Underwriters Laboratories Inc.
333 Pfingsten Rd.
Northbrook, IL 60062

www.ul.com/emc
(847) 272-8800

Job Number:	954504
Project Number	08CA15013B
File Number:	MC15905
Date:	April 25, 2008
Model:	REMOTE

Electromagnetic Compatibility Test Report

For

Murphy Industries Inc.

Test Report Details

Tests Performed By:	**Underwriters Laboratories Inc.** **333 Pfingsten Rd.** **Northbrook, IL 60062**
Tests Performed For:	**Murphy Industries Inc.** 5311 S. 122nd East Av Tulsa, OK 74146
Applicant Contact: Phone: E-mail:	**Mr. Chuck Strohm** (918) 317-4380 cstrohm@fwmurphy.com
Test Report Date:	**April 25, 2008**
Product Type:	**900MHz Frequency Hopping Transmitter w/ Receiver**
Product standards	47 CFR Part 15.247, Subpart C
Model Number:	**REMOTE**
EUT Category:	**Low Power Transmitter /w Receiver**
Testing Start Date:	**March 24, 2008**
Date Testing Complete:	**March 27, 2008**
Overall Results:	**Compliant**

Underwriters Laboratories Inc. reports apply only to the specific samples tested under stated test conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. Underwriters Laboratories Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from Underwriters Laboratories Inc. issued reports. This report shall not be used to claim, constitute or imply product certification, approval, or endorsement by NVLAP, A2LA, or any agency of the US government.

This report may contain test results that are not covered by the NVLAP or A2LA accreditation. The scope of accreditation is limited to the specific tests that are listed on the NVLAP and/or A2LA websites referenced at the end of this report.

Report Directory

Report Revision History

Revision Date	Description	Revised By	Revision Reviewed By
none			

1.0 G E N E R A L - Product Description

1.1 Equipment Description

The *remote* is located at the sensor location. It is low power, battery operated, and small. It sends its information to the hub, which then passes this information on to an engine controller.
The remotes spend almost all of their time in a low power sleep state and only wakes up when it needs to send a heartbeat or a sensor event occurs.

SYSTEM:
The M2Wireless system is designed to replace expensive wiring and conduit that is part of a natural gas compressor system. Typically, a natural gas compressor skid requires conduit or tubing between the sensor and the control panel which monitors the sensor. By using a low power wireless system, this conduit and wiring cost is significantly reduced or completely eliminated.

The M2Wireles will use a star type of wireless network topology as shown in Figure 1. This type of topology utilizes a single wireless master, denoted as the “Hub”, and multiple slaves, denoted as “Remotes”. This topology has been chosen because it meets the following requirements:

1. Extremely low power consumption.
2. Near real-time throughput of data from the sensor to the engine controller.

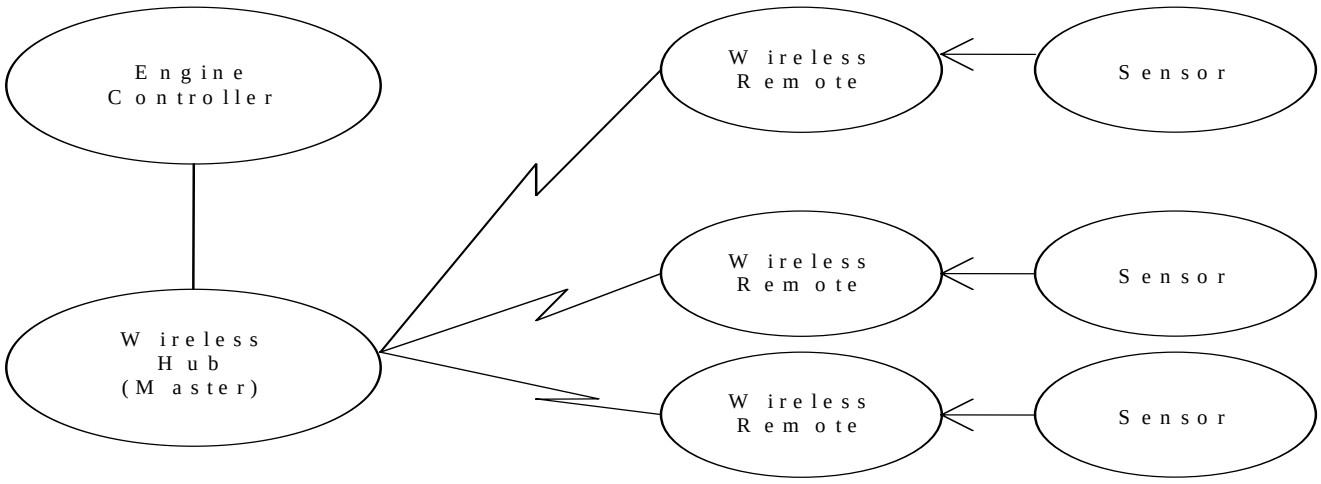


Figure 1. Wireless Star Architecture

1.2 Device Configuration During Test

1.2.1 Equipment Used During Test:

Use	Product Type	Manufacturer	Model	Comments
EUT	REMOTE	Murphy Industries, Inc.	53-00-0001	None
Note: **EUT** - Equipment Under Test, **AE** - Auxiliary/Associated Equipment, or **SIM** - Simulator (Not Subjected to Test)				

1.2.2 Input/Output Ports:

Port #	Name	Type*	Cable Max. >3m (Y/N)	Cable Shielded (Y/N)	Comments
0	Enclosure	N/E	—	—	None
1	Digital Input	I/O	N	N	Normally connected to EUT thru conduit. Not used during transmitter testing.

Note:
AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
TP = Telecommunication Ports

1.2.3 Power Interface:

Mode # /Rated	Voltage (V)	Frequency (DC/AC-Hz)	Phases (#)	Comments
1	3V	DC	-	Internal Battery

1.3 EUT Configurations

Mode #	Description
1	Configured in Semi-Anechoic chamber on 80cm non-conductive support
2	Configured on test bench connected to S/A thru coaxial cable

1.4 EUT Operation Modes

Mode #	Description
1	Transmitting
2	Receiving

2.0 Summary

The tests listed in the Summary of Testing section of this report have been performed and the results recorded by Underwriters Laboratories Inc. in accordance with the procedures stated in each test requirement and specification. The applicant determined the list of tests performed were applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.

2.1 Deviations from standard test methods

None

2.2 Device Modifications Necessary for Compliance

None

2.3 Reference Standards

Standard Number	Standard Name	Standard Date
FCC Part 15, Subpart C	Code of Federal Regulations, Part 15, Radio Frequency Devices	2007
RSS-210, Issue 7	Low-Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment	June 2007
RSS-Gen, Issue 2	General Requirements and Information for the Certification of Radiocommunication Equipment	June 2007

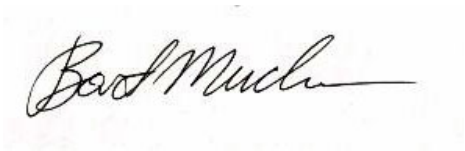
*In addition to the above standards, FCC DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems was used.

2.4 Results Summary

Requirement – Test	Requirement – Test	Result (Compliant / Non-Compliant)*
Conducted Emissions	47 CFR Part 15.207 RSS-Gen 7.2.2	N/A**
Carrier Frequency Separation	47 CFR Part 15.247(a)(1) RSS-210 A8.1(b)	Compliant
20dB Bandwidth	47 CFR Part 15.247(a)(1)(i) RSS-210 A8.1(c)	Compliant
Number of Hopping Frequency	47 CFR Part 15.247(a)(1)(i) RSS-210 A8.1(c)	Compliant
Dwell Time	47 CFR Part 15.247(a)(1)(i) RSS-210 A8.1(c)	Compliant
Maximum Peak Output Power	47 CFR Part 15.247(b)(2) RSS-210 A8.4(1)	Compliant
Band Edge Compliance	47 CFR Part 15.247(d) RSS-210 A8.5	Compliant
Spurious Emissions	47 CFR Part 15.247(d) RSS-210 A8.5 RSS-Gen 7.2.1 and 7.2.3	Compliant
99% Occupied Bandwidth	RSS-Gen 4.6.1	Compliant

**EUT is battery operated only.

Test Engineer:



Bartlomiej Mucha (Ext.41216)
Senior Project Engineer
International EMC Services
Conformity Assessment Services-

Reviewer:

Jack Steiner (Ext.42307)
Section Manager
International EMC Services
Conformity Assessment Services

3.0 Calibration of Equipment Used for Measurement

All test equipment and test accessories are calibrated on a regular basis. The maximum time between calibrations is one year or the manufacturers' recommendation, whichever is less.

All test equipment calibrations are traceable to the National Institute of Standards and Technology (NIST); therefore, all test data recorded in this report is traceable to NIST.

4.0 EMISSIONS TEST RESULTS

The emissions tests were performed according to following regulations:

---------- United States ----------

Code of Federal Regulations Title 47	Part 15, Subpart C, Radio Frequency Devices

---------- Canada ----------

Spectrum Management and Telecommunications - Radio Standards Specification	RSS-210, Issue 7: Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment
Spectrum Management and Telecommunications - Radio Standards Specification	RSS-Gen, Issue 2: General Requirements and Information for the Certification of Radiocommunication Equipment

Unless specified otherwise in the individual Methods, the tests shall be conducted under the following ambient conditions. Confirmation of these conditions shall be verified at the time the test is conducted.

Ambient Temperature, °C	22.5 ± 2.5	Relative Humidity, %	45 ± 15	Barometric Pressure, mBar	950 ± 150

4.1 Test Conditions and Results – Carrier Frequency Separation

Test Description	Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
Basic Standard	47 CFR Part 15.247(a)(1) RSS-210, A8.1(b)

Table 1 Carrier Frequency Separation Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	2	1
Supplementary information: Separation frequencies were measured for each channel and then averaged.		

Table 2 Carrier Frequency Separation Test Equipment

Test Equipment Used			
Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

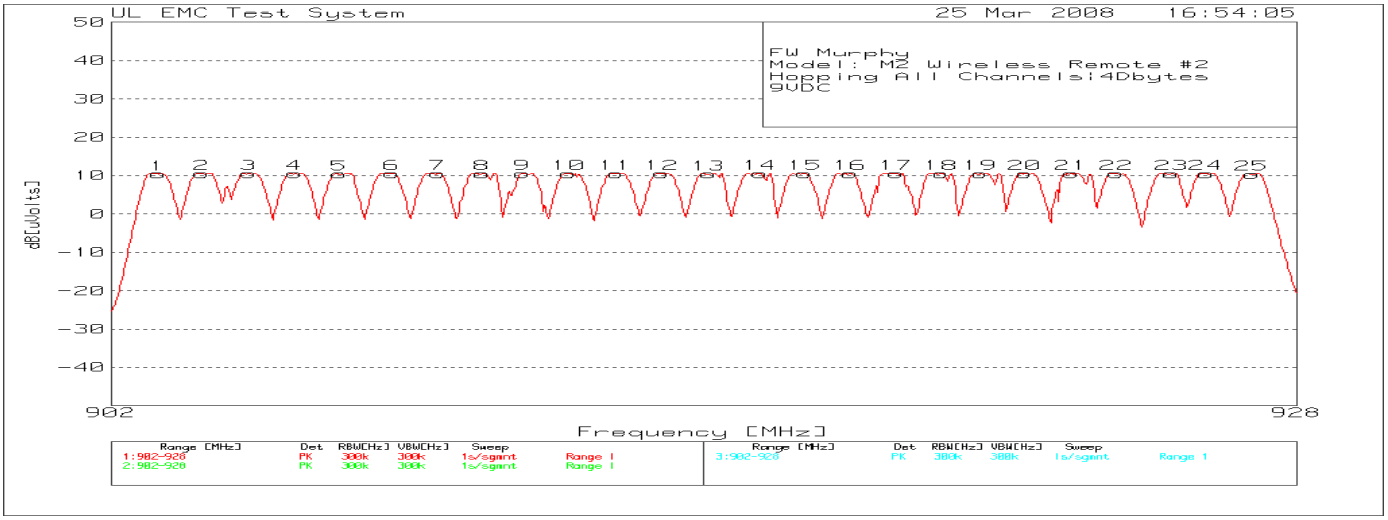
Table 3 Carrier Frequency Separation Results

Mode	Channel	Carrier Frequency Separation Limit	Average Separation
4 Data Bytes, Two Bursts	All	> 25kHz	0.9995 MHz
4 Data Bytes, Single Burst	All	> 25kHz	1.0002 MHz

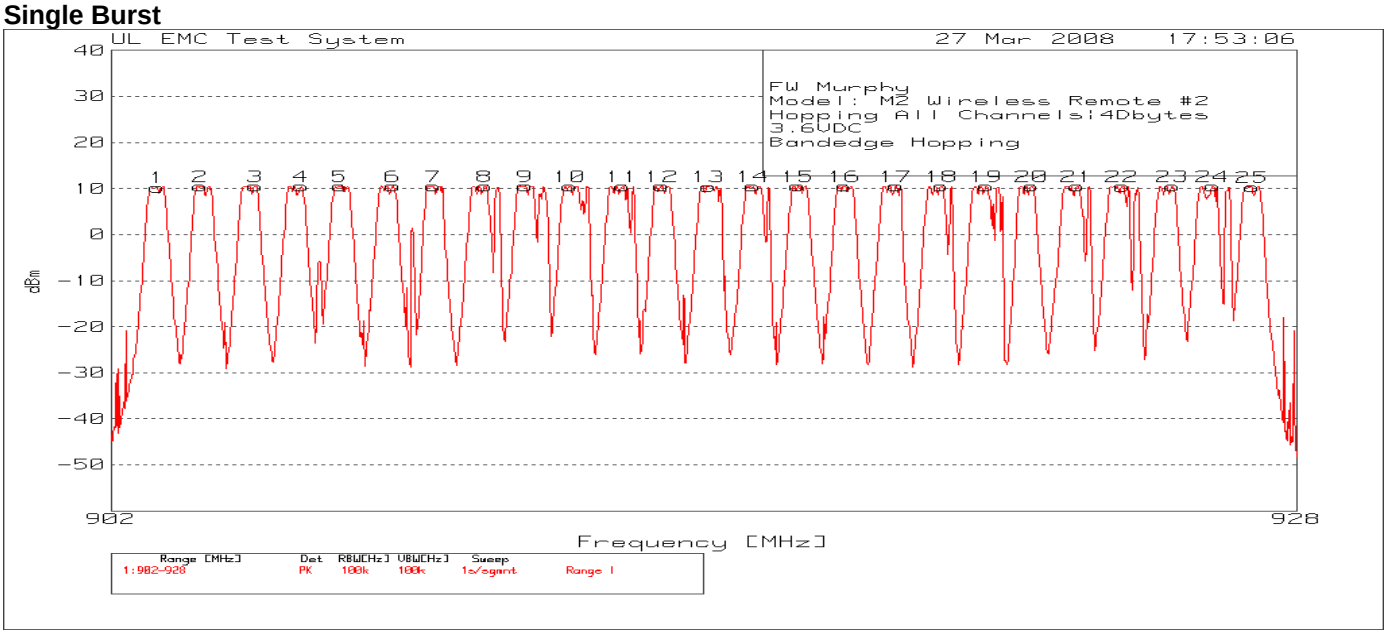
Figure 2 Test Setup for Carrier Frequency Separation

Figure 3 Carrier Frequency Separation Graphs

Double Burst



Single Burst



4.2 Test Conditions and Results – 20dB Bandwidth

Test Description	For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
Basic Standard	47 CFR Part 15.247(a)(1)(i) RSS-210, A8.1(c)

Table 4 20dB Bandwidth Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	2	1
Supplementary information: None		

Table 5 20dB Bandwidth Test Equipment

Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

Table 6 20dB Bandwidth Results

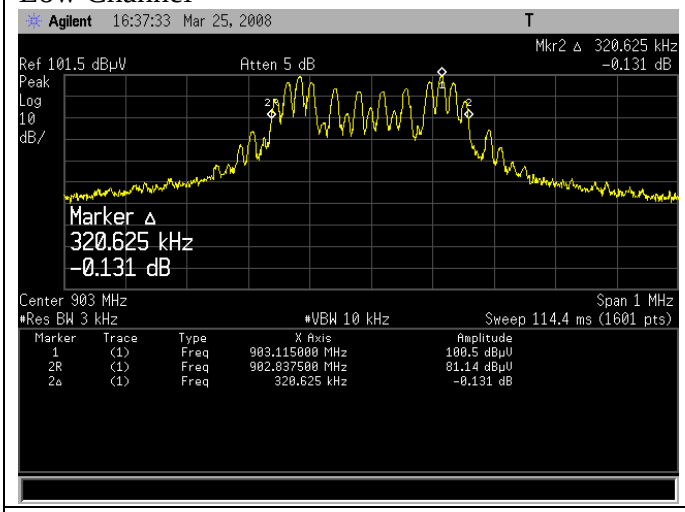
Mode	Channel	20dB Bandwidth
4 Data Bytes, Two Bursts	903 MHz - Low	320.625 kHz
	915 MHz - Middle	321.875 kHz
	927 MHz – High	353.125 kHz

Number of Bursts does not effect the 20dB Bandwidth Measurement.

