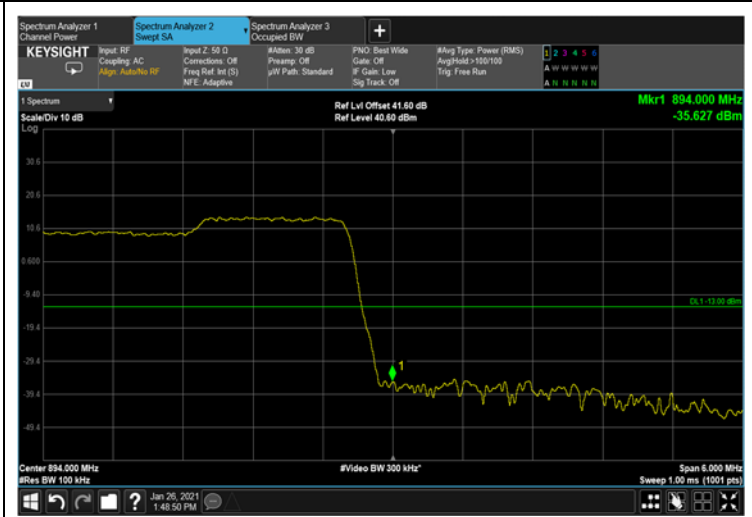


Figure 119: 16QAM 15MHz B.W.; 886.5MHz, 15kHz
Upper Edge

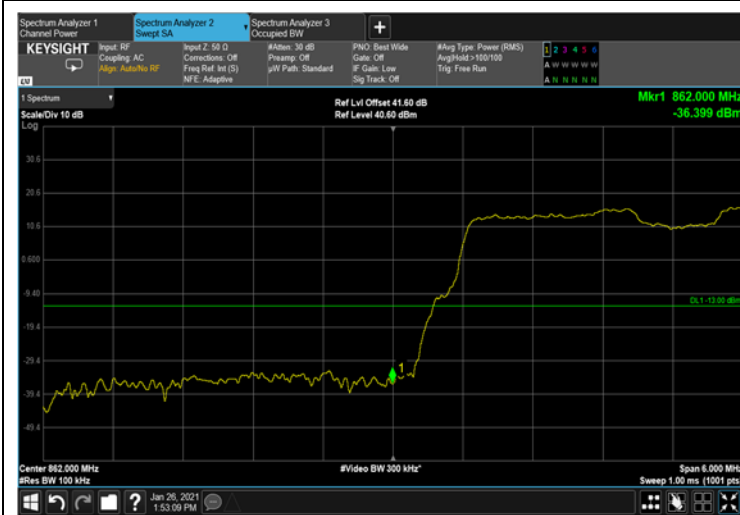


Figure 120: 16QAM 15MHz B.W.; 869.5MHz, 30kHz
Lower Edge

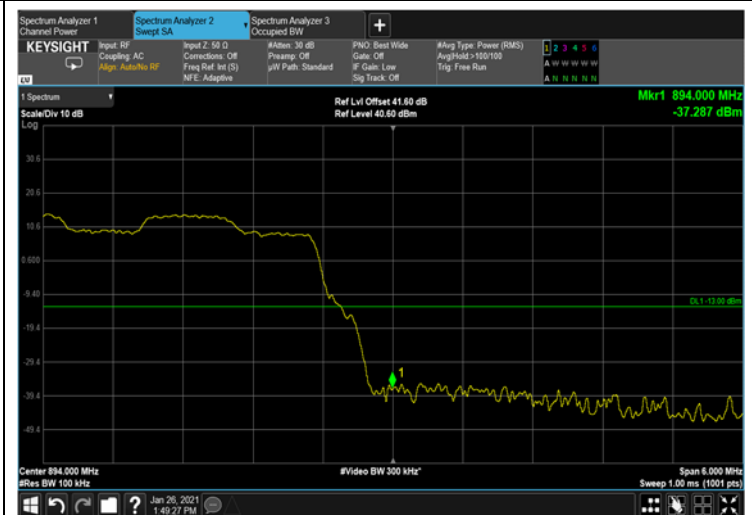


Figure 121: 16QAM 15MHz B.W.; 886.5MHz, 30kHz
Upper Edge

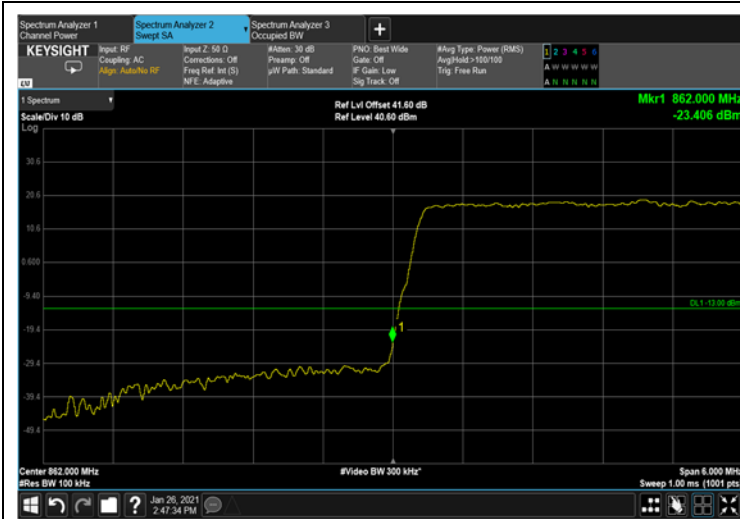


Figure 122: 64QAM 5MHz B.W.; 864.5MHz, 15kHz
Lower Edge

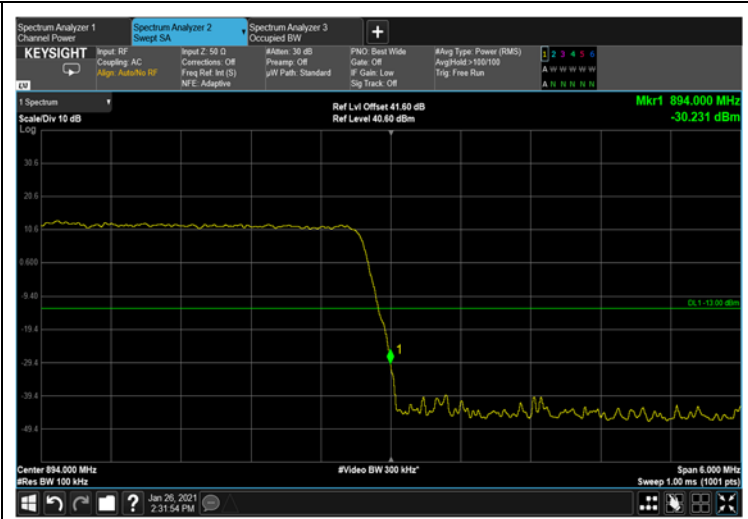


Figure 123: 64QAM 5MHz B.W.; 891.5MHz, 15kHz Upper
Edge



Figure 124: 64QAM 5MHz B.W.; 864.5MHz, 30kHz
Lower Edge



Figure 125: 64QAM 5MHz B.W.; 891.5MHz, 30kHz
Upper Edge

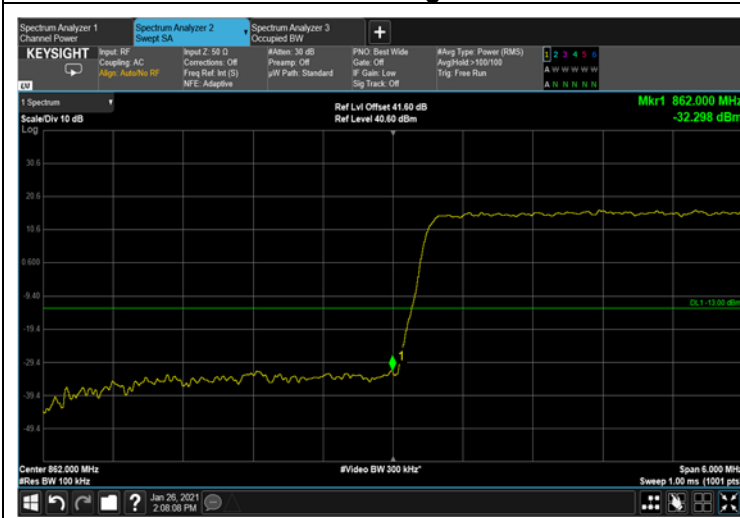


Figure 126: 64QAM 10MHz B.W.; 867.0MHz, 15kHz
Lower Edge

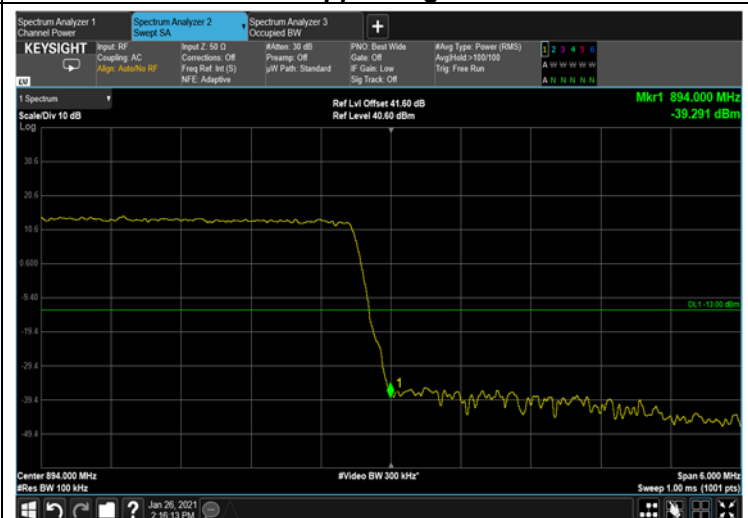


Figure 127: 64QAM 10MHz B.W.; 889.0MHz, 15kHz
Upper Edge

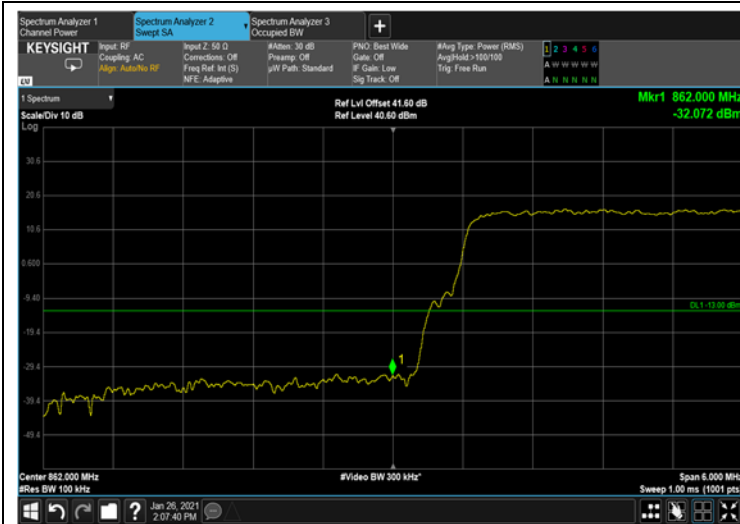


Figure 128: 64QAM 10MHz B.W.; 867.0MHz, 30kHz
Lower Edge

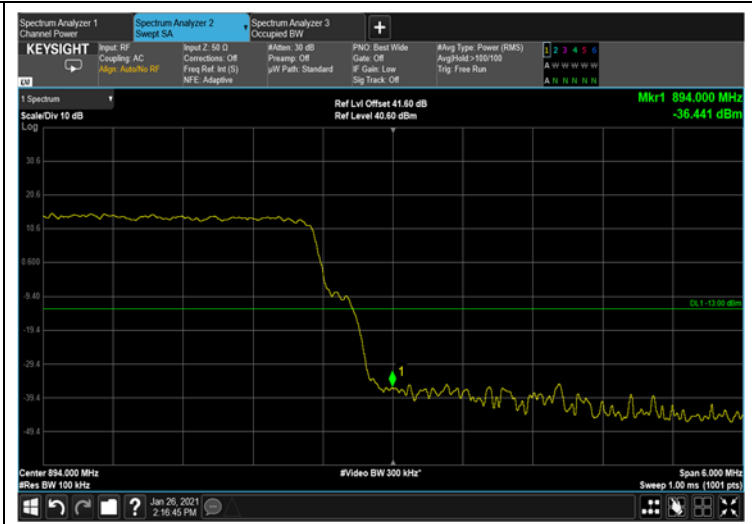


Figure 129: 64QAM 10MHz B.W.; 889.0MHz, 30kHz
Upper Edge

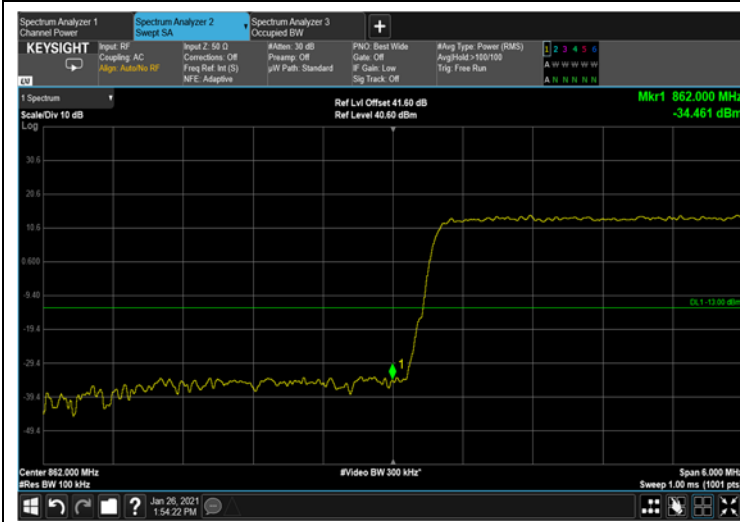


Figure 130: 64QAM 15MHz B.W.; 869.5MHz, 15kHz
Lower Edge

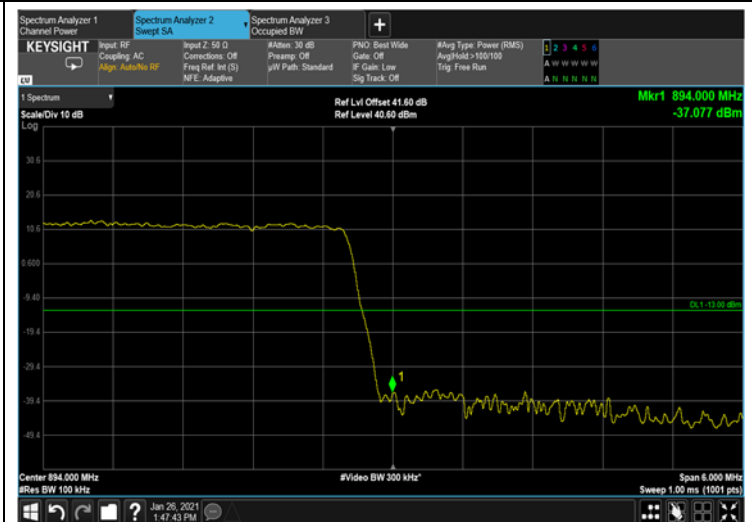


Figure 131: 64QAM 15MHz B.W.; 886.5MHz, 15kHz
