Excellence in Compliance Testing

Certification Test Report

Direct Sequence Spread Spectrum Transmitter

Test Report

FCC ID: HSW-Z2430A
IC: 4492A-Z2430A

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-210

ACS Report Number: 08-0059

Manufacturer: Cirronet, Inc.
Model: ZMN2430A

Test Begin Date: February 22, 2008
Test End Date: March 4, 2008

Report Issue Date: April 1, 2008

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report is not be used to claim certification, approval, or endorsement by NVLAP, NIST or any government agency.

Prepared by: _____
J. Kirby Munroe
Manager Wireless Certifications
ACS, Inc.

Reviewed by: _____
R. Sam Wismer
Engineering Manager
ACS, Inc.

This report contains 17 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 and Industry Canada's Radio Standards Specification RSS-210.

1.2 Product Description

1.2.1 General
The ZMN2430A is a stand alone Zigbee transceiver module. The ZMN2430A 2.4 GHz transceiver module is a low cost solution for point-to-point, point-to-multipoint and MESH wireless systems.

Manufacturer Information:
Cirronet, Inc.
3079 Premiere Parkway, Suite 140
Duluth, GA 30097

Test Sample Condition:
The test sample was provided in good working order with no visible defects.

Detailed photographs of the EUT are filed separately with this filing.

1.2.2 Intended Use
The application of the ZMN2430 Series is in a wireless network for data collection in industrial monitoring and control.

1.3 Test Methodology and Considerations
The ZMN2430A was tested stand alone but did utilize a support PCB for power and programming functionality.

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: 894540
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: 200612-0

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:

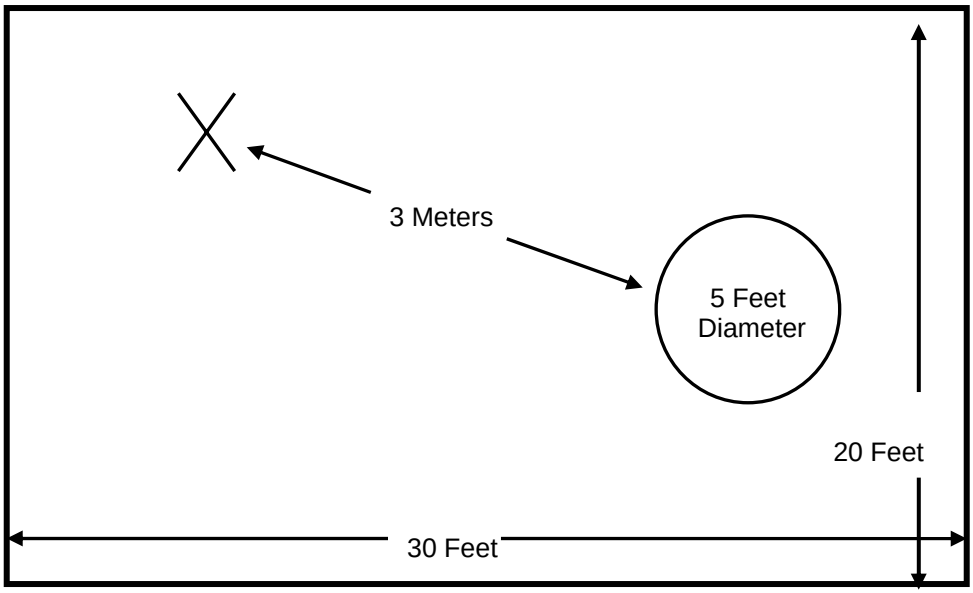

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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 re-enforced 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:

