8. Spurious Emissions at Antenna Terminals

8.1 Test Specification

FCC Part 27, Section: 53(a)(1)

8.2 Test Procedure

(Temperature (22°C)/ Humidity (40%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (max loss 10.7 dB).

Testing was performed in the 9K-24GHz frequency band without band edges tests, and for each modulation separately.

8.3 Test Limit

The power of any emission outside of the authorized operating frequency ranges (2345-2360 MHz) must be attenuated below the transmitting power (P) by a factor of at least as specified in this section.

Frequency Band (MHz)	Calculated Factor (dBc)
f<2285.0	75+10*log(0.05)=62
2285.0MHz<f<2287.5MHz	72+10*log(0.05)=59
2287.5MHz<f<2300.0MHz	70+10*log(0.05)=57
2300.0MHz<f<2320.0MHz	43+10*log(0.05)=30
2320.0MHz<f<2345.0MHz	75+10*log(0.05)=62
2345.0MHz<f<2360.0MHz	43+10*log(0.05)=30
2362.5MHz<f<2365.0MHz	55+10*log(0.05)=42
2365.0MHz<f<2367.5MHz	70+10*log(0.05)=57
2367.5MHz<f<2370.0MHz	72+10*log(0.05)= 59
2370.0<f	75+10*log(0.05)= 62

Figure 93 Mask Limit Table

8.4 Test Results

JUDGEMENT: Passed

See additional information in *Figure 94* to *Figure 141*.