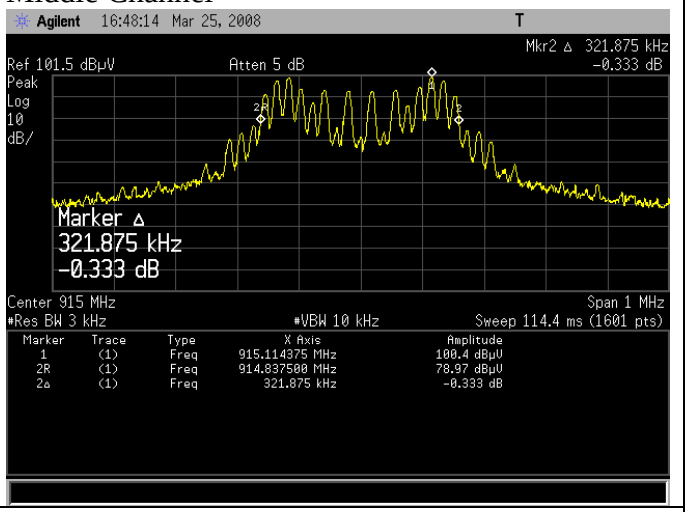
Figure 4 Test Setup for 20dB Bandwidth

Figure 5 20dB Bandwidth Graphs

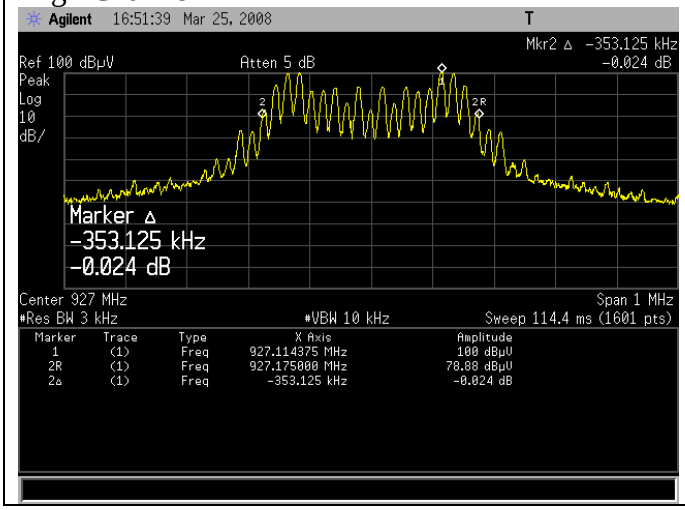
Low Channel



Middle Channel



High Channel



4.3 Test Conditions and Results – Number of Hopping Frequencies

Test Description	For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
Basic Standard	47 CFR Part 15.247(a)(1)(i) RSS-210, A8.1(c)

Table 7 Number of Hopping Frequencies Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	2	1
Supplementary information: None		

Table 8 Number of Hopping Frequencies Test Equipment

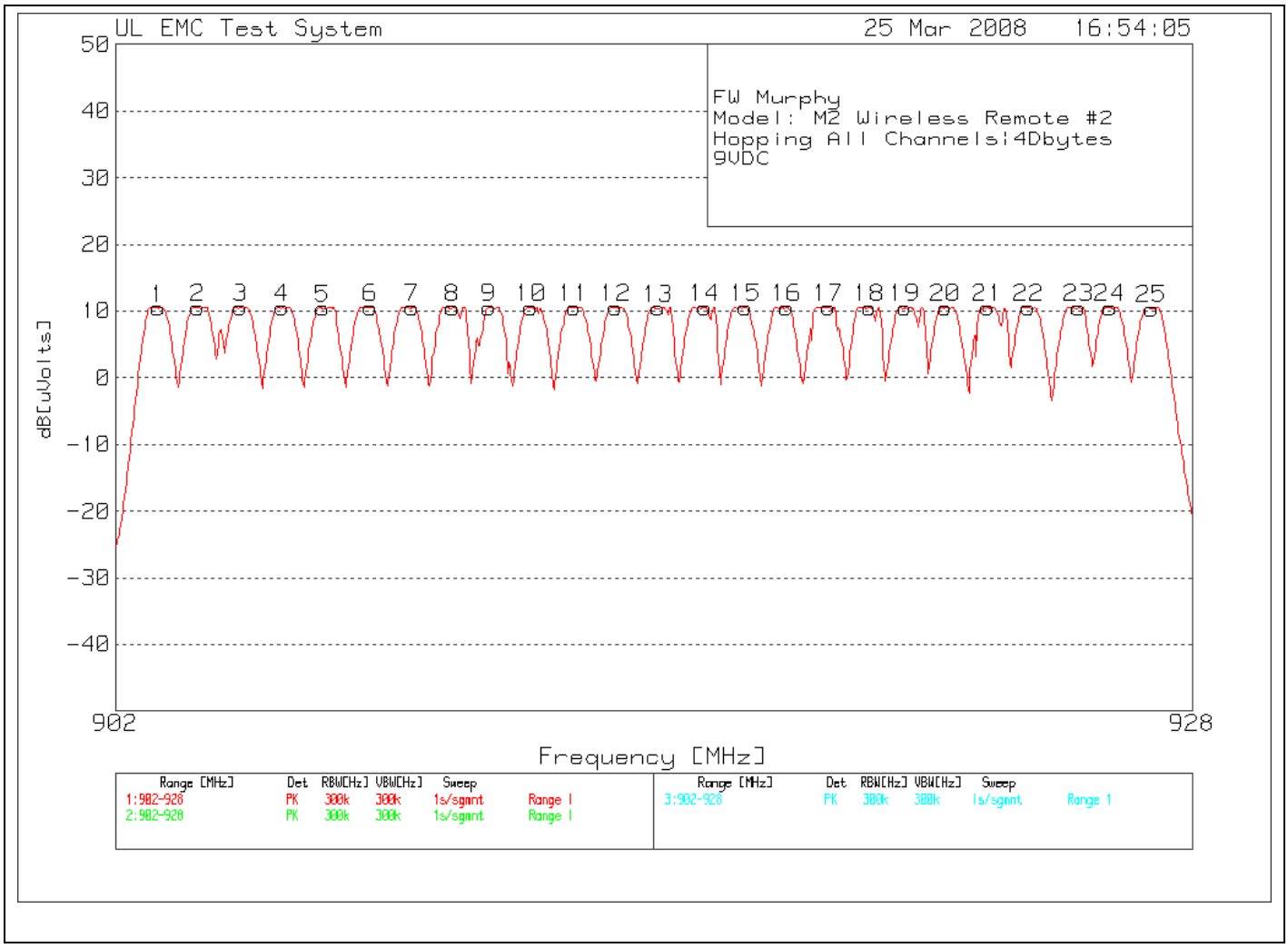
Test Equipment Used			
Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

Table 9 Number of Hopping Frequencies Results

Mode	Number of Channels	Minimum Number Required
4 Data Bytes, Two Bursts	25	25

Figure 6 Test Setup for Number of Hopping Frequencies

Figure 7 Number of Hopping Frequencies Graphs



4.4 Test Conditions and Results – Dwell Time

Test Description	For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
Basic Standard	47 CFR Part 15.247(a)(1)(iii) RSS-210, A8.1(c)

Table 10 Dwell Time Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	2	1
Supplementary information: Duty cycle also measured/calculated for use in radiated spurious measurements		

Table 11 Dwell Time Test Equipment

Test Equipment Used			
Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

Table 12 Dwell Time Results

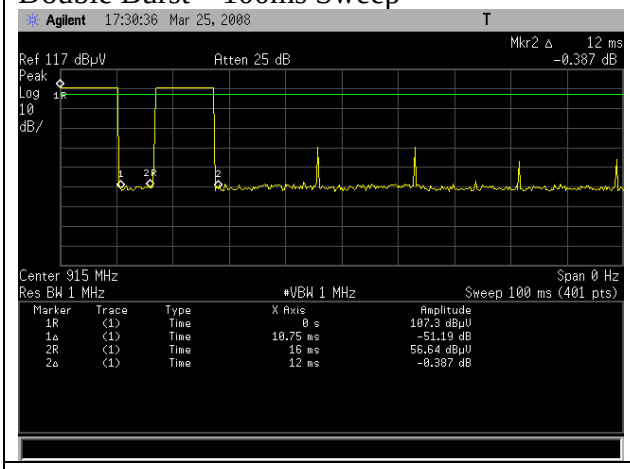
Mode	Number of Channels	Maximum Time Allowed	Measured Dwell Time	Measured TX time in 100ms	Duty Cycle Factor 20*log(t1/t2)
4 Data Bytes, Two Bursts	25	0.4s in 10s	0.273s in 10s	22.75mS	-12.86dB
4 Data Bytes, Single Burst	25	0.4s in 10s	0.253s in 10s	11mS	-19.17dB

Figure 8 Test Setup for Dwell Time

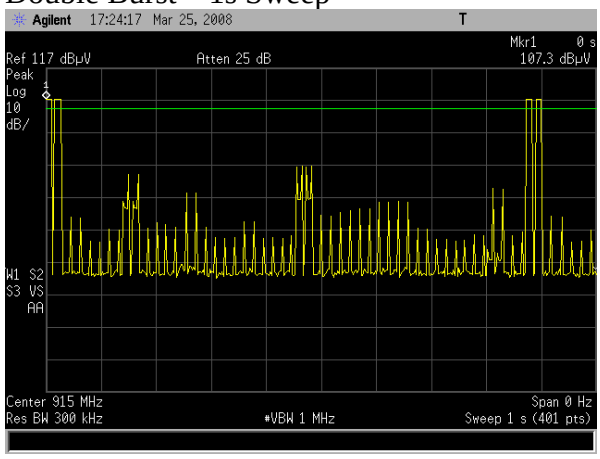
Figure 9 Dwell Time Graphs

Double Burst

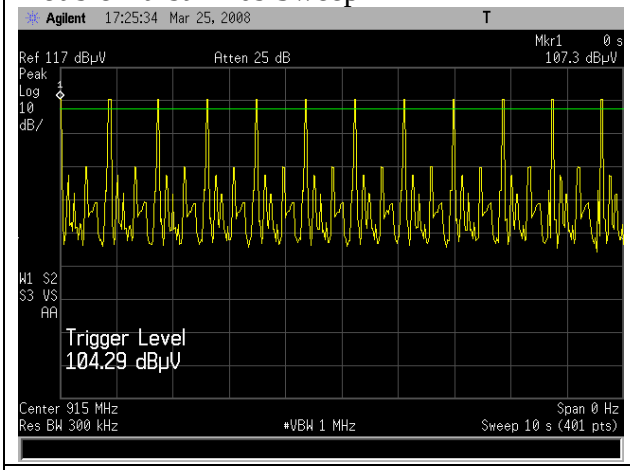
Double Burst – 100ms Sweep



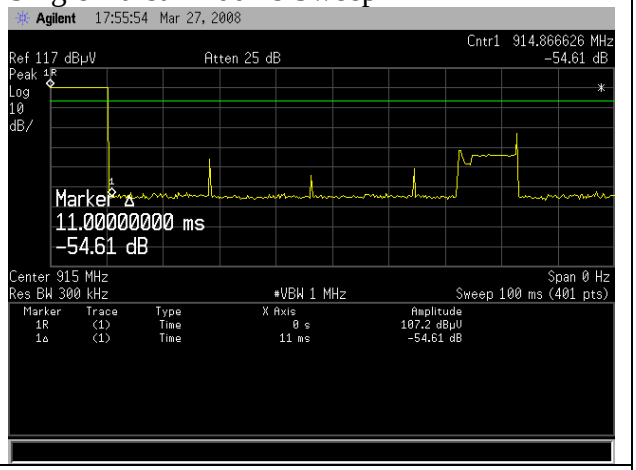
Double Burst – 1s Sweep



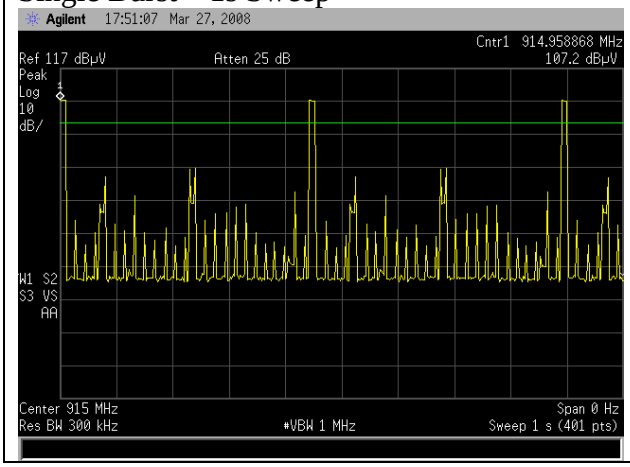
Double Burst – 10s Sweep



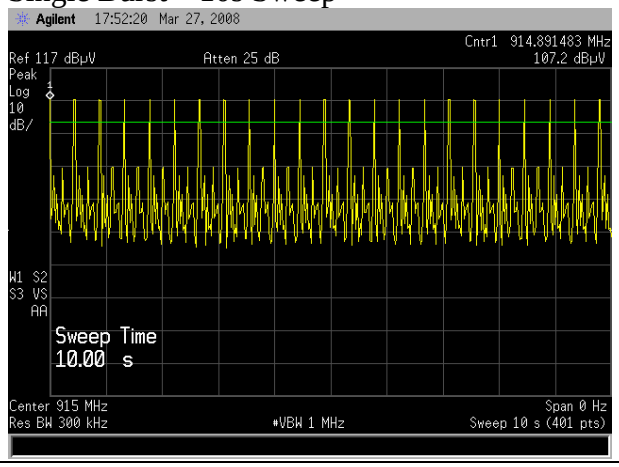
Single Burst – 100ms Sweep



Single Burst – 1s Sweep



Single Burst – 10s Sweep



4.5 Test Conditions and Results – Maximum Peak Output Power

Test Description	For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.	
Basic Standard	47 CFR Part 15.247(b)(2) RSS-210, A8.4(1)	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	902 MHz – 928MHz	Antenna Conducted
Limits		
Frequency (MHz)	Limit mW	
	Peak	
2400 – 2483.5	250 (24dBm)	
Supplementary information: None		

Table 13 Maximum Peak Output Power EUT Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	2	1
Supplementary information: None		

Table 14 Maximum Peak Output Power Test Equipment

Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

Table 15 Maximum Peak Output Power Results

Channel	Power dBm	Power W
Low Channel 903MHz	10.66	0.01164
Middle Channel 915MHz	10.70	0.01175
High Channel 927MHz	10.67	0.01167