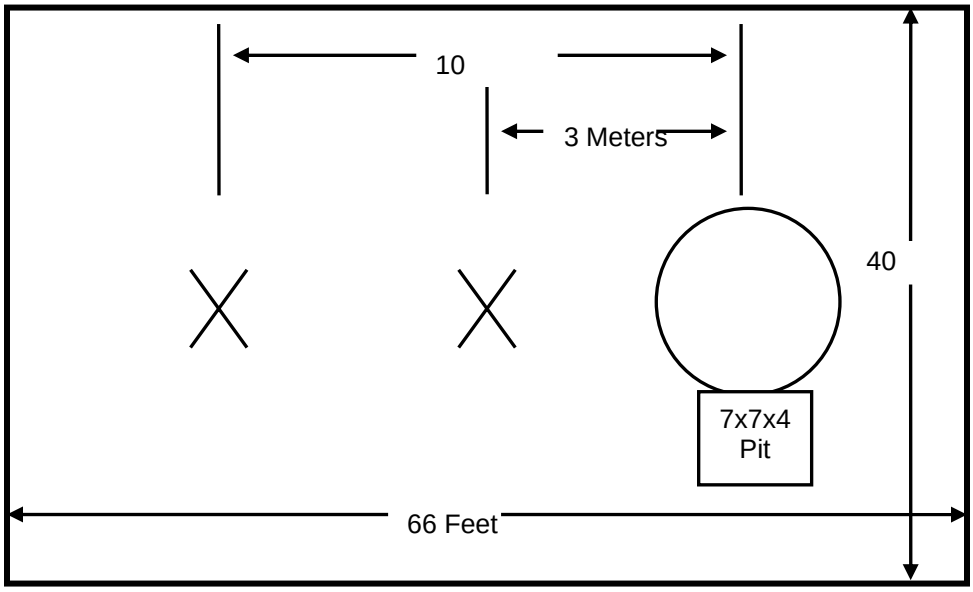

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal group reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site 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 4.1.3-1:

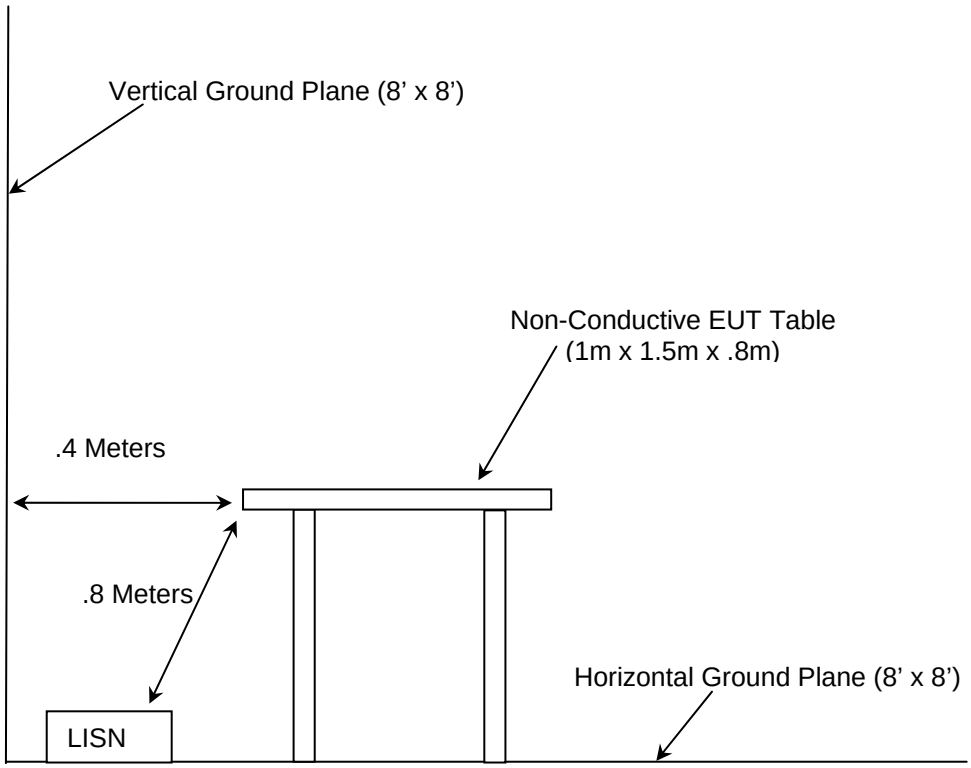

Figure 2.4-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2006
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2006
- FCC KDB Publication No. 558074 - Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247), March 2005
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 7 June 2007

