



*Testing Tomorrow's Technology*

**Application for**

**Cirronet, Incorporated  
FCC Part 15, Certification  
For the  
ZMN2405**

**FCC ID: HSW-Z2405**

**UST Project: 07-0300  
Issue Date: February 13, 2008**

**3505 Francis Circle Alpharetta, GA 30004  
PH: 770-740-0717 Fax: 770-740-1508  
[www.ustech-lab.com](http://www.ustech-lab.com)**



*Testing Tomorrow's Technology*

I certify that I am authorized to sign for the manufacturer and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

**US Tech (AGENT RESPONSIBLE FOR TEST):**

By: 

Name: Alan Ghasiani

Title: Operations & Engineering

Date: February 13, 2008

**Cirronet, Incorporated  
3079 Premiere Parkway  
Duluth, GA 30097**

By: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

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## MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: **Cirronet, Incorporated**

MODEL: **ZMN2405**

FCC ID: **HSW- Z2405**

DATE: **February 13, 2008**

This report concerns (check one): Original grant    
Class II change

Equipment type: **2.4 GHz Zigbee Radio**

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes  No

If yes, defer until: \_\_\_\_\_  
date

N.A. agrees to notify the Commission by N.A.  
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech  
3505 Francis Circle  
Alpharetta, GA 30004

Phone Number: (770) 740-0717  
Fax Number: (770) 740-1508

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### Agency Agreement

Federal Communications Commission  
P.O. Box 429  
Columbia, MD 21045  
Date: December 11, 2007

Gentlemen:

I hereby appoint US Tech to act as our agent in the preparation of an application for equipment authorization of ZMN2405, FCC ID: HSW-Z2405HPA under Part 15 of the FCC Rules and Regulations. I certify that the Exhibits properly describe the device or system for which authorization is sought, that the information described in the User's Manual will be provided with each item manufactured or distributed by the applicant, and that the labels described by Exhibit 3 will be affixed to each item manufactured or distributed by the applicant. I further certify that appropriate arrangements have been made to assure that production units of this equipment bearing the name and FCC IDENTIFIER listed in this application will continue to comply with the Commission's requirements.

I further certify by signature below that no party (per 47 CFR 1.2002(b)) to the application is subject to a denial of Federal benefits, including FCC benefits, pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 853(a).

This appointment also includes the authority to complete FCC Form 731 on our behalf and sign the application as an authorized agent.

Al Patrick,  
Sr. Compliance Engineer  
Cirronet Inc.  
3079 Premiere Parkway  
Duluth, GA 30097  
678 684 2000 ext. 138

Date: November 30, 2007  
Al Patrick  
apatrick@cirronet.com



**CONFIDENTIALITY REQUEST**

Federal Communications Commission  
Equipment Authorization Branch  
7435 Oakland Mills Road  
Columbia, MD 21046

Date: 12-18-07

Gentlemen:

Cirronet respectfully requests confidentiality of certain materials provided with the submission of the ZigBee Module under FCC ID: HSW-ZMN2405 in accordance with FCC Regulations 0.459. The confidentiality request applies to the (1) schematic diagrams, (2) detailed block diagrams, (3) detailed operational descriptions, and (4) parts lists, that may be contained in this filing. The ZigBee Module has been developed at considerable effort and expense by Cirronet. These items are considered as Trade Secrets and therefore public access to the proprietary material could possibly result in duplication of equipment that could severely damage the company's business advantage.

I appreciate your assistance in this matter.

Sincerely,

Al Patrick

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Sr. Compliance Engineer  
Cirronet Inc.  
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## **1. General Information**

### **1.1 Product Description**

The Equipment Under Test (EUT) is a Cirronet, Incorporated, model ZMN2405 modular 2.4 GHz spread spectrum transceiver. The EUT will be used with multiple antennas, including an omni-directional antenna, a patch antenna, and a corner-reflector antenna.

### **1.2 Related Submittal(s)/Grant(s)**

The EUT will be used to send/receive data. The transceiver presented in this report will be used with other like transceivers:

The EUT is subject to the following authorizations:

- a) Certification as a transceiver (modular approval)
- b) Verification as a digital device

The information contained in this report is presented for the certification & verification authorization(s) for the EUT. The manufacturer desires to seek a modular approval on this device.

## **2. Tests and Measurements**

### **2.1 Configuration of Tested System**

The EUT possesses the capability to connect to multiple types of antennas through a 50 Ohm connection, so conducted power measurements were performed when applicable. The test sample was tested per ANSI C63.4, Methods of Measurement from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2003), FCC KDB Publication Number 558074, FCC DA 00-705. Conducted and radiated emissions data below 1 GHz were taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. Above 1 GHz, bandwidths are 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off throughout the evaluation process. Block diagrams of the tested systems are shown in Figure 1. Test configuration photographs for spurious and fundamental emissions measurement are shown in Figures 2 and 3. Power line conducted emissions measurement setup is shown in Figure 4.

The sample used for testing was received by US Tech on January 28, 2008 in good condition.



## **2.2 Test Facility**

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and registered with the FCC under designation number US5117. Additionally this site has also been fully described and submitted to Industry Canada (IC) and has been approved under file number 2982A-1.

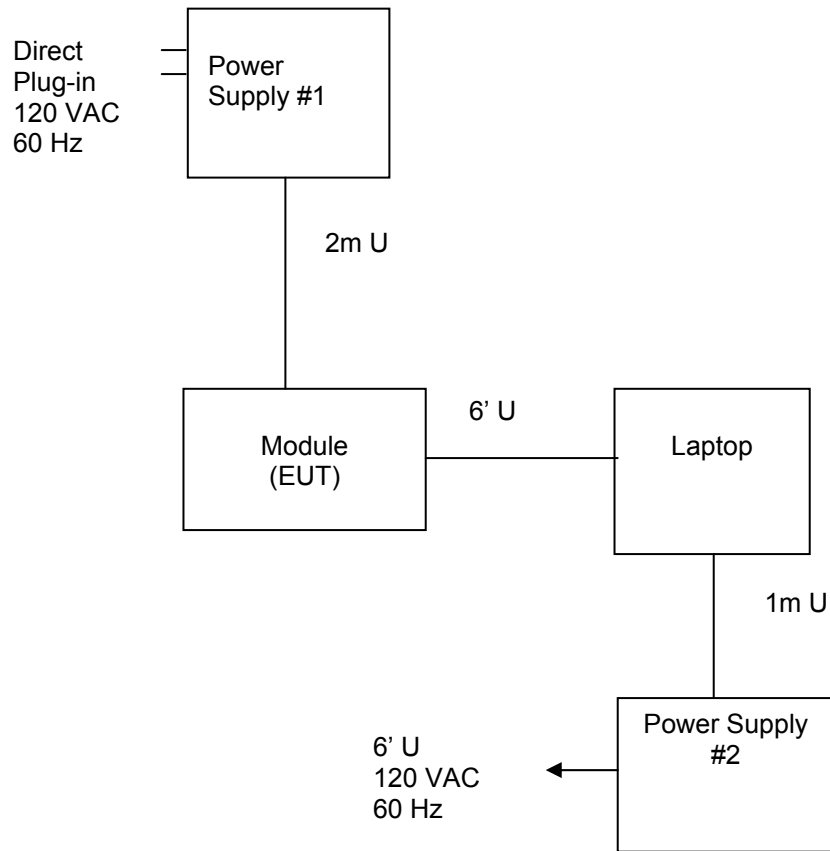
## **2.3 Test Equipment**

Table 1 contains a list of EUT and peripherals. Table 2 describes test equipment used to evaluate this product.

## **2.4 Modifications**

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15, Subpart C Limits for the transmitter portion of the EUT or the Subpart B, Class B Digital Device Requirements for the Receiver.

**Figure 1.**  
**Test Configuration**



**Table 1.**

**EUT and Peripherals**

<b>PERIPHERAL MANU.</b>	<b>MODEL NUMBER</b>	<b>SERIAL NUMBER</b>	<b>FCC ID:</b>	<b>CABLES P/D</b>
(EUT) Cirronet, Incorporated	ZMN2405	None	Pending: HSW-Z2405	2 m U
Antenna Various, see antenna descriptions			None	Varied from 0.2 to 1 meter, Shielded
Power Supply GlobTek	GT-41052- 1509	None	None	Direct Plug-in 120 VAC/ 60 Hz
Laptop Computer IBM	600X	78-WHPB3	None	1m U 6' U
Power Supply IBM	None	None	None	6' U 120 VAC/ 60 Hz