Figure 10 Test setup for Maximum Peak Output Power

Figure 11 Maximum Peak Output Power Graph

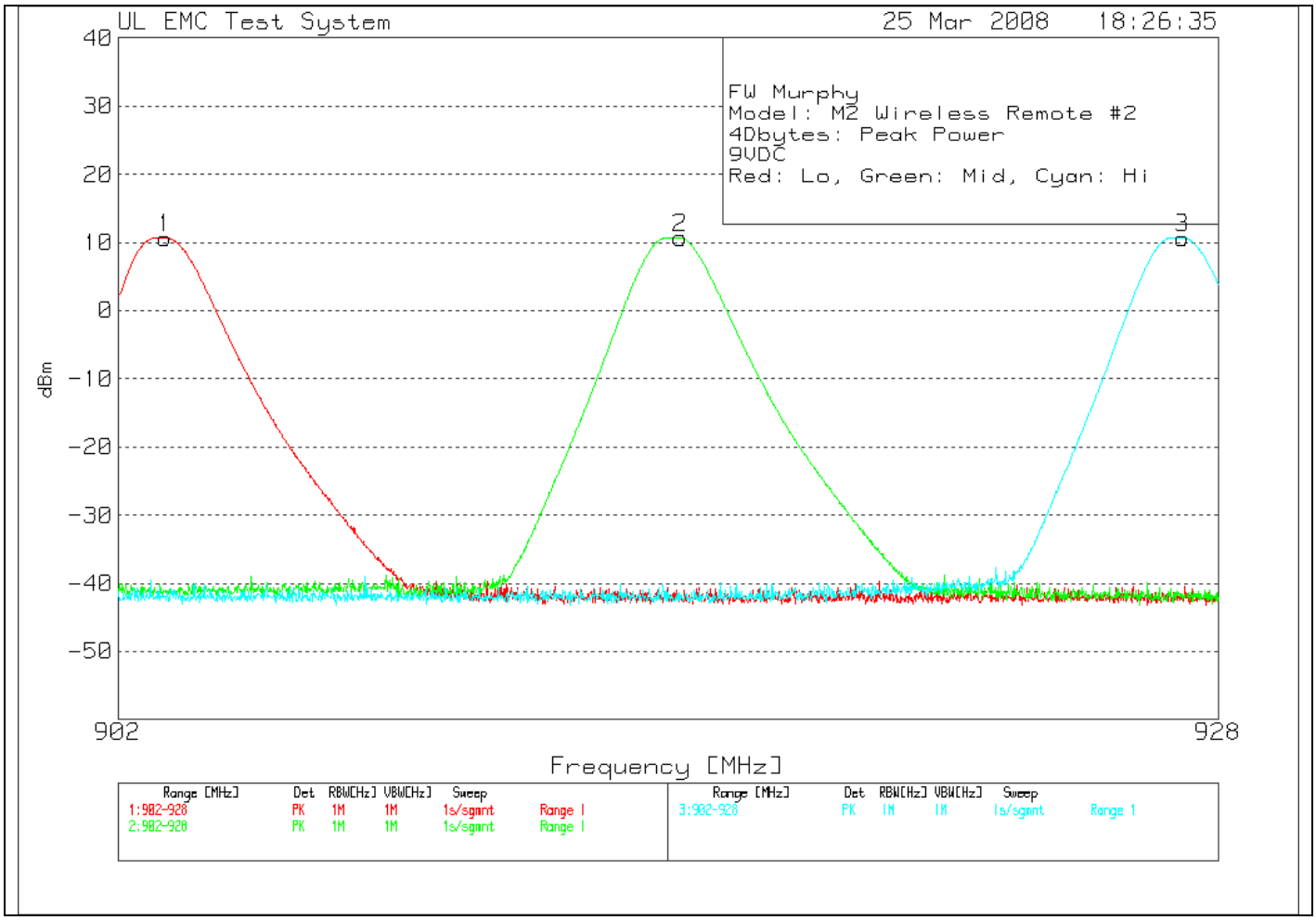


Table 16 Maximum Peak Output Power Emissions Data Points

Model: M2 Wireless Remote #2
4Dbytes: Peak Power – Double Burst 9VDC
Red: Lo, Green: Mid, Cyan: Hi

No.	Test Frequency [MHz]	Meter Reading [dB(uV)]	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dBm	Limit:1	2	3	4	5	6
Low Channel											
1	903.1029	107.36 pk	10.3	-107	10.66	-	-	-	-	-	-
				Margin [dB]		-	-	-	-	-	-
Middle Channel											
2	915.1946	107.4 pk	10.3	-107	10.7	-	-	-	-	-	-
				Margin [dB]		-	-	-	-	-	-
High Channel											
3	927.1485	107.37 pk	10.3	-107	10.67	-	-	-	-	-	-
				Margin [dB]		-	-	-	-	-	-

4.6 Test Conditions and Results – Band Edge Compliance

Test Description	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section15.205(c)).

Basic Standard	47 CFR Part 15.247(d) RSS-210, A8.5	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	852MHz – 978MHz	Antenna Conducted

Limits

Frequency (MHz)	Limits	
	Antenna Conducted - 20dB below the fundamental	Radiated – Peak 20dB below the fundamental and Average must meet the general limit in restricted bands.
Below 902MHz and Above 928MHz	Aprox. –10dBm (See Data Table Below)	54dBuV/m

Supplementary information: Spurious limits are only applied against products of the transmitter. All other emissions must meet the general limits. Portable transmitters are to be checked in 3 orthogonal axis.

Table 17 Band Edge Compliance EUT Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1, 2	1
Supplementary information: None		

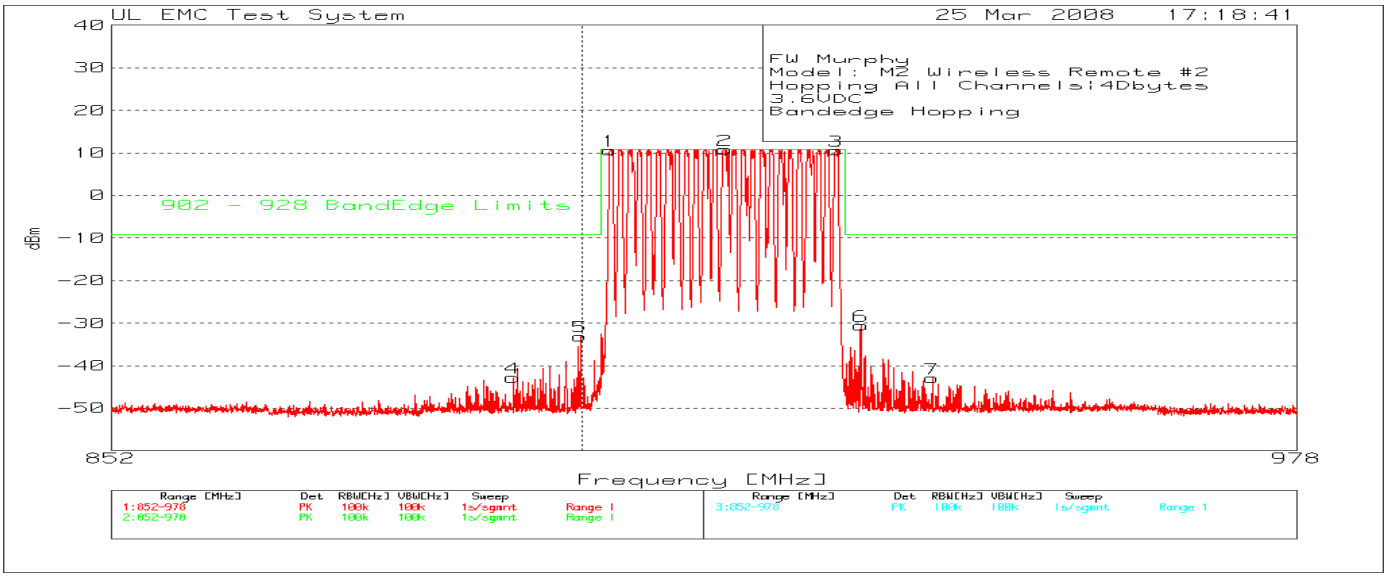
Table 18 Band Edge Compliance Test Equipment

Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Rhode & Schwartz	FSEK	EMC4182
Antenna Array	UL	BOMS	EMC4276
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

Figure 12 Test setup for Band Edge Compliance - Conducted

Figure 13 Conducted Band Edge Compliance Graph

Double Burst



Single Burst

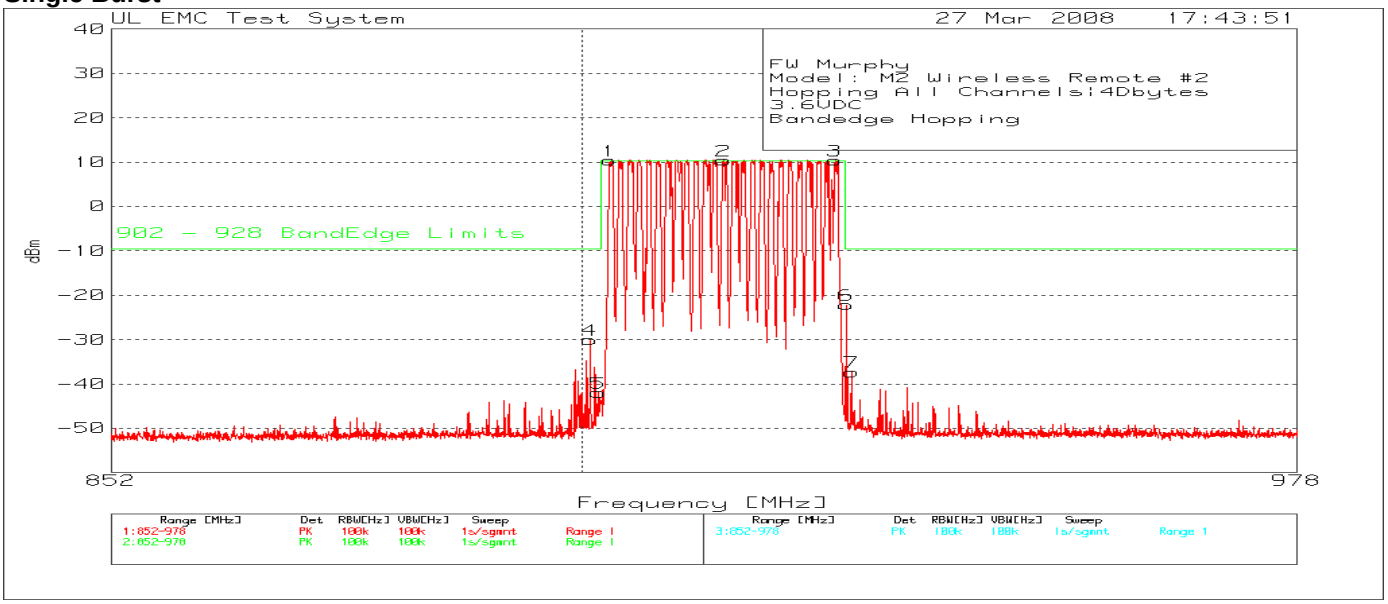


Table 19 Band Edge Compliance Data Points

FW Murphy
Model: M2 Wireless Remote #2
Hopping All Channels|4Dbytes
9VDC
Bandedge Hopping

No.	Test Frequency [MHz]	Meter Reading [dB(uV)]	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dBm	Limit:1	2	3	4	5	6
1	902.8793	107.3 pk	10.3	-107	10.6	9	-	-	-	-	-
				Margin [dB]		1.6	-	-	-	-	-
2	915.0196	107.46 pk	10.3	-107	10.76	9	-	-	-	-	-
				Margin [dB]		1.76	-	-	-	-	-
3	927.0028	107.29 pk	10.3	-107	10.59	9	-	-	-	-	-
				Margin [dB]		1.59	-	-	-	-	-
4	892.782	53.92 pk	10.3	-107	-42.78	-9.2	-	-	-	-	-
				Margin [dB]		-33.58	-	-	-	-	-
5	899.7755	63.6 pk	10.3	-107	-33.1	-9.2	-	-	-	-	-
				Margin [dB]		-23.9	-	-	-	-	-
6	929.6352	66.13 pk	10.3	-107	-30.57	-9.2	-	-	-	-	-
				Margin [dB]		-21.37	-	-	-	-	-
7	937.3751	53.81 pk	10.3	-107	-42.89	-9.2	-	-	-	-	-
				Margin [dB]		-33.69	-	-	-	-	-

LIMIT 1: 902 - 928 BandEdge Limits
pk - Peak detector

FW Murphy
Model: M2 Wireless Remote #2
Hopping All Channels|4Dbytes
3.6VDC
Bandedge Hopping

No.	Test Frequency [MHz]	Meter Reading [dB(uV)]	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dBm	Limit:1	2	3	4	5	6
1	902.8793	107.07 pk	10.3	-107	10.37	10.4	-	-	-	-	-
				Margin [dB]		-.03	-	-	-	-	-
2	914.9411	107.09 pk	10.3	-107	10.39	10.4	-	-	-	-	-
				Margin [dB]		-.01	-	-	-	-	-
3	926.8457	107.09 pk	10.3	-107	10.39	10.4	-	-	-	-	-
				Margin [dB]		-.01	-	-	-	-	-
4	900.797	66.64 pk	10.3	-107	-30.06	-9.6	-	-	-	-	-
				Margin [dB]		-20.46	-	-	-	-	-
5	901.7007	54.71 pk	10.3	-107	-41.99	-9.6	-	-	-	-	-
				Margin [dB]		-32.39	-	-	-	-	-
6	928.0636	74.54 pk	10.3	-107	-22.16	-9.6	-	-	-	-	-
				Margin [dB]		-12.56	-	-	-	-	-
7	928.6137	59.38 pk	10.3	-107	-37.32	-9.6	-	-	-	-	-
				Margin [dB]		-27.72	-	-	-	-	-

LIMIT 1: 902 - 928 BandEdge Limits
pk - Peak detector

4.7 Test Conditions and Results – SPURIOUS EMISSIONS

Test Description	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section15.205(c)).

Basic Standard	47 CFR Part 15.247(d) RSS-210, A8.5 RSS-Gen 7.2.1 and 7.2.3	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	(10 meter measurement distance)
Fully configured sample scanned over the following frequency range	1GHz – 10GHz	(3 meter measurement distance)

Limits

Frequency (MHz)	Limit (dBµV/m)		
	Quasi-Peak	Average	
	General Emissions	Fundamental	Spurious
30 – 88	40	-	-
88 – 216	43.5	-	-
216-960	46	-	
1,000-25,000	-	-	54

Supplementary information: Spurious limits are only applied against products of the transmitter. All other emissions must meet the general limits. Since EUT is a fixed mounted and antenna is attached thru coaxial cable, antenna position was tested in two axis (X-axis Vertical and Y-Axis Horizontal)

Table 20 SPURIOUS EMISSIONS EUT Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1
Supplementary information: None		

Table 21 SPURIOUS EMISSIONS Test Equipment

Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Rhode & Schwartz	FSEK	EMC4182
Antenna Array	UL	BOMS	EMC4276
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