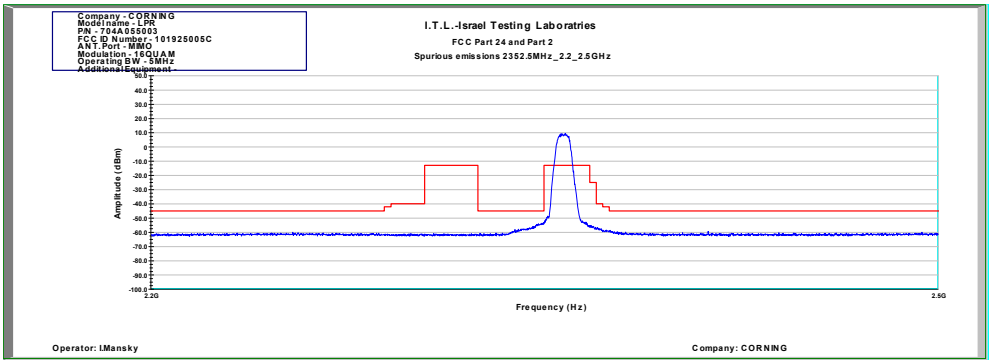

Figure 94 16QAM, 5MHz BW, 2352.5MHz, Frequency Range 2.2-2.5GHz

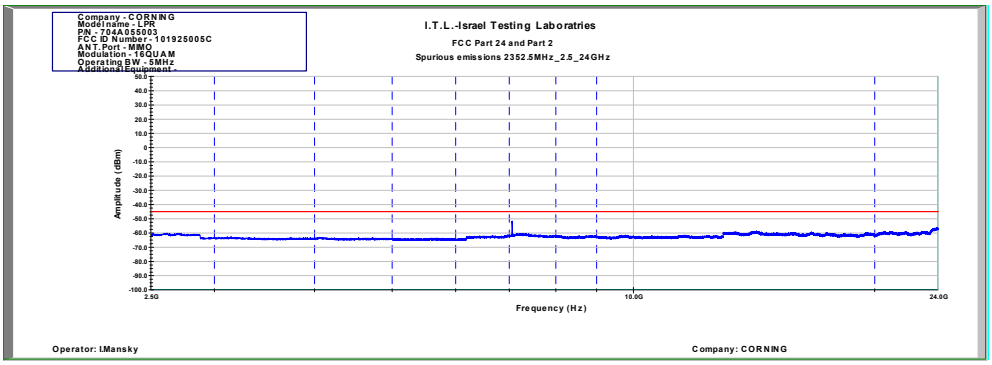

Figure 95 16QAM, 5MHz BW, 2352.5MHz, Frequency Range 2.5-24GHz

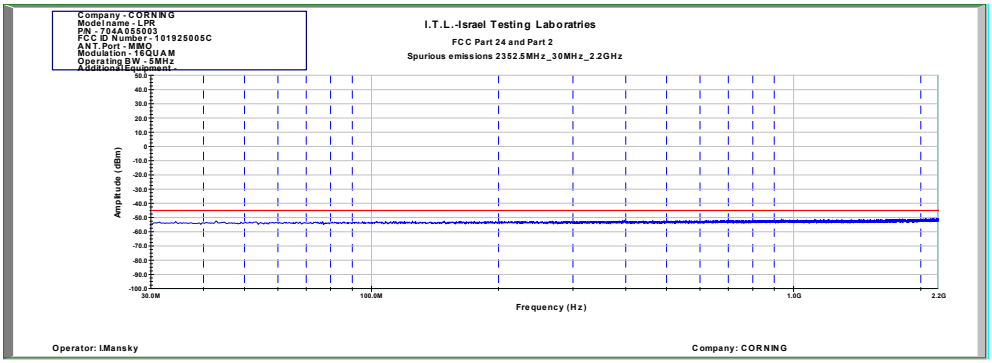

Figure 96 16QAM, 5MHz BW, 2352.5MHz, Frequency Range 30MHz-2.2GHz

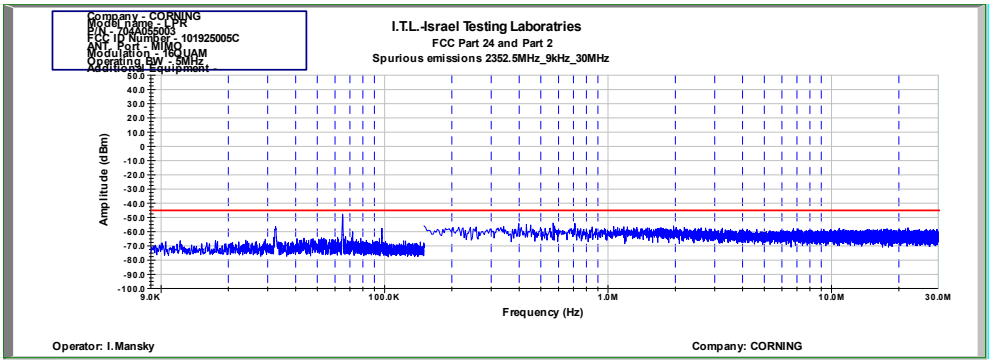

Figure 97 16QAM, 5MHz BW, 2352.5MHz, Frequency Range 9kHz-30MHz

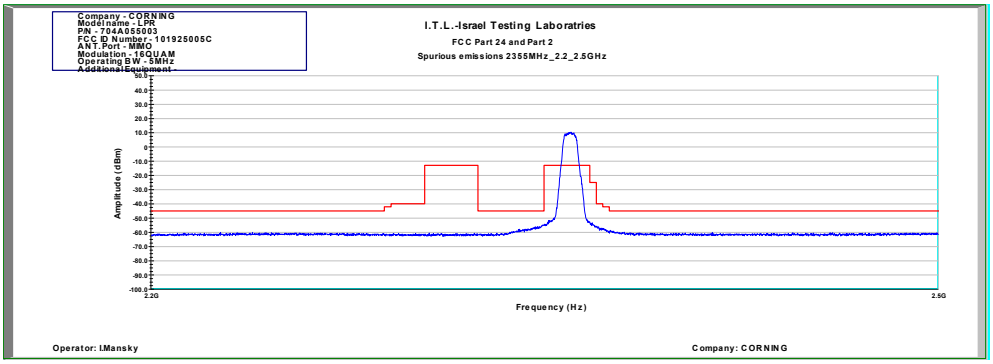

Figure 98 16QAM, 5MHz BW, 2355MHz, Frequency Range 2.2-2.5GHz

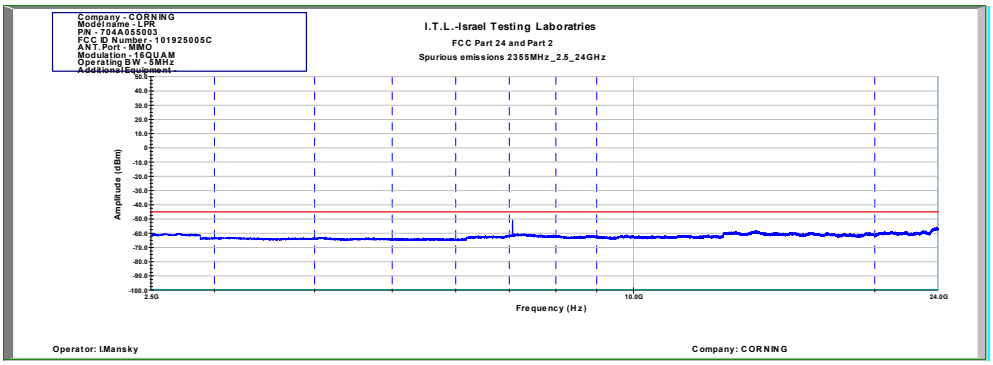

Figure 99 16QAM, 5MHz BW, 2355MHz, Frequency Range 2.5-24GHz

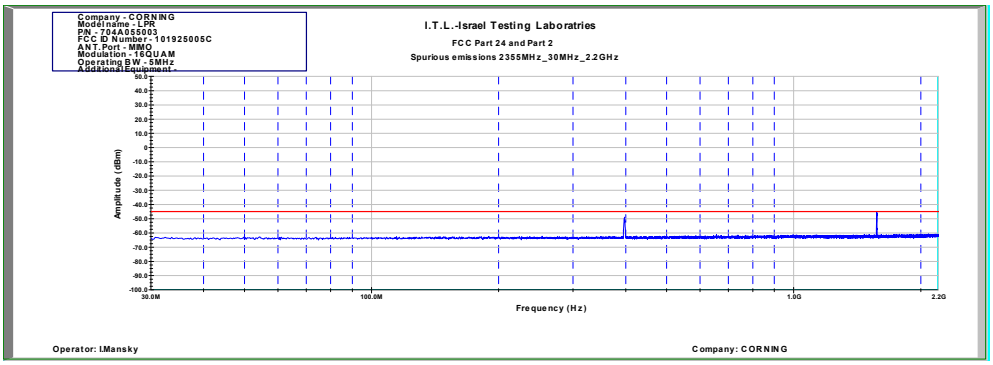

Figure 100 16QAM, 5MHz BW, 2355MHz, Frequency Range 30MHz-2.2GHz

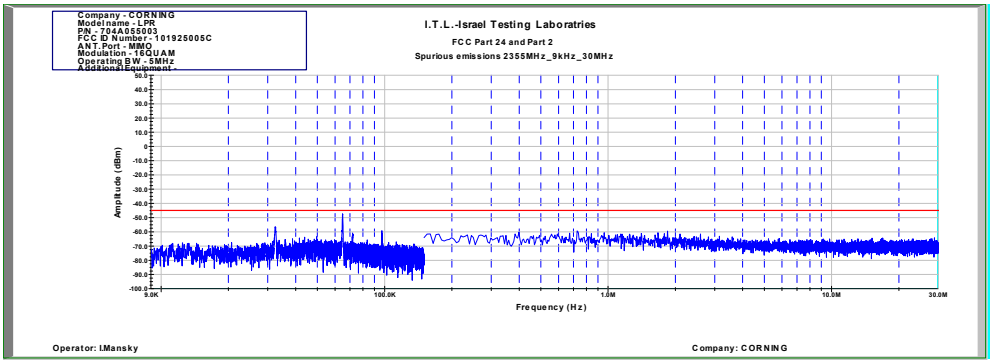

Figure 101 16QAM, 5MHz BW, 2355MHz, Frequency Range 9kHz-30MHz

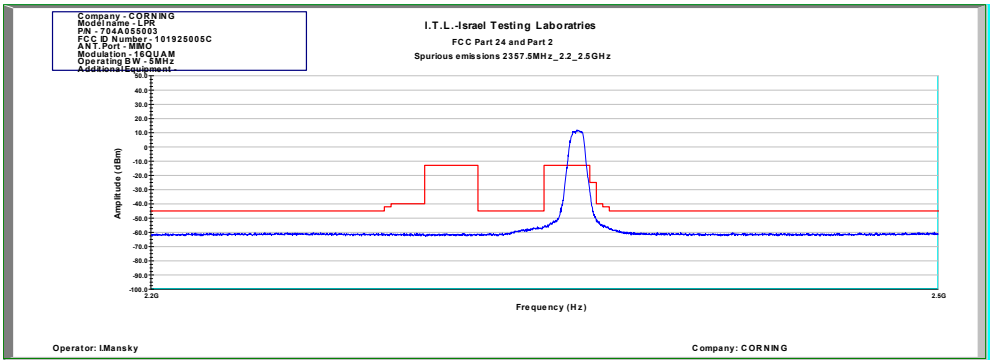

Figure 102 16QAM, 5MHz BW, 2357.5MHz, Frequency Range 2.2-2.5GHz

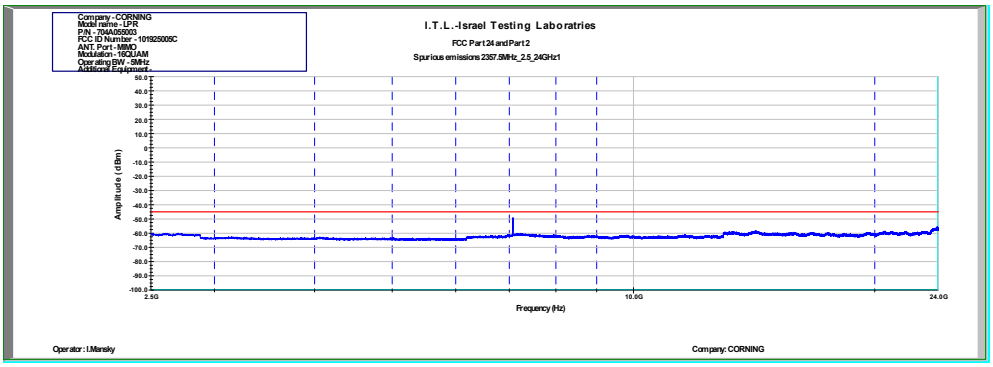

Figure 103 16QAM, 5MHz BW, 2357.5MHz, Frequency Range 2.5-24GHz

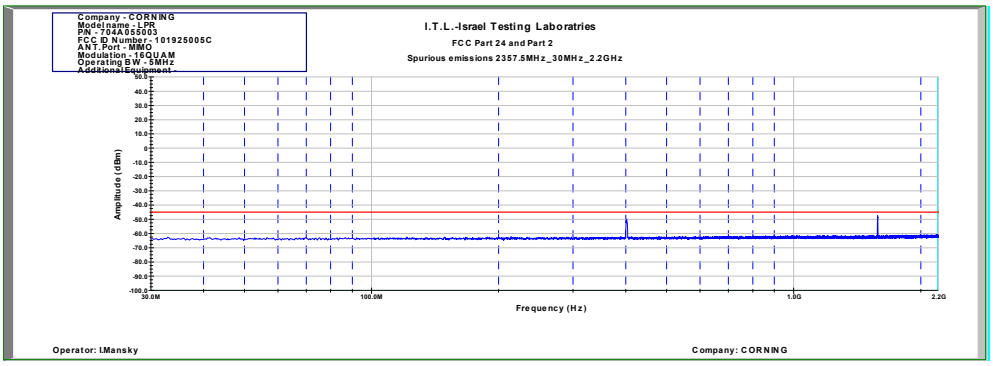

Figure 104 16QAM, 5MHz BW, 2357.5MHz, Frequency Range 30MHz-2.2GHz

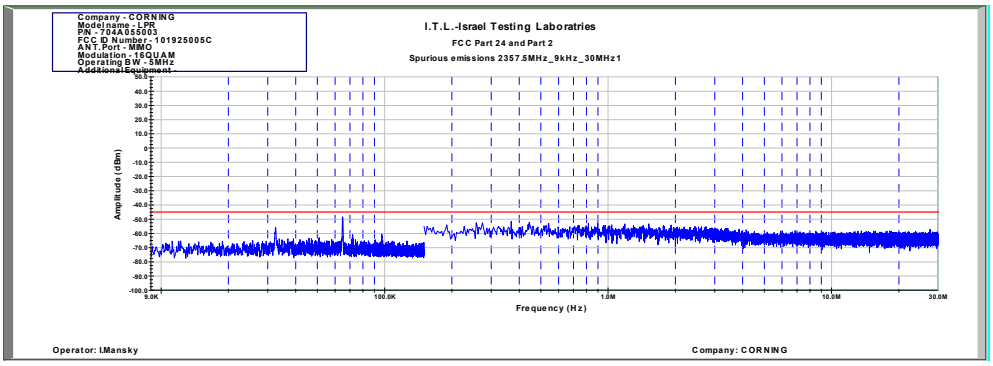

