

REPORT OF MEASUREMENTS

DEVICE: 902 – 928 MHz 21 CHANNEL DIRECT
SEQUENCE SPREAD SPECTRUM
WIRELESS ROUTER BRIDGE

MODEL: EUM3000

MANUFACTURER: WAVERIDER COMMUNICATIONS
(CANADA) INC.

ADDRESS: 6120 – 1A STREET S.W.
CALGARY ALBERTA
CANADA T2H 0G3

WORK ORDER: 9181HR



American Association for Laboratory Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC GUIDE 25:1990 (EN45001)

ACME TESTING
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ELECTRICAL (EMC)

Valid to: November 30, 2001

Certificate Number: 0829-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following Electromagnetic Compatibility (EMC) tests:

Radiated & Conducted Emissions
Immunity
Voltage sags
Harmonics
Flicker

On the following materials and products:

Electrical and electronic equipment for information technology, industrial, scientific, and medical applications; residential service; receivers; and licensed and unlicensed transmitters.

Using the following standards:

U.S. Code of Federal Regulations (CFR) 47, FCC Method Parts 15 (using ANSI C63.4-1992), 18 & 90
CISPR: 11; 13; 14 (excluding click measurements); 22 (including Amendments 1 and 2)
CNS: 13439; 13438
EN: 50081-1; 50081-2; 50082-1; 50082-2; 55011; 55013; 55014-1 (excluding click measurements); 55014-2; 55022; 55103-1; 55103-2; 60601-1-2; 60945 (sections 9 & 10 only); 61000-4-2; 61000-4-3; 61000-4-4; 61000-4-5 (single phase only, excluding 10/700 surge testing); 61000-4-6; 61000-4-8; 61000-4-11; 61000-3-2; 61000-3-3
AS/NZS: 3548, 2064.1/2, 4251.1, 4252.1
IEC: 801-2; 801-3; 801-4; 801-5; 1000-4-2; 1000-4-3; 1000-4-4; 1000-4-5; 1000-4-6
ENV: 50140; 50204
ICES-003 Issue 2 Revision 1
RSS-210 Issue 2
Bellcore GR-1089-CORE (Sections 2 through 3.2.4)

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14.	MISCELLANEOUS COMMENTS AND NOTES	ERROR! BOOKMARK NOT DEFINED.

1. General

1.1 Document History

REVISION	DATE	COMMENTS
-	7 February 2001	Initial Release, Paul G. Slavens
A	27 February 2001	15.31 (e) Power Output Data inclusive of 3 voltages (Pg 20) – Paul G. Slavens

Note: Acme Testing Co. hereby makes the following statements so as to conform with Chapter 10 (Test Reports) Requirement of ANSI C63.4:1992 “Methods and Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”:

- The units described in this report were received at Acme Testing Co.’s facilities and testing was performed on the units described in this report on 19, 21, 22, & 28 December 2000.
- The Test Results reported herein apply only to the Units actually tested, and to substantially identical Units.
- This test report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government, or any other foreign government.

This document is the property of Acme Testing, Co., and shall not be reproduced, except in full, without prior written approval of Acme Testing Co. However, all ownership rights are hereby returned unconditionally to WaveRider Communications (Canada) Inc., and approval is hereby granted to WaveRider Communications (Canada) Inc and its employees and agents to reproduce all or part of this report for any legitimate business purpose without further reference to Acme Testing Co.

1.2 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.