Figure 14 Test setup for SPURIOUS EMISSIONS

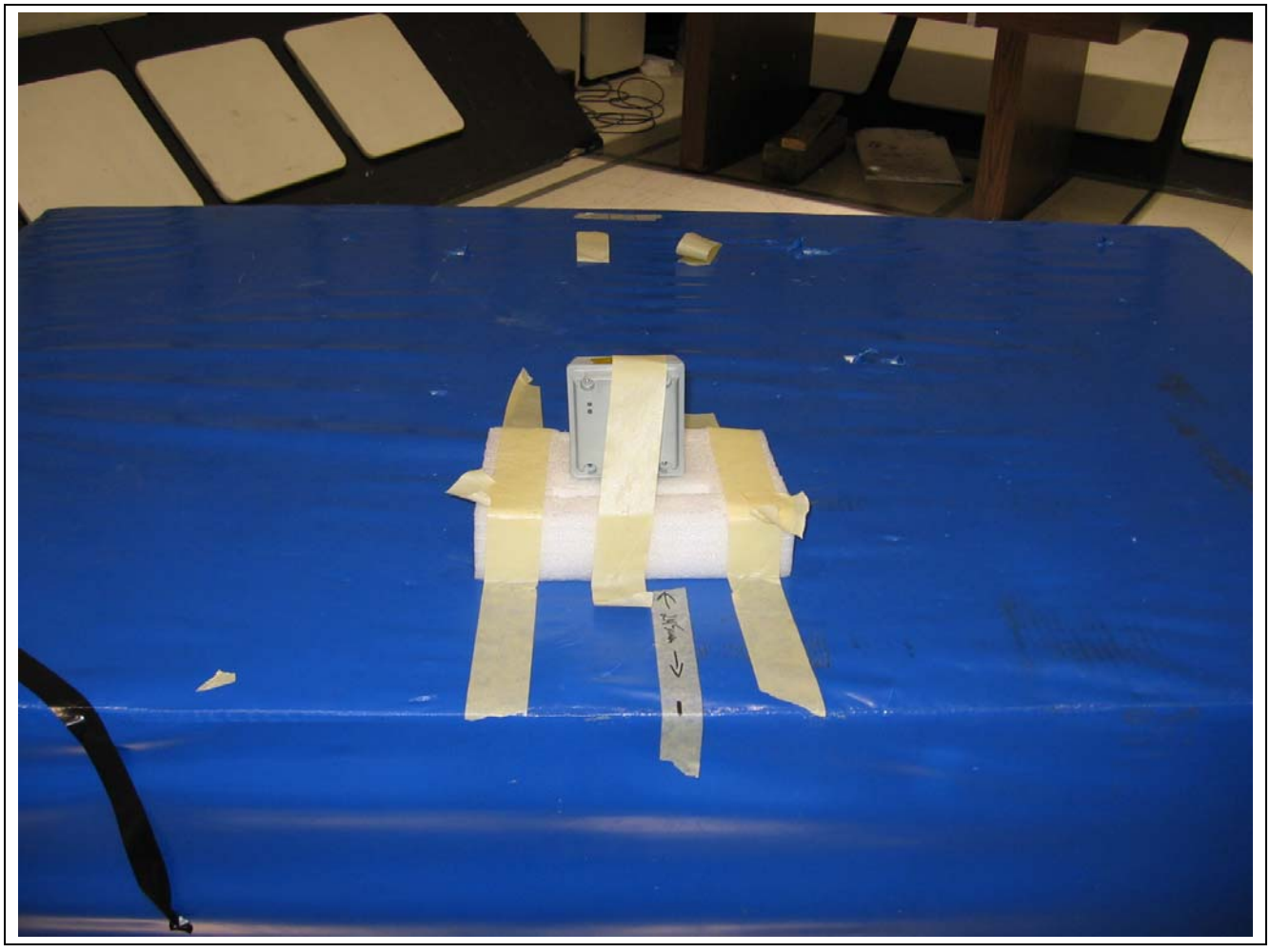
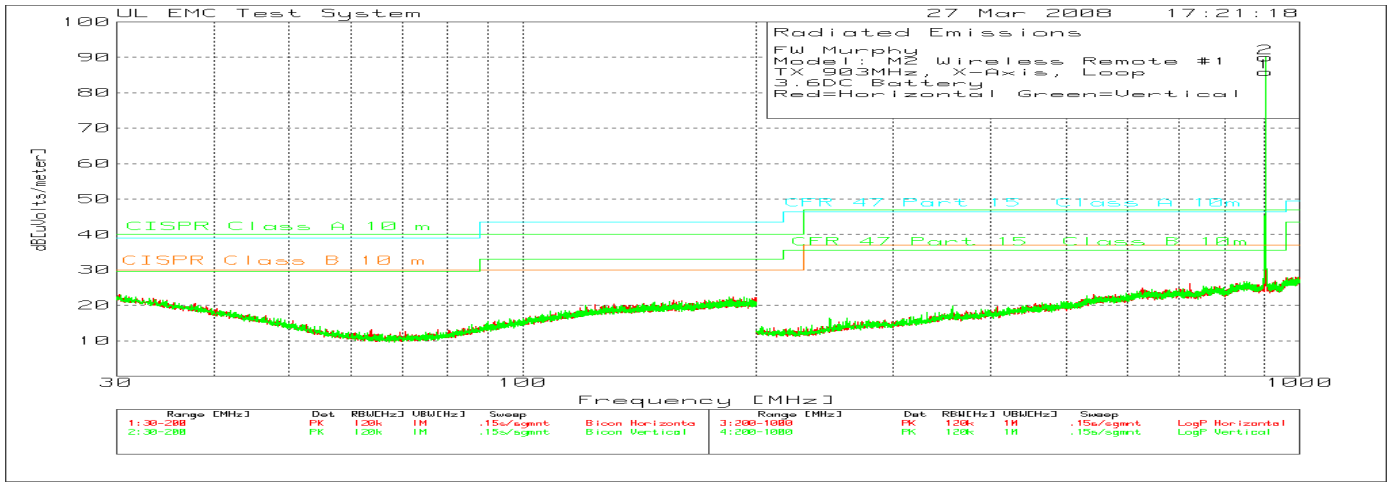
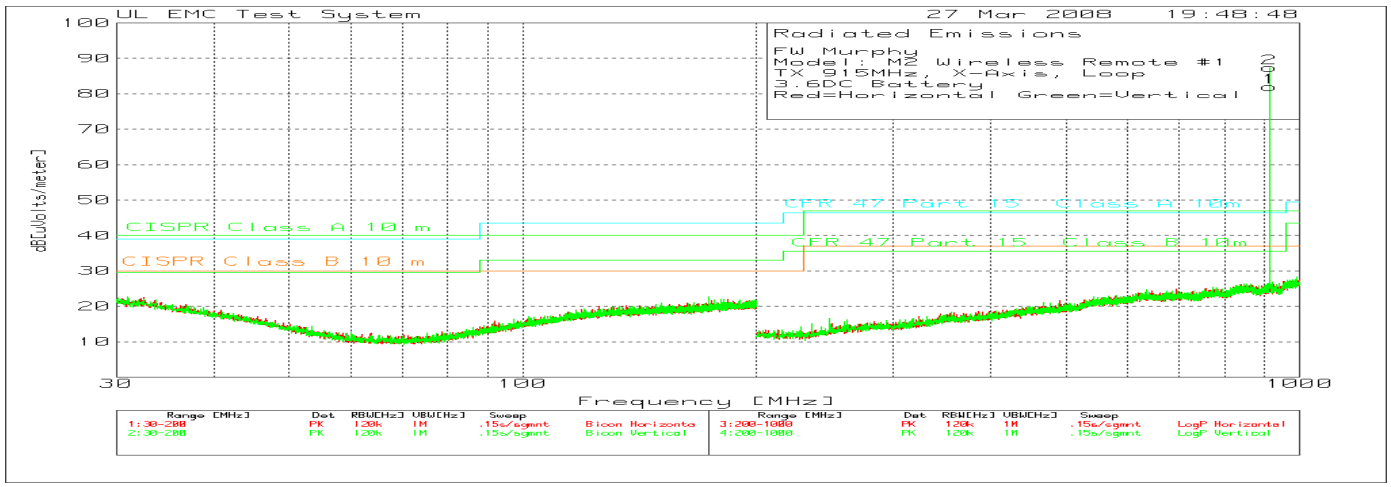
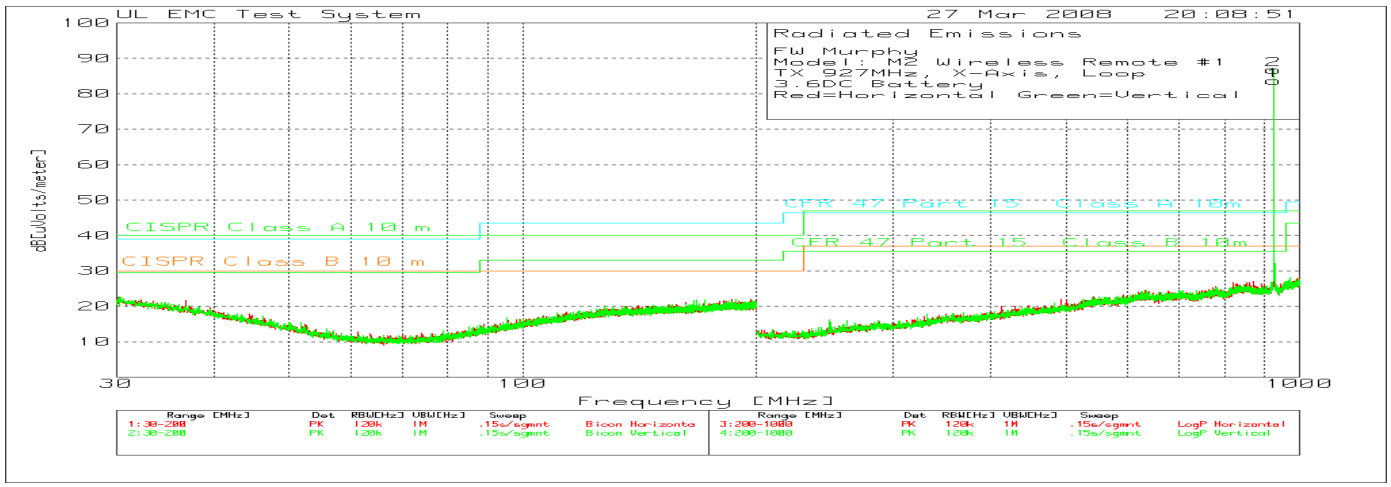


Figure 15 Radiated Emissions Graph, 30MHz – 1GHz, X-Axis, Low, Mid and High Channels

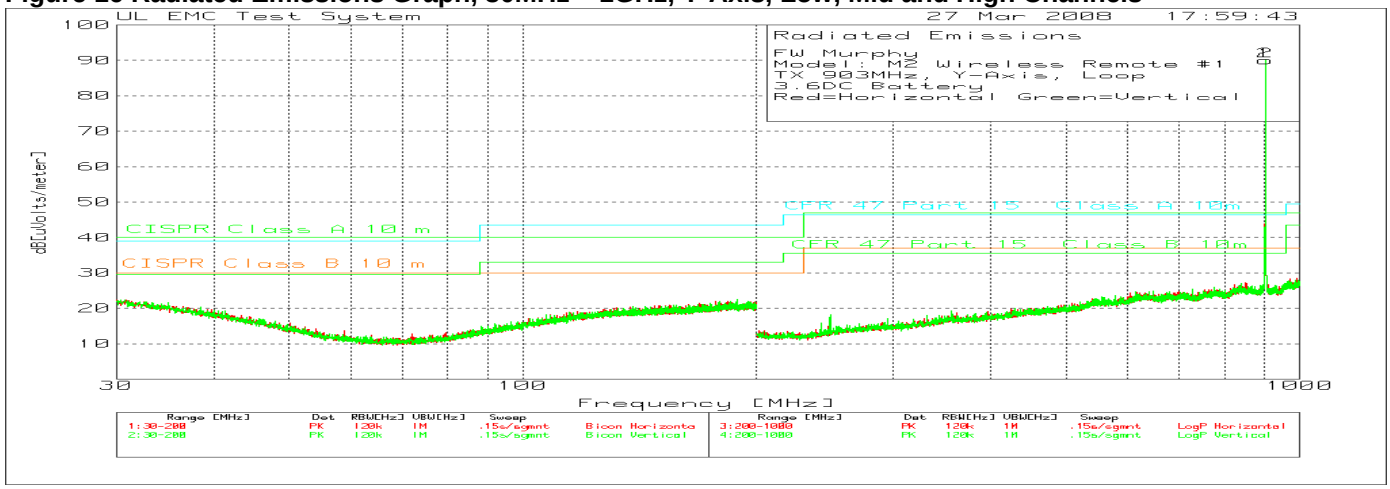


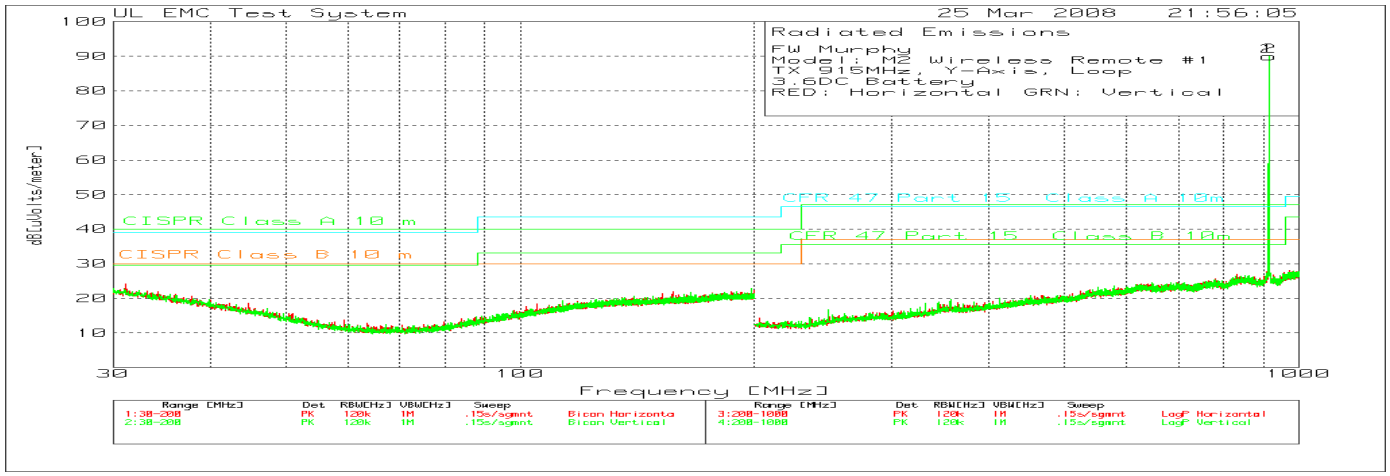


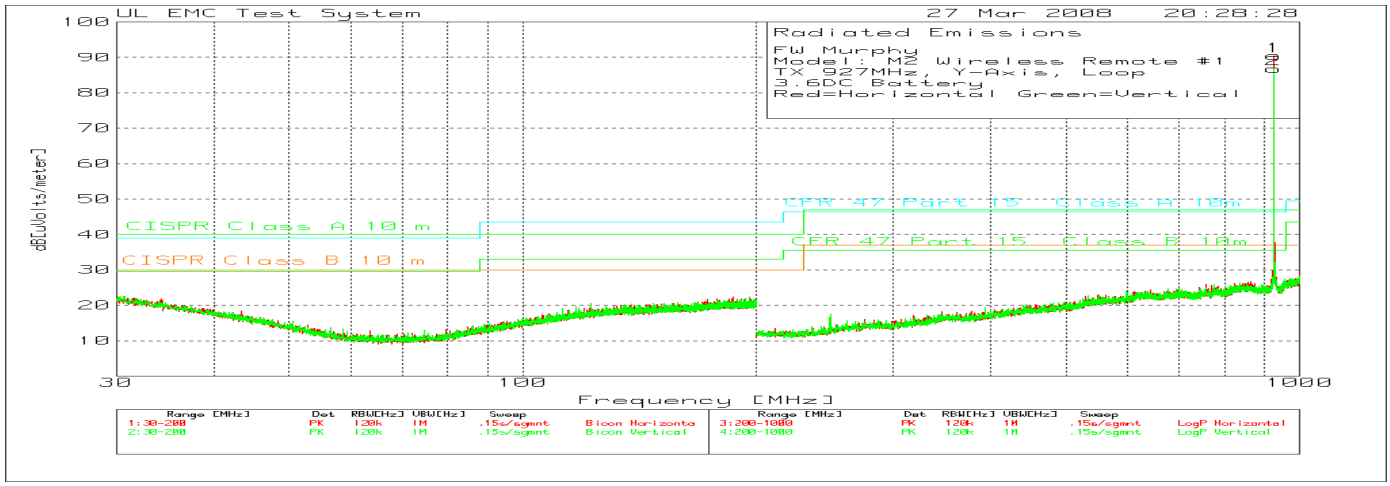


No emissions other the fundamental frequency detected. Measurements Not Required.

Figure 16 Radiated Emissions Graph, 30MHz – 1GHz, Y-Axis, Low, Mid and High Channels

