

FCC Part 15 Subpart C Transmitter Certification

Direct Sequence Spread Spectrum Transmitter

Test Report

FCC ID: HSW-ZMN2400

FCC Rule Part: 15.247

ACS Report Number: 05-0454-15C-B

Manufacturer: Cirronet, Inc.
Model: ZMN2400


Test Begin Date: December 12, 2005

Test End Date: December 20, 2005

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FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612

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This report contains 20 pages

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1.0 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15, Subpart C of the FCC's Code of Federal Regulations.

1.2 Product Description

1.2.1 General

The Cirronet ZMN2400 Series radio modules utilizes the IEEE 802.15.4 standard ZigBee Physical layer hardware for wireless low data rate monitoring and control applications. The application of the ZMN2400 Series is a wireless network for data collection in industrial monitoring and control.

1.2.2 Manufacturer Information

Cirronet Inc
3079 Premiere Parkway
Suite 140
Duluth, GA 30097

1.2.3 Antenna List

Manufacture	Antenna Type	Model Number	Antenna Gain	Connector Type
Mobile Mark	Corner Ref.	SCR14-2400	14 dBi	Type N
Mobile Mark	Omni	OD9-2400	9 dBi	Type N
Cirronet	Patch	PA12	12 dBi	MMCX

2.0 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment. In addition, ACS is compliant to ISO 17025 as certified by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program. The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 89450

Industry Canada Lab Code: IC 4175

VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

NVLAP Lab Code: 200612

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

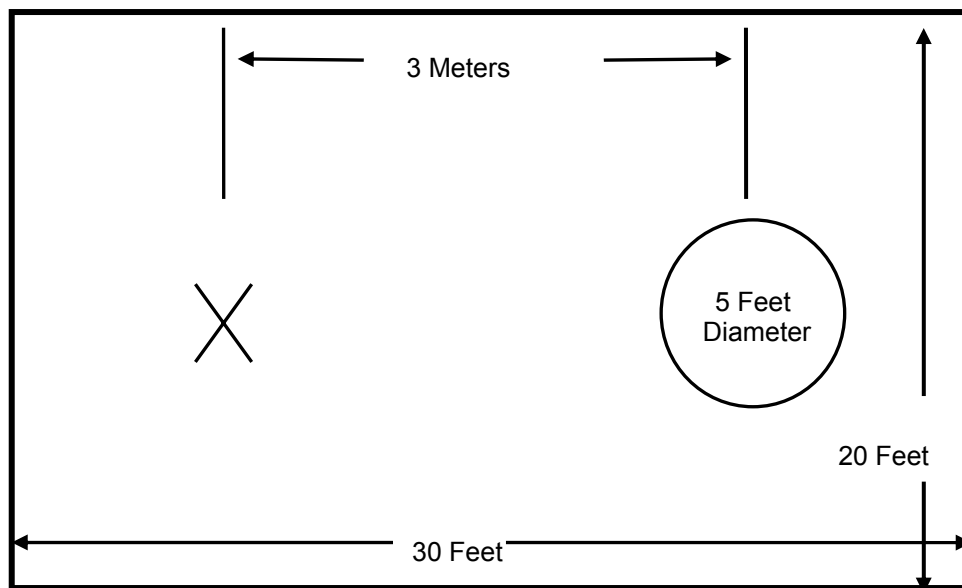


Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style reinforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

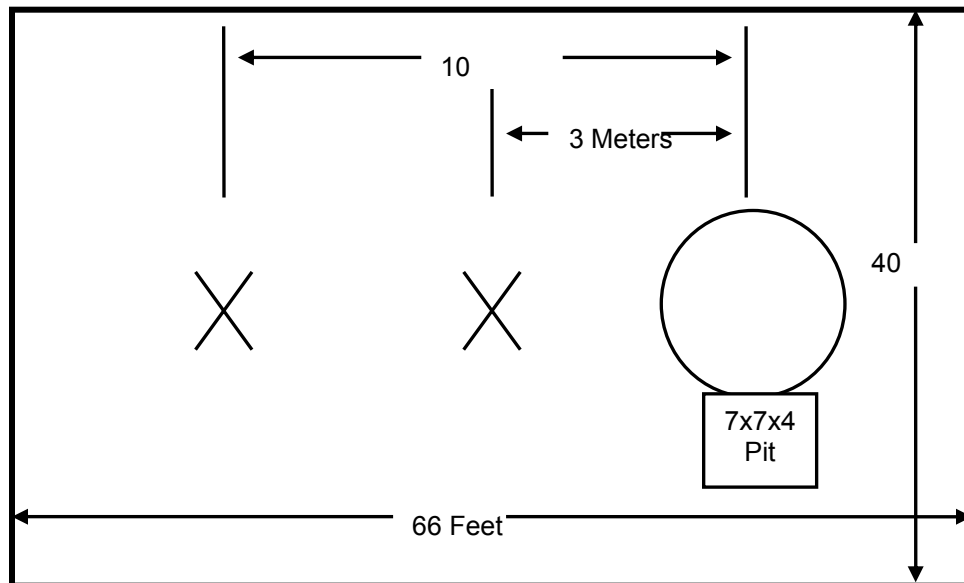


Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is a shielded room with the following dimensions:

- Height: 3.0 Meters
- Width: 3.6 Meters
- Length: 4.9 Meters

The room is manufactured by Rayproof Corporation and installed by Panashield, Inc. Earth ground is provided to the room via an 8' copper ground rod. Each panel of the room is connected electrically at intervals of 4".

Power to the room is filtered to prevent ambient noise from coupling to the EUT and measurement equipment. Filters are models 1B42-60P manufactured by Rayproof Corporation.

