

# **ENGINEERING TEST REPORT**

**Spread Spectrum Multiple Address Radio Transceiver  
MODEL NO.: MDS 24810**

**FCC ID: E5MDS24810**

**FCC PART 15, SUBPART C, PARA. 15.247  
FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTERS  
OPERATING IN THE FREQUENCY BAND FROM 2400.64 - 2472.24 MHz**

**UltraTech FILE NO.: MIC15-FTX**

**Tested for:**

**ADAPTIVE BROADBAND**

**175 Science Parkway  
Rochester, New York  
USA, 14620**

**Tested by:**

**ULTRATECH GROUP OF LABS**

**3000 Bristol Circle  
Oakville, Ontario  
Canada L6H 6G4**

**REPORT PREPARED BY: Dan Huynh**

**DATE: May 27, 1999**

## **UltraTech**

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**3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4**

**Telephone (905) 829-1570 Facsimile (905) 829-8050**

**Website: [www.ultratech-labs.com](http://www.ultratech-labs.com)  
Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca)**

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

# 1. EXHIBIT 1 - SUMMARY OF TEST RESULTS & GENERAL STATEMENT OF CERTIFICATION

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.247(a)(1) & 15.247(a)(1)(ii)	Hopping Channel Frequency Characteristics	Yes
15.247(b)(2) & 1.1310	Peak Output Power and RF Exposure Limit	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
15.107	AC Power Conducted Emissions	Not applicable for DC power supply

**Note:** The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class A Digital Devices, the associated Radio Receiver operating in 2400.64 –2472.24 MHz is exempted from FCC authorization. The engineering test report can be provided upon FCC requests.

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Tel. #: 905-829-1570, Fax. #: 905-829-9050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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### TESTIMONIAL AND STATEMENT OF CERTIFICATION

*THIS IS TO CERTIFY:*

- 1) *THAT the application was prepared either by, or under the direct supervision of the undersigned.*
- 2) *THAT the measurement data supplied with the application was taken under my direction and supervision.*
- 3) *THAT the data was obtained on representative production units.*
- 4) *THAT, to the best of my knowledge and belief, the facts set forth in the application and accompanying technical data are true and correct.*

**Certified by:**



**Tri Minh, P.Eng.  
V.P., Engineering**

**DATE: May 27, 1999**

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## 2. EXHIBIT 2 - GENERAL INFORMATION

### 2.1 APPLICANT

ADAPTIVE BROADBAND  
175 Science Parkway  
Rochester, New York  
USA, 14620

Applicant's Representative: Mr. Jacob Z. Schanker

### 2.2 MANUFACTURER

ADAPTIVE BROADBAND  
175 Science Parkway  
Rochester, New York  
USA, 14620

### 2.3 DESCRIPTION OF EQUIPMENT UNDER TEST

<b>PRODUCT NAME:</b>	Spread Spectrum Multiple Address Radio Transceiver
<b>MODEL No:</b>	MDS 24810
<b>SERIAL NUMBER:</b>	Pre-production
<b>TYPE OF EQUIPMENT:</b>	Frequency Hopping Spread Spectrum Transmitters
<b>OPERATING FREQ.:</b>	2400.64 - 2472.24 MHz
<b>NUMBER OF HOPPING FREQUENCY CHANNELS:</b>	896
<b>SEPERATION BETWEEN HOPPING FREQUENCY CHANNELS:</b>	80 kHz
<b>CHANNEL 20 dB BW:</b>	69.1 kHz
<b>CHANNEL OCCUPANCY TIME IN 30 SEC. PERIOD:</b>	9.2 ms

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**POWER RATING:** 693.4 milli-W peak @ antenna terminal or 5046.3 mili-Watts EIRP (with S2403BP antenna)  
116 mili-Watts peak @ antenna terminal or 21.1 mili-Watts EIRP (with PC2415N antenna)  
18 mili-Watts peak @ antenna or 0.4 mili-Watts EIRP (with SPG-36 antenna)

**EMISSION DESIGNATION:** Frequency Hopping Spread Spectrum

**DUTY CYCLE:** Continuous

**OSC. FREQUENCY(IES):** 1st LO 2154.0 - 2237.5MHz, 2nd LO 235.3MHz

**CPU SPEED:** 16MHz

**INPUT SUPPLY:** 13.8 Vdc supply

**ASSOCIATED DEVICES:**

1. Cushcraft Omni-directional Vertical Antenna, Model S2403BP, Gain: 5.1 dBi
2. Cushcraft/Signals Yagi Antenna Model PC2415N, Gain: 16.0 dBi
3. Phillips-Tech Electronics Grid Parabolic Antenna, Model SPG-36, Gain: 24.0 dBi

**FCC ID:** E5MDS24810

**INTERFACE PORTS:**

- (1) Antenna (Type N Female Jack)
- (2) DC Power
- (3) Interface (female DB25)
- (4) Diagnostics (RJ 11)

The above antennas shall be professionally installed by manufacturer or its professional technical service contractor, and they shall be located at the location away from the users for RF safety purposes.

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## 2.4 RELATED SUBMITTAL(S)/GRANT

Not applicable.

## 2.5 TEST METHODOLOGY

These tests were conducted on a sample of the equipment for the purpose of certification compliance with Code of Federal Regulations (CFR47-1991), Part 15, Subpart C, Para. 15.247, Frequency Hopping Spread Spectrum Transmitters operating in the Frequency Band 2400.64-2472.24 MHz.

Radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4-1992 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz.

## 2.6 TEST FACILITY

Radiated Emissions were performed at the UltraTech's 3-to-10 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above site have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT1300F2) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: Sep. 20, 1998.

The above test site is also filed with Interference Technology International Ltd (ITI - An EC Directive on EMC).

## 2.7 UNITS OF MEASUREMENTS

Measurements of radiated emissions are reported in units of dB referenced to one microvolt per meter [dB(uV)/m] at the distance specified in the report, wherever it is applicable.

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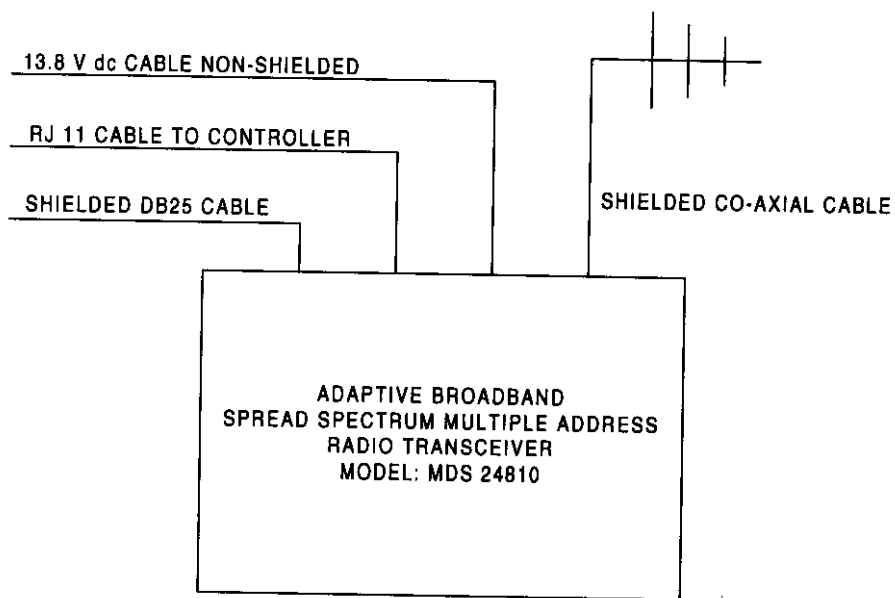
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### 3. EXHIBIT 3 - SYSTEM TEST CONFIGURATION

#### 3.1 BLOCK DIAGRAMS FOR CONDUCTED & RADIATED EMISSION MEASUREMENTS



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### 3.3 JUSTIFICATION

No deviation, in both configuration and operation manners, different from normal operation were required.

### 3.4 EUT OPERATING CONDITION

The transmitter was specially set to operate at lowest, middle and highest frequencies for testing.

### 3.5 SPECIAL ACCESSORIES

No special accessories were required.

### 3.6 EQUIPMENT MODIFICATIONS

To achieve compliance, the following change(s) were made by UltraTech's test house during compliance testing:

Not required.

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## 4. EXHIBIT 4 - TEST DATA

### 4.1 HOPPING CHANNEL CARRIER FREQUENCY CHARACTERISTICS @ FCC CFR 47, PARA 15.247(A)(1) & (A)(1)(II)

**PRODUCT NAME:** Spread Spectrum Multiple Address Radio Transceiver,  
Model No.: MDS 24810

**FCC REQUIREMENTS:**

@ FCC CFR 47, Para 15.247(a)(1):- 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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

@ FCC CFR 47, Para 15.247(a)(1)(ii):- Frequency hopping systems operating in the 2400-2483.5 MHz and 5725-5850 MHz bands shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

**CLIMATE CONDITION:**

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

**POWER INPUT:**

13.8 VDC.

**TEST EQUIPMENT:**

- Spectrum Analyzer, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- Microwave Amplifier, HP, Model 83017A, Frequency Range 1 to 26.5 GHz, 34-38 dBdB gain nominal.
- Log Periodic/Bow-Tie Antenna, Emco, Model 3143, SN 1029, 20 - 1000.MHz, @ 50 ohms.
- Horn Antenna, Emco, Model 3115, SN 9701-5061, Frequency Range: 1 - 18 GHz, @ 50 Ohms.

**METHOD OF MEASUREMENTS:**

The measurements under this section will be performed at 3 meter distance.

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**TEST RESULTS:** Conforms.

**TEST PERSONNEL:** Mr. Hung Trinh, EMI/RFI Technician

**DATE:** May 26, 1999

**MEASUREMENT DATA:**

Please refer of the attached plots for detailed measurements.

Test Description	FCC Specification	Measured Values	Comments
Channel Hopping Frequency Separation	minimum of 25 kHz or 20dB BW whichever is greater.	80 kHz	Pass
Channel frequency hopping method	See Note (1).	Please refer to the technical description provided by applicant.	Nil.
Number hopping frequencies	75 minimum	896 channels starting from 2400.64 MHz to 2472.24 MHz	Pass
20 dB BW of the hopping channel	80 kHz maximum	69.1 kHz	Pass
Average Time of Occupancy	0.4 seconds max. within 30 seconds period	9.2 ms within 30 seconds period	Pass

**Note (1):-** The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals

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Engineering Labs Inc.

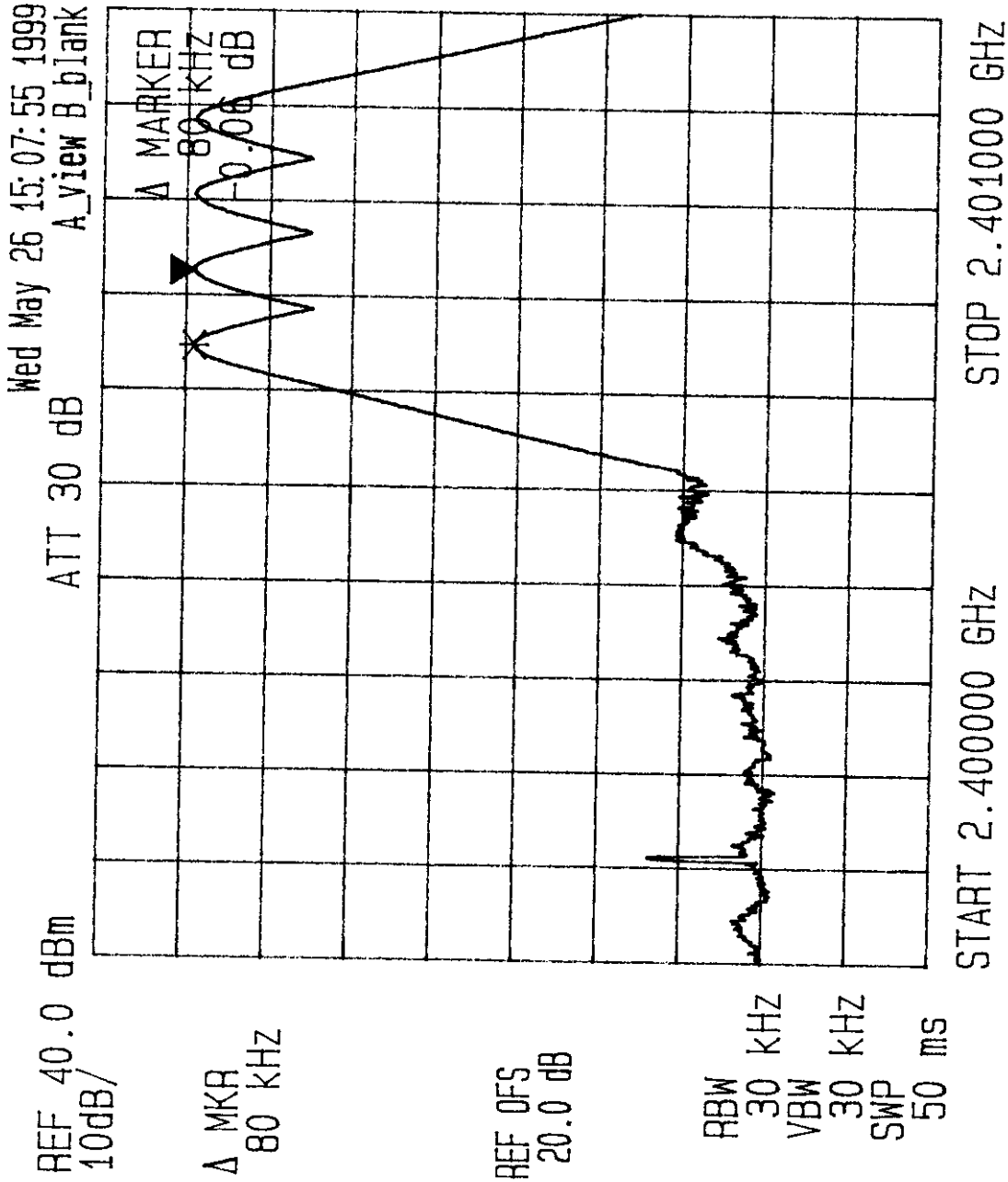
**MICROWAVE DATA SYSTEMS INC.**

Model: 24810 & | S2403BP Antenna | | PC-2415N Antenna | | SPG-36 Antenna

Tx Frequency: \_\_\_\_\_ MHz

2.4 GHz Frequency Hopping Spread Spectrum Transceivers

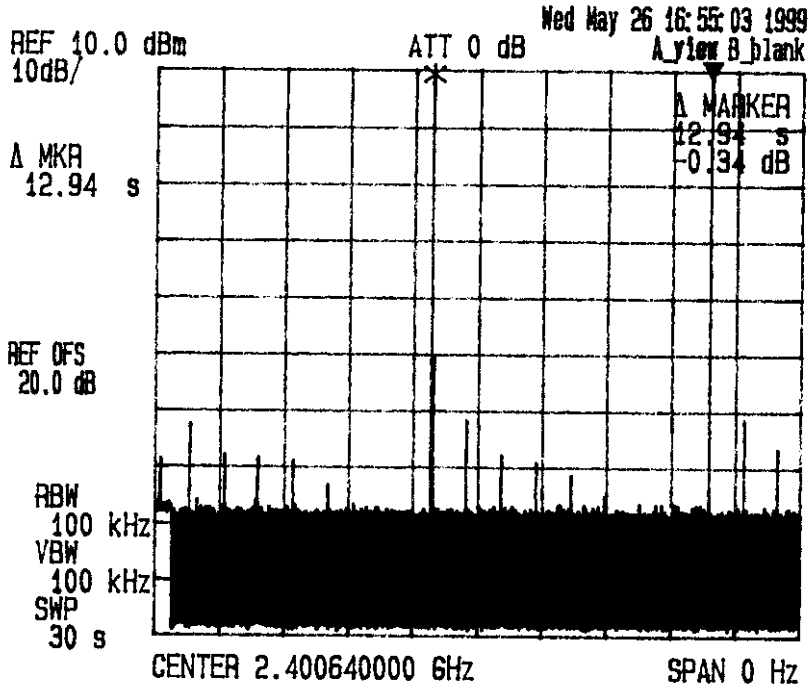
Date: May 26 1999  
Tested by: Hung Trinh



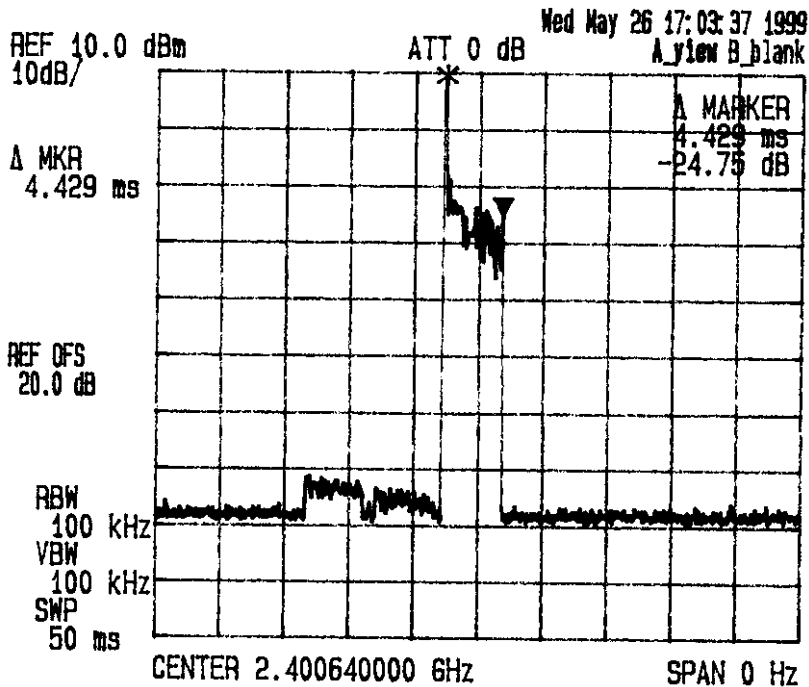


Date: May 26 1999  
Tested by: Hung Trinh

**MICROWAVE DATA SYSTEMS INC.**  
Model: 24810 & || S2403BP Antenna || PC-2415N Antenna || SPG-36 Antenna  
Tx Frequency: 2400.64 MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceivers

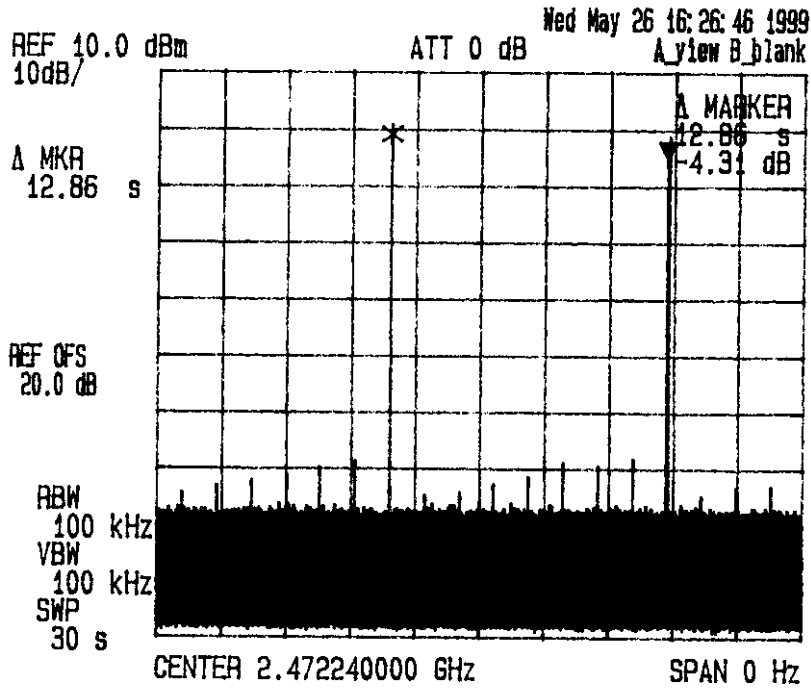


*Occupancy in 30 sec = 2 x 4.4ms = 8.8ms.*

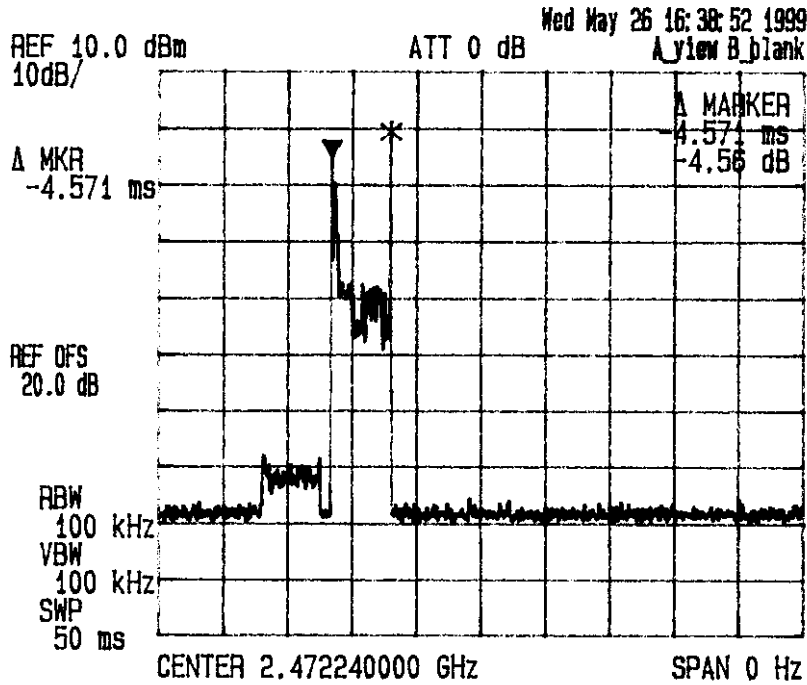


Date: May 26, 1999  
 Tested by: Hung Trinh

**MICROWAVE DATA SYSTEMS INC.**  
 Model: 24810 & || S2403BP Antenna || PC-2415N Antenna || SPG-36 Antenna  
 Tx Frequency: 2.47224 MHz  
 2.4 GHz Frequency Hopping Spread Spectrum Transceivers



*Occupancy in 30 sec = 2 x 4.6ms = 9.2ms.*



## 4.2 MAXIMUM PEAK OUTPUT POWER @ FCC 15.247(B) AND RF EXPOSURE LIMIT FCC 1.1310

**PRODUCT NAME:** Spread Spectrum Multiple Address Radio Transceiver,  
 Model No.: MDS 24810

### FCC REQUIREMENTS:

**FCC 15.247(b):**- Maximum peak output power of the transmitter shall not exceed 1 Watt. If the antenna of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**FCC 1.1310:**- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in 1.1307(b).

### LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Average Time (minutes)
<b>(A) Limits for Occupational/Control Exposures</b>				
300-1500	...	...	F/300	6
1500-100,000	...	...	5	6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
300-1500	...	...	F/1500	6
1500-100,000	...	...	1.0	30

F = Frequency in MHz

### CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23+3 °C
- Relative humidity: 50+5 %
- Atmospheric Pressure: 100+5 kPa

### POWER INPUT:

13.8 VDC.

### TEST EQUIPMENT:

- HP RF Peak Power Meter, Model 8900, S/N: 2131A00124, Measuring Freq. Range: 01 - 18 GHz, 50 Ohm IN.
- HP RF Peak Power Sensor, Model 8481A, S/N: 2551A01965, Measuring Freq. Range: 0.1 - 18 GHz, 50 Ohm IN/OUT
- Spectrum Analyzer, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- Microwave Amplifier, HP, Model 83017A, Frequency Range 1 to 26.5 GHz, 34-38 dBdB gain nominal.
- Active Loop Antenna, Emco, Model 6507, SN 8906-1167, Frequency Range 1 KHz - 30 MHz, @ 50 Ohms
- Log Periodic/Bow-Tie Antenna, Emco, Model 3143, SN 1029, 20 - 1000 MHz, @ 50 ohms.
- Horn Antenna, Emco, Model 3115, SN 9701-5061, Frequency Range: 1 - 18 GHz, @ 50 Ohms.

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**METHOD OF MEASUREMENTS:**

FCC @ 1.1310 & OST Bulletin No. 65-October 1985

$$S = PG/4\pi r^2 = EIRP/4\pi r^2$$

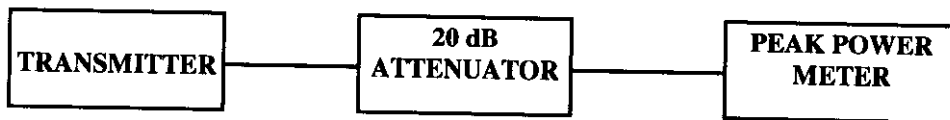
Where: P: power input to the antenna in mW  
EIRP: Equivalent (effective) isotropic radiated power.  
S: power density mW/cm<sup>2</sup>  
G: numeric gain of antenna relative to isotropic radiator  
r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

$$r = \sqrt{PG/4\pi S}$$

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

**TEST ARRANGEMENT**



**TEST RESULTS:** Conforms.

**TEST PERSONNEL:** Mr. Hung Trinh, RFI/EMI Technician

**DATE:** May 26, 1999

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**MEASUREMENT DATA:**

**PEAK POWER MEASUREMENT**

**Test Configuration #1: MDS 24810 with S2403BP External Antenna**

ANTENNA GAIN: 5.1 dBi typical or 3.2 numeric

**DIRECT PEAK POWER MEASUREMENTS AT THE ANTENNA TERMINAL  
 WITH THE ANTENNA REPLACED BY A SMA CONNECTOR**

TRANSMITTER CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	MEASURED PEAK TOTAL POWER @ ANTENNA TERMINAL (mW)	PEAK POWER LIMIT (mW)
Lowest	2400.64	Binary CPFSK modulation with external random data source @ 19.2 kbps	691.8	1000.0
Middle	2442.00	Binary CPFSK modulation with external random data source @ 19.2 kbps	635.3	1000.0
Highest	2472.24	Binary CPFSK modulation with external random data source @ 19.2 kbps	693.4	1000.0

**EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) MEASURED AT 3 METER DISTANCE  
 (Substitution Method)**

FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	Tx Antenna Gain (Numeric)	Max. Field Strength Level @ 1 MHz BW At 3 m (dBuV/m)	EIRP POWER In a full BW (mW)	(1) MINIMUM ALLOWABLE DISTANCE (r) FROM SKIN (cm)
2400.64	Binary CPFSK modulation with external random data source @ 19.2 kbps	3.2	136.31	4008.4	17.9
2442.00	Binary CPFSK modulation with external random data source @ 19.2 kbps	3.2	137.31	5046.3	20.0
2472.24	Binary CPFSK modulation with external random data source @ 19.2 kbps	3.2	137.19	4908.8	19.8

Applicant shall apply for exemption of the S.A.R. tests with professional installation of the antenna in such a way that the users will not have access close to the antenna.

**Remarks:**

(1) RF EXPOSURE DISTANCE LIMITS:  $r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$   
 $S=1mW/cm^2$ ,  $G = 5.1$  dBi

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-9050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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**Test Configuration #2: MDS 24810 with PC2415N External Antenna**

ANTENNA GAIN: 16.0 dBi typical or 39.8 numeric

**DIRECT PEAK POWER MEASUREMENTS AT THE ANTENNA TERMINAL  
 WITH THE ANTENNA REPLACED BY A SMA CONNECTOR**

TRANSMITTER CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	MEASURED PEAK TOTAL POWER @ ANTENNA TERMINAL (mW)	PEAK POWER LIMIT (mW)
Lowest	2400.64	Binary CPFSK modulation with external random data source @ 19.2 kbps	116	1000.0
Middle	2442.00	Binary CPFSK modulation with external random data source @ 19.2 kbps	97	1000.0
Highest	2472.24	Binary CPFSK modulation with external random data source @ 19.2 kbps	94	1000.0

**EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) MEASURED AT 3 METER DISTANCE  
 (Substitution Method)**

FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	Tx Antenna Gain (Numeric)	Max. Field Strength Level @ 1 MHz BW At 3 m (dBuV/m)	EIRP POWER In a full BW (mW)	(1) MINIMUM ALLOWABLE DISTANCE (r) FROM SKIN (cm)
2400.64	Binary CPFSK modulation with external random data source @ 19.2 kbps	39.8	124.47	21.1	1.3
2442.00	Binary CPFSK modulation with external random data source @ 19.2 kbps	39.8	123.38	16.4	1.1
2472.24	Binary CPFSK modulation with external random data source @ 19.2 kbps	39.8	122.47	13.3	1.0

Applicant shall apply for exemption of the S.A.R. tests with professional installation of the antenna in such a way that the users will not have access close to the antenna.

**Remarks:**

(1) RF EXPOSURE DISTANCE LIMITS:  $r = (PG/4\pi IS)^{1/2} = (EIRP/4\pi IS)^{1/2}$   
 $S = 1mW/cm^2, G = 16 dBi$

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**Test Configuration #3: MDS 24810 with SPG-36 External Antenna**

ANTENNA GAIN: 24.0 dBi typical or 251.2 numeric

**DIRECT PEAK POWER MEASUREMENTS AT THE ANTENNA TERMINAL  
 WITH THE ANTENNA REPLACED BY A SMA CONNECTOR**

TRANSMITTER CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	MEASURED PEAK TOTAL POWER @ ANTENNA TERMINAL (mW)	PEAK POWER LIMIT (mW)
Lowest	2400.64	Binary CPFSK modulation with external random data source @ 19.2 kbps	18	1000.0
Middle	2442.00	Binary CPFSK modulation with external random data source @ 19.2 kbps	15	1000.0
Highest	2472.24	Binary CPFSK modulation with external random data source @ 19.2 kbps	14	1000.0

**EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) MEASURED AT 3 METER DISTANCE  
 (Substitution Method)**

FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	Tx Antenna Gain (Numeric)	Max. Field Strength Level @ 1 MHz BW At 3 m (dBuV/m)	EIRP POWER In a full BW (mW)	(1) MINIMUM ALLOWABLE DISTANCE (r) FROM SKIN (cm)
2400.64	Binary CPFSK modulation with external random data source @ 19.2 kbps	251.2	114.34	0.3	0.2
2442.00	Binary CPFSK modulation with external random data source @ 19.2 kbps	251.2	114.56	0.3	0.2
2472.24	Binary CPFSK modulation with external random data source @ 19.2 kbps	251.2	115.47	0.4	0.2

Applicant shall apply for exemption of the S.A.R. tests with professional installation of the antenna in such a way that the users will not have access close to the antenna.

**Remarks:**

(1) RF EXPOSURE DISTANCE LIMITS:  $r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$   
 $S = 1mW/cm^2, G = 24 dBi$

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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### 4.3 RF CONDUCTED EMISSIONS AT THE TRANSMITTER ANTENNA TERMINAL, FCC CFR 47, PARA. 15.247(C)

**PRODUCT NAME:** Spread Spectrum Multiple Address Radio Transceiver,  
Model No.: MDS 24810

**FCC REQUIREMENTS:**

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power.

**CLIMATE CONDITION:**

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

**POWER INPUT:**

13.8 VDC.

**TEST EQUIPMENT:**

- Spectrum Analyzer, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- Spectrum Analyzer, Hewlett Packard, Model HP 8593EM, S/N: 3412A00103, 9 KHz - 26.5 GHz.
- Attenuators, 50 Ohm IN/OUT
- Microphase Highpass Filter, P/N: CR220HIB, S/N: 1301, Cut-off Freq. 1.8 GHz. (Optional)

**METHOD OF MEASUREMENT:**

A scan was made by using a spectrum analyzer with the detector function set to PEAK mode.

Set RBW = 100 KHz, VBW = 100 KHz.

**FCC CFR 47, Para. 2.997 - Frequency spectrum to be investigated**

The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10<sup>th</sup> harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

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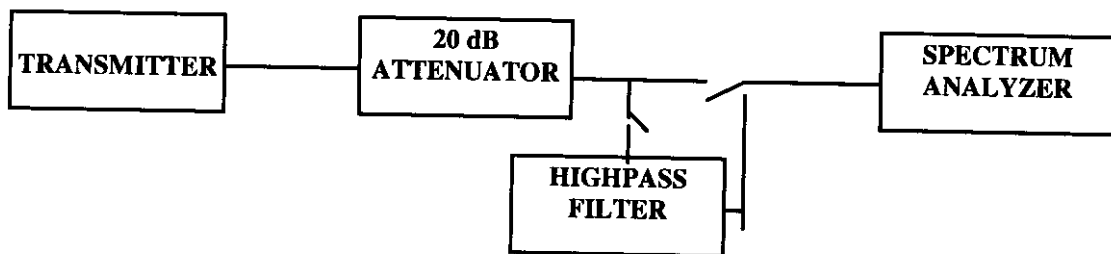
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**FCC CFR 47, Para. 2.991 - Spurious Emissions at Antenna Terminal**

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.989 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

**TEST ARRANGEMENT**



**TEST RESULTS:** Conforms.

**TEST PERSONNEL:** Mr. Hung Trinh, EMI/RFI Technician

**DATE:** May 26, 1999

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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**MEASUREMENT DATA**

**SPURIOUS & HARMONIC EMISSIONS  
 AT THE TRANSMITTER ANTENNA TERMINAL**

**TEST CONFIGURATION**

- The transmitter was coupled to the Spectrum Analyzer through a 20 dB attenuator.
- The insertion loss between the transmitter output terminal and the spectrum analyzer was measured to be 20 dB
- The channel frequencies were established on the extreme edges (both upper and lower) and middle of the 2400.64-2472.24 MHz band at its full rated output power. The emissions was investigated up to the tenth harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Part 15.247(c)

Channel Frequency: 2400.64MHz Full Rated Power: 691.8 mW		Power Level in 100 KHz BW: 28.41dBm Limit = 28.41dBm – 20dB = 8.41dBm		
FREQUENCY (MHz)	RF LEVEL (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2368.7	-35.13	8.41	-43.54	PASS
2385.0	-28.84	8.41	-37.25	PASS
2389.6	-38.75	8.41	-47.16	PASS
2449.6	-43.09	8.41	-51.50	PASS
24743.0	-28.31	8.41	-36.72	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details				

Channel Frequency: 2442 MHz Full Rated Power: 635.3 mW		Power Level in 100 KHz BW: 28.03dBm Limit = 28.03dBm – 20dB = 8.03dBm		
FREQUENCY (MHz)	RF LEVEL (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2362.1	-42.69	8.03	-50.72	PASS
2378.4	-40.03	8.03	-48.06	PASS
2410.4	-41.00	8.03	-49.03	PASS
2426.7	-34.59	8.03	-42.62	PASS
2459.0	-39.53	8.03	-47.56	PASS
2475.0	-39.97	8.03	-48.00	PASS
2507.0	-42.28	8.03	-50.31	PASS
24979.0	-28.38	8.03	-36.41	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details				

