ACME TESTING INC., 2002 VALLEY HWY, P.O. BOX 3, ACME, WASHINGTON 98220-0003 888-226-3837.

REPORT OF MEASUREMENTS
PART 15C - INTENTIONAL RADIATOR

DEVICE: 902 – 928 MHz FREQUENCY HOPPING TRANSMITTER

MODEL: AP-1648

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 6 OCTOBER 1998 AND COMPILED BY:

PAUL G. SLAVENS
CHIEF EMC ENGINEER

WORK ORDER: 30003

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, AP-1648

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.

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.

Paul G. Slavens
Chief EMC Engineer

Date of Issuance

3. Description of Equipment and Peripherals

3.1 Equipment Under Test (EUT)

Device:	902 – 928 MHz Frequency Hopping Transmitter
Model Number:	AP-1648
Serial Number:	971120
FCC ID:	IA9FH1648T
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 of a short length of RG174 coaxial cable with a 1/4 wave section stripped free of the outer shield braid. The antenna is contained inside the transmitter housing and is not user accessible.

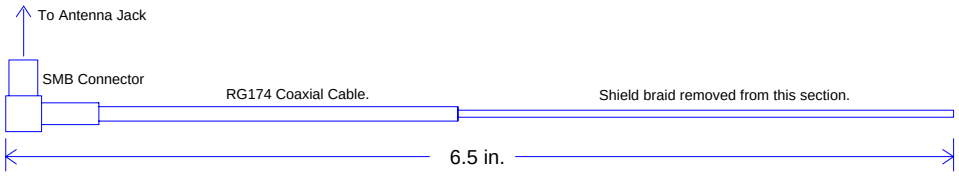

FIGURE 3 ANTENNA

5. Conducted Emissions Tests

Test Requirement: FCC CFR47, Part 15C

Test Procedure: ANSI C63.4:1992

5.1 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Line Impedance Stabilization Network: EMCO 3825/2, Serial Number 9002-1601, Calibrated:
27 August 1997, Calibration due Date: 31 December 1998

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

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: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

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 = 100 kHz and VBW = 3KHz.

6.4 Test Results

The measured 20 dB bandwidth of the carrier frequency is 49 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.

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	**Add 400 KHz per Frequency Hop Number**			
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 49 kHz. The average time of occupancy on any frequency is.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: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

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 9.8 dBm.

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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 is 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 .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: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

11.3 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 = 100 kHz and VBW = 300 kHz.

11.4 Test Results

PRODUCT EMISSIONS
LOWEST CHANNEL
Fc = 902.2

No	FREQUENCY (MHz)	POWER (dBm)	RELATIVE LEVEL (dBc)
1	1804.4	-51.6	-61.4

PRODUCT EMISSIONS
LOWEST CHANNEL
Fc = 914.4

No	FREQUENCY (MHz)	POWER (dBm)	RELATIVE LEVEL (dBc)
1	1828.8	-50.3	-60.1

PRODUCT EMISSIONS
LOWEST CHANNEL
Fc = 927.7

No	FREQUENCY (MHz)	POWER (dBm)	RELATIVE LEVEL (dBc)
1	1804.4	-51.0	-60.8

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: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Line Impedance Stabilization Network: Rhode & Schwarz ESH2-Z5, Calibrated: 4 June 1997, Calibration due Date: 31 December 1998

⇒ Broadband Biconical Antenna (20 MHz to 200 MHz): EMCO 3110, Serial Number 1115, Calibrated: 27 July 1997, Calibration due Date: 31 December 1998

⇒ Broadband Log Periodic Antenna (200 MHz to 1000 MHz): EMCO 3146, Serial Number 2853, Calibrated: 27 July 1997, Calibration due Date: 31 December 1998

⇒ EUT Turntable Position Controller: EMCO 1061-3M 9003-1441, No Calibration Required

⇒ Antenna Mast: EMCO 1051 9002-1457, No Calibration Required

⇒ 2 GHz to 10 GHz Low Noise Preamplifier: Milliwave 593-2898, Serial Number 2494, Calibrated: 19 June 1997, Calibration due Date: 31 December 1998

⇒ Double Ridge Guide Horn Antenna: EMCO 3115, Serial Number 5534, Calibrated: 21 July 1998, Calibration due Date: 21 November 1999

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	
Frequency range	30 MHz – 10,000 MHz **15.205 RESTRICTED BANDS ONLY**
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

Calculation of average correction factor = 20 * log (20 mSec/100 mSec)
= 20 * log .2
= -14 dB

20 milliseconds is the worst case on time for any 100 milliseconds time frame.

12.4 Test Results

PRODUCT EMISSIONS
LOWEST CHANNEL
Fc = 902.2
PEAK DATA

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	1353.30	74.0	52.4	-21.6	PK	V	100	343	31.1
2	2255.49	74.0	61.3	-12.6	PK	V	100	281	2.5

PRODUCT EMISSIONS
LOWEST CHANNEL
Fc = 902.2
CALCULATED AVERAGE DATA

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	1353.30	54.0	38.4	-15.6	AVG	V	100	343	31.1
2	2255.49	54.0	47.3	-6.7	AVG	V	100	280	2.5

PRODUCT EMISSIONS
MIDDLE CHANNEL
Fc = 914.4
PEAK DATA

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	1371.56	74.0	51.0	-23.0	PK	V	100	340	31.7
2	2286.00	74.0	60.2	-13.8	PK	V	100	302	2.3

PRODUCT EMISSIONS
MIDDLE CHANNEL
Fc = 914.4
CALCULATED AVERAGE DATA

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	1371.56	54.0	37.0	-17.0	AVG	V	100	340	31.7
2	2286.00	54.0	46.2	-7.8	AVG	V	100	302	2.3

PRODUCT EMISSIONS
HIGHEST CHANNEL
Fc = 927.7
PEAK DATA

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	1391.54	74.0	50.3	-23.7	PK	V	100	315	31.3
2	2319.26	74.0	61.7	-12.3	PK	V	100	292	2.4

PRODUCT EMISSIONS
HIGHEST CHANNEL
Fc = 927.7
CALCULATED AVERAGE DATA

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	1391.54	54.0	36.3	-17.7	AVG	V	100	315	31.3
2	2319.26	54.0	47.7	-6.3	AVG	V	100	292	2.4

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.