The room is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 2.4-1:

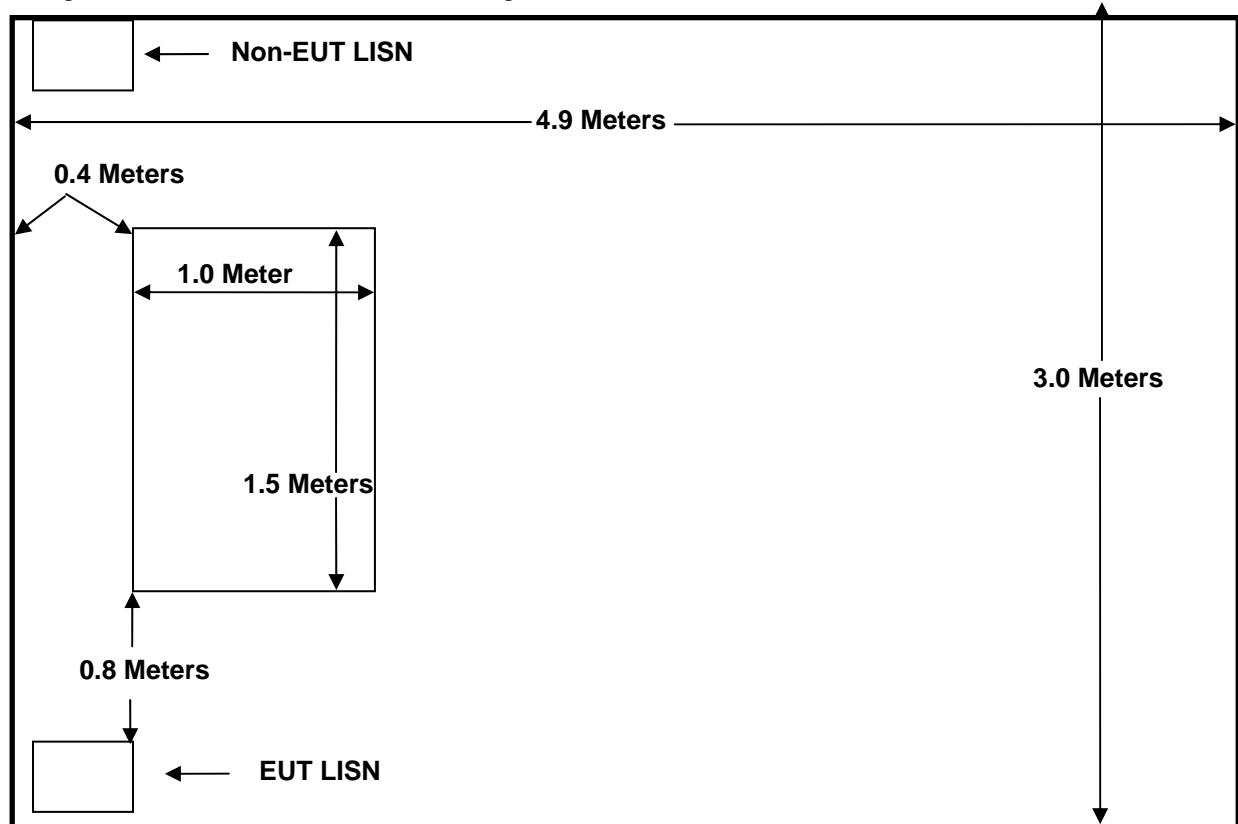


Figure 2.4-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

- 1 - ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the 9 KHz to 40GHz
- 2 - US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators
- 3 - FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

4.0 LIST OF TEST EQUIPMENT

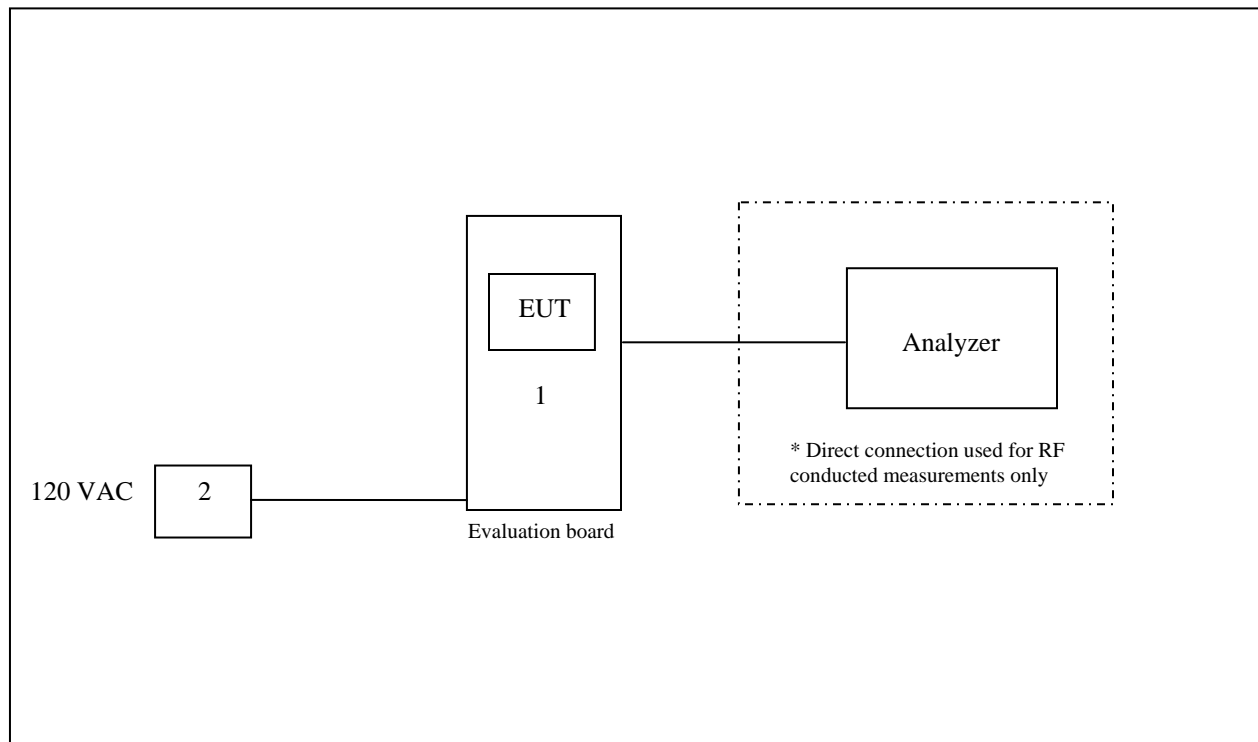
All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