Upper Edge

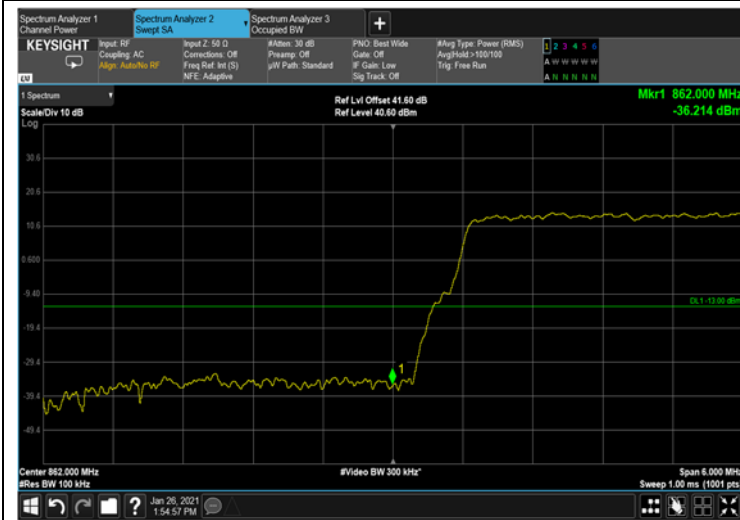


Figure 132: 64QAM 15MHz B.W.; 869.5MHz, 30kHz
Lower Edge

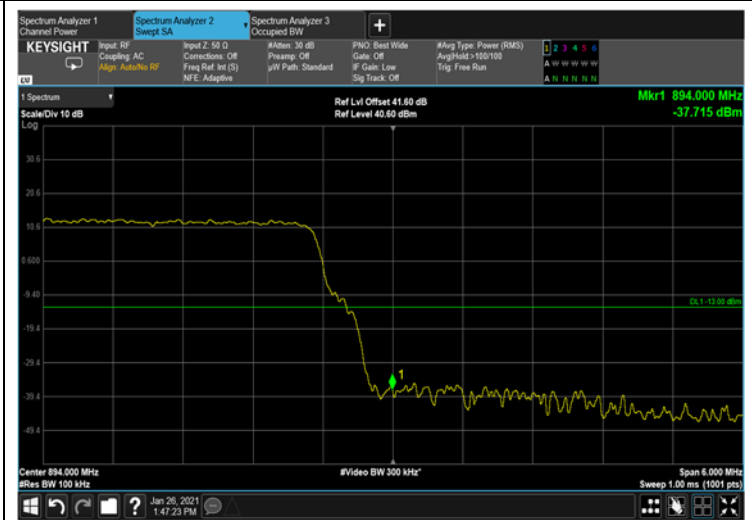


Figure 133: 64QAM 15MHz B.W.; 886.5MHz, 30kHz
Upper Edge

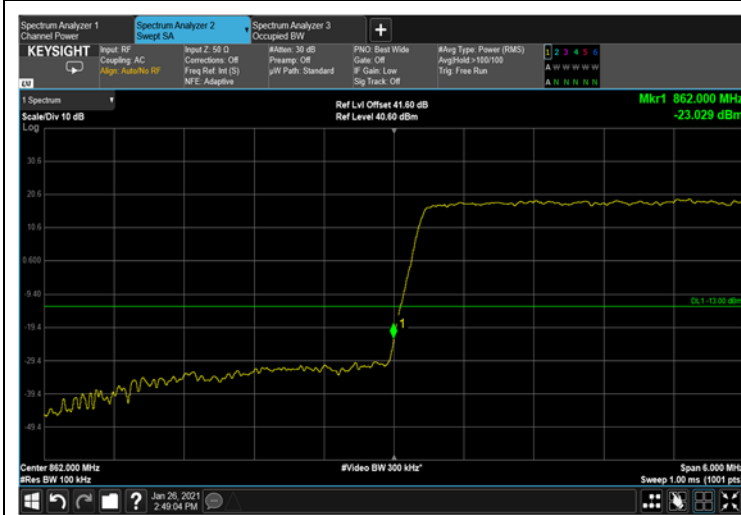


Figure 134: 256QAM 5MHz B.W.; 864.5MHz, 15kHz
Lower Edge

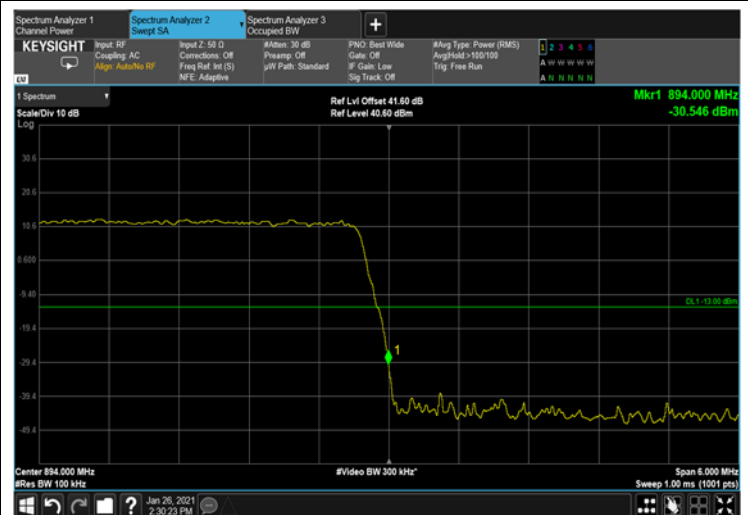


Figure 135: 256QAM 5MHz B.W. 891.5MHz, 15kHz
Upper Edge



Figure 136: 256QAM 5MHz B.W.; 864.5MHz, 30kHz
Lower Edge

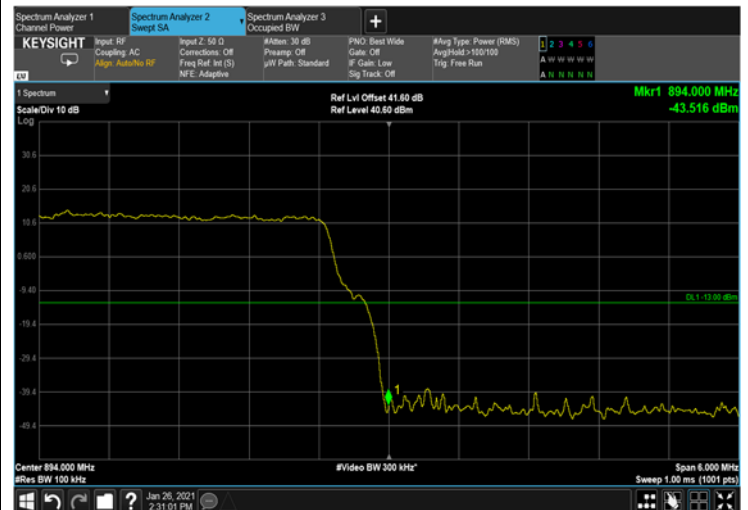


Figure 137: 256QAM 5MHz B.W.; 891.5MHz, 30kHz
Upper Edge

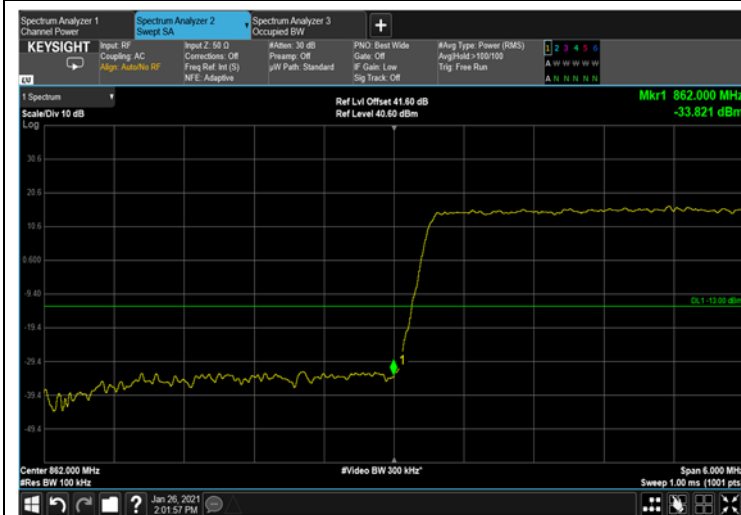


Figure 138: 256QAM 10MHz B.W.; 867.0MHz, 15kHz
Lower Edge

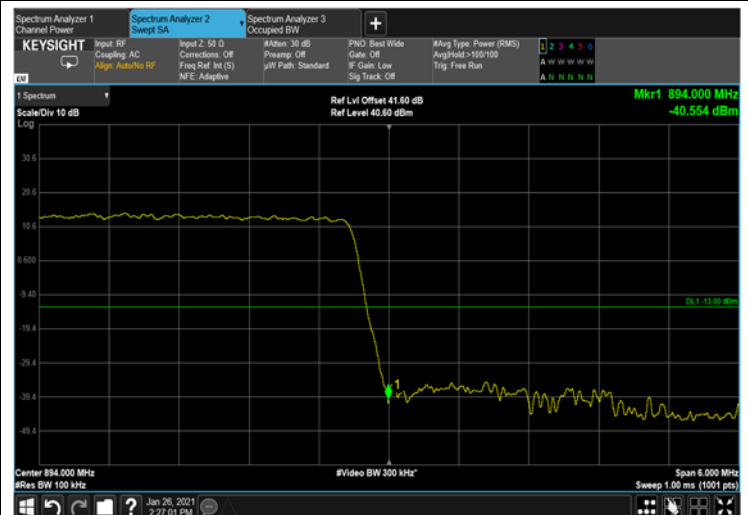


Figure 139: 256QAM 10MHz B.W.; 889.0MHz, 15kHz
Upper Edge

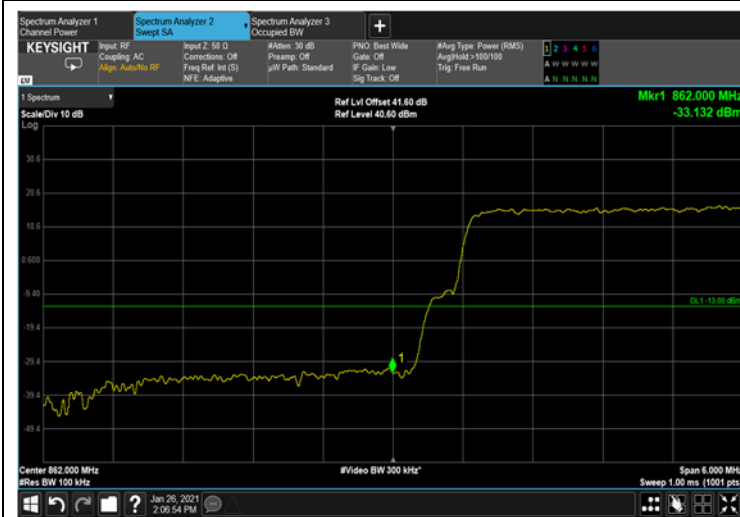


Figure 140: 256QAM 10MHz B.W.; 867.0MHz, 30kHz
Lower Edge

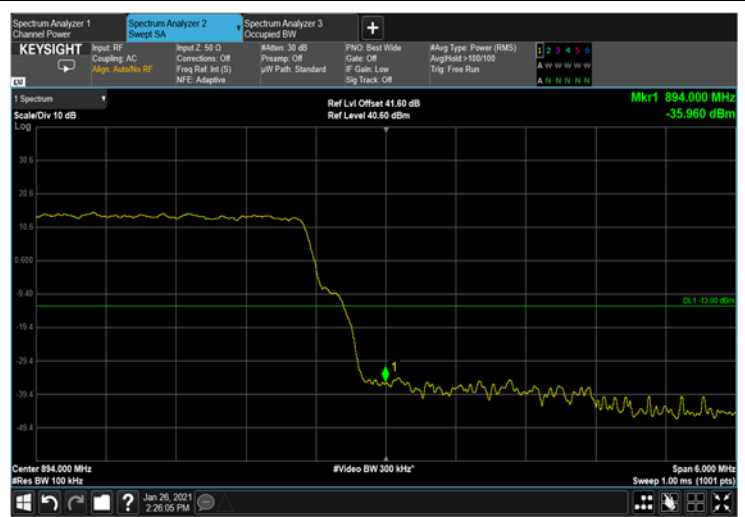


Figure 141: 256QAM 10MHz B.W.; 889.0MHz, 30kHz
Upper Edge

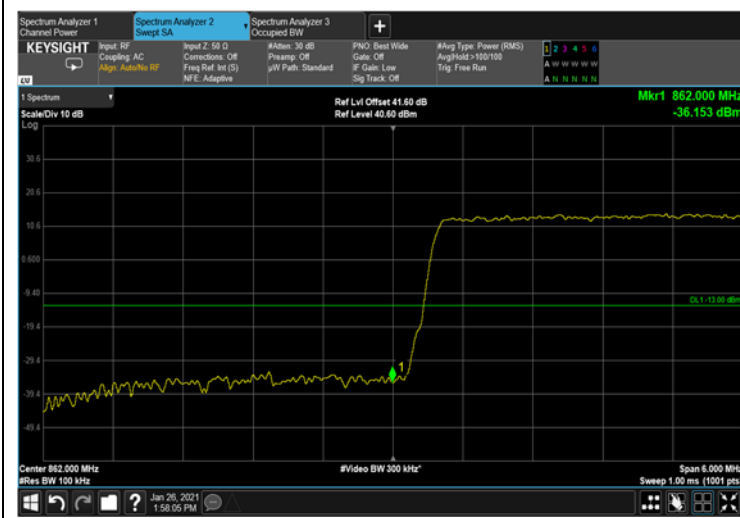


Figure 142: 256QAM 15MHz B.W.; 869.5MHz, 15kHz Lower
Edge

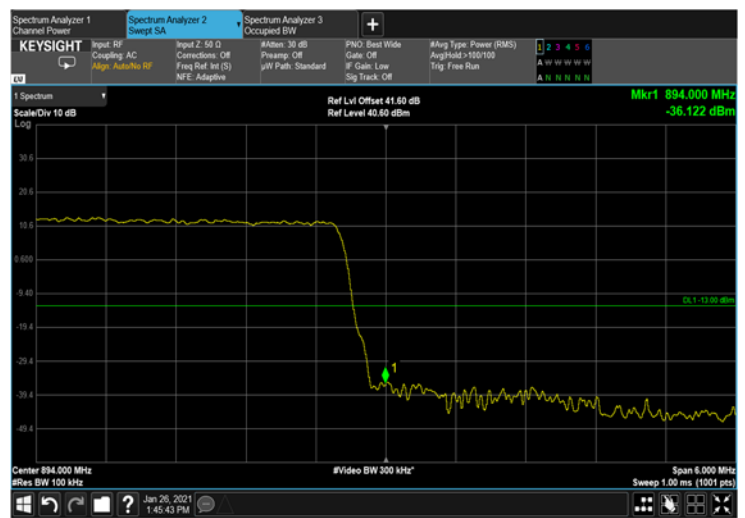


Figure 143: 256QAM 15MHz B.W.; 886.5MHz, 15kHz
Upper Edge