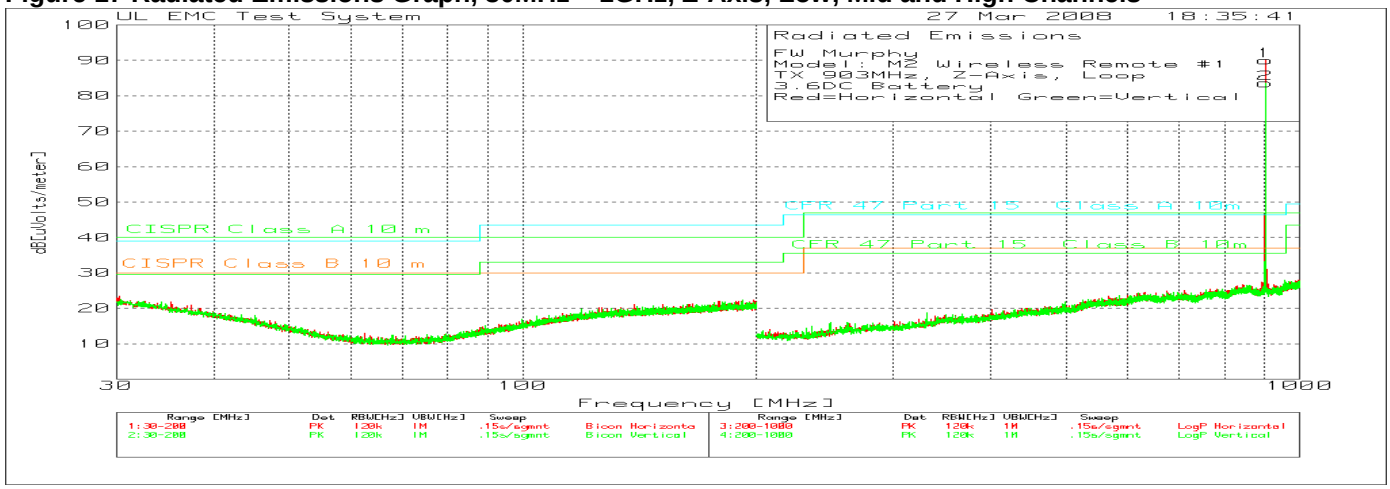


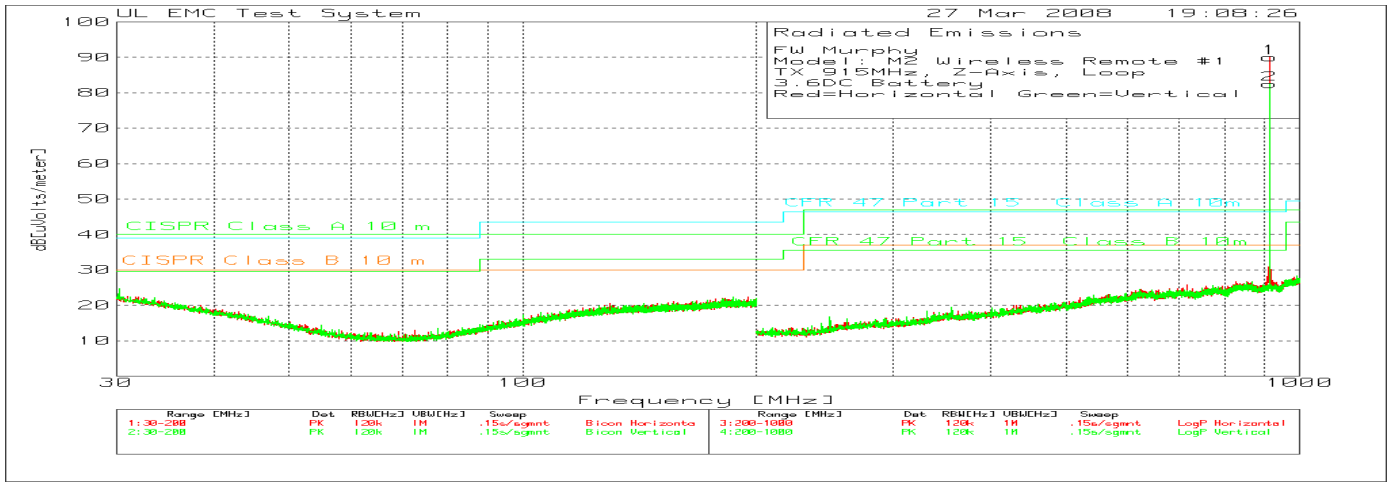


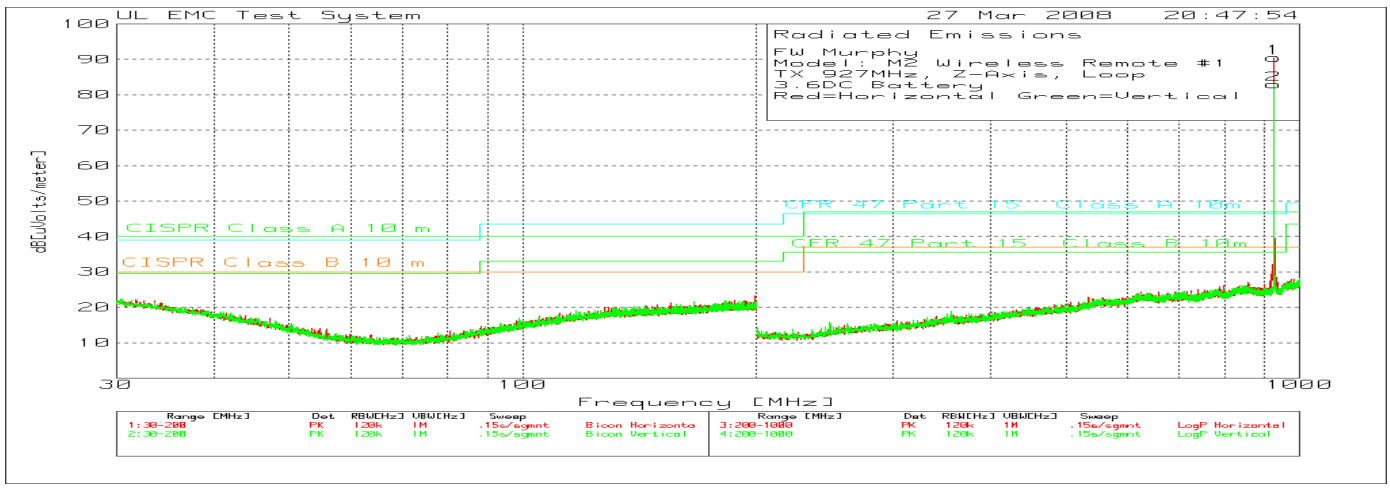


No emissions other the fundamental frequency detected. Measurements Not Required.

Figure 17 Radiated Emissions Graph, 30MHz – 1GHz, Z-Axis, Low, Mid and High Channels

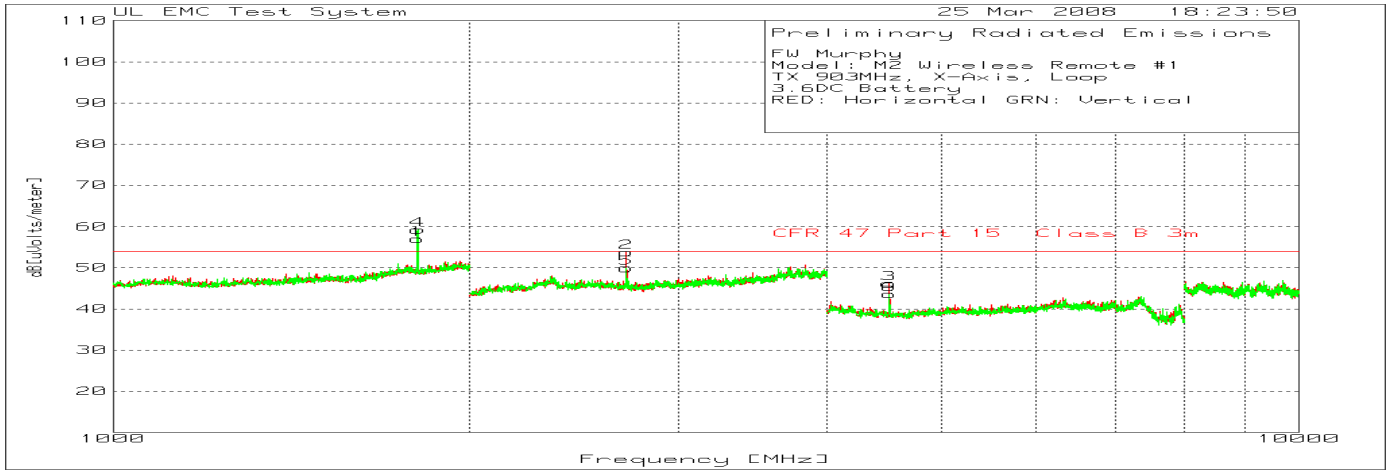


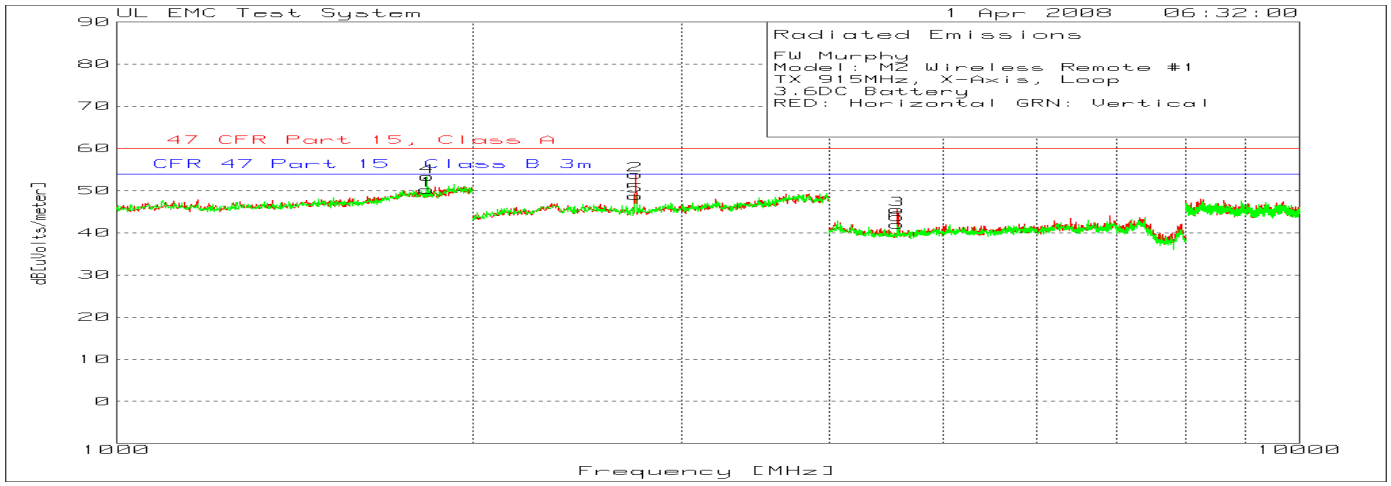




No emissions other the fundamental frequency detected. Measurements Not Required.

Figure 18 SPURIOUS EMISSIONS Preliminary Scan Data, X-Axis, Low, Middle and High Channels





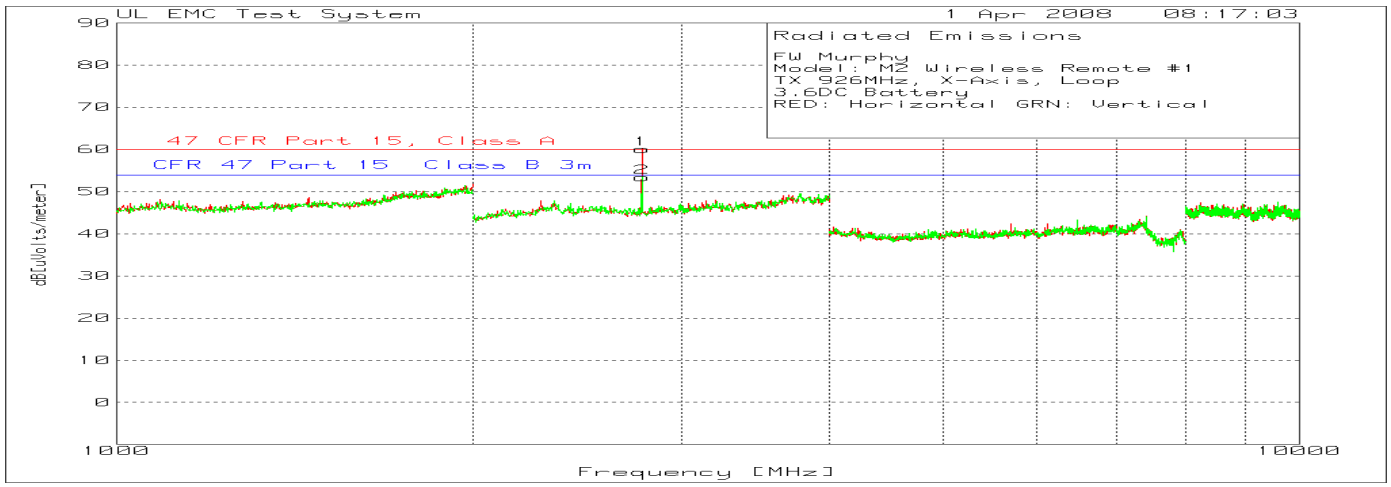


Table 22 X-Axis Peak Scan Data

Preliminary Peak Scan Data

FW Murphy
Model: M2 Wireless Remote #1
TX 903MHz, X-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uV/m]	Limit 1	Margin 1[dB]	Height [cm]	Polarity
1	1805.806	26.7	pk	3.59	26.7	56.99	54	2.99	100	Horz
2	2709.807	27.55	pk	4.14	22.1	53.79	54	-.21	100	Horz
3	4512.342	70.86	pk	-52.5	27.8	46.16	54	-7.84	100	Horz
4	1806.807	28.96	pk	3.59	26.7	59.25	54	5.25	100	Vert
5	2709.807	23.69	pk	4.14	22.1	49.93	54	-4.07	100	Vert
6	4515.01	68.25	pk	-52.48	27.8	43.57	54	-10.43	100	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 915MHz, X-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uV/m]	Limit 1	Margin 1[dB]	Height [cm]	Polarity
1	1829.659	19.82	pk	3.58	26.8	50.2	54	-3.8	100	Horz
2	2745.491	27.64	pk	4.03	22.1	53.77	54	-.23	101	Horz
3	4572.573	70.27	pk	-52.46	27.7	45.51	54	-8.49	100	Horz
4	1831.663	22.91	pk	3.61	26.8	53.32	54	-.68	100	Vert
5	2745.491	22.62	pk	4.03	22.1	48.75	54	-5.25	150	Vert
6	4572.573	66.74	pk	-52.46	27.7	41.98	54	-12.02	150	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 926MHz, X-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uV/m]	Limit 1	Margin 1[dB]	Height [cm]	Polarity
1	2781.563	33.68	pk	4.24	22.2	60.12	54	6.12	100	Horz
2	2781.563	26.96	pk	4.24	22.2	53.4	54	-.6	150	Vert

LIMIT 1: CFR 47 Part 15 Class B 3m
pk - Peak detector

Table 23 X-Axis Maximized Worst Case Peak and Average Measurement (Restricted Band Only)

FW Murphy
Model: M2 Wireless Remote #1
TX 903MHz, X-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]		Limit 1	Margin 1[dB]	Azimuth [degs]	Height [cm]	Polarity
2709.3156	32.05	pk	4.14	22.1	58.29	-	74	-15.71	353	120	Horz
2709.3156	25.33	av	4.14	22.1	51.57	12.86	54	-15.29	353	120	Horz

pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

FW Murphy
Model: M2 Wireless Remote #1
TX 915MHz, X-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]		Limit	Margin 2[dB]	Azimuth [degs]	Height [cm]	Polarity
2745.4148	32.8	pk	4.03	22.1	58.93	-	74	-15.07	358	108	Horz
2745.0261	27.78	av	4.03	22.1	53.91	12.86	54	-12.95	358	108	Horz
2744.485	28.79	pk	4.04	22.1	54.93	-	74	-19.07	54	163	Vert
2745.01	21.16	av	4.03	22.1	47.29	12.86	54	-19.57	54	163	Vert

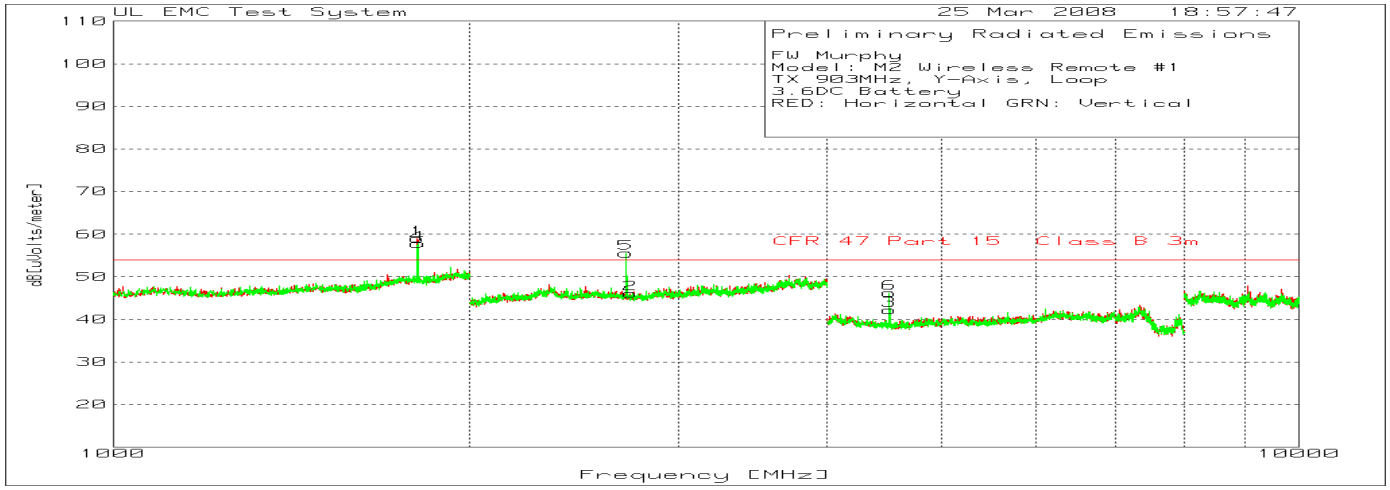
pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