Figure 105 16QAM, 5MHz BW, 2357.5MHz, Frequency Range 9kHz-30MHz

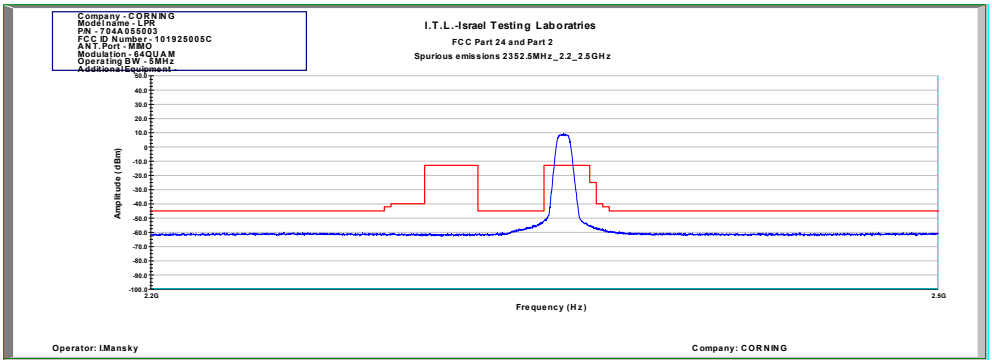

Figure 106 64QAM, 5MHz BW, 2352.5MHz, Frequency Range 2.2-2.5GHz

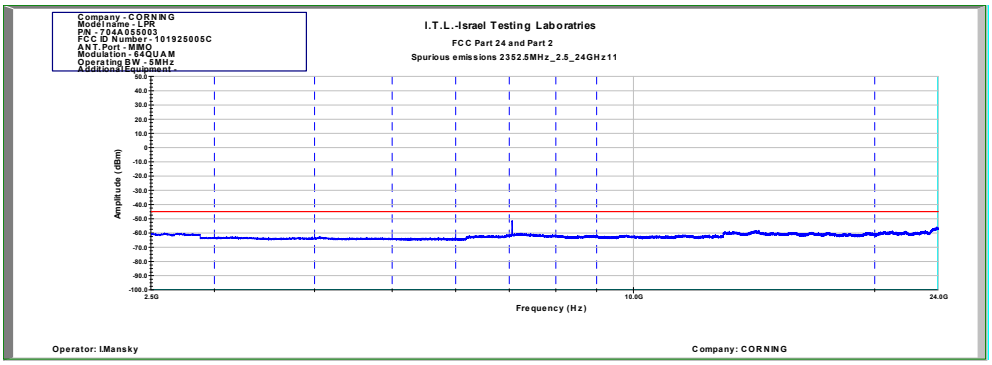

Figure 107 64QAM, 5MHz BW, 2352.5MHz, Frequency Range 2.5-24GHz

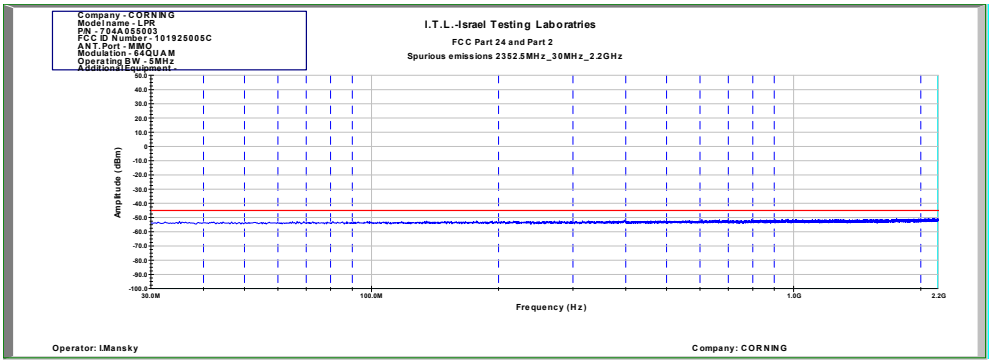

Figure 108 64QAM, 5MHz BW, 2352.5MHz, Frequency Range 30MHz-2.2GHz

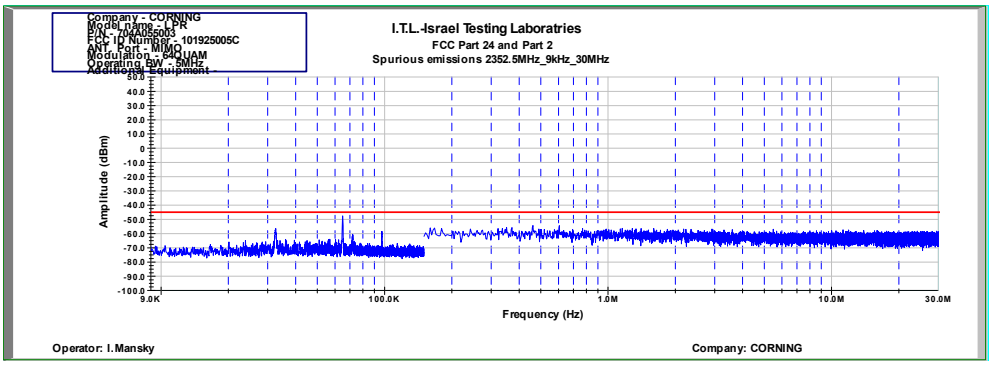

Figure 109 64QAM, 5MHz BW, 2352.5MHz, Frequency Range 9kHz-30MHz

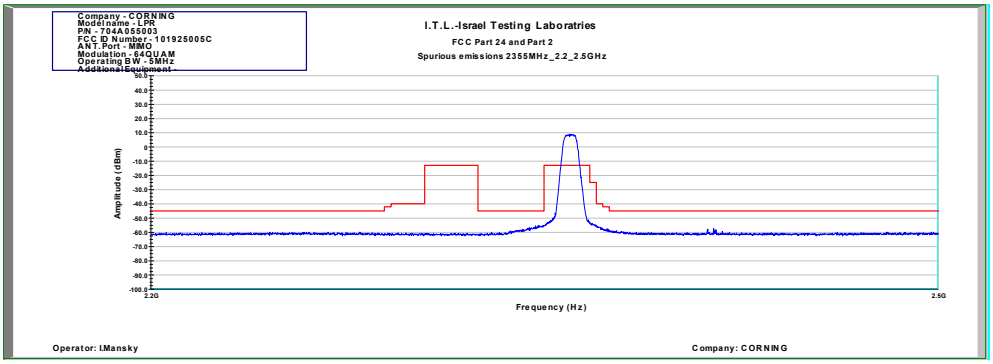

Figure 110 64QAM, 5MHz BW, 2355MHz, Frequency Range 2.2-2.5GHz

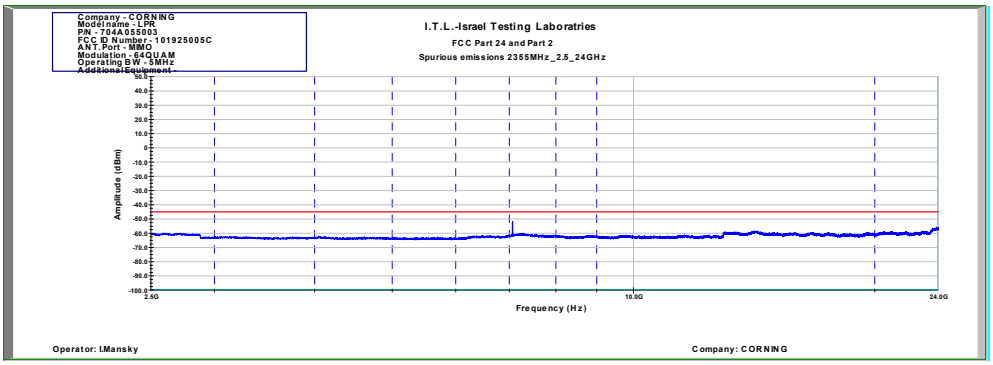

Figure 111 64QAM, 5MHz BW, 2355MHz, Frequency Range 2.5-24GHz

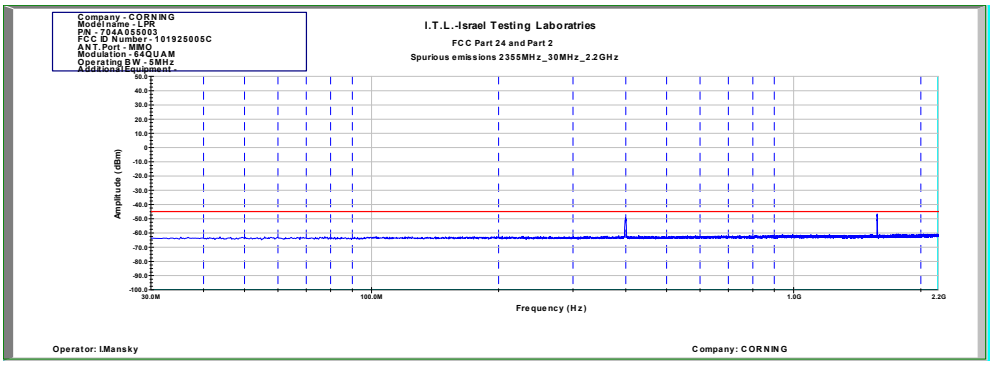

Figure 112 64QAM, 5MHz BW, 2355MHz, Frequency Range 30MHz-2.2GHz

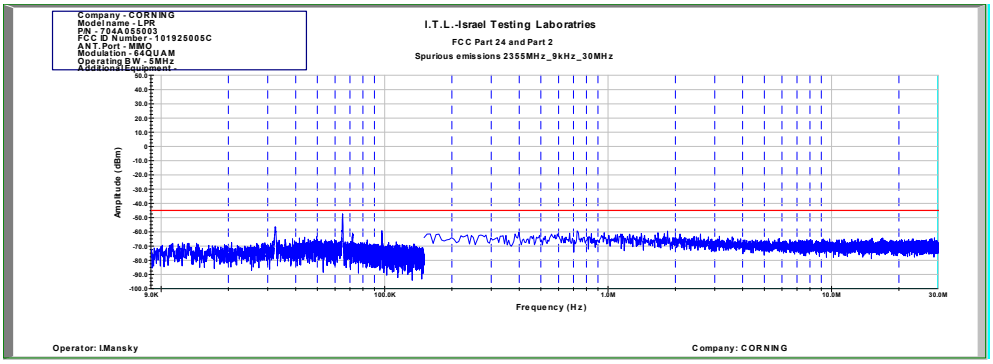

Figure 113 64QAM, 5MHz BW, 2355MHz, Frequency Range 9kHz-30MHz

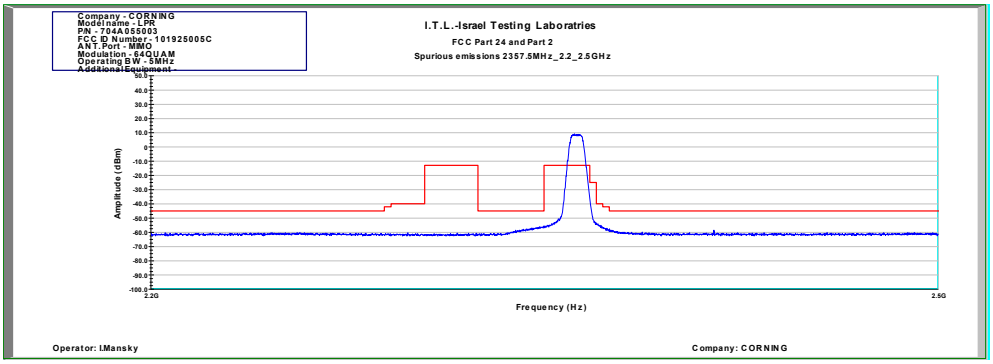

Figure 114 64QAM, 5MHz BW, 2357.5MHz, Frequency Range 2.2-2.5GHz

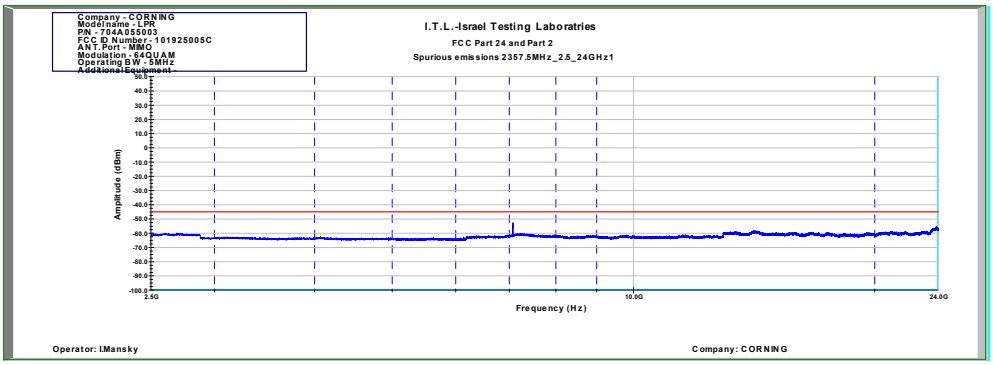

Figure 115 64QAM, 5MHz BW, 2357.5MHz, Frequency Range 2.5-24GHz

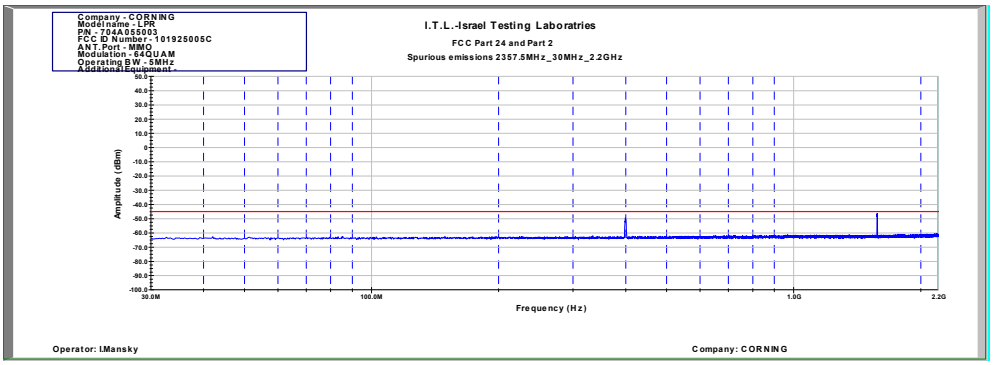