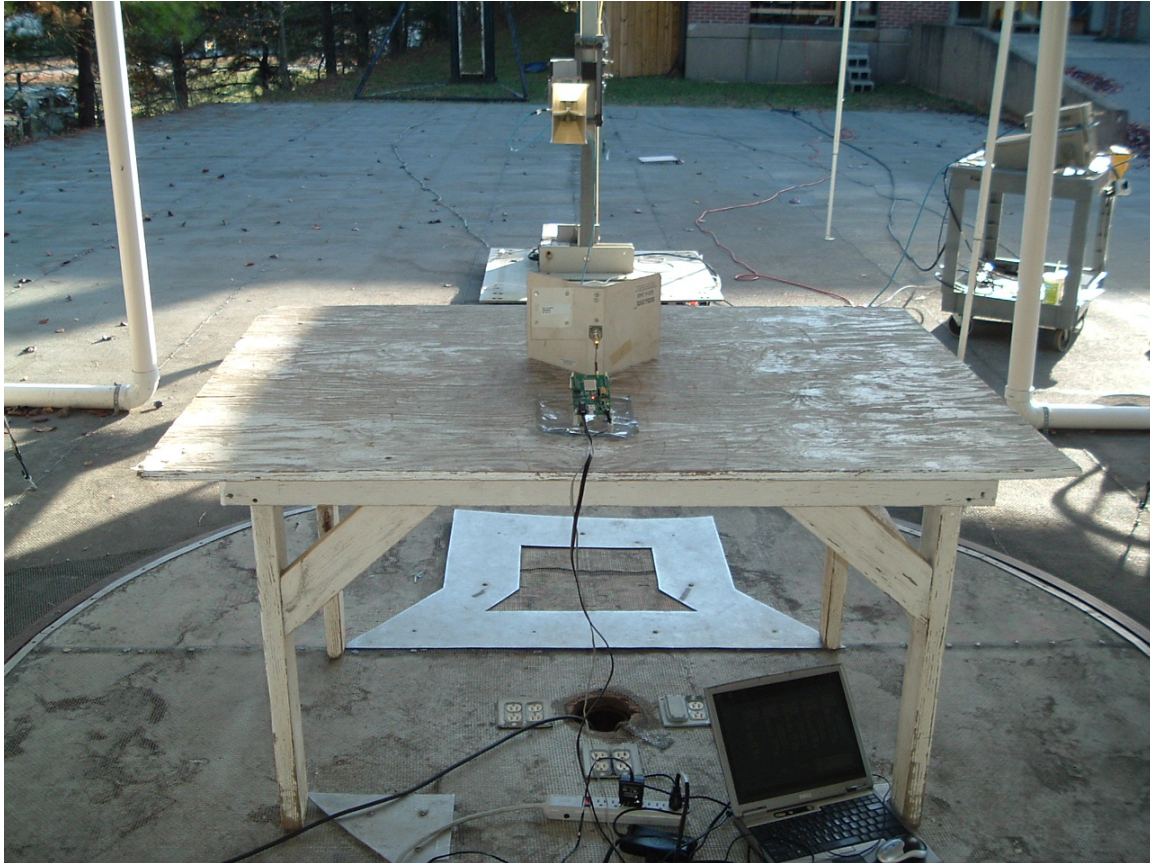
**Figure 2.**

**Photograph(s) of Spurious Emissions Measurement Setup, Corner Antenna, Front**



**Figure 3.**

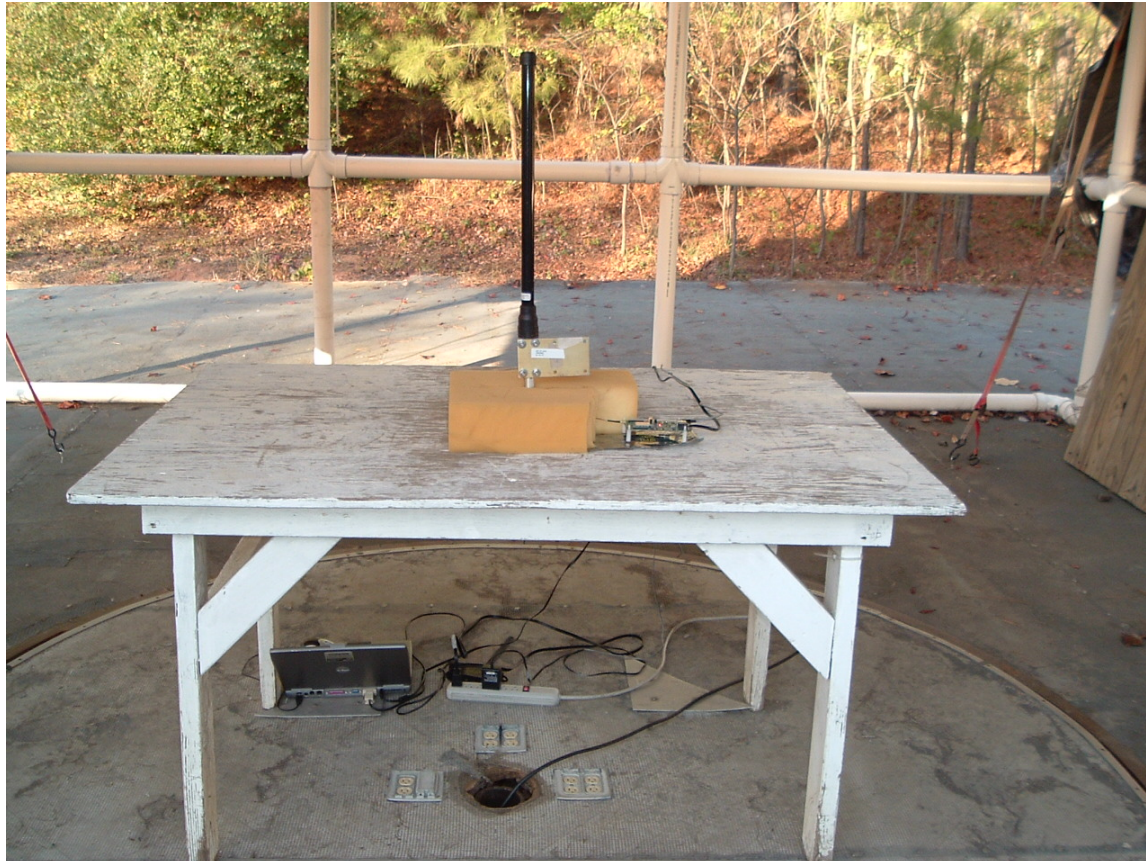
**Photograph(s) of Spurious Emissions Measurement Setup, Corner Antenna, Rear**





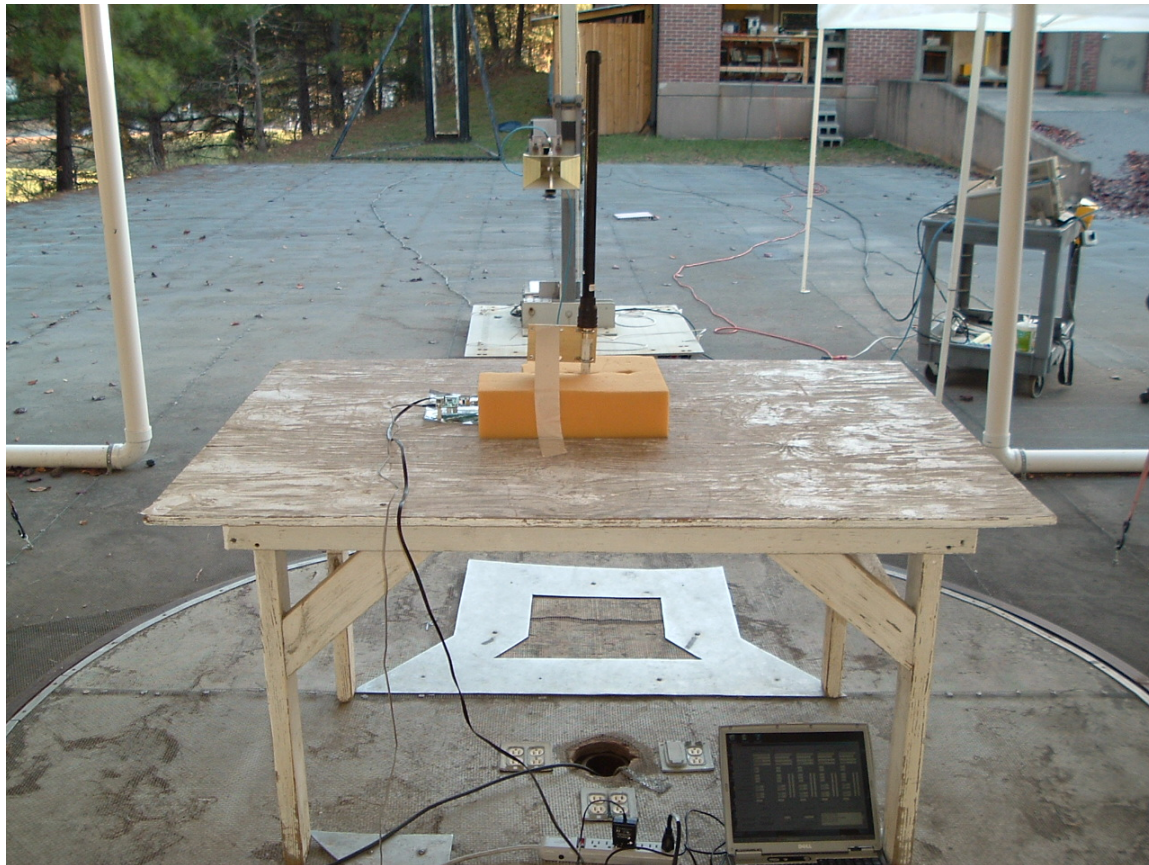
**Figure 4.**

**Photograph(s) of Spurious Emissions Measurement Setup, Omni Antenna, Front**



**Figure 5.**

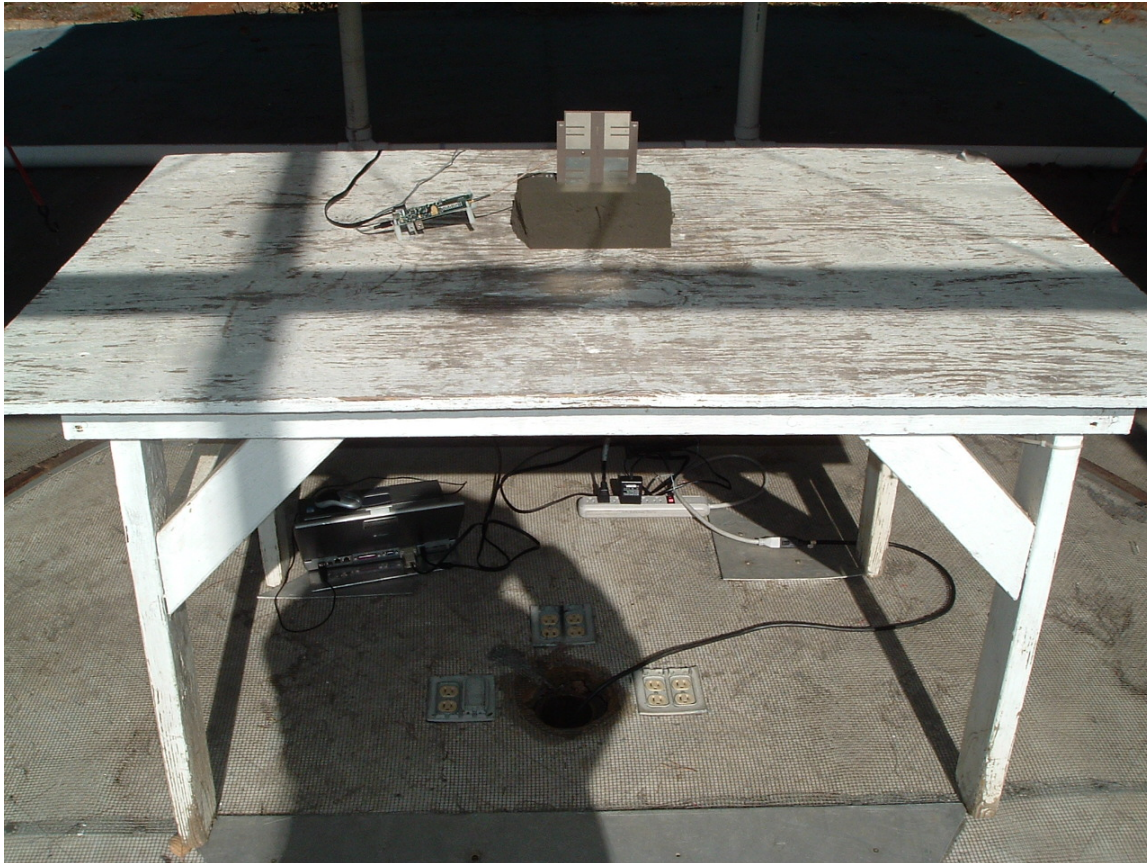
**Photograph(s) of Spurious Emissions Measurement Setup, Omni Antenna, Rear**





**Figure 6.**

**Photograph(s) of Spurious Emissions Measurement Setup, Patch Antenna, Front**





**Figure 7.**

**Photograph(s) of Spurious Emissions Measurement Setup, Patch Antenna, Rear**



**Figure 8.**

**Photograph(s) of Conducted Emissions Measurement Setup**



**Table 2.**  
**Test Instruments**

<b>EQUIPMENT</b>	<b>MODEL NUMBER</b>	<b>MANUFACTURER</b>	<b>SERIAL NUMBER</b>	<b>DATE OF LAST CALIBRATION</b>
SPECTRUM ANALYZER	8566B	HEWLETT-PACKARD	2332A10055	1/10/08
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	7/16/07
SIGNAL GENERATOR	8648B	HEWLETT-PACKARD	3642U01679	10/30/07
RF PREAMP	8447D	HEWLETT-PACKARD	2944A06291	6/14/07
BICONICAL ANTENNA	3110B	EMCO	9307-1431	11/15/07
LOG PERIODIC	3146	EMCO	3110-3236	11/21/07
LISN (x 2) 8028-50-TS24-BNC	8028	SOLAR ELE.	910494 & 910495	5/10/07
HORN ANTENNA	3115	EMCO	9107-3723	10/16/06 2 yr.
PREAMP	8449B	HEWLETT PACKARD	3008A00480	8/21/07
CALCULATION PROGRAM	N/A	N/A	Ver. 6.0	N/A

## 2.5 Number of Operating Frequencies (CFR15.31(m))

In accordance with the requirements of CFR 15.31 (m) the EUT was tested with three operating frequencies: low channel; mid channel; and high channel.

## 2.6 Peak Limits for Signals above 1000 MHz (CFR 15.35)

In accordance with the requirements of CFR 15.35 the limit on the EUT's measured peak signals have been relaxed by 20 dB from the limits stated in 15.209.