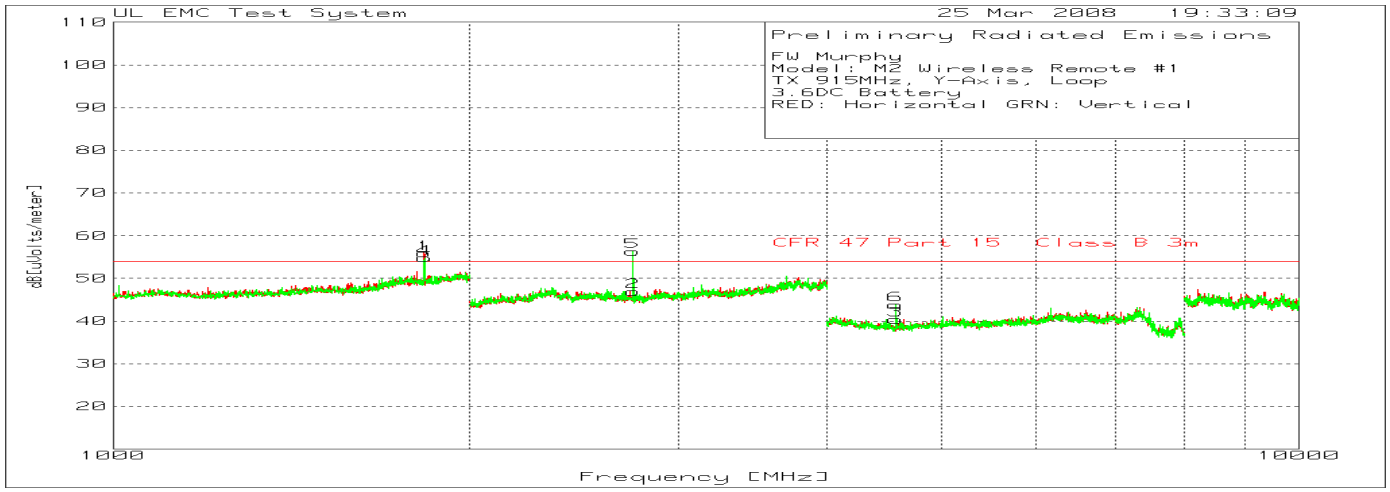
FW Murphy
Model: M2 Wireless Remote #1
TX 926MHz, X-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Duty Cycle Correction dB	Limit 1	Margin 1[dB]	Azimuth [degs]	Height [cm]	Polarity
2781.4629	37	pk	4.24	22.2	63.44	-	74	-10.56	0	104	Horz
2781.0341	33.07	av	4.24	22.2	59.51	12.86	54	-7.35	0	104	Horz
2781.3267	32.27	pk	4.24	22.2	58.71	-	74	-15.29	53	163	Vert
2781.0261	27	av	4.24	22.2	53.44	12.86	54	-13.42	53	163	Vert

LIMIT 1: CFR 47 Part 15 Class B 3m
pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

Figure 19 SPURIOUS EMISSIONS Preliminary Scan Data, Y-Axis, Low, Middle and High Channels





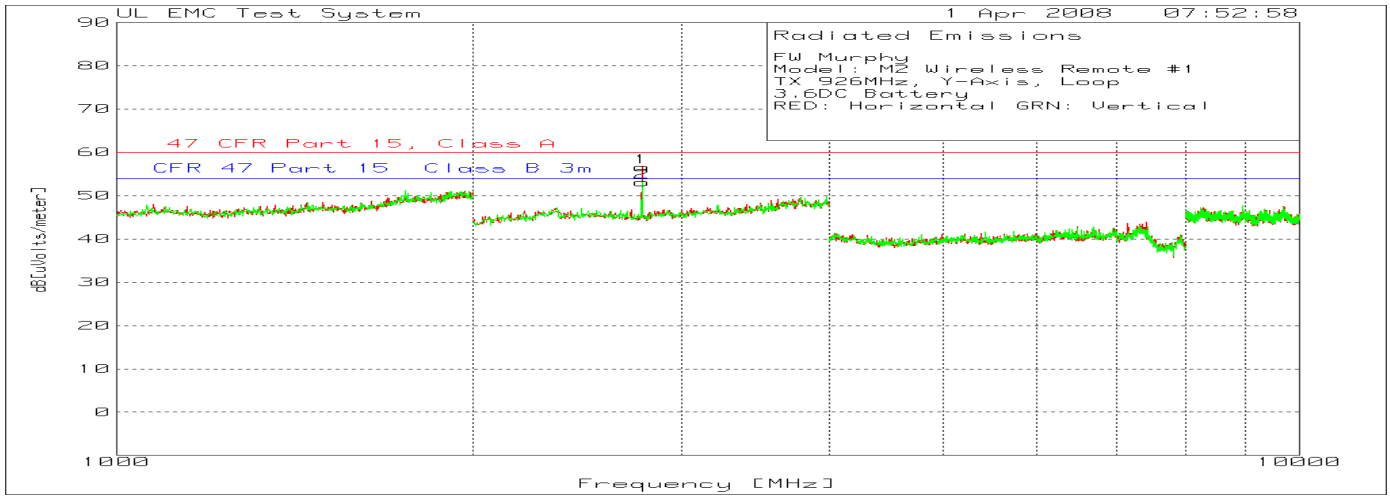


Table 24 Y-Axis Peak Scan Data

Preliminary Peak Scan Data

FW Murphy
Model: M2 Wireless Remote #1
TX 903MHz, Y-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Limit 1	Margin 1[dB]	Height [cm]	Polarity
1	1805.806	28.72	pk	3.59	26.7	59.01	54	5.01	100	Horz
2	2731.154	19.85	pk	4.12	22.1	46.07	54	-7.93	149	Horz
3	4515.01	66.89	pk	-52.48	27.8	42.21	54	-11.79	100	Horz
4	1806.807	27.5	pk	3.59	26.7	57.79	54	3.79	100	Vert
5	2708.472	29.28	pk	4.14	22.1	55.52	54	1.52	150	Vert
6	4515.01	70.89	pk	-52.48	27.8	46.21	54	-7.79	100	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 915MHz, Y-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Limit 1	Margin 1[dB]	Height [cm]	Polarity
1	1829.83	25.51	pk	3.59	26.8	55.9	54	1.9	100	Horz
2	2745.831	20.8	pk	4.03	22.1	46.93	54	-7.07	100	Horz
3	4573.716	65.09	pk	-52.47	27.7	40.32	54	-13.68	100	Horz
4	1830.831	24.38	pk	3.6	26.8	54.78	54	.78	100	Vert
5	2744.496	30.13	pk	4.04	22.1	56.27	54	2.27	150	Vert
6	4573.716	68.56	pk	-52.47	27.7	43.79	54	-10.21	100	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 926MHz, Y-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Limit 1	Margin 1[dB]	Height [cm]	Polarity
1	2781.563	30.17	pk	4.24	22.2	56.61	54	2.61	100	Horz
2	2781.563	26.69	pk	4.24	22.2	53.13	54	-.87	150	Vert

LIMIT 1: CFR 47 Part 15 Class B 3m

pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

Table 25 Y-Axis Maximized Worst Case Peak and Average Measurement (Restricted Band Only)

FW Murphy
Model: M2 Wireless Remote #1
TX 903MHz, Y-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Duty Cycle Correction dB	Limit 1	Margin 1[dB]	Azimuth [degs]	Height [cm]	Polarity
2709.4078	32.78	pk	4.14	22.1	59.02	-	74	-14.98	345	145	Vert
2709.4078	26.17	av	4.14	22.1	52.41	12.86	54	-14.45	345	145	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 915MHz, Y-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Duty Cycle Correction dB	Limit 1	Margin 1[dB]	Azimuth [degs]	Height [cm]	Polarity
2745.3938	33.41	pk	4.03	22.1	59.54	-	74	-14.46	345	151	Vert
2745.3938	27.24	av	4.03	22.1	53.37	12.86	54	-13.49	345	151	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 926MHz, Y-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Duty Cycle Correction dB	Limit 1	Margin 1[dB]	Azimuth [degs]	Height [cm]	Polarity
2781.1784	34.99	pk	4.24	22.2	61.43	-	74	-12.57	169	115	Horz
2781.0581	31.05	av	4.24	22.2	57.49	12.86	54	-9.37	169	115	Horz
2781.2826	37.39	pk	4.24	22.2	63.83	-	74	-10.17	12	147	Vert
2781.0341	34.18	av	4.24	22.2	60.62	12.86	54	-6.24	12	147	Vert

LIMIT 1: CFR 47 Part 15 Class B 3m

pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

Figure 20 SPURIOUS EMISSIONS Preliminary Scan Data, Z-Axis, Low, Middle and High Channels

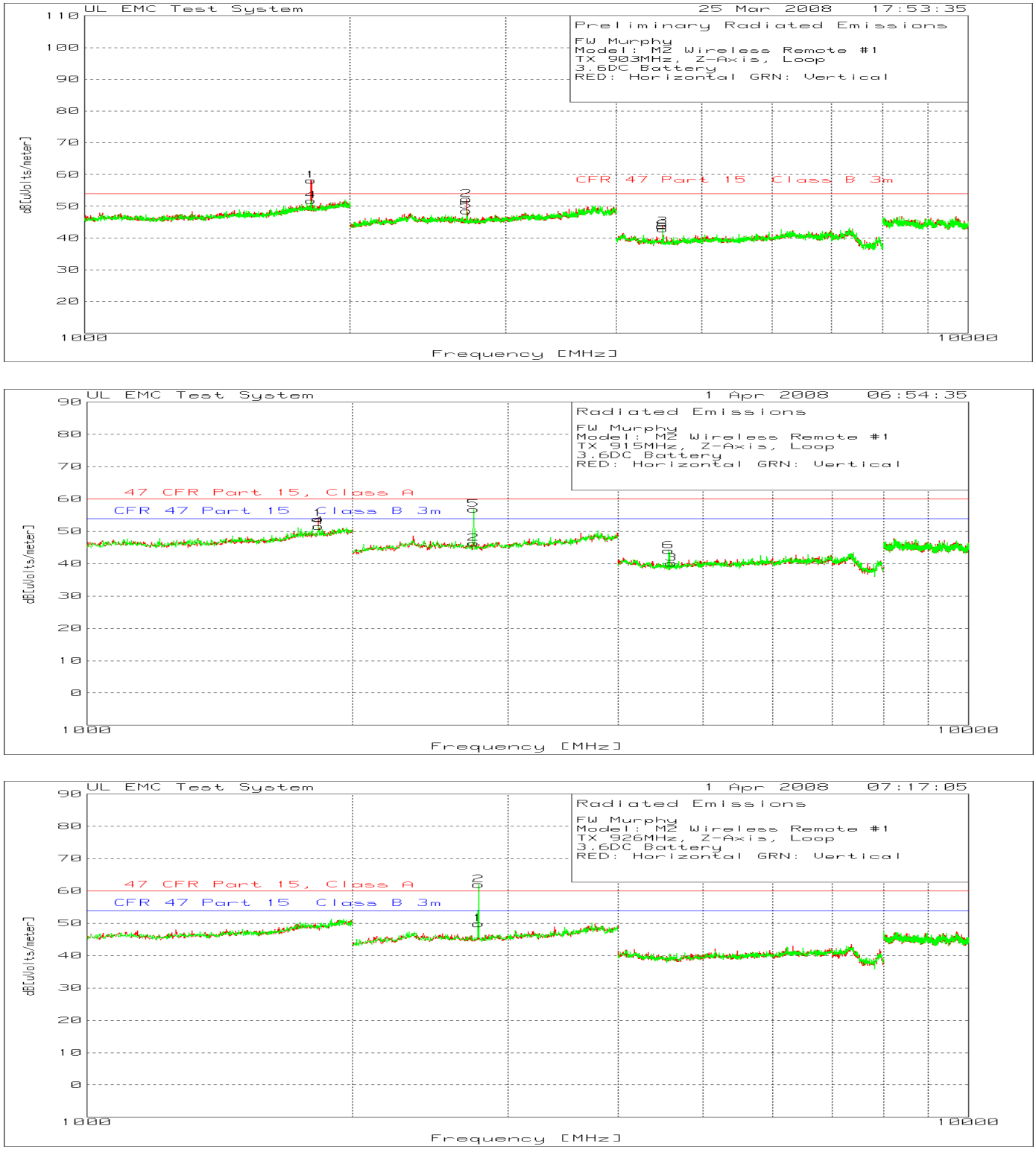


Table 26 Z-Axis Peak Scan Data

FW Murphy
Model: M2 Wireless Remote #1
TX 903MHz, Z-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Limit 1	Margin 1[dB]	Limit 1	Margin 1[dB]	Height [cm]	Polarity
1	1805.806	27.83	pk	3.59	26.7	58.12	60	-1.88	54	4.12	100	Horz
2	2708.472	26.02	pk	4.14	22.1	52.26	60	-7.74	54	-1.74	100	Horz
3	4512.342	68.45	pk	-52.5	27.8	43.75	60	-16.25	54	-10.25	100	Horz
4	1805.806	21.47	pk	3.59	26.7	51.76	60	-8.24	54	-2.24	150	Vert
5	2708.472	22.28	pk	4.14	22.1	48.52	60	-11.48	54	-5.48	150	Vert
6	4515.01	67.47	pk	-52.48	27.8	42.79	60	-17.21	54	-11.21	150	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 915MHz, Z-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Limit 1	Margin 1[dB]	Limit 2	Margin 2[dB]	Height [cm]	Polarity
1	1829.659	23.49	pk	3.58	26.8	53.87	60	-6.13	54	-.13	100	Horz
2	2745.491	20.2	pk	4.03	22.1	46.33	60	-13.67	54	-7.67	101	Horz
3	4608.609	64.7	pk	-52.23	27.7	40.17	60	-19.83	54	-13.83	150	Horz
4	1831.663	21.13	pk	3.61	26.8	51.54	60	-8.46	54	-2.46	100	Vert
5	2745.491	30.71	pk	4.03	22.1	56.84	60	-3.16	54	2.84	100	Vert
6	4572.573	68.77	pk	-52.46	27.7	44.01	60	-15.99	54	-9.99	150	Vert

FW Murphy
Model: M2 Wireless Remote #1
TX 926MHz, Z-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Marker Number	Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/meter]	Limit 1	Margin 1[dB]	Limit 2	Margin 2[dB]	Height [cm]	Polarity
1	2781.563	23.43	pk	4.24	22.2	49.87	60	-10.13	54	-4.13	100	Horz
2	2781.563	35.55	pk	4.24	22.2	61.99	60	1.99	54	7.99	150	Vert

LIMIT 1: 47 CFR Part 15, Class A
LIMIT 2: CFR 47 Part 15 Class B 3m

pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

Table 27 Z-Axis Maximized Worst Case Peak and Average Measurement (Restricted Band Only)

FW Murphy
Model: M2 Wireless Remote #1
RX, Z-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts/ meter]	Duty Cycle Correction dB	Limit 1	Margin 2[dB]	Azimuth [degs]	Height [cm]	Polarity
2745.1904	32.65	pk	4.03	22.1	58.78	-	74	-15.22	152	115	Horz
2745.0301	26.74	av	4.03	22.1	52.87	12.86	54	-13.99	152	115	Horz
2744.7244	29.3	pk	4.04	22.1	55.44	-	74	-18.56	37	174	Vert
2745.019	21.35	av	4.03	22.1	47.48	12.86	54	-19.38	37	174	Vert

LIMIT 1: 47 CFR Part 15, Class B

pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

FW Murphy
Model: M2 Wireless Remote #1
TX 926MHz, Z-Axis, Loop
3.6DC Battery
RED: Horizontal GRN: Vertical

Test Frequency [MHz]	Meter Reading [dB(uV)]	Detector Type	Gain/Loss Factor [dB]	Transducer Factor [dB]	Level dB[uVolts /meter]	Duty Cycle Correctio	Limit 1	Margin 2[dB]	Azimuth [degs]	Height [cm]	Polarity
2781.1122	29.71	pk	4.24	22.2	56.15	-	74	-17.85	218	107	Horz
2781.024	22.99	av	4.24	22.2	49.43	12.86	54	-17.43	218	107	Horz
2780.8597	30.67	pk	4.25	22.2	57.12	-	74	-16.88	257	144	Vert
2781.0361	23.66	av	4.24	22.2	50.1	12.86	54	-16.76	257	144	Vert

LIMIT 1: 47 CFR Part 15, Class B

pk - Peak detector
qp - Quasi-Peak detector
av - Average detector

4.8 Test Conditions and Results – Radiated Emissions – Digital / Receiver

Test Description	Measurements were made in a 10-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.4. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 10-meter below 1GHz and 3 meters above 1GHz. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in both horizontal and vertical polarities. Final measurements (quasi-peak or average as noted) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4-meters. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.

