

REPORT OF MEASUREMENTS  
PART 15C - INTENTIONAL RADIATOR

DEVICE: 902 – 928 MHz FREQUENCY  
HOPPING TRANSMITTER

MODEL: T245 (1847)

MANUFACTURER: OMNEX CONTROL SYSTEMS, INC.

ADDRESS: #74 – 1833 COAST MERIDIAN ROAD  
PORT COQUITLAM BRITISH COLUMBIA  
CANADA V3C 6G5

THE DATA CONTAINED IN THIS REPORT WAS  
COLLECTED ON 23 MARCH 2000 AND COMPILED BY:

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PAUL G. SLAVENS  
CHIEF EMC ENGINEER

WORK ORDER: 2251

<b>1. GENERAL .....</b>	<b>4</b>
1.1 PURPOSE.....	4
1.2 MANUFACTURER.....	4
1.3 TEST LOCATION .....	4
1.4 TEST PERSONNEL.....	4
<b>2. TEST RESULTS SUMMARY.....</b>	<b>5</b>
<b>3. DESCRIPTION OF EQUIPMENT AND PERIPHERALS.....</b>	<b>6</b>
3.1 EQUIPMENT UNDER TEST (EUT).....	6
3.2 EUT PERIPHERALS .....	6
3.3 DESCRIPTION OF INTERFACE CABLES.....	6
3.4 MODE OF OPERATION DURING TESTS .....	6
3.5 MODIFICATIONS REQUIRED FOR COMPLIANCE .....	6
<b>4. ANTENNA REQUIREMENT .....</b>	<b>7</b>
4.1 REGULATION .....	7
4.2 RESULT.....	7
<b>5. CONDUCTED EMISSIONS TESTS .....</b>	<b>8</b>
5.1 TEST EQUIPMENT.....	8
5.2 PURPOSE.....	8
5.3 TEST PROCEDURES .....	8
5.4 TEST RESULTS .....	8
<b>6. 20 DB BANDWIDTH AND CHANNEL SEPARATION.....</b>	<b>9</b>
6.1 REGULATION .....	9
6.2 TEST EQUIPMENT.....	9
6.3 TEST PROCEDURES .....	9
6.4 TEST RESULTS .....	9
<b>7. NUMBER OF CHANNELS.....</b>	<b>11</b>
7.1 REGULATION .....	11
7.2 TEST RESULTS .....	11
<b>8. POWER OUTPUT .....</b>	<b>12</b>
8.1 REGULATION .....	12
8.2 TEST EQUIPMENT.....	12
8.3 TEST PROCEDURES .....	12
8.4 TEST RESULTS .....	12
<b>9. ANTENNA GAIN REQUIREMENTS.....</b>	<b>13</b>
9.1 REGULATION .....	13
9.2 RESULT.....	13
<b>10. RADIO FREQUENCY EXPOSURE.....</b>	<b>14</b>
10.1 REGULATION .....	14
10.2 RESULT.....	14

<b>11.</b>	<b>CONDUCTED SPURIOUS EMISSIONS .....</b>	<b>15</b>
11.1	REGULATION .....	15
11.2	TEST EQUIPMENT.....	15
11.3	TEST PROCEDURES .....	15
11.4	TEST RESULTS .....	15
<b>12.</b>	<b>RADIATED SPURIOUS EMISSIONS .....</b>	<b>22</b>
12.1	REGULATION .....	22
12.2	TEST EQUIPMENT.....	22
12.3	TEST PROCEDURES .....	23
12.4	TEST RESULTS .....	23
<b>13.</b>	<b>CONTINUOUS DATA AND SHORT TRANSMISSIONS .....</b>	<b>24</b>
13.1	REGULATION .....	24
13.2	TEST RESULTS .....	24
<b>14.</b>	<b>COORDINATION OF FREQUENCY HOPPING.....</b>	<b>25</b>
14.1	REGULATION .....	25
14.2	RESULT.....	25
<b>15.</b>	<b>MISCELLANEOUS COMMENTS AND NOTES.....</b>	<b>26</b>

# 1. General

## 1.1 Purpose

The purpose of this report is to show compliance to the FCC regulations for spread spectrum unlicensed devices operating under section 15.247 of the Code of Federal Regulations title 47.