Figure 116 64QAM, 5MHz BW, 2357.5MHz, Frequency Range 30MHz-2.2GHz

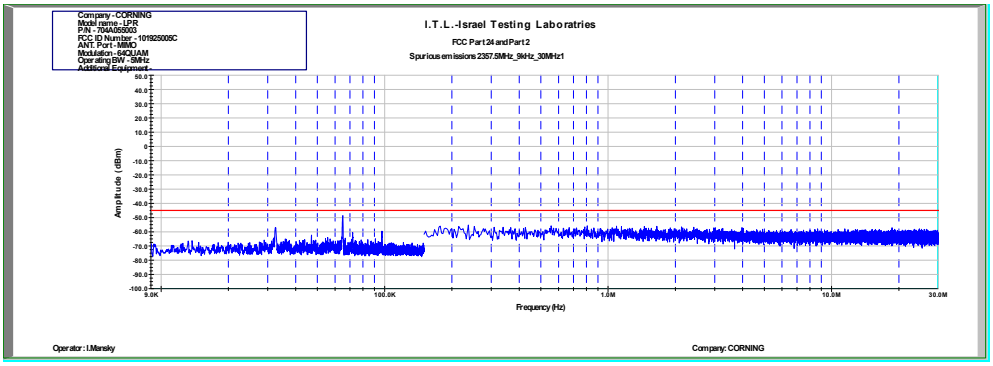

Figure 117 64QAM, 5MHz BW, 2357.5MHz, Frequency Range 9kHz-30MHz

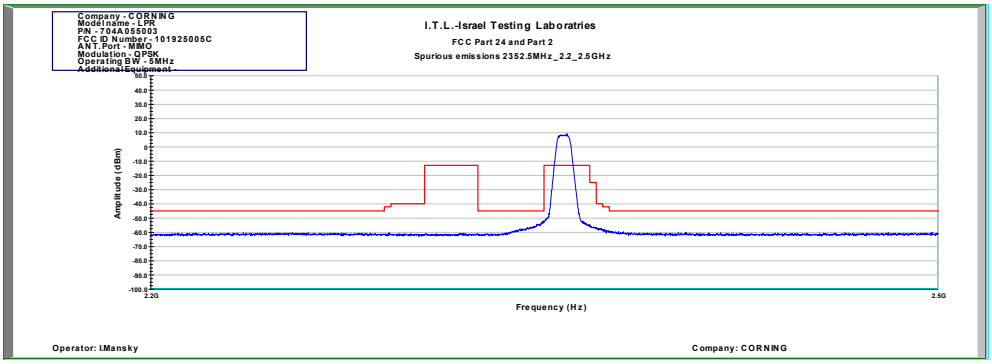

Figure 118 QPSK, 5MHz BW, 2352.5MHz, Frequency Range 2.2-2.5GHz

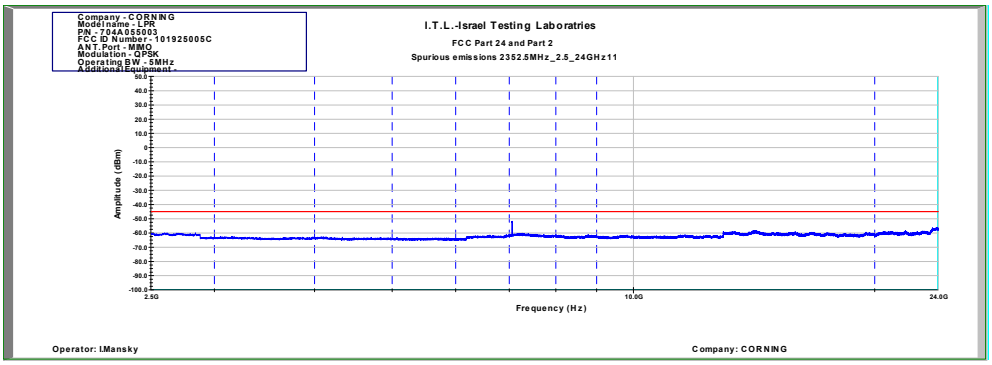

Figure 119 QPSK, 5MHz BW, 2352.5MHz, Frequency Range 2.5-24GHz

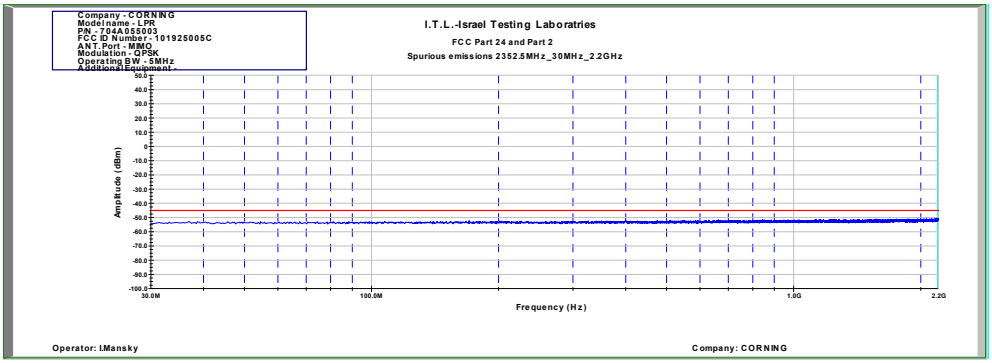

Figure 120 QPSK, 5MHz BW, 2352.5MHz, Frequency Range 30MHz-2.2GHz

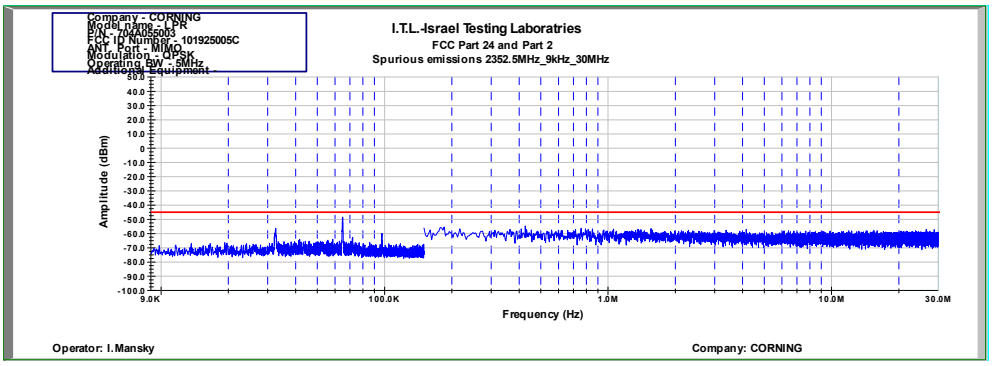

Figure 121 QPSK, 5MHz BW, 2352.5MHz, Frequency Range 9kHz-30MHz

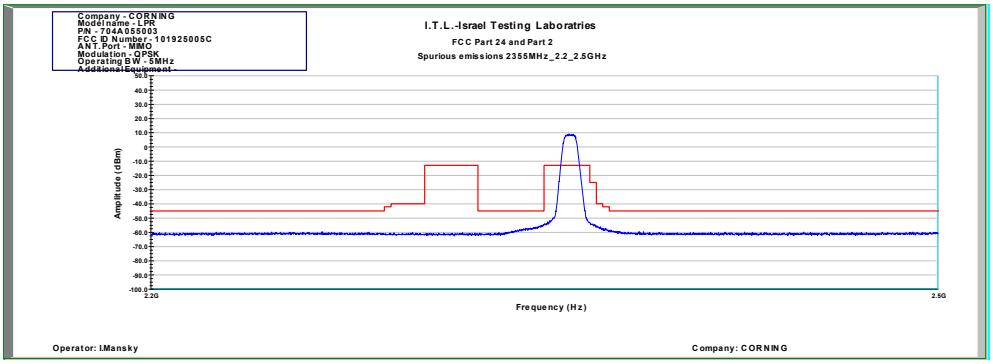

Figure 122 QPSK, 5MHz BW, 2355MHz, Frequency Range 2.2-2.5GHz

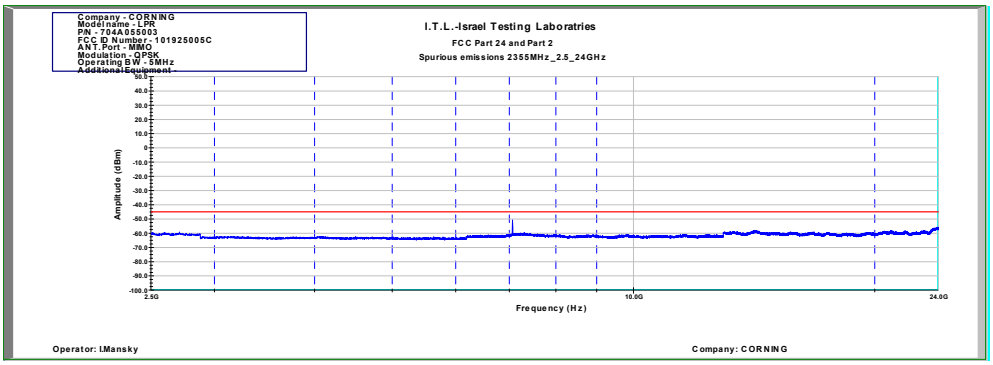

Figure 123 QPSK, 5MHz BW, 2355MHz, Frequency Range 2.5-24GHz

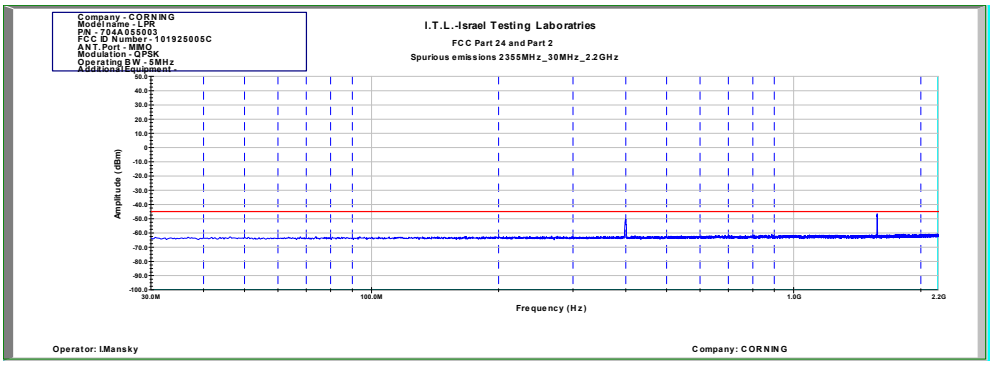

Figure 124 QPSK, 5MHz BW, 2355MHz, Frequency Range 30MHz-2.2GHz

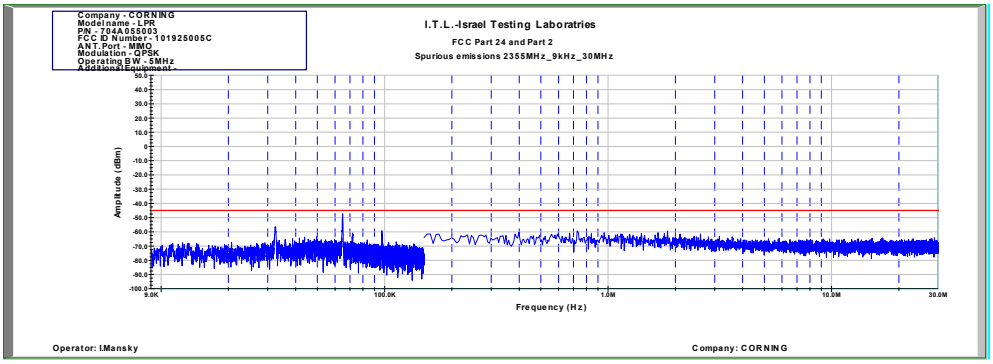

Figure 125 QPSK, 5MHz BW, 2355MHz, Frequency Range 9kHz-30MHz

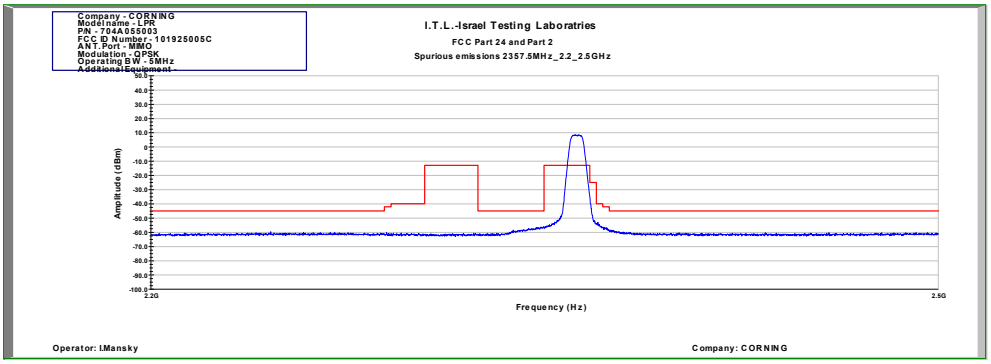

Figure 126 QPSK, 5MHz BW, 2357.5MHz, Frequency Range 2.2-2.5GHz

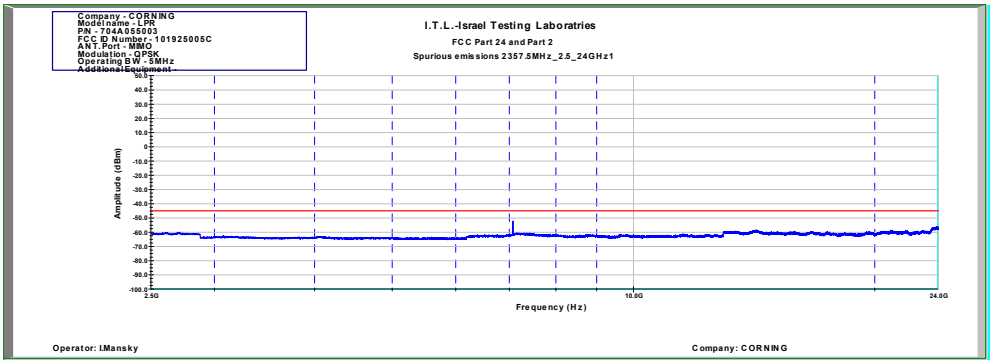