Basic Standard	47 CFR Part 15.209 RSS-Gen 7.2.1 and 7.2.3	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	(10 meter measurement distance)
Fully configured sample scanned over the following frequency range	1GHz – 10GHz	(3 meter measurement distance)

Limits

Frequency (MHz)	Limit (dBµV/m)		
	Quasi-Peak	Average	
	General Emissions	Fundamental	Spurious
30 – 88	40	-	-
88 – 216	43.5	-	-
216-960	46	-	
1,000-25,000	-	-	54

Supplementary information: None

Table 28 SPURIOUS EMISSIONS EUT Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	1	1, 2

Supplementary information: None

Table 29 SPURIOUS EMISSIONS Test Equipment

Description	Manufacturer	Model	Identifier
Spectrum Analyzer	HP	8566B	EMC4085
Quasi-Peak Detector	HP	85650A	EMC4016
Bicon Antenna	Electro-Metrics	EM6912A	EMC4070
Log-P Antenna	Chase	UPA6109	EMC4258
Spectrum Analyzer	Rhode & Schwartz	FSEK	EMC4182
Antenna Array	UL	BOMS	EMC4276

Figure 21 Test setup for SPURIOUS EMISSIONS

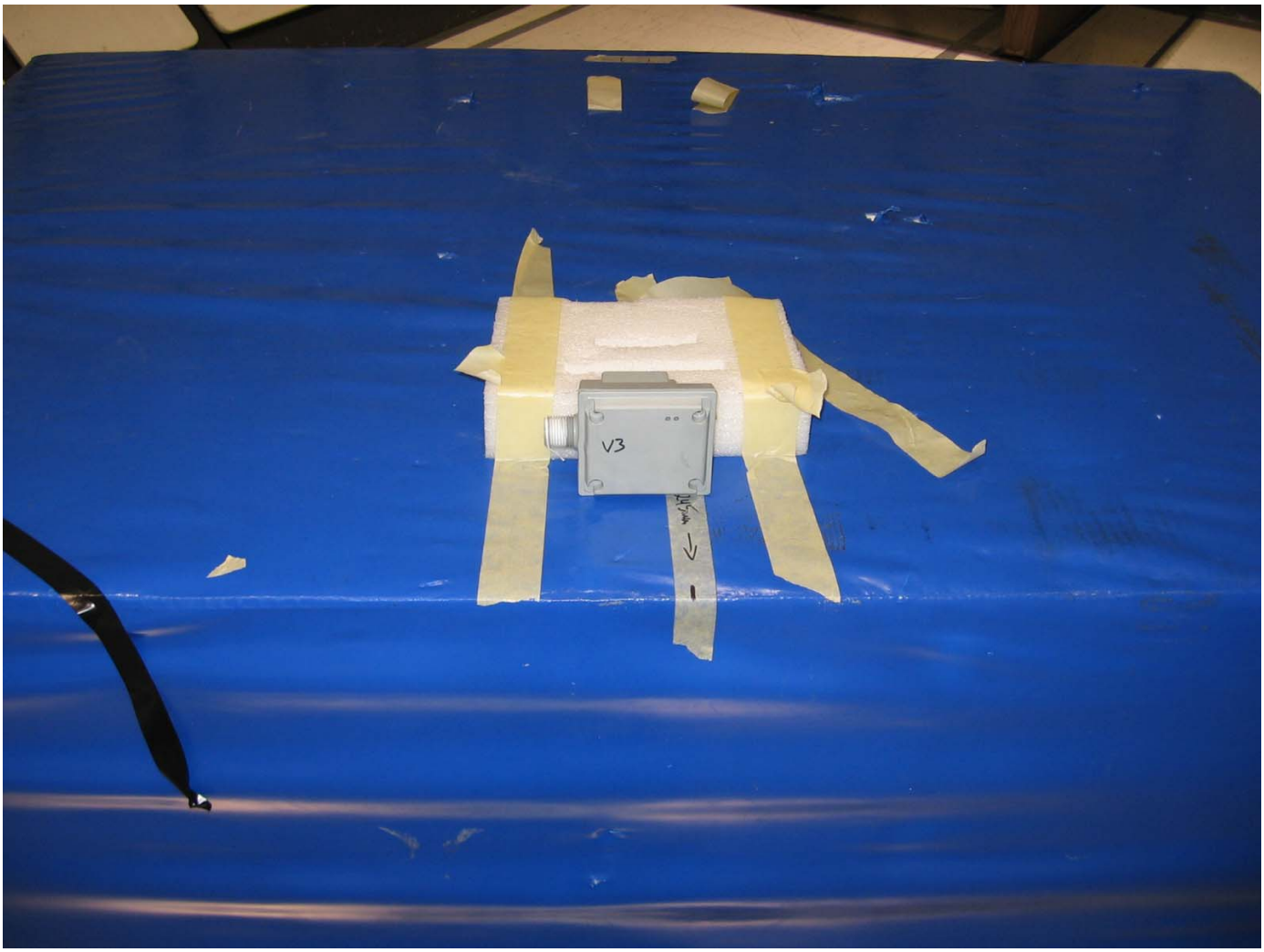
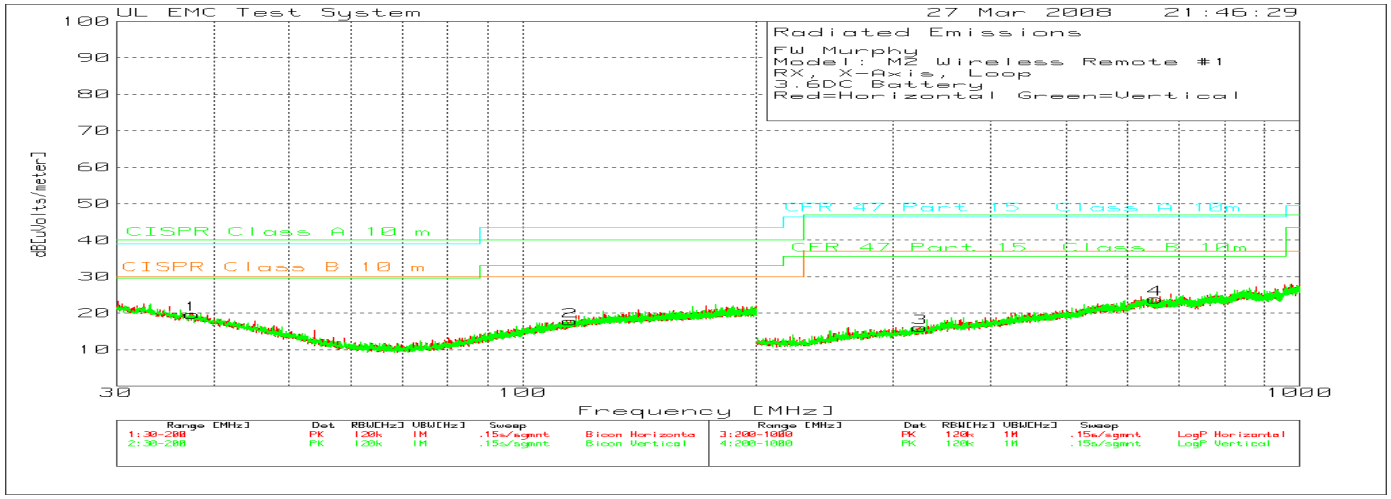
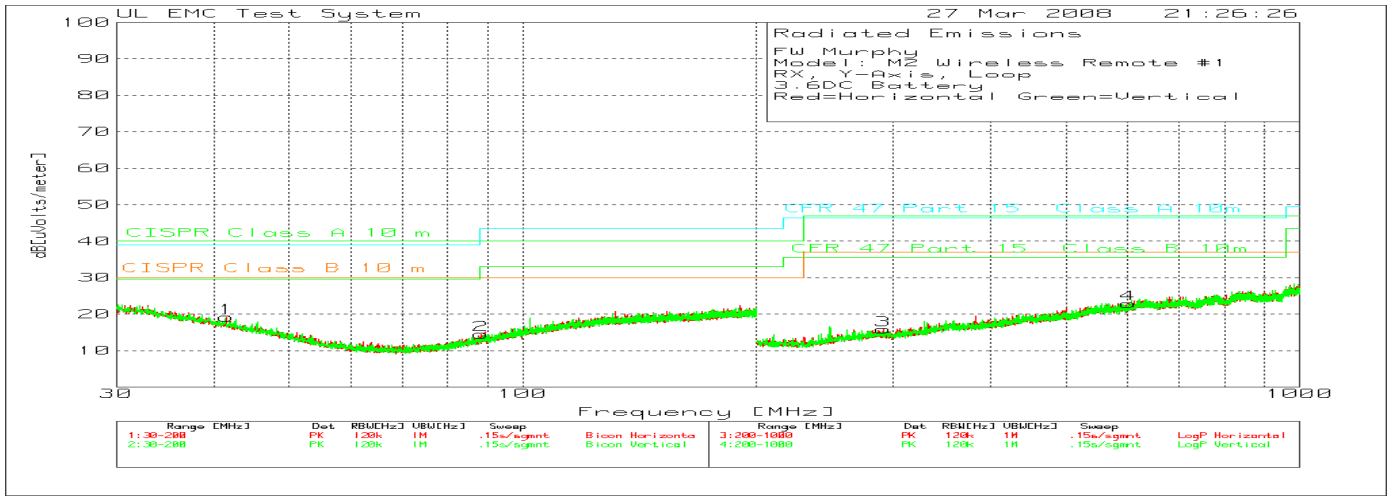
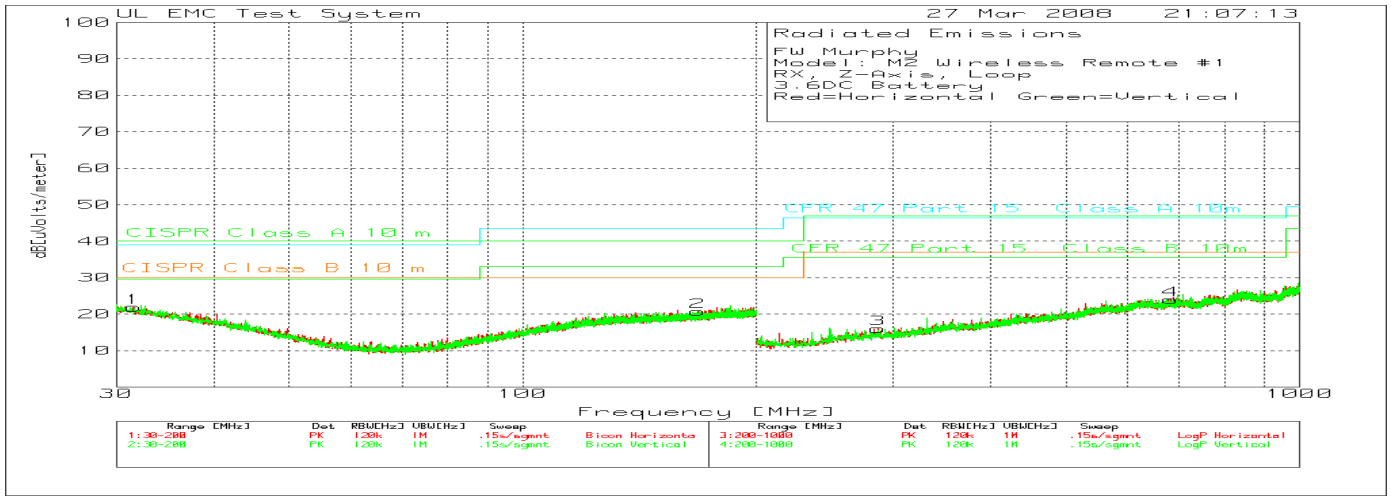


Figure 22 Radiated Emissions Graph 30MHz – 1GHz

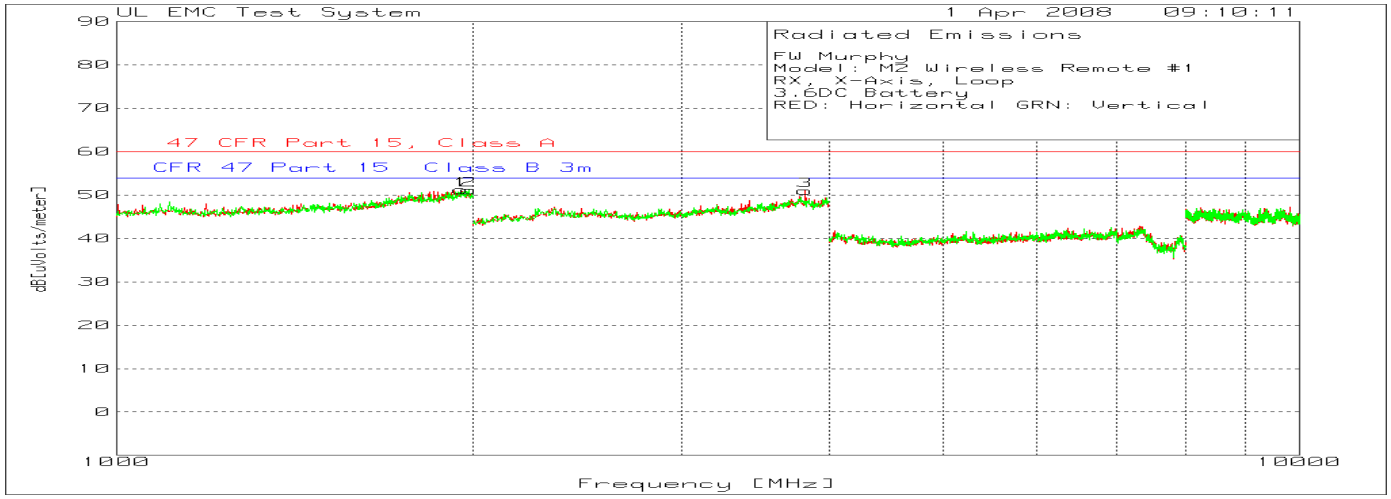


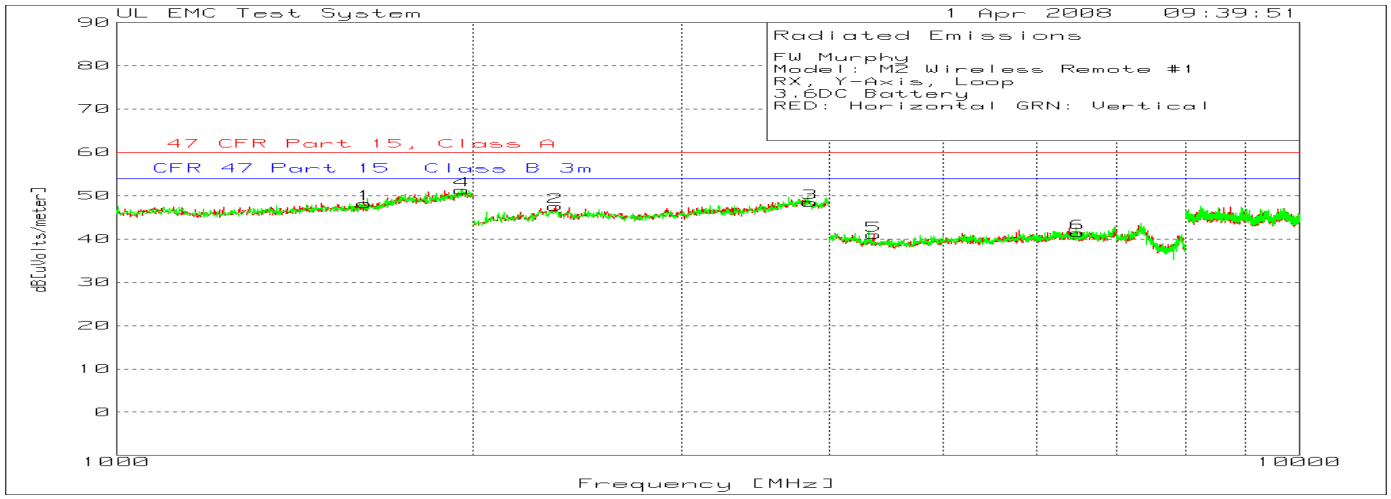


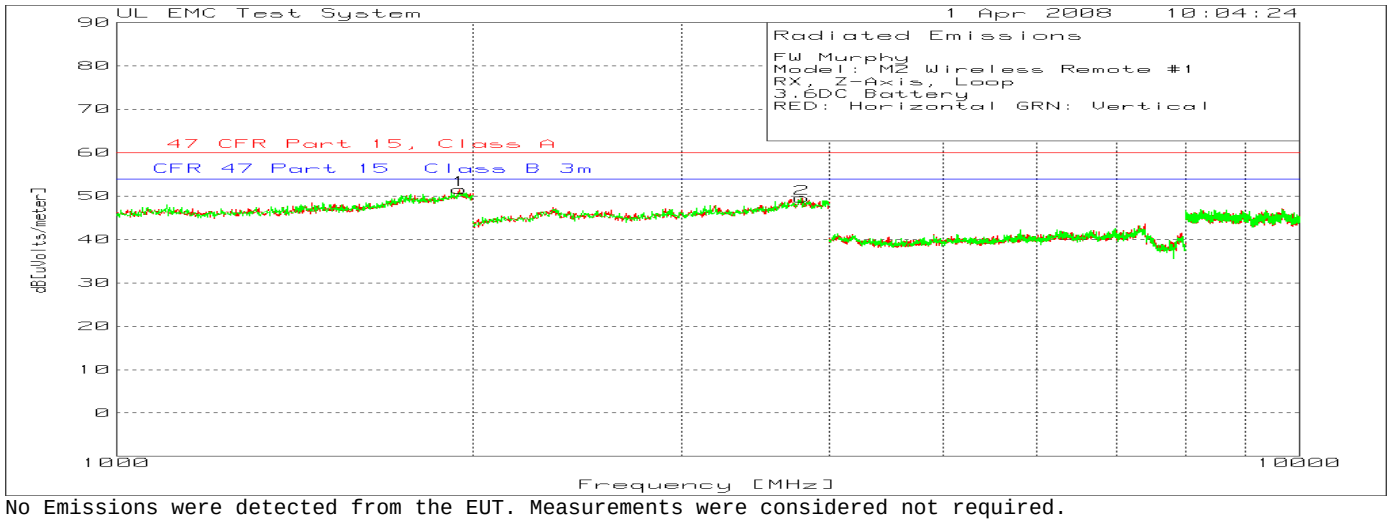


No emissions were detected in RX / Digital Mode. Measurements are not considered required.