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<b>Channel Frequency: 2472.24 MHz</b> <b>Full Rated Power: 693.4 mW</b>		<b>Power Level in 100 KHz BW: 28.41dBm</b> <b>Limit = 28.41dBm – 20dB = 8.41dBm</b>		
FREQUENCY (MHz)	RF LEVEL (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2376.4	-43.84	8.41	-52.25	PASS
2408.7	-41.19	8.41	-49.60	PASS
2457.0	-42.59	8.41	-51.00	PASS
2505.3	-41.50	8.41	-49.91	PASS
2537.6	-42.53	8.41	-50.94	PASS
24679.0	-28.44	8.41	-36.85	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details				

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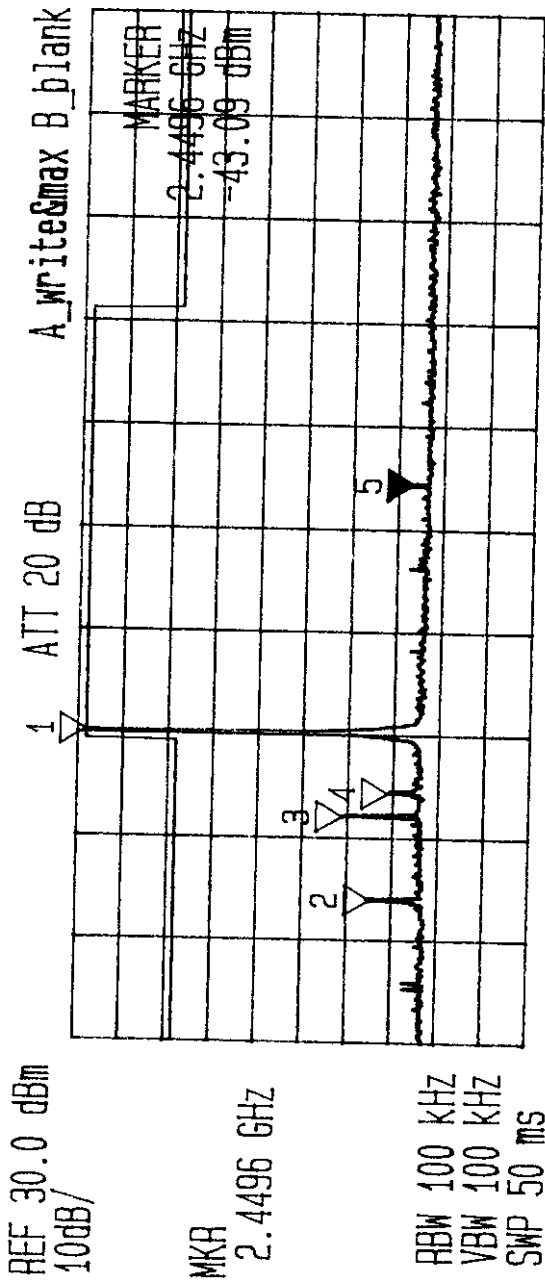
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- Recognized/Listed by FCC (USA), Industry Canada (Canada)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)





**MICROWAVE DATA SYSTEMS INC.**  
 Model: 24810 & | S2403BP Antenna | | PC-2415N Antenna | | SPG-36 Antenna  
 Tx Frequency: 2400.64 MHz  
 2.4 GHz Frequency Hopping Spread Spectrum Transceivers

Date: May 26 1999  
 Tested by: Hung Trinh



START 2.3410 GHz

STOP 2.5410 GHz

\*\*\* Multi Marker List \*\*\*

No.	Marker	GHz	dBm
1	2.4013	28.41	dBm
2	2.3687	-35.13	dBm
3	2.3850	-28.84	dBm
4	2.3896	-38.75	dBm
5	2.4496	-43.09	dBm

No. 1:  
 No. 2:  
 No. 3:  
 No. 4:  
 No. 5:  
 No. 6:  
 No. 7:  
 No. 8:  
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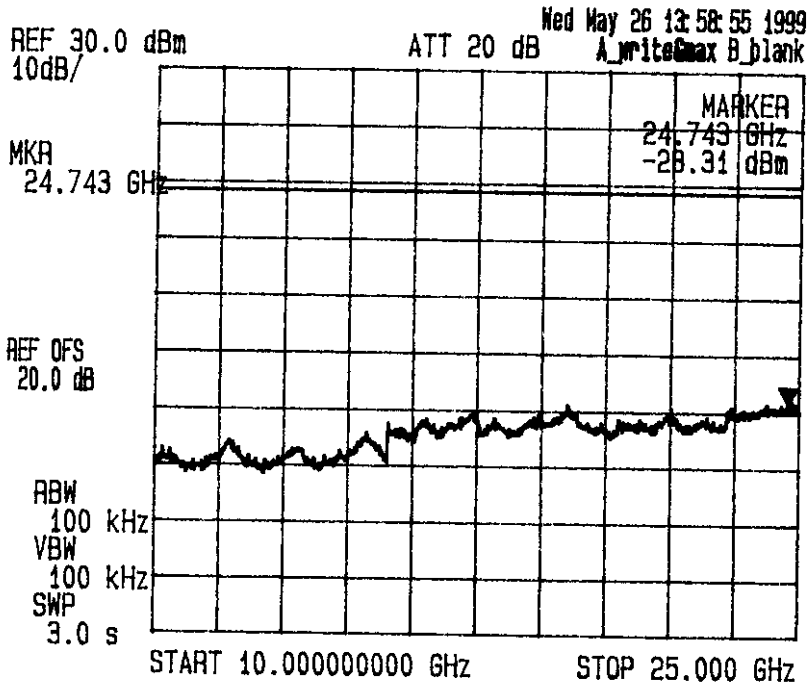
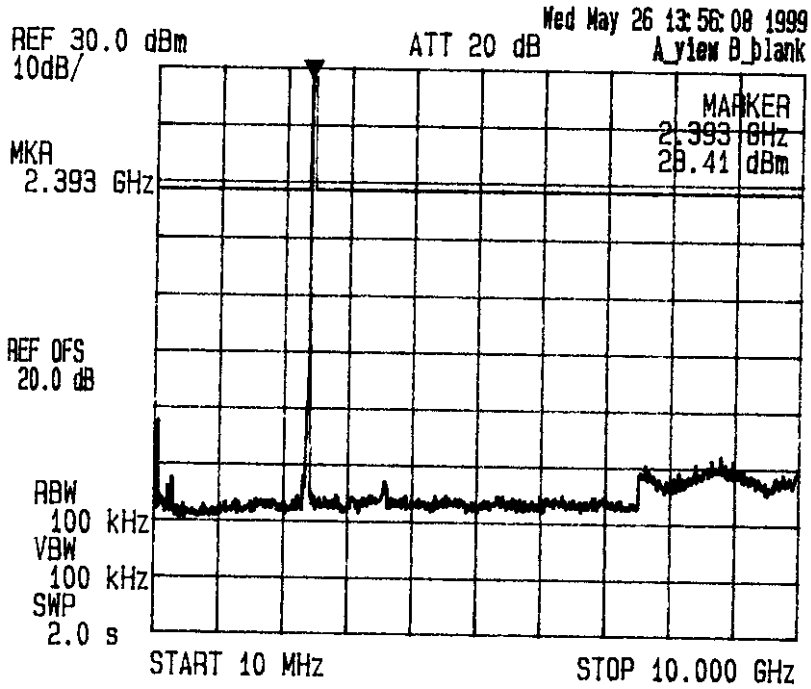
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Date: May 26 1999  
Tested by: Hung Trinh

**MICROWAVE DATA SYSTEMS INC.**

Model: 24810 & | S2403BP Antenna | | PC-2415N Antenna | | SPG-36 Antenna  
Tx Frequency: 24.00 GHz MHz

2.4 GHz Frequency Hopping Spread Spectrum Transceivers

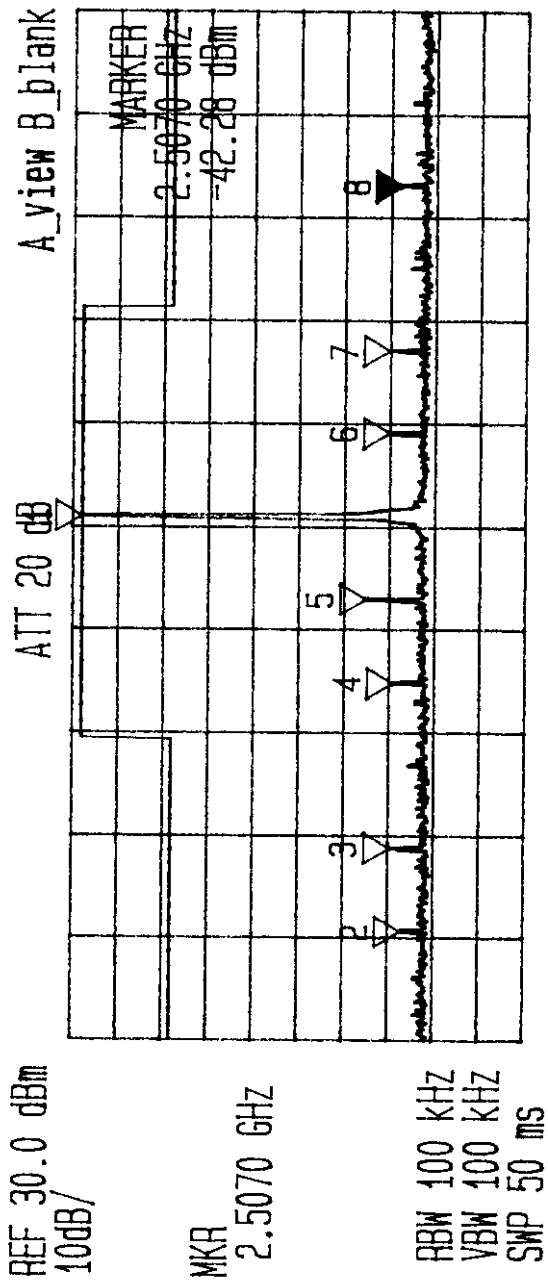




**MICROWAVE DATA SYSTEMS INC.**

Model: 24810 & | S2403BP Antenna | PC-2415N Antenna | SPG-36 Antenna  
 Tx Frequency: 2442.2 MHz  
 2.4 GHz Frequency Hopping Spread Spectrum Transceivers

Date: May 26 1999  
 Tested by: Hung Trinh



START 2.3410 GHz

STOP 2.5410 GHz

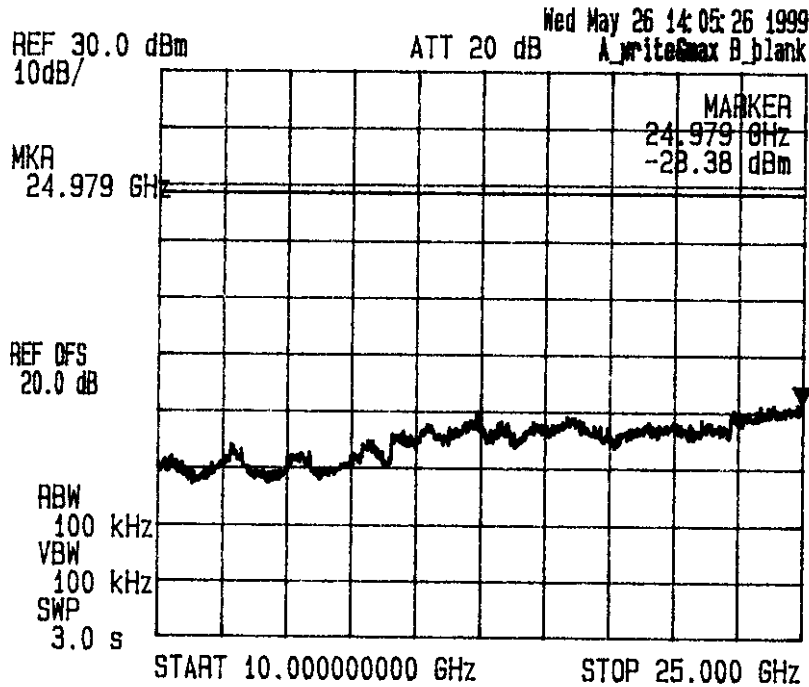
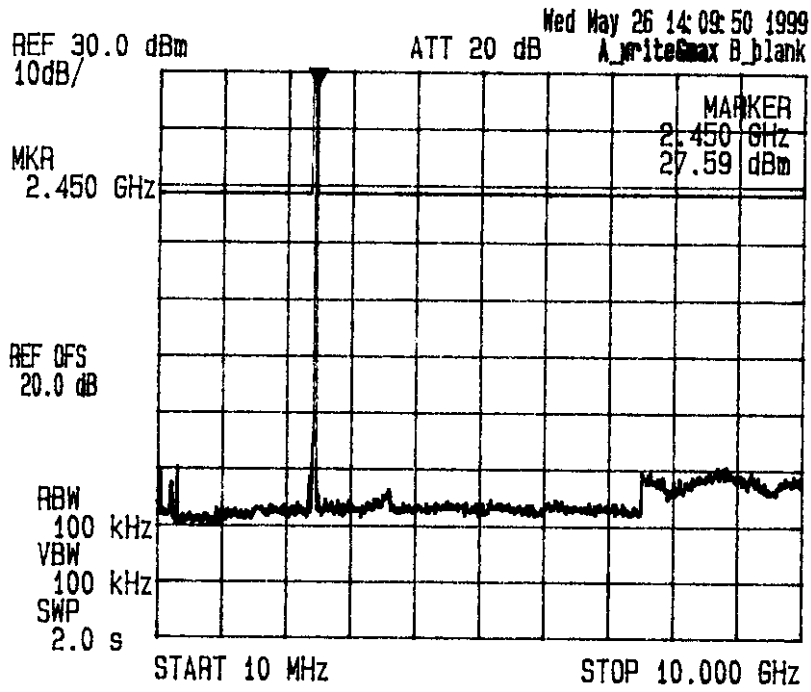
\*\*\* Multi Marker List \*\*\*

No.	Frequency (GHz)	Power (dBm)	Marker Label
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2.	2.3621	-42.69	A
3.	2.3784	-40.03	A
4.	2.4104	-41.00	A
5.	2.4267	-34.59	A
6.	2.4590	-39.53	A
7.	2.4750	-39.97	A
8.	2.5070	-42.28	A

Date: May 26 1999  
Tested by: Hung Trinh

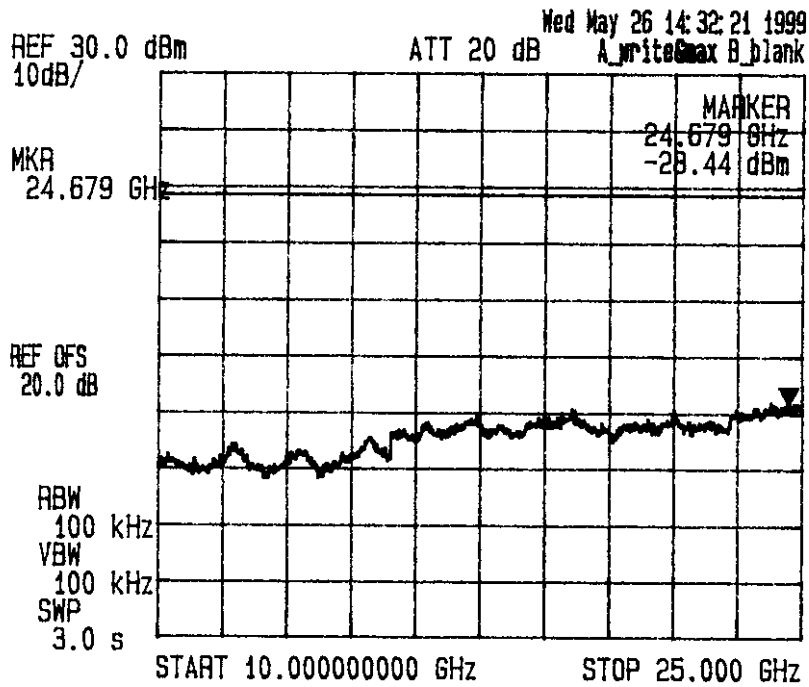
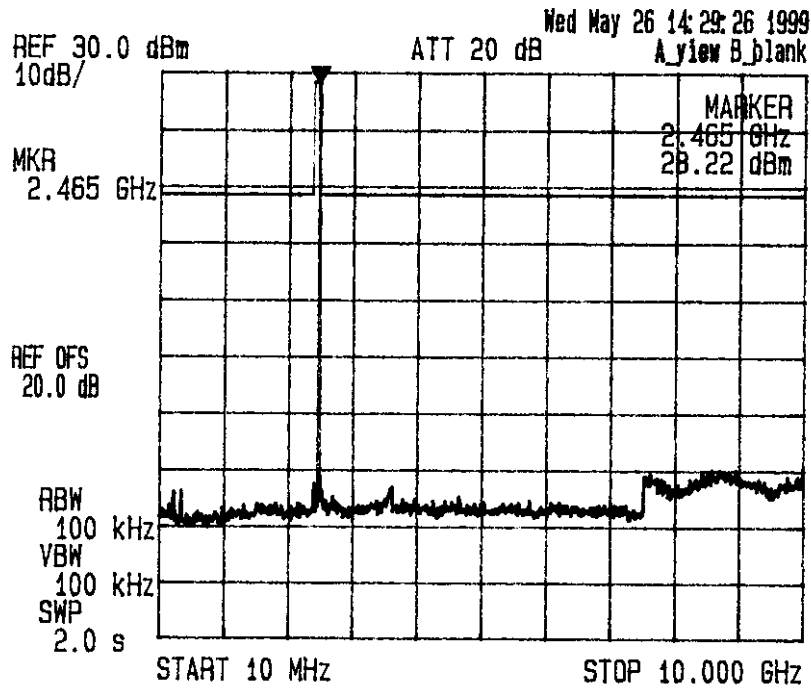
**MICROWAVE DATA SYSTEMS INC.**

Model: 24810 & | S2403BP Antenna | PC-2415N Antenna | SPG-36 Antenna  
Tx Frequency: 24810 MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceivers



Date: May 26 1999  
 Tested by: Hung Trinh

**MICROWAVE DATA SYSTEMS INC.**  
 Model: 24810 & | S2403BP Antenna | PC-2415N Antenna | SPG-36 Antenna  
 Tx Frequency: 2472.84 MHz  
 2.4 GHz Frequency Hopping Spread Spectrum Transceivers



**4.4 TRANSMITTER RADIATED EMISSIONS @ 3 METERS, FCC CFR 47, PARA. 15.247(C), 15.209 & 15.205**

**PRODUCT NAME:** Spread Spectrum Multiple Address Radio Transceiver,  
 Model No.: MDS 24810

**FCC REQUIREMENTS:**

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in @ 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in @ 15.205(a) shall not exceed the general radiated emission limits specified in @ 15.209(a)

**Remarks:**

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- @ FCC CFR 47, Para. 15.237(c) - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in @15.35 for limiting peak emissions apply.

**FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) - Restricted Frequency Bands**

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 - 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 - 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 - 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 - 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 - 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 - 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 - 156.9	2200 - 2300	9000 - 9200	

**FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)  
 -- Field Strength Limits within Restricted Frequency Bands --**

FREQUENCY (MHz)	FIELD STRENGTH LIMITS (microvolts/m)	DISTANCE (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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**CLIMATE CONDITION:**

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

**POWER INPUT:**

13.8 VDC.

**TEST EQUIPMENT:**

- **Spectrum Analyzer**, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- **Microwave Amplifier**, HP, Model 83017A, Frequency Range 1 to 26.5 GHz, 34-38 dBdB gain nominal.
- **Active Loop Antenna**, Emco, Model 6507, SN 8906-1167, Frequency Range 1 KHz - 30 MHz, @ 50 Ohms
- **Log Periodic/Bow-Tie Antenna**, Emco, Model 3143, SN 1029, 20 - 1000 MHz, @ 50 ohms.
- **Horn Antenna**, Emco, Model 3115, SN 9701-5061, Frequency Range: 1 - 18 GHz, @ 50 Ohms.
- **Horn Antenna**, Emco, Model 3160-09, 18-26.5GHz
- **Horn Antenna**, Emco, Model 3160-09, 18-26.5GHz
- **Horn Antenna**, Emco, Model 3160-10, 26.5-40GHz
- **Mixer**, Tektronix, P/N 118-0098-00, 18-26.5GHz
- **Mixer**, Tektronix, P/N 119-0098-00, 26.5-40GHz

**METHOD OF MEASUREMENTS:**

Refer to **ANSI 63.4-1992, Para. 8** for detailed radiated emissions measurement procedures.

Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.

For measurement below 1 GHz, set RBW = 100 KHz, VBW  $\geq$  100 KHz, SWEEP=AUTO.

For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.

If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

**FCC CFR 47, Para. 2.997 - Frequency spectrum to be investigated**

The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10<sup>th</sup> harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

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May 27, 1999

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**FCC CFR 47, Para. 2.993 - Field Strength Spurious Emissions**

- (a) Measurements was made to detect spurious emissions radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data were supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph 2.989(c) as appropriate. For equipment operating on frequencies below 1 GHz, an Open Field Test is normally required, with the measuring instrument antenna located in the far field at all test frequencies. In event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurement will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with the reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.
- (b) Measurements specified in paragraph (a) of this section shall be made for the following equipment:
- (1) Those in which the spurious emission are required to be 60 dB or more below the mean power of the transmitter.
  - (2) All equipment operating on frequencies higher than 25 MHz
  - (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
  - (4) Other types of equipment as required, when deemed necessary by the commission.

**TEST RESULTS:** Conforms.

**TEST PERSONNEL:** Mr. Hung Trinh, EMI/RFI Technician

**DATE:** May 25, 1999

**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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**MEASUREMENT DATA**

**RADIATED EMISSIONS MEASUREMENTS @ 3 METERS**

**TEST CONFIGURATION**

- This lowest, middle and highest channels were established at its full rated output power. The emissions were investigated from the lowest frequency generated by the transmitter up to the 10th harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Parts 15.247(c) or 15.209(a) whichever was applicable.
- For measuring radiated emissions at frequencies below 1 GHz, the Spectrum Analyzer was set as 100 KHz RBW, VBW  $\geq$  RBW, SWEEP TIME: AUTO, PEAK DETECTOR.
- For measuring radiated emissions at frequencies above 1 GHz, the Spectrum Analyzer was set as 1 MHz RBW, 1 MHz VBW, SWEEP TIME: AUTO for PEAK measurements and 1 MHz RBW, 10 Hz VBW, SWEEP TIME: AUTO for AVERAGE measurements.
- The following measurements were the worst cases when the radiating antenna was placed in both horizontal and vertical polarization.
- The following AVERAGE rf levels were obtained from either Peak or Average readings added by the duty cycle correction factor. DUTY CYCLE FACTOR = Continuous

**Test Configuration #1: MDS 24810 with S2403BP External Antenna**

CHANNEL FREQUENCY TESTED: 2400.64 MHz FULL RATED POWER: 691.8 mW							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2400.64	136.3	--	V	--	--	--	--
2400.64	120.9	--	H	--	--	--	--
4801.28**	52.6	44.4	V	54.0	116.3	-9.6	PASS
4801.28**	52.0	43.1	H	54.0	116.3	-10.9	PASS
7201.92	56.9	50.4	V	54.0	116.3	-65.9	PASS
7201.92	54.8	46.2	H	54.0	116.3	-70.1	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

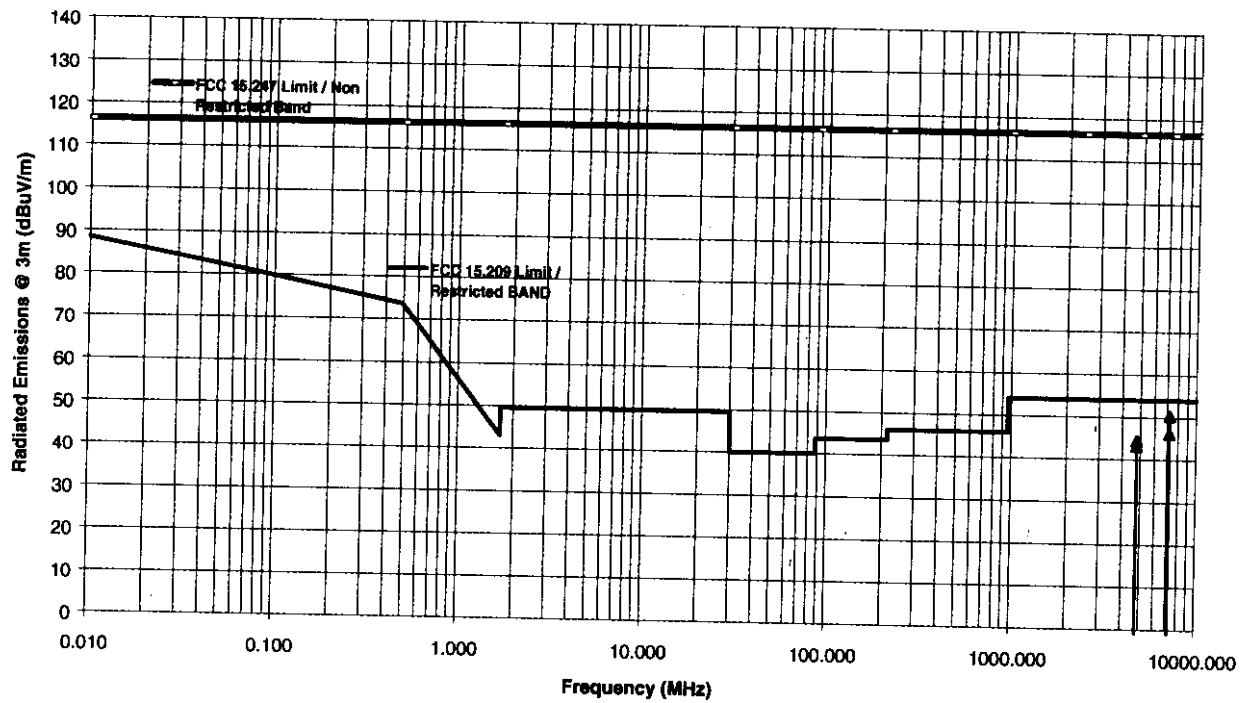
**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
Adaptive Broadband, MDS 24810 with S2403BP External Antenna  
TRANSMIT Freq.: 2400.64 MHz



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File #: MIC15-FTX

May 27, 1999

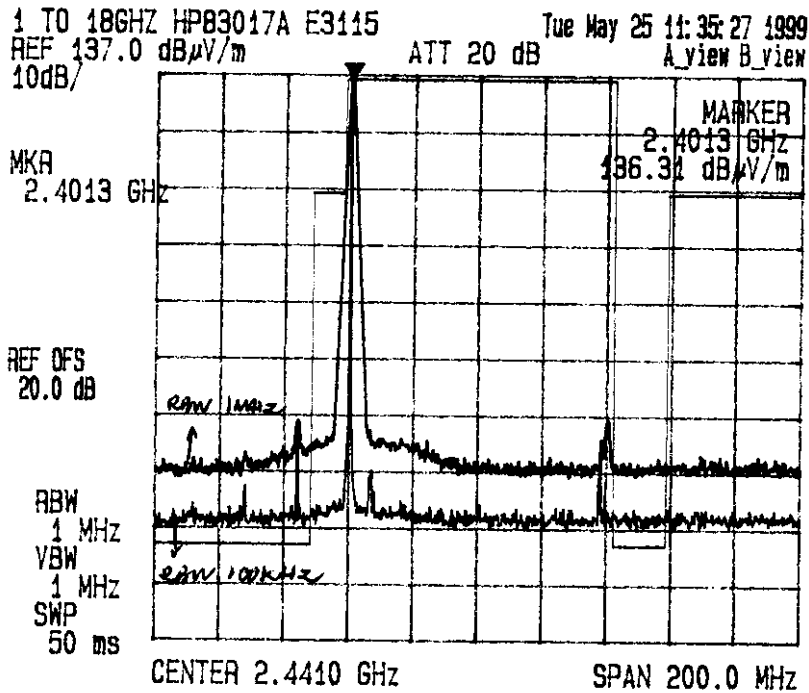
- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia)
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Date: May 25 1999  
Tested by: Hung Trinh

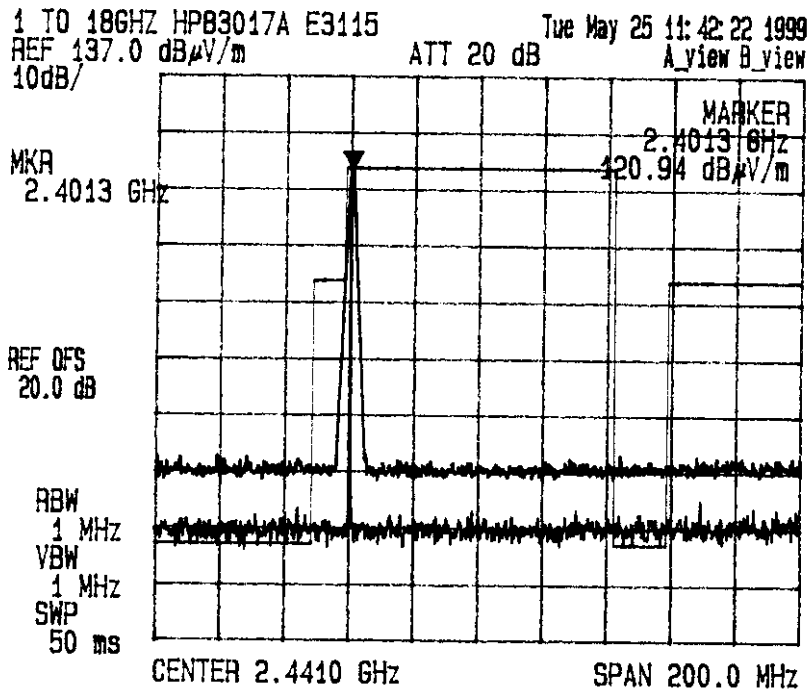
**MICROWAVE DATA SYSTEMS INC.**

Model: 24810 & MS2403BP Antenna | PC-2415N Antenna | SPG-36 Antenna  
Tx Frequency: 2400.64 MHz

2.4 GHz Frequency Hopping Spread Spectrum Transceivers



VERTICAL



HORIZONTAL

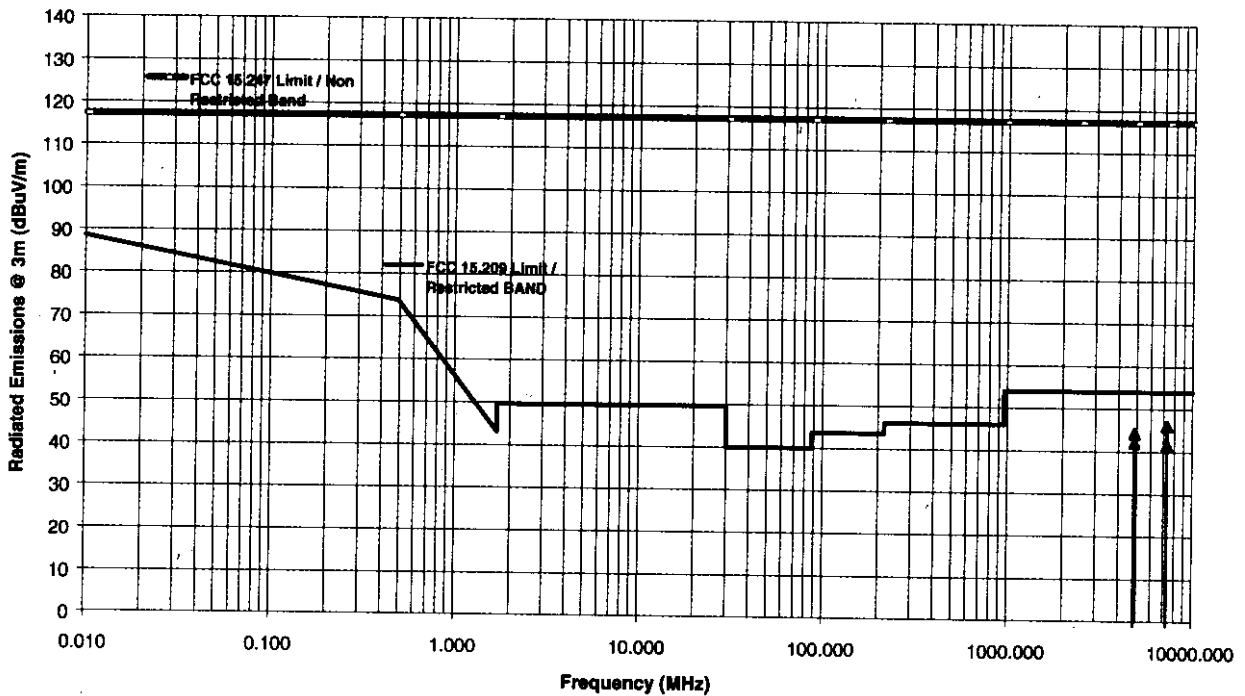
**CHANNEL FREQUENCY TESTED: 2442.00 MHz**  
**FULL RATED POWER: 635.3 mW**

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2442.00	137.3	--	V	--	--	--	--
2442.00	123.4	--	H	--	--	--	--
4884.00**	53.0	44.3	V	54.0	117.3	-9.7	PASS
4884.00**	52.3	42.1	H	54.0	117.3	-11.9	PASS
7326.00**	54.5	46.0	V	54.0	117.3	-8.0	PASS
7326.00**	53.5	41.6	H	54.0	117.3	-12.4	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
 Adaptive Broadband, MDS 24810 with S2403BP External Antenna  
 TRANSMIT Freq.: 2442.00 MHz



**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

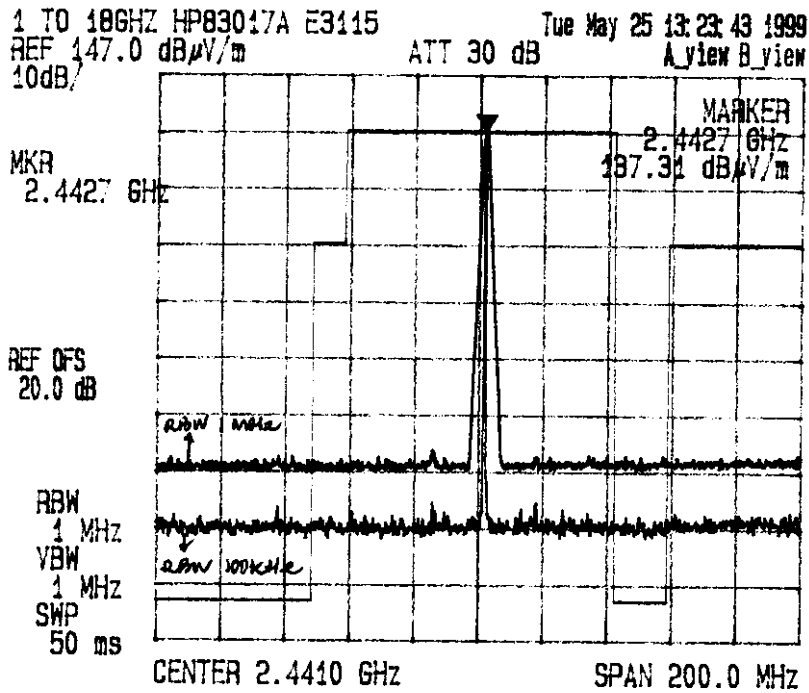
File #: MIC15-FTX  
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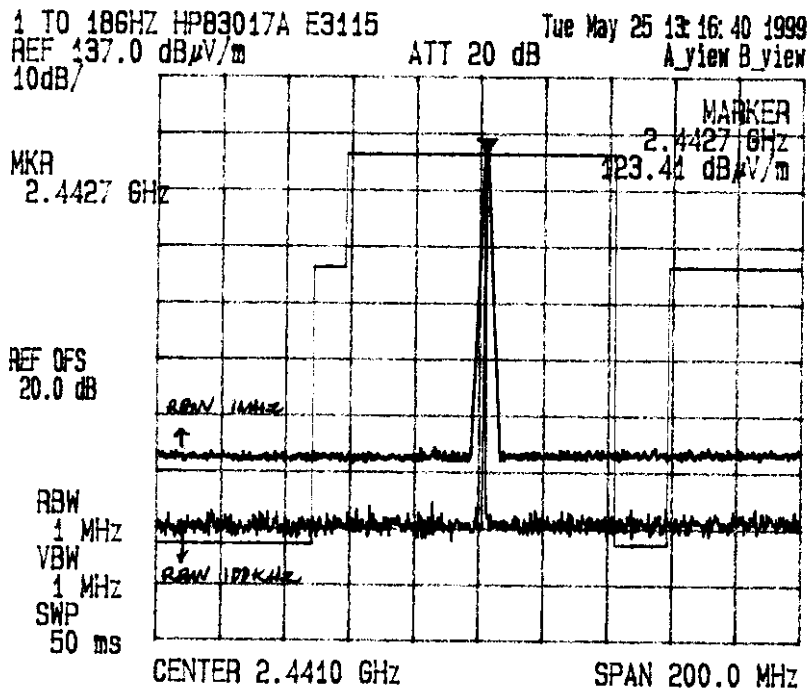
Date: May 25 1999  
Tested by: Hung Trinh

**MICROWAVE DATA SYSTEMS INC.**  
Model: 24810 & M S2403BP Antenna [ ] PC-2415N Antenna [ ] SPG-36 Antenna  
Tx Frequency: 2.4427 MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceiver.