## 1.2 Manufacturer

Company Name: Omnex Control Systems, Inc.  
Contact: George Ronnenkamp  
Street Address: #74 - 1833 Coast Meridian Road  
City/Province: Port Coquitlam British Columbia  
Country/Postal Code: Canada V3C 6G5  
Telephone: 604 944-9247  
Fax: 604 944-9267  
E-mail: georger@omnexcontrols.com

## 1.3 Test location

Company: Acme Testing Inc.  
Street Address: 2002 Valley Highway  
Mailing Address: PO Box 3  
City/State/Zip: Acme WA 98220-0003  
Laboratory: Test Site 2  
Telephone: 888 226-3837  
Fax: 360 595-2722  
E-mail: acmetest@acmetesting.com  
Web: www.acmetesting.com

## 1.4 Test Personnel

Paul G. Slavens, Chief EMC Engineer

## 2. Test Results Summary

Summary of Test Results  
902 – 928 MHz Frequency Hopping Transmitter, T245 (1847)

Requirement	CFR Section	Test Result
Radiated Spurs < 15.209	15.205(b)	PASS
Conducted Emissions < 48.0 dBuV	15.207	PASS
Channel Separation > 25 kHz	15.247(a1)	PASS
Number of Channels > 50	15.247(a1i)	PASS
20 dB BW < 500 kHz	15.247(a1i)	PASS
Max Output Power < 1 W	15.247(b2)	PASS
Antenna Gain < 6 dBi	15.247(b3)	PASS
Conducted Spurious >-20 dBc	15.247(c)	PASS

The signed original of this report, supplied to the client, represents the only “official” copy. Retention of any additional copies (electronic or non-electronic media) is at Acme Testing’s discretion to meet internal requirements only. The client has made the determination that EUT Condition, Characterization, and Mode of Operation are representative of production units, and meet the requirements of the specifications referenced herein.

Consistent with Industry practice, measurement and test equipment not directly involved in obtaining measurement results but having an impact on measurements (such as cable loss, antenna factors, etc.) is factored into the “Correction Factor” documented in certain test results. Instrumentation employed for testing meets tolerances consistent with known Industry Standards and Regulations.

The measurements contained in this report were made in accordance with the procedure ANSI C63.4 - 1992 and all applicable Public Notices received prior to the date of testing. All emissions from the device were found to be within the limits outlined in this report. Acme Testing assumes responsibility only for the accuracy and completeness of this data as it pertains to the sample tested.

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Paul G. Slavens  
Chief EMC Engineer

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Date of Issuance

### **3. Description of Equipment and Peripherals**

#### **3.1 Equipment Under Test (EUT)**

Device: 902 – 928 MHz Frequency Hopping Transmitter  
Model Number: T245  
Serial Number: 1847  
FCC ID: IA9FH1847D  
Power: 9.6 volt battery  
Grounding: Local  
Antenna Distance: 3 meter

#### **3.2 EUT Peripherals**

Not applicable, the EUT is a stand-alone device.

#### **3.3 Description of Interface Cables**

Not applicable, the EUT is a stand-alone device.

#### **3.4 Mode of Operation During Tests**

The EUT was exercised by constantly transmitting.

#### **3.5 Modifications Required for Compliance**

1. None.

## **4. Antenna requirement**

### **4.1 Regulation**

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 Part 15C. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

### **4.2 Result**

The antenna consists 1/4 wave piece of coaxial cable with the shield removed. The antenna is contained inside the transmitter housing and is not user accessible.

## 5. Conducted Emissions Tests

Test Requirement: FCC CFR47, Part 15C

Test Procedure: ANSI C63.4:1992

### 5.1 Test Equipment

- ⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001
- ⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001
- ⇒ Quasi Peak Adapter (yellow): Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 19 November 1999, Calibration due Date: 19 November 2000
- ⇒ Line Impedance Stabilization Network: Rhode & Schwarz ESH2-Z5, Serial Number ACMERS1, Calibrated: 1 September 1999, Calibration due Date: 01 September 2000

### 5.2 Purpose

The purpose of this test is to evaluate the level of conducted noise the EUT imposes on the AC mains.

### 5.3 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that is placed above the groundplane. Floor standing equipment is placed directly on the groundplane. Any supplemental grounding mechanisms are connected, if appropriate. The EUT is connected to its associated peripherals, with any excess I/O cabling bundled to approximately 1 meter. The EUT is connected to a dedicated LISN and all peripherals are connected to a second separate LISN circuit. The LISNs are bonded to the groundplane.

#### Conducted Emissions Test Characteristics

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Frequency range	0.45 MHz - 30.0 MHz
Test instrumentation resolution bandwidth	9 kHz
Lines Tested	Line 1/Line 2

### 5.4 Test Results

Not applicable the EUT is DC powered.



## **6. 20 dB Bandwidth and Channel Separation**

### **6.1 Regulation**

15.247(a1) 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.

### **6.2 Test Equipment**

- ⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001
- ⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001

### **6.3 Test Procedures**

The RF output of the EUT was connected to the RF input port of the RF preselector through a 20-dB pad. The following measurements were made with a RBW = 10 kHz and VBW = 3KHz.

### **6.4 Test Results**

The measured 20 dB bandwidth of the carrier frequency is 50.8 kHz. The transmitter has hopping channel carrier frequencies separated by 400 kHz. The transmitter generates a Reed-Solomon pseudo random frequency hop sequence of length 64 based on a pre-programmed seed.