Table 4.0-1: Test Equipment

Equipment Calibration Information					
ACS#	Mfg.	Eq. type	Model	S/N	Cal. Due
<input type="checkbox"/> 25	Chase	Bi-Log Antenna	CBL6111	1043	5/23/06
<input type="checkbox"/> 268	Agilent	Sensor	N1921A	MY45240184	10/10/06
<input type="checkbox"/> 041	ElectroMetrics	Bi-Con Antenna	BIA-25	2925	5/25/06
<input type="checkbox"/> 090	ElectroMetrics	LPA Antenna	LPA-25	1476	5/27/06
<input type="checkbox"/> 78	EMCO	Loop Antenna	6502	9104-2608	1/13/2006
<input type="checkbox"/> 152	EMCO	LISN	3825/2	9111-1905	1/18/06
<input type="checkbox"/> 153	EMCO	LISN	3825/2	9411-2268	12/5/06
<input type="checkbox"/> 225	Andrew	OATS RF cable	Helix	225	1/07/07
<input type="checkbox"/> 165	ACS	Conducted EMI Cable Set	RG8	165	1/06/06
<input type="checkbox"/> 22	Agilent	Pre-Amplifier	8449B	3008A00526	5/06/06
<input type="checkbox"/> 73	Agilent	Pre-Amplifier	8447D	272A05624	5/18/06
<input type="checkbox"/> 30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	5/09/06
<input type="checkbox"/> 105	Microwave Circuits	High Pass Filter	H1G810G1	2123-01 DC0225	9/13/06
<input type="checkbox"/> 209	Microwave Circuits	High Pass Filter	H3G020G2	4382-01 DC0421	9/20/06
<input type="checkbox"/> 1	Rohde & Schwarz	Receiver Display	804.8932.52	833771/007	3/07/06
<input type="checkbox"/> 2	Rohde & Schwarz	ESMI Receiver	1032.5640.53	839587/003	3/07/06
<input type="checkbox"/> 3	Rohde & Schwarz	Receiver Display	804.8932.52	839379/011	11/02/06
<input type="checkbox"/> 4	Rohde & Schwarz	ESMI Receiver	1032.5640.53	833827/003	11/02/06
<input type="checkbox"/> ---	Agilent	Spectrum Analyzer	E7405A	US39110103	6/6/06
<input type="checkbox"/> 213	Test Equipment Corp.	Pre-Amplifier	PA-102	44927	12/5/06
<input type="checkbox"/> 204	ACS	Cable	RG8	204	3/16/06
<input type="checkbox"/> 6	Harbour Industries	HF RF Cable	LL-335	00006	3/16/06
<input type="checkbox"/> 7	Harbour Industries	HF RF Cable	LL-335	00007	3/16/06
<input type="checkbox"/> 208	Harbour Industries	HF RF Cable	LL142	00208	6/24/06
<input type="checkbox"/> 167	ACS	Chamber EMI Cable Set	RG6	167	1/7/07
<input type="checkbox"/> 204	ACS	Chamber EMI RF cable	RG8	204	3/16/06
<input type="checkbox"/> 237	Gigatronics	Signal Generator	900	282706	1/10/07
<input type="checkbox"/> 267	Agilent	Power Meter	N1911A	MY45100129	10/30/06

5.0 SUPPORT EQUIPMENT**Table 5-3: Support Equipment**

Item	Equipment Type	Manufacturer	Model Number	Serial Number	FCC ID
1	Evaluation Board	Cirronet	NA	NA	NA
2	Volgen	Power Supply	SPU10R-2	NA	NA

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM**Figure 6-1: EUT Test Setup**

7.0 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement - FCC Section 15.203

Cirronef's ZigBee Module output is through a set of connections which are like a ball grid array and once soldered to a PC board the connects are not accessible. Without a support PC board the module is unusable. The antennas evaluated with this device are listed in Section 1.2.3.

7.2 Power Line Conducted Emissions - FCC Section 15.207

7.2.1 Test Methodology

ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss

Margin = Applicable Limit - Corrected Reading

7.2.2 Test Results

Results of the test are shown below in and Tables 7.2-1 through 7.2-4 and Figure 7.2-1 through 7.2-2.

Table 7.2-1: Line 1 Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dBμV	Transducer dB	Limit dBμV	Margin dB	Line	PE
8.070	12.5	9.6	60.0	47.4	L1	FLO
8.124	17.3	9.6	60.0	42.6	L1	FLO
8.226	14.9	9.6	60.0	45.0	L1	FLO
8.334	17.3	9.6	60.0	42.6	L1	FLO
8.544	19.8	9.6	60.0	40.1	L1	FLO
8.754	25.9	9.6	60.0	34.0	L1	FLO
9.900	24.5	9.5	60.0	35.5	L1	FLO
10.422	22.0	9.5	60.0	37.9	L1	FLO

Table 7.2-2: Line 1 Conducted EMI Results (Average)

Frequency MHz	Level dBμV	Transducer dB	Limit dBμV	Margin dB	Line	PE
8.028	30.3	9.6	50.0	19.6	L1	FLO
8.130	25.2	9.6	50.0	24.7	L1	FLO
8.238	26.4	9.6	50.0	23.5	L1	FLO
8.340	19.0	9.6	50.0	30.9	L1	FLO
8.550	24.8	9.6	50.0	25.1	L1	FLO
8.760	30.9	9.6	50.0	19.0	L1	FLO
9.906	31.2	9.5	50.0	18.7	L1	FLO
10.530	18.4	9.5	50.0	31.5	L1	FLO

Table 7.2-3: Line 2 Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dB μ V	Transducer dB	Limit dB μ V	Margin dB	Line	PE
0.522	36.8	9.7	56.0	19.1	L2	FLO
0.630	42.6	9.7	56.0	13.3	L2	FLO
0.732	38.8	9.7	56.0	17.1	L2	FLO
1.464	36.1	9.7	56.0	19.8	L2	FLO
1.566	36.0	9.7	56.0	19.9	L2	FLO
1.674	36.0	9.7	56.0	19.9	L2	FLO
2.610	34.8	9.6	56.0	21.1	L2	FLO
28.206	39.4	8.8	60.0	20.5	L2	FLO

Table 7.2-4: Line 2 Conducted EMI Results (Average)

Frequency MHz	Level dB μ V	Transducer dB	Limit dB μ V	Margin dB	Line	PE
0.522	36.3	9.7	46.0	9.6	L2	FLO
0.630	42.1	9.7	46.0	3.8	L2	FLO
0.732	38.2	9.7	46.0	7.7	L2	FLO
1.464	35.7	9.7	46.0	10.2	L2	FLO
1.566	35.5	9.7	46.0	10.4	L2	FLO
1.674	35.4	9.7	46.0	10.5	L2	FLO
2.610	34.0	9.6	46.0	11.9	L2	FLO
28.104	38.3	8.8	50.0	11.6	L2	FLO
28.206	36.7	8.8	50.0	13.2	L2	FLO