## 2.7 Antenna Description (CFR15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

**Table 3.**

**Antenna(s) Supplied With EUT**

MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dBi	TYPE OF CONNECTOR
	<b>Corner Reflector</b>		<b>14</b>	<b>Reverse threaded SMA</b>
	<b>Omni Directional</b>		<b>12</b>	<b>Reverse threaded SMA</b>
	<b>Patch</b>		<b>9</b>	<b>Reverse threaded SMA</b>

## 2.8 Power line conducted emissions for Digital Peripherals and Receivers (CFR15.107)

The conducted voltage measurements have been carried out in accordance with CFR 15.107, with a spectrum analyzer connected to a LISN and the EUT placed into an idle condition or a continuous mode of receive. The test procedure used was ANSI C63.4, paragraph 7. Please refer to the results as shown in Table 4 below.

**Table 4. Conducted Emissions Test Data, Class B**

**Test Date:** January 16, 2008  
**UST Project:** 07-0300  
**Customer:** Cirronet, Incorporated  
**Model:** ZMN2405

(Quasi-Peak vs Average Limits)

Conducted Emissions									
<b>Test By:</b>	<b>Test:</b> Peak vs Average Conducted Emissions					<b>Client:</b> Cirronet, Incorporated			
D.A.	<b>Project:</b> 07-0300			<b>Class:</b> B		<b>Model:</b> ZMN2405			
Frequency	Test Data	AF	Test Data	AF+CA-AMP	Results	Limits	Distance /	Margin	PK
(MHz)	(dBm)	Table	(dBuV)	(dB)	(dBuV)	(dBuV)	Polarity	(dB)	/ QP
0.15	-61.5	LISNP	45.5	-0.2	45.3	56.0	Phase	10.7	PK
0.505	-69.3	LISNP	37.7	-0.1	37.6	46.0	Phase	8.4	PK
2.076	-71.5	LISNP	35.5	0.3	35.8	46.0	Phase	10.2	PK
6.64	-67.6	LISNP	39.4	0.4	39.8	50.0	Phase	10.2	PK
19.24	-81.4	LISNP	25.6	0.6	26.2	50.0	Phase	23.8	PK
20.03	-82.7	LISNP	24.3	0.6	24.9	50.0	Phase	25.1	PK
0.194	-69.2	LISNN	37.8	-0.1	37.7	54.7	Neutral	17.0	PK
0.493	-73.3	LISNN	33.7	-0.1	33.6	46.0	Neutral	12.4	PK
2.076	-72.7	LISNN	34.3	0.3	34.6	46.0	Neutral	11.4	PK
6.64	-67.6	LISNN	39.4	0.4	39.8	50.0	Neutral	10.2	PK
18.17	-68.1	LISNN	38.9	0.7	39.6	50.0	Neutral	10.4	PK
24.22	-80.4	LISNN	26.6	0.7	27.3	50.0	Neutral	22.7	PK

**SAMPLE CALCULATIONS: 45.5 + -0.2 = 45.3 dBuV**

**Tester** *Daniel Aparaschivei*  
**Signature:** \_\_\_\_\_

**Name:** Daniel Aparaschivei

## 2.9 Power Line Conducted Emissions for Transmitter (CFR 15.207)

The conducted voltage measurements have been carried out in accordance with CFR15.207, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmit. The test procedure used was ANSI C63.4, paragraph 7. The results are given in Table 4 above.

## 2.10 Worst-Case Transmitter Duty Cycle for ZMN2405

The duty cycle de-rating factor used in the calculation of average radiated limits (per CFR 15.209) is described below. This factor was calculated by first determining the worst case scenario for system operation.

The worst case operating scenario is as follows:

Maximum transmit On-time over a 100 ms period:

The transmitter delivers 253 Bytes @ 8 bits/Byte with a rate of 1/4060 kbits per second

= (253 x 8 x 1/4060) m Seconds = 0.5 msec

The transmission duty cycle correction factor is then calculated as:

$$20 \log_{10} (0.5\text{ms}/100\text{ms}) = - 46\text{dB}$$

## 2.11 Radiated Emissions Measurement for Digital Peripherals and Receiver (CFR 15.109)

The test procedure used was ANSI C63.4, paragraph 8. The transmitter was powered off and the remaining electronics were left on. Test results are found in Table 5 below.

**Table 5. Radiated Emissions Data (Digital Device & Receiver)**

### Class B

Test Date: February 16, 2008  
 UST Project: 07-0300  
 Customer: Cirronet, Incorporated  
 Product: ZMN2405

Measurements 30 MHz – 1 GHz w/14 dBi antenna in place

Radiated Emissions									
Test By: K.M.		Test: FCC Part 15			Client: Cirronet, Incorporated				
Project: 07-0300			Class: B		Model: ZMN2405				
Frequency (MHz)	Test Data (dBm)	AF Table	Test Data (dBuV)	AF+CA- AMP (dB)	Results (uV/m)	Limits (uV/m)	Distance/ Polarity	Margin (dB)	PK / QP
37.2	-96	1BI3mV	11.0	12.3	14.6	100.0	3m/vert	16.7	Pk
60.1	-96	1BI3mV	11.0	10.5	11.9	100.0	3m/Vert	18.5	Pk
No other signals within 20 dB of limit.									

Tester  
 Signature: *Keyvan Movahed*

Name: Keyvan Movahed

## **2.12 Radiated Emissions Measurement for Harmonics and other Spurious (CFR 15.209 ((IC RSS 210, A2.9 (a)))**

Radiated spurious emissions in the frequency range of 30 MHz – 25000 MHz were measured per FCC KDB Publication 558074. The spectrum analyzer was set for an RBW = 100 kHz & VBW = 300 kHz. All spurious other than harmonics are greater than 20 dB below the limit. The result of the radiated spurious emissions test is given in Tables 6 through 11 below.



**2.12 Radiated Emissions Measurement for Harmonics and other Spurious (CFR 15.209 ((IC RSS 210, A2.9 (a))) (Cont'd)**

**Table 6. Peak Radiated Emissions for Harmonics and other Spurious, Corner Antenna**

Peak Radiated Emissions for Harmonics and other Spurious									
Test By:		Test:			Client:				
DA		FCC Part 15			Cirronet, Incorporated				
		Project:		Class:		Model:			
		07-0300		B		ZMN2405 W/Corner Antenna			
Frequency	Test Data	AF	Test Data	AF+CA-AMP	Results	Limits	Distance /	Margin	PK = n
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/ QP
<b>Low</b>									
*4809.6	-49.0	1HN3mH	58.0	5.2	1450.5	5000.0 <sup>(1)</sup>	3m./HORZ	10.7	PK
7214.57	-60.7	1HN3mH	46.3	9.9	644.3	11937.9	3m./HORZ	25.4	PK
<b>Mid</b>									
*4879.7	-48.5	1HN3mH	58.5	5.5	1578.9	5000.0 <sup>(1)</sup>	3m./HORZ	10.0	PK
*7319.67	-59.8	1HN3mV	47.2	10.2	736.6	5000.0 <sup>(1)</sup>	3m./VERT	16.6	PK
<b>High</b>									
*4949.71	-47.6	1HN3mH	59.4	5.7	1799.5	5000.0 <sup>(1)</sup>	3m./HORZ	8.9	PK
*7424.72	-59.0	1HN3mH	48.0	10.4	831.5	5000.0 <sup>(1)</sup>	3m./HORZ	15.6	PK

\* - Falls into Restricted Bands of CFR 15.205.

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

(1) Limit from CFR 15.209(a) modified by 15.35. All other limits from 15.247(d).

\*\* Conversion from 1 meter to 3 meters = -9.54 dB

SAMPLE CALCULATION:

RESULTS At 4809 MHz, = Antilog ((-49.0 + 5.5 + 107)/20) = 1496.2 (uV/m @ 3m)

CONVERSION FROM dBm TO dBuV = 107 dB

Test Date: January 29, 2008

Tester Signature: *Daniel Aparaschivei*

Name: Daniel Aparaschivei

**2.12 Radiated Emissions Measurement for Harmonics and other Spurious (CFR 15.209 ((IC RSS 210, A2.9(a)))**

**Table 7. Average Radiated Emissions for Harmonics and other Spurious, Corner Antenna**

Average Radiated Emissions for Harmonics and other Spurious									
Test By:		Test:			Client:				
DA		FCC Part 15			Cirronet, Incorporated				
		Project:		Class:		Model:			
		07-0300		B		ZMN2405, W/Corner Antenna			
Frequency	Test Data	AF	Test Data	AF+CA-AMP	Results	Limits	Distance /	Margin	Average
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	
<b>LOW</b>									
*4809.68	-95.0	1HN3mH	12.0	5.5	7.5	500.0 <sup>(1)</sup>	3m./HORZ	36.5	AVG
7214.57	-106.7	1HN3mH	0.3	9.9	3.2	500.0	3m./HORZ	41.7	AVG
9619.2	-98.6	1HN3mV	8.4	13.1	11.9	500.0	3m./VERT	32.5	AVG
*12023.9	-105.4	1HN3mV	1.6	17.3	8.8	500.0 <sup>(1)</sup>	3m./VERT	35.0	AVG
<b>MID</b>									
*4879.7	-99.2	1HN3mH	7.8	5.7	4.7	500.0 <sup>(1)</sup>	3m./HORZ	40.5	AVG
*7319.67	-106.3	1HN3mV	0.7	9.9	3.4	500.0 <sup>(1)</sup>	3m./VERT	43.4	AVG
9759.25	-96.6	1HN3mV	10.4	13.3	15.3	500.0	3m./VERT	30.3	AVG
<b>HIGH</b>									
*4949.71	-99.9	1HN3mH	7.1	5.9	4.5	500.0 <sup>(1)</sup>	3m./HORZ	41.0	AVG
*7424.72	-105.7	1HN3mH	1.3	10.4	3.9	500.0 <sup>(1)</sup>	3m./HORZ	42.2	AVG
9899.26	-96.1	1HN3mv	10.9	13.5	16.5	500.0	3m./VERT	29.6	AVG

\* Falls within the Restricted Bands of CFR 15.205.  
 Data corrected by 0.1 dB for loss of high pass filter.

(1) Limit per 15.249, remaining limits from 15.209.

\*\* Conversion from 1 meter to 3 meters = -9.54 dB

SAMPLE CALCULATION:  
 RESULTS AT 4809 MHz (uV/m @ 3m) = Antilog ((-95.0 + 5.5 + 107)/20) = 7.1  
 CONVERSION FROM dBm TO dBuV = 107 dB

**Test Date: January 29, 2008**

Tester Signature: *Daniel Aparaschivei*

Name: Daniel Aparaschivei

**Table 8. Peak Radiated Spurious Emissions, Omni Antenna**

Radiated Spurious Emissions									
Test By: DA	Test: FCC Part 15				Client: Cirronet, Incorporated				
	Project: 07-0300			Class: B		Model: ZMN2405 w/omni Antenna			
Frequency (MHz)	Test Data (dBm)	AF Table	Test Data (dBuV)	AF+CA-AMP (dB)	Results (uV/m)	Limits (uV/m)	Distance / Polarity	Margin (dB)	PK = n / QP
<b>LOW</b>									
2404.88	-38.2	1HN3mV	68.8	31.9	108392		3m./VERT		PK
*4809.66	-46.7	1HN3mV	60.3	5.2	1892.4	5000.0 <sup>(1)</sup>	3m./VERT	8.4	PK
7214.6	-62.8	1HN3mV	44.2	9.6	487.9	10839 <sup>(2)</sup>	3m./VERT	27.0	PK
<b>MID</b>									
2439.86	-36.2	1HN3mV	70.8	32.0	138038		3m./VERT		PK
*4879.8	-53.0	1HN3mV	54.0	5.5	945.9	5000.0 <sup>(1)</sup>	3m./VERT	14.5	PK
*7319.71	-58.7	1HN3mV	48.3	9.9	811.4	5000.0 <sup>(1)</sup>	3m./VERT	15.8	PK
<b>HIGH</b>									
2474.81	-37.4	1HN3mV	69.6	32.0	120226.0		3m./VERT		PK
*4949.71	-50.8	1HN3mV	56.2	5.7	1250.7	5000.0 <sup>(1)</sup>	3m./VERT	12.0	PK
*7424.43	-60.8	1HN3mV	46.2	10.1	654.0	5000.0 <sup>(1)</sup>	3m./VERT	17.7	PK

\* - Falls within restricted bands of CFR 15.205.