The transmitter can be set to operate on any one of 256 frequency channels in the 902-928MHz band. The frequencies are divided into four groups of 64 frequencies; each group using every fourth available frequency. 63 out of 64 frequencies in a group are then used equally by the spread spectrum transmitter in a pseudo random sequence. 63 different sequences are available for use in each frequency group.

The associated 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.

## FREQUENCY PLAN

HOP FREQ. NUMBER	GROUP #1 (MHz)	GROUP #2 (MHz)	GROUP #3 (MHz)	GROUP #4 (MHz)
0	902.3	902.4	902.5	902.6
1	902.7	902.8	902.9	903.0
2	903.1	903.2	903.3	903.4
3	903.5	903.6	903.7	903.8
4	903.9	904.0	904.1	904.2
5	904.3	904.4	904.5	904.6
6	904.7	904.8	904.9	905.0
7	905.1	905.2	905.3	905.4
8	905.5	905.6	905.7	905.8
9	905.9	906.0	906.1	906.2

XX	<b>Add 400 KHz per Frequency Hop Number</b>
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54	923.8	923.9	924.0	924.1
55	924.2	924.3	924.4	924.5
56	924.6	924.7	924.8	924.9
57	925.0	925.1	925.2	925.3
58	925.4	925.5	925.6	925.7
59	925.8	925.9	926.0	926.1
60	926.2	926.3	926.4	926.5
61	926.6	927.7	926.8	926.9
62	927.0	927.1	927.2	927.3
63	927.4	927.5	927.6	927.7

## **7. Number of Channels**

### **7.1 Regulation**

15.247(a1i) For frequency hopping systems operating in the 902-928 MHz band: if the 20-dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20-dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20-dB bandwidth of the hopping channel is 500 kHz.

### **7.2 Test Results**

The transmitter uses 63 hopping frequencies and has a 20 dB bandwidth of 50.8 kHz. The average time of occupancy on any frequency is 0.317 seconds in a 20 second period.

## **8. Power Output**

### **8.1 Regulation**

15.247(b2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph 15.247(a)(1)(i).

### **8.2 Test Equipment**

⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519,  
Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated:  
17 March 2000, Calibration due Date: 17 March 2001

### **8.3 Test Procedures**

The RF output of the EUT was connected to the RF input port of the RF preselector through a 20-dB pad. The following measurements were made with a RBW = 3 MHz and VBW = 3 MHz.

### **8.4 Test Results**

Measured maximum Peak Envelope Power was 17.1 dBm or 58.9 mW.

## **9. Antenna gain requirements**

### **9.1 Regulation**

15.247(b3) Except as shown below, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the above stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### **9.2 Result**

The equipment uses the stripped coax antenna described in section four of this report. The gain of this antenna should approach that of a monopole at 2.1 dBi.

## **10. Radio Frequency exposure**

### **10.1 Regulation**

15.247(b4) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. *See* §1.1307(b)(1) of this Chapter.

### **10.2 Result**

The device uses an integral monopole antenna. The devices EIRP is less than 0.3 watts. According to OET bulletin 65 supplement C no special instructions or warnings are necessary.

## 11. Conducted Spurious Emissions

### 11.1 Regulation

15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

### 11.2 Test Equipment

- ⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001
- ⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001
- ⇒ Quasi Peak Adapter (yellow): Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 19 November 1999, Calibration due Date: 19 November 2000

### 11.3 Test Procedures

The RF output of the EUT was connected to the RF input port of the RF preselector through a 6 dB pad. The following measurements were made with a RBW = 100 kHz and VBW = 300 kHz.