Radiated Emissions Measurements @ 3 Meters



VERTICAL



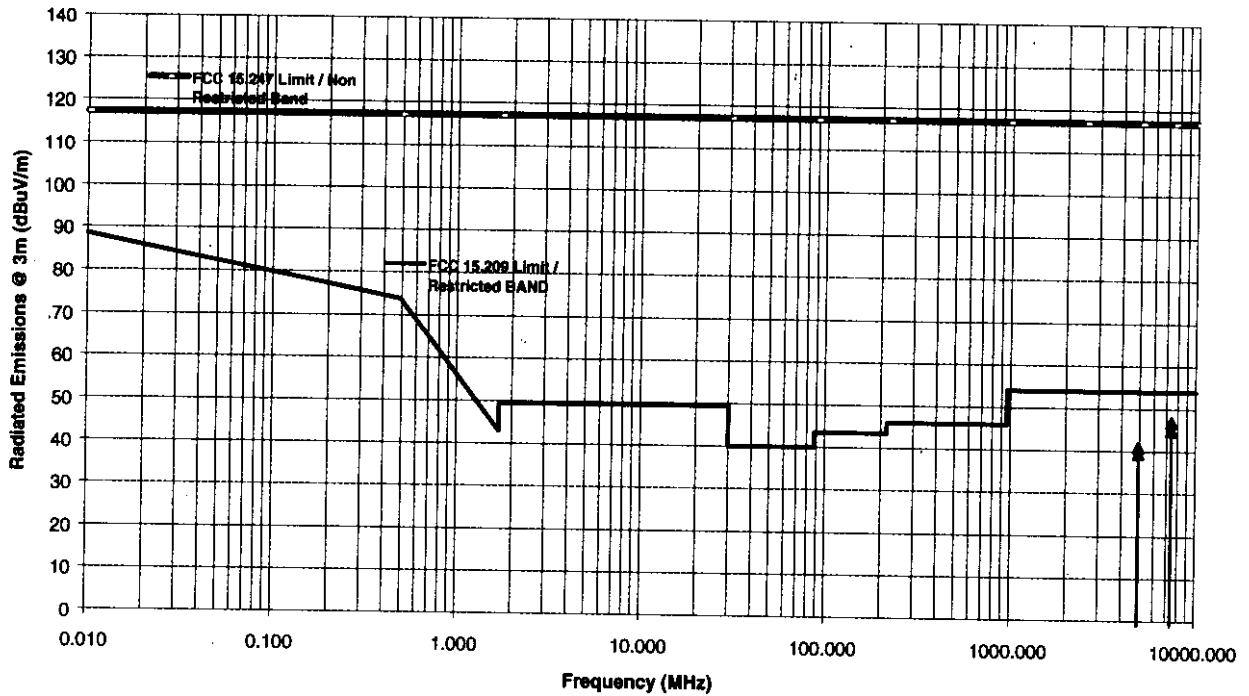
HORIZONTAL

CHANNEL FREQUENCY TESTED: 2472.24 MHz FULL RATED POWER: 693.4 mW							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2472.24	137.2	--	V	--	--	--	--
2472.24	119.4	--	H	--	--	--	--
4944.48**	52.1	40.9	V	54.0	117.2	-13.1	PASS
4944.48**	51.6	39.4	H	54.0	117.2	-14.6	PASS
7416.72**	56.0	46.9	V	54.0	117.2	-7.1	PASS
7416.72**	55.5	44.9	H	54.0	117.2	-9.1	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
 Adaptive Broadband, MDS 24810 with S2403BP External Antenna  
 TRANSMIT Freq.: 2472.24 MHz



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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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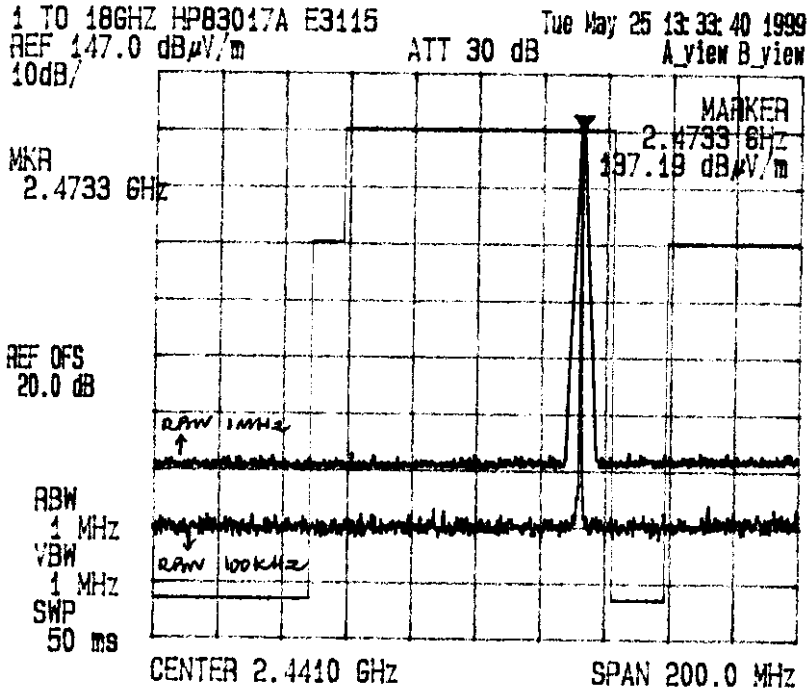
Date: May 25 1999  
Tested by: Hung Trinh

### MICROWAVE DATA SYSTEMS INC.

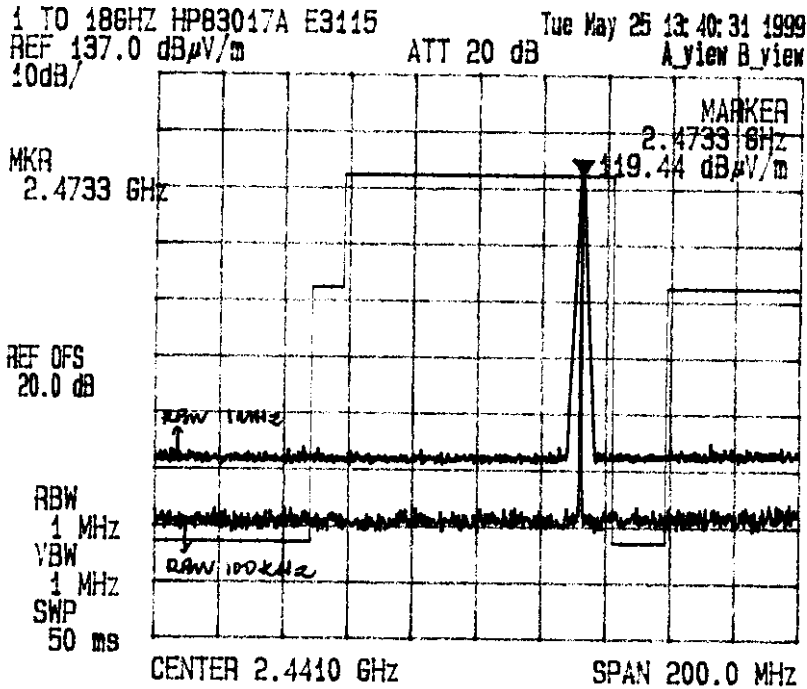
Model: 24810 & [X]S2403BP Antenna [ ] PC-2415N Antenna [ ] SPG-36 Antenna  
Tx Frequency: ~~2.4~~ 2.4 MHz

2.4 GHz Frequency Hopping Spread Spectrum Transceiver.

Radiated Emissions Measurements @ 3 Meters



VERTICAL



HORIZONTAL

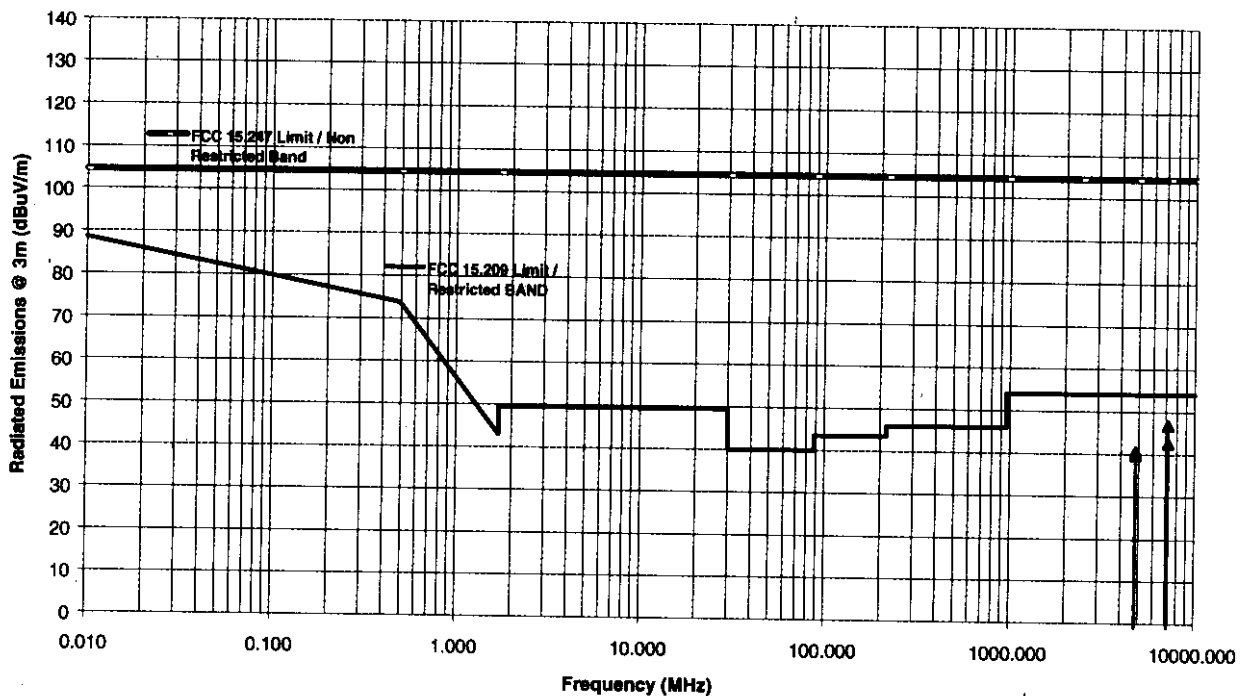
**Test Configuration #2: MDS 24810 with PC2415N External Antenna**

CHANNEL FREQUENCY TESTED: 2400.64 MHz FULL RATED POWER: 116 mW							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2400.64	124.5	--	V	--	--	--	--
2400.64	111.3	--	H	--	--	--	--
4801.28**	50.7	39.8	V	54.0	104.5	-14.2	PASS
4801.28**	51.0	40.6	H	54.0	104.5	-13.4	PASS
7201.92	55.0	46.8	V	54.0	104.5	-57.7	PASS
7201.92	53.5	42.6	H	54.0	104.5	-61.9	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

**Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
 Adaptive Broadband, MDS 24810 with PC2415N External Antenna  
 TRANSMIT Freq.: 2400.64 MHz**



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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@symcatco.ca](mailto:vhk.ultratech@symcatco.ca), Website: <http://www.ultratech-labs.com>

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 May 27, 1999

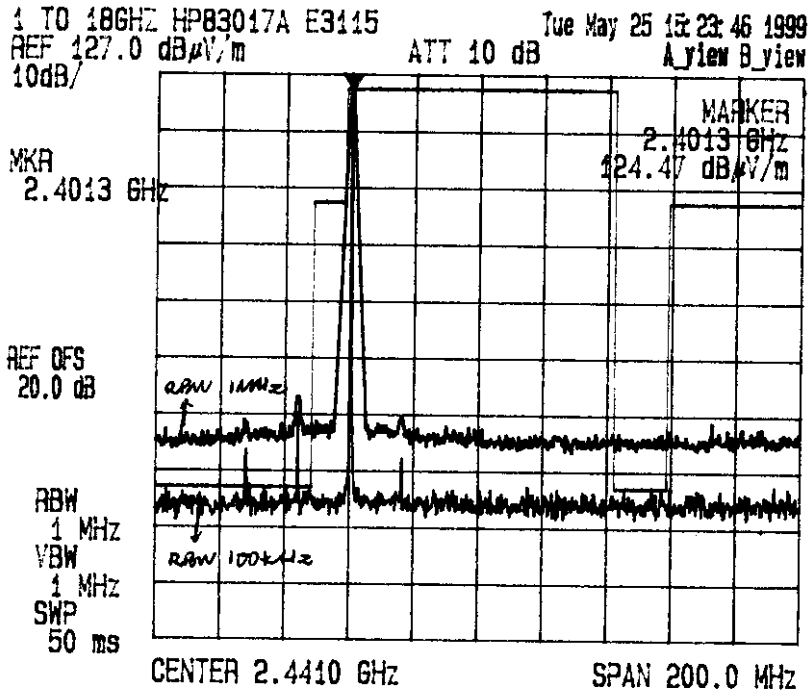
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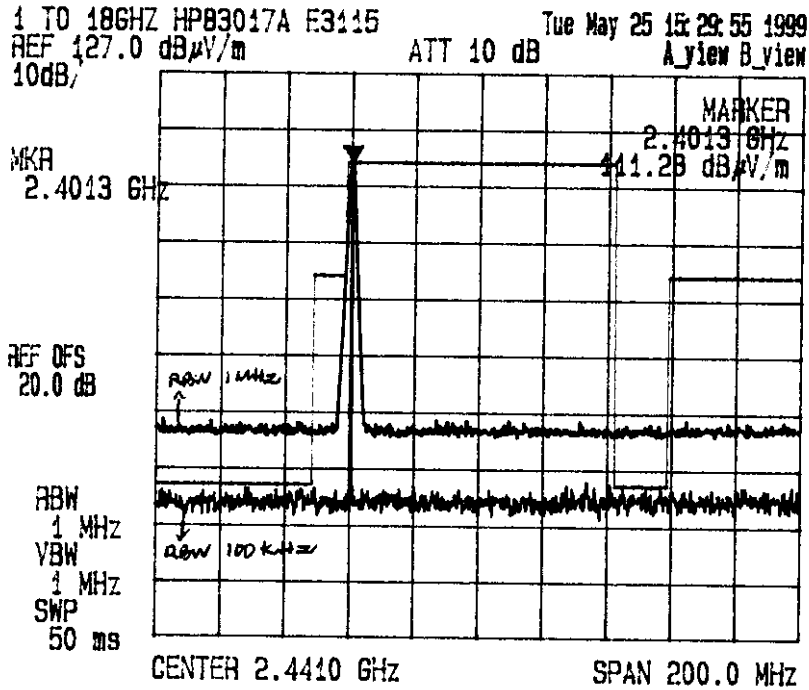
Date: May 25 1999  
Tested by: Hung Trinh

MICROWAVE DATA SYSTEMS INC.  
Model: 24810 & [ ] S2403BP Antenna [ ] PC-2415N Antenna [ ] SPG-36 Antenna  
Tx Frequency: ~~2.4420 GHz~~ MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceiver.