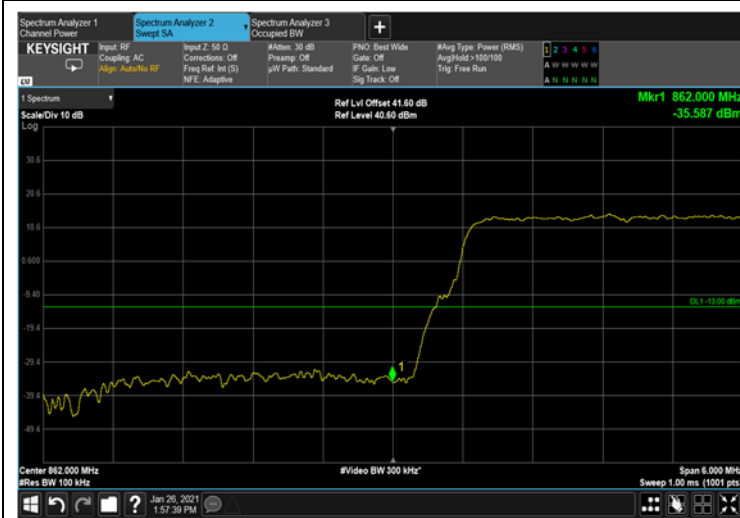


Figure 144: 256QAM 15MHz B.W.; 869.5MHz, 30kHz
Lower Edge

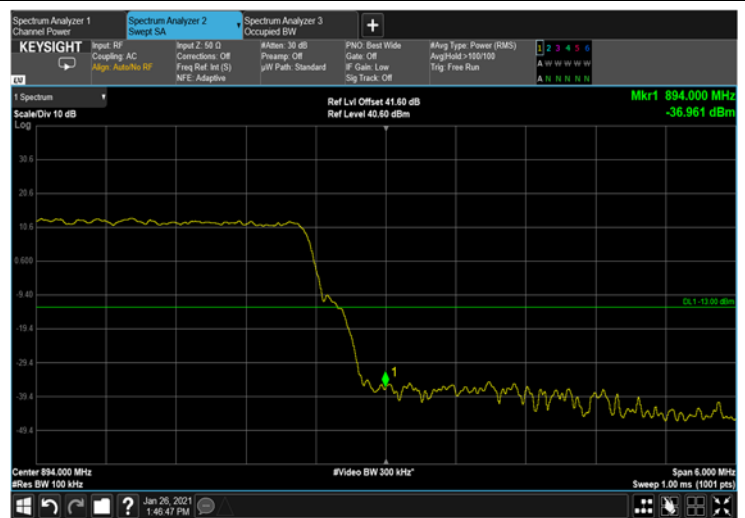


Figure 145: 256QAM 15MHz B.W.; 886.5MHz, 30kHz
Upper Edge

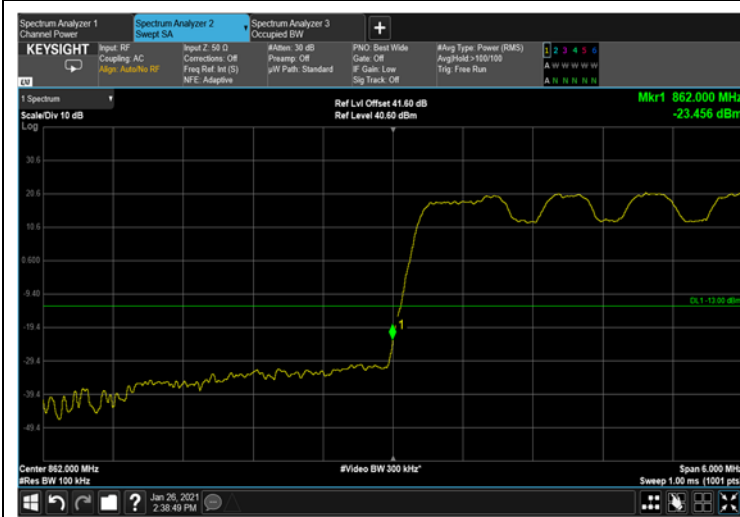


Figure 146: QPSK 5MHz B.W.; 864.5MHz, 15kHz Lower Edge

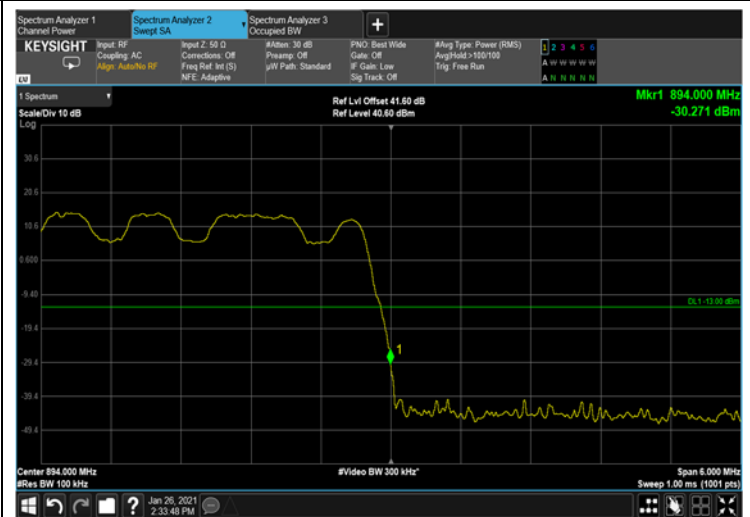


Figure 147: QPSK 5MHz B.W.; 891.5MHz, 15kHz Upper Edge



Figure 148: QPSK 5MHz B.W.; 864.5MHz, 30kHz Lower Edge

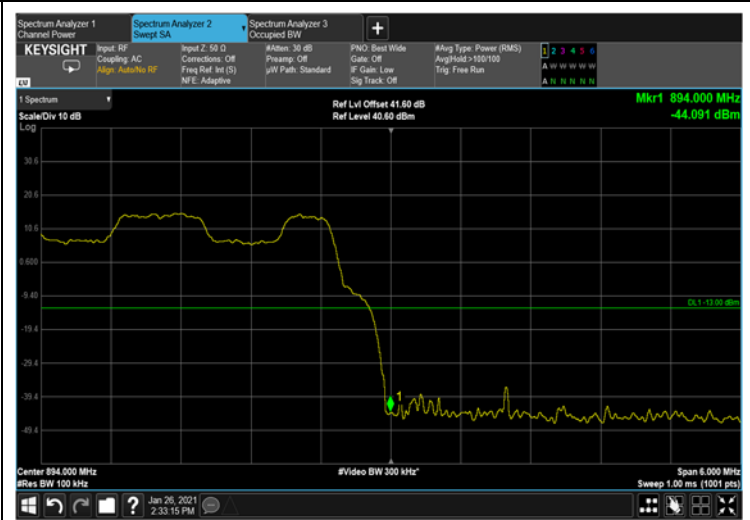


Figure 149: QPSK 5MHz B.W.; 891.5MHz, 30kHz Upper Edge



Figure 150: QPSK 10MHz B.W.; 867.0MHz, 15kHz Lower Edge

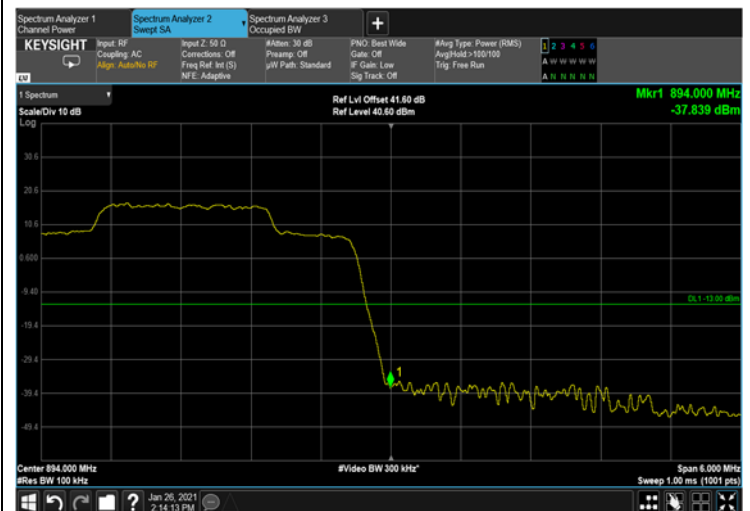


Figure 151: QPSK 10MHz B.W.; 889.0MHz, 15kHz Upper Edge



Figure 152: QPSK 10MHz B.W.; 867.0MHz, 30kHz
Lower Edge

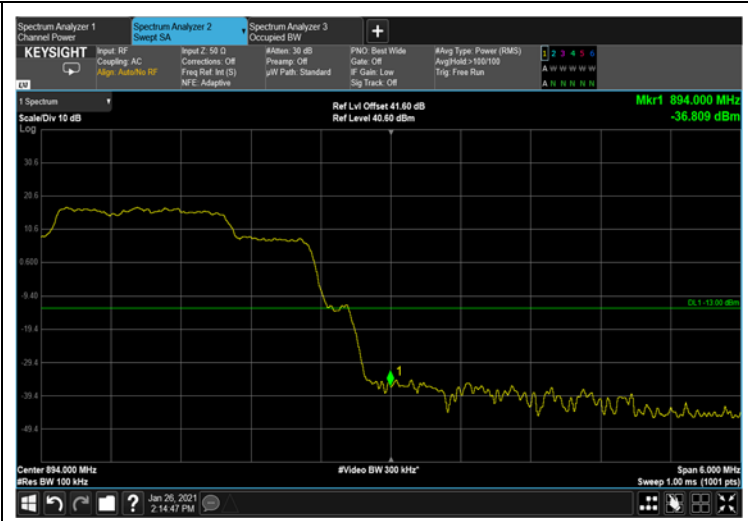


Figure 153: QPSK 10MHz B.W.; 889.0MHz, 30kHz
Upper Edge

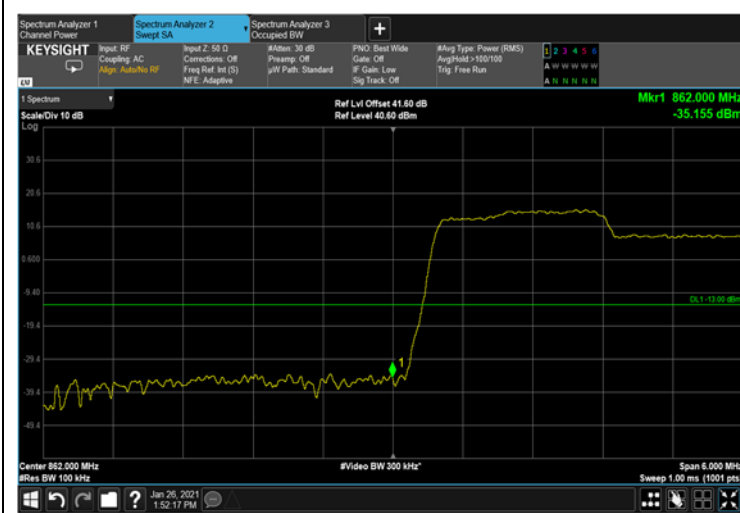


Figure 154: QPSK 15MHz B.W.; 869.5MHz, 15kHz
Lower Edge

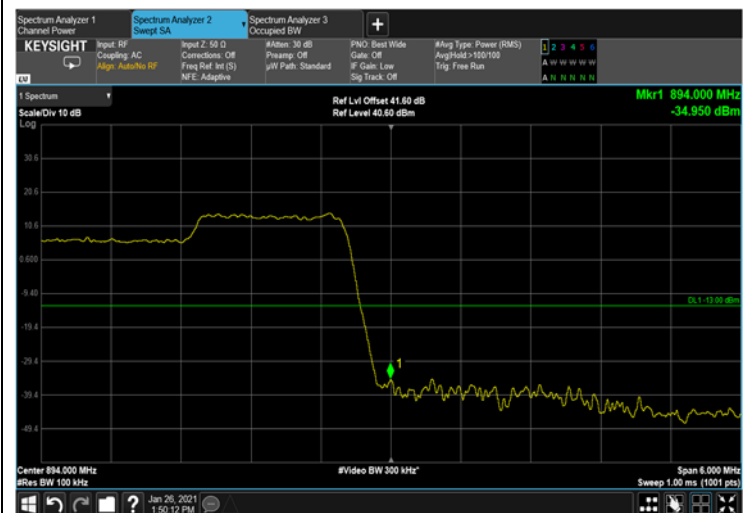


Figure 155: QPSK 15MHz B.W.; 886.5MHz, 15kHz
Upper Edge

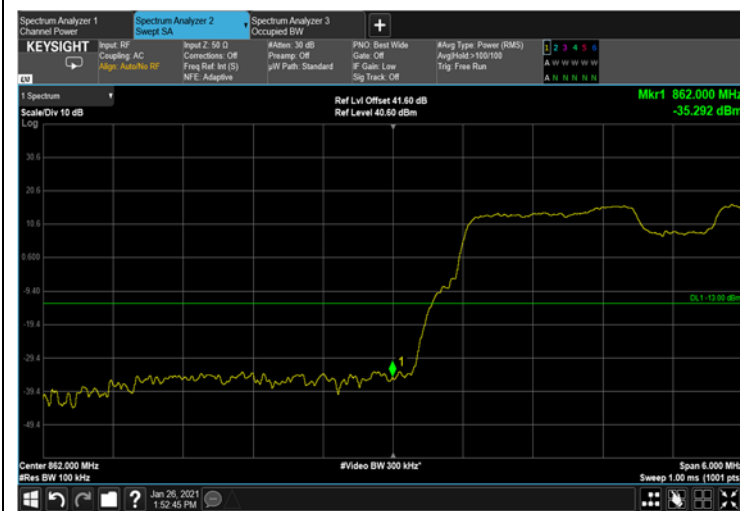


Figure 156: QPSK 15MHz B.W.; 869.5MHz, 30kHz
Lower Edge