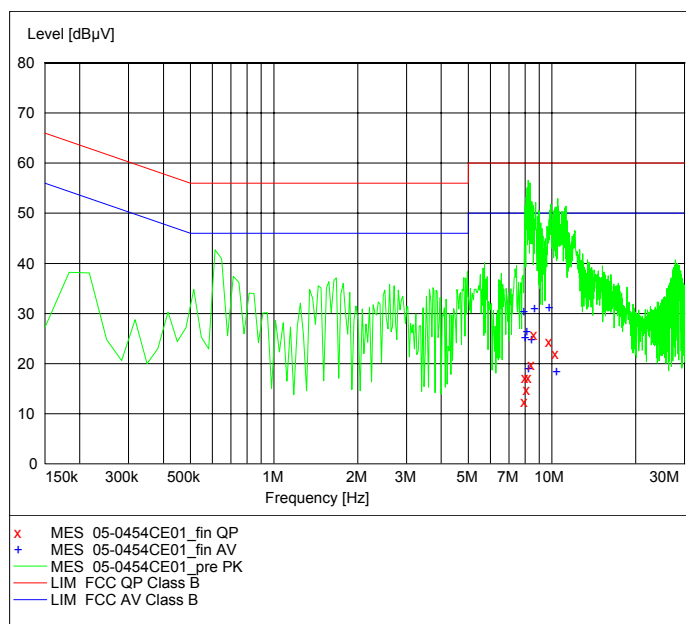


Figure 7.2-1: Conducted Emissions Graph – Line 1

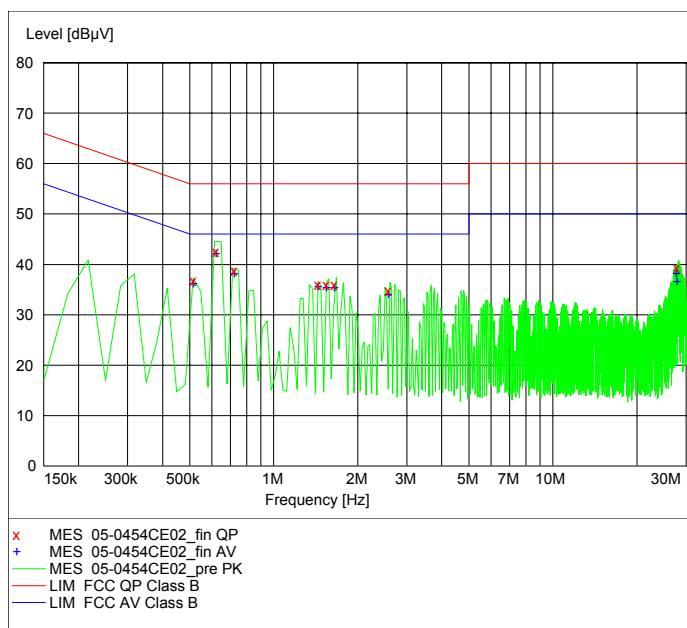


Figure 7.2-2: Conducted Emissions Graph – Line 2

7.3 Radiated Emissions - FCC Section 15.109(Unintentional Radiation)

7.3.1 Test Methodology

Radiated emissions tests were performed over the frequency range of 30MHz to 1 GHz. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Radiated measurements were made with the Spectrum Analyzer's resolution bandwidth set to 120 KHz for measurements above 30MHz.

7.3.2 Test Results

Results of the test are given below in Table 7.3.2-1:

Table 7.3.2-1: Radiated Emissions

Frequency (MHz)	Polarization (H/V)	Height (cm)	Azimuth (deg)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
30.16	VERTICAL	100	156	30.2	40	9.8
77.04	VERTICAL	130	352	1.1	40	38.9
116.08	VERTICAL	105	244	15.8	43.5	27.7
135.6	VERTICAL	104	210	13.5	43.5	30
151.36	VERTICAL	100	200	17.1	43.5	26.4
225.36	VERTICAL	105	358	12	46	34
269.92	VERTICAL	130	272	9.4	46	36.6
481.6	HORIZONTAL	260	60	18.4	46	27.6
704	HORIZONTAL	370	110	23.6	46	22.4
953.36	HORIZONTAL	310	110	26.4	46	19.6

* Note: All emissions above 953.36 MHz were attenuated at least 20 dB below the permissible limit.

7.4 6dB Bandwidth – FCC Section 15.247(a)

7.4.1 Test Methodology

The 6dB bandwidth was measured in accordance with the FCC publication “New Guidance on Measurements for Digital Transmission Systems in Section 15.247”. The RBW of the spectrum analyzer was set to 100 kHz and VBW 300 kHz. Span was set large enough to capture the entire emissions and >> RBW.

7.4.2 Test Results

Results are shown below in table 7.4.2-1 and figure 7.4.2-1 to 7.4.2-3:

Table 7.4.2-1: 6dB Bandwidth

Frequency [MHz]	Bandwidth [MHz]	Limit	Result
2405	1.55	≥ 500 kHz	PASS
2440	1.59	≥ 500 kHz	PASS
2475	1.58	≥ 500 kHz	PASS

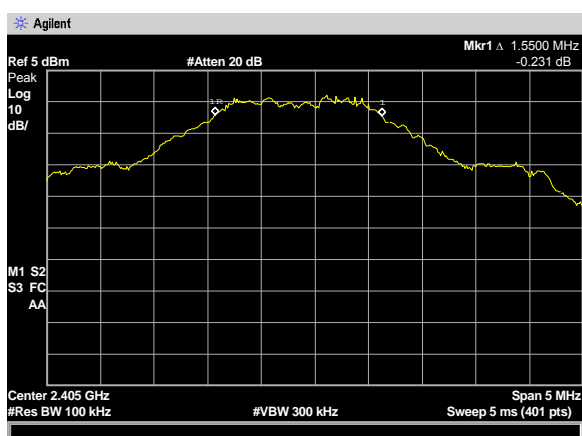


Figure 7.4.2-1: 6dB Bandwidth Plot – Low Channel

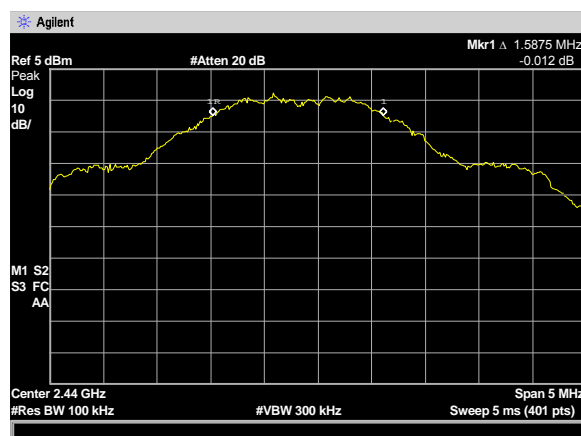


Figure 7.4.2-2: 6dB Bandwidth Plot – Mid Channel

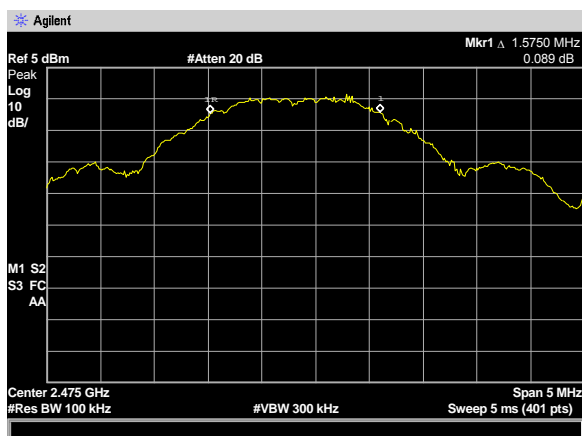


Figure 7.4.2-3: 6dB Bandwidth Plot – High Channel

7.5 Peak Output Power Requirement - FCC Section 15.247(b)

7.5.1 Test Methodology

The Peak Output Power was measured in accordance with the FCC publication “New Guidance on Measurements for Digital Transmission Systems in Section 15.247” Power Option 1. The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer. The resolution bandwidth of the spectrum analyzer was set to 3 MHz.