Radiated Emissions Measurements @ 3 Meters



VERTICAL



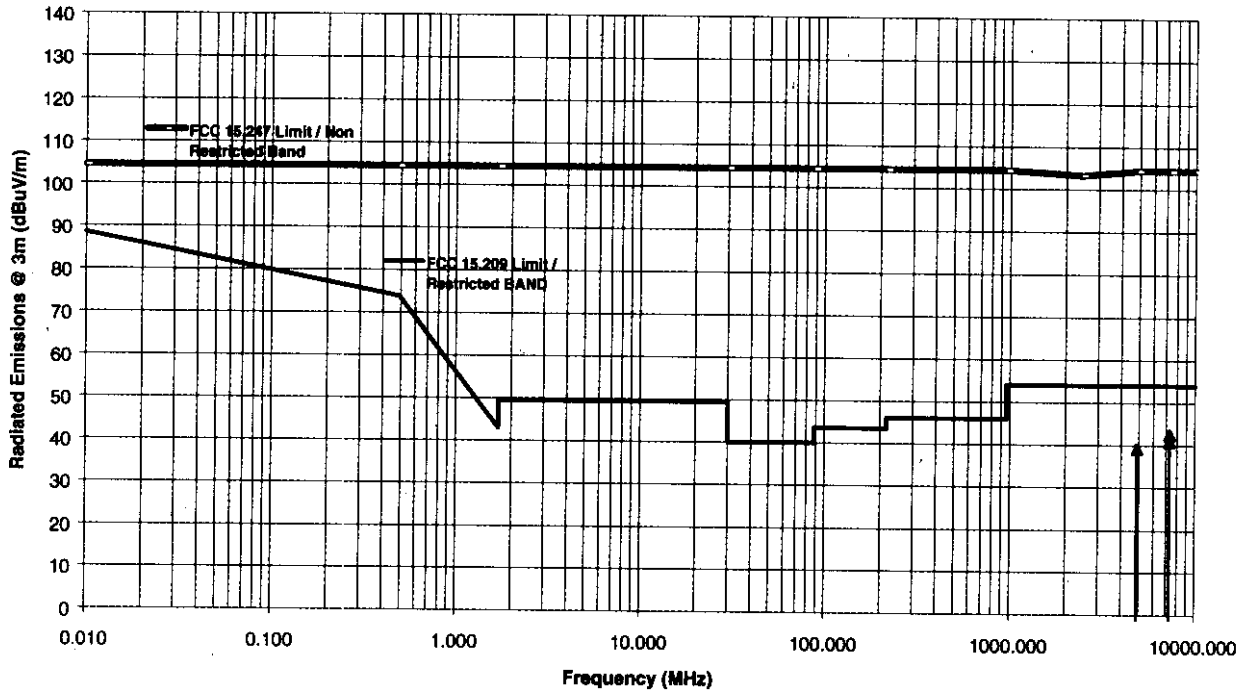
HORIZONTAL

CHANNEL FREQUENCY TESTED: 2442.00 MHz FULL RATED POWER: 97 mW							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2442.00	123.4	--	V	--	--	--	--
2442.00	111.3	--	H	--	--	--	--
4884.00**	51.3	39.3	V	54.0	104.5	-14.8	PASS
4884.00**	51.3	39.2	H	54.0	104.5	-14.8	PASS
7326.00**	53.8	40.8	V	54.0	104.5	-13.2	PASS
7326.00**	53.5	42.5	H	54.0	104.5	-11.5	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
 Adaptive Broadband, MDS 24810 with PC2415N External Antenna  
 TRANSMIT Freq.: 2442.00 MHz



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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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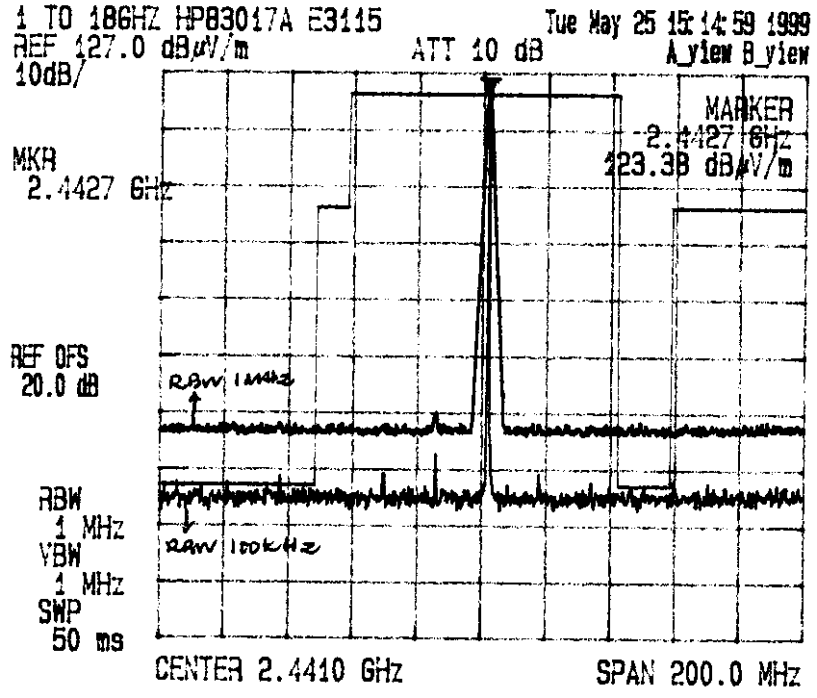
- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia)
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Date: May 25 1999  
Tested by: Hung Trinh

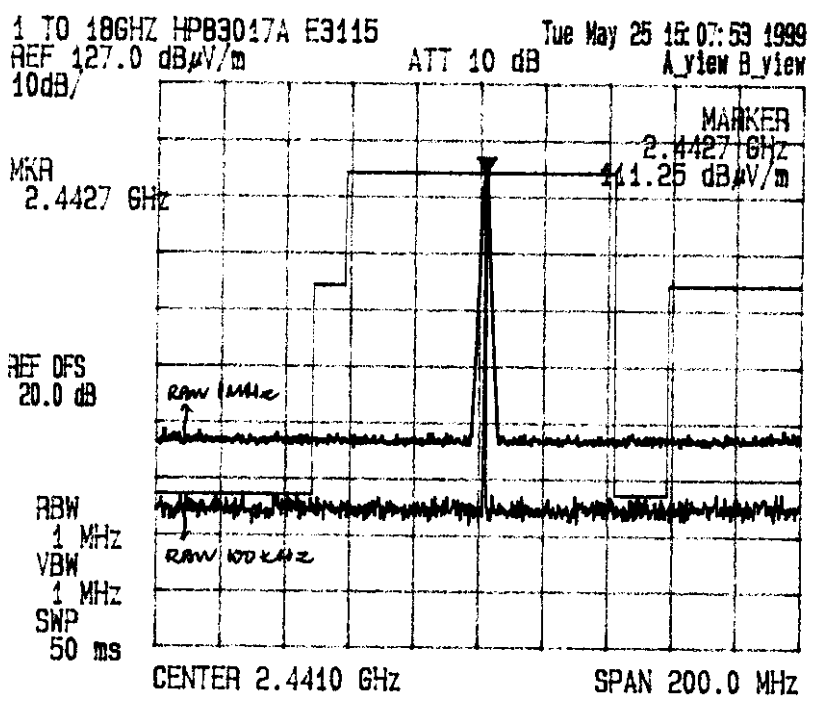
**MICROWAVE DATA SYSTEMS INC.**  
Model: 24810 & [ ] S2403BP Antenna [ ] PC-2415N Antenna [ ] SPG-36 Antenna  
Tx Frequency: 2.442 MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceiver.



Radiated Emissions Measurements @ 3 Meters



VERTICAL



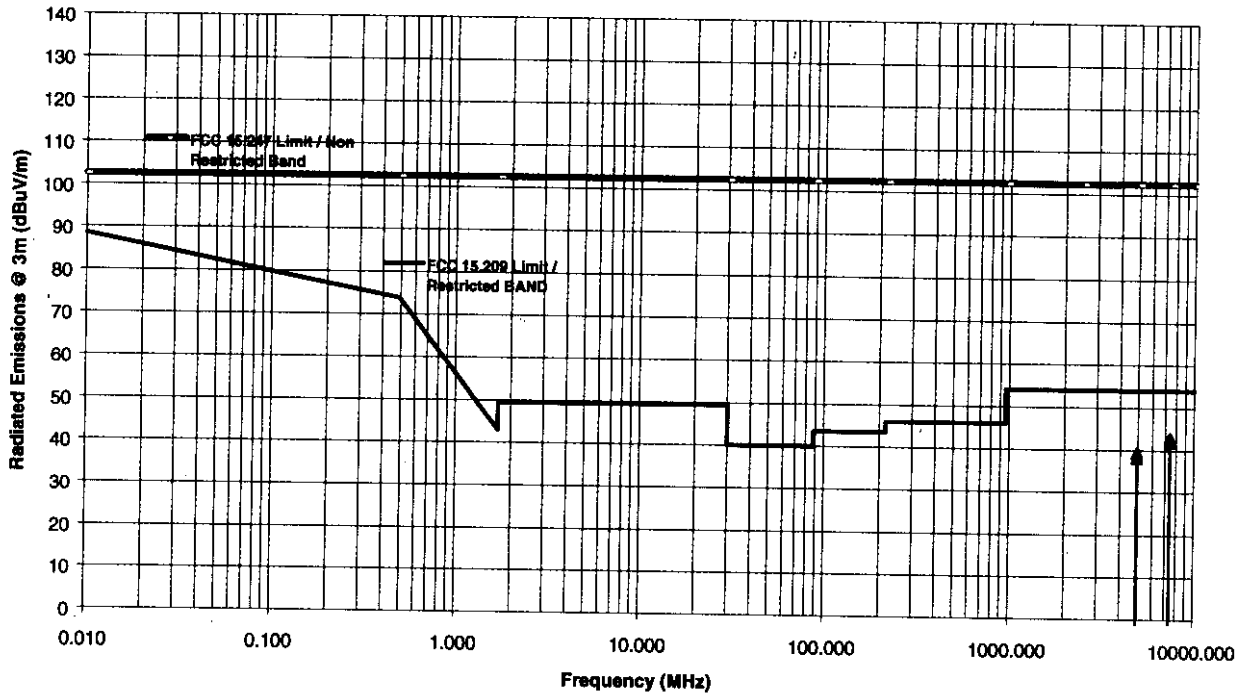
HORIZONTAL

CHANNEL FREQUENCY TESTED: 2472.24 MHz FULL RATED POWER: 94 mW							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2472.24	122.5	--	V	--	--	--	--
2472.24	109.7	--	H	--	--	--	--
4944.48**	50.6	38.3	V	54.0	102.5	-15.7	PASS
4944.48**	50.9	39.5	H	54.0	102.5	-14.5	PASS
7416.72**	54.7	42.8	V	54.0	102.5	-11.2	PASS
7416.72**	53.8	42.0	H	54.0	102.5	-12.0	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
 Adaptive Broadband, MDS 24810 with PC2415N External Antenna  
 TRANSMIT Freq.: 2472.24 MHz



**ULTRATECH GROUP OF LABS**

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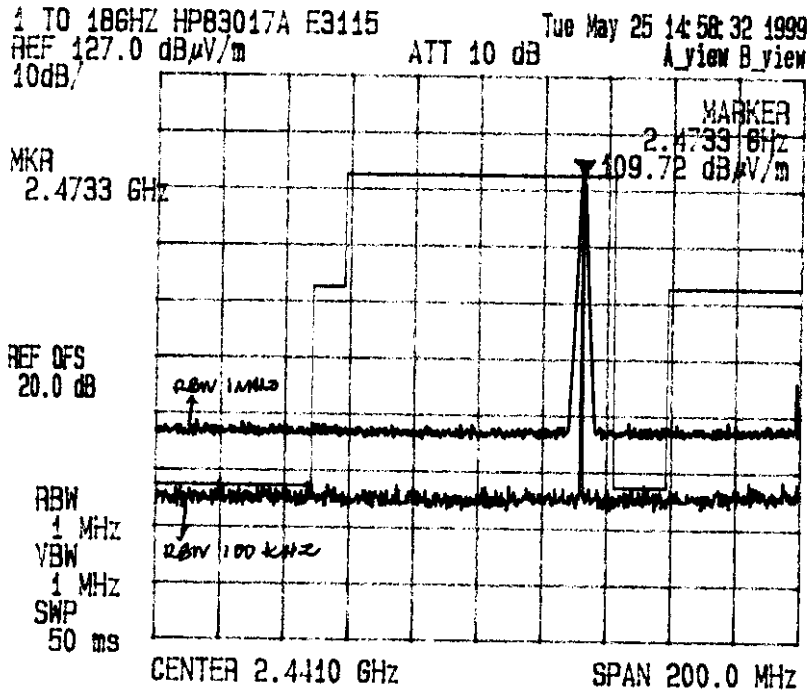
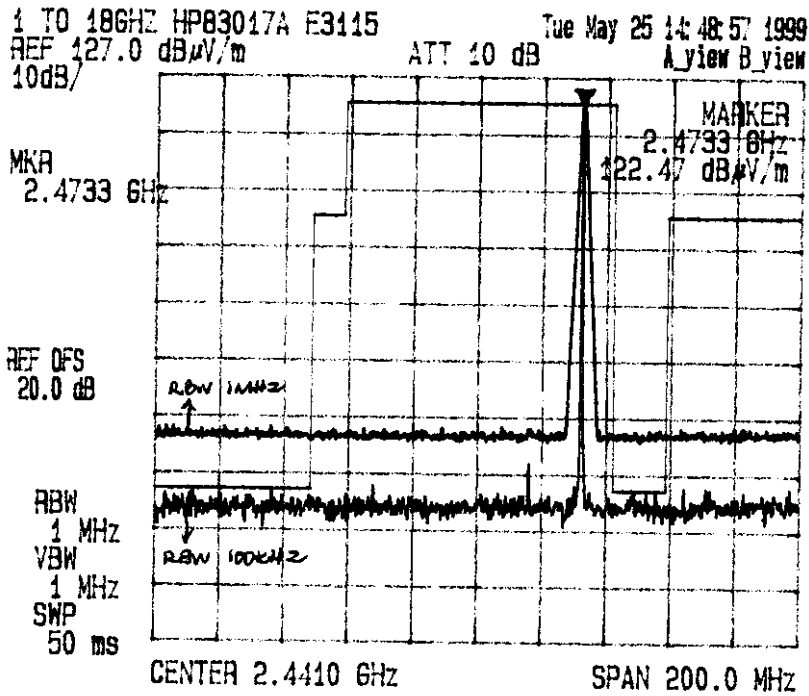
Date: May 25 1999

Tested by: Hung Trinh

### MICROWAVE DATA SYSTEMS INC.

Model: 24810 & [ ] S2403BP Antenna [ ] PC-2415N Antenna [ ] SPG-36 Antenna  
Tx Frequency: ~~2.473~~ 2.44 MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceiver.

Radiated Emissions Measurements @ 3 Meters



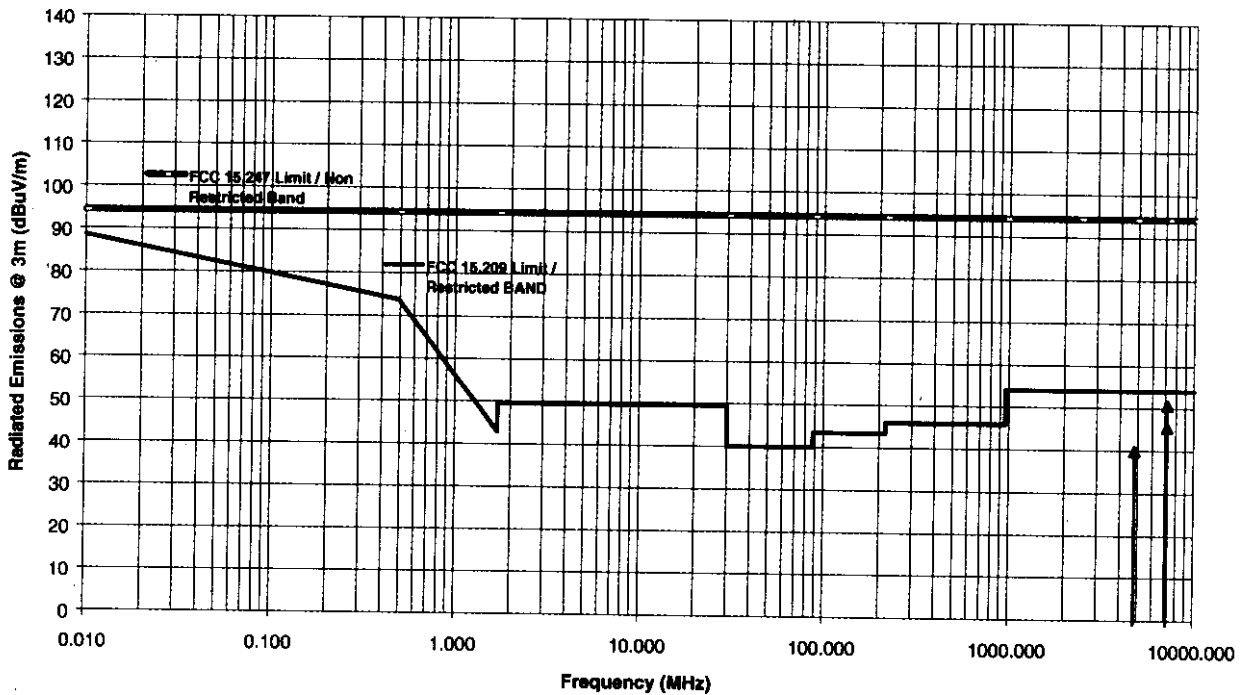
**Test Configuration #3: MDS 24810 with SPG-36 External Antenna**