4.0 LIST OF TEST EQUIPMENT

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

Table 4-1: Test Equipment

Equipment Calibration Information					
ACS#	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
1	Rohde & Schwarz	Spectrum Analyzers	ESMI - Display	833771/007	10-26-2008
2	Rohde & Schwarz	Spectrum Analyzers	ESMI-Receiver	839587/003	10-26-2008
16	ACS	Cables	Cable	16	05-21-2008
22	Agilent	Amplifiers	8449B	3008A00526	10-25-2008
25	Chase	Antennas	CBL6111	1043	06-06-2008
73	Agilent	Amplifiers	8447D	2727A05624	12-19-2008
153	EMCO	LISN	3825/2	9411-2268	11-27-2008
167	ACS	Cables	Chamber EMI Cable Set	167	01-04-2009
168	Hewlett Packard	Attenuators	11947A	44829	02-18-2009
193	ACS	Cable Set	OATS cable Set	193	01-04-2009
211	Eagle	Filters	C7RFM3NFNM	HLC-700	01-04-2009
282	Microwave Circuits	Filters	H2G020G4	74541	02-25-2009
283	Rohde & Schwarz	Spectrum Analyzers	FSP40	1000033	11-09-2008
291	Florida RF Cables	Cables	SMRE-200W-12.0-SMRE	None	11-21-2008
292	Florida RF Cables	Cables	SMR-290AW-480.0-SMR	None	11-21-2008
321	Hewlett Packard	Amplifiers	HPC 8447D	1937A02809	07-17-2008
324	ACS	Cables	Belden	8214	07-10-2008
329	A.H.Systems	Antennas	SAS-571	721	08-13-2008
338	Hewlett Packard	Amplifiers	8449B	3008A01111	10-24-2008

5.0 SUPPORT EQUIPMENT

Table 5-3: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	EUT	Cirronet	ZMN2430A	NA
2	Development Board	Cirronet	NA	NA
3	AC Adapter	GlobTek, Inc.	WR9HD1000KCP-Y	020309 48/03