Figure 127 QPSK, 5MHz BW, 2357.5MHz, Frequency Range 2.5-24GHz

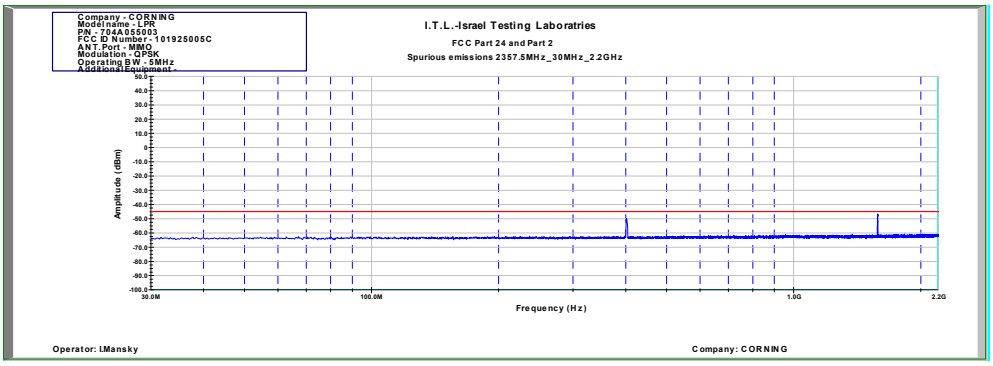

Figure 128 QPSK, 5MHz BW, 2357.5MHz, Frequency Range 30MHz-2.2GHz

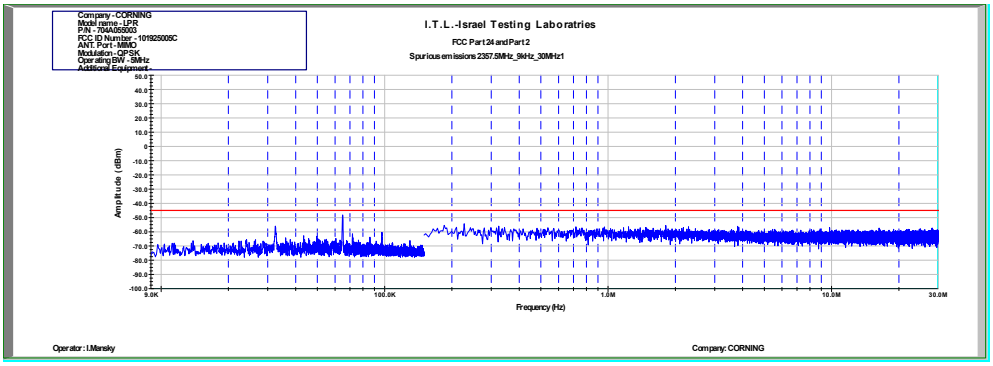

Figure 129 QPSK, 5MHz BW, 2357.5MHz, Frequency Range 9kHz-30MHz

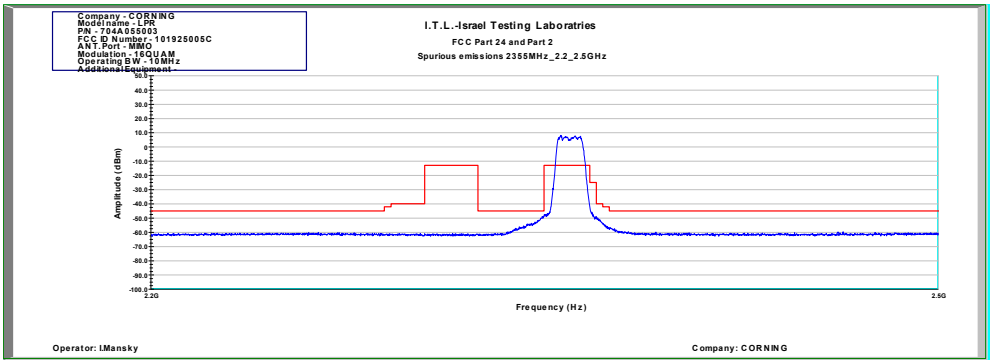

Figure 130 16QAM, 10MHz BW, 2355MHz, Frequency Range 2.2-2.5GHz

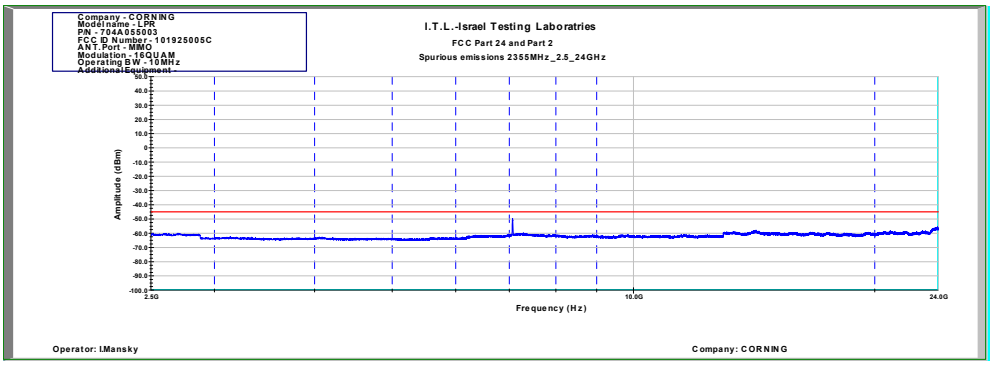

Figure 131 16QAM, 10MHz BW, 2355MHz, Frequency Range 2.5-24GHz

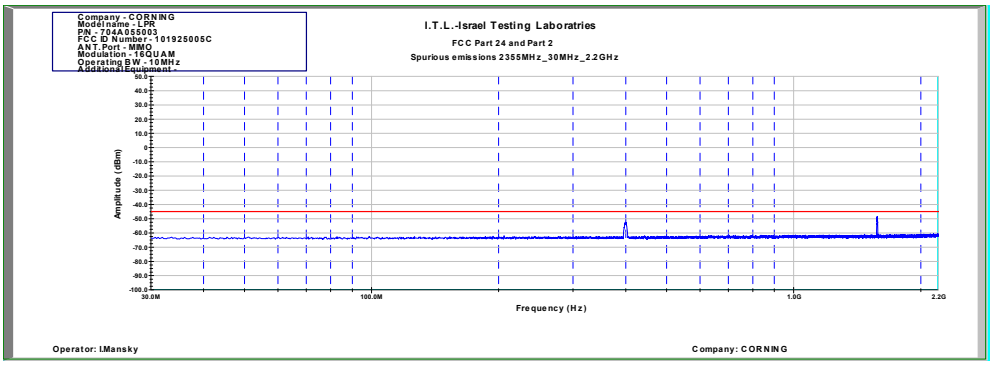

Figure 132 16QAM, 10MHz BW, 2355MHz, Frequency Range 30MHz-2.2GHz

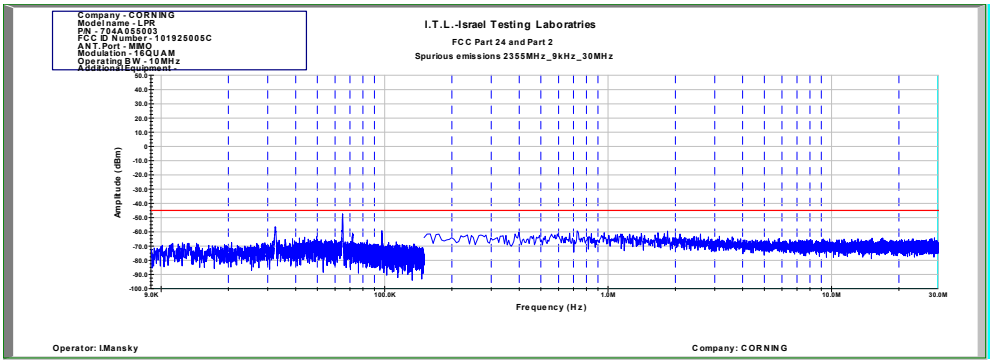

Figure 133 16QAM, 10MHz BW, 2355MHz, Frequency Range 9kHz-30MHz

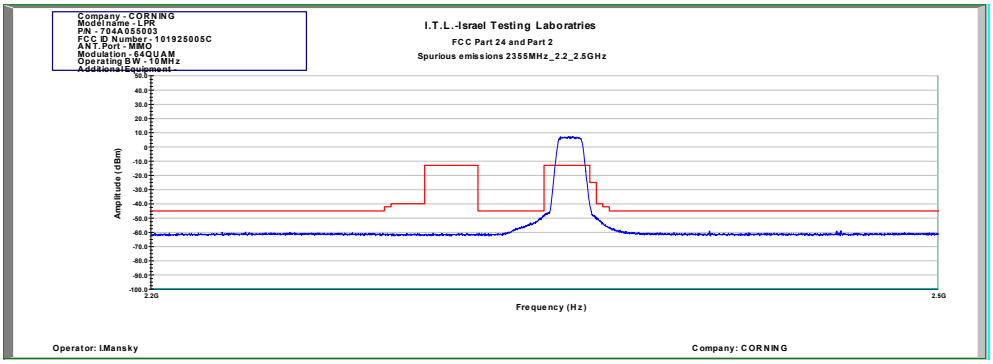

Figure 134 64QAM, 10MHz BW, 2355MHz, Frequency Range 2.2-2.5GHz

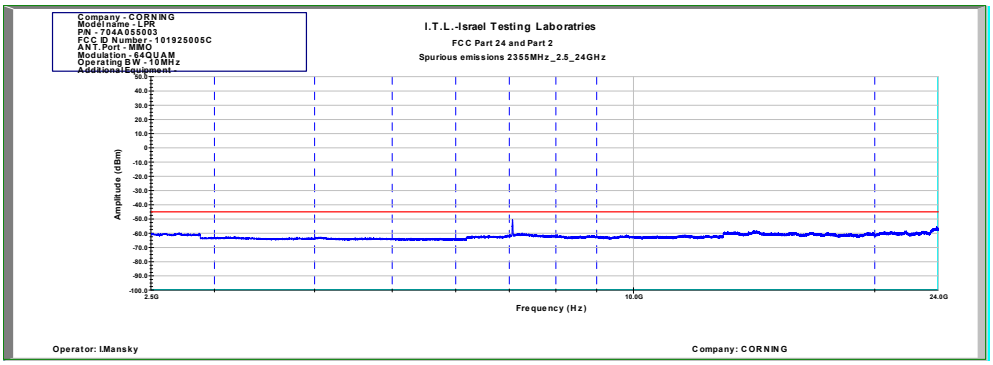

Figure 135 64QAM, 10MHz BW, 2355MHz, Frequency Range 2.5-24GHz

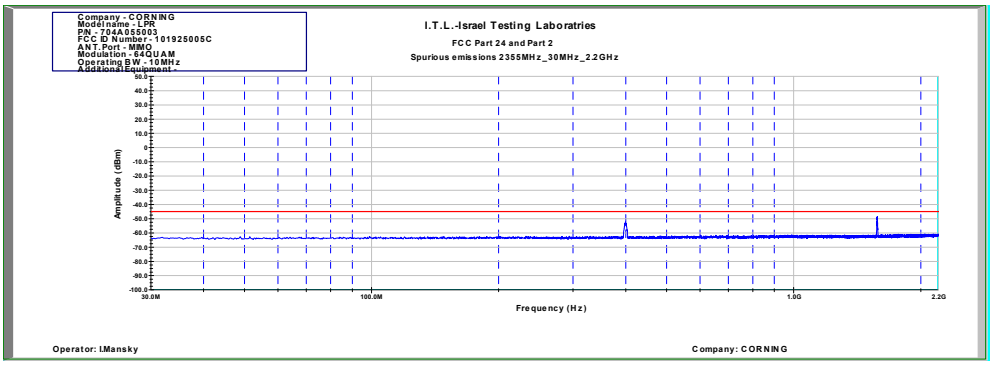

Figure 136 64QAM, 10MHz BW, 2355MHz, Frequency Range 30MHz-2.2GHz

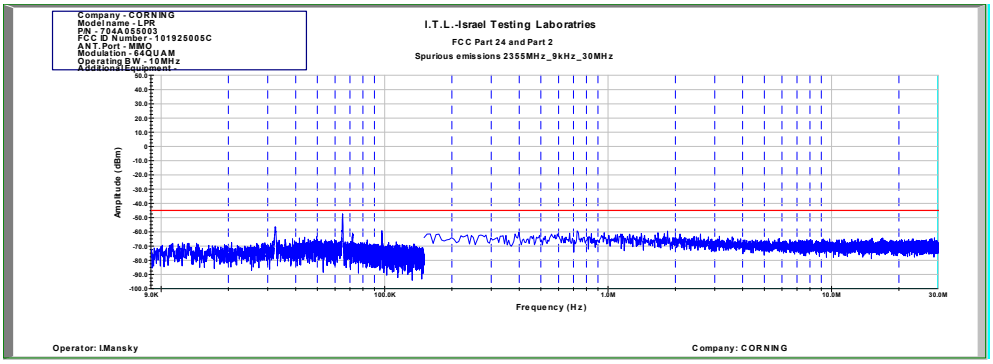

Figure 137 64QAM, 10MHz BW, 2355MHz, Frequency Range 9kHz-30MHz

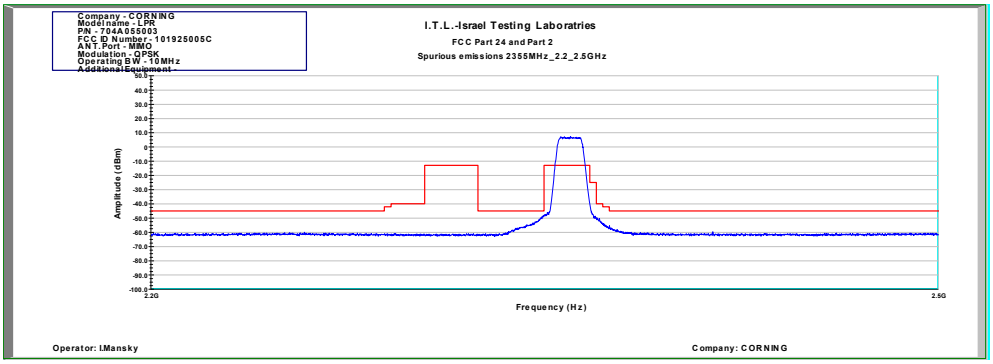

Figure 138 QPSK, 10MHz BW, 2355MHz, Frequency Range 2.2-2.5GHz