### 11.4 Test Results

**\* There were no detectable conducted spurious emissions, please see following graphs.**

ACME TESTING - SITE #2

MKR 1.200 GHz

hp

REF 20.0 dBm

ATTEN 20 dB + 30 dB

-54.80 dBm

10 dB/

POS PK

OFFSET

10.0

dB

FCC CFR47, PART 15C, 15.247

OMNEX CONTROL SYSTEMS, INC.  
T245

CONDUCTED SPURIOUS W/6 dB PAD  
LOW CHANNEL

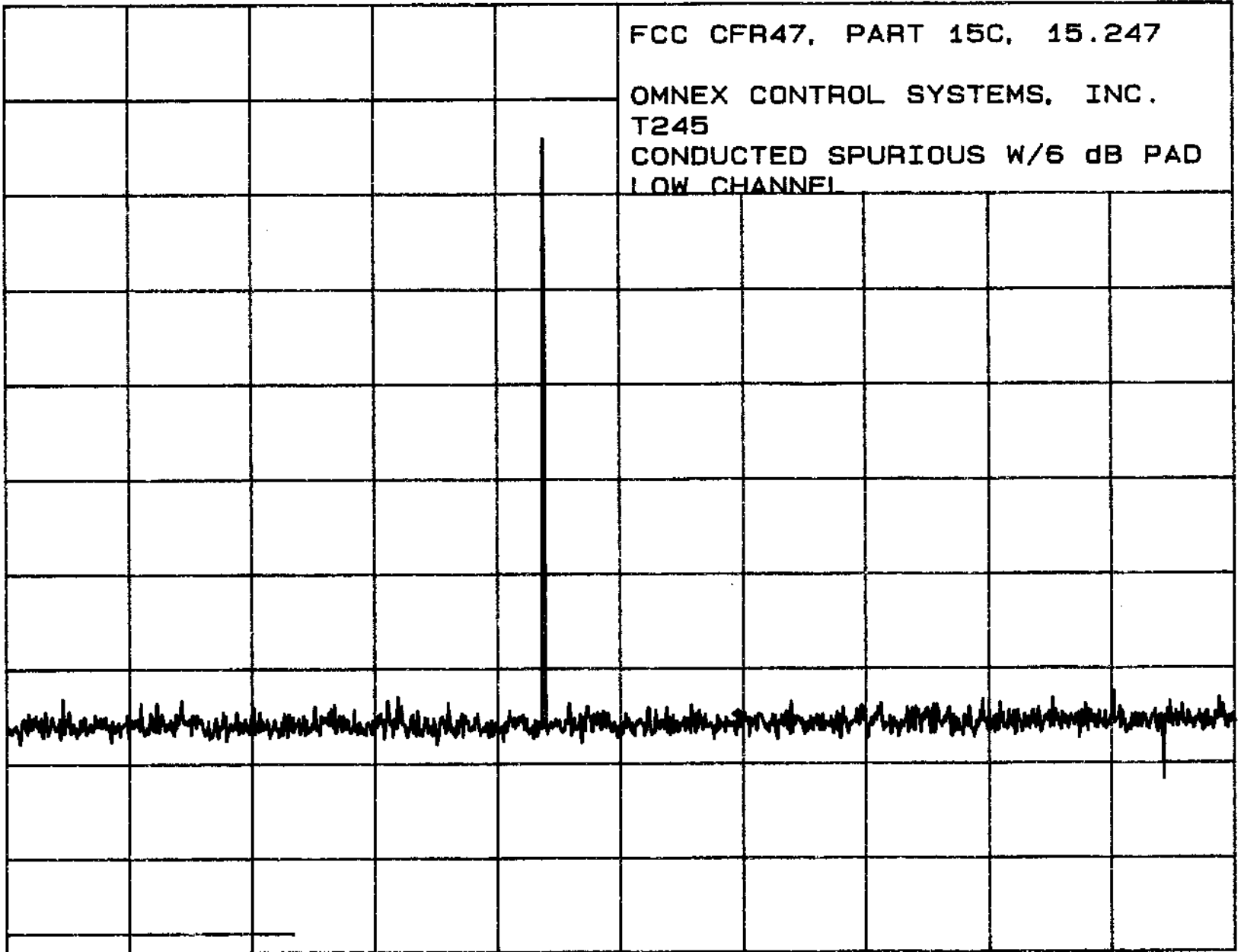
START 30 MHz

RES BW 100 KHz

VBW 300 KHz

STOP 2.00 GHz

SWP 1.00 sec





ACME TESTING - SITE #2

MKR 1.200 GHz

hp

REF 20.0 dBm

ATTEN 20 dB + 30 dB

-57.00 dBm

10 dB/

POS PK

OFFSET

10.0

dB

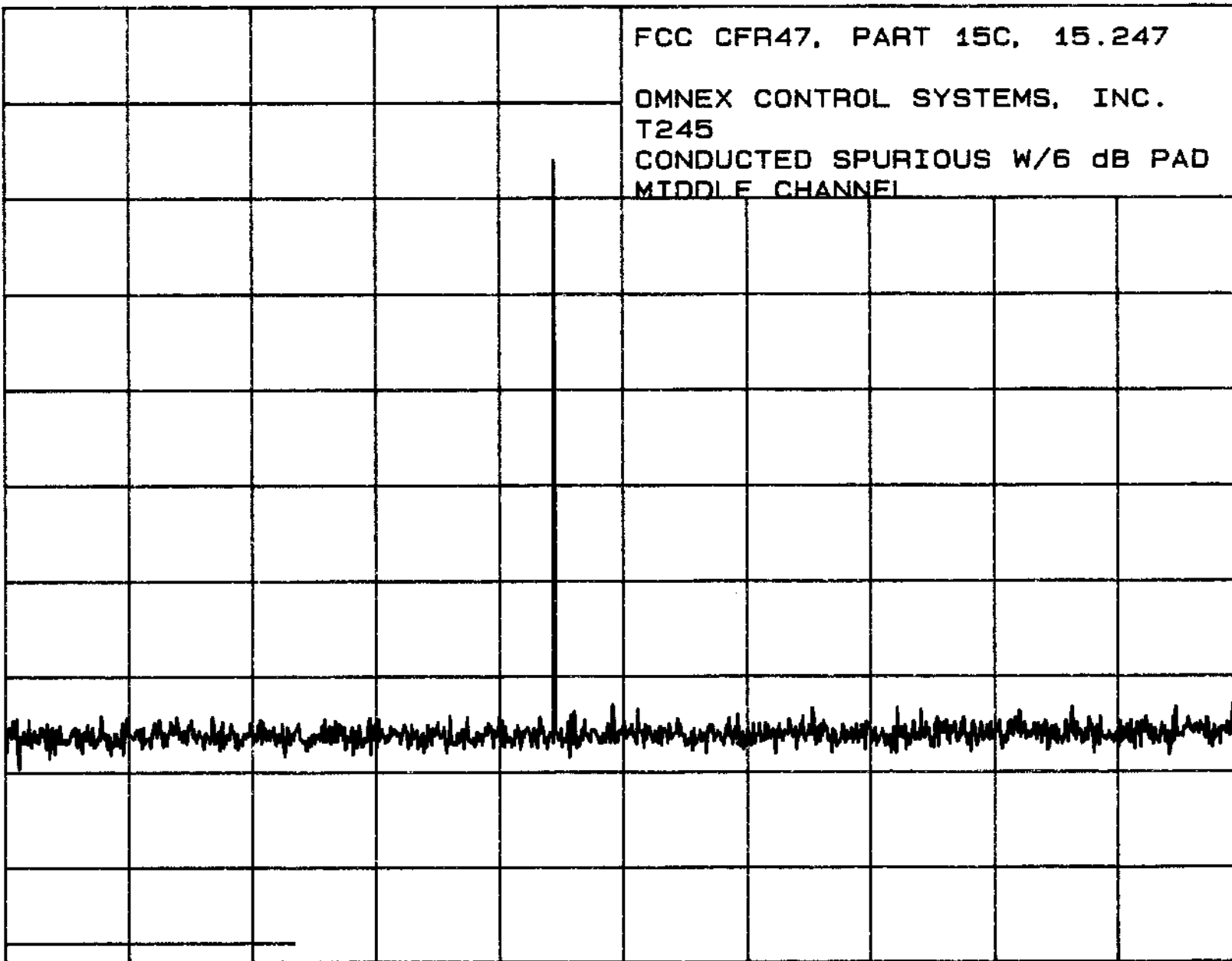
FCC CFR47, PART 15C, 15.247

OMNEX CONTROL SYSTEMS, INC.