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

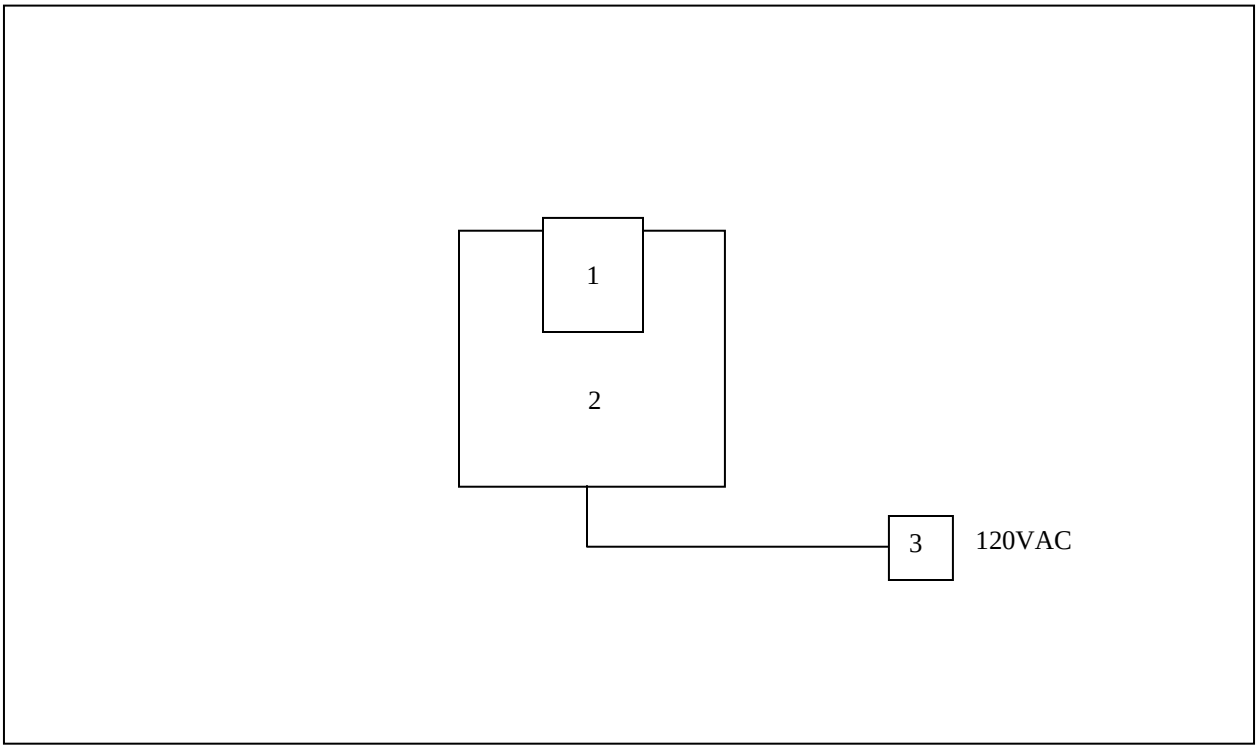

Figure 6-1: EUT Test Setup

*See Test Setup photographs for additional detail.

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

The device uses a surface-mount chip antenna with 0dBi max gain.

7.2 Power Line Conducted Emissions

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 Table 7.2-1.

Table 7.2-1: Conducted EMI Results

Frequency (MHz)	Uncorrected Reading (dBuV)		Total Correction Factor (dB)	Corrected Level (dBuV)		Limit (dBuV)		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
Line 1									
0.21	21.9	15.1	9.80	31.70	24.90	63.21	53.21	31.5	28.3
0.31	19.3	17.2	9.80	29.10	27.00	59.97	49.97	30.9	23.0
0.52	28.3	25.1	9.80	38.10	34.90	56.00	46.00	17.9	11.1
2.49	22.7	20.4	9.80	32.50	30.20	56.00	46.00	23.5	15.8
3.63	19.5	18	9.80	29.30	27.80	56.00	46.00	26.7	18.2
4.98	22.8	21	9.80	32.60	30.80	56.00	46.00	23.4	15.2
Line 2									
0.21	22.8	13.4	9.80	32.60	23.20	63.21	53.21	30.6	30.0
0.31	18.9	16.7	9.80	28.70	26.50	59.97	49.97	31.3	23.5
0.52	27.5	24.1	9.80	37.30	33.90	56.00	46.00	18.7	12.1
1.35	21.6	18.5	9.80	31.40	28.30	56.00	46.00	24.6	17.7
2.39	20.4	17.5	9.80	30.20	27.30	56.00	46.00	25.8	18.7
4.88	22.8	22.4	9.80	32.60	32.20	56.00	46.00	23.4	13.8

7.3 Radiated Emissions - Unintentional Radiation

7.3.1 Test Methodology

Radiated emissions tests were performed over the frequency range of 30MHz to 12.5GHz. 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 above 30MHz and below 1GHz were made with the Spectrum Analyzer's resolution bandwidth set to 120 KHz using a Quasi-peak detector. Above 1GHz, average measurements are taken with the RBW and VBW were set to 1MHz and 10 Hz respectively.