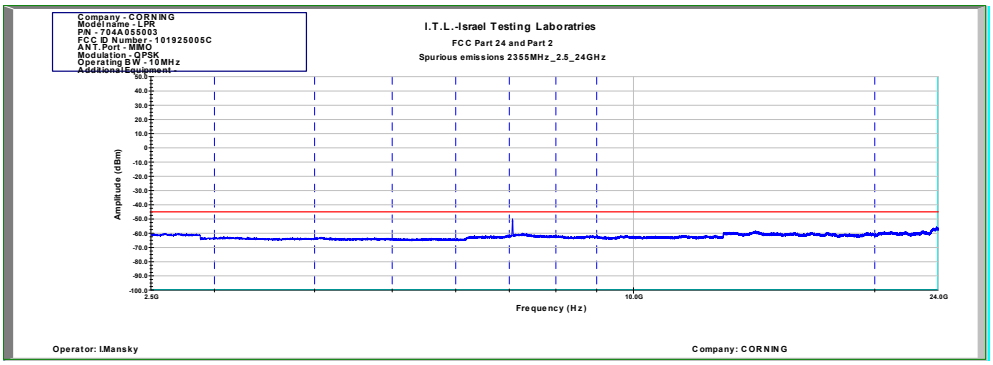

Figure 139 QPSK, 10MHz BW, 2355MHz, Frequency Range 2.5-24GHz

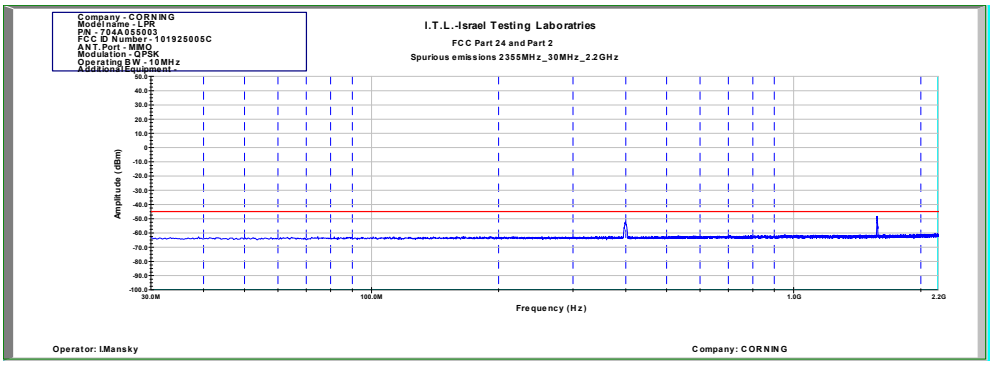

Figure 140 QPSK, 10MHz BW, 2355MHz, Frequency Range 30MHz-2.2GHz

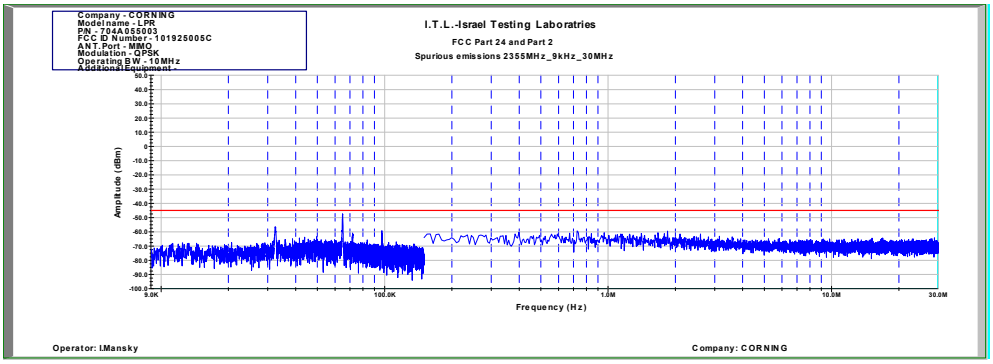

Figure 141 QPSK, 10MHz BW, 2355MHz, Frequency Range 9kHz-30MHz

8.5 Test Equipment Used; Out of Band Emission at Antenna Terminals

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration Date	Next Calibration Date
Spectrum Analyzer	HP	8564E	3442A00275	September 1, 2019	September 1, 2020
Vector Signal Generator	VIAVI	MTS 5800	WMNK0071690263	July 1, 2018	July 1, 2021
Attenuator 10dB	Bird	8304-N10DB	N/A	December 24, 2018	December 31, 2019

Figure 142 Test Equipment Used

9. Band Edge Spectrum

9.1 Test Specification

FCC Part 27, Section 53(a)(1)

9.2 Test Procedure

(Temperature (22°C)/ Humidity (40%RH))
The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (31.7 dB).
The spectrum analyzer RBW was set to at least 1% from OBW.
The evaluation was repeated for all modulations.

9.3 Test Limit

The power of any emission in the 1 MHz bands immediately outside and adjacent to the channel blocks (2350-2360MHz) was attenuated below the transmitting power (P) by a factor of at least 43 +10 log (P) dB , yielding – 13dBm.