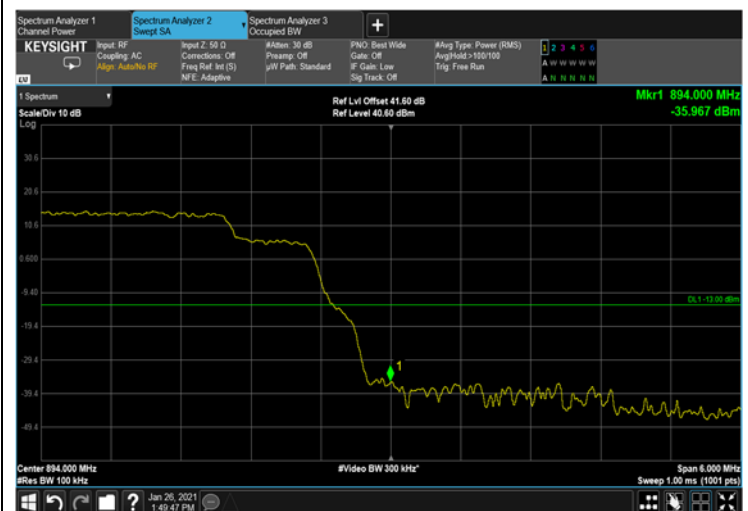


Figure 157: QPSK 15MHz B.W.; 886.5MHz, 30kHz
Upper Edge



6.5 Test Equipment Used; Band Edge Spectrum

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration Date	Next Calibration Due
EXA signal Analyzer	Keysight	UXA N9040B	MY56080119	January 31, 2020	January 31, 2022
EXG Vector Signal Generator	Agilent Technologies	N5172B	MY53051952	January 17, 2019	January 17, 2022
40 dB Attenuator	Weinschel Associates	WA 39-40-33	-	November 1, 2020	November 1, 2021
RF Coaxial Cable	Huber-Suner	SLLS210B	-	November 1, 2020	November 1, 2021

Table 15 Test Equipment Used

7 Band Edge Spectrum – 3G and 4G

7.1 Test Specification

FCC Part 27, Subpart C, Section 27.53 (c)(1)

7.2 Test Procedure

(Temperature (22°C)/ Humidity (35%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (39.7 dB).

The spectrum analyzer was set to 100 kHz R.B.W.

7.3 Test Limit

The power of any emission outside of the authorized operating frequency ranges (862-894MHz) must be attenuated below the transmitting power (P) by a factor of at least $43 + \log(P)$ dB, yielding -13dBm.

7.4 Test Results

JUDGEMENT: Passed

See additional information in Table 16 to Table 19 and Figure 158 to Figure 177.

