Partial reproduction of this document is prohibited without prior written consent of Acme Testing Inc.
ACME TESTING INC., 2002 VALLEY HWY, P.O. BOX 3, ACME, WASHINGTON 98220-0003 888-226-3837.

REPORT OF MEASUREMENTS
PART 15C (15.247) - INTENTIONAL RADIATOR

DEVICE:	905 - 925 MHz 41 CHANNEL DIRECT SEQUENCE SPREAD SPECTRUM TRANSCEIVER
MODEL:	CCU3200
MANUFACTURER:	WAVERIDER COMMUNICATIONS (CANADA) INC.
ADDRESS:	6120 – 1A STREET S.W. CALGARY ALBERTA CANADA T2H 0G3

THE DATA CONTAINED IN THIS REPORT WAS
COLLECTED ON 1, 11, & 24 AUGUST 2000 AND COMPILED BY:

PAUL G. SLAVENS
CHIEF EMC ENGINEER

WORK ORDER: 23500HR

(Table of Contents Continued)

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:	WaveRider Communications (Canada) Inc.
Contact:	Ivan Rodrigues
Street Address:	6120 – 1A Street S.W.
City/Province:	Calgary Alberta
Country/Postal Code:	Canada T2H 0G3
Telephone:	403 319-2350
Fax:	403 319-2359

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
Receipt of EUT:	1 August 2000

1.4 Test Personnel

Paul G. Slavens, Chief EMC Engineer

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'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 assumes responsibility only for the accuracy and completeness of this data as it pertains to the sample tested.

___________________________ _________________________

Paul G. Slavens — Date of Issuance
Chief EMC Engineer

3. Description of Equipment and Peripherals

3.1 Equipment Under Test (EUT)

Device:	905 - 925 MHz 41 Channel Direct Sequence Spread Spectrum Transceiver
Model Number:	CCU3200
FCC ID:	OOX-WRM3200
Power:	120 V/60 Hz
Grounding:	3-Wire AC Plug
Antennas:	Yagi, Omni-directional, Circular, and Patch
Number of Channels:	41
Lowest Frequency:	905 MHz
Highest Frequency:	925 MHz

3.2 EUT Peripherals

The EUT was tested as a stand-alone device.

3.3 Description of Interface Cables for Emissions

CPU and Transmitter Unit/Antenna

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	12 m (coiled)	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).

3.4 Mode of Operation During Tests

The EUT was exercised by transmitting a modulated signal on channels 1, 21 & 41. During radiated spurious emissions testing the EUT was tested with four (Yagi, Omni-directional, Circular, and Patch) antennas.

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 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 standard connector, however the intentional radiator is only installed by professionals.

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 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

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

⇒ Quasi Peak Adapter: 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.

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

LINE 1
PEAK EMISSIONS

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	19.31	47.1
2	0.5435	45.9
3	0.4615	45.7
4	0.5019	45.2
5	0.6268	45.1
6	0.6676	45.1
7	0.7079	45.1

LINE 2
PEAK EMISSIONS

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	4.211	45.7
2	0.5458	45.6
3	0.5861	45.6
4	0.504	45.4
5	0.4595	45.3
6	0.7109	45.2
7	0.8768	45.2
8	1.246	45.2

A summary of the highest amplitude emissions is listed above. For detailed plots of all emissions from 0.45 MHz – 30 MHz, please refer to the accompanying data in the list of attachments.

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: Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

⇒ RF Preselector: 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 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 2.6 MHz.
⇒ The measured 6 dB bandwidth at channel 21 is 2.48 MHz.
⇒ The measured 6 dB bandwidth at channel 41 is 2.48 MHz.

Please see plots in the list of attachments.

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: Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

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

7.3 Test Procedures

The modulated RF output of the EUT is connected to the RF input port of the RF preselector with a 10 dB pad. The following measurements were made with a RBW = 3 MHz and VBW = 3 MHz.

7.4 Test Results

⇒ Measured maximum Peak Envelope Power for channel 1 was 26.0 dBm.
⇒ Measured maximum Peak Envelope Power for channel 21 was 24.8 dBm.
⇒ Measured maximum Peak Envelope Power for channel 41 was 26.0 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, omnidirectional 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

Maximum measured power is 26.0 dBm. The maximum gain antenna is the Yagi's gain on 9.2 dBi.

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 Radiofrequency Electromagnetic Fields".

9.3 CALCULATIONS

Per Table 1 of Section 1.1310 the limit for general population exposure at 902 - 928 MHz is 1.0 mW/cm^2

Per OET Bulletin 65, edition 97-01 the formula for calculating power density is:
$S = P*G/4\pi R^2$
with
Power = 26.0 dBm = 400 mW
Gain of Antenna = 9.2 dBi or a numeric gain of 8.3
therefore
Solving for R gives a minimum safe distance of <u>20 cm</u>

9.4 CONCLUSION

The EUT user's manual instructs the installer to maintain the at least minimum safe distance.

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: Hewlett-Packard 8566B, Serial Number 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

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

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 19 November 1999, Calibration due Date: 19 November 2000

10.3 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.

10.4 Test Results

No out of band conducted emissions were detected within 50 dB of the carrier power. Please see plots in the list of attachments.

11. Radiated Spurious Emissions

11.1 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)).

11.2 Test Equipment

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

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

⇒ Quasi Peak Adapter: 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 (20 MHz to 200 MHz): EMCO 3110, Serial Number 1115, Calibrated: 28 December 1999, Calibration due Date: 28 December 2000

⇒ Broadband Log Periodic Antenna (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

⇒ Pyramidal Horn Antenna: EMCO 3160-10, Serial Number 9708-1055, Calibration Not 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

⇒ 8 – 22GHz Preamplifier: MITEQ AFS4-35LN, Serial Number 484280, Calibrated: 3 January 2000, Calibration Due Date: 3 January 2001

11.3 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 – 22000 MHz **15.205 RESTRICTED BANDS ONLY**
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz (30 MHz – 10,000 MHz) 1 MHz (10,000 MHz – 22,000 MHz)
Receive antenna scan height	1 m – 4 m
Receive antenna polarization	Vertical/Horizontal

11.4 Test Results

WITH THE YAGI ANTENNA
Channel 1

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2714.40	52.6	74	-21.4	PK	H	100	142
2	2714.40	50.2	74	-23.8	PK	V	100	1
3	2715.59	38.6	54	-15.4	AVG	H	100	142
4	2715.59	35.7	54	-18.3	AVG	V	100	1
5	3619.27	32.5	54	-21.5	AVG	H	100	15
6	3619.27	31.4	54	-22.6	AVG	V	100	163
7	3619.60	41.8	74	-32.2	PK	H	100	15
8	3619.60	41.7	74	-32.3	PK	V	100	163
9	4524.21	46.2	74	-27.8	PK	H	130	124
10	4524.05	45.0	74	-29.0	PK	V	100	180
11	4524.89	35.0	54	-19	AVG	H	130	124
12	4524.89	33.2	54	-20.8	AVG	V	100	180

Channel 21

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2744.70	54.2	74	-19.8	PK	H	130	149
2	2744.82	55.1	74	-18.9	PK	V	100	246
3	2745.63	37.6	54	-16.4	AVG	H	130	149
4	2745.63	38.3	54	-15.7	AVG	V	100	246
5	3659.61	39.3	54	-14.7	AVG	H	130	136
6	3659.47	36.4	54	-17.6	AVG	V	100	1
7	3659.70	46.4	74	-27.6	PK	H	130	136
8	3659.70	45.4	74	-28.6	PK	V	100	1
9	4574.80	40.4	74	-33.6	PK	H	100	129
10	4574.80	45.0	74	-29.0	PK	V	100	249
11	4575.36	31.2	54	-22.8	AVG	H	100	129
12	4575.03	33.3	54	-20.7	AVG	V	100	249

Channel 41

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2774.80	58.8	74	-15.2	PK	H	100	165
2	2774.80	60.3	74	-13.7	PK	V	100	289
3	2775.89	41.3	54	-12.7	AVG	H	100	165
4	2775.89	43.4	54	-10.6	AVG	V	100	289
5	3699.78	38.5	54	-15.5	AVG	H	100	118
6	3699.71	43.9	74	-30.1	PK	V	100	353
7	3699.87	46.5	74	-27.5	PK	H	100	118
8	3699.78	33.7	54	-20.3	AVG	V	100	353
9	4624.72	40.3	74	-33.7	PK	H	100	236
10	4624.60	31.5	54	-22.5	AVG	V	100	353
11	4624.80	30.1	54	-23.9	AVG	H	100	236
12	4624.72	43.2	74	-30.8	PK	V	100	353

WITH THE OMNI-DIRECTIONAL ANTENNA

Channel 1

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2714.44	50.5	74	-23.5	PK	H	100	195
2	2714.52	50.9	74	-23.1	PK	V	130	330
3	2715.30	31.6	54	-22.4	AVG	H	100	195
4	2715.31	33.5	54	-20.5	AVG	V	130	330
5	3619.12	32.5	54	-21.5	AVG	V	130	330
6	3619.45	44.1	74	-29.9	PK	V	130	330
7	4524.37	45.7	74	-28.3	PK	H	150	190
8	4524.34	47.3	74	-26.7	PK	V	160	170
9	4524.63	33.2	54	-20.8	AVG	H	150	190
10	4524.88	34.8	54	-19.2	AVG	V	160	170

Channel 21

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2744.66	51.8	74	-22.2	PK	H	200	95
2	2744.66	57.7	74	-16.3	PK	V	160	180
3	2745.52	33.9	54	-20.1	AVG	H	200	95
4	2745.52	37.1	54	-16.9	AVG	V	160	180
5	4574.71	43.6	74	-30.4	PK	H	150	150
6	4574.58	47.0	74	-27	PK	V	150	330
7	4575.16	31.9	54	-22.1	AVG	H	150	150
8	4574.80	31.1	54	-22.9	AVG	V	150	330

Channel 41

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2774.78	55.2	74	-18.8	PK	H	115	200
2	2774.80	60.2	74	-13.8	PK	V	130	180
3	2775.69	34.1	54	-19.9	AVG	H	115	200
4	2775.78	38.4	54	-15.6	AVG	V	130	180
5	3699.66	33.1	54	-20.9	AVG	H	205	190
6	3699.59	35.3	54	-18.7	AVG	V	200	330
7	3699.80	49.8	74	-24.2	PK	H	205	190
8	3699.86	50.8	74	-23.2	PK	V	200	330
9	4624.63	45.7	74	-28.3	PK	H	205	205
10	4624.70	50.5	74	-23.5	PK	V	160	160
11	4625.26	34.5	54	-19.5	AVG	H	205	205
12	4625.26	38.0	54	-16.0	AVG	V	160	160

WITH THE CIRCULAR ANTENNA

Channel 1

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2714.45	46.4	74	-27.6	PK	H	140	0
2	2714.44	49.0	74	-25.0	PK	V	115	15
3	2715.17	30.7	54	-23.3	AVG	H	140	0
4	2715.40	32.1	54	-21.9	AVG	V	115	15

Channel 21

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2744.76	45.2	74	-28.8	PK	H	190	50
2	2744.61	49.0	74	-25.0	PK	V	130	10
3	2745.47	30.4	54	-23.6	AVG	H	190	50
4	2745.52	33.1	54	-20.9	AVG	V	130	10

Channel 41

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2774.73	48.5	74	-25.5	PK	V	130	350
2	2774.73	43.4	74	-30.6	PK	H	140	10
3	2775.81	33.7	54	-20.3	AVG	V	130	350
4	2775.45	29.4	54	-24.6	AVG	H	140	10

WITH THE PATCH ANTENNA

Channel 1

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2714.60	54.7	74	-19.3	PK	H	260	10
2	2714.47	60.2	74	-13.8	PK	V	100	352
3	2715.59	40.9	54	-13.1	AVG	H	260	10
4	2715.59	46.4	54	-7.6	AVG	V	100	352
5	3619.27	35.7	54	-18.3	AVG	H	170	330
6	3619.28	37.6	54	-16.4	AVG	V	100	314
7	3619.54	45.2	74	-28.8	PK	H	170	330
8	3619.60	45.3	74	-28.7	PK	V	100	314

Channel 21

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2744.62	52.9	74	-21.1	PK	H	160	355
2	2744.67	57.0	74	-17.0	PK	V	100	330
3	2745.55	35.0	54	-19.0	AVG	H	160	355
4	2745.59	37.6	54	-16.4	AVG	V	100	330
5	3659.48	33.1	54	-20.9	AVG	H	160	325
6	3659.56	38.3	54	-15.7	AVG	V	110	310
7	3659.66	43.7	74	-30.3	PK	H	160	325
8	3659.68	46.9	74	-27.1	PK	V	110	310

Channel 41

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)
1	2774.79	57.2	74	-16.8	PK	H	110	100
2	2774.82	61.2	74	-12.8	PK	V	110	288
3	2775.89	43.4	54	-10.6	AVG	H	110	100
4	2775.89	47.2	54	-6.8	AVG	V	110	288
5	3699.77	35.1	54	-18.9	AVG	H	110	34
6	3699.77	38.9	54	-15.1	AVG	V	110	7
7	3699.88	42.8	74	-31.2	PK	H	110	34
8	3699.88	45.1	74	-28.9	PK	V	110	7

12. Peak Power Spectral Density

12.1 Regulation

For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

12.2 Test Equipment

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

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

12.3 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 = 3 kHz, VBW = 10 kHz and Sweep Time = 666 seconds.

12.4 Test Results

Maximum peak power spectral density of channel 1 is –7.2 dBm.
Maximum peak power spectral density of channel 21 is –4.2 dBm.
Maximum peak power spectral density of channel 41 is –6.0 dBm.

Please see plots in the list of attachments.

13. Process gain requirements

13.1 Regulation

The processing gain of a direct sequence system shall be at least 10 dB. The processing gain represents the improvement to the received signal-to-noise ratio, after filtering to the information bandwidth, from the spreading/despreading function. The processing gain may be determined using one of the following methods:

(1) As measured at the demodulated output of the receiver: the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the system spreading code turned on.

(2) As measured using the CW jamming margin method: a signal generator is stepped in 50 kHz increments across the passband of the system, recording at each point the generator level required to produce the recommended Bit Error Rate (BER). This level is the jammer level. The output power of the intentional radiator is measured at the same point. The jammer to signal ratio (J/S) is then calculated, discarding the worst 20% of the J/S data points. The lowest remaining J/S ratio is used to calculate the processing gain as follows: Gp = (S/N)o + Mj + Lsys, where Gp = processing gain of the system, (S/N)o = signal-to-noise ratio required for the chosen BER, Mj = J/S ratio, and Lsys = system losses. Note that total losses in a system, including intentional radiator and receiver, should be assumed to be no more than 2 dB.

13.2 Result

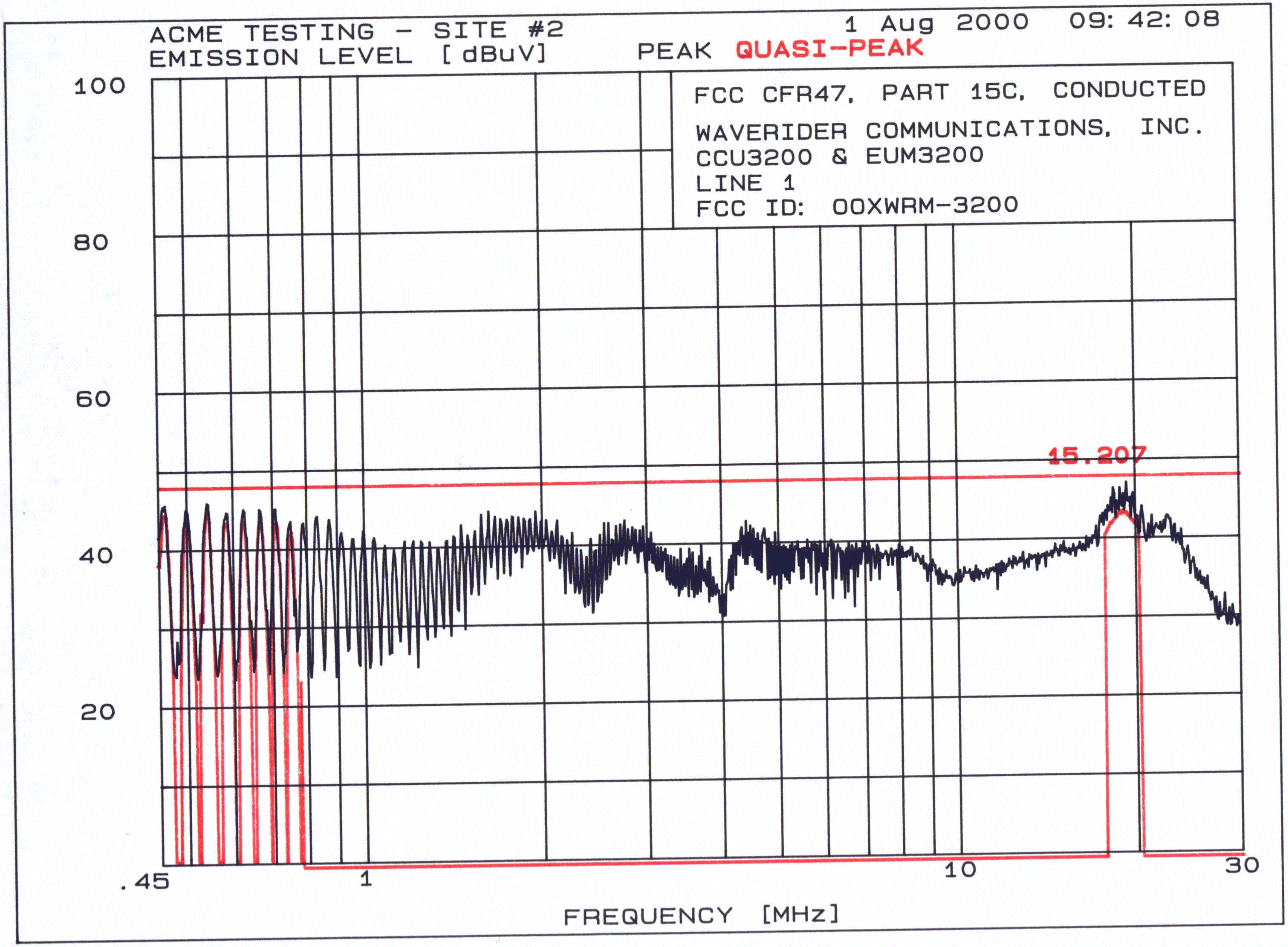
Please see the process gain measurements in the attachments. The process gain of the product exceeds 10 dB.

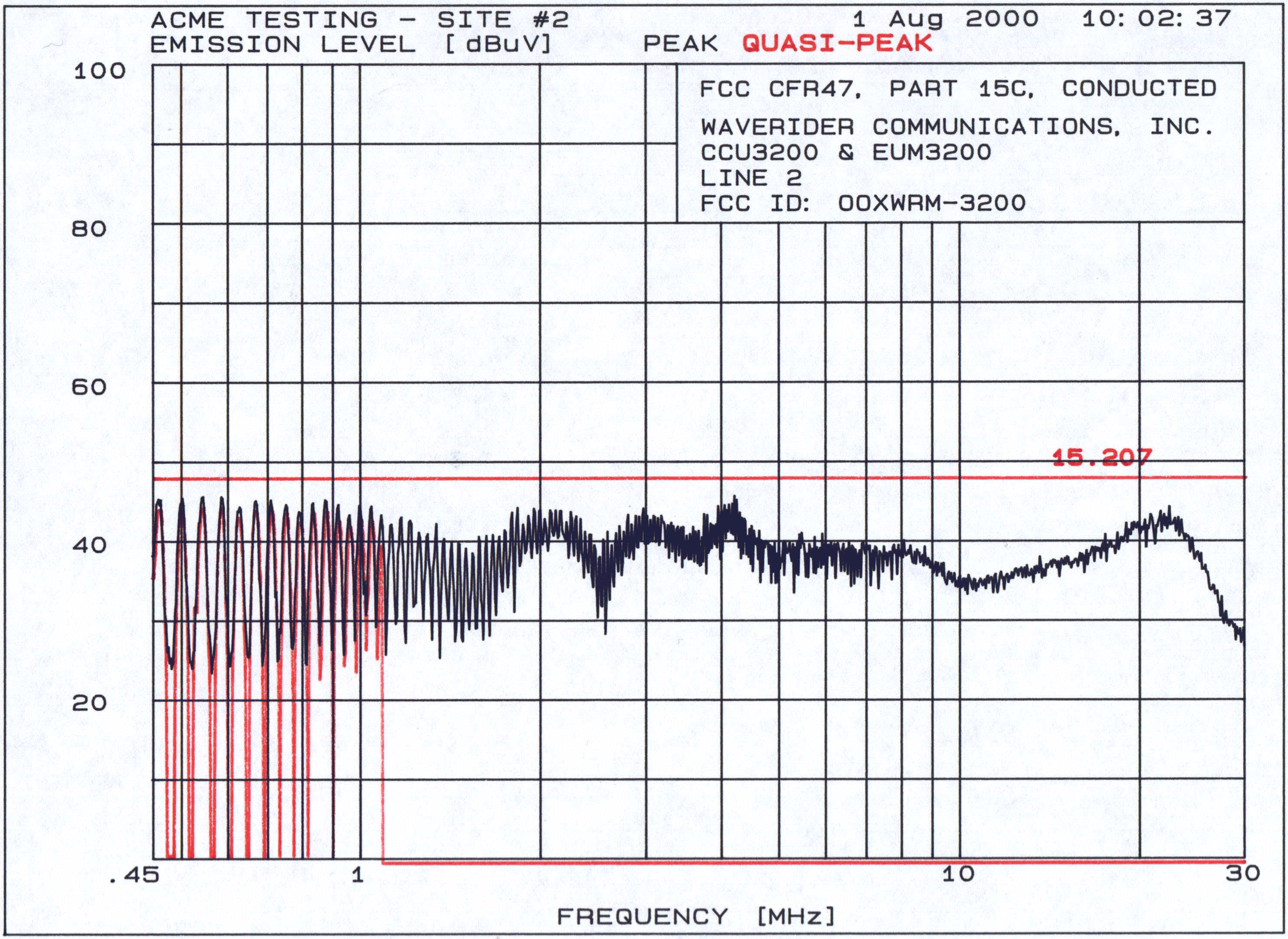
14. Miscellaneous Comments and Notes

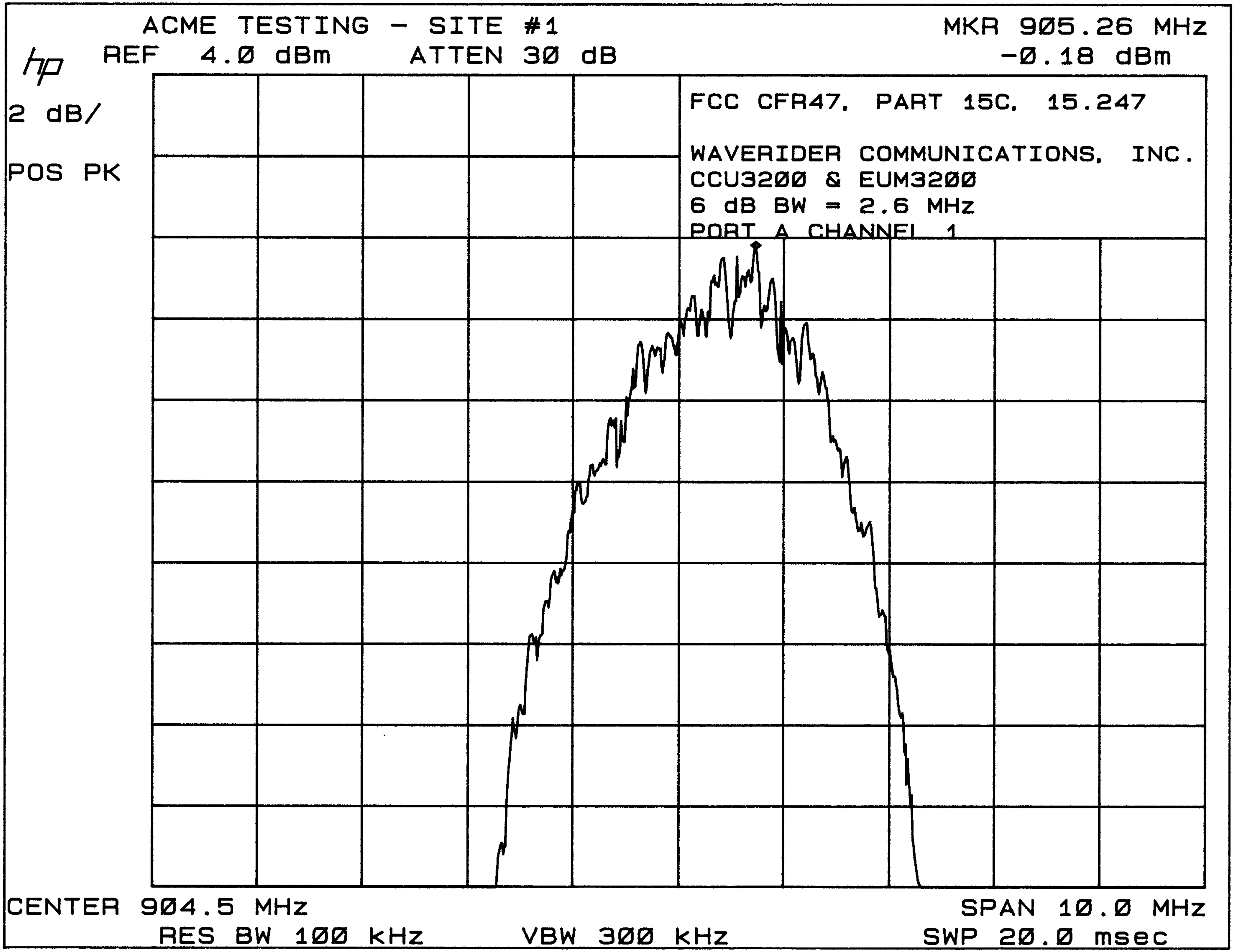
1. None.

15. List of Attachments

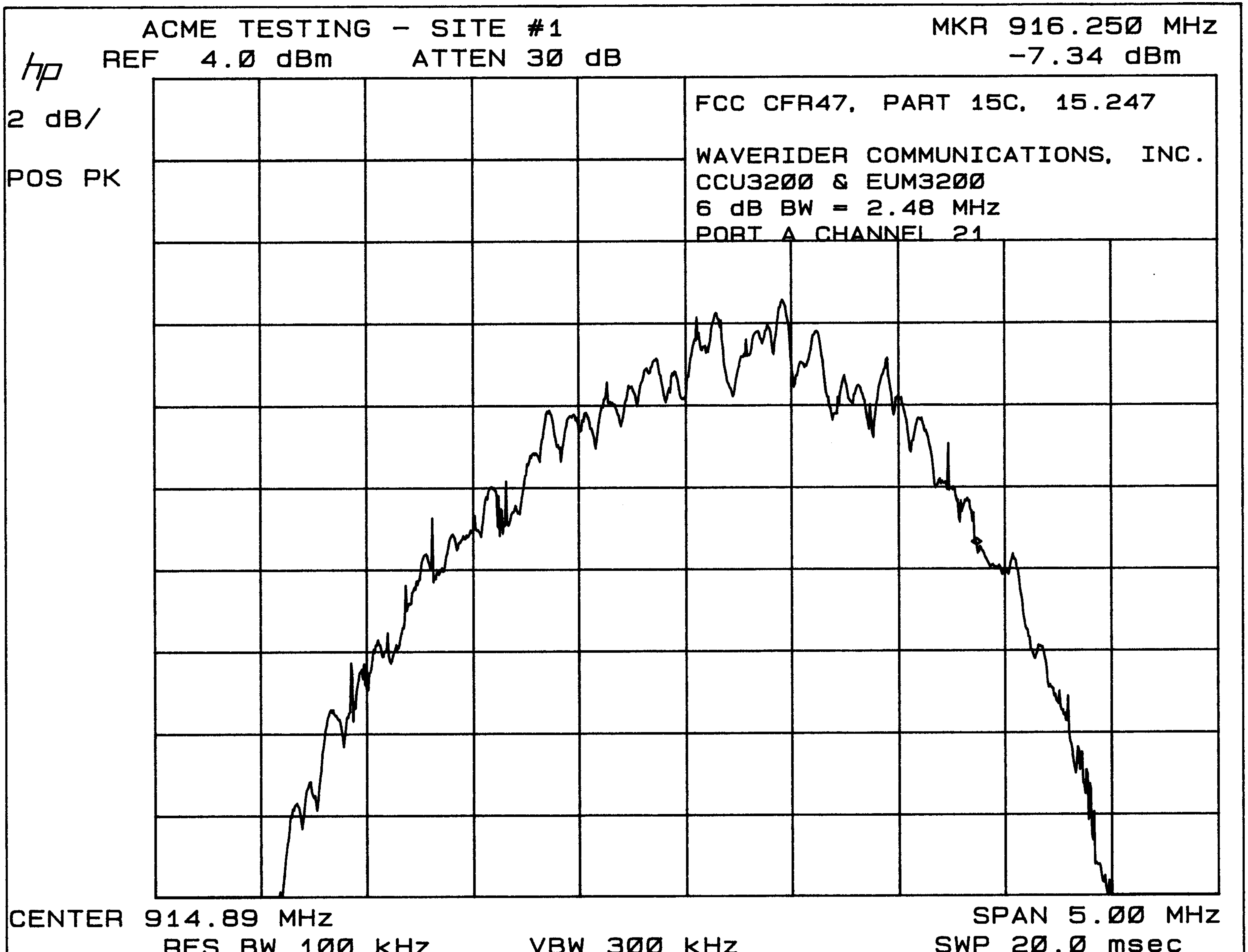
1 Conducted Emissions Plots. (2)
2 6 dB Bandwidth Plots. (3)
3 Power Output Plots. (3)
4 Conducted Spurious Emissions Plots. (6)
5 Spectral Density Plots. (3)
6 Process Gain Testing. (28)
7 Photos of test set-up. (2)


ACME TESTING - SITE #2
1 Aug 2000 09: 42: 08
EMISSION LEVEL [dBuV]
PEAK QUASI-PEAK
FCC CFR47, PART 15C, CONDUCTED
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
LINE 1
FCC ID: OOXWRM-3200
100
80
60
40
20
15.207
.45
1
10
30
FREQUENCY [MHz]

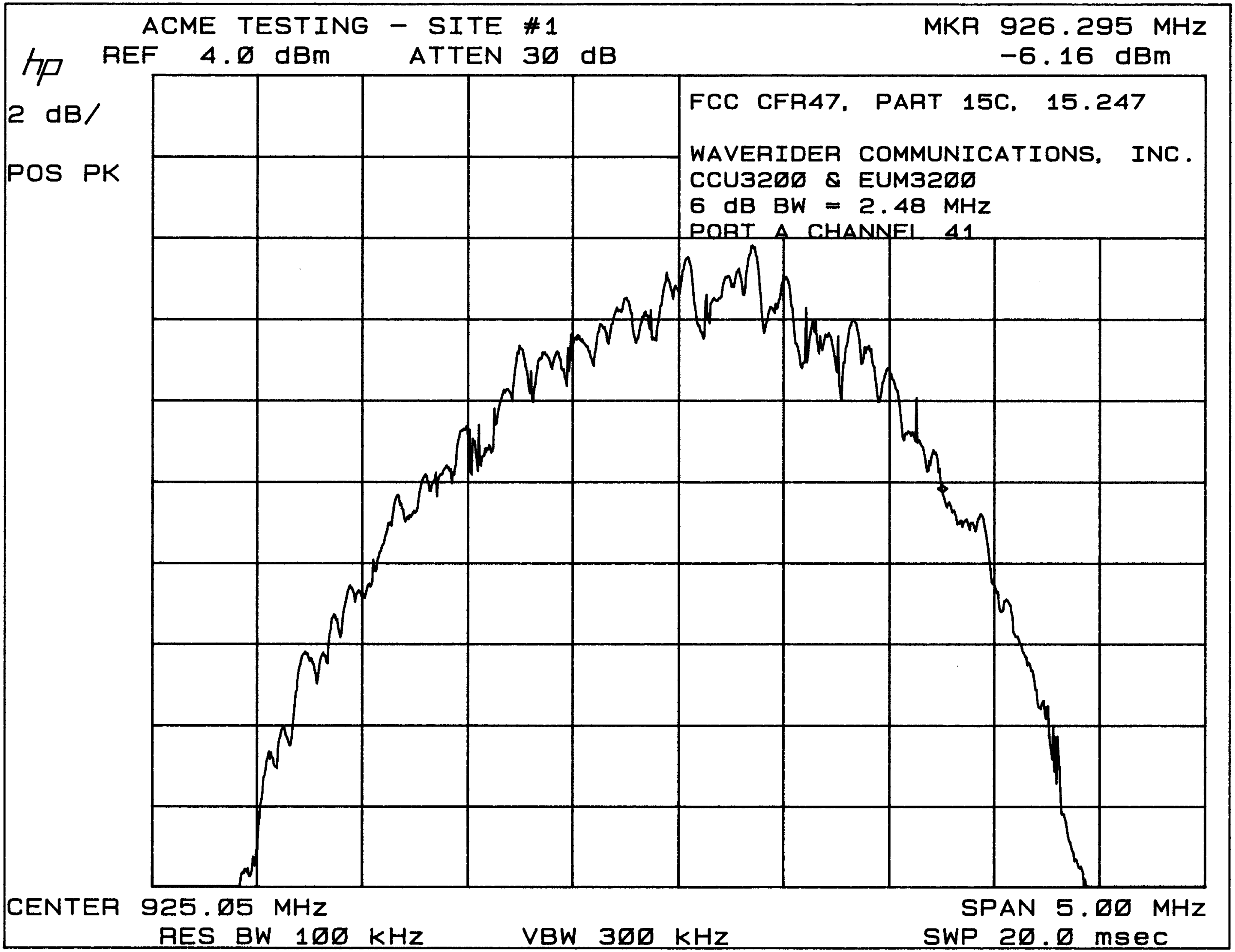

ACME TESTING - SITE #2
1 Aug 2000 10: 02: 37
EMISSION LEVEL [dBuV]
PEAK QUASI-PEAK
FCC CFR47, PART 15C, CONDUCTED
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
LINE 2
FCC ID: OOXWRM-3200
100
80
60
40
20
15.207
.45
1
10
30
FREQUENCY [MHz]



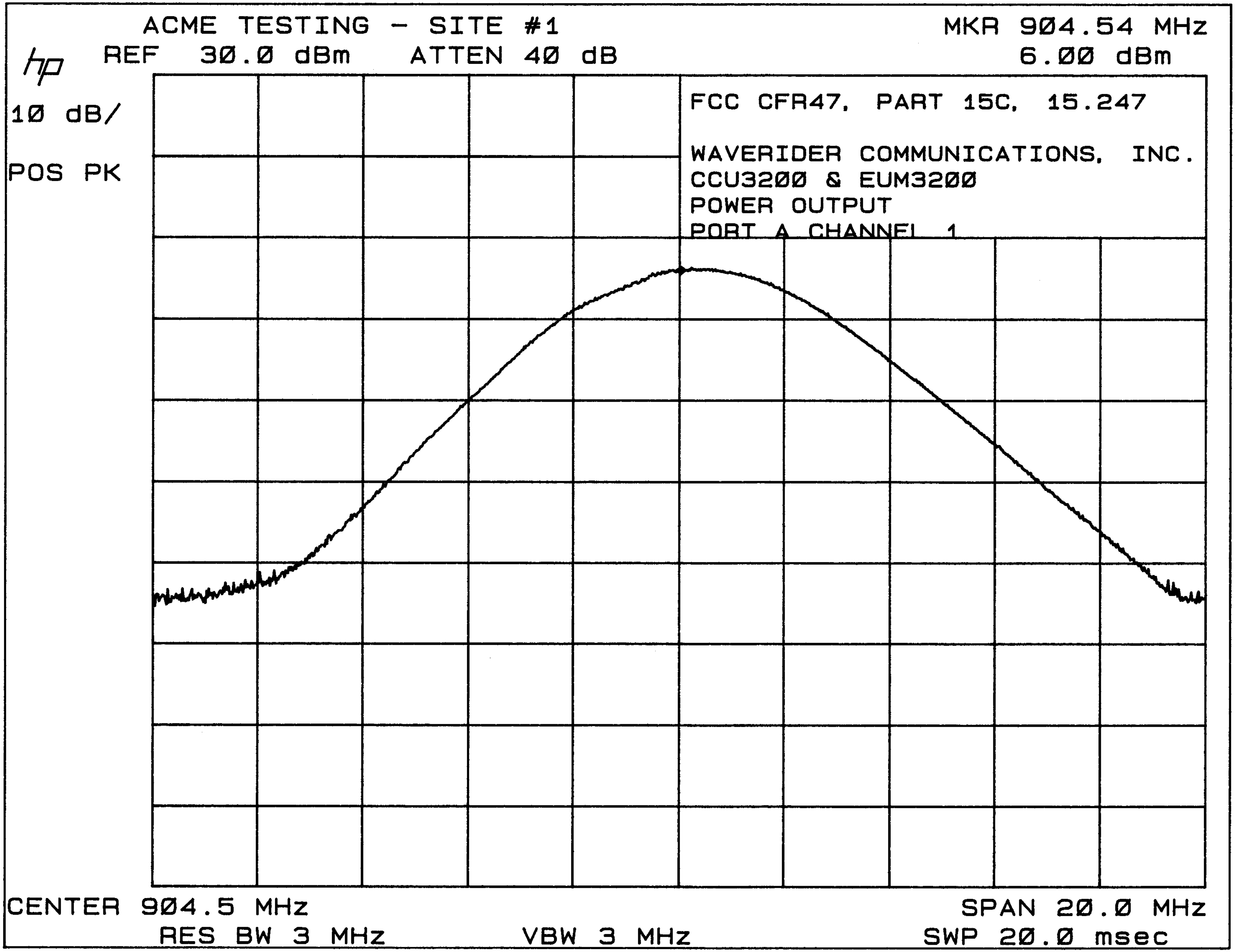
ACME TESTING - SITE #1
MKR 905.26 MHz
-0.18 dBm
REF 4.0 dBm ATTEN 30 dB
hp
2 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
6 dB BW = 2.6 MHz
PORT A CHANNEL 1
CENTER 904.5 MHz
SPAN 10.0 MHz
RES BW 100 kHz
VBW 300 kHz
SWP 20.0 msec



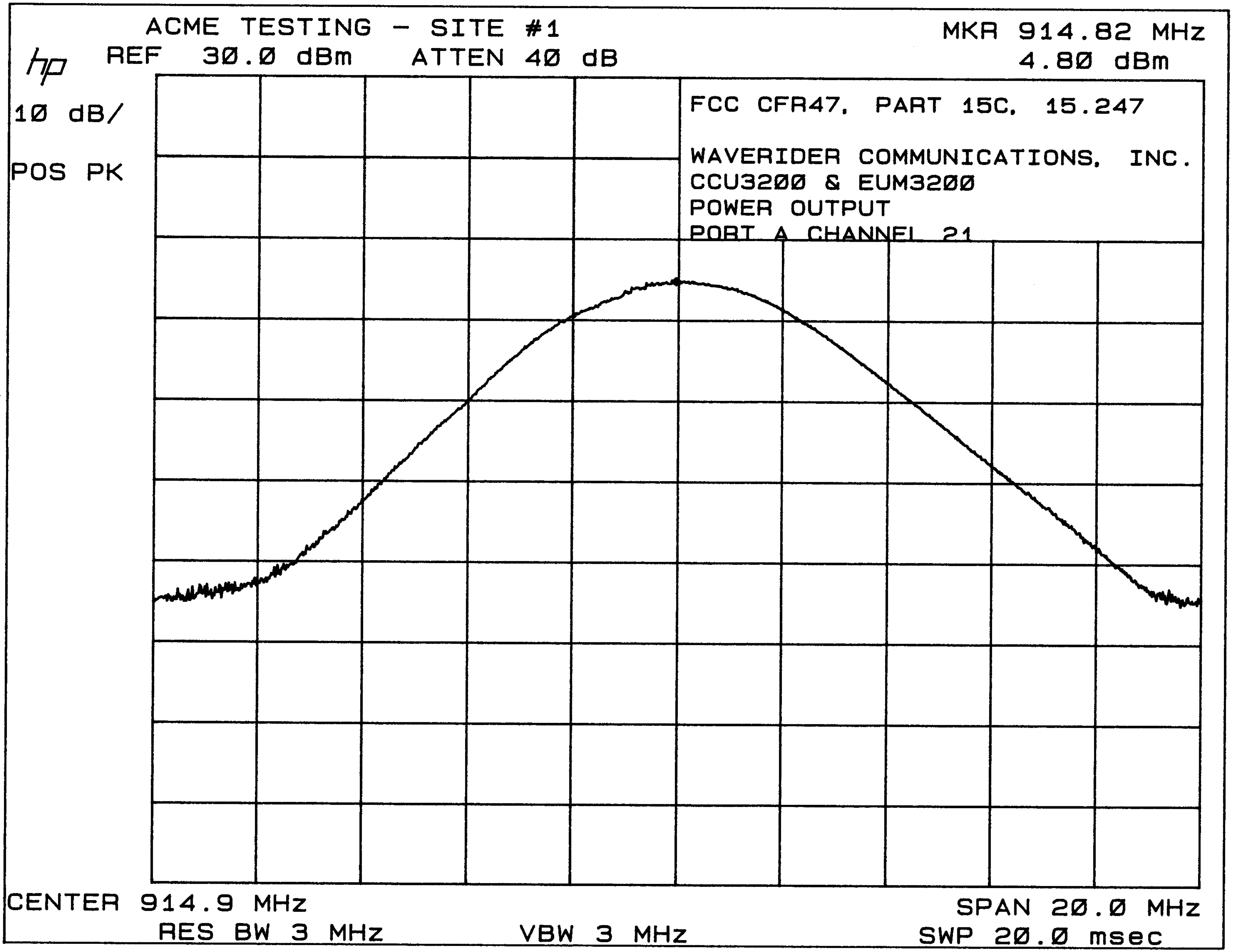
ACME TESTING - SITE #1
MKR 916.250 MHz
-7.34 dBm
hp
REF 4.0 dBm ATTEN 30 dB
2 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
6 dB BW = 2.48 MHz
PORT A CHANNEL 21
CENTER 914.89 MHz
SPAN 5.00 MHz
RES BW 100 kHz
VBW 300 kHz
SWP 20.0 msec

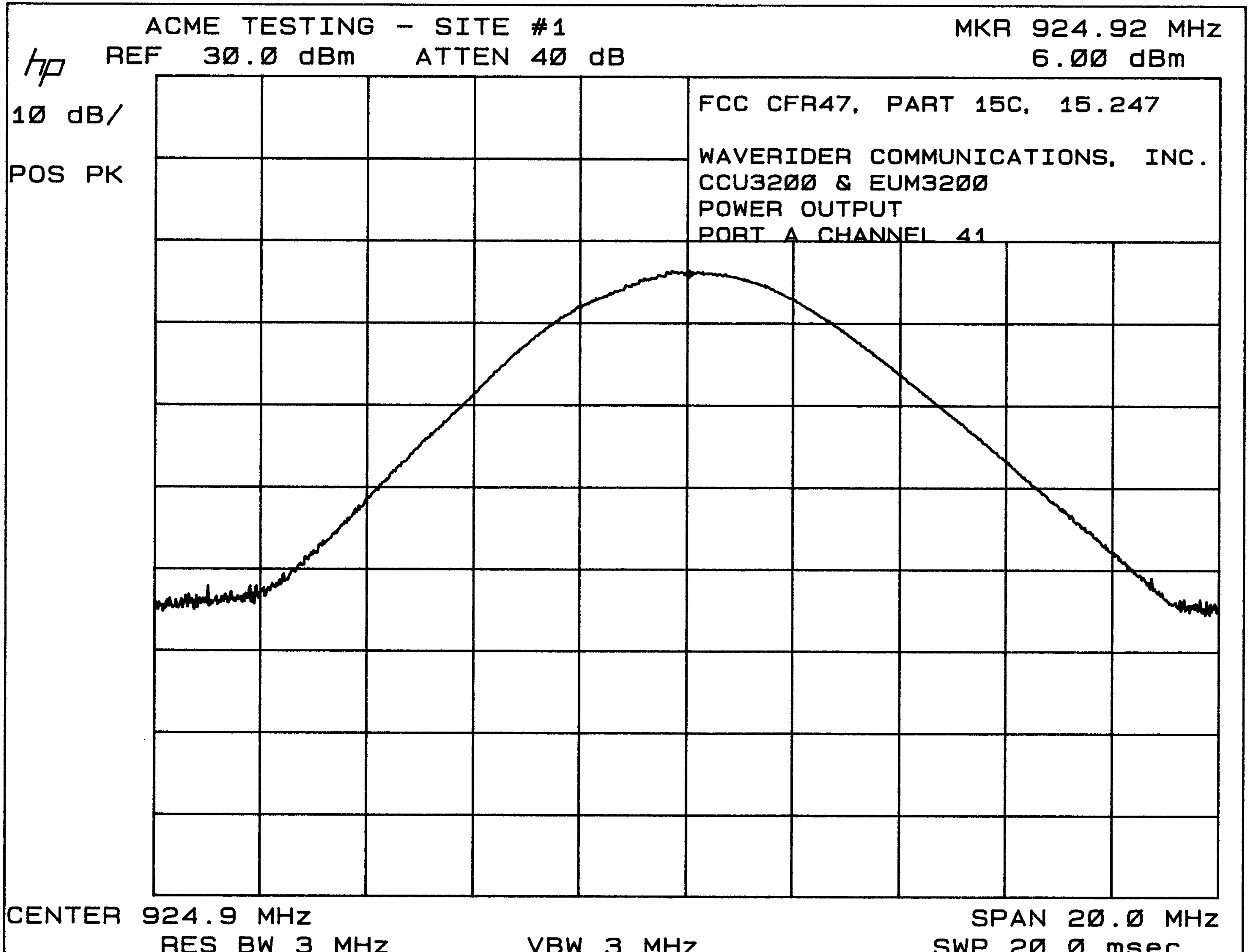


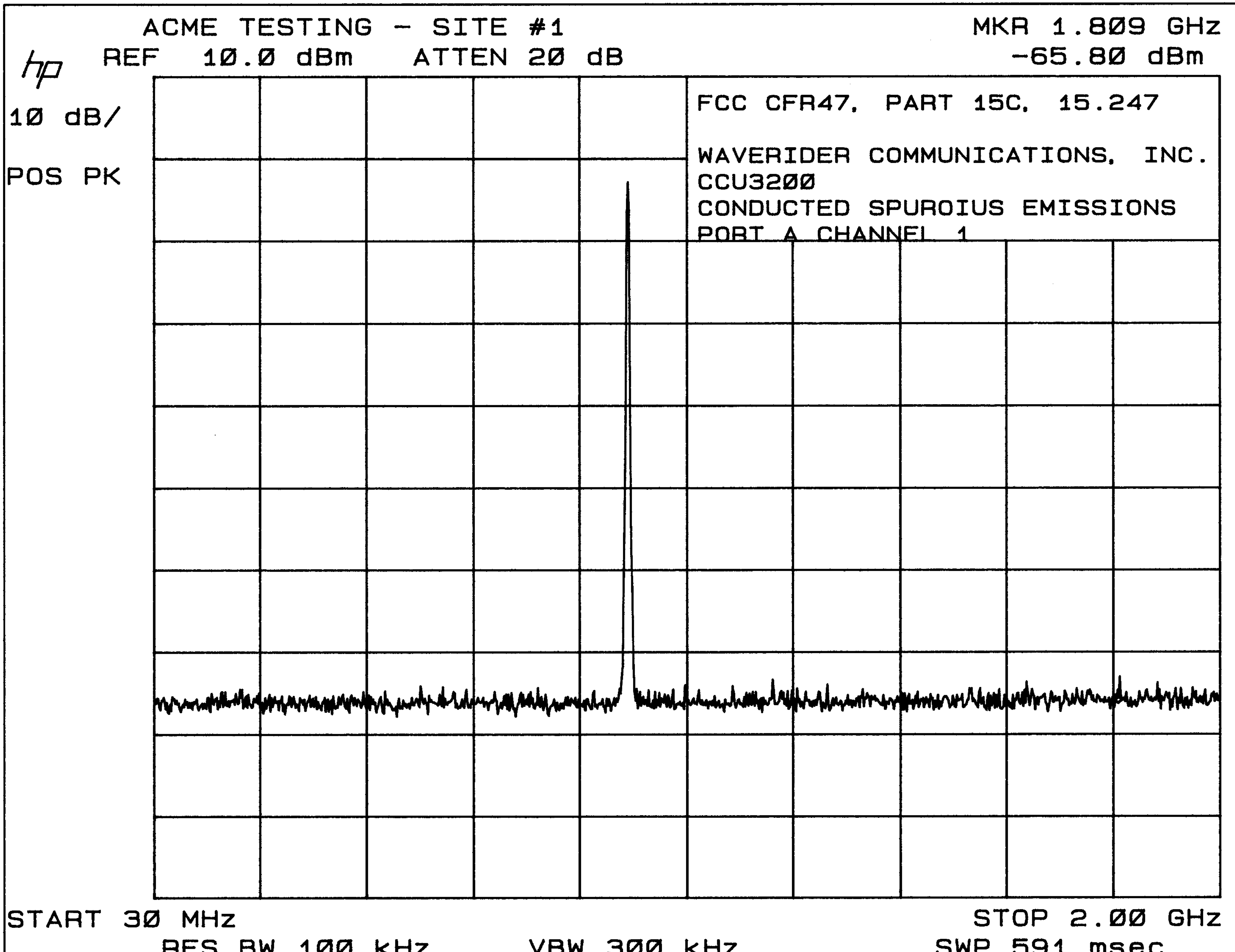
ACME TESTING - SITE #1
MKR 926.295 MHz
-6.16 dBm
hp
REF 4.0 dBm
ATTEN 30 dB
2 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
6 dB BW = 2.48 MHz
PORT A CHANNEL 41
CENTER 925.05 MHz
SPAN 5.00 MHz
RES BW 100 kHz
VBW 300 kHz
SWP 20.0 msec



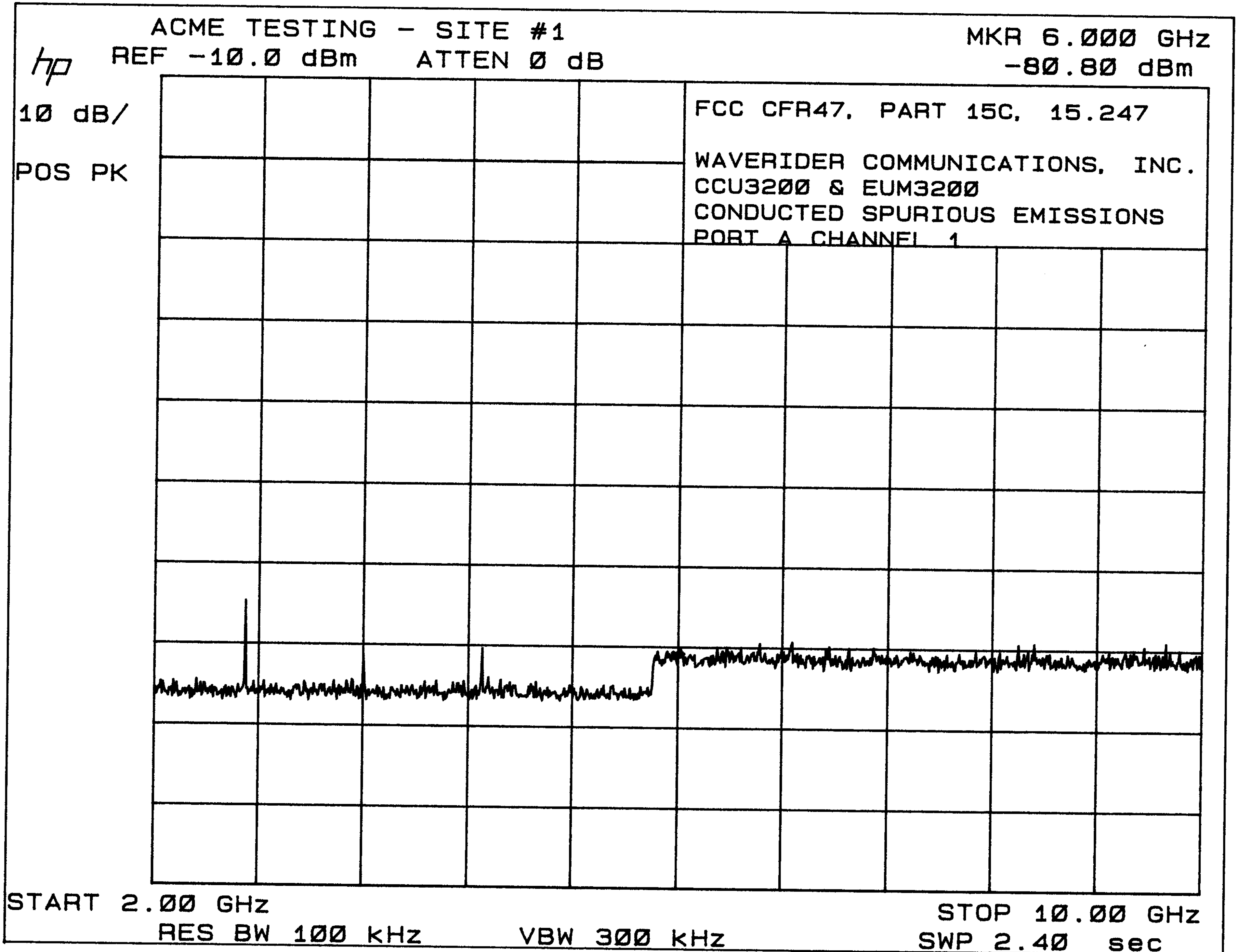
ACME TESTING - SITE #1
MKR 904.54 MHz
6.00 dBm
REF 30.0 dBm ATTEN 40 dB
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
POWER OUTPUT
PORT A CHANNEL 1
CENTER 904.5 MHz
SPAN 20.0 MHz
RES BW 3 MHz
VBW 3 MHz
SWP 20.0 msec

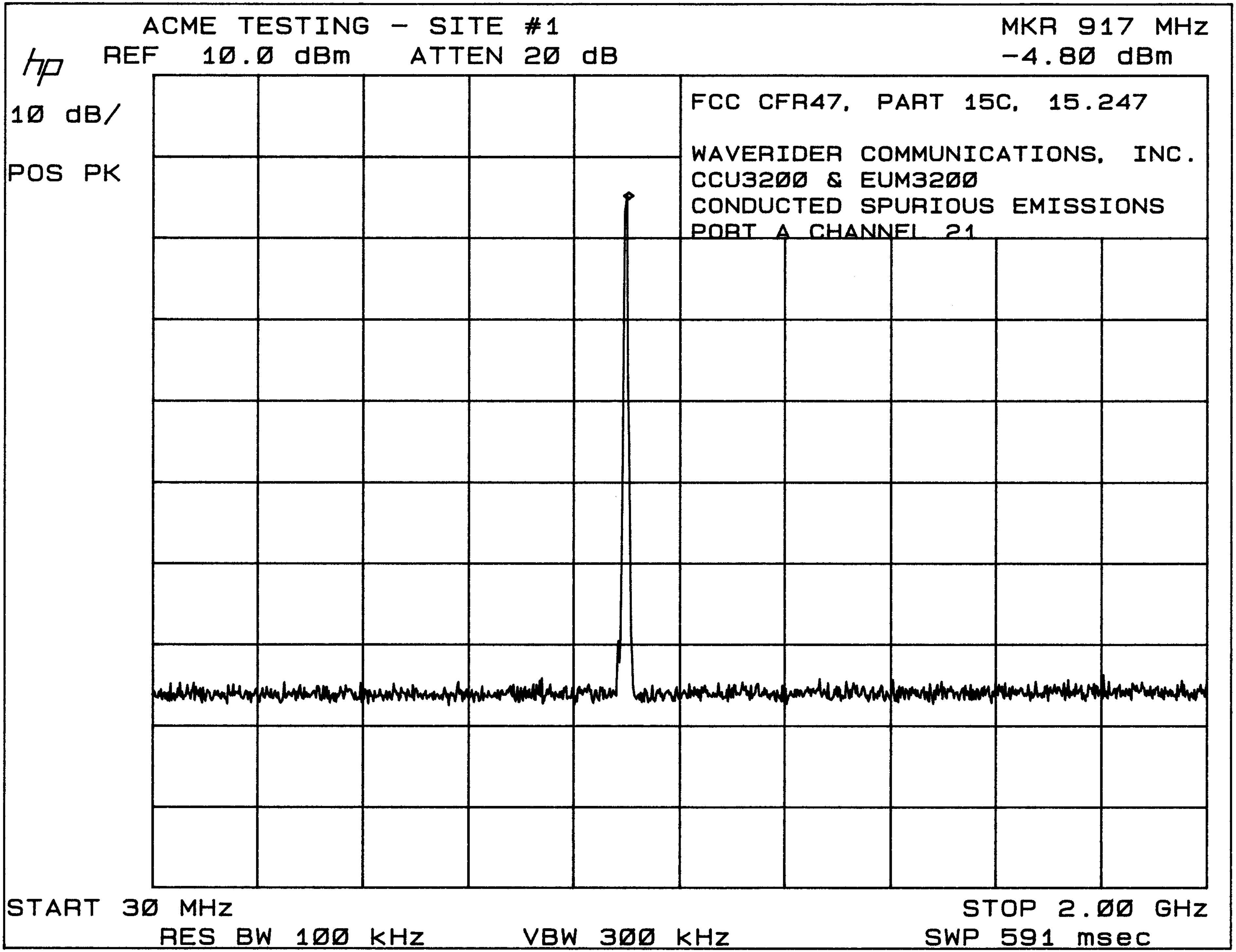

ACME TESTING - SITE #1
REF 30.0 dBm ATTEN 40 dB
MKR 914.82 MHz
4.80 dBm
hp
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
POWER OUTPUT
PORT A CHANNEL 21
CENTER 914.9 MHz
RES BW 3 MHz
VBW 3 MHz
SPAN 20.0 MHz
SWP 20.0 msec


ACME TESTING - SITE #1
MKR 924.92 MHz
REF 30.0 dBm ATTEN 40 dB
6.00 dBm
hp
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
POWER OUTPUT
PORT A CHANNEL 41
CENTER 924.9 MHz
SPAN 20.0 MHz
RES BW 3 MHz
VBW 3 MHz
SWP 20.0 msec

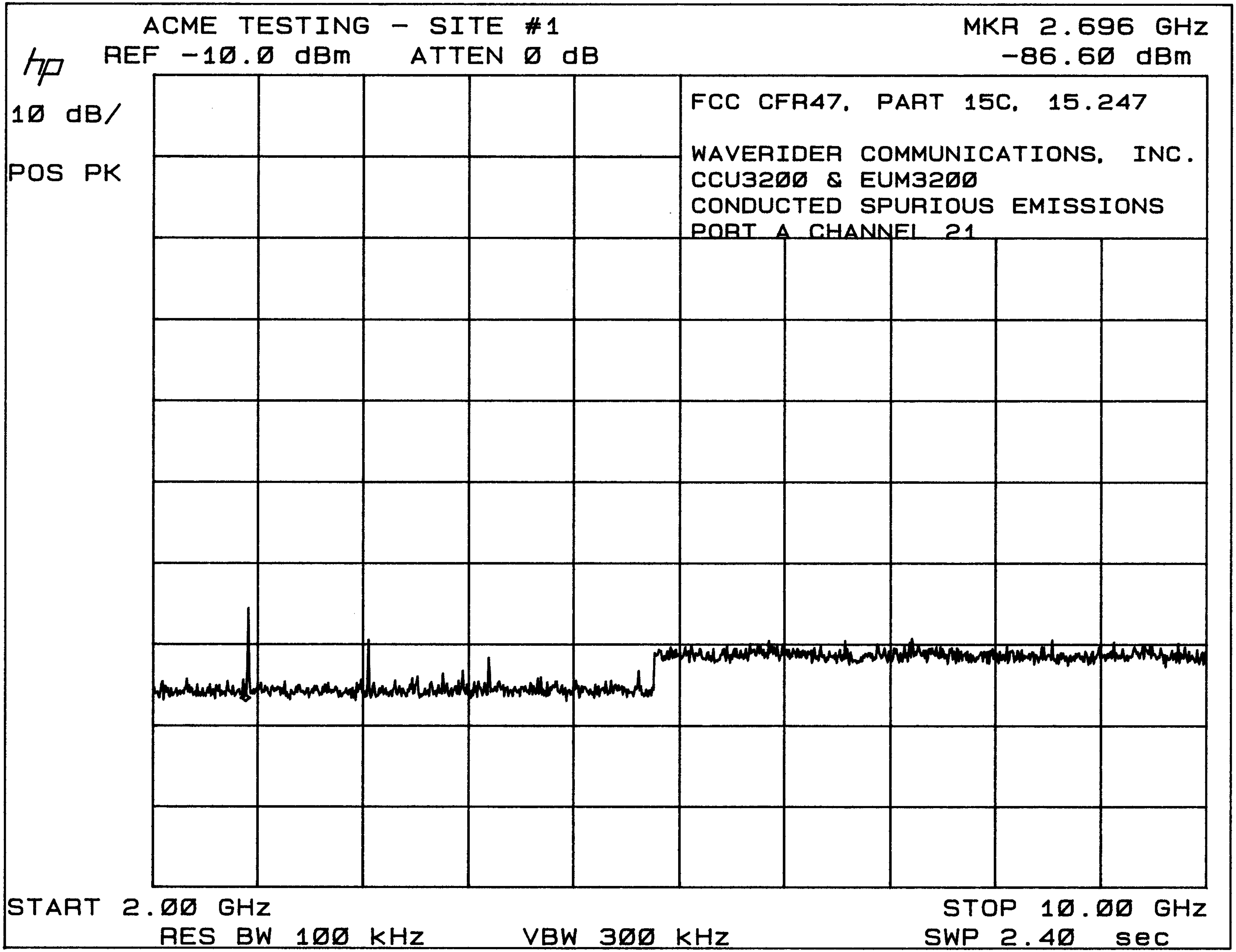


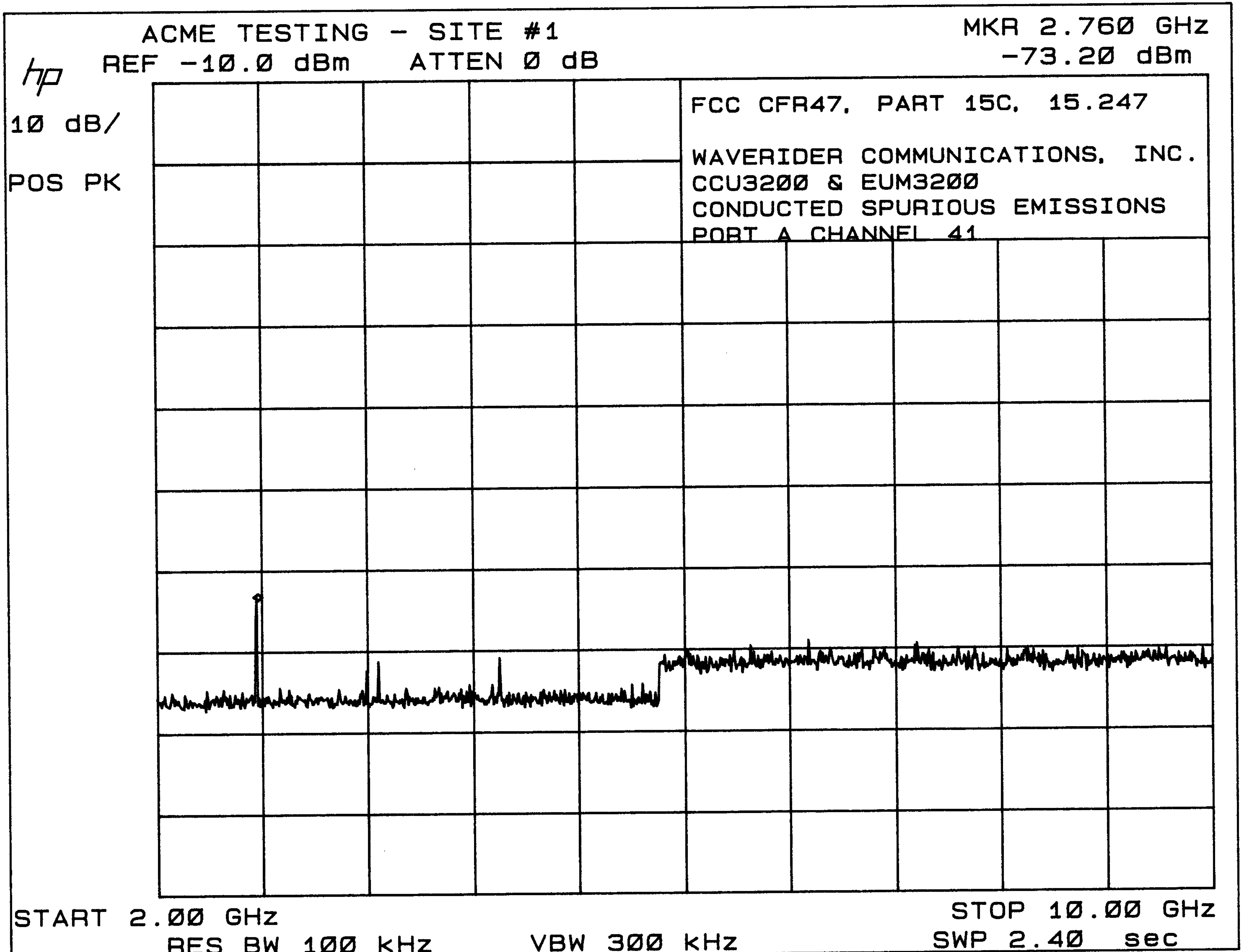
ACME TESTING - SITE #1
MKR 1.809 GHz
-65.80 dBm
REF 10.0 dBm ATTEN 20 dB
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200
CONDUCTED SPUROIUS EMISSIONS
PORT A CHANNEL 1
START 30 MHz
STOP 2.00 GHz
RES BW 100 kHz
VBW 300 kHz
SWP 591 msec


ACME TESTING - SITE #1
REF -10.0 dBm ATTEN 0 dB
MKR 6.000 GHz
-80.80 dBm
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
CONDUCTED SPURIOUS EMISSIONS
PORT A CHANNEL 1
START 2.00 GHz
STOP 10.00 GHz
RES BW 100 kHz
VBW 300 kHz
SWP 2.40 sec

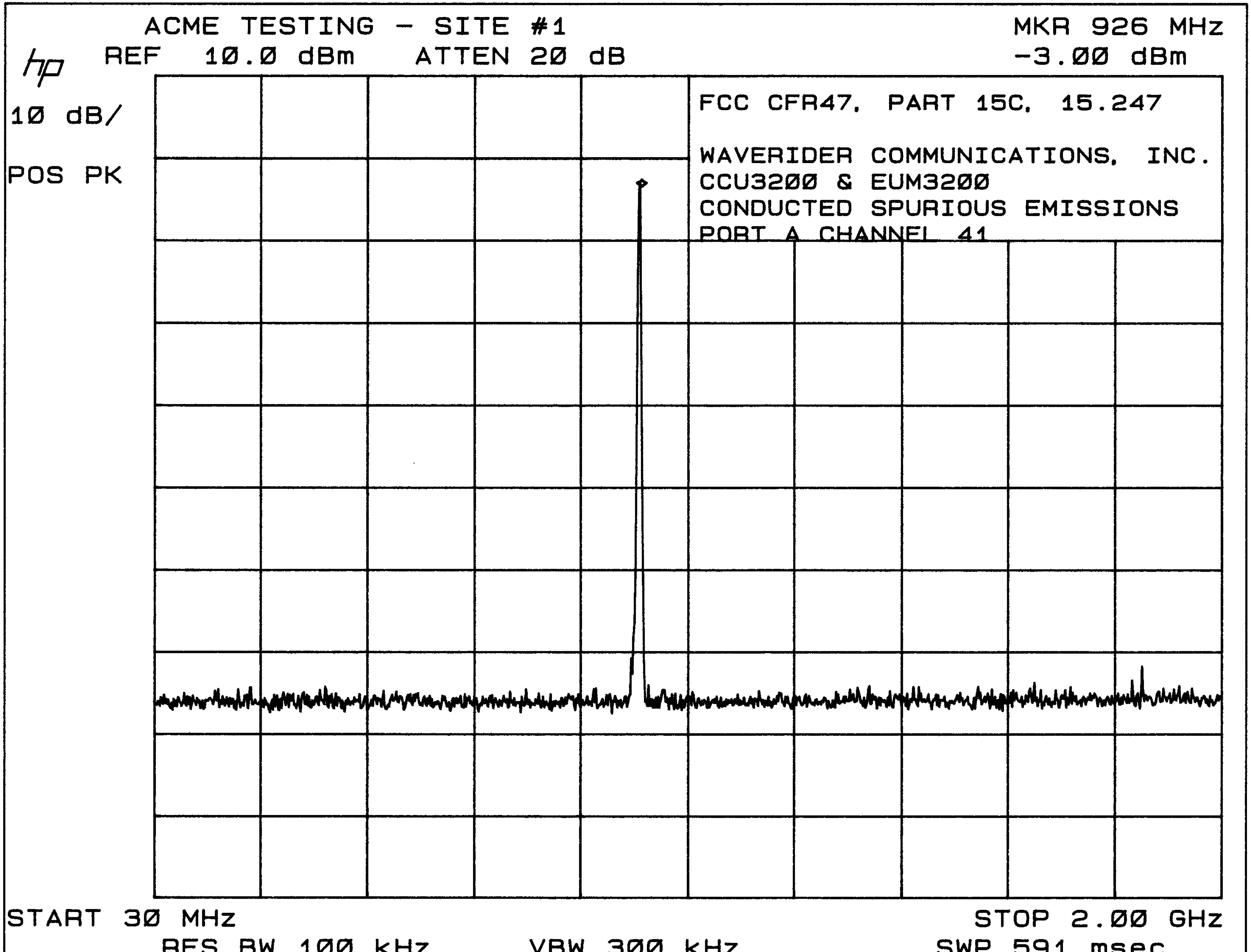


ACME TESTING - SITE #1
MKR 917 MHz
-4.80 dBm
hp
REF 10.0 dBm ATTEN 20 dB
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
CONDUCTED SPURIOUS EMISSIONS
PORT A CHANNEL 21
START 30 MHz
STOP 2.00 GHz
RES BW 100 kHz
VBW 300 kHz
SWP 591 msec

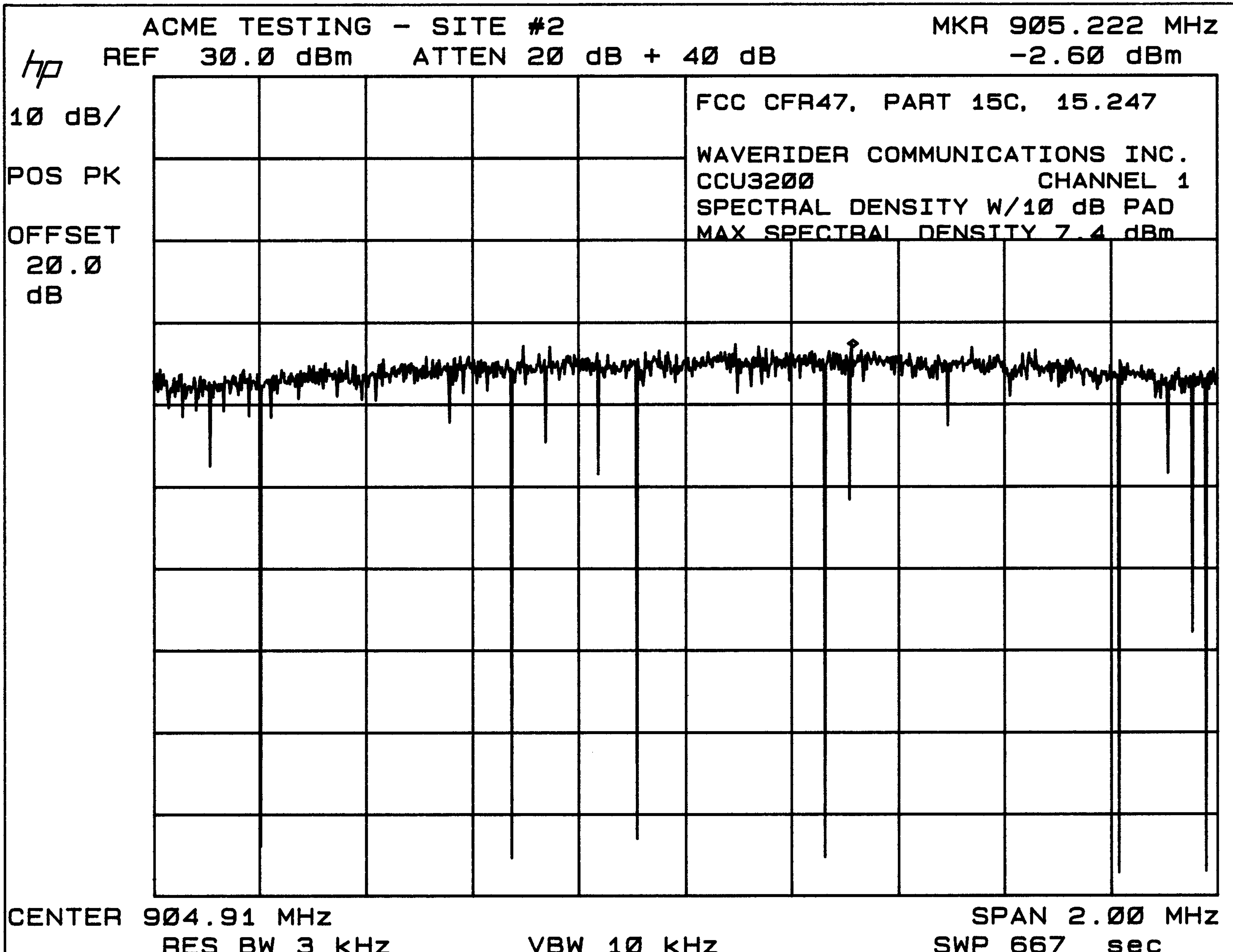

ACME TESTING - SITE #1
MKR 2.696 GHz
-86.60 dBm
hp
REF -10.0 dBm ATTEN 0 dB
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
CONDUCTED SPURIOUS EMISSIONS
PORT A CHANNEL 21
START 2.00 GHz
STOP 10.00 GHz
RES BW 100 kHz
VBW 300 kHz
SWP 2.40 sec

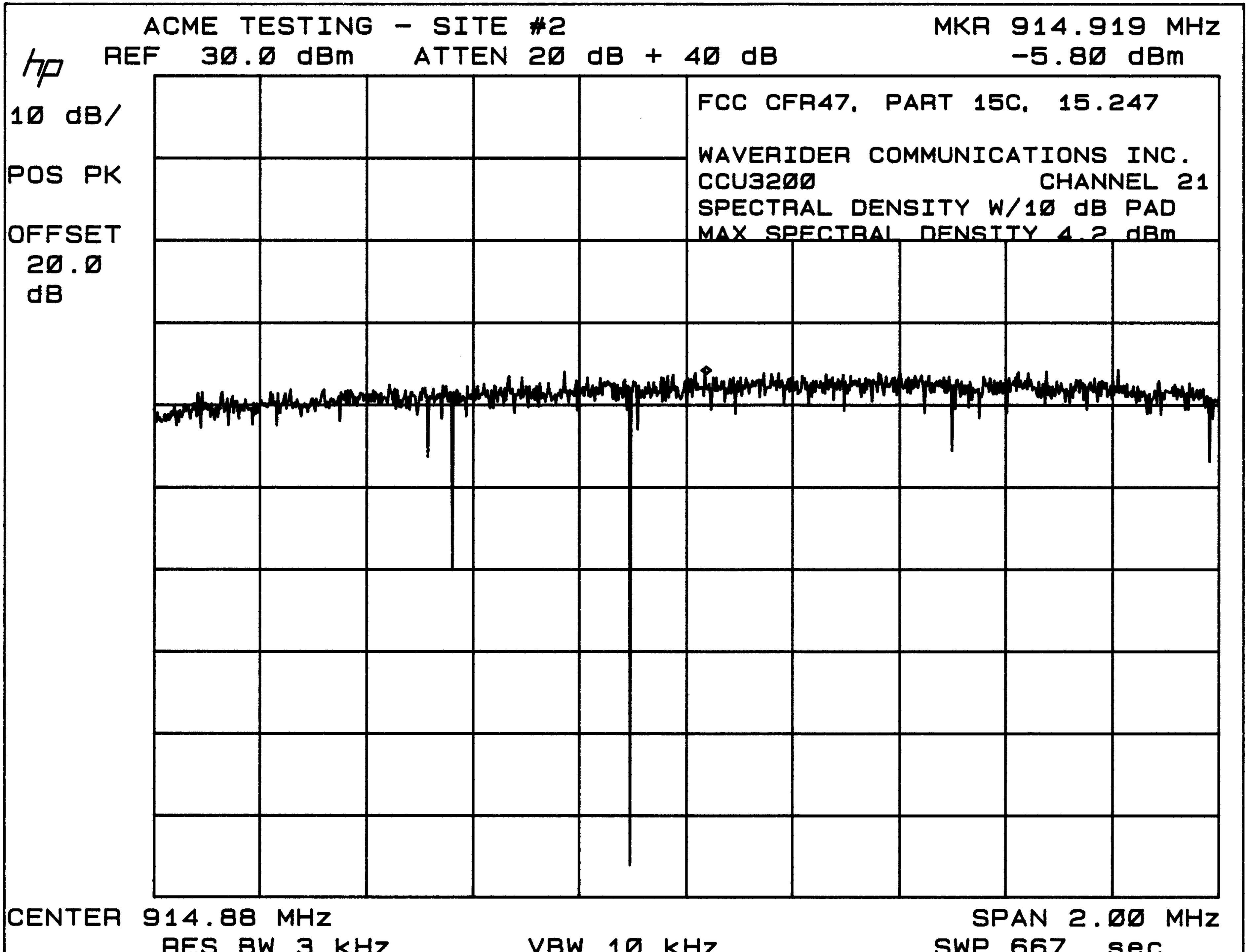


ACME TESTING - SITE #1
hp
REF -10.0 dBm ATTEN 0 dB
MKR 2.760 GHz
-73.20 dBm
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
CONDUCTED SPURIOUS EMISSIONS
PORT A CHANNEL 41
START 2.00 GHz
STOP 10.00 GHz
RES BW 100 kHz
VBW 300 kHz
SWP 2.40 sec

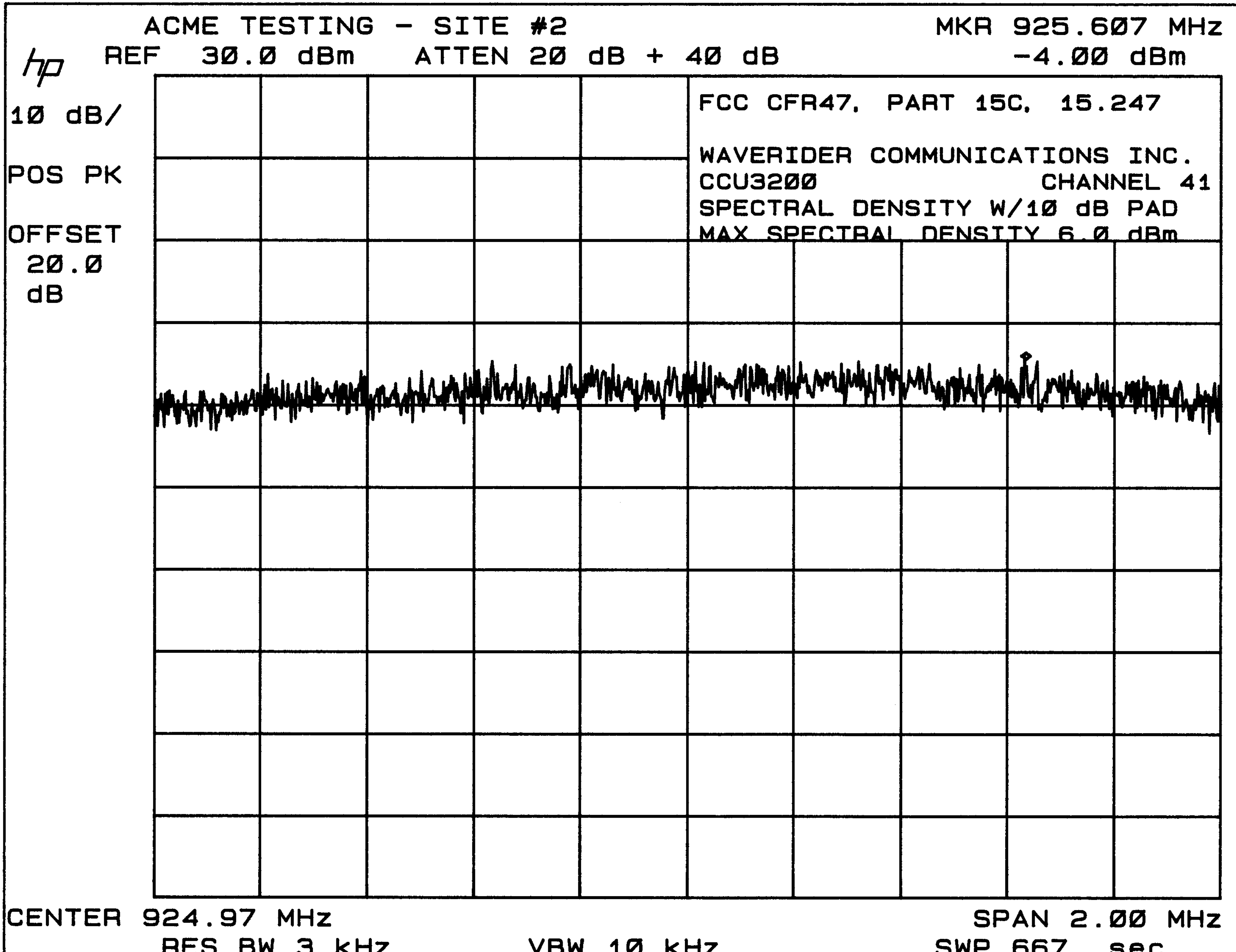


ACME TESTING - SITE #1
MKR 926 MHz
-3.00 dBm
REF 10.0 dBm ATTEN 20 dB
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS, INC.
CCU3200 & EUM3200
CONDUCTED SPURIOUS EMISSIONS
PORT A CHANNEL 41
START 30 MHz
STOP 2.00 GHz
RES BW 100 kHz
VBW 300 kHz
SWP 591 msec


ACME TESTING - SITE #2
MKR 905.222 MHz
-2.60 dBm
hp
REF 30.0 dBm ATTEN 20 dB + 40 dB
10 dB/
POS PK
OFFSET
20.0
dB
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS INC.
CCU3200
CHANNEL 1
SPECTRAL DENSITY W/10 dB PAD
MAX SPECTRAL DENSITY 7.4 dBm
CENTER 904.91 MHz
SPAN 2.00 MHz
RES BW 3 kHz
VBW 10 kHz
SWP 667 sec



ACME TESTING - SITE #2
MKR 914.919 MHz
-5.80 dBm
REF 30.0 dBm ATTEN 20 dB + 40 dB
10 dB/
POS PK
OFFSET
20.0
dB
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS INC.
CCU3200 CHANNEL 21
SPECTRAL DENSITY W/10 dB PAD
MAX SPECTRAL DENSITY 4.2 dBm
CENTER 914.88 MHz
SPAN 2.00 MHz
RES BW 3 kHz
VBW 10 kHz
SWP 667 sec


ACME TESTING - SITE #2
MKR 925.607 MHz
REF 30.0 dBm ATTEN 20 dB + 40 dB
-4.00 dBm
hp
10 dB/
POS PK
OFFSET
20.0
dB
FCC CFR47, PART 15C, 15.247
WAVERIDER COMMUNICATIONS INC.
CCU3200 CHANNEL 41
SPECTRAL DENSITY W/10 dB PAD
MAX SPECTRAL DENSITY 6.0 dBm
CENTER 924.97 MHz
SPAN 2.00 MHz
RES BW 3 kHz
VBW 10 kHz
SWP 667 sec

Waverider Communications

WRM3200

Test Report: FCC 15.247(e) Jamming Margin Test

WaveRider Communications Inc. 6120 1A Street SW Calgary, Alberta Canada, 2H 0G3 Tel: 403-319-2350		Draft Oct. 3, 2000. Prepared by: Russ Fretenburg Approved by:

Table of Contents

1.0 Scope

This report presents the test procedure, test configuration and test data associated with a FCC Part 15.247 (e) Jamming Margin test for the indirect measurement of processing gain on the Waverider Communications WRM3200 Radio.

2.0 Applicable Reference Documents.

1. "Operation within the bands 902-928 MHz, 2400-2483.5, and 5725-5850 MHz" ***Title 47 Part 15 section 247 (e) Code of Federal Regulations***. **(47 CFR 15.247).**

2. "Report and Order: Amendment of Parts 2 and 15 of the Commission's Rules Regarding Spread Spectrum Transmitters. Appendix C: 'Guidance on Measurements for Direct Sequence Spread Spectrum Systems" ***FCC 97-114. ET Docket No. 96-8, RM-8435, RM-8608, RM-8609.***

3. "HFA3860B Direct Sequence Spread Spectrum Baseband Processor" ***Harris Corporation Semiconductor Sector Preliminary Data Sheet***, Melbourne FL, June 1997.

4. " M-ary Orthogonal Keying BER Curve",

3.0 Test Background and Procedure.

According to FCC regulations [1], a direct sequence spread spectrum system must have a processing gain, G_p of at least 10 dB. Compliance to this requirement can be shown by demonstrating a relative bit-error-rate (BER) performance improvement (and corresponding signal to noise ratio per symbol improvement of at least 10 dB) between the case where spread spectrum processes (coding, modulation) are engaged relative to the processes being bypassed. In some practical systems, the spread spectrum processing cannot simply be bypassed. In these cases, the processing gain can be indirectly measured by a jamming margin test [2]. In accordance with the new NPRM 99-231, if the vendor has a system with less than 10 chips per symbol, the CW jamming results must be supported by a theoretical explanation of the system processing gain.

4.0 Theoretical calculations

The processing gain is related to the jamming margin as follows [2]:

$$G_p = BER_{REFERENCE} \leftrightarrow \left(\frac{S}{N}\right)_{output} + \left(\frac{J}{S}\right) + L_{system}$$

Where $BER_{REFERENCE}$ is the reference bit error ratio with its corresponding, theoretical output signal to noise ratio per symbol, $(S/N)_{output}$, (J/S) is the jamming margin (jamming signal power relative to desired signal power), and L_{system} are the system implementation losses.

The maximum allowed total system implementation loss is 2 dB.

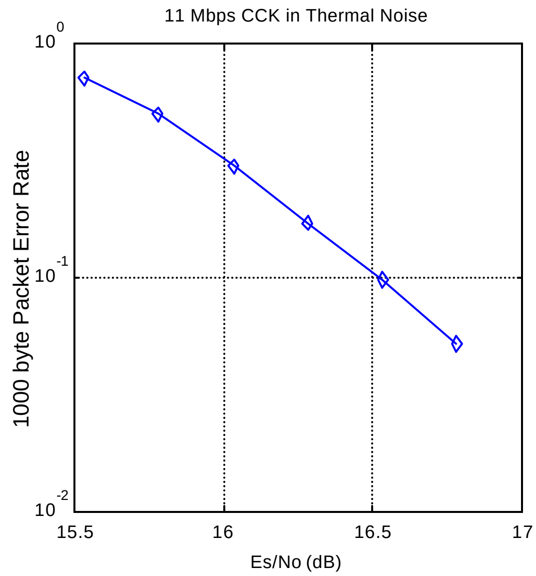
The HFA3860 direct sequence spread spectrum baseband processor uses CCK modulation which is a form of M-ary Orthogonal Keying. The BER performance curve is given by [4]:

" The probability of error for generalized M-ary Orthogonal signaling using coherent demodulation is given by:

$$P_e = 1 - P_{c1} = 1 - \frac{1}{\sqrt{2p}} \int_{-\frac{S_{01}}{N_0}}^{\infty} \left[2(1 - Q\left\{ z + \sqrt{2\,\frac{E_b}{h}} \right\}) \right]^{\frac{M}{2}-1} \exp\left\{ -\frac{z^2}{2} \right\} dz$$

This integral cannot be solved in closed form, and numerical integration must be used. There are error rate extensions for differential decoding and descrambling that are also to be accounted for. This is done in a MATHCAD environment and is displayed in graphical format below.

4.01 1000 byte PER vs. Es/No



The reference PER is specified as 8% . The corresponding Es/No (signal to noise ratio per symbol) is 16.4 dB. The Es/No required to achieve the desired PER with maximum system implementation losses is 18.4 dB. The minimum processing gain is again, 10 dB, therefore:

$$G_p = \left(\frac{E_s}{N_o}\right)_{output} + \left(\frac{J}{S}\right) + L_{system} = 16.4dB + 2.0dB + \left(\frac{J}{S}\right) \geq 10dB$$

$$G_p = 18.4dB + \left(\frac{J}{S}\right) \geq 10dB$$

The minimum jammer to signal ratio is as follows:

$$\left(\frac{J}{S}\right) \geq -8.4dB$$

For the case of the HFA3860, the bit rates are 1, 2, 5.5, and 11 Mbps. The corresponding symbol rates are 1, 1, 1.375, and 1.375 MSps. The chip rate is always 11 MCps, so the ratio of chip rate to symbol rate is 11:1 for the 1 and 2 Mbps rates and 8:1 for the 5.5 and

11 Mbps rates. Since the symbol rate to bit rate is less than 10 for the higher rates, we supply the theoretical processing gain calculation for these cases where spread spectrum processing gain with embedded coding gain is utilized. This is reasonable in that they cannot be separated in the demodulation process. If a separable FEC coding scheme were used, we would not be comfortable making this assertion.
As can be seen from the curve of figure 1, the Es/N0 is 16.4 dB at the PER of 8%. This PER can be related to a BER of 1e-5 on 1000 byte packets. With 8 bits per symbol, the Eb/N0 is then 7.4 dB or 9 dB less than the Es/N0. It is well known that the Eb/N0 of BPSK is 9.6 dB for 1e-5 BER, so therefore the coding gain of CCK over BPSK is 2.2 dB. We add this to the processing gain of 9 dB to get 11.2 dB overall processing gain for the CW jammer test.

Taking the calculations above, if the $\left(\frac{J}{S}\right) \geq -8.4dB$ then the equipment passes the CW jamming test.

Note:

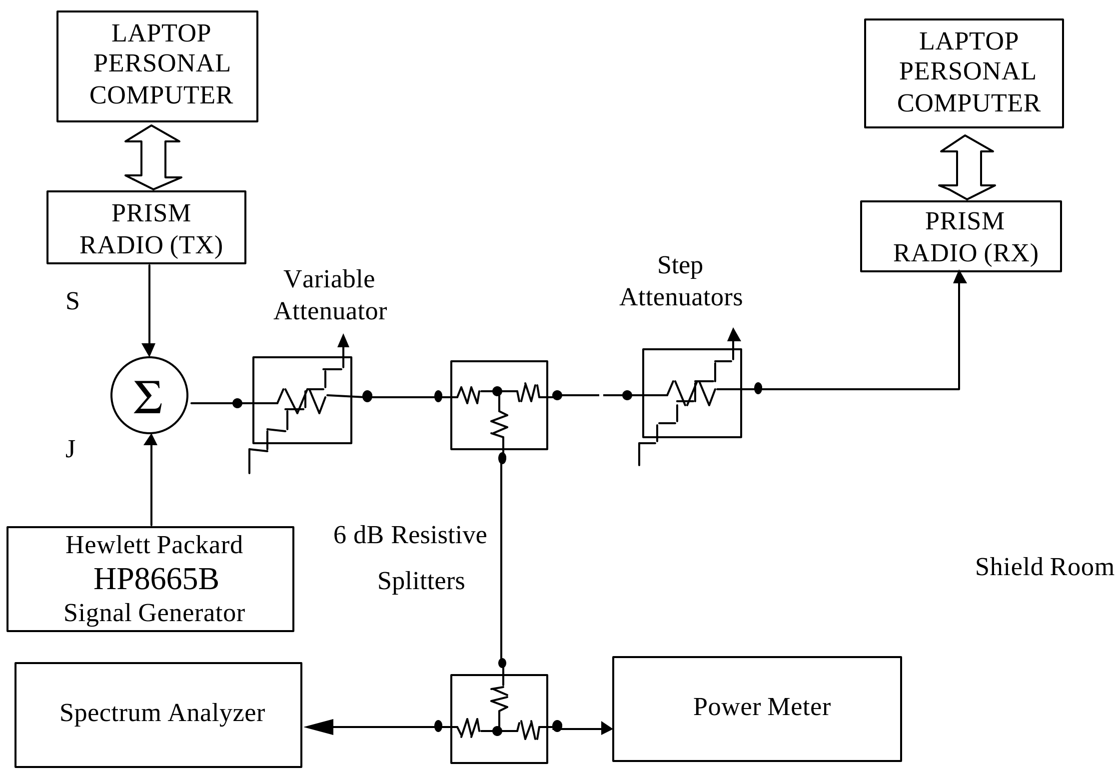
In this product (WRM3200) the chip rate and data rates are ¼ of the standard system described above. This results in the following rates:

Chip Rate: 2.75 MCps
Data Rates: 250 Kbps, 500 Kbps, 1.375 Mbps, 2.75 Mbps.
Symbol Rates: 250 KSps, 250 KSps, 343.75 KSps, 343.75 KSps.

Therefore the ratio of chip rate to symbol rate is still 11 for the two lower data rates and 8 for the two higher data rates and the above theory still applies.

5.0 Test Configuration: CW Jamming Margin (15.247) (e)

5.01 Basic Test Block Diagram



5.02 Test Procedure

Set up the simplex link shown. Perform all independent instrumentation calibrations prior to this procedure. Set operating power levels using fixed and variable attenuators in system to meet the following objectives:

1. Signal Power at receiver approximately -60 dBm (above thermal sensitivity such that thermal noise does not cause bit errors).

2. Signal Power at power meter (using high sensitivity probe) between -20 and -40 dBm for optimal linearity.

3. Use spectrum analyzer to monitor test.

4. Ensure that CW Jammer generator RF output is disabled and measure the power at the power meter port using the power meter. This is the relative signal power, S_r .

5. Disable Transmitter, and set CW Jammer generator RF output frequency equal to the carrier frequency and enable generator output. Set reference CW Jammer power level at power meter port 8.4 dB below S_r (minimum J/S, or 10 dB processing gain reference level). Note the power level setting on the generator, this is the reference CW Jammer power setting, J_r.

6. Disable CW Jammer, re-establish link. PER test should be operating essentially error-free.

7. Enable CW Jammer at a low power level and gradually increase the CW Jammer power until the PER is 8%. Note nominal Jammer power setting, Jn

This test is repeated for a fixed signal carrier frequency and for uniform steps in frequency increments of 50 kHz across the receiver passband with the CW Jammer. In this case the receiver passband is ±2.125 MHz. The procedure can be illustrated as follows:

For offset frequency – 2.125 MHz to carrier frequency + 2.125 MHz , Step 50 kHz.

Do:

Adjust Nominal Jammer Level setting.

Until:

Average PER is equal to reference PER.

Record Indicated Nominal Jammer Level setting.

Next offset frequency.

5.03 Data Calculation

The nominal Jammer Level settings are tabulated versus offset frequency. The J/S ratio and the processing gain are then calculated as follows:

$$\left(\frac{J}{S}\right) = -\left[\left(S_r - J_n\right) - \left(S_r - 8.6\,dB - J_r\right)\right]$$

If $J_n = J_r$ then:

$$\left(\frac{J}{S}\right) = -\left[8.6\,dB\right]$$

is the J/S ratio associated with 10 dB processing gain.

The processing gain then is determined using the J/S ratio:

$$G_p = 18.6\ dB\ + \left(\frac{J}{S}\right)$$

The number of points where the S/J fails to achieve 8.4 dB (is higher than 8.4 dB) is determined and if this is above 20% of the total, the test is failed. Otherwise it is passed.

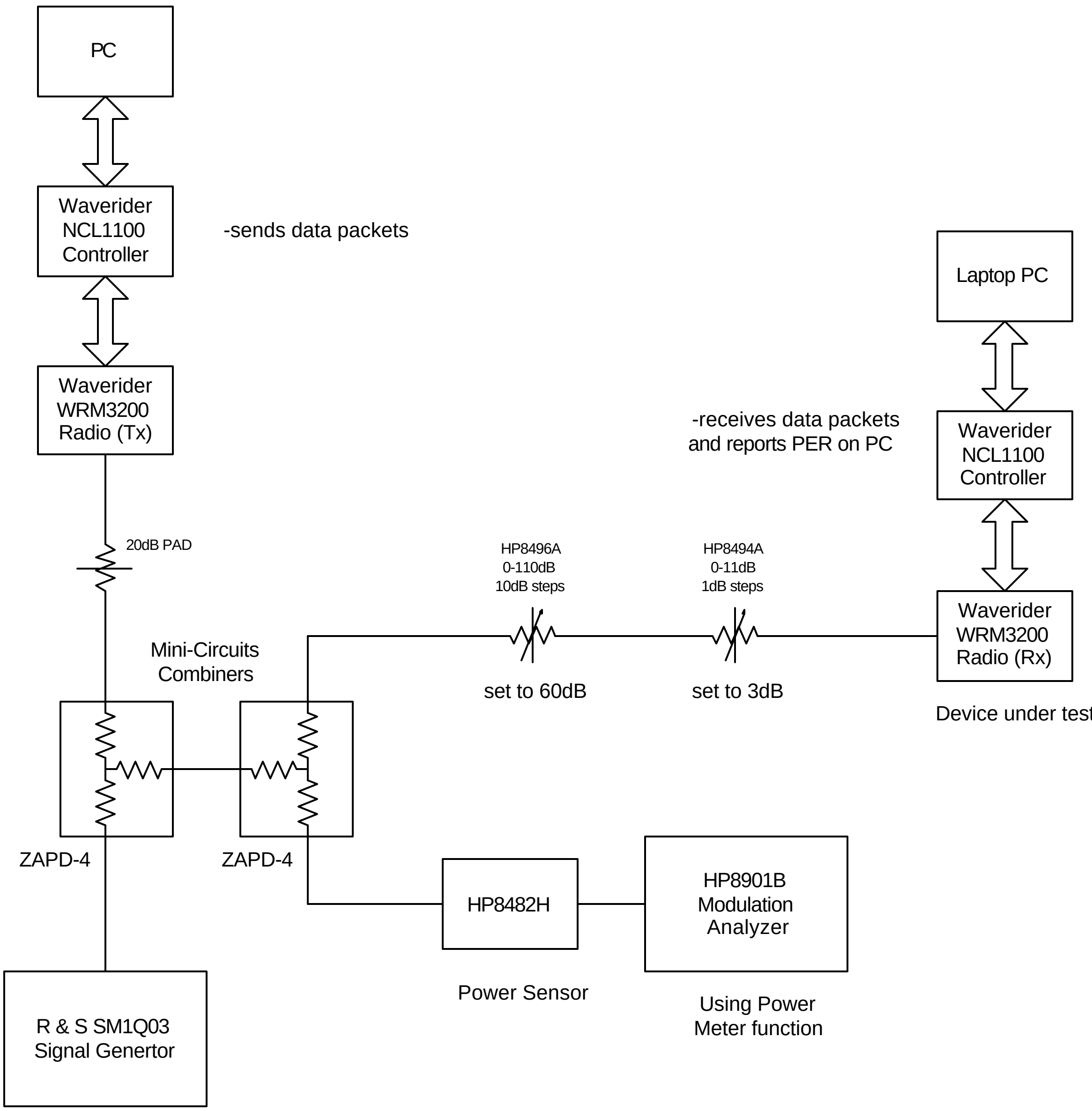
The numerical data associated with the following radio channels is tabulated and presented for:

Channel 1: 905 MHz

Channel 6: 915 MHz

Channel 11: 925 MHz

5.04 Test Configuration



5.05 Measurement Equipment List

Equipment	Serial Number	Calibration
Rhode and Scwartz SMIQ03 Signal Gen.	1084.8004.03	March 2, 1998.
HP 8482H RF Power Sensor	2704A04288	August 31, 2000.
HP 8901B Modulation Analyzer	3116A03490	N/A
HP 8496A Step Atten. 0-110 dB	1350A00108	N/A
HP 8494A Step Atten. 0-11 dB	1510A07617	N/A
Mini-Circuits ZAPD-4 Power Splitters (2)	none	N/A
Waverider NCL1100 Controller (TX)	035005	N/A
Waverider NCL1100 Controller (RX)	035148	N/A
Waverider WRM3200 Radio (TX)	013	N/A
Waverider WRM3200 Radio (RX- DUT)	1001	N/A

6.0 Test Data

6.01 Channel 1: 905 MHz

Relative signal power (Sr):	-3.5 dBm	Power meter
Reference Jamming level:	-11.9 dBm	Power meter
Reference jamming level setting (Jr):	-3.6 dBm	Sig. Gen. setting

Freq. offset (KHz)	Jammer level (Jn)	J/S	Proc. Gain	Pass/Fail
0	-6.0	-11.0	7.6	F
50	-5.7	-10.7	7.9	F
100	-2.7	-7.7	10.9	P
150	-1.6	-6.6	12.0	P
200	-2.0	-7.0	11.6	P
250	-4.6	-9.6	9.0	F
300	-4.4	-9.4	9.2	F
350	-2.8	-7.8	10.8	P
400	-1.5	-6.5	12.1	P
450	-2.0	-7.0	11.6	P
500	-3.6	-8.6	10.0	P
550	-3.4	-8.4	10.2	P
600	-2.2	-7.2	11.4	P
650	-1.5	-6.5	12.1	P
700	-1.3	-6.3	12.3	P
750	-3.0	-8.0	10.6	P
800	-2.8	-7.8	10.8	P
850	-0.8	-5.8	12.8	P
900	0.2	-4.8	13.8	P
950	0.4	-4.6	14.0	P

1000	-2.8	-7.8	10.8	P
1050	-3.0	-8.0	10.6	P
1100	0.5	-4.5	14.1	P
1150	1.4	-3.6	15.0	P
1200	1.4	-3.6	15.0	P
1250	1.4	-3.6	15.0	P
1300	2.0	-3.0	15.6	P
1350	2.0	-3.0	15.6	P
1400	2.1	-2.9	15.7	P
1450	2.7	-2.3	16.3	P
1500	2.9	-2.1	16.5	P
1550	3.1	-1.9	16.7	P
1600	3.4	-1.6	17.0	P
1650	4.1	-0.9	17.7	P
1700	4.5	-0.5	18.1	P
1750	4.9	-0.1	18.5	P
1800	5.0	0.0	18.6	P
1850	5.1	0.1	18.7	P
1900	5.5	0.5	19.1	P
1950	5.8	0.8	19.4	P
2000	6.0	1.0	19.6	P
2050	6.5	1.5	20.1	P
2100	6.7	1.7	20.3	P
2150	7.0	2.0	20.6	P
-50	-1.5	-6.5	12.1	P
-100	-1.5	-6.5	12.1	P
-150	-1.7	-6.7	11.9	P
-200	-1.7	-6.7	11.9	P
-250	-1.4	-6.4	12.2	P
-300	-1.4	-6.4	12.2	P

-350	-1.8	-6.8	11.8	P
-400	-2.0	-7.0	11.6	P
-450	-1.9	-6.9	11.7	P
-500	-2.4	-7.4	11.2	P
-550	-2.5	-7.5	11.1	P
-600	-2.4	-7.4	11.2	P
-650	-2.8	-7.8	10.8	P
-700	-2.8	-7.8	10.8	P
-750	-3.0	-8.0	10.6	P
-800	-3.2	-8.2	10.4	P
-850	-7.2	-12.2	6.4	F
-900	-6.0	-11.0	7.6	F
-950	-2.4	-7.4	11.2	P
-1000	-2.5	-7.5	11.1	P
-1050	-2.7	-7.7	10.9	P
-1100	-2.2	-7.2	11.4	P
-1150	-2.4	-7.4	11.2	P
-1200	-2.1	-7.1	11.5	P
-1250	-1.9	-6.9	11.7	P
-1300	-1.5	-6.5	12.1	P
-1350	-2.4	-7.4	11.2	P
-1400	-1.9	-6.9	11.7	P
-1450	-1.4	-6.4	12.2	P
-1500	-1.4	-6.4	12.2	P
-1550	-1.2	-6.2	12.4	P
-1600	-0.8	-5.8	12.8	P
-1650	-0.6	-5.6	13.0	P
-1700	-0.5	-5.5	13.1	P
-1750	-0.1	-5.1	13.5	P
-1800	0.3	-4.7	13.9	P
-1850	0.7	-4.3	14.3	P

-1900	1.3	-3.7	14.9	P
-1950	2.0	-3.0	15.6	P
-2000	2.4	-2.6	16.0	P
-2050	3.0	-2.0	16.6	P
-2100	3.2	-1.8	16.8	P
-2150	3.5	-1.5	17.1	P

6.02 Channel 21: 915 MHz

Relative signal power (Sr):	-4.9 dBm	Power meter
Reference Jamming level:	-13.3 dBm	Power meter
Reference jamming level setting (Jr):	-6.1 dBm	Sig. Gen. Setting

Freq. offset (KHz)	Jammer level (Jn)	J/S	Proc. Gain	Pass/Fail
0	-2.5	-5.0	13.6	P
50	-2.5	-5.0	13.6	P
100	-2.5	-5.0	13.6	P
150	-2.8	-5.3	13.3	P
200	-2.6	-5.1	13.5	P
250	-2.9	-5.4	13.2	P
300	-2.9	-5.4	13.2	P
350	-2.7	-5.2	13.4	P
400	-3.5	-6.0	12.6	P
450	-3.0	-5.5	13.1	P
500	-14.0	-16.5	2.1	F
550	-3.9	-6.4	12.2	P
600	-3.5	-6.0	12.6	P
650	-3.9	-6.4	12.2	P

700	-3.0	-5.5	13.1	P
750	-2.9	-5.4	13.2	P
800	-2.8	-5.3	13.3	P
850	-2.2	-4.7	13.9	P
900	-2.5	-5.0	13.6	P
950	-2.4	-4.9	13.7	P
1000	-1.8	-4.3	14.3	P
1050	-1.7	-4.2	14.4	P
1100	-2.0	-4.5	14.1	P
1150	-1.5	-4.0	14.6	P
1200	-1.5	-4.0	14.6	P
1250	-1.6	-4.1	14.5	P
1300	-1.6	-4.1	14.5	P
1350	-0.9	-3.4	15.2	P
1400	-1.4	-3.9	14.7	P
1450	-1.4	-3.9	14.7	P
1500	0.0	-2.5	16.1	P
1550	0.2	-2.3	16.3	P
1600	0.7	-1.8	16.8	P
1650	1.2	-1.3	17.3	P
1700	1.6	-0.9	17.7	P
1750	1.7	-0.8	17.8	P
1800	2.1	-0.4	18.2	P
1850	2.7	0.2	18.8	P
1900	2.9	0.4	19.0	P
1950	3.0	0.5	19.1	P
2000	3.2	0.7	19.3	P
2050	3.7	1.2	19.8	P
2100	3.9	1.4	20.0	P
2150	4.0	1.5	20.1	P

-50	-3.0	-5.5	13.1	P
-100	-3.3	-5.8	12.8	P
-150	-2.9	-5.4	13.2	P
-200	-2.8	-5.3	13.3	P
-250	-2.8	-5.3	13.3	P
-300	-3.1	-5.6	13.0	P
-350	-3.1	-5.6	13.0	P
-400	-3.2	-5.7	12.9	P
-450	-3.5	-6.0	12.6	P
-500	-3.5	-6.0	12.6	P
-550	-3.8	-6.3	12.3	P
-600	-4.0	-6.5	12.1	P
-650	-4.0	-6.5	12.1	P
-700	-4.0	-6.5	12.1	P
-750	-4.8	-7.3	11.3	P
-800	-3.9	-6.4	12.2	P
-850	-20.0	-22.5	-3.9	F
-900	-3.7	-6.2	12.4	P
-950	-3.5	-6.0	12.6	P
-1000	-4.2	-6.7	11.9	P
-1050	-3.2	-5.7	12.9	P
-1100	-13.7	-16.2	2.4	F
-1150	-2.6	-5.1	13.5	P
-1200	-2.5	-5.0	13.6	P
-1250	-4.5	-7.0	11.6	P
-1300	-2.1	-4.6	14.0	P
-1350	-2.1	-4.6	14.0	P
-1400	-1.6	-4.1	14.5	P
-1450	-1.7	-4.2	14.4	P
-1500	-1.5	-4.0	14.6	P
-1550	-1.2	-3.7	14.9	P

-1600	-0.9	-3.4	15.2	P
-1650	-0.6	-3.1	15.5	P
-1700	-0.1	-2.6	16.0	P
-1750	0.1	-2.4	16.2	P
-1800	0.5	-2.0	16.6	P
-1850	1.0	-1.5	17.1	P
-1900	1.4	-1.1	17.5	P
-1950	1.9	-0.6	18.0	P
-2000	2.8	0.3	18.9	P
-2050	3.1	0.6	19.2	P
-2100	3.6	1.1	19.7	P
-2150	3.7	1.2	19.8	P

6.03 Channel 41: 925 MHz

Relative signal power (Sr):	-3.1 dBm	Power meter
Reference Jamming level:	-11.5 dBm	Power meter
Reference jamming level setting (Jr):	-4.4 dBm	Sig. Gen. setting

Freq. offset (KHz)	Jammer level (Jn)	J/S	Proc. Gain	Pass/Fail
0	-1.3	-5.5	13.1	P
50	-1.2	-5.4	13.2	P
100	-1.5	-5.7	12.9	P
150	-1.5	-5.7	12.9	P
200	-1.5	-5.7	12.9	P
250	-1.3	-5.5	13.1	P
300	-1.4	-5.6	13.0	P
350	-1.2	-5.4	13.2	P

400	-1.0	-5.2	13.4	P
450	-1.3	-5.5	13.1	P
500	-1.3	-5.5	13.1	P
550	-7.5	-11.7	6.9	F
600	-1.6	-5.8	12.8	P
650	-1.6	-5.8	12.8	P
700	-1.6	-5.8	12.8	P
750	-1.0	-5.2	13.4	P
800	-1.3	-5.5	13.1	P
850	-1.0	-5.2	13.4	P
900	-0.1	-4.3	14.3	P
950	0.0	-4.2	14.4	P
1000	0.4	-3.8	14.8	P
1050	0.4	-3.8	14.8	P
1100	0.7	-3.5	15.1	P
1150	0.6	-3.6	15.0	P
1200	-1.3	-5.5	13.1	P
1250	1.1	-3.1	15.5	P
1300	0.5	-3.7	14.9	P
1350	0.8	-3.4	15.2	P
1400	1.7	-2.5	16.1	P
1450	1.8	-2.4	16.2	P
1500	1.0	-3.2	15.4	P
1550	2.7	-1.5	17.1	P
1600	2.7	-1.5	17.1	P
1650	3.0	-1.2	17.4	P
1700	3.6	-0.6	18.0	P
1750	4.1	-0.1	18.5	P
1800	4.7	0.5	19.1	P
1850	5.6	1.4	20.0	P
1900	6.0	1.8	20.4	P

1950	6.3	2.1	20.7	P
2000	6.7	2.5	21.1	P
2050	7.0	2.8	21.4	P
2100	7.4	3.2	21.8	P
2150	7.7	3.5	22.1	P
-50	-2.0	-6.2	12.4	P
-100	-1.3	-5.5	13.1	P
-150	-1.2	-5.4	13.2	P
-200	-1.5	-5.7	12.9	P
-250	-18.8	-23.0	-4.4	F
-300	-24.4	-28.6	-10.0	F
-350	-1.6	-5.8	12.8	P
-400	-2.2	-6.4	12.2	P
-450	-2.4	-6.6	12.0	P
-500	-14.5	-18.7	-0.1	F
-550	-23.5	-27.7	-9.1	F
-600	-2.8	-7.0	11.6	P
-650	-2.5	-6.7	11.9	P
-700	-22.5	-26.7	-8.1	F
-750	-2.6	-6.8	11.8	P
-800	-22.0	-26.2	-7.6	F
-850	-2.1	-6.3	12.3	P
-900	-2.2	-6.4	12.2	P
-950	-18.0	-22.2	-3.6	F
-1000	-1.9	-6.1	12.5	P
-1050	-2.0	-6.2	12.4	P
-1100	-1.8	-6.0	12.6	P
-1150	-1.4	-5.6	13.0	P
-1200	-1.4	-5.6	13.0	P
-1250	-1.2	-5.4	13.2	P

-1300	-1.4	-5.6	13.0	P
-1350	-0.6	-4.8	13.8	P
-1400	-0.8	-5.0	13.6	P
-1450	-0.6	-4.8	13.8	P
-1500	-0.5	-4.7	13.9	P
-1550	0.0	-4.2	14.4	P
-1600	0.1	-4.1	14.5	P
-1650	0.4	-3.8	14.8	P
-1700	1.1	-3.1	15.5	P
-1750	1.3	-2.9	15.7	P
-1800	2.0	-2.2	16.4	P
-1850	2.5	-1.7	16.9	P
-1900	3.1	-1.1	17.5	P
-1950	3.6	-0.6	18.0	P
-2000	4.2	0.0	18.6	P
-2050	4.6	0.4	19.0	P
-2100	4.7	0.5	19.1	P
-2150	5.4	1.2	19.8	P

6.04 Sorted Processing Gain Data

The processing gain data from sections 6.01, 6.02, and 6.03 were sorted from lowest to highest value and are shown in order below. The worst 20% of the data are highlighted. These points are discarded and the remaining worst data point from each channel is used to define a pass or fail. These values are:

Channel 1: 10.9 dB

Channel 21: 12.6 dB

Channel 41: 12.5 dB

Point no.	Chan. 1 sorted Proc. Gain	Chan. 21 sorted Proc. Gain	Chan. 41 sorted Proc. Gain
1	6.4	-3.9	-10.0
2	7.6	2.1	-9.1
3	7.6	2.4	-8.1
4	7.9	11.3	-7.6
5	9.0	11.6	-4.4
6	9.2	11.9	-3.6
7	10.0	12.1	-0.1
8	10.2	12.1	6.9
9	10.4	12.1	11.6
10	10.6	12.2	11.8
11	10.6	12.2	11.9
12	10.6	12.2	12.0
13	10.8	12.3	12.2
14	10.8	12.4	12.2
15	10.8	12.6	12.3
16	10.8	12.6	12.4
17	10.8	12.6	12.4
18	10.9	12.6	12.5

19	10.9	12.6	12.6
20	11.1	12.8	12.8
21	11.1	12.9	12.8
22	11.2	12.9	12.8
23	11.2	13.0	12.8
24	11.2	13.0	12.9
25	11.2	13.1	12.9
26	11.2	13.1	12.9
27	11.4	13.1	12.9
28	11.4	13.2	13.0
29	11.5	13.2	13.0
30	11.6	13.2	13.0
31	11.6	13.2	13.0
32	11.6	13.3	13.1
33	11.7	13.3	13.1
34	11.7	13.3	13.1
35	11.7	13.3	13.1
36	11.8	13.4	13.1
37	11.9	13.5	13.1
38	11.9	13.5	13.1
39	12.0	13.6	13.2
40	12.1	13.6	13.2
41	12.1	13.6	13.2
42	12.1	13.6	13.2
43	12.1	13.6	13.4
44	12.1	13.7	13.4
45	12.2	13.9	13.4
46	12.2	14.0	13.6
47	12.2	14.0	13.8
48	12.2	14.1	13.8
49	12.3	14.3	13.9

50	12.4	14.4	14.3
51	12.8	14.4	14.4
52	12.8	14.5	14.4
53	13.0	14.5	14.5
54	13.1	14.5	14.8
55	13.5	14.6	14.8
56	13.8	14.6	14.8
57	13.9	14.6	14.9
58	14.0	14.7	15.0
59	14.1	14.7	15.1
60	14.3	14.9	15.2
61	14.9	15.2	15.4
62	15.0	15.2	15.5
63	15.0	15.5	15.5
64	15.0	16.0	15.7
65	15.6	16.1	16.1
66	15.6	16.2	16.2
67	15.6	16.3	16.4
68	15.7	16.6	16.9
69	16.0	16.8	17.1
70	16.3	17.1	17.1
71	16.5	17.3	17.4
72	16.6	17.5	17.5
73	16.7	17.7	18.0
74	16.8	17.8	18.0
75	17.0	18.0	18.5
76	17.1	18.2	18.6
77	17.7	18.8	19.0
78	18.1	18.9	19.1
79	18.5	19.0	19.1
80	18.6	19.1	19.8

81	18.7	19.2	20.0
82	19.1	19.3	20.4
83	19.4	19.7	20.7
84	19.6	19.8	21.1
85	20.1	19.8	21.4
86	20.3	20.0	21.8
87	20.6	20.1	22.1

7.0 Conclusions

The system passes the CW jamming margin test on all three channels with the results shown below:

Channel	Min. Processing Gain (after 20% discarded)
1	10.9 dB
21	12.6 dB
41	12.5 dB