6. Spurious Emissions at Antenna Terminals AWS

6.1 Test Specification

FCC Part 27, Subpart C, Section: 27.53(h)

6.2 Test Procedure

(Temperature (22°C)/ Humidity (38%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (max loss =10.8 dB). The spectrum analyzer was set to 300Hz RBW for the frequency range 9.0-150.0 kHz, 10kHz for the frequency range 150.0kHz–30.0MHz, 100kHz for the frequency range 30.0–1000.0MHz, and 1MHz for the frequency range 1.0- 22.0 GHz.

6.3 Test Limit

The power of any emission outside of the authorized operating frequency ranges (2110-2200MHz) must be attenuated below the transmitting power (P) by a factor of at least 43 + 10*log (P) dB, yielding –13dBm.

6.4 Test Results

JUDGEMENT: Passed

See additional information in *Figure 126* to *Figure 161*.

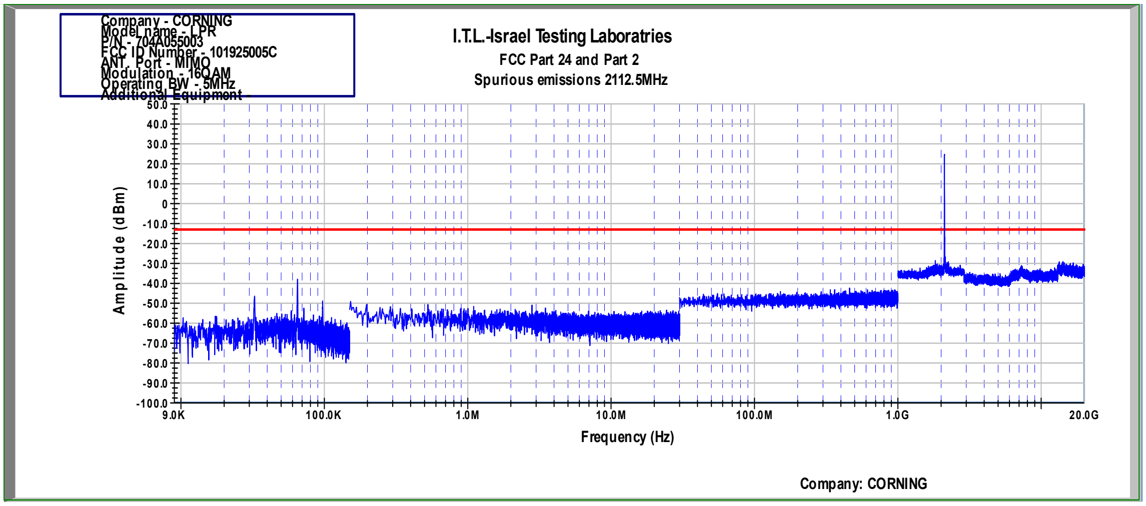


Figure 126 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 5 MHz (Low)

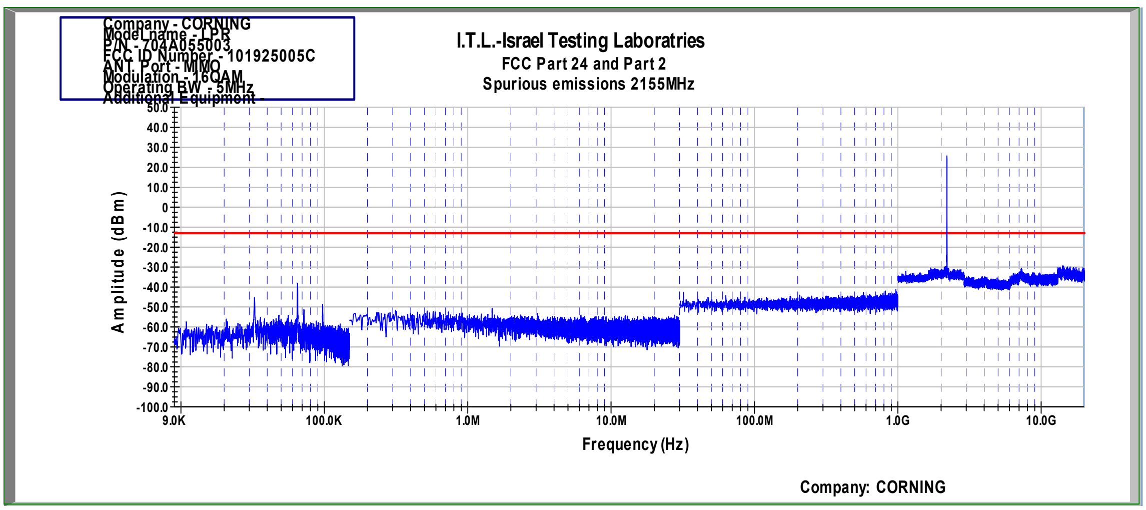


Figure 127 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 5 MHz (Mid)

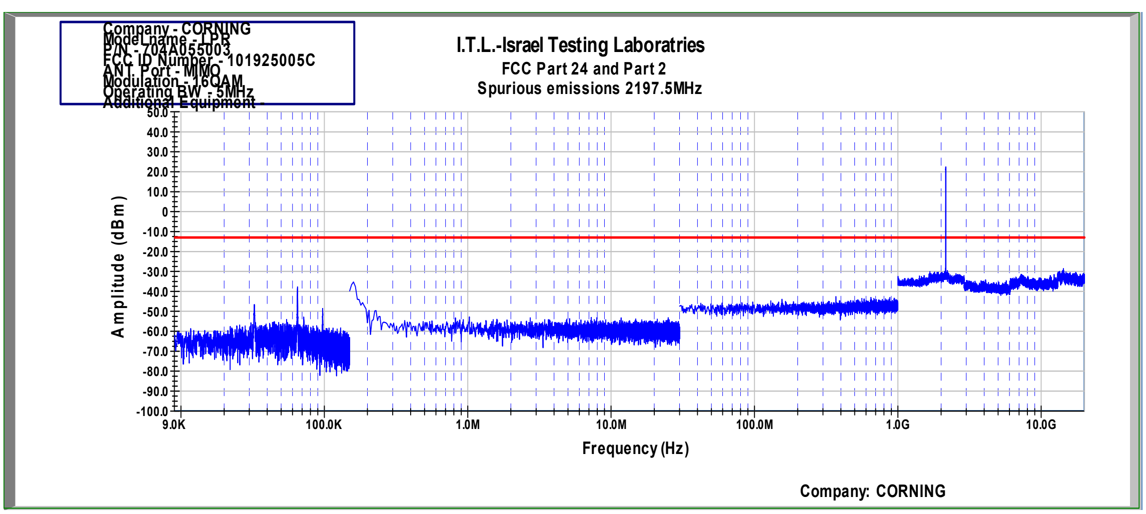


Figure 128 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 5 MHz (High)

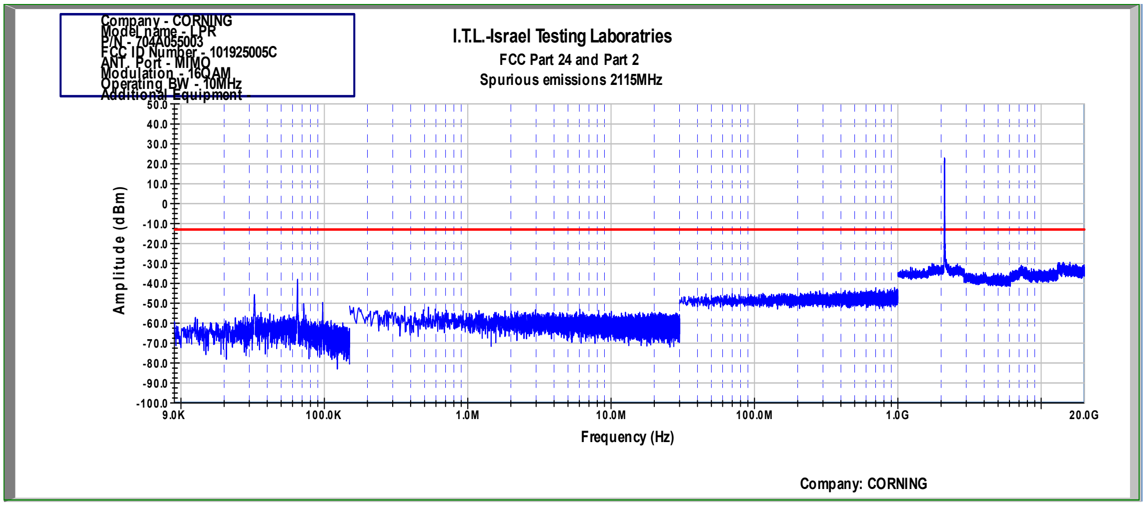


Figure 129 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 10 MHz (Low)

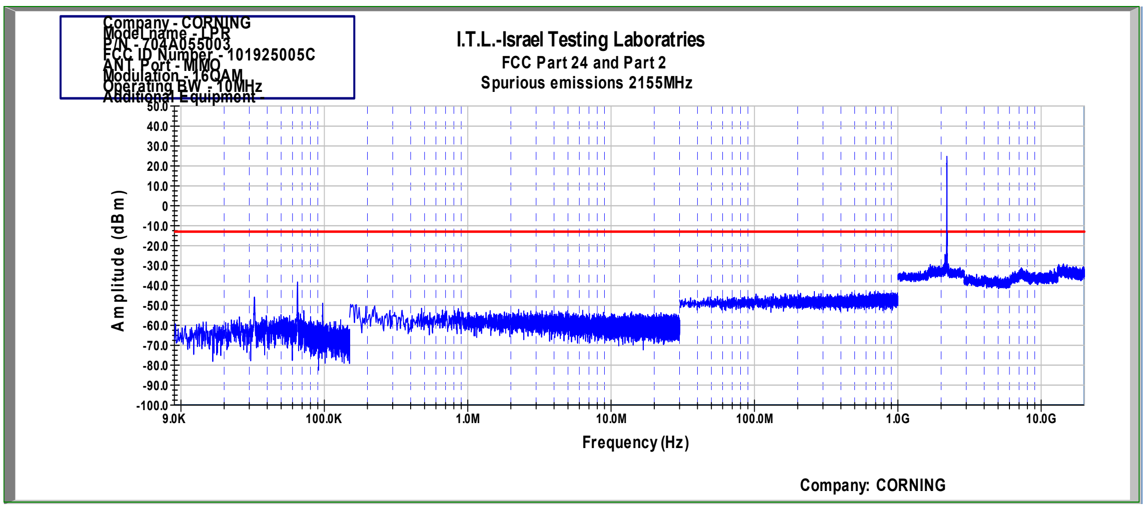


Figure 130 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 10 MHz (Mid)

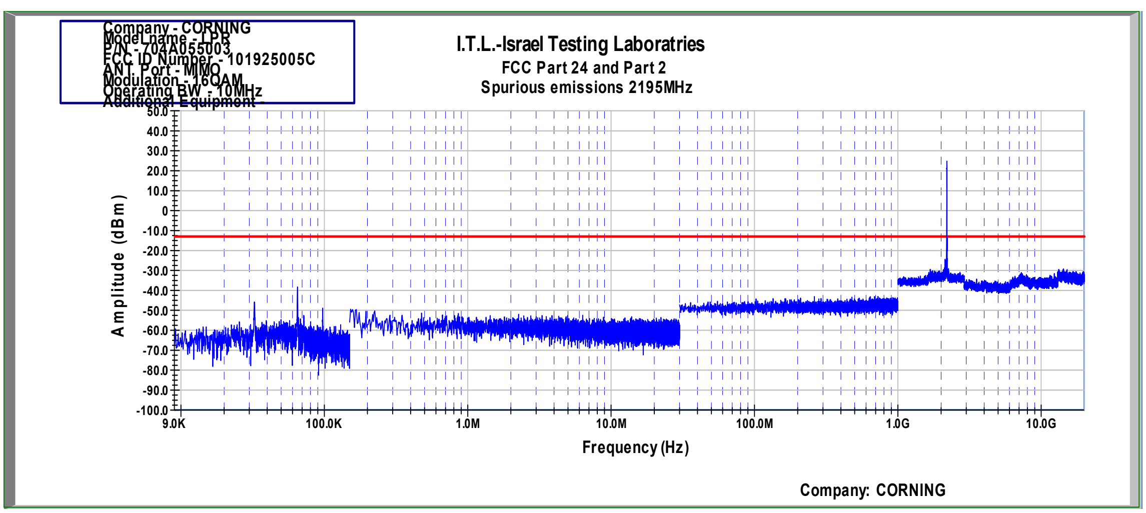


Figure 131 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 10 MHz (High)