Modulation	Bandwidth	Band Edge Frequency	Reading	Limit
WCDMA	(MHz)	(MHz)	(dBm)	(dBm)
	5	864.5	-23.258	-13.0
		891.5	-32.196	

Table 16 Band Edge Spectrum Results WCDMA – 3G

Modulation	Bandwidth	Band Edge Frequency	Reading	Limit
16QAM	(MHz)	(MHz)	(dBm)	(dBm)
	5	864.5	-23.106	-13.0
		891.5	-33.552	
	10	867.0	-21.148	
		889.0	-29.748	
	15	869.5	-21.538	
		886.5	-27.782	

Table 17 Band Edge Spectrum Results 16QAM – 4G

Modulation	Bandwidth	Band Edge Frequency	Reading	Limit
64QAM	(MHz)	(MHz)	(dBm)	(dBm)
	5	864.5	-23.510	-13.0
		891.5	-34.000	
	10	867.0	-21.030	
		889.0	-27.217	
	15	869.5	-22.043	
		886.5	-28.751	

Table 18 Band Edge Spectrum Results 64QAM – 4G



Modulation	Bandwidth	Band Edge Frequency	Reading	Limit
	(MHz)	(MHz)	(dBm)	(dBm)
QPSK	5	864.5	-23.448	-13.0
		891.5	-32.691	
	10	867.0	-20.483	
		889.0	-26.981	
	15	869.5	-22.377	
		886.5	-27.844	

Table 19 Band Edge Spectrum Results QPSK – 4G

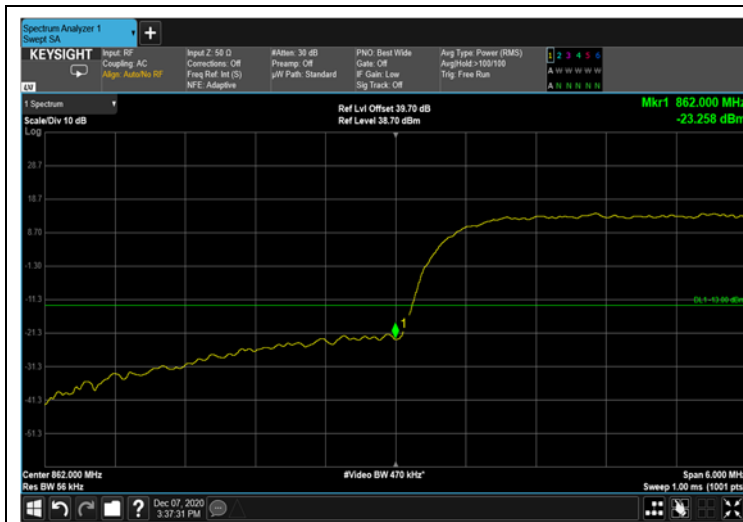


Figure 158: WCDMA 5MHz B.W.; 864.5MHz
Lower Edge – 3G



Figure 159: WCDMA 5MHz B.W.; 891.5MHz
Upper Edge – 3G



Figure 160: 16QAM 5MHz B.W.; 864.5MHz
Lower Edge – 4G



Figure 161: 16QAM 5MHz B.W.; 891.5MHz
Upper Edge – 4G

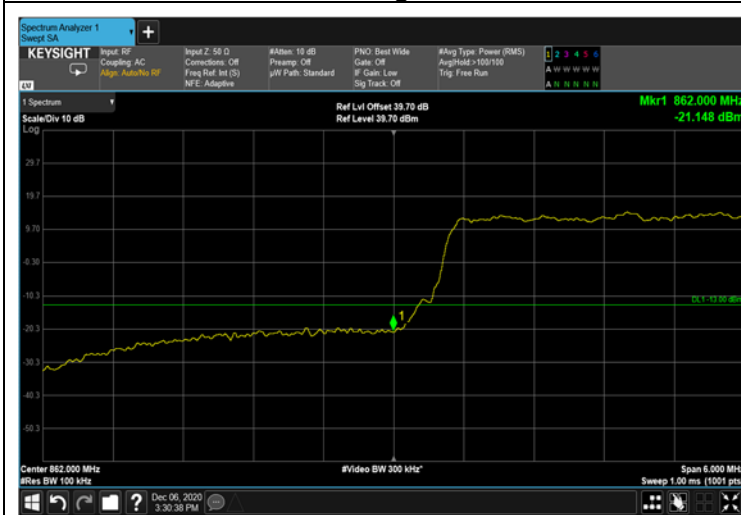


Figure 162: 16QAM 10MHz B.W.; 867.0MHz
Lower Edge – 4G

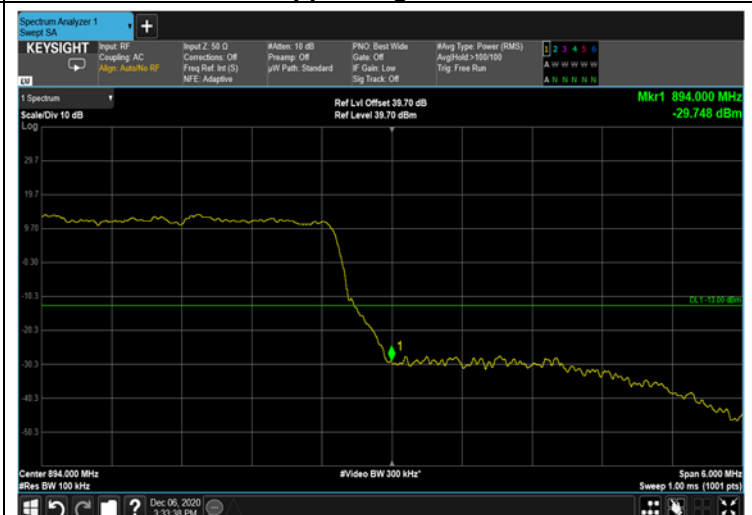


Figure 163: 16QAM 10MHz B.W.; 889.0MHz
Upper Edge – 4G

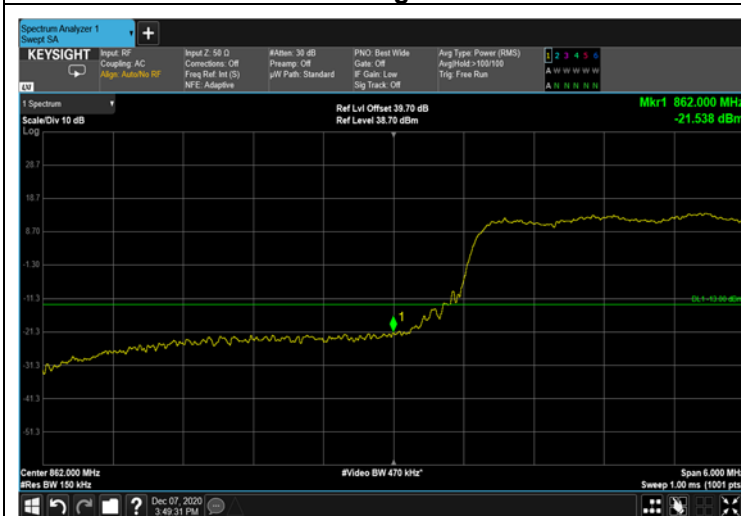


Figure 164: 16QAM 15MHz B.W.; 869.5MHz
Lower Edge – 4G



Figure 165: 16QAM 15MHz B.W.; 886.5MHz
Upper Edge – 4G

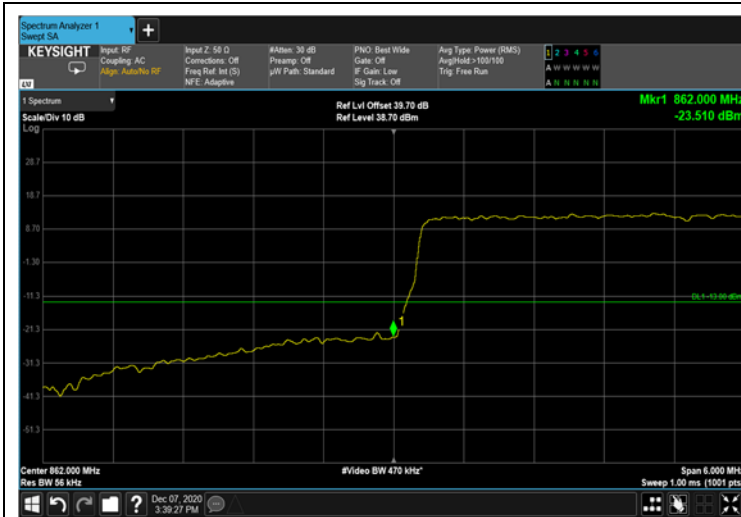


Figure 166: 64QAM 5MHz B.W.; 864.5MHz
Lower Edge – 4G



Figure 167: 64QAM 5MHz B.W.; 891.5MHz
Upper Edge – 4G

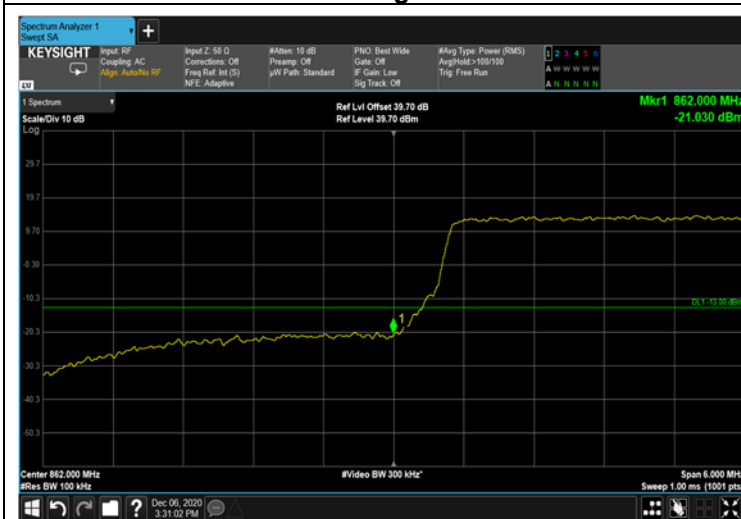


Figure 168: 64QAM 10MHz B.W.; 867.0MHz
Lower Edge – 4G



Figure 169: 64QAM 10MHz B.W.; 889.0MHz
Upper Edge – 4G



Figure 170: 64QAM 15MHz B.W.; 869.5MHz
Lower Edge – 4G

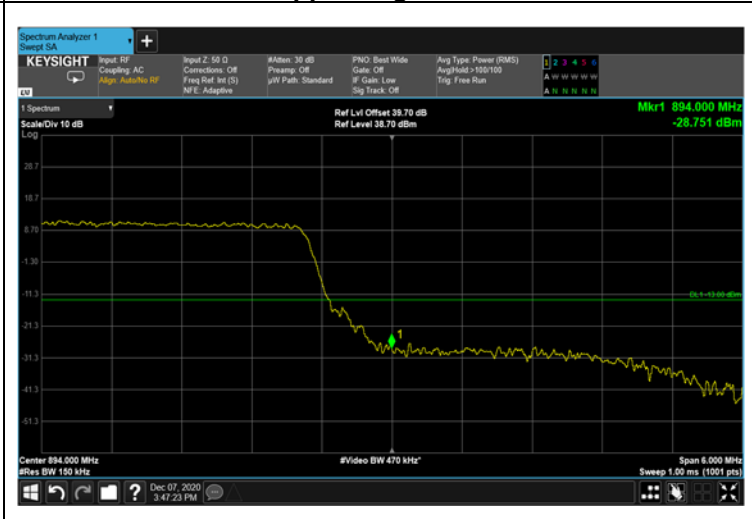


Figure 171: 64QAM 15MHz B.W.; 886.5MHz
Upper Edge – 4G



Figure 172: QPSK 5MHz B.W.; 864.5MHz
Lower Edge – 4G



Figure 173: QPSK 5MHz B.W.; 891.5MHz
Upper Edge – 4G



Figure 174: QPSK 10MHz B.W.; 867.0MHz
Lower Edge – 4G

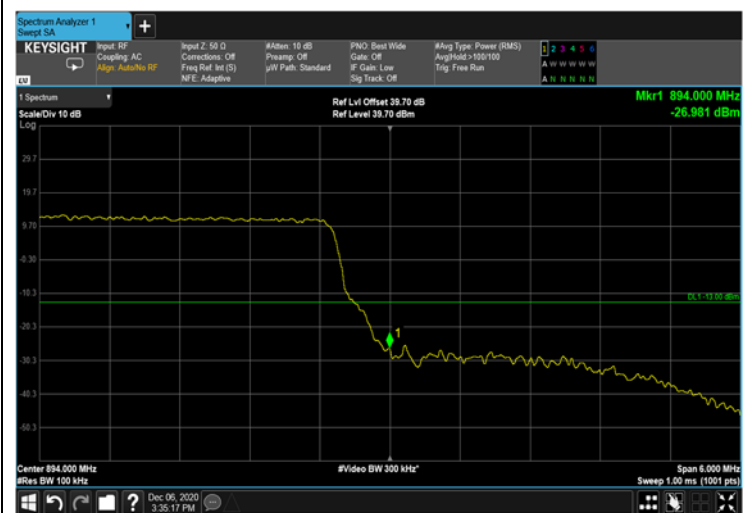


Figure 175: QPSK 10MHz B.W.; 889.0MHz
Upper Edge – 4G

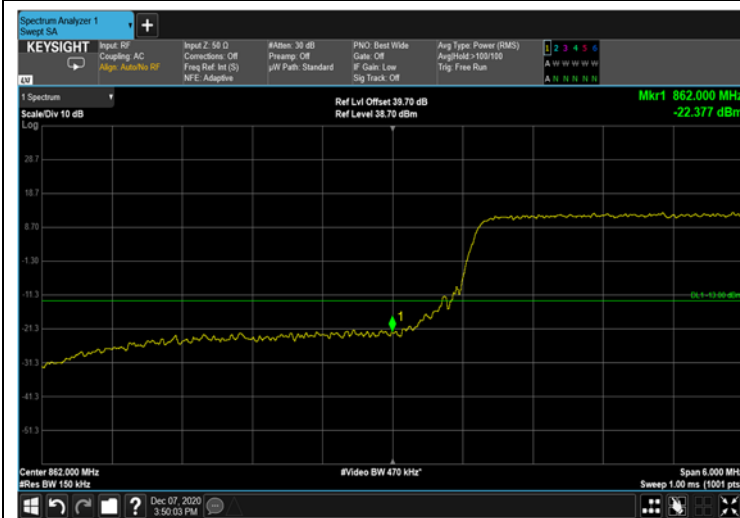


Figure 176: QPSK 15MHz B.W.; 869.5MHz
Lower Edge – 4G

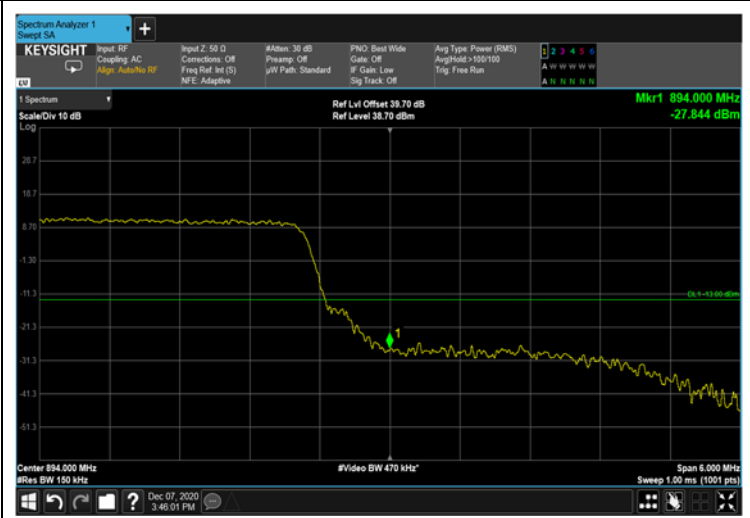


Figure 177: QPSK 15MHz B.W.; 886.5MHz
Upper Edge – 4G



7.5 Test Equipment Used; Band Edge Spectrum

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration Date	Next Calibration Due
EXA signal Analyzer	Keysight	UXA N9040B	MY56080119	January 31, 2020	January 31, 2022
EXG Vector Signal Generator	Agilent Technologies	N5172B	MY53051952	January 17, 2019	January 17, 2022
40 dB Attenuator	Weinschel Associates	WA 39-40-33	-	November 1, 2020	November 1, 2021
RF Coaxial Cable	Huber-Suner	SLLS210B	-	November 1, 2020	November 1, 2021

Table 20 Test Equipment Used



8 Occupied Bandwidth – 5G

8.1 Test Specification

FCC Part 2, Section 1049

8.2 Test Procedure

(Temperature (22°C)/ Humidity (35%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (loss=39.7 dB). The spectrum analyzer was set to proper resolution B.W.

OBW function (99%) was employed for this evaluation.

Occupied bandwidth measured was repeated in the input terminal of the E.U.T.

8.3 Test Limit

N/A

8.4 Test Results

JUDGEMENT: Passed

See additional information in Table 21 to Table 28 and Figure 178 to Figure 321.

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
16QAM	5	15	864.5	4.5365
		30	878.0	4.0616
		15	891.5	4.5365
		30	864.5	4.0600
		15	878.0	4.5283
		30	891.5	4.0647
	10	15	867.0	9.2498
		30	878.0	8.5962
		15	886.5	9.2495
		30	867.0	8.5841
		15	878.0	9.2502
		30	886.5	8.6009
	15	15	869.5	14.170
		30	878.0	13.551
		15	886.5	14.178
		30	869.5	13.551
		15	878.0	14.173
		30	886.5	13.549

Table 21 Occupied Bandwidth 16 QAM Input - 5G

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
16QAM	5	15	864.5	4.5147
		30	878.0	4.0522
		15	891.5	4.5295
		30	864.5	4.0615
		15	878.0	4.5130
		30	891.5	4.0608
	10	15	867.0	9.2310
		30	878.0	8.5808
		15	886.5	9.2468
		30	867.0	8.6066
		15	878.0	9.2140
		30	886.5	8.5794
	15	15	869.5	14.155
		30	878.0	13.517
		15	886.5	14.170
		30	869.5	13.541
		15	878.0	14.138
		30	886.5	13.464

Table 22 Occupied Bandwidth 16QAM Output - 5G

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
64QAM	5	15	864.5	4.4916
		30	878.0	4.0011
		15	891.5	4.4942
		30	864.5	3.9999
		15	878.0	4.4941
		30	891.5	3.9995
	10	15	867.0	9.3319
		30	878.0	8.6337
		15	886.5	9.3332
		30	867.0	8.6300
		15	878.0	9.3287
		30	886.5	8.6375
	15	15	869.5	14.137
		30	878.0	13.642
		15	886.5	14.135
		30	869.5	13.651
		15	878.0	14.142
		30	886.5	13.657

Table 23 Occupied Bandwidth 64QAM Input - 5G

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
64QAM	5	15	864.5	4.4871
		30	878.0	3.9941
		15	891.5	4.4890
		30	864.5	3.9989
		15	878.0	4.4861
		30	891.5	4.0005
	10	15	867.0	9.3157
		30	878.0	8.6246
		15	886.5	9.3310
		30	867.0	8.6276
		15	878.0	9.3155
		30	886.5	8.6195
	15	15	869.5	14.121
		30	878.0	13.630
		15	886.5	14.136
		30	869.5	13.652
		15	878.0	14.097
		30	886.5	13.616

Table 24 Occupied Bandwidth 64QAM Output - 5G

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
256AM	5	15	864.5	4.4901
		30	878.0	4.0223
		15	891.5	4.4894
		30	864.5	4.0190
		15	878.0	4.4921
		30	891.5	4.0218
	10	15	867.0	9.3245
		30	878.0	8.6270
		15	886.5	9.3123
		30	867.0	8.6466
		15	878.0	9.3127
		30	886.5	8.6274
	15	15	869.5	14.131
		30	878.0	13.600
		15	886.5	14.105
		30	869.5	13.609
		15	878.0	14.107
		30	886.5	13.589

Table 25 Occupied Bandwidth 256QAM Input - 5G

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
256QAM	5	15	864.5	4.4826
		30	878.0	4.0141
		15	891.5	4.4896
		30	864.5	4.0217
		15	878.0	4.4814
		30	891.5	4.0232
	10	15	867.0	9.3025
		30	878.0	8.6067
		15	886.5	9.3076
		30	867.0	8.6335
		15	878.0	9.3003
		30	886.5	8.6180
	15	15	869.5	14.119
		30	878.0	13.580
		15	886.5	14.136
		30	869.5	13.605
		15	878.0	14.109
		30	886.5	13.552

Table 26 Occupied Bandwidth 256QAM Output - 5G

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
QPSK	5	15	864.5	4.5189
		30	878.0	4.1173
		15	891.5	4.5219
		30	864.5	4.1076
		15	878.0	4.5254
		30	891.5	4.1174
	10	15	867.0	9.1692
		30	878.0	8.5295
		15	886.5	9.1674
		30	867.0	8.5260
		15	878.0	9.1661
		30	886.5	8.5229
	15	15	869.5	14.180
		30	878.0	13.400
		15	886.5	14.179
		30	869.5	13.394
		15	878.0	14.181
		30	886.5	13.393

Table 27 Occupied Bandwidth QPSK Input - 5G

Modulation	Bandwidth	Sub Carrier	Operation Frequency	Reading
	(MHz)	(kHz)	(MHz)	(MHz)
QPSK	5	15	864.5	4.5158
		30	878.0	4.1100
		15	891.5	4.5150
		30	864.5	4.1191
		15	878.0	4.5130
		30	891.5	4.1154
	10	15	867.0	9.1422
		30	878.0	8.5026
		15	886.5	9.1646
		30	867.0	8.5222
		15	878.0	9.1054
		30	886.5	8.4792
	15	15	869.5	14.163
		30	878.0	13.363
		15	886.5	14.176
		30	869.5	13.385
		15	878.0	14.150
		30	886.5	13.266