Figure 23 Radiated Emissions Graph 1GHz – 10GHz







No Emissions were detected from the EUT. Measurements were considered not required.

4.9 Test Conditions and Results – 99% Bandwidth

Test Description	When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.	
Basic Standard	RSS-Gen 4.6.1	
UL LPG	None	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	902 MHz – 928 MHz	Antenna Port Conducted
Supplementary information: None		

Table 30 99% Bandwidth EUT Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	2	1
Supplementary information: None		

Table 31 99% Bandwidth Test Equipment

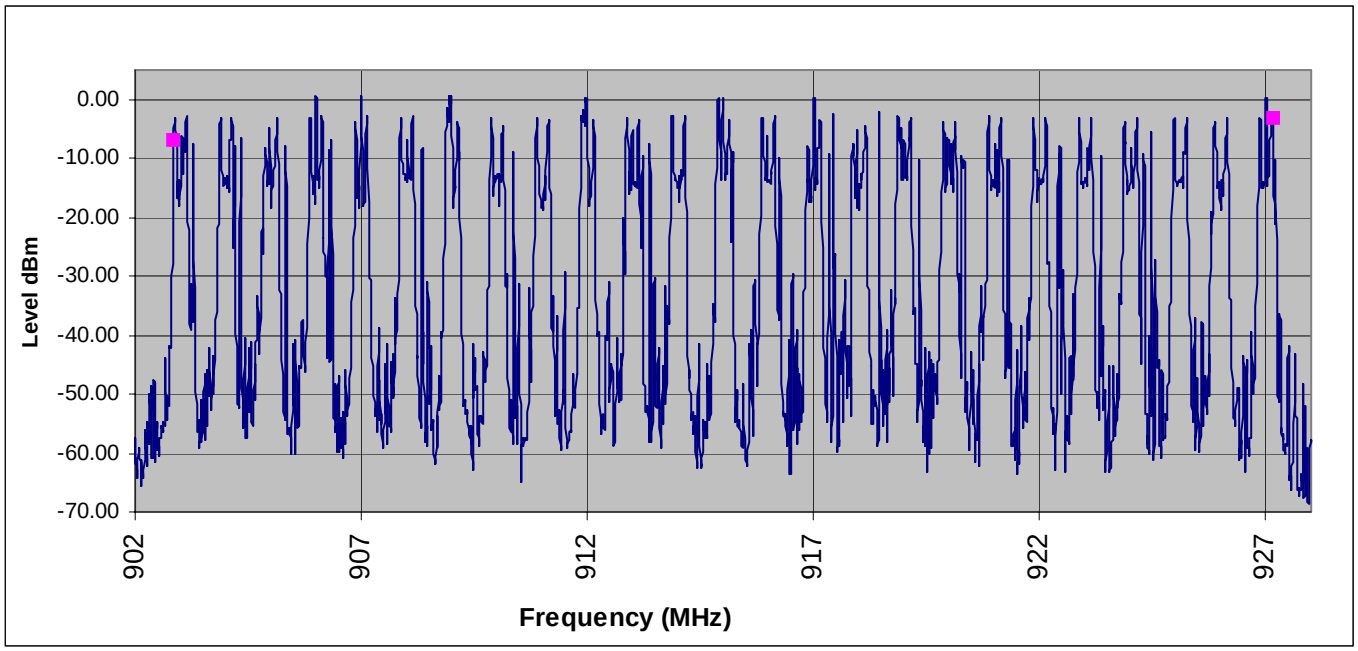
Description	Manufacturer	Model	Identifier
Spectrum Analyzer	Agilent	E7405A	US41160342
Attenuator	Pasternek	10dB	None

Table 32 99% Bandwidth Results

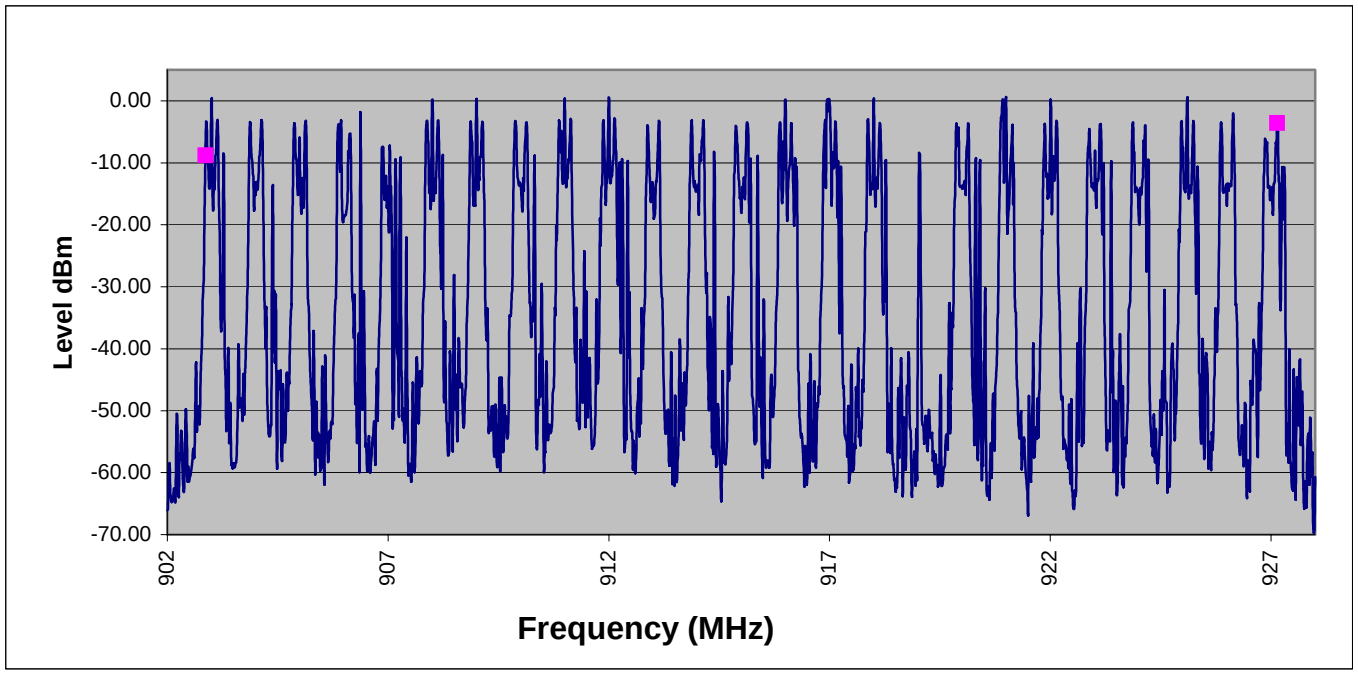
Modulation Mode	99% Bandwidth
Double Burst, All Channels	24,277.500kHz
Single Burst, All Channels	24,277.500kHz
Double Burst, Low Channel	318.125kHz
Double Burst, Middle Channel	324.375kHz
Double Burst, High Channel	333.750kHz

Figure 24 99% Band Width

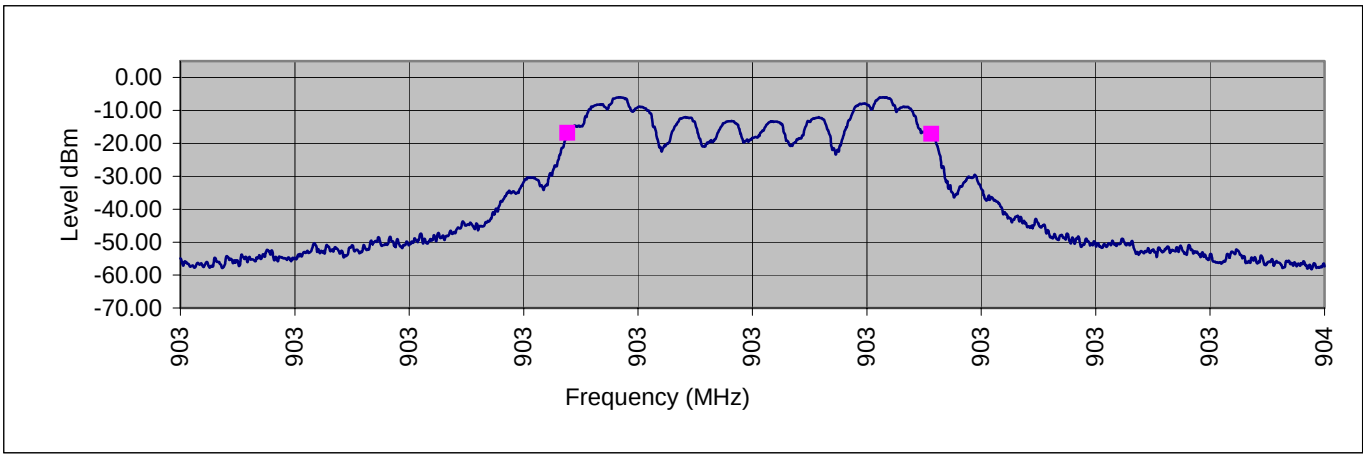
99%, All Channels, Double Burst



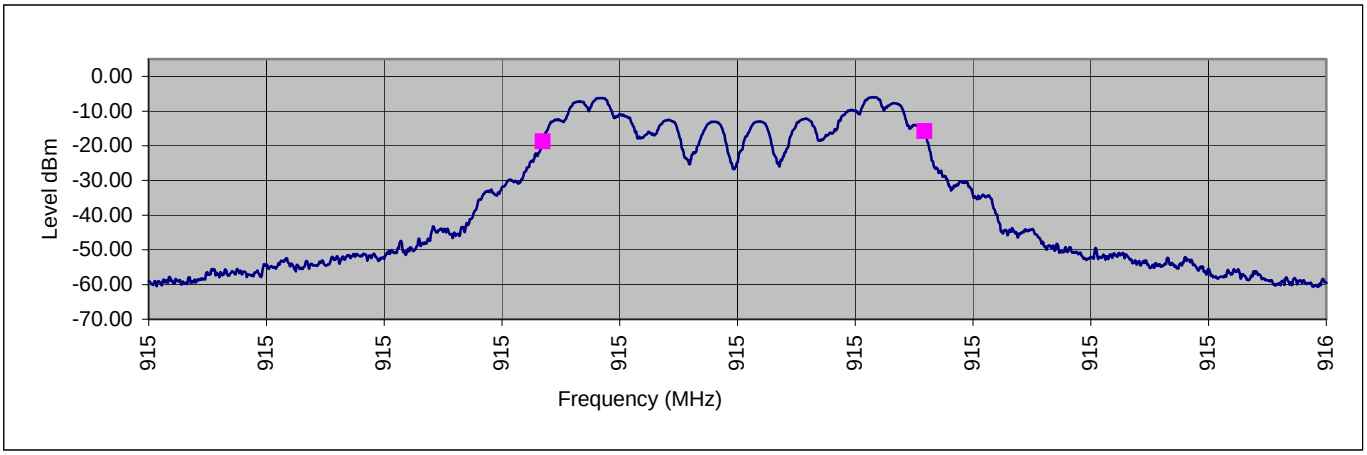
99%, All Channels, Single Burst



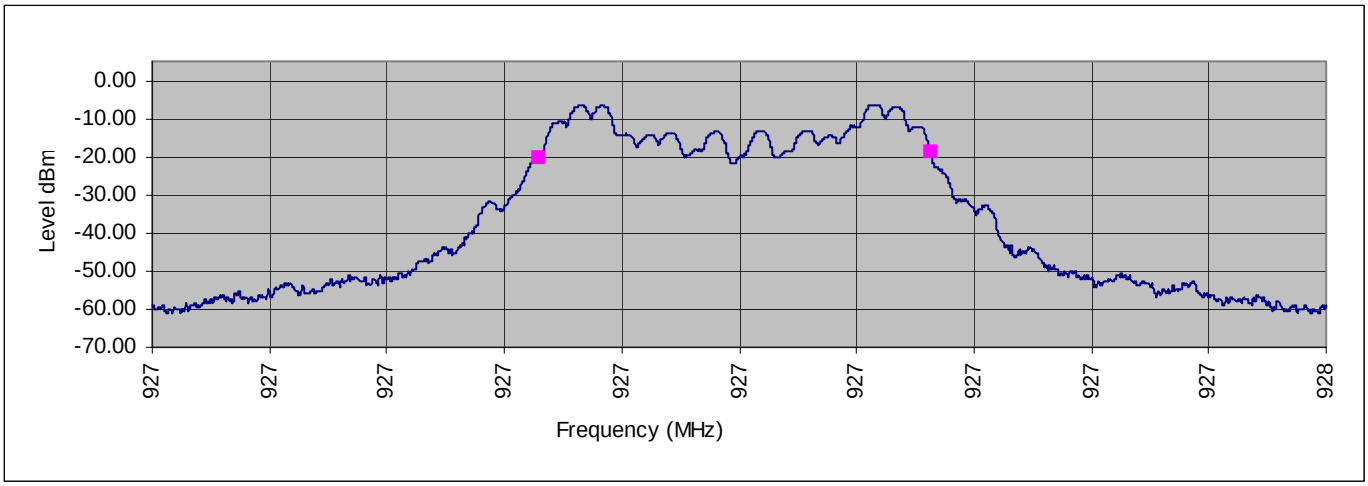
99% BW, Low Channel, Double Burst



99% BW, Middle Channel, Double Burst



99% BW, High Channel, Double Burst



5.0 IMMUNITY TEST RESULTS

The immunity tests were not performed nor required:

Appendix A

Accreditations and Authorizations

NVLAP Lab code: 100414-0

NVLAP: Recognized under the National Voluntary Laboratory Accreditation Program (NVLAP) for satisfactory compliance with criteria established in Title 15, Part 285 Code of Federal Regulations. These criteria encompass the requirements of ISO/IEC EN17025 and the relevant requirements of ISO 9002 (ANSI/ASQC Q92-1987) as suppliers of calibration or test results. For a full scope listing see http://ts.nist.gov/ts/htdocs/210/214/scopes/1004140.htm

FCC: Details of the measurement facilities used for these tests have been filed with the Federal Communications Commission's Laboratory in Columbia, Maryland (Ref. No. 91044).

Industry Canada Industrie Canada

Industry of Canada: Accredited by Industry Canada for performance of radiated measurements. Our test site complies with RSP 100, Issue 7, Section 3.3. File #: IC 2180

VCCI: Accepted as an Associate Member to the VCCI. The measurement facilities detailed in this test report have been registered in accordance with Regulations for Voluntary Control Measures, Article 8. Registration Nos.: Radiated Emissions R-621, Conducted Emissions C-642.

ICASA: ICASA (Independent Communications Authority of South Africa) has appointed UL as a Designated Test Laboratory to test Telecommunications equipment for type approval in compliance with CISPR 22 to assist in fulfilling its mandate under section 54(1) of the Telecommunications Act, 1996 (Act 103 of 1996).

NIST/CAB: Validated by the European Commission as a U.S. Conformity Assessment Body (CAB) of the U.S.-EU Mutual Recognition Agreement (MRA) for the Electromagnetic Compatibility - Council Directive 89/336/EEC, Article 10 (2). Also validated for the Telecommunication Equipment-Council Directive 99/5/EC, Annex III and IV, Identification Number: 0983.
NIST/CAB: Provisioned to act as a U.S. Conformity Assessment Body (CAB) under Appendix B, Phase I Procedures, of the Asia Pacific Economic Cooperation (APEC) MRA between the American Institute in Taiwan (AIT) and the United States. Our laboratory is considered qualified to test equipment subject to the applicable EMC regulations of the Chinese Taipei Bureau of Standards, Metrology and Inspection (BSMI) which require testing to CNS 13438 (CISPR 22).
NIST/CAB: Recognized by the Infocomm Development Authority of Singapore (IDA) under the Asia Pacific Economic Cooperation Mutual Recognition Agreement (APEC MRA). Our laboratory is provisionally designated to act as a Conformity Assessment Body (CAB) under Appendix B, Phase I Procedures, of the APEC MRA. Our scope of designation includes IDA TS EMC (CISPR 22), IEC 61000-4-2, -4-3, -4-4, -4-5, and -4-6