T245

CONDUCTED SPURIOUS W/6 dB PAD

MIDDLE CHANNEL



START 30 MHz

STOP 2.00 GHz

RES BW 100 KHz

VBW 300 KHz

SWP 1.00 sec

ACME TESTING - SITE #2

MKR 1.200 GHz

hp

REF 20.0 dBm

ATTEN 20 dB + 30 dB

-56.20 dBm

FCC CFR47, PART 15C, 15.247

OMNEX CONTROL SYSTEMS, INC.  
T245

CONDUCTED SPURIOUS W/6 dB PAD  
HIGH CHANNEL

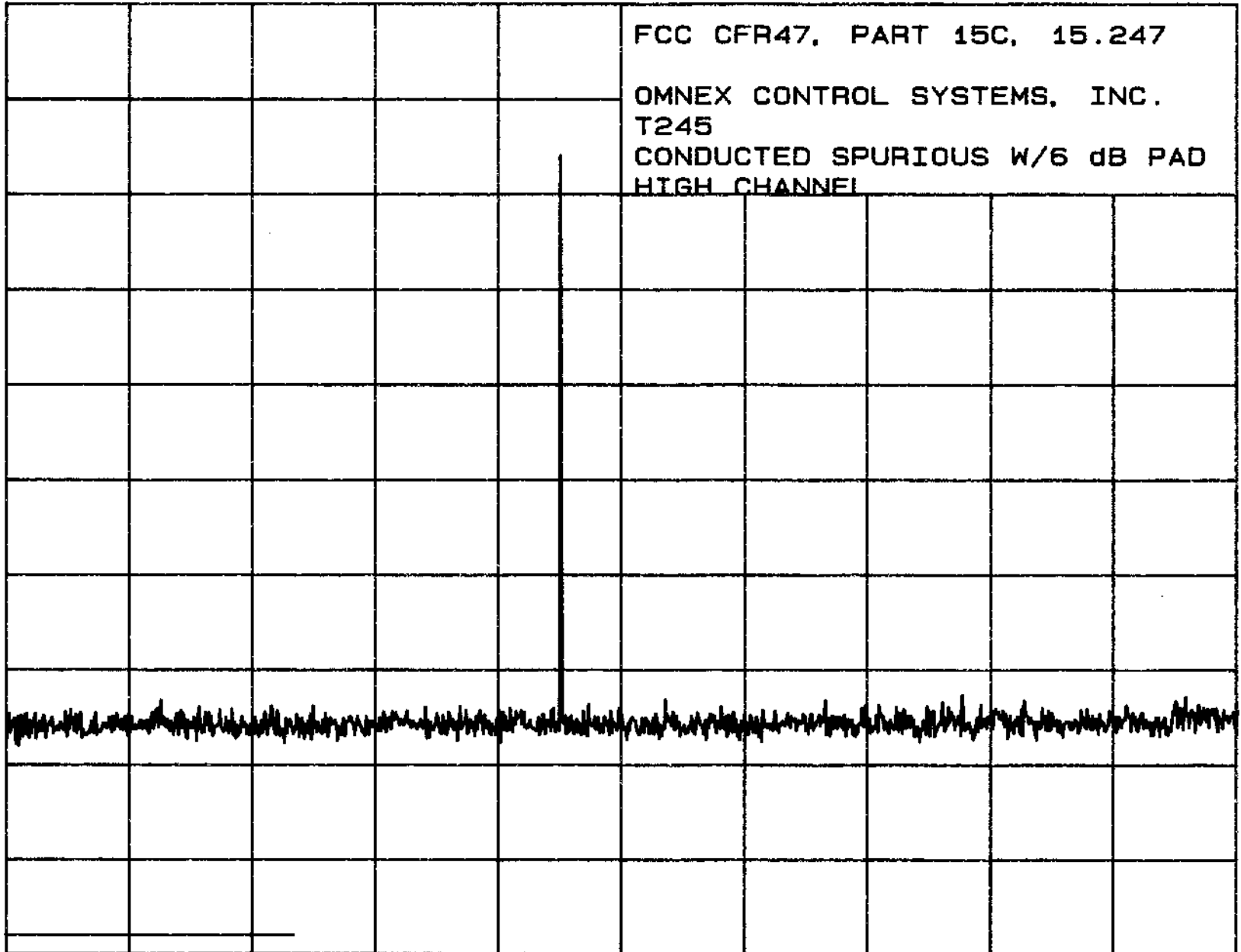
10 dB/

POS PK

OFFSET

10.0

dB



START 30 MHz

RES BW 100 KHz

VBW 300 KHz

STOP 2.00 GHz

SWP 1.00 sec

ACME TESTING - SITE #2

MKR 6.752 GHz

hp

REF 10.0 dBm ATTEN 20 dB

-61.00 dBm

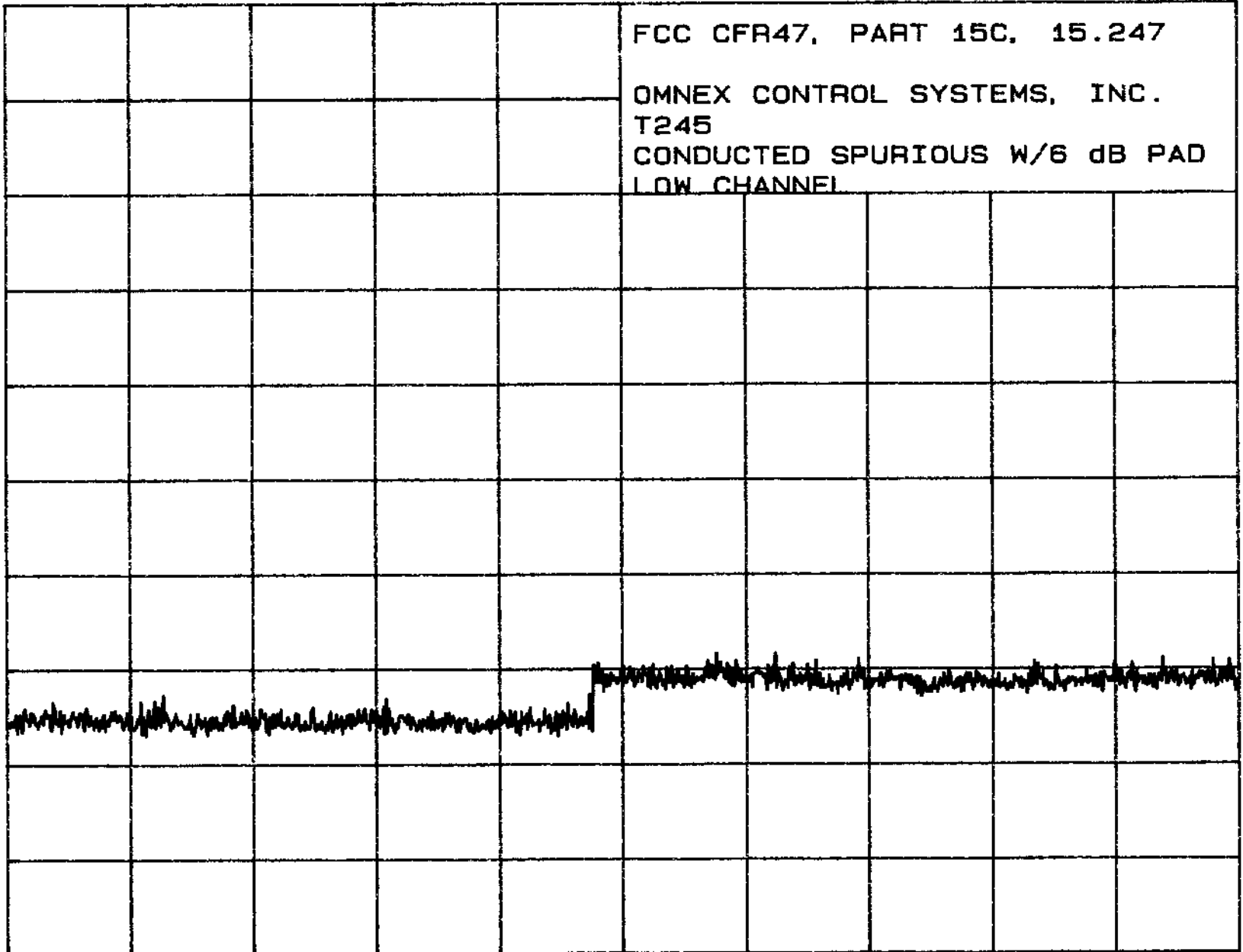
10 dB/

POS PK

FCC CFR47, PART 15C, 15.247

OMNEX CONTROL SYSTEMS, INC.  
T245

CONDUCTED SPURIOUS W/6 dB PAD  
LOW CHANNEL



START 2.00 GHz

STOP 10.00 GHz

RES BW 100 KHz

VBW 300 KHz

SWP 2.40 sec

ACME TESTING - SITE #2

MKR 6.752 GHz

hp

REF 10.0 dBm ATTEN 20 dB

-61.70 dBm

10 dB/

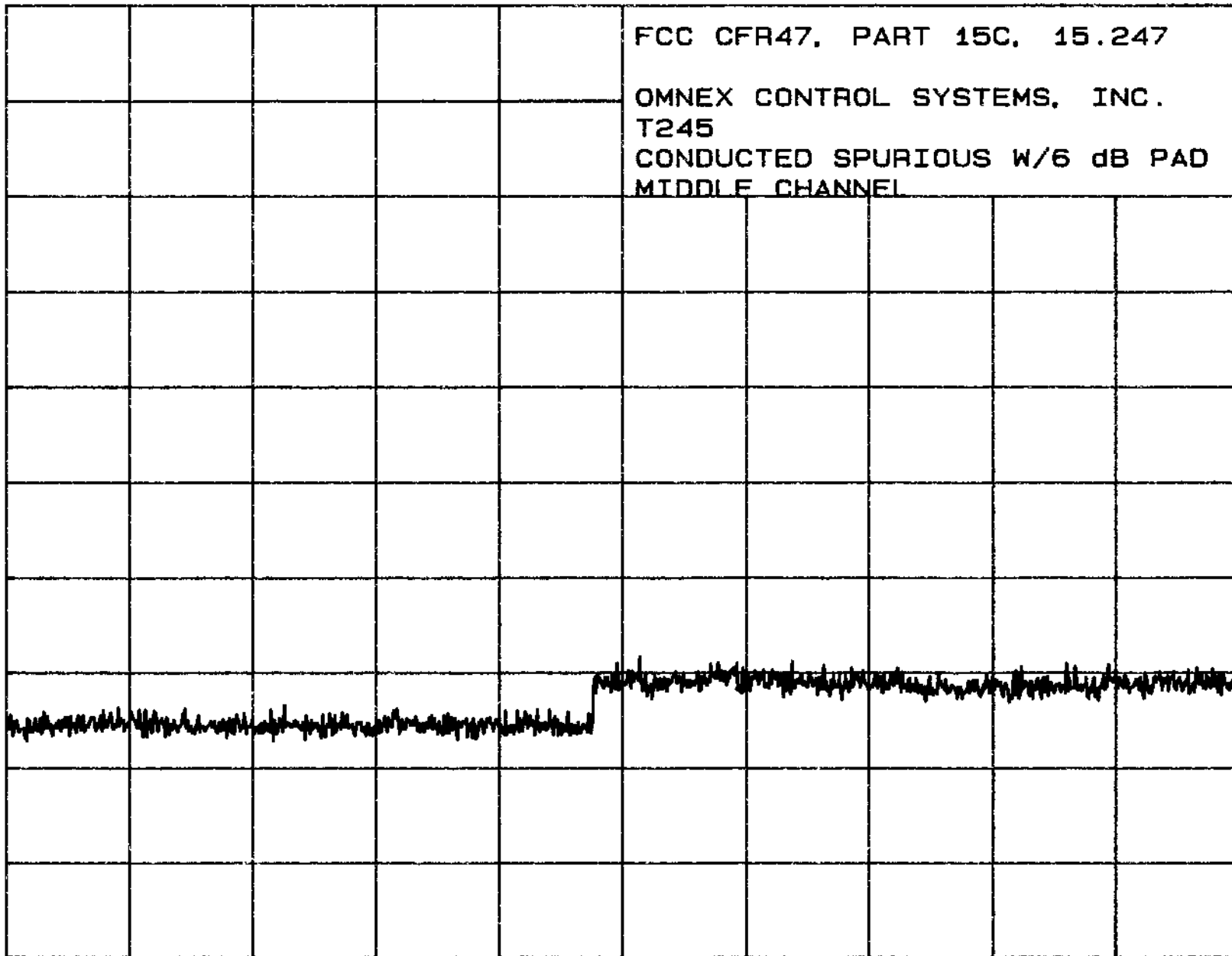
POS PK

FCC CFR47, PART 15C, 15.247

OMNEX CONTROL SYSTEMS, INC.

T245

CONDUCTED SPURIOUS W/6 dB PAD  
MIDDLE CHANNEL



START 2.00 GHz

STOP 10.00 GHz

RES BW 100 KHz

VBW 300 KHz

SWP 2.40 sec

ACME TESTING - SITE #2

MKR 6.752 GHz

hp

REF 10.0 dBm ATTEN 20 dB

-61.10 dBm

10 dB/

POS PK

FCC CFR47, PART 15C, 15.247

OMNEX CONTROL SYSTEMS, INC.  
T245

CONDUCTED SPURIOUS W/6 dB PAD  
HIGH CHANNEL

START 2.00 GHz

RES BW 100 KHz

VBW 300 KHz

STOP 10.00 GHz

SWP 2.40 sec

## 12. Radiated Spurious Emissions

### 12.1 Regulation

15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