Data was collected with the EUT operating at maximum power.

7.5.2 Test Results

Results are shown below in Table 7.5.2-1 and figures 7.5.2-1 to 7.5.2-3

Table 7.5.2-1: Peak Output Power

Frequency (MHz)	Output Power (dBm)
2405	0.60
2440	0.68
2475	0.21

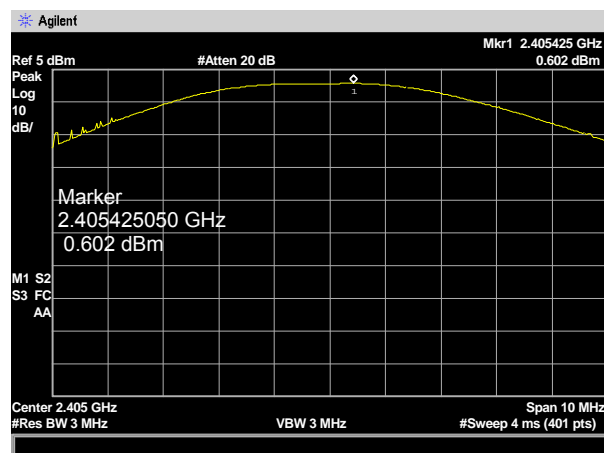


Figure 7.5.2-1: Peak Output Power Plot – Low Channel

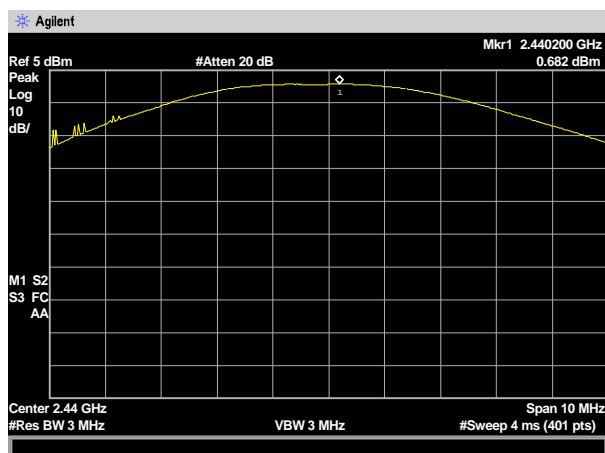


Figure 7.5.2-2: Peak Output Power Plot – Mid Channel

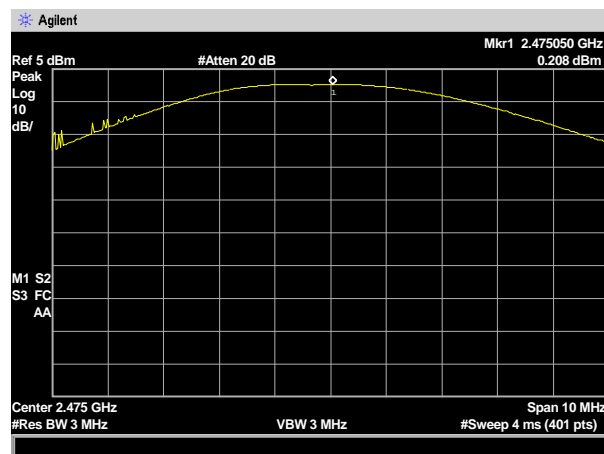


Figure 7.5.2-3: Peak Output Power Plot – High Channel

7.6 Band-Edge Compliance and Spurious Emissions - FCC Section 15.247(d)

7.6.1 Band-Edge Compliance of RF Emissions

7.6.1.1 Test Methodology

The EUT was investigated at the low and high channels of operation to determine band-edge compliance. All antenna types were evaluated. Because the upper band-edge coincides with a restricted band, band-edge compliance for the upper band-edge was determined using the radiated mark-delta method as outlined in FCC DA 00-705. The radiated field strength of the fundamental emission was first determined and then the mark-delta method was used to determine the field strength of the band-edge emissions.

The lower band-edge compliance was determined using the marker-delta method in which the radio frequency power that is produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

7.6.1.2 Test Results

Band-edge compliance is displayed in Table 7.6.1.2-1 – 7.6.1.2-3 and Figures 7.6.1.2-1 – 7.6.1.2-6.

Table 7.6.1.2-1: Upper Band-edge Marker Delta Method – 9 dBi Omni-directional Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Fundamental Field Strength (dBuV/m)		Delta- Marker (dB)	Band-edge Field Strength (dBuV/m)		Margin to Limit (dBuV/m)	
	pk	avg			pk	avg		pk	avg	pk	avg
	Fundamental Frequency										
2475	102.30	102.30	V	0.46	102.76	102.76	53.53	49.23	3.21	24.77	50.79

Table 7.6.1.2-2: Upper Band-edge Marker Delta Method – 12 dBi Patch Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Field Strength (dBuV/m)		Delta- Marker (dB)	Band-edge Field Strength (dBuV/m)		Margin to Limit (dBuV/m)	
	pk	avg			(H/V)	(dB)		pk	avg	pk	avg
	Fundamental Frequency										74
2475	107.60	107.60	V	0.46	108.06	108.06	53.13	54.93	8.91	19.07	45.09

Table 7.6.1.2-3: Upper Band-edge Marker Delta Method – 14 dBi Corner Reflector Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Field Strength (dBuV/m)		Delta- Marker (dB)	Band-edge Field Strength (dBuV/m)		Margin to Limit (dBuV/m)		
	pk	avg			(H/V)	(dB)		pk	avg	(dB)	pk	avg
	Fundamental Frequency											
2475	105.70	105.70	V	0.46	106.16	106.16	53.09	53.07	7.05	20.93	46.95	