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

(1) Limit from CFR 15.209(a) modified by 15.35. All other limits from 15.247(d).

\*\* Conversion from 1 meter to 3 meters = -9.54 dB

(1)Limit from CFR 15.209 modified by CFR 15.35.

(2)Limit from CFR 15.247(d)

SAMPLE CALCULATION:

RESULTS: At 4809.66 MHz, = Antilog ((-46.7 + 5.2 + 107)/20) = 1892.4 (uV/m @ 3m)

CONVERSION FROM dBm TO dBuV = 107 dB

Test Date: December 4, 2007

Tester  
 Signature: *Daniel Aparaschivei*

Name: Daniel Aparaschivei

**Table 9. Average Radiated Spurious Emissions Omni Antenna**

Radiated Spurious Emissions									
Test By: DA		Test: FCC Part 15 Project: 07-0300			Class: B		Client: Cirronet, Incorporated Model: ZMN2405 W/Omni Antenna		
Frequency (MHz)	Test Data (dBm)	AF Table	Test Data (dBuV)	AF+CA-AMP (dB)	Results (uV/m)	Limits (uV/m)	Distance / Polarity	Margin (dB)	Average
LOW									
2404.88	-84.2	1HN3mV	22.8	31.9	543.2		3m./VERT		AVG
*4809.66	-92.7	1HN3mV	14.3	5.2	9.5	500.0 <sup>(1)</sup>	3m./VERT	34.5	AVG
7214.6	-108.8	1HN3mV	-1.8	9.6	2.4	500.0	3m./VERT	73.8	AVG
MID									
2439.86	-82.3	1HN3mV	24.8	32.0	685.4		3m./VERT		AVG
*4879.8	-99.0	1HN3mV	8.0	5.5	4.7	500.0 <sup>(1)</sup>	3m./VERT	40.5	AVG
*7319.71	-104.7	1HN3mV	2.3	9.9	4.1	500.0 <sup>(1)</sup>	3m./VERT	41.8	AVG
HIGH									
2474.81	-83.4	1HN3mV	23.6	32.0	604.5		3m./VERT		AVG
*4949.71	-96.8	1HN3mV	10.2	5.7	6.3	500.0 <sup>(1)</sup>	3m./VERT	38.1	AVG
*7424.43	-106.9	1HN3mV	0.2	10.1	3.3	500.0 <sup>(1)</sup>	3m./VERT	43.7	AVG

\* - Falls within the restricted Bands of CFR 15.205.

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

(1) Limit from CFR 15.209 Modified by CFR 15.35

(2) Limit from CFR 15.247 (d)

\*\* Conversion from 1 meter to 3 meters = -9.54 dB

SAMPLE CALCULATION:

RESULTS: At 4809 MHz, = Antilog  $((-92.7 + 5.2 + 107)/20) = 9.5$  (uV/m @ 3m)

CONVERSION FROM dBm TO dBuV = 107 dB

Test Date: December 4, 2007

Tester Signature: *Daniel Aparaschivei*

Name: Daniel Aparaschivei

**Table 10. Peak Radiated Spurious Emissions Patch Antenna**

Radiated Spurious Emissions									
Test By: DA		Test: FCC Part 15				Client: Cirronet, Incorporated			
		Project: 07-0300		Class: B		Model: ZMN2405 W/patch antenna			
Frequency	Test Data	AF	Test Data	AF+CA-AMP	Results	Limits	Distance /	Margin	PK = n
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	/ QP
<b>LOW</b>									
2404.88	-31.6	1HN3mV	75.4	32.1	238886		3m./VERT		PK
*4809.66	-40.3	1HN3mV	66.7	5.2	3954	5000.0 <sup>(1)</sup>	3m./VERT	2.0	PK
7214.6	-45.6	1HN3mV	61.5	9.9	3682.2	5000.0	3m./VERT	10.2	PK
<b>MID</b>									
2439.86	-34.5	1HN3mV	72.5	32.2	171487.2		3m./VERT		PK
*4879.8	-51.3	1HN3mV	55.7	5.5	1145.2	5000.0 <sup>(1)</sup>	3m./VERT	12.8	PK
*7319.71	-56.3	1HN3mV	50.7	10.2	1098.3	5000.0 <sup>(1)</sup>	3m./VERT	13.2	PK
<b>HIGH</b>									
2474.81	-35	1HN3mV	72	32.2	161911		3m./VERT		PK
*4949.71	-49.5	1HN3mV	57.5	5.9	1473.7	5000.0 <sup>(1)</sup>	3m./VERT	10.6	PK
*7424.43	-57.7	1HN3mV	49.3	10.4	974.8	5000.0 <sup>(1)</sup>	3m./VERT	14.2	PK

\* - Falls within restricted bands of CFR 15.205.  
 Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

\*\* Conversion from 1 meter to 3 meters = -9.54 dB  
 (1)Limit from CFR 15.209 modified by CFR 15.35.  
 (2)Limit from CFR 15.247(d)

SAMPLE CALCULATION:  
 RESULTS: At 4809.66 MHz, = Antilog ((-46.7 + 5.2 + 107)/20) = 1892.4 (uV/m @ 3m)  
 CONVERSION FROM dBm TO dBuV = 107 dB

**Test Date: December 4, 2007**

Tester  
 Signature: *Daniel Aparaschivei*

Name: Daniel Aparaschivei

**Table 11. Average Radiated Spurious Emissions Patch Antenna**

Radiated Spurious Emissions									
Test By:		Test:			Client:				
DA		FCC Part 15			Cirronet, Incorporated				
		Project:		Class:		Model:			
		07-0300		B		ZMN2405 W/Patch Antenna			
Frequency	Test Data	AF	Test Data	AF+CA-AMP	Results	Limits	Distance /	Margin	Average
(MHz)	(dBm)	Table	(dBuV)	(dB)	(uV/m)	(uV/m)	Polarity	(dB)	
LOW									
2404.83	-77.6	1HN3mH	29.4	32.1	1194.5		3m./VERT		AVG
*4809.66	-86.3	1HN3mV	20.7	5.2	19.8	500.0 <sup>(1)</sup>	3m./VERT	28.1	AVG
7214.6	-91.6	1HN3mH	15.4	9.9	18.4	119.5 <sup>(2)</sup>	3m./VERT	16.2	AVG
MID									
2439.86	-80.5	1HN3mH	26.5	32.2	857.5		3m./VERT		AVG
*4879.8	-97.3	1HN3mV	9.7	5.5	5.7	500.0 <sup>(1)</sup>	3m./VERT	38.8	AVG
*7319.71	-102.4	1HN3mH	4.6	10.2	5.5	500.0 <sup>(1)</sup>	3m./VERT	39.2	AVG
HIGH									
2474.81	-81.1	1HN3mH	25.9	32.2	809.6		3m./VERT		AVG
*4949.71	-95.6	1HN3mH	11.4	5.9	7.4	500.0 <sup>(1)</sup>	3m./VERT	36.6	AVG
*7424.43	-103.7	1HN3mH	3.3	10.4	4.9	500.0 <sup>(1)</sup>	3m./VERT	40.2	AVG

\* - Falls within the restricted Bands of CFR 15.205.

Data corrected by 0.1 dB for loss of high pass filter, except to fundamental

(2) Limit from CFR 15.209 Modified by CFR 15.35

(2) Limit from CFR 15.247 (d)

\*\* Conversion from 1 meter to 3 meters = -9.54 dB

SAMPLE CALCULATION:

RESULTS: At 4809 MHz, = Antilog  $((-86.3 + 5.2 + 107)/20) = 19.3$  (uV/m @ 3m)

CONVERSION FROM dBm TO dBuV = 107 dB

Test Date: December 4, 2007

Tester  
 Signature: *Daniel Aparaschivei*

Name: Daniel Aparaschivei

### 2.13 Restricted Bands (CFR15.205)

All radiated signals must be compared to the list of CFR 15.205. No fundamentals can be in the restricted bands. All harmonics can be in the restricted bands but their limits must conform to 15.209 modified by 15.35. All other spurious can fall into the restricted bands but they must conform to the limits of 15.247.

### 2.14 Minimum Six (6) dB Bandwidth per CFR 15.247(a) (2)

This measurement was performed by the methods of FCC KDB Publication Number 558074. The test antenna port was connected to a spectrum analyzer that was set for a 50  $\Omega$  impedance with the RBW = 100 kHz. The results of this test are given in Table 12 and Figure 9 through Figure 11.

**Table 12**  
**Six (6) dB Bandwidth**

**Test Date:** January 16, 2008  
**UST Project:** 07-0300  
**Customer:** Cirronet, Incorporated  
**Model:** ZMN2405

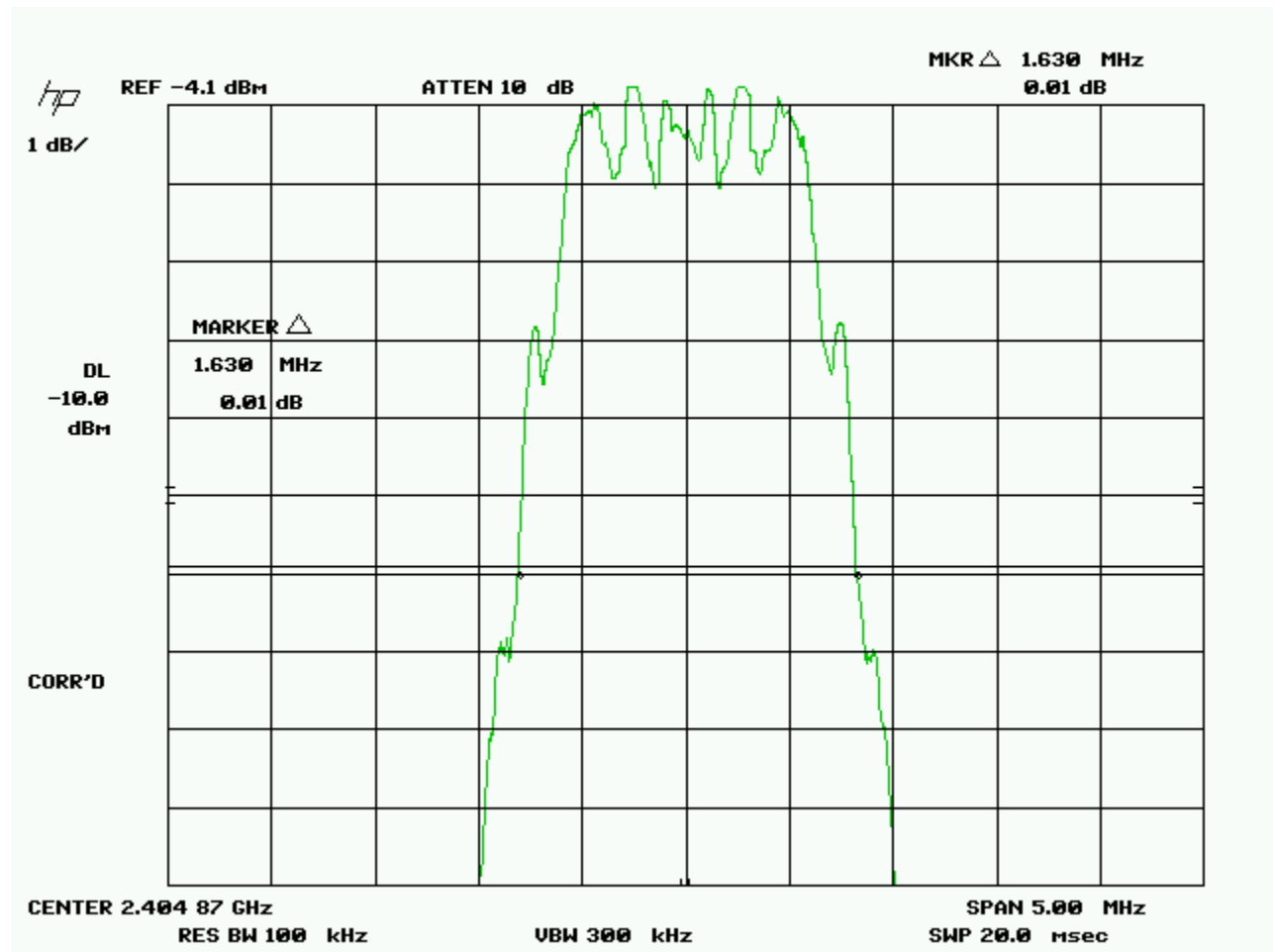
Frequency (GHz)	6 dB Bandwidth (MHz)	MINIMUM FCC LIMIT (MHz)
2.40487	1.63	0.5
2.44000	1.62	0.5
2.47500	1.62	0.5