CHANNEL FREQUENCY TESTED: 2400.64 MHz FULL RATED POWER: 18 mW							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2400.64	114.3	--	V	--	--	--	--
2400.64	111.3	--	H	--	--	--	--
4801.28	51.1	39.8	V	54.0	94.3	-14.2	PASS*
4801.28	51.5	39.9	H	54.0	94.3	-14.1	PASS*
7201.92	57.7	50.7	V	54.0	94.3	-43.6	PASS
7201.92	55.6	45.6	H	54.0	94.3	-48.7	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
 Adaptive Broadband, MDS 24810 with SPG-36 External Antenna  
 TRANSMIT Freq.: 2400.64 MHz



**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@symptaco.ca](mailto:yhk.ultratech@symptaco.ca), Website: <http://www.ultratech-labs.com>

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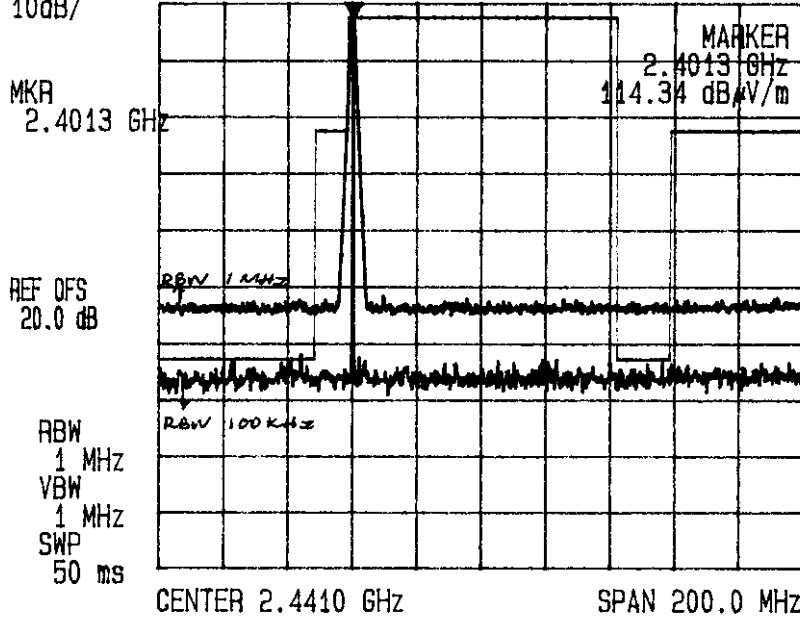
Date: May 26 1999  
Tested by: Hung Trinh

**MICROWAVE DATA SYSTEMS INC.**  
Model: 24810 & [ ] S2403BP Antenna [ ] PC-2415N Antenna [ ] SPG-36 Antenna  
Tx Frequency: 2.4013 GHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceiver.

Radiated Emissions Measurements @ 3 Meters

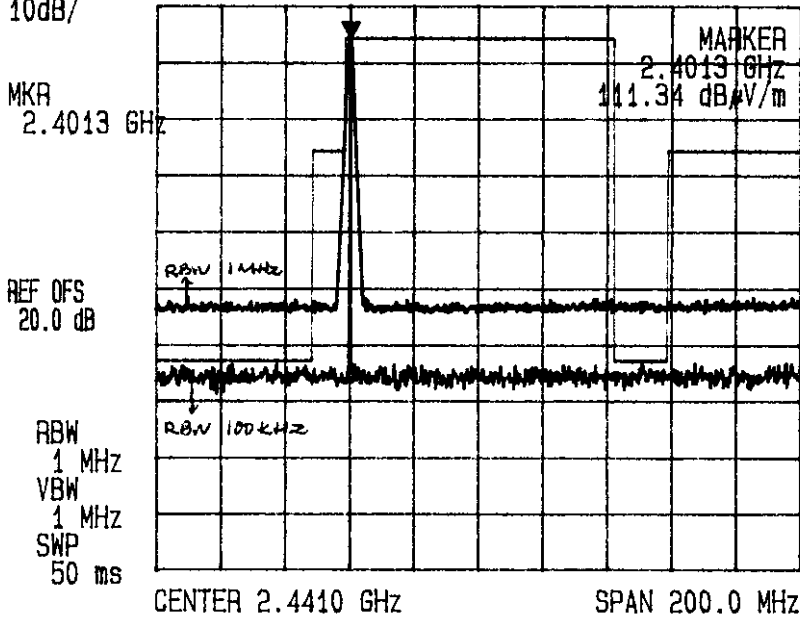


1 TO 18GHz HP83017A E3115 Wed May 26 10:09:58 1999  
REF 117.0 dB $\mu$ V/m ATT 10 dB A\_view B\_view  
10dB/



VERTICAL

1 TO 18GHz HP83017A E3115 Wed May 26 10:18:14 1999  
REF 117.0 dB $\mu$ V/m ATT 10 dB A\_view B\_view  
10dB/



HORIZONTAL

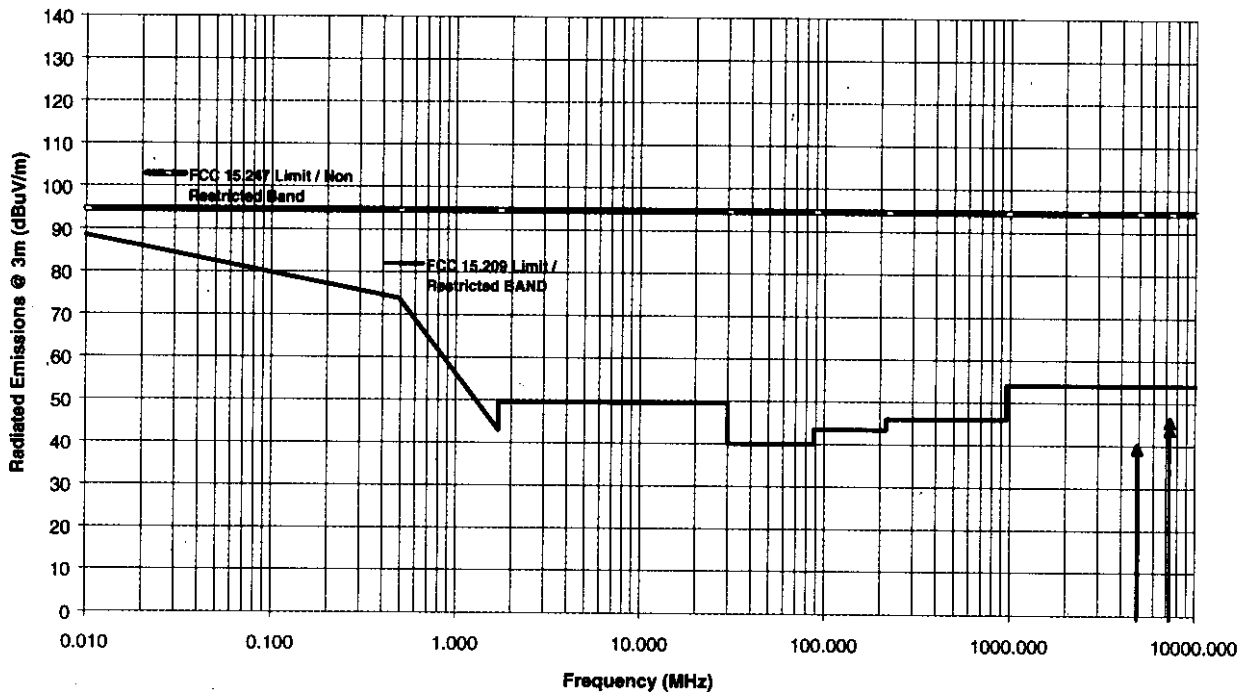
**CHANNEL FREQUENCY TESTED: 2442.00 MHz**  
**FULL RATED POWER: 15 mW**

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2442.00	114.6		V	54.0	94.6	-94.6	PASS
2442.00	112.6		H	54.0	94.6	-94.6	PASS
4884.00**	51.4	39.4	V	54.0	94.6	-14.6	PASS
4884.00**	51.4	39.2	H	54.0	94.6	-14.8	PASS
7326.00**	55.5	45.6	V	54.0	94.6	-8.4	PASS
7326.00**	54.4	43.7	H	54.0	94.6	-10.3	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

**Transmitter Radiated Emissions Measurements at 3 Meter OFTS**  
**Adaptive Broadband, MDS 24810 with SPG-36 External Antenna**  
**TRANSMIT Freq.: 2442.00 MHz**



**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L8H 6G4  
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: MIC15-FTX  
 May 27, 1999

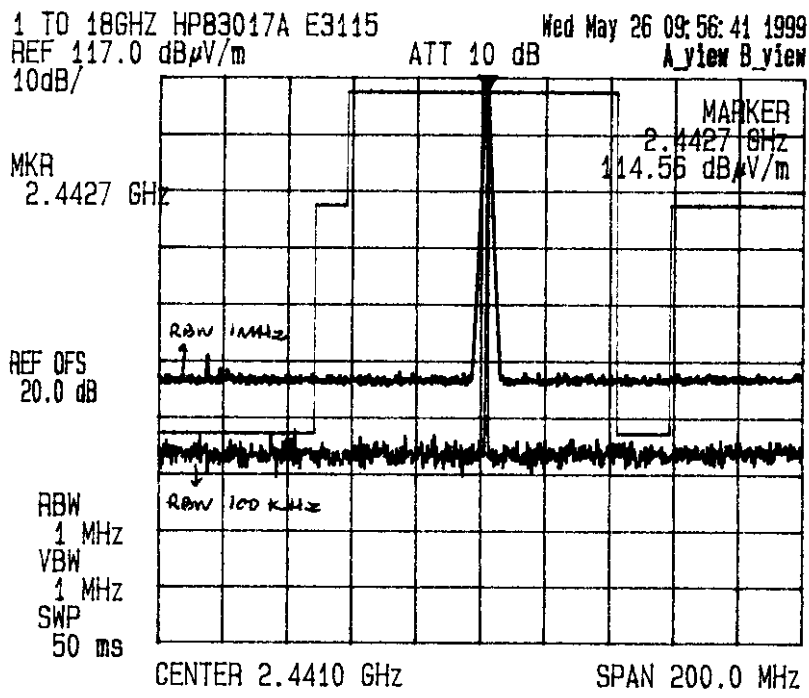
- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia)
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- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



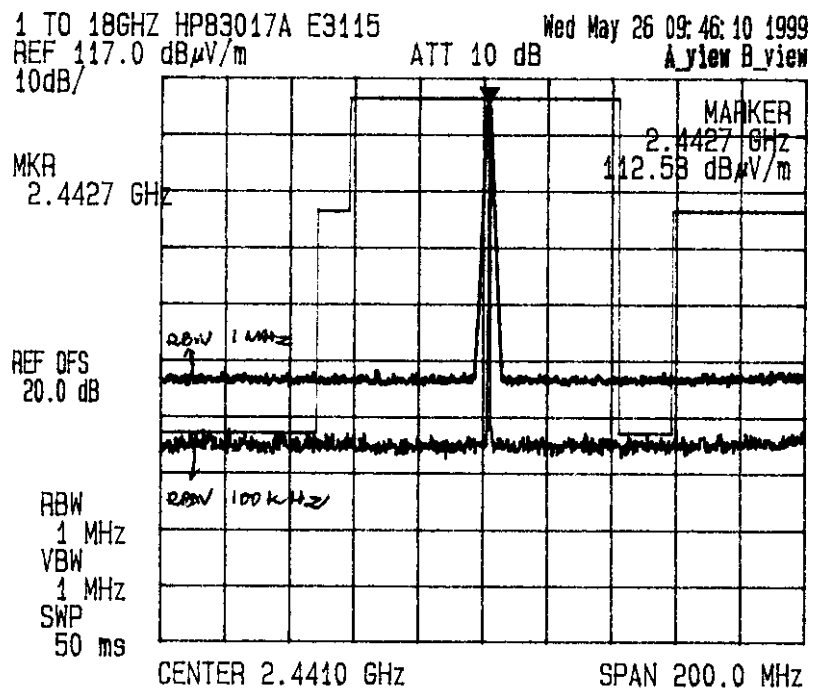
Date: May 26 1999  
Tested by: Hung Trinh

**MICROWAVE DATA SYSTEMS INC.**  
Model: 24810 & [ ] S2403BP Antenna [ ] PC-2415N Antenna [ ] SPG-36 Antenna  
Tx Frequency: 2.4427 MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceiver.

Radiated Emissions Measurements @ 3 Meters



VERTICAL



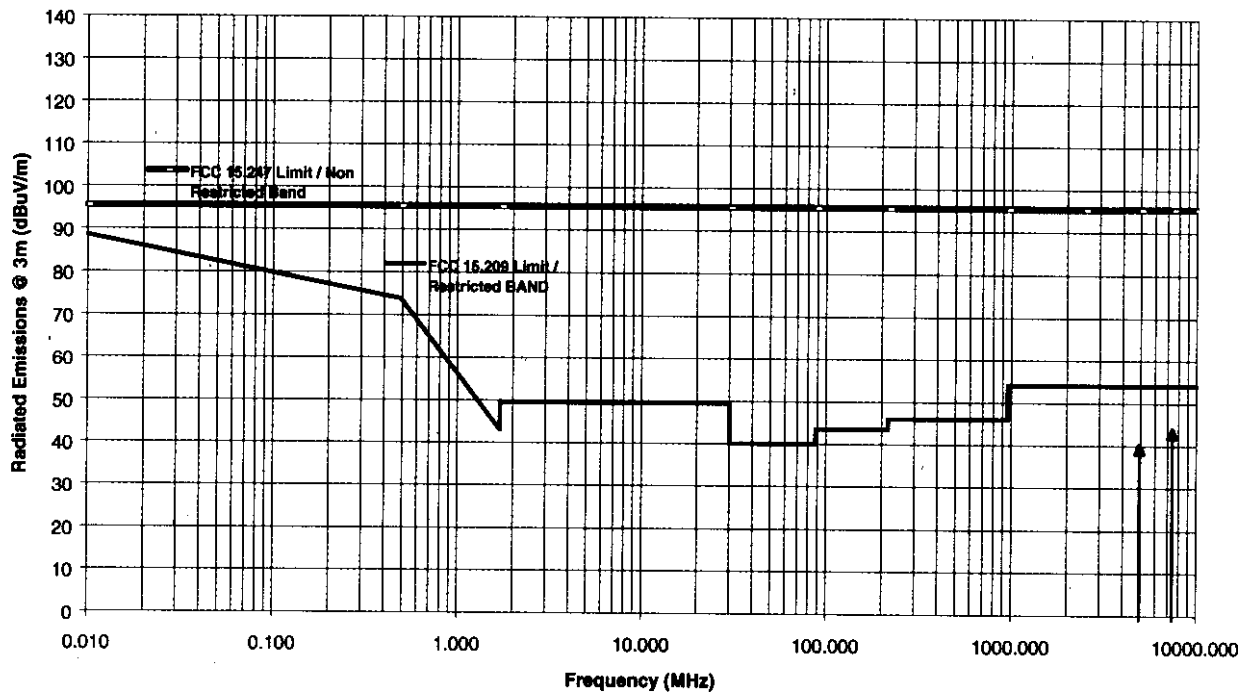
HORIZONTAL

CHANNEL FREQUENCY TESTED: 2472.24 MHz FULL RATED POWER: 14 mW							
FREQUENCY (MHz)	PEAK LEVEL (dBuV/m)	AVG LEVEL (dBuV/m)	PLANE (H/V)	15.209 (dBuV/m)	15.247 (dBuV/m)	MARGIN (dB)	PASS/FAIL
2472.24	115.5		V	54.0	95.5	-95.5	PASS
2472.24	113.7		H	54.0	95.5	-95.5	PASS
4944.48**	50.7	39.3	V	54.0	95.5	-14.7	PASS
4944.48**	51.7	39.3	H	54.0	95.5	-14.7	PASS
7416.72**	55.1	43.0	V	54.0	95.5	-11.0	PASS
7416.72**	54.2	43.0	H	54.0	95.5	-11.0	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details

\*\* Emission within the restricted band specified in @ 15.205(a)

Transmitter Radiated Emissions Measurements at 3 Meter OFTS  
 Adaptive Broadband, MDS 24810 with SPG-36 External Antenna  
 TRANSMIT Freq.: 2472.24 MHz



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 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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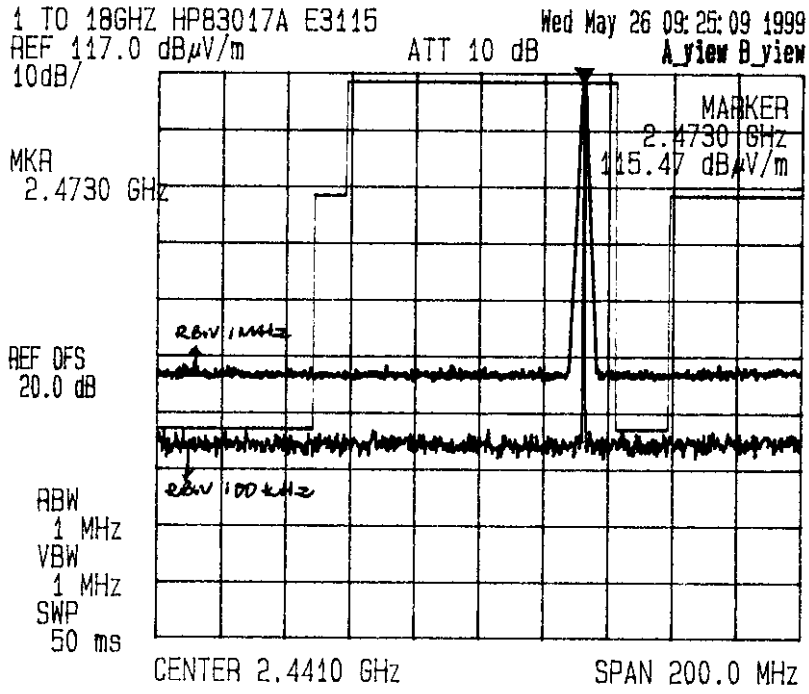
- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia)
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Date: May 26 1999  
Tested by: Hung Trinh