THE DATA CONTAINED IN THIS REPORT WAS COLLECTED AND COMPILED BY:

PAUL G. SLAVENS
CHIEF EMC ENGINEER

DANIEL B. STATON
EMC TECHNICIAN

1.3 Manufacturer

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Country/Postal Code: Canada T2H 0G3
Telephone: 403 319-2350
Fax: 403 319-2359

1.4 Test location

Laboratory: Test Site #1
Street Address: 2002 Valley Highway
Mailing Address: PO Box 3
City/State/Zip: Acme WA 98220-0003
Telephone: 888 226-3837
Fax: 360 595-2722
E-mail: acmetest@acmetesting.com
Web: www.acmetesting.com

1.5 Accreditation and Listing

Acme Testing Co.'s test facilities are accredited by A2LA for the specific scope of accreditation under Certificate Numbers: 0829-01 (Acme, WA), and 0829-02 (Plummer, ID). Acme Testing Co.'s test facilities that are used to perform radiated and conducted emissions are currently registered with the Federal Communications Commission under registration numbers: 90420 (Acme, WA), and 96502 (Plummer, ID). In addition test facilities are also registered with the Industry Canada under registration numbers: 3251 (Acme, WA), and 3618 (Plummer, ID).

2. Test Results Summary

Summary of Test Results

Requirement	CFR Section	Test Result
Radiated Spurs < 15.209	15.205(b)	PASS
AC Emissions < 48 dBuV	15.207	PASS
6 dB BW > 500 kHz	15.247(a)	PASS
Max Output Power < 1 W	15.247(a)	PASS
Antenna Gain Requirements	15.247(b)	PASS
Radio Frequency Exposure	15.247(b)	PASS
Conducted Spurious >-20 dBc	15.247(c)	PASS
Power Density < 8dBm in 3 kHz	15.247(d)	PASS
Process Gain > 10 dB	15.247(e)	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 Co.’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 referenced standards and all applicable Public Notices received prior to the date of testing. Acme Testing Co. 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 21 Channel Direct sequence Spread
Spectrum Wireless Router/Bridge
Model Number: EUM3000
FCC ID: OOX-LMS3000
Power: 120 V/60 Hz
Grounding: 3-Wire AC Plug
Antennas: Omni-directional & Diversity Patch
Number of Channels: 21
Lowest Frequency: 905 MHz
Highest Frequency: 925 MHz

3.2 Mode of Operation During Testing

The EUT was exercised by transmitting a modulated signal on channels 1, 11, & 21. During radiated spurious emission testing the EUT was tested with two antennas.

3.3 Modifications Required for Compliance

1. None.

3.4 EUT Peripherals for Emissions

Device	Manufacturer	Model Number	FCC ID	Serial Number
Laptop Computer	Compaq	Series 2920A	DGIP5665	None
Power Supply	Acbel Polytech Inc.	APIOAD56-000	None	000044

3.5 Description of Interface Cables for Emissions

CPU and Transmitter Unit/Omni directional Antenna

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	0.35 m	No

CPU and Transmitter Unit/Patch Antenna

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	0.25 m	No

CPU and Transmitter Unit/Laptop Computer (RS-232 cable)

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	1.3 m	No

CPU and Transmitter Unit/Laptop Computer (CAT 5 cable)

Shielded	Unshielded	Flat	Round	Length	Ferrite
No	Yes	No	Yes	1 m	No

CPU and Transmitter Unit/Power Supply

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	2 m	No

ARRANGEMENT OF INTERFACE CABLES: All interface cables were positioned for worst case maximum emissions within the manner assumed to be a typical operation condition (please reference photographs).

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 this Section. 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 intentional radiator uses a propriety connector QMI part number WAVRPCAJ M0D1.

5. Conducted Emissions Tests

Test Requirement: FCC CFR47, Part 15C

Test Procedure: ANSI C63.4:1992, (FCC CFR47 15.207)

Date of Test: 19 December 2000

Laboratory: Test Site #1 (Acme, WA)

5.1 Test Equipment

- ⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001
- ⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2648A00392, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001
- ⇒ Quasi Peak Adapter (yellow): Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001
- ⇒ Line Impedance Stabilization Network: EMCO 3825/2, Serial Number 9002-1601, Calibrated: 2 January 2000, Calibration due Date: 2 January 2001

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.

Preview tests are performed to determine the “worst case” mode of operation. With the EUT operating in “worst case” mode, final conducted measurements are taken. Conducted measurements are made on each current carrying conductor with respect to ground.

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

A summary of the highest amplitude emissions from 0.45 MHz – 30 MHz are listed below.

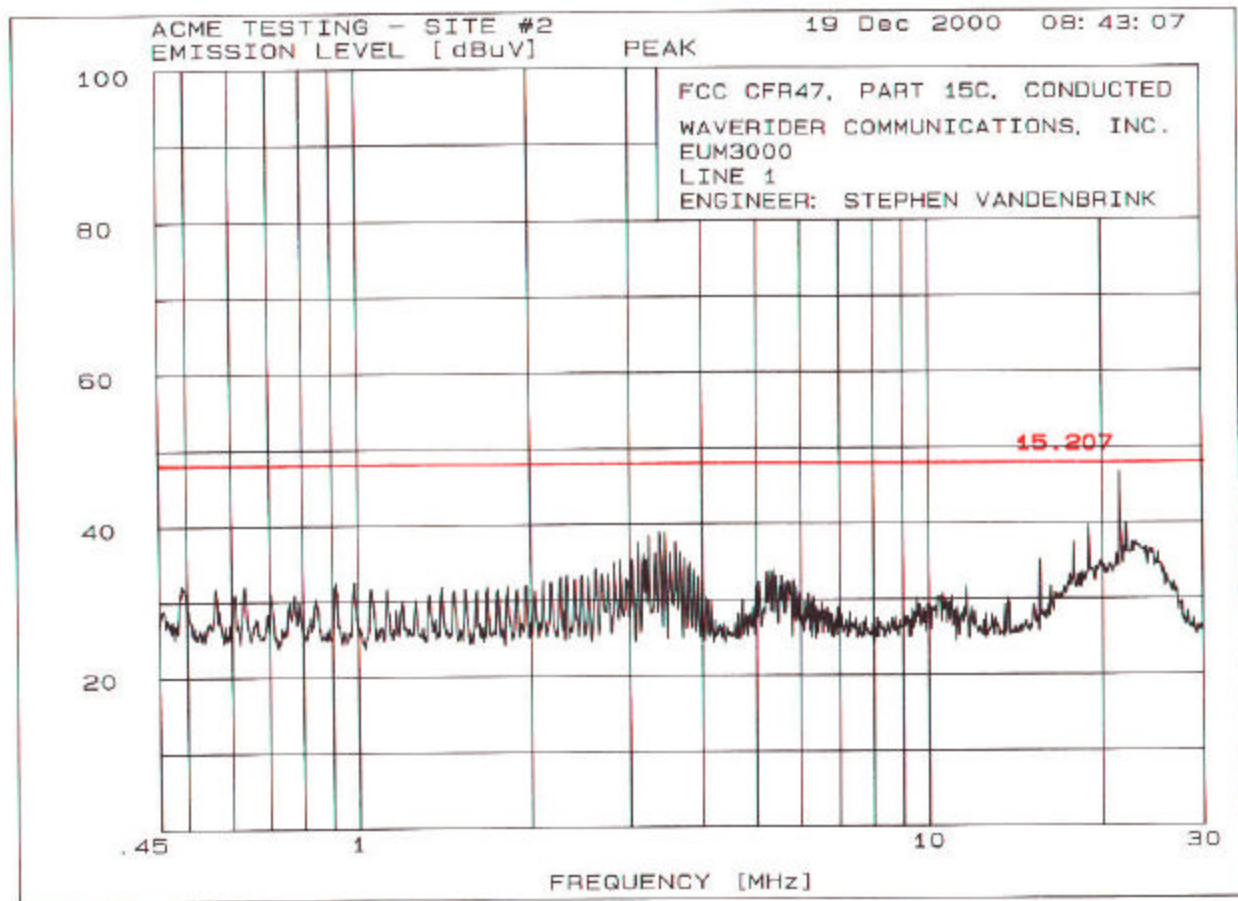
LINE 1
PEAK EMISSIONS

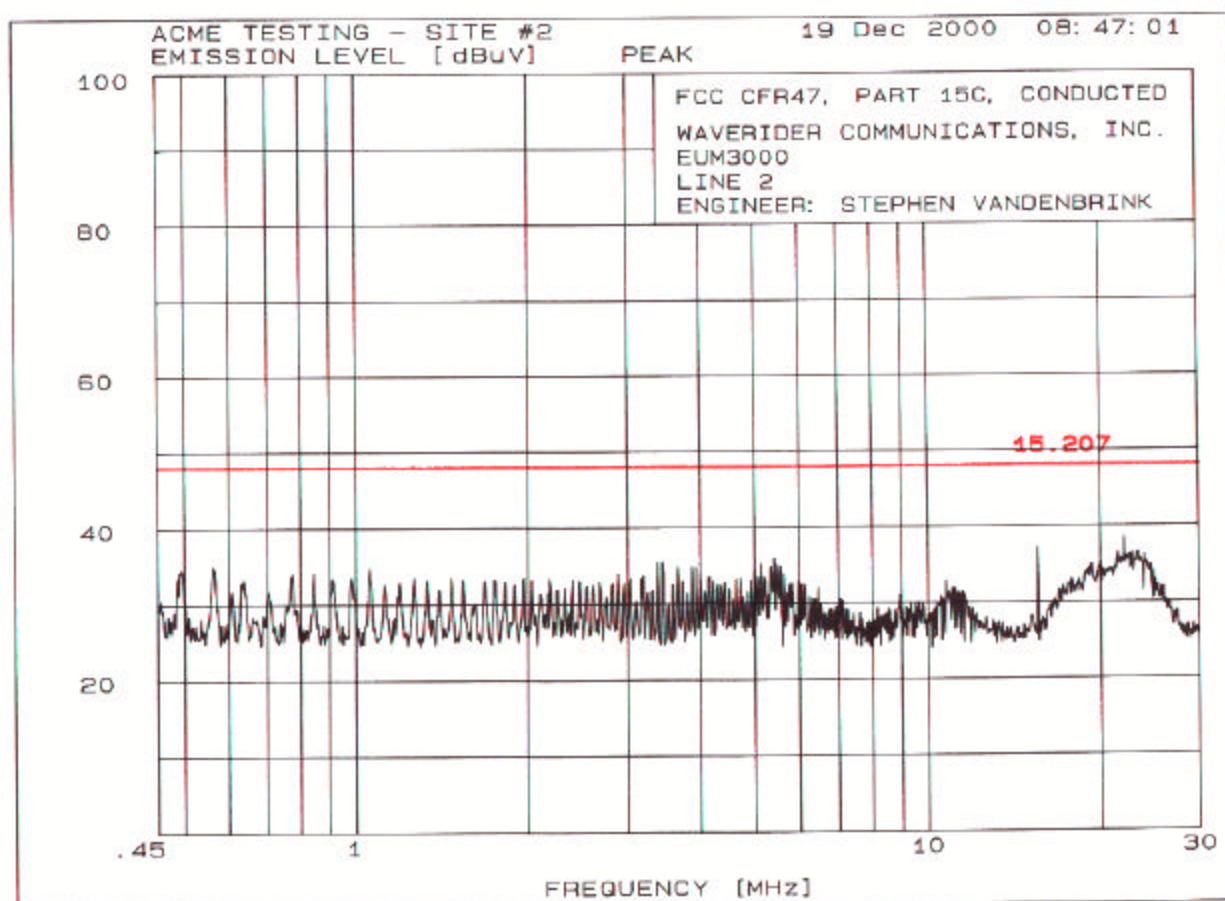
PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	3.1	37.6
2	3.233	38.5
3	3.371	39.0
4	3.443	38.8
5	3.59	37.6
6	18.91	39.6
7	21.45	46.7

LINE 2
PEAK EMISSIONS

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	3.386	35.4
2	3.443	35.5
3	5.129	35.2
4	5.416	35.9
5	15.59	37.1
6	21.99	38.4

5.5 Graphical Data





6. 6 dB Bandwidth

6.1 Regulation

15.247(a2) For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

6.2 Test Equipment

⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001

⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2648A00392, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001

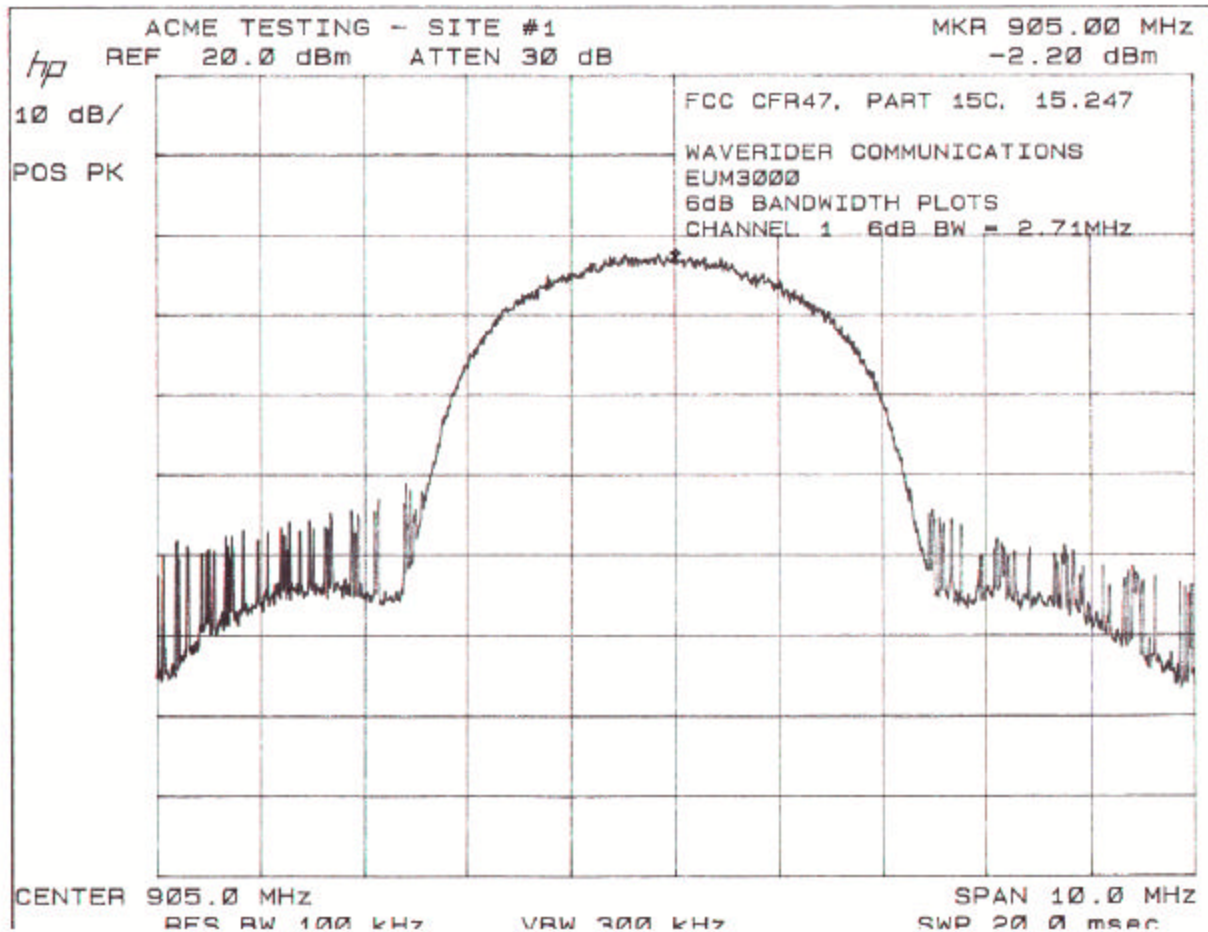
6.3 Test Procedures

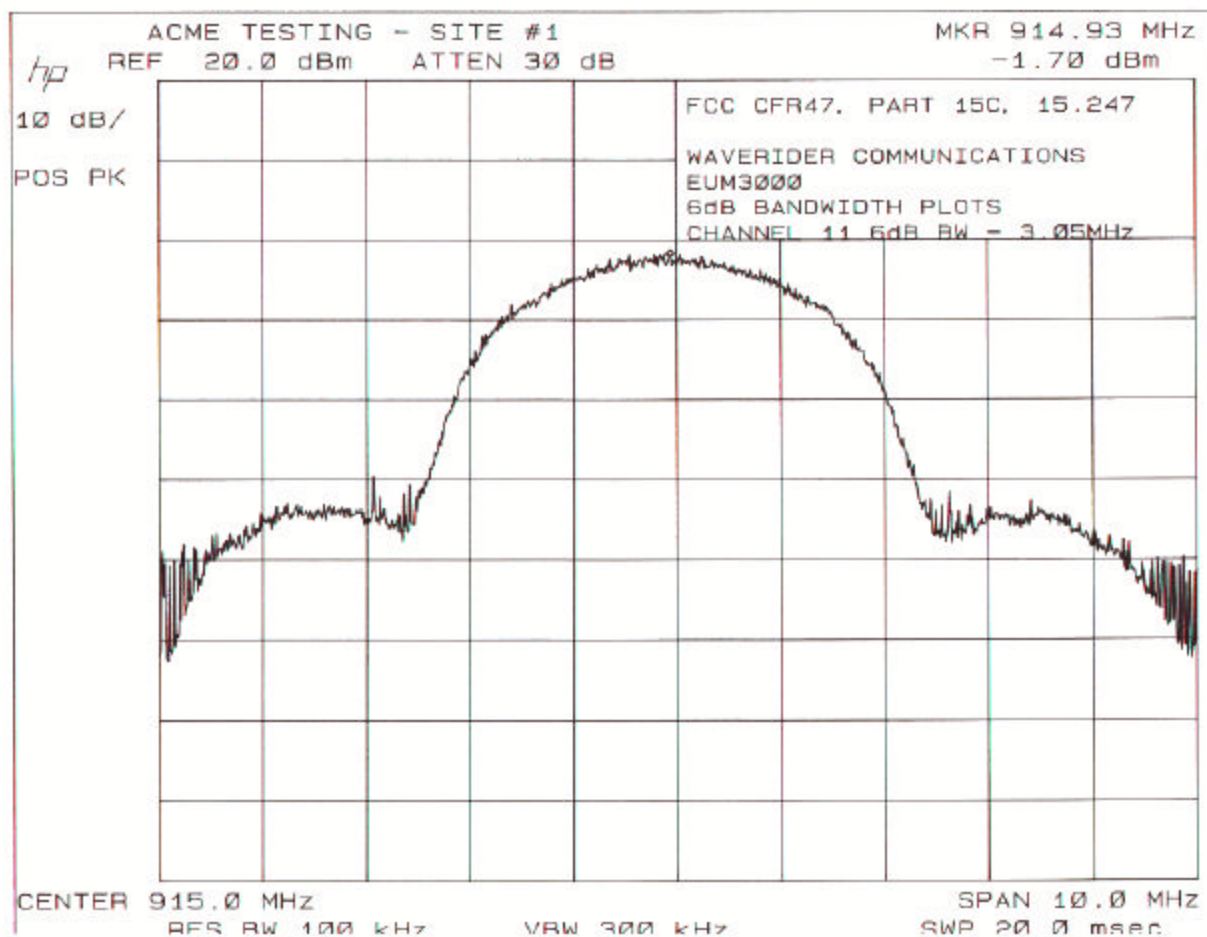
The RF output of the EUT is connected to the RF input port of the RF preselector through a 10 dB pad. The following measurements were made with a RBW = 100 kHz and VBW = 300 KHz.

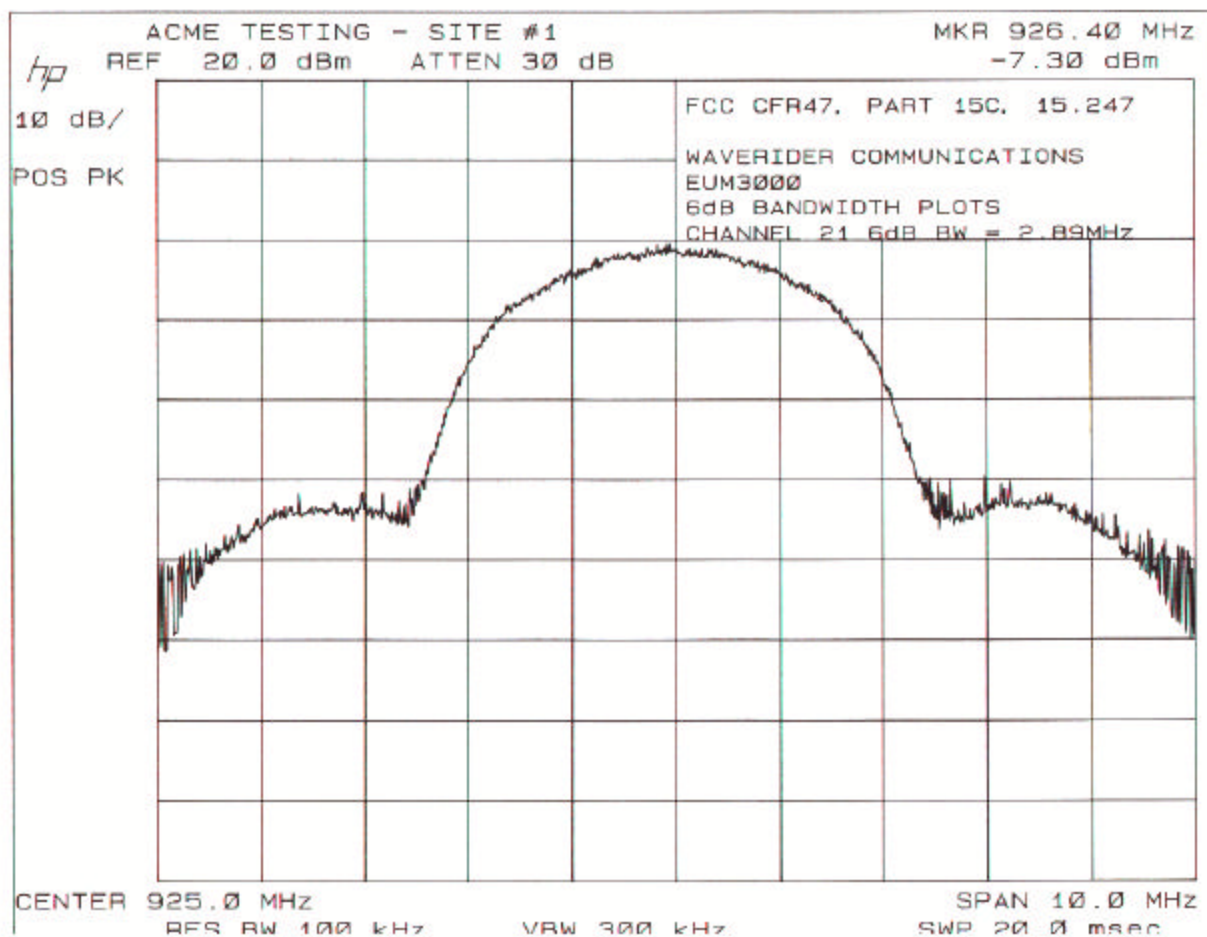
6.4 Test Results

- ⇒ The measured 6 dB bandwidth at channel 1 is 2.71 MHz.
- ⇒ The measured 6 dB bandwidth at channel 11 is 3.05 MHz.
- ⇒ The measured 6 dB bandwidth at channel 21 is 2.89 MHz.