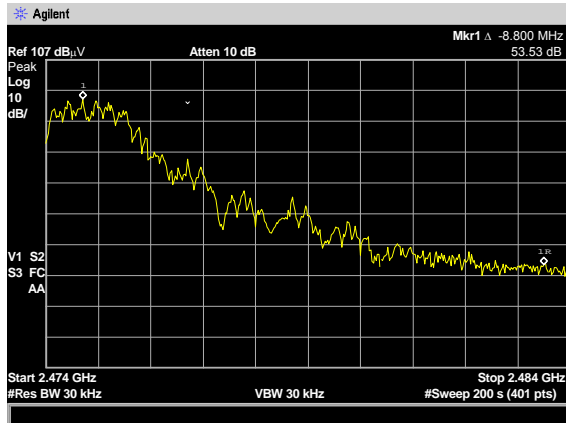


Figure 7.6.1.2-1: Upper Band-edge Omni (Radiated)

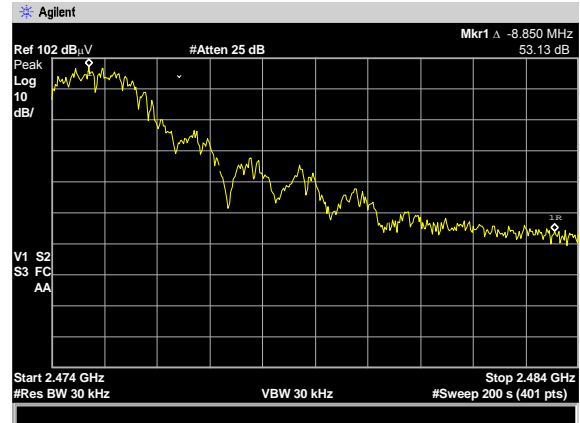


Figure 7.6.1.2-2: Upper Band-edge Patch (Radiated)

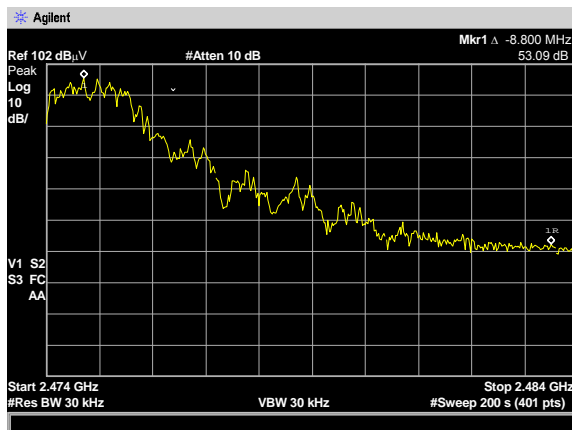


Figure 7.6.1.2-3: Upper Band-edge Corner (Radiated)

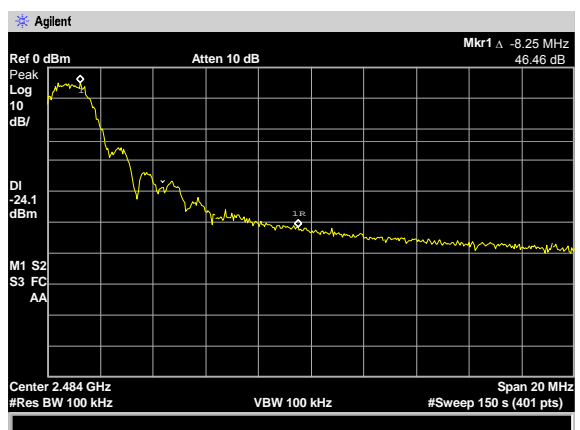


Figure 7.6.1.2-4: Upper Band-edge (Conducted)

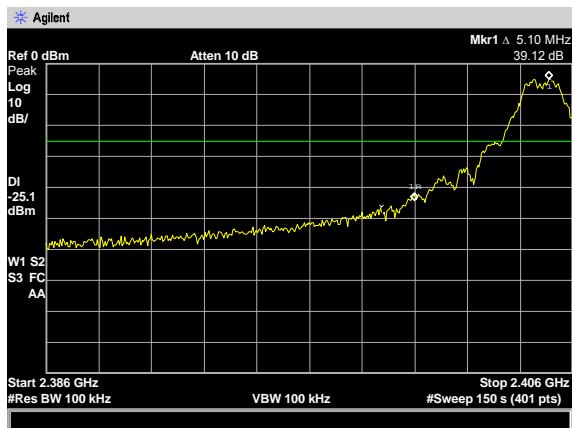


Figure 7.6.1.2-5: Lower Band-edge (Conducted)

7.6.2 RF Conducted Spurious Emissions

The RF Conducted Spurious Emissions were measured in accordance with the FCC publication “New Guidance on Measurements for Digital Transmission Systems in Section 15.247”. The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer. The EUT was investigated for conducted spurious emissions from 30 MHz to 25 GHz, 10 times the highest fundamental frequency. For each measurement, the spectrum analyzer’s RBW was set to 100 kHz and the VBW was set to 300 kHz. The peak detector and Max Hold function of the analyzer were utilized.

7.6.2.2 Test Results

In a 100 kHz bandwidth, the radio frequency power that was produced by the EUT emissions is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. RF Conducted Emissions are displayed in Figures 7.6.2.2-1 through 7.6.2.2-6.

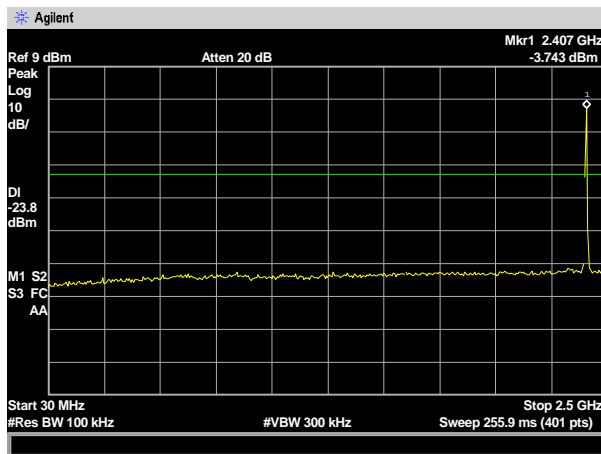


Figure 7.6.2.2-1: 30 MHz – 2.5 GHz – Low Channel

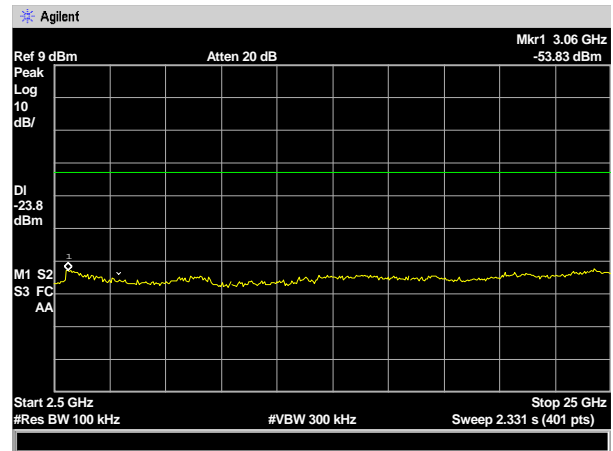


Figure 7.6.2.2-2: 2.5 GHz – 25 GHz – Low Channel

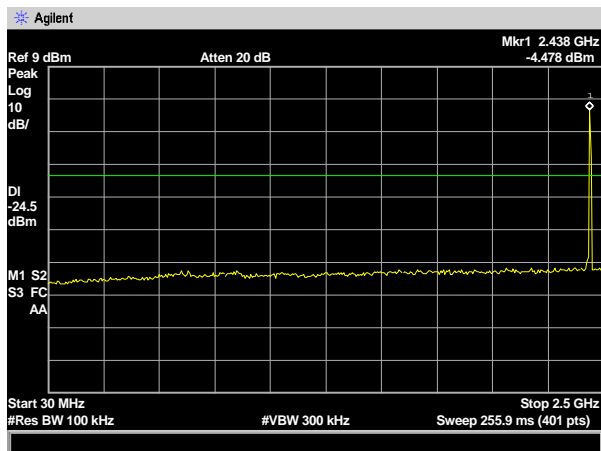


Figure 7.6.2.2-3: 30 MHz – 2.5 GHz – Mid Channel

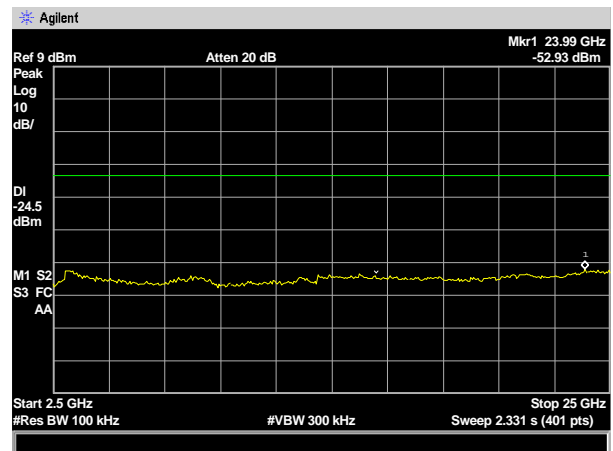


Figure 7.6.2.2-4: 2.5 GHz – 25 GHz – Mid Channel

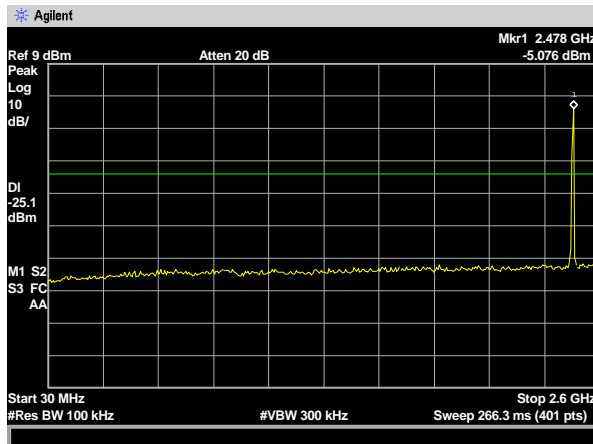


Figure 7.6.2.2-5: 30 MHz – 2.5 GHz – High Channel

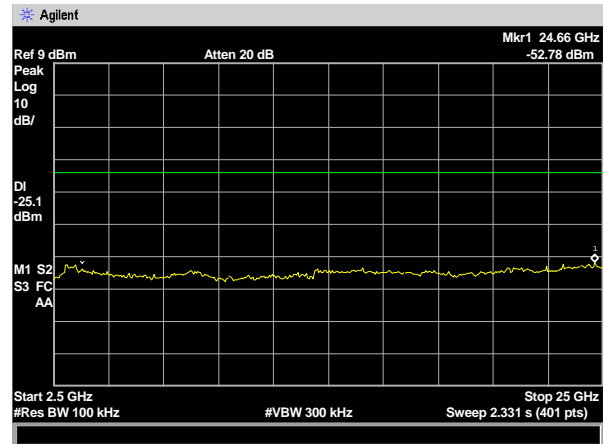


Figure 7.6.2.2-6: 2.5 GHz – 25 GHz –High Channel

7.6.3 Radiated Spurious Emissions (Restricted Bands) - FCC Section 15.205

7.6.3.1 Test Methodology

Radiated emissions tests were made over the frequency range of 30MHz to 25GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000MHz, peak measurements made with RBW and VBW of 1 MHz. Average measurements were made with RBW of 1MHz and a VBW of 10Hz. The average emissions were further corrected by applying the duty cycle correction of the EUT to the average measurements for comparison to the average limit.

7.6.3.2 Duty Cycle Correction

For average radiated measurements, the measured level was reduced by a factor 46.02dB to account for the duty cycle of the EUT. The packet transmissions length is 0.5ms. The duty cycle correction factor is determined using the formula: $20\log(0.5/100) = -46.02\text{dB}$.

A detailed analysis of the duty cycle timing is provided below in figure 7.6.3.3-1.

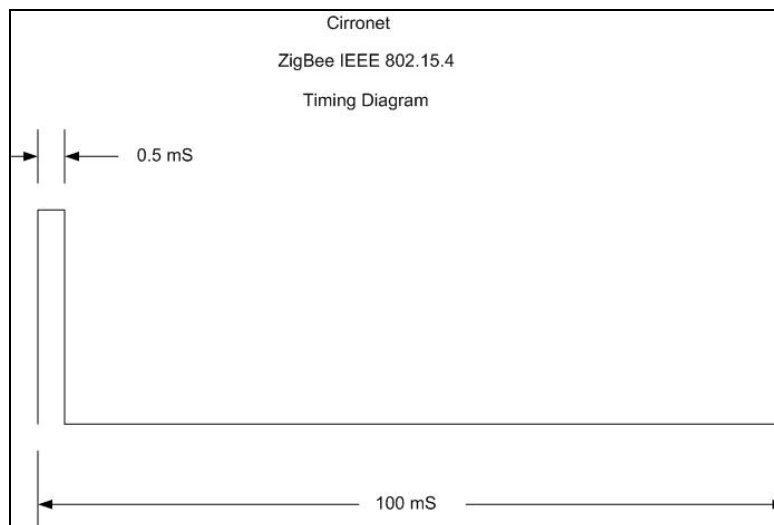


Figure 7.6.3.3-1: Duty Cycle Timing Diagram

7.6.3.3 Test Results

Using the procedures set forth in the FCC publication “New Guidance on Measurements for Digital Transmission Systems in Section 15.247”, radiated spurious emissions found in the band of 30MHz to 25GHz are reported in Table 7.6.3.3-1 to 7.6.3.3-3. Each emission found to be in a restricted band as defined by section 15.205, was compared to the radiated emission limits as defined in section 15.209.