### 12.2 Test Equipment

- ⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001
- ⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001
- ⇒ Quasi Peak Adapter (yellow): Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 19 November 1999, Calibration due Date: 19 November 2000
- ⇒ Line Impedance Stabilization Network: Rhode & Schwarz ESH2-Z5, Serial Number ACMERS1, Calibrated: 1 September 1999, Calibration due Date: 01 September 2000
- ⇒ Broadband Biconical Antenna (red) (20 MHz to 200 MHz): EMCO 3110, Serial Number 1115, Calibrated: 28 December 1999, Calibration due Date: 28 December 2000
- ⇒ Broadband Log Periodic Antenna (red) (200 MHz to 1000 MHz): EMCO 3146, Serial Number 2853, Calibrated: 28 December 1999, Calibration due Date: 28 December 2000
- ⇒ EUT Turntable Position Controller: EMCO 1061-3M, Serial Number 9003-1441, No Calibration Required
- ⇒ Antenna Mast with Controller: EMCO 1051, Serial Number 9002-1457, No Calibration Required
- ⇒ 2 GHz to 10 GHz Low Noise Preamplifier: Milliwave 593-2898, Serial Number 2494, No Calibration Required
- ⇒ Double Ridge Guide Horn Antenna: EMCO 3115, Serial Number 9807-5534, Calibrated: 30 December 1999, Calibration due Date: 30 December 2000

### 12.3 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that sits on a flush mounted metal turntable. Floor standing equipment is placed directly on the flush mounted metal turntable. The EUT is connected to its associated peripherals with any excess I/O cabling bundled to approximately 1 meter.

Preview tests are performed to determine the “worst case” mode of operation. With the EUT operating in “worst case” mode, emissions from the unit are maximized by adjusting the polarization and height of the receive antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions.

#### Radiated Emissions Test Characteristics

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Frequency range	30 MHz – 10,000 MHz <b>15.205 RESTRICTED BANDS ONLY</b>
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1000 MHz) 1 MHz (1000 MHz - 10000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/Horizontal

### 12.4 Test Results

**There were no detectable radiated emissions in the 15.205 Bands.**

## **13. Continuous Data and Short Transmissions**

### **13.1 Regulation**

15.247(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

### **13.2 Test Results**

When required to send continuous data, all frequencies of a sequence (63) are used one before any re-use of frequencies occurs. When presented with a short burst, any one frequency is not re-used until all frequencies (63) of sequence have been used. The sequence is not truncated and re-started.



## **14. Coordination of Frequency Hopping**

### **14.1 Regulation**

15.247(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

### **14.2 Result**

This system does not incorporate intelligence to avoid interfering carriers. It progresses linearly through the hopping sequence.

## **15. Miscellaneous Comments and Notes**

1. None.