6.5 Graphical Data







7. Power Output

7.1 Regulation

15.247(b1) The maximum peak output power of the intentional radiator shall not exceed the following:
For frequency hopping systems operating in the 2400-2483.5 MHz or 5725-5850 MHz band and for all direct sequence systems: 1 watt.

7.2 Test Equipment

⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001

⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2648A00392, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001

7.3 Test Procedures

The modulated RF output of the EUT is connected to the RF input port of the RF preselector. The following measurements were made with a RBW = 3 MHz and VBW = 3 MHz.

7.4 Test Results

Power Output @ 100 % Nominal Input Voltage

- ⇒ Measured maximum Peak Envelope Power for channel 1 was 25.6 dBm.
- ⇒ Measured maximum Peak Envelope Power for channel 11 was 25.6dBm.
- ⇒ Measured maximum Peak Envelope Power for channel 21 was 25.6 dBm.

Power Output @ 85 % Nominal Input Voltage

- ⇒ Measured maximum Peak Envelope Power for channel 1 was 25.6 dBm.
- ⇒ Measured maximum Peak Envelope Power for channel 11 was 25.6dBm.
- ⇒ Measured maximum Peak Envelope Power for channel 21 was 25.6 dBm.

Power Output @ 115 % Nominal Input Voltage

- ⇒ Measured maximum Peak Envelope Power for channel 1 was 25.6 dBm.
- ⇒ Measured maximum Peak Envelope Power for channel 11 was 25.6dBm.
- ⇒ Measured maximum Peak Envelope Power for channel 21 was 25.6 dBm.

8. Antenna gain requirements

8.1 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.

- 1 Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omni directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

8.2 Result

Power = 25.6 dBm

Maximum Antenna Gain = 6.0 dBi

System E.I.R.P < 36 dBm

9. Radio Frequency exposure

9.1 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.

9.2 Result

According to par 1.1307b(1), the EUT does not require an environmental evaluation.

1. This equipment classification is not present within table 1 of part 1.1307 and is not listed in section 1.1307b(2).
2. The EUT categorically exempt from routine environmental evaluation per section 2.1093.

Included are calculations that determine that minimum distance I from the transmitter antenna that will ensure an exposure limit at or below the guidelines given in table 1 of part 1.1310 for the general population. The formula for these calculations are taken from OET Bulletin 65, edition 97-01, August 1997; "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields".

9.3 CALCULATIONS

Per Table 1 of Section 1.1310 the limit for general population exposure at 902 MHz is 0.6 mW/cm^2

Per OET Bulletin 65, edition 97-01 the formula for calculating power density is:

$$S = P \cdot G / 4\pi R^2$$

with

$$\text{Power} = 25.6 \text{ dBm} = 363 \text{ mW}$$

For the Omni-directional Antenna

Gain of Antenna = 5.1 dBi or a numeric gain of 3.2

therefore

Solving for R gives a minimum safe distance of 12.4 cm

For the Diversity Patch Antenna

Gain of Antenna = 6.0 dBi or a numeric gain of 4.0

therefore

Solving for R gives a minimum safe distance of 13.9 cm

9.4 CONCLUSION

Page 15 of the user manual instructs the user to maintain at least a 20centimeter separation between personal and the user.

10. Conducted Spurious Emissions

10.1 Regulation

15.247 I 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)).

10.2 Test Equipment

- ⇒ Spectrum Analyzer (yellow): Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001
- ⇒ RF Preselector (yellow): Hewlett-Packard 85685A, Serial Number 2648A00392, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001
- ⇒ Quasi Peak Adapter (yellow): Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 20 November 2000, Calibration due Date: 20 November 2001

10.3 Test Procedures

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

10.4 Test Results

No out of band conducted emissions were detected within 35 dB of the carrier power.

10.5 Graphical Data