**Tester Signature:** *Daniel Aparaschivei*

**Name:** Daniel Aparaschivei

### 2.14 Minimum Six (6) dB Bandwidth per CFR 15.247(a) (2)

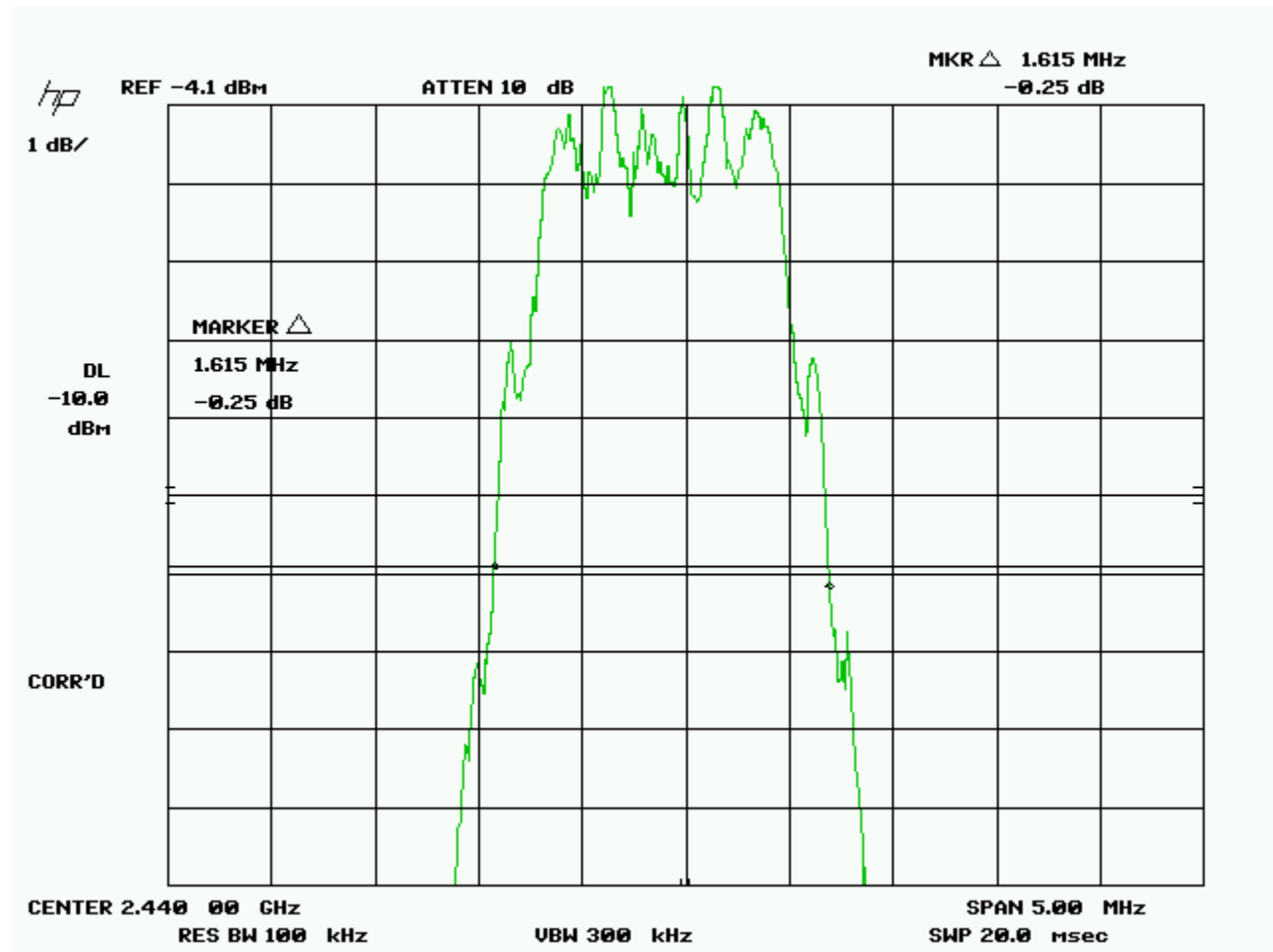
**Figure 9**  
**Six (6) dB Bandwidth per CFR 15.247(a)(2), Low**





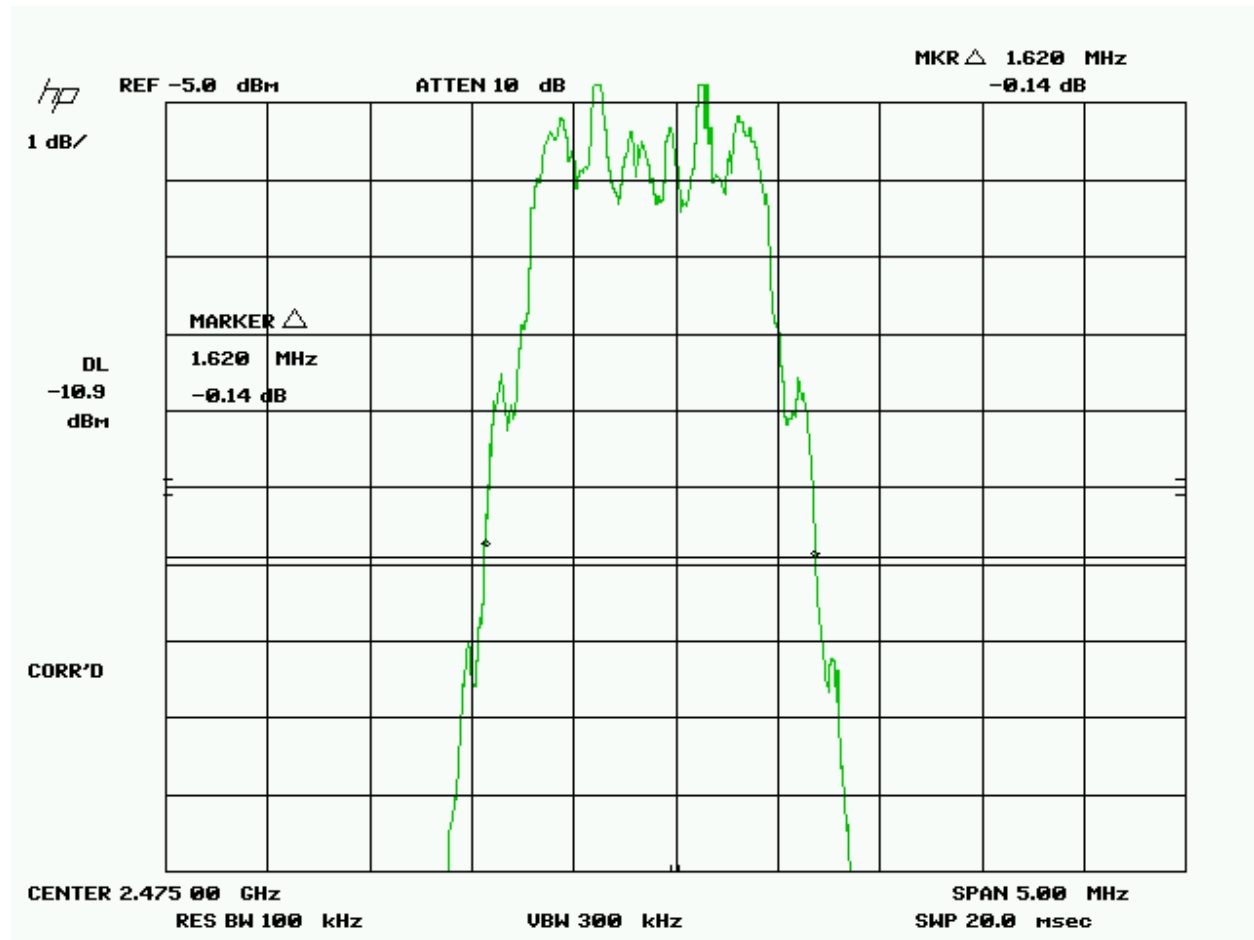
### 2.14 Minimum Six (6) dB Bandwidth per CFR 15.247(a) (2)

**Figure 10**  
**Six (6) dB Bandwidth per FCC Section 15.247(a)(2), Mid**



### 2.14 Minimum Six (6) dB Bandwidth per CFR 15.247(a) (2)

**Figure 11**  
**Six (6) dB Bandwidth per FCC Section 15.247(a)(2), High**



**2.15 Peak Power Output (CFR 15.247(b)(3)) (IC RSS 210, A8.4(4))**

For the ZMN2405, the transmitter was programmed to operate at nominal power. Peak power of the fundamental for Low, Mid and High channels within the band 2400 MHz to 2483.5 MHz was measured per FCC KDB Publication 558074 with a spectrum analyzer by connecting the spectrum analyzer directly to the EUT's 50 Ohm output port. The spectrum analyzer was set for a VBW = RBW = 3 MHz. The results of the measurements are given in Table 9 and Figures 12 through 14.

**2.15 Peak Power Output (CFR 15.247(b)(3)) (IC RSS 210, A8.4(4))**

**Table 13  
 Conducted Peak Power Output**

Frequency of Fundamental (MHz)	Measurement @Analyzer dBuV/(dBm)	Calculated (mW)*	FCC Limit (mW)
2405.02	75.4 /(-31.6)	0.66	1000
2439.96	73.8 /(-33.2)	0.46	1000
2474.78	73.6 /(-33.4)	0.44	1000

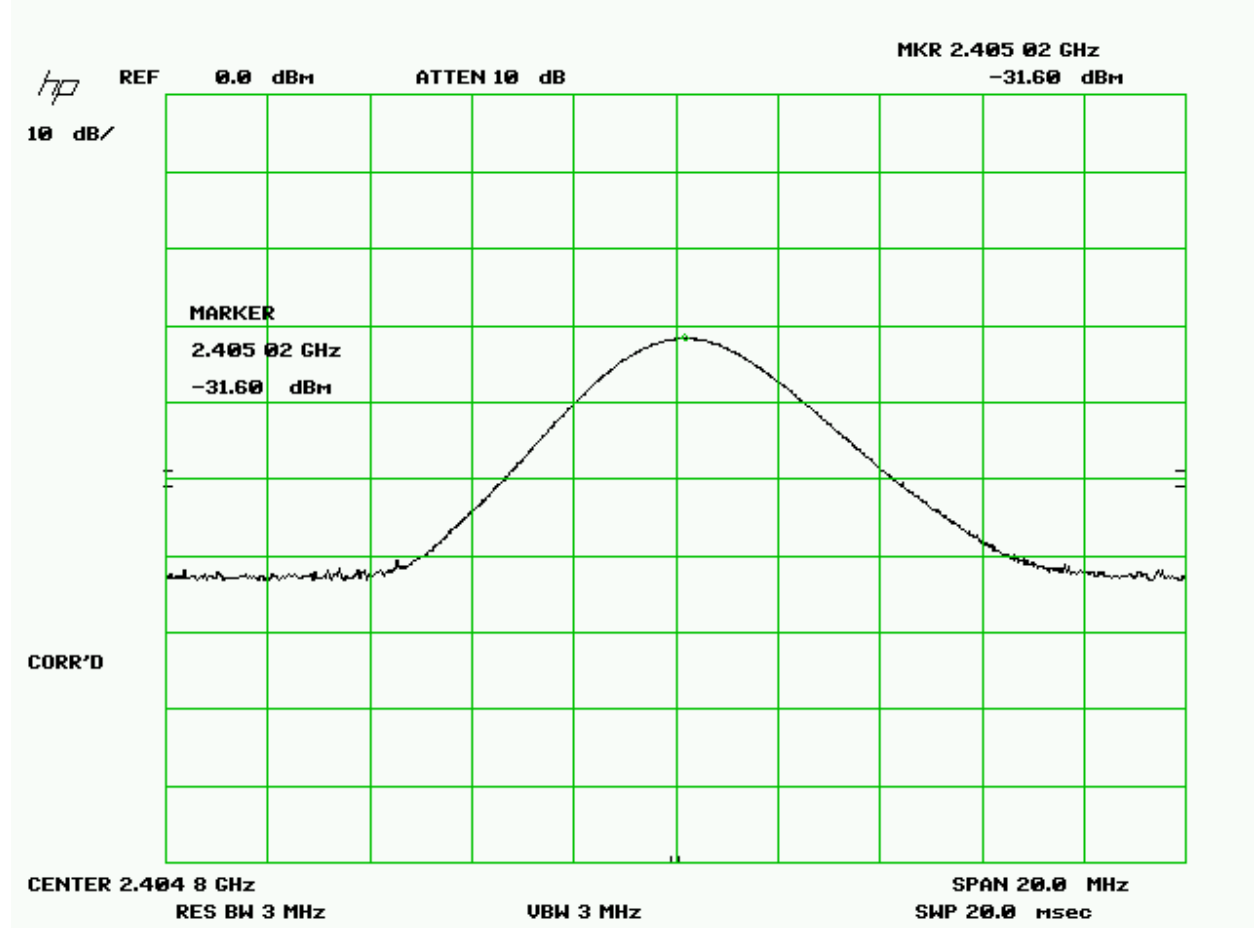
\* Measurement includes cable loss factor

Tester Signature: *Daniel Aparaschivei*

Name: Daniel Aparaschivei

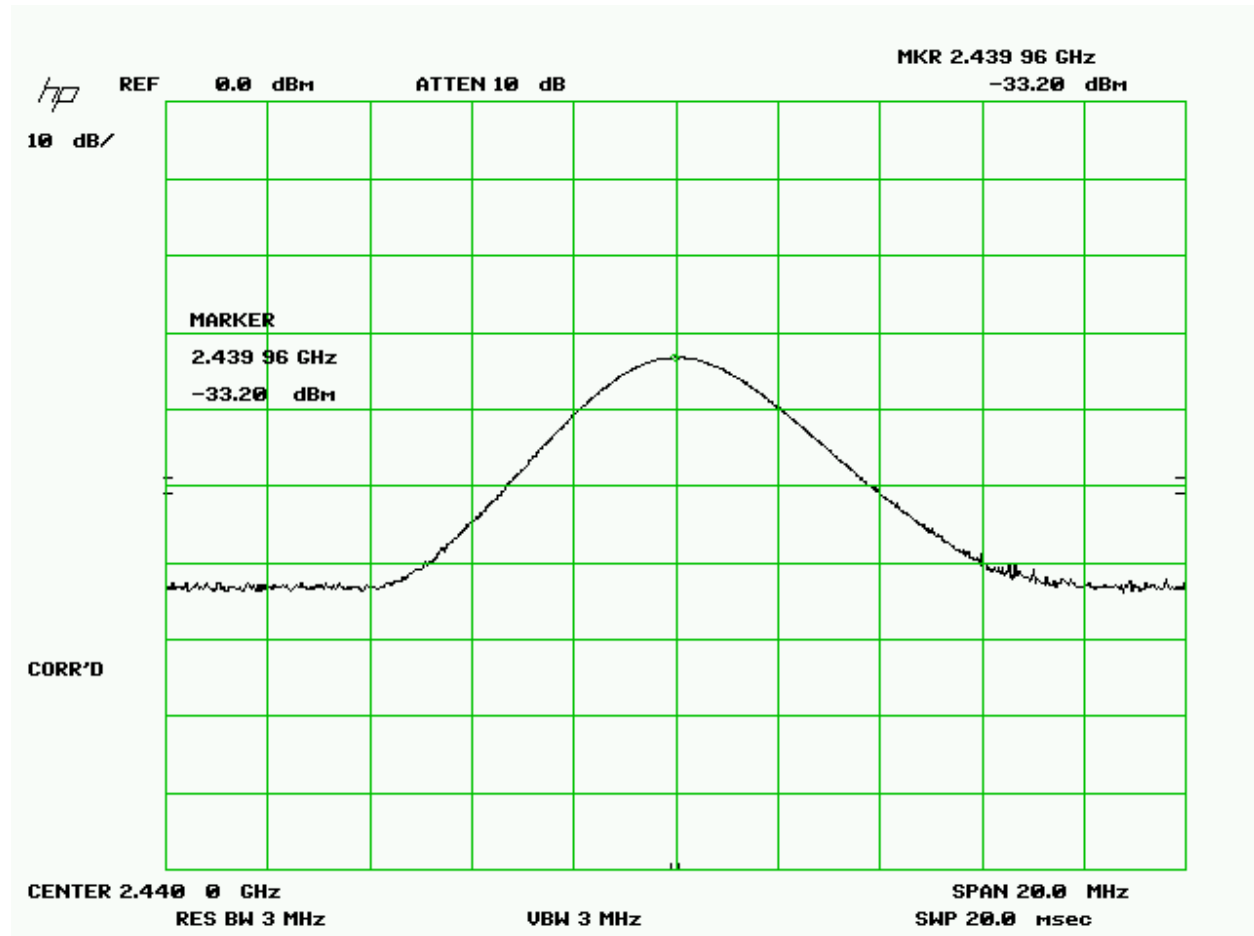
**2.15 Peak Power Output (CFR 15.247(b)(3)) (IC RSS 210, A8.4(4)) (Cont'd)**

**Figure 12  
Peak Power Output 15.247(b)(3) – Fundamental, Low**



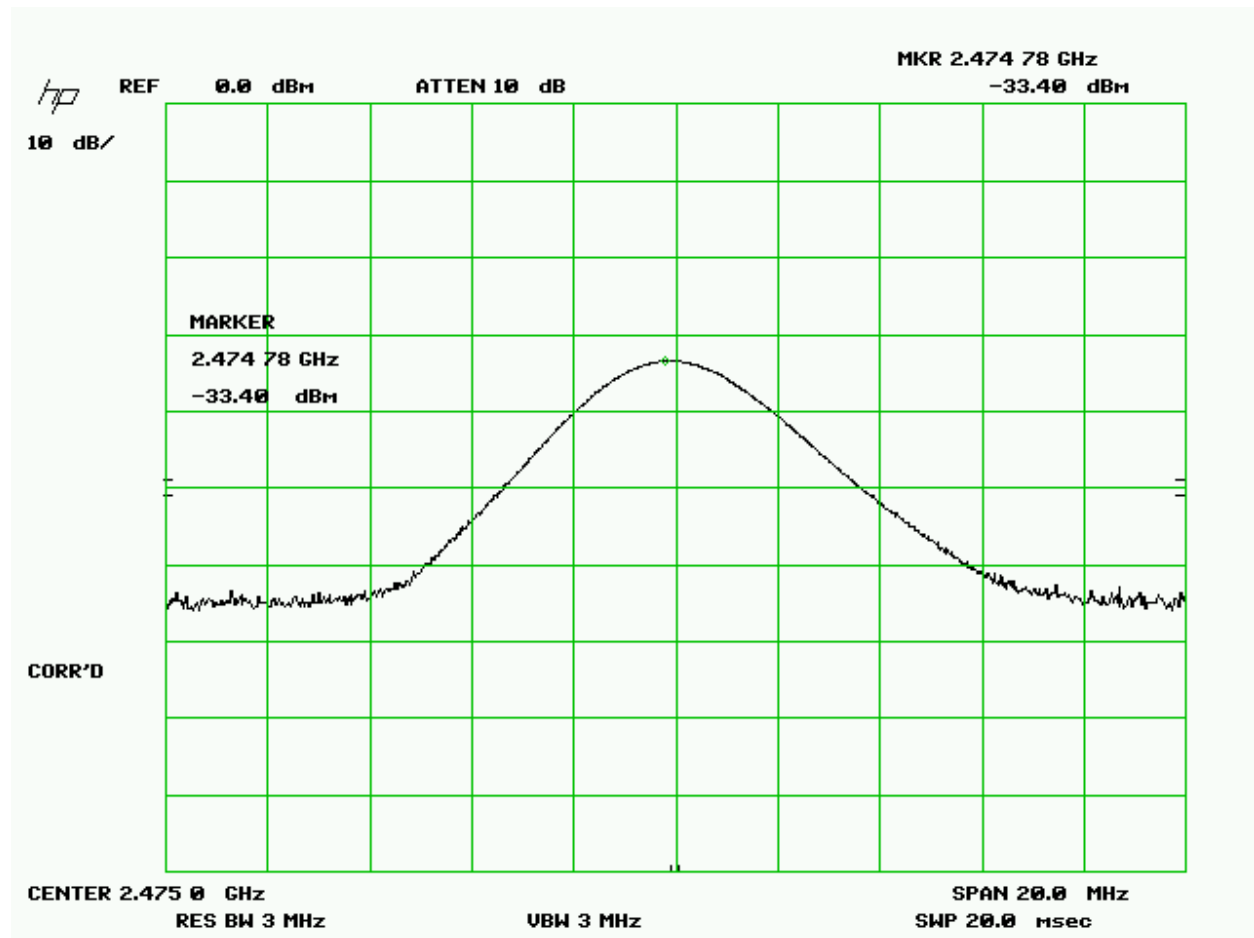
### 2.15 Peak Power Output (CFR 15.247(b)(3)) (IC RSS 210, A8.4(4)) (Cont'd)

**Figure 13**  
**Peak Power Output 15.247(b)(3) Fundamental, Mid**



### 2.15 Peak Power Output (CFR 15.247(b)(3)) (IC RSS 210, A8.4(4)) (Cont'd)

**Figure 14**  
**Peak Power Output 15.247(b)(3) Fundamental, High**



## **2.16 Directional Antenna Gains greater than 6dBi (CFR 15.247 (c))**

For point to point operation, the EUT has antennae with 14, 12 and 9 dBi gains, therefore its power output must be reduced from the 1 Watt maximum by 3 dB for the 14 dBi antenna to 2 dB for the 12 dBi antenna and 1 dB for the 9 dBi antenna. (1 dB for each 3 dB that the antenna gain exceeds 6 dBi).

## 2.17 Band - Edge Measurements (CFR 15.247 (d))

Band Edge measurements were made at a Low Channel and High Channel peak at the highest EUT related emission outside the occupied bandwidth. A peak measurement was made of the fundamental. The emission was measured using a peak detector setting. A Resolution Bandwidth of 100 kHz was used. The Video Bandwidth was 300 kHz. This procedure was repeated for the low channel. Refer to figures 15 and 16.

The limits were derived as follows:

### 2.17.1 Higher Band - Edge:

From CFR 15.209 and 15.35, limit for Peak measurements of all but fundamental is  $5000 \text{ uV/m} = -32 \text{ dBm/m}$ .

Subtract antenna factors and cable loss for this frequency =  $-33 \text{ dBm} - 32.0 \text{ dB}$  (antenna factor and cable loss) =  $-65 \text{ dBm} = \text{Limit}$ .

Maximum level of Fundamental measured at High Channel:  $-33.4 \text{ dBm}$  (from Figure 14).

The difference of measurement, (delta), of band- edge from the fundamental peak to the band edge:  $-52.8 \text{ dB}$

Therefore:  $-33.4 \text{ dBm} - 52.8 \text{ dB} = -86.2 \text{ dBm} < -65 \text{ dBm}$

Also, at 2483.5 MHz, for the limit =  $-65 \text{ dBm/m}$ , its dBuV equivalent is  $42 \text{ dBuV/m} = 10^{(42/20)} = 10^{2.1} = 125.9 \text{ uV/m}$  which is less than CFR 15.209 requires and per 15.247(d) is not required to be lower than  $500 \text{ uV/m}$ . Band 2480 MHz is not used with this product.

### 2.17.2 Lower Band - Edge:

Limit =  $-33 \text{ dBm} - 31.9 \text{ dB}$  (antenna factor and cable loss) =  $-64.9 \text{ dBm}$

Maximum level of Fundamental measured at Low Channel:  $-31.6 \text{ dBm}$  (from Figure 12)

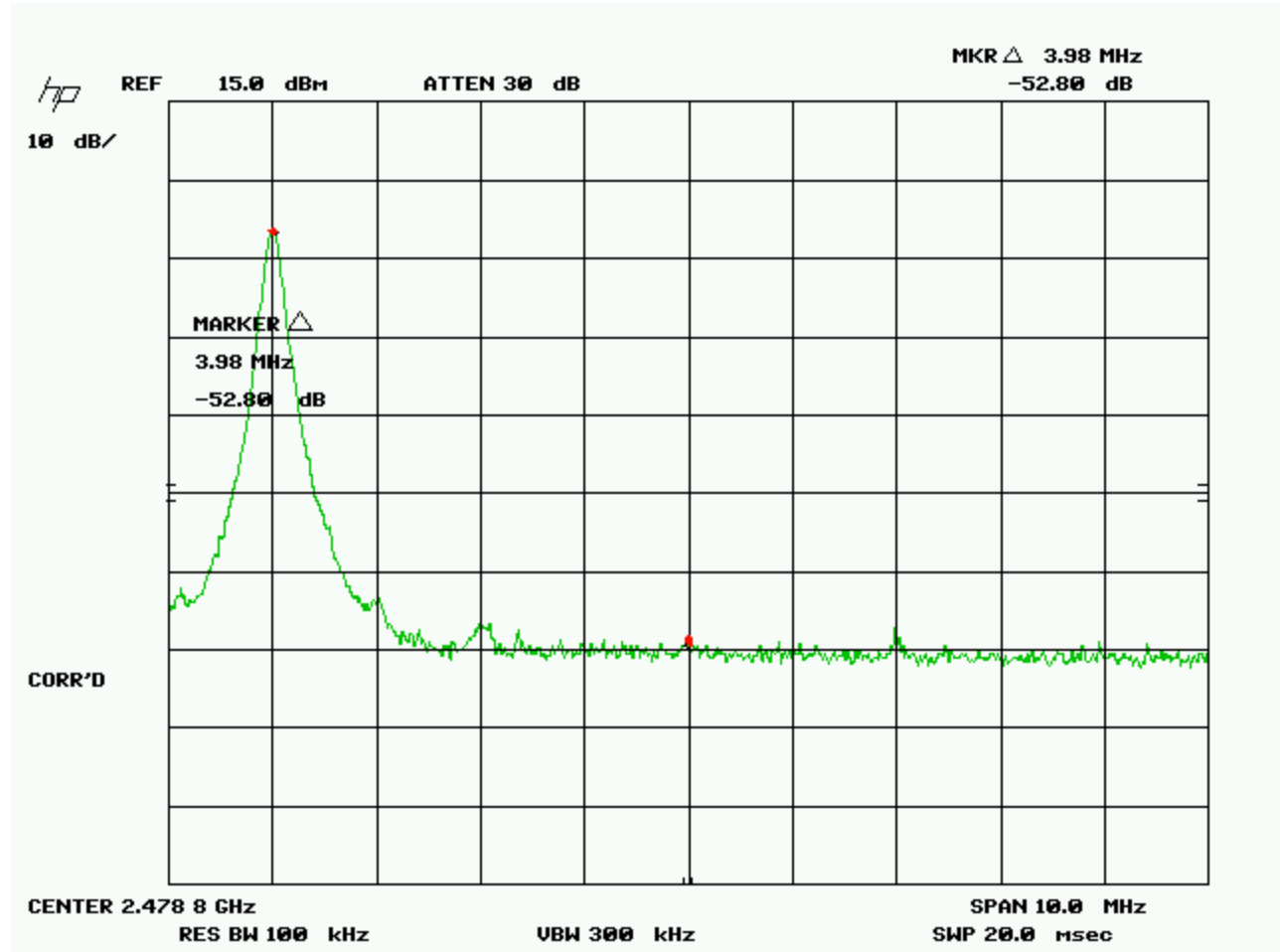
Delta from conducted measurement of band - edge from fundamental peak to highest spur 10 MHz outside band edge:  $-53.6 \text{ dB}$

$-31.6 \text{ dBm} - 53.6 \text{ dB} = -85.2 \text{ dBm} < -64.9 \text{ dBm}$



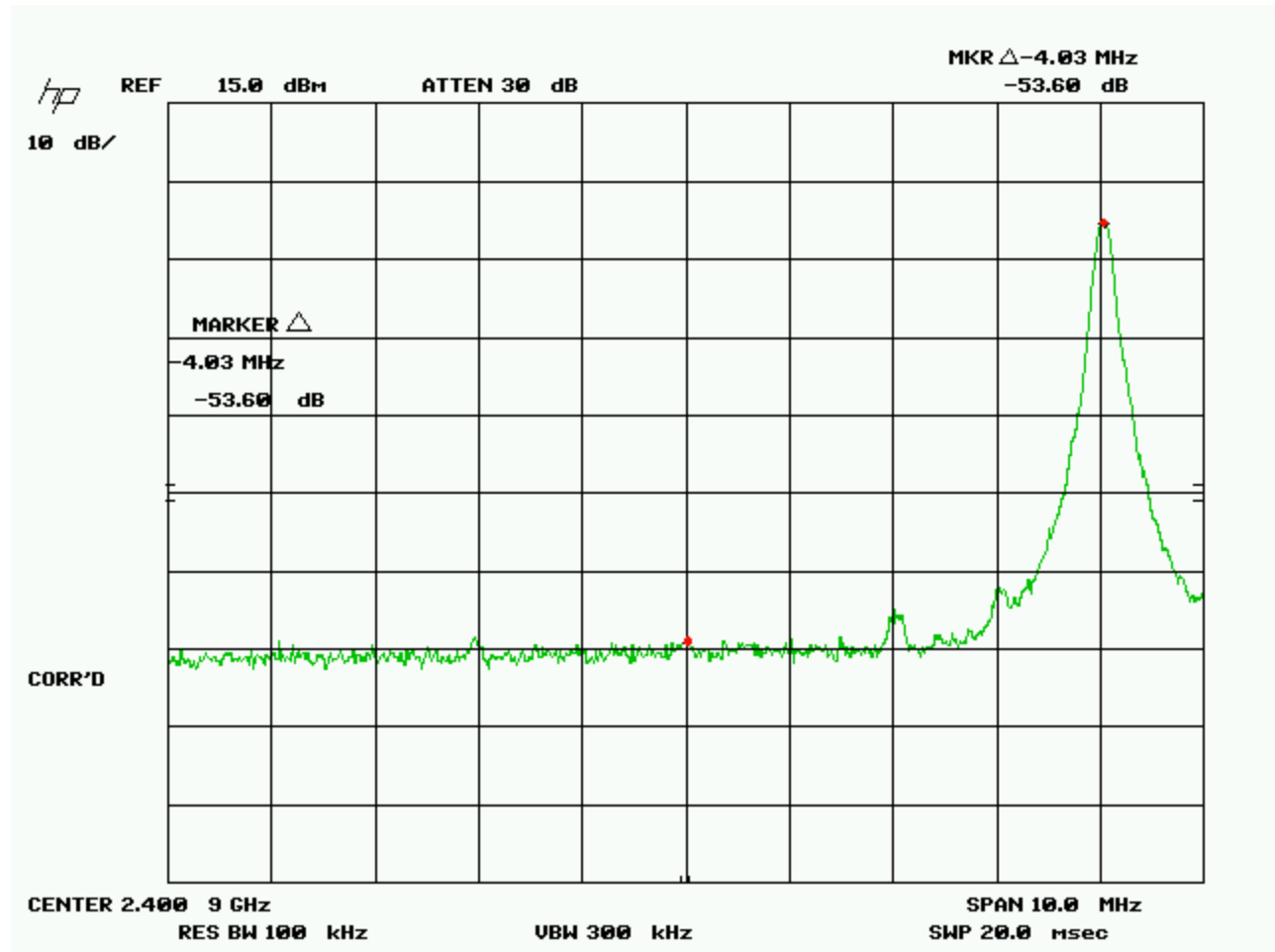
### 2.17 Band - Edge Measurements (CFR 15.247 (d))

**Figure 15. Band Edge Compliance  
Radiated Emissions, High Channel**



### 2.17 Band - Edge Measurements (CFR 15.247 (d))

**Figure 16. Band Edge Compliance Radiated Emissions, Low Channel**



## 2.18 Power Spectral Density (15.247(e))

The power spectral density was calculated following the procedures specified in FCC KDB Publication 558074, PSD Option 1.

The peaks at each channel (low, mid, and high) were located and zoomed in on. The RBW was set to 3 kHz and the VBW was set to 10 kHz. The span was set to be 1.5 MHz, and the sweep time was set to be a value equal to the span divided by 3 kHz, or 100 seconds.

The results and the limits are listed and summarized in Table 14. The graphs are shown in Figures 2.18, 2.19 and 2.20.

**Test Date:** February 13, 2008  
**UST Project:** 07-0300  
**Customer:** Cirronet, Incorporated  
**Product:** ZMN2405

**Table 14. Peak Power Spectral Density**

Frequency (GHz)	Peak Value (dBm/3kHz)	FCC Maximum Limit (dBm/3kHz)
2404.64	-16.09	8
2439.43	-17.52	8
2474.97	-19.47	8

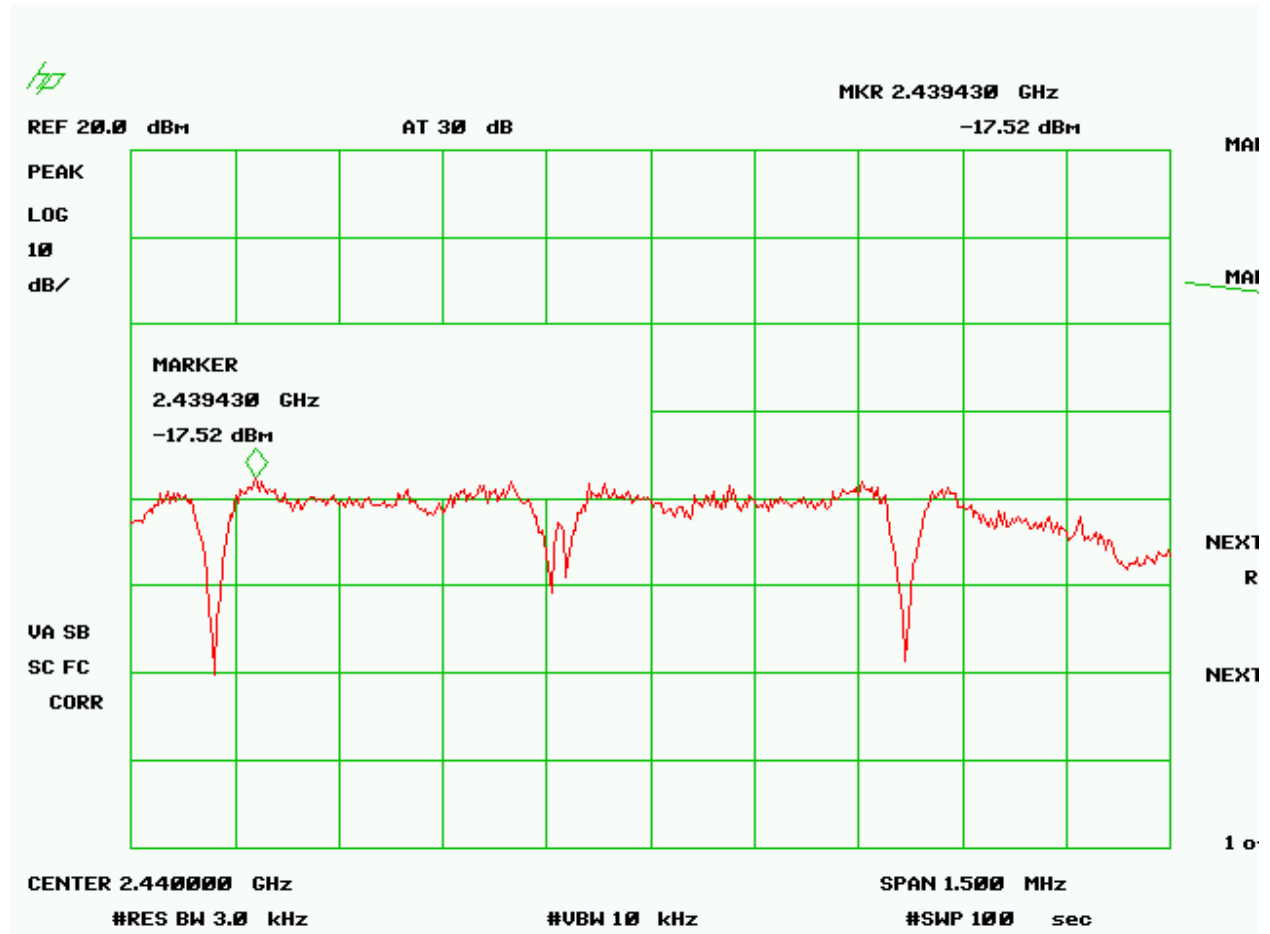
## 2.18 Power Spectral Density Measurements (CFR 15.247 (e))

### Figure 17. PSD Compliance Peak Emissions, Low Channel



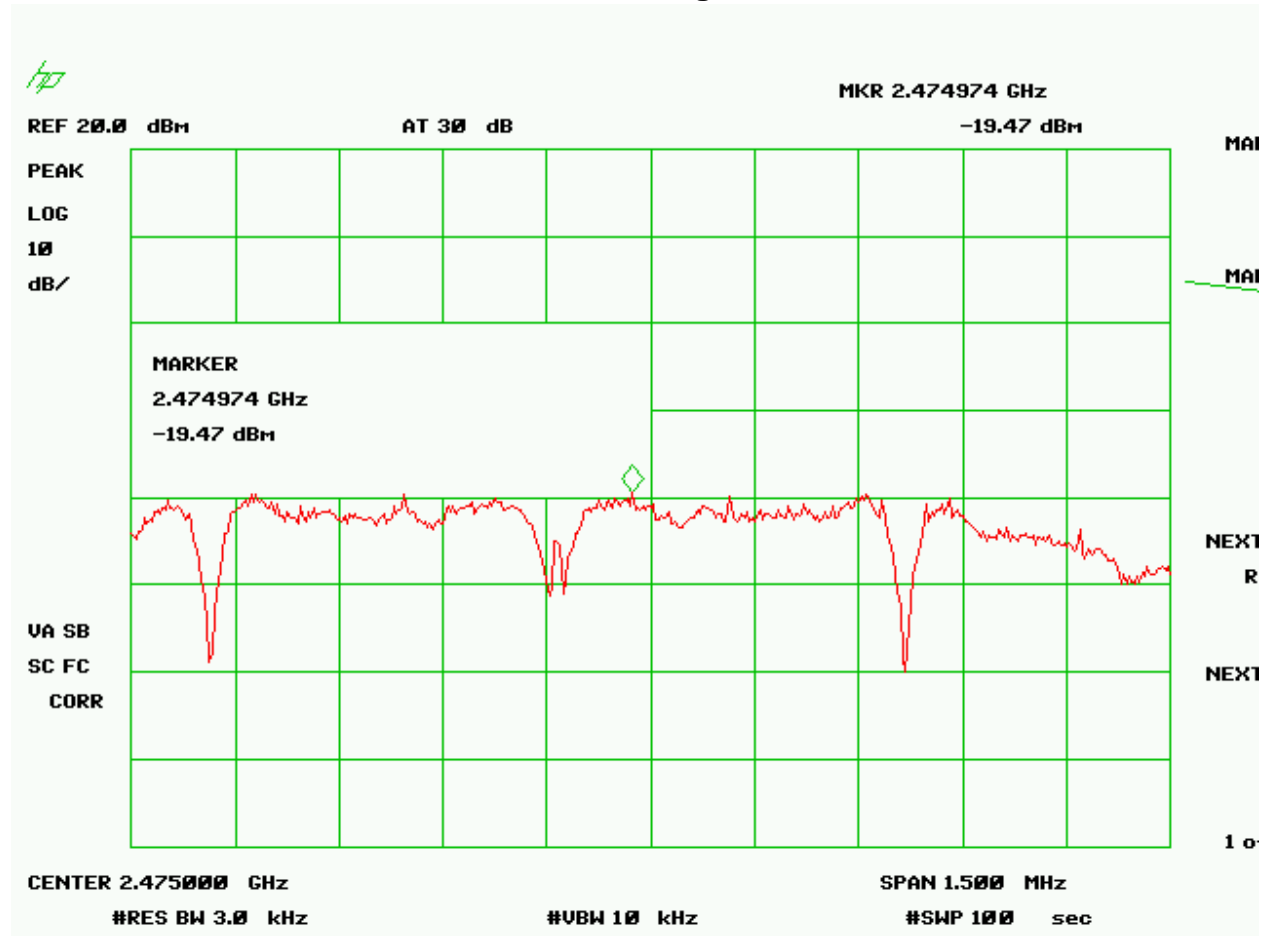
## 2.17 Power Spectral Density Measurements (CFR 15.247 (e))

### Figure 18. PSD Compliance Peak Emissions, Mid Channel



### 2.18 Power Spectral Density Measurements (CFR 15.247 (e))

**Figure 19. PSD Compliance  
Peak Emissions, High Channel**



## 2.19 Maximum Public Exposure to RF Radiation (MPE) CFR 15.247 (i)

The maximum exposure level to the public from the RF power of the EUT shall not exceed a power density,  $S$ , of  $1 \text{ mW/cm}^2$  at a distance,  $d$ , of 20 cm from the EUT.

Therefore, for :

Peak Power (Watts) = 0.00066 (from Table 12, herein)  
Gain of Transmit Antenna =  $14 \text{ dB}_i = 25.1$  numeric (from Table 3, herein)  
Distance,  $r = 20 \text{ cm}$

$$S = (PG / 4\pi r^2) = \text{EIRP} / 4A$$

Where:  $A$  = the area of a circle with radius,  $r = 20\text{cm}$ .

Therefore,

$$S = 0.016 \times 1 / 4 \times 3.1416 \times (20)^2 = 0.016 / 1600\pi = 3.3 \text{ } \mu\text{W/cm}^2$$





US Tech

Issue Date: February 13, 2008

Report Number: 07-0300

FCC ID: HSW-Z2405

Test Report: FCC Spread Spectrum Radio

Customer: Cirronet, Inc.

Model ZMN2405

**4. Block Diagram(s)/ Schematic(s) confidential information removed**

US Tech

Issue Date: February 13, 2008

Report Number: 07-0300

FCC ID: HSW-Z2405

Test Report: FCC Spread Spectrum Radio

Customer: Cirronet, Inc.

Model ZMN2405

#### **4. Block Diagram(s)/ Schematic(s) (cont.) confidential information removed**

## 5. Photographs

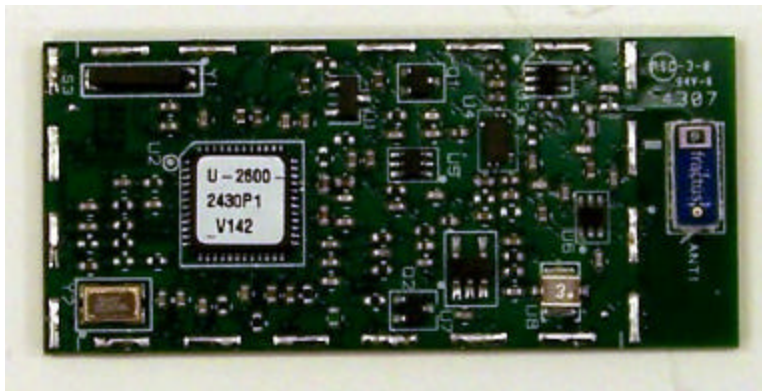
**Figure 21. ZMN2405 with Shield**



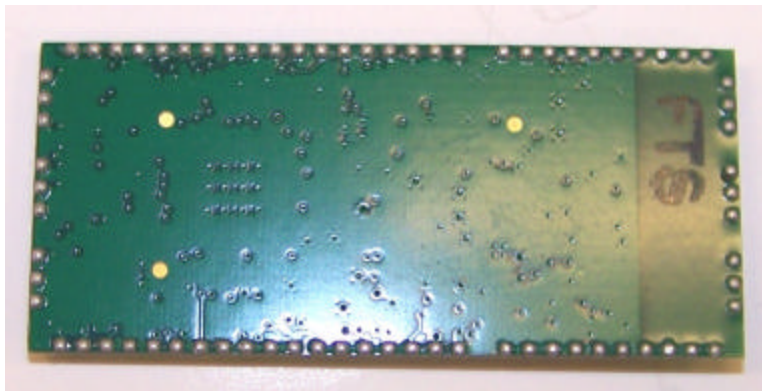
ZMN2405

5. Photographs (cont.)

Figure 22. ZMN2405 Top and Bottom



ZMN2405 Top



ZMN2405 Bottom

US Tech  
Issue Date: February 13, 2008  
Report Number: 07-0300

FCC ID: HSW-Z2405  
Test Report: FCC Spread Spectrum Radio  
Customer: Cirronet, Inc.  
Model ZMN2405

## **6. Theory of Operation**

CONFIDENTIAL INFORMATION REMOVED

**7. User's Manual -- UPLOADED SEPARATELY**