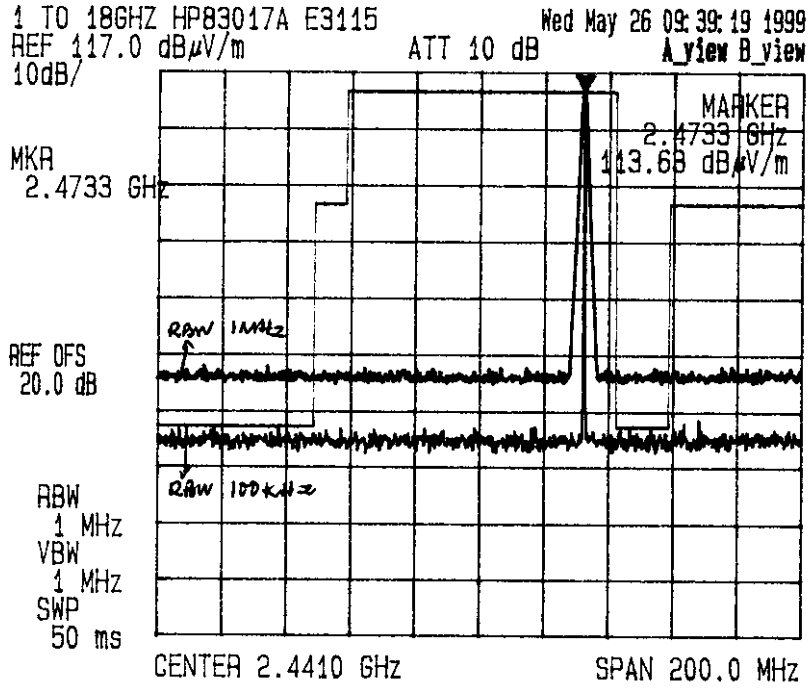
**MICROWAVE DATA SYSTEMS INC.**  
Model: 24810 & [ ] S2403BP Antenna [ ] PC-2415N Antenna M SPG-36 Antenna  
Tx Frequency: 2.472 & 2.474 MHz  
2.4 GHz Frequency Hopping Spread Spectrum Transceiver.



**Radiated Emissions Measurements @ 3 Meters**



**VERTICAL**



**HORIZONTAL**

## 5. EXHIBIT 5 - GENERAL TEST PROCEDURES

### 5.1 ELECTRICAL FIELD RADIATED EMISSIONS MEASUREMENTS - GENERAL TEST METHOD

- The radiated emission measurements were performed at the UltraTech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC.
- Radiated emissions measurements were made using the following test instruments:
  - 1) Calibrated EMCO active loop antenna in the frequency range from 10 KHz to 1 MHz
  - 2) Calibrated EMCO biconilog antenna in the frequency range from 30 MHz to 2000 MHz.
  - 3) Horn Antennas:
    - a) Horn Antenna, Emco, Model 3115, 1 – 18 GHz
    - b) Horn Antenna, Emco, Model 3160-09, 18-26.5GHz
    - c) Horn Antenna, Emco, Model 3160-10, 26.5-40GHz
    - d) Mixer, Tektronix, P/N 118-0098-00, 18-26.5GHz
    - e) Mixer, Tektronix, P/N 119-0098-00, 26.5-40GHz
  - 4) Calibrated Advantest spectrum analyzer and pre-selector/pre-amplifier. In general, the spectrum analyzer would be used as follows:
    - The rf electric field levels were measured with the spectrum analyzer set to PEAK detector (1 KHz RBW and 1 KHz VBW for frequency below 30 MHz, 100 KHz RBW and VBW  $\geq$  RBW for Frequency below 1 GHz and 1 MHz RBW and 1 MHz VBW for frequency greater than 1 GHz).
    - If any rf emission was observed to be a broadband noise, the spectrum analyzer's CISPR QUASI-PEAK detector (120 KHz RBW and 1MHz VBW) was then set to measure the signal level.
    - If the signal being measured was narrowband and the ambient field was broadband, the bandwidth of the spectrum analyzer was reduced.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.
- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.
- During this process, cables and peripheral devices were manipulated within the range of likely configuration.
- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement (each variable within bounds specified elsewhere) were explored to produce the highest amplitude signal relative to the limit.

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

- Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.
- Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.
- Step3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.
- Step4: Move the antenna over its full allowed range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.
- Step5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.
- Step6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.
- Step7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

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**Calculation of Field Strength:**

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength  
RA = Receiver/Analyzer Reading  
AF = Antenna Factor  
CF = Cable Attenuation Factor  
AG = Amplifier Gain

**Example:** If a receiver reading of 60.0 dBuV is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be..

Field Level in dBuV/m =  $60 + 7.0 + 1.0 - 30 = 38.0$  dBuV/m.

Field Level in uV/m =  $10^{(38/20)} = 79.43$  uV/m.

**Notes:** The frequency and amplitude of at least six highest conducted emissions relative to the limit are recorded unless such emissions are more than 20 dB below the limit. If less than six emissions are within 20dB of the limit, the background or receiver noise level shall be reported at representative frequencies.

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## **6. EXHIBIT 6 - INFORMATION RELATED TO EQUIPMENT UNDER TESTS**

### **6.1 FCC ID LABELING AND SKETCH OF FCC LABEL LOCATION**

Refer to the attached sheets

### **6.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST**

Refer to the attached photographs

### **6.3 SYSTEM BLOCK DIAGRAM(S)**

Refer to the attached sheets

### **6.4 SCHEMATIC DIAGRAMS**

Refer to the attached sheets

### **6.5 USER'S MANUAL WITH "FCC INFORMATION TO USER STATEMENTS"**

Refer to the attached Users' manual

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# S2403BP

## 2400 MHz Antenna

### SAFETY

The antenna has been designed to attach to and hang from standard ceiling panel runners. To prevent personal injury or equipment damage, the antenna must be securely mounted per instructions.

### LOCATION

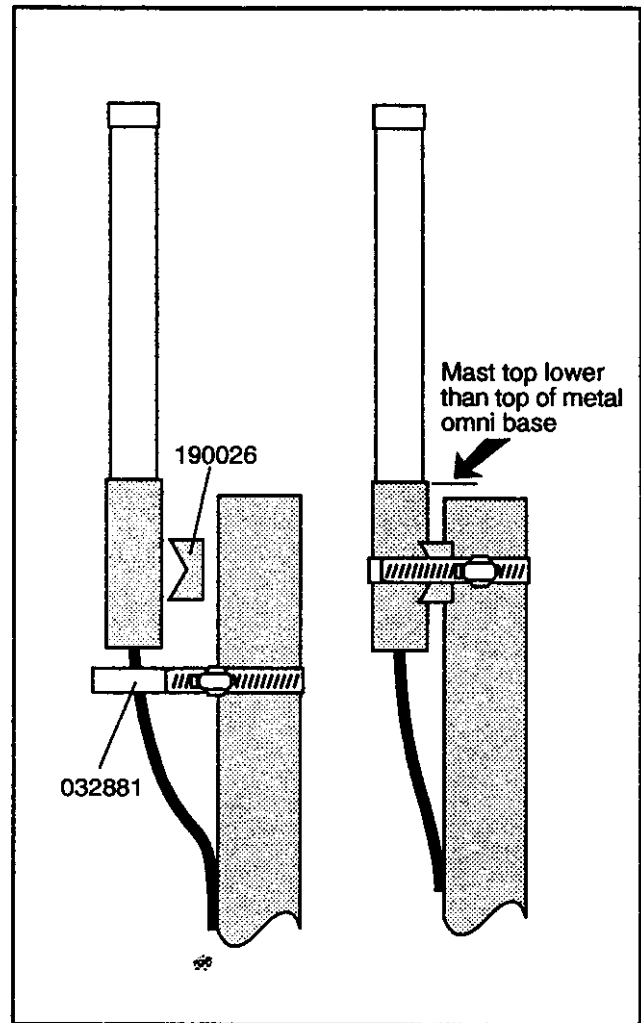
The location of the antenna is important. Objects such as metal columns, walls, etc. will reduce efficiency. Best performance is achieved when transmit and receive antennas are mounted at the same height and in a direct line of sight with no obstructions. If this is not possible and reception is poor, it's a good idea to try a few different mounting positions to optimize reception.

### MOUNTING

The hose clamp and mounting bracket provided will accommodate a 1.25 to 2 inch (3.2-5.1 cm) mast. A 1.5 inch (3.8 cm) OD or larger tubing mast should be used. Make sure that the mast does not extend above the metal base on the omni. If multiple antennas are mounted on the same mast, it is important to place this antenna at least 12 inches (30 cm) from the other to keep interaction to a minimum.

### CONNECTOR ATTACHMENT

This antenna has a pigtail feed with a female N-connector which provides great flexibility during installation. Dress the pigtail down the mast and connect it to the feedline. Then weatherproof the connectors and attach the pigtail and feedline to the mast with cable ties or tape.



Model	S2403BP
Frequency, MHz	2400-2500
Gain, dBd	3.0
Wind Surface Area, ft <sup>2</sup> (m <sup>2</sup> )	0.122 (0.011)
Wind Survivability, mph (kph)	125 (200)
Weight, lb (kg)	0.29 (0.64)
Height, in (cm)	9 (22.9)
Nominal Impedance, Ohms	50
VSWR	1.5:1 nominal
Power handling, Watts	50
Radiating Element	Plated copper laminate
Enclosure	Polycarbonate
Feed	N
	3" (7.6 cm) UltraLink pigtail

### Limited Warranty

Cushcraft Corporation, 48 Perimeter Road, Manchester, New Hampshire 03103, warrants to the original consumer purchaser for one year from date of purchase that each Cushcraft antenna is free of defects in material or workmanship. If, in the judgement of Cushcraft, any such antenna is defective, then Cushcraft will, at its option, repair or replace the antenna at its expense within thirty days of the date the antenna is returned (at purchaser's expense) to Cushcraft or one of its authorized representatives. This warranty is in lieu of all other expressed warranties. Any implied warranty is limited in duration to one year. Cushcraft Corporation shall not be liable for any incidental or consequential damages which may result from a defect. Some states do not allow a limitation on how long an implied warranty lasts or exclusions or limitations of incidental or consequential damages, so the above limitation and exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. This warranty does not extend to any products which have been subject to misuse, neglect, accident or improper installation. Any repairs or alterations outside of the Cushcraft factory will nullify this warranty.



P.O. BOX 4680, MANCHESTER, NH 03018 • Phone: 603-627-7877 • Fax: 603-627-1764  
Web: <http://www.cushcraft.com> • E-mail: [hamsales@cushcraft.com](mailto:hamsales@cushcraft.com)

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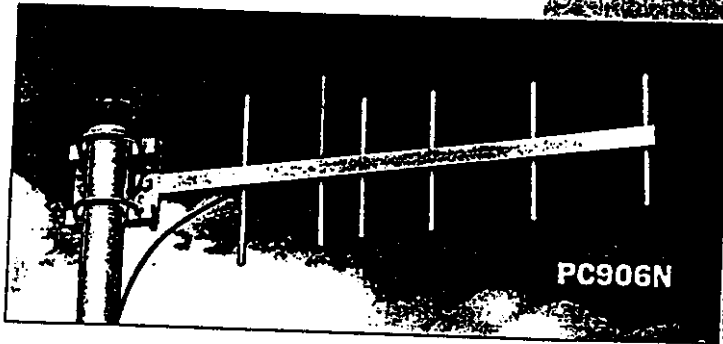


### Custom Antennas To Meet Special Needs

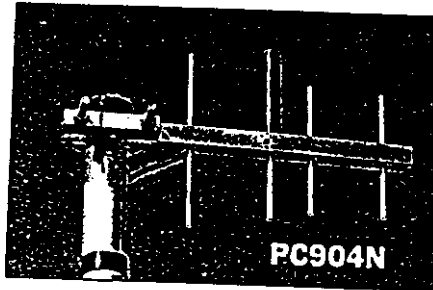
Whatever your connector of choice, it is likely that Cushcraft/Signals can meet your needs. We stock connectors for most of the approved systems. Also, if you require special lengths of cable or other changes to the antenna, please do not hesitate to contact us. Cushcraft would like to respond to your need for new antenna designs. If you have a quantity requirement, please let us know.

Check our specifications in the Yagi Selector Chart. Look over the features in the Features Box. Then call your favorite distributor or the factory for immediate shipment or to ask any additional questions you may have.

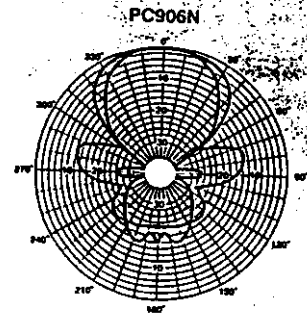
Yagi	Spread Spectrum	SCADA
PC-8910N	Yes	No
PC-904N	Yes	Yes
PC-906N	Yes	No
PC-9010N	No	Yes
PC-9013N	Yes	No
PC2415N	Yes	No



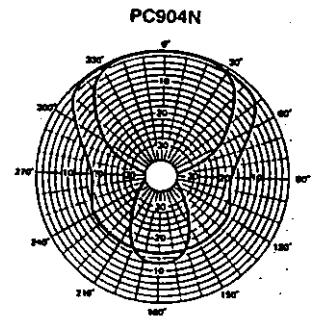
PC906N



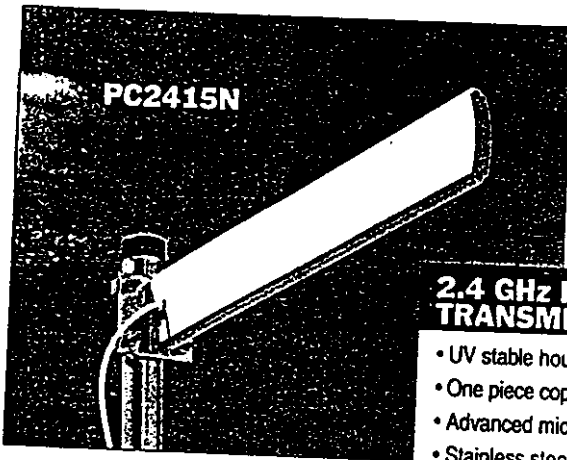
PC904N



PC906N



PC904N



PC2415N

### NEW 2.4 GHz Yagi

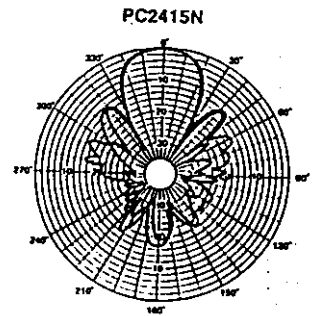
For those long-range directional applications, Cushcraft has designed the PC2415N Yagi. It produces a gain of 13.9 dBd and can be mounted in a number of ways. The model shown utilizes the flat plate design. Many others could be used. Cushcraft has the ability to modify this model for OEM applications to fit your needs.

The UV-stabilized polycarbonate radome shields the antenna from the sun and all weather conditions.

#### 2.4 GHz DATA TRANSMISSION YAGI

- UV stable housing
- One piece copper radiating element
- Advanced microwave substrate
- Stainless steel hardware
- Pigtail mounted connector

S152.01 20.  
H.V



PC2415N

### DATA YAGI SELECTOR CHART

Model	Freq. MHz	Gain dBd	No. Elem	F to B dB	Bandwidth 1.5:1 -3dB Beamwidth		Conn. Type (Female)	W/ surf. Area ft <sup>2</sup> (m <sup>2</sup> )	W/ surv. mph (kph)	W/ 1/2" Ice	Length in (cm)	WL lb. (kg)
					E-Plane*	H-Plane*						
PC8910N	896-940 MHz	11	10	20	40	45	N	0.38 (0.035)	125 (200)	100 (161)	41-7/16 (105.2)	2.31 (1.04)
PC904N	896-980 MHz	6	4	12	70	100	N	0.11 (0.01)	125 (200)	100 (161)	13 (33)	1.12 (1.50)
PC906N	896-940 MHz	8.5	6	18	55	65	N	0.26 (0.024)	125 (200)	100 (161)	24-3/4 (62.9)	1.62 (1.73)
PC9010N	928-960 MHz	12	10	20	40	45	N	0.38 (0.035)	125 (200)	100 (161)	41-7/16 (105.2)	2.31 (1.04)
PC9013N	902-928 MHz	13	13	20	35	40	N	0.46 (0.043)	125 (200)	100 (161)	53-1/2 (135.9)	3.12 (1.40)

Common Specifications: Power handling - 200 Watts; Elements - 1/4 in. (.63 cm) 6061T6 aluminum rod. Boom - 3/4 in (1.9 cm) 6061T6 aluminum channel; Mounting style - U-bolt; Maximum mast diameter - 2-1/8in (5.4 cm)

PC2415N	2.4-2.5 GHz	13.9	15	18	30	34	N	0.4 (.04)	125 (200)	100 (161)	26 (66)	<1 (.473)
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Power handling - 50Watts; Radiating element - copper; Enclosure material - UV stable polycarbonate; Maximum mast diameter - 2-1/8" (5.4 cm)