7.3.2 Test Results

Results of the test are given in Table 7.3-1 below:

Table 7.3-1: Radiated Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
79.57	---------	45.77	V	-19.18	---------	26.59	--------	40.0	---------	13.41
147.47	---------	52.27	V	-14.25	---------	38.02	--------	43.5	---------	5.48
199.21	---------	52.37	V	-15.04	---------	37.33	--------	43.5	---------	6.17
698.22	---------	43.18	V	-2.60	---------	40.58	--------	46.0	---------	5.42
765.04	---------	28.86	H	-1.90	---------	26.96	--------	46.0	---------	19.04
798.45	---------	38.78	H	-1.40	---------	37.38	--------	46.0	---------	8.62
1128	47.12	38.18	H	-7.05	40.07	31.13	74.0	54.0	33.93	22.87
1393	44.84	34.78	V	-5.33	39.51	29.45	74.0	54.0	34.49	24.55
1495	45.76	32.54	H	-4.88	40.88	27.66	74.0	54.0	33.12	26.34
1596	44.56	31.12	V	-4.29	40.27	26.83	74.0	54.0	33.73	27.17
2194	35.87	22.09	V	-1.95	33.92	20.14	74.0	54.0	40.08	33.86

* Note: All emissions above 2194 MHz were attenuated below the permissible limit.

7.4 6dB Bandwidth

7.4.1 Test Methodology

The 6dB bandwidth was measured in accordance with the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 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 figures 7.4.2-1 to 7.4.2-3:

Table 7.4.2-1: 6dB Bandwidth

Frequency [MHz]	Bandwidth [MHz]
2405	1.6
2440	1.6
2475	1.59

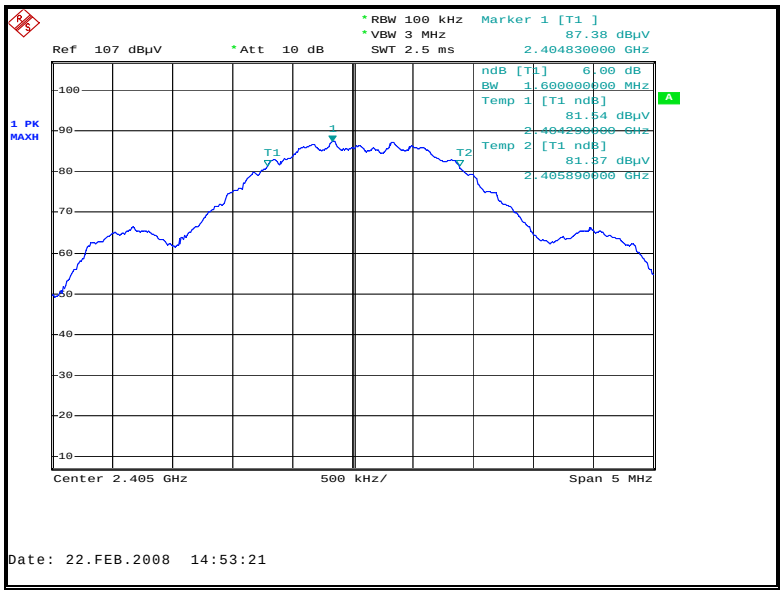

Figure 7.4.2-1: 6dB Bandwidth Plot – Low Channel

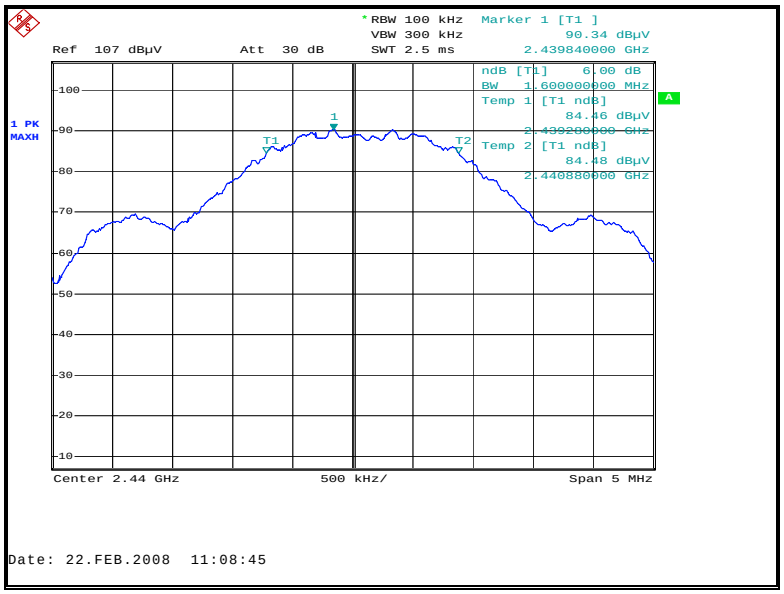

Figure 7.4.2-2: 6dB Bandwidth Plot – Mid Channel

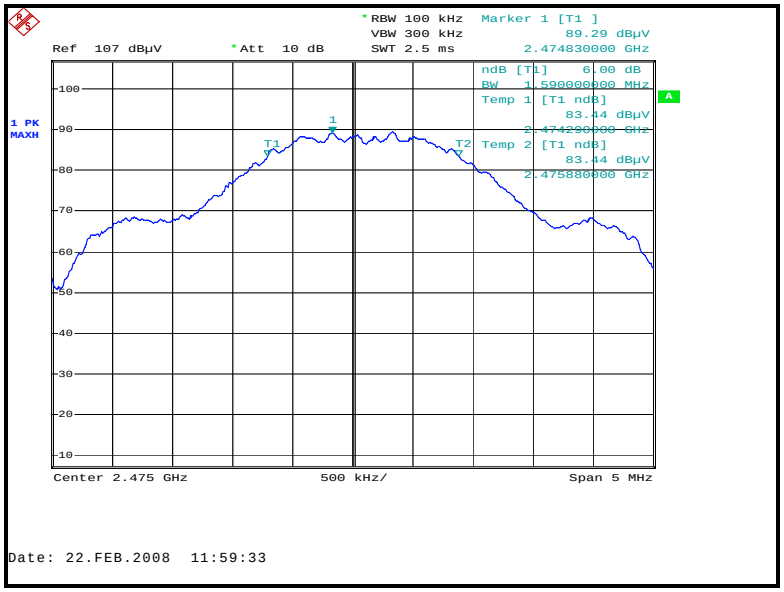

Figure 7.4.2-3: 6dB Bandwidth Plot – High Channel

7.5 Peak Output Power Requirement

7.5.1 Test Methodology

Antenna conducted measurements could not be performed on this device, therefore radiated tests were performed to show compliance with the peak output power limit according to the alternative test methods in the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)".

The procedures set forth in ANSI C63.4 were followed with respect to maximizing the peak emission. The resolution bandwidth of the spectrum analyzer was set to 3 MHz which was greater the 6 dB bandwidth measured in section 7.4. The video bandwidth was set to 3 MHz and a peak detector using the Max Hold function was utilized.

The power was calculated using the following equation:

$$P = (E * d)^2 / 30 * G$$

Where: G = Numeric Gain of the transmitting antenna with reference to an isotropic radiator
d = The distance in meters from which the field strength was measured
E = The measured maximum fundamental field strength in V/m

Data was collected with the EUT operating at maximum power.

7.5.2 Test Results

Results are shown below in Tables 7.5.2-1 to 7.5.2.2 for the channel with the maximum fundamental field strength reading.