Table 7.6.3.3-1: Radiated Spurious Emissions – 9dBi Omni-directional Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	avg			pk	avg	pk	avg	pk	avg
Spurious Emissions										
4810	47.80	47.80	H	12.33	60.13	14.11	74	54	13.87	39.89
4810	56.33	56.33	V	12.33	68.66	22.64	74	54	5.34	31.36
4880	47.29	47.29	H	12.57	59.86	13.84	74	54	14.14	40.16
4880	53.79	53.78	V	12.57	66.36	20.33	74	54	7.64	33.67
4950	49.30	49.30	V	12.81	62.11	16.09	74	54	11.89	37.91

Table 7.6.3.3-2: Radiated Spurious Emissions – 12dBi Patch Antenna

No emissions could be detected above the noise floor of the measurement equipment.

Table 7.6.3.3-3: Radiated Spurious Emissions – 14dBi Corner Reflector Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	avg			pk	avg	pk	avg	pk	avg
Spurious Emissions										
4810	49.32	49.32	H	12.33	61.65	15.63	74	54	12.35	38.37
4810	53.92	53.92	V	12.33	66.25	20.23	74	54	7.75	33.77
4880	51.30	51.30	V	12.57	63.87	17.85	74	54	10.13	36.15
4950	48.10	48.10	V	12.81	60.91	14.89	74	54	13.09	39.11

7.6.3.4 Sample Calculation:

$$R_C = R_U + CF_T$$

Where:

- CF_T = Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
 R_U = Uncorrected Reading
 R_C = Corrected Level
 AF = Antenna Factor
 CA = Cable Attenuation
 AG = Amplifier Gain
 DC = Duty Cycle Correction Factor

Example Calculation: Peak

Corrected Level: $47.80 + 12.33 = 60.13$ dBuV/m

Margin: $74\text{dBuV/m} - 60.13\text{ dBuV/m} = 13.87\text{ dB}$

Example Calculation: Average

Corrected Level: $42.80 + 12.33 - 46.02 = 14.11$ dBuV

Margin: $54\text{dBuV} - 14.11\text{ dBuV} = 39.89\text{ dB}$

7.7 Peak Power Spectral Density- FCC Section 15.247(d)

7.7.1 Test Methodology

The power spectral density was measured in accordance with the FCC publication “New Guidance on Measurements for Digital Transmission Systems in Section 15.247”. The emission peaks within the pass band were located and zoomed in on. The spectrum analyzer RBW was set to 3 kHz and VBW 10 kHz. Span was adjusted to 500 kHz and the sweep time was calculated to be 168s (Span/3 kHz).

7.7.2 Test Results

Results are shown below in table 7.7.2-1 and figures 7.7.2-1 – 7.7.2-3:

Table 7.7.2-1: Peak Power Spectral Density

Frequency [MHz]	Level [dBm]	Limit [dBm]	Result
2405	-11.74	8	PASS
2440	-12.43	8	PASS
2475	-14.38	8	PASS

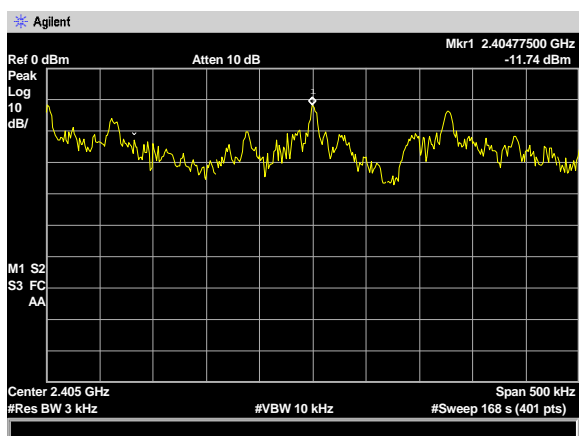


Figure 7.7.2-1: Power Spectral Density Plot – Low Channel

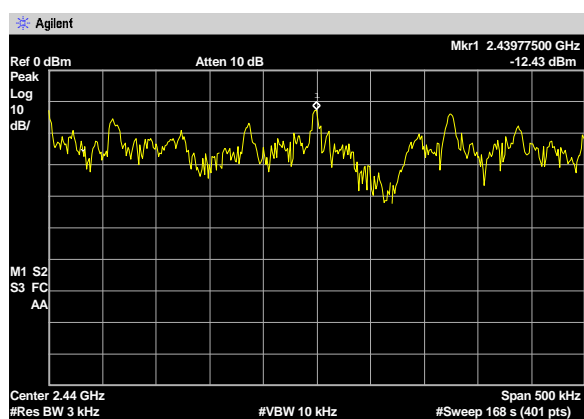


Figure 7.7.2-2: Power Spectral Density Plot – Mid Channel

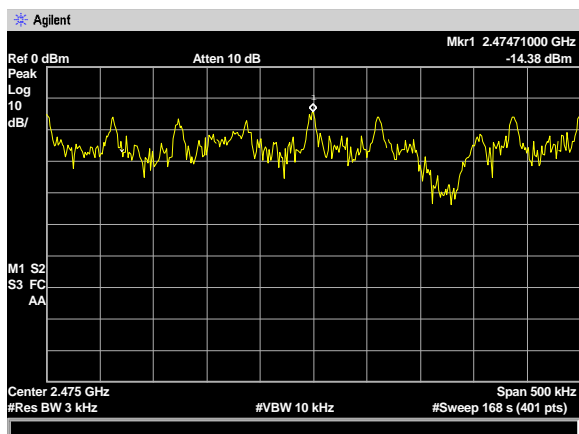


Figure 7.7.2-3: Power Spectral Density Plot – High Channel

8.0 CONCLUSION

In the opinion of ACS, Inc. the ZMN2400, manufactured by Cirronet, Inc. does meet the requirements of FCC Part 15 subpart C.