Table 28 Occupied Bandwidth QPSK Output - 5G

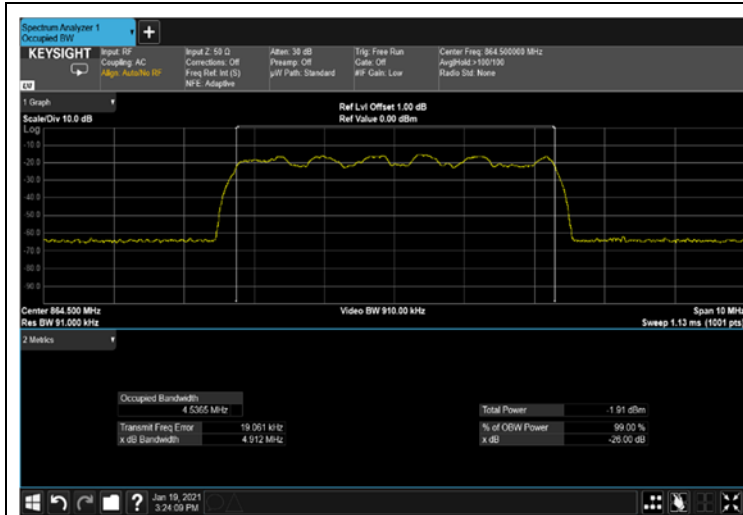


Figure 178: 16QAM 5MHz B.W.; 864.5MHz, 15kHz INPUT

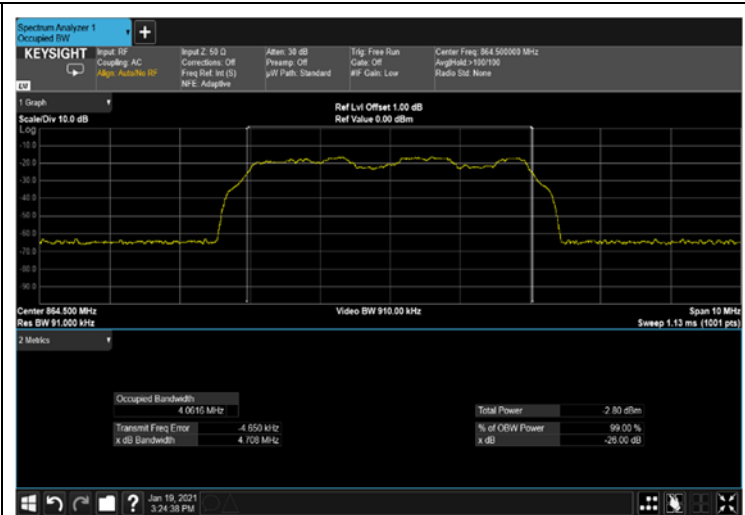


Figure 179: 16QAM 5MHz B.W.; 878.0MHz, 30kHz INPUT

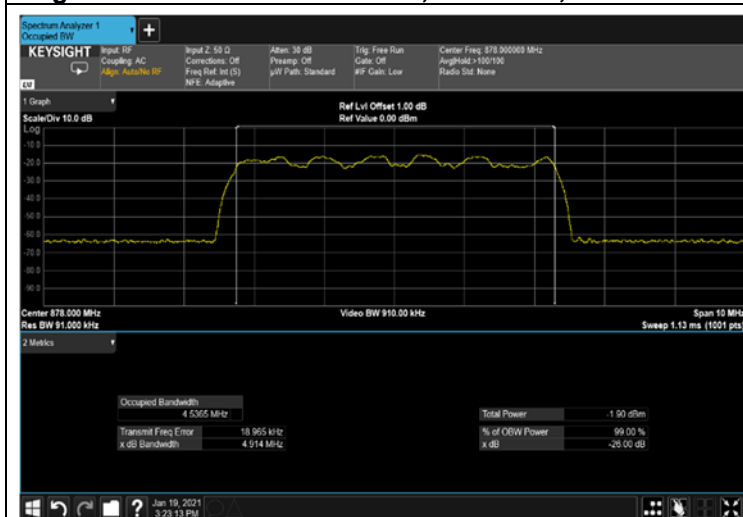


Figure 180: 16QAM 5MHz B.W.; 891.5MHz, 15kHz INPUT

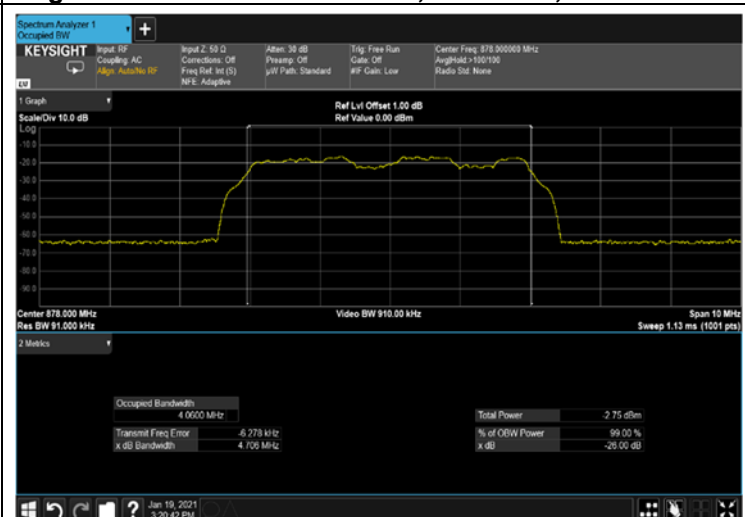


Figure 181: 16QAM 5MHz B.W.; 864.5MHz, 30kHz INPUT

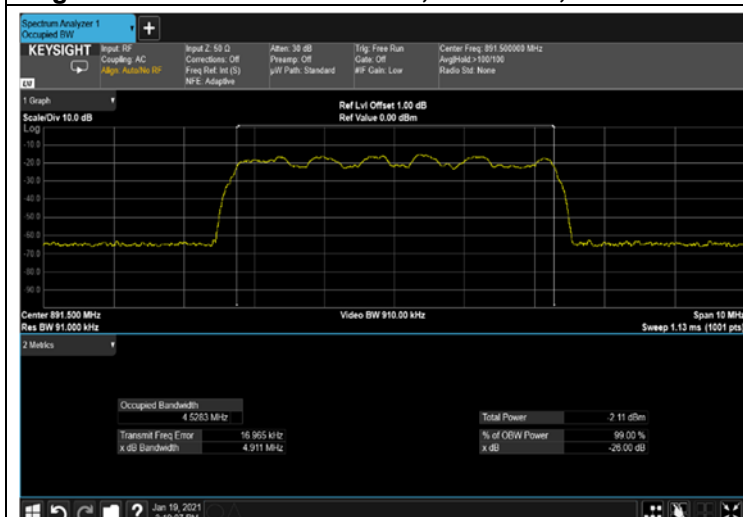


Figure 182: 16QAM 5MHz B.W.; 878.0MHz, 15kHz INPUT

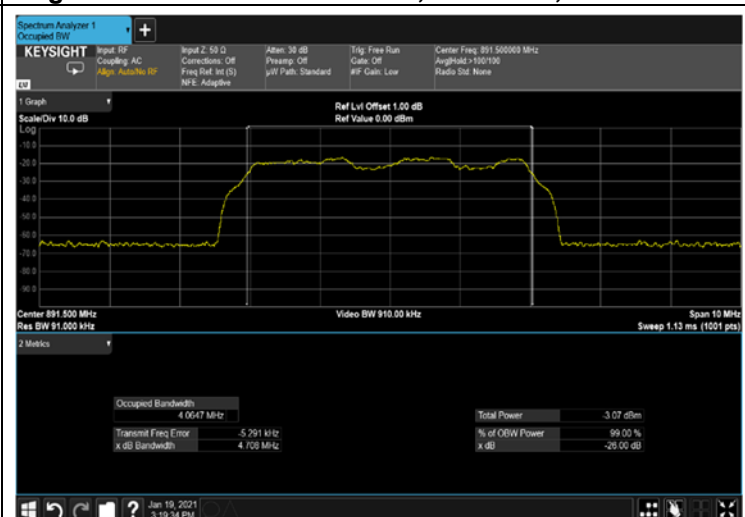


Figure 183: 16QAM 5MHz B.W.; 891.5MHz, 30kHz INPUT

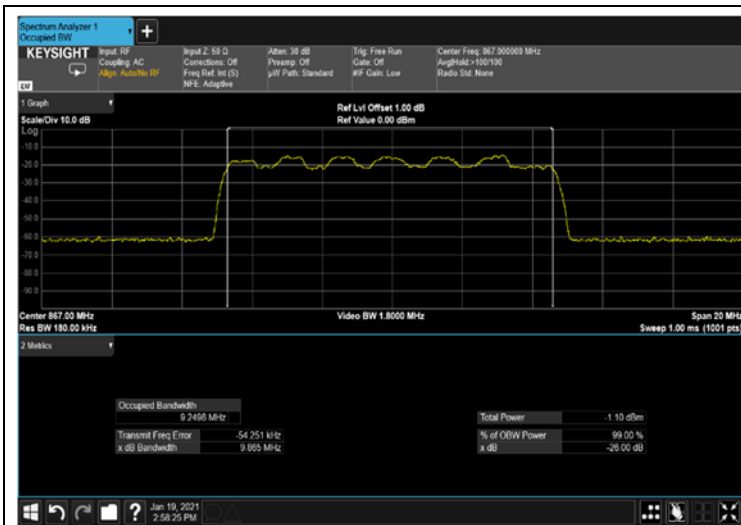


Figure 184: 16QAM 10MHz B.W.; 867.0MHz, 15kHz INPUT

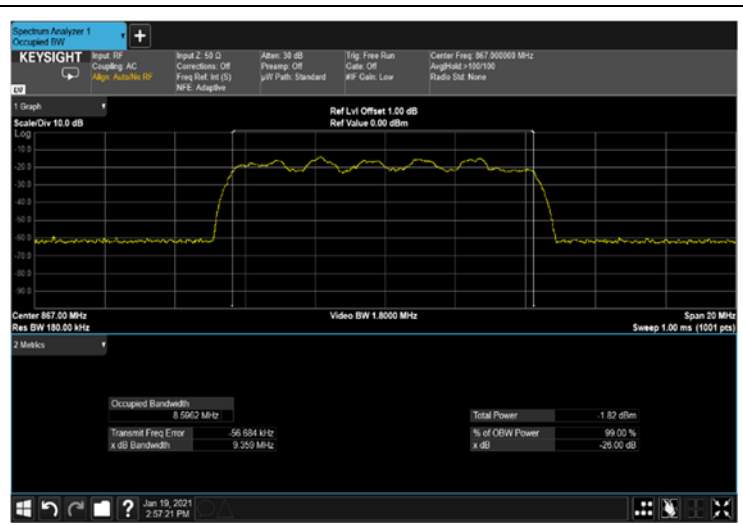


Figure 185: 16QAM 10MHz B.W.; 878.0MHz, 30kHz INPUT

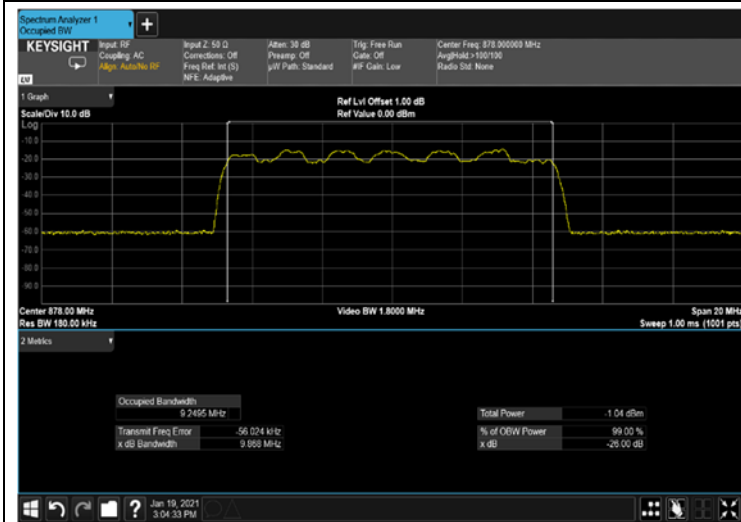


Figure 186: 16QAM 10MHz B.W.; 886.5MHz, 15kHz INPUT

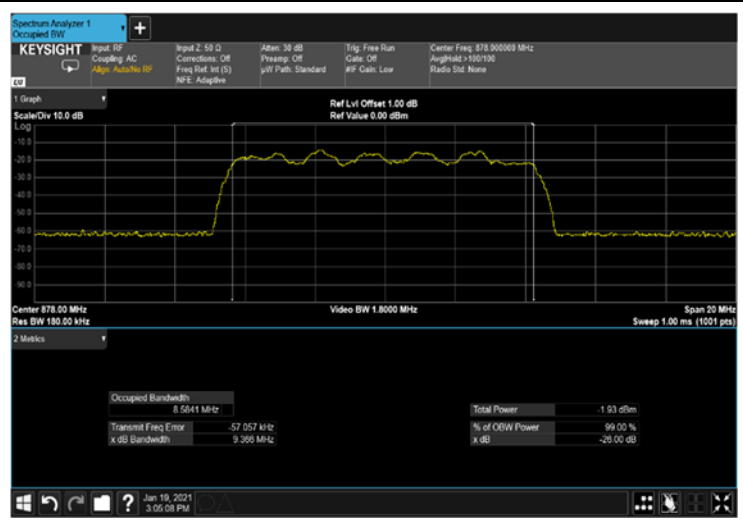


Figure 187: 16QAM 10MHz B.W.; 867.0MHz, 30kHz INPUT

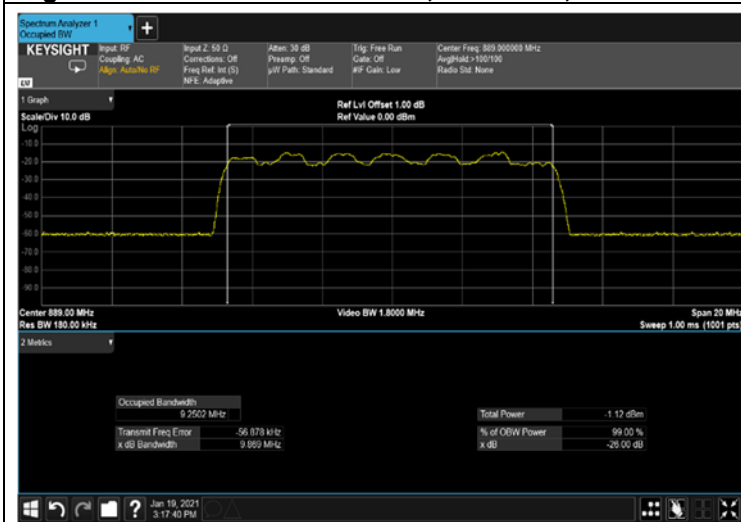


Figure 188: 16QAM 10MHz B.W.; 878.0MHz, 15kHz INPUT

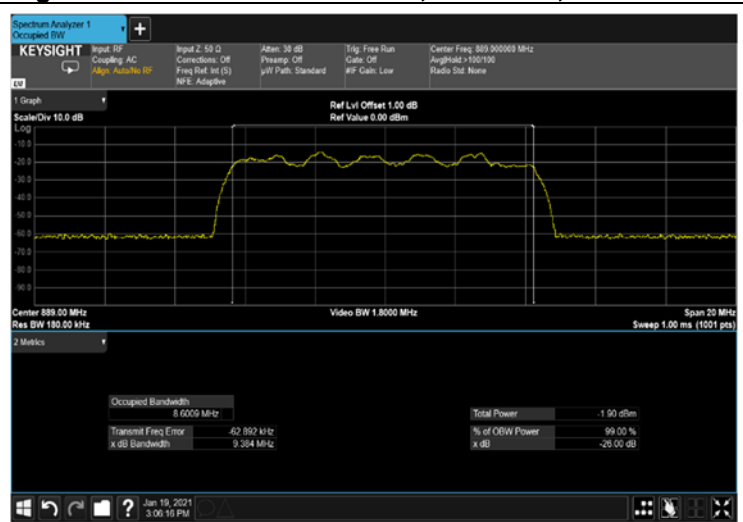


Figure 189: 16QAM 10MHz B.W.; 886.5MHz, 30kHz INPUT

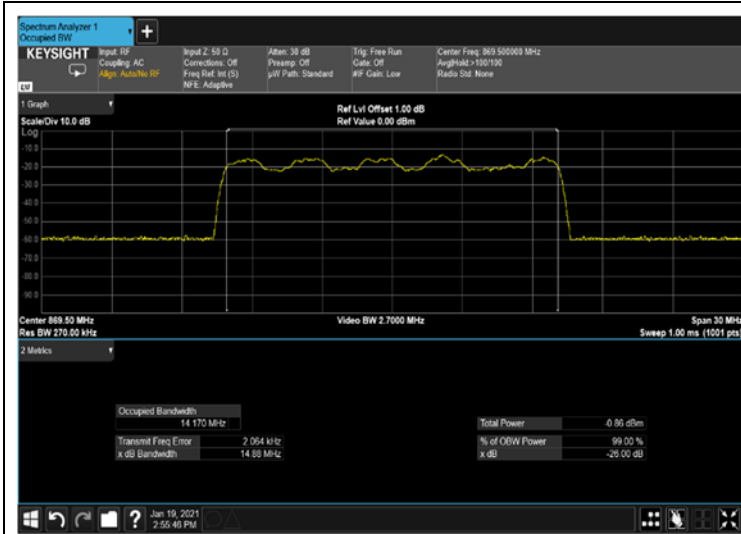


Figure 190: 16QAM 15MHz B.W.; 869.5MHz,15kHz INPUT

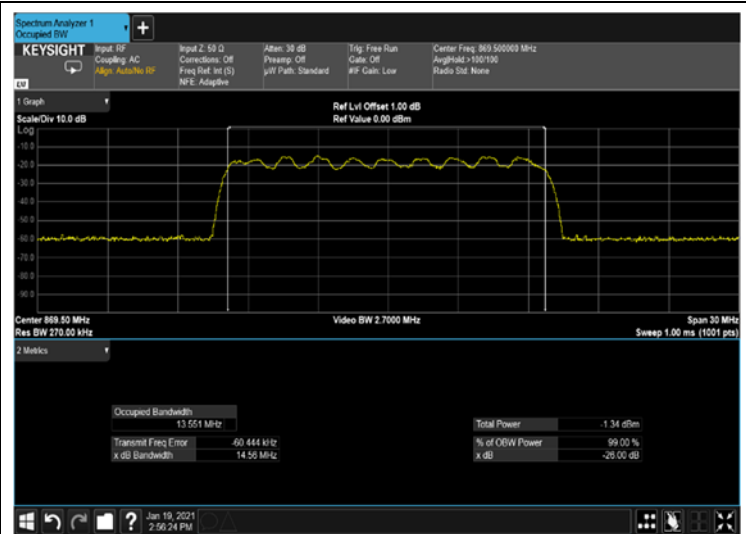


Figure 191: 16QAM 15MHz B.W.; 878.0MHz, 30kHz INPUT

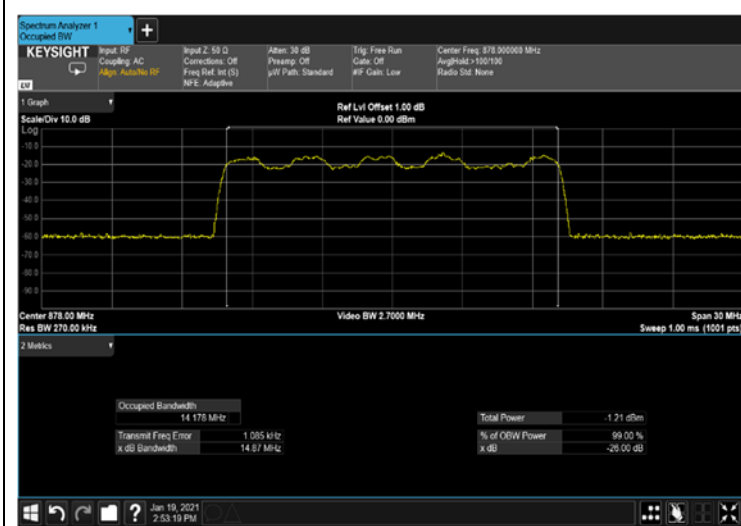


Figure 192: 16QAM 15MHz B.W.; 886.5MHz, 15kHz INPUT

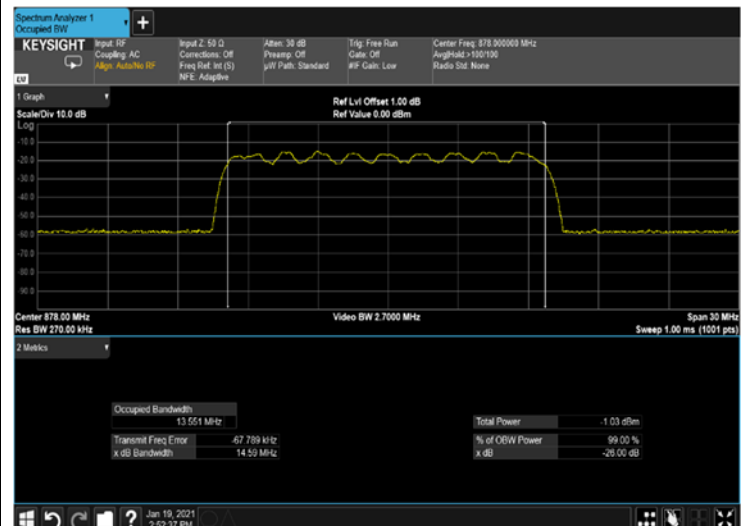


Figure 193: 16QAM 15MHz B.W.; 869.5MHz, 30kHz INPUT

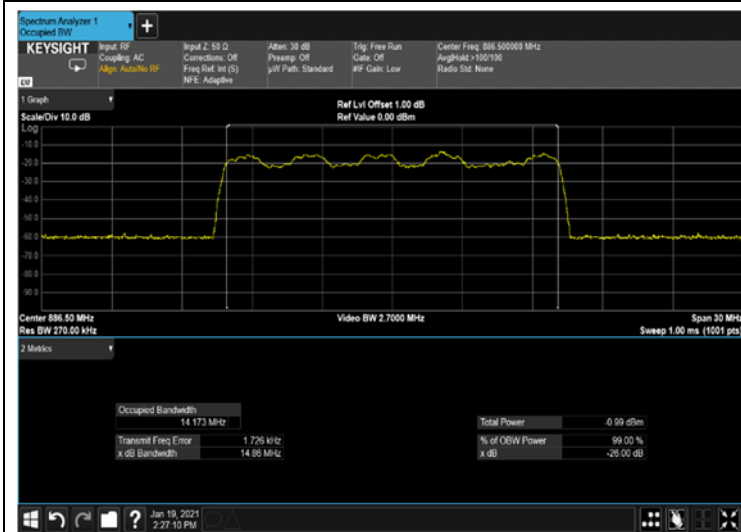


Figure 194: 16QAM 15MHz B.W.; 878.0MHz, 15 kHz INPUT

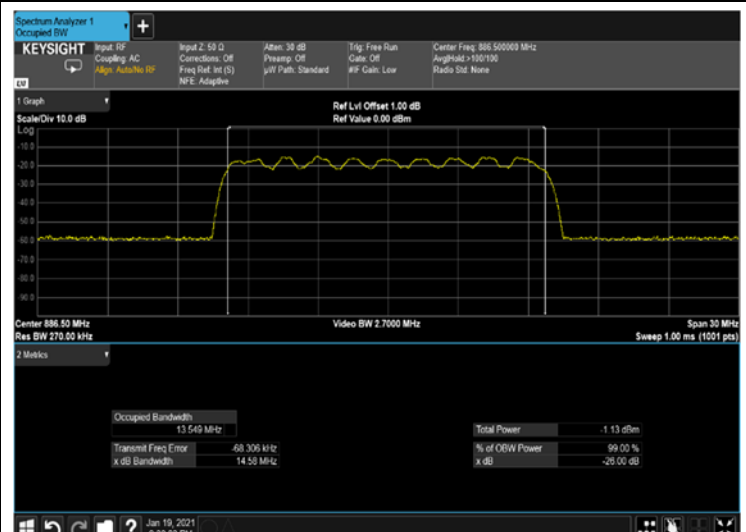


Figure 195: 16QAM 15MHz B.W.; 886.5MHz, 30 kHz INPUT