Table 7.5.2-1: Fundamental Field Strength

Frequency (MHz)	Uncorrected Level (dBuV)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)
2405	91.90	V	-1.91	89.99
2440	92.07	V	-1.76	90.31
2475	95.56	V	-1.62	93.94

Table 7.5.2-2: Peak Output Power

Frequency (MHz)	Measurement Distance (m)	Antenna Gain (dBi)	Field Strength (V/m)	Antenna Gain (Num)	Power (mW)	Power (dBm)
2405	3	0	0.03	1.00	0.30	-5.23
2440	3	0	0.03	1.00	0.32	-4.92
2475	3	0	0.05	1.00	0.74	-1.28

7.6 Band-Edge Compliance and Spurious Emissions

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 and Figure 7.6.1.2-1 – 7.6.1.2-2.

Table 7.6.1.2-1: Upper Band-edge Marker Delta Method

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) 74	54
	pk	avg	(H/V)	(dB)	pk	avg		pk	avg	pk	avg
Fundamental Frequency											
2475	95.56	93.84	V	-1.62	93.95	92.23	54.32	39.63	37.91	34.37	16.10

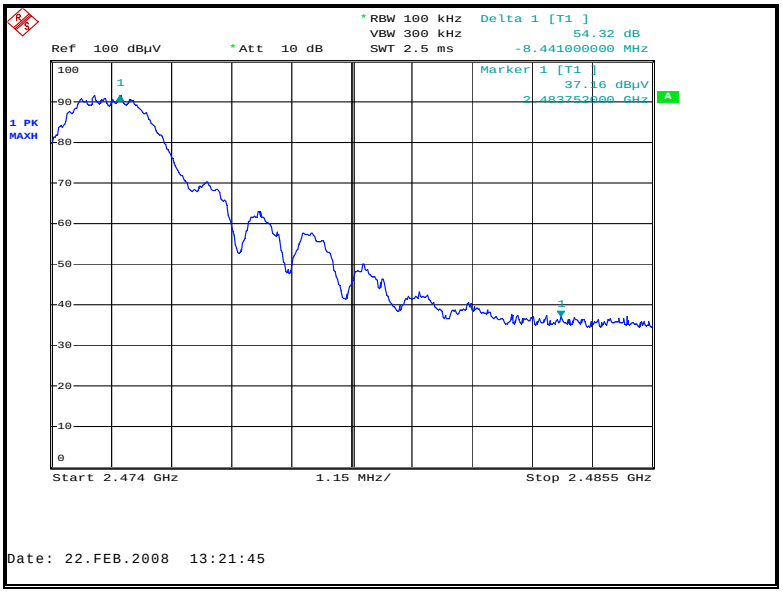

Figure 7.6.1.2-1: Upper Band-edge

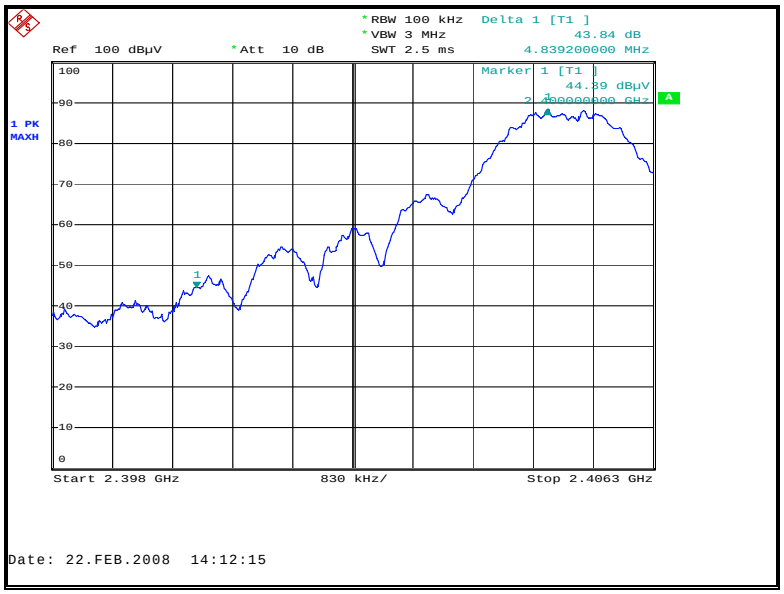

Figure 7.6.1.2-2: Lower Band-edge

7.6.2 RF Conducted Spurious Emissions

7.6.2.1 Test Methodology

The EUT was investigated for conducted spurious emissions from 30MHz to 25GHz, 10 times the highest fundamental frequency.