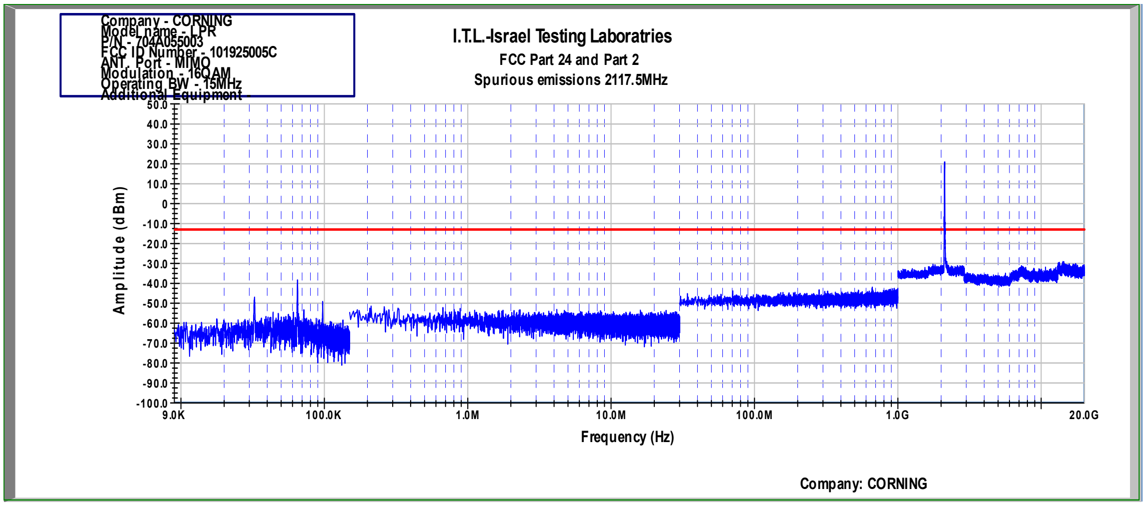


Figure 132 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 15 MHz (Low)

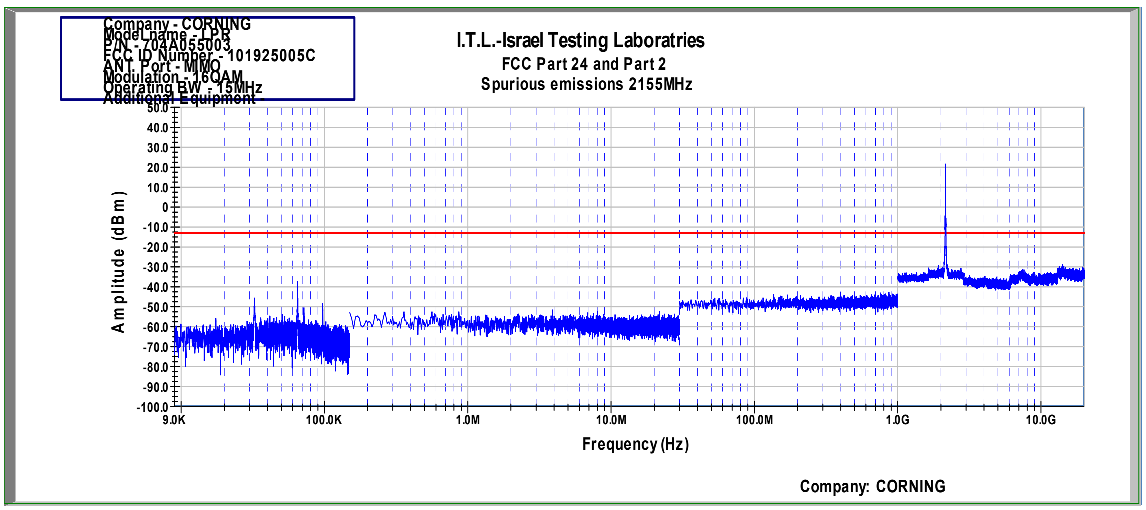


Figure 133 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 15MHz (Mid)

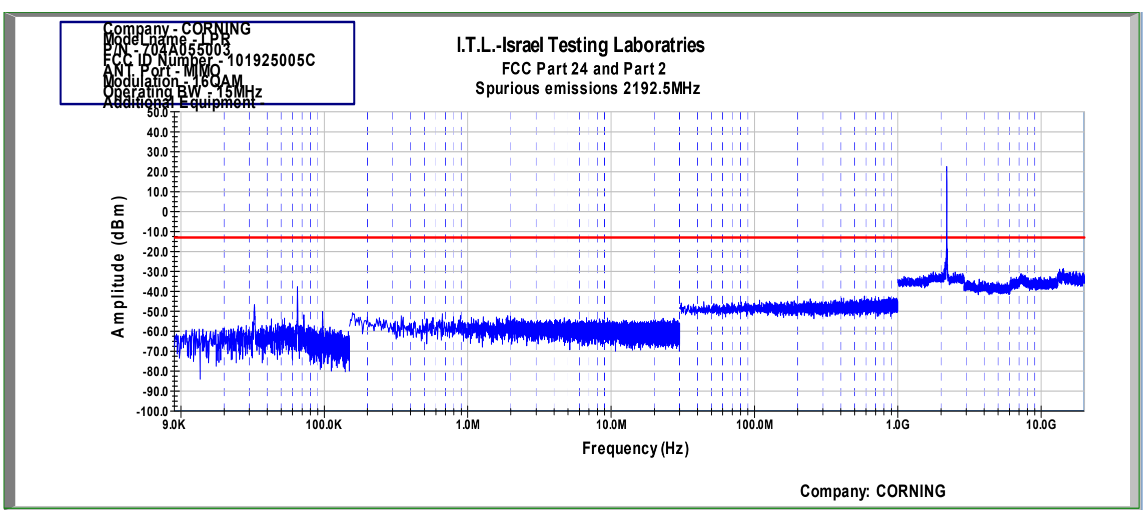


Figure 134 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 15MHz (High)

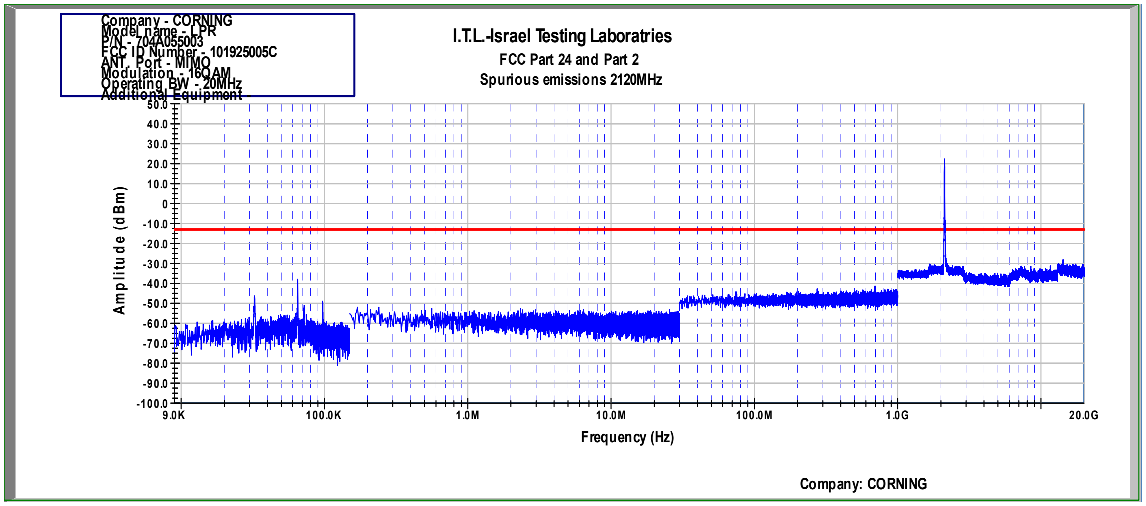


Figure 135 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 20 MHz (Low)

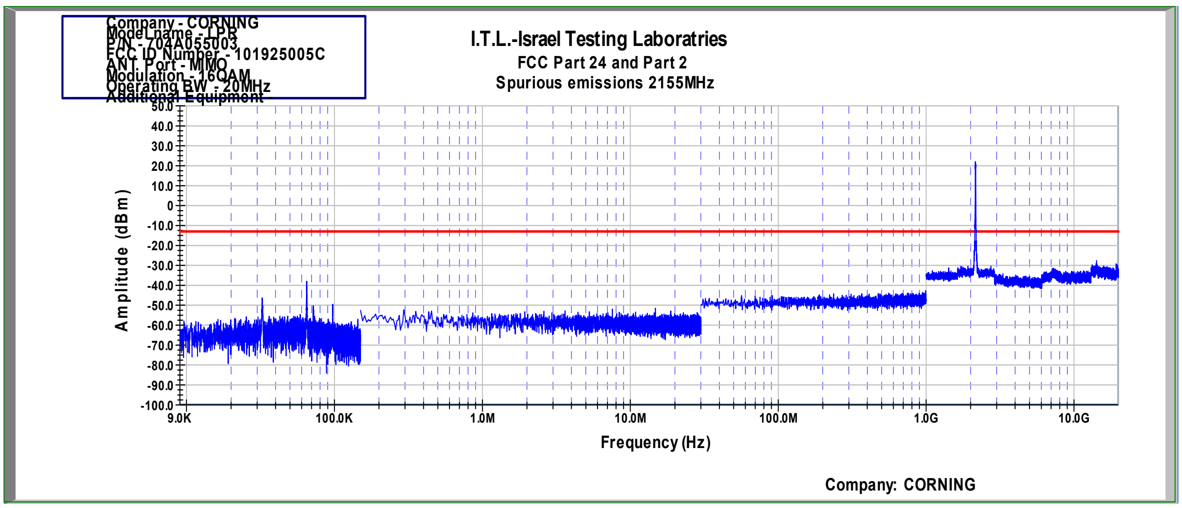


Figure 136 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 20 MHz (Mid)

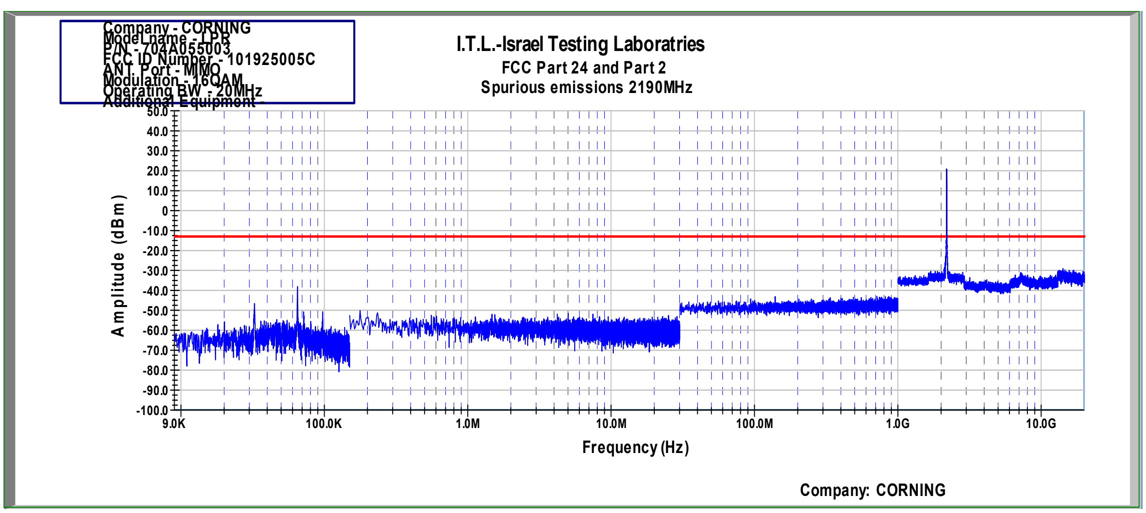


Figure 137 Spurious Emissions at Antenna Terminals 16QAM, MIMO, 20 MHz (High)

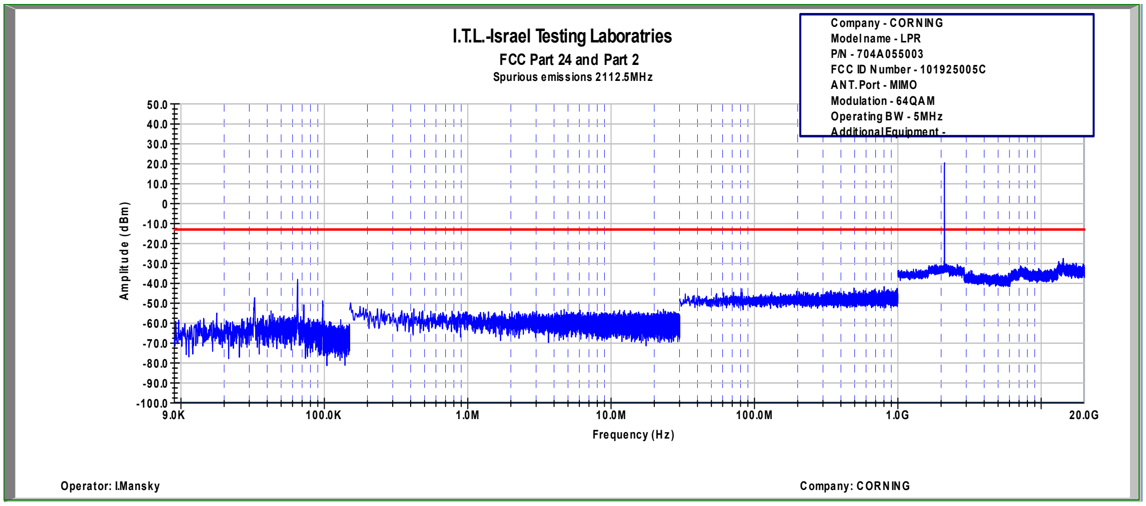


Figure 138 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 5 MHz (Low)

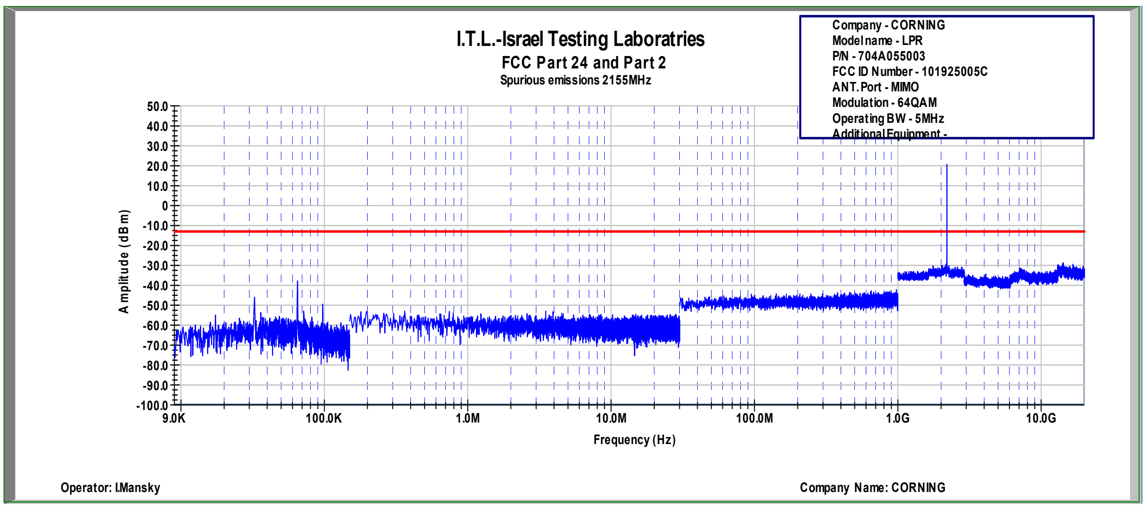


Figure 139 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 5 MHz (Mid)

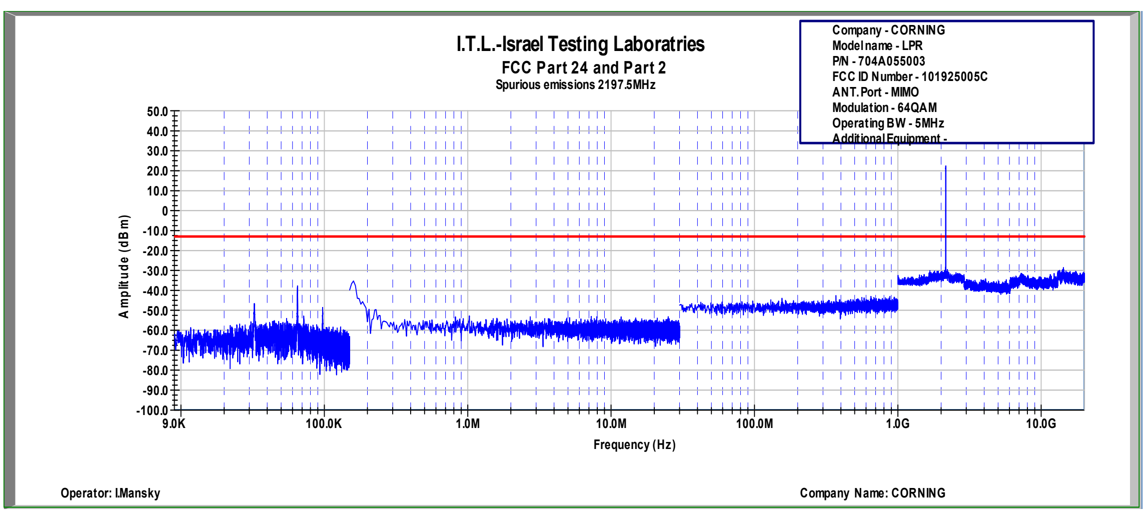


Figure 140 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 5 MHz (High)

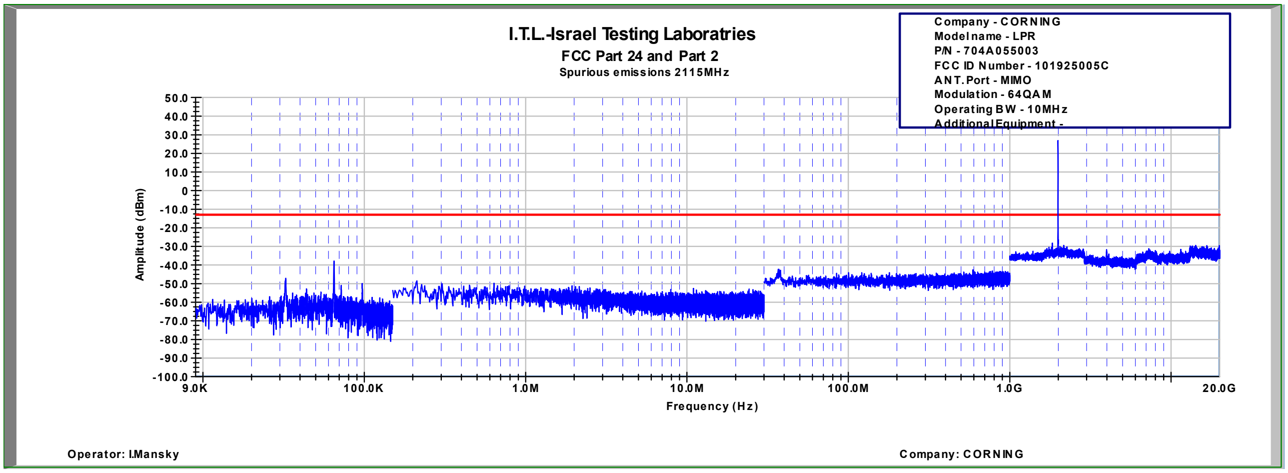


Figure 141 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 10 MHz (Low)

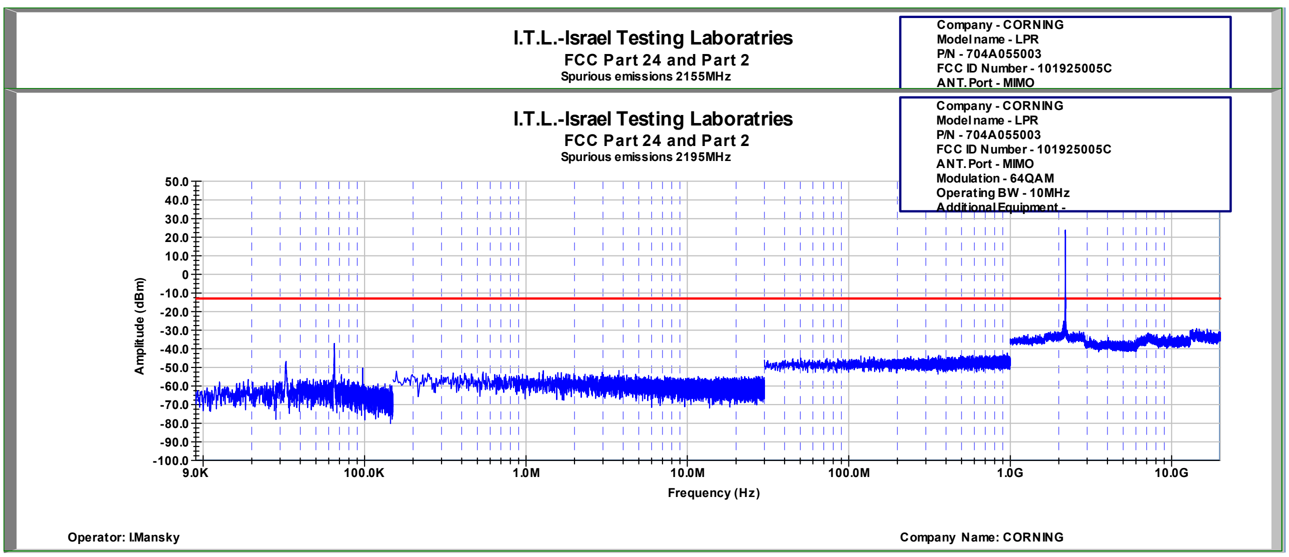


Figure 142 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 10 MHz (Mid)

???

Figure 143 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 10 MHz (High)

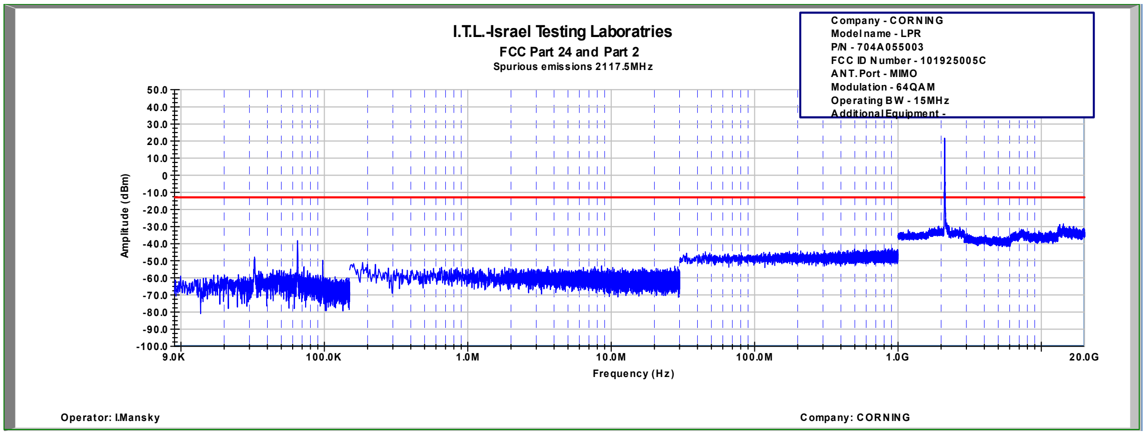


Figure 144 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 15 MHz (Low)

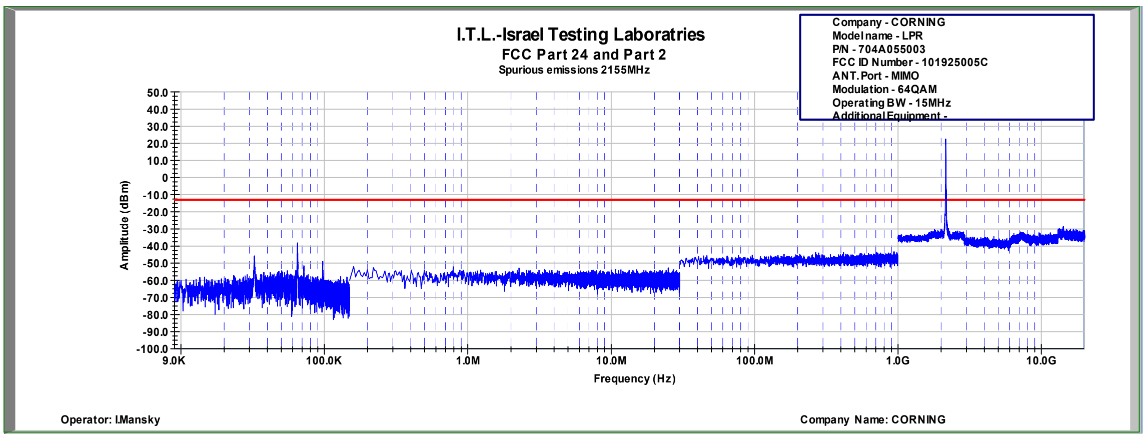


Figure 145 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 15 MHz (Mid)

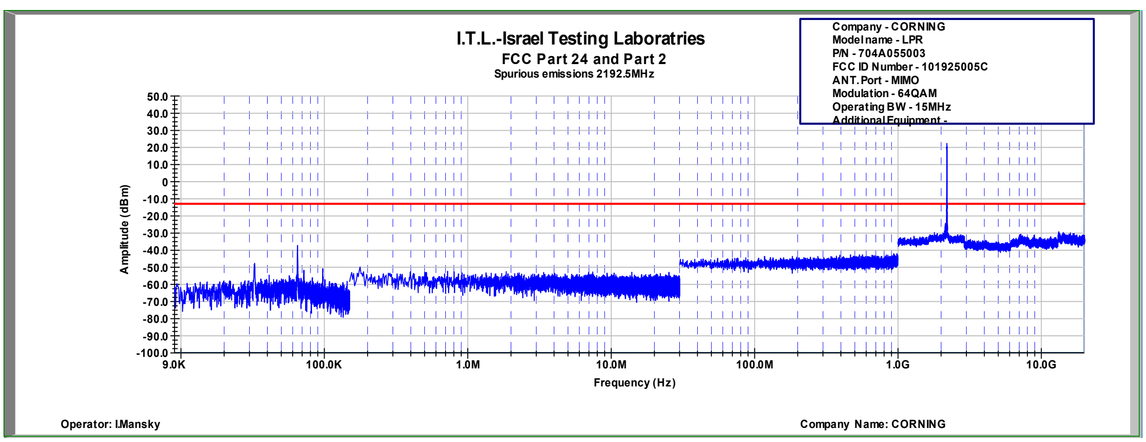


Figure 146 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 15 MHz (High)

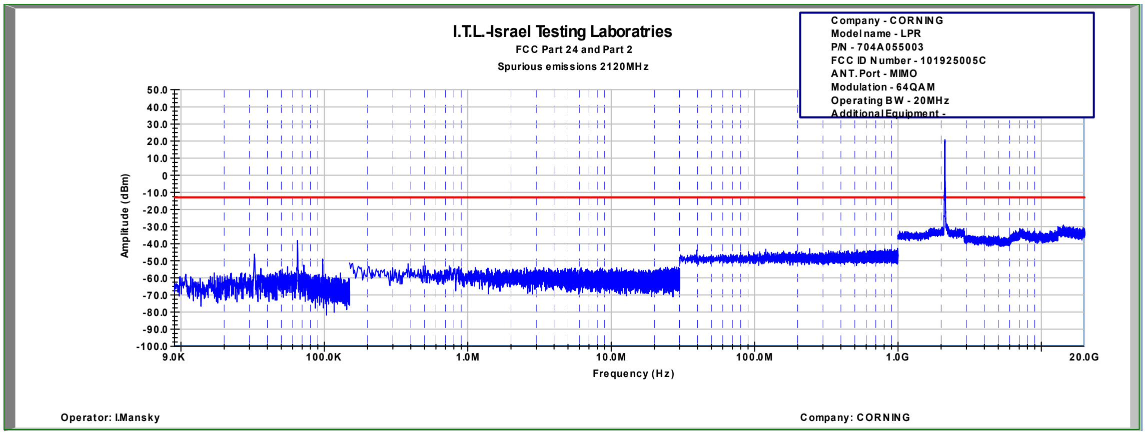


Figure 147 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 20 MHz (Low)

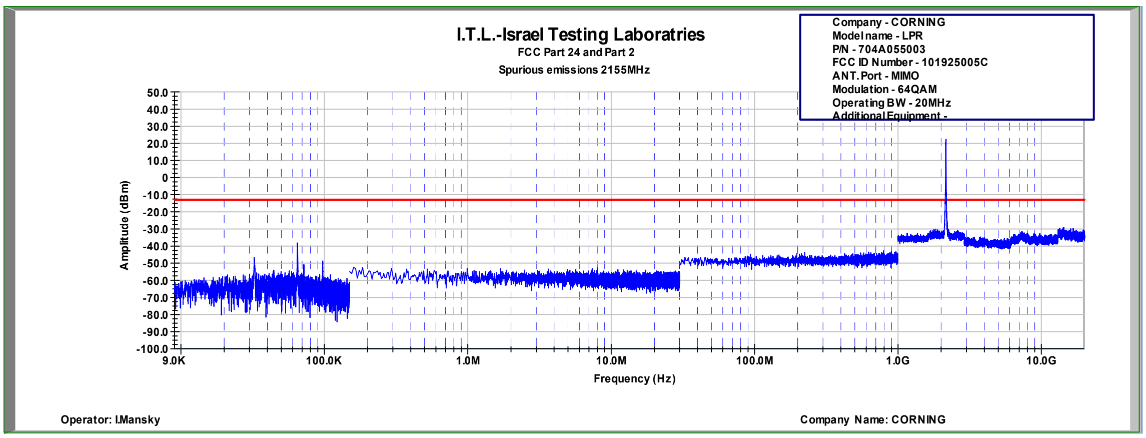


Figure 148 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 20 MHz (Mid)

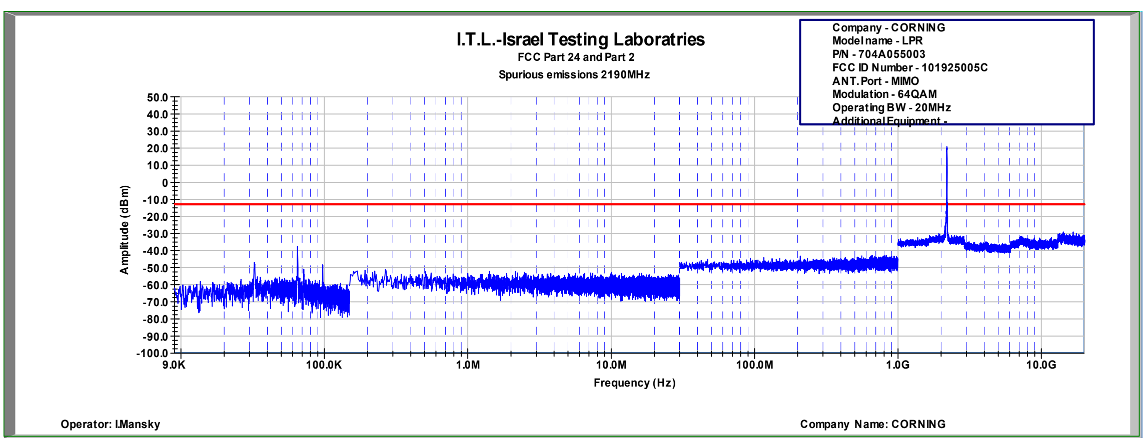


Figure 149 Spurious Emissions at Antenna Terminals 64QAM, MIMO, 20 MHz (High)

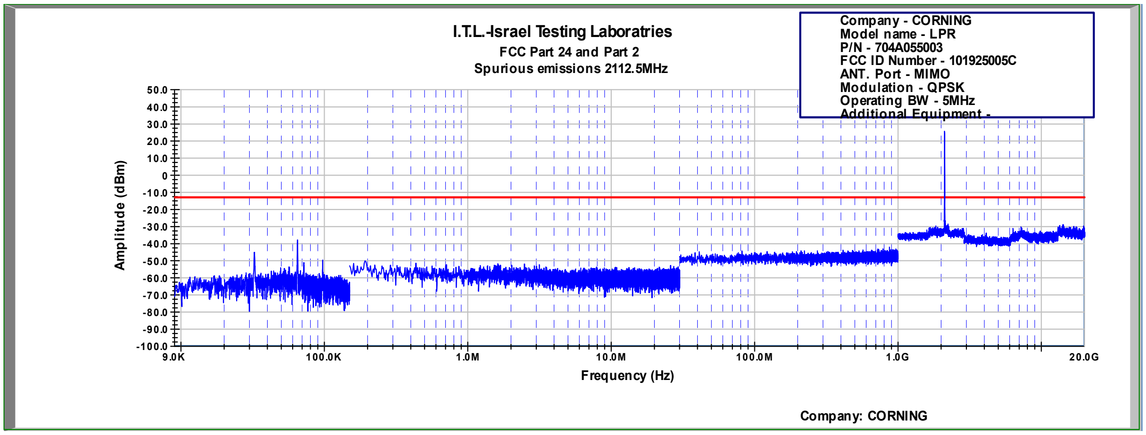


Figure 150 Spurious Emissions at Antenna Terminals QPSK, MIMO, 5 MHz (Low)

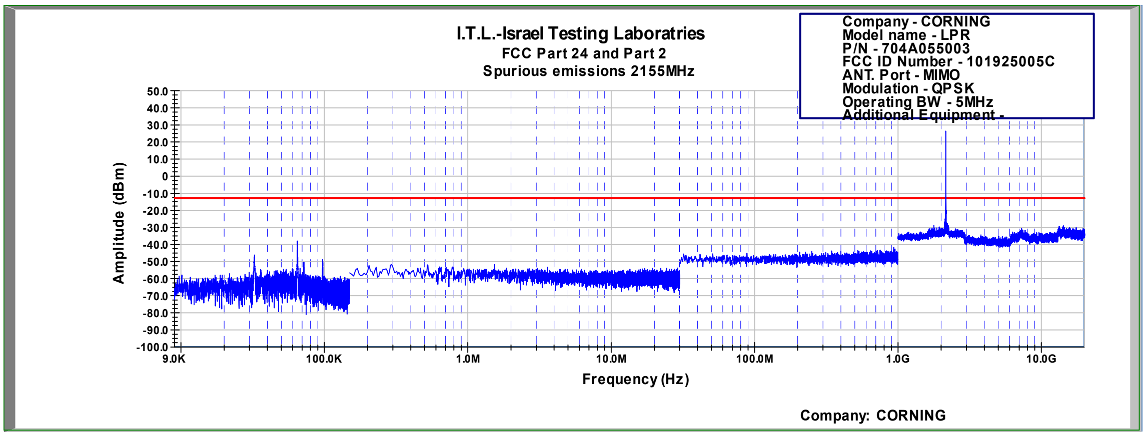


Figure 151 Spurious Emissions at Antenna Terminals QPSK, MIMO, 5 MHz (Mid)

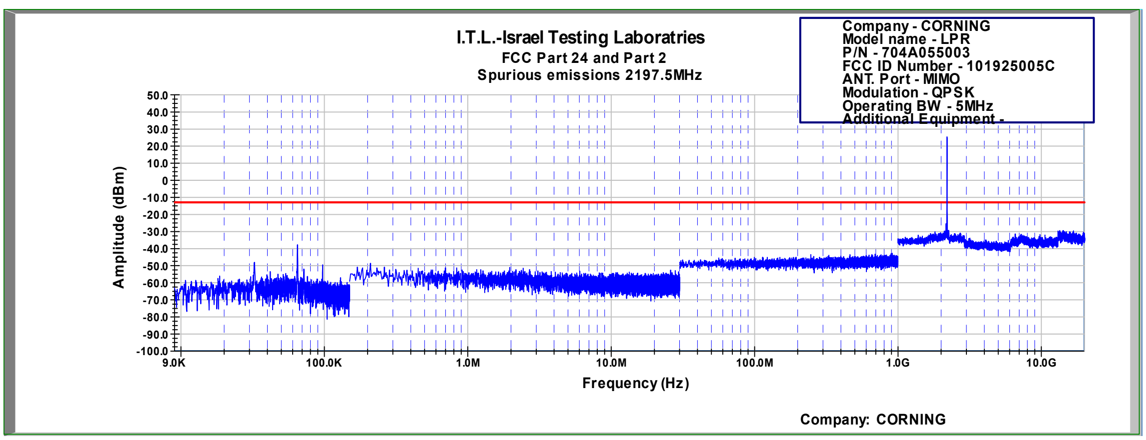


Figure 152 Spurious Emissions at Antenna Terminals QPSK, MIMO, 5 MHz (High)

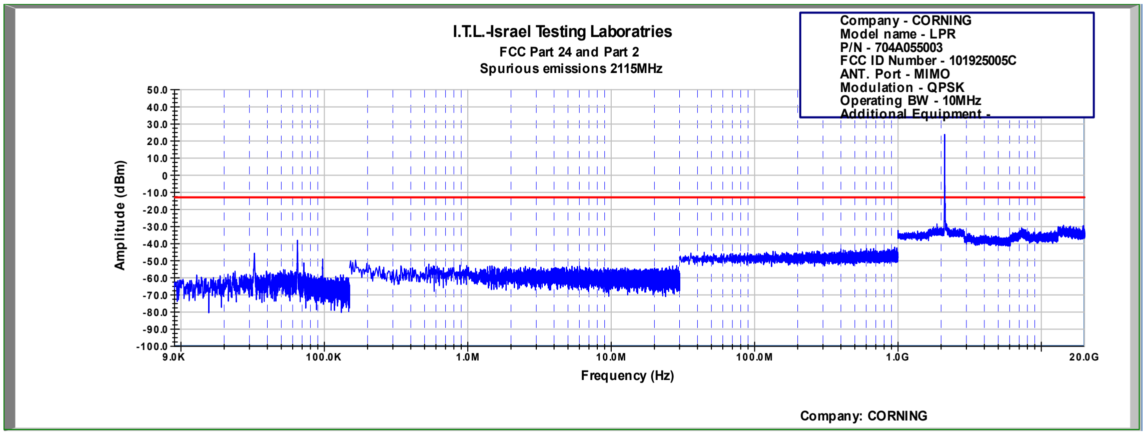


Figure 153 Spurious Emissions at Antenna Terminals QPSK, MIMO, 10 MHz (Low)

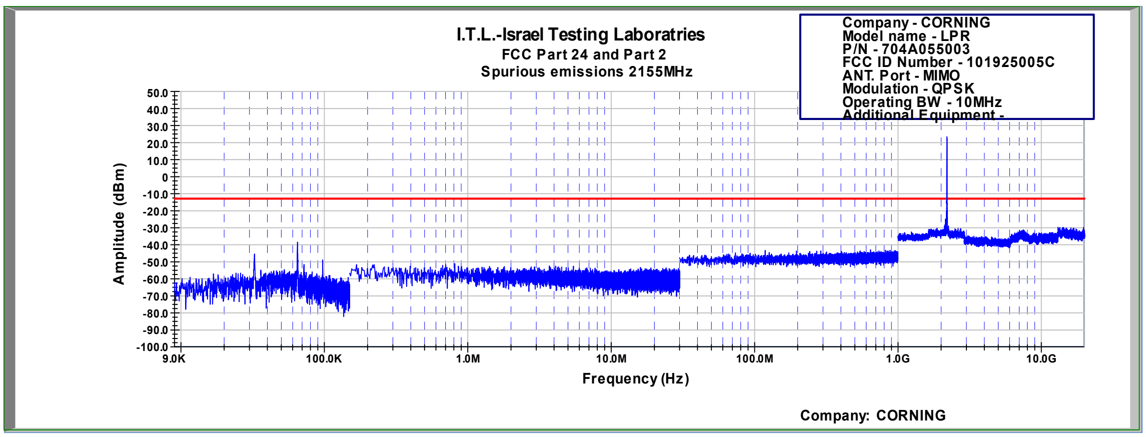


Figure 154 Spurious Emissions at Antenna Terminals QPSK, MIMO, 10 MHz (Mid)

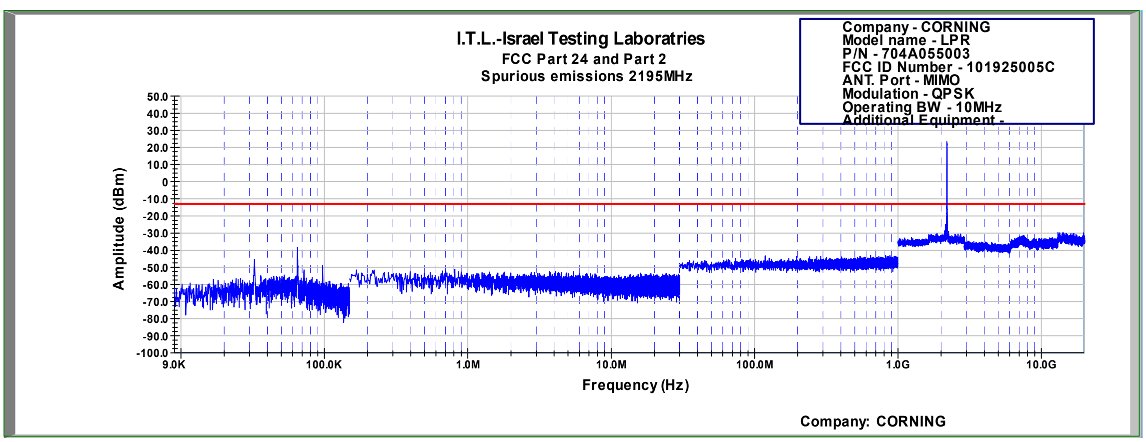


Figure 155 Spurious Emissions at Antenna Terminals QPSK, MIMO, 10 MHz (High)

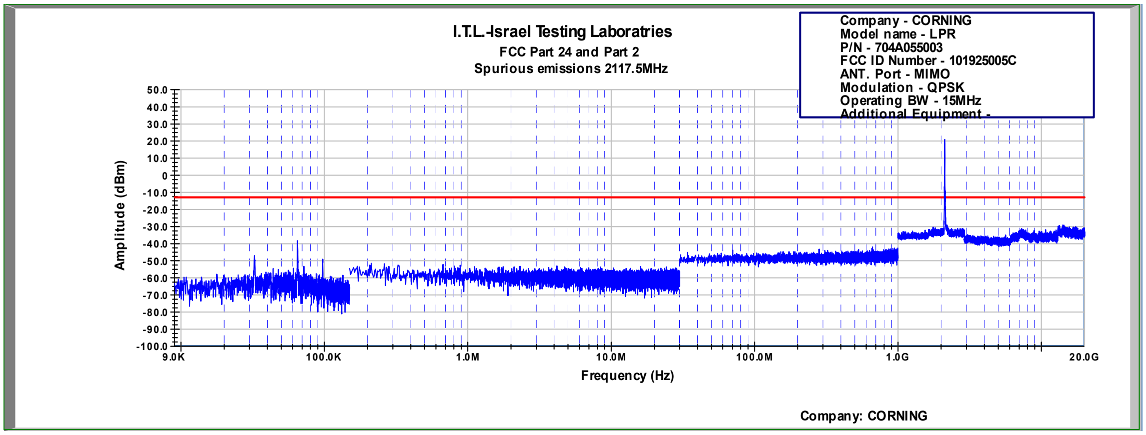


Figure 156 Spurious Emissions at Antenna Terminals QPSK, MIMO, 15 MHz (Low)

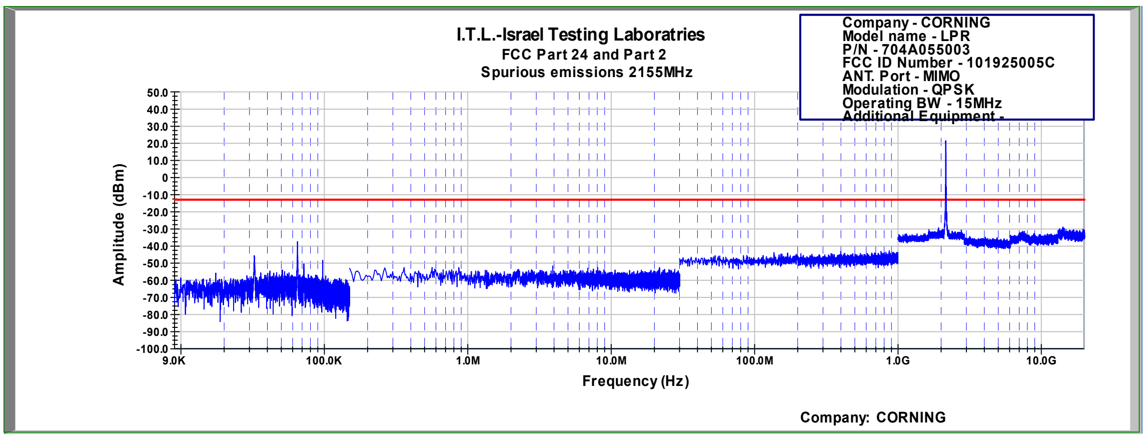


Figure 157 Spurious Emissions at Antenna Terminals QPSK, MIMO, 15 MHz (Mid)

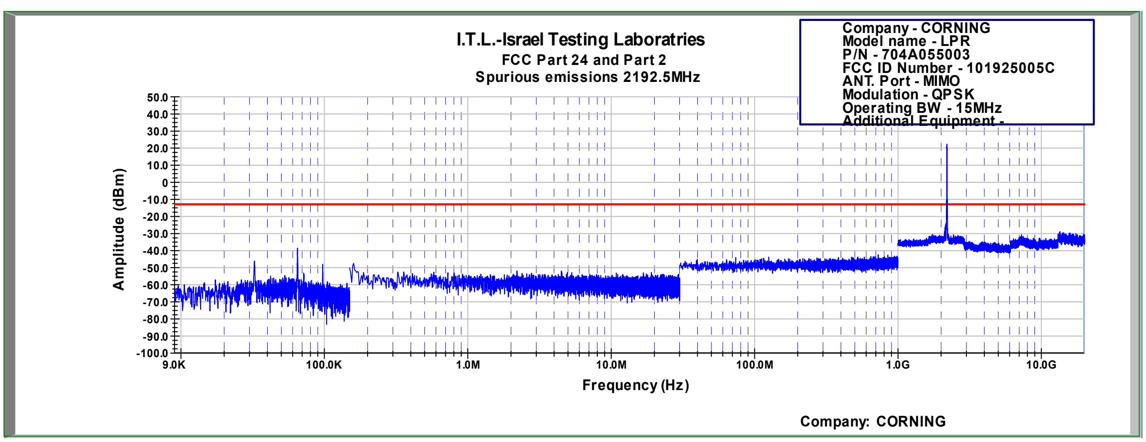


Figure 158 Spurious Emissions at Antenna Terminals QPSK, MIMO, 15 MHz (High)

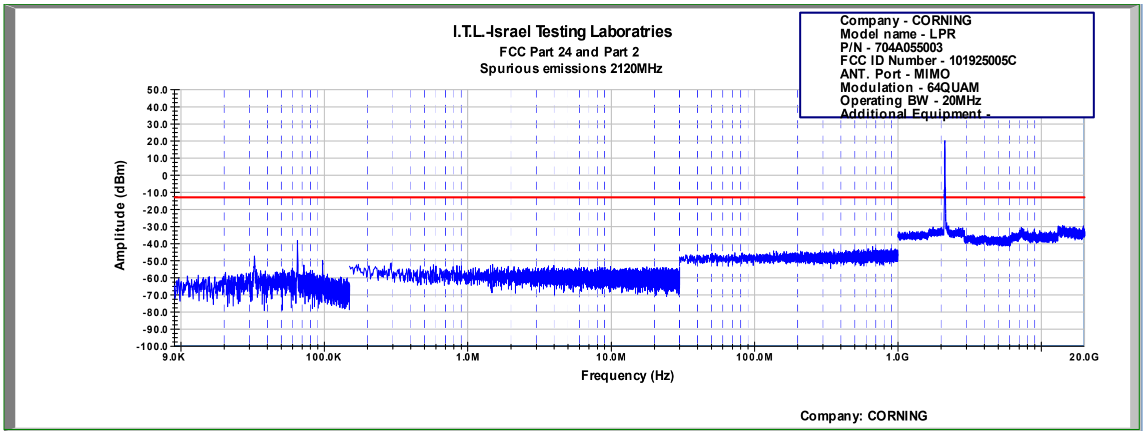


Figure 159 Spurious Emissions at Antenna Terminals QPSK, MIMO, 20 MHz (Low)

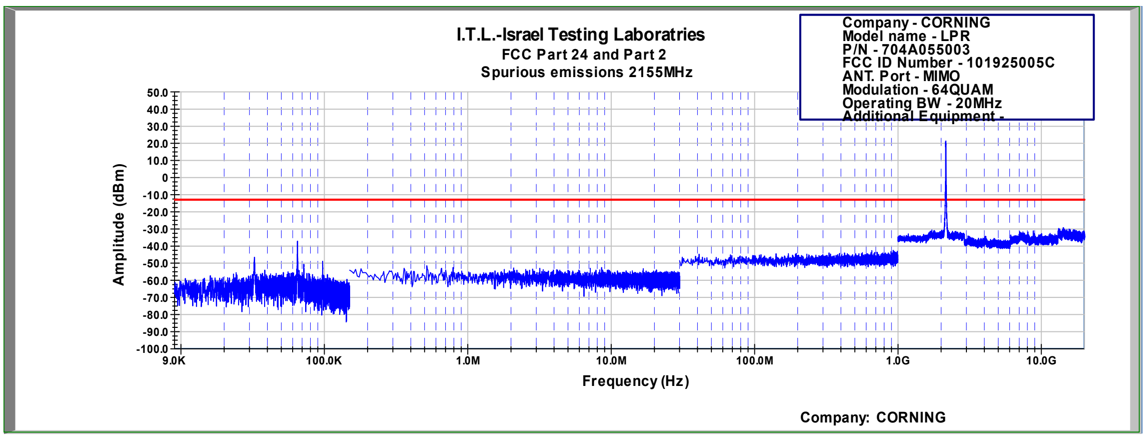


Figure 160 Spurious Emissions at Antenna Terminals QPSK, MIMO, 20 MHz (Mid)

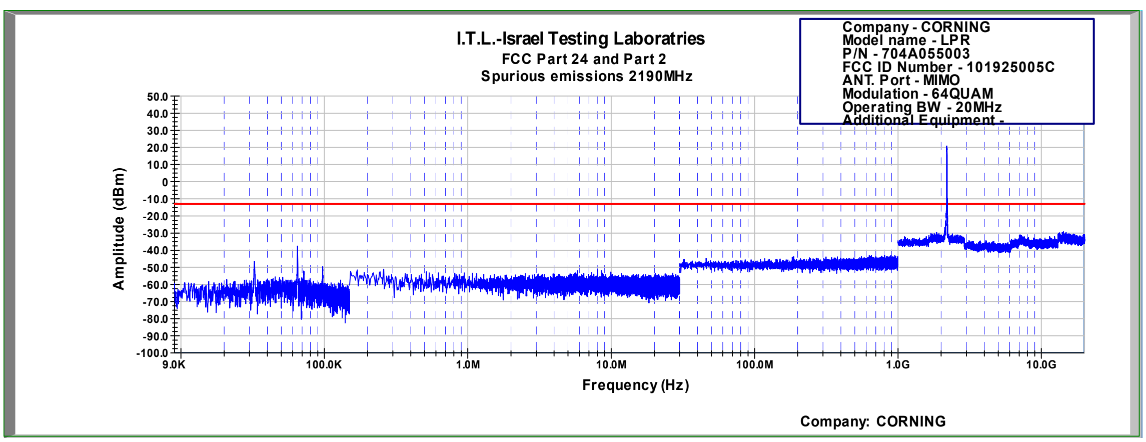


Figure 161 Spurious Emissions at Antenna Terminals QPSK, MIMO, 20 MHz (High)

6.5 Test Equipment Used; Spurious Emissions at Antenna Terminals AWS

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration Date	Next Calibration Due
Spectrum Analyzer	HP	8564E	3442A00275	September 1, 2019	September 30, 2020
Vector Signal Generator	VIAVI	MTS 5800	WMNK00716 90263	July 1, 2018	July 1, 2021
Attenuator 10dB	Bird	8304-N10DB	N/A	December 24, 2018	December 31, 2019

Figure 162 Test Equipment Used

7. Band Edge Spectrum AWS

7.1 Test Specification

FCC Part 27, Subpart C, Section 27.53(h)

7.2 Test Procedure

(Temperature (22°C)/ Humidity (36%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an appropriate coaxial cable (loss = 0.8 dB).

RBW was set to 1% of OBW.

7.3 Test Limit

The power of any emission outside of the authorized operating frequency range (2110-2200MHz) must be attenuated below the transmitting power (P) by a factor of at least 43 + 10*log (P) dB, yielding –13dBm.

7.4 Test Results

Band	Modulation	Operation Frequency	Port Reading	Limit	Margin
		(MHz)	(dBm)	(dBm)	(dB)
AWS 1-3	QPSK	2112.5	-44.5	-13.0	-31.5
		2197.5	-48.6	-13.0	-35.6
	16QAM	2112.5	-45.0	-13.0	-32.0
		2197.5	-46.4	-13.0	-33.4
	64QAM	2112.5	-45.1	-13.0	-32.1
		2197.5	-47.7	-13.0	-34.7

Figure 163 RF Power Output, 5MHz BW

Band	Modulation	Operation Frequency	Port Reading	Limit	Margin
		(MHz)	(dBm)	(dBm)	(dB)
AWS 1-3	QPSK	2115.0	-45.0	-13.0	-32.0
		2195.0	-50.7	-13.0	-37.7
	16QAM	2115.0	-46.3	-13.0	-33.3
		2195.0	-50.6	-13.0	-37.6
	64QAM	2115.0	-46.4	-13.0	-33.4
		2195.0	-51.1	-13.0	-38.1

Figure 164 RF Power Output, 10MHz BW

Band	Modulation	Operation Frequency	Port Reading	Limit	Margi n
		(MHz)	(dBm)	(dBm)	(dB)
AWS 1-3	QPSK	2117.5	-45.9	-13.0	-32.9
		2192.5	-51.3	-13.0	-38.3
	16QAM	2117.5	-46.4	-13.0	-33.4
		2192.5	-50.0	-13.0	-37.0
	64QAM	2117.5	-45.6	-13.0	-32.6
		2192.5	-51.2	-13.0	-38.2

Figure 165 RF Power Output, 15MHz BW

Band	Modulation	Operation Frequency	Port Reading	Limit	Margin
		(MHz)	(dBm)	(dBm)	(dB)
AWS 1-3	QPSK	2120.0	-45.8	-13.0	-32.8
		2190.0	-51.9	-13.0	-38.9
	16QAM	2120.0	-51.2	-13.0	-38.2
		2190.0	-46.6	-13.0	-33.6
	64QAM	2120.0	-46.3	-13.0	-33.3
		2190.0	-51.8	-13.0	-38.8

Figure 166 RF Power Output, 20MHz BW

JUDGEMENT: Passed

See additional information in *Figure 167* to *Figure 190*.

Antenna Port:	**1**
Modulation:	**16QAM**

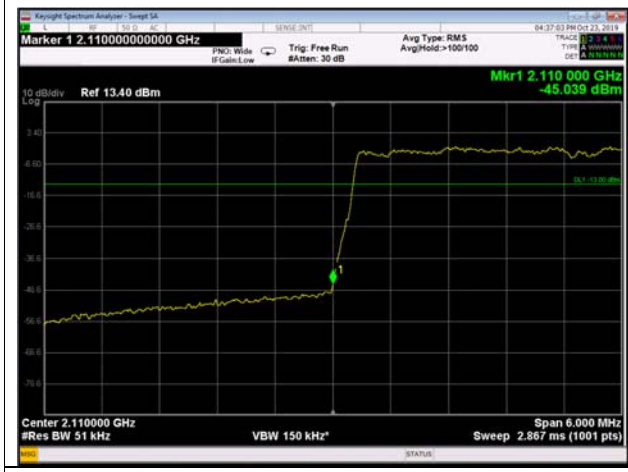


Figure 167 5MHz BW, 2112.5MHz

Figure 168 5MHz BW, 2197.5MHz

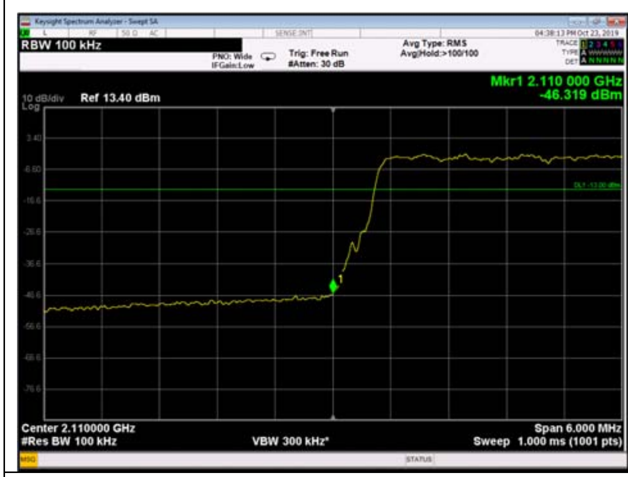


Figure 169 10MHz BW, 2115MHz

Figure 170 10MHz BW, 2195MHZ

Antenna Port:	**1**
Modulation:	**16QAM**

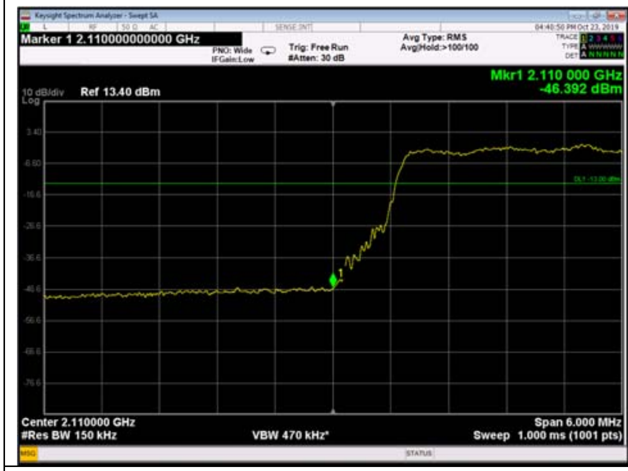


Figure 171 15MHz BW, 2117.5MHz

Figure 172 15MHz BW, 2192.5MHz

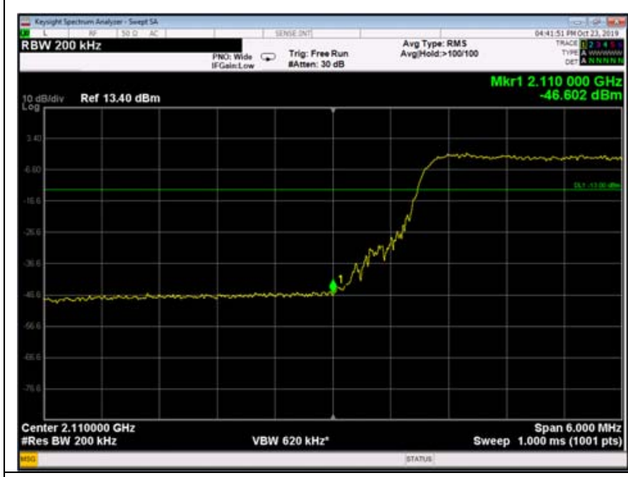


Figure 173 20MHz BW, 2120MHz

Figure 174 20MHz BW, 2190MHz

Antenna Port:	1
Modulation:	**64QAM**

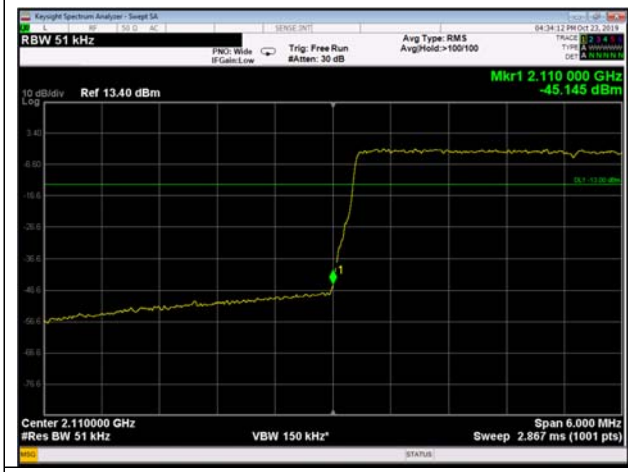


Figure 175 5MHz BW, 2112.5MHz

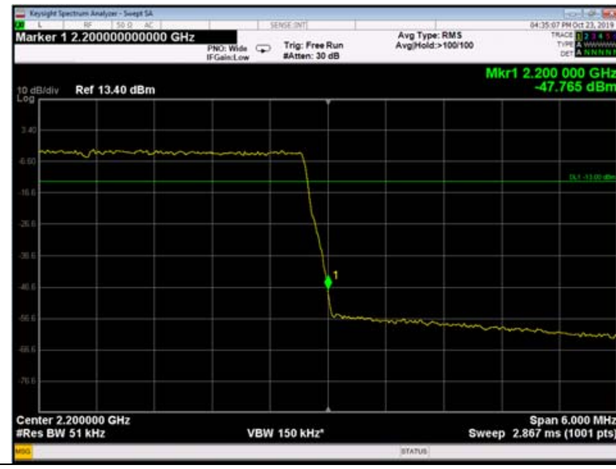


Figure 176 5MHz BW, 2197.5MHz

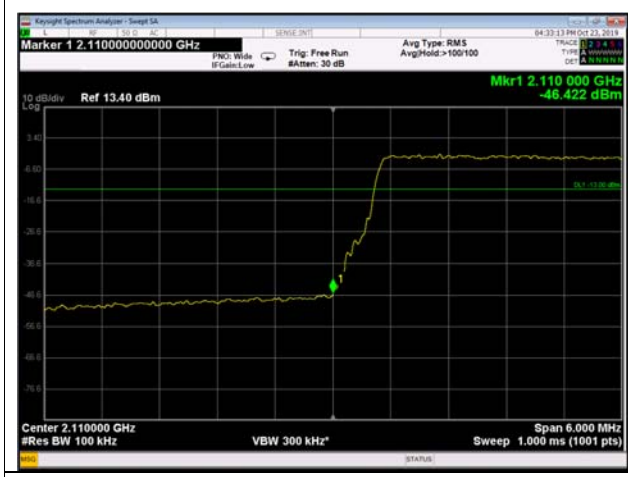


Figure 177 10MHz BW, 2115MHz

Figure 178 10MHz BW, 2195MHz

Antenna Port:	1
Modulation:	**64QAM**

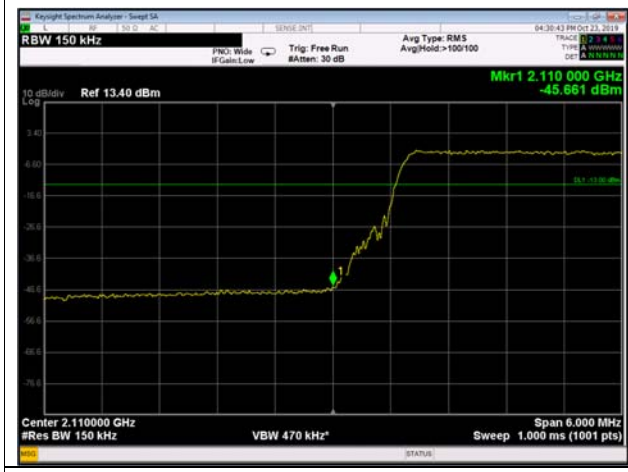


Figure 179 15MHz BW, 2117.5MHz

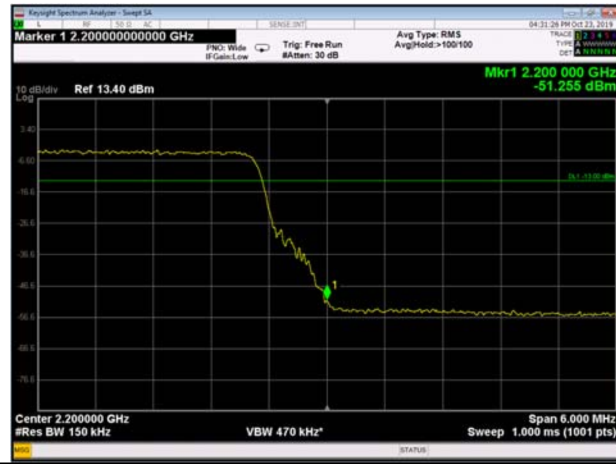


Figure 180 15MHz BW, 2192.5MHz

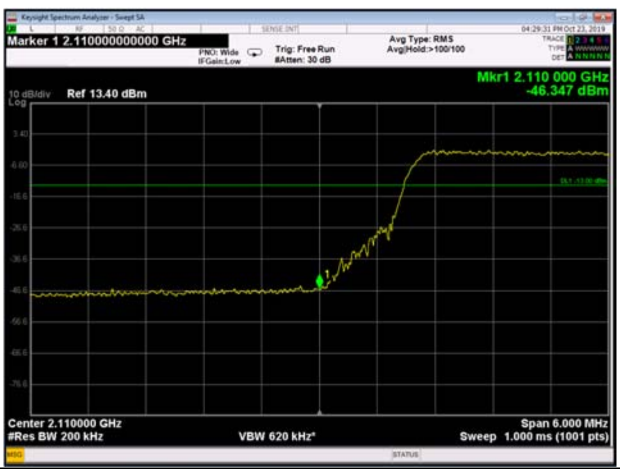


Figure 181 20MHz BW, 2120MHz

Figure 182 20MHz BW, 2190MHZ

Antenna Port:	**1**
Modulation:	**QPSK**

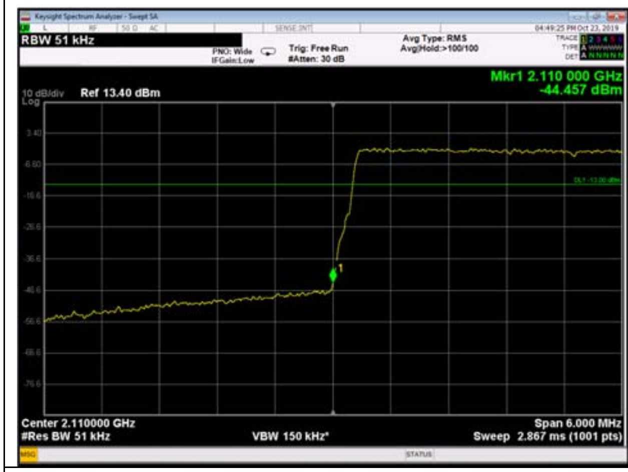
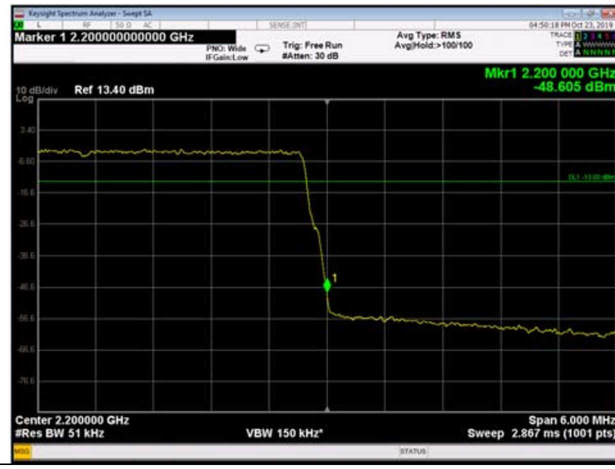

	

Figure 183 5MHz BW, 2112.5MHz	**Figure 184 5MHz BW, 2197.5MHz**

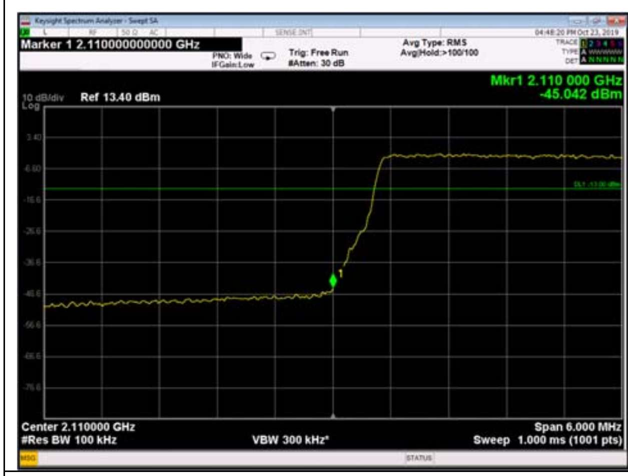
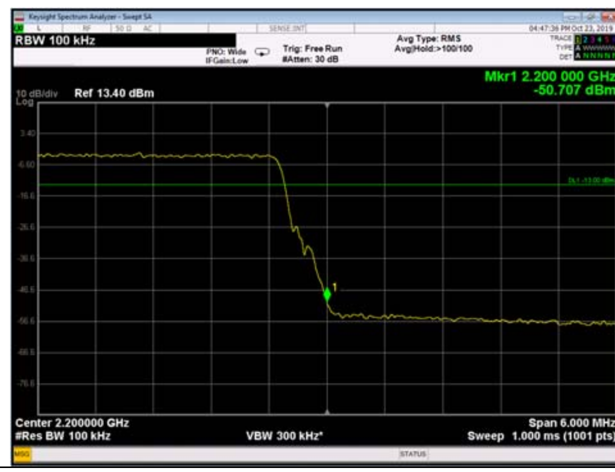

	

Figure 185 10MHz BW, 2115MHz	**Figure 186 10MHz BW, 2195MHz**

Antenna Port:	1
Modulation:	**QPSK**

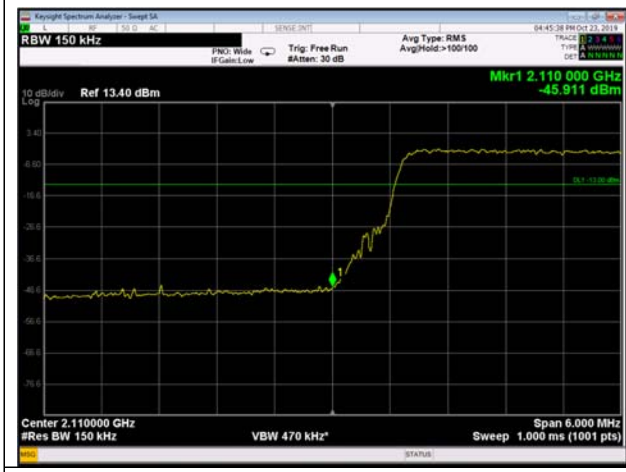
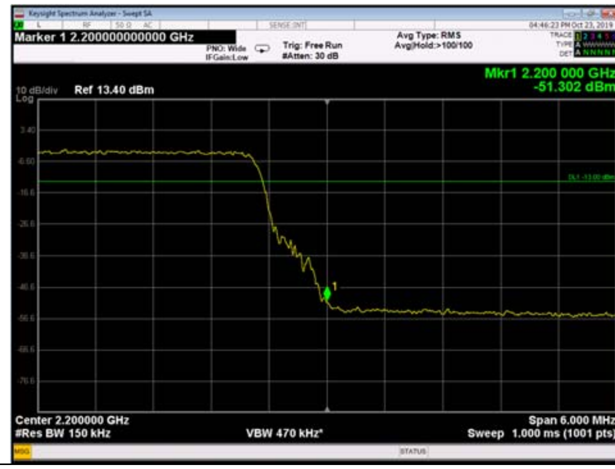

	

Figure 187 15MHz BW, 2117.5MHz	**Figure 188 15MHz BW, 2192.5MHz**

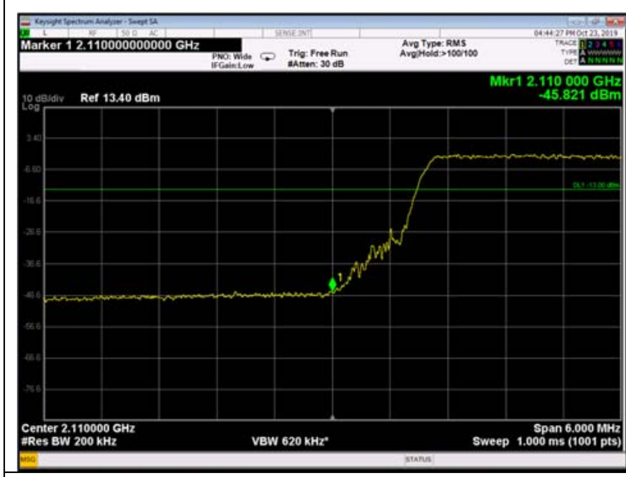
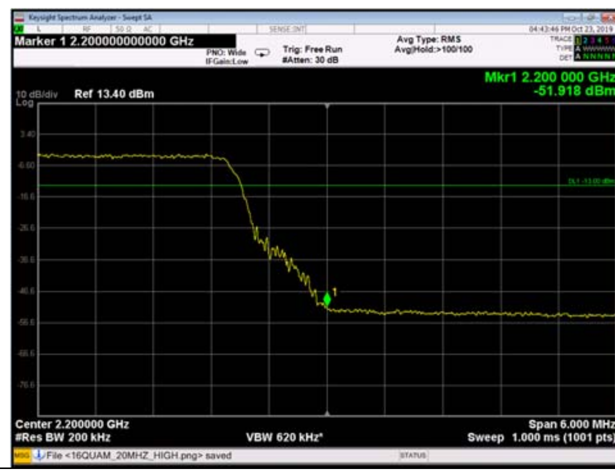

	

Figure 189 20MHz BW, 2120MHz	**Figure 190 20MHz BW, 2190MHz**

7.5 Test Equipment Used; Band Edge Spectrum AWS

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration Date	Next Calibration Due
Spectrum Analyzer	Agilent	N9010A	MY52220686	November 28, 2018	November 28, 2020
Vector Signal Generator	VIAVI	MTS 5800	WMNK0071690263	July 1, 2018	July 1, 2021

Figure 191 Test Equipment Used

8. Spurious Radiated Emission AWS

8.1 Test Specification

FCC, Part 27, Subpart C, Section 27.53(h)

8.2 Test Procedure

(Temperature (20°C)/ Humidity (47%RH))

The test method was based on ANSI/TIA-603-E- 2016, Section 2.2.12 Unwanted Emissions: Radiated Spurious.

The E.U.T. operation mode and test set-up are as described in Section 2 of this report.

For measurements between 0.009MHz-30.0MHz:

The E.U.T was tested inside the shielded room and placed on a non-metallic table, 0.8 meters above the ground.. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization. The emissions were measured at a distance of 3 meters.

The frequency range 0.009MHz-30MHz was scanned.

For measurements between 30.0MHz-1.0GHz:

A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground, at a distance of 3 meters. The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization.

The frequency range 30.0MHz -1.0GHz was scanned and the list of the highest emissions was verified and updated accordingly.

For measurements between 1.0GHz-22.0GHz:

The E.U.T was tested inside the shielded room and placed on a non-metallic table, 1.5 meters above the ground. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization. The emissions were measured at a distance of 3 meters.

The frequency range 1.0GHz -22.0GHz was scanned.

The E.U.T. was replaced by a substitution antenna driven by a signal generator. The height was readjusted for maximum reading. The signal generator level was adjusted to obtain the same reading on the EMI receiver

The signals observed were converted to radiated power using:

$$P_d(\text{dBm}) = P_g(\text{dBm}) - \text{Cable Loss (dB)} + \text{Substitution Antenna Gain (dBd)}$$

P_d = Dipole equivalent power (result).

P_g = Signal generator output level.

A Peak detector was using for this test.

The test was performed in 3 operation frequency (low, mid and high) with all the modulations and operational bandwidths.

Testing was performed when the RF port was connected to antenna port.

8.3 Test Limit

The power of any emission outside of the authorized operating frequency ranges (2110-2180 MHz) must be attenuated below the transmitting power (P) by a factor of at least 43 + 10*log (P) dB, yielding –13dBm.

8.4 Test Results

No emissions were detected above the EMI Receiver noise level which is at least 10dB margin below the limit.

JUDGEMENT: Passed

The E.U.T met the requirements of the FCC, Part 27, Subpart C, Section 27.53 (h) specifications.

8.5 *Test Instrumentation Used, Radiated Measurements AWS-3*

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration Date	Next Calibration Due
EMI Receiver	HP	8542E	3906A00276	February 28, 2019	February 28, 2020
RF Filter Section	HP	85420E	3705A00248	February 28, 2019	February 28, 2020
EMI Receiver	R&S	ESCI7	100724	February 27, 2019	February 28, 2020
Spectrum Analyzer	HP	8593EM	3536A00120ADI	February 26, 2019	February 28, 2020
Active Loop Antenna	EMCO	6502	9506-2950	February 5, 2019	February 28, 2021
Antenna Biconical	EMCO	3110B	9912-3337	May 21, 2019	May 31, 2020
Antenna Log Periodic	EMCO	3146	9505-4081	May 31, 2018	May 31, 2020
Horn Antenna 1G-18G	ETS	3115	29845	May 31, 2018	May 31, 2021
Horn Antenna 18G-26G	ARA	SWH-28	1007	December 13, 2017	December 31, 2020
Low Noise Amplifier	Narda	LNA-DBS-0411N313	013	December 24, 2018	December 31, 2019
Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	December 24, 2018	December 31, 2019
Vector Signal Generator	VIAVI	MTS 5800	WMNK0071690263	July 1, 2018	July 1, 2021
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR
Antenna Mast	ETS	2070-2	-	NCR	NCR
Turntable	ETS	2087	-	NCR	NCR
Mast & Table Controller	ETS/EMCO	2090	9608-1456	NCR	NCR

Figure 192 Test Equipment Used

9. Out-of-Band Rejection (AWS-3)

9.1 Test Specification

KDB 935210 D05 v01r01, Section 3.3

9.2 Test Procedure

(Temperature (21°C)/ Humidity (35%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an appropriate coaxial cable.

The signal and spectrum analyzer frequency range were set to ±250% of the passband, Dwell time set to approximately 10msec.

RBW was set between 1% to 5% of the EUT passband and VBW set to ≥3*RBW.

9.3 Test Limit

N/A

9.4 Test Results

JUDGEMENT: Passed

Figure 193. — Out-of-Band Rejection Plot 20MHz

9.5 Test Equipment Used; Out-of-Band Rejection

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration Date	Next Calibration Date
Spectrum Analyzer	Agilent	N9010A	MY52220686	November 28, 2018	November 28, 2020
Vector Signal Generator	VIAVI	MTS 5800	WMNK0071690263	July 1, 2018	July 1, 2021

Figure 194 Test Equipment Used

10. APPENDIX A - CORRECTION FACTORS

10.1 Correction factors for RF OATS Cable 35m ITL #1911

Frequency (MHz)	loss (dB)
30.0	1.3
50.0	1.7
100.0	2.6
200.0	3.7
300.0	4.7
400.0	5.5
500.0	6.3
600.0	7.0
700.0	7.6
800.0	8.4
900.0	9.0
1000.0	9.6

10.2 Correction Factors for RF Cable for Anechoic Chamber ITL #1840

FREQ (MHz)	LOSS (dB)
1000.0	1.5
2000.0	2.1
3000.0	2.7
4000.0	3.1
5000.0	3.5
6000.0	4.1
7000.0	4.6
8000.0	4.9
9000.0	5.7
10000.0	5.7
11000.0	6.1
12000.0	6.1
13000.0	6.2
14000.0	6.7
15000.0	7.4
16000.0	7.5
17000.0	7.9
18000.0	8.1
19000.0	8.8
20000.0	9.1

NOTES:

1. The cable is manufactured by Commscope

2. The cable type is 0623 WBC-400, serial # G020132 and 10m long

10.3 Correction Factors for Active Loop Antenna ITL # 1075

F(MHz)	AF(dB/m)
0.01	18.4
0.02	14.3
0.03	13.3
0.05	11.7
0.1	11.4
0.2	11.2
0.3	11.2
0.5	11.2
0.7	11.2
1	11.4
2	11.5
3	11.5
4	11.4
5	11.3
6	11.1
7	11.1
8	11.1
9	11
10	11
20	10
30	8

10.4 Correction Factors for Biconical Antenna ITL #1356, EMCO 3110B 9912-3337

Frequency	AF
[MHz]	[dB/m]
30	13.00
35	10.89
40	10.59
45	10.63
50	10.12
60	9.26
70	7.74
80	6.63
90	8.23
100	11.12
120	13.16
140	13.07
160	14.80
180	16.95
200	17.17

10.5 Correction Factors for Log Periodic Antenna ITL # 1349, EMCO 3146 s/n 9505-4081

Frequency	AF
[MHz]	[dB/m]
200	11.58
250	12.04
300	14.76
400	15.55
500	17.85
600	18.66
700	20.87
800	21.15
900	22.32
1000	24.22

10.6 Correction Factors for Double – Ridged Waveguide Horn ANTENNA 3 meter range;

ITL # 1352, ETS 3115 s/n 29845

FREQUENCY	AFE		FREQUENCY	AFE
(GHz)	**(dB/m)**		**(GHz)**	**(dB/m)**
0.75	25.0		9.5	38.0
1.0	23.5		10.0	38.5
1.5	26.0		10.5	38.5
2.0	29.0		11.0	38.5
2.5	27.5		11.5	38.5
3.0	30.0		12.0	38.0
3.5	31.5		12.5	38.5
4.0	32.5		13.0	40.0
4.5	32.5		13.5	41.0
5.0	33.0		14.0	40.0
5.5	35.0		14.5	39.0
6.0	36.5		15.0	38.0
6.5	36.5		15.5	37.5
7.0	37.5		16.0	37.5
7.5	37.5		16.5	39.0
8.0	37.5		17.0	40.0
8.5	38.0		17.5	42.0
9.0	37.5		18.0	42.5

10.7 Correction Factors for Horn Antenna Model SWH-28 ITL # 1353

CALIBRATION DATA

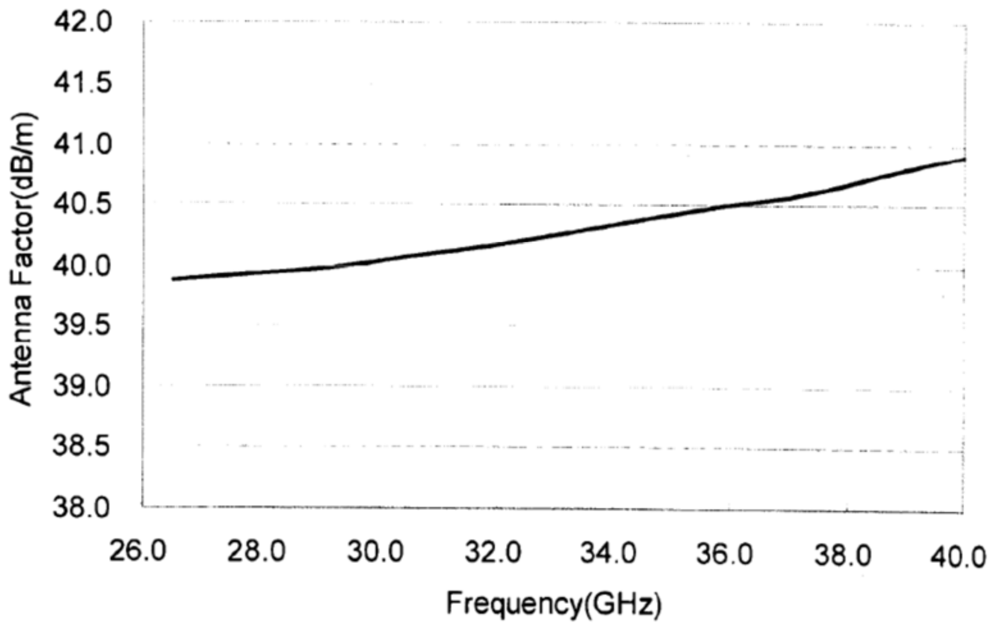
3 m distance

Frequency, MHz	Measured antenna factor, dB/m [1]
18000	32.4
18500	32.0
19000	32.3
19500	32.4
20000	32.3
20500	32.8
21000	32.8
21500	32.7
22000	33.1
22500	33.0
23000	33.1
23500	33.8
24000	33.5
24500	33.5
25000	33.8
25500	33.9
26000	34.2
26500	34.7

[1] The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

10.8 Correction factors for Horn Antenna Ka Band

Model: PE9850R-20
Serial No: J202021732; ITL #:1777



Frequency(GHz)	Gain(dB)	Antenna Factor(dB/m)
26.50	18.80	39.87
27.85	19.18	39.93
29.20	19.53	39.99
30.55	19.83	40.08
31.90	20.12	40.17
33.25	20.37	40.28
34.60	20.60	40.39
35.95	20.82	40.50
37.30	21.05	40.59
38.65	21.20	40.75
40.00	21.34	40.91

Frequency	Low Signal Gain (dB)	Noise Figure	Supply Current
20.0 GHz	47.7	2.9 dB	0.37A
20.5 GHz	50.1	2.9 dB	0.37A
21.0 GHz	50.5	2.9 dB	0.37A
21.5 GHz	51.2	2.9 dB	0.37A
22.0 GHz	50.8	2.9 dB	0.37A
22.5 GHz	50.4	2.9 dB	0.37A
23.0 GHz	50.0	2.9 dB	0.37A
23.5 GHz	50.0	2.9 dB	0.37A
24.0 GHz	50.0	2.9 dB	0.37A
24.5 GHz	50.6	2.9 dB	0.37A
25.0 GHz	51.3	2.9 dB	0.37A
25.5 GHz	51.5	2.9 dB	0.37A
26.0 GHz	52.0	2.9 dB	0.37A
26.5 GHz	51.5	2.9 dB	0.37A
27.0 GHz	52.2	2.9 dB	0.37A
27.5 GHz	52.5	2.9 dB	0.37A
28.0 GHz	52.1	2.9 dB	0.37A
28.5 GHz	51.8	2.9 dB	0.37A
29.0 GHz	52.0	2.9 dB	0.37A
29.5 GHz	52.2	2.9 dB	0.37A
30.0 GHz	52.0	2.9 dB	0.37A
30.5 GHz	51.5	2.9 dB	0.37A
31.0 GHz	51.3	2.9 dB	0.37A
31.5 GHz	50.5	2.9 dB	0.37A
32.0 GHz	49.3	2.9 dB	0.37A
32.5 GHz	49.2	2.9 dB	0.37A
33.0 GHz	48.2	2.9 dB	0.37A
33.5 GHz	48.5	2.9 dB	0.37A
34.0 GHz	47.7	2.9 dB	0.37A
34.5 GHz	48.1	2.9 dB	0.37A
35.0 GHz	47.9	2.9 dB	0.37A
35.5 GHz	48.2	2.9 dB	0.37A
36.0 GHz	47.8	2.9 dB	0.37A
36.5 GHz	48.4	2.9 dB	0.37A
37.0 GHz	48.3	2.9 dB	0.37A
37.5 GHz	48.6	2.9 dB	0.37A
38.0 GHz	47.8	2.9 dB	0.37A
38.5 GHz	47.0	2.9 dB	0.37A
39.0 GHz	47.1	2.9 dB	0.37A
39.5 GHz	47.1	2.9 dB	0.37A
40.0 GHz	48.3	2.9 dB	0.37A