9.4 Test Results

Modulation	Operation Frequency	Band Edge Frequency	Reading	Limit	Margin
	(MHz)	(MHz)	(dBm)	(dBm)	(dB)
64QAM	2355.0	2350.0	-45.1	-13.0	-32.1
	2355.0	2360.0	-45.5	-13.0	-32.5
16QAM	2355.0	2350.0	-44.8	-13.0	-31.8
	2355.0	2360.0	-45.7	-13.0	-32.7
QPSK	2355.0	2350.0	-44.1	-13.0	-31.1
	2355.0	2360.0	-46.4	-13.0	-33.4

Figure 143 Band Edge Spectrum Results for 5MHz OBW

Modulation	Operation Frequency	Band Edge Frequency	Reading	Limit	Margin
	(MHz)	(MHz)	(dBm)	(dBm)	(dB)
64QAM	2355.0	2350.0	-46.3	-13.0	-33.3
	2355.0	2360.0	-46.2	-13.0	-33.2
16QAM	2355.0	2350.0	-45.8	-13.0	-32.8
	2355.0	2360.0	-46.7	-13.0	-33.7
QPSK	2355.0	2350.0	-45.7	-13.0	-32.7
	2355.0	2360.0	-45.0	-13.0	-32.0

Figure 144 Band Edge Spectrum Results for 10MHz OBW

JUDGEMENT: Passed by 31.1 dB

See additional information in *Figure 145* to *Figure 156.*

Antenna Port	1
Modulation	16QAM
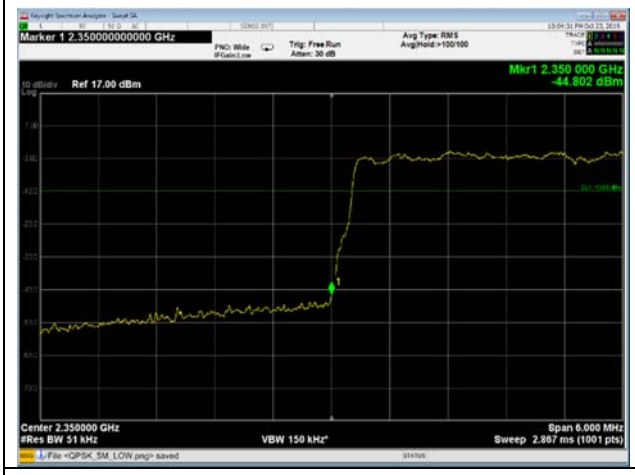	
Figure 145 5MHz BW, Lower edge	**Figure 1465MHz BW, Upper edge**
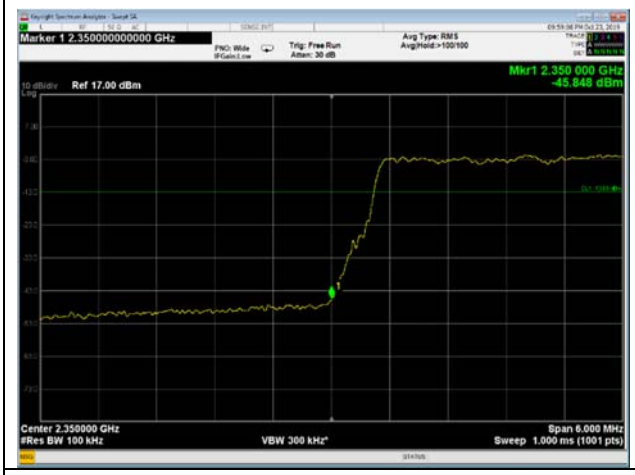	
Figure 147 10MHz BW, Lower edge	**Figure 148 10MHz BW, Upper edge**

Antenna Port	1
Modulation	64QAM

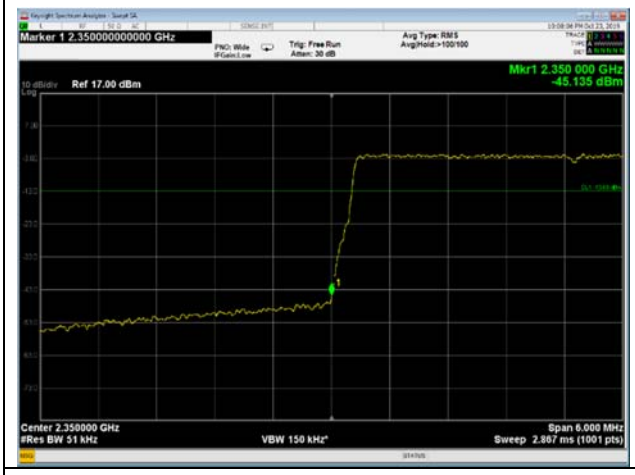

Figure 149 5MHz BW, Lower edge

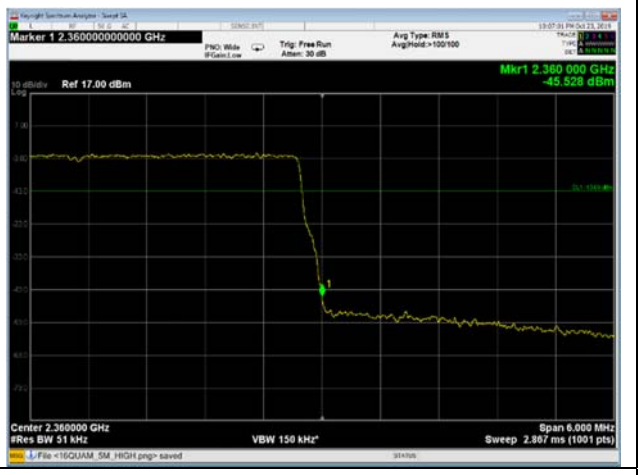

Figure 1505MHz BW, Upper edge

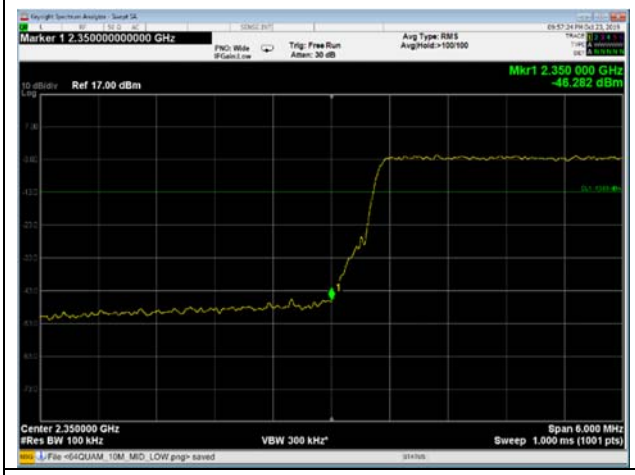

Figure 151 10MHz BW, Lower edge

Figure 152 10MHz BW, Upper edge

Antenna Port	1
Modulation	QPSK

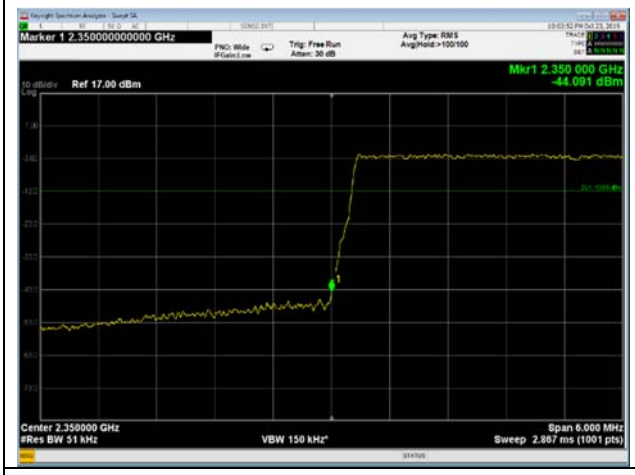

Figure 153 5MHz BW, Lower edge

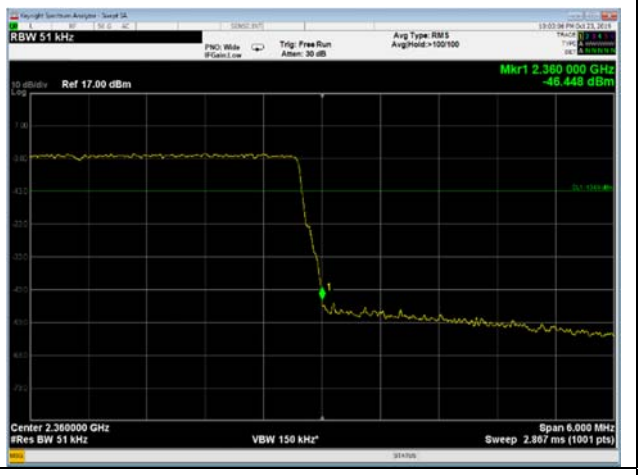

Figure 1545MHz BW, Upper edge

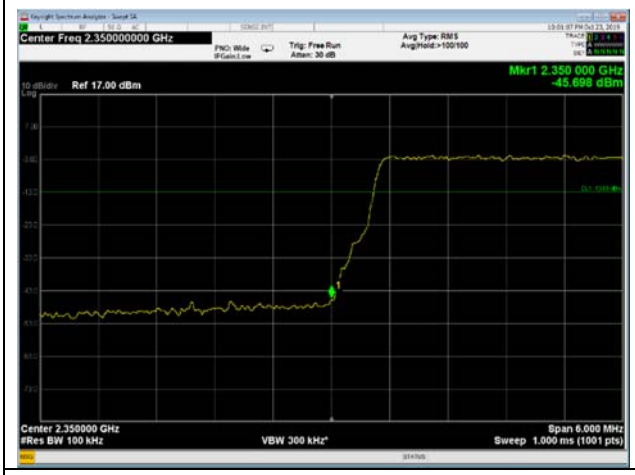

Figure 155 10MHz BW, Lower edge

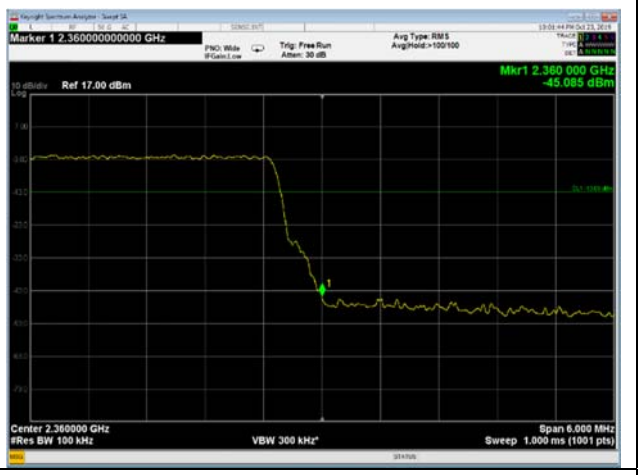

Figure 156 10MHz BW, Upper edge

9.5 Test Equipment Used; Band Edge Spectrum

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
Attenuator 10dB	Bird	8304-N10DB	-	December 24, 2018	December 31, 2019
Attenuator 20dB	Bird	8304-N20DB	-	December 24, 2018	December 31, 2019

Figure 157 Test Equipment Used

10. Spurious Emissions (Radiated)

10.1 Test Specification

FCC Part 27, section 53(a)(1)

10.2 Test Procedure

(Temperature (22°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. The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization. The emissions were measured at a distance of 3 meters.

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-24.0GHz:

The E.U.T was tested inside the shielded room at a distance of 3 meters and the E.U.T was 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 -24.0GHz 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:

$P_d(dBm) = P_g(dBm) – Cable\ Loss\ (dB) + Substitution\ Antenna\ Gain\ (dBd)$

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 one operation frequency (2355.0MHz) with all modulations.

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

10.3 Test Limit

Frequency Band (MHz)	Calculated Factor (dBc)
f<2285.0	75+10*log(0.05)=62
2285.0MHz<f<2287.5MHz	72+10*log(0.05)=59
2287.5MHz<f<2300.0MHz	70+10*log(0.05)=57
2300.0MHz<f<2320.0MHz	43+10*log(0.05)=30
2320.0MHz<f<2345.0MHz	75+10*log(0.05)=62
2345.0MHz<f<2360.0MHz	43+10*log(0.05)=30
2360.0MHz<f<23650MHz	55+10*log(0.05)=42
2365.0MHz<f<2367.5MHz	70+10*log(0.05)=57
2367.5MHz<f<2370.0MHz	72+10*log(0.05)= 59
2370.0<f	75+10*log(0.05)= 62

Figure 158 Mask Limit Table

10.4 Test Results

No emissions were detected above the EMI Receiver noise level which is at least 6dB margin below the limit.

JUDGEMENT; Passed

The E.U.T met the requirements of the FCC Part 27, Section 917; FCC Part 2.1053 specifications.

10.5 Test Instrumentation Used, Radiated Measurements

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 159 Test Equipment Used

11. Out-of-Band Rejection (WCS)

11.1 Test Specification

KDB 935210 D05 v01r01, Section 3.3

11.2 Test Procedure

(Temperature (22°C)/ Humidity (40%RH))

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (max Loss= 32 dB).

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

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

11.3 Test Limit

N/A

11.4 Test Results

JUDGEMENT: Passed

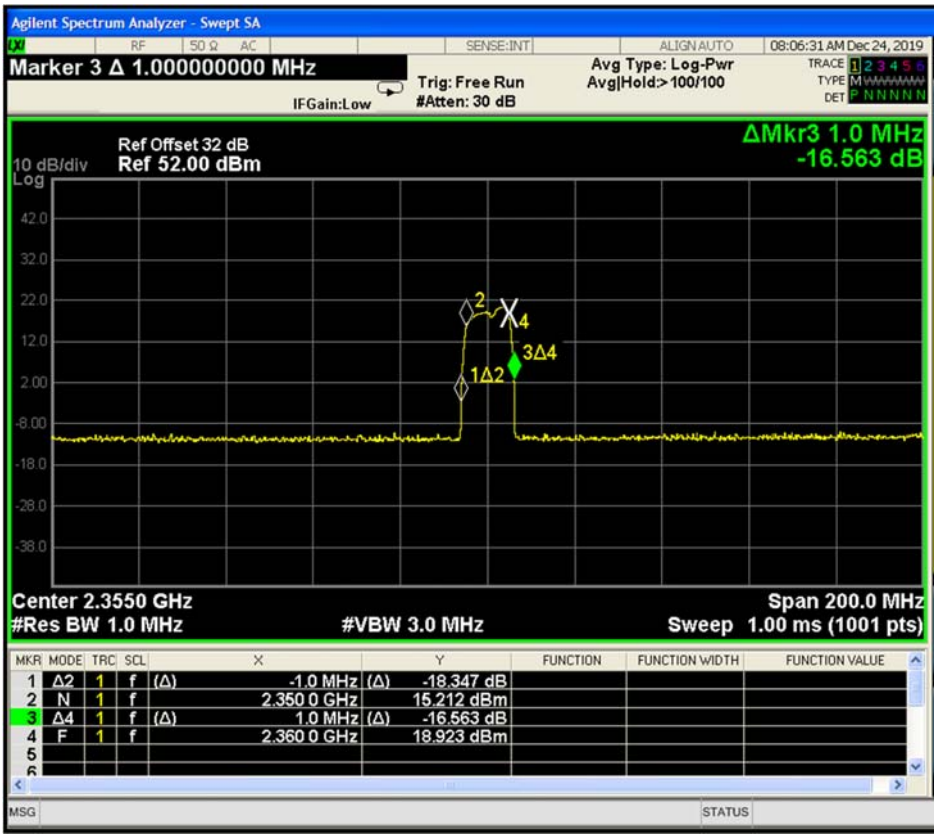

Figure 160. — Out-of-Band Rejection Plot 10 MHz BW

11.5 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
Attenuator 10dB	Bird	8304-N10DB	-	December 24, 2018	December 31, 2019
Attenuator 20dB	Bird	8304-N20DB	-	December 24, 2018	December 31, 2019

Figure 161 Test Equipment Used

12. APPENDIX A - CORRECTION FACTORS

12.1 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

12.2 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*

12.3 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

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

Frequency [MHz]	AF [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

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

Frequency [MHz]	AF [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

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

ITL # 1352, ETS 3115 s/n 29845

FREQUENCY (GHz)	AFE (dB/m)	FREQUENCY (GHz)	AFE (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

12.7 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.