Antenna conducted measurements could not be performed on this device, therefore radiated tests were performed to show compliance with the spurious RF conducted limit according to FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)".

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. The field strength of both the fundamental emission and all spurious emissions outside of the restricted bands were measured with these settings. Procedures in ANSI C63.4 with respect to maximizing the emissions were followed.

7.6.2.2 Test Results

The magnitudes of all emissions are reported in section 7.6.3 with the appropriate limit as referenced to 20 dB below the fundamental frequency field strength.

7.6.3 Radiated Spurious Emissions – Intentional Radiation (Restricted Bands)

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 were made using an RBW of 1 MHz and a VBW of 3 MHz and average measurements using a RBW of 1MHz and VBW of 10Hz. The average emissions were further correcting for the duty cycle of the EUT.

As specified in section 7.6.2, for those frequencies that fall outside the restricted bands, the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)" for conducted spurious emissions was followed using a RBW of 100 kHz and VBW of 300 kHz.

The EUT was evaluated in multiple orientations and the worst case data presented in section 7.6.3.3.

7.6.3.2 Duty Cycle Correction

For average radiated measurements in restricted bands, the measured level was reduced by a factor 21.46dB to account for the duty cycle of the EUT. The EUT transmits for approximately 8.45mS within a 100ms period. The duty cycle correction factor is determined using the formula: 20log (8.45/100) = -21.46dB.

A detailed analysis of the duty cycle timing is provided in the Theory of Operation contained in this filing.

7.6.3.3 Test Results

Using the procedures set forth in the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)", radiated spurious emissions and conducted spurious emissions found in the band of 30MHz to 25GHz are reported in Tables 7.6.3.3-1 to 7.6.3.3-3. Each emission found to be in a restricted band, was compared to the radiated emission limits. Those spurious emissions outside the restricted bands were compared to the limits of 20 dB below the fundamental frequency field strength.

All emissions at the low, middle and high channels were below the Noise Floor of the measurement system and were therefore not reported.

7.7 Peak Power Spectral Density

7.7.1 Test Methodology

The peak power spectral density was measured in accordance with the alternative test methods in the FCC KDB Publication No. 558074 "Guidance on Measurements for Digital Transmission Systems (47 CFR 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 170s (Span/3 kHz). A peak detector using the Max Hold function was utilized.

The power was calculated using the following equation:

$$P = (E * d)^2 / 30 * G$$

Where: G = Numeric Gain of the transmitting antenna with reference to an isotropic radiator
d = The distance in meters from which the field strength was measured
E = The measured maximum fundamental field strength in V/m

Results are shown below in Table 7.7.2-1 to Table 7.7.2-2 and Figure 7.7.2-1 to 7.7.2-3.

7.7.2 Test Results

Table 7.7.2-1: Fundamental Field Strength in 3 kHz bandwidth

Frequency (MHz)	Uncorrected Level (dBuV)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)
2405	76.43	V	-1.91	74.52
2440	78.63	V	-1.76	76.87
2475	80.23	V	-1.62	78.61

Table 7.7.2-2: Peak Power Spectral Density

Frequency (MHz)	Measurement Distance (m)	Antenna Gain (dBi)	Field Strength (V/m)	Antenna Gain (Num)	Power Density (mW)	Power Density (dBm)
2405	3	0	0.01	1.00	0.01	-20.70
2440	3	0	0.01	1.00	0.01	-18.36
2475	3	0	0.01	1.00	0.02	-16.61

8.0 CONCLUSION

In the opinion of ACS, Inc. the ZMN2430A, manufactured by Cirronet, Inc.meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT